NEURAL NETWORK MODEL TRAINING METHOD AND APPARATUS, COMPUTER DEVICE, AND STORAGE MEDIUM

FIELD OF INVENTION

[0001] The present application relates to the technical field of neural network, in particular to a neural network model training method and apparatus, a computer device, and a storage medium.

BACKGROUND OF INVENTION

[0002] At present, deep learning algorithm plays an important role in the application development of computer vision, and deep learning algorithms have certain requirements for training data. When the amount of training data is insufficient, the fitting effect for low-frequency hard examples is not good. Based on the above situation, traditionally, some training methods of difficult sample mining were proposed, in which the low-frequency samples and under-fitting samples in the training set were retained and the high-frequency samples and easy-to-identify samples were removed, so as to achieve the purpose of simplifying the training set and improving the pertinence of training. However, the inventor realizes that in the above-mentioned traditional solutions, on the one hand, the training data in the training set is reduced, which is not conducive to the training of the model, and on the other hand, it is difficult to enhance the pertinence of the training data in the model training even if the training data are increased or supplemented, and the samples lacking in the model training process that is, the difficult samples, cannot be analyzed directly, which leads to the low pertinence and training efficiency of the above-mentioned traditional training methods.

SUMMARY OF THE INVENTION

[0003] The embodiment of the present application provides a neural network model training method and apparatus, a computer device, and a storage medium, for use in selecting a targeted training sample and improving the targeted property and training efficiency of model training.

[0004] A neural network model training method, comprising: training a deep neural network model according to training samples in a training set to obtain a trained deep neural network model; performing data verification on all reference samples in a reference set according to the trained deep neural network model to obtain a model prediction value of each reference sample in all reference samples, and the reference set comprising a verification set and/or a test set; calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data; taking a target reference sample of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as a comparison sample; calculating a similarity between the training sample in the training set and each comparison sample; taking the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified; performing data amplification on the sample to be amplified to obtain a target training sample; and taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

[0005] A neural network model training apparatus, comprising: a training module, for

training a deep neural network model according to training samples in a training set to obtain a trained deep neural network model; a verification module, for performing data verification on all reference samples in a reference set according to the trained deep neural network model to obtain a model prediction value of each reference sample in all reference samples, and the reference set comprising a verification set and/or a test set; a first calculation module, for calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data; a first determination module, for taking a target reference sample of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as a comparison sample; a second calculation module, for calculating a similarity between the training sample in the training set and each comparison sample; a second determination module, for taking the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified; an amplification module, for performing data amplification on the sample to be amplified to obtain a target training sample; and the training module, for taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

[0006] A computer device including a memory, a processor, and computer readable instructions stored in the memory and running on the processor, when the processor executes the computer readable instructions, the steps corresponding to the above neural network model training method are implemented.

[0007] One or more non-volatile computer readable storage stored with computer programs, when the computer readable instructions are executed by one or more processors, the one or more processors execute the steps corresponding to the neural network model training method.

[0008] The details of one or more embodiments of the present application are presented in the following drawings and descriptions, and other features and advantages of the present application will become apparent from the description, drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In order to explain the technical solutions of the embodiments of the present application more clearly. The drawings that need to be used in the description of the embodiments of the present application are briefly introduced as follows. Obviously, the drawings in the following description are only some of the embodiments of the present application. For those of ordinary skill in the art, other drawings can be obtained based on these drawings without creative labor.

[0010] FIG. 1 is a schematic block diagram of a neural network model training method of the present application;

[0011] FIG. 2 is a flow chart of a neural network model training method in accordance embodiments of the present application;

[0012] FIG. 3 is a flow chart of a neural network model training method in accordance embodiments of the present application;

[0013] FIG. 4 is a flow chart of a neural network model training method in accordance embodiments of the present application;

[0014] FIG. 5 is a flow chart of a neural network model training method in accordance embodiments of the present application;

[0015] FIG. 6 is a flow chart of a neural network model training method in accordance embodiments of the present application;

[0016] FIG. 7 is a schematic block diagram of a neural network model training apparatus in accordance with embodiments of the present application; and

[0017] FIG. 8 is a schematic block diagram of a computer device of the present application.

DESCRIPTION OF THE EMBODIMENTS

[0018] The technical solutions in the embodiments of the present application will be described clearly and completely in conjunction with the drawings in the embodiments of the present application. Obviously, the described embodiments are part of the embodiments of the present application, not all of the embodiments. Based on the embodiments of the present application, all other embodiments obtained by those of ordinary skill in the art without creative work fall within the protection scope of the embodiments of the present application.

[0019] The present application provides a neural network model training method, which can be applied to the schematic diagram of FIG. 1. The neural network model training apparatus can be implemented by an independent server or a server cluster composed of multiple servers, or the neural network model training apparatus is implemented as an independent device or integrated in the above-mentioned server, which is not limited here. The server can obtain training samples in the training set and reference samples used for model training, and train a deep neural network model according to training samples in a training set to obtain a trained deep neural network model; perform data verification on all reference samples in a reference set according to the trained deep neural network model to obtain a model prediction value of each

reference sample in all reference samples, and the reference set includes a verification set and/or a test set; calculate a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample; use target reference samples of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as comparison samples; calculate a similarity between the training sample in the training set and each comparison sample; use the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified; perform data amplification on the sample to be amplified to obtain a target training sample; use the target training sample as the training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition. It can be seen from the above solution that because the sample data to be amplified is selected in a targeted manner, the training sample data for model training is amplified, and the prediction results of the samples in the test set and/or the verification set are involved in the model training, directly interact with the verification set and the test set, and directly analyze the samples that are lacking in the model training process from the results, that is, the hard example, so that targeted training samples are selected, thereby improving the pertinence of model training and training efficiency. The following is a detailed description of this application:

[0020] With reference to FIG. 2 for a flow chart of a neural network model training method in accordance with an embodiment of the present application, the method includes the following steps:

[0021] S10: Train a deep neural network model according to training samples in a

training set to obtain a trained deep neural network model.

[0022] The training set is the foundation of deep neural network model training. The deep neural network model can be imagined as a powerful nonlinear fitting device to fit the data on the training set, that is, the training samples. Therefore, after the training set is prepared, the deep neural network model can be trained according to the training samples of the training set to obtain the trained deep neural network model. It should be noted that the above-mentioned deep neural network model refers to a convolutional neural network model, it may also be a recurrent neural network model, or other types of convolutional neural network models, which are not limited in the embodiment of the present application. In addition, the above training process is an effective supervision training process, and the training samples in the training set are pre-annotated. Exemplarily, if it is to train a deep neural network model for image classification, the training samples will be classified and annotated, so as to train a deep neural network model for image classification, such as a deep neural network model used to classify lesion images.

[0023] Specifically, the embodiment of the present application can preset a training period (epoch). Illustratively, 10 epochs can be used as a complete training period, where each epoch refers to training the deep neural network model one time according to all the training samples in the training set, and each 10 epoch refers to training the deep neural network model 10 times according to all the training samples in the training set. It should be noted that the specific number of epochs is not limited in the embodiments of the present application, and it is exemplary, and 8 periods can also be used as a complete training period.

[0024] S20: Perform data verification on all reference samples in a reference set

according to the trained deep neural network model to obtain a model prediction value of each reference sample in all reference samples, and the reference set includes a verification set and/or a test set.

[0025] The verification set refers to the sample data used to evaluate the effectiveness of the deep neural network model during the entire training process in the embodiments of the present application. When the deep neural network model training progresses to a certain level, the sample data on the verification set will be used to verify the deep neural network model to prevent the deep neural network model from overfitting, so the sample data on the verification set indirectly participates in the model training process, according to the verification result, it is determined whether the training state of the deep neural network model at the moment is valid for the data outside the training set. The test set is the final sample data used to evaluate the accuracy of the deep neural network model.

[0026] In the embodiments of the present application, the above verification set and/or test set are used as the reference set, and the sample data of the verification set and/or test set is used as the reference sample in the reference set. Exemplarily, after training every 10 epochs, a trained deep neural network model can be obtained. At this time, a data verification operation is performed on all reference samples in the reference set according to the trained deep neural network model to obtain the model prediction value of each reference sample in all reference samples. It should be noted that the model prediction value refers to the verification result generated by the deep neural network model to verify the reference sample after a certain training period. For example, if the deep neural network model is used for image classification, the model prediction value is used to characterize the accuracy of image classification.

[0027] S30: Calculate a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample, and each reference sample is pre-annotated with data.

[0028] After obtaining the model prediction value of each reference sample in all the reference samples, calculate the difference measurement index between the model prediction value of each reference sample and the real annotation corresponding to the reference sample in all reference samples.

[0029] It can be understood that, as an effective method of supervised training, the sample data in the verification set or test set is pre-annotated, that is, the real annotation corresponding to each reference sample, and the difference measurement index is an index used to characterize the degree of difference between the model prediction value of the reference sample and the real annotation corresponding to the reference sample. Exemplarily, for reference sample A, the model prediction value predicted by the deep neural network model is [0.8.5,0,0.2,0,0], and the real annotation is [1,0,0,0,0]. The difference measurement index can be calculated based on these two sets of data, therefore, the difference between the model prediction value and the real annotation can be obtained.

[0030] In an embodiment, as shown in FIG. 3, in step S30, that is, the step of calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample includes the following steps:

[0031] S31: Determine a type of the difference measurement index used by the trained deep neural network model.

[0032] It should be understood that before calculating the difference measurement

index between the model prediction value of each reference sample and the real annotation corresponding to each reference sample, it needs to firstly determine the type of the difference measurement index adopted by the trained deep neural network model according to the present application. It depends on the function of the trained deep neural network model. The function of the deep neural network model means that the deep neural network model is used for image segmentation or image classification and other functions. According to the function of different deep neural network models, appropriate types of the difference measurement index are selected.

[0033] In an embodiment, as shown in FIG. 4, in step S31, that is, the step of determining a type of the difference measurement index used by the trained deep neural network model includes the following steps:

[0034] S311: Acquire a preset index corresponding list, and the preset index list comprising a corresponding relationship between the type of the difference measurement index and a model function indicator character, the model function indicator character being used to indicate the function of the deep neural network model.

[0035] The model function indication characters can indicate the function of the deep neural network model, which can be customized by numbers, letters, etc., which are not limited here. Specifically, the types of the difference measurement index include cross-entropy coefficient, Jaccard coefficient, and dice coefficient. Wherein, the model function indicator character indicating that the deep neural network model is used for image classification corresponds to the cross-entropy coefficient, the model function indicator character indicating that the deep neural network model is used for image segmentation corresponds to the Jaccard coefficient or dice coefficient.

[0036] S312: Determine the model function indicator character corresponding to the trained deep neural network model.

[0037] S313: Determine the type of the difference measurement index used by the trained deep neural network model, according to the corresponding relationship between the difference measurement index and the model function indicator character, and the model function indicator character corresponding to the trained deep neural network model.

[0038] For steps S312-S313, it can be understood that after obtaining the preset index corresponding list, the corresponding relationship between the difference measurement index and the model function indicator character can be determined according to the preset index corresponding list. Therefore, the type of the difference measurement index used by the trained deep neural network model can be determined according to the model function indicator characters corresponding to the trained deep neural network model.

[0039] S32: Calculate the difference measurement index between the model prediction value of each reference sample and the real annotation corresponding to each reference sample, according to the type of the difference measurement index.

[0040] For example, assuming that the model function corresponding to the deep neural network model in the embodiment of the present application is used for image classification, the cross-entropy coefficient can be used as the difference measurement index between the model prediction value of each reference sample and the real annotation corresponding to each reference sample.

[0041] Assuming that there is now a reference sample of which real annotation distribution is $p(x)$ and the model prediction value of the reference sample is $q(x)$,

that is, the predicted distribution of the trained deep neural network model is $q(x)$, then the cross-entropy $H(p,q)$ between the real annotation and the model prediction value can be calculated according to the following formula:

[0042] $H(p,q)=\sum_{x} p(x) \bullet \log\left(\frac{1}{q(x)}\right)$.

[0043] It should be noted that, assuming that the deep neural network model in the embodiment of the present application is used for image segmentation, the Jaccard coefficient or dice coefficient can be calculated as the measurement index of the difference between the model prediction value and the real annotation, and the specific calculation process is not described in detail here.

[0044] S40: Take a target reference sample of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as a comparison sample.

[0045] It can be understood that after step S30, the difference measurement index corresponding to each reference sample in all reference samples in the reference set can be obtained. In the embodiment of the present application, the target reference samples of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples is used as comparison samples for subsequent calculation of similarity of the training samples. It can be understood that the comparison sample obtained at this time is the hard example mentioned above, and the comparison sample obtained can be one or more, which is specifically determined by the training situation of the deep neural network model. It should be noted that the preset threshold is determined according to project requirements or actual experience, which is not limited

here. As an example, taking the deep neural network model as the model for image segmentation as an example, the above preset threshold can be set to 0.7.

[0046] S50: Calculate a similarity between the training sample in the training set and each comparison sample.

[0047] After the comparison samples are obtained, the similarity between the training samples in the training set and each comparison sample is calculated. For ease of understanding, here is a simple example for illustration. For example, assuming that there are 3 comparison samples and 10 training samples, the similarity between each comparison sample and each of the 10 training samples can be calculated, and a total of 30 similarities will be obtained.

[0048] In an embodiment, as shown in FIG. 5, in step S50, that is, the step of calculating a similarity between the training sample in the training set and each comparison sample includes the following steps:

[0049] S51: Perform feature extraction on each training sample of the training set according to a preset feature extraction model to obtain a feature vector of each training sample, and the preset image feature extraction model is a feature extraction model trained based on a convolutional neural network.

[0050] S52: Perform feature extraction on the comparison sample according to the preset feature extraction model to obtain a feature vector of each comparison sample.

[0051] S53: Calculate the similarity between the training sample in the training set and the comparison sample according to the feature vector of each training sample and the feature vector of each comparison sample.

[0052] For steps S51-S53, in the embodiment of the present application, the similarity between the training sample in the training set and the comparison sample is calculated

based on the feature vector. Wherein, based on the image feature vector extraction of convolutional neural, the effectiveness of the pictures finally found based on different image similarity algorithms is different, there is a higher pertinence, which is conducive to model training.

[0053] In an embodiment, as shown in FIG. 6, in step S53, that is, the step of calculating the similarity between the training sample in the training set and the comparison sample according to the feature vector of each training sample and the feature vector of each comparison sample includes the following steps:

[0054] S531: Calculate a cosine distance between the feature vector of each training sample and the feature vector of each comparison sample.

[0055] S532: Take the cosine distance between the feature vector of each training sample and the feature vector of each comparison sample as the similarity between each training sample and each comparison sample.

[0056] For steps S531-S532, it should be understood that in addition to the above-mentioned cosine distance to characterize the similarity between the training sample and the comparison sample, the feature vector of each training sample and the feature vector of each comparison sample can also be calculated to obtain Euclidean distance, Manhattan distance, etc., which are used to characterize the aforementioned similarity, and it is not specifically limited in the embodiment of the present application. Here, taking the cosine similarity calculation method as an example, suppose the feature vector corresponding to the training sample is $x_i, i \in (1,2,...,n)$, and the feature vector corresponding to the comparison sample is $y_i, i \in (1,2,...,n)$, where n is a positive integer, then the cosine distance between the feature vector of the training sample and

the feature vector of each comparison sample is $\cos(\theta)=\frac{\sum_{i=1}^{n}(x_i \times y_i)}{\sqrt{\sum_{i=1}^{n}(x_i)^2} \times \sqrt{\sum_{i=1}^{n}(y_i)^2}}$.

[0057] S60: Take the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified.

[0058] After calculating the similarity between the training sample in the training set and each comparison sample, the training sample of which similarity with the comparison sample meets a preset amplification condition is used as the sample to be amplified. It should be noted that the aforementioned preset amplification conditions can be adjusted according to actual application scenarios. Exemplarily, if the similarity between the training sample in the training set and the comparison sample is ranked in the top 3, then the top 3 training samples meet the aforementioned preset amplification condition. For example, there are comparison sample 1 and comparison sample 2, calculate the similarity between comparison sample 1 and each training sample in the training set, and use the training samples with the top 3 similarities as the samples to be amplified; similarly calculate the similarity between comparison sample 2 and each training sample in the training set, and use the training samples with the top 3 similarities as the samples to be amplified. The samples to be amplified for other comparison samples are determinized in a similar way, so that the samples to be amplified for each comparison sample can be determined. It should be understood that the samples to be amplified obtained above is a set of samples most similar to the comparison sample.

[0059] It can be seen that; the highest global similarity and the highest local similarity can be found to meet the needs according to different application scenarios. The entire

process does not require human observation and human selection of samples, which is an efficient screening mechanism.

[0060] S70: Perform data amplification on the sample to be amplified to obtain a target training sample.

[0061] After obtaining the training sample of which similarity with the comparison sample meets the preset amplification condition as the sample to be amplified, a data amplification operation is performed on the sample to be amplified to obtain a target training sample. It should be noted that, in the embodiments of the present application, a conventional image amplification method may be used to perform an unified data amplification operation on the determined sample to be amplified. For example, it can be amplified with double data enhancement, etc. (such as rotation, translation, and zoom), and the amplified sample is the target training sample. The total amount of data gain can be reduced here, and only a small part of the data is gained, which is convenient for improving the efficiency of model training.

[0062] S80: Take the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

[0063] After obtaining the amplified samples which are the target training samples, the target training samples are used as the training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition. That is, after obtaining the amplified target training samples, the target training samples are used as the training set again to train the deep neural network model with the sample data of the verification set, and a new round of training is repeated again and again. Based on

this operation, which is starting from the results of model predictions, returning to the source to optimize and the purpose of improving the prediction results is achieved, thereby improving model prediction performance and improving model training efficiency.

[0064] In an embodiment, the above-mentioned target training samples are allocated to the training set and verification set according to a certain ratio. Illustratively, the above allocation result is that the ratio of the samples in the training set to the samples in the verification set is maintained at about 5:1, or other distribution ratios, which is not limited here.

[0065] In an embodiment, the step of taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition includes: taking the target training sample as a training sample in the training set to train the trained deep neural network model until the corresponding difference measurement index of each verification sample of all the verification samples in the verification set is lower than or equal to the preset threshold. In addition, there may be other preset training ending conditions. For example, the number of training iterations of the model has reached the preset upper limit, which is not specifically limited here.

[0066] It should be understood that the sequence number of each step in the foregoing embodiment does not mean the order of execution, and the execution sequence of each process should be determined by its function and internal logic, and should not constitute any limitation to the implementation process of the embodiment of the present application.

[0067] In an embodiment, a neural network model training apparatus is provided, and the neural network model training apparatus corresponds to the neural network model training method in the above-mentioned embodiment. As shown in FIG. 7, the neural network model training apparatus 10 includes a training module 101, a verification module 102, a first calculation module 103, a first determination module 104, a second calculation module 105, a second determination module 106, an amplification module 107, and the detailed description of each functional module is as follows: the training module 101 is provided for training a deep neural network model according to training samples in a training set to obtain a trained deep neural network model; the verification module 102 is provided for performing data verification on all reference samples in the reference set according to the trained deep neural network model trained by the training module 101 to obtain a model prediction value of each reference sample in all reference samples, and the reference set including a verification set and/or a test set; the first calculation module 103 is provided for calculating a difference measurement index between the model prediction value of each reference sample obtained by the verification module 102 and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data; the first determination module 104 is provided for taking target reference samples of which the difference measurement index calculated by the first calculation module 103 is lower than or equal to a preset threshold in all the reference samples as comparison samples; the second calculation module 105 is provided for calculating a similarity between the training sample in the training set and each comparison sample determined by the first determining module 104; the second determination module 106 is provided for taking the training sample of which the similarity with the comparison sample calculated by

the second calculation module 105 meets a preset amplification condition as a sample to be amplified; the amplification module 107 is provided for performing data amplification on the sample to be amplified determined by the second determining module 106 to obtain a target training sample; and the training module 101 is further provided for taking the target training sample obtained by amplifying the amplified sample as the training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

[0068] In an embodiment, the training module 101 provided for taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition, specifically includes: the training module 101 provided for taking the target training sample as a training sample in the training set to train the trained deep neural network model until the difference measurement index corresponding to each verification sample of all the verification samples in the verification set is lower than or equal to the preset threshold.

[0069] In an embodiment, the first calculation module 103 is specifically provided for determining a type of the difference measurement index used by the trained deep neural network model; and calculating the difference measurement index between the model prediction value of each reference sample and the real annotation corresponding to each reference sample, according to the type of the difference measurement index.

[0070] In an embodiment, the first calculation module 103 provided for determining a type of the difference measurement index used by the trained deep neural network model, specifically includes: the first calculation module 103 provided for acquiring a

preset index corresponding list, the preset index list including a corresponding relationship between the type of the difference measurement index and a model function indicator character, and the model function indicator character being used to indicate the function of the deep neural network model; determining the model function indicator character corresponding to the trained deep neural network model; and determining the type of the difference measurement index used by the trained deep neural network model, according to the corresponding relationship between the difference measurement index and the model function indicator character, and the model function indicator character corresponding to the trained deep neural network model.

[0071] In an embodiment, the type of the difference measurement index includes cross-entropy coefficient, Jacquard coefficient and dice coefficient, wherein the model function indicator character indicating that the deep neural network model is used for image classification is corresponding to the cross-entropy coefficient, and the model function indicator character indicating that the deep neural network model is used for image segmentation is corresponding to the Jaccard coefficient or dice coefficient.

[0072] The second calculation module 105 is specifically provided for performing feature extraction on each training sample of the training set according to a preset feature extraction model to obtain a feature vector of each training sample, the preset image feature extraction model being a feature extraction model trained based on a convolutional neural network; performing feature extraction on the comparison sample according to the preset feature extraction model to obtain a feature vector of each comparison sample; and calculating the similarity between the training sample in the training set and the comparison sample according to the feature vector of each training

sample and the feature vector of each comparison sample.

[0073] In an embodiment, the second calculation module 105 provided for calculating the similarity between the training sample in the training set and the comparison sample according to the feature vector of each training sample and the feature vector of each comparison sample, includes:

[0074] The second calculation module 105 is provided for calculating a cosine distance between the feature vector of each training sample and the feature vector of each comparison sample; and taking the cosine distance between the feature vector of each training sample and the feature vector of each comparison sample as the similarity between each training sample and each comparison sample.

[0075] The specific definition of the neural network training device can be referred to the above definition of the neural network training method, which will not be repeated here. The various modules in the above neural network training device can be implemented in whole or in part by software, hardware and combinations thereof. The above modules can be embedded in the form of hardware or independent of the processor in the computer device, or can be stored in the memory of the computer device in the form of software, so that the processor can call the software to perform the operations corresponding to the above modules.

[0076] In an embodiment, a computer device is provided. The computer device may be a server, and its internal structure diagram may be as shown in FIG. 8. The computer device includes a processor, a memory, a network interface and a database connected by a system bus. Wherein, the processor of the computer device is used to provide calculation and control capabilities. The memory of the computer device includes a non-volatile storage medium and an internal memory. The non-volatile storage

medium stores an operating system, a computer program, and a database. The internal memory provides an environment for the operation of the operating system and computer programs in the non-volatile storage medium. The database of the computer device is used to temporarily store training samples, reference samples, etc. The network interface of the computer device is used to communicate with an external terminal through a network connection. The computer program is executed by the processor to realize a neural network training method.

[0077] In an embodiment, a computer device is provided, which includes a memory, a processor, and computer readable instructions stored in the memory and run in the processor, and the processor implements the following steps when the processor executes the computer readable instructions: training a deep neural network model according to training samples in a training set to obtain a trained deep neural network model; performing data verification on all reference samples in a reference set according to the trained deep neural network model to obtain a model prediction value of each reference sample in all reference samples, and the reference set including a verification set and/or a test set; calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data; taking a target reference sample of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as a comparison sample; calculating a similarity between the training sample in the training set and each comparison sample; taking the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified; performing data amplification on the sample to be amplified to

obtain a target training sample; and taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

[0078] In an embodiment, one or more non-volatile readable storage media storing computer readable instructions are provided, the non-volatile readable storage medium storing computer readable instructions, and when the computer readable instructions executed by one or more processors, one or more processors are caused to implement the following steps: training a deep neural network model according to training samples in a training set to obtain a trained deep neural network model; performing data verification on all reference samples in a reference set according to the trained deep neural network model to obtain a model prediction value of each reference sample in all reference samples, and the reference set including a verification set and/or a test set; calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data; taking a target reference sample of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as a comparison sample; calculating a similarity between the training sample in the training set and each comparison sample; taking the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified; performing data amplification on the sample to be amplified to obtain a target training sample; and taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the

verification set meet a preset training ending condition.

[0079] A person of ordinary skill in the art can understand that all or part of the processes in the above-mentioned embodiment methods can be implemented by instructing relevant hardware through a computer program. The computer program can be stored in a non-volatile computer readable storage. In the medium, when the computer program is executed, it may include the procedures of the embodiments of the above-mentioned method. Wherein, any reference to memory, storage, database or other media used in the embodiments provided in the present application may include non-volatile and/or volatile memory. Non-volatile memory may include read-only memory (ROM), programmable ROM (PROM), electrically programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), or flash memory. Volatile memory may include random access memory (RAM) or external cache memory. As an illustration and not a limitation, RAM is available in many forms, such as static RAM (SRAM), dynamic RAM (DRAM), synchronous DRAM (SDRAM), double data rate SDRAM (DDRSDRAM), enhanced SDRAM (ESDRAM), synchronous link (Synchlink) DRAM (SLDRAM), Rambus direct RAM (RDRAM), direct Rambus dynamic RAM (DRDRAM), and Rambus dynamic RAM (RDRAM), etc.

[0080] A person skilled in the art can clearly understand that, for the convenience and conciseness of description, only the division of the above functional units and modules is used as an example. In actual applications, the above functions can be allocated to different functional units or modules to complete. That is, the internal structure of the device is divided into different functional units or modules to complete all or part of the functions described above.

[0081] The above-mentioned embodiments are only used to illustrate the technical solutions of the present application, but not to limit them; although the embodiments of the present application are described in detail with reference to the foregoing embodiments, those of ordinary skill in the art should understand that it is still possible to modify the technical solutions recorded in the foregoing embodiments, or equivalently replace some of the technical features; and these modifications or replacements do not cause the essence of the corresponding technical solutions to deviate from the spirit and scope of the technical solutions of the embodiments of the present application, and should be included in the protection scope of the embodiments of the present application..

What is claimed is:

1. A neural network model training method, comprising:

   training a deep neural network model according to training samples in a training set, to obtain a trained deep neural network model;

   performing data verification on all reference samples in a reference set according to the trained deep neural network model, to obtain a model prediction value of each reference sample in all reference samples, and the reference set comprising a verification set and/or a test set;

   calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data;

   taking a target reference sample of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as a comparison sample;

   calculating a similarity between the training sample in the training set and each comparison sample;

   taking the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified;

   performing data amplification on the sample to be amplified, to obtain a target training sample; and

   taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

2. The neural network model training method as claimed in claim 1, wherein the step of taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition

comprises:

taking the target training sample as a training sample in the training set to train the trained deep neural network model until the difference measurement index corresponding to each verification sample of all the verification samples in the verification set is lower than or equal to the preset threshold.

3. The neural network model training method as claimed in claim 1 or 2, wherein the step of calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample comprises:

determining a type of the difference measurement index used by the trained deep neural network model; and

calculating the difference measurement index between the model prediction value of each reference sample and the real annotation corresponding to each reference sample, according to the type of the difference measurement index.

4. The neural network model training method as claimed in claim 3, wherein the step of determining a type of the difference measurement index used by the trained deep neural network model comprises:

acquiring a preset index corresponding list, the preset index list comprising a corresponding relationship between the type of the difference measurement index and a model function indicator character, and the model function indicator character being used to indicate the function of the deep neural network model;

determining the model function indicator character corresponding to the trained deep neural network model; and

determining the type of the difference measurement index used by the trained deep neural network model, according to the corresponding relationship between the difference measurement index and the model function indicator character, and the model function indicator character corresponding to the trained deep neural network model.

5. The neural network model training method as claimed in claim 4, wherein the type

of the difference measurement index comprises cross-entropy coefficient, Jacquard coefficient and dice coefficient, the model function indicator character indicating that the deep neural network model is used for image classification is corresponding to the cross-entropy coefficient, the model function indicator character indicating that the deep neural network model is used for image segmentation is corresponding to the Jaccard coefficient or dice coefficient.

6. The neural network model training method as claimed in claim 1 or 2, wherein the step of calculating a similarity between the training samples in the training set and each comparison sample comprises:

performing feature extraction on each training sample of the training set according to a preset feature extraction model to obtain a feature vector of each training sample, the preset image feature extraction model being a feature extraction model trained based on a convolutional neural network;

performing feature extraction on the comparison sample according to the preset feature extraction model to obtain a feature vector of each comparison sample; and

calculating the similarity between the training sample in the training set and the comparison sample according to the feature vector of each training sample and the feature vector of each comparison sample.

7. The neural network model training method as claimed in claim 6, wherein the step of calculating the similarity between the training sample in the training set and the comparison sample according to the feature vector of each training sample and the feature vector of each comparison sample comprises:

calculating a cosine distance between the feature vector of each training sample and the feature vector of each comparison sample; and

taking the cosine distance between the feature vector of each training sample and the feature vector of each comparison sample as the similarity between each training sample and each comparison sample.

8. A neural network model training apparatus, comprising:

a training module, for training a deep neural network model according to training samples in a training set to obtain a trained deep neural network model;

a verification module, for performing data verification on all reference samples in the reference set according to the trained deep neural network model, trained by the training module, to obtain a model prediction value of each reference sample in all reference samples, and the reference set comprising a verification set and/or a test set;

a first calculation module, for calculating a difference measurement index between the model prediction value of each reference sample, obtained by the verification module, and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data;

a first determination module, for taking target reference samples of which the difference measurement index, calculated by the first calculation module, is lower than or equal to a preset threshold in all the reference samples as comparison samples;

a second calculation module, for calculating a similarity between the training sample in the training set and each comparison sample determined by the first determining module;

a second determination module, for taking the training sample of which the similarity with the comparison sample, calculated by the second calculation module, meets a preset amplification condition as a sample to be amplified;

an amplification module, for performing data amplification on the sample to be amplified, determined by the second determining module, to obtain a target training sample; and

the training module, for taking the target training sample, obtained by the amplification module, as the training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

9. The neural network model training apparatus as claimed in claim 8, wherein the training module is further provided for taking the target training sample as a training

sample in the training set to train the trained deep neural network model until the difference measurement index corresponding to each verification sample of all the verification samples in the verification set is lower than or equal to the preset threshold.

10. The neural network model training apparatus as claimed in claim 8 or 9, wherein the first calculation module is further provided for:

determining a type of the difference measurement index used by the trained deep neural network model; and

calculating the difference measurement index between the model prediction value of each reference sample and the real annotation corresponding to each reference sample, according to the type of the difference measurement index.

11. A computer device, comprising a memory, a processor, and computer readable instructions stored in the memory and run in the processor, wherein the processor executes the computer readable instructions to implement the steps of:

training a deep neural network model according to training samples in a training set to obtain a trained deep neural network model;

performing data verification on all reference samples in a reference set according to the trained deep neural network model to obtain a model prediction value of each reference sample in all reference samples, and the reference set comprising a verification set and/or a test set;

calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data;

taking a target reference sample of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as a comparison sample;

calculating a similarity between the training sample in the training set and each comparison sample;

taking the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified;

performing data amplification on the sample to be amplified to obtain a target training sample; and

taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

12. The computer device as claimed in claim 11, wherein the step of taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition comprises:
taking the target training sample as a training sample in the training set to train the trained deep neural network model until the difference measurement index corresponding to each verification sample of all the verification samples in the verification set is lower than or equal to the preset threshold.

13. The computer device as claimed in claim 11 or 12, wherein the step of calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample comprises:

determining a type of the difference measurement index used by the trained deep neural network model; and

calculating the difference measurement index between the model prediction value of each reference sample and the real annotation corresponding to each reference sample, according to the type of the difference measurement index.

14. The computer device as claimed in claim 13, wherein the step of determining a type of the difference measurement index used by the trained deep neural network model comprises:
acquiring a preset index corresponding list, the preset index list comprising a corresponding relationship between the type of the difference measurement index and a model function indicator character, and the model function indicator character

being used to indicate the function of the deep neural network model;

determining the model function indicator character corresponding to the trained deep neural network model; and

determining the type of the difference measurement index used by the trained deep neural network model, according to the corresponding relationship between the difference measurement index and the model function indicator character, and the model function indicator character corresponding to the trained deep neural network model.

15. The computer device as claimed in claim 14, wherein the type of the difference measurement index comprises cross-entropy coefficient, Jacquard coefficient and dice coefficient, the model function indicator character indicating that the deep neural network model is used for image classification is corresponding to the cross-entropy coefficient, the model function indicator character indicating that the deep neural network model is used for image segmentation is corresponding to the Jaccard coefficient or dice coefficient.

16. One or more non-volatile computer readable storage stored with computer programs, wherein when the computer readable instructions executed by one or more processors, one or more processors are caused to implement the following steps:

training a deep neural network model according to training samples in a training set to obtain a trained deep neural network model;

performing data verification on all reference samples in a reference set according to the trained deep neural network model to obtain a model prediction value of each reference sample in all reference samples, and the reference set comprising a verification set and/or a test set;

calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample, and each reference sample being pre-annotated with data;

taking a target reference sample of which the difference measurement index is lower than or equal to a preset threshold in all the reference samples as a comparison

sample;

calculating a similarity between the training sample in the training set and each comparison sample;

taking the training sample of which the similarity with the comparison sample meets a preset amplification condition as a sample to be amplified;

performing data amplification on the sample to be amplified to obtain a target training sample; and

taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition.

17. The non-volatile computer readable storage as claimed in claim 16, wherein the step of taking the target training sample as a training sample in the training set to train the trained deep neural network model until the model prediction values of all verification samples in the verification set meet a preset training ending condition comprise:

taking the target training sample as a training sample in the training set to train the trained deep neural network model until the difference measurement index corresponding to each verification sample of all the verification samples in the verification set is lower than or equal to the preset threshold.

18. The non-volatile computer readable storage as claimed in claim 16 or 17, wherein the step of calculating a difference measurement index between the model prediction value of each reference sample and a real annotation corresponding to each reference sample comprises:

determining a type of the difference measurement index used by the trained deep neural network model; and

calculating the difference measurement index between the model prediction value of each reference sample and the real annotation corresponding to each reference sample, according to the type of the difference measurement index.

19. The non-volatile computer readable storage as claimed in claim 18, wherein the step of determining a type of the difference measurement index used by the trained deep neural network model comprises:

acquiring a preset index corresponding list, the preset index list comprising a corresponding relationship between the type of the difference measurement index and a model function indicator character, and the model function indicator character being used to indicate the function of the deep neural network model;

determining the model function indicator character corresponding to the trained deep neural network model; and

determining the type of the difference measurement index used by the trained deep neural network model, according to the corresponding relationship between the difference measurement index and the model function indicator character, and the model function indicator character corresponding to the trained deep neural network model.

20. The non-volatile computer readable storage as claimed in claim 19, wherein the type of the difference measurement index comprises cross-entropy coefficient, Jacquard coefficient and dice coefficient, the model function indicator character indicating that the deep neural network model is used for image classification is corresponding to the cross-entropy coefficient, the model function indicator character indicating that the deep neural network model is used for image segmentation is corresponding to the Jaccard coefficient or dice coefficient.