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Enterprise Projects Set Risk Element Transmission Chaotic Genetic Model

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Abstract: In order to research projects set risk transfer process and improve risk management efficiency in projects management, combining chaos theory and genetic algorithm, put forward enterprise projects set risk element transmission chaos genetic model. Using logistic chaos mapping and chebyshev chaos mapping mixture, constructed a hybrid chaotic mapping system. The steps of adopting hybrid chaos mapping for genetic operation include projects set initialization, calculation of fitness, selection, crossover and mutation operators, fitness adjustment and condition judgment. The results showed that the model can simulate enterprise projects set risk transmission process very well and it also provides the basis for the enterprise managers to make decisions.

Keywords: Chaos, Genetic Algorithm (GA), projects set, risk element transmission

INTRODUCTION

Enterprise is composed by many projects. The relationship between these projects is complex and forms a project set. Through interaction between multiple projects, it can realize the general objective of the enterprise. Risk exists in the whole process of project management. Risk occurring in the certain stage of the individual project, will produce effects to the project goal. The impact of the project transmits the risk to the related projects through the connection of projects. Then the series of risk transmission process can produce an effect to the ultimate goal of the enterprise. Consequently, the risk transmission between projects becomes the focus research of project risk management.

For multi-projects risk management research, there are so many literatures. Xie constructed risk decision model that use in technology innovation project portfolio choice. This model can use to make risk management research for technology innovation project portfolio (Xie, 1994). Xian-jin *et al.* (2007), proposed uncertain conditions R&D project portfolio selection optimization model. The model using fuzzy set theory describes fuzzy uncertainty of R&D project portfolio and sets up R&D project portfolio risk measure under uncertainty by bringing fuzzy entropy (Xian-jin *et al.*, 2007). Based on single project risk and the interaction effects between projects, Guo *et al*. (2009) reveals the risk change from single project to projects portfolio by the risk two elements (Guo *et al*., 2009). Chen analysis the problem of single project risk management model firstly, then put forward project portfolio risk management model and projects set risk management model based on enterprise multi-projects risk management (Chang-fu, 2010). Eunchang *et al*. (2009) put forward a kind of risk management mode of large engineering projects based on Bayesian incredible network and application in South Korea shipping industry (Eunchang *et al*., 2009). Goncalves *et al*. (2008) put forward a genetic algorithm that used to solve the resource constrained multi-project progress problem (Goncalves *et al*., 2008). Through the analogy economic concept, Costa and Barros put forward an evaluation software project portfolio risk level technology. The content mainly include that it allow managers to estimate the probability distribution of the profit and loss (Helio *et al*., 2007). The above researches are considering the risk management from the view of static and didn display of the dynamic characteristics of the risk, that is no consider the risk transmission.

To the research of project risk transmission, the different scholar research direction is difference. The mainly literatures are shown as follows: (Yuan-Ming and Dao-zhi, 2008) made a research of construction project risk transmission. They analyzed construction project quality risk occurrence and transmit mechanism and proposed two stages quality control risk transfer model (Yuan-Ming and Dao-zhi, 2008). On the basis of produce period risk that affected by it and project environment factors, Dao-zhi and Yuan-Ming (2008), studied the risk formation in PERT project single time and all time period and transmission mechanism (Dao-zhi and Yuan-Ming, 2008). Xiao *et al*. (2009). considered that product quality risk has transmission and expand effect from level to level under the environment of supply chain. They constructed

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the concept of quality supply chain based on quality function deployment, which used to analysis the technical characteristic under supply chain environment and customer demand transfer relationship. Finally, set up the quality risk transfer model under supply chain environment (Xiao *et al*., 2009). Considering the relationship between construction period and risk of big integration system project, Xiao-ju and Wang (2004) put forward a kind of risk transfer algorithm. It can calculate the system integration project total duration risk (Xiao-ju and Wang, 2004). Ragnar (1993), devote to the research of Switzerland energy sector risk transmission influence. The main content is that CO2 emissions threshold value change brings the influence of the greenhouse effect risk (Ragnar, 1993). Bostrom (2003) proposed that: the development of science and technology has changed the risk forms of communication. With the Internet and broadband in the home, the carrier and the medium risk transfer is changed (Bostrom, 2003). Jürgen (2006) put forward a different risk spread notion. The risk spread is not task that spread from the sender information to the receiver's but a process. In the process, the sender and receiver made interaction each other in order to achieve the objective (J gen, 2006). These research results rich single project risk management theory and provides the theoretical support for better making project risk management. And it also laid the solid foundation for research the risk transfer of multi-projects or projects set.

Based on the analysis of characteristics of the project set risk element transmission, the study puts forward the enterprise project set risk element transmission model. In addition, chaos theory and genetic algorithm are introduced to study projects set risk element transmission. The study constructs the projects set risk element transmission model based on hybrid chaotic genetic algorithm. It can well solve the enterprise project risk transfer problem and provide a new method to multi-project risk management.

METHODOLOGY

Enterprise projects set risk element transmission model: Whether construction enterprise or production enterprise, it can be regarded as the organic combination of multiple projects. We called a group projects that in order to complete the common goal as projects set. Risk exists in every link of the project implementation. Because of the transmission of risk and the risk transmission has "dominoes" effect, if it is not handled properly or not controlled in risk occurrence link, which means that a slight change of project risk will bring huge impact to the ultimate goal of project and projects set. Risk element is uncertainty factor that can produce influence to the specific practical consequences at a specific environment and specific time.

Projects set contain lots of projects and each project affect by kinds of risk elements. Risk element transmission in project and between projects, which make the projects set risk element transmission more complexity, look be like without rules, desultorily, etc. Risk element transmits through the time limit chain, supply chain, cost control chain resources and mixed chain in projects set. The transmission result has effect on the goal of projects set. E.g., a project has a time delay in a stage, which leading to the project period delay or cast limit time to generate additional costs. Then it leads project period of delays, cost rise and bring influence to start or normal operation of the related project. Finally, it leads to deviate from the project set overall goal, even lost and so on.

In order to study the complex process, this study constructs projects set risk element transmission model. It can be briefly described as follows: First of all, few risk elements changed in a project, thus caused relevant risk element change; then integrated these risk elements change, it can produce effect to the project and make this project in risk state. Next, the project produces effects to the related projects, that is, risk element transmission in projects. Finally, through a series of changes, it has a great effect on projects set. The model is shown in Fig. 1.

In the process of enterprise projects set risk element transmission, the transmission from project to another project is accomplished by the interaction of risk elements that in projects. The process of interaction between risk elements is very complex. The change of some risk elements follow a certain mathematical laws, but in most cases the risk element change mechanism is quite complex, not completely obey random distribution. Therefore, the realization of project objectives based on the probability model is very different than actual conditions. In addition, the pattern of risk element transmission includes chain, hierarchy, network and chaos etc. The transfer pattern in projects set mix together and form the complexity transmission process of projects set. On one hand, project risk element transmission process is similar to chaotic system, which is not seem rules, but in some sense, existence rule. On the other hand, risk element transmission constant changes with time went on, the risk element that has strong adaptability reserve down to the next phase of the transfer process. This point is similar evolution process, therefore, genetic algorithm can effectively simulation project sets risk element transmission process. To sum up, the study using chaos theory and genetic algorithm, studies the process of projects set risk element transmission.

Enterprise projects set risk element transmission chaos genetic model: The projects set risk element transmission has chaos characteristics and evolution characteristics, this study constructs enterprise projects set risk element transmission chaos genetic model to study risk element transmission in enterprise projects set. Chaos

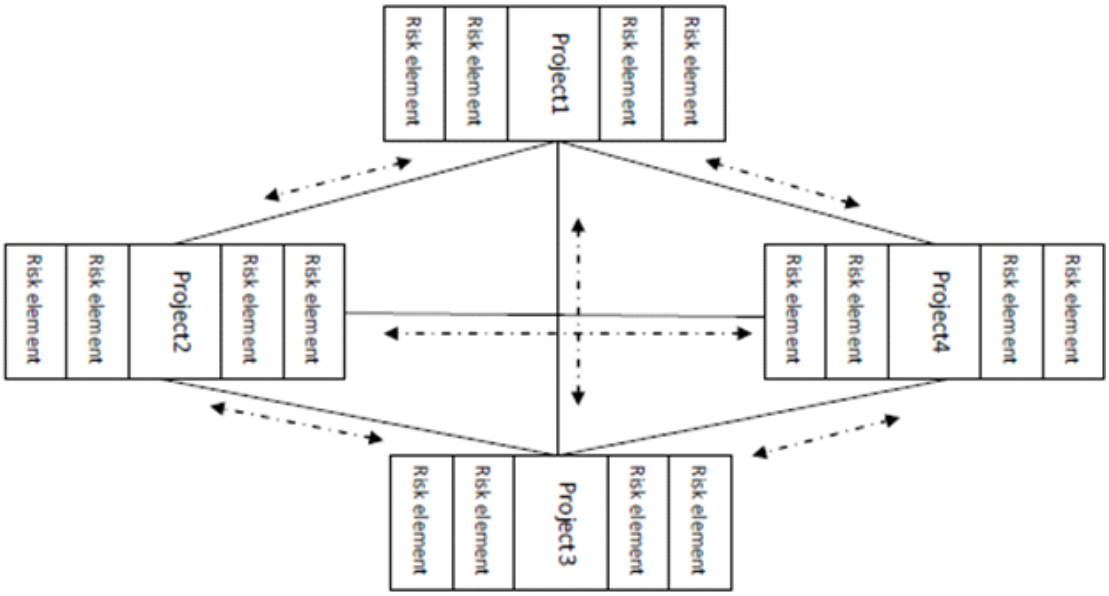


Fig. 1: Projects set risk element transmission model

genetic model steps include: projects set chaos mapping initialization, calculation of the individual project risk fitness, selection, crossover and mutation operations, etc. Specific modeling process is as follows (Yun-Xiao and Zhou, 2011; Xuefeng *et al*., 2003).

Hybrid chaos mapping: Projects set risk element transmission has chaos characteristics, each project contain few risk elements. Therefore, adopt chaotic sequence to initialize the risk state of projects set. The risk element of project has sensitivity of initial state and the uniformity of changes and so on. So, a single chaos mapping can't meet its requirements. Using Logistic mapping and Chebyshev mapping mixed chaos mapping is constructed.

The hybrid mapping makes the connection variables of Chebyshev map and Logistic map. The seed values of offspring chaotic sequence use the father generation chaos mapping result. It improves the uniformity of the generation chaotic sequence and formats a unified output sequence. The specific expression is shown as following:

$$\begin{aligned} y_0 &= x_0 \\ y_{n+1} &= \cos\left(k \arccos y_n\right) \\ tep &= \mu x_n\left(1 - x_n\right) + \left|y_{n+1}\right| \\ x_{n+1} &= \mathrm{mod}\left(temp, 1\right) \end{aligned} \quad (1)$$

x_0, y_0 is the initial value of hybrid chaos. μ, k is the control variable of the hybrid chaotic sequence. According to the characters of Logistic map and Chebyshev map, we can know that the value of k and μ is 4, respectively. The hybrid chaotic sequence gets to chaotic state. The system first generated y_n through the Chebyshev map chaos generator, then based on Logistic chaos mapping generation intermediate state chaotic sequence, finally, it obtains the final chaotic sequence through amendment. Through the hybrid chaotic system to produce a chaotic sequence, it has the initial value sensitivity, ergodicity and uniformity, as shown in Fig. 2 shows.

Projects set risk element chaos initialization: Firstly, generate a chaotic sequence by hybrid chaos mapping to initialize projects set. Then, make the initial project set chaotic sequence as the initial value and generate a new chaotic sequence by hybrid chaotic system. Finally, use the new chaotic sequence as the individual project risk element value. The specific process is as follows:

Suppose: Projects set contain N projects. The number of influence risk of each project is m. Then the projects set show as following:

$$\begin{aligned} &P\ \{P_1, P_2, \ldots\ldots, P_N\} \\ &P\ \{Pi_1, Pi_2, \ldots\ldots, P_{im}\} \end{aligned} \quad (2)$$

P = indicate the initial projects set
P_i = indicate the individual of projects set
P_{ij} = stand for the risk element of individual of projects set

The maximum value of influence by risk element is L and then the initial of projects set show as follow:

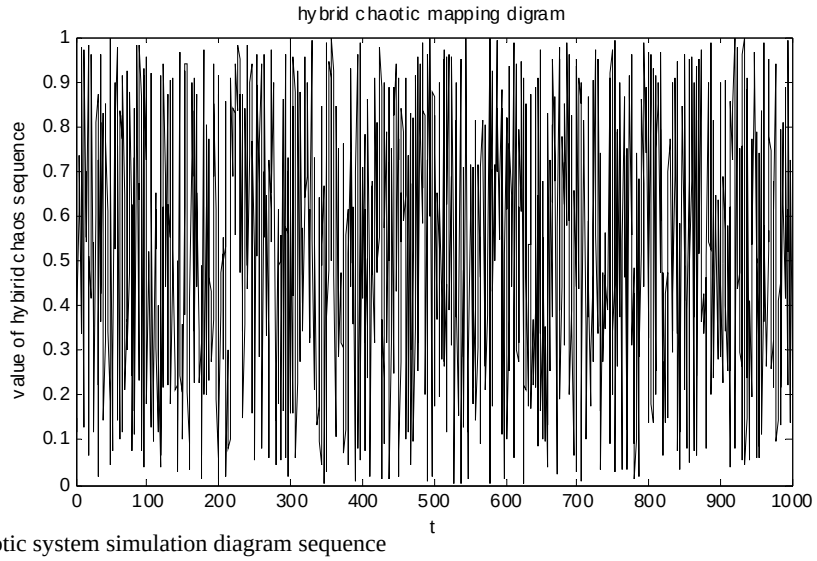


Fig. 2: Hybrid chaotic system simulation diagram sequence

$$P_1 = L\times\{x_{11}, x_{12}, ..., x_{1j}, ..., x_{1m}\}$$
$$P_2 = L\times\{x_{21}, x_{22}, ..., x_{2j}, ..., x_{2m}\}$$
$$\cdots$$
$$P_i = \tilde{L}\times\{x_{i1}, x_{i2}, ..., \tilde{x}_{ij}, ..., x_{im}\} \quad (3)$$

where, x_{11}, x_{21},..., x_{i1},..., x_{N1} is the chaotic sequence generate by hybrid chaos system.

Genetic operations based on hybrid chaos: Apply hybrid chaos sequence in selection, crossover and mutation operation, which can improve randomness and uniformity in projects set risk element transfer process by using the features of hybrid chaotic sequence.

Chaotic selection operation: Generate a chaotic sequence by using hybrid chaotic system. $\{x_0, x_1, x_2, ... x_k\}$
where, k is the number of joining selection operation. Then, the sequence number of selection is decision by the formula shown as follow:

$$\left\{\left([k\times x_0],[k\times x_1]\right),\left([k\times x_2],[k\times x_3]\right),.....,\left([k\times x_{2k-2}],[k\times x_{2k-1}]\right)\right\} \quad (4)$$

where, x_0, x_1, x_2, x_3,....., x_{2k-1} indicate the hybrid chaotic sequence generate by the initial value x_0. $[k\times x_0]$ indicate get the round number.
After the process, we get k pairs number of project.

Chaotic crossover operation: The number of risk element is m. So, the position of attention crossover operation risk element is decision by the formula (5):

$$\{[m\times x_0], [m\times x_1], [m\times x_2], ..., [m\times x_k]\} \quad (5)$$

where, x_0, x_1, x_2, ..., x_s is a chaotic sequence generate by the initial value x_0 .

Chaotic mutation operation: The mutation operation also uses the hybrid chaotic sequence to choose the risk element mutation serial number j. The serial number j is decision by the formula (6):

$$j = [m\ x_i] \quad (6)$$

where, x_i is the hybrid chaotic sequence.
Adaptive crossover probability and mutation probability: Crossover probability and mutation probability play an important role in chaos genetic models. Fixed probability can't real-time reflect the dynamic situation of projects set, so the study puts forward a adaptive crossover probability and mutation probability (Gharooni-farda *et al*., 2010; Wu, 201.0)

Adaptive crossover probability: According to the general crossover probability in between 0.4 and 0.99, we make the change as following:

$$\begin{cases} P_{cross} = 0.4 + 0.6\times K_1\dfrac{f_{\max} - f_{ave}}{f_{\max}}, & f_{ave} \le f_{\max} \\ P_{cross} = 0.4 + 0.6\times k_1, & f_{ave} > f_{\max} \end{cases} \quad (7)$$

Adaptive mutation probability:

$$\begin{cases} P_{mutation} = k_3\dfrac{f_{\max} - f}{f_{\max} - f_{ave}}, & f > f_{ave} \\ P_{mitation} = k_4, & f \le f_{ave} \end{cases} \quad (8)$$

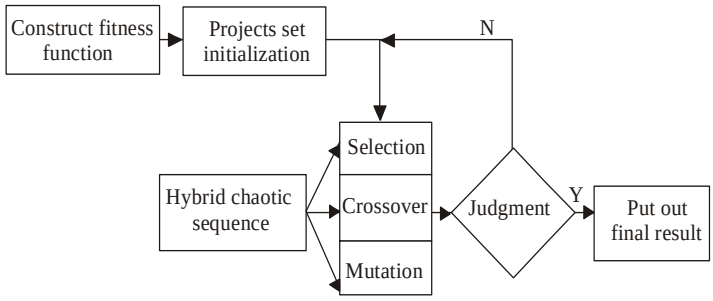


Fig. 3: Flow chart of enterprise projects set risk element transmission chaos genetic model

where,

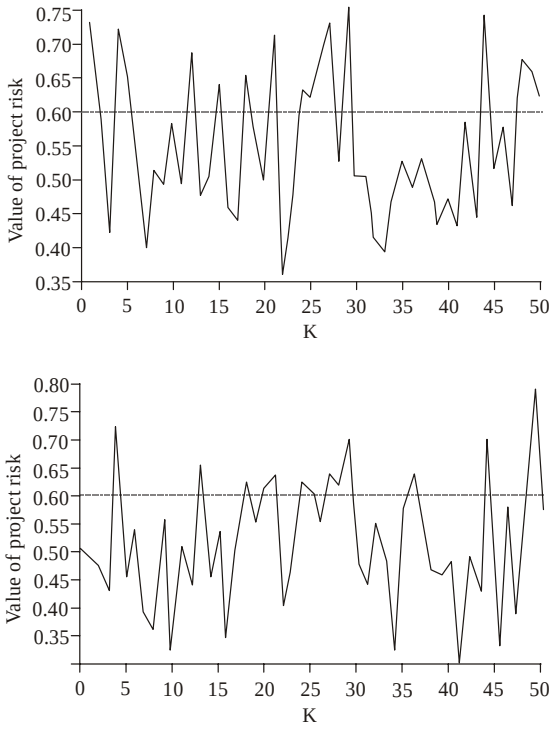
P_{cross} = The crossover probability
$P_{mutation}$ = The mutation probability
f_{max} = The biggest value of fitness
f_{ave} = The average value of fitness
f = The individual value of fitness
k_1, k_2, k_3, k_4 = Constant coefficient

Basic process of enterprise projects set risk element transmission chaos genetic model: The projects set risk element transmission chaos genetic model Flow chart is shown in Fig. 3.

Model simulation and analysis:
Basic assumptions: A projects set contains 50 projects. These projects connect together through capital chain, period chain, resources supply chain and cost chain and form a complex nonlinear system. There are many kinds of risk elements in project environment. For example, policies and regulations and natural conditions, economic conditions and technological conditions, human factors and so on. Those risk elements have effect on the project and the connection of projects. A slight change of point, that will give related node and project bring certain effect, finally bring the influence to the projects set goal. In order to the simulation of convenient, this study takes 8 risk elements for simulation. In order to keep the initial model operation, set the initial crossover probability was 0.85, the variation probability for 0.07.

RESULTS OF THE SIMULATION EXPERIMENT

Figure 4 is the simulation figure of 50 projects and 8 risk elements. The time of iteration is 50. The projects set eventually risk probability distribution shows in Fig. 4. We can see that, after 50 times between projects risk element transmission, the project risk probability have a greatly change than the initial state. The simulation results show that the risk status value of projects set gradually change from the initial uneven to uniform. In the initial



state, risk value difference is bigger from project to project among projects set, besides risk value of many projects is greater than the threshold level (0.6); After fifty generation of chaos genetic risk transmission, risk

Fig. 4: Projects set risk element transmission simulation the red line is the normal value of project risk

state of projects set moderate and most projects' risk value is under normal level, only a few of projects are at risk state. According to the distribution of project risk value at the end of simulation, we can be used for analyzing the impact change of the whole project through risk element transmission. Then monitor the risk value project and prevent the occurrence of a risk, so as to achieve the ultimate goal of the project set.

Application of enterprise projects set risk element transmission chaotic genetic model: Because of the complexity of the projects set connection, the traditional analytical method to solve the projects set risk element transfer problems has failed to meet the needs of practical application. Therefore, intelligent simulation method will become the first choice tools of projects set risk element transfer. The change of a project node, will lead to the corresponding node change. That is the projects set risk element transmission has initial value sensitivity and randomness. Above analysis show that projects set risk element transmission is a complex system and chaotic systems. Therefore, we can use the chaos mapping to simulate the evolution process of enterprise projects set risk element transmission. Random change of some nodes in projects set, can simulate through the chaos genetic model before enterprise decision, we can forecast the projects set risk and analyze some factors change to variations of projects set risks.

CONCLUSION

Along with the enterprise scale and business expansion, the links between enterprise projects become more closely. The effects of projects set risk element transmission is expanding at the same time. Based on the analysis of projects set risk element, the study proposes the model of enterprise projects risk element transmission and construct the chaos genetic model of enterprise projects set risk element. The chaos genetic model of enterprise projects set risk element, adopt chaos theory and genetic algorithm and apply hybrid chaos mapping system to build enterprise projects set risk element initial transmission state. Then, use the chaotic selection, crossover and mutation operation for genetic operation, which is the process of projects set risk element transmission. Utilizing the model can help the manger to make decision. When the decision maker faces the change of risk element, the model could help to forecast the projects set risk state change. According to the forecast results, the manager can make relevant decision and avoid high-risk decisions.

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