

WHAT IS CLAIMED IS:

1. A computer-implemented method comprising:
 - receiving, with at least one processor, network resource data associated with network resource activity of a plurality of users on a network comprising at least one network resource;
 - generating, with at least one processor, a plurality of layers of a multilayer graph from the network resource data, wherein each layer of the plurality of layers comprises a plurality of nodes connected by a plurality of edges, each node of the plurality of nodes is associated with a user of the plurality of users, each edge of the plurality of edges represents an interdependency of nodes, and each layer represents interdependencies of nodes according to a unique parameter of network resource activity;
 - generating, with at least one processor, an adjacency matrix associated with each layer of the plurality of layers to produce a plurality of adjacency matrices;
 - assigning, with at least one processor, a weight to each adjacency matrix of the plurality of adjacency matrices to produce a plurality of weights;
 - generating, with at least one processor, a merged single layer graph by merging the plurality of layers based on a weighted sum of the plurality of adjacency matrices using the plurality of weights, the merged single layer graph comprising a merged set of nodes;
 - generating, with at least one processor, a set of anomaly scores by generating, for each node in the merged set of nodes, an anomaly score based on an attribute of said node and at least one attribute of at least one peer node to which said node is connected in the merged set of nodes; and
 - determining, with at least one processor, a set of anomalous users of the plurality of users based on the set of anomaly scores.
2. The computer-implemented method of claim 1, further comprising:
 - (a) modifying, with at least one processor, the plurality of weights based on at least one loss function to produce a modified plurality of weights;

(b) generating, with at least one processor, an updated merged single layer graph by merging the plurality of layers based on a weighted sum of the plurality of adjacency matrices using the modified plurality of weights;

(c) generating, with at least one processor, a new set of anomaly scores based on the updated merged single layer graph; and

(d) updating, with at least one processor, the set of anomalous users based on the new set of anomaly scores.

3. The computer-implemented method of claim 2, wherein the at least one loss function comprises a weighted sum of at least two loss functions, and wherein the at least two loss functions comprises a loss function based at least partly on the merged single layer graph.

4. The computer-implemented method of claim 3, wherein the at least two loss functions further comprise a loss function based at least partly on input feedback of externally identified anomalous users.

5. The computer-implemented method of claim 3, further comprising repeatedly executing steps (a)-(d) in an unsupervised training environment by altering weights of the weighted sum of the at least two loss functions before each new execution of step (a).

6. The computer-implemented method of claim 4, further comprising repeatedly executing steps (a)-(d) in an at least partly supervised training environment by receiving new input feedback of externally identified anomalous users and by altering weights of the weighted sum of the at least two loss functions before each new execution of step (a).

7. The computer-implemented method of claim 1, further comprising:

detecting, with at least one processor, fraudulent network activity based on the set of anomalous users; and

in response to detecting fraudulent network activity, executing, with at least one processor, at least one fraud mitigation process.

8. A system comprising a server comprising at least one processor, the server being programmed or configured to:

receive network resource data associated with network resource activity of a plurality of users on a network comprising at least one network resource;

generate a plurality of layers of a multilayer graph from the network resource data, wherein each layer of the plurality of layers comprises a plurality of nodes connected by a plurality of edges, each node of the plurality of nodes is associated with a user of the plurality of users, each edge of the plurality of edges represents an interdependency of nodes, and each layer represents interdependencies of nodes according to a unique parameter of network resource activity;

generate an adjacency matrix associated with each layer of the plurality of layers to produce a plurality of adjacency matrices;

assign a weight to each adjacency matrix of the plurality of adjacency matrices to produce a plurality of weights;

generate a merged single layer graph by merging the plurality of layers based on a weighted sum of the plurality of adjacency matrices using the plurality of weights, the merged single layer graph comprising a merged set of nodes;

generate a set of anomaly scores by generating, for each node in the merged set of nodes, an anomaly score based on an attribute of said node and at least one attribute of at least one peer node to which said node is connected in the merged set of nodes; and

determine a set of anomalous users of the plurality of users based on the set of anomaly scores.

9. The system of claim 8, wherein the server is further programmed or configured to:

(a) modify the plurality of weights based on at least one loss function to produce a modified plurality of weights;

(b) generate an updated merged single layer graph by merging the plurality of layers based on a weighted sum of the plurality of adjacency matrices using the modified plurality of weights;

(c) generate a new set of anomaly scores based on the updated merged single layer graph; and

(d) update the set of anomalous users based on the new set of anomaly scores.

10. The system of claim 9, wherein the at least one loss function comprises a weighted sum of at least two loss functions, and wherein the at least two loss functions comprises a loss function based at least partly on the merged single layer graph.

11. The system of claim 10, wherein the at least two loss functions further comprise a loss function based at least partly on input feedback of externally identified anomalous users.

12. The system of claim 10, wherein the server is further programmed or configured to repeatedly execute steps (a)-(d) in an unsupervised training environment by altering weights of the weighted sum of the at least two loss functions before each new execution of step (a).

13. The system of claim 11, wherein the server is further programmed or configured to repeatedly execute steps (a)-(d) in an at least partly supervised training environment by receiving new input feedback of externally identified anomalous users and by altering weights of the weighted sum of the at least two loss functions before each new execution of step (a).

14. The system of claim 8, wherein the server is further programmed or configured to:

detect fraudulent network activity based on the set of anomalous users;

and

in response to detecting fraudulent network activity, execute at least one fraud mitigation process.

15. A computer program product comprising at least one non-transitory computer-readable medium including program instructions that, when executed by at least one processor, cause the at least one processor to:

receive network resource data associated with network resource activity of a plurality of users on a network comprising at least one network resource;

generate a plurality of layers of a multilayer graph from the network resource data, wherein each layer of the plurality of layers comprises a plurality of nodes connected by a plurality of edges, each node of the plurality of nodes is associated with a user of the plurality of users, each edge of the plurality of edges represents an interdependency of nodes, and each layer represents interdependencies of nodes according to a unique parameter of network resource activity;

generate an adjacency matrix associated with each layer of the plurality of layers to produce a plurality of adjacency matrices;

assign a weight to each adjacency matrix of the plurality of adjacency matrices to produce a plurality of weights;

generate a merged single layer graph by merging the plurality of layers based on a weighted sum of the plurality of adjacency matrices using the plurality of weights, the merged single layer graph comprising a merged set of nodes;

generate a set of anomaly scores by generating, for each node in the merged set of nodes, an anomaly score based on an attribute of said node and at least one attribute of at least one peer node to which said node is connected in the merged set of nodes; and

determine a set of anomalous users of the plurality of users based on the set of anomaly scores.

16. The computer program product of claim 15, wherein the program instructions further cause the at least one processor to:

(a) modify the plurality of weights based on at least one loss function to produce a modified plurality of weights;

(b) generate an updated merged single layer graph by merging the plurality of layers based on a weighted sum of the plurality of adjacency matrices using the modified plurality of weights;

(c) generate a new set of anomaly scores based on the updated merged single layer graph; and

(d) update the set of anomalous users based on the new set of anomaly scores.

17. The computer program product of claim 16, wherein the at least one loss function comprises a weighted sum of at least two loss functions, and wherein the at least two loss functions comprises a loss function based at least partly on the merged single layer graph.

18. The computer program product of claim 17, wherein the at least two loss functions further comprises a loss function based at least partly on input feedback of externally identified anomalous users.

19. The computer program product of claim 18, wherein the program instructions further cause the at least one processor to repeatedly execute steps (a)-(d) in an at least partly supervised training environment by receiving new input feedback of externally identified anomalous users and by altering weights of the weighted sum of the at least two loss functions before each new execution of step (a).

20. The computer program product of claim 15, wherein the program instructions further cause the at least one processor to:

detect fraudulent network activity based on the set of anomalous users;

and

in response to detecting fraudulent network activity, execute at least one fraud mitigation process.