

Claims

1. A device fault prediction method, comprising:

determining feature information of a target device and detection point data information

5 corresponding to the target device;

determining, based on the feature information of the target device and the detection point data information corresponding to the target device, a probability distribution model of feature data of the target device and a probability distribution model of detection point data with unshared data;

10 determining a weight of the unshared data according to the probability distribution model of the feature data and the probability distribution model of the detection point data;

establishing a federated learning model according to the unshared data, the weight of the unshared data and a device fault label corresponding to the unshared data; and

predicting a device fault of the target device according to the federated learning model.

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2. The method according to claim 1, wherein the step of determining a weight of the unshared data according to the probability distribution model of the feature data and the probability distribution model of the detection point data comprises:

determining a target device distribution probability of the unshared data according to the probability distribution model of the feature data;

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determining a detection point distribution probability of the unshared data according to the probability distribution model of the detection point data; and

determining a ratio of the target device distribution probability of the unshared data to the detection point distribution probability of the unshared data as the weight of the unshared data.

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3. The method according to claim 1, wherein the step of determining, based on the feature information of the target device and the detection point data information corresponding to the target device, a probability distribution model of feature data of the target device and a probability distribution model of detection point data with unshared data comprises:

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determining, based on the feature information of the target device and the detection point data information corresponding to the target device, the feature data of the target device and the

detection point data with the unshared data;

calculating data distribution of the feature data according to a feature data parameter model, and determining the feature data parameter model with determined parameters as the probability distribution model of the feature data; and

5 calculating data distribution of the detection point data according to a detection point data parameter model, and determining the detection point data parameter model with determined parameters as the probability distribution model of the detection point data.

10 ~~4. The method according to claim 3, wherein the feature data parameter model and/or the detection point data parameter model comprise/comprises a Gaussian mixture model.~~

54. The method according to claim 1, wherein the step of establishing a federated learning model according to the unshared data, the weight of the unshared data and a device fault label corresponding to the unshared data comprises:

15 determining a detection point local model according to the unshared data, the weight of the unshared data and the device fault label corresponding to the unshared data; and

establishing the federated learning model according to at least two detection point local models.

20 ~~6. The method according to claim 5, wherein the step of establishing the federated learning model according to at least two detection point local models comprises:~~

~~repeatedly iterating the at least two detection point local models based on a combined learning algorithm, and establishing the federated learning model based on at least two iterated detection point local models.~~

25 ~~7. The method according to claim 5, wherein the detection point local model comprises a neural network model or a regression model.~~

85. A device fault prediction method, comprising:

30 acquiring, according to attributes of a target device, a training data set configured to establish a prediction model for the target device, wherein sample data in the data set is shared

data;

calculating a weight of each piece of sample data in the training data set;

training a fault prediction local model of the target device by using the weights;

establishing a combined model based on the fault prediction local model and a combined

5 learning algorithm; and

performing fault prediction on the target device according to the combined model.

96. The device fault prediction method according to claim 85, wherein the sample data in the training data set comprises feature data of the target device, feature data of sample devices and fault data of the sample devices; and the sample devices are devices related to or similar to the target device;

~~10. The device fault prediction method according to claim 9, wherein the step of calculating a weight of each piece of sample data in the training data set comprises: for each of the sample~~
15 devices,

differentiating the feature data of sample devices from the feature data of the target device;

training a classification model according to the feature data after differentiation; and

calculating the weight of each piece of feature data of the sample devices according to the trained classification model.

~~117. The device fault prediction method according to claim 106, wherein the step of calculating a weight of each piece of sample data in the training data set comprises: for each of the sample devices,~~
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marking the feature data of the sample devices as first data, and marking the feature data of the target device as second data; and

training the classification model according to the first data and the second data, the classification model being a combined-learning-based classification model;

in the step of calculating the weight of each piece of feature data of the sample devices according to the trained classification model, a calculation formula of the weight is:

$$\omega_i = \frac{P_{2i}}{P_{1i}}$$

where ω_i denotes a weight of an i^{th} piece of data in the first data, P_{1i} denotes a probability of the i^{th} piece of data belonging to the sample device, and P_{2i} denotes a probability of the i^{th} piece of data belonging to the target device.

5 ~~128.~~ The device fault prediction method according to claim ~~106~~, wherein the step of training a fault prediction local model of the target device by using the weights comprises:—

training, according to the feature data of each of the sample devices, the weight of each piece of feature data of the sample device and the fault data of each of the sample devices, the fault prediction local model of the target device on training data sets with weights of the sample devices respectively by using a neural network;—

~~13. The device fault prediction method according to claim 10, wherein the step of establishing a combined model based on the fault prediction local model and a combined learning algorithm comprises:—~~

15 performing repeated iteration by using the combined learning algorithm according to the fault prediction local mode, to obtain a combined model of the sample devices on the training data sets with respect to the target device.

~~14. The device fault prediction method according to claim 9, wherein the target device and the sample devices are edge nodes in an Internet of Things, the feature data of the target device is not exposed to other sample devices, and the feature data and the fault data of each of the sample devices are not exposed to other sample devices and the target device.~~

~~159.~~ A device state prediction method, comprising:

25 acquiring at least two pieces of feature data corresponding to a target device, at least two pieces of model training data corresponding to at least two reference devices and device state labels corresponding to the model training data respectively, the target device and the reference devices being of a same device type;

determining error weights corresponding to the model training data according to the feature data; and

performing model training according to the model training data, the device state labels

corresponding to the model training data respectively and the error weights corresponding to the model training data respectively, to determine a device state prediction model, the device state prediction model being configured to predict a device state of the target device.

5 ~~46~~10. The method according to claim ~~45~~9, wherein the step of determining error weights corresponding to the model training data according to the feature data comprises:

 determining replacement data corresponding to the model training data from the feature data;

10 determining first distribution information of the model training data in the model training data corresponding to the reference device to which the model training data belongs and second distribution information of the replacement data in the feature data; and

 determining the error weights corresponding to the model training data according to the first distribution information of the model training data and the second distribution information of the replacement data corresponding to the model training data.

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~~47~~11. The method according to claim ~~46~~10, wherein the step of determining first distribution information of the model training data in the model training data corresponding to the reference device to which the model training data belongs and second distribution information of the replacement data in the feature data comprises: _

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 determining, based on a first non-parameter estimation method corresponding to the reference device to which the model training data belongs, a first distribution probability of the model training data in the model training data corresponding to the reference device to which the model training data belongs, and determining the first distribution probability as the first distribution information; and _

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 determining a second distribution probability of the replacement data in the feature data based on a second non-parameter estimation method, and determining the second distribution probability as the second distribution information; _

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~~18. The method according to claim 17, wherein the first non-parameter estimation method and the second non-parameter estimation method are kernel density estimation algorithms.~~

~~19. The method according to claim 17, wherein the step of determining the error weights corresponding to the model training data according to the first distribution information of the model training data and the second distribution information of the replacement data corresponding to the model training data comprises: _~~

5 for each piece of the model training data, determining a distribution probability ratio of the second distribution probability of the replacement data corresponding to the model training data to the first distribution probability of the model training data, and determining the distribution probability ratio as the error weight corresponding to the model training data.

10 ~~20. The method according to claim 15, wherein the method is applied to an edge server or a local server corresponding to the target device.~~

~~21~~12. The method according to claim ~~15~~9, wherein the step of performing model training according to the model training data, the device state labels corresponding to the model training data respectively and the error weights corresponding to the model training data respectively, to
15 determine a device state prediction model comprises:

A1. determining first errors corresponding to the model training data according to a prediction result of substituting the model training data into a to-be-predicted model and the device state labels corresponding to the model training data, and determining second errors
20 corresponding to the model training data according to the first errors corresponding to the model training data and the error weights;

A2. determining whether a number of iterations is met or the second errors corresponding to the model training data meet a preset condition, if yes, determining the to-be-predicted model as a device state prediction model, and if no, performing A3; and

25 A3. adjusting model parameters in the to-be-predicted model according to the second errors corresponding to the model training data, to determine adjusted model parameters, replacing the model parameters in the to-be-predicted model with the adjusted model parameters, and performing A1.

30 ~~22~~13. A device fault prediction apparatus, comprising:
an information determination module configured to determine feature information of a

target device and detection point data information corresponding to the target device;

a probability model determination module configured to determine, based on the feature information of the target device and the detection point data information corresponding to the target device, a probability distribution model of feature data of the target device and a

5 probability distribution model of detection point data with unshared data;

a weight determination module configured to determine a weight of the unshared data according to the probability distribution model of the feature data and the probability distribution model of the detection point data;

10 a model establishment module configured to establish a federated learning model according to the unshared data, the weight of the unshared data and a device fault label corresponding to the unshared data; and

a prediction module configured to predict a device fault of the target device according to the federated learning model.

15 ~~23. A device fault prediction apparatus, wherein the device fault prediction apparatus comprises: a data acquisition module, a weight calculation module, a local model training module, a combined model establishment module and a fault prediction module, wherein~~

~~the data acquisition module is configured to acquire, according to attributes of a target device, a training data set configured to establish a prediction model for the target device,~~
20 ~~wherein sample data in the data set is shared data;~~

~~the weight calculation module is configured to calculate a weight of each piece of sample data in the training data set;~~

~~the local model training module is configured to train a fault prediction local model of the target device by using the weights;~~

25 ~~the combined model establishment module is configured to establish a combined model based on the fault prediction local model and a combined learning algorithm; and~~

~~the fault prediction module is configured to perform fault prediction on the target device according to the combined model.~~

30 ~~24. A device state prediction apparatus, comprising:~~

~~an acquisition module configured to acquire at least two pieces of feature data~~

~~corresponding to a target device, at least two pieces of model training data corresponding to at least two reference devices and device state labels corresponding to the model training data respectively, the target device and the reference devices being of a same device type;~~

~~a weight determination module configured to determine error weights corresponding to the model training data according to the feature data; and~~

~~a training module configured to perform model training according to the model training data, the device state labels corresponding to the model training data respectively and the error weights corresponding to the model training data respectively, to determine a device state prediction model, the device state prediction model being configured to predict a device state of the target device.~~

~~2514. A readable medium, comprising execution instructions, when a processor of an electronic device executes the execution instructions, the electronic device performing the method according to any one of claims 1 to 21.~~

~~2615. An electronic device, comprising a processor and a memory storing execution instructions, when the processor executes the execution instructions stored by the memory, the processor performing the method according to any one of claims 1 to 21.~~