SADAF KHALIL
01-134132-161
KHUNSHA ALI SATTI
01-134132-079

Medical Prescription Using Fuzzy Logic

Bachelor of Science in Computer Science

Supervisor: Dr. Muhammad Asfand e Yar

Department of Computer Science
Bahria University, Islamabad

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Abstract

Fuzzy Cognitive Mapping is a computing technique based on decision making FCM uses linguistic variables as like human thinking and fuzzy rules to formulate human reasoning. Here we proposed a system that allow the medical doctor to get instant guidance on their patients' health issues through an intelligent medical prescription. It provides the facility to medical doctors to know about the interaction between the medicine and food intake according to particular disease. The system database is populated with various symptoms and association of the diseases. It then process patient symptoms to check for various illness. We use fuzzy cognitive mapping to map the interaction between the medicines and food for multiple diseases. We use chemical formulas to show the interaction between the medicines for different diseases and decide which medicine is better for the patient with daily usage of food. The objective of the system is to facilitate the doctors and to automate the prescription.

Acknowledgments

We would like to thank ALLAH Almighty for his countless blessings. Then we would like to thank our parents, friends and especially to our dear friend Komal Ayaz for her help and support in completing the project successfully. They have always inspired us to tackle each and every task with confidence, full devotion and dedication. Furthermore, we are very grateful to our supervisor Dr. Muhammad Asfand-e-Yar who has given us the chance to work on such an amazing project and for providing professional guidance to complete this project in successful manner. His support, professional guidance and advice throughout the project is highly appreciated.

KHUNSHA ALI SATTI AND SADAF KHALIL

BAHRIA UNIVERSITY ISLAMABAD, PAKISTAN

DEPARTMENT OF COMPUTER SCIENCE

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"We think someone else, someone smarter than us,
someone more capable, someone with more resources will solve that problem.
But there isn't anyone else."

Regina Dugan

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Acronyms and Abbreviations

MPPFLICMA	Medical prescription pattern using Fuzzy Logic in case of minor ailments
MF	Membership Function
MDS	Medical Diagnostic System
FIS	Fuzzy Interface System
MDSFL	Medical Diagnostic System using Fuzzy Logic
FLA	Fuzzy Logic Algorithm
GMFES	Generic Medical Fuzzy Expert System for Diagnosis of Cardiac Diseases
MFES	Medical Fuzzy Expert System for Diagnosis of Cardiac Diseases
FL	Fuzzy Logic
FCM	Fuzzy Cognitive Mapping

Chapter 1

Introduction

1.1 Introduction

The project is based on interaction between the medicines and food items. We'll use fuzzy cognitive mapping to indicate the interaction between them. FCM algorithm is a soft computing technique for building complicated applications which follows the approach same as human thinking and decision-making. The core medication plays an important role in treatment of diseases symptoms or sickness. The ordinarily used analysis strategies against the core prescription are the statistical analysis of the frequency of drug and also the statistical analysis of drug chemist. The project is predicated on FCMs that is employed to construct analysis of the core prescribed drugs and mine the core prescribed drugs.

1.2 Problem Description

In a global world, wherever economic development is grows, so as the technology is changing. Therefore, the importance of time become double without delay. Nowadays, focus is to search out reliable data over internet that may not solve the user's problems accordingly. Nowadays internet has become standardized, therefore every individuals of any age is using technology associated with internet. The improved searching mechanism of internet helps to find a particular topic they want to know about. The major problem in developed and under developed countries is to treat ill patients and wrongly diagnose the diseases due to negligence of doctors. The advancement of computer technology over the time, the Artificial Intelligence helps the doctors in patient treatment. Scientist evolved in making many innovations, formulas and scientific knowledge including (including Fuzzy Logic, Genetic Algorithms and even Artificial Neural Network) to make sure correctness and perfection in the field of medicine. They are domain of Artificial Intelligence. Majority of people are suffering from multiple diseases like diabetes and blood pressure at the same time. Due to these multiple diseases, the doctors face difficulties in prescribing patient the sequence of medicines, which should cure them accordingly. Medical doctors require medication information, pattern of the illness and performance of drug effectiveness. Therefore, we need a system which

provide medication and its interaction with the better use of Nutrients. The project is based on medication and its interaction with the best suitable nutrition. The information systems used for medication were not human friendly and not accurate accordingly. The core of prescribing drugs plays an important role in treatment against multiple diseases. The project is to design the information system that prescribe medicines according to interaction with medicine and nutrition. The doctors prescribe medicines according to the pattern of illness, drug effectiveness and history of prescription.

1.3 Objective

Most doctors are confused about the medicines which should be taken or which should be not because of their multiple diseases. The objective of the application is to facilitate the doctor in automatic generation of medical prescription. Users can easily get information of all medicines. Here we proposed a system that allow the medical doctor to get instant guidance on their patient's health issues through an intelligent medical prescription. It provides the facility to medical doctors to know about the interaction between the medicine for multiple diseases and importance of food intake according to particular disease. The system database is populated with various symptoms and association of the diseases. It then processes patient's symptoms to check for numerous illness that could be associated with patient's symptoms. For specific diseases we map the interaction between the medicines include as follow

1. Heartburn
2. Hypertension
3. Rheumatoid arthritis
4. Motion sickness
5. Panic Disorder
6. Diabetes
7. Nasal congestion
8. Gastroenteritis
9. Constipation
10. Narcolepsy

In this system we need active agent for the interaction between different diseases. We will be implementing this project using Fuzzy Logic. FCM is a soft computing technique based on decision making, human thinking, reasoning process and other conceptual mapping tool with fuzzy logic and other techniques. FCM used in many applications and domains like politics, education and

other medical diagnostic systems. Fuzzy was originally invented by scientist Kosko. The FCM is a tool which is used to discover hidden relationships between concepts in it there are nodes and edges nodes represent factors and edges represent relationship between those nodes. Its value is between (0,1).

1.4 Proposed Solution

The thesis focuses on the FCM ideal technique and rationalizing it with the infrastructure of the acquire Medical Records Data. The method will be used to make design of the staple prescription drugs and mining them using the FCM. We use fuzzy cognitive mapping to map the interaction between the medicines and food for multiple diseases. We use chemical formulas to show the interaction between the medicines for different diseases and decide which medicine is better for the patient with daily usage of food. We are also designing a database which include following fields; diseases, medicine, food, active agent. We apply Fuzzy Structure Query Language (FSQL) statements to the database that adds fuzzy features. FSQL statements include conditional statements, linguistics label, threshold etc. We apply FSQL statements to the following tables:

- Diseases contain fields (disease and medicines).
- Medicine interaction contain fields (multiple diseases and their medicines including active agent).
- Food contain fields (multiple diseases and their medicines including active agent, food intake).

Input to the system is multiple diseases of the patients and our system map the interaction of the multiple diseases through medicines. Our system tells the interaction between the medicines with their active agent. The output of the system is intake food, medicines with active agent.

Chapter 2

Literature Review

2.1 Existing System

The Expert System technology and computer technologies based system has flourished over the years in the field of Artificial Intelligence. Expert system firstly flourished from the research laboratories of a few leading United States Universities during the 1960's and 1970's. They were developed by specialized and expert decision makers, which focused mainly on information provided rather than frameworks and searching methods. DENDRAL initial Expert system to be developed at the Stanford University and the very first medical expert system was the MYCIN, which was use for the diagnoses of infectious blood diseases and determines a recommended list of different therapies for the patients. Some other medical diagnostic systems may include PUFF for diagnosis of lung disease, BLUE Box for depression. Different research papers and articles have been proposed in the field of medicines. Other recent work in the field of Artificial intelligent-based related systems include: ASUDA. ASUDA is a program, which has the potentials to examine software to see if it is capable of handling the tasks one need to perform. Existing system also reported a work on the Service Oriented Architecture (SOA), which is an expert system, intended to provide both the basis for building integrated intelligent systems and a unified theory of human thinking. Furthermore, past provide us with several Diagnostic medical expert systems for different diseases in the field of Artificial Intelligence. The first logic-based approach to medical diagnosis was invented by Ledley and Lusted in 1959 there work also got national coverage in the field of medical decision making. Due to the uncertainty of the problem domain pure binary logic was soon found to be insufficient as a language of medical problem formulation. The MYCIN, PIP, CASNET, EXPERT and INTERNIST systems were among the more prominent systems. At the same time, but unfortunately they remain unnotified first investigations examining the suitability of fuzzy sets in overcoming the insufficiencies of symbolic reasoning in medical field were undertaken generalized fuzzy approaches to medical diagnosis system followed a fuzzy quantification of the decision making process of MYCIN's certainty factors. The functions and organs of human body are highly complicated so with the diagnostic expert system available today it is often possible to examine a patient thoroughly to overcome the complains of the patients.

2.2 Working of Existing System

These are the following existing system or application which we discuss:

2.2.1 Medical prescription pattern using Fuzzy Logic in case of minor ailments

A paper represent the design of MPPFLICMA [1]. Aliments such as fever, cough, Diarrhea, Burn, Acidity. Body Pain, Headache, skin order etc. is diagnosed in MPPFLICMA system. Various component is investigated through building fuzzy interface system. The rule is design using expert knowledge of medical. There are total 10 symptoms used in this application. The specification of input variables are as follow

1. FIS System (symptom's)
2. Input 1(weight).
3. Input 2(age).
4. Input 3(severity).
5. Output (Medicine).

The above are system interface engine. The main idea behind the project was avoid wrong medication and to help medical doctors, intern's etc.to know about the prescription pattern in sufficient manner. The pattern of prescription starts from selection of symptom by user. Selected symptom activates the corresponding FIS system. As user specifies the values for input variable depend on selected symptom, the inference engine starts so as to give output value. Depend upon this output value System will look for the medicine in database. Then user will able to get desired medicine which is being prescribed according to symptoms. If GUI provides provision for print then patient can get the hardcopy of the printed prescription. The project works with the symptoms interface region if the patient select the symptoms fever then FIS system has two condition for the prescribed medicine which is output of the system. The conditions are as follow:

1. If temperature is low and age is teen then medicine is in tablet form.
2. If temperature is high and age is adult then medicine is in syrup form.

The temperature is modeled by Gaussian MF and age by triangular MF.AND operator is being used for the evaluation of both the rules [1]. The FIS system is implemented in MATLAB using fuzzy logic toolbox.

2.2.2 Medical Diagnosis System Using Fuzzy Logic

The other application is Medical Diagnosis System (MDS), it is using fuzzy logic .The system was implemented in Visual Prolog Programming language. The proposed system can be helpful in prescribed medicines, registered and to document patient's data. The expert system was designed

for the common disease known as Malaria. For the construction of MDS, fuzzification [2] has been used. The first step for fuzzification, is fuzzy set for parameters. The parameters are the input and output of the system based upon four linguistic variables (minor, moderate, severe and very severe). Second step of fuzzification is fuzzy rules. Fuzzy rules for this expert system was developed under 5 expert medical doctors. A rule fulfills the parameters (mild, moderate, severe, very severe) if true (1) else false (0). They are in the form of tables. In this system the defuzzifier [2] translates the output from the inference engine into crisp output. The defuzzification input is a fuzzy set while the output of the defuzzification is a single number (crisp). System interface consist of the following things:

1. File Menu.
2. Symptoms Interface.
3. Diagnosis Result.
4. Result Interface.

2.2.3 Medical Diagnostic System using Fuzzy Logic

Some other application of MDSFL [3] is of Fuzzy inference which is employed to implement a computer program that can automate to find out that patient having some specified symptoms suffering from anyone of a set of suspected diseases. For every suspected disease crisp [3] percentage value is specified. The proposed algorithm is of Fuzzy Logic Algorithm (FLA):

1. Linguistic variables and membership function used for the initialization (rule base) in the system.
2. To convert crisp input data to fuzzy values by using fuzzification.
3. To evaluate the rules in the rule base (inference) and also combine the rules of each results(Inference).
4. Conversion of the output data into non-fuzzy values.

The implementation of MDSFL contain three tables:

Table 1: Consists of symptoms of various diseases during different stages and its relevance. The table consists of symptoms of inuenza like fever, head ache etc., the stage of the disease in which the symptom is shown and its relevance. For example if the person having inuenza always have fever from third day to fth day from the onset of the disease, sometimes show collapse from third day to fth day etc [3].

Disease				
index	Symptom	lower	upper	relevance
1	Fever	3	5	always
2	Headache	3	5	always
3	Vertigo	3	5	always
4	Chills	3	5	always
5	pains in the back	3	5	always
6	pains in the muscles	3	5	always
7	Collapse	3	5	sometimes
8	Coughing	4	5	often
9	eves are running	4	5	often
10	nose is running	4	5	often
11	sore throat	4	5	often

Figure 2.1: Table 1

Table 2: Shows patients id and symptoms of a patient during different days [3].

Patient		
patient_id	Symptom	fromday
1	Fever	3
1	Headache	4
2	Fever	3
2	Chills	3
2	Vertigo	4
2	pains in the back	5
2	Headache	3
3	Fever	3
3	Chills	3
3	Vertigo	4
3	pains in the back	5
3	Headache	3
4	Chills	1
4	Fever	1
5	Fever	4
5	Chills	4
5	Vertigo	3
5	pains in the back	5

Figure 2.2: Table 2

Table 3: Patient id, patient diseases and stages of the diseases in days, like the patient with id 1 has no symptoms of inuenza while patient with id 2 have inuenza at its fteenth day shown in the above table [3].

Results	
Patientid	Stage
1	No symptoms of Influenza
2	May be Influenza At Day:15
3	May be Influenza At Day:15
4	No symptoms of Influenza
5	No symptoms of Influenza

Figure 2.3: Table 3

This system help many doctors in consultation of different diseases and ease other problems associated with clinical consultations

2.3 DESIGNING SYSTEM FOR MEDICAL DIAGNOSIS.

The project work similar to fuzzy logic in a field of medicine is of design of expert system for medical diagnosis using fuzzy logic. The system is for diagnosis of diagnosis of Hemorrage, brain tumor, cardiac disease and thyroid disease. Fuzzy logic [4] design has been used in the system

with its four components [4]: Fuzzifier , rule base , inference engine and last but not the least defuzzification .The system takes five inputs in total for hemorrage and brain diseases: protein, red blood cells, lymphocytes, neutrophils, eosinophils and give three outputs: normal, hemorrhage, brain tumor for Brain disease. While in Heart disease only one input is taken: C.P.K.M.B value giving output cardiac disease or not. Similarly for thyroid disease the three input are take: T-3 value, T-4 count, Ultrasensitive Hormone (T.S.H) giving output thyroid disease or not. The medical diagnosis for the model, fuzzy rules are formulated using MATLAB simulation. The simulation result are calculated on the bases of model design. The work carried in the paper proposes to develop an expert system to enhance the efficiency to diagnose a disease related to human body. Design algorithms has been proposed for the above mentioned diseases through there member functions. The result was stimulated in MATLAB software using fuzzy toolbox. Calculations has also been made for the input parameters of the diseases and the comparison of those diseases were shown in the form of the table [4] which consists of stimulation results and calculated values. For the designing Process of this expert system involve the designing of Front page consist of GUI, Patient Information , Brain Disease, Heart Disease, Thyroid button as input buttons. Next below button developed for Membership Function [4] as input Protein, RBC, Lymphocytes, Neutrophils and Eosinophils. Each Membership function have three values MF1, MF2 MF3. Training Fuzzy System button consist of training fuzzy system through Mamdani Model [4]. Through Mamdani Model system is trained with 17 rules. Fuzzy System button display the 17 rules graphics, and at last close button the close the graphics. The design model and simulation result are same. The designed system can be extended for any number of inputs. Normal, hemorrhage and the brain tumor all depend on the inputs. As the inputs are the blood cells and the designed system use five blood cells as inputs, similarly this system can have more than five inputs to get more reliable diagnostic results.

2.4 Generic Medical Fuzzy Expert System for Diagnosis of Cardiac Diseases

Last application which we have search is of GMFES for Diagnosis of Cardiac Diseases. Mathematical models [5] has been designed in system for the prediction of heart disease and check the comparison with performance of fuzzy expert system. The system is implemented for patient and doctors.

The Architectural model [5] of this generic experts system comprises of the following:

1. Choose the relevant input and output of the parameters.
2. Selection of accurate membership functions, fuzzy operators, reasoning mechanisms.
3. Choose the specific type of FIS.
4. Rule base formulation.

The system contain smart user interface to enables users for the selection of appropriate symptoms. Physiological inputs specific to the patients are accepted by the system. The observations and reading are accepted by the system are laboratory readings, electrocardiogram and x-ray observations. There are total 11 tables for this expert systems showing different types, ranges, member functions of inputs parameter and parameters showing risk computed using MFES [5] and mathematical model. The input variables considered are age, blood pressure, cholesterol, heart rate, blood sugar, sex, ECG, old peak and the thallium scan. Linguistic variables are assigned to membership values. The model is formulated to compute the risk of heart disease. In the medical diagnosis pertaining to heart diseases, the clinical parameters are age, blood pressure, lipid profile, heart rate and peak. There are other parameters as well but they are less influencing then that mentioned above.

The generic system has been designed for the medical diagnosis using MATLAB tools. A knowledge base consist of 1000 rules pertaining to heart disease is the backbone of the system. The system uses for diagnosis of diseases related with heart, liver, lung, kidney, abdomen, bladder, brain, prostate, eyes and ears. The input accepted by the system is in the form of physiological, radiological and clinical parameters from the user. There are many more applications which have been successfully proposed in the field of medicine using fuzzy logic as fuzzy logic is an efficient and powerful tool for the representation of human decision making and reasoning.

2.5 MEDICAL DIAGNOSIS SYSTEM USING FUZZY LOGIC TOOLBOX

Another application using fuzzy logic was represented in paper 2015 [6] was of MEDICAL DIAGNOSIS SYSTEM USING FUZZY LOGIC TOOLBOX .This application was implemented in MATLAB software using fuzzy logic toolbox as mentioned above. This Toolbox is an application software. It create fuzzy inference system and fuzzy classification in the MATLAB .The base element in the Collection is the Fuzzy Inference System abbreviated as FIS- structure [6].It has functional blocks for implementation of fuzzy interface.

2.6 Fuzzy interface system

In order to design Fuzzy Diagnosis System a FIS toolbox [6] is a powerful GUI. The FIS editor shows information about a fuzzy interface structure. It shows the title bar of each input on the left side and output on the right side. The 14 disease which the system generated as input are as under:

1. Temperature
2. Headache
3. Joint/Muscle Pain
4. Abdominal Pain

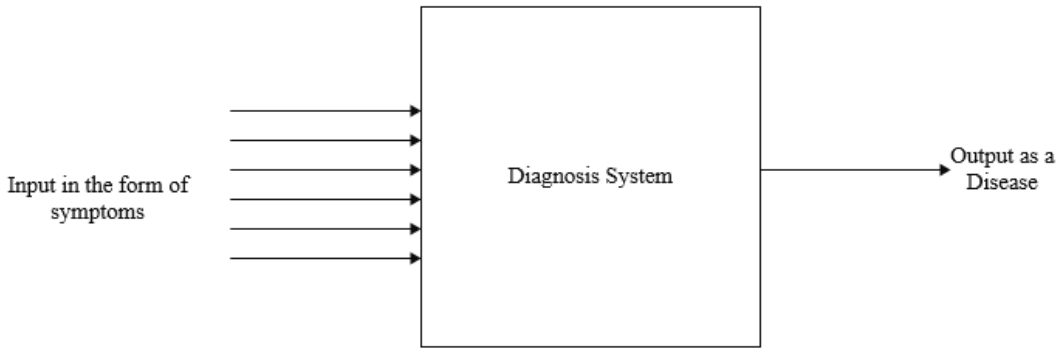

Figure 2.4: Medical Diagnosis System.

5. Vomiting
6. Dark Urine
7. Yellow Eyes
8. Cough
9. No Appetite
10. Chest Pain
11. Chills
12. Dehydration
13. Cramping.
14. Pain behind Eyes

The 6 outputs provided by the system are:

1. Viral Fever
2. Dengue Fever
3. Hepatitis
4. Tuberculosis
5. Malaria
6. Diarrhea

The system also contain [6]. membership Function Editor, Rule Viewer, Rule Editor and Surface Viewer .Memberships Functions editor [6], shows the range of a temperature set at 98 to 100 this means they are taking a values in which there is probability that a person can a diseases it is not accepting values for a fixed person. Fuzzy Rule Editor shows control Rules .Rules are created on the basis of input and output which system imposes e.g. If a patient is suffering from 104F temperature with severe headache, stomach pain, and cough then there is a possibility that a patient is having a Viral Fever so according to this situation system will give the output as Viral Fever. Rule Viewer shows whole roadmap for Fuzzy interface process. Surface Viewer shows the response of output with respect to input.

The diagnosis system can make the result of treatment more reasonable. System have been tested by user because of this, the system is supposed to be a reliable system. The system is user friendly and operated by user or patients without any expert person.

Viral Fever so according to this situation system will give the output as Viral Fever. Rule Viewer shows wsshole roadmap for Fuzzy interface Process. Surface Viewer shows the response of output with respect to input.

The medical diagnosis system can make the result of diagnosis and treatment scheme more reasonable. Humans have been applied to test the system. Because of this, the system really is supposed to be an efficient and trusted system. This system user friendly and most importantly can be utilized and operated by user or patients without any expert person.

Chapter 3

Requirement Specifications

3.1 Existing System

There are different researches and applications design for medical interpretation using Fl but all were about certain diseases with symptoms and there medication to that particular disease. In previous diagnosis systems the input was in the form of limited symptoms and output in the form of diseases matches with the particular symptoms. The existing system of some application also consists of condition for the prescribed medicine which is output of the system. Some other applications in existing system was helpful in drugs prescription, registering of patients as well as keeping of patient's records, but it was only for the common disease Malaria. Similarly all other previous application researches were implanted in the medical diagnosis system using fuzzy logic in different programing language such as Matlab , Visual prolog programming etc. The systems use fuzzy interface employed with the diseases, symptoms and medications. Previous proposed system was implemented with proposed algorithm that is fuzzy logic algorithm. The drawback of all existing and previous applications were they all were consists of limited amount of Fuzzy logic in the medical expert system there work was not much sufficient and portable. Requirements were specific and limited.

3.2 Proposed System

The application focuses on (FCM) construction model method and reasoning, with the foundation of the accumulated Medical Records Data. The methods will be used to construct analysis of the core prescription drugs using the Fuzzy Cognitive Map, and mining the core prescription drugs using FCM algorithm. We use fuzzy cognitive mapping to map the interaction between the medicines and food for multiple diseases. We use chemical formulas to show the interaction between the medicines for different diseases and decide which medicine is better for the patient with daily usage of food. We are also designing a database which include following fields; Diseases Medicine, food, active agent, Description (This field contain the detailed information of interaction between the medicine which is used to inform doctor) and solution (contain the solution of the problem which

is mention in the description).We apply Fuzzy Structure Query Language (FSQL) statements to the database that adds fuzzy features. FSQL statements include conditional statements, linguistics label, threshold etc. We apply FSQL statements to the following tables:

- Diseases contain fields (disease and medicines).
- Medicine interaction contain fields (multiple diseases and their medicines including active agent).
- Food contain fields (Multiple Diseases and their medicines including active agent, food intake).

Input to the system is multiple diseases of the patients and our system map the interaction of the multiple diseases through medicines. Our system tells the interaction between the medicines with their active agent. The output of the system is intake food, medicines with active agent or the description contain the detailed information of interaction between the medicines used to inform doctor if the patient have following symptoms which are mention in the hierarchical form and the solution is also available for those description.

3.3 Functional Requirements

3.3.1 Admin login Module

This module is for the Administrator to login to the entire system the very first person to log in to the system is admin. The admin will have its required user name and password. Admin is responsible for the maintainability or changeability of the system.

3.3.2 Login Module

The log in module is for doctor to login with its specific account. An authorized medical doctor need to log in in order to get required information feed within the system. An unauthorized person cannot access the system due do security issues. As the expert system is for medical doctors.

3.3.3 Register Module

This module consists for doctors to register a patient with the respective patient id and other relevant description with respect to the patient.

3.3.4 Patient Information Module

Patient information module is a very important module with respect to the system as with the help of this a doctor can get complete information about all patients. It consists of all patient's medical history and records of existing and new patient. It may consist of a diseases, medication or other medical record with respect to the particular patient a doctor wants to know so that a system may provide automatic prescription.

3.4 Non-functional Requirements

3.4.1 Usability

Interface of the system is very easy to understand and consistent. The medical expert doctor can easily use the system and can easily get access to the relevant information while designing the conformity is kept in mind for the user.

3.4.2 Time Saving

The system is time saving in the senses previously doctors or medical expert person feel difficulty to prescribed patient medicine it was quite time consuming but with the help of this system doctor can easily prescribed an automatic prescription to its patient with no time.

3.4.3 Consistency

The system is consistent which has been designed user friendly. All functionalities performed by the system are consistent.

3.4.4 Security

The system is secure like login and sign up account cannot be accessed by any other person it have been authorized from the web server that is developed with high security.

3.4.5 Maintainability

If any change and maintain of a system is required then admin is responsible for it .Admin make sure of every changeability and maintainability of a system.

3.4.6 Use Case Scenario

If a patient is suffering from more than one disease (multiple diseases) e.g. hypertension and rheumatoid arthritis. Sodium is not suitable for hypertensive patients which act as an active agent in the chemical composition of medicine of rheumatoid arthritis disease. For rheumatoid arthritis patient we have to give a medicine which used potassium instead of sodium as an active agent in their chemical composition. Therefore, we need an application which automatically suggest the medicines and Intake food, which has potassium and other related chemicals as show in figure 3.1.

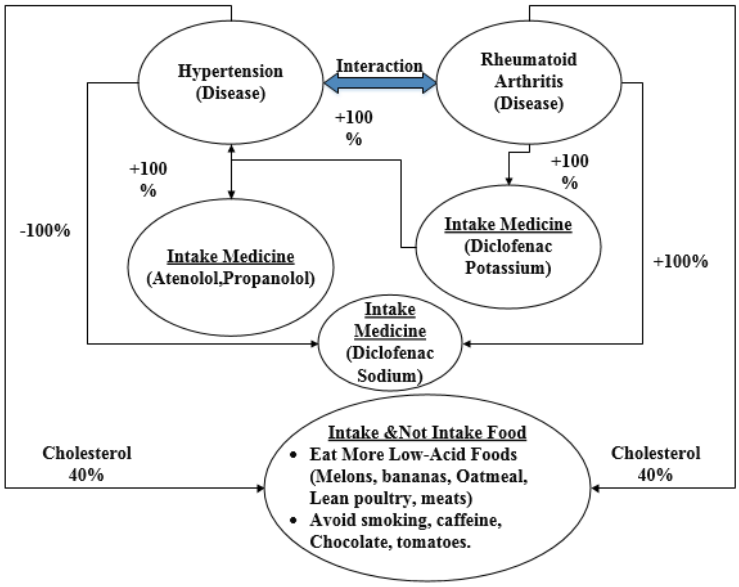

Figure 3.1: Use Case Senario

3.5 Use Cases

3.5.1 Use Case diagram

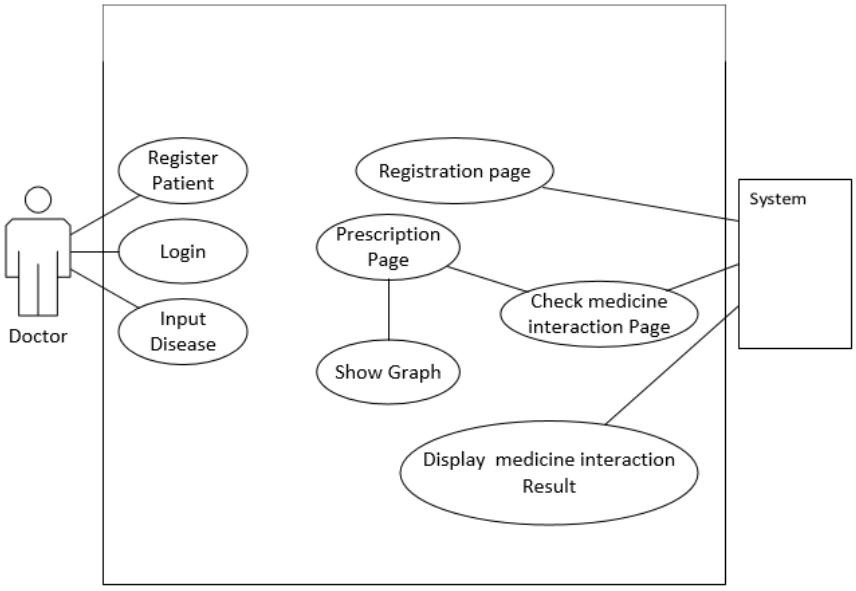

Figure 3.2: Doctor And Sytem Interaction Use Case

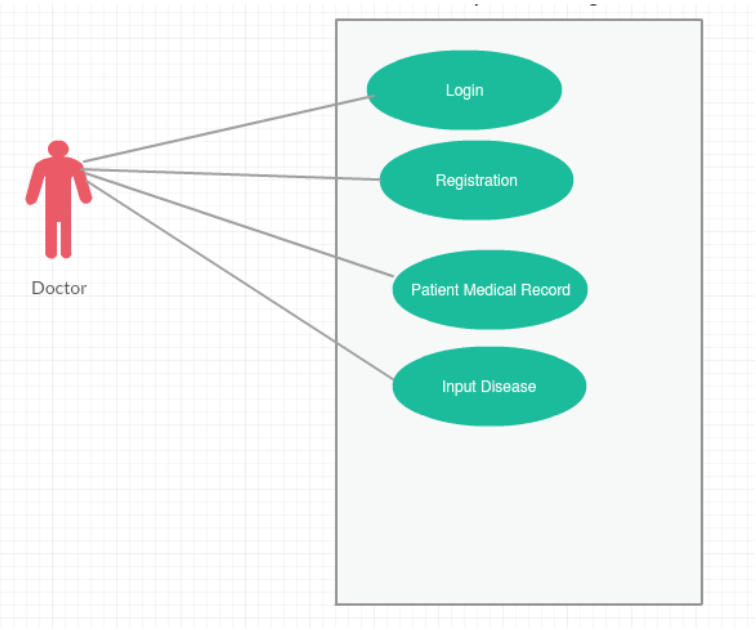

Figure 3.3: doctor usecase diagram

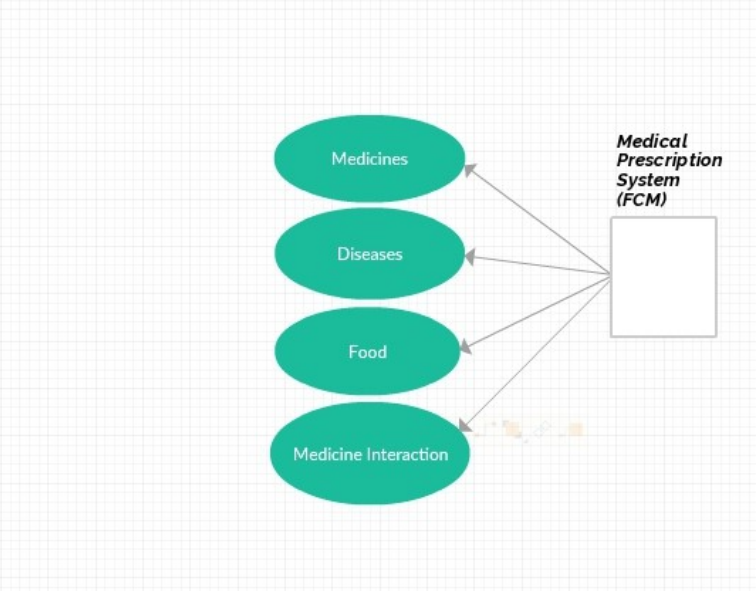

Figure 3.4: System Usecase diagram

In figure 3.2, 3.3 or 3.4 show the interaction of the user or doctor with the system. First doctor register the patient. After this doctor have to login with the system to access the system. When the doctor login successfully the "check medicine interaction page" will be open where the doctor input the diseases to check the interaction between the medicines and suggest nutrition. In result the system will go to the "Prescription Page" which show the medicine interaction details to the doctor. The Prescription page contain show graph button which show the threshold of the medicine (taken or not taken) and food (taken or not taken).

3.6 Use Case Specification

Following represent specification of use case diagram of the entire system. In Use Case table format as shown in figure 3.1, 3.2, 3.3 and 3.4.

Table 3.1: Log in

Use Case ID	UC-1
Title	Log in
Description	Doctor must login with its login account to check the required details feed in the system.
Primary Actor	Doctor
Pre-conditions	Enter username,disease and password
Post-conditions	Main screen of the respective panel will appear.

Table 3.2: Registration

Use Case ID	UC-2
Title	Registration
Description	This use case represents the registration procedure where the doctor will be able to register the patient(patient details also include genetic disease) in the system using his demographical data.
Primary Actor	Doctor
Pre-conditions	To get registered.
Post-conditions	The doctor will able to use the system after this.

Table 3.3: Patient Medical Record.

Use Case ID	UC-3
Title	Patient Medical Record.
Description	The record of the patient(all details) can be store into the database which are registered.
Primary Actor	Doctor
Pre-conditions	Patient should have patient id.
Post-conditions	The record will be stored in the table.

Table 3.4: Input Disease.

Use Case ID	UC-4
Title	Input Disease.
Description	Here doctor can input the disease which is present in the system and get all the information according to requirement of a disease.
Primary Actor	Doctor
Pre-conditions	Doctor must login in order to take further action.
Post-conditions	Information displayed.

Chapter 4

Design

Systems design defines the methodology, diagrams, descriptions for a system to satisfy required requirements. The high level design of the system is shown for the better understanding of the working of the system. The chapter have the following sections:

4.1 High Level Diagram

4.1.1 Medicine Interaction Flow Diagram

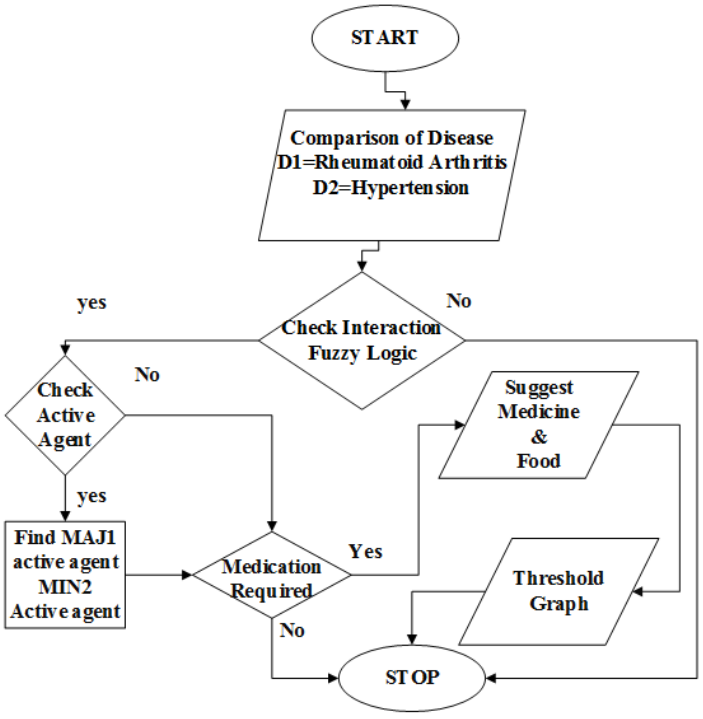

Figure 4.1: Medical Interaction Flow Chart

The figure 4.1 shows medicine interaction firstly it will start from shows comparison of any two diseases and we want to check interaction through fuzzy logic and our condition implies to yes then we will simply check active agent and if it's no then it will stop. Now let say if condition implies to yes then check active agent will flow into the condition that is find MAJ 1 active agent and MAJ 2 active agent then if medication is required and it implies the condition yes then suggest medicine and food will and threshold graph will be shown if it implies to no then the flow will be stop.

4.1.2 Context Diagram

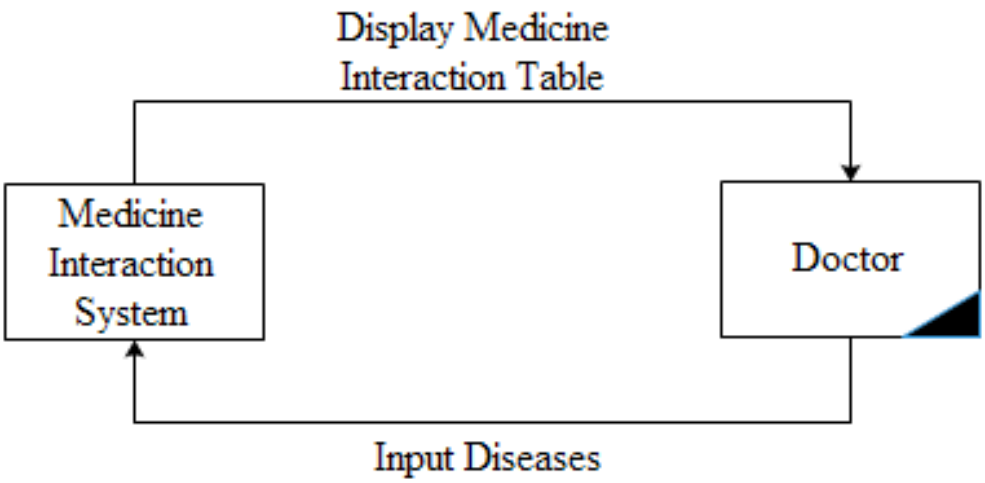

Figure 4.2: Context Diagram

The figure 4.2 shows context diagram of our system show one and only external entity that is doctor which implies to the system medicine interaction system. The input which will flow from medicine interaction system to doctor is display interaction table this will display interaction with respective medicines feed in the system and output from doctor to medicines interaction system as a result will be inform of input diseases.

4.1.2.1 Component Diagram

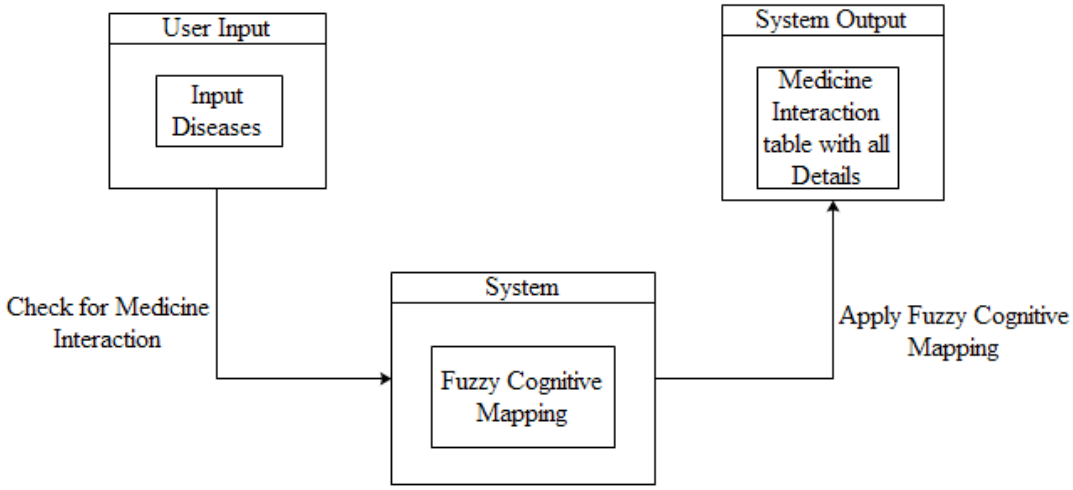

Figure 4.3: Component Diagram

The figure 4.3 shows a component diagram of the system in this there is a user input which contain input diseases which will go into the system which is fuzzy cognitive mapping the user input and system will have input that will go into the system is check for medicine interaction. Then fuzzy cognitive mapping will go into medicine interaction table with all details which is actually a system output which will then flow with apply fuzzy cognitive mapping.

4.1.2.2 Data Flow Diagram

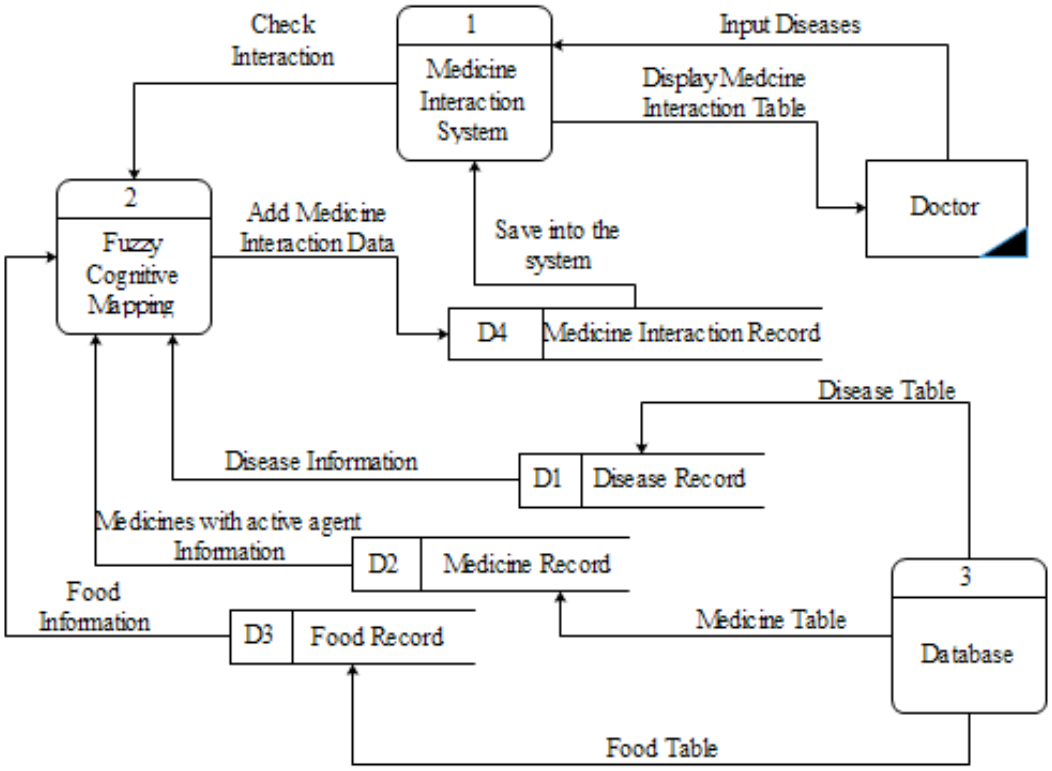

Figure 4.4: Data Flow Diagram

The figure 4.4 shows the flow diagram consists of one external entity doctor, two processes process 1 as medicine interaction system and process 2 fuzzy cognitive mapping and four data stores which is disease record, medicine record, food record and medicine interaction record. The process 1 medicine interaction system will go into process 2 fuzzy cognitive mapping as check interaction input process 1 with external entity doctor have same flow of input and output as show in the context diagram. Process 1 with data store D4 result in as output save into system. Now process 2 will flow with input add interaction data into data store D4 medicine interaction record but with process 2 it will result in output into D1, D2, D3 for D1 it will result in as disease information where information about all diseases will be show similar for D2 it will result as medicine with active agent information and at last with D3 it will result in food information.

4.1.3 Entity Relationship Diagram

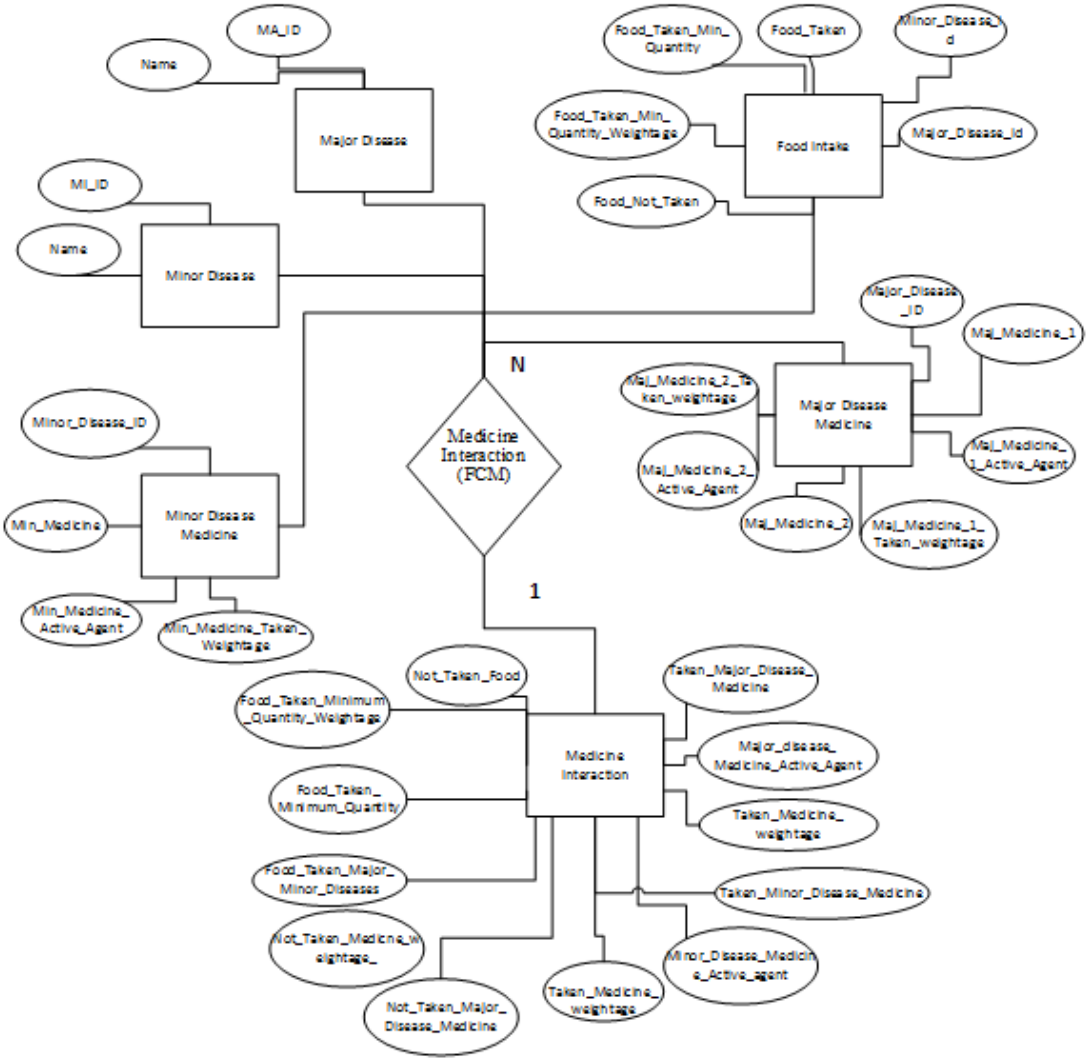

Figure 4.5: Entity Relationship Diagram

The above entity diagram shown in figure 4.5 consists of six entities Major disease medicine, Minor disease medicine Major diseases, Minor disease, food intake and medicine interaction and they all connected with one relationship in diamond symbol that is medicine interaction (FCM) .All entities share one to one relationship with medicine interaction. Entities contain their respective attributes as shown in the above figure 4.5.

4.1.4 Process Diagram

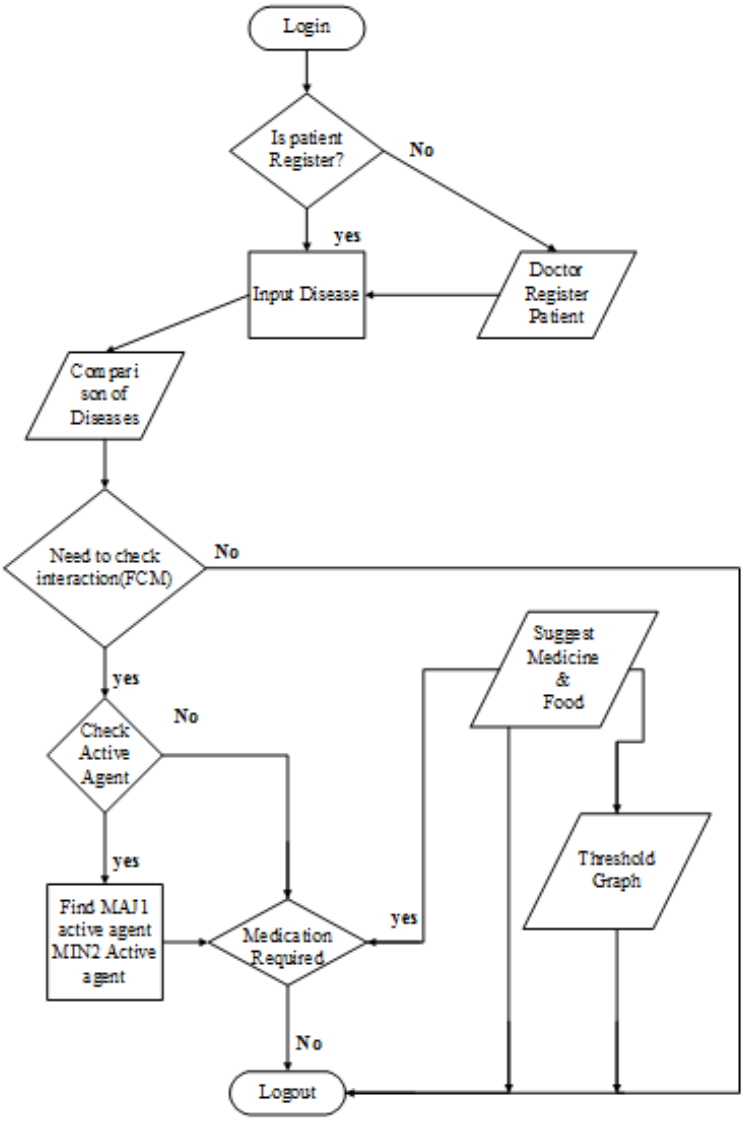

Figure 4.6: Process Diagram

The figure 4.6 represent a process diagram of the entire system .A process diagram represent step wise process of a system here first step is of input of system next step is of components of a system which is basically medicines, diseases, food and medicine interaction table then in next step which is step 3 Fuzzy Cognitive Mapping will be apply to the components and validation of it is in next step last step is if its yes then it will going to execute and if it's no then system need to check again .

Chapter 5

System Implementation

Implementation is the process of moving an idea from concept to reality.

System Architecture

The system architecture consists of fuzzy inference system as shown in the figure 5.1 below fuzzy inference system consists of three basic steps fuzzification, Rule evaluation and defuzification. The project is based on the fuzzification and rule evaluation by using fuzzy cognitive mapping algorithm (FCM).

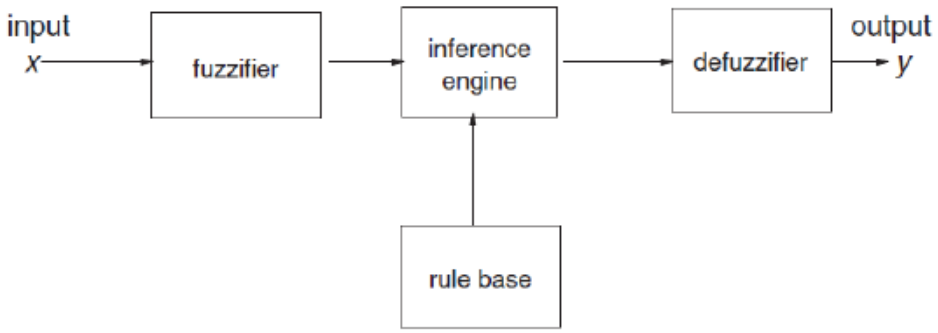

Figure 5.1: Fuzzy Inference System

5.1 Tool and Technologies

Tools and Technologies which were involved in implementing the project are defined below:

5.1.1 Visual Studio for Web based application asp.net.

A Visual Studio Web application is built around ASP.NET. It is a platform which include design-time objects, controls and a run-time execution context for developing and running applications on a Web server. We use .NET application based on Web which run on a Web server using WAMP server for Medical prescription using fuzzy logic. Visual Studio's Windows Forms are used in the Graphical User Interface (GUI) designing and Interacting with the users. Visual Studio supports different programming languages and Permits the debugger and compiler to effectively execute and diagnose any bugs. We use .Net framework for the development of Webpages. Visual Studio provides tools that make application development much faster, easier, and more reliable.

5.1.1.1 MySQL Databases.

We use FSQL databases to apply fuzzy cognitive mapping using SQL query such as SELECT, DELETE, UPDATE etc. operations. Fuzzy SQL query can be expressed as given below; SELECT attributes FROM sourceTableName WHERE condition. Create Table etc.

The result of applying FSQL QUERY is given in the form of table. Which is shown in the figure 5.2

dbo.Major_Disease_Medicine [Data]

Max Rows: 1000

MAJ_DISEASE_ID	MAJ_Medicine...	MAJ_Active_A...	MAJ_Medicine...	MAJ_Active_A...	MAJ_Medicine...	MAJ_Medicine...
MAJ1	Diclofenac Sodi...	Sodium	Diclofenac Pota...	Potassium	-100%	+100%
MAJ2	Xyrem	Sodium Oxybate	Provigil	Modafnil	-100%	+100%
MAJ3	Dulcolax	Bisacodyl	Amitiza	Lubiprostone	-100%	+100%
MAJ4	Omperazole	Magnesium	Zantac	Ranitidine Hydr...	-100%	+100%
MAJ5	Metformin	Metformin Hyd...	Victoza	Liraglutide	-100%	+100%
NULL	NULL	NULL	NULL	NULL	NULL	NULL

dbo.FoodIntakeTable [Data]

Max Rows: 1000

Major_Disease...	Minor_Disease...	Food_Taken	Food_Taken_...	Food_Taken_...	Food_Not_Tak...
MAJ1	MIN1	Low Acid Food(...	Cholestrol	+40%	Avoid(Alchoho...
MAJ2	MIN2	Light meals, wa...	Milk and carbo...	+30%	Starchy fruits a...
MAJ3	MIN3	Toast,banana, F...	soda crackers a...	+35%	Dairy products, ...
MAJ4	MIN4	Fruits and Low ...	Cholestrol	+30%	Alchohol Bever...
MAJ5	MIN5	Grains, fruits,ve...	Sugar	+20%	Juice, Dried Fru...
NULL	NULL	NULL	NULL	NULL	NULL

dbo.Min_Disease_Medicine [Data]

Max Rows: 1000

Min_Disease_ID	Min_Medicine	Min_Active_A...	Min_Medicine...
MIN1	Tenormin	Atenolol	+100%
MIN2	Dramamine	Dimenhydrinate	+100%
MIN3	Ondansetron	Ondansetron H...	+100%
MIN4	Xanax	Alprazolam	+100%
MIN5	Phenylephrine	Phenylephrine ...	+100%
NULL	NULL	NULL	NULL

Figure 5.2: Result of Fuzzy Querry

5.1.2 Application Startup

Application consists of main menu of the application which contain certain description about the system as shown in figure 5.3.

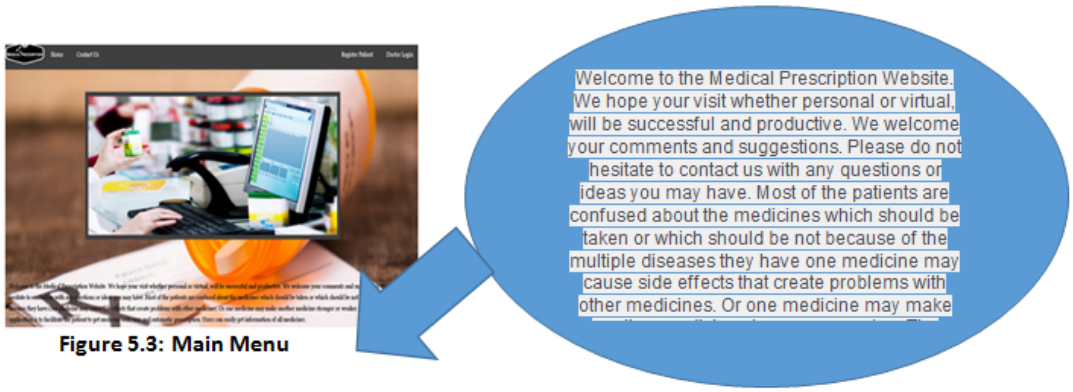

Figure 5.3: Main Menu

Doctor Module: Doctor Module is where doctor will login and will make registration of a patient shown in figure 5.4 and 5.5.

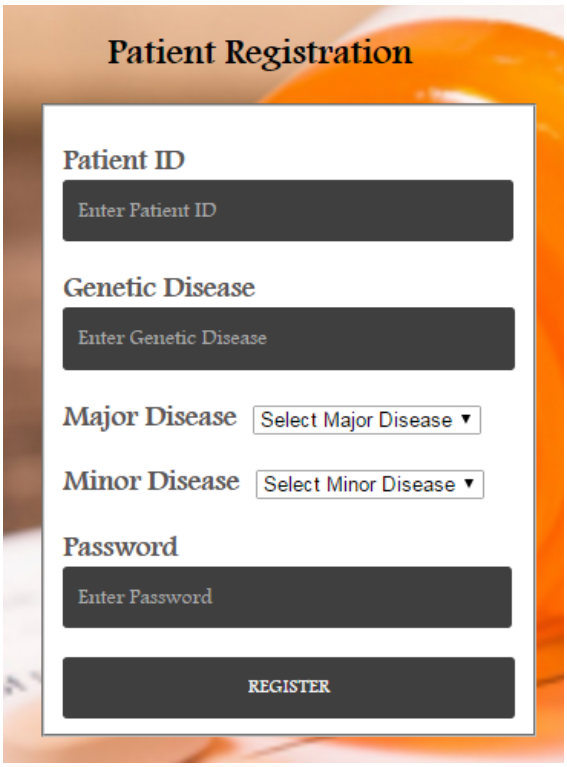

Figure 5.4: Patient Registration

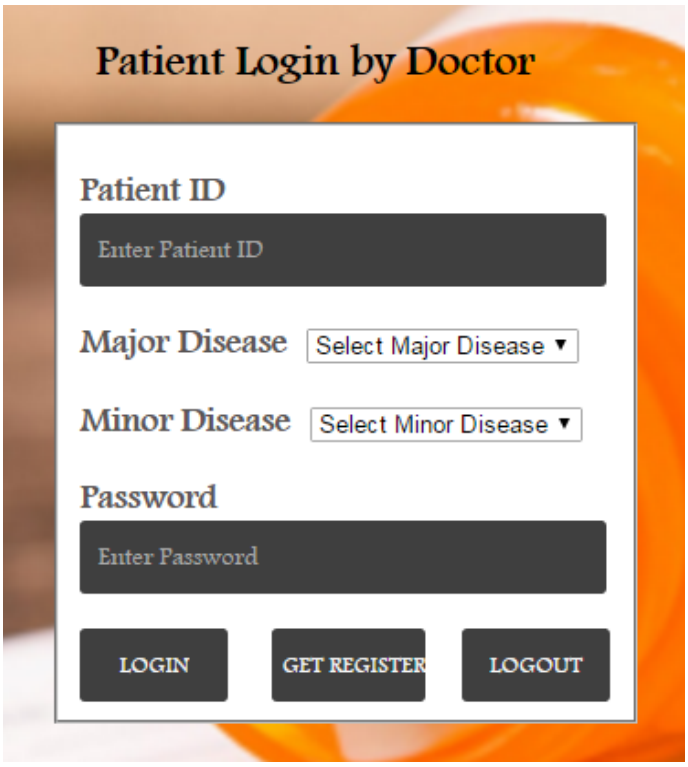

Figure 5.5: Patient Login by Doctor

Contact Us Page: Application also consists of contact us page where user can give the feedback about the application as shown in figure 5.6.

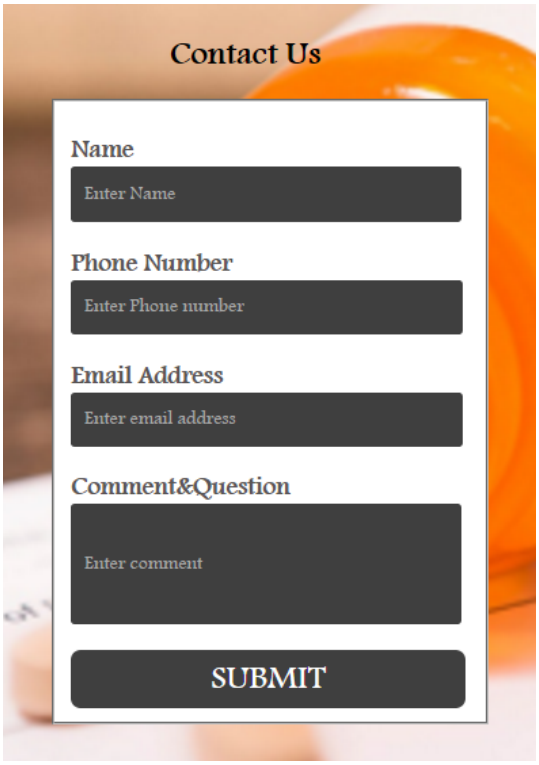

Figure 5.6: Contact Us

Admin Module: Admin is responsible about changeability of the system administrator has the right to add delete and update major and minor disease record as shown in figure 5.7, 5.8, 5.9, 5.10, 5.11 and 5.12.

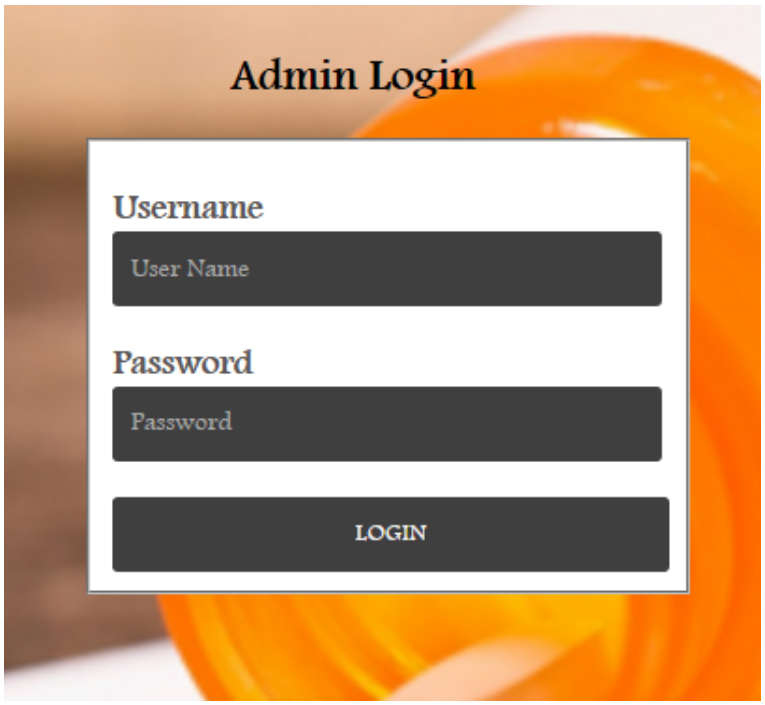

Figure 5.7: Admin Login

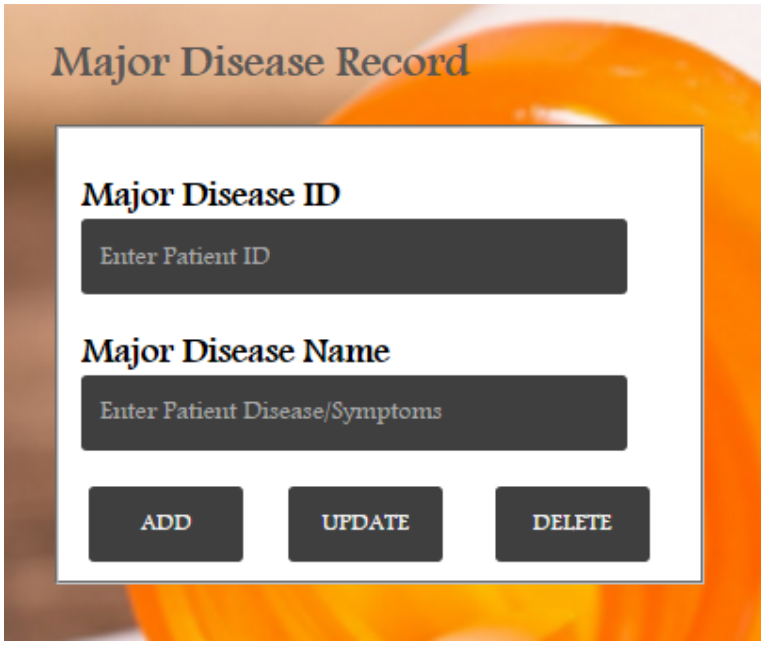

Figure 5.8: Major Disease Record

Figure 5.9: Minor Disease Record

Figure 5.10: Major Disease Medicine Record

Figure 5.11: Minor Disease Medicine Record

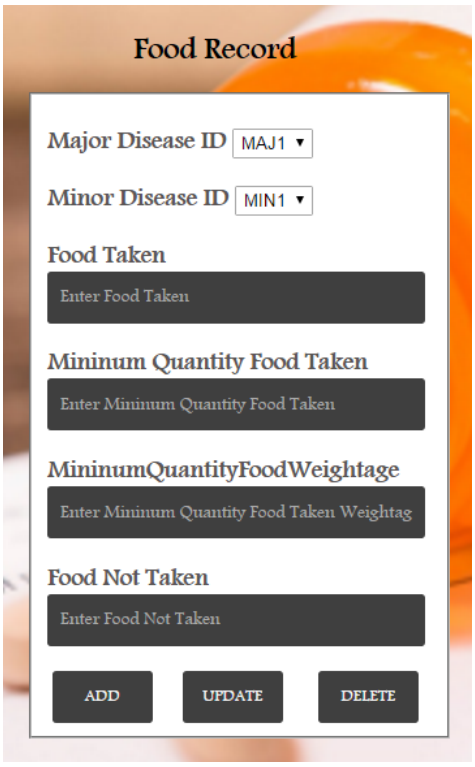

Figure 5.12: Food Record

5.1.3 Fuzzification.

The very first step of fuzzy inference system is fuzzification. The fuzzy sets for the indicators, and the output of each disease along with the membership function defined in fuzzification. In the above figure 5.13 Red bar show (the percentage of medicine not taken for major disease) Blue bar show (the percentage of medicine taken for major or minor disease) Yellow bar show (food taken with minimum quantity)

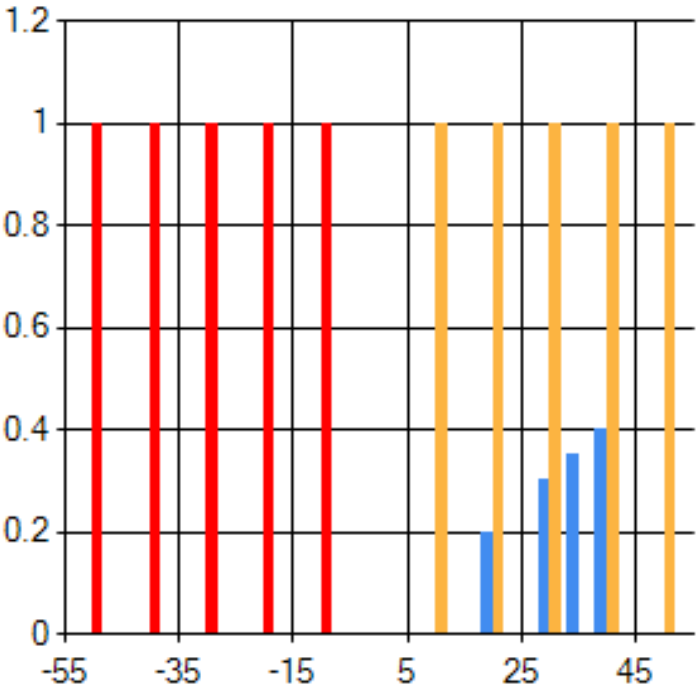

Figure 5.13: Membership Function

5.1.4 Rule Evaluation.

Rule Evaluation is a process of evaluating rules in the form of IF/Then rules .It consists of Antecedent and Consequent .Antecedent is if part which is input of the system and consequent is then part which is output of the system. For medical prescription using fuzzy logic 5 rules have been applied which are as follow.

5.1.5 RULE 1:

If (Major_Disease is Rheumatoid Arthirits) AND (Minor -Disease is hypertension)
THEN
Taken_Major _Med is Diclofenec Potassium
AND
Active agent of Maj_Med is potassium

AND
Taken_Weightage is +100%
AND
Minor_Med is Tenormin
AND
Active agent of Minor_Med is Atenolol
AND
Taken_Weightage is +100%
AND
Medicine_Not_Taken_for_Major_Disease is Diclofenac Sodium
AND
Not _taken_Weightage is -100%
AND
Food_Intake_for_major_minor is attribute food$_t akenvalue(lowacidfood....)$
AND
FoodNotTakenisAvoidAlcholic...
AND
Food_Taken_with_minimum_quantityisCholestrol
AND
Food_Taken_with_minimum_quantity_weightageis + 40%

5.1.6 RULE 2:

If (Major_Disease is Narcolepsy)AND (Minor$_D iseaseisMotionSickness$)
THE
Taken_Major_MedisProvigil
AND
ActiveagentofMaj_MedisModafnil
AND
Taken_Weightageis + 100%
AND
Minor_MedisDramamine
AND
ActiveagentofMinor$_M$edisDimenhydrinate
AND
Taken_Weightageis + 100%
AND
Medicine_Not_Taken_for_Major_DiseaseisXyrem
AND
Not_taken_Weightageis − 100%

AND
$Food\_Intake\_for\_major\_minorisattributefood\_takenvalue(Lightmeals, water, Greenvegetables, gingerale.)$
AND
$FoodNotTakenisStarchyfruitsandvegetables, GrainsandSugar.$
AND
$Food\_Taken\_with\_minimum\_quantityisMilkandcarbonatedsodas$
AND
$Food\_Taken\_with\_minimum\_quantity\_weightageis + 30\%$

5.1.7 RULE 3:

If (Major_Disease is Constipation)AND ($Minor_Diseaseis Gastroenteritis$)
THEN
$Taken\_Major\_MedisAmitiza$
AND
$Activeagentof Maj\_MedisLubiprostone$
AND
$Taken\_Weightageis + 100\%$
AND
$Minor\_MedisOndansetron$
AND
$ActiveagentofMinor\_MedisOndansetronHydrochloride$
AND
$Taken\_Weightageis + 100\%$
AND
$Medicine\_Not\_Taken\_for\_Major\_DiseaseisDulcolax$
AND
$Not\_taken\_Weightageis - 100\%$
AND
$Food\_Intake\_for\_major\_minorisattributefood\_takenvalue(Toast, banana,$
$Fiber - RichFoods, Beans, DriedFruit$
AND
$FoodNotTakenisDairyproducts, caffeine, alcohol, nicotine$
AND
$Food\_Taken\_with\_minimum\_quantityissodacrackersandBroccoli$
AND
$Food\_Taken\_with\_minimum\_quantity\_weightageis + 35\%$

5.1.8 RULE 4:

If (Major_Disease is Heartburn)AND (Minor_Disease is Panic Disorder)
THEN
Taken_Major _Med is Zantac
AND
Active agent of Maj_Med is Ranitidine Hydrochloride
AND
Taken_Weightage is +100AND
Minor_Med is Xanax
AND
Active agent of Minor$_{M}edisAlprazolam$
AND
$Taken\_Weightageis + 100AND$
$Medicine\_Not\_Taken\_for\_Major\_DiseaseisOmperazole$
AND
$Not\_taken\_Weightageis - 100AND$
$Food\_Intake\_for\_major\_minorisattributefood_takenvalue(FruitsandLowacidFood)$
AND
$FoodNotTakenisAlchoholBeverges, nicotine$
AND
$Food\_Taken\_with\_minimum\_quantityisCholestrol$
AND
$Food\_Taken\_with\_minimum\_quantity_weightageis + 30\%$

5.1.9 RULE 5:

If (Major_Disease is Diabetes)AND (Minor_Disease is Nasal Congestion)
THEN
Taken_Major _Med is Victoza
AND
Active agent of Maj_Med is Liraglutide
AND
Taken_Weightage is +100%
AND
Minor_Med is Phenylephrine AND
Active agent of Minor_Med is Phenylephrine Hydrochloride AND
Taken_Weightage is +100AND
Medicine_Not_Taken_for_Major_Disease is Metformin AND
Not _taken _Weightage is -100AND

Food_Intake_for_major_minor is attribute food_taken value(Grains,fruits,veggies,lean protein)
AND
Food Not Taken is Juice, Dried Fruit, White Rice, Bread,Flour
AND
Food_Taken_with_minimum_quantity is Sugar
AND
Food_Taken_with_minimum_quantity_weightage is +20

When Rule 1 is applied it shows the following results when doctor enter corresponding Major and Minor diseases. The other rules are also the same as Rule 1 as shown in figure:

Figure 5.14: Medicine Interaction

Figure 5.15: Prescription

Chapter 6

System Testing and Evaluation

6.1 Chapter Overview

Software testing is an essential part to check and to evaluate the performance of any system. Testing is a process of planning, preparation and measuring aimed at establishing the characteristics of an information system and demonstrating the difference between the actual and the desired results. Testing is a process where a complete software system is tested. The idea of it is to make sure the software functions before it will go into production, but it also means making sure the software is spontaneous and user friendly. This chapters consists of different types of software testing methods in order to test our system.

6.2 Software Testing Techniques

There are several testing strategies in regard to the system testing process. They are divided into four steps:

1. Function Testing
2. Performance Testing
3. Acceptance Testing
4. Installation Testing

The following are different types of testing that should be considered during System testing:

6.2.1 Graphical User Interface (GUI) Testing

Graphical user interface testing is an important aspect of any system. It is basically how a user interacts with the system. GUI explains an user how to use the system in a sufficient manner. It should be easy and simple to use so every common user could easily and efficiently interact with the system. Graphical user interface consists of different buttons, icons, menus, colors and metaphors.

The user of our system is a doctor which interacts with the system by logging into the system with its logging id and password.

6.2.2 Usability Testing

It is a way of to see how it is easy to use the system components by testing it with respect to real users. Usability is difficult to evaluate and measure as it is with respect to user but still can be evaluate using certain parameters like time to learn, speed of performance, skills to use the software, subjective satisfaction etc. It is practical implementation of Human Computer Interaction (HCI). Our System have been used by the user and he/she hardly find any bug or error in the system, was easy to handle and felt quite satisfied using our system. The feedback was good and satisfactory for us.

6.2.3 Software performance Testing

It is a testing that is performed to determine how system performs under a particular workload. Performance testing can serve different purposes. It demonstrate that the system meets criteria of a system being performed. It is difficult to cost performance of a new system that performance test efforts begin at the inception of the development project. The performance of our system was quite satisfactory for the user.

6.2.3.1 Compatibility testing

Compatibility testing is a process to ensure that system run on different operating system and is compatible with different versions of windows operating system. Our system is developed on visual studio for web based application using ASP.net which is compatible with different version of windows. Our project is designed to run on windows operating system which includes windows XP7810 etc.

6.2.3.2 Exception handling

Exception Handling is important in system evaluation and testing. The system can through exceptions in order to avoid that we did exceptional handling on interaction checker like if doctor enter wrong major and minor disease or any other irrelevant information than it will display an error message on screen.

6.2.4 Load testing

Load testing test behavior of the system under certain conditions. It is performed to determine different conditions and system's performance under load. Our system show certain diseases and their interaction it is feed with limited amount of diseases. The data is limited so the system may not get overload.

6.2.5 Security testing

Security tests ensure that the security requirements are met. We test system characteristics related to availability, integrity, and confidentiality of data and services. Security test was conducted efficiently in our system.

6.2.6 Functional Testing

In functional testing "Functions are tested by feeding inputs to get outputs". Test case 01, 02, 03 and 05 have been testing in this.

6.2.6.1 Unit Testing

Testing the individual programs as they are written. Typically occurs with access to the code. Unit testing in this took place by testing each component occurs within the access to our code. IF/Then rules were tested here.

6.2.7 Integration Testing

Integration testing is process of verification of the interaction between system components. Integration testing ore mainly of two types such as top-down or bottom-up, are used with, ordinarily and hierarchically strategies which are architecture driven, which implies integrating the software components or subsystems based on identified functional aspects. In this FCM algorithm integrity was check with respect to system components.

6.2.8 System Testing

System testing is concerned with the behavior of a whole system. "Testing of group of programs". Our system went through system testing and the output was according to the requirements declared with respect to the respective input. In This Rules were tested in correspondence to the input of the system.

6.2.9 White Box Testing (Glass Box Testing)

White Box Testing is also known as Glass Box Testing or clear box testing check the productivity of a program, the provided input makes the conformation of the structural specification of the program. In our thesis project testing is done with the aspect of the code which is used to execute certain functionality. The design phase of the project was tested.

6.2.10 Black Box Testing

Black Box which is also known as concrete box used to test the specifications of the interface between device and application circuit is tested with respect to hardware. It test the functionality of our system.

6.2.11 Acceptance Testing

Acceptance testing is defined as “Testing to verify the working of program for implementation or use”.For our system the acceptance testing criteria is to apply Fcm algorithm on medicines and it’s interaction so this was successfully applied and the system fulfill the requirements completely. Test case 01 have been tested.

6.2.12 Installation Testing

The final round of testing involves installing the system at user sites. Installation testing is carried out to check whether the application is installed on the system for which it is developed successfully. The application is tested on different platforms and it is insured that any major issue do not occur while application is run on different platforms that can be different versions of windows.. The customer was satisfied with the results, testing is complete and the system is formally delivered. It was successfully took place.

6.2.12.1 Test Cases

Table 6.1: TC_01: Medicine InteractionTC_1

Test Case ID	TC_01
Unit of Test	Medicine interaction
Steps to be executed	Enter Major Disease and Minor Disease
Expected Result	Medicine interact
Actual Result	Major disease and Minor disease interact
Testing Technique	6.2.9 Acceptance Testing and 6.2.8 Functional testing have been applied to the medicines and its interaction using (FCM) algorithm.
Status	Pass

Above table 6.1 shows medicine interaction of major and minor disease input major and minor disease is entered by the doctor in system then it shows the interaction of that particular diseases medicine that may interact.

Table 6.2: TC_02: Food Interaction TC_2

Test Case ID	TC_02
Unit of Test	Food Interaction
Steps to be executed	Enter Major Disease and Minor Disease
Expected Result	Food Taken for the diseases.
Actual Result	Food to avoid
Testing Technique	6.2.8 Functional testing and its types were applied on food.
Status	Pass

The table 6.2 it shows food interaction its shows food to be taken and food to be avoid when the particular food interact.

Table 6.3: TC_03: Active AgentTC_3

Test Case ID	TC_03
Unit of Test	Active Agent
Steps to be executed	Enter Major Disease and Minor Disease
Expected Result	Major and Minor diseases active agent.
Actual Result	Active Agent to be taken for the particular disease interact.
Testing Technique	6.2.8 Functional testing technique have been applied to check which medicine act as an act agent.
Status	Pass

Active agent shown in the table 6.3 is about active agent of major minor disease .It shows which active agent to be taken when the particular disease interact.

Table 6.4: TC_04: Interaction Checker TC_4

Test Case ID	TC_04
Unit of Test	Interaction Checker
Steps to be executed	Enter Major Disease and Minor Disease
Expected Result	Interaction Table shown
Actual Result	Prescription to be made on the basis of interaction table. Prescription to be made on the basis of interaction table.
Testing Technique	6.2.5Exception handling have been done on interaction checker if doctor enter wrong major minor disease then it will through exceptions.
Status	Pass

Above table 6.4 Interaction checker show the main interaction table which may consist of the output of the system on the basis of the interaction checker table prescription is made.

Table 6.5: TC_05: Weightage TC_5

Test Case ID	TC_05
Unit of Test	Weightage
Steps to be executed	Enter Major Disease and Minor Disease
Expected Result	Weightage to be taken
Actual Result	Weightage percentage
Testing Technique	6.2.8 Functional testing technique have been applied to check minimum quantity food taken.
Status	Pass

Table 6.5 weightage consist of weightage to be taken it shows percentage weightage required when particular interaction of major minor disease take place.

Chapter 7

Conclusions

7.1 Overview

In conclusion, the proposed Medical prescription using Fuzzy logic is implemented successfully. FCM algorithm is applied efficiently. The system input as major and minor diseases and gives the output as food, medicine, weightage and active agent. We use Fuzzy logic algorithm (FCM) we do fuzzification and apply 5 basic rules which is implemented successfully. Rules which is applied gives the output in form of tables as food, medicine, active agent etc. This application is predicated on fuzzy cognitive map that is employed to construct analysis of the core prescribed drugs and mine the core prescribed drugs. The medical prescription can make the prescription easy and efficient to use hence it can easily utilized by doctors or medical expert with the use of this system doctor can easily prescribed drugs to the patients. System is safe and user friendly.

7.2 Major Accomplishment

One of the major difficulty which we feel was to apply fuzzy sets and to make membership function but with continues self-study, tutorials and researches we managed to apply it successfully. We design the application to automate the prescription and to ease the doctor which we think we did it successfully our continuous effort and hard work paid off.

7.3 Limitations and Enhancements

This system has certain limitations which should be kept in mind while the user is using the system. The limitation of this system are that it only check the interaction for five major and five minor diseases. By consulting certain pharmaceuticals and other drugs website system can be enhance with more diseases. System enhancements can be done but now this system is restricted with 10 disease in total.

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