Measuring the Interdisciplinarity of Technology based on Knowledge Flows in Patents: a Case Study in Synthetic Biology

Knowledge is power and it is flowing. The flow of knowledge plays a central role in a wide variety of fields (Rogers Everett, M., 1995). With the development of information technology, technology knowledge is becoming an increased focus on the research on knowledge flow. Technology fusion is recently becoming a mainstream phenomenon which provides a definite path to innovation by creating new inventions with the convergence of diverse technologies (Jin, J. H. et al., 2011), whose essence is still the flow of technology knowledge. As science and engineering research advances beyond the boundaries of single disciplines, many scientists have realized the potential of Interdisciplinary Research (IDR). Woodworth was possibly the first person to use the expression ‘‘interdisciplinary research’’ in public (Frank, R. et al., 1988). Technological boundaries have become blurred, and thus outstanding inventions do not appear within a single technological field anymore but rather between technological fields (Hacklin, F. et al., 2009). Therefore, technology interdisciplinarity based on knowledge flow is paid attention in our paper, especially the measure for interdisciplinarity of technology.

A knowledge flow represents knowledge-needs and its referencing behavior. (Chu, K. C., & Yeh, C. C., 2016), which is reflected in citation relations. A citation implies that there is knowledge flow between the citing article and the cited article. Such citations form a knowledge flow network that enables knowledge to flow between different scientific projects to promote interdisciplinary research and scientific development (Lai, C. H., & Liu, D. R., 2009). Based on this, many researchers paid more attention to measuring interdisciplinarity. The diversity concept (Stirling, A., 2007; Magurran, A. E., 2013.) and social network indicators (Leydesdorff, L., 2007; Rafols, I., & Meyer, M., 2010) are also used for measuring interdisciplinarity. Despite many researches on the interdisciplinarity of publications across subject categories, there are a few studies to analyze interdisciplinarity of technology from the perspective of knowledge flow. Ko, N et al. analyzed interdisciplinary trends of technology convergence from an industry-wide perspective (Ko, N., Yoon, J., & Seo, W., 2014). Their method constructed indicators for measuring interdisciplinarity using indegree and outdegree from a view of statistics, but ignored the diversity of technology categories and the similarity between them, which will be all taken into consideration in our method following.

In this paper, we present a procedural method to analyze citation-based interdisciplinarity by measuring technology knowledge flow of patents. The method constructs a technology knowledge flow map that shows knowledge flows among IPC codes, and can also represent it in the form of technology field knowledge flow map by exploiting the concordance between IPC codes and technology fields. In order to measure the degree of technology interdisciplinarity in a special research system, we propose the indicators of integration(I), diffusion(D) and specialization(S) in publications (Porter, A. L. et al., 2007; Porter, A. L. et al., 2008; Wang, X et al., 2017), and apply them to patents data. What’s more, we output a visual interdisciplinary map to interpret the interdisciplinary impact and interdisciplinary causality of technology at the end of our method. The framework for this paper is shown in Fig.1.

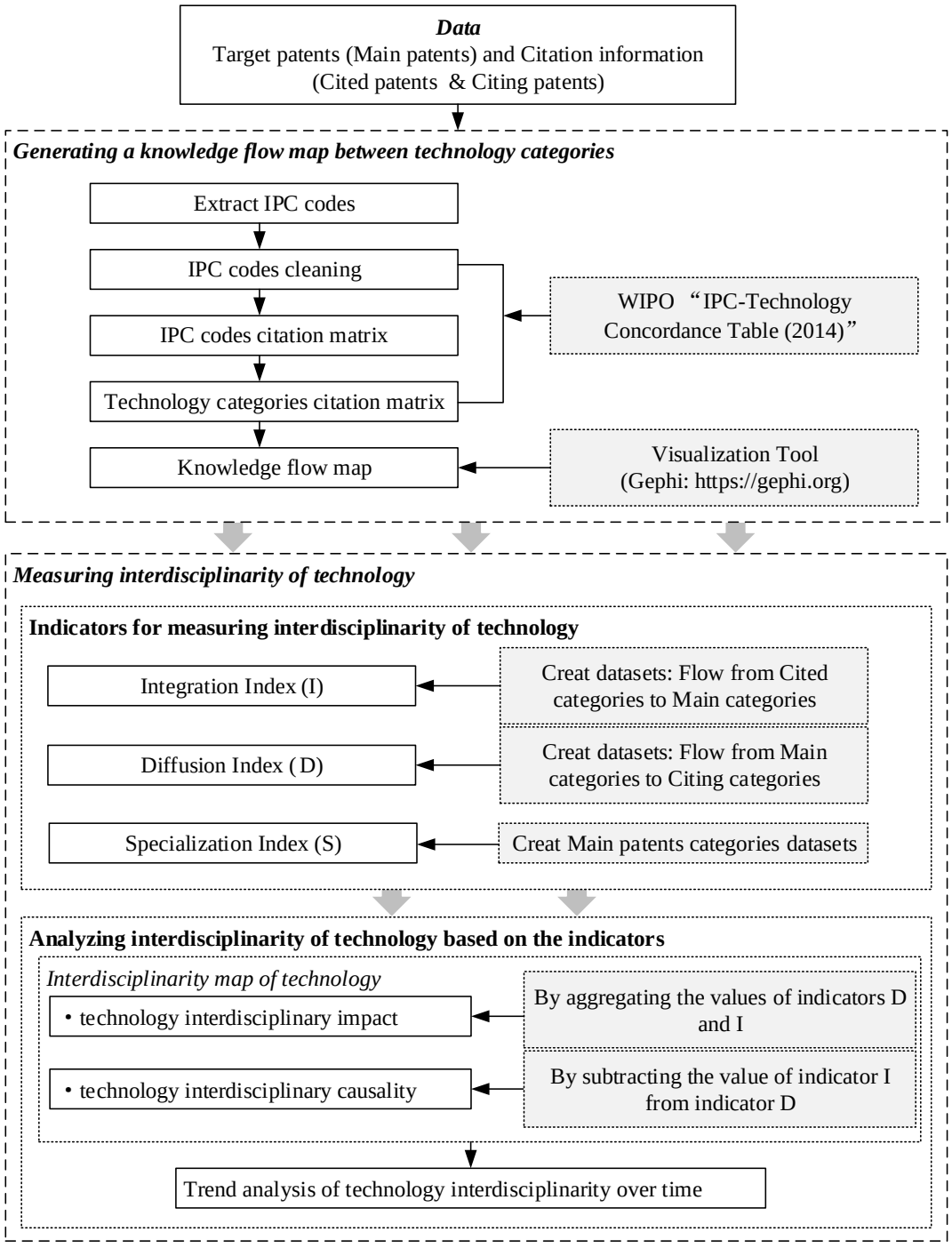

Fig.1 The framework of research on interdisciplinarity of technology

The presented method is illustrated using patents related to synthetic biology. The result shows that synthetic biology is an active interdisciplinary technology, both originated from a number of technology categories, and also feedback to these categories. The assignees in this technical field play different roles in the process of knowledge flow of technology, and most of them, especially TYCO HEALTHCARE GROUP LP (COVI-C), MASSACHUSETTS INST TECHNOLOGY (MASI-C) and HARVARD COLLEGE (HARD-C), the representatives of Industry-University-Research, are of absolutely high interdisciplinary impact and positive interdisciplinary causality, which can be considered to play representative roles as knowledge sources involved in active technical exchanges by mainly providing external features to create

value. In this way, we consider that our method for interdisciplinarity is valid. Furthermore, we expect that the method will be incorporated to become a basis of systematic systems for assess interdisciplinarity of technology and support technology exports to conduct knowledge-intensive technology planning activities.

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