

Claims:

1. A method (100) for determining the state of health (1*) of an industrial process (1), wherein the process (1) is executed by at least one industrial plant comprising an arrangement of entities (2a-2f) and the state of each such entity (2a-2f) is characterized by a set of entity state variables (3a-3f), comprising the steps of:
 - obtaining (110) values, and/or time series of values, of the entity state variables (3a-3f);
 - for each entity (2a-2f), providing (120) the values (3a-3f), and/or time series of values (3a-3f), to a model (4a-4f) corresponding to the respective entity (2a-2f), thereby obtaining a prediction of the state of health (5a-5f) of the respective entity (2a-2f);
 - determining (130), based at least in part on the layout (1a) of the industrial plant executing the process (1), propagation paths (6) for anomalies between said entities (2a-2f);
 - determining (140), based at least in part on said propagation paths (6), importances (7a-7f) of the states of health (5a-5f) of the individual entities (2a-2f) for the overall state of health (1*) of the process; and
 - aggregating (150), based at least in part on said importances (7a-7f), the individual states of health (5a-5f) of the entities (2a-2f) to obtain the overall state of health (1*) of the process (1).
2. The method (100) of claim 1, wherein the propagation paths (6) of anomalies are determined (131) based at least in part on a topology of material and/or energy flows between entities (2a-2f).
3. The method (100) of any one of claims 1 to 2, wherein at least one known directional interaction path from a first entity (2a-2f) to a second entity (2a-2f) during normal operation of the plant is expanded (132) to a bidirectional propagation path for anomalies between the first entity and the second entity.
4. The method (100) of any one of claims 1 to 3, wherein at least one propagation path (6) specifically comprises (133) a cause-effect relationship between
 - a first entity state variable (3a-3f) of a first entity (2a-2f) and a second entity state variable (3a-3f) of a second entity (2a-2f); and/or

- occurrence of a first event in a first entity (2a-2f) and occurrence of a second event in a second entity (2a-2f).

5. The method (100) of any one of claims 1 to 4, wherein the determining (130) of at least one propagation path (6) from a first entity (2a-2f) to a second entity (2a-2f) specifically comprises:

- computing (134) a statistical impact of a first time series of a first entity state variable (3a-3f) of the first entity (2a-2f) onto a second time series of a second entity state variable (3a-3f) of the second entity (2a-2f); and
- quantifying (135) the strength of propagation of anomalies between the first and second entities (2a-2f) based at least in part on this statistical impact.

6. The method (100) of claim 5, wherein the computing (134) of a statistical impact specifically comprises: computing (134a) the Granger Causality, and/or the Transfer Entropy, between the first and second time series.

7. The method (100) of any one of claims 1 to 6, wherein the determining (130) of propagation paths (6) specifically comprises:

- verifying (136) a feasibility of each propagation path (6) from a set of candidate propagation paths (6); and
- in response to a propagation path (6) not being feasible, removing (137) this propagation path (6) from the set of candidate propagation paths (6).

8. The method (100) of any one of claims 1 to 7, wherein the importance (7a-7f) of the state of health (5a-5f) of an entity (2a-2f) increases (141) with the number, and/or the strengths, of propagation paths (6) that comprise this entity (2a-2f).

9. The method (100) of any one of claims 1 to 8, wherein the model (4a-4f) corresponding to at least one entity (2a-2f) comprises (121):

- a machine learning model; and/or
- a simulation model; and/or
- a surrogate approximation of this simulation model.

10. The method (100) of any one of claims 1 to 9, wherein the aggregating (150) of individual states of health (5a-5f) comprises computing (152) a weighted sum of these individual states of health (5a-5f), wherein the weights are determined (151) based on the importances (7a-7f) of the respective individual states of health (5a-5f).

11. The method (100) of any one of claims 1 to 10,
wherein the industrial process (1) is a chemical production process that
converts one or more educts into one or more products, and at least one entity
in the arrangement of entities is a pipe, a pump, or a tank.
- 5 12. A computer program, comprising machine-readable
instructions that, when executed by one or more computers, cause the one or
more computers to perform the method (100) of any one of claims 1 to 11.
13. A non-transitory machine-readable storage medium,
and/or a download product, with the computer program of claim 12.
- 10 14. One or more computers with the computer program
of claim 12, and/or with the non-transitory machine-readable storage medium
and/or download product of claim 13.