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(71) Applicant: **NEC CORPORATION** [JP/JP]; 7-1, Shiba 5-chome, Minato-ku, Tokyo, 1088001 (JP).

(72) Inventor: **TEH Seng Khoon**; c/o NEC Asia Pacific Pte. Ltd., 2 Fusionopolis Way, #07-01, Innovis, 138634 (SG).

(74) Agent: **SHIMOSAKA Naoki**; c/o NEC CORPORATION, 7-1, Shiba 5-chome, Minato-ku, Tokyo, 1088001 (JP).

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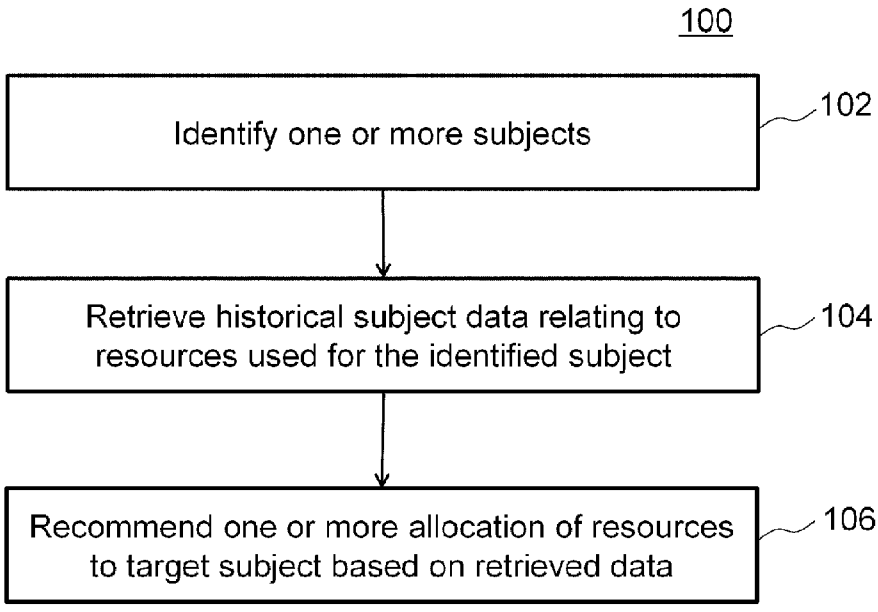
(54) Title: METHOD, SYSTEM AND STORAGE MEDIUM FOR RECOMMENDING RESOURCE ALLOCATION TO TARGET SUBJECT



(57) Abstract: The provided is a method etc. to improve effectiveness of allocation of resources to a subject. A computer-implemented method, according to an exemplary aspect of the present invention, for recommending resource allocation to a target subject, the method includes: identifying one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the one or more subjects each having states of recovery at the end of the predetermined time period, the states of recovery matching the predicted state of recovery of the target subject; retrieving historical subject data, the historical subject data relating to resources used for the identified subjects; and recommending one or more allocation of resources to the target subject based on the retrieved historical subject data.

[Continued on next page]

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Description

Title of Invention: METHOD, SYSTEM AND STORAGE MEDIUM FOR RECOMMENDING RESOURCE ALLOCATION TO TARGET SUBJECT

Technical Field

[0001] The present invention relates broadly, but not exclusively, to a method and a system etc. for recommending resource allocation to a target subject.

Background Art

[0002] Recovery outcomes for different health conditions depend on many complex factors including psychological factors, age and gender of a target subject (also referred to as a target patient). However, it is important to predict a possible health outcome for the target patient in order to plan the limited resources at an institution, e.g., a hospital. Typically, it takes time to increase the number of resources which include, among other things, the number of health care workers, the number of intensive care unit beds, the number of psychological sessions, the number of rehabilitation sessions to provide the health condition of the target patient.

[0003] Effective medical care demands that limited resources are properly matched with a need of a subject appropriately, while avoiding the excessive use of medical care resources that are more time and resource intensive. Advantageously, effective allocation of resources can lead to improved access for a subject to the limited resources, while reducing the cost for the subject by minimizing the use of expensive resources, yet achieving the maximum possible recovery outcome for the subject.

[0004] Conventionally, the institution depends on the experience of the health care workers to predict a possible recovery outcome for a patient. One of the disadvantages about this approach is that it is not accurate. More importantly, it does not help to allocate the limited resources at the institution effectively so as to achieve the maximum possible recovery outcome of the patient.

Summary of Invention

[0005] A need therefore exists to provide a method, a system etc. for recommending one or more resources to a target patient in order to address the above-mentioned problems.

Solution to Problem

[0006] According to a first aspect of the present invention, a computer implemented method for recommending resource allocation to a target subject includes: identifying one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the one

or more subjects each having states of recovery at the end of the predetermined time period, the states of recovery matching the predicted state of recovery of the target subject; retrieving historical subject data, the historical subject data relating to resources used for the identified subjects; and recommending one or more allocation of resources to the target subject based on the retrieved historical subject data.

[0007] According to a second aspect of the present invention, a computing system for recommending resource allocation to a target subject includes: subject identifier means for identifying one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the one or more subjects having states of recovery at the end of the predetermined time period, the states of recovery matching the predicted state of recovery of the target subject; retrieving means for retrieving historical subject data, the historical subject data relating to resources used for the identified subjects; and recommending means for recommending one or more allocation of resources to the target subject based on the retrieved historical subject data.

[0008] According to a third aspect of the present invention, a computer readable medium includes computer program code for recommending resource allocation to a target subject. The computer program code is configured to, with at least one processor, cause a computer at least to: identify one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the identified subjects each having states of recovery at the end of the predetermined time period that matches the predicted state of recovery of the target subject; retrieve historical subject data, the historical subject data relating to resources used for the identified subjects; and recommend one or more allocation of resources to the target subject based on the retrieved historical subject data.

Advantageous Effects of Invention

[0009] The present invention is capable of improving effectiveness of allocation of resources to a subject.

Brief Description of Drawings

[0010] Example embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, which provides examples only, and in conjunction with the drawings in which:
[fig.1]Figure 1 shows a flow chart illustrating a method for recommending resource allocation to a subject according to a first example embodiment of the present invention;
[fig.2A]Figure 2A shows a block diagram illustrating a configuration of a system for recommending resource allocation to a subject according to the first example embodiment of the present invention;

[fig.2B]Figure 2B shows a block diagram illustrating an alternative configuration of a system for recommending resource allocation to a subject according to the first example embodiment of the present invention and a configuration of a system for recommending resource allocation to a subject according to a second example embodiment of the present invention;

[fig.3]Figure 3 shows a flow chart illustrating identifying one or more subject and retrieving historical data of the one or more subject according to present invention;

[fig.4]Figure 4 shows an exemplary detection of the most similar cluster of patients for the target patient, according to the first example embodiment of the present invention;

[fig.5]Figure 5 shows a graphical representation of functional status against time, hospital discharged functional recovery potential, length of stay and resource requirement of healthcare intervention, according to the first example embodiment of the present invention;

[fig.6]Figure 6 shows a graphical representation of efficiency against effectiveness based on ranking of the various patient case scenarios, according to the first example embodiment of the present invention;

[fig.7]Figure 7 shows an exemplary process of efficiency and effectiveness recommendation engine to recommend the cases for target patients which meet a resource constraint, according to the first example embodiment of the present invention;

[fig.8]Figure 8 shows a schematic of a system for recommending resource allocation to a subject according to the first example embodiment of the present invention; and

[fig.9]Figure 9 shows an exemplary computing device suitable for executing the method for recommending resource allocation to a subject according to present embodiments.

Description of Embodiments

[0011] Unless context dictates otherwise, the following terms will be given the meaning provided here.

The terms "healthcare institute", "healthcare institution" and similar include a hospital, a clinic and any other establishment in which healthcare services are provided.

The term "patient information" includes data relating to at least a patient or a patient's condition, which may include, among other information, at least a disease, injury or other condition. In one example, past clinical records for the patient's condition may be patient information, as may be a diagnosis for a new patient or new patient condition.

The terms "treatment", "healthcare intervention", "hospital admission" and similar refer to any action by a healthcare resource (e.g. a human or a machine) for the purpose

of facilitating recovery of the patient. Counselling for a patient and prescribing medicine for a patient may also be included in this definition.

The term "healthcare institute resource" and similar will be understood to include, among other things, various types of resource such as healthcare human resources, medical equipment, beds for patients and so forth. Nursing staffs and doctors are included in the intended meaning of "healthcare human resources".

The term "prediction" refers to an action taken to estimate a functional status of the patients after a specific period from hospital admission - for example, 6 months.

The terms "functional status", "state of recovery", "health status", "degree of recovery" and similar refer to a healthcare related status of patients such as ability of movement of a part of body in comparison with the corresponding status prior to an incident or a health issue such as heart stroke.

The term "one or more databases" refers to any database or databases located within a computing system or remote server such as a computer in hospital or cloud server. Each of the database and the databases may be a cloud database running on a cloud computing platform.

[0012]Example embodiments of the present invention will be described, by way of example only, with reference to the drawings. The same reference numerals and characters in the drawings refer to the same elements or equivalents.

[0012] Some portions of the description which follows are explicitly or implicitly presented in terms of algorithms and functional or symbolic representations of operations on data within a computer memory. These algorithmic descriptions and functional or symbolic representations are the means used by those skilled in the data processing arts to convey most effectively the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities, such as electrical, magnetic or optical signals capable of being stored, transferred, combined, compared, and otherwise manipulated.

[0013] Unless specifically stated otherwise, and as apparent from the following, it will be appreciated that throughout the present specification, discussions utilizing terms such as "identifying", "retrieving", "recommending" or the like, refer to the action and processes of a computer system, or similar electronic device, that manipulates and transforms data represented as physical quantities within the computer system into other data similarly represented as physical quantities within the computer system or other information storage, transmission or display devices.

[0014] The present specification also discloses apparatus for performing an operation of the method. Such apparatus may be specially constructed for a required purpose, or may include a computer or other device selectively activated or reconfigured by a computer

program stored in the computer. The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various machines may be used with programs in accordance with the teachings herein. Alternatively, the construction of more specialized apparatus to perform the required method steps may be appropriate. An example of a structure of a computer will be described below.

[0015] In addition, the present specification also implicitly discloses a computer program, in that it would be apparent to the person skilled in the art that the individual steps of the method described herein may be put into effect by computer code. The computer program is not intended to be limited to any particular programming language and implementation thereof. It will be appreciated that a variety of programming languages and coding thereof may be used to implement the teachings of the disclosure contained herein. Moreover, the computer program is not intended to be limited to any particular control flow. There are many other variants of the computer program, which can use different control flows without departing from the spirit or scope of the invention.

[0016] Furthermore, one or more of the steps of the computer program may be performed in parallel rather than sequentially. Such a computer program may be stored on any computer readable medium. The computer readable medium may be any one of storage devices such as magnetic or optical disks, memory chips, or other storage devices suitable for interfacing with a computer. The computer readable medium may also be a hard-wired medium such as exemplified in the Internet system, or a wireless medium such as exemplified in the GSM mobile telephone system. The computer program when loaded and executed on such a computer effectively results in an apparatus that implements the steps of the preferred method.

[0017] <First Example Embodiment>

Figure 1 shows a flow chart illustrating a method 100 for recommending resource allocation to a subject (a patient), according to a first example embodiment of the present invention. It can also be understood that the method is suitable for recommending resource allocation to a care giver. The method 100 may be performed by a computer coupled to one or more databases. Furthermore, the method 100 may be performed by a computing device which may be a server system, a mobile device (e.g. a smart phone or a tablet computer) or a personal computer. Further details on the computer and databases will be provided below with reference to Figures 8 and 9.

[0018] The method 100 broadly includes:

Step 102: identifying one or more subjects, each of the identified subjects having a state of recovery at the end of the predetermined time period, the state of recovery matching the predicted state of recovery of a target subject;

Step 104: retrieving historical subject data, the historical subject data relating to resources used for the identified subjects; and

Step 106: recommending one or more allocation of resources to the target subject based on the retrieved historical subject data.

[0019] Without loss of generality, the description will largely focus on example embodiments of the invention relating to hospitals rather than the more general "healthcare institution" case, though it will be understood to apply equally to clinics or other healthcare institutions.

[0020] Step 102 involves identifying one or more subjects, each of the identified subjects having a state of recovery at the end of the predetermined time period, the state of recovery matching the predicted state of recovery of the target subject. The one or more subjects include one or more patients who have already suffered a disease or an injury, and are at various stages of recovery from the disease or the injury. Additionally or alternatively the one or more subjects are discharged from a hospital after receiving resources towards recovery, such as several rehabilitation sessions, at the hospital. Therefore, health status of the one or more subjects at the time of hospital admission, at the time of discharge from the hospital and at the end of predetermined time period such as 6 months from the hospital admission are available.

[0021] In an example, the target subject has a profile characteristic which is used to determine the predicted state of recovery. The step 102 includes identifying the one or more subjects having a profile characteristic that matches to the profile characteristic of the target subject. The profile characteristic includes; among other things, demographic information; gender information; and health condition information.

[0022] The identified one or more subjects are ranked based on the similarity among subjects in view of functional status at the time of admission and at the end of predetermined time period from the admission. If a subject has a functional status at the time of admission which matches to the functional status of the target subject, the subject is ranked high. If a subject has a functional status, at the end of predetermined time period from the admission, which matches to the predicted functional status of the target subject, the subject is also ranked high.

[0023] Additionally or alternatively, the identified one or more subjects are ranked in accordance with efficiency and effectiveness levels. A level of efficiency (Ef) and a level of effectiveness (Es) may be calculated as follows:

[Math.1]

$$Efficiency(E_f) = \frac{FIM_{discharge} - FIM_{admission}}{LOS^{number\ of\ rehabilitation\ session\ in\ a\ day}}$$

$$Effectiveness(E_s) = 1 - \frac{FIM_{discharge} - FIM_{admission}}{FIM_{end} - FIM_{admission}}$$

FIM stands for Functional Independence Measure e.g. an example of functional status. $FIM_{discharge}$ means functional status at the time when the subject discharged from a hospital. $FIM_{admission}$ means functional status at the time when the subject admitted at the hospital. FIM_{end} means functional status at the end of predetermined time period. LOS stands for a length of (hospital) stay. LOS $^{number\ of\ rehabilitation\ session\ in\ a\ day}$ is proportional to a resource allocated to the subject.

[0024] The efficiency score (Ef), i.e. the level of efficiency (Ef), for each of the one or more subjects is calculated based on (i) a degree of recovery and (ii) a number of resources that have been used during the period during which at least one resource is used on the subject. In an example, the efficiency score for each of the one or more subjects is directly proportional to the degree of recovery during the period during which at least one resource is used on the subject and is inversely proportional to the number of resources that have been used during the period during which at least one resource is used on the subject. In other words, maximizing the degree of recovery together with minimizing usage of resources will result in high efficiency score. The period during which at least one resource is used on the subject may include the period the subject is hospitalized.

[0025] The effectiveness score (Es) , i.e. the level of effectiveness (Es), for each of the one or more subjects is calculated based on a degree of recovery during which resources are not used on the subject and a degree of recovery of the subject during the predetermined time period. In an example, the effectiveness score for each of the one or more subjects is directly proportional to the degree of recovery during which resources are not used on the subject, and is inversely proportional to the degree of recovery of the subject during the predetermined period. In other words, maximizing a ratio of the degree of recovery after discharging from the hospital to the degree of recovery during the predetermined period, e.g. a combination of a hospitalized period and a period after discharging from the hospital, will result in high effectiveness score. Details of ranking are explained with reference to Figure 6.

[0026] Step 104 may include retrieving historical subject data, the historical subject data relating to resources used for the identified subjects. The resources include type and administration of medicaments, the number of rehabilitation sessions in a day, a time period from admission to discharge. After identifying a subject who is similar to the target subject in step 102, resources used for the identified subjects is retrieved from one or more databases.

[0027] In a preferred embodiment, resources used for the subject who has the highest efficiency score and the highest effectiveness score should be used for the target subject. However, due to insufficiency of healthcare institution resources, resources used for the subject with such high scores are not always available. Accordingly, the method

100 may further include determining resources available at a point in time, i.e., determining resources available at the healthcare institution (also referred to as available healthcare institution resources) at the point in time. Additionally, the step 102 may include ranking the one or more subjects based on the determined resources available at the point in time. The case for a past patient to follow is determined by comparing available resources with required resources to follow the case of the identified subjects. The comparison is explained together with Figure 7.

[0028] Step 106 may include recommending one or more allocation of resources to the target subject based on the retrieved historical subject data. In an example, the recommended one or more allocation of resources to the subject is displayed on a display. The recommended resources may include an intensive care unit bed, a medical care system and a general ward bed. The recommended resources may include the number of rehabilitation sessions in a day. The recommended one or more allocation of resource to the subject may be displayed together with available rehabilitation facility information so that the recommended rehabilitation sessions may be reserved without additional steps.

[0029] Figure 2A shows a block diagram illustrating a configuration of a system (i.e. a system 200) for recommending resource allocation to a target subject in accordance with the present example embodiment. The system 200 includes a receiver 202 for receiving inputs from a clinical process, a functional recovery potential engine 208 for predicting patient's functional recovery potential, a patient similarity engine 210 for matching a target patient with patients with similar profile characteristics, a recommendation engine 212 for making recommendation of resource allocation based on efficiency and effectiveness in view of a healthcare resource and a schedule constraints, a display 206 for generating visualization output for healthcare staff to use, and a healthcare resource and schedule management engine 214. The system 200 may include a computer system 204. The functional recovery potential engine 208, the patient similarity engine 210, the recommendation engine 212 and the healthcare resource and schedule management engine 214 may be incorporated in the computer system 204.

[0030] The receiver 202 receives clinical process of a target subject. The clinical process may include a type of diseases or injuries and a part or parts suffering diseases or injuries, and diagnostic results of the target subject. The clinical process is stored in one or more database in a computer system e.g. electronic health records or one or more servers in medical institutes. The receiver 202 receives the clinical process stored in the one or more databases.

[0031] The functional recovery potential engine 208 obtains the clinical process from the receiver 202. Based on the obtained clinical process, the functional recovery potential

engine 208 predicts a maximum functional recovery potential for the target subject. More specifically, the functional recovery potential engine 208 considers current functional status of the target subject and age, gender, a type of diseases or injuries and a body part suffering the disease or injuries. These may be the profile characteristics of the target subject. In addition, the functional recovery potential engine 208 may consider a profile characteristic of the target subject including a demographic information and a psychological information of the target patient.

[0032] By comparing the clinical process of the target patient with past data stored in one or more database, the functional recovery potential engine 208 predicts the functional recovery potential of the target subject.

[0033] The patient similarity engine 210 also obtains the clinical process from the receiver 202. An example of the patient similarity engine 210 is a subject identifier. The patient similarity engine 210 also obtains the functional recovery potential predicted by the functional recovery potential engine 208. Based on the clinical process and the functional recovery potential of the target subject, the patient similarity engine 210 identifies a group of patients who are similar to the target subject in view of current functional status and the predicted functional recovery potential. That is, the identified group of patients have a profile characteristic (e.g. predicted functional recovery potential) that is similar to that of the target subject. Details of the functions of the patient similarity engine 210 are explained with reference to Figure 4.

[0034] The recommendation engine 212 obtains the predicted functional recovery potential of the target subject from the functional recovery potential engine 208. An example of the recommendation engine 212 is a recommending module. The recommendation engine 212 further obtains information of the group of similar patients from the patient similarity engine 210. An example of a module of the recommendation engine 212 which obtains the information of the group of similar patients from the patient similarity engine 210 is a retrieving module. Each of the patients in the group of similar patients may be ranked based on efficiency and effectiveness. The efficiency is measured as an amount of recovery per resource allocated for the target patient. On the other hand, the effectiveness is measured as an amount of recovery after discharge of the target subject per total amount of recovery from admission to a specific timing after the discharge.

[0035] The recommendation engine 212 further receives data from the healthcare resource and schedule management engine 214 so that the recommendation engine 212 can provide a recommendation in view of available healthcare resource and schedule. In an example, the recommendation engine 212 checks a resource allocated to a past patient who is ranked highly based on the efficiency and the effectiveness. By comparing the allocated resource with available resource informed by the healthcare resource and

schedule management engine 214, the recommendation engine 212 determines whether the allocated resource for the past patient with highly ranked is applicable to the target subject. If the hospital has a sufficient healthcare resource to follow the resource allocation of the past patient with highly ranked, the recommendation engine 212 sends recommendation information such as the number of rehabilitation sessions in a day, available facilities and timing of rehabilitation, and an available room for the target subject to display 206. If the hospital does not have a sufficient resource, the recommendation engine 212 checks resource allocation information of the next past patient. Detailed procedures are explained with reference to Figure 7.

[0036] The display 206 receives the recommendation information from the recommendation engine 212. The display 206 shows the recommendation information on how to allocate resource to the target subject on the display 206 (e.g. on a screen of the display 206). In an example, a staff in a hospital sees the recommendation information on the display 206, determines resource allocations to the target subject and fixes the schedule of rehabilitation sessions. The display 206 may include any other type of user interface to show the recommendation information. For example, the display 206 may be a speaker for providing recommendation information via acoustic sound by voice synthesis. In one example, the display 206 may include a system that provides a service of a short message or an email to show recommended resource allocation.

[0037] It is to be understood that the hardware components mentioned in Figure 2A may be arranged in various different arrangements. For example, the functional recovery potential engine 208 may be configured to be operationally coupled to the recommendation engine 212 without the patient similarity engine 210. Additionally or alternatively not every hardware components are necessarily required to generate the same output. More details will be provided in Figure 2B.

[0038] Figure 2B shows a block diagram illustrating an alternative configuration of a system (i.e. a system 250) for recommending resource allocation to a target subject in accordance with the present example embodiment. The system 250 includes a subject identifier 252, a retrieving module 254 and a recommending module 256. The system 250 of Figure 2B is described later as a second example embodiment.

[0039] Figure 3 shows a flow chart illustrating a method 300 of identifying one or more subject and retrieving historical data of the one or more subject according to present example embodiment. The method 300 broadly includes:

Step 302: measuring target patient and input patient hospital admission functional status;

Step 304: predicting maximum functional recovery potential using the functional recovery potential engine 208;

Step 306: employing functional status at the time of hospital admission and

maximum functional recovery potential; and

Step 308: identifying patients most similar to the target patient and output data of the most similar patients.

[0040] Step 302 may include measuring target patient and input patient hospital admission functional status. At the time of hospital admission, functional status of the target patient is measured and the measured functional status of the target patient is compared with functional status at the time of admission in the clinical records of past patients. The functional status may be defined as a percentage of functionality of a patient comparing with fully functioned status of the patient.

[0041] Step 304 may include predicting maximum functional recovery potential using functional recovery potential engine 208. Based on the functional status in Step 302 and past clinical records, maximum functional recovery potential is predicted in view of age, gender, and a type of disease or injuries.

[0042] Step 306 may include employing functional status at the time of hospital admission and the maximum functional recovery potential. In this step, the functional status at the time of hospital admission and the maximum functional recovery potential are determined for the target subject so that past patient similar to the target patient is identified in step 308 using the functional status and the maximum functional recovery potential.

[0043] Step 308 may include identifying patients most similar to the target subject and outputting data of the most similar patients. Based on the functional status at the time of hospital admission and the maximum functional potential employed in step 306, a group of patients most similar to the target subject is identified. Healthcare resource allocation data used for each patient in the group of patients may be stored in one or more database in the hospital. The healthcare resource allocation data used for each patient in the group of patients most similar to the target subject is output and used for recommendation to the target subject.

[0044] Figure 4 shows an exemplary detection of the most similar cluster of patients 400 for the target patient, according to present example embodiment. Patient 1 (402), patient 2 (404) and patient 3 (406) are the candidates who may be considered to be similar to a target patient 408. In an example, a graph based approach with community detection algorithm is used to identify the most similar cluster of patients for the target patient. In the community detection approach, each of the patients 402, 404, 406 and 408 is linked together based on similarity between each two patients. In an example, thickness of lines between two patients indicates an index of similarity using the admission functional status, the maximum functional recovery potential and other patient information. For example, a line 410 between patient 2 and patient 3 is indicated thicker than a line 412 between patient 1 and patient 3, which means that an

index of similarity between patient 2 and patient 3 is higher than that between patient 1 and patient 3. After checking similarities between other two patients, a most similar cluster (group) 414 of patients is detected. Other algorithms may be used to determine the most similar group of patients.

[0045] Figure 5 shows a graphical representation of functional status against time, hospital discharged functional recovery potential, length of stay and resource requirement of healthcare intervention (i.e. (functional status information 500)), according to present example embodiment. In a vertical axis, functional status is shown as arbitrary unit e.g. Functional Independence Measure (FIM). In this example, the maximum score is defined as 126. In a horizontal axis, time (e.g. days) from hospital admission for stroke is shown. In this example, the maximum time from the hospital admission for stroke is defined as 6 month. Also, three patients (patient 1, patient 2 and patient 3) are shown in this example. Historical subject data of functional status, e.g. functional status at the time of hospital admission, discharge and the end of the predetermined period, e.g. 6 months from the hospital admission for each of three patients are shown.

[0046] Historical subject data of patient 1 is shown as historical subject data 502. Functional status of patient 1 at the time of hospital admission is higher than that of the target patient shown as functional status 508. Also, functional status of patient 1 at the end of the predetermined period is slightly higher than maximum functional recovery potential of the target patient shown as functional status 510.

[0047] Historical subject data of patient 2 is shown as historical subject data 504. Functional status of patient 2 at the time of hospital admission is slightly lower than that of the target patient shown as functional status 508. Also, functional status of patient 2 at the end of the predetermined period is slightly lower than maximum functional recovery potential of the target patient shown as functional status 510. In addition, patient 2 was discharged earlier than patient 1, in other words, healthcare resources allocated to patient 2 was less than that of patient 1.

[0048] Historical subject data of patient 3 is shown as historical subject data 506. Functional status of patient 3 at the time of hospital admission is slightly higher than that of the target patient shown as functional status 508. Also, functional status of patient 3 at the end of the predetermined period is lower than the maximum functional recovery potential of the target patient shown as functional status 510. In addition, patient 3 was discharged later than patient 1, in other words, healthcare resources allocated to patient 3 was more than that of patient 1.

[0049] As shown in Figure 4, patient 2 and patient 3 are considered to be similar to the target patient. Figure 5 further clarifies that patient 1 and the target patient are different in historical data of functional status. Also, recovery in functional status of patient 2 is higher than that of patient 3. In addition, allocated resources to patient 2 is less than

that of patient 3. Details of comparison between patient 2 and patient 3 are explained with reference to Figure 6.

[0050] Figure 6 shows a graphical representation of efficiency and effectiveness 600 based on ranking of the various patient case scenarios, according to present example embodiment. In Figure 6, vertical axis indicates the efficiency in log scale. Horizontal axis indicates the effectiveness. The efficiency and the effectiveness are defined in the following equations as explained in the description of step 102 of Figure 1.

[Math.2]

$$Efficiency(E_f) = \frac{FIM_{discharge} - FIM_{admission}}{LOS^{number\ of\ rehabilitation\ session\ in\ a\ day}}$$

$$Effectiveness(E_s) = 1 - \frac{FIM_{discharge} - FIM_{admission}}{FIM_{end} - FIM_{admission}}$$

[0051] The efficiency may be considered as an amount of recovery in view of allocated resources. During hospitalization, functional status of patient 2 was recovered significantly. On the other hand, functional status of patient 3 was gradually recovered. On the other hand, the effectiveness may be considered as a ratio between an amount of recovery after discharge and an amount of recovery for the entire period e.g. 6 months from hospital admission. Accordingly, the efficiency and effectiveness of patient 2 is plotted at a location 602, and the efficiency and effectiveness of patient 3 is plotted at a location 604.

[0052] Ranking of efficiency and effectiveness is based on an area under curve (AUC). AUC for patient 2 is shown as an area 606. AUC for patient 2 is larger than AUC for patient 3. Accordingly patient 2 is ranked higher than patient 3 in view of the efficiency and effectiveness. Other methods for ranking patient will be applicable.

[0053] Figure 7 shows an exemplary process 700 of the efficiency and effectiveness recommendation engine 704 to recommend the optimal case for target patients to refer based on the resource and schedule management engine 702, according to present example embodiment. After ranking each of the past patients, the efficiency and effectiveness recommendation engine 704 may check whether resource allocations used for the past patients are applicable to the target patient in view of resource availability.

[0054] For example, in step 706, the Rank 1 case is selected, and resource allocation used for the Rank 1 case is considered. Available resource information is obtained from the resource and schedule management engine 702. In step 708, whether an allocated resource for Rank 1 is within a resource constraint in view of available resource information is determined. If the allocated resource for Rank 1 is within the resource

constraint, the Rank 1 case is recommended in step 710. If the allocated resource for Rank 1 goes beyond the resource constraint, Rank 2 case is considered in step 712.

[0055] Similar to Rank 1, in step 712, Rank 2 is selected and resource allocation used for the Rank 2 case is considered. Available resource information is obtained from the resource and schedule management engine 702. In step 714, whether an allocated resource for Rank 2 is within the resource constraint in view of available resource information is determined. If the allocated resource for Rank 2 is within the resource constraint, the Rank 2 case is recommended in step 716. If the allocated resource for Rank 2 goes beyond the resource constraint, another case will be considered or resource availability will be redefined.

[0056] In accordance with the present example embodiment, resource allocation to a target subject may be recommended. Such a recommendation is advantageous for the target subject to provide appropriate advice in view of past clinical information and current resource availability. Selecting similar cases from the past clinical information and ranking the selected similar cases based on the efficiency and the effectiveness will provide a recommendation of efficient and effective resource allocation. Thus, patients can receive healthcare treatment efficiently and effectively. Also, the healthcare institute can reduce waste of healthcare resources by the recommendation.

[0057] <Second Example Embodiment>

Figure 2B shows a block diagram illustrating a configuration of a system (i.e. a system 250) for recommending resource allocation to a target subject in accordance with the second example embodiment of the present invention. The system 250 includes a subject identifier 252, a retrieving module 254 and a recommending module 256. The subject identifier 252 corresponds to the functional recovery potential engine 208, and operates in the same manner as the functional recovery potential engine 208. The subject identifier 252 identifies one or more subjects. The one or more subjects each have states of recovery at the end of a predetermined time period. A target subject has a predicted state of recovery at the end of the predetermined time period. The state of recovery of the one or more subjects match the predicted state of recovery of the target subject. The retrieving module 254 and the recommending module 256 correspond to the recommendation engine 212, and operate in the same manner as the recommendation engine 212. The retrieving module 254 retrieves historical subject data. The historical subject data relates to resources used for the identified subjects. The recommending module 256 recommends one or more allocation of resources to the target subject based on the retrieved historical subject data.

[0058] The system 250 of the present example embodiment is capable of improving effectiveness of allocation of resources to a subject. The reason is that the recommending module 256 recommends one or more allocation of resources to the target subject

based on the retrieved historical subject data.

[0059] Figure 8 shows a schematic of a network-based system 800 for recommending resource allocation to a target subject according to a second example embodiment of the present invention. The system 800 includes a computer 802, one or more databases $804_1 \ldots 804_n$, a user input module 806 and a user output module 808. Each of the one or more databases $804_1 \ldots 804_n$ is communicably coupled with the computer 802. The user input module 806 and the user output module 808 may be separate and distinct modules communicably coupled with the computer 802. Alternatively, the user input module 806 and the user output module 808 may be integrated within a single mobile electronic device (e.g. a mobile phone, a tablet computer, etc.). The mobile electronic device may have appropriate communication modules for wireless communication with the computer 802 via existing communication protocols.

[0060] The computer 802 may include: at least one processor; and at least one memory storing computer program code; the at least one memory and the computer program code configured to, with the at least one processor, cause the computer at least to: (A) identify one or more subjects, each of the one or more subjects each having states of recovery at an end of the predetermined time period, the states of recovery matching a predicted state of recovery of a target subject; (B) retrieve historical subject data, the historical subject data relating to resources used for the identified subjects; and (C) recommend one or more allocation of resources to the target subject based on the retrieved historical subject data.

[0061] The various types of data, e.g. historical subject data, healthcare institute resource availability, functional status of patient can be stored in a single database (e.g. 804_1), or stored in a plurality of databases (e.g. healthcare institute resource availability are stored on database 804_1, historical subject data, functional status of patient are stored on database 804_n, etc.). The databases $804_1 \ldots 804_n$ may be achieved using cloud computing storage modules and/or dedicated servers communicably coupled with the computer 802.

[0062] Figure 9 depicts an example configuration of an exemplary computer / computing device 900, hereinafter interchangeably referred to as a computer system 900, where one or more such computing devices 900 may be used to facilitate execution of the above-described method for recommending allocation of resources to a subject. In addition, one or more components of the computer system 900 may be used to achieve the computer 802. The following description of the computing device 900 is provided by way of example only and is not intended to be limiting.

[0063] As shown in Figure 9, the example computing device 900 includes a processor 904 for executing software routines. Although a single processor is shown for the sake of clarity, the computing device 900 may also include a multi-processor system. The

processor 904 is connected to a communication infrastructure 906 for communication with other components of the computing device 900. The communication infrastructure 906 may include, for example, a communications bus, a cross-bar, or a network.

[0064] The computing device 900 further includes a main memory 908, such as a random access memory (RAM), and a secondary memory 910. The secondary memory 1010 may include, for example, a storage drive 912, which may be a hard disk drive, a solid state drive or a hybrid drive and/or a removable storage drive 914, which may include a magnetic tape drive, an optical disk drive, a solid state storage drive (such as a universal serial bus (USB) flash drive, a flash memory device, a solid state drive or a memory card), or the like. The removable storage drive 914 reads from and/or writes to a removable storage medium 944 in a well-known manner. The removable storage medium 944 may include a magnetic tape, an optical disk, non-volatile memory storage medium, or the like, which is read by and written to by removable storage drive 914. As will be appreciated by persons skilled in the relevant art(s), the removable storage medium 944 includes a computer readable storage medium having stored therein computer executable program code instructions and/or data.

[0065] In an alternative implementation, the secondary memory 910 may additionally or alternatively include other similar means for allowing computer programs or other instructions to be loaded into the computing device 900. Such means can include, for example, a removable storage unit 922 and an interface 940. Examples of the removable storage unit 922 and the interface 940 include a program cartridge and a cartridge interface (such as that found in video game console devices), a removable memory chip (such as an EPROM or a PROM) and an associated socket, a removable solid state storage drive (such as a USB flash drive, a flash memory device, a solid state drive or a memory card), and other removable storage units 922 and interfaces 940 which allow software and data to be transferred from the removable storage unit 922 to the computer system 900.

[0066] The computing device 900 also includes at least one communication interface 924. The communication interface 924 allows software and data to be transferred between the computing device 900 and an external devices via a communication path 926. In various example embodiments of the present invention, the communication interface 924 permits data to be transferred between the computing device 900 and a data communication network, such as a public data communication network or a private data communication network. The communication interface 924 may be used to exchange data between different computing devices 900 which such computing devices 900 form part of an interconnected computer network. Examples of a communication interface 924 can include a modem, a network interface (such as a network card), a commu-

nication port (such as a serial port, a parallel port, a printer port, a general purpose interface bus (GPIB) port, an Institute of Electrical and Electronics Engineers (IEEE) 1394 port, a registered jack 35 (RJ35) port, a USB port), an antenna with associated circuitry and the like. The communication interface 924 may be wired or may be wireless. Software and data transferred via the communication interface 924 are in the form of signals which can be electronic, electromagnetic, optical or other signals capable of being received by communication interface 924. These signals are provided to the communication interface via the communication path 926.

[0067] As shown in Figure 9, the computing device 900 further includes a display interface 902 which performs operations for rendering images to an associated display 930 and an audio interface 932 for performing operations for playing audio content via an associated speaker(s) 934.

[0068] As used herein, the term "computer program product" may refer, in part, to the removable storage medium 944, the removable storage unit 922, a hard disk installed in the storage drive 912, or a carrier wave carrying software over communication path 926 (wireless link or cable) to the communication interface 924. A computer readable storage medium refers to any non-transitory, non-volatile tangible storage medium that provides recorded instructions and/or data to the computing device 900 for execution and/or processing. Examples of such a storage medium include magnetic tape, a compact disc read only memory (CD-ROM), a DVD, a Blu-ray Disc, a hard disk drive, a read only memory (ROM) or integrated circuit, a solid state storage drive (such as a USB flash drive, a flash memory device, a solid state drive or a memory card), a hybrid drive, a magneto-optical disk, or a computer readable card such as a secure digital (SD) card and the like, whether or not such devices are internal or external of the computing device 900. Examples of a transitory or non-tangible computer readable transmission medium that may also participate in the provision of software, application programs, instructions and/or data to the computing device 900 include radio or infrared transmission channels as well as a network connection to another computer or networked device, and the Internet or Intranets including e-mail transmissions and information recorded on Websites and the like.

[0069] The computer programs (also called computer program code) are stored in the main memory 908 and/or the secondary memory 910. The computer programs can also be received via the communication interface 924. Such computer programs, when executed, enable the computing device 900 to perform one or more features of the example embodiments discussed herein. In various embodiments, the computer programs, when executed, enable the processor 904 to perform features of the above-described example embodiments. Accordingly, such computer programs represent controllers of the computer system 900.

[0070] Software may be stored in a computer program product and loaded into the computing device 900 using the removable storage drive 914, the storage drive 912, or the interface 940. Alternatively, the computer program product may be downloaded to the computer system 900 over the communications path 926. The software, when executed by the processor 904, causes the computing device 900 to perform functions of embodiments described herein.

[0071] It is to be understood that the embodiment of Figure 9 is presented merely by way of example. Therefore, in some embodiments, one or more features of the computing device 900 may be omitted. Also, in some embodiments, one or more features of the computing device 900 may be combined together. Additionally, in some embodiments, one or more features of the computing device 900 may be split into one or more component parts.

[0072] It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

[0073] The whole or part of the example embodiments disclosed above can be described as, but not limited to, the following supplementary notes.

[0074] (Supplementary Note 1)

A computer-implemented method for recommending resource allocation to a target subject, the method including:

identifying one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the one or more subjects each having states of recovery at the end of the predetermined time period, the states of recovery matching the predicted state of recovery of the target subject;

retrieving historical subject data, the historical subject data relating to resources used for the identified subjects; and

recommending one or more allocation of resources to the target subject based on the retrieved historical subject data.

(Supplementary Note 2)

The computer-implemented method in accordance with Supplementary Note 1, further including determining resources available at a point in time,

wherein the identifying the one or more subjects includes ranking the one or more subjects based on the determined resources available at the point in time.

(Supplementary Note 3)

The computer-implemented method in accordance with Supplementary Note 2,

wherein the recommending one or more allocation of resources to the target subject is further based on the ranking of the one or more subjects.

(Supplementary Note 4)

The computer-implemented method in accordance with any one of Supplementary Notes 1 to 3,

wherein the target subject has a profile characteristic which is used to determine the predicted state of recovery, and

wherein the identifying the one or more subjects includes identifying the one or more subjects having a profile characteristic that matches to the profile characteristic of the target subject.

(Supplementary Note 5)

The computer-implemented method in accordance with any one of Supplementary Notes 1 to 4,

wherein the identifying includes computing similarity among subjects using a graph-based approach.

(Supplementary Note 6)

The computer-implemented method in accordance with Supplementary Note 2,

wherein the predetermined time period includes a period during which at least one resource is used on the one or more subjects and a period during which resources are not used on the one or more subjects, and

wherein the ranking the one or more subjects includes calculating a efficiency score for each of the one or more subjects based on a degree of recovery during the period during which at least one resource is used on the subject and a resource number of resources that have been used during the period during which at least one resource is used on the subject.

(Supplementary Note 7)

The computer-implemented method in accordance with Supplementary Note 6,

wherein the efficiency score for each of the one or more subjects is directly proportional to the degree of recovery during the period during which at least one resource is used on the subject and inversely proportional to the resource number of resources that have been used during the period during which at least one resource is used on the subject.

(Supplementary Note 8)

The computer-implemented method in accordance with Supplementary Note 6 or Supplementary Note 7,

wherein the ranking the one more subjects further includes calculating an effectiveness score for each of the one or more subjects based on a degree of recovery during which resources are not used on the subject and a degree of recovery of the subject during the

predetermined time period.

(Supplementary Note 9)

The computer-implemented method in accordance with any one of Supplementary Notes 6 to 8,

wherein the effectiveness score for each of the one or more subjects is directly proportional to the degree of recovery during which resources are not used on the subject and inversely proportional to the degree of recovery of the subject during the predetermined time period.

(Supplementary Note 10)

The computer-implemented method in accordance with any one of Supplementary Notes 1 to 9, further including:

displaying, on a display, the recommended one or more allocation of resources, the resources include intensive care unit bed, medical care system and general ward bed.

(Supplementary Note 11)

The computer-implemented method in accordance with any one of Supplementary Notes 4 to 10, further including:

identifying the profile characteristic of the target patient at the beginning of the time period, the profile characteristic including a demographic information and a psychological information of the target patient.

(Supplementary Note 12)

A computing system for recommending resource allocation to a target subject, the system including:

subject identifier means for identifying one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the one or more subjects having states of recovery at the end of the predetermined time period, the states of recovery matching the predicted state of recovery of the target subject;

retrieving means for retrieving historical subject data, the historical subject data relating to resources used for the identified subjects; and

recommending means for recommending one or more allocation of resources to the target subject based on the retrieved historical subject data.

(Supplementary Note 13)

The computing system in accordance with Supplementary Note 12, further including a determining means for determining resources available at a point in time,

wherein the subject identifier means includes ranking means for ranking the one or more identified subjects based on the determined resources available at the point of time.

(Supplementary Note 14)

The computing system in accordance with Supplementary Note 13, wherein the recommending means recommends one or more allocation of resources based on the ranking of the one or more subjects.

(Supplementary Note 15)

The computing system in accordance with any one of Supplementary Notes 12 to 14, wherein the target subject has a profile characteristic which is used to determine the predicted state of recovery, and

wherein the subject identifier means identifies the one of more subjects having a profile characteristic that matches to the profile characteristic of the target subject.

(Supplementary Note 16)

The computing system in accordance with any one of Supplementary Notes 12 to 15, wherein the subject identifier means computes similarity among subjects using graph-based approach.

(Supplementary Note 17)

The computing system in accordance with Supplementary Note 13,

wherein the predetermined time period includes a period during which at least one resource is used on the one or more subjects and a period during which resources are not used on the one or more subjects, and

wherein the ranking the one or more subjects includes calculating a efficiency score for each of the one or more subjects based on a degree of recovery during the period during which at least one resource is used on the subject and a number of resources that have been used during the period during which at least one resource is used on the subject.

(Supplementary Note 18)

The computing system in accordance with Supplementary Note 17,

wherein the efficiency score for each of the one or more subjects is directly proportional to the degree of recovery during the period during which at least one resource is used on the subject and inversely proportional to the number of resources that have been used during the period during which at least one resource is used on the subject.

(Supplementary Note 19)

The computing system in accordance with Supplementary Note 17 or 18,

wherein the ranking the one more subjects further includes calculating an effectiveness score for each of the one or more subjects based on a degree of recovery during which resources are not used on the subject and a degree of recovery of the subject during the predetermined time period.

(Supplementary Note 20)

The computing system in accordance with any one of Supplementary Notes 17 to 19, wherein the effectiveness score for each of the one or more subjects is directly pro-

portional to the degree of recovery during which resources are not used on the subject and inversely proportional to the degree of recovery of the subject during the predetermined time period.

(Supplementary Note 21)

The computing system in accordance with any one of Supplementary Notes 12 to 20, further including a display means for displaying the recommended one or more allocation of resources, the resources include intensive care unit bed, medical care system and general ward bed.

(Supplementary Note 22)

The computing system in accordance with any one of Supplementary Notes 15 to 21, wherein the subject identifier means further identifies the profile characteristic of the target patient at the beginning of the time period, the profile characteristic including a demographic information and a psychological information of the target patient.

(Supplementary Note 23)

A computer readable medium including computer program code for recommending resource allocation to a target subject, the computer program code configured to, with at least one processor, cause a computer at least to:

identify one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the identified subjects each having states of recovery at the end of the predetermined time period that matches the predicted state of recovery of the target subject;

retrieve historical subject data, the historical subject data relating to resources used for the identified subjects; and

recommend one or more allocation of resources to the target subject based on the retrieved historical subject data.

[0075] This application is based upon and claims the benefit of priority from Singapore patent application No. 10201610983S, filed on December 30, 2016, the disclosure of which is incorporated herein in its entirety by reference.

Reference Signs List

[0076] 100 Method

200 System

202 Receiver

204 Computer system

206 Display

208 Functional recovery potential engine

210 Patient similarity engine

212 Recommendation engine

214 Healthcare resource and schedule management engine
250 System
252 Subject identifier
254 Retrieving module
256 Recommending module
300 Method
400 Patients
402 Patient 1
404 Patient 2
406 Patient 3
408 Patient (Target)
410 Line
412 Line
414 Cluster
500 Functional status information
502 Historical subject data
504 Historical subject data
506 Historical subject data
508 Functional status
510 Functional status
600 Efficiency and effectiveness
602 Location
604 Location
606 Area
700 Exemplary process
702 Resource and schedule management engine
704 Efficiency and effectiveness recommendation engine
710 Recommend Rank 1
716 Recommend Rank 2
800 System
802 Computer
804_1 Database
804_n Database
806 User input module
808 User output module
900 Computer / Computing device
902 Display interface
904 Processor

906 Communication infrastructure
908 Main memory
910 Secondary memory
912 Storage drive
914 Removable storage drive
922 Removable storage unit
924 Communication interface
926 Communication path
932 Audio interface
934 Speaker(s)
940 Interface
944 Removable storage medium

Claims

[Claim 1] A computer-implemented method for recommending resource allocation to a target subject, the method comprising:
identifying one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the one or more subjects each having states of recovery at the end of the predetermined time period, the states of recovery matching the predicted state of recovery of the target subject;
retrieving historical subject data, the historical subject data relating to resources used for the identified subjects; and
recommending one or more allocation of resources to the target subject based on the retrieved historical subject data.

[Claim 2] The computer-implemented method in accordance with claim 1, further comprising determining resources available at a point in time,
wherein the identifying the one or more subjects includes ranking the one or more subjects based on the determined resources available at the point in time.

[Claim 3] The computer-implemented method in accordance with claim 2,
wherein the recommending one or more allocation of resources to the target subject is further based on the ranking of the one or more subjects.

[Claim 4] The computer-implemented method in accordance with any one of claims 1 to 3,
wherein the target subject has a profile characteristic which is used to determine the predicted state of recovery, and
wherein the identifying the one or more subjects comprises identifying the one or more subjects having a profile characteristic that matches to the profile characteristic of the target subject.

[Claim 5] The computer-implemented method in accordance with any one of claims 1 to 4,
wherein the identifying includes computing similarity among subjects using a graph-based approach.

[Claim 6] The computer-implemented method in accordance with claim 2,
wherein the predetermined time period comprises a period during which at least one resource is used on the one or more subjects and a period during which resources are not used on the one or more subjects,

and

wherein the ranking the one or more subjects comprises calculating a efficiency score for each of the one or more subjects based on a degree of recovery during the period during which at least one resource is used on the subject and a resource number of resources that have been used during the period during which at least one resource is used on the subject.

[Claim 7] The computer-implemented method in accordance with claim 6, wherein the efficiency score for each of the one or more subjects is directly proportional to the degree of recovery during the period during which at least one resource is used on the subject and inversely proportional to the resource number of resources that have been used during the period during which at least one resource is used on the subject.

[Claim 8] The computer-implemented method in accordance with claim 6 or claim 7,

wherein the ranking the one more subjects further comprises calculating an effectiveness score for each of the one or more subjects based on a degree of recovery during which resources are not used on the subject and a degree of recovery of the subject during the predetermined time period.

[Claim 9] The computer-implemented method in accordance with any one of claims 6 to 8,

wherein the effectiveness score for each of the one or more subjects is directly proportional to the degree of recovery during which resources are not used on the subject and inversely proportional to the degree of recovery of the subject during the predetermined time period.

[Claim 10] The computer-implemented method in accordance with any one of claims 1 to 9, further comprising:

displaying, on a display, the recommended one or more allocation of resources, the resources comprise intensive care unit bed, medical care system and general ward bed.

[Claim 11] The computer-implemented method in accordance with any one of claims 4 to 10, further comprising:

identifying the profile characteristic of the target patient at the beginning of the time period, the profile characteristic comprising a demographic information and a psychological information of the target patient.

[Claim 12] A computing system for recommending resource allocation to a target subject, the system comprising:
subject identifier means for identifying one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the one or more subjects having states of recovery at the end of the predetermined time period, the states of recovery matching the predicted state of recovery of the target subject;
retrieving means for retrieving historical subject data, the historical subject data relating to resources used for the identified subjects; and
recommending means for recommending one or more allocation of resources to the target subject based on the retrieved historical subject data.

[Claim 13] The computing system in accordance with claim 12, further comprising a determining means for determining resources available at a point in time,
wherein the subject identifier means comprises ranking means for ranking the one or more identified subjects based on the determined resources available at the point of time.

[Claim 14] The computing system in accordance with claim 13, wherein the recommending means recommends one or more allocation of resources based on the ranking of the one or more subjects.

[Claim 15] The computing system in accordance with any one of claims 12 to 14, wherein the target subject has a profile characteristic which is used to determine the predicted state of recovery, and
wherein the subject identifier means identifies the one of more subjects having a profile characteristic that matches to the profile characteristic of the target subject.

[Claim 16] The computing system in accordance with any one of claims 12 to 15, wherein the subject identifier means computes similarity among subjects using graph-based approach.

[Claim 17] The computing system in accordance with claim 13,
wherein the predetermined time period comprises a period during which at least one resource is used on the one or more subjects and a period during which resources are not used on the one or more subjects, and
wherein the ranking the one or more subjects comprises calculating a efficiency score for each of the one or more subjects based on a degree

of recovery during the period during which at least one resource is used on the subject and a number of resources that have been used during the period during which at least one resource is used on the subject.

[Claim 18] The computing system in accordance with claim 17, wherein the efficiency score for each of the one or more subjects is directly proportional to the degree of recovery during the period during which at least one resource is used on the subject and inversely proportional to the number of resources that have been used during the period during which at least one resource is used on the subject.

[Claim 19] The computing system in accordance with claim 17 or 18, wherein the ranking the one more subjects further comprises calculating an effectiveness score for each of the one or more subjects based on a degree of recovery during which resources are not used on the subject and a degree of recovery of the subject during the predetermined time period.

[Claim 20] The computing system in accordance with any one of claims 17 to 19, wherein the effectiveness score for each of the one or more subjects is directly proportional to the degree of recovery during which resources are not used on the subject and inversely proportional to the degree of recovery of the subject during the predetermined time period.

[Claim 21] The computing system in accordance with any one of claims 12 to 20, further comprising a display means for displaying the recommended one or more allocation of resources, the resources comprise intensive care unit bed, medical care system and general ward bed.

[Claim 22] The computing system in accordance with any one of claims 15 to 21, wherein the subject identifier means further identifies the profile characteristic of the target patient at the beginning of the time period, the profile characteristic comprising a demographic information and a psychological information of the target patient.

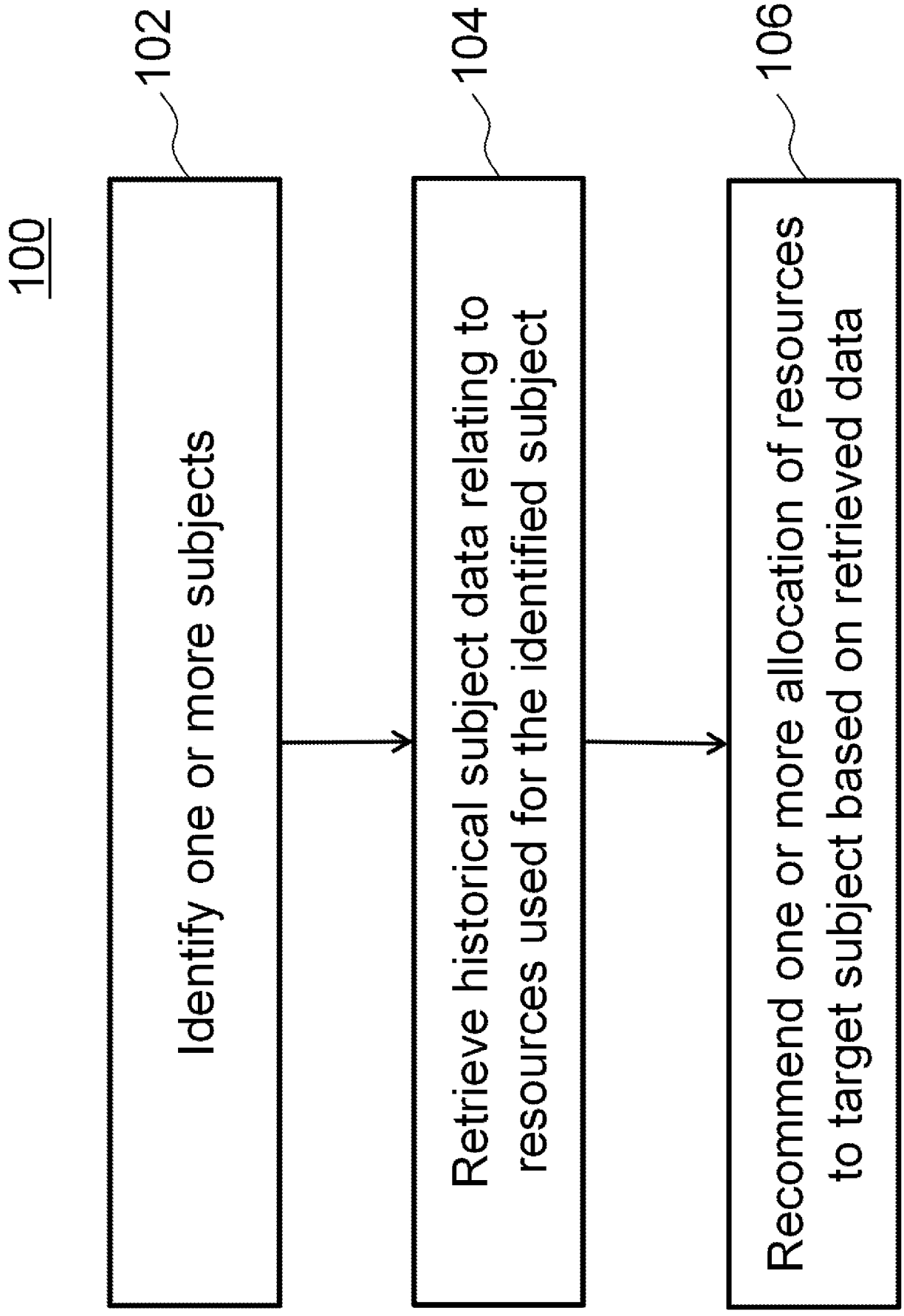
[Claim 23] A computer readable medium including computer program code for recommending resource allocation to a target subject, the computer program code configured to, with at least one processor, cause a computer at least to:

identify one or more subjects, the target subject having a predicted state of recovery at which the target subject is capable of reaching at an end of a predetermined time period, the identified subjects each having states of recovery at the end of the predetermined time period that matches the predicted state of recovery of the target subject;

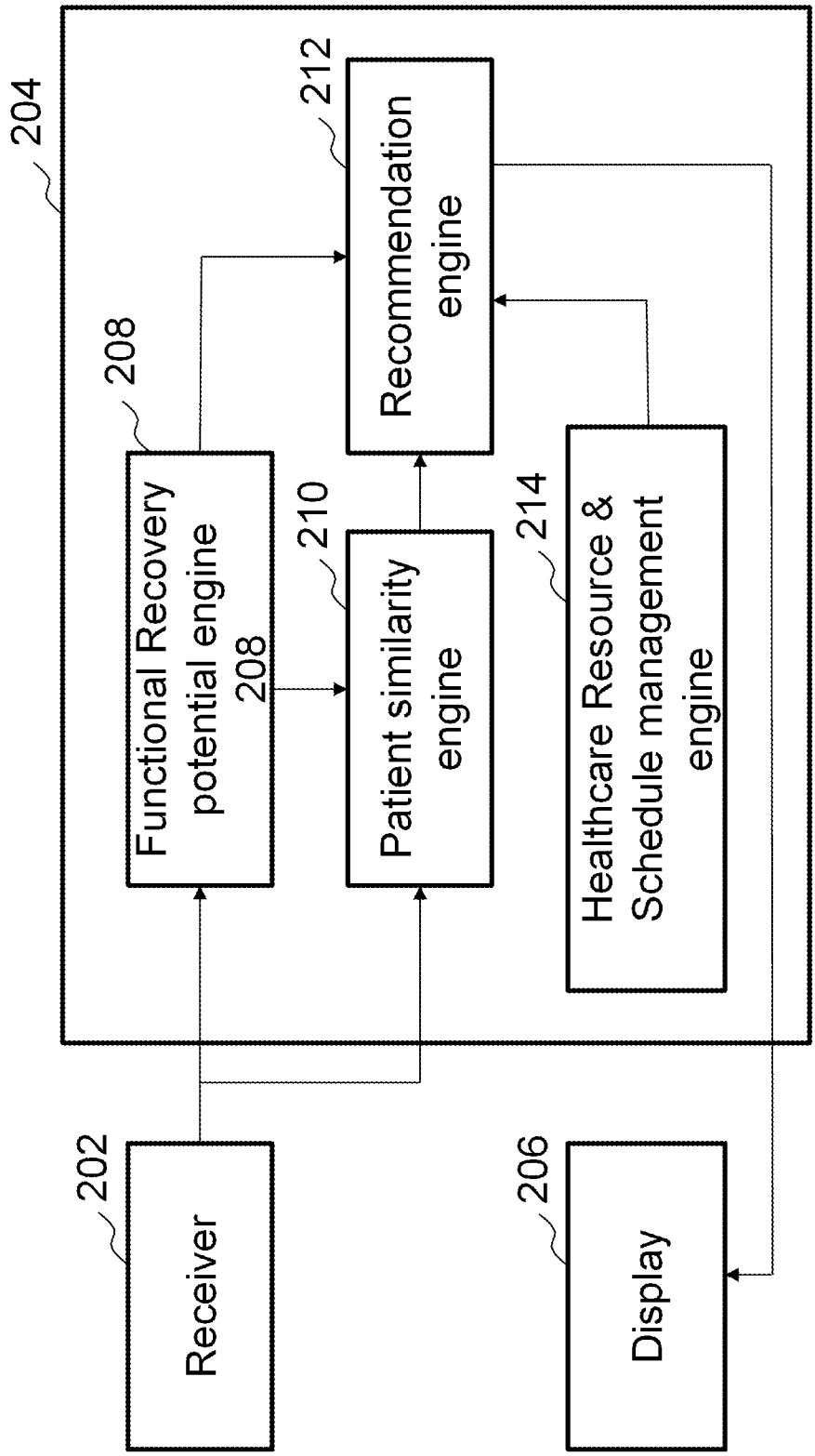
retrieve historical subject data, the historical subject data relating to resources used for the identified subjects; and

recommend one or more allocation of resources to the target subject based on the retrieved historical subject data.

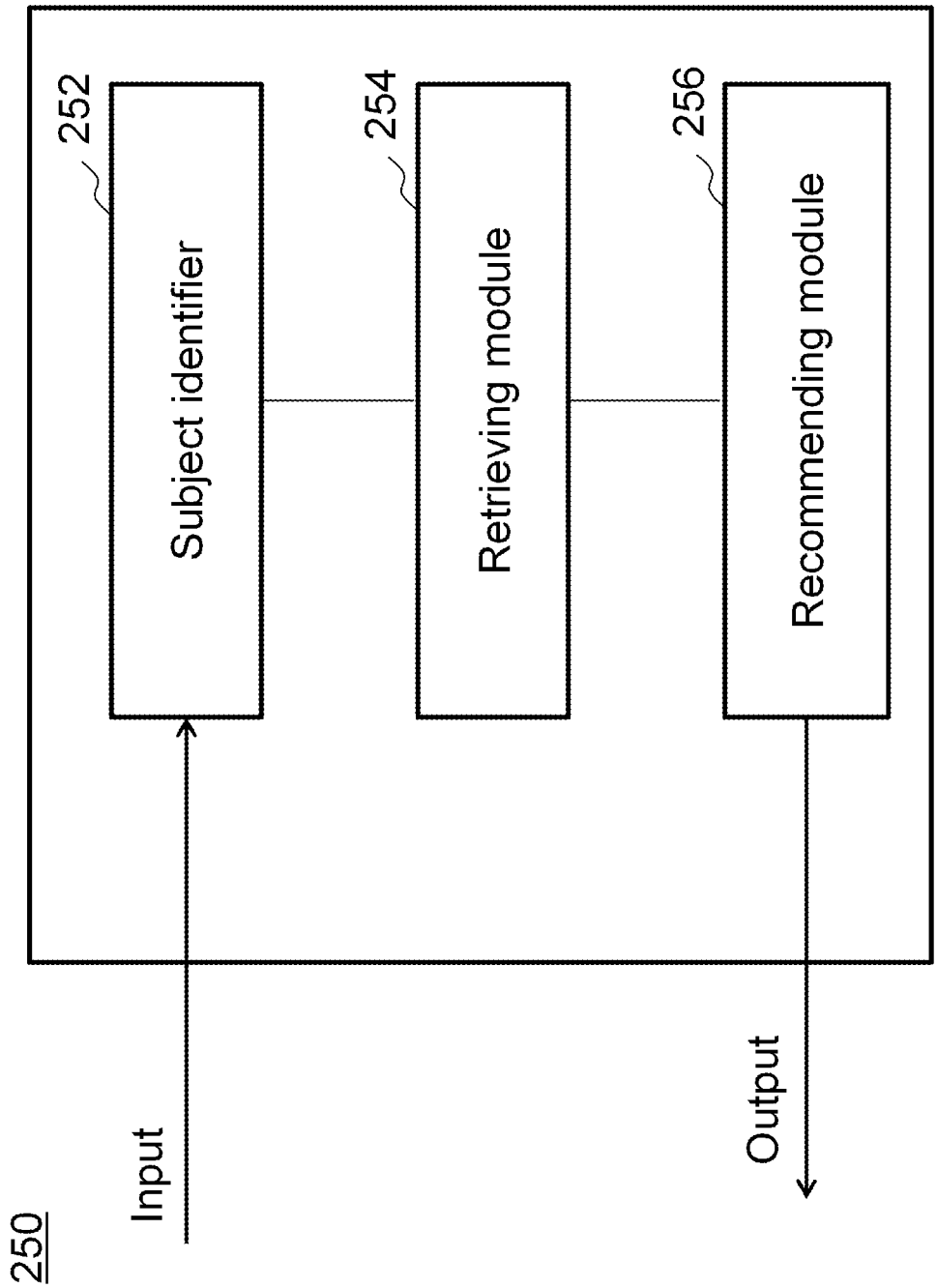
[Fig. 1]


100
102
Identify one or more subjects
104
Retrieve historical subject data relating to resources used for the identified subject
106
Recommend one or more allocation of resources to target subject based on retrieved data

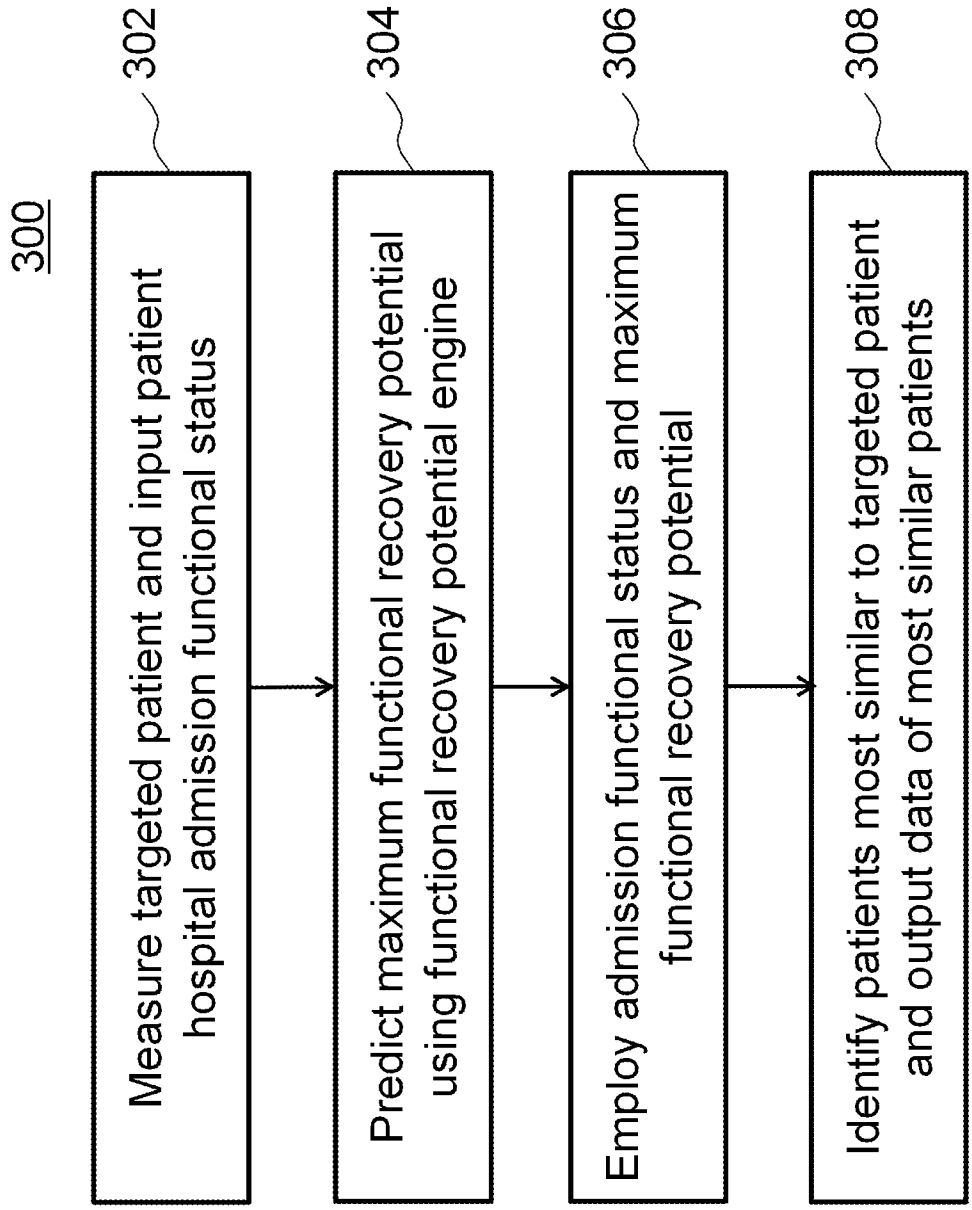
[Fig. 2A]


204
212
Recommendation engine
208
Functional Recovery potential engine 208
210
Patient similarity engine
214
Healthcare Resource & Schedule management engine
202
Receiver
206
Display

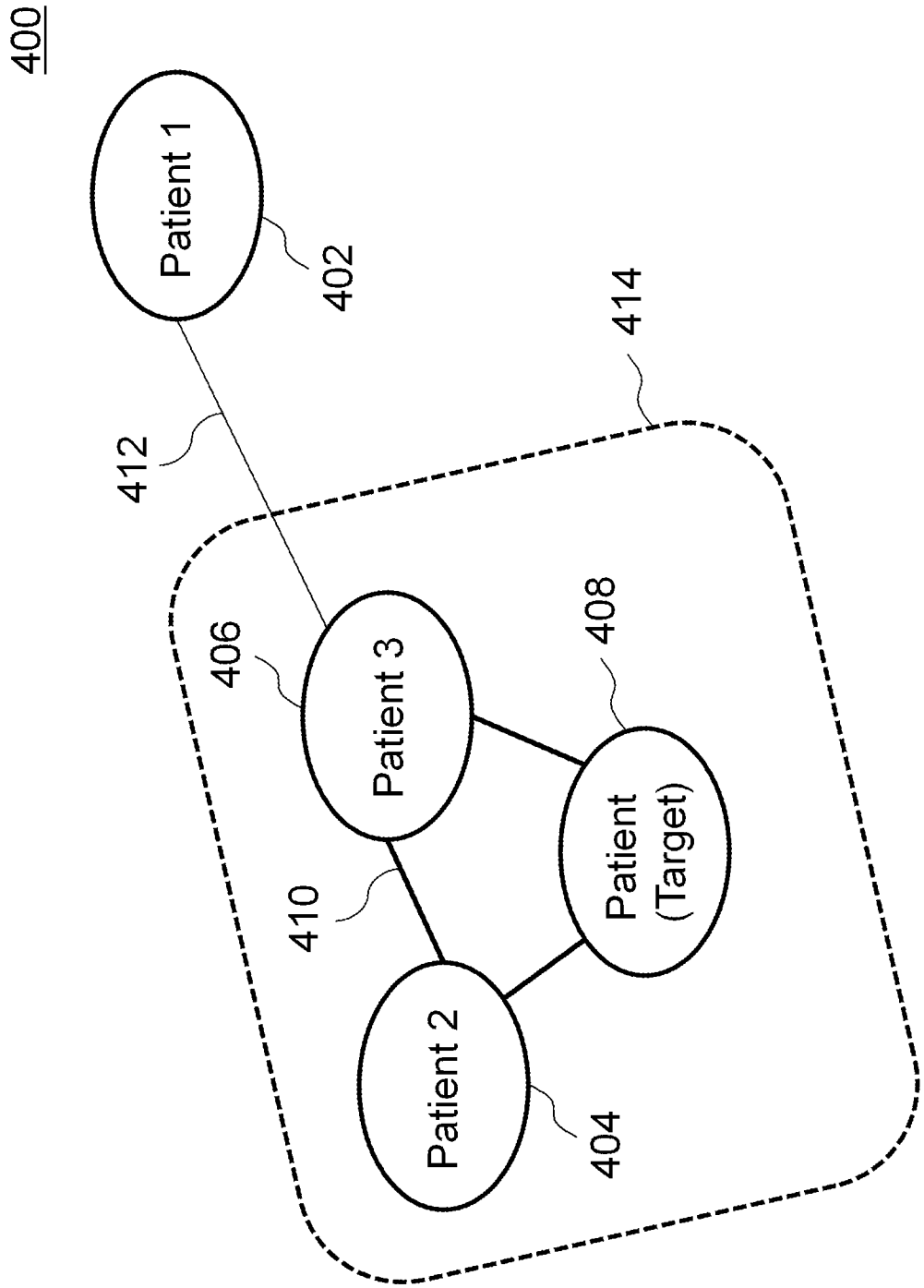
[Fig. 2B]


250
Input
Output
252
Subject identifier
254
Retrieving module
256
Recommending module

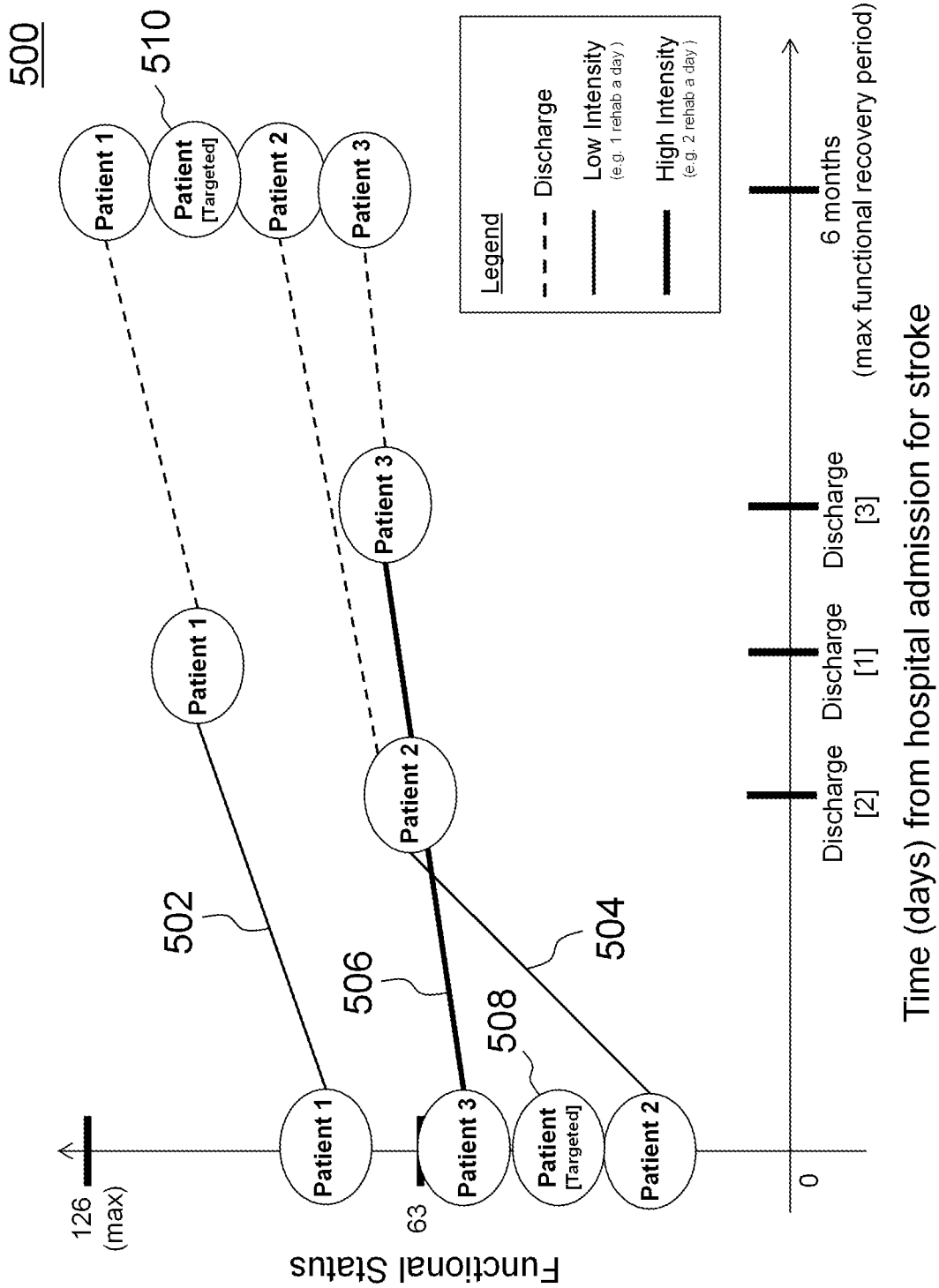
[Fig. 3]


300
302
Measure targeted patient and input patient hospital admission functional status
304
Predict maximum functional recovery potential using functional recovery potential engine
306
Employ admission functional status and maximum functional recovery potential
308
Identify patients most similar to targeted patient and output data of most similar patients

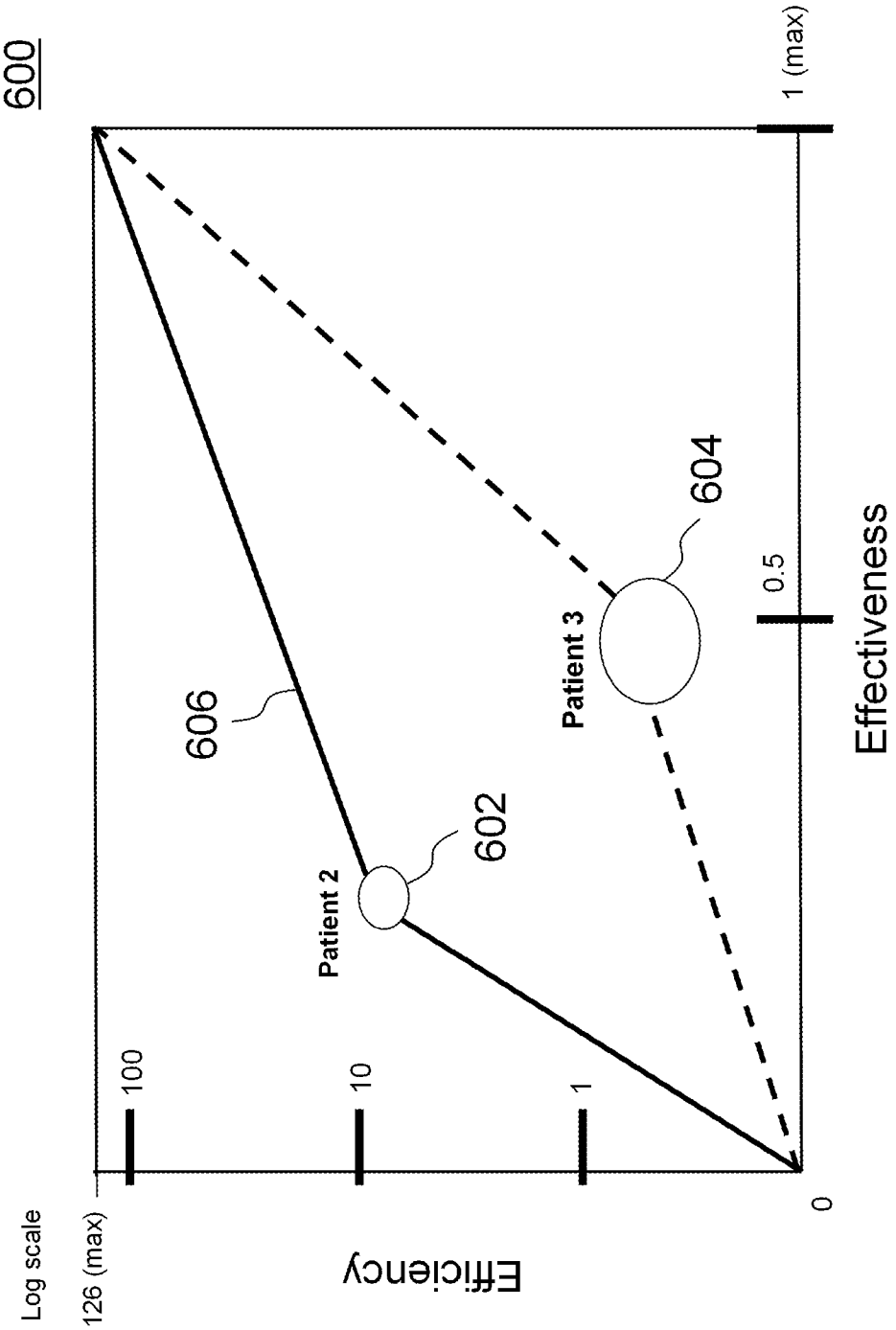
[Fig. 4]


400
Patient 1
402
414
412
406
Patient 3
408
Patient (Target)
410
Patient 2
404

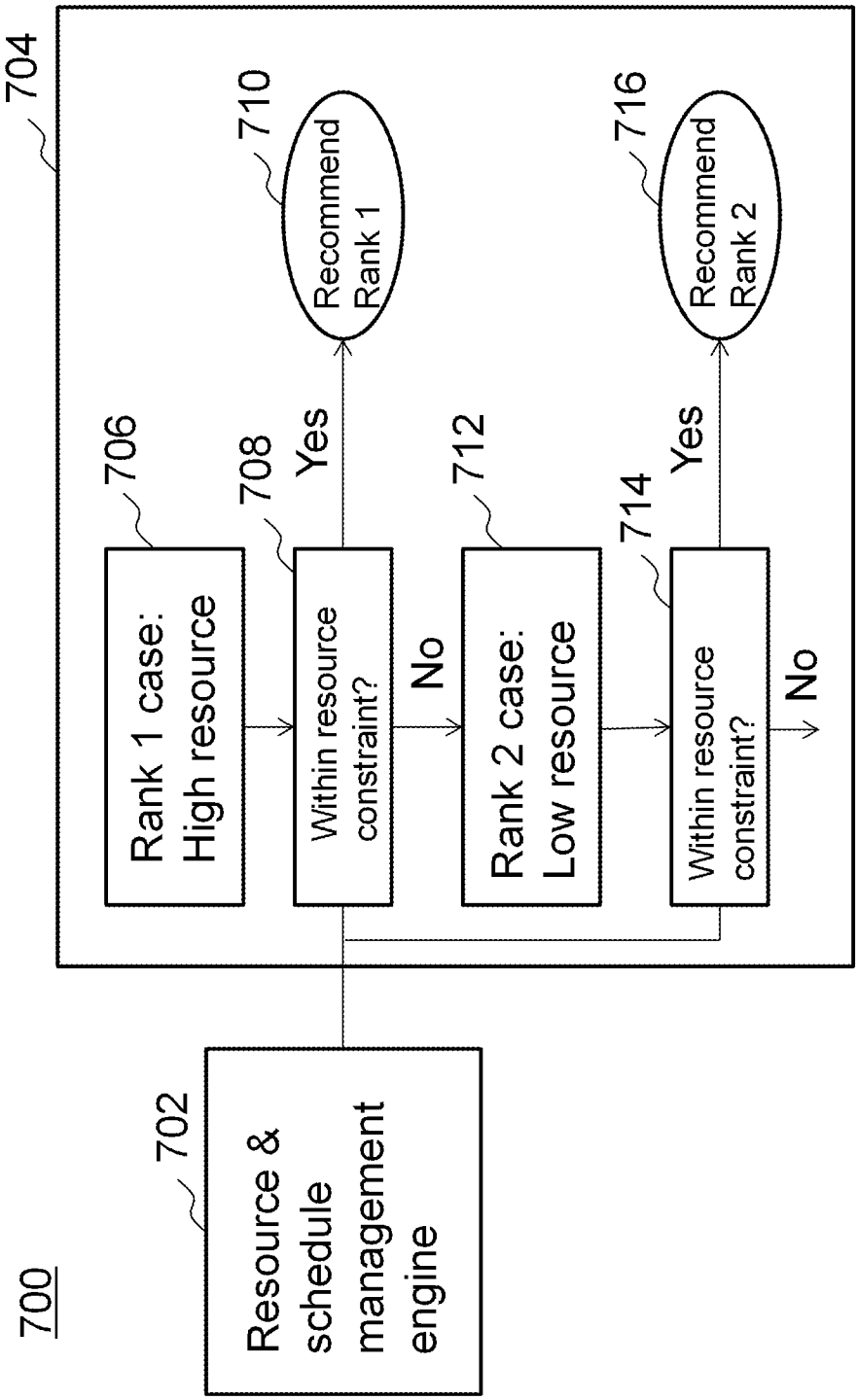
[Fig. 5]


500
510
Patient 1
Patient [Targeted]
Patient 2
Patient 3
Legend
Discharge
Low Intensity
(e.g. 1 rehab a day)
High Intensity
(e.g. 2 rehab a day)
6 months
(max functional recovery period)
Discharge [2]
Discharge [1]
Discharge [3]
Time (days) from hospital admission for stroke
Functional Status
126
(max)
63
0
502
504
506
508
Patient 1
Patient 3
Patient [Targeted]
Patient 2
Patient 1
Patient 2
Patient 3

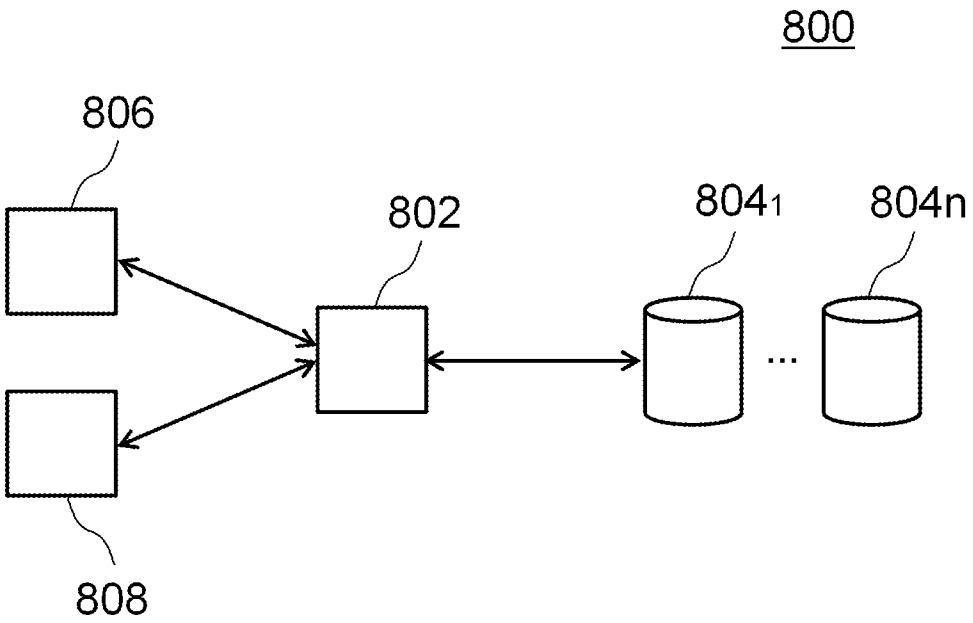
[Fig. 6]


600
1 (max)
Effectiveness
0.5
0
604
606
602
Patient 3
Patient 2
100
10
1
Efficiency
Log scale
126 (max)

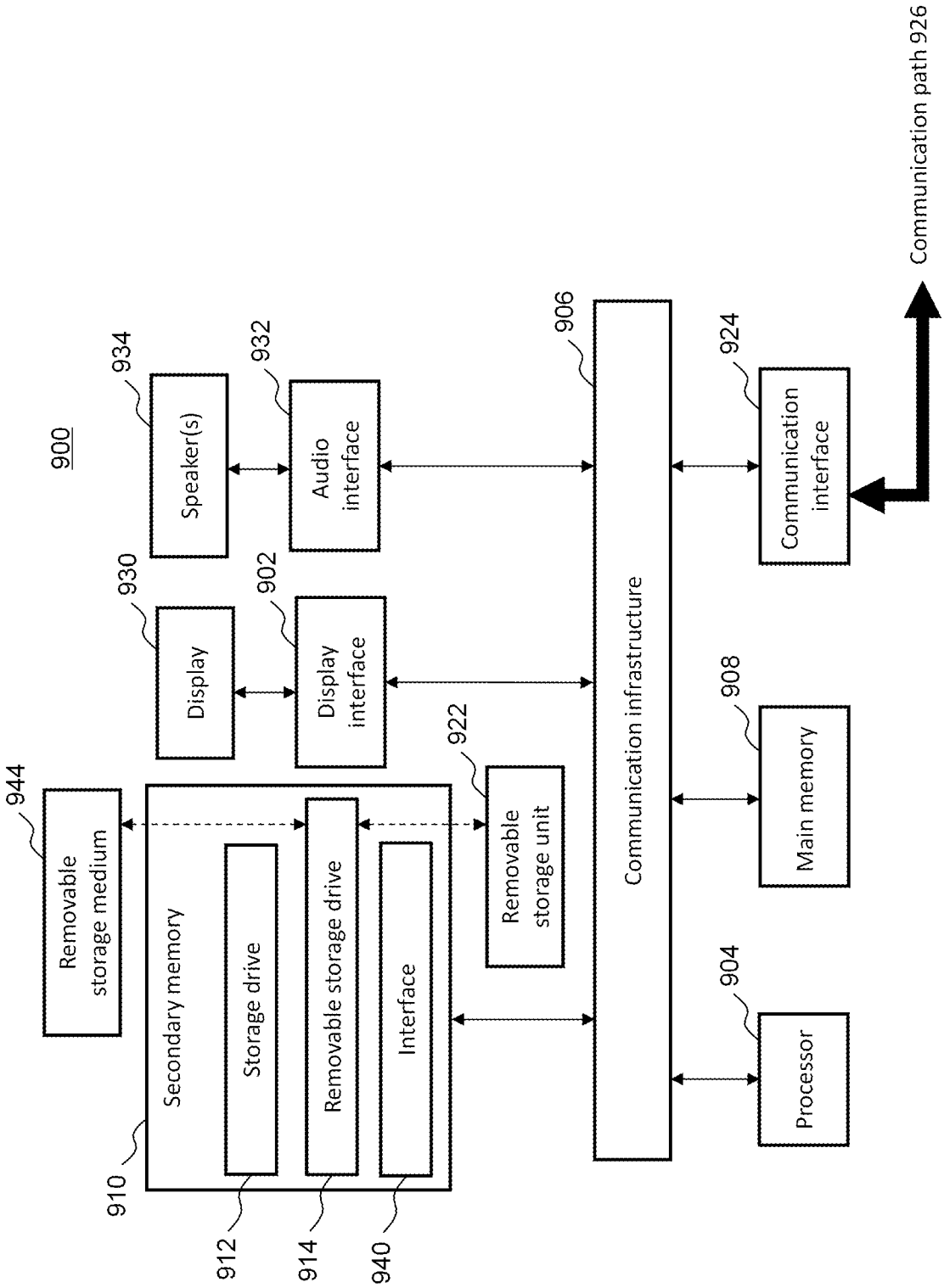
[Fig. 7]


700
Resource & schedule management engine
702
704
Rank 1 case: High resource
706
Within resource constraint?
708
Yes
No
Recommend Rank 1
710
Rank 2 case: Low resource
712
Within resource constraint?
714
Yes
No
Recommend Rank 2
716

[Fig. 8]



[Fig. 9]


900
Communication path 926
Speaker(s)
934
Audio interface
932
906
924
Communication interface
Display
930
Display interface
902
Communication infrastructure
908
Main memory
922
Removable storage unit
944
Removable storage medium
Secondary memory
910
Storage drive
912
Removable storage drive
914
Interface
940
904
Processor

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/045867

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. G06Q50/22(2018.01)i, G06Q10/06(2012.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. G06Q50/22, G06Q10/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2018
Registered utility model specifications of Japan 1996-2018
Published registered utility model applications of Japan 1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 2013/0268547 A1 (KONINKLIJKE PHILIPS NV) 2013.10.10, paragraphs [0014]-[0015] & JP 2014-503894 A & WO 2012/080906 A1 & EP 2652656 A1 & CN 103380428 A & RU 2013132759 A	1,4,5,10-12, 15,16,21-23 2,3,6-9,13,14,17-20
A	JP 2001-118014 A (HITACHI LTD) 2001.04.27, the whole document (Family:none)	1-23
A	US 2016/0210421 A1 (FUJIFIME CORP) 2016.07.21, the whole document & WO 2015/050072 A1 & EP 3054413 A1	1-23

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08.02.2018	20.02.2018

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	MAKI, Yuko Telephone No. +81-3-3581-1101 Ext. 3562

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