

# Simulation Analysis of Brand Dynamic Equilibrium Equation Based on Neural network and Structure Constraint Equations

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**Abstract.** In order to study the contribution of hotel founder, senior managers and ordinary employees on the hotel service brand core value, this paper studies the main function and the internal structure constraint relationship of the three, and uses the neural network algorithm to design the dynamic equilibrium equations of investment and the income, uses two order difference quotient to optimize the iterative error, finally uses MATLAB software to do numerical simulation calculation on three space distribution characteristics. Through calculation, the 3D distribution characteristics curve of hotel service brand internal constraint relation is obtained, and the fitting curve of the hotel internal and external relationships construction is obtained. From the curve it can be seen, the hotel internal structural constraints has dependence relationship with external relationship building, and success service brand internal construction can better ensure the external construction.

## Introduction

Hotel service brand is consistent with product brand in principle, but there are obvious differences in the implementation. The service brand building should include internal and external, but the existing theory and practice often focus on service brand external construction, ignoring the internal construction of service brand. Service brand internal construction involves hotel founder, hotel managers and ordinary employees. In effect of hotel brand relations, it presents the obvious 3D distribution structure characteristics [1-3]. In order to study the main body functions and relations of the hotel under the constraint of brand structure, this paper uses the neural network algorithm to design the dynamic equilibrium equations of investment and income, and uses MATLAB software to calculate the space distribution characteristics of the three. The overall frame is as shown in Figure 1.

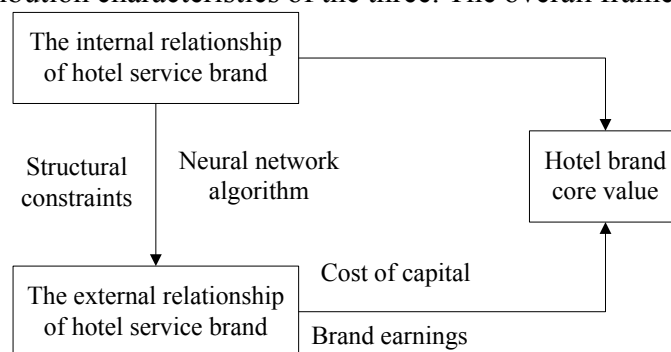


Fig. 1 The main body function frame of hotel service brand

Figure 1 shows the main body function frame of hotel service brand [4]. From the chart it can be seen, the hotel service brand internal relationship can act on external relations, which can be evaluated by the structural constraints and neural network algorithm, finally through the capital cost and the brand income acting on the hotel brand core value.

## The Service Brand Value Balance Algorithm Design based on Neural Network

Neural network algorithm is a common method in data mining [5, 6]. In the investment and profit balance relationship of hotel service brand, the leading role is the magnitude of service brands value,

including hotel founder, senior managers and ordinary employees, and the balance equation is as shown in formula (1).

$$C\ddot{U} + G\dot{U} + YU = R. \quad (1)$$

$C$  is the core value amount of hotel founder service brand,  $G$  is the core value of hotel managers service brand,  $Y$  is core value of ordinary employees service brand,  $R$  is the hotel external relations function,  $\ddot{U}$ ,  $\dot{U}$  and  $U$  are respectively investment acceleration, speed, and investment amount functions. And the equilibrium relation can be expressed as:

$$F_I(t) + F_D(t) + F_E(t) = R(t). \quad (2)$$

$$\begin{aligned} F_I(t) &= C\ddot{U} \\ F_D(t) &= G\dot{U} \\ F_E(t) &= YU \end{aligned} \quad (3)$$

Among them,  $F_I(t)$  is founders return balance equation,  $F_D(t)$  is the manager revenue balance equation,  $F_E(t)$  represents a general staff income balance equation, and they are related with the time  $t$  [7, 8]. This equation can be solved with the central difference method, as shown in the formula (4).

$$\begin{aligned} \ddot{U}_t &= \frac{1}{\Delta t^2} \{U_{t-\Delta t} - 2U_t + U_{t+\Delta t}\} \\ \dot{U}_t &= \frac{1}{2\Delta t} \{-U_{t-\Delta t} + U_{t+\Delta t}\} \end{aligned} \quad (4)$$

Putting the formula (4) into formula (2) with time  $t$ , it can get:

$$\left(\frac{1}{\Delta t^2}M + \frac{1}{2\Delta t}C\right)U_{t+\Delta t} = R_t - \left(K - \frac{2}{\Delta t^2}M\right)U_t - \left(\frac{1}{\Delta t^2}M - \frac{1}{2\Delta t}C\right)U_{t-\Delta t}. \quad (5)$$

From the formula (5) it can get  $U_{t+\Delta t}$ . In order to accelerate the convergence of residuals, it can adopt the neural network training to define one order difference, as shown in formula (6).

$$U(x_0, x_1) = \frac{U(x_1) - U(x_0)}{x_1 - x_0}. \quad (6)$$

The two order training difference quotient is defined as:

$$7U(x_0, x_1, x_2) = \frac{U(x_0, x_2) - U(x_0, x_1)}{x_2 - x_1}. \quad (7)$$

The neural network training can greatly improve the convergence of computing. In order to realize the algorithm, it needs the help of the software programming [9]. This paper uses the MATLAB to design the algorithm, and the program is as follows:

```
function net=GABPNET(XX,YY)
GABPNET.m
nntwarn off
XX=premnmx(XX);
YY=premnmx(YY);
et=newff(minmax(XX),[19,25,1],{'tansig','tansig','purelin'},'trainlm')
P=XX;
T=YY;
R=size(P,1);
S2=size(T,1);
```

```

S1=25;
S=R*S1+S1*S2+S1+S2;
aa=ones(S,1)*[-1,1];
popu=50;
initPpp=initializega(popu,aa,'gabpEval')
.....

```

### Simulation of Hotel Service Brand Structure Constraint Relation

In order to effectively verify the effectiveness and reliability of hotel brand constraint relation neural network algorithm designed in second section, this paper uses MATLAB to study the hotel service brand constraint relationship, by drawing graphs and curve fitting, the constraint relation is visual.

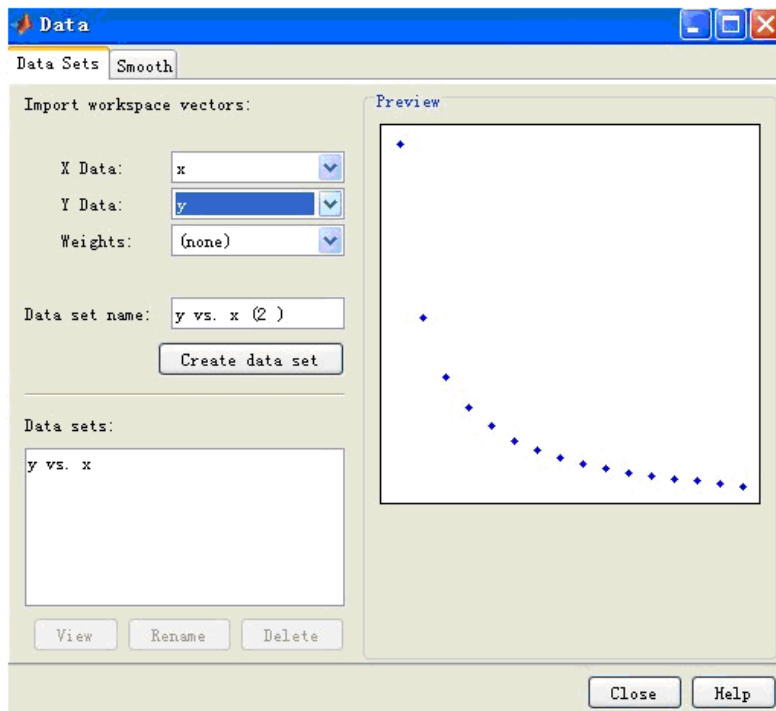


Fig. 2 MATLAB image rendering toolbox

Figure 2 is the MATLAB image rendering toolbox. MATLAB has powerful data processing function, supporting programming and image visual display [10]. And the curve can be done fitting, getting the data internal relations and structural distribution.

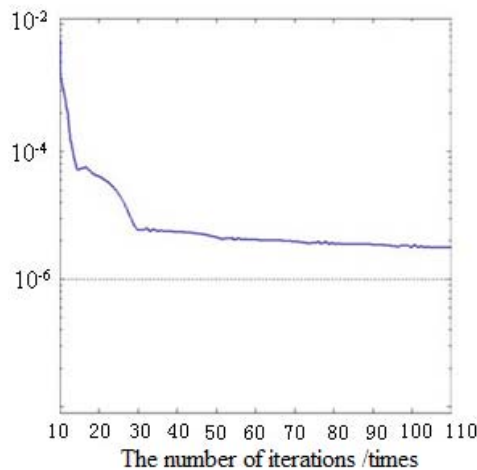


Fig. 3 The MATLAB calculation convergence curve

Figure 3 shows the convergence curves calculated by MATLAB. From the chart it can be seen, when the calculating step is 10 step, the convergence accuracy has reached  $10^{-2}$  [11, 12]; when the

calculating step is 110, the convergence precision is below  $10^{-5}$ , and the calculation convergence is better and meets the requirements of calculation accuracy.

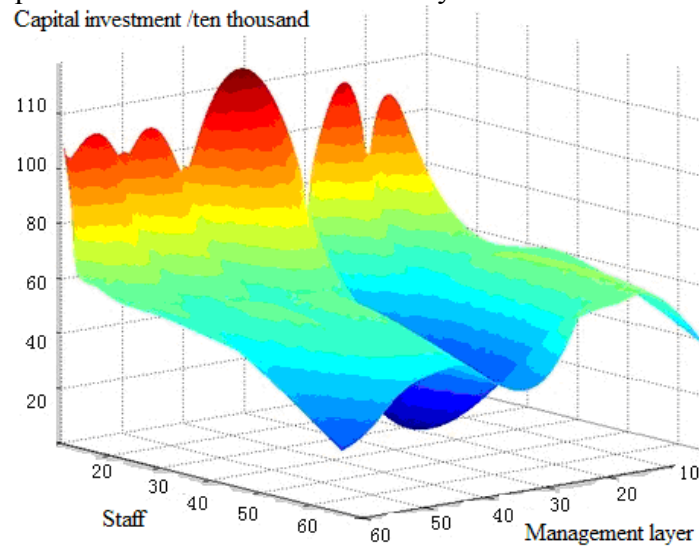


Fig. 4 The hotel service brand internal constraint relation

This paper uses MATLAB software to do data mining on the brand core value contribution of the staff and management, and gets the hotel service brand internal constraint 3D diagram, as shown in Figure 4 [13]. From the chart it can be seen, when the core value of management layer and the staff reaches the highest, hotel management and maintenance of inputs required minimum capital; when the management core value or employee is higher at one side, hotel investment costs will reach peak, reducing the hotel service brand earnings.

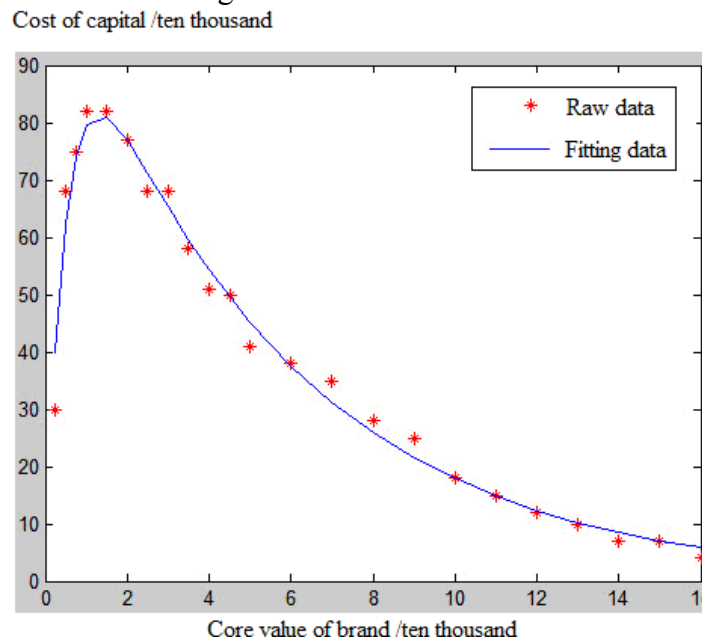


Fig. 5 The curve fitting of hotel internal structure relation and external structure.

Figure 5 represents structure relation fitting curve using MATLAB. From the chart it can be seen, the core value of service brand can effectively reduce the capital cost of hotel management [14, 15]. In the structural constraints of capital's core values, the service brand profits created by hotel internal relationship can gradually approach the external relations, this shows that the construction of the internal relationship is very important, the hotel should strengthen the internal construction in the management process and create better service brand.

## Summary

In order to study the investment and benefits dynamic balance relationship of hotel service brand, this paper established the structure constraint of hotel founder, senior management and hotel staff, and uses it to evaluate the hotel investment and the income. This paper uses MATLAB to do numerical simulation on the hotel service brand internal constraints 3D distribution characteristics, and does curve fitting on the hotel brand internal and external structural relationship. In order to improve the precision of iterative calculation and reduce the calculating error, this paper uses the neural network two order difference quotient to optimize the calculation results. Through the computing, when the core value of management layer and the staff reaches the highest, the inputting cost of hotel management and maintenance requires minimum. In the structure constraint of capital core values, the service brand profit created by hotel internal relationship gradually approaches to the external relations.

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