Discovering potential application areas for technology using function-based SAO semantic analysis

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Technology application is one of the most important links in technological innovation process. With the current acceleration of disruptive and convergent technologies, a single technology can often have a wide range of applications. For example, artificial intelligence, block chain, Internet and other technologies are widely penetrated and applied in various industries and fields, including agriculture, communication, medical care, education and other areas, thus generating a transformative and disruptive impact. It is worth noting that behind the revolutionary emergence of new technologies, application fields transfer and the rapid growth in new fields play a key role (Adner and Levinthal, 2002). At the same time, exploiting existing technology is also an effective technology strategy for enterprises (David, 1988; Yoon et al., 2015). Not only can companies try to acquire external technology and quickly apply the technology that has been developed without or with lower risk of R&D failure, but also profit by transferring the internal technologies to external company and even external field. With such advantages, technology application opportunities can help enterprises reduce risks and obtain profits, as well as expand their application scope and transformative impact either. However, how to discover potential application areas of a technology is often an important question to be solved in the practical management.

Technology opportunity discovery (TOD) basically includes two types of activities undertaken: to identify new applications of existing technologies, or to predict new and emerging technologies (Yoon et al., 2014). In previous research, there are already some TOD related work done on exploring potential application areas of existing technologies. For example, Park et al. (2013) proposed a function-based patent analysis to link technologies with the outside industries, to explore cross-domain application opportunities. By constructing functional linkage between technologies and products, Yoon et al. (2015) have identified the potential applications of internal existing technology to external products, and the applications of external existing technology to internal products as well. Kim et al. (2019) have built a framework of SAOx extraction to mine the purposes and effects that technologies can achieve, to help explore convergence with other technologies across areas. To sum up, it is an effective way to explore potential application areas of technology through functional information. However, current research mostly focused on the existing links between technologies and functions, there is still a lack of research on hidden, yet-to-be-achieved but great

potential links among these elements, which is also important especially in today's high integration and multi-field application situation.

To solve the above question, this research proposed a comprehensive research framework for discovering potential application areas using function-based SAO semantic analysis. There are two types of technology application opportunities discovered in this research. One is explicit application opportunities, the other is implicit application opportunities. Their difference is shown in Fig.1. For T1 in firm A, functions like A3, A4 that have been achieved in the whole field but not achieved by firm A are explicit application opportunities, while function A6 that has not been achieved by the whole filed but has great potential is an implicit application opportunity.

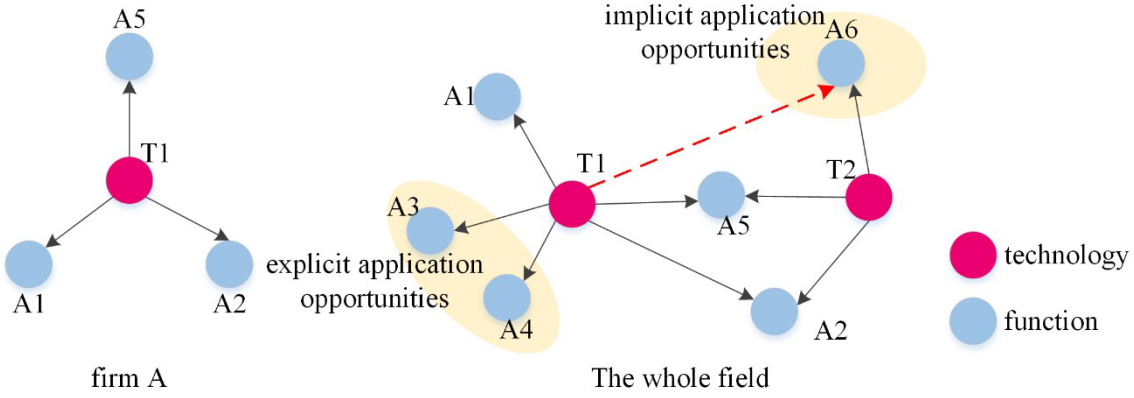

Fig.1 Schematic diagram of explicit and implicit application opportunities of technology

Fig.2 presents the whole process of this research. First, the SAO structures are extracted from the titles and abstracts in patent documents based on the SAO semantic analysis. By screening the A-Os that characterize functional information, their corresponding SAOs are mined as technology-function pairs. Second, bi-layer technology-function network is constructed based on their co-occurrence relationship. In this process, considering that this study aims to discover the association between technologies and functions, only the technology-function links in the network are retained to reduce network redundancy. Third, both explicit and implicit technology application opportunities are detected for a certain innovator C. By comparing bi-layer technologyfunction network for innovator C, and the whole field, explicit technology application areas (functions that have been achieved in the whole field but not achieved by innovator C) for technologies owned by innovator C are detected. By using Node2vec and link prediction, functions that has not been achieved by the whole filed but has great potential are discovered, and those functions for technologies that owned by innovator C are its implicit application opportunities.

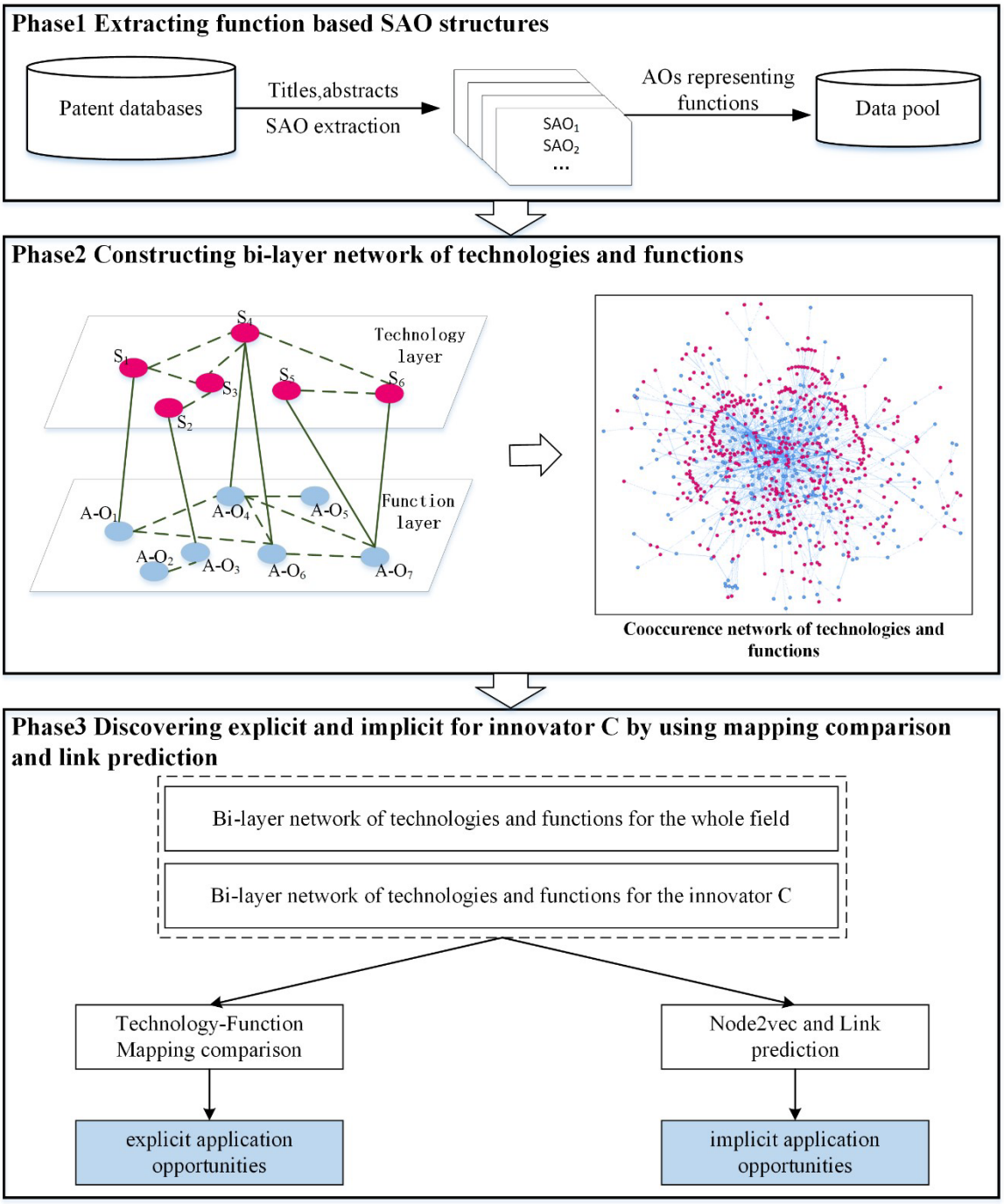

Fig.2 The research framework

This paper uses a patent dataset of immunotherapy technology as a case study, in which explicit and implicit application opportunities are explored for patent assignees. An example of results is shown in Fig.3. Bi-layer technology-function networks of kinase inhibitor for JOHJ-C, INYT-C, MERI-C, ABBO-C as well as the whole field are constructed to help find their explicit application areas. The case study of immunotherapy technology has demonstrated the reliability and practical meaning of our research framework.

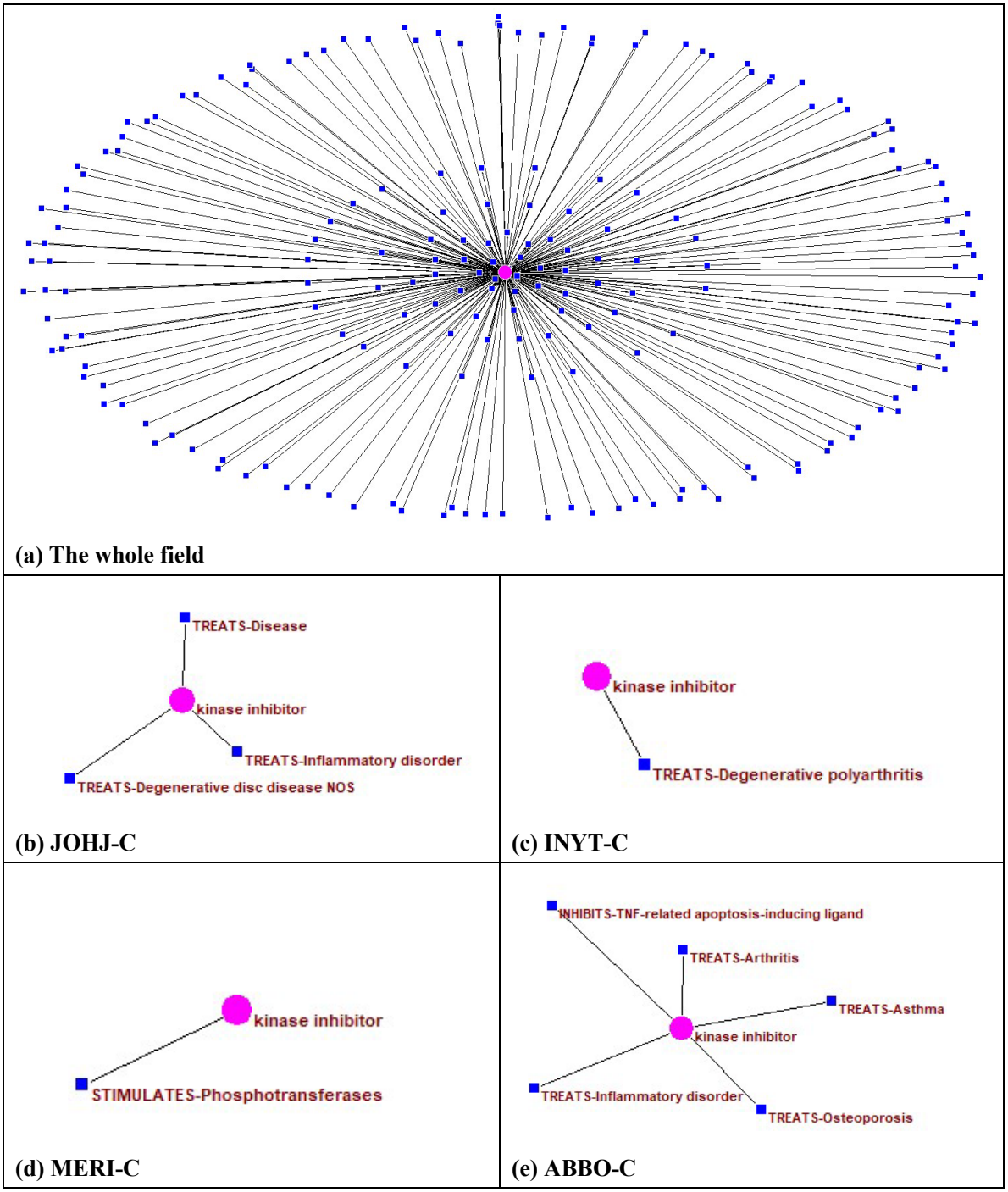

Fig.3 Mapping comparison of the patentee's explicit application opportunity for the technology point kinase inhibitor

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