

**ADNAN MENDERES UNIVERSITY**

**CSE 429 Fuzzy Logic**

**Report of Term Project**

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Abstract

In the project developed with fuzzy logic method; water amount, amount of wheat planted and the amount of sunshine hours by looking at the variables are aimed to find the amount of wheat taken from the field. The purpose of the system is to create a program that calculates wheat productivity based on the input information provided.

Introduction

Wheat is a leading field crop throughout the world , including Turkey. Turkey has a suitable, but diverse, ecology for wheat production and is part of the center of origin for wheat. Therefore, Turkey has advantages for the development of productive high-quality varieties of wheat, a nationally strategic crop.**[**[**1**](https://www.sciencedirect.com/science/article/pii/S221451411500104X)**]**

Material and methods

Mamdani Fuzzy Model

It was first developed in 1975 by Ibrahim Mamdani, a mathematician and computer scientist at the University of London. The most commonly used fuzzy inference method is the Mamdani Fuzzy Model. The main reasons for this are; Mamdani extraction is more appealing to human perception, it is relatively easy to design and has greater interpretability[[13](https://medium.com/@ahmetatasoglu98/bulan%C4%B1k-mant%C4%B1k-3-bulan%C4%B1k-kurallar-ve-%C3%A7%C4%B1kar%C4%B1m-8f9d411080c)][[14](http://www.emo.org.tr/ekler/10e258cacf13acd_ek.pdf)]. Because of the Mamdani fuzzy model is suitable for the system structure, I preferred to use the Mamdani fuzzy model for all fuzzy inferences in the study.

In my fuzzy model system, after determining the input values in the system according to my fuzzy logic model, fuzzification process will be performed according to the input values. After the fuzzification process, defuzzification process will be performed according to the output value and the system will be completed by matching the rules in the system according to the input values and applying the appropriate rule or rules.

Input Variables

1. Amount of Water

1.1 tons of water is normally used to produce 1 kg of wheat[[2](https://www.dunya.com/kose-yazisi/tarimda-bilincli-sulama/19257)]. Based on this information, 11 thousand tons of water is used to produce 10 tons of wheat. Water is very important for the formation of wheat, so while the membership function of the amount of water is formed, I divided it into different sections as low, medium, very and very high. Since 100 acres of land can produce 70-80 tons of wheat harvest, I set the end point of my very high range to 80. Details are available in figure 1.1

1. Amount of Wheat Seed

Wheat seed is an important factor for the formation of wheat. Although the cultivated wheat seed varies according to the climate and soil structure in the region, as a result of my research, I concluded that a maximum of 40 kilograms of seed is required for 100 acres of land[[3](https://www.trakkulup.net/threads/100-donumluk-tarladan-kac-ton-bugday-cikar.34684/)] [[4](https://egitim.tarim.gov.tr/adana/Belgeler/L%C4%B0FTLER/04%20Serpme%20Ekim.pdf)]. While creating the membership function I divided it into 4 different sections. After divide my departments in the same way as low, medium, high and very high, I made arrangements according to the information I got. In my own system, the maximum yield of wheat will be approximately 70-75 wheat seeds as the very high part of the limits of 24-36 kilograms have determined. Details are available in figure 1.2

1. Amount of Sunny Hours

Membership function for amount of sunny hours (HOURS) { (low),(med),(high) }

Wheat sowing is generally carried out in our country between 15 October and 15 November. Sowing should not be late. Otherwise low yield is achieved[[5](http://www.tarimkutuphanesi.com/bugday_yetistiriciligi_00033.html)]. The harvesting time for wheat varies between the beginning of June and the end of July. When the plants are completely yellow and hardened, harvest is made with a combine harvester. Delay in harvest reduces yield[[6](http://settohum.com/tarim/bugday/genel-bilgiler)]. Based on this information, I calculated that wheat growth was at least 5.5 months and at most 9.5 months. Even though it varies according to the season and climate, I calculated the sunny time of the day as approximately 10 hours. Then, to find the maximum sunshine time, I multiply 10 hours with a maximum wheat growing time of 9.5 months (280 days) and I reached 2800 results. Details are available in figure 1.3

Output Variable

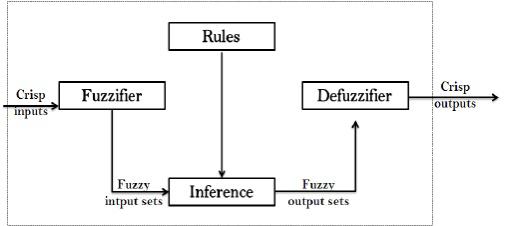
1. Amount of Wheat

I organized my membership functions based on the information that a maximum of 75-80 tons of wheat was extracted from 100 acres of wheat in our country and I obtained the results. Details are available in figure 1.4

|  |  |
| --- | --- |
| Input Variable | Fuzzification Part |
| figure 1.1 | amountOfWater – THOUSAND TONS    FUZZIFY amountOfWater  TERM low := (0,0) (10,1) (19,0);  TERM med := (10,0) (25,1) (40,0);  TERM high := (30,0) (45,1) (70,0);  TERM veryHigh := (60,0) (70,1) (80,1);  END\_FUZZIFY |
| figure 1.2 | amountOfWheatSeed – KG  FUZZIFY amountOfWheatSeed  TERM low := (0,0) (4,1) (12,0);  TERM med := (8,0) (16,1) (20,0);  TERM high := (18,0) (24,1) (28,0);  TERM veryHigh := (26,0) (30,1) (36,1);  END\_FUZZIFY |
| figure 1.3 | amountOfSunnyHours – HOURS  FUZZIFY amountOfSunnyHours  TERM low := (0,0) (600,1) (1200,0);  TERM med := (1000,0) (1600,1) (2000,0);  TERM high := (1800,0) (2400,1) (2800,1);  END\_FUZZIFY |

|  |  |
| --- | --- |
| Output Variable | Defuzzification Part |
| figure 1.4 | resultingWheat -- TON  DEFUZZIFY resultingWheat  TERM low := (0,1) (10,1) (15,0);  TERM med := (8,0) (25,1) (45,0);  TERM high := (35,0) (50,1) (65,0);  TERM veryHigh := (55,0) (65,1) (80,1);    METHOD : COG;  DEFAULT := 0;  END\_DEFUZZIFY |

Defuzzification is the process of producing a quantifiable result in Crisp logic, given fuzzy sets and corresponding membership degrees. It is the process that maps a fuzzy set to a crisp set. It is typically needed in fuzzy control systems. These will have a number of rules that transform a number of variables into a fuzzy result, that is, the result is described in terms of membership in fuzzy sets. A common and useful defuzzification technique is center of gravity. First, the results of the rules must be added together in some way. The most typical fuzzy set membership function has the graph of a triangle. Now, if this triangle were to be cut in a straight horizontal line somewhere between the top and the bottom, and the top portion were to be removed, the remaining portion forms a trapezoid. The first step of defuzzification typically "chops off" parts of the graphs to form trapezoids. In the most common technique, all of these trapezoids are then superimposed one upon another, forming a single geometric shape. Then, the centroid of this shape, called the fuzzy centroid, is calculated. The x coordinate of the centroid is the defuzzified value.[[15](https://en.wikipedia.org/wiki/Defuzzification)](figure 1.1, figure 1.2, figure 1.3, figure 1.4, figure 1.5)



(figure 1.5)

Result

I used the center of gravity method in the fuzzy logic system I created. With this method, I tried the left most method and the right most method. I found the result with the error rate of 31.96% while using the left most method, and I found the result with the error rate of 36.83% when using the right most method. When I made calculations using the center of gravity method in my system, I found that I reached the right result with an accuracy rate of 87.89% and an error rate of 12.11%

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Amount of Water | Amount of Wheat Seed | Amount of Sunny Hours | Expected Amount of Wheat | Amount of Wheat Shown by the program | Accuracy |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | 25 | 2000 | 0 | 0 | 1 |
| 50 | 0 | 2000 | 0 | 0 | 1 |
| 50 | 25 | 0 | 0 | 0 | 1 |
| 10 | 4.5 | 600 | 9 | 6.31 | 0,70 |
| 20 | 9 | 1100 | 18 | 21.65 | 1,20 |
| 30 | 13.5 | 1600 | 27 | 26.08 | 0,96 |
| 40 | 18 | 1900 | 36 | 34.375 | 0,95 |
| 50 | 22.5 | 2000 | 45 | 50 | 1,11 |
| 60 | 27 | 2200 | 54 | 58.40 | 1,08 |
| 70 | 31.5 | 2400 | 63 | 69.06 | 1,09 |
| 80 | 36 | 2800 | 72 | 70 | 0,97 |

|  |  |
| --- | --- |
| Accuracy Rate | Error Rate |
| 87.89% | 12.11% |

References

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3. <https://www.trakkulup.net/threads/100-donumluk-tarladan-kac-ton-bugday-cikar.34684/>
4. <https://egitim.tarim.gov.tr/adana/Belgeler/L%C4%B0FTLER/04%20Serpme%20Ekim.pdf>
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