Research on Technology Foresight Method Based on Intelligent Convergence in Open Network Environment

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Abstract: With the development of technology, the technology foresight becomes more and more important. Delphi method as the core method of technology foresight is increasingly questioned. This paper propose a new technology foresight method based on intelligent convergence in open network environment. We put a large number of scientific and technological innovation topics into the open network technology community. Through the supervision and guidance to stimulate the discussion of expert groups, a lot of interactive information can be generated. Based on the accurate topic delivery, effective topic monitoring, reasonable topic guiding, comprehensive topic recovering, and interactive data mining, we get the technology foresight result and further look for the expert or team engaged in relevant research.

Keywords: Technology Foresight, Intelligent Convergence, Open Network Environment.

1   Introduction

After 40 years of reform and opening up, China has entered a new historical stage of relying on scientific and technological progress to promote economic and social development. Economic and social development has relied more and more on scientific and technological innovation than ever before [1]. The report of the 19th NPC pointed out that innovation is the first impetus to development and a strategic support for building a modern economic system. More than 10 times mentioned science and technology, more than 50 times emphasized innovation [2].

Technical foresight is a systematic study of the future development of science, technology, economy and society, and the selection of strategic research fields and new generic technologies with the greatest economic and social benefits [3]. As a new tool for strategic analysis and integration, technology foresight creates a new mechanism that is more conducive to the formulation of long-term planning [4]. Technology foresight is an important means of support for strengthening macro-science and technology management capabilities, raising the level of science and technology strategic planning and optimizing the allocation of science and technology resources [5]. With the development of technology, the importance of technology foresight becomes more and more obvious. More and more countries, regions and organizations attach importance to it and form a global wave. The major developed countries such

as the United States, Japan, the United Kingdom and Germany have stepped up their foresight research work on the trend of science and technology development. Some developing countries have also carried out technical foresight research. China has always attached great importance to the macro-strategy study of science and technology and actively carried out technical foresight and key national technology selection tasks, such as the Chinese Academy of Science in the next 20 years in terms of technology foresight research, the Beijing technology foresight action plan and the Shanghai science and technology priority field technology foresight work research plan [6].

The outcome of technology foresight activities depends much on the selection and use of the method. The notable feature of the Delphi method forecaster approach is its increased investment, long duration, and difficult outcome assessment [7], which is increasingly questioned as the scientific and validity of the core technology foresight approach [8] [9]. The development of technology foresight methods and the improvement of research quality are the frontiers and focuses of research in the field of technology foresight. Technology foresight research methods and models are still under continuous development. It is of great theoretical and practical value to carry out the research on methodology of technology foresight in this context.

2   Literature Review

Professor Ben Martin of the University of Sussex first proposed the concept of technology foresight in 1995 as a systematic study of the development of science and technology in the long term so as to determine the most economically and socially important areas of strategic research and major generic technologies [10]. The APEC and OECD also have similar definitions of technological foresight. Technology foresight studies key technologies and common technologies that maximize economic and social benefits based on systematic trends in science, technology, economy and society [11]. The definition of technical foresight in China is slightly biased. In the 2003 China Technology Foresight Report, technological foresight is a systematic study of science, technology, economy and social development in the longer term. Its goal is to identify areas of strategic research and to choose Technological group that has the greatest contribution to economic and social benefits [12]. In general, scholars at home and abroad have basically reached a consensus on the definition of technical foresight and content interpretation.

There are many kinds of technical foresight methods [13] [14], and the foreseeable methods of this dissertation are divided into exploratory predictions, normative predictions, exploratory and normative combinations [15]. Exploratory predictions predict the future of technology based on past and present knowledge. Exploratory foresight is more applicable to situations in which a new technology is predicted to evolve along a deterministic curve, which is thought to describe the inevitable future and almost impossible to influence or change future developments through planning [16]. Normative foresight first assesses future goals, needs, tasks, etc., and then dates back to the present, assuming that the situation to be assessed is reached, pointing out the ways in which these goals can be achieved. Normative foresight provides a reference for allocating the resources needed for the realization of technology [17].

Exploratory predictive methods such as growth curves, TFDEA, bibliometrics, patent analysis, social network analysis, data mining, etc.; normative predictive methods such as morphological analysis, analytic hierarchy process, etc.; exploratory And normative portfolio foresight, such as Delphi method, scenario analysis, cross impact analysis, technology roadmap and so on [18].

Delphi method is the core technology foreseen method [19], mostly using many rounds of expert

interviews conducted large-scale consulting survey, the final expert opinion reached consensus to achieve the technical foresight. As technology evolves, large-scale expert surveys have been implemented and are used in a wide variety of applications. For example, in the key technologies and the identification of influencing factors: Some scholars use quantitative Delphi method in many rounds of expert surveys using questionnaires to collect expert opinion [20] [21]. Halal adopts online surveys and statistical methods to improve the efficiency and results of the delphi method [22]. Jun et al. provide patent analysis results to expert-assisted decision-making [23]. Such as science and technology strategy and policy making: Some scholars cluster the questionnaire feedback results [24]. The results of questionnaire analysis are used to support the development strategy and policy formulation of a certain technology, and the key influencing factors of technological development are screened [25]. Rohrbeck builds a network of experts based on interviews with experts and analyzes industry support technologies to advise on technology management in the enterprise [26]. Chen et al. Combined expert survey data with literature and patent data to describe the industry's technology trends using logical growth curve models and formulate patented technology development strategies accordingly [27]. Such as future technology demand forecast: Celiktas screened participants using bibliometrics and provided SWOT results to participants, then conducted an on-line questionnaire using the Delphi method to predict the technical needs for the future energy needs of Turkish countries [28]. Ivlev sets standards for assessment in terms of education, academic achievement and work experience, and provides a screening method for the Delphi method panel system [29].

3   Technology Foresight Method Based on Intelligent Convergence in Open Network Environment

Intelligent convergence in an open network environment will be an important way of predicting the technology, and may even be a disruptive way. Technology foresight are characterized by such characteristics as "crossover, destructiveness, permeability." The open network environment is characterized by "cross-border, openness and community penetration" hotbed". Examples include monitoring, analyzing, calculating and refining scientific and technological innovation topics through Facebook and Twitter social media.

We put a large number of scientific and technological innovation topics into the open network technology community. Through the supervision and guidance to stimulate the discussion of expert groups, we get a lot of interactive information including comments, likes and other interactive activities. Based on the interactive environment of human-human and human-machine, stimulating the emergence of experts' wisdom, putting accurate delivery on innovation topics, effectively monitoring, reasonably guiding, comprehensively recovering, and interactive data mining, we get the result forecasted and find Innovative topic-related research to solve the problem. Specific content as shown below
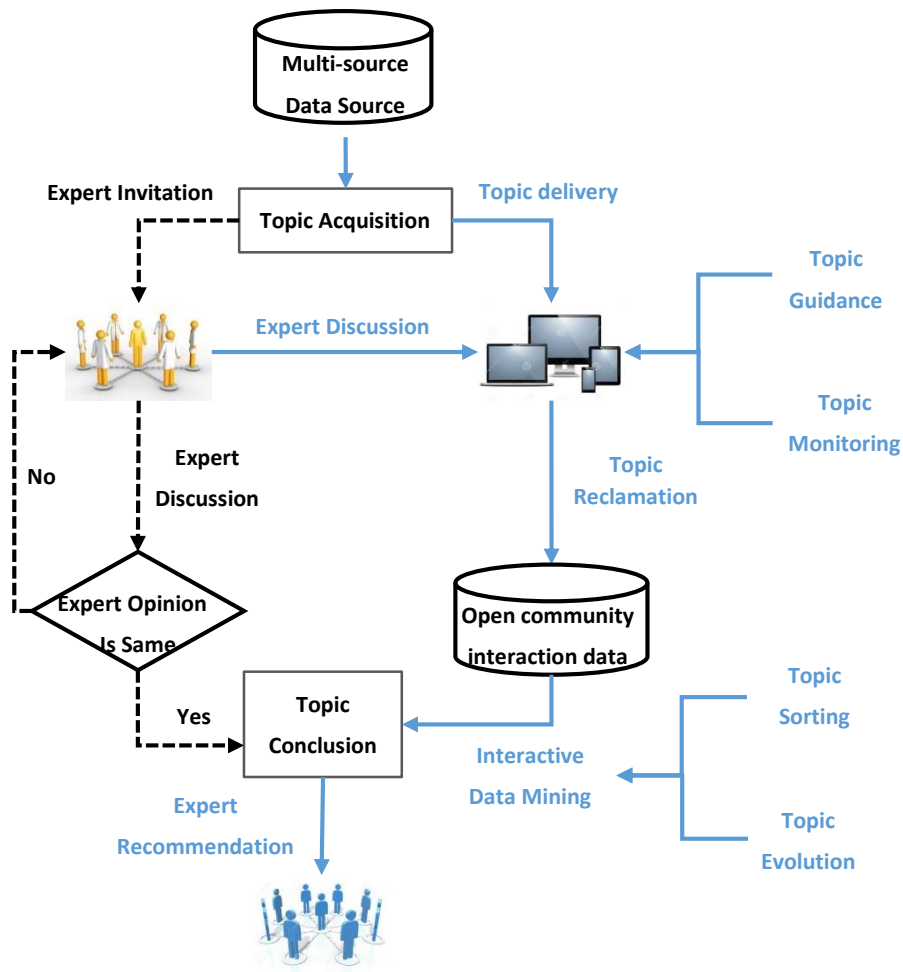
Fig. 1. Technology foresight frame based on intelligent convergence in open network environment

The research has the following innovations: 1) Propose a new method of technology foresight framework based on intelligent convergence in open network environment. Topic Acquisition – Topic Delivery - Topic Monitoring - Topic Guidance - Topic Reclamation - Interactive Data Mining - Topic Conclusion - Expert Testimonials. 2) The combination of qualitative and quantitative, which taking into account the subjective analysis and objective data. 3) The method of data mining for expert wisdom mining. 4) Not only technical foresight, but also problem solving, recommending experts and teams engaged in relevant research. 5) Make full use of open network environment for expert discussions with wide coverage, high participation and high feasibility. 6) Excavation of experts in an open network environment makes the process of technology foresight more automated and intelligent. 7) Based on the discussion of the original science and technology topic, explore the new topic of drift evolution.

4   Critical Technology Joints of Technology Foresight Method Based on Intelligent Convergence in Open Network Environment

The wisdom of science and technology groups under the open network environment will be an important way to produce innovative ideas, and may even be subversive. The group - wise analysis of this study will move from traditional artificial mode to artificial intelligence. The traditional intelligence analysis

process relies on the experienced expert team, mainly adopts the mode of " presupposition logic framework + computer assistant processing + artificial judgment ", this project will adopt the mode of" big data processing frame + computer depth learning + artificial assistant ", which will be a kind of work mode based on artificial intelligence. The scientific and technological prediction based on literature and published scientific and technological information has very significant innovation, and is an important guarantee of this research. For example, the intelligence research institute like IARPA has implemented projects such as ace, fuse, forest, etc. Automatic discovery of scientific frontier and emerging technology from the mass of literature and invite science and technology experts to predict the trend of development to achieve Intelligent convergence.

Based on the large number of scientific and technological topics generated by the wisdom mining of scientific and technological groups, and put into the network technology community, through the guidance to stimulate the experts' speeches, discussions, comments, likes and other interactive behavior, will produce a large amount of interactive information. Based on this interactive information and related data, using the combination of data mining, expert mining, intelligent knowledge management and integrated research hall, thinking science and system science and other theories and methods, further digs out the group wisdom, and obtains the real basic, forward - looking, innovative and subversive science and technology topics.

4.1   Intelligent Delivery of Innovative Topic Based on Semantic Computing

The research content mainly includes the core expert portrait and the important organization portrait, the science and technology community portrait construction, the innovation idea topic and the science and technology community intelligence match, the innovation idea topic and the expert intelligence match.
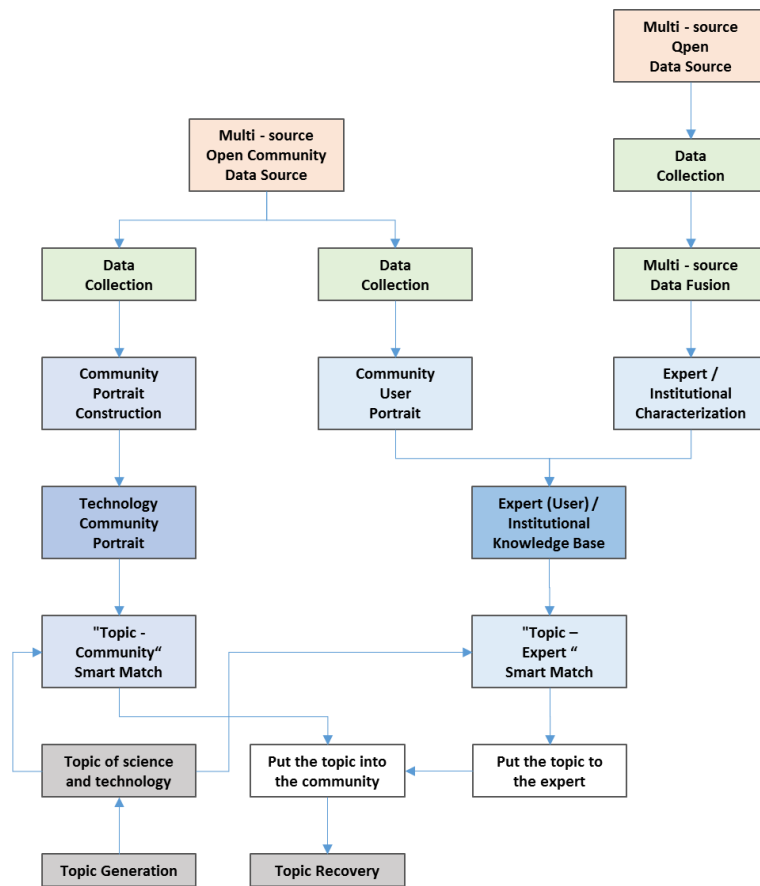

Fig. 2. Intelligence delivery process of innovative topic based on semantic computing

4.2   Intelligent Recycling of Innovative Topics Based on Topic Relevance

Put the topic of innovation into the relevant tech community, and invite relevant experts or users to participate in the discussion. The main research content of intelligent recycling of innovative topics based on topic relevance is how to recycle these discussions on innovative ideas periodically. Specifically, 1) weak relevance topic reply filtering. The two main difficulties in the intelligent recycling of innovative topics under open network environment are the dynamic evolution of topics and the sparsity of training samples. Direct use of recycled comments can lead to a bias in subsequent guidance, so a weak correlation topic comment needs to be filtered in the recovery process. 2) topic summary. There are too many redundant information in the science and technology community, the topic summary aims to extract a few sentences from the innovative topic and its comments for concise topic expression.

4.3   Intelligent Guidance of Innovative Topic Based on Information Recommendation

After the generation and delivery, Based on the large data of literature information, real-time analysis and calculation of the topic background knowledge, topic perspective related background knowledge and the background knowledge of interactive information, and then recommend the relevant knowledge and information materials, to carry on the continuous guidance of the topic. The research scheme is shown in the following figure.
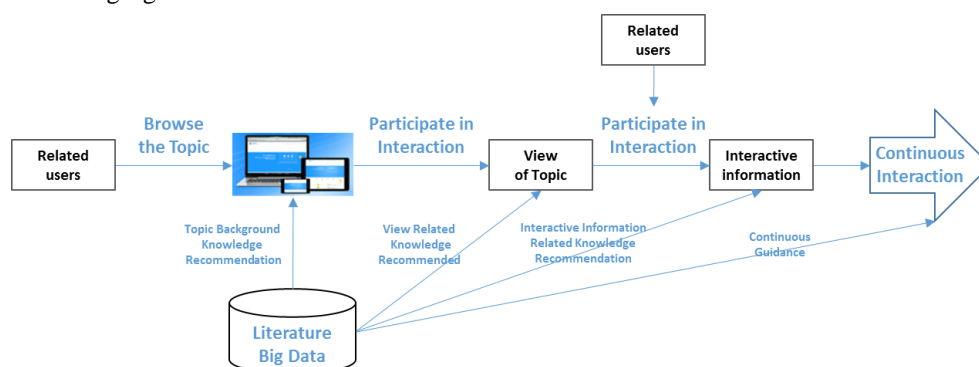

Fig. 3. Intelligent guidance of innovative topic based on information recommendation

4.4   Multi - Dimensional Innovation Topic Monitoring and Targeted Guidance

In the whole system structure of this project, the overall effect of the topic is optimized through the topic monitoring module and topic guidance module. The monitoring module and the guide module separately undertake the role of topic launch effect evaluation and topic launch effect evaluation. Specifically, the information flow source of the guidance module includes the multi-dimensional evaluation of topic monitoring and the reasoning of public support knowledge map.

The main research content of topic monitoring includes: topic monitoring: focus tracking, monitoring review information, and monitoring the user login and interactive data in the community, identify the interaction of the problem solving. The main research content of topic guidance includes two parts: module activation and guidance action decision. The guiding action decision-making part is divided into five aspects: sensitive information block, topic answer correction, active topic active activation, topic answer depth guidance and topic answer multiple perspectives.
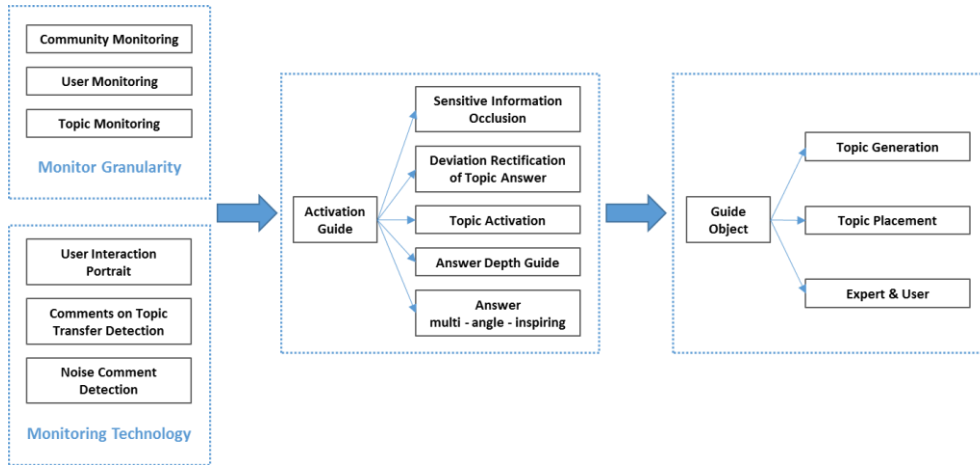
Fig. 4. Multi - dimensional innovation topic monitoring process

4.5　Solution of Innovative Topic Based on Intelligent Convergence

1) Topic - regeneration based on machine learning and short text mining: A lot of interactive data of innovative topics will get after being put into the network community which is mainly composed of short texts. We use depth learning, parallel / distributed computing method, short text clustering to generate the topic.

　　2) Sorting important topics based on expert experience: Users in the network community are a group of people with different cultural and professional backgrounds. How to evaluate their professional level and give scientific weight, which has an important impact on the ranking of the topics.

　　3) Expert recommendation based on graph mining, expert mining, intelligent knowledge management and other technologies: Through the complete characterization of experts and establishment of scientific research social network find the high-level experts or teams who can undertake the topic research.

5　Empirical Study of Topic Sorting

This paper first constructs a scoring matrix to sort the topics. The abscissa is n topics in the same field (such as the advanced material field), and the ordinate is m users participating in the review. For example, if user i has commented on topic j, we will perform sentiment analysis on the comment and give a positive or negative score. This score needs to be multiplied with the weight of the commenting user to obtain a weighted score. In this way, a sparse matrix of n*m is formed. The sparse matrix is further calculated and the n topics are sorted. The final score is calculated as follows:

$$final\ score = comment\ score * expert\ weight$$

5.1　Calculation of Comment Score

Sentiment analysis is performed on the user i's comment on the topic j. This article uses crawler technology to crawl AI-related topics from Zhihu communities. Based on Chinese HowNet's Chinese emotional lexicon, the number of positive and negative emotional words matched is respectively obtained. The two tentative weights are both 0.5, final comment score is calculated as follows:

$$final\ comment\ Score= the\ number\ of\ positive\ words * 0.5 - the\ number\ of\ negative\ words * 0.5$$

5.2 Calculation of Expert Weight

According to the pre-set expert user index system, using the specific scoring rules and weights, the expert weights are calculated as follows:

	user_ID	achieve	recog	page	include	resid	dipl	univ	fans	like	tha	sav	edi	score
0	闲吟客	0.0	0.0	0.0	1.0	0	PhD	加州理工学院（California Institute of Technology）	2317.0	5205.0	1024.0	1888.0	90.0	5.0
1	韩迪	0.0	1.0	2.0	1.0	北京	博士	清华大学	61585.0	458078.0	64728.0	92080.0	566.0	5.0
2	吴辰晔	0.0	0.0	3.0	0.0	上海	0	清华大学	4735.0	4099.0	418.0	704.0	9.0	5.0
3	何之源	0.0	0.0	0.0	0.0	0	0	0	5248.0	0.0	0.0	0.0	0.0	1.4
4	Since	0.0	0.0	0.0	0.0	上海	硕士	上海交通大学	943.0	2231.0	439.0	831.0	51.0	1.3
5	暮暮迷了路	0.0	0.0	0.0	0.0	0	0	0	1685.0	10771.0	1172.0	723.0	90.0	1.9
6	李炎亮	0.0	0.0	0.0	0.0	陕西	0	0	6.0	4.0	0.0	6.0	2.0	1.0
7	耿锐	0.0	0.0	1.0	0.0	悉尼(Sydney)	硕士	悉尼大学 (University of Sydney)	1649.0	2670.0	517.0	1317.0	0.0	5.0
8	jackxy	0.0	0.0	0.0	0.0	0	0	0	8.0	61.0	13.0	24.0	9.0	1.1
9	杨熠	0.0	0.0	0.0	0.0	0	0	北京邮电大学(BUPT)	13.0	5.0	2.0	6.0	15.0	1.0
10	zzzz	0.0	0.0	0.0	0.0	0	0	0	3.0	3.0	0.0	1.0	0.0	1.0

Fig. 5. Example of expert weight calculation result

The score of the comment is multiplied with the weight of the expert to get the score of the topic. According to the score, the degree of importance of the topic can be selected. Based on the thesaurus is a traditional sentiment analysis method, the next step we can use machine learning and other methods of supervised learning, and choose a method with higher accuracy.

6 Conclusion

The traditional method of technology foresight has the disadvantages of high cost, low accuracy and deviation of result. The technology foresight method based on intelligent convergence in open network environment combines the qualitative method with quantitative method and has obvious advantages in accuracy and objectivity. Based on the literature and published information, we get potential innovative topics. Then based on human - human, human - machine interaction environment, we discover innovative topic results and related important experts with the method of accurate topic delivery, effective topic monitoring, reasonable topic guidance, comprehensive topic recovery, and interactive data mining.

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