Method and Apparatus for Determining Risk Management Decision-Making Critical Values

Technical Field

[01] The embodiments of the present specification relate to the technical field of risk management, and in particular relate to a method and apparatus for determining risk management decision-making critical values.

Background

[02] Risk identification and decision control are the two major concerns in a risk management system. Risk identification focuses on how to identify potential risks, while decision control focuses on how to take proper actions according to the identification result.

[03] A quantitative score is usually given for an event at the risk identification stage. Accordingly, the fundamental principle at the decision control stage is as follows: if the identified risk is high, strong intervention measures are taken, and if the identified risk is low, weak intervention measures are taken. However, an objective criterion is required to determine whether a risk is a high or low, that is, one or more decision-making critical values need to be determined in practical applications. In a traditional solution, these critical values are manually determined based on experience, and the manually determined critical values cannot comprehensively reflect the requirements in many aspects in a complicated risk management system.

Summary of the Invention

[04] The embodiments of the present specification provide a method and apparatus for determining decision-making critical values in risk management for the above-mentioned technical problem. The technical solution of the present specification is as follows:

[05] A method for determining decision-making critical values in risk management comprises:

[06] acquiring the relation functions between critical values of M features and N index values, wherein each index value corresponds to one relation function, all or a part of M critical values are input and one index value is output for each relation function,

[07] initializing set P comprising K combinations, each combination comprising M critical values and K being a preset value, and utilizing the following steps for cyclic processing until

a preset stop condition is satisfied:

[08] calculating the score of each combination in set P according to the acquired N relation functions, the score being used to represent the overall quality of the N index values of the corresponding combination and being positively correlated to positive index values of N index values and negatively correlated to negative index values of N index values,

[09] selecting two combinations from set P each time and exchanging any critical value thereof to generate two new combinations until the number of new combinations reaches a preset number, wherein the probability of each combination being selected from set P is positively correlated to the score of the combination, and

[10] updating set P according to the new combinations, the number of combinations in set P after updating remaining unchanged.

[11] An apparatus for determining risk management decision-making critical values comprises:

[12] a relation function acquisition module, configured to acquire the relation functions between M critical values of M features and N index values, wherein each index value corresponds to one relation function, all or a part of the M critical values are input and one index value is output for each relation function,

[13] a set initialization module, configured to initialize set P comprising K combinations, each combination comprising M critical values and K being a preset value,

[14] a set updating module, configured to utilize the following sub-modules for cyclic processing until a preset stop condition is satisfied:

[15] a score calculation sub-module, configured to calculate the score of each combination in set P according to the acquired N relation functions, the score being used to represent the overall quality of N index values of the corresponding combination and being positively correlated to the positive index values of N index values and negatively correlated to the negative index values of N index values,

[16] a reorganization sub-module, configured to select two combinations from set P each time and exchange any critical value to generate two new combinations until the number of new combinations reaches a preset number, wherein the probability of each combination being selected from set P is positively correlated to the score of the combination,

[17] an updating sub-module, configured to update set P according to the new combinations, the number of combinations in set P after updating remaining unchanged, and

[18]a critical value determination module, configured to determine the corresponding M critical values of the combination having the highest score in set P to be available critical values after cyclic processing is stopped.

[19]In the technical solution provided in the embodiments of the present specification, for a multi-critical-value and multi-target-value risk management system, a plurality of combinations of critical values are generated through an initialization, then new combinations are continuously generated by exchanging the elements between combinations, bad combinations are eliminated, good combinations are kept, and best combinations are obtained through a plurality of iterations. Since each iteration follows the principle of the survival of the fittest, the best combinations may be found at a high efficiency.

[20]It should be understood that the general description above and the detailed description below are only exemplary and explanatory, and do not limit the embodiments of the present specification.

[21]In addition, any of the embodiments of the present specification may not be required to achieve all the above-mentioned effects.

Brief Description of the Drawings

[22]To describe the embodiments of the present specification or the technical solution in the existing solutions more clearly, the following briefly describes the drawings required in the description of the embodiments or the existing solutions. Obviously, the drawings in the following description are only some embodiments of the present specification. Those skilled in the art may obtain other drawings on the basis of these drawings.

[23]Fig. 1 is a flowchart of the method for determining decision-making critical values in risk management according to the embodiments of the present specification.

[24]Fig. 2 shows the function relation in the embodiments of the present specification.

[25]Fig. 3 shows the structure of the apparatus for determining decision-making critical values in risk management according to the embodiments of the present specification.

[26]Fig. 4 shows the structure of a device for configuring the apparatus in the embodiments of the present specification.

Detailed Description of the Invention

[27]To let those skilled in the art better understand the technical solution in the embodiments

of the present specification, the following will describe in detail the technical solution in the embodiments of the present specification in combination with the drawings in the embodiments of the present specification. Obviously, the embodiments described are only a part, but not all of the embodiments of the present specification. All other embodiments obtained by those skilled in the art on the basis of the embodiments of the present specification should fall within the scope of protection of the present specification.

[28]For example, in order to avoid or reduce fund losses of customers in a financial risk management scenario, the risk management system usually assesses the risk of a fund transfer event before the a fund is transferred out of an account and determines whether to take some actions according to the assessment result, such as, requiring the customer to enter the payment password (relative to password-free payment), requiring the customer to enter the verification code received by a mobile phone, or even intercepting the transaction or freezing the account.

[29]Since a plurality of features concerned at the time of a risk assessment have continuous values (or multiple values), in order to determine whether to perform a risk management process or determine what level of actions need to be performed, it is necessary to set one or more decision-making critical values for the features having continuous values. For example, if the concerned feature is "total amount currently transferred", and the corresponding action is "require the customer to enter the verification code received by the mobile phone when the transferred amount exceeds t yuan, and otherwise directly transfer the amount by payment password," then "t" is a decision-making critical value for the "total amount currently transferred" feature.

[30]On the other hand, from the perspective of the overall design of the risk management system, a plurality of assessment indexes often need to be concerned. When a decision-making critical value is changed, a plurality of indexes may be affected at the same time. For example, the design direction of a risk management system is "a high prediction coverage and a low customer interruption rate". It may be understood that for the "total amount currently transferred" feature, a low decision-making critical value will improve not only the prediction coverage, but also the customer interruption rate. It is obvious that the plurality of indexes influenced by a critical value should be comprehensively considered when the decision-making critical value is set. A plurality of critical values need to be determined for more features in a large risk management system. This further increases the implementation difficulty.

[31]For the above-mentioned requirement, a solution for determining decision-making critical

values in risk management is provided. It is used to determine a better combination of critical values in a "multiple-critical-value and multiple-index-value" risk management system.

[32] As shown in Fig. 1, the method comprises the following steps:

[33] S101: Acquire the relation functions between the critical values of M features and N index values.

[34] Without loss of generality, in the present specification, the system is first modeled as follows:

[35] N risk management indexes (for example, prediction coverage, prediction hit rate and customer interruption rate) exist, and they are set to $y_1, y_2, \ldots y_N$;

[36] N decision-making critical values need to be set for the M features (for example, total amount being transferred out, a total amount transferred out within 24 hours, and a time interval from current login to the last secure operation, and a risk score of current transfer), respectively and the decision-making critical values are set to $x_1, x_2, \ldots x_M$;

[37] It may be understood that a relation exists between a critical value and an index value. Since each index value is affected by all or a part of the M critical values, a function relation may be established between each index value and a plurality of critical values:

$$y_1=f_1(x_1, x_2, \ldots x_M)$$

$$y_2=f_2(x_1, x_2, \ldots x_M)$$

……

$$y_N = f_N (x_1, x_2, \ldots x_M)$$

[38] It may be seen that N index values correspond to N relation functions. Each relation function includes all or a part of M critical values as input (if a part of critical values are input, it may be understood that the effect of some critical values on the function value is 0) and one index value as output. Fig. 2 shows the function relation.

[39] In practical applications, the relation functions f between critical values and index values are often implicit, and these relation functions may be mined from a large amount of historical data through a machine learning algorithm:

[40] First, acquire data of a plurality of correspondences comprising M critical values and N index values from historical data; for example, regarding the "require the customer to enter the verification code received by the mobile phone when the transferred amount exceeds t yuan" risk management measure, the statistics values of prediction coverage and customer

interruption rate within a certain period of time after t is set to 100 yuan, 200 yuan, 500 yuan and so on may be obtained from the historical data. Then the acquired plurality of correspondences are used as samples to obtain the relation functions between M critical values and N index values through supervised learning.

[41]For the specific method for acquiring the relation functions between critical values and index values through training, see other relevant literatures. No detail is given in the present specification. Of course, the method for acquiring relation functions is not limited to the above-mentioned method. In fact, for the solution provided in the present specification, the relation functions between critical values and index values may be considered as known information, and therefore it is unnecessary to define a specific acquisition method.

[42]S102: Initialize set P comprising K combinations.

[43]In the present specification, data comprising M critical values is referred as to one combination, and when x_1, x_2, …x_M are respectively set to different values, different combinations may be obtained.

[44]At the initialization stage, an integer K may be preset and K combinations may be generated to form set P. The K combinations in set P may be expressed as follows:

Combination 1: x_{11}, x_{21}, …x_{M1}

Combination 2: x_{12}, x_{22}, …x_{M2}

……

Combination k: x_{1k}, x_{2k},…x_{Mk}

……

Combination K: x_{1K}, x_{2K},…x_{MK}

[45]Specific values for the critical values in each combination may be obtained according to the actual data, or may be randomly generated. Of course, "randomly generated" here should be based on the prerequisite that the values themselves make sense. A range may be set for each type of critical values according to the practical requirements. In addition, the value of K may be a single-digit number or two-digit number or three-digit number, and is not defined in the present specification.

[46]S103: Calculate the score of each combination in set P according to the acquired N relation functions.

[47]The "score" parameter defined in the present specification is used to assess the quality of

each combination of critical values so as to finalize the "best" combination of critical values. The superiority of a "combination" is more intuitively reflected by the corresponding N index values of the combination, and therefore, the "score" parameter is actually also a parameter used to assess the overall quality of N indexes. Supposing that a score is denoted by z, then z may be expressed as the value determined by y_1, y_2, …y_N, that is, a function g which satisfies $z= g(y_1, y_2, \ldots y_N)$ exists.

[48] Further, for any combination k (k=1, 2, …K):

[49] M critical values may be expressed as:

$$x_{1k}, x_{2k}, \ldots x_{Mk}$$

[50] N index values are:

$$y_{1k} = f_1(x_{1k}, x_{2k}, \ldots x_{Mk})$$

$$y_{2k} = f_2(x_{1k}, x_{2k}, \ldots x_{Mk})$$

……

$$y_{Nk} = f_N (x_{1k}, x_{2k}, \ldots x_{Mk})$$

[51] The score is:

$$z_k = g(y_{1k}, y_{2k}, \ldots y_{Nk})$$

[52] Since the above-mentioned function g is a function used to comprehensively assess the overall quality of N indexes, the basic requirements for the function are: the function is positively correlated to positive index values of N index values and negatively correlated to negative index values of N index values. Here, positive indexes refer to "the larger the better" indexes, for example, predicted hit rate and prediction coverage, and negative indexes (also called reverse indexes) refer to "the smaller the better" indexes, for example, customer interruption rate.

[53] The score z may be calculated as a difference, for example,

$z=\Sigma$ positive index values of N index values $-\ \Sigma$ negative index value of N index values

[54] "Σ" is a sum operator, that is, for any group of N indexes, "all positive index values minus all negative index values" is used to assess the overall quality of N indexes, and the larger the value of z is, the better the group of indexes are.

[55] Besides, the score z may be calculated as a ratio, for example,

$$z = \frac{\pi(positive\ index\ values\ of\ N\ index\ values)}{\pi(positive\ index\ values\ of\ N\ index\ values)}.$$

[56] where, "π" is a product operator, that is, for any group of N indexes, "the ratio of all positive index values to all negative index values" is used to assess the overall quality of N indexes, and the larger the value of z is, the better the group of indexes are.

[57] It may be understood that the above are only two simple examples of the function g, and according to the actual requirements, the function may have other variants. For example, the weighting method may be used for the function in the form of a difference, that is, a correction factor is specified as a weight for each index value.

[58] If the priorities of different index values are predefined, a fixed correction factor may be specified for each index value. These correction factors may be obtained through machine learning based on the historical data, or may be manually allocated (for example, a correction factor with a larger absolute value may be specified for an important index).

[59] If the priorities of different index values cannot be predefined, correction factors may be randomly generated as weights for N index values, respectively, and then the corrected N index values are weighted. During the cyclic processing, different correction factors may be randomly generated in each cycle, and the best (or approximately the best) correction factor combination may be adaptively selected through a plurality of cyclic selections.

[60] In addition, the score of each combination may be corrected according to the overall distribution of K combinations. The principle is that the denser the distribution points are, the larger the penalty correction factor may be given to the corresponding score. For example, if M features are mapped into an M-dimension space, then K combinations may be mapped into K points in the space. For point k (k=1, 2, …K), if other points are distributed around, a penalty correction is made for the score z_k and the penalty correction factor is positively correlated to the number of other points distributed around. For example, the penalty correction formula may be set to $z_k' = \frac{z_k}{\text{number of other points around point k within the radius R}}$, where R is a preset value, for example, a Euclidean distance in the M-dimension space. Of course, the correction formula is only used to give an exemplary description and should not be interpreted as a restriction of the solution in the present specification.

[61] In addition, it may be understood that the execution sequence of steps S101 and S102 is not restricted as long as they are completed before step S103.

[62] S104: Cross the combinations in set P in pairs to reorganize the combinations.

[63] "Crossing the combinations in pairs to reorganize the combinations" means selecting two

combinations from K combinations in set P and exchanging any critical value to generate two new combinations. For example, for the following two combinations:

Combination 1: $x_{11}, x_{21}, \ldots x_{M}$

Combination 2: $x_{12}, x_{22}, \ldots x_{M2}$

[64] if the first critical value (x_{11} and x_{12}) is exchanged, two new combinations may be obtained.

New combination 1: $x_{12}, x_{21}, \ldots x_{M1}$

New combination 2: $x_{11}, x_{22}, \ldots x_{M2}$

[65] The above-mentioned process may be repeated for multiple times. Two combinations are selected from set P each time, and any critical value is exchanged to generate two new combinations each time. After a plurality of cycles, a set comprising new combinations may be generated. The new set is denoted by P' in the present specification.

[66] The following points should be noted in the above-mentioned cyclic process:

[67] Firstly, a combination in the original set P may be selected for multiple times or may be never selected in the cyclic process. In the solution provided in the present specification, the probability of any combination k (k=1, 2, …K) being selected is positively correlated to the score z_k thereof.

[68] "The probability of any combination k being selected may be positively correlated to the score z_k thereof" may be implemented in the following way:

[69] calculate the sum $\sum z_k$ of the scores of K combinations in set P, and

[70] for a combination k, determine the ratio of z_k to $\sum z_k$ to be the probability of the combination k being selected each time.

[71] For example, if the scores of combinations 1 to 4 are 10, 20, 20 and 40, respectively, then the probabilities of combinations 1 to 4 being selected each time are: 10/90, 20/90, 20/90 and 40/90, respectively.

[72] Of course, the above-mentioned algorithm is used to give an exemplary description. In practical applications, an improved algorithm of the above-mentioned algorithm or other algorithms may be used to implement "the probability of any combination k being selected positively correlated to the score z_k thereof". For example, the softmax function may be used to calculate the probability of combination k being selected. The prerequisite is that the algorithm satisfies the principle of "the larger z_k is, the higher the probability of combination

k being selected is." The meaning of the principle is as follows: the larger z_k is, the higher "quality" M critical values in combination k are; such critical values should have higher probabilities of being selected to participate cross reorganization, thus helping to generate more superior combinations.

[73] Secondly, the exchanged object for each reorganization may be any of M critical values (the first critical value is exchanged in the above-mentioned example). The exchanged object may be randomly selected or determined according to a certain polling algorithm at each exchange. The general principle is that critical values in different positions all have a chance to be selected to participate in cross reorganization so as to cover more comprehensive combinations in the cyclic process.

[74] Thirdly, after an exchange is completed each time, the exchanging results may be randomly corrected. For example, the values of the exchanged objects in the exchanging results may be randomly corrected and thus the new combinations are corrected into:

New combination 1: $0.9*x_{12}, x_{21}, \ldots x_{M1}$

New combination 2: $1.1*x_{11}, x_{22}, \ldots x_{M2}$

[75] Where, 0.9 and 1.1 are randomly generated correction factors. The purpose of such process is to avoid any restriction of the initialized set P and attempt to generate new "high quality critical values." Of course, a random correction may be a random correction of an exchanged object, or a random correction of other critical values than the exchanged object. The algorithm for a random correction is not limited to the multiplication by a factor, and those skilled in the art may flexibly select a specific random correction scheme according to the practical requirements. In addition, a certain random correction probability may be set after each exchange. For example, if the initialized set P contains a small number of combinations, a high random correction probability may be set.

[76] Finally, the stop condition of the above-mentioned cyclic process may be: the number of new combinations (namely, the number of combinations in set P') reaches a preset number. For the convenience of processing, the "preset number" may usually be set to K. Of course, the "preset number" may also be set to other values, for example, K-2, 2K, 3K, etc.

[77] S105: Update set P according to the new combinations.

[78] Since set P needs to participate in the processing in each cyclic process, the number of combinations in set P before and after the update should remain unchanged. On condition that the principle is guaranteed, the following updating method, for example, may be adopted.

[79]if the number of new combinations in step S104 is K, K new combinations (namely, set P') may be directly determined to be set P after the update. This is because set P' itself is formed by reorganizing high quality critical values in set P. Therefore, set P' should be superior to set P as a whole. That is, the combinations tend to be better after each update, and the best (or approximately the best) combinations of critical values may be favorably found after a plurality of cycles.

[80]It may be understood that if the number of new combinations in step S104 is greater than K, the scores of the new combinations may be calculated, the new combinations may be sorted by the scores, and K of the new combinations having the highest scores may be determined to be set P after updating. For the method for calculating the scores of combinations, see step S103. It will not be described repeatedly here.

[81]In addition, after K combinations in the original set P and the new combinations are merged (that is, P and P' are merged), the combinations may be sorted by the corresponding scores and K of the combinations having the highest scores may be determined to be set P after updating. Since the exchanged object for each reorganization is randomly selected, superior combinations in the original set P may be discarded during the selection. The merged updating method may effectively avoid this case.

[82]S106: Determine whether the stop condition of the cyclic process is satisfied. If yes, continue to perform step S107, and otherwise, go back to step S103.

[83]From the flowchart in Fig. 1, it may be seen that steps S103 to S105 are cyclic processing steps. The stop condition of the cyclic process may be set in different ways. The following only gives some exemplary description.

[84]The cyclic process may be stopped after the number of cycles reaches a preset number (for example, 5, 10, or 50).

[85]The cyclic process may be stopped after the highest combination score in set P already satisfies a preset condition of convergence. For example, if the change of the highest combination score in set P obtained after two cycles is already less than a threshold, the optimal solution may be considered found.

[86]The cyclic process may be stopped after the corresponding N index values of any combination in set P already satisfy the requirements. For example, if the system design requirements are a customer interruption rate below 1% and a prediction coverage above 90%, and if combinations (possibly one or more) of critical values satisfying the indexes are obtained after a cycle is completed, then the cyclic process will not continue even though the

combinations may be further optimized in this case.

[87]If the stop condition of the cyclic process is not satisfied, go back to step S104, and use the set P obtained after the current update as the initial set P of the next cycle and perform steps S103 to S105 again. If the stop condition of the cyclic process is satisfied, perform step S107.

[88]S107: Determine the corresponding M critical values of the combination having the highest score in set P to be available critical values.

[89]In the solution provided in the present specification, steps S103 to S105 are utilized for cyclic processing, and new combinations of critical values are continuously generated by crossing the combinations of critical values for a plurality of times. Since the principle of "the higher the score is, the higher the probability of being selected is" is followed in the reorganization process, the combinations of critical values continuously tend to be better in the way of "survival of the fittest," and thus the best (or approximately the best) combinations of critical values may be efficiently found.

[90]Corresponding to the embodiment of the above-mentioned method, the embodiments of the present specification further provide an apparatus for determining decision-making critical values in risk management. As shown in Fig. 3, the apparatus may comprise:

[91]a relation function acquisition module 110, configured to acquire the relation functions between critical values of M features and N index values, wherein each index value corresponds to one relation function, and each relation function includes all or a part of M critical values as input and one index value as output,

[92]a set initialization module 120, configured to initialize set P comprising K combinations, each combination comprising M critical values and K being a preset value,

[93]a set updating module 130, utilizing the following sub-modules (not shown) for cyclic processing until a preset stop condition is satisfied:

[94]a score calculation sub-module, configured to calculate the score for each combination in set P according to the acquired N relation functions, the score being used to represent the overall quality of N index values of the corresponding combination and being positively correlated to the positive index values of N index values and negatively correlated to the negative index values of N index values,

[95]a reorganization sub-module, configured to select two combinations from set P each time and exchange one or more critical values to generate two new combinations until the number

of new combinations reaches a preset number, wherein the probability of each combination being selected from set P is positively correlated to the score of the combination,

[96] an updating sub-module, configured to update set P according to the new combinations, the number of combinations in set P after updating remaining unchanged, and

[97] a critical value determination module 140, configured to determine the corresponding M critical values of the combination having the highest score in set P to be available critical values after cyclic processing is stopped.

[98] In a specific implementation mode provided in the present specification, the relation function acquisition module 110 may be specifically configured to:

[99] acquire a plurality of correspondences comprising M critical values and N index values from historical data, and

[100] use the acquired plurality of correspondences as samples to obtain the relation functions between M critical values and N index values through training.

[101] In a specific implementation mode provided in the present specification, the score calculation sub-module may be specifically configured to:

[102] calculate the score of the combination according to the following formula:

[103] Σ positive index values of N index values – Σ negative index value of N index values

[104] In a specific implementation mode provided in the present specification, the score calculation sub-module may be specifically configured to:

[105] generate random correction factors for N index values, respectively, and

[106] calculate the score of the combination according to the corrected N index values.

[107] In a specific implementation mode provided in the present specification, the reorganization module 130 may determine the probability of each combination being selected from set P in the following way:

[108] calculate the sum of the scores of K combinations in set P, and

[109] determine the ratio of the score of each combination to the sum of the scores to be the probability of the each combination being selected.

[110] In a specific implementation mode provided in the present specification, the reorganization module may be specifically configured to:

[111] randomly correct the exchanged results to generate two new combinations after

selecting two combinations from set P each time and exchanging any critical value.

[112] In a specific implementation mode provided in the present specification, the updating sub-module may be specifically configured to:

[113] sort the new combinations by score and determine K combinations having the highest scores to be set P after updating; or

[114] merge K combinations in the original set P and the new combinations, sort the combinations by the scores and determine K of the new combinations having the highest scores to be set P after updating.

[115] The embodiments of the present specification further provide a computer device, which at least comprises a memory, a processor and a computer program stored in the memory and capable of running on the processor, wherein the processor realizes the above-mentioned method for determining risk management decision-making critical values when executing the program. The method at least comprises:

[116] acquiring the relation functions between critical values of M features and N index values, wherein each index value corresponds to one relation function, each relation function includes all or some of the M critical values as input and one index value as output,

[117] initializing set P comprising K combinations, each combination consisting of M critical values and K being a preset value, and utilizing the following steps for cyclic processing until a preset stop condition is satisfied:

[118] calculating the score for each combination in set P according to the acquired N relation functions, the score being used to represent the overall quality of N index values of the corresponding combination and being positively correlated to the positive index values of N index values and negatively correlated to the negative index values of N index values,

[119] selecting two combinations from set P each time and exchanging one or more critical values to generate two new combinations until the number of new combinations reaches a preset number, wherein the probability of each combination being selected from set P is positively correlated to the score of the combination, and

[120] updating set P according to the new combinations, the number of combinations in set P after updating remaining unchanged, and

[121] determining the corresponding M critical values of the combination having the highest score in set P to be available critical values.

[122] Fig. 4 shows the hardware structure of a specific computer device provided by the embodiments of the present specification. The device may comprise a processor 1010, a memory 1020, an input/output interface 1030, a communication interface 1040 and a bus

1050. The processor 1010, memory 1020, input/output interface 1030 and communication interface 1040 realize communication connections between them in the device through the bus 1050.

[123] The processor 1010 may be a general-purpose central processing unit (CPU), microprocessor, application specific integrated circuit (ASIC) or one or more integrated circuit and is used to execute a related program to realize the technical solution provided in the embodiments of the present specification.

[124] The memory 1020 may be a read-only memory (ROM), random access memory (RAM), static storage device or dynamic storage device. The memory 120 may store an operating system and other applications. When the technical solution provided in the embodiments of the present specification is realized by software or firmware, related program codes are stored in the memory 1020 and are invoked by the processor 1010 to execute.

[125] The input/output interface 1030 is used to connect an input/output module to realize information input and output. The input/output module may be configured as a component (not shown) in the computer device or may be externally connected to the computer device to provide the corresponding function. The input devices may include a keyboard, a mouse, a touch screen, a microphone and various sensors, and the output devices may include a monitor, a loudspeaker, a vibrator and an indicator.

[126] The communication interface 1040 is used to connect the communication module (not shown) to realize communication interactions between the computer device and other devices. The communication module may realize communication in wired mode (for example, USB and network cable) or wireless mode (for example, mobile network, Wi-Fi and Bluetooth).

[127] The bus 1050 comprises a path and transmits information between different components (for example, the processor 1010, the memory 1020, the input/output interface 1030 and the communication interface 1040) of the computer device.

[128] It should be noted that although only the processor 1010, the memory 1020, the input/output interface 1030, the communication interface 1040 and the bus 1050 of the computer device are shown, the computer device may further comprise other components necessary for the normal operation during the specific implementation. In addition, those skilled in the art may understand that the computer device may comprise only the components required to realize the solution in the embodiments of the present specification, and unnecessarily comprise all the components shown in the figure.

[129] The embodiments of the present specification further provide a computer-readable storage medium. A computer program is stored in the computer-readable storage medium and the program realizes the method for determining risk management decision-making critical values when executed by the processor. The method at least comprises:

[130] acquiring the relation functions between critical values of M features and N index values, wherein each index value corresponds to one relation function, each relation function includes all or some of the M critical values as input and one index value as output,

[131] initializing set P comprising K combinations, each combination consisting of M critical values and K being a preset value, and utilizing the following steps for cyclic processing until a preset stop condition is satisfied:

[132] calculating the score for each combination in set P according to the acquired N relation functions, the score being used to represent the overall quality of N index values of the corresponding combination and being positively correlated to the positive index values of N index values and negatively correlated to the negative index values of N index values,

[133] selecting two combinations from set P each time and exchanging one or more critical values to generate two new combinations until the number of new combinations reaches a preset number, wherein the probability of each combination being selected from set P is positively correlated to the score of the combination, and

[134] updating set P according to the new combinations, the number of combinations in set P after updating remaining unchanged, and

[135] determining the corresponding M critical values of the combination having the highest score in set P to be available critical values.

[136] Computer-readable media include volatile and nonvolatile media and mobile and immobile media, and they may realize information storage by use of any method or technique. Information may be computer-readable commands, data structures, modules of a program or other data. Examples of storage media of a computer include but are not limited to phase-change RAM (PRAM), static random access memory (SRAM), dynamic random access memory (DRAM), other types of random access memory (RAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), flash memory or other memory techniques, compact disk read-only memory (CD-ROM), digital versatile disk (DVD), cassette tape, magnetic tape, magnetic disk or other storage device or any other non-transmission medium, and they may be used to store information which may be accessed by a computer device. According to the definition in this document, computer-readable media excludes transitory media, for example, modulated data signals and carriers.

[137] From the description of the above-mentioned embodiments, it may be learned that those skilled in the art may clearly understand that the embodiments of the present specification may be implemented with the aid of software and a required general-purpose hardware platform. On the basis of the understanding, the technical solution provided in the embodiments of the present specification or the part of the technical solution which has made contributions to the existing solutions may be essentially embodied in the form of a software product. The computer software product may be stored in a storage medium, such as ROM/RAM, disk, optical disk, comprise a plurality of commands and are used to enable a computer device (a PC, a server or a network device) to execute the method described in all or some embodiments of the present specification.

[138] The system, apparatus, modules or units described in the embodiments above may be realized by a computer chip or entity, or realized by a product having a function. A typical device is a computer, and the specific form of the computer may be a personal computer, a laptop computer, a cellular phone, a camera phone, a smart phone, a personal digital assistant, a media player, a navigation device, an e-mail device, a game console, a tablet computer, a wearable device or any combination of these devices.

[139] The embodiments in the description are described in a progressive way. For the same or similar parts between the embodiments, refer to these embodiments. Each embodiment focuses the differences from the others. In particular, the description of the embodiments of the apparatus is simple because they are similar to the embodiments of the method. For the related parts, see the description of the embodiments of the method. The above-mentioned embodiments of the apparatus are given only for the exemplary purpose, wherein the modules described as separate components may or cannot be physically separated, and the functions of all modules may be realized in one or more pieces of software/hardware when the solution in the embodiments of the present specification is implemented. Part or all of the modules may be selected to realize the solution in the embodiments according to the actual requirement. Those skilled in the art may understand and implement the solution without any creative work.

[140] Only specific embodiments of the present specification are described above. It should be noted that those skilled in the art may make improvements and modifications without departing from the principle of the present specification and these improvements and modifications should also fall within the scope of protection of the embodiments of the present specification.

Claims

1. A method for determining decision-making critical values in risk management, comprising:

acquiring relation functions between M critical values of M features and N index values, wherein each of the N index values corresponds to one of the relation functions, and each of the relation functions comprises all or some of the M critical values as input and one of the N index values as output;

initializing a set P comprising K combinations, wherein each of the K combinations comprise the M critical values, and K is a preset value;

performing a cyclic process comprising the following steps until a preset stop condition is satisfied:

calculating a score for each combination in the set P according to the acquired N relation functions, wherein the score represents an overall quality of the N index values corresponding to the each combination, and the score is positively correlated to positive index values of the N index values and negatively correlated to negative index values of the N index values;

selecting two combinations from the set P each time and exchanging one or more critical values thereof to generate two new combinations until a number of new combinations reaches a preset number, wherein a probability for each of the K combinations being selected from the set P is positively correlated to the score of the each combination; and

updating the set P according to the new combinations, wherein a number of combinations in the set P remains unchanged after updating the set P; and

after the cyclic process stops, determining the M critical values corresponding to a combination having a highest score in the set P to be available critical values.

2. The method as claimed in claim 1, wherein acquiring the relation functions between the M critical values and the N index values comprises:

acquiring a plurality of correspondences comprising the M critical values and the N index values from historical data; and

using the acquired plurality of correspondences as samples to obtain the relation functions between the M critical values and the N index values through training.

3. The method as claimed in claim 1, wherein the calculating a score for each combination in the set P according to the acquired N relation functions comprises:

calculating the score for the each combination according to the following formula:

Σ the positive index values of the N index values – Σ the negative index value of the N index values.

4. The method as claimed in claim 1, wherein the calculating a score for each combination in the set P according to the acquired N relation functions comprises:

generating a random correction factor for each of the N index values; and

calculating the score of the each combination according to corrected N index values.

5. The method as claimed in claim 1, wherein the probability for each combination being selected from the set P is determined in a following way:

calculating a sum of the scores of the K combinations in the set P; and

determining a ratio of the score of each of the K combinations to the sum of the scores as the probability of the each combination being selected.

6. The method as claimed in claim 1, wherein selecting two combinations from the set P each time and exchanging one or more critical values thereof to generate two new combinations comprises:

after selecting the two combinations from the set P each time and exchanging the one or more critical values thereof, randomly correcting the two combinations to generate two new combinations.

7. The method as claimed in claim 1, wherein updating the set P according to the new combinations comprises:

sorting the new combinations by the corresponding scores, and determining K of the new combinations having the highest scores to be the set P after updating.

8. The method as claimed in claim 1, wherein updating the set P according to the new combinations comprises:

merging the K combinations in original set P and the new combinations, sorting the merged combinations by the corresponding scores, and determining K of the merged combinations having the highest scores to be the set P after updating.

9. The method as claimed in claim 1, wherein the preset stop condition includes:

a preset number of cycles is reached, or

the highest combination score in the set P already satisfies a preset condition of convergence, or

the corresponding N index values of each combination in the set P already satisfy the requirements.

10. An apparatus for determining decision-making critical values in risk management, comprising:

a relation function acquisition module, configured to acquire relation functions between

M critical values of M features and N index values, wherein each of the N index values corresponds to one of the relation functions, and each of the relation functions comprises all or some of the M critical values as input and one of the N index values as output,

a set initialization module, configured to initialize a set P comprising K combinations, each combination comprising the M critical values and K being a preset value,

a set updating module, configured to utilize following sub-modules to perform a cyclic process until a preset stop condition is satisfied:

a score calculation sub-module, configured to calculate a score for each combination in the set P according to the acquired N relation functions, the score representing an overall quality of the N index values of the corresponding combination and being positively correlated to positive index values of the N index values and negatively correlated to negative index values of the N index values,

a reorganization sub-module, configured to select two combinations from the set P each time and exchange one or more critical values to generate two new combinations until a number of the new combinations reaches a preset number, wherein a probability for each combination being selected from the set P is positively correlated to the score of the combination, and

an updating sub-module, configured to update the set P according to the new combinations, the number of combinations in the set P after updating remaining unchanged, and

a critical value determination module, configured to determine the M critical values of the combination having a highest score in the set P to be available critical values after the cyclic process is stopped.

11. The apparatus as claimed in claim 10, wherein the relation function acquisition module is specifically configured to:

acquire a plurality of correspondences comprising the M critical values and the N index values from historical data, and

use the acquired plurality of correspondences as samples to obtain the relation functions between the M critical values and the N index values through training.

12. The apparatus as claimed in claim 10, wherein the score calculation sub-module is specifically configured to:

calculate the score of the combination according to a following formula:

Σ the positive index values of the N index values – Σ the negative index value of the N index values

13. The apparatus as claimed in claim 10, wherein the score calculation sub-module is

specifically configured to:

generate random correction factors for the N index values, respectively, and

calculate the score of the combination according to corrected N index values.

14. The apparatus as claimed in claim 10, wherein the reorganization sub-module determines the probability for each combination being selected from the set P in a following way:

calculating a sum of the scores of the K combinations in the set P, and

determining a ratio of the score of the each combination to the sum of the scores as the probability for the combination being selected.

15. The apparatus as claimed in claim 10, wherein the reorganization sub-module is specifically configured to:

after selecting the two combinations from the set P each time and exchanging the one or more critical values thereof, randomly correct the two combinations to generate two new combinations.

16. The apparatus as claimed in claim 10, wherein the updating sub-module is specifically configured to:

sort the new combinations by the corresponding scores and determine K of the new combinations having the highest scores to be the set P after updating.

17. The apparatus as claimed in claim 10, wherein the updating sub-module is specifically configured to:

merge the K combinations in original set P and the new combinations, sort the merged combinations by the corresponding scores and determine K of the merged combinations having the highest scores to be the set P after updating.

18. The apparatus as claimed in claim 10, wherein the preset stop condition includes:

a preset number of cycles is reached, or

the highest combination score in the set P already satisfies a preset condition of convergence, or

the corresponding N index values of each combination in the set P already satisfy the requirements.

19. A computer device, comprising a memory, a processor and a computer program which is stored in the memory and runs on the processor, wherein the processor executes the program to implement the method as claimed in any of claims 1 to 9.