

MODEL TRAINING METHOD, CONTENT RANKING METHOD, APPARATUS AND ELECTRONIC DEVICE

The present application claims the priority to a Chinese patent application No. 202311638415.7 filed with the China National Intellectual Property Administration on December 01, 2023 and entitled “MODEL TRAINING METHOD, CONTENT RANKING METHOD, APPARATUS AND ELECTRONIC DEVICE”, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates to the technical field of computer application, specifically to the field of data processing, artificial intelligence and so on, and in particular to a model training method, content ranking method, apparatus and electronic device.

BACKGROUND

With the rapid development of digitalized entertainment media, more and more users tend to watch items of content such as movies or videos online. When watching items of content such as movies or videos online, since users are faced with a large amount of items of content to watch, they need to select the item of content they want to watch before they can watch it.

In related technologies, in the scenario of recommending an item of content to users, current hot items of content are mainly recommended to the users, or items of content are recommended to the users through traditional recommendation algorithms. However, the current hot item of content may not seem interesting to the users. The traditional recommendation algorithms mainly rely on the user's interest preferences, which are targeted at the general public. Therefore, the related technologies cannot accurately determine the points of interest of users for different users, resulting in that the recommended front-end page will frequently display items of content that the user is not interested in, making it difficult to achieve accurate recommendation of items of content.

SUMMARY

An objective of embodiments of the present disclosure is to provide a model training

method, a content ranking method, apparatus and electronic device, so as to quickly and accurately recommend items of content that a user would like to watch. Specific technical solutions are as follows:

In a first aspect of embodiments of the present disclosure, a model training method is provided. The method is applied to an electronic device that performs model training and includes:

obtaining a first attribute characteristic of a first item of content to be ranked, a negative feedback characteristic of a negatively-marked item of content corresponding to a user, and a user characteristic of the user;

obtaining a ground-truth label corresponding to the first item of content to be ranked, wherein the ground-truth label includes an interest level value of the first item of content to be ranked;

inputting the first attribute characteristic, the negative feedback characteristic and the user characteristic into a ranking model for predictive ranking, to obtain a ranking result corresponding to the first item of content to be ranked; and

calculating a loss between the ranking result and the ground-truth label, and adjusting parameters of the ranking model based on the loss.

In a possible implementation, the negative feedback characteristic includes at least one of content type, content name, and content producer.

In a second aspect of embodiments of the present disclosure, a content ranking method is provided. The method is applied to a server that performs ranking services and includes:

obtaining a ranking request, wherein the ranking request includes a target user identifier and an identifier of a target negatively-marked item of content, and the target negatively-marked item of content is determined by a client corresponding to the target user identifier based on a received selection instruction for a target item of content in items of content that have been recommended;

obtaining a target negative feedback characteristic corresponding to the target negatively-marked item of content according to the identifier of the target negatively-marked item of content;

for each of second items of content to be ranked, extracting a second attribute characteristic of the second item of content to be ranked;

inputting the second attribute characteristic, the target negative feedback characteristic and a target user characteristic corresponding to the target user into a ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked, wherein, the ranking model is trained with the method according to claim 1 or 2;

ranking the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content; and

sending the target recommended items of content to a client, such that the client displays the target recommended items of content.

In a possible implementation, the method further includes:

obtaining an acquisition request sent by the client for the target recommended items of content, wherein the acquisition request is determined by the client based on the items of content that have been recommended; and

in response to the acquisition request, executing operations of: based on the identifier of the target negatively-marked item of content, obtaining the target negative feedback characteristic corresponding to the identifier of the target negatively-marked item of content; extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked; and inputting the second attribute characteristic, the target negative feedback characteristic and the target user characteristic corresponding to the target user into the ranking model for predictive ranking, to obtain the predicted ranking result of the second item of content to be ranked.

In a possible implementation, extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked, includes:

determining items of content to be recommended that have not been sent to the client as the second items of content to be ranked; and

for each of the second items of content to be ranked, extracting the second attribute characteristic of the second item of content to be ranked.

In a possible implementation, extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked, includes:

determining all recalled items of content as the second items of content to be ranked, wherein the recalled items of content are items of content to be recommended which are obtained from a content database by the server in response to a content acquisition request sent by the client; and

for each of the second items of content to be ranked, extracting the second attribute characteristic of the second item of content to be ranked.

In a possible implementation, the negatively-marked item of content includes a negatively-marked item of content in historical recommended items of content from the client corresponding to the target user identifier, or an item of content determined in real time by the client corresponding to the target user identifier based on the received selection instruction for the target item of content in the items of content that have been recommended.

In a third aspect of embodiments of the present disclosure, a model training apparatus is provided. The apparatus is applied to an electronic device that performs model training, and includes:

a first obtaining module, configured to obtain a first attribute characteristic of a first item of content to be ranked, a negative feedback characteristic of a negatively-marked item of content corresponding to a user, and a user characteristic of the user;

a second obtaining module, configured to obtain a ground-truth label corresponding to the first item of content to be ranked, wherein the ground-truth label includes an interest level value of the first item of content to be ranked;

a predicting module, configured to input the first attribute characteristic, the negative feedback characteristic and the user characteristic into a ranking model for predictive ranking, to obtain a ranking result corresponding to the first item of content to be ranked; and

a training module, configured to calculate a loss between the ranking result and the ground-truth label, and adjust parameters of the ranking model based on the loss.

In a fourth aspect of embodiments of the present disclosure, a content ranking apparatus is provided. The apparatus is applied to a server that performs ranking services, and includes:

a third obtaining module, configured to obtain a ranking request, wherein the ranking request includes a target user identifier and an identifier of a target negatively-marked item of content, and the target negatively-marked item of content is determined by a client corresponding to the target user identifier based on a received selection instruction for a target item of content in items of content that have been recommended;

a fourth obtaining module, configured to obtain a target negative feedback characteristic corresponding to the target negatively-marked item of content according to the identifier of the target negatively-marked item of content;

a characteristic extracting module, configured to extract, for each of second items of content to be ranked, a second attribute characteristic of the second item of content to be ranked;

a predictive ranking module, configured to input the second attribute characteristic, the target negative feedback characteristic, and a target user characteristic corresponding to the target user into a ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked, wherein, the ranking model is trained with the method according to claim 1 or 2;

a content ranking module, configured to rank the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content; and

a content sending module, configured to send the target recommended items of content to a client, such that the client displays the target recommended items of content.

In yet another aspect of embodiments of the present disclosure, an electronic device is provided. The electronic device includes a processor, a communication interface, a memory and a communication bus, wherein the processor, the communication interface and the memory communicate with each other via the communication bus;

the memory is configured to store a computer program;

the processor is configured to carry out, when executing the program stored in the memory, any of the above-mentioned methods.

In yet another aspect of embodiments of the present disclosure, a computer readable storage medium is provided. A computer program is stored on the computer readable storage medium,

and the computer program, when executed by a processor, carries out any of the above-mentioned methods.

In yet another aspect of embodiments of the present invention, a computer program product containing instructions is also provided, which, when run on a computer, causes the computer to carry out any of the above methods.

With the model training method, content ranking method, apparatus and electronic device provided by the embodiments of the present disclosure, the ranking model is trained by using the first attribute characteristic of the first item of content to be ranked, the negative feedback characteristic of the negatively-marked item of content corresponding to the user and the user characteristic as inputs, and using the ground-truth label containing the interest level value of the first item of content as an output. The ranking model trained in the embodiments of the present disclosure integrates the attribute characteristic of the first item of content to be ranked, the negative feedback characteristic of the negatively-marked item of content corresponding to the user, and the user characteristic, such that when respective first items of content to be ranked are ranked by the trained ranking model, the item of content that has been ranked to be on top is allowed to be more aligned with the item of content that the user is interested in. Therefore, it enables the change of the order of the item of content that the user is not interested in, improves the probability of prioritizing the display of the item of content that the user is interested in, improves the display efficiency of the front-end content display page, and improves the matching accuracy between the displayed item of content and the user's points of interest, thereby enabling the item of content that the user wants to watch to be recommended quickly and accurately.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to illustrate the technical solutions in embodiments of the present disclosure or the prior art more clearly, the drawings needed to describe the embodiments or the prior art will be briefly introduced below.

Fig. 1 is a schematic flow chart of a model training method in an embodiment of the present disclosure;

Fig. 2 is a schematic flow chart of a content ranking method in an embodiment of the

present disclosure;

Fig. 3 is a schematic diagram of a content ranking method in an embodiment of the present disclosure;

Fig. 4 is a schematic diagram of a content ranking implementation process in an embodiment of the present disclosure;

Fig. 5 is a schematic structure diagram of a model training apparatus in an embodiment of the present disclosure;

Fig. 6 is a schematic structure diagram of a content ranking apparatus in an embodiment of the present disclosure;

Fig. 7 is a schematic diagram of an electronic device in an embodiment of the present disclosure.

DETAILED DESCRIPTION

The technical solutions in embodiments of the present disclosure will be described below with reference to the accompanying drawings in the embodiments of the present disclosure.

In related technologies, searching for an item of content that a user wants to watch through a search engine requires the user to provide a clear goal or interest. If the user does not have a clear goal or interest, the user often needs to spend a lot of time and energy to search massive amounts of items of content and select the item of content that the user wants to watch, which results in a low user recommendation accuracy.

In order to quickly and accurately recommend an item of content that the user wants to watch, embodiments of the present disclosure provide a model training method, a content ranking method, an apparatus, and an electronic device. The model training method and content ranking method provided by the embodiments of the present disclosure are suitable for content recommendation scenarios, especially for content recommendation scenarios where all users do not have clear goals or interests. The content ranking method provided by the embodiments of the present disclosure may be targeted at the items of content such as videos, movies, novels, games, commodities, or the like.

First, the model training method provided by an embodiment of the present disclosure is introduced in detail below:

As shown in Fig. 1, Fig. 1 is a schematic flow chart of a model training method in an embodiment of the present disclosure. The method is applied to an electronic device that performs model training and includes the following steps:

S101: obtaining a first attribute characteristic of a first item of content to be ranked, a negative feedback characteristic of a negatively-marked item of content corresponding to a user, and a user characteristic of the user.

S102: obtaining a ground-truth label corresponding to the first item of content to be ranked.

wherein, the ground-truth label includes an interest level value of the first item of content to be ranked.

S103. inputting the first attribute characteristic, the negative feedback characteristic and the user characteristic into a ranking model for predictive ranking, to obtain a ranking result corresponding to the first item of content to be ranked.

S104: calculating a loss between the ranking result and the ground-truth label, and adjusting parameters of the ranking model based on the loss.

Applying the model training method provided by the embodiment of the present disclosure, the ranking model is trained by using the first attribute characteristic of the first item of content to be ranked, the negative feedback characteristic of the negatively-marked item of content corresponding to the user and the user characteristic as inputs, and using the ground-truth label including the interest level value of the first item of content to be ranked as an output. The trained ranking model integrates the attribute characteristic of the first item of content to be ranked, the negative feedback characteristic of the negatively-marked item of content corresponding to the user and the user characteristic, so that when respective first items of content to be ranked are ranked by the trained ranking model, the item of content that has been ranked to be on top is allowed to be more aligned with the item of content that the user is interested in. Therefore, it enables the change of the order of the item of content that the user is not interested in, improves the probability of prioritizing the display of the item of content that the user is interested in, improves the display efficiency of the front-end content display page,

and improves the matching accuracy between the displayed item of content and the user's points of interest, thereby enabling the content that the user wants to watch to be recommended quickly and accurately.

The above-mentioned training process of the ranking model can be completed offline or online in real time. Corresponding to the online real-time training of the ranking model, the obtained negative feedback characteristic of the negatively-marked item of content corresponding to the user can be obtained through extracting the negative feedback characteristic from the negatively-marked item of content fed back in real time by the client corresponding to the user, or can be sent by a server after extracting the negative feedback characteristic based on the negatively-marked item of content fed back in real time feedback by the client corresponding to the user.

The above-mentioned first item of content to be ranked can be any item of content that needs to be ranked. For example, it may be an item of content that has been recalled but has not been ranked in the content database, or it may be an item of content that has been ranked but has not been sent to the client for display in a content recommendation pool. The negatively-marked item of content corresponding to the user indicates the item of content that the user is not interested in or dislikes.

When there is multiple negatively-marked items of content corresponding to the user, the negative feedback characteristic of the negatively-marked item of content corresponding to the user is the union of characteristics of the multiple negatively-marked items of content.

In an example, the first attribute characteristic of the first item of content to be ranked obtained in step S101 may include: content ID (identifier), content type, or the like. The content ID can be represented by a number or a code, or can be the name of the item of content. The content type can be, for example, TV series, movies, children's entertainment, variety entertainment shows, comedy movies, horror movies, costume dramas or modern dramas, or the like. The user characteristic of the user may include: user ID, age, gender, and VIP (Very Important Person) attributes of the user, or the like.

In a possible implementation, the negative feedback characteristic of the negatively-marked item of content may include at least one of content type, content name and content producer. As an example, the content producer may be a person who uploads the item of content, a content

writer, or the like. The user corresponding to the negative feedback characteristic of the negatively-marked item of content and the user corresponding to the user characteristic should be a same user.

As an example, in step S102, in addition to the interest level value of the first item of content to be ranked, the ground-truth label may further include a clicking rate, like rate, viewing rate, or the like of the first item of content to be ranked.

For each first item of content to be ranked, the first attribute characteristic of the first item of content to be ranked, the negative feedback characteristic corresponding to the user, and the user characteristic are used as inputs of the ranking model, and the ranking result of the first item of content to be ranked is predicted, to obtain the ranking result corresponding to the first item of content to be ranked, and then the loss between the ranking result and the ground-true label is calculated. The parameters of the ranking model are adjusted according to the loss until a preset termination condition is satisfied, thus obtaining the trained ranking model.

The preset termination condition may be a preset number of iterations, or may be that the loss reaches a preset loss threshold, or the like.

Referring to Fig. 2, Fig. 2 is a schematic flow chart of a content ranking method in an embodiment of the present disclosure, which method is applied to a server that performs ranking services and includes the following steps:

S201, obtaining a ranking request.

The server that performs ranking services obtains the ranking request from a client. The ranking request includes a target user identifier and an identifier of a target negatively-marked item of content. The target user identifier is the identifier of a target user corresponding to the client. The target negatively-marked item of content is determined by the client corresponding to the target user identifier based on a received selection instruction for a target item of content in items of content that have been recommended. Specifically, the client displays the recommended items of content, that is, the items of content that have been recommended, to the target user, and prompts the target user to select the item of content that he is not interested in or dislikes. When the target user clicks on the target item of content that he is not interested in or dislikes in the items of content that have been recommended, the client determines the target negatively-marked item of content based on the received selection instruction from the target user for the target item

of content in the items of content that have been recommended, and then when the client sends the ranking request to the server, the ranking request carries the identifier of the target negatively-marked item of content.

In an application scenario, the client recommends items of content to the target user for the first time. It starts the search engine, and triggers the sending of the ranking request to the server. The ranking request contains the target user identifier and the identifier of the target negatively-marked item of content. The target negatively-marked item of content includes: a negatively-marked item of content in historical recommended items of content from the client corresponding to the target user identifier. The negatively-marked item of content in the historical recommended items of content from the client is specifically the item of content that the target user is not interested in or dislikes in the historical recommended items of content from the client.

In another application scenario, the client recommends items of content to the target user in real time. The target user selects an item of content that he is not interested in or dislikes for the items of content currently recommended by the client and feeds it back to the server in real time, triggering the sending of the ranking request to the server. The target negatively-marked item of content corresponding to the identifier of the target negatively-marked item of content included in the ranking request includes: the item of content determined by the client corresponding to the target user identifier in real time based on the received selection instruction for the target item of content in items of content that have been recommended.

S202: obtaining a target negative feedback characteristic corresponding to the target negatively-marked item of content according to the identifier of the target negatively-marked item of content.

The characteristic of the target negatively-marked item of content corresponding to the identifier of the target negatively-marked item of content is extracted, to obtain the target negative feedback characteristic. The target negative feedback characteristic may include at least one of content type, content name, and content producer. When there are multiple target negatively-marked items of content, the target negative feedback characteristic is the union of characteristics of the multiple target negatively-marked items of content.

The target negatively-marked item of content is usually the item of content that the user is

not interested in or dislikes. Extracting the characteristic of the target negatively-marked item of content corresponding to the identifier of the target negatively-marked item of content can collect the negative feedback characteristic of the user, thus overcoming the technical defects in prior art that the negative feedback characteristic of a user cannot be collected.

S203: for each of second items of content to be ranked, extracting a second attribute characteristic of the second item of content to be ranked.

The second item of content to be ranked is the item of content that currently needs to be ranked. The second item of content to be ranked may be the item of content that has been recalled but has not been ranked in the content database, or may be the item of content that has been ranked but has not been sent to the client for display in the content recommendation pool.

The second attribute characteristic of the second item of content to be ranked may include content ID, content type, or the like. The content ID can be represented by a number or a code, or can be the name of the item of content. The content type can be, for example, TV series, movies, children's entertainment, variety entertainment shows, comedy movies, horror movies, costume dramas or modern dramas, or the like.

S204: inputting the second attribute characteristic, the target negative feedback characteristic and a target user characteristic corresponding to the target user into a ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked.

The ranking request contains the target user identifier. According to the target user identification, the target user characteristic corresponding to the target user can be obtained. The target user characteristic may include the user ID, age, gender, and VIP attribute of the target user, or the like. As an example, a table of correspondence relationships between user identifiers and user characteristics is stored in the server in advance. Then, when obtaining the ranking request, the server can directly read the table of correspondence relationships between user identifiers and user characteristics to obtain the target user characteristic corresponding to the target user. The table of correspondence relationships between user identifiers and user characteristics can also be stored in a characteristic database. When obtaining the ranking request, the server can read the table of correspondence relationships between user identifiers and user characteristics stored in the characteristic database to obtain the target user characteristic corresponding to the target user.

For each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked, the target negative feedback characteristic corresponding to the target user and the target user characteristic are spliced and inputted into the ranking model for predictive ranking, obtaining the predicted ranking result of the second item of content to be ranked. The ranking model is trained with the method of the embodiment shown in Fig. 1. The predicted ranking result includes the interest level value of the second item of content to be ranked.

S205: ranking the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content.

The second items of content to be ranked are ranked in ascending or descending order according to the predicted ranking result of each of the second items of content to be ranked, to obtain the target recommended items of content.

S206: sending the target recommended items of content to the client, so that the client displays the target recommended items of content.

In an example, all the target recommended items of content can be sent to the client. Alternatively, the number of target recommended items of content to be sent to the client can be determined based on the display capability of the client.

With applying the content ranking method provided by the embodiment of the present disclosure, the second attribute characteristic of the second item of content to be ranked, the target negative feedback characteristic of the target negatively-marked item of content corresponding to the target user and the target user characteristic are integrated and inputted into the ranking model predictive ranking, wherein the ranking model has been trained by integrating the content attribute characteristic, the negative feedback characteristic of the negatively-marked item of content corresponding to the user and the user characteristic. Therefore, when the second items of content to be ranked are ranked, the item of content that has been ranked to be on top is allowed to be more aligned with the item of content that the user is interested in. Therefore, it enables the change of the order of the items of content that the user is not interested in, improves the probability of prioritizing the display of the item of content that the user is interested in, improves the display efficiency of the front-end content display page, and improves the matching

accuracy between the displayed item of content and the points of interest of the user, thereby enabling the content that the user would like to watch to be recommended quickly and accurately.

In a possible implementation, the content ranking method shown in Fig. 2 can also include:

obtaining an acquisition request sent by the client for the target recommended items of content, wherein the acquisition request is determined by the client based on the items of content that have been recommended;

in response to the acquisition request, performing operations of obtaining the target negative feedback characteristic corresponding to the target negatively-marked item of content based on the identifier of the target negatively-marked item of content, extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked, and inputting the second attribute characteristic, the target negative feedback characteristic and the target user characteristic corresponding to the target user into the ranking model for predictive ranking, to obtain the predicted ranking result of the second items of content to be ranked.

In an example, after the client displays a first screen or a batch of recommended item of content to the target user, if the number of items of content clicked by the target user, which he is not interested in or dislikes, among the items of content that have been recommended by the client reaches a certain number, the client sends the acquisition request for the target recommended items of content to the server. The acquisition request may include the target user identifier and the identifier of the target negatively-marked item of content. In response to the acquisition request, the server triggers a procedure for re-ranking the second items of content to be ranked, and executes the above steps S202 to S206. As an example, the certain amount can be set according to actual needs, for example, the certain amount can be one-third, one-half, or two-thirds of the items of content that have been recommended by the client.

In response to the acquisition request for the target recommended items of content sent by the client, the server integrates the target negative feedback characteristic of the target negatively-marked item of content corresponding to the target user and the target user characteristic, and re-ranks the second items of content to be ranked, such that the target recommended items of content sent to the client again change the order of the item of content

that the user is not interested in, improves the probability of prioritizing the display of the item of content that the user is interested in, thereby enabling the items of content that the user would like to watch to be quickly and accurately recommended to the user.

In a possible implementation, the above step S203 of extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked includes: determining items of content to be recommended that have not been sent to the client as the second items of content to be ranked; extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked.

In the embodiments of the present disclosure, when the client recommends items of content to the target user and feeds back the identifier of the target negatively-marked item of content to the server in real time, the server can determine the items of content to be recommended that have not been sent to the client as the second item of content to be ranked, wherein the items of content to be recommended that have not been sent to the client may be newly recalled and un-ranked items of content to be recommended, or may be items of content to be recommended which have been recalled and ranked but have not been sent to the client; extract the second attribute characteristic of each of the second items of content to be ranked; integrate the target negative feedback characteristic of the target negatively-marked item of content corresponding to the target user and the target user characteristic; and re-rank the second items of content to be ranked without the need to re-rank all of the recalled items of content to be ranked, thus reducing the workload of content ranking and saving computing resources on the server.

In another possible implementation, the above step S203 of extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked includes: determining all recalled items of content as the second items of content to be ranked, wherein the recalled items of content are items of content to be recommended which are obtained from a content database by the server in response to a content acquisition request sent by the client; and for each of the second items of content to be ranked, extracting the second attribute characteristic of the second item of content to be ranked.

In scenarios such as the first-screen recommendation after a content recommendation application and system startup, refresh operations after restarting due to factors such as power

outages and failures, and the reception of search instructions to search for items of content to be recommended, the client needs to obtain the items of content to be recommended. At this time, the client can send a content acquisition request to the server. In response to the content acquisition request, the server recalls relevant items of content from the massive items of content and stores the relevant items of content in the content database. All the items of content stored in the content database are the recalled items of content. The server determines all the recalled items of content as the second items of content to be ranked, and extracts the second attribute characteristic of each of the second items of content to be ranked, and further integrates the target negative feedback characteristic of the target negatively-mark item of content corresponding to the target user and the target user characteristic, and ranks the second items of content to be ranked to obtain the target recommended items of content which will be recommended to the client.

The server determines all the recalled items of content as the second items of content to be ranked, integrates the target negative feedback characteristic of the target negatively-marked item of content corresponding to the target user and the target user characteristic, and re-ranks the second items of content to be ranked, enabling to recommend target recommended items of content that is more aligned with the client's point of interest.

As an example, taking the above model training method is implemented offline as an example, as shown in Fig. 3, the implementation process of the content ranking method in the embodiment of the present disclosure may include the following steps:

Step 1. sending, by the client, a ranking request to the server;

wherein, the ranking request includes a target user identifier and an identifier of a first target negatively-marked item of content, and the first target negatively-marked item of content is a negatively-marked content in the historical recommended items of content from the client corresponding to the target user identifier.

Step 2: in response to the ranking request sent by the client, by the server, obtaining a first target negative feedback characteristic corresponding to the first target negatively-marked item of content according to the identifier of the first target negatively-marked item of content; and determining all the recalled items of content as the second items of content to be ranked; extracting, for each of second items of content to be ranked, a second attribute characteristic of

the second item of content to be ranked; inputting the second attribute characteristic of the second item of content to be ranked, the first target negative feedback characteristic and the target user characteristic corresponding to the target user into the ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked; ranking the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content; and sending the target recommended items of content to the client;

wherein, the ranking model is trained offline with the first attribute characteristic of the first item of content to be ranked, the negative feedback characteristic of the negatively-marked item of content corresponding to the user and the user characteristic, as well as the ground-truth label corresponding to the first item of content to be ranked.

Step 3: by the client, displaying the target recommended items of content, receiving a selection instruction from the target user for the target item of content in the displayed target recommended items of content; removing the target item of content from the displayed target recommended items of content; and sending an acquisition request for the target recommended items of content to the server;

wherein, the acquisition request includes the target user identifier and an identifier of a second target negatively-marked item of content, and the second target negatively-marked item of content is the target item of content.

In actual application scenarios, the number of items of content that can be displayed in a current view displayed to the user by the client, is limited, and respective target recommended items of content can be displayed through scrolling. As an example, after obtaining the target recommended items of content sent by the server, the client can display a target number of items of content in the target recommended items of content, and output a prompt message to prompt the target user to select and delete an item of content that he is not interested in or dislikes. The client converts respective displayed target recommended items of content into an editable state, receives a selection instruction from the target user for the target item of content in the respective displayed target recommended items of content, and removes the target item of content from the respective displayed target recommended items of content. The target number can be set according to actual needs, for example, it can be 6, 9, or 12, or the like. Of course, the target

number can also be greater than the number of items of content that can be displayed in the current view.

In the embodiments of the present disclosure, a mode of selecting an item of content that the user is interested in from a large amount of items of content by the user is converted into a mode of removing an item of content that the user is not interested in, which can improve the user's freedom of selection.

In an example, in order to reduce the data processing workload when the server re-ranks the respective second items of content to be ranked, the client can store the target item of content selected by the target user in a negative feedback queue. When the number of the target items of content in the negative feedback queue reaches a certain number, the client sends the acquisition request for the target recommended items of content to the server.

Step 4: in response to the acquisition request sent by the client, by the server, obtaining the second target negative feedback characteristic corresponding to a second target negatively-marked item of content based on the identifier of the second target negatively-marked item of content; determining the items of content to be recommended that have not been sent to the client as the second items of content to be ranked; extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked; inputting the second attribute characteristic of the second item of content to be ranked, the second target negative feedback characteristic and target user characteristic corresponding to the target user into the ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked; ranking the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content; and sending the target recommended items of content to the client.

Step 5: displaying, by the client, the target recommended items of content.

As an example, taking the above model training method is implemented online as an example, the implementation process of the content ranking method in the embodiment of the present disclosure may include the following steps:

Step A: sending, by the client, a ranking request to the server, wherein the ranking request includes a target user identifier and an identifier of a first target negatively-marked item of

content, and the first target negatively-marked item of content is a negatively-marked item of content in the historical recommended items of content from the client corresponding to the target user identifier.

Step B. in response to the ranking request sent by the client, by the server, obtaining a first target negative feedback characteristic corresponding to the first target negatively-marked item of content based on the identifier of the first target negatively-marked item of content, and sending the first target negative feedback characteristic and the target user identifier to an electronic device that performs model training;

Step C: by the electronic device that performs model training, obtaining the first attribute characteristic of the first item of content to be ranked, the first target negative feedback characteristic and the target user characteristic corresponding to the target user identifier, and obtaining a ground-truth label corresponding to the first item of content to be ranked, wherein the ground-truth label includes the interest level value of the first item of content to be ranked; inputting the first attribute characteristic, the first target negative feedback characteristic and the target user characteristic into the ranking model for prediction ranking, to obtain a ranking result corresponding to the first item of content to be ranked; calculating a loss between the ranking result and the ground-truth label; and adjusting parameters of the ranking model based on the loss, to obtain the trained ranking model;

Step D. by the server, determining all the recalled items of content as second items of content to be ranked; extracting, for each of the second items of content to be ranked, a second attribute characteristic of the second item of content to be ranked, inputting the second attribute characteristic of the second item of content to be ranked, the first target negative feedback characteristic and the target user characteristic corresponding to the target user into the trained ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked; ranking the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content; and sending the target recommended items of content to the client;

Step E. by the client, displaying the target recommended items of content; receiving a selection instruction from the target user for the target item of content in the displayed respective target recommended items of content; removing the target item of content from the displayed

respective target recommended items of content; and sending an acquisition request for the target recommended items of content to the server, wherein the acquisition request includes the target user identifier and an identifier of a second target negatively-marked item of content; wherein the second target negatively-marked item of content is the target item of content;

Step F. in response to the acquisition request sent by the client, by the server, obtaining a second target negative feedback characteristic corresponding to the second target negatively-marked item of content based on the identifier of the second target negatively-marked item of content; sending the second target negative feedback characteristic and the target user identifier to the electronic device that performs model training;

Step G. by the electronic device that performs model training, acquiring the second target negative feedback characteristic; updating the trained ranking model by combining the second target negative feedback characteristic, the second target negative feedback characteristic, the first attribute characteristic of the first item of content to be ranked, the target user characteristic corresponding to the target user identifier, and the ground-truth label corresponding to the first item of content to be ranked; wherein the implementation of step G can refer to step C, which differs from step C in the content of the negative feedback characteristic;

Step H: by the server, determining the items of content to be recommended that have not been sent to the client as the second items of content to be ranked; extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked; and inputting the second attribute characteristic of the second item of content to be ranked, the second target negative feedback characteristic and the target user characteristic corresponding to the target user into the ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked; re-ranking the second items of content to be ranked, to obtain the target recommended items of content; and sending the target recommended items of content to the client;

Step I: displaying, by the client, the target recommended items of content.

As an example, referring to Fig. 4, Fig. 4 is a schematic diagram of a content ranking implementation process in an embodiment of the present disclosure. As an example, the server contains 100 target recommended items of content, and the 100 target recommended items of content are stored in a candidate list LC in the order of 1-100. The server sends to the client the

first 9 target recommended items of content in the target recommended items of content for display to a target user. The 9 target recommended items of content displayed by the client are represented by a recommended content list L , $L=[V1, V2, V3, V4, V5, V6, V7, V8, V9]$.

The client outputs a prompt message to prompt the target user to select and delete the item of content that he is not interested in or dislikes; converts each target recommended item of content in the displayed target recommended items of content (i.e., the recommended content list L) into an editable state; and receives a selection instruction from the target user for the target item of content from the displayed respective target recommended items of content, and removes the target item of content from the target recommended items of content (removing the item of content in Fig. 4). For example, the removed target items of content are $V9, V2, V5$ and $V6$. Correspondingly, the recommended content List $L=[V1, V3, V4, V7, V8]$. The target items of content are added to the negative feedback queue NL , $NL=[V9, V2, V5, V6]$. When the number of target items of content in the negative feedback queue reaches a certain amount, the client sends the acquisition request for the target recommended items of content to the server. The acquisition request includes the target user identifier and the identifiers of the target contents.

In response to the acquisition request sent by the client, the server extracts the target negative feedback characteristic of each of the target items of content in the negative feedback queue (real-time analysis in Fig. 4) according to the identifiers of the target items of content to obtain the negative feedback characteristic NF , and sends the negative feedback characteristic NF and the target user identifier to the electronic device that performs model training. As an example, when the server receives an acquisition request sent by the client that contains the target user identifier and the identifiers of the target item of contents, the server can directly extract the target negative feedback characteristic of each of the target items of content in the negative feedback queue based on the identifiers of the target item of contents, and can also search for the historical negative feedback characteristic corresponding to the negatively-marked items of content marked by the target user in different clients according to the target user identifier. For example, the current target user logs in to the client in country A. Through interaction with the client, the client feeds back to the server the identifiers of the target items of content that the target user clicked when logging in in country A. The server extracts the target negative feedback characteristic of each of the target items of content and simultaneously obtains the historical negative feedback characteristic corresponding to the identifiers of the historical

negatively-marked items of content that the target user clicked when logging into the client in country B in the past. The server sends the obtained target negative feedback characteristic currently fed back in real time from the client and the synchronously obtained historical negative feedback characteristic to the electronic device that performs model training for training of the ranking model. When the second items of content to be ranked is re-ranked later, not only the target negative feedback characteristic currently fed back by the target user in real time is integrated, but also the historical negative feedback characteristic of the target user is integrated, such that the item of content recommended to the target user is more aligned with the target user's points of interest.

The electronic device that performs model training obtains the negative feedback characteristic NF, and trains the ranking model by combining the negative feedback characteristic NF, the first attribute characteristic of the first item of content to be ranked, the target user characteristic corresponding to the target user identifier, and the ground-truth label corresponding to the first item of content to be ranked (content recommendation strategy in Fig. 4).

For each of the second items of content to be ranked (candidate list LC in Fig. 4, $LC=[V10, V11, V12, \dots, V100]$), the server extracts the second attribute characteristic of the second item of content to be ranked, and inputs the second attribute characteristic of the second item of content to be ranked, the negative feedback characteristic NF and the target user characteristic corresponding to the target user into the ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked, and ranks the second items of content to be ranked based on the predicted ranking result of each of the second items of content (real-time re-ranking in Fig. 4) to obtain the target recommended items of content. The target recommended items of content can be expressed as $LC=[V55, V78, V13, \dots, V38, V77, V69, \dots, V32]$. Then the sever sends the first 9 target recommended items of content in the target recommended items of content to the client for display (recommending items of content in Fig. 4). The target recommended items of content displayed on the client are expressed as: the recommended content list $L=[V1, V3, V4, V7, V8, V55, V78, V13, V66, V31, V28, V99, V11, V42]$, with the corresponding candidate list $LC=[V38, V77, V69, \dots, V32]$.

The above process is repeated until the candidate list LC is empty or the user has selected

the content he want to watch.

Corresponding to the above method embodiments, an embodiment of the present disclosure also provides corresponding apparatus embodiments.

As shown in Fig. 5, Fig. 5 is a schematic structure diagram of a model training apparatus in an embodiment of the present disclosure. The apparatus is applied to an electronic device that performs model training, and includes:

a first obtaining module 501, configured to obtain a first attribute characteristic of a first item of content to be ranked, a negative feedback characteristic of a negatively-marked item of content corresponding to a user, and a user characteristic of the user;

a second obtaining module 502, configured to obtain a ground-truth label corresponding to the first item of content to be ranked, wherein the ground-truth label includes an interest level value of the first item of content to be ranked;

a predicting module 503, configured to input the first attribute characteristic, the negative feedback characteristic and the user characteristic into a ranking model for predictive ranking, to obtain a ranking result corresponding to the first item of content to be ranked; and

a training module 504, configured to calculate a loss between the ranking result and the ground-truth label, and adjust parameters of the ranking model based on the loss.

With applying the model training apparatus provided by the embodiment of the present disclosure, the ranking model is trained by using the first attribute characteristic of the first item of content to be ranked, the negative feedback characteristic of the negatively-marked item of content corresponding to the user and the user characteristic as inputs, and using the ground-truth label containing the interest level value of the first item of content as an output. Because the trained ranking model integrates the attribute characteristic of the first item of content to be ranked, the negative feedback characteristic of the negatively-marked item of content corresponding to the user, and the user characteristic, when respective first items of content to be ranked are ranked with the trained ranking model, the item of content that has been ranked to be on top is allowed to be more aligned with the item of content that the user is interested in. Therefore, it enables the change of the order of the item of content that the user is not interested

in, improves the probability of prioritizing the display of the item of content that the user is interested in, improves the display efficiency of the front-end content display page, and improves the matching accuracy between the displayed item of content and the user's points of interest, thereby enabling the item of content that the user wants to watch to be recommended quickly and accurately.

In a possible implementation, the negative feedback characteristic includes at least one of content type, content name, and content producer.

As shown in Fig. 6, Fig. 6 is a schematic structure diagram of a content ranking apparatus in an embodiment of the present disclosure. The apparatus is applied to a server that performs ranking services, and includes:

a third obtaining module 601, configured to obtain a ranking request, wherein the ranking request including a target user identifier and an identifier of a target negatively-marked item of content, and the target negatively-marked item of content is determined by a client corresponding to the target user identifier based on a received selection instruction for a target item of content in items of content that have been recommended;

a fourth obtaining module 602, configured to obtain a target negative feedback characteristic corresponding to the target negatively-marked item of content according to the identifier of the target negatively-marked item of content;

a characteristic extracting module 603, configured to extract, for each of second items of content to be ranked, a second attribute characteristic of the second item of content to be ranked;

a predictive ranking module 604, configured to input the second attribute characteristic, the target negative feedback characteristic and a target user characteristic corresponding to the target user into a ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked; wherein, the ranking model is trained with the above-mentioned model training method;

a content ranking module 605, configured to rank the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content; and

a content sending module 606, configured to send the target recommended items of content to a client, such that the client displays the target recommended items of content.

With applying the content ranking apparatus provided by the embodiment of the present disclosure, the second attribute characteristic of the second item of content to be ranked, the target negative feedback characteristic of the target negatively-marked item of content corresponding to the target user, and the target user characteristic are integrated and inputted into the ranking model for predictive ranking, wherein the ranking model has been trained by integrating content attribute characteristic, the negative feedback characteristic of the negatively-marked item of content and the user characteristic corresponding to the user. Therefore, when the second items of content to be ranked are ranked, the item of content that has been ranked to be on top is allowed to be more aligned with the item of content that the user is interested in. Therefore, it enables the change of the order of the item of content that the user is not interested in, improves the probability of prioritizing the display of the item of content that the user is interested in, improves the display efficiency of the front-end content display page, and improves the matching accuracy between the displayed item of content and the user's points of interest, thereby enabling the item of content that the user would like to watch to be recommended quickly and accurately.

In a possible implementation, the above-mentioned apparatus further includes:

a fifth obtaining module, configured to obtain an acquisition request sent by the client for the target recommended items of content, wherein the acquisition request is determined by the client based on items of content that have been recommended;

a re-ranking module, configured to trigger, in response to the acquisition request, the fourth obtaining module 602, the characteristic extracting module 603, the predictive ranking module 604, the content ranking module 605 and the content sending module 606 to perform re-ranking.

In a possible implementation, the characteristic extracting module 603 is specifically configured to determine items of content to be recommended that have not been sent to the client as the second items of content to be ranked; and extract, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked.

In a possible implementation, the characteristic extracting module 603 is specifically configured to determine all the recalled items of content as the second items of content to be

ranked, wherein the recalled items of content are the items of content to be recommended which are obtained from a content database by the server in response to the content acquisition request sent by the client; extract, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked.

In a possible implementation, the negatively-marked item of content includes a negatively-marked item of content in historical recommended items of content from the client corresponding to the target user identifier, or the item of content determined in real time by the client corresponding to the target user identifier based on the received selection instruction for the target item of content in the items of content that have been recommended.

An embodiment of the present disclosure further provides an electronic device, as shown in Fig. 7, including a processor 701, a communication interface 702, a memory 703 and a communication bus 704, wherein the processor 701, the communication interface 702 and the memory 703 communicate with each other via the communication bus 704;

the memory 703 is configured to store a computer program;

the processor 701 is configured to implement the above any method embodiment when executing the program stored in the memory 703, to achieve the same technical effects.

The communication bus mentioned in the above terminal may be a Peripheral Component Interconnect (PCI) bus or an Extended Industry Standard Architecture (EISA) bus, or the like. The communication bus can be divided into address bus, data bus, control bus, or the like. For the convenience of presentation, only one thick line is used in the figure, but it does not mean that there is only one bus or one type of bus.

The communication interface is used for communication between the above terminal and other devices.

The memory may include a random access memory (RAM), and may also include a non-volatile memory, such as at least one disk memory. Optionally, the memory may also be at least one storage device located far away from the aforementioned processor.

The above-mentioned processor can be a general-purpose processor, including a central processing unit (CPU), a network processor (NP), or the like; or can also be a digital signal processor (DSP), Application Specific Integrated Circuit (ASIC), Field-Programmable Gate

Array (FPGA) or other programmable logic devices, discrete gate or transistor logic devices, discrete hardware components.

In yet another embodiment provided by the present disclosure, a computer readable storage medium is further provided, wherein a computer program is stored on the computer readable storage medium, and the computer program, when executed by a processor, implementing the above any method embodiment, to achieve the same technical effects.

In yet another embodiment provided by the present disclosure, a computer program product containing instructions is further provided, wherein the instructions, when run on a computer, implement the above any method embodiment, to achieve the same technical effects.

In the above embodiments, it may be implemented in whole or in part by software, hardware, firmware or any combination thereof. When implemented in software, it can be implemented in whole or in part in the form of a computer procedure product. The computer procedure product includes one or more computer instructions. When the computer procedure instructions are loaded and executed on a computer, the processes or functions described in the embodiments of the present disclosure are generated in whole or in part. The computer may be a general purpose computer, special purpose computer, computer network, or other programmable device. The computer instructions may be stored in a computer readable storage medium or transmitted from one computer readable storage medium to another computer readable storage medium, for example, the computer instructions may be transmitted from a website, computer, server or data center to another website, computer, server, or data center by wire (such as coaxial cable, fiber optic, digital subscriber line (DSL)) or wirelessly (such as infrared, wireless, microwave, etc.). The computer-readable storage medium may be any usable medium that can be accessed by a computer or a data storage device such as a server and a data center and the like that includes an integration of one or more available media. The usable media may be magnetic media (such as a floppy disk, a hard disk, a magnetic tape), optical media (such as DVD), or semiconductor media (such as Solid State Disk (SSD)) and the like.

It should be noted that, relational terms such as first and second and the like herein are only used to distinguish one entity or operation from another and do not necessarily require or imply any such actual relationship or order between these entities or operations. Moreover, the terms "comprising", "including" or any other variations thereof are intended to encompass a

non-exclusive inclusion such that a process, method, article or device that includes a series of elements includes not only those elements, but also includes other elements not explicitly listed or other elements inherent to such a process, method, article or apparatus. Without further limitation, elements defined by the phrase "comprising one..." do not preclude the presence of additional identical elements in a process, method, article or device that includes the mentioned elements.

The various embodiments in this specification are described in a related manner. Each embodiment focuses on the differences from other examples, and the same and similar parts between the various embodiments can be referred to each other. Especially, for the embodiment of the apparatus and the electronic device, the description is relatively simple because it is basically similar to the embodiment of the method, and the relevant points can be referred to the partial description of the embodiment of the method.

The above descriptions are only preferred embodiments of the present application, and are not intended to limit the protection scope of the present application. Any modifications, equivalent replacements, improvements, or the like made within the spirit and principles of the present application are included within the protection scope of the present disclosure.

Claims

What is claimed is:

1. A model training method, which is applied to an electronic device that performs model training, the method comprising:

obtaining a first attribute characteristic of a first item of content to be ranked, a negative feedback characteristic of a negatively-marked item of content corresponding to a user, and a user characteristic of the user;

obtaining a ground-truth label corresponding to the first item of content to be ranked, wherein the ground-truth label comprises an interest level value of the first item of content to be ranked;

inputting the first attribute characteristic, the negative feedback characteristic and the user characteristic into a ranking model for predictive ranking, to obtain a ranking result corresponding to the first item of content to be ranked; and

calculating a loss between the ranking result and the ground-truth label, and adjusting parameters of the ranking model based on the loss.

2. The method according to claim 1, wherein, the negative feedback characteristic comprises at least one of content type, content name, and content producer.

3. A content ranking method, which is applied to a server that performs ranking services, the method comprising:

obtaining a ranking request, wherein the ranking request comprises a target user identifier and an identifier of a target negatively-marked item of content, and the target negatively-marked item of content is determined by a client corresponding to the target user identifier based on a received selection instruction for a target item of content in items of content that have been recommended;

obtaining a target negative feedback characteristic corresponding to the target negatively-marked item of content according to the identifier of the target negatively-marked item of content;

for each of second items of content to be ranked, extracting a second attribute characteristic

of the second item of content to be ranked;

inputting the second attribute characteristic, the target negative feedback characteristic and a target user characteristic corresponding to the target user into a ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked, wherein, the ranking model is trained with the method according to claim 1 or 2;

ranking the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content; and

sending the target recommended items of content to a client, such that the client displays the target recommended items of content.

4. The method according to claim 3, wherein, the method further comprising:

obtaining an acquisition request sent by the client for the target recommended items of content, wherein the acquisition request is determined by the client based on the items of content that have been recommended; and

in response to the acquisition request, executing operations of: based on the identifier of the target negatively-marked item of content, obtaining the target negative feedback characteristic corresponding to the identifier of the target negatively-marked item of content; extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked; and inputting the second attribute characteristic, the target negative feedback characteristic and the target user characteristic corresponding to the target user into the ranking model for predictive ranking, to obtain the predicted ranking result of the second item of content to be ranked.

5. The method according to claim 3, wherein, extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked, comprises:

determining items of content to be recommended that have not been sent to the client as the second items of content to be ranked; and

for each of the second items of content to be ranked, extracting the second attribute characteristic of the second item of content to be ranked.

6. The method according to claim 3, wherein, extracting, for each of the second items of content to be ranked, the second attribute characteristic of the second item of content to be ranked, comprises:

determining all recalled items of content as the second items of content to be ranked, wherein the recalled items of content are items of content to be recommended which are obtained from a content database by the server in response to a content acquisition request sent by the client; and

for each of the second items of content to be ranked, extracting the second attribute characteristic of the second item of content to be ranked.

7. The method according to claim 3, wherein, the negatively-marked item of content comprises a negatively-marked item of content in historical recommended items of content from the client corresponding to the target user identifier, or an item of content determined in real time by the client corresponding to the target user identifier based on the received selection instruction for the target item of content in the items of content that have been recommended.

8. A model training apparatus, which is applied to an electronic device that performs model training, the apparatus comprising:

a first obtaining module, configured to obtain a first attribute characteristic of a first item of content to be ranked, a negative feedback characteristic of a negatively-marked item of content corresponding to a user, and a user characteristic of the user;

a second obtaining module, configured to obtain a ground-truth label corresponding to the first item of content to be ranked, wherein the ground-truth label comprises an interest level value of the first item of content to be ranked;

a predicting module, configured to input the first attribute characteristic, the negative feedback characteristic and the user characteristic into a ranking model for predictive ranking, to obtain a ranking result corresponding to the first item of content to be ranked; and

a training module, configured to calculate a loss between the ranking result and the ground-truth label, and adjust parameters of the ranking model based on the loss.

9. A content ranking apparatus, which is applied to a server that performs ranking services, the apparatus comprising:

a third obtaining module, configured to obtain a ranking request, wherein the ranking request comprises a target user identifier and an identifier of a target negatively-marked item of content, and the target negatively-marked item of content is determined by a client corresponding to the target user identifier based on a received selection instruction for a target item of content in items of content that have been recommended;

a fourth obtaining module, configured to obtain a target negative feedback characteristic corresponding to the target negatively-marked item of content according to the identifier of the target negatively-marked item of content;

a characteristic extracting module, configured to extract, for each of second items of content to be ranked, a second attribute characteristic of the second item of content to be ranked;

a predictive ranking module, configured to input the second attribute characteristic, the target negative feedback characteristic, and a target user characteristic corresponding to the target user into a ranking model for predictive ranking, to obtain a predicted ranking result of the second item of content to be ranked, wherein, the ranking model is trained with the method according to claim 1 or 2;

a content ranking module, configured to rank the second items of content to be ranked based on the predicted ranking result of each of the second items of content to be ranked, to obtain target recommended items of content; and

a content sending module, configured to send the target recommended items of content to a client, such that the client displays the target recommended items of content.

10. An electronic device, comprising a processor, a communication interface, a memory and a communication bus, wherein the processor, the communication interface and the memory communicate with each other via the communication bus;

the memory is configured to store a computer program;

the processor is configured to carry out, when executing the program stored in the memory, the method according to any of claims 1-7.

11. A computer readable storage medium having a computer program stored therein, wherein the computer program, when executed by a processor, carries out the method according to any of claims 1-7.