ETHICS IN STS:
A BIBLIOMETRIC EXPLORATORY STUDY

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to my grandmothers…

ABSTRACT

Science, Technology and Society (STS) is an interdisciplinary study field that focuses on the interwoven structure between science and technology in society. This study, using bibliometric word co-occurrence analysis and network visualization, looks to keyword network established around ethic keyword in this field. Data of scholarly articles are downloaded from Web of Science database, covering years 2000 – 2017. Graphs are generated with VosViewer and Gephi. Within four divisions of years (2000 to 2004, 2005 to 2009, 2010 to 2014 and 2015 to 2017) it is found that two major areas with dedicated journals play consistently significant role. Further study of those two approaches reveals that they have different method, coverage and structure and overlapping terms. It concludes that ethics discussion is a central but rare topic in STS studies and diverse approaches exist. Varying forms of ethics terminology are to be found. There are some central established discussions with strong links, but plurality and variations are the most significant attribute of the network.

Keywords: ethics, science and technology studies, science technology and society, bibliometrics, co-word analysis, network visualization

ÖZ

Bilim, Teknoloji ve Toplum (BTT) toplumda bilim ve teknolojinin içiçe örülmüş yapısına odaklanan disiplinler arası bir çalışma alanıdır. Bu çalışma bibliometrik kelime birlikteliklerinin analizi ve ağ görselleştirmesi ile bu alanda etik anahtar kelimesinin çevresinde kurulmuş anahtar kelimeler ağını inceler. Akademik makalelerin verileri 2000-2017 yıllarını kapsayarak Web of Science veri tabanından indirilmiştir. Grafikler VosViewer ve Gephi ile üretilmiştir. Yılların bölündüğü dört grup içerisinde (2000-2004, 2005-2009, 2010-2014 ve 2015-2017), ilişkili dergilerde iki temel alanın sürekli olarak önemli bir rol oynadığı bulunmuştur. Bu iki yaklaşımın daha detaylı araştırılması farklı yöntemler, kapsamlar, yapılar ve örtüşen terimlerin olduğunu ortaya çıkarır. Bu etik tartışmasının BTT içerisinde önemli ancak nadir gözüken bir başlık olduğu ve farklı yaklaşımlar içermesi ile sonuçlanır. Etik terminolojisinin farklı formları bulunmuştur. Güçlü bağlantıları olan merkezi tartışmalar vardır ancak ağın büyük çoğunluğunda çoğulluk belirgindir.

Anahtar Sözcükler: etik, bilim ve teknoloji çalışmaları, bilim teknoloji ve toplum, bibliyometri, ortak kelime analizi, ağ görselleştirme

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CHAPTER 1

Introduction

Science is one of the most important social activity in human history. The capability and power it grants to humankind is unquestionable, or is it? Science combined with technology, considering the 20th century, was held responsible for a lot of destruction and suffering as well as progress, enhancement and proliferation.

Second half of 20th century witnessed the most destructive and most productive sides of humanity simultaneously, nearly revealing a schizophrenia. This destructive outcomes of science in recent history through technology rendered possible negative futures. Anxieties about climate change, nuclear warfare, depletion of clean water supplies, autonomy of artificial intelligence, development in genetics, unsustainability in production and similar issues grew, giving way to dystopic futures. Scientific endeavor and technological advancements promoting each other revealed an acceleration, yet society could not always maneuver as fast as expected, failing to catch up and the gap in between widening. This gap is not only between themes (such as science and society) but also between part of the society succeeding to catch and failing to catch; polarized between two extremes such as total denial, or total obedience. Theories of hierarchical explanation of concepts such as technocracy or social construction of technology failed to depict the dialectic relationship between society and technology.

Science and Technology Studies (STS) or used interchangeably Science Technology and Society is a field that has evolved in this direction. The effort to put those terms back in social context triggered different approaches to establish. In the introduction of 3rd edition of Science and Technology Studies Handbook, authors emphasize three major thematic elements of Science and Technology studies. First of those focus on how the knowledge is produced and arranged, stressing the role of various social activities. Second point resembles a more postmodernist approach of blurred boundaries; clear cut separations and contrasting definitions give way to

greyer areas, as causalities are disseminated revealing other underlying factors and their interaction originating the process of causation. The final element is about realization of the surrounding context at both small and large scale, from the level of the individual to the institutional structure emphasizing the importance of history and place (Bijker et al., 2007, p. 4).

Science and technology studies have been highlighting plurality in society during scholarly discussions. If science and technology have a social aspect they therefore have social obligations, and if '*the singulars become plural*' (Bijker et al., 2007, p. 4) concepts like truth becoming truths and objectivity losing its significant position in scientific discourse then how can this effect ethics of science?

It is impossible to find a form of ethics that encompasses all of science or technology. Today science has rather partial ethics depending on context that operate more locally on different divisions. This can be interpreted as diffusion of ethics into a field. This paper is focused to understand how that diffusion takes place.

The dynamic change of 'ethics' concept has an interesting relationship with its wider social context and the small interrelations in between. This study attempts to reveal some key elements within discussion of ethics approaching it as a complex network.

1.1 Scope

Within the interwoven discourse of science, technology and society this study focuses on the concept of ethics in major STS journals listed in Society for Social Studies of Science. Scholarly articles published in those journals are queried with ethic tag and then downloaded, later to be converted into co-occurrence maps, intending to find the structure of literature surrounding them. The subcategories, different types of ethic, major trends and historical establishment in four periods from 2000 to 2017 are of subject. By studying subcategories and the contexts in which those subcategories stand, it might be possible to come to a conclusion about the shared roots of those different kinds of branches.

Understanding the interaction of those categories and the ways they connect might help us to locate the anxieties society develops against techno scientific issues. Studying the paper keywords could also provide a general outlook of what ethics is constituted of, how it is understood evolved intrinsically in a critical environment with relation to society.

CHAPTER 2

Conceptual Framework

2.1 Literature Review

2.1.1 An Overview of Ethics in Science:

David Resnik in his book Ethics of Science defines ethics as "*the standards of a particular profession, occupation, institution or group with-in society*" (Resnik, 2005, p. 14). Before defining ethics author also defines morality as "*Moral standards distinguish between right and wrong, good and bad, virtue and vice, justice and injustice*". Standards of conduct in a basic sense define an act's goodness, badness, wrongness or rightfulness but with these definitions author is distinguishing the former more dependent on the group with-in society (generally mentioned as ethics of …) while the latter is much more generalized. Morality is about being a member of society in general and ethics is about being a member of subgroups within society.

Resnik in his book also makes emphasize on ethical dilemmas(Resnik, 2005, p. 21). An ethical dilemma happens when two ethical rules conflict with each other. For example: A scientist as being a scientist has a responsibility of integrity of research, but on the other hand also has a responsibility with the privacy of the research. Let's say when something wrong happens with the research integrity if s(he) spreads the issue, then s(he) is breaking research privacy as a professional but on the other hand if s(he) is not spreading, then s(he) would be participating in that problematic research resulting with wrong results and committing against scientists. If we consider this with prior definition of ethics, most of the time, we belong to several groups at the same time and standards of conduct of those groups being not necessarily consistent with each other. Hence in many cases one can find herself/himself in the middle of an ethical dilemma to decide on which direction to move necessarily breaking one.

Ethics may be either normative or applied. The prior being more theoretical and the latter being more case based. There are some major branches of ethics in science; one of them is utilitarianism which is a consequentialist approach emphasizing the greatest happiness of greatest number of people. Other branches of ethics are deontological ethics contrasting itself from consequentialist ones, virtue ethics and ethics of care. An example from Stanford Encyclopedia of Philosophy is as follows: *"Suppose it is obvious that someone in need should be helped. A utilitarian will point to the fact that the consequences of doing so will maximize well-being, a deontologist to the fact that, in doing so the agent will be acting in accordance with a moral rule such as "Do unto others as you would be done by" and a virtue ethicist to the fact that helping the person would be charitable or benevolent."*(Hursthouse & Pettigrove, 2018)

Resnik also evaluates science as a profession and underlines several benefits of having a profession bringing responsibility with those benefits. Such as professions grant people power so people are responsible of that power, professions grant people quality so anyone with a profession has an obligation to ensure that quality of work is sufficient, scientists are governed by certain institutions so they are responsible against those institutions, scientists are also experts who are responsible of for the key role given to them to shape public policy.(Resnik, 2005, p. 33). Approaching science as an institution and scientist as a professional and also expertise he evaluates ethics in three categories, in publication practices, in laboratory environment and in society as a responsibility.(Resnik, 2005)

Unethical behaviors can have varying reasons: such as reputative awards of publishing practices, tighter funding that scientist needs to sustain researches, economical gains, wrong or lack of ethics education (Resnik, 2005, p. 3) or pressures upon scientists; such as deadlines and expectations of tangible outcomes. (De Vries, Anderson, & Martinson, 2006)

Demarcation of science (differentiating scientific knowledge from non-scientific) is as much important as definition of ethics when we talk about ethics of science(Resnik, 2005, p. 35) in which he adopts the view of *"justified true belief about world."*. This study's aim is not to try to

find a definition of ethics nor science because that will be an overwhelming task but to examine a pile of documents. Science has been studied by many philosophers of science: A brief history of attempts to distinguish scientific from non-scientific is given in (Sismondo, 2010) Vienna Circle offering logical positivism, Popper emphasizing falsification, Merton attempting to define it as an institution and explaining its norms, Kuhn approaching historically to divide scientific activity into two (normal and revolutionary), Actor Network Theory trying to explain scientists over their interests. More could be counted but the debate is far from being over, all of them failed in some sense and succeeded in another in the act of defining science; approaching it in varying ways as an activity, concept, institution or society.

2.1.2 Science and Technology Studies (STS):

Mertonian perspective can be considered as a turning point in the understanding of science. Instead of attempting to understand science as an arbitrary entity, Merton was more focused on its integration with society and also taking it as an institution, considered it as a society of scientists. Four norms he found are foundational for the proper functioning of science which are as follows: universalism (Merton, 1973, p. 270) (knowledge contributed should not be judged by scientist's personal or social characteristics), communism (Merton, 1973, p. 273) (knowledge should not be owned by particular groups or person), disinterestedness(Merton, 1973, p. 275) (interests of scientists should not overlap with their research activity), organized skepticism(Merton, 1973, p. 277) (scientific community should not depend on newly discovered knowledge until they are tested and established). Those norms usually are not perceived as what science is but are perceived as what science should be to keep its proper functioning (Hull, 1988, p. 384)(Sismondo, 2010, p. 34). However, his perspective of science in society and science as a society was a revolutionary perspective.

Science and Technology studies (Science, Technology and Society) is a critical interdisciplinary field to study the interwoven and dynamic relation of science, technology and society. Deriving itself from disciplines like history and philosophy of science and collaborating with many other

fields(such as sociology, psychology, political science, engineering, medicine, …) STS' attempt to understand science and technology (can also be referred as technoscience) is mainly from a lens of society promoting culture, democracy, diversity, public participation and critical thinking on terms like governance, misuse, singularity, determinism.

Likewise, from social perspective another central concept of STS studies is anti-essentialism or in other words the effort of unblackboxing themes or things. Bruno Latour establishes issue of blackboxing in the very beginnings of his groundbreaking book Science In Action referring to complexity of a particular thing (Latour, 1987, p. 2). Usually a blackbox is a mechanism reduced to input and output but how the system operates is hidden from sight.

The attempt to understand science is nothing new but what STS is trying to do is not just to find dynamics of science but to fill former gaps. In the fourth edition of Handbook of Science and Technology Studies' introduction (referring to the introduction of first edition's handbook written by Spiegel-Rösing) authors emphasize five trends of STS studies. *"(1) the humanistic tendency to "get back the 'actor' into the picture"; (2) the relativistic tendency focusing "on the role of the specific historical moment in which knowledge and technologies are created"; (3) the reflexive tendency to analyze "science and technology as taking place within a situation at a given time"; (4) the desimplifying tendency that fosters "movement away from black-boxism"; and (5) the normative tendency which points at "increasing readiness to take the normative aspects of science and technology into account" (Law et al., 2016, p. 6)*

Revisiting first edition and emphasizing again in the final edition of handbook series these five points are important because those are what goes on from the early stages of the development of STS up until today defining the backbone of the discipline. These five points are: an attempt to reveal actors, studying history of production of knowledge, taking events and context into consideration, the attempt to reveal complexity of things, and being critical of norms and standards. One of those points is especially important which is the fourth point; the desimplifying tendency that fosters "movement away from black-boxism". Previously Latour

defined complexity as the main characteristic of blackboxes yet a desimplifying tendency might sound suspicious. Revealing complexity is nothing simple and the effort to explain complexity simply is the engine of blackboxism which is what STS is trying to overcome. It questions why blackboxes are complex by articulating possible actosrs connected to the blackboxes.

2.1.3 Bibliometrics:

Bibliometrics can be defined as the application of mathematics and statistical methods to books and other type of media of communication (Pritchard, 1969). These mathematical studies, with the help of graph theory can be represented as networks. Networks are also potential visualizations of social systems that can reveal patterns otherwise hard to notice(Wasserman & Faust, 1994).

One of the foundational works of bibliometrics (or sometimes also referred as scientometrics) is Little Science, Big Science(Price, 1965). This work tries to establish quantitative methods to study growth of science, more generally reflecting science back on science to form a sociology of science, making science a research subject in itself. This work is also considered in some papers (Edge, 1995) to be one of the triggering elements of forming STS discipline. Quoting from author (a later and extended version of same work) "*I believe we are getting to the point where there must arise a fairly hard, respectable, and useful academic discipline that will do for science what economics does for the economic life of nations"* and he adds *"... partly because we need to understand the machinery that makes science act the way it does and grow the way it grows"*(Price, 1986, p. 136).

This field is mainly focused to analyze and depict the dynamics of collaborations or communications in a field or discipline, to reveal practices like co-authorship, to locate research fronts or to find significant actors or clusters of a field. There are four main approaches which either can be applied singularly or combined to deepen the analysis and validate the findings.

Common ways of coupling items (as seen in Figure 1):

- Co-Citation: Co-Citation analysis in bibliometric studies relates two items depending on the referring articles. If articles are cited together then they are coupled. For example: as an example case: Consider having an article named X and that has three references A, B and C; in this case A and B, B and C also A and C are co-cited. One particular example that drew my attention was a study which used this method to look at the field of philosophy (epistemology and philosophy of science) deeper (Kreuzman, 2001). He clustered 62 important preselected authors in the field by creating a map, benefiting also from cluster analysis and multidimensional scaling. Another study benefiting from actor network theory (White & Griffith, 1981), looked for major authors to identify five clusters containing them in the field of information science using co-citation. A paper by Small and Griffith examines science literature using co-citation method (Small & Griffith, 1974) in which authors were able to detect and compare different specialties at different levels to reveal subtle connections in between. A new version of co-citation analysis has been introduced newly (Gipp & Beel, 2009). This new version citation proximity analysis (CPA) not only works on the references but also considers how those references are located within corpus of the article. Estimating that the closer they are in the text more likely they are to be similar.

- Bibliometric Coupling: This kind of analysis relates items depending on the references they share. This in fact is the opposite of Co-Citation analysis. Extending the same case mentioned above, article X citing articles A, B and C, article Y citing articles A, B and D, article Z citing E, F and G then article X and Y are bibliometricly coupled. This method is the oldest of bibliometric measurements. First introduced in 1963 (Kessler, 1963) coupling is mainly used to find epistemological groups that a discipline is established upon. It is seen to be the predecessor of co-citation analysis.

One thing to mention here is those two coupling methods (bibliometric coupling and co-citation) function at different levels. Co-citation couples referred articles yet bibliometric coupling couples referring articles.

- Co-authorship: This coupling method functions over authors. If an article has more than one author, then those authors are coupled. It is mainly used to depict author collaborations in a field. Liu et al. conducted a research in the digital library field (Liu, Bollen, Nelson, & Van de Sompel, 2005), another study by Acedo et al. (Acedo, Barroso, Casanueva, & Galán, 2006) marking important authors and their effects on information diffuse in the field of Management and Organizational Studies.

- Co-word (Co-occurrence): This coupling method takes words as unit of analysis, if two or more terms appear together in a tagging line, in a sentence, in a title or so they are coupled. M. Callon in his article develops co-word study as a research method; as an example he compares academic and applied divisions of chemistry field (Callon, Courtial, & Laville, 1991), he also unfolds patent interactions using co-word analysis in an earlier work (Callon, 1986). J. P. Courtial (1994) looked at field of scientometrics using co-word analysis to analyze field dynamics over crossroad clusters revealing core keywords of the field. Ozgur, Cetin & Bingol (2007) used this method to measure the changes of importance of figures within years.

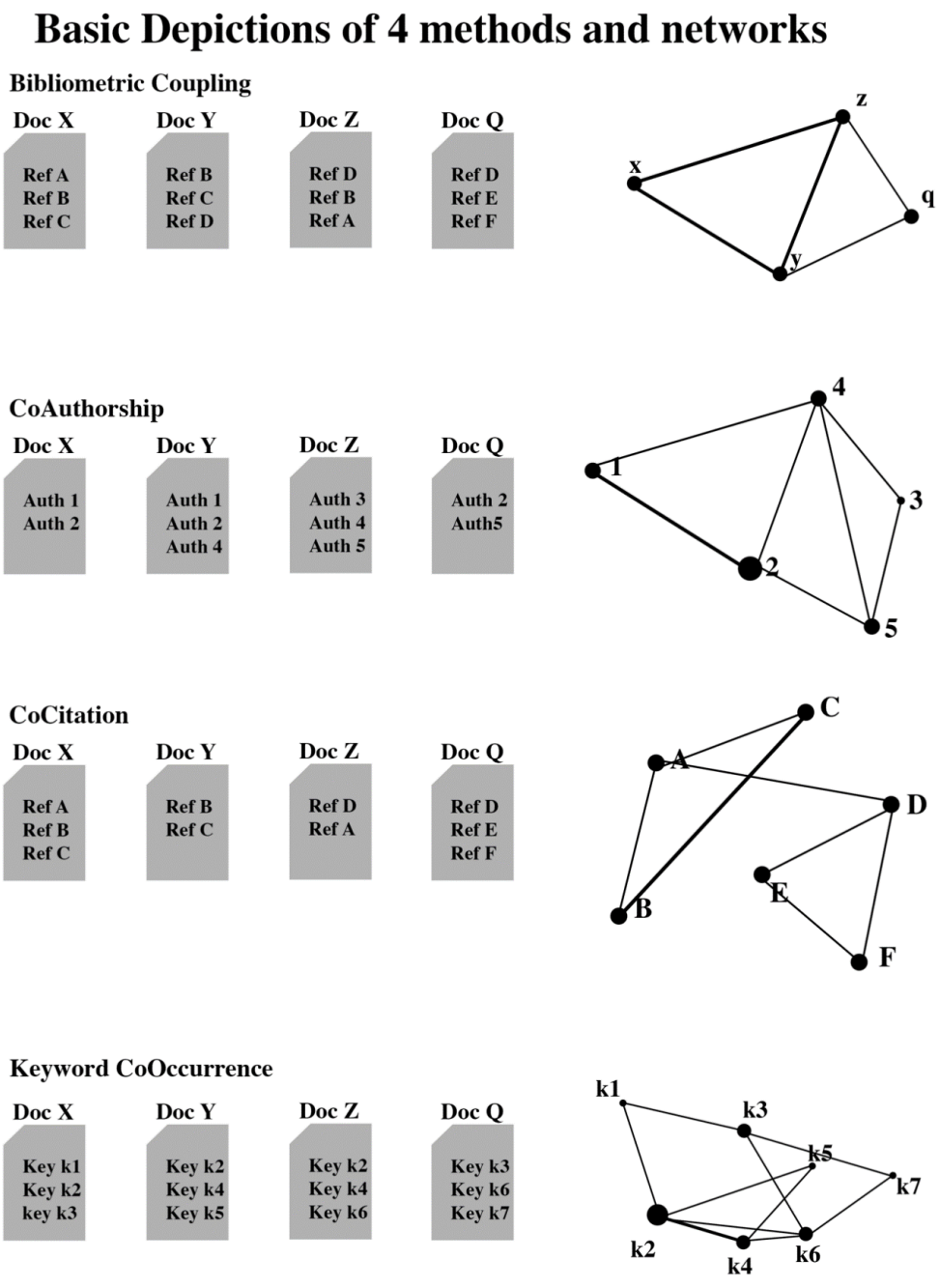

Figure 1. Basic depictions of coupling methods and representations as networks.

M. Callon articulates the method for co-word analysis in his book “Mapping the Dynamics of Science” followed by many studies applying similar methods published by social scientists. J.P. Courtial & Law (1989) studied artificial intelligence field in which they focused to find the intellectual core of the field. Neff and Corley (2009) studied the field of ecology focusing on research priorities by looking at emerged and declined trends in article titles over 35 years.

As mentioned before these methods can be combined to reveal deeper understanding to validate findings. For example Ahlgren et al. (Ahlgren, Pagin, Persson, & Svedberg, 2015), looked to the field of philosophy under two subdomains (issue of free will and the paradoxical problem of sorites or in short vagueness) finding they are significantly different from each other. Using co-citation and term co-occurrence methods and comparing the subdomains they could identify free will as an interdisciplinary term and sorites or vagueness as a more disciplinary term.

Another particularly very interesting article is by Van Heur et al. (Van Heur, Leydesdorff, & Wyatt, 2013), that not only focuses on word but also on authors. In this study authors combine two networks together (words and authors) to reveal the history of ontological turn in STS studies. That instead of a swift turn shifting to ontology happened more slowly. Another study is again focusing on words (combination of keywords and title words) of Information Retrieval field to find trends and clusters it contains (Ding, Chowdhury, & Foo, 2001).

All of these studies listed above take the words as unit of analysis, some of them might consider other data also, for example: authors and words but all of them function on words. This reveals words as an important element of scientific communication which can be harvested from titles of the article, keywords of the article, abstract or main body of the article. However, depending on textual data has downsides since texts are in themselves complex phenomena. Most basic

mechanical problems are the issue of polysemy[1], synonymy [2]and metonymy[3]. There might be also social factors such as conditions an author might consider while deciding an article's title or keywords; e.g. to make his or her study more visible through hot topics or trending keywords this is called as indexer effect and discussed in next page.

Upsides of co-word analysis is that first of all it offers a quantitative way of representing texts allowing one to trace connections within them otherwise hard to notice (Callon, Law, & Rip, 1986, p. 225) and also reducing easy generalization of explanations which is often practiced by qualitativists (Callon et al., 1986, p. 108). The second benefit is its flexibility to zoom (this actually refers to simplification of network by setting threshold value to reveal any intended subnetwork) and capacity of iteration (Callon et al., 1986, p. 193).

Downside of co-word analysis is its strict dependence on keywords. Keywords can suffer from the indexer effect. That means to increase visibility or attraction indexer can alter the keywords other than the ones that actually represent the text. (Callon et al., 1986, p. 226)

Whittaker (1989) did not find indexer effect problematic in PASCAL database or in the logic method. Authors also found that whether or not titles or keywords represent an article more sufficiently is dependent on the complexity and length of the article, if an article is lengthy and complex then keywords seem to represent the text much accurately even if title words are closer to the author's ideas. Another study by He (He, 1999) concludes that possibility of using co-word technique with the title, abstract, summary sections of the articles can reduce indexer effect and also measurement techniques used in co-occurrence analysis are getting better. Wyatt et al. approach scientometric maps as performative because parameters generally change a lot how a map is shown, making alternative conclusions possible yet most of the time user does not have

[1] Polysemous: having multiple meanings ("Definition of POLYSEMOUS," n.d.)

[2] Synonym: one of two or more words or expressions of the same language that have the same or nearly the same meaning in some or all senses("Definition of SYNONYM," n.d.)

[3] Metonymy: a figure of speech consisting of the use of the name of one thing for that of another of which it is an attribute or with which it is associated("Definition of METONYMY," n.d.)

access to the parameters of maps while reading a paper. (Wyatt, Milojević, Park, & Leydesdorff, 2015)

Words also have different meanings but to escape from this issue in general, keywords are chosen to be tags and not just common words, but more likely terms which play a central role in the article. Terms have a particular meaning under certain disciplines and situations. Keywords or terms even if they inherit the subjective interpretation (because they are words in the final sense) are things much more framed and discussed in the article and terms are agreed on and peculiar. M. Callon sometimes refers to these as signal words. In fact, this is relatively hard in social sciences (such as in this study) because when one chooses, for example, "chemotherapy "as his/her study keyword then it is less ambiguous than a social scientist tagging with "ethics".

Textuality is a double-sided weapon. On the positive side textuality places texts in which information is traded to a significant point, a good point to start tracing to reveal the connections. On the other hand, texts are hard to interpret. Meaning has multiple layers and even if it is algorithmically possible to guess the meaning of a word it is very hard to do so and most likely impossible to actually find it, because it has a subjective interpretation. Different kind of readings of same text will bring different conclusions. Therefore, computational approach to texts is problematic.

Texts in science:

Scientific literature is crucial for knowledge production. It is not only used for searching previous works and publishing new ones but also is a critical process for reviews. Scientists establish their studies according to previous works done in their fields. It takes a long time to cumulate knowledge within a field or generating new research fields. However, scientist depends on other scientists to move forward, and does not try to reinvent the wheel every single time. This accumulation process of texts would eventually lead to archives. Texts are one of the very basic form of information exchange, they help us to transfer, transform and translate knowledge.

For example Latour divides scientific activity into two. First element is the laboratories and the second is literature. Laboratories are the artificial worlds in which things are examined, measured and studied and on the contrary literature is the place where controversies establish and studies are tested against each other(Latour, 1987). Literature, in his sense, contains any kind of textual data; field notes, previously published works, inscription of device outputs and so on.

Organization of science is very important in the ways in which it operates. Steve Woolgar situates organization of science as the core object of science and textuality as the main attribute. His proposal is nothing precedes discourse (Woolgar, 1988, p. 81)**.** That makes texts significantly important in knowledge production and granting a theme how something is being discussed; the potential of revealing important things about science.

M. Callon also sees literature as a space where scientists create funnels of interests with their published articles to create passage points which other scientists have to follow(Callon et al., 1986, p. 80). He then continues *"The words of a scientific paper may thus be seen as a network of problematisations which stand for an actor-network,…*" (Callon et al., 1986, p. 81). Translation also, in his sense, is the way in which scientists mobilize actors and actants for their interest.

Graphs and Networks:

Networks emerging from mathematics (mostly graph theory and matrix operations) are a common way of representing data as visuals to interpret or make measurements. Measurements can be made via mathematical or statistical analyses (some examples are centrality, shortest path between two nodes, size of largest partition of network) or one can also approach these networks as a structure for finding different clusters, major pathways or significant nodes. Even if used at different levels (usually micro level in social sciences such as public health, management,

consulting and macro level in physical sciences such as physics, biology) network analysis is an interdisciplinary method applied in varying fields (Borgatti, Mehra, Brass, & Labianca, 2009, p. 893).

Maps, network graphs and other kind of data visualization is exhibited in an extent in Katy Börner's book from diverse disciplines (Börner, 2015). With four dedicated parts for economic decision makers, science policy makers, scholars, digital libraries her work reveals how different areas can benefit from visualization of large datasets also including maps and networks.

Networks (sometimes also referred as graphs) commonly have two elements, nodes (actors or actants) and edges (relations) between nodes. Networks ,as a main property, take their unit as interdependent rather than independent. This interdependency makes the edge as important as the node itself. Depending on type of analysis and the unit of analysis chosen nodes might be different words in a co-word study, or different authors in a co-authorship study, or documents in a bibliometric coupling study, or so. In the visualizations, visual attributes can be mapped to different mathematical attributes but generally speaking nodes have attributes like position, size and color. Size represents the number of occurrences; for example in a co-word study it is the occurrence of a word in a text corpus, for co-authorship it might represent document count of an author, for bibliometric coupling it might represent citations to the document. Networks might be laid out with several algorithms. Those might be categorized in two different categories; one is distance-based and other is graph-based (see Figure 2 and Figure 3 for a visual comparison). For those which are distance-based, closeness of two nodes indicates the tendency to be seen together. These networks are visually more complex. On the other hand, graph-based layout algorithms are visually more legible but harder to interpret in some ways, such as clusters.

Edges are the connections which can represent co-occurrence of words, collaboration of authors, or papers referring to same document signifying values like degree. They have thickness attribute to depict the relation strength. For example, if word A co-occurs with B more frequently than C then the edge between A and B is thicker than the edge between A and C, same might be applied to authors as an example for collaboration and documents as an example of bibliometric coupling. Networks can be analyzed focusing on dyads and triads. Dyads are *"an unordered pair of actors and the arcs that exist between the two actors in the pair"* (Wasserman & Faust, 1994, p. 510). Triads are same but including three nodes and possible edges between them. Another important way to analyze networks is to focus on subgraphs. If all edges and nodes of a graph X is a subset of graph Y then X is a subgraph of Y (Wasserman & Faust, 1994, p. 97).

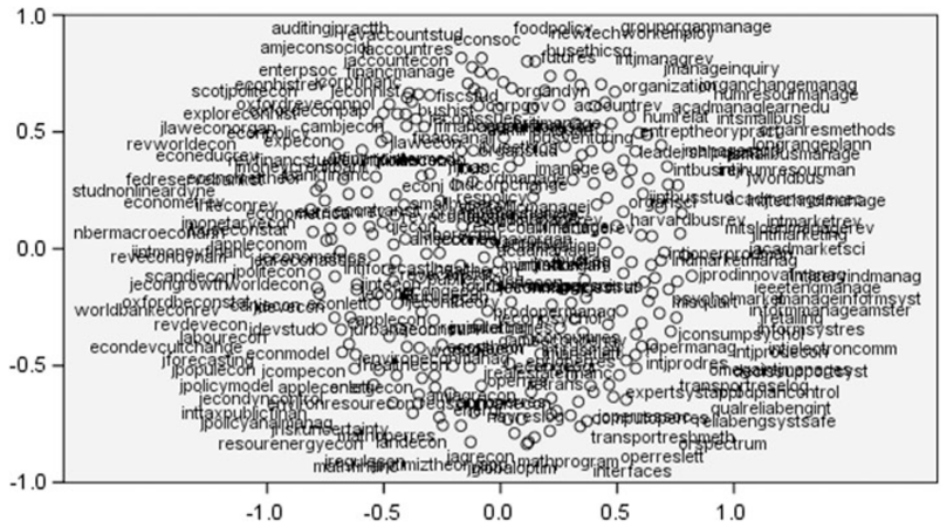

Figure 2. Depiction of distance based map obtained via SPSS. Reprinted from "Software survey: VOSviewer, a computer program for bibliometric mapping", by N.J. Van Eck and L. Waltman, 2010, Scientometrics, 84(2), p.527. (reused with permission from N.J. Van Eck and L. Waltman.)

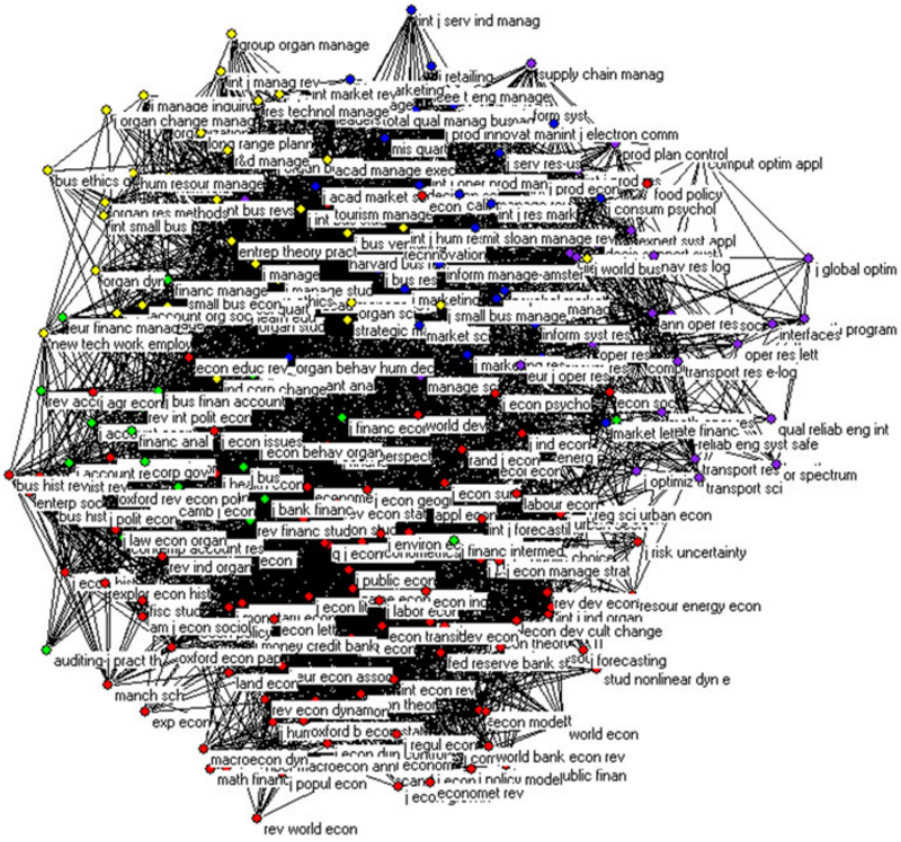

Figure 3. Depictions of a graph based map. Reprinted from "Software survey: VOSviewer, a computer program for bibliometric mapping", by N.J. Van Eck and L. Waltman, 2010, Scientometrics, 84(2), p.527. (reused with permission from N.J. Van Eck and L. Waltman.)

Texts as Networks:

Co-word studies can also be defined as kind of mixture of network and content analysis. The main difference is that because it is also a network, it does not reveal only counts of words but instead reveals the connections of words in a web. This web of nodes and connections might have different attributes such as position, size, distance, connection, cluster, density, thickness. Those attributes are explained in the methods section of the study.

So far, I have tried to reveal the bibliometric study of science as a network of words as a possible method for an overall understanding of the establishment of the discourse. Texts can be represented as networks, this would be not the only but also one type of unfolding the text. This

technique can be either co-occurrence analysis or another algorithm (such as latent semantic analysis).

This study uses co-occurrence networks in two ways. First to find the central significant nodes and polarities. Secondly between these polarities to identify the probable pathways that connect the significant concepts. In fact, a particularly good study as an example would be a study by Dmitry Paranyushkin (Paranyushkin, 2011)**.** This study in fact focuses on the network representation of text corpus and that is more complicated than bibliometric co-occurrence study. However, as far as I could try out the technique articulated in that paper in the website results are promising ("Infranodus," n.d.). The web application not only generates a network in a very practical sense (such as getting tweets from any given hashtag and being able to make mathematical operations such as showing difference or intersection of two graphs also revealing subnetwork depending on a chosen narrative of

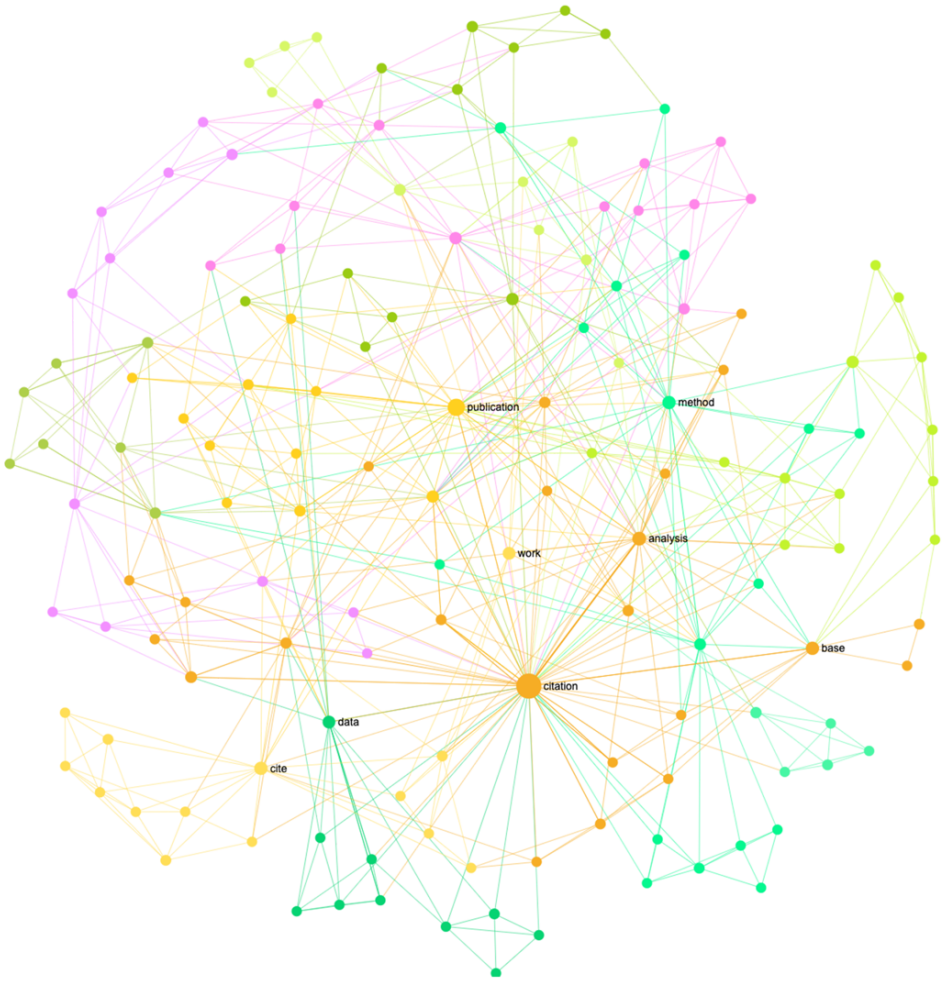

Figure 4. Network representation of subject bibliometrics in Wikipedia. Generated using Infranodus ("Infranodus.com", n.d.)

a series of keywords) but also is able to generate questions considering nodes with strong or weak links. An application of bibliometrics page of Wikipedia can be found in (Figure 4 and Figure 5)

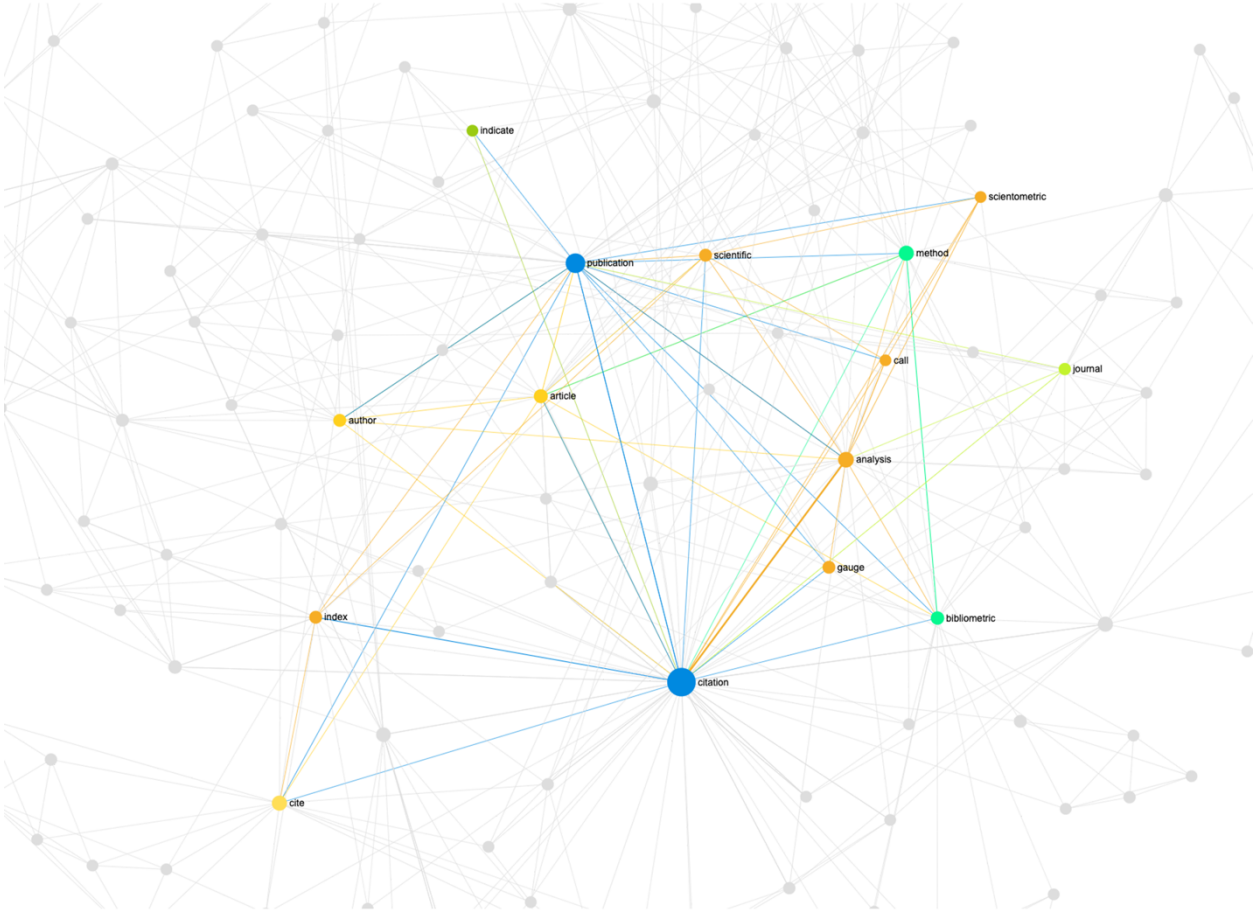

Figure 5. Subnetwork representation of subject bibliometrics in Wikipedia with narrative of "citation" -> "publication". Generated using Infranodus ("Infranodus.com", n.d.)

Varying softwares exist which can be used for bibliometrics or graph creation and they are very handy in tasks such as querying, cleaning and converting data into graphs. Especially when working with large scale networks software becomes not only handy but also necessary. Some of the most common softwares can be listed as Gephi (Bastian, Heymann, & Jacomy, 2009) and Pajek (Mrvar & Batagelj, 2016) since they are not specifically built for science or domain maps but to work for varying purposes which are also capable of making science maps. On the other hand Vos Viewer (van Eck & Waltman, 2010), CiteSpace2 (Chen, 2006), Sci2 (Team, 2009) is built for specifically creating science maps (for example automatic support for database files, being plugin free therefore making them easier to operate within this context). Each one of them

has great community and immense literature around itself. All listed other than Pajek requires Java to function, which is a disadvantage for Pajek because that makes it work in Mac Os harder but workarounds are possible. A further detailed examination of softwares is written by Cobo et al. (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011).

Some of appliances of graphs accessible free over internet also can be found at following sites.

("Six Degrees of Francis Bacon," n.d.)- History,
("InPhO - The Internet Philosophy Ontology Project," n.d.)- Philosophy
("Visuwords," n.d.)- Thesaurus
("Textexture," n.d.) formerly was free which is now ("Infranodus," n.d.) and has a fee.

For the reasons mentioned earlier such as, unblackboxing effort, critical approaches to science and technology and social explanation characteristics of STS, it is a suitable field to reveal the ethical issues present in science and how they are discussed. Attempting to reveal the discussion, this study focuses to literature of STS field and to additional keywords that are chosen to tag articles besides ethics keyword. These keywords used as basic unit to generate co-occurrence maps using Vos Viewer and Gephi to discuss findings in the final chapter.

CHAPTER 3

Data

Data in this study is the metadata of articles. Metadata is basically the data about data. This can be in our case the category of the published text (such as conference proceeding, journal article, patent or so), author(s) name(s), title, keywords (either author or keywords plus) the publication date, the published journal, the institution of author(s) (which is usually the first author), abstract of the article etc. Simply to put into; metadata is the extended information about the written article. Web of Science holds that information (41 type of information) about articles and presents them in varying formats available to download.

Journals listed in 4S website was an initial starting point. Metadata of scholarly articles covering years between 2000 and 2017 are downloaded. A total of 103 journals are listed in their website ("Scholarly Resources | Society for Social Studies of Science," n.d.), only two of them Science, Technology & Human Values and Engaging Science, Technology, and Society are listed as sponsored, rest of the journals are listed as other resources. Three of them were not in English and total 40 of them were not covered in Web of Science therefore I was not able to download metadata of those articles. So, this study includes 63 of those journals covered in Web of Science.

With a search algorithm [see appendix A for search algorithms] which focuses to topical search of keyword ethics scholarly articles are downloaded from Web of Science. Algorithm also eliminates publications other than scholarly articles. There was a big difference between using wildcard and not using wildcard. Wildcards are used to mean alternates in computer inputs. When it is added behind a series of characters the search would include different endings, without it the query would return only the matches for the given input. For example: searching with ethic and ethic* will find different amount of results because the latter would include findings that include ethical, ethics, ethical debate, ethical issues and many more. Also searching

with eth* would include words like ethnic, ethnography or so... Therefore ethic* query seemed working for this reason.

A total of 1744 scholarly articles were acquired. To gain an insight to data and to eliminate the indexer effect (explained before) I had to read abstracts of the downloaded articles to clean and categorize them.

After initial reading of abstracts, I have decided to categorize them in two categories as relevant, and irrelevant. There were total of 1164 articles in relevant group and 580 articles in irrelevant group. Most of the acquired articles focused on critique or discussion of either a method or application of a research, instead of defining what is good or bad, adopting a more applied approach than a theoretical one. At a glance most significant issues can be listed as ethics education, medical research [genetics and genomatics], data privacy [medical data], governance of data[biobanks] and privacy.

Relevant category includes the articles that are either central on an ethical issue or dilemma or are discussing philosophical aspects of science in relation to society. Subject matters include both theoretical and applied issues of ethics in science . For this, first of all I have looked at the titles of the articles. An article's title is the most representative element of its content therefore if it contains ethics or any version of this word, I put them in the relevant section. If the "ethics" word was missing in the title then I checked keywords of the article. If it was tagged with "ethics" by the author then I included them in the relevant section. If this was also missing then I looked for an explicit emphasis that the study was about an ethical subject in the abstracts of the articles. If an explicit statement such as "In this study we looked at the ethical issues …." was present in the abstract then I also included them in the relevant section. If authors did not explicitly mention this but instead made a connection in their findings to an ethical context, then I put them in the irrelevant section.

There was actually a third set that emerged from the need to put articles in, that I could not decide about. Some of them, in fact, did not satisfy the criteria (such as not explicitly mentioning necessary statements or absence of required keywords) or did not have a direct connection but the indirect connection they had seemed fairly sufficient for them to be considered (400 found to be irrelevant and 180 found to be borderline). Even if there emerged a third set of documents, for the study presented in this paper they are discarded. So only relevant ones are included for the dataset (that is the 1164 of articles).

There are two different kinds of keywords used in this study. One of them is author keywords and the other is keywords plus. When one makes a topical query in Web of Science for example: Web of Science looks for given the term in title, abstract, keywords and keywords plus. Author keywords are given by the author and Keywords plus automatically generated by the Web of Science. According to Clarivate Analytics website *"KeyWords Plus® is called derivative indexing because the terms are derived from the titles of articles cited by the author of the article being indexed"*, ("Citation-Based and Descriptor-Based Search Strategies," n.d.) the harvesting criteria is an algorithm works on the frequency of words encountered in the referred articles' title that author refers to (Garfield, 1990)**.** Title as can be seen is also crucial to represent the study. In this sense title, abstract and author keywords carry the intention of the author. Yet the keywords plus reveal the frequently referenced interests of the article that is in a sense the context in which a particular title is evaluated.

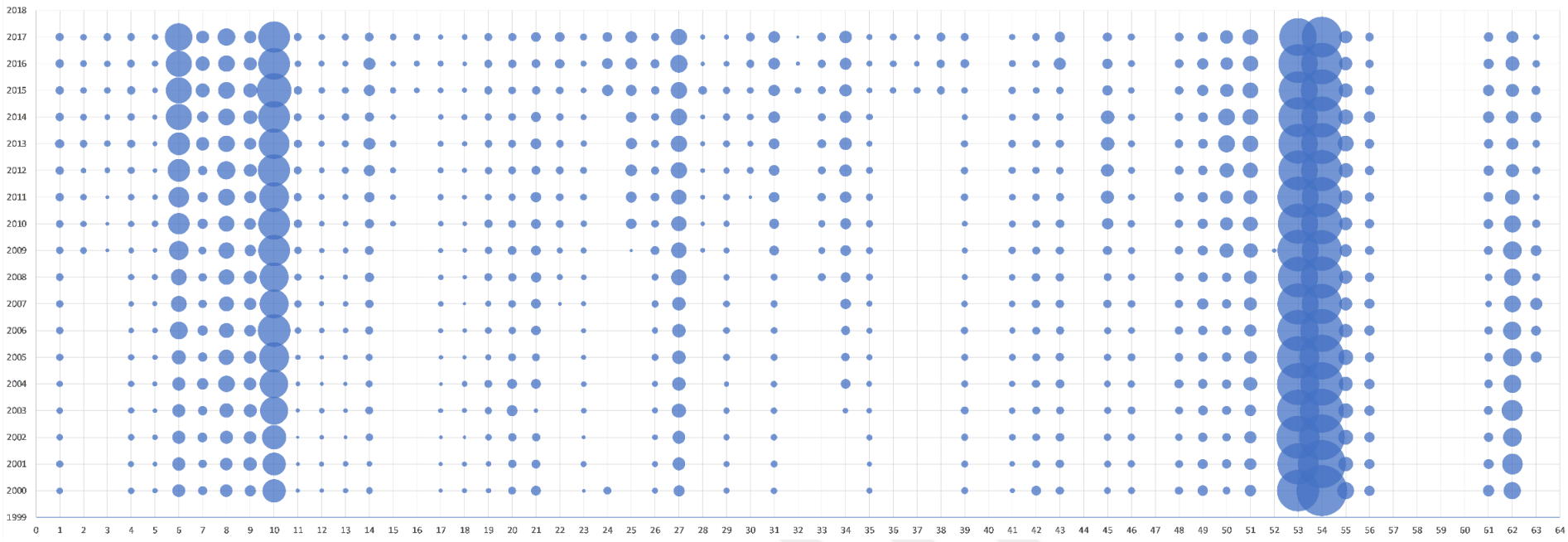

Figure 6. Initial data for each journal per

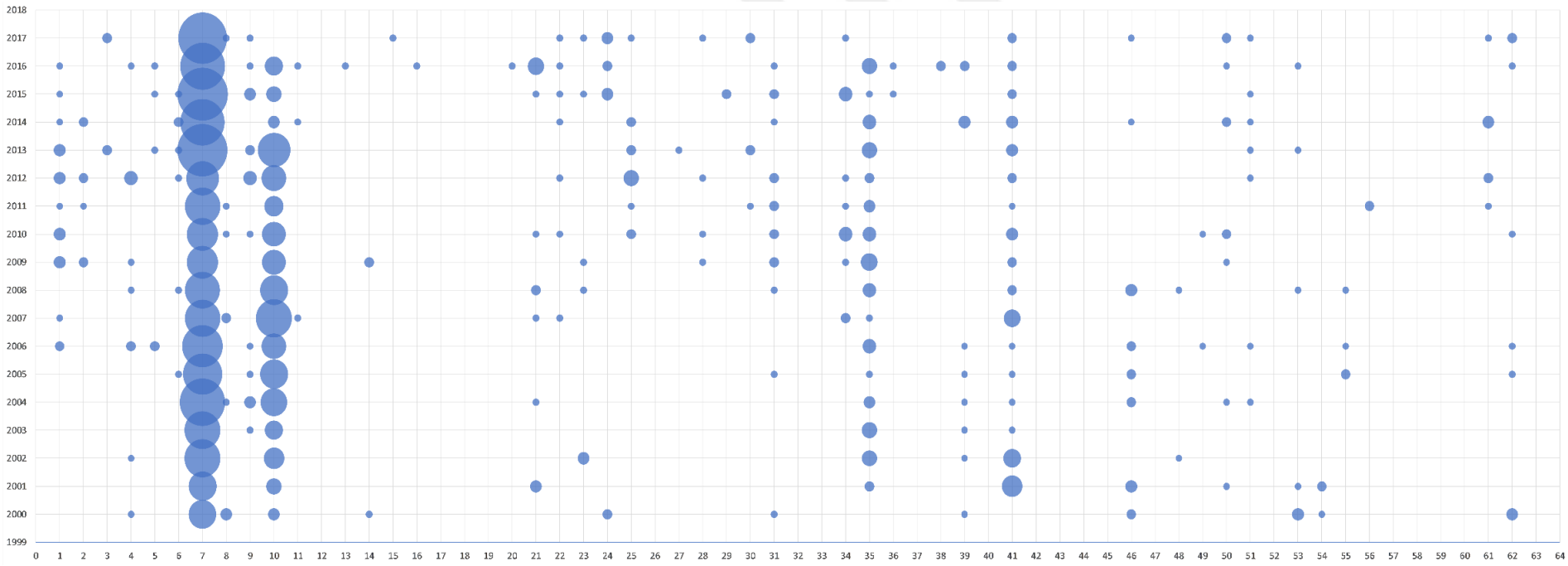

Figure 7. Remaining data for each journal per year after

Table 1: Journal list with Ids

Name of the Journal	ID		Name of the Journal	ID
Social Studies Of Science	1		Industry And Innovation	33
Science As Culture	2		Journal of Risk Research	34
Science, Technology, and Society	3		New Genetics and Society	35
Science Communication	4		Corporate Reputation Review	36
Configurations	5		Cultural Dynamics	37
Scientometrics	6		Perspectives on Global Development And Technology	38
Science and Engineering Ethics	7		Space Policy	39
Risk Analysis	8		Research Management	40
BioScience	9		IEEE Technology and Society Magazine	41
Social Science & Medicine	10		Research - Technology Management	42
ISIS	11		R&D Management	43
History of Science	12		SRA - Journal of the Society of Research Administrators	44
British Journal for the History of Science	13		Journal of Product Innovation Management	45
Studies in History and Philosophy of Science	14		Interdisciplinary Science Reviews	46
International Studies in the Philosophy of Science	15		Impact of Science on Society	47
East Asian Science, Technology and Society: an International Journal	16		Research in Higher Education	48
Annals of Science	17		Journal of Research in Science Teaching	49
Osiris	18		Science Education	50
Technology and Culture	19		International Journal of Science Education	51
Issues in Science and Technology	20		Politics and the Life Sciences	52
Daedalus	21		Science	53
Environmental Communication: A Journal of Nature and Culture	22		Nature	54
Minerva	23		Scientific American	55
Technology In Society	24		American Scientist	56
Science and Public Policy	25		National Geographic	57
Research Evaluation	26		Omni	58
Research Policy	27		Discover	59
Engineering Studies	28		Science News	60
Science in Context	29		Bulletin of the Atomic Scientists	61
Social Epistemology	30		Communications of the ACM	62
Public Understanding of Science	31		Journal of Computer-Mediated Communication	63
Prometheus	32			

Table 1 shows ids and Figure 4 and Figure 6 show frequencies of articles published in journals over years as a bubble plot. What easily can be seen is all journals do not keep being published during the given timespan or their web of science coverage is absent, and their published article count is also heterogeneous. Figure 6 is the frequency of initial data and figure 7 is frequency of relevant findings. Secondly their found relevancy weight is also different. [7] Science and Engineering Ethics and [10] Social Science & Medicine are the journals which are found to contain most relevant articles. Seven journals have no articles between those years with the ethic* keywords tagged; and again [54] Nature and [53] Science seems to have the biggest lost comparing pre filter and after filter bubble plots. This initially grants two major fields, engineering and medicine, with a significant weight compared to others and one can conclude that journals centered around natural sciences do not include "ethics" topic much. In fact, Science has only 10 articles tagged with ethic* between 2000 -2017 but its total article count is 14.652; also, Nature published 16.261 articles but only 13 of them are tagged with ethic*. Former with ratio of 0.0007 and latter with a ratio of 0.0008; though they have been listed on the 4s website I will be excluding those two for rest of the initial statistics but include articles published in the co-occurrence visualizations.

During this reading process and initial analysis, I have realized that there were overlapping terms, so I have created a simple thesaurus file to eliminate overlapping terms like "clinical-trials" "clinical trials". Thesaurus file is basically a file used to map one term over another(van Eck & Waltman, 2013, p. 42). In the first thesaurus file there were 69 terms that only focused on linguistically same but syntactically different terms.

Table 2: Initial findings of overlapping terms.

Label	*replace by*	*Label*	*replace by*
benefit-sharing	benefit sharing	**medical-research**	medical research
biomedical-research	biomedical research	**mixed-methods**	mixed methods
brain-death	brain death	**national-security**	national security
breast-cancer	breast cancer	**national-survey**	national survey

Label	*replace by*	*Label*	*replace by*
case-studies	case studies	**north-america**	north america
child-development	child development	**nuclear-waste**	nuclear waste
climate-change	climate change	**old-age**	old age
clinical-research	clinical research	**peer-review**	peer review
clinical-trial	clinical trial	**pharmaceutical-industry**	pharmaceutical industry
clinical-trials	clinical trials	**physician-patient-relationship**	physician-patient relationship
college-students	college students	**placebo-control**	placebo control
conflicts-of-interest	conflicts of interest	**policy-analysis**	policy analysis
content-analysis	content analysis	**prenatal-diagnosis**	prenatal diagnosis
decision-making	decision making	**problem-solving**	problem solving
developing-countries	developing countries	**professional-responsibility**	professional responsibility
developing-world	developing world	**property-rights**	property rights
down-syndrome	down syndrome	**public-health**	public health
drug-discovery	drug discovery	**public-opinion**	public opinion
dual-use	dual use	**public-policy**	public policy
engineering-education	engineering education	**quality-of-life**	quality of life
ethical-issues	ethical issues	**research-and-development**	research and development
genetic-modification	genetic modification	**risk-assessment**	risk assessment
graduate-students	graduate students	**role-play**	role play
health-care	health care	**science-education**	science education
human-dignity	human dignity	**service-learning**	service learning

Label	*replace by*	*Label*	*replace by*
human-genetics	human genetics	**social-justice**	social justice
human-genome	human genome	**social-responsibility**	social responsibility
human-rights	human rights	**social-sciences**	social sciences
individual-differences	individual differences	**stem-cells**	stem cells
information-society	information society	**technology-assessment**	technology assessment
informed-consent	informed consent	**technology-transfer**	technology transfer
intensive-care	intensive care	**united-kingdom**	united kingdom
medical-education	medical education	**united-states**	united states
medical-ethics	medical ethics	**young-people**	young people
medical-records	medical records		

For example, in Table 2 two very similar terms “clinical-trials” and “clinical-trial” are not mapped onto each other. Instead “clinical-trials” mapped to “clinical trials” and “clinical-trial” mapped on “clinical trial” therefore merging ones with dashes with ones with spaces but “clinical trials” and “clinical trial” [single and plural terms] still existed separately. Another problem was terms without a space such as “study” and “studies”. Considering these two problems first file did not seem to be satisfactory and more processing was needed.

Python is a relatively new programming language (1.0 edition released in 1994, 2.0 released in 2000 and 3.0 released in 2008) that in short can be used for varying simple or complex functionalities and is very popular in data science. Modules are also in short predefined set of functions that are more likely to be used together for more specific purposes. Python has some popular linguistic libraries but those were not necessary for this simple mapping purpose. Difflib is a core python module in Python 2.1 or later, a module intended to compare sequences. Function of SequenceMacher is a function to compare pairs of similar terms based on an

improved version of algorithm developed by Ratcliff and Obershelpare. This is a multipurpose function that can be applied for comparing pairs of sequences of any type. (“7.4. Difflib—Helpers for computing deltas—Python 2.7.15 documentation,” n.d.)

With this operator all keywords are listed in another excel file. For each term in this list all other terms are searched for similar elements. First column is used as searched term and elements in Table 2 are found as similar terms. Similarity parameter is set to >0.85 and <1; to find not identical (if similarity is 1 this means two elements are identical) but similar terms (more than %85 similarity threshold found to be enough for this purpose). Without the thesaurus file I had 4402 keywords. In the thesaurus file 286 word pairs (total of 572 words) listed as similar. Finally, by processing and filtering them by hand a new thesaurus file is created eliminating 274 and containing 4128 words. New thesaurus table can be found in appendix C) and figure 8 shows frequency of keywords as a bubble plot. I must note that one particular keyword pair is excluded. That is “ethics” and “ethic” word pair. This is due to “ethic” keyword to be never found in either keyword categories.

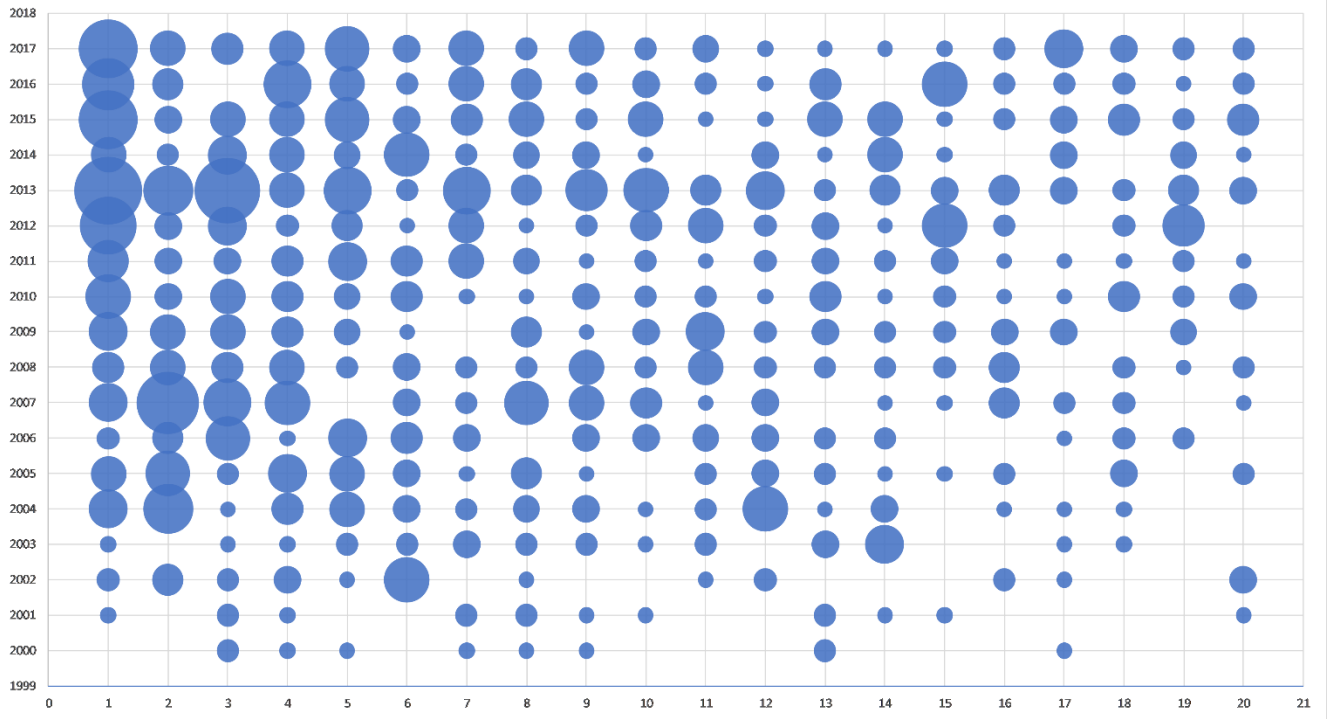

Figure 8. Keyword frequency including author and keyword plus discarding the search term.

Ids: [1] science, [2] informed consent, [3] bioethics, [4] research ethics, [5] engineering ethics, [6] risk, [7] education, [8] issue, [9] decision making, [10] health, [11] attitude, [12] clinical trial, [13] technology, [14] responsibility, [15] policy, [16] care, [17] knowledge, [18] perspective, [19] politics, [20] clinical research

CHAPTER 4

Methods

Vosviewer (van Eck & Waltman, 2010) is a graph visualization software using vos technique (vos stands for visualization of similarities) which is a distance-based graph generation algorithm; meaning that distance is a relation indicator. If two terms are close, they have a strong relationship and, if they are distant they have more subtle relationship (van Eck & Waltman, 2010, p. 525)

One problem is generated co-occurrence maps are too big to print to A4 format; anyone interested in data or graph files can download them and open with Vosviewer. You can download saved files from this link[4]. You can directly run Vosviewer from browser via http://www.vosviewer.com/vosviewer.php or download it from http://www.vosviewer.com/download to install. Maps are zoomed and cropped for formatting purposes therefore leaving some areas unprinted.

According to VosViewer manual a brief description of parameters, which are used for map creation are as follows:(van Eck & Waltman, 2013)

- Normalization method: Normalization is the way in which VosViewer calculates the similarity of two items therefore deciding the strength of links between two items.[5] Association strength is one type of normalization method that can be used to normalize the data.
- Layout: These parameters affect how the nodes on the graph will be laid out. Depending on the combination of Attraction and Repulsion parameters the location of nodes is determined.

[4] https://drive.google.com/drive/folders/1c1tlyR3tuGk5GWLwQ821BUawpFHG66yh?usp=sharing.
[5] For an extended comparison of methods see (Eck & Waltman, 2009)

- Use Default Values: If checked VosViewer will automatically determine the attraction and repulsion parameter depending on the map type being created, if unchecked it will use the user input values for those parameters while creating a new map.
- Clustering: The section includes the parameters for clustering of the items in the viewer.
- Resolution: This is for the direct control of clustering algorithm. The lower the parameter less clusters will be created and higher the parameter more clusters will be generated.
- Minimum Cluster Size: The minimum number of items in a cluster. Those clusters which have items less than parameter set will be defined as small clusters.
- Merge Small Clusters: If checked merges small clusters to larger clusters, if not checked discards the small clusters leaving them unassigned.
- Visualization scale: Used for the scale of node sizes and labels.
- Weights: Which weight attribute will be used for display. This parameter also affects the label size and density map.
- Labels: This section includes options for node label's display:
- Maximum Length: For long words this defines the maximum character count of labels.
- Size Variation: This parameter creates contrast for the size of label, making more weighted nodes larger and less weighted nodes smaller.
- Lines: This section contains options for rendering of lines.
- Size Variation: Like size variation of nodes this one is for the lines, making stronger connections thicker and lighter connections thinner.
- Minimum Strength: This parameter is to hide insignificant connections, if a connection's strength is lower than the threshold given, it will not display.
- Maximum Lines: This parameter is to display only significant connections; maximum number of strongest links will be displayed.

For creating maps in general section Vosviewer was used with the following settings:

Method - Association strength, Layout - Attraction:2, Repulsion:0, Use default values checked Clustering: **Resolution "depends",** Min. cluster size: 1, Merge small clusters checked. Visualization: Scale:1, Weights: Occurrences, Labels: Max. length:50, Lines: Size variation: 0.5, Min strength: 0, **Max lines:10000**. These are in fact initial default settings except Max lines. It is

set to 10000 to reveal as many connections as possible and also clustering resolution is the main parameter that affects cluster counts therefore it is not constant.

Co-occurrence analysis mainly takes words as unit of analysis. This analysis can be done in two ways in VosViewer. One can choose to analyze co-occurrence of words in keywords the article tagged with or in text corpus of the article. While looking at text corpus Vosviewer can take data from titles of articles, abstract of articles or from both. While looking at keywords Vosviewer can get data from author keywords, KeyWords Plus, or from both. This study mainly focuses on author keywords.

During import processes I unchecked the “ethics” keyword only; to exclude it from the analysis. This is because “ethics” is the main search keyword that exists in many of the articles; removing it permits us to see the network of keywords surrounding it. Including it, on the other hand, creates a big node overlapping with other nodes and many edges creating a visual complexity.

Vosviewer can overlay colors depending on parameters chosen; that allows to use color of a node as an indicator. Those overlay colors can indicate average citations, average normalized citations or average publication years depending on the chosen type. What kind of an overlay used will be mentioned below each graph. Average citation will show average number of citations received for papers tagged with a certain keyword. When a keyword exists longer it is likely for that keyword to have more citation count. Normalization can be used for citation overlay to discard the time factor, Vosviewer has the normalization of average citation option (van Eck & Waltman, 2013, p. 35). Another kind of overlay is the average publication years, this is similar to average citation technique but instead it renders the average publication year of articles tagged with each keyword.

For every map in the following section legend will display necessary information acting with same colors. For average citation trends yellow, green and blue colours indicate high, average and low citations respectively. For year yellow is newer, green is average, blue is older.

Density maps are another kind of visualization Vosviewer offers. Density visualization can also be considered as a heatmap of centrality and weights. The more surrounding nodes there are or the more its weight (in our case this is ratio of occurrence of a term) (van Eck & Waltman, 2013, p. 5) the more yellowish color it shows and the more the keyword is left alone the more blue it will be. Green again is the middle value (van Eck & Waltman, 2013, p. 10).

A very useful ability of Vosviewer is that it is possible to export the occurrence matrix (or any other kind of matrix used for other analyses), and its ascii format while saving a file. If anyone saves the graphs in Vosviewer it will create two files. Both of them would have .txt extension meaning that those files are readable and editable by users. One of them would be a map file and the other would be a net file.

In our case; a map file in fact is a tabbed file, which is possible to import to excel or any other spreadsheet editing software. This map file is also a matrix including the result of initially created co-occurrence matrix. In this file we have eleven columns. From left to right they are id of the keyword, label of the keyword, x position on graph, y position on graph, cluster id, links weight, total link strength weight, occurrence weight, average publication year, average citations and average normalized citations. Input data is first converted into a matrix then normalized to a similarity matrix to be mapped and finally converted to graph via VOS mapping technique (van Eck & Waltman, 2007).

This exporting to an ascii text file capacity of Vosviewer allowed me to import that data to excel and with tools like filtering and sorting to make additional visualizations to represent keyword and publication frequencies.

As a secondary software I used Gephi (*Gephi*, n.d.) for it supports to visualize egocentric[6] filtering of networks. Egocentric filtering complex networks can isolate a node and connected nearby nodes to see the connections within this subset. The biggest advantage of Gephi is the user interaction it supports through the software interface. I can select nodes independently to filter, center and isolate. The biggest disadvantage is you have to do all the matrix operations, weight calculations and normalizations yourself. I have mostly used Vosviewer because it handles this part quite well but for some situations, I used Gephi to visualize more clearly. Vosviewer can export to .net file format which is Pajek file format that can be directly imported to Gephi that can be combined with spreadsheet columns. I followed a procedure of importing Vosviewer saves (after converting those files to .xlsx) for maps to be consistent with the one generated in Vosviewer. One thing to mention here is there are a lot of layout options in Gephi and unlike Vosviewer closeness of nodes does not necessarily emphasize similarity. But it is still very useful for seeing network connections.

[6] Egocentric networks are the network established around a central actor (for our case this is "ethics" keyword). For example an egocentric network of node A contains only nodes that have connection to node A and edges between those nodes. (Wasserman & Faust, 1994, p. 42)

CHAPTER 5

Findings

5.1 Initial Analysis of Data

My data in total considered 63 journals and 18 years (including 2000 and 2017). Yearly published articles centered around "ethics" subject increases as shown in Figure 9. Considering that yearly published papers in total also increase in journals after a normalization (articles acquired here divided by total number of publications) shows us that in fact articles centered on subject matter of ethics yearly cover 2% to 4.5% of total publications (see Figure 10).

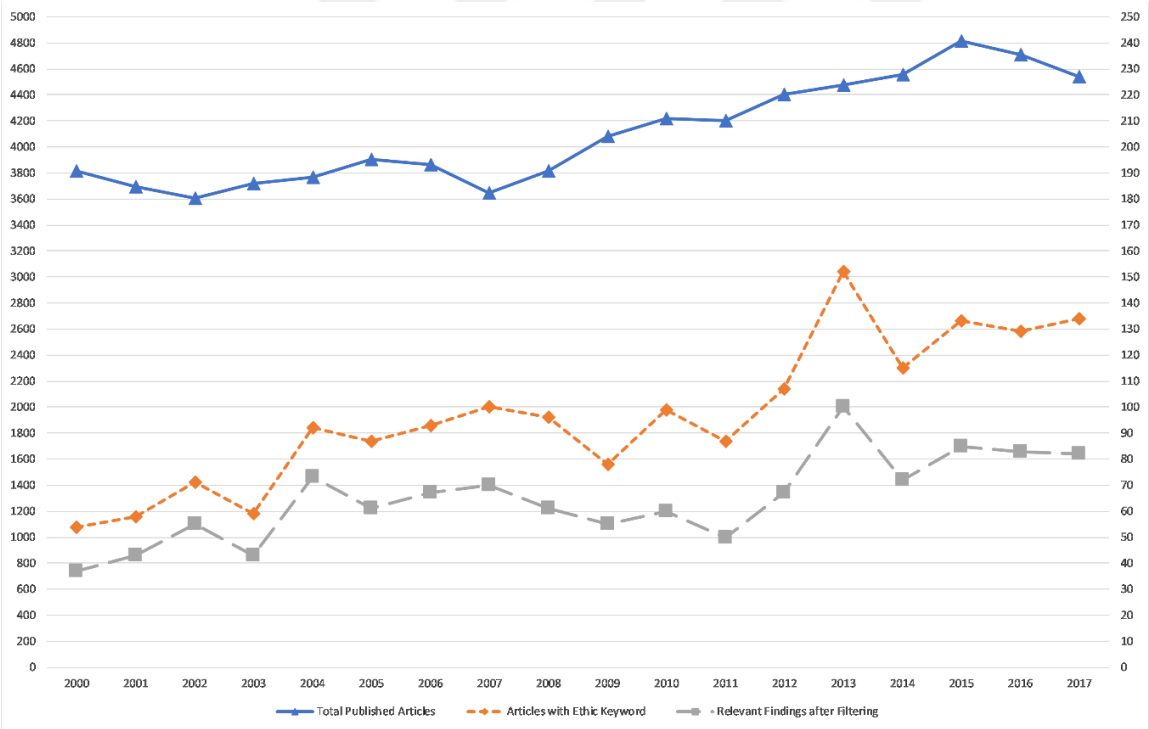

Figure 9. Article counts by year.

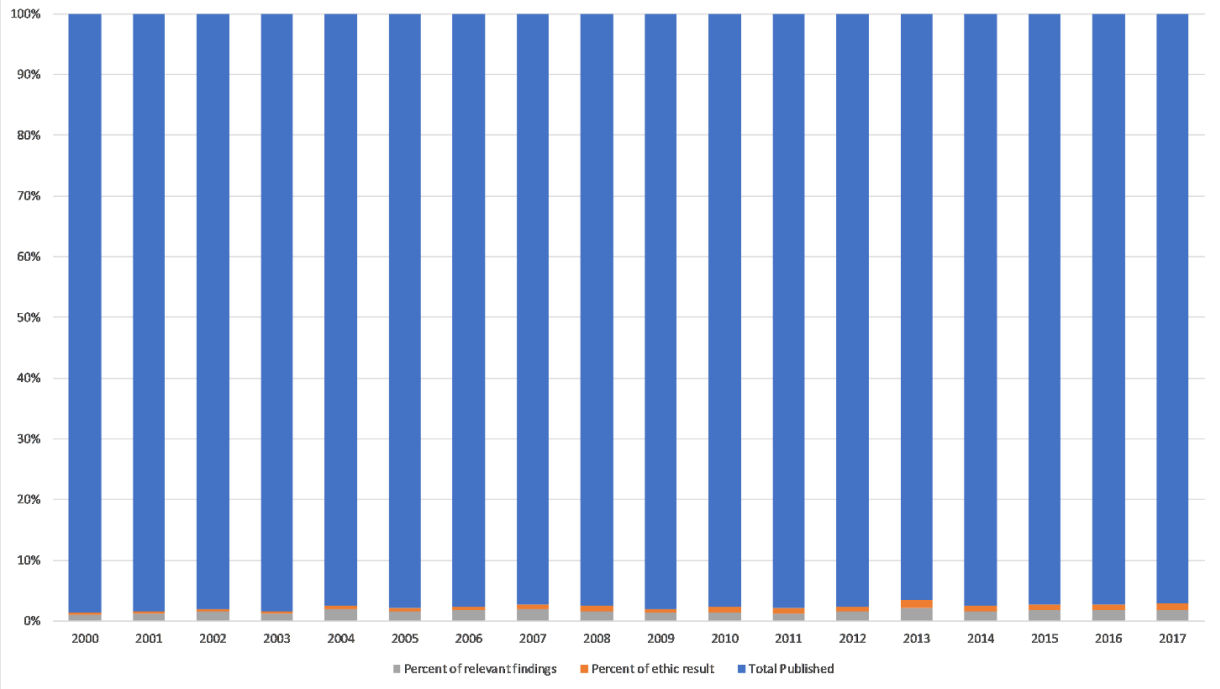

Figure 10. Percentage of relevant findings by year.

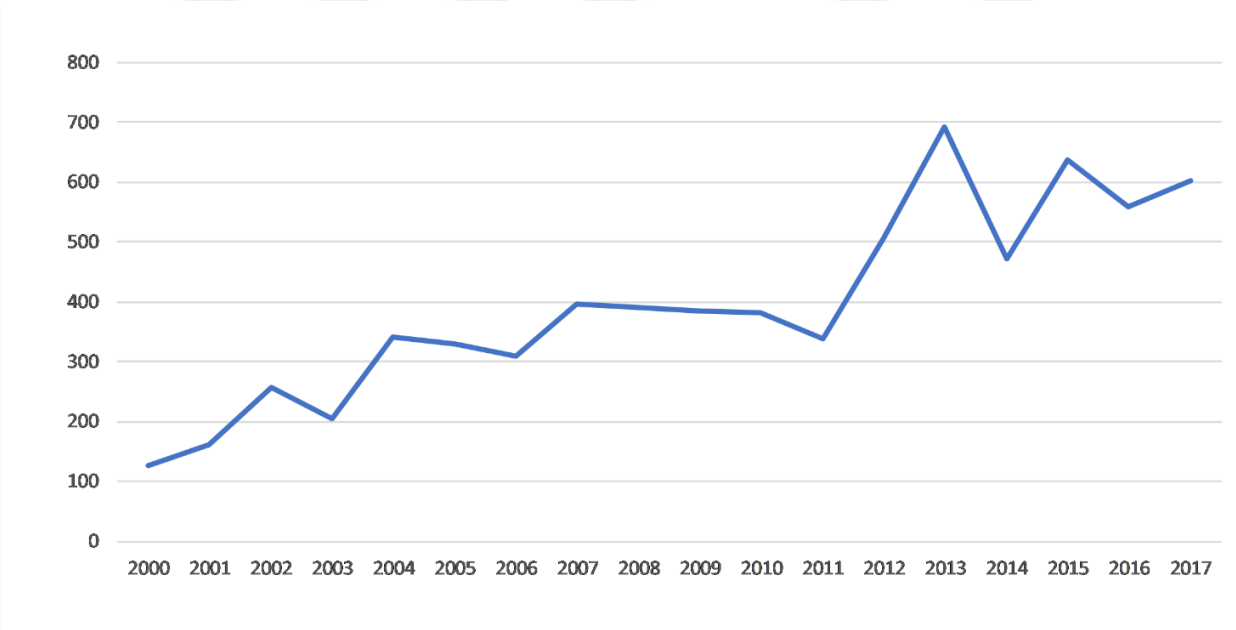

Figure 11. Keyword usage by year.

If we look at article keywords with which articles are tagged with (see Figure 11), we can easily see an increase over years. Starting with a total of 118 keywords in 2000 and around 600 in 2017 we can say that it is covering nearly 6 times more keywords than in the beginning of millennia. This means that concepts which relate to ethics expand either introducing new ones or integrating this subject to previous studies.

The size of largest connected set of the network seems drastically increased in 2002 (see Figure 12) and then fairly stable and in fact it is a high percentage. Which means considering the possible paths that can be drawn between concepts year of 2002 was an important rallying point. This is due to the unifying existence of the term “conflict of interest”.

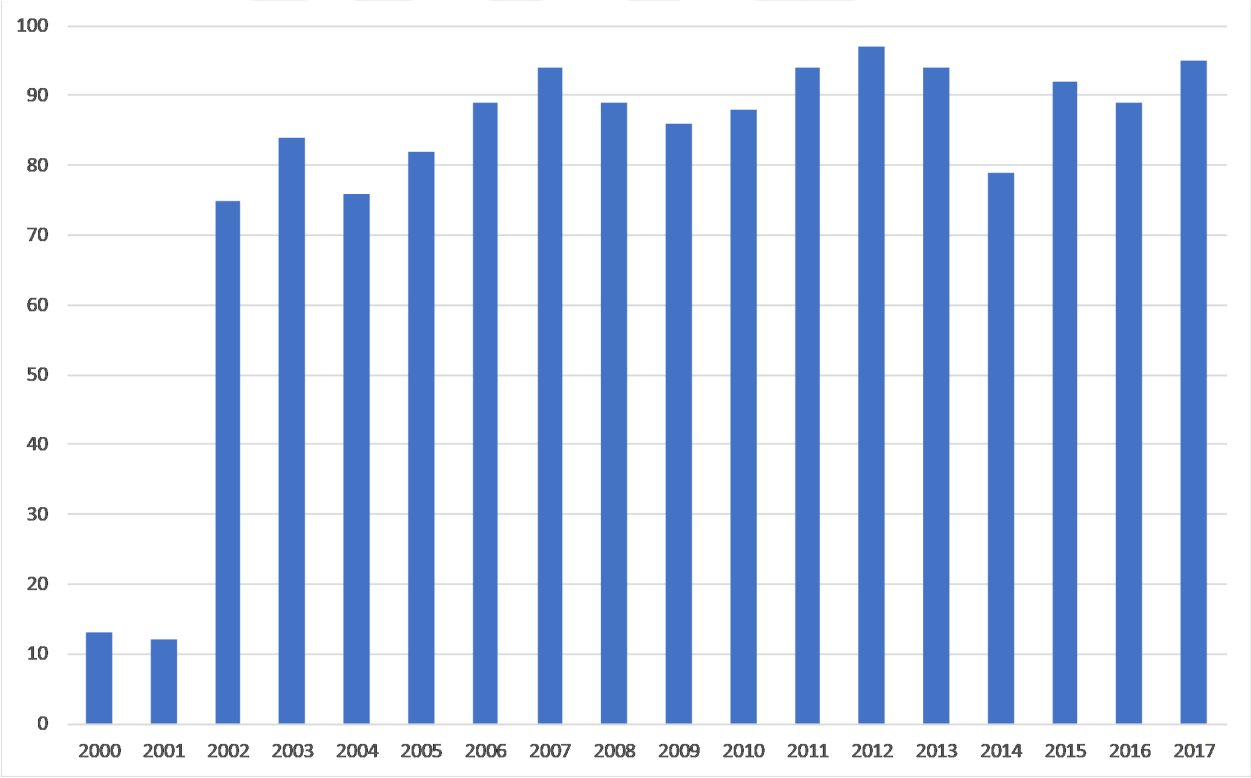

Figure 12. Keyword size of largest partition of network. 100 meaning no disconnected nodes.

There are 290 keywords including ethic (excluding ethic keyword itself). Top 20 of those are listed in Table 3. For the full list you can check the appendix section (appendix B). These are most occurring types of ethic including keywords. “bioethics”, “research ethics”, “engineering ethics” are significantly more occurring than the rest and 200 of those keywords occur only once. 82 of those keywords include “ethical” and 203 of those keywords include “ethics”. These keywords can reveal us the ways in which ethics can be pluralized; functioning under different duties and approaches. There are 11 keywords that contain “ethics in” the most significant being “ethics in science” and there are 19 keywords that contain “ethics of” the most significant being “ethics of technology” and 19 keywords that contain “ethics and” or “ethical and” with most occurring “ethics and technology”.

Table 3.

Top 20 keywords including ethics.

Keywords	**occ**
bioethics	82
research ethics	73
engineering ethics	71
ethics education	18
medical ethics	18
professional ethics	18
code of ethics	17
ethical decision making	14
ethics committee	14
virtue ethics	14
business ethics	13
neuroethics	13
applied ethics	12
ethical issues	11
computer ethics	8
environmental ethics	8
publication ethics	8
information ethics	7
macroethics	7
science ethics	7

To see shared interests, I could make clustering in Vosviewer but as mentioned that is created by a complex algorithm which is defined by cluster resolution parameter. To create a reference for this I created a bubble plot in excel. First of all, I have important saved map files created with Vosviewer into excel as tables; afterwards in a separate excel sheet I have gathered those tables. I sorted those tables according to their occurrence from significant to insignificant and copied twenty top occurring labels in a separate column. If same keyword significantly occurs in more than one journal there should be duplicates in this column so I removed the duplicates and gave the keywords another id. By doing this my final table included each most frequently occurred 20 keywords in the previous tables and ids. I also gave journal divisions ids. Afterwards 20 times for each journal using VLookup function in excel I found the keyword in initially gathered tables in this sheet and matched it with the proper ids (overwriting the VosViewer ids with the one I have given them). This I had to do because same terms in different Vos viewer saves had different Ids. For example, in first saved map file science term had id of 4 and in the second file

science term again had the id of 3. After having the same id, I could compare journals for their overlapping terms which would also create a reference for clustering purposes. Finally, to another column near the ones found with VLookup I have copied the occurrence count to define bubble size. Figure 13 is showing the resulting bubble plot. Here we can see that in three journals considering both type of keywords, most occurring keywords do not seem to overlap much. The most overlapping term is “science” that is in top 20 keywords in all journals’ keywords plus and also in other journals’ author keywords; another example of similar situation can be “bioethics” and “risk” keywords.

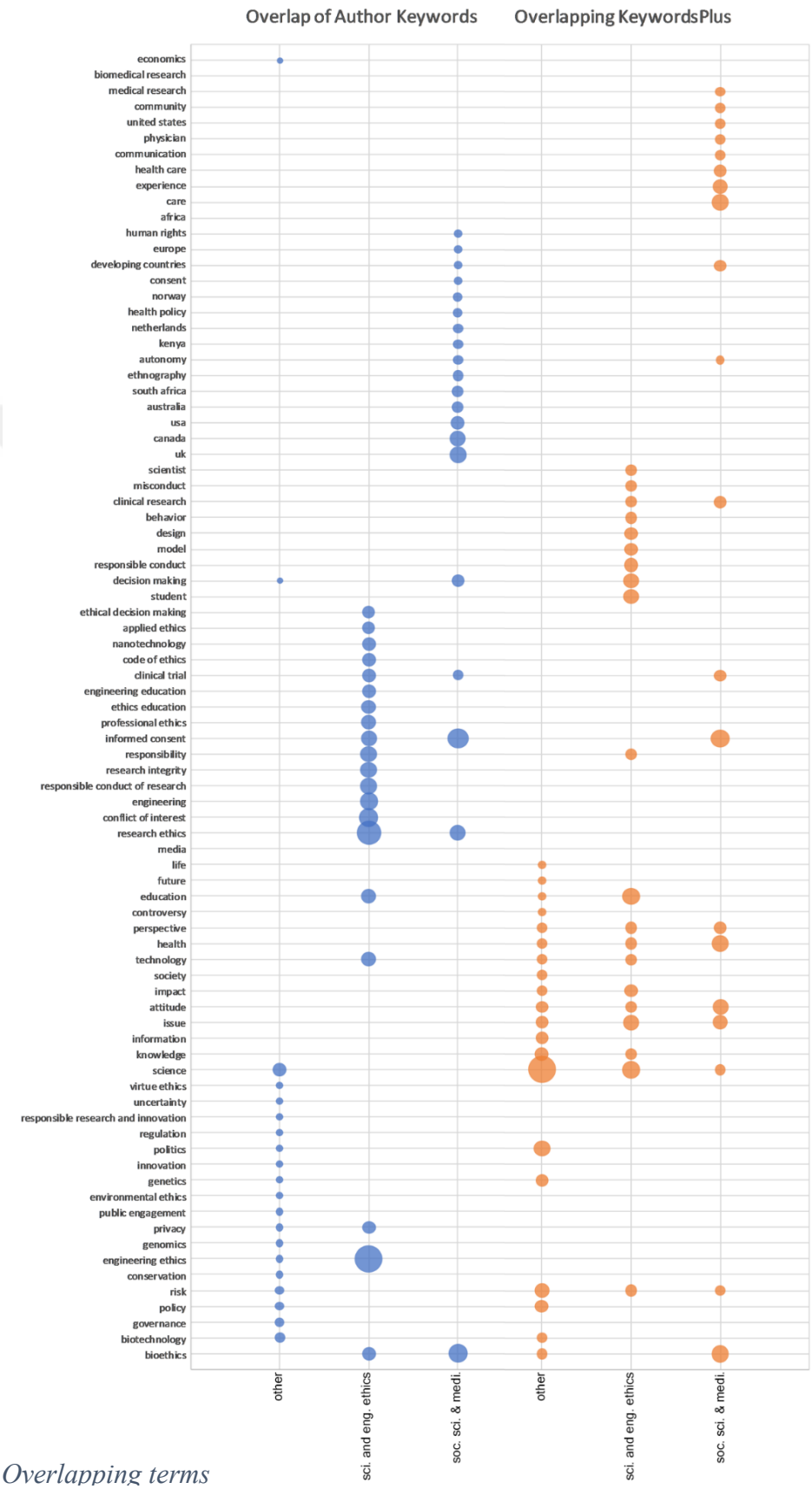

Figure 13. Overlapping terms

5.2 General Map

This section starts with a general co-occurrence map of the data. I initiated two branches from here first one containing four periods. First period considering years 2000-2004, second 2005-2009, third one for 2010-2014 and the fourth period for 2015-2017. Second one is for two categories which would include journals categorized according to their bibliometric coupling similarities. This is because those two journals have significant amount of articles in the data acquired therefore it would be better to focus their analysis separately. I am planning that the study centered around years covering all journals will reveal the historical establishment during 2000 -2017 and the category-based study will reveal major approaches in this discourse in two divisions. Finally, this section has some experimental co-occurrence maps for strong connections in categories and for different types of ethics keywords

Whole map of author keyword graph of all years can be found in the appendix section (Appendix D). As mentioned, there are many nodes which overlap and reduce legibility; for this reason, instead of whole map, I preferred to focus terms that occur more than three times between 2000 - 2017 which are shown in figure 14 and even with this filtering not all labels are visible. For example, if there are two large nodes close or overlapping, label of the bigger one is displayed. I keep mentioning other significant nodes but to see a more detailed and interactive version please check the links in the beginning of this section.

Most significant keyword with size and central position is “research ethics” and, in the density map we can see four major hotspots (see figure 15); one in the center located around “research ethics”, one to the top left “engineering ethics”, one to the top right “bioethics” and “informed consent” to the bottom right. There is in fact a fifth one just below the research ethics that is “conflict of interest”. These are the significant topics in this discussion. The two other significant nodes are “responsible conduct of research” and “research integrity” located in the left bottom quarter.

Clearly considering the data acquired in this study two journals had significantly more articles than the rest, “Science and Engineering Ethics” and “Social Science and Medicine”. This can be understood from the left and right parts of the map. Left side is engineering ethics and right side is social science and medicine. Bottom quarters show the important topics. Informed Consent is clearly the most important topic in Medicine but for Engineering there is not a significant node like this but instead many smaller nodes such as “ethical decision making”, “research integrity”, “responsible conduct of research”.

“Research ethics” is in the center but relatively close to the medicine side. This might be because it is used in both divisions but relatively more frequently in medicine. Conflict of interest is a low cited topic but a central and a big sized one. This shows that is an important topic in both fields. It is close to the keyword “science”. “science” keyword as shown in previous chapter in overlapping terms (figure 13) is a unifying keyword in all of three journal divisions for the keywords plus category but in this section only author keywords are focused upon.

Some of the nodes close to “research ethics” are “privacy”, “technology” and “genetics”. Two of large nodes close to bioethics are “governance” and “biotechnology”. “clinical trials” and ”decision making” are two significant nodes located near the “informed consent”. There is not any dominant node in the left bottom quarter.

There are many country names in the medical side. Trendy keywords are not large. Biggest of those is “canada” located in the medical side. This might indicate studies in this location, in the field of medical studies might be trending.

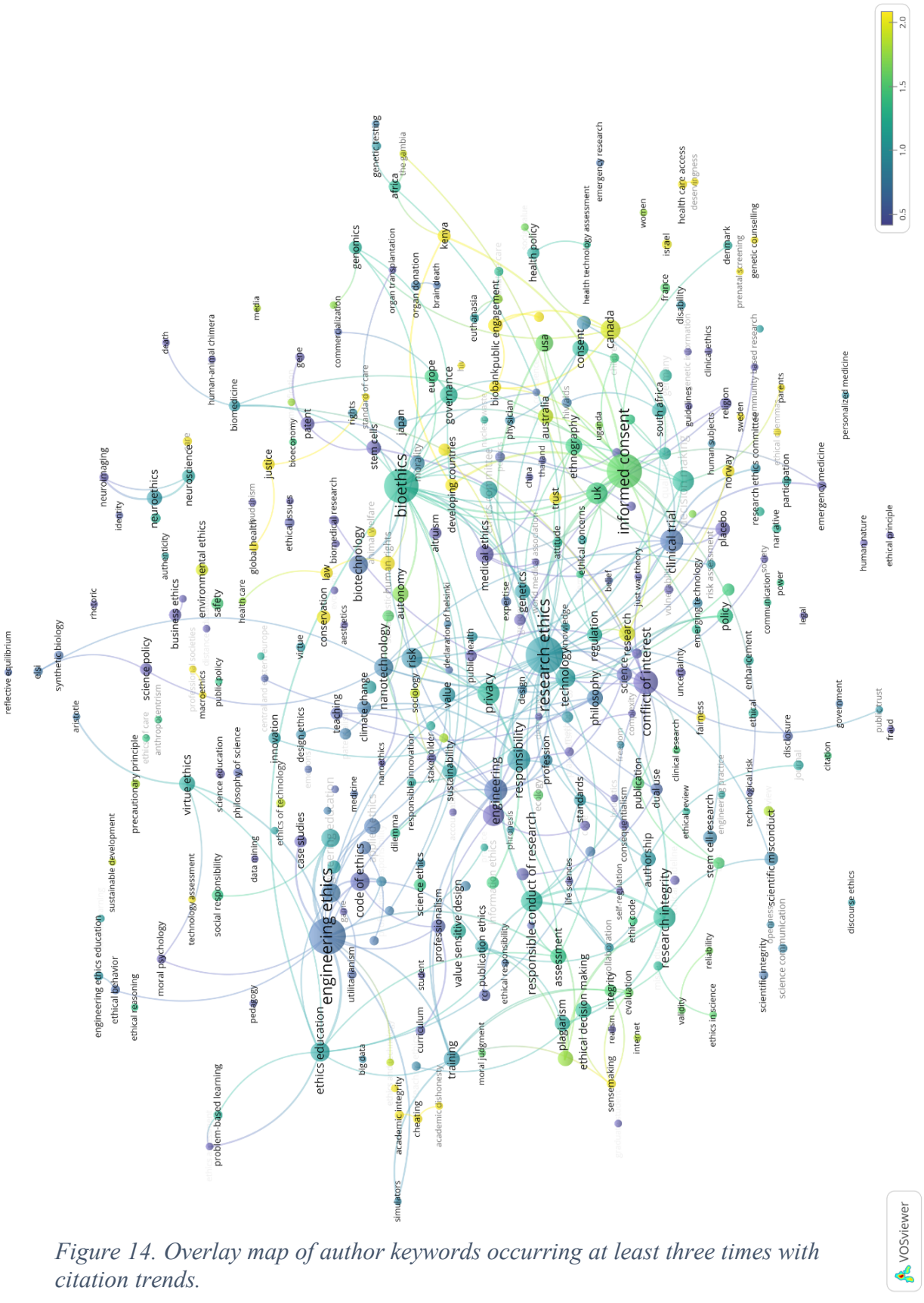

Figure 14. Overlay map of author keywords occurring at least three times with citation trends.

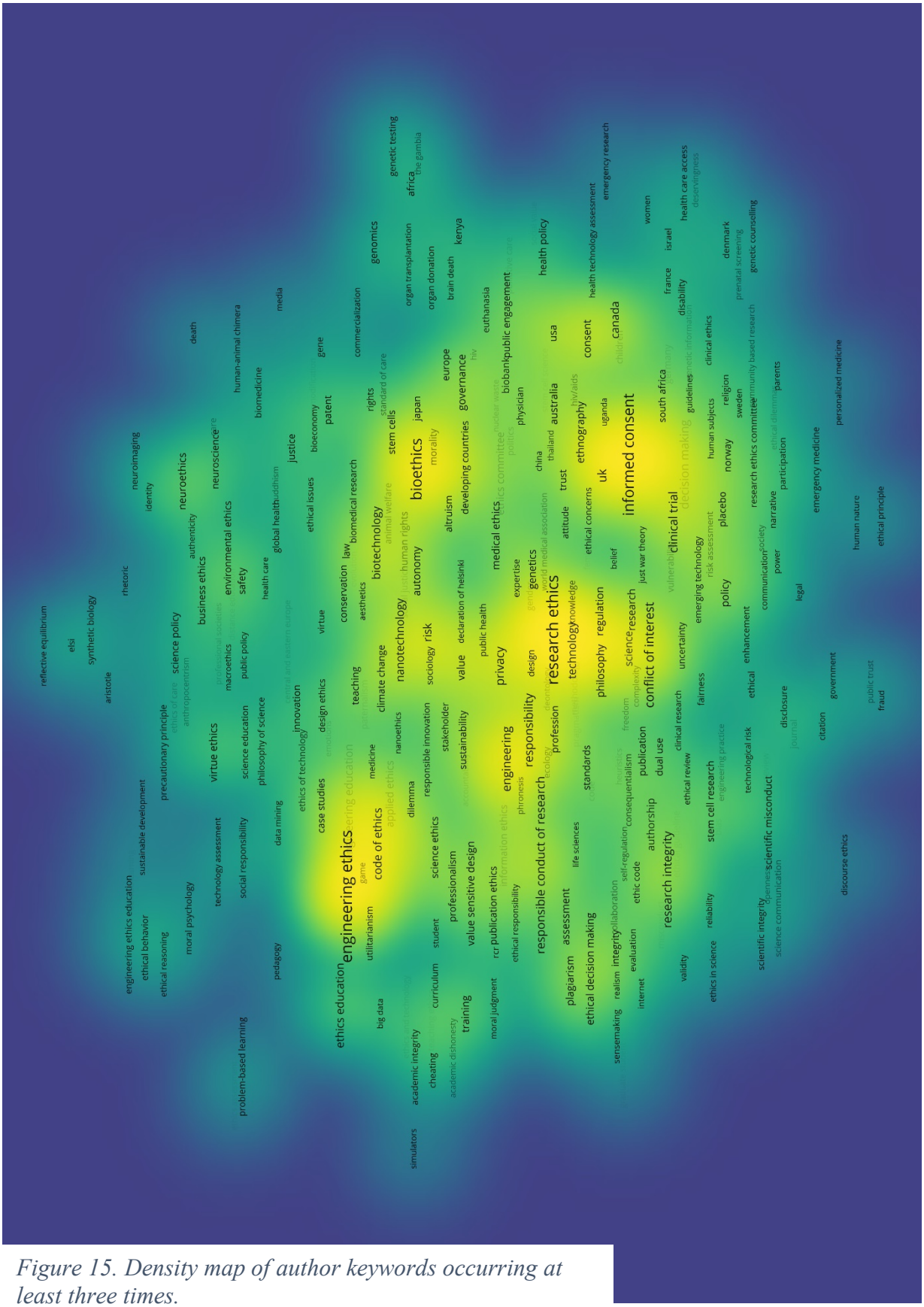

Figure 15. Density map of author keywords occurring at least three times.

5.3 Historical Development

In the historical development section, I have divided the 18 years span into four periods; three of them include five years' and the final one includes three years' data. First period considers 2000 to 2004, second period contains years 2005 to 2009, third period contains years 2010 to 2014 and finally fourth period containing 2015 to 2017. I have tried to find significant changes related to a nodes' size and position, focusing on most occurrent ones.

Vosviewer used with the following parameters:

Method - Association strength Layout - Attraction:2, Repulsion:0, Use default values checked Clustering: Resolution 1.00, Min. cluster size: 1, Merge small clusters checked. Visualization: Scale:1, Weights: Occurrences, Labels: Max. length:50, Lines: Size variation: 0.6, Min. strength: 0, Max. lines:10000 (Only size variation parameter is set different than previous analysis which is good for printing purposes but can alter comparison so I kept it constant for all historical analysis section)

Overlay colors are same for this section but instead of normalized average citations (because this section intends on historical development) they indicate average publication years. This means if a keyword is blue average publication year of the articles containing that keyword is old, greenish colors mean it is neither old nor new but in the middle age and if it is yellow average publication year is new considering the timespan.

Another thing to mention in this subsection is I have tried different Max. lines and Max. length parameters and set it to quite high (maximum value was 10000 for this parameter, also keeping in mind that I have already used Min. strength with minimum value of 0), meaning that I have tried to render every connection to see the general form of the graph but it does not change much from the one presented here. From here I can conclude that graphs have two elements; the main central body and branches reaching outwards. This is most significant in the fourth period (figure 22) which contains less years compared to other periods. Three years might not be enough for

outer nodes to connect to nearby other outer nodes to fill the gaps between branches of the graphs, or keywords needed to emerge to fill the gap. Another thing is to narrate significant connections and nodes, most of the time I have also tried different parameters for value of size variation of the nodes and edges to contrast important ones and Max. lines to eliminate insignificant connections. For graphs here I have chosen to use mostly ones including most connections which are quite complex to see, for this reason you might also need to change parameters to see mentioned connections or groups clearly.

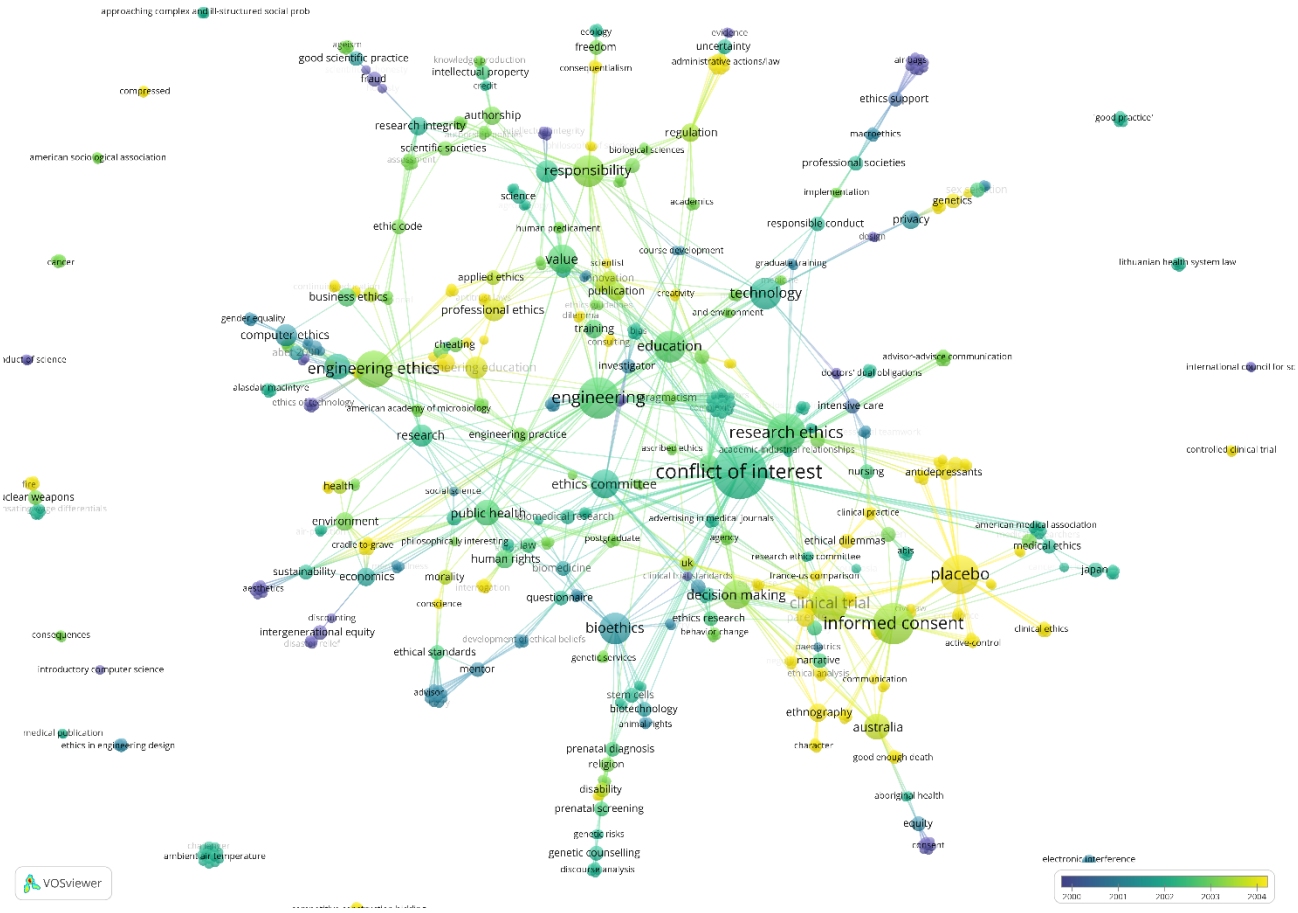

Figure 16. Author keywords 2000-2004.

If we look at 2000-2004 period (figure 16) “conflict of interest” is the most central and biggest node of the map. There are other large nodes like “engineering”, “education” and “research ethics” close to this node and at a distance “informed consent”, “placebo”, “engineering ethics” and “responsibility”. Yellow nodes are more frequent around “informed consent” node, which is

close to the outer border of the map. This indicates that it is a topic that is being studied with other keywords in this period's final years and probably becoming a major research area in the following period. "Placebo" is the largest node that is yellow. This means that it is a trending topic in the final years of the period which is 2005.

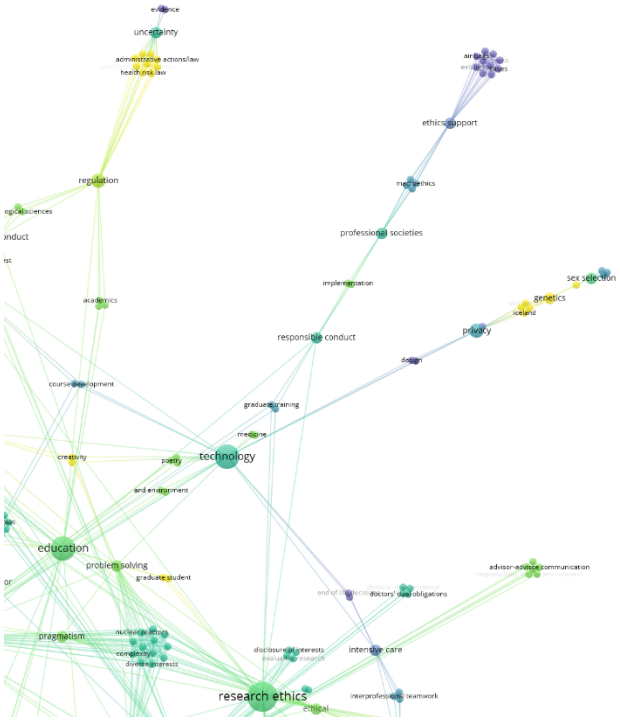

Figure 17. Upper Right Section of Figure 16.

Structure of a branch needs a linear directional alignment of connected nodes and it also needs a disconnection from the other nodes surrounding the connection of branch to the body. Here (figure 17) we can see two branch like structures. First branch's entrance is "responsible conduct" connected to two big and more central nodes, which are "education" and "research ethics" and to outwards "implementation", then to "professional societies", then to "macroethics", then to "ethics support". Finally, at most distant position to center there is a discussion containing many keywords. Instead of focusing on these keywords I wanted to emphasize the structure of their branch type connections. Another particularly important thing in this form is considering overlay colors: the outer discussion (the purple area with average publication year of 2000) is older than the discussion connecting it to the map (greenish colors with average publication year around 2002). This is a repeating pattern especially in this period. Keywords, or discussions which have older average publication years connect to main body of the graph over newer keywords. This also can be seen in a branching out from "technology" to upper right direction over nodes "design", "privacy", "Iceland", "genetics", "cloning", "sex selection" and end up with a group of keywords which have older average publication years.

There can be seen four major branches reaching outwards from the right side of the map and one from the right. The one to the right with keywords like “good scientific practice”, “scientific dishonesty”, “fraud”, “honesty” connects to a bigger node which is “research integrity”. The left one at the bottom is branching out from “bioethics” and “conflict of interest” seems like showing a debate about genetical tests made before birth; including “prenatal diagnosis”, “prenatal screening”, “genetic risks”, “abortion” and “genetic counselling”. Two of very large nodes of this period are “conflict of interest” and “bioethics” which seem to directly connect to “stem cells” and “prenatal diagnosis” nodes which are located at the entrance of this branch.

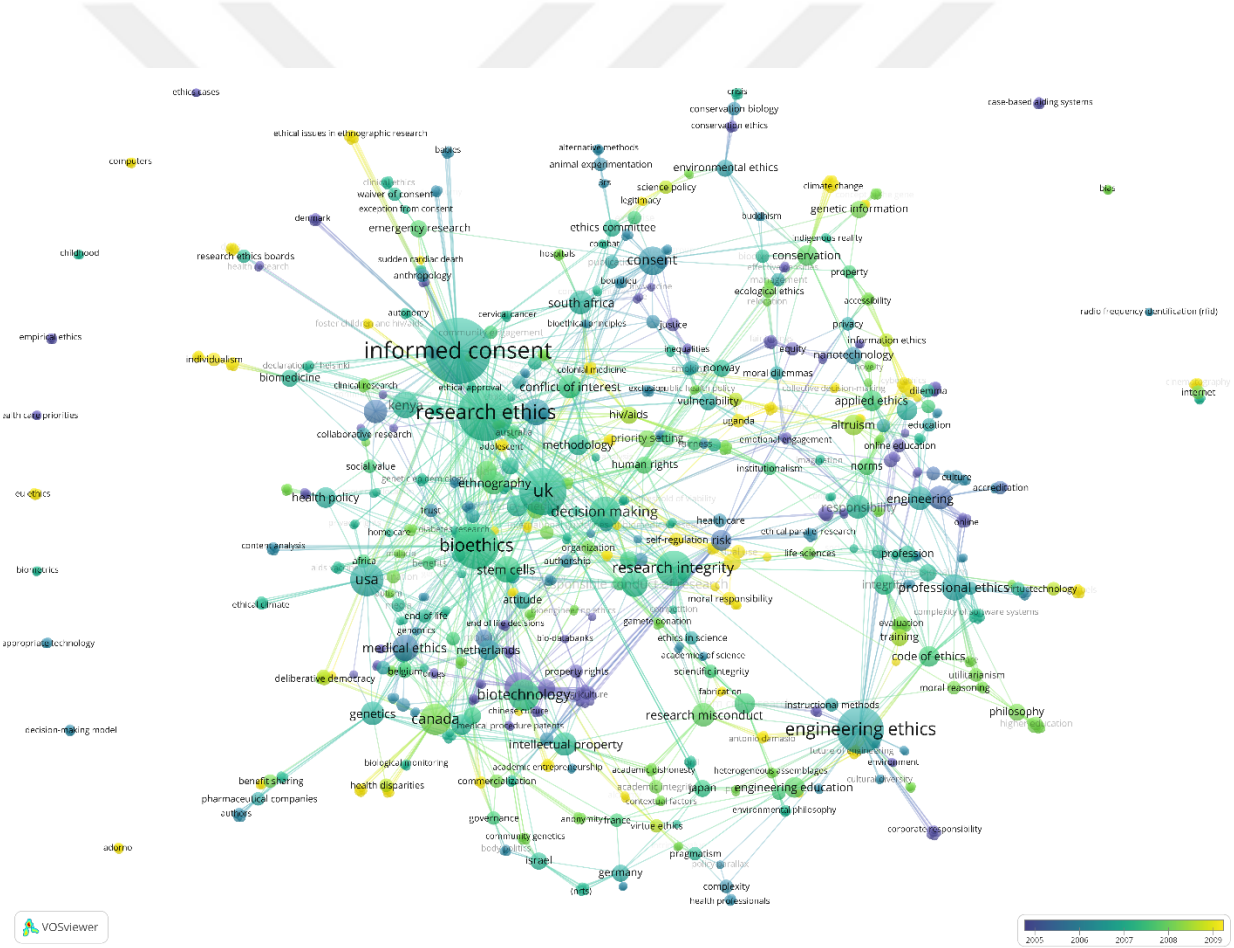

Figure 18. Author keywords 2005-2009.

Now looking at the 2005-2009 period (figure 18) the largest nodes are to the left of the map which are “informed consent”, “research ethics”, “uk” and “bioethics”; more precisely those four

nodes locate in the upper left quarter. In general, here we can see a more connected network and yellow nodes seem to be distributed more homogeneously. Towards the center is “research integrity”, “decision making” and “responsible conduct of research”. Towards the bottom of right side, we can see “engineering ethics” but no other large nodes. Three large nodes “informed consent”, “research ethics” and “bioethics” close to each other reveal that social studies concerning medicine are trending in this period. One interesting thing is that there are two significant nodes containing ethic keyword located on the opposite sides. One is on the left side “medical ethics” and one is on the right side “professional ethics”. Some of the keywords directly connected to “medical ethics” (ascending in size) are “patent”, “clinical trial”, “emergency medicine”, “medical research” and “human experimentation”. Some of the keywords directly connected to “professional ethics” (ascending in size) are “decision making”, “engineering”, “teaching”, “code of ethics”, “philosophy” and “virtue”. This might indicate that ethics in medicine is more focused on patenting issues in biotechnology (because “biotechnology” is a keyword so close to “patent” and significant in size) and ethics in engineering is more focused on academic integration of ethics yet, keyword of “ethics education”, even if it exists, is very insignificant.

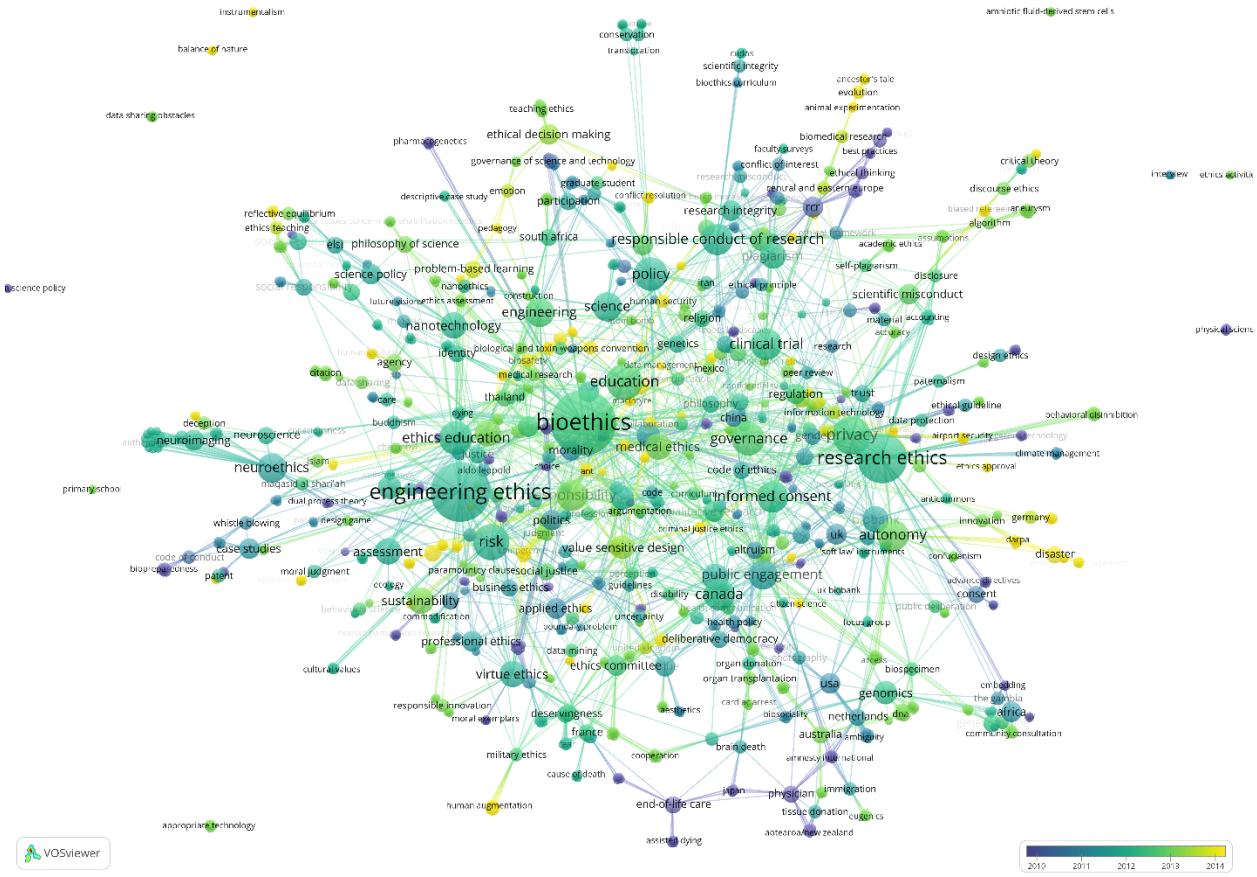

Figure 19. Author keywords 2010-2014.

In this third period containing years 2010-2014 (figure 19) the largest node is “bioethics”. Other major nodes are “engineering ethics” and “research ethics”. This triangular structure also existed in previous period but “engineering ethics” gets closer to other two nodes in this period and all three of them are directly connected to each other. A fourth significant keyword is “privacy” which can be seen close to “research ethics”. None of those four nodes are in the center, in fact at the center of map there is not any significant node but a cloud of a smaller nodes. Some central relatively large nodes are “medical ethics”, “governance”, “informed consent” and “responsibility”. “nanotechnology” is an emerging and important keyword directly connected to “bioethics”, “engineering ethics” and “research ethics” and also “ethics education”.

For this period, considering previous periods identifying pathways to major nodes is harder because major nodes got closer and start to connect to directly each other. These direct connections also reveal a unity of period.

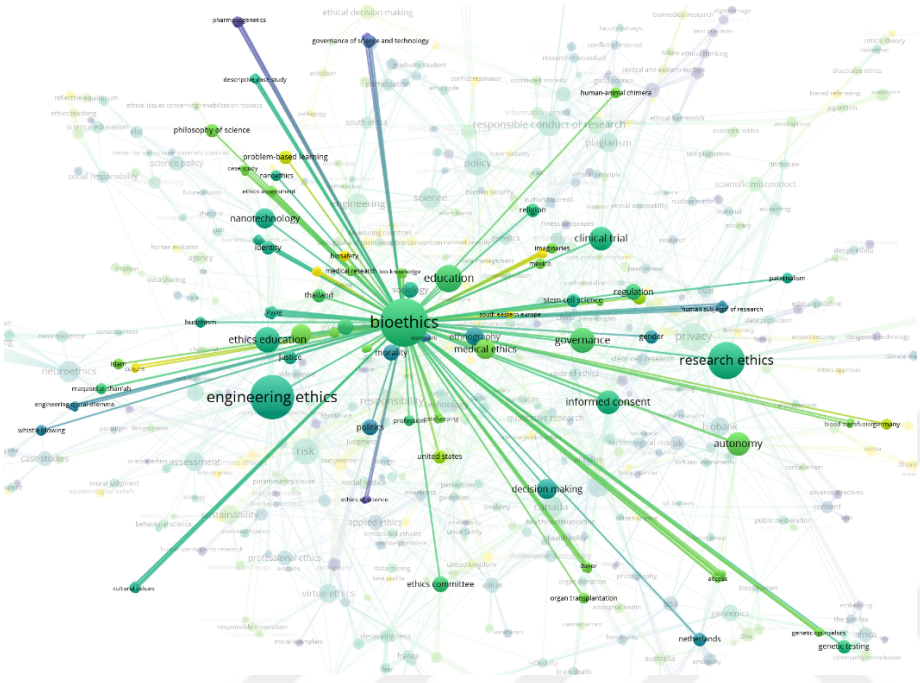

Figure 20. Direct connections of bioethics keyword in 2010-2014 period.

Bioethics (figure 20) has direct connection to major nodes likes "informed consent", "autonomy", "governance", "clinical trial", "ethics education" "education", "biotechnology", "ethics committee".

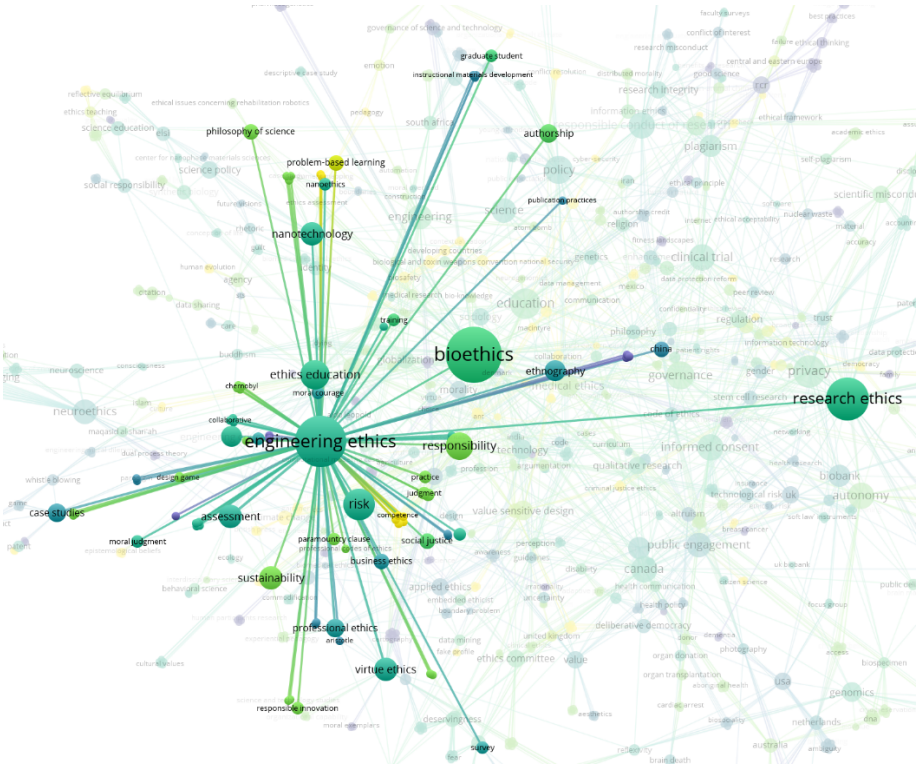

Figure 21. Direct connections of engineering ethics keyword in 2010-2014 period.

Engineering ethics (figure 21) has direct connection to "ethics education", "sustainability", "nanotechnology", "assessment", "case studies" and "virtue ethics". This shows that "ethics education" is an important topic in both medical and engineering divisions. In the previous period it was very insignificant and also very distant to bioethics.

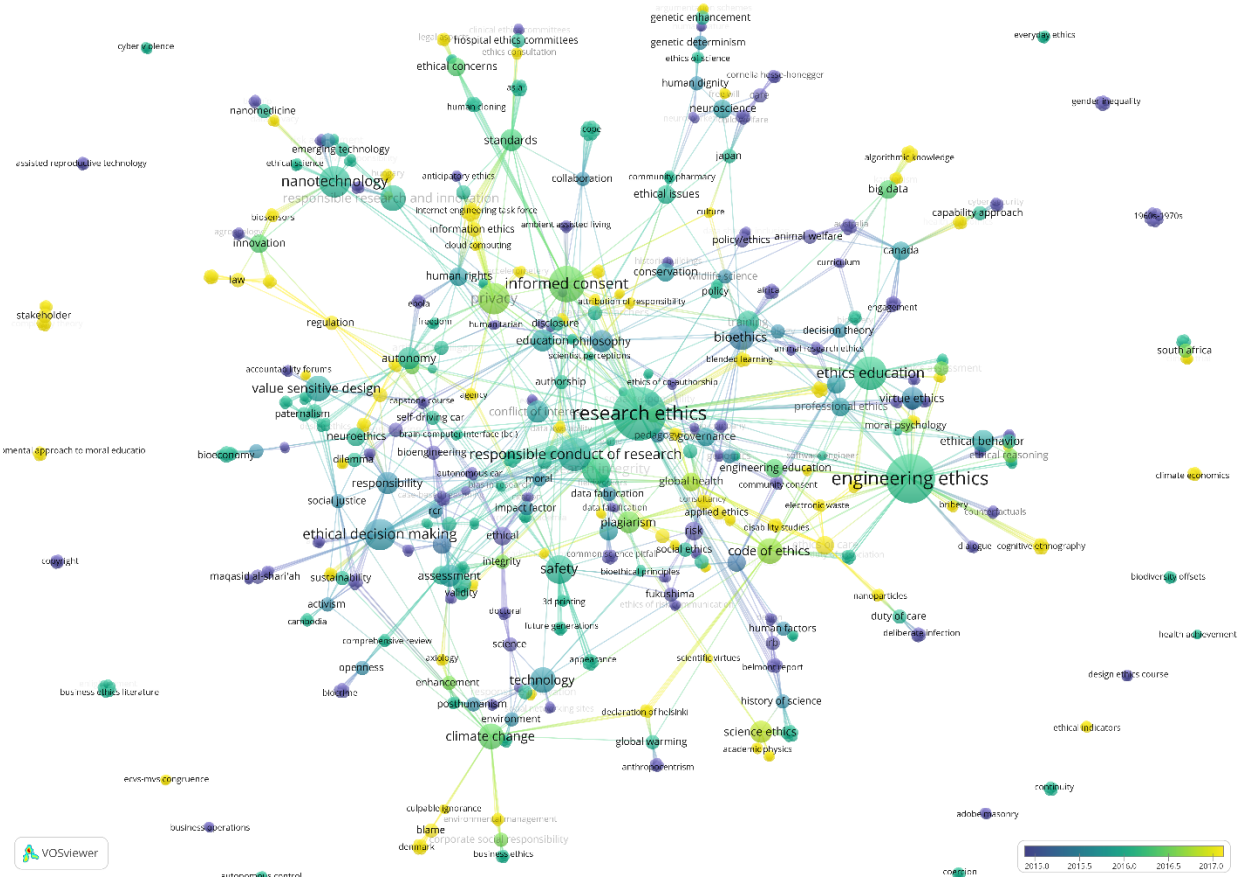

Figure 22. Author Keywords 2015-2017.

The final period considering years 2015-2017 (figure 22) shows as usual "research ethics" in the center and "engineering ethics" as distant to center but a large node to the right. "Bioethics" on the contrary lost both its significant size and opposite position in this period compared to the previous periods its color became blueish that showing that is not studied much in these years. If we refer to figure 8, it shows "bioethics" is absent in year 2016; this might be the reason to explain its size getting smaller but not its position shifting this much. In the previous graphs there were considerable distance between "engineering ethics" and "bioethics", now this distance is much smaller. This might be due to the fact that there was an effort in bioethics studies that tries to draw a distinction between "engineering ethics". When the frequency of the studies drops, the relevant keyword got lost in "engineering ethics"' gravity. Another reason could be that during my abstract reading process, articles I found more related might be less about bioethics; I mean researcher bias might be effective. Another reason might be the three-year span

of this period compared to previous five-year span periods is short. Considering the historical section, this is an interesting finding which needs further studies to find more precise answers. As mentioned earlier there are many outwards branching forms during this period.

Until this far I have tried to reveal the dynamics in four different periods. So far what can be concluded is that there seems to be two major divisions within STS studies concerning ethics. This outcome can be arrived by looking at most frequently publishing journal names, from the general map at the beginning of this section or from trending keyword frequencies. One of them is bioethics result of biological or medical discourses and on the other side engineering ethics concerning more technoscientific discourse. Some related nodes can be observed but it is hard to define which is affected by which. To look deeper into those polarities, I have decided to divide journals according to their knowledge base and run co-occurrence in those subsets.

To categorize them I did a bibliometric-coupling map of all articles for their sources. Bibliometric coupling as mentioned in the VosViewer map creation interface, relates items according to the references they share (Van Eck & Waltman, 2018) figure 23 shows all articles' bibliometric coupling density map, unit of analysis here is sources. Therefore, journals that share similar references are close to each other. This density map clearly shows certain hotspots but it is not so clear where to draw the line to group journals. I have ended up with following Table 4.

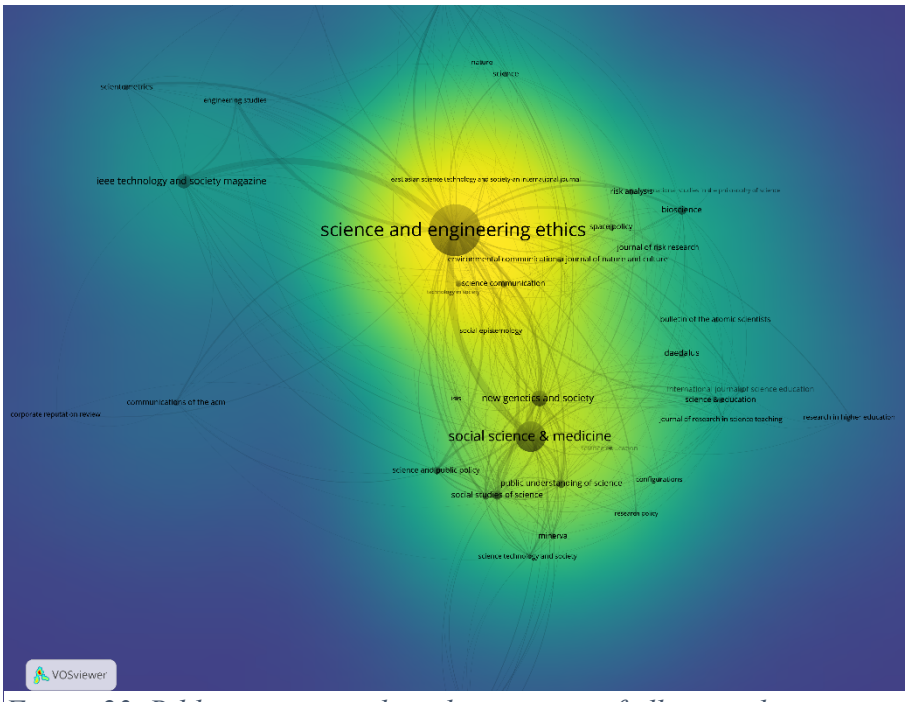

Figure 23. Bibliometric coupling density map of all journals.

Table 4.

Categorization of journals according to bibliometric coupling map

Category 1(top)	**Category 2(bottom)**	**Category 3 (other)**
East Asian Science Technology and Society-An International Journal	Configurations	American Scientist
Environmental Communication - A Journal of Nature and Culture	Isis	Bioscience
Journal of Risk Research	Minerva	British Journal for the History of Science
Risk Analysis	New Genetics and Society	Bulletin of the Atomic Scientists
Science and Engineering Ethics	Public Understanding of Science	Communications of the ACM
Science Communication	Research Policy	Corporate Reputation Review
Social Epistemology	Science and Public Policy	Daedalus
Space Policy	Science as Culture	Engineering Studies
Technology in Society	Science Education	IEEE Technology and Society Magazine
	Science Technology and Society	Interdisciplinary Science Reviews
	Social Science & Medicine	International Journal of Science Education
	Social Studies of Science	International Studies in the Philosophy of Science
		Issues in Science and Technology
		Journal of Research in Science Teaching
		Nature
		Perspectives on Global Development and Technology
		Research in Higher Education
		Research Policy
		Science in Context
		Science
		Scientific American
		Scientometrics
		Studies in History and Philosophy of Science

5.4 Journals Divisions

5.4.1 Co-occurrence of Author Keywords

First map in this section (figure 24) covers articles listed in category 1. Overlay colors are publication years. There are some greenish big nodes with average publication years equal to timespan average. These can be considered as established concepts which are “engineering ethics”, “research ethics”, “engineering education”, “professional ethics”, “risk”, “responsibility”, “engineering”, “code of ethics” and towards the top “informed consent”. There are also some blueish ones which are getting old: larger bluish ones are “conflict of interest”, “patent”,” engineering”, “value”, also a lot of minor bluish nodes are distributed mainly towards the right half and grouped more in the upper left quarter around “conflict of interest”. Right half of the network seems to be much more yellowish indicating newer average publication years.

In fact, if we look at connections of large nodes in the upper right quarter “research ethics” with surrounding nodes seems to be bridging upper left older cluster with bottom right newer cluster; similar can be said for “bioethics” on the left.

Filtering connections with strength of five reveals some disconnected islands, they seem to be important academic topics co-occurring together in this category; biggest of those discussions with five nodes locate in the upper half containing keywords “informed consent”, “research ethics”, responsible conduct of research”, “research integrity”, “research misconduct”. One to the bottom contains three nodes “ethics education”, “engineering ethics”, “engineering education” and a final one on the upper left connects only two nodes “policy” and ”philosophy”.

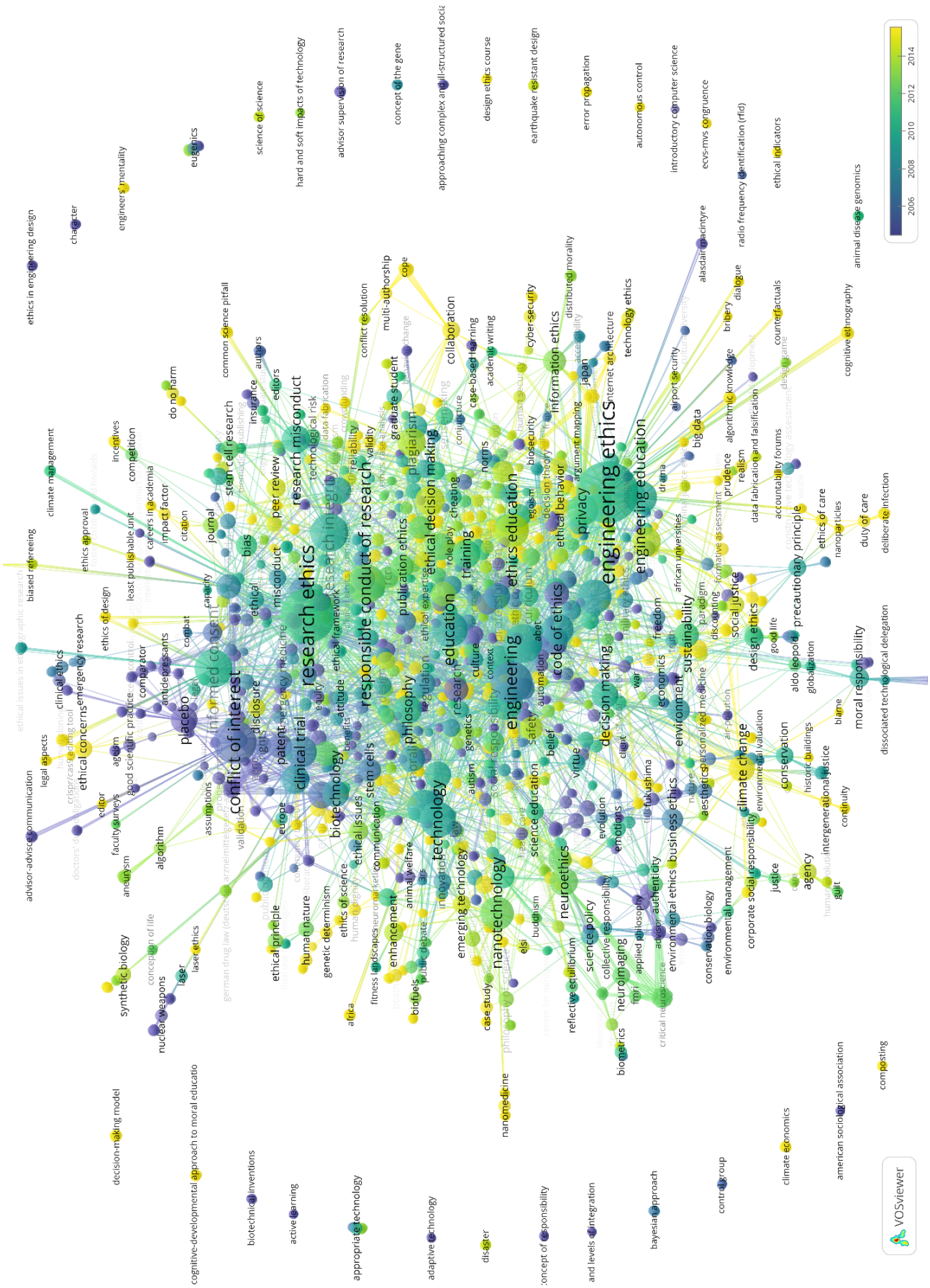

Figure 24. Co-occurrence graph of Category 1 author keywords [Min Num of Occ:1]

“research ethics” seems to be close to significant nodes like “responsible conduct of research”, “research integrity” and “conflict of interest”. Major nodes surrounding “engineering ethics” are “privacy”, “engineering education”, “value sensitive design” and “professional ethics”. At the bottom of map “design ethics” is located close to “social justice”, “sustainability” and “autonomy”.

“neuroethics” is a large node at the bottom left having a significant connection to “neuroimaging” and “neuroscience” bridging those two and more subtle connection to “applied ethics” positioned close to “nanotechnology”. When we look at these nodes’ colors, this island seems to be as emerging topics.

There are many yellow nodes and not any one of those is in significant size, “climate change” at the bottom is the largest one of those. It is connected to “responsibility” strongly and to “sustainability” directly also to “engineering ethics” via “environment”.

“applied ethics” is at the very center of the graph having direct connections to many major nodes like “engineering ethics”, “research ethics”, “informed consent”, “technology”. This central position with connections to large nodes makes it an important pathway in this graph.

This map also includes “bioethics” which is a significant node on the left. Other significant nodes are “technology” and “nanotechnology” at the bottom of the map and “privacy” in the middle. There are total 55 items that contain tech root and 233 items that contain ethic root some of the significant ones are “engineering ethics”, “research ethics”, “professional ethics”, “bioethics”, “neuroethics”, “business ethics”, “virtue ethics”, “information ethics”.

Next map in this section (figure 25) shows co-occurrence map of author keywords for category 2. What we can initially see in this map is it has less nodes than the previous graph. Previous

graph had 2013 nodes and this one had 972 nodes, but also their document count is different (this category contains 343 articles whereas first category contained 658 articles). Largest nodes are “bioethics” and “informed consent”, former being most central. There are many country names, some significant ones are “canada”, “south africa”, “usa”, “australia” and “uk”. This in fact shows the studies are much more local in this category. Some of the newer publication keywords “governance”, “privacy”, “autonomy”, “research ethics” are significant but have a blueish color showing that they are getting old like “informed consent” and “decision making”.

A structural difference in this map is that we can see a line that surrounds the central nodes, this line starts from bottom of map travelling ¾ of the graph ends in “denmark” node on the left. This is interesting when we consider it as a pathway of keywords. Some large nodes on this line are “physician”, “japan”, “constructivism”, biotechnology”, “politics”, “israel” and “germany”.

Compared to the previous map this map does not include “engineering ethics” also even if it contains half of documents it does not contain many keywords considering technology. Total node count containing tech root is 21 and none of them have a significant size or centrality, also most of them are disconnected from the main cluster or are at the border of the map. Number of items containing “ethic” keyword is 50 and most significant ones are “bioethics”, “research ethics”, “empirical ethics”, “ethics committee”, “medical ethics”, “research ethics committee” and “ethical dilemmas”. A comparison of two categories’ popular author keywords can be seen in following table (Table 5).

Table 5.

Most occurrent 10 keywords of 2 categories for author keywords.

Category 1		Category 2	
keyword	occ	keyword	occ
ethics	168	ethics	71
engineering ethics	59	bioethics	37
research ethics	45	informed consent	35
conflict of interest	27	uk	21
engineering	25	research ethics	20
responsibility	22	canada	19
responsible conduct of research	22	usa	15
informed consent	21	decision making	12
research integrity	21	australia	11
education	18	ethnography	11

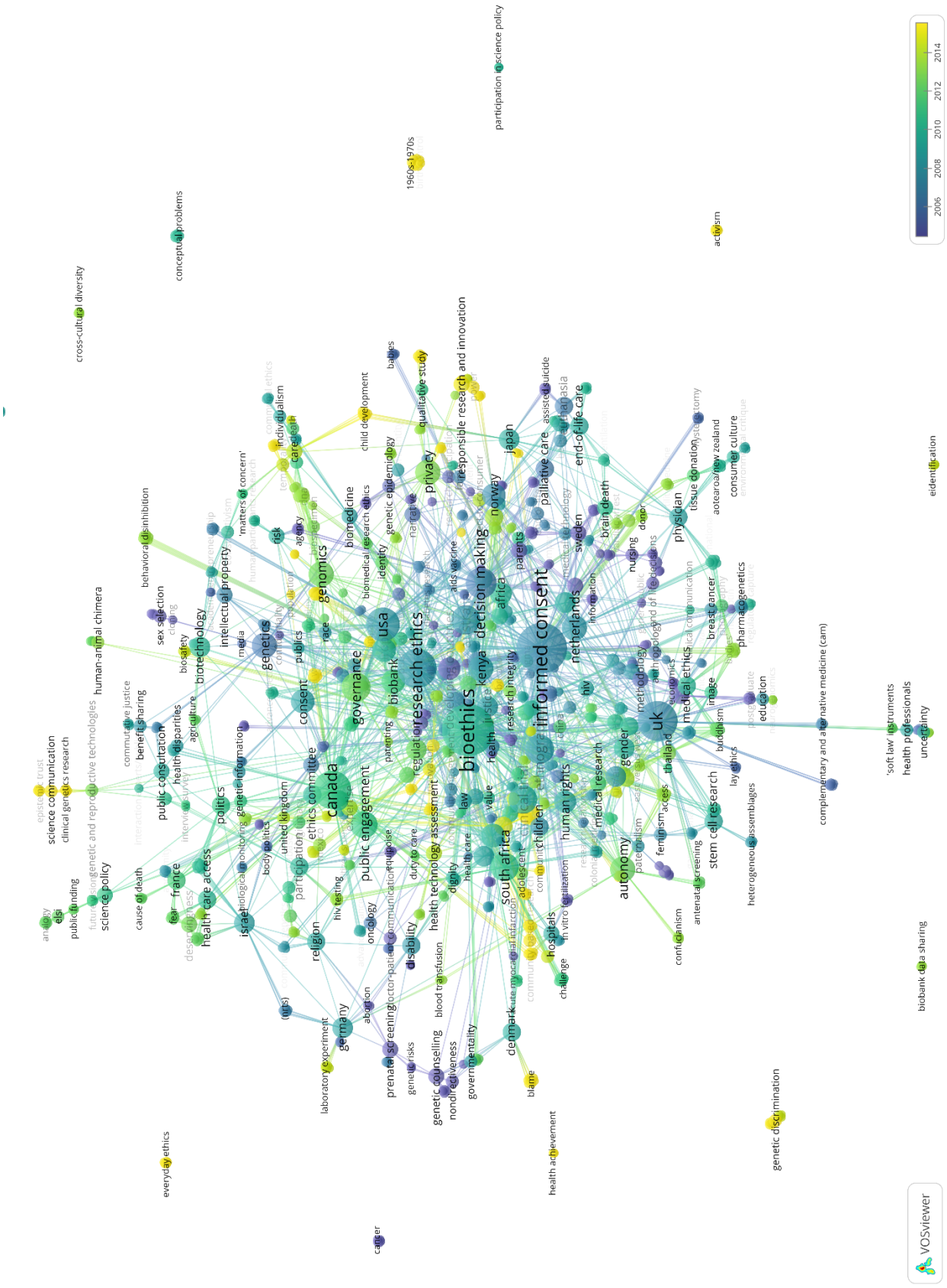

Figure 25. Co-occurrence graph of Category 2 author keywords [Min Num of Occ:1].

5.4.2 Co-occurrence of KeywordsPlus

Keywords plus are harvested from articles' reference titles as mentioned before. Here, I must note that for both keywords plus graphs I discarded "ethics" keyword as usual but it was less occurrent than "science" keyword in category 1. If "science" is more frequent then the search term "ethics", this initially reveals a hierarchical shift when considering only keywords plus. Table 6 shows frequencies of top 10 keywords in different categories for keywords plus. Despite the article difference between two categories node counts for keywords plus seems like unaffected. First category has 957 nodes and second category has 913 nodes. "science", "ethics", and "issue" keywords are found in both of the categories.

Table 6

Most occurrent 10 keywords of 2 categories for keywords plus

Category 1		**Category 2**	
keyword	occ	keyword	occ
science	57	**ethics**	53
ethics	48	**science**	45
education	24	informed consent	29
issue	22	bioethics	28
student	18	attitude	26
decision making	17	health	25
model	16	**issue**	23
responsible conduct	16	care	21
risk	16	politics	21
impact	15	experience	16

Figure 26 shows category 1. "science" is the biggest and most centric node. There are many yellow nodes compared to the second category (figure 27). In fact, second category has many blue and purple nodes indicating that older keywords are dominant. Keywords plus is an extended search, the surrounding in which a field is located. Category 2 was unable to extend its already established surrounding and we might see that category 1 is in the period of extending the surroundings. Another thing is when I changed overlay from years to normalized average citations, category 2 seems to have much more trending keywords as in citation metrics (those

figures with normalized average citation overlay are not included[7]). This would reveal an opposite dynamic in the two categories, category 1 aggressively introducing new keywords and category 2 instead of expanding, keeping current discussions ongoing to explore possibilities.

It would be expected a graph to shift colors when changing overlay from average citations to average publication years because the longer a keyword stands in the network it is more probable for it to be cited than a newly introduced keyword therefore, to discard this factor, I preferred normalized average citations.

[7] These maps can be found in google drive folder.

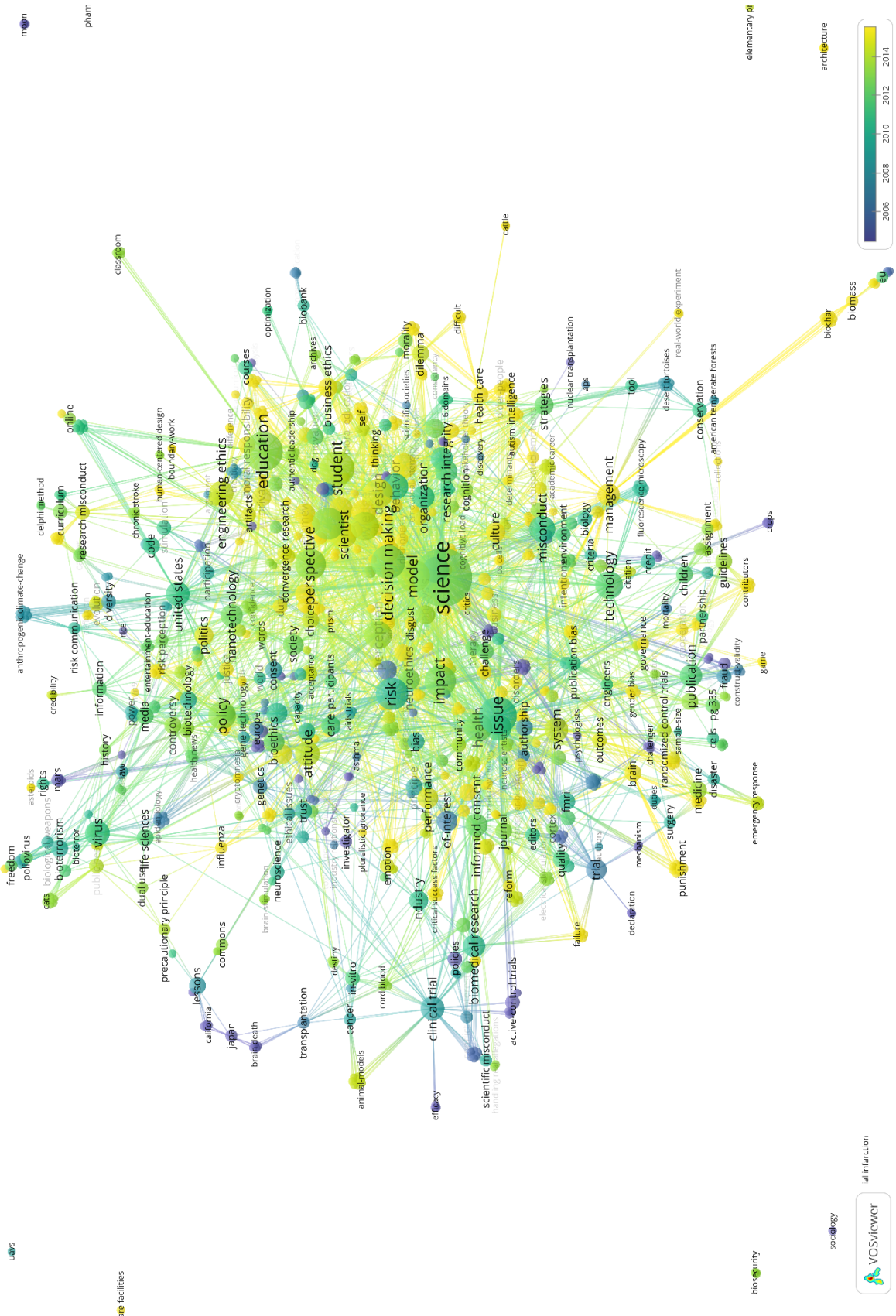

Figure 26. Keywords plus co-occurrence graph of category 1.

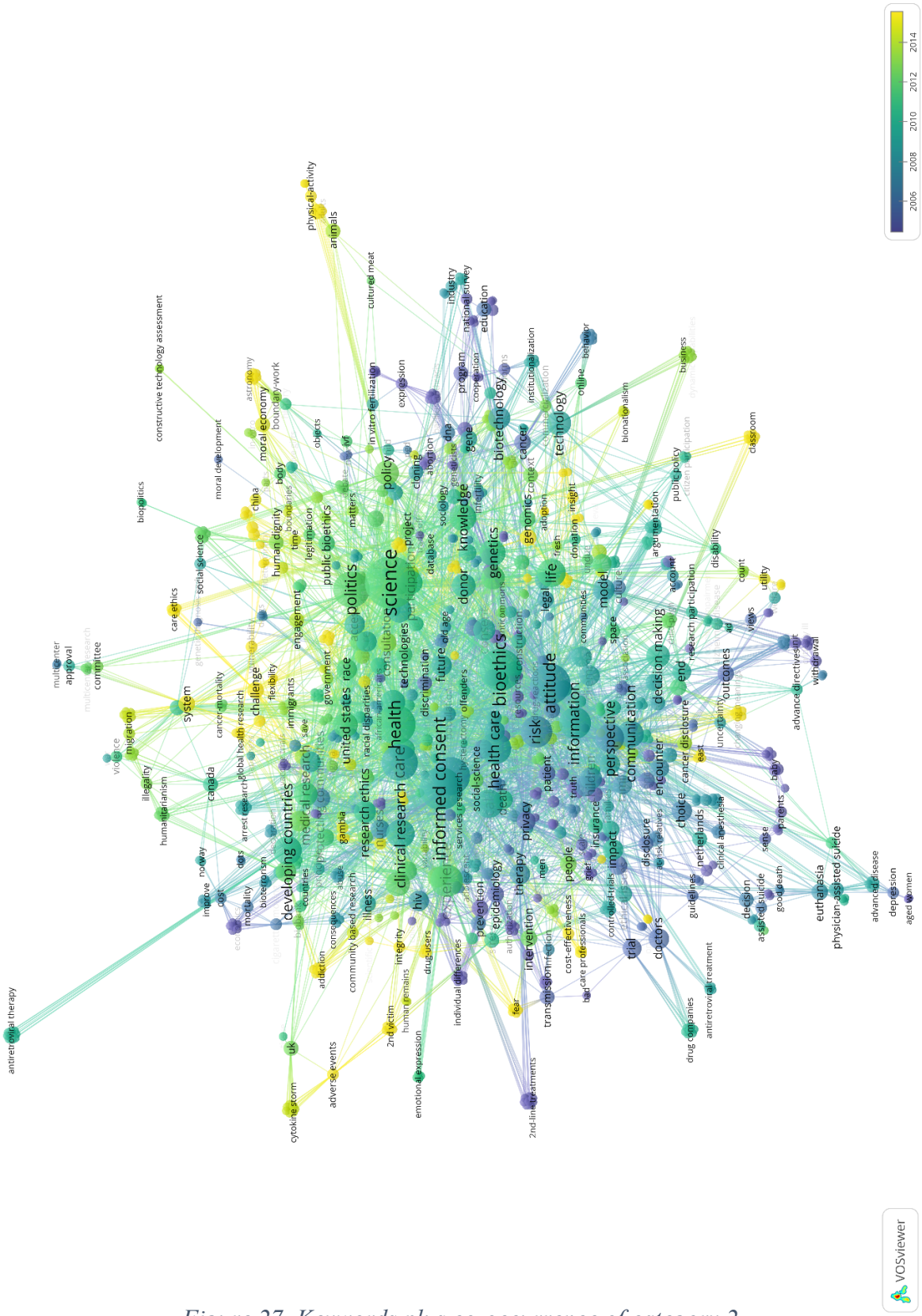

Figure 27. Keywords plus co-occurrence of category 2.

This particular movement of category 1 journals can be seen in comparison of bibliometric coupling graphs of articles in different categories; for these maps unit of analysis is documents. Referring to figure 28 and figure 29 (overlay colors are average publication years and size of node shows citations) there can be seen that many articles with average publication year higher than period average locate between two older poles in figure 28. Those two poles are the greenish and blueish big nodes on the left and on the right of map. Newer articles in the middle share references from both poles trying to fill a gap with newly explored areas neighboring to their own field; which is ethics related to science and engineering. In figure 29 where we look at the bibliometric coupling graph of category 2 there are also light green and yellow nodes in the upper right moving away from older nodes in bottom left of the graph. What is missing in this graph compared to previous one is another established pole with older average publication years, which by its existence accelerates the proliferation process but as it can be noticed category 2 is also in an exploration process.

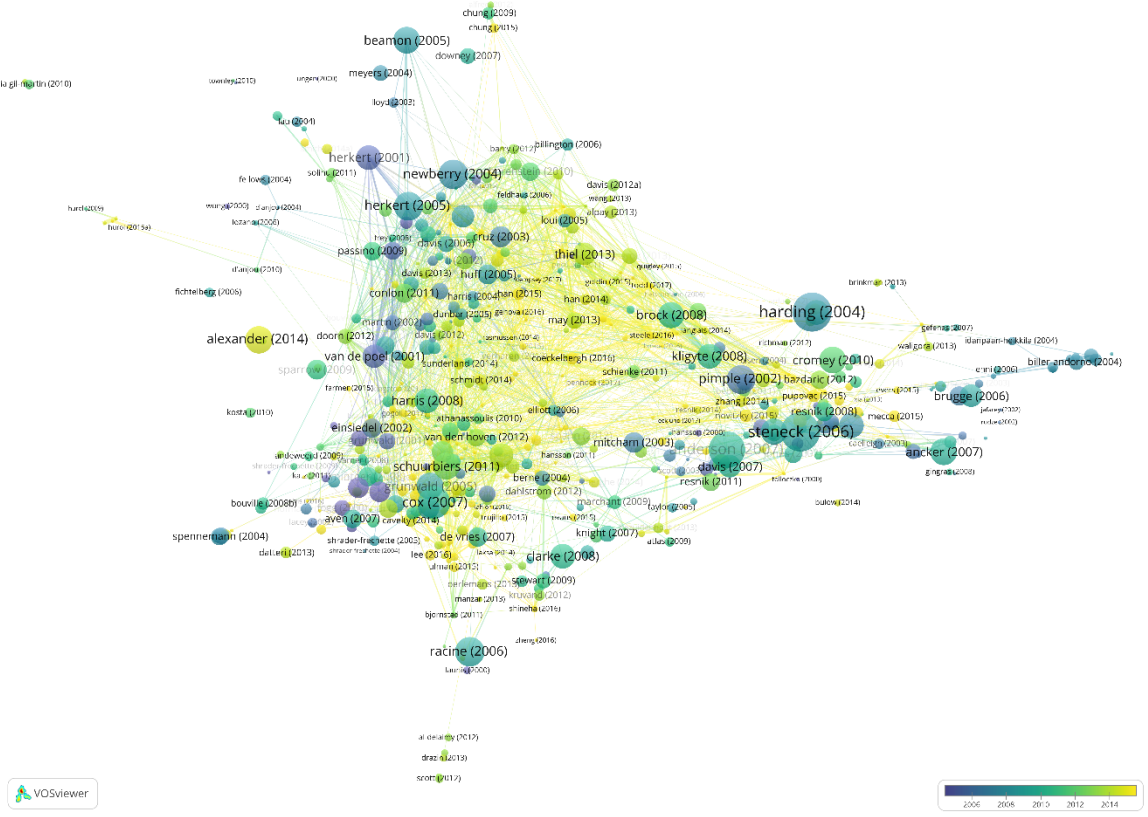

Figure 28. Bibliometric coupling graph of documents in Category 1.

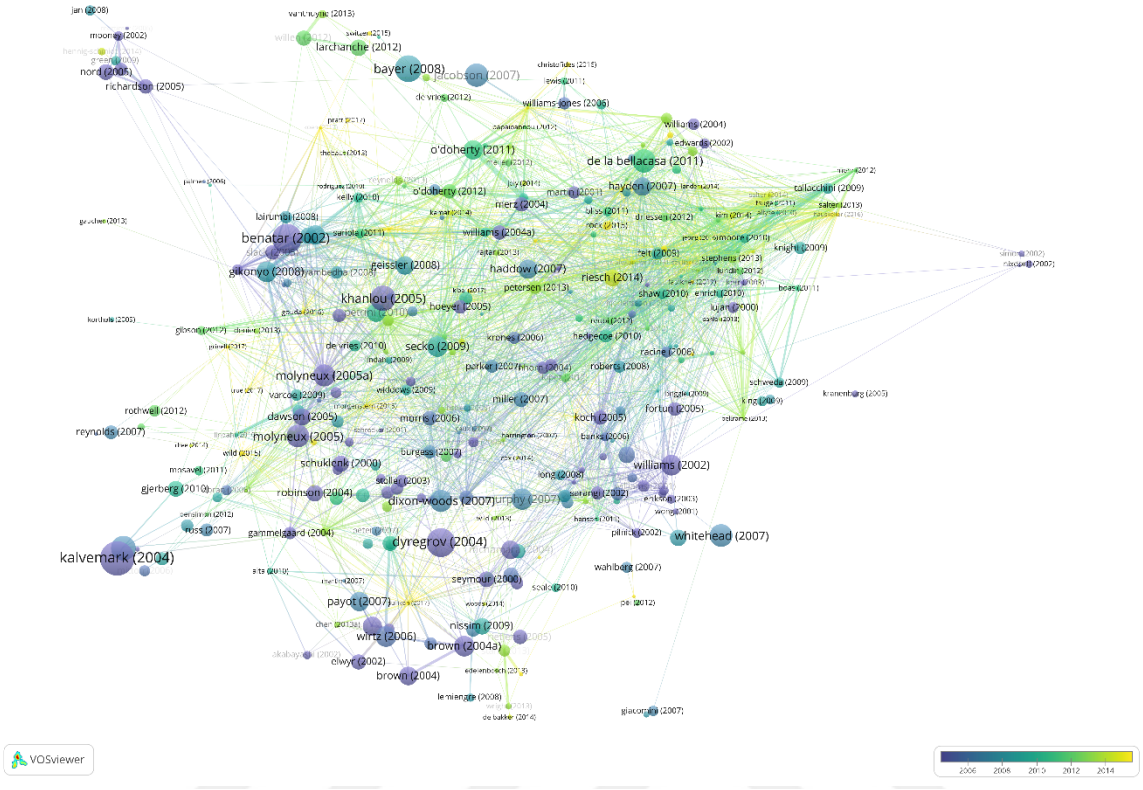

Figure 29. Bibliometric Coupling graph of documents in Category 2.

Some particularly new and significant nodes in category 1 are “sensemaking approach”, “future”, “judgement”, “moral judgement”, “management” and “politics”. I need to note also “research ethics” keyword which was large and present in both of the categories is absent in these keyword plus graphs. Some of the highly cited keywords in category 2 are “future”, “public engagement”, “participation”, “human rights”, “health care”, “community”.

5.4.3 Important connections within network of “ethics”

Journal categories helped to sharpen some distinctions but up until now I have always generated networks discarding “ethics” keyword. This helped a lot to study on the surrounding of the node but I also wanted to see how significant nodes connect to main query keyword of “ethics”. Hoping to see these connections would help to draw further distinctions I have generated the following maps. Following next four graphs (figure 30, figure 31, figure 32, figure 33) are exported from Vosviewer but their layout modified in Gephi with graph laying out algorithms

like Forceatlas2, Noverlap, Label adjust or so; therefore, distance does not necessarily reflect similarity. Their colors are average publication years. Yellow for 2000 and red for 2017 gradient oranges in between.

Maps shown in this section reveal the connections of “ethics” keyword to the other keywords in separate categories (figure 30 for first category and figure 31 for second category). These graphs show nodes with edge weight of 2 or more allowing us to focus on important connections.

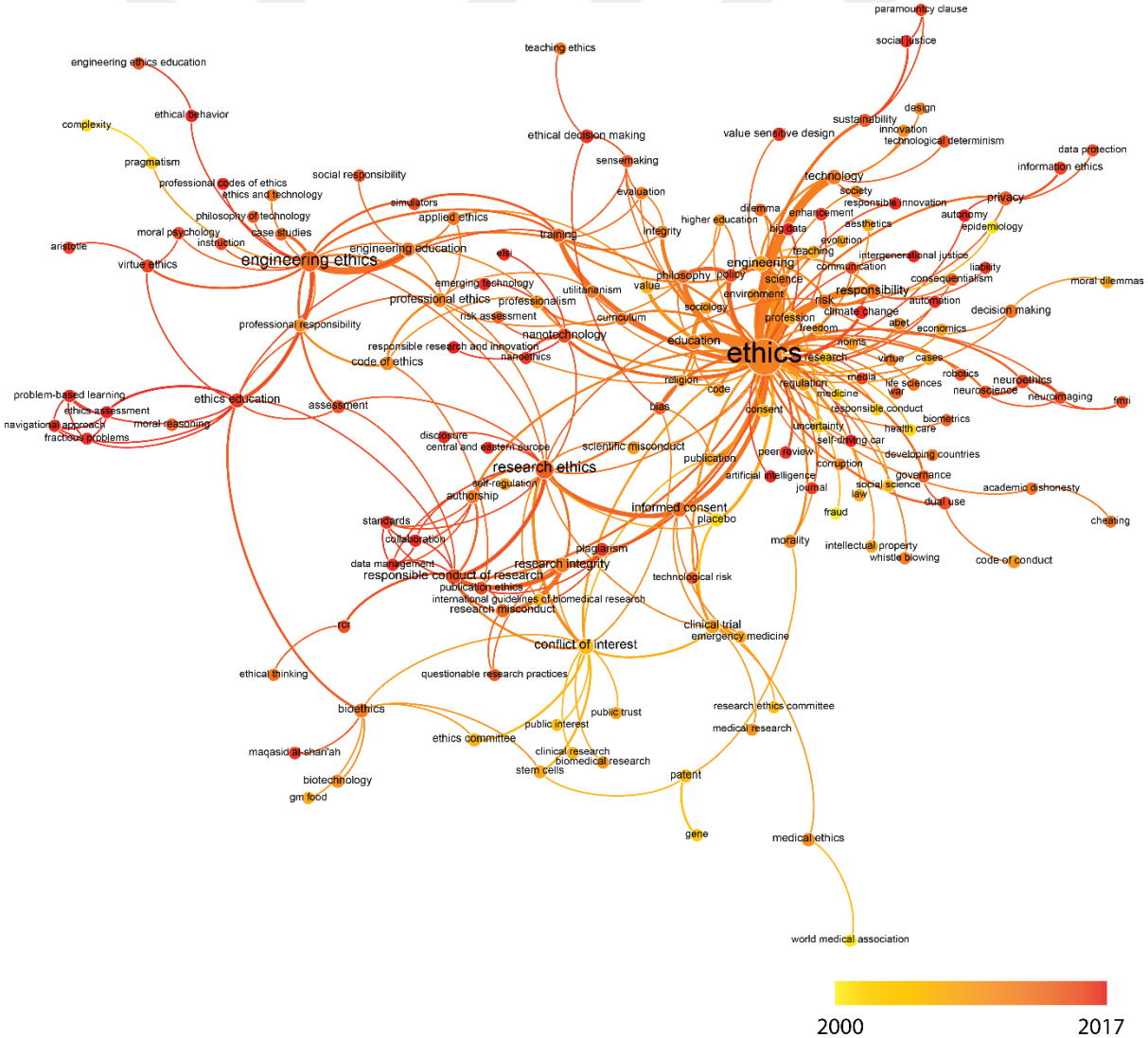

Figure 30. Network of ethics keyword for category 1 in Gephi (filtered Link strength>=2).

For both maps (figure 30 and figure 31) we can see some main nodes. For the former these are “ethic” “engineering ethics” “research ethics” for the latter these are “ethics” “informed consent” “bioethics” and “research ethics”. There are much more keywords in Figure 29 but this is because it contains much more articles compared to category 2.

For figure 30 “ethics” keyword is strongly connected to “technology”, “science”, “responsibility”, “training”and “research ethics”. “engineering ethics” is also strongly connected to “engineering education” and “professional responsibility”. “engineering education” is a very important node connecting to “engineering ethics”, “ethics”, “applied ethics”and “professional ethics”. “training” is also a very important node functioning as an intermediate node connecting “engineering ethics” and “ethics”. At the bottom of map there are many keywords which also exist in the category 2’s map such as “stem cells”, “medical ethics”, “bioethics”, “biotechnology”. This map does not exclude other category. There are four nodes that connect this area with main network. Those are “morality”, “clinical trials”, “conflict of interest” and “ethics education”. Those four cocepts can be supplied with “technological risk” and “research ethics” to list some important boundary concepts between two distinct cores.

This can be explained with Table 6. As shown in that table “science” was prior to “ethics” keyword in the keywordsplus category. Category 1 takes science as a whole, category 2 meanwhile is much more focused to a subfield of science that is medical studies.

In figure 31 “ethics” is strongly connected to “informed consent” and “canada”. Connection between “bioethics” and “ethics” is not very strong. They are also connected with intermediate keywords “biotechnology”, “genetics”, “uk”, “informed consent”. Surrounding the “research ethics” there are many country names and at the bottom of map there are many new keywords. Governance and commercialization of biobanks, stem cells and genomics establishing as a concern within this category.

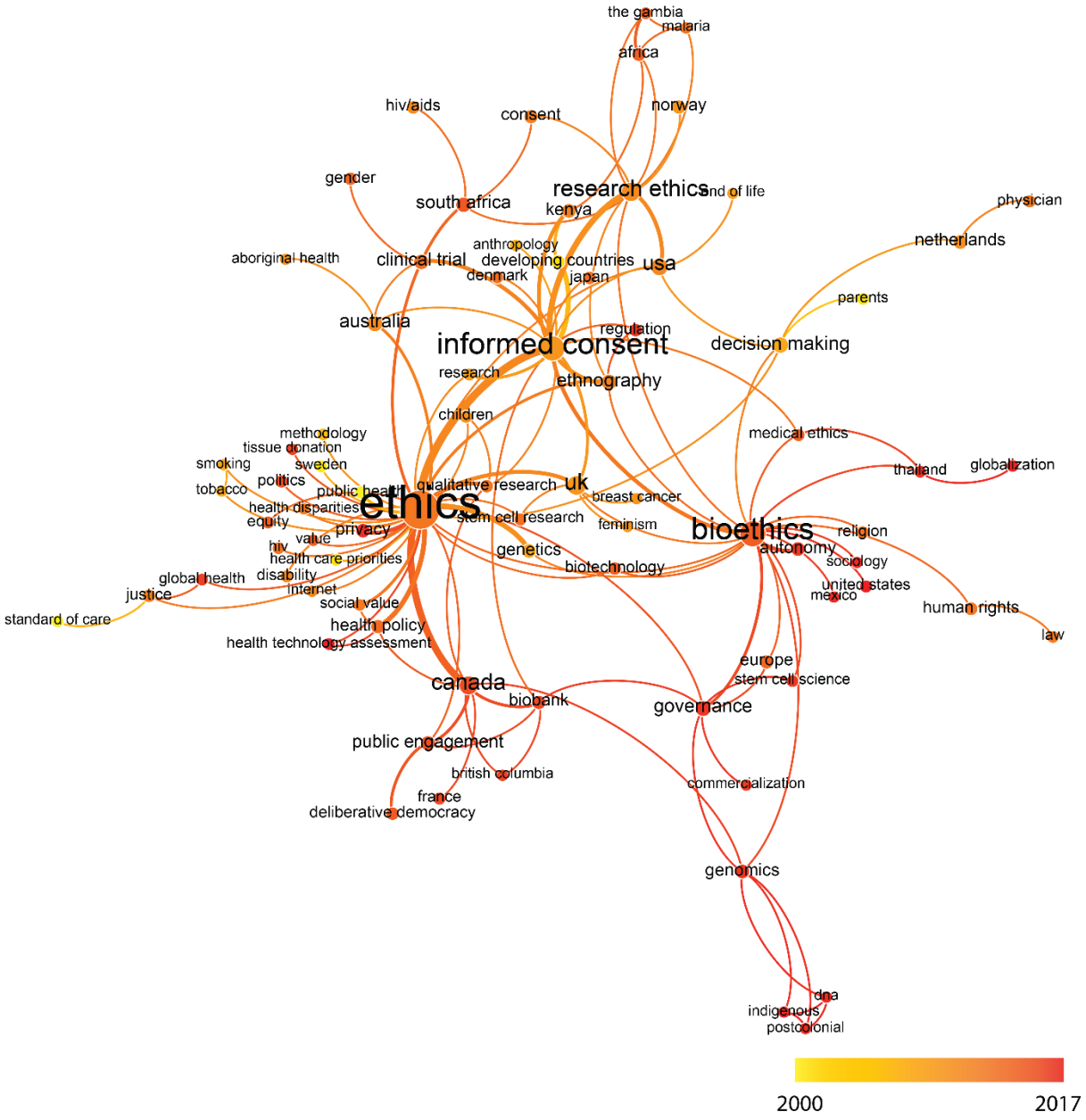

Figure 31. Network of ethics keyword for category 2 in Gephi (filtered Link strength>=2).

5.4.4 Network of variants of ethics keyword

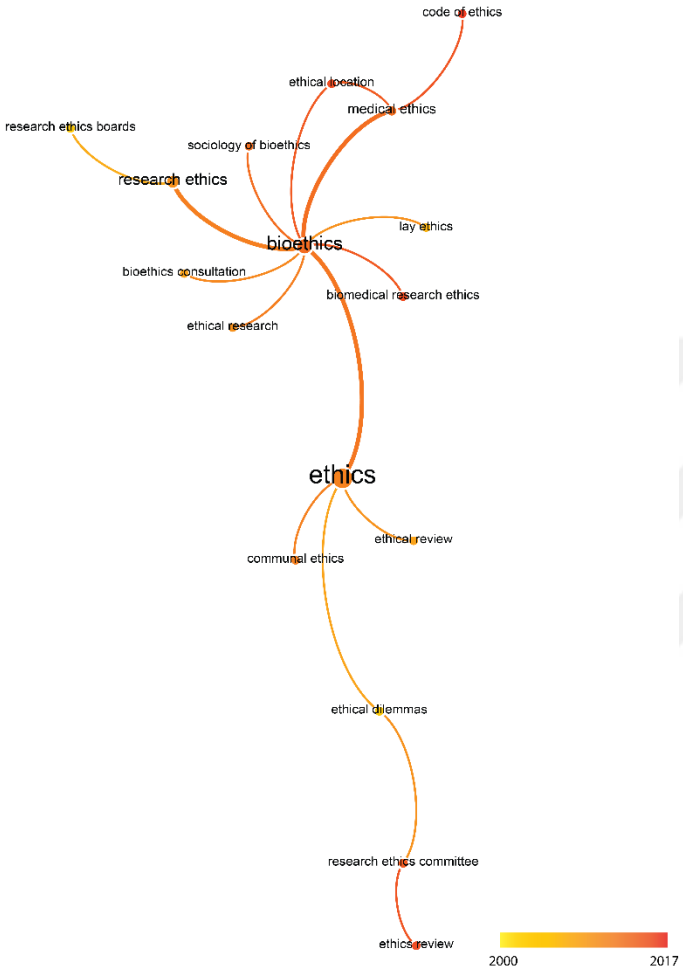

Figure 32. Network of different variants of ethic keyword for category 2 in Gephi.

These two figures figure 32, figure 33 reveal kinds and variants of ethic keyword as a network. These are the main compartments and there were many disconnected variants. figure 32 is the graph for variants of ethics keyword in category 2 and figure 33 is the graph of variants of ethic keyword in category1.

Category 1 has much bigger network and this seems to be unproportional to the article count difference of two categories. In figure 33 “engineering ethics” has 42 directly connected nodes. Other central nodes are “research ethics” with 34, “applied ethics” and “bioethics” with 23, “ethics” keyword with 22 directly connected nodes. Category 2 has a very small network, “bioethics” has 9 directly connected nodes and “ethics” keyword has 4 directly connected nodes which can be seen in figure 32.

Strongest links in category 2 are between “ethics” and “bioethics”, between “bioethics and research ethics” and between “ bioethics” and “medical ethics”. In category 1 strongest link is between “ethics education” and “engineering ethics” other strong connections are between “ethics” and “neuroethics”, “engineering ethics” and “virtue ethics”, “engineering ethics” and

“professional ethics”, “professional ethics” and “code of ethics”, “ethics education” and “ethics assessment”, “ethics education” and “bioethics”.

Therefore category 1 has much more centers than category 2; making it covering much more types and versions of “ethics” keywords. In both of the categories “ethics” is not the most central keyword. Considering strong connections; in category 1 “ethics” “neuroethics” pair is not a part of the main compartment which is the compartment of “engineering ethics”.

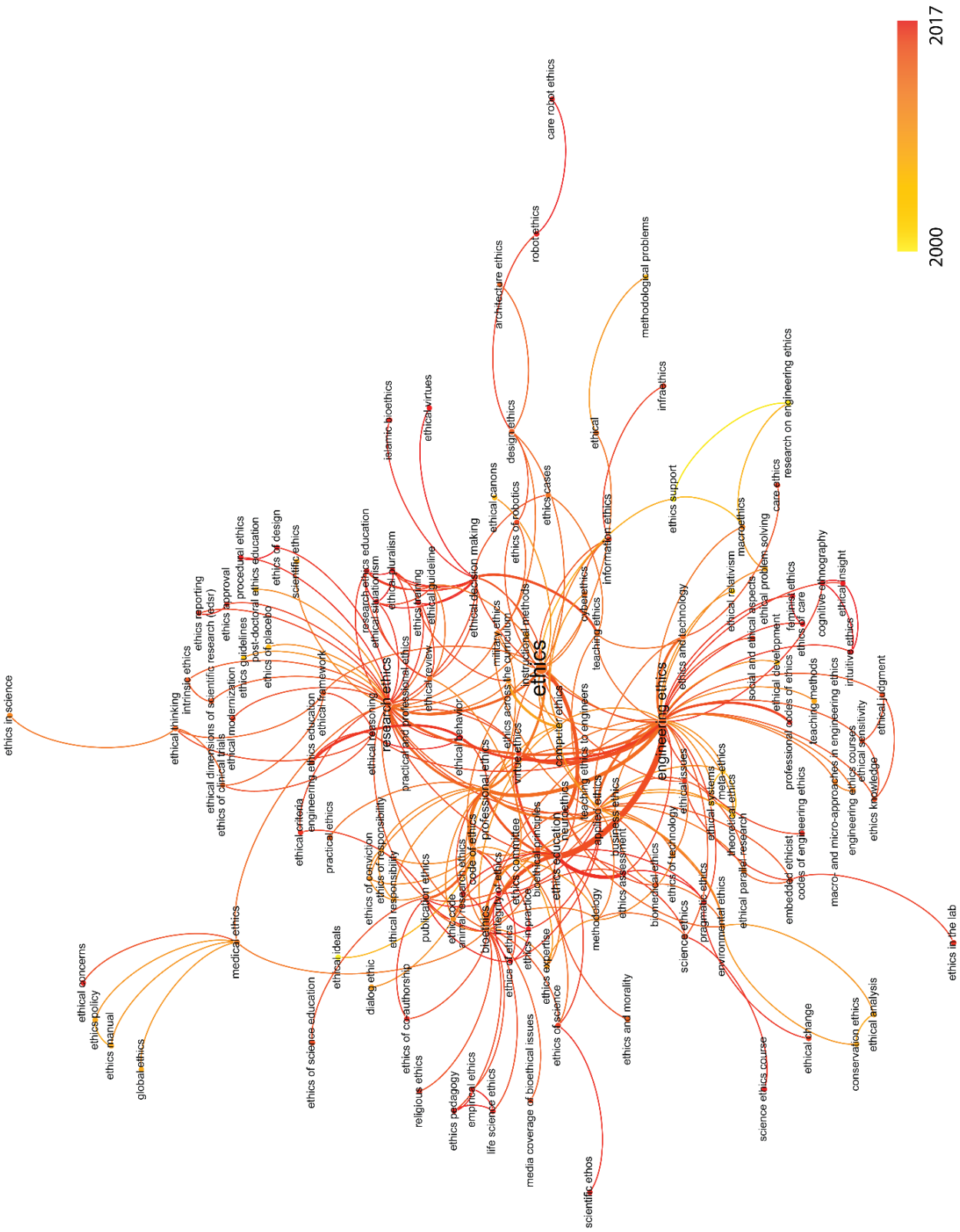

Figure 33. Network of different variants of ethic keyword for category 1 in Gephi.

CHAPTER 6

General Discussion

Language of this study is limited to “English” considering a universal and cultural term such as “ethics”; this perspective is a big limitation; data query is limited to “Web of Science” indexing. As mentioned before this dataset has gaps within research period. Time is limited to 2000-2017 years. Journals are limited to Society for Social Study of Science website. Analysis is dependent on software bugs which are or will be applicable to versions mentioned. Considering a rich word like “ethics” and the complex network established around it above all are encumbering limitations. Considering these limitations, the conclusions that I could draw are below.

First of all, considering publication frequencies as mentioned earlier in chapter two, “ethics” keyword covers 1.5-2 % of studies published in STS. Material published is increasing but considering the total articles published they have a stable percentage. There are two major divisions, one is “engineering ethics” and the other is “bioethics” and for these major divisions there are significant journals focusing on these divisions; for the former this is Science and Engineering Ethics Journal and for the latter this is Social Science and Medicine Journal. “research ethics” is the greatest shared node for those two divisions. Journals that focus on hard sciences such as Science and Nature are very dominant in knowledge production, but they have very low interest in the concept of ethics. Science and Engineering Ethics as a dedicated journal, reveals that ethics is an important concept in science. General publication practice on the other hand that it is not trending. Within same period more trendy keywords such as innovation or design would give many more results.

There were 39 journals published in the year 2000 and this increased to 57 in the year of 2017 meaning 18 journals started to be published during this period. Journals with biggest article count after filtering is (in descending order) Science and Engineering Ethics, Social Science and

Medicine, New Genetics and Society, IEEE Technology and Society Magazine, Daedalus. This also reveals that “ethics” is an ongoing discussion in varying fields.

The lack of standardization of keywords was a handicap. There were many overlapping terms written in different formats or in plural version to be found; such as “clinical trial”, “clinical-trials”, “clinical-trial” and “clinical trials”. A topical query at web of science with different versions also finds different amount of results.

Another finding looking at this dataset and analysis is the emergence of “conflict of interest” keyword which is crucial for the unity of network. Its existence in 2002 united disconnected clusters of words increasing the size of largest container to establish different possible paths between nodes making it as a central problem in Science, Technology and Society discourse. Engineering ethics is generally observed close with utilitarianism and professional ethics and bioethics generally observed with morality and altruism.

Within the four periods a significant question one can raise is the unexpected weakness of “bioethics” in the 2015-2017 period. Social Science and Medicine Journal keeps its frequency to be published and is present in dataset but its frequency after 2014 drops dramatically. This happens due to my filtering of irrelevant articles which might signal a shift from ethics centered discussion to something else in that journal. This also can be seen in total absence as a keyword in year 2016, low average years of keywords plus graph and its much smaller size in historical keyword graphs’ final period. One thing to mention is in 2016 this journal has published articles in the relevant set but “bioethics” is totally absent from keywords. This final issue might be an indicator of a change in trends within this category.

Publication frequencies and counts are higher in 1st category compared to 2nd. Keywords contained in 1st category are much more varying and broader than keywords contained in 2nd category. 2nd category is more like a specific expert area focusing on a smaller spot compared to

1st category. A significant node in category 1 is “education”, and in category 2 is “informed consent”. Most of the keywords appearing in 2nd category are also present in the 1st category. A characteristic of 2nd category is that it includes much more localized keywords signaling studies are much more local compared to 1st category. Another thing to mention is that “bioethics” and “engineering ethics” have much more direct connections than “ethics” keyword itself.

The greatest intersection of category 1 and category 2 is research ethics. This would on the other hand can be interpreted as ethics of research is a central question within ethics discourse in STS. Both categories found to be significant are diverse research fields capable to establish their own ethical discussions. Neither engineering ethics nor bioethics is the main actor in this co-occurrence network but research ethics.

It is very true that instead of ethic we should approach it as ethics because of the rich variations and combinations of the ethic keyword distributed in different areas of graphs operating locally. One can take research as an act in different categories like duty, profession or approach it locally in different countries Kenya, United Kingdom, U.S.A, developing countries, west, east, or in different fields, like medicine, engineering, academic practice; every combination of those networks seems to have some sort of different ethics. The more one gets deeper in a field different kinds of ethic seem to emerge. Therefore, one good that governs all seems to be not possible.

Even if one node that governs all of the network is absent, some permanent and significant issues can be found in the network. Those can be listed as governance, respect to autonomy of research participant, integrity of research, environmental damage, privacy, misconduct in research, conflict of interest, and alteration of human life and also a stable concept is ethics education. Some of the emerging topics can be listed as climate change, neuroethics, nanotechnology, responsible conduct of research, genetics, genomatics, governance of biobanks.

Future studies needed to move this study further than descriptive. Considering STS' interdisciplinary role it would be proliferating to study one of surrounding disciplines with STS, also combining co-occurrence with other methods would yield better understanding and deeper insights to dynamics of complex networks. After the study it is found to be productive to look at the subnetworks of major keywords and how they connect to each other. This suggested study will reveal the discussions centered around a certain concept at a better extent.

APPENDICES:

Appendix A: Journal List and Web of Science search algorithm:

Publication Name [SO]	Included	Advanced Search Algorithm	Root Found Results	Wildcard Found Results
Science, Technology & Human Values	NO	This Journal is excluded.	na	na
Engaging Science, Technology, and Society	NO	This Journal is excluded.	na	na
Social Studies of Science	YES	TS= (ethic*) AND DT= Article AND SO= "Social Studies of Science" AND PY= (2000-2017)	2	32
Science As Culture	YES	TS= (ethic*) AND DT= Article AND SO= "Science As Culture" AND PY= (2000-2017)	0	15
Science, Technology, and Society	YES	TS= (ethic*) AND DT= Article AND SO= "Science, Technology, and Society" AND PY= (2000-2017)	0	5
Gender, Technology, and Development	NO	This Journal is excluded.	na	na
Science Communication	YES	TS= (ethic*) AND DT= Article AND SO= "Science Communication" AND PY= (2000-2017)	0	24
Sociology of the Sciences Yearbook	NO	This Journal is excluded.	na	na
Catalyst	NO	This Journal is excluded.	na	na
Knowledge and Policy	NO	This Journal is excluded.	na	na
Configurations	YES	TS= (ethic*) AND DT= Article AND SO= "Configurations" AND PY= (2000-2017)	0	13

Scientometrics	YES	TS= (ethic*) AND DT= Article AND SO= "Scientometrics" AND PY= (2000-2017)	0	18
Revue d'Anthropologie des Connaissances	NO	This Journal is excluded.	na	na
Science and Engineering Ethics	YES	TS= (ethic*) AND DT= Article AND SO= "Science and Engineering Ethics" AND PY= (2000-2017)	8	707
Risk Analysis	YES	TS= (ethic*) AND DT= Article AND SO= "Risk Analysis" AND PY= (2000-2017)	2	35
BioScience	YES	TS= (ethic*) AND DT= Article AND SO= "BioScience" AND PY= (2000-2017)	2	35
Journal of Deliberative Mechanisms in Science	NO	This Journal is excluded.	na	na
Science Studies	NO	This Journal is excluded.	na	na
Social Science & Medicine	YES	TS= (ethic*) AND DT= Article AND SO= "Social Science & Medicine" AND PY= (2000-2017)	11	332
ISIS	YES	TS= (ethic*) AND DT= Article AND SO= "ISIS" AND PY= (2000-2017)	0	5
History of Science	YES	TS= (ethic*) AND DT= Article AND SO= "History of Science" AND PY= (2000-2017)	0	1
British Journal for the History of Science	YES	TS= (ethic*) AND DT= Article AND SO= "British Journal for the History of Science" AND PY= (2000-2017)	0	2
Studies in History and Philosophy of Science	YES	TS= (ethic*) AND DT= Article AND SO= "Studies in History and Philosophy of Science" AND PY= (2000-2017)	0	12
International Studies in the Philosophy of Science	YES	TS= (ethic*) AND DT= Article AND SO= "International Studies in the Philosophy of Science" AND PY= (2000-2017)	0	1
East Asian Science, Technology and Society: an International Journal	YES	TS= (ethic*) AND DT= Article AND SO= "East Asian Science, Technology and Society: an International Journal" AND PY= (2000-2017)	0	2

Annals of Science	YES	TS= (ethic*) AND DT= Article AND SO= "Annals of Science" AND PY= (2000-2017)	0	0
Osiris	YES	TS= (ethic*) AND DT= Article AND SO= "Osiris" AND PY= (2000-2017)	1	3
Technology and Culture	YES	TS= (ethic*) AND DT= Article AND SO= "Technology and Culture" AND PY= (2000-2017)	0	0
History of Technology	NO	This Journal is excluded.	na	na
Issues in Science and Technology	YES	TS= (ethic*) AND DT= Article AND SO= "Issues in Science and Technology" AND PY= (2000-2017)	1	1
Daedalus	YES	TS= (ethic*) AND DT= Article AND SO= "Daedalus" AND PY= (2000-2017)	0	18
Environmental Communication: A Journal of Nature and Culture	YES	TS= (ethic*) AND DT= Article AND SO= "Environmental Communication: A Journal of Nature and Culture" AND PY= (2000-2017)	2	19
Minerva	YES	TS= (ethic*) AND DT= Article AND SO= "Minerva" AND PY= (2000-2017)	0	9
Technology In Society	YES	TS= (ethic*) AND DT= Article AND SO= "Technology In Society" AND PY= (2000-2017)	0	12
Science and Public Policy	YES	TS= (ethic*) AND DT= Article AND SO= "Science and Public Policy" AND PY= (2000-2017)	0	22
Research Evaluation	YES	TS= (ethic*) AND DT= Article AND SO= "Research Evaluation" AND PY= (2000-2017)	0	3
Outlook on Science Policy	NO	This Journal is excluded.	na	na
Research Policy	YES	TS= (ethic*) AND DT= Article AND SO= "Research Policy" AND PY= (2000-2017)	0	3

Japan Journal for Science, Technology, and Society	NO	This Journal is excluded.	na	na
REDES - Revista de Estudios Sociales de la Ciencia	NO	This Journal is excluded.	na	na
QUIPU - Revista Latinoamericana de Historia de las Ciencias y la Tecnología	NO	This Journal is excluded.	na	na
Tapuya	NO	This Journal is excluded.	na	na
RAC - Revue d'Anthropologie des Connaissances	NO	This Journal is excluded.	na	na
Engineering Studies	YES	TS= (ethic*) AND DT= Article AND SO= "Engineering Studies" AND PY= (2000-2017)	0	9
Technology Studies	NO	This Journal is excluded.	na	na
Science in Context	YES	TS= (ethic*) AND DT= Article AND SO= "Science in Context" AND PY= (2000-2017)	0	5
Perspectives on Science: Historical, Philosophical, Social	NO	This Journal is excluded.	na	na
Social Epistemology	YES	TS= (ethic*) AND DT= Article AND SO= "Social Epistemology" AND PY= (2000-2017)	0	11
Public Understanding of Science	YES	TS= (ethic*) AND DT= Article AND SO= "Public Understanding of Science" AND PY= (2000-2017)	0	41
Current Literature on Science of Science	NO	This Journal is excluded.	na	na
Technology Analysis and Strategic Management	NO	This Journal is excluded.	na	na

Prometheus	YES	TS= (ethic*) AND DT= Article AND SO= "Prometheus" AND PY= (2000-2017)	0	0
Industry And Innovation	YES	TS= (ethic*) AND DT= Article AND SO= "Industry And Innovation" AND PY= (2000-2017)	0	0
Journal of Risk Research	YES	TS= (ethic*) AND DT= Article AND SO= "Journal of Risk Research" AND PY= (2000-2017)	1	30
New Genetics and Society	YES	TS= (ethic*) AND DT= Article AND SO= "New Genetics and Society" AND PY= (2000-2017)	1	95
Corporate Reputation Review	YES	TS= (ethic*) AND DT= Article AND SO= "Corporate Reputation Review" AND PY= (2000-2017)	0	6
Cultural Dynamics	YES	TS= (ethic*) AND DT= Article AND SO= "Cultural Dynamics" AND PY= (2000-2017)	0	1
Perspectives on Global Development And Technology	YES	TS= (ethic*) AND DT= Article AND SO= "Perspectives on Global Development And Technology" AND PY= (2000-2017)	0	3
Information Technologies and International Development	NO	This Journal is excluded.	na	na
Space Policy	YES	TS= (ethic*) AND DT= Article AND SO= "Space Policy" AND PY= (2000-2017)	3	14
Research Management	YES	TS= (ethic*) AND DT= Article AND SO= "Research Management" AND PY= (2000-2017)	0	0
IEEE Technology and Society Magazine	YES	TS= (ethic*) AND DT= Article AND SO= "IEEE Technology and Society Magazine" AND PY= (2000-2017)	0	50
Research - Technology Management	YES	TS= (ethic*) AND DT= Article AND SO= "Research - Technology Management" AND PY= (2000-2017)	0	0

R&D Management	YES	TS= (ethic*) AND DT= Article AND SO= "R&D Management" AND PY= (2000-2017)	0	0
SRA - Journal of the Society of Research Administrators	YES	TS= (ethic*) AND DT= Article AND SO= "SRA - Journal of the Society of Research Administrators" AND PY= (2000-2017)	0	0
Journal of Product Innovation Management	YES	TS= (ethic*) AND DT= Article AND SO= "Journal of Product Innovation Management" AND PY= (2000-2017)	0	0
Project Appraisal	NO	This Journal is excluded.	na	na
Bulletin of Science, Technology, and Society	NO	This Journal is excluded.	na	na
Interdisciplinary Science Reviews	YES	TS= (ethic*) AND DT= Article AND SO= "Interdisciplinary Science Reviews" AND PY= (2000-2017)	2	27
Impact of Science on Society	YES	TS= (ethic*) AND DT= Article AND SO= "Impact of Science on Society" AND PY= (2000-2017)	0	0
Science and Society	NO	This Journal is excluded.	na	na
Research in Higher Education	YES	TS= (ethic*) AND DT= Article AND SO= "Research in Higher Education" AND PY= (2000-2017)	0	4
Journal of Research in Science Teaching	YES	TS= (ethic*) AND DT= Article AND SO= "Journal of Research in Science Teaching" AND PY= (2000-2017)	0	13
Science Education	YES	TS= (ethic*) AND DT= Article AND SO= "Science Education" AND PY= (2000-2017)	1	25
International Journal of Science Education	YES	TS= (ethic*) AND DT= Article AND SO= "International Journal of Science Education" AND PY= (2000-2017)	1	28
Politics and the Life Sciences	YES	TS= (ethic*) AND DT= Article AND SO= "Politics and the Life Sciences" AND PY= (2000-2017)	0	0

Philosophy & Social Action	NO	This Journal is excluded.	na	na
Journal of Biomedical Discovery and Collaboration (DISCO)	NO	This Journal is excluded.	na	na
Journal of Social Science Research	NO	This Journal is excluded.	na	na
Spontaneous Generations: A Journal for the History and Philosophy of Science	NO	This Journal is excluded.	na	na
Science	YES	TS= (ethic*) AND DT= Article AND SO= "Science" AND PY= (2000-2017)	5	10
Nature	YES	TS= (ethic*) AND DT= Article AND SO= "Nature" AND PY= (2000-2017)	2	13
The Scientist	NO	This Journal is excluded.	na	na
Scientific American	YES	TS= (ethic*) AND DT= Article AND SO= "Scientific American" AND PY= (2000-2017)	2	6
American Scientist	YES	TS= (ethic*) AND DT= Article AND SO= "American Scientist" AND PY= (2000-2017)	1	2
National Geographic	YES	TS= (ethic*) AND DT= Article AND SO= "National Geographic" AND PY= (2000-2017)	0	0
Omni	YES	TS= (ethic*) AND DT= Article AND SO= "Omni" AND PY= (2000-2017)	0	0
Discover	YES	TS= (ethic*) AND DT= Article AND SO= "Discover" AND PY= (2000-2017)	0	0
Science News	YES	TS= (ethic*) AND DT= Article AND SO= "Science News" AND PY= (2000-2017)	0	0
STI--Science, Technology, Industry Review	NO	This Journal is excluded.	na	na

Main Science and Technology Indicators	NO	This Journal is excluded.	na	na
Bulletin of the Atomic Scientists	YES	TS= (ethic*) AND DT= Article AND SO= "Bulletin of the Atomic Scientists" AND PY= (2000-2017)	7	9
Science & Government Report	NO	This Journal is excluded.	na	na
The Electronic Journal on Information Systems in Developing Countries	NO	This Journal is excluded.	na	na
International Journal of Networking and Virtual Organisations	NO	This Journal is excluded.	na	na
Communications of the ACM	YES	TS= (ethic*) AND DT= Article AND SO= "Communications of the ACM" AND PY= (2000-2017)	9	11
Journal of Computer-Mediated Communication	YES	TS= (ethic*) AND DT= Article AND SO= "Journal of Computer-Mediated Communication" AND PY= (2000-2017)	1	2
Journal of Online Behavior	NO	This Journal is excluded.	na	na
Computers and Society	NO	This Journal is excluded.	na	na
Information, Communication, and Society	NO	This Journal is excluded.	na	na
The Information Society	NO	This Journal is excluded.	na	na
New Media and Society	NO	This Journal is excluded.	na	na
Journal of Social Science Research	NO	This Journal is excluded.	na	na
	Total		65	1744

Root results are without wildcard(“ethic”) and wildcard results are with wildcard(“ethic*”).

Appendix B: Types of Ethics Keywords.

keyword	occurrence		keyword	occurrence		keyword	occurrence
ethics	358		bioengineering ethics	1		ethics in decision making	1
bioethics	82		bioethical expertise	1		ethics in engineering design	1
research ethics	73		bioethical issues	1		ethics in higher education	1
engineering ethics	71		bioethics commissions	1		ethics in practice	1
ethics education	18		bioethics committees	1		ethics in publishing	1
medical ethics	18		bioethics consultation	1		ethics in research	1
professional ethics	18		bioethics curriculum	1		ethics in scientific publications	1
code of ethics	17		biomedical ethics	1		ethics in technology development	1
ethical decision making	14		biomedical research ethics	1		ethics in the lab	1
ethics committee	14		business ethics literature	1		ethics knowledge	1
virtue ethics	14		care robot ethics	1		ethics manual	1
business ethics	13		clinical ethics committees	1		ethics of clinical trials	1
neuroethics	13		clinical ethics support	1		ethics of co-authorship	1
applied ethics	12		codes of engineering ethics	1		ethics of conviction	1
ethical issues	11		collegial ethics	1		ethics of design	1
computer ethics	8		communal ethics	1		ethics of engagement	1
environmental ethics	8		competence in ethics	1		ethics of ethics	1
publication ethics	8		conservation ethics	1		ethics of nanotechnology	1
information ethics	7		consulting ethicist	1		ethics of placebo	1
macroethics	7		corporate ethics	1		ethics of placebo use	1
science ethics	7		criminal justice ethics	1		ethics of responsibility	1
design ethics	5		critical business ethics education	1		ethics of risk	1

ethical	5		critical context-sensitive bioethics	1		ethics of risk communication	1
research ethics committee	5		cross-cultural ethics	1		ethics of science and technology	1
engineering ethics education	4		cyberethics	1		ethics of science education	1
ethic code	4		design ethics course	1		ethics pedagogy	1
ethical behavior	4		design ethics education	1		ethics regulation	1
ethical concerns	4		development of ethical beliefs	1		ethics reporting	1
ethical guideline	4		dialog ethic	1		ethics review	1
ethics across the curriculum	4		egoism ethics	1		ethics stress	1
ethics of technology	4		engineering codes of ethics	1		ethics websites	1
military ethics	4		engineering ethics courses	1		ethics, risk, and genetically modified food	1
public bioethics	4		ethical acceptability	1		eu ethics	1
teaching ethics	4		ethical and legal aspects	1		everyday ethics	1
clinical ethics	3		ethical and social dimensions of innovation	1		family ethics	1
discourse ethics	3		ethical approval	1		feminist care ethics	1
ecological ethics	3		ethical assessment	1		feminist engineering ethics	1
empirical ethics	3		ethical canons	1		genethics	1
ethical challenges	3		ethical change	1		global ethics	1
ethical dilemmas	3		ethical competence	1		health ethics	1
ethical duty	3		ethical conduct	1		history of engineering ethics	1
ethical principle	3		ethical criteria	1		infraethics	1
ethical reasoning	3		ethical design standards (edss)	1		integrating ethics	1

ethical responsibility	3		ethical development	1		integrity of ethics	1
ethical review	3		ethical dimensions of scientific research (edsr)	1		intensive care ethics	1
ethics and technology	3		ethical education	1		intergenerational ethics	1
ethics assessment	3		ethical evaluation	1		intertwinement of ethical and technical issues in engineering	1
ethics in science	3		ethical governance	1		intrinsic ethics	1
ethics of care	3		ethical hazards	1		intuitive ethics	1
microethics	3		ethical ideals	1		islamic bioethics	1
nanoethics	3		ethical indicators	1		laboratory ethics curriculum	1
scientific ethics	3		ethical information retrieval systems	1		laser ethics	1
bioethical principles	2		ethical insight	1		lay ethics	1
care ethics	2		ethical issues concerning rehabilitation robotics	1		legitimate goals of ethics teaching	1
embedded ethicist	2		ethical issues in ethnographic research	1		life science ethics	1
empirical bioethics	2		ethical judgment	1		macro- and micro-approaches in engineering ethics	1
ethical analysis	2		ethical justification	1		media coverage of bioethical issues	1
ethical climate	2		ethical leadership	1		meta-ethics	1
ethical considerations	2		ethical location	1		naturalistic ethics	1
ethical expertise	2		ethical matrix	1		nest-ethics	1
ethical framework	2		ethical measurement	1		normative ethics	1
ethical parallel research	2		ethical modernization	1		nursing ethics	1
ethical standards	2		ethical norms	1		occupational ethics	1

ethical thinking	2		ethical obligations	1		post-doctoral ethics education	1
ethics cases	2		ethical perceptions	1		postcolonial bioethics	1
ethics consultation	2		ethical performance	1		practical and professional ethics	1
ethics of architecture	2		ethical pluralism	1		president's council on bioethics	1
ethics of robotics	2		ethical problem solving	1		procedural ethics	1
ethics of science	2		ethical ranking model	1		professional ethics code	1
ethics policy	2		ethical reflection	1		publishing ethics	1
ethics research	2		ethical relativism	1		religious ethics	1
ethics support	2		ethical research	1		research agenda for engineering ethics	1
ethics teaching	2		ethical science	1		research agenda for ethics in engineering	1
ethics training	2		ethical scientist	1		research and publication ethics	1
feminist ethics	2		ethical sensitivity	1		research bioethics	1
global bioethics	2		ethical situationism	1		research ethics' africa	1
hospital ethics committees	2		ethical stem cells	1		research on engineering ethics	1
international research ethics	2		ethical systems	1		robo-ethics	1
land ethic	2		ethical theory	1		science and engineering ethics	1
modern virtue ethics	2		ethical virtues	1		science ethics course	1
policy/ethics	2		ethical, legal, and social issues	1		science ethics education	1
practical ethics	2		ethico-legal	1		scientific vs. ethical aspects	1
pragmatic ethics	2		ethics activities	1		scientist's code of ethics	1
professional codes of ethics	2		ethics and business	1		social and ethical aspects	1

public health ethics	2		ethics and experimental social psychology	1		societal and ethical issues	1
research ethics boards	2		ethics and morality	1		sociology of bioethics	1
research ethics education	2		ethics and publication	1		survival ethics	1
robot ethics	2		ethics and social responsibility	1		survival ethics model	1
social ethics	2		ethics and technology assessment	1		teaching engineering ethics	1
technology ethics	2		ethics approval	1		teaching ethics to engineers	1
unethical behavior	2		ethics breaches	1		teaching medical-ethics	1
academic ethics	1		ethics by design	1		teaching-research ethics	1
animal ethics	1		ethics case analysis	1		team science ethics	1
animal research ethics	1		ethics consultation service	1		theoretical ethics	1
anticipatory ethics	1		ethics courses	1		unethical conflict	1
architecture ethics	1		ethics expertise	1		unethical use	1
ascribed ethics	1		ethics guidelines	1		veterinary ethics	1

Appendix C: Final thesaurus file:

label	*replace by*	***label***	*replace by*	***label***	*replace by*
accounts	account	**games**	game	**preferences**	preference
acute myocardial-infarction	acute myocardial infarction	**gaps**	gap	**prenatal-diagnosis**	prenatal diagnosis
adolescents	adolescent	**generations**	generation	**principles**	principle
algorithms	algorithm	**genes**	gene	**problem-based learning (pbl)**	problem-based learning
arguments	argument	**genetic-modification**	genetic modification	**problem-solving**	problem solving
assessments	assessment	**genetically-modified foods**	genetically-modified food	**products**	product
anti-commons	anticommons	**global positioning systems**	global positioning system	**professional-responsibility**	professional responsibility
assisted reproductive technologies	assisted reproductive technology	**gm foods**	gm food	**professionals**	professional
attitudes	attitude	**graduate-students**	graduate student	**professions**	profession
benefit	benefit	**graduate students**	graduate student	**programs**	program
benefit-sharing	benefit sharing	**health-care**	health care	**projects**	project
beliefs	belief	**healthcare**	health care	**property-rights**	property rights

biases	bias	**healthcare access**	health care access	**public consultations**	public consultation
bio-economy	bioeconomy	**hiv vaccines**	hiv vaccine	**public-health**	public health
biological materials	biological material	**honor codes**	honor code	**public-opinion**	public opinion
biobanks	biobank	**human-dignity**	human dignity	**public perceptions**	public perception
biomedical-research	biomedical research	**human-genetics**	human genetics	**public policies**	public policy
brain-death	brain death	**human-genome**	human genome	**public-policy**	public policy
breast-cancer	breast cancer	**human-rights**	human rights	**public-policy**	public policy
case-studies	case studies	**human/animal chimeras**	human-animal chimera	**publications**	publication
capabilities approach	capability approach	**human-animal chimeras**	human-animal chimera	**quality-of-life**	quality of life
careers	career	**huntingtons-disease**	huntington's disease	**questionnaires**	questionnaire
challenges	challenge	**images**	image	**racial/ethnic disparities**	racial disparities
chemicals	chemical	**impacts**	impact	**randomisation**	randomization
co-authorship	coauthorship	**impact factors**	impact factor	**randomised control trials**	randomized control trials
child-development	child development	**in-vitro fertilization**	in vitro fertilization	**randomized controlled trials**	randomized control trials
choices	choice	**incidental findings**	incidental finding	**randomized controlled-trial**	randomized control trials

citations	citation	**individual-differences**	individual differences	**randomized controlled-trials**	randomized control trials
classrooms	classroom	**information-society**	information society	**recommendations**	recommendation
clients	client	**informed-consent**	informed consent	**reflections**	reflection
climate-change	climate change	**insights**	insight	**regulations**	regulation
of-climate-change	climate change	**intellectual property-rights**	intellectual property rights	**representations**	representation
clinical-research	clinical research	**intellectual property rights (ipr)**	intellectual property rights	**research articles**	research article
clinical-trial	clinical trial	**intensive-care**	intensive care	**research ethics committee (rec)**	research ethics committee
clinical-trials	clinical trial	**intensive-care units**	intensive care unit	**research ethics committees**	research ethics committee
clinical trials	clinical trial	**interfaces**	interface	**research relationships**	research relationship
codes	code	**interventions**	intervention	**research-and-development**	research and development
codes of conduct	code of conduct	**interviews**	interview	**responsibilities**	responsibility
codes of ethics	code of ethics	**interviews**	interview	**responsible conduct of research (rcr)**	responsible conduct of research
collaborations	collaboration	**investigators**	investigator	**retractions**	retraction
college-students	college students	**irbs**	irb	**rhetorics**	rhetoric

conflict of interests	conflict of interest	**issues**	issue	**risk-assessment**	risk assessment
conflicts of interest	conflict of interest	**jehovah-witnesses**	jehovah's witnesses	**risks**	risk
conflicts-of-interest	conflict of interest	**journals**	journal	**role-play**	role play
conflicts of interests	conflict of interest	**judgments**	judgment	**samples**	sample
conflicts	conflict	**lasers**	laser	**schools**	school
consultations	consultation	**laws**	law	**science-education**	science education
constructions	construction	**maqasid al-shariah**	maqasid al-shari'ah	**sciences**	science
contexts	context	**materials**	material	**scientists**	scientist
constructive technology-assessment	constructive technology assessment	**mechanisms**	mechanism	**service-learning**	service learning
controversies	controversy	**medical-education**	medical education	**simulations**	simulation
committees	committee	**medical-ethics**	medical ethics	**situations**	situation
costs	cost	**medical-records**	medical records	**social-justice**	social justice
community-based research	community based research	**medical-research**	medical research	**social values**	social value
compensating wage differential (cwd)	compensating wage differentials	**medical technologies**	medical technology	**social-responsibility**	social responsibility
content-analysis	content analysis	**medicines**	medicine	**social sciences**	social science
conflict of interests	conflict of interest	**metaphors**	metaphor	**social-sciences**	social science

cultures	culture	**mixed-methods**	mixed methods	**socio-scientific issues**	socioscientific issue
databases	database	**models**	model	**spectrum disorders**	spectrum disorder
decisions	decision	**morals**	moral	**stakeholders**	stakeholder
decision-making	decision making	**moral economies**	moral economy	**standardisation**	standardization
decision-making models	decision-making model	**moral judgment/**	moral judgment	**states**	state
developing-countries	developing countries	**multi-author**	multi-authorship	**stem-cell research**	stem cell research
developing-world	developing world	**multiple authorship**	multi-authorship	**stem-cell science**	stem cell science
difficulties	difficult	**mutations**	mutation	**stem-cells**	stem cells
dilemmas	dilemma	**nanotechnologies**	nanotechnology	**students**	student
dimension	dimensions	**narratives**	narrative	**students perceptions**	student perceptions
diseases	disease	**national-security**	national security	**systems**	system
disasters	disaster	**national-survey**	national survey	**technological risks**	technological risk
donors	donor	**neonatal intensive-care**	neonatal intensive care	**technology-assessment**	technology assessment
down-syndrome	down syndrome	**networks**	network	**technology-transfer**	technology transfer
downs-syndrome	down syndrome	**non-directiveness**	nondirectiveness	**the netherlands**	netherlands
drug-discovery	drug discovery	**non-inferiority**	noninferiority	**the precautionary principle**	precautionary principle

dual-use	dual use	**north-america**	north america	**thresholds**	threshold
early-career researchers	early career researchers	**nuclear-waste**	nuclear waste	**traumatic brain-injury**	traumatic brain injury
drug-discovery	drug discovery	**nudges**	nudge	**trials**	trial
ethical principles	ethical principle	**obligations**	obligation	**united-kingdom**	united kingdom
embryos	embryo	**old-age**	old age	**united-states**	united states
emerging technologies	emerging technology	**online courses**	online course	**units**	unit
end-of-life decisions	end of life decisions	**opinions**	opinion	**vaccinations**	vaccination
enhancements	enhancement	**organ donations**	organ donation	**vaccine trials**	vaccine trial
ethical decision-making	ethical decision making	**organisations**	organization	**value-sensitive design**	value sensitive design
engineering-education	engineering education	**organizations**	organization	**value-sensitive design (vsd)**	value sensitive design
ethics committees	ethics committee	**paradigms**	paradigm	**values**	value
ethical-issues	ethical issues	**partnerships**	partnership	**virtues**	virtue
ethical frameworks	ethical framework	**patents**	patent	**whistleblowing**	whistle blowing
ethical guidelines	ethical guideline	**patients' rights**	patient rights	**worlds**	world
ethical principles	ethical principle	**peer-review**	peer review	**young-people**	young people
ethical reviews	ethical review	**perceptions**	perception		
ethics codes	ethic code	**personalised medicine**	personalized medicine		

ethics code	ethic code	**perspectives**	perspective
ethic codes	ethic code	**pharmaceutical-industry**	pharmaceutical industry
ethics policies	ethics policy	**physician-patient-relationship**	physician-patient relationship
ethical reviews	ethical review	**physicians**	physician
expectations	expectation	**placebo-control**	placebo control
experiences	experience	**placebo-controlled trial**	placebo controlled trial (pct)
failures	failure	**placebos**	placebo
focus groups	focus group	**policy-analysis**	policy analysis
frameworks	framework	**populations**	population

Appendix D: Whole map of author keywords

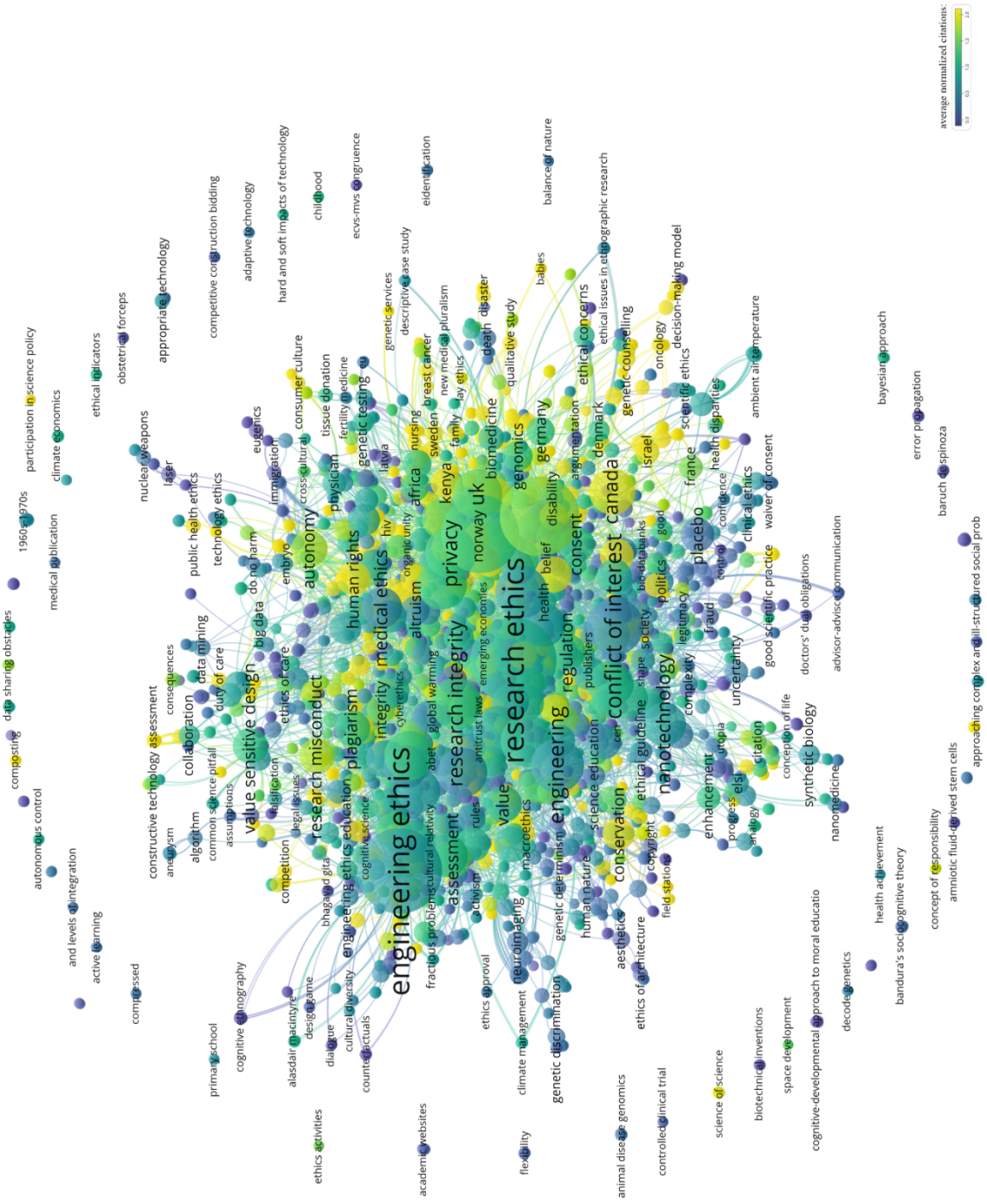

Figure 34. Whole map of author keywords. Colors indicate citation popularity.

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