MODEL TRAINING METHOD, RESOURCE PUSHING METHOD, DEVICE, MEDIUM, AND COMPUTER PROGRAM PRODUCT

RELATED APPLICATION

[0001] This application claims priority to Chinese Patent Application No. 202411757211. X, entitled "MODEL TRAINING METHOD, RESOURCE RECOMMENDATION METHOD, AND RELATED DEVICE" filed on November 29, 2024, which is incorporated by reference in its entirety.

FIELD OF THE TECHNOLOGY

[0002] This application relates to the technical field of data processing, and in particular, to a model training method, a resource push method, a device, a medium, and a computer program product.

BACKGROUND OF THE DISCLOSURE

[0003] A personalized push system constructs user interest preferences by using user historical interaction data and a specific rule or a machine learning algorithm, thereby implementing efficient distribution of items, which can effectively implement information filtering, improve user product experience, and has made significant progress in fields such as information flow. However, in the field of information flow, there are typically multiple scenarios that require efficient information distribution. For example, for some network interaction platforms, corresponding information flow push scenarios may include multiple scenarios, such as article subscription, short video, live streaming, and mini program scenarios.

[0004] A conventional push algorithm mainly focuses on single-scenario modeling. A push algorithm is constructed using user historical interaction data in each scenario for item distribution. However, development of a single-scenario push algorithm has the following problems: (1) Affected by an information modality (such as text/image-text/video/live streaming), historical interaction data of users in a single scenario is subject to modality bias/data silos, and comprehensive information flow preferences of the users cannot be re-mined, leading to poor accuracy of the constructed personalized push system. (2) The single scenario is subject to data bias caused by scarcity of user interaction data, which poses a huge challenge to constructing an accurate personalized push system and seriously affects product experience of the users. (3) Single-scenario modeling requires research and development personnel to simultaneously maintain a plurality of

push systems, greatly increasing operation and maintenance costs and research and development costs.

SUMMARY

[0005] Embodiments of this application provide a model training method, a resource push method, a device, a medium, and a computer program product.

[0006] According to a first aspect, an embodiment of this application provides a model training method, performed by an electronic device, including:

acquiring scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios;

connecting the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph;

constructing, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes; and

training initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object.

[0007] Correspondingly, an embodiment of this application provides a model training apparatus, including:

an acquisition unit, configured to acquire scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios;

a connection unit, configured to connect the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph;

a construction unit, configured to construct, in the global scenario interaction graph,

a global object feature of each of the object nodes and a global resource feature of each of the resource nodes; and

a training unit, configured to train initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object.

[0008] According to a second aspect, an embodiment of this application further provides a resource push method, performed by an electronic device, including:

detecting, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located;

selecting, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks including graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, and the global scenario interaction graph being obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios; and

determining, based on the target scenario graph network, at least one push resource associated with the target object, and pushing the push resource to the target object.

[0009] Correspondingly, an embodiment of this application provides a resource push apparatus, including:

a receiving unit, configured to detect, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located;

a filtering unit, configured to select, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks including graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, and the global scenario interaction graph being obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios; and

a push unit, configured to: determine, based on the target scenario graph network, at least one push resource associated with the target object, and push the push resource to the target

object.

[0010] In addition, an embodiment of this application further provides an electronic device, including a processor and a memory. The memory stores an application program, and the processor is configured to run the application program in the memory to perform the model training method and the resource push method provided in the embodiments of this application.

[0011] In addition, an embodiment of this application further provides a computer program product, including a computer program or instruction. The computer program or instruction, when executed by a processor, implements operations in the model training method and in the resource push method provided in the embodiments of this application.

[0012] In addition, an embodiment of this application further provides a computer-readable storage medium. The computer-readable storage medium stores a plurality of instructions. The instructions are adapted to be loaded by a processor to perform operations in the model training method and in the resource push method provided in the embodiments of this application.

[0013] Details of one or more embodiments of this application are provided in the following accompanying drawings and descriptions. Other features, objectives, and advantages of this application become clear with reference to the specification, the accompanying drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] To describe the technical solutions in the embodiments of this application more clearly, the following briefly describes the accompanying drawings required for use in the embodiments. Apparently, the accompanying drawings in the following description are merely embodiments of this application, and a person of ordinary skill in the art may still derive other accompanying drawings according to the disclosed accompanying drawings without creative efforts.

[0015] FIG. 1 is a schematic diagram of graph structure modeling based on a graph neural network (GNN) according to an embodiment of this application.

[0016] FIG. 2 is a schematic diagram of an application scenario of a model training method according to an embodiment of this application.

[0017] FIG. 3 is a schematic flowchart of a model training method according to an embodiment of this application.

[0018] FIG. 4A is a schematic diagram of an information flow scenario of an article

subscription type.

[0019] FIG. 4B is a schematic diagram of an information flow scenario of a short video type.

[0020] FIG. 4C is a schematic diagram of an information flow scenario of a live streaming type.

[0021] FIG. 4D is a schematic diagram of an information flow scenario of a mini program type.

[0022] FIG. 5 is a scenario interaction graph corresponding to an information flow scenario according to an embodiment of this application.

[0023] FIG. 6 is a schematic diagram of a processing manner involved in a model training method according to an embodiment of this application.

[0024] FIG. 7 is a schematic diagram of a global scenario interaction graph according to an embodiment of this application.

[0025] FIG. 8 is a schematic diagram of constructing virtual object connection nodes and virtual resource connection nodes in any scenario interaction graph according to an embodiment of this application.

[0026] FIG. 9 is a schematic flowchart of training starting from a global scenario interaction graph according to an embodiment of this application.

[0027] FIG. 10 is a schematic diagram of generating augmented interaction graphs according to an embodiment of this application.

[0028] FIG. 11 is a schematic flowchart of a resource push method according to an embodiment of this application.

[0029] FIG. 12A is a schematic diagram of point-wise modeling involved in a conventional mainstream push algorithm.

[0030] FIG. 12B is a schematic diagram of sequence modeling involved in the conventional mainstream push algorithm.

[0031] FIG. 13A is a schematic diagram of an auxiliary paradigm involved in an existing multi-scenario joint construction push system.

[0032] FIG. 13B is a schematic diagram of a multi-tower paradigm involved in the existing multi-scenario joint construction push system.

[0033] FIG. 13C is a schematic diagram of an expert paradigm involved in the existing multi-scenario joint construction push system.

[0034] FIG. 14 is another schematic flowchart of a resource push method according to an embodiment of this application.

[0035] FIG. 15 is a schematic structural diagram of a model training apparatus according to an embodiment of this application.

[0036] FIG. 16 is a schematic structural diagram of a resource push apparatus according to an embodiment of this application.

[0037] FIG. 17 is a schematic structural diagram of an electronic device according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[0038] The following clearly and completely describes the technical solutions in the embodiments of this application with reference to the accompanying drawings in the embodiments of this application. Apparently, the described embodiments are some of the embodiments of this application rather than all of the embodiments. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of this application without creative efforts fall within the protection scope of this application.

[0039] A push system is one of core services of modern Internet enterprises, which pushes personalized content or products to users by analyzing information such as object behaviors and content features. The push system mainly includes the following several basic components: (1) users: representing users in the system, which may be individual users, enterprise users, or the like; (2) items: representing commodities, services, content, and the like in the system; (3) object behaviors: representing various operations of the users in the system, such as browsing, purchasing, and liking; and (4) content features: representing various attributes of the items, such as prices, brands, and categories of the commodities.

[0040] A GNN is an emerging artificial intelligence technology, which may learn structural information on graphs in an unsupervised manner and perform tasks such as node classification and graph classification in a supervised manner. In the push system, a GNN-based graph structure modeling (as shown in FIG. 1) approach may be employed to learn graph structures such as object behaviors and item features, and may fully mine high-order interests of users (e.g., user-user, user-item, and user-item-user) to capture more comprehensive user preferences, thereby improving push quality. GNN-based graph structure modeling aggregates neighbor information of nodes and

updates feature identifiers of the nodes by using a message-passing mechanism, to learn graph structures such as object behaviors and item features. Specifically, for nodes corresponding to object behaviors and item features, in each round of iteration, the nodes may receive information from neighbor nodes thereof, aggregate the information, and update feature representations thereof. After multiple rounds of iteration, the feature identifier of each node may include information of neighbors thereof and more distant nodes, thereby mining high-order interests of the users. The GNN is a type of deep learning model for processing graph-structured data. Entities in the graph-structured data are represented in the form of nodes, and relationships between the entities are represented in the form of edges. Main components of the GNN include: (1) a graph: representing information such as relationships and connections in the system; (2) nodes: representing entities on the graph, such as users and items; (3) edges: representing information such as relationships and connections between the nodes; (4) message passing: representing a process of information transfer between the nodes on the graph; and (5) aggregation: representing a process of information aggregation on the nodes. A goal of the GNN is to learn useful identifiers from the graph-structured data, and perform various tasks, such as node classification, graph classification, and prediction, by using these identifiers. A core idea of the GNN is to aggregate neighbor information of nodes and update feature identifiers of the nodes by using a message-passing mechanism. This process may generally involve multiple rounds of iteration to capture information from farther distances in the graph. Eventually, the feature identifier of each node may include information of neighbors thereof and more distant nodes.

[0041] In the push system, the information such as object behaviors and content features may be represented as nodes and edges of the graph. Therefore, the GNN may be utilized to learn the information and generate personalized push results. Specifically, the GNN may be configured to learn information such as similarities between users, similarities between items, and correlations between the users and the items.

[0042] As described above, the conventional push algorithm mainly focuses on single-scenario modeling, while the single-scenario push algorithm has many problems (such as data bias and modality bias), making it difficult to accurately mine an information flow preference of a user. In this regard, embodiments of this application provide a model training method, a resource push method, a device, a medium, and a computer program product. More specifically, the device, the medium, and the computer program product are an electronic device, a computer-readable storage medium, and a computer program product. The model training apparatus may be integrated into an electronic device. The electronic device may be a server, or may be a device such as a terminal.

[0043] The server may be an independent physical server, or may be a server cluster or a distributed system including a plurality of physical servers, or may be a cloud server providing basic cloud computing services such as a cloud service, a cloud database, cloud computing, a cloud function, cloud storage, a network service, cloud communication, a middleware service, a domain name service, a security service, a content delivery network (CDN), and a big data and artificial intelligence platform. The terminal may be a smartphone, a tablet computer, a notebook computer, a desktop computer, a smart speaker, a smartwatch, or the like, but is not limited thereto.

[0044] FIG. 2 is a schematic diagram of an application scenario of a model training method according to an embodiment of this application. As shown in FIG. 2, for example, the model training apparatus is integrated into an electronic device, and the electronic device is a server. A user terminal (i.e., a client) in which a user (including a target object) is located may establish a communication connection with the server. Based on this, the server may acquire scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios; then connect the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph; construct, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes; and train initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object.

[0045] There may be a plurality of clients in FIG. 2, and the plurality of clients may transmit data access requests to the server at a same moment, or may transmit data access requests to the server at different moments.

[0046] In specific implementations of this application, related data (such as object description information, resource description information, and historical interaction data between object nodes and resource nodes) is involved. When the following embodiments of this application are applied to a specific product or technology, permission or consent needs to be obtained, and collection, use, and processing of the related data need to comply with relevant laws, regulations, and standards of relevant countries and regions.

[0047] Detailed descriptions are respectively provided below. A description order of the following embodiments is not intended to limit a preferred order of the embodiments.

[0048] This embodiment will be described from the perspective of a model training apparatus. The model training apparatus may specifically be integrated into an electronic device. The electronic device may be a server.

[0049] A model training method, including: acquiring scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenario; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios; connecting the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph; constructing, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes; and training initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object.

[0050] FIG. 3 is a schematic flowchart of a model training method according to an embodiment of this application. As shown in FIG. 3, a specific flow of the model training method is as follows:

[0051] 101: Acquire scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios.

[0052] The information flow scenario is a specific service scenario defined according to a service function and a resource push goal in an information flow field. In this scenario, the system pushes, for a specific type of objects, interactable resources adapted thereto. In different scenarios, mutually independent interactive data is generated due to differences in resource types, object features, and interaction rules. The information flow scenario may be understood as a scenario related to a push task in the field of information flow. For example, for a network interaction platform, information flow scenarios covered may include article subscription (as shown in FIG. 4A), short video (as shown in FIG. 4B), live streaming (as shown in FIG. 4C), and mini program (as

shown in FIG. 4D) scenarios. Subscribed articles of interest may be pushed to users in the article subscription scenario, short videos of interest may be pushed to the users in the short video scenario, commodities of interest may be pushed to the users in the live streaming scenario, mini programs of interest may be pushed to the users in the mini program scenario, and so on. A scenario interaction graph corresponding to any information flow scenario may include two different types of nodes, which are object nodes and resource nodes respectively. The object nodes may be understood as users entering the information flow scenario by using application software. The resource nodes may be understood as interactable resources provided for the user in the information flow scenario. For example, in the article subscription scenario, the resource nodes may be various articles available for the users to browse. In the short video scenario, the resource nodes may be video resources for the users to watch. In the live streaming scenario, the resource nodes may be live streaming video resources for the users to watch. In the mini program scenario, the resource nodes may be various types of mini programs for the users to use.

[0053] The scenario interaction graph is a bipartite diagram formed by modeling an interaction relationship between objects and resources in the information flow scenario by using a GNN. In the graph, object nodes represent objects participating in interaction, resource nodes represent resources available for object interaction, and edges between nodes represent historical interaction data between objects and resources, which reflects an object-resource interaction structure in a specific scenario. As shown in FIG. 1, the scenario interaction graph may be understood as a graph model obtained by modeling users and items by using a GNN-based graph structure in a push system. Since functions of the information flow scenarios are different, correspondingly generated intra-scenario interaction information may be independent of each other. Taking the article subscription scenario and the short video scenario as examples, the article subscription scenario mainly pushes article resources, while the short video scenario mainly pushes video resources. The types of resources pushed by the two are different. Moreover, users (objects) involved in the article subscription scenario may be different from users (objects) involved in the short video scenario. That is, a user using a short video function may not necessarily use an article subscription function. Similarly, a user using the article subscription function may not necessarily use the short video function. In addition, since the pushed resource types differ and users may also differ, interaction information generated in different information flow scenarios also differs. Therefore, different information flow scenarios may generate different interaction logs, thereby having different scenario interaction graphs.

[0054] In any scenario interaction graph, object nodes representing users and resource nodes representing items may be distinguished by using different shapes, and connecting lines may be

used to represent historical interaction data between the object nodes and the resource nodes. The historical interaction data may be understood as interaction relationships that have actually been generated between the object nodes and the resource nodes in the information flow scenario. For example, in FIG. 1, "circles" are used to represent object nodes corresponding to users, "squares" are used to represent resource nodes corresponding to items, and connecting lines between the "circles" and the "squares" represent interaction relationships between the object nodes and the resource nodes.

[0055] The acquiring scenario interaction graphs respectively corresponding to a plurality of information flow scenarios may include: acquiring object nodes, resource nodes, and historical interaction data between the object nodes and the resource nodes respectively corresponding to the plurality of information flow scenarios; and constructing a bipartite graph based on the object nodes, the resource nodes, and the historical interaction data, to obtain the scenario interaction graphs.

[0056] In this embodiment of this application, firstly, user information, resource information, and historical interaction data existing between users and resources that correspond to each information flow scenario may be acquired. The user information is represented as object nodes, and the resource information is represented as resource nodes. Then, connection relationships between the object nodes and the resource nodes are established according to the historical interaction data, thereby taking the obtained bipartite graph as the scenario interaction graph.

[0057] The bipartite graph is a special model in graph theory, which is defined as a graph in which vertices may be divided into two mutually exclusive sets, so that each edge in the graph connects vertexes in the two sets, and no edge may connect vertices within the same set. For example, FIG. 5 is a scenario interaction graph corresponding to an information flow scenario according to an embodiment of this application. As shown in FIG. 5, u is used to denote object nodes in the information flow scenario, and v is used to denote resource nodes in the information flow scenario. To facilitate differentiation between a plurality of object nodes in the information flow scenario, Arabic numerals are respectively added after the object nodes u, such as u1, u2, u3, and u4, to respectively represent different object nodes. Similarly, Arabic arrays are respectively added after the resource nodes v to distinguish a plurality of resource nodes in the information flow scenario, such as v1, v2, and v3, to respectively represent different resource nodes.

[0058] The vertices in FIG. 5 may be divided into two disjoint sets, which are respectively an object node set and a resource node set. The object node set includes 4 object nodes, which are

respectively u1, u2, u3, and u4. The resource node set includes 3 resource nodes, which are respectively v1, v2, and v3. If historical interaction data exists between an object node and a resource node, the object node and the resource node may be connected by using an edge. For example, if historical interaction data exists between u1 and v1, u1 and v1 may be connected, if historical interaction data exists between u2 and v1, u2 and v1 may be connected, and so on.

[0059] After a connection operation is completed according to the historical interaction data between the object nodes and the resource nodes, a bipartite graph corresponding to the information flow scenario may be obtained. The bipartite graph is the scenario interaction graph. In the bipartite graph, the object nodes in the object node set are not connected to each other, and the resource nodes in the resource node set are not connected to each other either.

[0060] Since object nodes and resource nodes exist in the scenario interaction graph involved in this embodiment of this application, the scenario interaction graph is a heterogeneous graph. Each scenario interaction graph may be represented as $G_i(u, v, e)$, where u denotes object nodes, v denotes resource nodes, and e denotes historical interaction data between the object nodes and the resource nodes. Therefore, scenario interaction graphs collected from a plurality of scenarios may be represented as a set:

[0061] $G = \{G_1(u, v, e), \quad G_2(u, v, e) \quad G_i(u, v, e)\}$, where i denotes a natural number greater than 2.

[0062] 102: Connect the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph.

[0063] Specific operations are as follows: Firstly, object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in each scenario interaction graph are acquired. The object description information may include features such as attributes and behaviors of objects, and the resource description information may include features such as types and content of resources. Then, at least one virtual object connection node is constructed in the scenario interaction graph according to the object description information. A method for constructing the virtual object connection node may involve clustering object nodes having similar object description information, and taking a cluster center as the virtual object connection node. The virtual object connection node is configured to connect object nodes having an association relationship with the virtual object connection node, and the association relationship may be determined by using a similarity of the object description information. Similarly, at least one virtual resource connection node is constructed in the scenario interaction graph according to the resource description information, and a construction method is

similar to that for the virtual object connection node. Finally, the scenario interaction graphs are connected based on the virtual object connection nodes and the virtual resource connection nodes. Specifically, virtual object connection nodes having the same virtual object description information are connected, and virtual resource connection nodes having the same virtual resource description information are connected, to obtain the global scenario interaction graph.

[0064] The virtual object connection node is a virtual node constructed according to the object description information of the object nodes in the scenario interaction graph, is configured to connect object nodes having similar object description information, and during connection of multi-scenario interaction graphs, constructs association channels between object nodes across different scenarios. The virtual resource connection node is a virtual node constructed according to the resource description information of the resource nodes in the scenario interaction graph, is configured to connect resource nodes having similar resource description information, and during connection of multi-scenario interaction graphs, constructs association channels between resource nodes across different scenarios.

[0065] FIG. 6 is a schematic diagram of a processing manner involved in a model training method according to an embodiment of this application. As shown in FIG. 6, after the scenario interaction graphs respectively corresponding to the plurality of information flow scenarios are acquired, the plurality of scenario interaction graphs may be integrated into a global scenario interaction graph. In this embodiment of this application, a plurality of information flow scenarios are involved, and each information flow scenario corresponds to one scenario interaction graph. As described above, for a single information flow scenario, if a push algorithm is constructed within a range of the single information flow scenario for item distribution, problems such as modality bias and data bias may exist, affecting accuracy of the push system. To resolve the foregoing problems, an embodiment of this application provides a multi-scenario joint modeling algorithm that integrates a plurality of information flow scenarios, which may fully utilize commonalities and differences among the plurality of information flow scenarios, and then construct a push algorithm based on integrated global information, thereby mining information flow preferences of users across scenarios and eliminating modality bias and data bias of single-scenario modeling.

[0066] In this process, the scenario interaction graphs corresponding to the plurality of information flow scenarios need to be connected based on object nodes and resource nodes in the scenario interaction graphs, to obtain the global scenario interaction graph. The global scenario interaction graph is a comprehensive graph formed by constructing, for the scenario interaction graphs corresponding to the plurality of information flow scenarios, virtual connection nodes based

on object description information and resource description information, and connecting virtual nodes having the same description information, which integrates interaction information of multiple scenarios, and is configured for mining associations between different scenarios and eliminating data bias of single-scenario modeling.

[0067] The global scenario interaction graph may be understood as a global comprehensive interaction graph including the scenario interaction graphs. The connecting the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph may include: acquiring object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs; constructing, in the scenario interaction graphs, at least one virtual object connection node according to the object description information, the virtual object connection node being configured to connect object nodes having an association relationship with the virtual object connection node; constructing, in the scenario interaction graphs, at least one virtual resource connection node according to the resource description information, the virtual resource connection node being configured to connect resource nodes having an association relationship with the virtual object connection node; and connecting the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph.

[0068] In this embodiment of this application, in the process of connecting the scenario interaction graphs to obtain the global scenario interaction graph, a virtual object connection node and a virtual resource connection node may be first constructed in each scenario interaction graph. The virtual object connection node may be constructed according to object description information corresponding to the object nodes in the scenario interaction graph, and the virtual resource connection node may be constructed according to resource description information corresponding to resource nodes in the scenario interaction graph. Then, the plurality of scenario interaction graphs are connected by taking the virtual object connection nodes and the virtual resource connection nodes as a basis for connection, thereby forming the global scenario interaction graph.

[0069] The object description information may be understood as node attribute features of the object nodes. For example, the object description information may reflect basic profile information of users corresponding to the object nodes, such as age, gender, and education background. The resource description information may be understood as node attribute information of the resource nodes. For example, the resource description information may reflect category information, style information, and the like of resources corresponding to the resource nodes.

[0070] FIG. 7 is a schematic diagram of a global scenario interaction graph according to an embodiment of this application. As shown in FIG. 7, the global scenario interaction graph is obtained by connecting a scenario interaction graph A and a scenario interaction graph B. To distinguish scenario interaction graphs corresponding to different information flow scenarios and object nodes and resource nodes in different scenario interaction graphs, uppercase letters (such as A, B, C, and D) may be added before the object nodes and the resource nodes for distinction. For example, A may be used to denote an information flow scenario A, and B may be used to denote an information flow scenario B. For the information flow scenario A, A-u1 may denote an object node in the scenario interaction graph A corresponding to the information flow scenario A, A-v1 may denote a resource node in the scenario interaction graph A corresponding to the information flow scenario A, and so on. For the information flow scenario B, B-u1 may denote an object node in the scenario interaction graph B corresponding to the information flow scenario B, B-v1 may denote a resource node in the scenario interaction graph B corresponding to the information flow scenario B, and so on.

[0071] A-u1 and B-u1 belong to different scenario interaction graphs, and object description information corresponding to the object nodes represented by the two may be the same or different. That is, A-u1 and B-u1 may be the same user or different users. Similarly, A-v1 and B-v1 belong to different scenario interaction graphs. Resource description information corresponding to the resource nodes represented by the two may be the same, or different, or partially the same and partially different.

[0072] To facilitate distinction between virtual object connection nodes from virtual resource connection nodes, a lowercase letter m may be used to denote the virtual object connection nodes, and a lowercase letter n may be used to denote the virtual resource connection nodes. Any scenario interaction graph in which virtual object connection nodes and/or virtual resource connection nodes are constructed may be represented as $G_i(u, v, e, m, n)$, where u denotes object nodes, v denotes resource nodes, e denotes historical interaction data between the object nodes and the resource nodes, m denotes virtual object connection nodes, and n denotes virtual resource connection nodes. Therefore, scenario interaction graphs collected from a plurality of scenarios may also be represented as a set:

[0073] $G = [G_1(u, v, e, p, q), \quad G_2(u, v, e, p, q) \quad G_i(u, v, e, p, q)]$, where i denotes a natural number greater than 2. In this case, G denotes the global scenario interaction graph.

[0074] Based on this, Arabic numerals may be added after the lowercase letter m to denote different virtual object connection nodes, and Arabic numerals may be added after the lowercase

letter n to denote different virtual resource connection nodes. For example, different virtual object connection nodes may be represented as m1, m2, m3, m4, and the like, and different virtual resource connection nodes may be represented as n1, n2, n3, n4, and the like. For virtual object connection nodes or virtual resource connection nodes constructed in different scenario interaction graphs, uppercase letters (such as A, B, C, and D) may be added before the virtual object connection nodes and the virtual resource connection nodes for distinction. For example, A-m1 may denote a virtual object connection node constructed in the scenario interaction graph A, A-n1 may denote a virtual resource connection node constructed in the scenario interaction graph A, and so on. Similarly, B-m1 may denote a virtual object connection node constructed in the scenario interaction graph B, B-n1 may denote a virtual resource connection node constructed in the scenario interaction graph B, and so on.

[0075] As shown in FIG. 7, a virtual object connection node A-m1 and a virtual resource connection node A-n1 are constructed in the scenario interaction graph A. The virtual object connection node A-m1 is constructed according to an object node A-u1 and an object node A-u2, and the virtual resource connection node A-n1 is constructed according to a resource node A-v1 and a resource node A-v3. Moreover, a virtual object connection node B-m1 and a virtual resource connection node B-n1 are constructed in the scenario interaction graph B. The virtual object connection node B-m1 is constructed according to an object node B-u1 and an object node B-u2, and the virtual resource connection node B-n1 is constructed according to a resource node B-v1 and a resource node B-v2. After respective virtual object connection nodes and virtual resource connection nodes in the scenario interaction graph A and the scenario interaction graph B are determined, the scenario interaction graphs may be connected based on the virtual object connection nodes and the virtual resource connection nodes, to obtain a global scenario interaction graph. During the connection, the connection between different scenario interaction graphs needs to be completed by following a rule of connecting virtual object connection nodes in the different scenario interaction graphs and connecting virtual resource connection nodes in the different scenario interaction graphs. For example, in FIG. 7, the virtual object connection node A-m1 is connected to the virtual object connection node B-m1, and the virtual resource connection node A-n1 is connected to the virtual resource connection node B-n1, thereby achieving an effect of connecting the scenario interaction graph A and the scenario interaction graph B, and obtaining a global scenario interaction graph.

[0076] In FIG. 7, if only the virtual object connection node A-m1 is connected to the virtual object connection node B-m1, the purpose of connecting the scenario interaction graph A and the scenario interaction graph B may also be achieved, thereby obtaining one global scenario

interaction graph. Similarly, if only the virtual resource connection node A-n1 is connected to the virtual resource connection node B-n1, the purpose of connecting the scenario interaction graph A and the scenario interaction graph B may also be achieved, thereby obtaining another global scenario interaction graph.

[0077] The global scenario interaction graph shown in FIG. 7 is merely an example for describing the technical solutions of this application. A quantity of scenario interaction graphs, and data such as specific correspondences and quantities of object nodes, resource nodes, virtual object connection nodes, and virtual resource connection nodes involved in each scenario interaction graph neither have a limiting effect on actual scenario interaction graphs, nor have a limiting effect on a global scenario interaction graph obtained according to the actual scenario interaction graphs.

[0078] Operations of constructing the global scenario interaction graph are respectively described in detail below. The object description information may include object description tags of at least one dimension, and tag values of the object nodes under the object description tags. The object description tags may include tag types, such as age, gender, and education background, which describe the object nodes from different dimensions. The tag values under the object description tags may be understood as specific attribute values corresponding to the object nodes under the object description tags. For example, if an object description tag is age, a tag value of an object node under the object description tag may be 20 years old, 30 years old, 40 years old, or another value. If the object description tag is gender, the tag value of the object node under the object description tag may be male or female. If the object description tag is education background, the tag value of the object node under the object description tag may be primary school, middle school, high school, college, or the like.

[0079] Based on this, the constructing, in the scenario interaction graphs, at least one virtual object connection node according to the object description information may include: selecting at least one target-object description tag from the object description tags, and adding an object tag value range to the target-object description tag; and constructing, in the scenario interaction graphs, the at least one virtual object connection node based on the target-object description tag and the object tag value range, virtual object description information corresponding to the virtual object connection node including the target-object description tag and the object tag value range.

[0080] Each scenario interaction graph includes a plurality of object nodes, and each object node has corresponding object description information. In this embodiment of this application, the at least one virtual object connection node may be constructed according to the object description tags and the tag values of the object nodes under the object description tags included in the object

description information. Specifically, first, the at least one target-object description tag may be selected from the object description tags, and a tag value related to the target-object description tag is acquired. An object tag value range is added to the target-object description tag according to the tag value. Then, virtual object connection nodes are constructed in the scenario interaction graph based on the target-object description tag and the object tag value range.

[0081] FIG. 8 is a schematic diagram of constructing virtual object connection nodes and virtual resource connection nodes in any scenario interaction graph according to an embodiment of this application. As shown in FIG. 8, the scenario interaction graph includes 5 object nodes (respectively denoted as u1, u2, u3, u4, and u5) and 3 resource nodes (respectively denoted as v1, v2, and v3). For ease of description, object description information of the object nodes in the scenario interaction graph is shown in Table 1 as an example.

[0082] Table 1. Object description information of object nodes in the scenario interaction graph shown in FIG. 8

Object node	Object description tag		
	Age	Gender	Education background
u1	30 years old	Female	High school
u2	25 years old	Male	High school
u3	48 years old	Female	College
u4	35 years old	Female	Middle school
u5	50 years old	Male	College

[0083] Based on the data exemplified in Table 1, at least one of the foregoing three object description tags may be extracted as a target-object description tag. For example, "age", "gender", and "education background" may all be used as target-object description tags, and three target-object description tags may be obtained. For each target-object description tag, an object tag value range corresponding to the target-object description tag further needs to be determined. For example, for the target-object description tag "age", the object tag value range thereof may be set to 22 to 26 years old. For the target-object description tag "gender", the object tag value range thereof may be set to female. For the target-object description tag "education background", the object tag value range thereof may be set to college.

[0084] Based on this, three virtual object connection nodes may be constructed in the scenario interaction graph shown in FIG. 8, which are respectively m1, m2, and m3. For ease of distinction, m1 is configured for denoting a virtual object connection node corresponding to the target-object description tag "age", m2 is configured for denoting a virtual object connection node

corresponding to the target-object description tag "gender", and m3 is configured for denoting a virtual object connection node corresponding to the target-object description tag "education background". Since an object tag value range of m1 is 22 to 26 years old, the object node satisfying the condition is u2. m1 and u2 may be connected by a dashed line, to indicate that an association relationship exists between m1 and u2. Since an object tag value range of m2 is female and the object nodes satisfying the condition are u1, u3, and u4, m2 may be respectively connected to u1, u3, and u4 by dashed lines, to indicate that m2 has association relationships with u1, u3, and u4 respectively. Similarly, since an object tag value range of m3 is college and the object nodes satisfying the condition are u3 and u5, m3 may be respectively connected to u3 and u5 by dashed lines, to indicate that m3 has association relationships with u3 and u5 respectively.

[0085] The related information of the object nodes and the virtual object connection nodes shown in FIG. 8 and Table 1 is merely an example for facilitating the description of the technical solution of this application, which does not limit specific information of actual object nodes and virtual object connection nodes.

[0086] The resource description information may include resource description tags of at least one dimension, and tag values of the resource nodes under the resource description tags. The resource description tags may include tag types such as technology, retro, funny, and lifestyle, which describe the resource nodes from different dimensions. The tag values under the resource description tags may be understood as specific attribute values corresponding to the resource nodes under the resource description tags. For example, if a resource description tag is technology, a tag value of a resource node under the resource description tag may be food technology, genetic technology, computer technology, or the like. If the resource description tag is lifestyle, the tag value of the resource node under the resource description tag may be beverage, clothing, home appliance, flower, or the like.

[0087] Based on this, the constructing, in the scenario interaction graphs, at least one virtual resource connection node according to the resource description information may include: selecting at least one push-resource description tag from the resource description tags, and adding a resource tag value range to the push-resource description tag; and constructing, in the scenario interaction graphs, the at least one virtual resource connection node based on the push-resource description tag and the resource tag value range, virtual resource description information corresponding to the virtual resource connection node including the push-resource description tag and the resource tag value range.

[0088] Each scenario interaction graph includes a plurality of resource nodes, and each

resource node has corresponding resource description information. In this embodiment of this application, the at least one virtual resource connection node may be constructed according to the resource description tags and the tag values of the resource nodes under the resource description tags included in the resource description information. Specifically, first, the at least one push-resource description tag may be selected from the resource description tags, and a tag value related to the push-resource description tag is acquired. A resource tag value range is added to the push-resource description tag according to the tag value. Then, virtual resource connection nodes are constructed in the scenario interaction graph based on the push-resource description tag and the resource tag value range.

[0089] The scenario interaction graph shown in FIG. 8 includes 3 resource nodes, which are respectively v1, v2, and v3. For ease of description, resource description information of the resource nodes in the scenario interaction graph is shown in Table 2 as an example.

[0090] Table 2. Resource description information of resource nodes in the scenario interaction graph shown in FIG. 8

Resource node	Resource description tag		
	Technology	Lifestyle	Funny
v1	Computer technology	Flower	Funny movie
v2	Computer technology	Clothing	Bad joke
v3	Computer technology	Clothing	Bad joke

[0091] Based on the data exemplified in Table 2, at least one of the foregoing three resource description tags may be extracted as a push-resource description tag. For example, "technology" and "lifestyle" may be used as push-resource description tags, and two push-resource description tags may be obtained. For each push-resource description tag, a resource tag value range corresponding to the push-resource description tag further needs to be determined. For example, for the push-resource description tag "technology", the resource tag value range thereof may be set to computer technology. For the push-resource description tag "lifestyle", the resource tag value range thereof may be set to "clothing".

[0092] Based on this, two virtual resource connection nodes may be constructed in the scenario interaction graph shown in FIG. 8, which are respectively n1 and n2. For ease of distinction, n1 is configured for denoting a virtual resource connection node corresponding to the push-resource description tag "technology", and n2 is configured for denoting a virtual resource connection node corresponding to the push-resource description tag "lifestyle". Since a resource tag value range of n1 is computer technology, the resource nodes satisfying the condition are v1, v2,

and v3. n1 may be respectively connected to v1, v2, and v3 by dashed lines, to indicate that n1 has association relationships with v1, v2, and v3 respectively. Since a resource tag value range of n2 is clothing and the resource nodes satisfying the condition are v2 and v3, n2 may be respectively connected to v2 and v3 by dashed lines, to indicate that n2 has association relationships with v2 and v3 respectively.

[0093] The related information of the resource nodes and the virtual resource connection nodes shown in FIG. 8 and Table 2 is merely an example for facilitating the description of the technical solution of this application, which does not limit specific information of actual resource nodes and virtual resource connection nodes.

[0094] The connecting the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph may include: acquiring virtual object description information corresponding to the virtual object connection node and virtual resource description information corresponding to the virtual resource connection node in each scenario interaction graph; and connecting virtual object connection nodes having the same virtual object description information, and connecting virtual resource connection nodes having the same virtual resource description information, to obtain the global scenario interaction graph.

[0095] After the virtual object connection nodes and the virtual resource connection nodes constructed in each scenario interaction graph are determined, the plurality of scenario interaction graphs may be connected by taking the virtual object connection nodes and the virtual resource connection nodes as a basis for connection, thereby obtaining the global scenario interaction graph. In this process, the virtual object description information corresponding to the virtual object connection nodes constructed in the scenario interaction graphs may be compared, and the virtual resource description information corresponding to the virtual resource connection nodes constructed in the scenario interaction graphs may be compared. Then, based on comparison results, the virtual object connection nodes having the same virtual object description information are connected, and the virtual resource connection nodes having the same virtual resource description information are connected, thereby achieving a purpose of connecting the scenario interaction graphs, to obtain the global scenario interaction graph.

[0096] Taking FIG. 7 as an example, the virtual object description information corresponding to the virtual object connection node A-m1 in the scenario interaction graph A is the same as the virtual object description information corresponding to the virtual object connection node B-m1 in the scenario interaction graph B. Therefore, the virtual object connection node A-m1

and the virtual object connection node B-m1 may be connected. Similarly, the virtual resource description information corresponding to the virtual resource connection node A-n1 in the scenario interaction graph A is the same as the virtual resource description information corresponding to the virtual resource connection node B-n1 in the scenario interaction graph B. Therefore, the virtual resource connection node A-n1 and the virtual resource connection node B-n1 may be connected. In this way, a global scenario interaction graph covering the scenario interaction graph A and the scenario interaction graph B is obtained.

[0097] Since the virtual object connection nodes are virtual nodes constructed based on actual object nodes and the virtual resource connection nodes are virtual nodes constructed based on actual resource nodes, both the virtual object connection nodes and the virtual resource connection nodes are virtual connection nodes. In this embodiment of this application, to distinguish from connection relationships between actual object nodes and resource nodes, in a process of connecting different scenario interaction graphs by using virtual object connection nodes and/or virtual resource connection nodes, connection relationships between the virtual object connection nodes are represented with dashed lines, and connection relationships between the virtual resource connection nodes are represented with dashed lines.

[0098] In addition, in the global scenario interaction graph shown in FIG. 7, the scenario interaction graph A and the scenario interaction graph B may be connected by using the virtual object connection nodes A-m1 and B-m1. The virtual object connection node A-m1 has association relationships with the object nodes A-u1 and A-u2 in the scenario interaction graph A, and the virtual object connection node B-m1 has association relationships with the object nodes B-u1 and B-u2 in the scenario interaction graph B. The object node A-u establishes connection relationships respectively with B-u1 and B-u2 by using the virtual object connection nodes A-m1 and B-m1. Since resource nodes having interaction relationships with B-u1 include B-v1 and B-v2, A-u1 may indirectly establish association relationships with the resource nodes B-v1 and B-v2. Since resource nodes having interaction relationships with B-u2 include B-v2, A-u1 may also indirectly establish an association relationship with the resource node B-v2. Association relationships of the remaining object nodes in another scenario interaction graph may also be determined according to the foregoing method, and details are not described herein one by one.

[0099] In the global scenario interaction graph shown in FIG. 7, the scenario interaction graph A and the scenario interaction graph B may be connected by using the virtual resource connection nodes A-n1 and B-n1. The virtual resource connection node A-n1 has association relationships with the resource nodes A-v1 and A-v3 in the scenario interaction graph A, and the

virtual resource connection node B-n1 has association relationships with B-v1 and B-v2 in the scenario interaction graph B. The resource node B-v1 establishes a connection relationship respectively with A-v1 and A-v3 by using the virtual resource connection nodes A-n1 and B-n1. Since an object node having an interaction relationship with A-v1 is A-u3, B-v1 may indirectly establish an association relationship with the object node A-u3. Since an object node having an interaction relationship with A-v3 is A-u2, B-v1 may also indirectly establish an association relationship with the object node A-u2. Association relationships of the remaining resource nodes in another scenario interaction graph may also be determined according to the foregoing method, and details are not described herein one by one.

[00100] In this embodiment of this application, after the acquiring object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs, the method may further include: acquiring an object node quantity corresponding to the object nodes and a resource node quantity corresponding to the resource nodes in the scenario interaction graphs; determining, based on the object node quantity, a virtual object node construction quantity corresponding to the virtual object connection nodes in the scenario interaction graphs, and determining, based on the resource node quantity, a virtual resource node construction quantity corresponding to the virtual resource connection nodes in the scenario interaction graphs; and constructing the virtual object connection nodes in the scenario interaction graphs according to the virtual object node construction quantity and the object description information, and constructing the virtual resource connection nodes in the scenario interaction graphs according to the virtual resource node construction quantity and the resource description information.

[00101] The object node quantity and the resource node quantity included in each scenario interaction graph are different. Some scenario interaction graphs include more object nodes and/or resource nodes. Correspondingly, the object node quantity and/or the resource node quantity in the scenario interaction graph are.is larger. Some scenario interaction graphs include fewer object nodes and/or resource nodes. Correspondingly, the object node quantity and/or the resource node quantity in the scenario interaction graph are/is smaller.

[00102] In this embodiment of this application, a quantity of virtual object connection nodes that need to be constructed in each scenario interaction graph may be determined according to the object node quantity in the scenario interaction graph, and a quantity of virtual resource connection nodes that need to be constructed in each scenario interaction graph may be determined according to the resource node quantity in the scenario interaction graph. For ease of description, the quantity

of virtual object connection nodes that need to be constructed is referred to as the virtual object node construction quantity, and the quantity of virtual resource connection nodes that need to be constructed is referred to as the virtual resource node construction quantity. For example, for a scenario interaction graph with a smaller number of object nodes, more virtual object connection nodes may be constructed therein, that is, the virtual object node construction quantity in the scenario interaction graph is appropriately increased. In this manner, the virtual object connection nodes may be refined, thereby improving a probability of connection between the object nodes in the scenario interaction graph and object nodes in another scenario interaction graph. Similarly, for a scenario interaction graph with a smaller number of resource nodes, more virtual resource connection nodes may be constructed therein, that is, the virtual resource node construction quantity in the scenario interaction graph is appropriately increased. In this manner, the virtual resource connection nodes may be refined, thereby improving a probability of connection between the resource nodes in the scenario interaction graph and resource nodes in another scenario interaction graph.

[00103] After the virtual object node construction quantity and the virtual resource node construction quantity in a certain scenario interaction graph are determined, virtual object connection nodes whose quantity is the same as the virtual object node construction quantity may be constructed according to the object description information in the scenario interaction graph, and virtual resource connection nodes whose quantity is the same as the virtual resource node construction quantity may be constructed according to the resource description information in the scenario interaction graph. For example, if the virtual object node construction quantity in a certain scenario interaction graph is 10 and the virtual resource node construction quantity is 6, 10 virtual object connection nodes and 6 virtual resource connection nodes need to be constructed in the scenario interaction graph. For specific manners of constructing the virtual object connection nodes and/or the virtual resource connection nodes, refer to the foregoing method, and details are not described herein one by one.

[00104] As described above, both the virtual object connection nodes and the virtual resource connection nodes in the global scenario interaction graph are virtual connection nodes. That is, the virtual object connection nodes and the virtual resource connection nodes play a role of connecting different scenario interaction graphs, and are configured to construct information paths between the different scenario interaction graphs. In the global scenario interaction graph, neither the virtual object connection nodes nor the virtual resource connection nodes participate in actual GNN calculation, that is, feature update on the virtual object connection nodes and the virtual resource connection nodes is not involved.

[00105] 103: Construct, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes.

[00106] For ease of distinction, the object node in the global scenario interaction graph may be referred to as a global object node, and the resource node in the global scenario interaction graph may be referred to as a global resource node.

[00107] The global object feature is a feature vector representation of the global object node in the global scenario interaction graph in the GNN, which is obtained by performing operations such as performing data augmentation on the global scenario interaction graph, determining a sample pair, and updating a graph network parameter, integrates multi-scenario interaction information, and reflects a potential interaction feature between an object and a resource in a global scenario. The global object feature may be understood as a feature vector corresponding to the global object node in the global scenario interaction graph, that is, an embedding representation of the global object node in the GNN corresponding to the global scenario interaction graph. The global resource feature is a feature vector representation of the global resource node in the global scenario interaction graph in the GNN, which is obtained by performing operations such as performing data augmentation on the global scenario interaction graph, determining a sample pair, and updating a graph network parameter, integrates multi-scenario interaction information, and reflects a potential interaction feature between a resource and an object in a global scenario. The global resource feature may be understood as a feature vector corresponding to the global resource node in the global scenario interaction graph, that is, an embedding representation of the global resource node in the GNN corresponding to the global scenario interaction graph.

[00108] In this embodiment of this application, the constructing, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes may include: performing data augmentation on the global scenario interaction graph to obtain a first augmented interaction graph and a second augmented interaction graph; determining positive sample pairs and negative sample pairs based on the first augmented interaction graph and the second augmented interaction graph, the positive sample pairs including node pairs formed by same nodes in the first augmented interaction graph and the second augmented interaction graph, and the negative sample pairs including node pairs formed by different nodes in the first augmented interaction graph and the second augmented interaction graph; and determining, according to the positive sample pairs and the negative sample pairs, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes.

[00109] The first augmented interaction graph is a graph obtained after a data augmentation operation is performed on the global scenario interaction graph, is generated by selecting some object nodes, resource nodes, and interaction data thereof from the global scenario interaction graph, and is configured for constructing positive and negative sample pairs in contrastive learning training. The second augmented interaction graph is a graph obtained after a data augmentation operation is performed on the global scenario interaction graph, is generated by selecting some object nodes, resource nodes, and interaction data thereof from the global scenario interaction graph, may include some nodes overlapping with those in the first augmented interaction graph, and is configured for constructing positive and negative sample pairs in contrastive learning training.

[00110] The positive sample pairs are node pairs formed by the same nodes in the first augmented interaction graph and the second augmented interaction graph, and is configured for prompting a graph network to learn similar feature representations of the same nodes in different augmented graphs in contrastive learning training. The negative sample pairs are node pairs formed by different nodes in the first augmented interaction graph and the second augmented interaction graph, and is configured for prompting the graph network to learn feature differences between different nodes in contrastive learning training.

[00111] Specific manners of data augmentation are as follows: node deletion and node addition may be employed. For node deletion, object nodes and resource nodes are randomly deleted from the global scenario interaction graph with a probability, to respectively generate a first-part graph after deletion and a second-part graph after deletion. For node addition, based on the graphs after deletion, new object nodes and resource nodes are randomly added according to a probability, and an interaction relationship between the new nodes and existing nodes is established according to historical interaction data in the global scenario interaction graph. A first-part graph after deletion and addition of nodes is taken as the first augmented interaction graph, and a second-part graph after deletion and addition of nodes is taken as the second augmented interaction graph.

[00112] Specifically, firstly, a loss function L is defined. The loss function considers feature differences between the positive sample pairs and the negative sample pairs. For the positive sample pairs, feature representations of two nodes thereof are expected to be as close as possible. For the negative sample pairs, feature representations of two nodes thereof are expected to be as different as possible. The loss function L may be expressed as $L = \alpha \sum_{(p^+,p^-)\in P^+} d\,(p^+,p^-) - \beta \sum_{(n^+,n^-)\in P^-} d\,(n^+,n^-)$, where P^+ denotes a positive sample pair set, P^- denotes a negative sample pair set, d denotes a distance metric function (such as a cosine distance) between features, and α and β are weight coefficients. Then, parameters of an initial first graph network and an

initial second graph network are updated by using gradient descent, so that the loss function L is minimized. After multiple iterative updates, a first graph network and a second graph network that are trained are obtained, and a global object feature of each of the object nodes and a global resource feature of each of the resource nodes are determined according to the two graph networks.

[00113] FIG. 9 is a schematic flowchart of training starting from a global scenario interaction graph according to an embodiment of this application. As shown in FIG. 9, after construction of the global scenario interaction graph is completed, a GNN corresponding to the global scenario interaction graph may be trained to obtain a global object feature of each of the object nodes and a global resource feature of each of the resource nodes in the global scenario interaction graph.

[00114] In this embodiment of this application, self-supervised training may be performed using a contrastive learning paradigm, thereby determining the global object feature of each of the object nodes and the global resource feature of each of the resource nodes in the global scenario interaction graph. Specifically, based on the global scenario interaction graph, two augmented interaction graphs (which are respectively a first augmented interaction graph and a second augmented interaction graph) may be constructed by controlling random dropout rates of global object nodes and global resource nodes. Then, the two augmented interaction graphs are compared to determine positive sample pairs and negative sample pairs for training. Then, the positive sample pairs and the negative sample pairs are taken as tags to train the two augmented interaction graphs, to obtain a trained augmented interaction graph. Finally, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes are determined based on the trained augmented interaction graph.

[00115] The global scenario interaction graph may include a plurality of global object nodes, a plurality of global resource nodes, and historical interaction data between the global object nodes and the global resource nodes. In the global scenario interaction graph, feature representations of the global object nodes and feature representations of the global resource nodes may be performed using common graph neural network algorithms, as follows:

$$h_u^i = \mathrm{GNN}(G);\ h_v^i = \mathrm{GNN}(G)$$

[00116] where i denotes indexes originating from different scenario interaction graphs in the global scenario interaction graph, and u denotes object nodes in the scenario interaction graph; v denotes resource nodes in the scenario interaction graph; G denotes the global scenario interaction graph; and GNN is a GNN node embedding algorithm.

[00117] Based on this, the performing data augmentation on the global scenario interaction

graph to obtain a first augmented interaction graph and a second augmented interaction graph may include: extracting, from the plurality of global object nodes, at least one global object node as augmented object nodes, and extracting, from the plurality of global resource nodes, at least one global resource node as augmented resource nodes; selecting, from the historical interaction data, historical interaction data between the augmented object nodes and the augmented resource nodes, to obtain augmented node interaction data; and generating the first augmented interaction graph and the second augmented interaction graph based on the augmented object nodes, the augmented resource nodes, and the augmented node interaction data.

[00118] For example, a process of generating the first augmented interaction graph may include the following operations: randomly selecting a plurality of global object nodes from the global scenario interaction graph as augmented object nodes in the first augmented interaction graph, and randomly selecting a plurality of global resource nodes from the global scenario interaction graph as augmented resource nodes in the first augmented interaction graph. After the augmented object nodes and the augmented resource nodes corresponding to the first augmented interaction graph are determined, historical interaction data between the augmented object nodes and the augmented resource nodes may be selected from the historical interaction data included in the global scenario interaction graph, and the selected historical interaction data is taken as the augmented node interaction data. The first augmented interaction graph may be generated based on the randomly selected augmented object nodes and augmented resource nodes and the augmented node interaction data.

[00119] Similarly, a process of generating the second augmented interaction graph may include the following operations: randomly selecting a plurality of global object nodes from the global scenario interaction graph as augmented object nodes in the second augmented interaction graph, and randomly selecting a plurality of global resource nodes from the global scenario interaction graph as augmented resource nodes in the second augmented interaction graph. After the augmented object nodes and the augmented resource nodes corresponding to the second augmented interaction graph are determined, historical interaction data between the augmented object nodes and the augmented resource nodes may be selected from the historical interaction data included in the global scenario interaction graph, and the selected historical interaction data is taken as the augmented node interaction data. The second augmented interaction graph may be generated based on the randomly selected augmented object nodes and augmented resource nodes and the augmented node interaction data.

[00120] A quantity of the augmented object nodes in the first augmented interaction graph is

less than that of the global object nodes in the global scenario interaction graph, and a quantity of the augmented resource nodes in the first augmented interaction graph is also less than that of the global resource nodes in the global scenario interaction graph. Similarly, a quantity of the augmented object nodes in the second augmented interaction graph is less than that of the global object nodes in the global scenario interaction graph, and a quantity of the augmented resource nodes in the second augmented interaction graph is also less than that of the global resource nodes in the global scenario interaction graph. In addition, the augmented object nodes in the first augmented interaction graph and the augmented object nodes in the second augmented interaction graph may partially overlap or may be completely different. The augmented resource nodes in the first augmented interaction graph and the augmented resource nodes in the second augmented interaction graph may partially overlap or may be completely different.

[00121] The generating the first augmented interaction graph and the second augmented interaction graph based on the augmented object nodes, the augmented resource nodes, and the augmented node interaction data may include: randomly extracting, from the augmented object nodes, at least one augmented object node as a first augmented object node, and randomly extracting, from the augmented object nodes, at least one augmented object node as a second augmented object node, the first augmented object node partially overlapping with the second augmented object node; randomly extracting, from the augmented resource nodes, at least one augmented resource node as a first augmented resource node, and randomly extracting, from the augmented resource nodes, at least one augmented resource node as a second augmented resource node, the first augmented resource node partially overlapping with the second augmented resource node; selecting, from the augmented node interaction data, first augmented node interaction data between the first augmented object node and the first augmented resource node, and selecting, from the augmented node interaction data, second augmented node interaction data between the second augmented object node and the second augmented resource node; and generating the first augmented interaction graph based on the first augmented object node, the first augmented resource node, and the first augmented node interaction data, and generating the second augmented interaction graph based on the second augmented object node, the second augmented resource node, and the second augmented node interaction data.

[00122] For ease of distinction, augmented object nodes configured to generate the first augmented interaction graph are referred to as first augmented object nodes, and augmented object nodes configured to generate the second augmented interaction graph are referred to as second augmented object nodes. Similarly, augmented resource nodes configured to generate the first augmented interaction graph are referred to as first augmented resource nodes, and augmented

resource nodes configured to generate the second augmented interaction graph are referred to as second augmented resource nodes.

[00123] Any augmented object node may serve as the first augmented object node, or may serve as the second augmented object node, or may serve as both the first augmented object node and the second augmented object node. Any augmented resource node may serve as the first augmented resource node, or may serve as the second augmented resource node, or may serve as both the first augmented resource node and the second augmented resource node.

[00124] FIG. 10 is a schematic diagram of generating augmented interaction graphs according to an embodiment of this application. FIG. 10 is merely an exemplary description of a process of generating a first augmented interaction graph and a second augmented interaction graph based on a global scenario interaction graph. In the illustrated global scenario interaction graph, only global object nodes and global resource nodes are shown, and virtual object connection nodes and/or virtual resource connection nodes are omitted. In an actual application, the global scenario interaction graph may include a virtual object connection node and/or a virtual resource connection node. Therefore, the global scenario interaction graph shown in FIG. 10 does not limit an actual global scenario interaction graph.

[00125] As shown in FIG. 10, the global scenario interaction graph includes 4 global object nodes (respectively denoted as u1, u2, u3, u4) and 3 global resource nodes (respectively denoted as v1, v2, v3). At least one of the 4 global object nodes may be taken as an augmented object node, and at least one of the 3 global resource nodes may be taken as an augmented resource node. Node interaction data between the augmented object node and the augmented resource node is augmented node interaction data.

[00126] In FIG. 10, u1, u3, and u4 are extracted from the augmented object nodes as first augmented object nodes. For ease of distinction, u1 as the first augmented object node is denoted as u1a, u3 as the first augmented object node is denoted as u3a, and u4 as the first augmented object node is denoted as u4a. Moreover, u1, u2, u3, and u4 are also extracted from the augmented object nodes as second augmented object nodes. For ease of distinction, u1 as the second augmented object node is denoted as u1b, u2 as the second augmented object node is denoted as u2b, u3 as the second augmented object node is denoted as u3b, and u4 as the second augmented object node is denoted as u4b. The first augmented object nodes (u1a, u3a, and u4a) partially overlap with the second augmented object nodes (u1b, u2b, u3b, and u4b).

[00127] Meanwhile, v1, v2, and v3 are extracted from the augmented resource nodes as first augmented resource nodes. For ease of distinction, v1 as the first augmented resource node is

denoted as v1a, v2 as the first augmented resource node is denoted as v2a, and v3 as the first augmented resource node is denoted as v3a. Moreover, v2 and v3 are also extracted from the augmented resource nodes as second augmented resource nodes. For ease of distinction, v2 as the second augmented resource node is denoted as v2b, and v3 as the second augmented resource node is denoted as v3b. The first augmented resource nodes (v1a, v2a, and v3a) partially overlap with the second augmented resource nodes (v2b and v3b).

[00128] After the first augmented object nodes and the first augmented resource nodes are determined, first augmented node interaction data that exists between the first augmented object nodes and the first augmented resource nodes may be selected from the augmented node interaction data. Similarly, after the second augmented object nodes and the second augmented resource nodes are determined, the second augmented node interaction data that exists between the second augmented object nodes and the second augmented resource nodes may be selected from the augmented node interaction data. Then, the first augmented interaction graph may be generated based on the first augmented object nodes, the first augmented resource nodes, and the first augmented node interaction data, and the second augmented interaction graph may be generated based on the second augmented object nodes, the second augmented resource nodes, and the second augmented node interaction data.

[00129] In this embodiment of this application, with reference to a node sampling policy and a graph learning algorithm representation manner for the global object nodes and the global resource nodes in the global scenario interaction graph, node embedding representation may be performed on the augmented object nodes and the augmented resource nodes in the two augmented interaction graphs.

$$h_u^i(1) = \mathrm{GNN}(G1);\ h_v^i(1) = \mathrm{GNN}(G1)$$

$$h_u^i(2) = \mathrm{GNN}(G2);\ h_v^i(1) = \mathrm{GNN}(G2)$$

[00130] where G1 denotes the first augmented interaction graph, and G2 denotes the second augmented interaction graph.

[00131] The determining positive sample pairs and negative sample pairs based on the first augmented interaction graph and the second augmented interaction graph may include: comparing the first augmented object nodes in the first augmented interaction graph with the second augmented object nodes in the second augmented interaction graph, and determining, based on comparison results, object positive sample pairs and first negative sample pairs corresponding to the augmented object nodes; comparing the first augmented resource nodes in the first augmented

interaction graph with the second augmented resource nodes in the second augmented interaction graph, and determining, based on comparison results, resource positive sample pairs and second negative sample pairs corresponding to the augmented resource nodes; comparing the first augmented object nodes in the first augmented interaction graph with each other, determining third negative sample pairs based on a comparison result, comparing the first augmented resource nodes in the first augmented interaction graph with each other, and determining fourth negative sample pairs based on a comparison result; comparing the second augmented object nodes in the second augmented interaction graph with each other, determining fifth negative sample pairs based on a comparison result, comparing the second augmented resource nodes in the second augmented interaction graph with each other, and determining sixth negative sample pairs based on a comparison result; and taking the object positive sample pairs and the resource positive sample pairs as positive sample pairs, and taking at least one of the first negative sample pairs, the second negative sample pairs, the third negative sample pairs, the fourth negative sample pairs, the fifth negative sample pairs, and the sixth negative sample pairs as negative sample pairs.

[00132] After the first augmented interaction graph and the second augmented interaction graph are constructed, the positive sample pairs and the negative sample pairs may be constructed according to the first augmented interaction graph and the second augmented interaction graph. Specifically, the first augmented interaction graph and the second augmented interaction graph may be compared, and positive sample pairs and part of negative sample pairs are determined based on a comparison result. Alternatively, comparisons may be performed within the first augmented interaction graph, and part of negative sample pairs are determined based on a comparison result. Alternatively, comparisons may be performed within the second augmented interaction graph, and part of negative sample pairs are determined based on a comparison result. Table 3 shows positive sample pairs and negative sample pairs that may be obtained based on FIG. 10.

[00133] Table 3. Positive sample pairs and negative sample pairs corresponding to FIG. 10

Positive sample pair	Object positive sample pair	u1a-u1b, u3a-u3b, u4a-u4b
	Resource positive sample pair	v2a-v2b, v3a-v3b
Negative sample pair	First negative sample pair	u1a-u2b, u1a-u3b, u1a-u4b, u3a-u1b, u3a-u2b, u3a-u4b, u4a-u1b, u4a-u2b, u4a-u3b
	Second negative sample pair	V1a-v2b, v1a-v3b, v2a-v3b, v3a-v2b
	Third negative sample pair	u1a-u3a, u1a-u4a, u3a-u4a

	Fourth negative sample pair	v1a-v2a, v1a-v3a, v2a-v3a
	Fifth negative sample pair	u1b-u2b, u1b-u3b, u1b-u4b, u2b-u3b, u2b-u4b, u3b-u4b
	Sixth negative sample pair	v2b-v3b

[00134] In Table 3, the positive sample pairs include object positive sample pairs and resource positive sample pairs. The object positive sample pairs are determined by: comparing the first augmented object nodes in the first augmented interaction graph with the second augmented object nodes in the second augmented interaction graph, and taking the same augmented object nodes as the object positive sample pairs. For example, since the first augmented object nodes in the first augmented interaction graph include u1a, u3a, and u4a and the second augmented object nodes in the second augmented interaction graph include u1b, u2b, u3b, and u4b, where u1a and u1b originate from the same augmented object node u1, u3a and u3b originate from the same augmented object node u3, and u4a and u4b originate from the same augmented object node u4, it may be determined that the object positive sample pairs include u1a-u1b, u3a-u3b, and u4a-u4b.

[00135] The resource positive sample pairs are determined by comparing the first augmented resource nodes in the first augmented interaction graph with the second augmented resource nodes in the second augmented interaction graph, and taking the same augmented resource nodes as the resource positive sample pairs. For example, since the first augmented resource nodes in the first augmented interaction graph include v1a, v2a, and v3a and the second augmented resource nodes in the second augmented interaction graph include v2b and v3b, where v2a and v2b originate from the same augmented resource node v2, and v3a and v3b originate from the same augmented resource node v3, it may be determined that the resource positive sample pairs include v2a-v2b and v3a-v3b.

[00136] The negative sample pairs are determined in a variety of manners. For example, in the process of comparing the first augmented object nodes in the first augmented interaction graph with the second augmented object nodes in the second augmented interaction graph, different augmented object nodes may be taken as the first negative sample pairs. For example, in FIG. 10, the first augmented object node u1a in the first augmented interaction graph and the second augmented object nodes u2b, u3b, and u4b in the second augmented interaction graph respectively originate from different augmented object nodes, from which it may be determined that the first negative sample pairs include u1a-u2b, u1a-u3b, and u1a-u4b. Moreover, the first augmented object node u3a in the first augmented interaction graph and the second augmented object nodes u1b, u2b, and u4b in the second augmented interaction graph respectively originate from different augmented

object nodes, from which it may be determined that the first negative sample pairs further include u3a-u1b, u3a-u2b, and u3a-u4b. In addition, the first augmented object node u4a in the first augmented interaction graph and the second augmented object nodes u1b, u2b, and u3b in the second augmented interaction graph respectively originate from different augmented object nodes, from which it may be determined that the first negative sample pairs further include u4a-u1b, u4a-u2b, and u4a-u3b.

[00137] The negative sample pairs may also be determined by: taking different augmented resource nodes as the second negative sample pairs in the process of comparing the first augmented resource nodes in the first augmented interaction graph with the second augmented resource nodes in the second augmented interaction graph. For example, the first augmented resource node v1a in the first augmented interaction graph and the second augmented resource nodes v2b and v3b in the second augmented interaction graph respectively originate from different augmented resource nodes, from which it may be determined that the second negative sample pairs include v1a-v2b and v1a-v3b. Moreover, the first augmented resource node v2a in the first augmented interaction graph and the second augmented resource node v3b in the second augmented interaction graph originate from different augmented resource nodes, from which it may be determined that the second negative sample pairs further include v2a-v3b. In addition, the first augmented resource node v3a in the first augmented interaction graph and the second augmented resource node v2b in the second augmented interaction graph originate from different augmented resource nodes, from which it may be determined that the second negative sample pairs further include v3a-v2b.

[00138] The negative sample pairs may also be determined by: performing comparisons within the first augmented interaction graph, and determining part of the negative sample pairs based on a comparison result. For example, the first augmented object nodes in the first augmented interaction graph may be compared with each other, and different first augmented object nodes are taken as the third negative sample pairs; and the first augmented resource nodes in the first augmented interaction graph may be compared with each other, and different first augmented resource nodes are taken as the fourth negative sample pairs. For example, the first augmented object nodes in the first augmented interaction graph include u1a, u3a, and u4a, where u1a and u3a are different first augmented object nodes, u1a and u4a are different first augmented object nodes, and u3a and u4a are different first augmented object nodes, from which it may be concluded that the third negative sample pairs include u1a-u3a, u1a-u4a, and u3a-u4a. The first augmented resource nodes in the first augmented interaction graph include v1a, v2a, and v3a, where v1a and v2a are different first augmented resource nodes, v1a and v3a are different first augmented resource nodes, and v2a and v3a are different first augmented resource nodes, from which it may be concluded that

the fourth negative sample pairs include v1a-v2a, v1a-v3a, and v2a-v3a.

[00139] The negative sample pairs may also be determined by: performing comparisons within the second augmented interaction graph, and determining part of the negative sample pairs based on a comparison result. For example, the second augmented object nodes in the second augmented interaction graph may be compared with each other, and different second augmented object nodes are taken as the fifth negative sample pairs; and the second augmented resource nodes in the second augmented interaction graph may be compared with each other, and different second augmented resource nodes are taken as the sixth negative sample pairs. For example, the second augmented object nodes in the second augmented interaction graph include u1b, u2b, u3b, and u4b. By using the same determination method as the third negative sample pairs described above, it may be obtained that the fifth negative sample pairs include u1b-u2b, u1b-u3b, u1b-u4b, u2b-u3b, u2b-u4b, and u3b-u4b. The second augmented resource nodes in the second augmented interaction graph include v2b and v3b. By using the same determination method as the fourth negative sample pairs described above, it may be obtained that the sixth negative sample pairs include v2b-v3b.

[00140] As can be seen from Table 3, in the positive sample pairs and the negative sample pairs constructed by using the first augmented interaction graph and the second augmented interaction graph, a quantity of the negative sample pairs is generally much higher than that of the positive sample pairs. In this regard, all the positive sample pairs may be retained, and an appropriate quantity of negative sample pairs may be selected from the first negative sample pairs to the sixth negative sample pairs as the negative sample pairs finally configured for training the GNN.

[00141] In this embodiment of this application, alternatively, all the positive sample pairs and the negative sample pairs may be taken as sample pairs finally configured for training the GNN.

[00142] The determining, according to the positive sample pairs and the negative sample pairs, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes may include: acquiring an initial first graph network corresponding to the first augmented interaction graph and an initial second graph network corresponding to the second augmented interaction graph; predicting, by using the initial first graph network, a predicted first feature of each augmented node in the first augmented interaction graph, the predicted first feature including a predicted first object feature of the first augmented object node and a predicted first resource feature of the first augmented resource node; predicting, by using the initial second graph network, a predicted second feature of each augmented node in the second augmented interaction graph, the predicted second feature including a predicted second object feature of the second

augmented object node and a predicted second resource feature of the second augmented resource node; determining, based on the positive sample pairs, the negative sample pairs, the predicted first features, and the predicted second features, a first contrastive loss corresponding to the object nodes and a second contrastive loss corresponding to the resource nodes; converging the initial first graph network and the initial second graph network according to the first contrastive loss and the second contrastive loss, to obtain a first graph network and a second graph network; and determining, according to the first graph network and the second graph network, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes.

[00143] In this embodiment of this application, the process of determining a global object feature of each of the (global) object nodes and a global resource feature of each of the (global) resource nodes according to the positive sample pairs and the negative sample pairs may be understood as a process of updating, according to the positive sample pairs and the negative sample pairs, parameters of GNNs respectively corresponding to the first augmented interaction graph and the second augmented interaction graph.

[00144] Training of a GNN model is similar to that of a conventional neural network, and mainly includes the following operations: (1) initializing model parameters: the model parameters need to be randomly initialized, or pre-trained model parameters are used for fine-tuning; (2) forward propagation: data is inputted into the model, and a predicted value of the model is calculated; (3) calculating a loss function: a corresponding loss function such as a cross entropy or mean square error loss function is selected according to a task type; (4) backward propagation: a gradient of the loss function with respect to the model parameters is calculated, and the model parameters are updated; and (5) iterative repetition: forward propagation and backward propagation processes are repeated until the model converges or reaches a specified quantity of iterations.

[00145] In this embodiment of this application, for ease of distinction, an untrained GNN corresponding to the first augmented interaction graph is referred to as the initial first graph network, and an untrained GNN corresponding to the second augmented interaction graph is referred to as the initial second graph network. For the initial first graph network, features of the first augmented object nodes and the first augmented resource nodes therein may be initialized, initialized features of the first augmented object nodes are referred to as initial first object features, and initialized features of the first augmented resource nodes are referred to as initial first resource features. For the initial second graph network, features of the second augmented object nodes and the second augmented resource nodes therein may be initialized, initialized features of the second augmented object nodes are referred to as initial second object features, and initialized features of

the second augmented resource nodes are referred to as initial second resource features. Then, the initial first object features and the initial first resource features are inputted into the initial first graph network, and predicted first object features of the first augmented object nodes and predicted first resource features of the first augmented resource nodes in the first augmented interaction graph are predicted by using the initial first graph network. The predicted first object features and the predicted first resource features may be collectively referred to as predicted first features. Meanwhile, the initial second object features and the initial second resource features may be inputted into the initial second graph network, and predicted second object features of the second augmented object nodes and predicted second resource features of the second augmented resource nodes in the second augmented interaction graph are predicted by using the initial second graph network. The predicted second object features and the predicted second resource features may be collectively referred to as predicted second features.

[00146] After the predicted first features of the augmented nodes in the first augmented interaction graph (including the predicted first object features of the first augmented object nodes and the predicted first resource features of the first augmented resource nodes) and the predicted second features of the augmented nodes in the second augmented interaction graph (including the predicted second object features of the second augmented object nodes and the predicted second resource features of the second augmented resource nodes) are obtained, a first contrastive loss corresponding to the object nodes and a second contrastive loss corresponding to the resource nodes may be determined based on the positive sample pairs, the negative sample pairs, the predicted first features, and the predicted second features. Specifically, the predicted first features and the predicted second features may be combined according to a combination manner of the positive sample pairs and the negative sample pairs to form corresponding combined sample pairs, the combined sample pairs are then compared with the positive sample pairs and the negative sample pairs, and the first contrastive loss corresponding to the object nodes and the second contrastive loss corresponding to the resource nodes are determined based on a comparison result. For example, u1a-u1b is an object positive sample pair. The predicted first object feature corresponding to u1a and the predicted second object feature corresponding to u1b may be combined to form a combined sample pair, the combined sample pair is then compared with u1a-u1b, and a comparison result is incorporated into the first contrastive loss corresponding to the object nodes. In another example, u1a-u2b is a negative sample pair. The predicted first object feature corresponding to u1a and the predicted second object feature corresponding to u2b may be combined to form a combined sample pair, the combined sample pair is then compared with u1a-u2b, and a comparison result is also incorporated into the first contrastive loss corresponding to the object nodes. Similarly, v2a-v2b is a

resource positive sample pair. The predicted first resource feature corresponding to v2a and the predicted second resource feature corresponding to v2b may be combined to form a combined sample pair, the combined sample pair is then compared with v2a-v2b, and a comparison result is incorporated into the second contrastive loss corresponding to the resource nodes, and so on.

[00147] After the first contrastive loss and the second contrastive loss are determined, the initial first graph network and the initial second graph network may be converged based on the first contrastive loss and the second contrastive loss, to obtain the first graph network and the second graph network. In this embodiment of this application, a contrastive loss in a self-supervised training process by using a comparison learning paradigm includes the first contrastive loss corresponding to the object nodes and the second contrastive loss corresponding to the resource nodes. A calculation formula of the contrastive loss is as follows: the contrastive loss $L_{ssl} = L_{ssl}^{user} + L_{ssl}^{item}$.

$$L_{ssl}^{user} = \sum_{u1 \in U} -\log \frac{\exp(s(G1_{u1}, G2_{u1})/\tau)}{\sum_{u2 \in U} \exp(s(G1_{u1}, G2_{u2})/\tau)}$$

$$L_{ssl}^{item} = \sum_{v1 \in V} -\log \frac{\exp(s(G1_{v1}, G2_{v1})/\tau)}{\sum_{v2 \in U} \exp(s(G1_{v1}, G2_{v2})/\tau)}$$

[00148] where L_{ssl}^{user} denotes a self-supervised contrastive loss of the object nodes, that is, the first contrastive loss; L_{ssl}^{item} denotes a self-supervised contrastive loss of the resource nodes, that is, the second contrastive loss; G1 denotes the first augmented interaction graph, and G2 denotes the second augmented interaction graph; U denotes object nodes, and V denotes resource nodes; τ is a common temperature coefficient in the contrastive loss, and is configured for adjusting distribution of similarity scores in the contrastive loss; and s is a similarity measurement function. In this embodiment of this application, a cosine similarity may be configured for measurement.

[00149] As described above, in this embodiment of this application, the first contrastive loss and the second contrastive loss may be summed, the initial first graph network is converged based on a summed contrastive loss, to obtain the first graph network, and the initial second graph network is converged based on the summed contrastive loss, to obtain the second graph network.

[00150] The foregoing process of performing self-supervised training by using the contrastive learning paradigm may be understood as a process of updating parameters of the corresponding GNNs, so as to make feature representations of two object nodes that are in the same positive sample pair in the first augmented interaction graph and the second augmented interaction graph infinitely close to, or even the same as, each other, and a process of updating parameters of

the corresponding GNNs, so as to make feature representations of two resource nodes that are in the same positive sample pair in the first augmented interaction graph and the second augmented interaction graph infinitely close to, or even the same as, each other, Additionally, the parameters of the corresponding GNNs need to be updated to make the feature representations of the two object nodes that are in the same negative sample pair in the first augmented interaction graph and the second augmented interaction graph different and the feature representations of the two resource nodes that are in the same negative sample pair in the first augmented interaction graph and the second augmented interaction graph different.

[00151] After the trained first graph network and the trained second graph network are obtained, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes may be determined according to the first graph network and the second graph network. The first augmented interaction graph and the second augmented interaction graph may not completely cover each global object node and each global resource node in the global scenario interaction graph. However, the global object features of the first augmented object nodes and the global resource features of the first augmented resource nodes in the first augmented interaction graph may be directly determined according to the first graph network, and the global object features of the second augmented object nodes and the global resource features of the second augmented resource nodes in the second augmented interaction graph may be directly determined according to the second graph network. Based on this, the first augmented object nodes and the second augmented resource nodes covered in the first augmented interaction graph and the second augmented object nodes and the second augmented resource nodes covered in the second augmented interaction graph may be substituted into corresponding positions in the global scenario interaction graph, and the global object features corresponding to the remaining global object nodes and the global resource features corresponding to the remaining global resource nodes may be determined according to historical interaction data in the global scenario interaction graph.

[00152] The global object features and the global resource features obtained after the self-supervised training is performed by using the comparative learning paradigm integrate historical interaction data in a plurality of scenario interaction graphs, fully mine high-order information between object nodes and resource nodes in the plurality of scenario interaction graphs, and can well reflect an intrinsic connection between object nodes and resource nodes in a global scenario.

[00153] 104: Train initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a

target object, to push the push resources to the target object.

[00154] The scenario graph networks are GNNs obtained after the initial scenario graph networks are trained using the global object features and the global resource features constructed based on the global scenario interaction graphs, which are configured for predicting an interaction possibility between the target object and resources, and determining push resources for the target object.

[00155] Considering that an actual situation of each information flow scenario differs, if, for any information flow scenario, the global object features and the global resource features are directly used for similarity calculation and resources are pushed according to a calculation result, specific information of the information flow scenario may be inevitably ignored, so that push results may still have a deviation. In this regard, in this embodiment of this application, the initial scenario graph network corresponding to the scenario interaction graph of each information flow scenario may further be trained based on the global object features and the global resource features, to obtain a trained scenario graph network, thereby achieving an effect of fine-tuning the feature representations of the object nodes and the resource nodes in each scenario interaction graph, so that interaction preferences between the object nodes and the resource nodes may be more accurately estimated.

[00156] The initial scenario graph network is an untrained GNN model corresponding to the scenario interaction graph, and is used as a basis for subsequent training based on the global object features and the global resource features, to learn an interaction mode between objects and resources in the scenario. The initial scenario graph network may be understood as an untrained GNN corresponding to the scenario interaction graph.

[00157] Specifically, the training an initial scenario graph network corresponding to each scenario interaction graph according to the global object feature and the global resource feature, to obtain a scenario graph network may include: selecting, from the global object features, global object features corresponding to the object nodes in each of the scenario interaction graphs, to obtain scenario global object features, and selecting, from the global resource features, global resource features corresponding to the resource nodes in each of the scenario interaction graphs, to obtain scenario global resource features; calculating, based on the initial scenario graph networks corresponding to the scenario interaction graphs, predicted object features corresponding to the scenario global object features, and calculating, based on the initial scenario graph networks, predicted resource features corresponding to the scenario global resource features; calculating a first similarity between the predicted object features and the predicted resource features, to determine

predicted interaction data between the object nodes and the resource nodes in the scenario interaction graphs; and comparing the predicted interaction data with the historical interaction data, and converging the initial scenario graph networks based on a comparison result, to obtain the scenario graph networks.

[00158] A process of calculating the predicted object features and the predicted resource features by the initial scenario graph networks may be as follows: The initial scenario graph networks each include a plurality of neural network layers, for example, an input layer, a hidden layer, and an output layer. Firstly, the scenario global object features are inputted into the input layer of the initial scenario graph network, and the input layer passes the features to the hidden layer. In the hidden layer, each neuron may perform a weighted sum on the input features, and perform nonlinear transformation by using an activation function (such as an ReLU function), to obtain an intermediate feature representation. After processing by a plurality of hidden layers, the intermediate feature representation is finally passed to the output layer, and the output layer outputs the predicted object features. Similarly, the scenario global resource features are also processed by the input layer, the hidden layer, and the output layer in the same manner, to obtain the predicted resource features.

[00159] Specifically, a similarity threshold θ is preset. When the first similarity between the predicted object features and the predicted resource features is greater than θ, it is considered that a predicted interaction relationship exists between the object nodes and the resource nodes, and predicted interaction data between the object nodes and the resource nodes is marked as positive. When the first similarity is less than or equal to θ, it is considered that there is no predicted interaction relationship between the object nodes and the resource nodes, and the predicted interaction data between the object nodes and the resource nodes is marked as negative. In this way, predicted interaction data between the object nodes and the resource nodes in the scenario interaction graph is determined according to the first similarity and the preset similarity threshold θ.

[00160] For example, for a scenario interaction graph corresponding to an information flow scenario, global object features corresponding to object nodes in the scenario interaction graph in the global interaction graph may be taken as scenario global object features, and global resource features corresponding to resource nodes in the scenario interaction graph in the global interaction graph may be taken as scenario global resource features, thereby obtaining the scenario global object features respectively corresponding to all the object nodes in the scenario interaction graph and the scenario global resource features respectively corresponding to all the resource nodes in the

scenario interaction graph. Then, the scenario global object features are inputted into the initial scenario graph network, to obtain predicted object features, and the scenario global resource features are inputted into the initial scenario graph network, to obtain predicted resource features. In this process, the global object features corresponding to the object nodes may be considered as initial object embedding representations of the object nodes in the initial scenario graph network, and the global resource feature corresponding to the resource nodes may be considered as initial resource embedding representations of the resource nodes in the initial scenario graph network.

[00161] Then, a first similarity between the predicted object features and the predicted resource features is calculated, the first similarity may be a cosine similarity, and predicted interaction data between the object nodes and the resource nodes is determined according to the first similarity. The predicted interaction data between the object nodes and the resource nodes may be determined according to the first similarity in a variety of manners. For example, a similarity threshold may be preset, and an interaction relationship may be established between an object node and a resource node whose first similarity exceeds the similarity threshold. That is, the predicted interaction data indicates that an interaction relationship may exist between a certain object node and a certain resource node.

[00162] A specific mechanism by which the calculation of the first similarity affects the determination of the predicted interaction data is as follows: the first similarity reflects a degree of similarity between features of the object node and the resource node. When the first similarity is relatively high, it indicates that the object node and the resource node are relatively similar in feature, and a possibility of interaction therebetween is relatively high. In this case, the predicted interaction data may be marked as positive, indicating that an interaction relationship may exist between the object node and the resource node. When the first similarity is relatively low, it indicates that the object node and the resource node differ greatly in feature, and a possibility of interaction therebetween is relatively low. In this case, the predicted interaction data may be marked as negative, indicating that no interaction relationship may exist between the object node and the resource node. A similarity threshold may be set. The first similarity is marked as positive when greater than the threshold, and is marked as negative when less than or equal to the threshold.

[00163] Each scenario interaction graph already includes historical interaction data that truly exists between the object nodes and the resource nodes. Therefore, the predicted interaction data may be compared with the historical interaction data, and a difference between the predicted interaction data and the historical interaction data is taken as loss information of the initial scenario graph network, thereby performing supervised training on the initial scenario graph network, to

obtain a trained scenario graph network. The comparing the predicted interaction data with the historical interaction data, and converging the initial scenario graph network based on a comparison result, to obtain the scenario graph network may include: calculating difference information between the predicted interaction data and the historical interaction data; determining loss information of the initial scenario graph network based on the difference information; and training the initial scenario graph network based on the loss information, to obtain the scenario graph network.

[00164] The historical interaction data may include data indicating real interaction between the object nodes and the resource nodes in the scenario interaction graph, and may also include data indicating no interaction between the object nodes and the resource nodes in the scenario interaction graph. For example, in the scenario interaction graph shown in FIG. 5, a real interaction relationship exists between u1 and v1, and no interaction relationship exists between u1 and v2. The historical interaction data in the scenario interaction graph shown in FIG. 5 may include data indicating the real interaction relationship between u1 and v1, and may also include data indicating no interaction relationship between u1 and v2. In this regard, historical interaction data between u1 and v1 may be taken as a positive sample, and historical interaction data between u1 and v2 may be taken as a negative sample. Based on this, the predicted interaction data is compared with the positive sample and the negative sample, respectively, respective difference information is calculated, and then loss information of the initial scenario graph network is determined based on the difference information, thereby converging the initial scenario network according to the loss information, to obtain the scenario graph network.

[00165] In this embodiment of this application, for ease of distinction, a scenario interaction graph in which global object features are used for feature representations of object nodes and global resource features are used for feature representations of resource nodes is denoted as $\widehat{G}_i(u, v, e)$. Based on this, loss information in a process of performing supervised training on the initial scenario graph network by using historical interaction data may be expressed as follows:

$$L_{rec} = -\sum_{(u,v)\in E_i} \log\left(\sigma\left(\hat{y}_{u,v}\right)\right) - \sum_{(u,\tilde{v})\setminus E_i} \log\left(1-\sigma\left(\hat{y}_{u,\tilde{v}}\right)\right)$$

[00166] where E_i denotes an actually existing object-resource interaction edge on an interaction graph $\widehat{G}_i$; (u, v) denotes positive samples with real interaction; $(u, \tilde{v})$ denotes negative samples with no interaction relationship; $\hat{y}_{u,v}$ denotes the first similarity between the predicted object features and the predicted resource features, reflecting an interaction tendency score of the object node with respect to the resource node; and σ is an activation function. In this

embodiment of this application, a sigmoid function may be used as the activation function.

[00167] As can be seen from the above, in this embodiment of this application, scenario interaction graphs respectively corresponding to a plurality of information flow scenarios are acquired. The scenario interaction graphs are configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios. The object nodes represent objects, and the resource nodes represent interactable resources provided for the objects in the information flow scenarios. Then, the scenario interaction graphs are connected based on the object nodes and the resource nodes, to obtain a global scenario interaction graph. Afterwards, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes are constructed in the global scenario interaction graph. Then, initial scenario graph networks corresponding to the scenario interaction graphs are trained according to the global object features and the global resource features, to obtain scenario graph networks. The scenario graph networks are configured for determining push resources for a target object, to push the push resources to the target object. According to the solution, the scenario interaction graphs respectively corresponding to the plurality of information flow scenarios may be integrated, to construct a global scenario interaction graph that can fully reflect commonalities and differences between the information flow scenarios, thereby eliminating modality bias and data bias that exist in single-scenario modeling, more accurately mining information flow preferences of users, and reducing operation and maintenance costs. In addition, for a global object feature corresponding to each of the object nodes and a global resource feature corresponding to each of the resource nodes in the global scenario interaction graph, the global object features and the global resource features are further taken as initialization features of object nodes and resource nodes in a single scenario interaction graph, to continue training an initial scenario graph corresponding to the single scenario interaction graph to obtain a scenario graph network that can more precisely reflect feature representations of the object nodes and the resource nodes in the single scenario interaction graph, thereby improving prediction accuracy of subsequent resource push by using the scenario graph network.

[00168] Embodiments of this application further provide a resource push method and apparatus, an electronic device, and a computer-readable storage medium. The resource push may be integrated into an electronic device. The electronic device may be a server, or may be a device such as a terminal.

[00169] The server may be an independent physical server, or may be a server cluster or a distributed system including a plurality of physical servers, or may be a cloud server providing

basic cloud computing services such as a cloud service, a cloud database, cloud computing, a cloud function, cloud storage, a network service, cloud communication, a middleware service, a domain name service, a security service, a CDN, and a big data and artificial intelligence platform. The terminal may be a smartphone, a tablet computer, a notebook computer, a desktop computer, a smart speaker, a smartwatch, or the like, but is not limited thereto.

[00170] The schematic diagram of the application scenario shown in FIG. 2 is also applicable to the resource push method. As shown in FIG. 2, for example, a resource push apparatus is integrated into an electronic device, and the electronic device is a server. A user terminal (i.e., a client) in which a user (including a target object) is located may establish a communication connection with the server. Based on this, when receiving a resource push request for the target object, the server may detect a target information flow scenario in which the target object is currently located; selects, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks including graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, where the global scenario interaction graph is obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios; and determines, based on the target scenario graph network, at least one push resource associated with the target object, and pushes the push resource to the target object.

[00171] Detailed descriptions are respectively provided below. A description order of the following embodiments is not intended to limit a preferred order of the embodiments.

[00172] This embodiment will be described from the perspective of a resource push apparatus. The resource push apparatus may specifically be integrated into an electronic device. The electronic device may be a server.

[00173] A resource push method, including: detecting, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located; selecting, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks including graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, where the global scenario interaction graph is obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios; and determining, based on the target scenario graph network, at least one push resource associated with

the target object, and pushing the push resource to the target object.

[00174] FIG. 11 is a schematic flowchart of a resource push method according to an embodiment of this application. As shown in FIG. 11, a specific flow of the resource push method is as follows:

[00175] 201: Detect, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located.

[00176] A target object refers to an object that receives system-pushed resources in a resource push system. The system selects, according to features thereof and scenario information, a suitable resource from the scenario graph network for pushing. The target information flow scenario refers to a specific information flow scenario in which the target object is currently located when the resource push request for the target object is received. The system may select, based on the scenario, a corresponding scenario graph network for resource push.

[00177] The resource push request for the target object may be received in a variety of manners. For example, the terminal may detect an operating state of a current object, and when detecting that the current object starts application software corresponding to an information flow scenario, take the current object as the target object, and generate a resource push request corresponding to the target object. The terminal then transmits the resource push request to a server corresponding to the resource push apparatus. After receiving the resource push request for the target object, the server may transmit, based on the scenario graph network obtained through training in the foregoing operation, at least one push resource to the terminal in which the target object is located, thereby completing resource push to the target object.

[00178] A specific method for detecting the target information flow scenario in which the target object is currently located is as follows: the target information flow scenario may be determined by analyzing information carried in the resource push request. For example, the request may include an identifier of an application program currently used by the target object, and an information flow scenario corresponding thereto may be determined according to the identifier of the application program. In addition, the target information flow scenario may also be detected by monitoring a device state and behavioral data of the target object. For example, a scenario in which the target object is currently located is determined by using sensor data (such as screen display content or a running state of an application program) of the device. Comprehensive determination may also be performed with reference to historical behavior data and context information of a user. For example, a target information flow scenario is inferred according to a common scenario of the user in a specific time period and current information such as time and location.

[00179] 202: Select, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks including graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, and the global scenario interaction graph being obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios.

[00180] The target scenario graph network is a GNN selected from the scenario graph networks and corresponding to the target information flow scenario, which is trained based on features of the global scenario interaction graph, and is configured to determine the push resource for the target object in the target scenario.

[00181] The resource push request may carry information of the target information flow scenario in which the target object is currently located. When the resource push request for the target object is received, the target information flow scenario may be identified from the resource push request. Since each information flow scenario corresponds to one scenario interaction graph and each scenario interaction graph corresponds to one trained scenario graph network, after the target information flow scenario is determined, the scenario interaction graph corresponding to the target information flow scenario may be taken as the target scenario interaction graph, and the scenario graph network corresponding to the target scenario interaction graph may be taken as the target scenario graph network.

[00182] A specific implementation of selecting the target scenario graph network is as follows: The scenario graph networks may be stored as a data structure, and each scenario graph network is associated with a corresponding information flow scenario. After the target information flow scenario is determined, the data structure may be traversed, to search for a scenario graph network having the same identifier as the target information flow scenario. Alternatively, an indexing mechanism may be used, to establish an index for each information flow scenario, and directly position the corresponding target scenario graph network according to the index of the target information flow scenario. In addition, if the scenario graph networks are stored in a database, a query may be performed according to the information of the target information flow scenario by using a database query statement, to select the target scenario graph network.

[00183] 203: Determine, based on the target scenario graph network, at least one push resource associated with the target object, and push the push resource to the target object.

[00184] The push resource is a resource that is determined according to a prediction result of the scenario graph network, is associated with the target object, is suitable for pushing to the object.

[00185] In this embodiment of this application, after supervised learning is performed by using the historical interaction data in the scenario interaction graphs, object nodes and resource nodes in each scenario interaction graph may be represented as follows:

$$h_u^i = \mathrm{GNN}(\widehat{G}_i);\ h_v^i = \mathrm{GNN}(\widehat{G}_i)$$

[00186] where h_u^i denotes an object node feature corresponding to an object node on which supervised fine-tuning is performed in an i^{th} scenario interaction graph, h_v^i denotes a resource node feature corresponding to a resource node on which supervised fine-tuning is performed in the i^{th} scenario interaction graph, and h_u^i and h_v^i may be directly configured for resource push in the scenario interaction graph.

[00187] After the target scenario graph network is determined, a target-object feature of the target object may be determined according to the target scenario graph network. The target-object feature is a feature representation of the target object in the target scenario graph network, is determined by comparing target description information of the target object with object description information of the object node in the scenario, and is configured for calculating similarities with scenario resources to select the push resource. The target-object feature may be understood as a scenario object feature corresponding to the target object in the target scenario graph network. Further, at least one push resource associated with the target object is calculated according to the scenario object feature, thereby pushing the push resource to the target object. Specifically, the determining, based on the target scenario graph network, at least one push resource associated with the target object may include: determining a target-object feature corresponding to the target object; determining, according to the target scenario graph network, a scenario resource feature corresponding to each resource node in the target information flow scenario; and calculating, based on the target-object feature and the scenario resource feature, the at least one push resource associated with the target object. The scenario resource feature is a feature representation of a resource node calculated according to the target scenario graph network in the scenario interaction graph corresponding to the target information flow scenario, and is configured for calculating a similarity with the target-object feature to select a resource suitable for pushing to the target object.

[00188] In the process of determining the target-object feature corresponding to the target object, the following two situations may exist:

[00189] In the first situation, the determining a target-object feature corresponding to the target object may include: acquiring target description information of the target object, and object description information corresponding to the object nodes included in the target information flow

scenario;

[00190] taking, if the object description information is the same as the target description information, the object node corresponding to the target object as a target-object node; determining, according to the target scenario graph network, a scenario object feature corresponding to the target-object node; and taking the scenario object feature as the target-object feature.

[00191] The first situation is directed to a process of determining the target-object feature when the target object is originally an object node in the target information flow scenario. To determine whether the target object is an object node already existing in the target information flow scenario, the target description information of the target object and the object description information respectively corresponding to all object nodes included in the target information flow scenario may first be acquired. The target description information may be basic profile information reflecting a user corresponding to the target object, such as age, gender, and education background. Then, the target description information is compared with each piece of object description information. If there is object description information consistent with the target description information, an object node corresponding to the object description information is the target-object node of the target object in the target information flow scenario. After the target-object node is determined, a scenario object feature corresponding to the target-object node may be determined according to the target scenario graph network, and the scenario object feature is taken as the target-object feature corresponding to the target object.

[00192] In the second situation, the determining a target-object feature corresponding to the target object may include: acquiring target description information of the target object, and object description information corresponding to the object nodes included in the target information flow scenario;

[00193] acquiring, if the object description information is different from the target description information, global object description information corresponding to each global object node in the global scenario interaction graph; selecting, from the global scenario interaction graph, a global object node corresponding to global object description information identical to the target description information, to obtain a target global object node; and determining, based on the scenario graph network, a scenario object feature corresponding to the target global object node, to obtain the target-object feature of the target object.

[00194] The second situation is directed to a process of determining the target-object feature when the target object is not an object node in the target information flow scenario. After the target description information of the target object and the object description information corresponding to

the object nodes included in the target information flow scenario are acquired, the target description information may be compared with each piece of object description information. If there is no object description information consistent with the target description information, a comparison range may be expanded to the global scenario interaction graph, global object description information corresponding to each global object node in the global scenario interaction graph is compared with the target description information, and a global object node corresponding to the global object description information consistent with the target description information is taken as a target global object node. Then, according to a scenario graph network in which the target global object node is located, a scenario object feature corresponding thereto is determined, and the scenario object feature is taken as the target-object feature of the target object.

[00195] In the second situation, the scenario interaction graph in which the target global object node is located is different from the scenario interaction graph corresponding to the target information flow scenario, so that the scenario graph network in which the target global object node is located is also different from the scenario graph network corresponding to the target information flow scenario. That is, even if the target object is not an object node in the target information flow scenario in which the target object is currently located, the target-object feature corresponding to the target object may still be determined from the global scenario interaction graph, and then the target-object feature is applied to the target scenario graph network corresponding to the target information flow scenario, to calculate the at least one push resource associated with the target object in the target information flow scenario. In this manner, functions of object-side and resource-side cold start in a new scenario may be implemented.

[00196] The scenario resource features may be understood as feature representations corresponding to the resource nodes and calculated according to the target scenario graph network in the scenario interaction graph corresponding to the target information flow scenario.

[00197] The calculating, based on the target-object feature and the scenario resource feature, the at least one push resource associated with the target object may include: calculating a second similarity between the target-object feature and the scenario resource feature; comparing the second similarity with a preset similarity threshold, and selecting, based on a comparison result, a push-resource node from the resource nodes in the target information flow scenario; and taking a resource corresponding to the push-resource node as the push resource.

[00198] The second similarity refers to a similarity between the target-object feature and the scenario resource feature calculated during resource push, and is configured for selecting a push-resource node from resource nodes in the target information flow scenario.

[00199] After the target-object feature corresponding to the target object and the scenario resource features corresponding to the resource nodes in the target scenario graph network are determined, a similarity between the target-object feature and each scenario resource feature may be calculated (for ease of distinction, the similarity is referred to as the second similarity), and at least one resource node is selected as a push-resource node according to the second similarity.

[00200] At least one resource node may be selected as the push-resource node according to the second similarity in a variety of manners. For example, the second similarity may be compared with a preset similarity threshold, and a resource node corresponding to the second similarity greater than the similarity threshold is taken as the push-resource node. For example, the calculated second similarities may also be sorted in descending order, and a resource node corresponding to at least one of the top-ranked second similarities is taken as the push-resource node. After the push-resource node is determined, a resource corresponding to the push-resource node may be taken as the push resource, and the resource is pushed to the target object.

[00201] Based on comparison from the perspective of an organization form of "user-item" interaction data, as a data scale increases, a conventional mainstream push algorithm cannot meet user requirements by modeling historical interaction data of a user by using paradigms such as point-wise modeling (as shown in FIG. 12A) and sequence modeling (as shown in FIG. 12B). Therefore, new push technologies need to be continuously developed. For example, a push system based on graph structure modeling adopted in this embodiment of this application can capture more comprehensive user preferences than point-wise modeling and sequence modeling.

[00202] Based on the graph structure modeling, researchers have developed some multi-scenario joint construction push systems, for example, push systems such as an auxiliary paradigm (as shown in FIG. 13A), a multi-tower paradigm (as shown in FIG. 13B), and an expert paradigm (as shown in FIG. 13C). The auxiliary paradigm relies on a common module to learn commonalities between multiple scenarios, and further relies on scenario features and a multi-layer perceptron to learn scenario differences. When user preferences are estimated, the two types of characteristics are combined. Since fusion of multi-scenario common characteristic information and single-scenario difference information is unstable, the multi-tower paradigm is improved based on this, and single-scenario characteristic information is learned by using a plurality of sub-modules based on a shared bottom layer. Precision of the multi-tower paradigm is easily affected by sparsity of single-scenario data. The expert paradigm employs a lightweight expert network to characterize multi-scenario differences, and further employs a gating mechanism for adaptive fusion of information. However, bias in scenario data easily causes load imbalance among a plurality of

experts during learning, leading to suboptimal characterization of user preferences.

[00203] According to the technical solution of this application, based on organization of user interaction data by using a graph structure, virtual object connection nodes and virtual resource connection nodes are proposed to communicate scenario interaction graphs corresponding to a plurality of information flow scenarios. Under effects of the virtual object connection nodes and the virtual resource connection nodes, bias in multi-scenario interaction data is resolved by controlling magnitude of cross-graph sampling, multi-scenario joint modeling is implemented by establishing an information exchange mechanism among the scenario interaction graphs, and the problem of bias in multi-scenario data is resolved by using a sampling policy.

[00204] To comprehensively evaluate effectiveness of the resource push method provided in this application, push effects in academic multi-scenarios and industrial multi-scenarios are further evaluated, and recall effects of a conventional single-scenario supervised modeling method, a multi-scenario joint construction push method (for example, an auxiliary paradigm, a multi-tower paradigm, and an expert paradigm), and the resource push method provided in this application are respectively compared, to prove that the resource push method provided in this application achieves a better effect. Table 4 shows evaluation results of push effects in academic multi-scenarios, and Table 5 shows evaluation results of push effects in industrial multi-scenarios.

[00205] During comparative evaluation, LightGCN (a push algorithm based on a graph convolutional network (GCN)) is uniformly used as a graph-structured node representation learning method. Both single-scenario node sampling and multi-scenario joint graph node sampling use 2-hop (second-order). Evaluation of the recall effects mainly focuses on gains of metrics: a recall, a mean reciprocal rank (MRR), a normalized discounted cumulative gain (NDCG), and a hit ratio when Top K=10.

[00206] The recall is a ratio of relevant items successfully recommended by the system to all relevant items. A larger value thereof indicates better performance.

[00207] The MRR is a metric configured for evaluating ranking quality of a push system, pays special attention to ranking of the first relevant item, and is an average value of reciprocal ranks over all queries. A larger value thereof indicates better performance.

[00208] The NDCG is a metric that considers both relevance and ranking of push results, and evaluates quality of pushing by discounting gains of relevant items in a push list. A larger value thereof indicates better performance.

[00209] The hit ratio is a proportion of at least one relevant item included in the push list. A

larger value thereof indicates better performance.

[00210] Table 4. Evaluation results of push effects in academic multi-scenarios

Scenario	Method	Recall @10	MRR @10	NDCG @10	Hit Ratio @10
Book Push	Single-scenario supervised modeling method	0.1585	0.1062	0.1120	0.1848
	Multi-scenario joint construction push method	0.1615	0.1080	0.1142	0.1877
	Resource push method of this application	0.1656	0.1093	0.1160	0.1928
Electronic commodity Push	Single-scenario supervised modeling method	0.1605	0.1070	0.1131	0.1874
	Multi-scenario joint construction push method	0.1614	0.1112	0.1160	0.1883
	Resource push method of this application	0.1644	0.1113	0.1168	0.1916
Movie Push	Single-scenario supervised modeling method	0.1569	0.1016	0.1083	0.1824
	Multi-scenario joint construction push method	0.1615	0.1080	0.1142	0.1877
	Resource push method of this application	0.1641	0.1114	0.1169	0.1916

[00211] Table 5. Evaluation results of push effects in industrial multi-scenarios

Scenario	Method	Recall @10	MRR @10	NDCG @10	Hit Ratio @10
Article Push	Single-scenario supervised modeling method	0.1678	0.1531	0.1225	0.3130
	Multi-scenario joint construction push method	0.1704	0.1533	0.1235	0.3157
	Resource push method of this application	0.1715	0.1533	0.1238	0.3160
Music Push	Single-scenario supervised modeling method	0.1682	0.1536	0.1221	0.3141
	Multi-scenario joint construction push method	0.1691	0.1533	0.1227	0.3155
	Resource push method of this application	0.1711	0.1545	0.1245	0.3177
Video Push	Single-scenario supervised modeling method	0.1683	0.1509	0.1215	0.3134

	Multi-scenario joint construction push method	0.1704	0.1558	0.1251	0.3187
	Resource push method of this application	0.1708	0.1561	0.1251	0.3187

[00212] According to the comprehensive multi-scenario recall metric data obtained from Table 4 and Table 5, it can be seen that the resource push method of this application achieves significant gains. As can be learned from analysis of split data, the gains mainly come from a solution in an unsupervised learning stage of constructing, based on a global scenario interaction graph, two augmented interaction graphs by controlling random dropout rates of global object nodes and global resource nodes, and then performing contrastive learning to determine global object features and global resource features.

[00213] As can be seen from the above, in this embodiment of this application, scenario interaction graphs respectively corresponding to a plurality of information flow scenarios are acquired. The scenario interaction graphs are configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios. The object nodes represent objects, and the resource nodes represent interactable resources provided for the objects in the information flow scenarios. Then, the scenario interaction graphs are connected based on the object nodes and the resource nodes, to obtain a global scenario interaction graph. Afterwards, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes are constructed in the global scenario interaction graph. Then, initial scenario graph networks corresponding to the scenario interaction graphs are trained according to the global object features and the global resource features, to obtain scenario graph networks. At least one push resource is pushed to a target object based on the scenario graph network when a resource push request for the target object is received. According to the solution, the scenario interaction graphs respectively corresponding to the plurality of information flow scenarios may be integrated, to construct a global scenario interaction graph that can fully reflect commonalities and differences between the information flow scenarios, thereby eliminating modality bias and data bias that exist in single-scenario modeling, more accurately mining information flow preferences of users, and reducing operation and maintenance costs. In addition, for a global object feature corresponding to each object node and a global resource feature corresponding to each resource node in the global scenario interaction graph, the global object features and the global resource features are further taken as initialization features of object nodes and resource nodes in a single scenario interaction graph, to continue training an initial scenario graph corresponding to the single scenario interaction graph to obtain a scenario graph network that

can more precisely reflect feature representations of the object nodes and the resource nodes in the single scenario interaction graph, thereby applying the scenario graph network to resource push, which can improve accuracy of resource push.

[00214] According to the method described in the foregoing embodiments, a further detailed description will be provided below with examples.

[00215] In this embodiment, for example, a resource push apparatus is specifically integrated into an electronic device, and the electronic device is a server.

[00216] FIG. 14 is another schematic flowchart of a resource push method according to an embodiment of this application. As shown in FIG. 14, a specific flow of the resource push method is as follows:

[00217] 301: A server acquires scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios.

[00218] For example, the server may acquire object nodes and resource nodes respectively corresponding to the plurality of information flow scenarios, and historical interaction data between the object nodes and the resource nodes; and construct a bipartite graph based on the object nodes, the resource nodes, and the historical interaction data, to obtain the scenario interaction graphs.

[00219] 302: The server acquires object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs.

[00220] For example, the object description information may be understood as node attribute features of the object nodes. For example, the object description information may reflect basic profile information of users corresponding to the object nodes, such as age, gender, and education background. The resource description information may be understood as node attribute information of the resource nodes. For example, the resource description information may reflect category information, style information, and the like of resources corresponding to the resource nodes.

[00221] 303: The server constructs, in the scenario interaction graphs, at least one virtual object connection node according to the object description information, the virtual object connection node being configured to connect object nodes having an association relationship with the virtual object connection node.

[00222] For example, the server may select at least one target-object description tag from the object description tags, and add an object tag value range to the target-object description tag; and construct, in the scenario interaction graphs, the at least one virtual object connection node based on the target-object description tag and the object tag value range, virtual object description information corresponding to the virtual object connection node including the target-object description tag and the object tag value range.

[00223] 304: The server constructs, in the scenario interaction graphs, at least one virtual resource connection node according to the resource description information, the virtual resource connection node being configured to connect resource nodes having an association relationship with the virtual object connection node.

[00224] For example, the server may select at least one push-resource description tag from the resource description tags, and add a resource tag value range to the push-resource description tag; and construct, in the scenario interaction graphs, the at least one virtual resource connection node based on the push-resource description tag and the resource tag value range. Virtual resource description information corresponding to the virtual resource connection node includes the push-resource description tag and the resource tag value range.

[00225] 305: The server connects the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph.

[00226] For example, the server may acquire virtual object description information corresponding to the virtual object connection nodes and virtual resource description information corresponding to the virtual resource connection nodes in the scenario interaction graphs; and connect virtual object connection nodes having the same virtual object description information, and connect virtual resource connection nodes having the same virtual resource description information, to obtain the global scenario interaction graph.

[00227] For example, the server may acquire an object node quantity corresponding to the object nodes and a resource node quantity corresponding to the resource nodes in the scenario interaction graphs; determine, based on the object node quantity, a virtual object node construction quantity corresponding to the virtual object connection nodes in the scenario interaction graphs, and determine, based on the resource node quantity, a virtual resource node construction quantity corresponding to the virtual resource connection nodes in the scenario interaction graphs; and construct the virtual object connection nodes in the scenario interaction graphs according to the virtual object node construction quantity and the object description information, and construct the

virtual resource connection nodes in the scenario interaction graphs according to the virtual resource node construction quantity and the resource description information.

[00228] 306: The server constructs, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes.

[00229] For example, the server may perform data augmentation on the global scenario interaction graph to obtain a first augmented interaction graph and a second augmented interaction graph; determine positive sample pairs and negative sample pairs based on the first augmented interaction graph and the second augmented interaction graph; and determine, according to the positive sample pairs and the negative sample pairs, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes.

[00230] Augmented object nodes are partial nodes selected from the global object nodes of the global scenario interaction graph, and are configured to generate the first augmented interaction graph and the second augmented interaction graph, to increase diversity and richness of training data. Augmented resource nodes are partial nodes selected from the global resource nodes of the global scenario interaction graph, and are configured to generate the first augmented interaction graph and the second augmented interaction graph, to increase diversity and richness of training data.

[00231] For example, the server may extract, from the plurality of global object nodes, at least one global object node as augmented object nodes, and extract, from the plurality of global resource nodes, at least one global resource node as augmented resource nodes; select, from the historical interaction data, historical interaction data between the augmented object nodes and the augmented resource nodes, to obtain augmented node interaction data; and generate the first augmented interaction graph and the second augmented interaction graph based on the augmented object nodes, the augmented resource nodes, and the augmented node interaction data. The augmented node interaction data is interaction data between the augmented object nodes and the augmented resource nodes that is selected from the historical interaction data of the global scenario interaction graph, and is configured to generate the first augmented interaction graph and the second augmented interaction graph, thereby providing data support for contrastive learning.

[00232] For example, the server may randomly extract, from the augmented object nodes, at least one augmented object node as a first augmented object node, and randomly extracting, from the augmented object nodes, at least one augmented object node as a second augmented object node, the first augmented object node partially overlapping with the second augmented object node; randomly extract, from the augmented resource nodes, at least one augmented resource node as a

first augmented resource node, and randomly extracting, from the augmented resource nodes, at least one augmented resource node as a second augmented resource node, the first augmented resource node partially overlapping with the second augmented resource node; select, from the augmented node interaction data, first augmented node interaction data between the first augmented object node and the first augmented resource node, and select, from the augmented node interaction data, second augmented node interaction data between the second augmented object node and the second augmented resource node; and generate the first augmented interaction graph based on the first augmented object node, the first augmented resource node, and the first augmented node interaction data, and generate the second augmented interaction graph based on the second augmented object node, the second augmented resource node, and the second augmented node interaction data.

[00233] For example, the server may compare the first augmented object nodes in the first augmented interaction graph with the second augmented object nodes in the second augmented interaction graph, and determine, based on comparison results, resource positive sample pairs and second negative sample pairs corresponding to the augmented object nodes; compare the first augmented resource nodes in the first augmented interaction graph with the second augmented resource nodes in the second augmented interaction graph, and determine, based on comparison results, resource positive sample pairs and second negative sample pairs corresponding to the augmented resource nodes; compare the first augmented object nodes in the first augmented interaction graph with each other, determine third negative sample pairs based on a comparison result, compare the first augmented resource nodes in the first augmented interaction graph with each other, and determine fourth negative sample pairs based on a comparison result; compare the second augmented object nodes in the second augmented interaction graph with each other, determine fifth negative sample pairs based on a comparison result, compare the second augmented resource nodes in the second augmented interaction graph with each other, and determine sixth negative sample pairs based on a comparison result; and take the object positive sample pairs and the resource positive sample pairs as positive sample pairs, and take at least one of the first negative sample pairs, the second negative sample pairs, the third negative sample pairs, the fourth negative sample pairs, the fifth negative sample pairs, and the sixth negative sample pairs as negative sample pairs.

[00234] For example, the server may acquire an initial first graph network corresponding to the first augmented interaction graph and an initial second graph network corresponding to the second augmented interaction graph; predict, by using the initial first graph network, a predicted first feature of each augmented node in the first augmented interaction graph, the predicted first

feature including a predicted first object feature of the first augmented object node and a predicted first resource feature of the first augmented resource node; predict, by using the initial second graph network, a predicted second feature of each augmented node in the second augmented interaction graph, the predicted second feature including a predicted second object feature of the second augmented object node and a predicted second resource feature of the second augmented resource node; determine, based on the positive sample pairs, the negative sample pairs, the predicted first features, and the predicted second features, a first contrastive loss corresponding to the object nodes and a second contrastive loss corresponding to the resource nodes; converge the initial first graph network and the initial second graph network according to the first contrastive loss and the second contrastive loss, to obtain a first graph network and a second graph network; and determine, according to the first graph network and the second graph network, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes. The first contrastive loss is a contrastive loss for object nodes that is calculated in contrastive learning training based on the positive sample pairs, the negative sample pairs, predicted features of nodes in the first augmented interaction graph, and predicted features of nodes in the second augmented interaction graph, and is configured for updating graph network parameters. The second contrastive loss is a contrastive loss for resource nodes that is calculated in contrastive learning training based on the positive sample pairs, the negative sample pairs, predicted features of nodes in the first augmented interaction graph, and predicted features of nodes in the second augmented interaction graph, and is configured for updating graph network parameters.

[00235] 307: The server trains initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks.

[00236] For example, the server may select, from the global object features, global object features corresponding to the object nodes in each of the scenario interaction graphs, to obtain scenario global object features, and select, from the global resource features, global resource features corresponding to the resource nodes in each of the scenario interaction graphs, to obtain scenario global resource features; calculate, based on the initial scenario graph networks corresponding to the scenario interaction graphs, predicted object features corresponding to the scenario global object features, and calculate, based on the initial scenario graph networks, predicted resource features corresponding to the scenario global resource features; calculate a first similarity between the predicted object features and the predicted resource features, to determine predicted interaction data between the object nodes and the resource nodes in the scenario interaction graph; and compare the predicted interaction data with the historical interaction data,

and converge the initial scenario graph network based on a comparison result, to obtain the scenario graph network. The first similarity refers to a similarity between the predicted object features and the predicted resource features that is calculated during training of the scenario graph network, and is configured for determining predicted interaction data between the object nodes and the resource nodes in the scenario interaction graph, to assist model convergence.

[00237] For example, the server may calculate difference information between the predicted interaction data and the historical interaction data; determine loss information of the initial scenario graph network based on the difference information; and train the initial scenario graph network based on the loss information, to obtain the scenario graph network.

[00238] 308: The server pushes at least one push resource to a target object based on the scenario graph network when receiving a resource push request for the target object.

[00239] For example, the server may detect a target information flow scenario in which the target object is currently located, and filter a target scenario graph network corresponding to the target information flow scenario from the scenario graph network; and calculate, based on the target scenario graph network, at least one push resource associated with the target object, and push the push resource to the target object.

[00240] For example, the server may determine a target-object feature corresponding to the target object; determine, according to the target scenario graph network, a scenario resource feature corresponding to each resource node in the target information flow scenario; and calculate, based on the target-object feature and the scenario resource feature, the at least one push resource associated with the target object.

[00241] For example, the server may acquire target description information of the target object, and object description information corresponding to the object nodes included in the target information flow scenario; take, if the object description information is the same as the target description information, the object node corresponding to the target object as a target-object node; determine, according to the target scenario graph network, a scenario object feature corresponding to the target-object node; and take the scenario object feature as the target-object feature.

[00242] For example, the server may acquire target description information of the target object, and object description information corresponding to the object nodes included in the target information flow scenario; acquire, if the object description information is different from the target description information, global object description information corresponding to each global object node in the global scenario interaction graph; select, from the global scenario interaction graph, a

global object node corresponding to global object description information the same as the target description information, to obtain a target global object node; and determine, based on the scenario graph network, a scenario object feature corresponding to the target global object node, to obtain the target-object feature of the target object.

[00243] For example, the server may calculate a second similarity between the target-object feature and the scenario resource feature;

[00244] compare the second similarity with a preset similarity threshold, and select, based on a comparison result, a push-resource node from the resource nodes in the target information flow scenario; and take a resource corresponding to the push-resource node as the push resource.

[00245] As can be seen from the above, the server acquires scenario interaction graphs respectively corresponding to a plurality of information flow scenarios. The scenario interaction graphs are configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios. The object nodes represent objects, and the resource nodes represent interactable resources provided for the objects in the information flow scenarios. Then, the server acquires object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs. Afterwards, the server constructs, in the scenario interaction graphs, at least one virtual object connection node according to the object description information. The virtual object connection node is configured to connect object nodes having an association relationship with the virtual object connection node. Moreover, the server constructs, in the scenario interaction graphs, at least one virtual resource connection node according to the resource description information. The virtual resource connection node is configured to connect resource nodes having an association relationship with the virtual object connection node. Then, the server connects the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph. The server constructs, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes. Then, the server trains initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks. Finally, the server pushes at least one push resource to a target object based on the scenario graph networks when receiving a resource push request for the target object. According to the solution, the scenario interaction graphs respectively corresponding to the plurality of information flow scenarios may be integrated, to construct a global scenario interaction graph that can fully reflect commonalities and differences

between the information flow scenarios, thereby eliminating modality bias and data bias that exist in single-scenario modeling, more accurately mining information flow preferences of users, and reducing operation and maintenance costs. In addition, for a global object feature corresponding to each object node and a global resource feature corresponding to each resource node in the global scenario interaction graph, the global object features and the global resource features are further taken as initialization features of object nodes and resource nodes in a single scenario interaction graph, to continue training an initial scenario graph corresponding to the single scenario interaction graph to obtain a scenario graph network that can more precisely reflect feature representations of the object nodes and the resource nodes in the single scenario interaction graph, thereby improving accuracy of resource push.

[00246] To better implement the foregoing model training method, an embodiment of this application further provides a model training apparatus. The model training apparatus may be integrated into a network device, for example, a device such as a server or a terminal. The terminal may include a tablet computer, a notebook computer, a personal computer, and/or the like.

[00247] FIG. 15 is a schematic structural diagram of a model training apparatus according to an embodiment of this application. As shown in FIG. 15, the model training apparatus may include an acquisition unit 401, a connection unit 402, a construction unit 403, and a training unit 404 as follows.

[00248] (1) Acquisition unit 401

[00249] The acquisition unit 401 is configured to acquire scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios.

[00250] For example, the acquisition unit 401 may specifically be configured to: acquire object nodes and resource nodes respectively corresponding to the plurality of information flow scenarios, and historical interaction data between the object nodes and the resource nodes; and construct a bipartite graph based on the object nodes, the resource nodes, and the historical interaction data, to obtain the scenario interaction graphs.

[00251] (2) Connection unit 402

[00252] The connection unit 402 is configured to connect the scenario interaction graphs

based on the object nodes and the resource nodes, to obtain a global scenario interaction graph.

[00253] For example, the connection unit 402 may specifically be configured to: acquire object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs; construct, in the scenario interaction graphs, at least one virtual object connection node according to the object description information, the virtual object connection node being configured to connect object nodes having an association relationship with the virtual object connection node; construct, in the scenario interaction graphs, at least one virtual resource connection node according to the resource description information, the virtual resource connection node being configured to connect resource nodes having an association relationship with the virtual object connection node; and connect the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph.

[00254] For example, the connection unit 402 may specifically be configured to: select at least one target-object description tag from the object description tags, and add an object tag value range to the target-object description tag; and construct, in the scenario interaction graphs, the at least one virtual object connection node based on the target-object description tag and the object tag value range, virtual object description information corresponding to the virtual object connection node including the target-object description tag and the object tag value range.

[00255] For example, the connection unit 402 may specifically be configured to: select at least one push-resource description tag from the resource description tags, and add a resource tag value range to the push-resource description tag; and construct, in the scenario interaction graphs, the at least one virtual resource connection node based on the push-resource description tag and the resource tag value range. Virtual resource description information corresponding to the virtual resource connection node includes the push-resource description tag and the resource tag value range.

[00256] For example, the connection unit 402 may specifically be configured to: acquire virtual object description information corresponding to the virtual object connection nodes and virtual resource description information corresponding to the virtual resource connection nodes in the scenario interaction graphs; and connect virtual object connection nodes having the same virtual object description information, and connect virtual resource connection nodes having the same virtual resource description information, to obtain the global scenario interaction graph.

[00257] (3) Construction unit 403

[00258] The construction unit 403 is configured to construct, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes.

[00259] For example, the construction unit 403 may specifically be configured to: perform data augmentation on the global scenario interaction graph to obtain a first augmented interaction graph and a second augmented interaction graph; determine positive sample pairs and negative sample pairs based on the first augmented interaction graph and the second augmented interaction graph; and determine, according to the positive sample pairs and the negative sample pairs, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes.

[00260] For example, the construction unit 403 may specifically be configured to: extract, from the plurality of global object nodes, at least one global object node as augmented object nodes, and extract, from the plurality of global resource nodes, at least one global resource node as augmented resource nodes; select, from the historical interaction data, historical interaction data between the augmented object nodes and the augmented resource nodes, to obtain augmented node interaction data; and generate the first augmented interaction graph and the second augmented interaction graph based on the augmented object nodes, the augmented resource nodes, and the augmented node interaction data.

[00261] For example, the construction unit 403 may specifically be configured to: randomly extract, from the augmented object nodes, at least one augmented object node as a first augmented object node, and randomly extract, from the augmented object nodes, at least one augmented object node as a second augmented object node, the first augmented object node partially overlapping with the second augmented object node; randomly extract, from the augmented resource nodes, at least one augmented resource node as a first augmented resource node, and randomly extract, from the augmented resource nodes, at least one augmented resource node as a second augmented resource node, the first augmented resource node partially overlapping with the second augmented resource node; select, from the augmented node interaction data, first augmented node interaction data between the first augmented object node and the first augmented resource node, and select, from the augmented node interaction data, second augmented node interaction data between the second augmented object node and the second augmented resource node; and generate the first augmented interaction graph based on the first augmented object node, the first augmented resource node, and the first augmented node interaction data, and generate the second augmented interaction graph based on the second augmented object node, the second augmented resource node, and the second

augmented node interaction data.

[00262] For example, the construction unit 403 may specifically be configured to: acquire an initial first graph network corresponding to the first augmented interaction graph and an initial second graph network corresponding to the second augmented interaction graph; predict, by using the initial first graph network, a predicted first feature of each augmented node in the first augmented interaction graph, the predicted first feature including a predicted first object feature of the first augmented object node and a predicted first resource feature of the first augmented resource node; predict, by using the initial second graph network, a predicted second feature of each augmented node in the second augmented interaction graph, the predicted second feature including a predicted second object feature of the second augmented object node and a predicted second resource feature of the second augmented resource node; determine, based on the positive sample pairs, the negative sample pairs, the predicted first features, and the predicted second features, a first contrastive loss corresponding to the object nodes and a second contrastive loss corresponding to the resource nodes; converge the initial first graph network and the initial second graph network according to the first contrastive loss and the second contrastive loss, to obtain a first graph network and a second graph network; and determine, according to the first graph network and the second graph network, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes.

[00263] (4) Training unit 404

[00264] The training unit 404 is configured to train initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object.

[00265] For example, the training unit 404 may be specifically configured to: select, from the global object features, global object features corresponding to the object nodes in each of the scenario interaction graphs, to obtain scenario global object features, and select, from the global resource features, global resource features corresponding to the resource nodes in each of the scenario interaction graphs, to obtain scenario global resource features; calculate, based on the initial scenario graph networks corresponding to the scenario interaction graphs, predicted object features corresponding to the scenario global object features, and calculate, based on the initial scenario graph networks, predicted resource features corresponding to the scenario global resource features; calculate a first similarity between the predicted object features and the predicted resource

features, to determine predicted interaction data between the object nodes and the resource nodes in the scenario interaction graphs; and compare the predicted interaction data with the historical interaction data, and converge the initial scenario graph networks based on a comparison result, to obtain the scenario graph networks.

[00266] During specific implementation, the foregoing units may be implemented as independent entities, or may be combined arbitrarily, or may be implemented as the same entity or several entities. For specific implementation of the foregoing units, refer to the foregoing method embodiments. Details are not described herein again.

[00267] As can be seen from the above, in this embodiment of this application, the acquisition unit 401 acquires scenario interaction graphs respectively corresponding to a plurality of information flow scenarios. The scenario interaction graphs are configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios. The object nodes represent objects, and the resource nodes represent interactable resources provided for the objects in the information flow scenarios. Then, the connection unit 402 connects the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph. Then, the construction unit 403 constructs, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes. The training unit 404 trains initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks. According to the solution, the scenario interaction graphs respectively corresponding to the plurality of information flow scenarios may be integrated, to construct a global scenario interaction graph that can fully reflect commonalities and differences between the information flow scenarios, thereby eliminating modality bias and data bias that exist in single-scenario modeling, more accurately mining information flow preferences of users, and reducing operation and maintenance costs. In addition, for a global object feature corresponding to each object node and a global resource feature corresponding to each resource node in the global scenario interaction graph, the global object features and the global resource features are further taken as initialization features of object nodes and resource nodes in a single scenario interaction graph, to continue training an initial scenario graph corresponding to the single scenario interaction graph to obtain a scenario graph network that can more precisely reflect feature representations of the object nodes and the resource nodes in the single scenario interaction graph, thereby improving accuracy of subsequent resource push by using the scenario graph network.

[00268] To better implement the foregoing resource push method, an embodiment of this application further provides a resource push apparatus. The resource push apparatus may be integrated into a network device, for example, a device such as a server or a terminal. The terminal may include a tablet computer, a notebook computer, a personal computer, and/or the like.

[00269] FIG. 16 is a schematic structural diagram of a resource push apparatus according to an embodiment of this application. As shown in FIG. 16, the resource push apparatus may include a receiving unit 501, a filtering unit 502, and a push unit 503 as follows.

[00270] (1) Receiving unit 501

[00271] The receiving unit 501 is configured to detect, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located.

[00272] (2) Filtering unit 502

[00273] The filtering unit 502 is configured to select, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks including graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, and the global scenario interaction graph being obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios.

[00274] (3) Push unit 503

[00275] The push unit 503 is configured to determine, based on the target scenario graph network, at least one push resource associated with the target object, and push the push resource to the target object.

[00276] For example, the push unit 503 may specifically be configured to: determine a target-object feature corresponding to the target object; determine, according to the target scenario graph network, a scenario resource feature corresponding to each resource node in the target information flow scenario; and calculate, based on the target-object feature and the scenario resource feature, the at least one push resource associated with the target object.

[00277] For example, the push unit 503 may specifically be configured to: acquire target description information of the target object, and object description information corresponding to the object nodes included in the target information flow scenario; take, if the object description information is the same as the target description information, the object node corresponding to the

target object as a target-object node; determine, according to the target scenario graph network, a scenario object feature corresponding to the target-object node; and take the scenario object feature as the target-object feature.

[00278] For example, the push unit 503 may specifically be configured to: acquire target description information of the target object, and object description information corresponding to the object nodes included in the target information flow scenario; acquire, if the object description information is different from the target description information, global object description information corresponding to each global object node in the global scenario interaction graph; select, from the global scenario interaction graph, a global object node corresponding to global object description information the same as the target description information, to obtain a target global object node; and determine, based on the scenario graph network, a scenario object feature corresponding to the target global object node, to obtain the target-object feature of the target object.

[00279] For example, the push unit 503 may specifically be configured to: calculate a second similarity between the target-object feature and the scenario resource feature; compare the second similarity with a preset similarity threshold, and select, based on a comparison result, a push-resource node from the resource nodes in the target information flow scenario; and take a resource corresponding to the push-resource node as the push resource.

[00280] During specific implementation, the foregoing units may be implemented as independent entities, or may be combined arbitrarily, or may be implemented as the same entity or several entities. For specific implementation of the foregoing units, refer to the foregoing method embodiments. Details are not described herein again.

[00281] An embodiment of this application further provides an electronic device, as shown in FIG. 17, which is a schematic structural diagram of the electronic device according to this embodiment of this application. Specifically,

[00282] The electronic device may include components such as a processor 601 with one or more processing cores, a memory 602 with one or more computer-readable storage media, a power supply 603, and an input unit 604. A person skilled in the art may understand that the structure of the electronic device shown in FIG. 17 does not constitute a limitation on the electronic device, and may include more or fewer components than those illustrated, or combine certain components, or have a different arrangement of components.

[00283] The processor 601 is a control center of the electronic device, is connected to various

parts of the entire electronic device by using various interfaces and lines, and by running or executing a software program and/or a module stored in the memory 602 and invoking data stored in the memory 602, performs various functions and data processing of the electronic device. In some embodiments, the processor 601 may include one or more processing cores. Preferably, the processor 601 may integrate an application processor and a modem. The application processor mainly processes an operating system, a user interface, an application program, and the like. The modem mainly processes wireless communication. The foregoing modem processor may alternatively not be integrated into the processor 601.

[00284] The memory 602 may be configured to store a software program and a module. The processor 601 runs the software program and the module stored in the memory 602, to implement various functional applications and data processing. The memory 602 may mainly include a program storage area and a data storage area. The program storage area may store an operating system, an application program required by at least one function (such as a sound playback function and an image display function), and the like. The data storage area may store data created according to use of the electronic device, and the like. In addition, the memory 602 may include a high-speed random access memory (RAM), and may also include a non-volatile memory such as at least one magnetic disk storage device, a flash memory, or another volatile solid-state storage device. Correspondingly, the memory 602 may further include a memory controller, to provide access of the processor 601 to the memory 602.

[00285] The electronic device further includes the power supply 603 supplying power to the components. Preferably, the power supply 603 may be logically connected to the processor 601 by using a power management system, thereby implementing functions such as charging, discharging, and power consumption management by using the power management system. The power supply 603 may further include any components such as one or more direct-current or alternating-current power supplies, a re-charging system, a power failure detection circuit, a power supply converter or inverter, and a power supply state indicator.

[00286] The electronic device may further include the input unit 604. The input unit 604 may be configured to receive input digit or character information, and generate a keyboard, mouse, joystick, optical, or track ball signal input related to the user setting and function control.

[00287] Although not shown in the figure, the electronic device may further include a display unit and the like, which are not described in detail herein. Specifically, in this embodiment, the processor 601 in the electronic device may load, according to the following instructions, executable files corresponding to processes of one or more application programs into the memory 602. The

processor 601 runs the application program stored in the memory 602, to implement various functions as follows:

[00288] acquiring scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios; connecting the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph; constructing, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes; and training initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object;

[00289] and/or

[00290] detecting, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located; selecting, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks including graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, where the global scenario interaction graph is obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios; and determining, based on the target scenario graph network, at least one push resource associated with the target object, and pushing the push resource to the target object.

[00291] Specifically, the electronic device may acquire scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios; then acquiring object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs; constructing, in the scenario interaction graphs, at least one virtual

object connection node according to the object description information, the virtual object connection node being configured to connect object nodes having an association relationship with the virtual object connection node; constructing, in the scenario interaction graphs, at least one virtual resource connection node according to the resource description information, the virtual resource connection node being configured to connect resource nodes having an association relationship with the virtual object connection node; connecting the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph; constructing, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes; training initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks; and finally, pushing at least one push resource to a target object based on the scenario graph networks when receiving a resource push request for the target object.

[00292] For a specific implementation of each of the foregoing operations, reference may be made to the foregoing embodiments. Details are not described herein again.

[00293] As can be seen from the above, in this embodiment of this application, scenario interaction graphs respectively corresponding to a plurality of information flow scenarios are acquired. The scenario interaction graphs are configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios. The object nodes represent objects, and the resource nodes represent interactable resources provided for the objects in the information flow scenarios. Then, the scenario interaction graphs are connected based on the object nodes and the resource nodes, to obtain a global scenario interaction graph. Afterwards, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes are constructed in the global scenario interaction graph. An initial scenario graph network corresponding to the scenario interaction graph is trained according to the global object feature and the global resource feature, to obtain a scenario graph network. At least one push resource is pushed to a target object based on the scenario graph network when a resource push request for the target object is received. According to the solution, the scenario interaction graphs respectively corresponding to the plurality of information flow scenarios may be integrated, to construct a global scenario interaction graph that can fully reflect commonalities and differences between the information flow scenarios, thereby eliminating modality bias and data bias that exist in single-scenario modeling, more accurately mining information flow preferences of users, and reducing operation and maintenance costs. In addition, for a global object feature corresponding to each object node and a global resource feature

corresponding to each resource node in the global scenario interaction graph, the global object features and the global resource features are further taken as initialization features of object nodes and resource nodes in a single scenario interaction graph, to continue training an initial scenario graph corresponding to the single scenario interaction graph to obtain a scenario graph network that can more precisely reflect feature representations of the object nodes and the resource nodes in the single scenario interaction graph, thereby improving accuracy of resource push.

[00294] A person of ordinary skill in the art may understand that all or some of the operations of the methods in the foregoing embodiments may be implemented by an instruction, or implemented by an instruction controlling relevant hardware. The instruction may be stored in a computer-readable storage medium, and loaded and executed by a processor.

[00295] To this end, an embodiment of this application further provides a computer-readable storage medium. The computer-readable storage medium stores a plurality of instructions. The instructions can be loaded by a processor to perform operations in the model training method and in the resource push method provided in the embodiments of this application. For example, the instructions may perform the following operations:

[00296] acquiring scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios; connecting the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph; constructing, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes; training initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object;

[00297] and/or

[00298] detecting, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located; selecting, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks including graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object

features and global resource features constructed based on a global scenario interaction graph, where the global scenario interaction graph is obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios; and determining, based on the target scenario graph network, at least one push resource associated with the target object, and pushing the push resource to the target object.

[00299] Specifically, scenario interaction graphs respectively corresponding to a plurality of information flow scenarios are acquired. The scenario interaction graphs are configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios. The object nodes represent objects, and the resource nodes represent interactable resources provided for the objects in the information flow scenarios. Then, object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs are acquired. At least one virtual object connection node is constructed in the scenario interaction graphs according to the object description information. The virtual object connection node is configured to connect object nodes having an association relationship with the virtual object connection node. Moreover, at least one virtual resource connection node is constructed in the scenario interaction graphs according to the resource description information. The virtual resource connection node is configured to connect resource nodes having an association relationship with the virtual object connection node. Then, the scenario interaction graphs are connected based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph. A global object feature of each of the object nodes and a global resource feature of each of the resource nodes are constructed in the global scenario interaction graph. Then, an initial scenario graph network corresponding to the scenario interaction graph is trained according to the global object feature and the global resource feature, to obtain a scenario graph network. Finally, at least one push resource is pushed to a target object based on the scenario graph network when a resource push request for the target object is received.

[00300] For specific implementation of the foregoing operations, refer to the foregoing embodiments. Details are not described herein again.

[00301] The computer-readable storage medium may include: a read only memory (ROM), a RAM, a magnetic disk, an optical disc, or the like.

[00302] Since the instructions stored in the computer-readable storage medium may perform operations in any one of the model training methods and the resource push methods provided in the embodiments of this application, beneficial effects that can be achieved by any one of the model

training methods and the resource push methods provided in the embodiments of this application can be achieved. For details, refer to the foregoing embodiments, which are not described herein again.

[00303] According to an aspect of this application, a computer program product or a computer program is provided. The computer program product or the computer program includes a computer instruction. The computer instruction is stored in a computer-readable storage medium. A processor of an electronic device reads the computer instruction from the computer-readable storage medium, and the processor executes the computer instruction, causing the electronic device to perform the methods provided in the various optional implementations in the foregoing data access aspect.

[00304] In summary, this application provides a model training method, a resource push method, apparatuses, a device, a computer-readable storage medium, and a computer program product. An electronic device acquires scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios, connects the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph, constructs, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes, and trains initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, for determining push resources for a target object and pushing the resources. According to the solution, scenario interaction graphs of a plurality of information flow scenarios are integrated, to construct a global scenario interaction graph, and modality bias and data bias existing in single-scenario modeling are eliminated, so that more complex high-order information between object nodes and resource nodes can be mined more comprehensively by using multi-scenario historical interaction data, thereby more accurately reflecting intrinsic connections between object nodes and resource nodes in a global scenario, and improving accuracy of mining user information flow preferences. Meanwhile, an initial scenario graph network is trained by using global object features and global resource features, to obtain a scenario graph network that can more accurately represent features of object nodes and resource nodes in a single scenario interaction graph, thereby improving prediction accuracy of subsequent resource push. In addition, multi-scenario joint modeling reduces a quantity of push systems that need to be maintained, reduces system complexity, and improves resource utilization.

[00305] Further, when the global scenario interaction graph is obtained by connecting the scenario interaction graphs, the electronic device acquires object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs, constructs at least one virtual object connection node according to the object description information, constructs at least one virtual resource connection node according to the resource description information, and connects the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node. The virtual object connection node and the virtual resource connection node establish association channels for object nodes and resource nodes in different scenario interaction graphs, thereby enabling information flow and sharing between different scenarios. This helps to break down single-scenario data silos and integrate multi-scenario data more effectively, which avoids information loss caused by single-scenario data bias, and improves a comprehensive representation capability of the global scenario interaction graph for multi-scenario information, thereby providing a better data basis for subsequent construction of more accurate global object features and global resource features.

[00306] Further, when the object description information includes object description tags of at least one dimension and tag values of the object nodes under the object description tags, the electronic device selects at least one target-object description tag from the object description tags, adds an object tag value range, and constructs a virtual object connection node based on this. In this manner, targeted node construction can be performed according to specific features of objects, so that the virtual object connection node can more accurately connect object nodes with similar features. By refining connection relationship between the object nodes, associations between the object nodes can be more clearly captured, which improves connection closeness and information transfer efficiency of the object nodes in the global scenario interaction graph, and helps to more accurately mine global features of the object nodes, thereby improving accuracy of resource push.

[00307] Further, if the resource description information includes resource description tags of at least one dimension and tag values of the resource nodes under the resource description tags, the electronic device selects at least one push-resource description tag from the resource description tags, adds a resource tag value range, and constructs a virtual resource connection node based on this. In this way, construction of the virtual resource connection node is associated with specific features of resources, and resource nodes having similar features can be more effectively connected. By strengthening the connections between the resource nodes, resource information can be better integrated, which improves information flowing of the resource nodes in the global scenario interaction graph, and helps to mine a potential relationship between the resource nodes, thereby

more accurately determining global features of the resource nodes and providing more accurate resource information for resource push.

[00308] Further, when connecting the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph, the electronic device acquires virtual object description information corresponding to the virtual object connection node and virtual resource description information corresponding to the virtual resource connection node in each scenario interaction graph, connects the virtual object connection nodes having the same virtual object description information, and connects the virtual resource connection nodes having the same virtual resource description information. This connection manner based on description information ensures that nodes having the same feature in different scenario interaction graphs can be accurately connected, so that the global scenario interaction graph can more accurately reflect commonalities and differences between multiple scenarios. Through such a precise connection, multi-scenario data can be more effectively integrated, which avoids errors and redundancy during connection, improves accuracy and effectiveness of the global scenario interaction graph, and provides a more reliable data basis for subsequent feature construction and model training.

[00309] Further, after acquiring the object description information corresponding to the object nodes and the resource description information corresponding to the resource nodes in the scenario interaction graph, the electronic device acquires an object node quantity corresponding to the object nodes and a resource node quantity corresponding to the resource nodes in the scenario interaction graph, determines, based on the object node quantity, a virtual object node construction quantity corresponding to the virtual object connection node in the scenario interaction graph, determines, based on the resource node quantity, a virtual resource node construction quantity corresponding to the virtual resource connection node in the scenario interaction graph, constructs the virtual object connection node according to the virtual object node construction quantity and the object description information, and constructs the virtual resource connection node according to the virtual resource node construction quantity and the resource description information. Such a manner of dynamically adjusting the virtual connection node construction quantity according to a quantity of nodes enables flexible processing according to actual data conditions of different scenario interaction graphs. For a scenario interaction graph with a relatively small quantity of object nodes or resource nodes, increasing the quantity of virtual connection nodes can improve a connection probability between the scenario and another scenario, enhance information exchange between different scenarios, and avoid information isolation caused by a small data volume, which ensures balanced integration of the global scenario interaction graph for each piece of scenario information

and improves adaptability and a processing capability of a model for different scenario data.

[00310] Further, when constructing the global object feature of each object node and the global resource feature of each resource node in the global scenario interaction graph, the electronic device performs data augmentation on the global scenario interaction graph to obtain a first augmented interaction graph and a second augmented interaction graph, determines positive sample pairs and negative sample pairs based on the first augmented interaction graph and the second augmented interaction graph, and determines the global object feature of each object node and the global resource feature of each resource node according to the positive sample pairs and the negative sample pairs. Data augmentation, by generating different augmented interaction graphs, increases diversity and richness of training data, so that the model can learn more different node features and interaction patterns. The use of the positive sample pair and the negative sample pair provides a clear learning target for the model, prompting the model to learn similar features of the same node in different augmented graphs and feature differences between different nodes. Through such contrastive learning, features of nodes can be more accurately captured, and accuracy and representativeness of global object features and global resource features are improved, thereby improving the model's capability to understand and predict user preferences.

[00311] Further, when the global scenario interaction graph includes a plurality of global object nodes, a plurality of global resource nodes, and historical interaction data between the global object nodes and the global resource nodes, the electronic device extracts at least one global object node from the plurality of global object nodes as an augmented object node, extracts at least one global resource node from the plurality of global resource nodes as an augmented resource node, selects, from the historical interaction data, historical interaction data between the augmented object node and the augmented resource node, to obtain augmented node interaction data, and generates a first augmented interaction graph and a second augmented interaction graph based on the augmented object node, the augmented resource node, and the augmented node interaction data. Such a manner of selecting some nodes and interaction data for data augmentation in a targeted manner can focus on key information, reduce interference from irrelevant data, and improve efficiency and effectiveness of data augmentation. By generating more representative augmented interaction graphs, node features and interaction relationships in the global scenario interaction graph can be more accurately reflected, providing better data support for determining global object features and global resource features.

[00312] Further, when generating the first augmented interaction graph and the second augmented interaction graph based on the augmented object node, the augmented resource node,

and the augmented node interaction data, the electronic device randomly extracts at least one augmented object node from the augmented object nodes as a first augmented object node, randomly extracts at least one augmented object node from the augmented object nodes as a second augmented object node, where the first augmented object node partially overlaps with the second augmented object node, randomly extracts at least one augmented resource node from the augmented resource nodes as a first augmented resource node, randomly extracts at least one augmented resource node from the augmented resource nodes as a second augmented resource node, where the first augmented resource node partially overlaps with the second augmented resource node, selects first augmented node interaction data between the first augmented object node and the first augmented resource node from the augmented node interaction data, selects second augmented node interaction data between the second augmented object node and the second augmented resource node from the augmented node interaction data, generates the first augmented interaction graph based on the first augmented object node, the first augmented resource node, and the first augmented node interaction data, and generates a second augmented interaction graph based on the second augmented object node, the second augmented resource node, and the second augmented node interaction data. The manner of randomly extracting nodes and partially overlapping increases randomness and diversity of the augmented interaction graphs, enabling the model to learn a wider range of node features and interaction patterns. Such diversity helps to avoid model overfitting and improve a generalization capability of the model, so that the model can more accurately predict features of nodes when facing different input data, thereby improving quality of global object features and global resource features.

[00313] Further, when determining the global object feature of each object node and the global resource feature of each resource node according to the positive sample pairs and the negative sample pairs, the electronic device acquires an initial first graph network corresponding to the first augmented interaction graph and an initial second graph network corresponding to the second augmented interaction graph, predicts, by using the initial first graph network, a predicted first feature of each augmented node in the first augmented interaction graph, predicts, by using the initial second graph network, a predicted second feature of each augmented node in the second augmented interaction graph, determines, based on the positive sample pairs, the negative sample pairs, the predicted first features, and the predicted second features, a first contrastive loss corresponding to the object nodes and a second contrastive loss corresponding to the resource nodes, converges the initial first graph network and the initial second graph network according to the first contrastive loss and the second contrastive loss, to obtain a first graph network and a second graph network, and determines, according to the first graph network and the second graph

network, the global object feature of each object node and the global resource feature of each resource node. By calculating the contrastive losses and converging the graph networks, the model can continuously adjust parameters, so that feature representations of the same node in different augmented graphs are closer, and feature differences between different nodes are more apparent. In this manner, features of nodes can be more accurately learned, which improves accuracy and representativeness of global object features and global resource features, thereby improving the model's capability to capture user preferences and accuracy of resource push.

[00314] Further, when training the initial scenario graph network corresponding to each scenario interaction graph according to the global object features and the global resource features to obtain the scenario graph network, the electronic device selects global object features corresponding to the object nodes in each scenario interaction graph from the global object features, to obtain scenario global object features, selects global resource features corresponding to the resource nodes in each scenario interaction graph from the global resource features, to obtain scenario global resource features, calculates predicted object features corresponding to the scenario global object features based on the initial scenario graph networks corresponding to the scenario interaction graphs, calculates predicted resource features corresponding to the scenario global resource features based on the initial scenario graph networks, calculates a first similarity between the predicted object features and the predicted resource features, to determine predicted interaction data between the object nodes and the resource nodes in the scenario interaction graphs, compares the predicted interaction data with the historical interaction data, and converges the initial scenario graph networks based on a comparison result, to obtain the scenario graph networks. Such a training manner combining global features and scenario historical interaction data can make full use of global information to fine-tune a single scenario. By comparing the predicted interaction data with the historical interaction data, deviations in the model's predictions can be found, to perform targeted adjustment on the initial scenario graph network, so that the scenario graph network can more accurately predict interaction preferences between the object nodes and the resource nodes, improving adaptability and accuracy of the scenario graph network for a single scenario, thereby improving an effect of resource push.

[00315] Further, during resource push, when receiving a resource push request for a target object, the electronic device detects a target information flow scenario in which the target object is currently located, selects a target scenario graph network corresponding to the target information flow scenario from the scenario graph networks, determines, based on the target scenario graph network, at least one push resource associated with the target object, and pushes the push resource to the target object. Such a manner of performing resource push according to a specific scenario in

which the target object is located can improve pertinence of resource push in consideration of characteristics and requirements of different scenarios. Resource filtering is performed by using the target scenario graph network, so that requirements of the target object can be more accurately matched, which avoids inaccurate pushing caused by using a general-purpose model in different scenarios, improving accuracy and effectiveness of resource push, and enhancing user experience.

[00316] Further, when determining at least one push resource associated with the target object based on the target scenario graph network, the electronic device determines a target-object feature corresponding to the target object, determines a scenario resource feature corresponding to each resource node in the target information flow scenario according to the target scenario graph network, and calculates, based on the target-object feature and the scenario resource feature, the at least one push resource associated with the target object. Accurately determining the target-object features and the scenario resource feature can provide a more precise basis for resource calculation. By calculating an association between the two, a resource matching a requirement of the target object can be more precisely selected, thereby improving accuracy and correlation of resource push, and enabling the pushed resource to better meet an actual requirement of a user.

[00317] Further, when determining the target-object feature corresponding to the target object, the electronic device acquires target description information of the target object and object description information corresponding to the object nodes included in the target information flow scenario, takes, if the object description information is the same as the target description information, the object node corresponding to the target object as a target-object node, determines a scenario object feature corresponding to the target-object node according to the target scenario graph network, and takes the scenario object feature as the target-object feature. Such a manner of acquiring the target-object feature by directly using the target scenario graph network can make full use of historical information and a training result of a scenario, thereby improving accuracy and efficiency of feature acquisition. By using the scenario object feature as the target-object feature, a feature of the target object in the current scenario can be more accurately reflected, and a more reliable basis is provided for subsequent resource push.

[00318] Further, after acquiring the target description information of the target object and the object description information corresponding to the object nodes included in the target information flow scenario, if the object description information is different from the target description information, the electronic device acquires global object description information corresponding to each global object node in the global scenario interaction graph, selects, from the global scenario interaction graph, a global object node corresponding to global object description information the

same as the target description information, to obtain a target global object node, and determines a scenario object feature corresponding to the target global object node based on a scenario graph network, to obtain the target-object feature of the target object. In this manner, the problem that the target object is not in the target information flow scenario is resolved, and by expanding a search range to the global scenario interaction graph, features of the target object can be accurately acquired in different scenarios. This enables the resource push system to adapt to a new scenario, which implements object-side and resource-side cold start, improves flexibility and applicability of the system, and expands coverage of resource push.

[00319] Further, when calculating, based on the target-object feature and the scenario resource feature, the at least one push resource associated with the target object, the electronic device calculates a second similarity between the target-object feature and the scenario resource feature, compares the second similarity with a preset similarity threshold, selects a push-resource node from the resource nodes in the target information flow scenario based on a comparison result, and takes a resource corresponding to the push-resource node as the push resource. By calculating the similarity and comparing the similarity with a threshold, a resource node matching the target-object feature can be objectively selected. This filtering manner can improve accuracy and relevance of resource push, avoid pushing irrelevant resources, and improve resource utilization, so that the pushed resource better meets the requirement of the target object.

[00320] The model training method, the resource push method, the device, the medium, and the computer program product provided in the embodiments of this application are described above in detail. Although the principles and implementations of this application are described by using specific examples herein, descriptions of the foregoing embodiments are merely intended to help understand the method of this application and core ideas thereof. Meanwhile, a person skilled in the art may make modifications to the specific implementations and application scopes according to the ideas of this application. In summary, the content of this specification is not to be construed as limiting this application. Technical features of the foregoing embodiments may be combined in different manners to form other embodiments. For brevity of description, not all possible combinations of the technical features in the foregoing embodiments are described. However, as long as combinations of the technical features do not contradict each other, the combinations fall within the scope described in this specification.

[00321] The foregoing embodiments only describe several implementations of this application, which are described specifically and in detail, and therefore cannot be construed as limiting the patent scope of the present disclosure. A person of ordinary skill in the art may further

make various modifications and improvements without departing from the concept of this application, all of which fall within the protection scope of this application. Therefore, the protection scope of the patent of this application shall be defined by the appended claims.

CLAIMS

1. A model training method, performed by an electronic device, comprising:

acquiring scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios;

connecting the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph;

constructing, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes; and

training initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object.

2. The model training method according to claim 1, wherein the connecting the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph comprises:

acquiring object description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs;

constructing, in the scenario interaction graphs, at least one virtual object connection node according to the object description information, the virtual object connection node being configured to connect object nodes having an association relationship with the virtual object connection node;

constructing, in the scenario interaction graphs, at least one virtual resource connection node according to the resource description information, the virtual resource connection node being configured to connect resource nodes having an association relationship with the virtual object connection node; and

connecting the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph.

3. The model training method according to claim 2, wherein the object description information

comprises object description tags of at least one dimension and tag values of the object nodes under the object description tags; and

the constructing, in the scenario interaction graphs, at least one virtual object connection node according to the object description information comprises:

selecting at least one target-object description tag from the object description tags, and adding an object tag value range to the target-object description tag; and

constructing, in the scenario interaction graphs, the at least one virtual object connection node based on the target-object description tag and the object tag value range, virtual object description information corresponding to the virtual object connection node comprising the target-object description tag and the object tag value range.

4. The model training method according to claim 2 or 3, wherein the resource description information comprises resource description tags of at least one dimension and tag values of the resource nodes under the resource description tags; and

the constructing, in the scenario interaction graphs, at least one virtual resource connection node according to the resource description information comprises:

selecting at least one push-resource description tag from the resource description tags, and adding a resource tag value range to the push-resource description tag; and

constructing, in the scenario interaction graphs, the at least one virtual resource connection node based on the push-resource description tag and the resource tag value range, virtual resource description information corresponding to the virtual resource connection node comprising the push-resource description tag and the resource tag value range.

5. The model training method according to any one of claims 2 to 4, wherein the connecting the scenario interaction graphs based on the virtual object connection node and the virtual resource connection node, to obtain the global scenario interaction graph comprises:

acquiring virtual object description information corresponding to the virtual object connection node and virtual resource description information corresponding to the virtual resource connection node in each scenario interaction graph; and

connecting virtual object connection nodes having the same virtual object description information, and connecting virtual resource connection nodes having the same virtual resource description information, to obtain the global scenario interaction graph.

6. The model training method according to any one of claims 2 to 5, after the acquiring object

description information corresponding to the object nodes and resource description information corresponding to the resource nodes in the scenario interaction graphs, further comprising:

acquiring an object node quantity corresponding to the object nodes and a resource node quantity corresponding to the resource nodes in the scenario interaction graphs;

determining, based on the object node quantity, a virtual object node construction quantity corresponding to the virtual object connection nodes in the scenario interaction graphs, and determining, based on the resource node quantity, a virtual resource node construction quantity corresponding to the virtual resource connection nodes in the scenario interaction graphs; and

constructing the virtual object connection nodes in the scenario interaction graphs according to the virtual object node construction quantity and the object description information, and constructing the virtual resource connection nodes in the scenario interaction graphs according to the virtual resource node construction quantity and the resource description information.

7. The model training method according to any one of claims 1 to 6, wherein the constructing, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes comprises:

performing data augmentation on the global scenario interaction graph to obtain a first augmented interaction graph and a second augmented interaction graph;

determining positive sample pairs and negative sample pairs based on the first augmented interaction graph and the second augmented interaction graph, the positive sample pairs comprising node pairs formed by same nodes in the first augmented interaction graph and the second augmented interaction graph, and the negative sample pairs comprising node pairs formed by different nodes in the first augmented interaction graph and the second augmented interaction graph; and

determining, according to the positive sample pairs and the negative sample pairs, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes.

8. The model training method according to claim 7, wherein the global scenario interaction graph comprises a plurality of global object nodes, a plurality of global resource nodes, and historical interaction data between the global object nodes and the global resource nodes; and

the performing data augmentation on the global scenario interaction graph to obtain a first augmented interaction graph and a second augmented interaction graph comprises:

extracting, from the plurality of global object nodes, at least one global object node as augmented object nodes, and extracting, from the plurality of global resource nodes, at least one global resource node as augmented resource nodes;

selecting, from the historical interaction data, historical interaction data between the augmented object nodes and the augmented resource nodes, to obtain augmented node interaction data; and

generating the first augmented interaction graph and the second augmented interaction graph based on the augmented object nodes, the augmented resource nodes, and the augmented node interaction data.

9. The model training method according to claim 8, wherein the generating the first augmented interaction graph and the second augmented interaction graph based on the augmented object node, the augmented resource node, and the augmented node interaction data comprises:

randomly extracting, from the augmented object nodes, at least one augmented object node as a first augmented object node, and randomly extracting, from the augmented object nodes, at least one augmented object node as a second augmented object node, the first augmented object node partially overlapping with the second augmented object node;

randomly extracting, from the augmented resource nodes, at least one augmented resource node as a first augmented resource node, and randomly extracting, from the augmented resource nodes, at least one augmented resource node as a second augmented resource node, the first augmented resource node partially overlapping with the second augmented resource node;

selecting, from the augmented node interaction data, first augmented node interaction data between the first augmented object node and the first augmented resource node, and selecting, from the augmented node interaction data, second augmented node interaction data between the second augmented object node and the second augmented resource node; and

generating the first augmented interaction graph based on the first augmented object node, the first augmented resource node, and the first augmented node interaction data, and generating the second augmented interaction graph based on the second augmented object node, the second augmented resource node, and the second augmented node interaction data.

10. The model training method according to claim 8 or 9, wherein the determining, according to the positive sample pairs and the negative sample pairs, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes comprises:

acquiring an initial first graph network corresponding to the first augmented interaction graph

and an initial second graph network corresponding to the second augmented interaction graph;

predicting, by using the initial first graph network, a predicted first feature of each augmented node in the first augmented interaction graph, the predicted first feature comprising a predicted first object feature of the first augmented object node and a predicted first resource feature of the first augmented resource node;

predicting, by using the initial second graph network, a predicted second feature of each augmented node in the second augmented interaction graph, the predicted second feature comprising a predicted second object feature of the second augmented object node and a predicted second resource feature of the second augmented resource node;

determining, based on the positive sample pairs, the negative sample pairs, the predicted first features, and the predicted second features, a first contrastive loss corresponding to the object nodes and a second contrastive loss corresponding to the resource nodes;

converging the initial first graph network and the initial second graph network according to the first contrastive loss and the second contrastive loss, to obtain a first graph network and a second graph network; and

determining, according to the first graph network and the second graph network, the global object feature of each of the object nodes and the global resource feature of each of the resource nodes.

11. The model training method according to any one of claims 1 to 10, wherein the training initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks comprises:

selecting, from the global object features, global object features corresponding to the object nodes in each of the scenario interaction graphs, to obtain scenario global object features, and selecting, from the global resource features, global resource features corresponding to the resource nodes in each of the scenario interaction graphs, to obtain scenario global resource features;

calculating, based on the initial scenario graph networks corresponding to the scenario interaction graphs, predicted object features corresponding to the scenario global object features, and calculating, based on the initial scenario graph networks, predicted resource features corresponding to the scenario global resource features;

calculating a first similarity between the predicted object features and the predicted resource features, to determine predicted interaction data between the object nodes and the resource nodes in

the scenario interaction graphs; and

comparing the predicted interaction data with the historical interaction data, and converging the initial scenario graph networks based on a comparison result, to obtain the scenario graph networks.

12. A resource push method, performed by an electronic device, comprising:

detecting, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located;

selecting, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks comprising graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, and the global scenario interaction graph being obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios; and

determining, based on the target scenario graph network, at least one push resource associated with the target object, and pushing the push resource to the target object.

13. The resource push method according to claim 12, wherein the determining, based on the target scenario graph network, at least one push resource associated with the target object comprises:

determining a target-object feature corresponding to the target object;

determining, according to the target scenario graph network, a scenario resource feature corresponding to each resource node in the target information flow scenario; and

calculating, based on the target-object feature and the scenario resource feature, the at least one push resource associated with the target object.

14. The resource push method according to claim 13, wherein the determining a target-object feature corresponding to the target object comprises:

acquiring target description information of the target object and object description information corresponding to the object nodes comprised in the target information flow scenario;

taking, if the object description information is the same as the target description information, the object node corresponding to the target object as a target-object node;

determining, according to the target scenario graph network, a scenario object feature

corresponding to the target-object node; and

taking the scenario object feature as the target-object feature.

15. The resource push method according to claim 14, after the acquiring target description information of the target object and object description information corresponding to the object nodes comprised in the target information flow scenario, further comprising:

acquiring, if the object description information is different from the target description information, global object description information corresponding to each global object node in the global scenario interaction graph;

selecting, from the global scenario interaction graph, a global object node corresponding to global object description information the same as the target description information, to obtain a target global object node; and

determining, based on the scenario graph network, a scenario object feature corresponding to the target global object node, to obtain the target-object feature of the target object.

16. The resource push method according to any one of claims 13 to 15, wherein the calculating, based on the target-object feature and the scenario resource feature, the at least one push resource associated with the target object comprises:

calculating a second similarity between the target-object feature and the scenario resource feature;

comparing the second similarity with a preset similarity threshold, and selecting, based on a comparison result, a push-resource node from the resource nodes in the target information flow scenario; and

taking a resource corresponding to the push-resource node as the push resource.

17. A model training apparatus, comprising:

an acquisition unit, configured to acquire scenario interaction graphs respectively corresponding to a plurality of information flow scenarios, the scenario interaction graphs being configured for indicating historical interaction data between a plurality of object nodes and a plurality of resource nodes in the information flow scenarios; the object nodes representing objects, and the resource nodes representing interactable resources provided for the objects in the information flow scenarios;

a connection unit, configured to connect the scenario interaction graphs based on the object nodes and the resource nodes, to obtain a global scenario interaction graph;

a construction unit, configured to construct, in the global scenario interaction graph, a global object feature of each of the object nodes and a global resource feature of each of the resource nodes;

a training unit, configured to train initial scenario graph networks corresponding to the scenario interaction graphs according to the global object features and the global resource features, to obtain scenario graph networks, the scenario graph networks being configured for determining push resources for a target object, to push the push resources to the target object.

18. A resource push apparatus, comprising:

a receiving unit, configured to detect, when a resource push request for a target object is received, a target information flow scenario in which the target object is currently located;

a filtering unit, configured to select, from scenario graph networks, a target scenario graph network corresponding to the target information flow scenario, the scenario graph networks comprising graph networks obtained by training an initial scenario graph network corresponding to each scenario interaction graph based on global object features and global resource features constructed based on a global scenario interaction graph, and the global scenario interaction graph being obtained by connecting scenario interaction graphs corresponding to a plurality of information flow scenarios; and

a push unit, configured to: determine, based on the target scenario graph network, at least one push resource associated with the target object, and push the push resource to the target object.

19. An electronic device, comprising a processor and a memory, the memory storing an application program, and the processor being configured to run the application program in the memory to perform operations in the model training method according to any one of claims 1 to 11 and in the resource push method according to any one of claims 12 to 16.

20. A computer program product, comprising a computer program/instruction, the computer program/instruction, when executed by a processor, implementing operations in the model training method according to any one of claims 1 to 11 and in the resource push method according to any one of claims 12 to 16.

21. A computer-readable storage medium, the computer-readable storage medium storing a plurality of instructions, the instructions being adapted to be loaded by a processor to perform operations in the model training method according to any one of claims 1 to 11 and in the resource push method according to any one of claims 12 to 16.