INT246 – SOFT COMPUTING TECHNIUES

PROJECT REPORT

Name	Registration No.	Roll No.
Satyam Shandilya	11917942	RKM025B82
Utkarsh Kumar	11917830	RKM025A41

TOPIC

Modeling and Diagnosis of Typhoid Fever Using a Fuzzy Logic Controlled Inference System

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Typhoid

Typhoid is a bacterial infection that can lead to a high fever, diarrhea, and vomiting. It can be fatal. It is caused by the bacteria Salmonella typhi. The infection is often passed on through contaminated food and drinking water, and it is more prevalent in places where handwashing is less frequent. It can also be passed on by carriers who do not know they carry the bacteria. Globally, around 21.5 million people a year contract typhoid.

If untreated, around 1 in 5 cases of typhoid can be fatal. With treatment, fewer than 4 in 100 cases are fatal. According to the World Health Organization (WHO), typhoid and paratyphoid fever are now most commonly found in Southeast Asia and sub-Saharan Africa. On a worldwide scale, the occurrence of typhoid and paratyphoid fever reduced dramatically through the twentieth century. This was partly due to improved access to clean water and sanitation and to better understanding of hygiene. It was also due to the discovery of antibiotics which can treat the disease.

Symptoms of typhoid fever

The incubation period is the time from ingesting the germs (bacteria) until the time you actually start to feel ill. It depends on how many bacteria you have swallowed. It is usually between seven and fourteen days, but can be as short as three days, or as long as 30 days.

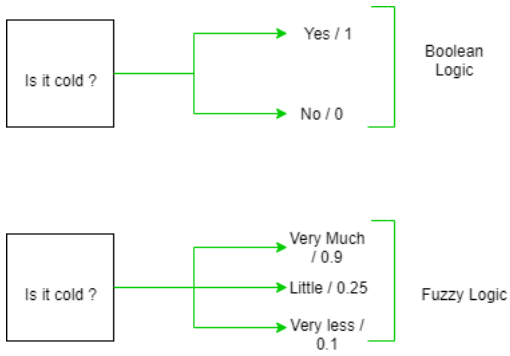
- Raised temperature (fever) and headache are the most common symptoms. Typically, the temperature increases gradually day by day during the first week. People usually experience raised temperature mostly in the evenings.
- Vomiting
- Dizziness
- Loss of appetite
- Jaundice
- Joint Pain
- Feeling sick (nausea)
- Body Weakness

These prompted for the development of a typhoid diagnosis system that can be used by anyone of average intelligence as this will assist in quick diagnosis of the disease despite shortage of health institutions and medical experts. A fuzzy logic technique was used on the labeled set of typhoid fever conditional variables to generate explainable rules for the diagnosis of typhoid fever. The fuzzy systems are designed for modeling the available knowledge and thinking process of medical practitioners. In recent years there were many methods proposed for the generation of fuzzy rules presented a method for inducing fuzzy rules and membership functions from training instances to deal with the data classification problem. They discussed the effect of merging order on performance of fuzzy rules induction.

Fuzzy Logic

The term fuzzy refers to things that are not clear or are vague. In the real world many times we encounter a situation when we can't determine whether the state is true or false, their fuzzy logic provides very valuable flexibility for reasoning. In this way, we can consider the inaccuracies and uncertainties of any situation.

In the Boolean system truth value, 1.0 represents the absolute truth value and 0.0 represents the absolute false value. But in the fuzzy system, there is no logic for the absolute truth and absolute false value. But in fuzzy logic, there is an intermediate value too present which is partially true and partially false.

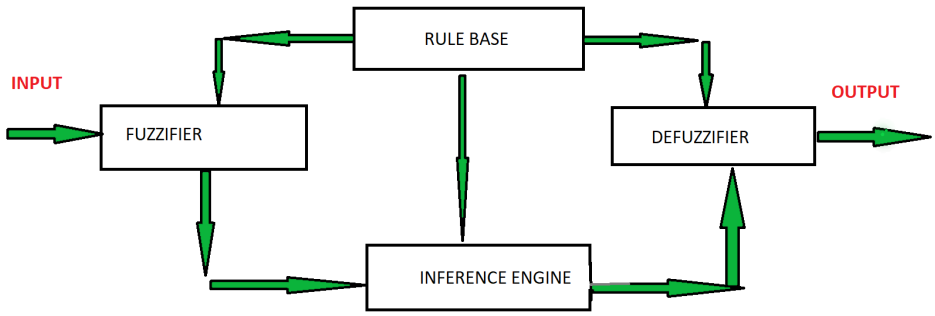


Its Architecture contains four parts :

- RULE BASE: It contains the set of rules and the IF-THEN conditions provided by the experts to govern the decision-making system, on the basis of linguistic information. Recent developments in fuzzy theory offer several effective methods for the design and

tuning of fuzzy controllers. Most of these developments reduce the number of fuzzy rules.

- FUZZIFICATION: It is used to convert inputs i.e. crisp numbers into fuzzy sets. Crisp inputs are basically the exact inputs measured by sensors and passed into the control system for processing, such as temperature, pressure, rpm's, etc.
- INFERENCE ENGINE: It determines the matching degree of the current fuzzy input with respect to each rule and decides which rules are to be fired according to the input field. Next, the fired rules are combined to form the control actions.
- DEFUZZIFICATION: It is used to convert the fuzzy sets obtained by the inference engine into a crisp value. There are several defuzzification methods available and the best-suited one is used with a specific expert system to reduce the error.



FUZZY LOGIC ARCHITECTURE

Data Set of the Project

Data set for this project is self-created with the random data. Data of 50 patients is generated randomly with the symptoms as indexes of the data. Total 9 symptoms are considered in creating the data which are Fever, Headache, Nausea, Vomiting, Jaundice, Joint Pain, Body Weakness, Dizziness, Loss of Appetite. The data is the associated degree of intensity of a particular symptoms between 1 to 10. Degree of intensity is further divided into 4 different classes i.e., Mild, Moderate, Severe and Very Severe. 1 to 3 is considered as Mild, 2 to 5 is considered as Moderate, 4 to 8 is considered as Severe and 7 to 10 is considered as Very Severe.

Attribute Symptoms	Symbols
Fever	FVR
Headache	HDE
Nausea	NUA
Vomiting	VOM
Jaundice	JDE
Joint Pain	JPN
Body Weakness	BWS
Dizziness	DZS
Loss of Appetite	LAE

Linguistic Variable	Fuzzy Value
Mild	$1 \le x \le 3$
Moderate	$2 \le x \le 5$
Severe	$4 \le x \le 8$
Very Severe	$7 \le x \le 10$

$$\mu_{mild} = \begin{cases} 0 & \text{if } x < 1 \\ \frac{3 - x.}{3-1} & \text{if } 1 \le x \le 3 \\ 0 & \text{if } x \ge 3 \end{cases}$$

$$\mu_{moderate.} = \begin{cases} 0 & \text{if } x < 2 \\ \frac{x - 2.}{3-2} & \text{if } 2 \le x \le 3 \\ 1 & \text{if } 3 \le x \le 4 \\ \frac{5 - x.}{5-4} & \text{if } 4 \le x \le 5 \\ 0 & \text{if } x > 5 \end{cases}$$

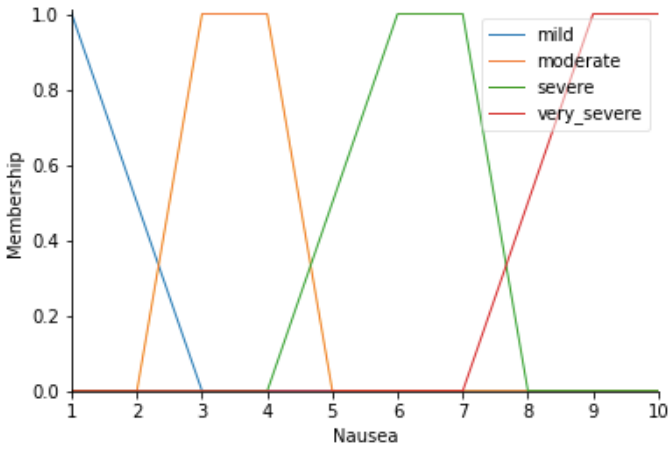
$$\mu_{severe} = \begin{cases} 0 & \text{if } x < 4 \\ \frac{x - 4.}{6-4} & \text{if } 4 \le x \le 6 \\ 1 & \text{if } 6 \le x \le 7 \\ \frac{8 - x.}{8-7} & \text{if } 7 \le x \le 8 \\ 0 & \text{if } x > 8 \end{cases}$$

$$\mu_{Very.severe} = \begin{cases} 0 & \text{if } x < 7 \\ \frac{x - 7.}{9-7} & \text{if } 7 \le x \le 9 \\ 1 & \text{if } 9 \le x \le 10 \\ 0 & \text{if } x > 10 \end{cases}$$

Membership Function of any value (X)

```
df=pd.DataFrame({'FVR':np.random.randint(96,104,50),
                 'HDE':np.random.randint(1,11,50),
                 'NAU':np.random.randint(1,11,50),
                 'VOM':np.random.randint(1,11,50),
                 'JDE':np.random.randint(1,11,50),
                 'JPN':np.random.randint(1,11,50),
                 'BWS':np.random.randint(1,11,50),
                 'DZS':np.random.randint(1,11,50),
                 'LAE':np.random.randint(1,11,50)})
df.index = np.arange(1, len(df)+1)
print(df)
```

	FVR	HDE	NAU	VOM	JDE	JPN	BWS	DZS	LAE
1	102	10	2	1	3	5	8	9	5
2	103	9	1	4	2	8	3	5	7
3	102	9	4	6	8	4	8	7	3
4	103	1	1	7	1	5	10	1	3
5	96	9	9	4	10	10	9	8	3
6	98	9	4	10	5	7	6	1	2
7	100	4	9	7	5	9	8	6	10
8	103	8	8	9	9	8	7	5	10
9	101	3	9	6	2	1	3	9	6
10	100	4	7	4	5	7	2	2	8
11	102	3	6	3	4	3	7	9	7
12	99	4	7	4	6	5	1	3	8
13	98	1	9	10	10	6	8	6	7
14	96	10	1	8	10	8	5	4	4
15	98	3	1	4	3	1	1	6	10
16	97	4	2	6	10	5	9	5	9
17	98	2	9	8	10	9	3	8	4
18	101	2	10	2	1	1	1	10	2
19	102	7	5	3	2	5	7	7	1
20	101	6	3	10	5	8	3	9	3
21	101	1	5	10	2	5	9	4	7
22	100	10	6	7	2	4	4	9	9
23	100	4	5	9	2	2	10	10	2
24	98	6	10	7	10	4	5	6	3
25	97	3	2	2	3	2	7	6	7



Algorithm for fuzzy logic

The developed algorithm for the fuzzy diagnostic process of typhoid fever is:

Step 1: - Input all the symptoms shown in a patient.

Step 2: - Determine the degree of intensity of a particular symptom in the range of 0 to 10.

Step 3: - Categorize the given degree of intensity for any particular symptom into 4 different class.

Linguistic Variable	Fuzzy Value
Mild	$1 \leq x \leq 3$
Moderate	$2 \leq x \leq 5$
Severe	$4 \leq x \leq 8$
Very Severe	$7 \leq x \leq 10$

Step 4: Apply fuzzy rules.

Step 5: Map fuzzy inputs into their respective weighing factors to determine their degree of membership.

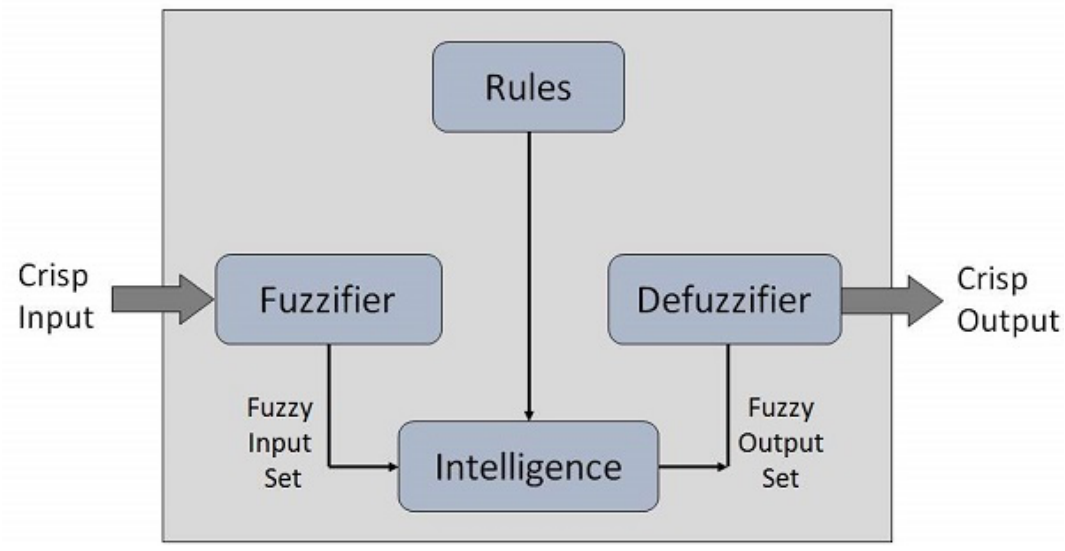
Step 6: Determine the rule base evaluating (non-minimum values).

Step 7: Determine the firing strength of the rules R.

Step 8: Calculate the degree of truth R, of each rule by evaluating the nonzero minimum value.

Step 9: Compute the intensity of the disease.

Step 10: Output fuzzy diagnosis.



Rules of the Fuzzy System

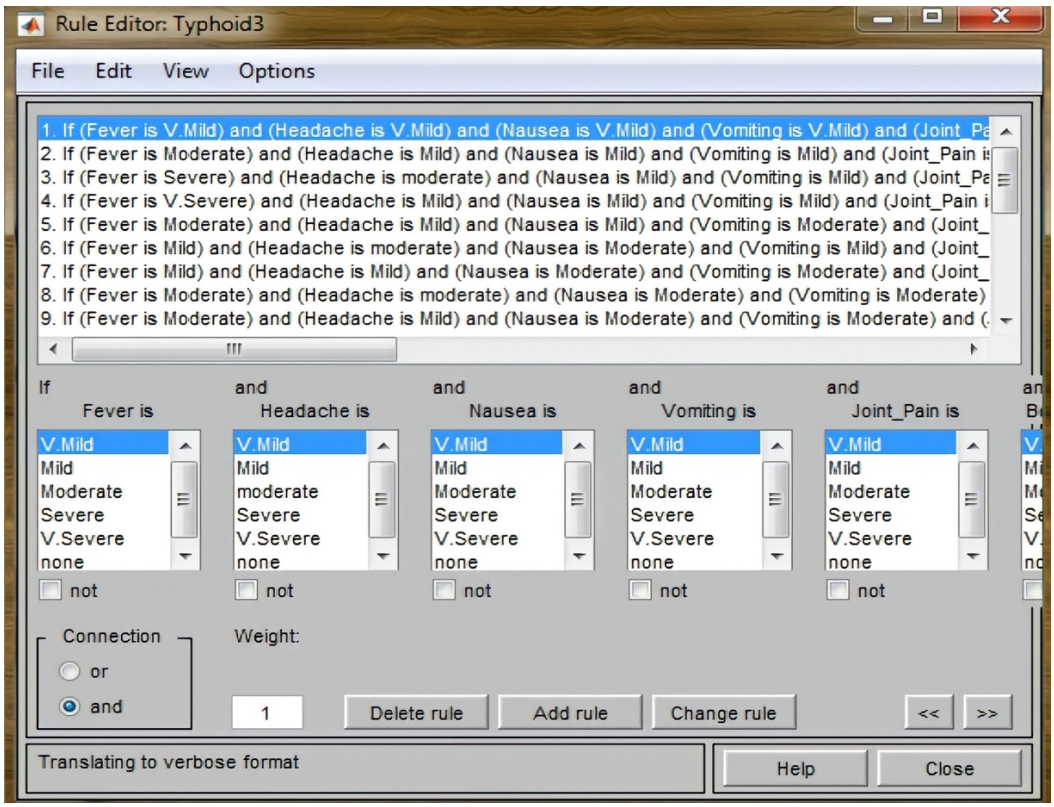
Rule 1: IF fever = mild and headache = mild and nausea= mild and vomiting = mild and jaundice = mild joint pain = mild and body weakness = mild and dizziness =severe, and loss of appetite = mild THEN typhoid fever = mild.

Rule 2: IF fever = moderate and headache = mild and nausea = mild and vomiting = mild and jaundice = mild and joint pain = moderate and body weakness = severe and dizziness = very severe, and loss of appetite = severe THEN typhoid fever = moderate.

Rule 3: IF fever = moderate and headache = mild and nausea = mild and vomiting = moderate and jaundice = mild and joint pain = moderate and body weakness = moderate and dizziness = moderate and loss of appetite = severe THEN typhoid fever = moderate.

Rule 4: IF fever = moderate and headache = moderate and nausea = moderate and vomiting = moderate and jaundice = moderate and joint pain = moderate and body weakness = moderate and dizziness = moderate and loss of appetite = moderate THEN typhoid fever = moderate.

Rule 5: IF fever = mild and headache = mild and nausea = moderate and vomiting = moderate and jaundice = mild and joint pain = mild and body weakness = mild and dizziness = mild and loss of appetite = mild THEN typhoid fever = mild.



System Evaluation

With the concept of Fuzzy Rule Based Systems that incorporate fuzzy techniques in simplifying the diagnosis of typhoid. A fuzzy expert system for diagnosis typhoid was developed. In the fuzzy logic implementation, the selection of fuzzifier, rule base and inference engine determined the output. Triangular and trapezoidal fuzzifier were used. the rule base was designed based on knowledge of domain Fuzzy logic was utilized to remove uncertainty, ambiguity and vagueness inherent in medical diagnosis.

9-input variables where given (fever, nausea, body pain, joint pain, headache, vomiting, loss of appetite and body weakness and jaundice) into Typhoid fever (Mamdani) and yields 2-output of typhoid condition and its treatment. Triangular membership function was used all through.

GitHub Link for Code

https://github.com/sshandilya1550/Fuzzy-logic-for-Typhoid-Diagnosis

or

https://github.com/UtkarshKumar088/Fuzzy-logic-for-Typhoid-Diagnosis

Conclusion

This work has successfully presented the development of diagnostic support system for diagnosing typhoid fever due to the inherent problems in the conventional method of medical prescription. These problems range from ambiguous writing style by doctors, difficulty in accessing patient record, the unreliable method in keeping medical record and also the queue posed on patients when coming to get the prescribed drug. Therefore recommending the deployment of the system at the national level where patient record can be centrally stored and accessed. Also, the system can be made interoperable with mobile devices in future works.

Medical practitioners should be trained on the use of the system and encouraged of the advantages posed when using the system. In future the diagnostic system can be evaluated by medical practitioners to establish the level of satisfactory on health outcomes.

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