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A Prototype System for the Early Prediction of Ulcer Using Neuro-Fuzzy Approach

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ABSTRACT

This work is aimed at providing a neuro-fuzzy system for peptic ulcer prediction. The neuro-fuzzy system is designed with five input fields and one output field. The input variables are acid level, NSAID, H.Pylori, Smoking and Alcohol Level. The output detects the risk levels of patients which are classified into three different fields: Low-Risk, Risk and High-risk. The output of the system is designed in a way that the patient can use it personally. The patient needs to supply some values which serve as input to the system and based on the values supplied the system will be able to predict the risk level of the patient. Using the medical history of a patient and some chosen risk factors, the proposed system checks the input data with the risk factors. Predictions are made to determine the risk factor of a patient developing Peptic Ulcer.

Keywords: Fuzzy, Neural Network, Ulcer.

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1. INTRODUCTION

According to Caufield (2012), **an "ulcer" is an open sore. "Peptic" means a corrosive which is the main cause of the ailment.** Stomach ulcers are agonizing bruises that are found in the small digestive system or stomach lining. Stomach ulcers are the most obvious indication of peptic ulcer sickness. These ulcers happen when the thick layer of bodily fluid which shields the stomach from digestive juices is significantly decreased, along these lines bringing on the digestive acids in the stomach to consume the covering tissues of the stomach.

Typically, in the stomach of a normal individual, a thick layer of bodily fluid shields the stomach lining from the impact of its digestive juices. However, a great deal of variables can diminish this defensive layer, permitting ulcers to happen.
Peptic ulcer disease speaks to a genuine restorative issue. In spite of the fact that death rates from peptic ulcer infection are low, the high pervasiveness and the subsequent torment, enduring, and cost are unreasonable. In 1857, William Brinton was one of the principal specialists to depict the stomach ulcer, however without the necessary tools used in diagnosis, for example, endoscopy and X-beams, ulcer discovery was still difficult. After some time, this hypothesis advanced into a more broad origination of the ethology of ulcers, in which individuals with elevated stomach acidity were at danger. This hypothesis of the acid induced ulcer was still held in high regard in the late 1970s. Most specialists suspected that due to its high acidity, the stomach was sterile. Around this time, specialists likewise watched a connection in the between ulcers and the use of non-steroidal anti-inflammatory drugs (NSAIDs).

to Sharma and Mukharjee,(2013), Peptic ulcer infection influences around 4.6 million individuals yearly. The event of peptic ulcer sickness is comparative in men and ladies. Roughly 11%-14% of men and 8%-11% of ladies will get peptic ulcer ailment in their lifetime. No single cause has been found for peptic ulcers. Notwithstanding, it is presently clear that a ulcer is the final after effect of a lop-sidedness between digestive liquids (hydrochloric corrosive and pepsin, a digestive compound) in the stomach and duodenum.

The Adaptive Neuro-Fuzzy Inference System (ANFIS) strategy was initially presented by Jang in 1993. According to Anuradha and Ashtankar (2013), "ANFIS is basic information learning procedure that uses Fuzzy Logic to change given inputs into a craved yield through exceedingly interconnected Neural Network handling components and data associations, which are weighted to outline numerical inputs into a yield". ANFIS joins the upsides of the two machine learning methodologies (Fuzzy Logic and Neural Network) into a singular framework.

An ANFIS works by applying Neural Network learning methodologies to tune the parameters of a Fuzzy Inference System (FIS).Various creators have utilized ANFIS to take care of some health related issues, for example,

- Kuwana et al.(2008) developed an implantable telemetry holder for checking heartbeat with an FM transmitter and power supply. The case was fit for looking at imperative signs as time goes on. However, the whole structure was fairly unusual and financially inefficient.
- Zakrzewski et al.(2009) built up the framework which was focused on both for observing elderly and for checking restoration after hospitalization period.
- Nukaya et al. (2012) portrayed a novel bed detecting technique for non-obtrusive, requirement free, subliminal recognition of bio signs.
- Kyung-Ah Kim et al.(2013) actualized a home self medicinal service observing framework which can screen breath, blood glucose, urinary stream, and temperature.
- Vaidehi et al. (2011) proposed a human services observing framework which empowers critical responsiveness and procedure advancement by incorporating complex occasion preparing that influences setting mindfulness in Service Oriented Architecture

This research aims to predict the risk of ulcer occurring in humans based on certain factors thereby increasing early detection and rate of survivability using ANFIS.

2. LITERATURE REVIEW

This section of the paper attempts to consider the fundamental various views, opinions and past works by experts and scholars as regards to the various applications and uses of ANFIS as a prediction technique.

2.1 Soft Computing

Zadeh (1994) defined Soft Computing as “an emerging approach to computing which parallel the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision”. It is not accurately defined. It comprises of various ideas and systems which tries to defeat the challenges experienced in the real world. These issues rise because of the way that our reality is by all accounts loose, questionable and hard to order. Soft computing is tolerant of imprecision, vulnerability, halfway truth and estimation. It addresses an imperative viewpoint change in the purposes of enrolling, which reflects the way that the human mind, unlike present day PCs, has an outstanding ability to store and process information which is pervasively dubious and needs categoricity.

Thus, the human mind is a perfect example of soft computing. The controlling guideline of soft computing is: Exploit the resilience for imprecision, defenselessness, inadequate truth and estimation to finish tractability, power and minimal effort of arrangement and tackle the issue associated with the current technological development. The absence of the required insight of the late data innovation that empowers functionality centered on humans. The primary purpose behind the prevalence of soft computing is the collaboration gotten from its parts. i e instead of having only one component, two or more components are used so that their combined effect is better than that of their individual effects. Truth be told, Soft Computing’s primary trademark is its inborn capacity to make crossover systems that depend on the mix of constituent innovations. This incorporation of the constituents of Soft Computing gives correlative thinking and seeking strategies that permit us to combine domain knowledge and observational information to create flexible computing devices and take care of complex problems.

2.2. Expert Systems

“Experts systems are computer programs that are derived from a branch of computer science research called Artificial Intelligence” (Arekete, 2015). Other definitions for Expert Systems include “Expert system is a computer program that represents and reasons with knowledge of some specialists subject with a view to solving problems or giving advice” (Nukaya, 2012). The objective of AI is to comprehend knowledge, which thus prompts the building or the improvement of PCs that display intelligence. It additionally manages the techniques and ideas of typical induction or thinking by a PC and how the data used to make those conclusions will be shown in the machine.

An Expert System is an AI program that has expert learning around a specific area and is knowledgeable on utilizing it to react appropriately. This area refers to the space inside which the task is taking place. In a perfect world, the Expert Systems ought to substitute a human master. Edward Feigenbaum who created the first expert system in 1965 has described Expert System as “a perceptive PC program that uses information and surmising methodology to take care of issues that are sufficiently troublesome to require noteworthy human expertise for their answers".

The Expert Systems is a subset of AI expected to work within a particular area. As a specialist is a man who can take care of an issue with the knowledge of that field in hands, an Expert system ought to have the capacity to take care of issues at the level of a human expert. The source of information might originate from an expert or from books and the web. As knowledge assumes a key part in the working of Expert Systems they are otherwise called information based systems and information based Expert Systems. The knowledge of the expert about taking care of a given particular issue or problem is called knowledge domain of that expert.

2.3 Adaptive Neuro Fuzzy Inference System

An Adaptive Neuro-Fuzzy Inference System or Adaptive Network-Based Fuzzy Inference system (ANFIS) is a sort of simulated neural system that depends on Takagi–Sugeno fuzzy inference system. The method was produced in the mid 1990s. ANFIS comprises of both neural systems and fuzzy logic techniques, it uses the upsides of both. Its inference system relates to an arrangement of IF–THEN rules in fuzzy form that have learning ability to surmise non-linear capacities. ANFIS is in this manner thought to be an all-inclusive estimator. To successfully explain the concept of ANFIS, we have to first understand Fuzzy Logic and Neural Networks.

2.3.1 Fuzzy Logic

Fuzzy logic is a superset of standard (Boolean) rationale that has been extended to handle the thought of fragmentary truth - truth values between "absolutely certifiable" and "absolutely false". It is a consistent structure which is a development of multivalued rationale. Fuzzy logic is a growth of Boolean rationale, considering the investigative theory of fuzzy sets, which is a hypothesis of the built up set speculation (Zadeh, 1965).

2.3.2 Neural Networks

In machine learning and mental science, artificial neural networks (ANNs) are a gathering of models pushed by characteristic neural systems (the central tactile frameworks of animals, particularly the cerebrum) and are used to gauge or assess limits that can depend on a generous number of inputs and are overall obscure. Artificial neural networks are generally shown as structures of interconnected "neurons" which exchange messages between each other. The affiliations have numeric weights that can be tuned considering background, making neural networks adaptable to inputs and fit for learning.

2.4 Utilization of ANFIS For Prediction

Several Researchers have used ANFIS to detect some ailments in the field of medicine, they are outlined as follows:

- **Early Heart Attack Prediction**
  Obanijesu and Emuoyibofarhe (2013), added to a Neuro-Fuzzy framework for heart attack recognition. A Neuro-Fuzzy system for detecting and discovery of heart attack was executed utilizing ANFIS. The Neuro-Fuzzy framework was outlined with eight input field and one output field. The input variables are heart rate, exercise, pulse, age, cholesterol, mid-section torment sort, glucose and sex. The output distinguishes the danger levels of patients which are characterized into 4 unique fields: very low, low, high and very high. The information set utilized was extricated from the database and demonstrated so as to make it fitting for the preparation, then the introductory FIS structure was produced, the system was prepared with the arrangement of preparing information after which it was tried and approved with the arrangement of testing information. The yield of the framework was composed in a way that the patient can utilize it by and by. The patient simply needs to supply a few qualities which serve as data to the framework and in light of the qualities supplied the framework will have the capacity to foresee the danger level of the patient.
- **Blood Flow and its influence on the body.**
  Mayilvaganan and Rajeswari (2014) added to a framework to check how circulatory strain influences the diverse parts of the human body with the utilization of a fuzzy logic controller. The framework concentrated on ANFIS and relies on the fuzzy logic controller to analyze the different level of wellbeing danger component esteem which is accumulated with Blood Pressure, Pulse Rate and kidney capacity in view of different Input Parameters. Fuzzy Logic circuit was created with 2's Complement in full viper utilizing the info, for example, Blood Pressure esteem taken from Systolic and Diastolic quality, Pulse Rate and GFR esteem, because of expansion in circulatory strain estimation qualities, The framework utilizes the Mat Lab Fuzzy Tool Box, and produces as output the danger variable estimation of a person.

3. PROPOSED ANFIS MODEL

The proposed model made use of the Sugeno fuzzy logic approach. It is very similar to the Mamdani technique in many ways. The first two sections of the fuzzy inference process, fuzzifying the inputs and applying the fuzzy operator, are exactly the same. The basic difference between the Mamdani and Sugeno fuzzy logic is that the Sugeno output membership functions are either linear or constant. The Sugeno model for this case was designed in light of various potential peptic ulcer risk factors. Some of these include:

Alcohol Intake, Smoking, Helicobacter pylori, Nonsteroidal Anti-Inflammatory Drugs (NSAIDS), Acid Level, Family History, and Age

The formula for calculating the risk factor

$$\text{Low Risk when } c \leq 33.3 = \frac{1}{1+\left|\frac{x-33.3}{a}\right|^{2b}}$$

$$\text{Risky when } c \leq 66.6 = \frac{1}{1+\left|\frac{x-66.6}{a}\right|^{2b}}$$

$$\text{High Risk when } c \leq 100 = \frac{1}{1+\left|\frac{x-100}{a}\right|^{2b}}$$

Where
a,b,c are membership functions.

4. SYSTEM IMPLEMENTATION

This aspect contains the implementations of the proposed system. Various input membership functions, output membership functions, the graphical interface are shown in this section.

4.1 Input Membership Functions

Smoking input variable comprised of three membership functions. It is of the Generalized Bell Membership Function type. It has a range between 0 and 5. Alcohol input variable has three linear membership functions. It is of the Generalized Bell Membership Function type. It has a range between 0 and 5. Non-Steroidal Anti-Inflammatory drug input variable consists of two linear membership functions. It is of the Generalized Bell Membership Function type. It has a range between 0 and 1. Acid input variable which has four membership functions. It is of the Generalized Bell Membership Function type. It has a range between 1.5 and 3.5. Helicobacter Pylori input variable which comprises of two linear membership functions. Which are named Yes and No respectively. It is of the Generalized Bell Membership Function type. It has a range between 0 and 1.

4.2. Output Membership Function

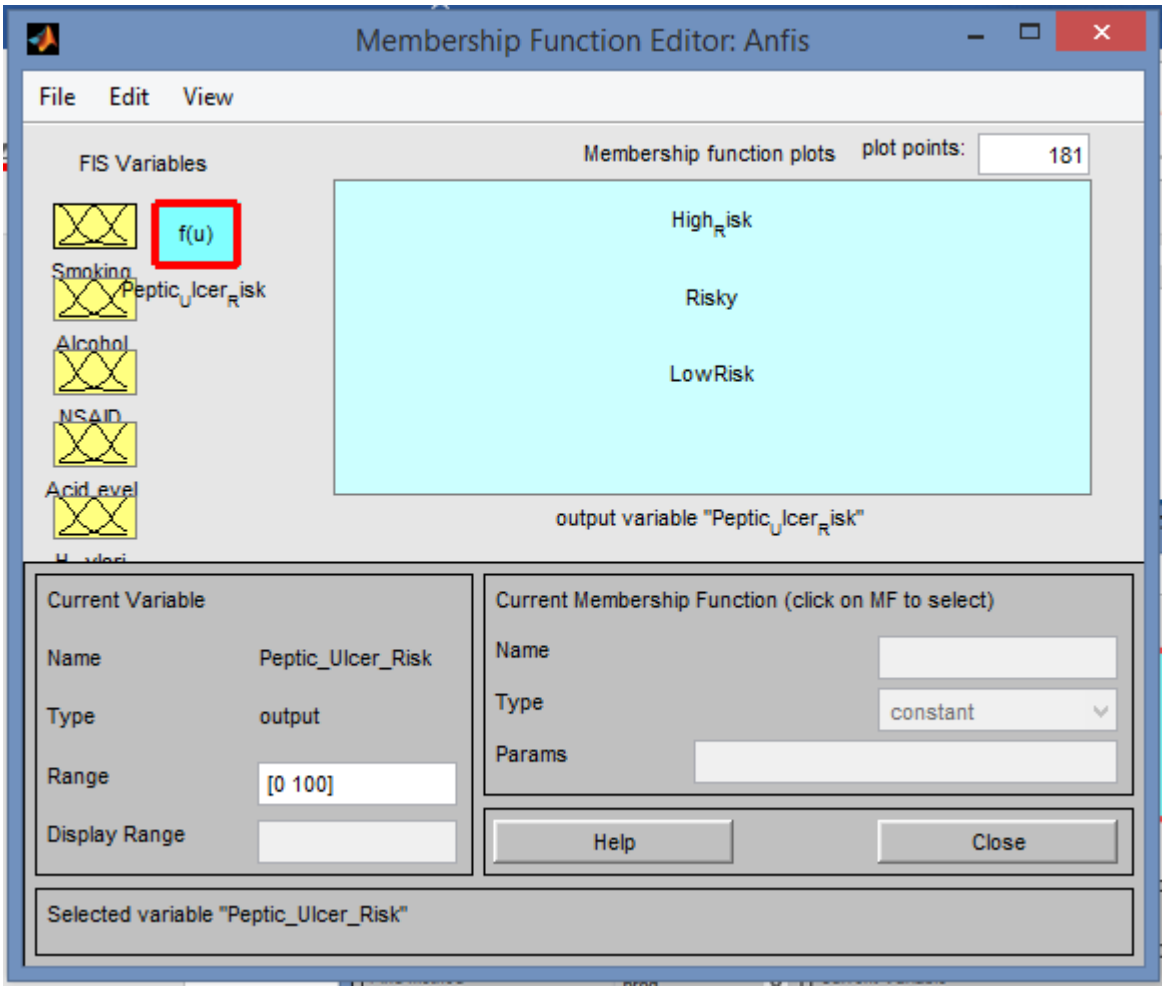

Figure 1: Peptic Ulcer Risk Output Variable

Figure 1 shows the peptic ulcer risk output variable which consists of three linear membership functions. It is of the Generalized Bell Membership Function type. It has a range between 0 and 100. This part of the research shows the Graphical User Interface of the Peptic Ulcer Risk Predictor (PURP) application. The application runs on Windows Operating System using the rule based that was got from the expert and built into ANFIS to develop the application.

4.3 Peptic Ulcer Interface

- **Input Factors**

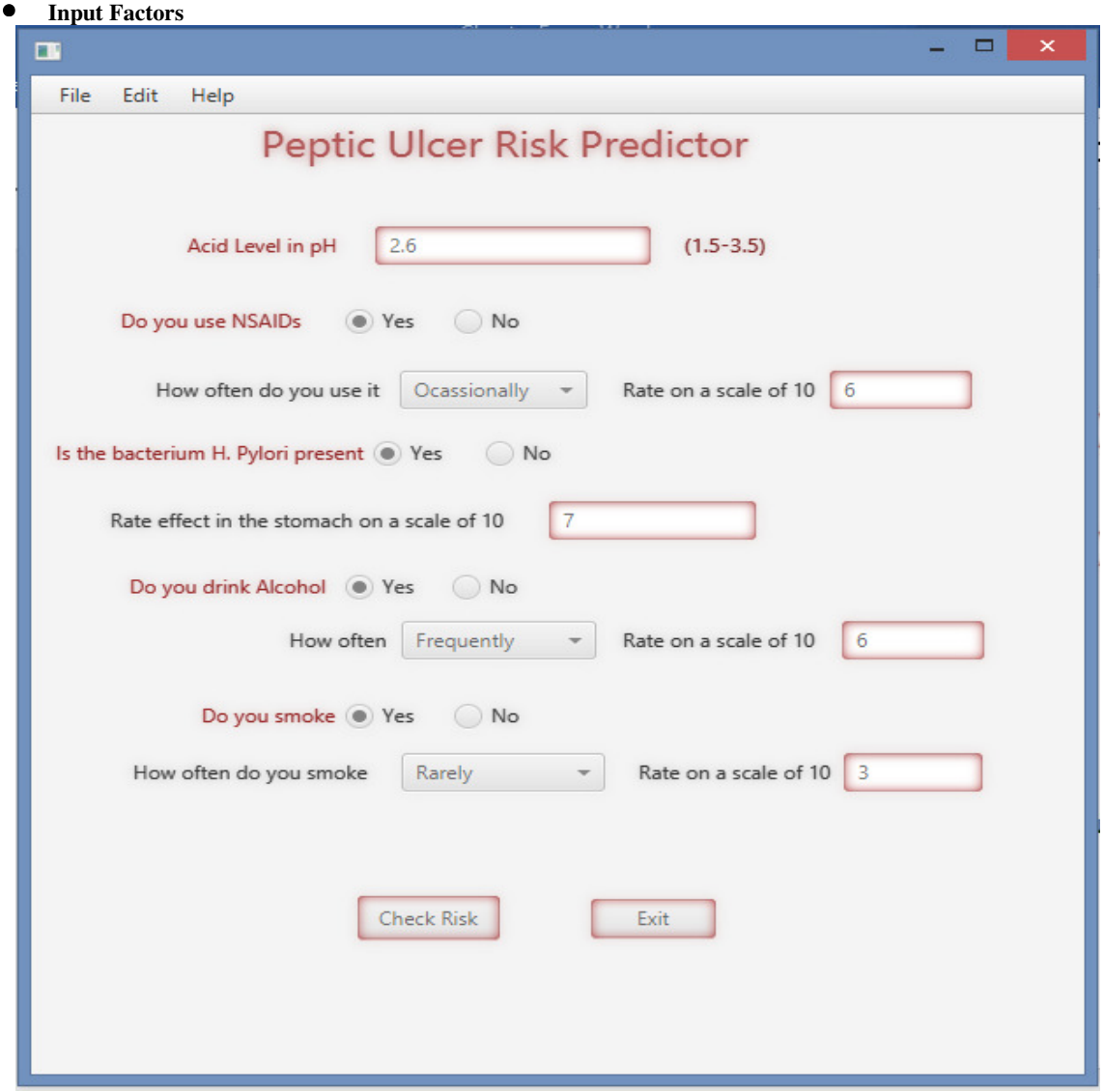

Figure 2: Graphical User Interface to accept Input

The Graphical User Interface in figure 2 accepts input from the users with factors such as the alcohol intake, smoking, acid levels etc. The application then processes these factors and produces the risk factor after the Check Risk button is clicked. Figure 2 shows the input factors for a particular person with acid level of 2.6, rate of scale of 10, Rate effect in the stomach on a scale of 7 among others.

- **Risk Factor Output.**

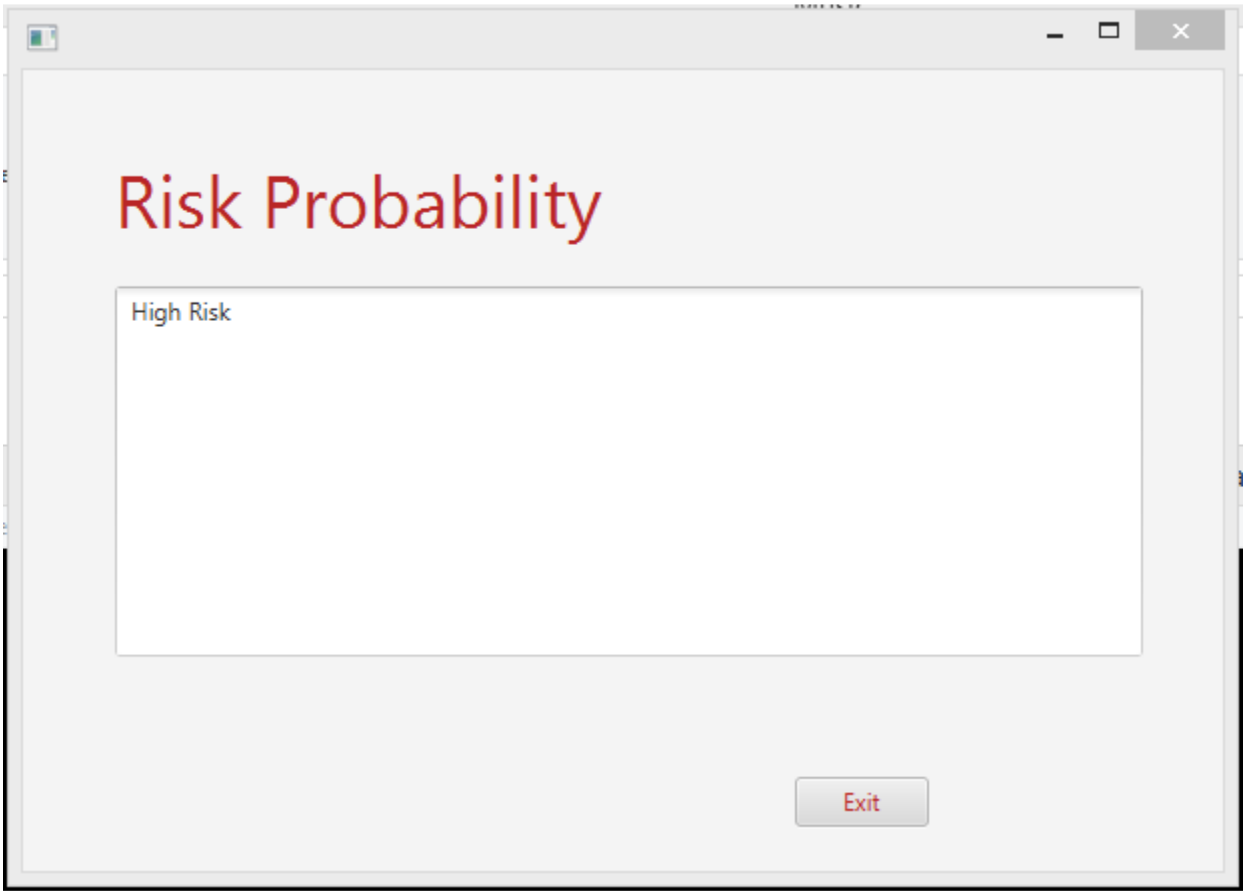

Figure 3: Graphical User Interface to show result.

Figure 3 shows the risk factor output based on the input factors of a patient that were supplied in figure 2. From figure 3, it is shown that the patient has a high risk of peptic ulcer.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Peptic Ulcer is one of the most common diseases that affect man regardless of status of the individual. Hence, the early detection of peptic ulcer is one of the major means of preventing the disease which is always better and cheaper than the cure. In this research work, an expert clinical decision support system has been developed using the Sugeno Fuzzy logic approach for the standardized prediction of peptic ulcer. This system alongside medical examinations and tests would help medical practitioners predict the risk of an individual getting ulcer. A dataset was gotten from the website of organization that focuses on the cure of peptic ulcer in order to validate the proposed work.

5.2 Recommendation

This research work has been designed to help its clients to foresee the danger of an individual getting peptic ulcer however it is still subject to some medicinal examinations. The model utilized as a part of this research study that uses just a couple of factors for its forecast. The framework can be further enhanced by considering other risk factors which can be useful for the risk prediction of the framework. Different models for predictions can likewise be utilized to improve this research work.

REFERENCES

1. Caufield, P. (2012). Peptic Ulcer Overview. Retrieved on 9th October, 2015 from http://patients.gi.org/topics/peptic-ulcer-disease/
2. Anuradha, A. &Ashtankar, P. (2013). An Expert System for Home Health Monitoring: The ANFIS Approach IJSRP, Volume 3, Issue 7.
3. Kuwana, K., Dohi, T., Hashimoto, Y., Matsumoto, K., & Shimoyama, I.(2008). "Implantable telemetry capsule for monitoring arterial oxygen saturation and heartbeat". 30th Annual International IEEE EMBS Conference Vancouver, British Columbia, Canada.
4. Zakrzewski, P., Medema, M., Gevorgyan, A., Kierzek, A., Breitling, R., & Takano, E. (2009) MultiMetEval: comparative and multi-objective analysis of genome-scale metabolic models. PLoS ONE, 7 (12). e51511. ISSN 1932-6203
5. .Nukaya,S. Shino,T., Kurihara, Y., K. Watanabe K., and Tanaka, H(2012) "Noninvasive Bed Sensing of Human Biosignals Via Piezoceramic Devices Sandwiched Between the Floor and Bed",IEEE Sensors Journal, vol.12, no. 3,.
6. Vaidehi V., Vardhini M., Yogeshwaran H., Inbasagar G., Bhargavi R., Hemalatha C.(2011). Agent based health monitoring of elderly people in indoor environments using wireless sensor networks. ProcediaComput. Sci;19:64–71. doi: 0.1016/j.procs.06.014.
7. Zadeh, L.(1994), "Fuzzy Logic, Neural Networks and Soft Computing", Communication of the ACM, 37(3), pp77-84.
8. Arekete, A., Anidu, A. &Adekoya, A. (2015). Dynamic Computation of RungeKutta Fourth Order Algorithm for First and Second Order Ordinary Differential Equation Using Java.
9. Obanijesu, O. &Emuoyibofarhe, O.(2012), "Development of Neuro-fuzzy System for Early Prediction of Heart Attack", IJITCS, vol.4, no.9, pp.22-28,
10. Sharma, M. &Mukharjee, S.(2013). "Brain Tumor Segmentation Using Genetic Algorithm and Artificial Neural Network Fuzzy Inference System", Advances in Computing and Information Advances in Intelligent Systems and Computing Volume 177, pp 329-339,.
11. Mayilvaganan M, Rajeswari K (2014). Patient Health Care Analysis based on ANFIS Sugeno Model". International Journal of Computer Trends and Technology (IJCTT) V17(4) ISSN:2231-2803. www.ijcttjournal.org. Published by Seventh Sense Research Group.
12. Sungging, H., Sylvia-Ayu, P., Santoso, M., Arifin, S.,(2011).Application of Adaptive Neuro Fuzzy Inference System (ANFIS)for Lung Cancer Detection Software, Nominator TICA Cluster II.

APPENDIX

LINGUISTIC VARIABLES

Table 1: Linguistic Labels for Variables.

S/NO	INPUT/OUTPUT PARAMETERS	MEMBERSHIP FUNCTION
1	SMOKING	Never(NV), Occasionally(OC), Frequently(FR)
2	ALCOHOL INTAKE	Less(LS), Moderate(MT), More(MR)
3	NSAID	TRUE, FALSE
4	H. PYLORI	YES, NO
5	ACID LEVEL	Low(LW), Medium(MD), High(H), Very High(VH)
6	PEPTIC ULCER RISK	Low Risk(LR), Risky(RS), High Risk(HR)

Table 1 contains the membership functions of the proposed system.

Table 2: Range for Input Variables

INPUT VARIABLES	MINIMUM VALUES	MAXIMUM VALUES
SMOKING	0.1	5.0
ALCOHOL INTAKE	0.1	5.0
NSAID	0.1	1.0
H. PYLORI	0.1	1.0
ACID LEVEL	1.5	3.5

Table 3: Numerical variation interval for output variables.

OUTPUT VARIABLE	MINIMUM VALUE	MAXIMUM VALUE
Peptic Ulcer Risk	0%	100%

Table 4: Linguistic Labels and their ranges.

S/NO	INPUT/OUTPUT PARAMETERS	NUMERICAL RANGE
1	SMOKING	Never(NV):0.1-1.0 Occasionally(OC):1.1-2.5 Frequently(FR):2.6-5.0
2	ALCOHOL INTAKE	Less(LS): 0.1-1.0 Moderate(MT): 1.1-2.5 More(MR): 2.6-5.0
3	NSAID	FALSE:0.1-0.5 TRUE:0.6-1.0
4	H. PYLORI	NO:0.1-0.5 YES:0.6-1.0
5	ACID LEVEL	Low(LW): 1.5-1.9 Medium(MD): 2.0-2.4 High(H): 2.5-2.9 Very High(VH):3.0-3.5
6	PEPTIC ULCER RISK	Low risk(LR):1-33.3% Risky(R):33.4-66.6% High Risk(HR): 66.7-100%

Table 5: Rules for the proposed system.

RULE NUMBER	SMOKING	ALCOHOL	NSAID	ACID LEVEL	H PYLORI	OUTPUT: PEPTIC ULCER RISK
1	FR	MT	TRUE	LW	NO	R
2	FR	MT	TRUE	LW	YES	HR
3	FR	MT	TRUE	MD	NO	R
4	FR	MT	TRUE	MD	YES	HR
5	FR	MT	TRUE	H	NO	HR
6	FR	MT	TRUE	H	YES	R
7	FR	MT	TRUE	VH	NO	R
8	FR	MT	TRUE	VH	YES	HR
9	FR	MT	FALSE	LW	NO	R
10	FR	MT	FALSE	LW	YES	R
11	FR	MT	FALSE	MD	NO	LR
12	FR	MT	FALSE	MD	YES	R
13	FR	MT	FALSE	H	NO	R
14	FR	MT	FALSE	H	YES	HR
15	FR	MT	FALSE	VH	NO	R
16	FR	MT	FALSE	VH	YES	HR
17	FR	MT	TRUE	LW	NO	R
18	FR	MT	TRUE	LW	YES	HR
19	FR	MT	TRUE	MD	NO	R
20	FR	MT	TRUE	MD	YES	HR
…	…	…	…	…	…	…
127	NV	MT	FALSE	VH	NO	R
128	NV	MT	FALSE	VH	YES	HR
129	NV	MR	TRUE	LW	NO	R
130	NV	MR	TRUE	LW	YES	R
131	NV	MR	TRUE	MD	NO	R
132	NV	MR	TRUE	MD	YES	R
133	NV	MR	TRUE	H	NO	R
134	NV	MR	TRUE	H	YES	HR
135	NV	MR	TRUE	VH	NO	HR
136	NV	MR	TRUE	VH	YES	HR
137	NV	MR	FALSE	LW	NO	LR
138	NV	MR	FALSE	LW	YES	R
139	NV	MR	FALSE	MD	NO	LR
140	NV	MR	FALSE	MD	YES	R
141	NV	MR	FALSE	H	NO	R
142	NV	MR	FALSE	H	YES	R
143	NV	MR	FALSE	VH	NO	R
144	NV	MR	FALSE	VH	YES	HR