Tech mining for monitoring technology trends: related methods, sources and software tools

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Background and purpose of the study
The quantitative methods are increasingly being used in the studies devoted to monitoring technology trends. It is caused by the need for validation of expert assessments with empirical data through searching for implicit signs of technological change in large amounts of information. Tech mining as a special form of "big data" analytics is becoming especially popular in FTA. In the context of information overload and limited resources, the question is how to use tech mining in combination with other related methods on different stages of technology monitoring, what sources of information to select and how to automate this process in order to increase its efficiency. This paper performs a quantitative analysis of tech mining approaches that can be used in technology monitoring: it provides the overview, dynamics and potentials for existing and advanced tech mining tools and related techniques; identifies the main groups and combinations of methods; studies the possibilities of using them on different stages of technology monitoring; and provides a discussion on the factors that could influence the choice of suitable tech mining techniques for technology monitoring purposes. The results are considered to be taken as a guide for researchers, practitioners or policy makers involved in an FTA activity.

Methodology
For the purpose of this study the collection of conference proceeding was created using the abstracts of the GTM participants' presentations made in recent 5 years (2011-2015). This collection was created using structured and unstructured data for creating the following fields: title, year, abstract, keywords, country, organization. Data were processed (cleaned and grouped), analyzed (based on the keywords co-occurrence) and mapped with Vantage Point software. The analysis was conducted in 3 iterations through discussions with experts. Thus, the tech mining proceedings were processed with quantitative methods, providing the approach "tech mining for analyzing tech mining".

Conclusions
As a result of this study, the evolution of tech mining approaches to monitoring technology trends (from the point of methods, sources and tools) used by different authors in 2011-2015 was studied using quantitative data processing (bibliometric analysis, natural language processing, statistical analysis, PCA). The tech mining and related methods were divided into two groups: main (bibliometrics for structured data, text mining for unstructured data) and auxiliary (for example, network analysis, cluster analysis, trend analysis) methods, and the most frequently used combinations of them were studied. Key trends and weak signals concerning to the use of existing and emerging methods in technology monitoring (web-scraping, ontology modelling, advanced bibliometrics, semantic TRIZ, sentiment analysis, and others) were detected. The possibilities of employing tech mining and related methods on different stages of technology monitoring (scanning and monitoring; data analysis and integration; discussion, validation and prioritization; updating the database of trends) were explored and analysed. It is concluded, that the following factors could influence the choice of tech mining methods for technology monitoring: the task of the study (to find technology trends, patenting patterns, invisible colleges or others), the type of the trends (f.e., emerging technologies, research fronts, disruptive technologies), the sort of information sources (publications, patents, web content), the search strategy (broad query, topic category or specific keywords), the units of analysis (documents, structured data, unstructured data) and others. In the future it

will be possible to analyse in detail the evolution of tech mining approaches to technology monitoring from the point of subject areas, countries, and centres of excellence.

Figure 1: Technology monitoring process (stages, information sources and methods)
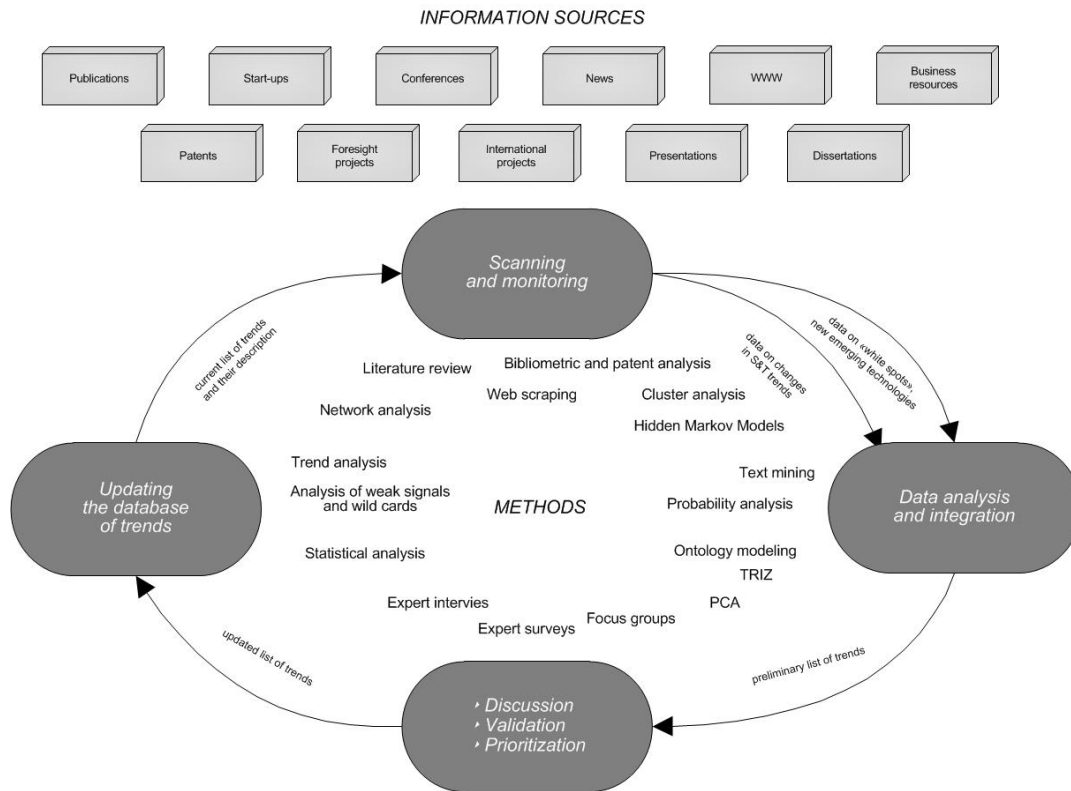
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