

Technology Complementarity Measurement on Enterprise Level Based on Technical Topics

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With the rapid economic growth and constant changes in social needs, the complexity of new products is constantly increasing. For some emerging industries, the cumulative features of technological innovation are significant and often need to be introduced complementary technologies to develop new products and services, which can promote many major technological innovations and is also important for enterprises to seek technically complementary collaborators. Makri. M. considered technology complementarity refers to the extent to which two patent subjects focus on different narrow technical areas in their common general technical field (Makri M, Hitt M A, Lane P J, 2010). The measurement of technology complementarity is mainly as follows: Makri. M proposed that technology complementarity is operationalized as the overlap in patents in the same subcategory but in a different class. Ming-Yeu Wang proposed the association analysis to mine complementary technology areas among various technologies based on IPC (Wang M Y, 2012). P. C. Chang designed the common external indicators to describe the technology complementarity between the two enterprises from the perspective of the citation relationship (Chang P C, 2014). However, research on technology complementarity is relatively weak especially in terms of quantitative measurement of the complementarity of patent technologies on enterprise level, which is essential to enterprises selecting collaborators. What's more, studies that quantitatively measure the complementarity of patent technologies are mainly based on IPC classification codes and patent citations, which have some problems such as lacking of accuracy and timeliness. To overcome these shortcomings, we choose to proceed from the

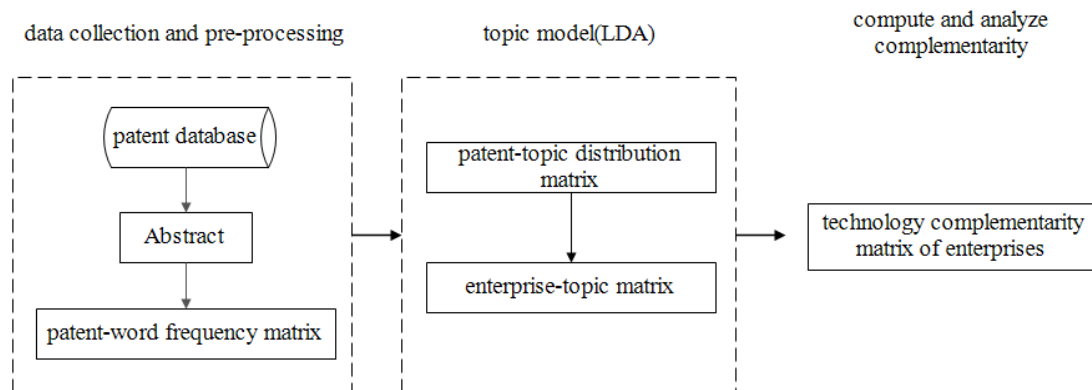
contents of patent texts, based on the technical topics, to make some attempts to measure the technology complementarity on enterprise level.

We propose a framework combining two exploratory analysis procedures to measure the technology complementarity on enterprise level. Firstly, we use LDA topic model to identify technology topics, then we get the enterprise-topic matrix, which indicates the technical strength of each enterprise in each technical topic and also expresses the attention of enterprises about technical topics. Secondly, a technology complementarity measurement on enterprise level is proposed based on the definition of technology complementarity, which means that technical complementarity is the degree to which their technological problem solving focuses on different narrowly defined areas of technology within a broadly defined area of technology that they share. The measurement is as follows:

$$\text{complementarity}(A \leftarrow B : \text{complementarity of } B \text{ to } A) = \sum_{c=1}^n \left(\frac{\text{TN in } C_i \text{ of } B - \text{TN in } C_i \text{ of both } A \ \& \ B}{\text{TN in } C_i - \text{TN in } C_i \text{ of } A} \times \frac{\text{the PN in } C_i}{\text{PN}} \right)$$

Where TN is the number of topics, C is the technical classification that from industry analysis report, PN is the number of patents. We finally obtain a technology complementarity matrix of enterprises, which intuitively display the technological complementarity among enterprises.

The specific framework is as follows:



This paper uses a patent dataset of 3D printing technology which is a kind of innovation and high technology industry as a case study. Taking a certain target enterprise as an example, a list of complementary enterprises ranking with the target enterprise is obtained, based on the technology complementarity matrix of enterprises that We finally get. According to the value of technology complementarity between the target enterprise and other enterprises, enterprises that are complementary to the target enterprises are divided into three levels—strong, medium and weak in technology complementation with the target enterprises. This method has made some attempts to measure the complementarity of technologies on enterprise level

quantitatively, which is currently relatively weak. It make it is possible to visually demonstrate the technology complementarities on enterprise level to provide guidance for enterprises to select partners. It also enriches the quantitative measure of technology complementarity.

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