

# R&D trend analysis based on patent mining: an integrated use of patent application and invalidation data

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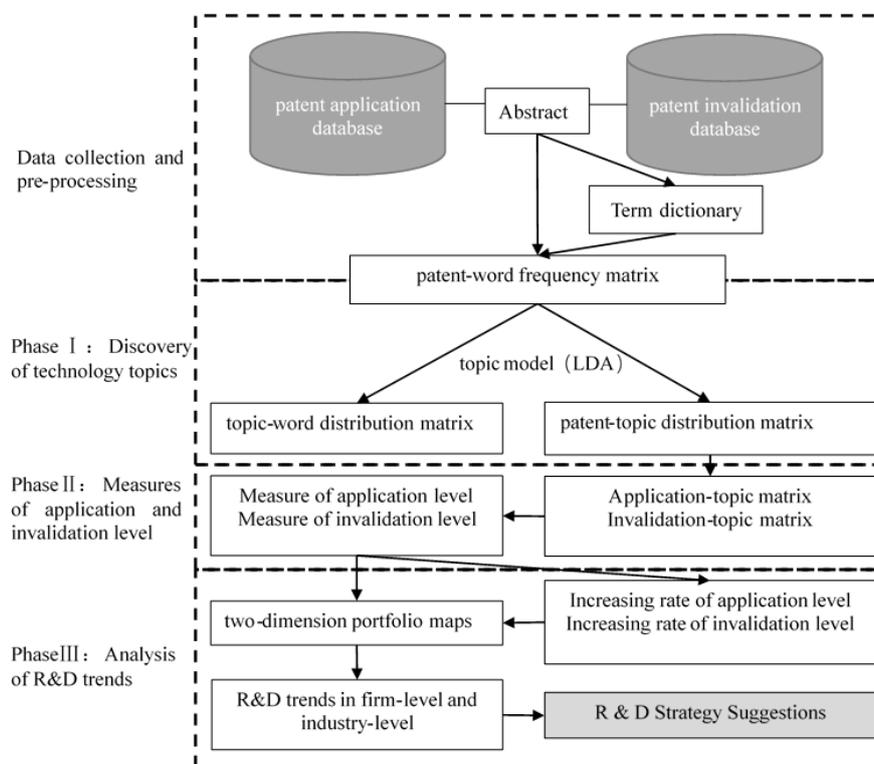
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Technology innovation is fundamental for successful enterprise development. Technology opportunities analysis(TOA), which was first proposed by Porter and Detampela (1995), can discover opportunities for technology innovation. But previous studies of TOA mostly focus on a specific technology and discover its technology vacancies through methods such as morphology analysis(Yoon & Park, 2005), semantic analysis(Choi, Yoon, Kim, Lee, & Kim, 2011). While few studies focus on innovation decision, the first step of technology innovation, which is very important to an enterprise, especially a newcomer of the industry to decide a reasonable R&D orientation and formulate its R&D strategy. To discover a suitable innovation direction, an enterprise should find out its competitors' R&D strategies and the R&D trend of the industry it is involved in, which is the problem we try to solve.

Furthermore, almost all the previous studies of TOA have ignored patent legal status, which is of great significance in technology trend identification. For example, it can't be distinguished without the amount of patent invalidations whether the technology is in decline or just encounters a bottleneck when the amount of patent applications drops sharply. If the amount of patent invalidations increases rapidly, the technology is likely in decline, otherwise it may just be in the bottleneck. Taking patent invalidation into consideration can identify which technologies enterprises give up, for more than half of the invalidations in China are due to applicants' initiative. Not only emerging technologies but also updating and declining technologies can be discovered.

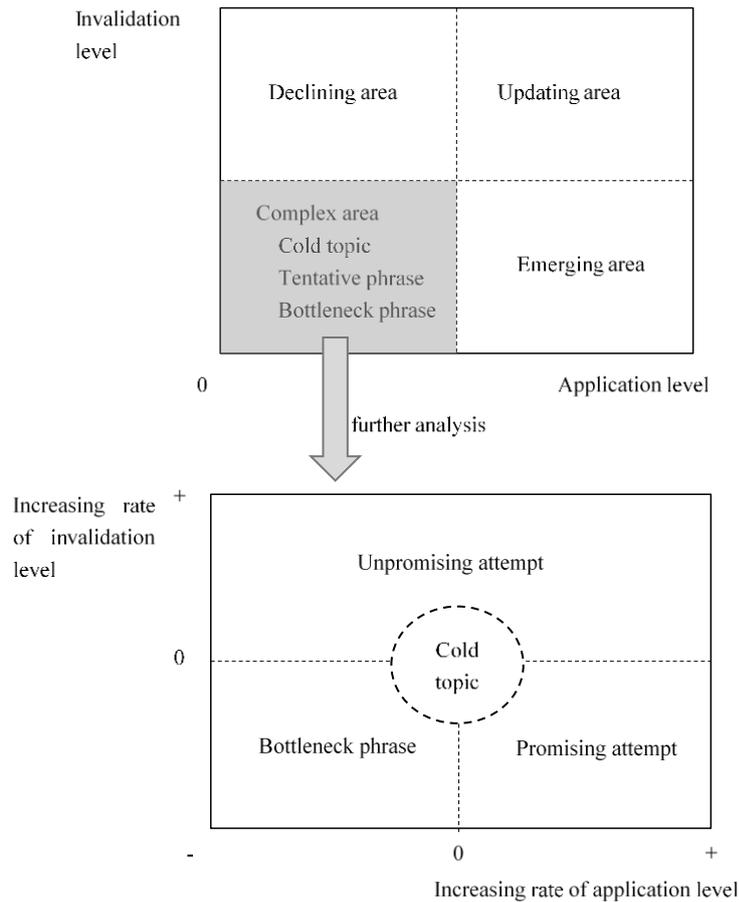
We propose an approach to analyze R&D trends customized to a whole industry based on both patent application and invalidation data. Firstly, LDA topic model(Blei, Ng & Jordan, 2003) is adapted to identify technology topics of each patent. Secondly, we construct two measures to evaluate application and invalidation level of each technology topic. Thirdly, a two-dimension portfolio map is used to show scatter plots of technology topics. According to the values of application and invalidation measures, the map is divided into four areas, three of which present

emerging (high-application, low-invalidation), updating (high-application, high-invalidation) and declining (low-application, high-invalidation) stages of a technology topic. The remaining fourth area (low-application, low-invalidation) is further analyzed by calculating increasing rates of application and invalidation. Fig.1 shows the whole process of the approach.



**Fig.1 Research framework**

Electronic Information Industry of China is taken as a practical application to our approach. According to values and increasing rates of patent application and invalidation level, we expect to draw scatter plots of technology topics as Fig.2 to analyze R&D trends. Then advice on enterprises' R&D strategic planning can be provided. Technologies in emerging area are R&D focuses of competitors, which are not advised for other enterprises to choose as the main R&D directions, for the market may have been already occupied by competitors. Technologies in the updating area are not outdated but need to be updated. Enterprises with strong R&D competence can try to discover more promising updating directions in these technological areas, while enterprises without enough R&D strength can mining core invalidated patents, which have lost legal protection, to apply in their own productions. In declining area are technologies abandoned by competitors, which might be outdated or encounter technical bottlenecks. Enterprises with enough R&D strength can explore whether there is still market prospect or whether the bottleneck can be breakthrough. The remaining complex area can be further analyzed by calculating the increasing rates of application and invalidation measures. According to the positive and negative properties of increasing rates, cold technologies, technologies in tentative stage (including promising attempt and unpromising attempt) and technologies in bottleneck stage can be distinguished.



**Fig.2 Expected results**

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