Discriminant Analysis on Complex Material and Variable Structure System Life

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Abstract. In this paper, the discriminant categorization on complex material and variable structure system life are given, and there are two kinds of variable structure on complex material system life based on the empirical data and the simulating data and the evaluating and analyses rooted in actual system. Here, according to the two kinds of variable structure with the corresponding data, complex material system lives are categorized based on principal component analysis and classification discriminant analysis, and the front is used to predigest data, the latter is used to categorize data. Thus, the system life data might be categorized as the two kinds of variable structure with runtime and environment based on system life indexes, the precise radio is , and the misjudged radio and the undetermined ratio are summed as 20%.

Introduction

In resent two decades, the studies on complex material system life have achieved quiet great progresses, and the main excellences of these progresses are in a large scale intellectualized calculation and analysis under life data of complex system [1-4]. Here gives some examples, such as, network analysis and computation, optimal design of system life, graphic method and data resources visualization, various of intellectual and optimal algorithms, instantaneous tracking technologies, and so on. However, there are still many of troublesome and rudimental issues of complex system life, and that are at least not put across up to the present. Among the issues, it is most prominent essential issue that the initialized data of complex material system life are felicitously disposed, so that subsequent design and analysis on complex material system life might be efficaciously realized. Contrarily, if there are some of defaults and shortages in the felicitous dispose of initialized data on complex material system life, the farther analysis, the designs and applications of life on complex material system must be badly influenced. In fact, many applied effects of studies on complex system life have obviously proved this point up to now. In other words, modern computing techniques and implements are imprudently or blindly applied to complex system life before that the data are suitably and adequately disposed, so that it might be result in jumbled analysis. To solve these troublesome issues, the two advises are given as below: (1) predigesting data structure of complex material system life; (2) partitioning complex material system on life.

In analysis of complex system life, there is a kind of issue which that is not seriously investigated, and that is analysis of complex material system life under variable structures. Indeed, the disparate system behaviors are accordingly determined by the system structures, and foremost, the disparate system lives are also accordingly determined by the variable structures[5-8]. In this paper, the more rudimental issue will be discussed, that is, the analysis of system life are discriminated in two kinds of variable structures on system life indexes. At first, for the sake of the simple and convenient, the discriminant analysis of variable structure system on four subsystems is not straightly put in practice, and through the principal component analysis for the four life indexes of original subsystem, the two principal component indexes are picked up among the four indexes. The second, according to two kinds of variable structure based on the two indexes, the discriminant categorizing of the data 20

groups are approximately categorized into two kinds. Thus, the discriminant categorizing on the empirical data and simulating data on variable structure life of complex material system is realized, and the subsequent analysis on system life might be expediently disposed. In fact, multivariable structures might also be easily implemented as the analogous tactics.

Principal Component Analysis based on Empirical Data

Data Pretreatments before Principal Component Analysis. Here, the topical circumstances of this paper are at first stated as below, the entire system consists of four subsystems, and shows itself as two kinds of variable structure with runtime and environment, and so on, that the running structure of the real system is not factitiously decided. For the four subsystems, 20 groups of their life indexes are gained by the empirical data and the simulating data and the evaluating and analyses, and the 20 groups of data have been standardized and shown in Table 1 for sake of the length saving of the paper.

In the Table 1, the most left row denotes the serial number of the data order by the empirical data and the simulating data and the evaluating and analyses, the most right row denotes the running categorization states of the system in A and B for the two kinds of variable structures. X_1, X_2, X_3, X_4 denote the four subsystems, and the data in the middle of Table 1 denote standardization data.

Table 1 Standardization data and categorization table on life indexes

Serial number	X_1	X_2	X_3	X_4	Categorization
1	334.1113	36.49658	11.6619	80.53768	A
2	716.7205	75.82216	12.04159	48.74299	A
3	774.505	58.13777	16.97056	40.81508	A
4	1295.376	59.5063	27.73085	155.1576	A
5	372.5112	39.40812	12.04159	125.7067	A
6	419.3877	34.1321	15.65248	121.8274	A
7	266.115	31.89044	10.63015	131.1859	A
8	539.6714	62.24147	11.04536	66.31791	A
9	302.0649	30.23243	12.72792	124.2157	AD
10	2244.484	73.40981	38.94868	114.121	A
11	845.9387	77.36924	13.92839	153.1038	B
12	396.0883	34.98571	14.42221	59.03624	B
13	389.6796	57.70615	8.602325	81.02737	BD
14	742.3631	70.29225	13.45362	129.8056	B
15	1060.331	85.42833	15.81139	115.6652	B
16	240.6368	21.84033	14.03567	164.0546	BD
17	303.7859	32.24903	12	172.875	B
18	383.3662	51.47815	9.486833	24.0755	B
19	249.73	39.45884	8.062258	81.25384	CB
20	899.154	71.44928	16.03122	83.57125	B

Principal Component Analysis on Complex Material System Life. Let X denote the data in the middle of Table 1, then X is a 20×4 matrix. Now, principal component analysis on the standardized

index data of four subsystem life are given as the below where that are algorithmic steps and calculating achievement of the data.

(1)The original data are standardized as shown in Table 1, and denoted the matrix X;

(2) Calculating the relation matrix $R = X^T X$, and R is a 4×4 matrix;

(3) Calculating the eigenvalues and eigenvectors of R;

(4)Based on the above results and the principle of principal component analysis, the summing contribution ratio of the front two principal components on their eigenvalues in the four principal components has reached beyond 89.85%. Thus, the reasons are highly sufficient that the front two principal components consist basically of the full information on system life indexes, and the formulas of the front two principal components are shown as below:

$$F_1 = -0.9959\, X_1 + 0.0596\, X_2 + 0.0568\, X_3 + 0.0362\, X_4. \tag{1}$$

$$F_2 = 0.6077\, X_1 + 0.5660\, X_2 + 0.0886\, X_3 + 0.0142\, X_4 \tag{2}$$

Where F_1 is the first principal component, and F_2 is the second principal component. On second thoughts, there are still highly sufficient reasons that the front two standardized indexes consist basically of the full information on the primary four life indexes according to the coefficients in the above two formulas. Therefore, the below categorizing analysis only is considered in the form of the front two standardized indexes on system life. Here, the routine test on statistics analysis is omitted, for the sake of the saving length of this paper.

The Results on the Classification Discriminant of System Life

The classification results about the two principal components. References are cited in the text just by square brackets[1]. (If square brackets are not available, slashes may be used instead, e.g. /2/.) Two or more references at a time may be put in one set of brackets[3,4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under a heading *References*, see our example below.

Now there are two kinds of states in system running, G_1, G_2 denote the two states, and the classification discriminant are put in practice with the above analysis, according to the front two standardized indexes on system reliability in Table 1. Here, the Euclidian distance is used in data categorization, that is, the Euclidian distance $D(Y, G)$, and the testing data denote $Y_1, Y_2, \text{ } K \text{ } Y_{20}$, and general Y. Through the averaging method from the prep-data, G_1, G_2 are quantitatively translated into $G_1 = (79.849, 36.726)^T$ and $G_2 = (58.913, 31.704)^T$ [9-12]. Moreover, the discrimination criterion are noted as below:

(1) $Y \in G_1$, if $D(X, G_1) < D(X, G_2)$;

(2) $Y \in G_2$, if $D(X, G_1) > D(X, G_2)$;

(3) the undetermined, when $D(Y, G_1) = D(Y, G_2)$;

(4) $D(Y, G) = (Y - G)^T \Sigma^{-1} (Y - G)$, here Σ^{-1} might be denoted as the relation matrix of the front two principal component vectors that the matrix is 2×2 non-singular one. The results of the classification discriminant on the data are shown in Table 1, where AD, BD denote the misjudged with the original belongs respectively to A or B, moreover, CB denotes the undetermined. Thus, according to Table 1, the precise radio is 80%, and the misjudged radio and the undetermined ratio are summed as 20%. In fact, the ratio 20% is still reduced as the elaborating method is employed.

Conclusions

The conclusion of this paper was given as the following: (1) According to the principal component analysis and classification discriminant analysis, the data might be categorized as the two kinds of

variable structure with runtime and environment based on system life indexes, the precise radio is 80%, and the misjudged radio and the undetermined ratio are summed as 20%; (2) The principal component analysis and classification discriminant analysis can be the same with the life analysis on variable structure and complex material system.

Acknowledgements

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