Claims

1. A method for determining an error threshold value when a vector distance based error measure is to be used for machine failure prediction, the method comprising:

identifying, by a first processor in a first computer system, a plurality of basic memory depth values based on a target sequence to be used for machine failure prediction;

calculating, by the first processor, an average depth value based on the plurality of basic memory depth values;

based on the average depth value, retrieving, by the first processor, an elementary error threshold value from a pre-stored table which is stored in a memory and includes a plurality of mappings wherein each mapping associates a predetermined depth value of an elementary sequence to an elementary error threshold value; and

calculating, by the first processor, an error threshold value corresponding to the target sequence based on both the retrieved elementary error threshold value and a standard deviation of the plurality of basic memory depth values.

2. The method according to claim 1, wherein the step of retrieving an elementary error threshold value based on the average depth value comprises:

retrieving, by the first processor, an elementary error threshold value corresponding to the average depth value as stored in the pre-stored table if the average depth value is equal to a depth value in the pre-stored table.

3. The method according to claim 1 or claim 2, wherein the step of retrieving an elementary error threshold value based on the average depth value comprises:

retrieving, by the first processor, an elementary error threshold value corresponding to a depth value closest to the average depth value as stored in the pre-stored table if the average depth value is not equal to any depth value in the pre-stored table.

4. The method according to any preceding claim, wherein the step of calculating an error threshold value corresponding to the target sequence comprises:

calculating, by the first processor, the error threshold value corresponding to the target sequence according to the following Equation:

$$Ec = Ee + C * \delta$$

wherein Ec refers to the error threshold value corresponding to the target sequence; Ee refers to the elementary error threshold value retrieved from the pre-stored table; C refers to a predetermined constant coefficient and δ refers to the standard deviation of the plurality of basic memory depth values in the target sequence.

5. The method according to claim 4, wherein the predetermined constant coefficient is 1/1800.

6. The method according to any one of the preceding claims, further comprising:

ascertaining, by a second processor in a second computer system, an elementary error threshold value corresponding to each of a plurality of predetermined depth values of elementary sequences by experimentation; and

storing, in a table, each mapping between an ascertained elementary error threshold value and a corresponding predetermined depth value of an elementary sequence.

7. The method according to claim 6, wherein the step of ascertaining an elementary error threshold value corresponding to a predetermined depth value of an elementary sequence, further comprises:

calculating a vector distance value between the elementary sequence and a corresponding predicted sequence which is generated by replacing 0 and 1 in the elementary sequence with two predetermined fixed values respectively; and

ascertaining, by the second processor, the elementary error threshold value corresponding to the predetermined depth value based on the calculated vector distance by experimentation.

8. The method according to claim 7, wherein the predetermined fixed value corresponding to 1 is 0.974 and the predetermined fixed value corresponding to 0 is 0.026.

9. The method according to any one of claim 6 to claim 8, wherein the first computer system and the second computer system are provided as the same computer system and the first processor and the second processor are provided as the same processor in the same computer system.

10. The method according to any preceding claim, wherein the target sequence is a composite sequence which includes a plurality of different basic memory depth values.

11. A system for determining an error threshold value when a vector distance based error measure is to be used for machine failure prediction, the system comprising: a first computer system having a first processor and a memory communicably coupled thereto, wherein the memory is configured to store data to be executed by the first processor, wherein the first processor is configured to

identify a plurality of basic memory depth values based on a target sequence to be used for machine failure prediction;

calculate an average depth value based on the plurality of basic memory depth values;

based on the average depth value, retrieve an elementary error threshold value from a pre-stored table which is stored in a memory and includes a

plurality of mappings wherein each mapping associates a predetermined depth value of an elementary sequence to an elementary error threshold value; and

calculate an error threshold value corresponding to the target sequence based on the retrieved elementary error threshold value and a standard deviation of the plurality of basic memory depth values.

12. The system according to claim 11, wherein the first processor is further configured to retrieve an elementary error threshold value corresponding to the average depth value as stored in the pre-stored table if the average depth value is equal to a depth value in the pre-stored table.

13. The system according to claim 11 or claim 12, wherein the first processor is further configured to retrieve an elementary error threshold value corresponding to a depth value closest to the average depth value as stored in the pre-stored table if the average depth value is not equal to any depth value in the pre-stored table.

14. The system according to any one of claims 11 to 13, wherein the first processor is further configured to calculate the error threshold value corresponding to the target sequence according to the following Equation:

$$Ec = Ee + C * \delta$$

wherein Ec refers to the error threshold value corresponding to the target sequence; Ee refers to the elementary error threshold value retrieved from the pre-stored table; C refers to a predetermined constant coefficient and δ refers to

the standard deviation of the plurality of basic memory depth values in the target sequence.

15. The system according to claim 14, wherein the predetermined constant coefficient is 1/1800.

16. The system according to any one of claims 11 to 15, further comprising a second computer system having a second processor system, wherein the second processor is configured to ascertain an elementary error threshold value corresponding to each of a plurality of predetermined depths values of elementary sequences by experimentation; and

store each mapping between a calculated elementary error threshold value and a predetermined depth value of an elementary sequence in a table.

17. The system according to claim 16, wherein the second processor is further configured to calculate a vector distance value between the elementary sequence and a corresponding predicted sequence which is generated by replacing 0 and 1 in the elementary sequence with two predetermined fixed values respectively; and

ascertain the elementary error threshold value corresponding to the predetermined depth value based on the calculated vector distance value by experimentation.

18. The system according to claim 17, wherein the predetermined fixed value corresponding to 1 is 0.974 and the predetermined fixed value corresponding to 0 is 0.026.

19. The system according to any one of claims 16 to 18, wherein the first computer system and the second computer system are provided as the same computer system and the first processor and the second processor are provided as the same processor in the same computer system.

20. A method for machine failure prediction using a RNN, the method comprising:

calculating, by a processor, a vector distance between an input sequence and a current predicted sequence at end of each epoch in the RNN;

comparing, by the processor, the calculated vector distance with a predetermined error threshold value to determine whether a predetermined convergence condition is satisfied, and stopping RNN training if the predetermined convergence condition is satisfied.

21. A non-transitory computer readable medium comprising computer program code for determining an error threshold value when a vector distance based error measure is to be used for machine failure prediction, wherein the computer program code, when executed, is configured to cause a processor in a computer system to perform a method according to any one of claim 1 to claim 10.