EXPLORING THE MODELLING & SIMULATION KNOWLEDGE BASE THROUGH JOURNAL CO-CITATION ANALYSIS

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Abstract: Co-citation analysis is a form of content analysis that can be applied in the context of scholarly publications with the purpose of identifying prominent articles, authors and journals being referenced to by the *citing* authors. It identifies co-cited references that occur in the reference list of two or more citing articles, with the resultant co-citation network providing insights into the constituents of a knowledge domain (e.g., significant authors and papers). The contribution of the paper is twofold; (a) the demonstration of the added value of using co-citation analysis, and for this purpose the underlying dataset that is chosen is the peer-reviewed publication of the *Society for Modeling and Simulation International (SCS) - SIMULATION;* (b) the year 2012 being the 60th anniversary of the SCS, the authors hope that this paper will lead to further acknowledgement and appreciation of the Society in charting the growth of Modeling & Simulation (M&S) as a discipline.

Keywords: Modelling and Simulation (M&S)**;** Co-citation Analysis; Simulation Research; Society for Modeling and Simulation International, SIMULATION: Transactions of the Society for Modeling and Simulation International

1. INTRODUCTION

The Society for Modeling and Simulation International (SCS) is a technical society that is devoted to furthering the field of Modeling and Simulation (M&S) (SCS, 2013). Since its inception in 1952, the Society has widely disseminated the advancements in this field through its peer-reviewed journals (*SIMULATION: Transactions of The SCS*; *Journal of Defense Modeling and Simulation: Applications, Methodology, Technology*), conferences (for e.g., the *Spring and the Summer Simulation Multi-conferences*) and its newsletter and magazines publications (*SCS M&S Magazine*; *SCS M&S Newsletter*). The 60th anniversary of the Society was held in the year 2012, and we believe that a fitting tribute to those "scientists and engineers, who had actively shaped and influenced the growth and development of SCS and continue to contribute to the theory, methodology, and applications of simulation science" (Yilmaz, 2011) would be to perform a form of content analysis that would seek to identify important publications and the authors that can be regarded as having made significant contribution to the field of M&S. In a previous publication associated with the 60th anniversary of the Society, the authors have presented a review of papers published in the Society's journal *Simulation: Transactions of the SCS* (Mustafee et al., 2012).

The content analysis that is presented in this paper is *co-citation analysis;* we present a visualisation-based analysis of bibliographic data downloaded from the from the ISI Web of Science (Thomson Scientific Solutions, 2013) and is an approach similar to that used by Niazi and Hussain (2011), Zhao and Wang (2011) and Liu (2013). The underlying dataset for the co-citation analysis will be based on the references that have been *cited* by the authors that have published in the journal *Simulation*. Thus, through the medium of these authors we endeavor to provide insights into the significant constituents of the M&S knowledge domain. At the very outset we would like the readers to note that the limitation of this work is its reliance on one journal; however, as our research is further motivated by the desire to focus on SCS in its anniversary year, this limitation can be regarded as informed choice on the part of the authors.

The remainder of the paper is organized as follows. Section 2 provides further information on co-citation analysis and reviews related literature. This is followed by a section on research methodology (section 3). In this section we describe the dataset and the software used; we enumerate the questions that inform the analyses that we perform. The findings are described in section 4. This is followed by the closing section on discussion and conclusions (section 5).

2. CO-CITATION ANALYSIS AND REVIEW OF RELATED LITERATURE

What is co-citation analysis? Let's take an example where there are three articles (A1, A2, and A3), each of which, cites two articles (B1, B2). Even though B1 and B2 may not directly cite each other, B1 and B2 form a kind of semantic cluster since A1, A2, and A3 all cite B1 and B2. B1 and B2 are, therefore, related by *co-citation*. Co-citation analysis can be regarded as a form of bibliometric and meta-data analysis – other examples include *profiling studies* and *citation-based analysis*. Profiling studies are usually conducted in relation to a particular journal (Katsaliaki et al., 2010; Palvia et al., 2007), studies that compare between journals (Mustafee, 2011; Claver et al., 2000), or indeed those that aim to methodologically study the contribution of specific research fields (e.g, M&S, parallel and distributed simulation, grid computing) with regard to particular application domains, e.g., application of M&S in manufacturing and business (Jahangirian et al., 2010), supply chain management (Terzi and

Cavalieri, 2004), healthcare (Katsaliaki and Mustafee, 2011; Mustafee et al., 2010; Brailsford et al 2009; Jun et al., 1999). Such studies help to identify currently under-explored research issues, and select theories and methods appropriate to their investigation, all of which are recognized in Information Systems as important issues for conducting fruitful, original and rigorous research (Galliers et al., 2007; Palvia et al., 2007). It can be argued that the same holds true for research in M&S, and indeed, most other research areas.

Our study is more closely related to the second form of bibliometric and meta-data analysis called citation-based analysis. This seeks to determine the popularity of articles based on the number of citations it has had. However it can be argued that there may exist certain articles that can be considered high-impact even though the number of citations they have received is comparatively less (for example, papers that have been cited a few times but across domains; papers that have been cited consistently through the years; papers that have been published recently). The opposite of this may also be true (for example, self-citations or a group of authors citing each other's work will usually increase the number of citations for a paper). Furthermore, it usually takes more than 5-6 years for a paper to build up its citation count. Using only citation metrics to identify significant papers would risk excluding articles that hold promise.

Co-citation analysis identifies clusters of "co-cited" references by creating a link between two or more references when they co-occur in the reference lists of citing articles (Raghuram et al., 2009). The resultant co-citation networks provide important insights into knowledge domains by identifying frequently co-cited papers, authors and journals related to the domains in question; and this would have been overlooked if only conventional citation analysis techniques were used. Thus, the paper demonstrates the added value of using co-citation analysis, as compared with citation-only analysis, when it comes to undertaking bibliometric research.

3. RESEARCH METHODOLOGY

3.1 Dataset

Simulation: Transactions of the SCS encourages submissions on methodology and applications and has a strong inter-disciplinary focus (SAGE, 2013). So as to eliminate the ambiguity between the name of the journal and the discipline that it caters to (both being "Simulation"), the journal is henceforth referred to as *SIMULATION* (in capitalized italics). Presently in its 88th volume, *SIMULATION* is indexed in numerous scholarly databases (including the ISI Web of Knowledge) and has a 5-year impact factor of 0.812 (JCR Science Edition, 2013). The reputation of the journal has meant that it continues to attract a large number of submissions, which are then subjected to peer review (each submission is usually allocated three reviewers); and this constant throughput of original research and review articles have ensured that the journal has continued to offer a monthly publication frequency. The number of research papers that were published in the time span 2000-2010 varied from a minimum of 39 in 2001 to a maximum of 56 articles in 2002, with a yearly average of around 48 papers.

For the purposes of this study, citation data pertaining to *SIMULATION* was downloaded from the ISI Web of Science. A search for papers associated with our target journal revealed that the journal was indexed in ISI Web of Science starting from September 2001 - the search criterion used was as follows: *Publication Name=(SIMULATION-TRANSACTIONS OF THE SOCIETY FOR MODELING AND SIMULATION INTERNATIONAL); Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH.* For this study we considered a time span of 10 years, starting from January 2002 (Volume 78, issue 1) to December 2011 (Volume 87, issue 12). In total, we extracted 564 papers that were published during this period.

3.2 CiteSpace

In our research we have used the knowledge domain visualization software called *CiteSpace* (Chen, 2004). CiteSpace identifies turning points associated with articles from citation data. We have analyzed cited articles, cited authors and cited journals in order to identify significant papers, authors and journals irrespective of their citation count. This is achieved through use of the full feature set of CiteSpace, including visual identifications of significant articles, authors and journals through innovative visualization techniques (Chen, 2004). These significant articles and authors are also referred to as "turning point" articles and authors.

The use of CiteSpace requires careful selection of a multitude of options, and an acceptable options' combination frequently requires learning through "trial and error" as well as knowledge of the underlying research domain. For the purpose of ensuing repeatability of this exercise, we now present the specific option values that were selected in CiteSpace.

[a] Time interval of analysis: 2002-2011inclusive

[b] The unit of analysis: 2 years per time slice

[c] C, CC, CCV for the earliest time slice: 2,2,20

[d] C, CC, CCV for the middle time slice: 2,2,20

[e] C, CC, CCV for the last time slice: 2,2,20

[f] Pruning and merging: Pathfinder network scaling (Chen, 2006) is used to prune the merged co-citation networks.

[g] Visualization: A merged network cluster view has been selected.

The various CiteSpace options are now briefly discussed. An extensive discussion of these variables is outside the scope of this paper and the reader is referred to Chen (2006). A total of five individual co-citation networks are created (the unit of analysis being 2 years; this was selected based on multiple trials with varying values) [b] and the timespan is from 2002-2011 [a]). We have selected a merged network cluster view [g], and we are therefore presented with a single cross-cluster co-citation network visualization, wherein each of the five co-citation networks (2002-2003; 2004-2005; 2006-2007; 2008-2009; 2010-2011) are merged and the resultant *merged network* is pruned using the *pathfinder network scaling algorithm* [f]. In this study the co-citation network may be related to articles, authors or journals.

The *C*, *CC* and *CCV* values in [c], [d] and [e] refer to the *citation threshold* (for example, C=2 for [c] implies that only those articles (or authors, journals) that have been cited at least two times will be considered in the co-citation network for the earliest time slice of 2002-2003), the *co-citation threshold* (for example, CC=2 for [d] implies that for any two papers (or authors, journals) to be included in the co-citation network for the middle time slice of 2006-2007, they should have been co-cited at least two times), and the *co-citation co-efficient threshold* (this is a normalized co-citation association strength, for example, for the last time slice of 2010-2011 the CCV=20 [e]). For the remaining time slices, CiteSpace will assign interpolated threshold values automatically. A comparison of the threshold values for [c], [d] and [e] show that the C, CC and CCV are constant across time slices. However, keeping in line with the generally accepted fact that the number of citations for an article usually increases with time, it may be argued that the C, CC and CCV values could have been increased across time slices; and indeed we did experiment with such a scheme. However, owing to the comparatively fewer number of papers in our underlying dataset (564 papers), having higher thresholds meant that we risked excluding important papers, authors and journals.

3.3 Variables for Analysis

In this study, the aforementioned CiteSpace options (and their selected values) have been used consistently for generating co-citation networks pertaining to cited articles – this is also referred to as *Document Co-citation Network (DCN)*, cited authors - *Author Co-citation Network (ACN)* and cited journals - *Journal Co-citation Network (JCN)*. The resultant networks have been used for answering several questions. These are listed below:

- DCN – What are the underlying clusters that have high article co-citation counts associated with them?
- DCN – Which articles are the most frequently cited by the *SIMULATION* authors?
- DCN – Which are the turning point articles?
- ACN – Who are the authors that are most frequently cited by the *SIMULATION* authors?
- ACN – Who are the turning point (strategically important) authors?
- JCN – Which journals are highly cited?

4. FINDINGS

The findings section is organized into seven sub-sections, each of which confirms to one of the questions being asked in this research. These questions are listed in section 3.3.

4.1 List of clusters identified using DCN

Nodes and links are the building blocks of a co-citation network. CiteSpace supports a total of eleven Node Types (NTs). In this and the two subsequent findings (sections 4.2 and 4.3) we are interested in NT "cited references" and the resultant DCN. For findings pertaining to authors (section 4.4 and 4.5) and journals (section 4.6) we are interested in NT "cited authors" (and the corresponding ACN) and NT "cited journals (JCN) respectively. This discussion in the next paragraph apply equally to DCN, ACN and JCN.

Each node in the DCN/ACN/JCN refers to an article/author/journal. The different time-sliced DCN/ACN/JCN co-citation networks are distinguished by their color. The colors indicate time and through the use of either the VIBGYOR spectrum or multiple shades of blue (depending on user selection), they represent the complete time interval of the analysis. The links can visually represent various characteristics of the underlying network, for example, the color of the link represents the year in which a connection between two nodes was first established (e.g., with regard to the DCN it is the year in which two articles were first co-cited), the strength of connection between any two nodes is represented by the thickness of the link (e.g., in the context of ACN the thicker the connection between two nodes, the greater the number of times that the two authors were co-cited).

The DCN visualization allows us to identify underlying relationships among the cited articles. For example, a thick link between two nodes (denoting high co-citation count among the articles), both of which also have a relatively large diameter (denoting high citation count) and have been consistently over the years would identify two papers that are equally important to a subject matter. But the question is what is the subject matter? It is possible to infer this from reading the abstracts of the papers with high-citation count? However, this process is time consuming and the interpretation is subjective as it is based on a researcher's domain knowledge.

A better way to achieve this is to automatically assign meaningful labels to the co-citation clusters that are identified in a co-citation network; CiteSpace "characterizes clusters with candidate labels selected by multiple ranking algorithms from the citers of these clusters and reveals the nature of a cluster in terms of how it has been cited" (Chen et al., 2010). CiteSpace presently supports nine different ways of labeling the clusters – allowing selection of candidate terms from three sources (titles, abstracts, and index terms) all of which belong to the citing articles and three ranking algorithms (tf*idf weighting, LLR, MI) (Chen et al., 2010). In our study we have selected index terms and have used the tf*idf weighting algorithm. The output is shown in Figure 1 (a). The list of clusters and their corresponding labels are presented in Table 1. It shows a total of 35 unique clusters. These clusters were identified from among 212 nodes and a total of 221 links. Figure 1 (b) focuses on one such cluster (#40 scalability) and it shows five paper with high co-citation count (De Boer, 2006; Dupuis et al., 2007; Glasserman and Kou, 1995; Kroese and Nicola, 2002; Parekh, 1989). All of these papers are on queuing networks (tandem queues, jackson network).

[Figure 1(a) about here]

[Figure 1(b) about here]

[Table 1 about here]

4.2 List of frequently cited articles identified using DCN

The following discussion is also relevant to sections 4.4 (ACN) and 4.6 (JCN). The highly cited papers/authors/journals can be visually identified by interacting with the node size control in CiteSpace. The higher the citations the more prominent the nodes will be in terms of their diameter. The node comprises of multiple colored rings having varying thicknesses, with the colors representing the citation time-slice and the thickness corresponding to the number of citations in that year. The text beside the citation rings identify the article/author/journal being represented by the node. For example, from Figure 2 we can visually identify that an article by Zeigler BP as having the highest number of citation. In this figure the identified nodes are also attributed to specific clusters in a process similar to the one described above. Table 2 presents a list of articles with eight or more citations. Seven of the 11 articles in this list are authored books. Only four articles are journal papers.

[Figure 2 about here]

[Figure 3 about here]

[Table 2 about here]

4.3 List of turning point articles identified using DCN

The following discussion is also relevant to turning point authors (section 4.5) .CiteSpace identifies turning point articles and authors in a co-citation network through landmark nodes (a node with extraordinary attributes), hub nodes (widely co-cited article) and pivot nodes (common nodes that are shared between two co-citation network or gateway nodes that are interconnected by inter-network links), and by enhancing the visual features of such nodes it makes it easier to detect them through visual inspection (Chen, 2004). For NT "cited references" and "cited authors", the purple rings that surround the citation ring identify turning point articles/authors. It is important to note that turning point articles/authors that are identified by CiteSpace are not necessarily those that have high citations. This analysis is very different to the previous analysis, which only considers the number of article citations as the key indicator. The identification of turning point papers/authors is mainly possible because CiteSpace does a time-sliced co-citation analysis, as against a simplistic citation analysis of cited references/authors. In this scheme of things, an article/author that has been co-cited many times within one time slice (say 2002-2003) may be considered less important than a article/author that has been co-cited less number of times but across different time slices.

Figure 3 shows a screenshot of turning point articles that were identified by the DCN and Table 3 lists them in the order of significance (this is referred to as *centrality* in CiteSpace). However, the centrality measure should only be considered as indicative. The reader will note that the citation frequency (first column in Table 3) is mostly irrelevant in this analysis. Comparing Tables 2 and 3, we find that almost half of the articles appear in both the tables; however their rankings have changed between the tables. The five highly-cited articles that do not appear in the list for the turning point articles are Kuhl et al. (1999); Jefferson (1985); Gamma et al. (1995); Murata (1989); Barros (1997). These have been indicated with a grey background in Table 2. Similarly, the seven turning point articles that do not feature in the list of highly cited articles have been similarly indicated in Table 3. These articles are Foster et al. (2001); Zeigler and Sarjoughian (2003); Xiaolin et al. (2005); Ntaimo et al. (2004); Abdulnabi (1985); IEEE Computer Society (2000); Kelton et al. (1998).

[Table 3 about here]

4.4 List of frequently cited authors identified using ACN

The findings in this section relate to frequently cited authors. In this analysis all the publications of a particular author are combined into one; this is different to the measure of frequently cited articles wherein each publication is treated unique. One limitation of the present analysis is that it considers only the first author. This is due to the limitation imposed by the downloaded ISI format data which identifies a cited reference with only the lead author's names. Also, some of the authors were identified more than once owing to inconsistent referencing with regard to the author names. For example, some citing authors have used WAINER G and others WAINER GA to refer to the same authors' work. In such cases we have combined the authors' instances into one. Table 4 lists the authors with a citation frequency greater than 13. Comparing Table 4 with the authors of the articles listed in the previous two tables, we find seven new authors - BANKS J, RILEY GF, JAIN R, PAGE EH, MOSTERMAN PJ, FLOYD S and CHEN Y.

[Table 4 about here]

4.5 List of turning point authors identified using ACN

Figure 4 presents a screenshot of the turning point authors that were identified using ACN and Table 5 lists these 17 authors. It is to be noted that two of the authors represent an organization (IEEE and The ATM Forum). Comparing with the list of frequently cited authors in Table 4, we find that all but two authors (FOSTER I and MOSTERMAN PJ) have also been identified as turning point authors in Table 5; Conversely, all but four authors in Table 5 (GAMBARDELLA LM; THE ATM FORUM; HU XL; BALCI O) also appear in the list of most frequently cited authors. The exceptions have been indicated with a grey background in the corresponding tables.

[Figure 4 about here]

[Figure 5 about here]

[Table 5 about here]

4.6 List of frequently cited journals identified using JCN

Table 6 presents a list of scholarly literature that are frequently cited by authors of *SIMULATION*. The majority of the items identified are journals, with the exception of three books (authored by Zeigler BP; Law AM & Kelton WD; Fujimoto RM), an edited book series by Springer (LNCS) and five conference proceedings (Proc. of WSC, 1998, 2000, 2002 and 2005; Proc. of ASimS). If we combine the WSC citations (like in the case of Proc. of ASimS) then WSC is the third most popular citation source, with number of citations being higher than ACM TOMACS.

[Table 6 about here]

The JCN has identified that ACM TOMACS is most frequently co-cited with Communications of the ACM, Journal of Parallel and Distributed Computing, IEEE Transactions on Software Engineering, Proc. of WSC (1997 and 2000) and Proc. from the Workshop on Principles of Advanced and Distributed Simulation (PADS). This is shown in Figure 5.

5. DISCUSSION AND CONCLUSION

Our purpose in this paper was to extract quantitatively derived observations about a corpus of information centered around the publications of a society (The Society for Modeling and Simulation International, or SCS). The method used was *co-citation*, which is a graph-theoretic approach frequently employed for identifying topics, clusters, and categories. Co-citation is also a method employed in search engine optimization (SEO) for web content, and therefore, is one of a number of useful network analysis approaches. We have used this method not only to determine important modeling and simulation publications, articles, and authors but also to identify possible “turning point” papers and authors. The three main graph types studied were document, author, and journal co-citation networks (DCN,ACN, and JCN respectively).

While these three graph types were useful in identifying key areas, trends, and authors within simulation, the analysis also paints a larger picture. In the emerging era of “big data, “ modeling and simulation practitioners should consider data-centric methods (e.g., graph and network theory) for determining important questions about our discipline. What types of dynamic models are being used and can they be stratified over time, or correlated with specific authors or disciplinary areas? What programming languages predominate in simulation? Answers to these questions at one time were mainly answered through survey articles; however, in the future with so much available data, we might consider new forms of data and graph analysis along the lines of the methods discussed in this article.

Future research directions could involve broadening the boundaries of our profiling dataset. For example, we could utilize a more inclusive set of data that is representative of the whole domain and not restricted to a single publishing outlet with the purpose of capturing a more complete picture of the interrelationships between the key variables discussed in this paper. Moreover, such co-citation analysis could also exclude authored books from the analysis (as it can be argued that most papers will refer to general books on the topic) and focus on the impact of articles in the development of the field.

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FIGURES

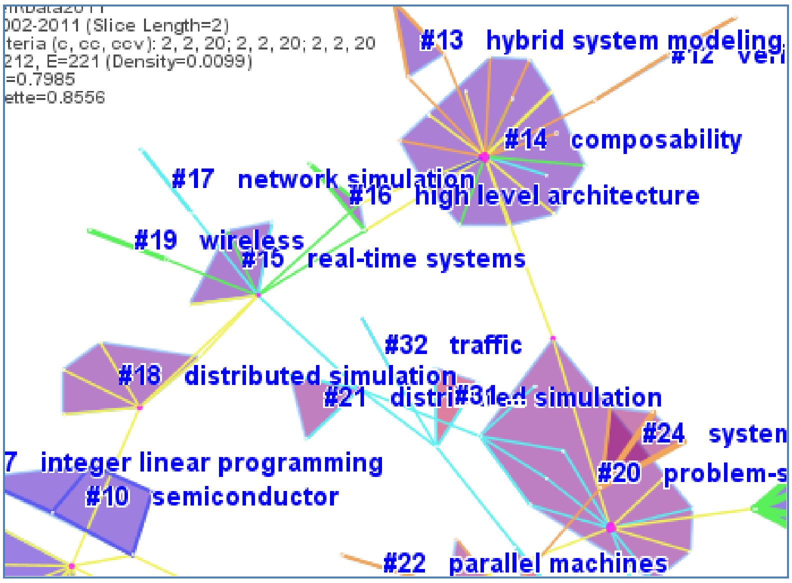

Figure 1(a): Clusters identified in the DCN solution space and named using candidate labels

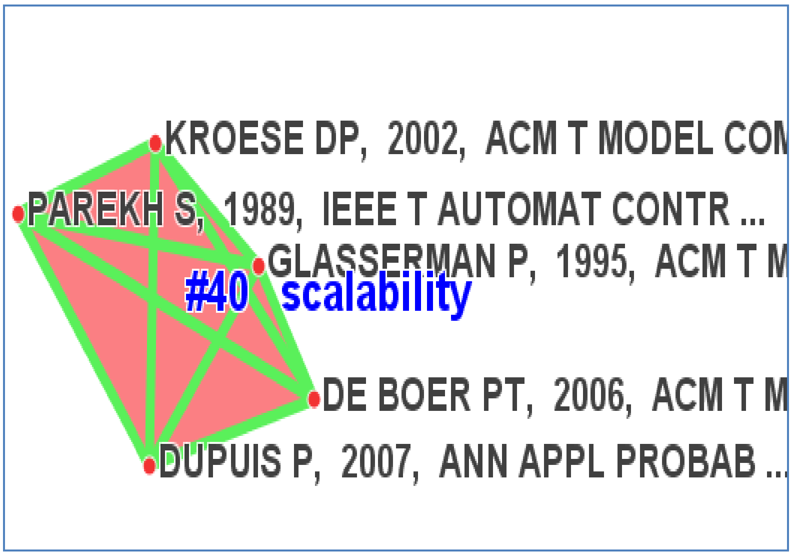

Figure 1 (b): Articles with high co-citation counts for cluster on scalability

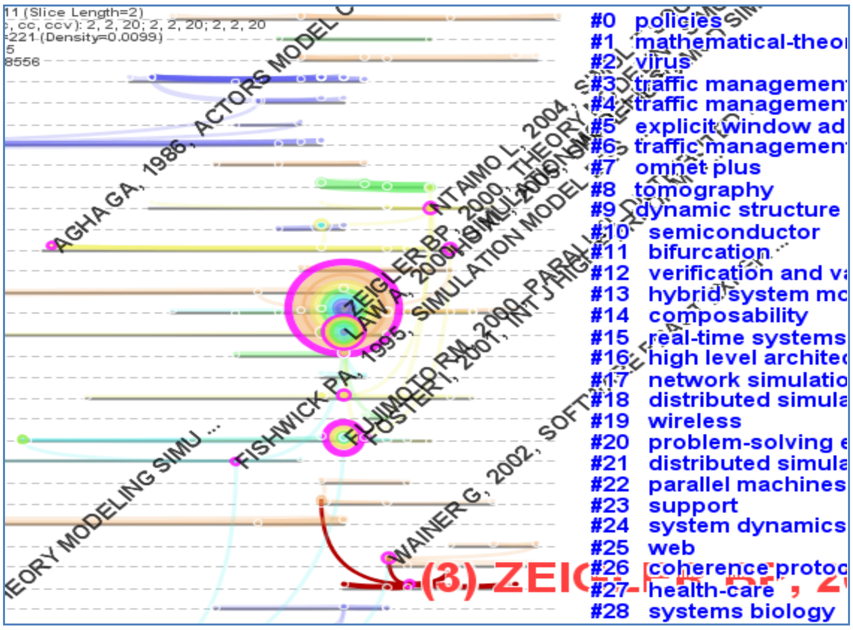

Figure 2: Frequently cited papers and their corresponding clusters (clusters listed on the right)

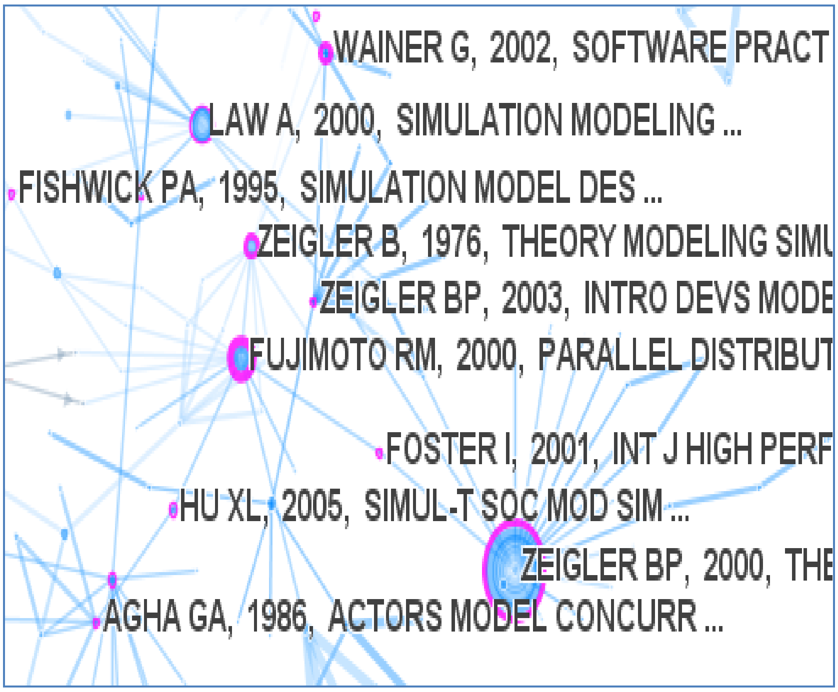

Figure 3: Turning point articles denoted by a purple ring (refer to section 4.3)

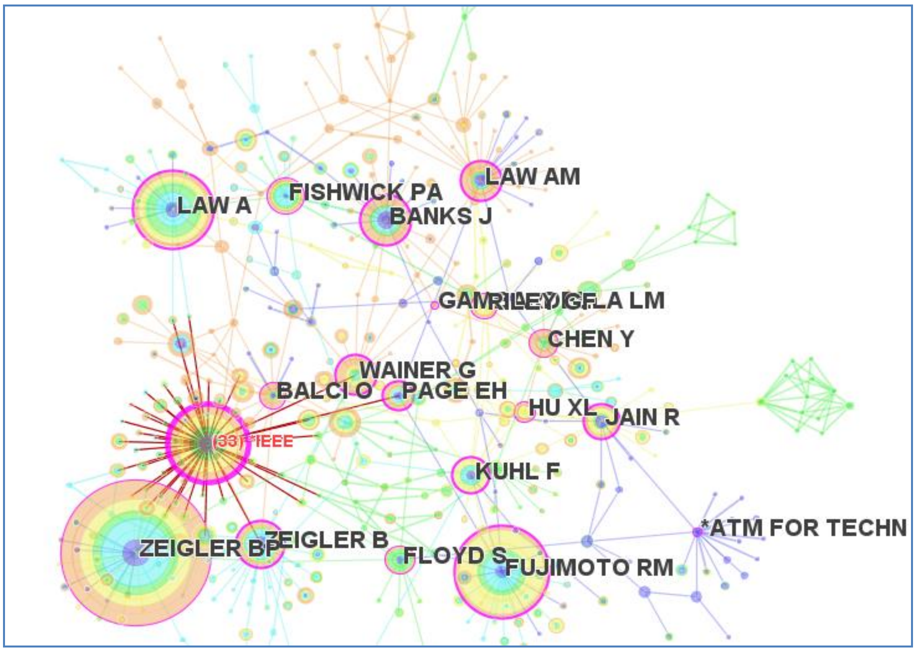

Figure 4: Author Co-citation Network identifying 17 turning point authors

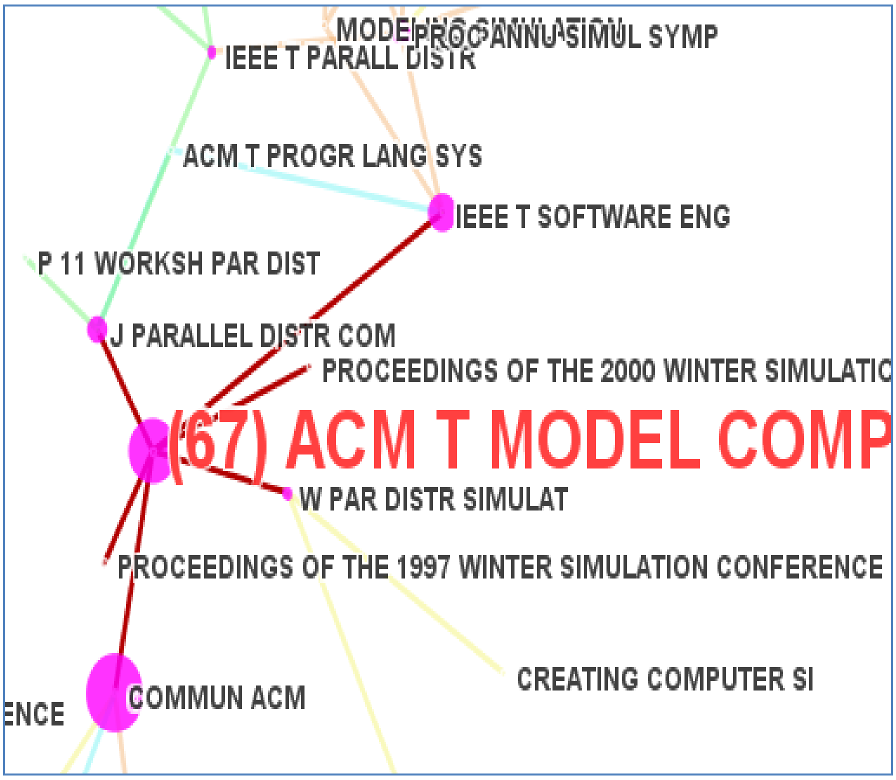

Figure 5: Journal Co-citation Network (refer to section 4.6)

TABLES

Table 1: List of research clusters identified using Document Co-citation Network

Cluster	**Cluster**	**Cluster**
policies	composability	health-care
mathematical-theory	real-time systems	systems biology
virus	high level architecture	continuous system simulation
traffic management	network simulation	traffic
explicit window adaptation	distributed simulation	architecture
omnet plus	wireless	combat simulation
tomography	problem-solving environment	system dynamics modelling
dynamic structure discrete event system specification	parallel machines	telemedicine
semiconductor	support	integer linear programming
bifurcation	system dynamics	demand
verification and validation	web	scalability
hybrid system modelling	coherence protocol	

Table 2: List of frequently cited articles (Freq >= 8) identified through Document Co-citation Network

Freq	**Author**
49	Zeigler, B.P., H. Praehofer, and T. G. Kim. 2000. *Theory of Modeling and Simulation*. 2nd Edition. Academic Press.
30	Law, A.M. and W. D. Kelton. 2000. *Simulation Modeling and Analysis*. 3rd Edition. McGraw Hill Higher Education.
17	Fujimoto, R.M. 2000. *Parallel and Distributed Simulation Systems*. Wiley Interscience.
11	Zeigler, B.P. 1976. *Theory of Modeling and Simulation*. John-Wiley.
10	Kuhl, F., R. Weatherly, and J. Dahmann. 1999. *Creating Computer Simulation Systems: An introduction to the High Level Architecture*. Prentice Hall PTR.
9	Wainer, G. 2002. “CD++: A Toolkit to Develop DEVS Models.” *Software: Practice and Experience* 32(13):1261-1306.
9	Fishwick, P.A. 1995. *Simulation Model Design and Execution: Building Digital Worlds*. Prentice Hall PTR.
9	Jefferson, D.R. 1985. “Virtual time.” *ACM Transactions on Programming Languages and Systems*

	7(3):404-425.
9	Gamma, E., R. Helm, R. Johnson, and J. Vlissides. 1995. *Design Patterns: Elements of Reusable Object-Oriented Software*. Addison-Wesley Professional.
8	Murata, T. 1989. "Petri Nets: Properties, Analysis and Applications. " *Proceedings of the IEEE* 77(4):541-580.
8	Barros, F.J. 1997. "Modelling Formalisms for Dynamic Structure System." *ACM Transactions on Modeling and Computer Simulation* 7(4):501-515.

Table 3: List of all turning point articles identified through Document Co-citation Network

Freq	Articles
17	Fujimoto, R.M. 2000. *Parallel and Distributed Simulation Systems*. Wiley Interscience.
11	Zeigler, B.P. 1976. *Theory of Modeling and Simulation*. John-Wiley.
49	Zeigler, B.P., H. Praehofer, and T. G. Kim. 2000. *Theory of Modeling and Simulation*. 2nd Edition. Academic Press.
9	Wainer, G. 2002. "CD++: A Toolkit to Develop DEVS Models." *Software: Practice and Experience* 32(13):1261-1306.
30	Law, A.M. and W. D. Kelton. 2000. *Simulation Modeling and Analysis*. 3rd Edition. McGraw Hill Higher Education.
3	Foster, I., C. Kesselman, and S. Tuecke. 2001. "The Anatomy of the Grid: Enabling Scalable Virtual Organizations." *International Journal of High Performance Computing Applications* 15(3): 200-222.
3	Zeigler, B.P. and H. S. Sarjoughian. 2003. "Introduction to DEVS Modeling and Simulation with JAVA: Developing Component-Based Simulation Models." *Arizona Center for Integrative Modeling and Simulation*, Arizona, USA.
6	Xiaolin, H., B. P. Zeigler, and S. Mittal 2005. "Variable Structure in DEVS Component-Based Modeling and Simulation". *Simulation: Tran SCS* 81(2):91-102.
6	Ntaimo, L., B. P. Zeigler, M. J. Vasconcelos, and B. Khargharia. 2004. "Forest Fire Spread and Suppression in DEVS." *Simulation: Tran SCS* 80(10):479-500.
9	Fishwick, P.A. 1995. *Simulation Model Design and Execution: Building Digital Worlds*. Prentice Hall PTR.
4	Abdulnabi, A.G. 1985. "ACTORS: A Model of Concurrent Computation in Distributed Systems." MIT Artificial Intellience Lab, Technical Report 844.
7	IEEE Computer Society. 2000. "IEEE standard for modelling and simulation (M&S) High Level Architecture (HLA)." IEEE std 1516-2000.
3	Kelton, W.D., R. P. Sadowski, and N. B. Swets. 1998. Simulation with Arena. McGraw-Hill.

Table 4: List of frequently cited authors (freq >=13) identified through Author Co-citation Network

Freq	Authors	Freq	Authors	Frequency	Authors
85	ZEIGLER BP	22	BANKS J	14	FOSTER I
53	LAW AM	21	FISHWICK PA	13	PAGE EH
40	FUJIMOTO RM	19	RILEY GF	13	MOSTERMAN PJ
33	IEEE	16	JAIN R	13	FLOYD S
30	WAINER GA	15	KUHL F	13	CHEN Y

Table 5 List of all turning point authors identified through Author Co-citation Network

Freq	Authors	Freq	Authors	Freq	Authors
33	IEEE	13	PAGE EH	13	FLOYD S
30	WAINER GA	40	FUJIMOTO RM	3	THE ATM FORUM
16	JAIN R	13	CHEN Y	19	RILEY GF
22	BANKS J	85	ZEIGLER BP	17	HU XL
53	LAW AM	3	GAMBARDELLA LM	12	BALCI O
15	KUHL F	21	FISHWICK PA		

Table 6: List of frequently cited journals, books, conferences (Freq >= 20) identified using Journal Co-citation Network

Freq	Journal	Freq	Journal	Freq	Journal
193	Simulation: Transactions of the SCS	33	Proc. Annual Simulation Symposium (ASimS)	25	European Journal of Operational Research
102	Lecture Notes in Computer Science (LNCS)	31	Simulation Modelling Practice and Theory	25	Journal of Parallel and Distributed Computing
67	ACM TOMACS	30	Parallel and Distributed Simulation Systems (Fujimoto RM)	24	IEEE Transactions on Software Engineering
57	Theory of Modeling and Simulation (Zeigler BP)	30	Operations Research	22	Proc. 2000 Winter Simulation Conference (WSC)
55	Communications of the	29	IEEE Transactions on Parallel and	22	Proc. 1998 WSC

	ACM		Distributed Systems		
48	IEEE/ACM Transaction s on Networking	29	Management Science	22	Artificial Intelligence
43	IEEE Journal on Selected Areas in Com munications	28	IEEE Transactions on Computers	21	Journal of the Operational Research Society
38	Proceedings of the IEEE	26	Computer Communications	20	Proc. 2005 WSC
38	Simulation Modeling and Analysis (Law AM & Kelton WD)	26	IEEE Communications Magaz ine	20	Proc. 2002 WSC
				20	International Journal of Production Research