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Research Article

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Table tennis size to competition experience quality influence research based on BP neural network and ASCI model

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ABSTRACT

The paper applies differential equation researching table tennis players' competition experience quality; it gets athletes to table tennis size experience degree relative conclusions, and finds that table tennis enlarging has greater influence on athletes. And then utilize BP neural network and ASCI model to discuss audience appreciation quality to competition, and get that 39.4mm as table tennis diameter is optimal solution that accepted by both athlete experience quality and audience appreciation quality.

Key words: differential equation, BP neural network, ASCI model, difference equation, table tennis

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INTRODUCTION

In 2000, international table tennis federation increased international table tennis professional competition official ball diameter from 38mm to 40mm. The aim is to further increase ball's air resistance during air running, slow down competition's ball running speed, so that achieve the purpose of further increasing and enriching table tennis professional athletes hitting techniques and skills, and finally increase table tennis competitions' overall appreciation. However, since incoming of table tennis "big ball era" up to now, dispute about ball diameter has never ceased .Chinese and foreign coaches and athletes from all walks of life have mixed. It is worth noting that due to professional athletes' height, playing habit, gripping habit differences, their sensitivities to ball diameter changes are also different.

Diameter changes, the most direct influence is ball rotational speed. Athlete experience quality should be converted into quantitative indicator to reflect, regard table tennis drop point time and kinetic energy integration as quantitative indicators, when table tennis drop point time and kinetic energy are optimal, establish corresponding evaluation system with corresponding optimal initial angular speed, take corresponding angular ratios when diameter corresponded initial angular speed and athlete experience quality are optimal as indicators that reflects problems. Therefore, it can optimization control theory solving athlete experience quality optimal problem with table tennis drop point time and kinetic energy integration as quantitative indicators.

In the aspect of table tennis audience appreciation quality, it applies ASCI model, uses audience appreciation quality replacing customer satisfaction degree, others are respectively: athletic image, athlete performance expectation, athlete performance perception, perceptive value, audience fidelity, audience complain as investigation indicators. It collects audience watching table tennis objective evaluation actual data and result, and these become training and testing basic data, training samples by sorting and normalizing indicators. After fulfilling training, verify the samples. Make comparison between BP neural network evaluation result and actual audience evaluation result. It gets 38mm audience score and 40mm audience score, use scores as audience appreciation quality evaluation indicator. High score means high audience appreciation quality.

Finally the paper establishes difference equation model, solving the equation, and get that both athlete experience

quality and audience appreciation quality acceptable solution that is best table tennis diameter length.

Differential equation model

2.1 Model preparation

It is known that original 38 mm table tennis spherical shell thickness is 0.39 mm, inner diameter is 18.61 mm(R_2), its external radius is 19 mm(R_1), ball mass is 2.5g(m_1).Set that ball manufacturing material volume is V_1 , ball manufacturing material density is ρ :

$$\rho = \frac{m_1}{V_1} = \frac{2.5}{1.7333} = 1.44\ \left(g/cm^3\right)$$

It is known that big ball diameter is 40 mm, external radius r_1 is20 mm, internal radius r_2 is 19.61 mm, and then big ball manufacturing material volume V_2 、 mass m_2 are respectively:

$$V_2 = \frac{4}{3}\pi r_1^{\ 3} - \frac{4}{3}\pi r_2^{\ 3} = 1.9217\ \left(cm^2\right)$$
$$m_2 = V_2\rho = 2.17177\ \left(g\right)$$

Two ball volume difference and ball manufacturing mass difference are respectively ΔV and Δm :

$$\Delta V = \frac{4}{3}\pi r_1^{\ 3} - \frac{4}{3}\pi R_1^{\ 3} = 4.781\ \left(cm^3\right)$$
$$\Delta m = m_2 - m_1 = 0.21717\ \left(g\right)$$

40mm table tennis rotational speed changes

Rotational inertia $J = \frac{2}{3}mr^2$

Angular momentum theorem $L = J\omega$

Law of rotation $M = J\alpha = J\frac{d\omega}{dt} = \frac{d(J\omega)}{dt} = \frac{dL}{dt}$

Fixed-axis rotational rigid body angular momentum theorem $\int_{t_1}^{t_2} Mdt = L_2 - L_1$

Momentum theorem $Ft = m\Delta v$

If athlete hits different sizes two balls in the same way and with equal size force, due to big ball and small ball rotational inertias are different, and then ball movement state changes will obviously different, two kinds of balls rotational inertia computing formula is:

$$J_1 = \frac{2}{3}mr_1^{\ 2} = 6\ \left(g\cdot cm^2\right)$$
$$J_2 = \frac{2}{3}mr_2^{\ 2} = 7.3912\ \left(g\cdot cm^2\right)$$

Calculate according to small ball rotational speed 50 r/s, according to moment of momentum theorem, it can work out big ball rotational speed ω_2 , because $Mt_1 = J_1\omega_1$, $Mt_2 = J_2\omega_2$, and then $J_1\omega_1 = J_2\omega_2$,

$\omega_2 = \frac{J_1\omega_1}{J_2} = 40.59(r/s)$. Two balls angular speed difference is $\Delta\omega = \omega_2 - \omega_1 = 9.4112(r/s)$, it decreases $\frac{9.4112}{50} = 18.82\%$. By calculating, it is clear when hitting different sizes two balls in the same way, big ball rotational speed reduces 9.4112 r/s(decrement rate is nearly1 / 5)by comparing with small ball rotational speed.

40 mm table tennis flight speed to its offensive influence: When athlete vigorously smashes, table tennis speed can

arrive at 42.22 m/s(170 km/h), on the condition of certain distance, it is easily know that the larger speed is the shorter flight time would be. Ball drop point over the net is up to flight speed, the more important is up to ball rotational speed and rotational direction that first arc, and the second arc is up to rotational speed and direction before touching table, as Figure 1 show.

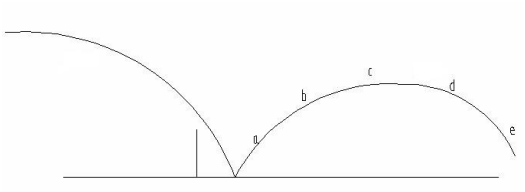

Figure 1: Table tennis path schematic diagram

By Figure 1, it is clear that except for first arc absolute speed, the more important is deciding hitting time and position according to the second arc. Chinese quick attack is mainly in the second arc rising period(Figure l a、b) or high point period(c), if hitting back to d、e segment, even greater attack strength is, it cannot correct, fast and strongly arrive at opponent area due to ball air running so long distance.

According to momentum theorem, object suffered resultant impulse is equal to its momentum increment. If same size impulse acts on different two balls, due to ball mass is different, two balls speed are also different. Therefore, it can calculate v_2.

To two different balls, respectively list momentum theorem, $Ft = m_1 v_1$, $Ft = m_2 v_2$, so

$$v_2 = \frac{m_1 v_1}{m_2} = 38.0813\ (m/s)$$

Two balls speed difference: $v = v_1 - v_2 = 4.1387\ (m/s)$, it decreases $\frac{4.1387}{42.22} = 9.80\%$.

By calculation result, it is clear: big ball speed decreases nearly 4.1387 m / s(decrement rate is nearly1/10).

By above calculation, it gets preliminary conclusion: big ball rotational speed decreases 9.4112 r/s(decrement rate is nearly 1 / 5) to small ball rotational speed. Big ball speed decreases nearly 4.1387 m / s(decrement rate is nearly 1/10).

Athlete experiment quality should be converted into quantitative indicator to reflect, regarding table tennis drop point time and kinetic energy integration as quantitative indicators, when table tennis drop point time and kinetic energy integration are optimal, athlete experience quality is the best. So it can use optimization control theory solving athlete experience quality optimization problem with table tennis drop point time and kinetic energy integration as quantitative indicators.

Optimization control theory is one of main branches in modern control theory; it puts emphasis research on realizing optimal control system performance index basic condition and comprehensive method. Adopt two methods, one is solving different drop point rigid body dynamical inverse problems, it gets optimal time's hitting way and drop point by comparing, another is setting optimal control target (as time is shortest), on the constraint condition of athlete maximum capacity (swinging speed), according to optimization control theory, solving optimization control force that is best hitting point and angle of bat. It can image that excellent athlete counter attack ways are mostly reasonable, which near to optimal way. For example, when incoming ball springs up from table and is higher than net, directly forward hit and then can arrive at fastest returning ball that is "attack"; if hitting point is lower, "attack" is prone to drop into net, now it should quickly return ball and also let ball get over the net (overcome obstacles), it should simultaneously exert forward and upward forces, if resultant gets across table tennis mass center(non spinning), is not prone to control and ball is easier to be out of table, if resultant doesn't get across table tennis mass center, returning will bring into spinning, the one with top spinning is "loop", with back spinning is "cutting". Under the same swinging speed, though loop is not faster than attack, it may has larger kinetic energy(average kinetic energy and rotational kinetic energy sum), short court returning loop should according to incoming ball rotation strength, timely adjust bat, and use proper angle of bat to return so that bring into difficulty to return.

Research objects select same textile seamless different diameters table tennis. According to optimization control theory without involving in athlete implemented hitting motions, only meet hitting instant swinging speed, angle of bat, contacting point and so on. Regard table tennis diameter as variable, it can continue to change, and extract values at random. The research only considers table tennis whole process that stars from struck instant to dropping in opponent table and springing instant, without involving athletes' human movement that means without involving athletes' before stroking paces, body, handle, arms, wrist, and fingers as well as other technical motions.

2.2 Table tennis differential equation

Establish Figure 2 showed space coordinate system（o-xyz）, table midpoint coordinate origin o, from the perspective of hitter, right hand direction is positive direction of x axis, forward is positive direction of y axis, upward is positive direction of z axis.

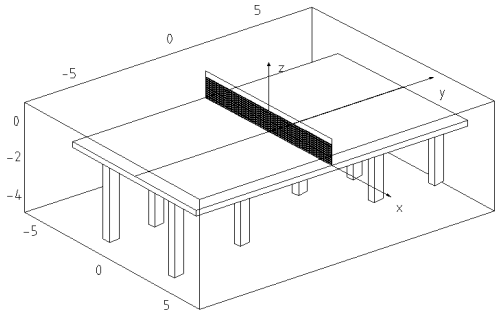

Figure 2: Space coordinate system

In Figure 2, geometric size makes nondimensionalization with net height（$h=152.5mm$）as criterion, table width is $\frac{1525}{152.5}=10$, table length is $\frac{2740}{152.5}=17.97\approx 18$, net width is $\frac{1830}{152.5}=12$.Diameter 40mm table tennis radius r nondimensional quantity is

$$r=\frac{20}{152.5}=0.131$$（net height）

Gravity accelerated speed（half）nondimensional quantity is

$$g=\frac{9.8\times 10^3}{152.5}=64.262$$（net height / s^2）

Set table tennis surrounding x、y、z axis rotational angles are respectively x_1、y_1、z_1, table tennis air movement instant suffered action force is as Figure 3 show. In Figure 3, $(x_2)y_2(z_2)$ is table tennis mass center speed component in the direction of $(x)y(z)$；$x_3(y_3、z_3)$ is table tennis surrounding $x(y、z)$ axis rotational angular speed component；F_{vx}、$F_{\omega y}$、F_{mz} are respectively air resistance, rotational resistance and Magnus force components, according to basic assumption 5, calculate as following formula

$$F_{vy1}=-k_v rmy_3,\ F_{\omega x1}=-k_\omega rJx_4,\ F_{mz1}=k_m rm(x_4y_3-y_4x_3)$$

Similarly other components computing formulas are

$$F_{vz1}=-k_v rmz_3,\ F_{\omega y1}=-k_\omega rJy_4,\ F_{mx1}=k_m rm(y_4z_3-z_4y_3)$$
$$F_{vx1}=-k_v rmx_3,\ F_{\omega z1}=-k_\omega rJz_4,\ F_{my1}=k_m rm(z_4x_3-x_4z_3)$$

In formula, $m=2.7\times 10^{-3}kg$ is table tennis mass, $J=\frac{2}{3}mr^2$ is table tennis rotational inertia, coefficient k_v,k_ω,k_m according to experience and by comparing with experiment, approximately value $k_v\approx 38.1$, $k_\omega\approx 0$,

$k_m \approx 7.6$

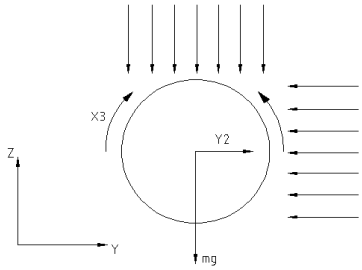

Figure 3: Table tennis air force schematic diagram

According to Newton second law, it can get table tennis movement differential equation

$$x'(t) = x_2(t)$$
$$y'(t) = y_2(t)$$
$$z'(t) = z_2(t)$$
$$x_1'(t) = x_3(t)$$
$$y_1'(t) = y_3(t)$$
$$z_1'(t) = z_3(t)$$
$$x_2'(t) = k_m r(y_3(t) - z_3(t)) - k_v r x_2(t)$$
$$y_2'(t) = k_m r(z_3(t) - x_3(t)) - k_v r y_2(t)$$
$$z_2'(t) = k_m r(x_3(t) - y_3(t)) - k_v r z_2(t) - g$$
$$x_3'(t) = -k_\omega r x_3(t)$$
$$y_3'(t) = -k_\omega r y_3(t)$$
$$z_3'(t) = -k_\omega r z_3(t)$$

In formula x_2, y_2, z_2 are respectively table tennis mass center x, y, z directions speed components; x_3, y_3, z_3 are respectively table tennis surrounding x, y, z axis rotational angular speed components; k_v, k_ω, k_m are respectively air speed resistance coefficient, rotational resistance coefficient and Magnus force parameter, and take values by formula.

Establish table tennis drop point time and kinetic energy integration optimization mathematical planning model that similar to time optimization control model as Figure 4.

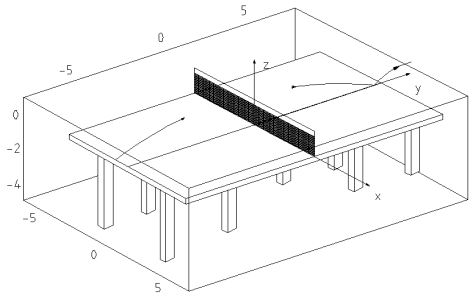

Figure 4: Table tennis under coordinate system schematic diagram

$$\min\ f = k\frac{t_f}{0.09443} + (1-k)\frac{46.652}{T(t_f)}$$

s.t. $g_1 = x_3(t_{net}) - (1+r) \geq 0$

$$g_2 = x_2(t_f) \geq 0$$
$$g_3 = 9 - x_2(t_f) \geq 0$$
$$g_4 = x_1(t_f) + 5 \geq 0$$
$$g_5 = 5 - x_1(t_f) \geq 0$$
$$g_6 = v_{\max} - \left(\sqrt{v_0 \cdot v_0} + \frac{2}{3} \frac{r^2 \omega_0 \cdot \omega_0}{\sqrt{v_0 \cdot v_0}} \right) \geq 0$$
$$g_7 = 1 - \frac{2}{3} \frac{r^2 \omega_0 \cdot \omega_0}{\sqrt{v_0 \cdot v_0}} \geq 0,$$

and $h_1 = v_0 \cdot \omega_0 = 0$

Among them, k value range is 0~1, when $k = 1$, it is time optimization control, when $k = 0$, it is kinetic energy optimization control. Take $k = 10\%$

Table tennis initial position and maximum swinging speed values are as following:

$$x_1(0) = 0, x_2(0) = -10, x_3(0) = 1,$$

$$x_4(0) = 0, x_5 = 0, x_6(0) = 0$$

$$v_{\max} = 200$$

Table tennis falling optimization control numerical computing result:

$$t_f = 0.11964s$$
$$t_{net} = 0.06551s$$
$$v_0 = \{0, 153.013, 44.049\},$$
$$\omega_0 = \{-752.455, 0, 0\},$$
$$\alpha = \frac{d}{r} = 0.4132,$$

$$\{x, y, z\}_{tf} = \{0, 8.2319, 0.1311 = r\},$$
$$z(t_{net}) = 1.78478,$$
$$T(t_f) = 43.188$$

Time and kinetic energy integrated optimization loop initial angular speed is: $\omega_m = \frac{752.455}{2\pi} = 119.757 r/s$

2.3 Model evaluation system

Table 1 any diameters corresponding initial angular speed, when $\frac{\omega}{\omega_m} > 1$, athlete experience quality is bad. When $0 < \frac{\omega}{\omega_m} \leq 1$ athlete experience quality is good, the bigger $\frac{\omega}{\omega_m}$ is, the better athlete experience quality would be. And when $\frac{\omega}{\omega_m} = 1$, athlete experience quality is the best.

Table 1: Athlete experience quality evaluation system

Initial speed ω	Athlete experience quality
$0 < \frac{\omega}{\omega_m} \le 1$	Good
$\frac{\omega}{\omega_m} = 1$	Best
$\frac{\omega}{\omega_m} > 1$	Bad

By formula, it solves $\frac{\omega_{38mm}}{\omega_m} = 0.784 = 78.4\%$, $\frac{\omega_{40mm}}{\omega_m} = 0.756 = 75.6\%$ .Therefore, it can get that starts from the perspective of athlete experience quality, 38mm table tennis is better than 40mm table tennis, 40mm is bad for athlete experiencing.

3 ACSI model based on BP neural network

Back propagation neural network（BP network）Is by far one of most mature, widely applied artificial neural networks, its basic network is three-layer feedforward network, which includes input layer, hidden layer, output layer. To input signal, it should firstly front propagate to hidden node, after function effecting, then transfer hidden node output information to output node, and finally get output variable result, nerve cell node function generally takes S type function. BP network can implement any complicated non-linear map relation from input to output, and possesses better generalization ability, and can fulfill complex mode identification task. Algorithm learning process is composed of positive direction propagation process and counter propagation process, in the former process, input information carries out layer-to-layer handling from input layer and through hidden layer unit, and then transfer to output layer, every layer nerve cell state only affects next layer nerve cell state. If it cannot get expected output form output layer, then it converts into counter propagation, return error signal along original connection access, and let error signal be minimum by revising each layer nerve cell weight.

3.1 Model establishment

（1）Evaluation model structural designing. In 1989, Robea Hecht Nielson proved that any one continuous function in closed interval can approach by using a hidden layer BP network, therefore three-layer BP neural network can complete any N dimensions to M dimensions mapping, BP network mostly adopts single hidden layer network, the paper established evaluation model also adopts single hidden layer network structure, meanwhile regards three levels indicators as input layer node numbers, it totally has 11 nodes, the paper's hidden layer preliminary selected node numbers are four. To output layer node number, the paper hopes that can make a proper evaluation for audience satisfaction degree by output layer result, therefore according to output layer five nodes setting that output as 10000 represents very satisfied with satisfaction degree evaluation result, output as 01000 represents relative satisfied with satisfaction degree evaluation result, output as 00100 represents basic satisfied with satisfaction degree evaluation result, output as 00010 represents dissatisfied with satisfaction degree evaluation result, output as 00001 represents very dissatisfied with satisfaction degree evaluation result,

（2）BP network learning. According to previous stated indicator system, according to learning samples, carry out normalizing with different audience investigation each indicator value, input them into above structure established BP neural network by referencing BP algorithm, and define each layer nerve cell weight to calculate output.

（3）According to output, carry out evaluation on audience satisfaction degree with evaluation criterion. To audience appreciation quality evaluation, it is the same as customer satisfaction degree, which always tends to decompose it into several audience appreciation influence factors.

In the aspect of table tennis audience appreciation quality, it applies ASCI model, uses audience appreciation quality replacing customer satisfaction degree, others are respectively: athletic image, athlete performance expectation, athlete performance perception, perceptive value, audience fidelity, audience complain as investigation indicators.

3.2 Training and verifying

According to above constructed audience appreciation quality evaluation model, use MATLAB neural network toolbox establishing a BP neural network model that input layer, hidden layer and output layer node numbers are respectively 11, 4 and 5, which is used for network training and testing.

It has collected 15 audiences watching table tennis objective evaluation actual data and result, let it become training and testing basic data (Table 2) by normalization handling and sorting the indicators, from which the 1st, 3rd, 4th, 5th, 7th, 8th, 9th, 10th, 11th, 13th, 14th, 15th enterprises as training samples to carry out network weight training, and can get input layer to hidden layer, hidden layer to output layer weights and threshold values. The network by initializing, preset error is 0.01, after training to 1666 steps; network error arrives at set error requirement.

Table 2: Training and testing basic data

Audience	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	C_4	C_5	Result
1	0.932	0.907	0.943	0.875	0.962	0.947	0.974	0.950	0.913	0.935	0.973	Very satisfied
2	0.942	0.930	0.917	0.862	0.957	0.913	0.977	0.921	0.957	0.927	0.971	Very satisfied
3	0.935	0.912	0.890	0.810	0.910	0.885	0.854	0.878	0.890	0.855	0.824	Relative satisfied
4	0.901	0.887	0.825	0.757	0.852	0.780	0.784	0.765	0.860	0.770	0.733	Satisfied
5	0.912	0.901	0.792	0.767	0.807	0.724	0.812	0.776	0.870	0.787	0.807	Satisfied
6	0.934	0.914	0.889	0.808	0.908	0.884	0.862	0.876	0.890	0.857	0.822	Relative satisfied
7	0.779	0.787	0.720	0.641	0.707	0.690	0.749	0.787	0.831	0.755	0.681	Dissatisfied
8	0.697	0.688	0.585	0.517	0.627	0.590	0.617	0.607	0.812	0.530	0.603	Very dissatisfied
9	0.930	0.922	0.887	0.802	0.901	0.878	0.894	0.870	0.891	0.965	0.815	Relative satisfied
10	0.617	0.612	0.552	0.490	0.617	0.578	0.575	0.601	0.762	0.410	0.621	Very dissatisfied
11	0.927	0.917	0.847	0.812	0.890	0.887	0.832	0.887	0.901	0.875	0.832	Relative satisfied
12	0.897	0.878	0.772	0.750	0.790	0.711	0.807	0.787	0.896	0.803	0.811	Satisfied
13	0.772	0.757	0.702	0.676	0.727	0.709	0.719	0.754	0.829	0.765	0.721	Dissatisfied
14	0.954	0.947	0.890	0.905	0.933	0.907	0.966	0.932	0.950	0.937	0.969	Very satisfied
15	0.679	0.672	0.718	0.701	0.757	0.705	0.801	0.773	0.840	0.695	0.721	Dissatisfied

After fulfilling network training, regard the second, sixth, twelfth audience as verifying samples, input verifying samples to verify network fitness, network output result is as Table 3 show, network verifying result and expected evaluation result comparison is as Table 4 show.

Table 3: Verification output result

	Audience 2	Audience 6	Audience 12
Verification output	0.9352	0.0569	0.0637
	0.3284	0.8449	-0.1544
	-0.2997	0.1143	0.9738
	0.0386	-0.0198	0.1372
	-0.0025	0.0039	-0.0205

Table 4: Audience evaluation and verification result

	Expected evaluation result	Network verification result
Audience 2	Very satisfied	Very satisfied
Audience 6	Relative satisfied	Relative satisfied
Audience 12	Satisfied	Satisfied

From verification and comparison result, it is clear that network evaluation result is basically consistent with actual evaluation result, which stands for audience appreciation quality evaluation model based on BP neural network has been successfully established, learning samples training has also ended. In future when making relative audience appreciation quality evaluation, only need to input evaluated samples standardized indicators data, and then it can get evaluation data.

Table 1 :38mm and 40mm audience evaluation table

Audience	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	C_4	C_5	Result
（38mm）	0.963	0.917	0.844	0.812	0.867	0.887	0.881	0.903	0.875	0.836	0.887	Relative satisfied
(40mm)	0.897	0.978	0.772	0.850	0.893	0.7911	0.904	0.787	0.896	0.808	0.811	Satisfied

3.3 Model solution

Input investigation obtained audience watching 38mm scores and 4mm scores, as Table 5 show.

Table 6 output result represents audience appreciation quality.

Table 6: Audience appreciation quality table

Diameter（mm）	Audience appreciation quality	Result
38	0.667	Relative satisfied
40	0.842	Satisfied

By above Table 6, it is clear present competition ball diameter (40mm) comparing to “small ball era” (38mm), it promotes audience appreciation quality.

4 Difference equation model

Same time frame audience appreciation quality y_k athlete experience quality x_k, set $y_k = f(x_k)$

It reflects audience to appreciation quality demand relation, it is called demand function. Sport development suffers audience appreciation quality influence, therefore in Figure 1 use a decreasing curve f to represent, f is called demand curve.

Next time athlete experience quality x_{k+1} is up to last time frame audience appreciation quality y_k, set $x_{k+1} = h(y_k)$, or $y_k = g(x_{k+1})$

Here g is h inverse function.。h or g reflects producers supply relation, it is called supply function.

4.1 Model establishment

According to obtained diameter and athlete experience quality data fitting equation $f(x)$. With diameter as independent variable, use it and get data ratio fitting demand curve $h(x)$.Nearby P_0 point can use straight line to approximate to curve $f(x)$ and $h(x)$, set $f(x)$ and $h(x)$ are approximate to:

$$y_k - y_0 = -\alpha(x_k - x_0), \alpha > 0$$
$$x_{k+1} - x_0 = \beta(y_k - y_0), \beta > 0$$

Eliminate y_k from above formula and can get: $x_{k+1} - x_0 = -\alpha\beta(x_k - x_0), k = 1,2,...$

is one order linear constant coefficient difference equation, make recurrence of k and easily get: $x_{k+1} - x_0 = (-\alpha\beta)^k (x_1 - x_0)$

It is easily seen that, when $k \to \infty$, $x_k \to x_0$, that P_0 point stable condition is: $\alpha\beta < 1$ or $\alpha < \frac{1}{\beta}$

And when $k \to \infty$, $x_k \to \infty$, that P_0 point unstable condition is $\alpha\beta > 1$ or $\alpha > \frac{1}{\beta}$

Notice α, β definitions in formula, it has $K_f = \alpha, K_g = 1/\beta$, therefore condition and difference equation model intuitional result formula are consistent.

4.2 Model solution

By calculating, it gets supply and demand equations relations and gets following Figure 5.

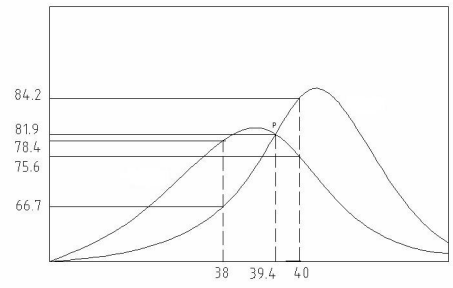

Figure 5: Diameter and experience quality as well as appreciation quality relations

By Figure 5, it gets optimal solution, table tennis diameter as 39.4mm is achieved optimal solution that both athlete experience quality and audience appreciation quality can accept.

According to difference equation model specified test method solving above Figure solution cross points two curves slopes, set $f(x)$ slope is k_g, $h(x)$ slope is k_h, by calculating, k_g absolute value in cross point is 311.216, k_h absolute value in cross point is 43.9023, now $k_g > k_h$, so P_0 point is stable point.

CONCLUSION

BP neural network algorithm established audience appreciation quality evaluation model hasn't obvious subjective elements and human factors, it only needs to input processed data into network so that effective avoid traditional evaluation method subjectivity and simplicity, and let evaluation result more effective, objective. Differential equation is ordered and clear, iterative computation is relative simple. Difference equation model carries out stability analysis, model is stable and feasible.

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