Visualizing Scientific Paradigms: An Introduction

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This special topic issue includes a collection of seven articles on visualizing scientific paradigms. All articles in this special issue reflect the influence of Thomas Kuhn's structure of scientific revolutions on our understanding of the growth of scientific knowledge. On the other hand, each article represents a unique perspective of how one may pursue the quest for transforming something as intangible and empirically evasive as invisible colleges and competing paradigms into something that is more accessible and traceable to scholars and professions of various disciplines, ranging from historians, philosophers, and educators to scientists and engineers.

The opening article is Henry Small's personal account of the endeavor in probing scientific paradigms using science mapping. His article, entitled "Paradigms, Citations and Maps of Science: A Personal History," provides a valuable introduction to the key issues involved in this area and reveals an overview of promising avenues as well as challenging routes. He identifies an emerging trend that reflects and redefines Kuhn's paradigms and emphasizes the empirical viability of research methodologies in understanding the growth of scientific knowledge. He suggests that revolutionary and normal science should be seen as extremes on a continuum of rates of change rather than, as Kuhn originally asserted, as an all-or-none proposition.

The second and third articles take a prominent historical perspective in depicting the evolution of scientific citations. Eugene Garfield and his collaborators' article is entitled "Why Do We Need Algorithmic Historiography?" They explain the rationale for creating HistCite, their new program that produces historiographs of scholarly topics. These historiographs help analysts and historians identify key events, people, and journals in a particular field. Scholars can evaluate the evolution of a scientific paradigm by studying the genealogic profile of such evolution.

The third article is entitled "Timeline Visualization of Research Fronts." Steven Morris and his colleagues focus on temporal changes in research fronts and explain the power of timeline visualizations. They first cluster documents into research fronts based on bibliographic coupling and then visualize research fronts using horizontal timeline tracks. Documents from research fronts are plotted along corresponding timeline tracks. Because time line visualizations can reveal temporal relations among research fronts and their member documents, time lines are potentially useful tools in identifying new research fronts as well as existing research expertise and research excellence.

Although both the fourth and fifth articles have connections to Pathfinder networks, they address different topics. Howard White's article, entitled "Pathfinder Networks and Author Cocitation Analysis: A Remapping of Paradigmatic Information Scientists," clarifies an important methodological issue, whereas Chen and Kuljis focus on a general framework for visualizing scientific paradigms in their article.

Author Cocitation Analysis (ACA) is a long established methodology for studying intellectual structures. Researchers have routinely used Pearson correlation coefficients rather than raw cocitation counts as the measure of similarity between author pairs. Howard White compellingly demonstrates the advantages of using raw cocitation counts in Pathfinder network visualizations of author cocitation structures. He compares Pathfinder networks of the information scientists derived from raw cocitation counts and Pearson correlation coefficients, respectively.

In the fifth article "The Rising Landscape: A Visual Exploration of Superstring Revolutions in Physics," Chen and Kuljis introduce a general framework for visualizing the growth of scientific paradigms based on Kuhn's theory on scientific revolutions. They illustrate the use of this framework in a case study of superstring revolutions in physics. The evolution of cocitation networks is depicted and explained through animated visualizations of citations and cocitation links. Visual-spatial properties as well as structural patterns associated with superstring revolutions are identified.

The sixth and seventh articles deal with heterogeneous data sources. In their article entitled "Indicator-Assisted Evaluation and Funding of Research: Visualizing the Influ-

ence of Grants on the Number and Citation Counts of Research Papers," Kevin Boyack and Katy Börner report their research on analyzing and visualizing the relationship between the funding level and intellectual outputs of research, namely the quantity of research publications and their citations. They analyze grant and publication data from one of the research programs at the National Institue on Aging (NIA) using the VxInsight® system developed at Sandia National Laboratories.

The title of the seventh article is "Simultaneous Mapping of Interactions between Scientific and Technological Knowledge Bases: The Case of Space Communications." Emmanuel Hassan examines the knowledge structure of space communications using a combined methodology based on scientific publications and patent data. His work focuses on the need of visualizing scientific and technologic structures of knowledge simultaneously. A bibliometric map is constructed to depict research and development activities in Triad countries, which include the United States, Japan, and the European Union countries.

I hope that this collection of articles will stimulate more studies on this fascinating topic and more applications of research findings, methodologies, and techniques in a wider variety of real-world settings.