The Application of Improved Genetic Algorithm in Business Model

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Abstract
With the increasingly fierce competition and technological progress, business model has gradually become the focus of attention, through the business model innovation to establish their own competitive advantage, become the internal pursuit of the enterprise. This work is based on the research of business model innovation based on complex system theory, the innovation of business model is regarded as a dynamic evolution process, and then the Innovation Law of business model is analyzed. Based on the traditional model of business, this work firstly studies the innovation of business model by genetic algorithm and analyzes the evolution rule of business model with different complexity. Secondly, in order to further study the dynamic influence of the business model structure on innovation, the business model structure is also coded to participate in the evolution process to analyze the innovation pattern of business model under the radical innovation vision. Finally, this work introduces the improved genetic algorithm, dynamically adjusts the strategic parameters in the evolution process, and better describes the decision-making process of the business model innovation.

Keywords: Improved Genetic Algorithm, Business Model, Complex system theory, Innovation.

1. INTRODUCTION
So far, the business model has not formed a unified understanding and system in the theoretical research. The theoretical research on the business model is mostly put forward in the conceptual and analytical framework, combined with the descriptive research level of case analysis. The characteristics of the business model and its constituent elements have not yet been defined. Researchers usually describe the importance of the business model from the areas of interest and the role and influence of the business model. The theory of mesoscopic business model not only provides a set of methods and frameworks for the analysis of business model, more importantly, it lays the foundation for the quantitative research of Science, which is the object which can be simulated by computer(Kannan et al.,2010).

The business behavior of the enterprise can be saved in the form of practice, the existence of business practices can effectively control their own to maintain the relative stability. The existence of a convention does not mean that it is constant in the evolution of the business model, and firms often need to learn through continuous learning and innovation to find a practice which is more adaptable to the environment in the environment. The new practice will become another way to dominate the next decision point of the firm. Thus, the evolution of the business model is not bound to meet the environmental changes, it is subject to the original development path and way. The characteristics of the business model determine the need for innovation to change the relationship between its complex system components and elements, components and elements, which inevitably involves business model module innovation and business model structure innovation(Lee et al.,2002).

Based on the genetic algorithm with stronger ability, this work introduces the dynamic evolution of the business model into the research and analysis framework, not only from the static fitness terrain, but rather the analysis of the complexity of the business model (Bačić, 2016; Jalal et al., 2017). Based on the statistical analysis of the model results, this work investigates the influence of imitation innovation, independent innovation, module innovation and structural innovation on the optimization of business model and the feedback mechanism in the process of decision-making, and the feedback mechanism in the decision process is used to compare the results of evolutionary innovation, then it summarizes the general rules and strategies that are followed in the dynamic process of business model innovation (Finoand Kojima, 2009). The research of this work has some new theoretical achievements, it is a supplement to the innovation of business model, enriches the theoretical system.
of the intermediary business model, and points out the need for further research, which has important theoretical significance.

2. RESEARCH ON BUSINESS MODEL INNOVATION BASED ON TRADITIONAL MODEL

According to the definition of the mesoscopic business model, the model is a meaningful combination of the customer interface, the internal structure and the elements of the interface. Therefore, the scale of the NK component of the business model is N = 3, and c, s and P respectively represent the client, internal structure and partner interface. We can divide the complexity of the business model into 10 types, as follows: 000, 001, 002, 011, 012, 022, 112, 122, and 222. Here to explain that, because from the complexity point of view, business model 011 and 101,110 complexity is the same, so ten types are simplified after the situation. The sum of the values on the parameters of the parameter K reflects the magnitude of the interaction between the business model components, and the combination of the different values reflects the distribution of the interaction between the business model components. The degree of complexity of the business model is determined by the number of interactions between its components, that is, the complexity of the business model first depends on the sum of the numerical values of the parameters K. On this basis, in turn, compare the size of the numerical value of each digit. For example, the scale of model K=111 is 3 and the scale of model K = 011 is 2, so the complexity of model 111 is greater than model 011. While the size of the model K = 012 is also 3, but the maximum number of bits in its bits is 2, so its complexity is greater than the model 111(Herrera et al., 2001).

The evaluation index of the business model is measured by the fitness degree, in reality, it is necessary to give different meanings according to the background of the actual problem, such as some meaningful economic and management indicators. At the same time, it is assumed that the 3 components have the same impact on business model fitness. Thus, the fitness of the business model is the average of the impact of all components on the fitness of business model(Shin et al., 2002), namely:

\[ W(c, s, p) = \frac{1}{3}[W_c(c) + W_s(s) + W_p(p)] \]  

Due to the complex system characteristics of the business model, the interaction between the three components is nonlinear and random, so it is difficult to predict the specific form of \( W_c \), \( W_s \) and \( W_p \). However, according to the basic idea and principle of the NK model, the statistical mechanics of the complex system, it is assumed that the influence of the business model components on the business model fitness is a random variable which is evenly distributed over the (0,1) interval. Therefore, When the business model is innovating, that is, that is, the composition of the business model of the form of variation, it can be based on the components of the interaction with other components, the number of random numbers uniformly distributed on a certain (0,1) interval is taken as the result of the influence of the components and other components on the business model fitness., so the new fitness value of the business model is obtained, and the interaction relationship between the components of the business model as a complex system and its results are simulated, as shown in Table 1:

<table>
<thead>
<tr>
<th></th>
<th>c</th>
<th>s</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>( W_c )</td>
<td>x</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>( W_s )</td>
<td>x</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>( W_p )</td>
<td>x</td>
<td>-</td>
<td>x</td>
</tr>
</tbody>
</table>

3. ADAPTIVE GENETIC ALGORITHM

Most genetic algorithms use fixed parameters, the selection of the parameter value is based on the method of setting a test. Since the genetic algorithm is essentially dynamic and adaptive, the method of using fixed parameters is contrary to the general evolutionary spirit. The adaptive genetic algorithm with deterministic rules can achieve a high level of enterprise business model adaptability in a short time and less innovation. However, the decision-makers in the decision-making process is bound to analyze the decision once, feedback information
is thus obtained to dynamically adjust strategic parameters in the innovation process of business model, it is necessary to adapt to adaptive genetic algorithm for modeling analysis (Wang et al., 2010).

In this work, an adaptive genetic algorithm is proposed, which enables \( p_c \) and \( p_m \) to change automatically as the value of the adaptation function changes. This method is only a simple algorithm point of view when the individual population adaptation value tends to be consistent or tend to local optimum, so that \( p_c \) and \( p_m \) increase. And when the population fitness is relatively dispersed, so that \( p_c \) and \( p_m \) reduced. At the same time, for individuals with fitness values above the population mean, they correspond to lower \( p_c \) and higher \( p_m \); individuals with individual fitness values below the mean, corresponding to the higher \( p_c \) and \( p_m \), this adaptive way to adopt the formula is as follows (Wu et al., 2007):

\[
\begin{align*}
    p_c &= \begin{cases} 
    p_{c1} & f' < f_{avg} \\
    p_{c1} - \frac{(p_{c1} - p_{c2})(f' - f_{avg})}{f_{max} - f_{avg}} & f' \geq f_{avg}
    \end{cases} \\
    p_m &= \begin{cases} 
    p_{m1} & f < f_{avg} \\
    p_{m1} - \frac{(p_{m1} - p_{m2})(f_{max} - f)}{f_{max} - f_{avg}} & f \geq f_{avg}
    \end{cases}
\end{align*}
\]

Where:
- \( f_{avg} \): The average fitness of each group;
- \( f_{max} \): The maximum fitness of the population;
- \( f \): The group should change the fitness value of the individual;
- \( f' \): The larger fitness values of the two individuals to be crossed;
- \( p_{c1}, p_{c2} \): Maximum crossover rate and minimum crossover rate;
- \( p_{m1}, p_{m2} \): Maximum variability and minimum variability.

This adaptive genetic algorithm can keep the diversity of the group while ensuring the convergence of the algorithm, but the convergence rate is slow. From the point of view of the decision makers, they want to mimic the good business model to obtain useful fragments in the gene, so the probability of crossing should be increased. For good business models, decision makers are more likely not to ruin their structure, therefore, the probability of variation is reduced so as to find the best and stable business model in the shortest possible time. This work uses the following formula:

\[
\begin{align*}
    p_c &= \begin{cases} 
    p_{c1} & f' < f_{avg} \\
    p_{c1} - \frac{(p_{c1} - p_{c2})(f' - f_{avg})}{f_{avg} - f_{min}} & f' \geq f_{avg}
    \end{cases}
\end{align*}
\]
According to the deterministic rules AGA obtained by the numerical table to do comparison, as shown in Tables 1 and 2. Adaptive AGA has lower fitness values than deterministic adaptive ones, we note that the adaptability based on the AGA evolution results show that the pay cost is much lower than deterministic adaptation. Thus we get the evolution of the law of nine: In the business model evolution process, the analysis of each innovation results to guide the next moment of innovation can greatly reduce the cost of business model innovation, the business model innovation results than pure from the module latitude of the innovation results are better, and in a shorter time to find a better business model prototype. Figure 1, 2 show the adoption rate of business model structure. Table 2 shows the adoption rate of high and low complexity business model structure. The graphs show symmetrical distribution between the components, the more complex the structure, the lower the adoption rate. Among the medium complexity K = 111 type of business model structure of the highest rate, which once again verify the aesthetic principles of the structure. As can be seen from Figure 3, the adaptive genetic algorithm has a higher rate of self innovation at the same time (Kuo et al., 2004).

### Table 2
Index values based on adaptive evolution of AGA

<table>
<thead>
<tr>
<th>bestfit</th>
<th>pcinnotime</th>
<th>pminnotime</th>
<th>pcarc-time</th>
<th>pmarc-time</th>
<th>generation</th>
</tr>
</thead>
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<tr>
<td>0.810121</td>
<td>100.8802</td>
<td>54.0148</td>
<td>97.4002</td>
<td>53.6586</td>
<td>27.7431</td>
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### Table 3
Business model structure adoption rate based on adaptive AGA

<table>
<thead>
<tr>
<th>K</th>
<th>000</th>
<th>001</th>
<th>011</th>
<th>002</th>
<th>111</th>
<th>012</th>
<th>112</th>
<th>022</th>
<th>122</th>
<th>222</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0864</td>
<td>0.1021</td>
<td>0.1409</td>
<td>0.0871</td>
<td>0.1602</td>
<td>0.0991</td>
<td>0.1369</td>
<td>0.0677</td>
<td>0.0642</td>
<td>0.0533</td>
</tr>
</tbody>
</table>

### Figure 1
Curves of adaptability and decay rate
4. CONCLUSIONS

Based on the business model of the NK model, the adaptive genetic algorithm is used to study business model innovation, business innovation model is created based on genetic algorithm. By analyzing the evolution law of business models with different complexities, the strategic parameters in the evolution process are dynamically adjusted to better describe the decision-making process of business model innovation. The simulation results show that the adaptive genetic algorithm can optimize the business model better than the traditional NK model, and the scheme is feasible.

5. ACKNOWLEDGEMENT

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