CLAIMS

1. A machine learning device that performs machine learning to a substrate processing device having

a mounting unit on which a cassette that houses a plurality of substrates is mounted,

a first processing unit and a second processing unit that surface-treat a substrate,

a cleaning unit that cleans a substrate after surface treatment,

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second processing unit, and the cleaning unit, and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit,

or to a simulator of the substrate processing device, the machine learning device comprising:

a state information acquisition unit that acquires state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate located in each unit in a relevant unit;

an action selection unit having a prediction model that predicts a value, in a certain state, to performing an action whether to take out a new substrate from the cassette and a value to which one of the first processing

unit and the second processing unit a new substrate is transferred when a new substrate is taken out, the action selection unit selecting one action based on the prediction model taking, as an input, the state information acquired by the state information acquisition unit;

an instruction signal transmission unit that transmits an instruction signal to the control unit so as to perform the action selected by the action selection unit;

an operation result acquisition unit that acquires, after finishing processing a predetermined number of substrates, an operation result including a predetermined number of substrates processed per unit time and a waiting time that elapses until cleaning of a substrate after surface treatment is started in the cleaning unit; and

a prediction model update unit that calculates a reward based on an operation result acquired by the operation result acquisition unit such that a reward increases as the number of substrates processed increases and the waiting time becomes shorter and that updates the prediction model based on the reward.

2. The machine learning device according to claim 1, wherein

the first processing unit and the second processing unit are polishing units that polish a substrate.

3. The machine learning device according to claim 1 or 2, wherein

the state information further includes use time of a consumable member used in the first processing unit and the second processing unit.

4. The machine learning device according to claim 3, citing claim 2, wherein

the consumable member is one or two or more of a polishing pad attached to a rotary table, a retainer ring attached to a top ring, the retainer ring supporting an outer edge of the substrate, and an elastic film attached to the top ring, the elastic film supporting a back surface of the substrate.

5. The machine learning device according to any one of claims 1 to 4, wherein

the state information further includes recipe information on treatment applied in advance to the substrate housed in the cassette.

6. The machine learning device according to any one of claims 1 to 5, wherein

the state information further includes failure

occurrence information or continuous operation time of the first processing unit and the second processing unit.

7. The machine learning device according to any one of claims 1 to 6, wherein

the state information further includes recipe information on surface treatment in the first processing unit and the second processing unit.

8. A substrate processing device comprising:

a mounting unit on which a cassette that houses a plurality of substrates is mounted;

a first processing unit and a second processing unit that surface-treat a substrate;

a cleaning unit that cleans a substrate after surface treatment;

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second processing unit, and the cleaning unit; and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit, wherein

the control unit has a trained model created by the machine learning device according to any one of claims 1 to 7, the control unit selects an action whether to take out a

new substrate from the cassette and to which one of the first processing unit and the second processing unit the new substrate is transferred when taking out the new substrate from the cassette, taking, as an input, state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate in the units in a relevant unit based on the trained model, and the control unit controls an operation of the transfer unit so as to perform the selected action.

9. A trained model created by performing machine leaning to a substrate processing device having

a mounting unit on which a cassette that houses a plurality of substrates is mounted,

a first processing unit and a second processing unit that surface-treat a substrate,

a cleaning unit that cleans a substrate after surface treatment,

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second processing unit, and the cleaning unit, and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit,

or to a simulator of the substrate processing device,

the trained model comprising:

an input layer, one or more intermediate layers connected to the input layer, and an output layer connected to the intermediate layer, wherein

the trained model is subjected to reinforcement learning on timing of starting transfer of a substrate and a transfer route of the substrate in which

state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate located in each unit in the relevant unit is acquired, the acquired state information is input to the input layer, based on an input then output from the output layer, the value to performing an action whether to take out a new substrate from the cassette, and to which one of the first processing unit and the second processing unit a new substrate is transferred when a new substrate is taken out, one action is selected, an operation of the transfer unit is controlled so as to perform the selected action, after processing of a predetermined number of substrates is ended, an operation result including a number of substrates processed per unit time and a waiting time that elapses until cleaning of a surface-treated substrate is started in the cleaning unit is acquired, a reward is calculated based on the acquired operation result such that the reward increases as the number of substrates processed is large

and the waiting time is short, a process of updating a parameter of each node is repeated based on the reward, such that the number of substrates processed is large and the waiting time is short, and

the trained model causes a computer to function to predict, upon inputting state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate located in each unit in a relevant unit to the input layer, a value to performing an action whether to take out a new substrate from the cassette, and to which one of the first processing unit and the second processing unit a new substrate is transferred when a new substrate is taken out and output the value from the output layer.

10. A machine learning method executed by a computer to a substrate processing device having

a mounting unit on which a cassette that houses a plurality of substrates is mounted,

a first processing unit and a second processing unit that surface-treat a substrate,

a cleaning unit that cleans a substrate after surface treatment,

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second

processing unit, and the cleaning unit, and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit,

or to a simulator of the substrate processing device, the machine learning method comprising:

a state information acquisition step of acquiring state information including a position of a substrate in the substrate processing device and an elapsed time of a substrates located in each unit in a relevant unit;

an action selecting step of selecting one action based on a prediction model that predicts a value, in a certain state, to performing an action whether to take out a new substrate from the cassette and a value to which one of the first processing unit and the second processing unit the new substrate is transferred when the new substrate is taken out, taking, as an input, the state information acquired by the state information acquisition step;

an instruction signal transmission step of transmitting an instruction signal to the control unit so as to perform the action selected by the action selection step;

an operation result acquisition step of acquiring, after finishing processing a predetermined number of substrates, an operation result including a predetermined number of substrates processed per unit time and a waiting

time that elapses until cleaning of a substrate after surface treatment is started in the cleaning unit; and

a prediction model update step of calculating a reward based on an operation result acquired in the operation result acquisition step such that a reward increases as the number of substrates processed increases and the waiting time is short and updating the prediction model based on the reward.

11. A machine learning program that causes a computer to perform machine learning to a substrate processing device having

a mounting unit on which a cassette that houses a plurality of substrates is mounted,

a first processing unit and a second processing unit that surface-treat a substrate,

a cleaning unit that cleans a substrate after surface treatment,

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second processing unit, and the cleaning unit, and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit,

or to a simulator of the substrate processing device,

the machine learning program that causes the computer to function as

a state information acquisition unit that acquires state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate located in each unit in a relevant unit;

an action selection unit having a prediction model that predicts a value, in a certain state, to performing an action whether to take out a new substrate from the cassette and a value to which one of the first processing unit and the second processing unit a new substrate is transferred when a new substrate is taken out, the action selection unit selecting one action based on a value function taking, as an input, the state information acquired by the state information acquisition unit,

an instruction signal transmission unit that transmits an instruction signal to the control unit so as to perform the action selected by the action selection unit;

an operation result acquisition unit that acquires, after finishing processing a predetermined number of substrates, an operation result including a number of substrates processed per unit time and a waiting time that elapses until cleaning of a substrate after surface treatment is started in the cleaning unit; and

a prediction model update unit that calculates a reward

based on an operation result acquired by the operation result acquisition unit such that a reward increases as the number of substrates processed increases and the waiting time becomes shorter and that updates the prediction model based on the reward.

12. A machine learning device that performs machine learning to a substrate processing device having

a mounting unit on which a cassette that houses a plurality of substrates is mounted,

a first processing unit and a second processing unit that surface-treat a substrate,

a cleaning unit that cleans a substrate after surface treatment,

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second processing unit, and the cleaning unit, and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit according to a transfer rule defined with a correspondence between an order of substrates taken out from the cassette and to which one of the first processing unit and the second processing unit a substrate is transferred,

or to a simulator of the substrate processing device,

the machine learning device comprising:

a state information acquisition unit that acquires state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate located in each unit in a relevant unit;

an action selection unit having a prediction model that predicts a value, in a certain state, to performing an action whether to take out a new substrate from the cassette, the action selection unit selecting one action based on the prediction model taking, as an input, the state information acquired by the state information acquisition unit;

an instruction signal transmission unit that transmits an instruction signal to the control unit so as to perform the action selected by the action selection unit;

an operation result acquisition unit that acquires, after finishing processing a predetermined number of substrates, an operation result including a number of substrates processed per unit time; and

a prediction model update unit that calculates a reward based on an operation result acquired by the operation result acquisition unit such that a reward increases as the number of substrates processed increases and that updates the prediction model based on the reward.

13. The machine learning device according to claim 12, wherein

the first processing unit and the second processing unit are polishing units that polish a substrate.

14.The machine learning device according to claim 12 or 13, wherein

the state information further includes use time of a consumable member used in the first processing unit and the second processing unit.

15. The machine learning device according to claim 14, citing claim 13 wherein

the consumable member is one or two or more of a polishing pad attached to a rotary table, a retainer ring attached to a top ring, the retainer ring supporting an outer edge of the substrate, and an elastic film attached to the top ring, the elastic film supporting a back surface of the substrate.

16. The machine learning device according to any one of claims 12 to 15, wherein

the state information further includes recipe information on treatment applied in advance to the substrate housed in the cassette.

17. The machine learning device according to any one of claims 12 to 16, wherein

the state information further includes a continuous operation time of the first processing unit and the second processing unit.

18. The machine learning device according to any one of claims 12 to 17, wherein

the state information further includes recipe information on surface treatment in the first processing unit and the second processing unit.

19. A substrate processing device comprising:

a mounting unit on which a cassette that houses a plurality of substrates is mounted;

a first processing unit and a second processing unit that surface-treat a substrate;

a cleaning unit that cleans a substrate after surface treatment;

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second processing unit, and the cleaning unit; and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning

unit, and the transfer unit according to a transfer rule defined with a correspondence between an order of substrates taken out from the cassette and to which one of the first processing unit and the second processing unit a substrate is transferred, wherein

the control unit has a trained model created by the machine learning device according to any one of claims 12 to 18, the control unit selects an action whether to take out a new substrate from the cassette, taking, as an input, state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate in the units in a relevant unit based on the trained model, and the control unit controls an operation of the transfer unit so as to perform the selected action.

20. A trained model created by performing machine leaning to a substrate processing device having

a mounting unit on which a cassette that houses a plurality of substrates is mounted,

a first processing unit and a second processing unit that surface-treat a substrate,

a cleaning unit that cleans a substrate after surface treatment,

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second

processing unit, and the cleaning unit, and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit according to a transfer rule defined with a correspondence between an order of substrates taken out from the cassette and to which one of the first processing unit and the second processing unit a substrate is transferred,

or to a simulator of the substrate processing device, the trained model comprising:

an input layer, one or more intermediate layers connected to the input layer, and an output layer connected to the intermediate layer, wherein

the trained model is subjected to reinforcement learning on timing of starting transfer of a substrate in which

state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate located in each unit in the relevant unit is acquired, the acquired state information is input to the input layer,

based on the input then output from the output layer, the value to performing an action whether to take out a new substrate from the cassette, one action is selected, an operation of the transfer unit is controlled so as to

perform the selected action, after processing of a predetermined number of substrates is ended, an operation result including a number of substrates processed per unit time is acquired, a reward is calculated based on the acquired operation result such that the reward increases as the number of substrates processed is large, a process of updating a parameter of each node is repeated based on the reward, so that the number of substrates processed is large, and

the trained model causes a computer to function to predict, upon inputting state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate located in each unit in a relevant unit to the input layer, a value to performing an action whether to take out a new substrate from the cassette, and output the value from the output layer.

21. A machine learning method executed by a computer to a substrate processing device having

a mounting unit on which a cassette that houses a plurality of substrates is mounted,

a first processing unit and a second processing unit that surface-treat a substrate,

a cleaning unit that cleans a substrate after surface treatment,

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second processing unit, and the cleaning unit, and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit according to a transfer rule defined with a correspondence between an order of substrates taken out from the cassette and to which one of the first processing unit and the second processing unit a substrate is transferred,

or to a simulator of the substrate processing device, the machine learning method comprising:

a state information acquisition step of acquiring state information including a position of a substrate in the substrate processing device and an elapsed time of a substrates located in each unit in a relevant unit;

an action selecting step of selecting one action based on a prediction model that predicts a value, in a certain state, to performing an action whether to take out a new substrate from the cassette, taking, as an input, the state information acquired by the state information acquisition step;

an instruction signal transmission step of transmitting an instruction signal to the control unit so as to perform the action selected by the action selection step;

an operation result acquisition step of acquiring, after finishing processing a predetermined number of substrates, an operation result including a number of substrates processed per unit time; and

a prediction model update step of calculating a reward based on an operation result acquired in the operation result acquisition step such that a reward increases as the number of substrates processed increases and updating the prediction model based on the reward.

22. A machine learning program that causes a computer to function to perform machine learning to a substrate processing device having

a mounting unit on which a cassette that houses a plurality of substrates is mounted,

a first processing unit and a second processing unit that surface-treat a substrate,

a cleaning unit that cleans a substrate after surface treatment,

a transfer unit that transfers a substrate between the mounting unit, the first processing unit and the second processing unit, and the cleaning unit, and

a control unit that controls operations of the first processing unit, the second processing unit, the cleaning unit, and the transfer unit according to a transfer rule

defined with a correspondence between an order of substrates taken out from the cassette and to which one of the first processing unit and the second processing unit a substrate is transferred,

or to a simulator of the substrate processing device, the machine learning program that causes the computer to function as

a state information acquisition unit that acquires state information including a position of a substrate in the substrate processing device and an elapsed time of a substrate located in each unit in a relevant unit;

an action selection unit having a prediction model that predicts a value, in a certain state, to performing an action whether to take out a new substrate from the cassette, the action selection unit selecting one action based on the prediction model taking, as an input, the state information acquired by the state information acquisition unit;

an instruction signal transmission unit that transmits an instruction signal to the control unit so as to perform the action selected by the action selection unit;

an operation result acquisition unit that acquires, after processing of a predetermined number of substrates is ended, an operation result including a number of substrates processed per unit time; and

a prediction model update unit that calculates a reward based on an operation result acquired by the operation result acquisition unit such that a reward increases as the number of substrates processed increases and that updates the prediction model based on the reward.