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DESIGN AND DEVELOP AN EXPERT SYSTEM FOR DIAGNOSIS AND TREATMENT OF DIABETES USING DATA MINING TECHNIQUES

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ABSTRACT

Diabetes is a disease that affects the body's ability to produce or use insulin. According to International diabetes Federation, Ethiopia is one of the 32 countries in African region. 425 million people have diabetes in the world and more than 16 million people in the Africa Region; by 2045, it will be around 41 million. There were 2.567.900 cases of diabetes in Ethiopia in 2015.In the incident of Ethiopia different problems are observed in health care centers. From different perspectives, these problems are the scarcity of domain experts, practitioners, domain experts' skills, health facilities etc.

The general objective of this study is to design and develop prototype knowledge based system using data mining techniques for diagnosis and treatment of diabetes. In this study, to develop prototype knowledge base system using data mining techniques for diagnosis and treatment of diabetes is proposed by applying experimental research design. The researcher used domain expert knowledge as supplement of data mining techniques knowledge.

KEYWORDS

Diabetes, Health Facilities, Data Mining, Algorithms etc.

INTRODUCTION

Knowledge based system (KBS) is one of the areas of artificial intelligence. KBS also known as an expert system is a computer program that contains the knowledge and analytical skills of one or more human experts in a specific problem domain. The aim of the design of the expert system is to capture the knowledge of a human expert relative to some specific domain and code this in a computer in such a way that the knowledge of the expert is available to a less experienced user. KBS is a computer program that simulates the judgment and behavior of a human that has expert knowledge and experience in a particular field. It contains a knowledge base containing accumulated experience and a set of rules. Expert system provides high quality experience, domain specific knowledge; apply heuristics, forward or backward reasoning, uncertainty and explanation capability. Rule based expert system contains knowledge base, Inference engine, knowledge acquisition, explanation facility and user interface (Tripathi, 2011).

STATEMENT OF THE PROBLEM

According to IDF statistics, there are 230 millions of diabetics through the world, at present time of which 80% of them are living in the developing countries. In 2025,the number of diabetics is estimated to reach 380 million (Kulani, 2012). In 2015, the IDF also estimated that, in the Africa region, 14.2 million adults aged 20–79 years had diabetes, representing a prevalence of 3.2%. The majority (59%) of people with diabetes live in cities, even though the population is predominantly (61%) rural. This region has also the highest proportion of previously undiagnosed diabetes; over two-thirds (67%) of people with diabetes being unaware they have the disease. Currently, Ethiopia has been challenged by the growing magnitude of non-communicable diseases such as diabetes. Ethiopia is among the top four countries with the highest adult diabetic populations in sub-Saharan Africa. Patient attendance rates and medical admissions related to diabetes in major hospitals have been rising.

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OBJECTIVES OF STUDY

General Objective

The general objective of this study is to design and develop prototype knowledge based system using data mining techniques for diagnosis and treatment of diabetes.

Specific Objectives

- To build the suitable system architecture for the prototype KBS to be developed.
- To identify and acquire appropriate knowledge, both that is explicit and tacit.
- To identify the main attributes that can properly support for rule based and decision making.

SIGNIFICANCE OF STUDY

The intelligent system used for diabetes are important within the medical area because it allows doctors and nurses to quickly gather information and process it in various ways in order to assist with making diagnosis and treatment decisions. These systems could help in diverse areas from the storing and retrieval of medical records, storing and retrieval of key substances in medicines, examination of real-time data gathered from monitors, analysis of patient history for the purposes of diagnosis, analysis of family history, and in many other areas. The KBS applies intelligent reasoning to a domain to solve a problem that requires considerable human time, effort and proficiency. KBS have valuable asset to any institutions as a substantial source to support decisions making (Tripathi, 2011).

METHODOLOGY

Research Design

Experimental research is a study that strictly adheres to a scientific research design. The primary goal of an experimental design is to establish a causal connection between the variables. A secondary goal is to extract the maximum amount of information with the minimum expenditure of resources. It is the process of planning a study to meet specified objectives. Planning an experiment properly is very important in order to ensure that the right type of data and a sufficient sample size and influence are available to answer the research questions of interest as clearly and efficiently as possible (Morrison, 2014).

Study Site and Population

Study sites for this research are Jimma University Specialized Hospital, Saint Paulos Millennium Medical Hospital and Adama Medical College Hospital. Jimma University Specialized Hospital, which is found in Oromia regional state, Jimma town in Jimma University main campus, Saint Paulos Millennium Medical Hospital which is found in Addis Abeba city administration and Adama medical college hospitals which found in Oromia regional state, Adama town. The total population interviewed was twelve. The datasets used for research was also collected from this each hospital.

Data Collection Method

For primary data collection interview was used to collect domain knowledge (tacit) from the domain experts and by documents analysis explicit knowledge was extracted from secondary sources of data. For hidden knowledge to be discovered from database by automatic data mining (KDD and Crisp model method) techniques and dataset was collected from baseline diabetic patients' medical record using secondary data collection method also known as retrospective method.

Techniques and Algorisms

Data mining process inputs predominantly cleaned, transformed data, searches the data using techniques and algorisms, and outputs patterns and relationships to the interpretation/ evaluation step of the KDD process (Pillay et al., 2009).

CLASSIFICATION TECHNIQUE

Classic data mining technique based on machine learning maps data into predefined groups or classes. Supervised learning is a technique where by the classes are determined before examining the data. Classification algorithms require that the classes be predefined based on data attribute values. It is often describe these classes by looking at the characteristics of data already known to belong to the classes (Ambilwade, 2014). A Rule-based classification extracts a set of rules that show relationships between attributes of the data set and the class label .For this study three algorithms namely J48 pruned, PART, and JRip was used.

CLASSIFIER ALGORISM

J48: Decision trees are mainly used in the classification and prediction. It is a simple and a powerful way of representing knowledge. Decision tree is built; many of the branches reflect anomalies in the training data due to noise or outliers. Tree pruning methods use statistical measures to remove the least reliable branches. A classifier system takes input from the cases described by values and attributes and output a classifier that can accurately predict classes of new cases. C 4.5 is a descendant of CLS and IDE creates classifier and generated decision tree. It can also make classifier in most comprehensive rule-set forms (Abuhay & Tesema, 2015).

PART: rule-based classifier uses a set of IF-THEN rules for classification. An IF-THEN rule is an expression of the form IF condition THEN conclusion. The IF-part (or left-hand side) of a rule is known as the rule antecedent or precondition. The THEN-part (or right-hand side) is the rule consequent. Class for generating a decision list and uses separate-and-conquer. Builds a partial C4.5 decision tree in each iteration and makes the "best" leaf into a rule. A rule induction algorithm which grabs rule from a decision tree (Abuhay & Tesema, 2015).

JRip: is also a rule-based classifier uses a set of IF-THEN rules for classification and this experiment conducted with default parameters of WEKA and the algorithm generates a model with rules and identify Correctly Classified Instances and Incorrectly Classified Instances (Abuhay & Tesema, 2015).

EXPERIMENT TOOL

WEKA has several graphical user interfaces that enable it easy access to primary functionality. Therefore data mining techniques, algorisms and tools was applied on the patients' medical datasets for discovering rules used for develop the prototype KBS. The algorithm can either be applied directly to dataset or called from Java code. It contains tools for data pre-processing, classification, regression, clustering, association rules and visualization. A set of data items, the dataset, is a very basic concept of machine learning (Witten, 2011).

KBS DEVELOPING TOOL

KBS shell with the ready-to-wear utilities of self-learning, explanation and inference etc. like Quincy prolog, visual prolog, and Clips rule based, Java Expert System Shell (JESS), GURU, and Vidwan are more specific and can be useful to develop KBS. KBS can be developed using programming languages like LISP and Prolog (Chala ,Million and T., 2016). Therefore, for the study tool the used to develop prototype KBS was Clisp.net.

DOMAIN EXPERTS KNOWLEDGE ACQUISITION

In this work, the tradition methods (such as interview and document analysis) are used primarily for understanding the basic concepts related to diagnosis, treatment and prognosis of diabetes disease. More specifically, interviews and document analysis are used to access the general and domain-specific knowledge and to obtain comprehensive

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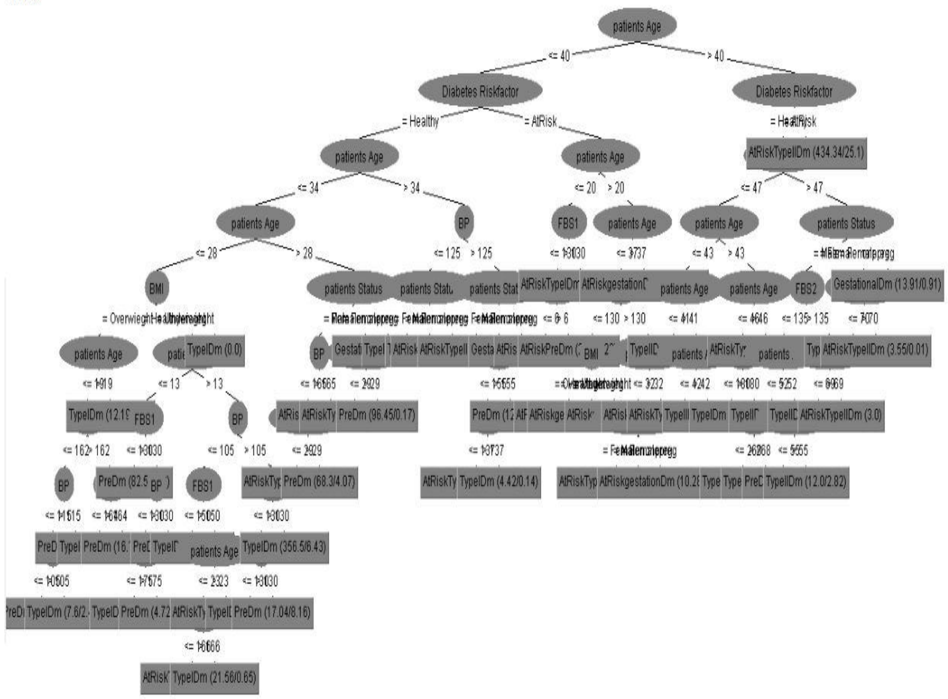
example sets. On the other hand, data mining approach is particularly fruitful in automating the knowledge acquisition task of rule-based system. However, it is a mistake to believe that one can do data mining process without a domain expert. Because at the very least the researchers need an expert to select the training examples and to explain the domain terminology as well as to identify the features of the examples which are likely to be relevant. Therefore, the researcher used the traditional methods to supplement the automatic knowledge's acquisition of the KBS development.

Figure-1



Sources: Authors Compilation

J48 pruned decision tree Weka output

Figure-2

=== Confusion Matrix ===

a	b	c	d	e	f	g	h	i	j	<-- classified as
3	0	0	0	0	0	0	0	0	0	a = Healthy
0	0	3	0	1	0	0	0	0	0	b = Diabetes
0	0	458	0	12	0	3	0	2	0	c = PreDm
0	0	0	0	0	2	0	0	0	2	d = AtRiskPreDm
0	0	15	0	656	4	0	0	0	3	e = TypeIDm
0	0	4	0	10	171	0	4	0	0	f = AtRiskTypeIDm
0	0	2	0	4	0	450	1	0	0	g = TypeIIDm
0	0	4	1	8	0	40	616	0	1	h = AtRiskTypeIIDm
0	1	0	0	0	0	0	0	60	2	i = GestationalDm
0	0	0	1	3	0	0	1	2	91	j = AtRiskgestationDm

Sources: Authors Compilation

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Figure-3

Confusion Matrix J48

```
patients Age <= 40
|   Diabetes Riskfactor = Healthy
|   |   patients Age <= 34
|   |   |   patients Age <= 28
|   |   |   |   BMI = Overwieght
|   |   |   |   |   patients Age <= 19
|   |   |   |   |   |   FBS1 <= 162
|   |   |   |   |   |   |   BP <= 115
|   |   |   |   |   |   |   |   BP <= 105: PreDm (46.69/1.77)
|   |   |   |   |   |   |   |   BP > 105: TypeIDm (7.54/2.45)
|   |   |   |   |   |   |   BP > 115: PreDm (90.8/3.44)
|   |   |   |   |   |   FBS1 > 162
|   |   |   |   |   |   |   FBS1 <= 164: TypeIDm (8.74/0.25)
|   |   |   |   |   |   |   FBS1 > 164: PreDm (16.3/0.98)
|   |   |   |   |   patients Age > 19: TypeIDm (12.09/1.96)
|   |   |   |   BMI = Healthywieght
|   |   |   |   |   patients Age <= 13
|   |   |   |   |   |   FBS1 <= 130: PreDm (82.09/9.72)
|   |   |   |   |   |   FBS1 > 130
|   |   |   |   |   |   |   BP <= 130
|   |   |   |   |   |   |   |   FBS2 <= 175: TypeIDm (58.99/3.54)
|   |   |   |   |   |   |   |   FBS2 > 175: PreDm (4.73/0.67)
|   |   |   |   |   |   |   BP > 130: PreDm (9.24/0.35)
|   |   |   |   |   patients Age > 13
|   |   |   |   |   |   BP <= 105
|   |   |   |   |   |   |   FBS1 <= 150: TypeIDm (9.55/1.27)
|   |   |   |   |   |   |   FBS1 > 150
|   |   |   |   |   |   |   |   patients Age <= 23
|   |   |   |   |   |   |   |   |   FBS1 <= 166: AtRiskTypeIDm (8.2/1.09)
|   |   |   |   |   |   |   |   |   FBS1 > 166: TypeIDm (21.56/0.65)
|   |   |   |   |   |   |   |   patients Age > 23: AtRiskTypeIDm (23.9/3.74)
|   |   |   |   |   |   BP > 105
```

Sources: Authors Compilation

MODEL EVALUATION

All the selected algorithms allow generating rules from the data set. The results of the algorithms are evaluated based on prediction accuracy in classifying the instances of the dataset into Healthy, Diabetes, PreDm, AtRiskPreDm, TypeIDm, AtriskTypeIDm, TypeIIDm, AtRiskTypeIIDm, GestationalDm and AtRiskgestationDm. The performance of classifier algorithms is compared and the one, which performed better, is selected as prime choice for the knowledge acquisition step.

The accuracy, precision, recall and f-measure of each of the mentioned classifiers, which are obtained from the experiment, are shown in table.

Table-1: Performance of Classifiers

Model Evaluation	**Correctly Classified Instances**		**Incorrectly Classified Instances**		**Time taken to Build Model**	**Precision**	**Recall**	**F Measure**
Classifiers	Instances	Percentage	Instances	Percentage	Time / seconds			
J48	2512	95.1515 %	128	4.8485 %	0.31	0.949	0.952	0.95
PART	2495	94.5076 %	145	5.4924%	0.69	0.944	0.945	0.944
JRip	2501	94.7348 %	139	5.2652%	2.69	0.95	0.947	0.947

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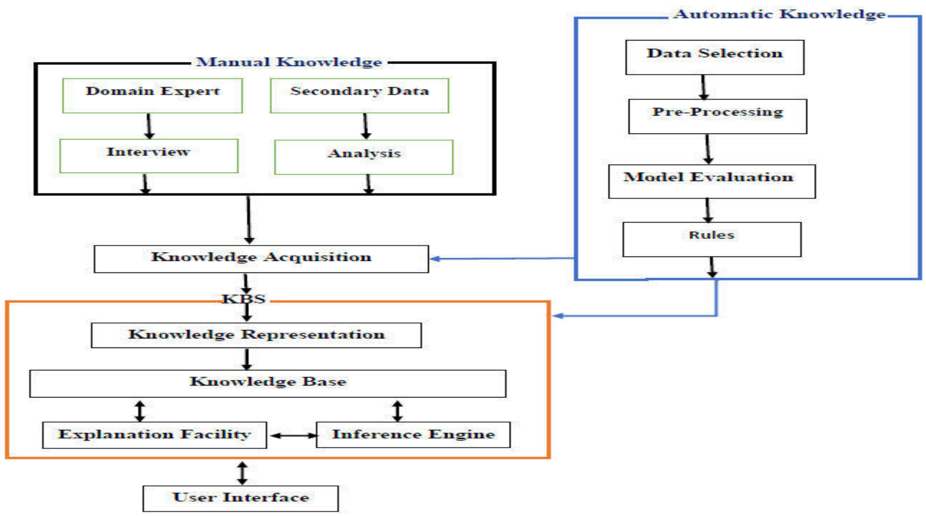
ARCHITECTURE OF THE PROTOTYPE SYSTEM

An architecture is a blueprint showing how the components of the prototype self-learning knowledge-based system interacts and interrelates.

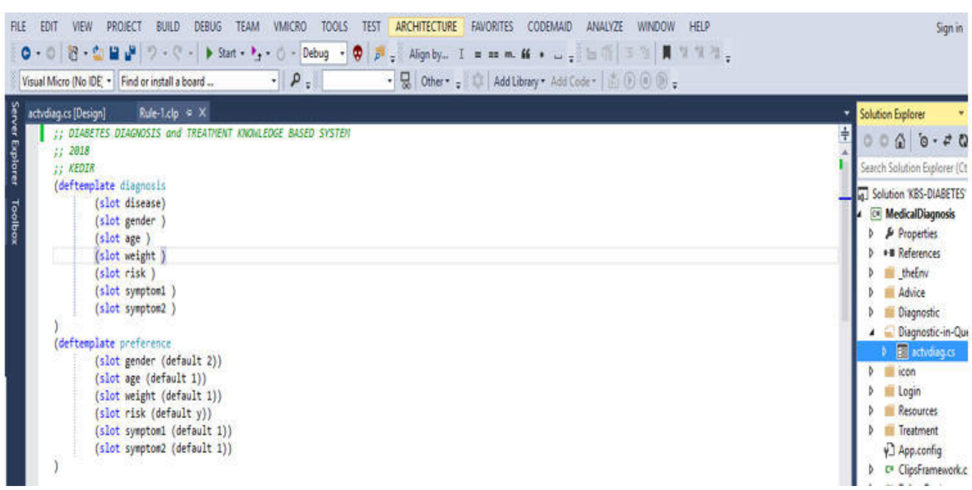
Figure-4: Architecture of KBS



Sources: Authors Compilation

SOFTWARE REQUIREMENT FOR DEVELOPMENT KBS

Figure-5: Prototype of KBS Development Environment

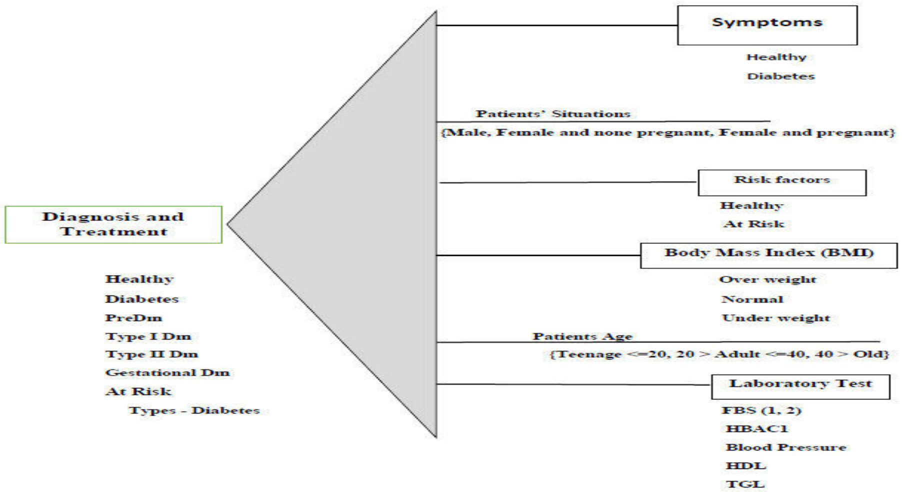


Sources: Authors Compilation

DIAGNOSIS AND TREATMENT

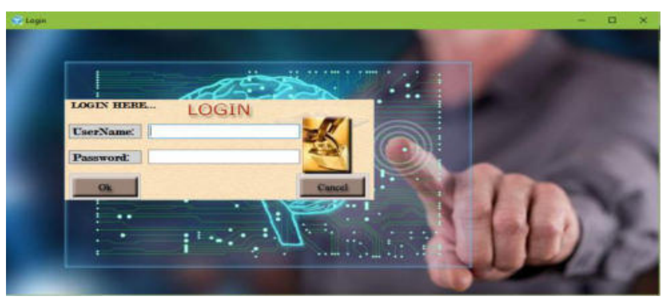
Diagnosis of diabetes is based on several cases like patient's physical exam, presence or absence of symptoms, medical history, risk factors, blood test reports etc. Blood tests can be used to confirm a diagnosis of diabetes, based on the amount of glucose found. Urine test can also be used to check protein in the urine that may help diagnose diabetes. These tests also can be used to monitor the disease once the patient is on a standardized diet, physical exercise, oral medications, or insulin therapy. The system can provide necessary information about the indications, diagnosis and primary treatment advices to the diabetics. Prototype KBS developed using both automatic extracted and expert based knowledge used for diagnosis and treatment of diabetes as shown below using Mockler Chart. This Mockler Chart of diagnosis and treatment has been drawn to show the relation of components tests, patient's situation, patient's age, Body Mass Index (BMI), symptoms and risk factors. The used Mockler Chart of symptoms, the questions and choices related to determining of the patient's symptoms, which concluded diabetes, or further analysis of the patients.

Figure-5: Mockler Chart Shows Relations How KBS Used for Diagnosis and Treatment of Diabetes Mellitus



Sources: Authors Compilation

Figure-6: Login Screen User Interface

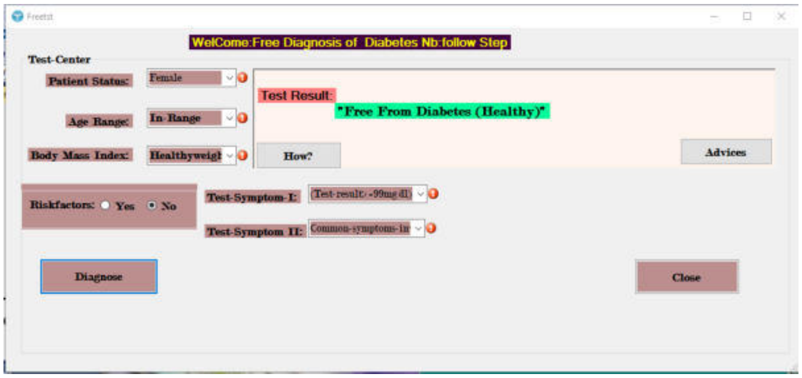


Sources: Authors Compilation

Figure-7: Home Screen User Interface of the Proposed System

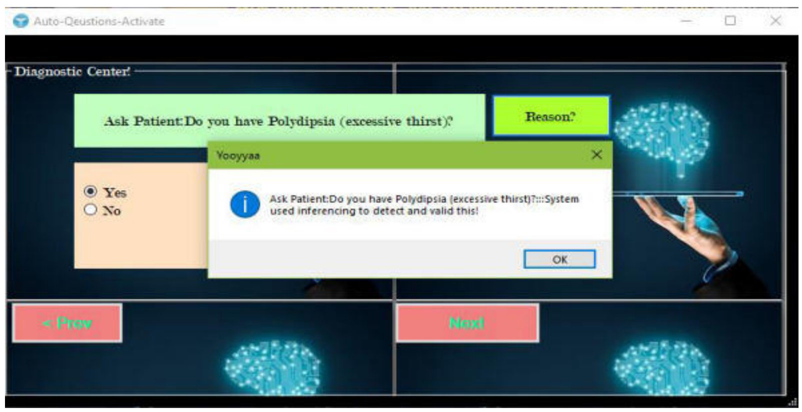
Sources: Authors Compilation

Figure-8: User Interface Used Identify Whether Patients Healthy



Sources: Authors Compilation

Figure-9: User Interface Used to Identify Patients Diabetes using Questions



Sources: Authors Compilation

Figure-10: User Interface Detects Patients Got Diabetes Using Questions

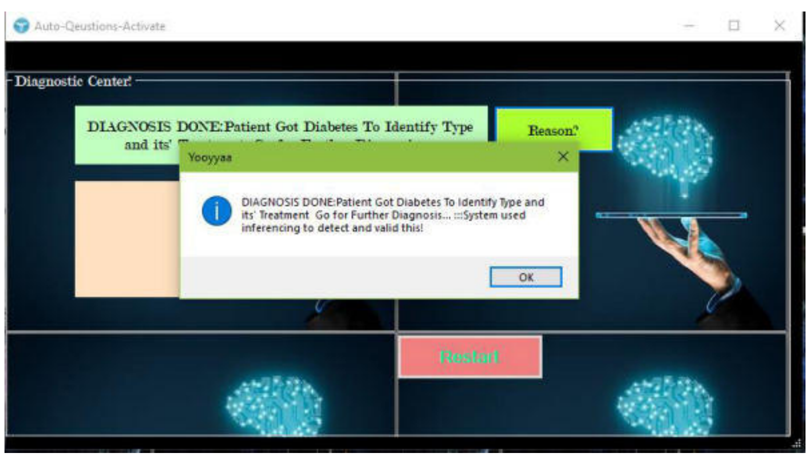


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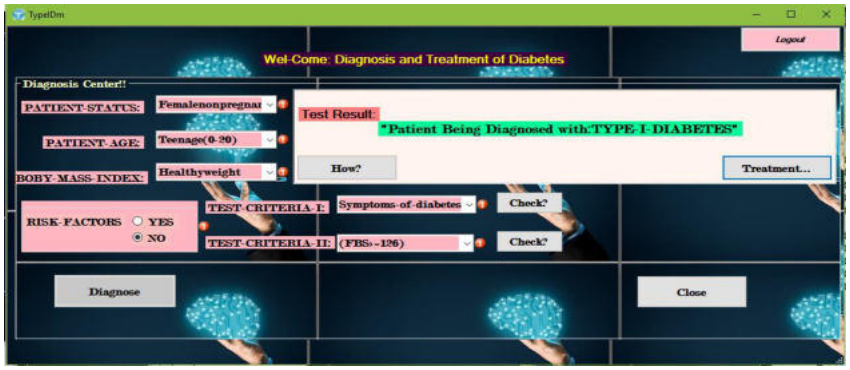
Figure-11: Graphical User Interface for Clinical Diagnosis



Sources: Authors Compilation

Figure-12: Graphical User Interface for Clinical Treatment

Sources: Authors Compilation

DISCUSSION

The purpose of this research is to develop prototype KBS for diagnosis and treatment of diabetes using data mining techniques. The use of data mining techniques to build the knowledge base of the KBS can be taken as strong features of the system. The findings are discussed in this section. The main aim of data mining is classifying the attribute based on the given attribute. Decision trees achieve this even though three algorithms are selected for this purpose. Classification maps data into predefined groups. It is often referred to as supervised learning as the classes are determined prior to examining the data. Classification Algorithms usually require that the classes be defined based on the data attribute values. On this study different types of situation were conducted for the purpose of developing prototype KBS for diagnosis and treatment of diabetes, as well which rules(knowledge), which model and which algorithm would perform very well and it is approved under this study.

For this study three algorithm were selected to test on the diabetic datasets in order to generate rules i.e. J48, PART and JRip algorithms. Three of them are raised under the methodology of this study. Therefore, analyzing one by one and seeing the result that they performed during the previous experiment has been tabularized accordingly. Additionally the J48 algorithm is the most performing model more than the rest of the algorithm. In addition, the other algorithm had been resulted according to the nature and ability of evaluation based on the algorithm is set by default.

The J48 algorithm is the most accurate model from the other due the result that this algorithm demonstrated in case of performance, time, labeling, specificity and confusion Matrix. From the previous situation the J48 algorithm had scored a time of 0.31 seconds to classy the 2512 records according the class they belongs too. Beside this, the model also showed the good performance more than the other did. The ROC which this model displayed is almost approximate to one which is 0.997 and the result of precision and recall (0.949 and 0.952) also pretty well more than the left model. This model showed the most performing one in case of diabetic datasets classifying.

CONCLUSION

Diabetes is a metabolic condition that leads to high blood sugar levels. It is a kind of disease in which the body does not produce or properly use insulin. The amount of glucose in blood is too high because the body cannot use it properly. This is because pancreas does not produce any insulin, or not enough, to help glucose enter patient body's cells or the insulin that is produced does not work properly. Insulin is the hormone produced by the pancreas that allows glucose to enter the body's cells, where it is used as fuel for energy so we can work, play and generally live our lives. Due to this reason, patients need diagnosis and consistent treatment. However, in our country, there are no sufficient numbers of domain experts. This situation leads to disproportional numbers of experts and patients also available resource, urbanization and high obesity, lack of know how. As a result, diabetic patients are not getting enough diagnosis and treatment. Hence, in this study an effort has been made to design and develop a prototype of effective and efficient knowledge-based system that can provide advice for experts and patients to facilitate the diagnosis and treatment of patients living with diabetes.

RECOMMENDATIONS

Data mining techniques was applied on diabetic patients' baseline datasets in order to generate rules used for developing prototype KBS for diagnosis and treatment. However, diabetic datasets are manually stored witch made preprocessing datasets difficult. For future if, such challenge solved automatically rule generating from database and integrating to knowledge base the rule generated with data mining techniques become easy. A method must be investigated on how to integrate the prototype system with the existing health information systems. This would lead to the development of standards applicable to all, enabling suitable information exchange and planning for additional improvement of functionality. Since such types of systems developed in English language, the applicability of the system is limited, so the researcher recommended that the system would have more applicability if it can be developed in local languages.

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