A Citation Based View of the Ontology Community in Philosophy

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Abstract
While many bibliometric techniques have been employed to represent the structure of academic research communities over the years, much of this work has been conducted on scientific fields as opposed to those in the humanities. Here we use graphing techniques to present two networks that allow us to explore the structure of a subset of the philosophy community by mapping the citations between philosophical texts on the topic of ontology (the study of what exists). We find a citation gap between philosophers studying material and abstract objects, and between analytic and continental ontologists, but other predictions were not confirmed by this method. We conclude by considering several additional methods for further exploring both the structure of philosophy and other disciplines in the humanities.

Author Keywords
Philosophy; network analysis; citation analysis; Google scholar

ACM Classification Keywords
E.1. Data structures - Graphs and networks; H.3.4. Information storage and retrieval: Systems and software – Information networks; J.5. Arts and humanities

Introduction

Over the past couple decades several bibliometric techniques have been employed to represent the structure of academic research communities. Such network representations and analysis have been insightful, but to date most network analyses of academia have been limited to representations of the sciences rather than the humanities [2, 3, 9]. This is unfortunate, as researchers in the humanities could benefit from a more accurate understanding of the social and intellectual topology of their fields. The aim of the present research is to apply some of these bibliometric techniques to the field of philosophy while considering several additional applications of information network analysis for philosophy and the humanities.

We begin by presenting a brief overview of the intuitive picture of professional philosophy. This is the common perception of professional philosophy by professional philosophers. We use these perceptions as a set of assumptions to be compared with two citation-based representations of one sub-field, ontology, chosen because of our familiarity with the literature. The first representation is a graph created using citations of 2,260 articles on the topics of material and abstract objects (ontology) retrieved from Google Scholar. The second filters the first graph to only include instances of co-citation. We highlight features of these networks of interest to philosophers and compare our results with the common self-image of philosophers. What we take to be the philosopher's self-image turns out to be generally accurate but mistaken on several specific points. We conclude by considering several methods for further exploring the structure of philosophy and other disciplines in the humanities.

Philosophical Communities: An Intuitive Overview

Contemporary philosophy is thought to be divided into two communities: analytics and continentals. Analytic philosophers tend to be more concerned with symbolic representation, formal argumentation, scientific evidence, semantics, and conceptual content [4, 6]. Thus, analytic philosophers tend to engage more with linguistics, mathematics, physics, and cognitive science. In contrast, continental philosophers tend to engage more with history, literary theory, political theory, and the fine arts. Continental philosophy includes the traditions of critical theory, existentialism, phenomenology, and post-structuralism [8]. In general, philosophers conceive of the analytic/continental divide as marking a strong communication barrier between two distinct communities of philosophers.

Along with these methodological differences, philosophers within both groups specialize into sub-communities based on their areas of interest. The basic divide is between descriptive and normative fields. Descriptive fields include metaphysics (the study of existence), epistemology (the study of knowledge), philosophy of mind, philosophy of science, logic, philosophy of mathematics, and the philosophy of language. Normative fields include ethics, legal and political theory, and aesthetics (the study of art and beauty).

Our study targets articles written on the topic of objects. 'Objects' should be understood in a broad sense to include every entity in existence, rather than the ordinary sense of 'objects' which is limited to medium sized dry goods. This potentially includes abstract objects (e.g., numbers, concepts, fictional

characters) and physical objects (e.g., electrons, people, the universe). Ontologists, a sub-set of metaphysicians, are in the business of studying such objects. Ontology is more popular in analytic circles, but influential continental philosophers (e.g., Heidegger, Levinas) have also written on ontology.

Based on these observations we predict that ontologists will engage primarily with other metaphysicians and very little with ethicists or continental philosophers. To the extent that they engage with non-metaphysicians, we anticipate most of their interactions are with logicians, philosophers of physics, and philosophers of mind. We also predict that philosophers writing on ontology fall into two sub-communities, those writing on physical objects and those writing on abstract objects, because of the intuitive distinction between physical and abstract objects.

To test our hypotheses about the philosophers with publications in the Objects category, we use data from Philpapers, an online archive of philosophical texts [7]. Therein, over 500,000 texts have been archived and categorized either automatically, by direct author submissions, or by one of approximately four hundred editors. This corpus allows us to get a (potentially) less biased view of ontologists to see whether they are mistaken in their perception of the communication structure of the field, just as philosophers have been shown to be mistaken about the popularity of some philosophical theories [1]. In the following section we show two networks that indicate that at least some of these common opinions about the structure of the philosophy community may be incorrect.

	Object Sub-categories
1	Abstract Objects
2	Identity
3	Material Objects
4	Mereology (the study of composition)
5	Ontology of Mathematics
6	Minor Entities
7	Non-existent Objects
8	Objects and Properties
9	Persistence
10	Objects Miscellaneous

Table 1. The ten sub-categories in the Objects category on Philpapers

A Citation-based Network Representation of Material & Abstract Objects

The structure of an academic community can be captured by several measures, such as conference attendance, co-authorship, citation, and surveying academics directly. We focus our attention on citations because this data is readily available and a reliable indicator of intellectual influence. Measuring all citations in philosophy would be an immense project, both because of the sheer number of citations and because of practical difficulties in obtaining accurate and current citation data. Due to these limitations, we focused on a small sub-set of philosophy articles, those listed under the Objects category on Philpapers, which consisted of 2,260 papers in ten sub-categories (see Table 1). These articles span from the 1920s to the present, but most were published in the last two decades. This particular category was chosen because one of us specializes in this area of philosophy.

To collect data, a script was written to first get the original papers from Philpapers; then their citations were automatically retrieved from Google Scholar. This data was cleaned to identify single authors with multiple labels (e.g., W Quine and WVO Quine were treated as identical). A network was constructed consisting of nodes representing the authors of those papers. In instances where a paper was co-authored by *A* and *B*, and cited by *C*, we treated this as two directed edges (*A*-*C* and *B*-*C*). This results in 66,146 citations. Where *A* cited *C* multiple times, duplicate edges were removed and the single edge between *A* and *C* was assigned additional weight (edge weight = number of citations). The final citation network can be seen in

	Cluster name
1	Material Objects Nominalism
2	Material Objects Mereology and Identity
3	Philosophy of Language
4	Material Objects Identity
5	Personal Identity
6	Critical Theory
7	Personal Identity and Morality
8	Psychology of Object Cognition
9	Phenomenology
10	Logic and Philosophy of Math
11	Philosophy of Math
12	Philosophy of Math

Table 2. Names of clusters depicted in Figure 1.

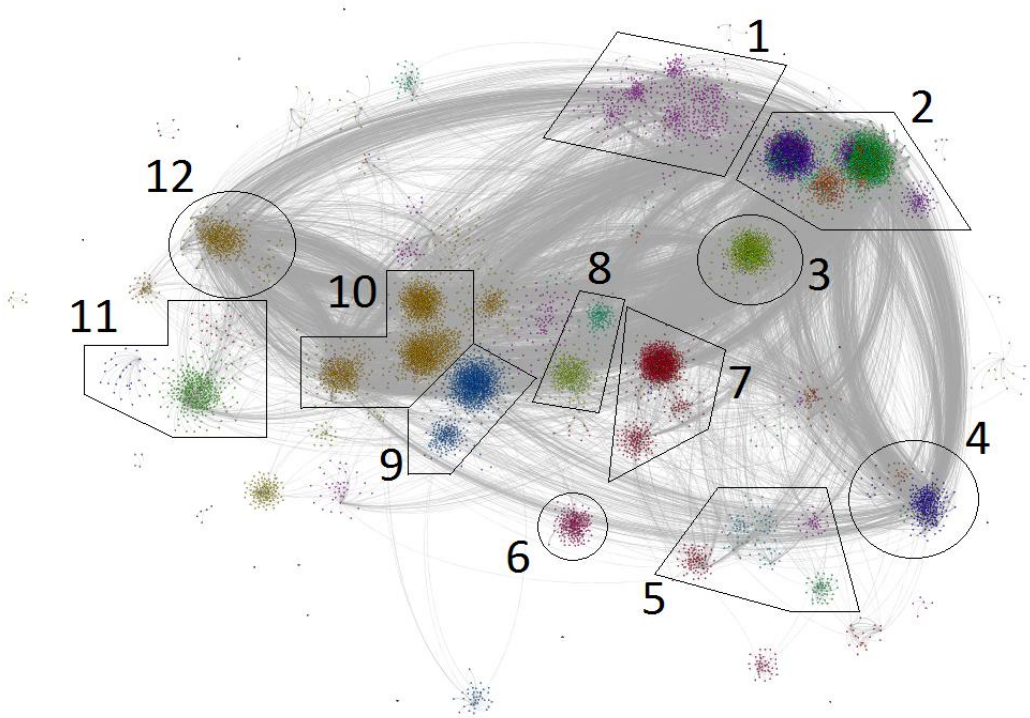

Figure 1. A Citation-based network of philosophers writing on material and abstract objects. Twelve of the largest clusters are labeled. Node color is based on groups as defined by Gephi's modularity measure.

Figure 1 where the graph is visualized using the OpenOrd layout in Gephi [5], which is a force-directed layout algorithm based on the Frutcherman-Reingold algorithm that scales nicely for large-scale undirected graphs. Twelve of the largest clusters found are labeled in Figure 1 and named in Table 2 based on our judgment of the general theme amongst the most significant texts in each cluster.

We predicted that the network in Figure 1 would consist of two large, central groups, corresponding to discussions of abstract and material objects, but the actual citation network does not reflect this prediction. Theorists concerned with material and abstract objects tend to cluster together, but there are multiple clusters surrounding both topics and topics that do not naturally

	Cluster name
1	Artifacts
2	Material Objects
3	Technical Discussions of Material Objects
4	Matter and Physics
5	Vagueness and Material Objects
6	Vagueness and Parthood
7	Logic and Philosophy of Math
8	Philosophy of Math
9	Logical Fictionalism and Structuralism
10	Object Identity

Table 3. Names of clusters depicted in Figure 2.

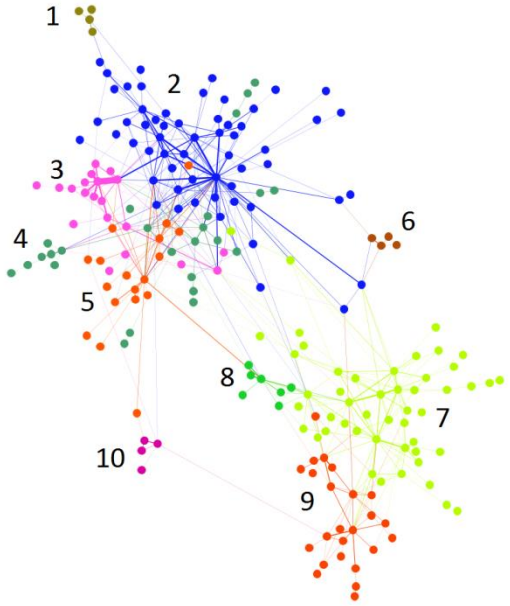

Figure 2. A force-directed layout of the co-citation network of philosophers in the Objects field. Node color is based on groups as defined by Gephi's modularity measure.

fit into either category, such as 3 and 6-9. This result was not anticipated. In addition, the prediction that continental and normative philosophy would not be significantly represented was not confirmed. Both continental (6, 9) and normative (5, 7, 9) philosophers are represented in this network. However, the primary editor for Philpapers' Objects category removed the book generating group 6 after using our results to detect misclassified material, leaving only one major continental author (Levinas, group 9) in this analysis. This indicates that the Objects archive has a strong analytic bias. With this qualification in mind, less than ten citations were found between analytic and continental ontologists. However, hundreds of citations related ontology to normative fields such as ethics and meta-ethics, particularly in groups 2 and 7. Lastly, we predicted a strong communication bridge between ontology and logic, philosophy of mind, and philosophy of science. Our results show strong connections between ontology and logic (10) and between ontology and philosophy of science (2, 4), yet there are few connections between ontology and philosophy of mind.

Because of these unexpected results, we wanted to focus our attention on communication even further by filtering the data to only consider co-citation. That is, we only included edges between *A* and *B* if *A* cites *B* and *B* cites *A*. Bidirectional citation is a more reliable indicator of communication because it indicates a two-way relation of intellectual influence. After removing nodes disconnected from the primary component, the resulting network included 964 citations (482 edges) between 215 philosophers. From this data we created the graph in Figure 2 displayed using Gephi's ForceAtlas layout (see Table 3 for cluster names).

As expected, the co-citation graph in Figure 2 confirmed the conjectures about the separation of those who study abstract objects and those who study material objects. The nodes in groups 1-6 and 10 are those philosophers who specialize in topics concerning material objects, and nodes in groups 7-9 represent philosophers specializing in the ontology of abstract objects. Author grouping was still sensitive to their more specific interests, but this indicates that the intuitive distinction between material and abstract objects discussions is reflected in the actual

communication structure. Historically significant authors (e.g., Frege and Russell, Figure 1 group 10) disappeared because they cannot cite contemporary figures, and non-ontologists (e.g., Parfit, Figure 1 group 7) disappeared because they do not cite the ontologists who are citing them. This affected the identities of the major clusters, removing most philosophers prior to the 1970s and those from other sub-disciplines. Interestingly, material and abstract objects are related primarily by discussions concerning identity (10), the ontology of physics and mathematics (5, 8), and the realism/anti-realism debate (2, 7).

Conclusions and Future Work

We have shown two depictions of a sub-community in philosophy. We confirmed that there is a separation between philosophers studying material objects and abstract objects. Our prediction that ontologists have very little communication with continentals was confirmed, though this may simply reflect a biased sample of texts. We also predicted little communication between ontologists and normative theorists, but we were surprised to discover significant communication between ontologists and ethicists. We anticipate that much could be gained by expanding this type of citations-based network analysis to all of philosophy and to other humanities disciplines.

We also anticipate that related applications of network analysis - networks based on the topical categorization of articles, co-authorship, keyword co-occurrence, and relations between philosophers based on their reported opinions on philosophical questions - and other techniques could be used to generate additional, informative representations of philosophy and other research communities in the humanities.

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