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On the algorithm of the medical diagnostic decision support system under the mobile platform

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ABSTRACT

Amobile platform usually refers to a complete platform that provides a reference design, a hardware chipset and upper communication protocols and supporting software and development tools. The downstream vendors can design and manufacture appropriate mobile products in a shorter time as required. The app developers mustn't pay attention to the content of platform hardware, but systematically understand the types of mobile devices, supporting software and appropriate development tools in mobile platform. The key for the medical experts to deal with the patients is decision-making. They make the decisions in diagnosing the patient's status, adjusting the therapeutic plan and monitoring the changing disease status. In recent decades, aseries of methods and tools have been developedto assist the clinicians for decision. Typically,these tools and methods are not intended to substitute the human's job, but used for assistant and supportive purpose.The doctors, healthcare professionals and other healthcare staffs have been being aware of the importance of these algorithms and techniques in order to support the decision-making process as the information and communication technology has become increasingly importantfor the infrastructure construction in healthcare organizations,.

KEYWORDS

Mobile platform; Medical diagnostic decision support system; Algorithm.

INTRODUCTION

Android was published by Google in November 5, 2007, which was early developed by Google and latterlyby Open Handset Alliance. Android is a Linux-cored open-source software platform and handset operating system and it adopts SoftwareStack J architecture. The platform consists of an operating system, a middleware, and user interface and application software[1]. It is an open and complete mobile platform software system that is created for the mobile terminal. Android platform has a top application layer developed based on Java by various companies. The application framework layer comes secondly, which is a kernel API framework published by Google and with which the developers can develop their own applications. The third layer includes Library and Android RunTime. Android-provided C/C++ libraries are usable to all components in Android system. These functionalities are delivered to the developers via Android Application Framework. Android RunTime includes a virtual machine and a core library. Dalvik virtual machine is a kind of "register-based"Java virtual machine where the variables are stored in the registers. The virtual machine has relatively less commands whilst the core library provides most features available in the Java programming language core library. The bottom layer based on the Linux kernel is developedwithC++ and onlyprovides basic functions. Application development under the mobile platform refers to the expansion of mobile platform functionalities using Java, C++, etc on the mobile platform operating system[2].

FRAME OF MEDICAL DIAGNOSIS DECISION SUPPORT SYSTEM FRAMEWORK UNDER THE MOBILE PLATFORM

The medical decisions include diagnosis, prediction and treatment as per each patient's needs. In the whole medical system, these decisions are through the different stages of whole patient's health care system. Decisions vary with the stages to different extents. On one hand, quick decision must be made when at life-threatening conditions; on the other hand, the drug dispensing must be determined with looser time scale for the chronic diseases, such as diabetes and hypertension [3]. The time factor will affect the use of diagnostic decision support technology. The normal decision support mechanism cannot be selected when the time is a very critical factor. Diagnosis, prediction and treatment decisions involve specific patients. Decisions must be made in the level of policy, management and resource. Can the medical agencies in a country develop expensive drugs in the event of life-threatening conditions: What is the aftermath when a community hospital is closed? What level of medical care service is provided for the patients aged delirious patients? The decision support technology plays an important role in making of these decisions.

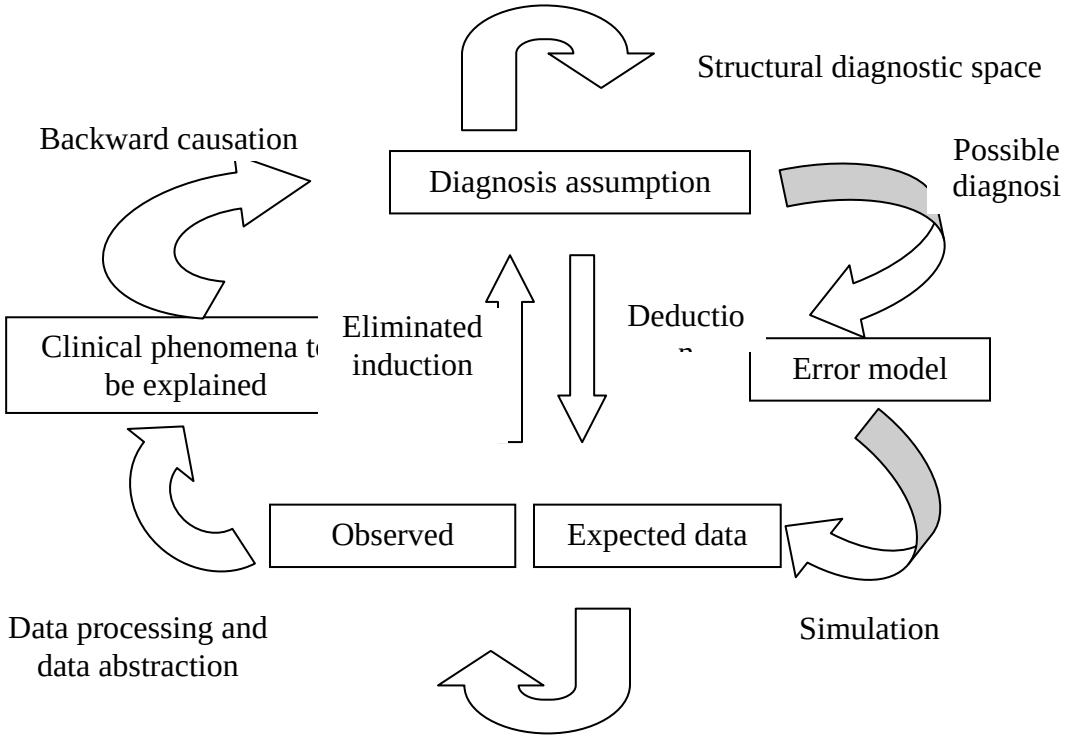

Fig.1.Diagnostic Deduction Model

Another way to express the deduction is to contain thecausal relationship between events, i.e. one event is caused by occurrence of another event. For example, hypertension is caused by heart disease. The causal belief is represented with

conditional statement with links. Each connection is defined as the form of probability. The associated number of these causal beliefs is known as Bayesian network and causal probabilistic network. These methods are very popular as they can express the uncertainty of medical knowledge in an effective manner. The nodes are representative of variables, the directed line segment between nodes is representative of a causal relationship, the state probability distribution for each arc is representative of a deviation, the relationship between the nodes is expressed by conditional probability tables, and the model deduction is based on Bayesian theory. Bayesian networks can be easily integrated with decision theory for medical decision, thereby producing the selection choice of optimal treatment, or developing the healthcare model under the uncertainty conditions.

Dalvik virtual machine is a Google's important component used for the Android platform of mobile devices. The virtual machine can run Java platform applications, which are converted into a compact Dalvik executable format (.Dex) that is suitable to the system limited to the memory and processor speed. Most of the virtual machines (including Java virtual machine) are different from Dalvik virtual machine. The former is a stack machinewhilstDalvik VMis of register-based architecture. Just likethe disputes betweenCISC and RISC, the relative advantages of both methodologies are a subject of ongoing debate, and the boundaries of technologybecome blurred sometimes. In addition, the relative advantages of both methodologiesare dependentupon the chosen interpretation/compilation strategy [4]. Conclusively, the stack-based virtual machine must use the command to load the stack-based data, or use the commands to manipulate the data. Therefore, comparing to the register-based virtual machine, more commands are needed. The dX tool is used to convert Java.Class files to.Dex format. A plurality of class files can be contained into a single.Dex file. The repeatedstrings useable to a plurality of classes can be output to the reserved space when they are converted to .Dex format together with other constants. Java byte code can also be converted into alternativeinstruction sets usable to Dalvik VM. An uncompressed.Dex file is less than jar files compressed from the similar .class files in the file size[5].

DESIGN OF MEDICAL DIAGNOSIS DECISION SUPPORT SYSTEM UNDER THE MOBILE PLATFORM

The decision-making process can be divided into 4 stages as below:

In the first stage, to give the necessity of decision-making, clearly point out the problem to be solved, and then focus on collecting related knowledge to solve the problem. The gathered knowledge may include some important literature review, evidence-based drug experiment or discussion and analysis of relevant persons[6].

In the second stage, to create a possible decision option set to solve the proposed problems in the first stage. The realistic solution must be considered preferably as the decision set may be large. In particular, No making decisions may be a strategy.

In the third stage, to consider the consequence and potential response in the subsequent stages to evaluate each possible solution; the evaluation scope includes ethics, technologies, cost, politics as well as the long-term interests of patients and their families. It is time-assuming to audit every solution in a detailed way; nevertheless, it is necessary to develop the appropriate emergency pre-plan in order to prevent against the condition change or errors that are evidenced in the preferable solution. The final stage of the decision-making process is to select the practical execution plan out of all. The most appropriate plans must be selected by taking into comprehensive account the interest, success rate, risk, cost and other factors [7].

The process is described as a one-way circulation, but in some cases, the previous stages may be re-visited and the details may be revised as per the consequence of the next stages. For example, the initial problem is erroneously defined and must be modified after the other possible solution is considered.

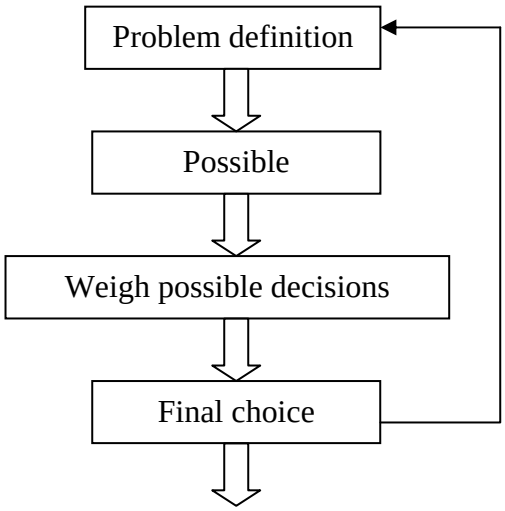

Fig. 2 Decision-makingProcess

CONSTRUCTION OF THE MEDICAL DIAGNOSIS DECISION SUPPORT SYSTEM MODEL UNDER THE MOBILE PLATFORM

The analysis model contains qualitative and quantitative mathematical models, can predict the patient's future status and predict the progress based on the status at that time and experienced description, thus helping the decision makers. These models include descriptions of system behavior, which allows the use of a test signal so that the system can study all kinds of problems to predict the progress of patient's status [8].

The qualitative model can be used to dredge the time-related behaviors and express the patient's status trajectory with a series of connected nodes. The connection between nodes reflects the systematic leap constraints. These models can be used to support the patient's disease assessment and treatment option design. For diagnosis and evaluation, the causal mechanism of disease process is defined by the pioneering nodes and pathway of key nodes (decisions) [9]. For treatment planning, the expected therapies are formulated as per the investigated values as appropriate to the relationship of disease-treatment. These practical values relate to a cost function where the cost is defined as therapy cost, efficiency and effect of patient's treatment.Typically, the quantitative model is described by differential equation and additional equations. The model can operate under dissimilar conditions, such as diverse drug treatment rules, when the model parameters are adjustedas per the characteristics of the individual patients. Therefore, the clinical users can know the influence of such changes on the major physiological variables. This is another decision-supporting pattern.

A typical example of quantitative model is the human cardiovascular system that has been mentioned in the literature. The model can predict the venous blood pressure, cardiac output and peripheral resistance. However, it is worth noting that the clinicians usually prefer to the use of continuous variable symbols, such as flow direction, increased value or decreased value, etc, but not the discrete numberswhen the physiological system behaviors are checked for decision support. In addition, they are tended to substitute the mathematical equations instead of qualitative or logical constraints in managing the variables and its temporal variation [10].

A qualitative mathematical model can also become a major part of the active decision support system. For an example, the model-based predictive control mean is developed for maintaining the normal blood sugar level in the fasting period (at night) for patients with Type I diabetes. It includes sub-model of subcutaneous and intestinal absorption of insulin, etc. With Bayesian parameters, the controller estimated and determined the model parameters which are varying with the time. The model can predict the blood glucose for nextmore than 15 minutes. These predictions are used to correct the pumped insulin dosage to attain or maintain a desired value of blood sugar.

Database search: Searching large clinical databaseappropriately can help find the statistical evidence with diagnostic value. Usually, these arguments can lay a foundation for creating a professional system. However, the most direct method for clinical decision making is to make statistics of relative frequency of an entity, even an entity group (frequentism'sapproach) so as to estimate the prior probability. Such simple and direct troubleshooting approach has such shortcomings asmore arguments, and less matched entities in database. This is typically contrary to the normal thinking. It is not that the more evidences indicate larger possibility of diagnostic matches. Additionally, it lacks a measurement method for single argument and it cannot therefore determine which argument has larger influence on the patient's outcome [11].

Database search is one of the earliest statistical methods. The people are now interested in this method again because the human genomics is completed. The data inquiry methodsthat have been developed (such as single polymorphic nucleotide) are existed in many genetic databasesacross the world. Regression analysis can be used for relationship modeling between interested response variable and a group of explanatory variables. This method includes the adjustment of the regression coefficients in the model (model parameters) until the most suitable data set is derived. This model has improved the use of relative frequency asthelogistic regression is showed legibly and theevidence elements are very important to the value of the regression coefficient. There are many such cases in many clinical applications as well as in the gastroenterological field.

Statistical pattern analysis is an important tool for decision support. With this method, the recognition of data model can be expressed as a statistical problem, which is used to classify the clinically-found results that both meet the mutually-exclusive, but is in exhaustive decision-making zones. It can thus classify the physiological data whilst the appropriate disease status and therapies can be classified. This approach has been widely applied clinically from rhythm analysis to head injury treatment.It is necessary to carry out the data diversity analysis in order to distinguish the data pattern, includingmeasures of dissimilarity between different classes[12].

ALGORITHM DESIGN OF MEDICAL DIAGNOSIS DECISION SUPPORT SYSTEM MODEL UNDER THE MOBILE PLATFORM

Issues of pattern recognition can be divided into two stages. The pattern vector P is a row dimensional vector evolved from a data set. We define the pattern space Y_P representative of all possible P values.Issues of pattern recognition can be regarded as how to divide Y_P into mutually-exclusive and exhaustive zonal problems. A complete waveform can be used to classify the diagnosis valueson the ECG analysis. A complex decision-making method may be harvested by such a condition. However, sometimes for thestudy on the sub-features inside models, it will be more fitted to simplify the pattern vector. For example, in arrhythmia analysis, a simpler decision-making equation can be used only if there is theECG R-R interval data.This may be a linear or nonlinear conversion process [13]:

$$X = \tau P$$

The pattern vector P belongs to the pattern space Y_P, whilst the feature vector X belongs to the feature spaceYX. Some information will be lost as the feature extraction function is purposed to reduce the dimensions of the input vector. YX categories can be obtained through a number of statistical methods, includingclassification function (linear and polynomial), core evaluation, k neighborhood, cluster analysis and Bayesian analysis.

Bayesian analysis is one of methods applied in decision support system broadly[14]. Essentially, it is a parameter method to estimate the class conditional probability density function. Clinical knowledge is manifested as some disease's prior probabilities, which are matched with the conditional probabilities clinically found in each disease in patient group. Classifying the issues has become an option of the decision makers. It eliminates the misclassifications to the most extent and minimizes the maximum of conditional average loss function (also called the minimax criterion). Bayesian rule is an optimal decision-making rule to minimize the average ratio of misclassification. As a deduction mechanism, the method can be used to calculate the probabilityof competitive diagnosis when there is a patient-specific discovery[15].

Bayesian classification is not based on historical cases in clinical database. Therefore, it costs less time comparing to other database search technology. Additionally, the misclassification caused byclinical deduction errors can be quantified. Nevertheless, the method is confined to theassumed complete and mutually-exclusive disease status as could not be tenable in fact.

CONCLUSION

Android as an important part of Google enterprise strategy will further promote the fulfillment of enterprise goal "providing info for everybody whenever and wherever". We found that the many global mobile phone users have never used anyAndroid-based mobile communication devices. Google's goal is to make that mobile communication does not depend on a device, even on aplatform. For this purpose, Android will supplement, but not substitute the mobile development strategy upheld byGoogle for long term: with liaison of partnership with globalmobile phone manufacturers and mobile operators, it will developand promote both useful and attractive mobile serviceand products. In the present paper, the medical diagnosis decision support systemunder the mobile platform is developed and designed; the decision-making process, decision supportnecessity and some widely-applied means and technologies are reviewed. The specific contents include reviewing the essence of decision-making process, classifying the decision support systems structurally and demonstrating some actual clinical applications of decision support technologyunder the mobile platform.

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