

DESCRIPTION

[Title of Invention] RECOMMENDATION DEVICE,
RECOMMENDATION METHOD, AND RECOMMENDATION PROGRAM

[Technical Field]

5 [0001] The present invention relates to a recommendation device, a recommendation method, and a recommendation program.

[Background Art]

10 [0002] In recent years, a technique that learns and utilizes features of time-series data of a sensor or the like generated in various places in urban space including a plant has been expected.

[Citation List]

[Patent Citation]

15 [0003] Patent Document 1: Japanese Laid-open Patent Publication No. 2019-185194

[Summary of Invention]

[Technical Problem]

20 [0004] However, the distribution pattern of time-series data generated in a plant and urban space frequently changes according to the situation. For example, the distribution pattern of the time-series data may change due to the difference in the operation rate of the device, the concentration of the material, or the like. In such a case,
25 a model generated earlier by training in which time-series data is used may become inapplicable.

[0005] The present invention has been made in view of the above, and an object of the present invention is to
30 apply a trained model according to the distribution pattern of the time-series data generated in a plant and urban space.

[Solution to Problem]

[0006] In order to solve the above-described problems

and achieve the object, a recommendation device according to the present invention includes: a storage unit that stores therein a model generated by training in which time-series data in a certain period is used as training data, 5 in association with a distribution of the training data; an acquisition unit that acquires time-series data in a certain period; a calculation unit that calculates a similarity by comparing a distribution of the acquired time-series data with the distribution of the training 10 data; and a specification unit that specifies the model generated by training in which the training data is used, when the calculated similarity is equal to or greater than a certain threshold.

[Advantageous Effects of Invention]

15 [0007] According to the present invention, it is possible to apply a trained model according to the distribution pattern of the time-series data generated in a plant and urban space.

[Brief Description of Drawings]

20 [0008] FIG. 1 is a schematic diagram illustrating a schematic configuration of a recommendation device.

FIG. 2 is a diagram illustrating a data structure of a model list.

25 FIG. 3 is a diagram for explaining a process performed by a presentation unit.

FIG. 4 is a flowchart illustrating a procedure of a recommendation process.

FIG. 5 is a diagram illustrating a computer that executes a recommendation program.

30 [Embodiments for Carrying Out the Invention]

[0009] Hereinafter, an embodiment of the present invention will be described in detail with reference to the accompanying drawings. However, the present invention is

not limited to the embodiment. Moreover, in the description of the drawings, the same reference numerals denote the same portions.

[0010] [Configuration of Recommendation Device]

5 FIG. 1 is a schematic diagram illustrating a schematic configuration of a recommendation device. As illustrated in FIG. 1, a recommendation device 10 is implemented by a general-purpose computer such as a personal computer, and includes an input unit 11, an output unit 12, a
10 communication control unit 13, a storage unit 14, and a control unit 15.

[0011] The input unit 11 is implemented using an input device such as a keyboard and a mouse, and in response to an input operation by an operator, inputs various types of
15 instruction information such as starting a process, to the control unit 15. The output unit 12 is implemented by a display device such as a liquid crystal display, a printing device such as a printer, and the like.

[0012] The communication control unit 13 is implemented
20 by a network interface card (NIC) or the like, and controls communication between an external device and the control unit 15 via a network. For example, the communication control unit 13 controls communication between the control unit 15, and a sensor that outputs time-series data to be
25 processed in a recommendation process, which will be described later, a management device that manages the time-series data, and the like.

[0013] The storage unit 14 is implemented by a semiconductor memory element such as a random-access memory
30 (RAM) and a flash memory, or a storage device such as a hard disk and an optical disc. In the storage unit 14, a processing program for operating the recommendation device 10, data used during the execution of the processing

program, and the like are stored in advance, or are temporarily stored each time the process is performed. The storage unit 14 may be configured to communicate with the control unit 15 via the communication control unit 13.

5 [0014] In the present embodiment, for example, the storage unit 14 stores therein in advance a model list 14a used in the recommendation process, which will be described later. The model list 14a is information where the model generated by training in which time-series data in a
10 certain period is used as training data is associated with the distribution of the training data.

[0015] In this example, FIG. 2 is a diagram illustrating a data structure of a model list. Specifically, as illustrated in FIG. 2, the model list 14a includes a
15 trained model and the distribution of past time-series data with a certain time width, used as training data to generate the model. For example, the distribution of time-series data means a graph representing the relation between the time and the data value. For example, the model list
20 14a illustrated in FIG. 2 includes a combination of a model A and distribution A of training data corresponding to the model A.

[0016] In the model list 14a, a model may be associated with training data itself corresponding to the model. For
25 example, the data value at the time may be stored as training data.

[0017] Returning to the description of FIG. 1. The control unit 15 is implemented using a central processing unit (CPU) or the like, and executes a processing program
30 stored in the memory. Consequently, as illustrated in FIG. 1, the control unit 15 functions as an acquisition unit 15a, a calculation unit 15b, a presentation unit 15c, a specification unit 15d, and a generation unit 15e. All or

some of the functional units may be installed in different hardware. For example, the generation unit 15e may be installed in a device different from that of the other functional units. Moreover, the control unit 15 may also
5 include other functional units.

[0018] The acquisition unit 15a acquires time-series data in a certain period. For example, the acquisition unit 15a acquires time-series data such as a sensor value with a certain time width on which the recommendation
10 process, which will be described later, is performed via the input unit 11. Alternatively, the acquisition unit 15a acquires the time-series data from a sensor, a management device for managing sensor values, or the like, via the communication control unit 13. In this example, it is
15 assumed that a period during which the acquisition unit 15a acquires time-series data is equal to or greater than the time width of the training data in the model list 14a.

[0019] In this example, the distribution pattern of the time-series data may change due to the difference in the
20 operation rate of the device, the concentration of the material, or the like.

[0020] The calculation unit 15b calculates a similarity by comparing the distribution of the acquired time-series data with the distribution of training data. Specifically,
25 the calculation unit 15b first obtains the distribution of the acquired time-series data. For example, the calculation unit 15b generates a graph representing the relation between the time and the data value of the acquired time-series data.

30 [0021] Next, the calculation unit 15b calculates a similarity by comparing the distribution of the acquired time-series data with the distribution of training data corresponding to each model in the model list 14a. For

example, the calculation unit 15b calculates a similarity by normalizing the value of the time-series data and the value of the training data having the same time width, and comparing the two values. The calculation unit 15b

5 calculates the similarity between the distributions of the time-series data to be processed and each of a plurality of pieces of training data.

[0022] When the calculated similarity is equal to or greater than a certain threshold, the presentation unit 15c
10 presents a model corresponding to the distribution of the training data in descending order of the similarity. For example, the presentation unit 15c outputs the corresponding models to a user terminal or the like in descending order of the similarity of the distributions of
15 the pieces of training data, via the output unit 12 or the communication control unit 13. Consequently, the presentation unit 15c can recommend a plurality of models in an appropriate order.

[0023] In this example, FIG. 3 is a diagram for
20 explaining a process performed by the presentation unit. In FIG. 3, for example, by using 10% as a threshold, models A to C having the similarity of 10% or more are presented in descending order of similarity. Moreover, as illustrated in FIG. 3, the presentation unit 15c may
25 display and output the distribution of training data corresponding to each model. Furthermore, as illustrated in FIG. 3, the distribution of the acquired time-series data to be processed may also be presented.

[0024] The presentation unit 15c may receive an input
30 operation of the selection of the presented models made by the operator. In this case, the operator can select the optimal model, by comparing the results. Moreover, in particular, when the distributions of training data and

time-series data are displayed and output, the operator can select the model trained by the training data with the highest similarity, after visually confirming the distributions of the time-series data to be processed and the training data.

[0025] Returning to the description of FIG. 1. When the calculated similarity is equal to or greater than a certain threshold, the specification unit 15d specifies the model generated by training in which training data is used. For example, among the pieces of training data, the specification unit 15d specifies the model corresponding to the training data with the highest similarity. In this case, the specification unit 15d can automatically apply the specified model to the time-series data to be processed.

[0026] Alternatively, among the models presented to the operator by the presentation unit 15c described above, the specification unit 15d may specify the model selected by the operator, as a model to be applied to the time-series data to be processed.

[0027] When the similarities calculated by the calculation unit 15b described above are all less than a certain threshold, the recommendation device 10 may issue an alarm. For example, the presentation unit 15c outputs a message indicating that there is no trained model applicable to the time-series data to be processed, among the trained models that have been generated so far. In this case, for example, the operator can instruct the generation unit 15e to execute a process, which will be described below.

[0028] Alternatively, when the calculated similarities are all less than a certain threshold, the generation unit 15e may automatically execute the process. The generation unit 15e generates a model by training in which the

acquired time-series data is used as training data. For example, the generation unit 15e generates a model, by extracting and training the features of the acquired time-series data.

5 [0029] Moreover, the generation unit 15e adds the generated model to the model list 14a, in association with the distribution of time-series data to be processed. Consequently, the model list 14a is automatically updated.

[0030] [Procedure of Recommendation Process]

10 Next, with reference to FIG. 4, an example of the recommendation process performed by the recommendation device 10 according to the present embodiment will be described. FIG. 4 is a flowchart illustrating a procedure of a recommendation process. For example, the flowchart in
15 FIG. 4 starts at the timing when an instruction to start the recommendation process is input.

[0031] First, the acquisition unit 15a acquires time-series data in a certain period. For example, the acquisition unit 15a acquires time-series data such as a
20 sensor value with a certain time width on which the recommendation process, which will be described later, is performed (step S1).

[0032] Next, the calculation unit 15b calculates a similarity by comparing the distribution of the acquired
25 time-series data with the distribution of training data corresponding to each model in the model list 14a (step S2).

[0033] Then, when the calculated similarity is equal to or greater than a certain threshold, the specification unit 15d specifies the model generated by training in which
30 training data is used, as a model to be applied to the time-series data to be processed (step S3).

[0034] For example, among the pieces of training data, the specification unit 15d specifies the model

corresponding to the training data with the highest similarity, as a model to be applied to the time-series data to be processed. Alternatively, the specification unit 15d specifies the model selected by the operator, as a model to be applied to the time-series data to be processed. Consequently, a series of recommendation processes is finished.

[0035] When the calculated similarity is equal to or greater than a certain threshold, the presentation unit 15c may present the model corresponding to the distribution of the training data in descending order of the similarity, and receive a selection operation of the model made by the operator.

[0036] Moreover, when the calculated similarities are all less than a certain threshold, the recommendation device 10 may issue an alarm. Alternatively, the generation unit 15e may automatically generate a model by training in which the acquired time-series data is used as training data, and update the model list 14a.

[0037] [Effects]

As described above, in the recommendation device 10 of the embodiment described above, the storage unit 14 stores therein the model generated by training in which time-series data in a certain period is used as training data, in association with the distribution of the training data. The acquisition unit 15a acquires time-series data in a certain period. The calculation unit 15b calculates a similarity by comparing the distribution of the acquired time-series data with the distribution of training data. When the calculated similarity is equal to or greater than a certain threshold, the specification unit 15d specifies the model generated by training in which training data is used.

[0038] Consequently, for example, it is possible to automatically apply the optimal model to the time-series data to be processed. In this manner, it is possible to apply the trained model according to the distribution
5 pattern of the time-series data generated in a plant and urban space.

[0039] Moreover, when the calculated similarity is equal to or greater than a certain threshold, the presentation unit 15c presents the model corresponding to the
10 distribution of the training data in descending order of the similarity. Consequently, the recommendation device 10 can recommend a plurality of models in an appropriate order. Furthermore, the operator can select the optimal model, while comparing the results.

15 [0040] Still furthermore, when the calculated similarities are all less than a certain threshold, the generation unit 15e generates a model by training in which the acquired time-series data is used as training data. Consequently, it is possible to automatically update the
20 model list 14a, and improve the accuracy of the recommendation process.

[0041] [System Configuration and Like]

Each component of each device illustrated in the drawings is functionally conceptual, and does not
25 necessarily have to be physically configured as illustrated in the drawings. In other words, the specific mode of distribution and integration of the devices is not limited to the ones illustrated in the drawings, and all or some thereof can be functionally or physically distributed or
30 integrated in any unit according to various loads and usage conditions. Moreover, all or some of the processing functions performed in the devices may be implemented by a CPU, a graphics processing unit (GPU), and a computer

program analyzed and executed by the CPU and the GPU, or may be implemented as hardware by wired logic.

[0042] Furthermore, among the processes described in the present embodiment, all or some of the processes described
5 as being automatically performed may be manually performed, or all or some of the processes described as being manually performed may be automatically performed by a known method. In addition, the processing procedures, control procedures, specific names, and information including various kinds of
10 data and parameters illustrated in the above document and drawings can be optionally changed unless otherwise specified.

[0043] [Program]

It is also possible to create a computer program in
15 which processing executed by the recommendation device described in the above embodiment is described in a computer-executable language. For example, it is also possible to create a computer program in which processing executed by the recommendation device 10 according to the
20 embodiment is described in a computer-executable language. In this case, the same effects as those in the embodiment described above can be obtained, when a computer executes the computer program. Moreover, the same process as that of the embodiment described above may be implemented, by
25 recording such a computer program in a computer-readable recording medium, and by causing a computer to read and execute the computer program recorded in the recording medium.

[0044] FIG. 5 is a diagram illustrating an example of a
30 computer that executes a recommendation program. For example, a computer 1000 includes a memory 1010, a CPU 1020, a hard disk drive interface 1030, a disk drive interface 1040, a serial port interface 1050, a video adapter 1060,

and a network interface 1070. These units are connected by a bus 1080.

[0045] The memory 1010 includes a read-only memory (ROM) 1011 and a RAM 1012. For example, the ROM 1011 stores
5 therein a boot program such as a basic input output system (BIOS). The hard disk drive interface 1030 is connected to a hard disk drive 1031. The disk drive interface 1040 is connected to a disk drive 1041. For example, a removable storage medium such as a magnetic disk or an optical disc
10 is inserted into the disk drive 1041. For example, a mouse 1051 and a keyboard 1052 are connected to the serial port interface 1050. For example, a display 1061 is connected to the video adapter 1060.

[0046] In this example, the hard disk drive 1031 stores
15 therein an operating system (OS) 1091, an application program 1092, a program module 1093, and program data 1094, for example. For example, each piece of the information described in the above embodiment is stored in the hard disk drive 1031 and the memory 1010.

[0047] Moreover, for example, the recommendation program
20 is stored in the hard disk drive 1031, as the program module 1093 in which the instruction executed by the computer 1000 is described. Specifically, the program module 1093 in which the processes executed by the
25 recommendation device 10 described in the above embodiment are described, is stored in the hard disk drive 1031.

[0048] Furthermore, for example, the data used for
information processing by the recommendation program is stored in the hard disk drive 1031 as the program data 1094.
30 Then, the CPU 1020 reads the program module 1093 and the program data 1094 stored in the hard disk drive 1031 to the RAM 1012 as necessary, and executes each procedure described above.

[0049] The program module 1093 and the program data 1094 according to the recommendation program are not limited to being stored in the hard disk drive 1031, and, for example, may be stored in a removable storage medium and read out by the CPU 1020 via the disk drive 1041 or the like.

Alternatively, the program module 1093 and the program data 1094 according to the recommendation program may be stored in another computer connected via a network such as a local area network (LAN) or wide area network (WAN), and may be read out by the CPU 1020 via the network interface 1070.

[0050] While the embodiment to which the invention made by the present inventors is applied has been described above, the present invention is not limited to the descriptions and drawings that form part of the disclosure of the present invention according to the present embodiment. In other words, other embodiments, examples, operation techniques, and the like made by those skilled in the art or the like based on the present embodiment are all included in the scope of the present invention.

[Explanation of Reference]

[0051] 10 recommendation device
11 input unit
12 output unit
13 communication control unit
25 14 storage unit
14a model list
15 control unit
15a acquisition unit
15b calculation unit
30 15c presentation unit
15d specification unit
15e generation unit

CLAIMS

1. A recommendation device comprising:

a storage unit that stores therein a model generated by training in which time-series data in a certain period is used as training data, in association with a distribution of the training data;

an acquisition unit that acquires time-series data in a certain period;

a calculation unit that calculates a similarity by comparing a distribution of the acquired time-series data with the distribution of the training data; and

a specification unit that specifies the model generated by training in which the training data is used, when the calculated similarity is equal to or greater than a certain threshold.

2. The recommendation device according to claim 1, further including a presentation unit that presents the model corresponding to the distribution of the training data in descending order of the similarity, when the calculated similarity is equal to or greater than a certain threshold.

3. The recommendation device according to claim 1, further including a generation unit that generates a model by training in which the acquired time-series data is used as training data, when each calculated similarity is less than a certain threshold.

4. A recommendation method executed by a recommendation device, the recommendation device including a storage unit that stores therein a model generated by training in which time-series data in a certain period is used as training

data, in association with a distribution of the training data, the recommendation method comprising:

a process of acquiring time-series data in a certain period;

5 a process of calculating a similarity by comparing a distribution of the acquired time-series data with the distribution of the training data; and

a process of specifying the model generated by training in which the training data is used, when the
10 calculated similarity is equal to or greater than a certain threshold.

5. A recommendation program, by referring a storage unit that stores therein a model generated by training in which
15 time-series data in a certain period is used as training data, in association with a distribution of the training data, that causes a computer to execute:

a step of acquiring time-series data in a certain period;

20 a step of calculating a similarity by comparing a distribution of the acquired time-series data with the distribution of the training data; and

a step of specifying the model generated by training in which the training data is used, when the calculated
25 similarity is equal to or greater than a certain threshold.