A Fuzzy Expert System & Neuro-Fuzzy System Using Soft Computing For Gestational Diabetes Mellitus Diagnosis

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ABSTRACT

Gestational diabetes mellitus (GDM) is a kind of diabetes that requires persistent medical care in patient self management education to prevent acute complications. One of the common and main problems in diagnosis of the diabetes is the weakness in its initial stages of the illness. This paper intends to propose an expert system in order to diagnose the risk of GDM by using FIS model. The knowledge base was based on the opinion of experts and also by using ANFIS model in order to extract rules that based on real data. The data were collected from the patient's file in a medical health care center that contains effective risk factors in giving rise to GDM. The effective factors consist of fast blood suger, weight and age in the initial months of pregnancy and the output is the risk of GDM in pregnant women. Based on the results, the level of minimum square error in the fuzzy expert system was calculated as 0.227. For diagnosis of illnesses such as diabetes, in lack of accesses to experts, one can rely on intelligent softwares such as expert systems, wich can assist the speedy and better diagnosis.

Key Words
Expert systems, fis & anfis, Diagnosis, GDM, OGTT

1. INTRODUCTION
Diabetes means increase in the level of blood sugar. Gestential diabet mellitus(GDM), for the first time is diagnosed in the pregnancy and if it is not treated, mother and child both are at the risk of various side effects. GDM is one of the most common metabolic disorders during pregnancy that often does not have any sign and a range of between 0,2 to 18.2 percent for its occurrence is reported. Hence, it is one of the most common illnesses during pregnancy [7],[16]. This illness requires persistent medical care and it can be avoided by training the patients and their self-management. The main problem that currently exists in relation to this dangerous illness is not being able to diagnose it on time or in general, weakness in its diagnosis in the initial stages. Therefore, the patient realizes about the illness when it is slightly late for treatment and control of the illness. Hence, implementation of a method that can assist everyone in its risk of occurrence, is a significant stage if prevention and control of this illness, specifically in the initial stages of it. This study attempts to find a method for timely detection GDM and also alarm pregnant women to treat the illness before reaching to the acute phase of the illness . This is because if mother or child develop this illness there is no treatment course for it and it will be a life-long illness for the individual[2].

2. LITERATURE REVIEW
There are various researches and studies in diagnosis of the illness , with the use of neural networks and expert systems and many medical diagnostic expert systems in the literature: like CLIPS ,MYCIN,Easy Diagnosis,PERFEX, INTERNIST-I, ONCOCIN, DXplain, and PUFF[11],[12]. MYCIN was the first well known medical expert system developed by Shortliffe at Stanford University to help doctors, not expert in antimicrobial drugs, prescribe such drugs for blood infections. EasyDiagnosis is expert system software that provides a list and clinical description of the most likely conditions based on an analysis of your particular symptoms. EasyDiagnoses focuses on the most common medical complaints that account for the majority of physician visits and hospitalizations. It has a poorly designed user-interface, the user is required to answer a large number of questions without any notion that gives him the feeling that his data is accepted and will be diagnosed. PERFEX is a medical expert system that support solving problems clinicians currently have in evaluating perfusion studies. The heart of the PERFEX system is the knowledge-base, containing over 250 rules. DXplain is a decision support system which uses a set of clinical findings (signs, symptoms, laboratory data) to produce a ranked list of diagnoses which might explain (or be associated with) the clinical manifestations. PUFF is an

expert system for the interpretation of pulmonary function tests for patients with lung disease. PUFF was probably the first AI system to have been used in clinical practice. we can point out to the use of neural networks in diagnosis and treatment of breast cancer in 2011[4] ,and neural networks and genetic algorithm to identify the presences of hypoglycemic episodes for TIDM (Type 1 diabetes mellitus) patients in 2010[1]. Moreover, in order to diagnose blood cancer, an expert system was offered with the use of vp-expert in 2010 [17].In an article titled as ' diagnosis of the diabetes 1 with the use of ANFIS and GA-NN algorithms', it is attempted to examine the intelligent diagnosis of the diabetes[13]. There are researches and studies in diagnosis of diabete mellitus with the use of neural networks and expert systems based on risk factors [14][15]. In an article in 2013, titled as model construction of an expert system for diagnosis of diabetes in pregnancy, based on risk factors, it has examined the diabetes mellitus based on construction of an expert system with the use of feedforward neural network[6] ,and in another article used ANN to forecasting The diabetes mellitus , The back-propagation algorithm has been chosen for learning and testing of data[3]. In this study the inputs are different from the ones that are considered as effective factors or risk factors in this paper . A fuzzy expert system for diabetes decision support application,is an article in 2010. This paper presents a novel fuzzy expert system for diabetes decision support application. A five-layer fuzzy ontology, is developed in the fuzzy expert system to describe knowledge with uncertainty[8].

3. RESEARCH METHOD

Around thousand patients file between the years, 1388 to 1391 in a private specialist clinic were examined and among these, four hundred and forty eight had complete information from the beginning to the end of the pregnancy (the required information consist of effective factors of blood sugar, weight and age of pregnancy in the initial months of pregnancy and also test results of Oral Glucose Challenge Test (OGCT)at 24-28 weeks of the pregnancy. After studying the patient's file and extraction of required information and effective factors, we have attempted to design an expert fuzzy system and indicate the rules , by using the matlab software. Characteristics of patient are considered as input of the system and risk of developing GDM is determined as output system
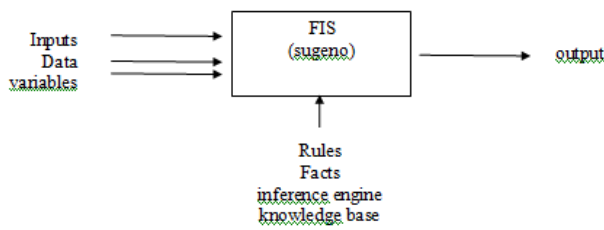
Fig1: Framework of fuzzy expert system(fis)

Given the existing literature of the field with regard to the existing effective risk factors in developing the illness and the specialist opinion, three factors of blood sugar, age and weight that are very important in the main medical texts, were considered as inputs of the expert system[2].In order to make the non-fuzzy variants (numerical) as fuzzy , gussian function was used. The ranges of change in variants are as following: The range of changes of entry variant of "fast blood sugar": Fbs<92------→normal
92<Fbs<120---→warninig
Fbs>120--→dangerous
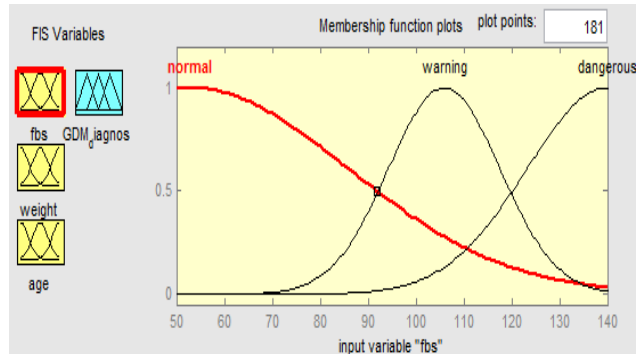
Fig2: Range of fbs

the range of entry of weight:
Weight<80------→good
Weight>80------→danger

Fig3: range of weight

and range of entry of suitable age is:
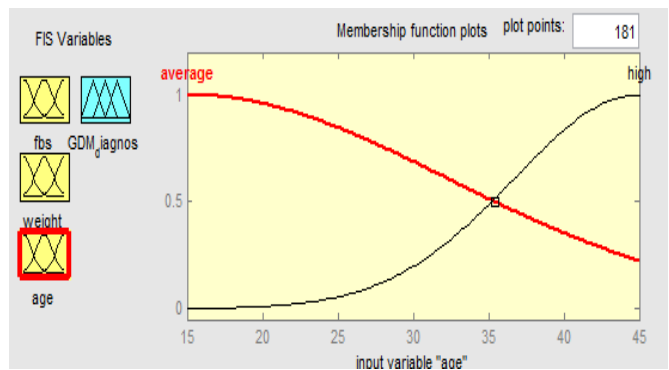Age<35------>average
Age>35-------------->high

Fig4: Range of age

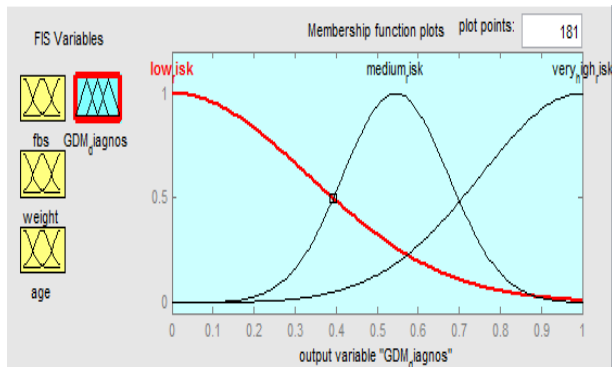The verbal variants , fuzzy number and risk of developing GDM in output :

Fig5: range of output

By comparing these outputs with the result of (OGTT), the correctness of system outputs can be examined.
The Evaluation Engine diagnoses the GDM Patient by the following Screening process proposed by ADA (American Diabetic Association) Method [6]:
Perform a 75-g OGTT, with OGTT, with plasma Glucose measurement fasting and at 1 and 2h at 24-28

weeks of gestation in women not previously diagnosed with overt diabetes. The OGTT should be performed in the morning after an overnight fast of at least 8h. The diagnosis of GDM is made when any of the following plasma glucose values are exceeded:
* Fasting ≥ 92 mg/dl (5.1 mmol/l)
* 1h ≥ 180 mg/dl (10.0 mmol/l)
* 2h ≥ 153 mg/dl (8.5 mmol/l)

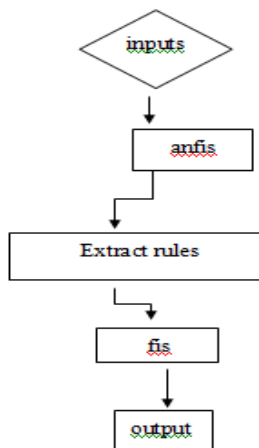**Fig6: system modeling proucider**

An example of rules is as following:
If fbs is   & weight is   &age is   then------→diagnosis is low risk
If fbs is   & weight is   &age is   then------→diagnosis is low risk
If fbs is   & weight is   &age is   then------→diagnosis is low risk

In designing expert fuzzy system, the relevant knowledge related to determining the inputs and output of the systems and also the infrence rules were obtained by speaking to specialist doctor and also using the knowledge of experts. The extraction rules were obtained from the ANFIS mode(sugeno). In anfis model, by using real data, the neuronal network extracts the relevant parameters and rules based on the data. Sugono model, ultimately assist us in extraction of rules from the existing relations between input and output data. In making the rules, we share the contradictions and ambiguous points with the experts and make the necessary corrections

In the output, for the data, values in the range between[0-1] are considered, in which 1 means high risk of developing the illness and zero means low level risk in developing GDM. In this case, by multiplying the output percentage, we can estimate the approximate risk of developing diabetes in the initial stage of pregnancy.
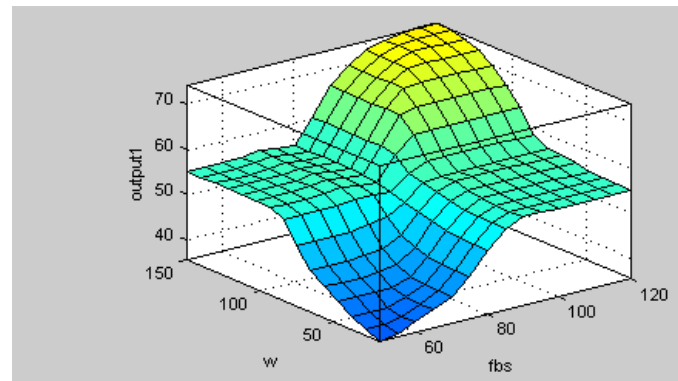

Fig7: the relationship between inputs and output

This figure indicates the effect of change of two entry variants of blood sugar and weight on the output .

4. CONCLUSION
Discussion and conclusion:
By entering the initial data to the expert fuzzy system and comparing the obtained results with the real output, we can examine the correctness of the results and their generalizability. This was done in the case of 240 patients in which the MSE error level was obtained as 0.227. The glucose test result was positive for all those who were examined in the initial stages of pregnancy and were in the high risk stage, which means they have developed pregnancy diabetes. Hence, in case of existence of a system to alert the patient on time, it can be very useful and in these initial stages, by taking a suitable food diet and ansolene, the development of the illness can be prevented.
Therefore, for diagnosing illnesses such as diabetes, in instances of lack of access to experts and specialist doctors, to a reliable extend intelligent software such as expert systems can be used for diagnosis of the illness, which can be used for speedy and better diagnosis of the illness.

5. SUGGESTIONS
The entries in this study that are considered as effective factors or risk factors are different from other local studies (the studies undertaken in 2013). Examination of this issue

requires more research over data from different areas and comparing effective factors on their output results.

It is recommended that expert system be used in other illnesses and medical cases, in which early diagnosis and treatment is important and in which there is a possibility of replacing expert system with a doctor, in instances of lack of access to doctor.

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