A Comparison of

Self-Organizing Maps and Pathfinder Networks

for the Mapping of Co-Cited Authors

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Jan William Buzydlowski

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Dedications

To my father.

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Abstract

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Jan William Buzydlowski
Howard D. White, Ph.D.

Author co-citation analysis (ACA) is a methodology for determining the relationships between author pairs as specified by patterns of repeated co-citation. These patterns are visualized through computerized mapping techniques that now include self-organized maps or SOMs (also known as Kohonen feature maps) and Pathfinder networks (PFNETs).

In this research, ACA maps of authors in the humanities were produced as both SOMs and PFNETs using an experimental Web-based system called AuthorLink based on author co-citation data from the Arts & Humanities Citation Index for the years 1988–1997. The intent was to test how well each map type corresponded to a set of mental maps of experts, the "gold standard," for the same authors. The mental maps were elicited from 20 experts in the humanities with card sorts.

The first research question was: How well do SOMs and PFNETs based on one famous author—here, Plato—correspond to the experts' *combined* mental map for that author? A Pearson correlation of the SOM with the mental map was compared to a Pearson correlation of the PFNET with the mental map. While *both* correlations proved highly

significant ($p<0.001$), the SOM's ($r = 0.968$) was significantly higher ($p < 0.001$) than the PFNET's ($r = 0.783$).

The second research question was: How well do SOMs and PFNETs based on personally chosen authors correspond to the experts' *individual* mental maps of these authors? Here, SOMs and PFNETS for 20 different authors were compared with the mental maps of those authors so as to produce difference scores for the two mapping techniques. These were analyzed through a paired-sample t-test. The 20 individual SOMs corresponded to the experts' mental maps better than the 20 individual PFNETs ($p = 0.002$).

The third research question was: Is one type of map, SOM or PFNET, preferred by experts? The 20 experts were statistically equal, 11 for the PFNET to 9 for the SOM. However, during interviews with the experts it was suggested that the two types are complementary and that both are needed to do a thorough exploration.

1. INTRODUCTION AND STATEMENT OF PROBLEM

1.1. Goal of the Research

Data visualization helps to reveal structures within data that cannot easily be absorbed in any other way (Cleveland, 1993). The graphic display of raw or transformed numeric data helps the analyst explore and identify the underlying information.

The use of visualization in the area of statistical analysis has a well-established history with many techniques in its repertoire. In a similar vein, the application of visualization techniques to bibliographic or textual data—here called *information visualization*—has added greatly to the discipline of information science. However, textual data can be more challenging to visualize than numerical data because one must first develop metrics (Hearst, 1999). The proper metric and visualization technique are critical to meaningful data display. Also critical is the unit of analysis. Terms from the title, abstract, or entire text of a document can be considered. Even the titles and authors from the bibliography of a work can be used as data.

One of the first applications of information visualization to bibliographic data, White & Griffith (1981), used author co-citation analysis (ACA). Author co-citation is the citation of two different authors by a third author (White & McCain, 1997). ACA defines a metric for relating authors cited in the bibliographies at the end of articles—the co-citation count. It is used to depict the relationships between those authors and to identify research specialties in terms of author groupings. The primary method to visualize the relationships between authors in ACA is a map in which the authors' names are algorithmically positioned according to how frequently the authors are cited together.

Three different methods of mapping dominate the ACA research literature. The goal of the present research is a critical evaluation of them.

The first method used, historically, was multidimensional scaling (MDS), which is now well established (Kruskal, 1978). MDS seeks to map author names so as to render the ordering of authors' co-citation counts in terms of distances. It produces maps in which authors are positioned as points on a page, like cities on a geographic map. In general, authors placed closely together have similar research interests, whereas authors placed further apart have less in common. Cluster analysis (Hair, 1995) can be added to define groups of authors. The points representing similar authors are circumscribed on the MDS map to indicate clusters of authors that are related in some respect. Additionally, a coordinate system is assumed to exist on the map so that the various axes suggest additional meaning. Clusters and axes are usually interpreted and labeled by the researcher. The reader is referred to McCain (1990) for examples of this technique.

A second mapping method for ACA is self-organizing maps or SOMs (Kohonen, 1989). Lin (1993) was one of the pioneers in applying them to bibliographic data. The technique uses self-training neural networks to determine the placement of authors in two dimensions. The method is similar to MDS in that it produces a map with authors represented as points on a page, with the distance between points indicating the strength of the relationships. Point placements are similar in effect to the cluster-analysis routines applied with the MDS methodology, but it is done automatically by the SOM algorithm rather than as a separate step.

A third mapping methodology that can be applied to ACA is Pathfinder Networks (PFNET). The algorithm for PFNETs was developed in cognitive science to determine the most salient links in a network (Schvaneveldt 1990). C. Chen (1999) reported the first application of the technique to cited-author data. In this method it is not the placement of authors, *per se,* that reflects the strength of the relationships, but the linking of two names by means of a line segment. The output consists of a network with the names as nodes and the most salient linkages between names as links. A second algorithm is required for the visual rendering of this network.

The three different methodologies produce maps that differ not only in appearance but also in the placement of authors' names. Although several papers have suggested a comparison of the different display techniques to establish an order of superiority (White, et al., 1998; White, et al., 2000; Lin, 1993), no specific research has made this comparison in any rigorous way. Consequently, the goal here is to compare the performance and reception of ACA maps in actual field trials with users.

1.2. Research Questions

This research will compare the visual maps created by author co-citation analysis in order to establish a ranking of preference or superiority. To do so, we must first establish the standard for the comparison.

Through years of training, experts learn both the concepts associated with their field and the researchers who have made important contributions to it. In doing so, they form cognitive maps of the concepts and leaders in their fields and of the associations between them. For instance, based on a cognitive map of relationships among authors, an expert in philosophy would most likely claim that Plato and Aristotle or Augustine and the Bible were highly related.

The impetus of ACA is to produce visual maps similar to the cognitive maps of experts. One of the advantages of ACA is that this can be done in the absence of the expert, i.e., from the bibliographic data alone. However, since the goal of this study is to determine whether one of the map types is better at arranging and presenting a collection of authors in a field of study, experts in various fields of study will be used as the standard of comparison to evaluate the visual maps.

The crux of this research, then, is to compare the visual maps generated by the different computer algorithms with the cognitive maps of experts. The similarity of a cognitive map to a visual map will be termed its *degree of correspondence*. That is, how well do groupings of authors in the computer-produced maps correspond to the groupings in the experts' cognitive maps?

The next decision is what will be compared. It has been suggested that SOMs and MDS maps convey similar information (White, et al., 2000). The same has also been suggested of PFNETs and MDS (Buzydlowski, 2002). Furthermore, it will be shown later in this work that MDS and PFNETs are similar in their display methodologies (although PFNETs may be more tractable to create in real-time; see Buzydlowski, 2002). Based on these suggested similarities, it is possible to imagine the three map types on a continuum with SOMs on one end, MDS in the middle, and PFNETs on the other end.

SOM ———————— MDS ———————— **PFNET**

Consequently, to help reduce the complexity of the study and to compare the most disparate types of maps, this research compares only SOMs and PFNETs in their degree of correspondence with mental maps. In general, this research seeks to establish 1) whether one map type is better than the other by objective measures; and 2) whether experts prefer one map type over the other.

To obtain the mental maps for this study, experts from humanities disciplines were asked to:

• Make intuitively meaningful groups of a set of authors co-cited with a single famous author. The researcher presented each expert with the same set of names, and their groupings were pooled into a *composite* mental map of the famous author, based on all experts' contributions.

• Make intuitively meaningful groups of a set of authors co-cited with an author of their choice. Their choice was based on their interest and expertise. Guided by these choices, the researcher presented each expert with a different set of names, and their groupings were converted into *individual* mental maps of their chosen authors. The individual maps were used in separate analyses for each expert. Results were then compared as a number of "field trials."

Experts were further asked to:

• State a preference for SOMs or PFNETs when forced to choose between them.

This leads to three research questions:

R1: How well do SOMs and PFNETs based on one famous author correspond to the experts' *composite* mental map of that author?

R2: How well do SOMs and PFNETs based on personally chosen authors correspond to the experts' *individual* mental maps of these authors?

R3: Is one type of map, SOM or PFNET, preferred by experts?

These questions will be examined in much more detail in Chapter 5. The next section introduces the system used to produce the SOMs and PFNETs—a system that was designed to automate author co-citation analysis and co-cited author retrieval.

1.3. Context of the Research

Until recently, the process of creating a SOM or PFNET from a bibliographic database was done manually and required many hours—even days—of labor. The present author has participated in a project that automates both the extraction of author co-citation counts and the conversion of those counts to SOMs and PFNETs in seconds. The resulting system is called AuthorLink (White et al., 2000; Lin, 2001a). It analyzes data from the Arts & Humanities Citation Index (AHCI) for the decade 1988 to 1997, and it was used to generate the materials for this research. AuthorLink and the AHCI database will be described further in Chapter 5 on Methodology. Those wishing additional insight into its capabilities may consult a series of papers: Buzydlowski et al., 2000, 2001, 2002; Lin et al., 2000, 2001a, 2001b, 2003; White 2002, 2003; White et al., 2000, 2001a, 2001b. Most of these papers focus on interpretations of the AuthorLink maps and their uses for information seekers, but there is some discussion of the system's technical side as well.

Figure 1 below illustrates the first AuthorLink screen seen by a user. The initial screen is a general introduction to the system and gives a brief description of how it is to be used.

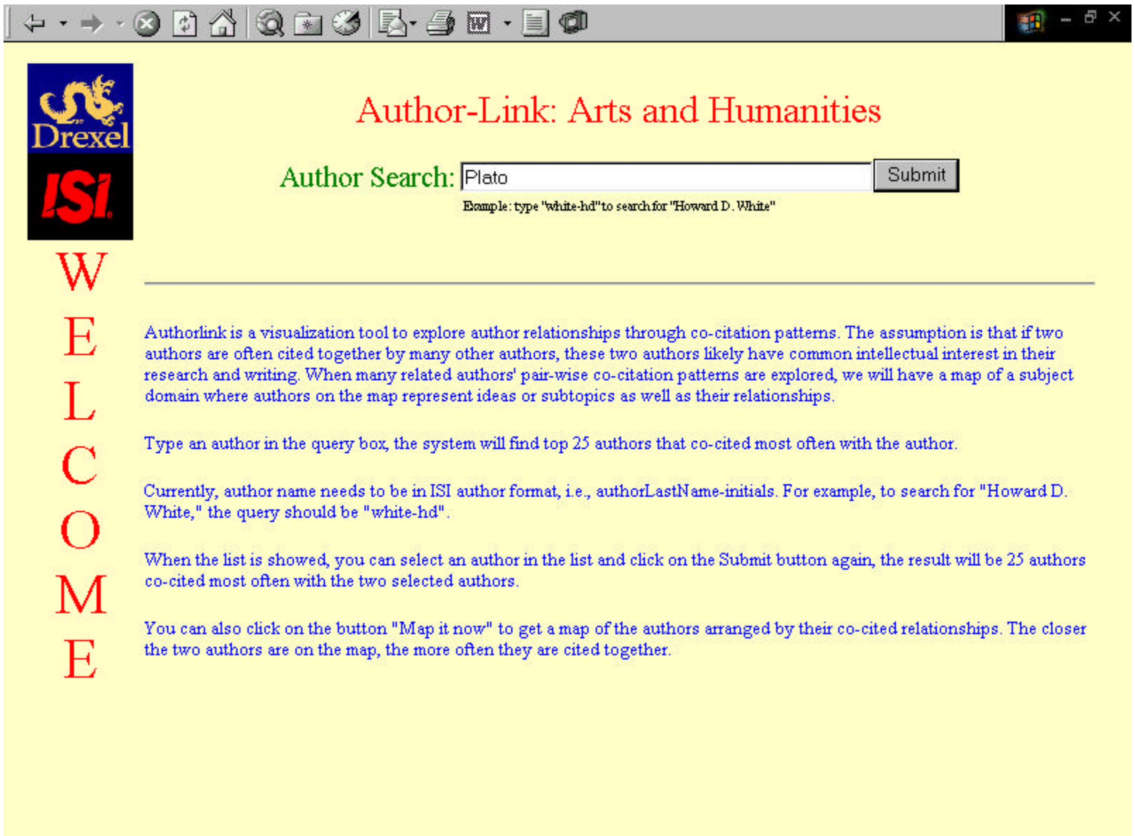

Figure 1: Initial AuthorLink Screen

A user types a name in the Author Search field; in Figure 1 the name is Plato. This requests Plato as a *cited author* in the 1.26 million records of the database. After the Submit button is clicked, a list of twenty-four other authors is returned. These are the authors most frequently cited *with* Plato—his top 24 co-citees out of many hundreds. The actual co-citation counts are also returned. Examining Figure 2, one can see that Plato was cited 5177 times in the database, and Aristotle was cited 1939 times in the records that contained Plato. In other words, something by Aristotle appeared together with something by Plato in the reference lists of 1939 articles. Plato and Plutarch were similarly co-cited in 845 articles and so on.

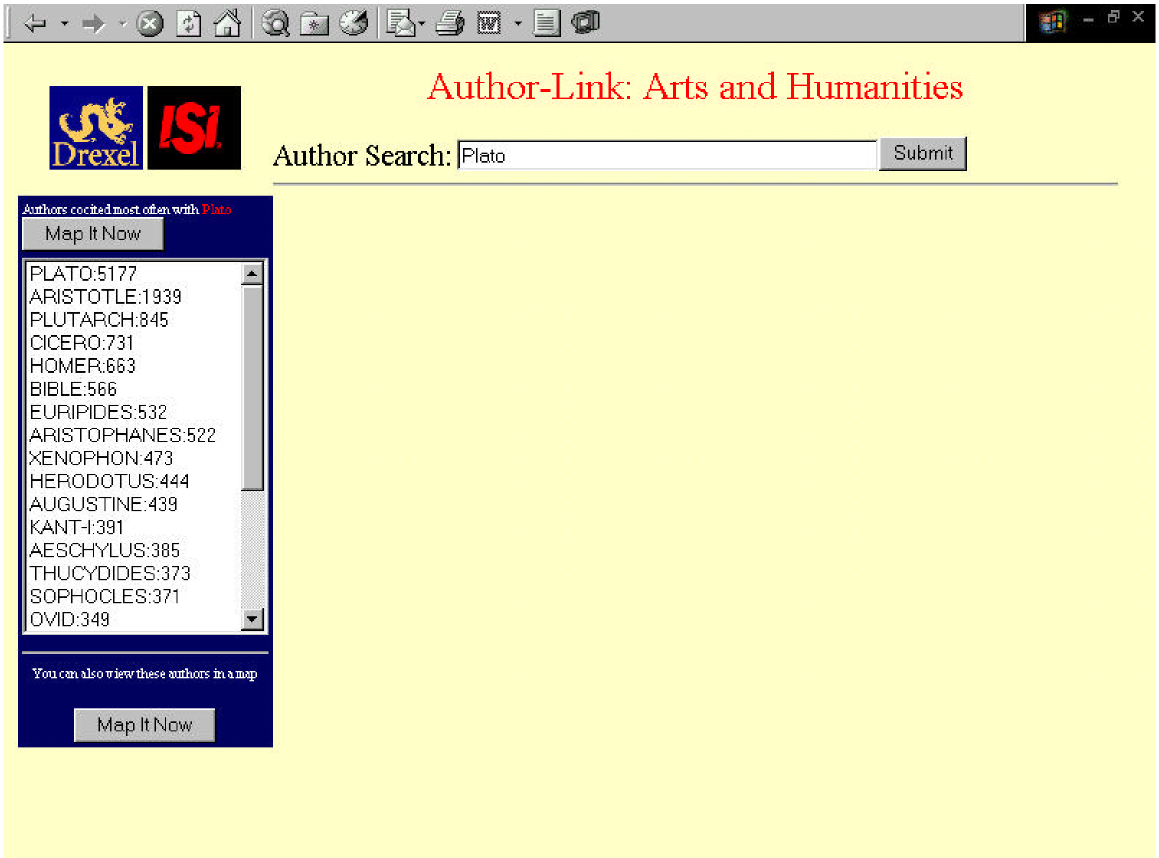

Figure 2: Authors with Counts

The user then clicks the button Map It Now. As shown in Figure 3, the system initially displays a Kohonen map—in this case based on Plato.

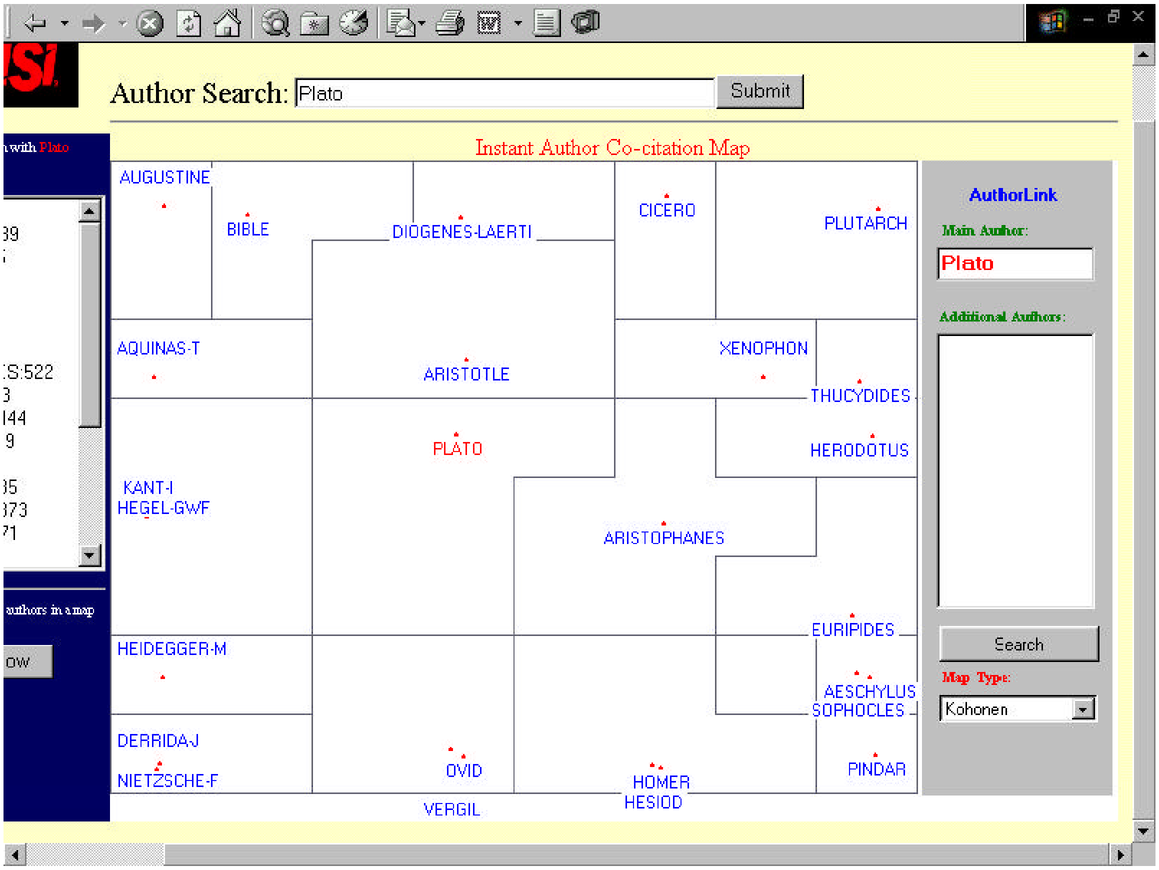

Figure 3: SOM of Plato

The user can switch map types in the menu at the bottom-right of the screen by selecting the Pathfinder Network rather than the Kohonen map. An example of a PFNET based on Plato appears in Figure 4.

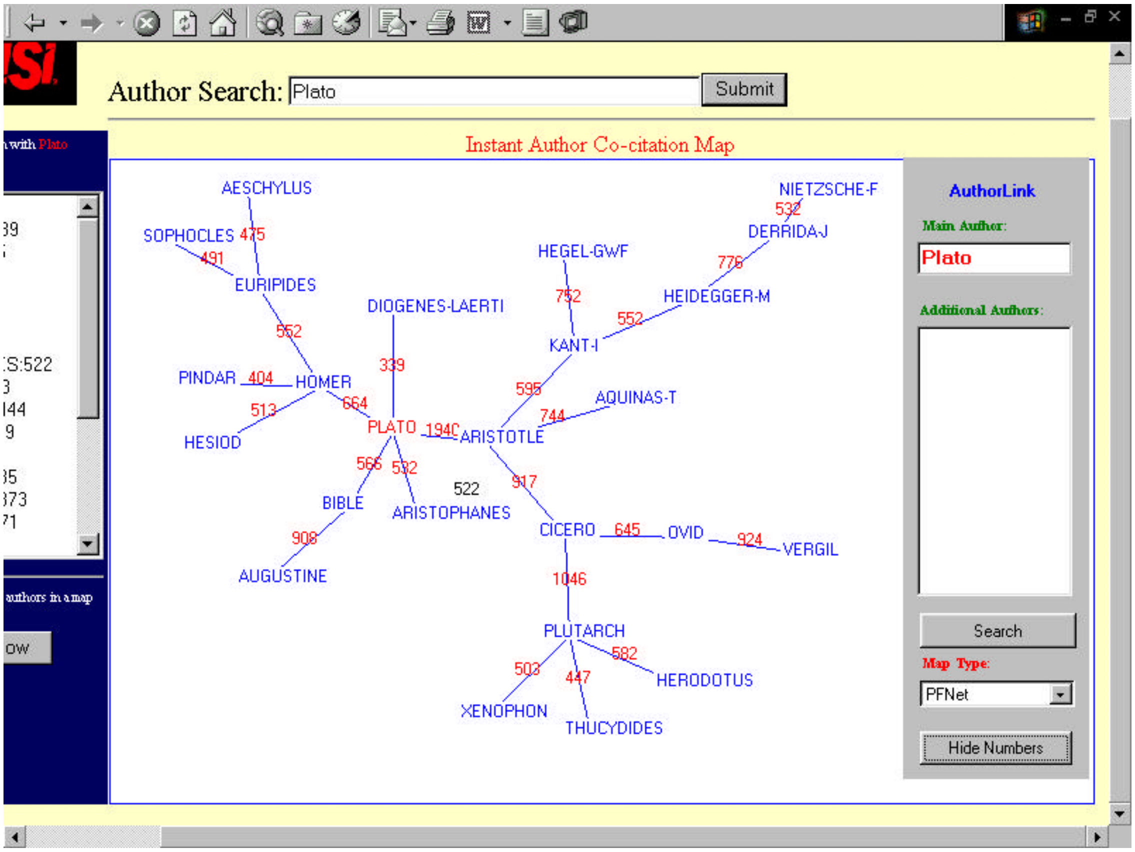

Figure 4: PFNET of Plato

Figure 4 shows the authors and their links as provided by the Pathfinder algorithm. The various co-citation counts are also shown, an option that can be toggled on and off. For example, Cicero and Ovid are co-cited 645 times in the database, and this is the highest count for each among their co-citation counts with the other 24 authors. The PFNET algorithm reflects this highest count by linking them explicitly in the map.

The user may also position the mouse above a name, and the system will show the co-citation count of that author and the starting author (here, Plato). In this example, Aristophanes was chosen, and he was co-cited with Plato in 522 articles in AHCI. (This latter capability reproduces the counts in the box at the left of the map, but those counts may not always be visible.)

The system is also a visual information retrieval interface (VIRI)—that is, it is capable of retrieving the articles that co-cite the author names in the map. If a user wishes to explore the relationship between Plato and any other author listed, the user can click on the other name to place it in the Additional Authors box on the right in Figure 4. The user can then press the Search button, and the documents that co-cited Plato and the other author will be retrieved, as shown in Figure 5.

The user can then select one of the hyper-linked documents and ISI's full bibliographic record for that document will be shown.

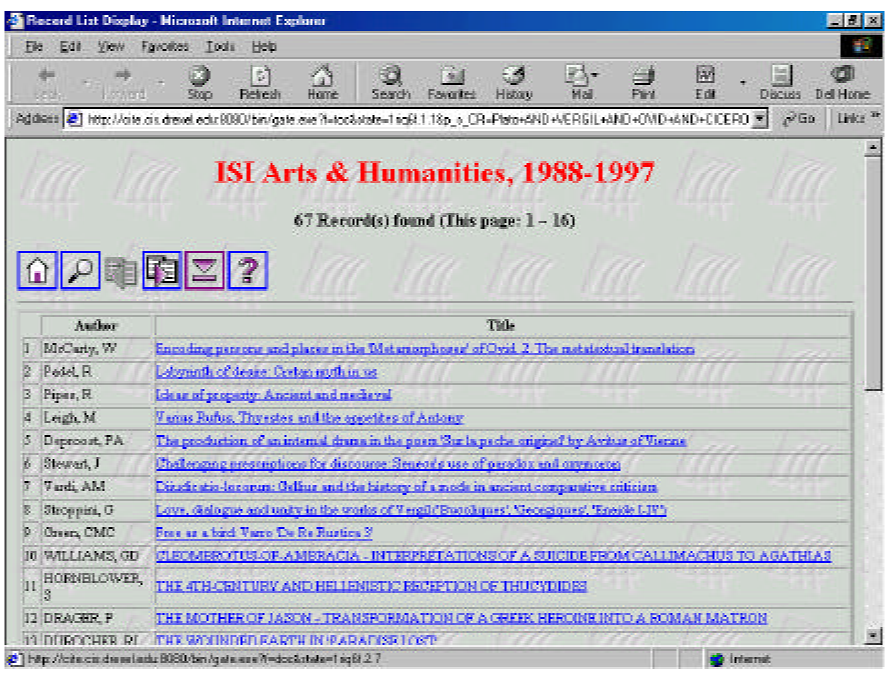

Figure 5: Retrieved Articles

The input to the two mapping algorithms is co-citation count data. Consequently, both map types reveal how citers consciously or unconsciously group the authors they cite. One would expect Plato and Aristotle to be close together on a map because they are the most famous Greek philosophers and are often compared and contrasted by experts and laypeople alike. Technically, however, they are close on the map because contemporary scholars indexed in the Arts & Humanities Citation Index often co-cite them. But that amounts to the same thing as continuing fame and influence. Their very high co-citation count in the journal literature indicates that they are still a dominant pair in Western culture.

1.4. Interpreting AuthorLink Maps: An Example

A fundamental difference between PFNETs and SOMs is how they indicate the relatedness of the authors. As noted above, PFNETs use line segments to connect authors, whereas SOMs use contiguity to do the same. Of the names that are not directly related, the linear distance is indicative of relatedness, i.e., the farther apart two names are in SOMs, the less related they are.

Another fundamental difference between the two maps is how a single author's prominence is shown. This prominence is calculated differently by the two mapping algorithms. In SOMs, a single author is prominent if he or she occurs with significant relative frequency; the more prominent, the larger the area that is "staked out" around his or her name. In PFNETs, very prominent authors are often centered within clusters with many single authors connected to them. They can be termed *stars* (Schvaneveldt, 1990).

The differences between the two algorithms is best illustrated with two maps based on the same author. Figures 6 and 7 show a SOM and PFNET based on René Descartes. For many of the authors co-cited with Descartes, the maps are equivalent, but there are a few differences in the way the space is partitioned by the two different methodologies and in the impact they have on the way names are grouped, especially in the identification of clusters.

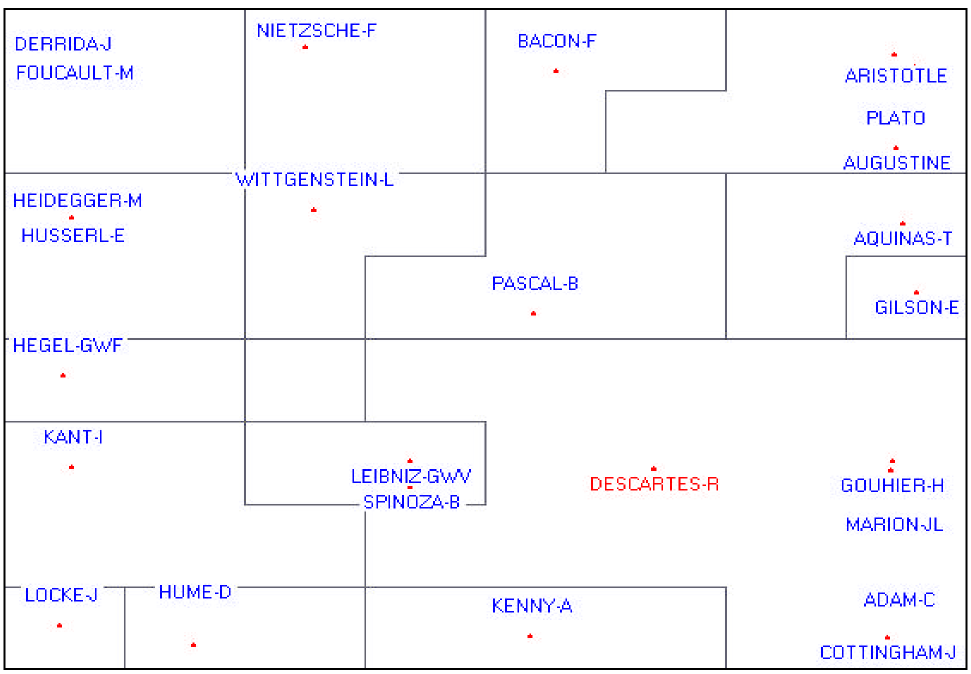

Figure 6: SOM of Descartes

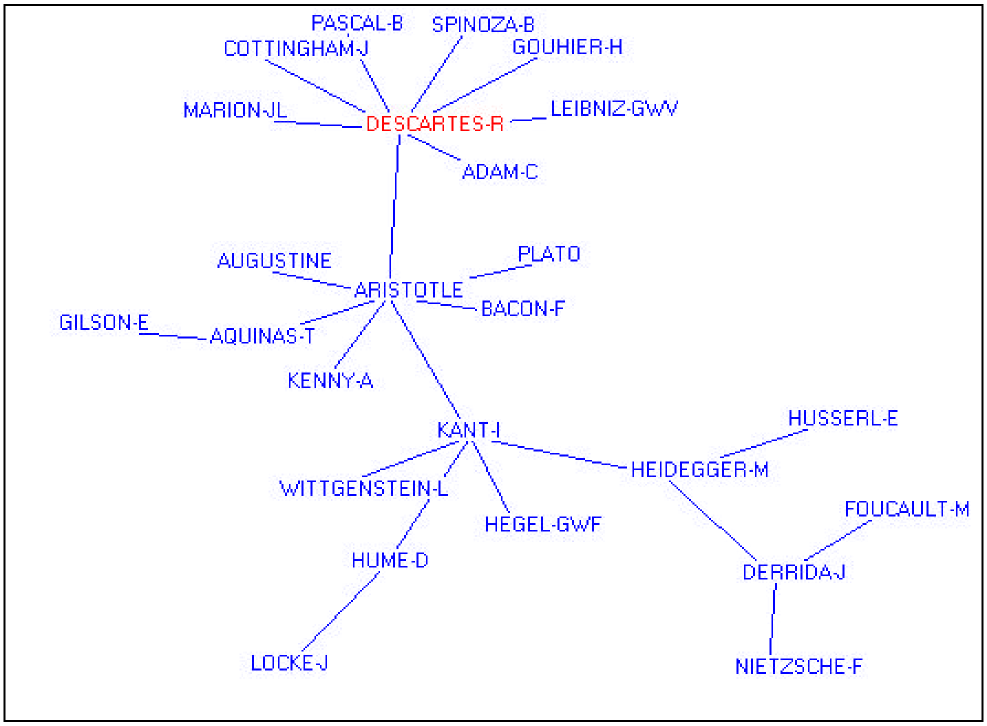

Figure 7: PFNET of Descartes

One can immediately see the grouping around Descartes in the two maps. Three of his 17th-century peers are Pascal, Spinoza, and Leibnitz, who share his rationalist bent. They are shown grouped via lines in the PFNET and are associated with him in the SOM by contiguous placement, but they are in separate areas. The biographers and other modern scholars associated with Descartes, e.g., J. L. Marion and J. Cottingham, are linked to him by lines in the PFNET and are enclosed with him in an area of the SOM.

The next cluster evident in the PFNET is the group associated with Aristotle. The famous philosophers Plato, Augustine, and Bacon are connected to him, but note also the direct connection with A. Kenny, a scholar who wrote on Aristotelian ethics. E. Gilson, a French Christian philosopher and historian of medieval thought, is tied to Aristotle indirectly through Aquinas.

Note that all of these authors are among the top 24 co-citees of Descartes, but some, such as Plato and Bacon, have their highest co-citation counts with Aristotle rather than with Descartes, and those higher counts are what the PFNET algorithm marks with links while eliminating the links associated with lower counts.

The placement of names associated with Aristotle in the PFNET is slightly different in the SOM. Here, Aristotle is directly related with Plato and Augustine, while Aquinas, Bacon and Pascal are in contiguous areas. Gilson is contiguous with Aquinas, but Kenny is more closely associated with Descartes on the other side of the map. Kenny translated Descartes' *Philosophical Letters.*

The third cluster is centered on Kant. It contains some great descendents of Descartes in the Western philosophical tradition. In the PFNET, Kant is linked with his younger contemporary, Hegel, and also with Wittgenstein and Hume, for reasons that could be probed through AuthorLink retrievals. (For instance, does the Hume-Kant-Descartes link reflect recent scholarly discussions of their psychological theories?) Heidegger was schooled in Kantian philosophy and studied with the phenomenologist Husserl. Derrida took the theories of phenomenology and used them in his interpretation of literature; he is similarly associated with Foucault through deconstructionism. Both Derrida and Foucault are influenced by the ideas of Nietzsche. But all are also discussed in the context of Descartes, and it is contemporary "Descartes studies," in the broad sense, that are being mapped here.

The linkages just described are similar in the SOM and form the left area of the map. However, Wittgenstein and Nietzsche are more closely related in the SOM. Heidegger and Husserl, as well as Foucault and Derrida, are also grouped together.

Arguments can be made for and against the placement of some of the names, and overall arguments can be made as to which type of map better represents a domain expert's knowledge. It is precisely these arguments that will form the basis of the remainder of this research, which is an effort to determine whether one type of map is better than the other in some sense and whether scholars prefer one type over the other.

1.5. Setting the Stage

Researchers have now used PFNETs and SOMs to visualize author co-citation data in several published articles. These mapping techniques hold promise as a means for exploring any field of study by novice and expert alike. The maps have also been used in AuthorLink, a prototype visual interface for information retrieval. The time is ripe to compare the two mapping techniques.

A problem in the past has been that the papers published on PFNETs and SOMs focused simply on the interpretation of the maps. However, this assumes that the maps are valid in the first place and can be criticized as *Petitio Principii* (Copi, 1972), also known as *begging the question*. This research will not assume the validity of the maps, but will instead submit that to empirical investigation. Maps will be scored numerically and compared statistically to get an objective comparison. They will also be judged by experts in the humanities to get a subjective comparison.

With the automation of the mapping process via the AuthorLink system, the co-citation record of any author cited in the database may be analyzed. Consequently, this research will explore both well-known and lesser-known authors.

2. RELEVANT LITERATURE

If MDS maps, SOMs, and PFNETs are used to help the user query a large collection of documents or browse a large general search space such as the World Wide Web, they become visual information retrieval interfaces (VIRIs). While many workers in computer science and information science are engaged in research in this area, they tend to focus on the retrieval capabilities only. Since the present research will not focus on the retrieval capabilities of author co-citation analysis (ACA), the broader literature on VIRIs will not be reviewed here. Instead, this chapter will focus on mapping techniques used in ACA and their evaluation as pictures of intellectual domains. It will lay the ground for a comparative study of two of ACA map types and how well they capture the cognitive maps of experts.

Extending the previous work by Small on the co-citation of single papers (Small, 1973), ACA seeks to analyze the combined works of authors so as to help define the intellectual structure of a discipline (White & Griffith, 1981). A major difference between ACA and Small's work on cited papers, is that in ACA the author's entire *oeuvre* is the unit of analysis as opposed to a single work (White & Griffith, 1981).

The underlying principle of ACA is that when two authors are frequently co-cited by many different papers within a particular field, those two authors are generally related in some way. For instance, in the bibliography of this work there are a number of articles cited, each with an author or authors who wrote the cited paper.[1] However, this work represents only the present author's research. If, however, hundreds of dissertations are examined and if two authors are frequently co-cited by the dissertation writers, then all of those writers have collectively suggested that the two frequently co-cited authors have something in common. Since disciplines cross-fertilize, the suggestion is not limited to a specific field but may come from different fields of study.

The first step in creating a map based on ACA is to obtain a list of authors in whom one is interested. This list may be obtained simply by specifying a number of authors, say 50, that one wants to study. A second method for selecting authors is to take the authors most highly cited in certain journals covered by ISI databases, as in White & McCain (1998) and Morris (2001). Yet another method to extract such a list from one or more works, such as textbooks, that summarize a field. For a general overview of these methods, see McCain (1990).

A different method is to select a single author of interest, a *nameseed*, and determine the authors most frequently co-cited with the seed author from a given bibliographic collection (White et al., 2000; Buzydlowski et al., 2002). This is the method of AuthorLink, as described above.

Having obtained a list of names to start with, the analysis of co-occurrences, i.e., the number of times each of the pairs of authors are cited in a collection of works, will give a

[1] It is important to note that, although many authors may be involved with a work, ISI bibliographic databases list only the first author for the cited references. ACA has traditionally credited only the first author in cited reference when co-citations are being analyzed, and this is the format this research will use.

metric to determine the strengths of the associations. The data structure that represents the co-occurrence of all of the different pairs is called a *co-occurrence matrix*. The row and column headings represent the authors, and the intersections of the rows and columns, i.e., the individual cells, hold the counts of the number of times each pair of authors is co-cited.

Because the pairwise comparison of different authors' co-citation counts grows quadratically, C(N, 2), it is nearly impossible to understand the implications of all of the derived data in a sizable matrix. For example, 25 systematically paired authors yield 300 co-citation counts; 100 authors yield 4950 counts! Consequently, visualization techniques are needed to explore the implications of the co-occurrence matrix.

The initial visualizations of ACA used non-metric multidimensional scaling (MDS) (Kruskal, 1978) to display the co-citation counts, or, rather, Pearson r correlations, a function of the counts (White & Griffith, 1981). In essence, MDS seeks to project a higher-order dimensionality onto a lower-order one, usually two dimensions. By giving each author name 2-D co-ordinates on the map, it reflects the ordering of the counts as distances between points representing names.

Among recent applications, Rorvig & Fitzpatrick (1998) used MDS to display documents for the TREC dataset. Ding (2000) used a system based on MDS, the Bibliometric Information Retrieval System (BIRS), to study users' search strategies. BIRS, which has certain similarities with AuthorLink, was shown to be helpful in forming and expanding their queries.

Another approach to visualization in ACA uses Pathfinder Networks. Pathfinder Networks (PFNETs) are graph-theoretic displays used to represent the salient linkages (edges) between co-occurring terms (nodes).

In a volume of research papers on Pathfinder Networks (Schvaneveldt, 1990), PFNETs were specifically applied to information visualization by Fowler & Dearholt and McDonald et al. with promising results.

C. Chen developed the use of PFNETs for displaying co-cited documents and authors (e.g., Chen, 1998; Chen 1999; Chen & Czerwinski, 1998). In a summary work on information visualization (Chen, 1999), Chen describes three studies of PFNETs on spatial ability, associative memory and visual memory. Although the original displays were based on two dimensions, others have applied those techniques to three dimensions, (e.g., Chen & Paul, 2001). The value of such extensions has been questioned, however, especially if nodes are not clearly labeled (White & McCain, 1997).

White (2003) proposes that PFNETs for author co-citation maps are best made with matrices of raw co-citation counts rather than matrices of Pearson correlation coefficients.

PFNETS have been used successfully in monolingual, translingual, and multilingual retrieval (Davis, 1997), where the relationships between the terms of the retrieval are shown in a graphical model. Also, PFNETs have been used to analyze the perceptual differences between waste management experts and the general public regarding terms used to describe nuclear waste (Martin et al., 1993). Since PFNETs are an integral part of the present research, a fuller exposition of them will be presented in Chapter 3.

Using techniques of artificial intelligence, Lin (1993; 1997) developed a third approach to visualization in author co-citation analysis: self-organizing maps (SOMs), also known as Kohonen feature maps, can be used to display the author points. In his doctoral dissertation, Lin (1993) studied the capabilities of a SOM for displaying bibliographic data. Terms co-occurring in the titles of articles were analyzed to indicate subject matter in an area of study. Lin suggested the comparison of different mapping algorithms to produce maps. Later, Lin (1996) compared SOMs, as implemented as a Graphical Table of Contents (GTOC) with a printed table of contents (TOC) to perform title searches. Three types of GTOC were generated. Two were based on title keywords, the third was based on keywords from the title and abstract, as well as the key document terms. No significant differences were found in the search success rates for the first two GTOCs, but the third GTOC was significantly less successful than the TOC. In terms of the time spent in searching, the 3 GTOCs took significantly longer to use than the TOC. Nonetheless, the users preferred using the GTOC to the TOC based on their comments.

Several other authors have extended or paralleled Lin's work. H. Chen (1998) studied the use of SOMs to explore the Entertainment subcategory in Yahoo! versus the traditional interface. Although no inferential statistics were generated from the study, the authors suggest that the SOM interface is a good tool for browsing, but not for searching. Also, based on anecdotal evidence from the users' comments, the graphical nature of the SOM was preferred to the traditional interface. Langus et al. (1996) used SOMs to explore document collections on the World Wide Web, but did not perform a user study to substantiate their performance. SOMs are also be integral to this research, and a more extensive description of them will be presented in Chapter 4.

Two previous studies that use human experts to validate ACA are of interest to this study. McCain (1983a, 1983b) compared the maps generated by MDS to the cognitive maps of experts in the fields of macroeconomics and genetics. The cognitive maps were obtained by card sorts—the same technique that will be used in the present study. There was a positive correlation between the MDS maps and the cognitive maps in both fields. Lenk (1983) took lists of leading authors as nominated by experts in various subjects and compared them to lists of frequently co-cited authors in the same subjects. His results showed marked overlaps between the lists.

As of now there is no specific research that formally compares the different information visualization techniques of ACA. There are, however, suggestions to do these comparisons. White et al. (1998) informally contrasted an MDS map of information scientists with a self-organizing map of the same set of authors and found that "they are in effect the same map, differing mainly in matters of nuance." (p. 59). White et al (2000) considered MDS maps, PFNETs, and SOMs and conjectured that "… PFNET clusters for a given field may be even more interpretable to domain experts than comparable clusters in other forms of mapping."

Based on the literature, then, there does seem to be a need to compare the three different visual approaches to ACA. However, it has been suggested that SOMs and MDS are alike (White, et al., 2000). Moreover, it will be shown later in this work that MDS and PFNETs are alike in their display of the names. Consequently, it will help reduce the complexity of this study to focus only upon the comparison of SOMs and PFNETs. The following two chapters will explore and explain each type of map. Further articles and books that are technically relevant to the mapping techniques will be cited there.

3. PATHFINDER NETWORKS

3.1. Computing Pathfinder Networks

Pathfinder Networks (PFNETs) were developed as a representation of concept association models in cognitive science. They have been suggested as an alternative to multidimensional scaling, providing “a more accurate representation of local data relationships” (p. 3) and a more appropriate metric when the data are not ratio-scaled (Schvaneveldt, 1990). PFNETs achieve this suggested advantage by incorporating two major elements: a more generalized distance metric based on the Minkowski Distance Metric and an extension of the triangle inequality.

The Minkowski Distance Metric, indexed in the PFNET algorithm by the parameter *r*, is defined as follows:

$$\sqrt[r]{a^r + b^r}\ .$$

The defined metric is a parametric equation that subsumes the traditional Euclidean Metric (r = 2), which is often used in traditional multidimensional scaling

$$\sqrt{a^2 + b^2}\ ,$$

as well as the graph-theoretic path length distance (r = 1)

$$a + b\ .$$

The Minkowski metric also allows for a parametric r value of infinity ($r \to \infty$), which produces the following limiting value:

$$maximum(a\ , b).$$

This parametric value, infinity, has been shown to be appropriate for ordinal data (Schvaneveldt, 1990).

The second element involved in the generation of a PFNET is the triangle inequality, which specifies that the sum of the distances of two sides of a triangle must be greater than or equal to the third side. Using the distance notation, d(a,b), to indicate the distance from point a to b, the triangle inequality requires that a third point, c, be restricted as follows:

$$d(a,c)\ \text{£}\ d(a,b) + d(b,c).$$

Schvaneveldt contends that it is important to relax the triangle-inequality restriction in different scenarios where distances or similarities are used to compute different metrics, such as multidimensional scaling.

Although the triangle inequality must hold in Euclidean space, the triangle inequality may not hold for other interpretations, such co-citation counts. For example, imagine a triangle consisting of three authors, White, McCain, and Lin, with the co-citation counts used to indicate the length of the line segments connecting them. If authors White and McCain are co-cited 100 times in a bibliographic database, and authors White and Lin are co-cited 50 times, nothing can be inferred about the co-citation of authors McCain and Lin; consequently, the triangle inequality is not applicable. Likewise, the triangle inequality may be violated in subjective estimates of similarity. Subjects may view two entities, A and B, as similar, and may view B and C as equally similar, but may use different judgment criteria when comparing A and C.

Although some early work examined metrics to allow for the violation of the triangle inequality (non-adherence), e.g., Hutchinson's NETSCALE procedure (Hutchinson, 1989), Schvaneveldt criticizes this early work as inadequate, since it only considered two of the links (sides) in determining the validity of a third link (side) (Schvaneveldt, 1990). PFNETs allow for an extension of the triangle inequality by examining paths of longer lengths (number of links), from a minimum of two (the traditional triangle inequality) to a maximum of n –1, where n is the total number of links in a network. The parameter which represents the number of links examined is represented in the PFNET algorithm by the letter *q*. (The use of the phrase "triangle inequality" in this case may be misleading, since the number of links considered may be greater than two—perhaps a better phrase would be "polygonal inequality.")

Graphs consist of a set of nodes and edges[2]. Networks are graphs with non-negative values assigned to the links (weights). Given the above definitions of *r* and *q*, PFNETs are a parametric family of networks and are indexed as PFNET(*r*,*q*). The networks are

[2] Connected networks have at least one path from every node to every other node. Fully connected networks link every node with every other node. It is possible for a network to not be fully connected; however, every network considered in this research is connected. For a general description of theory and applications of networks, see, e.g., Busacker and Saaty, 1965.

generated by examining each link in the original network. Links between nodes which violate the triangle inequality based on *q* links or fewer, as computed by a Minkowski Distance Metric with a parametric value of *r*, are considered less salient and thus removed.

The resulting network consists of all of the original nodes and the links that were not removed by the algorithm. By pruning the less salient links from the connected or fully-connected network, the algorithm eliminates much of the complexity—and visual noise—of the original network.

PFNETs are directly applicable to this research, since author co-citation data captured in a co-occurrence matrix can be readily represented by a network. The nodes of the graph represent the authors, and the link weights are given by the co-citation counts of all pairs of authors. The removal of all but the most highly weighted links reveals the most strongly related authors and usually makes for highly interpretable maps (White et al., 2000). An example of an interpretable PFNET, the Plato map from the first chapter, is reshown in Figure 8.

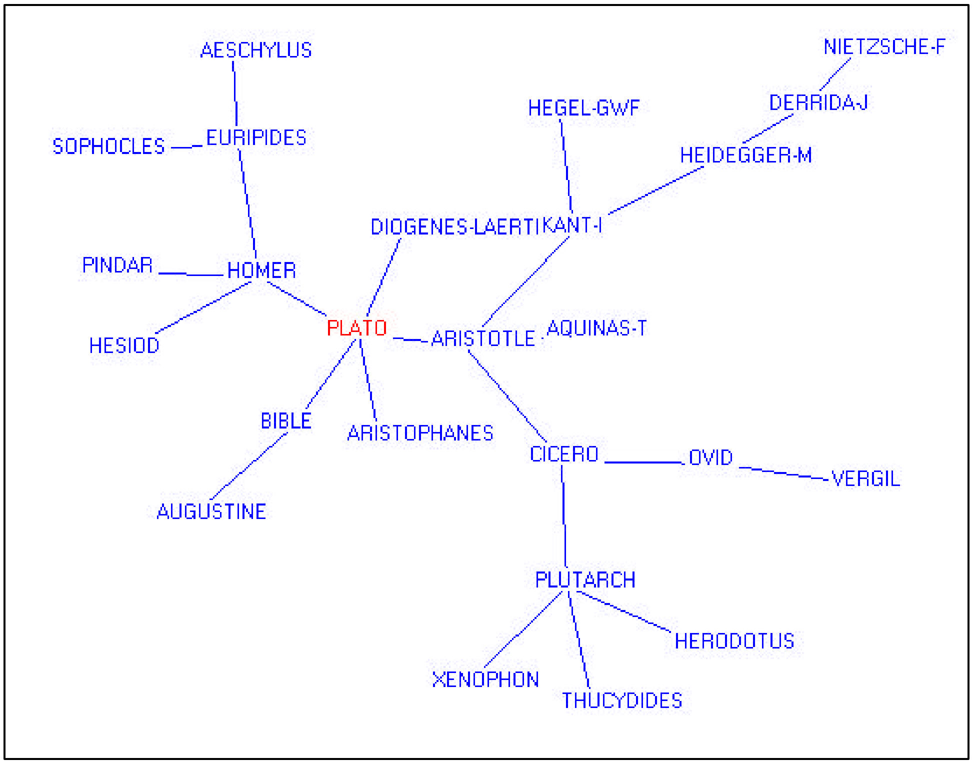

Figure 8: PFNET of Plato

3.2. Displaying Pathfinder Networks

Once the network is determined, it must be viewed on paper or a computer screen. The position of the nodes and links must be calculated so that they can be rendered onto a coordinate system. The PFNETs in this research are undirected graphs (i.e., links without any direction implied between nodes), and specialized algorithms for the display of undirected graphs are available. The process of assigning co-ordinates to vertices so that the resulting displayed graphs are pleasing to the eye is known as *embedding* (Eades, 1984). The process of embedding a coordinate system from a theoretical graph has been well studied. (For a comprehensive listing of research on the subject, see DiBattista, 1998.) Two major extensions of the algorithm suggested by Eades were developed by

Fruchterman and Reingold (1991) and Kamada and Kawai (1989), here abbreviated as F&R and K&K, respectively.

Criteria for evaluating embedding algorithms revolve around aesthetic considerations such as symmetry, evenly distributed nodes, uniform edge lengths, minimized edge crossings, and so on. C. Chen (1999) illustrates six different algorithms based on those criteria and describes three of them. Brandenburg (1995) studied the performance of five different algorithms using aesthetic considerations, efficiency, etc., and concluded, "…there is no universal winner." Although he showed that no single algorithm is best, the algorithm by Kamada and Kawai was chosen for this research for several reasons.

One reason is that the F&R may not reach configurations that are within the local minimum (Davidson, 1996), whereas K&K does. Another reason for the choice is that the K&K algorithm seeks to minimize the overall differences between all the graph's theoretical links and that of the embedded coordinates, whereas the F&R seeks only the minimize local distances amongst the graph's links.

It was the last reason, i.e., to model graph theoretic distance with Euclidean distances or path lengths among all vertices, that was the most significant. Moreover, the K&K algorithm subsumes another common visualization technique, multidimensional scaling (MDS), using Kruskal's methodology (cf. Kruskal 1978; Davison, 1983). Multidimensional scaling is a technique for mapping higher-order dimensional data onto fewer (often two) dimensions, so that the meaning of the underlying axes is revealed.

MDS has been used extensively in co-citation analysis (e.g., see McCain, 1990 for a general overview). As both Cohen (1997) and Krempel (1999) note, the K&K algorithm uses a criterion measure (spring) similar to that of multidimensional scaling (stress) for goodness of fit between distances on the map and differences in values of the original data.

The K&K algorithm models a system of springs (links) and rings (nodes). The rings are ordered so as to reduce the overall spring tension, computed as

$$\frac{1}{2}k_{uv}\left((\mathrm{d}(\mathrm{p}_{\mathrm{u}}, \mathrm{p}_{\mathrm{v}}) - \boldsymbol{\delta}(u,v))^2 \right)$$

where $d(p_u, p_v)$ are the Euclidean (embedded) distances and $\delta(u, v)$ are the graph-theoretic distances (k is an arbitrary constant).

The MDS-derived mapping coordinates are compared with the values in the original data and are adjusted until the differences, the stress, are within an acceptable limit. A measure of stress is computed as follows:

$$\sqrt{\frac{(\mathrm{d}(\mathrm{p}_{\mathrm{u}}, \mathrm{p}_{\mathrm{v}}) - \boldsymbol{\delta}(u,v))^2}{\mathrm{d}(\mathrm{p}_{\mathrm{u}}, \mathrm{p}_{\mathrm{v}})^2}}\ .$$

Although the two metrics are slightly different, the squared distance between the derived distance and the graph-theoretic one is the core of each.

The similarity of MDS to the K&K embedding algorithm in PFNETs is a justification for eliminating MDS in favor of the two mapping techniques that this research will explore.

4. SELF-ORGANIZING MAPS

4.1. Computing Self-Organizing Maps

Neural networks are a promising extension of artificial intelligence (AI), since they directly mimic the workings of the human brain (Dreyfus, 1997) and are less labor-intensive than other traditional AI techniques, such as expert systems, which require significant human interaction. What is unique to neural networks, as compared to other machine-learning techniques, is their ability to learn in the presence of noise and their ability to predict in the absence or degradation of a full dataset.

Neural networks are defined by the atomic elements of a system, neurons, which are iteratively trained by comparing the current state of the system with the proposed or desired state, based on examples provided to the system. A set of examples called the *training set* contains categories that are already identified. The system is trained to predict these categories on the basis of other variables (predictors) associated with them. This is known as *supervised learning*. Self-organizing maps (SOMs), also known as Kohonen maps after the technique's developer, differ from traditional neural networks in that they are created with categories that are not explicitly presented in the training data but that the system learns to recognize. This technique is known as *unsupervised learning*.

Self-organizing maps have the ability to suggest high-level organization while preserving distance relationships as faithfully as possible (Kohonen, 1989). The SOM's ability to maintain a topological ordering from the n-dimensional space of the original data to a lower-dimensional space allows hierarchical and/or clustering organization to be maintained. Moreover, neural networks are inherently robust, in that a single errant or atypical value will not adversely affect the training. These attributes of SOMs make the application of the methodology to author co-citation analysis attractive.

Doszkocs et al. (1990) described the application of neural (connectionist) models in general to information retrieval. Lin (1997) and C. Chen (1998) applied SOMs in particular to bibliographic and textual data. To create a semantic map based on bibliographic data, the data are converted to a vector-space model (Salton, 1989). Each term (author) is an element in a Boolean vector. Each vector corresponds to a bibliographic record and consists of elements of either zero or one, depending upon whether the term (author name) appears in the record. For instance, if Brown, Jones, and Smith are authors of interest and Brown and Smith co-occur in a cited reference but Jones does not, the vector would be <1, 0, 1>.

SOMs make data visible to the user in one, two, or three dimensions. This research will focus on two-dimensional SOMs, which provide more information than the one-dimensional and are less overwhelming than the three-dimensional. Three-dimensional displays have many advantages, but in the context of information visualization it has not been shown that they are worth the cognitive effort (Nielsen, 1998; A. Skupin, personal correspondence). They have been criticized as resembling computer games when designers favor visual pizzazz over bibliographic purpose (White et al., 2000).

The self-organizing map itself is created by defining a rectangular, two-dimensional grid of nodes. For example, a grid may contain 10 columns and 14 rows, for a total of 140 individual nodes. Each node has associated with it a vector whose elements correspond to the number of unique terms in the bibliographic data. The initial values of the elements of the vectors in the grid are randomly assigned, usually random numbers between 0 and 1.

Upon start of training, a bibliographic record is chosen at random (with replacement), represented as a vector, and compared to each node vector in the grid. The node vector whose Euclidean distance is closest to the record vector is chosen as the *winning node*, and the values of the elements of the vector of the winning node are updated to bring them further into agreement with the selected record. There are various specific formulas for updating the values of the winning node, but a general form is:

$$W(t+1) = W(t) + \alpha(t)[x(t) - W(t)].$$

The above function is an iterative function of the training cycle, t. The general formula shows that the new weight for a node, $W(t+1)$, is a function of the current weight, $W(t)$, adjusted by the distance from the bibliographic record to the current weight, $x(t) - W(t)$, proportionally adjusted by the adaptive gain term, $\alpha(t)$. The adaptive gain term is also a function of the training cycle, t, with the value being slowly decreased according to the training cycle, eventually reaching a value of zero.

The nodes surrounding the winning node—its *neighborhood* (e.g., the eight nodes surrounding the middle node in a three-by-three submatrix)—are also updated to reflect the current bibliographic record's value. This process of random selection of a bibliographic record, computation of the winning node, and updating the node and its neighborhood repeats many times—from 1,000 to 25,000 or more. As the process continues, the area of the neighborhood decreases, as does the magnitude of the adjustment to the winning and neighboring nodes.

When the process is complete, the terms (authors) are arranged on the two-dimensional grid. Each author name has a vector associated with it, such that the defined position in the vector is given a value of 1, and the other elements are given a value of zero. For example, for the first author, the first element will be one and the remaining elements will be zero. For the second author, the second element will be one, with the first, third, etc., elements zero. This same scheme applies to all remaining authors.

The author names are placed on the maps such that the node with the highest value in the vector is labeled with the corresponding author. For example, if the node in row 1, column 2, has the second element of the vector as its maximum, then the second author will be associated with it. All of the surrounding nodes that have a similar profile, e.g., second element greatest, will be considered part of the label. Since SOMs maintain the topological ordering of the original space, proximate authors are more similar and more distant authors are less similar by various criteria.

4.2. Displaying Self-Organizing Maps

The display of results in trained self-organizing maps is straightforward (unlike Pathfinder Networks). The display of the nodes themselves is simple, as the original configuration, say 10 columns and 14 rows, is rendered as equidistant dots on a page. To avoid distraction, only the nodes that are most strongly associated with an author are shown. The SOM for Plato appears in Figure 9.

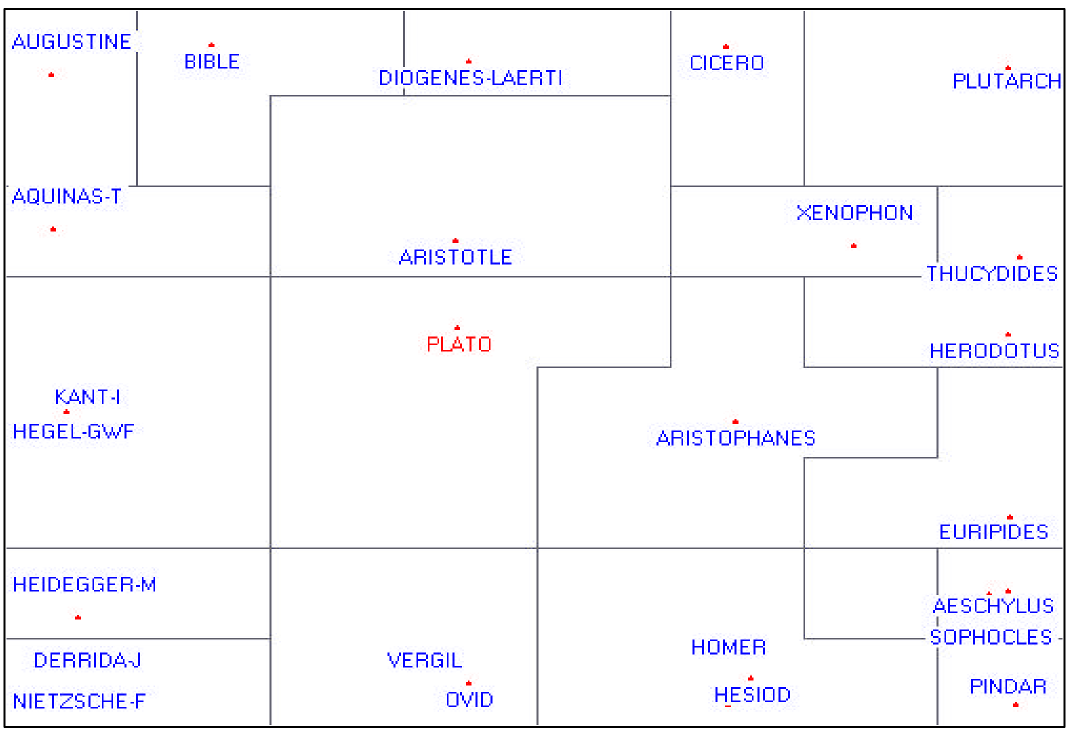

Figure 9: SOM of Plato

Although Figure 9 has 140 nodes associated with 140 points in the 10 by 14 rectangular grid, only the 25 nodes (points) with the strongest matches to the various authors are displayed, along with the authors' names. Information in addition to the labeled nodes can be displayed, and the techniques for doing so are described in Lin (1993). Rectangular areas have been delineated by line segments in the node matrix by finding contiguous nodes which share the same maximum weight element in the node's weight vector (they could also be color coded). The size of the area indicates the prominence of the author.

5. METHODOLOGY

5.1. Overview

The purpose of this research is to compare Pathfinder Networks, PFNETs, with Kohonen self-organizing maps, SOMs, in rendering author co-citation relationships. Two studies are planned: (1) whether the similarities and dissimilarities of authors in a field of study, as understood by experts, are better represented by SOMs or PFNETs; and (2) which of the two map types is preferred by the users.

This chapter will focus upon the materials used for the study, the procedures used for the generation and extraction of the required data, and the union of the two as framed in the research questions.

5.1.1 Data

The data used in this study are from the Arts & Humanities Citation Index (AHCI) for the decade 1988 to 1997. AHCI indexes important journals in the areas of the arts and humanities. The 1988-97 dataset was provided by the Institute for Scientific Information (ISI), located in Philadelphia, Pennsylvania. ISI is a respected source of bibliographic data, and the quality of the records is high. Furthermore, the size of the dataset is significant: it contains approximately 1.26 million records, reflecting primarily journal articles, but also other journal items such as notes, letters, book reviews, and reviews of literatures. These are called "source" items by ISI, because they are the sources of the citations appearing in the cited reference field of each record. Each record consists of 59 data fields (author, title, and so on). The main field used in this study is the cited reference field.

The cited reference field is a repeating field—that is, it repeats as many times as needed to capture each of the set of references at the end of a source item. The number of cited authors within records of AHCI varies greatly, from none to more than 1,000—a quantity that exceeds AuthorLink's processing capabilities. To enable the system to process all records, a limit of 300 unique cited authors was enforced. Less than one percent of records were thereby reduced. The total number of rows for the resulting dataset was approximately seven million. The number of unique cited authors was approximately 1.3 million.

Figure 10 shows an AHCI record of a source item—an article from the *New York Times Book Review* that cites six well-known novels in its cited references field. Cited authors—for example, Jong E (Erica Jong) and Mailer N (Norman Mailer)—are a *part* of this field, and are obtained by omitting the data on which of their works are cited. (It may be noted that ISI abbreviates the names of many works, such as "Advertisements for M" for what is actually Mailer's *Advertisements for Myself*.) Jong and Mailer here exemplify co-cited authors; this particular article would increase their co-citation count by one. Appendix A gives another example of a full record, the field descriptions, and a corresponding parsed and extracted record.

```
02410305   GENUINE ARTICLE#: 419HF   NUMBER OF REFERENCES: 6
TITLE: On writers and writing: What goes around comes around
AUTHOR(S): Jefferson M
JOURNAL: NEW YORK TIMES BOOK REVIEW, 2001 (APR 15), P31-31
PUBLISHER: NEW YORK TIMES, 229 W 43RD ST, NEW YORK, NY 10036-3959 USA
ISSN: 0028-7806
LANGUAGE: English   DOCUMENT TYPE: Article
JOURNAL SUBJECT CATEGORY: HUMANITIES, MULTIDISCIPLINARY
CITED REFERENCES:
  BANKS M, GIRLS GUIDE TO HUNTI
  JONG E, FEAR OF FLYING
  BRIDGET JONESS DIARY
  EGGERS D, HEATBREAKING WORK ST
  WALLLACE DF, INFINITE JEST
  MAILER N, ADVERTISEMENTS FOR M
```

Figure 10: Sample record from Arts & Humanities Search online

Due to the frequent cross-fertilization of fields, the cited references in the source publications may touch disciplines outside the traditional arts and humanities, such as sociology, computer science, artificial intelligence, and information science. Consequently, a number of authors outside the arts and humanities may be included in the cited articles.

5.1.2. The Computer System Used to Generate the Maps

AuthorLink automates both the determination of author co-citation counts and the process of converting the counts to maps (Lin, 2001a). This system was used to generate the output for this research from the AHCI data.

AuthorLink has three tiers. The first tier generates a list of authors most frequently co-cited in records with a single, or seed, author. It also calculates the number of their co-citations with the seed author. For example, the system returns the 24 authors most frequently cited with Plato, in descending order. Then, all 25 are systematically paired with Boolean AND logic, and their co-citation counts are obtained. There are a total of 300 (=25 * 24) co-citation counts based on 25 authors. A specialized database, Noah, was created to retrieve the necessary information quickly. It is based on a co-occurrence calculus using optimized indices for co-occurrence data, with programs written in C (Kernighan & Ritchie, 1978.) An overview of the co-occurrence calculus is given in Appendix B.

The middle tier is composed of a CGI server allowing the execution of C programs and a Java server to allow the execution of a servlet. The C programs take the co-citation counts and determine the coordinates of the labels, lines, author names, etc., for both the SOMs and the Pathfinder Networks. The servlet is responsible both for passing the original author name to determine the other associated authors, and for passing the 25 author names to the database to retrieve the co-citation counts.

The third tier is the user interface. This consists of a Java applet which allows for the entry of the original author name and the display of the twenty-four associated authors. It also displays the maps and allows for the direct manipulation of the names so that overlapping labels can be shifted and documents based on the authors can retrieved by double clicking on the labels.

The system architecture is shown in Figure 11.

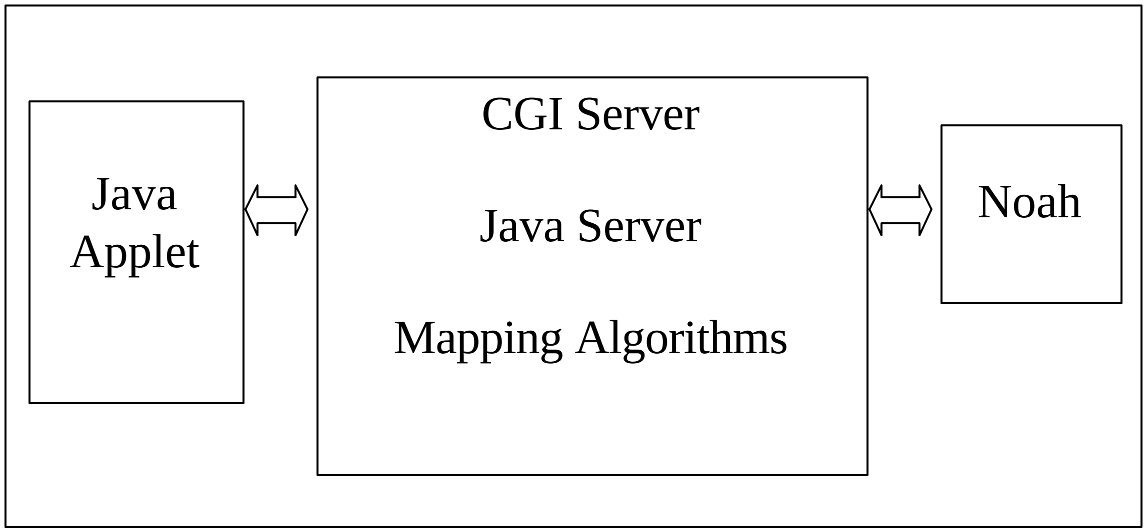

Figure 11: Architecture of AuthorLink

5.2. Procedure

The following steps were taken to produce the data of this study:

- Selecting the experts
- Selecting author names used for the experiment
- Extracting the experts' mental maps
- Creating a data structure to represent the groupings
- Determining the groupings that exist on generated visual maps.

Each will be addressed in turn in this section.

5.2.1. Selecting the Experts

Since the main purpose of this study was to measure the correspondence of SOMs or PFNETs with the mental maps of people well versed in a field of study, the subjects chosen for this study were experts on particular authors. The criterion of expert status was a doctor of philosophy degree in a field of the humanities. An alternate criterion was a doctor of philosophy degree in Information Systems, if the subject had an extensive background in a humanities field. Appendix C lists the area of expertise of the subjects.

The experts were selected using a convenience sampling technique. A total of thirty-two were contacted for their participation in the study. Twenty were ultimately involved. Twelve were eliminated for various reasons. Six never responded to the initial email requests. Three responded that they were too busy to participate. One felt it was not possible to do the card sorts because of the many possible associations of authors. Two were willing to participate, but were removed, for a reason to be explained in Section 5.2.3. The request-for-participation letter appears in Appendix D.

When the experts agreed to be subjects, they were given materials based on two different sets of author names. The instructions accompanying those materials are in Appendix E. Upon return of the materials, an interview was scheduled and a general account of the system was sent. The latter appears in Appendix H.

The data were collected over the course of one year. The first expert was interviewed during May 2001, and the twentieth, during April 2002.

Appendix F lists the affiliation of the experts. A discussion of the demographics of the experts is in Section 6.3.1.

5.2.2. Selecting Author Names Used for the Experiment

ACA maps portray fields (or disciplines or specialties) in terms of groups of authors that are created by citers in the aggregate. These maps have been called "the field's eye view" of key authors, and are based on co-citation counts to which many citers contribute (White 2003). Whatever automated technique is used to map author groups— MDS, SOMs, or PFNETs—the co-citation counts remain composite in nature. They can be taken as pooled judgments about how closely authors are interrelated.

Citers are of course unconscious of how their co-citations contribute to the groupings of an ACA map. However, data parallel to co-citation counts can be obtained by pooling the *conscious* judgments of experts as to which authors belong together. Such judgments can be elicited directly from individual experts through card sorts (McCain 1983a, 1983b, 1986). Once pooled, they can be considered a *composite* mental map of a particular field.

In the present study, the seed author chosen for the composite mental map was Plato. This was because people trained in the humanities would presumably know a good deal about him and the authors associated with him, most of whom are very famous in Western cultural history. (They also represent a wide range of humanistic endeavor—not only philosophy, but history, theology, religion, poetry, drama, and biography.) Thus, it was of interest to see how well a SOM and a PFNET of authors co-cited with Plato matched the experts' mental map of the same authors.

AuthorLink was used to return the twenty-four names most highly co-cited with a Plato—twenty-five names in all. Although the system can return *all* the co-citees associated with a nameseed, such a list is sometimes thousands of items long. The set of names was kept at twenty-five to reduce the expert's cognitive load.

Table 1 lists the AuthorLink output on Plato and his top 24 related authors in alphabetical order. (ISI style renders names as surnames first, with initials placed after. The hyphens are called for by the AuthorLink search software.) Using these names as the stimulus in a common judgment task allowed results for all the experts to be combined.

Table 1: 24 Authors Associated with Plato

AESCHYLUS	DIOGENES-LAERTIUS	NIETZSCHE-F
AQUINAS-T	EURIPIDES	OVID
ARISTOPHANES	HEGEL-GWF	PINDAR
ARISTOTLE	HEIDEGGER-M	PLUTARCH
AUGUSTINE	HERODOTUS	SOPHOCLES
BIBLE	HESIOD	THUCYDIDES
CICERO	HOMER	VERGIL
DERRIDA-J	KANT-I	XENOPHON

Even so, an experiment with a composite mental map does not tell the whole story. Co-cited author maps have been promoted for use in document retrieval or as graphics accompanying intellectual histories and research reviews (White, 1990). If they are to be accepted as such, they must not require too much supplementary explanation, and this would argue that they must match existing mental maps of individual scholars reasonably well. It therefore seemed essential to test how well SOMs and PFNETs corresponded to the expert's *individual* mental map of authors co-cited with a particular seed. That is what the second research question was intended to test.

Thus, four maps were generated for this research. One pair was the same for all experts —the SOM and a PFNET based on Plato. The other pair was a SOM and PFNET based on each expert's unique nameseed. Since ACA mapping must support the research efforts of individuals, this second nameseed represented a personal interest of each expert. When the experts were initially contacted, they were asked to supply five authors about whom they were knowledgeable. The five were searched in AuthorLink to learn the one most frequently cited in the AHCI database. Based on this *interest nameseed,* a list of 24 other related authors was created with AuthorLink for each expert and presented for a separate card-sorting experiment. A list of the selected interest nameseeds for each expert is given in Appendix C. (If it turned out that a name had already been chosen by another expert, then the second highest nameseed was used, so that each expert would have a unique one.)

5.2.3. Extracting the Experts' Mental Maps

Card sorting is a common research technique to determine degrees of similarity of words, concepts, and in this case, authors. Subjects are asked to sort items of interest into smaller, non-overlapping groups (see, e.g., Borgatti, 1996; Davidson, 1983.). This makes visible how items are perceived, based on which items are sorted with other items. The sorted piles can in turn be rendered as the subjects' mental or cognitive maps. Card sorting has been previously used as a validation technique for ACA maps (McCain 1983a, 1983b, 1986).

The names of the authors generated on AuthorLink with Plato and the interest nameseed were entered on twenty-five index cards, one to a card, and the experts were presented with the two sets. For each set, the experts were asked to create an indefinite number (>1) of piles of author cards. Authors were to be put into a pile if the expert thought of them as similar (on unspecified grounds). Authors were to be put in their own single piles if the expert found them unlike anyone else. Authors that the expert was unfamiliar with were to go into a single combined pile. After the piles were assembled, the expert was instructed to label each card in a pile with the pile number. The cards in the pile that contained unfamiliar author names were to be labeled with a "?." This method of card sorting is described in Borgatti (1996). Appendix E gives a description of the instructions to the experts.

A rule was set that no more than five authors from the list of twenty-five that could be labeled "?," because it was felt that that demonstrated insufficient expertise to participate in the study. Such a limit seemed a good way of differentiating between experts and non-experts for a particular author seed. Two experts from the original list of 32 were eliminated from the study by this rule.

The remaining twenty experts demonstrated good knowledge of the authors they were presented with. Table 2 lists the number of unknowns, i.e., number of cards labeled with an "?," for the selected experts.

Table 2: Grouping Statistics for the Card Sorts

	Card Sort Groupings	
	Plato	Interest
Expert #	# Unknown	# Unknown
1	0	0
2	0	1
3	2	3
4	1	0
5	2	0
6	1	3
7	0	1
8	0	0
9	5	2
10	0	5
11	0	0
12	0	0
13	1	2
14	1	1
15	2	0
16	0	0
17	2	2
18	0	3
19	0	2
20	0	0
Median:	0	1
Max:	5	5
Min:	0	0

After the card sorts were returned, the author was contacted and an interview was conducted. The length of the interviews was generally about one hour, with a range of about twenty minutes to about one-and-a-half hours. Most of the interviews were done face-to-face; five interviews with distant experts were done over the phone. Appendix F lists the locations of the experts and their institutions.

The experts had not seen the AuthorLink maps of Plato or their interest nameseed before they sorted their cards. They did not see these maps until their interviews, which took place after their cards had been returned. Thus, they were not influenced in their sorts by PFNET or SOM visualizations of the same data.

Sorts by a fictitious expert are given in Table 3. (They are purely an example, not a real ordering.) Each group shows how the authors are related in the mind of that expert. For example, in Pile 1, Plato, Aristotle, Diogenes, and Augustine are considered to be directly related to one another. The Bible, in Pile 4, is not considered similar to any of the other authors. The five authors at right in Pile ? are unknown to the expert.

Table 3: A Possible Grouping of the 25 Authors Associated with Plato

Pile 1	Pile 2	Pile 3	Pile 4	Pile 5	Pile ?
PLATO	EURIPIDES	HEIDEGGER	BIBLE	CICERO	AESCHYLUS
ARISTOTLE	HERODOTUS	NIETZSCHE		VERGIL	PINDAR
DIOGENES	OVID	KANT		PLUTARCH	ARISTOPHANES
AUGUSTINE	HOMER	HEGEL		XENOPHON	SOPHOCLES
	AQUINAS	DERRIDA		THUCYDIDES	HESIOD

5.2.4. Creating a Data Structure to Represent the Groupings.

This section will describe the data structure used to represent the different card-sort groupings so that they can be compared.

The various groupings can be represented by a *co-membership matrix*. Each of the twenty-five authors is represented by a row and column heading. If an expert groups certain authors in the same pile, this is represented by a "1" at the intersection of all the different pairings of those authors' names. Authors not grouped with other authors or grouped alone will have a value of "0."

A co-membership matrix corresponding to the fictitious card sorts of Table 3 is shown in Table 4. Plato, Aristotle, Diogenes, and Augustine were grouped in one pile, and so their row/column intersections (shaded) are set to one. The intersections of an author with himself, e.g., Plato-Plato, are zero, and so the diagonal element will have no significance. The Bible was placed in a group by itself and so its row/column intersections will contain zeroes. Authors in the "?" pile are treated as singletons; their corresponding columns and rows have zero values, since they add no information.

Table 4: A Possible Grouping of the 25 Authors Associated with Plato

	PLATO	ARISTOTLE	PLUTARCH	CICERO	HOMER	BIBLE	EURIPIDES	ARISTOPHANES	XENOPHON	HERODOTUS	AUGUSTINE	KANT-I	AESCHYLUS	THUCYDIDES	SOPHOCLES	OVID	HESIOD	DIOGENES	HEIDEGGER-M	DERRIDA-J	NIETZSCHE-F	PINDAR	HEGEL-GWF	VERGIL	AQUINAS-T
PLATO	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
ARISTOTLE	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
PLUTARCH	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
CICERO	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
HOMER	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
BIBLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EURIPIDES	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
ARISTOPHANES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XENOPHON	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
HERODOTUS	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
AUGUSTINE	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
KANT-I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0
AESCHYLUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THUCYDIDES	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
SOPHOCLES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OVID	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
HESIOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIOGENESI	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEIDEGGER-M	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	0	0
DERRIDA-J	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0
NIETZSCHE-F	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0
PINDAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEGEL-GWF	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0
VERGIL	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
AQUINAS-T	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

5.2.5. Determining the Groupings that Exist on Generated Visual Maps

A method is needed to compare the groupings in the card sorts to those in SOMs and PFNETs, to see how well each map accords with the expert's cognitive map. Since each map type has a different format, two different methods will be discussed. They are called *circling*.

For each map, the first step is to label each author with the number of the pile into which that author was sorted by the expert. From Table 3, for example, Plato, Aristotle, Diogenes, and Augustine would be labeled 1; the Bible, 4; Aeschylus, Pindar, etc., ?, and so on.

For the SOM, the following rule was then used:

> Code as positive all pairs of authors that have the same pile number and that are in the same bounded area. Also code as positive all pairs of authors that have the same pile number and that are in areas with a common side. (The positive code is a 1 in the matrix cells where the paired authors intersect. The corresponding negative code is a 0.)

As an illustration, consider the positioning of three authors from Table 3 in an imaginary SOM in Figure 12. Plato and Aristotle were in Pile 1 and Euripides was in Pile 2.

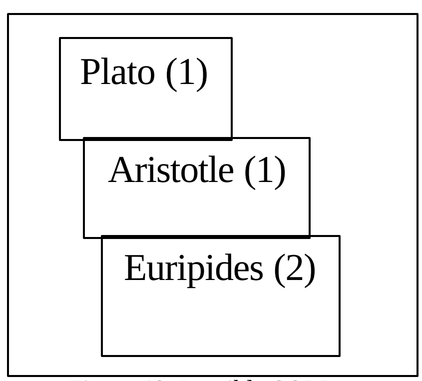

Figure 12: Possible SOM

According to the rule, since the areas encompassing the authors Plato and Aristotle share a common side and have the same group number, 1, that pair would be given a 1 in the corresponding cell in the co-membership matrix. The pair Aristotle-Euripides would be given a 0 in the matrix, since, although their areas have a common side, they do not have a common pile number. The pair Plato-Euripides would also be coded 0 since they do not share a common side.

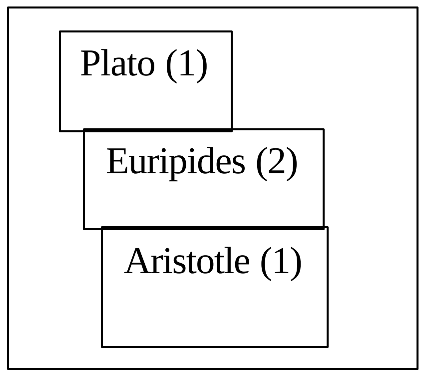

Figure 13: Another Possible SOM

If another SOM is given as in Figure 13, then the pairs of Plato-Euripides and Euripides-Aristotle would be coded 0, since these common-sided author pairs lack the same pile number. Plato and Aristotle would also be coded 0 since they do not share a side.

The SOM algorithm places more than one name in a rectangular region when the vectors associated with the names have a similar profile—i.e., are almost identical in terms of their maximum element. The circling rule for SOMs addresses this situation by applying the same rule as above: if they are in the same area and have the same group number, then they are coded 1; if not, they are coded 0.

For the PFNET, the following rule was used:

> Code as positive all pairs of authors that have the same group code and that are directly linked.

For example, consider Figure 14, a sub-tree of a larger PFNET based on the names Plato, Aristotle, and Euripides with their pile numbers from Table 3.

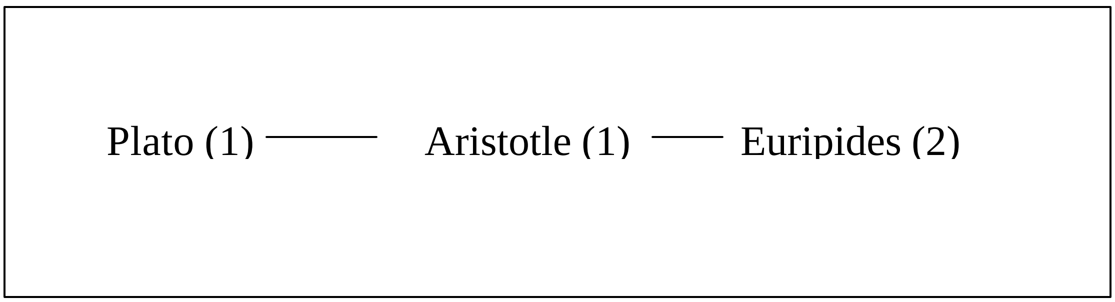

Figure 14: Possible PFNET

In this case, since Plato and Aristotle are directly linked and are coded with the same pile number, they would be given a 1 in the cell where they intersect in the co-occurrence matrix. However, the pair Aristotle-Euripides would be given a 0, since, although they are directly linked, they do not have the same pile number. The pair Plato-Euripides would be given a 0 since they are not directly linked and are not from the same pile.

Now consider a sub-tree from another possible PFNET, as shown in Figure 15.

Plato (1) —— Euripides (2) —— Aristotle (1)

Figure 15: Another Possible PFNET

Here, no directly linked author pair has the same pile number assigned to it. Plato-Euripides and Euripides-Aristotle would be coded 0 in the co-membership matrix. So would Plato-Aristotle, since they are not directly linked, even though they have the same pile number.

Finally, for each of the circlings, the transitive property was applied. If Author A and Author B were coded as positive, and Author B and Author C were also coded as positive in the same map, then Author A and Author C would also be coded as positive. By applying the transitive property, the maps could be directly compared to the card sorts, since the card sorts exhibit this property. That is, if Authors A, B, and C are in the same pile, then the individual pairs are related. As the individual pairs are related, then so are all of the pairs.

Table 5 and Figures 16 and 17 show the application of the circling rules and the transitive property on a full set of data. Table 4 shows the card sorts based on the names associated with Plato. Figure 16 shows the circling performed, based on the rules for a PFNET. Figure 17 shows the circling performed, based on the rules for a SOM.

Table 5: Example of a Card Sort

PLATO

Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - ?
aristotle	homer	aeschylus	cicero	aquinas-t	derrida-j	Thucydides
hegel-gwf	ovid	aristophanes	herodotus	augustine		diogenes-laertius
heidegger-m	pindar	euripides	hesiod	Bible		
kant-i	vergil	xenophon	plutarch			
nietzsche-f		sophocles				
plato						

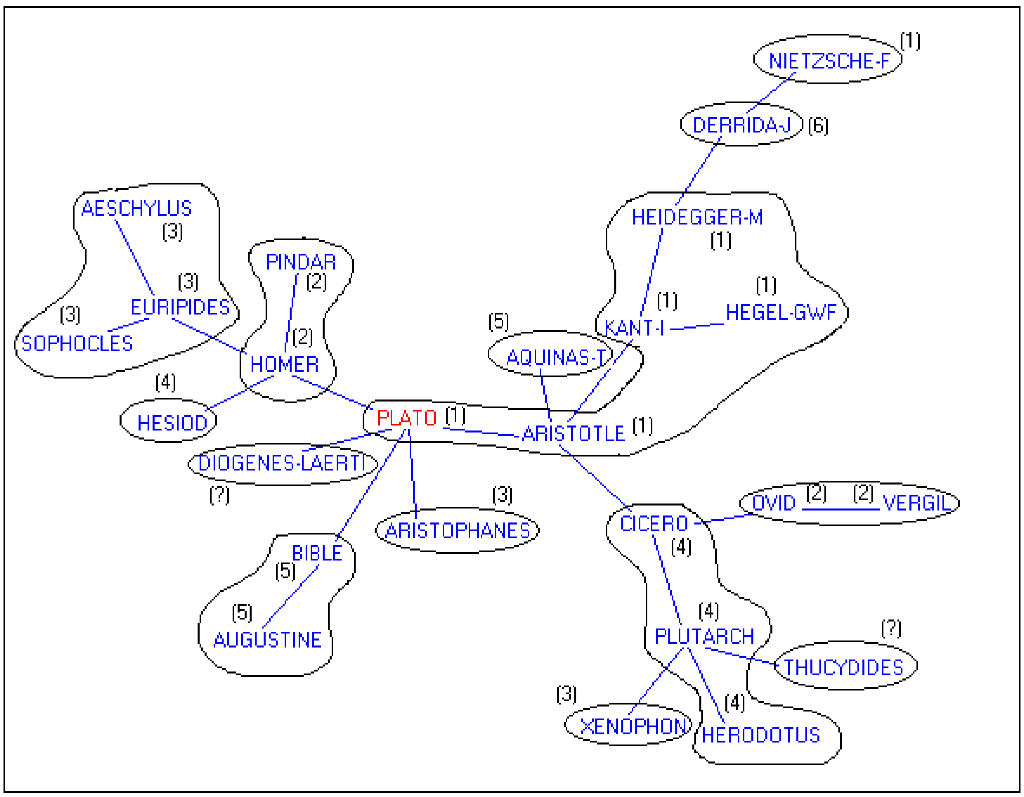

Figure 16: Numbered PFNET

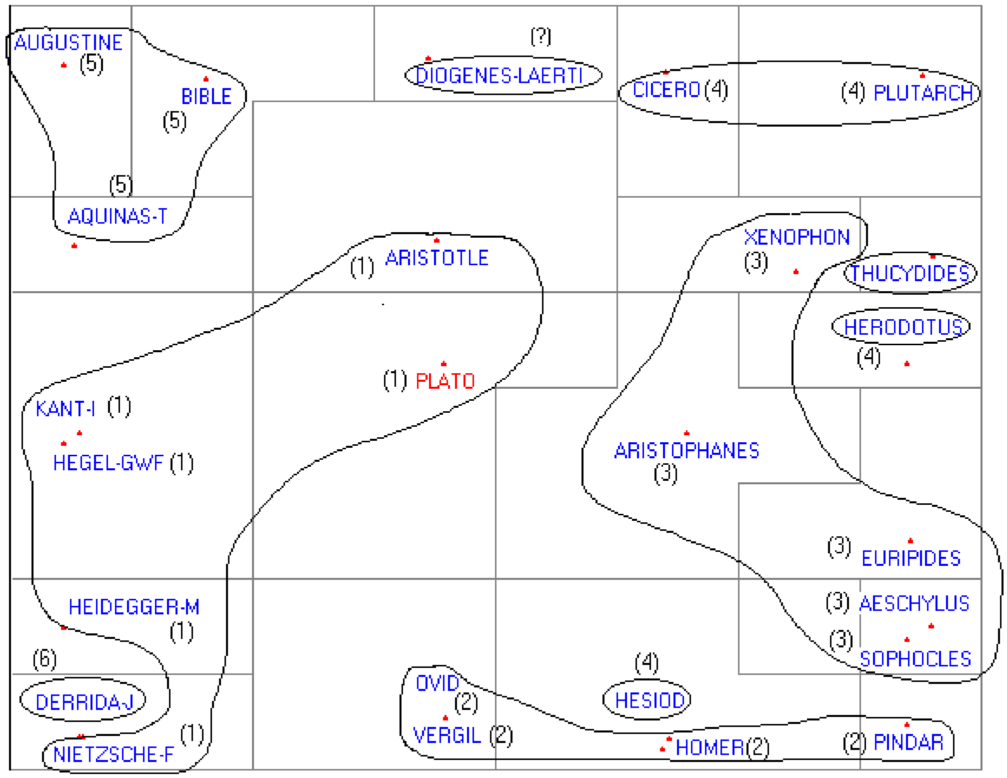

Figure 17: Numbered SOM

The card sort data were converted to map circling by hand and are shown in Appendix G for all of the experts. The associated groupings were entered into a computer with the aid of software written by this author and were stored in Microsoft Excel. The data were double entered to ensure accuracy. The data were analyzed using Microsoft Excel, SPSS, and UCINet.

5.2.6. Combining the Co-Membership Matrices

Six co-membership matrices were collected for each expert—the three for Plato included one based on the card sort, a second based on the SOM circling, and a third based on the

PFNET circling. The other three duplicated these types for the interest nameseed chosen by each expert.

It is important to note that the 1's in the matrices for Plato may be summed over all twenty experts since they are based on the same author names on the rows and columns. However, the 1's in the matrices for the different interest nameseeds cannot be summed because none has the same author names on its rows and columns.

5.3. Research Questions

Having defined 1) the subjects, the data, and the system; and 2) the data collection procedures and the corresponding data structures, this section will show how those elements will be used to answer this study's research questions.

As previously mentioned, this research focuses on the correspondence of the SOM and PFNET maps to the card-sort choices of the experts, which reflect their mental maps. There are two components to this comparison. The first is how well each visual map type does in reproducing the experts' *joint* cognitive map made with Plato as nameseed. The second is how the two map types do in reproducing the *individual* cognitive map each expert has of a particular author—the map made with the interest nameseed. These two components generate two separate questions. The third question will consider the preferences of the experts as to map type.

5.3.1. Research Question 1

The first research question is:

> **R1:** How well do SOMs and PFNETs based on one famous author correspond to the experts' *composite* mental map of that author?

The test compares matrices for each visual map type with a matrix representing the experts' composite mental map of Plato, as illustrated in Figure 18. (The three boxes are linked with lines to show that the circlings of the lower two matrices depend on the card sorts in the top one.) The gray double-headed arrows represent the two statistical comparisons to be made. Each comparison focuses solely on the correspondence of one of the computer-generated maps to the experts' composite cognitive map.

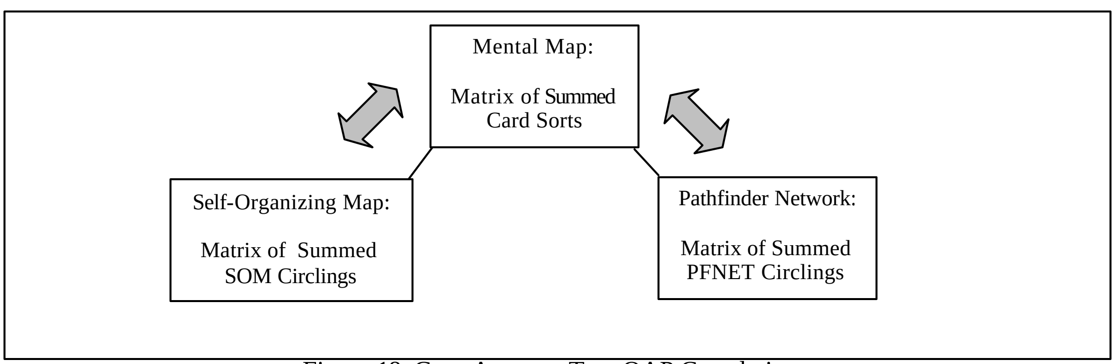

Figure 18: Gray Arrows: Two QAP Correlations

Since there are two visual maps, a SOM and PFNET, and one cognitive map, there will be two separate tests. In the first, the matrix of the summed co-membership matrices of the Plato card sorts will be compared to the matrix of summed co-membership matrices of the SOMs, based on all of the circlings. In the second, the matrix of the summed co-membership matrix of the same Plato card sorts will be compared to the summed co-membership matrices of the PFNETs, based on all of the circlings.

A statistic is needed that gives the degree of similarity of two matrices and associates a probability with that degree of similarity. The statistic used is based on the quadratic assignment paradigm (QAP) (Hubert and Schultz, 1976). The quadratic assignment paradigm statistic compares two matrices, a *data* matrix, D, and a *structure* matrix, S. A statistic , Γ_0 , is computed, based on the product-sum of the two matrices:

$$\Gamma_0 = \sum_{i,j} d_{i,j} \bullet s_{i,j} \, .$$

The measure Γ can be thought of as an un-normalized correlation coefficient. (In UCINET, the software used here, the statistic computed is actually Pearson's correlation coefficient; see Borgatti, 1999.) The statistic Γ is then re-computed for all possible permutations of the rows and columns of the structure matrix to examine other matrix combinations. If the data matrix is similar to the structure matrix, the initial value, Γ_0 , should be large compared to the Γ-distribution based on other permuted versions of the structure matrix.

There are N! ways to permute the rows and columns of an N x N matrix. This would be computationally intractable with 25 x 25 matrices required for this study, so formulas or repeated random permutations are used to estimate the expected value and variance of the

Γ-distribution. A probability is calculated from what is observed, given the distribution. A small probability indicates that the correlation observed is not likely to have occurred by chance. (In computing the QAP statistic, UCINET uses random permutations of rows and columns to estimate the expected value and variance of the Γ-distribution.)

For two separate tests, there are two separate hypothesis statements of the same form:

> Null Hypothesis: The groupings obtained from the card sorts are uncorrelated with the groupings obtained from the visual (SOM or PFNET) map.

Since there are two null hypotheses based on the groupings obtained from the circling of the SOM and the circling of the PFNET, two p-values will be computed using the QAP statistic. One will be the probability calculated from the comparison of the card sort co-membership matrix to the SOM circling co-membership matrix. The other will be the probability calculated from the comparison of the card sort co-membership matrix to the PFNET circling co-membership matrix.

The p-values are compared to a traditional critical value, 0.05, to determine the answer to the first research question. *Either* map type, *neither*, or *both* may be sufficiently similar to the expert's mental map to be statistically significant.

Once the two QAP correlations are obtained, it is possible to test for a significant difference between them. This allows a conclusion to be drawn as to whether one map type, SOM or PFNET, corresponds to the experts' mental map of Plato significantly better than the other. The statistic used will be that of a modification of Hotelling's T test (Cramer, 1994).

5.3.2. Research Question 2

Whereas the first research question examines the overall correspondence of each map type with the experts' joint cognitive map, the second question will compare the correspondence of each map type with the individual card-sort map generated for each expert's author of interest.

> **R2:** How well do SOMs and PFNETs based on personally chosen authors correspond to the experts' *individual* mental maps of these authors?

The data used to answer this question are based on twenty interest nameseeds (who include figures as diverse as Arnold Thackray, Virginia Woolf, Dell Hymes, Richard Rorty, Andy Warhol, Donald Worster, and Lucretius; For a full listing, see Appendix C.) Thus, there will be twenty different comparisons, one for each expert. As with Plato, each expert has one co-membership matrix for the card sort, another for the SOM circling, and a third for the PFNET circling. But, unlike the Plato data, 1's in the individual matrices cannot be combined (summed) because each contains different co-cited authors.

The measures and statistics required for Research Question 2 also differ from those required for Research Question 1. That is because there will be twenty different pairwise comparisons, one for each expert, and if separate statistical tests were used for each of them, the problem of multiple comparisons of the probabilities would arise (see Neter et al., 1985). Therefore, a single test is needed that makes all of the comparisons simultaneously. Figure 19 illustrates the general setup. The boxes are again linked with lines to show that the circling data in the SOM and PFNET matrices depend on the card sort data. However, instead of three matrices that are each the sums of 20 separate matrices, we now have 20 separate sets of three matrices each. The gray double-headed arrow here represents a single t-test by which SOMs will be directly compared with PFNETs in capturing the personal mental maps of 20 experts. It resembles a single ANOVA test that replaces many pairwise t-test comparisons, and it involves difference scores.

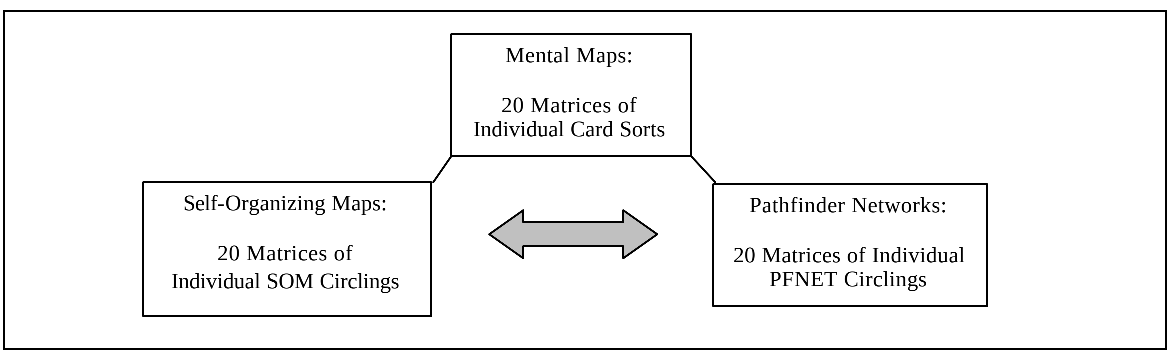

Figure 19: Gray Arrow: Paired t-test

Note that the co-membership matrices are symmetric—e.g., if Author A and Author B are grouped (= 1), so, too, are Author B and Author A. They can, therefore, be reduced to their upper triangles. The upper triangles for two fictitious co-membership matrices (based on seven of the twenty names associated with Plato) are shown in Table 6. One is for an expert's card sort; the other is for a PFNET circling.

Table 6: Two Abridged Co-Membership Matrices

Abridged co-membership matrix based on fictitious card sort	NIETZSCHE-F	DERRIDA-J	HEIDEGGER-M	FOUCAULT-M	KANT-I	HEGEL-GWF	NIETZSCHE-F
NIETZSCHE-F	0	**1**	1	0	1	0	0
DERRIDA-J	**1**	0	0	1	0	1	1
HEIDEGGER-M	0	0	0	0	1	1	1
FOUCAULT-M	0	0	0	0	0	1	0
KANT-I	0	0	0	0	0	0	0
HEGEL-GWF	0	0	0	0	0	0	1
NIETZSCHE-F	0	0	0	0	0	0	0

Abridged co-membership matrix based on fictitious PFNET circling	NIETZSCHE-F	DERRIDA-J	HEIDEGGER-M	FOUCAULT-M	KANT-I	HEGEL-GWF	NIETZSCHE-F
NIETZSCHE-F	0	**1**	0	0	1	0	0
DERRIDA-J	**1**	0	0	1	0	1	1
HEIDEGGER-M	0	0	0	0	1	1	1
FOUCAULT-M	1	0	0	0	0	1	0
KANT-I	0	0	0	0	0	0	0
HEGEL-GWF	0	0	0	0	0	1	1
NIETZSCHE-F	0	0	0	0	0	0	0

The upper-triangular vectors for the card sort matrix and PFNET circling matrix are shown in row-major form in Table 7. A metric for comparing the vector of a circled map with the vector of the card sort, a *co-membership agreement measure* (CAM), will compare the number of matching 0's and 1's. As illustrated in Table 7, twenty of the 21 cells agree in their binary codes (cell 2 does not), so a CAM score of 20 is assigned. Each CAM measure will be indexed by a subscript—CAM_P or CAM_S—depending on whether it was derived from a PFNET or a SOM.

Table 7: Scoring the Difference of Two Vectors

CARDS	<1, **1**, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0, 0,1>
PFNET	<1, **0**, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0, 0,1>
CAM_P	20

Other measures of agreement are sometimes used to determine the similarity of binary vectors (see, e.g., Narusis 1997). For instance, it can be argued that only positive ("1") scores should be used to determine agreement, since non-positive ("0") scores do not add any information. However, it can be shown that the final product of the CAM score, the CAM_d (to be defined shortly), is equivalent under both definitions. The current definition of CAM will be used since it ranges from 0 to a maximum score regardless of the number of groups produced by the expert.

Given the data shown in the previous examples, a 7 x 7 matrix has 21 (= C(7,2)) possible elements to consider for the upper-triangular vector. Given the 25 x 25 matrices that this study uses, the corresponding vectors have 300 elements (= C(25,2)).

For each CAM, the larger the value, the better the agreement, with a maximum value of 300 (total agreement) and a minimum value of 0 (no agreement).

There will be two CAM scores for each expert. One will be the CAM_P score based on the agreement between the card sort co-membership matrix and the circling for the PFNET. The other, CAM_S, is the score for the agreement between the card-sort co-membership matrix and the circling for the SOM.

Finally, to compare the difference in measures of the congruence of the PFNET with that of the SOM, one CAM score will be subtracted from the other for each expert. This difference measure will be denoted as CAM_d (= CAM_P - CAM_S).

Table 8: Fictitious Scores of 5 Experts

Expert #	CAM_P	CAM_S	CAM_d
1	15	13	2
2	13	18	-5
3	17	17	0
4	20	18	2
• • •			
20	17	19	-2
AVERAGE	17.2	17.8	-0.6

The subtraction for each of the experts will produce twenty signed integral numbers ranging from zero (i.e., both maps were the same in relation to the card sort) to ± 300 (i.e., one map was in total agreement with the card sort while the other map was in total disagreement). For instance, a fictitious abridged result table for the twenty experts is shown in Table 8. The data shown is based on a maximum score of 20.

Each CAM score, CAM_P and CAM_S , is based on the agreement of the cognitive map with each PFNET and SOM respectively. If the two map types correspond equally for each expert, then CAM_d , the difference between the two CAM scores, will be zero, or nearly so. See, for example, Expert No. 3's results in Table 8. Although the agreement between card-sort and map-circling scores was not perfect (i.e., each CAM score was 17, and the maximum is 20), each did equally well, and the difference is zero.

To answer Research Question No. 2, a statistic based on the difference measures as determined above is needed. If the two map types are alike in how they correspond to the card sort for each expert, then the average difference in the co-membership agreement scores will be zero, or nearly so. The average difference score will be denoted as $\overline{CAM}_{\Delta}$. This leads to the following Null Hypothesis, corresponding to Research Question No. 2:

$$\text{Null Hypothesis: } \overline{CAM}_{\Delta} = 0.$$

The alternate hypothesis is that one map type corresponds better than the other, i.e., the $\overline{CAM}_{\Delta}$ is significantly different from zero, and the sign of the value will indicate which map type is more congruent. Since the SOM score is being subtracted from the PFNET score, a positive average indicates that the PFNETs are more congruent and a negative score indicates that the SOMs are more congruent to the card sort. Since either direction is to be considered, a two-tailed test is indicated for the alternate hypothesis.

The statistical test used to examine the null hypothesis is a t-test using paired comparisons (because each difference is from the same expert). The t-test will determine the overall probability of the hypothesis that there is no difference in the congruence of the two map types. The result of the t-test will give the answer to Research Question 2.

An level of significance, alpha, of 0.05 will be used for the paired t-test. The t-test will be two-sided. A delta (or difference) value of at least 0.8 will be regarded as important. Given this alpha and delta, a sample size of 20 will yield a statistical test with the power of 0.924. (Statistical power is a measure of the probability that a difference will be detected when, if fact, the difference does exist.)

5.3.3. Research Question 3

Finally, although one map type's superiority perhaps may be determined statistically, users may still prefer one map type over the other because it suggests more intriguing comparisons, or has a more attractive format, or even for reasons not known to the users themselves.

It is also of interest, therefore, to know whether experts prefer one of the two types of visual maps. Whereas the first two questions call for strictly quantitative treatment, this third suggests the consideration of qualitative as well as quantitative data.

R3: Is one map type, SOM or PFNET, preferred by experts?

This question calls for a kind of vote. However, reasons for a preference can be quite varied. Accordingly, the experts were encouraged to give their opinions as answers to open-ended questions. AuthorLink is Web-based, real-time, and capacious enough to allow them to input almost any name of their choosing. While they used the system, an audiotape was made of their general comments and reactions.

Prior to the interview, the experts were given a written explanations of AuthorLink and the methods of this study. The text appears in Appendix H. At the interview, they were shown for the first time the SOMs and PFNETS based on Plato and their interest nameseeds and were asked to describe any groupings or clusters they perceived. Afterward, they were directed to log onto the AuthorLink System and to type in any names they wished. They then were asked to describe what they saw and to give their opinions of the maps. The list of questions asked during the interview is shown in Appendix I. Asking experts to talk aloud as they perform their tasks is similar to the methodology described in Lewis and Reiman (1994) for capturing user reaction to interfaces.

The audiotapes were transcribed and read to determine if there were any overriding issues. Salient features and issues of the interviews are addressed in Chapter 7. A fully-transcribed interview for one of the subjects will be found in Appendix J.

6. RESULTS

6.1. Research Question 1

As previously discussed, the following is the first research question and corresponding null hypothesis:

> **R1:** How well do SOMs and PFNETs based on one famous author correspond to the experts' *composite* mental map of that author?
>
> Null Hypothesis: The groupings obtained from the card sorts are uncorrelated with the groupings obtained from the SOM or PFNET visual map.

Since there are two null hypotheses, one for the SOM and for the PFNET, there will be two QAP correlation statistics and two corresponding p-values.

The correlation calculated from the comparison of the card sort co-membership matrix to the SOM circling co-membership matrix will be referred to as TEST-S. The correlation calculated from the comparison of the card sort co-membership matrix to the PFNET circling co-membership matrix will be referred to as TEST-P. As mentioned in Section 5.3.1., the correlation is the QAP version of Pearson r, and the associated significance is the probability that a value as large as the observed r occurred by chance alone.

Tables 9 and 10 show the results as calculated and output by UCINET.

Table 9: QAP Correlation between SOM Circling and Card Sort

QAP MATRIX CORRELATION TEST-S	
Observed matrix:	Plato SOM
Structure matrix:	Card sort
CORRELATION	
Observed value:	0.968
Significance:	0.000

Table 10: QAP Correlation between PFNET Circling and Card Sort

QAP MATRIX CORRELATION TEST-P	
Observed matrix:	Plato PFNET
Structure matrix:	Card Sort
CORRELATION	
Observed value:	0.783
Significance:	0.000

The QAP statistic shows that the correlation is highly significant for each map type when compared to the card sort. TEST-S has an observed correlation of 0.968 ($p < 0.001$) and TEST-P had an observed correlation of 0.783 ($p < 0.001$). This suggests that *both* visual maps correspond very well to the cognitive map based on the composite perceptions of 20 experts. The accumulated matrices for the Plato card sorts and map circlings are shown in Appendix K.

Although the SOM has a higher correlate value, both p-values are statistically significant. The results show that both methods, *each by themselves*, appear to capture much of what the experts think about the arrangement of the authors associated with Plato.

Having determined that each visual map is significantly correlated with the experts' cognitive map, it is also possible to test whether the difference between the two r's is significant. The statistic used to test this is Williams' modification of Hotelling's T test (Cramer, 1994), called the T2 Test.

The calculation of the T2 Test yields a value of –25.58 ($p < 0.001$), indicating that there is a highly significant difference between the two correlated values. That is, the correlation between the SOM and the expert's map is greater than the correlation between the PFNET and the experts' map, and the difference is very unlikely to be attributable to chance.

6.2. Research Question 2

The following is the second research question:

> **R2:** How do SOMs and PFNETs compare in their congruence with an expert's individual mental map of an author?

For each expert, there is a card sort, a PFNET circling, and a SOM circling, each based on an interest nameseed. Each of the three elements is converted to a vector, as discussed in Section 5.3.2. For each expert, the card sort vector was compared to: 1) the SOM circling vector; and, 2) the PFNET circling vector. The vector comparisons yield a co-membership agreement measure (CAM) score for each of the two comparisons (also discussed in Section 5.3.2). Higher CAM scores indicate greater agreement. The null hypothesis is that the average difference in the CAM scores for SOMs and PFNETs is zero:

Null Hypothesis: $\overline{CAM}_{\Delta} = 0$.

Table 11 shows the two CAM scores , the difference scores (CAM_d), and the overall $\overline{CAM}_{\Delta}$ score, -13.30. A two-tailed paired-sample t-test was used to determine whether the hypothesized difference between the two means is zero. It gave a t-value of approximately –3.6, with a corresponding p-value of less than 0.01. Table 12 shows the results as output by Microsoft's Excel, using the Data Analysis Add-in.

Table 11: Co-membership Agreement Measures and Average

Expert #	CAM_P	CAM_S	CAM_d
1	266	292	-26
2	255	290	-35
3	275	282	-7
4	285	297	-12
5	274	288	-14
6	273	267	6
7	287	286	1
8	295	295	0
9	286	294	-8
10	269	300	-31
11	236	286	-50
12	281	271	10
13	284	291	-7
14	282	292	-10
15	250	295	-45
16	281	281	0
17	285	288	-3
18	284	296	-12
19	273	295	-22
20	286	287	-1
$\overline{CAM}$	275.35	288.65	-13.30

Table 12: Results of the t-test

t-Test: Paired Two Sample for Means

	CAM-P	*CAM-S*
Mean	275.35	288.65
Variance	207.2921053	70.13421053
Observations	20	20
Hypothesized Mean Difference	0	
Df	19	
t Stat	-3.586331464	
P(T<=t) two-tail	0.00196872	

As the null hypothesis is $\overline{CAM}_{\Delta} = 0$, the calculated $\overline{CAM}_{\Delta} = -13.30$ with the corresponding p-value suggests that we may fail to accept the null hypothesis. In other words, there is a significant difference between the two maps in terms of their congruence with the card sorts of the experts.

Looking at the direction of the differences, the Self-Organizing Map (or Kohonen feature map) appears to be more congruent to the experts' opinions. As shown in Table 11, the SOM did better for fifteen of the experts, as indicated by the negative differences. In two cases, the results were tied. In three cases, the PFNET did better, with a minimum difference of 1 and a maximum difference of 10.

It is interesting to note that the CAM score associated with the PFNET had a much wider variance than that of the SOM: 207.3 versus 70.1. The minimum and maximum values for the PFNET, 236 and 295, had a range of 59. The minimum and maximum values for the SOM, 267 and 300, had a range of 33. Of other interest is that there is no linear correlation between the two paired scores; the Pearson r is 0.0. Figure 20 shows a graph of the two scores plotted against one another. If a linear correlation existed, the points would have formed around a line; instead, a formless cluster appears.

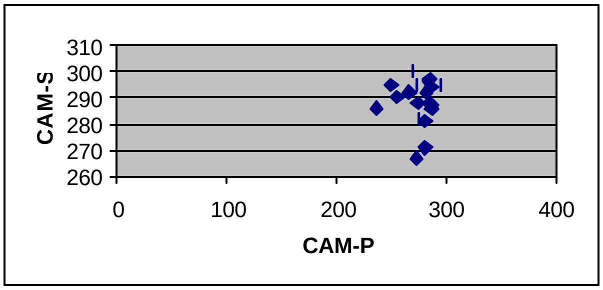

Figure 20: Graph of CAM-P versus CAM-S

A standard assumption in using a t-test is that the data are normally distributed, or nearly so. A quick, visual technique to determine whether a set of data is normally distributed is the quantile-quantile, or Q-Q, plot. A Q-Q plot displays the quantile values of the observed data against the quantile values of a normal distribution with the same mean and variance of the data. If the data is normally distributed, then the data should form a straight line, or nearly so.

The Q-Q plot of the difference data in Figure 21 shows a nearly linear trend. The application of the t-test in this case seems to be warranted.

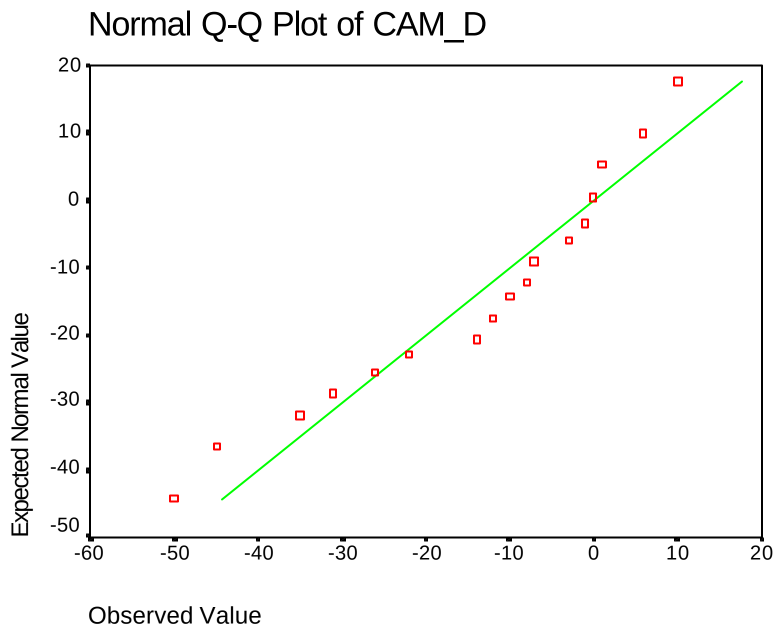

Figure 21: Quantile-Quantile Plot of Differences

Nonetheless, the data are not perfectly normally distributed; otherwise they would form a perfectly straight line. It may be prudent, therefore, to execute a non-parametric test in which the assumption of normality is not required. The non-parametric test used is a sign test, which examines only the sign, not the magnitude, of the differences. Looking only at the sign of the differences in Table 11, one finds that only 3 of 18 signs are positive (2 values were tied at zero and lacked signs). Using tables developed for this test (e.g., Kanji, 1995), the difference between map types is again significant at the 0.01 level.

6.3. Research Question 3

As previously stated, the third research question is:

> **R3:** Is one map type, SOM or PFNET, preferred by experts?

The primary method of determining the answer was an interview with each subject. The qualitative results are presented in Chapter 7. Nonetheless, a quantifiable final question was put to each expert at the end of the interview:

> For your participation in the study, we will give you a free subscription to the system. However, only one of the two maps can be used for the first six months and you must now choose which one you wish to use. Which map type do you choose? Why?

The "Why?" will be addressed in the next chapter. Here, since each of the experts was forced to choose one of the two map types, we can see whether there is a significant difference between the number of respondents choosing each type. The null hypothesis is that there is no difference in preference: the same number of people would chose a SOM as would chose a PFNET—a "50–50 split."

In the observed data for the twenty respondents, nine chose the SOM and eleven chose the PFNET as the map they would want if they could use only one. The distribution is shown in Table 13. (Details of the experts' preferences are shown in Appendix L).

Table 13: Distribution of Map Preference

Preference	N	Observed Proportion	Test Proportion	Exact Sig. (2-tailed)
PFNET	11	.55	.50	.824
SOM	9	.45		
	20	1.00		

Testing for a significant difference between what was observed (0.45, or 9 out of 20) and what the null hypothesis suggests (0.50, or 10 out of 20), a binomial exact test fails to reject the null hypothesis ($p = 0.824$). As shown in Table 13, the difference in preference is not significant.

6.3.1. Effects of Demographics

It was of interest to see if any of the demographic characteristics of the experts influenced their preferences as to a map type. Three categories of characteristics were examined: area of expertise, gender, and institutional affiliation.

There were three major areas of expertise: history, language/literature, and philosophy. Appendix L shows the individual preferences by category. Table 14 shows the distribution of the area of expertise by the map preference.

Table 14: Counts of Area of Expertise by Map Preference

	Area of Expertise			
Map Preference	History	Literature/ Language	Philosophy	Total
PFNET	3	5	3	11
SOM	2	5	2	9
Total	5	10	5	20

A chi-square test and a Fisher's exact test were performed in SPSS. They show that area of expertise has no effect on map preference, with p-values of 0.904 and 1.0, respectively. Table 15 shows the statistics and the associated p-values.

Table 15: Statistics of Area of Expertise by Map Preference

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	.202	2	.904	.
Likelihood Ratio	.202	2	.904	1.000
Fisher's Exact Test	.385			1.000
N of Valid Cases	20			

There were equal numbers of male and female subjects in the subject pool. Table 16 shows the distribution of gender by map preference.

Table 16: Counts of Gender by Map Preference

	GENDER		
Map Preference	Female	Male	Total
PFNET	5	6	11
SOM	5	4	9
Total	10	10	20

A chi-square test and a Fisher's exact test performed in SPSS show that gender has no effect on map preference, with p-values of 0.653 and 1.0, respectively. Table 17 has the statistics and the associated p-values.

Table 17: Statistics of Gender by Map Preference

Chi-Square Tests	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.202	1	.653	1.000	.500
Continuity Correction	.000	1	1.000		
Likelihood Ratio	.202	1	.653	1.000	.500
Fisher's Exact Test				1.000	.500
N of Valid Cases	20				

Finally, the style of bibliometrics as presented in this research has long been associated with the College of Information Science and Technology at Drexel University. It was considered possible that intellectual or social ties with people in that College could influence the preferences of experts from Drexel as opposed to other universities. Appendix F lists the institutions from where the experts were selected and Appendix L shows the map preferences by affiliation. Table 18 indicates the institution from which the experts came, either Drexel University or Other (i.e., not Drexel University). The table shows that there were an equal number from each category.

Table 18: Counts of Institutional Affiliation by Map Preference

	Institution		
Map Preference	Drexel	Other	Total
PFNET	4	7	11
SOM	6	3	9
Total	10	10	20

A chi-square test and Fisher's exact test in Table 19 shows that there is no association between the institutional affiliation of the expert and choice of map type (p = 0.370 for both).

Table 19: Statistics of Institution by Map Preference

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.818	1	.178	.370	.185
Continuity Correction	.808	1	.369		
Likelihood Ratio	1.848	1	.174	.370	.185
Fisher's Exact Test				.370	.185
N of Valid Cases	20				

7. SUMMARY OF INTERVIEWS

This section will explore the experts' comments about the maps themselves and about the AuthorLink system. Prior to the interview, the experts received an explanation of the system and how the visualizations were constructed. The interview began with a question as to whether the explanation was understood. (Experts who had not had a chance to read the materials were asked to read them during the interview.) The explanation sent to the experts is given in Appendix H.

The interviews were audio-taped, with an initial announcement of this fact. The experts were then shown the SOM based on Plato and asked to find author groups based on whatever similarities they perceived in the map. Next, the experts were shown the PFNET based on Plato and asked to repeat the process. The process was repeated for the maps of the authors that the experts were interested in, with the PFNET shown first and the SOM second, i.e., in the reverse order of presentation of the Plato maps. Since the study involved presenting a number of different maps based on different authors, it was not felt that random presentation of the map types was needed

The maps of Plato and the author of interest were presented on paper. After those maps were examined, experts were instructed to log onto the AuthorLink System and to type in names of additional authors in whom they knew well. The experts then tried to find groups within the maps for those authors, as they had with the paper maps.

Although the experts were instructed to find and label groups as part of the interview, it was difficult to get them to do it consistently for all four of the maps. Since this step was intended simply to introduce the experts to the map types, the interviewer did not insist on capturing the data generated by the process. Consequently, and unfortunately, the data are either missing or too inconsistent to use for any type of analysis.

The interviews ranged from twenty minutes to well over an hour in length. During that time the experts were reminded to verbalize their thoughts. Many of the interviewer's questions were intended to elicit general comments on the AuthorLink system. Numerous comments about the system and the overall form of the maps were received. The comments about the maps are particularly germane to this study because they help to justify the rules used to extract the metrics that were needed to compare the maps statistically.

By rule, two authors were linked in a SOM if their names shared a side in the SOM's automatically created areas (or if they were both inside an area). By rule, two authors were linked in a PFNET if their names shared a link. A possible criticism of these rules is that the former has a greater chance of associating authors' names. Some of the experts preferred this feature of a SOM. For instance, these are quotes:

- What the SOM allows is for multiple points of contact, much more easily than a PFNET.

- Yes, I like the SOM better, because you can have more connections. On a PFNET, you have just the single connections.

- If you gave me a map that [was] supposed to represent the relations between the thinkers, then I think I would prefer the SOM, because it seems to take into account a greater number of relations, because the borders touch more than one of the other borders. But in the PFNET, you have only one line connecting the thinkers.

However, as mentioned in Section 6.4., a slight majority chose the PFNET over the SOM. The following comment shows some of the thinking behind this choice.

- Yes, [I prefer] the tree map [PFNET], because I am vested with value and I am presuming that there will be certain integral relationships that the floor plan [SOM] seems less insistent about. The tree map kind of guides your thinking, and although I am a rebel, I prefer direction to stasis. I like someone telling you what to think.

Some experts found it difficult to chose one format over the other. Although they were forced to choose one map to use for six months in the final question of the interview, the following comment shows their ambivalence:

- I can see that the tree [PFNET] leads you, and sometimes I want to be led. With the SOM, it presents more open possibilities, and gives you the chance to move and make the connection. With the PFNET, I found I followed the lines out and

> out and out, while the SOM gives the viewer more flexibility to make their own connections. But the PFNET is more helpful because if you are not clear on the connections, it gives you one. I don't know, I like them both, but for different reasons.

Author co-citation analysis reveals relationships between authors in a way that seems to fit the cognitive maps of the experts. Many of the visual maps fit the experts' cognitive maps extremely well. However, this study also shows that the maps, although statistically significant as a group, are not always perfect individually. Although there are many reasons why the visualizations are not completely correct (e.g., because low co-citation counts associated with lesser known authors introduce distortion), the direct lines of the PFNETs emphasize these inconsistencies. Also, the lines sometimes connote meanings to the experts that are algorithm did not intend. The following comments reveal this fact.

- That [a particular PFNET] is so alien and strange to me and that could be because lines have a connotation of a more historical or time element than the SOM. The SOM is more contemporaneous. The lines suggest a temporal connection and the suggestions that are offered make less sense to me. I find the PFNET less helpful in terms of pointing out connections that I might have understood before, because I get too distracted with the wrong historical connections.

- …the PFNET implies certain relationships which may or may not exist.

- When it [PFNET] is good, it is very good, but when it is bad, it is horrid.

Another issue in the less-than-perfect capture of an expert's cognitive map is the data from which the maps are derived. The data for this study were from the *Arts & Humanities Citation Index* for the years 1988 to 1997. Although the dataset was large, significant, and of good quality, it is nonetheless limited in its scope and range. This is an issue than can be addressed in future studies and is illustrated by the following comments.

- If I wanted to do research on early childhood education, then I would need to pick my database very carefully; otherwise I would get a mistaken and distorted view of Bruner's work, because this database is picking Foucault [as a connection] and it is a different type of work. So you are getting a distortion because of the database. (Interviewer's response: Distortion might not be the right word; how about a different slant or context?) That's interesting, and this would be interesting to look at—someone's work in a variety of different contexts. This is the first time I thought about that, but it is the lens of the database you are looking at.

- This requires people to give a lot of thought to the database and the centrality of the person. I think if you want to examine someone's intellectual tradition or relationship, you should pick a database in which they have written in themselves. But if you are interested in how they are seen by others, I can see that that could be very interesting. I did not think of that initially: how the database itself is related.

Finally, some of the experts were interested in the possibility of retrieval based on the system. The system does have the ability to retrieve the articles that are used in the maps, but the retrieval aspect of the system was not explored. This is something that could be done in future studies. The following comments illustrate the need and desire for such a feature.

- I would have paid a service to be able to retrieve the articles that co-cite one another.

- Here is a proviso, if you could retrieve articles, it would be even better. (Shown how to do retrieval by the Interviewer.) This is cool, this is really cool…

8. THE EXPERTS' COMPOSITE MAP OF PLATO

In this chapter we return to a subject first taken up in Section 5.2.1: how well the experts knew the authors in the various lists and maps presented to them.

To review briefly, the experts were asked to sort two different card stacks. One contained names associated with an author the expert was knowledgeable about—the so-called interest nameseed. The other contained the names of a group of famous authors associated with Plato, whose names appear in Table 20. The expert was instructed to form groups of names with something in common; those in different groups were different in some respect.

Table 20: 24 Associated Authors with Plato

AESCHYLUS	DIOGENES-LAERTIUS	NIETZSCHE-F
AQUINAS-T	EURIPIDES	OVID
ARISTOPHANES	HEGEL-GWF	PINDAR
ARISTOTLE	HEIDEGGER-M	PLUTARCH
AUGUSTINE	HERODOTUS	SOPHOCLES
BIBLE	HESIOD	THUCYDIDES
CICERO	HOMER	VERGIL
DERRIDA-J	KANT-I	XENOPHON

The interest nameseed was used to create author lists and maps that were individualized for each expert. Plato, on the other hand, was chosen so that the names associated with a single name could be examined by all the experts. It was felt that "Plato and Company" were famous enough to be recognized and interrelated by anyone in the humanities. In this sense, Plato was a *salient nameseed*, a term used in the analysis below. Appendix G lists all of the card sort grouping results along with the circling based on the rules previously discussed in Section 5.2.5.

The salient nameseed, Plato, was used to answer whether either map type captured the composite mental map of the experts. Since all twenty experts responded to the same names associated with Plato, one can look at their combined responses, and it is of interest to do so. Individual co-occurrence matrices were based on whether the experts grouped two authors together in their card piles. The values were 0, for “did not group,” and 1, for “did group.” Those matrices were summed over the twenty experts to create a single matrix, as shown in Table 21.

Table 21: Accumulated Parings by Experts

	Plato	Aristotle	Plutarch	Cicero	Homer	Bible	Euripides	Aristophanes	Xenophon	Herodotus	Augustine	Kant-i	Aeschylus	Thucydides	Sophocles	Ovid	Hesiod	Diogenes-laerti.	Heidegger-m	Derrida-j	Nietzsche-f	Pindar	Hegel-gwf	Vergil	Aquinas-t
Plato	0	19	2	2	2	0	3	3	4	3	3	6	3	3	4	1	3	5	6	4	5	1	6	1	4
Aristotle	19	0	2	2	2	0	3	3	3	3	3	6	3	3	4	1	3	5	6	4	5	1	6	1	4
Plutarch	2	2	0	11	4	0	1	1	4	9	0	0	1	9	1	7	4	4	0	0	0	3	0	7	0
Cicero	2	2	11	0	6	0	3	3	1	5	0	1	3	3	3	9	6	3	1	0	0	4	1	9	0
Homer	2	2	4	6	0	1	6	6	0	3	0	0	6	4	6	12	12	4	0	0	0	11	0	13	0
Bible	0	0	0	0	1	0	0	0	0	0	14	0	0	0	0	0	1	0	0	0	0	0	0	1	13
Euripides	3	3	1	3	6	0	0	20	2	4	0	0	19	4	19	3	3	3	0	0	0	2	0	3	0
Aristophanes	3	3	1	3	6	0	20	0	2	4	0	0	19	4	19	3	3	3	0	0	0	2	0	3	0
Xenophon	4	3	4	1	0	0	2	2	0	10	0	0	2	10	2	1	2	2	0	0	0	1	0	1	0
Herodotus	3	3	9	5	3	0	4	4	10	0	0	0	3	18	3	3	7	5	0	0	0	3	0	3	0
Augustine	3	3	0	0	0	14	0	0	0	0	0	2	0	0	0	0	0	1	2	2	2	0	2	0	19
Kant	6	6	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	17	11	17	0	19	0	3
Aeschylus	3	3	1	3	6	0	19	19	2	3	0	0	0	3	19	3	3	3	0	0	0	2	0	3	0
Thucydides	3	3	9	3	4	0	4	4	10	18	0	0	3	0	3	4	5	5	0	0	0	4	0	4	0
Sophocles	4	4	1	3	6	0	19	19	2	3	0	0	19	3	0	3	3	3	0	0	0	2	0	3	0
Ovid	1	1	7	9	12	0	3	3	1	3	0	0	3	4	3	0	7	4	0	0	0	12	0	18	0
Hesiod	3	3	4	6	12	1	3	3	2	7	0	0	3	5	3	7	0	4	0	0	0	7	0	6	0
Diogenes	5	5	4	3	4	0	3	3	2	5	1	0	3	5	3	4	4	0	0	0	0	2	0	4	1
Heidegger	6	6	0	1	0	0	0	0	0	0	2	17	0	0	0	0	0	0	0	13	18	0	17	0	3
Derrida-j	4	4	0	0	0	0	0	0	0	0	2	11	0	0	0	0	0	0	13	0	13	0	11	0	3
Nietzsche	5	5	0	0	0	0	0	0	0	0	2	17	0	0	0	0	0	0	18	13	0	0	17	0	3
Pindar	1	1	3	4	11	0	2	2	1	3	0	0	2	4	2	12	7	2	0	0	0	0	0	11	0
Hegel	6	6	0	1	0	0	0	0	0	0	2	19	0	0	0	0	0	0	17	11	17	0	0	0	3
Vergil	1	1	7	9	13	1	3	3	1	3	0	0	3	4	3	18	6	4	0	0	0	11	0	0	0
Aquinas	4	4	0	0	0	13	0	0	0	0	19	3	0	0	0	0	0	1	3	3	3	0	3	0	0

Although this matrix can be readily examined for judgments on various author pairs—for instance, Plato and Aristotle were grouped together by 19 of the twenty experts—there are far too many numbers to examine and understand simultaneously. A much better way to examine the grouping of the names is through the use of a vertical icicle plot produced by the SPSS Cluster program. Figure 22, a icicle plot, shows the common groups that were chosen by the experts. It allows the pairing and clustering of authors based on the accumulated card sorts to be quickly taken in. Author names are listed on top, the number of times the authors were grouped by the experts are listed on the left, and the body of the matrix shows, via an “X,” the clusters formed.

```
                          D
                          I
                          O
                          G
                  A       E
                  R       N   H N
              T   I       E   E I
            H H E S A S   A S D I E   H                 A A
          X E U U T E O   R - E D T   E P               U Q
          E R C R O S P   I L R E Z   G L               G U
          N O Y I P C H   S A R G S K E U C   H P   V   U I
          O D D P H H O P T E I G C A L T I H E I   E B S N
          P O I I A Y C L O R D E H N - A C O S N O R I T A
          H T D D N L L A T T A R E T G R E M I D V G B I S
          O U E E E U E T L I - - - - W C R E O A I I L N -
          N S S S S S S O E . J M F I F H O R D R D L E E T

    20    . . . XXX . . . . . . . . . . . . . . . . . . . .
    19    . . . XXXXXXX XXX . . . . XXX . . . . . . . . XXX
    18    . XXX XXXXXXX XXX . . XXX XXX . . . . . XXX . XXX
    17    . XXX XXXXXXX XXX . . XXXXXXX . . . . . XXX . XXX
    13    . XXX XXXXXXX XXX . . XXXXXXX . . . . . XXX XXXXX
    12    . XXX XXXXXXX XXX . . XXXXXXX . . XXX . XXX XXXXX
    11    . XXX XXXXXXX XXX . XXXXXXXXX XXX XXX XXXXX XXXXX
    10    XXXXX XXXXXXX XXX . XXXXXXXXX XXX XXX XXXXX XXXXX
     6    XXXXX XXXXXXX XXX . XXXXXXXXX XXX XXXXXXXXX XXXXX
     5    XXXXX XXXXXXX XXXXX XXXXXXXXX XXX XXXXXXXXX XXXXX
     3    XXXXX XXXXXXXXXXXXX XXXXXXXXX XXXXXXXXXXXXX XXXXX
     2    XXXXXXXXXXXXXXXXXXX XXXXXXXXX XXXXXXXXXXXXX XXXXX
     0    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Figure 22: Icicle Plot

As in the raw matrix, one can see that Plato and Aristotle were grouped 19 times, as indicated by the boldfaced “XXX” in the row labeled “19” and the columns labeled “Plato” and “Aristotle.” The matrix shows that all twenty experts grouped Euripides with Aristophanes. All but one grouped Kant with Hegel and Augustine with Aquinas, and formed a larger group of the Greek playwrights Euripides, Aristophanes, Aeschylus and Sophocles. The reader may examine Figure 22 for other groupings, which will generally make good sense to anyone steeped in the humanities.

A PFNET can be created from the same data from Table 21. Figure 23 shows a PFNET based on the Plato cards sorts. For comparison, Figure 24 shows the PFNET based on the co-citation counts of the same authors in the AHCI database.

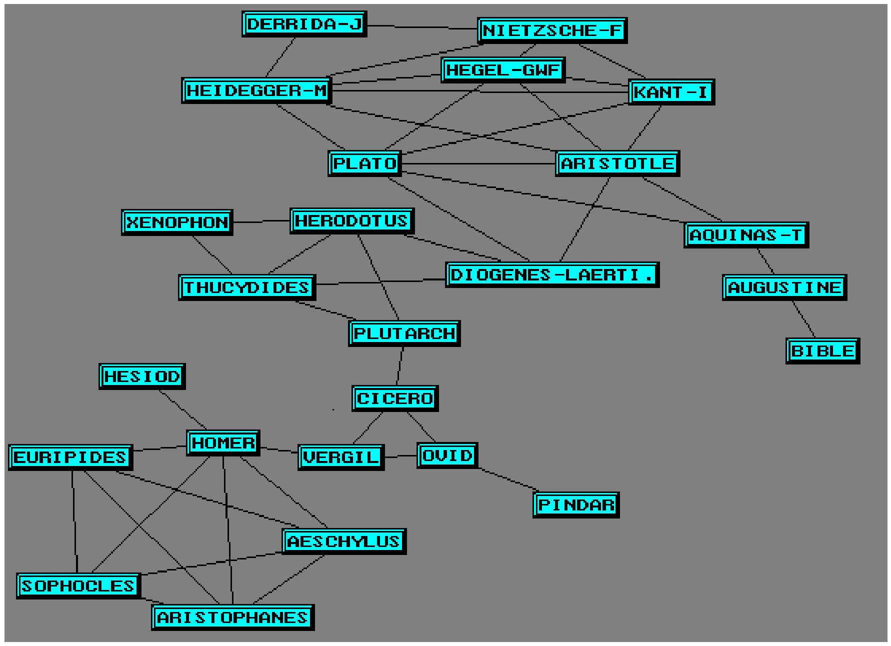

Figure 23: PFNET Based on Plato Card Sorts

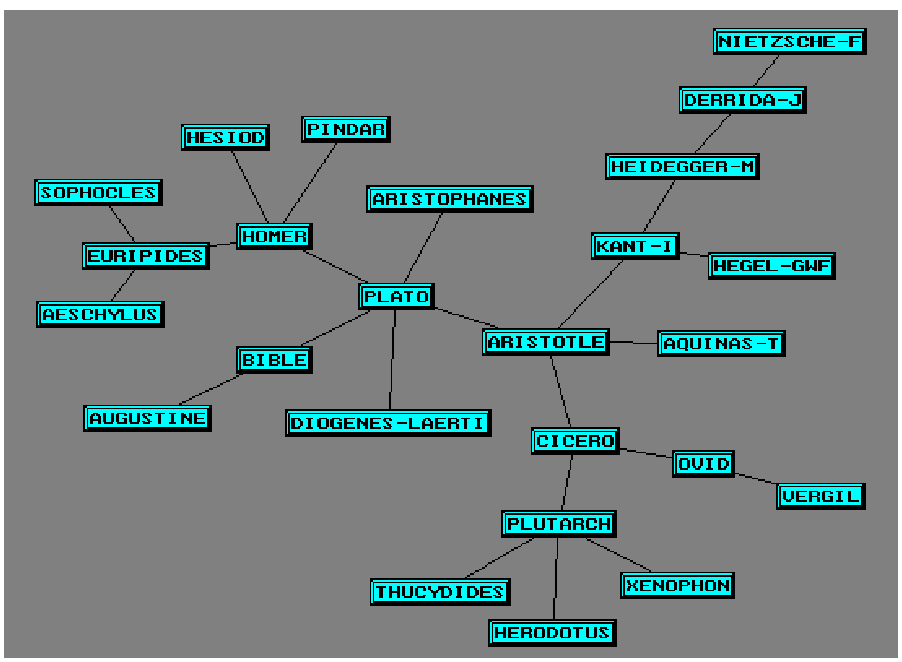

Figure 24: PFNET Based on Plato Co-Citation Counts in AHCI

On examining the two maps, one immediately sees that the card-sort data have many more links between the names. This is a consequence of applying the algorithm to data that are sparse (many zeros) and that have many tied counts. (In the present case, this occurs because of a small number of subjects; it can also occur when authors are not well known and have small counts.) Nonetheless, the maps are both very similar and readily intelligible. For instance, the German philosophers are still linked together in the PFNET, but in the card sorts they have even more connections. The additional links bring names together like the SOM, where the sides of one author-area can touch many other author-areas.

This is especially true with the links between the Bible, Augustine, and Aquinas. In the PFNET based on the AHCI data, Aquinas is linked solely with Aristotle. This is certainly reasonable; Aquinas is known for synthesizing Aristotle and Christian theology. But with the multiple links of the card sorts, Aquinas is linked also with Augustine, who is connected in turn to the Bible. Thus, in their card sorts, experts brought out a major religious triad in a way the AHCI PFNET did not.

The comparison with SOMs is also interesting. Figure 25 shows the SOM based on the cards sorts of Plato; Figure 26 shows the SOM based on the Plato co-citation counts from AHCI. Diogenes Laertius has been moved from the center to the edge and shares an edge with Aristotle. Aristophanes has also been moved away from the center. However, the major clusters—Plato and Aristotle, the Greek playwrights and poets, the Greek and Roman historians, the German philosophers, and the Christian tradition represented by Aquinas, Augustine, and the Bible—all remain intact.

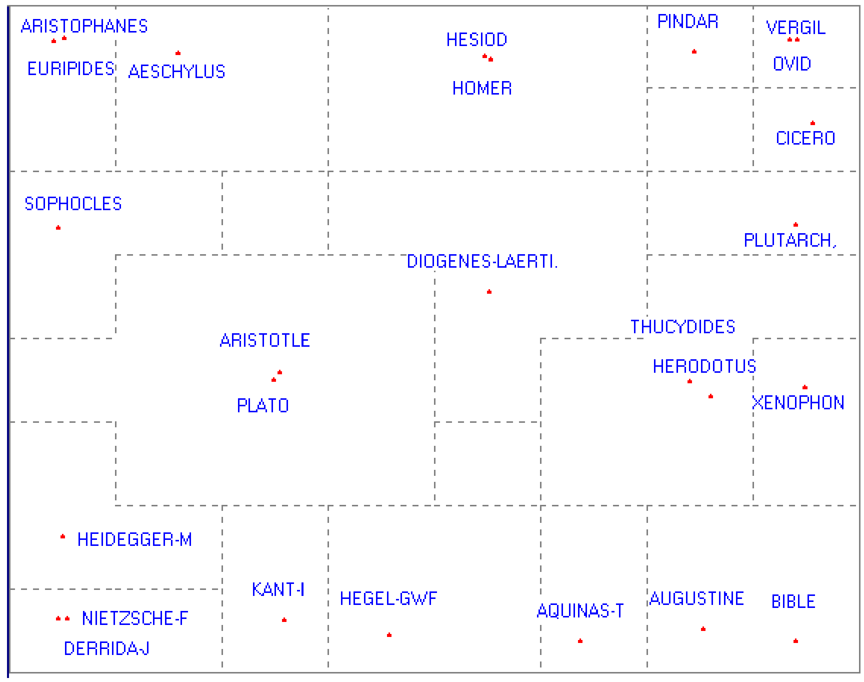

Figure 25: SOM Based on Card Sorts

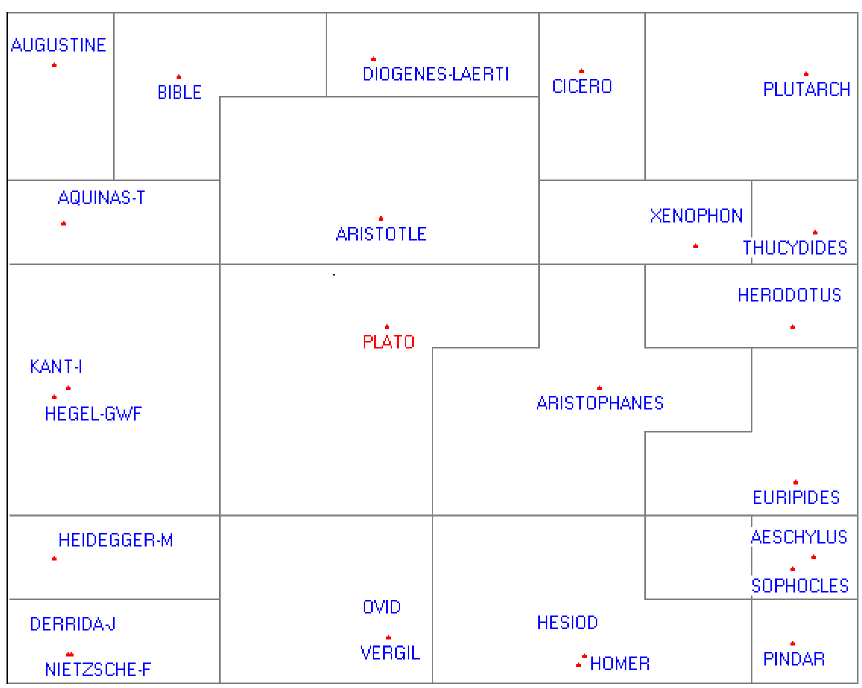

Figure 26: SOM Based on AHCI

It appears that the SOM is more robust, or less invariant, than the PFNET in representing the experts' composite mental map, as reflected in their card sorts. The PFNET is similar in author placements, but dissimilar in the number of links used to connect related authors.

This raises an interesting issue, however. In creating PFNETs, the current standard methodology is to set $r =$ and $q = n - 1$, which are the largest possible values for the two parameters (see Chapter 3 for further discussion). Using the largest values creates a PFNET that is the union of all minimal spanning trees (Chen, 1999). (A minimal spanning tree is a network in which every node is connected to every other node with a single link, such that each link value is the smallest possible value.) Moreover, using the largest values for the parameters usually creates a network with only one link between two names when generated from a large dataset. This is clearly not the case with the PFNET generated from the card sorts, where there are forty-five links instead of the twenty-four of the AHCI map.

It could be argued that a map with more links, while perhaps less readable because of the increase in the number of lines, is more understandable in terms of the associations. For instance, in the card sorts, the "star" generated from Homer, Aeschylus, Euripides, Aristophanes, and Sophocles does not string single authors together like the co-citation count PFNET, but shows the interrelatedness of everyone to everyone else. This same effect of adding more links, however, can be achieved by varying the PFNET parameter r, and so will be discussed in the final chapter.

9. FINAL SUMMARY AND FUTURE WORK

Author co-citation analysis is widely used to explore how authors in a field of study are related. The purpose of this study was to determine the validity of two types of maps associated with the ACA technique—PFNETs and SOMs. The results indicate that both types capture the mental maps of experts quite well. Both were highly and significantly correlated with these mental maps. The SOM's correlation was the higher of the two, on both the Plato maps and the interest-seed maps, and the difference was statistically significant. There was no clear winner, however, when experts were asked to choose one map type over the other. Their comments suggested that both are needed when exploring an author, since each map type displays different aspects of an author's relationships.

Two problems in previous work—begging the question and reasoning from a few or atypical examples—have been addressed. The answer to the first research question validated the assumption that PFNETs and SOMs reflect the cognitive maps of experts. It also reinforced earlier ACA validation studies such as McCain (1983a, 1983b, 1986) and Lenk (1983). As for reasoning from a few examples, the second research question used twenty different authors, and the interviews used at least forty additional authors; AuthorLink provides a virtually inexhaustible supply. Since sets of maps for at least sixty authors were examined, the charge that ACA researchers argue from few or atypical examples can be put to rest.

In most research, the answers to the questions generate more questions. That is certainly true in the present case. Some suggestions for future lines of inquiry follow.

9.1. Database Development

When this research began, the database system used in AuthorLink was BRS Search, a commercial product from Dataware. Although BRS Search is a robust system that could produce the results required for this study, the creation of the database itself was time-consuming and required substantial disk space.

Parallel to the data gathering for this dissertation was a search for a general, open-source system that could produce the same results as BRS Search, but in a more efficient manner. When several attempts at using a relational database failed to yield efficient results (compared to BRS Search), an effort was made to create a specialized system. The effort yielded a co-occurrence calculus, as discussed in Appendix B, and this theoretical model was in turn transformed into a working system called *Noah*.

Here is one example of why Noah is important. In interviewing the experts, it was discovered that the method of producing the co-occurrences—i.e., choosing a nameseed, finding the associated authors, and then finding the co-citation counts within the entire database rather than within the "nameseed set"—produces results that are not as focused as they could be. For instance, in the name-pairs associated with Plato, say Hegel and Heidegger, the co-citation count for the two was computed within the entire database, rather than within only those articles that also cite Plato. In other words, the co-citation count was for "Hegel AND Heidegger," rather than "Plato AND Hegel AND Heidegger." This idea of using a third name to focus the analysis has been called "tri-citation" and is currently an area of research in Marion (2002). Tri-citation is also built into AuthorLink retrievals, where the nameseed is always automatically ANDed with other author pairs entered in the Search box. However, to have enough records to achieve robust tri-citation *maps* in every case requires a very large database, since three ANDed names will usually return lower counts than two. Instead of ten years of AHCI, it might require the thirty-plus years of AHCI in its entirety.

Noah becomes vital in such a context because it enables one to work with very large datasets, such as the entire AHCI database. With the use of such large datasets, or the combination of different sources of data (e.g., SciSearch and Social Scisearch), it is possible to explore the co-citation of author pairs within the seed author's space, i.e., tri-citation. It also allows the development of different maps from different sources, as suggested in the interviews in Chapter 7.

The development of Noah to perform fast co-occurrence analysis also introduces the possibility of processing co-occurrence data from a variety of fields in records. As mentioned in Chapter 1, the authors co-cited in a paper are not the only types of terms that can be analyzed. Others candidates are terms from titles of works, keywords used to index papers, natural-language terms from full texts, and so on. Combinations such as the simultaneous analysis of co-cited authors and title terms become possible.

Moreover, co-occurrences are present in many sources other than bibliographic datasets, and similar analyses may yield interesting results. A possible major application for the methodology is market basket analysis, the examination of the buying patterns of consumers (see, e.g., Berry, 1997). For instance, a food shopper selects a number of items to purchase and then proceeds to the check-out line to buy those items. Say that they are tomato sauce, tomato paste, and pasta. This purchase pattern represents one co-occurrence each of sauce-paste, sauce-pasta, and paste-pasta. The examination of a day's or week's data may show that these conjunctions frequently occur: when customers buy pasta, they often buy sauce and/or paste. This would be a valuable piece of information for store managers (if they did not already know it), since it would enable them to place frequently co-purchased items close together on their shelves to suggest that they be bought together and to make purchasing them easy. Such associations, along with many others as yet unknown, could be shown to exist via visual maps—among them, SOMs or PFNETs.

9.2. Enrichment of PFNETs.

Another area that needs to be further explored is the use of varying parameters within PFNET. As illustrated in Chapter 8, a less parsimonious tree for a PFNET, i.e., a network with many more links, may be required to produce effects similar to a SOM, since a SOM can have many author-areas touching other author-areas. The same effect can be achieved in a PFNET by providing more links between names. To achieve more links, the parameter q for the length of the "walk" from one node to another can be decreased. In this study, the number of links considered was from every node to every other node—i.e., a length of twenty-four nodes or q - 1. However, if q is made smaller, networks will have more links. Moreover, the parameter r for the index in the Minkowski Metric could also be varied. Currently the value used for r is infinity, but values of 1 or 2 (for city-block or Euclidean distance, respectively) could also be considered. Either would yield networks with a greater number of links. These parameters could be adjusted on the fly, with users choosing the value of the parameter that best suits them. It would be of interest to consider such a system in the future.

An additional aspect of a PFNET that has not been examined is the use of the embedding algorithm itself. Although the algorithm supplied by Kamada and Kawai (1989) (K&K) was used to display the networks, the position of all of the authors was not used in the analysis of the efficacy of the results. It may be of interest in the future to examine the effect not only of the linkages, but also of the placement of all names that are not directly linked. Furthermore, the link length used for this study was uniform to conform with the uniform spacing of nodes for a SOM; however, the K&K algorithm does allow the use of proportional length links and could also be further studied.

9.3. Further Improvement of AuthorLink

One of the added aspects to the system from the original system developed for this study is the ability to retrieve articles based on the map data, i.e., the co-cited authors. Several experts said this would be a worthwhile addition to the system. Only bibliographic data can be retrieved by the system now, e.g., title, authors, etc., because that is the only data that is available. It is possible, however, to consider in the future the retrieval of the entire article itself as the databases expand their capabilities. This raises an interesting research question: does the use of maps enhance the ability to retrieve relevant documents as opposed to the traditional listing of the ranked and related documents to a term. Studies that compare a visualization with a traditional list were discussed in the literature review of this work, but it may be of interest to extend this research to compare the retrieval aspects of a PFNET with a SOM.

To conclude, examine the following quote from (White & McCain, 1997), which addresses the issue of retrieval:

> It is not too much to hope that, sometime in the future, the same computer interface will facilitate both bibliometric domain analyses and retrieval of documents. Quite possibly, the two activities will come to be viewed as alternatives in a single process, with the choice of one or the other, or both, depending solely on the user's goals. The right VIRI would allow one to do quick domain analyses on the basis of kinds of co-occurring terms (e.g., authors, journals, subject phrases, organizations, or combinations of these, in the style of bibliometric mappers) and either stop when one had a satisfactory overview or pass on to find-grained retrievals.

It appears that AuthorLink enables the above to be performed. It is now much easier to examine the question of whether the use of the maps in this study enable a user to retrieve information more efficiently that with a simple list alone, since the system is now in place. It can be suggested that AuthorLink is a significant advance in systems for visualizing bibliographic data and for information retrieval. To show this, consider another quote from White & McCain (1997):

> Here is an exercise: Name a world-class writer in a learned field, someone whose work you know and admire. Now consider, as concretely as possible, whether

> that person's research would be furthered by an printed or electronic scheme for visualizing literatures you have yet seen. We think that most readers would have to conclude, not much. It is easy, of course, to say why such a test is unfair or unrealistic. The fact remains that no scheme has yet vanquished skepticism; as of this writing, there is no "killer app."

Now, read the following quotes from the experts:

- Now, this is something that would be a great research tool… I would have paid a service to be able to retrieve the articles that co-cite one another
- It is a way of tracking around in the literature…more rational than just going to the shelves…It is organized browsing
- Oh, this is very cool…
- This is cool, this is really cool…

AuthorLink is perceived as quite helpful in research, and the last two quotes suggest that it may be at least a beginning toward a "killer app."

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APPENDIX A: SOURCE AND DERIVED DATA

An example of one of the 1.26 million records within the AHCI dataset used for this research is shown below. Of particular importance for this study is the Cited Item Fields which are delineated by "CR" – "EC" tags. The cited authors are shown in bold and are indicated within the file with a "/A" tag. The original linear data order in the table is from left to right, e.g., "IO," "GA," "SQ," etc.

IO 19889622978770	GA K8520
SQ 03405J0	PT J
CF H	CF Y
SN 0270-7993	J1 WOMAN ART J
J2 WOMAN ART J	J9 WOMAN ART J
JI Womans Art J.	SO WOMANS ART JOURNAL
PY 1988	PD FAL-WIN
VL 8	IS 2
PU WOMANS ART INC	PI LAVEROCK
PA 1711 HARRIS ROAD, LAVEROCK, PA 19118	SC H BP ART
SC Q BP ART	TV Y
KS HOBB0003880008WR	T9 0034331452
AU HOBBS, R	TI MICHEL,SALLY - THE OTHER AVERY
BP 3	EP &
PG 0	DT @ Article
LA EN English	AV N
NR 16	CR
/A AVERY M	/Y 1928
/W ARTIST AND HIS WIFE	/I I
EC	CR
/A AVERY M	/Y 1938
/W GASPE LANDSCAPE	/I I
EC	CR
/A AVERY M	/Y 1934
/W MY WIFE SALLY	/I I
EC	CR
/A AVERY M	/Y 1931
/W SUN WORSHIPPERS	/I I
EC	CR
/A AVERY M	/Y 1942
/W WOMAN DRAWING	/I I
EC	CR
/K AVER006387 AS	R9 0034331453
/A AVERY SM	/Y 1987
/W ART ANTIQUES JAN	/P 63
EC	CR
/K HASK018282 MB	R9 0034331454
/A HASKELL B	/Y 1982
/W M AVERY	/P 182
EC	CR
/A MICHEL S	/Y 1985
/W BIG BABY	/I I
EC	CR
/A MICHEL S	/Y 1955
/W CIGARETTE SMOKING	/I I

EC
CR
/Y 1956
/I I
CR
/Y 1977
/I I
CR
/Y 1938
/I I
CR
/Y 1976
/I I
CR
/Y 1936
/I I
CR
/Y 1946
/I I
CR
R9 0034331455
/Y 1952
/P 8
/A MICHEL S
/W CLERGY
EC
/A MICHEL S
/W CURIOUS COWS
EC
/A MICHEL S
/W HARBOR GASPE PENINSU
EC
/A MICHEL S
/W MOUNTAIN AND MEADOWS
EC
/A MICHEL S
/W UMBRELLA BY
EC
/A MICHEL S
/W WORSHIPPERS
EC
/K WIGH000852 MF
/A WIGHT FS
/W M AVERY
EC

The extracted field was the cited author field, "/A." Only unique authors were extracted, so a repeating author is only captured once. The representation of the data extracted from the record above is as follows:

AVERY-M
AVERY-SM
HASKELL-B
MICHEL-S
WIGHT-FS

Each record was given a unique record number, starting with 1. The basket representation, via the co-occurrence calculus (described in Appendix B) , is:

<1, {AVERY-M, AVERY-SM, HASKELL-B, MICHEL-S, WIGHT-FS}>.

A description of the article tags in the original AHCI dataset is given below:

Article/item tags

Code	Description / comment
KS	internal ISI unification code
T9	internal ISI unification code
AU	author, one per line
8	corporate author, one per line
EM	author email address
TI	article title
BP	beginning page number
EP	ending page number
PG	number of pages
MA	meeting abstract number
RW	reviewed author name
RY	reviewed work publication year
RL	reviewed work language code
DT	document type code and name
LA	language code and name
DE	author assigned keyword
ID	ISI assigned keyword
AV	abstract available
AB	abstract
UT	ISI assigned article identifier
RF	ISI research front number
NR	number of cited references

Cited references

Code	Description / comment
CR	start of cited reference
/K	internal ISI unification code
R9	internal ISI unification code
/A	cited author
/Y	cited year
/W	cited work
/V	cited volume
/P	cited page
/I	implicit citation code
EC	end of cited reference

APPENDIX B: A CO-OCCURRENCE CALCULUS

The co-occurrence manipulations that are required for this research are based on a set of elements, mappings, and operators for computing co-occurrences and the associated metrics, i.e., a co-occurrence calculus.

The reader unfamiliar with the terminology or symbolism used herein is directed to any textbook on computation theory, e.g., (Hein, 1996).

The primary element of the calculus is a basket, B. B is defined as a the following 2-tuple:

$B_i = (r_i, E_i)$; where:

$r_i \in J$, J = set of positive integers. R will be called the record number of the tuple. Often, r will equal the index i for convenience.

$E_i = \{e_1, e_2, \ldots e_n\}$, where e_i is an arbitrary element of **E**, the set of all possible elements. **E** may be defined *a priori* or may be defined based on the elements appearing.

For example, let B_{100} = (100, {toothpaste, mouthwash, toothbrush}), a transaction of one customer at a drug store. The Set **E** would be all of the products that were possible for purchase in that store. Another example pertinent to this study is B_1 = (1, {AVERY-M, AVERY-SM, HASKELL-B, MICHEL-S, WIGHT-FS}), the first record in the Arts & Humanities Citation Index for the year 1988. The set E is the set of all authors cited in the for the years 1988 – 1997.

The set of all baskets pertinent to a particular purpose, the dataset, is denoted as $D = \{B_1, B_2, \ldots B_n\}$.

For instance, D may be all of the purchases within a particular drug store for the month of February in a particular year, or may be all of the records with at least one author within the cited reference section for the AHCI database for the years 1988 to 1997, as per this study. The r_i's must be unique within D.

Let | | denote the cardinality or number of elements within a set. For instance, |D|, for the AHCI dataset, is approximately 1.26 million, and, |**E**| for the same dataset, the number of unique authors cited, is approximately 1.3 million.

Two mappings, e and r, will be defined to retrieve the associated elements given a key element.

The mapping, e, will be defined as:

$\boldsymbol{e}$ (r) → e,

i.e., given the record number of a basket, return the elements associated with the record number. The return set will consist of the bag [e_1, e_2, …, e_n].

The mapping $\boldsymbol{e}$ may operate on more than one record number, e.g., $\boldsymbol{e}$({r_1, r_2, …, r_n}), and is defined as follows:

$$\boldsymbol{e}(\{r_1, r_2, \ldots, r_n\}) = \oplus_1^n \boldsymbol{e}(r_i);$$

where $\oplus$ is defined as a concatenation operator over the bags.

For instance, if

D = {(1, {a, b}), (2, {b}), (3, {a, b})}, then

$\boldsymbol{e}$ (1) = [a, b], and

$\boldsymbol{e}$ ({1, 2, 3}) = [a, b, b, a, b].

A second mapping, $\boldsymbol{r}$, will be defined as:

$\boldsymbol{r}$ (e) → R,

i.e., given a particular element, return the set of all of the record numbers in which the element occurred.

The co-occurrence of two elements e_1, e_2, is denoted as either e_1 AND e_2, or, e_1 OR e_2, depending on the requirement. For this study, only AND will be used. Co-occurrence is defined as follows:

$$\boldsymbol{r}(e_i \text{ AND } e_j) = \boldsymbol{r}(e_i) \cap \boldsymbol{r}(e_j),$$

$$\boldsymbol{r}(e_i \text{ OR } e_j) = \boldsymbol{r}(e_i) \cup \boldsymbol{r}(e_j).$$

That is, $\boldsymbol{r}$ (e_i AND e_j) is the intersection of the set of record numbers in which both e_i, e_j occur. $\boldsymbol{r}$ (e_i OR e_j) is the union of the set of record numbers in which both e_i, e_j occur. | $\boldsymbol{r}$ (e_i AND e_j)| and | $\boldsymbol{r}$ (e_i OR e_j)| indicate the number of elements in which e_i and e_j, or e_i or e_j co-occur, respectively.

A pair-set operator, P, creates the set of all pair-wise combinations for the elements of a set. For instance, the pair-set for $E = \{e_1, e_2, e_3\}$ is $P(E) = \{ \{e_1, e_2\}, \{e_1, e_3\}, \{e_2, e_3\}\}$. Given n elements, there will be C(n, 2), elements in the pair set for a given set.

A co-occurrence matrix operator, M(P, op), produces an array indexed by a pair set over a given set, E, with the value of the array given by $|\, r\ ()|$, using either an AND or an OR, or some function of both or either, as the operator, op, and the element of the pair set as parameters. Op may be a simple AND operator, or more complex operators as conditional probabilities, etc.

For instance, in the above example, if $E = \{e_1, e_2, e_3\}$ and if $|\, r\ (e_1 \text{AND } e_2)| = 3$, $|\, r\ (e_1 \text{AND } e_3)| = 4$, and $|\, r\ (e_2 \text{ AND } e_3)| = 5$, then the co-occurrence matrix, M(P(E), (e_i AND e_j)), is as follows:

		e_1	e_2	e_3
	e_1	0	3	4
M =	e_2	3	0	5
	e_3	4	5	0

Although $|\, r\ (e_i \text{ AND } e_i)|$, equals the number of records that contain only e_i, for the purposes of this research, this element will not be used and thus given the value zero. It could, however, be used to normalize the row/column, define conditional probabilities, etc. Also, since union and intersection are commutative in these operations, the matrix M is symmetric and may be represented by either the upper- or the lower-triangle. This research will use the upper-triangle as to minimize storage requirements without loss of information.

Finally, a Garden, G, is defined as the names associated with a seed, S, which is a single element or Boolean-paired elements, and is defined as the function composition $e \circ r$ as follows:

$$e\ (\ r\ (S)).$$

That is, given the set of records that contain the seed S, find all of the other elements that are associated with that set of record numbers. As some elements will repeatedly occur within some records, the count of the number of times each element appears will also be pertinent. The operator MAX(G, n), where n is a positive integer, will return the unique elements of G in order of descending occurrence. For instance, MAX(G, 25) will return the twenty-five most frequently co-occurring elements of Garden G with seed element S.

As an example of the above calculus, define D as

D = {{1, {a, b, c}}, {2, {a, b, d}}, {3, {a, e, f}}, {4, {b, c}}, {5, {a, b}}, {6, {g}}},

where **E** is the set of letters of the alphabet.

e (1) = [a, b, c],

r (a) = {1, 2, 3, 5},

r (a AND b) = {1, 2, 5},

r (a OR b) = {1, 2, 3, 4, 5},

P({a, b, c}) = {{a, b}, {a, c}, {b, c}}, and M(P({a, b, c}), (e_i AND e_j)) is:

M =

	a	b	c
a	0	3	1
b	3	0	2
c	1	2	0

(or, as the upper triangle: <3, 1, 2>).

Finally, the garden G, based on the seed, S = a , is <a, b, c, a, b, d, a, e, f, a ,b>. MAX(G, 2) = (a, b), as “a” occurs four times and “b” occurs three.

APPENDIX C: THE EXPERTS' AREAS OF EXPERTISE AND NAMESEEDS

Expert #	Area of Doctoral Degree/Expertise	Interest Nameseed
1	Logic & Methodology of Science	Friedrich Nietzsche
2	History (Medieval Europe)	Marc Bloch
3	Information Systems/Art History	Andy Warhol
4	Comparative Literature	James Joyce
5	English Literature	Vernon Lee
6	German Language and Literature	Clifford Geertz
7	English Language and Literature	William Butler Yeats
8	Philosophy	Martin Heidegger
9	Communications	Fredric Jameson
10	Information Systems/Philosophy	Jurgen Habermas
11	Linguistics	Dell Hymes
12	Comparative Literature	Jorges Borges
13	American History	Bernard Bailyn
14	History	Donald Worster
15	20th Century US & British Literature	Virginia Woolf
16	Philosophy	Immanuel Kant
17	Comparative Literature	Charles Dickens
18	Information Systems/Theology	Catherine Keller
19	History of Science	Arnold Thackray
20	Classical Studies	Lucretius

APPENDIX D: INTRODUCTORY LETTER

Dear Dr. ___,

I am a Ph.D. candidate at the College of Information Science and Technology at Drexel University under the direction of Dr. Howard D. White. I would like to enlist your help and expertise to conduct an experiment for my dissertation to explore a visual and automated way to display relationships between authors in the humanities.

Author co-citation analysis has been a method to explore the many and varied relationships between authors in a discipline and has been a vital part of the research in bibliometrics at our College for the past twenty years. The production of maps indicating those relationships have been published in many journals over the past years for various subject areas. Those published maps delineate the major research fronts in a field for the perusal of experts in that field to hopefully exhibit insights not before seen and for aspiring experts so as to show them the current research areas.

The maps in the past, however, have been very labor intensive and required many hours for their preparation. Consequently, only the most prominent authors in a field are chosen in order to serve the biggest audience. Additionally, different map styles have been used to illustrate the resulting author co-citation analysis, but no real study has been done as to whether one is preferred to another by the readers or if one captures the true relationships as compared against the experts in the field.

I have been involved in the development of a web-based system that produces author co-citation maps almost instantaneously, using the two most preferred map types to realize their presentation. It is our desire to study the preference of these two map types by a user and the fidelity in which the representation of the maps match that of an expert in the humanities field. Consequently, I would like to acquire your participation in this study to answer these questions, both as a user and as an expert.

I will respect your time and keep your involvement to a minimum. For the “low-tech” part of the experiment, you will be asked to create different groupings using index cards containing authors associated with the philosopher Plato and circle groups on the maps which you perceive as forming a cluster. You will also do the same thing, grouping and circling, based on a second author whom you find interesting and wish to explore. This first part should take no more than twenty-minutes of your time. Finally, for the “high-tech” part, you will be able to use the system we have designed and will be instructed to type in any author(s) you wish to explore and will be asked to “think aloud” while your comments are recorded. This process should take no more than thirty minutes.

We have published several papers on the system already and it has met with great review. Users of the system find it to be of great fun and highly addictive! I cannot at this time direct you to the system so as to not taint or bias you for the experiment, but I do hope you agree to be a part of this research.

If you do agree, please e-mail me at janb@drexel.edu with your mailing address so that I can arrange to send you the materials necessary for the first part of the experiment and a list of times/days so I can schedule a thirty-minute meeting with you to have you use the system. I am hoping to collect the data over the summer, i.e., the months June, July, and August, so please list your available times accordingly.

Finally, please send a list of five authors which you have an interest in and would like to explore (you may also include yourself in the list and see who is related to you!). The data comes from the Arts & Humanities Citation Index provided by the Institute for Scientific Information, so the list should be primarily oriented, but not limited, to the humanities.

I thank you very much for your time and I hope to have you join my research.

Sincerely,

Jan W. Buzydlowski, M.S.

APPENDIX E: INSTRUCTIONS TO EXPERT

Dear Dr. ___,

Thank you for agreeing to be involved with my research. The experiment will consist of two parts. This first part should take no more than fifteen minutes.

Enclosed with this letter are two stacks of index cards bearing authors' names. One stack contains Plato, plus the twenty-four authors most often cited with him in the Arts & Humanities Citation Index, 1988-97. The other stack contains the author you wished to explore, plus the twenty-four authors most often cited with him or her, again from AHCI 1988-97. (How the associated authors were obtained will be discussed later when we meet.)

I ask you to do two *separate* card sorts with the two stacks, one for Plato and one for your chosen author.

For Plato, sort the 25 cards into smaller piles based on in your expert sense of who should be grouped with whom. That is, if you feel two or more authors are related, place them in the same pile. Authors whom you know but do not feel are related to anyone else can be placed in their own piles as singletons. Authors you do not know should be placed in one big Don't Know pile.

The result will be a set of two or more card piles. When you are finished, label each card in a pile with the same number at the upper right-hand side (from 1 to as many groups as you have). Mark each of the cards in the Don't Know stack with a question mark at upper right rather than a number. Finally, re-assemble the numbered cards back into one group for mailing.

Here is a nine-card example with authors' named A, B, C, D, E, F ,G, H, and I:

Group 1	Group 2	Group 3	Group 4	Group ?
A	B	D	I	E
C	F			H
G				

A, C, and G are related and would be labeled 1; B and F are also related and would be labeled 2. D and I are not seen as related to anyone else and have been placed in piles 3 and 4 by themselves. E and H are not known and have been placed in the question-mark pile.

Now, repeat the above steps for the second set of cards—the one created for the author of your choice.

Finally, please fill out the enclosed brief form and mail the two numbered card stacks and form in the envelope provided. If you have any questions whatsoever, please contact me at janb@drexel.edu or [phone number omitted].

I thank you sincerely for your time and your participation in this low-tech part of the study. I am sure you will find the next, face-to-face part more interesting. This final part should take no more than thirty minutes. It is important that we meet in a place that has a computer with a connection to the Internet and a current version of Internet Explorer, since we will need those to connect to our web page. I will ask you to think aloud during the session, which I would like to audio-tape. Please think of any additional author names you would like to explore. I will be in contact soon to schedule this interview.

Personal Data

Name: ____

Current Position: ____

Highest Degree Obtained: __________________________

Area of Degree: ____

Granting University: ____

APPENDIX F: AFFILIATION OF EXPERTS

Expert #	Institution	State
17	Drexel University	PA
11	Drexel University	PA
10	Drexel University	PA
20	Drexel University	PA
1	Drexel University	PA
16	Drexel University	PA
5	Drexel University	PA
7	Drexel University	PA
12	Drexel University	PA
9	Drexel University	PA
8	Holy Family College	PA
13	Holy Family College	PA
19	Chemical Heritage Foundation	PA
6	Temple University	PA
3	University of Pennsylvania	PA
18	Drew University	NJ
14	University of Southern California	CA
15	Franklin College	IN
2	University of Southern California	CA
4	Yale University	CT

APPENDIX G: DATA FROM EXPERTS

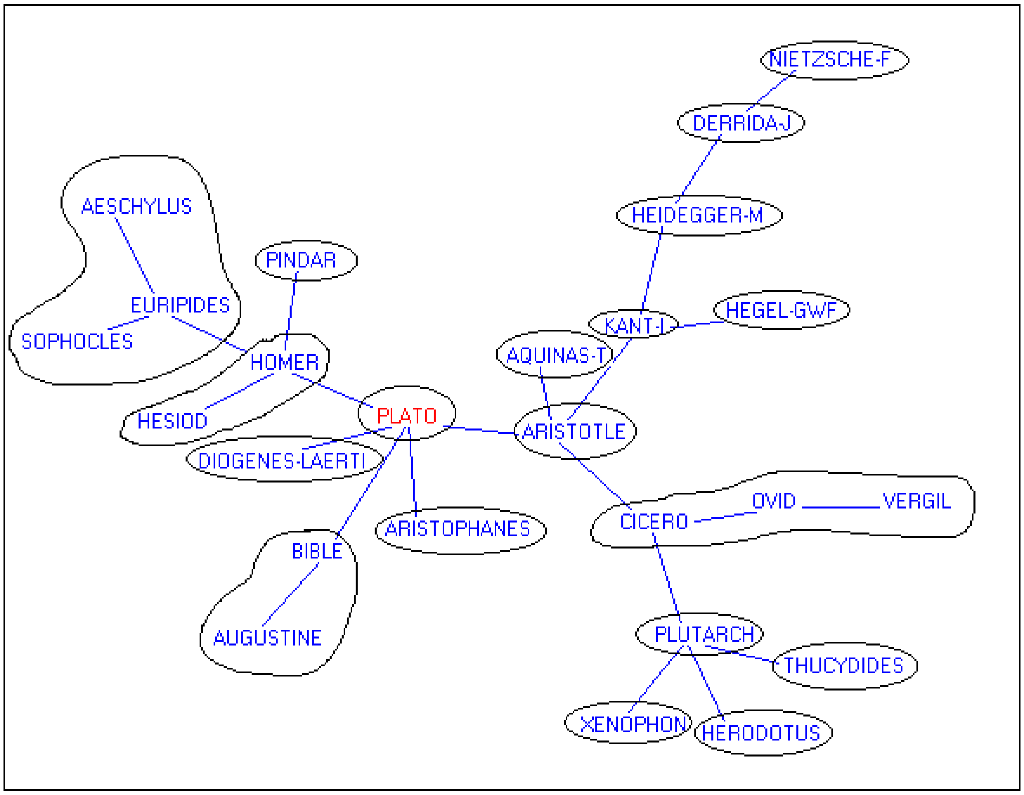
Expert #: 1

Card Sort Data

plato					
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6
plato	diogenes-laerti.	aristotle	aeschylus	cicero	plutarch
xenophon	herodotus		aristophanes	ovid	
	hesiod		euripides	vergil	
	homer		sophocles		
	thucydides				
Group - 7	Group - 8	Group - 9	Group - 10	Group - 11	Group - 12
pindar	kant-i	hegel-gwf	heidegger-m	derrida-j	aquinas-t
			nietzsche-f		augustine
					Bible

nietzsche-f						
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - 7
nietzsche-f	freud-s	hegel-gwf	aristotle	wittgenstein-l	adorno-tw	sartre-jp
	goethe-jwv	marx-k	plato		heidegger-m	
	schopenhauer-a					
Group - 8	Group - 9	Group - 10	Group - 11	Group - 12	Group - 13	
barthes-r	gadamer-hg	rorty-r	benjamin-w	kant-i	kaufmann-w	
deleuze-g	habermas-j					
deman-p						
derrida-j						
foucault-m						
lacan-j						
lyotard-jf						

Plato Maps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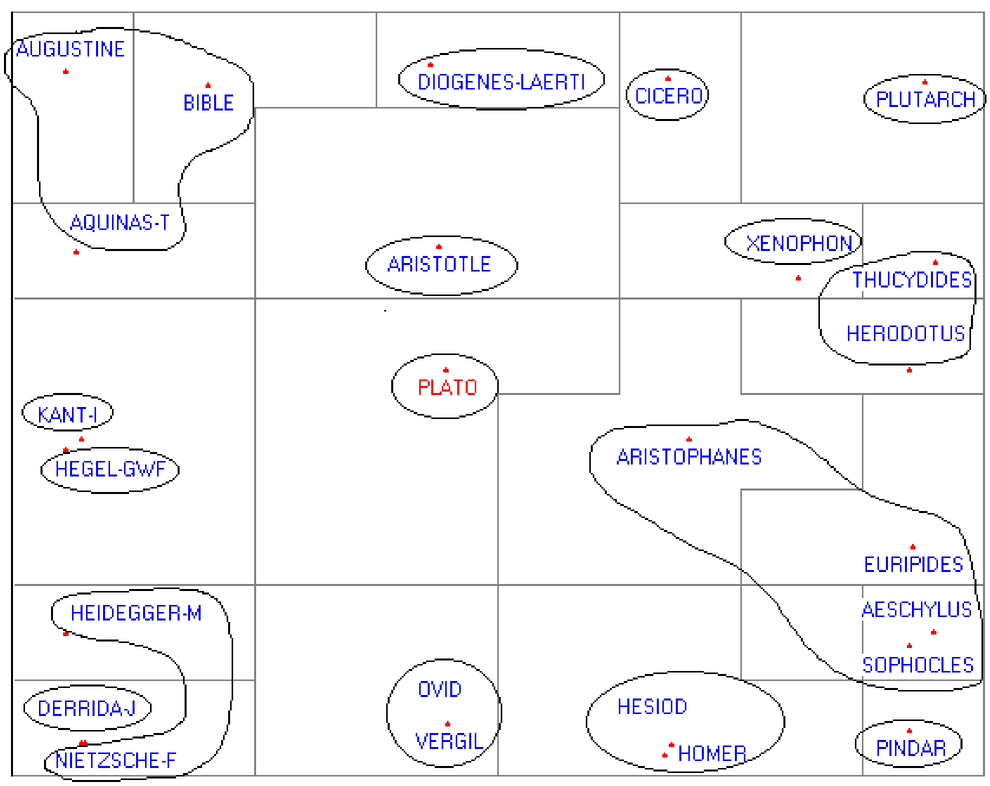
DERRIDA-J
HEIDEGGER-M
HEGEL-GWF
KANT-I
AQUINAS-T
ARISTOTLE
AESCHYLUS
PINDAR
EURIPIDES
SOPHOCLES
HOMER
PLATO
HESIOD
DIOGENES-LAERTI
ARISTOPHANES
BIBLE
AUGUSTINE
OVID
VERGIL
CICERO
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
AESCHYLUS
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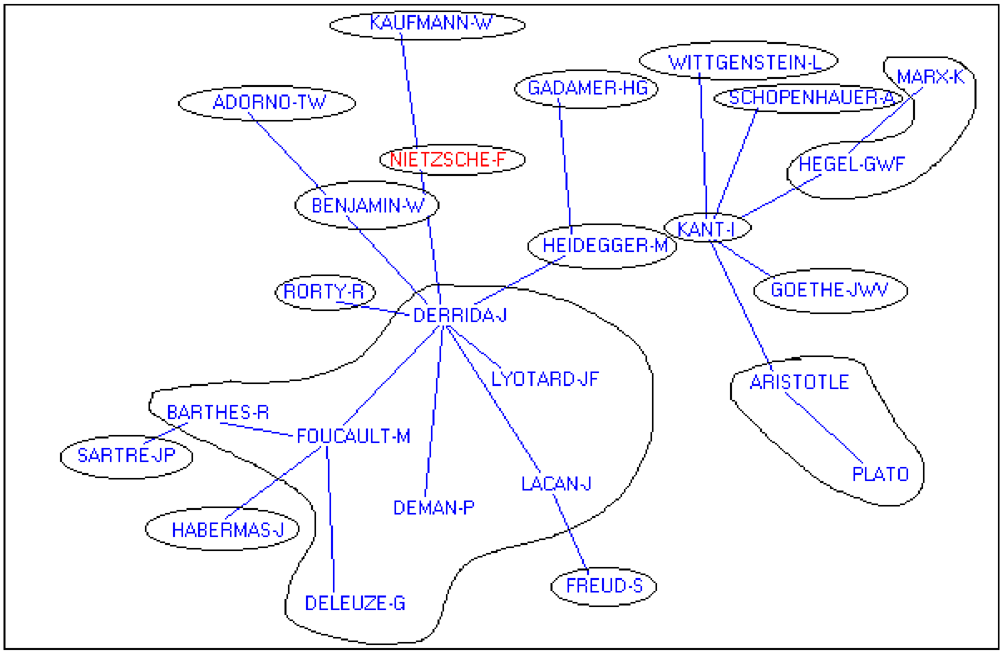
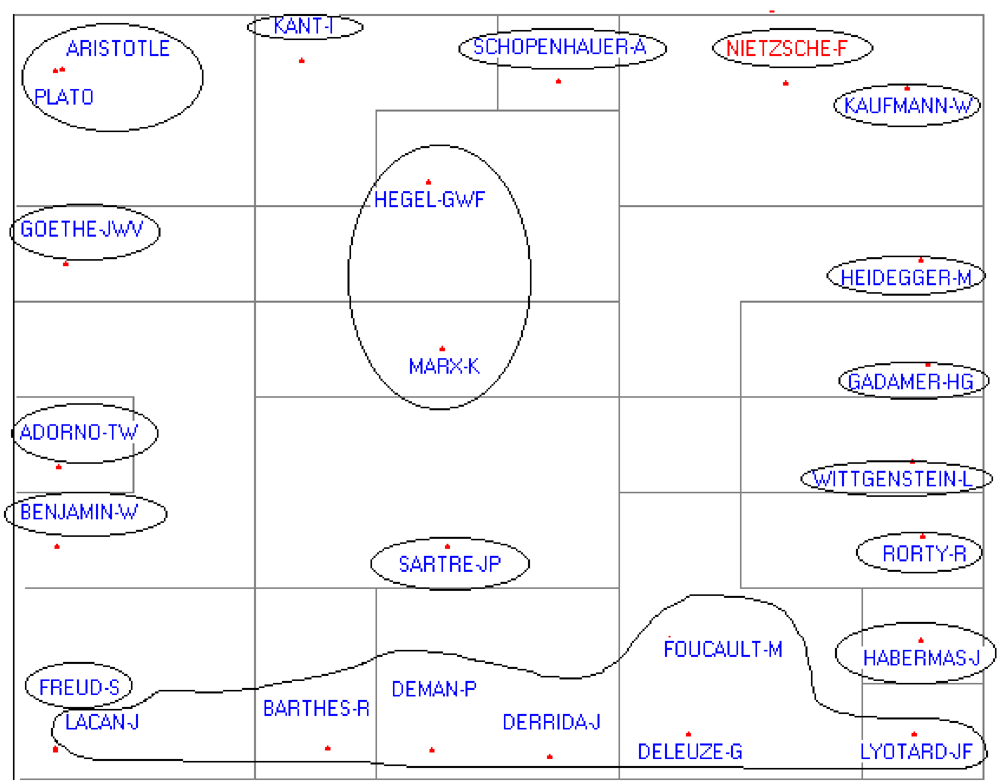
HEIDEGGER-M
DERRIDA-J
NIETZSCHE-F
OVID
VERGIL
HESIOD
HOMER
PINDAR

Nietzsche Maps





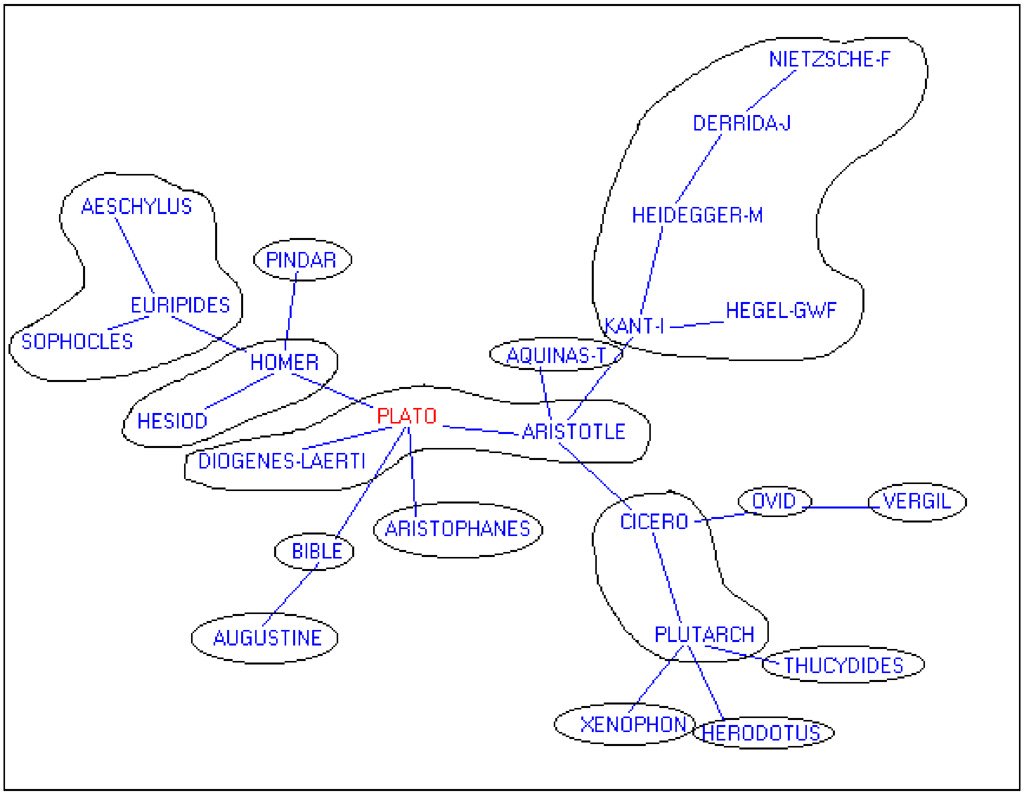
Expert #: 2

Card Sort Data

Plato				
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5
aquinas-t	derrida-j	aristotle	Bible	vergil
augustine	hegel-gwf	diogenes-laerti.		
	heidegger-m	plato		
	kant-i			
	nietzsche-f			
Group - 6	Group - 7	Group - 8	Group - 9	Group - 10
ovid	cicero	aeschylus	hesiod	herodotus
pindar	plutarch	aristophanes	homer	thucydides
		euripides		xenophon
		sophocles		

bloch-m					
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6
bloch-m	burke-p	duby-g	ginzburg-c	brown-p	davis-nz
braudel-f	thompson-ep		legoff-j		
febvre-l	tilly-c				
Group - 7	Group - 8	Group - 9	Group - 10	Group - ?	
douglas-m	evanspritchard-ee	bourdieu-p	durkheim-e	giddens-a	
geertz-c	goody-j	foucault-m	fmarx-k		
turner-v	sahlins-m		leach-er		
			levistrauss-c		
			weber-m		

Plato Maps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KANT-I
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HOMER
AQUINAS-T
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
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AUGUSTINE
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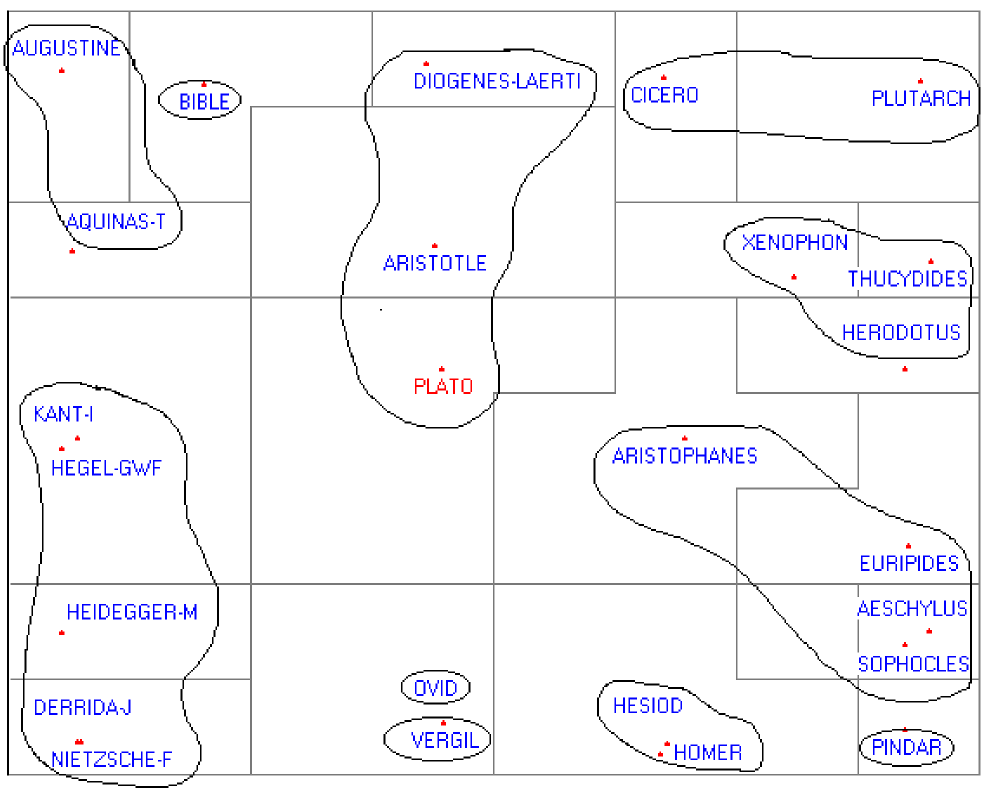
HERODOTUS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KANT-I
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HEGEL-GWF
EURIPIDES
HEIDEGGER-M
AESCHYLUS
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OVID
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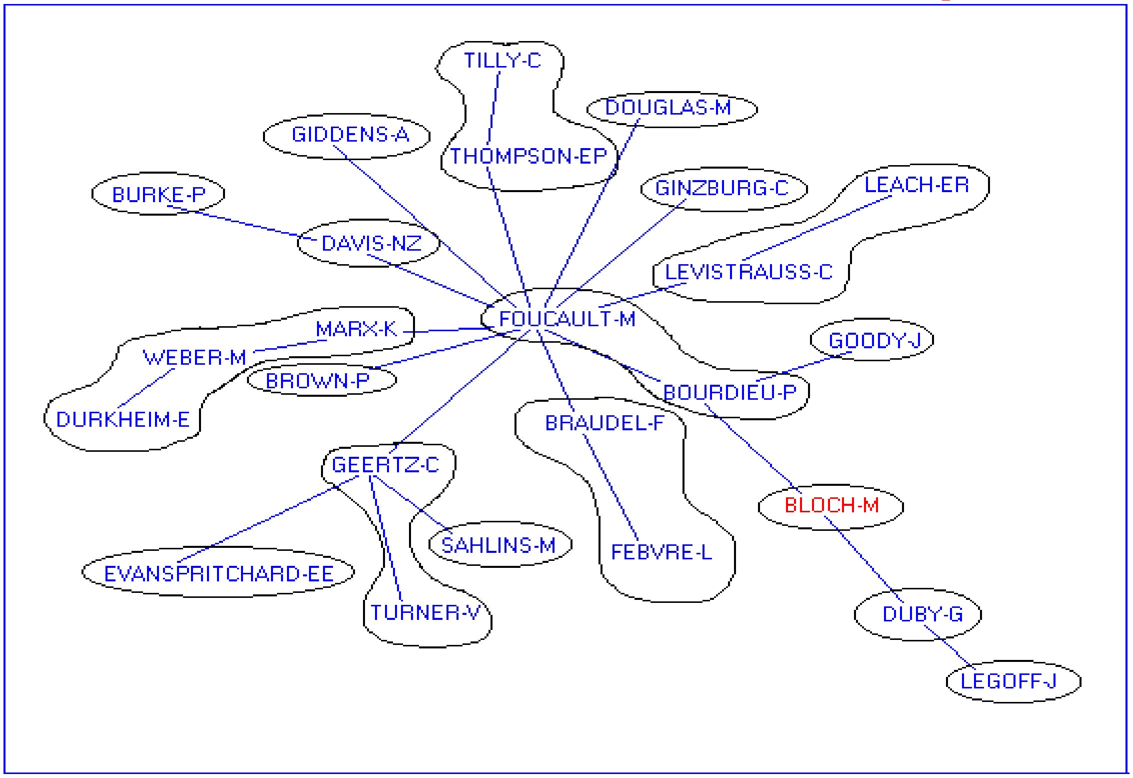
HESIOD
VERGIL
NIETZSCHE-F
HOMER
PINDAR

Bloch Maps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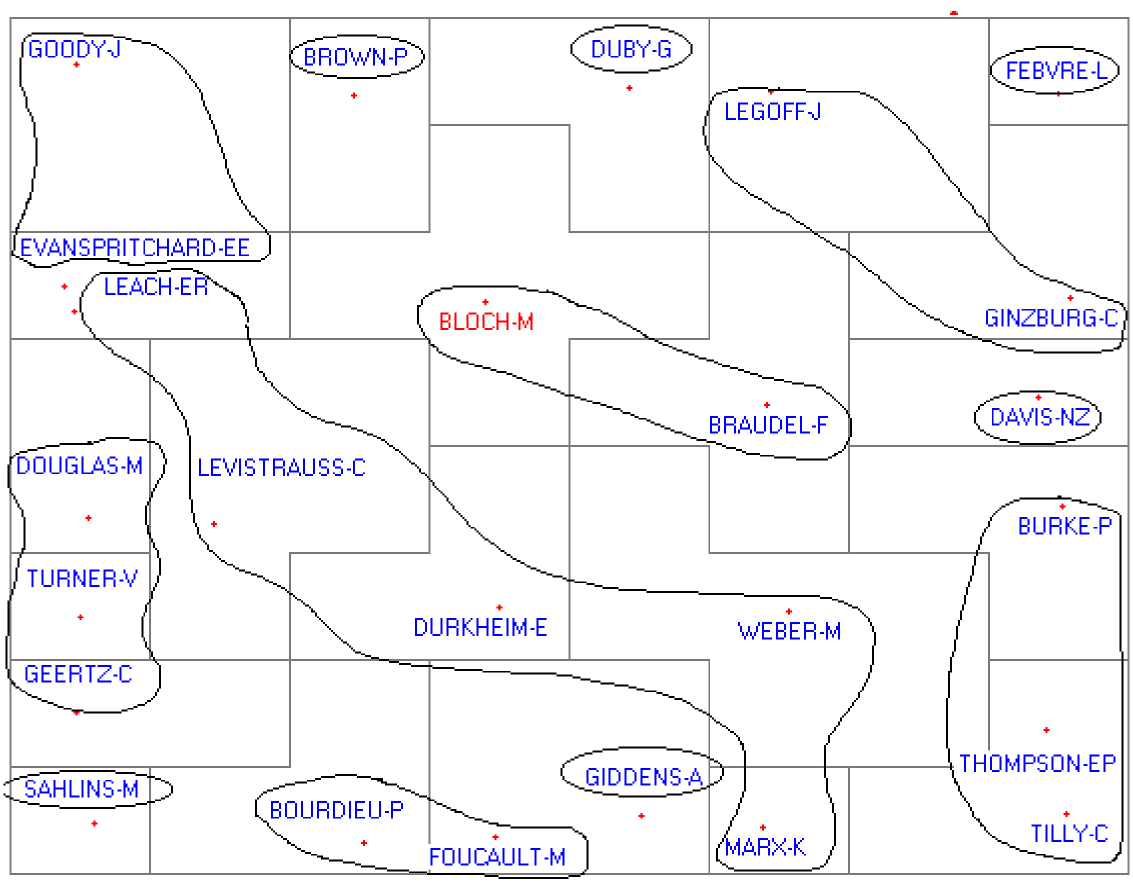
GIDDENS-A
THOMPSON-EP
BURKE-P
GINZBURG-C
LEACH-ER
DAVIS-NZ
LEVISTRAUSS-C
MARX-K
FOUCAULT-M
GOODY-J
WEBER-M
BROWN-P
BOURDIEU-P
DURKHEIM-E
BRAUDEL-F
GEERTZ-C
BLOCH-M
SAHLINS-M
FEBVRE-L
EVANSPRITCHARD-EE
TURNER-V
DUBY-G
LEGOFF-J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BROWN-P
DUBY-G
FEBVRE-L
LEGOFF-J
EVANSPRITCHARD-EE
LEACH-ER
BLOCH-M
GINZBURG-C
BRAUDEL-F
DAVIS-NZ
DOUGLAS-M
LEVISTRAUSS-C
BURKE-P
TURNER-V
DURKHEIM-E
WEBER-M
GEERTZ-C
THOMPSON-EP
GIDDENS-A
SAHLINS-M
BOURDIEU-P
TILLY-C
MARX-K
FOUCAULT-M

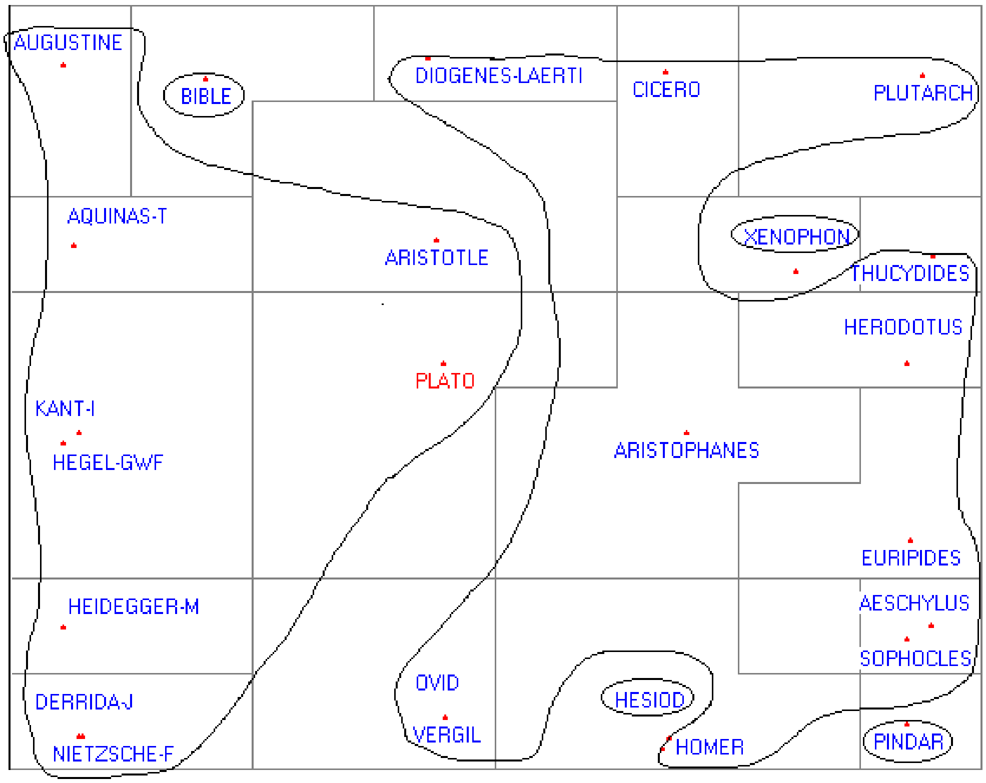
Expert #: 3

Card Sort Data

plato			
Group - 1	Group - 2	Group - 3	Group - ?
aquinas-t	aeschylus	Bible	pindar
aristotle	Aristophanes	hesiod	xenophon
augustine	cicero		
derrida-j	diogenes-laerti.		
hegel-gwf	euripides		
heidegger-m	herodotus		
kant-i	homer		
nietzsche-f	ovid		
plato	plutarch		
	Sophocles		
	Thucydides		
	vergil		

warhol-a				
Group - 1	Group - 2	Group - 3	Group - 4	Group - ?
bockris-v	alloway-l	greenberg-c	adorno-tw	colacello-b
johns-j	bourdon-d	hughes-r	barthes-r	foster-h
lichtenstein-r	coplans-j	koch-s	baudrillard-j	huyssen-a
rauschenberg-r	crone-r	ratcliff-c	benjamin-w	
warhol-a	mcshine-k		crow-t	
			derrida-j	
			freud-s	
			jameson-f	

Plato Maps


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
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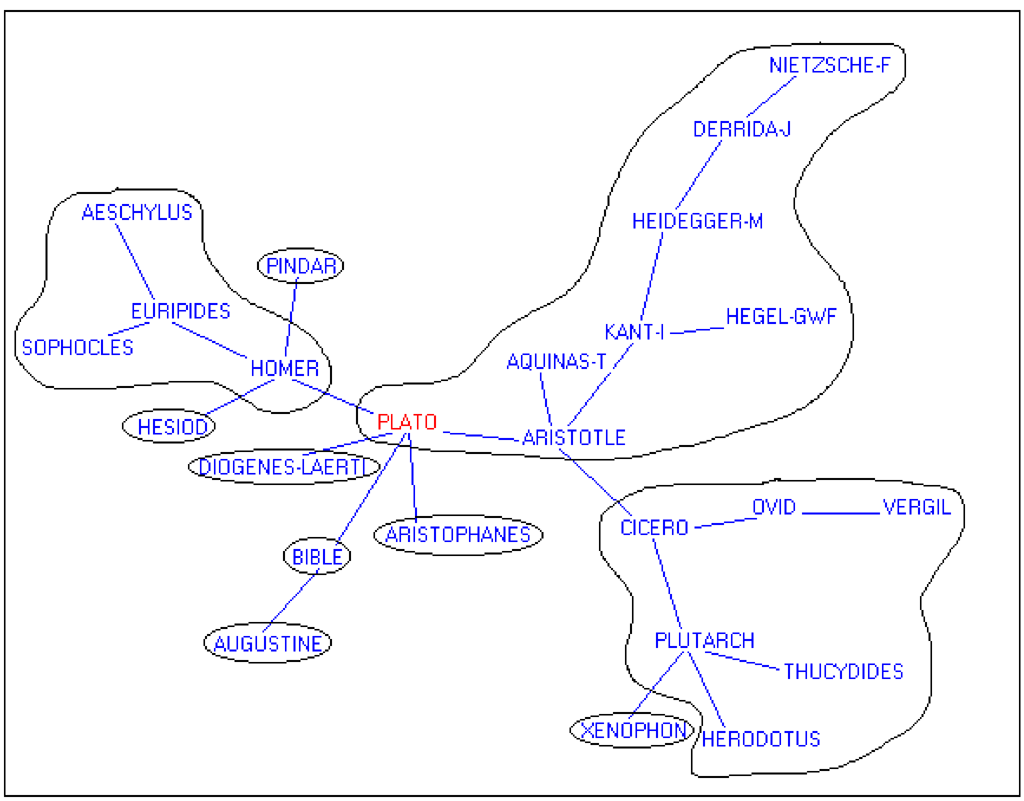
PINDAR
NIETZSCHE-F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ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
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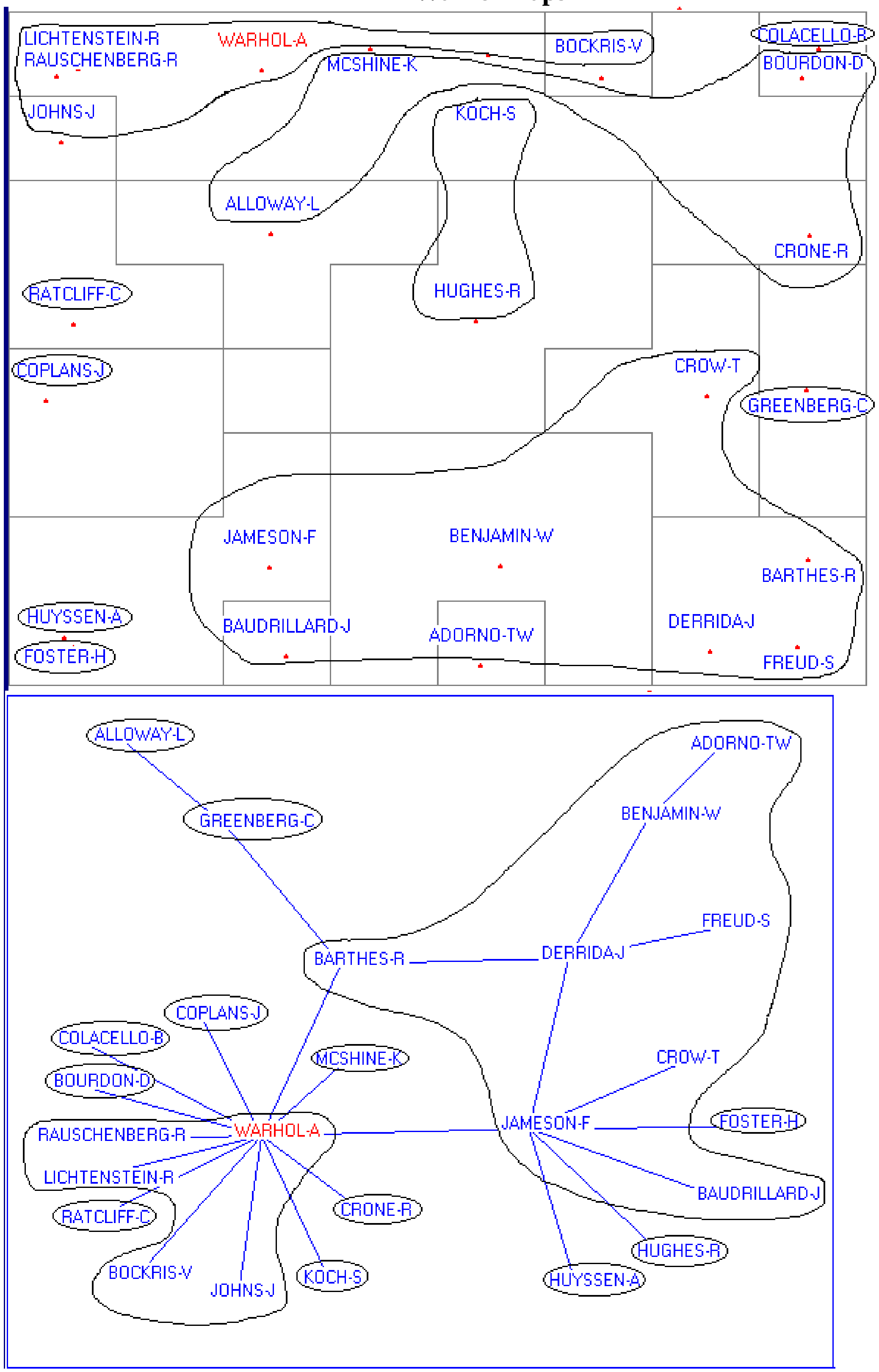
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS

Warhol Maps



LICHTENSTEIN-R
RAUSCHENBERG-R
WARHOL-A
MCSHINE-K
BOCKRIS-V
COLACELLO-B
BOURDON-D
JOHNS-J
KOCH-S
ALLOWAY-L
CRONE-R
RATCLIFF-C
HUGHES-R
COPLANS-J
CROW-T
GREENBERG-C
JAMESON-F
BENJAMIN-W
BARTHES-R
HUYSSEN-A
BAUDRILLARD-J
ADORNO-TW
DERRIDA-J
FOSTER-H
FREUD-S
ALLOWAY-L
ADORNO-TW
GREENBERG-C
BENJAMIN-W
FREUD-S
BARTHES-R
DERRIDA-J
COPLANS-J
COLACELLO-B
MCSHINE-K
CROW-T
BOURDON-D
RAUSCHENBERG-R
WARHOL-A
JAMESON-F
FOSTER-H
LICHTENSTEIN-R
BAUDRILLARD-J
RATCLIFF-C
CRONE-R
HUGHES-R
BOCKRIS-V
JOHNS-J
KOCH-S
HUYSSEN-A

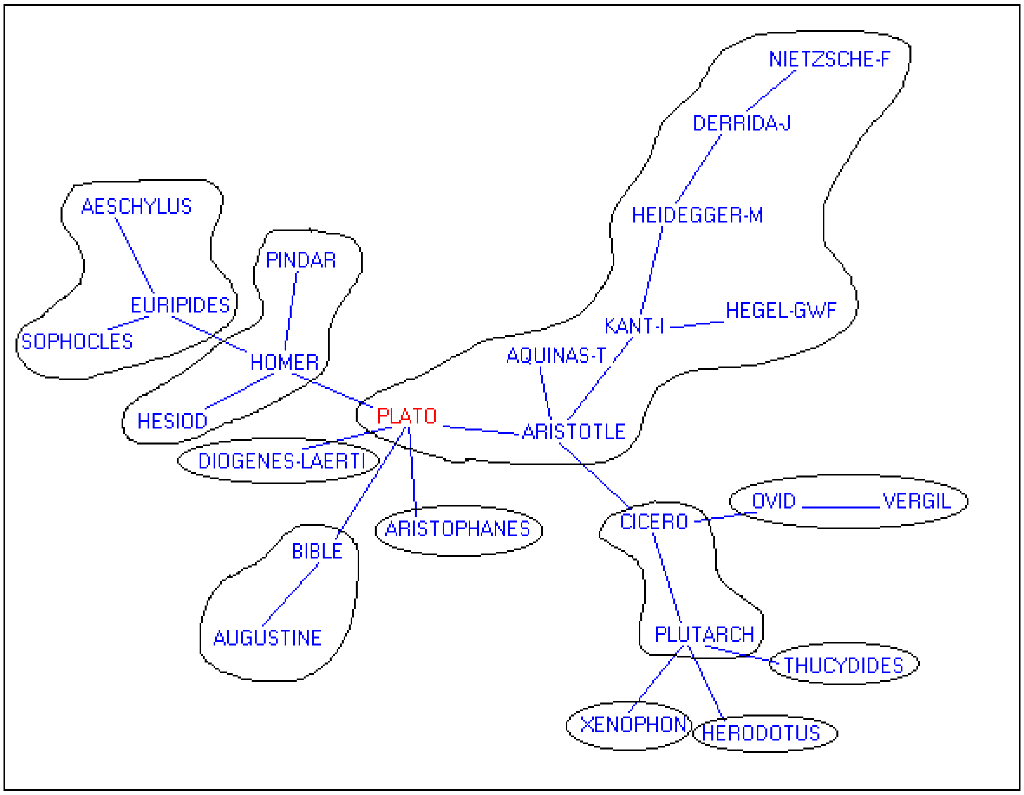
Expert #: 4

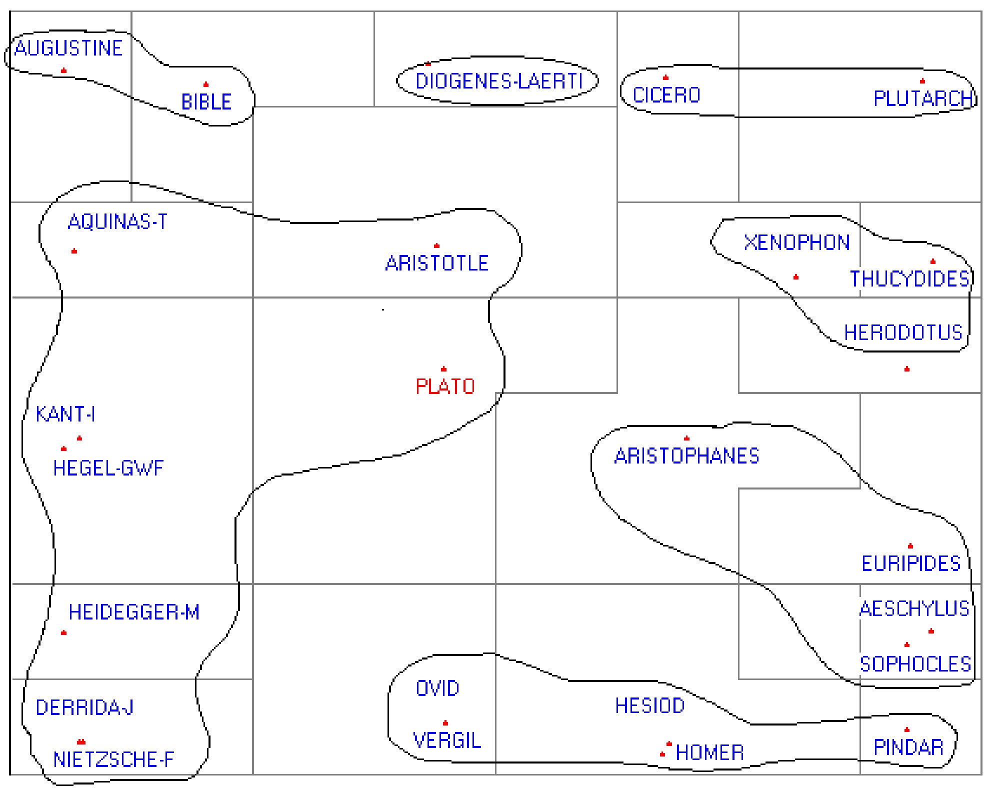
Card Sort Data

plato						
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - ?
aquinas-t	hesiod	aeschylus	herodotus	augustine	cicero	diogenes-laerti.
aristotle	homer	aristophanes	thucydides	Bible	plutarch	
derrida-j	ovid	euripides	xenophon			
hegel-gwf	pindar	sophocles				
heidegger-m	vergil					
kant-i						
nietzsche-f						
plato						

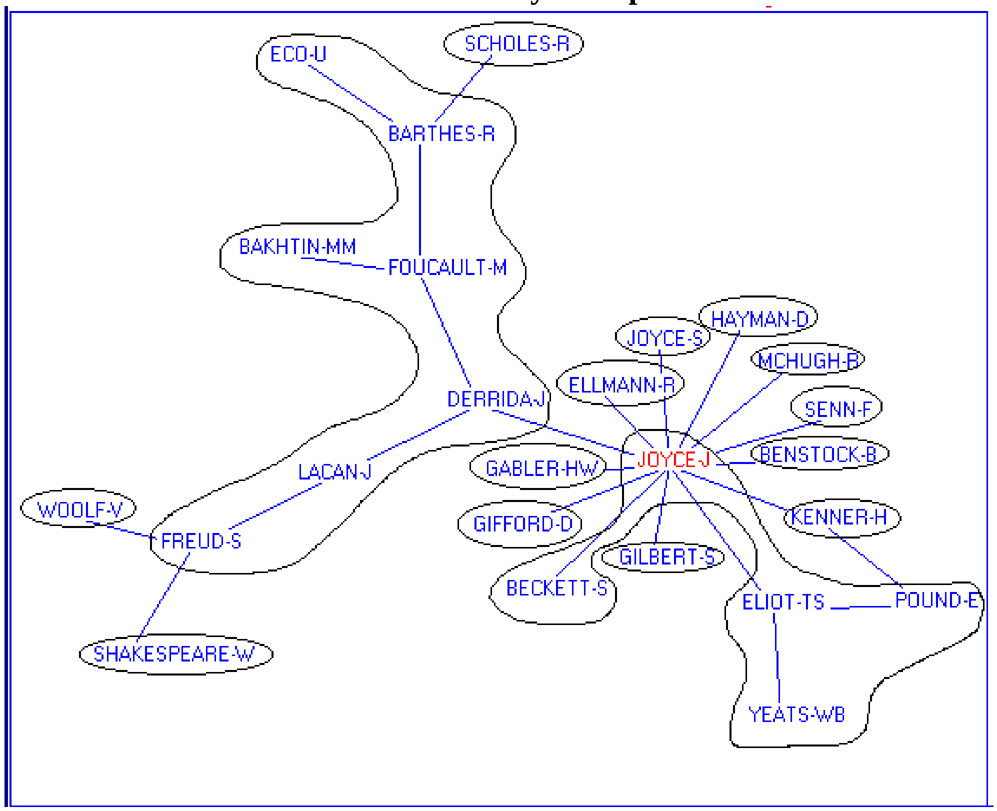
joyce-j				
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5
beckett-s	shakespeare-w	benstock-b	bakhtin-mm	joyce-s
eliot-ts		ellmann-r	barthes-r	
joyce-j		gabler-hw	derrida-j	
pound-e		gifford-d	eco-u	
woolf-v		gilbert-s	foucault-m	
yeats-wb		hayman-d	freud-s	
		kenner-h	lacan-j	
		mchugh-r		
		scholes-r		
		senn-f		

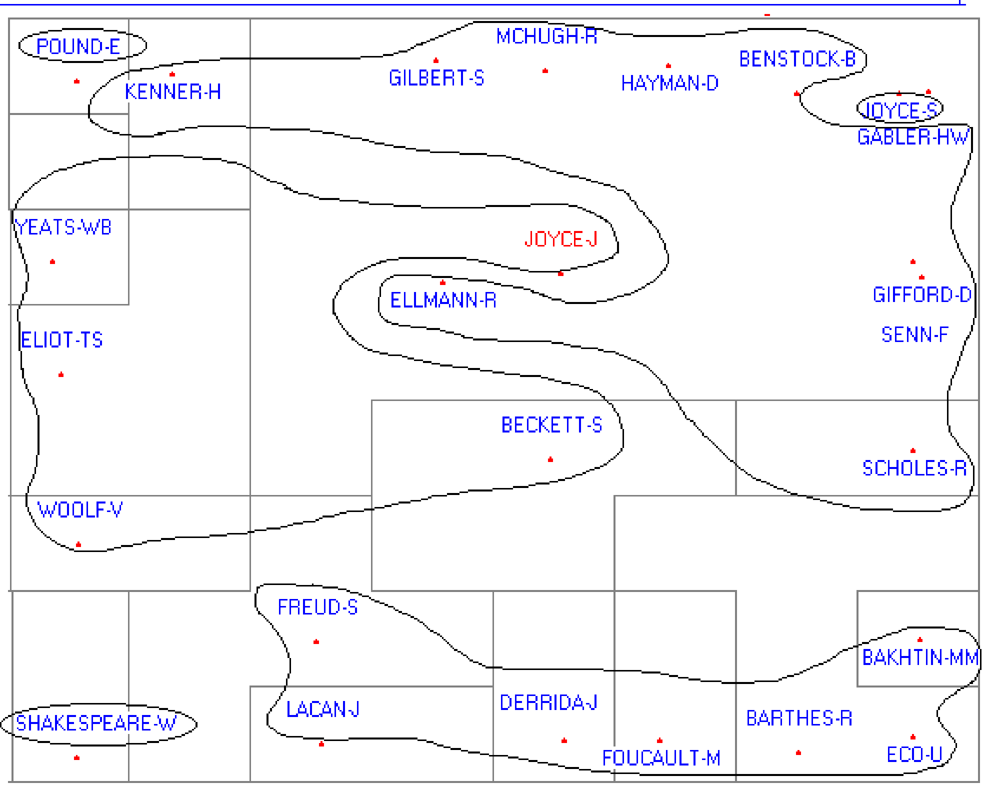
Plato Maps


NIETZSCHE-F
DERRIDA-J
HEIDEGGER-M
AESCHYLUS
PINDAR
EURIPIDES
SOPHOCLES
HOMER
HEGEL-GWF
KANT-I
AQUINAS-T
PLATO
ARISTOTLE
HESIOD
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
HOMER
PINDAR
NIETZSCHE-F

Joyce Maps


ECO-U
SCHOLES-R
BARTHES-R
BAKHTIN-MM
FOUCAULT-M
HAYMAN-D
JOYCE-S
MCHUGH-R
ELLMANN-R
SENN-F
DERRIDA-J
JOYCE-J
BENSTOCK-B
GABLER-HW
LACAN-J
WOOLF-V
GIFFORD-D
KENNER-H
FREUD-S
GILBERT-S
BECKETT-S
ELIOT-TS
POUND-E
SHAKESPEARE-W
YEATS-WB


POUND-E
MCHUGH-R
BENSTOCK-B
GILBERT-S
HAYMAN-D
KENNER-H
JOYCE-S
GABLER-HW
YEATS-WB
JOYCE-J
ELLMANN-R
GIFFORD-D
SENN-F
ELIOT-TS
BECKETT-S
SCHOLES-R
WOOLF-V
FREUD-S
BAKHTIN-MM
LACAN-J
DERRIDA-J
BARTHES-R
SHAKESPEARE-W
FOUCAULT-M
ECO-U

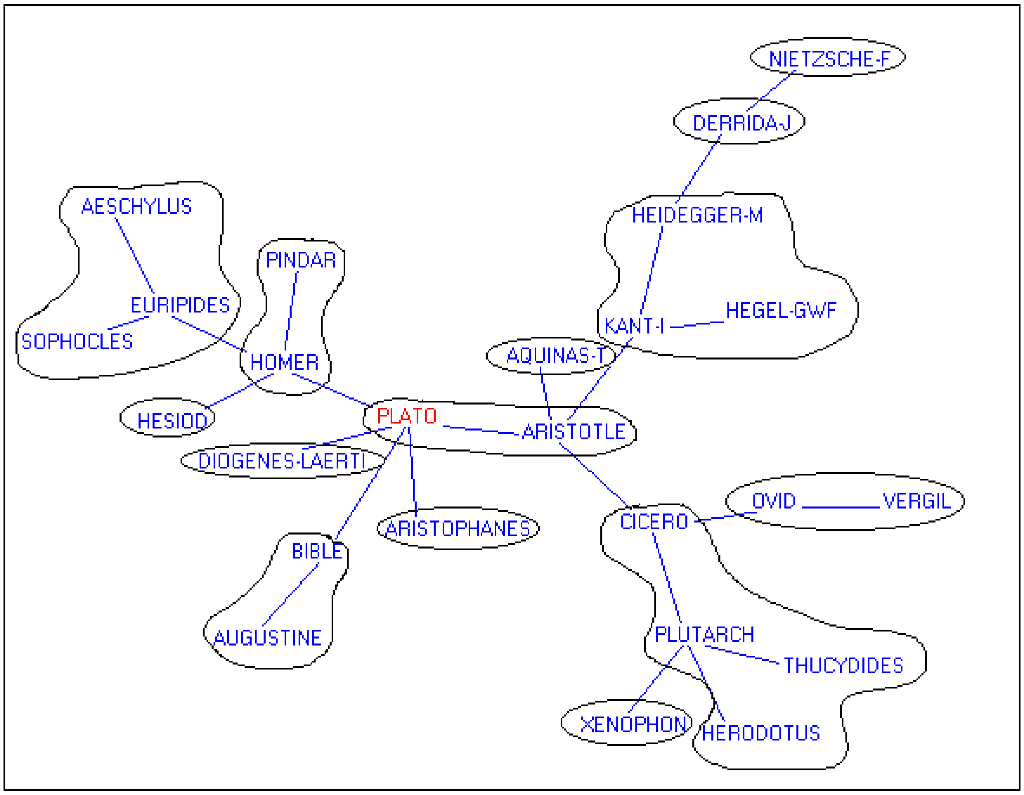
Expert #: 5

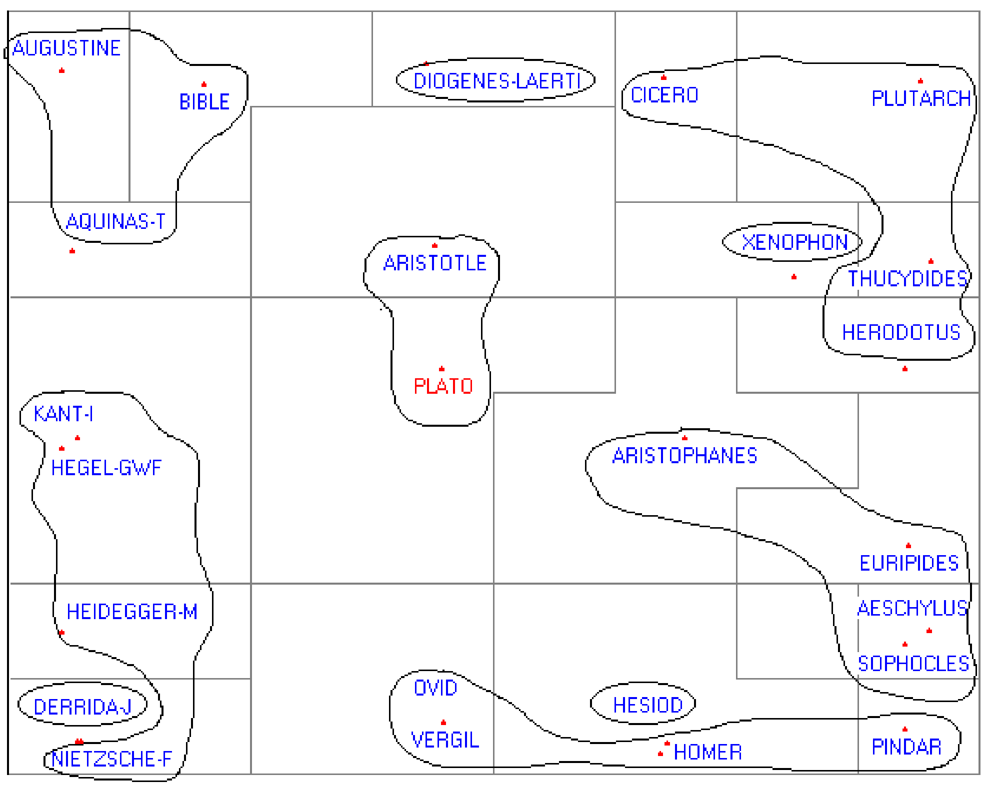
Card Sort Data

Plato							
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - 7	Group - ?
homer	aeschylus	cicero	aristotle	aquinas-t	hegel-gwf	derrida-j	diogenes-laerti.
ovid	aristophanes	herodotus	plato	augustine	heidegger-m		xenophon
pindar	euripides	hesiod		Bible	kant-i		
vergil	sophocles	plutarch			nietzsche-f		
		thucydides					

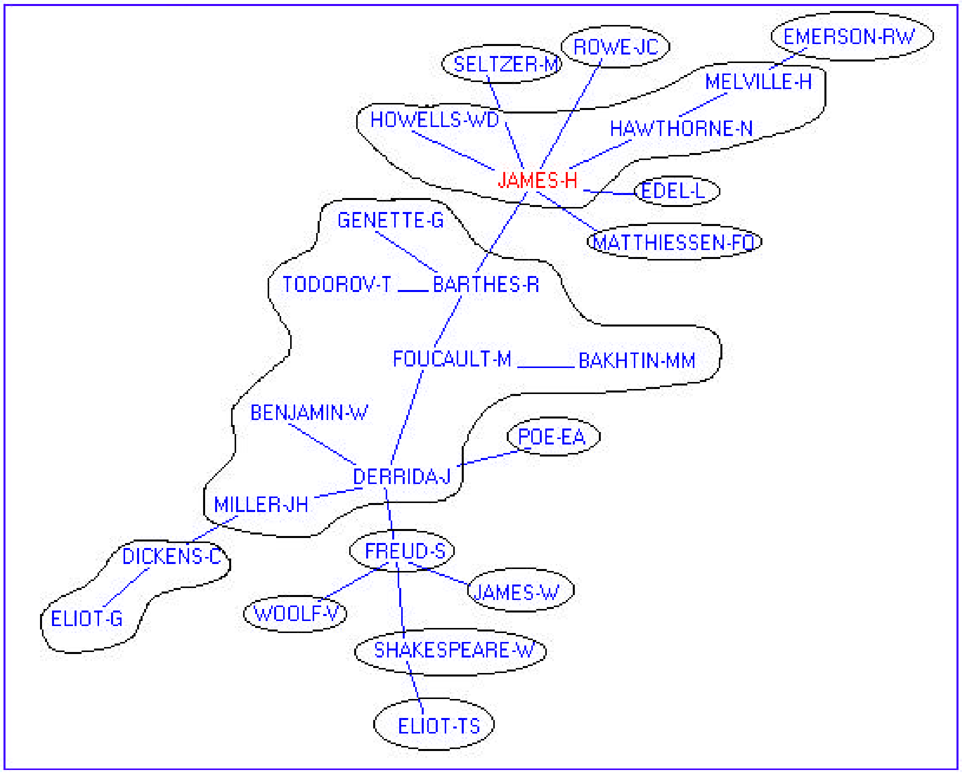
James						
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - 7
shakespeare-w	dickens-c	freud-s	eliot-ts	edel-l	bakhtin-mm	emerson-rw
	eliot-g		Woolf-v	matthiessen-fo	barthes-r	james-w
	hawthorne-n			rowe-jc	benjamin-w	
	howells-wd				derrida-j	
	james-h				foucault-m	
	melville-h				genette-g	
	poe-ea				miller-jh	
					seltzer-m	
					todorov-t	

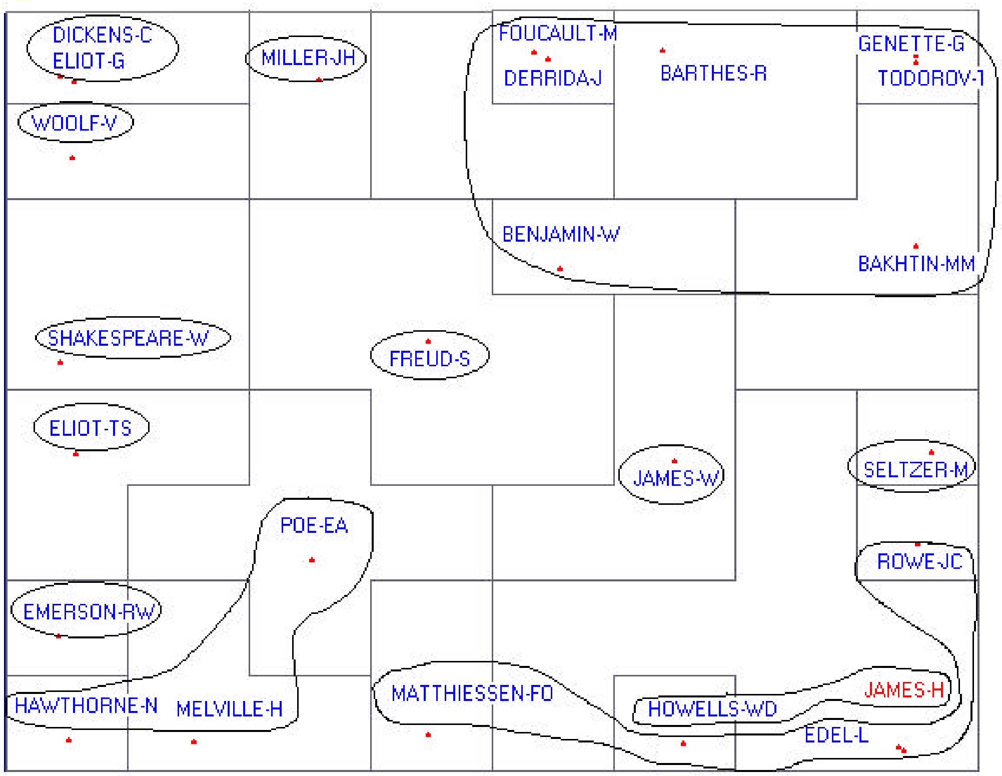
Plato Maps


NIETZSCHE-F
DERRIDA-J
AESCHYLUS
HEIDEGGER-M
PINDAR
EURIPIDES
KANT-I
HEGEL-GWF
SOPHOCLES
HOMER
AQUINAS-T
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
XENOPHON
ARISTOTLE
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
NIETZSCHE-F
HOMER
PINDAR

James Maps


SELTZER-M
ROWE-JC
EMERSON-RW
MELVILLE-H
HOWELLS-WD
HAWTHORNE-N
JAMES-H
EDEL-L
GENETTE-G
MATTHIESSEN-FO
TODOROV-T
BARTHES-R
FOUCAULT-M
BAKHTIN-MM
BENJAMIN-W
POE-EA
DERRIDA-J
MILLER-JH
DICKENS-C
FREUD-S
JAMES-W
ELIOT-G
WOOLF-V
SHAKESPEARE-W
ELIOT-TS


DICKENS-C
ELIOT-G
MILLER-JH
FOUCAULT-M
DERRIDA-J
BARTHES-R
GENETTE-G
TODOROV-T
WOOLF-V
BENJAMIN-W
BAKHTIN-MM
SHAKESPEARE-W
FREUD-S
ELIOT-TS
JAMES-W
SELTZER-M
POE-EA
ROWE-JC
EMERSON-RW
JAMES-H
HAWTHORNE-N
MELVILLE-H
MATTHIESSEN-FO
HOWELLS-WD
EDEL-L

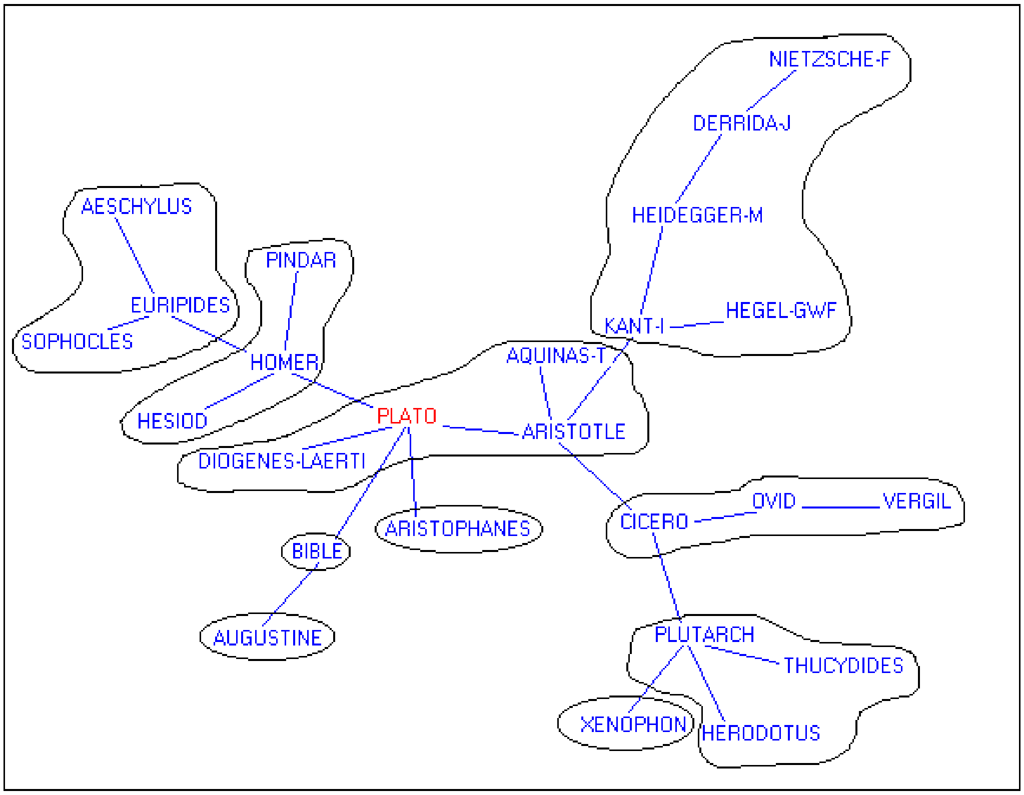
Expert #: 6

Card Sort Data

Plato						
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - ?
cicero	aeschylus	herodotus	derrida-j	aquinas-t	Bible	xenophon
hesiod	aristophanes	plutarch	hegel-gwf	aristotle		
homer	euripides	thucydides	heidegger-m	augustine		
ovid	sophocles		kant-i	diogenes-laerti.		
pindar			nietzsche-f	plato		
vergil						

geertz-c					
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - ?
douglas-m	bourdieu-p	durkheim-e	barthes-r	taylor-c	anderson-b
geertz-c	derrida-j	giddens-a	berger-pl	williams-r	clifford-j
sahlins-m	foucault-m	goffman-e	bloch-m		white-h
turner-v	levistrauss-c	habermas-j			
	ricoeur-p	jameson-f			
	rorty-r	weber-m			
	said-ew				

Plato Maps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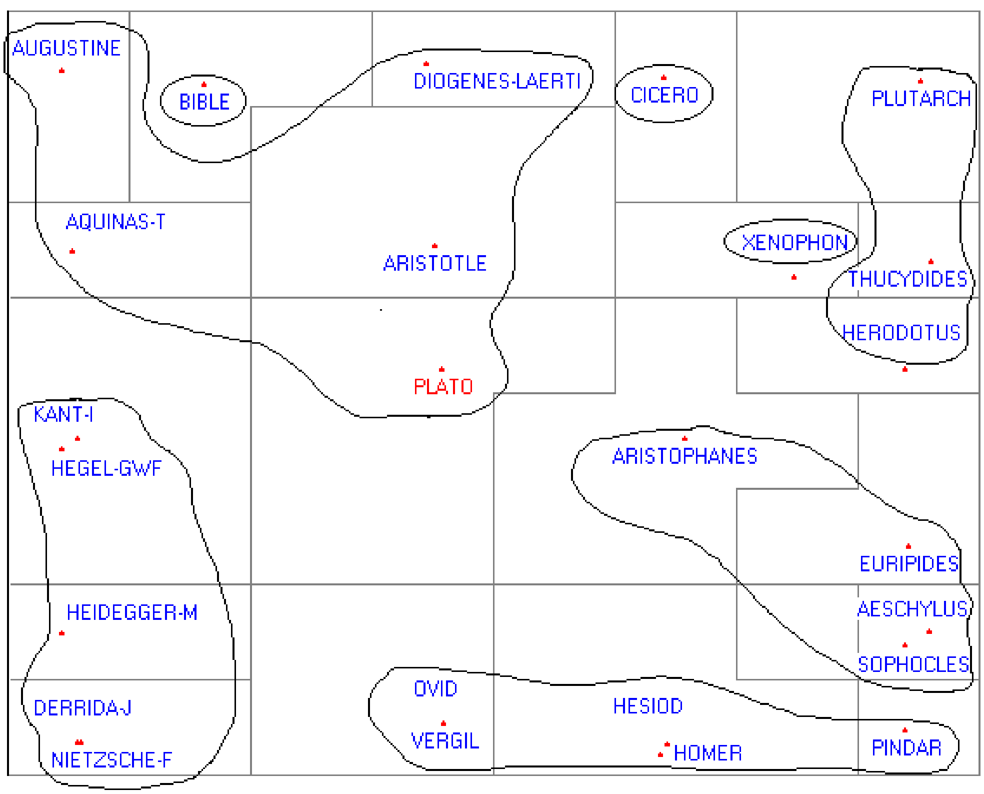
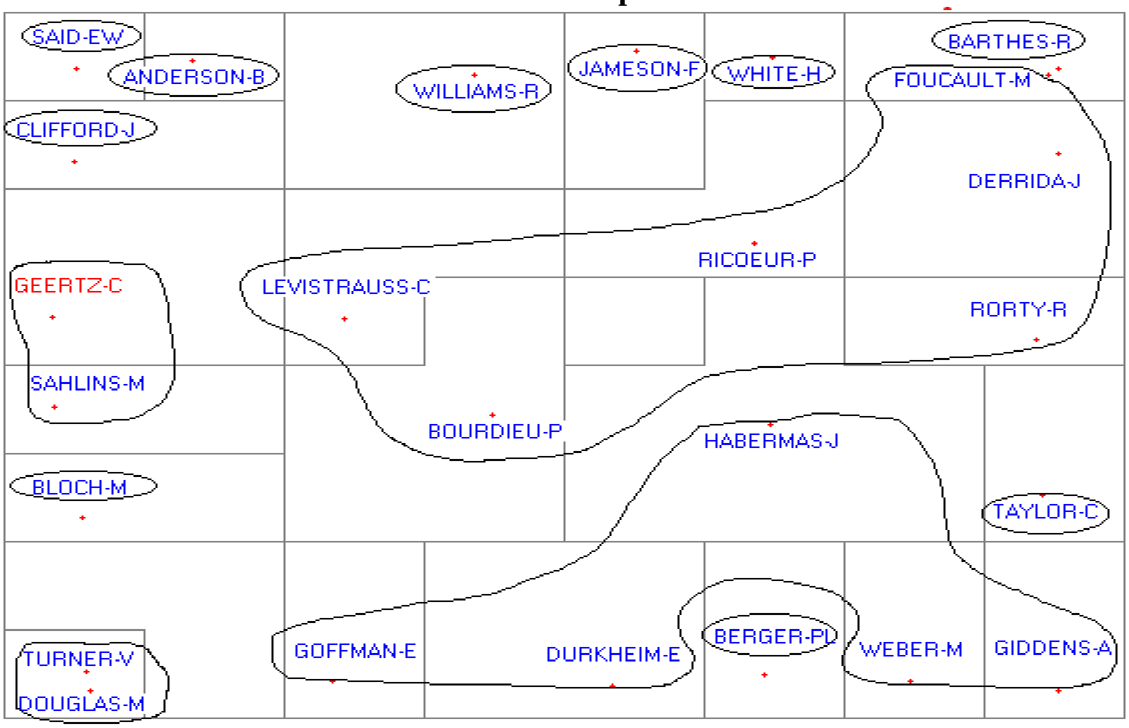
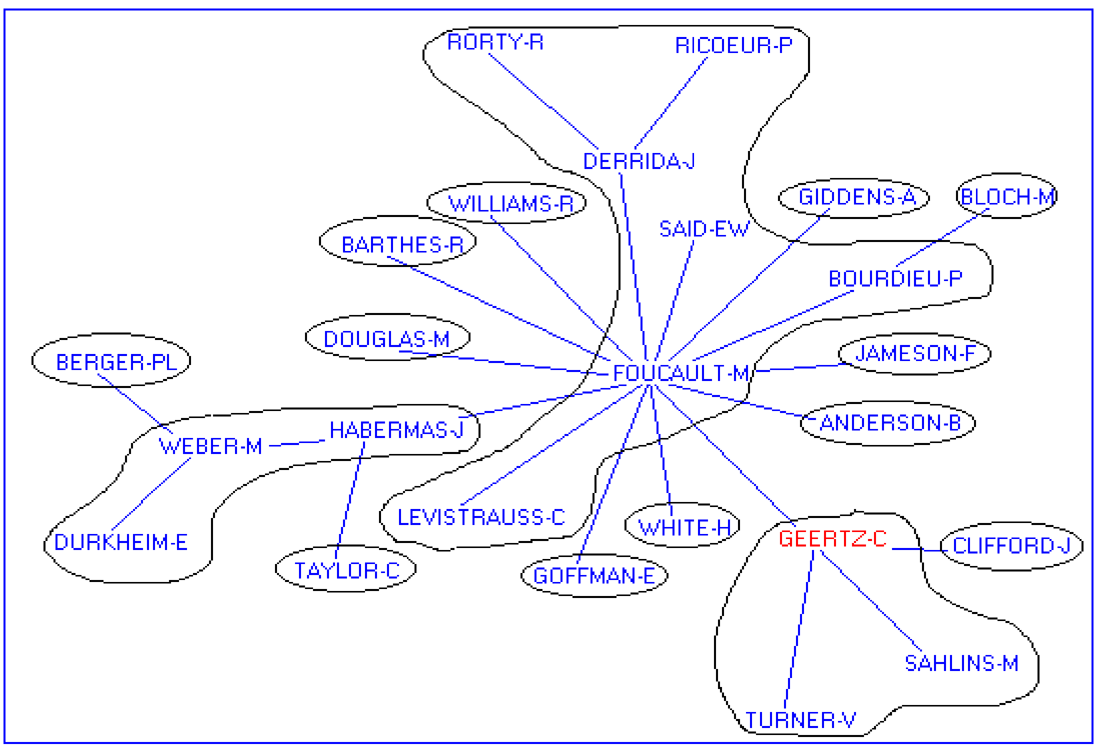
DERRIDA-J
HEIDEGGER-M
AESCHYLUS
PINDAR
EURIPIDES
HEGEL-GWF
SOPHOCLES
KANT-I
HOMER
AQUINAS-T
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
HOMER
PINDAR
NIETZSCHE-F

Geertz Maps


SAID-EW
ANDERSON-B
WILLIAMS-R
JAMESON-F
WHITE-H
BARTHES-R
FOUCAULT-M
CLIFFORD-J
DERRIDA-J
RICOEUR-P
GEERTZ-C
LEVISTRAUSS-C
RORTY-R
SAHLINS-M
BOURDIEU-P
HABERMAS-J
BLOCH-M
TAYLOR-C
TURNER-V
DOUGLAS-M
GOFFMAN-E
DURKHEIM-E
BERGER-PL
WEBER-M
GIDDENS-A


RORTY-R
RICOEUR-P
DERRIDA-J
WILLIAMS-R
GIDDENS-A
BLOCH-M
SAID-EW
BARTHES-R
BOURDIEU-P
DOUGLAS-M
BERGER-PL
FOUCAULT-M
JAMESON-F
ANDERSON-B
HABERMAS-J
WEBER-M
LEVISTRAUSS-C
WHITE-H
GEERTZ-C
CLIFFORD-J
DURKHEIM-E
TAYLOR-C
GOFFMAN-E
SAHLINS-M
TURNER-V

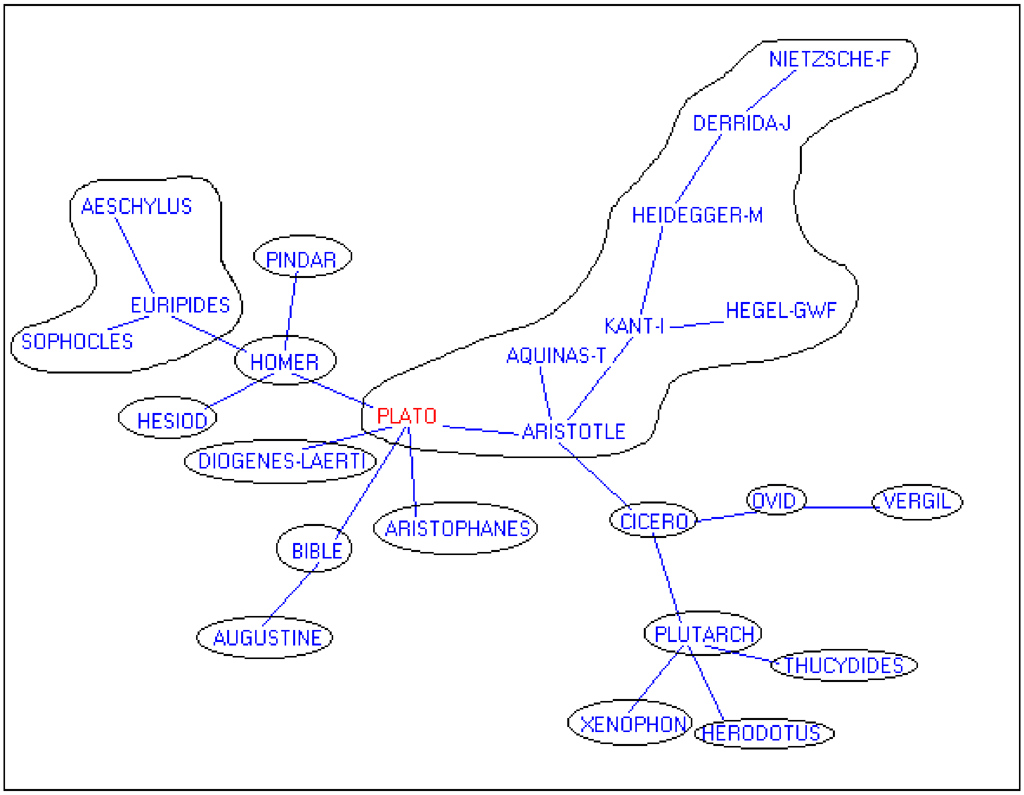
Expert #: 7

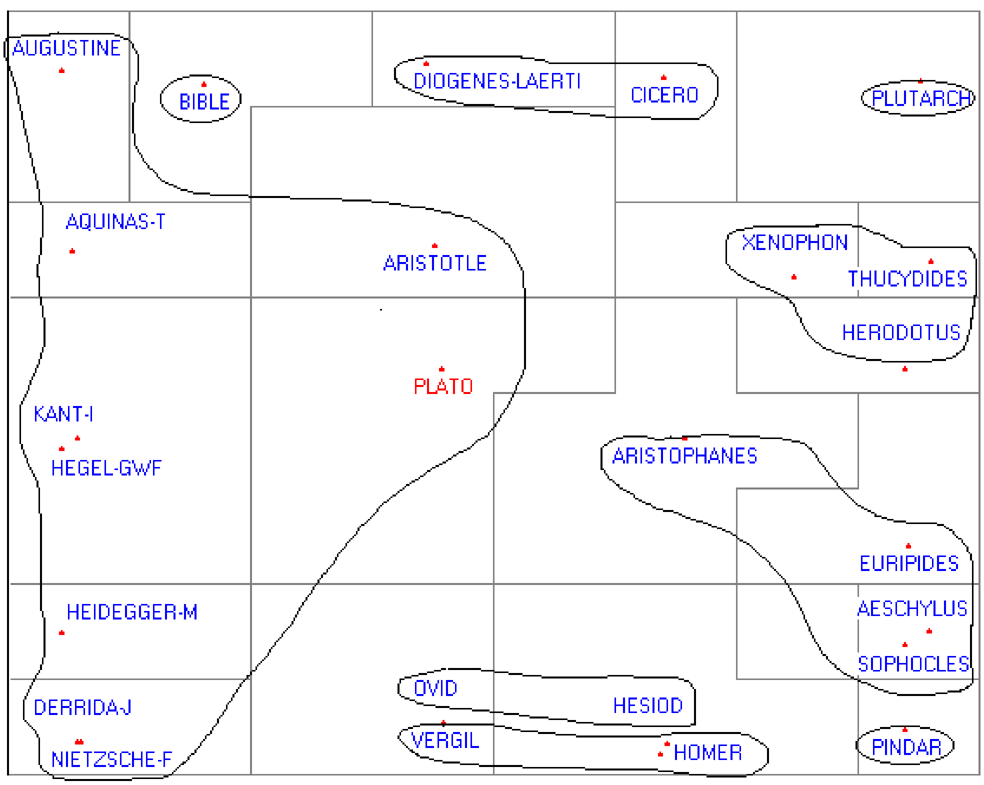
Card Sort Data

Plato							
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - 7	Group - 8
aquinas-t	bible	herodotus	hesiod	aeschylus	cicero	pindar	plutarch
aristotle	homer	thucydides	ovid	aristophanes	diogenes-laerti.		
augustine	vergil	xenophon		euripides			
derrida-j				sophocles			
hegel-gwf							
heidegger-m							
kant-i							
nietzsche-f							
plato							

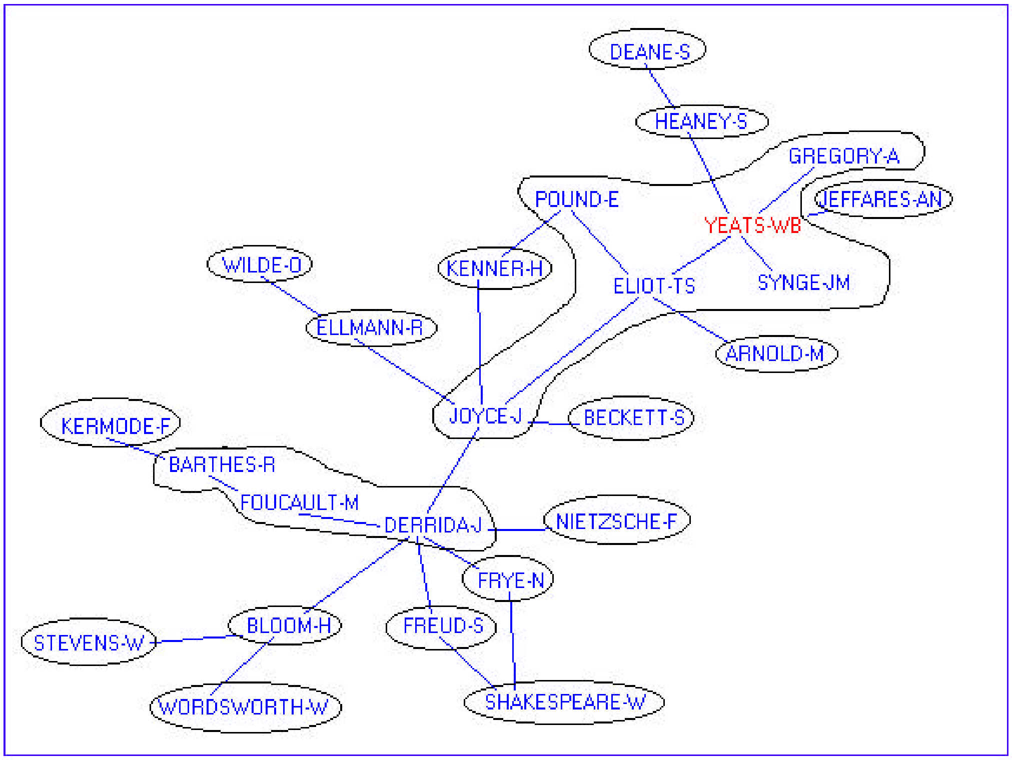
Yeats						
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - ?
arnold-m	freud-s	eliot-ts	beckett-s	bloom-h	barthes-r	deane-s
shakespeare-w	nietzsche-f	gregory-a	heaney-s	ellmann-r	derrida-j	
wilde-o		joyce-j	stevens-w	frye-n	foucault-m	
wordsworth-w		pound-e		jeffares-an		
		synge-jm		kenner-h		
		yeats-wb		kermode-f		

Plato Maps

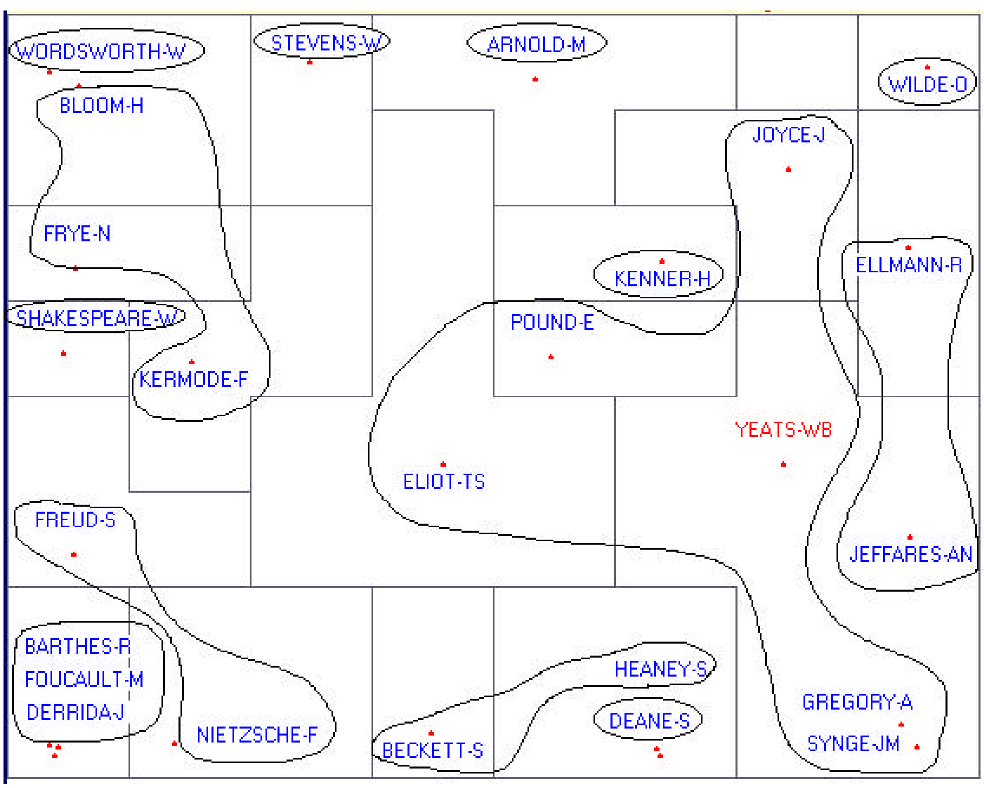

NIETZSCHE-F
DERRIDA-J
HEIDEGGER-M
AESCHYLUS
PINDAR
EURIPIDES
SOPHOCLES
HOMER
KANT-I
HEGEL-GWF
AQUINAS-T
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
HESIOD
DERRIDA-J
VERGIL
HOMER
PINDAR
NIETZSCHE-F

Yeats Maps



DEANE-S
HEANEY-S
GREGORY-A
POUND-E
JEFFARES-AN
YEATS-WB
WILDE-O
KENNER-H
ELIOT-TS
SYNGE-JM
ELLMANN-R
ARNOLD-M
KERMODE-F
JOYCE-J
BECKETT-S
BARTHES-R
FOUCAULT-M
DERRIDA-J
NIETZSCHE-F
FRYE-N
STEVENS-W
BLOOM-H
FREUD-S
WORDSWORTH-W
SHAKESPEARE-W



WORDSWORTH-W
STEVENS-W
ARNOLD-M
WILDE-O
BLOOM-H
JOYCE-J
FRYE-N
ELLMANN-R
KENNER-H
SHAKESPEARE-W
POUND-E
KERMODE-F
YEATS-WB
ELIOT-TS
FREUD-S
JEFFARES-AN
BARTHES-R
FOUCAULT-M
DERRIDA-J
HEANEY-S
GREGORY-A
DEANE-S
NIETZSCHE-F
BECKETT-S
SYNGE-JM

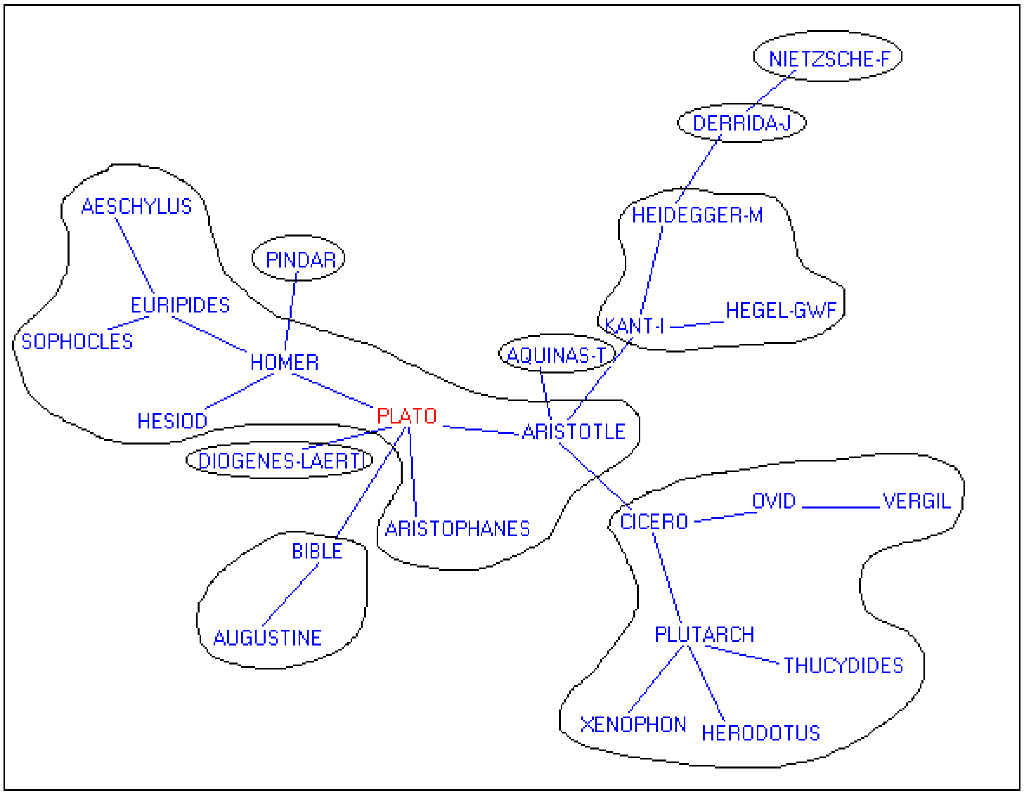
Expert #: 8

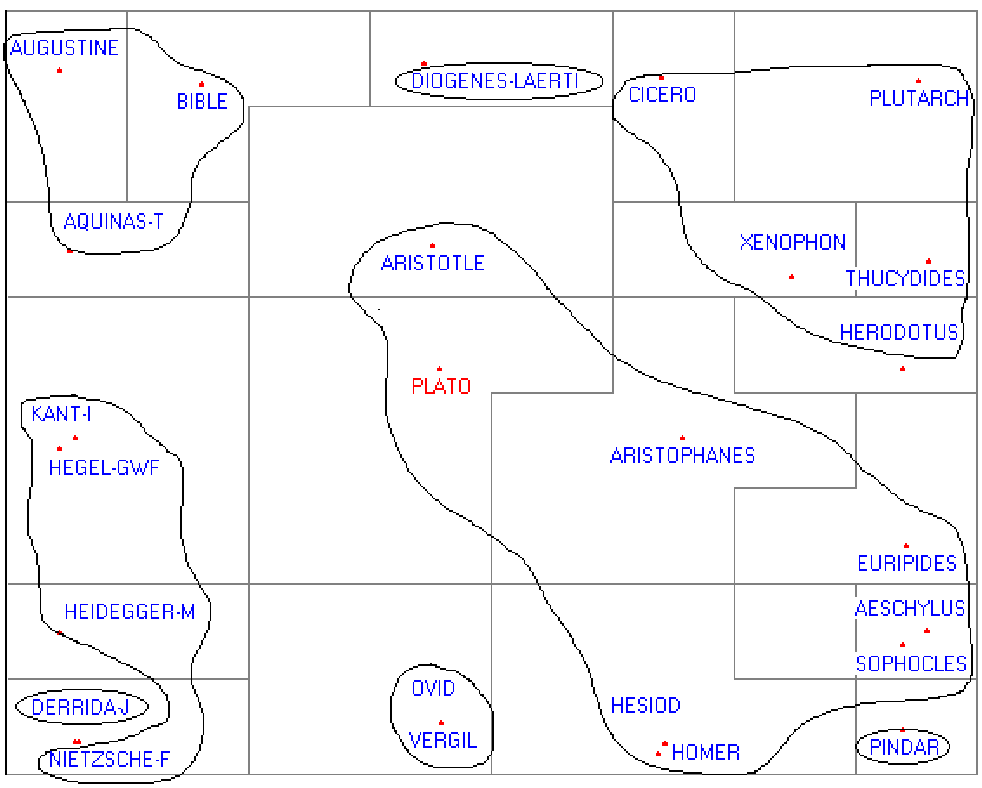
Card Sort Data

plato					
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6
aeschylus	cicero	aquinas-t	hegel-gwf	diogenes-laerti.	derrida-j
aristophanes	herodotus	augustine	heidegger-m		
aristotle	ovid	Bible	kant-i		
euripides	pindar		nietzsche-f		
hesiod	plutarch				
homer	thucydides				
plato	vergil				
sophocles	xenophon				

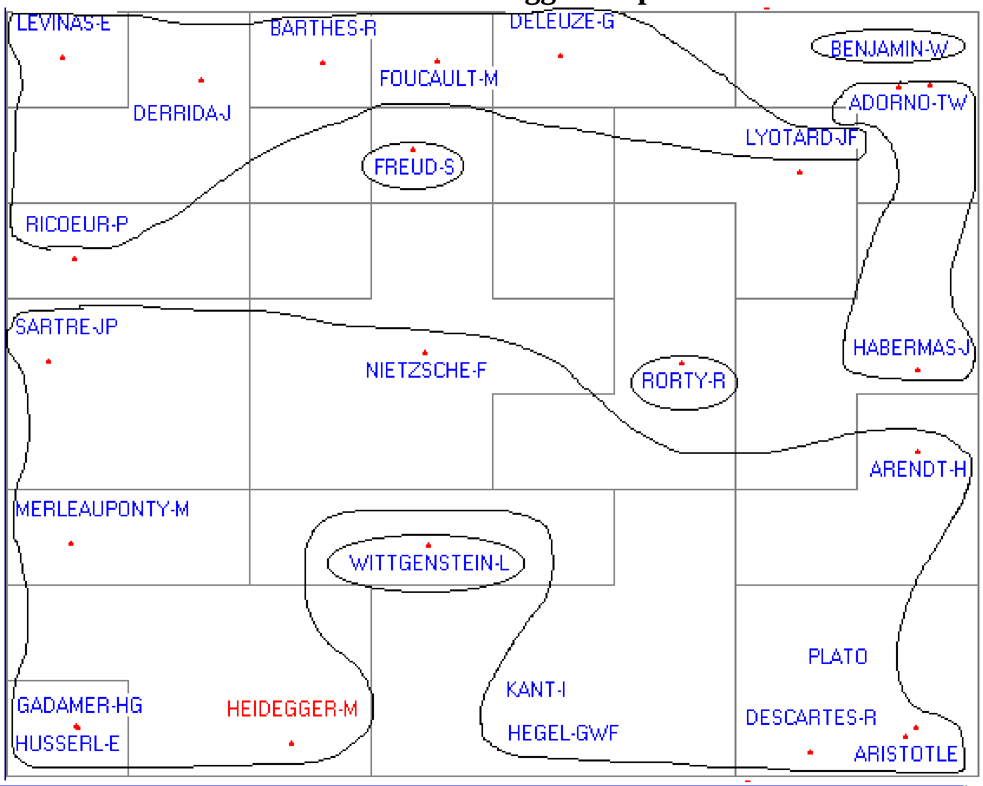
heidegger-m:						
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - 7
arendt-h:	rorty-r:	barthes-r:	adorno-tw:	wittgenstein-l:	benjamin-w:	freud-s:
aristotle:		deleuze-g:	habermas-j:			
descartes-r:		derrida-j:				
gadamer-hg:		foucault-m:				
hegel-gwf:		levinas-e:				
heidegger-m:		lyotard-jf:				
husserl-e:		ricoeur-p:				
kant-i:						
merleauponty-m:						
nietzsche-f:						
plato:						
sartre-jp:						

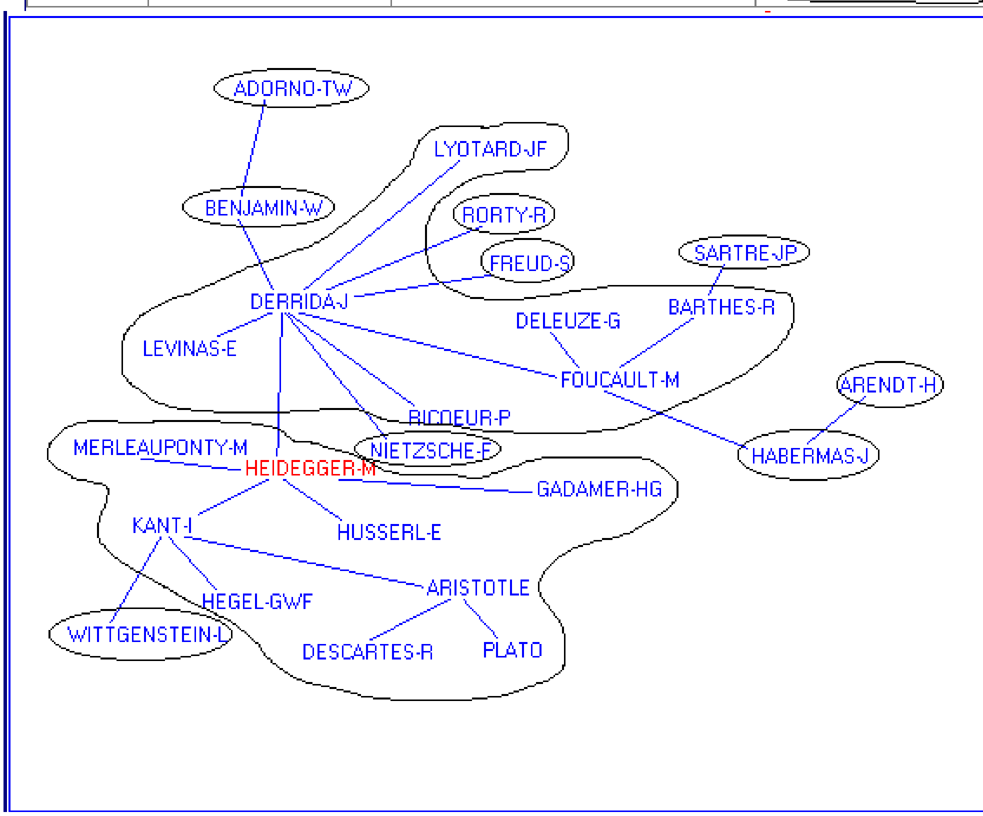
Plato Maps


NIETZSCHE-F
DERRIDA-J
AESCHYLUS
HEIDEGGER-M
PINDAR
EURIPIDES
HEGEL-GWF
SOPHOCLES
KANT-I
AQUINAS-T
HOMER
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
NIETZSCHE-F
HOMER
PINDAR

Heidegger Maps





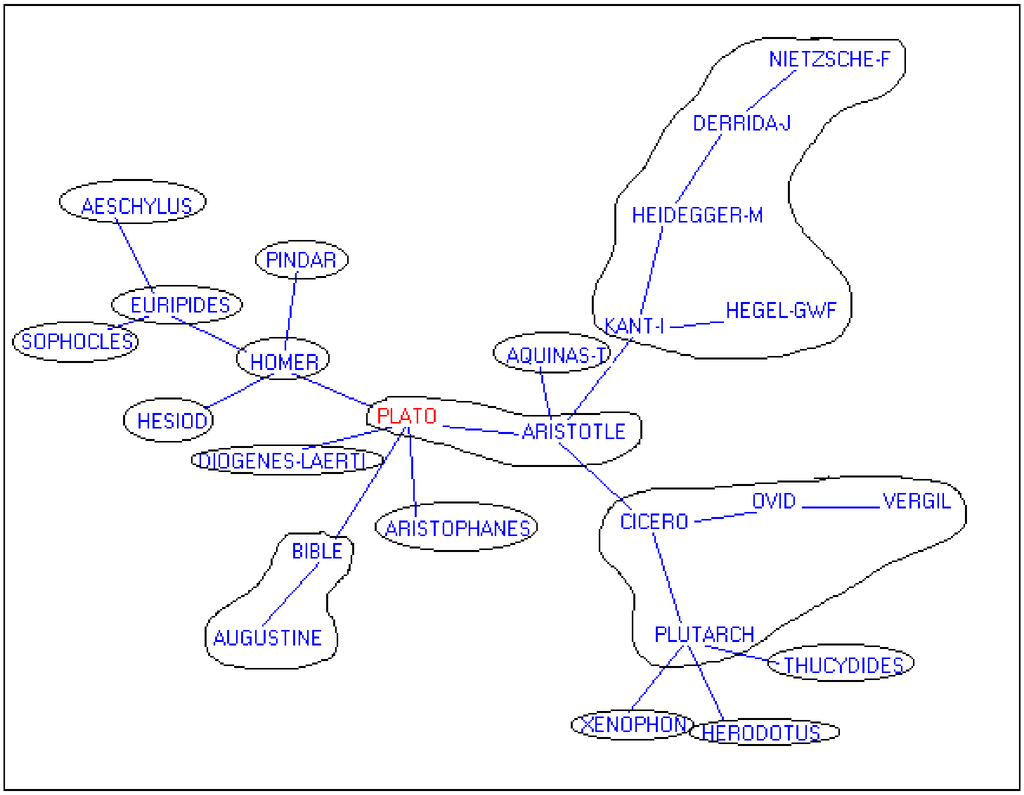
Expert #: 9

Card Sort Data

PLATO					
Group - 1	**Group - 2**	**Group - 3**	**Group - 4**	**Group - 5**	**Group - ?**
derrida-j	cicero	aristophanes	Aquinas-t	aristotle	aeschylus
hegel-gwf	homer	euripides	augustine	plato	diogenes-laerti.
heidegger-m	ovid	herodotus	Bible	sophocles	hesiod
kant-i	plutarch	thucydides			pindar
nietzsche-f	vergil				xenophon

Jameson						
Group - 1	**Group - 2**	**Group - 3**	**Group - 4**	**Group - 5**	**Group - 6**	**Group - ?**
barthes-r	adorno-tw	freud-s	eagleton-t	bourdieu-p	bakhtin-mm	culler-j
baudrillard-j	althusser-l	kristeva-j	hutcheon-l	williams-r	lukacs-g	white-h
deleuze-g	benjamin-w	lacan-j	jameson-f		said-ew	
deman-p	habermas-j					
derrida-j	marx-k					
foucault-m						
lyotard-jf						

Plato Maps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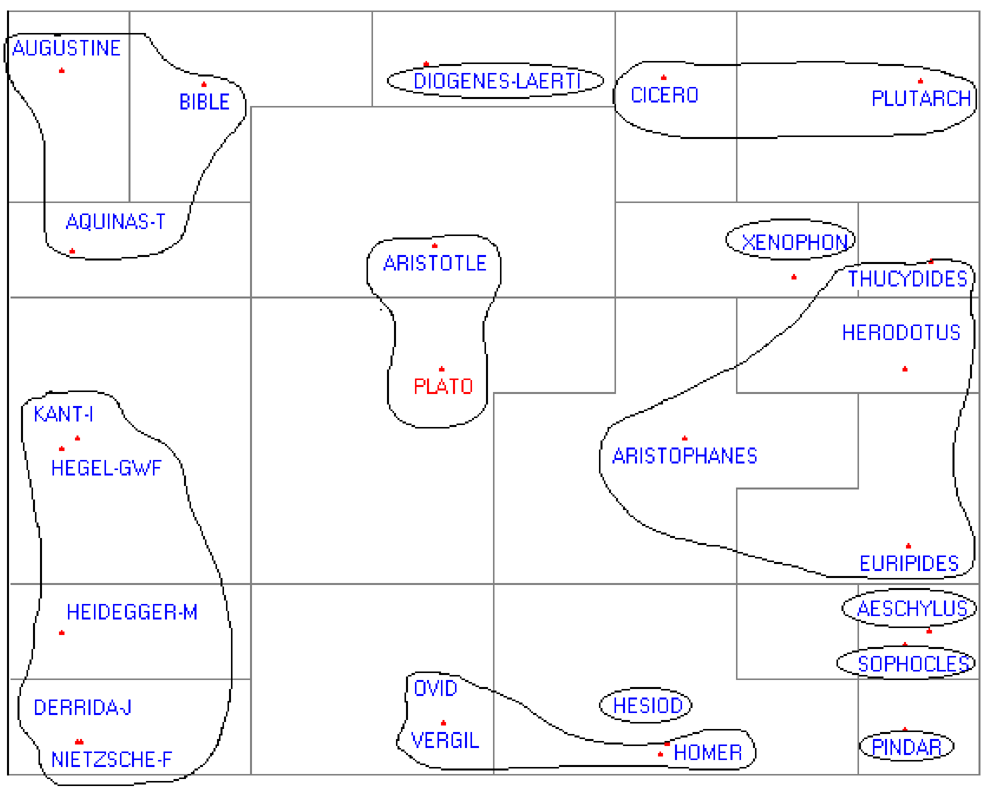
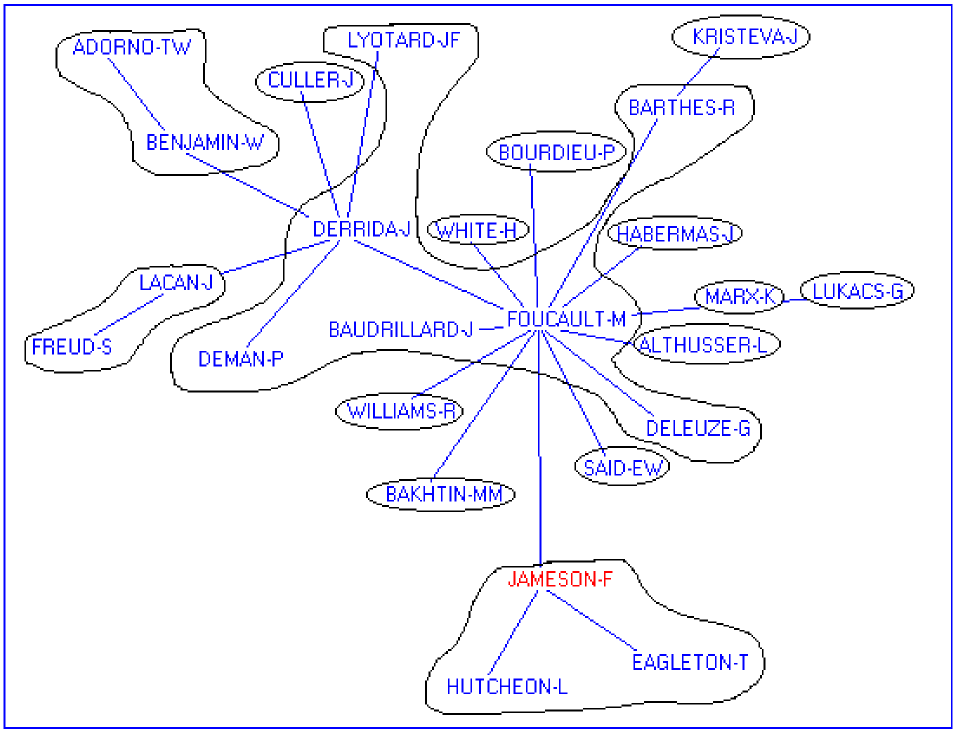
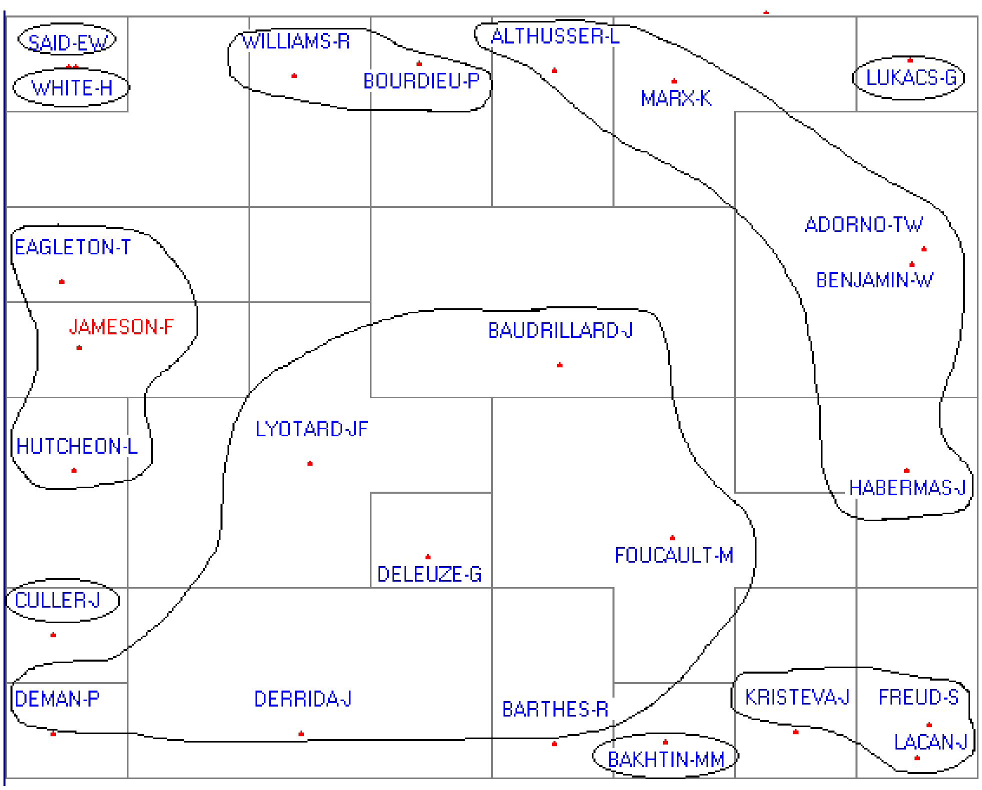
DERRIDA-J
HEIDEGGER-M
AESCHYLUS
PINDAR
EURIPIDES
SOPHOCLES
HOMER
HEGEL-GWF
KANT-I
AQUINAS-T
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
HOMER
PINDAR
NIETZSCHE-F

Jameson Maps





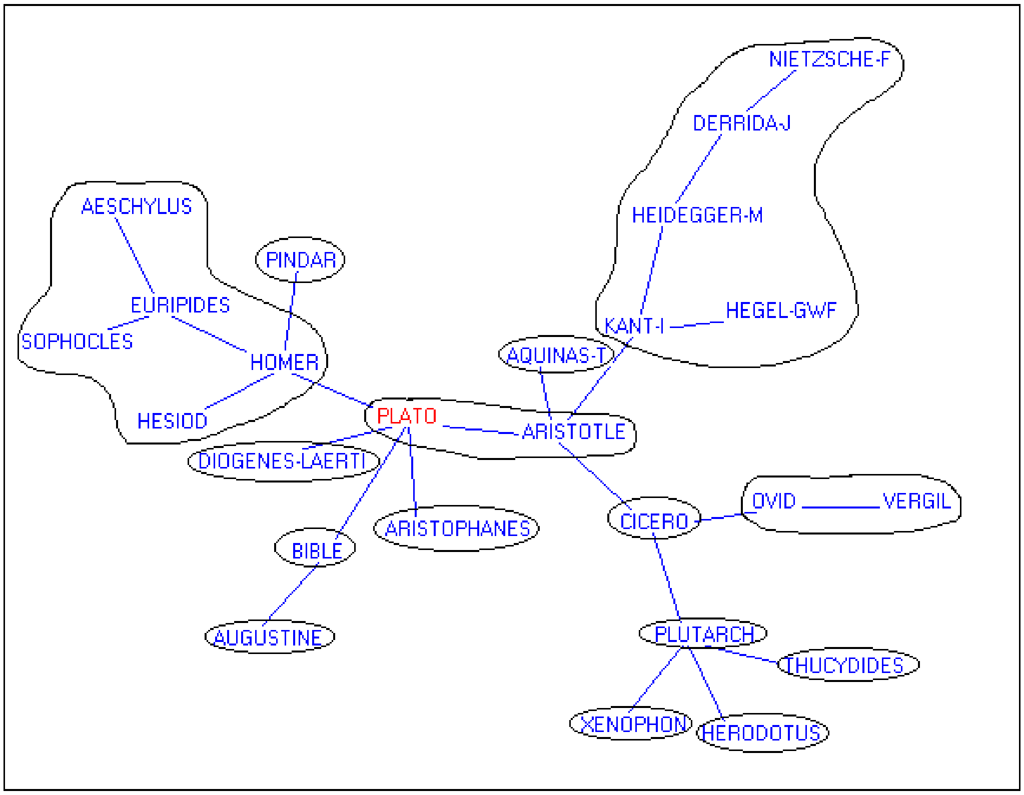
Expert #: 10

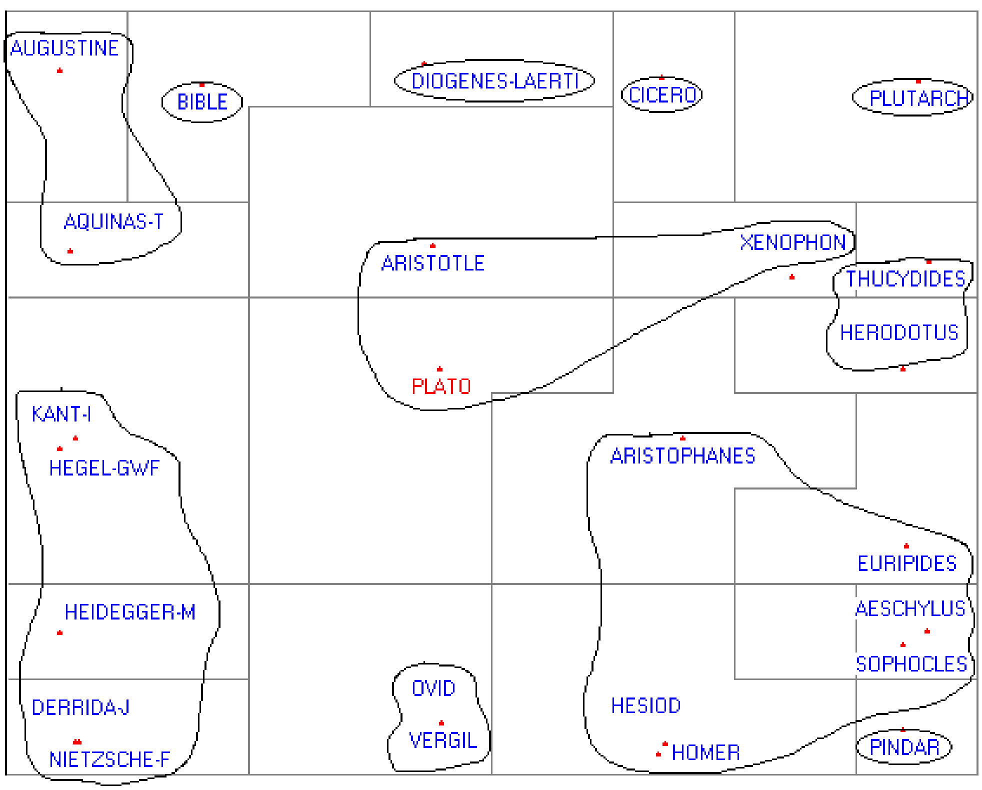
Card Sort Data

plato						
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - 7
Bible	aeschylus	aristotle	herodotus	diogenes-laerti.	aquinas-t	derrida-j
	aristophanes	plato	Pindar	ovid	augustine	hegel-gwf
	cicero	xenophon	thucydides	plutarch		heidegger-m
	euripides			vergil		kant-i
	hesiod					nietzsche-f
	homer					
	sophocles					

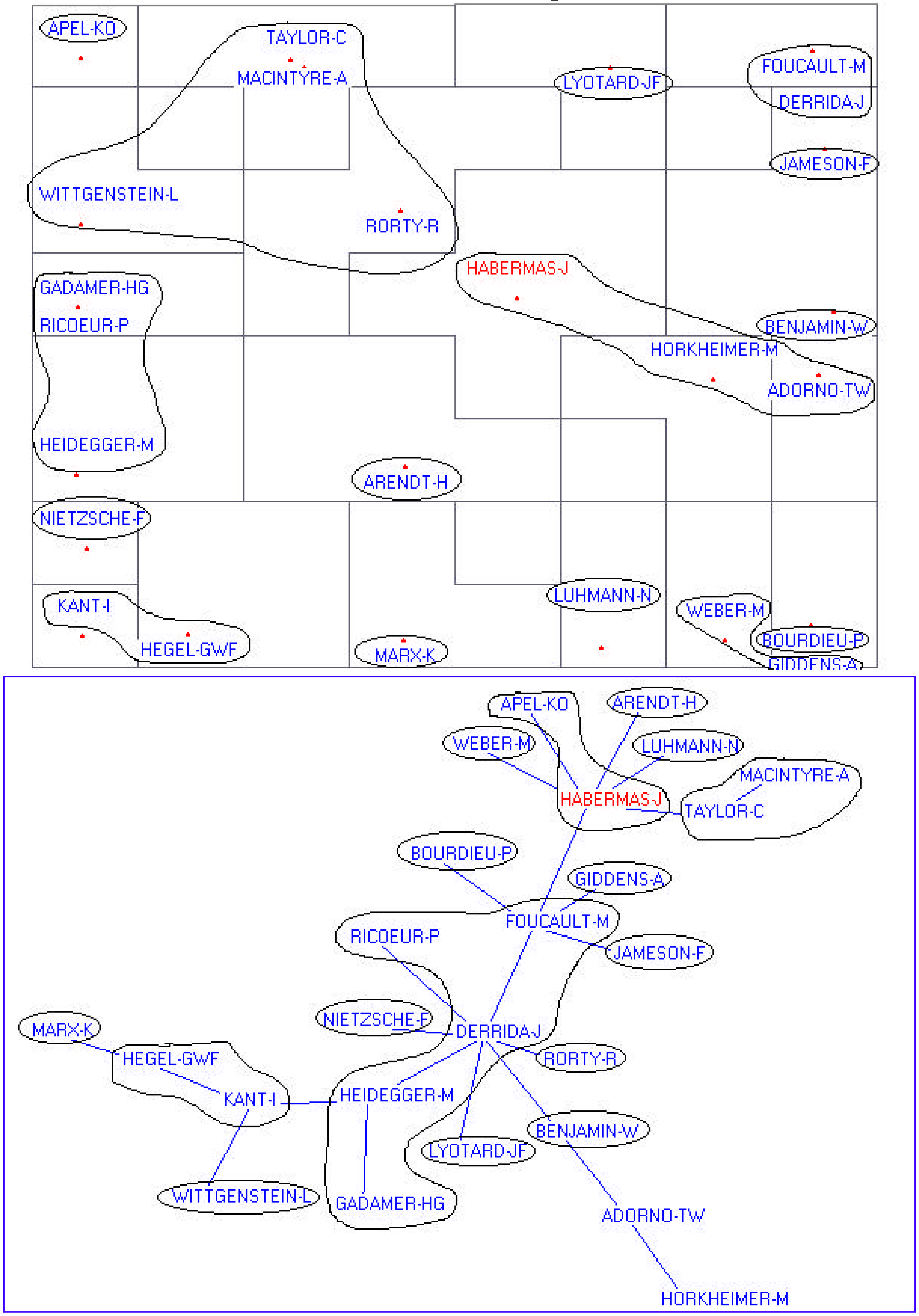
Habermas			
Group - 1	Group - 2	Group - 3	Group - 4
Kant-I	Derrida-J	Arendt-H	Horkheimer-M
Hegle-GWF	Foucault-M	Adorno-TW	Habermas-J
	Heidegger-M		Mark-K
	Gadamer-HG		Apel-KO
	Ricoeur-P		
Group - 5	Group - 6	Group - 7	Group - ?
Giddens-A	Nietzsche-F	MacIntyre-A	Bourdieu-P
Weber-M		Taylor-C	Lyotard-JF
		Wittgenstein-L	Luhmann-N
		Rorty-R	Jameson-F
			Benjamin-W

Plato Maps


NIETZSCHE-F
DERRIDA-J
HEIDEGGER-M
HEGEL-GWF
KANT-I
AESCHYLUS
PINDAR
EURIPIDES
SOPHOCLES
HOMER
AQUINAS-T
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
DERRIDA-J
OVID
VERGIL
HESIOD
HOMER
PINDAR
NIETZSCHE-F

Habermas Maps



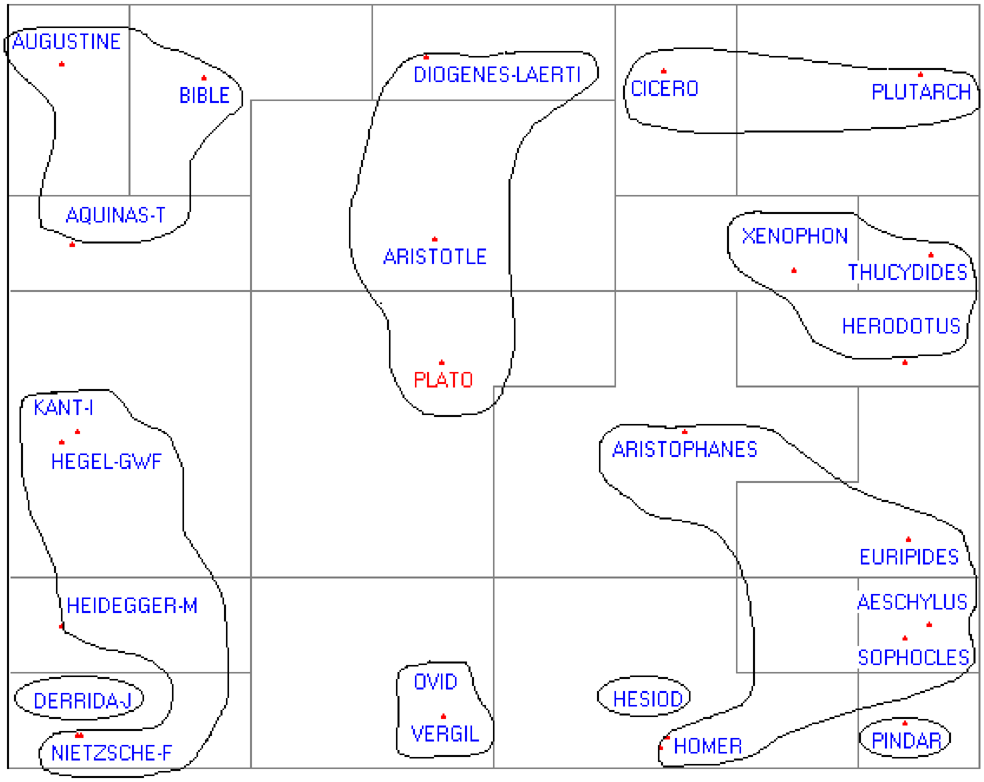
Expert #: 11

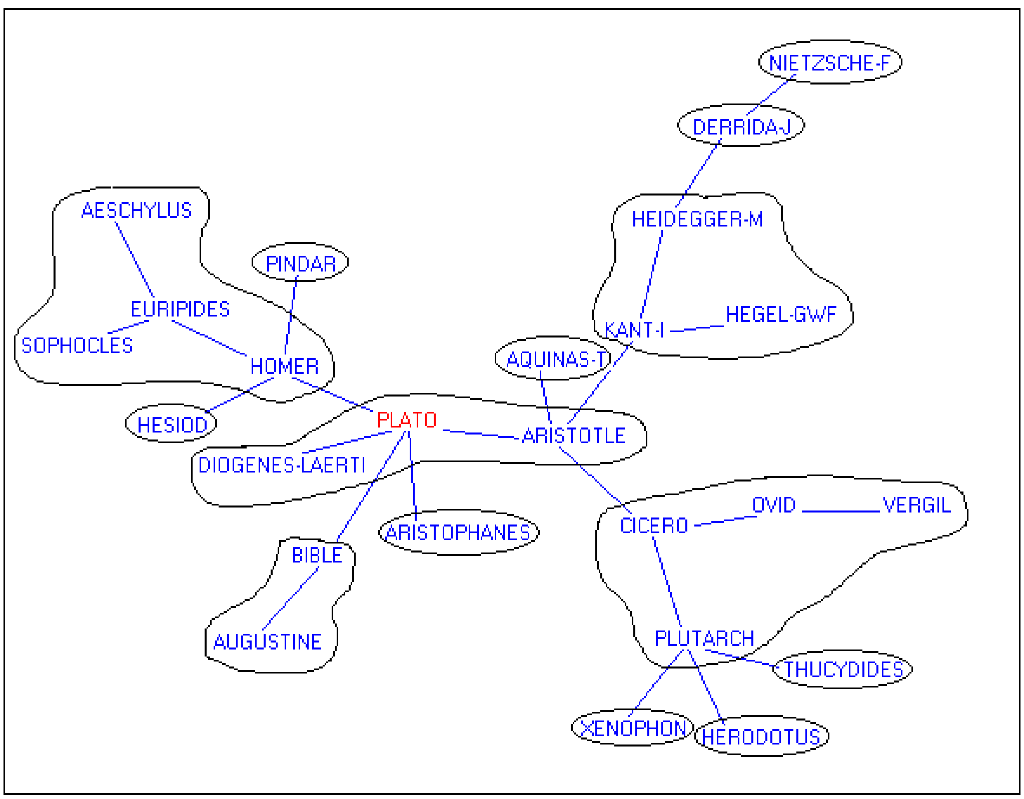
Card Sort Data

Plato							
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - 7	Group - 8
derrida-j	cicero	herodotus	hegel-gwf	aquinas-t	aeschylus	aristotle	pindar
	ovid	hesiod	heidegger-m	augustine	aristophanes	diogenes-laerti.	
	plutarch	thucydides	kant-i	Bible	euripides	plato	
	vergil	xenophon	nietzsche-f		homer		
					sophocles		

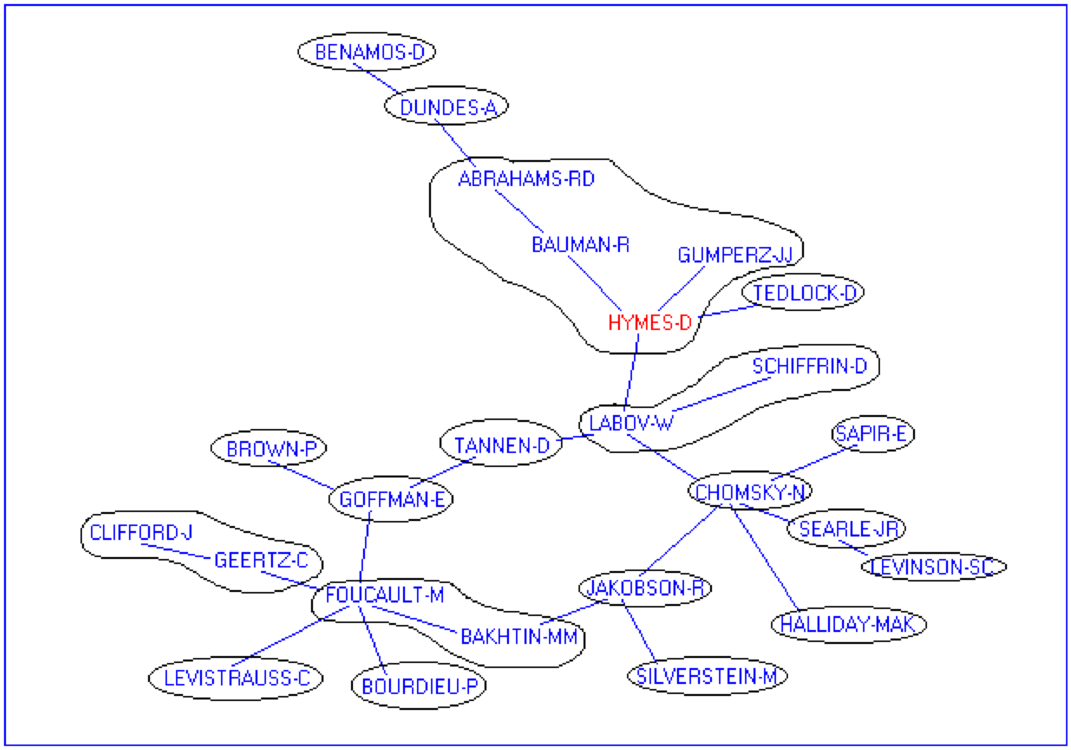
Hymes							
Group - 1	Group - 2	Group - 3	Group – 4	Group - 5	Group - 6	Group - 7	Group - 8
chomsky-n	bakhtin-mm	clifford-j	brown-p	abrahams-rd	goffman-e	halliday-mak	bourdieu-p
	foucault-m	geertz-c	levinson-sc	bauman-r	labov-w	jakobson-r	dundes-a
		levistrauss-c		benamos-d	schiffrin-d	searle-jr	tedlock-d
		sapir-e		gumperz-jj			
				hymes-d			
				silverstein-m			
				tannen-d			

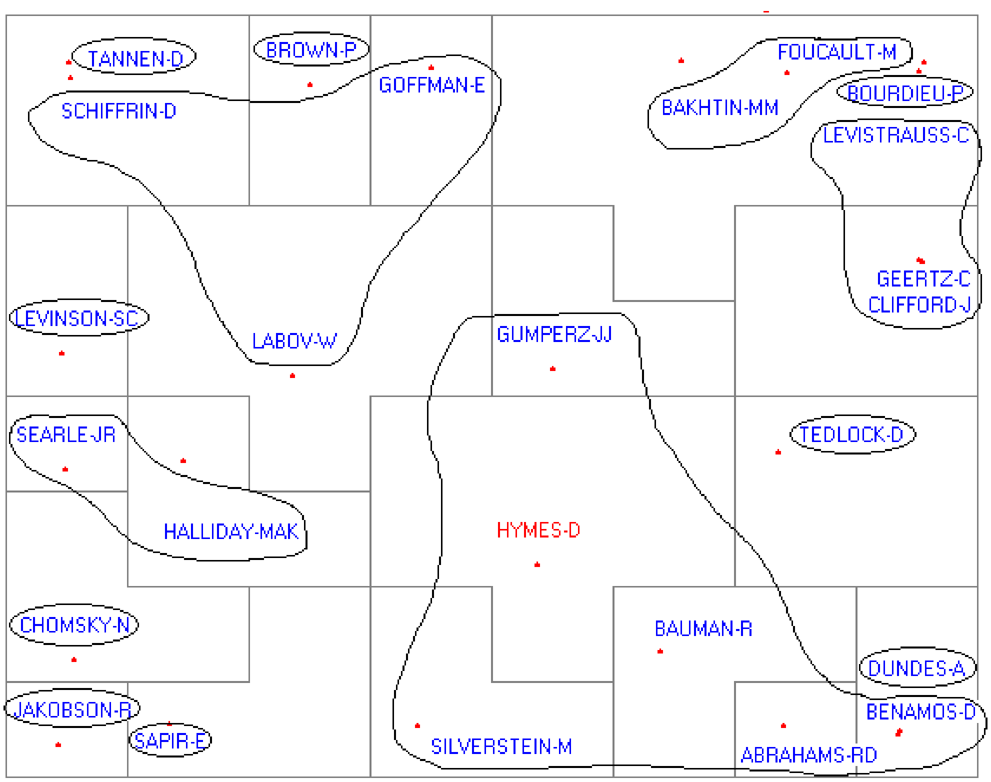
Plato Maps


AUGUSTINE
BIBLE
AQUINAS-T
DIOGENES-LAERTI
ARISTOTLE
PLATO
CICERO
PLUTARCH
XENOPHON
THUCYDIDES
HERODOTUS
KANT-I
HEGEL-GWF
HEIDEGGER-M
DERRIDA-J
NIETZSCHE-F
OVID
VERGIL
ARISTOPHANES
EURIPIDES
AESCHYLUS
SOPHOCLES
HESIOD
HOMER
PINDAR


NIETZSCHE-F
DERRIDA-J
AESCHYLUS
HEIDEGGER-M
PINDAR
EURIPIDES
HEGEL-GWF
SOPHOCLES
KANT-I
AQUINAS-T
HOMER
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS

Hymes Maps


BENAMOS-D
DUNDES-A
ABRAHAMS-RD
BAUMAN-R
GUMPERZ-JJ
TEDLOCK-D
HYMES-D
SCHIFFRIN-D
LABOV-W
SAPIR-E
BROWN-P
TANNEN-D
GOFFMAN-E
CHOMSKY-N
CLIFFORD-J
GEERTZ-C
SEARLE-JR
LEVINSON-SC
FOUCAULT-M
JAKOBSON-R
BAKHTIN-MM
HALLIDAY-MAK
LEVISTRAUSS-C
BOURDIEU-P
SILVERSTEIN-M


TANNEN-D
BROWN-P
GOFFMAN-E
SCHIFFRIN-D
FOUCAULT-M
BAKHTIN-MM
BOURDIEU-P
LEVISTRAUSS-C
LEVINSON-SC
LABOV-W
GUMPERZ-JJ
GEERTZ-C
CLIFFORD-J
SEARLE-JR
TEDLOCK-D
HALLIDAY-MAK
HYMES-D
CHOMSKY-N
BAUMAN-R
DUNDES-A
JAKOBSON-R
BENAMOS-D
SAPIR-E
SILVERSTEIN-M
ABRAHAMS-RD

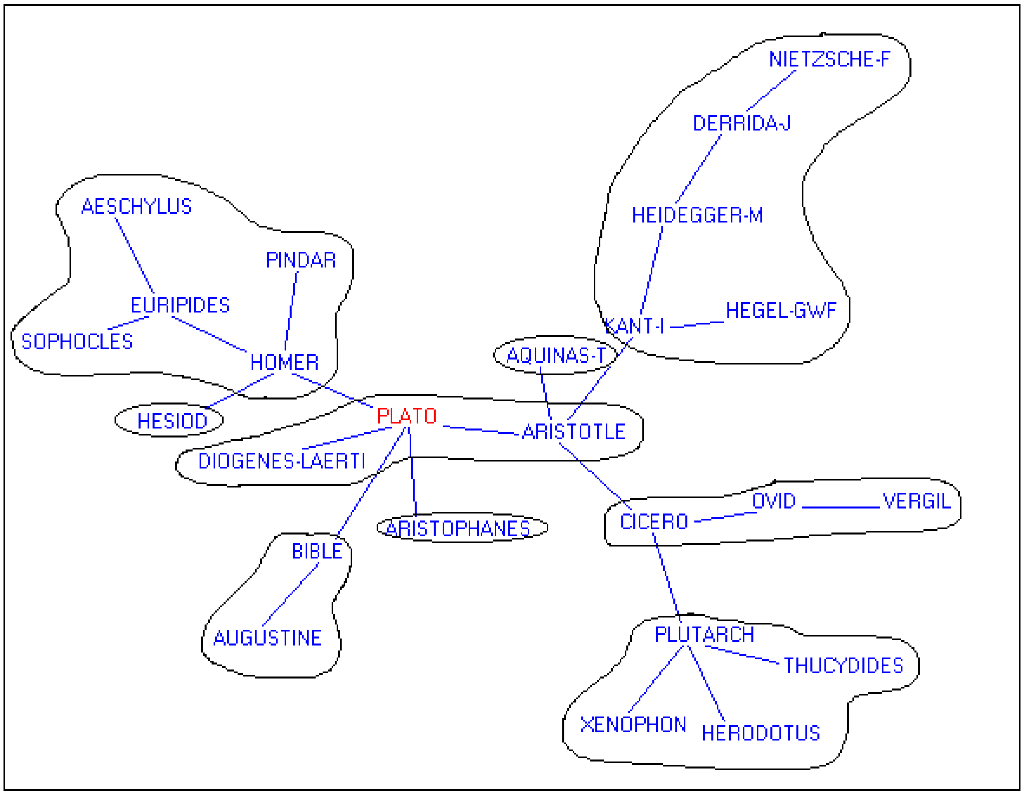
Expert #: 12

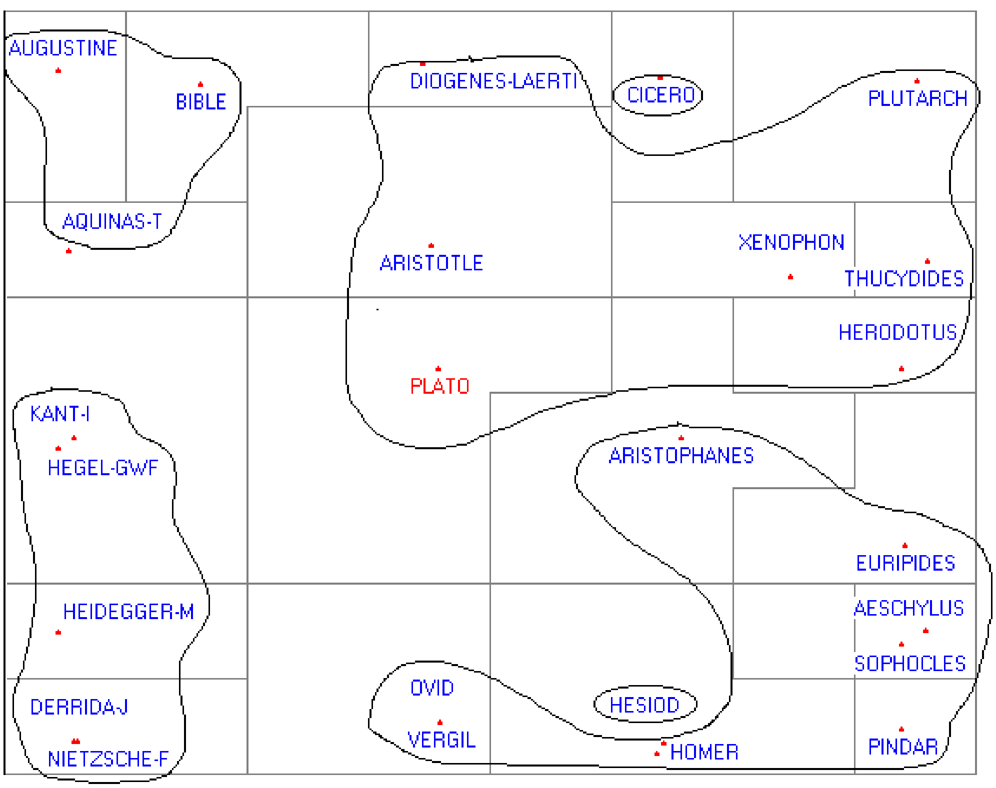
Card Sort Data

Plato			
Group 1	Group 2	Group 3	Group 4
Plato	Bible	Aristophanes	Derrida-J
Aristotle	Aquinas-T	Pindar	Hegel-GWF
Diogenese-Laetri	Augustine	Homer	Kant-I
Herodotus		Euripides	Nietzsche-F
Thucydides		Sophocles	Heidegger-M
Hesiod		Aeschylus	
Plutarch		Vergil	
Xenophon		Ovid	
		Cicero	

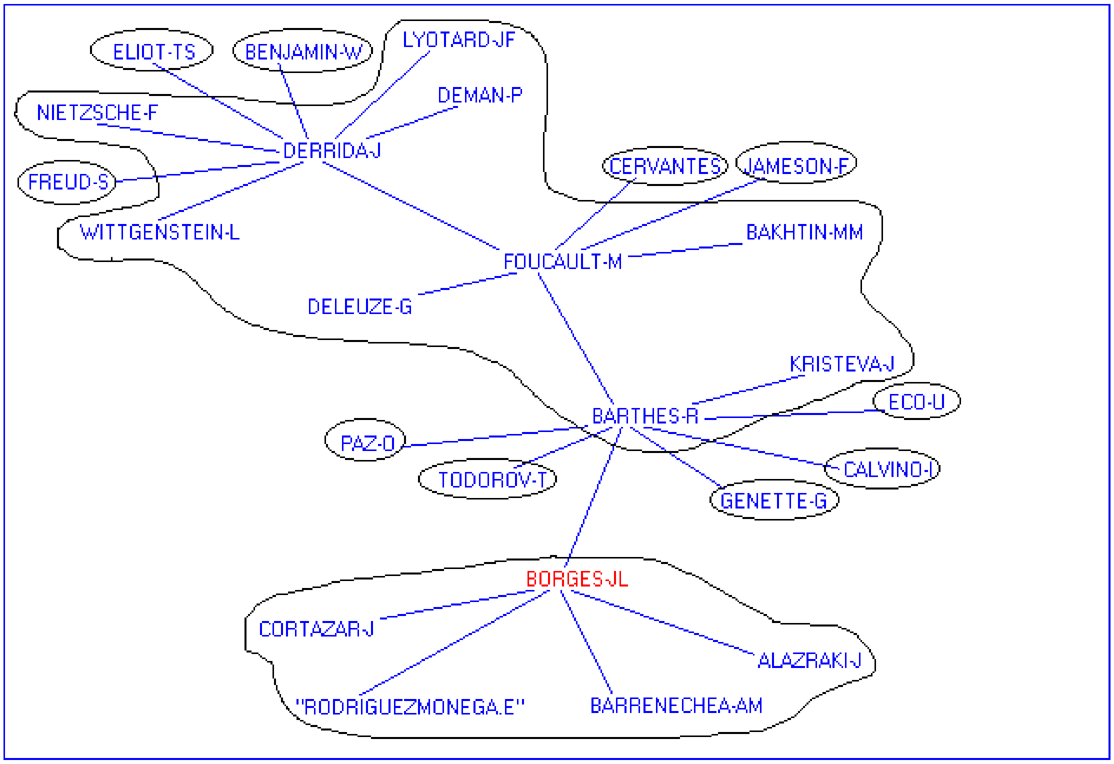
Borges					
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6
alazraki-j	bakhtin-mm	freud-s	jameson-f	benjamin-w	genette-g
barrenechea-am	barthes-r				
borges-jl	deleuze-g				
calvino-i	deman-p				
cervantes	derrida-j				
cortazar-j	foucault-m				
eco-u	kristeva-j				
eliot-ts	lyotard-jf				
paz-o	nietzsche-f				
rodriguezmonega.e	wittgenstein-l				

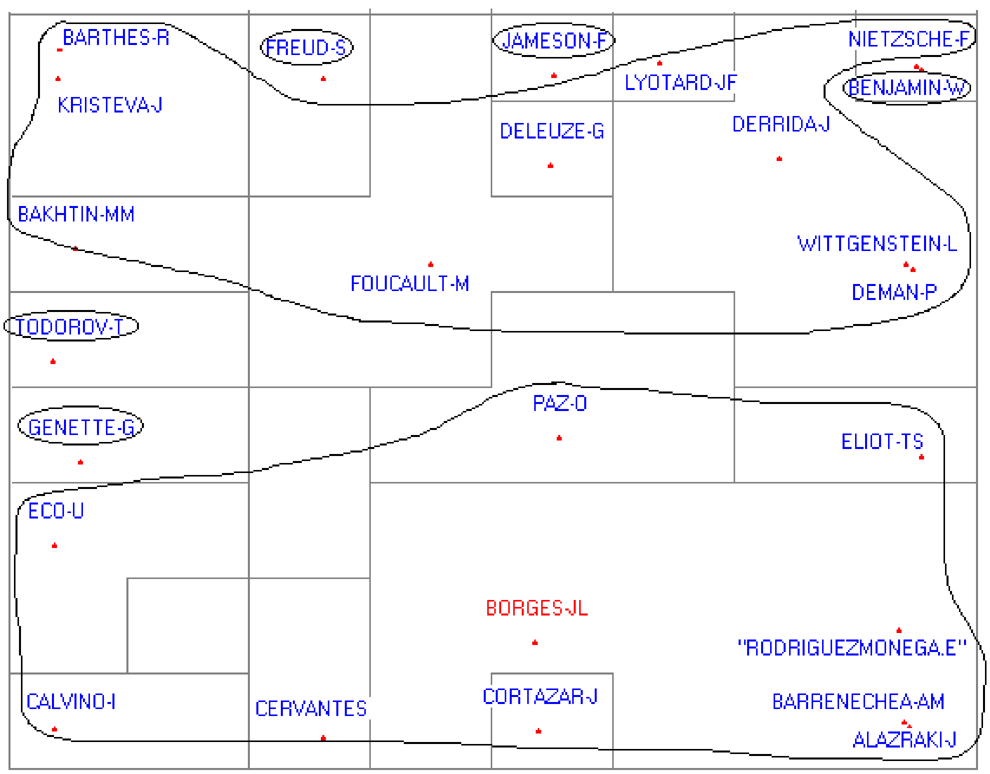
Plato Maps


NIETZSCHE-F
DERRIDA-J
HEIDEGGER-M
HEGEL-GWF
KANT-I
AESCHYLUS
PINDAR
EURIPIDES
SOPHOCLES
HOMER
AQUINAS-T
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
NIETZSCHE-F
HOMER
PINDAR

Borges Maps


ELIOT-TS
BENJAMIN-W
LYOTARD-JF
DEMAN-P
NIETZSCHE-F
DERRIDA-J
FREUD-S
CERVANTES
JAMESON-F
WITTGENSTEIN-L
BAKHTIN-MM
FOUCAULT-M
DELEUZE-G
KRISTEVA-J
ECO-U
BARTHES-R
PAZ-O
CALVINO-I
TODOROV-T
GENETTE-G
BORGES-JL
CORTAZAR-J
ALAZRAKI-J
"RODRIGUEZMONEGA.E"
BARRENECHEA-AM


BARTHES-R
FREUD-S
JAMESON-F
NIETZSCHE-F
LYOTARD-JF
BENJAMIN-W
KRISTEVA-J
DELEUZE-G
DERRIDA-J
BAKHTIN-MM
WITTGENSTEIN-L
FOUCAULT-M
DEMAN-P
TODOROV-T
PAZ-O
GENETTE-G
ELIOT-TS
ECO-U
BORGES-JL
"RODRIGUEZMONEGA.E"
CALVINO-I
CERVANTES
CORTAZAR-J
BARRENECHEA-AM
ALAZRAKI-J

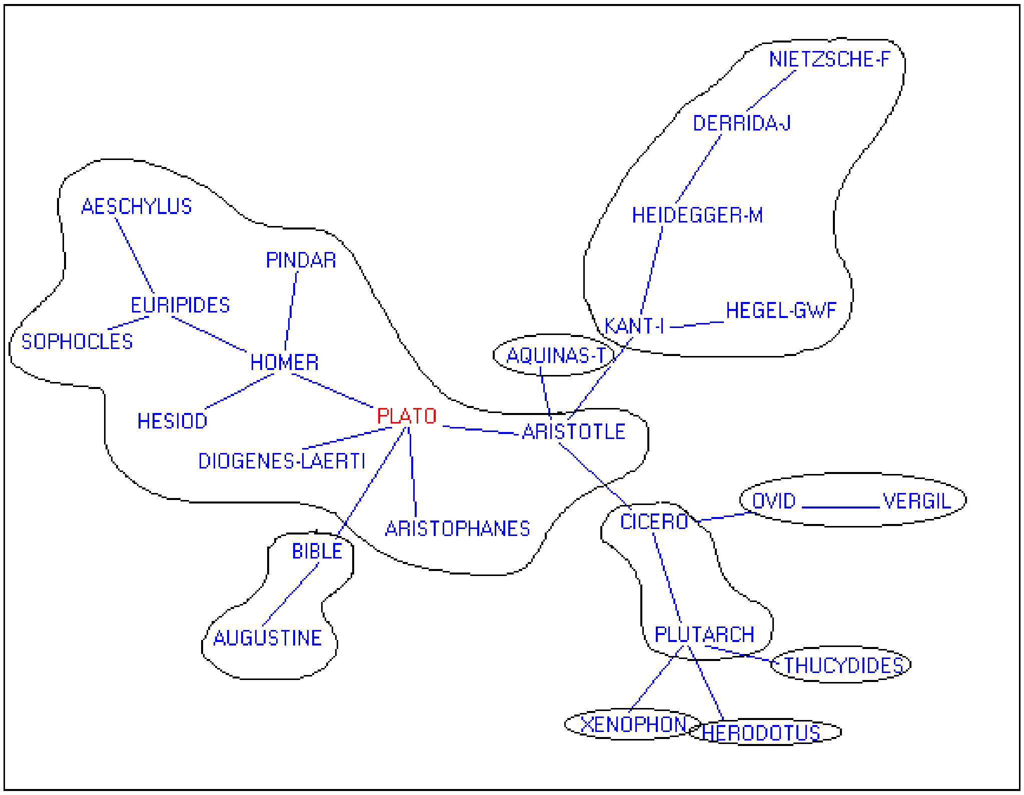
Expert #: 13

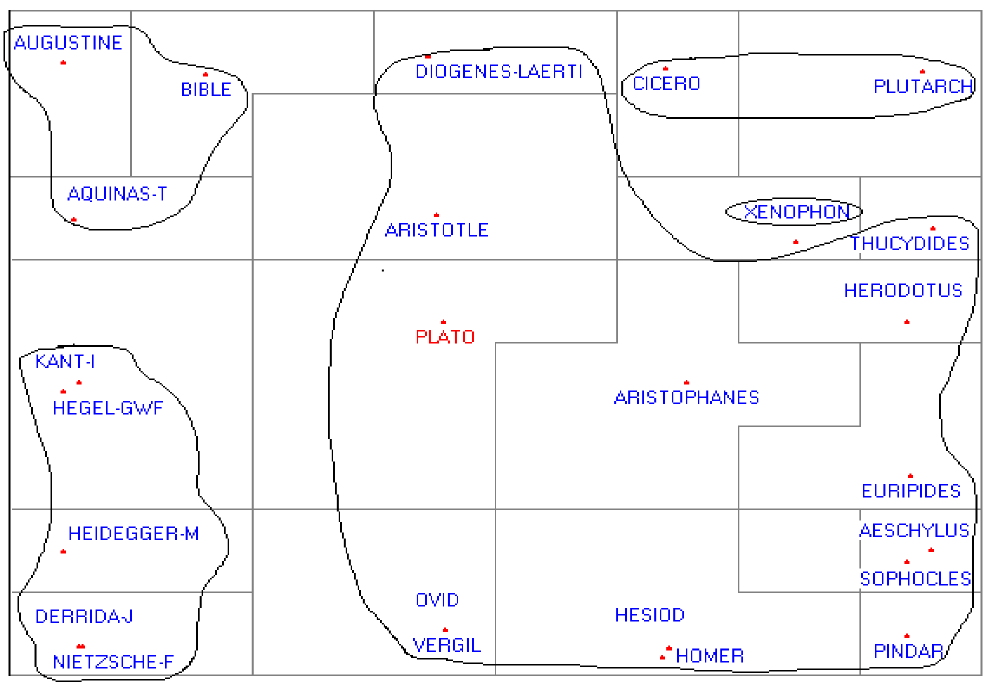
Card Sort Data

plato				
Group - 1	Group - 2	Group - 3	Group - 4	Group - ?
aeschylus	cicero	aquinas-t	derrida-j	xenophon
aristophanes	plutarch	augustine	hegel-gwf	
aristotle		Bible	heidegger-m	
diogenes-laerti.			kant-i	
euripides			nietzsche-f	
herodotus				
hesiod				
homer				
ovid				
pindar				
plato				
sophocles				
thucydides				
vergil				

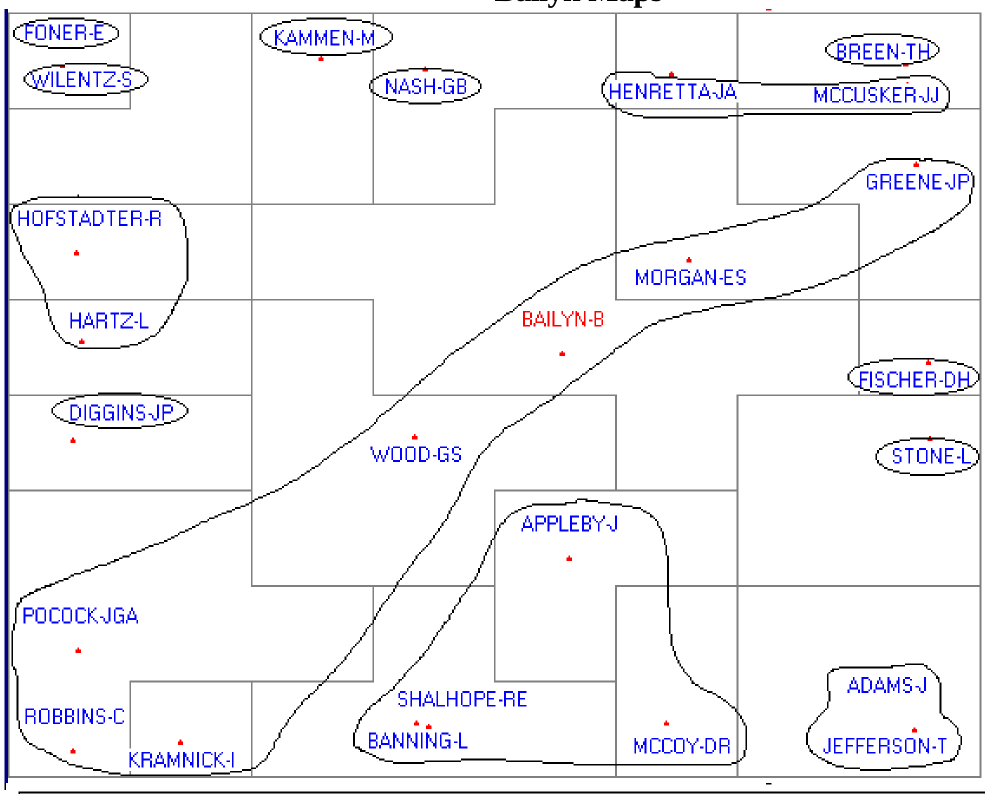
bailyn-b							
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - 7	Group - ?
bailyn-b	appleby-j	breen-th	fischer-dh	henretta-ja	hartz-l	adams-j	diggins-jp
greene-jp	banning-l	foner-e	kammen-m	mccusker-jj	hofstadter-r	jefferson-t	stone-l
kramnick-i	mccoy-dr	nash-gb		wilentz-s			
morgan-es	shalhope-re						
pocock-jga							
robbins-c							
wood-gs							

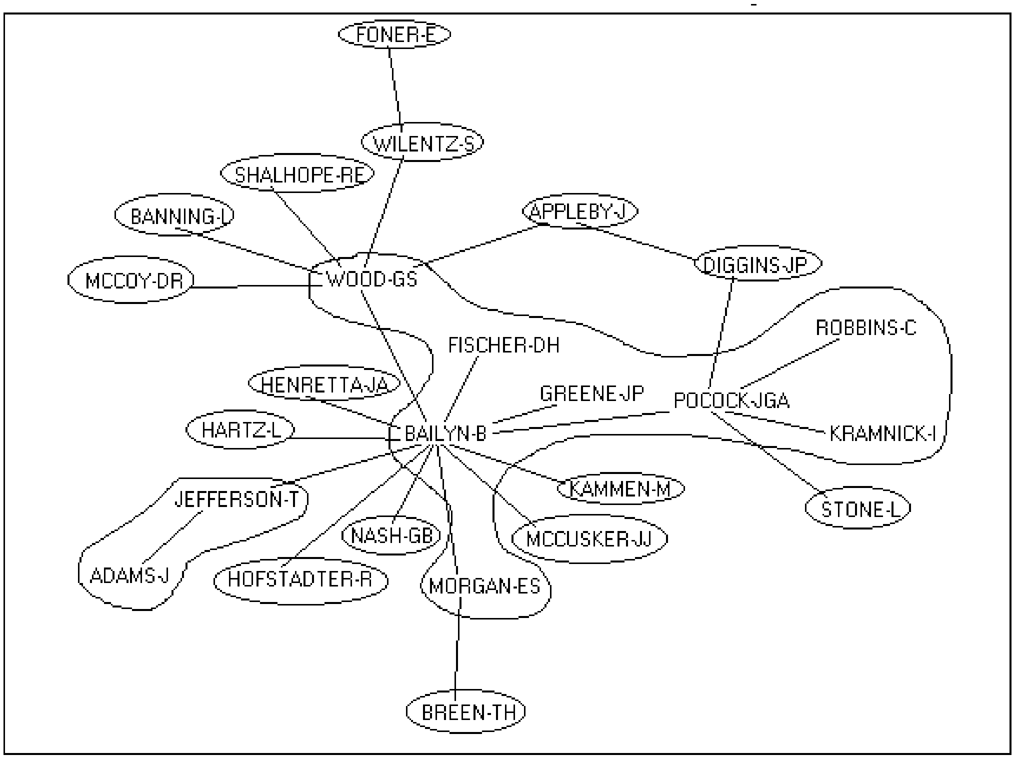
Plato Maps


NIETZSCHE-F
DERRIDA-J
AESCHYLUS
HEIDEGGER-M
PINDAR
EURIPIDES
HEGEL-GWF
SOPHOCLES
KANT-I
AQUINAS-T
HOMER
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS


AUGUSTINE
DIOGENES-LAERTI
BIBLE
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
HOMER
PINDAR
NIETZSCHE-F

Bailyn Maps


FONER-E
WILENTZ-S
KAMMEN-M
NASH-GB
HENRETTA-JA
BREEN-TH
MCCUSKER-JJ
GREENE-JP
HOFSTADTER-R
MORGAN-ES
HARTZ-L
BAILYN-B
FISCHER-DH
DIGGINS-JP
WOOD-GS
STONE-L
APPLEBY-J
POCOCK-JGA
ADAMS-J
SHALHOPE-RE
ROBBINS-C
BANNING-L
MCCOY-DR
JEFFERSON-T
KRAMNICK-I


FONER-E
WILENTZ-S
SHALHOPE-RE
BANNING-L
APPLEBY-J
DIGGINS-JP
MCCOY-DR
WOOD-GS
ROBBINS-C
FISCHER-DH
HENRETTA-JA
GREENE-JP
POCOCK-JGA
HARTZ-L
BAILYN-B
KRAMNICK-I
KAMMEN-M
JEFFERSON-T
STONE-L
NASH-GB
MCCUSKER-JJ
ADAMS-J
HOFSTADTER-R
MORGAN-ES
BREEN-TH

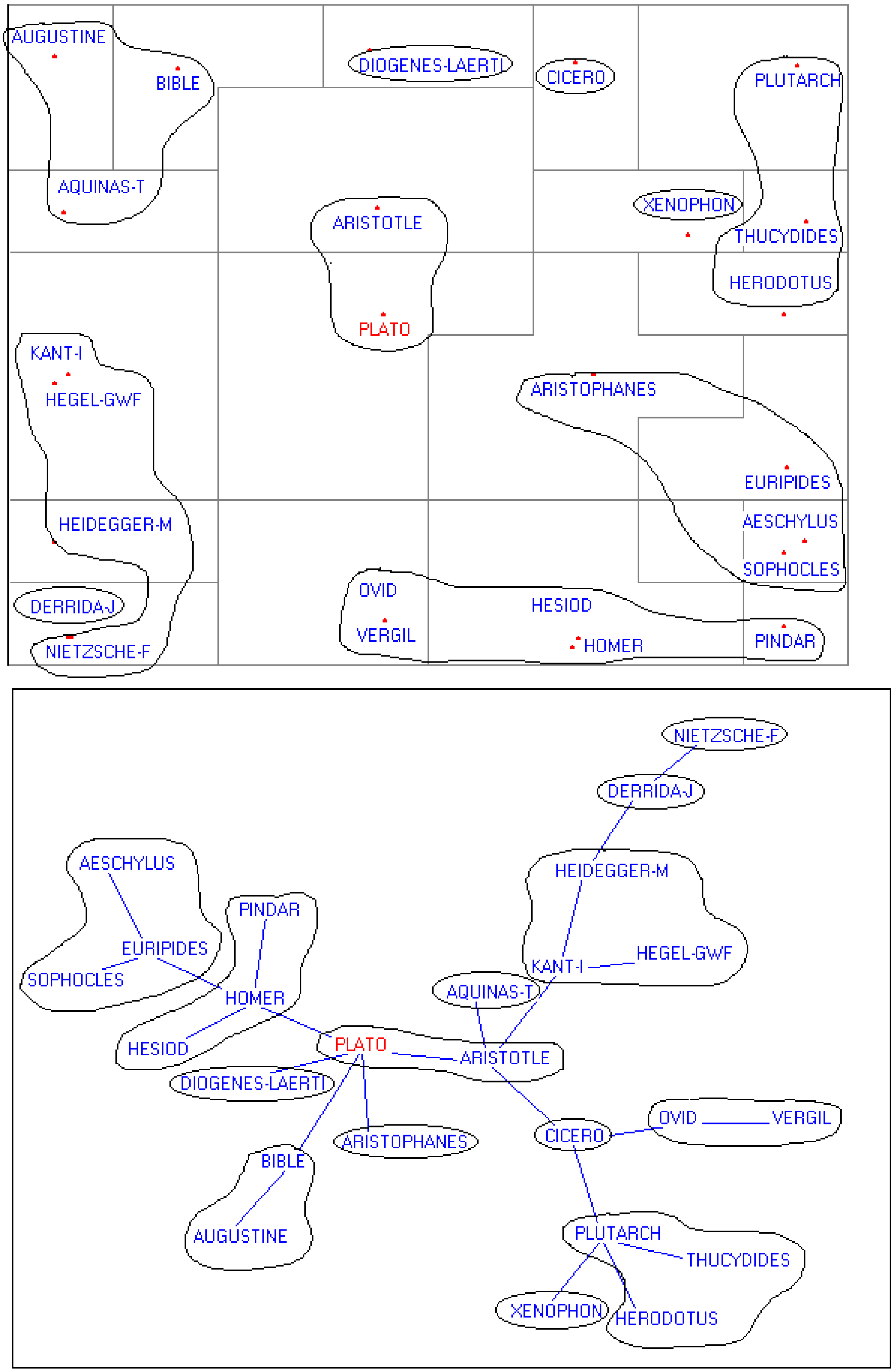
Expert #: 14

Card Sort Data

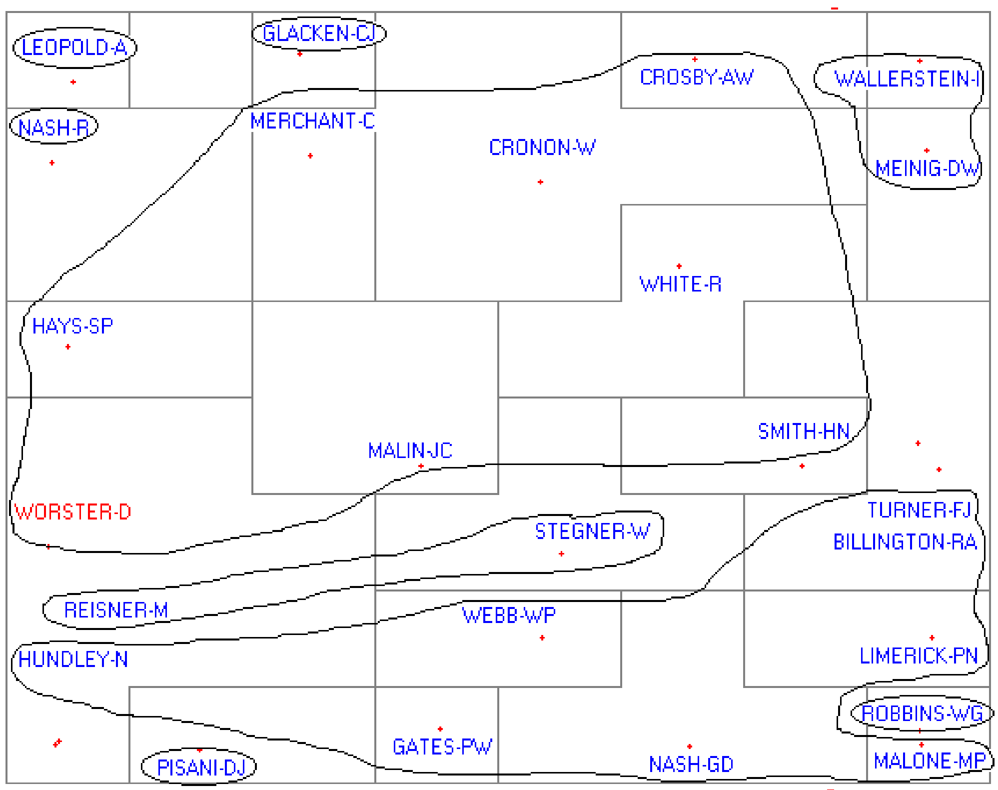
plato				
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5
aristotle	herodotus	Aquinas-t	hegel-gwf	derrida-j
plato	plutarch	augustine	heidegger-m	
	thucydides	Bible	kant-i	
			nietzsche-f	
Group - 6	Group - 7	Group - 8	Group - 9	Group - ?
hesiod	aeschylus	cicero	xenophon	diogenes-laerti.
homer	aristophanes			
ovid	euripides			
pindar	sophocles			
vergil				

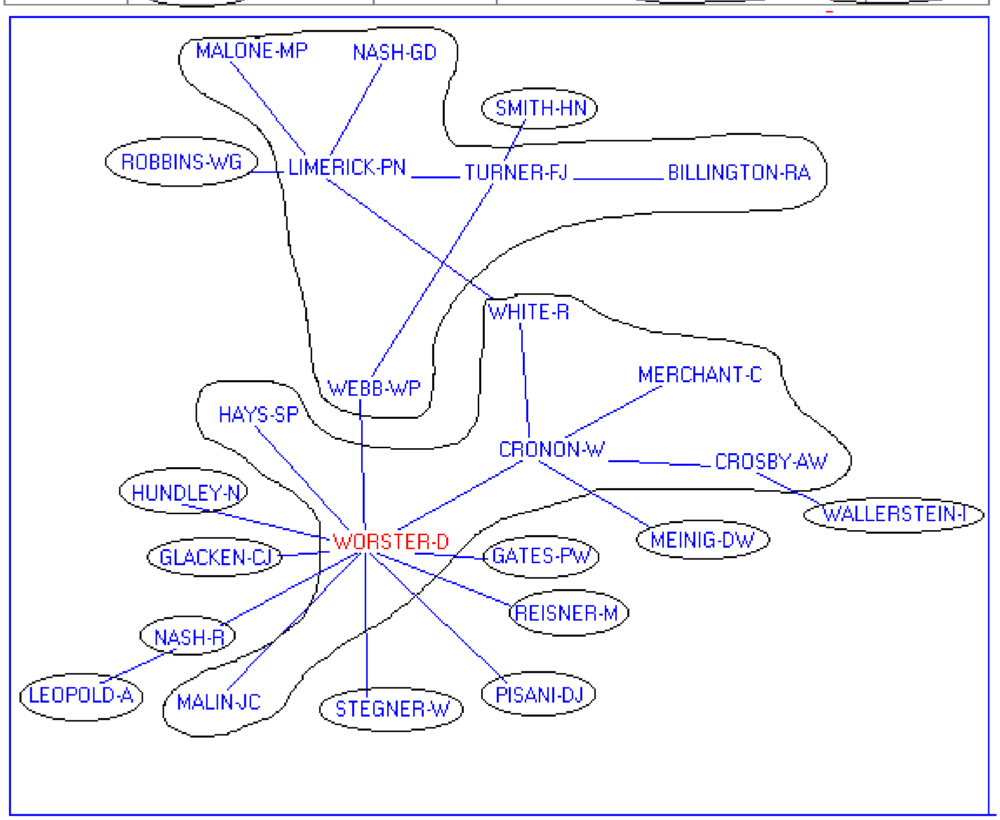
worster-d					
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - ?
cronon-w	billington-ra	leopold-a	meinig-dw	glacken-cj	robbins-wg
crosby-aw	gates-pw	reisner-m	wallerstein-i	nash-r	
hays-sp	hundley-n	stegner-w		pisani-dj	
malin-jc	limerick-pn				
merchant-c	malone-mp				
smith-hn	nash-gd				
white-r	turner-fj				
worster-d	webb-wp				

Plato Maps


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
HOMER
PINDAR
NIETZSCHE-F
NIETZSCHE-F
DERRIDA-J
HEIDEGGER-M
AESCHYLUS
PINDAR
EURIPIDES
HEGEL-GWF
KANT-I
SOPHOCLES
AQUINAS-T
HOMER
PLATO
HESIOD
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS

Worster Maps





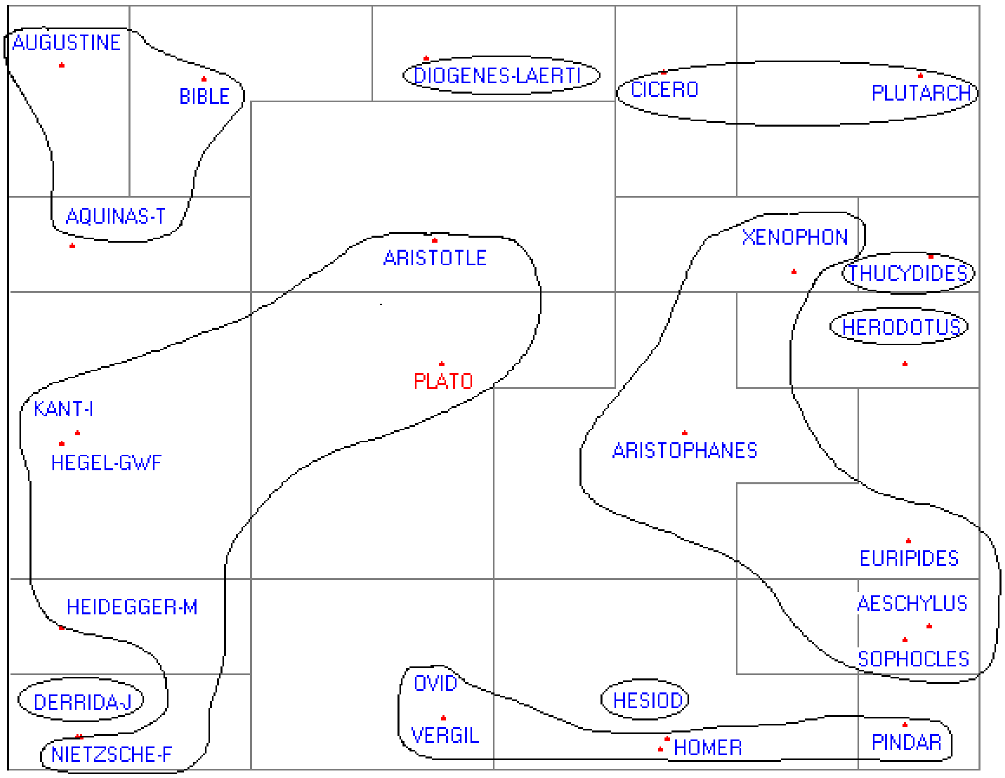
Expert #: 15

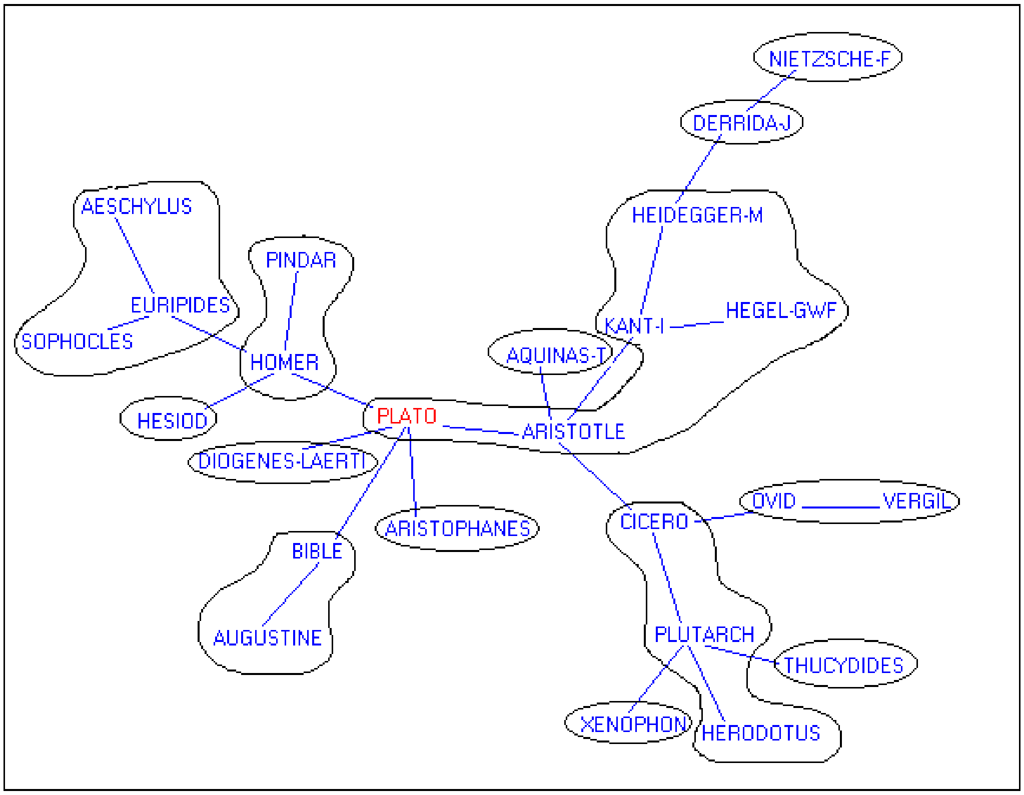
Card Sort Data

PLATO						
Group - 1	**Group - 2**	**Group - 3**	**Group - 4**	**Group - 5**	**Group - 6**	**Group - ?**
aristotle	homer	aeschylus	cicero	aquinas-t	derrida-j	Thucydides
hegel-gwf	ovid	aristophanes	herodotus	augustine		diogenes-laerti.
heidegger-m	pindar	euripides	hesiod	Bible		
kant-i	vergil	xenophon	plutarch			
nietzsche-f		sophocles				
plato						

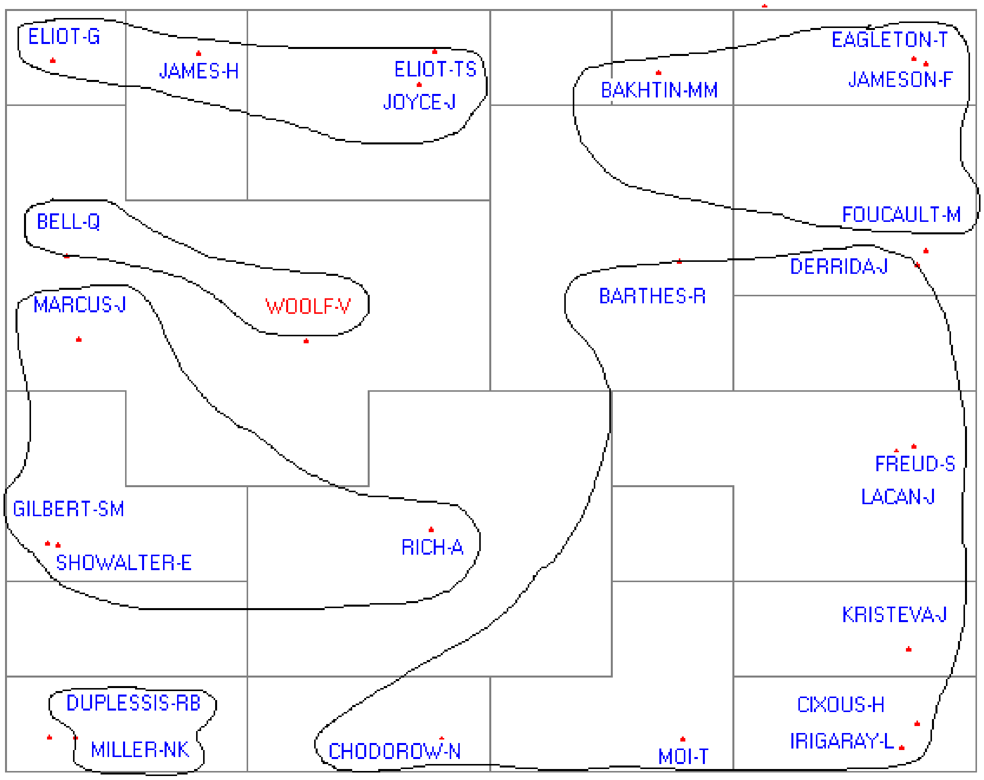
woolf-v				
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5
bell-q	eliot-g	duplessis-rb	barthes-r	bakhtin-mm
woolf-v	eliot-ts	gilbert-sm	chodorow-n	eagleton-t
	james-h	marcus-j	cixous-h	foucault-m
	joyce-j	miller-nk	derrida-j	jameson-f
		rich-a	freud-s	
		Showalter-e	irigaray-l	
			kristeva-j	
			lacan-j	
			moi-t	

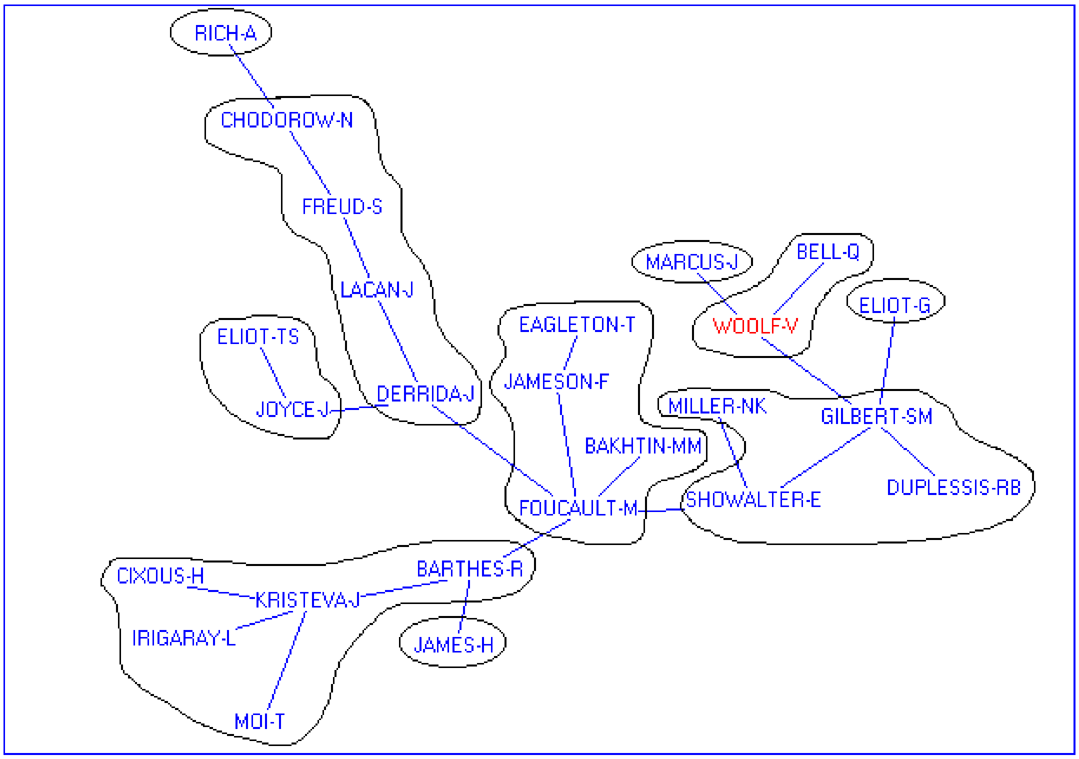
Plato Maps


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
DERRIDA-J
HESIOD
VERGIL
NIETZSCHE-F
HOMER
PINDAR


NIETZSCHE-F
DERRIDA-J
AESCHYLUS
HEIDEGGER-M
PINDAR
EURIPIDES
HEGEL-GWF
KANT-I
SOPHOCLES
AQUINAS-T
HOMER
PLATO
HESIOD
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS

Woolf Maps


ELIOT-G
JAMES-H
ELIOT-TS
JOYCE-J
BAKHTIN-MM
EAGLETON-T
JAMESON-F
BELL-Q
WOOLF-V
MARCUS-J
FOUCAULT-M
DERRIDA-J
BARTHES-R
FREUD-S
LACAN-J
GILBERT-SM
SHOWALTER-E
RICH-A
KRISTEVA-J
DUPLESSIS-RB
MILLER-NK
CHODOROW-N
MOI-T
CIXOUS-H
IRIGARAY-L


RICH-A
CHODOROW-N
FREUD-S
LACAN-J
MARCUS-J
BELL-Q
ELIOT-G
WOOLF-V
ELIOT-TS
EAGLETON-T
JOYCE-J
DERRIDA-J
JAMESON-F
MILLER-NK
GILBERT-SM
BAKHTIN-MM
FOUCAULT-M
SHOWALTER-E
DUPLESSIS-RB
CIXOUS-H
BARTHES-R
KRISTEVA-J
IRIGARAY-L
JAMES-H
MOI-T

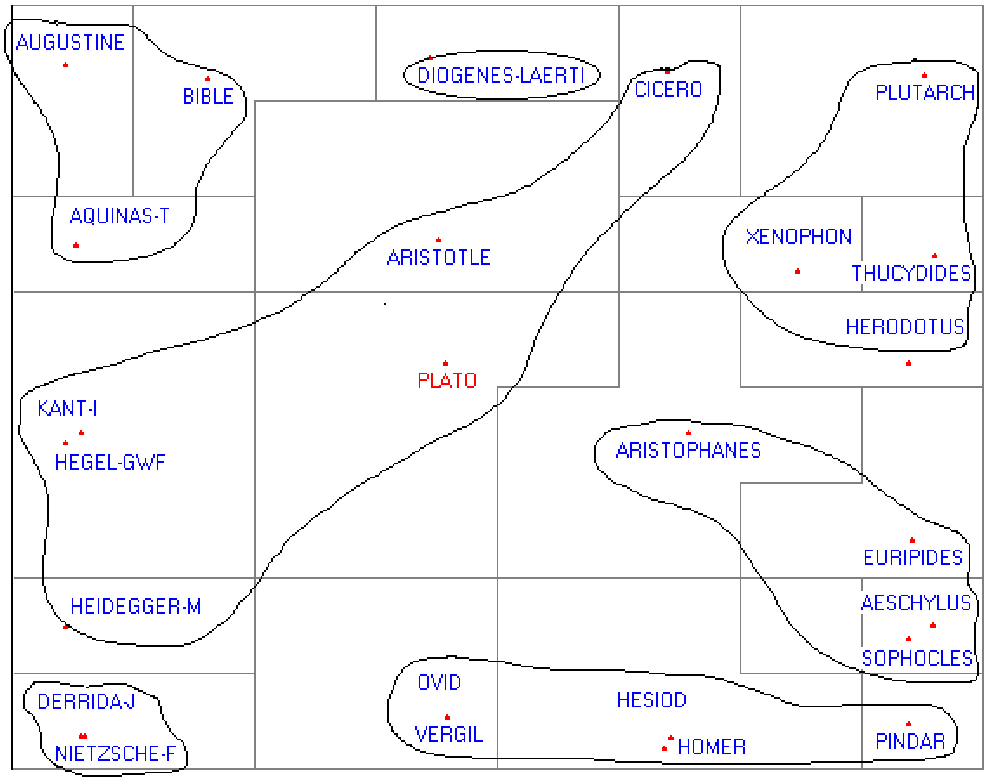
Expert #: 16

Card Sort Data

plato					
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6
aristotle	herodotus	aquinas-t	derrida-j	hesiod	aeschylus
cicero	plutarch	augustine	nietzsche-f	homer	aristophanes
hegel-gwf	thucydides	Bible		ovid	diogenes-laerti.
heidegger-m	xenophon			pindar	euripides
kant-i				vergil	sophocles
plato					

Kant							
Group - 1	Group - 2	Group - 3	Group – 4	Group - 5	Group - 6	Group - 7	Group - 8
goethe-jwv	aristotle	fichte-jg	derrida-j	wittgenstein-l	descartes-r	adorno-tw	rorty-r
schiller-f	gadamer-hg	hegel-gwf	foucault-m		hume-d	cassirer-e	
		marx-k	heidegger-m		kant-i	habermas-j	
		plato	husserl-e		locke-j		
			lyotard-jf		rawls-j		
			nietzsche-f		rousseau-jj		

Plato Maps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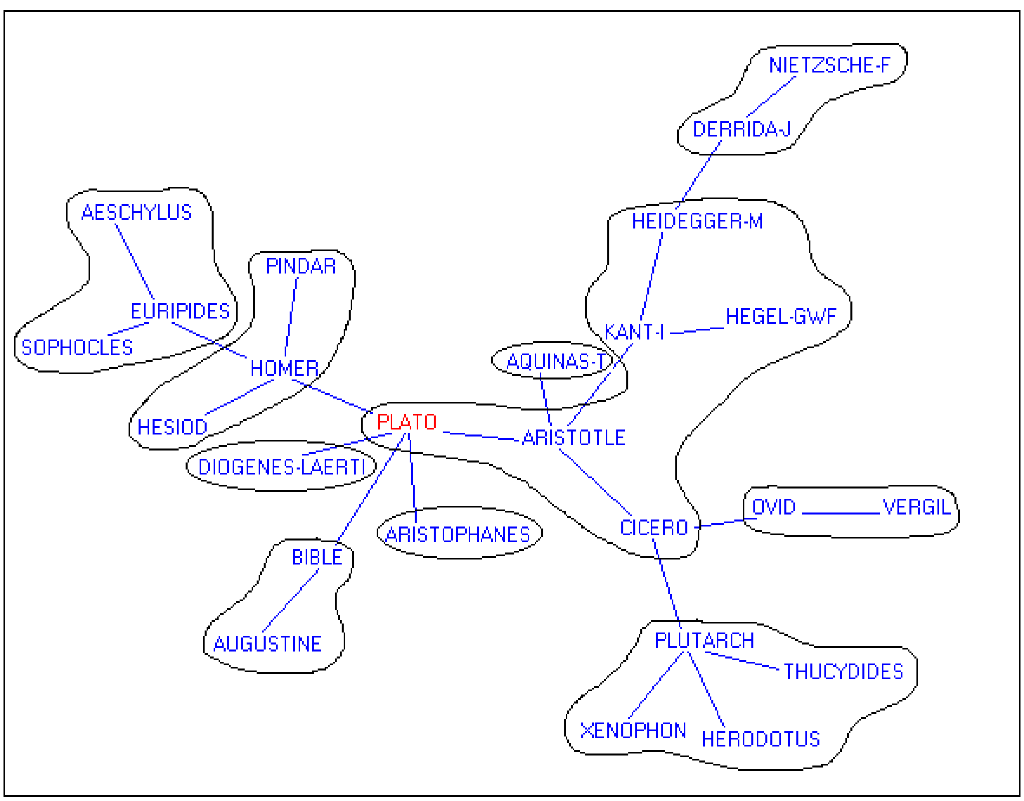
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
AESCHYLUS
SOPHOCLES
HEIDEGGER-M
OVID
HESIOD
VERGIL
HOMER
PINDAR
DERRIDA-J
NIETZSCHE-F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EURIPIDES
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AQUINAS-T
HOMER
PLATO
HESIOD
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
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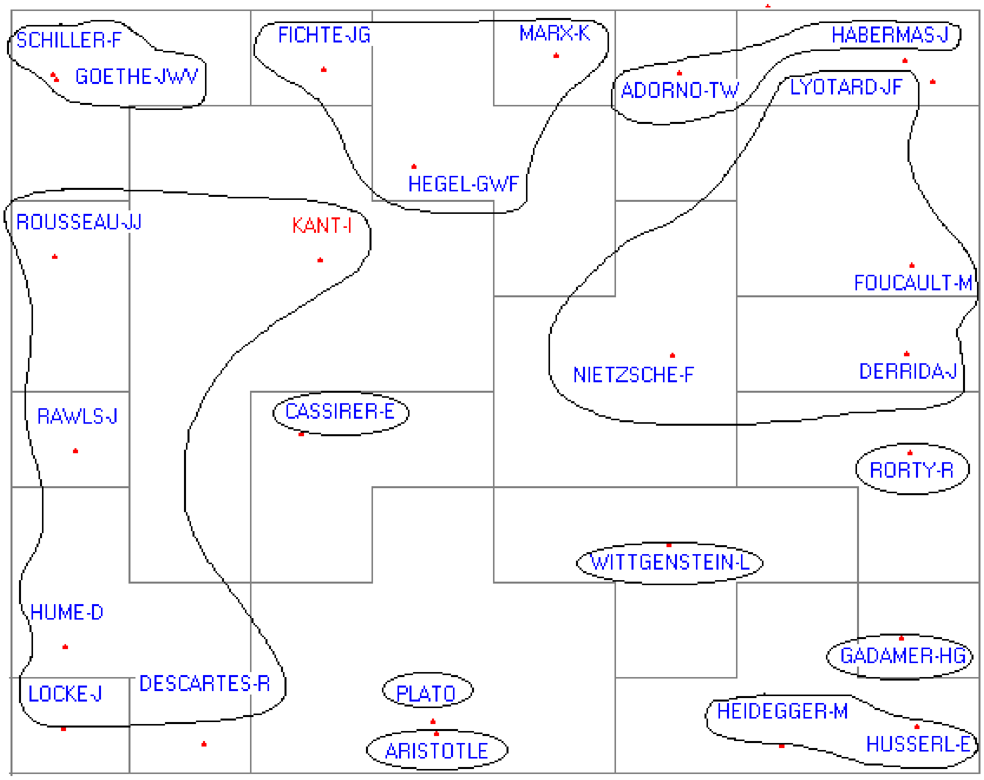
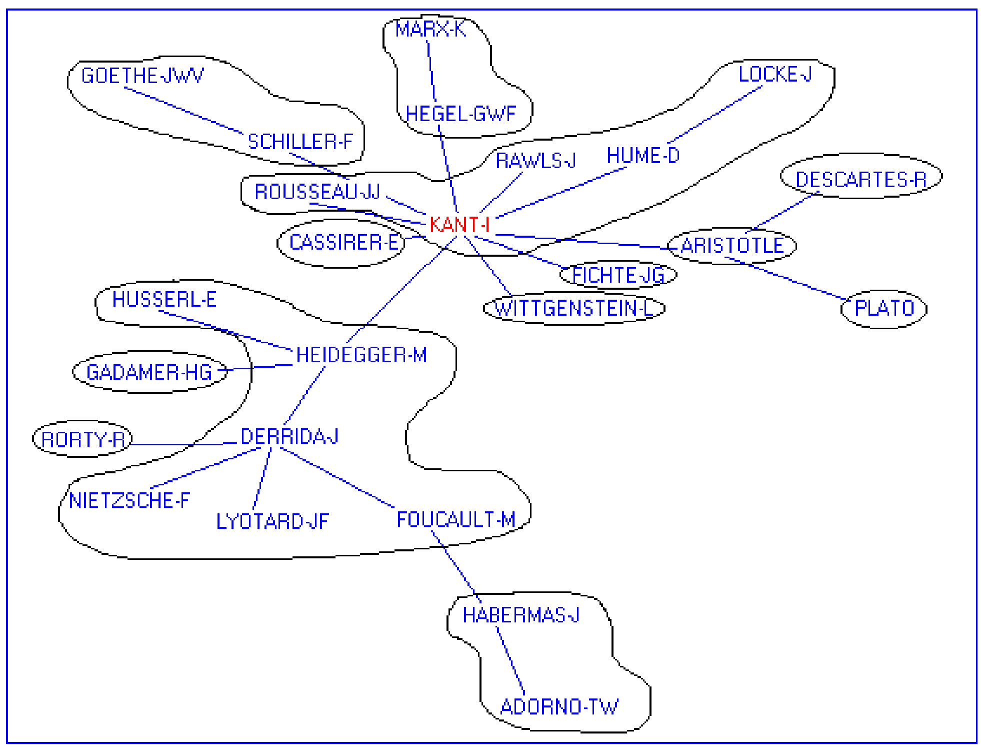
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS

Kant Maps


SCHILLER-F
GOETHE-JWV
FICHTE-JG
MARX-K
HABERMAS-J
ADORNO-TW
LYOTARD-JF
HEGEL-GWF
ROUSSEAU-JJ
KANT-I
FOUCAULT-M
NIETZSCHE-F
DERRIDA-J
RAWLS-J
CASSIRER-E
RORTY-R
WITTGENSTEIN-L
HUME-D
GADAMER-HG
LOCKE-J
DESCARTES-R
PLATO
HEIDEGGER-M
HUSSERL-E
ARISTOTLE


MARX-K
GOETHE-JWV
LOCKE-J
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SCHILLER-F
RAWLS-J
HUME-D
DESCARTES-R
ROUSSEAU-JJ
KANT-I
CASSIRER-E
ARISTOTLE
FICHTE-JG
HUSSERL-E
WITTGENSTEIN-L
PLATO
HEIDEGGER-M
GADAMER-HG
RORTY-R
DERRIDA-J
NIETZSCHE-F
LYOTARD-JF
FOUCAULT-M
HABERMAS-J
ADORNO-TW

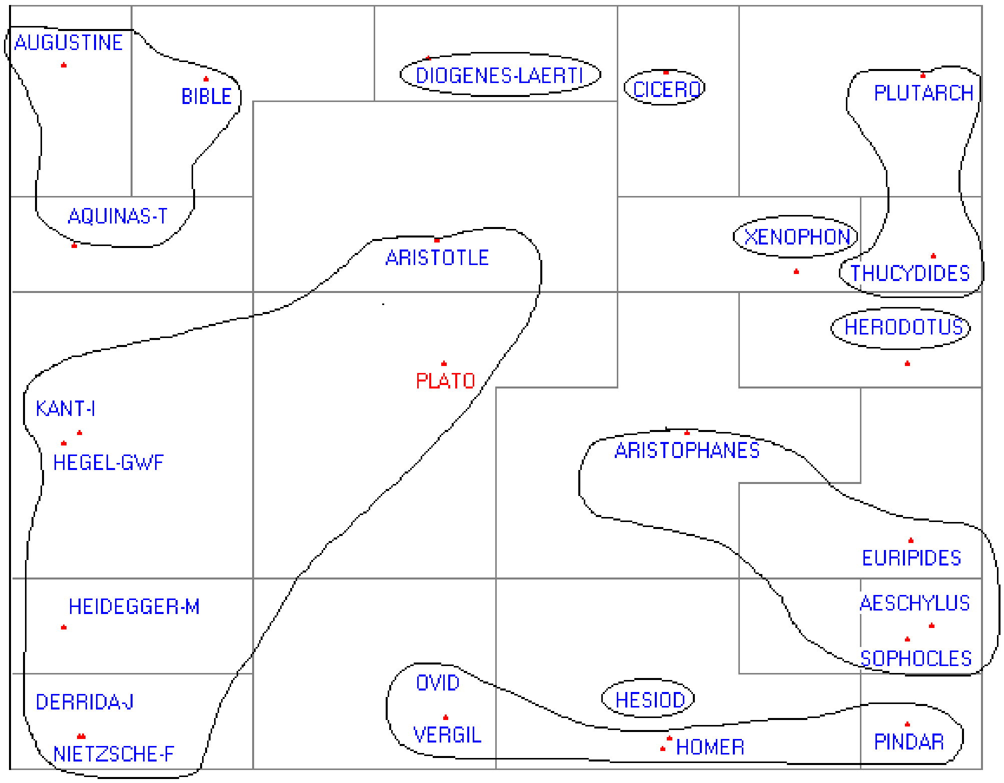
Expert #: 17

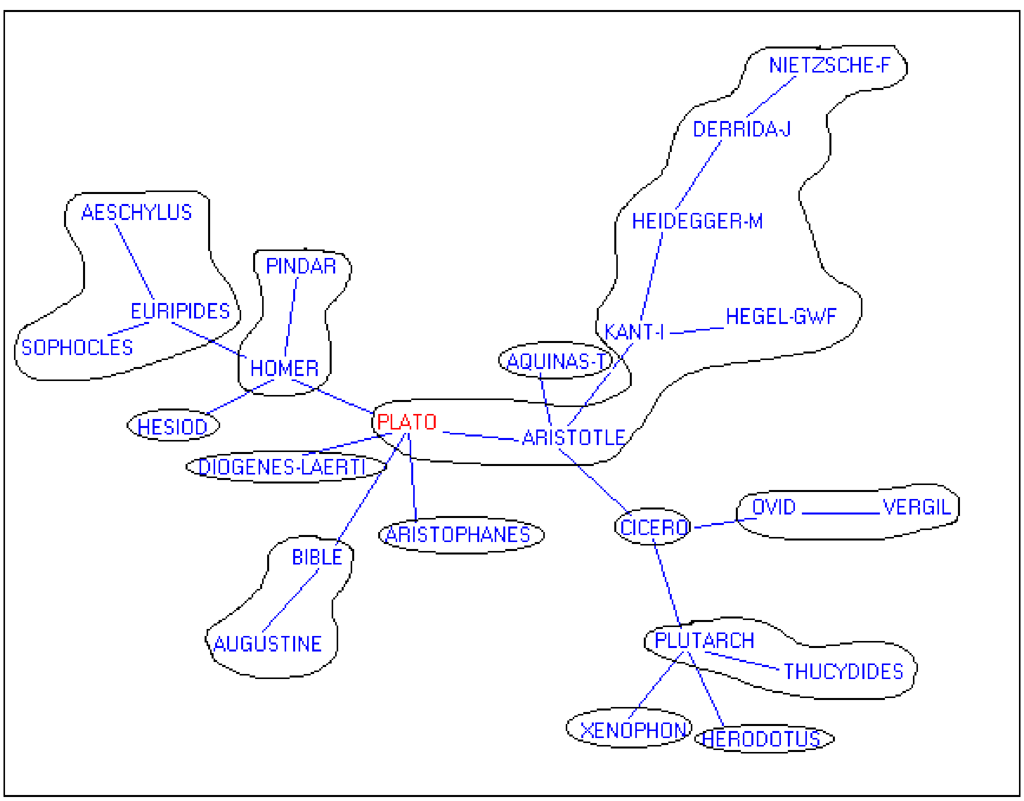
Card Sort Data

plato					
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - ?
aristotle	aquinas-t	cicero	homer	aeschylus	diogenes-laerti.
derrida-j	augustine	herodotus	ovid	aristophanes	xenophon
hegel-gwf	Bible	hesiod	pindar	euripides	
heidegger-m			plutarch	sophocles	
kant-i			thucydides		
nietzsche-f			vergil		
plato					

dickens-c			
Group - 1	Group - 2	Group - 3	Group - ?
brooks-p	bronte-c	derrida-j	johnson-e
butt-j	carlyle-t	foucault-m	stone-h
collins-p	eliot-g		
dickens-c	freud-s		
forster-j	gaskell-e		
kaplan-f	james-h		
marcus-s	ruskin-j		
miller-da	shakespeare-w		
miller-jh	thackeray-wm		
slater-m			
welsh-a			
williams-r			

Plato Maps


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
XENOPHON
ARISTOTLE
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
HESIOD
DERRIDA-J
VERGIL
HOMER
PINDAR
NIETZSCHE-F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DERRIDA-J
AESCHYLUS
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PINDAR
EURIPIDES
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KANT-I
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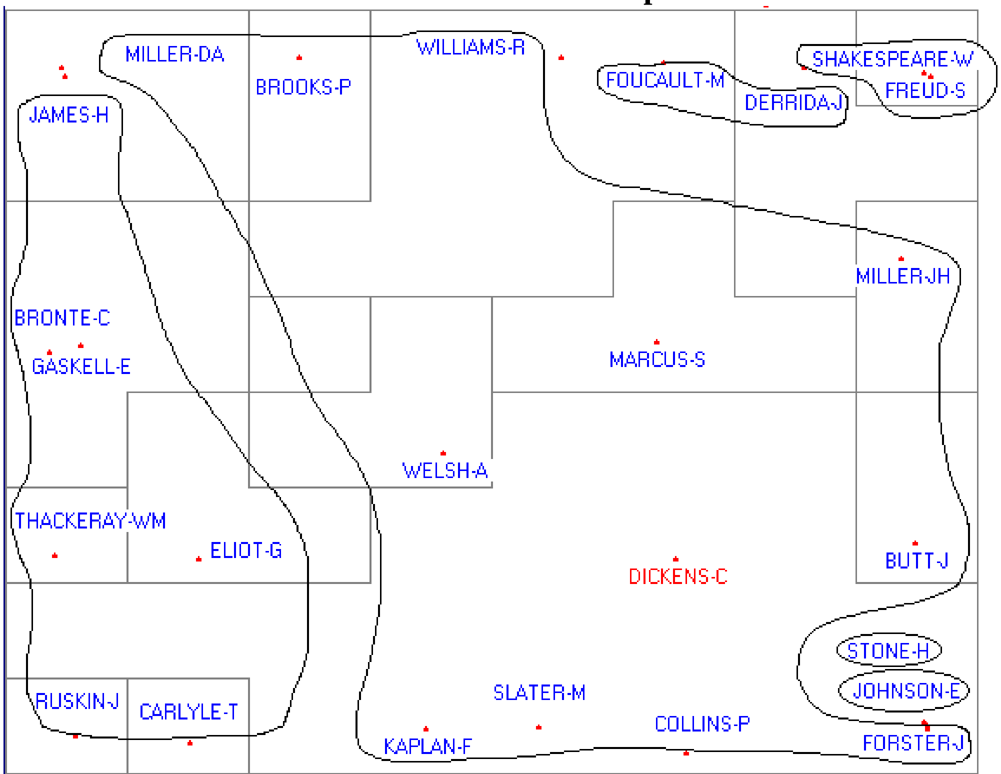
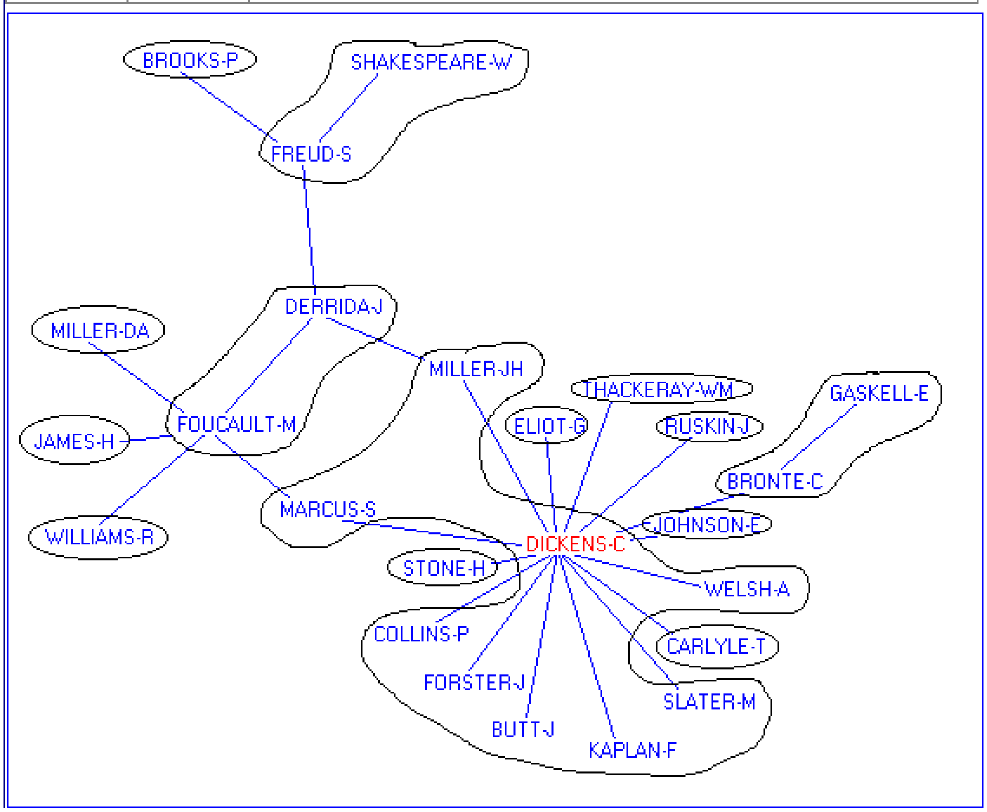
AQUINAS-T
HOMER
HESIOD
PLATO
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS

Dickens Maps





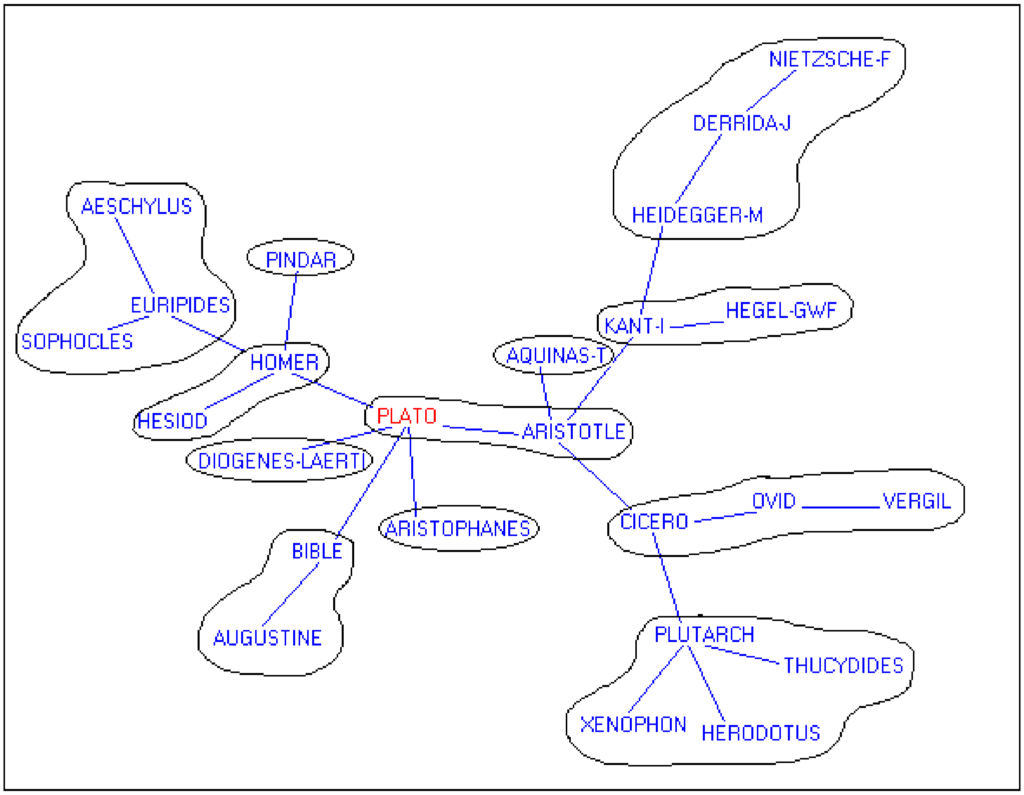
Expert #: 18

Card Sort Data

plato				
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5
cicero	hesiod	aeschylus	pindar	diogenes-laerti.
ovid	homer	aristophanes		
vergil		euripides		
		sophocles		
Group - 6	Group - 7	Group - 8	Group - 9	Group - 10
herodotus	aristotle	aquinas-t	hegel-gwf	derrida-j
plutarch	plato	augustine	kant-i	heidegger-m
thucydides		Bible		nietzsche-f
xenophon				

keller-c				
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5
cobb-jb	christ-cp	heyward-c	harrison-bw	benhabib-s
davaney-sg	fiorenza-es	mcfague-s	ruddick-s	foucault-m
keller-c	plaskow-j	spretnak-c		harding-s
whitehead-an	ruether-rr			
	tillich-p			
Group - 6	Group - 7	Group - 8	Group - ?	
daly-m	chodorow-n	rich-a	keller-ef	
	gilligan-c		kristeva-j	
	goldenberg-nr		morton-n	

Plato Maps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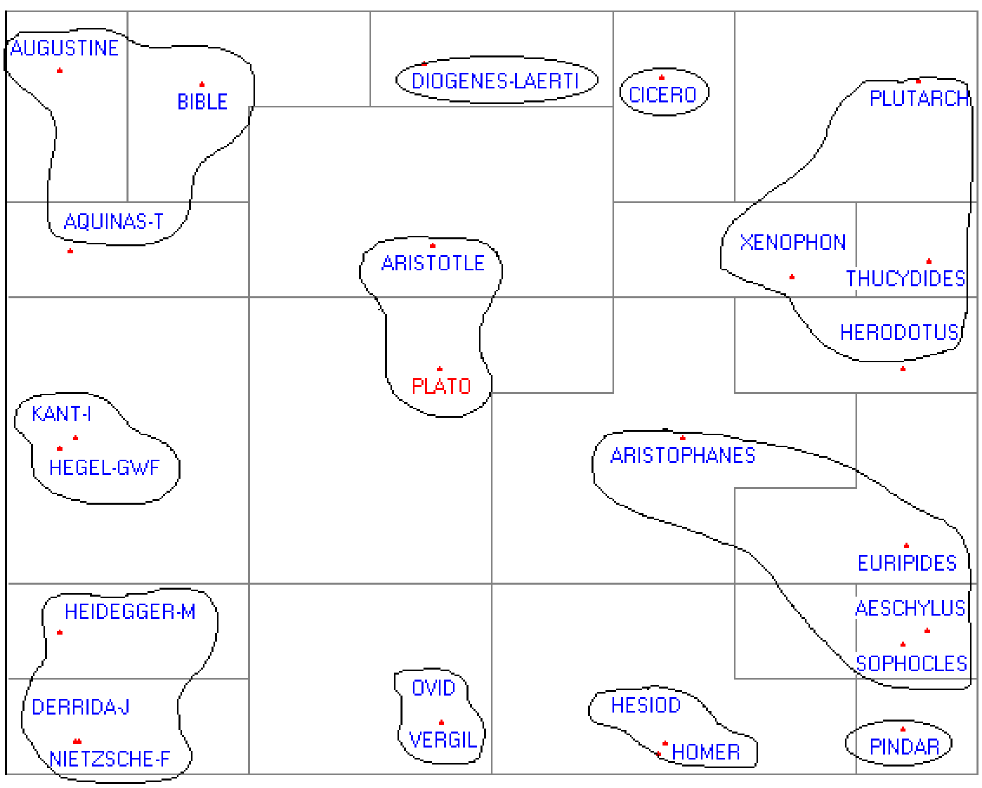
DERRIDA-J
AESCHYLUS
HEIDEGGER-M
PINDAR
EURIPIDES
KANT-I
HEGEL-GWF
SOPHOCLES
HOMER
AQUINAS-T
PLATO
HESIOD
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS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BIBLE
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AQUINAS-T
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XENOPHON
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HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
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OVID
DERRIDA-J
VERGIL
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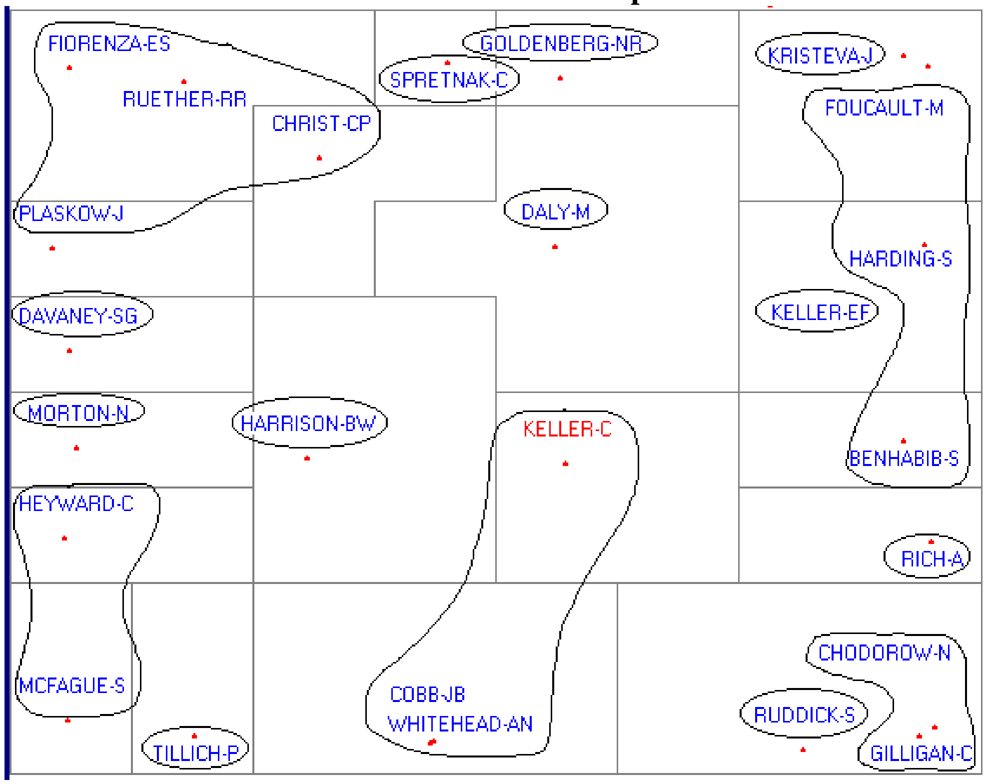
HOMER
PINDAR
NIETZSCHE-F

Keller Maps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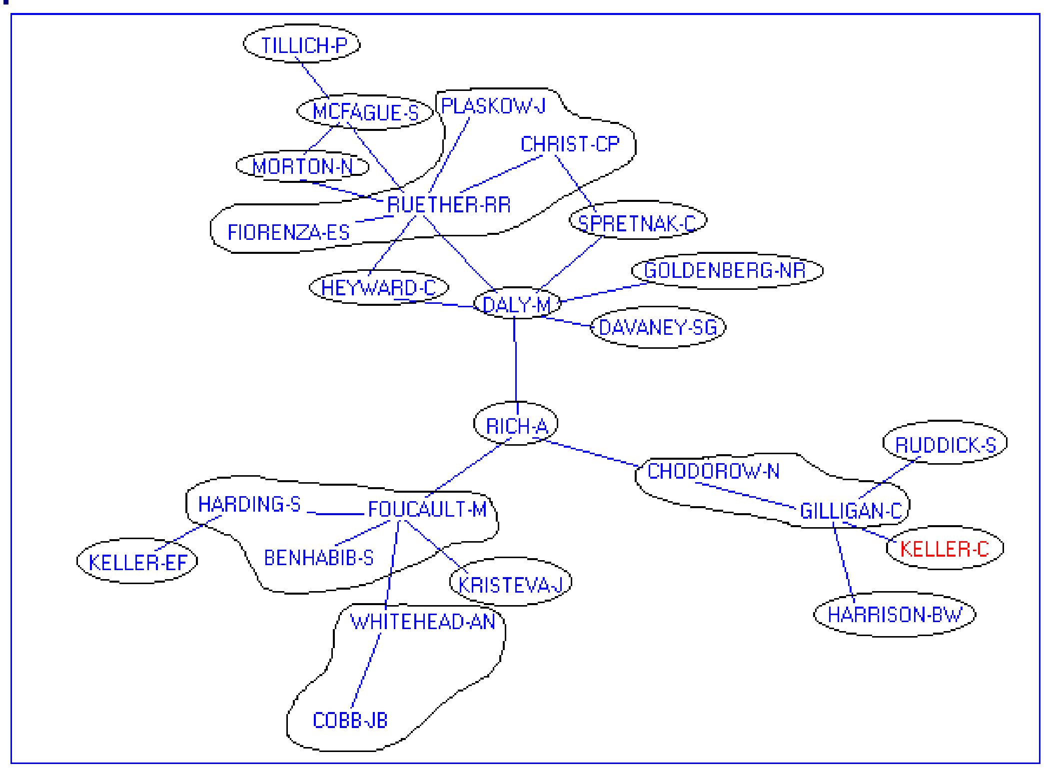
RUETHER-RR
CHRIST-CP
GOLDENBERG-NR
SPRETNAK-C
KRISTEVA-J
FOUCAULT-M
PLASKOW-J
DALY-M
HARDING-S
DAVANEY-SG
KELLER-EF
MORTON-N
HARRISON-BW
KELLER-C
BENHABIB-S
HEYWARD-C
RICH-A
CHODOROW-N
MCFAGUE-S
COBB-JB
WHITEHEAD-AN
RUDDICK-S
TILLICH-P
GILLIGAN-C


TILLICH-P
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MORTON-N
RUETHER-RR
FIORENZA-ES
SPRETNAK-C
GOLDENBERG-NR
HEYWARD-C
DALY-M
DAVANEY-SG
RICH-A
RUDDICK-S
CHODOROW-N
HARDING-S
FOUCAULT-M
GILLIGAN-C
KELLER-EF
BENHABIB-S
KELLER-C
KRISTEVA-J
WHITEHEAD-AN
HARRISON-BW
COBB-JB

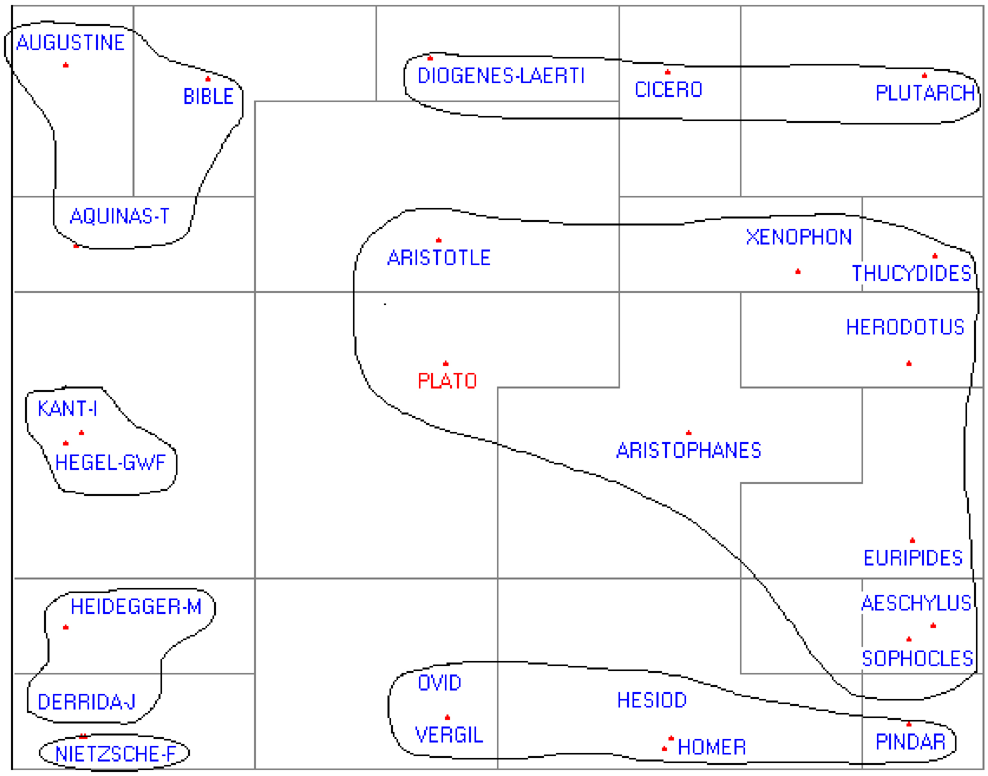
Expert #: 19

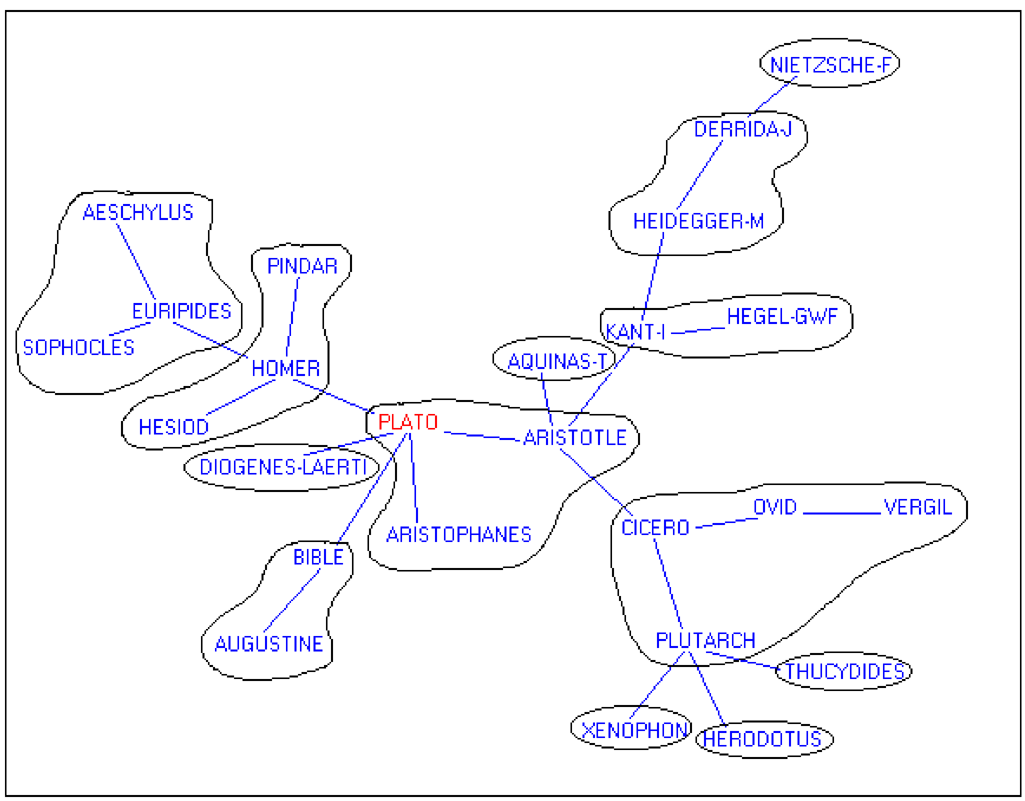
Card Sort Data

plato				
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5
aeschylus	cicero	aquinas-t	hegel-gwf	derrida-j
aristophanes	diogenes-laerti.	augustine	kant-i	heidegger-m
aristotle	hesiod	Bible	nietzsche-f	
euripides	homer			
herodotus	ovid			
plato	pindar			
sophocles	plutarch			
thucydides	vergil			
xenophon				

Thanckray						
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6	Group - ?
priestley-j	cassirer-e	metzger-h	cohen-ib	crosland-m	latour-b	davidoff-l
		partington-jr	gillispie-cc	inkster-i	porter-r	morris-rj
		sarton-g	guerlac-h	kargon-rh	schaffer-s	
			hall-ar	morrell-jb	secord-ja	
			kuhn-ts	thackray-a	shapin-s	
			merton-rk			
			musson-ae			
			schofield-re			

Plato Maps


AUGUSTINE
BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
HEIDEGGER-M
AESCHYLUS
SOPHOCLES
OVID
HESIOD
DERRIDA-J
VERGIL
HOMER
PINDAR
NIETZSCHE-F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DERRIDA-J
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PINDAR
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AQUINAS-T
HOMER
PLATO
HESIOD
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
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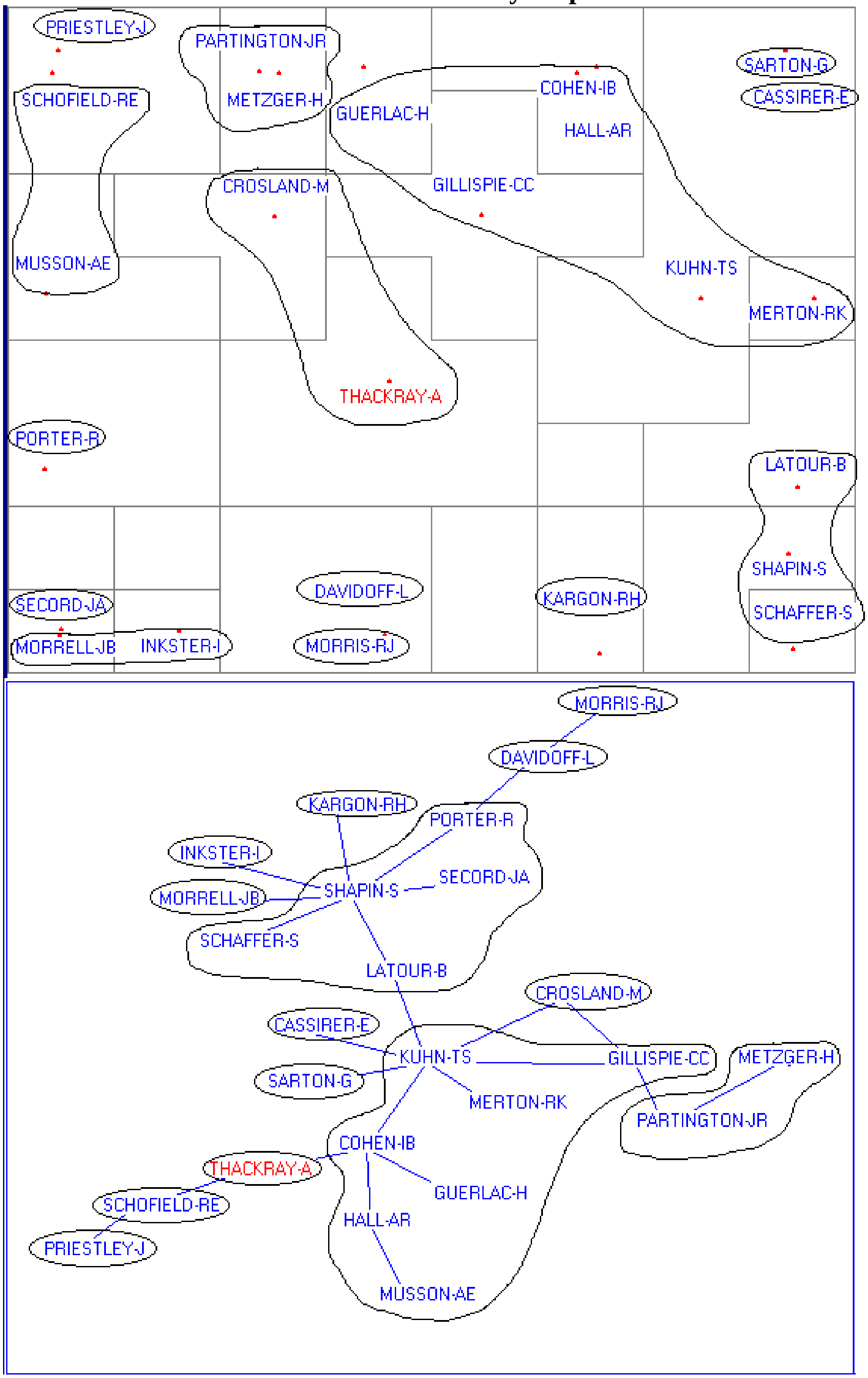
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS

Thackray Maps



Expert #: 20

Card Sort Data

plato			
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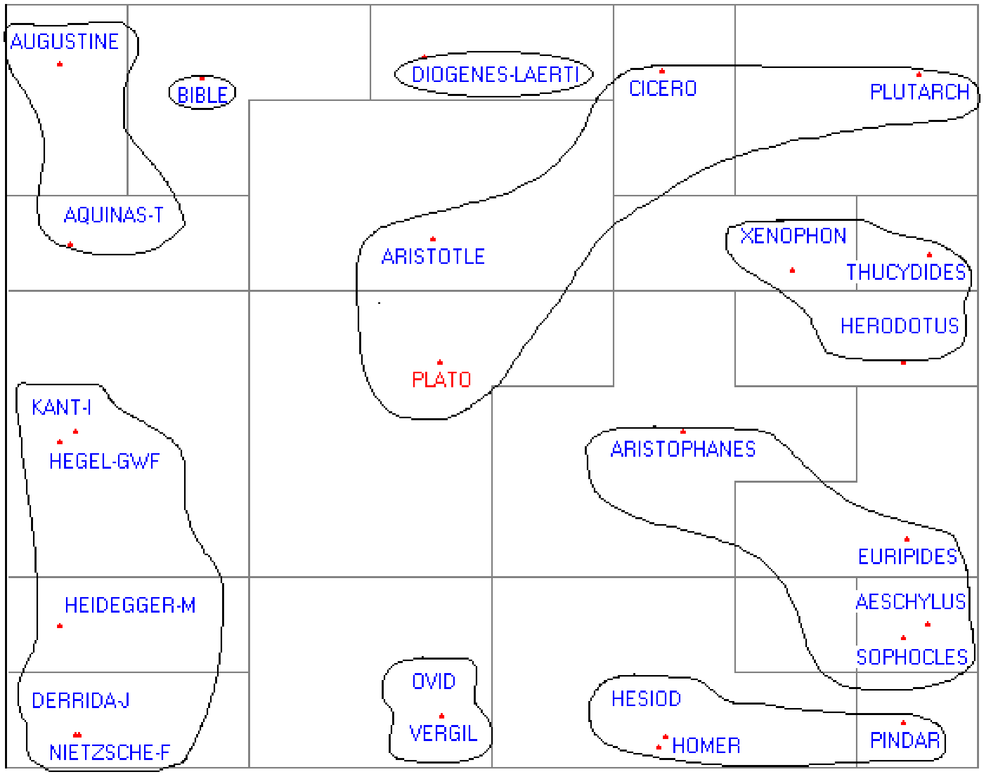
aristotle	diogenes-laerti.	hesiod	aeschylus
cicero	herodotus	homer	aristophanes
plato	thucydides	pindar	euripides
plutarch	xenophon		sophocles
Group - 5	Group - 6	Group - 7	Group - 8
ovid	Bible	aquinas-t	derrida-j
vergil		augustine	hegel-gwf
			heidegger-m
			kant-i
			nietzsche-f

lucretius:				
Group - 1	Group - 2	Group - 3	Group - 4	Group - 5
aristotle	catullus	euripides	cicero	plautus
epicurus	horace	Homer	seneca-younger	
lucretius	ovid			
plato	propertius			
plutarch	statius			
	vergil			
Group - 6	Group - 7	Group - 8	Group - 9	Group - 10
augustine	livy	pliny-elder	bailey-c	bible
quintilian	suetonius	Varro		
servius				

Plato Maps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BIBLE
DIOGENES-LAERTI
CICERO
PLUTARCH
AQUINAS-T
ARISTOTLE
XENOPHON
THUCYDIDES
HERODOTUS
PLATO
KANT-I
HEGEL-GWF
ARISTOPHANES
EURIPIDES
AESCHYLUS
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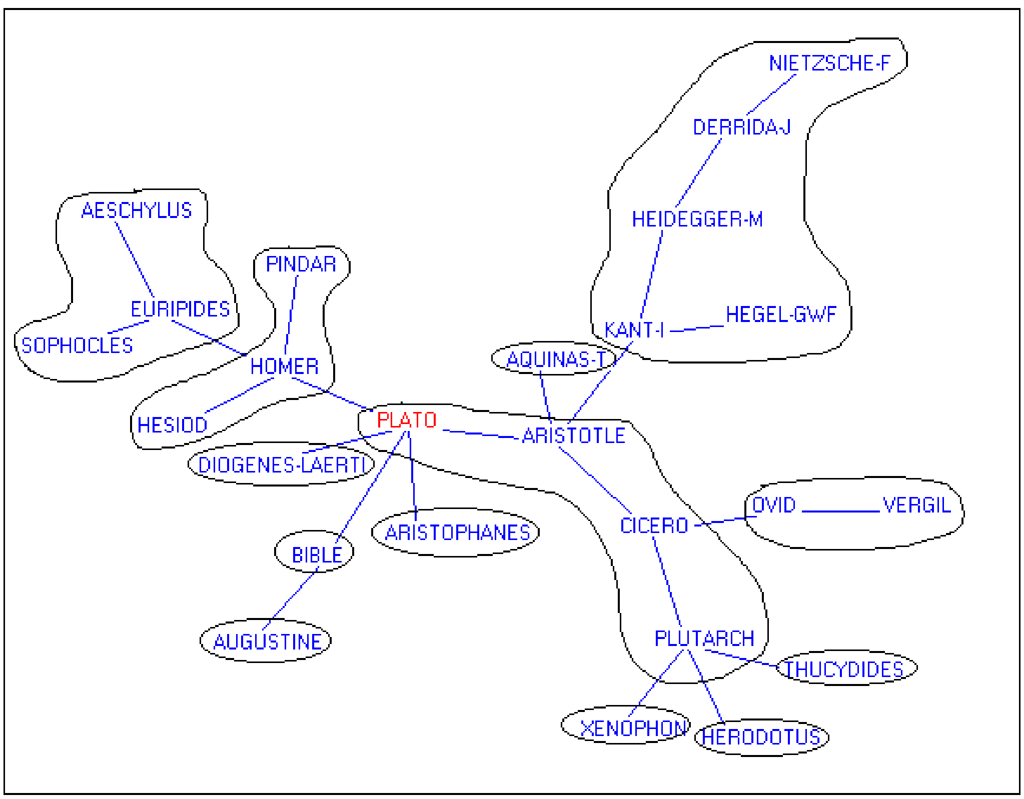
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AESCHYLUS
HEIDEGGER-M
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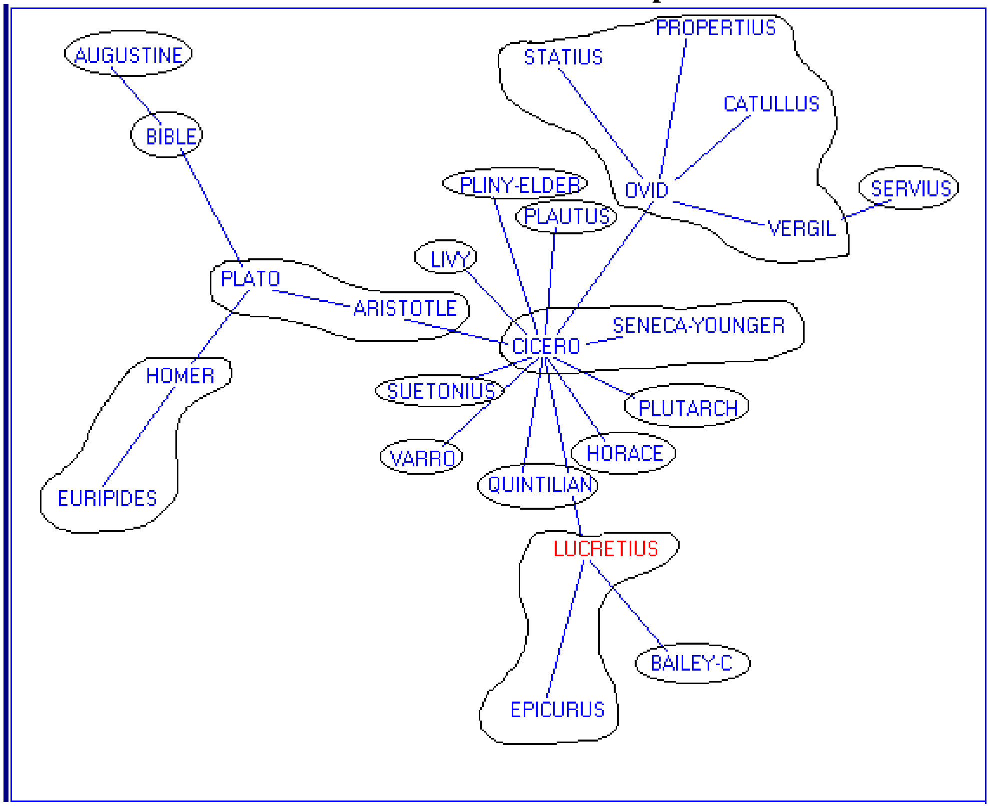
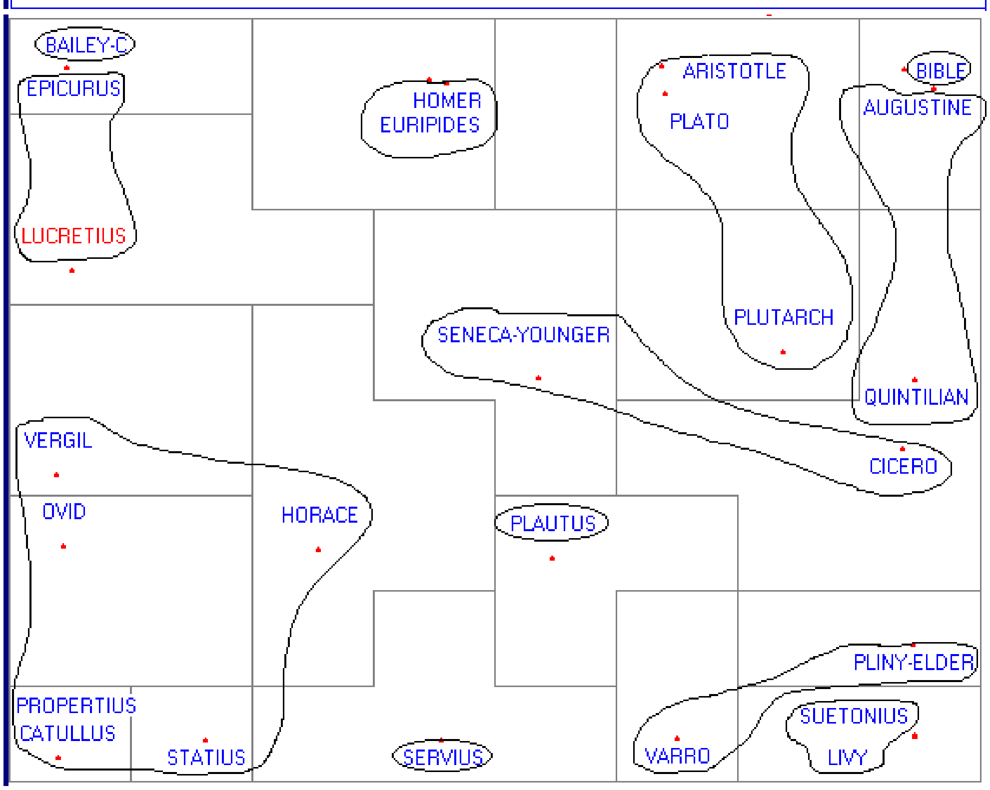
AQUINAS-T
HOMER
PLATO
HESIOD
ARISTOTLE
DIOGENES-LAERTI
OVID
VERGIL
CICERO
ARISTOPHANES
BIBLE
AUGUSTINE
PLUTARCH
THUCYDIDES
XENOPHON
HERODOTUS

Lucretius Maps





APPENDIX H: EXPLANATION OF THE SYSTEM

Dear Subject,

Below is a description of the terms and methodology that I will use for the second component of the research experiment. Please read them before we meet for the second component.

Data: The data come from the Arts and Humanities Citation Index (AHCI) for the years 1988–1997, as provided by the Institute for Scientific Information (ISI). The records in this database are bibliographic entries for scholarly articles (and other items) in the journals covered by AHCI, which ISI calls "source items." Each record consists of 59 data fields (for author, title, and so on). . The main field used in our study is *the cited reference field*—that is, the set of references at the end of a source item. Our data are the *authors cited within the endnotes* of these articles. The number of cited authors in each record varies greatly, from one (or none) to more than 1000 The number of unique cited authors is approximately 1.3 million. Here is an example of an AHCI record of a source item (show subject):

02410305 GENUINE ARTICLE#: 419HF NUMBER OF REFERENCES: 6
TITLE: On writers and writing: What goes around comes around
AUTHOR(S): Jefferson M
JOURNAL: NEW YORK TIMES BOOK REVIEW, 2001 (APR 15), P31-31
PUBLISHER: NEW YORK TIMES, 229 W 43RD ST, NEW YORK, NY 10036-3959 USA
ISSN: 0028-7806
LANGUAGE: English DOCUMENT TYPE: Article
JOURNAL SUBJECT CATEGORY: HUMANITIES, MULTIDISCIPLINARY
CITED REFERENCES:
  BANKS M, GIRLS GUIDE TO HUNTI
  JONG E, FEAR OF FLYING
  BRIDGET JONESS DIARY
  EGGERS D, HEATBREAKING WORK ST
  WALLLACE DF, INFINITE JEST
  MAILER N, ADVERTISEMENTS FOR M

This is an article from the *New York Times Book Review* that cites several well-known novels in its Cited References field. Cited Authors are a *part* of this field, and are obtained by omitting the references to particular works by the authors. (ISI abbreviates the names of many works, such as "Advertisements for M" for what is actually *Advertisements for Myself*.) Six authors are cited, for example, Jong E (Erica Jong) and Mailer N (Norman Mailer). Jong and Mailer here exemplify *co-cited* authors; this particular article would increase their co-citation count by one.

Author Co-citation Analysis (ACA): ACA is based on counts of how many times any work by any author is cited with any other work by any other author. The logic is that the more frequently two authors are cited together, the more closely the works of the two are related, as determined by the citers. The exact nature of the relationship is open to interpretation. It is often similarity of subject matter or of methodology or both. No single citing author creates the relationship; rather, it emerges incrementally over time from the actions of many citers.

Nameseed: This is the name of the author used to generate the data. In one trial we use Plato as a nameseed. In a second trial, we use a nameseed of your choice.

Derived data: The 25 associated authors are obtained by looking at all of the records in AHCI that contain the nameseed and finding the twenty-four other authors who most frequently co-occur with the nameseed in reference lists. (The nameseed will be the most frequently occurring name since it occurs in every record.) Our software then pairs every author in the 25 with every other author in a Boolean AND relationship and obtains the counts of AHCI articles that cite each pair jointly; e.g., Mailer N AND Jong E. Given twenty-five authors, there will be 25(24)=600 different possible pairings. But this is always cut in half, to 300, because "Mailer N AND Jong E" retrieves the same co-citation count as "Jong E AND Mailer N"; we don't need both forms of the pair.

Visualization: With 300 paired-author-counts in a matrix, a visual technique is needed to show all of the names simultaneously so that the user can get a holistic view in addition to focusing in on clusters of authors. The visualization technique used is that of mapping.

Maps, or the First law of geography: everything is related to everything else; the things more closely placed together, however, are more closely related. For our maps, the association between names is indicated by the size of the co-citation counts; the higher they are, the more closely are authors related. We place authors with the highest co-citation counts in relatively close proximity on the maps; authors not as closely related are placed farther apart.

Name placement on the map is determined by an algorithm. This research will make use of two different mapping algorithms:

1) Self-Organizing Map (SOM): Uses a neural network to draw a map. Each name is surrounded by an area, as delineated by the lines, which is proportional to the frequency of the name's occurrence.

2) Pathfinder Network (PFNET): Uses a mathematical techniques to determine the strongest links on a map and the placement of the names. Each name is linked with another name indicating the strongest pairing.

***

For the second part of the experiment, you will shown maps of the two types mentioned above and asked a series of questions on them. We are purposely not showing you examples of the maps at this time as we wish to get your initial reaction to them.

I look forward to meeting with you, and again, the second part should take no more than 30 minutes.

-Jan

APPENDIX I: THE INTERVIEW QUESTIONS

1. **Start tape recorder (turn on mic/midboost)**

2. **State**: This session will be recorded. Please remember to vocalize your thoughts as parts of this session will be transcribed and analyzed. I should have given you a description of the system and terminology concerning the system. Do you have any questions on the material?

3. **Show list of names associated with Plato**:

   - Are the names on the map representative?
   - Should there be a name there which is not?

4. **Show Plato SOM first; repeat for PFNET**.

   - Given the placement of the names, can you describe why those names are placed where they are and can you circle groups of names and give them a category name?

5. After showing two maps:

   - Does one map type better represent your idea of how the names should be placed and do you prefer one map type's format over the other?

6. **Show list of names associated with Interest Nameseed**:

   - Are there names which you do not recognize?
   - Are the names on the map representative?
   - Should there be a name there which is not?

7. **Show Interest Nameseed PFNET first; repeat for SOM**.

   - Given the placement of the names, can you describe why those names are placed where they are and can you circle groups of names and give them a category name?

8. After showing two maps:

   - Does one map type better represent your idea of how the names should be placed and do you prefer one map type's format over the other?

- Does a map shown suggest anything novel to you that you would not think of or intrigues you?

9. **Log onto system**: cite.cis.drexel.edu

10. **State**: The AuthorLink System: This website is linked to the Arts & Humanities Citation Index (AHCI) Database for the years 1987 to 1998 / The system will take a single name and return 24 other names related to the entered name / This step is accomplished by entering a name in the top box and pressing the SUBMIT Button / Remember to enter names as LAST NAME-FIRST INITIAL, e.g., WHITE-HD / Those names are then passed to the two mapping algorithms and the maps are displayed when the "Map it now" button is pressed / Each map can be shown by selecting the option.

11. **Invite user to enter any name**. Press SUBMIT Button.

    - Are there names which you do not recognize?
    - Are the names representative?
    - Should there be a name there which is not?

12. **Have user Press MAP IT NOW button**.

13. **Ask for SOM/PFNET**

    - Given the placement of the names, can you describe why those names are placed where they are and can you identify groups of names and give them a category name, using the mouse?

14. After showing two maps:
    - Does one map type better represent your idea of how the names should be placed and do you prefer one map type's format over the other?

15. **Invite user to use system using another name** (if time).

16. **Ask after thirty minutes** (or when the user seems done):

    - For your participation in the study, we will give you a free subscription to the system. However, only one of the two maps can be used for the first six months and you must choose which one you wish to use. Which map type do you choose? Why?

APPENDIX J: INTERVIEW EXAMPLE

[**Interviewer is in boldface**; Expert interviewed is in normal font. Comments and supplemental information are in brackets.]

[Start of interview]

This session will be recorded. Please remember to vocalize your thoughts, as part of the session will be transcribed and analyzed. I've shown you the list of the instructions. Do you have any questions on those instructions?

I think I understand it. My only question was at the end of the instructions when you say you'll also be showing maps during the second part of the experiment. Is that now?

Yes, it is. I will show you the maps within a couple minutes.

Okay, fine.

There were two stacks of cards that I gave you. One was based on Plato and one was based on the name of your choosing. What I have here is the list of names associated with Plato. Are these authors representative of names to be associated with Plato?

With the disclaimer that I am not a classical scholar, the list of names seemed unsurprising.

What I will do now is show you a visualization [SOM] based on those names derived from co-citation counts within the AHCI database. It is the map the instructions describe. Now, given the placement of names, can you say why they are where they are? Also, can you identify clusters of names, drawing circles around them and giving them a label?

Well, yes, within limits. The easy one is in the bottom—well, the cluster immediately to the left of Kant and Hegel and—

Could you draw a circle around it now and label it.

I'll certainly draw that around them because that's sort of Germanic philosophers who would, among other things, I'm sure, comment on Plato.

Could you label that by putting the initials "GP."

Okay. This Heidegger, Derrida, and Nietzsche down there are commentators—it's interesting that they do spread out, because you could link Hegel and Heidegger certainly. I mean, there's a certain sort of continuum there, but at the same time we could certainly put Derrida and Nietzsche as what I would call—what shall we say?—extremist philosophers. So I'll call them "EP."

Heidegger is interestingly, quite literally, in the middle between the Germanic and the extremist. So that doesn't seem bad to me.

Likewise, Augustine, Aquinas, and the Bible are all kind of—we'll call those "CPers," Christian philosophers, or something.

Now, after that we're kind of groping a little bit—my imperfect knowledge of the classics—but if I were to say Ovid and—were Ovid and Vergil Roman? I'm not sure, but I would—so I'll call them Roman philosophers for a moment.

And then we look over here and see—well, all of the ancient philosophers are over on the right-hand side of the diagram as opposed to the modern philosophers on the left. So that makes sense.

The particular clusterings are—really, there's people who seem sort of somewhat equidistant from one another and all connected to Plato but distinct from Plato. So you've got a series with Diogenes and Cicero, Plutarch, Aristotle, Xenophon, Thucydides, Herodotus, Aristophanes. So that seems to me unsurprising. I wouldn't necessarily have made that mapping myself, because I'm kind of groping with my ignorance of the territory.

And then Hesiod and Homer go together. I'm not quite sure why, but I have to say I'm not surprised to see those names together, but I can't give you an immediate reason for that.

And then you've really got—I'm not sure whether it's one group or three groups, because you've got this clustering in the bottom corner of Euripides, Aeschylus, Sophocles, and Pindar. And, again, I don't know enough to differentiate or put together, but I'd say the map—if we were both to go to a dictionary and find out further things and refresh my rusty knowledge, it would not surprise me if there was a logic to these placements.

What I'll do is now is show you a second map [PFNET], again based on the authors associated with Plato.

This was machine-generated from the information?

Yes.

You've ordered them differently in some way here, have you or not?

Yes, they should be different somehow.

Yes, I can see they're different somehow. I'm not quite sure, but I'm just looking—well, Plato, Bible, Augustine makes a logical line to Christianity through time.

Okay. If you wanted to draw a circle around that now.

Around the whole thing or just around the Bible—

What you see as a group.

Well, since Plato belongs to everything, I'm not going to put him in any of them, though he could be in all of them.

Interestingly, Aquinas is really—I always think of him as the commentator on Aristotle. So he's in that same Christian tradition, but it is a different branch of it, which you have here.

Plato to Aristotle to Kant is a line of development, and you could—it goes off sideways from Kant to Hegel or it goes off in another line through Heidegger to Derrida and Nietzsche. And I'm not quite sure why Hegel is off on the side rather than in the—I haven't read enough of Hegel or Heidegger to know if they're antithetical or belong together. So that's really a sort of—are we supposed to loop it around like this in a long sausage?

You can, if you'd like.

And, certainly, Kant to Hegel is kind of, sort of, well known. I mean, that's the main German tradition, as it were.

What else are we seeing here? Well, yes, up on the left, these branches and sub-branches, the Homer with Hesiod and Pindar off on to Euripides and Sophocles and Aeschylus, I mean that's the sort of—that's an ancient world commentating tradition. Again, I don't know enough to know why that's a different tradition from the one that's going Cicero, Ovid, Vergil, Plutarch, Xenophon, but I would assume these are—if we read the texts more closely, we might find reasons to kind of group them together.

So I can certainly agree that it's not gibberish.

Now, placing the maps side by side, does one map type better represent your idea of how names should be placed and do you prefer one map's format over the other?

I think I prefer—I mean, I don't have enough subject knowledge, but I prefer the one on the left [PFNET] that actually—as is instanced in the Plato, Aristotle, Aquinas that—whereas this other one [SOM] has Aristotle and Aquinas, and their relationship to Plato is—you don't have to go through Aristotle to get to Aquinas on the one on the right, whereas on the one on the left you do go that route, and that is, in fact, kind of a—Aquinas is reading through Aristotle's eyes.

So the one on the left makes more sense, though the one on the right is certainly defensible.

For the remainder of the interview, we'll call these trees [PFNET] and we'll call that squares [SOM].

Okay, yes.

Now, what we have is a list of names that are associated with your name of interest in the database. [He had chosen the historian of science, Arnold Thackray.]

All right.

Now, again, are they representative of names you think should be associated with Thackray?

It did not surprise me to see any of those names on that list, yes.

Are there names there that should not be there?

Not necessarily. Since some of them died before Thackray was born, I mean, clearly, they're not citing Thackray.

Right, but Thackray is co-cited with them.

Yes.

And is there a name, given the top 25, that should be there that isn't?

Oh, well, that's an interesting question. I hadn't thought on that dimension. There is no name that springs to mind, but it's—that's an interesting question I hadn't thought about.

Now, again, what I'll do is show you two maps that are created based on co-occurrences with Thackray, this time starting with the tree map. Now, again, if you could, take your pen and indicate groups that you see on this tree map.

Well, certainly to start on the easy territory, the Schofield-Priestley [link] is not surprising since Schofield was a scholar working in areas very close to Thackray's, but also who had a primary focus to the 18th Century figure of Joseph Priestley, who Thackray also wrote about. If you asked people in the field, "Talk to me about Schofield," they would mention Priestley before too long. So that kind of fits right there.

It's a little surprising to me that Thackray only has two links—namely, to Schofield and to Cohen—and everything is through those two links.

There are variations on this type of map. We use the most parsimonious, and, so, therefore, we use the minimal number of links. There could be more by varying some of the parameters.

I'm not quite sure how you want me to proceed. Do you want me to discuss the names or the groups.

Given the placement of names, can you describe why they're placed there? Ultimately, do you agree or do you disagree with the map?

Well, Cohen was the senior Harvard professor, the ranking scholar in the field in which Thackray was writing in relation to citations that you are dealing with, so—and, indeed, Thackray came to this country because he went to replace Cohen at Harvard when he was on leave. So I'm not surprised to see that link there.

And Guerlac and Hall are two other senior scholars whose work very much interacted with the work of Cohen. So that makes sense.

Musson really, I think, doesn't belong out on the end of that line. Musson is closer to Schofield in some way. Musson was really an economic historian, and most of these people are historians of ideas. So he doesn't quite belong on any line. He almost deserves a little line of his own.

Kuhn, of course, is the great Thomas S., and that he appears here linked—that Thackray goes through Cohen to Kuhn is kind of all right. And if I'm remembering, when Thackray was at Harvard, he literally went down to Princeton at Kuhn's invitation and gave a seminar down there and was talking to Kuhn. So it's almost literal representation. And, of course, Kuhn was very much in Thackray’s thinking since his theses were the hot news as Thackray was kind of coming into the field.

Sarton and Merton, who you've got linking to Kuhn, could equally well link to Cohen because, in fact, Sarton was Cohen's predecessor at Harvard. Cohen was Sarton's student. Merton in some sense was Sarton's student. And that's a sort of Harvard axis in which Kuhn also floated. Kuhn was ejected to Berkeley and then to Princeton. He never recovered from being ejected from Harvard though, and he eventually ended up at M.I.T. as the next best thing. So they really kind of belong together, in a sort of social-intellectual coterie.

That Cassirer is out there is a horse of a different color, because he is an earlier historian of ideas whom people would cite. You've got him linked to Kuhn, but almost anyone might have cited him a little bit. He's really weakly connected in a sort of great distant-figure sense.

If I go up this strand up here through Latour, who has become a latter-day guru, as has Shapin—Shapin was actually Thackray's student, so there are all sorts of links there. But what you've then got coming off from them is really people of a—it's another generation that you're dealing with out here. So they do all belong in some way in a sort of cluster. You've got Shapin at the middle, which is interesting because Shapin is possibly the youngest of that group, but he has become the intellectually dominant figure. So it's not surprising that you see him kind of showing up centrally in citations.

Over here what you've really got is—you know, there's a different—I mean, the diagramming is correct because these people on the right—Gillispie plugs right into Kuhn. Gillispie was Kuhn's colleague at Princeton, and they couldn't help but influence one another in different ways. But Gillispie and all these people in this group, the Crosland and Partington and Metzger, this is a more traditional history of chemistry grouping of people. So they do belong in some relationship to each other.

So I should say that's not half bad as an attempt to—as a machine derived [figure], these are the links; and it's pretty impressive.

Good. What I'll do now is show you the other type of map [SOM], which is based on neural networks, and again ask you to go through the same exercise, if you would.

Yes, it's interesting. Priestley and Schofield...as we've said, Schofield worked primarily on Priestley, so they belong together.

Partington and Metzger are the classic historians of chemistry. I mean, if you said their names, people would say historian of chemistry. And, so, they belong together and close to Crosland, who is a younger generation but pretty much in that ilk. Guerlac is half historian of chemistry, so it's kind of neat. I don't know how you got him close by, but that's neat. And Musson, yes, belongs better where he is, in some sort of juxtaposition to that grouping.

Cohen and Hall surely belong together because Hall was a sort of younger British version of Cohen, very much kind of taking that mind-set to England. And Gillispie is kind of in there somewhere. That's okay, yes. Kuhn is in there somewhere, yes.

Sarton and Cassirer are out on the margin, that's correct. They are in some way close to each other. They're chronologically close and they're both sort of European scholars of a certain ilk and period. Merton, yes, is not that far from Sarton. He shouldn't be that far from Sarton or from Kuhn, but he's out on the edges of this world. That's all right. And Latour on the edges of this world, Kargon, all these people.

I'm not quite sure why Secord and Morrell are, as it were, quite so far away. Morrell, he and Thackray collaborated on a number of things and were quite close. And Shapin might have been in closer.

But in terms of kind of saying that's one way around, it's kind of a set of individuals. Certainly, who is close to whom on the map makes reasonably good sense. Inkster certainly ought to be close to Morrell, for instance, and Porter and Musson up there. That quadrant all makes sense in terms of who is close to each other, and Latour and Shapin and Schaffer.

So I think the relative closeness of people to one another makes sense. Their closeness or distance from Thackray seems a bit more arbitrary in the sense that I would think, actually, of the people closest to Thackray, you see, would be Morrell and Shapin. And Thackray actually collaborated on some papers with Merton, and Schofield was very much working on the same thing. They're actually out at the edges, whereas I would think of them as being intellectually close to Thackray. So that would be my sort of criticism of that articulation.

But if you can do all this by machine, that's pretty impressive, I think, because it is making some sense of the territory.

Good. Now, let's make the comparison again side by side. Given these two maps, does one map better represent your idea of how the names should be placed and do you prefer one map's format over the other?

Yes. I think, again, I like the trees [PFNET] more, but, interestingly, the other one [SOM] shows some things better. But I just sort of like the trees more because the squares almost suggests a more arbitrary connection of the ideas in some way.

Does either map shown suggest something novel to you that you would not have thought of otherwise or intrigue you to explore through additional inquiry?

Well, certainly, number one, I should say I haven't thought systematically about who—I guess this is initially who cites Thackray and then who co-cites.

This is more an issue of who is co-cited with Thackray.

Yes, and I haven't thought about that. And, so, what I find interesting is that it is a certain sort of intellectual map of the field and you might almost say, I suppose, is an attempt to produce a map of reality as I might perceive it.

And since I haven't articulated my perception of reality, it's kind of interesting to see it, yes, and say, well, yes, that probably is a kind of useful way to think about things. So what it might prompt in a certain sense is sort of—it might have feedback into one's intellectual argumentation in some way—or, sort of, well, if I'm trying to convince this grouping or draw on that grouping or to be a little more self-conscious about what one is up to essentially. I would see it from my point of view as a tool for being more self-conscious about the influence of what Thackray was scribbling.

We have a system available on-line that you can work with interactively. What I'd like to do is to look at one or two of those maps and then make some more comments.

Okay.

[The URL of AuthorLink, via the subject's browser, is entered.] **This is the AuthorLink system. This website is linked to the Arts and Humanities Citation Index for the years '87 to '98. The system takes a single name and returns 24 other names related to the entered name. This step is accomplished by entering a name at the top box and pressing the "Submit" button. Remember to enter the names as the last name, hyphen, and their first initial and middle initial if it's known.**

For example, by typing in Howard D. White as "White-HD," these are names that are associated with him; Clicking on the "Map it now" button shows the associated map [PFNET]. Clicking on "Regions," will give you the other type of map [SOM].

Oh, I see, yes.

So you can enter in any name that you would like to explore. Is there any other name that you would like to examine?

Well, let me examine a couple of Thackray's collaborators. Let's put in Morrell for a moment.

[Types "Morrell-J"] **You can click on "Submit." Now, it could be "J" or it could be "JB" sometimes. It depends on how they're entered into the database at ISI. It takes a little while for the system to present the map.**

It's doing it, all right. Okay. So what do we do now?

Are the names that you see representative of Morrell?

Yes, those make sense as names.

You can scroll down the list, there are other names there.

Oh, I see. I'll just see if he no longer cites Thackray, you see. Yes, okay.

Now, if you want, you can click on "Map it now," and it should produce the tree map.

Okay.

Now, you see, he's in there twice, so he's a little bit of a problem. Morell is shown as "Morrell-J" and he's also under "Morrell-JB."

Oh, I see, yes, yes.

It's kind of interesting to see how different variations on his name are cited differently.

Yes.

When he's cited as "J," he's cited with Schaffer; but when he's stated as "JB," he's with Shapin.

Shapin, yes.

Now, again, you don't need to go through the same details that you did with the previous maps, but is the map intelligible?

It's certainly intelligible. It's a little more puzzling to me as to quite, sort of, why it has come out the way it has.

If you wanted to compare it with the other map, you can click on the "Links" there and choose "Regions."

[The SOM is displayed.] Well, at least he's close to himself. That's good.

Well, again, it's making some sort of overall sense in the sense that, just over here, these are all 19th Century figures, Babbage, Whewell, and Darwin. And these are all kind of high theorists of the territory, Collins and Kuhn and Latour, and Shapin is much of that ilk. And then we've got people who are more ordinary historians scattered around here. So there's some reasoning to it.

Yes, and, actually, it probably comes out slightly better on that one [PFNET]. How do I go back on this?

You click on "Regions" again, and you can switch back—click on "Links."

You see, on this one [PFNET] the—well, Babbage and Whewell, you see, are both—Whewell is another 19th Century figure, but they're coming off in the same way that sort of contemporary people are. So that's a little more—and I don't know where Darwin is, where Darwin has got into this. Desmond is the biographer of Darwin. That's why that link is there. And Corsi writes on Darwin, and I guess Kuhn must have talked about Darwin.

So there is a logic to it, but, on the other hand, Darwin is a horse of a different color from the other people in there. So I guess that's some of the limitation of the machine, while the human would instantly register that.

Right. Do you want to try another name?

Yes. Who else shall we go to? Well, let's just try Shapin. [Expert types in "Shapin-S."]

Now, what it's doing, it's going into the records, those records that cite Shapin, and it's finding the other 24 most frequently co-cited with Shapin.

It's just amazing, this business of having the ability to sort through a zillion things in some other place and bring you the answer immediately.

He's very well cited.

[Looking at the PFNET] Yes, it's interesting. This is basically a sort of younger set of people that are in this business of—people don't change their mind, it's just that they die. We've got some new people on the case, yes.

Yes, well, he has written a lot about Robert Boyle, so it's not surprising that Boyle shows up there.

And Latour is, of course, now a great guru name, so it's interesting that people are co-citing—they're doing their guru cite. That makes sense as the main axis of that. And then I guess what we've got here in part is the Latour school, which I wouldn't necessarily recognize, but that's part of why they would cluster around there.

Yes, and it's interesting, Shapin-Latour-Foucault, I mean, that is the guru line. I mean, that's really sort of the main line out to Kuhn, and then—but it shows you—these are the old gurus, and Foucault and Kuhn and Shapin and Latour are the new gurus.

Right. Now, if you want, if you use the scroll bars, you want to see a little bit more of the bottom right-hand screen. Now, one of the things you can do with this system is you can show the numbers.

Oh, I see.

So you can see the co-citation counts.

Yes. So who are the high scorers here? Let's just see. Well, it's 191 to Latour—that's why he's kind of on the main axis—and then 150 to Foucault.

Right.

How does that work? That's Shapin and Foucault being cited together, is it? Or Latour and Foucault being cited together in a work that cited Shapin?

Well, Latour and Foucault are co-cited 150 times together.

Oh, just in works [that cite Shapin]?

Overall.

Yes. And Foucault and Kuhn, yes, you see those—

Right, very large links.

Yes.

We have the ability to draw the links proportionately to the co-citation, but it tends to produce less intelligible maps. So we're sort of avoiding that for the first pass.

Yes, I'm not sure that drawing links proportionally would necessarily tell you anything, as it were. I mean, it's interesting to see the numbers on there.

If you wanted to, you can go into the region map and explore that.

Well, Collins and Latour—where has Kuhn gone? We've lost him right now.

Up there.

He's right up here, yes.

You can click on him and drag him down if you'd like.

Well, it's just interesting to me that he's sort of so far away in this version [SOM]. I mean, this seems much less informative than the previous one simply because almost everybody is just sort of scattered around in this one.

Kuhn and Laudan are in the same thing because they were citing each other quite a bit.

I feel this one is much less informative. I mean, the other one really seemed interesting.

I'd like to show you another possibility. If you were interested in finding those articles that co-cited Shapin and, say, Latour, you could double-click on "Latour" and he shows up on the right-hand side. So if you click on "Go get it," button, it will retrieve those articles that co-cite Shapin and Latour. There are 191 records that cite them. This gives you sort of a glimpse of doing some information retrieval based on co-citation.

Yes. I mean, that begins to then become intellectually interesting as producing some—I mean, it would be very hard to kind of manually get to this territory, but—this is of co-citation, is it?

Yes. If you click on one of the titles, you'll see the other authors that are also cited, and will show you the article as well as.

Now, this is telling you the—

These were the cited authors in that article.

Yes.

And both of those authors that you looked for are in there.

Were in there, yes.

Yes, it seems to me you would have to—to actually intelligently use this, you would have to really develop an understanding of the tool and spend some significant time just understanding what the tool is. I can see it's certainly a way of sort of tracking around in the literature that's more rational ultimately than just kind of going to the library shelves and saying who's writing what or just browsing around the stacks. It's organized browsing, isn't it, in some sense?

Yes. And one of the things it enables you to do is that given one name, you can find the other names that are related; and given those names, you can see how they're related to one another. So you can start to see clusters, and, so, you can do research along those clusters if you wanted to.

Yes. I mean, can you actually—you can't see the actual article?

No. That data is not available to us.

Well, I've taken enough of your time, so we can just sort of close it up here. One final thing: For your participation in the study, we will give you a free subscription to the system.

Oh, I would appreciate that. That's good.

I will email your information: your login and your password.

Excellent. Thank you.

There's one final question though: you may use the system as much as you would like, but only one of the two maps which were shown can be used for the first six months, which you must choose right now. Which map do you choose and why?

Oh, the tree.

You prefer the tree?

Yes, because it somehow gives a better—I mean, there are some things in the other one that aren't in the tree, but the tree gives you a more immediate visualization of reality in some way. I mean, it just seemed to me to be more evocative.

Okay, good.

All right. Well, thank you for that. That was interesting.

[End of interview.]

APPENDIX K: ACCUMULATED MATRICES BASED ON PLATO

Accumulated matrix from Card Sorts

Card Sorts	Plato	Aristotle	Plutarch	Cicero	Homer	Bible	Euripides	Aristophanes	Xenophon	Herodotus	Augustine	Kant	Aeschylus	Thucydides	Sophocles	Ovid	Hesiod	Diogenes-	Heidegger	Derrida	Nietzsche	Pindar	Hegel	Vergil	Aquinas
Plato	0	19	2	2	2	0	3	3	4	3	3	6	3	3	4	1	3	5	6	4	5	1	6	1	4
Aristotle	19	0	2	2	2	0	3	3	3	3	3	6	3	3	4	1	3	5	6	4	5	1	6	1	4
Plutarch	2	2	0	11	4	0	1	1	4	9	0	0	1	9	1	7	4	4	0	0	0	3	0	7	0
Cicero	2	2	11	0	6	0	3	3	1	5	0	1	3	3	3	9	6	3	1	0	0	4	1	9	0
Homer	2	2	4	6	0	1	6	6	0	3	0	0	6	4	6	12	12	4	0	0	0	11	0	13	0
Bible	0	0	0	0	1	0	0	0	0	0	14	0	0	0	0	0	1	0	0	0	0	0	0	1	13
Euripides	3	3	1	3	6	0	0	20	2	4	0	0	19	4	19	3	3	3	0	0	0	2	0	3	0
Aristophanes	3	3	1	3	6	0	20	0	2	4	0	0	19	4	19	3	3	3	0	0	0	2	0	3	0
Xenophon	4	3	4	1	0	0	2	2	0	10	0	0	2	10	2	1	2	2	0	0	0	1	0	1	0
Herodotus	3	3	9	5	3	0	4	4	10	0	0	0	3	18	3	3	7	5	0	0	0	3	0	3	0
Augustine	3	3	0	0	0	14	0	0	0	0	0	2	0	0	0	0	0	1	2	2	2	0	2	0	19
Kant	6	6	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	17	11	17	0	19	0	3
Aeschylus	3	3	1	3	6	0	19	19	2	3	0	0	0	3	19	3	3	3	0	0	0	2	0	3	0
Thucydides	3	3	9	3	4	0	4	4	10	18	0	0	3	0	3	4	5	5	0	0	0	4	0	4	0
Sophocles	4	4	1	3	6	0	19	19	2	3	0	0	19	3	0	3	3	3	0	0	0	2	0	3	0
Ovid	1	1	7	9	12	0	3	3	1	3	0	0	3	4	3	0	7	4	0	0	0	12	0	18	0
Hesiod	3	3	4	6	12	1	3	3	2	7	0	0	3	5	3	7	0	4	0	0	0	7	0	6	0
Diogenes	5	5	4	3	4	0	3	3	2	5	1	0	3	5	3	4	4	0	0	0	0	2	0	4	1
Heidegger	6	6	0	1	0	0	0	0	0	0	2	17	0	0	0	0	0	0	0	13	18	0	17	0	3
Derrida	4	4	0	0	0	0	0	0	0	0	2	11	0	0	0	0	0	0	13	0	13	0	11	0	3
Nietzsche	5	5	0	0	0	0	0	0	0	0	2	17	0	0	0	0	0	0	18	13	0	0	17	0	3
Pindar	1	1	3	4	11	0	2	2	1	3	0	0	2	4	2	12	7	2	0	0	0	0	0	11	0
Hegel	6	6	0	1	0	0	0	0	0	0	2	19	0	0	0	0	0	0	17	11	17	0	0	0	3
Vergil	1	1	7	9	13	1	3	3	1	3	0	0	3	4	3	18	6	4	0	0	0	11	0	0	0
Aquinas	4	4	0	0	0	13	0	0	0	0	19	3	0	0	0	0	0	1	3	3	3	0	3	0	0

Accumulated matrix from PFNET Circling

PFNET Circling	Plato	Aristotle	Plutarch	Cicero	Homer	Bible	Euripides	Aristophanes	Xenophon	Herodotus	Augustine	Kant	Aeschylus	Thucydides	Sophocles	Ovid	Hesiod	Diogenes	Heidegger	Derrida	Nietzsche	Pindar	Hegel	Vergil	Aquinas
Plato	0	19	1	2	2	0	2	3	0	0	0	6	2	0	2	0	2	5	6	4	4	1	6	0	4
Aristotle	19	0	1	2	2	0	2	3	0	0	0	6	2	0	2	0	2	5	6	4	4	1	6	0	4
Plutarch	1	1	0	11	0	0	0	0	4	9	0	0	0	9	0	5	0	0	0	0	0	0	0	5	0
Cicero	2	2	11	0	0	0	0	0	1	4	0	1	0	3	0	9	0	0	1	0	0	0	1	9	0
Homer	2	2	0	0	0	0	6	2	0	0	0	0	6	0	6	0	12	1	0	0	0	11	0	0	0
Bible	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euripides	2	2	0	0	6	0	0	2	0	0	0	0	19	0	19	0	3	1	0	0	0	2	0	0	0
Aristophanes	3	3	0	0	2	0	2	0	0	0	0	0	2	0	2	0	2	1	0	0	0	1	0	0	0
Xenophon	0	0	4	1	0	0	0	0	0	4	0	0	0	4	0	1	0	0	0	0	0	0	0	1	0
Herodotus	0	0	9	4	0	0	0	0	4	0	0	0	0	8	0	2	0	0	0	0	0	0	0	2	0
Augustine	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kant	6	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	11	11	0	19	0	3
Aeschylus	2	2	0	0	6	0	19	2	0	0	0	0	0	0	19	0	3	1	0	0	0	2	0	0	0
Thucydides	0	0	9	3	0	0	0	0	4	8	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0
Sophocles	2	2	0	0	6	0	19	2	0	0	0	0	19	0	0	0	3	1	0	0	0	2	0	0	0
Ovid	0	0	5	9	0	0	0	0	1	2	0	0	0	2	0	0	0	0	0	0	0	0	0	18	0
Hesiod	2	2	0	0	12	0	3	2	0	0	0	0	3	0	3	0	0	1	0	0	0	7	0	0	0
Diogenes	5	5	0	0	1	0	1	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	1
Heidegger	6	6	0	1	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	13	12	0	17	0	3
Derrida	4	4	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	13	0	13	0	11	0	3
Nietzsche	4	4	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	12	13	0	0	11	0	3
Pindar	1	1	0	0	11	0	2	1	0	0	0	0	2	0	2	0	7	1	0	0	0	0	0	0	0
Hegel	6	6	0	1	0	0	0	0	0	0	0	19	0	0	0	0	0	0	17	11	11	0	0	0	3
Vergil	0	0	5	9	0	0	0	0	1	2	0	0	0	2	0	18	0	0	0	0	0	0	0	0	0
Aquinas	4	4	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	3	3	3	0	3	0	0

Accumulated matrix from SOM Circling

SOM Circling	Plato	Aristotle	Plutarch	Cicero	Homer	Bible	Euripides	Aristophanes	Xenophon	Herodotus	Augustine	Kant	Aeschylus	Thucydides	Sophocles	Ovid	Hesiod	Diogenes	Heidegger	Derrida-	Nietzsche	Pindar	Hegel	Vergil	Aquinas
Plato	0	19	2	2	2	0	3	3	3	3	3	6	3	3	3	1	2	5	6	4	5	1	6	1	4
Aristotle	19	0	2	2	2	0	3	3	3	3	3	6	3	3	3	1	2	5	6	4	5	1	6	1	4
Plutarch	2	2	0	11	1	0	1	1	4	8	0	0	1	9	1	1	0	3	0	0	0	0	0	1	0
Cicero	2	2	11	0	1	0	1	1	1	3	0	1	1	3	1	1	0	3	1	0	0	0	1	1	0
Homer	2	2	1	1	0	0	6	6	0	2	0	0	6	2	6	12	12	2	0	0	0	11	0	13	0
Bible	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Euripides	3	3	1	1	6	0	0	20	2	4	0	0	19	4	19	3	3	2	0	0	0	2	0	3	0
Aristophanes	3	3	1	1	6	0	20	0	2	4	0	0	19	4	19	3	3	2	0	0	0	2	0	3	0
Xenophon	3	3	4	1	0	0	2	2	0	10	0	0	2	10	2	0	0	1	0	0	0	0	0	0	0
Herodotus	3	3	8	3	2	0	4	4	10	0	0	0	3	18	3	2	1	3	0	0	0	1	0	2	0
Augustine	3	3	0	0	0	14	0	0	0	0	0	2	0	0	0	0	0	1	2	2	2	0	2	0	19
Kant	6	6	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	17	11	16	0	19	0	3
Aeschylus	3	3	1	1	6	0	19	19	2	3	0	0	0	3	19	3	3	2	0	0	0	2	0	3	0
Thucydides	3	3	9	3	2	0	4	4	10	18	0	0	3	0	3	2	1	3	0	0	0	1	0	2	0
Sophocles	3	3	1	1	6	0	19	19	2	3	0	0	19	3	0	3	3	2	0	0	0	2	0	3	0
Ovid	1	1	1	1	12	0	3	3	0	2	0	0	3	2	3	0	7	2	0	0	0	10	0	18	0
Hesiod	2	2	0	0	12	0	3	3	0	1	0	0	3	1	3	7	0	1	0	0	0	7	0	6	0
Diogenes	5	5	3	3	2	0	2	2	1	3	1	0	2	3	2	2	1	0	0	0	0	1	0	2	1
Heidegger	6	6	0	1	0	0	0	0	0	0	2	17	0	0	0	0	0	0	0	13	18	0	17	0	3
Derrida	4	4	0	0	0	0	0	0	0	0	2	11	0	0	0	0	0	0	13	0	13	0	11	0	3
Nietzsche	5	5	0	0	0	0	0	0	0	0	2	16	0	0	0	0	0	0	18	13	0	0	16	0	3
Pindar	1	1	0	0	11	0	2	2	0	1	0	0	2	1	2	10	7	1	0	0	0	0	0	10	0
Hegel	6	6	0	1	0	0	0	0	0	0	2	19	0	0	0	0	0	0	17	11	16	0	0	0	3
Vergil	1	1	1	1	13	0	3	3	0	2	0	0	3	2	3	18	6	2	0	0	0	10	0	0	0
Aquinas	4	4	0	0	0	13	0	0	0	0	19	3	0	0	0	0	0	1	3	3	3	0	3	0	0

APPENDIX L: MAP PREFERENCES OF EXPERTS

By Area of Study

Expert #	Doctoral Degree/Expertise[3]	Category	Preference
8	Philosophy	Philosophy	PFNET
10	Information Systems/Philosophy	Philosophy	PFNET
18	Information Systems/Theology	Philosophy	PFNET
13	American History	History	PFNET
14	History	History	PFNET
19	History of Science	History	PFNET
15	20th Century US & British Literature	Literature/Language	PFNET
6	German Language and Literature	Literature/Language	PFNET
17	Comparative Literature	Literature/Language	PFNET
11	Linguistics	Literature/Language	PFNET
20	Classical Studies	Literature/Language	PFNET
1	Logic & Methodology of Science	Philosophy	SOM
16	Philosophy	Philosophy	SOM
2	History (Medieval Europe)	History	SOM
3	Information Systems/Art History	History	SOM
4	Comparative Literature	Literature/Language	SOM
5	English Literature	Literature/Language	SOM
7	English Language and Literature	Literature/Language	SOM
12	Comparative Literature	Literature/Language	SOM
9	Communications	Literature/Language	SOM

[3] Three of the experts had doctoral degrees in information systems with an area of expertise in a humanities discipline. The area of the expertise is listed after the slash "/"

By Gender

Expert #	Gender	Map Preference
8	Male	PFNET
10	Male	PFNET
18	Male	PFNET
14	Male	PFNET
19	Male	PFNET
17	Male	PFNET
1	Male	SOM
4	Male	SOM
7	Male	SOM
9	Male	SOM
15	Female	PFNET
6	Female	PFNET
11	Female	PFNET
20	Female	PFNET
13	Female	PFNET
16	Female	SOM
2	Female	SOM
3	Female	SOM
5	Female	SOM
12	Female	SOM

By Affiliation

Expert #	Affiliation	Map Preference
8	Other	PFNET
17	Drexel	PFNET
18	Other	PFNET
19	Other	PFNET
11	Drexel	PFNET
20	Drexel	PFNET
15	Other	PFNET
10	Drexel	PFNET
6	Other	PFNET
13	Other	PFNET
14	Other	PFNET
1	Drexel	SOM
4	Other	SOM
3	Other	SOM
9	Drexel	SOM
12	Drexel	SOM
2	Other	SOM
7	Drexel	SOM
16	Drexel	SOM
5	Drexel	SOM

APPENDIX M: AUTHORS ASSOCIATED WITH THE INTEREST NAMESEEDS

(Last Name – Initial(s): frequency of co-occurrence with NAMESEED in AHCI)

NIETZSCHE-F:3321	BLOCH-M:1013	JOYCE-J:1570
DERRIDA-J:532	DUBY-G:116	ELLMANN-R:284
HEIDEGGER-M:525	BOURDIEU-P:115	KENNER-H:161
FOUCAULT-M:441	LEGOFF-J:99	ELIOT-TS:135
KANT-I:382	GEERTZ-C:95	DERRIDA-J:128
HEGEL-GWF:346	FOUCAULT-M:82	GIFFORD-D:125
FREUD-S:306	BRAUDEL-F:74	FREUD-S:114
PLATO:306	LEVISTRAUSS-C:65	BARTHES-R:93
ARISTOTLE:283	WEBER-M:62	GILBERT-S:93
DELEUZE-G:235	GOODY-J:61	YEATS-WB:76
BENJAMIN-W:225	TURNER-V:58	BAKHTIN-MM:74
HABERMAS-J:211	FEBVRE-L:57	BECKETT-S:74
LYOTARD-JF:199	SAHLINS-M:56	LACAN-J:74
BARTHES-R:197	GIDDENS-A:49	BENSTOCK-B:73
RORTY-R:191	BURKE-P:48	FOUCAULT-M:72
GOETHE-JWV:189	DURKHEIM-E:47	WOOLF-V:71
ADORNO-TW:189	THOMPSON-EP:46	HAYMAN-D:66
DEMAN-P:175	DAVIS-NZ:42	SCHOLES-R:66
KAUFMANN-W:173	TILLY-C:41	SHAKESPEARE-W:64
GADAMER-HG:170	BROWN-P:40	ECO-U:63
WITTGENSTEIN-L:169	DOUGLAS-M:40	JOYCE-S:62
SCHOPENHAUER-A:159	GINZBURG-C:40	GABLER-HW:61
MARX-K:145	LEACH-ER:38	POUND-E:61
LACAN-J:139	EVANSPRITCHARD-EE:37	SENN-F:59
SARTRE-JP:136	MARX-K:37	MCHUGH-R:58

JAMES-H:1310	GEERTZ-C:2181	YEATS-WB:803
EDEL-L:164	FOUCAULT-M:288	ELIOT-TS:109
HAWTHORNE-N:88	CLIFFORD-J:267	JOYCE-J:79
BARTHES-R:81	BOURDIEU-P:263	ELLMANN-R:74
FOUCAULT-M:74	TURNER-V:240	POUND-E:55
FREUD-S:68	LEVISTRAUSS-C:181	FREUD-S:47
MATTHIESSEN-FO:67	WEBER-M:171	WORDSWORTH-W:46
JAMES-W:63	SAHLINS-M:158	BLOOM-H:45
DERRIDA-J:56	RICOEUR-P:149	JEFFARES-AN:45
HOWELLS-WD:53	DOUGLAS-M:144	SHAKESPEARE-W:44
ELIOT-TS:48	BARTHES-R:134	HEANEY-S:41
WOOLF-V:48	HABERMAS-J:132	STEVENS-W:38
BAKHTIN-MM:47	GOFFMAN-E:130	KENNER-H:37
DICKENS-C:46	WILLIAMS-R:130	NIETZSCHE-F:37
ROWE-JC:45	DURKHEIM-E:126	WILDE-O:32
TODOROV-T:45	BERGER-PL:113	KERMODE-F:31
ELIOT-G:45	DERRIDA-J:112	DEANE-S:30
GENETTE-G:44	GIDDENS-A:112	ARNOLD-M:30
SELTZER-M:43	RORTY-R:110	DERRIDA-J:30
EMERSON-RW:42	SAID-EW:109	SYNGE-JM:29
BENJAMIN-W:41	WHITE-H:108	GREGORY-A:29
MILLER-JH:40	JAMESON-F:106	BECKETT-S:29
POE-EA:38	TAYLOR-C:103	BARTHES-R:28
MELVILLE-H:38	ANDERSON-B:100	FOUCAULT-M:27
SHAKESPEARE-W:38	BLOCH-M:95	FRYE-N:27

HYMES-D:482	BORGES-JL:958	BAILYN-B:571
BAUMAN-R:100	BARTHES-R:108	WOOD-GS:157
LABOV-W:87	DERRIDA-J:93	POCOCK-JGA:143
GUMPERZ-JJ:78	FOUCAULT-M:88	MORGAN-ES:101
GOFFMAN-E:77	ECO-U:77	APPLEBY-J:85
BAKHTIN-MM:68	ALAZRAKI-J:65	GREENE-JP:78
JAKOBSON-R:59	GENETTE-G:64	NASH-GB:61
TANNEN-D:52	TODOROV-T:58	KRAMNICK-I:58
GEERTZ-C:50	RODRIGUEZMONEGA.E:57	JEFFERSON-T:56
BOURDIEU-P:49	CORTAZAR-J:54	BANNING-L:54
TEDLOCK-D:47	BENJAMIN-W:46	HARTZ-L:53
FOUCAULT-M:46	PAZ-O:45	HOFSTADTER-R:50
CLIFFORD-J:45	FREUD-S:44	BREEN-TH:49
HALLIDAY-MAK:43	BAKHTIN-MM:41	HENRETTA-JA:44
SAPIR-E:43	ELIOT-TS:40	ADAMS-J:42
ABRAHAMS-RD:42	CALVINO-I:39	DIGGINS-JP:42
BROWN-P:40	DELEUZE-G:39	SHALHOPE-RE:42
BENAMOS-D:39	WITTGENSTEIN-L:39	FONER-E:41
LEVISTRAUSS-C:36	KRISTEVA-J:36	KAMMEN-M:41
CHOMSKY-N:35	NIETZSCHE-F:36	ROBBINS-C:41
SILVERSTEIN-M:33	LYOTARD-JF:35	MCCUSKER-JJ:40
DUNDES-A:31	BARRENECHEA-AM:34	WILENTZ-S:39
SCHIFFRIN-D:31	CERVANTES:34	FISCHER-DH:38
SEARLE-JR:31	JAMESON-F:34	STONE-L:38
LEVINSON-SC:30	DEMAN-P:32	MCCOY-DR:37

HEIDEGGER-M:3494	JAMESON-F:2719	RORTY-R
DERRIDA-J:776	FOUCAULT-M:506	WITTGENSTEIN-L
KANT-I:552	DERRIDA-J:431	TAYLOR-C
NIETZSCHE-F:525	LYOTARD-JF:400	MACINTYRE-A
GADAMER-HG:477	BARTHES-R:371	NIETZSCHE-F
HEGEL-GWF:453	EAGLETON-T:340	WEBER-M
ARISTOTLE:412	BAUDRILLARD-J:309	GIDDENS-A
HUSSERL-E:407	BENJAMIN-W:301	APEL-KO
FOUCAULT-M:349	WILLIAMS-R:275	MARX-K
HABERMAS-J:331	BAKHTIN-MM:236	HABERMAS-J
PLATO:317	SAID-EW:228	HORKHEIMER-M
RICOEUR-P:288	HABERMAS-J:210	ADORNO-TW
WITTGENSTEIN-L:260	LACAN-J:205	ARENDT-H
RORTY-R:258	FREUD-S:201	RICOEUR-P
LYOTARD-JF:234	ADORNO-TW:195	GADAMER-HG
MERLEAUPONTY-M:224	KRISTEVA-J:193	HEIDEGGER-M
SARTRE-JP:209	MARX-K:189	FOUCAULT-M
LEVINAS-E:206	DELEUZE-G:180	DERRIDA-J
ADORNO-TW:205	DEMAN-P:180:	HEGEL-GWF
BENJAMIN-W:199	HUTCHEON-L:180	KANT-I
FREUD-S:193	ALTHUSSER-L:176	BORDIEU-P
DESCARTES-R:166	WHITE-H:170	LYOTARD-JF
DELEUZE-G:164	CULLER-J:165	LUHMANN-N
BARTHES-R:156	LUKACS-G:157	JAMESON-F
ARENDT-H:155	BOURDIEU-P:152	BENJAMIN-W

WORSTER-D:304	WOOLF-V:1168	KANT-I:4576
CRONON-W:73	GILBERT-SM:128	HEGEL-GWF:752
WHITE-R:64	SHOWALTER-E:113	ARISTOTLE:593
LIMERICK-PN:48	FREUD-S:109	HEIDEGGER-M:552
NASH-R:45	MARCUS-J:102	PLATO:391
TURNER-FJ:38	KRISTEVA-J:96	HABERMAS-J:385
PISANI-DJ:34	FOUCAULT-M:90	NIETZSCHE-F:382
HAYS-SP:33	BARTHES-R:76	DERRIDA-J:372
MERCHANT-C:33	IRIGARAY-L:74	HUME-D:363
HUNDLEY-N:30	JOYCE-J:72	WITTGENSTEIN-L:305
REISNER-M:29	CIXOUS-H:71	DESCARTES-R:303
CROSBY-AW:28	DERRIDA-J:69	FOUCAULT-M:270
WEBB-WP:28	ELIOT-TS:68	LYOTARD-JF:248
NASH-GD:26	MOI-T:64	GADAMER-HG:241
GATES-PW:21	BAKHTIN-MM:64	RAWLS-J:240
MALONE-MP:21	RICH-A:62	CASSIRER-E:231
MEINIG-DW:21	BELL-Q:55	ROUSSEAU-JJ:230
STEGNER-W:21	JAMES-H:48	MARX-K:228
LEOPOLD-A:20	JAMESON-F:48	RORTY-R:228
ROBBINS-WG:20	LACAN-J:48	SCHILLER-F:220
SMITH-HN:20	DUPLESSIS-RB:48	HUSSERL-E:215
BILLINGTON-RA:18	CHODOROW-N:45	LOCKE-J:210
MALIN-JC:18	EAGLETON-T:44	ADORNO-TW:209
GLACKEN-CJ:17	ELIOT-G:44	FICHTE-JG:209
WALLERSTEIN-I:17	MILLER-NK:43	GOETHE-JWV:207

DICKENS-C:1136	KELLER-C:100	WARHOL-A:191
FORSTER-J:101	GILLIGAN-C:19	BARTHES-R:12
COLLINS-P:86	CHODOROW-N:17	JAMESON-F:12
MILLER-JH:79	RUETHER-RR:16	BAUDRILLARD-J:10
JOHNSON-E:72	DALY-M:15	GREENBERG-C:9
FOUCAULT-M:71	CHRIST-CP:11	HUGHES-R:9
ELIOT-G:67	MCFAGUE-S:11	JOHNS-J:9
SLATER-M:58	HARRISON-BW:9	KOCH-S:9
MARCUS-S:56	RICH-A:9	RAUSCHENBERG-R:9
CARLYLE-T:54	WHITEHEAD-AN:9	LICHTENSTEIN-R:8
STONE-H:53	COBB-JB:7	MCSHINE-K:8
FREUD-S:49	FIORENZA-ES:7	BOCKRIS-V:7
WILLIAMS-R:49	FOUCAULT-M:6	DERRIDA-J:7
JAMES-H:46	HARDING-S:6	HUYSSEN-A:7
SHAKESPEARE-W:46	KRISTEVA-J:6	RATCLIFF-C:7
MILLER-DA:44	PLASKOW-J:6	ADORNO-TW:6
THACKERAY-WM:44	TILLICH-P:6	ALLOWAY-L:6
RUSKIN-J:42	BENHABIB-S:5	BENJAMIN-W:6
BRONTE-C:41	DAVANEY-SG:5	BOURDON-D:6
BROOKS-P:41	GOLDENBERG-NR:5	COLACELLO-B:6
WELSH-A:41	HEYWARD-C:5	COPLANS-J:6
KAPLAN-F:39	KELLER-EF:5	CRONE-R:6
BUTT-J:36	MORTON-N:5	CROW-T:6
GASKELL-E:35	RUDDICK-S:5	FOSTER-H:6
DERRIDA-J:34	SPRETNAK-C:5	FREUD-S:6

THACKRAY-A:90	LUCRETIUS:663
COHEN-IB:21	CICERO:265
SHAPIN-S:20	VERGIL:239
SCHAFFER-S:19	OVID:197
PORTER-R:17	HORACE:174
SCHOFIELD-RE:17	PLATO:145
GILLISPIE-CC:16	PLUTARCH:123
HALL-AR:16	SENECA-YOUNGER:120
KUHN-TS:15	ARISTOTLE:118
INKSTER-I:12	HOMER:111
MERTON-RK:12	PLINY-ELDER:88
CROSLAND-M:11	EPICURUS:83
GUERLAC-H:11	PROPERTIUS:78
KARGON-RH:11	CATULLUS:76
LATOUR-B:11	EURIPIDES:71
PARTINGTON-JR:11	VARRO:70
PRIESTLEY-J:11	BAILEY-C:69
DAVIDOFF-L:10	SUETONIUS:69
SARTON-G:10	AUGUSTINE:68
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Vita

Jan William Buzydlowski was born in Philadelphia, Pennsylvania, on September 12, 1957. He is a United States citizen.

Education

BA, 1979, Mathematics, Holy Family University
MA in Ed, 1984, Computer Science, Arcadia University
MS, 1992, Statistics, Temple University
PhD, 2003, Information Systems, Drexel University

Honors

2001 Belver C. Griffith Doctoral Research Award

Selected Peer-Reviewed Publications and Presentations while at Drexel University

Buzydlowski, J., White, H.D., Lin, X., Term Co-occurrence Analysis as an Interface for Digital Libraries, Lecture Notes in Computer Science, Volume 2539, pp. 133 – 144, 2002

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Balachandran, K., Buzydlowski, J. , Dworman, G. , Kimbrough, S. O., Vachula, W. , Shafer, T., MOTC: An Interactive Aid for Multidimensional Hypothesis Generation, Journal of Management Information Systems, (Special Section on Data Mining), Vol. 16 No. 1, pp. 17 - 36, Summer 1999.

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Buzydlowski, Jan W., Visualizing Repeated Measures Data in Clinical Trials Using SAS/Insight, (Invited paper for Information Visualization Section), 1996 Proceedings of the 9th Annual Conference of the Northeast SAS Users Group, pp 409-411.

Buzydlowski, Jan W., Tools for the Visualization of Patient Accrual Trends in Clinical Trials, Society for Clinical Trials Annual Meeting, May 1996.

Experience

Dr. Buzydlowski taught mathematics and computer science and served as department head at Holy Ghost Preparatory School for three years. He taught computer studies and served as department chair at Community College of Philadelphia for ten years. Jan taught operations and information management at the University of Pennsylvania for two years.

Dr. Buzydlowski worked as a biostatistician and statistical programmer for five years at the American College of Radiology.