Estimating Economic Contribution Rate of Education with Soft-Computing Method

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Abstract: Education plays an important role in economy development. Research on economic contribution rate of education (ECRE) is of great importance. Traditional hard computing method has enhanced the development of this research. However, hard computing method has difficulty in solving problems from uncertainty and complexity of social and economic systems. Researchers need a new tool and find soft computing method which combines fuzzy logic and intelligent technology. It integrates fuzzy thought, fuzzy logic and intellectual technology to model and optimize the uncertain and complex systems. Therefore, some researchers applied soft computing method to estimate ECRE. We analyze recent researches on estimating ECRE with Soft-Computing Methods, and introduce relevant methods, in hope of presenting some reference for solving problems.

Keywords: Education economy, Contribution rate, Soft computing

1 Introduction

Education is of great importance to economic growth [1-3]. Researchers give a lot of attention to economic contribution rate of education. To measure ECRE quantificationally is to calculate the increase of national economic product brought by education.

At the beginning of the 1960s, Theodore W. Schultz and Edward Fulton Denison delivered innovative research result of education’s contribution to the economic growth in USA. Then, researchers of the world devote themselves to this research, and explore a lot of calculation methods [4-5]. These methods are mainly based on traditional classical mathematics methods, such as statistics. They are called hard computing. For example, Produce Function, Increasing speed equation, The returns to education brought forward by Schultz, Factor Analysis Approach by Denison and coefficients of simplified labor. Hard computing helps people a lot to understand economic contribution of education, but still have following questions [6]: 1) Traditional computing follows “education-human resource-economic growth” chain, ignoring the long term influence and hysteresis of education to economic growth. 2) Labor of the whole society is supposed the sum of individual, which does not accord with social system. 3) Hard computing adopts classical computing methods based on rigorous theory, without consideration of complexity of objective factor, and subjectivity and fuzzy characteristic of man’s thought.

In face of complicated social economic system, which is of great uncertainty, to measure the economic contribution of education in this system more accurately, we need tools with following features: 1) Nonlinear social economic system is a large complicated changeful body, which requires measuring tools with capability of highly nonlinear mapping and large scale parallel processing, and self learning and self adapting. 2) Uncertainty and fuzzy feature of social economic system and its need for man’s qualitative knowledge require measuring tools to deal with fuzzy probability and use man’s qualitative knowledge effectively. 3) Statistics may be short of some aspects, which require tools have some stability and Tolerance. Soft computing is a newly method brought forward recently to create Intelligent Systems, which exactly contains the above three features and catch researchers’ eyes.

Soft computing [7] is not a single method, but a combination of methods. To solve the practical problems, soft computing harmonizes, not exclude Artificial Neural Networks, Fuzzy systems and Genetic Algorithm, which are not only independent, but also share close-knit links. Soft computing is just like human brain, can deal with complicated practical problems, carry on reasoning and study in uncertain
and inaccurate environment. Therefore, adopting soft computing to analyze economic contribution rate of education has an incomparable advantage over hard computing.

2 The theory of soft computing

Soft computing integrates Artificial Neural Networks, Fuzzy systems and Genetic Algorithm. These three technique are not simply add one by one, but link together, cooperating closely, and each also perform one’s responsibilities, which realizes pattern recognition, knowledge reasoning, optimization and so on. Artificial Neural Networks is responsible for pattern recognition and self-organizing learning in changeful environment. Fuzzy systems realize reasoning and strategic decision of human knowledge. Genetic Algorithm optimizes the system.

2.1 Artificial neural networks
Research started in 1940s. Neural Network is a highly complicated nonlinear dynamics system. Artificial Neural Networks is a processing system constituted by a large amount of processing units through abundant links. Artificial Neural Networks simulate living creature’s neural system, with application of nonlinear mathematics theory. Information processing ability is determined by input-output feature of network units (neurons), topology structure of networks, weight of link and threshold of neurons. One of the biggest functions of Artificial Neural Networks is the strong ability to map nonlinearly. If Artificial Neural Networks is supposed to be a input-output mapping, then this mapping is highly nonlinear. Artificial Neural Networks realize nonlinear mapping with its ability to learn and reason. When the topology structure is fixed, its learning ability is affected by the change of weight of link.

The main characteristics of Artificial Neural Networks are: 1) tolerance. In neural networks, information is not stored in one place, but distributed allover the networks based on content. A piece of information is not stored in one point of networks. Every neuron stored parts of kinds of information. Points in networks have the same affection to information storage. When part of information is not intact, or missed, networks can recover the original correct complete information; 2) large scale parallel processing. Artificial Neural Networks are parallel in structure, and every unit of networks can carry on similar processing at the same time, therefore, information processing in networks is executed in a parallel way, with speed much higher than traditional sequent computer; 3) self-learning, self-organizing, and adaptability. Learning and adaptability require the system internal structure and linkage can change with time. Neural Network is a kind of system whose structure changes with time, therefore, it is adaptive to environment and learn from the out. Linkages between neurons are various, and the intensity of the linkage between different neurons is changeable, and networks can learn and train self-organizing to adapt to the demands of different information processing. 4) Neural Networks is integrated by large amounts of neurons, not simply add every unit together, which leads to the feature of common complex nonlinear dynamic system. 5) Neurons can deal with some problems with complicated environment, unclear knowledge background and uncertain reasoning rules. With the above features of Neural Networks, it is an appropriate approach to solve complicated uncertain fuzzy problems.

2.2 Fuzzy systems
The fuzz provides an artificial tradeoff of qualitative and quantitative, subjective and objective, fuzzy and clear. Fuzzy mathematics is a research on dealing with fuzzy phenomenon, with the help of quantitative approach. Fuzzy system is an advanced computing framework established on the basis of fuzzy sets theory, fuzzy if-then rules, fuzzy reasoning and so on.

Fuzzy systems contain three main parts: rule base, with a series of fuzzy rules; data base, defining membership functions used in fuzzy rules; reasoning mechanism, carrying on reasoning procedure based on rules and factor to get logical output or conclusion. Fuzzy systems commonly are consisted of fuzzification, rule base, inference engine, and defuzzification.
Fuzzy systems have a lot of important advantages: 1) because input and output are real variable, it is quite applicable for engineering application system; 2) they offer generalized pattern of fuzzy if-then rules, which describe expert organization; 3) it is free to choose fuzzification, fuzzy reasoning and defuzzification. Therefore, when fuzzy logic systems deal with some special questions, they can choose the most appropriate fuzzy logic system through learning, to use data and language effectively. With the above advantages, fuzzy systems can easily use experts’ knowledge and experience directly, and establish fuzzy model when own the input-output data, that is why fuzzy systems are used widely.

2.3 Genetic algorithm
Genetic Algorithm is a kind of global optimization algorithms based on Natural Selection and Natural Genetic. Its operand is population consisted of individuals. Starting from initial population, adopting choice strategy based on fitness ratio to choose an individual from the current population, and producing next generation through hybrid and variation, that is to optimize the individuals in population generation by generation, and get close to optimal solution little by little until reach the termination conditions. Genetic Algorithm contains three basic operations: 1) choice. That is to choose a better individual from current population, providing opportunity to produce offspring as parents. Based on Survival of the fittest, the probability of choice is proportional to the adaptability of the individual, which can increase the average adaptability. The approaches of choice are variable, and nothing to do with adaptability. 2) Crossover. Crossover operator plays a core role in Genetic Algorithm. It replaces part of structures of two father individual to produce new individual, just like exchange information in nature. 3) Mutation. Mutation operator is to compensate a chromosome maybe lacked by an individual in population, promising Genetic Algorithm can search all parts of the space.

3 Soft computing in calculating ECRE

Recent years, part of researchers has begun trying to adopt soft computing theory to analyzing ECRE.

3.1 Fuzzy neural networks
Self-Organizing Feature Map(SOFM) Network was proposed by Kohonen in 1981. It is a competitive learning network, with unsupervised learning pattern. It is based on Basic Competitive Network algorithm. Through competition and lateral interaction between neurons adjacent in networks, it extracts features of input information and establishes character distribution topology map. Yijun Kuang adopted SOM networks to the research of ECRE in 2003[8], for pattern recognition. Based on the statistic data of recent 10 years, Kuang analyzed Growth Rate of GDP per capita, Growth Rate of resource per capita, Growth rate of labor force, and GDP per capita, to get the Technical coefficient of every district, and classified the districts based on this coefficient distribution.

Research of the application of the integration of Fuzzy logic and Neural Networks is Fuzzy Neural Networks. Fuzzy logic expresses macro ability of human brain with language and concept. It deals with kinds of fuzzy information with logical reasoning based on membership function and series of rules defined by human. Neural Networks focus on micro structure of human brain with the features of self-learning, adaptive and self-organization, and deal with pattern information that cannot be expressed by language. Fuzzy Neural Networks integrate advantages of the above two, which enable the Fuzzy Neural Networks can deal with fuzzy information, and also use learning function of Neural Networks to realize self-learning and adaptability, that means it can overcome the subjectivity of fuzzy systems and the disadvantage of over reliant on experts. Fuzzy Neural Networks is to get parameters of fuzzy rules in fuzzy sets through self-organization and self-learning of neural networks based on sample data and model precision of input and output. Literature[8] fuzzy mapped the human resource capital and economic growth in different districts. Taking data of Shanghai in 2001 for example, ECRE of 2000-2001 was 33.07%.
3.2 GA-ISODATA
The number of input pattern and distribution status are very big, which restricts the precision and accuracy of SOM. That is, SOM has strict requirement for sample size and distribution function. In 2005, Haixiang Guo and his fellows adopted iterative self-organizing data analysis technique (ISODATA) into Genetic Algorithm, promoted GA-ISODATA [9-10], Analyzing social economic system with ISODATA is a frequently used soft computing method. It defines the number for pre-classify C and convergence precision based on the details of the research subject, to soft-classify the samples. According to Optimal classification, this algorithm establishes a new fitness function, integrating GA and ISODATA to GA-ISODATA, which cannot only realize optimal classification under the precondition with C defined, but also get the number of optimal classification of Fuzzy C-Means without any information about the number of classification. GA-ISODATA embeds ISODATA in GA, with GA as a coating, and ISODATA as an endoderm. Talking about function, ISODATA is in charge of optimal approximation, realizing fuzzy C classification, and GA searches in the whole status space to get the number of optimal classification. From the aspect of cross-association, the individual of the population in GA is the number of classification redefined for ISODATA, and the result of ISODATA is the parameter of GA fitness function. They cooperate with each other, to get two optimal results. Literature [10] adopted GA-ISODATA soft-classify districts according to the technique level. Based on the soft classification, Haixiang Guo established fuzzy mapping relationship between human capital and economic growth in subsystem (first filter FNN1), and education and human capital (secondary filter FNN2). According to the data analysis, ECRE in China was 18.5967% in 2002. GA-ISODATA Algorithm adopts traditional binary coding, whose procedure is complex, what is more, it costs long time to decode and the length of coding is affected by sample size. To cover all sample, it will generate illegal individuals not stand for sample. For this reason, Yuzhi Huang and her fellows revised in 2008. Huang promoted GA-ISODATA based on symbol coding [11], using symbol to represent sample, equal in quantity. The algorithm revised takes shorter processing time and gets the same result.

4 Conclusion
Since 1960s, researchers of Educational Economics have devoted themselves to explore methods for calculating ECRE precisely. However, traditional hard computing cannot establish precise model in complication practical social economic system. At the same time, soft computing integrates Artificial Neural Networks, Fuzzy systems and Genetic Algorithm, which bring a novel way to calculate ECRE. It’s robust, parallel and highly nonlinear, which overcome the shortcomings of hard computing, dealing with complicated practical problems in uncertain and inaccurate environment, carrying on reasoning and learning. On the other hand, as an advanced computing tool, soft computing has a long way to go with educational economics principle. Researchers have done much in designing indicator system based on pedagogy, economics and so on. However, to design a reasonable indicator system based on features of soft computing, we still have a lot to do.

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References