

Cross Reference to Related Applications

[0001] The present application claims the priority to Chinese Patent Application No. 202010896318.8, filed to the Chinese Patent Office on August 31, 2020 and entitled “INTER-OBJECT SIMILARITY DETERMINATION METHOD AND APPARATUS”, which is incorporated in its entirety herein by reference.

Field

[0002] The present disclosure relates to the field of similarity analysis, and particularly relates to an inter-object similarity determination method and apparatus.

Background

[0003] Various objects will be involved during daily operation of institutions. However, different objects may have different characteristics. For example, types of services and ways suitable for institutions vary from region to region. To improve decision-making efficiency of the institutions, it is necessary to investigate characteristics of different objects and make decisions reasonably for different objects.

[0004] If one object’s performance can be inferred from another similar object’s performance under decision, decision-making of the evaluated object will be undoubtedly guided accordingly. Therefore, how to determine similarity between evaluated objects is of great research value for institutions to make decisions. But there is no method to evaluate similarity between different objects yet, which is an urgent problem to be solved.

Summary

[0005] The present disclosure provides an inter-object similarity determination method and apparatus, so as to solve a problem that there is no method to evaluate similarity between different objects in the prior art.

[0006] In a first aspect, the present disclosure provides the inter-object similarity determination method. The method includes: for at least one dimension attribute of any one attribute group among a plurality of attribute groups and for at least one dimension attribute of an evaluated object, generating an attribute association network of a plurality of evaluated objects under the at least one dimension attribute, where each evaluated object has a unique mapped node in the attribute association network, and side information between nodes in the attribute association network represents an association degree between the evaluated objects under the at least one dimension

attribute, for any two attribute association networks, fusing the two attribute association networks, to obtain a fused association network, where each evaluated object has a unique mapped node in the fused association network, and side information between nodes in the fused association network represents a comprehensive association degree between the evaluated objects, randomly
5 traversing nodes in each fused association network, to obtain a plurality of node sequences of the fused association network, and determining similarity between any two evaluated objects among the plurality of evaluated objects under the fused association network according to the plurality of node sequences.

[0007] In the method, the attribute association network of the plurality of evaluated objects under the at least one dimension attribute is generated, the association degree between the plurality of evaluated objects is represented in the attribute association network, then the two attribute association networks are fused to obtain the fused association network, so as to fully represent the comprehensive association degree between the plurality of evaluated objects for regional features, and the nodes in the fused association network are further randomly traversed to obtain the
15 plurality of node sequences of the fused association network, so as to determine the similarity between any two evaluated objects among the plurality of evaluated objects under the fused association network. In this way, the inter-object similarity determination method is provided.

[0008] Optionally, the for at least one dimension attribute of an evaluated object, generating an attribute association network of a plurality of evaluated objects under the at least one dimension attribute includes: for any two evaluated objects among the plurality of evaluated objects, determining side information between two nodes corresponding to the two evaluated objects in the attribute association network according to attribute values of the two evaluated objects under the dimension attribute, and generating the attribute association network of the plurality of
20 evaluated objects for the dimension attribute according to side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

[0009] In the method, according to the attribute values of the two evaluated objects under the dimension attribute, the side information between the two nodes corresponding to the two evaluated objects in the attribute association network is further determined, and the attribute association network is generated. In this way, a method for generating an attribute association
30 network under the condition of same attribute values under the dimension attribute is provided, and then flexibility of generating the attribute association network of the plurality of evaluated objects for the dimension attribute is enhanced.

[0010] Optionally, the evaluated objects are regions, the dimension attribute includes a time sequence position attribute of a user in the regions, the attribute values of the user in the regions
35 under the time sequence position attribute include a user identifier, and the determining side

information between two nodes corresponding to the two evaluated objects in the attribute association network according to attribute values of the two evaluated objects under the dimension attribute includes determining side information of two regions according to user identifiers in the two regions.

5 **[0011]** In the method, when the evaluated objects are regions, because the time sequence position attribute is capable of representing time sequence association of the regions, a method for determining the side information of the two regions more accurately is achieved according to the user identifiers in the two regions.

10 **[0012]** Optionally, the at least one dimension attribute includes a first-type attribute dimension and a second-type attribute dimension, the first-type attribute dimension and the second-type attribute dimension are preset associated attribute dimensions, and the for at least one dimension attribute of an evaluated object, generating an attribute association network of a plurality of evaluated objects under the at least one dimension attribute includes: for a first evaluated object and a second evaluated object among the plurality of evaluated objects, determining side
15 information between two nodes corresponding to the two evaluated objects in the attribute association network according to an attribute value of the first evaluated object under the first-type attribute dimension and an attribute value of the second evaluated object under the second-type attribute dimension, or determining side information between two nodes corresponding to the two evaluated objects in the attribute association network according to an attribute value of the
20 first evaluated object under the second-type attribute dimension and an attribute value of the second evaluated object under the first-type attribute dimension, and generating attribute association networks of the plurality of evaluated objects for the first-type attribute dimension and the second-type attribute dimension according to the side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

25 **[0013]** According to the method, because the first-type attribute dimension and the second-type attribute dimension are the preset associated attribute dimensions, the side information between the two corresponding nodes in the attribute association network may be determined according to the attribute values of the first evaluated object and the second evaluated object under different types of attribute dimensions, and then the attribute association networks are generated. In this
30 way, a method for generating the attribute association networks for different types of attribute dimensions is provided.

[0014] Optionally, the randomly traversing nodes in each fused association network, to obtain a plurality of node sequences includes determining a random walk probability between the nodes in the fused association network according to side information between the nodes in the fused
35 association network, and randomly traversing the nodes in the fused association network, to obtain

the plurality of node sequences based on the random walk probability between the nodes in the fused association network.

[0015] According to the method, the random walk probability between the nodes is determined according to the side information between the nodes in the fused association network, such that based on the random walk probability between the nodes, the nodes in the fused association network are randomly traversed, so as to obtain the plurality of node sequences more accurately.

[0016] Optionally, the side information between the nodes in the attribute association network is an attribute association weight value between the nodes, the side information between the nodes in the fused association network is a comprehensive association weight value between the nodes, and the fusing the two attribute association networks, to obtain a fused association network includes: for any two nodes in the fused association network, determining a comprehensive association weight value of the two nodes in the fused association network according to attribute association weight values and weighting coefficients of the two nodes in the two attribute association networks, and based on the comprehensive association weight value between the nodes in the fused association network, generating a feature association network of the plurality of evaluated objects.

[0017] According to the method, the side information between the nodes in the attribute association network is the attribute association weight value between the nodes. Considering the attribute association weight values and the weighting coefficients of the two nodes in the two attribute association networks, and based on the comprehensive association weight value between the nodes in the fused association network, the feature association network of the plurality of evaluated objects is generated. In this way, the feature association network of the plurality of evaluated objects may be generated more accurately.

[0018] Optionally, the determining similarity between any two evaluated objects among the plurality of evaluated objects according to the plurality of node sequences includes inputting the plurality of node sequences into a related model preset with a word vector, to generate an embedded vector of the fused association network, and determining similarity between any two evaluated objects among the plurality of evaluated objects according to the embedded vector of the fused association network.

[0019] According to the method, after the embedded vector of the fused association network is generated, the similarity between any two evaluated objects among the plurality of evaluated objects may be determined according to the embedded vector of the fused association network. Because the embedded vector is capable of more fully and finely representing the fused association network, the similarity between any two evaluated objects among the plurality of evaluated objects may be determined more accurately.

[0020] In a second aspect, the present disclosure provides the inter-object similarity determination apparatus. The apparatus includes a generation module configured to generate an attribute association network of a plurality of evaluated objects under the at least one dimension attribute for at least one dimension attribute of any one attribute group among a plurality of attribute groups and for at least one dimension attribute of an evaluated object, where each evaluated object has a unique mapped node in the attribute association network, and side information between nodes in the attribute association network represents an association degree between the evaluated objects under the at least one dimension attribute; a fusion module configured to fuse the two attribute association networks, to obtain a fused association network for any two attribute association networks, where each evaluated object has a unique mapped node in the fused association network, and side information between nodes in the fused association network represents a comprehensive association degree between the evaluated objects; and a processing module configured to randomly traverse nodes in each fused association network, to obtain a plurality of node sequences of the fused association network, and configured to determine similarity between any two evaluated objects among the plurality of evaluated objects under the fused association network according to the plurality of node sequences.

[0021] Optionally, the generation module is configured to: for any two evaluated objects among the plurality of evaluated objects, determine side information between two nodes corresponding to the two evaluated objects in the attribute association network according to attribute values of the two evaluated objects under the dimension attribute, and generate the attribute association network of the plurality of evaluated objects for the dimension attribute according to side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

[0022] Optionally, the evaluated objects are regions, the dimension attribute includes a time sequence position attribute of a user in the regions, the attribute values of the user in the regions under the time sequence position attribute include a user identifier, and the generation module is configured to determine side information of two regions according to user identifiers in the two regions.

[0023] Optionally, the at least one dimension attribute includes a first-type attribute dimension and a second-type attribute dimension, the first-type attribute dimension and the second-type attribute dimension are preset associated attribute dimensions, and the generation module is specifically configured to: for a first evaluated object and a second evaluated object among the plurality of evaluated objects, determine side information between two nodes corresponding to the two evaluated objects in the attribute association network according to an attribute value of the first evaluated object under the first-type attribute dimension and an attribute value of the second

evaluated object under the second-type attribute dimension, and alternatively, determine side information between two nodes corresponding to the two evaluated objects in the attribute association network according to an attribute value of the first evaluated object under the second-type attribute dimension and an attribute value of the second evaluated object under the first-type attribute dimension, and generate attribute association networks of the plurality of evaluated objects for the first-type attribute dimension and the second-type attribute dimension according to the side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

[0024] Optionally, the processing module is configured to determine a random walk probability between the nodes in the fused association network according to side information between the nodes in the fused association network, and based on the random walk probability between the nodes in the fused association network, configured to randomly traverse the nodes in the fused association network, to obtain the plurality of node sequences.

[0025] Optionally, the side information between the nodes in the attribute association network is an attribute association weight value between the nodes, the side information between the nodes in the fused association network is a comprehensive association weight value between the nodes, and the fusion module is configured to: for any two nodes in the fused association network, determine a comprehensive association weight value of the two nodes in the fused association network according to attribute association weight values and weighting coefficients of the two nodes in the two attribute association networks, and based on the comprehensive association weight value between the nodes in the fused association network, generate a feature association network of the plurality of evaluated objects.

[0026] Optionally, the fusion module is configured to input the plurality of node sequences into a related model preset with a word vector, to generate an embedded vector of the fused association network, and configured to determine similarity between any two evaluated objects among the plurality of evaluated objects according to the embedded vector of the fused association network.

[0027] Beneficial effects of the second aspect and various optional apparatuses according to the second aspect may refer to those of the first aspect and various optional methods according to the first aspect, which will not be repeated herein.

[0028] In a third aspect, the present disclosure provides a computer device, which includes a program or an instruction. When the program or instruction is executed, the first aspect and various optional methods according to the first aspect are executed.

[0029] In a fourth aspect, the present disclosure provides a storage medium, which includes a program or an instruction. When the program or instruction is executed, the first aspect and various optional methods according to the first aspect are executed.

Brief Description of the Drawings

[0030] Fig. 1 is a schematic flowchart of steps of an inter-object similarity determination method provided in an embodiment of the present application;

5 **[0031]** Fig. 2 is a schematic flowchart of specific steps of an inter-object similarity determination method provided in an embodiment of the present application; and

[0032] Fig. 3 is a structural schematic diagram of an inter-object similarity determination apparatus provided in an embodiment of the present application.

10 Detailed Description of the Embodiments

[0033] For better understanding of the above-described technical solution, the above-described technical solution will be described in detail below with reference to drawings of the description and specific implementations. It should be understood that embodiments of the present application and specific features in the embodiments are detailed descriptions of the technical
15 solution of the present application, rather than limitations on the technical solution of the present application. The embodiments of the present application and technical features in the embodiments may be combined with each other without conflict.

[0034] Various objects may be involved during daily operation of institutions. If one object's performance may be inferred from another similar object's performance under decision, decision-
20 making of the evaluated object may be undoubtedly guided accordingly. Therefore, how to determine similarity between evaluated objects is of great research value for institutions to make decisions. But, at present, there is no method to evaluate similarity between different objects, which is an urgent problem to be solved. In view of this, as shown in Fig. 1, the present application provides an inter-object similarity determination method.

25 **[0035]** Step 101: for at least one dimension attribute of any one attribute group among a plurality of attribute groups and for at least one dimension attribute of an evaluated object, an attribute association network of a plurality of evaluated objects under the at least one dimension attribute is generated.

[0036] Step 102: for any two attribute association networks, the two attribute association
30 networks are fused to obtain a fused association network.

[0037] Step 103: nodes in each fused association network are randomly traversed to obtain a plurality of node sequences of the fused association network.

[0038] Step 104: similarity between any two evaluated objects among the plurality of evaluated
35 objects under the fused association network is determined according to the plurality of node sequences.

[0039] In steps 101-104, each evaluated object has a unique mapped node in the attribute association network, and side information between nodes in the attribute association network represents an association degree between the evaluated objects under the at least one dimension attribute. Each evaluated object has a unique mapped node in the fused association network, and side information between nodes in the fused association network represents a comprehensive association degree between the evaluated objects. It should be noted that the evaluated objects may be various objects, such as regions or institutions. The method may be used not only for evaluating similarity between regions, but also for evaluating similarity between recommended systems. The attribute association networks may include an attribute association network for user behaviors and an attribute association network for non-user behaviors. When the attribute association network for user behaviors and the attribute association network for non-user behaviors are included, the side information between the nodes in the fused association network represents the comprehensive association degree between the evaluated objects under the influence of user behaviors.

[0040] In an optional implementation, step 101 may specifically include followings.

[0041] Step (1-1): for any two evaluated objects among the plurality of evaluated objects, side information between two nodes corresponding to the two evaluated objects in the attribute association network is determined according to attribute values of the two evaluated objects under the dimension attribute.

[0042] It should be noted that the dimension attributes may include one or more dimension attributes, including, for example, attribute values under a merchant count dimension attribute and a business setting user count dimension attribute in region A and region B, such as a merchant count of the region A and a business setting user count of the region A, and a merchant count of the region B and a business setting user count of the region B.

[0043] Step (1-2): the attribute association network of the plurality of evaluated objects for the dimension attribute is generated according to side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

[0044] For example, in step (1-2), side information of two evaluated objects may be specifically expressed to be an association weight value.

[0045] In an optional implementation, the evaluated objects are regions, the dimension attribute includes a time sequence position attribute of a user in the regions, and the attribute values of the user in the regions under the time sequence position attribute include a user identifier. Step (1-2) may include:

side information of two regions is determined according to user identifiers in the two regions.

[0046] In some embodiments, the side information of the two regions may be determined

according to the number of users having same user identifiers in the two regions.

[0047] It should be noted that in the implementation, the side information of the two regions may also be determined according to time lags of the users having the same user identifiers in the two regions, in addition to the user identifiers in the two regions.

5 **[0048]** In another optional implementation, the at least one dimension attribute includes a first-type attribute dimension and a second-type attribute dimension, and the first-type attribute dimension and the second-type attribute dimension are preset associated attribute dimensions. Step 101 may specifically include:

10 Step (2-1): for a first evaluated object and a second evaluated object among the plurality of evaluated objects, side information between two nodes corresponding to the two evaluated objects in the attribute association network is determined according to an attribute value of the first evaluated object under the first-type attribute dimension and an attribute value of the second evaluated object under the second-type attribute dimension, and alternatively, side information
15 is determined according to an attribute value of the first evaluated object under the second-type attribute dimension and an attribute value of the second evaluated object under the first-type attribute dimension.

[0049] For example, when the evaluated objects are regions, in step (2-1), the first-type attribute dimension is a business setting merchant proportion in the regions, and the second-type attribute dimension is a business setting user proportion in the regions. In this way, side information
20 between two nodes corresponding to a first region and a second region in the attribute association network may be determined according to a business setting merchant proportion in the first region and a business setting user proportion in the second region, and alternatively, side information between two nodes corresponding to a first region and a second region in the attribute association
25 network may be determined according to a business setting user proportion in the first region and a business setting merchant proportion in the second region.

[0050] Step (2-2): attribute association networks of the plurality of evaluated objects for the first-type attribute dimension and the second-type attribute dimension are generated according to the side information between nodes corresponding to the plurality of evaluated objects in the
30 attribute association network.

[0051] In an optional implementation, the side information between the nodes in the attribute association network is an attribute association weight value between the nodes, and the side information between the nodes in the fused association network is a comprehensive association weight value between the nodes. Step 102 may specifically include:

35 for any two nodes in the fused association network, a comprehensive association weight value

of the two nodes in the fused association network is determined according to attribute association weight values and weighting coefficients of the two nodes in the two attribute association networks, and a feature association network of the plurality of evaluated objects is generated based on the comprehensive association weight value between the nodes in the merged association network.

5 **[0052]** For example, the two attribute association networks may be any one attribute association network for user behaviors and any one attribute association network for non-user behaviors. An attribute association weight value of the attribute association network for user behaviors is a first weight value and a weighting coefficient of the attribute association network for user behaviors is a first weighting coefficient value, and an attribute association weight value of the attribute
10 association network for non-user behaviors is a second weight value and a weighting coefficient of the attribute association network for non-user behavior is a second weighting coefficient value. Only an example of a comprehensive association weight value of any two attribute association networks in the fused association network is provided above, but actually, more attribute association networks may be fused together, and furthermore, there may be a plurality of first
15 weight values and second weight values. For example, the comprehensive association weight value may be computed as follows:

$$W_{\text{comprehensive}} = W_{1-1} \cdot a_{1-1} + W_{1-2} \cdot a_{1-2} + W_{1-3} \cdot a_{1-3} + \dots + W_{2-1} \cdot a_{2-1} + W_{2-2} \cdot a_{2-2} + W_{2-3} \cdot a_{2-3} + \dots$$

w_{1-x} represents a first weight value, w_{2-x} represents a second weight value, a_{1-x} represents a first weighting coefficient, and a_{2-x} represents a second weighting coefficient.

20 **[0053]** In an optional implementation, step 103 may include:

Step (3-1): a random walk probability between the nodes in the fused association network is determined according to side information between the nodes in the fused association network.

[0054] It should be noted that in step (3-1), edges between two nodes may be two directed edges, such as an edge from node A to node B and an edge from node B to node A. The side information
25 may be weight values of two directed edges. A random walk probability of one node walking to another node may be determined according to a weight value proportion. For example, if there are edges between node A and nodes B, C and D, and weight values of node A to nodes B, C and D are 3, 4 and 5, a random walk probability of node A to node B is 1/4, a random walk probability of node A to node C is 1/3, and a random walk probability of node A to node C is 5/12.

30 **[0055]** Step (3-2): based on the random walk probability between the nodes in the fused association network, the nodes in the fused association network are randomly traversed to obtain the plurality of node sequences.

[0056] It should be noted that each fused association network may be traversed many times, to obtain a plurality of node sequences. For example, the node sequences of the fused association
35 network are ABCDE, ABCEF, ACEF and ABEC. The node sequences may be counted to

determine similarity between two evaluated objects under the fused association network. For example, the more successive sequences of two nodes account for a total sequence, the higher the similarity.

[0057] In an optional implementation, step 104 may include:

5 the plurality of node sequences are input into a related model preset with a word vector, to generate an embedded vector of the fused association network, and similarity between any two evaluated objects among the plurality of evaluated objects is determined according to the embedded vector of the fused association network.

[0058] Based on descriptions of steps 101-104 in the present application, the inter-object similarity determination method provided in the present application is further described in detail with examples. For example, if the evaluated objects are regions, the process may be summarized as follows:

15 through a spatial data processing method, geographic positions are divided into different regions. According to spatio-temporal data of a user global positioning system (GPS) and regional feature attribute data, a plurality of attribute association networks are created, the node sequences are generated through a probabilistic random walk method, and finally, a word vector model (such as Skip-Gram) is used to obtain a plurality of embedded vectors of region nodes, so as to compute similarity between regions. In this way, other unexpanded regions similar to the currently expanded regions are explored. This method fully considers association degrees between regions, similarity between regional attribute image features, etc., to explore regions that are more similar to the current regions in terms of network structures and attribute information. Steps may include:

(1) According to spatio-temporal migration data of the user GPS, a spatio-temporal association network G_{gps} between regions is formed;

25 (2) Regional image features are extracted, and a feature set $V(v_1, v_2, v_3, \dots, v_n)$ of a region is created, including a user age distribution of the region, a merchant distribution of the region, a user consumption level of the region, etc. An edge is created between regions having similar attributes, such that an attribute association network G_{v1}, G_{v2}, G_{vn} between the regions is created;

(3) Through fusion of attribute association networks, the fused association network is formed, and a regional node sequence is generated through probabilistic walk;

30 (4) By means of Skip-Gram, a plurality of embedded vectors of the regions and similarity between region nodes under different fused networks are generated;

(5) The similarity between the regions is comprehensively evaluated through a weighted average method.

[0059] As shown in Fig. 2, for example, if the attribute association networks are the attribute association network for user behaviors and the attribute association network for non-user

behaviors, a process of steps 101-104 is as follows.

[0060] (1) The attribute association network for user behaviors is generated as follows:

in a use process of an application (APP) by a user, some GPS position data may be generated. A position of the user at a certain moment t_1 is recorded as G_{t1} , a position of the user at a next moment is recorded as G_{t2} , and so on. An edge is formed between positions G_{t1} and G_{t2} according to a user behavior relation. Similarly, an attribute association network based on user behaviors may be created between different regions according to a plurality of user position data. Strength of connection between the regions is determined according to the number of users generating the edge and a time lag. Therefore, the regional user behavior relation network is a weighted and directed association network.

[0061] (2) The attribute association network for non-user behaviors is generated as follows:

for a region without user GPS coverage, the region cannot join the attribute association network for user behaviors, and the region is also a high potential expansion region. In view of this, image features based on regions may be designed to generate the attribute association network for non-user behaviors.

[0062] The attribute association network for non-user behaviors is as follows: Regional feature images are classified, including a regional flow density, a regional merchant industry distribution, a regional user age distribution, a regional user consumption level, a regional user consumption preference, etc., such that regional image information may be increased. Similarity between different features between regions is computed, and an edge is created for regions having similar features. For example, if merchants in region A and region B are basically catering merchants, an edge may be created between region A and region B when an association network is generated on the basis of a feature of a merchant type distribution. If ages of users in region C and region D are 25-40, an edge may be created between region C and region D when an association network is generated on the basis of a feature of a user age distribution, and the same is true for others.

[0063] Through division of different non-user attributes, a plurality of attribute association networks for non-user behaviors may be generated.

[0064] The fused association network is generated as follows:

the attribute association network for user behaviors and the attribute association network for non-user behaviors are fused to obtain a plurality of fused association networks.

[0065] Region node similarity is computed as follows:

for different fused association networks, embedded vectors of region nodes under different fused association networks are computed through the above-described method, and similarity between nodes under different fused association networks is obtained.

[0066] As shown in Fig. 3, the present disclosure provides the inter-object similarity

determination apparatus. The apparatus includes a generation module 301 configured to generate an attribute association network of a plurality of evaluated objects under the at least one dimension attribute for at least one dimension attribute of any one attribute group among a plurality of attribute groups and for at least one dimension attribute of an evaluated object, where each
5 evaluated object has a unique mapped node in the attribute association network, and side information between nodes in the attribute association network represents an association degree between the evaluated objects under the at least one dimension attribute; a fusion module 302 configured to fuse the two attribute association networks, to obtain a fused association network for any two attribute association networks, where each evaluated object has a unique mapped node
10 in the fused association network, and side information between nodes in the fused association network represents a comprehensive association degree between the evaluated objects; and a processing module 303 configured to randomly traverse nodes in each fused association network, to obtain a plurality of node sequences of the fused association network, and configured to determine similarity between any two evaluated objects among the plurality of evaluated objects
15 under the fused association network according to the plurality of node sequences.

[0067] Optionally, the generation module 301 is configured to: for any two evaluated objects among the plurality of evaluated objects, determine side information between two nodes corresponding to the two evaluated objects in the attribute association network according to attribute values of the two evaluated objects under the dimension attribute, and generate the
20 attribute association network of the plurality of evaluated objects for the dimension attribute according to side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

[0068] Optionally, the evaluated objects are regions, the dimension attribute includes a time sequence position attribute of a user in the regions, the attribute values of the user in the regions
25 under the time sequence position attribute include a user identifier, and the generation module 301 is specifically configured to determine side information of two regions according to user identifiers in the two regions.

[0069] Optionally, the at least one dimension attribute includes a first-type attribute dimension and a second-type attribute dimension, the first-type attribute dimension and the second-type
30 attribute dimension are preset associated attribute dimensions, and the generation module 301 is configured to: for a first evaluated object and a second evaluated object among the plurality of evaluated objects, determine side information between two nodes corresponding to the two evaluated objects in the attribute association network according to an attribute value of the first evaluated object under the first-type attribute dimension and an attribute value of the second
35 evaluated object under the second-type attribute dimension, and alternatively, determine side

information between two nodes corresponding to the two evaluated objects in the attribute association network according to an attribute value of the first evaluated object under the second-type attribute dimension and an attribute value of the second evaluated object under the first-type attribute dimension, and generate attribute association networks of the plurality of evaluated objects for the first-type attribute dimension and the second-type attribute dimension according to the side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

[0070] Optionally, the processing module 303 is configured to determine a random walk probability between the nodes in the fused association network according to side information between the nodes in the fused association network, and based on the random walk probability between the nodes in the fused association network, configured to randomly traverse the nodes in the fused association network, to obtain the plurality of node sequences.

[0071] Optionally, the side information between the nodes in the attribute association network is an attribute association weight value between the nodes, the side information between the nodes in the fused association network is a comprehensive association weight value between the nodes, and the fusion module 302 is configured to: for any two nodes in the fused association network, determine a comprehensive association weight value of the two nodes in the fused association network according to attribute association weight values and weighting coefficients of the two nodes in the two attribute association networks, and based on the comprehensive association weight value between the nodes in the fused association network, generate a feature association network of the plurality of evaluated objects.

[0072] Optionally, the fusion module 302 is configured to input the plurality of node sequences into a related model preset with a word vector, to generate an embedded vector of the fused association network, and configured to determine similarity between any two evaluated objects among the plurality of evaluated objects according to the embedded vector of the fused association network.

[0073] An embodiment of the present application provides a computer device, which includes a program or an instruction. When the program or instruction is executed, the inter-object similarity determination method and any one optional method provided in the embodiments of the present application are executed.

[0074] An embodiment of the present application provides a computer-readable storage medium, which includes a program or an instruction. When the program or instruction is executed, the inter-object similarity determination method and any one optional method provided in the embodiments of the present application are executed.

[0075] It should be finally noted that those skilled in the art should understand that the

embodiments of the present application may be provided as methods, systems, or computer program products. Therefore, the present application may employ full hardware embodiments, full software embodiments, or software and hardware combined embodiments. Moreover, the present application may take the form of a computer program product implemented on one or more computer usable storage media (including, but not limited to, disk memories, optical memories, etc.) containing computer usable program codes.

[0076] The present application is described with reference to flowcharts and/or block diagrams of methods, devices (systems), and computer program products according to the present application. It should be understood that each flow and/or block in the flowcharts and/or block diagrams and combinations of the flows and/or blocks in the flowcharts and/or block diagrams may be implemented by computer program instructions. The computer program instructions may be provided for a processor of a general-purpose computer, a special-purpose computer, an embedded processor, or other programmable data processing devices, to produce a machine, such that instructions executed by the processor of the computer or other programmable data processing devices produce an apparatus used for implementing functions specified in one or more flows of each flowchart and/or one or more blocks of each block diagram.

[0077] The computer program instructions may also be stored in a computer-readable memory that is capable of guiding a computer or other programmable data processing devices to work in a specific manner, such that the instructions stored in the computer-readable memory produce an article of manufacture including an instruction apparatus, and the instruction apparatus implements functions specified in one or more flows of each flowchart and/or one or more blocks in each block diagram.

[0078] Apparently, those skilled in the art may make various modifications and variations to the present application without departing from the scope of the present application. In this way, if the modifications and variations of the present application fall within the scope of the claims of the present application and their equivalent technologies, the present application is also intended to cover the modifications and variations.

WHAT IS CLAIMED IS:

1. An inter-object similarity determination method, comprising:

for at least one dimension attribute of any one attribute group among a plurality of attribute groups and for at least one dimension attribute of an evaluated object, generating an attribute association network of a plurality of evaluated objects under the at least one dimension attribute, wherein each evaluated object has a unique mapped node in the attribute association network, and side information between nodes in the attribute association network represents an association degree between the evaluated objects under the at least one dimension attribute;

for any two attribute association networks, fusing the two attribute association networks, to obtain a fused association network, wherein each evaluated object has a unique mapped node in the fused association network, and side information between nodes in the fused association network represents a comprehensive association degree between the evaluated objects;

randomly traversing nodes in each fused association network, to obtain a plurality of node sequences of the fused association network; and

determining similarity between any two evaluated objects among the plurality of evaluated objects under the fused association network according to the plurality of node sequences.

2. The method according to claim 1, wherein the for at least one dimension attribute of an evaluated object, generating an attribute association network of a plurality of evaluated objects under the at least one dimension attribute comprises:

for any two evaluated objects among the plurality of evaluated objects, determining side information between two nodes corresponding to the two evaluated objects in the attribute association network according to attribute values of the two evaluated objects under the dimension attribute; and

generating the attribute association network of the plurality of evaluated objects for the dimension attribute according to side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

3. The method according to claim 2, wherein the evaluated objects are regions, the dimension attribute comprises a time sequence position attribute of a user in the regions, the attribute values of the user in the regions under the time sequence position attribute comprise a user identifier, and the determining side information between two nodes corresponding to the two evaluated objects in the attribute association network according to attribute values of the two evaluated

objects under the dimension attribute comprises:

determining side information of two regions according to user identifiers in the two regions.

4. The method according to claim 1, wherein the at least one dimension attribute comprises a first-type attribute dimension and a second-type attribute dimension, the first-type attribute dimension and the second-type attribute dimension are preset associated attribute dimensions, and the for at least one dimension attribute of an evaluated object, generating an attribute association network of a plurality of evaluated objects under the at least one dimension attribute comprises:

for a first evaluated object and a second evaluated object among the plurality of evaluated objects, determining side information between two nodes corresponding to the two evaluated objects in the attribute association network according to an attribute value of the first evaluated object under the first-type attribute dimension and an attribute value of the second evaluated object under the second-type attribute dimension, or, determining side information between two nodes corresponding to the two evaluated objects in the attribute association network according to an attribute value of the first evaluated object under the second-type attribute dimension and an attribute value of the second evaluated object under the first-type attribute dimension; and

generating attribute association networks of the plurality of evaluated objects for the first-type attribute dimension and the second-type attribute dimension according to the side information between nodes corresponding to the plurality of evaluated objects in the attribute association network.

5. The method according to any one of claims 1-4, wherein the randomly traversing nodes in each fused association network, to obtain a plurality of node sequences comprises:

determining a random walk probability between the nodes in the fused association network according to side information between the nodes in the fused association network; and

randomly traversing the nodes in the fused association network to obtain the plurality of node sequences based on the random walk probability between the nodes in the fused association network.

6. The method according to any one of claims 1-4, wherein the side information between the nodes in the attribute association network is an attribute association weight value between the nodes, the side information between the nodes in the fused association network is a comprehensive association weight value between the nodes, and the fusing the two attribute association networks, to obtain a fused association network comprises:

for any two nodes in the fused association network, determining a comprehensive association

weight value of the two nodes in the fused association network according to attribute association weight values and weighting coefficients of the two nodes in the two attribute association networks; and

generating a feature association network of the plurality of evaluated objects based on the comprehensive association weight value between the nodes in the fused association network.

7. The method according to any one of claims 1-4, wherein the determining similarity between any two evaluated objects among the plurality of evaluated objects according to the plurality of node sequences comprises:

inputting the plurality of node sequences into a related model preset with a word vector to generate an embedded vector of the fused association network; and

determining similarity between any two evaluated objects among the plurality of evaluated objects according to the embedded vector of the fused association network.

8. An inter-object similarity determination apparatus, comprising:

a generation module configured to generate an attribute association network of a plurality of evaluated objects under the at least one dimension attribute for at least one dimension attribute of any one attribute group among a plurality of attribute groups and for at least one dimension attribute of an evaluated object, wherein each evaluated object has a unique mapped node in the attribute association network, and side information between nodes in the attribute association network represents an association degree between the evaluated objects under the at least one dimension attribute;

a fusion module configured to fuse the two attribute association networks to obtain a fused association network for any two attribute association networks, wherein each evaluated object has a unique mapped node in the fused association network, and side information between nodes in the fused association network represents a comprehensive association degree between the evaluated objects; and

a processing module configured to randomly traverse nodes in each fused association network to obtain a plurality of node sequences of the fused association network, and determine similarity between any two evaluated objects among the plurality of evaluated objects under the fused association network according to the plurality of node sequences.

9. A computer device, comprising a program or an instruction, configured to implement the method according to any one of claims 1-7 in response to the program or instruction being executed.

10. A computer-readable storage medium, comprising a program or an instruction, wherein when the program or instruction is executed, the method according to any one of claims 1-7 is executed.