CLAIMS

1. A conveyance abnormality prediction system comprising:

an estimation unit that has a learned model having machine learned a relationship between a data set including sensor data outputted, at a time of substrate transport in a past, from each of a plurality of sensors provided on a substrate transport unit and a degree of conveyance abnormality at the time of the substrate transport, estimates a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted from each of the plurality of sensors at the time of the new substrate transport, and outputs the estimated degree of conveyance abnormality, wherein

the learned model is generated by machine learning by long short-term memory (LSTM) using, as teacher data, a data set including sensor data at a time of normal substrate transport in a past,

the estimation unit calculates, by using as an input a data set including actual sensor data until a time of new substrate transport, a deviation between a data set including sensor data, at the time of the new substrate transport, predicted by the learned model from the data set including actual sensor data immediately before the time of

the new substrate transport and a data set including actual sensor data at the time of the new substrate transport, and

the estimation unit estimates the degree of conveyance abnormality, based on the deviation, and outputs the estimated degree of conveyance abnormality.

2. A conveyance abnormality prediction system comprising:

an estimation unit that has a learned model having machine learned a relationship between a data set including sensor data outputted, at a time of substrate transport in a past, from each of a plurality of sensors provided on a substrate transport unit and a degree of conveyance abnormality at the time of the substrate transport, estimates a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted from each of the plurality of sensors at the time of the new substrate transport, and outputs the estimated degree of conveyance abnormality, wherein

the learned model is generated by machine learning of teacher data in which a data set including sensor data at a time of substrate transport in a past is labeled with whether the time of the substrate transport is an occurrence time of conveyance abnormality or not,

the estimation unit estimates the degree of conveyance abnormality by using, as an input, a data set including sensor data at a time of new substrate transport, based on a probability that is predicted by the learned model and indicates a probability that the time of the new substrate transport is an occurrence time of conveyance abnormality, and

the estimation unit outputs the estimated degree of conveyance abnormality.

3. The conveyance abnormality prediction system according to claim 2, wherein the learned model is generated by machine learning of teacher data in which a data set including sensor data at a time of substrate transport in a past is labeled with whether the time of the substrate transport is an occurrence time of conveyance abnormality or not and is labeled with a cause of conveyance abnormality when the time of the substrate transport is an occurrence time of conveyance abnormality,

the estimation unit estimates the degree of conveyance abnormality for each cause of conveyance abnormality by using, as an input, a data set including sensor data at a time of new substrate transport, based on a probability that is predicted by the learned model for each cause of conveyance abnormality and indicates a

probability that the time of the new substrate transport is an occurrence time of conveyance abnormality, and

the estimation unit outputs the estimated degree of conveyance abnormality.

4~~2~~. The conveyance abnormality prediction system according to any one of claims 1 to 3, wherein the plurality of sensors includes one or more than one of a vibration sensor, a sound sensor, an image sensor, a video sensor, a temperature sensor, an equipment movement speed sensor, an equipment operation torque sensor, and an equipment parallelism sensor.

5~~3~~. The conveyance abnormality prediction system according to any one of claims 1 to~~or~~ 4~~2~~, further comprising an output signal transmission unit that compares the degree of conveyance abnormality outputted by the estimation unit with a predetermined threshold value and transmits an output signal for outputting a maintenance notification and/or alarm to the output device when the degree of conveyance abnormality exceeds the predetermined threshold value.

6~~4~~. The conveyance abnormality prediction system according to any one of claims 1 to 5~~3~~, wherein the

estimation unit estimates a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data from a start of transport to a present point of time at the time of the new substrate transport, and

the estimation unit outputs the estimated degree of conveyance abnormality.

7~~5~~. The conveyance abnormality prediction system according to any one of claims 1 to 5~~3~~, wherein the estimation unit estimates a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data from a start of transport to an end of transport at the time of the new substrate transport, and

the estimation unit outputs the estimated degree of conveyance abnormality.

8~~6~~. The conveyance abnormality prediction system according to any one of claims 1 to 5~~3~~, wherein the estimation unit estimates a degree of conveyance abnormality at a time of new substrate transport of a plurality of substrates by using, as an input, a data set including sensor data from a start of transport of a first substrate of the plurality of substrates to an end of

transport of a last substrate of the plurality of substrates at the time of the new substrate transport of the plurality of substrates, and

the estimation unit outputs the estimated degree of conveyance abnormality.

9~~7~~. The conveyance abnormality prediction system according to any one of claims 1 to 8~~6~~, further comprising a relearning unit that causes the learned model to relearn by using, as teacher data, the data set including the sensor data outputted at the time of the new substrate transport.

10~~8~~. The conveyance abnormality prediction system according to any one of claims 1 to 9~~7~~, wherein the data set further includes time information of at least one of an equipment operation time, an elapsed time after maintenance, and a component use time of a substrate handling unit at the time of the substrate transport.

~~9. The conveyance abnormality prediction system according to any one of claims 1 to 108, wherein the learned model is generated by machine learning of teacher data in which a remaining time or a remaining number of times of transport from the time of the substrate transport~~

~~to an occurrence time of conveyance abnormality is associated to a data set including sensor data at a time of substrate transport in a past,~~

~~the estimation unit estimates the degree of conveyance abnormality by using as an input a data set including sensor data at a time of new substrate transport, based on the remaining time or the remaining number of times of transport predicted by the learned model, and~~

~~the estimation unit outputs the estimated degree of conveyance abnormality.~~

~~10. The conveyance abnormality prediction system according to any one of claims 1 to~~ 108~~, wherein the learned model is generated by machine learning using a k-nearest neighbor algorithm while using, as teacher data, a data set including sensor data at a time of normal substrate transport in a past,~~

~~the estimation unit estimates the degree of conveyance abnormality by using, as an input, a data set including sensor data at a time of new substrate transport and based on a distance to a k-nearest neighbor calculated by the learned model, and~~

~~the estimation unit outputs the estimated degree of conveyance abnormality.~~

~~11. The conveyance abnormality prediction system according to any one of claims 1 to 8, wherein the learned model is generated by machine learning by long short-term memory (LSTM) using, as teacher data, a data set including sensor data at a time of normal substrate transport in a past,~~

~~the estimation unit calculates, by using as an input a data set including actual sensor data until a time of new substrate transport, a deviation between a data set including sensor data, at the time of the new substrate transport, predicted by the learned model from the data set including actual sensor data immediately before the time of the new substrate transport and a data set including actual sensor data at the time of the new substrate transport, and~~

~~the estimation unit estimates the degree of conveyance abnormality, based on the deviation, and outputs the estimated degree of conveyance abnormality.~~

~~12. The conveyance abnormality prediction system according to any one of claims 1 to 8, wherein the learned model is generated by machine learning of teacher data in which a data set including sensor data at a time of substrate transport in a past is labeled with whether the time of the substrate transport is an occurrence time of conveyance abnormality or not,~~

the estimation unit estimates the degree of conveyance abnormality by using, as an input, a data set including sensor data at a time of new substrate transport, based on a probability that is predicted by the learned model and indicates a probability that the time of the new substrate transport is an occurrence time of conveyance abnormality, and

the estimation unit outputs the estimated degree of conveyance abnormality.

13. The conveyance abnormality prediction system according to claim 12, wherein the learned model is generated by machine learning of teacher data in which a data set including sensor data at a time of substrate transport in a past is labeled with whether the time of the substrate transport is an occurrence time of conveyance abnormality or not and is labeled with a cause of conveyance abnormality when the time of the substrate transport is an occurrence time of conveyance abnormality,

the estimation unit estimates the degree of conveyance abnormality for each cause of conveyance abnormality by using, as an input, a data set including sensor data at a time of new substrate transport, based on a probability that is predicted by the learned model for each cause of conveyance abnormality and indicates a

~~probability that the time of the new substrate transport is an occurrence time of conveyance abnormality, and~~

~~the estimation unit outputs the estimated degree of conveyance abnormality.~~

11~~14~~. The conveyance abnormality prediction system according to any one of claims 1 to 10~~13~~, wherein the estimation unit has a plurality of the learned models, estimates the degree of conveyance abnormality, based on a combination of predictions by the plurality of learned models, and outputs the estimated degree of conveyance abnormality.

12~~15~~. A substrate processing apparatus comprising:

a substrate transport unit; and

the conveyance abnormality prediction system according to any one of claims 1 to 11~~14~~.

13~~16~~. A conveyance abnormality prediction method executed by a computer, the method comprising:

estimating, by using a learned model having machine learned a relationship between a data set including sensor data outputted, at a time of substrate transport in a past, from each of a plurality of sensors provided on a substrate transport unit and a degree of conveyance abnormality at

the time of the substrate transport, a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted from each of the plurality of sensors at the time of the new substrate transport, and then outputting the estimated degree of conveyance abnormality, wherein

the learned model is generated by machine learning by long short-term memory (LSTM) using, as teacher data, a data set including sensor data at a time of normal substrate transport in a past, and

estimating and outputting the degree of conveyance abnormality comprises:

calculating, by using as an input a data set including actual sensor data until a time of new substrate transport, a deviation between a data set including sensor data, at the time of the new substrate transport, predicted by the learned model from the data set including actual sensor data immediately before the time of the new substrate transport and a data set including actual sensor data at the time of the new substrate transport;

estimating the degree of conveyance abnormality, based on the deviation; and

outputting the estimated degree of conveyance abnormality.

14. A conveyance abnormality prediction method executed by a computer, the method comprising:

estimating, by using a learned model having machine learned a relationship between a data set including sensor data outputted, at a time of substrate transport in a past, from each of a plurality of sensors provided on a substrate transport unit and a degree of conveyance abnormality at the time of the substrate transport, a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted from each of the plurality of sensors at the time of the new substrate transport, and then outputting the estimated degree of conveyance abnormality, wherein

the learned model is generated by machine learning of teacher data in which a data set including sensor data at a time of substrate transport in a past is labeled with whether the time of the substrate transport is an occurrence time of conveyance abnormality or not, and

estimating and outputting the degree of conveyance abnormality comprises:

estimating the degree of conveyance abnormality by using, as an input, a data set including sensor data at a time of new substrate transport, based on a probability that is predicted by the learned model and

indicates a probability that the time of the new substrate transport is an occurrence time of conveyance abnormality; and

outputting the estimated degree of conveyance abnormality.

15~~17~~. A conveyance abnormality prediction program for causing a computer to execute:

estimating, by using a learned model having machine learned a relationship between a data set including sensor data outputted, at a time of substrate transport in a past, from each of a plurality of sensors provided on a substrate transport unit and a degree of conveyance abnormality at the time of the substrate transport, a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted from each of the plurality of sensors at the time of the new substrate transport, and then outputting the estimated degree of conveyance abnormality, wherein

the learned model is generated by machine learning by long short-term memory (LSTM) using, as teacher data, a data set including sensor data at a time of normal substrate transport in a past, and

estimating and outputting the degree of conveyance abnormality comprises:

calculating, by using as an input a data set including actual sensor data until a time of new substrate transport, a deviation between a data set including sensor data, at the time of the new substrate transport, predicted by the learned model from the data set including actual sensor data immediately before the time of the new substrate transport and a data set including actual sensor data at the time of the new substrate transport;

estimating the degree of conveyance abnormality, based on the deviation; and

outputting the estimated degree of conveyance abnormality.

16. A conveyance abnormality prediction program for causing a computer to execute:

estimating, by using a learned model having machine learned a relationship between a data set including sensor data outputted, at a time of substrate transport in a past, from each of a plurality of sensors provided on a substrate transport unit and a degree of conveyance abnormality at the time of the substrate transport, a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted from each of the plurality of sensors at the time of the new substrate transport, and then outputting the estimated

degree of conveyance abnormality, wherein

the learned model is generated by machine learning of teacher data in which a data set including sensor data at a time of substrate transport in a past is labeled with whether the time of the substrate transport is an occurrence time of conveyance abnormality or not, and

estimating and outputting the degree of conveyance abnormality comprises:

estimating the degree of conveyance abnormality by using, as an input, a data set including sensor data at a time of new substrate transport, based on a probability that is predicted by the learned model and indicates a probability that the time of the new substrate transport is an occurrence time of conveyance abnormality; and

outputting the estimated degree of conveyance abnormality.

17~~18~~. A computer-readable recording medium storing a conveyance abnormality prediction program for causing a computer to execute:

estimating, by using a learned model having machine learned a relationship between a data set including sensor data outputted, at a time of substrate transport in a past, from each of a plurality of sensors provided on a substrate

transport unit and a degree of conveyance abnormality at the time of the substrate transport, a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted from each of the plurality of sensors at the time of the new substrate transport, and then outputting the estimated degree of conveyance abnormality, wherein

the learned model is generated by machine learning by long short-term memory (LSTM) using, as teacher data, a data set including sensor data at a time of normal substrate transport in a past, and

estimating and outputting the degree of conveyance abnormality comprises:

calculating, by using as an input a data set including actual sensor data until a time of new substrate transport, a deviation between a data set including sensor data, at the time of the new substrate transport, predicted by the learned model from the data set including actual sensor data immediately before the time of the new substrate transport and a data set including actual sensor data at the time of the new substrate transport;

estimating the degree of conveyance abnormality, based on the deviation; and

outputting the estimated degree of conveyance abnormality.

18. A computer-readable recording medium storing a conveyance abnormality prediction program for causing a computer to execute:

estimating, by using a learned model having machine learned a relationship between a data set including sensor data outputted, at a time of substrate transport in a past, from each of a plurality of sensors provided on a substrate transport unit and a degree of conveyance abnormality at the time of the substrate transport, a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted from each of the plurality of sensors at the time of the new substrate transport, and then outputting the estimated degree of conveyance abnormality, wherein

the learned model is generated by machine learning of teacher data in which a data set including sensor data at a time of substrate transport in a past is labeled with whether the time of the substrate transport is an occurrence time of conveyance abnormality or not, and

estimating and outputting the degree of conveyance abnormality comprises:

estimating the degree of conveyance abnormality by using, as an input, a data set including sensor data at a time of new substrate transport, based on

a probability that is predicted by the learned model and indicates a probability that the time of the new substrate transport is an occurrence time of conveyance abnormality; and

outputting the estimated degree of conveyance abnormality.

19. A learned model used in an estimation unit that calculates, by using as an input a data set including actual sensor data outputted, until a time of new substrate transport, from each of a plurality of sensors provided on a substrate transport unit, a deviation between a data set including sensor data, at the time of the new substrate transport, predicted by the learned model from the data set including actual sensor data immediately before the time of the new substrate transport and a data set including actual sensor data at the time of the new substrate transport, estimates a degree of conveyance abnormality, based on the deviation, and outputs the estimated degree of conveyance abnormality, the learned model comprising:

an input layer;

one or more than one intermediate layer connected to the input layer; and

an output layer connected to the intermediate layers,

wherein the learned model is generated by machine learning by long short-term memory (LSTM) using, as teacher data, a data set including sensor data at a time of normal substrate transport in a past~~machine learning of a relationship between a data set including sensor data outputted at a time of substrate transport in a past and a degree of conveyance abnormality at the time of the substrate transport, by repeating a process of inputting to the input layer the data set including sensor data outputted, at the time of the substrate transport in the past, from each of a plurality of sensors provided on a substrate transport unit, comparing an output result outputted, due to the inputting, from the output layer with the degree of conveyance abnormality at the time of the substrate transport, and updating a parameter of each node depending on an error of the comparison, where the process is repeated with respect to a data set including sensor data at a plurality of the times of substrate transport in the past~~, and

the learned model causes a computer to function such that, when a data set including actual sensor data until ~~outputted from each of the plurality of sensors at~~ a time of new substrate transport is inputted to the input layer, sensor data~~a degree of conveyance abnormality~~ at the time of the new substrate transport is predicted~~estimated~~ and

~~the estimated degree of conveyance abnormality is~~ outputted from the output layer.

20. A learned model used in an estimation unit that estimates a degree of conveyance abnormality at a time of new substrate transport by using, as an input, a data set including sensor data outputted, at a time of new substrate transport, from each of a plurality of sensors provided on a substrate transport unit, based on a probability that is predicted by the learned model and indicates a probability that the time of the new substrate transport is an occurrence time of conveyance abnormality, and outputs the estimated degree of conveyance abnormality, the learned model comprising:

an input layer;

one or more than one intermediate layer connected to the input layer; and

an output layer connected to the intermediate layers,

wherein the learned model is generated by machine learning of teacher data in which a data set including sensor data at a time of substrate transport in a past is labeled with whether the time of the substrate transport is an occurrence time of conveyance abnormality or not, and

the learned model causes a computer to function such

that, when a data set including sensor data at a time of new substrate transport is inputted to the input layer, a probability that the time of the new substrate transport is an occurrence time of conveyance abnormality is predicted and outputted from the output layer.