INFORMATION RECOMMENDATION METHOD AND APPARATUS

[0001] The present application claims priority to Chinese Patent Application No. 201510831206.3, filed on November 25, 2015 and entitled "INFORMATION RECOMMENDATION METHOD AND APPARATUS", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present application relates to the field of information technologies, and in particular, to a hybrid recommendation method and apparatus.

BACKGROUND

[0003] With the development of information society, people are accustomed to using the Internet for social activities such as online shopping, online banking, and instant messaging. To improve user experience of website browsing and allow users to quickly find content they want to browse, online-service providers usually provide recommended information on websites based on user behavioral data. For example, a music website can recommend songs to users, and social networking websites can recommend friends to users.

[0004] Recommendation list for recommending information is usually calculated based on recommendation algorithms. There are generally two types of recommendation algorithms: recommendations based on information content and recommendations based on user behavior. The former can directly calculate a recommendation list without user behavioral data. However, a recommendation result in the recommendation list cannot be customized to user preference, and has low accuracy. The latter can calculate a relatively accurate recommendation list but is limited because the accuracy depends on the amount of user behavioral data. Traditionally, to address the disadvantages of those two types of recommendation algorithms, results of a plurality of recommendation algorithms are usually combined

to calculate a hybrid recommendation list. A weight coefficient-based hybrid recommendation method is most commonly used because of advantages such as ease of combination, convenience of combining recommended algorithms, and high flexibility.

[0005] However, whether a recommendation list obtained by using the weight coefficient-based hybrid recommendation method satisfies user preference, that is, whether a recommendation result in the recommendation list satisfies the user's need depends on the weight coefficients used in weighted hybrid recommendation. Traditionally, weight coefficients used in the weight coefficient-based hybrid recommendation are usually set and adjusted based on observation or heuristic experience.

[0006] Setting and adjusting weight coefficients based on observation or heuristic experience requires a lot of time and labor. Moreover, accuracy of the resultant recommendation list is relatively low. In addition, the user preference can change, but the weight coefficients that are set based on heuristic experience may be unchanged for a relatively long time. When the user preference changes, the existing method may not be able to provide timely adjustment accordingly. Therefore, the recommendation list obtained using the weight coefficient-based hybrid recommendation method may be difficult to satisfy the user's need. Correspondingly, the user may need to spend a lot of time searching to find information, which consumes network resources and increases server pressure.

SUMMARY

[0007] Implementations of the present application provide an information recommendation method and apparatus, so as to resolve an existing problem of high network resource consumption and server pressure, because a user needs to spend a lot of time searching for useful information when a recommendation list obtained based on manually set weight coefficients does not satisfy the user's need.

[0008] An implementation of the present application provides an information recommendation method, including: determining historical behavioral information of a user; determining a plurality of recommended information sets based on the historical behavioral information; determining a recommendation list based on a weight coefficient predetermined for each recommended information set;

determining whether the recommendation list satisfies a predetermined recommendation condition; and if the recommendation list satisfies the condition, recommending information included in the recommendation list to the user; or if the recommendation list does not satisfy the condition, adjusting the weight coefficient of each recommended information set, determining a new recommendation list based on the adjusted weight coefficient until the determined recommendation list satisfies the recommendation condition, and recommending information included in the recommendation list to the user.

[0009] An implementation of the present application provides an information recommendation apparatus, including: a behavior determining module, configured to determine historical behavioral information of a user; an information set determining module, configured to determine a plurality of recommended information sets based on the historical behavioral information; a combination module, configured to determine a recommendation list based on a weight coefficient predetermined for each recommended information set; and a determining and recommendation module, configured to determine whether the recommendation list satisfies a predetermined recommendation condition; and if the recommendation list satisfies the condition, recommend information included in the recommendation list to the user; or if the recommendation list does not satisfy the condition, adjust the weight coefficient of each recommended information set, instruct the combination module to determine a new recommendation list based on the adjusted weight coefficient until the recommendation list determined by the combination module satisfies the recommendation condition, and recommend information included in the recommendation list to the user.

[0010] The implementations of the present application provide the information recommendation method and apparatus. In the method, the plurality of recommended information sets are determined through different recommendation algorithms based on the historical behavioral information of the user. The recommendation list is determined based on the weight coefficient corresponding to each recommended information set. When the recommendation list does not satisfy the predetermined recommendation condition, the weight coefficient of each recommended information set corresponding to the recommendation list is adjusted, and an adjusted recommendation list is obtained until the obtained recommendation list satisfies the predetermined recommendation condition. Then the information in the

recommendation list is recommended to the user. In the information recommendation method, the weight coefficient of each recommended information set does not need to be manually set, and can be automatically adjusted based on historical behavioral data of the user to obtain a recommendation list that satisfies the user's needs. Therefore, accuracy of the recommendation list can be improved, so that the user does not need to spend a lot of time searching for relevant information. In addition, network resources can be saved and server pressure can be relieved.

BRIEF DESCRIPTION OF DRAWINGS

[0011] The accompanying drawings described here are intended to provide a further understanding of the present application, and constitute a part of the present application The illustrative implementations of the present application and descriptions of the implementations are intended to describe the present application, and do not constitute limitations on the present application. In the accompanying drawings:

[0012] FIG. 1 illustrates an information recommendation process, according to an implementation of the present application; and

[0013] FIG. 2 is a schematic structural diagram illustrating an information recommendation apparatus, according to an implementation of the present application.

DESCRIPTION OF EMBODIMENTS

[0014] In the implementations of the present application, a weight coefficient-based hybrid recommendation method is still used to obtain a recommendation list. A weight coefficient of each recommended information set in the weight coefficient-based hybrid recommendation method can be iteratively determined through an optimization algorithm based on historical behavioral information of a user, and does not need to be determined based on heuristic experience. As such, the obtained recommendation list is relatively accurate, and the user does not need to spend additional time searching for relevant information, which in turn, saves network resources and relieves server pressure.

[0015] To illustrate the objectives, technical solutions, and advantages of the

present application, the following clearly and completely describes the technical solutions of the present application with reference to the implementations of the present application and corresponding accompanying drawings. Apparently, the described implementations are merely some but not all of the implementations of the present application. All other implementations obtained by a person of ordinary skill in the art based on the implementations of the present application without creative efforts shall fall within the protection scope of the present application.

[0016] FIG. 1 illustrates an information recommendation process, according to an implementation of the present application. The process includes the following steps:

[0017] S101: Determine historical behavioral information of a user.

[0018] In this implementation of the present application, a server needs to recommend more accurate information to the user that better conforms to the user's behavior habit, in order to save network resources and relieve server pressure. Therefore, the server needs to determine at least related information such as the user's preferences or needs, and selectively recommend information to the user based on the related information. Because such related information can be associated with user's behavior, a website can select recommended information based on the historical behavioral information of the user.

[0019] In step S101 of the implementation of the present application, the server first determines historical behavioral information of the user. The historical behavioral information of the user can be information corresponding to historical behavior of the user on the server, for example, content and attributes of information that the user browsed, content and attributes of information that the user searched, and content and attributes of information that the user followed or collected. It can be seen that such information is related to the user's preference, needs, etc. The server can determine historical data of the user in a predetermined time period. The time period can be determined based on needs. For example, the historical time period can be set as the past three months.

[0020] S102: Determine a plurality of recommended information sets based on the historical behavioral information.

[0021] In this implementation of the present application, the server uses a weight coefficient-based hybrid recommendation method to determine a final recommendation list to be recommended to the user. Therefore, after determining the historical behavioral information of the user in step S101, the server can use different

recommendation algorithms to determine the plurality of recommended information sets based on the historical behavioral information, so that hybrid weighting is subsequently performed on the recommended information sets to obtain the recommendation list. The recommendation algorithms can be a collaborative filtering-based recommendation algorithm, a content-based recommendation algorithm, an association rule-based recommendation algorithm, a knowledge-based recommendation algorithm, etc. The recommendation algorithms used to determine the recommended information sets are not limited for any particular implementations.

[0022] It is worthwhile to note that, a relative recommended weight coefficient can be obtained for each piece of information in the recommended information sets obtained through different recommendation algorithms. That is, for each recommended information set, each piece of information included in the recommended information set has a recommended weight coefficient corresponding to the recommended information set. Information included in a recommended information set can have the same recommended weight coefficient or different recommended weight coefficients corresponding to the recommended information set.

[0023] For example, after obtaining historical behavioral information of a user I, if the server uses a user-based collaborative filtering recommendation algorithm and a merchandise-based collaborative filtering recommendation algorithm to separately perform calculation based on the historical behavioral information, the server can determine two recommended information sets: a recommendation set α and a recommendation set β. Because the two recommended information sets are obtained through different recommendation algorithms, information included in the two recommended information sets may not be the same.

[0024] S103: Determine a recommendation list based on a weight coefficient predetermined for each recommended information set.

[0025] Because each recommended information set is determined in step S102, in the present application, the recommendation list can be determined based on the weight coefficient predetermined for each recommended information set. The predetermined weight coefficient can be an initial weight coefficient predetermined based on experience or a random initial weight coefficient obtained based on a random function. The predetermined weight coefficient represents an initial coefficient and may not be the weight coefficient used to obtain the final recommendation list.

[0026] In this implementation of the present application, determining a recommendation list based on a weight coefficient predetermined for each recommended information set can be described below.

[0027] First, for each recommended information set, a sub-weight coefficient of each piece of information included in the recommended information set can be determined based on a weight coefficient of the recommended information set and a recommended weight coefficient of each piece of information relative to the recommended information set. Here, each piece of information included in the recommended information set has a recommended weight coefficient corresponding to the recommended information set. Therefore, the sub-weight coefficient of each piece of information relative to the recommended information set in the present application can be a product of the recommended weight coefficient of each piece of information relative to the recommended information set and the weight coefficient of the recommended information set.

[0028] In addition, for each piece of information, a sum of sub-weight coefficients of the pieces of information relative to all recommended information sets can be determined, and the sum is used as a total weight coefficient of the particular piece of information. Finally, the recommendation list can be determined based on the total weight coefficient of each piece of information.

[0029] Further, determining the recommendation list based on the total weight coefficient of each piece of information can include determining the recommendation list based on a descending order of total weight coefficients of all pieces of information. The pieces of information having larger total weight coefficients can be preferably recommended to the user. Because the recommendation list is determined based on the total weight coefficient of each piece of information, the recommendation list can include information from each recommended information set. When the recommendation list includes a large amount of information, if all the information in the recommendation list is recommended to the user, it may be difficult for the user to find needed information from the recommended information, and the user still needs to search for information. Accordingly, in the method provided in the present application, the recommendation list can be formed by first few pieces of information among all the information. That is, the pieces of information included in each recommended information set can be ordered in descending order based on their total weight coefficients. Then a specific number of pieces of information can be

selected according to the order to form the recommendation list.

[0030] Continuing with the earlier described example, assume that weight coefficients predetermined for the two recommended information sets are (0.4, 0.6). The weight coefficients for the recommended information set α and the recommended information set β are 0.4 and 0.6, respectively. Table 1 lists information included in the recommended information set α, recommended information set β, and recommended weight coefficients of each piece of information included in the two recommended information sets.

Table 1

Information included in the recommended information set α	**Recommended weight coefficient of information in the recommended information set α**	**Information included in the recommended information set β**	**Recommended weight coefficient of information in the recommended information set β**
Merchandise A	0.9	Merchandise M	0.8
Merchandise O	0.8	Merchandise A	0.6
Merchandise C	0.6	Merchandise O	0.5
Merchandise G	0.4	Merchandise G	0.3
Merchandise F	0.3	Merchandise T	0.2

[0031] In Table 1, a recommended weight coefficient of merchandise A in the recommended information set α is 0.9, and a recommended weight coefficient of merchandise A in the recommended information set β is 0.6; a weight coefficient of the recommended information set α is 0.4, and a weight coefficient of the recommended information set β is 0.6. Accordingly, a sub-weight coefficient of the piece of information corresponding to the recommended information set α is 0.36, and a sub-weight coefficient of the piece of information corresponding to the recommended information set β is 0.36. In this case, a total weight coefficient of the piece of information is 0.72, that is, a total weight coefficient of merchandise A is 0.72.

[0032] Table 2 lists total weight coefficients determined for the merchandises.

Table 2

Information	Total weight coefficient
Merchandise A	0.72
Merchandise O	0.62
Merchandise M	0.48
Merchandise G	0.34
Merchandise C	0.24
Merchandise T	0.12
Merchandise F	0.12

[0033] In Table 2, the merchandises are ordered in descending order based on the total weight coefficients: merchandise A, merchandise O, merchandise M, merchandise G, merchandise C, merchandise T, and merchandise F. If the first five pieces of information are selected to form the recommendation list, the final recommendation list includes merchandise A, merchandise O, merchandise M, merchandise G, and merchandise C.

[0034] S104: Determine whether the recommendation list satisfies a predetermined recommendation condition; and if the recommendation list satisfies the condition, proceed to step S105, or if the recommendation list does not satisfy the condition, proceed to step S106.

[0035] In this implementation of the present application, the recommendation list is determined in steps S101 to S103. However, it cannot be determined whether the information in the recommendation list meets the user's expectation. Therefore, whether the recommendation list satisfies the predetermined recommendation condition needs to be further determined in the present application. Different subsequent processing methods can be selected based on different determination results.

[0036] In addition, whether the information included in the recommended information list meets the user's expectation needs to be determined based on the historical behavioral information of the user. Therefore, in the present application, accuracy of the recommendation list can be determined based on the historical behavioral information of the user determined in step S101. Further, whether the

accuracy of the recommendation list is greater than a predetermined threshold can be determined. If the accuracy is greater than the threshold, the recommendation list satisfies the predetermined recommendation condition, and step S105 is performed. If the accuracy is not greater than the threshold, the recommendation list does not satisfy the predetermined recommendation condition, and step S106 is performed.

[0037] The number of pieces of information included in the recommendation list and consistent with the historical behavioral information of the user can be determined first. Then a ratio of the number to the total number of pieces of information included in the recommendation list is determined. The ratio is used as the accuracy of the recommendation list.

[0038] Continuing with the earlier described example, assume that a predetermined threshold on the server is 0.4. The historical behavioral information of the user is: the user clicks merchandise A, merchandise Q, merchandise R, merchandise H, merchandise M, merchandise F, and merchandise L. The information in the recommendation list determined in step S103 includes: merchandise A, merchandise O, merchandise M, merchandise G, and merchandise C. Therefore, the information included in the recommendation list and consistent with the historical behavioral information of the user is merchandise A and merchandise M, and the number of pieces of consistent information is 2. Because the recommendation list includes a total of five pieces of information, the ratio of the number of pieces of consistent information to the total number of pieces of information included in the recommendation list is 0.4. Finally, the ratio (0.4) is used as the accuracy of the recommendation list. The accuracy is not greater than the predetermined threshold. Therefore, the recommendation list does not satisfy the predetermined recommendation condition, and step S106 is performed.

[0039] S105: Recommend information included in the recommendation list to the user.

[0040] In this implementation of the present application, if it is determined in step S104 that the recommendation list satisfies the predetermined condition, the recommendation list can satisfy the user's needs. Therefore, step S105 can be performed to recommend the information included in the recommendation list to the user.

[0041] S106: Adjust the weight coefficient of each recommended information set, and return to step S103.

[0042] When it is determined in step S104 that the recommendation list does not satisfy the recommendation condition, the server can use a predetermined optimization algorithm to adjust the weight coefficient of each recommended information set and determine a new recommendation list based on the adjusted weight coefficient until the determined recommendation list satisfies the recommendation condition. Then the server recommends information included in the recommendation list to the user.

[0043] In the present application, the weight coefficient of each recommended information set can be automatically adjusted through an iterative process of steps S103 to S106 to more quickly determine accurate recommended information, save network resources, and relieve server pressure.

[0044] The predetermined optimization algorithm can be used to determine a value of an adjustment to the weight coefficient of each recommended information set based on at least one of the following iteration information: a value of the last adjustment to the weight coefficient of each recommended information set, accuracy of a recommendation list that is determined last time, or a largest accuracy value among accuracy values of all obtained recommendation lists. Then the weight coefficient of each recommended information set is adjusted based on the determined value of the adjustment.

[0045] In the following example of the weight coefficient adjustment process, the used optimization algorithm is the particle swarm algorithm. The server can use the equation $V_{k+1}=W_k\times V_k+C_1\times rand_1\times(Pbest-X_k)+C_2\times rand_2\times(Gbest-X_k)$ to determine the value of the adjustment to the weight coefficient of each recommended information set, and then use the equation $X_{k+1}=X_K+V_{K+1}$ to determine an adjusted weight coefficient of each recommended information set.

[0046] V_{k+1} is a value of the (K+1)th adjustment to the weight coefficient of each recommended information set. V_k is a value of the Kth adjustment to the weight coefficient. W_k is an inertia weight coefficient of the Kth adjustment. C_1 and C_2 are predetermined constants. $rand_1$ and $rand_2$ are random functions whose value ranges are (0, 1). *Pbest* is a weight coefficient of each recommended information set corresponding to the more accurate one in a recommendation list determined after the Kth adjustment and a recommendation list determined after the (K+1)th adjustment. *Gbest* is a weight coefficient of each recommended information set corresponding to the most accurate one in all determined recommendation lists. X_k is a weight

coefficient of each recommended information set corresponding to the recommendation list determined after the Kth adjustment.

[0047] It is worthwhile to note that the inertia weight coefficient W_k decreases with an increase in the number K of adjustments. W_k can be determined through the equation $W_k=W_s-(W_s-W_e)\times(K/K_{max})^2$. In the equation, W_s is a predetermined initial inertia weight coefficient and can be set based on experience. W_e is a predetermined final inertia weight coefficient and can also be set based on experience. K is the current number of adjustments. K_{max} is the predetermined maximum number of adjustments.

[0048] As can be seen from the earlier described equation, if the present adjustment is the (K+1)th adjustment, *Pbest* in the equation can be determined by comparing the accuracy of the recommendation list determined last time in the iteration information with accuracy of the recommendation list obtained after the present adjustment. *Gbest* can be determined by comparing the largest accuracy value with the accuracy of the recommendation list obtained after the present adjustment. V_k can be determined based on the value of the last adjustment to the weight coefficient of each recommended information set in the iteration information. Then the value V_{k+1} of the present adjustment can be determined through calculation. The weight coefficient of each recommended information set after the present adjustment can be determined based on the equation $X_{k+1}=X_K+V_{K+1}$.

[0049] In addition, it is worthwhile to note that the optimization algorithm used in the present application can be the particle swarm algorithm, the genetic algorithm, the ant colony algorithm, the annealing algorithm, etc. In the present application, only the particle swarm algorithm is used as an example for description. The optimization algorithm used to determine the value of the adjustment to the weight coefficient of each recommended information set is not limited.

[0050] After the adjusted weight coefficient of each recommended information set is determined, a new recommendation list can be determined based on the method described in step S103. It can then be determined whether the new recommendation list satisfies the recommendation condition based on the method described in step S104. If the recommendation list satisfies the recommendation condition, step S105 is performed to recommend information in the recommendation list to the user. If the recommendation list does not satisfy the recommendation condition, step S106 can be repeated until the determined recommendation list satisfies the recommendation

condition, and step S105 is then performed.

[0051] In addition, in step S104, the accuracy of the recommendation list is determined based on the historical behavioral information of the user. It can be seen from steps S101 to S103 that the recommendation list is also determined based on the historical behavioral information of the user. Therefore, in step S104, the server determines whether a recommendation list determined based on the information set is consistent with the information set. It affects the accuracy of the determined recommendation list, and leads to low accuracy reliability.

[0052] In view of this, in the present application, the historical behavioral information of the user can be further divided into test information and reference information before the plurality of recommended information sets are determined in step S102, so that the accuracy of the determined recommendation list is more reliable.

[0053] The test information is used to determine the recommendation list based on step S102 and step S103 in the present application. In step S102, the plurality of recommended information sets can be determined through different recommendation algorithms based on the test information. Then the recommendation list is determined in step S103.

[0054] In step S104, the reference information is compared with the recommendation list to determine the accuracy of the recommendation list. That is, the accuracy of the recommendation list can be determined based on the reference information in step S104.

[0055] The reference information is also historical behavioral information of the user but is different from the historical behavioral information of the user used to determine the recommendation list. Therefore, the comparison based on the reference information can more accurately determine the accuracy of the recommendation list, and the determined accuracy is more reliable.

[0056] When the accuracy of the recommendation list is determined based on the reference information, the equation $P_u = R_u \cap T_u / R_u$ can be used to calculate the accuracy. P indicates the accuracy. R indicates a set of the information included in the recommendation list. T indicates a set of information included in the reference information. u indicates accuracy for a user u. It can be seen that the recommendation list determined based on the reference information can more accurately reflect the amount of information that satisfies the user's needs in the recommendation list.

[0057] For example, assume that the server divides the historical behavioral information of the user I into test information and reference information in step S102, and the recommendation list is determined based on the test information in step S103. The predetermined threshold in the present application is 0.4. The accuracy of the information: merchandise A, merchandise O, merchandise M, merchandise G, and merchandise C included in the recommendation list is determined based on the reference information (for example, merchandise A, merchandise Q, merchandise R, merchandise H, and merchandise M). It can be seen based on the equation $P_u = R_u \cap T_u / R_u$ that $P_I = 0.4$. In this case, the accuracy is not greater than the predetermined threshold, and the recommendation list does not satisfy the recommendation condition. Therefore, step S106 needs to be repeated.

[0058] Further, when the weight coefficient of each recommended information set is adjusted through the iteration process of steps S103 to S106, the accuracy of the determined recommendation list is still not greater than the predetermined threshold after a plurality of adjustments. In this case, the server still cannot accurately recommend information to the user after consuming a lot of resources.

[0059] To avoid the problem that the determined recommendation list still cannot satisfy the recommendation condition after many adjustments, whether the number of adjustments reaches a predetermined number of times needs to be further determined in the present application. When the number of adjustments to the recommendation list reaches the predetermined number of times, information in a recommendation list determined based on *Gbest* is recommended to the user. The predetermined number of times can be the maximum number K_{max} of adjustments.

[0060] The recommendation list corresponding to *Gbest* is the most accurate one in all determined recommendation lists, and can satisfy the user's needs to some extent. It avoids the problem that the server still cannot accurately recommend information to the user after consuming a lot of resources.

[0061] In addition, the recommendation method illustrated in FIG. 1 provided in the present application can be triggered by some specific operations performed the user. For example, when the user logs in to an account, the method illustrated in FIG. 1 can be triggered to recommend information to the user. Certainly, the method can also be triggered at a predetermined time interval. Details are not repeated here for simplicity.

[0062] It is worthwhile to note that a plurality of servers can be used to perform

the recommendation method described in the present application. For example, a plurality of servers in a content delivery network can be used to share pressure of performing the recommendation method.

[0063] Based on the information recommendation process illustrated in FIG. 1, as shown in FIG. 2, an implementation of the present application further provides an information recommendation apparatus.

[0064] FIG. 2 is a schematic structural diagram illustrating an information recommendation apparatus, according to an implementation of the present application. The apparatus includes: a behavior determining module 201, configured to determine historical behavioral information of a user; an information set determining module 202, configured to determine a plurality of recommended information sets based on the historical behavioral information; a combination module 203, configured to determine a recommendation list based on a weight coefficient predetermined for each recommended information set; and a determining and recommendation module 204, configured to: determine whether the recommendation list satisfies a predetermined recommendation condition; and if the recommendation list satisfies the condition, recommend information included in the recommendation list to the user; or if the recommendation list does not satisfy the condition, adjust the weight coefficient of each recommended information set, instruct the combination module 203 to determine a new recommendation list based on the adjusted weight coefficient until the recommendation list determined by the combination module 203 satisfies the recommendation condition, and recommend information included in the recommendation list to the user.

[0065] The information set determining module 202 is further configured to divide the historical behavioral information of the user into test information and reference information before determining the plurality of recommended information sets based on the historical behavioral information. The information set determining module 202 is then configured to determine the plurality of recommended information sets through different recommendation algorithms based on the test information.

[0066] The combination module 203 is configured to: for each recommended information set, determine a sub-weight coefficient of each piece of information included in the recommended information set based on a weight coefficient of the recommended information set and a recommended weight coefficient of each piece of information relative to the recommended information set; for each piece of

information, determine a sum of sub-weight coefficients of the pieces of information relative to all recommended information sets, and use the sum as a total weight coefficient of the particular piece of information; and determine the recommendation list based on the total weight coefficient of each piece of information.

[0067] The determining and recommendation module 204 is configured to: determine accuracy of the recommendation list based on the reference information; determine whether the accuracy is greater than a predetermined threshold; and if the accuracy is greater than the threshold, determine that the recommendation list satisfies the predetermined recommendation condition; or if the accuracy is not greater than the threshold, determine that the recommendation list does not satisfy the predetermined recommendation condition.

[0068] The determining and recommendation module 204 is configured to: determine a value of an adjustment to the weight coefficient of each recommended information set based on at least one of the following iteration information: a value of the last adjustment to the weight coefficient of each recommended information set, accuracy of a recommendation list that is determined last time, or a largest accuracy value among accuracy values of all obtained recommendation lists; and adjust the weight coefficient of each recommended information set based on the determined value of the adjustment.

[0069] The determining and recommendation module 204 is further configured to determine the most accurate one in all obtained recommendation lists when the number of adjustments to the weight coefficient of each recommended information set reaches a predetermined number of times; and recommend information included in the most accurate recommendation list to the user.

[0070] The information recommendation apparatus illustrated in FIG. 2 can be located on servers in various networks. There can be one or more servers. When there are a plurality of servers, the plurality of servers can be connected through a content delivery network. The implementation method is not limited in the present application.

[0071] In a typical configuration, a computing device includes one or more processors (CPU), an input/output interface, a network interface, and a memory.

[0072] The memory can include a non-persistent memory, a random access memory (RAM), and/or a non-volatile memory in a computer readable medium, such as a read-only memory (ROM) or a flash memory (flash RAM). The memory is an

example of the computer readable medium.

[0073] The computer readable medium includes persistent, non-persistent, movable, and unmovable media that can store information by using any method or technology. The information can be a computer readable instruction, a data structure, a program module, or other data. Examples of a computer storage medium include, but are not limited to, a parameter random access memory (PRAM), a static RAM (SRAM), a dynamic RAM (DRAM), another type of RAM, a ROM, an electrically erasable programmable ROM (EEPROM), a flash memory or another memory technology, a compact disc-ROM (CD-ROM), a digital versatile disc (DVD) or another optical storage, a magnetic cassette tape, a magnetic tape disk storage or another magnetic storage device or any other non-transitory medium, which can be used to store information that can be accessed by the computing device. As defined here, the computer readable medium does not include transitory media such as modulated data signals and carriers.

[0074] It is also worthwhile to note that, the terms "include", "comprise", or their any other variant is intended to cover a non-exclusive inclusion, so that a process, a method, an article, or a device that includes a list of elements not only includes those elements but also includes other elements that are not expressly listed, or further includes elements inherent to such a process, method, article, or device. An element preceded by "includes a ..." further includes, without more constraints, another identical element in the process, method, article, or device that includes the element.

[0075] A person skilled in the art should understand that the implementations of the present application can be provided as a method, a system, or a computer program product. Therefore, the present application can use a form of hardware only implementations, software only implementations, or implementations with a combination of software and hardware. Moreover, the present application can use a form of a computer program product implemented on one or more computer usable storage media (including but not limited to a magnetic disk memory, a CD-ROM, an optical memory, etc) that include computer usable program code.

[0076] The earlier descriptions are merely the implementations of the present application, but are not intended to limit the present application. A person skilled in the art can make various modifications and variations to the present application. Any modification, equivalent replacement, or improvement made without departing from the spirit and principle of the present application shall fall within the scope of the

claims of the present application.

CLAIMS

1. A method for generating an information recommendation, the method comprising:

retrieving, by one or more processors, historical behavioral information of a user, the historical behavioral information comprising data associated to operations performed by the user on a server (S101);

determining, by the one or more processors, a plurality of recommended information sets based on the historical behavioral information (S102);

generating, by the one or more processors, a plurality of weight coefficients, each weight coefficient of the plurality of weight coefficients being generated for each recommended information set of the plurality of recommended information sets;

determining, by the one or more processors, a recommendation list based on a plurality of weight coefficients (S103);

determining an accuracy of the recommendation list based on reference information included in the historical behavioral information;

determining whether the accuracy is larger than a threshold;

determining whether the recommendation list satisfies a predetermined recommendation condition, wherein the recommendation list is determined to satisfy the predetermined recommendation condition if the accuracy is larger than the threshold, and the recommendation list is determined to not satisfy the predetermined recommendation condition if the accuracy is not greater than the threshold (S104); and

in response to determining that the recommendation list satisfies the predetermined recommendation condition, transmitting, by the one or more processors, a recommendation based on the recommendation list to the user (S105); or

in response to determining that the recommendation list does not satisfy the predetermined recommendation condition, performing operations comprising:

adjusting, by the one or more processors, each weight coefficient of each recommended information set,

determining, by the one or more processors, a new recommendation list based on the adjusted weight coefficient until the determined recommendation list satisfies the predetermined recommendation condition, and

transmitting, by the one or more processors, a recommendation based on the recommendation list to the user (S106).

2. The method according to claim 1, further comprising:

dividing the historical behavioral information of the user into test information and the reference information, the reference information being different from the test information.

3. The method according to claim 1, wherein determining the accuracy of the recommendation list is based on comparing a largest accuracy value with a recommended accuracy of the recommendation list obtained after a recent adjustment.

4. The method according to claim 2, wherein determining the plurality of recommended information sets based on the historical behavioral information comprises:

determining the plurality of recommended information sets through a plurality of recommendation algorithms different from each other, the test information comprising results of a portion of the historical behavioral information analyzed by the plurality of recommendation algorithms.

5. The method according to claim 4, wherein the plurality of recommendation algorithms comprise two or more of a collaborative filtering-based recommendation algorithm, a content-based recommendation algorithm, an association rule-based recommendation algorithm, and a knowledge-based recommendation algorithm.

6. The method according to any one of claims 1 to 5, wherein determining the recommendation list comprises:

for each recommended information set, determining a sub-weight coefficient of each piece of information comprised in the recommended information set based on a weight coefficient of the recommended information set and a recommended weight coefficient of each piece of information relative to the recommended information set;

for each piece of information, determining a sum of sub-weight coefficients of the pieces of information relative to all recommended information sets, and using the sum as a total weight coefficient of the particular piece of information; and

determining the recommendation list based on the total weight coefficient of each piece of information.

7. The method according to any one of claims 1 to 5, wherein adjusting the weight coefficient of each recommended information set comprises:

determining a value of an adjustment to the weight coefficient of each recommended information set based on an iteration information; and

adjusting the weight coefficient of each recommended information set based on the determined value of the adjustment.

8. The method according to claim 7, wherein the iteration information comprises at least one of a value of a previous adjustment of the weight coefficient of each recommended information set, an accuracy of a recommendation list that was previously determined, and highest accuracy value of a plurality of accuracy values of previously determined recommendation lists.

9. The method according to claim 7, further comprising:

determining the most accurate one in all obtained recommendation lists when the number of adjustments to the weight coefficient of each recommended information set reaches a predetermined number of times; and

recommending information comprised in the most accurate recommendation list to the user.

10. An apparatus for generating an information recommendation, the apparatus comprising a plurality of modules configured to perform the method of any one of claims 1 to 5.