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OPPOSITE DEGREE COMPUTATION AND ITS APPLICATION

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ABSTRACT

In order to predict numerical value, we propose a new intelligent algorithm opposite degree computation algorithm. The opposite degree computation algorithm is based on the degree of antagonism between the data to analyze the approximate relationship. The experiment was conducted at Chinese Xinjiang Province, during year 1995 to year 2010. Opposite degree computation algorithm is based on priori value, posteriori value, priori matrix, posterior matrix and the relationship between calculation data. By learning Chinese Xinjiang cotton production data from 1995 - 2005, forecasts 2006 - 2010 cotton production; the result of the absolute error is 9.3237%. Meanwhile, we introduce the prediction method based on BP neural network for the result comparison and found opposite degree computation method is superior to the BP neural network method. Cotton production prediction based on opposite degree computation proved the algorithm is feasible and effective and can be used in numerical value prediction.

KEYWORDS

Opposite degree computation, cotton production prediction, prior value, posteriori value, BP neural network.

1. INTRODUCTION

Information technology application in cotton production prediction is a useful research area for agriculture and social development, which has gained increasing popularity in China [1]. It is because cotton production prediction is very important for cultivation, consumption, exports [2]. Cotton belongs to market price crops, so its acreage may be very volatility; and climate change is essential for its production. Therefore, compared to food crops, the cotton production prediction has more difficulties [3]. We try to find a new way for cotton production prediction.

2. OPPOSITE DEGREE COMPUTATION

The person's thinking can be attributed to underlying similarity and opposition. There is researcher proposed semantic contrary degree concept in 2008. This concept is based on the performed relationship of semantic calculations. It is preferably used in natural language processing for calculating closeness among words and word relationships. Although the semantic contrary degree concept and the underlying principle of intelligent data processing algorithms are not the same, the opposition expressed by the idea of positive and negative data can be applied to the numerical calculation [4].

We propose the opposite degree; it is mainly related to the following five concepts [5].

1) Prior value- Prior value refers to the value which has been used for training and learning. Prior values have been obtained from selected data.

2) Posteriori value- Posteriori value refers to the value which is used to prediction and analysis. It has certain relevance with prior value.

3) Opposite degree computation value- Opposite degree shows the difference between prior value and posteriori value. It ranges from infinity to infinitesimal. Suppose A and B represent prior value and posteriori value, respectively. Opposite degree O (A, B) between A and B is defined by equation 1 as below

$$O(A,B)=\frac{B-A}{A}=\begin{cases}\text{negative, indicates } B<A\\ 0\text{, indicates } A=B\\ \text{positive, indicates } B>A\end{cases}$$ (Equation 1)

If O is more closed to 0, A more tends to B. O equals to 0 while A equals to B.

4) Prior matrix- Prior matrix refers to the matrix (data set) which has been used for training and learning. Prior matrix is a value matrix which has been obtained from selected data. It had been constituted by a_{ij} ($a_{ij}\in A_{m\times n}$, $1\le i\le m$, $1\le j\le n$); $A_{m\times n}$ has n column attributes. Every row has m row data. Each data means one prior value r_i ($r_i\in R$, $1\le i\le m$). Set $A_{m\times n}$ as a priori matrix:

$$A_{m\times n}=\begin{vmatrix} a_{11} & a_{12} & \dots & a_{1n}\\ a_{21} & a_{22} & \dots & a_{2n}\\ \dots & \dots & \dots & \dots\\ a_{m1} & a_{m2} & \dots & a_{mn}\end{vmatrix}$$

The corresponding column vector of priori value is R :

$$R=\begin{bmatrix} r_1\\ r_2\\ \dots\\ r_m\end{bmatrix}$$

5) Posteriori matrix- Posteriori matrix is the matrix which is used to prediction and analysis. Posteriori matrix is a data matrix which has the same attribute with Prior matrix. It had been constituted by b_{kj} ($b_{kj}\in B_{p\times n}$, $1\le k\le p$, $1\le j\le n$), $B_{p\times n}$ has n column attributes. Every row has p row data. Each data means one posteriori value s_k ($s_k\in S$, $1\le k\le p$). It is an expectation that predict the category or posteriori value after calculating opposite degree.

Set $B_{p\times n}$ as a posteriori matrix:

$$B_{p\times n}=\begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ b_{p1} & b_{p2} & \cdots & b_{pn} \end{bmatrix}$$

Through calculate opposite degree, we can predict the corresponding column vector S of $B_{p\times n}$.

$$S=\begin{bmatrix} s_1 \\ s_2 \\ \cdots \\ s_p \end{bmatrix}$$

3. CALCULATION STEPS

Step 1: Selected Data

Select Xinjiang's cotton planting area in China (ten thousand mu, 1 mu = 0.0667 hectares), the effective irrigation area (ten thousand mu), mechanical ownership (million kilowatts) as input variables, cotton total production (ten thousand tons) as the output variables. Building the calculation models based on the principle of ODC algorithm. As shown in Table 1, the simulation experiment is according to data from year 1995 to 2010 [3].

Table 1: The basic situation of China Xinjiang cotton planting

Years	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)	Total Production (ten thousand tons)
1995	1114.35	4170	67.76	93.50
1996	1198.89	4262.1	77.29	94.04
1997	1325.475	4365.3	83.77	115.00
1998	1498.89	4475.4	85.59	140.00
1999	1493.895	4598.1	78.33	140.75
2000	1518.585	4641.4	79.2	150.00
2001	1694.58	4707.2	83.3	157.00
2002	1415.955	4580.85	84.3	150.00
2003	1555.575	4575.9	90.74	160.00
2004	1691.325	4660	99.17	175.25
2005	1736.985	4806.4	107.77	195.70
2006	2496.645	4989.2	118.03	267.53
2007	2673.9	5198.1	131.53	290.00
2008	2502.015	5611.06	148.89	301.73
2009	2015.6	5924.7	156.28	250.00
2010	2190.6	6098	167.57	260.00

Step 2: Training Data Based on The Opposite Degree Computation

Select the data from 1995 to 2005 as training data. Calculate opposite degree of each row with all rows, and then delete the row that contains the calculation result 0. For example, calculate the opposite degree between the 1995 data and the corresponding data from 1995 to 2005. The results are shown in Table 2.

Table 2: Training data based on the opposite degree computation

Years	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)	Total Production (ten thousand tons)
1995	0.0759	0.0221	0.1406	0.0058
1995	0.1895	0.0468	0.2363	0.2299
1995	0.3451	0.0732	0.2631	0.4973
1995	0.3406	0.1027	0.1560	0.5053
1995	0.3628	0.1130	0.1688	0.6043
1995	0.5207	0.1288	0.2293	0.6791
1995	0.2707	0.0985	0.2441	0.6043
1995	0.3959	0.0973	0.3391	0.7112
1995	0.5178	0.1175	0.4635	0.8743
1995	0.5587	0.1526	0.5905	1.0930
1996	-0.0705	-0.0216	-0.1233	-0.0057
1996	0.1056	0.0242	0.0838	0.2229
1996	0.2502	0.0500	0.1074	0.4887
1996	0.2461	0.0788	0.0135	0.4967
1996	0.2667	0.0890	0.0247	0.5951
1996	0.4135	0.1044	0.0778	0.6695
1996	0.1811	0.0748	0.0907	0.5951
1996	0.2975	0.0736	0.1740	0.7014
1996	0.4107	0.0934	0.2831	0.8636
1996	0.4488	0.1277	0.3944	1.0810
1997	-0.1593	-0.0447	-0.1911	-0.1870
1997	-0.0955	-0.0236	-0.0774	-0.1823

1997	0.1308	0.0252	0.0217	0.2174
1997	0.1271	0.0533	-0.0649	0.2239
1997	0.1457	0.0632	-0.0546	0.3043
1997	0.2785	0.0783	-0.0056	0.3652
1997	0.0683	0.0494	0.0063	0.3043
1997	0.1736	0.0482	0.0832	0.3913
1997	0.2760	0.0675	0.1838	0.5239
1997	0.3105	0.1010	0.2865	0.7017
1998	-0.2565	-0.0682	-0.2083	-0.3321
1998	-0.2001	-0.0477	-0.0970	-0.3283
1998	-0.1157	-0.0246	-0.0213	-0.1786
1998	-0.0033	0.0274	-0.0848	0.0054
1998	0.0131	0.0371	-0.0747	0.0714
1998	0.1306	0.0518	-0.0268	0.1214
1998	-0.0553	0.0236	-0.0151	0.0714
1998	0.0378	0.0225	0.0602	0.1429
1998	0.1284	0.0412	0.1587	0.2518
1998	0.1588	0.0740	0.2591	0.3979
1999	-0.2541	-0.0931	-0.1349	-0.3357
1999	-0.1975	-0.0731	-0.0133	-0.3319
1999	-0.1127	-0.0506	0.0694	-0.1829
1999	0.0033	-0.0267	0.0927	-0.0053
1999	0.0165	0.0094	0.0111	0.0657
1999	0.1343	0.0237	0.0634	0.1155
1999	-0.0522	-0.0038	0.0762	0.0657
1999	0.0413	-0.0048	0.1584	0.1368
1999	0.1322	0.0135	0.2661	0.2451
1999	0.1627	0.0453	0.3758	0.3904
2000	-0.2662	-0.1016	-0.1444	-0.3767
2000	-0.2105	-0.0817	-0.0241	-0.3731
2000	-0.1272	-0.0595	0.0577	-0.2333
2000	-0.0130	-0.0358	0.0807	-0.0667
2000	-0.0163	-0.0093	-0.0110	-0.0617
2000	0.1159	0.0142	0.0518	0.0467
2000	0.0244	-0.0141	0.1457	0.0667
2000	0.1138	0.0040	0.2521	0.1683
2000	0.1438	0.0355	0.3607	0.3047
2001	-0.3424	-0.1141	-0.1866	-0.4045
2001	-0.2925	-0.0946	-0.0721	-0.4010
2001	-0.2178	-0.0726	0.0056	-0.2675
2001	-0.1155	-0.0492	0.0275	-0.1083
2001	-0.1184	-0.0232	-0.0597	-0.1035
2001	-0.1039	-0.0140	-0.0492	-0.0446
2001	-0.1644	-0.0268	0.0120	-0.0446
2001	-0.0820	-0.0279	0.0893	0.0191
2001	-0.0019	-0.0100	0.1905	0.1162
2001	0.0250	0.0211	0.2938	0.2465
2002	-0.2130	-0.0897	-0.1962	-0.3767
2002	-0.1533	-0.0696	-0.0832	-0.3731
2002	-0.0639	-0.0471	-0.0063	-0.2333
2002	0.0586	-0.0230	0.0153	-0.0667
2002	0.0550	0.0038	-0.0708	-0.0617
2002	0.1968	0.0276	-0.0119	0.0467
2002	0.0986	-0.0011	0.0764	0.0667
2002	0.1945	0.0173	0.1764	0.1683
2002	0.2267	0.0492	0.2784	0.3047
2003	-0.2836	-0.0887	-0.2533	-0.4156
2003	-0.2293	-0.0686	-0.1482	-0.4123
2003	-0.1479	-0.0460	-0.0768	-0.2813
2003	-0.0364	-0.0220	-0.0568	-0.1250
2003	-0.0397	0.0049	-0.1368	-0.1203
2003	-0.0238	0.0143	-0.1272	-0.0625
2003	0.0894	0.0287	-0.0820	-0.0188
2003	-0.0898	0.0011	-0.0710	-0.0625
2003	0.0873	0.0184	0.0929	0.0953

2003	0.1166	0.0504	0.1877	0.2231
2004	-0.3411	-0.1052	-0.3167	-0.4665
2004	-0.2912	-0.0854	-0.2206	-0.4634
2004	-0.2163	-0.0632	-0.1553	-0.3438
2004	-0.1138	-0.0396	-0.1369	-0.2011
2004	-0.1167	-0.0133	-0.2101	-0.1969
2004	-0.1021	-0.0040	-0.2014	-0.1441
2004	0.0019	0.0101	-0.1600	-0.1041
2004	-0.1628	-0.0170	-0.1499	-0.1441
2004	-0.0803	-0.0180	-0.0850	-0.0870
2004	0.0270	0.0314	0.0867	0.1167
2005	-0.3585	-0.1324	-0.3713	-0.5222
2005	-0.3098	-0.1132	-0.2828	-0.5195
2005	-0.2369	-0.0918	-0.2227	-0.4124
2005	-0.1371	-0.0689	-0.2058	-0.2846
2005	-0.1399	-0.0433	-0.2732	-0.2808
2005	-0.1257	-0.0343	-0.2651	-0.2335
2005	-0.0244	-0.0206	-0.2271	-0.1978
2005	-0.1848	-0.0469	-0.2178	-0.2335
2005	-0.1044	-0.0480	-0.1580	-0.1824
2005	-0.0263	-0.0305	-0.0798	-0.1045

Step 3: Computation Weights

Calculate the weights of each column (each data item). Calculate the opposite degree between the first three data and the last data. The results are shown in Table 3.

Table 3: Opposite degree of weights

Years	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)
1995	12.1359	2.8242	23.3522
1995	-0.1761	-0.7963	0.0275
1995	-0.3061	-0.8527	-0.4709
1995	-0.3260	-0.7968	-0.6913
1995	-0.3997	-0.8129	-0.7206
1995	-0.2333	-0.8103	-0.6623
1995	-0.5521	-0.8370	-0.5961
1995	-0.4433	-0.8631	-0.5232
1995	-0.4078	-0.8656	-0.4698
1995	-0.4888	-0.8604	-0.4598
1996	11.2801	2.7632	20.4728
1996	-0.5263	-0.8914	-0.6238
1996	-0.4880	-0.8976	-0.7803
1996	-0.5046	-0.8413	-0.9729
1996	-0.5519	-0.8504	-0.9585
1996	-0.3824	-0.8440	-0.8839
1996	-0.6957	-0.8743	-0.8476
1996	-0.5758	-0.8950	-0.7519
1996	-0.5244	-0.8919	-0.6722
1996	-0.5848	-0.8819	-0.6352
1997	-0.1480	-0.7607	0.0223
1997	-0.4760	-0.8703	-0.5756
1997	-0.3982	-0.8840	-0.9001
1997	-0.4325	-0.7618	-1.2900
1997	-0.5213	-0.7922	-1.1792
1997	-0.2375	-0.7855	-1.0154
1997	-0.7757	-0.8378	-0.9792
1997	-0.5564	-0.8767	-0.7874
1997	-0.4732	-0.8711	-0.6491
1997	-0.5576	-0.8560	-0.5917
1998	-0.2276	-0.7945	-0.3728
1998	-0.3903	-0.8548	-0.7046
1998	-0.3521	-0.8622	-0.8809
1998	-1.6221	4.1178	-16.8336
1998	-0.8160	-0.4807	-2.0452

1998	0.0752	-0.5735	-1.2203
1998	-1.7746	-0.6701	-1.2110
1998	-0.7353	-0.8428	-0.5788
1998	-0.4901	-0.8362	-0.3698
1998	-0.6007	-0.8141	-0.3487
1999	-0.2432	-0.7227	-0.5980
1999	-0.4050	-0.7798	-0.9600
1999	-0.3838	-0.7233	-1.3796
1999	-1.6275	4.0079	-18.3938
1999	-0.7485	-0.8567	-0.8310
1999	0.1636	-0.7945	-0.4504
1999	-1.7939	-1.0571	0.1597
1999	-0.6981	-1.0353	0.1584
1999	-0.4608	-0.9451	0.0854
1999	-0.5832	-0.8840	-0.0373
2000	-0.2933	-0.7304	-0.6165
2000	-0.4357	-0.7809	-0.9354
2000	-0.4550	-0.7451	-1.2473
2000	-0.8055	-0.4635	-2.2102
2000	-0.7363	-0.8487	-0.8219
2000	1.4834	-0.6962	0.1093
2000	-0.6346	-1.2117	1.1856
2000	-0.3243	-0.9762	0.4979
2000	-0.5279	-0.8833	0.1840
2001	-0.1534	-0.7178	-0.5388
2001	-0.2706	-0.7642	-0.8201
2001	-0.1858	-0.7285	-1.0211
2001	0.0665	-0.5452	-1.2539
2001	0.1442	-0.7761	-0.4236
2001	1.3294	-0.6865	0.1039
2001	2.6877	-0.3980	-1.2693
2001	-5.2929	-2.4598	3.6742
2001	-1.0165	-1.0863	0.6390
2001	-0.8985	-0.9145	0.1917
2002	-0.4345	-0.7619	-0.4791
2002	-0.5891	-0.8135	-0.7771
2002	-0.7261	-0.7983	-0.9731
2002	-1.8786	-0.6547	-1.2295
2002	-1.8926	-1.0611	0.1484
2002	3.2166	-0.4090	-1.2542
2002	0.4791	-1.0162	0.1459
2002	0.1553	-0.8974	0.0479
2002	-0.2558	-0.8384	-0.0862
2003	-0.3176	-0.7866	-0.3907
2003	-0.4438	-0.8337	-0.6404
2003	-0.4741	-0.8364	-0.7269
2003	-0.7085	-0.8243	-0.5460
2003	-0.6704	-1.0403	0.1367
2003	-0.6195	-1.2290	1.0348
2003	-5.7658	-2.5303	3.3729
2003	0.4361	-1.0173	0.1356
2003	-0.0844	-0.8072	-0.0253
2003	-0.4773	-0.7742	-0.1589
2004	-0.2687	-0.7746	-0.3210
2004	-0.3717	-0.8157	-0.5239
2004	-0.3708	-0.8161	-0.5483
2004	-0.4343	-0.8031	-0.3192
2004	-0.4070	-0.9325	0.0675
2004	-0.2911	-0.9723	0.3976
2004	-1.0185	-1.0973	0.5367
2004	0.1300	-0.8821	0.0407
2004	-0.0776	-0.7926	-0.0231
2004	-0.7686	-0.7308	-0.2568

2005	-0.3136	-0.7465	-0.2891
2005	-0.4036	-0.7820	-0.4556
2005	-0.4255	-0.7774	-0.4600
2005	-0.5184	-0.7580	-0.2769
2005	-0.5016	-0.8457	-0.0271
2005	-0.4616	-0.8530	0.1352
2005	-0.8765	-0.8956	0.1482
2005	-0.2085	-0.7990	-0.0674
2005	-0.4275	-0.7371	-0.1338
2005	-0.7484	-0.7085	-0.2363

3.1 Calculate the results of weights

(1) All of the data in Table 3 take positive value;
(2) Calculate the average value of each column;
(3) Calculate the reciprocal of each average value;
(4) Sum the reciprocal of each average value;
(5) Weights are got from Reciprocal of each column divided by the above sum. As shown in Equation 2, $\overline{\omega_i}$ means the average of each column; ω_i means the weight of each column. After calculation, we get the results in Table 4.

$$\omega_1 = \frac{\frac{1}{\overline{\omega_1}}}{\frac{1}{\overline{\omega_1}} + \frac{1}{\overline{\omega_2}} + \ldots + \frac{1}{\overline{\omega_n}}}$$

$$\omega_2 = \frac{\frac{1}{\overline{\omega_2}}}{\frac{1}{\overline{\omega_1}} + \frac{1}{\overline{\omega_2}} + \ldots + \frac{1}{\overline{\omega_n}}}$$

$$\ldots$$

$$\omega_n = \frac{\frac{1}{\overline{\omega_n}}}{\frac{1}{\overline{\omega_1}} + \frac{1}{\overline{\omega_2}} + \ldots + \frac{1}{\overline{\omega_n}}}$$

(Equation 2)

Table 4: The weight of data item

Category	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)
Weight	0.3844	0.3618	0.2538

3.2 Calculate the Opposite Degree of Prediction Data

Calculate the opposite degree between prediction row and each row of training data, and then delete the row that contains the calculation result 0.

For the prediction data of the first line (2006), the results are shown in Table 5.

Table 5: The result of opposite degree (2006)

Years	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)
1995	1.2404	0.1965	0.7419
1996	1.0825	0.1706	0.5271
1997	0.8836	0.1429	0.4090
1998	0.6657	0.1148	0.3790
1999	0.6712	0.0851	0.5068
2000	0.6441	0.0749	0.4903
2001	0.4733	0.0599	0.4169
2002	0.7632	0.0891	0.4001
2003	0.6050	0.0903	0.3007
2004	0.4761	0.0706	0.1902
2005	0.4373	0.0380	0.0952

For the prediction data of the second line (2007), the results are shown in Table 6.

Table 6: The result of opposite degree (2007)

Years	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)
1995	0.9658	0.4624	1.4730
1996	0.8272	0.4308	1.1681
1997	0.6527	0.3969	1.0004
1998	0.4615	0.3626	0.9578
1999	0.4664	0.3262	1.1393
2000	0.4425	0.3138	1.1158
2001	0.2927	0.2955	1.0116
2002	0.5471	0.3312	0.9878
2003	0.4082	0.3326	0.8467
2004	0.2952	0.3086	0.6897
2005	0.2612	0.2687	0.5549

For the prediction data of the third line (2008), the results are shown in Table 7.

Table 7: The result of opposite degree (2008)

Years	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)
1995	1.3995	0.2465	0.9411
1996	1.2303	0.2196	0.7018
1997	1.0173	0.1908	0.5701
1998	0.7839	0.1615	0.5367
1999	0.7899	0.1305	0.6792
2000	0.7608	0.1199	0.6607
2001	0.5779	0.1043	0.5790
2002	0.8884	0.1347	0.5603
2003	0.7189	0.1360	0.4495
2004	0.5809	0.1155	0.3263
2005	0.5394	0.0815	0.2205

For the prediction data of the fourth line (2009), the results are shown in Table 8.

Table 8: The result of opposite degree (2009)

Years	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)
1995	1.2453	0.3456	1.1973
1996	1.0869	0.3165	0.9264
1997	0.8876	0.2854	0.7774
1998	0.6692	0.2538	0.7396
1999	0.6748	0.2203	0.9008
2000	0.6476	0.2089	0.8799
2001	0.4765	0.1920	0.7874
2002	0.7670	0.2249	0.7662
2003	0.6084	0.2262	0.6408

2004	0.4793	0.2041	0.5014
2005	0.4404	0.1674	0.3816

For the prediction data of the fifth line (2010), the results are shown in Table 9.

Table 9: The result of opposite degree (2010)

Years	Planting Area (ten thousand mu)	The effective Irrigation Area (ten thousand mu)	Mechanical Ownership (million kilowatts)
1995	0.8088	0.4208	1.3064
1996	0.6812	0.3901	1.0220
1997	0.5207	0.3572	0.8656
1998	0.3447	0.3238	0.8259
1999	0.3492	0.2885	0.9951
2000	0.3273	0.2765	0.9732
2001	0.1894	0.2586	0.8761
2002	0.4235	0.2934	0.8539
2003	0.2957	0.2948	0.7223
2004	0.1917	0.2714	0.5759
2005	0.1604	0.2327	0.4501

3.3 Compare the Result of Key Parameters Through Calculating Prediction Data

In order to predict the true value, three key parameters will be calculated. The three important parameters are: ξ_k (the average opposite degree of row k, $2006 \le k \le 2010$), $\hat{\xi}_k$ (the sum of weighted opposite degree of row k) and γ_k (absolute difference of row k).

The equation of ξ_k is shown in Equation 3.

$$\xi_{kj} = \frac{\sum(O(a_{m1},b_{k1}) + O(a_{m2},b_{k2}) + ... + O(a_{mn},b_{kn}))}{n}$$
(Equation 3)

In the Equation 3, $m = 1995, 1996, 1997, ..., 2005$, $n = 1,2,3,...$, $1995 \le j \le 2005$, When, $k = 2006$ ξ_k means that the average opposite degree based on row j (prediction data of 2006). When $k = 2007$, ξ_k means that the average opposite degree based on row j (prediction data of 2007). When $k = 2008$, ξ_k means that the average opposite degree based on row j (prediction data of 2008). When $k = 2009$, ξ_k means that the average opposite degree based on row j (prediction data of 2009). When $k = 2010$, ξ_k means that the average opposite degree based on row j (prediction data of 2010).

Calculate the sum of weighted opposite degree. It is shown in Equation 4.

$$\hat{\xi}_{kj} = \sum(O(a_{m1},b_{k1}) \cdot \omega_1 + O(a_{m2},b_{k2}) \cdot \omega_2 + ... + O(a_{mn},b_{kn}) \cdot \omega_n)$$
(Equation 4)

ω_i means the weight. When $k = 2006$, $\hat{\xi}_k$ means that the weighted sum of opposite degree based on row j (prediction data of 2006). When $k = 2007$, $\hat{\xi}_k$ means that the weighted sum of opposite degree based on row j (prediction data of 2007). When $k = 2008$, $\hat{\xi}_k$ means that the weighted sum of opposite degree based on row j (prediction data of 2008). When $k = 2009$, $\hat{\xi}_k$ means that the weighted sum of opposite degree based on row j (prediction data of 2009). When $k = 2010$, $\hat{\xi}_k$ means that the weighted sum of opposite degree based on row j (prediction data of 2010).

Calculate the absolute difference γ_k. It is shown in Equation 5.

γ_k is the absolute value between ξ_{kj} and $\hat{\xi}_{kj}$.

$$\gamma_k = |\xi_{kj} - \hat{\xi}_{kj}|$$
(Equation 5)

Calculate the prediction data of the first group (2006). The results are shown in Table 10.

Table 10: The key parameters of prediction data (2006)

Years	ξ_k	$\hat{\xi}_k$	γ_k
1995	0.7263	0.7362	0.0099
1996	0.5934	0.6116	0.0182
1997	0.4785	0.4951	0.0166
1998	0.3865	0.3936	0.0071
1999	0.4210	0.4174	0.0036
2000	0.4031	0.3991	0.0040
2001	0.3167	0.3094	0.0073
2002	0.4175	0.4272	0.0097
2003	0.3320	0.3415	0.0095
2004	0.2457	0.2568	0.0112
2005	0.1902	0.2060	0.0158

Calculate the prediction data of the second group (2007). The results are shown in Table 11.

Table 11: The key parameters of prediction data (2007)

Years	ξ_k	$\hat{\xi}_k$	γ_k
1995	0.9671	0.9124	0.0547
1996	0.8087	0.7703	0.0384
1997	0.6833	0.6484	0.0350
1998	0.5940	0.5517	0.0423
1999	0.6440	0.5864	0.0575
2000	0.6241	0.5668	0.0572
2001	0.5333	0.4762	0.0571
2002	0.6220	0.5808	0.0412
2003	0.5292	0.4922	0.0370
2004	0.4312	0.4002	0.0310
2005	0.3616	0.3384	0.0231

Calculate the prediction data of the second group (2008). The results are shown in Table 12.

Table 12: The key parameters of prediction data (2008)

Years	ξ_k	$\hat{\xi}_k$	γ_k
1995	0.8624	0.8660	0.0036
1996	0.7172	0.7305	0.0132
1997	0.5927	0.6047	0.0120
1998	0.4941	0.4960	0.0019
1999	0.5332	0.5232	0.0100
2000	0.5138	0.5035	0.0103
2001	0.4204	0.4068	0.0136
2002	0.5278	0.5324	0.0046
2003	0.4348	0.4396	0.0048
2004	0.3409	0.3479	0.0070
2005	0.2805	0.2928	0.0123

Calculate the prediction data of the second group (2009). The results are shown in Table 13.

Table 13: The key parameters of prediction data (2009)

Years	ξ_k	$\hat{\xi}_k$	γ_k
1995	0.9294	0.9076	0.0218
1996	0.7766	0.7674	0.0092
1997	0.6501	0.6417	0.0084
1998	0.5542	0.5368	0.0174
1999	0.5986	0.5677	0.0309
2000	0.5788	0.5478	0.0310
2001	0.4853	0.4525	0.0328
2002	0.5860	0.5706	0.0154
2003	0.4918	0.4784	0.0135
2004	0.3949	0.3853	0.0096
2005	0.3298	0.3267	0.0031

Calculate the prediction data of the second group (2010). The results are shown in Table 14.

Table 14: The key parameters of prediction data (2010)

Years	ξ_k	$\hat{\xi}_k$	γ_k
1995	0.8453	0.7947	0.0506
1996	0.6978	0.6624	0.0354
1997	0.5812	0.5491	0.0321
1998	0.4982	0.4593	0.0389
1999	0.5443	0.4912	0.0531
2000	0.5257	0.4729	0.0528
2001	0.4414	0.3888	0.0526
2002	0.5236	0.4856	0.0380
2003	0.4376	0.4036	0.0340
2004	0.3463	0.3181	0.0283
2005	0.2811	0.2601	0.0210

3.4 Data Prediction

3.4.1 The data of first group

Select the year of the minimum value of each column in Table 5, after screening, the selected reference value is year 2005. Denote reference value as s_{2006}.

Select the minimum s_k as the basis of calculation. Calculate predicted value $\hat{s}_k$ based on $\hat{\xi}_{kj}$. It is shown in Equation 6.
Since this prediction data generated only one reference value, therefore, γ has no effect, if it is multiple reference value, it will play a role.

$$\hat{s}_k = s_k \times (1 + \hat{\xi}_{kj})$$

(Equation 6)

The prediction result is 236.0142. The result is shown as follows.

$$\hat{s}_{2006} = s_{2006} \times (1 + \hat{\xi}_{2006,2005}) = 195.7 \times (1 + 0.2060) = 236.0142$$

3.4.2 The data of second group

Select the year of the minimum value of each column in Table 6, after screening, the selected reference value is year 2005. Denote reference value as s_{2007}.
The prediction result is 261.9249. The result is shown as follows.

$$\hat{s}_{2007} = s_{2007} \times (1 + \hat{\xi}_{2007,2005}) = 195.7 \times (1 + 0.3384) = 261.9249$$

3.4.3 The data of third group

Select the year of the minimum value of each column in Table 7, after screening, the selected reference value is year 2005. Denote reference value as s_{2008}.
The prediction result is 253.0010. The result is shown as follows.

$$\hat{s}_{2008} = s_{2008} \times (1 + \hat{\xi}_{2008,2005}) = 195.7 \times (1 + 0.2928) = 253.0010$$

3.4.4 The data of fourth group

Select the year of the minimum value of each column in Table 8, after screening, the selected reference value is year 2005. Denote reference value as s_{2009}.
The prediction result is 259.6352. The result is shown as follows.

$$\hat{s}_{2009} = s_{2009} \times (1 + \hat{\xi}_{2009,2005}) = 195.7 \times (1 + 0.3267) = 259.6352$$

3.4.5 The data of fifth group

Select the year of the minimum value of each column in Table 9, after screening, the selected reference value is year 2005. Denote reference value as s_{2010}.

The prediction result is 246.6016. The result is shown as follows.

$$\hat{s}_{2010} = s_{2010} \times (1 + \hat{\xi}_{2010,2005}) = 195.7 \times (1 + 0.2601) = 246.6016$$

3.4.6 Compare the results

By using ODC algorithm, results are shown in Table 15. The predictive value of year 2006 is 236.0142, the real value of the year 2006 is 267.53, and the absolute error of the year 2006 is 11.7803%. The predictive value of year 2007 is 261.9249, the real value of the year 2007 is 290, and the absolute error of the year 2007 is 9.6811%. The predictive value of year 2008 is 253.0010, the real value of the year 2008 is 301.73, and the absolute error of the year 2008 is 16.1499%. The predictive value of year 2009 is 259.6352, the real value of the year 2009 is 250, and the absolute error of the year 2009 is 3.8541%. The predictive value of year 2010 is 246.6016, the real value of the year 2010 is 260, and the absolute error of the year 2010 is 5.1532%. The average absolute error of data of five groups is 9.3237%.

Table 15: The comparison of the results based on ODC algorithm

Years	$\hat{\xi}_k$	Reference Value (Ten thousand tons)	Prediction Value (Ten thousand tons)	Real Value (Ten thousand tons)	Absolute Error
2006	0.2060	195.7	236.0142	267.53	11.7803%
2007	0.3384	195.7	261.9249	290	9.6811%
2008	0.2928	195.7	253.0010	301.73	16.1499%
2009	0.3267	195.7	259.6352	250	3.8541%
2010	0.2601	195.7	246.6016	260	5.1532%

In order to compare the test results, we used classical BP neural network algorithm to do a comparative analysis. In the Matlab environment, set the maximum number of training frequency is 1000; set minimum mean square error is 0.001; set learning step is 0.3. After training, we can get the result. The result is shown in figure 1.

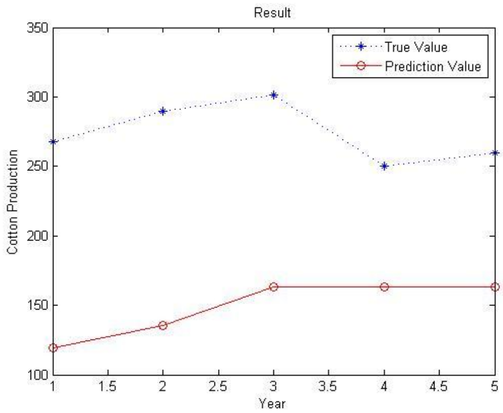

Figure 1: Predictive results based on BP neural network algorithm

By using BP neural network algorithm, results are shown in Table 16. The predictive value of year 2006 is 119.5868, the real value of the year 2006 is 267.53, and the absolute error of the year 2006 is 55.30%. The predictive value of year 2007 is 135.3948, the real value of the year 2007 is 290, and the absolute error of the year 2007 is 53.31%. The predictive value of year 2008 is 163.3200, the real value of the year 2008 is 301.73, and the absolute error of the year 2008 is 45.87%. The predictive value of year 2009 is 163.3219, the real value of the year 2009 is 250, and the absolute error of the year 2009 is 34.67%. The predictive value of year 2010 is 163.3235, the real value of the year 2010 is 260, and the absolute error of the year 2010 is 37.18%. The average absolute error of data of five groups is 45.27%.

Table 16: The predictive results based on BP neural network algorithm

Years	Predictive value	Real Value	Absolute Error
2006	119.5868	267.53	55.30%
2007	135.3948	290	53.31%
2008	163.3200	301.73	45.87%
2009	163.3219	250	34.67%
2010	163.3235	260	37.18%

After comparing the results, we can find that the absolute errors of ODC algorithms for Cotton yield prediction are significantly better than BP neural network algorithm.

4. CONCLUSION

By analyzing the basic concept of the contrary degree, we proposed an opposite degree computation algorithm. The algorithm is based on the degree of antagonism between the data to analyze the approximate relationship. In order to verify the effectiveness of the algorithm, by using the cotton production of Chinese Xinjiang from year 1995 to year 2010, the ODC algorithm has a good performance. The average error is 9.3237%. In order to compare the prediction results, we introduce the classical BP neural network algorithm to do a comparative analysis. The average error is 45.27%. ODC algorithm is significantly better than BP neural network. Experimental results initially show that the ODC algorithm is a feasible and effective method and the algorithm can be used in cotton production prediction. More tests are also required for the use of the algorithm in numerical value prediction and analysis.

CONFLICT OF INTEREST

The authors confirm that the article content has no conflict of interest.

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