Opposite degree algorithm and its application in engineering data processing

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Abstract

In order to analysis and predict data, a new intelligent algorithm (opposite degree algorithm) is used for actual engineering example. The algorithm is based on concept of prior numerical, posterior values and opposite degree in the nature. The human's languages have positive words and negative words. The matrix method can calculate the opposite degree and predict data by considering data's relationship and opposite degree. At the same time, relevant results are obtained through the opposite degree calculation by using the data of coal and gas outburst. After the comparison of the actual results, the accuracy of prediction is 100%. The preliminary validation of opposite degree algorithm shows that the algorithm is basically feasible and effective. If this algorithm can be improved, it is expected to be applied in practical fields more widely.

Keywords: opposite degree, algorithm, engineering data processing, coal and gas outburst, prior value, posterior value, prediction method

1 Introduction

In China, coal and gas outburst accidents often happen in the disasters. Every year, a number of incidents caused casualties. Therefore, it has a very important realistic significance for the study of coal and gas prediction. There are lots of staff's deaths or injury event in China. So it has an important practical significance to research the forecasting methods in the field of mining engineering. In the study of engineering, there are many intelligent algorithms has been used. There are lots of new intelligent algorithms and improved algorithms for solving engineering problems, such as data driven nonlinear control strategy [1], improved GA-ANFIS [2], improved SVM [3] and CIP [4] and HCDCCMM [5] and so on. This research tries to put forward a new method for computing the opposite degree, and hope to be able to predict the classification. In order to verify the effectiveness of the algorithm, based on the coal and gas outburst instance data, we make a prediction results compared with other method. In the nature, the opposite degree is inseparable from the use of the synonyms, and antipodal opposites in people's daily life [6-8]. Judging from intuition, the opposite degree between "male" and "female" is relatively absolute, and the opposite degree should be very high. So, for intelligent information processing, especially in nature situation, it is very important to use a precise method to represent the relationship between the real relationships.

2 Opposite degree algorithm

Opposite degree is proposed by Xiao-Guang Yue [9], and it has many species can be divided into two or more than two kinds, called gender. Typically, a species can have two kinds of gender: male and female. Therefore, creatures with the opposition can be applied in the analysis of opposition a group of engineering data.

The definition of opposite degree are presented, mainly involves the following aspects:

1) A priori value refers to the value for the training.

2) A posteriori numerical refers to numerical prediction analysis.

3) Opposite degree is a priori and posteriori numerical value between degrees of difference, $(-\infty, +\infty)$ is the range of the values.

In general, the definition of opposite degree is C, a priori value is A, the posterior value is B:

$$C = \frac{B-A}{A} = \begin{cases} <0, B<A \\ =0, A=B \\ >0, B>A \end{cases},$$

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C is close to $+\infty$, it shows that *B* is more big, and indicates that the difference of *B* and *A* is greater. *C* is close to $-\infty$, it shows that *B* is small, and indicates that the difference of *B* and *A* is greater. *C* is close to 0, indicating that *B* and *A* are closer. *C* is equal to 0, show that the *A* is equal to *B*.

There is a prior matrix $A_{m\times n}$:

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

The classification column vector of $A_{m\times n}$ is *X*:

$$X=\begin{bmatrix} x_1 \\ x_2 \\ \dots \\ x_n \end{bmatrix}.$$

There is a posterior matrix $B_{p\times n}$:

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

The opposite degree of $A_{m\times n}$ and $B_{p\times n}$ can be calculated by using the following equation:

$$C(a_{ij},b_{kj})=\frac{b_{kj}-a_{ij}}{a_{ij}}.$$

Based on the opposite degree calculation, the corresponding classification column vector *Y* of $B_{p\times n}$ can be calculated:

$$Y=\begin{bmatrix} y_1 \\ y_2 \\ \dots \\ y_p \end{bmatrix}.$$

3 Calculation steps

1) According to the following formula, calculated separately for each line of the opposite, and returns the absolute value of the minimum value. $S(k)$ is the opposite degree calculation results of the *k* line data of $B_{p\times n}$ and each line of $A_{m\times n}$, the minimum absolute value can be got (if the results obtained with two or more than two of the same value, it returns the first value):

$$C(k)=\min\begin{cases} \left|\sum_{j=1}^{n}\frac{b_{kj}-a_{1j}}{a_{1j}}\right| \\ \dots \\ \left|\sum_{j=1}^{n}\frac{b_{kj}-a_{ij}}{a_{ij}}\right| \end{cases}.$$

2) Returns the corresponding x_i to the y_p, the *k* line classification of $B_{p\times n}$ can be obtained.

3) Repeat (1) and (2), until calculate all the results.

4) Output *Y*.

4 Analysis of calculation results

Firstly, the example of coal and gas outburst data comes from Yunnan Enhong coal mine [10]. This is a big coal mine in China. And 20 sets of data are selected as the training samples in Table 1. In order to do a comparison, 8 sets of data are selected as testing samples in Table 2. Initial speed, consistency coefficient, gas pressure, destruction of coal type and mining depth are selected as influencing factors in Table 2. We choose the factors. We choose the 5 factors based on effectiveness, independence and feasibility. The last column corresponds to the classification column vector.

Secondly, by using the OD algorithm, the opposite result is obtained (results accurate to four digits after the decimal point). Opposite degree calculation is based on each test data and 20 sets of training data; the results are shown in Table 3. In order to express the degree of deviation between the data, the data do not take absolute value. Where, the minimum data results indicate that is the minimum absolute opposite degree results, namely the forecast error data and the training data with minimum computational results.

Thirdly, the minimum opposite degree results and corresponding approximate data rows are shown in Table 4.

Finally, the experimental results show that the accuracy of OD algorithm is 100% (as shown in Table 5). The accuracy of OD and accuracy of Chen Zuyun et al’s method [10] are the same (as shown in Table 6). This results show that the algorithm has a positive role in classification and prediction.

TABLE 1 Training samples

No.	Initial speed	Consistency coefficient	Gas pressure (mpa)	Destruction of coal type	Mining depth (m)	Coal and gas outburst
1	19.0	0.31	2.76	3	620	yes
2	6.00	0.24	0.95	5	445	yes
3	18	0.16	1.2	3	462	yes
4	5	0.61	1.17	1	395	no
5	8	0.36	1.25	3	745	yes
6	8	0.59	2.8	3	425	yes
7	7	0.48	2	1	460	no
8	14	0.22	3.95	3	543	yes
9	11	0.28	2.39	3	515	yes
10	4.8	0.6	1.05	2	477	no
11	6	0.24	0.95	3	455	yes
12	14	0.34	2.16	4	510	yes
13	4	0.58	1.4	3	428	no
14	6	0.42	1.4	3	426	yes
15	4	0.51	2.9	5	442	yes
16	14	0.24	3.95	3	552	yes
17	4	0.53	1.65	2	438	no
18	6	0.54	3.95	5	543	yes
19	7.4	0.37	0.75	4	740	yes
20	3	0.51	1.4	3	400	no

TABLE 2 Testing samples

No.	Initial speed	Consistency coefficient	Gas pressure (mpa)	Destruction of coal type	Mining depth (m)
21	11	0.37	2.1	3	412
22	12.1	0.49	2	3	412
23	11.5	0.28	1.9	3	407
24	11.8	0.36	2.3	3	403
25	10.8	0.3	2.2	3	396
26	12.4	0.38	1.8	3	410
27	11.8	0.57	1.6	3	408
28	10	0.55	1.5	3	405

TABLE 3 Opposite degree calculation results

No.	21st group OD	22nd group OD	23rd group OD	24th group OD	25th group OD	26th group OD	27th group OD	28th group OD
1	–0.8021	–0.3934	–1.1467	–0.7343	1.028	–0.8081	–0.3025	–0.5028
2	2.11137	2.68944	1.59794	2.39334	1.85568	2.06609	2.54273	2.04739
3	1.56539	2.29316	0.85317	1.69452	1.16548	1.45133	2.43451	2.11968
4	3.64447	3.97572	3.41333	3.93623	3.53468	3.67939	3.69486	3.20901
5	0.6358	1.02663	0.28159	0.85594	0.47488	0.59589	0.88598	0.5214
6	–0.2785	0.02671	–0.4517	–0.1452	–0.424	–0.1984	–0.0275	–0.3291
7	2.28791	2.64506	2.06097	2.4618	2.12873	2.3544	2.56017	2.20484
8	–0.2421	0.35664	–0.6753	–0.1963	–0.5787	–0.1763	0.59021	0.33989
9	0.00009	0.48682	–0.3693	0.10331	–0.2573	0.03367	0.57013	0.2874
10	2.27206	2.60599	2.02527	2.59367	2.17543	2.29049	2.28749	1.77763
11	2.49102	3.06909	1.97784	2.77343	2.23612	2.44584	2.92258	2.42739
12	–0.596	–0.2108	–0.9274	–0.4933	–0.8012	–0.6094	–0.1899	–0.4295
13	1.85055	2.26102	1.66584	2.15514	1.7139	1.99883	2.02889	1.46597
14	1.18142	1.57904	0.89588	1.41268	1.01529	1.21958	1.42441	0.99832
15	0.73175	1.20757	0.60001	0.96075	0.54278	0.99339	1.14245	0.61196
16	–0.3946	0.15866	–0.7936	–0.3448	–0.7042	–0.3325	0.36205	0.11939
17	2.16148	2.60229	1.98404	2.44328	2.00348	2.34396	2.42668	1.87148
18	–0.5911	–0.2108	–0.7343	–0.4422	–0.7582	–0.4189	–0.2213	–0.5892
19	1.59324	1.93288	1.14414	1.92883	1.48874	1.40676	1.56982	1.13514
20	2.92216	3.45269	2.757	3.28957	2.74966	3.18915	3.21384	2.49569

TABLE 4 The minimum opposite degree results and corresponding approximate data rows

Results	21st group	22nd group	23rd group	24th group	25th group	26th group	27th group	28th group
The minimum opposite degree results	0.00009	0.02671	0.28159	0.10331	–0.2573	–0.1763	–0.0275	0.2874
Corresponding approximate data rows' No.	9	6	5	9	9	8	6	9

TABLE 5 Comparison of the testing results and the actual results

Results	21st group	22nd group	23rd group	24th group	25th group	26th group	27th group	28th group
Testing Results	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Actual Results	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

TABLE 6 Comparison of different methods

No.	Method name	Accuracy
1	Chen Zuyun et al's method	100%
2	OD	100%

5 Conclusions

Human thinking with divergent characteristics, new things in the human brain will produce antagonism and association. We propose a new intelligent algorithm – opposite degree algorithm. The algorithm can calculate the opposite degree of values, so as to achieve the purpose of classification and prediction. Meanwhile, in order to verify the effectiveness of the algorithm, using coal and gas outburst instance data and OD algorithms to predict the classification, and do a comparison with other methods. Its prediction result is 100%. The study shows that the algorithm is feasible and effective. The next focus of the work is divided into two parts, on the one hand, to further verify the algorithm from the point of view of mathematics, and attempts to prove that the algorithm is applicable and feasible; on the other hand, to further improve the algorithm, especially in the numerical prediction to make supplement, expected application in actual field more.

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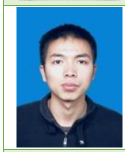

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