BioTechnology

An Indian Journal

Research on prediction of economic fluctuations based on agent simulation

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ABSTRACT

The economic system is a typical complex system, which consists of various kinds of economic agents. In consequence, the according research methods should focus on new tools, which adapt to complex system study, instead of the traditional equilibrium static modeling methods. In this paper, we set up a simple market economy MS model based on the foregoing methods. This paper designs agent models for four different nodes agents, and enterprise, government and foreign trade actions, and makes an economy simulation in which the author apply created MS modeling to simulate the basic status. We have made policy recommendations, that the Government should continue to steadily promote the reform of the market economy system, assure their roles well, reduced the unnecessary intervention on the economy, meanwhile improved own macroeconomic regulation level to prevent surplus macroeconomic fluctuations, and promoted the healthy development of the economy. The principles and steps, which should be followed in agent-based complex systems modeling and simulations is established.

KEYWORDS

Economic fluctuations; Agent simulation; Economy model; Factors affecting.

INTRODUCTION

Agent theoretical research aimed strictly formalized explain various cognitive status (cognitive state) concept of cognitive structure of Agent research, analysis feature Agent. It involves economics, philosophy, sociology, cognitive science, software engineering, object-oriented systems, distributed computing and artificial intelligence and other fields. Agent current structure of the main categories: cognitive structure, reaction-type structure, hybrid structures. Cognitive structure proposed is based Newell and Simon's physical symbol of the creation of assumptions. Typical reaction structure characteristic Agent is not in use symbols to represent the world, nor the use of complex rules to represent. Hybrid structure is the combination of these two types of structure formed together, in this structure, the cognitive subsystem includes symbolic world model for decision-making and planning; events important events in the scene reactive subsystem respond to the current structure is used in the layered architecture.

The corresponding system of economic theory believes should learn economics theory of biological evolution, the socio-economic system as a complex system composed by the intelligent individual research. Compared with the traditional neoclassical economic theory, the result is no longer the pursuit of balance and stability of the system, but the process of trying to understand the correlation between emergent and adaptive development. In this approach, the individual composition of the economic system is called the agent on behalf of the person (Agent), it has the cognitive ability to learn and adapt, through simple individual behavior constitute complex economic scene. Fluctuations in the system contains a large part of the economy, not just those constituent together, but also there are complex interactions and mutual influence, through these interactions and mutual influence the formation and evolution of complex structures, thus presenting a series of macroscopic phenomena, this is the case of many micro-macro (partial integration) and presented[1].

Object of economic and social science of human society, relatively natural science, the date of the human society is not enough, some of the important social and economic differences that exist in nature. Based modeling and simulation methods under study based on Agent, and support complex systems distributed simulation framework, is built on the basis of distributed simulation platform. In this chapter, describes a framework for distributed simulation of complex systems network Cluster environment, with platform-independent, open and strong, transparent communication and so on. Economic modeling, very suitable for mixed analog economic individuals. In other words, in addition to the assumption of classical economic theory of pure reason, the economy still has a considerable number of individual irrational behaviors, not the cognitive and reasoning intelligence factors can explain, so we can build an agent using a simple reaction mechanism to describe some of its behavior.

Advantages of agent-based modeling

In the economic system and other social sciences systems, more emphasis on the use of Agent thoughts with Agent target system simulation to characterize the behavior of a single individual, by the individual and the relationship between the individual simulation to achieve the replication of reality system, and thus achieve the purpose of these systems can be controlled, but not to find an optimal solution, which is based on the simulation Agent in these applications, the definition of Agent with greater extension. And other complex systems simulation platform for comparing the distribution of Agent-based simulation of complex systems framework has the following advantages[2]. Fig.1 shows the advantages of Agent-based modeling.
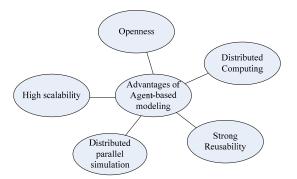

Figure 1 : The advantages of agent-based modeling

Support distributed parallel simulation. Since each Agent operations than the smaller, usually on one node can run multiple Agent, in accordance with the design and simulation framework for multi-processor nodes, on the same node parallel simulation method Agent simulation, can fully utilize the performance of multi-processor, even for a single processor, the simulation can still reach a certain degree of parallelism through threads and the like; the same time, between the node simulation mode connection between nodes through the network for distributed simulation; openness. By defining a unified messaging interface and messaging systems, to achieve an independent platform that can facilitate the conduct of simulation applications on different platforms; at the same time, by defining Agent yuan and inheritance among them, aggregation relationships can facilitate different Agent were coupled; scalability. Under the framework of distributed simulation of complex systems based on Agent, you can easily add new nodes, increased computing power nodes without the

need to modify the simulation framework, or the application on other nodes; support level simulation. Simulation framework defined in relation Agent yuan, inheritance and aggregation, as well as various Agent logic clock, internal state-level simulation can be achieved.

Simulation need to be convenience, reusability strong. Using the library (library) in the form of providing users with the simulation interface, you can easily use the object-oriented features such as inheritance, fast simulation studies, and can be full use of the existing work, the application of transparent communication support. Agent simulation target system there is no need to consider the purpose of Agent location information in communication, all guaranteed by the location routing platform communication systems. Can be simulated in a highly dynamic environment behavior research in traditional methods is difficult to obtain the "emergent" behavior. Through the complex system of individuals with Agent to describe, with great freedom and flexibility, for microscopic behavior of complex systems has a good ability to describe.

Support for the initiative to conduct simulations. Agent is an effective way to describe the individual initiative of science, Agent can receive information on other Agent and the external environment, and in accordance with the rules of the constraint itself, after processing the information, modify own rules and internal state, and send messages to other Agent or the environment, this pattern of behavior Agent, and suitable for the simulation of the initiative; suitable for distributed computing. By Agent distributed multiple nodes, distributed or parallel computing support complex systems; dynamic and flexible simulation. Manifested in two aspects: convenience agent and corresponding simulation entity or person interaction; we can have the ability to add or delete entities in the simulation process; reusability of models. By using the Agent to describe the various parts of a complex system, we can make some ripe Agent model is widely used to improve the efficiency of the software.

Prediction of economic fluctuations

We believe that the economic and social system can be understood as a number of different types of body evolution system constituted by the interaction, and we can use the Agent in the computer simulation modeling of these subjects. Agent is an autonomous, adaptive computer program body, they will be like the real economic subjects completed the same decision-making behavior of independent production, sales and trading, such as in a computer environment, so that a simulation of a virtual economy and society in the computer system. A virtual economy and society as a whole system, it will be able to map the phenomenon of universal law and the reality of the economic and social system[3].

Economic and social system simulation constructed "artificial society" is actually a complex, multi-Agent model in the model Agent on behalf of individuals. Relies on fairly simple rules of conduct, Agent interaction between social structures and led to the emergence of group behavior. Common Agent with different simulation applications, based on artificial social model is the use of Agent and the establishment of a large amount of interaction between the established rules of Agent overall evolution of complex adaptive systems. Its core is the study of changes in the local details of how the emergence of a complex global behavior, reflects a bottom-up modeling ideas. The Common Agent simulation is based on Multi-Agent Cooperation solving perspective, that is due to the distribution of the actual system, complex, dynamic and hope through the effective division of a single individual capacity, coordination, organization and achieve the purpose of optimizing the overall system, embodied in a top-down modeling point of view.

Agent-based simulation model is personal, residents, businesses and other micro-units as described and simulated objects, using computers to simulate the real socio-economic system through some sort of process simulation model, such as an analog implementation of a policy, in order to analyze the impact of policies on the micro units and cause macroscopic effects. The base model is to obtain two types of data sources: based on the socio-economic system of micro-unit data file consisting of sample survey data obtained; data file structure simulation model based on real socio-economic activities and the resulting sample survey. Microscopic changes in the value of individual characteristics associated with the application of computer simulation based on this method to simulate specific macroeconomic policy and economic variables (such as prices, taxes, welfare, etc.) caused by changes through the characteristic variable statistics, analysis, inference, comprehensive. We can get the impact of policy changes on the microstructure of the individual, and then get the macro as well as all levels of policy implementation results. We use the Agent on behalf of the economy in a variety of decision-making departments.

Innovation theory suggests that the development of new technologies, new products, open new markets for enterprise innovation activities can bring profits higher than the market average earnings, which would make more business innovation activities in order to promote economic prosperity; when innovation is not means profit opportunities while creating additional revenue disappear again, innovation is stopped, the economy in a slump. Pure monetary theory of the economic cycle is a purely monetary phenomenon, as banks alternating expansion and contraction of credit, resulting in cyclical fluctuations in the economy. When the banks have lower interest rates, economic expansion to increase output, when banks tightened credit, economic contraction, output declined. Overinvestment theory that increased investment will lead to economic prosperity, but the development of capital goods production is likely to cause excessive macroeconomic imbalances structure, even over production, the economy enters recession[4].

Interactive analysis system of the main social-economic is very important. That study of the interaction of economic and social behavior in various types of small systems between analyzed subjects, the main difference between the various types of hierarchy and relationships. The core idea of complex adaptive systems theory is adaptive creating complexity, adaptability shows the basic position and the main role of interaction in the presence and evolution of the system, adaptive behavior of artificial social model mainly in behavioral decision Agent way reflected. Economic and social system is a complex system in order to simplify the model must make some assumptions.

When the economic cycle fluctuations to explain a large number of scholars believe that economic fluctuations in aggregate demand from the side, on the contrary, the founder of real business cycle theory of aggregate demand caused by factors that are not considered within the economy of the system of economic fluctuations, but changes in technology from outside the economic system, its impact on economic volatility is persistent. And other economic fluctuations theory, in general, some of the external search for the root causes of economic fluctuations, while others look for fluctuations in the economy from internal sources to explain economic fluctuations.

Model-designing

Currently, Agent-based simulation method, in the economic field has been a certain application. Such as the Santa Fe Institute in the SW platform virtual stock market, success will be based on the idea and genetic algorithm is applied to the simulation of Agent stock market, the market trading mechanism in the economic structure and based classifier (Classifier) have inspired to learn together. In this artificial stock market, providing risk-free and risky bonds and dividends are subject to a random distribution of shares. In fact, until now, the stock market model Santa Fe's also just a very simple economic framework, model real innovation lies in its forecasting methods, namely genetic algorithms.

Modeling and simulation methodology based Agent, the interaction between the Agent: Agent or get information from other environments, and then based on the information obtained and their own state and its own rules, and modify its state / Rules and send a message to other agents or the environment interacts. Through the interaction of these forms, "emergent" the target system as a whole has, and does not have a single Agent overall behavior. Such as the ecosystem, by a large number of species, each species can be seen as a relationship of mutual restraint and promotion of Agent, species and between species, constitute the complex ecosystem environment; in the economic system, there are a lot of individuals, families, businesses, government organizations and other individuals, these individuals can be seen as a different Agent, with different rules of behavior and mutual interaction between these Agent, forming a great variety of complex economic systems. In Agent-based simulation, Agent includes an object from the ordinary to the Artificial Intelligence Agent in the full sense of the wide range. Agent's internal rules can be based on the principle of rational calculation of costs and benefits, or derived from the analysis of forward-looking, of course, the internal rules of Agent may simply adapt to their environment.

In the simulation system model, the real economic and social complex systems-related policies and related behaviors among individual units of real economic activity and social behavior of a complex system logic rules between economic ties constitute individual microscopic simulation system model simulation model database document and simulation rules may have three operational components, then we can test the model. The use of the simulation model and attribute rules, for the data file in the parameter value unit each of a survey scan, in accordance with the requirements of the system simulation model, the input to the attribute value to change the uninterrupted change the value of the corresponding output attributes, it has been a kind of economic policy is applied to the response after the relevant economic entities. Switching to a single response, but the simulation system is not a single simulation model in response to the post, but showing a series of responses, all the responses are aggregated summary, we can draw the real economic impact of complex systems after the implementation of the policy performance results and overall behavior of macroscopic[5].

Agent-based simulation model incorporates the latest technology evolution of learning and parallel computing, compared with the traditional economic model has many obvious advantages: Analog economy in a single, consistent computing environment; allows changing laws, rules and policies effects, such as to make the model more detailed study of the monetary policy, tax and trade policies; allow for different economic sectors analyzed separately and (or) a comprehensive analysis together with other departments in order to better understand the whole economic process; on the economy conduct basic decision making departments were accurately simulated, such as residents, banks, companies and policy.

Agent simulation algorithm according to the kernel to obtain from the message channel and internal messages (such as internal events, output messages, etc.) in the message, then the message to the message processing section for processing. Another feature of the simulation model is that it can provide a variety of multi-faceted and multi-angle data, these data can be our next step to modify the data base simulation model parameters, using these parameters, we use historical experience to master data parameters well we get by combining parametric statistical methods, can be compared to our simulation model structure and parameters optimization and processing. Based on the above discussion of the various parts of the distributed simulation framework is given below distributed simulation framework based on the logical structure of a complex system of Agent. Figure 2 shows the structure of the Agent element.
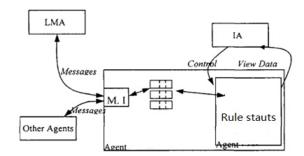

Figure 2 : The structure of the agent element

Process of economic fluctuations prediction

In order to analyze the system, demand analysis (selected by the survey system has the function, development tools), the needs of the target (the system to achieve the goal); followed by the design of the system on the basis of systems analysis to determine the establishment of "Agent man "model rule table and event tables. Then use the computer programming language. The simulation process needs to running on the computer, and the system model calibration and adjustment, complete micro-simulation modeling system model. The main steps and process micro-simulation model is shown below[6].

Social and economic fluctuations System Simulation most important job is to policy regulations, the relationship between the microscopic behavior and their abstract for a causal relationship, will respond to events, conditions and results of regulatory satisfied for some function expressions. A function of self-expression and dependent variables are the microscopic behavior of individual eigenvalues, when building complex simulation system is to be created on the basis of these microscopic behaviors reflect individual has the timing, response, condition relations events table. Simulation study of economic fluctuations in the system, the probability distribution of events can be divided into theoretical and empirical distribution, which is based on the practical application of the theoretical distribution of the use of certain semi-empirical distribution. Theoretical distribution includes the exponential distribution, normal distribution. For a given theoretical distribution, in some interval less on digital distribution function, you can use some specific values into the theoretical distribution function, reasonable in the absence of actual observation data interpolation interval, rational interpolation contribute to analytical analysis and sensitivity studies and simulation system. In the form of a concise theoretical distribution formula, repeatability can be determined under actual process that belongs to a theoretical distribution of case, and we can give priority to theoretical distributions.

The analysis also need to focus on the needs of the target simulation required hardware and software resources, hardware configuration that is required is a computer simulation system and environment should be able to match; software programming language is required economic complex systems required by the database environment; hardware and software resources should be compatible with the economic complex simulation systems. Artificial social model parameters need to collect a certain reality to be supported by the social survey data, making the initial parameter realistic conditions. Social model, artificial social model can help to better understand certain social phenomena and processes. For example, a computer game by repeated prisoner's dilemma experiment, it was found that the cooperation will produce in a competitive environment. In addition, you can also help predict, for example, prediction demographic trends, as well as policy development and evaluation, and so on.

In order to create multiple Agent node agent to complete the four sectors of the economy behavioral simulation models must be considered from two points, one of which is the definition of a reasonable model of the first micro-economy and the behavior of individuals; the other is the model should have a mechanism to achieve the interaction issues between the simulation model agent, modeling the first step is to establish various departments, node-oriented model as Agent, the definition of each of the properties and events agent. Based on the study of practical problems need to establish a personal, corporate, government, foreign trade and banking five agents around individuals, businesses, government, foreign trade, economic activity defines the respective properties and behavior. Personal agent model is mainly for consumer personal, individual investment classes. Consumer durables including individual, non-durable consumer goods (such as clothing, food, etc.) and services (such as medical, travel, makeup, hairdressing, etc.) spending, according to their own personal Agent setting rules for consumption, purchase products to businesses according to their personal preferences when different consumption. Figure 3 shows the main procedure and steps of the microscopic simulation.
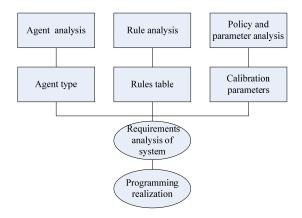

Figure 3 : The main procedure and steps of the microscopic simulation

In the simulation runtime system that is often constant communication often call a personal database and personal agent occur, in order to avoid system instability occurs and brings not robust, the program is designed in a public module design in the design of two powerful public class respectively DB Connection class and DB Operate classes. This class defines a function My Connection, My Connection is mainly used to connect to the database, so the system when connecting to the database can directly call the My Connection, the DB Operate class defines a common method used in some systems, are used to achieve interaction between programs which form, data communication[7].

Relevant factors affecting economic fluctuations

Gold is a special commodity, its unique physical properties, property characteristics determine its currency price changes with own characteristics. Investors making gold investment, gold price needs to be analyzed. Since gold has intrinsic value in itself is a commodity, and its product attributes determine its price changes with changes in commodity prices in general characteristics, namely prices, declining demand, supply increases; prices, rising demand, supply reduction, demand and supply sides of the Price changes affect the final form of dynamic equilibrium. Gold demands are mainly from consumer demand, industrial demand, demand for international reserves and investment demand aspects.

Generally speaking, it will cause gold prices increase when official gold reserves increases In addition, the price of gold and the world's official gold reserves of foreign exchange reserves accounted for the proportion of the relevant countries. Typically, this ratio is reduced as the price of gold will decline. The central bank gold sales policy is a factor supply factors in the most direct impact on the price of gold greatest. The stock market is a barometer of the national economy, stock market fluctuations and fluctuations in the price of gold was changing in the opposite direction. This mainly reflects investor expectations about the prospects for economic development, if it was generally optimistic about the economic outlook, the large amount of capital into the stock market, stock market investing warm, gold will decline. As an alternative investment vehicles stocks, gold prices and the U.S. stock market in most of the time showed high negative correlation.

In the international commodity markets, crude oil is one of the most important commodities. Crude oil prices have no direct relationship with the gold market in most cases. However, crude oil price fluctuations directly affect the world economy, especially the U.S. economy, which led to the value of the dollar and inflation concerns. Currently, the price of crude oil has become the global economy, "barometer", high oil prices also mean increased uncertainty of economic growth and inflation is expected to gradually heat up, then push up the price of gold. Trends in the commodity market prices can have a significant impact on the price of gold, in view of the gold product attributes, so the price trend analysis and tracking commodity investors must face the problem and solve. Global or regional financial crisis, the debt crisis will stimulate gold prices. Other factors that affect the price of gold are: geopolitical factors, seasonal factors, other changes such as gold interest rates, changes in gold ETF holdings of gold and cultures of different countries for the price of gold and other factors.

Trends in the commodity market prices have a significant impact on the economy, given the gold product attributes, so the price trend analysis and tracking of goods is an issue for investors to confront and solve. Global or regional financial crisis, the debt crisis will stimulate economic grid yellow rose. Other factors that affect the economy are: geopolitical factors, seasonal factors, other gold interest rate changes, changes in gold ETF holdings and gold yellow cultures of different countries for economic and other factors such as the impact of the grid. With the restoration and improvement of the international economic environment, the economy, investment in risky assets will gradually win the majority of investors. agent model can be a very effective measure of market risk in the gold market. In the current global financial market ups and downs, great mobility lattice wave yellow economic situation, we need to choose the relatively high level of confidence during the risk management and control of the process, the only way to effectively prevent the dramatic gold market turmoil and great risks. Further enhance investor awareness of gold investment, gold investment to learn more knowledge, a good grasp of investment opportunities and investment strategies to prevent risk aversion is good, they will get excess returns[8].

Analysis of estimation results

Rental price factors, for example, through the analysis of simulation results can be drawn with the commercial land price factors relevant conclusions: Booth no effect on the accumulation of government revenue, but it has a direct impact on the cumulative number of employees hired, the higher the price of the booth, industrial clusters cumulative hire fewer employees, is not conducive to employment, which has the influence on the macroeconomic economy and other enterprises' economy. The analysis and one economic explain are given for the simulation outcome, which verifies the feasibility and validity of the methods put forward in the paper Conclusion help us analyze the newspapers often publish productive land prices, business difficulties lead to bankruptcy of labor unemployment phenomenon. The simulation results indicate that trade barriers certain trade barriers in order to ensure access to basic enterprise development fund, or the whole industry cluster will be a lack of motivation for further development. For some indicators can be used to quantitatively describe indicators of decomposition and escape methods. Figure 4 shows the impact of market demand for the economic fluctuations.
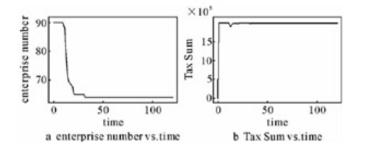

a enterprise number vs.time   b Tax Sum vs.time

Figure 4 : Impact of market demands for economic fluctuations

For example, the number of models to market demand, government tax, booth rental price, the market risk factor, industry profit margins can be carried out directly in the quantitative description of the simulation model. The labor market impact on the entire industry cluster development can't be directly quantified description. So the labor market must be broken down into the adequacy of the labor force, labor wages, labor productivity measured by three indicators. Labor wages and labor rates can quantitatively describe two indicators, and the result is a direct result of the labor shortage companies can't recruit enough labor market, unable to meet production orders, forced to discard some orders, so the simulation model of corporate behavior add a rule: under orders over production capacity, the enterprise discarded orders escaping.

In order to improve the realism of the simulation study, we used micro-enterprise case studies provided as a simulation model, the simulation model of environmental parameters using industry statistics, enterprise data parameters using the actual case, the simulation model directly to simulate the behavior of the corresponding Agent corporate decision-making behavior of the data is temporarily not available by way of the use of simulation obtained equilibrium, this series of measures and innovative ways to improve the fidelity of the simulation, making simulation results more credible. All in all, Agent-based modeling and application of artificial social process reference in this paper can create more artificial social model is applied to analyze the economic and social system[9].

The idea Agent modeling and neural networks, artificial intelligence technology to enhance learning combine Agent stock market by using different strategies, from simple to complex strategies to interact. Kwan economic simulation model based on Agent combines the latest technology evolution of learning and parallel computing, compared with the traditional economic model has many obvious advantages, simulate the economy in a single, consistent computing environment that allows changes in laws, rules and the impact of policies in other personal, residents and business units as described and simulated microscopic objects, in order to analyze the effect of the impact of macro policy and the micro units caused. Through statistical characteristic variables, analysis, inference, integrated, you can get the impact of policy changes on the microstructure of the individual, and then get the macro as well as all levels of policy implementation results.

CONCLUSIONS

Agent application economy is more pan plant a field, off the country's economic simulation model based on Agent combines the latest technology evolution of learning and parallel computing, compared with the traditional economic model has many obvious advantages in a single, consistent laws, rules affecting economic simulation computing environment that allows changes and policies to other personal, residential and business units, as described and simulated microscopic objects, in order to analyze the impact of policies on the microscopic and macroscopic effects units caused. Agent based artificial society modeling methodology is discussed firstly, then it is used to model industry clusters, and simulation descriptions to production and marketing behavior of enterprise in a cluster is given. The system realization related basic technology and theory. Modeling method of multi- agent economy complex system: creating Agent, Rule table, Agent Event Table method. The computer simulation model can help to analysis the influence factor of cluster development. The modeling process is a new attempt to apply Agent simulation into concrete economic social object.

ACKNOWLEDGEMENT

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