

DESCRIPTION

Title of Invention: MEDICAL INSTITUTION SELECTION SERVER AND
MEDICAL INSTITUTION SELECTION METHOD

Technical Field

[0001]

The present invention relates to a medical institution selection server and a medical institution selection method.

Background Art

[0002]

JP-A-2011-48775 (PTL 1) is a background art in this technical field. PTL 1 discloses that "in an emergency hospital selection system 1, a vehicle terminal 2 is mounted on an emergency vehicle, acquires identification information of a hospital that should be headed to from an emergency site from a management server 3, and displays the identification information. The management server 3 is disposed in a control center managing a predetermined region. When an inquiry about a hospital is received from the vehicle terminal 2, the management server 3 inquires a hospital server 4 about a acceptable time of each hospital (a time until an emergency patient can be accepted), selects an optimal hospital in consideration of a travel time acquired based on a distance

between the emergency site and each hospital, and notifies the vehicle terminal 2 of the optimal hospital. The hospital server 4 is disposed for each hospital in the management region and communicates with the management server 3. When the inquiry about the reception time is received from the management server 3, the hospital server 4 calculates a current acceptable time based on a state of a doctor, an operation room, or the like and notifies the management server 3 of the calculated acceptable time. The management server 3 and each hospital server 4 are configured to be communicable with each other via, for example, a network 5 such as a WAN" (refer to the abstract).

Prior Art Literature

Patent Literature

[0003]

PTL 1: JP-A-2011-48775

Summary of Invention

Technical Problem

[0004]

Depending on a state of the patient before emergency transportation, treatments required for the patient are different, and whether these treatments are possible depends on a medical institution. Even for a medical institution

capable of performing these treatments, a time when a treatment can be started for the patient differs depending on a state of a resource for performing the treatment. According to one aspect of the invention, by taking the above-mentioned circumstances into consideration, a time until start of a treatment for the patient can be predicted more accurately, and therefore a medical institution that can perform the treatment on the patient earlier can be selected.

Solution to Problem

[0005]

In order to solve the above problems, one aspect of the invention employs the following configurations. Provided is a medical institution selection server that selects a medical institution to which a patient is transported. The medical institution selection server includes a processor and a memory, in which the memory is configured to hold a flow prediction model that predicts a flow which includes one or more processes to be executed on the patient from state information of the patient, and medical institution information that indicates a state of a resource for executing each process included in an executable flow for each medical institution, and the processor is configured to acquire the state information of the patient, predict a flow to be executed on the patient based on the acquired state information of the patient and the flow

prediction model, acquire a state of a resource for executing each process included in the predicted flow in each medical institution with reference to the medical institution information, select medical institution candidates to which the patient is transported based on the acquired states of the resources, and output information of the selected medical institution candidates.

Advantageous Effect

[0006]

According to one aspect of the invention, a time until start of a treatment for a patient can be predicted more accurately, and therefore a medical institution that can treat the patient earlier can be selected.

[0007]

Problems, configurations, and effects other than those described above will be apparent from the following description of the embodiment.

Brief Description of Drawings

[0008]

[FIG. 1] FIG. 1 is a block diagram showing a configuration example of a hospital selection system according to a first embodiment.

[FIG. 2] FIG. 2 shows an example of an acceptability table

according to the first embodiment.

[FIG. 3] FIG. 3 shows an example of a diagnosis and treatment flow table according to the first embodiment.

[FIG. 4] FIG. 4 shows an example of a resource state table according to the first embodiment.

[FIG. 5] FIG. 5 shows an example of a patient classification history table according to the first embodiment.

[FIG. 6] FIG. 6 shows an example of an emergency transportation history table according to the first embodiment.

[FIG. 7] FIG. 7 shows an example of an admission inquiry required time history table according to the first embodiment.

[FIG. 8] FIG. 8 is a flowchart showing an example of hospital selection processing according to the first embodiment.

[FIG. 9] FIG. 9 shows an example of a patient classification based on a patient classification prediction model according to the first embodiment.

[FIG. 10] FIG. 10 shows an example of a possible treatment start time of each patient classification of each hospital according to the first embodiment.

[FIG. 11] FIG. 11 shows an example of a probability that each hospital cannot accept the patient, and of an expected value of the possible treatment start time in each hospital

according to the first embodiment.

[FIG. 12] FIG. 12 is a flowchart showing an example of prediction processing of the possible treatment start time of each patient classification according to the first embodiment.

[FIG. 13] FIG. 13 is a flowchart showing an example of calculation processing of the possible treatment start time according to the first embodiment.

[FIG. 14] FIG. 14 is an explanatory diagram showing an example of execution times of processes according to the first embodiment.

[FIG. 15] FIG. 15 is a flowchart showing an example of estimation processing of a transportation end time of the patient according to the first embodiment.

[FIG. 16] FIG. 16 shows an example of an input screen displayed on a terminal according to the first embodiment.

[FIG. 17] FIG. 17 shows an example of an output screen displayed on the terminal according to the first embodiment.

[FIG. 18] FIG. 18 shows an example of an output screen displayed on the terminal according to the first embodiment.

Description of Embodiments

[0009]

Hereinafter, an embodiment of the invention will be described in detail with reference to the accompanying drawings. In the present embodiment, the same components are denoted by

the same reference numerals, and the repetitive description thereof will be omitted. It should be noted that the present embodiment is merely an example for implementing the invention, and does not limit the technical scope of the invention.

[0010]

The present embodiment describes a hospital selection system that selects a hospital to which a patient is transported during an emergency. The hospital is an example of a medical institution, and the patient may be transported to a medical institution other than a hospital. The present embodiment describes an example of transporting a stroke patient, and it is obvious that the invention can also be applied to a case where a patient having diseases other than the stroke is transported by appropriately changing a process of a diagnosis and treatment flow, a model for determining a patient classification, and the like which are to be described below. The present embodiment describes an example of transporting the patient by using an emergency vehicle, but it is obvious that the invention can be applied not only to a vehicle but also to a case where the patient is transported using another transportation equipment such as a ship or an aircraft.

[First Embodiment]

[0011]

FIG. 1 is a block diagram showing a configuration example

of a hospital selection system. The hospital selection system includes, for example, a hospital selection server 100 and a terminal 200 that are connected via a network 300 such as the Internet or the like. The hospital selection server 100 is constituted by, for example, a computer including a Central Processing Unit (CPU) 101, a memory 102, an auxiliary storage device 103, and a communication device 104.

[0012]

The CPU 101 includes a processor and executes programs stored in the memory 102. The memory 102 includes a Read Only Memory (ROM) that is a nonvolatile storage element and a Random Access Memory (RAM) that is a volatile storage element. The ROM stores an invariable program (for example, a Basic Input/output System (BIOS)) and the like. The RAM is a high-speed and volatile storage element such as a Dynamic Random Access Memory (DRAM), and temporarily stores the programs to be executed by the CPU 101 and data used during execution of the programs.

[0013]

The auxiliary storage device 103 is, for example, a large-capacity and nonvolatile storage device such as a magnetic storage device (Hard Disk Drive (HDD)) and a flash memory (Solid State Drive (SSD)), and stores the programs to be executed by the CPU 101 and the data used during the execution of the programs. That is, the programs are read from the

auxiliary storage device 103, loaded into the memory 102 and executed by the CPU 101.

[0014]

The hospital selection server 100 may include an input interface 105 and an output interface 108. The input interface 105 is connected to an input device such as a keyboard 106 or a mouse 107 and receives an input from an operator. The output interface 108 is connected to a display device such as a display device 109 or a printer, and outputs an execution result of a program in a form that can be visually recognized by the operator.

[0015]

The communication device 104 is a network interface device that controls communication with other devices in accordance with a predetermined protocol. The communication device 104 includes, for example, a serial interface such as a USB.

[0016]

The programs to be executed by the CPU 101 are provided to the hospital selection server 100 via a removable medium (CD-ROM, flash memory, or the like) or the network 300, and are stored in the nonvolatile auxiliary storage device 103 that is a non-transitory storage medium. Therefore, the hospital selection server 100 may include an interface that reads data from the removable medium.

[0017]

The hospital selection server 100 is a computer system physically constituted on a single computer or logically or physically constituted on a plurality of computers, and may operate in a separate thread on the same computer, or may operate on a virtual computer constructed on a plurality of physical computer resources. The same applies to the terminal 200.

[0018]

The CPU 101 includes, for example, a patient classification prediction unit 111, a possible treatment start time prediction unit 112, a prediction result integration processing unit 113, a hospital candidate selection unit 114, and a transportation time estimation unit 115. The patient classification prediction unit 111 predicts a patient classification to which the patient is relevant, for example, by using input patient information and a patient classification prediction model 121 to be described below. The possible treatment start time prediction unit 112 predicts a time when treatment of the patient can be started.

[0019]

The prediction result integration processing unit 113 integrates prediction results for a plurality of patient classifications when there is a possibility that the patient is relevant to the plurality of patient classifications. The

hospital candidate selection unit 114 selects hospital candidates based on, for example, a possible treatment start time or a probability that the each hospital can accept the patient in the patient classification. The transportation time estimation unit 115 estimates a time until the patient is transported to the hospital by the emergency vehicle.

[0020]

For example, the CPU 101 functions as the patient classification prediction unit 111 by operating in accordance with a patient classification prediction program loaded to the memory 102, and functions as the possible treatment start time prediction unit 112 by operating in accordance with a program for predicting the possible treatment start time loaded to the memory 102. The relationship between a program and a functional unit applies in a similar manner to other functional units included in the CPU 101. The relationship between the program and the functional unit applies in a similar manner to a functional unit that is described below and included in a CPU 201 of the terminal 200.

[0021]

Some or all of functions of the functional units included in the CPU 101 and the CPU 201 may be implemented by hardware such as an Application Specific Integrated Circuit (ASIC) or a Field-Programmable Gate Array (FPGA).

[0022]

The auxiliary storage device 103 holds, for example, the patient classification prediction model 121, an acceptability table 122, a diagnosis and treatment flow table 123, a resource state table 124, an emergency vehicle travel time prediction model 125, a patient classification history table 126, an emergency transportation history table 127, and an admission inquiry required time history table 128. A part or all of information stored in the auxiliary storage device 103 may be stored in the memory 102 or may be stored in a database connected to the hospital selection server 100.

[0023]

The patient classification prediction model 121 predicts a patient classification from state information of the patient (for example, a patient symptom, past history, or information heard by emergency personnel). The acceptability table 122 indicates acceptability of respective hospitals accept the patient in the patient classification, and a diagnosis and treatment flow to be executed on the patient when respective hospitals can accept the patient. The diagnosis and treatment flow includes one or more processes. Hereinafter, the diagnosis and treatment flow is also simply referred to as a flow.

[0024]

The diagnosis and treatment flow table 123 holds information of the processes included in the flow. The

resource state table 124 indicates a state of resources necessary for execution of the process of each flow. The emergency vehicle travel time prediction model 125 predicts a travel time of the emergency vehicle from, for example, a time period, a day of a week, and a travel time based on route information and/or traffic jam information. The patient classification history table 126 indicates, for example, the state information of the patient and history of the patient classification, and is used for generation of the patient classification prediction model 121.

[0025]

The emergency transportation history table 127 indicates, for example, history of the time period, the day of the week, and the travel time based on the route information and/or the traffic jam information, and history of the travel time of the emergency vehicle, and is used for generation of the emergency vehicle travel time prediction model 125. The admission inquiry required time history table 128 indicates history of a time taken for the admission inquiry of each hospital.

[0026]

In the present embodiment, information used by the hospital selection system may be represented by any data structure independent of the data structure. Information is represented in a table format in the present embodiment, but information can be stored in, for example, a data structure

appropriately selected from a list, a database, or a queue.

[0027]

The terminal 200 is constituted by, for example, a computer including the CPU 201, a memory 202, an auxiliary storage device 203, a communication device 204, an input device 205, a display device 206, and a Global Positioning System (GPS) reception device 207. The terminal 200 is, for example, a tablet terminal carried by the emergency personnel or a Personal Computer (PC) installed in an ambulance.

[0028]

Hardware of the CPU 201, the memory 202, the auxiliary storage device 203, and the communication device 204 is the similar to that of the CPU 101, the memory 102, the auxiliary storage device 103, and the communication device 104, and therefore the description thereof will be omitted.

[0029]

The CPU 201 includes, for example, a patient state information input transmission unit 211 and a hospital candidate display unit 212. The patient state information input transmission unit 211 receives an input of the state information of the patient and transmits the state information to the hospital selection server 100. The hospital candidate display unit 212 causes the display device 206 to display information of the hospital candidates received from the hospital selection server 100.

[0030]

The input device 205 is, for example, a keyboard, or a mouse. The display device 206 is, for example, a display. For example, the input device 205 and the display device 206 may be integrated, such as a touch panel. Similar to the hospital selection server 100, the terminal 200 may include an input interface and an output interface and be connected to an external input device and a display device. The GPS reception device 207 receives a signal from a GPS satellite and acquires position information of the terminal 200 based on the received signal.

[0031]

FIG. 2 shows an example of the acceptability table 122. The acceptability table 122 includes, for example, an ID column 1221, a hospital column 1222, a patient classification column 1223, an acceptability column 1224, a diagnosis and treatment flow ID column 1225, and a position column 1226. The ID column 1221 holds an ID that identifies a record in the acceptability table 122. The hospital column 1222 holds a name of a hospital.

[0032]

The patient classification column 1223 stores a patient classification. The acceptability column 1224 holds a value indicating whether the hospital can accept a patient in the patient classification for a treatment. When a value of the acceptability column 1224 is "yes", the diagnosis and treatment

flow ID column 1225 holds a diagnosis and treatment flow ID, and when the value of the acceptability column 1224 is "no", the diagnosis and treatment flow ID column 1225 holds, for example, a null value.

[0033]

Even when patient classifications are the same, resources and the like may be different depending on hospitals, and therefore different diagnosis and treatment flow IDs may be stored for the same patient classifications. Even for the same patient classifications of the same hospital, a plurality of types of flows may be executed, and therefore a plurality of records may exist for the same patient classifications of the same hospital. When the acceptability and the diagnosis and treatment flow ID are unknown, a value "unknown", a null value, or the like is stored in the acceptability column 1224 and the diagnosis and treatment flow ID column 1225. The position column 1226 holds position information of the hospital. The position information is represented by, for example, coordinate values of a latitude and a longitude.

[0034]

FIG. 3 shows an example of the diagnosis and treatment flow table 123. The example of FIG. 3 shows a flow in which the diagnosis and treatment flow ID is "3". The diagnosis and treatment flow table 123 includes, for example, a process ID column 1231, a process name column 1232, a start condition

column 1233, and an execution time column 1234. The process ID column 1231 holds an ID that identifies a process.

[0035]

The process name column 1232 holds names of respective processes. In the example of FIG. 3, a "t-PA treatment" and a "catheter treatment" are treatment actions, and other flows are not the treatment actions, but preparation actions such as a test for performing the treatment actions or the like. For example, the diagnosis and treatment flow table 123 may include a flag for distinguishing a treatment action and a preparation action, or another data indicating a flow corresponding to a treatment action may be stored in the auxiliary storage device 103.

[0036]

The start condition column 1233 stores a condition for starting a corresponding process. For example, in FIG. 3, a "blood test" can be started any time after the patient is transported, but "CT" cannot be started until all processes with process IDs 1 to 4 (that is, the "blood test", "clinical history confirmation", an "electrocardiogram test", and an "echo") are completed.

[0037]

It is necessary to determine that start conditions of the two processes do not include completion of the processes of each other. Specifically, for example, when a start

condition of the process with the process ID "1" is "completion of 2" and a start condition of the process with the process ID "2" is "completion of 1", any process cannot be started. Examples of another start condition of a process include impossibility of simultaneously executing predetermined processes.

[0038]

The execution time column 1234 holds a time taken from a start to an end of execution of the process. In the example of FIG. 3, the diagnosis and treatment flow table 123 is prepared for each diagnosis and treatment flow ID, and therefore, for example, an index for searching each diagnosis and treatment flow table 123 may be stored in the auxiliary storage device 103. Flow information of all the diagnosis and treatment flow IDs may be stored in one diagnosis and treatment flow table 123, and in this case, for example, the diagnosis and treatment flow table 123 may further include a diagnosis and treatment flow ID column.

[0039]

FIG. 4 shows an example of the resource state table 124. The example of FIG. 4 shows a state of a resource in a "private hospital B". The resource state table 124 includes, for example, a process ID column 1241 and a possible use start time column 1242. The process ID column 1241 holds a process ID of a process included in a flow that can be executed by the

"private hospital B".

[0040]

The possible use start time column 1242 stores information indicating a time when use of a resource used for the process can be started. "0 minutes later" stored in the possible use start time column 1242 indicates that a resource by which the flow is executed can be used at a present time. The resource may include not only a physical resource such as an inspection equipment, a treatment equipment, and a surgical equipment, but also human resources such as a doctor, a laboratory technician, and a nurse.

[0041]

For example, the hospital selection server 100 is connected to a server of each hospital, the server of each hospital periodically or in real time transmits a state of a resource to the hospital selection server 100, and the hospital selection server 100 updates the resource state table 124 in accordance with the received state of the resource.

[0042]

FIG. 5 shows an example of the patient classification history table 126. The patient classification history table 126 is used for generation of the patient classification prediction model 121 that predicts a patient classification from a state of a patient. The patient classification history table 126 includes, for example, a patient ID column 1261, an

explanatory variable column 1262, and an objective variable column 1263.

[0043]

The patient ID column 1261 stores, for example, an ID that identifies a patient. The explanatory variable column 1262 holds values of explanatory variables of the patient. In the example of FIG. 5, variables indicating the state of the patient, such as presence or absence of dizziness, presence or absence of hemiplegia, whether a conversation is normal, whether an anticoagulant is taken, and whether there is history of diabetes are adopted as the explanatory variables.

[0044]

The objective variable column 1263 holds a value of an objective variable of the patient. In the example of FIG. 5, the patient classification is adopted as the objective variable. That is, for example, when the values of the explanatory variables and the value of the objective variable are unknown, for example, a value "unknown", a null value, or the like may be stored in the explanatory variable column 1262. Similarity applies to the emergency transportation history table 127 to be described below.

[0045]

The patient classification prediction model 121 may be given in advance, or may be generated by, for example, performing machine learning (for example, deep learning or

logistic regression) on the values of the explanatory variables and the value of the objective variable of the patient classification history table 126 by the patient classification prediction unit 111.

[0046]

FIG. 6 shows an example of the emergency transportation history table 127. The emergency transportation history table 127 is used for generation of the emergency vehicle travel time prediction model 125 that predicts the travel time of the emergency vehicle from time information or the like during emergency transportation. The emergency transportation history table 127 includes, for example, an ID column 1271, an explanatory variable column 1272, and an objective variable column 1273. The ID column 1271 holds an ID that identifies a record, that is, emergency transportation history in the emergency transportation history table 127.

[0047]

The explanatory variable column 1272 holds values of explanatory variables of history corresponding to the ID. In the example of FIG. 6, the day of the week and the time period when the emergency transportation is performed and the travel time based on the route calculation and/or the traffic jam are adopted as the explanatory variables. It should be noted that the travel time based on the route calculation and/or the traffic jam is, for example, a travel time of a general vehicle

predicted by a car navigation system or the like, and is a value acquired without considering characteristics of the emergency vehicle (for example, the emergency vehicle can pass through an intersection when a signal is red).

[0048]

The objective variable column 1273 holds a value of an objective variable of history corresponding to the ID. In the example of FIG. 6, the travel time of the emergency vehicle is adopted as the objective variable. The travel time of the emergency vehicle is an actual travel time of the emergency vehicle in the history.

[0049]

The emergency vehicle travel time prediction model 125 may be given in advance, or may be, for example, generated by performing machine learning (for example, deep learning or logistic regression) on the values of the explanatory variables and the value of the objective variable of the emergency transportation history table 127 by the transportation time estimation unit 115.

[0050]

FIG. 7 shows an example of the admission inquiry required time history table 128. The admission inquiry required time history table 128 includes, for example, a date and time column 1281, a hospital column 1282, and an inquiry required time column 1283. The date and time column 1281 holds a date and

a time when the admission inquiry has been made in the past. The hospital column 1282 stores a name of a hospital that is a destination of the admission inquiry made in the past. The inquiry required time column 1283 holds a time required by the admission inquiry.

[0051]

For a hospital whose resource usage state is recorded in the resource state table 124, it is not necessary to make the admission inquiry because the resource usage state is known. Accordingly, it is not necessary to calculate an admission inquiry required time to be described below for such a hospital. Therefore, the admission inquiry required time history table 128 may not hold admission inquiry required time history of the hospital.

[0052]

FIG. 8 is a flowchart showing an example of hospital selection processing. First, the patient state information input transmission unit 211 of the terminal 200 receives the state information of the patient input by a user of the terminal 200, and transmits the input state information and current position information of the terminal 200 that is acquired by the GPS receiving device 207 to the hospital selection server 100 (S801). The input state information includes the values of the explanatory variables of the patient classification prediction model 121. The current position information of the

terminal 200 indicates a position of the patient.

[0053]

The patient classification prediction unit 111 of the hospital selection server 100 inputs the values of the explanatory variables included in the received state information to the patient classification prediction model 121, thereby acquiring a patient classification that is the value of the objective variable of the patient classification prediction model 121 (S802).

[0054]

The possible treatment start time prediction unit 112 predicts a possible treatment start time of each patient classification acquired in step S802 for each hospital by using the acceptability table 122, the diagnosis and treatment flow table 123, and the resource state table 124 (S803). Details of step S803 will be described below.

[0055]

The prediction result integration processing unit 113 calculates a probability that each hospital cannot accept the patient from a probability of the patient classification acquired in step S802 and a value of the acceptability column 1224 of each patient classification of each hospital in the acceptability table 122 (step S804). Specifically, the probability that a certain hospital cannot accept the patient is calculated, for example, by a sum of probabilities of patient

classifications in which records indicating that the hospital cannot accept a patient do not exist in the acceptability table 122.

[0056]

In step S804, the prediction result integration processing unit 113 calculates an expected value of a possible treatment start time in each hospital based on the probability of the patient classification acquired in step S802 and the possible treatment start time of each patient classification predicted in step S803. It is not necessary for the prediction result integration processing unit 113 to calculate an expected value for a hospital whose probability of being unable to accept the patient is 100%.

[0057]

Subsequently, the hospital candidate selection unit 114 selects, for example, hospitals whose probabilities of being unable to accept the patient calculated in step S804 are equal to or less than predetermined values, sorts information including the probabilities that the hospitals cannot accept the patient and the expected values of the possible treatment start times for the hospitals selected in ascending order of the expected values of the possible treatment start times calculated in step S804, and causes the display device 109 to display the sorted information (S805).

[0058]

In step S805, for example, the hospital candidate selection unit 114 may select a predetermined number of hospitals in ascending order of probabilities of being unable to accept the patient calculated in step S804, or may select a hospital whose probability of being unable to accept the patient is lower than an average value.

[0059]

FIG. 9 shows an example of a result of the patient classification based on the patient classification prediction model 121 acquired in step S802. A probability that the patient is relevant to each patient classification is acquired based on the patient classification prediction model 121. The patient classification prediction model 121 may be a model that determines and returns a value of the objective variable. The patient classification prediction unit 111 may determine one patient classification based on the acquired probability. Specifically, for example, the patient classification prediction unit 111 may select a patient classification having a highest probability (when there are a plurality of patient classifications having the highest probability, a patient classification is randomly selected from these patient classifications).

[0060]

FIG. 10 shows an example of the possible treatment start time of each patient classification in each hospital acquired

in step S803. "Municipal hospital A" cannot accept a patient in patient classifications "(A)" and "(B)", and therefore a value "no" is stored instead of a possible treatment start time.

[0061]

FIG. 11 shows an example of the probability that each hospital cannot accept the patient, and the expected value of the possible treatment start time in each hospital that are acquired in step S804. A hospital which cannot accept the patient may be excluded from an output at the time of step S804.

[0062]

FIG. 12 is a flowchart showing an example of prediction processing of a possible treatment start time of each patient classification in step S803. The possible treatment start time prediction unit 112 sets $N = 1$ in a counter (S1201). The possible treatment start time prediction unit 112 reads a record in the Nth line of the acceptability table 122 (S1202).

[0063]

The possible treatment start time prediction unit 112 determines whether a value of the acceptability column 1224 of the record is "yes" (S1203). When determining that the value of the acceptability column 1224 of the record is "yes" (S1203: Yes), the possible treatment start time prediction unit 112 calculates a possible treatment start time for a hospital and a patient classification of the record (S1204), and the processing proceeds to step S1206. Details of step S1204 will

be described below.

[0064]

When determining that the value of the acceptability column 1224 of the record is the "no" (S1203: No), the possible treatment start time prediction unit 112 outputs information indicating that a correspondence of the patient classification indicated by the record is "no" at the hospital indicated by the record (S1205), and the processing proceeds to step S1206.

[0065]

For example, only estimation processing of a transportation time in step S1302 to be described below is performed for a record in which acceptability is unknown, or for a record in which a possible treatment start time cannot be calculated for reasons that, for example, a flow ID is unknown or a state of a resource corresponding to the flow ID is unknown even when the hospital can accept the patient.

[0066]

Subsequently, the possible treatment start time prediction unit 112 determines whether all the records in the acceptability table 122 have been read (S1206). When the possible treatment start time prediction unit 112 determines that all the records in the acceptability table 122 have been read (S1206: Yes), the processing in step S803 is ended.

[0067]

When the possible treatment start time prediction unit

112 determines that there is an unread record in the acceptability table 122 (S1206: No), the value N of the counter is incremented (S1207), and the processing returns to step S1202.

[0068]

In the example described above, the patient classification is predicted from the state of the patient by using the patient classification prediction model 121, a flow ID corresponding to the predicted patient classification is acquired from the acceptability table 122, each process of a flow corresponding to the flow ID is acquired from the diagnosis and treatment flow table 123, and a series of algorithms may be defined as one flow prediction model. The auxiliary storage device 103 may include a model that directly estimates a flow from the state of the patient, and in this case, the flow may be acquired by using the model.

[0069]

FIG. 13 is a flowchart showing an example of calculation processing of a possible treatment start time in step S1204. The possible treatment start time prediction unit 112 reads the diagnosis and treatment flow table 123 and the resource state table 124 that correspond to a diagnosis and treatment flow ID indicated by the record read in step S1202 (that is, corresponding to the hospital and the patient classification that are indicated by the record) (S1301). The transportation

time estimation unit 115 estimates a transportation end time of the patient to the hospital (S1302). Details of step S1302 will be described below.

[0070]

Among unselected processes of the read diagnosis and treatment flow table 123, the possible treatment start time prediction unit 112 selects one process for which a time when a start condition is satisfied can be calculated (the selected process is also referred to as a process X) (S1303).

[0071]

For example, in the example of FIG. 3, since a process having a process ID "5" cannot be executed until the processes having the process IDs of "1" to "4" are ended, it is impossible to select the process having the process ID "5" in step S1303 until end times of the processes having the process IDs of "1" to "4" are calculated. In the example of FIG. 3, in the first step S1303, the selectable processes are processes having the process IDs of "1" to "4" in which end of another process is not included in the start condition. In this example, in the first step S1303, the possible treatment start time prediction unit 112 randomly selects one process, for example, from the processes having the process IDs of "1" to "4".

[0072]

The possible treatment start time prediction unit 112 determines a later time, between (1) the time when the start

condition of the process X in the diagnosis and treatment flow table 123 is satisfied (for example, when end of one or more predetermined processes is the start condition, it is a latest time among end times of the one or more predetermined processes) and (2) a possible use start time of a resource of the process X in the resource state table 124, as a start time of the process X (S1304).

[0073]

The possible treatment start time prediction unit 112 calculates a time acquired by adding an execution time of the process X in the diagnosis and treatment flow table 123 read in step S1301 to the start time calculated in step S1304 as an end time of the process X (S1305). The possible treatment start time prediction unit 112 determines whether all flows of the diagnosis and treatment flow table 123 read in step S1301 have been selected (S1306).

[0074]

When the possible treatment start time prediction unit 112 determines that there is an unselected flow (S1306: No), the processing returns to step S1303. When determining that all the flows have been selected (S1306: Yes), the possible treatment start time prediction unit 112 calculates a possible treatment start time of a flow (that is, of a patient classification indicated by the record at a hospital indicated by the record) indicated by the record read in step S1202

(S1307).

[0075]

In step S1307, the possible treatment start time prediction unit 112 specifically calculates, for example, an earliest time (in the example of FIG. 3 (that is, the example of the stroke patient), an earlier time between a start time of the t-PA treatment and a start time of the catheter treatment) among start times of specific treatment actions that are not treatment preparation actions such as a test as a possible treatment start time.

[0076]

With the above-described processing, the hospital selection server 100 of the present embodiment can select a hospital which can accept a patient in a predicted patient classification, more accurately calculate a possible treatment start time in consideration of a state of a resource of a flow, and therefore can more accurately select a hospital whose possible treatment start time is early.

[0077]

For example, when the emergency vehicle is a doctor car or the like, there may be a case where a part or all of processes of a flow can be executed in the emergency vehicle during transportation of the patient. For example, it is assumed that the auxiliary storage device 103 holds process information of the emergency vehicle indicating a process executable in the

emergency vehicle, a start condition of the process, and an execution time of the process. For example, in steps S1303 to S1305, when the possible treatment start time prediction unit 112 refers to the process information of the emergency vehicle and determines that there is a process that can be ended in the emergency vehicle up to the transportation end time, the process is executed preferentially in the emergency vehicle, and a start time and an end time of the process may be calculated.

[0078]

FIG. 14 is an explanatory diagram showing an example of execution times of the processes calculated in steps S1304 and S1305. In cases (1) to (3), a termination time for transportation to a hospital is 10 minutes later.

[0079]

First, the case (1) will be described. The case (1) is an example in which a value indicating an elapsed time from symptom onset, which is the explanatory variable, is "less than 4.5 hours", a value indicating presence or absence of previous history which is the explanatory variable is "no", and a patient classification is determined as (A) based on the patient classification prediction model 121.

[0080]

First, a flow of the patient classification (A) of a hospital and a state of a resource of the flow in the case (1) will be described. In the flow of the patient classification

(A) of the hospital, a "blood test", "clinical history confirmation", "electrocardiogram", "echo", "CT", "contrast-enhanced CT", a "t-PA treatment", and a "catheter treatment" are executed.

[0081]

Start conditions of the "blood test", the "clinical history confirmation", the "electrocardiogram", and the "echo" are only "end of transportation". A start condition of the "CT" is end of the "blood test", the "clinical history confirmation", the "electrocardiogram", and the "echo". A start condition of the "catheter treatment" is end of the "contrast-enhanced CT".

[0082]

A start condition of the "t-PA treatment" is end of the "CT". The start condition of the "catheter treatment" is the end of the "contrast-enhanced CT". Possible use start times of resources of the "electrocardiogram" and the "echo" are 15 minutes later. A possible use start time of a state of a resource of another flow is earlier than a time when a use start condition is satisfied.

[0083]

As described with reference to FIG. 13, the possible treatment start time prediction unit 112 can determine an execution sequence of the processes to start the treatment actions earlier by determining the execution times of the

processes based on the start condition and the state of the resource of the flow described above.

[0084]

Similar to the case (1), the case (2) has the patient classification (A), but the case (2) is different from the case (1) in that a possible use start time of a resource of the "CT" is 30 minutes later. After 20 minutes, the "blood test", the "clinical history confirmation", the "electrocardiogram", and the "echo" which are the start condition of the "CT" are ended, but the resource of the "CT" cannot be used at a time after the 20 minutes. Since the start conditions of the "t-PA treatment", the "contrast-enhanced CT", and the "catheter treatment" cannot be satisfied during a stage where the "CT" is not ended, a time period is generated from after 20 minutes to after 30 minutes in which no process is executed.

[0085]

The case (3) is an example in which a value indicating an elapsed time from symptom onset, which is the explanatory variable, is "4.5 hours or more", a value indicating presence or absence of a kidney disease which is the explanatory variable is "yes", and a patient classification is determined as (B) based on the patient classification prediction model 121. Since the "CT" cannot be executed for a patient having the kidney disease, a flow of the case (3) is different from that of the case (1) in that the "t-PA treatment" and the

"contrast-enhanced CT" which set the "CT" as start conditions are not performed and the "catheter treatment" is performed after execution of "MRI".

[0086]

Similar to the start condition of the "CT", a start condition of the "MRI" is the end of the "blood test", the "clinical history confirmation", the "electrocardiogram", and the "echo". A start condition of the "catheter treatment" is end of the "MRI".

[0087]

FIG. 15 is a flowchart showing an example of the estimation processing of the transportation end time of the patient in step S1302 (S1302). The transportation time estimation unit 115 acquires position information of the hospital from the acceptability table 122 and current position information of the terminal 200 acquired in step S801 (S1501).

[0088]

The transportation time estimation unit 115 acquires a travel time taken by a general vehicle (not the emergency vehicle) from the current position to the hospital based on route calculation and/or traffic jam information by using the position information of the hospital and the current position information (S1502).

[0089]

The processing of step S1501 is executed as follows. For

example, the transportation time estimation unit 115 transmits the position information of the hospital and the current position information to a car navigation server outside the hospital selection server 100. The car navigation server calculates the travel time taken by the general vehicle based on route information in consideration of traffic jam prediction, and transmits the calculated travel time to the hospital selection server 100. When a transportation equipment such as a ship or an airplane is used instead of the emergency vehicle, the traffic jam prediction may not be considered.

[0090]

When the hospital selection server 100 includes a model for car navigation of the general vehicle, for example, the transportation time estimation unit 115 acquires the traffic jam prediction information from outside and applies the position information of the hospital, the current position information, and the traffic jam prediction information to the model, whereby the processing of step S1501 may be executed.

[0091]

Subsequently, the transportation time estimation unit 115 inputs a current day of a week, a time period, and the travel time calculated in step S1502 that are the explanatory variables to the emergency vehicle travel time prediction model 125, calculates a travel time of the emergency vehicle that is the objective variable, and adds the travel time of the

emergency vehicle to a current time, thereby calculating a transportation end time (S1503).

[0092]

With the processing of FIG. 15, the travel time taken by the emergency vehicle that is different from the general vehicle in terms of characteristics and constraint conditions can be calculated more accurately. Accordingly, a hospital with a short transportation time can be selected more accurately.

[0093]

For a hospital whose acceptability is unknown in the acceptability table 122, or for a hospital whose possible treatment start time cannot be calculated for reasons that, for example, a flow ID is unknown or a state of a resource corresponding to the flow ID is unknown even when the correspondence is possible, it is considered that the emergency personnel makes an admission inquiry about whether the patient can be admitted to the hospital, a possible treatment start time, or the like.

[0094]

Therefore, when calculating the end time for the transportation to the hospital in the above manner in step S1503, the transportation time estimation unit 115 may consider a time required for the admission inquiry. Specifically, for example, the transportation time estimation unit 115 adds (i) an average

value (may be other statistics such as a maximum value, a minimum value, or a median value) of times required for the admission inquiries at the hospital in the admission inquiry required time history table 128 and (ii) the travel time acquired based on the emergency vehicle travel time prediction model 125 to a current time, whereby the transportation end time may be calculated.

[0095]

When the hospital selection server 100 and the terminal 200 do not perform hospital resource reservation processing to be described below, in order to make a reservation (admission inquiry) to a hospital by telephone or the like, , times required for admission inquiries may be considered in calculating transportation end times for all hospitals.

[0096]

FIG. 16 shows an example of an input screen displayed on the terminal 200. An input screen 1600 is for inputting the state information of the patient (the values of the explanatory variables input to the patient classification prediction model 121) in step S801. The input screen 1600 includes, for example, an explanatory variable input region 1601, a determination execution button 1602, and an objective variable display region 1603.

[0097]

The explanatory variable input region 1601 is for

inputting the values of the explanatory variables to be input to the patient classification prediction model 121. In the example of FIG. 16, a user of the terminal 200 can input the explanatory variables by selecting the values of the explanatory variables displayed in the explanatory variable input region 1601. In the example of FIG. 16, a selected value of the explanatory variable is displayed with white characters.

[0098]

When the determination execution button 1602 is selected in a state where the explanatory variables are input in the explanatory variable input region 1601, for example, (i) a patient classification predicted by the hospital selection server 100 by using the patient classification prediction model 121 (for example, the patient classification having a most relevant and highest probability) and (ii) information of a flow to be executed on the patient are displayed in the objective variable display region 1603. In the objective variable display region 1603, for example, a plurality of patient classifications and probabilities that the patient is respectively relevant to the plurality of patient classifications may be displayed as in the information shown in FIG. 9.

[0099]

After the determination execution button 1602 is selected and the determination is executed, the input screen

1600 may include a button for displaying an output screen of FIG. 17 to be described below. Further, the input screen 1600 may not include the objective variable display region 1603, and the output screen of FIG. 17 may be automatically displayed after the determination execution button 1602 is selected and the determination is executed.

[0100]

FIG. 17 shows an example of the output screen displayed on the terminal 200. The output screen 1700 is displayed on the display device 206 by, for example, the hospital candidate display unit 212. The output screen 1700 includes, for example, an objective variable display region 1701 and a map information display region 1702. For example, similar to the objective variable display region 1603, the objective variable display region 1701 displays a patient classification predicted using the patient classification prediction model 121 and information of a flow to be executed on the patient.

[0101]

The map information display region 1702 displays, for example, position information of the hospitals selected as the candidates in step S805 and current position information of the terminal 200. The map information display region 1702 includes a hospital information display region 1703. The hospital information display region 1703 displays, for example, a possible treatment start time when the patient is transported

to a hospital candidate, which is calculated in step S803.

[0102]

For a hospital whose possible treatment start time cannot be calculated such as a hospital D, for example, a time acquired by adding a time predetermined for each patient classification to a transportation end time may be displayed as a possible treatment start time, the transportation end time may be displayed instead of the possible treatment start time, and further a predicted admission inquiry time may be displayed.

[0103]

The hospital information display region 1703 includes, for example, a state display button 1704 and a transportation reservation button 1705. When the state display button 1704 is selected, for example, a transition is made to an output screen that displays a resource state of FIG. 18 to be described below. For a hospital whose state of a resource is unknown such as the hospital D, the state display button 1704 is not displayed.

[0104]

When the transportation reservation button 1705 is selected, for example, a possible use start time of the resource state table 124 of the hospital is updated based on a start time and an end time of a resource corresponding to a process of a flow of the hospital. Specifically, for example, the end time is updated as the possible use start time. The hospital

selection server 100 may transmit the start time and the end time of the resource corresponding to the process of the flow of the hospital to a server of the hospital, and in this case, the server of the hospital reserves the resource until the end time at the hospital.

[0105]

For example, there is a possibility that a scheduled arrival time is changed due to an accident or the like while a hospital is determined and the patient is transported. In such a case, the hospital selection server 100 receives, for example, an input of a changed arrival time or receives the input from the terminal 200. The hospital selection server 100 may recalculate the start time and the end time of each flow based on the changed arrival time to update a reservation time of the resource. When a difference between an actual arrival time and a scheduled arrival time is equal to or larger than a predetermined value, the reservation time of the resource may also be similarly updated.

[0106]

The resource state table 124 can be updated in real time by executing these reservation processings, and therefore estimation of a possible treatment start time to be subsequently executed can be executed more accurately.

[0107]

For a hospital whose acceptability is unknown or whose

state of a resource is unknown such as the hospital D, an admission inquiry button 1706 may be displayed instead of the transportation reservation button 1705. When the admission inquiry button 1706 is selected, for example, a call to the hospital is started, or state information of the patient and a patient classification are transmitted to the hospital. For example, when admission to the hospital is completed by an admission inquiry even though acceptability is unknown, a value of acceptability of the patient classification of the hospital in the acceptability table 122 may be changed to "yes".

[0108]

FIG. 18 shows an example of an output screen displayed on the terminal 200. An output screen 1800 is displayed on the display device 206 by, for example, the hospital candidate display unit 212. For example, when the state display button 1704 described above is selected, a transition is made from the output screen 1700 to the output screen 1800, or the output screen 1800 pops up.

[0109]

The output screen 1800 displays a state of a resource for each process of a selected flow in a hospital corresponding to the state display button 1704. FIG. 18 shows an example in which the state display button 1704 corresponding to a hospital A is selected. In the example of FIG 18, the hospital A includes three sets (patient frames 1 to 3) of resources that

execute the selected flow.

[0110]

For example, "completed" indicates that even though use of a resource is completed, there is a reserved resource in a set to which the resource belongs. "Available" indicates a state where a resource is available, that is, can be reserved immediately. "Unavailable" indicates that a resource cannot be used due to a failure or the like, or that the resource is not used in the flow. A blank column indicates a state where a resource is reserved. For example, an "elapsed time" indicates an elapsed time since a use start of a resource of a set.

[0111]

The invention is not limited to the embodiments described above and includes various modifications. For example, the embodiments described above have been described in detail for easy understanding of the invention, and the invention is not necessarily limited to those including all the configurations described above. A part of the configuration of one embodiment can be replaced with the configuration of another embodiment, and the configuration of another embodiment can be added to the configuration of one embodiment. A part of the configuration of each embodiment may be subjected to addition, deletion and replacement of another configuration.

[0112]

Some or all of the above configurations, functions, processing units, processing options, and the like may be realized by hardware, for example, by designing an integrated circuit. The configurations, functions, and the like described above may be realized by software by a processor interpreting and executing a program for realizing the respective functions. Information such as a program, a table, and a file that implements each function can be stored in a recording device such as a memory, a hard disk, a Solid State Drive (SSD), or in a recording medium such as an IC card, an SD card, or a DVD.

[0113]

Control lines and information lines indicate what is considered necessary for explanation, and not all control lines and information lines in the products are shown. It may be considered that almost all the configurations are actually connected to each other.

Reference Sign List

[0114]

- 100 hospital selection server
- 101 CPU
- 102 memory
- 104 communication device
- 103 auxiliary storage device

112 possible treatment start time prediction unit
114 hospital candidate selection unit
115 transportation time estimation unit
121 patient classification prediction model
122 acceptability table
123 diagnosis and treatment flow table
124 resource state table
125 emergency vehicle travel prediction model
128 admission inquiry required time history table
200 terminal
201 CPU
202 memory
203 auxiliary storage device
206 display device
211 patient state information input unit
212 hospital candidate display unit

CLAIMS

[Claim 1]

A medical institution selection server configured to select a medical institution to which a patient is transported, the medical institution selection server comprising:

a processor; and

a memory, wherein

the memory is configured to hold

a flow prediction model that predicts a flow which includes one or more processes to be executed on the patient from state information of the patient, and

medical institution information that indicates a state of a resource for executing each process included in an executable flow for each medical institution, and

flow information that indicates a start condition and an execution time of each process included in a flow indicated by the flow prediction model, and

the state of the resource indicated by the medical institution information is configured to indicate a possible use start time of the resource, and

the processor is configured to

acquire the state information of the patient,

predict a flow to be executed on the patient based on the acquired state information of the patient and the flow

prediction model,

acquire a state of a resource for executing each process included in the predicted flow in each medical institution with reference to the medical institution information,

refer to the flow information to acquire the start condition and execution time of each process included in the predicted flow,

refer to the medical institution information to acquire the possible use start time of the resource for executing each process included in the predicted flow,

calculate a start time of each process included in the predicted flow based on the acquired start condition, the acquired execution time, and the acquired possible use start time, and

select medical institution candidates to which the patient is transported based on the acquired states of the resources and the calculated start time, and

output information of the selected medical institution candidates.

[Claim 2]

The medical institution selection server according to claim1, wherein

the processor is configured to calculate, for each

process included in the predicted flow, a later time between a time when the process satisfies a start condition and the possible use start time of the resource for executing the process as a start time of the process.

[Claim 3]

The medical institution selection server according to claim 1, wherein

the one or more processes include treatment actions, and the medical institution candidates are selected based on a possible treatment start time that is an earliest time among the calculated start times of the processes which are the treatment actions in the corresponding predicted flow.

[Claim 4]

The medical institution selection server according to claim 3, wherein

the processor is configured to output a possible treatment start time of the corresponding medical institution candidate by including the possible treatment start time of the corresponding medical institution candidate in information of the selected medical institution candidates.

[Claim 5]

The medical institution selection server according to

claim 1, wherein

the memory is configured to hold

a travel time prediction model that predicts a travel time taken by emergency transportation equipment from a predicted travel time based on a route,

position information of the emergency transportation equipment, and

position information of the medical institution, and

the processor is configured to

acquire an estimated travel time based on a route through which the emergency transportation equipment arrives at the medical institution, the route being indicated by the position information of the emergency transportation equipment and the position information of the medical institution,

calculate a transportation end time when the emergency transportation equipment arrives at the medical institution based on the acquired predicted travel time and the travel time prediction model, and

calculate a start time of each process included in the predicted flow based on the transportation end time.

[Claim 6]

The medical institution selection server according to

claim 5, wherein

the memory is configured to hold admission inquiry required time history information that indicates history of a time required for an admission inquiry at each medical institution, and

the processor is configured to calculate the transportation end time based on a predetermined statistic of the time required for the admission inquiry at each medical institution.

[Claim 7]

The medical institution selection server according to claim 1, wherein

the processor is configured to
acquire information that indicates a transportation destination medical institution to which the patient is transported, the transportation destination medical institution being determined from the medical institution candidates, and

update a state of a resource of the transportation destination medical institution in the medical institution information based on a start time of each process included in a flow scheduled to be executed in the transportation destination medical institution.

[Claim 8]

The medical institution selection server according to claim 1, wherein

the flow prediction model includes

a patient classification prediction model configured to predict a patient classification of the patient from a state information of the patient, and

acceptability information configured to indicate, for each medical institution, acceptability of the patient classification and a flow executed for a patient who can be accepted in a patient classification, and

the processor is configured to

predict a patient classification of the patient based on the acquired state information of the patient and the patient classification prediction model, and

specify a medical institution that accepts the patient in the predicted patient classification with reference to the acceptability information and predict a flow executed on the patient in the medical institution.

[Claim 9]

The medical institution selection server according to claim 8, wherein

the memory is configured to hold flow information that indicates a start condition and an execution time of each

process included in a flow indicated by the flow prediction model,

the state of the resource indicated by the medical institution information is configured to indicate a possible use start time of the resource,

the one or more processes include treatment actions,

the patient classification prediction model is configured to predict a probability that the patient is relevant to each patient classification from the state information of the patient, and

the processor is configured to

predict the probability that the patient is relevant to each patient classification based on the acquired state information of the patient and the patient classification prediction model,

calculate a probability that each flow is executed on the patient in each medical institution based on the predicted probability and the acceptability information,

refer to the medical institution information to acquire a possible use start time of the resource for executing each process included in each flow,

refer to the flow information to acquire the start condition and execution time of each process included in each flow,

refer to the medical institution information to

acquire a possible use start time of the resource for executing each process included in each flow,

calculate a start time of each process included in each flow based on the acquired start condition, the acquired execution time, and the acquired possible use start time,

calculate, for each flow, a possible treatment start time that is an earliest time among the calculated start times of the processes which are the treatment actions,

calculate an expected value of the possible treatment start time in each medical institution based on the calculated possible treatment start time and the probability that each flow is executed, and

select the medical institution candidates based on the calculated expected values.

[Claim 10]

The medical institution selection server according to claim 1, wherein

the processor is configured to output states of resources of the medical institution candidates by including the states of the resources in information of the selected medical institution candidates.

[Claim 11]

A method for selecting, by a medical institution

selection server, a medical institution to which a patient is transported, the method comprising:

by the medical institution selection server, holding a flow prediction model configured to predict a flow which includes one or more processes to be executed on the patient from state information of the patient;

by the medical institution selection server, holding medical institution information configured to indicate a state of a resource for executing each process included in an executable flow for each medical institution;

by the medical institution selection server, holding flow information that indicates a start condition and an execution time of each process included in a flow indicated by the flow prediction model,

by the medical institution selection server, holding the state of the resource indicated by the medical institution information is configured to indicate a possible use start time of the resource,

by the medical institution selection server, acquiring the state information of the patient;

by the medical institution selection server, predicting a flow to be executed on the patient based on the acquired state information of the patient and the flow prediction model;

by the medical institution selection server, acquiring a state of a resource for executing each process included in

the predicted flow in each medical institution with reference to the medical institution information;

by the medical institution selection server, referring to the flow information to acquire the start condition and execution time of each process included in the predicted flow,

by the medical institution selection server, referring to the medical institution information to acquire the possible use start time of the resource for executing each process included in the predicted flow,

by the medical institution selection server, calculating a start time of each process included in the predicted flow based on the acquired start condition, the acquired execution time, and the acquired possible use start time,

by the medical institution selection server, selecting medical institution candidates to which the patient is transported based on the acquired states of the resources and the calculated start time; and

by the medical institution selection server, outputting information of the selected medical institution candidates.