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The three dimensions of informetrics: a conceptual view

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The three
dimensions of
informetrics

295

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Abstract

Purpose – The aim of this paper is to propose a conceptual model of the field of informetrics. Specifically, the paper argues that informetrics comprises the study of entities in three dimensions: the social, documentary and epistemic dimensions containing respectively agents, documents, and concepts or cognitions.

Design/methodology/approach – The paper outlines a conceptual model, drawing on earlier work by Kochen, Leydesdorff, Borgman and others. Subsequently, each dimension and interdimensional relation is analyzed and discussed.

Findings – It is shown that not every study necessarily involves each of the three dimensions, but that the field as a whole cannot be reduced to one or two of them. Moreover, the dimensions should be kept separate but they are not completely independent. The paper discusses what kinds of relations exist between the dimensions. Special attention is given to the nature of the citation relation within this framework. The paper also considers the place of concepts like mapping, proximity and influence in the model.

Research limitations/implications – This conceptual paper is a first step. Multi-relational networks may be a key instrument to further the study of the interplay between the three dimensions.

Originality/value – The paper provides a framework to characterise informetric studies and makes the characteristics of the field explicit.

Keywords Informetrics, Bibliometrics, Citations, Entity-relationship model, Conceptual models, Information, Information retrieval

Paper type Conceptual paper

1. Introduction

What are the study objects (or units of analysis) of informetrics? What kinds of entities are studied in informetric research? The answers to these questions are useful to characterise informetric research, contrast it with related disciplines and discover underrepresented areas of informetrics. Furthermore, it may offer another perspective on questions regarding the nature of citations. Finally, as argued by McGrath (1996), clarifying exactly which objects are being studied is necessary to avoid misconceptions.

We argue that, on a high level, informetrics studies entities and relations in three dimensions:

- (1) the documentary dimension (documents);
- (2) the social dimension (people and groupings of people); and
- (3) the epistemic or cognitive dimension (topics and ideas).

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This general idea is not new; as we will see, it has regularly come up in the literature during the past four decades.

The word “dimension” is not intended to be understood in a rigorous, mathematical, sense. Rather, it functions as a quasi-synonym to “realm” or “domain”. We use the term “dimension” to avoid confusion with study domains (cf. Hjørland and Albrechtsen, 1) and to stress that these dimensions are separate. However, they are not completely orthogonal, – the documentary dimension can influence the social dimension, the epistemic dimension influences the documentary one, and so on. More specifically, it is possible, and in fact quite common, that relations occur between entities from different dimensions.

In this article, we take an entity–relationship view of informetrics. Originally introduced by Chen (1976), entity–relationship (E–R) modelling is nowadays a standard technique in database design. Similar diagrams are used in object-oriented programming and for knowledge representation and ontology development. These diagrams consist of entities, relations, and attributes. An entity is any “thing” about which one wants to record information. Informetric examples include authors, universities, journals and so on. Entities can be connected by relations: authors write articles, universities employ researchers, journals contain articles... Most relations involve two entities, although n -ary relations (connecting three or more entities) occasionally occur. Finally, entities and relations may have attributes; these are literal string values, such as a journal’s ISSN, an author’s name or an article’s keywords. It is up to the modeller to determine if something is an entity or a relationship. For instance, citations are regularly regarded as relations –, e.g. in citation networks –, but if one studies for instance citation contexts, it makes sense to see the citation as an independent entity. The important point here is that there is no single “right” model of informetrics: it depends on the modeller’s goals.

The remainder of the article is structured as follows. The next section provides a brief review of existing models of the content of informetrics. These point to a division into three dimensions, which are discussed in section 3. Section 4 looks at relations between entities, both within a dimension and between different dimensions. Section 5 contains a further discussion of some special topics and section 6 presents the conclusions.

2. Content models of informetrics: a literature review

The proposed model of informetrics as a discipline involving three dimensions is not new. In this section we present a brief overview of related earlier work.

Kochen (1974) proposes a conceptual model of the information (retrieval) universe. An adapted version is presented in Figure 1. Kochen’s model aims to elucidate the position of the information retrieval system in the information universe, but it is also remarkably applicable to informetrics. The model consists of three components: agents (people), documents, and topics. The components and relations in Figure 1 are abstract entities, – the “influences” relation, for instance, connects two agent entities. Each component is connected with itself and the two others; for instance, a document can be cited by other documents, is authored by one or more agents, and pertains to one or more topics. Clearly, these are ingredients that are highly relevant to informetrics: authorship and co-authorship, citations, topic distribution etc. are all central issues in

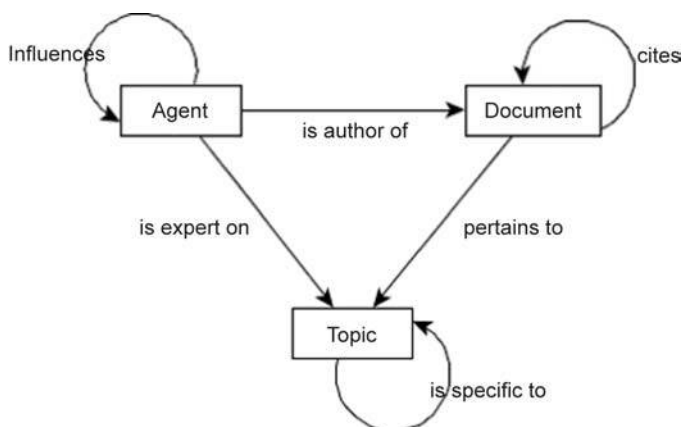


Figure 1.
Adaptation of Kochen's
(1974) conceptual model

informetrics. This illustrates that Kochen's model is also relevant outside of information retrieval.

Leydesdorff (1989, 2001) proposes that "science of science" is a multi-dimensional problem, where the three dimensions are scientists, texts and cognitions. The parallels to Kochen's (1974) model are quite clear: scientists are a kind of agents, texts correspond to documents, and cognitions reflect topics. Leydesdorff (1989) uses this three-dimensional model to clarify the distinction between information science, scientometrics and sociology of science. He positions scientometrics as the study area between scientists and texts, sociology of science between scientists and cognitions, and "information sciences" between cognitions and texts. We agree that the science of science is multi-dimensional but consider it problematic to leave cognitions out of scientometrics, since so much scientometric research precisely seeks to reveal the epistemic or cognitive structure of science.

Another model that is, again, quite similar, is proposed by Borgman (1990), who argues that there are three kinds of variables at play:

- (1) producers of communication (authors);
- (2) communication artefacts (documents); and
- (3) communication concepts (cognitions and epistemics).

Research involving communication concepts is subdivided into studies of author terminology and studies of citation motives.

In her review article on informetrics, Wilson (1999) devotes a lengthy section to "the content of informetrics". She presents a model where the basic unit of analysis is a collection of publications (or publication records). In the model, each publication has a number of properties (which correspond to E-R attributes) and maintains "quasi-links" to other entities like the journal and its authors. Wilson proposes that the only "real" links are the citations between publications; other relations are considered "indirect comparisons". While publications and citation relations are obviously important, in our opinion the model reduces agents and cognitions to second-rate ingredients without real justification. As we will argue, these entities are in fact central to many research areas in informetrics. Moreover, we see no need to

distinguish between “real” links and “quasi-links”; in an E–R view, these are simply different kinds of relationships.

Recently, Scharnhorst and Garfield (2010) characterised scientometrics as a field that studies (mainly) texts and actors. Their concept of texts roughly covers both our documentary and epistemic dimensions. Indeed, under texts they classify concepts like journals, journal articles, and references, which belong to the documentary dimension, as well as topics, paradigms, fields and disciplines, which belong to the epistemic dimension. Actors include authors, institutions and countries, and thus correspond well to the entities in the social dimension.

This short overview illustrates that different authors at different times have come to roughly similar conclusions regarding the study objects of informetrics (or related fields like bibliometrics or scientometrics). We will argue for the general model advocated by Kochen (1974), Leydesdorff (1989, 2001) and Borgman (1990): a division into three broad areas, encompassing social, documentary and epistemic entities.

Before turning to a more in-depth discussion, we want to point out that a similar distinction can also be found in information science literature outside of informetrics. The Functional Requirements for Bibliographic Records or, in short, FRBR (IFLA Study Group, 1998/2009) are a set of recommendations by the International Federation of Library Associations and Institutions (IFLA) that aim to modernise cataloguing in the light of today’s digital environment. FRBR is not a concrete implementation of a new cataloguing standard; rather, it is a conceptual model aimed at describing the “bibliographic universe”. At the highest level, FRBR distinguishes between three groups of entities that align well with the models discussed previously:

- (1) products of intellectual or artistic endeavour are documents in the broad sense;
- (2) persons or corporations (social entities) are responsible for the production and dissemination of entities from the first group; and
- (3) subjects of intellectual or artistic endeavour correspond to the epistemic dimension (what documents are about).

The fact that a set of cataloguing recommendations distinguishes the same three dimensions, coupled with the fact that Kochen’s model was originally intended for information retrieval, is remarkable. Could it be the case that the same three dimensions constitute not just the core of informetrics but all of library and information science? Although we will occasionally refer to information science as a whole, we do not actively pursue this line of thought here. We do, however, suggest it as a potentially fruitful perspective on the field in general.

In summary, the similarities between these models are not a coincidence but point to the base areas covered by (at least) informetrics.

3. The three dimensions

We propose, following earlier work, that informetrics studies entities and relations in three dimensions: the documentary, the social, and the epistemic dimension. Let us now discuss each of the three dimensions in greater detail. Each of the following subsections first characterises the kind of entities to be found in the discussed dimension, subsequently sketches how this dimension is important to information science in general, and finally reviews its importance to informetrics in particular.

3.1 *The documentary dimension*

The entities in the documentary dimension are documents. According to a long-standing tradition in information science (Buckland, 1997; Briet, 1951), a “document” is much broader than the traditional concept of printed, textual material. Any object that records data or knowledge in some form (written, printed, spoken, visual. . .) can be considered a document. Thus, documents may include photographs, e-mail messages, database records, maps, music sheets, voice recordings etc. As such, our use of the word “document” corresponds to Buckland’s (1991) “information as thing”: a document is an object that is informative.

The importance of documents to information science in general is uncontroversial: indeed, the field itself was called documentation (both in English and French) during roughly the first half of the twentieth century (Kline, 2004), suggesting an intimate relation between information science on the one hand and documents on the other. Many traces of this early name have persisted much longer, for instance in the *Fédération Internationale de Documentation* or the *Journal of Documentation*. (The term “information science” is much younger and first formally used in 1958, when Jason Farradane and colleagues established the Institute of Information Scientists in the UK.) This close relation between documents and information science is due to the fact that documents are primary carriers of information: knowledge is to a very large extent communicated through documents.

When looking specifically at informetrics, it is tempting to state that informetrics is obviously concerned with documents, simply by pointing at the number of studies concerned with documents such as articles, patents, journals, web pages and other documents. However, one should keep in mind that informetrics also covers aspects that do not draw directly on documents (e.g. some economic aspects). Tague-Sutcliffe (1992) considers *informetrics* the encompassing term and reserves the term *bibliometrics* for “the study of the quantitative aspects of the production, dissemination and use of recorded information” (emphasis mine). The same view is carried over into the model of Björneborn and Ingwersen (2004), who consider some parts of scientometrics (e.g. science policy) and cybermetrics (e.g. internet traffic) to be outside the scope of bibliometrics – that is, not dependent on documents. We do not consider this to be in opposition to our own views regarding the importance of the documentary dimension in informetrics: not every single research project or publication necessarily draws on all three dimensions.

The elements of the first dimension are intentionally broadly defined. To a very large extent, research in informetrics is concerned with only a few document types (articles, journals, patents, conference papers) but it would be reductionist to exclude any particular document type a priori. To illustrate this, imagine an attempt in 1990 to exhaustively list the document types relevant to informetrics. Obviously, the list would not have contained Web documents – hence, webometrics would have been excluded, although it is nowadays a small but important part of informetrics. However, a general characterisation such as the one given here does include such new developments, even if they cannot yet be foreseen. More generally, there are no document types that are a priori unsuitable to informetric research. After all, Tague-Sutcliffe (1992) defines informetrics as “the study of the quantitative aspects of information in any form, not just records or bibliographies, and in any social group, not just scientists” (emphasis mine).

3.2 *The social dimension*

The social dimension involves people, such as authors, editors, reviewers, library users etc., and how they interrelate. People are often part of larger groupings, which can be official and structural – such as organisations, universities or companies – or *ad hoc* groupings. To some extent, countries as well can be considered social constructs.

The social dimension is important to information science; this can be seen by asking questions like “whose knowledge is concerned?”, “to whom is this information relevant?” and so on. Put another way, information is produced by and for humans and institutions, consumed by humans and institutions, disseminated by humans and institutions. . . . There is little doubt that the social dimension is highly relevant to information science as a whole and even gaining in importance (Cronin, 2008).

In informetrics, all studies that try to rank authors, institutions or countries touch on the social dimension. So does research involving the use of information (downloads, library usage) or the sociology of scientific or Web communities (e.g. collaboration, invisible colleges). Most informetric research with an emphasis on the social dimension focuses on the producers of information (i.e. authors), but this is not a necessity: indeed, there also exists research on reviewers, editorial board members etc. (e.g. Frandsen and Nicolaisen, 2010).

Fairly recently, informetric research has imported many concepts and techniques from the field of social network analysis or SNA (e.g. Otte and Rousseau, 2002). We suggest that this is due to two factors:

- (1) the success of social network analysis in explaining and clarifying many issues that are also at play in informetrics (e.g. who is important or central?); and
- (2) a growing awareness of the social dimension.

Indeed, the nodes in these networks are very often social entities (researchers, universities etc.). On the other hand, some researchers also study networks of documentary or epistemic entities using SNA techniques (e.g. Bollen *et al.* 2006; Ding *et al.*, 2001).

3.3 *The epistemic dimension*

The epistemic dimension refers to the dimension of topics, ideas and concepts and corresponds to Buckland’s (1991) “information as knowledge”. While harder to pinpoint than the other two dimensions, the epistemic dimension is a crucial component. After all, information is (hopefully) not produced for the sake of itself, but because it is interesting or relevant to a group of people at some point in time. The epistemic dimension thus determines to a large extent which information will be communicated, reproduced and ultimately built upon in the creation of new information.

The epistemic dimension is especially strong in areas of information science that are related to knowledge organisation and knowledge organisation systems. Indeed, thesauri, classifications, taxonomies and folksonomies are all representations of a domain’s epistemics: the concepts used and the relations between them.

Although the exact delineation of entities may pose problems in any dimension, this is especially difficult in the epistemic dimension. The nature of concepts is problematic (Stock, 2010) and epistemic entities are subject to change (Tennis, 2002). Even more fundamentally, it has been argued that any form of categorisation is ultimately

miscellaneous (Weinberger, 2007). In our current framework, this means that there is no single correct delineation of epistemic entities.

When considered from an informetric point-of-view, the epistemic dimension is harder to perceive and measure than the other two dimensions. Nonetheless, researchers have devised different methods of operationalising the epistemic dimension – much informetric research is actually concerned with the general problem of how the epistemic dimension can be “made visible”. Perhaps the most direct approximation of a document’s epistemics is based on words and co-words as they occur in the title, abstract and/or full text of the document (cf. studies of terminology as mentioned by Borgman (1990)). Techniques like Latent Semantic Analysis (Deerwester *et al.*, 1990; Dumais, 2004) build upon simple word occurrences and co-occurrences to more accurately model a document’s epistemics. Another approach tries to approximate epistemic relations between documents or social actors on the basis of citation links. These will be discussed in the next part, where we look at the relations within and between the three dimensions.

As we previously mentioned, Scharnhorst and Garfield (2010) do not distinguish between the documentary and the epistemic dimensions, which are both gathered under the heading of “texts”. Their example research questions for the “texts” unit of analysis, however, all fall in the epistemic rather than the documentary dimension: these include issues such as topics, paradigms, knowledge flows, research fronts etc. This raises the question to what extent informetrics is concerned with questions regarding the documentary dimension in and of itself. It seems that very often documents are only used as a necessary proxy to approach the epistemic or social structures. Nevertheless, some purely documentary research does exist, such as studies on the informetric distributions (Egghe, 2005), the growth of information production (Morris and Yen, 2005), network structures in citation networks (Fang and Rousseau, 2001; Egghe and Rousseau, 2002) etc. Note, however, that explanations of the found regularities may still refer to epistemic and/or social factors (such as cumulative advantage, the Matthew effect, visibility...).

4. Relations within and between the dimensions

Entities do not exist in isolation. Instead, they are typically connected to many other entities, both of the same type and of other types. To a very large extent, informetric research focuses on these relations, their regularities and correlations, their evolution, and appropriate ways of characterising them by, for instance, indicators.

In general, we distinguish between relations within a dimension and relations between dimensions. A relation within a dimension connects two entities that belong to the same dimension (e.g. two authors, or an author and an institution), whereas a relation between two dimensions connects entities from two different dimensions (e.g. a topic and a paper).

4.1 Hierarchical relations

Entities in each dimension can be organised hierarchically – in practice, this is almost always the case. These hierarchical relations are based on hyponymy (“is a kind of”) or meronymy (“is a part of”) (see Stock, 2010). Hierarchical relations are always relations within a dimension. In the social dimension, people often form part of organisations, companies, countries etc. In the epistemic dimension, the hierarchical structure is

reflected in the structure of classifications and thesauri. Specifically with regard to scientometrics, we can discern a rough hierarchical structure from field over discipline and specialty to topic or niche. One example is: life sciences → biology → anatomy → anatomy of the respiratory system. Finally, in the documentary dimension, hierarchical structure is exhibited in journal-article relations, as well as series → book → chapter or conference series → conference → paper.

The importance of these hierarchical relations lies therein that they form the basis of aggregations. Rather than looking at, say, each cited and citing paper separately, we aggregate them into quantified groups (e.g. articles in a specific cited or citing journal). This forms the basis of virtually all scientometric indicators, such as the impact factor and the h-index.

4.2 Relations between the social and documentary dimensions

The main relation type between the social and documentary dimension is the creation or responsibility relation: social entities (agents) create documents. This relation is, in fact, even the basis of the FRBR guidelines' definition of group 2, their equivalent of the social dimension. Collaborations are in principle relations within the social dimension. However, they are often approximated by co-authorship relations, evidenced by documents that are created by two or more agents.

In the opposite direction, from the documentary to the social dimension, we find an important but not directly perceivable influence relation: documents are read (or, more generally, "consumed") by agents and, hence, they may influence agents. One of the key challenges of informetrics is finding ways of making such influences visible and measurable. Citations are the most well known "reflection" of intellectual influence, but they have some downsides:

- citations may also reflect interactions in the social dimension (see the section on citations);
- influence only becomes visible if the influenced agent subsequently publishes a document that cites the original document; and
- because citing requires the publication of a new document, citations are relatively slow.

For these reasons researchers try to find other ways of tracing the influence of documents on agents, e.g. through usage bibliometrics (Kurtz and Bollen, 2010), which includes library transactions and article downloads.

4.3 Relations between the social and epistemic dimensions

Kochen (1974) drew an "is expert on" relation from the social to the epistemic dimension. More generally, one could say that relations between the social dimension and the epistemic dimension are, very broadly, "knows of" relations. We propose that the "knows of" relation is graded: there exists a continuum ranging from "notions of" via "is well acquainted with" to "is an expert on" through to "is the founding father of". Many of these are, scientometrically speaking, not very interesting: one typically does not care if some agent has only vague notions of some concept. This is not necessarily the case for all areas of information science (or other fields); the presence of notions of a certain subject may, e.g. influence a research subject's information seeking behaviour.

This relation is invisible until an agent publishes a document. Note that, since “document” should be understood in a broad sense, agents may also reveal their knowledge of a concept through, e.g. a message to a mailing list or a blog post. Publication of a document on a subject requires at least some basic knowledge of the subject in question. This means that we automatically lose some part of the continuum: those who are only superficially acquainted with a given subject, are highly unlikely to publish a document on it. This loss of information is, if anything, a good thing for informetric research, since the missing part can only obscure the more important relations between the social and the epistemic dimensions.

The interplay between the social and epistemic dimensions is rather complex. Researchers that study the same topic are automatically more likely to know each other, to collaborate etc. At the same time, researchers who are socially related (e.g. because they belong to the same institution) have a much higher chance of influencing each other’s ideas.

4.4 Relations between the documentary and epistemic dimensions

The main relation between the documentary and the epistemic dimension is the “is about” relation, which connects documentary entities (documents) with epistemic entities (concepts). In other words, these are relations expressing the subject or aboutness of documents. In extreme cases, a document can become the symbol of a certain concept (Small, 1978): here, the relation between the documentary and the epistemic dimension is virtually one-on-one[1]. In less extreme cases, one document may be about several concepts. Looking at the same relation from the other side, we see that virtually each concept is represented in a multitude of documents.

As we have discussed earlier, the main problem is that these relations cannot be directly perceived. If we adopt the operationalisation of an epistemic entity as a word or phrase[2], one can draw explicit relations between documents and concepts. Such relations can even be quantified with the number of occurrences of a concept in a document or with more advanced measures like TF-IDF.

Two documents are connected by a secondary relation if they share one or more concepts. We can then say they are epistemically related. Another way in which researchers have tried to determine epistemic linkages between documents is through citation analysis. Given the importance of citations to informetrics, we discuss this kind of relations separately.

4.5 Citations

The citation relation is a relation within the documentary dimension, connecting two documents. Citation analysis is one of the most studied subjects in informetrics. Among the many issues is the question what a citation means or represents. We suggest that citations reflect relations in the other two dimensions. This is implicitly present in Kochen’s model (Figure 1): one agent influencing another one or one topic being relevant to another one (note that both are relations within their respective dimensions) may lead to a citation relation within the documentary dimension.

On a high level, one distinguishes between two major functions of citations: as a reward and for persuasion (Davis, 2009; White, 2004). A citation-as-reward can be considered a reward for the cited author, an acknowledgement to his or her intellectual work. One of the main problems with this view is negative citations, which criticise the

cited work. However, both “rewarding” (positive) and negative citations are documentary reflections of processes in the epistemic dimension. Citations-as-persuasion, on the other hand, are a kind of rhetorical device, used to persuade one’s peers of one’s arguments. They do not map as clearly to either the epistemic or social dimension, although they generally seem more social in nature. For instance, Cronin (1984) mentions the function of identity formation, which is clearly social in nature.

Research by Brooks (1986) suggests that the dichotomous nature of the “persuasion or reward” debate is a simplification and that in many cases both the epistemic and the social dimension may play a role in citations. This makes it exceedingly difficult to study the epistemic or social nature of citations in isolation; after all, how can one be sure which dimension is at play? We give one recent example. Larivière and Gingras (2010) examine duplicate publications, cases where the same article is published in two different journals. They find that articles published in the more prestigious journal (the one with the higher impact factor) gain significantly more citations than their counterparts. These authors are thus able to separate effects of the social dimension from those of the documentary dimension.

Much of informetrics implicitly assumes epistemic reasons for citation. This is the case for impact analysis on the basis of citations, an application that has also met substantive criticism (MacRoberts and MacRoberts, 1996): some researchers doubt that citations primarily reflect the epistemic dimension. The assumption of epistemic reasons for citation also underlies (citation-based) science mapping: visualising the structure of science on the basis of citations implies that citations adequately represent epistemic linkages. Only if we assume this general principle can it be the case, for instance, that author (co-citation) maps “reveal the “cognitive” or “intellectual” structure of a field” (White, 1990). White also indicates a more social aspect in that such maps may also reflect “common nationality, temporal conjunctions, teacher-student relationships, collegial and co-author relationships, or common philosophical orientations”. Results suggest that, at least on the aggregated level, citations can be used as an operationalisation of epistemic structure. White (2001), for instance, argues that “within its limits, citation analysis works”. Another example is the fact that most science maps exhibit a similar macro-structure (Klavans and Boyack, 2009).

5. Discussion

The issue of mapping deserves special attention. At least two of the dimensions – the social and epistemic one – can be considered as virtual spaces, where entities can be close or far apart. In other words, one can determine distance and proximity in these dimensions. Boschma (2005) distinguishes between five forms of proximity (see also Frenken *et al.*, 2009):

- (1) geographical;
- (2) cognitive;
- (3) social;
- (4) organisational; and
- (5) institutional.

Cognitive proximity is identical to our concept of proximity in the epistemic dimension. Proximity in the social dimension encompasses Boschma's social, organisational and institutional proximity. Again, we stress that many studies of the social and (especially) epistemic dimensions have only been able to determine proximities (and consequently create maps) by looking at the third, documentary dimension. It should be noted that the unit of analysis could belong to a dimension other than the dimension we are trying to map; e.g. author co-citation analysis tries to map social entities in epistemic space.

In the preceding paragraphs, we have already touched a few times upon the subject of influence. This is not a coincidence; influence is a multi-faceted notion that touches upon the three dimensions. Essentially, influence happens in the epistemic dimension – one idea, concept or theory helping to shape or reshape another. This, however, needs the social dimension to function: concepts influence each other via agents. Very often, but not necessarily, these agents use documents as a means of communicating their current epistemological state, since documents help to disseminate the ideas to a much wider audience. Moreover, documents also show the clearest traces of influence in the citation relation. Cases that do not directly involve documents for influence include, for instance, the PhD student and her supervisor, two colleagues meeting and exchanging ideas at a conference, and so on.

One issue which has to date not yet been thoroughly examined is the question how one can best study the interplay of the three dimensions. On the basis of our E–R model we suggest that so-called multi-relational networks may provide a key. Multi-relational networks connect entities of different kinds (agents, documents and concepts) using different relation types (citation, creation, aboutness...). In other words, entities and relations are not just abstract ideas, they can be implemented in practice. Although multi-relational networks are not part of the standard informetric toolbox, some existing studies illustrate their potential for informetric research (e.g. Guns, 2010; Morris and Yen, 2005; Yan *et al.*, 2011).

6. Conclusion

In summary, informetrics studies the interplay of the social, the documentary, and the epistemic dimensions. These dimensions should be kept separate but they are far from completely independent. Each dimension is affected by the other two through direct relations, such as the creation relation from the social to the documentary dimension. There also exist more subtle, indirect relations, – for instance, social relations (relations within the social dimension) may be reflected in the documentary citation relation. Multi-relational networks are a promising tool to study the interplay of these dimensions.

The conceptual framework put forward in this paper clarifies the importance of each dimension to the field of informetrics. Informetrics cannot be reduced to one or two of the dimensions mentioned: a full account of informetrics should take all three dimensions into account.

Notes

1. A document that functions as a concept symbol may well deal with several concepts and ideas. The one-on-one relationship refers mainly to its reception (how it is viewed by subsequent publications).

2. These words or phrases may be keywords, title words, full-text phrases, may be stemmed or not. . . Generally speaking, using words as an approximation of epistemics is relatively easy and practical, but not ideal. The reasons are well known: homonymy, synonymy, language issues etc.

References

- Björneborn, L. and Ingwersen, P. (2004), "Toward a basic framework for webometrics", *Journal of the American Society for Information Science and Technology*, Vol. 14 No. 55, pp. 1216-27.
- Bollen, J., Rodriguez, M.A. and Van de Sompel, H. (2006), "Journal status", *Scientometrics*, Vol. 69 No. 3, pp. 669-87.
- Borgman, C.L. (1990), "Editor's introduction", in Borgman, C.L. (Ed.), *Scholarly Communication and Bibliometrics*, Sage, London, pp. 10-27.
- Boschma, R.A. (2005), "Proximity and innovation: a critical assessment", *Regional Studies*, Vol. 39 No. 1, pp. 61-74.
- Briet, S. (1951), *Qu'est-ce que la documentation?*, Editions Documentaires Industrielles et Techniques, Paris.
- Brooks, T.A. (1986), "Evidence of complex citer motivations", *Journal of the American Society for Information Science*, Vol. 37 No. 1, pp. 34-6.
- Buckland, M. (1991), "Information as thing", *Journal of the American Society for Information Science and Technology*, Vol. 42 No. 5, pp. 351-60.
- Buckland, M. (1997), "What is a document?", *Journal of the American Society for Information Science*, Vol. 48 No. 9, pp. 804-9.
- Chen, P.P. (1976), "The entity-relationship model – toward a unified view of data", *ACM Transactions on Database Systems*, Vol. 1 No. 1, pp. 3-6.
- Cronin, B. (1984), *The Citation Process. The Role and Significance of Citations in Scientific Communication*, Taylor Graham, London.
- Cronin, B. (2008), "The sociological turn in information science", *Journal of Information Science*, Vol. 34 No. 4, pp. 465-75.
- Davis, P.M. (2009), "Reward or persuasion? The battle to define the meaning of a citation", *Learned Publishing*, Vol. 22 No. 1, pp. 5-11.
- Deerwester, S.C., Dumais, S.T., Landauer, T.K., Furnas, G.W. and Harshman, R.A. (1990), "Indexing by latent semantic analysis", *Journal of the American Society of Information Science*, Vol. 41 No. 6, pp. 391-407.
- Ding, Y., Chowdhury, G.G. and Foo, S. (2001), "Bibliometric cartography of information retrieval research by using co-word analysis", *Information Processing & Management*, Vol. 37 No. 6, pp. 817-42.
- Dumais, S.T. (2004), "Latent semantic analysis", *Annual Review of Information Science and Technology*, Vol. 38, pp. 189-230.
- Egghe, L. (2005), *Power Laws in the Information Production Process: Lotkaian Informetrics*, Elsevier, Amsterdam.
- Egghe, L. and Rousseau, R. (2002), "Co-citation, bibliographic coupling and a characterization of lattice citation networks", *Scientometrics*, Vol. V55 No. 3, pp. 349-61.
- Fang, Y. and Rousseau, R. (2001), "Lattices in citation networks: an investigation into the structure of citation graphs", *Scientometrics*, Vol. 50 No. 2, pp. 273-87.

- Frandsen, T.F. and Nicolaisen, J. (2010), "A lucrative seat at the table: are editorial board members generally over-cited in their own journals?", *Proceedings of the American Society for Information Science and Technology*, Vol. 47, pp. 1-8.
- Frenken, K., Hardeman, S. and Hoekman, J. (2009), "Spatial scientometrics: towards a cumulative research program", *Journal of Informetrics*, Vol. 3 No. 3, pp. 222-32.
- Guns, R. (2010), "Representation of scholarly activity as a multi-relational net-work: a case study", *Proceedings of the 11th International Conference on Science and Technology Indicators*, Poster presentation, pp. 113-114.
- Hjørland, B. and Albrechtsen, H. (1995), "Toward a new horizon in information science: domain-analysis", *Journal of the American Society for Information Science*, Vol. 46 No. 6, pp. 400-25.
- IFLA Study Group (1998/2009), *Functional Requirements for Bibliographic Records: Final Report*, available at: www.ifla.org/files/cataloguing/frbr/frbr_2008.pdf (accessed May 27, 2011).
- Klavans, R. and Boyack, K.W. (2009), "Toward a consensus map of science", *Journal of the American Society for Information Science and Technology*, Vol. 60, pp. 455-76.
- Kline, R.L. (2004), "What is information theory a theory of? Boundary work among information theorists and information scientists in the United States and Britain during the Cold War", in Rayward, W.B. and Bowden, M.E. (Eds), *The History and Heritage of Scientific and Technological Information Systems*, ASIST and the Chemical Heritage Foundation, Medford, NJ, pp. 15-28.
- Kochen, M. (1974), *Principles of Information Retrieval*, Melville Publishing Company, Los Angeles, CA, Hardcover.
- Kurtz, M.J. and Bollen, J. (2010), "Usage bibliometrics", *Annual Review of Information Science and Technology*, Vol. 44, pp. 3-64.
- Larivière, V. and Gingras, Y. (2010), "The impact factor's Matthew effect: a natural experiment in bibliometrics", *Journal of the American Society for Information Science and Technology*, Vol. 61 No. 2, pp. 424-7.
- Leydesdorff, L. (1989), "The relations between qualitative theory and scientometric methods in science and technology studies", *Scientometrics*, Vol. 15 No. 5, pp. 333-47.
- Leydesdorff, L. (2001), *The Challenge of Scientometrics. The Development, Measurement, and Self-Organization of Scientific Communications*, 2nd ed., Universal Publishers, Boca Raton, FL.
- MacRoberts, M.H. and MacRoberts, B.R. (1996), "Problems of citation analysis", *Scientometrics*, Vol. 36 No. 3, pp. 435-44.
- McGrath, W. (1996), "The unit of analysis (objects of study) in bibliometrics and scientometrics", *Scientometrics*, Vol. 35 No. 2, pp. 257-64.
- Morris, S.A. and Yen, G.G. (2005), "Construction of bipartite and unipartite weighted networks from collections of journal papers", available at: <http://arxiv.org/abs/physics/0503061>
- Otte, E. and Rousseau, R. (2002), "Social network analysis: a powerful strategy, also for the information sciences", *Journal of Information Science*, Vol. 28 No. 6, pp. 441-53.
- Scharnhorst, A. and Garfield, E. (2010), "Tracing scientific influence", *Dynamics of Socio-Economic Systems*, Vol. 2 No. 1, pp. 1-33.
- Small, H.G. (1978), "Cited documents as concept symbols", *Social Studies of Science*, Vol. 8 No. 3, pp. 327-40.
- Stock, W.G. (2010), "Concepts and semantic relations in information science", *Journal of the American Society for Information Science and Technology*, Vol. 61 No. 10, pp. 1951-69.

- Tague-Sutcliffe, J. (1992), "An introduction to informetrics", *Information Processing & Management*, Vol. 28 No. 1, pp. 1-3.
- Tennis, J.T. (2002), "Subject ontogeny: subject access through time and the dimensionality of classification", *Proceedings of the Seventh International ISKO Conference, Granada, Spain, July 10-13, 2002, Advances in Knowledge Organization, 8, Würzburg: Ergon*, pp. 54-59.
- Weinberger, D. (2007), *Everything is Miscellaneous: The Power of the New Digital Disorder*, Holt, New York, NY.
- White, H.D. (1990), "Author co-citation analysis: overview and defense", in Borgman, C.L. (Ed.), *Scholarly Communication and Bibliometrics*, Sage, London, pp. 84-106.
- White, H.D. (2001), "Authors as citers over time", *Journal of the American Society for Information Science and Technology*, Vol. 52 No. 2, pp. 87-108.
- White, H.D. (2004), "Reward, persuasion, and the Sokal hoax: a study in citation identities", *Scientometrics*, Vol. 60 No. 1, pp. 93-120.
- Wilson, C.S. (1999), "Informetrics", *Annual Review of Information Science and Technology*, Vol. 34, pp. 107-247.
- Yan, E., Ding, Y. and Sugimoto, C.R. (2011), "P-rank: an indicator measuring prestige in heterogeneous scholarly networks", *Journal of the American Society for Information Science and Technology*, Vol. 62 No. 3, pp. 467-77.

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