A DYNAMIC CULTURAL PERSPECTIVE ON THE FORMATION OF EMBEDDEDNESS IN SOCIAL NETWORK STRUCTURES

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A Dynamic Cultural Perspective on the Formation of Embeddedness

in Social Network Structures

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Thesis Abstract

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Embeddedness approach combines organization theory with social network theory by focusing on the structure of social relations and argue that social ties among actors, individual or collective, shape economic action by creating unique opportunities and access to those opportunities. Although by now literature accumulated a huge knowledge base on the consequences of embeddedness, the emergence of embeddedness is neglected to a large extend.

The current study formalizes a cultural perspective to implement a dynamic model in an aim to investigate formation of embeddedness in social networks. Principles derived from contemporary definition of culture as a system of symbols and practices lead to a derivation of a deconstructionist algebra. This algebra permits an explanation of the actions of individuals in micro scale while maintaining a macro perspective. A simulation model that implements this logic is developed in order to elaborate the dynamics of embedded network formations.

The simulation model is conceptually validated by empirical data obtained from two businessmen associations, TÜSİAD and MÜSİAD in Turkey, that have embedded characteristics. The model is also verified and operationally validated. The outcomes of the simulation suggest that not only topological properties of emerged embedded network structures but also the stability of strategically superior allocations in these networks depend on the cultural coherence of actors constituting the social group.

Tez Özeti

Raif Serkan Albayrak, "Sosyal Ağ Yapılarında Yerleşikliğin Oluşumu Üzerine Dinamik Kültürel Bir Perspektif"

Yerleşiklik yaklaşımı, organizasyon ve sosyal ağ teorilerini birleştirip, sosyal ilişkilerin yapısına odaklanır ve aktörler arasındaki sosyal bağların, birey veya grup bazında, benzersiz fırsatlar ve bu fırsatlara erişimi tanımlayarak iktisadi davranışı betimlediğini iddia eder. Bugün, her ne kadar literatür yerleşikliğin önemi ve sonuçları konusunda engin bir bilgi birikimi oluşturmuş olsa da, yerleşikliğin ortaya çıkışı soruları büyük ölçüde ihmal edilmiştir.

Mevcut çalışma, sosyal ağlarda yerleşikliğin ortaya çıkışını inceleyen dinamik bir model oluşturmak maksadıyla kültürel bir perspektife matematiksel bir somutluk kazandırdı. Kültürün sembol sistemleri ve uygulamalar şeklindeki çağdaş tanımının getirdiği prensiplerden faydalanarak bir yapı-bozum cebiri elde edildi. Bu cebir bireylerin davranışlarını mikro bazda açıklayabilirken aynı zamanda makro bir bakış açısına da sahiptir. Bu mantık çerçevesinde, yerleşik ağların oluşumunun dinamiklerini araştırmak üzere bir simülasyon modeli oluşturuldu.

Simülasyon modelinin kavramsal geçerliliği, yerleşik karakteristik gösteren iki Türk işadamları derneğinden, TÜSİAD ve MÜSİAD, elde edilen verinin nitel çözümleme yoluyla incelenmesiyle elde edildi. Model ayrıca teknik olarak doğrulandı ve operasyonelliği onaylandı. Simülasyon sonuçlarına göre, sosyal grubun kültürel tutarlılığı, sadece oluşan yerleşik ağ yapılarının topolojik özelliklerini değil aynı zamanda bu yapılar içinde stratejik öneme sahip yerleşimlerin kararlılığını da etkilemektedir.

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CHAPTER 1

INTRODUCTION

Traditional economic thought optimize efficiency by accessing the market information and by averting situations that interfere with unilateral action and add needless coordination costs to interfirm exchanges (Granovetter, 1985; Uzzi, 1996). Later revisions to the theory, particularly within game theory setup, have made additions to these principles. Bounded rationality and imperfect information can cause the definitive efficiency of markets to be displaced by hierarchies or hybrid organizational forms (Uzzi, 1996). However these forms neither increase efficiency nor coordinate transactions or eliminate malfeasance.

On the other hand, social network theory assess that embeddedness shifts actors' motivations away from narrow pursuit of immediate economic gains to the enriching of relationships through trust and reciprocity (Powell, 1990). Embeddedness approach combines organization theory with social network theory by focusing on the structure of social relations and argue that social ties among actors, individual or collective, shape economic action by creating unique opportunities and access to those opportunities. Thus social organizations and social relations are introduced into the analysis of economic systems not as a structure that pops up into place to fulfill an economic function, but as a structure with history and continuity that give it an independent effect on the functioning of economic systems (Coleman, 1988).

Unlike oversocialized views (Wrong, 1961), embeddedness approach does not attribute all motives of action to the structure. The concept of social capital clarifies the role of embeddedness in this respect. Social capital has two principle characteristics. First, it is a collection of entities that consist of some aspects of the social structure. Second, social capital facilitates certain actions of actors. “Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible.”(p: 98, Coleman, 1988). However unlike other forms of capitals, social capital is recorded in the structure of relations between and among actors. Consequently embeddedness is the source of social capital which is an independent resource to attain certain goals.

Today the literature in embeddedness studies is vast. Studies focus on different aspects of embeddedness and successfully relate social phenomena to topological properties of the social structure. However, the constitution of embeddedness is neglected to a large extent (Burt, 2007) which define the objective of this dissertation.

Inspiring from Coleman (1988) and DiMaggio (1994), this thesis seeks the cultural roots of embeddedness. Yet culture itself is a vague concept and if one is attributing a social phenomena (in this case embeddedness in social networks) to culture then this claim can only be tested within a cultural framework. In this regard the initial step of this thesis is to decide on and verify a cultural framework and develop a cultural model to analyze and interpret the constitution of embedded social networks.

In order to set the stage for the formal statement of the research question, Chapter 2 defines the embeddedness concept. Current literature in embeddedness subsumes two major interpretations; embeddedness according to Polanyi (1957) and embeddedness with respect to Granovetter (1985). Due to the fact that the model developed in this thesis is applicable to both interpretations, the next chapter starts with a review of Polanyi and Granovetter, respecting the chronological order of these works and then compares and contrasts these perspectives. Recent literature has also benefited from the cataloguing of embeddedness studies introduced by Zukin and DiMaggio (1990). According to them embeddedness can be studied under four largely overlapping catalogues: structural embeddedness, political embeddedness, cognitive embeddedness and cultural embeddedness. Second chapter also reviews some representative studies in each of these catalogues.

Since culture plays such a crucial role in this setting, most of Chapter 3 is devoted to a literature review on culture studies that are focused on social action. Indisputably, Parsons' (1951) Voluntaristic Theory of Action is the first instrumental cultural model of action. However this model has been severely criticized for its various shortcomings. Geertz's (1973) interpretation of culture as system of symbols demonstrates a completely different perspective of culture. Similarly, Bourdieu developed yet another distinctive interpretation which is called culture as practice. While anthropologists accepted Geertz's view and pursued "thick" form of culture studies, sociologists preferred Bourdieu's (1978) culture as practice view as an inheritor of Parsons. Both of these perspectives have their own unique advantages in explaining cultural phenomena. Recent literature on culture studies underscores various advantages that can be obtained from a merged framework. After Swidler's (1986) first attempt in merging symbol and practice views of culture in her culture as a toolkit approach, Sewell (1999) developed a framework with a deconstructionist stance in which both symbol and practice views of culture can be elaborated in coherence. Cultural theories of action have been reviewed in Chapter 3 by emphasizing the principle factors that interconnects a newer theory to the former. In the synthesis section, it is argued that Sewell's perspective of culture is the ideal framework to develop a model to study the objective of the thesis.

In order to develop a model to study the objective of the thesis, Sewell's cultural framework is formalized in Chapter 4. This formalization involves defining binary opposition relations over the set of symbols and describing the association between meanings and symbols. In this chapter it is argued that the model needs to be developed as a social simulation.

Chapter 5 reviews the social simulation literature. Simulations provide naturalness as an ontology or representational formalism of social sciences. Since the qualitative data can be blended within the methodology, simulations make extensive use of enormous amount of data and knowledge expressed in verbal representations about the behavior, motivations, and relationships of social actors. Also, in contrast to mathematical formalism, social simulations do not necessarily use this information for aggregation purposes but rather exploit the dynamics of the system which is the main focus of many social sciences (Bankes, 2002). In this chapter two simulation models that are closely related to the simulation model in this thesis are discussed.

Chapter 5 also introduces the model to study thesis objective. "THESIm" is a social simulation governed by the principles described in Sewell (1999) and formalization Chapter 4.

Credibility of simulation models depends on both the correctness of the model and accurate formulation of targeted social phenomenon (Balci, 1994). Sargent (2004, 2005) argues that the model development process in simulation studies involves conceptual model validation, computerized model verification and finally operational validation. In Chapter 6, conceptual model validation is performed first by, extracting the binary opposition relations of members of two embedded businessmen associations in Turkey, TÜSİAD and MÜSİAD, and second, by comparing this opposition relation with the findings from the literature. Computerized model verification requires an in – depth analysis of the components of the simulation. Operational validation requires comparing the outputs of THESIm with the characterization of social network structures in the literature.

Chapter 7 analyzes the formation of embedded social networks using the outputs of the social simulation model developed over the cultural framework defined by Sewell (1999). This chapter also involves statistical analyses of these outputs in order to achieve a conclusion in the objective of this dissertation.

Chapter 8 concludes with summarizing the perspective established in this thesis to reach the objective, findings, limitations, future research, and theoretical and practical implications.

CHAPTER 2

EMBEDDEDNESS

Organization theory has developed as a conceptual-analytical knowledge base that is empirically driven and integrating in character (Scott, 1961). Due to this character, predisposition of organization studies towards more contextualized approaches is still the rising trend. In this respect, theorists and researchers have engaged "embeddedness" arguments to identify new frameworks, new variables of interest and new opportunities for multi-level analysis (Ducin et al., 1999).

The concept "embeddedness" refers to numerous perceptions and uses just like many other key concepts in organization theory such as structure, culture, incentives, and power. In a very brief description, embeddedness corresponds to the social context that limits, stabilizes and describes the purposive behaviors of economic actors. Embeddedness is not a theoretical construct; on the contrary it is an observed social phenomenon that has been largely ignored by economic theories that describe and/or prescribe behaviors of actors.

In order to set the stage for the formal statement of the research question, this chapter defines the embeddedness concept. Current literature in embeddedness subsumes two major interpretations; embeddedness according to Polanyi (1957) and embeddedness with respect to Granovetter (1985). Chapter starts with a review of Polanyi and Granovetter, respecting the chronological order and then compares and contrasts these perspectives. Recent literature has also benefited from the cataloguing of embeddedness studies introduced by Zukin and DiMaggio (1990). According to them embeddedness can be studied under four largely overlapping catalogues:

structural embeddedness, political embeddedness, cognitive embeddedness and cultural embeddedness. This chapter also reviews some representative studies in each of these catalogues. The objective of this thesis is formally declared in the synthesis section of this chapter. In this section it is also explained that the development of a model that tests the objective of this dissertation stipulates a factor which introduces heterogeneousness to actors that interact in a social network. A previously mentioned endogenous variable, culture is manifested as an exogenous factor that initiates embeddedness.

Embeddedness Defined by Polanyi

The term embeddedness has been introduced[1] to social science literature by Karl Polanyi in his classic work "The Great Transformation [1940]" (Granovetter 1985). Polanyi starts with criticizing traditional economic thought referring to Malthus and Ricardo who define the economy as an interlocking system of markets that automatically adjust supply and demand through a price mechanism. He used the word "embeddedness" for the first time to express the idea that classical or neoclassical economy is not and can not be self-adjusting or in other words autonomous as it is dictated in economic theory but rather is governed by politics, religion and social relations (Block, 2001, 2003).

[1] Literature shows that the concept of embeddedness had also been discussed by Weber and Merton before Polanyi (Ghezzi and Mingione, 2007; Zukin and DiMaggio, 1990; Brinton and Nee, 1998). In this thesis I consider embeddedness term referring to its consequences not to its literal occurrence, thus it would be more appropriate to start with Polanyi for two reasons; first, contemporary literature attributes the concept of "embeddedness" to Polanyi (Granovetter 1985, p.9) and second it was Polanyi who offered a methodological approach in social studies (Rodrigues, 2004; Ghezzi and Mingione, 2007).

The basic theme behind Polanyi's (1957) argument is the distinction between two meanings of economy", formal meaning and substantive meaning. Formal meaning of economy refers to the autonomous, price-making market system in which all goods and services including labor, land and capital are available in the market with a corresponding price. Substantive meaning of economy, on the other hand is an instituted process that derives from, "…man's dependence for his living upon nature and his fellows. It refers to the interchange with his natural and social environment." (p.29)

According to Polanyi (1957) substantive concept is the empirical economy. He states that the empirical economy is "embedded" and enmeshed in institutions, economic and noneconomic. The embeddedness is crucial since economy needs unity and stability which is only achieved through "interdependence and recurrence of its parts" (p.35), that are; reciprocal exchange, redistributive exchange and market exchange. Reciprocity is the collective interests of small groups that have close relationships. In reciprocal exchange, sharing among individuals is common and group interest prevails over immediate self interests. Redistribution refers to membership to a large society in which resources are controlled by a legitimate authority such as the state. Market exchange refers to classical and neoclassical economists' definition of exchange where economic agents are supposed to be rational decision makers.

Polanyi (1957) states that market exchange is socially disrupting because it exists independent of any type of social relationship and guided by universal rules of the game that are not "natural" in essence. In this respect reciprocal and redistributive exchanges are embedded in but market exchange is disembedded from the society. The power Polanyi attached to the concept "embeddedness" makes it possible to explain the co-existence of market exchanges and social order (Ghezzi and Mingione, 2007).

I present an example in order to clarify how embeddedness concept can be used for this purpose. In modern life, market sets the wages within the logic of a competitive relationship of supply and demand of workforce. This is where market exchange takes place. Now, first consider with respect to pure market exchange logic what happens to a worker that becomes disabled after a work accident and who would not be able to work anymore. In market exchange logic, the employer would obviously fire him as the disabled worker would make no benefit to the company anymore and/or decrease efficiency. However the disabled worker needs to satisfy his (increased) needs or maybe also his family's needs. Meanwhile, when that worker is fired, other workers in that company would obviously get frustrated as a similar situation might occur for them. Clearly such a problem is unsolvable within market exchange logic. According to Polanyi, this is called disembeddedness. As a response (re-embeddedness) the adaptation process initiates through which solution external to market mechanism is traced. For instance that disabled worker might ask aid from his close relatives or neighbors (kin-network) that initiates reciprocal exchange. Alternatively, if it exists, he could make use of health insurance and/or healthcare opportunities institutionalized by the state or by the workers' union that might have initiated to solve such issues which implies a redistributive exchange.

Hence within the embeddedness framework, it is possible to explain the different orientation of social and economic actors. According to Ghezzi and Mingione (2007),"In fact, the institutional configuration of (kinship) organization continues to be an important dimension of all contexts of industrial societies (in contrast with utilitarian assumptions)" (p.20).

This definition of embeddedness is usually applied by anthropologists that belong to the "substantivist" school and by scholars from organization studies that used path analysis techniques to elaborate on the discriminated institutional forms and their emergence across nations (Granovetter, 1985; Ghezzi and Mingione, 2007).

Embeddedness with Respect to Granovetter

In his widely cited work Granovetter (1985) challenged the utilitarian interpretation of economic action by borrowing embeddedness concept from Polanyi, but departed from him to a great extent by opposing the political dimension of the concept. Understanding Granovetter's claims requires following his constructive logic in which he ends up with challenging the disembeddedness character of market exchanges[2] and proposes conceptualizing economic behavior as embedded within social relations in some particular forms.

Granovetter starts with criticizing the under-socialized view of economic behavior. He argues that this tradition, by hypothesis leaves no room for any impact of social structure and social relations on production, distribution or consumption. According to classical and neoclassical tradition, human action is strictly atomized and functions without the requirement of any contact between parties under the rules of perfect competition.

Highly influenced with Dennis Wrong's (1961) arguments, Granovetter defines over-socialized perspective, as actors that unquestioningly obey rules and

[2] The notion that economy is a separate differentiated sphere in modern society.

norms dictated by the society[3]. Furthermore, over-socialized individuals are essentially motivated by the desire to achieve a positive image of self by winning acceptance or status in the eyes of others. According to Granovetter, in over-socialized conceptions of economic behavior in modern sociology - which is in principle the anti-thesis to economists' interpretation – society influences individual behavior in a mechanical way. He argues that "…once we know the individual's social class…,everything else in behavior is automatic, since they are so well socialized." (p.57).

Granovetter stresses that this property inferred from the definition of over-socialized individual behavior implies that social relations completely determine human actions and therefore paradoxically, "…he or she can be atomized as any *Homo economicus*, though perhaps with different rules of decision making" (p.57).

In this manner the anticipated contrast between under and over-socialized views of economic behavior actually have a common conception of action and decision making that both refers to atomized actors. Granovetter used this important conclusion as a preliminary result to emphasize the failure of both views on explaining "trust" issue in economics. In this respect, Granovetter refers to Hobbes's concerns over the tension that leads to disorder; "conflict-free social and economic transactions depend on trust and malfeasance" (p.55). Hobbes's solution was to superimpose a structure of authority. On the other hand the explanation of classical and neoclassical economy "…, is antithetical: repressive political structures are rendered unnecessary by competitive markets that make force or fraud unavailing" (p.56). This, in practice, depends on the free-mobility assumption in economics. However, according to Williamson (1981), solving "trust" issue by referring to free-

[3] Wrong's (1961) work covers not only a critique for over-socialized individual but also the preliminaries of Granovetter's embeddedness argument. Wrong emphasizes *the role of individual and common interests* for social order.

mobility axiom is infeasible due to frictional costs. Unless there exists intrinsic motive(s) against malfeasance or for sustaining trust, atomistic self-interested actor assumption would imply that economic behavior embraces search for opportunism. Granovetter emphasizes this point,

> What has eroded this confidence in recent years has been increased attention to the micro-level details of imperfectly competitive markets, characterized by small number of participants with sunk costs and specific human capital investments. In such situations, the alleged discipline of competitive markets cannot be called on to mitigate deceit, so the classical problem of how it can be that daily economic life is not riddled with mistrust and malfeasance has resurfaced (p.59).

Institutional economists offers a solution emphasizing that institutions, once thought to be spurious, are actually efficient solutions to certain economic problems, for example the trust issue. Granovetter argues that these institutions are not sources of trust but rather they functionalize trust through contracts. He stresses this point first by noting that the individual would then develop "ever more ingenious attempts at deceit" (p.60).

The answer from the over-socialized view is in the similar tone of new institutional economists'. Granovetter refers to Schotter's (1981: cited from Granovetter, 1985) proposition that the presence of an institution implies the existence of the evolutionary problem that caused the particular institution to emerge. But if their power lies in their taken-for-grantedness in the sense that they are inefficient solutions to problems of coordination then actors would unveil their arbitrary character and jeopardize their sway (DiMaggio, 1994). In this respect any attempt that refers to atomistic conception of the individual is doomed to failure.

After pointing out the weaknesses of intrinsically atomistic conceptualization of both under-socialized and over-socialized views of economic behavior and thus setting the stage for the necessity of a new point of view, Granovetter offers an alternative unit of analysis. For this purpose he borrows the embeddedness concept from Polanyi and states that economic agents can not be isolated from their concrete relations in economic life. These relations, in the form of networks, serve as proxy for trust by developing the necessary infrastructure for discouraging malfeasance. The dual interpretation is that, embeddedness of economic agents in relations is the source of trust[4].

He refers to Prisoner's Dilemma arguments and provides various examples from social and economic life to stress the trust generating role of social relations. An example is about human behavior in a burning theater panic. In such a case the typical behavior is a rush to the door, which he states is quite rational and refers to Roger Brown's (1965: cited from Granovetter, 1985) analysis that the case is actually an n-person Prisoner's Dilemma[5]. Since no one has the guarantee that everybody will walk out calmly - a strategy best for all - it is perfectly rational for each of them to rush. However such a case would not happen for a burning house, because family members are tied with close relationships and each is confident that the others can be counted on. In business life same argument prevails although with quite volatile confidence levels.

[4] Granovetter warned that this does not imply that there will be no malfeasance within networks. Networks are the necessary structures for the emergence of trust, not the sufficient for trust to prevail.

[5] "n-person" Prisoners Dilemma is the generalization of standard Prisoners Dilemma game played by two players where each player has to choose one of two available strategies. Available strategies are {Defect, Cooperate}. If a player selects Defect while the other selects Cooperate, defecting player gets a huge payoff and the other gets very small payoff. If both players select Cooperate, both get moderate payoffs. If both players select Defect, both get small payoffs. In a single round of the *n*-person Prisoner's Dilemma game, *n* players simultaneously choose an action, cooperate or defect. Depending on the number *i* of others cooperating, you receive the score V(C | *i*) when you cooperate and the higher score V(D | *i*) when you defect. The scores V increase with an increasing number of cooperators, and also the total score given to all players increases if one player switches from defection to cooperation.

Granovetter continues by criticizing "markets and hierarchies"[6] of Oliver Williamson (1975: cited from Granovetter, 1985) frequently referring to the embeddedness concept. In order to keep the focus on "embeddedness" and the meanings attached to the concept, it would be more fruitful to carry the discussion onto elaborating the main differences between Polanyi's and Granovetter's concepts.

Elaborating Polanyi and Granovetter

According to Polanyi, social relations are epiphenomenon of the market, and market and social stability is sustained within a dynamics of disembeddedness and re-embeddedness in modern societies. Polanyi arrives at this point by arguing that in pre-capitalist societies, markets' role was secondary. Economic transactions were controlled and regulated by social authority which was embedded in society. Main forms of exchange (integration) were reciprocity and redistribution (Rodrigues, 2004). However during the nineteenth century, market pattern expanded and became the dominant form which caused reorganization in social life and hence initiated disembeddedness and thus necessitated re-embeddedness.

Granovetter totally disagrees with Polanyi on the role of the market in pre-capitalist societies. Referring to anthropology literature, he stresses that even in tribal societies, economic behavior was sufficiently independent, yet it was still embedded as it is in modern societies (Swedberg, 2004). In this respect attributing a

[6] Markets and Hierarchies approach or transaction cost analysis (Williamson, 1991) is about bounded rational economic agents that act opportunistically. These agents establish organizations in order to minimize transaction costs with regard to frequency, uncertainty and demand specificity of the transactions. Stated otherwise, organizations are formed to provide solutions for specified needs that markets fail to satisfy.

disembedding role to economic behavior and apprehending it in a differentiated sphere out of the society is not necessary and/or cannot be justified.

According to Polanyi, market exchange mechanism requires purely rational individuals that act according to rational decision making processes (Polanyi, 1957: p. 31-32) which is totally inline with classical and neoclassical economist view. On the other hand, Polanyi states that a rational decision maker motivated with self – interest is not "natural" to man and causes diversified processes of disembeddedness (Polanyi, 1957; Block, 1990; Ghezzi and Mingione, 2007). The logic behind this argument rests on Polanyi's distinction between real and fictitious commodities. Real commodity is produced through a process and can easily be attached a price. Fictitious commodities are land, money and labor. Labor simply means the actions of the individuals. According to Polanyi, individual actions that were once embedded in social life through collective consciousness, used to be in harmony with individual faculty in pre-capitalist societies. Commodification of labor within a market mechanism has an interfering effect on this harmony by virtually splitting the action from the faculty. Consequently, Polanyi argues that the embedded character of economic agent possess stable traits unless there is an exogenous impact which would trigger a re-embeddedness process in search for stability in the new "state of nature".

Granovetter's stance on individual decision making is completely different. Rational decision making individual is compatible with his setup[7]. The emphasis on

[7] Prisoner's Dilemma arguments discussed in this section. Also, Granovetter (1985) states that "…they (rational choice arguments) are inconsistent with the embeddedness position presented here. In a broader formulation of rational choice, however, the two views have much in common." (p. 74).

Models of rationality and rational choice have progressed considerably in economics. For example Field (1984) discusses game theoretic situations that may end-up with norm like behaviors and emergence of trust. Game theory is particularly useful in describing individual choices within constrains, however as Nee (1998) points out game theory does not attempt to explain the sources or the dynamics of these constraints. According to Nee, these constraints can only be defined over an

Granovetter's setup is on the empirical specificity of the structures of relations, namely networks. According to Granovetter (1985) networks do not only decrease transaction and information cost but networks are also instruments that generate many outcomes one of which is trust that prevents widespread[8] malfeasance. Another way to read Granovetter's thesis is that there is a causal link between actors' entanglement in networks and their behaviors and actions. This unfolds the implication that, Granovetter[9] actually offers an action model that belongs to the intersection of logic of appropriateness model of action and logic of consequentiality model of action defined by March and Olsen in (1998) [10]. Logic of consequences refers to the choice of an alternative with respect to its expected consequence(s) that would provide optimum benefit or in other words the logic of rational action. On the other hand logic of appropriateness implies that individuals behave according to their identities specified by the context and obey the rules dictated by the institutions. As March and Olsen points out these rules of actions are not mutually exclusive and any particular action probably contains elements from each. Granovetter (2001) later clarifies this point:

> Most sociologists have veered away from theoretical argument based on actors' shared value commitments because of the excess of mid-twentieth century sociology. This view, which has been called over-socialized (Wrong, 1961; Granovetter, 1985), leaped from observing that such commitments were a significant force in social life to the conclusion that all social action flowed from them. The opposite extreme is to imagine that moral sense about the

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integrated framework of the totality of societal relations, like a framework which Granovetter offers. In this respect rational decision making used in game theory is compatible with Granovetter's embeddedness. Nee (1998) has a similar position in defining context-bound rationality.

[8] This point once again refers the necessity but not sufficiency of networks for trust. Granovetter (1985) notes that:

> "But I then risk rejecting one kind of optimistic functionalism for another, in which networks of relations, rather than morality or arrangements, are the structure that fulfills the function of sustaining order, the embeddedness position is less sweeping than either alternative argument, since networks of social relations penetrate irregularly and in differing degrees in different sectors of economic life, life, thus allowing for what we already know: distrust, opportunism, and disorder are by no means absent." (p.61)

[9] Pages 74-75 in Granovetter (1985).

[10] Granovetter published his article four years before these terms first appear in the literature.

> economy is entirely subordinated to and derivative from some teleological quests for efficiency pursued by social systems, so that observed norms, though admitted to be important, can be assumed to have been selected out for their economic efficiency. The time has come to find a balanced account, to acknowledge the importance of such norms and conventions, while fitting them into a broader frame of social theory. (in press).

Amid the emergence of institutions and their embeddedness in social life, Granovetter's and Polanyi's interpretation once again diverge. According to Polanyi, institutions are residuals of disembeddedness and re-embeddedness processes that are driven by adaptation and evolutionary dynamics. Obviously this formulation refers to institutions in modern capitalism era within which, as Polanyi stresses, economic institutions emerged due to deliberate political interventions (Block, 2000). Furthermore, same dynamics and processes (re)shape and explain the changes in existing institutional forms also. Polanyi claims that all institutions except for market itself are embedded in social life, are natural, and are byproducts of adaptation[11].

Following Granovetter's logic on the spread of trust in networks of actors and his argument:

> …the long-term relations of contractors and subcontractors, as well as the embeddedness of those relations in a community…generate standards of expected behavior that not only obviate the need for but are superior to pure authority relations in discouraging malfeasance. (p.67)

It can be deduced that institutions can be defined as a network of networks –formal or informal- governing social relationships. Accumulating Granovetter's ideas on embeddedness, this definition serves the function of reducing costs and increasing efficiency. Yet, it appears that the embeddedness framework defined by himself, was not sufficient for Granovetter to embrace institutions. Although Granovetter did not

[11] Formal institutions have a special dual role for Polanyi, but concepts related to political embeddedness are reserved for the Contemporary definitions of Embeddedness section.

explicitly associate embeddedness to institutions in his 1985 article[12], he proposed this association in his "Nature of Economic Relations" (1992) (Nee and Ingram, 1998). Here, Granovetter shifts the unit of analysis from network structure to behavior of individuals by arguing that institutions are results of actions taken by socially situated individuals, embedded in networks of personal relationship with non-economic as well as economic aims. Nonetheless, neo-institutionalist sociologists credited Granovetter (1985) by defining institutions as a web of interrelated norms that regulate networks to produce group performance and stability (Nee, 1998: Nee and Ingram, 1998).

As a conclusion, concepts of embeddedness followed from Polanyi's and Granovetter's arguments diverge in several fundamental respects that have been discussed in this section. Polanyi provides a socio-historical perspective that permits a clear explanation for the emergence and roles of institutions. In this explanation, embeddedness refers to a dynamic process that reshapes the structure of the society. Due to this characteristic, Polanyi's setup is compatible with the principal law of nature, adaptation. Last, but not least, Polanyi's arguments have a political dimension. He insists that supply and demand of the fictitious commodities in actual market societies must be managed through political processes (Block, 2001).

Granovetter's embeddedness is rapidly associated with a formal framework borrowed from graph theory and has been transformed into a prescriptive body widely applicable in organization theory and particularly in strategic management through new concepts like structural holes (Burt, 1992), cliques, coupling and decoupling (White, 1992: cited in Granovetter, 2001). According to Granovetter, embeddedness refers to structure of social relations, which he conceives as a stable

[12] Granovetter does not explicitly refer institutions in his paper. "Institutions are largely bypassed in Granovetter's (1985) work" (Nee and Ingram, 1998:p.20).

trait. Granovetter's framework is actually inappropriate for path dependence or dynamic studies, since in most if not all of the cases it would be impossible to interpret the deformation of the particular structure. In this respect, embeddedness defined in terms of Granovetter provides a solid snapshot of the society. Correspondingly, the processes through which networks and bigger systems of social relations give rise to institutions and also in a similar vein the political aspects of behavior can hardly be explained by Granovetter's embeddedness.

Contemporary Definitions of Embeddedness

Following Granovetter, embeddedness applications became a major stream through several social science disciplines including organization theory and strategic management. Zukin and DiMaggio (1990) catalog contemporary embeddedness literature that grew in to a gigantic size into four forms: (1) structural embeddedness; (2) political embeddedness; (3) cognitive embeddedness; and (4) cultural embeddedness.

Structural Embeddedness

Zukin and DiMaggio (1990) label structural embeddedness as the contextualization of economic action in social relationship patterns. Mainstream economic frameworks overlook the influence of social relation on economic actions when they assume that social ties affect economic behavior only minimally or reduce the efficiency of the price system (Knoke and Kuklinski, 1994; Uzzi 1996). Contemporary literature on organization studies shows that embeddedness of organizations in social networks not only provides stability but also competitive advantage (Uzzi, 1996). To this end, network theory anchor social embeddedness research. For this purpose, a brief on basic terminology of network theory is required to review some influential applications of social embeddedness concept in organization theory.

Relations –also called links or ties- are the building blocks of the networks which are basically dyadic mappings over the Cartesian product[13] of the set of agents –also called nodes. Different types of relations identify different networks, even when implemented over the identical set. Relations such as partnership when defined over the Cartesian product of a set of organizations is symmetric in the sense that if for organizations A is a partner of organization B then the reverse is also true. On the other hand, relations that refer to superiority in status are asymmetric in nature. In this respect relations are either displayed by arrows or simply by lines corresponding to the type of the relation (Figure 1)

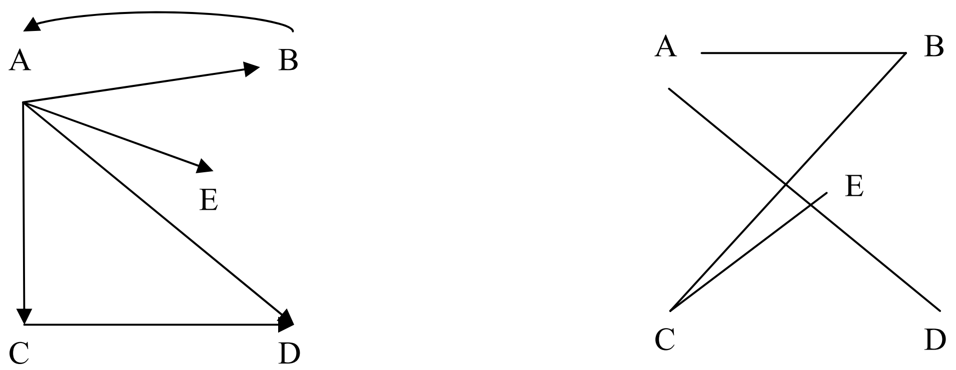

Figure 1. Graph on the left represents an asymmetric relation between nodes. Graph on the right represents a symmetric relation between nodes.

Structural embeddedness analysis over the network topology is typically carried over either one of four levels (Knoke and Kuklinski, 1994). The simplest level is the

[13] Relations are defined over dyads of agents.

egocentric network. Egocentric networks consist of a single node and its relations to other nodes. A typical example of research performed at this level has been established by Podolny (1993, 1994). Through an analysis of egocentric networks, Podolny (1994) found that the status of the organizations in the market is an important criterion in engaging exchange relationships in order to offset uncertainty. In this work, Podolny focused on primary securities markets in which investment banks serve as teams of underwriters for corporations and governmental agencies desiring to raise capital. He used the data that contains distribution of the offerings across banks. Particularly important for this dataset is that, investment banks are categorized with respect to an implicit hierarchy in terms of status in the market. Data is loaded into a relational matrix and hence the network structure is obtained. He used a centrality measure to construct a status index for all investment banks and associated the number partnerships with the status for each pair of banks.

Second level of analysis in structural embeddedness research is the analysis of dyads, formed by a pair of nodes. The focus of this analysis is the effects of absence or presence of links within dyads within the context of interest. For instance, Gulati (1995a, 1995b) studied the formation of interorganizational alliances within the context of prior alliances between firms. Alliances, direct or indirect, create a social network in which organizations are embedded. According to Gulati, this network structure contains valuable information to learn about new tie opportunities. His study is based on a longitudinal data in order to observe emergent network structures and results are reported for the relationships of pairs of organizations (dyads) not for the whole structure. Nevertheless, some of the hypotheses developed and tested in his study represent genuine efforts of employing structural embeddedness within organizational theory domain. For instance, he analyzed the influence of indirect paths between two firms on the probability of forming a new alliance with each other. This is in essence a transitivity property and controls for the flow of information within the network. Gulatti reports that, networks of alliances indeed, at least for his database, satisfy transitivity property.

The most important level of analysis is the complete network. In this level, topologic properties of the network is associated with relevant characteristics of the context. Relative positioning of agents sometimes give rise to positionings that have strategic superiority for an agent or a group of agents. In this respect the concept of "structural role" is widely studied after Burt (1992). Structural holes correspond to positions that link actors that are not linked otherwise. In Figure 2, E is a structural hole for agents A and B and also for A and [C, D] and for B and [C, D]. On the other hand the concept "clique" refers to a group property. A clique is a subgroup of agents that are tied to each other and is not a proper subset of another clique. In Figure 2, [C, D, E] is a clique. Other than "structural hole" and "cliques", researchers developed various indices to summarize structural properties of a network. These indices are basically used as a proxy to measure density, centrality and betweenness of a network or a subgroup of a network.

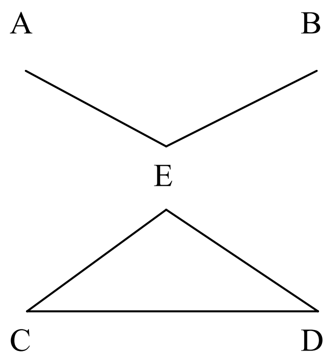

Figure 2. E is a structural hole for agents A and B and also for A and [C, D] and for B and [C, D].

Political Embeddedness

Political embeddedness refers to the political context defined by the factors that influence the interaction of corporate actors and overall industry dynamics (Murtha et al., 1996; Barnett and Carroll, 1993; Hardy et al., 2005). The influence of political embeddedness can take diverse forms such as impact on the probability of profit from technological innovation via administrating patent policies (Murtha et al., 1996) to tax laws and government procurement policies that affect the emergence or sustainability of national industries (Zukin and DiMaggio, 1990). Additionally, political embeddedness also points to the complex network of interrelations on competing macroeconomical claims and expectations.

Political embeddedness in the largest sense explains how power relations within society, institutions and across borders shape economic exchange and stratify rewards among economic actors (Tzeng and Uzzi, 2000; Hardy et al. 2005). In this sense, political embeddedness research follows Polanyi's idea in the framework of Granovetter such that the institutional settings, states and other political institutions provide a socially constructed framework of formal rules, regulations and even certain identities.

Welch and Wilkinson (2004) offer a taxonomy for political embeddedness that consist of four dimensions: political institutions, political actors, political activities and political resources. Political institutions are rule and regulation setters and therefore can be identified with ideological dimensions. Political actors are the members of political institutions such as political parties, bureaucrats, ministries, universities, media, interest groups, business groups, and organizations. Political activities are the actions and interactions of political actors. In this respect, economic activities that have nationwide consequences have also political remainders and hence considered under political activity dimension. Finally the last dimension is the political resources. The list is too huge to display here. Any means that has the potential to provide benefit belongs to this topic: information, regulations, rules, flow of capital, tax, quotas, licenses, and many more. The conceptual chart represented in Figure 3 is reproduced from Welch and Wilkinson (2004) in which they have analyzed the activities of an international sugar producer corporation by case study methodology.

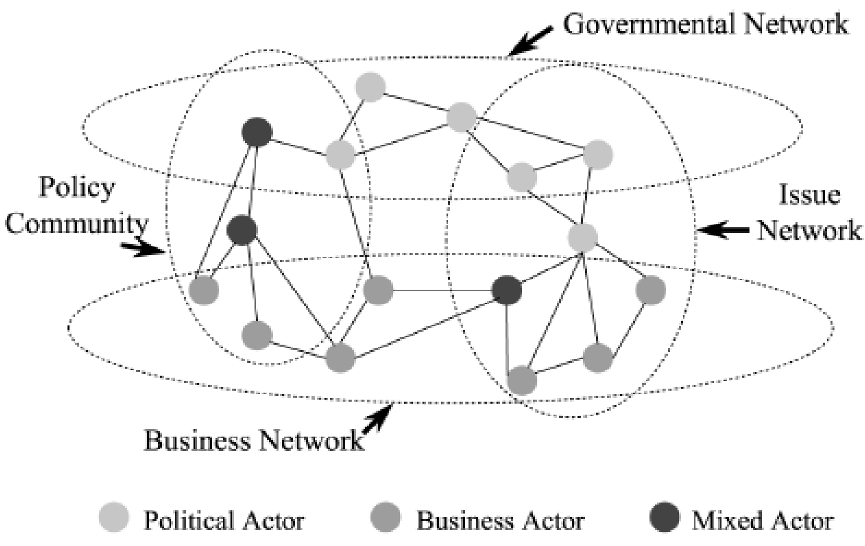

Figure 3. Reproduced from Welch and Wilkinson (2004). Interrelations of various networks.

There is no doubt that macroeconomic policies administered by the state have immense effects in domestic markets and also depending on the size of the industries effects might be observed in global bases. While macroeconomic theory and the theory of finance study the dynamic relationship within the conflicting benefits of economic actors, political embeddedness research focuses on how these conflicts have been resolved by extracting the relationships of the actors, national or international.

Cognitive Embeddedness

The concept of embeddedness is usually treated as synonymous with the notion that organizations and economy are related parts of a larger institutional structure and it defines the context that restricts the rational action (Baum et al. 2003). According to Zukin and DiMaggio (1990), cognitive embeddedness refers the ways in which the structured regularities of mental processes constrain behaviors of economic actors. These structured regularities have been studied under the domain of decision theory and cognitive psychology (Zukin and DiMaggio, 1990; Tzeng and Uzzi, 2000; Dequech, 2006). Results of these studies discredit rational choice theory by asserting the impossibility of the maximizing behavior due to cognitive incompetence and environmental constraints. For instance, Simon's (1957) formulation of the satisficing model of decision making lead the way for bounded rational theories to emerge which Zukin and DiMaggio directly associates with cognitive embeddedness. Bounded rationality emphasize four aspect of individual decision making process that distinguish from rational decision making (March, 1994): (1) Actors are limited in their cognitive capacities in both comprehending and interpreting knowledge; (2) Preferences of the actors are not necessarily exhaustive; (3) Agents do not maximize but rather satisfice or use readily available heuristics; (4) Agents are not anonymous. Their decisions are affected by their social status.

For instance, in his ethnographic study of embeddedness relationships on the exchange between manufacturers and contractors in the New York garment industry, Uzzi (1996, 1997) reports that embeddedness is a unique logic of exchange that results from both social structure and the microbehavioral decision-making processes they promote. On a microbehavioral level, actors follow heuristics rather than intensely calculative ones for at least three reasons: (1) heuristics are decision making processes that economize on cognitive resources but do not necessarily jeopardize the quality of the decisions in terms of speed and accuracy; (2) heuristics are especially useful when uncertainty is high and decision cues are socially defined; (3) the embeddedness of information within networks is consistent with employing heuristics. Furthermore, Montgomery (1998) made an effort to formalize the class of heuristics that are compatible with Uzzi's findings.

Another empirical work by Scharfstein and Stein (1990) outlines the tendency of financial analysts to imitate each other to extreme points of ignoring their own private information when it is inconsistent with the view of the majority. According to Scharfstein and Stein, this behavior pattern can be explained by referring to the fact that firing and promotion of analysts are based on their relative performance in the industry. Their research has been replicated in various regions and received extensive empirical support (Banerjee, 1992; Hong, Kubik and Solomon, 2000). In this respect, the reported behaviors of financial analysts are compatible with the idea of "reference points" and "framing effects" that are discussed in Prospect Theory (Kahneman and Tversky, 1979).

Another interpretation of cognitive embeddedness is the similarity in the representations, interpretations, and systems of meaning among firms (Nahapiet and Ghoshal, 1998; Simsek et al. 2003). Simsek et al. (2003) stated that there is a positive association between structural embeddedness and cognitive embeddedness. Furthermore, as network closure increases so does the cognitive similarity among central actors. The basic motivation behind this statement is that common socialization practices promotes interaction so that closed networks are more likely to develop a common sense of identity and shared mental models which shape their actions and interpretation of future events.

Porac and Rosa's (1996) detailed analysis on strategic aspects of cognitive embeddedness over the networks of organizations that are linked to each other by rivalry ties provides an alternative explanation for the statements put forward by Simsek et al. (2003).

In order to set the stage for the strategic implications of cognitive embeddedness, Porac and Rosa (1996) first explain their interpretation of market boundaries. They refer to White's (1981) argument on market ambiguity and suggest that market boundaries are defined by market players themselves; hence market is actually socially constructed. In this sense, market players try to reduce market ambiguity by establishing a "frame of comparability" (Leifer, 1985: cited from Porac and Rosa, 1996) that includes some as members of the same market and excludes others. Consequently, markets consist of clique like groups of organizations who define each others as rivals. The intuition behind this according to Porac and Rosa is that, since information is too costly and hard to process, rather than extracting supply – demand relationship within an industry, market players try to establish protected domains that they can exploit monopolistically. Consequently, instead of dealing with tremendous amount of information which may also involve uncertainty, market players develop a framework for describing variations among firms. Using simple routines they discriminate boundaries of competitive markets. These routines can be as simple as some taxonomic trees – a basic cognitive structure (D'Andrade, 1995). Then, the market player sets a position in the market for himself from the outcome of a trade-off between isomorphism and differentiation. Isomorphism is necessary to stay as a legitimate market player, whereas differentiation is required to find a market niche in order to act monopolistically.

Thus, Porac and Rosa (1996) and Simsek et al. (2003) bring incompatible explanations for the observation of clique like structures and shared mental models. In studies where embeddedness concept is used, relationships between agents are typically considered to carry a "positive" meaning such as exchange relationship or alliance. Consequently, network terminologies like centrality or structural holes are all based on this fact and interpreted accordingly. Actually, the very definition of "embeddedness" concept by Granovetter (1985) has been put forward to explain the "trust" issue. It has been previously stated that relationships in the form of networks, serve as proxy for "trust" by developing the necessary infrastructure for discouraging malfeasance. Hence ties necessarily carry "positive" meanings at least for one party. Furthermore, Porac and Rosa (1996) use the term "clique like" a couple of times in their article but they never discuss any relationship between market players within that "clique like" structure. A clique is a subgroup of agents that are *tied* to each other and is not a proper subset of another clique. In this sense, Porac and Rosa (1996) used "cognitive embeddedness" in the absence of "structural embeddedness" whereas Simsek et al. (2003) assumed "structural embeddedness" also. The disparity in their interpretations results from this fact.

Cultural Embeddedness

Zukin and DiMaggio (1990) define cultural embeddedness as collective understandings that shape economic strategies and goals. For instance, culture limits market exchange of sacred objects such as human beings and body organs. Culture also sets limits to market exchange between ritually classified groups. Furthermore, in the form of beliefs and ideologies, culture guides strategies, legitimacy for particular class of actors.

According to DiMaggio (1994) economic processes have an irreducible cultural component that enriches the understanding of cultural phenomena. But culture would have an effect on economic processes if it varies within the population or across the time span studied. On the other hand, literature embraces several definitions for culture that prescribes distinguished analysis methodologies and interpretations. For instance the classical definition discriminates cognitive, expressive and valuative aspects of culture such as beliefs about the physical world, emotionally laden symbols, and value orientations (Parsons and Shil, 1951: cited from DiMaggio, 1994). Another definition of culture underlines strategies or means rather than values or goals (Swidler, 1986). DiMaggio analyzes the effects of culture in production, exchange and consumption. Most relevant to the ongoing discussion is the constitutive and regulatory effects of culture on market exchange.

As the constitutive role of culture on market, DiMaggio cites Polanyi (1944: cited from DiMaggio, 1994) for adoption of the view that land and labor as commodities had been a necessary shift for the evolution of self regulating market mechanism. In this vein, culture has evolved in tandem with market. For example, financial institutions such as banks, insurance system, stock exchange markets require previously unfamiliar perceptions of risk that classifies economic agents according to their averseness for risk.

DiMaggio attributes emergence of institutions to the regularity effects of culture on markets. In this respect he reviews cross-national research that applied path dependence methodology and conclude that culture can explain the origins of distinct institutional forms in various national markets.

Furthermore, related to “structural embeddedness” concept culture has a regularity effect in the establishment of new ties between actors that had little previous contact. Coleman (1988) calls this effect as “social capital” of markets. Availability and understanding of cultural signals is the primary constituent of social capital. Actors typically make use of these symbols such as prestigious forms of knowledge or style or for example distinctive speech forms for interpreting one’s character or intentions (Bourdieu, 1986: cited from DiMaggio, 1994). Hence DiMaggio concludes with stating:

> Without adding a cultural dimension to structural accounts of embeddedness, it is difficult to understand the negotiated, emergent quality of trust in many concrete settings, and the ability of entrepreneurs to construct networks out of diverse regions of their social worlds. (p. 39)

In a similar vein, Herrman-Pillath (2006) underlines the importance of “cultural embeddedness” and criticizes the heavy emphasis on using analytical tools such as transaction costs, rents and structural embeddedness to explain economic phenomena. According to the author, even the meaning of these concepts in terms of their specific behavioral consequences is dependent on the cultural setting. In this respect the significance of cultural embeddedness is related with the role of collective action for a particular study. Consequently, there is no single relation between economic institutions and economic performance, so that universal definition of “efficiency” is only applicable if culture is kept under control across samples. He stress his point by: “We do have many examples where people’s behavior is different across times and places, even after taking most environmental constrains and boundaries into consideration. The unexplained is just named culture.” (p.541)

Gupta and Wang (2004) referred cultural embeddedness concept as a resistance to change or a resistance to adapt in the organizational domain. In this respect, a business enterprise is culturally embedded if it is guided by the process of cognition by sense making and rationality, culture by shared beliefs and perceptions, social structure by networks of relations and finally, politics by diplomacy and negotiation. Hence cultural embeddedness indicates organization’s local legitimacy. They note that as well as technological capability, cultural embeddedness plays a major role in the development of organization’s strategic perspective under globalization. Using case studies on the globalization practices of three Chinese firms they have reported that for varying degrees of cultural embeddedness, adaptable strategies towards globalization diverge.

Interim Conclusion

Traditional economic thought optimize efficiency by accessing the market information and by averting situations that interfere with unilateral action and add needless coordination costs to interfirm exchanges (Granovetter, 1985; Uzzi, 1996). Later revisions to the theory, particularly within game theory setup, have made additions to these principles. Bounded rationality and imperfect information can cause the definitive efficiency of markets to be displaced by hierarchies or hybrid organizational forms (Uzzi, 1996). However these forms neither increase efficiency nor coordinate transactions or eliminate malfeasance.

On the other hand, social network theory assess that embeddedness shifts actors' motivations away from narrow pursuit of immediate economic gains to the enriching of relationships through trust and reciprocity (Powell, 1990). Embeddedness approach combines organization theory with social network theory by focusing on the structure of social relations and argue that social ties among actors, individual or collective, shape economic action by creating unique opportunities and access to those opportunities. Thus social organizations and social relations are introduced into the analysis of economic systems not as a structure that pops up into place to fulfill an economic function, but as a structure with history and continuity that give it an independent effect on the functioning of economic systems (Coleman, 1988).

Unlike oversocialized views (Wrong, 1961), embeddedness approach does not attribute all motives of action to the structure. The concept of social capital clarifies the role of embeddedness in this respect. Social capital has two principle characteristics. First, it is a collection of entities that consist of some aspects of the social structure. Second, social capital facilitates certain actions of actors. "Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible."(p: 98, Coleman, 1988). However unlike other forms of capitals, social capital is recorded in the structure of relations between and among actors. Consequently embeddedness is the source of social capital which is an independent resource to attain certain goals.

Then, what is the source of embeddedness? Although by now literature accumulated a huge knowledge base on the consequences of embeddedness, the emergence embeddedness is neglected to a large extent. Within a perspective that maintains social capital as the principle benefit for actors in an embedded social network, this thesis seeks the sources of embeddedness.

According to some social scientists this source is culture. Bourdieu (1986: cited from DiMaggio, 1994) argues that availability and understanding of cultural signals is the primary constituent of social capital. Actors typically make use of these symbols such as prestigious forms of knowledge or style or for example distinctive speech forms for interpreting one's character or intentions (Bourdieu, 1986: cited from DiMaggio, 1994). In this vein DiMaggio states that:

> Without adding a cultural dimension to structural accounts of embeddedness, it is difficult to understand the negotiated, emergent quality of trust in many concrete settings, and the ability of entrepreneurs to construct networks out of diverse regions of their social worlds. (p. 39)

Objective of the Dissertation: The objective of this thesis is to understand the dynamics that constitute embedded social networks. This requires construction of a dynamic model in a cultural framework.

A cultural framework describes social action in reference to cultural endowments. Hence the model in this thesis associates the necessary cultural endowments of a social group to an index that measures the embeddedness of the network structure established by the group. Therefore inputs to the model are cultural endowments of groups and outputs of the model are network structures that have embedded indices in a plethora. Thus the methodology of such a model depends on the definition of "cultural endowment" and "embedded social networks".

According to Coleman (1988) embedded social networks possess a distinguishing topological property.

> All social relations and structures facilitate some forms of social capital; actors establish relations purposefully and continue them when they continue to provide benefits. Certain kinds of social structure, however, are especially important in facilitating some forms social capital. One property of social relations on which effective norms depend is what I will call closure. (Coleman, 1988: p.105).

In the similar vein Lin (1999) proposes that dense or closed networks are seen as the means by which collective capital can be maintained and reproduction of the group can be achieved. Closure is a topological property defined over triads. A triad is closed if all members of the triad are linked to each other (Figure 4b.). Since the existence of a triad requires three nodes and at least two links, Figure 4. displays all forms of triads.

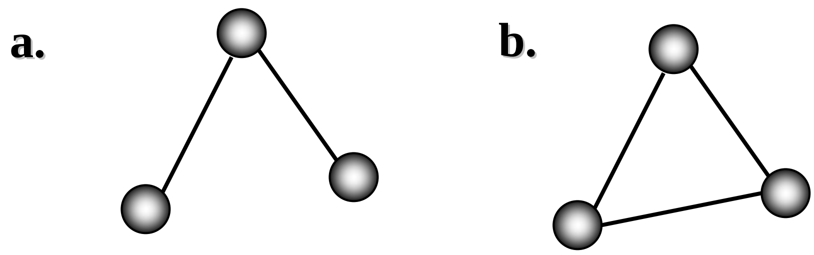

Figure 4. Closure in triads. Triad in a. is not closed whereas triad in b. is closed.

The essential point in this argument is, for a network to be embedded it is not necessary that all triads are closed which would automatically imply that the whole network is complete. Rather, an embedded network consists of enough number of closed triads. In return it is not meaningful to phrase that a particular network is embedded, but it is possible to say that a network is more embedded than another due to the ratio of closed triads to all triads. Coleman (1988) argues that closed triads imply repeated interactions and established norms.

On the other hand, a definition for cultural endowment is not readily available since there is an enormous volatility in the concept of culture in the last two decades (Sewell, 1999). The basic concepts of traditional culture sociology; Weber's "ideas" and Parsons' "values" had been considered as deriving motives for shaping social action (Warner, 1978). Both theorists established these concepts in an attempt to define the "goals" that the social actors; whether individual or collective would pursue. In Weber's and Parsons' perspective the cognitive nature of agents and particularly the decision making process are quite similar to the cognitive nature of agents presumed in Rational Choice Theory. The fundamental point of divergence was due to the subjective nature of social actors introduced by cultural elements via "ideas" or "values" (Swidler, 1986, 2001; Warner, 1978). Thus, the Voluntaristic Action Theory of Parsons which derives from "values" and Weber's famous switchman metaphor has been constructed in this logic (Weber, 1946, p.280: cited from Swidler, 1986; Parsons and Shils, 1951).

However, latest developments in cognitive psychology and especially increased interest of this branch towards culture, produced several results that demonstrate the nonexistence of a coherent structure like "values" or "ideals" within human cognition (DiMaggio, 1997). Some sociologists even objected to the very idea that culture causes action by setting goals or ends for action (Swidler, 1986):

> If culture influences action through end values, people in changing circumstances should hold on to their preferred ends while altering their strategies for attaining them…Does culture account for continuities in action independent of structural circumstances? It does, but…if culture plays the independent causal role Weber attributed to it, it must not change more easily than the structural and the economic patterns it supposedly shapes. (p. 278).

Geertz's (1973) interpretation of culture as system of symbols demonstrates a completely different perspective of culture. Similarly, Bourdieu developed yet another distinctive interpretation which is called culture as practice. While anthropologists accepted Geertz's view and pursued "thick" form of culture studies, sociologists preferred Bourdieu's (1978) culture as practice view as an inheritor of Parsons. Both of these perspectives have their own unique advantages in explaining cultural phenomena. Recent literature on culture studies underscores various advantages that can be obtained from a merged framework. After Swidler's (1986) first attempt in merging symbol and practice views of culture in her culture as a toolkit approach, Sewell (1999) developed a framework with a deconstructionist stance in which both symbol and practice views of culture can be elaborated in coherence.

Cultural theories of action have been reviewed in Chapter 3 by emphasizing the principle factors that interconnects a newer theory to the former. In the synthesis section, it is argued that Sewell's perspective of culture is the ideal framework to develop a model to study the objective of the thesis.

CHAPTER 3

LITERATURE REVIEW

Culture

If the focus is human groups in varying sizes, the idea of "culture" is commonplace and indispensable for scholars in many different fields of humanities and social sciences. However the common usage of the term "culture" has overlapping and even contradictory connotations (Spillman, 2002). Literature frequently underscores the difficulty in defining or rather setting the boundaries for the concept and even some social scientists have found the concept to vague to be useful (Faeges, 1999: cited from Spillman, 2002); but still numerous publications in "cultural studies" are devoted to elaboration of the functionality of culture with fuzzy definitions in human societies.

Due to richness and diversity of the new cultural studies and the volatility of the concept that the word "culture" refers to, literature is being populated with taxonomy and systematization efforts. For instance, Alexander and Seidman (1990) classify culture and consequently cultural studies into functionalist approach, semiotic approach, dramaturgical approach, weberian, durkheimian, marxian and poststructuralist approaches. According to Sewell (1999), until mid-1980s the new quasi-discipline of cultural studies has grown explosively by applying standard sociological methods all of which analyzed culture within their own axiomatic settings and introduced still more perturbations for cultural studies. Related to this, literature severely lacks mutually exclusive cultural studies taxonomy. In this respect recent literature in culture studies focus on a particular sub domain of culture and elaborate different perspectives of culture within that projection (Swidler 1986; Mohr, 1998; Schudson, 1989; Sewell, 1999; Demerath, 2002; Alexander, 2004; Vaisey, 2006).

The focus of this thesis related to culture is social action. Consequently the diversity of the implications of the culture concept is only relevant up to their interpretations and implications for social action. In this regard, the review on the concept of culture is intentionally simplified to and presented as a dichotomy; culture as a latent variable and culture as a system and practice.

Culture as a Latent Variable

Culture has been considered as something that connects us to other people in our groups and contrast with outsiders. Culture is the gross sum of certain ways of seeing the world, or habits, or shorthand codes and assumption we happen to share with members of our own group (Spillman, 2002). It is a body of knowledge that directs the persistence of interactions of the members of a society by sustaining the survival of the social system (Parsons, 1951: cited from Turner, 1998). Yet, culture is vague and unreducible. We observe the manifestations of culture but we can not see what is inside in it; pretty much like a black box. For this reason, it has been customary to refer to culture with a function of synthetic connotations called latent variables. As opposed to directly observable variables, latent variables are rather inferred from other directly observable variables. The primary objective in using latent variables is to reduce the dimensionality of the data; in this case the diversity of the manifestations via aggregating into “synthetic” latent variables.

In latent variable view, culture is the sum total of learned behavior patterns which are characteristic of the members of a society and which can not be the result of biological inheritance (Hoebel, 1949). Culture constitutes values, beliefs, and expectations that members come to share (Van Maanen and Schein, 1979: cited in Cooke and Rousseau, 1988).

Hofstede (1984, 1994) defines culture as “the collective programming of the mind; not only manifested in values but also in symbols, heroes, and rituals” (p.1), that contain a component of national culture developed in the family and reinforced in schools and organizations. For Hofstede, analysis of culture should focus on the diversity of the normative behaviors of social groups; thus he attributes the mental programs that have a distinguishing property to culture. In this respect he concludes that culture is a source of conflict rather than of synergy. Obviously the conflict is across groups that have distinct collective minds.

In latent variable view, culture influences in various manifestations such as media images, governments, educational systems, responses to attitude questions and values embedded in everyday practices and possibly many more (Di Maggio, 1997). Within this big set of available manifestations, literature on culture studies is dominated by methodologies which favor “values” as the fundamental indicator of culture. Although culture is related to a larger whole than social “values” *per se*, in the end it is claimed that “values” is the generative core of the normative behaviors (Parsons, 1959: cited from Camic, 1989).

According to Smith and Schwartz (1997) there are two primary reasons that values are favored in culture studies in the literature. First, values represent the most prevalent concepts in culture. Second, value priorities of individuals define the central goals and therefore can be related to the variations in behavior. For Swidler (1986) both of these arguments refer to Parsons' voluntaristic theory of action. Parsons emphasizes that the value factor, or the normative element of human behavior is not a derivative of biological factors and requires to be analyzed methodologically independent of sciences of nature and retrospectively he defines values as the ultimate connection between the individual and the society.

In Parsons' voluntaristic theory of action, actors internalize and also reproduce society's common culture through socialization process, families being the basic mechanism (Smelser, 1992). The theory is influenced overwhelmingly from Freudian perspective such that individuals internalize parental value orientations (DiMaggio and Powell, 1991). Parson explains the integration of value orientations in a functionalist setting (Miller, 1997):

> …roles are institutionalized when they are fully congruous with the prevailing culture patterns and are organized around expectations of conformity with morally sanctioned patterns of value-orientations shared by members of the collectivity. (Parsons and Shils, 1951, p. 54)

In an attempt to provide a detailed description for the normative side of action, Parsons attribute the dominant role in voluntaristic theory of action to culture which he embeds within personality and describes as a taxonomy that consists of two dimensions (Turner, 1998). First, the Motivation dimension constitutes three types of motives: (1) Cognitive; need for information, (2) Cathectic; need for emotional attachment, and (3) Evaluative; need for assessment. Second is the Value dimension which constitutes three standards: (1) Cognitive, evaluation by objective standards, (2) Appreciative; evaluation by aesthetic standards and (3) Moral; evaluation by absolute rightness or wrongness (Figure 5).

This highly multidimensional system of culture-personality parity generates three types of action: (1) Instrumental; action oriented towards reaching explicit goals efficiently, (2) Expressive; action oriented to satisfy emotional needs, and (3) Moral; action oriented towards sacred goals of what is right and wrong (Figure 5).

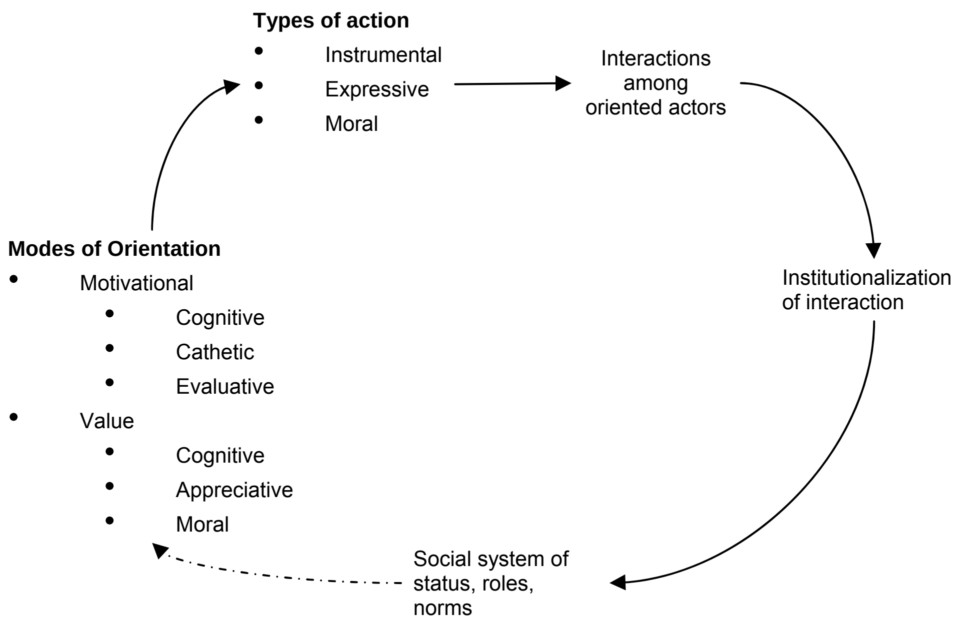

Figure 5. Parsons' conception of Action, Interaction, and Institutionalization.

Parsons does not prefer relating culture to those informal constraints or informal institutions so that basic structure of standard economic methodology can be maintained; he proposes a dynamic model which is more than a modification to the rational choice paradigm. For this purpose he switches the unit of analysis from the individual to social interactions. In this stance, the interactions of agents are conjoint products of the satisfaction of the needs in three systems, summarized in Figure 6 (Parsons and Shils, 1951). In the social system level, needs related to scarcity and allocation are satisfied and goals and means are decided accordingly (Alexander, 1990). In personality system level, actors are confronted with constraints such as own biological make up, heredity and ecology that influence the selection of goals and means. At the cultural system level, actors are governed by values, norms and other ideas that influence what a "goal" and appropriate "means" are (Alexander, 1990; DiMaggio and Powell, 1991; Turner, 1998).

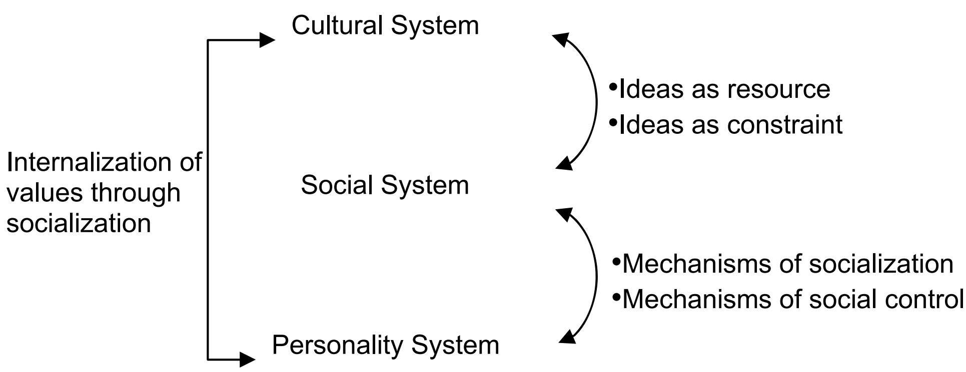

Figure 6. Parsons' conception of Integration among Systems of Action.

Parsons (1951) underscore cultural system and note that the analysis of this system is particularly essential in the theory of action and furthermore, other two systems; social system and personality system themselves should be considered as actors within cultural system.

> …value standards (criteria of selection) and other patterns of culture when institutionalized in social systems and internalized in personality systems, guide the actor with respect to both the orientation to ends and the normative regulation of means and of expressive activities, whenever the need disposition of the actor allow choices in these matters… (p. 40)

Hence Parsons tried to solve the dichotomy between the random, amoral, self-interested, disintegrative, individualistic chaos and normatively structured, value oriented, integrative social order. Moreover, Parsons' tendency was to load whatever "useful" – regarding his charter for sociology - onto the "value factor" (Camic, 1989).

Culture specifies value orientations as shared symbolic system which serves as a criterion or standard for selection among the alternatives of orientation which are intrinsically available in a situation (Turner, 1998; Swidler, 1986). Hence culture effects individual actions through values via directing to particular ends rather than others (Figure 7). In this respect values are belief structures about goals that can guide human social action in a variety of situations (Schwartz and Bilsky, 1990).

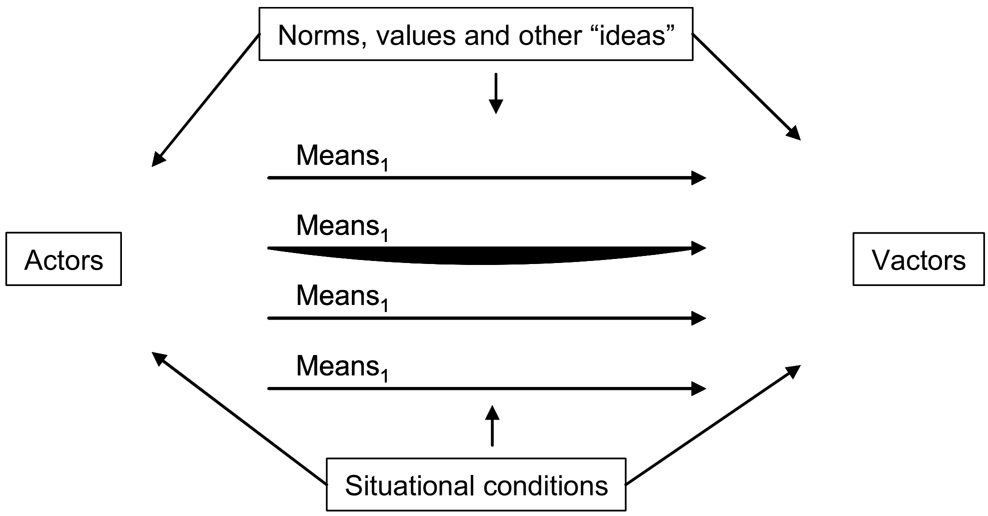

Figure 7. The units of voluntaristic action according to Parsons.

Parsons' Voluntaristic Action Theory has constituted explicitly or implicitly the core of numerous culture studies in sociology (Camic, 1989). For instance, Hofstede (1984) claims that there are actually four manifestations of culture which are mutually exclusive and reasonably comprehensive. He uses the famous onion metaphor to categorize symbols, heroes, rituals and values (Figure 8). Symbols embrace language, gestures, pictures and objects that carry a particular meaning for a cultural group. Hence symbols that belong to a group may be absent or interpreted differently in other cultures. The term heroes refer to individuals that serve as models for behavior. Rituals are social actions that manipulate cultural meaning for group and individual communication and categorization. Rituals occur in fixed and episodic sequences and performed with formality and seriousness. Values are defined similar to earlier paragraph as enduring beliefs that guides actions across situations and beyond immediate goal to more ultimate goals and are often unconscious. As Figure 8 depicts, symbols, heroes and rituals can be categorized under the term “practices” because they are visible although their cultural meaning lies in values and manifested in alternatives of behavior. Thus Hofstede does not treat values as concrete cultural manifestations but as essences around which concrete manifestations of culture are constituted.

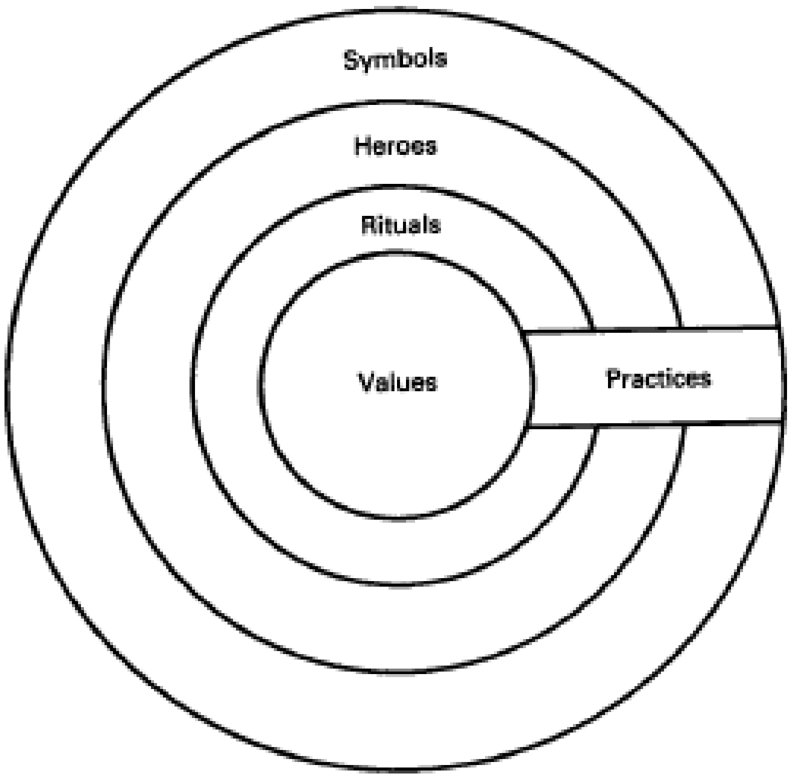

Figure 8. Hofstede’s Onion metaphor to categorize symbols, heroes, rituals and values.

To sum up, a cultural study, in particular a cross-cultural study for all practical purposes rests upon values as the basic essence of culture or with respect to Parsons’

Voluntaristic Action Theory the fundamental variable of the “unit act” that can be used for comparison purposes.

When values are used to characterize culture, one ends up with socially shared, abstract ideas about what is good, right and desirable for a society or for other bounded cultural group. For example, in cultural groups where individual ambition and success are highly valued, the economic and legal systems are likely to be competitive and developed. On the other hand, in a collectivist society where group welfare is more important, cooperative systems such as socialism are more likely to emerge (Smith and Schwartz, 1997). In the next section, cultural frameworks that describe the causal role of culture through values on action are reviewed.

Cultural Frameworks

Due to the constraints circumscribed by Parsons’ Volutaristic Theory of Action, values must be conceptualized as shared entities through a population. These constraints would also require that a cultural framework which loads discriminatory power on values is expected to reflect the social dynamics of underlying compatibility of interactions of the agents. Hence the frameworks to study culture are restricted to orientations that extract shared and average group behaviors using various statistical techniques. Such a framework would describe the attitudes of the majority in a population, neither the attitudes of a single individual nor the attitudes of the whole population. In this respect according to sociological stance in cross-culture studies, it is neither sensible nor possible to reduce social processes such as culture to the level of the individual (Thompson and Fine, 1999).

Based on this logic, Hofstede (1980) developed a large-scale value based research to quantifying average distances that would provide a method to measure the amplitude of cultural differences. I am aware of the fact that his work has important antecedents such as the theory developed by Inglehart (1977); but Hofstede's cultural values framework is the first in capturing the full range of potentially relevant value dimensions (Schwartz, 1999) and is the most influential one (Gerhart and Fang, 2005). For this reason I will focus on Hofstede's model in this section.

Hofstede (1980) conducted largest cross-cultural research ever conducted using a value survey in order to capture cross cultural differences assuming a monolithic structure within a population. He has collected matched samples of 117.000 (later extended to 160.000) IBM subordinates from 40 countries (later extended to 56 countries) between 1967 and 1973. This sample readily satisfies three important properties discussed in the previous paragraphs. First of all, subordinates had quite similar characteristics and therefore they would only expect to differ for possible cultural traits/aspects in particular values and gender. Second, he has used the most applicable and interpretable cultural boundary, namely the geographical boundaries. In order to make comparisons across countries he computed mean scores for each questionnaire item for each country. Finally he has used factor analysis over this data in order to extract orthogonal dimensions such that distinct cultures can be plotted and interpreted.

As the methodology that Hofstede used implies, he ended up with some hypothetically orthagonal constructs. He found that culture vary on four primary dimensions. A dimension (Hofstede, 1994, p 14) is "an aspect of a culture that can be measured relative to other cultures". The extracted dimension that explains the cultural variations are: individualism versus collectivism (orientation toward individual or group), power distance (willingness to tolerate differences in power and authority), uncertainty avoidance (willingness to tolerate ambiguity) and masculinity versus femininity (former stressing material success and achievement, the latter stressing harmony and care. Recently a fifth dimension has been added to this framework by a Chinese research group leaded by Michael Bond (1989: cited from Hofstede et al., 1990). This fifth dimension is called “Confucian dynamism” and measures long-term orientation to short-term orientation in life.

Hofstede’s study provides us with a way of classifying the differences found among 40 national cultures. Hofstede emphasized that he has used core national values and not individual values in his framework. As an example, a particular cultural trait such as collectivism observed in the population level does not mean that an individual of that population carry that trait in that amplitude. Put otherwise, if two nations differ on individualism versus collectivism dimension then one should not infer that two members of these nations would also differ in the same manner. Figure 9 depicts hypothetical distributions for two nations on individualism versus collectivism dimension. The mean score for a nation on a dimension is the mean scores of those who responded the questionnaire’s relevant questions. Obviously there would be variations within each culture (nation).

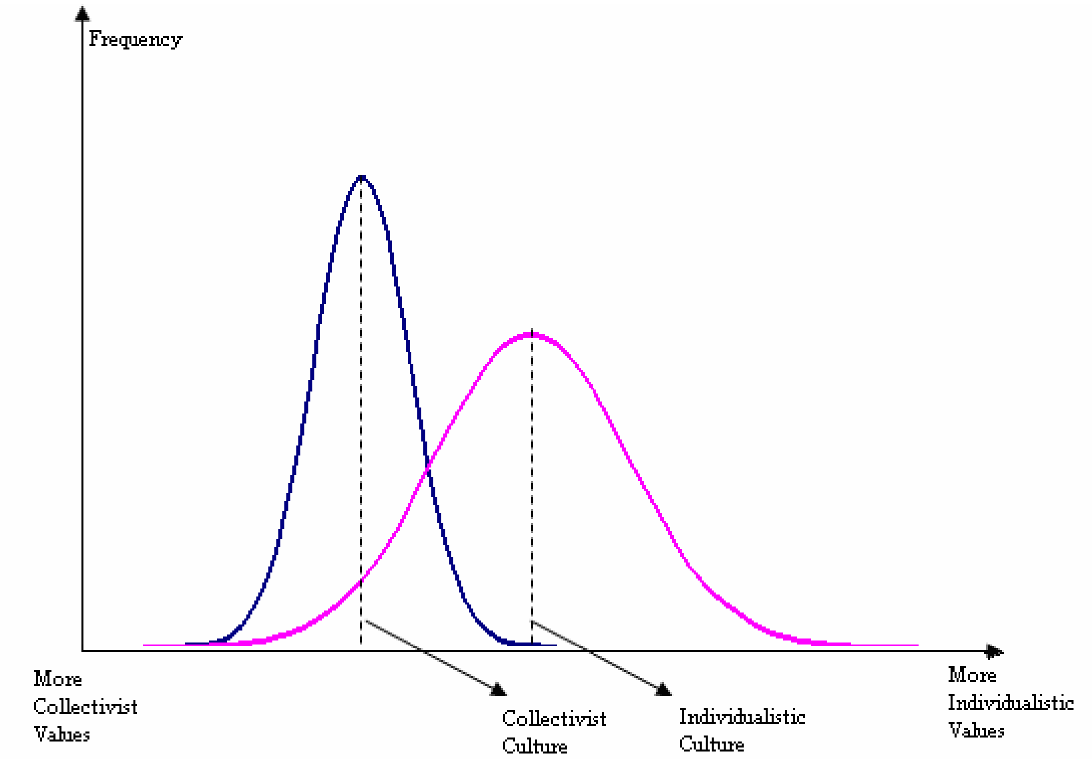

Figure 9. Hypothetical distributions for two nations on individualism versus collectivism dimension.

For that reason, even a significant difference observed between populations does not let a researcher to infer causations that are subject to individual domain. Robinson (1950) defines this type of inference making as ecological fallacy and provides various examples from the literature. The same concept has been discussed by Campbell (1958) under the term group fallacy as well.

Gerhart and Fang (2005) list the assumptions behind the framework developed by Hofstede. According to them, national culture framework is effective to the degree that the following axioms are satisfied.

Between cultural differences should be larger than within culture differences. Formally the analysis of variance defined as Hofstede's values as the dependent variable and country as an independent variable must have a high squared correlation (where only two countries are studied) or other related statistics in multivariate analysis of variance (where more than two countries are studied). Country differences are greater than organizational differences, because otherwise the rationale behind selecting geopolitical boundaries as the cultural boundaries would be questioned. A high statistical correlation between management practices and organizational structure with national culture is expected. Managerial discretion is substantially limited by national culture. This axiom strangely conflicts with the famous view that discrimination as a strategy could provide benefits, although it might be risky. Companies attract, select and retain employees in a random fashion

The degree that Hofstede's framework satisfies these axioms is still a debate and for that reason one should be cautious in interpreting national differences in culture. In this respect Gerhart and Fang (2005) warn researchers not to over-emphasize the importance of national culture before testing these axioms.

After discussing the national culture framework of Hofstede and providing theoretical support that one can classify national cultures in terms of the importance attached to different values, the consequences of cross-cultural studies for social action need to be elaborated.

For this purpose, first of all the universality of cross-cultural material should be discussed. Measurements based on standard tests or interviews do not necessarily produce scores that are culturally equivalent. In other terms, a particular score cannot be interpreted in the same way for subjects belonging to different cultural populations (Van de Vijer and Leung, 1997; Poortinga, 1997). Although methodological issues related to this phenomena is discussed in the preceding paragraphs, at this point it is crucial to note that failure of universality is also closely related to cultural embeddedness and calls for theoretical transformations to observed behaviors which is in principle a very hard task if not impossible. The emic – etic distinction refers to this problem.

Etic-Emic Distinction

Kenneth Pike introduced the idea of emic-etic distinction to the literature (1967: cited from D'Andrade, 1995) underscoring the orientation of the research. A cultural analysis is emic if the researcher studies a preset structure in a local environment and elaborates distinctive contrasts between cultural aspects by the use of these materials. In this respect the observer has a set of categories and tries to explore the explanatory power of these categories. Etic analyses on the other hand, are those that focus on universals, on features that are common in the universal domain. In order to clarify the difference between emic and etic studies, Smith and Bond (1998) refer to a study in the literature.

> …the California F scale, a measure of deference to authority and intolerance towards minority groups developed by Adorno et al. (1950) in the United States, and widely used subsequently elsewhere. Kağıtçıbaşı (1970) reported that when the scale was used in Turkey, responses to the items did not correlate with one another at all well, as they had done with the original American subjects. In Turkey, the same scale items tapped several different concepts. (p. 58)

Berry (1989) states that cross-cultural psychologists aim to develop frameworks that would imply generalizations which are etically valid. Furthermore he offers a methodology for reaching more valid set of derived-etic generalizations. Specifically, derived-etic research is based on derived-etic cultural materials which can be approximated through an iterative procedure that gradually leads unrevealing of what is culture-specific and what is culture-common. However, Berry et al. (1992: cited from Poortinga, 1997) admit that, such an iterative procedure is prone to subjective evaluations and is a research agenda more than a method.

The epic-emic criticism distress comparative research more than epistemological foundations; if a researcher starts with etic cultural materials and attempts to discriminate antecedent differences between cultural populations, and if inferences using the statistical tools that are available are not protected against alternative interpretations then comparative methods is vulnerable to invalid findings (Poortanga, 1997).

This brings the discussion to the issue of whether culture elaborated in a functionalist framework such as those derived from Parsons' Voluntaristic Theory of Action can ever legitimately be considered as a cause of social action. Clearly, assuming that particular cultural materials can explain behavior and then using variations in behaviors defining deviations for those cultural materials would impose a tautology (Rohner, 1984).

As Smith and Bond (1998) points out, a researcher may use characterizations of whole cultures (e.g. collectivist values) to explain specific attributes of that culture as a whole (e.g. the domestic political system, rate of disease, military expenditure and so forth). But it is necessary to use characterization of the values of particular individuals or groups of individuals to predict how those particular individuals will behave. Yet the characterization of values would point towards cognitive analysis which is far beyond the agenda of theories that define culture as a latent variable. The point in this discussion is not that one unit of analysis is superior to the other one; rather it underscores the technical problems that would emerge for causal inferences across different unit of analyses.

Hence the discussion on latent variable approach of culture boils down to emphasize the necessity of emic studies in order to explain its causal relation with social action; the idea at the core of the cultural studies that is reviewed in the next section: culture as system and practice approach.

Culture as System and Practice

This section develops two views; culture as system (Geertz, 1973) and culture as practice (Bourdieu, 1979; Swidler, 1986) views independently as much of the theoretical writings in the last 15 years assumed that practice view is at odds with the system view (Sewell, 1999) until the path breaking approaches of Swidler (1986) and Sewell (1999) who offer a framework that both of these views fit in.

Culture as System (of Symbols and Meanings)

Primarily influenced by Talcott Parsons, Geertz used the term "cultural system" as a system of symbols and meanings abstracted from social relations (Sewell, 1999; Ortner, 1984). In an effort to distinguish "cultural system" from "social system" and "personality system" – three intervened fundamentals of Parsons's framework, Geertz (1973) argued that culture is not a synthetic concept created inside people's heads, but instead is embodied in public symbols, symbols through which members of a society communicates their worldview and value orientations within each other and through populations. The principle of conceptualizing culture as symbols that are abstracted from concrete interactions such as economic, biological and technological is necessary to accomplish for a relatively fixed locus and degree of objectivity (Ortner, 1984: Sewell, 1999).

The symbols in Geertz's framework is important because they provide people a sense of meaning (Laitin, 1986: cited from Weeden, 2002) or stated otherwise they are vehicles for meanings. In particular, Geertzians such as Ortner, Blu, Meeker and Rosen (Ortner, 1984) have not interested in the functions of symbols, for instance, healing people through curing rites, but they have rather focused on the question of how symbols shape the ways social actors attach a meaning to the world they sense. For this purpose Geertzian framework requires studying culture "from the actor's point of view" through ethnographic methods and hence is necessarily emic (Ortner, 1984, p.130). Although the framework is defined as actor centered, "As interworked systems of construable signs," Geertz (1973) wrote, "culture is not a power, something to which social events, behaviors, institutions, or processes can be causally attributed; it is a context, something within which they can be intelligibly-that is, thickly-described" (p.14). Thus, Geertz was rather into the "ethos"[14] side of the culture: "You wouldn't go to Macbeth to learn about the history of Scotland – you go to it to learn what a man feels like after he's gained a kingdom and lost his soul." (1973, p. 450)

Thus, for Geertz, culture is not an ordered system in the positivist sense. It does not carry a logic derived from structured principles, "or from symbols that provide the 'keys' to its coherence." (Ortner, 1984, p.130). He emphasized the explication of meanings as opposed to cataloguing causal generalities. In this regard, culture becomes a background condition, a setting for observable practices, a necessary truth rather than a useful construction (Biernacki, 1999). For instance, in a political science application of Geertzian framework, Lynn Hunt (1984: cited from

[14] According to Geertz (Swidler, 1996), " 'sacred symbols', and especially ritual actions, generate an 'ethos' – an emotional tone, a set of feelings, 'moods and motivations' – that simultaneously make the religious worldview seem true and make the ethos seem 'uniquely realistic' given that kind of world.

Biernacky, 1999, 2000) asserted that the substance and the purpose of life are symbolic and that legitimacy is the general agreement on signs and symbols.

Due to its relevance to social action, it is crucial to clarify the dichotomy in the study of "behavior" and "symbol" in Geertzian framework. Geertz (1980) explains:

> . . . however raggedly, a challenge is being mounted to some of the central assumptions of mainstream social science. The strict separation of theory and data, the "brute fact" idea; the effort to create a formal vocabulary of analysis purged of all subjective reference, the "ideal language" idea; and the claim to moral neutrality and the Olympian view, the "God's truth" idea-none of these can prosper when explanation comes to be regarded as a matter of connecting action to its sense rather than behavior to its determinants. The refiguration of social theory represents, or will if it continues, a sea change in our notion not so much of what knowledge is, but of what it is we want to know. Social events do have causes and social institutions effects; but it just may be that the road to discovering what we assert in asserting this lies less through postulating forces and measuring them than through noting expressions and inspecting them. (p. 178)

Here Geertz states his vision of the program for social studies in particular culture studies as an interpretive method rather than explanatory / descriptive. Furthermore he claimed that interpretive methodology is not a mere substitute of, but is superior to explanatory / descriptive methodology. In this respect the task of theory building is not extract or abstract regularities across cases, but to generalize within cases:

> To generalize within cases is usually called, at least in medicine and depth psychology, clinical inference. Rather than beginning with a set of observations and attempting to subsume them under a governing law, such inference begins with a set of (presumptive) signifiers and attempts to place them within an intelligible frame. Measures are matched to theoretical predictions, but symptoms (even when they are measured) are scanned for theoretical peculiarities-that is, they are diagnosed. In the study of culture the signifiers are not symptoms or clusters of symptoms, but symbolic acts or clusters of symbolic acts, and the aim is not therapy but the analysis of social discourse. (Geertz, 1973, p. 26).

Geertz's rationale for noncomparative approach across cases has been perceived as an opposition to "conventional social science" and has met substaintial resistance by many scholars including Shankman (1984), Brintnall (1984), Darnell (1984), Ruijter (1984), Asad (1983), and Rosaldo (1997), who put forward the question that how Geertzian theory proceeds in terms of cumulative knowledge and that Geertz offers no criteria or method for how an adequate interpretation should be.

Geertz's conception of interpretation as a "science" derives from the hermeneutical perception of human sciences as opposed to natural sciences (Alexander and Siedman, 1990; Shankman, 1984). Similar to Geertz, hermeneutists have emphasized that human life is characterized by dimensions such as self-awareness, reflexivity, creativity, intentionality, purposiveness and meaningfulness that cannot be reduced like dimensions of natural world that are subject to natural laws. Thus hermeneutists, mainly Dilthey (1900[1972]) and Veblen (1904: cited from Herrmann-Pillath, 2006) developed an alternative approach called *Geisteswissenschaften* (the sciences of spirit) as opposed to observational, explanatory methods of natural science (*Naturwissenschaften*).

In this respect, cultural studies in Geertzian framework do not explain cultural systems by referencing one culture to another because such reference based studies would not let a researcher to learn the culture of a society but rather catalogue that particular culture among others by abstract formations such as power, gender asymmetry, ethnic violence, and colonial domination (Ortner, 1997). For instance, language as a cultural asset varies among cultures and a cataloguing perspective would focus on the variability of the structural aspects of languages and would explain a language by underscoring the diversities with respect to a selected base such as "English". However this approach would provide only informationally thin value as it is now evident that computerized translation softwares are incapable of translating across languages. For Geertzians, "scientific" cultural transformations are inappropriate. In this regard, a language is a system of symbols that carry meanings and only these meanings can be explored and interpreted. In particular only a human translator educated to interpret two cultural systems can transfer meanings from one culture to other.

Another example to facilitate clarification of the difference between two cultural methodologies could be spread of technological innovation. Assume a hypothetical ancient tribe that has the unique knowledge to utilize fire for heating and cooking. Unless this technology is perfectly understood and culturally transferred to other cultures and become common in other tribes as well, it would be a cultural endowment of the innovating tribe, and a cataloguing phrase such as "technologically improved" would be a "thin" description of that particular tribe[15].

The dual interpretation of this assortment is that the culture of a society is the set of all cross cultural transfer resistant symbols and associated meanings. In the broadest definition, culture is everything that humans are capable of but cannot be "scientifically" identified in detail; thus culture can only be studied in Geisteswissenschaften approach. This interpretation has led historian like Robert Darnton (Swidler, 1996) to move from

> …studying the influence of popular belief and practice on major social transformations (the influence of mesmerism on Enlightment thought, or the influence of book cencorship on French political thought) to using particular engaging, but often atypical, events or stories as texts that reveal the whole structure of meanings available in a historical era. (p. 301).

Consequently culture is conceptualized as a *coherent*, *static*, and *singular* structure that can only be understood within itself. With respect to sociologists, culture studies

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[15] In this regard some cultural attributes, especially the ones that can be "scientifically" identified are relatively easier to transfer across nations.

that define culture as a system of symbols and meanings and pursue ethnographic studies are actually sampling on the dependent variable.

> …who belongs to this school tend to select symbols and meanings and pass over those that are relatively fragmented or incoherent, thus confirming the hypothesis that symbols and meanings indeed form tightly coherent systems. (Sewell, 1999, p. 47).

Although Geertz labeled his culture view as a system he had never offered a systematic perspective to culture (Ortner, 1984). A systemic approach in this regard refers to identifying the relationship between contents of culture, in particular the relationship between symbols and meanings. Rather he implicitly assumed, in this regard followed Weber and Parsons that individuals acquire culture by imbibing it.

In sum, Geertzian interactionist framework for culture leaves no space to study causal relationship between culture and social action since ethnographic studies employ social action as sense making activities of agents via symbols. Thus not only the relationship explored in this thesis – culture to action – is reversed upside down but also the expected functionality of this relationship – causality – has been totally dismissed. Causal implications of culture on social action require a catalogue of diversified cultural ingredients and actions which by definition implies comparability within symbol – meaning pairings and another observable variable such as “goals” in Parsons’ Voluntaristic Action Theory. Yet, this still would imply the necessity of a social domain in which agents are gifted with enough social abilities to actively switch between symbol – meaning pairings to pursue certain interests.

However as it has been discussed in the preceding paragraphs Geertz deliberately pruned all social system and personality system related effects in order to arrive at a pure cultural analysis and that for Bourdieu (Wacquant, 1989; Turner,

1998) is a huge mistake since class based interests of agents are indispensable in a cultural framework. According to Bourdieu there is more for agents then "definitions of situations" as the "actor" of symbolic interactionism are always incumbents in particular groups and classes. Bourdieu asserts that people's definitions of structures are neither neutral nor innocent but are ideological weapons that are functions of objective class structures and interests generated by these structures (Turner, 1998).

Bourdieu's framework; Culture as Practice that he developed over objective class-based interests of agents, provides a lively habitat in which causal implications of culture on social action can be elaborated. This view has played the fundamental role in facilitating the cognitive turn in social theory, emphasizing the taken-for-granted elements of action, social classification, practical consciousness and the situated, embodied reproduction of the social system (Bonnell and Hunt, 1999; DiMaggio and Powell, 1991).

Culture as Practice approach agrees with Parsons' Voluntaristic Theory of Action to the extend that culture is deeply internalized habits, styles, and skills; but diverges from Parsons and gets in tandem with Geertz while allowing agents to make sense with each other in producing innovative actions. However Bourdieu diverges from both Parsons and Geertz in permitting individuals actively recreate culture and not dully follow cultural rules but seek strategic advantage by using culturally encoded skills (Swidler, 2002). His theory has been labeled as the most genuine alternative to Parsons' Voluntaristic Action Theory (DiMaggio and Powell, 1991). Furthermore for some social scientists, Bourdieu's Culture as Practice view carries Geertz's "thick" definition of culture as well:

> He [Bourdieu] points out the blind spots that are intrinsic to pretenses of sociological omniscience and resituates the researcher as a historical agent with a historical connection to what is studied. Interpretation as Bourdieu practices it involves a 'tacking back and forth' between actors' 'subjective'

> perceptions of their "objective condition" and the "objective" historicity of the context of practice. Given his understanding of cultural action as public, Clifford Geertz might well be sympathetic with Bourdieu's insistence on practice as embedded in relations and externalities. (Foster, 1986, p. 108)

Culture as Practice

Bourdieu's central concern is developing an alternative approach to two dominant extremes of social theory; one in which action is the mechanical ratification of learned cultural rules or internalized values, the other in which action is purely self-interested, unconstrained by normative values or other mental structures (D'Andrade, 1995). He focused on the relationship between culture and power, and questioned how stratified social systems of hierarchy and domination persist and reproduce intergenerationally without powerful resistance (Edles, 2001).

Bourdieu refers to Karl Marx for the notion that societies are structured and people are located in class positions, that this position gives them certain interests, and that their interpretive actions are often in the form of ideologies designed to legitimate these interests (Turner, 1998). Furthermore actors that are in a certain class share particular modes of classification, appreciation, judgment, perception, behavior or in sum the cultural know – how (Turner, 1998; Edles, 2001). Bourdieu defines this mediation process between class and generative scheme of individual dispositions as habitus.

In this sense habitus is the collective unconscious of the people that share similar positions within the structure of the society. Habitus provides emotional and cognitive guidelines that enable individuals to make sense of the world in common ways providing flexibility for new contexts instead of enacting the same structure over and over again (Quinn and Strauss n.d.: cited from D'Andrade, 1995).

Bourdieu’s point is not to say that people internalize habitus like Parsons’ agents internalize shared values. For Beurdieu, habitus constitutes fuzzy rules like “feeling of the game” or “practical sense” that allow people to generate infinite number of strategies for infinite number of situations. Furthermore dispositions in the habitus are adjusted to the social surroundings in which they emerge hence are not coherent throughout the society (Edles, 2001).

Habitus is an analytical construct that constitutes the cornerstone of culture as practice approach. Indeed in *Distinction*, Bourdieu (1984, p.468) defines his research objective as identifying “the cognitive structures which social agents implement in their practical knowledge of the world [and which] are internalized”.

> Because of common histories, members of each ‘class fraction’ share a similar habitus, creating regularities in thought, aspirations, dispositions, patterns of appreciation, and strategies of action that are linked to the positions persons occupy in the social structure they continually reproduce. (DiMaggio and Powell, 1991, p. 26)

Furthermore, habitus is also located as a solution attempt for one of the canonical debates of social science that distinguishes between macrosocial structures and microsocial behaviors (Thevenot, 2001). In this respect habitus is the correlation between the class hierarchy and the cultural objects, preferences and behaviors of those located at particular ranks in the hierarchy (Turner, 1989).

Although habitus constitutes shared practices like routines of individual actors, their habits, dress, food, musical taste, Bourdieu employs habitus concept to focus on social stratification rather than social integration. In this respect habitus also refers to taken for granted criteria that separate one category of person or event from another, art from what is not art, the sane from the mad or the legitimate from not legitimate (Swidler, 2001). Thus, Bourdieu defines the fundamental generative function of habitus; the class struggles over capital.

Bourdieu distinguishes four types of capital (Turner, 1998):

1. Economic capital: Productive property (money and material objects that can be used to produce goods and services)
2. Social capital: Positions and relations in groupings and social networks
3. Cultural capital: Informal interpersonal skills, habits, manners, linguistic styles, educational credentials, tastes, life styles.
4. Symbolic capital: The use of symbols to legitimate the possession (control) of varying levels and configurations of the other three types of capital.

Different types of capital can be converted into one another, but only to a certain extend and depends on parities which are functions of gross sums of capitals within the population. "The overproduction of academic qualifications, for example, can decrease the convertibility of educational into economic capital (credential inflation)" (Turner, 1998, p.511). Similarly, economic capital can be converted into social capital through struggles over control in the political arena. The distribution of these capitals determines the class structure of the social system. Each class also constitutes factions distinguished by (1) the distribution profile of their capital and (2) the social origin of families that have possessed a particular profile of capital resources for a period of time.

At this point Bourdieu takes another radical step and propose that actors in the society objectively conceive their social status designated by the class they belong to. Consequently actors are allowed to pursue class objective, independent goals or ends, constraint with class specific means. In this regard, while in the economy actors struggle for economic capital, Bourdieu makes it clear that there is also a cultural struggle for distinction to legitimate and reproduce economic capital:

“So closely intertwined is culture with the economy that Bourdieu conceives society as social field or space formed by intersection of the economic and cultural fields” (Gaartman, 2002, p. 257).

Consequently symbols become self-imposing cultural deep structures of stratified models of actors who contest for alternative meanings and interpretations rather than assuming symbols have unanimous and unproblematic meanings (Robb, 98). Hence for Bourdieu, cultural goods are primarily responsible to legitimize class distinction and cultural patterns provide the structure against which individuals can develop particular strategies.

Following Bourdieu, Swidler’s (1984) culture as a toolkit approach focuses on the subjectivity of meanings in such a way that, actors are allowed to construct and reconstruct meanings for symbols and use them strategically to pursue their own goals.

> …culture has an effect in that the ability to put together such a strategy depends on the available set of cultural resources. Furthermore, as certain cultural resources become more central in a given life, and become more fully invested with meaning, they anchor the strategies of action people have developed. (p. 281).

Thus, for Swidler, unlike Geertz’s coherent conception of symbol and meanings, cultures contain diverse, often conflicting symbols, rituals, stories, and guides to action. She solidifies her conception of culture by “The reader of Bible can find a passage to justify almost any act,…” and argues that a culture is not a uniform system that pushes action in a consistent direction.

> Rather it is more like a ‘toolkit’ or repertoire from which actors select differing pieces for constructing lines of action…People may have in readiness cultural capacities they rarely employ; and all people know more culture than they use. (p. 277)

Interim Conclusion

The basic concepts of traditional culture sociology; Weber's "ideas" and Parsons' "values" have been considered as deriving motives for shaping social action (Warner, 1978). Both theorists established these concepts in an attempt to define the "goals" that the social actors; whether individual or collective would pursue. In Weber's and Parsons' perspective the cognitive nature of agents and particularly the decision making process are quite similar to the cognitive nature of agents presumed in Rational Choice Theory. The fundamental point of divergence was due to the subjective nature of social actors introduced by cultural elements via "ideas" or "values" (Swidler, 1986, 2001; Warner, 1978). Thus, the Voluntaristic Action Theory of Parsons which derives from "values" and Weber's famous switchman metaphor have been constructed in this logic (Weber, 1946, p.280: cited from Swidler, 1986; Parsons and Shils, 1951).

Weber stressed the importance and independence of "ideas" in social actions (Swidler, 2001). Whereas, Parsons constructed a sophisticated framework to analyze the causal interaction of material and biological factors with cultural values. Swidler provides an example to facilitate the causal interaction in Parsonian Voluntaristic Action Theory. In her example architect's plans (cultural values) provide information about how to build a house,

> …but which cannot, by themselves, provide shelter, or even cause a house to be built. Other causal factors … like the pile of bricks, boards, mortar and energy of a worker (are) necessary to build a house. But without some input information, these are no more likely to become a house than to become a wall, a set of projectiles or simply an impediment. (p. 77)

Hence although material factors like are necessary conditions for action, "ideas" or "values" direct action. On the other hand, latest developments in cognitive psychology and especially increased interest of this branch towards culture, produced numerous results that demonstrate the nonexistence of a coherent structure like "values" or "ideals" within human cognition (DiMaggio, 1997). Even though these cognitive structures are assumed to exist, in the preceding paragraphs it is argued that for some concrete methodological issues it is infeasible to justify the theory with empirical support. Thus, embedding culture, the cause of social action, within human brain bereaved culture studies from observable objects. Last but not the least, Swidler (1986) objects to the very idea that culture causes action by setting goals or ends for action:

> If culture influences action through end values, people in changing circumstances should hold on to their preferred ends while altering their strategies for attaining them…Does culture account for continuities in action independent of structural circumstances? It does, but…if culture plays the independent causal role Weber attributed to it, it must not change more easily than the structural and the economic patterns it supposedly shapes. (p. 278).

In this respect Swidler (2001) suggests a joint approach of culture as symbol and culture as practice and argues that such an approach provides solution to the intrinsic problems of culture studies. First, she employed culture as practice perspective in order to emphasize culture is not inside the head of actors but it is within the practices as routines of individual actors, in their habits, in their taken for granted sense of space, dress, food, musical or in brief, in the social routines actors know so well as to be able improvise spontaneously without a second thought (Bourdieu, 1974, 1986: cited from Swidler, 2001). According to Swidler, "Practice theory moves the level of sociological attention 'down' from conscious ideas and values to the physical and the habitual." (p. 75).

However, in order to decode and describe social practices, impersonal arena of discourse or space of symbols were required. Yet these were readily available in culture as symbols perspective. The critical role played by culture as symbol perspective is not describing contents of practices, but rather this perspective constitutes system of meanings that allows actors to say anything meaningful at all or to make sense to each other.

Thus defining culture as symbols and practices within interactions of actors emancipated culture from individual subjectivism of "ideas" and "values" and provided observable objects such symbols or practices in either micro or macro scale to the disposal of culture studies.

In this regard Sewell (1999) develops Swidler's argument one step further[16] stating that the important question is not whether culture should be conceptualized as practice or as a system, but how to conceptualize the articulation of system and practice. Sewell proposed a dynamical framework of culture as system and practice particularly focusing on actor and structure relationships from a semiotic dimension. In the next section Sewell's framework will be introduced in detail since this is the framework implemented in this thesis.

Sewell's Framework of Culture as System of Meanings and Practice

Sewell start explaining his framework by listing his assumptions explicitly about social structure, and aspects of culture; practices and symbols. In his first assumption he states that practice is structured both by meaning and by other aspects of the environment such as power relations, spatiality or resource distribution. Second, he assumes that culture does not refer to particular practices or practices that take place in a particular social location. It is rather the semiotic dimension of human social

[16] Although reference dates of Sewell (1999) and Swidler (2001) seem contradictory with the meaning of the sentence, Swidler was highly influenced with Sewell's earlier articles especially from Sewell's 1995 article.

practice in general. Thus he discriminates three dimension of practice. In his third assumption, although he considers these dimensions of practice as relatively autonomous from each other but still assume that they shape and constrain each other.

First two assumptions of Sewell are quite clear but his third assumption requires clarification as Sewell himself also does. Cultural dimension of practice is autonomous from other dimension in two senses. First, he stresses that semiotic structuring of culture is different from political, economic and geographical structures that also inform practice. In this regard even if an action is determined to a large extent by economic sources, these sources would still have to be decoded into a meaning according to a semiotic logic.

> For example, an impoverished worker facing the only manufacturer seeking laborers in that district will have no choice but to accept the offer. Yet in accepting the offer she or he is not simply submitting to the employer but entering into a culturally defined relegation as a wageworker. (p. 48)

Second, the meanings that constitute the cultural dimension are shaped and reshaped by a multitude of other contexts. Therefore, Sewell emphasize that the meaning of a symbol always transcends any particular context. Similar to the habitus concept of Bourdieu (1984), symbol is freighted with its usages in a multitude of other instances of social practice.

> Thus our worker enters into a relationship of 'wageworker' that carries certain recognized meanings – of deference, but also independence from the employer and perhaps solidarity with other wageworkers. (p. 48).

Hence the meaning of wageworker is determined as a conjoint effect of all its meaning in different contexts such as instances of hiring, statues, legal arguments, strikes, socialist tracks and economic treaties. Then they define possibilities of practice, "…in this case perhaps granting the worker greater power to resist the employer than the local circumstances alone would have dictated." (p. 49).

Here Sewell underscores that culture should not only be conceptualized as a constraining factor. In certain situations culture with its aspects may enlarge the perspectives of actors. For Sewell, culture is a network of semiotic relations cast across society, a network with a different shape and different characteristic than institutional, or economic, or political networks.

After explicitly stating his assumptions regarding the symbol and practice aspects of culture, Sewell focuses on explaining semiotic logic of culture. He asserts that since culture has a distinct semiotic logic than it must in some sense be coherent. However, the level of coherence Sewell has in mind leads to label it as "thin coherence":

> …the users of culture will form a semiotic community – in the sense that they will recognize the same set of oppositions and therefore be capable of engaging in mutually meaningful symbolic action. (p. 49)

Thus in order to make sense to some actor, it is not necessary to be endowed with exactly same meaning system. Recognizing the same set of oppositions is less than requiring even a similar meaning system. Sewell emphasize that he is actually offering a deconstructionist argument which cultural analysts often drawn back from but which has been useful in explaining the instability in the signifying mechanism of language itself:

> …deconstructionist understanding of meaning is essential for anyone attempting to theorize cultural change. Deconstruction does not deny the possibility of coherence. Rather it assumes that the coherence inherit in a system of symbols is thin in the sense I have described: it demonstrates over and over that what are taken as the certainties or truths of texts or discourses are in fact disputable and unstable. This seems entirely compatible with a practice perspective on culture. (p. 50)

Thus the meaning of a sign or symbol is a function of its network of oppositions to or distinctions from other sign system. This implies that the space of symbols is not partitioned by set of meanings. While, generally a meaning set contains more than one symbol it may also be the case that a symbol is contained by more than one meaning set. However in the later case two meanings containing the same symbol can not be negations of each other. This concludes that a symbols system may correspond to more than one meaning system, up to the restriction that distinctions and oppositions are maintained. Sewell's point here is that, a semiotic community shares a dictionary of meanings for symbols and when you open up for a symbol you read the opposing symbols.

For instance, assume a very simple symbol system that constitutes five symbols: $\boldsymbol{S} = \{s_1, s_2, s_3, s_4, s_5\}$. Further assume that a user of culture in such a semiotic community responds to each symbol in a way that s_4 refers to a meaning that opposes with the meaning $\{s_1, s_2, s_3\}$ refers to and that s_5 seems to refer to a distinct meaning. Then two agents with visually two different meaning systems such as $\{\{s_1, s_2, s_3\}, \{s_4\}, \{s_5\}\}$ (Figure 10) and $\{\{s_1, s_2, s_3\}, \{s_4\}, \{s_2, s_5\}\}$ (Figure 11) would engage in mutually meaningful symbolic action since they recognize same set of oppositions.

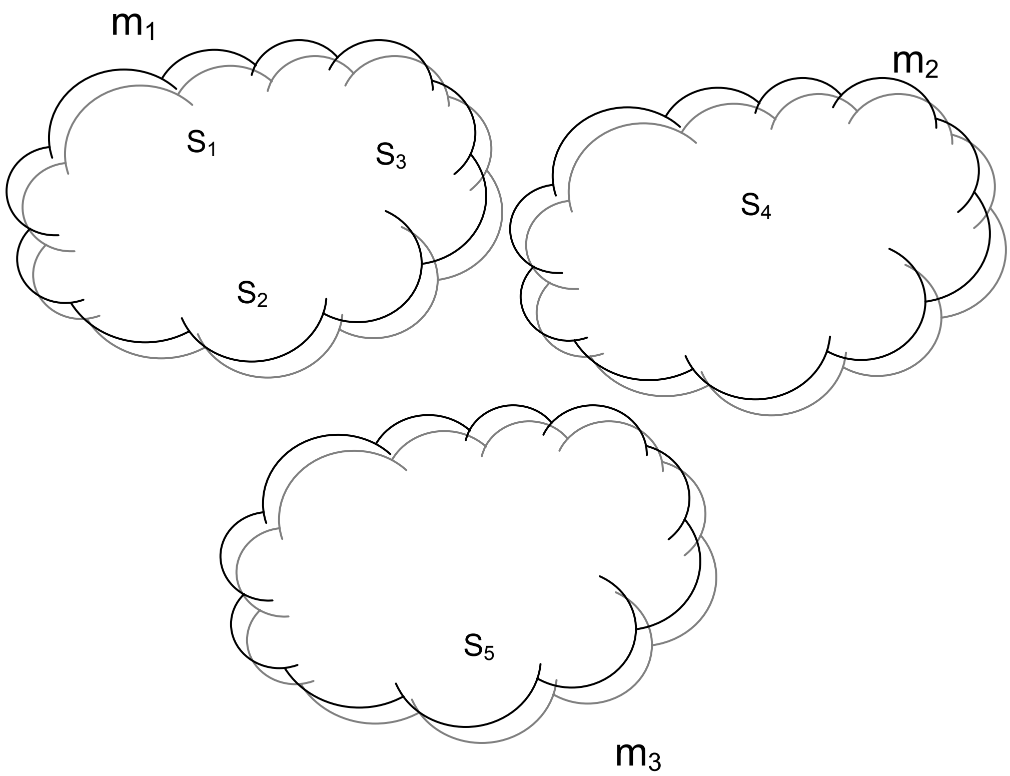


Figure 10. An example of a meaning collection : $\{\{s_1, s_2, s_3\}, \{s_4\}, \{s_5\}\}$ in a semiotic community that uses the symbol system $\boldsymbol{S} = \{s_1, s_2, s_3, s_4, s_5\}$.

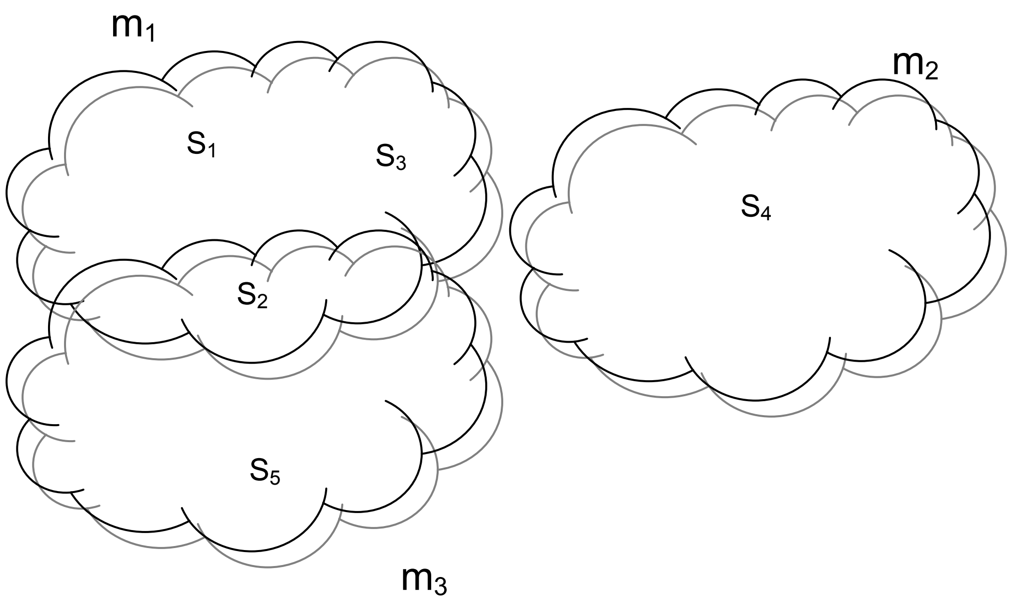


Figure 11. An example of a meaning collection : $\{\{s_1, s_2, s_3\}, \{s_4\}, \{s_2, s_5\}\}$ in a semiotic community that uses the symbol system $\boldsymbol{S} = \{s_1, s_2, s_3, s_4, s_5\}$.

The cultural framework defined by Sewell so far fulfills the requirements of a necessary theoretical background to build a cultural model in order to study the dynamics that constitute embedded social networks. Although Sewell did not attempt to formalize the mechanisms of actor interactions, he states that actors interact with making use of symbols. This symbolic interaction plays the critical role of subsuming a system of meanings that allows actors to understand each other.

All actors in a population share a common symbol system. However actors diverge from each other by their interpretations of symbols which are also called the belief systems. These belief systems generate meanings as sets of symbols, but how?

In constructionist logic, a belief system consists of symbols that are equivalent to each other. Thus actor specific equivalence relations can be constructed which also defines a partition over the set of symbols. This simple process can be achieved by defining agent based binary equivalence relation ***B***(~) over the set of symbols $\boldsymbol{S} = \{s_1, s_2, ..., s_n\}$.

1. ***B***(~) is reflexive: $\forall s_i \in \mathbf{S},\ s_i \sim s_i \in \boldsymbol{B}$.
2. ***B***(~) is symmetric: $\forall s_i, s_j \in \boldsymbol{S}, s_i \sim s_j \in \boldsymbol{B} \Rightarrow s_j \sim s_i \in \boldsymbol{B}$.
3. ***B***(~) is transitive: $\forall s_i, s_j, s_k \in \mathbf{S},\ \textit{if}\ \ s_i \sim s_j\ \textit{and}\ s_j \sim s_k \in \boldsymbol{B}, \textit{then}\ s_i \sim s_k \in \boldsymbol{B}$

A well known theory in algebra guarantees the existence of equivalence classes $\overline{s_i} = \{s_j \mid s_i \sim s_j \in \boldsymbol{B}\}$ for all $s_i \in \boldsymbol{S}$. These classes not only define a partition over ***S***, but also generate sets of meanings.

On the contrary, deconstructionist logic is more complicated and does not imply well defined partitions by which meanings can be generated. Furthermore in a deconstructionist algebra which is not necessarily transitive, one may not end up with a partition at all and the situation gets even more complicated. A deconstructionist algebra has been developed and explained in detail in the next chapter but the current point related to this algebra is that instead of equivalence classes, opposition classes generate meanings.

In this regard, when two actors interact, they make sense of a particular symbol by using their meanings sets and mutual understanding depends on the coherence (not necessarily equivalence) of each actor's evoked meaning sets. Consequently, the outcome of mutual understanding is not dichotomous as success or failure, but has varying degrees. Retrospectively, repeated interactions of agents imply that actors' interpretations of symbols are largely coherent.

In sum, initiation and stability of interactions between actors is a function of binary opposition relations of actors defined over the symbol set. However the formal setup and the implementation of these mechanisms are explained in detail in the next chapter.

CHAPTER 4

A DECONSTRUCTIONIST ALGEBRA OF SEMIOTIC LOGIC

Sewell (1999) proposed a dynamical framework of culture as system and practice particularly focusing on actor and structure relationships from a semiotic dimension. For Sewell as well as Swidler (1997), semiotic dimension defines the impersonal arena of discourse in such a way that it constitutes a system of meanings that allows actors to say anything meaningful at all or to make sense of each other. In this way, culture is a network of semiotic relations cast across society, a network with a different shape and different characteristic than institutional, or economic, or political networks.

The nature of the network of semiotic relations constitutes the interrelationship between symbols, meanings and practices. The basic element of this network is symbols and it is assumed that they exist and that they are everywhere; there is no instance of social life that is free of symbols. Sewell explains the relationship between meanings and symbols in a roughly[17] Saussurian way. Sewell states that the meaning of a symbol is a function of its network of oppositions to or distinctions from other symbols in the system. The entire thrust of this deconstructionist argument has been to reveal the instability of linguistic meaning.

> It has located this instability in the signifying mechanism of the language itself – claiming that because the meaning of a linguistic sign always depends on contrast with what the sign is opposed to or different from, language is inevitably haunted by the traces of the very terms it excludes. Consequently, the meaning of a text or utterance can never be fixed; attempts to secure

[17] At a footnote (1999, p. 60) Sewell clarifies that he is not adopting a full scale deconstructionist position but rather he is appropriating from deconstruction specific ideas that he finds useful.

meaning can only defer, never exclude, a plethora of alternative or opposed interpretations. (p. 50)

Then, the users of culture will form a semiotic community – in the sense that they will recognize the same set of oppositions and therefore be capable of engaging in mutually meaningful symbolic action. Sewell's point here is that, a semiotic community shares a dictionary of meanings for symbols such that when the dictionary is opened up for a symbol you read the opposing symbols for that symbol.

The meaning of a symbol in a given context may be subject to redefinition by dynamics entirely foreign to that institutional domain or spatial location. Thus, the meaning of a symbol always transcends any particular context in which they are employed because symbol is freighted with its usages in a multitude of other instances in social practice. Consequently a symbol might refer to a multitude of meanings and also a meaning might correspond to a set of symbols (Figure 12).

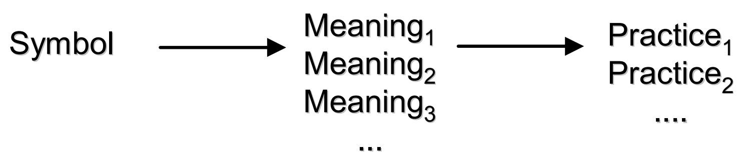


Figure 12. A symbol might refer a multitude of meanings and also a meaning might correspond to a set of symbols.

To me it is quite surprising that there is no algebraic model in the literature which focuses on sets in a deconstructionist framework. However the culture study explained by Sewell heavily depends on such a structure. El Guindi and Read (1979) offered an algebra of oppositions but left its development premature and low dimensional[18] and passed on an analysis on structural isomorphisms which currently are not related to the concept of this thesis. Therefore in the remaining part of this

[18] See Condition (3) in El Guindi and Read (1979, p.769).

chapter, an algebra on symbols and meanings correspondence in a deconstructionist framework is developed.

Symbol Systems – Opposition Relations - Meanings

<u>Opposition Relations</u>

A symbol set $\Sigma := \{s_1, s_2, ..., s_p\}$ consists of a finite number of symbols. An opposition relation '*O*' is a binary relation defined over $\Sigma \times \Sigma$ and satisfies the following properties[19]:

i. For all $s_m \in \Sigma$, $s_m \circ s_m \notin O$. That is the relation is *not* reflexive.
ii. For any $s_m, s_n \in \Sigma$, if $s_m \circ s_n \in O \rightarrow s_n \circ s_m \in O$. The relation is symmetric.

It is important to note that *O* does not necessarily satisfy transitivity property such that if $s_i \circ s_j \in O$ and $s_j \circ s_k \in O$ do not immediately imply $s_i \circ s_k \in O$. Any opposition relation, for instance $O_{example}$ can be represented as an undirected graph $O^G_{example}$ as shown[20] in Figure 13. In such an undirected graph, nodes represent symbols and links represent the opposition relation $O_{example}$. Figure represents an

[19] El Guindi and Read (1979, p.769) defined an opposition relation with i and ii and as third condition they stated if $s_i \circ s_j \in O$ and $s_i \circ s_k \in O$ then *j=k.* This implies that their opposition relation is strictly defined on a two dimensional opposes/same scale. The opposition relation algebra defined in this section is not limited in dimension.
[20] All graphs in this chapter has been obtained from MATLAB 2007a using Bioenformatics toolpack. As of April 2007 there are no graph theory toolpacks implemented for MATLAB.

opposition relation for a symbol set $\Sigma_{example} = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9\}$. From the figure we read that $s_2 \circ s_8 \in O$, or in other words *symbol 2* opposes *symbol 8*. Using a basic graph theoretical result we can also show this graph as a symmetric matrix $\boldsymbol{O}_{example}$ (Figure 14).

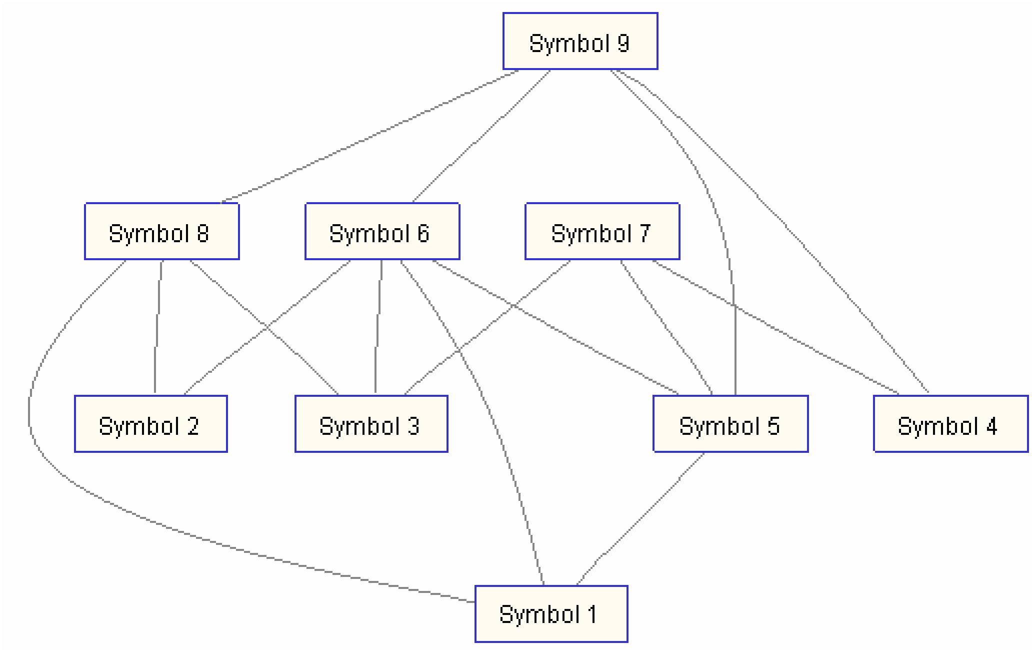


Figure 13. Undirected graph representation $O^G_{example}$ of the opposition relation $O_{example}$.

$$\boldsymbol{O}_{example} = \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 1 & 0 \end{bmatrix}$$

Figure 14. Symmetric matrix representation $\boldsymbol{O}_{example}$ of the opposition relation $O_{example}$.

Formally, i^{th} row or i^{th} column of ***O*** represents the *opposition class* $\overline{s_i} = \{s_j \mid s_i \circ s_j \in O\}$ which consists of all opposing symbols of s_i. For instance, $\overline{s_2} = \{s_6, s_8\}$ or $\overline{s_9} = \{s_4, s_5, s_6, s_8\}$.

Hence by symmetricity property of the opposition relation *O*, we easily obtain if $s_j \in \overline{s_i}$ then $s_i \in \overline{s_j}$. A collection of sets $X = \{x_1, x_2, \ldots x_g\}$ where each $x_i \subseteq \Sigma$ is said to be a cover[21] of Σ, if for all symbols $s \in \Sigma$ there exist at least one $x_i \in X$ such that $s \in x_i$. For instance, $X_{example} = \{\{s_1, s_4, s_5\}, \{s_2, s_3, s_4, s_8\}, \{s_3, s_7\}, \{s_6\}, \{s_4, s_9\}\}$ is a *cover* for $\Sigma_{example}$.

Meaning Collection

A *meaning collection*, $M = \{m_1, m_2, \ldots, m_q\}$ for (Σ, O) is a cover of Σ, such that if a symbol $s \in m_i$ then $\overline{s} \cap m_i = \varnothing$ for some opposition relation *O*. Stated otherwise no opposing symbol pairs can attain the same meaning. Clearly the trivial meaning collection is symbols as meanings. A meaning collection for $(\Sigma_{example}, O_{example})$ is $M_{example} = \{\{s_1, s_3\}, \{s_1, s_7\}, \{s_4, s_5, s_8\}, \{s_6, s_8\}, \{s_2\}, \{s_9\}\}$. Since $\bigcup_{m_i \in M_{example}} m_i = \Sigma_{example}$, $M_{example}$ is a cover of $\Sigma_{example}$. Furthermore for each set in $M_{example}$, there are no pairwise opposing symbols or in other words there are no links between any two symbols in $O^G_{example}$ for all elements of $M_{example}$.

It is crucial to note that, following Sewell's arguments, some symbols might receive a meaning after conjoining with another symbol such as $\{s_1, s_3\}$. Whereas some symbols might have meanings on their own such as $\{s_2\}$. The meaning

[21] This is the general definition of a 'cover' of a set but it has been particularized to the symbol set.

collection $M_{example}$, respects Sewell's assertion that symbols attain meaning with reference to their networks of oppositions or distinctions. In the example, if we focus on s_1 in $O^G_{example}$, we see that it opposes to s_5, s_6 and s_8. Thus $m_1 = \{s_1, s_3\}$ is constructed in relation or by reference to the network of meanings that include s_5, s_6 and s_8 which are m_3 and m_4. This is obviously true for all symbols in $\Sigma_{example}$. Hence meaning construction is not a linear or decomposable, step by step algorithm. It is necessary to evaluate the structure of oppositions all at once. Clearly, $M_{example}$ is not the unique meaning collection for $\Sigma_{example}$. It may be the meaning set of an arbitrary agent and another agent might have a completely different meaning collection for the same symbol system. So these two agents might attach different meanings to symbols but still these meanings refer to same oppositions.

If all agents in a group construct their own meaning collections over the symbol system $\Sigma_{example}$ with respect to the same opposition relation $O_{example}$, represented in $O^G_{example}$, then this group with probably different meaning collections becomes a semiotic community.

Meaning Generating Set

As it has been stated previously, construction of a meaning collection problem cannot be decomposed into sub-problems and therefore it is computationally expensive. In order to attach a meaning to a symbol one needs to check that symbol's oppositions and then the oppositions of the oppositions' and so on. Hence trying to construct a meaning collection in this manner is clearly obsolete. In this regard the following theorem constitutes the analytical backbone of this thesis. It systematizes meaning collection construction for a given symbol system. The principle idea is developing a set of base sets by which all meaning collections can be constructed;

more or less in the same manner one can construct any vector in a vector space by using unit vectors. This base set is called the meaning generating set.

Given an opposition relation O, over a set of symbols Σ, a meaning generating set, $\boldsymbol{M} = \{\boldsymbol{m_1}, \boldsymbol{m_2}, ..., \boldsymbol{m_k}\}$ consists of subsets $\boldsymbol{m_i} \in \Sigma$ such that for any meaning collection *M* of Σ, and for any $m_i \in M$, there exist at least one $\boldsymbol{m} \in \boldsymbol{M}$ such that $m_i \subseteq \boldsymbol{m}$ and for any $p \neq q$, $\boldsymbol{m_p}$ is not a proper subset of $\boldsymbol{m_q}$.

Intuitively, the elements of meaning generating set ***M*** are sets of symbols like all meaning collections. Also if *M* is an arbitrary meaning collection and for any $m_i \in M$, m_i cannot contain any $\boldsymbol{m_i} \in \boldsymbol{M}$. In fact the inverse of this is true such that for any $m_i \in M$, there exists at least one $\boldsymbol{m} \in \boldsymbol{M}$ such that $m_i \subseteq \boldsymbol{m}$. The following theorem not only guarantees the existence of a meaning generating set for any symbol set and binary opposition relation pair but also proves that this set is unique. After the proof of the theorem there is a step by step demonstration of the construction of the meaning generating set over an example.

Theorem : Any opposition relation *O* over a set of symbols Σ defines a unique meaning generating set ***M*** for (Σ, O).

Proof:

The proof constructs set ***M*** and shows that it is unique. Let ***O*** define the matrix representation of the opposition relation. Define $\boldsymbol{K} = I - \boldsymbol{O}$, where *I* is the identity matrix. Clearly, ***K*** matrix represents non-opposing symbols. Furthermore define ***G*** as the graph representation of ***K***.

Proof continues in graph theory framework. Construct ***M*** such that $\boldsymbol{m} \in \boldsymbol{M}$ if and only if ***m*** is a clique in ***G***. A clique ***C*** of a graph is a complete sub-graph such that there is no other complete sub-graph ***C`*** in ***G*** such that ***C*** is a proper sub-graph of ***C`***. Intuitively, cliques are the largest complete sub-graphs of a graph.

Thus each element of ***M*** contains cliques as sets of nodes. It has been previously shown by Luce and Perry (1949) that the set of cliques of a graph is unique and is a cover. Therefore ***M*** is unique and is a cover of Σ.

It only remains to show that if *M* is any meaning collection of Σ, and $m_i \in M$ then $m_i \subseteq \boldsymbol{m}$ for some $\boldsymbol{m} \in \boldsymbol{M}$. In other words any meaning collection contains sets that are subsets of some elements of ***M***. Since there can be no opposing pairs within m_i, it follows that a non-opposing graph representation of m_i is a complete sub-graph of ***G***. If m_i is not contained properly in another complete sub-graph then m_i is a clique so, $m_i \in \boldsymbol{M}$. On the other hand if m_i is not a clique then it must be contained in some clique $\boldsymbol{m} \in \boldsymbol{M}$ such that $m_i \subseteq \boldsymbol{m}$.

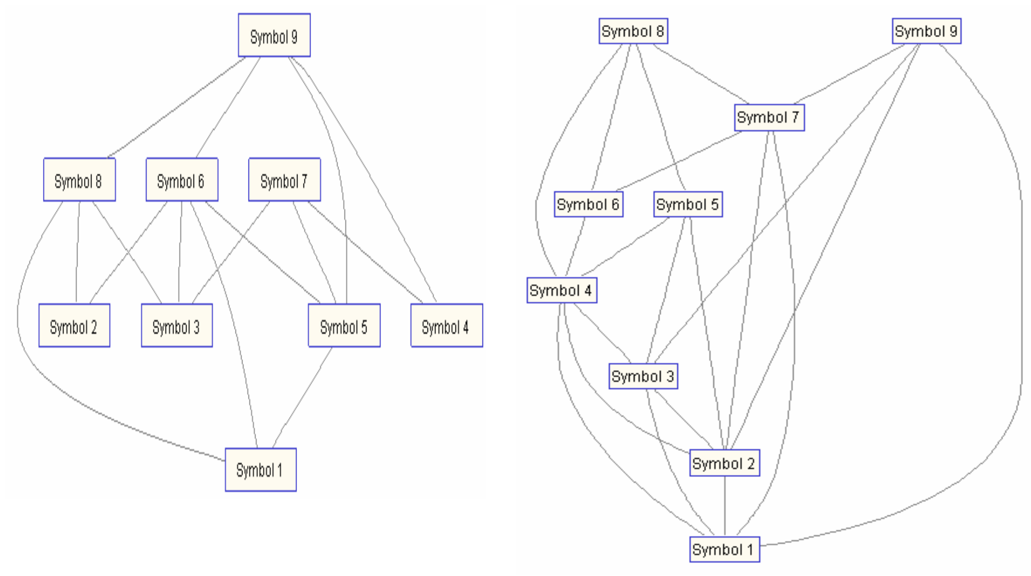
Q.E.D.

Next, a step by step visualization of the proof is demonstrated using the example $\left(\Sigma_{example}, O_{example}\right)$. In order to refresh the notation; $\Sigma_{example}$ denotes a set of symbol or in other words a symbol system that constitutes nine symbols.

$$\Sigma_{example} = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9\}$$

$O_{example}$ corresponds to a binary opposition relation over $\Sigma_{example}$. This opposition relation can be represented by using a graph $O^G_{example}$ in which nodes are symbols in $\Sigma_{example}$ and links are relations in $O_{example}$. This graph has been represented previously in Figure 13.

Proof constructs a new graph $\boldsymbol{G_{example}}$ by complementing $O^G_{example}$. In other words there is a link between two nodes in $\boldsymbol{G_{example}}$ if and only if these two nodes are not linked in $O^G_{example}$. Figure 15 demonstrates $O^G_{example}$ and $\boldsymbol{G_{example}}$.



$O^G_{example}$ $\boldsymbol{G}_{\boldsymbol{example}}$

Figure 15. Graph representation of opposition relation $O^G_{example}$ (left picture) and graph representation of complement of $O^G_{example}$ (right picture).

In the graph $\boldsymbol{G}_{\boldsymbol{example}}$ self loops are pruned for the sake of clear display. In the $\boldsymbol{G}_{\boldsymbol{example}}$ graph the link between *Symbol 1* and *Symbol 2* implies that these two symbols are not opposing symbols. Check that this link is not present in $O^G_{example}$. Shapes of the graphs $O^G_{example}$ and $\boldsymbol{G}_{\boldsymbol{example}}$ are different for optimal topological display.

The meaning generating set $\boldsymbol{M}_{\boldsymbol{example}}$, is constructed using $\boldsymbol{G}_{\boldsymbol{example}}$. An element of $\boldsymbol{M}_{\boldsymbol{example}}$ is a set of symbols that defines a clique in $\boldsymbol{G}_{\boldsymbol{example}}$. In other words every element of $\boldsymbol{M}_{\boldsymbol{example}}$ is a set of nodes in $\boldsymbol{G}_{\boldsymbol{example}}$ and for any such set in $\boldsymbol{M}_{\boldsymbol{example}}$ the nodes in this set with their links to each other is a clique in $\boldsymbol{G}_{\boldsymbol{example}}$. For instance, the set $\{s_1, s_2, s_3, s_4\}$ is a clique of $\boldsymbol{G}_{\boldsymbol{example}}$ because all elements are linked to each other (Figure 16), so that it is a complete sub-graph but also no other set that contains $\{s_1, s_2, s_3, s_4\}$ is a complete sub-graph. If we check for $\{s_1, s_2, s_3, s_4, s_5\}$ we see that there is no link between s_1 and s_5, so $\{s_1, s_2, s_3, s_4, s_5\}$ is not a complete sub-graph in $\boldsymbol{G}_{example}$.

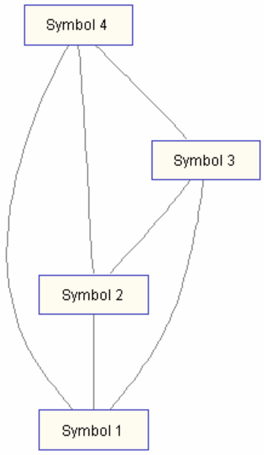


Figure 16. $\{s_1, s_2, s_3, s_4\}$ set as a clique.

There is no link between s_1 and s_5, because with respect to $O_{example}$, s_1 and s_5 opposes each other or formally, $s_1 \circ s_5 \in O_{example}$. Same is true for other sub-graphs that contain $\{s_1, s_2, s_3, s_4\}$ properly. So $\{s_1, s_2, s_3, s_4\}$ is a clique and for that reason it is an element of $\boldsymbol{M}_{example}$. Furthermore although $\{s_1, s_2, s_3\}$ is also a complete sub-graph but since $\{s_1, s_2, s_3\} \subset \{s_1, s_2, s_3, s_4\}$ properly, $\{s_1, s_2, s_3\}$ is not a clique so it can not be an element of $\boldsymbol{M}_{example}$. In that way one can construct $\boldsymbol{M}_{example}$ by adding the cliques found in $\boldsymbol{G}_{example}$. $\boldsymbol{G}_{example}$ contains 50 complete sub-graphs, but only seven of these are cliques.

The set of all cliques $\boldsymbol{C}_{example}$ in $\boldsymbol{G}_{example}$ are,

$$\boldsymbol{C}_{example} = \left\{ \begin{array}{l} \{s_1, s_2, s_3, s_4\}, \{s_1, s_2, s_3, s_9\}, \{s_1, s_2, s_7, s_9\}, \\ \{s_2, s_3, s_4, s_5\}, \{s_4, s_5, s_8\}, \{s_4, s_6, s_8\}, \{s_6, s_7, s_8\} \end{array} \right\}$$

Then theorem asserts that $\boldsymbol{M}_{\boldsymbol{example}}$ set is equal to the set of all cliques $\boldsymbol{C}_{\boldsymbol{example}}$, and then $\boldsymbol{M}_{\boldsymbol{example}} = \{\boldsymbol{m_1}, \boldsymbol{m_2}, \boldsymbol{m_3}, \boldsymbol{m_4}, \boldsymbol{m_5}, \boldsymbol{m_6}, \boldsymbol{m_7}\}$, where

$$\boldsymbol{m_1} = \{s_1, s_2, s_3, s_4\},\ \boldsymbol{m_2} = \{s_1, s_2, s_3, s_9\},\ \boldsymbol{m_3} = \{s_1, s_2, s_7, s_9\},$$
$$\boldsymbol{m_4} = \{s_2, s_3, s_4, s_5\},\ \boldsymbol{m_5} = \{s_4, s_5, s_8\},\ \boldsymbol{m_6} = \{s_4, s_6, s_8\},\ \boldsymbol{m_7} = \{s_6, s_7, s_8\}$$

Luce and Perry (1949) showed that the set of cliques of any graph is unique and covers that graph. So far $\boldsymbol{M}_{\boldsymbol{example}}$ set has been constructed and its uniqueness is guaranteed.

Theorem also says that $\boldsymbol{M}_{\boldsymbol{example}}$ generates all meaning collections. For a demonstration consider an arbitrary meaning collection such as;

$$M_{example} = \{\{s_1, s_3\}, \{s_1, s_7\}, \{s_4, s_5, s_8\}, \{s_6, s_8\}, \{s_2\}, \{s_9\}\}$$

Thus,

$M_{example} = \{m_1, m_2, m_3, m_4, m_5, m_6\}$ where, $m_1 = \{s_1, s_3\}$, $m_2 = \{s_1, s_7\}$, $m_3 = \{s_4, s_5, s_8\}$, $m_4 = \{s_6, s_8\}, m_5 = \{s_2\}$, $m_6 = \{s_9\}$

According to the theorem, for each $m_i \in M_{example}$ there exist at least one element $\boldsymbol{m_k} \in \boldsymbol{M}_{\boldsymbol{example}}$ such that $m_i \in \boldsymbol{m_k}$. This condition clearly holds for all $m_i \in M_{example}$. Then, $m_1 \subset \boldsymbol{m_1}$, $m_2 \subset \boldsymbol{m_3}$, $m_3 \subseteq \boldsymbol{m_5}$, $m_4 \subset \boldsymbol{m_6}$, $m_5 \subset \boldsymbol{m_1}$ and finally $m_6 \subset \boldsymbol{m_2}$. Hence $M_{example}$ can be constructed using the meaning generating set $\boldsymbol{M}_{\boldsymbol{example}}$ by paying only attention to the covering requirement. Actually, any set whose elements are subsets of $\boldsymbol{M}_{\boldsymbol{example}}$ and who cover $\Sigma_{example}$ is a meaning collection of $(\Sigma_{example}, O_{example})$.

Bron and Kerbosch (1973) presented an algorithm that computes all cliques of a graph and new algorithms are still being developed in computational graph theory literature. Yet, these algorithms have been developed with focus on efficiency and hardly implementable in MATLAB environment. For that reason a code is written in MATLAB that extracts the cliques of a graph. This code is presented in Appendix 3.

Implementation of the Deconstructionist Framework

Previous section is about the "construction" of meanings from symbols through a "deconstructionist" framework. However the implementation of this framework is in the reverse direction. Sewell states that "To engage in cultural practice is to make use of semiotic code to do something in the world." (p. 51). Whereas to use a semiotic code implies attaching abstractly available symbols to concrete things or circumstances and thereby posit something about them. So practices are symbolic and making sense of practices is through meanings. Sewell quotes Marshall Sahlins (1981: cited from Sewell 1999):

> …every act of symbolic attribution puts the symbols at risk, makes it possible that the meaning of the symbols will be inflected or transformed by the uncertain consequences of practice. Usually, such attributions result in only tiny inflections of the meaning of symbols. But on some occasions…novel attributions can have the result of transforming the meaning of a symbol in historically crucial ways. (p. 51)

Hence actors communicate via symbols but through meanings. This implies that actors store the symbol-meaning association not in the forms of meaning collections but actually as symbol-meaning correspondences. Thus meanings are universal for the population and only symbol – meaning associations are subjective.

For instance, consider an arbitrary agent in a population that has a symbol system, $\Sigma_{example} = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9\}$. As in the previous section let this agent develop a meaning collection $M_{example} = \{\{s_1, s_3\}, \{s_1, s_7\}, \{s_4, s_5, s_8\}, \{s_6, s_8\}, \{s_2\}, \{s_9\}\}$ for the opposition relation $O_{example}$. Meanings are universal for the population. So $\{s_1, s_3\}$ coincides to a unique meaning for the population labeled as, say, m_1. Everyone in the population know $m_1 = \{s_1, s_3\}$ but making use of this meaning is totally subjective. Same is true for all meanings in the meaning collection. For simplicity assume that the universal names for the meanings are,

$$m_1 = \{s_1, s_3\},\ m_2 = \{s_1, s_7\},\ m_3 = \{s_4, s_5, s_8\},\ m_4 = \{s_6, s_8\},\ m_5 = \{s_2\},\ m_6 = \{s_9\}$$

Then the subjective symbol – meaning correspondence for that agent, $\mathfrak{A}_{example}$ is,

$$\mathfrak{A}_{example} = \begin{pmatrix} s_1 \rightarrow \begin{pmatrix} m_1 \\ m_2 \end{pmatrix} \\ s_2 \rightarrow (m_5) \\ s_3 \rightarrow (m_1) \\ s_4 \rightarrow (m_3) \\ s_5 \rightarrow (m_3) \\ s_6 \rightarrow (m_4) \\ s_7 \rightarrow (m_2) \\ s_8 \rightarrow \begin{pmatrix} m_3 \\ m_4 \end{pmatrix} \\ s_9 \rightarrow (m_6) \end{pmatrix}$$

Thus through interaction with some other agent, our agent understands m_1 when he observes s_3 in symbolic communication. Before formalizing the full scheme of interaction which is called cultural practice, it is crucial to underscore some points about the $\mathfrak{A}_{example}$ correspondence. First, in addition to Sahlins' (1981: cited from Sewell 1999) arguments about the dynamic nature of this association, Sewell notes that:

> I would also argue that to be able to use a code means more than being able to apply it mechanically in stereotyped situations – it also means having the ability to elaborate it, to modify or adapt its rules to novel circumstances. (p. 51).

Sewell considers cultural practice – totally inline with Bourdieu (1977: cited from Sewell, 1999) and Swidler (1984) – by allowing agents to play on the multiple meanings of symbols in such a way that agents may redefine situations in ways that they believe will favor their purposes.

Hence for any agent, symbol – meaning correspondence is dynamical in nature. For that reason a symbol might not only correspond to multiple meanings but also an agent might attach a new meaning to a particular symbol or drop a meaning from it. Thus, it is crucial to implement this dynamical nature within the deconstructionist framework developed in the previous section. On the other hand as Swidler (1984) and DiMaggio (1997), Sewell also warns that roots of culture or in other words the beliefs – which is the oppositions relations in the deconstructionist framework - is not subject to a continuous evolution, but that they change only radically in a discrete manner, in the form of a cultural shock.

Rule 1: Agents are allowed to add new meanings or subtract old meanings from their symbol – meaning correspondences with the constraint that the change should not contradict with the opposition relation / meaning collection.

For the example agent that has $\mathfrak{A}_{example}$ as symbol – meaning correspondence, it is previously noted that s_3 corresponds to m_1. Through cultural practice, this agent might find appropriate to add another meaning such as m_{41} to interpret s_3, then addition of this meaning to $\mathfrak{A}_{example}$ results to a new correspondence. Hence now $s_3 \to \begin{pmatrix} m_1 \\ m_{41} \end{pmatrix}$. Since meanings are universal it must be the case that $s_3 \in m_{41}$.

Constraint in *Rule 1* says that this new addition should not contradict to the opposition relation $O_{example}$ of the agent. In other words, the extension to the meaning collection $M_{example} = \{m_1, m_2, m_3, m_4, m_5, m_6, m_{41}\}$ is still a meaning collection for $(\Sigma_{example}, O_{example})$. For instance if $m_{41} = \{s_3, s_9\}$, as a short-cut we check that $m_{41} \subseteq \boldsymbol{m_2}$, where $\boldsymbol{m_2} \in \boldsymbol{M_{example}}$ and $\boldsymbol{M_{example}}$ is the meaning generating set of $(\Sigma_{example}, O_{example})$ then addition of m_{41} to s_3 is justified and the symbol – meaning correspondence $\mathfrak{A}_{example}$ of the agent becomes:

$$\mathfrak{A}_{example} = \begin{pmatrix} s_1 \rightarrow \begin{pmatrix} m_1 \\ m_2 \end{pmatrix} \\ s_2 \rightarrow (m_5) \\ s_3 \rightarrow (m_1) \\ s_4 \rightarrow (m_3) \\ s_5 \rightarrow (m_3) \\ s_6 \rightarrow (m_4) \\ s_7 \rightarrow (m_2) \\ s_8 \rightarrow \begin{pmatrix} m_3 \\ m_4 \end{pmatrix} \\ s_9 \rightarrow (m_6) \end{pmatrix} \Rightarrow \begin{pmatrix} s_1 \rightarrow \begin{pmatrix} m_1 \\ m_2 \end{pmatrix} \\ s_2 \rightarrow (m_5) \\ s_3 \rightarrow \begin{pmatrix} m_1 \\ m_{41} \end{pmatrix} \\ s_4 \rightarrow (m_3) \\ s_5 \rightarrow (m_3) \\ s_6 \rightarrow (m_4) \\ s_7 \rightarrow (m_2) \\ s_8 \rightarrow \begin{pmatrix} m_3 \\ m_4 \end{pmatrix} \\ s_9 \rightarrow (m_6) \end{pmatrix}$$

It has been previously noted that a meaning collection covers the set of symbols. Hence in the case of a contraction in a meaning collection the cover property of a meaning collection can be damaged. As an example, if the previous agent drops m_2, then symbol s_7 would not be covered by the current meaning collection. Then in such a case it is assumed that agent automatically calls $\{s_7\}$ as a meaning.

From Sewell's arguments and especially from:

> I would also argue that to be able to use a code means more than being able to apply it mechanically in stereotyped situations – it also means having the ability to elaborate it, to modify or adapt its rules to novel circumstances. (p. 51).

it is deduced that addition or subtraction of a new meaning for a symbol is not a discrete process. This implies that an agent attaches some sort of reliability measures for each meaning of a symbol. Cultural practice might increase or decrease this reliability and according to Sahlins (1981: cited from Sewell 1999) the inflections are usually tiny. This property is recorded as a rule to the implementation of the framework.

Rule 2: Each agent in the population attaches a reliability measure to each meaning in his meaning collection. Reliability measure is inflected through cultural practice.

Thus it is necessary to modify the symbol – meaning correspondence of the example agent.

$$\mathfrak{A}_{example} = \begin{pmatrix} s_1 \rightarrow \begin{pmatrix} m_1, r_1 \\ m_2, r_2 \end{pmatrix} \\ s_2 \rightarrow (m_5, r_5) \\ s_3 \rightarrow \begin{pmatrix} m_1, r_1 \\ m_{41}, r_{41} \end{pmatrix} \\ s_4 \rightarrow (m_3, r_3) \\ s_5 \rightarrow (m_3, r_3) \\ s_6 \rightarrow (m_4, r_4) \\ s_7 \rightarrow (m_2, r_2) \\ s_8 \rightarrow \begin{pmatrix} m_3, r_3 \\ m_4, r_4 \end{pmatrix} \\ s_9 \rightarrow (m_6, r_6) \\ \end{pmatrix}$$

First two rules define the implementation of deconstructionist framework on dynamics of symbol – meaning correspondence. Cultural practice on the other hand is about when these rules are triggered. The basic element of cultural practice is semiotic code. Sewell refers semiotic code in multiple instances in his arguments as follows. (All emphasis in the quotations listed below are mine.)

Quotation A1: Culture is neither a particular kind of practice nor practice that takes place in a particular social location. It is, rather, the *semiotic* dimension of human social practice in general. (p. 48)

Quotation A2: …culture has a *semiotic* structuring principle that is different from the political, economic, or geographical structuring principles that also inform practice. Hence even if an action were almost entirely determined by, say, overwhelming disparities in economic resources, those disparities would still have to be rendered meaningful in action according to a *semiotic* logic – that is, in language or some other form of symbols. (p. 48)

Quotation A3: …it is important to note that the network of *semiotic* relations that make up culture is not isomorphic with the network of economic, political, geographical, social, or demographic relations that make up what we usually call a "society. (p. 49)

Quotation A4: Culture may be thought of as a network of *semiotic* relations cast across society, a network with a different shape and different spatiality than institutional, or economic, or political networks. The meaning of a symbol in a given context may therefore be subject to redefinition by dynamics entirely foreign to that institutional domain or spatial location… (p. 49)

Quotation A5: If culture has a distinct semiotic logic, then by implication it must in some sense be coherent. But it is important not to exaggerate or misspecify the coherence of symbols systems. I assume the coherence of a cultural system to be *semiotic* in a roughly Saussurian sense: that is, that the meaning of a sign or symbol is a function of its network of oppositions to or distinctions from other signs in the system. This implies that users of culture will form a *semiotic* community – in the sense that they will recognize the same set of oppositions and therefore be capable of engaging in mutually meaningful symbolic action. (p. 49)

Quotation A6: The fact that members of a *semiotic* community recognize a given set of symbolic oppositions does not determine what sort of statements or actions they will construct on the basis of their *semiotic* competence. Nor does it mean that they form a community in the fuller sense. They need not agree in their moral or emotional evaluations of given symbols. (p. 49-50)

Quotation A7: …I have mainly been considering culture as system. But what I have said has implications for how we might conceptualize culture as practice. First, the conception of culture as *semiotic* implies a particular notion of cultural practice. To engage in cultural practice is to make use of a *semiotic* code to do something in the world. People who are members of a *semiotic* community are capable of not only recognizing statements made in a *semiotic* code but of using the code as well, putting it into practice. To use a

> code means to attach abstractly available symbols to concrete things or circumstances and thereby to posit something about them. (p. 50)

Sewell uses the term semiotics in many different forms and it is necessary to translate these usages into the framework developed so far to proceed with the formalization of cultural practice. In quotations A1-A4, a *semiotic relation* corresponds to a symbol set and opposition relation pair of the framework such as $\left(\Sigma_{example}, O_{example}\right)$. This becomes evident especially in A5. *Semiotic competence* of a group of agents implies that all agents share the same semiotic relation and if this is the case then they form a *semiotic community*. On the other hand a *semiotic code* is just one instance of a semiotic relation or in other words a single symbol – meaning correspondence[22] such as (s_1, m_1).

In these quotations Sewell fully characterize the mechanisms of cultural practice. Accordingly, cultural practice has two sides; passive and active. If an agent is passive in a cultural practice, he receives a statement made in semiotic code or in the terminology developed in this chapter he receives a symbol – meaning correspondence such as (s_1, m_1). In A6, Sewell clarifies that semiotic competence does not imply that agents agree in their moral or emotional evaluations of given symbols. Hence an agent might or might not agree with the evaluation m_1 of a given symbol s_1 depending on his subjective evaluation criteria.

Rule 3: In cultural practice a passive agent receives a symbol – meaning correspondence and evaluates this correspondence according to his subjective evaluation criteria.

[22] This statement can easily be generalized to a subset of a symbol – meaning correspondence. Here it is assumed that a semiotic code corresponds to a single correspondence.

On the other hand, an agent might be active in a cultural practice as Sewell argues in A7. An active agent signals a symbol – meaning correspondence such as (s_1, m_1) presumably to concrete situations in economic, political, geographical, social, or demographic relations. To take active role in cultural practice requires motivation. Sewell barrows from Bourdieu (1977: cited from Sewell, 1999) and Swidler (1984):

> Part of what gives cultural practice its potency is the ability of actors to play on multiple meanings of symbols – thereby redefining situations in ways that they believe will favor their purposes. (p. 51)

Thus an agent has a particular motivation in signaling (s_1, m_1) rather than other any other correspondence. This motivation might be profit in economic networks or power in political networks or more generally an increase in social capital as Bourdieu (1980: cited from Burt, 2001) defines. Additionally, an agent that is active in cultural practice plays the role of an initiator of an interaction. Thus he has a target passive agent in this interaction[23].

Rule 4: In cultural practice an active agent selects a target agent who plays a passive role. Motivated to maximize his social capital, active agent signals a symbol – meaning correspondence to the passive agent.

Initiation of an interaction does not guarantee that the active actor would really interact with the passive actor. The behavior of the passive actor is characterized by Rule 3. If the passive actor evaluates the incoming symbol – meaning correspondence strictly positive the interaction takes place.

[23] In a more general model the target might be a group of agents but in the implementation of the framework in this thesis the simplest case is considered.

The last rule in the implementation of the cultural framework is about the cultural consequences of an interaction. Rule 2 explains[24] that actors attach reliability measures for meanings and this measure is dynamically updated with interactions as experiences. For instance, if an actor experiences a benefit as a consequence of using a semiotic code (s_1, m_1) in a different sphere than culture, maybe in the economic sphere, than he elevates the reliability of the meaning. Conversely, if the use of a semiotic code results in a loss then the reliability of the meaning deflates. In this regard, actors dynamically update reliability of each meaning. Sewell does not explain this mechanism explicitly, but it is clearly crucial for the implementation.

Should such a mechanism be symmetric for benefits and losses? Should it depend on absolute magnitudes or should it depend on relative increments or decrements? This mechanism models a cognitive process and as DiMaggio (1997) states it must be consistent with results of empirical research on cognition.

Kahneman and Tversky (1979) argued that individuals are tuned to relative changes rather than absolute magnitudes and that valuation is not symmetric for decrements or increments. They supported this view by numerous cognitive experiments. In this vein they have developed Prospect Theory of decision making which has been reviewed in Appendix 1. Since reliability is in essence a valuation procedure over meanings, adopting Value Function calculus from Prospect theory as a mechanism to update reliabilities fulfills the requirements that DiMaggio (1997) emphasize.

The mechanism that governs the reliability updates of meanings in the implementation of deconstructionist algebra uses:

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[24] Rule 2: Each agent in the population attaches a reliability measure to each meaning in his meaning collection. Reliability measure is inflected through cultural practice.

$$r_{t+1} = \begin{cases} r_t + e^{\alpha} & if \ e > 0 \\ r_t - \lambda(e)^{\beta} & \text{otherwise} \end{cases}$$

where, r_t, r_{t+1} are a reliability for some meaning, at time *t* and *t+1* respectively and ***e*** is a function of increments and decrements that realize in another sphere other than cultural sphere. Default characteristic of value function dictates that decreases are steeper than increases as shown in Figure 53.

<u>*Rule 5*</u>**:** Reliabilities of meanings are updated according to

$$r_{t+1} = \begin{cases} r_t + e^{\alpha} & if \ e > 0 \\ r_t - \lambda(e)^{\beta} & \text{otherwise} \end{cases}$$

In sum, this chapter developed a deconstructionist algebra formalization for the framework that Sewell mentions. The dynamics of the framework has been translated to the developed terminology and summarized as rules. Therefore these rules define a class of implementations of deconstructionist algebra within which the model of this thesis belongs to. Rules dictate a model that is not mathematically tractable. For that reason, model is developed as a simulation of agents that obey the rules listed in this section. Next chapter illustrates this model.

CHAPTER 5

RESEARCH METHODOLOGY

Ostrom (1988) proposed that social scientists use three different symbol systems[25]. First is formal logic of mathematics through which robust modeling of social phenomena is developed. Furthermore, consistence in the argumentation of the modeling phase is demonstrated by global proofs in order to prosper reliability. However these models have the primary disadvantage that social systems are generally too complicated to be analytically tractable, in particular when the phenomena being modeled involve nonlinear relationships (Gilbert and Terna, 2000). Thus mathematical models introduce simplifying assumptions such as linearity, homogeneity, normality, and stationarity until the equations become solvable.

Second symbol system is verbal argumentation. Similar to formal logic of mathematics, models that use verbal argumentation frequently refer to abstractions and simplifications or focus on manageable sub-domains of the phenomena as a result of human cognitive capacity. Verbal argumentations are most frequently used at times it is preferred to describe the social phenomena rather than prescribe or forecast future states. Since nonlinearity is pervasive in social systems, describing the behaviors of the system requires speaking the same language with the system. "Speaking the same language" or qualitative science argumentation has been discussed in the Culture chapter especially through Geertz's Culture as System view. Geertz's conception of interpretation as a "science" derives from the hermeneutical

[25] This symbol systems are obviously not related to the symbol systems discussed in the preceding chapters.

perception of human sciences as opposed to natural sciences (Alexander and Siedman, 1990; Shankman, 1984). Similar to Geertz, hermeneutists have emphasized that human life is characterized by dimensions such as self-awareness, reflexivity, creativity, intentionality, purposiveness and meaningfulness that cannot be reduced like dimensions of natural world that are subject to natural laws. Thus hermeneutists, mainly Dilthey (1900[1972]) and Veblen (1904: cited from Herrmann-Pillath, 2006) developed an alternative approach called *Geisteswissenschaften* (the sciences of spirit) as opposed to observational, explanatory methods of natural science, *Naturwissenschaften*.

However, verbal representations have at least two fundamental disadvantages. First, consistencies between various concepts of the proposed model for the social phenomenon and their relationships are not testable (Gilbert and Terna, 2000). Inference making and level of generalization are open to committing errors therefore validation of the models is subject to debates. Second, it is generally hard to develop onto the work of verbal representations. Therefore modeling efforts resemble intellectual islands and knowledge becomes very hard to manage and advance.

Finally, the third symbol system is computer simulation. Actually simulations are not independent from other two symbol systems and even it is argued that they link formal mathematics to verbal representations (Axelrod, 1997; Troitzsch, 1997; Gilbert and Terna, 2000). Simulations remove the assumptions needed for tractable mathematical analysis and therefore have the promise of allowing us to examine issues that have been avoided in theoretical disciplines based on mathematical derivation. For instance, simulations allow more aggressive exploration of the implications of imperfect rationality, the effects of learning and information, and social and institutional structure (Bankes, 2002).

Furthermore simulations provide naturalness as an ontology or representational formalism of social sciences. Since the qualitative data can be blended within the methodology, simulations make extensive use of the enormous amount of data and knowledge expressed in verbal representations about the behavior, motivations, and relationships of social actors whether individual or collectives. Also, in contrast to mathematical formalism, social simulations do not necessarily use this information for aggregation purposes but rather exploit the dynamics of the system which is the main focus of many social sciences (Bankes, 2002).

Bankes (2002) emphasizes the power of simulations as a methodology to demonstrate emergent phenomena.

> The idea of 'emergence' is one the touchstones of what has come to be called 'complexity science'. In social science, topics such as the emergence of cultural norms or institutions from the interaction of individual activity are indeed very important and not well addressed… (p. 7200)

> Emergence is fundamentally a multiresolution concept with,…, micromotives leading to macrobehaviors. Thus, emergence can be characterized by a measure of macroscopic behavior achieving a threshold value in a simulation built from microscopic behavior. (p. 7200)

Simulations has been widely adopted in the natural sciences and engineering as a methodology but only after open complex system approach it found application areas in social sciences. Social phenomena are characterized as open complex systems that interact with the environment and composed of a network of components. Anderson (1999) refers to three intellectual waves as the originator of this view. First is the paradigm shift in cognitive psychology and the birth of Gestalt Theory which highlight the idea of holism in contrast to atomistic principle. Second, cybernetics and general system theory that attempts to model and control nonlinear systems instead of the reductionist idea of simplifying into a best linear representative. Third, the emergence of catastrophe theory which examines the effects of small shifts in a parameter of a deterministic system, and chaos theory that expose the order in seemingly random systems.

Modeling nonlinearity has been so challenging that not only social scientists but also many natural scientists have attempted more analytically tractable problems. Unlike linear systems where the dependent and independent variables can be easily discriminated and equilibriums are identified as points, nonlinear systems imply complex associations between all components and define equilibriums in the form of attractors[26].

Simon (1996, p.1) states that, "the central task of natural science is to show that complexity, correctly viewed, is only a mask for simplicity". Accordingly, complexity theory offers dual premises. First, systems with high complexity that may involve numerous feedback loops and interconnections can produce surprisingly simple and predictable behavior. And second, complexity theory embraces very simple rules that can have complicated and unpredictable consequences.

Cybernetics, general system theory, catastrophe theory and chaos theory are about deterministically dynamic systems that are mainly used in situations where the system is highly complex and the expected outcome is predictable and controllable. On the other hand "Complex Adaptive Systems" that are composed of interconnected units, which act according to a set of simple procedures or routines, aim to capture complex patterns of behavior resulting from simplicity (Carley and Behrens, 1999).

[26] Attractors are bounded regions in a state space. When the system enters this region, it always stays there (Anderson, 1999).

These models involve a network of interacting intelligent adaptive agents. An intelligent adaptive agent makes decisions by using simple rules in response to changes in the environment (Carley and Behrens, 1999). System generates dynamic aggregate behavior that emerges from these agents. Furthermore in order to describe this aggregate behavior, a detailed knowledge of the individual agents is not necessary (Holland and Miller, 1991). Agents are adaptive in the sense that their actions affect their reproduction rate. In a typical scenario, as the system exhibits a transition state, agents act according to their decision rules using the information available in the environment and influence the decisions of other agents. At the transition instant, best agents survive and pass to the next state by reproducing to niches emptied by unsuccessful agents. The decision rules that an intelligent adaptive agent can take different forms. For example, an agent may select one rule from a possible set of rules, or it may use fuzzy logic or even may adopt a neural network or a genetic algorithm (Anderson, 1999).

Due to the dynamic nature of social phenomena intelligent adaptive agent systems applications in social sciences have been proliferated and labeled as "Social Simulations".

Social Simulations

Social sciences is about building formalized and refined models of social phenomena in a smaller, less detailed and less complex form in order understand the world. Simulation is a particular modeling tool like statistical models that require "inputs" from the researcher, produces outputs that the researcher interprets. However simulations diverge from statistical models in the sense that, statistical models use a set of independent variables to explain variation in one or more dependent variables.

Typically (Figure 17), outcomes at one level of the statistical models are explained by causal drivers at the same level of analysis (Anderson, 1999).

Figure 17. The statistical framework. (Reproduced from Schmidbauer and Rösch, forthcoming.)

Simulations take a different approach. For instance, consider that the research of interest is to understand how people select marriage partners. Instead of asking questions that are quite hard to receive answers like: Do you (did you?) keep looking and dating until you find someone who meets all your ideals, or do you stop as soon as you find someone "good enough"?, in simulation studies, social scientist start setting up a model with plausible assumptions for synthetic agents that interact with each other and see what happens, comparing the behavior of the program with the observed patterns of searching for a partner (Gilbert and Troitzsch, 2005).

Thus, in contrast to statistical techniques, simulations ask how changes in the agents' decision rules, the interconnections among agents, or the adaptability of the agent produce different aggregate outcomes. Anderson (1999) explains:

> These models are inherently multilevel, because order is considered an emergent property that depends on how lower level behaviors are aggregated. Accordingly, they [simulation models] respond well to contemporary calls for more integrative, cross-level research in organization science. (p. 220)

Anderson (1999) emphasizes that simulation models and standard causal statistical models are complements of each other. Yet, in order to explain social simulations which is a relatively young methodology in social sciences, it is customary to emphasize its divergent characteristics from statistical methods. In this vein, consider a real world phenomenon which Gilbert and Troitzsch (2005) label as “target”. The aim is to create a “model” of this target that is manageable to study than the target itself. The model is expected to be sufficiently similar to the target in the sense that it would be possible to draw conclusions from the model that would also hold for the target itself.

In the introduction section of this chapter, it has been argued that in social sciences, targets are always dynamic entities that not only change over time but also react to its environment. Sometimes these two characteristics of dynamic social phenomen, are phrased as “evolution”. Since the target is intrinsically dynamic, a statistic model would fail to capture most of its eminent characteristic.

In statistical models the researcher develops a model of set of equations through abstraction from the presumed social processes in the target. The model is then specified using an algorithm that minimize the difference in the observed data from the target and predicted data from the model. Finally the researcher asks whether the abstraction used in the model resolves into meaningful associations via hypothesis tests (Figure 18).

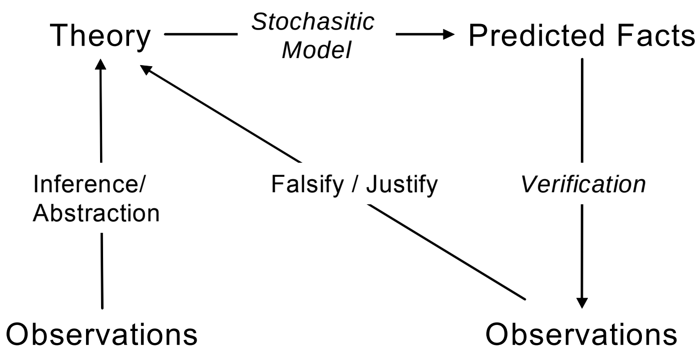

Figure 18. Frames of a social research with statistical models.

Much the same logic underlies the use of simulation models. Once again the researcher develops a model based on presumed social processes. But this time the abstraction may take place at various scales. In particular, the simulation consists of the environmental variables of the social process such as actors; whether individual or collectives, their interactions and possibly macro scale constraints or regulations as well (Figure 19).

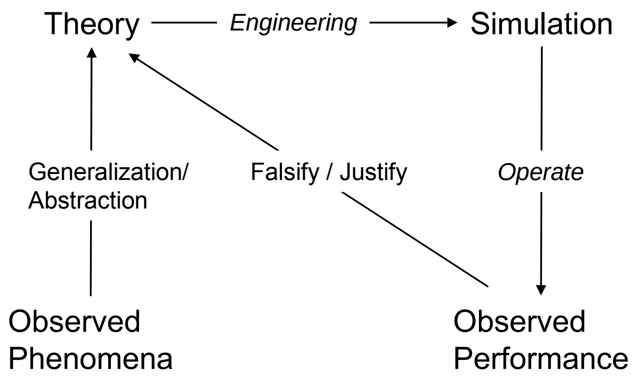

Figure 19. Frames of a social research with simulation models.

In this respect a simulation resembles a social theory written in verbal form. Then the simulation is run and resulting environment is elaborated. It is expected that presumptions of the theory on behaviors of actors, their interactions and macro scale regulations will resolve into a similar structure to that of inspected social process. Thomsen et al. (1999) explains this property of simulations focusing on organization studies domain without loss of generality.

> …we divide organizational theory into four principle areas of investigation – macro theories, micro theories, macro experience and micro experience. Macro theories describe the large scale behaviors within and among large groups and organizations. Micro theories explain how agent behavior is affected by organizations…In macro and micro theory developments, researchers confirm their hypotheses by observing macro experience and micro experiences…Simulation systems…however, are intermediate representations that relate micro theories and macro behavior. (p. 386)

The Stages of Simulation Based Research

Simulation based research constitutes three steps. In the first step the researcher has to decide on the simplification level of the social process which is usually anchored by an available theory that describes the social phenomenon. This step is called Designing the Model. Second step, Building the Model, is the technical side of simulation based research in which the researcher decides on appropriate platform to code the simulation. Third step is the Verification and the Validation phase of the research where researcher does not only explain the output but also elaborate on the complete simulating process especially focusing on particularly important localizations, effects of random perturbations in each scale. In this section each of these steps are discussed.

Designing the Model

Every social science model starts with a simplification of a social process. The crucial step in designing a model is to decide the consequences of the simplification or sometimes called abstraction by elaborating on what needs to be left out and what needs to be included. The more is left out, the more the model is abstracted from reality. In such a case a greater conceptual leap is required between the conclusions drawn from the model and their interpretations in relation to the target (Gilbert and Troitzsch, 2005).

On the contrary if the model involves less simplification of the real social phenomenon parameters should be measured or assumed more precisely since each would have dramatic effects on the simulation output.

> What one hopes for is a model that embodies the minimum number of assumptions, but which applies as general as possible to many different circumstances. The choice of where to place one's model on this continuum between the detailed and the abstract is partly a matter of skill and experience, partly a matter of research style and partly a matter of the amount of data one has available and how difficult it is to collect more. In general, accuracy (in terms of the number of data points and assumptions built into the model) is important when the aim is prediction, whereas simplicity is an advantage if the aim is understanding. (Gilbert and Troitzsch, 2005, p. 19)

Similarly Axelrod (1997) state that the goal of agent based simulation is to enrich our understanding of fundamental processes that may appear in a variety of applications: "This requires adhering to the KISS principle, which stands for the army slogan 'keep it simple, stupid'." (p. 5). In this respect Axelrod advices that in designing a model the aim is to explore fundamental processes by their fruitfulness, not by their accuracy.

A standard simulation model consists of a number of agents that are allowed to communicate, or more formally, transmit information to and affect the state of neighbor agents within an environment. Generally the environment is a two dimensional grid where the agents may or may not free to travel. The designs (Figure 20) in which agents are fixed are called cellular automata (Gilbert and Terna, 2000).

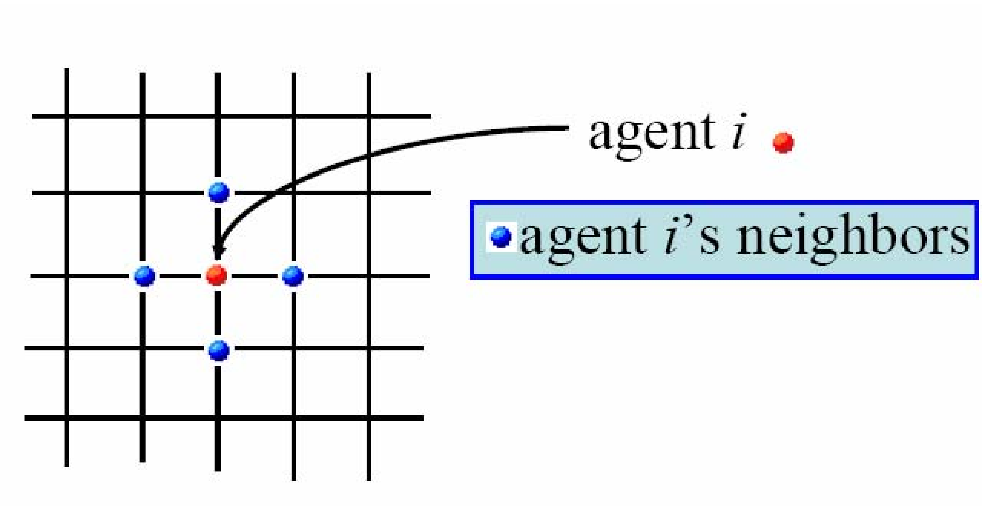

Figure 20. A cellular automaton model. Each agent has four neighbors as displayed in the picture. (Reproduced from Glemm et al, nd)

As Gilbert and Terna (2000) states there is a considerable confusion over the term "agent". Agents considered in social sciences are autonomous entities in the sense that they control their own action depending on certain constraints. Agents have social ability such that they interact with other agents, and this "other" agents are defined with the interaction domain per agent. For instance, in Figure 20, the interaction domains of the red agent (in the middle) are displayed as agents in blue color. Agents are also reactive so that they receive information by perceiving the environment and respond to it. Finally agents are pro-active thus they are able to undertake goal-directed actions.

In the designing phase, the task of the modeler is to define the cognitive capabilities of agents, the actions they are allowed to carry out and finally the characteristics of the environments in which agents are located. For instance, in production systems, low cognitive capabilities are attached to agents. A production system has three components: a set of rules, a working memory and a rule interpreter (Gibert and Terna, 2000). A rule constitutes two components. First component determines the execution condition for the rule. Second component which describes the actions of the agents involves the consequences of rule firing. Helbing et al. (2000) used a similar agent architecture in modeling collective human behavior stampede induced by panic that leads to fatalities as people crushed or trampled. Sometimes this behavior is triggered in life threatening situations such as fires in crowded buildings. They report that standard mathematical theories are incapable of modeling this dynamics when the crowd is large. So they decide to design a simulation first by listing the characteristics of panic behavior that they have collected from various literatures. Panic behavior can be summarized as follows: (1) People move or try to move considerably faster than normal. (2) Individuals start pushing, and interactions among people become physical in nature. (3) Moving and, in particular, passing of a bottleneck becomes uncoordinated. (4) At exists, arching and clogging are observed. (5) Jams build up. (6) The physical interactions in the jammed crowd add up and cause dangerous pressures up to 4,450 N m^{-1} which can bend steel barriers or push down brick walls. (7) Escape is further slowed by fallen or injured people acting as obstacles. (8) People show a tendency towards mass behavior, that is, do what other people do.

Thus they have modeled the crowd with agents with zero cognitive capacity, acting like robots with these rules. Yet the results are quite satisfactory. In Figure 21, agents are represented as circles, green (dark) circles being injured people. Simulations assume 200 people in a room. (a) No column. (b) With column after 10 seconds. (c) With column after 20 seconds. In the absence of the column, 44 people escaped within the threshold time of 45 seconds and 5 are injured; with the column, 72 people escape and no one is injured after 45 seconds.

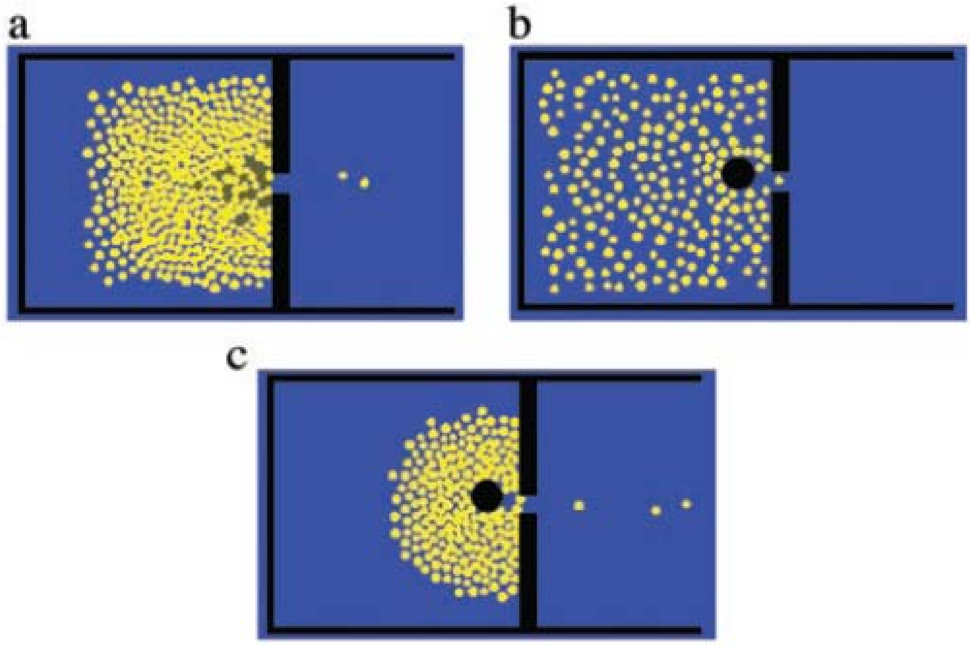

Figure 21. Instances from the simulation run of the model developed by Helbing et al. (2000).

Another example of a simulation with simple agent architectures with influential results is Axelrod's (1997) "The dissemination of culture: A model with local convergence and global polarization". Axelrod did not particularly interested in the contents of culture, but rather on the way in which culture is likely to emerge and spread. Nevertheless culture must be represented in one way or another to study the dynamics. Thus, the model assumes that an agent's culture can be described in terms of his or her attributes, such as language, religion, technology, style of dress, and so forth.

For each feature there is a set of traits, which are the alternative values a feature may have. For instance one feature might correspond to orientation towards group or individual score such that within a scale of 1 to 10, 1 denotes pure collectivism and 10 denotes pure individuality (Figure 22).

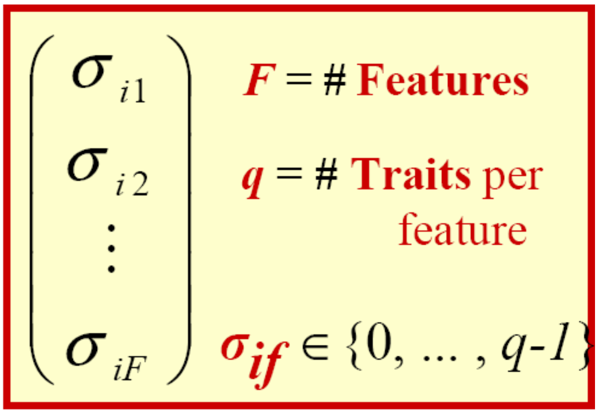

Figure 22. Representation of features and traits in Axelrod (1997).

Agents are arrayed on a ten by ten grid or in other words they are distributed on a cellular automata defined previously. Therefore each agent is allowed to interact only with its immediate neighbor. Agents assigned random features and traits. For instance if the number of features is three and each feature has two traits then agents with different cultural endowments can be displayed with the following color codes (Figure 23).

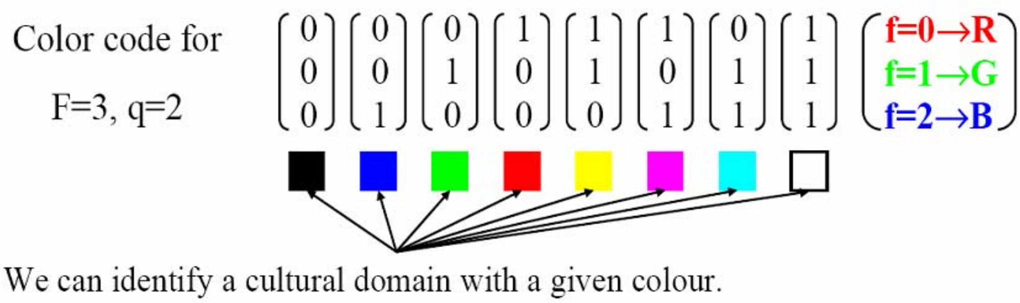

Figure 23. Representation of agents with heterogeneous cultural traits with color codes in Axelrod (1997).

As expected the initial environment is crowded with agents that are not similar (Figure 24).

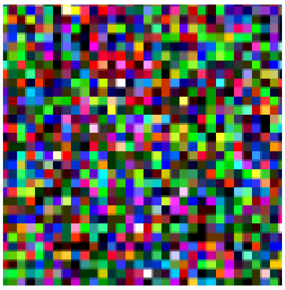

Figure 24. Distributions of the agents in the initial step (t=0) of the simulation run in Axelrod (1997).

The dynamic of the simulation which also defines the rules of action for each agent is summarized as follows (Figure 25):

Step 1. At random, pick an agent to activate and pick one of its neighbors.
Step 2. With probability equal to their cultural similarity, these two agents interact. An interaction consists of selecting at random a feature on which the active agent and its neighbor differ (if there is one), and changing the active agent's trait on this feature to the neighbor's trait on this feature. Note that in order to guarantee that each site has an equal chance of being a candidate for social influence, the activated site rather than its neighbor is the one that undergo change.

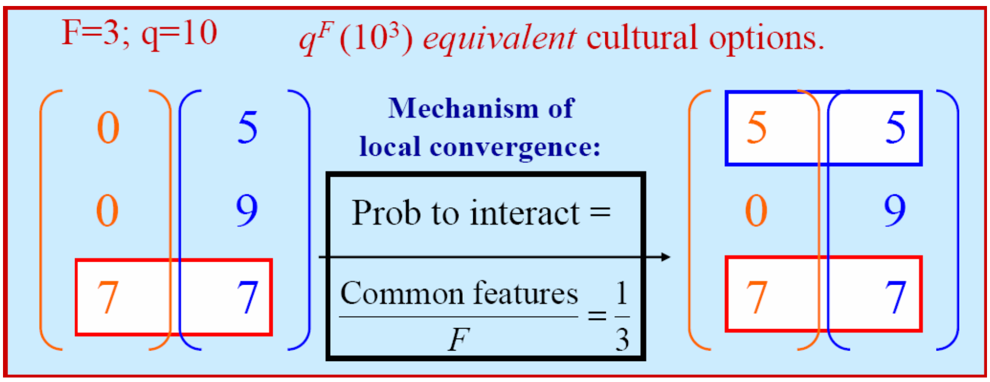

Figure 25. The meachanism of the simulation of Axelrod (1997).

The model is run many times (Figure 26) and answers are obtained for the questions like: How do cultural regions develop? Does anyone come to share the same culture, or do distinct cultural regions develop? Does the system settle down, and if so, how long does it take?

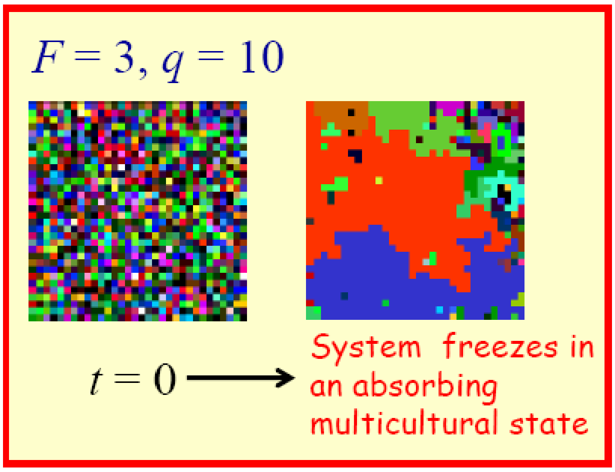

Figure 26. Picture on the left displays the initial state and picture on the right displays the final stable states of the simulation run in Axelrod (1997).

A number analysis focuses on the relationship of width of the territory and average number of stable regions, simulation time and number of cultural zones and finally the dynamics of cultural boundaries.

On the other hand modeling some other types of social phenomena might require cognitively rich model of agents in the sense that they do not follow some rules rigorously but rather interpret the situation and act according to an algorithm such as Rational or Bounded Rational Decision Making, Satisficing or make use of some heuristics. For instance, Hammond and Axelrod (2006) designed a simulation to study the emergence of ethnocentric behavior with bounded rational agents. They review the literature on ethnocentrism which underscores the cognitive ability in individuals and complex social and cultural inputs for ethnocentric behavior. They also report the empirical evidence from psychology which on the contrary to the literature on ethnocentrism suggests the prevalence of a strong individual predisposition toward bias in favor of in-groups, which can be observed even when cognition is minimal and social input very abstract. Furthermore, cognitive psychology asserts that categorization and discrimination based on group boundaries is preconscious.

Authors support the design of their agents by referring to the following theories:

> In political science, current research suggests that a number of political beliefs and behaviors may be influenced by heritable tendencies that are selected for evolution. The existence of broad and potentially heritable universals of the human mind has long been accepted in the study of psychology, and in anthropology as well there is increasing focus on universals of human thinking that result from evolution and are believed to leave the human mind "prepared to think" in a particular fashion and "predisposed" to react in certain ways (Brown 2004; Wrangham 2004). (p. 927)

> In-group bias (of the type we are studying here) is often included in the list of observed innate universal predispositions, and some anthropologists argue that nationalisms and racisms observed today are likely 'hypertrophies of an ethnocentrism that for many millennia played itself out on a much smaller scale' (Brown 2004). (p. 928)

Thus, to introduce group differences they attribute three traits to each agent. The first trait which is in principle a tag, represents the group membership which is the only observable tag for agents. Other two tags specify the strategies of the agent. Agents are organized in a 50 x 50 cellular automata and played Prisoner's Dilemma against each other to make cooperation individually costly. Also in order to remove reciprocity, authors use one-move Prisoner's Dilemma rather than iterated variant and further disregard social input of n-person Prisoner's Dilemma. First of thes strategy tags defines the strategy against in-group members; that is the agent decides either to cooperate or defect when playing the game with in-group members. The last tag specifies whether the agent cooperates or defect when meeting an agent from out-group. Clearly, ethnocentric behavior is only one of the possible four strategies and there is no predisposition coded into the agent architecture that favors ethnocentrism.

Since the group membership is not related to strategy tags, the model allows for the possibility of "cheaters" who free ride on the donations of ethnocentrics while themselves providing help to no one at all. The simulation proceeds as follows:

1. An immigrant with random traits enters at a random empty site.
2. Each agent has its potential to reproduce (PTR) set to 12 percent. Each pair of neighbors then interacts in a one-move prisoner's dilemma in which each chooses (independently) whether to help the other. Giving help has a cost—namely, a decrease in the agent's PTR by 1 percent. Receiving help has a benefit—namely, an increase in the agent's PTR by 3 percent.
3. Each agent is chosen in a random order and given a chance to reproduce with probability equal to its PTR. Reproduction consists of creating an offspring in an adjacent empty site, if there is one.2 An offspring receives the traits of its parent, with a mutation rate of 0.5 percent per trait.
4. Each agent has a 10 percent chance of dying, making room for future offspring.

Figure 27 and Figure 28 are obtained from the Netlogo – a simulation program. The software comes with ethnocentrism model built in. In the picture agents appear as circles if they cooperate with the same color. They are filled in if they also cooperate with a different color (altruists) or empty if they do not (ethnocentrics). Agents are squares if they do not cooperate with the same color. The agents are filled in if they cooperate with a different color (cosmopolitans) or empty if they do not (egoists). The automaton is initially filled with random agents. Pressing the "go" button runs the simulation by a prespecified amount of steps. At each step all agents interact.

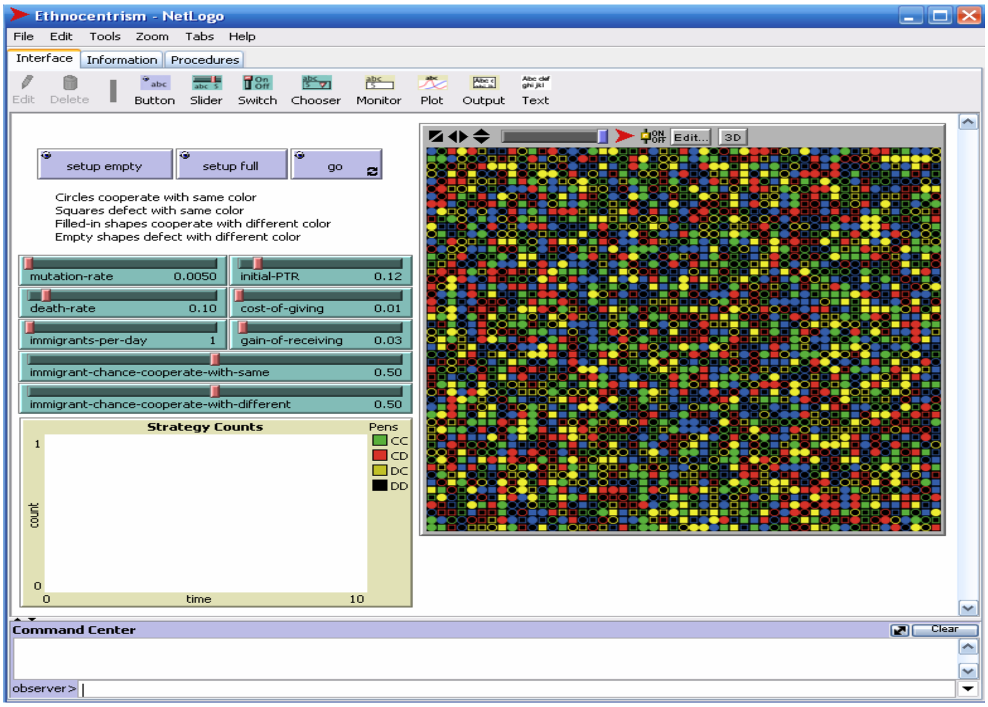

Figure 27. The initial state of the Ethnocentrism simulation of Hammond and Axelrod (2006).

After 1000 steps system stabilizes on the average around 70% of the population being ethnocentrics.

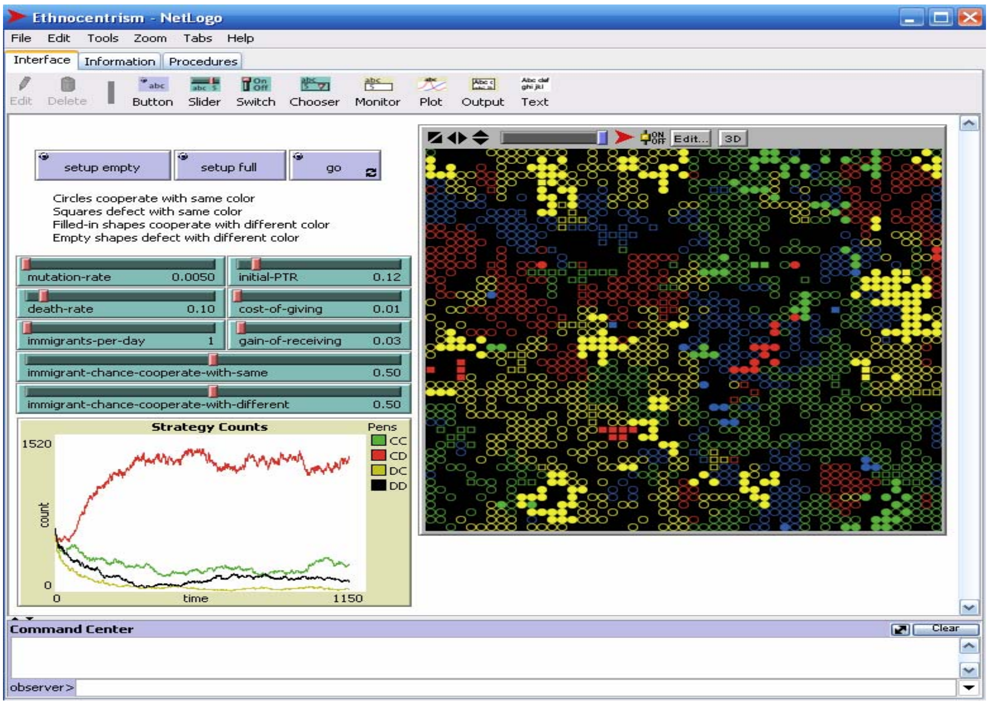

Figure 28. The ethnocentrism simulation of Hammond and Axelrod (2006) after 1000 steps.

Hammond and Axelrod analyze the simulation in the micro scale to explain the dominance of the ethnocentric behavior although the simulation is purposefully designed to produce one. They refer to Figure 29:

> This schematic diagram represents what can happen at the boundary of a region of red ethnocentric agents (on the left) and a region of blue egoists who cooperate with no one (on the right). When a red ethnocentric agent interacts with a blue egoist, neither cooperates so neither does well, as signified by the thin line between them. When this red ethnocentric agent interacts with its red ethnocentric neighbors, both cooperate and both do well, as signified by the thick lines between them. The blue egoist does not do as well when it interacts with blue egoists from its own region because egoists do not cooperate with each other. Overall, then, the red ethnocentric does better than the neighboring blue egoist does, by receiving 'help from behind' from its own region. Since doing better translates into a greater potential to reproduce, the red ethnocentric region will tend to grow at the expense of the blue egoist region. More generally, an ethnocentric region of any color will tend to expand at the expense of adjacent regions of egoists of a different color. Thus, 'cheaters' of a given color are suppressed by the ethnocentrics of the other colors. (p. 932)

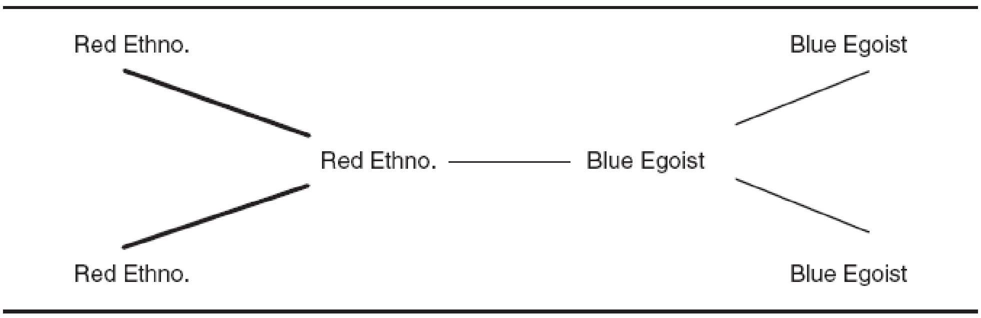

Figure 29. The dynamic of ethnocentrism simulation of Hammond and Axelrod (2006).

Building the Model

Once the model has been design next phase is its construction. This involves coding a special program with a universal programming language such as C, C++, C# or any language in .NET environment or Delphi or Java language for platform independence. Alternatively, one might use one of the many packages or toolkits that have been written to help in the development of simulations. Gilbert and Troitzsch (2005) compares these two approaches:

> It is almost always easier to use a package than to start afresh writing one's own program. This is because the many of the issues that take time when writing a program have already been dealt within developing the package. For example, writing code to show plots and charts from scratch is a skilled and very time consuming task, but most packages provide some kind of graphics facility for the display of the output variables. (p. 21).

On the other hand simulation packages have the primary disadvantage that they are limited in what they can offer. Also since the researcher most of the time cannot reach the code of the package, at least some of the bugs might spoil the outcomes. In this regard it is usually preferable to code the simulation from scratch if a similar version of the simulation is not readily built in a simulation package.

If one has decided to code a simulation, a question then arises about the best programming language to use. Gilbert and Troitzsch (2005) list the desirable features for a programming language for simulation:

- The language should be well structured and allow for incremental refinement. Most simulation programming is exploratory, because usually the specification of the program develops as the problem becomes better understood. It is therefore important that the programmer can cycle easily and quickly between coding, testing and modifying the code. Interpreted languages (such as Java, Visual Basic, Lisp) are often better than compiled languages (C, C++, Pascal) in this respect, but modern compilers and programming environments mean that the difference between compilation and interpretation is now much less than it used to be.

- The language should allow easy and rapid debugging, programs should be easily instrumented and there should be good graphics libraries. Simulations generate lots of data and there needs to be an easy way of processing them into manageable form. Because so much time in writing simulation programs (as with other types of program) consists of debugging, the quality of the facilities available for testing and tracking down faults is very important.

- Once the program has been written and tested, many hundreds of runs will be needed to carry out sensitivity analyses. For this reason, the final simulation program needs to run as efficiently as possible; this implies that the language needs to be compiled rather than interpreted.

- The language should preferably be familiar to the modeler and to researchers in the simulation community, so that it is possible for others to replicate simulation results and to take over and adapt the program to their needs. It is also useful if the language is easily portable between different types of computer." (p.21-22).

Except for the feature stated at the third bullet, MATLAB environment satisfies the remaining requirements. The argument in the third bullet underscores the length of the processing time for a simulation study. The simulation model developed in this thesis has been replicated in parallel with twenty five latest generation computers[27] in a computer laboratory of Istanbul Bilgi University which further decreases the run time twenty five times. For instance, the results that can only expect to be received in three weeks are obtained within a single day.

Since simulation coding requires programming skills, a relatively complicated simulation; Hammond and Axelrod's (2006) simulation to study the

[27] All Computer in the PC Laboratory have P – IV, 3 GHz central processing units.

emergence of ethnocentric behavior with bounded rational agents has been recoded in MATLAB from scratch and their outcomes have been compared with the outcomes obtained from the simulation in MATLAB. The MATLAB code that simulates the ethnocentric behavior with bounded rational agents is in Appendix 2.

Verification and Validation

The final step in a simulation study is the verification and validation of the design and the built of the model. Verification is the process of checking that the programming code does what it was planned to do. In the case of simulation studies the difficulties of verification is compounded due to the existence of random number generators which implies that every run of the simulation would produce different outcomes. Therefore only the distribution of the outcomes is meaningful (Gilbert and Troitzsch, 2005).

In social simulations it is argued that randomness is an important factor that fills in the intellectual gaps of the researcher in modeling the social phenomena such as mimicking the effects of exogenous factors such as the effects of the job market in a simulation of household income over time, or the effects of factors that are impossible to measure such as individual emotions (Gilbert and Troitzsch, 2005). Alchian (1950) explains the relationship between chance and adaptation that inspires the use of randomness in simulation study in this thesis.

Alchian’s objective is developing an alternative explanation to economic and social phenomena other than that of pure rational stance. He asserts that “pure” chance is a substantial element in determining the situation selected and also in determining its appropriateness or viability. A second element is the ability to adapt by various procedures to an appropriate situation. He develops his argument by abandoning all individual rationality, motivation and foresight in order to aid in assessing the role of chance in the operation of social system. In order to facilitate the argument he gives an example:

> Plants ‘grow’ to the sunny side of the buildings not because they ‘want to’ in awareness of the fact that optimum or better conditions prevail there but rather because the leaves that happen to have more sunlight grow faster and their feeding systems become stronger. Similarly, animals with configurations and habits more appropriate for survival under prevailing conditions have an enhanced viability and will with higher probability be typical conditions. Less appropriately acting organisms of the same general class having lower probabilities of survival will find survival difficult. More common types, the survivors, may appear to be those having adapted themselves to the environment, whereas the truth may well be that the environment has adopted them. (p. 214)

Hence, Alchian emphasizes environmental adopting as the alternative explanation to motivated individual adaptation but also warns that this does not imply a world lacking in order and apparent direction, as do some population ecologists might have falsely induced. “It might, however, be argued that the facts of life deny even a substantial role of the element of chance and the associated adoption principle in the economic system” (p. 215). Bearing in mind that a social simulation is a “fast-forward” way of replicating social dynamics, the role of chance necessarily enters into the calculus even if it does not solely determine the output. Consequently in tandem with Alchian’s advice that only the regression of the observations of the social system would make sense; in a simulation study the distribution of the outcomes are subject to interpretation.

Emulation of the chance factor in simulation studies is carried out by “pseudo – random” numbers, rather than truly random numbers, but if a good generator is used there should not be any significant difference (Gilbert and Troitzsch, 2005). In the usual practice, pseudo – random number generators imitate uniform distributions.

For instance in MATLAB, pseudo – random numbers are generated using an algorithm that generates double-precision values in the closed interval [2^(-53), 1-2^(-53)], with a period of (2^19937-1)/2.

While verification concerns whether the simulation is working as the researcher expects it to, validation concerns whether the simulation is an appropriate model of the target (Gilbert and Troitzsch, 2005). Thus, validity deals with determining that the model's output has sufficient accuracy with respect to the data obtained from the target system, theories and definition of intended purpose of the simulation study (Sargent, 1996).

THESIm

This section describes the basic components of the simulation model developed in order to study the dissertation objective. It is a multi-agent simulation where agents are distributed in a 10 x 10 cellular-automaton called the habitat. The dynamics of the simulation is governed by the rules listed in Chapter 4. Each component of the simulation is described below.

Habitat

Similar to Hammonds and Axelrod's (2006) ethnicity simulation, each agent in THESIm has exactly four neighbors as displayed in Figure 30. The automaton is coded as a 10 x 10 matrix where row number indicates the x – coordinate of an agent and column number indicates the y – coordinate. Thus for an agent that sits in (3,5) in the habitat, his neighbors are shown in blue in Figure 30.

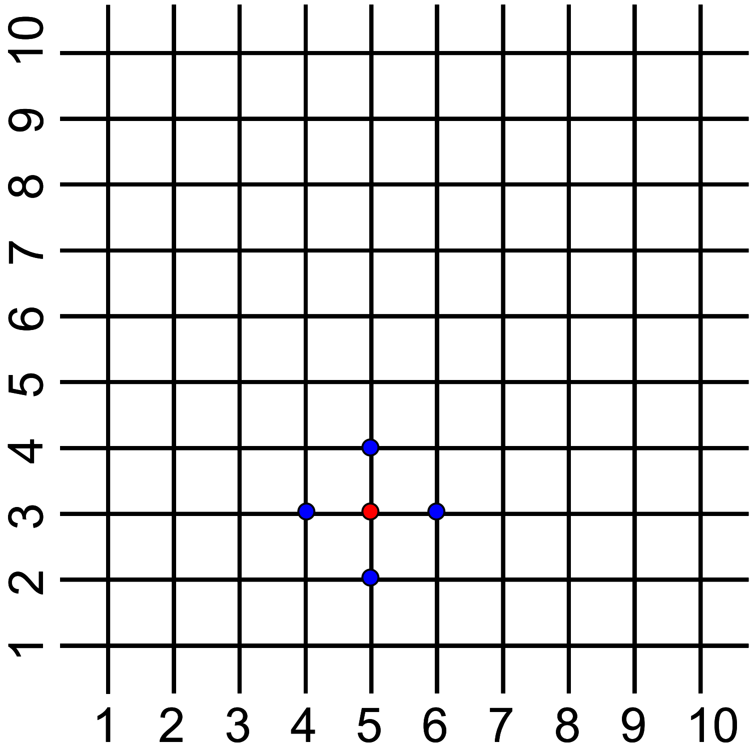

Figure 30. Habitat in THESIm is characterized as a 10 x 10 matrix.

Like each agent, red agent has a north neighbor at (5,4), a south neighbor at (5,2), a west neighbor at (4,3) and an east neighbor at (6,3). Habitat is modeled as bendable from four sides so that agents at the boundaries also have four neighbors (Hammonds and Axelrod, 2006). So for instance if an agent is at (5,1), then his south neighbor sits at (5,10). Similarly if an agent is at (1,3) then his west neighbor is at (10,3). Finally for an agent at the corners of the habitat same logic holds. For an agent at (1,1), his west neighbor is at (10,1) and south is at (1,10). The code below identifies the neighbors of an arbitrary agent by using simple modular arithmetic routines.

```
function out=neighborhoods_of(agentrow,agentcolumn)
%Output is: N,S,W,E as a column matrix.
center_row=mod(agentrow,10);
center_column=mod(agentcolumn,10);
%N
out(1,1)=mod(center_row-1,10);
out(1,2)=center_column;
%S
out(2,1)=mod(center_row+1,10);
out(2,2)=center_column;
%W
out(3,1)=center_row;
out(3,2)=mod(center_column-1,10);
%E
out(4,1)=center_row;
out(4,2)=mod(center_column+1,10);
```

Agents

Each agent is characterized by an address in the habitat, endowment, strategy, tag index representing the semiotic community that the agent belongs to, meaning collection set, symbol – meaning correspondence and finally a matrix of reliabilities for each meaning in his meaning collection.

For tractability all agents are indexed into a single matrix by using their habitat addresses. The function that converts an address into an index is $f(r,c)=10*(r-1)+c$, where (r,c) represents the habitat coordinate. This function is clearly a bijection and is therefore invertible, so that one can revert the process and find the habitat coordinates of an agent from his agent index. So in the set of all agents, if an agent is at row, say 25, then his index is 25, and he is in coordinates (3,5) in the habitat. Agents at the boundaries demand special care. The code below inverts $f(r,c)$.

```
if mod(agent_index,10)==0
        agentrow= agent_index /10;
        agentcolumn=10;
else
        agentrow=fix(agent_index /10)+1;
        agentcolumn= agent_index -(agentrow-1)*10;
end
```

As Sewell (1999) proposed, cultural sphere and other spheres are autonomous. This idea is implemented in THESIm. Agents have some certain amount of endowments and these endowment increase or decrease through economic interactions that they act according to their strategies. In return, endowment affects survival and reproduction chances of agents. In THESIm, agents are assumed to be purposive in their strategies in the sense that they are not allowed to act irrationally.

Strategy of an agent is a reel number $x \in [0, 0.5]$. Economic interaction is designed as a simple game such that each agent generates a return of x that he submits to the other party in the interaction with a quadratic cost of x^2 to himself. Thus in an interaction between two agents; agent$_i$ and agent$_j$, that have strategies x and y, the resulting payoffs are $y - x^2$ for agent$_i$ and $x - y^2$ for agent$_j$. Clearly, a strategy equal to zero implies opportunistic behavior, whereas a strategy equal to 0.5 implies cooperative behavior. As the strategy value increases cooperative returns increase. Thus the game constitutes a plethora of strategies ranging from pure rationality to bounded rationality.

Every agent has a belief structure that constitutes an opposition relation over the symbols. Opposition relations are explained in depth in Chapter 4. A sample of four opposition relations is displayed in Figure 31.

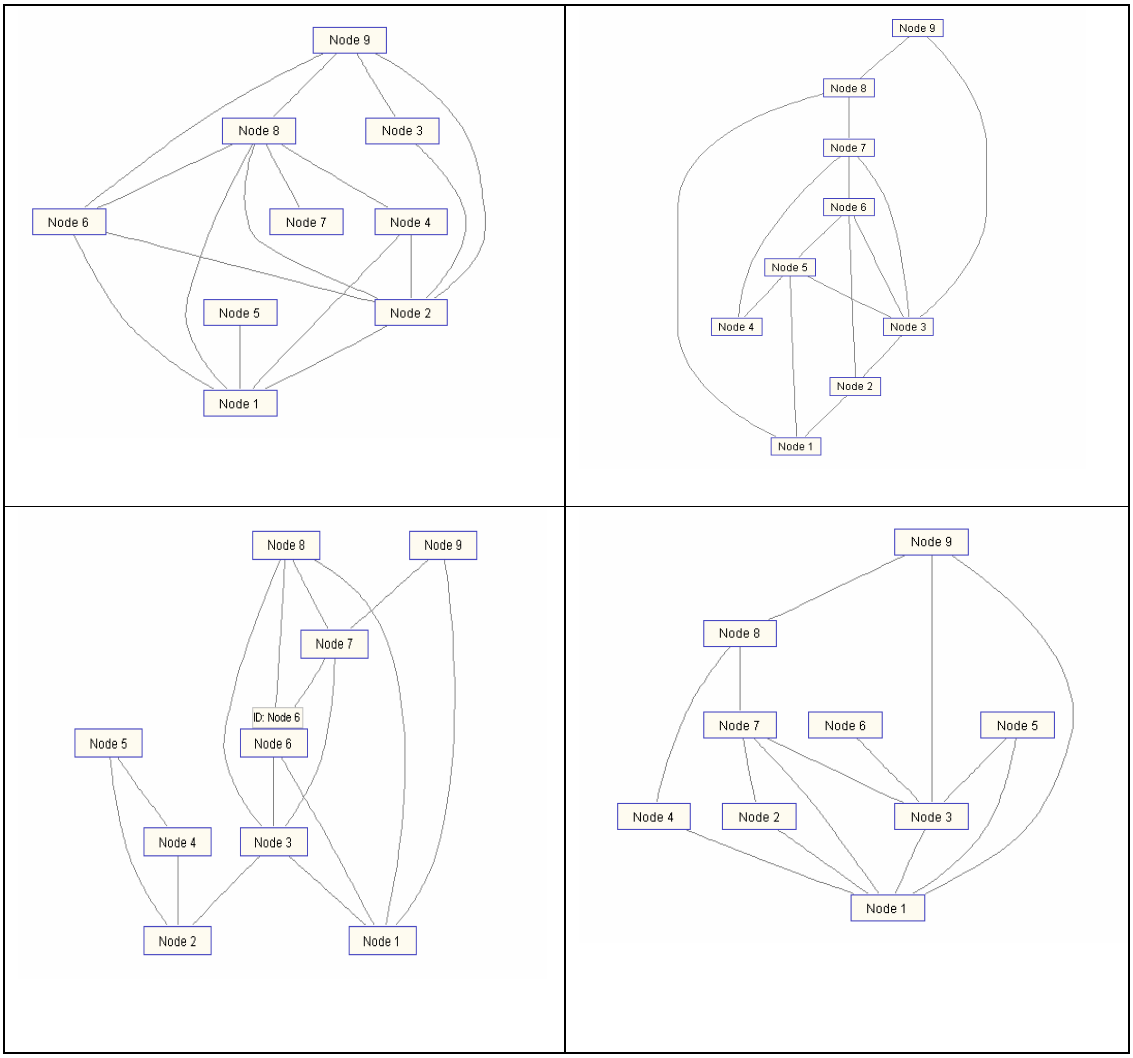

Figure 31. A sample of oppositions relations used in THESIm.

Using the Meaning Generating Set Theorem shown in Chapter 4, meaning generating sets that are used to construct meaning collections can be obtained. The code of the function responsible for this task is "symbols2meanings" shown in Appendix 3. Opposition relations as simple as those in Figure 31 generate thousands of distinguished meaning collections. For this reason it is necessary to keep the records of the tags of the agents.

According to the rules of implementation of the deconstructionist algebra discussed in Chapter 4, each agent has a meaning collecting that obeys a corresponding binary opposition relation called the belief set of the agent. In THESIm, meaning collections are constructed using the meaning generating sets of a corresponding tag. For instance, a meaning collection for a randomly generated agent whose belief structure is displayed in the upper left corner graph of Figure 31. A sample of oppositions relations used in THESIm.

is ,

$\{\{s_2,s_7\},\{s_3,s_4,s_5,s_6\},\{s_3,s_5,s_8\},\{s_3,s_4,s_6\},\{s_1,s_7\},\{s_5,s_9\},\{s_4,s_6\}\}$.

The minimum requirements of a meaning collection are dictated by its definition in Chapter 4. However the number of meanings in a collection is bounded from above with the number of meanings that can be generated with the corresponding meaning generating set.

A symbol – meaning correspondence is extracted from the corresponding meaning collection set. Thus, for indexing purposes in THESIm, elements of the power set of the set of symbols are created. These indices are then used to name meaning sets in a meaning collection. For instance, according to THESIm, the meaning collection displayed above is actually, $\{m_{22},m_{221},m_{102},m_{96},m_{15},m_{39},m_{32}\}$.

Then the symbol – meaning correspondence of this agent is :

$$\mathfrak{A}=\begin{pmatrix} s_1\rightarrow\{m_{15}\} \\ s_2\rightarrow\{m_{22}\} \\ s_3\rightarrow\{m_{221},m_{102},m_{96}\} \\ s_4\rightarrow\{m_{221},m_{96},m_{32}\} \\ s_5\rightarrow\{m_{221},m_{102},m_{39}\} \\ s_6\rightarrow\{m_{221},m_{96},m_{32}\} \\ s_7\rightarrow\{m_{22},m_{15}\} \\ s_8\rightarrow\{m_{102}\} \\ s_9\rightarrow\{m_{32}\} \end{pmatrix}$$

According to Rule 2 of the implementation of opposition relations described in the previous chapter each agent attaches a reliability measure to each meaning set. In

THESIm this measures are random values from [0,1] uniform distribution. For the example agent, who has not interacted with anyone so far has a reliability matrix shown in Table 1. where, the left column represents the meanings and the right column represents the corresponding reliabilities.

Table 1. Reliability Matrix of an Hypothetical Agent

$$\begin{pmatrix} 22 & 0.2445 \\ 221 & 0.1045 \\ 102 & 0.836 \\ 96 & 0.7843 \\ 15 & 0.0387 \\ 39 & 0.2383 \\ 32 & 0.1355 \end{pmatrix}$$

Cultural Practice

In THESIm cultural practice is a repeated application of Rule 3, Rule 4, Rule 5 and Rule 2 introduced in implementation deconstructionist algebra. Cultural practice or interaction of agents consists of many steps. In Hammond and Axelrod's (2006), ethnicity simulation agents interact only with their immediate neighbors. In THESIm, there is no such restriction. An agent can interact with any agent in some place of the habitat.

Cultural Practice – Step One

At every step of the simulation run habitat is populated by agents that managed to survive in the previous step plus some new offsprings. Most of the interactions are implemented as random trials and errors. Consequently at the initial step of cultural practice, THESIm first randomly sorts the available agents and then constructs a random square matrix, where the number of rows and columns is equal to the number of available agents in the habitat. It is worth nothing that the pseudo – random numbers are generated using an algorithm that generates double-precision values in the closed interval [2^(-53), 1-2^(-53)], with a period of (2^19937-1)/2. On the other hand THESIm constructs random square matrix with random values in [0,1] interval with reduced precision, 16 digits after the decimal.

To this random square matrix, identities of the agents are concatenated as a lead row (row number 1) and as a lead column (column number 1). Thus at this stage matrix is at the following format (Figure 32),

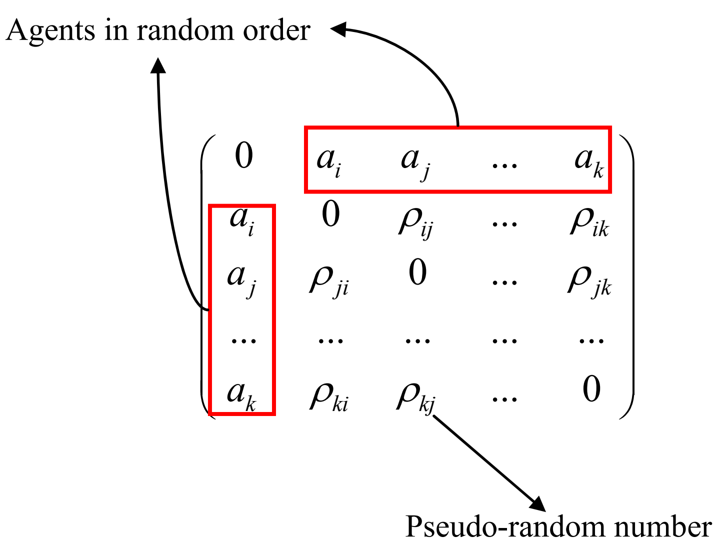

Figure 32. Random matrix of agents.

According to the deconstructionist framework, a cultural practice, thus an interaction has two sides; active and passive. Using random matrix of agents, THESIm constructs active and passive pairs. However before the identification of the active and the passive sides of the interaction there is one more operation. In THESIm, any agent can interact with another agent in the habitat. However as the distance between agents increase, their chances to interact decrease. This idea has been implemented in THESIm by adjusting the random matrix of agents according to the distance. For this purpose simulation calculates the distance between each pair of agent in the random matrix.

Previously, it is explained that agents' addresses are stored as indices. In order to calculate the distance matrix, first, indices of agents are reverted back to their habitat addresses. Then the distance between two agents ***i*** and ***j*** is calculated with respect to metric, $d(a_i, a_j) = \left|row_i - row_j\right| + \left|column_i - column_j\right|$. This metric is clearly non-euclidean but serves the purposes in THESIm.

On the other hand this metric must respect the neighborhood concept explained above. Thus for instance, the distance between an agent and its neighbor must be calculated with respect to the distance function as 1.

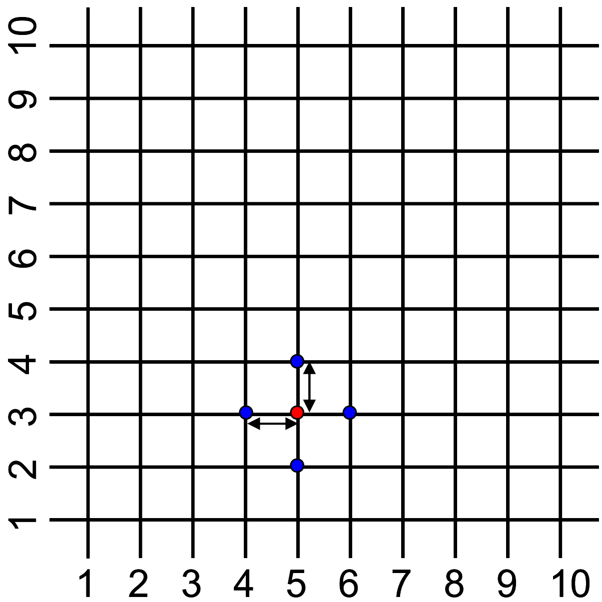

Figure 33. Distance between agents.

But although agent at (1,1) and agent at (10,1) are neighbors, distance function calculates the distance between these agents as 9. Hence the distance function is adjusted as follows,

$$d(a_i, a_j) = \min\left(\left|row_i - row_j\right|, sizehabitat - \left|row_i - row_j\right|\right) + \min\left(\left|column_i - column_j\right|, sizeofhabitat - \left|column_i - column_j\right|\right)$$

In this manner not only immediate neighborhood concept but also neighbor of a neighbor concept is preserved. This means, since an agent at (1,1) is a neighbor of an agent at (2,1), and an agent at (10,1) is a neighbor of the agent at (1,1), the distance between the agent at (2,1) and the agent at (10,1) must be equal to 2. The adjusted form of the distance matrix calculates,

$$\begin{aligned} d &= \min(|2-10|, 10-|2-10|) + \min(|1-1|, 10-|1-1|) \\ &= \min(8,2) + \min(0) \\ &= 2 \end{aligned}$$

As the distance between two agents increases, their chance of interaction decreases. Therefore the initial random matrix is adjusted with respect to distance matrix calculated in the previous section (Figure 34).

$$\underbrace{\begin{pmatrix} 0 & a_i & a_j & \dots & a_k \\ a_i & 0 & \rho_{ij} & \dots & \rho_{ik} \\ a_j & \rho_{ji} & 0 & \dots & \rho_{jk} \\ \dots & \dots & \dots & \dots & \dots \\ a_k & \rho_{ki} & \rho_{kj} & \dots & 0 \end{pmatrix}}_{\text{Random matrix of agents}} \qquad \underbrace{\begin{pmatrix} 1 & a_i & a_j & \dots & a_k \\ a_i & 1 & d_{ij} & \dots & d_{ik} \\ a_j & d_{ji} & 1 & \dots & d_{jk} \\ \dots & \dots & \dots & \dots & \dots \\ a_k & d_{ki} & d_{kj} & \dots & 1 \end{pmatrix}}_{\text{Distance matrix of agents}}$$

$$\underbrace{\begin{pmatrix} 0 & a_i & a_j & \dots & a_k \\ a_i & 0 & \frac{\rho_{ij}}{d_{ij}} & \dots & \frac{\rho_{ik}}{d_{ik}} \\ a_j & \frac{\rho_{ji}}{d_{ji}} & 0 & \dots & \frac{\rho_{jk}}{d_{jk}} \\ \dots & \dots & \dots & \dots & \dots \\ a_k & \frac{\rho_{ki}}{d_{ki}} & \frac{\rho_{kj}}{d_{kj}} & \dots & 0 \end{pmatrix}}_{\text{Adjusted Random matrix of agents}}$$

Figure 34. Preparation of distance adjusted random matrix.

Active and passive agents of interaction are matched using the following algorithm:

i. Select the first agent in the rows; that is a_i. Record this index as the active side of the interaction.

ii. Find the column with the greatest random number. For demonstration purposes assume that it is the second column.

iii. Record the index of the agent that leads this column as the passive side of the interaction.

iv. Record the active – passive agents pair for Step 2 in cultural practice.

v. Delete active agent's row so that another agent becomes the first agent.

vi. Delete passive agents column so that he can not be passive side anymore in this step.

vii. Repeat until adjusted random matrix of agents becomes null.

Cultural Practice – Step Two

Pairs that attempt to interact are identified at Cultural Practice – Step 1. According to Rule 4 in implementation of deconstructionist algebra, active side in each pair signals a randomly selected symbol and a meaning with maximum reliability. THESIm respects this rule and records this symbol and corresponding meaning. In the next phase, this signal is received by the passive agent, who triggers Rule 3 in implementation of deconstructionist algebra. Thus THESIm checks the symbols – meanings correspondence of the passive agent. If in this correspondence and for that particular symbol, the meaning send by the active agent is found, then agents make sense of each other and are recorded as a pair of success for interaction. Otherwise interaction attempt fails and agents cannot interact.

Cultural Practice – Step Three

After Cultural Practice – step two, agents that are able to make sense to each other are recorded. This record is merged with a cumulative record of previous successful interaction attempts. In every run of the simulation, pairs in this updated record are allowed to interact. Interaction takes place in an autonomous economic sphere. Both active and the passive side use their strategies in an aim to generate positive returns, to increase their endowments. In THESIm, the cumulative recorded interactions, which keeps the information of active agent, passive agent, symbol and meaning is randomized in rows at each turn.

Interactions of agents change the endowment of both parties. If the interaction results in an increase for both parties, active and passive sides carry the interaction for the next turn also and increase the reliability of the meaning according to calculus of prospect theory, $r_{t+1} = r_t + e^{\alpha}$, explained in Rule 5 in implementation of deconstructionist algebra. Here ***e*** is the increase in endowment for an agent. THESIm calculates the new reliability for the meanings for both agents.

Otherwise, if for at least one agent, either active or passive side, economic interaction decreases endowment then according to Rule 5 in implementation of deconstructionist algebra, meaning reliabilities are decreased, $r_{t+1} = r_t - \lambda(e)^{\beta}$. Here ***e*** is minus the decrease in endowment for an agent. Agent that felt unhappy with the interaction breaks the relationship and this record is deleted from the cumulative recorded interaction matrix.

<u>Cultural Practice – Step Four</u>

After Cultural Practice – step three, there may be some interactions that end up with negative adjustments in reliabilities. If after these adjustments, reliability of a meaning falls down below zero, then that meaning is pruned from the meaning collection of the corresponding agent according to Rule 1 in implementation of deconstructionist algebra. At this stage THESIm checks for the cover property of the meaning collection. If it finds a problem, fixes the problem by adding the trivial meaning(s) for the uncovered symbol(s).

Reproduction

At each turn of the simulation, agents are randomly ordered for reproduction to generate new offsprings that resemble them. Reproduction depends on a couple of factors. First, it depends on the relative endowment of the agent multiplied by a chance factor. Formally, this requirement is satisfied if, $\frac{e_i}{\sum_j e_j} > \pi.\rho$,where e_i is the endowment of the agent, $\sum_j e_j$ is the social welfare, π is some constant that controls the birth rate, ρ is a pseudo – random number from [0,1] uniform distribution. Second constraint is there must be an empty space among the neighbors of the agent.

If both constraints are satisfied an offspring is born with default endowment, similar strategy, identical tag index representing the semiotic community that the agent belongs to, identical meaning collection set, identical symbol – meaning correspondence and finally identical matrix of reliabilities for each meaning in his meaning collection to that of the parent. Similar strategy means that, new offspring's strategy differs from the parent up to 10%. Here is the line of code that implements this logic,

```
ALLAGENTS{doughterstrategy}=min(0.5,max(0,ALLAGENTS{motherstrategy}+
(rand*.2-.1)));
```

In THESIm there is also a controlled chance of mutation. If an agent is born as a mutant, then his meaning collection differs with 10% from the parent. This is achieved by first deleting the 10% of the meaning collection of the parent and adding with new random meanings that are generated from the identical opposition relation of the parent.

<u>Death</u>

In order to open new places for offsprings, at each turn of the simulation some agents die. The number of these agents is controlled with a ratio of population. Furthermore if an agent has negative endowment he dies before random deaths. In brief the algorithm works as follows:

i. Number agents that will die is calculated as a ratio of the current population which is typically 3-5%.
ii. Agents with negative endowments die and deduced from the number calculated in the previous step.
iii. Other agents randomly ordered. The ones that are matched with small random numbers die.

CHAPTER 6

DATA ANALYSIS

The social simulation model defined in the previous chapter is developed in order to understand the dynamics that constitute embedded social networks.

Credibility of simulation models depends on both the correctness of the model and accurate formulation of targeted social phenomenon (Balci, 1994). Sargent (2004, 2005) considers the model development process in simulation studies using the diagram in Figure 35.

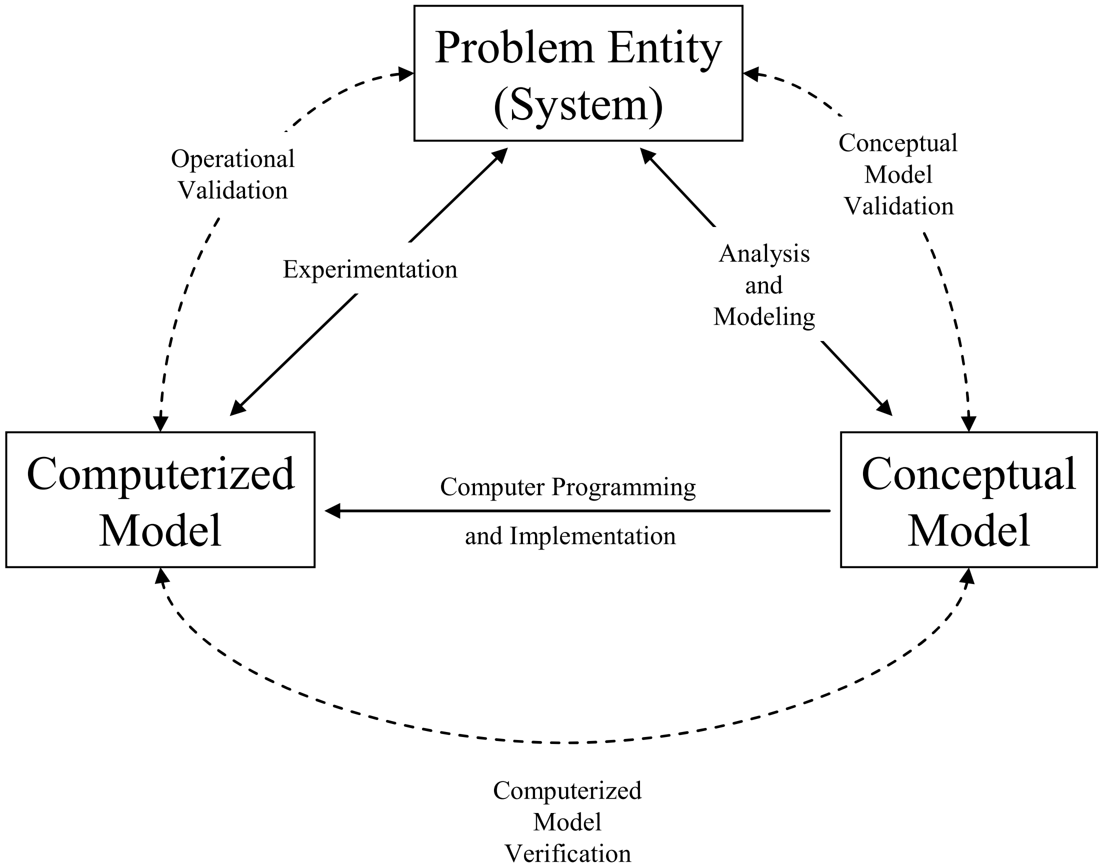

Figure 35. Simulation modeling process (adopted from Sargent, 2004,2005).

In this chapter all of the arrows in Figure 35 are processed for the simulation model of the thesis, THESIm. Thus the chart representing general phases of simulation modeling processes is specified for THESIm in Figure 36.

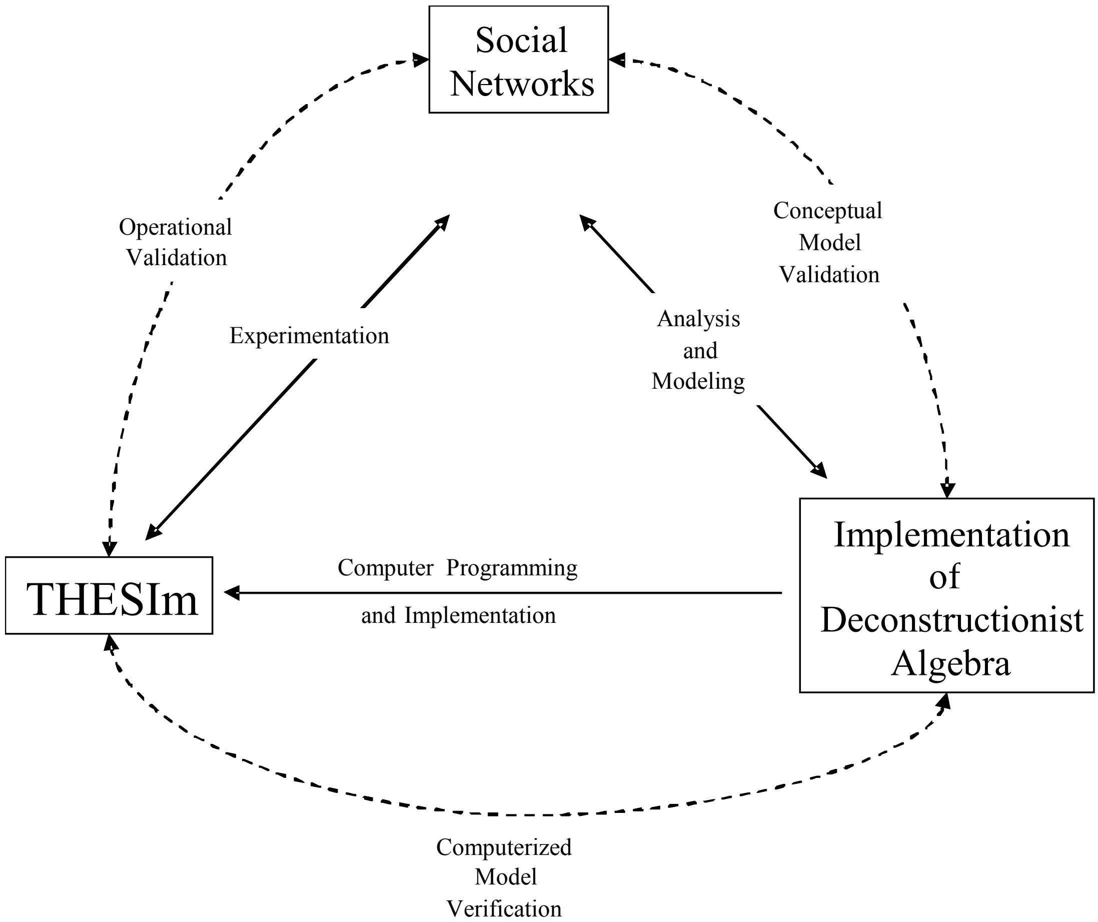

Figure 36. Modeling process of THESIm.

Conceptual model validation is about testing the credibility of the theories and assumptions underlying the conceptual model and the model representation of the problem entity is "reasonable" for the intended purpose. The conceptual theory behind THESIm is built over Sewell's (1999) cultural social action theory. In Chapter 4 it is argued that the construction of meaning sets with respect to a binary opposition relation defined over a set of symbols is not a decomposable task and requires a methodological approach. This approach is developed in Chapter 4 and needs conceptual validation. Thus, conceptual validation of the simulation process involves extraction of binary opposition relations of semantic societies and comparing the resulting relations among symbols with the findings from the literature that focus on the same semantic societies. One point needs immediate clarification. First four rules that are listed in the implementation of deconstructionist framework section belong to Sewell's (1999) cultural social action theory and are assumed to be valid. Same is also true for the last rule which is due to Kahneman and Tversky (1979). Consequently, conceptual validation is performed only for the constructs developed in this thesis.

Computerized model verification is defined as assuring that the computer programming and implementation of the conceptual model is correct. In most of social simulation models this step is skipped, the proficiency of the scientist in programming and implementing the conceptual model is assumed to be sufficient. In this chapter computerized model verification is performed by analyzing one complete epoch in THESIm and comparing the results with the rules presented in the implementation of the deconstructionist algebra in Chapter 4.

Operational validation is determining that the model's output behavior has sufficient accuracy for the model's intended purpose over the domain of the model's intended applicability. THESIm is constructed to associate cultural endowment of a group to their tendency in establishing an embedded social network. However the model is expected to generate social networks, embedded or not, that resemble the networks observable in real life.

Baum et al. (2003) characterized social networks that are empirically observable with four frequently shared features. One is these networks are typically sparsely connected with actual ties between actors representing only a small proportion of the possible relations. Second is that they are decentralized without one dominant actor to which most of other actors are directly connected, and instead characterized by the presence of competing subgroups consisting both central and peripheral actors. Third is that they are cliquey, with most partners of any given actors connected to each other and not to outsiders. Finally fourth feature, spanning trees or ‘shortcuts’ that connect actors in one clique to actors in other cliques, dramatically shortens the average path length.

Watts (1999) defined two topological indices in order to measure a network’s ability in satisfying these four properties. Thus operational validation of THESIm involves testing the output networks of the model with the indices developed by Watts(1999).

Conceptual Model Validation

A simulation model of a complex social system or social phenomena is only an approximation like all other models in social sciences, regardless from how much time, effort and resources are devoted. Therefore conceptual validation of a model, in particular a simulation model is not absolute. In fact a model is supposed to an abstraction and simplification of reality (Law, 2005).

Conceptual model validation has two components. One is the focused social phenomena, which are social networks. Second component is the theoretical model constructed to analyze or formalize the social phenomena, which is the deconstructionist algebra. Related to the first component, the aim of this section is to analyze qualitative data related to social networks. Qualitative data includes documentaries of utterances of members that belong to semantic societies. Data is examined by structural analysis (cognitive map) methodology. Structural analysis of qualitative data involves application of factor analysis, word co-occurrence matrices, and dimensional plotting to describe the relations among words.

Result of the structural analysis of the data is interpreted in the cultural framework according to deconstructionist algebra and then this interpretation is compared with other models from the literature. In this regard first, social networks of semantic societies observed in Turkish economic life (Keyman and Koyuncu, 2005) in the form of business associations, TÜSİAD and MÜSİAD, are briefly described. Second, data collection methodology on these associations is explained. Third, interpretation of data according to deconstructionist algebra is presented. Fourth, this interpretation is compared with the findings of Keyman and Koyuncu (2005) on TÜSİAD and MÜSİAD.

TÜSİAD and MÜSİAD

The Association of Turkish Industrialists and Businessmen (hereafter TÜSİAD) was established on 2 April 1971 by the twelve leading industrialists of Turkey. In the foundation Memorandum, the target of the association is declared as contributing to Turkey's achieving the standards of living and industrialization already attained by the developed western world (the TÜSİAD Founders Memorandum: cited from Keyman and Koyuncu, 2005). As of December, 2006, TÜSİAD has 566 members, composed of owners and managers of individual firms, groups of companies and holding companies operating in the Turkish manufacturing and service sectors. The number of companies represented by these members is approximately 1300 (TÜSİAD Brochure, 2007).

The companies represented by TÜSİAD's membership represent prominent positions in the Turkish economy. In 2005, TÜSİAD's member company's total sales volume is $121.9 billion. These companies employ more than 583,000 people. Table 2 shows the share of TÜSİAD's member companies in Total Exports of Turkey.

Table 2. Share of TÜSİAD's Member Companies in Total Exports of Turkey.

Exports (billion $)		1997	1999	2000	2005
TÜSİAD	(1)	9.2	12.5	13.1	28.1
Total Exports of Turley	(2)	26.2	26.6	27.8	73.5
Share of TÜSİAD	(1/2)	35.10%	46.80%	47.20%	38.20%

In the mission statement in TÜSİAD Brochure (2007), it is stated that, TÜSİAD is committed to the universal principles of democracy and human rights. It upholds the freedom of enterprise, belief and opinion. TÜSİAD seeks to promote the development of social structure in tandem with Atatürk's principles and reforms. TÜSİAD has six branch offices; in İstanbul, Ankara, Brussels, Washington, Berlin and Paris.

The Association of Independent Industrialists and Businessmen (hereafter, MÜSİAD) was established on 5 May 1990. It is now the largest business association in Turkey with nearly 3,000 members and 10,000 firms (Keyman and Koyuncu, 2005). The identity of MÜSİAD in their web page is stated as:

> dedicated to creating a developed country with advanced high-tech industry within a highly developed commercial environment, but without sacrificing national and moral values, where labor is not exploited and capital accumulation is not degraded and where the distribution of income is just and fair, a country with peace at home, influence in the region. Members of the organization committed to social and economic development in the country by promoting production in industry, honesty and fairness in trade, high ethical and moral politics. They are dedicated to finding solutions to the problems of Turkey, Islamic countries in the region and mankind in general. (MÜSİAD website)

Members of MÜSİAD are mostly in located in Central and Eastern Anatolian cities and are mainly export oriented. As of 2002, MÜSİAD members have nearly $35 billion share in Gross National Product (Keyman and Koyuncu, 2005).

Data

Deconstructionist cultural framework requires qualitative data that presents the utterances of members of a semantic society. In this regard organizational publications of both TÜSİAD and MÜSİAD are collected. MÜSİAD has a quarterly issued periodical, *Çerçeve*, that has been send to all of its members, some academicians and selected institutions. Director of R&D and Publications, Hüseyin Kahraman informed me that they are distributing more than 4,000 copies of the periodical. Periodicals are around 120 pages on the average. Each issue is focused on a particular topic. Other than the articles of academicians that are proficient on the topic, either articles or interviews of a fixed group of members are present in each issue. Furthermore, success stories of three members are also given in interview format in every issue. Starting from January 2001, periodical is scanned into image files in the headquarters of MÜSİAD. These files have been converted to text by an optical recognition software. The articles written by academicians are filtered out and the utterances of members are recorded as data related to MÜSİAD.

Unfortunately the corresponding periodical of TÜSİAD, *Görüş*, is not being published until September, 2004. Therefore, the speeches of TÜSİAD directors that are available from the web page of TÜSİAD starting from January 2001 are used. There are 94 speeches within this interval and each speech is on the average three pages. Speeches can be classified in two broad groups. Almost half of the speeches are focused on a particular topic which coincides with the topics covered in the periodical of MÜSİAD. Other half consist of a macro evaluation of economic and political dynamics, expectancies of TÜSİAD members, generally in the form of messages to governments, and the agenda of the organization. These documents have been scanned, processed with an optical recognition software.

Data obtained from two sources as uttered texts are analyzed with structural analysis. Regarding structural analysis methodology, Carley and Palmquist (1992) and D'Andrade (1995) argued that if cognitive schemata of individuals exist, they are expressed in the form of texts of people's speech and can be represented as network of concepts. Even small set of texts contain the information required for describing models (Ryan and Bernard, 2000).

The first step in structural analysis is the extraction of key concepts or themes in a text which are also called "codes". Codes are found by a human coder who reads the text and note the main themes. Codes can also be found by referring to scientific articles on the concept. Alternatively codes can be assigned to words (nouns) that frequently occur in a text. Except for the last method, code finding is subjective and the results of the qualitative analysis depend on who does the coding. Different coders produces different network of concepts by making different coding choices. The relationships between the concepts are interpreted as positive or negative causations (Carley, 1993). On the other hand third choice in code finding is objective but requires more data than the first two code finding methods. Also this method interprets relationships between concepts as associations, equivalencies or similarities rather than causations.

Coding process involves assigning the relevant codes to every paragraph in the text. This process has been applied in a qualitative data analysis software, QDA

Miner. If in a paragraph, for instance four words that are assigned as codes appear than the association between these four words is increased. Since some paragraphs may involve negations of some codes and at the same regular usages of some other codes, in order to prevent erroneous associations, if a word is used as a code then its negation is also added to the code set, like “secular” and “not-secular”. In some situations antonyms of a code also belongs to the code set. Even in these situations negations of both of the words are added to the code set. In Table 3, forty five codes which are extracted by the methodology described above are grouped as economy-politic and values. Negations of the codes are not shown in this table. Hence in total there are 90 codes.

Table 3. Codes Extracted from Data Obtained from Organizational Documentaries of TÜSİAD and MÜSİAD.

economy politic	capital markets
economy politic	civil rights
economy politic	community (egalitarian)
economy politic	consumption
economy politic	democracy
economy politic	dense networks (solidarity)
economy politic	development
economy politic	east Asia
economy politic	economic stability
economy politic	education
economy politic	EU
economy politic	foreign capital
economy politic	free market
economy politic	freedom
economy politic	globalization
economy politic	individual
economy politic	innovation
economy politic	Kemalist
economy politic	liberal
economy politic	long horizon (strategically)
economy politic	private sector
economy politic	privatization
economy politic	production
economy politic	quality
economy politic	rationalism
economy politic	rule of law
economy politic	secular
economy politic	state
economy politic	success
economy politic	transparency

values	altruistic
values	confidence
values	cultural
values	ethical
values	fair
values	hard work
values	honesty
values	Islamic
values	moral values
values	national values
values	Peace (*huzur*)
values	tradition
values	trust
values	western culture
values	modern

Coding of a paragraph is demonstrated with an example. The following paragraph is a translation from the original Turkish version to English, appeared in *Çerçeve* with education as the focused topic, issue number 37, December 2005, from the article "*İlim kendin bilmektir*" by Olcan Yazıcı.

> Does real prosperity exist in the accumulation of knowledge and virtue, or is it in profit and benefit? How will mankind balance in a peaceful route within "To be" and "To have"? Philosopher Schopenhauer says "The poorest person in the world is the one who has nothing other than money". Thus, should the purpose

> of education be to trigger the practical intelligence in earning money or to equip the individual with transcendent merits and morality? (p: 86)[28]

Clearly the codes “education”, “peace” and “moral values” are discussed in this paragraph. Although the word “rationality” is not present in the text, its discursive meaning “profit maximization” is mentioned in a negative tone. Thus paragraph is coded with “not-rationality” also. This coding increases the association between the codes “education”, “peace”, “moral values” and “not-rationality”. As an important note; the coding of this paragraph with “not-education”, “not-peace”, “not-moral values” and “rationality” is not equivalent to the first coding. The paragraph must be coded with the tone it represents.

When the coding of all paragraphs is completed structural analysis measures can be applied on the data. Co-occurrence analysis involves clustering and proximity measures for codes. In Figure 37, the clusters are formed according to data obtained from utterances of MÜSİAD members. In Figure 38 the clusters are formed according to the utterances of TÜSİAD members.

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[28] Original Turkish version of the text :
Gerçek zenginlik, bilgi ve erdem birikiminde mi, yoksa kâr ve kazançta mı? 'Olmakla-sahip olmak!' arasında nasıl sağlıklı bir çizgide denge kuracak insanoğlu? Filozof Schopenhauer, "Dünyanın en yoksul insanı, paradan başka hiçbir şeyi olmayandır" diyor. Öyleyse eğitimin amacı, para kazandıran pratik zekâyı harekete geçirmek mi, yoksa kişiyi üstün meziyetlerle/faziletlerle mücehhez kılmak mı olmalı?

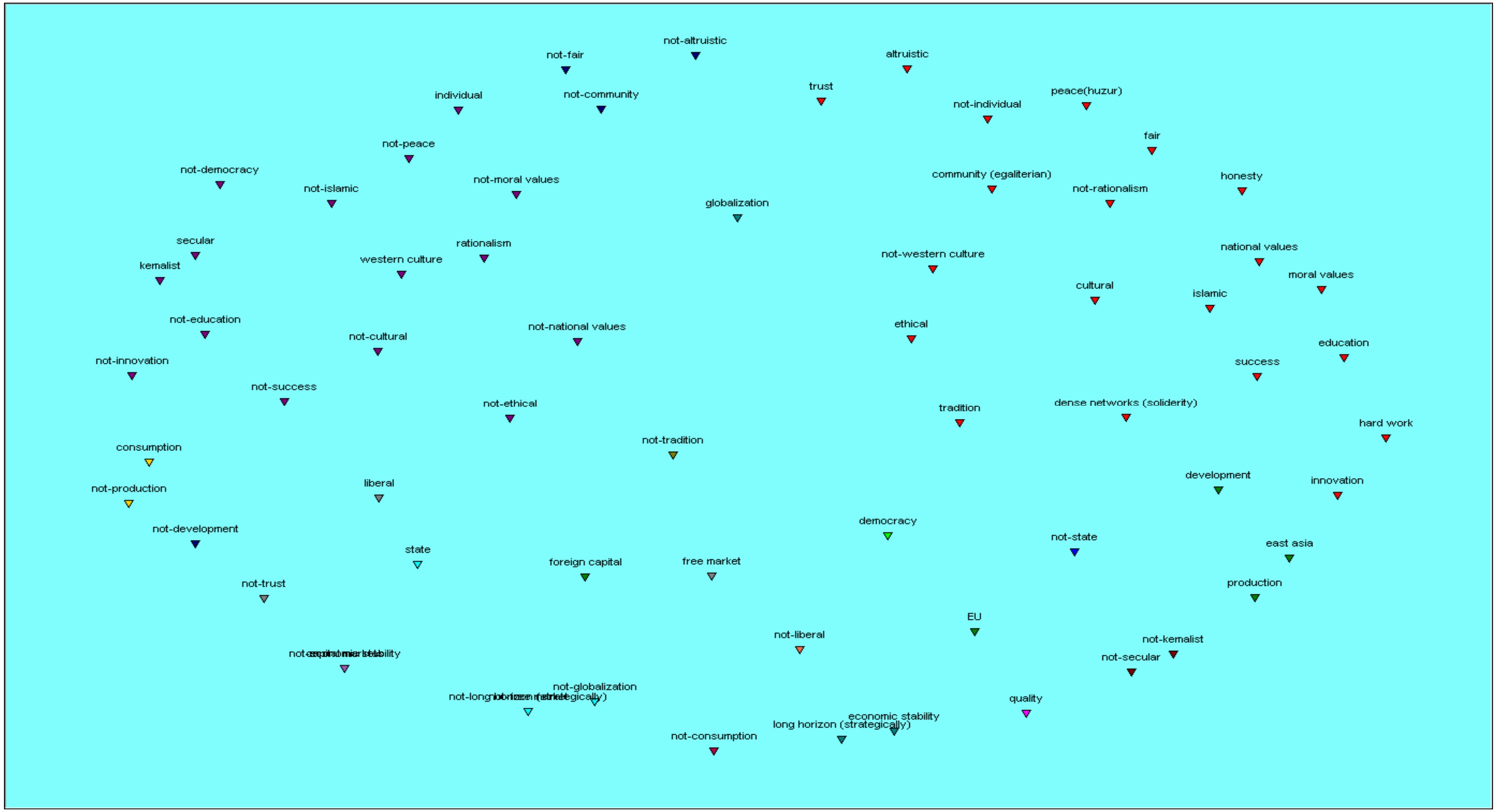

Figure 37. Clustering of codes of MÜSİAD members.

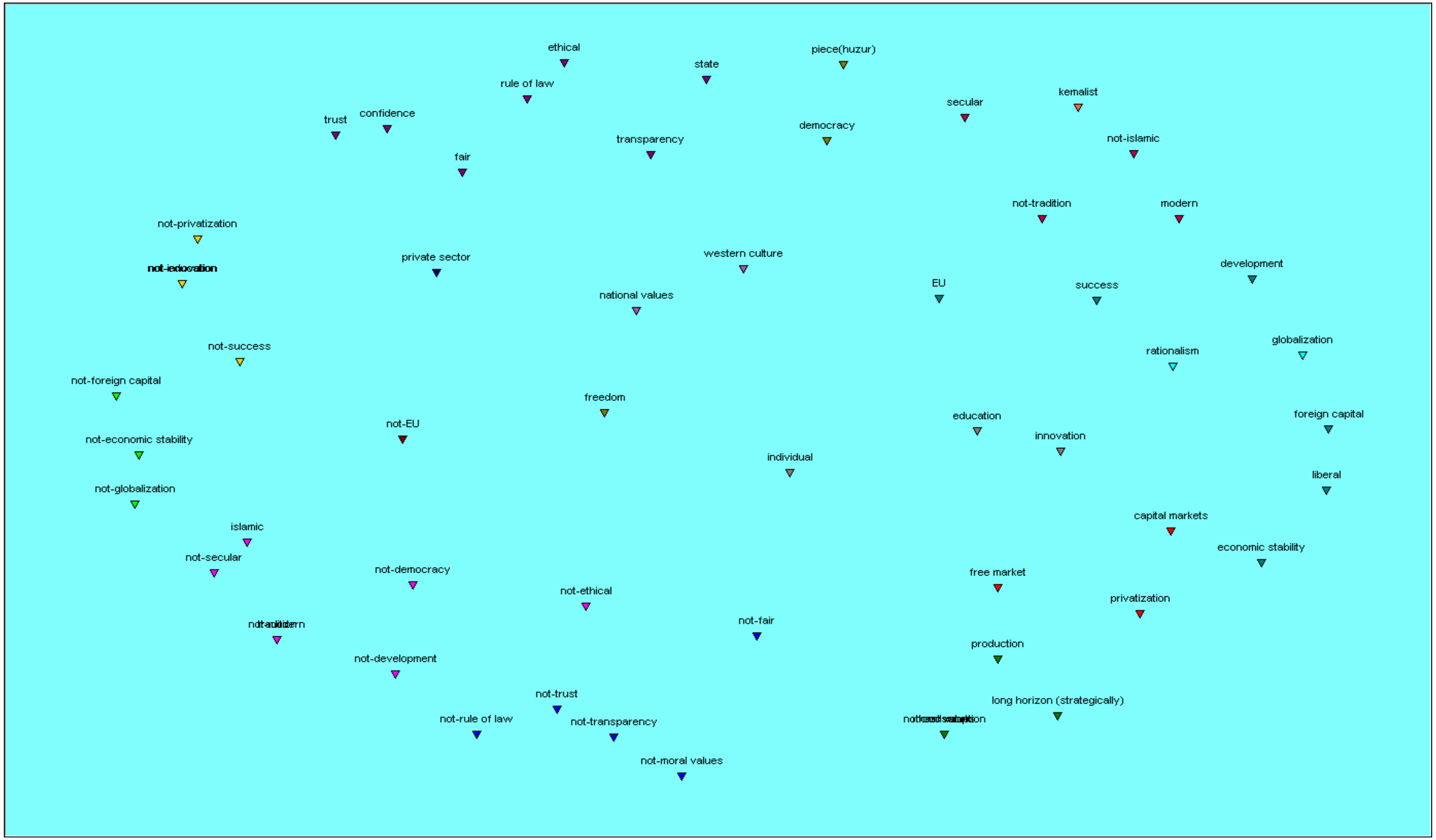

Figure 38. Clustering of codes of TÜSİAD members.

<u>Interpretation with respect to Deconstructionist Algebra</u>

Deconstructionist algebra is built upon binary opposition relations of symbols. Since each code is a symbol, oppositions between symbols are induced from association of a symbol with the negation of another symbol. Proximity table shows the relationships of symbols from where the oppositions can be extracted. For instance, the proximity table of "Altruistic" presented in Table 4. The code column shows the codes that have positive proximity to the code "Altruistic". "Co-Occurs" column represents the number where "Altruistic" occurs with the particular code. "Do Not" column shows the number where the selected code occurs in the absence of "Altruistic". "Is Absent" column displays the number where "Altruistic" is present in the absence of the relevant code.

Table 4. Proximity Table of the Code "Altruistic" for MÜSİAD Members.

CODE	CO-OCCURS	DO NOT	IS ABSENT	Jaccard	
not-individual	4	8	6	0.222	•••••••••••
not-rationalism	5	20	5	0.167	••••••••
community (egalitarian)	6	27	4	0.162	••••••••
moral values	4	21	6	0.129	••••••
Islamic	5	33	5	0.116	••••••
dense networks (solidarity)	2	9	8	0.105	•••••
fair	1	11	9	0.048	••
not-western culture	1	12	9	0.045	••
hard work	1	15	9	0.04	••
ethical	1	15	9	0.04	••
education	2	45	8	0.036	••

From the proximity table it is evident that the symbol "Altruistic" opposes symbols "individual" and "rationalism" for MÜSİAD members. Although "not-western culture" co-occurred with "Altruistic" symbol one time, Jaccard coefficient is too low. Jaccard coefficient is a measure that shows the association of two symbols. In this thesis, opposition relations are constructed with respect to a threshold value of 0.1 in Jaccard coefficients. The opposition relation for MÜSİAD and TÜSİAD members are extracted in this logic. Figure 39 shows binary opposition relation of MÜSİAD members extracted with the qualitative data obtained from the coding of the organizational journal *Çerçeve*. Figure 40 displays binary opposition relations of TÜSİAD in the same code system applied to TÜSİAD directors’ speeches. Conceptual validity of these opposition relations depends on the conformity to previous findings about MÜSİAD and TÜSİAD in the literature.

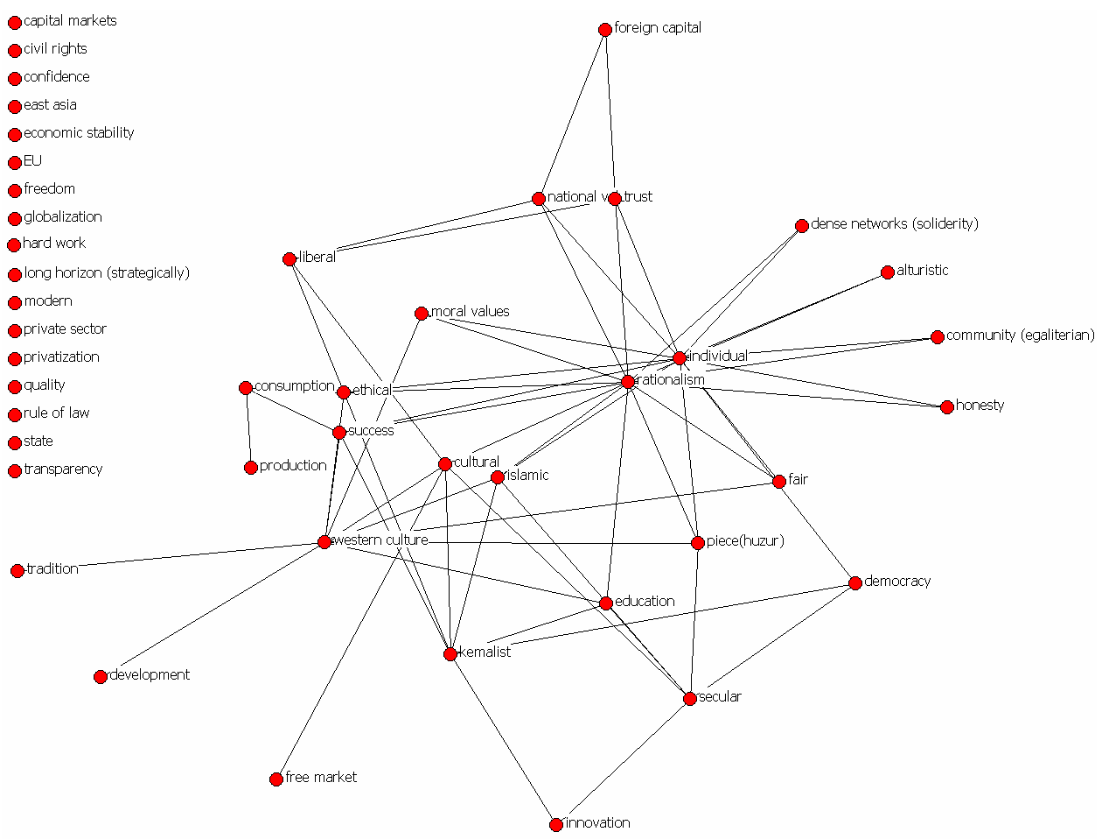

Figure 39. Binary Opposition Relation of MÜSİAD members with respect to data obtained from organizational documentaries.

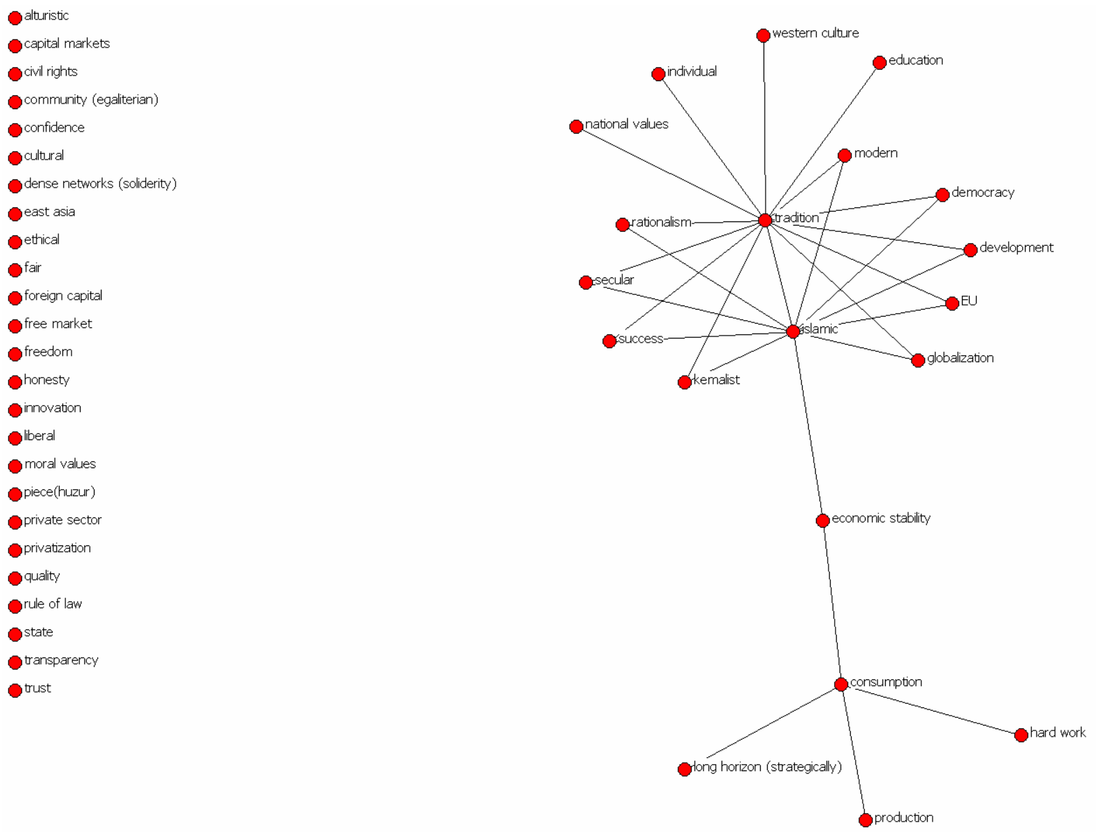

Figure 40. Binary Opposition Relation of TÜSİAD members with respect to data obtained from organizational documentaries.

Conceptual Validation of Binary Opposition Relations

There are two studies in the literature that are focused on TÜSİAD and MÜSİAD. First study is by Ayse Buğra in 1998. In this study Buğra focused on the diversity of class and ideology manifestations of the members of these business associations. The methodology of the study is qualitative analysis of speeches, documentaries, audiovisual shows, and one to one interviews. Unfortunately the period scanned by this study is incompatible with the period that has been focused in extracting the binary opposition relations in this thesis. Second study, by Keyman and Koyuncu in 2005 involves an in-depth analysis of TÜSİAD and MÜSİAD. This study also analyzes qualitative data obtained by interviews with the leaders of the associations, content analysis of their publications, and reports and public speeches. Although binary opposition relations extracted in the previous section also involves an additional two years period onto 2005, the study of Keyman and Koyuncu (2005) is used as the benchmark for conceptual validation.

Keyman and Koyuncu (2005) characterize the perspective of TÜSİAD members in five categories:

i. The process of integration to the EU constitutes the most important supra – national relations and it will determine the future of Turkey by contributing to advancing the level of both political modernization and economic development of Turkish society.

ii. Globalization brings about a new culture in economic life, that is, it forces the economic actors to acquire "new economic rationality" in accordance to which they are supposed to act, prepare economic strategies, and take decisions. This is only possible by technological innovation and quality maintenance. New economic rationality implies the advocating of knowledge and information over tradition and long term strategies over short term strategies.

iii. The rise of cultural identity which has taken the forms of resurgence of Islam and the "Kurdish Problem" and the need for the protection of civil rights require a democratic organization of the state-society relations and rule of law as the fundamental basis of state power.

iv. Democratization is the necessary condition for the elevation of Turkey to the first league nations in world affairs.

v. TÜSİAD positions itself against the politicization of the identity and recognition – claims of Islamic and Kurdish movements. TÜSİAD sees such politicization as an attempt that denounces rather than promotes democracy. Consequently, co – existence between western values and the religious and ethnic identity politics is possible as far as cultural life in Turkey is concerned and that is only possible by a liberal model of citizenship in which modern self accepts the primacy of individual rights over cultural identity claims, and acts according to the rule of law, and expresses his/her cultural identities in private sphere.

From (i.), it is induced that "modernization", "EU" and "development" symbols must not have opposition relationships with each other. In Figure 40, these symbols do not oppose each other. According to (ii.) "globalization", "rationality", "innovation" and "long-term strategy" symbols must not oppose. On the other hand "tradition" symbol opposes with "rationality" and "globalization". These requirements are present in the opposition relation in Figure 40. In (iii), "democracy" and "rule of law" do not oppose, which is satisfied in the opposition relation. From (iv.) "democracy", "success" and "development" symbols must not oppose with each other. Opposition relation extracted in the previous section satisfies this constraint. Finally, in (v.) "development" opposes "Islam" and it is also present in the opposition relation.

Keyman and Koyuncu (2005) elaborate characteristics of MÜSİAD members on the basis of five categories:

i. Globalization creates interconnectedness among societies, economies and cultures, and sets the rules of the game which requires rational thinking and long-term strategies. MÜSİAD advocates EU membership. MÜSİAD attributes a positive quality to globalization because it is as a result of the globalization of market relations that a suitable ground was created for the "rise and success of economic Islam" (Öniş, 1997: cited from Keyman and Koyuncu, 2005).

ii. MÜSİAD is founded on Islamic principles such as the feeling of trust and solidarity, the primacy of community over the individual, the discourse of the just self over the self interested actor, the privileged status of ethical codes over individual morality. Islamic discourse is more compatible with globalized market relations than the existing state – supported bourgeois class as it creates the relation of trust and solidarity in economy. East Asian development model is an example to the strategic with between traditional institutions that regulate social relations and the requirements of global markets that leads to success. As opposed to western industrial model this model is based on the culture of traditional values embedded in family or religion. East Asian model is an alternative to the nonviable capitalist development and centers its activities on '*Homo Islamicus*' which is the proper ethical basis for economic development, rather than '*Homo Economicus*' that has given rise to a self centered individualistic morality.

iii. Islamic discourse is open to economic and technological innovation, compatible with free trade and capitalism and able to create sources of wealth. MÜSİAD support long-term and rational strategies. Economic Islam promotes capitalism as economic globalization but situates it in Islamic discourse as its cultural basis. MÜSİAD articulates Islam with economic globalization, but at the same time creates societal vision, based on the primacy of cultural/communitarian identity individualistic morality.

iv. MÜSİAD is against secularism as the existing politico-economic order promotes Islam.

v. MÜSİAD does not support liberalism; it accords primacy to community over the individual. Self – identity is discursively constructed and defined over community but not individuality.

In (i.) it is seen that the binary opposition relation of MÜSİAD members must not involve opposition between "globalization", "EU", "Islam" and "success". Opposition relation extracted and displayed in Figure 39, satisfies these constraints. In (ii.) "Islam", "trust" and "solidarity" do not oppose each other. "Community" opposes "individual". "Moral values" opposes "individual". "East Asian does not oppose "traditional". "Western culture" opposes "tradition" and "Islam". "Islam" opposes "individual". "Ethics" does not oppose "development". All of these constraints are satisfied in the opposition relation in Figure 39. From (iii.), "Islam" does not oppose "tradition", "free trade" and "success". They are satisfied in the opposition relation. In (iv.) "secularism" opposes "Islam". This opposition is present in the opposition relation. Finally in (v.) "individual" opposes "community" and "liberal". Although the opposition between "community" and "individual" is present, data analyzed in this thesis does not support the opposition between "liberalism" and "individualism".

In sum, binary opposition relation methodology is conceptually validated. Extracted binary opposition relation is coherent with the findings of Keyman and Koyuncu (2005). Thus, deconstructionist algebra built over opposition relations of symbols is a conceptually valid representation for semantic societies.

Computerized Model Verification

In order to verify that THESIm actually obeys the rules that describe the implementation of deconstructionist algebra, scenarios that can be manually computed are compared with the simulation outputs. Kleijnen (1995) argues that simulation programs are big and good programming requires that the computer code be designed modularly. In that case, simulation can be verified module by module. Following this advice THESIm has been programmed in six linear modules so that it can be easily analyzed for verification. The modules of THESIm are presented in Figure 41. Each module is explained in detail with schematic representation. All analysis in the following sections use random data.

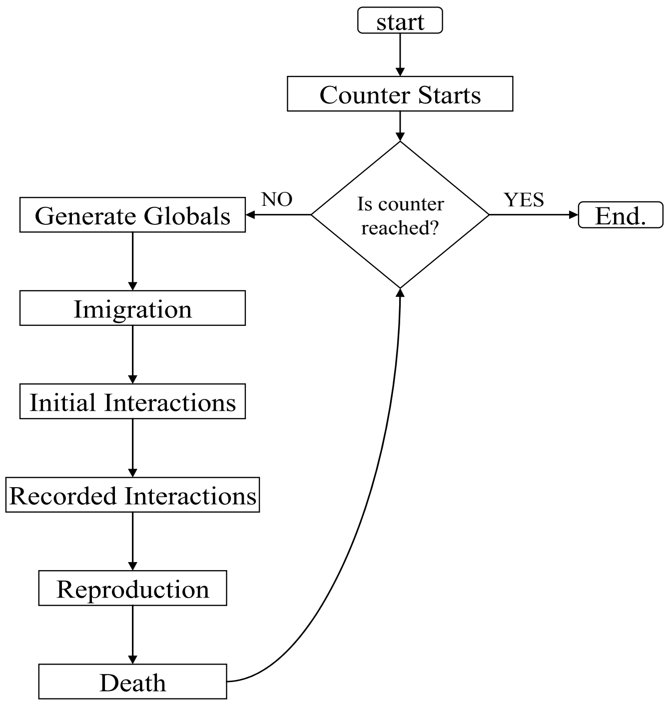

Figure 41. Run diagram of THESIm.

Globals

This module is responsible for generating the initial common variables that are going to be used in the proceeding modules of the simulation and preparing the random number generator seed of the mainframe which is MATLAB 7.4. In every initialization of MATLAB, the random number generator seed is set to exactly the same number so that independent of the hardware profile, MATLAB responds to “rand” command which means generate a random number as 0.8147. In order to guarantee that each run of the simulation is independent of each other, random number seed is set to a multiple of system clock.

In Chapter 4, it is argued that the symbol set is common to all society. In this manner, agents in THESIm, uses a unique symbols set but different opposition relations. In this respect the number tags controls the number of opposition relations that is used in the simulation. Hence “tag number” many binary opposition relations are randomly constructed in this module also. The screenshot below in Figure 42 verifies that the module successfully works till this phase.

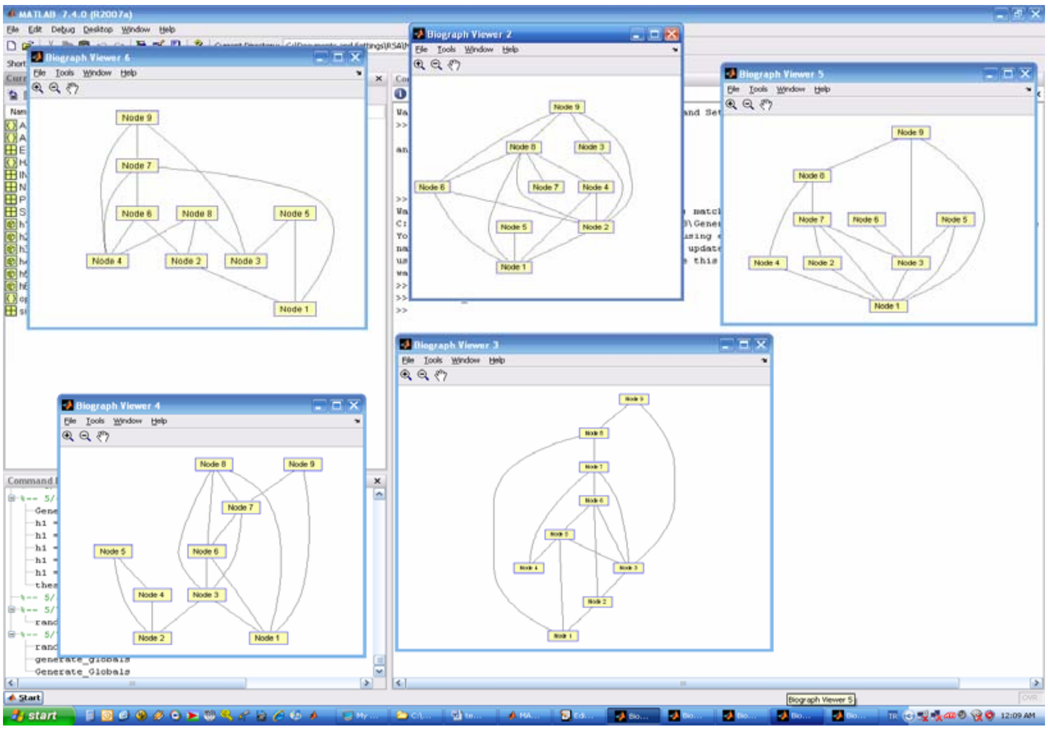

Figure 42. Screenshot that displays five opposition relation over the set of symbols.

Here, the number of symbols is given as nine; number of tags is set to five. Module also generates the meaning generating sets of each opposition relation and all possible meanings (not meaning collections). For instance for the binary opposition relation displayed in Figure 43,

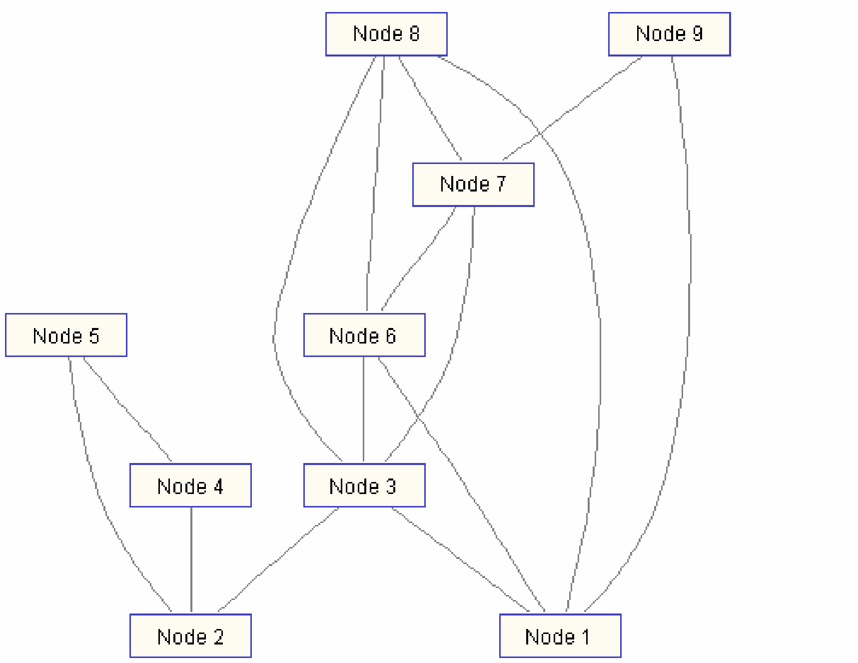

Figure 43. An arbitrary binary opposition relation constructed in Generate Globals module.

The meaning generating set represented in matrix form is;

$$\begin{pmatrix}
1 & 2 & 7 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 4 & 7 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 5 & 7 & 0 & 0 & 0 & 0 & 0 & 0 \\
2 & 6 & 9 & 0 & 0 & 0 & 0 & 0 & 0 \\
2 & 8 & 9 & 0 & 0 & 0 & 0 & 0 & 0 \\
3 & 4 & 9 & 0 & 0 & 0 & 0 & 0 & 0 \\
3 & 5 & 9 & 0 & 0 & 0 & 0 & 0 & 0 \\
4 & 6 & 9 & 0 & 0 & 0 & 0 & 0 & 0 \\
4 & 8 & 9 & 0 & 0 & 0 & 0 & 0 & 0 \\
5 & 6 & 9 & 0 & 0 & 0 & 0 & 0 & 0 \\
5 & 8 & 9 & 0 & 0 & 0 & 0 & 0 & 0
\end{pmatrix}$$

This meaning generating set defines 41 distinct meanings:

10	1	2	0	0	0	0	0	0	0
50	1	2	7	0	0	0	0	0	0
12	1	4	0	0	0	0	0	0	0
61	1	4	7	0	0	0	0	0	0
13	1	5	0	0	0	0	0	0	0
65	1	5	7	0	0	0	0	0	0
15	1	7	0	0	0	0	0	0	0
21	2	6	0	0	0	0	0	0	0
91	2	6	9	0	0	0	0	0	0
22	2	7	0	0	0	0	0	0	0
23	2	8	0	0	0	0	0	0	0
94	2	8	9	0	0	0	0	0	0
24	2	9	0	0	0	0	0	0	0
25	3	4	0	0	0	0	0	0	0
99	3	4	9	0	0	0	0	0	0
26	3	5	0	0	0	0	0	0	0
103	3	5	9	0	0	0	0	0	0
30	3	9	0	0	0	0	0	0	0
32	4	6	0	0	0	0	0	0	0
116	4	6	9	0	0	0	0	0	0
33	4	7	0	0	0	0	0	0	0
34	4	8	0	0	0	0	0	0	0
119	4	8	9	0	0	0	0	0	0
35	4	9	0	0	0	0	0	0	0
36	5	6	0	0	0	0	0	0	0
122	5	6	9	0	0	0	0	0	0
37	5	7	0	0	0	0	0	0	0
38	5	8	0	0	0	0	0	0	0
125	5	8	9	0	0	0	0	0	0
39	5	9	0	0	0	0	0	0	0
42	6	9	0	0	0	0	0	0	0
45	8	9	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0
2	2	0	0	0	0	0	0	0	0
3	3	0	0	0	0	0	0	0	0
4	4	0	0	0	0	0	0	0	0
5	5	0	0	0	0	0	0	0	0
6	6	0	0	0	0	0	0	0	0
7	7	0	0	0	0	0	0	0	0
8	8	0	0	0	0	0	0	0	0
9	9	0	0	0	0	0	0	0	0

These meanings can be used to generate numerous meaning collections characterized in Chapter 4. In the meanings matrix the first column represents the labels of the meanings. These labels are also set by identifying the rows of the power set of the set of symbols. For instance since the number symbols in this run is set as nine then the power set contains $2^9 = 512$ rows. As the theorem in Chapter 4 prescribes, each meaning is a subset of at least one element in the meaning generating set.

Module also creates an empty square habitat, empty agents matrix and an empty interactions matrix that are used in the proceeding modules of THESIm. Since these variables are only initialized in this matrix their verifications are shown in the modules that they are operationalized. This concludes the verification of Globals module.

Immigration

At each loop of the simulation displayed in Figure 41, an immigrant is placed in a random empty address in the habitat. In the initial run, the number of immigrants is a variable of the simulation. Hammond and Axelrod (2006) also used the idea of immigrants in a similar way in their ethnicity simulation in order to enrich the diversity of the agent profile. Immigration module works as follows:

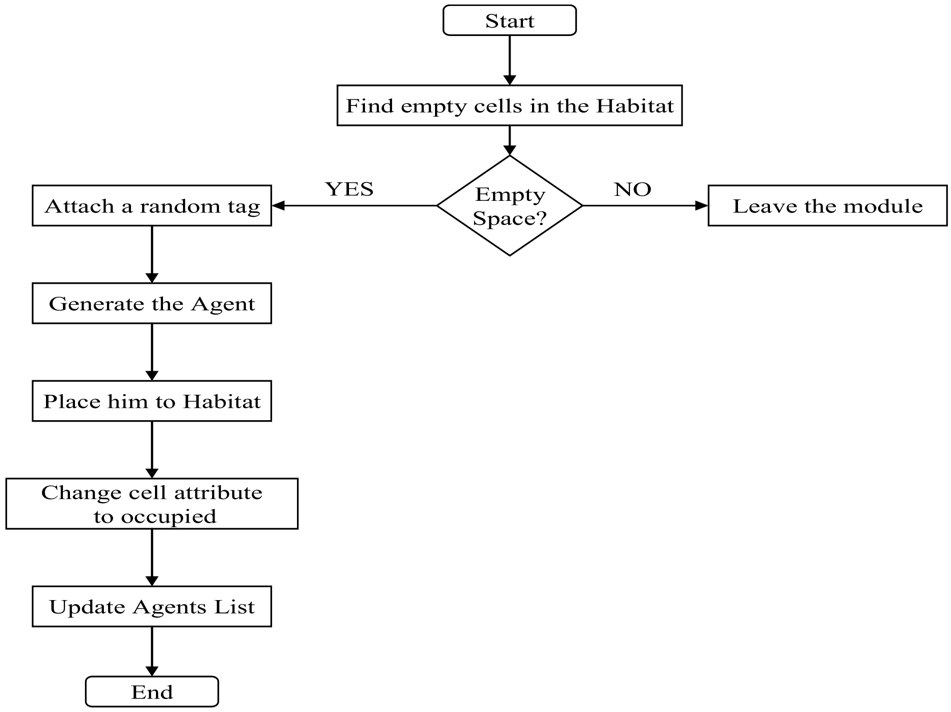

Figure 44. Run diagram of Immigration Module.

Module first seeks empty cells in the habitat. If there is none then it leaves the module. On the other hand if there is at least one unoccupied cell in the habitat, module reserves this address for the immigrant. If there is more than one empty cell, module randomly orders the cells and selects the address of the immigrant from this random list. After the address of the immigrant is set, module sets a random tag to the immigrant. Module then generates other characteristic which is discussed below and changes the attribute of the immigrant's address in the habitat from empty to full. After recording immigrant to the agents list module ends.

The simplest way to verify this module is the immigration of maximum number of agents to the habitat in the initial run. At this situation it is checked that the code successfully leaves the module after filling the habitat. In immigration module the most important sub-module is Generate the Agent sub-module. This sub-module randomly generates an agent according to agent characteristics discussed and verified by an example in the previous chapter.

Initial Interactions

This module sets the behavior of purposive agents that aim to create new economic ties in order to increase their endowments. This module works as in Figure 45. Module starts with getting the list of agents in the habitat. This list is randomized. Random matrix of agents which is explained in Chapter 5 is constructed (Table 5). In order to verify this phase, THESIm is run with 5 agents in the habitat. The random list of agents is : {32,74,29,39.81}. These indices of agents represent their addresses in the habitat as explained previously. For instance, agent named "74" is in cell (8,4) in the habitat.

Table 5: Random Matrix Created for Five Agents.

0	32	74	29	39	81
32	0.6206	0.4216	0.277	0.5622	0.2266
74	0.4508	0.9576	0.3538	0.6442	0.1897
29	0.6486	0.4528	0.5888	0.9605	0.7625
39	0.3283	0.8294	0.8536	0.4543	0.6269
81	0.8551	0.0738	0.3542	0.8299	0.0356

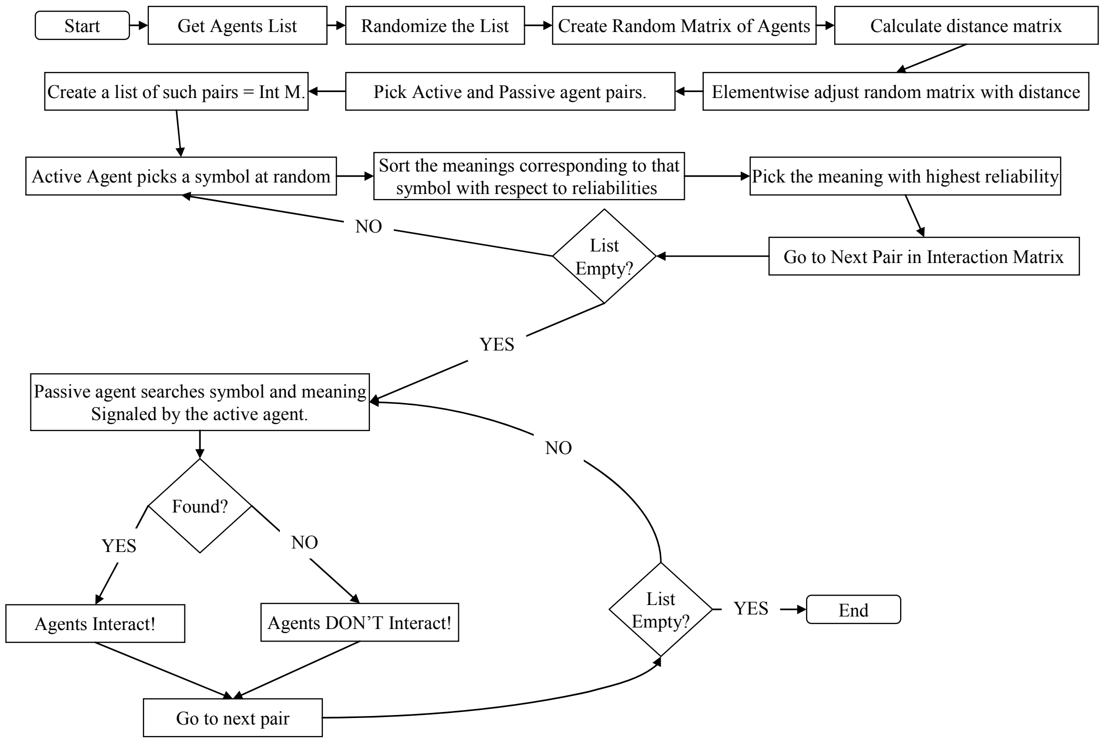

Figure 45. Run diagram of initial interactions module.

In the next step of the module, distance matrix for the agents is calculated, which is also explained in Chapter 5 (Table 6).

Table 6. A Distance Matrix Constructed for Five Agents

0	32	74	29	39	81
32	-1	6	4	3	6
74	6	-1	10	9	4
29	4	10	-1	1	6
39	3	9	1	-1	7
81	6	4	6	7	-1

Then each entry in the Random matrix of agents is divided by the corresponding entry in the distance matrix. The principle idea here is that as distance between agents increase, their probability to interact decrease. The resulting Adjusted Random matrix of agents is show in Table 7.

Table 7. Distance Adjusted Random Matrix of Agents

0	32	74	29	39	81
32	-0.6206	0.0703	0.0693	0.1874	0.0378
74	0.0751	-0.9576	0.0354	0.0716	0.0474
29	0.1621	0.0453	-0.5888	0.9605	0.1271
39	0.1094	0.0922	0.8536	-0.4543	0.0896
81	0.1425	0.0185	0.059	0.1186	-0.0356

After calculating this matrix, module picks active and passive agent pairs. First active agent is "agent 32" which is in the first column. Within this column the greatest value is 0.1621, which corresponds to "agent 29". Thus "agent 29" is matched with "agent 32" as the passive agent. Module calculates the pairs (Table 8).

Table 8. Active and Passive Agent pairs in an Interaction.

$$\begin{pmatrix} 32 & 29 \\ 74 & 39 \\ 29 & 32 \\ 39 & 81 \\ 81 & 74 \end{pmatrix}$$

Next, module emulates the symbol selection of active agents. For each active agent and the corresponding symbols the meaning with the highest reliability is selected. For instance, for the first pair (Agent 32, Agent 29), "Agent 32" selects "symbol 9". Module first checks the corresponding meanings that cover symbol 9 which are found to be [93 39 172 70 72 17]. Module checks these meanings and their reliabilities. The meaning collection of "Agent 32", and reliabilities of each meaning is displayed in Table 9.

Table 9. The Meaning Collection and Reliabilities of “Agent 32”.

22	0.5252
2	0.3909
23	0.4406
6	0.9166
93	0.3408
53	0.3684
41	0.5519
39	0.738
7	0.7703
172	0.5269
70	0.1518
15	0.3196
72	0.4674
37	0.377
34	0.5077
17	0.0559
8	0.2727

Clearly, “meaning 39” has the highest reliability for “symbol 9” for “Agent 32”. Similarly other active agents selects a symbol at random and a meaning corresponding to that symbol with the highest reliability. Module obtains Table 10.

Table 10. List of Active and Passive Agents, Symbol Sent by Active Agent to Passive Agent and the Corresponding Meaning of the Symbol that Active Agent Prefers.

32	29	9	39
74	39	5	38
29	32	9	93
39	81	5	37
81	74	6	60

So far, the verification of Rule 4 of implementation of deconstructionist algebra has been established. Next, the module searches the symbol-meaning for each passive agent. In order see this process in detail the meaning for the corresponding symbols of each passive agent is displayed.

Table 11. Symbol – Meaning Correspondence of Passive Agents.

29	9	[93 58 149 24 79 44 9]
39	5	[39 ***38*** 36 37 26]
32	9	[***93*** 39 172 70 72 17]
81	5	[20 215 87 86 38 ***37*** 124]
74	6	[115]

Some entries in Table 11 are emphasized. For passive "Agent 29", the signal received from "Agent 32" does not produce an interaction because these agents do not agree on the meaning of a selected symbol. However, pairs (74, 39), (29, 32), (39, 81) make sense to each other, thus they interact. This completes the verification of Rule 3 of implementation of deconstructionist algebra. Thus the verification of the Initial Interactions module is completed.

Recorded Interactions

Initial interaction matrix generated in the previous module is merged into a matrix called recorded interactions matrix. Recorded interaction matrix is composed of pairs of agents that continue to interact with each other. At each turn of the simulation, new pairs of agents are added and some pairs of agents leave this matrix. Previous section describes the mechanism that governs how new pairs are added to recorded interactions matrix. The mechanism that explains how pairs are deleted from this matrix is explained in this section. Furthermore the interactions of the pairs are emulated in this module. Recorded interactions module works as follows:

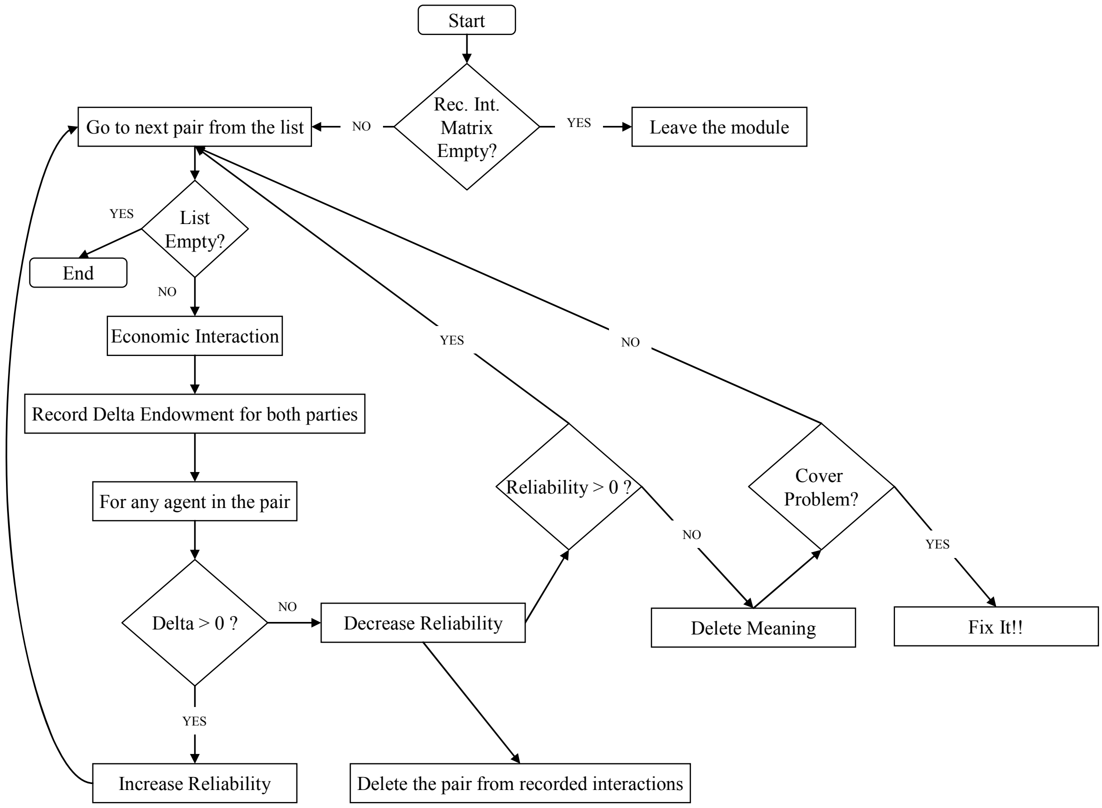

Figure 46. Run diagram of Recorded Interactions Module

Module starts with a check on the size of the recorded interactions matrix. If it is empty then module is leaved. Otherwise interaction between each pair in the matrix is executed one by one. As a result of this interaction endowments change. Module records the change in the endowments of both parties. In Figure 46, the change in endowment is referred as delta endowment. If delta is positive for both parties then reliabilities for the corresponding meaning is increased according to the mechanism explained in Chapter 5. Otherwise, that is, if for at least one of the party member delta is negative, then for that agent corresponding reliability is decreased according to the mechanism explained in Chapter 5. At this stage module checks whether the reliability of the meaning fell below zero. If this is the case, meaning is deleted from all entries of the relevant agent. Module checks whether there is a cover problem and if there is one fixes it.

Thus this module implements Rule 5 and Rule 2 and Rule 1 of implementation of deconstructionist algebra. For the verification of Rule 5, a run with 30 agents is displayed below. In this run following pairs are added to the recorded interaction matrix (Table 12).

Table 12. Pairs Added to the Recorded Interaction Matrix.

Active Agent	*Passive Agent*	*Symbol*	*Meaning*
35	23	3	25
38	39	8	29
55	44	1	17
88	96	4	53
92	82	7	7
93	74	1	15

For verification fifth and sixth rows of this matrix is focused. From the fifth row, it is read that “Agent 92” signaled “Symbol 7” to “Agent 82” and they arrived at a mutual understanding of this symbol via “Meaning 7”. This makes an economic interaction possible for these agents. Matrix below represents agent indices, corresponding endowments and strategies (Table 13). It is observed that from the interaction of “Agent 92” and “Agent 82” both parties benefited. On the other hand from the interaction for “Agent 93” and “Agent 74” only “Agent 74” benefited but “Agent 93” suffered a loss.

Table 13. Initial Endowments and Strategies of Agents.

Agent #	Endowment	Strategy
92	0.5227	0.1594
82	0.6571	0.0481
93	0.4845	0.2918
74	0.7869	0.0697

Endowment of each agent is calculated as follows:

$$0.5227 = 0.5 + 0.0481 - 0.1594^2$$
$$0.6571 = 0.5 + 0.1594 - 0.0481^2$$
$$0.4845 = 0.5 + 0.0697 - 0.2918^2$$
$$0.7869 = 0.5 + 0.2918 - 0.0697^2$$

Module also updates reliabilities of meanings according to success in interaction. In order to verify this mechanism, an interaction with positive benefits for both parties and an interaction with positive benefit only one party is demonstrated. In a run of THESIm, "Agent 8" and "Agent 18" have mutual understanding for a symbol and generated positive benefits for both sides in an interaction. Matrix below summarizes pre and post interaction data (Table 14).

Table 14. Pre and Post Interaction Data.

Agent #	*Strategy*	*E (t=0)*	*E(t=1)*	*Symbol*	*Meaning*	*Rel(t=0)*	*Rel(t=1)*
8	0.4686	0.5	0.562114	1	15	0.7386	0.782
18	0.2817	0.5	0.889245	1	15	0.3617	0.437
38	0.2758	0.5	0.4464	3	26	0.677	0.3546
39	0.0224	0.5	0.7753	3	26	0.5899	0.6578

According to the matrix, "Agent 8" increased the reliability of "Meaning 15" from 0.7386 to 0.782. Similarly "Agent 18" has increased the reliability of "Meaning 15" from 0.3617 to 0.437. The mechanism behind these calculations obeys value function calculus of prospect theory explained in section Chapter 5. This completes the verification of Rule 5 and Rule 2 of implementation of deconstructionist algebra.

In conclusion, computer programming and implementation of the conceptual model, deconstructionist algebra is correct. Hence THESIm is computationally verified.

Operational Validation

Operational validation is determining that the model's output behavior has sufficient accuracy for the model's intended purpose over the domain of the model's intended applicability. THESIm is constructed to associate cultural endowment of a group to their tendency in establishing an embedded social network. However the model is expected to generate social networks, embedded or not, that resemble the networks observable in real life.

Baum et al. (2003) characterized social networks that are empirically observable with four frequently shared features. One is these networks are typically sparsely connected with actual ties between actors representing only a small proportion of the possible relations. Second is that they are decentralized without one dominant actor to which most of other actors are directly connected, and instead characterized by the presence of competing subgroups consisting both central and peripheral actors. Third is that they are cliquey, with most partners of any given actors connected to each other and not to outsiders. Finally fourth feature, spanning trees or 'shortcuts' that connect actors in one clique to actors in other cliques, dramatically shortens the average path length.

Watts (1999) defined two topological indices in order to measure a network's ability in satisfying these four properties. Thus operational validation of THESIm involves testing the output networks of the model with the indices developed by Watts(1999).

In order to validate THESIm operationally, 2000 independent runs of THESIm is recorded. In each run approximately 200.000 interactions occur within agents. A typical interaction network as an output of THESIm is shown in Figure 47.

Here agents are diversified according to their belief structures or in the terminology formalized in the thesis, they are diversified according their binary opposition relations over the symbol set. This figure shows agents with strong ties. That means a link within any two agent implies that they make sense in at least two symbol – meaning pairs.

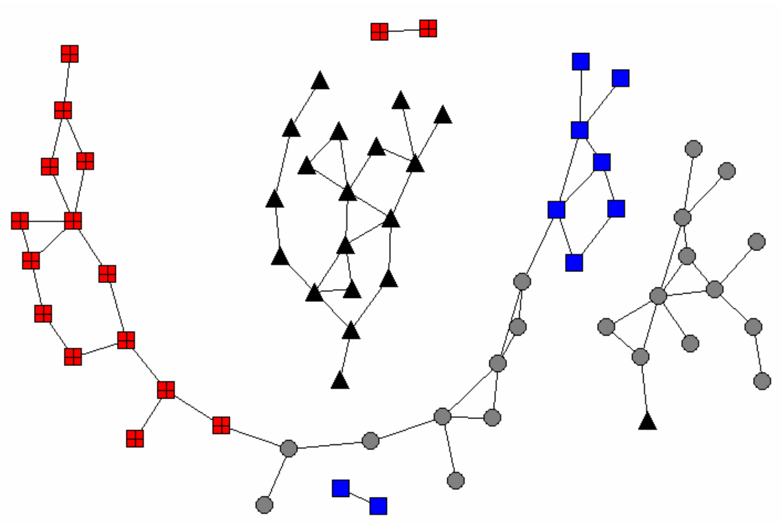

Figure 47. Interaction network of strong ties.

On the other hand interaction network displayed in Figure 48 shows all types of interaction between agents. The strength of ties is a function of the average number of links between agents in a particular run of THESIm. The interaction networks are drawn with UCINET from the data obtained from MATLAB.

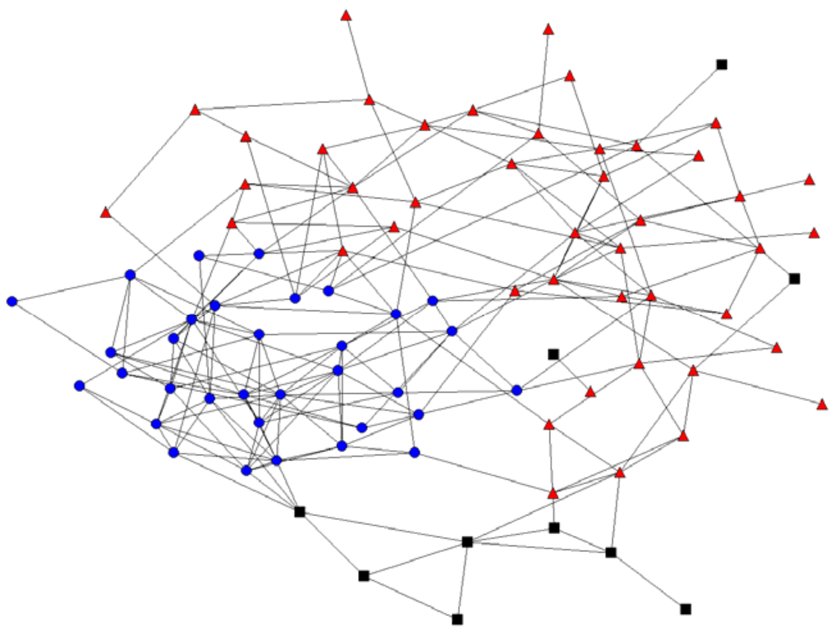

Figure 48. An interaction network with both weak and strong ties.

A crucial point in simulation studies is to set the stop point in a typical run. If the simulated dynamics converges to a stable state then the intuitive stopping point would be the convergence, since nothing much changes about the characteristics of the network after this step. The situation gets complicated if this is not a case for a simulation. In particular the dynamics of the simulation perturbates at each step into different forms then the researcher has few options other than visualizing some critical parameters and then defends the stopping point of the simulation in terms of these parameters (Gilbert and Troitzsch, 2005).

Due its underlying deconstructionist logic THESIm has no clear stable convergence, therefore the number of steps indicated as the stopping point need clarification. In this regard in Figure 49, the number of interactions during 1000 steps of THESIm is shown. Although this number significantly depends on the similarity of the randomly selected binary opposition relations of the population, number of distinct binary oppositions and finally the death rate implemented, the common characteristic is that after 300 iterations in other words after step 300, the number of interactions matures and changes within a band. For instance in Figure 49, after 300 iterations, number of interactions locked within 400 and 700. This characteristic does not change for 2000, 5000, 10000, 20000, and finally 100000 iterations. Thus, I have selected 600 as the stopping point of THESIm for two reasons: first, the volatility in the interactions is due to appearance and disappearance of weak ties and by 600 iterations a high percentage of strong ties are already established. Second, 600 iterations last for a moderate time for a simulation research which is about 4 minutes with a Pentium IV - 3 GHz processor. As the number of iterations increases this number increases linearly. In this regard 2000 runs of THESIm requires 200 uninterrupted hours of processing or equivalently about eight and a half days period. However data is obtained by making use of parallel runs of many computers instead of relying on just one computer. In particular, a computer laboratory that consists of 25 computers all of which are Pentium 4 with 3 GHz microprocessors are utilized for 12 hours. Finally as a last note, completely random data is used in the analyses in the following sections.

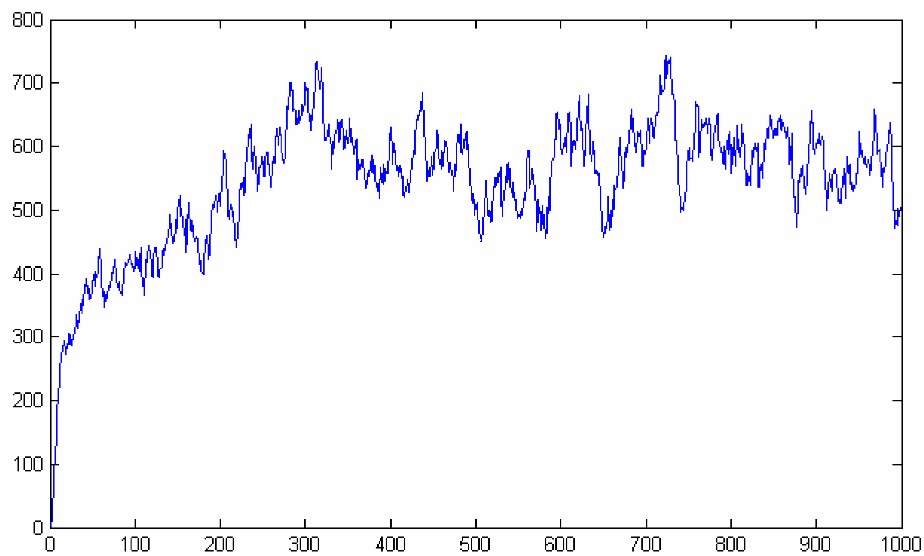

Figure 49. The number of interactions between agents in THESIM versus simulation steps.

Triads and Complete Networks

A triad is a network structure that consists of three nodes and their links to each other. Uzzi and Spiro (2005) showed that characterizing structural properties of a given network in particular observable interfirm networks over triads methodologically corresponds to analyzing the network topology as a whole. Watts (1999) characterized interfirm networks which are also called small world structures using two indices; characteristic coefficient and average path length. Average path length (*L*) is the average number of ties along the shortest path between any two nodes (i.e. agents) in a network. Thus the unit of analysis of this measure is the global network, because determining the shortest path length between any two nodes (agents) requires information about the topology of the entire network (Baum et al., 2003). On the other hand, the clustering coefficient (*C*) is a measure of local network structure. Local network structure is defined as a focal agent and his k interacting partners. Clustering coefficient is the ratio of existing ties to number of possible ties [$k(k-1)/2$]. This fraction is then averaged over all nodes (agents) in a network. In practice high values of L indicate that resources, such as information, must pass through a large number of intermediaries to travel between agents in the network. Whereas, high values of C indicate that the network is comprised of densely interconnected cliques.

In tandem with Kogut and Walker (2001), Baum et al. (2003) and Uzzi and Shapiro (2005) the following summary statistic indicates the presence and absence of small world:

$$SW = \frac{C_A / C_R}{L_A / L_R}$$

Here, C_R and L_R represents benchmarks indices developed by Watts (1999). Here $C_R = k/n$ and $L_R = \ln(n)/\ln(k)$. If a network is a small world network, it should exhibit a much larger clustering coefficient than the benchmark $(C_A > C_R)$, and a characteristic path length approximately equal to the benchmark result $(L_A \sim L_R)$.

Unfortunately, there is no generally accepted critical value for SW in the literature. Among organizational networks Uzzi et al. (2002) report SW = 2.72, Davis et al. (2003) report an average of SW = 4.87, Kogut and Walker (2001: cited from Baum et al., 2003) found SW = 22.46 and Baum et al. accepted SW = 4 as an acceptable value for small world phenomena. Kogut and Walker (2001: cited from Baum et al., 2003) indicate that SW should generally increase with the number of nodes in the focal network. In this logic, since Baum et al. studied 87 nodes networks, their benchmark of SW = 4 for existence of small world phenomena is accepted as a proxy for operational validation of THESIm.

Small world index is a powerful indicator (Baum et al., 2003) of observable social network structures since it distinguishes a random network (SW = 1) from a real life network.

Calculation of average path length is one of the hardest problems of graph theory and it is computationally expensive in both coding and processing respects. Also calculation of clustering coefficient geometrically increases with the number of links in a focal network[29]. The major problem in the calculation of SW index is the situation where there are some disconnected sub – networks. In this case average path length is computed as infinite and SW index is calculated as zero. In Table 15, descriptive statistics of a random sample of networks generated by THESIm is computed. From this table it can be concluded that all outputs of THESIm satisfies Small World property with the constraint that networks are not disconnected which is clearly a parameter controlled by the similarity of beliefs of agents in the population. This in return implies that THESIm is operationally validated.

Table 15. Descriptive Statistics of SW Index Computed for Networks Obtained from THESIm.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std.	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
SW Index	59	4.57	5.68	10.25	7.5879	.12246	.94062	.885
Valid N (listwise)	59							

[29] In order to calculate average path length in MATLAB, functions that are involved in Bioinformatics toolbox is used. Unfortunately this package is not installed in Istanbul Bilgi University Computer Laboratories. A single attempt of calculation SW index for a network produced by THESIm takes on the average 25 minutes. In order to produce Table 15, 73 runs are performed. 14 runs produced disconnected networks for which SW index can not be computed.

CHAPTER 7

DISCUSSION

The objective of this thesis is to understand the dynamics that constitute embedded social networks. This requires construction of a dynamic model in a cultural framework.

A cultural framework describes social action in reference to cultural endowments. Hence the model in this dissertation associates the necessary cultural endowments of a social group to an index that measures the embeddedness of the network structure established by the group. Therefore inputs to the model are cultural endowments of groups and outputs of the model are network structures that have embeddedness indices in a plethora. Thus the methodology of such a model depends on the definition of "cultural endowment" and "embedded social networks".

According to Coleman (1988) embedded social networks possess a distinguishing topological property.

> All social relations and structures facilitate some forms of social capital; actors establish relations purposefully and continue them when they continue to provide benefits. Certain kinds of social structure, however, are especially important in facilitating some forms social capital. One property of social relations on which effective norms depend is what I will call closure. (Coleman, 1988: p.105).

In the similar vein Lin (1999) proposes that dense or closed networks are seen as the means by which collective capital can be maintained and reproduction of the group can be achieved. Closure is a topological property defined over triads. A triad is closed if all members of the triad are linked to each other (Figure 50b.). Since the existence of a triad requires three nodes and at least two links, Figure 50 displays all forms of triads.

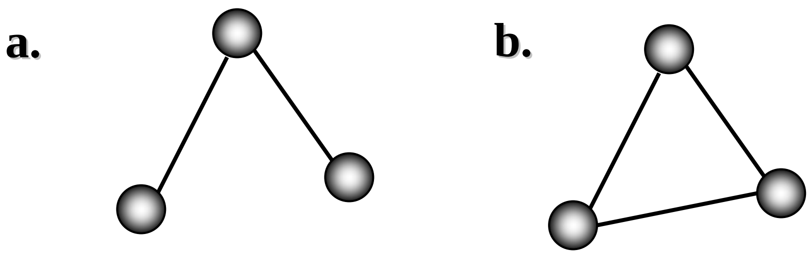

Figure 50. Closure in triads. Triad in a. is not closed whereas triad in b. is closed.

The essential point in this argument is, for a network to be embedded it is not necessary that all triads are closed which would automatically imply that the whole network is complete. Rather, an embedded network consists of enough number of closed triads. In return it is not meaningful to phrase that a particular network is embedded, but it is possible to say that a network is more embedded than another due to the ratio of closed triads to all triads.

In tandem with the contemporary cultural studies, in this thesis, culture is defined as a system of symbols and practice. Sewell's framework explains cultural social action in reference to symbol – meaning correspondences of actors. Chapter 4 developed the necessary formalization to implement the association between symbol – meaning correspondences and resulting interactions as practices. This implementation has been analyzed in a social simulation methodology which is built in Chapter 5. Chapter 6 validated and verified this simulation model.

The interactions of agents in THESIm are modeled with respect to the social cultural action theory explained by Sewell (1999). In THESIm agents act according to this theory and construct networks with varying degrees of embeddedness.

Every agent in THESIm belongs to a semantic society, which is defined by a binary opposition relation of symbols. Thus agents belonging to the same semantic society use the identical opposition relations to generate meaning sets. However these meaning sets need not be equal to each other, and in fact the meaning sets of agents of a single semantic society can be extremely heterogeneous. For instance, in MATLAB it is computed that a semantic society with an arbitrary opposition relation that generates 50 distinct meanings over 9 symbols may consist of more than 2 billion dissimilar agents in meaning collections.

Interaction of two agents requires a mutual understanding of a symbol by making use of a meaning that both agents provide in their symbol – meaning correspondences. In return, the reliability of a particular meaning in explaining a symbol is a function of the resulting interactions. Since each agent interacts with some other agents, the reliability of a meaning for a particular symbol is continuously under threat unless the interactions in the region are coherent. This in return implies that the sustainability of an interaction is a function of the coherence of the interactions that agents involve.

Although the dynamics of the deconstructionist algebra permits interaction of agents that belong to distinct semantic societies, resulting networks that consist of densely connected agents imply that agents have meaning collections that are similar to each other. Still it is possible that agents belonging to distinct semantic societies can form networks but the stability of these networks and hence the probability of observing such instances are low.

In Sewell's framework the *cultural endowment* that discriminates a semantic society is its *opposition relation*. On the other hand, opposition relations are described as networks of symbols and for this reason a valid measurement that describes all structural properties of an opposition relation does not exist. Simplest approach that may be used for classification purposes is the number of ties in an opposition relation. For instance, in Figure 39, binary opposition relation of MÜSİAD members contains eight three oppositions while binary opposition relation of TÜSİAD members, displayed in Figure 40 contains only forty three oppositions. However these numbers are far from describing the structures of the opposition relation of these two businessmen associations.

Furthermore, in a population, semantic societies do not exist in isolated islands. Members of one society interact with the members of another society. According to Baum et al. (2003) this is one of the distinguishing characteristics of interfirm networks. Therefore embedded social network forms are not particular to semantic societies. On the contrary embedded social networks may emerge with heterogeneous sets of agents from many semantic societies[30].

Since measuring cultural endowments of semantic societies invokes such difficulties and problems, a feasible perspective might be reducing the unit of analysis from semantic societies to pairs of agents. Sewell's (1999) framework permits agents that belong to the same semantic society to attach completely different meanings to symbols. On the other hand, theoretically, two agents from different semantic societies may have exactly equal meaning collections. Thus, cultural coherence of two agents that attempt to interact depends on the similarity of their meaning collections not primarily on the opposition relations. Thus, binary opposition relations of agents which define cultural endowments are expected to have only indirect effect. Intuitively this effect increases as the binary opposition relations gets dense.

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[30] Results of the statistical analyses performed in this chapter clarifies this point.

Within this logic, cultural coherence of two agents is defined as the ratio of the overlapping meaning sets to the count of all possible meanings. For instance, if the meaning collection of “Agent A” contains fifty distinct meanings, and meaning collection of “Agent B” contains fifty three distinct meanings of which twenty three are common with “Agent A”, then the cultural coherence of these agents are computed as 0.2875 = 23 / (50+53-23). By definition, cultural coherence varies between zero and one.

Figure 51 displays the relationship between cultural coherence and number of triads in 100 simulation runs. In order to focus the minimum cultural coherence required for a corresponding number of triads, the left frontier of this figure is displayed in Figure 52.

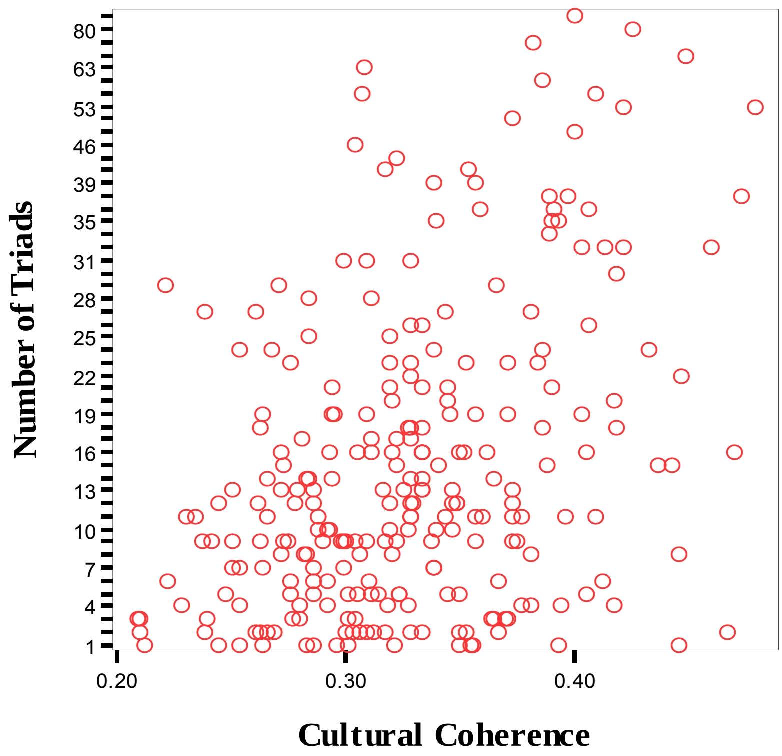

Figure 51. Scatter plot of cultural coherence versus number of triads.

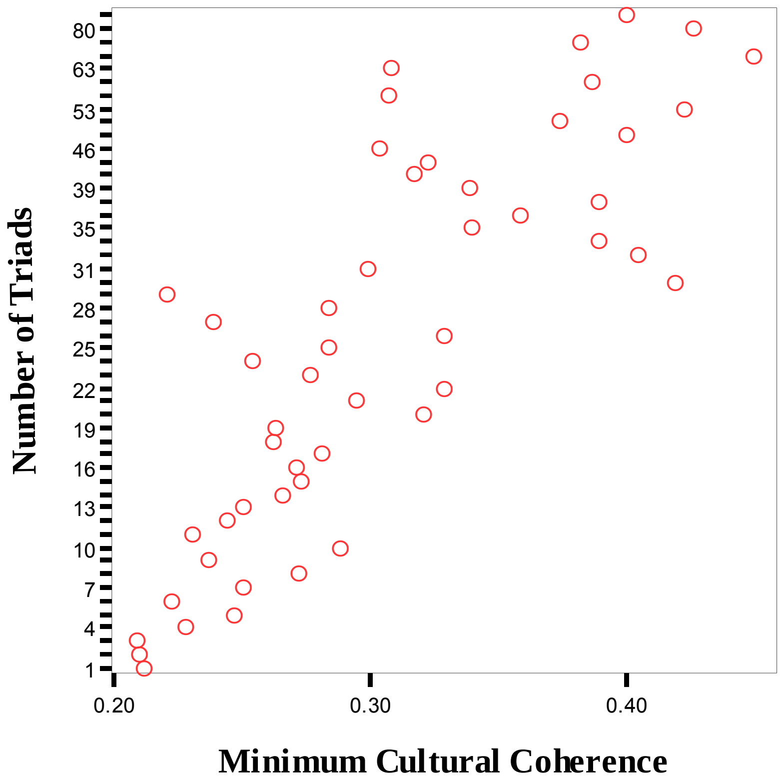

Figure 52. Scatter plot of minimum cultural coherence versus number of triads.

In order to test the relationship between cultural coherence and number of triads, a regression model is used in SPSS.

Table 16. Descriptive Statistics

	Mean	Std. Deviation	N
Number of Triads	29.34	20.872	50
Minimum Cultural Coherence	.3054	.06645	50

Table 17. Model Summary

Mode l	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.794(a)	.631	.623	12.808

a Predictors: (Constant), Minimum Cultural Coherence.

Table 18. ANOVA(b)

Mode l		Sum of Squares	df	Mean Square	F	Sig.
1	Regressio n	13473.014	1	13473.014	82.130	.000(a)
	Residual	7874.206	48	164.046		
	Total	21347.220	49			

a Predictors: (Constant), Minimum Cultural Coherence
b Dependent Variable: Number of Triads

Table 19. Coefficients(a)

Mode l		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	-46.869	8.602		-5.449	.000
	Minimum Cultural Coherence	249.535	27.535	.794	9.063	.000

a Dependent Variable: Number of Heterogeneous Triads

Regression model, explains 63.1% of the variability in the number of triads. Association between cultural coherence and the number of triads indicate that as the average cultural coherence of the members of a group increases, the embeddedness of the group increases as well. However this regression model focuses only on the cultural coherence of already established closed triads. Coleman (1988) argues that closed triads imply repeated interactions and established norms and therefore a huge ratio of embedded social networks contains the members of a single semantic society.

> A given merchant community is ordinarily very close, both in frequency of interactions and in ethnic and family ties. The wholesale diamond market in New York City for example, is Jewish, with a high degree of intermarriage, living in the same community in Brooklyn, and going to the same synagogues. It is essentially a closed community. (p. 99)

In order to test this claim a cross tabulation is used. Cultural coherence of triads has been grouped as follows: If for a triad, cultural coherence is less than 0.25 than then it belongs to group 1, if the cultural coherence is bigger than 0.25 but less than one then the triad belongs to group 2, in order to discriminate homogeneous triads, their cultural coherence has been assigned as one and they belong to group 3. Table 20 support Coleman's claim and shows that 92.1% of all closed groups are homogenous.

Table 20. Crosstabulation of Closure versus Cultural Coherence.

			Cultural Coherence			Total
			1	2	3	1
Closed Triads	0	Count	72	2337	11554	13963
		Expected Count	62.8	2179.1	11721.1	13963.0
		% within Closed Triads	.5%	16.7%	82.7%	100.0%
		% within Cultural Coherence	100.0%	93.5%	85.9%	87.2%
		% of Total	.4%	14.6%	72.1%	87.2%
	1	Count	0	163	1893	2056
		Expected Count	9.2	320.9	1725.9	2056.0
		% within Closed Triads	.0%	7.9%	92.1%	100.0%
		% within Cultural Coherence	.0%	6.5%	14.1%	12.8%
		% of Total	.0%	1.0%	11.8%	12.8%
Total		Count	72	2500	13447	16019
		Expected Count	72.0	2500.0	13447.0	16019.0
		% within Closed Triads	.4%	15.6%	83.9%	100.0%
		% within Cultural Coherence	100.0%	100.0%	100.0%	100.0%
		% of Total	.4%	15.6%	83.9%	100.0%

Table 21. Chi Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	118.274(a)	2	.000
Likelihood Ratio	143.971	2	.000
Linear-by-Linear Association	118.205	1	.000
N of Valid Cases	16019		

Table 22. Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.086	.000
	Cramer's V	.086	.000
	Contingency Coefficient	.086	.000
N of Valid Cases		16019	

a Not assuming the null hypothesis.
b Using the asymptotic standard error assuming the null hypothesis.

Although Table 20 and Table 21 show that the relationship between cultural coherence and closure property is significant, Table 22 shows that this relationship is weak.

The outcome of these statistical analysis with the rules listed in the interpretation of deconstructionist algebra describes dynamics of the formation of embedded social networks. First and foremost, the observation that more than 90% of all closed triads belong to same semantic society implies embeddedness is a semantic society property to a large extend. By the rules that govern the dynamics of the simulation it can be predicted that as more closures are formed in a semantic society, members increase the reliability of same meanings for symbols which further prospers embeddedness. However in none of 2000 runs of the simulation the dynamics locked down in a stable state where societies end up with a dense and completely closed network structures while such a situation is an expected outcome in Axelrod's (1997) dissemination of culture simulation. Sewell's cultural framework permits heterogeneous groups of agents within a single semantic society. It would not be speculative to interpret these groups as sub-semantic societies. Undisputedly these groups would further bifurcate as the symbol and population sizes increase. Therefore this heterogeneousness limits the number of closed triads in an embedded semantic society resulting into a rich continuous dynamics rather than convergence to a steady state.

Second, the finding that cultural coherence explains the number of closed triads in a population and the rules that govern the dynamics of the simulation imply that, in an embedded social network, as the number of closed triads an agent belongs to increase, the cultural coherence of the agent with his neighbors also increases. Baum et al. (2003) labels such agents as central agents while others as agents that belong to peripheries. Central agents are widely studied in embeddedness literature since they occupy strategically superior allocations (Dacine et al., 1999).

To sum up, the findings of this chapter support Coleman's (1988) and DiMaggio's (1994) claims that culture is a source of embeddedness in social networks. Due to the difficulties in measuring cultural endowment which is defined as the opposition relation of a semantic society, it is replaced by the concept of cultural coherence in the analysis. Cultural coherence measures the similarity of symbol – meaning correspondences of agents. Regression model that associates cultural coherence to the level of embeddedness measured in terms of number of closures shows that as agents in a group share more symbol – meaning correspondences the embeddedness of the group increases. Furthermore, crosstabulation analysis of cultural coherence versus closure of triads shows more than 90% of the triads are formed by agents that belong to same semantic society.

CHAPTER 8

CONCLUSIONS, LIMITATIONS, FUTURE RESEARCH DIRECTIONS AND IMPLICATIONS

This closing chapter of the thesis addresses the conclusion, findings of the developed perspective, limitations, proposes directions for future research and possible implications of its findings. Chapter is organized in three sections. Section 8.1 is a brief conclusion of the proposed framework and its findings. Section 8.2 discusses the limitations of the framework and the proposed model and future research directions. Finally, section 8.3 points out possible theoretical and practical implications of the study's findings.

A Deconstructionist Cultural Approach to Structural Embeddedness

Traditional economic thought optimize efficiency by accessing the market information and by averting situations that interfere with unilateral action and add needless coordination costs to interfirm exchanges (Granovetter, 1985; Uzzi, 1996). Later revisions to the theory, particularly within game theory setup, have made additions to these principles. Bounded rationality and imperfect information can cause the definitive efficiency of markets to be displaced by hierarchies or hybrid organizational forms (Uzzi, 1996). However these forms neither increase efficiency nor coordinate transactions or eliminate malfeasance.

On the other hand, social network theory assess that embeddedness shifts actors' motivations away from narrow pursuit of immediate economic gains to the enriching of relationships through trust and reciprocity (Powell, 1990). Embeddedness approach combines organization theory with social network theory by focusing on the structure of social relations and argue that social ties among actors, individual or collective, shape economic action by creating unique opportunities and access to those opportunities. Thus social organizations and social relations are introduced into the analysis of economic systems not as a structure that pops up into place to fulfill an economic function, but as a structure with history and continuity that give it an independent effect on the functioning of economic systems (Coleman, 1988).

Unlike oversocialized views (Wrong, 1961), embeddedness approach does not attribute all motives of action to the structure. The concept of social capital clarifies the role of embeddedness in this respect. Social capital has two principle characteristics. First, it is a collection of entities that consist of some aspects of the social structure. Second, social capital facilitates certain actions of actors. "Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible."(p: 98, Coleman, 1988). However unlike other forms of capitals, social capital is recorded in the structure of relations between and among actors. Consequently embeddedness is the source of social capital which is an independent resource to attain certain goals.

Today the literature in embeddedness studies is vast. Studies focus on different aspects of embeddedness and successfully relate social phenomena to topological properties of the social structure. Although by now literature accumulated a huge knowledge base on the consequences of embeddedness, the emergence of embeddedness is neglected to a large extend which is the objective of this dissertation. In April 2007, while this thesis is being written, one of the most dominant figures of social network theory, Ronald S. Burt published his article online regarding this issue as a pre-print chapter that will appear in the book “The Missing Links: Formation and Decay in Economic Networks” by James Rauch. In this article Burt states that “Questions about network formation and decay are central to the social capital of network closure because stability is essential to the mechanism”. Borrowing the idea of relationship between social capital and closure of triads in a social network from Coleman (1988) he analyzed stability of network formations within upper level bankers and analysts in a large financial organization.

Although the focus of this thesis and Burt’s (2007) article coincide, approaches are quite different. Inspiring from Coleman (1988) and DiMaggio (1994), this thesis seeks the cultural roots of embeddedness. The greatest difficulty in pursuing this aim is culture itself as a vague concept. Yet, if one is attributing a social phenomena (in this case social networks) to culture then this claim can only be tested within a domain defined by a cultural framework. In this regard the initial step of this thesis was to decide and verify a cultural framework to set the stage and only after then define and develop a cultural model to analyze and interpret the emergence and stability of social networks within this domain.

Among cultural frameworks that have been reviewed and elaborated, Sewell’s (1999) perspective defines the most appropriate framework to build a cultural model. Using culture as system of symbols and culture as practice views coherently, Sewell defines culture as the practice of “sense making” by making use of symbols. Although sense making is simply defined as attaching meanings to symbols, the relationship between symbols and meanings is not a trivial correspondence. Meaning of a particular symbol comes from the relationship of that symbol with other symbols. Sewell does not prefer the short and clean path of declaring that the relationship between symbols is a resemblance or an equivalence relation. Rather, he underscores the importance language in a cultural system. Since in language, meanings are assigned in a deconstructionist manner, by oppositions, then in real life meanings should have been attached to symbols within the same logic.

Chapter 4 as the first contribution of thesis formalizes the deconstructionist framework of Sewell. Since meanings are defined over the relationships of symbols with each other, symbols are defined as the nodes of a network called network of symbols. Opposition relations are the links between symbols. An algebra is developed and meanings are defined over the network of symbols. The theorem proved in this chapter identifies the mechanisms of meaning generation which is crucial for the implementation of the framework.

Although the formalization of the deconstructionist perspective of cultural framework is mathematically implementable, it is not analytically tractable due to high number of variables. For this reason it is not feasible to build a model in this framework with a solid methodology such as the toolkit of game theory. Simulations remove the assumptions needed for mathematical analysis and therefore have the promise of allowing us to examine issues that have been avoided in mathematical derivation.

THESIm is a simulation model that behaves according to the rules of deconstructionist framework of culture instrumentalized in Chapter 4. The running logic of the simulation is inspired from the ethnicity simulation of Hammond and Axelrod (2006). Simulation consists of agents that act according to the rules of cultural framework and play a simple economic game where both or only one can benefit. Absolutely no network effect is involved in the actions of the agents. It is claimed that, in such a model networks emerges and the emerged networks satisfies the properties of networks that are outlined by embeddedness studies. Furthermore, for conceptual validation, opposition relations of members of two businessmen associations, namely TÜSİAD and MÜSİAD are extracted and compared with the findings in the literature. The conclusion of chapter 6 is that THESIm is a valid and verified model to study structural embeddedness in a cultural framework.

Since the cultural framework has been selected, formalized and implementalized and also a model is built on this framework, now the objective of this thesis is testable. For this purpose 2000 independent runs of THESIm are analyzed. Each run is composed of random number of semantic societies that not only interact within each other but also interact with the members of other semantic societies.

Each run of the simulation consists of approximately 200,000 interactions that are modeled according to the rules derived from Sewell's framework. Correspondingly, if two agents make mutual sense on a symbol, then they interact. Stability of this interaction depends on the relative strategies of the agents and their ability in sustaining mutual sense making. Since each agent interacts with some other agents also the reliability of a meaning for a particular symbol is continuously under threat unless the interactions in the region are coherent. This in return implies that the sustainability of an interaction is a function of the coherence of the interactions that agents involve.

Although the dynamics of the deconstructionist algebra permits interaction of agents that belong to distinct semantic societies, resulting networks that consist of densely connected agents imply that agents have meaning collections that are similar to each other. Still it is possible that agents belonging to distinct semantic societies can form network but the stability of these networks are low.

The objective of this thesis is to understand the dynamics that constitute embedded social networks. Statistical results in Chapter 7 show that culture is a source of embeddedness in social networks. Due to the difficulties in measuring cultural endowment which is defined as the opposition relation of a semantic society, it is replaced by the concept of cultural coherence in the analysis. Cultural coherence measures the similarity of symbol – meaning correspondences of agents. Regression model that associates cultural coherence to the level of embeddedness measured in terms of number of closures shows that as agents in a group share more symbol – meaning correspondences the embeddedness of the group increases. Furthermore, crosstabulation analysis of cultural coherence versus closure of triads shows more than 90% of the triads are formed by agents that belong to same semantic society.

In sum, the objective of this dissertation is to explore the role of culture in the formation embedded social networks. The simulation model asserts that a cultural model explains network formations and their dynamics. The proposed model is theoretically verified and empirically validated.

Limitations and Future Research

This study has run in three dimensions. First, a cultural model has been transferred to a mathematical formalization. Second, a simulation study has been performed. Third, network analysis is conducted. Each of these studies encounter a number of limitations, and this study was no exception. These limitations along with the current study's findings highlight opportunities and suggest directions for future research.

In the mathematical formalization chapter, theorem shows that any meaning of a particular opposition relation is a subset of at least one set of the meaning generating set. Although this theorem is sufficient for the implementation of the deconstructionist framework, the algebra can be improved in various ways. For instance, investigation of the relationship between the density of the network of a binary opposition and the structure of the meaning generating set provides important information about the heterogeneous structure of a semantic society.

Another limitation of the mathematical formalization that affected the implementation of the framework is the assumption that agents make sense of each other if they have a mutual understanding of a symbol. Does mutual understanding refers to an agreement on exactly the same meaning set is not clear in Sewell (1999). Although in this dissertation a pure agreement on the meaning of a symbol is set as a necessary condition for symbolic interaction, it is at odds with the overall logic of the deconstructionist interpretation of culture. However, since Sewell did never focus on this issue any other assumption would be no more than a speculation. Nevertheless, different formulations to this issue would broaden our perspective about the implications of the deconstructionist framework.

Some institutions such as media, schools, and religion have tremendous effects on symbol – meaning correspondences of agents. These institutions are not implemented in the model. In a comprehensive framework where the effects of these institutions are analyzed, richer dynamics would be observed.

In the simulation studies one of the most frequently mentioned limitation is the hardware issue. The simulation study in this dissertation received the necessary hardware support from Istanbul Bilgi University. However the platform that the simulation code has been written onto, MATLAB, surprisingly lacks a graph theory package that would both speed up the simulation and more importantly make monitoring of the networks during the simulation possible. Most of the visualization has been established either by coding in bioinformatics toolbox of MATLAB or by transferring the complete population information to NetDraw. In this respect the cultural dynamics could be better explored when the simulation run can be monitored.

In embeddedness studies interfirm relationships are often equated with production markets. Cetina (2005) states that while economists left production and the labor theory of value behind and took the stock exchange as their point of departure when they developed the neoclassical model, embeddedness studies made just the opposite move when they returned to studying the economy. They mainly focused on producer markets, taking the firm as a point of departure. However financial markets have different characteristics than producer markets. The main focus in financial markets is information, instantly changing positions of buyers and sellers, the role of intermediaries and exchanges and the constitutive role of technology in enabling global markets. Does the role of social capital vanish in financial markets? A cultural perspective may be particularly useful in the analysis of global investment strategies and their consequences. The findings which report that each financial market has a domestic systematic risk, local investment strategies and risk evaluations is a connotation for the existence of embedded structures active and effective in financial markets.

The limitations regarding the methodology of network analysis are once again due to lack of a graph theory package in MATLAB. Nevertheless one of the most important network theory measures, minimum path length between nodes was fortunately found in the bioinformatics toolbox package. Other network measures, such as betweenness and closure had to be coded. Consequently, a complete network theory based analysis could not be performed. In this respect developing network theory related functions in a scientific package such as MATLAB would provide huge benefits to social scientists that study simulation.

Theoretical and Practical Implications

Besides the future research directions that are mentioned earlier, the perspective adopted in this study has three main theoretical implications. First, a more developed version of deconstructionist framework outlines an implementation for contemporary theoretical cultural studies. Unlike Parsons' (1951: cited from Turner, 1998) Voluntaristic Theory of Action, contemporary theories that merge Geertz's (1973) Culture as System of Symbols and Bourdieu's (1986) Culture as Practice perspectives views actors as active entities. In return cultural models require dynamic methodologies such as Game Theory or Simulations. Hence contemporary cultural theories that are in verbal representations need to be mathematically formalized. Swidler (2001) notes that the greatest difficulty in conceptualizing the relationship between symbols and meanings (practices) is that, symbols might have a hierarchical structure. Hence a pure set theoretic treatment is inapplicable. However, the algebra developed in this dissertation does not suffer from this issue. If a symbol is relatively more "important" than some other symbols, its position within the network of opposition relations would demonstrate its "importance".

Second, in this thesis a novel simulation topology is applied. In social simulations, either agents are fixed in cellular automata in order to control locality or allowed to move in the synthetic landscape in order to maximize simulated action. The approach adopted here is that agents are positioned in a cellular automaton but are allowed to interact with agents anywhere in the automaton. Hence as well as local properties of the landscape such as population density dynamics, also action dynamics can be analyzed at the same time.

Third, embeddedness studies in social network theory consider social structure as an independent variable in explaining social phenomena. In contrast, the approach in this dissertation permits the analysis of endogenous social structures. Burt (2007) agrees with this point by emphasizing that social networks are not stable by default. They are formed and reformed constantly.

The practical implications of the findings in this dissertation are two folds. First, the findings indicate that from a culture perspective embedded social networks are subject to semantic societies. In this respect, altruistic commitment of agents in a group can be established by formation of semantic societies.

Second, the finding that cultural coherence explains the number of closed triads in a population and the rules that govern the dynamics of the simulation imply that, in an embedded social network, as the number of closed triads an agent belongs to increase, the cultural coherence of the agent with his neighbors also increases. Baum et al. (2003) labels such agents as central agents while others as agents that belong to peripheries. Central agents are widely studied in embeddedness literature since they occupy strategically superior allocations (Dacine et al., 1999).

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APPENDICES

Appendix A. Decision Making

Models that attempt to explain social phenomena, especially cultural social phenomena necessarily make assumptions about cognitive processes. DiMaggio (1997) emphasizes this point:

> If we assume that a shared symbol evokes a sense of common identity, that a certain frame provokes people to think about a social issue in a new way, that lessons about the structure of space and time learned in school are generalized to the workspace, or that surveys can measure class consciousness, we are then making powerful cognitive assumptions. (p. 267)

Individuals do decide even in the cases that they do not act. In Chapter 3, it has been argued without questioning that culture causes action to a large degree. In particular, Sewell's (1999) framework of culture explains cognitive mechanisms and imposes strong restrictions on actor interactions. According to DiMaggio (1997) these cognitive level assumptions must be consistent with results of empirical research on cognition. This appendix chapter reviews and elaborates cognitive level decision making models and argues that Sewell's framework is consistent with Mental Model Theory of decision making.

Rational Choice Theory

With no doubt rational choice model of individual decision making has dominated the decision theory literature for more than 50 years. Its solid mathematical structure provided consistent and precise solution techniques for much of the decision making situations. The first formal setup of rationalism or utilitarianism attributed to von

Neumann and Morgenstern (1947). Some researchers of decision theory believe that in spite of the overflowing critiques of rational choice theory in decision making literature, almost none of the descendant models have been comparably successful and original (Starmer, 2000; Laroche, 1995; Goodrich et al., 2000). In this respect, conceptualizing the dominant models of decision making requires an understanding of rational choice theory framework.

The rational choice theory framework developed by von Neumann and Morgenstern initiates with the definition of alternatives. Alternatives are the set of courses of actions that are available to the decision maker. In the most basic case this set can be assumed as finite. As a demonstration, let set of alternatives for a lazy student in making a decision be; $A := \{\text{Cheat, Don't Cheat}\}$ in an exam. Clearly this set contains only two elements. In general the set of alternatives could be much more complex.

In addition to the alternatives set, the information resident in the environment which defines the states of nature also enters to the framework. A typical state of nature for the previous demonstration could be the toughness of the assistant as an invigilator in the exam room. The consequences in the decision making are defined over the combined effects of alternatives and the state of nature and usually displayed in matrix form. Table 23 presents the decision matrix of the student.

Table 23. Decision Matrix of the Student.

	Assistant is Tough	*Assistant is NOT Tough*
Cheat	Very Unpleasant	Great
Do NOT Cheat	Moderate	Bad

In the simplest case the student can assign utilities for each consequence. The matrix filled up with numerical utilities is then called the utility matrix. Table 24 presents the utility matrix of the student.

Table 24. Utility Matrix of the Student.

	Assistant is Tough	*Assistant is NOT Tough*
Cheat	0	10
Do NOT Cheat	5	3

Depending on the information that the student has regarding the state of nature, he may decide and pick the best consequence in this step. In particular if the student is certain that the assistant is "Tough", he would pick the consequence which offers highest utility to him from the first column of the table which corresponds to "Do NOT Cheat".

In the general case, decision makers have only partial knowledge about the states of nature and therefore can at best assign probabilities to each state. These types of situations are called decision making under risk. In the worst case, decision makers can not even assign probabilities to states of nature which describes decision making under uncertainty.

Returning back to the demonstration; assume that student attaches 70% probability that the assistant is "Tough". This probability is also called as the belief of the decision maker and is assumed to be subjective. According to rational choice theory, the best way for the student to continue at that point is to calculate the probability weighted averages of the consequences attached to each alternative or in other words to construct the subjective expected utility. Then the subjective expected utility of cheating in the exam is 0.7 x 0 + 0.3 x 10 = 3, and the subjective expected utility of not cheating is 0.7 x 5 + 0.3 x 3 = 4.4. According to this result the student should pick the alternative of "not cheating" in the exam.

This example demonstrates an oversimplified case of a decision making exercise. In the most general case, the number of alternatives is not necessarily finite and furthermore decision makers may not comfortably assign numerical utilities to consequences. Fortunately, the framework developed by von Neumann and Morgenstern (1947) guarantees the existence of a utility function under certain axioms.

Axiomatic Setup

In order to present an axiomatic setup (Fishburn, 1968) of decision making under risk, it is necessary to define some notation. Let $A = \{X_1, ..., X_n, ...\}$ be the set of alternatives. It is assumed that the decision maker has assigned probabilities for the state of nature and has a weak order $\succsim$ over alternatives. Furthermore, this preference relation is assumed to be complete, i.e. for all $X_i, X_j \in A$, either $X_i \succsim X_j$ or $X_j \succsim X_i$ and transitive, i.e. if $X_i \succsim X_j$ and $X_j \succsim X_k$ then $X_i \succsim X_k$ for all $X_i, X_j, X_k \in A$. Last assumption is about the alternative set, denseness[31]; there is a countable subset of A that is $\succsim$ dense in A. If all of these three axioms are satisfied then there exists a subjective utility function *u* such that for all $X_i, X_j \in A$, $X_i \succsim X_j \Leftrightarrow u(X_i) \geq u(X_j)$. Here, $u(X_i) = \sum_{\alpha} p_{\alpha}.X_i^{\alpha}$ with $\sum_{\alpha} p_{\alpha} = 1$ and X_i^{α} are the consequences corresponding

[31] A subset Y of X is called $\succsim$ dense in X if and only if for each pair a,b in X with a $\succsim$ b, there exists c in Y such that c $\succsim$ b and a $\succsim$ c. This axiom is necessary to guarantee the countability of equilivalency classes that emerges with the definition of a weak ordering.

to alternative X_i. Later, Savage extended this result for decisions under uncertainty (Fishburn, 1999).

The axioms of choice that prescribes a rational decision maker can be interpreted in two ways (Hastie & Dawes, 2001). Analytical interpretation is the extraction of revealed preferences of a decision maker from the actual choices. That means, given the axiomatic setup of von Neumann and Morgenstern (1947), and the observed choice, agent's initial ordering on the actions is inferred. In synthetic interpretation, the procedure is reversed; that is to say, given the agent's initial ordering and the axiomatic setup, the decision is predicted.

With this pure algebraic setup, Rational Choice Theory postulates that a social phenomenon with any complexity can be reduced to individual actions. In particular, organizations such as trade unions, political parties, and business enterprises could be personalized into rationally acting individuals that decide according to their self interests (Scott, 2000). Accordingly, policies of collective actors are nothing but the aggregate decision preferences of comprising agents. Rational choice is proven to be successful in predicting aggregate behaviors (March, 1994) especially in neoclassical economics.

Prospect Theory

There had been many attempts derived from the formal setup of rational decision making to provide a better descriptive theory that would harmonize the outcomes of psychological experiments and empirical observations (Hastie and Dawes, 2001). Out of these attempts, Prospect Theory is the most celebrated model, developed by Kahneman and Tversky (1979).

Prospect theory is particularly important in the individual decision theory literature for two reasons. First, the theory is developed in a prescriptive manner, by observing actual behaviors of humans under various psychological experiments. Second, unlike most psychology, theory provides a solid mathematical ground to analyze decision making under certain situations.

In their introduction of Prospect Theory, Kahneman and Tversky (1979) used 12 examples both as critiques to rational decision making theory and as basis for their mathematical model. Within the core of these criticisms lie two objections to the traditional setup; first, the domain that the utility functions are defined over and second, the probabilistic weighting of consequences in other terms the idea of expected utility.

Classical theory defines utility function over cardinal wealth, however Kahneman and Tversky showed that individual perception is tuned to relative changes in wealth in terms of gains or losses rather than cardinal differences. Also, in situations of uncertainty, classical framework calls for expected utility calculations. In this respect, Kahneman and Tversky referred to empirical observations that has been reported by mainly psychologists and offered an adjustment in the methodology of calculating expected utilities.

Value Functions

Prospect theory states that individuals base their decision not only looking at the final wealth that a certain alternative directs to but rather in the changes in the wealth that alternative premises. This observation requires the introduction of two concepts. First, in order to calculate increments or decrements in a given situation, decision making individual requires a reference point. Correspondingly, values are attached to deviations. Kahneman and Tversky (1979) provide a self explanatory example for this phenomenon.

> …,an object at a given temperature may be experienced as hot or cold to the touch depending on the temperature to which one has adapted. The same principle applies to non-sensory attributes such as health, prestige, and wealth. The same level of wealth, for example, may imply abject poverty for one person and great riches for another – depending on their current assets. (1979, p. 277)

The reference point or as some literature calls status quo is of primary importance for the second new concept that comes with the theory. Traditional theory handles losses and gains in a symmetric manner such that minus of the loss are treated in the models of gains without much difficulty and loss of generality such as the Cournot model of oligopolistic behavior. In this respect, Prospect Theory significantly diverges from the orthodoxy. In line with the empirical observations from many branches of decision making (Kahneman & Tversky, 1979), individuals treat losses and gains asymmetrically. In particular, decision makers value gains with a concave function but losses with a convex function which is generally steeper. A typical value function of this sort is given by the equation,

$$v(x) = \begin{Bmatrix} x^{\alpha} & if\ x \geq 0 \\ -\lambda(-x)^{\beta} & if\ x < 0 \end{Bmatrix}$$

In Figure 53, this function is graphed with parameters barrowed from Tversky and Kahneman (1992). Further characterization of the value function has been analyzed in Tversky and Kahneman (1991). For both gains and losses value function preserves a diminishing property.

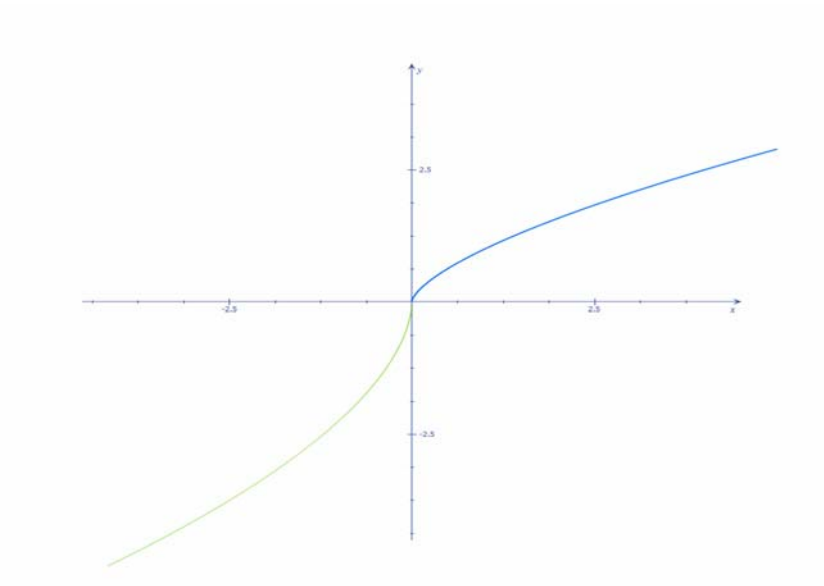

Figure 53. Graph of a value function according to Tversky and Kahneman (1992).

Weighting Risk

Preston and Baratta (1948) analyzed interrelation between the expected value of a gamble and the psychological value attached to it with an auction experiment. The main outcome of the study was that individuals' valuations of gambles are not inline with the mathematical expectation. Authors reported their findings that low probabilities are over valued, while high probabilities are undervalued in a cautious manner for they could not explain the effect of the prize of the gambles on the misevaluation. However this study took its place by pronouncing the concept of psychological probability for the first time in the literature. (They have calculated psychological probability by dividing the highest bid, by the prize of the gamble.) Later Tversky and Fox (1995) referred this study as one of the cornerstones of Prospect Theory.

Utilitarian decision theory states that individuals are generally risk averse in the sense that they prefer sure outcomes over an equal or greater expected return.

Risk seeking behavior is defined inversely in a similar vein. Numerous empirical studies consistently suggested that (Tversky & Fox, 1995) individuals are risk seeking for gains and risk averse for loses in low probabilities and risk averse for gains and risk seeking for losses in high probabilities. Consequently using mathematical expectation methodology in weighting consequences would not capture this important empirical fact. The solution provided in Prospect Theory is the idea of weight functions. These functions can be generated by using parametric approximations to a form proposed in Tversky and Kahneman (1992),

$$w_1(p) = \frac{p^{\delta}}{\left(p^{\delta} + (1-p)^{\delta}\right)^{1/\delta}}$$

$$w_2(p) = \frac{p^{\gamma}}{\left(p^{\gamma} + (1-p)^{\gamma}\right)^{1/\gamma}}$$

where, $0 < \delta < \gamma$. Here $w_1(p)$ denotes the weight function for losses and $w_2(p)$ denotes the weight function for gains. Figure 54 displays typical demonstrations of these functions. In their 1979 study where they have introduced Prospect Theory, Kahneman and Tversky have provided certain characteristics that a weight(ing) function should satisfy but actually did not propose a form.

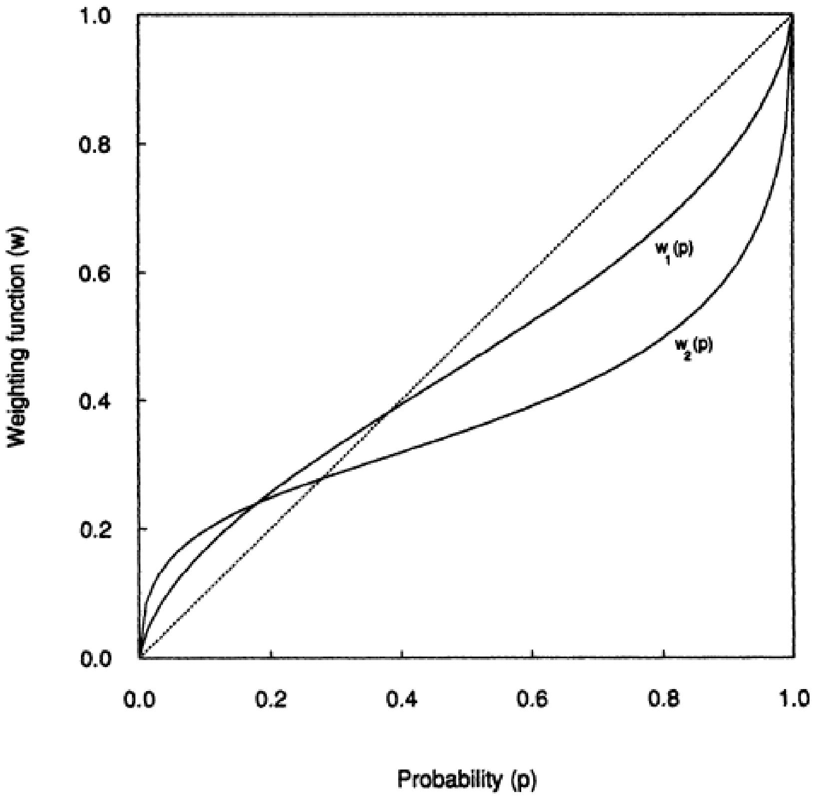

Figure 54. Graphs of weight functions. (Reproduced from Tversky & Wakker ,1995)

The effect of Prospect Theory in social sciences has been enormous. For example, a totally new sub branch of finance, Behavioral Finance is developed within this setup. The new definition of risk provoked new strategic implications in managerial decision theory (Shoham & Fiegenbaum, 2002). The incentives for cooperation had a totally new meaning.

On the other hand Prospect Theory has been criticized for the salient feature that it shares with other behavioral decision making models, namely the maximizing behavior. With respect to Simon (1957) individual decision makers have cognitive limits to access and process information. Hence assuming existence of utility or value functions would not be realistic because in reality this would require unlimited information and cognitive capacity (Alchian, 1950). In this respect Simon proposed an alternative perspective which states that, decision making processes are strongly affected by not only the quality and quantity of the information, but also depends on how decision makers perceive, remember and willing to expand energy on the decision processes.

Unlike maximization that involves pair-wise comparison of (all) the alternatives, Simon developed the concept of satisficing that evaluates the positions of the alternatives relative to a baseline called the aspiration level which is updated dynamically (Choo, 1998). Supporting information processing approach against behavioral decision making models, March (1994) argues that individuals do not intentionally or explicitly act bounded rationally but rather they struggle and cope with bounded rationality. In particular, individuals in organizations adopt reductionist strategies to deal with complexity in the information and huge set of constraints. In the decision making process they focus on the most salient features within the alternatives instead of the objective reality within the complicated Lagrangian.

Information processing perspective, sometimes called Carnegie school perspective explains individual decision making process in terms of the acquisition and use of the information. Information enters into decision making models in varying quantity and quality determined by factors of availability and complexity and constitutes intelligence (Figure 55). Intelligence is filtered and processed with the cognitive and organizational (social and cultural) limits. Process finalizes with act of choice.

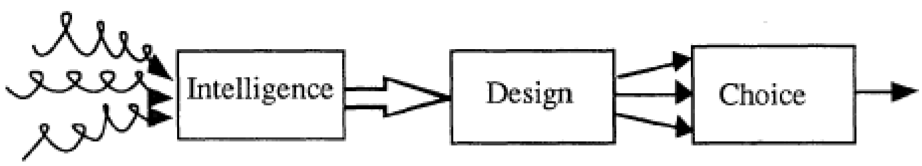

Figure 55. The individual as information processor framework. (Reproduced from Langlet et al., 1995)

Information processing perspective has been implemented by Bounded rationality Models.

Bounded Rationality

Luce (2003) interprets Bounded Rationality proposed by Simon (1957), primarily as an objection to the methodology of behavioral decision making models. Today, what has been referred as bounded rationality is a set of theories that defines the primary concepts in a decision making process as follows (March, 1994):

1. Knowledge: Decision makers are limited in their cognitive capacities in both comprehending and interpreting information.
2. Preferences: In line with Luce's (2003) interpretation, preferences may not be extracted for all consequences.
3. Decision Rule: Behavioral decision making models impose the decision maker to maximize among alternatives. Bounded rational agents use different selection criteria among alternatives.
4. Actors: The identities of the decision makers that are assumed to be anonymous entities have an effect on the outcome of a decision making course of action.

Knowledge

Bounded Rationality models state that decision makers have limitations regarding to information in at least three dimensions. First, because of their limited cognitive capacities, information can not be fully stored and correctly retrieved (March, 1994). Second, due to problems in communication, the distribution of information among decision makers is not uniform (March, 1994). Third, even for a super human decision maker who does not suffer from first and second issues just mentioned, the act of optimization is impossible when decision time is scarce (Gigerenzer & Selten, 2001).

Preferences & Decision Rule

Unlike a closed form game such as chess or poker, the list of alternatives most of the times is not initially provided to a decision maker. Therefore the decision maker conducts a search process for alternatives in the very first phase of decision making. But the search is costly for the reasons described in the paragraph above. Simon (1957) theorized that such an individual forms an aspiration level for the choice she seeks and continues her search among alternatives (and corresponding consequences) until her aspiration level is reached. This procedure is called satisficing. In the organization setting, satisficing is more than a framework of decision making; it is also a rule on how organizations search for information (Choo, 1998). Other than satisficing, bounded rational theory embraces several other different decision making rules (Figure 56) labeled as decision making with heuristics covered under the general name The Adaptive Toolbox (Gigerenzer and Todd, 1999).

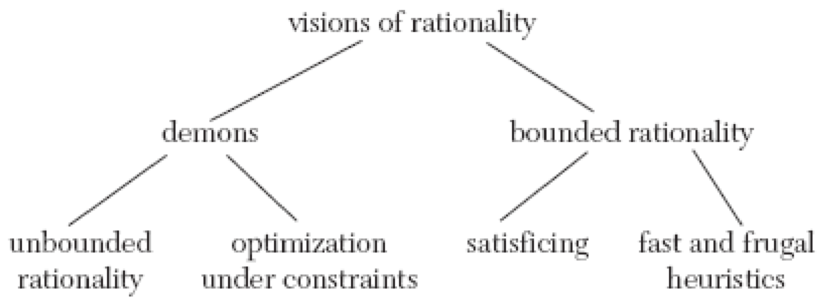

Figure 56. Visions of rationality (Reproduced from Gigerenzer and Todd, 1999).

Actors

Social environment endows numerous behavioral mechanisms in the forms of social norms and institutions. Culture for example, is a whole system of beliefs, fast and frugal mechanisms that can help a decision maker reduce cost of decision making in an environment full of uncertainties (Selten, 2001). At this point Bounded Rationalists' interpretation of the effect of society and culture significantly deviates from deductive anthropologists and sociologists view. In Bounded Rationalist stance, individuals preserve their goals and desires in a decision making process. However since they are bounded in knowledge and preference formation, the decision making rule is not an optimization as explained above but rather, the decision maker employs decision making rules that fit to certain situations.

Literature is growing with bounded rational models of decision makers. Regardless of the details how a bounded rational decision is made, be it a satisficing algorithm or a set of heuristics, the common theme in all the models is the *explicit* resolution of the trade-off between goal directed capabilities of a decision maker and the environmental affordances relevant to that goal (Goodrich et al., 2000). The resolution is explicit in the sense that, decision makers are assumed be endowed with some portfolio of heuristics that they call when confronted with a particular decision making situation. A situation might require heuristic X, whereas some other situation needs heuristic Y, and it is postulated that both of these heuristics exist in individual decision making menu. Hence decision makers develop a correspondence or an association of situations and heuristics in their agenda.

In this manner the decision making is actually transformed into a meta-decision making process that involves the selection of the most appropriate heuristic in a particular situation. Gigerenzer and Todd (1999) address this phenomenon as the evaluation of the performance of heuristics, as an auxiliary branch of bounded rational decision making program. Similar argument can be replicated for Simon's satisficing as well, since it involves the dynamic update of the aspiration level.

Empirical studies and reports show that decision makers are more than mechanistic decision making entities that mediate the alternatives and the choice or problems and solutions. They are typically heterogeneous in nature and contain faculties such as intuition developed through experience and social interaction and inspiration that effects the decision making process.

Mental Model Theory

According to cognitive psychologists, decision making process should not be conceived as a choice among consequences. They rather emphasize the implicitness or the tacit character in human decision making. Evidence regarding how the human brain works do not agree with the consequential logic approach of decision making (Fiske and Taylor, 1991) which was dominant in the theories briefed above.

In order to summarize cognitive psychologists' view of decision making, a new concept needs to be introduced. The concept of experience (not only routines, since routines do not exhaustively cover experiences but rather imply experienced decision making processes) that has been neglected by theories so far plays a crucial role in this setup. Clearly, individuals carry their past experiences into every decision making situation as structured knowledge in their brains. This knowledge, organized in terms of categories, influence how the individual understands the world (Senge, 1990). Decision making process, especially in complex situations is a result of attaching a meaning and significance to the events around the individual. Therefore, models developed in cognitive psychology seek to reveal the way in which decision makers are making sense of the situation. Mental models do not prescribe or even describe a decision making process. Their aim is to present the structure of the decision making problem from the lens of the decision maker (Eden, 1994). For this purpose mental models are in the form of context specific causal representations or associations.

Synthesis

Sewell's cultural framework assumes that individuals store symbol associations and construct meaning as a function of them. Experiences shape meaning extractions from the belief structures that are in the form of binary opposition relations. According to Sewell, in an interaction, sense making is a mutual agreement of meaning over symbols. Furthermore individuals are allowed to elaborate and modify meaning structures which Sewell refer to as codes in his following remark,

> I would also argue that to be able to use a code means more than being able to apply it mechanically in stereotyped situations – it also means having the ability to elaborate it, to modify or adapt its rules to novel circumstances. (p. 51)

Clearly Sewell's cultural framework is consistent with mental model theory of decision making. In fact it can further be argued that his framework is an interaction focused implementation of the theory. However, although Sewell's framework and mental model theory both assume the existence of significance values of meanings which individuals dynamically adjust with their experiences, its adjustment mechanism is not discussed. As it has been discussed in Chapter 4, such a mechanism is necessary in the implementation of the model in this thesis. For that purpose, value function mechanism of prospect theory (Kahneman and Tversky, 1979) has been used to update the significance of a meaning or with the terminology used in the dissertation; reliability of a meaning. Implementation of this mechanism is discussed in Chapter 4

Appendix B. Matlab Code of Ethnicity Simulation

```
%Initialize the global variables.
clear
%global cost benefit basePTR mutate_rate death_rate imm_rate lattice_size
run_length
 cost=0.01;
benefit=0.03;
maxtag=10;
basePTR=0.12; %PTR=Probability to reproduce
mutate_rate=0.005;
death_rate=0.1;
imm_rate=1;
lattice_size=50;
run_length=1000;
%For users…
%cost=input('Enter a value for cost : ');

global lattice
%Initialize the empty lattice
% lattice(x,y,:) = Coordinate of the cell.
% lattice(:,:,1) = status of the cell. If 0, cells is empty, if 1 cell is
% occupied.
% lattice(:,:,2) = Empty...
% lattice(:,:,3) = Tag (group id) of the agent in the cell. It may take 0,
% 1,2,3,... as value. Tags will be observable by other agents.
% lattice(:,:,4) = Strategy of the agent against alike (in-group) agents.
% lattice(:,:,5) = Strategy of the agent against different (out-group)
% agents.
% lattice(:,:,6) = Probability to reproduce.
lattice=initialize_lattice(lattice_size);

for runsim=1:run_length

   %***************************************************

   %IMMIGRATION
   %Involves two steps
   %STEP1: Create immigration rate new agents with random traits
   %STEP2:Place the new agents, one at a time, each in a random empty site
   % on the lattice.

   immigrate(maxtag,basePTR);

   %***************************************************

   %INTERACTION
   %STEP 1: Reset PTR of all agents to basePTR;
   lattice(:,:,6)=basePTR;
```

```
%STEP 2:For each adjacent(Von Neumann) neighboring agent N of each
%existing agent A:
%PARTa: A decides whether to donate to N(based on tags of each and
%strategy of A.
%PARTb: If A donates, PTR of A is lowered by Cost and PTR of N is
%raised by Benefit.
%PARTc,d: Totally unnecessary...since PARTa,b runs over all agents.

%Reset interactions!
%lattice(:,:,2)=0;
interaction(cost,benefit);

%*************************************************

%TAG FORMATION 1
%Agents immigate with random tags or immigrate taggless.
%Tagless agent creates an order of his tagged neighbors that has higher
%PTR then himself, including himself and select the tag of one randomly.

tag();

%TAG FORMATION 2
%Agents immigrate taggless.


%*************************************************

%REPRODUCTION
%STEP 1:Sort the list of currently existing agents into a new random
%order.
%STEP 2:In this new random order, each agent is given a chance to
%reproduce with probability equal to its PTR. If the PTR probability is
%realized for an agent:
   %A: Check if there are one or more emprty spaces adjacent to the
   %agent
   %B: If so, clone an offspring of the agent onto one of those empty
   %cells choosen at random. The offspring receives the traits to its
   %parent, except that each trait change with probability equal to
   %mutationrate. If no space is available, no offsprings are created.

reproduction(mutate_rate);

%*************************************************

%DEATH

death(death_rate);

%*************************************************
```

```
    %runningmean(runsim,1)=mean(mean(lattice(:,:,6)));
    %plot(emptycells);
    %cdata=chartdata1();

    cdata=chartdata1();
    %cdata1(runsim,1)=out(1);
    %cdata1(runsim,2)=out(2);
    %cdata1(runsim,3)=out(3);
    scatter(cdata(:,1),cdata(:,2),1000,cdata(:,3),'Marker','.');
    %runsim
    %scatter(1:50,1:50,lattice(:,:,3),'Marker','.')
    drawnow

end;
```

```
function out=initialize_lattice(lattice_size)
%fill up the status 'empty' for all cells
out=zeros(lattice_size,lattice_size,6);
% lattice(x,y,:) = Coordinate of the cell.
% lattice(:,:,1) = status of the cell. If 0, cells is empty, if 1 cell is
% occupied.
% lattice(:,:,2) = Baby signiture
% lattice(:,:,3) = Tag (group id) of the agent in the cell. It may take 0,
% 1,2,3,... as value. Tags will be observable by other agents.
% lattice(:,:,4) = Strategy of the agent against alike (in-group) agents.
% lattice(:,:,5) = Strategy of the agent against different (out-group)
% agents.
% lattice(:,:,6) = Probability to reproduce.
end
```

```
function []=immigrate(maxtag,basePTR)
global lattice
check_empty_space=is_full();

if check_empty_space==0
    rnd_ranked_cells=select_rnd_empty_cell();
    xcord=rnd_ranked_cells(1,1);
    ycord=rnd_ranked_cells(1,2);
    lattice(xcord,ycord,:)=newagent(maxtag,basePTR);
    %immigrated agent allocated.
end;
```

```
function [out]=select_rnd_empty_cell()
```

```
%Create a list of coordinates with status=0 ie. that are empty
global lattice
d=size(lattice);
indx=1;
for i=1:d(1)
   for j=1:d(2)
      if lattice(i,j,1)==0
         rand_m(indx,1)=i;
         rand_m(indx,2)=j;
         rand_m(indx,3)=rand;
         indx=indx+1;
      end;
   end;
end;
out=flipud(sortrows(rand_m,3));
end
```

```
function agent = newagent(maxtag,basePTR)

%Set the TAG of the agent
tagcode=ceil(rand*maxtag*2);
if tagcode>maxtag, tagcode=0; end;
tag=[0 tagcode];%Second column is the tag.

%Set the strategy among same tagged agents
attr1=rand;
if attr1>=.5
   strat_same=1;
else
   strat_same=0;
end;

%Set the strategy among different tagged agents
attr2=rand;
if attr2>=.5
   strat_other=1;
else
   strat_other=0;
end;

%Change the set of the occupied cell to not empty
status=1;

%Publish the output. It is going to be processed into the lattice as
%follows: lattice(xcord,ycord,:)=newagent(basePTR)
agent=[status tag strat_same strat_other basePTR]';

end
```

```
function []=interaction(cost,benefit)
global lattice
d=size(lattice);
for i=1:d(1)
   for j=1:d(2)
      if lattice(i,j,1)==1 %Calculate for occupied cells only
         %Need to locate Von Neumann Neighbors;
         Cords=Coord_of_neighs(i,j);
         for k=1:4 %1=N, 2=S, 3=W, 4=E
            Xcord=Cords(k,1);
            Ycord=Cords(k,2);
            if lattice(Xcord,Ycord,1)==1
               %Compare the tags of self and other.
               %If they are alike use Strategy1
               %If they are different or other is tagless use Strategy2
               %If myself is tagless go random.
               strat=0;
               if lattice(i,j,3)==0, strat=ceil(rand*2); end;

               if ((lattice(Xcord,Ycord,3)==lattice(i,j,3)) & strat==0)||strat==1
                  if lattice(i,j,4)==1
                     lattice(i,j,6)=lattice(i,j,6)-cost;
                     lattice(Xcord,Ycord,6)=lattice(Xcord,Ycord,6)+benefit;
                  end;
               else
                  if lattice(i,j,5)==1
                     lattice(i,j,6)=lattice(i,j,6)-cost;
                     lattice(Xcord,Ycord,6)=lattice(Xcord,Ycord,6)+benefit;
                  end;
               end;
            end;
         end;
      end;
   end;
end;
```

```
function out=Coord_of_neighs(i,j)
global lattice
d=size(lattice);
   %North
   if i==1
      out(1,1)=d(1);
   else
      out(1,1)=i-1;
   end;
```

```
    out(1,2)=j;
    %South
    if i==d(1)
        out(2,1)=1;
    else
        out(2,1)=i+1;
    end;
    out(2,2)=j;
    %West
    if j==1
        out(3,2)=d(2);
    else
        out(3,2)=j-1;
    end;
    out(3,1)=i;
    %East
    if j==d(2)
        out(4,2)=1;
    else
        out(4,2)=j+1;
    end;
    out(4,1)=i;
end
```

- -

```
function []=tag()
global lattice
d=size(lattice);
%Run through all taggless agents
for i=1:d(1)
    for j=1:d(2)
        if lattice(i,j,1)==1 && lattice(i,j,3)==0;
            Cords=Coord_of_neighs(i,j);
            counter=2;
            list(1,1)=i;
            list(1,2)=j;
            list(1,3)=lattice(i,j,6);
            for k=1:4 %1=N, 2=S, 3=W, 4=E
                Xcord=Cords(k,1);
                Ycord=Cords(k,2);
                if lattice (Xcord,Ycord,6)>=lattice(i,j,6)
                    list(counter,1)=Xcord;
                    list(counter,2)=Ycord;
                    list(counter,3)=lattice (Xcord,Ycord,6);
                    counter=counter+1;
                end;
            end;
            out=flipud(sortrows(list,3));
            if out(1,3)==lattice(i,j,6)
                lattice(i,j,3)=0;
```

```
            else
                %lattice(i,j,3)=3;
                lattice(i,j,3)=lattice(out(1,1),out(1,2),3);
            end;
            out=[];
        end;
    end;
end;
```

- -

```
function []=reproduction(mutate_rate)
global lattice
sortedlattice=rnd_sort_cells();
d=size(sortedlattice);
if d(1)==0
    return
else
    %Sort current agents ready to reproduce;
    for i=1:d(1)
        xcor=sortedlattice(i,1);
        ycor=sortedlattice(i,2);
        %if lattice(xcor,ycor,6)>rand
            neigh=Coord_of_neighs(xcor,ycor);
            count=0;
            for k=1:4
                nxcor=neigh(k,1);
                nycor=neigh(k,2);
                %pick unoccupied neighbors and attach a random rank.
                if lattice(nxcor,nycor,1)==0
                    emptyn(count+1,1)=nxcor;
                    emptyn(count+1,2)=nycor;
                    emptyn(count+1,3)=rand;
                    count=count+1;
                end;
            end;
            %If there is actually an empty space populate it with the
            %baby. If more than one space are available than pick one
            %randomly.
            if count>0
                rankedempty=flipud(sortrows(emptyn,3));
                babyxcor=rankedempty(1,1);
                babyycor=rankedempty(1,2);
                lattice(babyxcor,babyycor,:)=babyagent(xcor,ycor,mutate_rate);
                emptyn=[];
                rankedempty=[];
            end;
        %end;
    end;
end;
```

```
function out=rnd_sort_cells()
%Create a list of randomly sorted cells and assign a PTR check value as
%well as the forth column.
global lattice
d=size(lattice);
indx=1;
for i=1:d(1)
   for j=1:d(2)
      if lattice(i,j,1)==1
         if lattice(i,j,6)>=rand
            rand_m(indx,1)=i;
            rand_m(indx,2)=j;
            rand_m(indx,3)=rand;
            indx=indx+1;
         end;
      end;
   end;
end;
if indx==1
   out=[];
else
   out=flipud(sortrows(rand_m,3));
end;
end
```

```
function agent=babyagent(motherx,mothery,mutate_rate)
global lattice

%Set the TAG of the baby
if mutate_rate>=rand
   tag(1,1)=1;
end;

if mutate_rate>=rand
   tag(1,2)=mod(lattice(motherx,mothery,3)+ceil(rand*9),10);
else
   tag(1,2)=lattice(motherx,mothery,3);
end;


%Set the strategy
if mutate_rate>=rand
   strat_same=mod(lattice(motherx,mothery,4)+1,2);
else
   strat_same=lattice(motherx,mothery,4);
```

```
end;

if mutate_rate>=rand
    strat_other=mod(lattice(motherx,mothery,5)+1,2);
else
    strat_other=lattice(motherx,mothery,5);
end;


%Set the PTR
PTR=lattice(motherx,mothery,6);
%Change the set of the occupied cell to not empty
status=1;

%Publish the output. It is going to be processed into the lattice as
%follows: lattice(xcord,ycord,:)=newagent(basePTR)
agent=[status tag strat_same strat_other PTR]';


end
```

```
function []=death(death_rate)
%We assumed that each agent has an independent chance of dying
%Exercise: What if death probability is related to # of empty neighbours
global lattice
d=size(lattice);

for i=1:d(1)
    for j=1:d(2)
        if lattice(i,j,1)==1 && lattice(i,j,2)==0
            if death_rate>rand
                lattice(i,j,3)=0;
            end;
        end;
    end;
end;
```

```
function out=assign_meanings(allmeanings,symbols)
%This function assigns meanings to each symbol of a symbol system
using
%deconstructionist algebra."allmeanings" variable is constructed in
such a way
%that no opposing symbols have a common meaning in symbols2meaning
%procedure. Symbols must be entered as an integer.
%This function guarantees that all symbols are covered.
%THIS FUNCTION DEPENDS ON: meanings_cover_symbols
%IMPORTANT NOTE : BEFORE THIS FUNCTION IS RUN symbols2meanings MUST
RUN.



number_of_meanings=size(allmeanings);
Covered_Symbols=0;
out=[];
%randomly order the meaning set.
random_column=rand(number_of_meanings(1),1);
meanings=[allmeanings random_column];
meanings=flipud(sortrows(meanings,number_of_meanings(2)+1));
meanings(:,number_of_meanings(2)+1)=[];
%Set is randomly ordered
k=1;
while Covered_Symbols==0
    out=[out;meanings(k,:)];
    if meanings_cover_symbols(out,symbols)
        Covered_Symbols=1;
        k=k+1;
        %Add some random number of redundant meanings also. The
expected
        %number of redundant meanings is adjusted to half of the
symbol
        %size.
        redundant_meaning_number=fix(rand*symbols);
        deltaredundent=k+redundant_meaning_number;
        if deltaredundent<number_of_meanings(1)
            out=[out;meanings([k:deltaredundent],:)];
        end
    else
        k=k+1;
    end
end
```

```
function
out=calculate_distance(agent1row,agent1column,agent2row,agent2column
,sizeofhabitat)
%This function calculates distances between two nodes in a
%habitat. Habitat is assumed to be a continuous moore neighborhood.
%therefore in any dimension the maximum distance is size/2. Distance
is
%calculated as sum of the differences in two dimensions. Hence it is
not
%Euclidean. Habitat is assumed to be a square.
%The maximum distance between any agents is size of the habitat.
```

```
Rdist=abs(agent1row-agent2row);
Cdist=abs(agent1column-agent2column);
if Rdist>(sizeofhabitat/2)
    Rdist=sizeofhabitat-Rdist;
end
if Cdist>(sizeofhabitat/2)
    Cdist=sizeofhabitat-Cdist;
end
out=Rdist+Cdist;
end
```

```
function out=calculate_distance_matrix(MM)
%MM is a one column vector of integers. Values indicate the
coordinates of
%some certain locations. For example 25 corresponds to (3,5) and so
on.
global size_HABITAT
my_length=length(MM);
for rrr1=1:my_length
    if mod(MM(rrr1),10)==0
        agent1row=MM(rrr1)/10;
        agent1column=10;
    else
        agent1row=fix(MM(rrr1)/10)+1;
        agent1column=MM(rrr1)-(agent1row-1)*10;
    end
    for rrr2=rrr1:my_length
        if mod(MM(rrr2),10)==0
            agent2row=MM(rrr2)/10;
            agent2column=10;
        else
            agent2row=fix(MM(rrr2)/10)+1;
            agent2column=MM(rrr2)-(agent2row-1)*10;
        end

out(rrr1,rrr2)=calculate_distance(agent1row,agent1column,agent2row,a
gent2column,size_HABITAT);
    end
end
out=out+out';
end
```

```
function out=check_complete_subgraph(Subgraph,Graph)
%Returns TRUE if Subgraph is complete in Graph, otherwise returns
false.
%Subgraph is a vector of nodes.
%Graph is represented as a full undirected and unweighted matrix. In
other
%words all weights are 1.
%THIS FUNCTION DEPENDS ON: NONE
size_subgraph=length(Subgraph);
out=1;
for counter=1:size_subgraph
    for counter1=counter:size_subgraph %due to symmetry in
undirected graphs
        if Graph(Subgraph(counter),Subgraph(counter1))==0
            out=0;
```

```
            break;
        end
    end
end
```

```
function []=death_of_a_swan()
global ALLAGENTS HABITAT INTERACTIONM
agents_list=[];
r_r=size(ALLAGENTS);
for rrr=1:r_r(1)
    if isempty(ALLAGENTS{rrr,3})==0
        agents_list=[agents_list;rrr ALLAGENTS{rrr,1} rand];
    end
end
ggg=size(agents_list);
min_numb_of_death=fix(ggg(1)/30);
%1. Agents with zero endowments dies.
k=0;
hhh=1;
agents_list=sortrows(agents_list,2);
while hhh<ggg(1)
    if agents_list(hhh,2)>0
        break
    else
        %kill the agent
        ALLAGENTS(agents_list(hhh,1),:)=cell(1,7);
        k=k+1;
        %update HABITAT.
        if mod(agents_list(hhh,1),10)==0
            agentrow=agents_list(hhh,1)/10;
            agentcolumn=10;
        else
            agentrow=fix(agents_list(hhh,1)/10)+1;
            agentcolumn=agents_list(hhh,1)-(agentrow-1)*10;
        end
        HABITAT{agentrow,agentcolumn}{1}=0;
        %update INTERACTION matrix
        if isempty(INTERACTIONM)==0
        %1.Search within active agents.
        is_act=find(INTERACTIONM(:,1)==agents_list(1,1));
        if isempty(is_act)==0
            for QQQ=length(is_act):-1:1
                INTERACTIONM(is_act(QQQ),:)=[];
            end
        end
        %2.Search within passive agents.
        is_pass=find(INTERACTIONM(:,2)==agents_list(1,1));
        if isempty(is_pass)==0
            for QQQ=length(is_pass):-1:1
                INTERACTIONM(is_pass(QQQ),:)=[];
            end
        end
        end
        agents_list(hhh,:)=[];
    end
end
agents_list=sortrows(agents_list,3);
while k<min_numb_of_death
    %kill others
    ALLAGENTS(agents_list(1,1),:)=cell(1,7);
```

```
    k=k+1;
    %update HABITAT.
    if mod(agents_list(1,1),10)==0
        agentrow=agents_list(1,1)/10;
        agentcolumn=10;
    else
        agentrow=fix(agents_list(1,1)/10)+1;
        agentcolumn=agents_list(1,1)-(agentrow-1)*10;
    end
    HABITAT{agentrow,agentcolumn}{1}=0;

    %update INTERACTION matrix
        if isempty(INTERACTIONM)==0
        %1.Search within active agents.
        is_act=find(INTERACTIONM(:,1)==agents_list(1,1));
        if isempty(is_act)==0
            for QQQ=length(is_act):-1:1
                INTERACTIONM(is_act(QQQ),:)=[];
            end
        end
        %2.Search within passive agents.
        is_pass=find(INTERACTIONM(:,2)==agents_list(1,1));
        if isempty(is_pass)==0
            for QQQ=length(is_pass):-1:1
                INTERACTIONM(is_pass(QQQ),:)=[];
            end
        end
        end
        agents_list(1,:)=[];
end

----------------------------------------------------------------------

function
out=delete_meaning_from_fifthcell_of_ALLAGENTS(id_agent,id_meaning,r
elvntsymbols)
global ALLAGENTS
%Meaning is most probably associated to more than one symbol.
Therefore all
%entries of that meaning for each symbol must be deleted.
relvntsymbols(1)=[];%index deleted. This is a row matrix. Find
command works perfectly.
n_symbols=find(relvntsymbols);
for qqq=1:length(n_symbols)
    this_symbols(qqq)=relvntsymbols(n_symbols(qqq));

adres=find(ALLAGENTS{id_agent,5}{this_symbols(qqq)}==id_meaning);
    if isempty(adres)==0
        ALLAGENTS{id_agent,5}{this_symbols(qqq)}(adres)=[];
    end
end
out=this_symbols;
%Function returns as a logical value if there is a cover problem.

----------------------------------------------------------------------

function
out=delete_meaning_from_fourthcell_of_ALLAGENTS(id_agent,id_meaning)
global ALLAGENTS
%Locate the row address of the meaning
%First get meaning codes otherwise "find" command might cause
problems.
```

```
A_m_i=ALLAGENTS{id_agent,4}(:,1);
row_adres=find(A_m_i==id_meaning);
if isempty(row_adres)
    out=[];
    return
end
out=ALLAGENTS{id_agent,4}(row_adres,:);
ALLAGENTS{id_agent,4}(row_adres,:)=[];
end
```

```
function
[]=delete_meaning_from_sixthcell_of_ALLAGENTS(id_agent,id_meaning)
global ALLAGENTS
row_adres=find(ALLAGENTS{id_agent,6}==id_meaning);
if isempty(row_adres)
    return
end
ALLAGENTS{id_agent,6}(row_adres(1),:)=[];
end
```

```
function out=economic_interaction()
%Economic interactions realize. Endowments update. Change in
endowments for
%both active and passive agents are send out.
global ALLAGENTS INTERACTIONM
rrr=size(INTERACTIONM);
for qqq=1:rrr(1)
    agents_e(qqq,1)=ALLAGENTS{INTERACTIONM(qqq,2),2}-
ALLAGENTS{INTERACTIONM(qqq,1),2}^2;
    agents_e(qqq,2)=ALLAGENTS{INTERACTIONM(qqq,1),2}-
ALLAGENTS{INTERACTIONM(qqq,2),2}^2;

ALLAGENTS{INTERACTIONM(qqq,1),1}=ALLAGENTS{INTERACTIONM(qqq,1),1}+ag
ents_e(qqq,1);

ALLAGENTS{INTERACTIONM(qqq,2),1}=ALLAGENTS{INTERACTIONM(qqq,2),1}+ag
ents_e(qqq,2);
end
out=agents_e;
end
```

```
function out=find_emptycells_in_HABITAT()
global HABITAT size_HABITAT
out=[];
for rrr=1:size_HABITAT
    for ccc=1:size_HABITAT
        if HABITAT{rrr,ccc}{1}==0
            out=[out;[rrr ccc]];
        end
    end
end
```

```
function
[]=fix_cover_problem_after_perturbation(id_agent,this_symbols)
```

```
global ALLAGENTS
%Check the cover problem. If there is one update cells 4,5 and 6 for
each
%symbol.
for qqq=1:length(this_symbols)
    %Check for cover problem
    if isempty(ALLAGENTS{id_agent,5}{this_symbols(qqq)})
        %There is a cover problem. FIX IT!
        %Fix Cell 4 of ALLAGENTS
        %Generate trivial meaning.
        tri_m=[this_symbols(qqq) this_symbols(qqq) zeros(1,8)];
        ALLAGENTS{id_agent,4}=[ALLAGENTS{id_agent,4};tri_m];
        %Fix Cell 5 of ALLAGENTS

ALLAGENTS{id_agent,5}{this_symbols(qqq)}=[ALLAGENTS{id_agent,5}{this
_symbols(qqq)} this_symbols(qqq)];
        %Fix Cell 6 of ALLAGENTS

ALLAGENTS{id_agent,6}=[ALLAGENTS{id_agent,6};[this_symbols(qqq)
rand]];
        %COVER problem fixed. Leave.
    end
end
end

---------------------------------------------------------------------

function out=generate_agent(Endowment,Tag)
%This function generates an agent. Different than birth.
%An actor is a column cell to be added into the ACTORS cell. Cells
are
%ordered as rows. Correspondingly,
%CELL 1:    Initial endowment of an agent. Enters as an argument.
%CELL 2:    Strategy space.
%               Strategy space consist of a Real Number x in
[0,0.5]. Then
%               this agent generates a payoff x with a cost of x^2
in every
%               interaction.
%CELL 3:    TAG that defines the opposition relation.
%               The tag of the agent enters into the function as an
%               argument. All opposition relations are stored in a
global
%               cell variable called OPPOSITIONS. With the use of
tag
%               program knows from which allmeanings set the meaning
%               collection of the agent will be generated.
%CELL 4:    Meaning collection.
%               Based on the tag of the agent code calls
"assign_meanings"
%               function to generate a meaning for the agent. This
function
%               requires allmeanings of a predefined tag and symbols
as
%               integer in the format
assign_meanings(allmeanings,symbols).
%CELL 5:    Symbol-Meaning Correspondence.
%               Using the meaning collection of the agent Symbol -
Meaning
%               correspondence of the agent can be computed by the
help of
```

```
%               the "meanings2symbols" function. This function
requires a
%               meaning collection and number of symbols as an
integer in
%               the format meanings2symbols(meaning_collection,
%               number_of_symbols_as_integer).
%CELL 6:    Reliabilities.
%               Realiability matrix of an agent is a two column
matrix.
%               First column are the meaning indeces in the meaning
%               collection. this is basically the first column of
the
%               meaning collection. Second column corresponds to
%               reliabilities of each meaning.

global ALLMEANINGSD SymbolS
out=cell(1,6);
out{1,1}=Endowment;
out{1,2}=rand*.5;
out{1,3}=Tag; %Also represents the row index of the ALLMEANINGS
out{1,4}=assign_meanings(ALLMEANINGSD{Tag,2}, SymbolS);
out{1,5}=meanings2symbols(out{1,4},SymbolS);
rel_index=size(out{1,4});
rel_part1=out{1,4}(:,1);
rel_part2=rand(rel_index(1),1);
out{1,6}=[rel_part1 rel_part2];

---------------------------------------------------------------------

%This function calls the global variables. It might be merged with
the
%main code of the simulation later.

clear %Clear the workspace.
%opprelD:       Randomly generated 100 opposition relations. First
%               opposition relation is the one that has been used in
the
%               thesis for demonstration purposes. The variable is a
100x1
%               cell.
%ALLMEANINGSD:  This is a 100x2 cell. First column corresponds to
meaning
%               generating sets for each opposition relation in
opprelD.
%               Second column is all meaning collections for each
%               opposition relation in opprelD.
%SymbolS:       Number of symbols in the symbol set.
%HABITAT:       Habitat is a 10x10 Cellular Automata with Moore
%               neighborhood.Habitat is a sphere so that everyone
has
%               exactly 4 neighbors.Habitat affects the followings:
1. The
%               Interaction Probability, 2. Only if a neighborhood
is
%               available an agent can give birth to an offspring.
%NUMBEROFTAGS:  Maximum number of TAGS that the population has. Each
TAG
%               corresponds to a different opposition relation and
hence a
%               different row in opprelD.
```

```
%INTERACTIONM:  Records of linked agents. First column corresponds
to the
%               active side in the link establishment. Second row is
the ID
%               of the agent that is passive. Third row is the
symbol that
%               initiated and still the activation signifier of the
%               interaction. Fourth represents the common
understanding of
%               the symbol.


global opprelD ALLMEANINGSD HABITAT ALLAGENTS INTERACTIONM...
    NUMBEROFTAGS ENDOWMENT SymbolS size_HABITAT PERTURBATED...

rand('state',sum(100*clock)); %randomizes the random seed.

SymbolS=9; %Number of symbols in the symbols set.
size_HABITAT=10; %Size of the HABITAT
NUMBEROFTAGS=4;
ENDOWMENT=.5;
PERTURBATED=[];
%Load the opposition relations onto "opprel" variable
cd OppDATA
load opprel.mat %Generates opprel variable
load ALLMEANINGSDATA.mat %Generates ALLMEANINGS variable
opprelD=opprel;
ALLMEANINGSD=ALLMEANINGS;
clear opprel
clear ALLMEANINGS
cd ..

%Following lines plot the opposition relations
%h1 = view(biograph(opprelD{1,1},[],'ShowArrows','off'));
%h2 = view(biograph(opprelD{2,1},[],'ShowArrows','off'));
%h3 = view(biograph(opprelD{3,1},[],'ShowArrows','off'));

%Create the Habitat

HABITAT=cell(size_HABITAT,size_HABITAT);
%Set all cells initially empty. Initially there is no one in the
HABITAT.
for clearme1=1:size_HABITAT
    for clearme2=1:size_HABITAT
        HABITAT{clearme1,clearme2}{1}=0;
    end
end
clear clearme1
clear clearme2

%Create the ALLAGENTS. First column is the coordinate in the
HABITAT.
ALLAGENTS=cell(size_HABITAT*size_HABITAT,7);

INTERACTIONM=[];

----------------------------------------------------------------------

function []=imigrate_agent()
%STEP 1:    Empty cells in the HABITAT are randomly ordered.
```

```
%STEP 2:    An agent with random TAG is placed to the selected cell.
%STEP 3:    HABITAT is updated.
%STEP 4:    ALLAGENTS is updated.


global HABITAT ALLAGENTS ENDOWMENT NUMBEROFTAGS
%STEP 1:    Empty cells in the HABITAT are randomly ordered.
%First find the empty cells in the HABITAT.
empty_cells_in_HABITAT=find_emptycells_in_HABITAT();
if isempty(empty_cells_in_HABITAT)
    return %There are no free seats, so leave the function!
end
randomized_empty_cells_in_HABITAT=randomize_rows_of_matrix(empty_cel
ls_in_HABITAT);
cell_address_for_immigrant=randomized_empty_cells_in_HABITAT(1,:);


%STEP 2:    An agent with random TAG is placed to the selected cell.
immigrants_tag=fix(rand*(NUMBEROFTAGS))+1;
if immigrants_tag==(NUMBEROFTAGS+1)
    immigrants_tag=NUMBEROFTAGS;
end
immigrant=generate_agent(ENDOWMENT,immigrants_tag);

%STEP 3:    HABITAT is updated.
HABITAT{cell_address_for_immigrant(1),cell_address_for_immigrant(2)}
{1}=1;

%STEP 4:    ALLAGENTS is updated.

for ccc=1:6
    ALLAGENTS{(cell_address_for_immigrant(1)-
1)*10+cell_address_for_immigrant(2),ccc}=...
        immigrant{ccc};
end
%ALLAGENTS{(cell_address_for_immigrant(1)-
1)*10+cell_address_for_immigrant(2),7}=...
%    [cell_address_for_immigrant(1) cell_address_for_immigrant(2)];

---------------------------------------------------------------------

function out=initial_interaction_step3(MMM)
global ALLAGENTS SymbolS
initially_interacting_pairs=MMM;
rrr=size(initially_interacting_pairs);
out=initially_interacting_pairs;
for qqq=1:rrr(1)
    %ACTIVE AGENT picks up a symbol at random. This has been
recorded
    %immediately to the third column of initially_interacting_pairs.
    random_symbol=fix((rand*(SymbolS)))+1;
    if random_symbol==(SymbolS+1)
        random_symbol=SymbolS;
    end
    out(qqq,3)=random_symbol;
    %Call the meanings associated to that symbol.
    agent_name=initially_interacting_pairs(qqq,1);
    tempmeans=ALLAGENTS{agent_name,5}{random_symbol,1}';
    for qqq1=1:length(tempmeans)
        tempmeans_and_rels(qqq1,1)=tempmeans(qqq1);
```

```
        %Find the location of meaning in reliability catalog
        where_is_rel=find(ALLAGENTS{agent_name,6}==tempmeans(qqq1));

tempmeans_and_rels(qqq1,2)=ALLAGENTS{agent_name,6}(where_is_rel(1),2
);
    end
    %Sort the meanings according to reliabilities.
    tempmeans_and_rels=flipud(sortrows(tempmeans_and_rels,2));
    %Meaning found! Record it. Simulation may proceed in one of two
ways.
    %If the active agent is allowed to signal to most reliable
meaning then
    %execute the code:

    %out(qqq,4)=tempmeans_and_rels(1,1);

    %Second option, which is the default one randomize meanings
weighted
    %with their reliabilities. To execute this code:


%tempmeans_and_rels=meaning_lottary_wrt_reliabilities(tempmeans_and_
rels);
    %out(qqq,4)=tempmeans_and_rels(1,1);


tempmeans_and_rels=meaning_lottary_wrt_reliabilities(tempmeans_and_r
els);
    out(qqq,4)=tempmeans_and_rels(1,1);
    tempmeans_and_rels=[];
    %Replicate this for all ACTIVE AGENTS
end
end

--------------------------------------------------------------------

function []=initial_interactions()
%STEP 1:    All agents are randomly ordered for interaction.
%STEP 2:    For each agent interaction set is randomized by taking
%           distance into consideration.
%STEP 3:    Active agents selects a symbol at random and associates
a
%           meaning [RULE 4]
%STEP 4:    Passive agent receives the pair and checks whether the
pair
%           fits to his symbol-meaning correspondence [RULE 3]. If
it is in
%           his correspondence passive agent accepts interaction
offer.
%STEP 5:    Interacted agent indices and symbol-meaning pair of the
%           interaction is recorded to the interaction matrix.


global INTERACTIONM size_HABITAT

%STEP 1:    All agents are randomly ordered for interaction.

%STEP 1a:   Get agents list.
agents_list=present_agents();
%STEP 1b:   Randomize this list.
```

```
agents_list=randomize_rows_of_matrix(agents_list);


%STEP 2:    Passive Agent Selection.
%STEP 2a,b,c
agents_random_matrix=initial_interactions_step2abc(agents_list);
%First column of initially_interacting_pairs is active agents and
second
%column is passive agents.
initially_interacting_pairs=list_of_initially_interacting_agents(age
nts_random_matrix);


%STEP 3:    Executing [RULE 4] >> Each active agent in
%           initially_interacting_pairs variable (Column 1), selects
a
%           symbol and a meaning according to RULE 4.
%           initially_interacting_pairs variable was initially
holding pair
%           data. Now 3rd column stores the symbol and 4th column
stores
%           the meaning that the ACTIVE AGENT signals to PASSIVE
AGENT
%           whose identity is stored at (Column 2) of
%           initially_interacting_pairs variable.
initially_interacting_pairs=initial_interaction_step3(initially_inte
racting_pairs);


%STEP 4:    Executing [RULE 3]
initially_interacting_pairs=initial_interactions_step4(initially_int
eracting_pairs);

%STEP 5:    Updating the interaction matrix.

initially_interacting_pairs=flipud(sortrows(initially_interacting_pa
irs,5));
interaction_updater=[];
for kkk=1:size_HABITAT^2
    if initially_interacting_pairs(kkk,5)==0
        break
    else

interaction_updater=[interaction_updater;initially_interacting_pairs
(kkk,1:4)];
    end
end

INTERACTIONM=[INTERACTIONM;interaction_updater];
%Prune the interaction set for repetitions
INTERACTIONM=unique(INTERACTIONM,'rows');
```

```
function out=initial_interactions_step2abc(MMM)
%STEP 2a:   Create a random matrix with dimensions=agents_list+1,
%           agents_list+1. First Column and First Rows are agent
names.
agents_list=MMM;
```

```
agents_random_matrix=rand(length(agents_list)+1,length(agents_list)+
1);
agents_random_matrix(2:end,1)=agents_list;
agents_random_matrix(1,2:end)=agents_list';
agents_random_matrix(1,1)=0; %REDUNDANT
agents_random_matrix_values=agents_random_matrix(2:end,2:end);


%STEP 2b:   Create full symmetric distance matrix
agents_distance_matrix=calculate_distance_matrix(agents_list);
%Make diagonal entries unusable;
agents_distance_matrix=agents_distance_matrix+(-
eye(length(agents_list)));

%STEP 2c:   Elementwise adjust random matrix with distance.
agents_random_matrix_values=agents_random_matrix_values./agents_dist
ance_matrix;
agents_random_matrix(2:end,2:end)=agents_random_matrix_values;
out=agents_random_matrix;
end
```

```
function out=initial_interactions_step4(MMM)
global ALLAGENTS
initially_interacting_pairs=MMM;
rrr=size(initially_interacting_pairs);
out=initially_interacting_pairs;
for qqq=1:rrr(1)
    if
isempty(find(ALLAGENTS{initially_interacting_pairs(qqq,2),5}{initial
ly_interacting_pairs(qqq,3),1}==...
            initially_interacting_pairs(qqq,4)))==0 %#ok<EFIND>
        out(qqq,5)=1;
    else
        out(qqq,5)=0;
    end
end
```

```
function out=list_of_initially_interacting_agents(MMM)

agents_random_matrix=MMM;
agents_random_matrix_values=agents_random_matrix(2:end,2:end);
rrrr=size(agents_random_matrix_values);
out=[];
for qqq=1:rrrr(1)
    [gggg hhhh]=max(agents_random_matrix_values);
    out=[out;agents_random_matrix(1,2)
agents_random_matrix(hhhh(1)+1,1)];
    %Delete specified ACTIVE AGENT from the list so that the second
agent
    %becomes first.
    agents_random_matrix(:,2)=[];%That is the column
    %Now the delete associated PASSIVE AGENT to the ACTIVE AGENT. So
that
    %he can not be PASSIVE anymore.
    agents_random_matrix(hhhh(1)+1,:)=[];
    %Regenerate values matrix. Get ready for the next run.
    agents_random_matrix_values=agents_random_matrix(2:end,2:end);
```

```
end
end
```

```
function out=meaning_lottary_wrt_reliabilities(MMM)
tempmeans_and_rels=MMM;
rrr=size(tempmeans_and_rels);
tempmeans_and_rels(:,2)=tempmeans_and_rels(:,2).*rand(rrr(1),1);
tempmeans_and_rels=flipud(sortrows(tempmeans_and_rels,2));
out=tempmeans_and_rels;
end
```

```
function out=meanings2symbols(meaning_collection,
number_of_symbols_as_integer)
%This function associates meanings to each symbol. In other words
creates
%symbol-meaning correspondence.
%THIS FUNCTION REQUIRES:NONE
%NOTE:This function must be run after symbols2meanings and then
%assign_meanings.
out=cell(number_of_symbols_as_integer,1);
size_meaning_collection=size(meaning_collection);
for row_counter=1:size_meaning_collection(1)
    for column_counter=2:size_meaning_collection(2)
        if meaning_collection(row_counter,column_counter)~=0
            out{meaning_collection(row_counter,column_counter)}=...
            [out{meaning_collection(row_counter,column_counter)}
meaning_collection(row_counter,1)];
        end
    end
end
```

```
function out=meanings_cover_symbols(meanings, symbols)
%This function returns TRUE if a particular meaning set covers a
symbol set
%symbols enter as an integer. meanings is a matrix.
%THIS FUNCTION DEPENDS ON: NONE
meanings(:,1)=[];%delete the index column from allmeanings matrix
size_meanings=size(meanings);
cover=[];
for counter=1:size_meanings(1)
    cover=union(cover, meanings(counter,:));
end
cover(1)=[];%zero comes here
symbolset=1:symbols;
if isequal(cover,symbolset)
    out=1;
else
    out=0;
end
end
```

```
function out=neighborhoods_of(agentrow,agentcolumn)
%Output is: N,S,W,E as a column matrix.
center_row=mod(agentrow,10);
```

```
center_column=mod(agentcolumn,10);
%N
out(1,1)=mod(center_row-1,10);
out(1,2)=center_column;
%S
out(2,1)=mod(center_row+1,10);
out(2,2)=center_column;
%W
out(3,1)=center_row;
out(3,2)=mod(center_column-1,10);
%E
out(4,1)=center_row;
out(4,2)=mod(center_column+1,10);

for qqq=1:4
    if out(qqq,1)==0
        out(qqq,1)=10;
    end
    if out(qqq,2)==0
        out(qqq,2)=10;
    end
end
end
```

```
function out=present_agents()
global ALLAGENTS
out=[];
r_r=size(ALLAGENTS);
for rrr=1:r_r(1)
    if isempty(ALLAGENTS{rrr,3})==0
        out=[out;rrr];
    end
end
```

```
function out=randomize_rows_of_matrix(IMatrix)
%This function adds an additional random column to a matrix and
randomize
%the rows of the matrix with respect to that column.
out=IMatrix;
size_out=size(out);
out=[out rand(size_out(1),1)];
out=flipud(sortrows(out,size_out(2)+1));
out(:,size_out(2)+1)=[];
```

```
function []=recorded_interactions()
%STEP 2.6:    Economic interaction is performed for both parties.
%STEP 2.7:    Endowments of both Parties are updated.
%STEP 2.8:    Both agents adapt their meaning reliabilities
according to net
%             return from interaction. [RULE 2]
%STEP 2.9:    If a meaning is dropped (i.e. zero or less
reliability) then
%             check for cover. If there is a problem cover un-
covered symbols
%             with trivial meanings. If the dropped meaning belongs
to an
%             interaction then adjust the interaction matrix.

global INTERACTIONM

if isempty(INTERACTIONM)
    return
end

%STEP 2.6:    Economic interaction is performed for both parties.
But
%             before that interaction matrix is randomized.

INTERACTIONM=randomize_rows_of_matrix(INTERACTIONM);

%STEP 2.7:    Endowments of both Parties are updated.

Delta_endowments=economic_interaction();

%STEP 2.8:    Both agents adapt their meaning reliabilities
according to net
%             return from interaction. [RULE 2]

recorded_interactions_rule_2_8(Delta_endowments);
```

```
%STEP 2.9:    If a meaning is dropped (i.e. zero or less
reliability) then
%             check for cover. If there is a problem cover un-
covered symbols
%             with trivial meanings. If the dropped meaning belongs
to an
%             interaction then adjust the interaction matrix.

recorded_interactions_rule_2_9()
end
```

```
function []=recorded_interactions_rule_2_8(MMM)
%Update of the meaninings obey Prospect Theory Value Function
%characteristics. If an interaction triggered by a symbol-meaning
%correspondence generates positive payoffs then the reliability of
the
%meaning increases like the right hand side of the value function.
%Otherwise, if a negative payoff is generated then reliability
decreases
%sharply like the left hand side of the value function and
interaction is
%cancelled out. Parameters are at prospectvalue.m
%To generate the value function figure using matlab: ezplot
global ALLAGENTS INTERACTIONM PERTURBATED

Delta_endowments=MMM;
rrr=size(INTERACTIONM);
CopyINTERACTIONM=INTERACTIONM;
PERTURBATED=[];%Records the agents for STEP 2.9
for qqq=1:rrr(1)
    willbedeleted=0;
    a_agnt=INTERACTIONM(qqq,1); %ID of active agent
    p_agnt=INTERACTIONM(qqq,2); %ID of passive agent
    m_c=INTERACTIONM(qqq,4); %Meaning Code
    m_a_agnt=find(ALLAGENTS{a_agnt,6}(:,1)==m_c);%Meaning location
of active agent.
    m_p_agnt=find(ALLAGENTS{p_agnt,6}(:,1)==m_c);%Meaning location
of passive agent.
    %FIRST UPDATE MEANING RELIABILITY OF ACTIVE AGENT
    if Delta_endowments(qqq,1)<0
        willbedeleted=1;
        PERTURBATED=[PERTURBATED;[a_agnt INTERACTIONM(qqq,3) m_c
p_agnt]];
        my_value=-Delta_endowments(qqq,1);

ALLAGENTS{a_agnt,6}(m_a_agnt,2)=ALLAGENTS{a_agnt,6}(m_a_agnt,2)-
0.5*(my_value^.15);
    else
        my_value=Delta_endowments(qqq,1);

ALLAGENTS{a_agnt,6}(m_a_agnt,2)=ALLAGENTS{a_agnt,6}(m_a_agnt,2)+0.1*
(my_value^.3);
    end
    %NEXT UPDATE RELIABILITY OF PASSIVE AGENT
    if Delta_endowments(qqq,2)<0
        willbedeleted=1;
        PERTURBATED=[PERTURBATED;[p_agnt INTERACTIONM(qqq,3) m_c
a_agnt]];
        my_value=-Delta_endowments(qqq,2);
```

```
ALLAGENTS{p_agnt,6}(m_p_agnt,2)=ALLAGENTS{p_agnt,6}(m_p_agnt,2)-
0.5*(my_value^.15);
    else
        my_value=Delta_endowments(qqq,2);

ALLAGENTS{p_agnt,6}(m_p_agnt,2)=ALLAGENTS{p_agnt,6}(m_p_agnt,2)+0.1*
(my_value^.3);
    end
    if willbedeleted==1;
        CopyINTERACTIONM(qqq,5)=1;
    else
        CopyINTERACTIONM(qqq,5)=0;
    end
end
CopyINTERACTIONM=flipud(sortrows(CopyINTERACTIONM,5));
qqq=1;
while qqq<rrr(1)
    if CopyINTERACTIONM(qqq,5)>0
        CopyINTERACTIONM(qqq,:)=[];
        qqq=1;
    else
        break
    end
    if isempty(CopyINTERACTIONM)
        break
    end
end
CopyINTERACTIONM(:,5)=[];
INTERACTIONM=CopyINTERACTIONM;
INTERACTIONM=unique(INTERACTIONM,'rows');
PERTURBATED=unique(PERTURBATED,'rows');
end


---------------------------------------------------------------------

function []=recorded_interactions_rule_2_9()
%PERTURBATED is a global matrix that stores reliability deflations
in a
%turn of the simulation. This function first locate the meanings
that might
%be deleted due to low reliability and second it generates a meaning
%function that is coherent with the opposition relation of the
agent.
%Default setting is that it is the symbol itself.
global PERTURBATED ALLAGENTS
Threshold_Value=0;
if isempty(PERTURBATED)
    return
end
size_P=size(PERTURBATED);
for qqq=1:size_P(1)

rel_adres=find(ALLAGENTS{PERTURBATED(qqq,1),6}==PERTURBATED(qqq,3));
    if isempty(rel_adres)==0

PERTURBATED(qqq,5)=ALLAGENTS{PERTURBATED(qqq,1),6}(rel_adres(1),2);
    else
        PERTURBATED(qqq,5)=0;
    end
```

```
end

%Trim PERTURBATED matrix.

PERTURBATED=flipud(sortrows(PERTURBATED,5));
qqq=1;
while qqq<size_P(1)
    if PERTURBATED(qqq,5)>Threshold_Value
        PERTURBATED(qqq,:)=[];
        qqq=1;
    else
        break
    end
    if isempty(PERTURBATED)
        break
    end
end

size_P=size(PERTURBATED);

for qqq=1:size_P(1)
    %Delete the meaning from 4th cell of ALLAGENTS

relvntsymbols=delete_meaning_from_fourthcell_of_ALLAGENTS(PERTURBATE
D(qqq,1),PERTURBATED(qqq,3));
    if isempty(relvntsymbols)==0
        %Delete the meaning from 6th cell of ALLAGENTS

delete_meaning_from_sixthcell_of_ALLAGENTS(PERTURBATED(qqq,1),PERTUR
BATED(qqq,3));
        %Delete the meaning from the corresponding symbol at 5th
cell of ALLAGENTS

this_symbols=delete_meaning_from_fifthcell_of_ALLAGENTS(PERTURBATED(
qqq,1),PERTURBATED(qqq,3),relvntsymbols);
        %Check for cover problems and fix if necessary

fix_cover_problem_after_perturbation(PERTURBATED(qqq,1),this_symbols
)
    end
end

---------------------------------------------------------------------

function []=reproduce_into(motherindex,doughterindex)
%Read meaning collection mother from ALLAGENTS LIST.
global ALLAGENTS ALLMEANINGSD ENDOWMENT SymbolS


if rand<.1 %Offspring mutates.
    mother_meaning_collection=ALLAGENTS{motherindex,4};
    mother_TAG=ALLAGENTS{motherindex,3};

mother_allmeanings=randomize_rows_of_matrix(ALLMEANINGSD{mother_TAG,
2});
    mother_rels=ALLAGENTS{motherindex,6};
    %Delete 10% of meaning collection of mother.
    size_mmc=size(mother_meaning_collection);
    numberof_rows_todelete=fix(size_mmc(1)/10)+1;
```

```
    mother_meaning_collection=[mother_meaning_collection
rand(size_mmc(1),1)];

mother_meaning_collection=flipud(sortrows(mother_meaning_collection,
11));
    mother_meaning_collection(1:numberof_rows_todelete,:)=[];
    doughter_meaning_collection=mother_meaning_collection;
    doughter_meaning_collection(:,11)=[];
    Covered_Symbols=0;
    symbols=SymbolS;
    k=1;
    while Covered_Symbols==0

doughter_meaning_collection=[doughter_meaning_collection;mother_allm
eanings(k,:)];
        if
meanings_cover_symbols(doughter_meaning_collection,symbols)
            Covered_Symbols=1;
            k=k+1;
            %Add some random number of redundant meanings also. The
expected
            %number of redundant meanings is adjusted to half of the
symbol
            %size.
            redundant_meaning_number=numberof_rows_todelete;
            deltaredundent=k+redundant_meaning_number;

doughter_meaning_collection=[doughter_meaning_collection;mother_allm
eanings([k:deltaredundent],:)];
        else
            k=k+1;
        end
    end

doughter_meaning_collection=unique(doughter_meaning_collection,'rows
');
    ALLAGENTS{doughterindex,1}=ENDOWMENT;
    ALLAGENTS{doughterindex,2}=rand*.5;
    ALLAGENTS{doughterindex,3}=mother_TAG; %Also represents the row
index of the ALLMEANINGS
    ALLAGENTS{doughterindex,4}=doughter_meaning_collection;

ALLAGENTS{doughterindex,5}=meanings2symbols(doughter_meaning_collect
ion,SymbolS);
    rel_index=size(ALLAGENTS{doughterindex,4});
    rel_part1=ALLAGENTS{doughterindex,4}(:,1);
    for qqq=1:rel_index(1)
        yyyy=find(mother_rels(:,1)==rel_part1(qqq));
        if isempty(yyyy)
            rel_part2(qqq,1)=rand;
        else
            rel_part2(qqq,1)=mother_rels(yyyy(1),2);
        end
    end
    ALLAGENTS{doughterindex,6}=[rel_part1 rel_part2];
else
    for qqq=1:7
        ALLAGENTS{doughterindex,qqq}=ALLAGENTS{motherindex,qqq};
    end
```

```
ALLAGENTS{doughterindex,2}=min(0.5,max(0,ALLAGENTS{doughterindex,2}+
(rand*.2-.1)));
    ALLAGENTS{doughterindex,1}=ENDOWMENT;
end
%update HABITAT.
if mod(doughterindex,10)==0
    agentrow=doughterindex/10;
    agentcolumn=10;
else
    agentrow=fix(doughterindex/10)+1;
    agentcolumn=doughterindex-(agentrow-1)*10;
end
HABITAT{agentrow,agentcolumn}{1}=1;

---------------------------------------------------------------------

function []=ReproductioN()
%Each agent is chosen  at a random order and has given a chance of
%reproduction depending a random factor times their endowments and
with the
%constraint that there is an empty cell in neighborhood.
global ALLAGENTS
PRESENT_AGENTS=randomize_rows_of_matrix(present_agents());
social_welfare=0;
for qqq=1:length(PRESENT_AGENTS)
    PRESENT_AGENTS(qqq,2)=ALLAGENTS{PRESENT_AGENTS(qqq,1),1};
    PRESENT_AGENTS(qqq,3)=rand/50;
    social_welfare=social_welfare+PRESENT_AGENTS(qqq,2);
end
%Normalization of welfare with respect to social_welfare
PRESENT_AGENTS=[PRESENT_AGENTS PRESENT_AGENTS(:,2)/social_welfare];
%Trim the list to agents that can reproduce.
Trimmer=find(PRESENT_AGENTS(:,4)>PRESENT_AGENTS(:,3));
P_A=PRESENT_AGENTS(Trimmer,:);
%maybe no one can reproduce. then EXIT.
if isempty(P_A)
    return
end
%Check the constraint
kkk=size(P_A);
for qqq=1:kkk(1)
    if mod(P_A(qqq),10)==0
        agentrow=P_A(qqq)/10;
        agentcolumn=10;
    else
        agentrow=fix(P_A(qqq)/10)+1;
        agentcolumn=P_A(qqq)-(agentrow-1)*10;
    end
    N_LIST=neighborhoods_of(agentrow,agentcolumn);
    %if neighbor is not occupied add to availables.
    availableS=[];
    for ppp=1:4
        neighborindex=(N_LIST(ppp,1)-1)*10+N_LIST(ppp,2);
        if isempty(find(PRESENT_AGENTS(:,1)==neighborindex))==1
            availableS=[availableS;N_LIST(ppp,1) N_LIST(ppp,2)];
        end
    end
    if isempty(availableS)==0
        ssss=size(availableS);
        availableS=[availableS rand(ssss(1),1)];
        reproduce_into(P_A(qqq),neighborindex);
```

```
    end
end


---------------------------------------------------------------------

%Mainframe
Generate_Globals;

%The order of the simulation code is as follows:
%1. An agent imigrates to the HABITAT.
%2. Agents interact.
%3. Some agents give birth to new offsprings.
%4. Some agents die.
%5. Loop to the first step until counter.

for jjj=1:30
    imigrate_agent()
end

for jjj=1:10
    %jjj
%STEP 1: IMIGRATION
%Empty cells in the HABITAT are randomly ordered. An agent with
random TAG
%is placed to the selected cell. HABITAT is updated. ALLAGENTS is
updated.

%imigrate_agent()



%STEP 2: AGENTS INTERACT

%PHASE 1: INITIAL INTERACTIONS
%All agents are randomized. Each agent has exactly one active
interaction
%right. For all agents interaction set is randomized by taking
distance
%into consideration. Active agents selects a symbol at random and
%associates a meaning that is partly randomly selected. Here the
%reliability of the meaning has effects on the selection. Active
agent
%signal the selected (symbol,meaning) pair to passive agent [RULE
4].
%Passive agent receives the pair and checks whether the pair fits to
his
%symbol-meaning correspondence [RULE 3]. If it is in his
correspondence
%passive agent accepts interaction offer. Economic interaction is
performed
%for both parties. Both agents adapt their meaning reliabilities
according
%to net return from interaction. Interacted agent indices and
%symbol-meaning pair of the interaction is recorded to the
interaction
%matrix.
%STEP 2.1:    All agents are randomly ordered for interaction.
%STEP 2.2:    For each agent interaction set is randomized by taking
%             distance into consideration.
```

```
%STEP 2.3:    Active agents selects a symbol at random and
associates a
%             meaning [RULE 4]
%STEP 2.4:    Passive agent receives the pair and checks whether the
pair
%             fits to his symbol-meaning correspondence [RULE 3]. If
it is in
%             his correspondence passive agent accepts interaction
offer.
%STEP 2.5:    Interacted agent indices and symbol-meaning pair of
the
%             interaction is recorded to the interaction matrix.

initial_interactions()

%PHASE 2: RECORDED INTERACTIONS
%STEP 2.6:    Economic interaction is performed for both parties.
%STEP 2.7:    Endowments of both Parties are updated.
%STEP 2.8:    Both agents adapt their meaning reliabilities
according to net
%             return from interaction. [RULE 2]
%STEP 2.9:    If a meaning is dropped (i.e. zero or less
reliability) then
%             check for cover. If there is a problem cover un-
covered symbols
%             with trivial meanings. If the dropped meaning belongs
to an
%             interaction then adjust the interaction matrix.

recorded_interactions()

%STEP 3:    :REPRODUCTION
%Each agent is chosen  at a random order ans has given a chance of
%reproduction depending a random factor times their endowments and
with the
%constraint that there is an empty cell in neighborhood.

ReproductioN()

%STEP 4:    DEATH
%Some agents die to open new place for offsprings. Death rate is a
function
%of endowment and chance. Expected death rate is 10%.

death_of_a_swan()


end
---------------------------------------------------------------------

%Mainframe
%Generate_Globals;

%The order of the simulation code is as follows:
%1. An agent imigrates to the HABITAT.
%2. Agents interact.
%3. Some agents give birth to new offsprings.
%4. Some agents die.
%5. Loop to the first step until counter.
```

```
%for jjj=1:10
%    imigrate_agent()
%end

for jjj=1:1000
    %jjj
%STEP 1: IMIGRATION
%Empty cells in the HABITAT are randomly ordered. An agent with
random TAG
%is placed to the selected cell. HABITAT is updated. ALLAGENTS is
updated.

imigrate_agent()



%STEP 2: AGENTS INTERACT

%PHASE 1: INITIAL INTERACTIONS
%All agents are randomized. Each agent has exactly one active
interaction
%right. For all agents interaction set is randomized by taking
distance
%into consideration. Active agents selects a symbol at random and
%associates a meaning that is partly randomly selected. Here the
%reliability of the meaning has effects on the selection. Active
agent
%signal the selected (symbol,meaning) pair to passive agent [RULE
4].
%Passive agent receives the pair and checks whether the pair fits to
his
%symbol-meaning correspondence [RULE 3]. If it is in his
correspondence
%passive agent accepts interaction offer. Economic interaction is
performed
%for both parties. Both agents adapt their meaning reliabilities
according
%to net return from interaction. Interacted agent indices and
%symbol-meaning pair of the interaction is recorded to the
interaction
%matrix.
%STEP 2.1:     All agents are randomly ordered for interaction.
%STEP 2.2:     For each agent interaction set is randomized by taking
%              distance into consideration.
%STEP 2.3:     Active agents selects a symbol at random and
associates a
%              meaning [RULE 4]
%STEP 2.4:     Passive agent receives the pair and checks whether the
pair
%              fits to his symbol-meaning correspondence [RULE 3]. If
it is in
%              his correspondence passive agent accepts interaction
offer.
%STEP 2.5:     Interacted agent indices and symbol-meaning pair of
the
%              interaction is recorded to the interaction matrix.

initial_interactions()

%PHASE 2: RECORDED INTERACTIONS
```

```
%STEP 2.6:    Economic interaction is performed for both parties.
%STEP 2.7:    Endowments of both Parties are updated.
%STEP 2.8:    Both agents adapt their meaning reliabilities
according to net
%             return from interaction. [RULE 2]
%STEP 2.9:    If a meaning is dropped (i.e. zero or less
reliability) then
%             check for cover. If there is a problem cover un-
covered symbols
%             with trivial meanings. If the dropped meaning belongs
to an
%             interaction then adjust the interaction matrix.

recorded_interactions()

%STEP 3:    :REPRODUCTION
%Each agent is chosen  at a random order ans has given a chance of
%reproduction depending a random factor times their endowments and
with the
%constraint that there is an empty cell in neighborhood.

ReproductioN()

%STEP 4:    DEATH
%Some agents die to open new place for offsprings. Death rate is a
function
%of endowment and chance. Expected death rate is 10%.

death_of_a_swan()


end
---------------------------------------------------------------------
function out=create_matrices_for_analysis()
%Creates matrices for analysis
global ALLAGENTS INTERACTIONM

%Unweighted matrix of interactions
unweighted_matrix_of_interactions=unique(INTERACTIONM(:,[1
2]),'rows');
size_of=size(unweighted_matrix_of_interactions);
full_unweighted_matrix_of_interactions=zeros(100);
for qqq1=1:size_of(1)

full_unweighted_matrix_of_interactions(unweighted_matrix_of_interact
ions(qqq1,1),...
        unweighted_matrix_of_interactions(qqq1,2))=1;
end

h =
view(biograph(full_unweighted_matrix_of_interactions,[],'ShowArrows'
,'off'))

out{1}=unweighted_matrix_of_interactions;
out{2}=full_unweighted_matrix_of_interactions;

---------------------------------------------------------------------
```

```
%This file creates a file that consists 1. meaning generating 2. all
meanings of
%all opposition relations stored in the file opprel.mat.
%DO NOT RUN THIS CODE MORE THAN ONCE!!!!!!!!!!!!!!!!!!!!!!!!!!
%Or change the file names!!!!!!!

%ALLMEANINGS=cell(1,2);
%for count_this=1:100
%    func_out=symbols2meanings(opprel{count_this});
%    ALLMEANINGS{count_this,1}=func_out{1,1};
%    ALLMEANINGS{count_this,2}=func_out{1,2};
%end
%cd OppDATA
%save('ALLMEANINGSDATA.mat', 'ALLMEANINGS');
%cd ..

%STEP 1:    Generate the root index set which is basically the power
set.
%Since there are 9 symbols in the simulation the cardinality of this
set
%will be 2^9-1. Minus one is for the extraction of the empty set.
root_index_matrix=[];
for qqq=1:9
    ppp1=nchoosek(1:9,qqq);

root_index_matrix=[root_index_matrix;convert_full_matrix(ppp1,9)];
end

ALLMEANINGS=cell(1,2);
for count_this=1:100
    func_out=symbols2meanings(opprelD{count_this});
    ALLMEANINGS{count_this,1}=func_out{1,1};

ALLMEANINGS{count_this,2}=locate_index_for_meaning_collection(func_o
ut{1,2},root_index_matrix);
end
save('ALLMEANINGSDATA.mat', 'ALLMEANINGS');

--------------------------------------------------------------------

%This code fills up C:\Documents and Settings\RSA\My
%Documents\MATLAB\OppDATA directory with oppositions that have
density_0.6
%opprel1.mat stores the special example opposition relatio presented
in the
%thesis. The density value is an expected number.
%opprel is the cell of all opposition relations.
%DO NOT RUN THIS CODE MORE THAN ONCE!!!!!!!!!!!!!!!!!!!!!!!!!!
%Or change the file names!!!!!!!

cd OppDATA
load opprel1.mat
opprel1=UG;
clear UG



%populate the opposition relation with default values.
opprel=cell(1,1);
opprel{1,1}=opprel1;
```

```
%Following lines plot the opposition relations
%h1 = view(biograph(opprel{1,1},[],'ShowArrows','off'));


for opp_num=2:100
    opps__rel=create_random_sparse_matrix(9,0.6);
    opprel{opp_num,1}=opps__rel;
end

%fileindtext=num2str(opp_num);
%me_filename=['opprel' fileindtext '.mat'];
save('opprel.mat', 'opprel');
cd ..
```

```
function out=symbols2meanings(oppos_rel)
%The output of this function is a cell. In each column cell of the
function
%a different outcome is produced.
%In CELL :,1:   Function produces the meaning generating set of the
%               opposition relation.
%In CELL :,2:   Function produces the nodes of all of the complete
%               subgraphs that the opposition relation produces.
First
%               entry of each row is the name (index) of the
meaning.
UG=(1-(oppos_rel+oppos_rel'));
meaning_generating_graph=UG;
n=size(meaning_generating_graph);
matrix_of_cliques=[];
matrix_of_cliques=convert_full_row(matrix_of_cliques,n(1));
allmeanings=[];
allmeanings=convert_full_row(allmeanings,n(1));
%create testclique matrix
%in the clique matrix all entries should be one that indicates no
%pairs of symbol that a particular meaning is attached opposes each
other.
for i=1:(n(1)-1)
    %A couple of parameters need to be initialized.
    running_test_matrix=[i];
    k=i+1;
    %enlarge test_matrix by adding one node at a time until the last
node.
    while k<(n(1)+1)
        %enlarge the test matrix
        running_test_matrix=[running_test_matrix k];
        %if the test matrix is complete than check for cliqueness.
        if check_complete_subgraph(running_test_matrix,
meaning_generating_graph)
            if is_clique(running_test_matrix,matrix_of_cliques)
                ENlargeR=convert_full_row(running_test_matrix,n(1));
                matrix_of_cliques=[matrix_of_cliques;ENlargeR];
                allmeanings=[allmeanings;ENlargeR];
                ENlargeR=[]; %This line is redundant.
            else
                ENlargeR=convert_full_row(running_test_matrix,n(1));
                allmeanings=[allmeanings;ENlargeR];
                ENlargeR=[]; %This line is redundant.
            end
```

```
            %If the last node is included in a complete subgraph
then there
            %are no modes left behing to extend therefore last two
entries
            %of the test matrix should be pruned and continue
extending
            %from where we have left...
            if k==n(1)
                running_test_matrix(end)=[];
                k=running_test_matrix(end)+1;%That is where we have
left.
                running_test_matrix(end)=[];
                if k==i+1 %Initialization node is reached. Leave the
loop.
                    break
                end
            else
                k=k+1;
            end
        else
            %if the test matrix is not complete after the last added
node
            %then delete the last added node. But if this is the
last
            %available node then two entries must be deleted.
            if k==n(1)
                running_test_matrix(end)=[];
                k=running_test_matrix(end)+1;%That is where we have
left.
                running_test_matrix(end)=[];
                if k==i+1 %Initialization node is reached. Leave the
loop.
                    break
                end
            else
                running_test_matrix(end)=[];
                k=k+1;
            end
        end
    end
end

%Extend the meaning set for symbols as meanings also.
ENlargeR=zeros(n(1));
ENlargeR(:,1)=1:n(1);
allmeanings=[allmeanings;ENlargeR];
%Delete the null meaning
allmeanings(1,:)=[];
size_allmeanings=size(allmeanings);
allmeanings=[(1:size_allmeanings)' allmeanings];

out=cell(1,2);
out{1,1}=matrix_of_cliques;
out{1,2}=allmeanings;
end
```