

CLAIMS

What is claimed is:

1. A method for training a graph neural network, comprising:
 - 5 performing multiple rounds of updating on a graph neural network based on a relational graph, a round of the multiple rounds including:
 - processing the relational graph by using a current graph neural network, to obtain multiple classification prediction vectors corresponding to multiple nodes in the relational graph;
 - 10 allocating a corresponding pseudo classification label to a first quantity of unlabeled nodes in the multiple nodes based on the multiple classification prediction vectors;
 - determining, for each of the first quantity of unlabeled nodes, an information gain generated by training the current graph neural network by using the
 - 15 unlabeled node; and
 - updating a model parameter in the current graph neural network according to a classification prediction vector and a real classification label that are corresponding to each labeled node in the multiple nodes, and a classification prediction vector, a pseudo classification label, and the information gain that are corresponding to
 - 20 each unlabeled node.
 2. The method according to claim 1, wherein the multiple nodes comprise a second quantity of unlabeled nodes, and classification prediction vectors comprise multiple prediction probabilities corresponding to multiple categories;
 - 25 wherein the allocating the corresponding pseudo classification label to the first quantity of unlabeled nodes in the multiple nodes based on the multiple classification prediction vectors includes:
 - for each node in the second quantity of unlabeled nodes, in response to that a maximum prediction probability included in a classification prediction vector
 - 30 corresponding to the node reaches a threshold, classifying the node into the first quantity of unlabeled nodes, and determining a category corresponding to the maximum prediction probability as a pseudo classification label of the node.

3. The method according to claim 1, wherein the determining, for each of the first quantity of unlabeled nodes, the information gain generated by training the current graph neural network by using the unlabeled node includes:

for a first unlabeled node of the first quantity of unlabeled nodes,

5 training the current graph neural network by using a first classification prediction vector and a pseudo classification label that are corresponding to the first unlabeled node, and determining a second classification prediction vector of the first unlabeled node based on a trained first graph neural network;

 determining first information entropy according to the first classification
10 prediction vector;

 determining second information entropy according to the second classification prediction vector; and

 obtaining the information gain based on a difference between the second information entropy and the first information entropy.

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4. The method according to claim 3, wherein the trained first graph neural network comprises multiple aggregation layers and an output layer; and the determining the second classification prediction vector of the first unlabeled node based on the trained first graph neural network includes:

20 performing, at an aggregation layer in the multiple aggregation layers, random zeroing processing on vector elements in multiple aggregation vectors for the multiple nodes that are output by an upper aggregation layer, and determining, based on the multiple aggregation vectors after the random zeroing processing, multiple aggregation vectors that are output by the aggregation layer for the multiple nodes; and

25 processing, at the output layer, an aggregation vector output by a last aggregation layer for the first unlabeled node, to obtain the second classification prediction vector.

5. The method according to claim 3, wherein the trained first graph neural
30 network comprises multiple aggregation layers and an output layer; and the determining the second classification prediction vector of the first unlabeled node based on the trained first graph neural network includes:

performing, at an aggregation layer in the multiple aggregation layers, random zeroing processing on a matrix element in an adjacency matrix corresponding to the relational graph, and determining, based on the adjacency matrix after the random zeroing processing and multiple aggregation vectors that are output by an upper aggregation layer for the multiple nodes, multiple aggregation vectors for the multiple nodes that are output by the aggregation layer; and

processing, at the output layer, an aggregation vector output by a last aggregation layer for the first unlabeled node, to obtain the second classification prediction vector.

6. The method according to claim 4, wherein the determining the second classification prediction vector of the unlabeled node based on the trained first graph neural network includes:

performing for multiple times an operation of determining the second classification prediction vector to correspondingly obtain multiple second classification prediction vectors;

wherein the determining the second information entropy according to the second classification prediction vector includes:

determining an average value of multiple pieces of information entropy respectively corresponding to the multiple second classification prediction vectors as the second information entropy.

7. The method according to claim 1, wherein the updating the model parameter in the current graph neural network according to the classification prediction vector and the real classification label that are corresponding to each labeled node in the multiple nodes, and the classification prediction vector, the pseudo classification label, and the information gain that are corresponding to each unlabeled node includes:

determining a first loss term according to the classification prediction vector and the real classification label that are corresponding to each labeled node;

determining a second loss term for each unlabeled node according to the classification prediction vector and the pseudo classification label that are corresponding to each unlabeled node, and weighting the second loss term by using the information gain corresponding to the unlabeled node; and

updating the model parameter according to the first loss term and the weighted second loss term.

8. The method according to claim 7, wherein the weighting the second loss term
5 by using the information gain corresponding to the unlabeled node includes:

normalizing the information gain of each unlabeled node by using a first quantity of information gains corresponding to the first quantity of unlabeled nodes, to obtain a corresponding weighting coefficient; and

performing weighting processing by using the weighting coefficient.

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9. A computing system, comprising at least one memory and at least one processor, the at least one memory storing executable instructions, which when executed by the at least one processor enable the at least one processor to implement actions including:

15 performing multiple rounds of updating on a graph neural network based on a relational graph, a round of the multiple rounds including:

processing the relational graph by using a current graph neural network, to obtain multiple classification prediction vectors corresponding to multiple nodes in the relational graph;

20 allocating a corresponding pseudo classification label to a first quantity of unlabeled nodes in the multiple nodes based on the multiple classification prediction vectors;

determining, for each of the first quantity of unlabeled nodes, an information gain generated by training the current graph neural network by using the
25 unlabeled node; and

updating a model parameter in the current graph neural network according to a classification prediction vector and a real classification label that are corresponding to each labeled node in the multiple nodes, and a classification prediction vector, a pseudo classification label, and the information gain that are corresponding to
30 each unlabeled node.

10. The computing system according to claim 9, wherein the multiple nodes comprise a second quantity of unlabeled nodes, and classification prediction vectors comprise multiple prediction probabilities corresponding to multiple categories;

5 wherein the allocating the corresponding pseudo classification label to the first quantity of unlabeled nodes in the multiple nodes based on the multiple classification prediction vectors includes:

10 for each node in the second quantity of unlabeled nodes, in response to that a maximum prediction probability included in a classification prediction vector corresponding to the node reaches a threshold, classifying the node into the first quantity of unlabeled nodes, and determining a category corresponding to the maximum prediction probability as a pseudo classification label of the node.

11. The computing system according to claim 9, wherein the determining, for each of the first quantity of unlabeled nodes, the information gain generated by training
15 the current graph neural network by using the unlabeled node includes:

for a first unlabeled node of the first quantity of unlabeled nodes,

20 training the current graph neural network by using a first classification prediction vector and a pseudo classification label that are corresponding to the first unlabeled node, and determining a second classification prediction vector of the first unlabeled node based on a trained first graph neural network;

determining first information entropy according to the first classification prediction vector;

determining second information entropy according to the second classification prediction vector; and

25 obtaining the information gain based on a difference between the second information entropy and the first information entropy.

12. The computing system according to claim 11, wherein the trained first graph neural network comprises multiple aggregation layers and an output layer; and the
30 determining the second classification prediction vector of the first unlabeled node based on the trained first graph neural network includes:

performing, at an aggregation layer in the multiple aggregation layers, random zeroing processing on vector elements in multiple aggregation vectors for the multiple

nodes that are output by an upper aggregation layer, and determining, based on the multiple aggregation vectors after the random zeroing processing, multiple aggregation vectors that are output by the aggregation layer for the multiple nodes; and

5 processing, at the output layer, an aggregation vector output by a last aggregation layer for the first unlabeled node, to obtain the second classification prediction vector.

13. The computing system according to claim 11, wherein the trained first graph neural network comprises multiple aggregation layers and an output layer; and the
10 determining the second classification prediction vector of the first unlabeled node based on the trained first graph neural network includes:

performing, at an aggregation layer in the multiple aggregation layers, random zeroing processing on a matrix element in an adjacency matrix corresponding to the relational graph, and determining, based on the adjacency matrix after the random
15 zeroing processing and multiple aggregation vectors that are output by an upper aggregation layer for the multiple nodes, multiple aggregation vectors for the multiple nodes that are output by the aggregation layer; and

processing, at the output layer, an aggregation vector output by a last aggregation layer for the first unlabeled node, to obtain the second classification
20 prediction vector.

14. The computing system according to claim 13, wherein the determining the second classification prediction vector of the unlabeled node based on the trained first graph neural network includes:

25 performing for multiple times an operation of determining the second classification prediction vector to correspondingly obtain multiple second classification prediction vectors;

wherein the determining the second information entropy according to the second classification prediction vector includes:

30 determining an average value of multiple pieces of information entropy respectively corresponding to the multiple second classification prediction vectors as the second information entropy.

15. The computing system according to claim 9, wherein the updating the model parameter in the current graph neural network according to the classification prediction vector and the real classification label that are corresponding to each labeled node in the multiple nodes, and the classification prediction vector, the pseudo classification label, and the information gain that are corresponding to each unlabeled node includes:

5 determining a first loss term according to the classification prediction vector and the real classification label that are corresponding to each labeled node;

determining a second loss term for each unlabeled node according to the classification prediction vector and the pseudo classification label that are

10 corresponding to each unlabeled node, and weighting the second loss term by using the information gain corresponding to the unlabeled node; and

updating the model parameter according to the first loss term and the weighted second loss term.

15 16. The computing system according to claim 15, wherein the weighting the second loss term by using the information gain corresponding to the unlabeled node includes:

normalizing the information gain of each unlabeled node by using a first quantity of information gains corresponding to the first quantity of unlabeled nodes, to

20 obtain a corresponding weighting coefficient; and

performing weighting processing by using the weighting coefficient.

17. A non-transitory computer readable storage medium that stores computer executable instructions, which when executed by a processor, configure the processor

25 to perform actions comprising:

performing multiple rounds of updating on a graph neural network based on a relational graph, a round of the multiple rounds including:

processing the relational graph by using a current graph neural network, to obtain multiple classification prediction vectors corresponding to multiple nodes in

30 the relational graph;

allocating a corresponding pseudo classification label to a first quantity of unlabeled nodes in the multiple nodes based on the multiple classification prediction vectors;

determining, for each of the first quantity of unlabeled nodes, an information gain generated by training the current graph neural network by using the unlabeled node; and

5 updating a model parameter in the current graph neural network according to a classification prediction vector and a real classification label that are corresponding to each labeled node in the multiple nodes, and a classification prediction vector, a pseudo classification label, and the information gain that are corresponding to each unlabeled node.

10 18. The storage medium according to claim 16, wherein the multiple nodes comprise a second quantity of unlabeled nodes, and classification prediction vectors comprise multiple prediction probabilities corresponding to multiple categories;

wherein the allocating the corresponding pseudo classification label to the first quantity of unlabeled nodes in the multiple nodes based on the multiple classification
15 prediction vectors includes:

for each node in the second quantity of unlabeled nodes, in response to that a maximum prediction probability included in a classification prediction vector corresponding to the node reaches a threshold, classifying the node into the first quantity of unlabeled nodes, and determining a category corresponding to the maximum
20 prediction probability as a pseudo classification label of the node.

19. The storage medium according to claim 17, wherein the determining, for each of the first quantity of unlabeled nodes, the information gain generated by training the current graph neural network by using the unlabeled node includes:

25 for a first unlabeled node of the first quantity of unlabeled nodes, training the current graph neural network by using a first classification prediction vector and a pseudo classification label that are corresponding to the first unlabeled node, and determining a second classification prediction vector of the first unlabeled node based on a trained first graph neural network;

30 determining first information entropy according to the first classification prediction vector;

determining second information entropy according to the second classification prediction vector; and

obtaining the information gain based on a difference between the second information entropy and the first information entropy.

20. The storage medium according to claim 19, wherein the trained first graph
5 neural network comprises multiple aggregation layers and an output layer; and the determining the second classification prediction vector of the first unlabeled node based on the trained first graph neural network includes:

performing, at an aggregation layer in the multiple aggregation layers, random
zeroing processing on vector elements in multiple aggregation vectors for the multiple
10 nodes that are output by an upper aggregation layer, and determining, based on the multiple aggregation vectors after the random zeroing processing, multiple aggregation vectors that are output by the aggregation layer for the multiple nodes; and

processing, at the output layer, an aggregation vector output by a last
aggregation layer for the first unlabeled node, to obtain the second classification
15 prediction vector.