INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, ALLAHABAD

Assignment #7

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Course: *Soft Computing* – Professor: *Prof. G C Nandi*
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Question 1

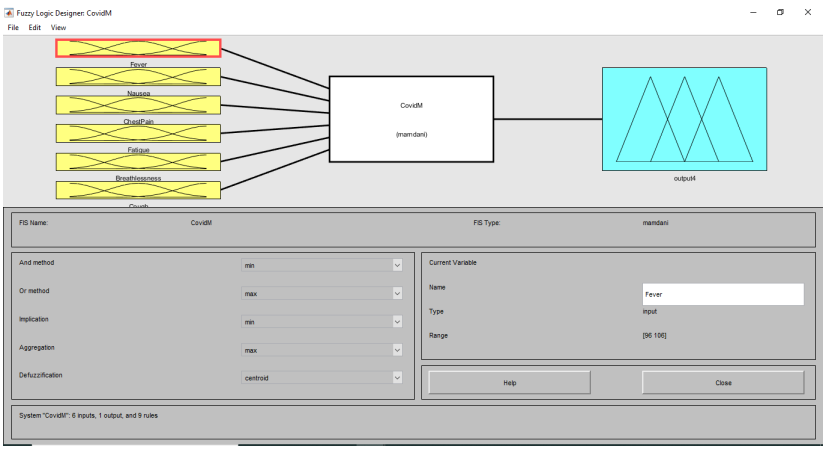
Design a FIS to help doctors to diagnose whether a person has Corona virus (COVID-19) infection or not based on symptoms. For designing FIS, use both Mamdani as well as Sugeno approaches and compare their results. Write comparative analysis as per your obtained results.

Answer. Fuzzy inference systems for diagnosis of COVID-19 are developed using Mamdani-type and Sugeno-type fuzzy models. MATLAB fuzzy logic toolbox is used for the simulation of both the models. Further a comparative analysis of the results is done. The Development of the models can be explained as folllows:

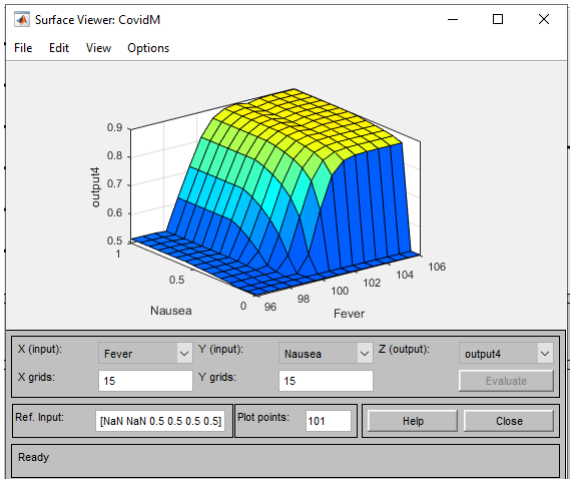
1. DEVELOPMENT OF MAMDANI-TYPE FUZZY INFERENCE SYSTEM

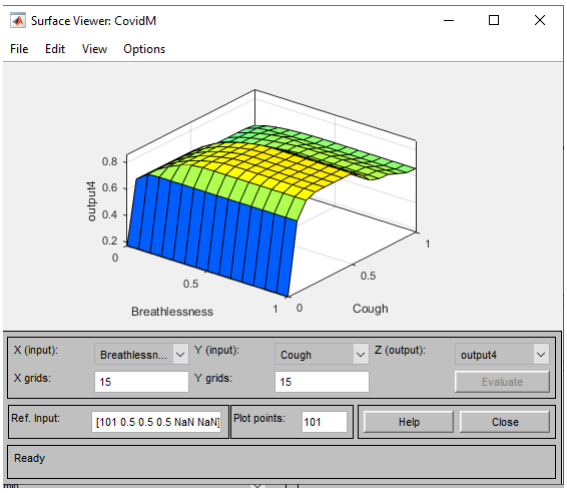
Fuzzy system for diagnosis of COVID-19 is initially developed by using mamdani fuzzy model. It is made up of six inputs from fever, chest pain, Fatigue, Breathlessness, Nausea and Cough. The system has one outcome that tells the percentage of occurrence of COVID-19 disease in a person based on symptoms. The different percentages signifies whether a person is normal(0-25), suffering from Influenza (25-50), Having Pneumonia (50-75) or a COVID positive (75-100) person. The membership functions used in different input are gaussmf, gauss2mf, trapmf functions. Screenshots of the Mamdani Fuzzy Inference System is given below:

Fuzzy Inference System using Mamdani

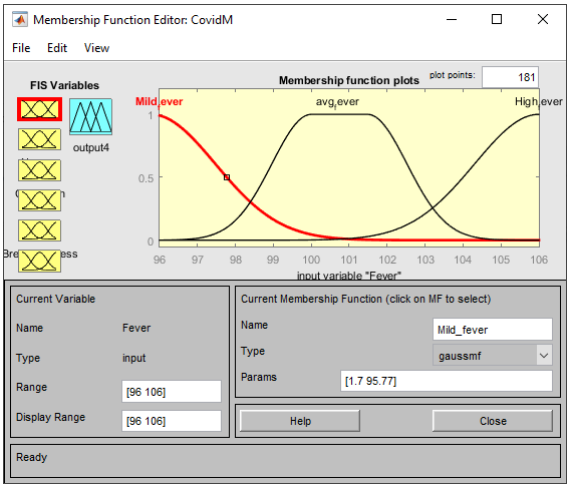


Surface Diagrams





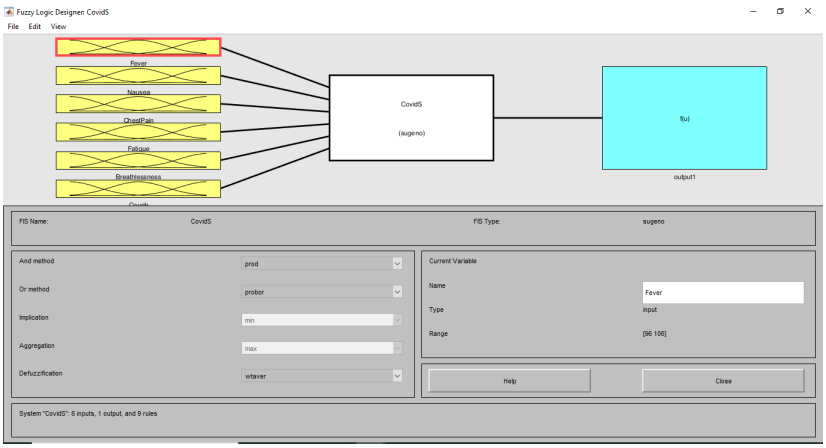
Output functions Diagrams



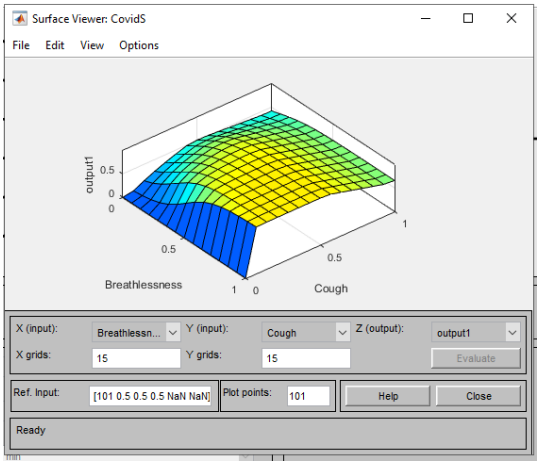
2. DEVELOPMENT OF SUGENO-TYPE FUZZY INFERENCE SYSTEM

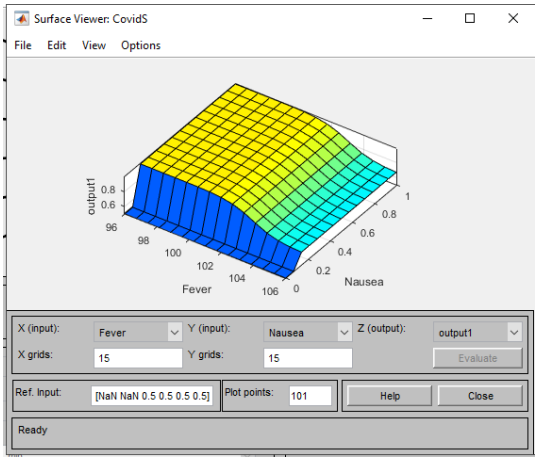
Fuzzy system for diagnosis of COVID-19 is initially developed by using sugeno fuzzy model. It is made up of six inputs from fever, chest pain, Fatigue, Breathlessness, Nausea and Cough. The system has one outcome that tells the percentage of occurrence of COVID-19 disease in a person based on symptoms. The different percentages signifies whether a person is normal(0-25), suffering from Influenza (25-50), Having Pneumonia (50-75) or a COVID positive (75-100) person. The membership functions used in different input are gaussmf, gauss2mf, trapmf functions. Screenshots of the Sugeno Fuzzy Inference System is given below:

Fuzzy Inference System using Sugeno

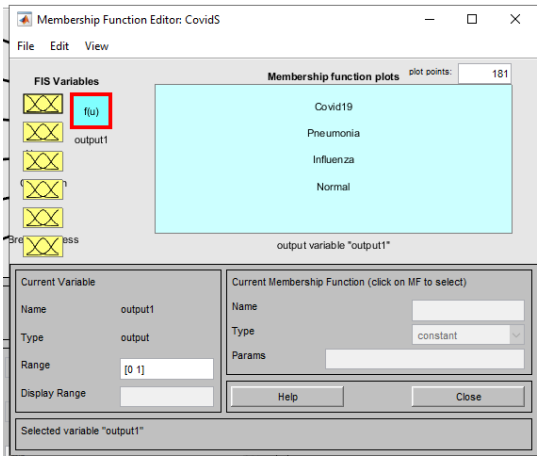


Surface Diagrams





Output functions Diagrams



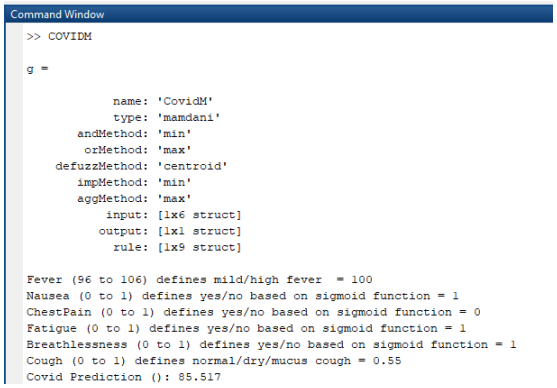
3. Comparative Analysis of Mamdani and Sugeno based Fuzzy Inference System

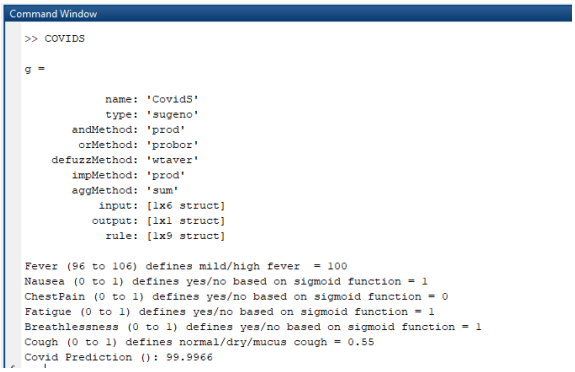
The most primary difference between Mamdani-type and Sugeno-type fuzzy inference systems can be given as follows:

- Mamdani-type fuzzy inference system employs the method of defuzzification of a fuzzy outcome, Sugeno-type fuzzy inference system employs weighted average to calculate the crisp outcome.
- The significant command and interpretability of Mamdani outcome is not available in the Sugeno fuzzy inference system while the resultants of the rules are not fuzzy. But Sugeno has improved processing time as the weighted average reinstate the time overwhelming defuzzification method.
- Mamdani-type fuzzy inference system has outcome membership functions while Sugeno-type fuzzy inference system has no outcome membership functions.
- Mamdani-type fuzzy inference system is not as much of flexible in system design in contradiction of Sugeno-type fuzzy inference system as latter can be incorporated with adaptive neurofuzzy inference system to optimize the outcomes.

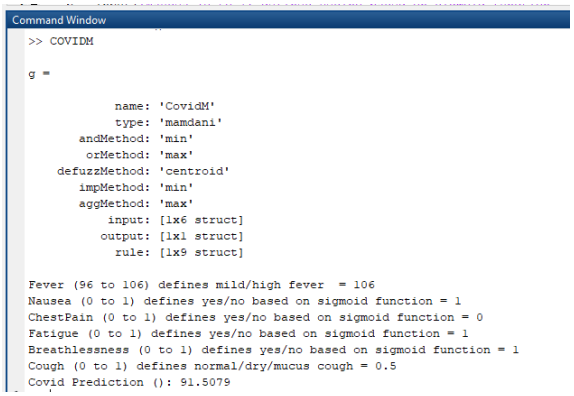
The Output generated from the two systems:

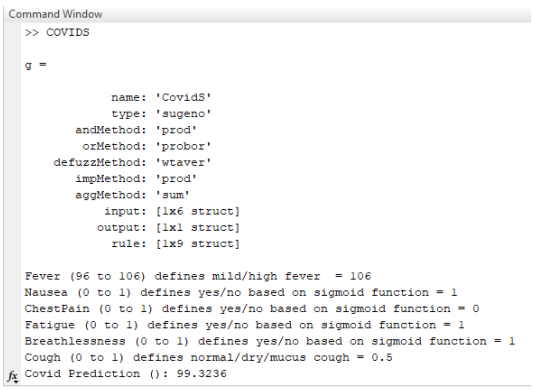
Mamdani(Left) and Sugeno(Right)





Changing input parameters





- As shown in the above screenshots for diagnosis of Covid-19, the outcome achieved from sugeno-type fuzzy inference system is more accurate as compared to mamdani-type fuzzy inference system.
- On the same set of input Mamdani is able to diagonise the Covid-19 with a percentage of 80-85 percent while Sugeno can able to do it with $>$ 95 percent.

- In Designing of both fuzzy inference systems is similar but the crisp outcome is generated in dissimilar ways for both fuzzy inference systems.
- The benefit of sugeno-type fuzzy inference system is that it can further integrate with many optimization techniques.