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# Introduction

This is a report for assignment 2 of Artificial Intelligence. This report is about fuzzy logic controller of a washing machine.

Fuzzy logic is a way to computing value base on “degrees of the factor”. It is different to usual programing “Boolean” on true or false, so different input factor can be taken care. In this assignment, fuzzy logic controller is going to control a washing machine to calculate correct washing time base on the condition of the clothes.

The architecture of the washing machine fuzzy logic controller is based on the dirtiness of the clothes ad the type of the dirt of the clothes. Basically, dirtier will cause longer washing time. Also, more inputs will by add in to the controller, this will be discussing more detailly in the report.

# Why do we need fuzzy logic controller on washing machines?

Reason can be simple, it is because washing machine does not like real human, if no fuzzy logic implemented, it will only be switch on or off, and wash all type of clothes in a fixed time with no matter how dirty they are. On of the characteristics of fuzzy logic can take care multiple type of input and calculate output by “degrees of the factor”. So that implement fuzzy logic on controller can make washing machine take care different types of clothes conditions (e.g. dirtiness, types of the dirt), by this way washing machine can be smarter and working more like a human thinking.

# Fuzzy logic controller architecture

The architecture of the fuzzy logic controller is shown in figure 1.

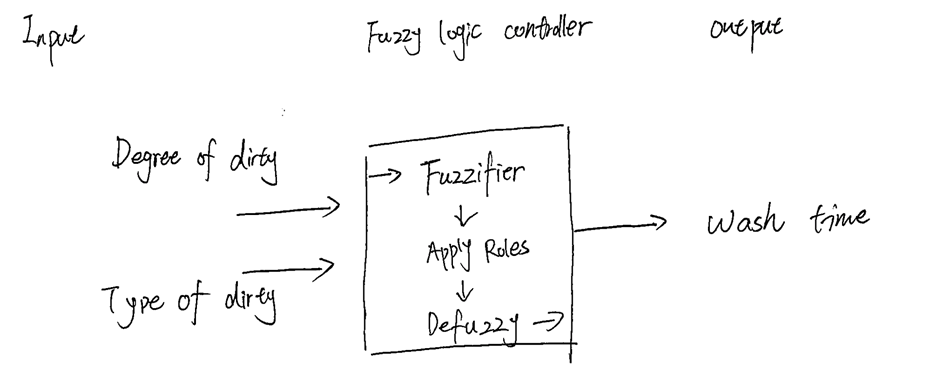


Figure 1 basic architecture of fuzzy logic controller

Fuzzy logic controller will process the information given by the sensors on the machine and calculate an output of wash time.

There are two type of data should be input

1. Degree of dirty
2. Type of dirty

Degree of dirty data can be read from the washing machine sensors by scan the dirt partials on the clothes, more dirt partials means dirtier.

Type of dirty will be determined by time of water get dirty, longer time means greasier (greasy is harder to dissolve).

After user put clothes into the washing machine and water added to the machine, there are will be a time that sensors get stable data reading. At this time, machine will begin to calculate the output wash time.

# Detail of the set applied

## Fuzzifier

Fuzzifier is a process to convert clear input value into a fuzzy value, in first, there are only two variables input so that there are two membership functions user to map input to fuzzy value.

Figure 2 shows membership function of DegreeOfDirty with range 0 to 100

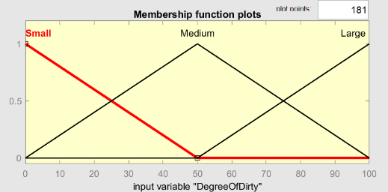


Figure 2 Membership function:DegreeOfDirty

Figure 3 shows membership function of TypeOfDirty with range 0 to 100

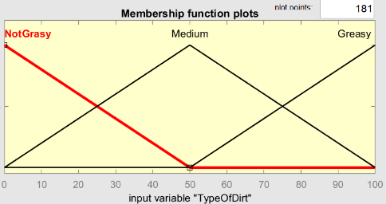


Figure 3 Membership function: TypeOfDirt

For example: If now has input 10 to membership function DegreeOfDirty, fuzzy output can be ‘Small’

## Rules

Rules are how the decisions made by fuzzy controller, there stored in knowledge database. In high level understand, rules are if-then statement and it is based on input variables, and easy to understand.

Rules that used in this report is based on the sense of more dirty takes longer and greasier takes longer, and their listed in table 1 down below.

Table 1 Rules: two input type

|  |
| --- |
| 1. If dirtiness\_of\_clothes is Large and type\_of\_dirt is Greasy then wash\_time is VeryLong; |
| 2. If dirtiness\_of\_clothes is Medium and type\_of\_dirt is Greasy then wash\_time is Long; |
| 3. If dirtiness\_of\_clothes is Small and type\_of\_dirt is Greasy then wash\_time is Long; |
| 4. If dirtiness\_of\_clothes is Large and type\_of\_dirt is Medium then wash\_time is Long; |
| 5. If dirtiness\_of\_clothes is Medium and type\_of\_dirt is Medium then wash\_time is Medium; |
| 6. If sdirtiness\_of\_clothes is Small and type\_of\_dirt is Medium then wash\_time is Medium; |
| 7. If dirtiness\_of\_clothes is Large and type\_of\_dirt is NotGreasy then wash\_time is Medium; |
| 8. If dirtiness\_of\_clothes is Medium and type\_of\_dirt is NotGreasy then wash\_time is Short; |
| 9. If dirtiness\_of\_clothes is Small and type\_of\_dirt is NotGreasy then wash\_time is VeryShort |

### About ‘and’ operator and ‘or’ operator:

‘and’ operator: The ‘and’ operator will take the lower value of member functions

‘or’ operator: The ‘or’ operator will take the higher value of the member functions

## Defuzzifier and output

After apply rule, fuzzy controller will have a bit clearer value to do the defuzzy processes. A membership function will cover the output and help defuzzy the value back to normalized clear value. Output membership function shown down below at figure 4.

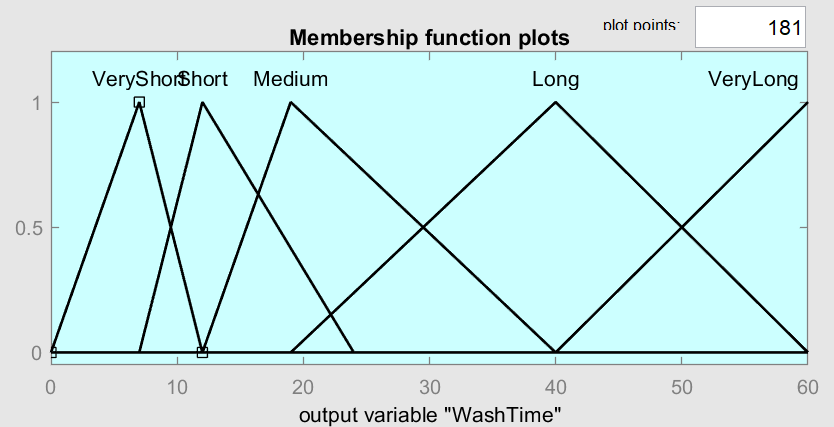


Figure 4 Output membership function:WashTime

After apply rule, fuzzy logic controller interprets fuzzy values as weightings. For example, 0.3 times of Medium and 0.4 times of long, wash time can be calculated by (3\*medium+4\*long)/7.

At last, a clear value will be output as answer of wash time as a clear value between 0 to 60.

# Surface

By using the method above, inputs values from sensors can be fuzzified and apply rules (including operators) than using the output membership function, we can get a clear output wash time.,

Output of wash time of different conditions can be representing by a response surface shown down below at figure 5.

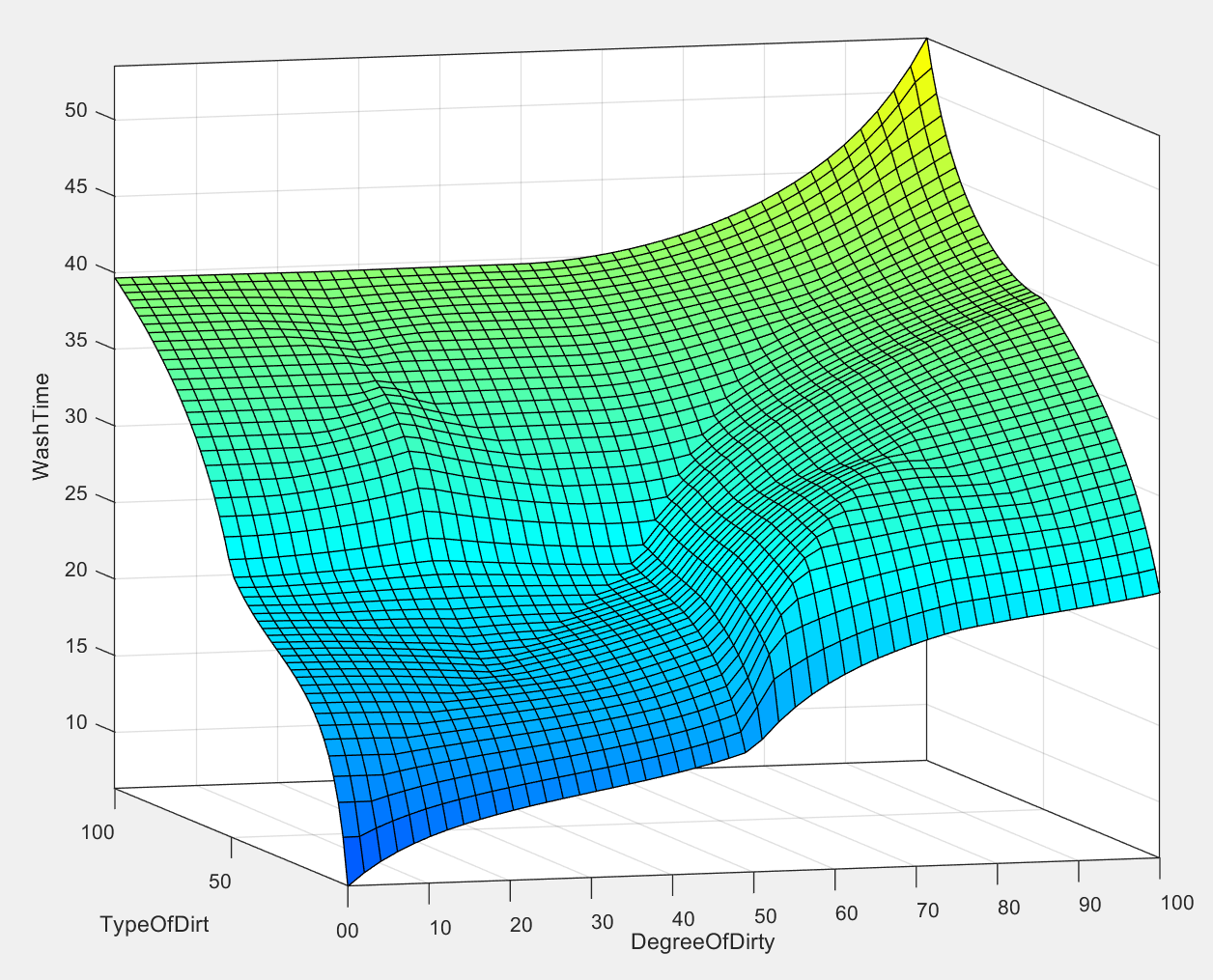


Figure 5 surface of the output

We can see there are some discontinue on the surface (figure 6), but its gradient does not change a lot. Since this output is wash time, discontinues does not affect user experience a lot because every single time of wash is independent, user is very hard to feel this little be discontinue.

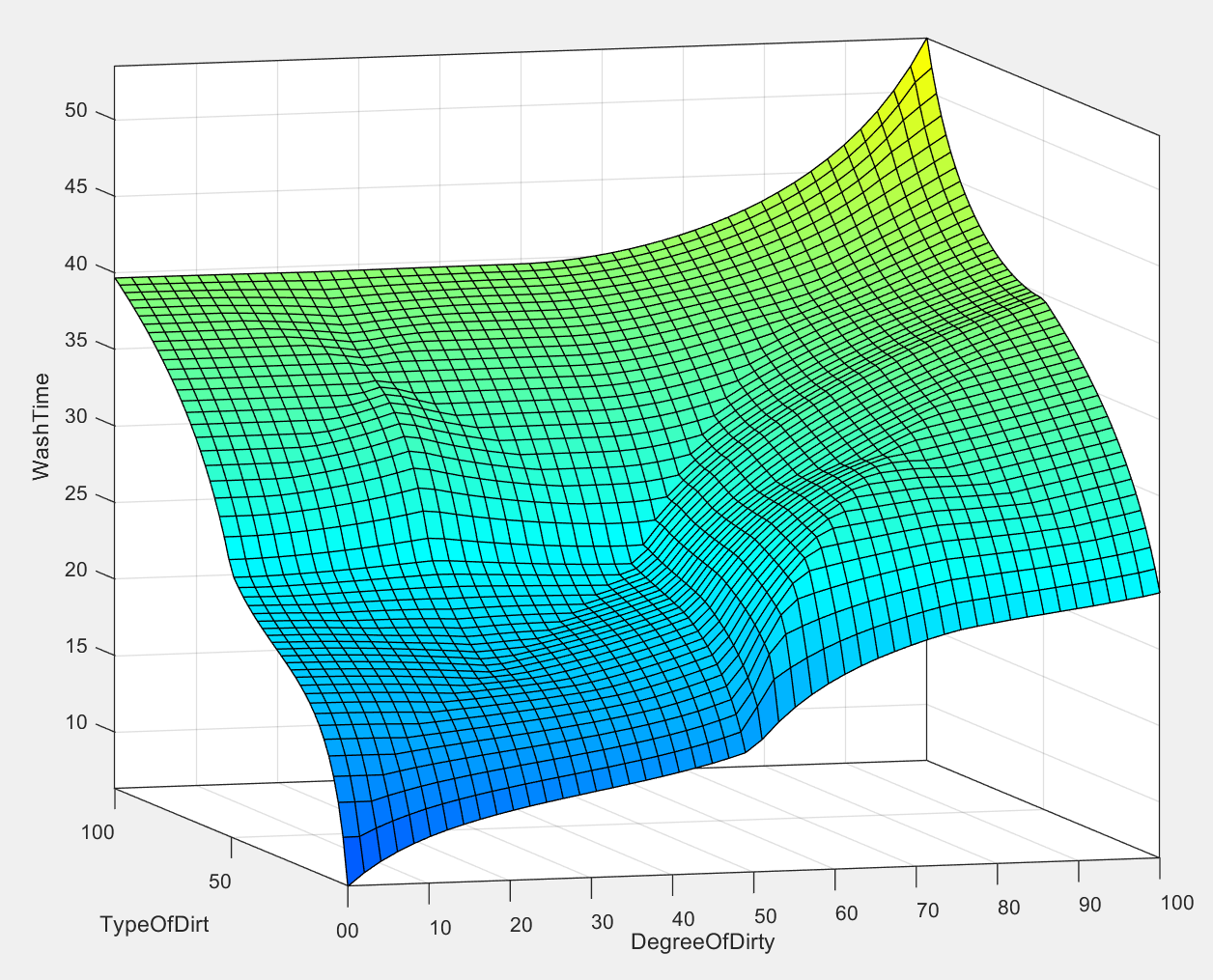




Figure 6surface with discontinue indication

# About more input

At current stage, the fuzzy controller already able to obtain a wash time for different type of dirt and different degree of dirt. But in real life, there are more factors able to affect wash time. More input means fuzzy logic controller takes more to calculation, so it is more human like and intelligent. We can add one more input into the system, that is temperature of water.

Temperature of water can be input from washing machine water temperature sensors. Higher temperature of water can make greasy dissolve more quickly and cooler water make greasy dissolve harder. So that higher water temperature can lower down the wash time, and lower temperature will make wash longer.

Figure 2 shows membership function of TemperatureOfWater with range 20 to 60.

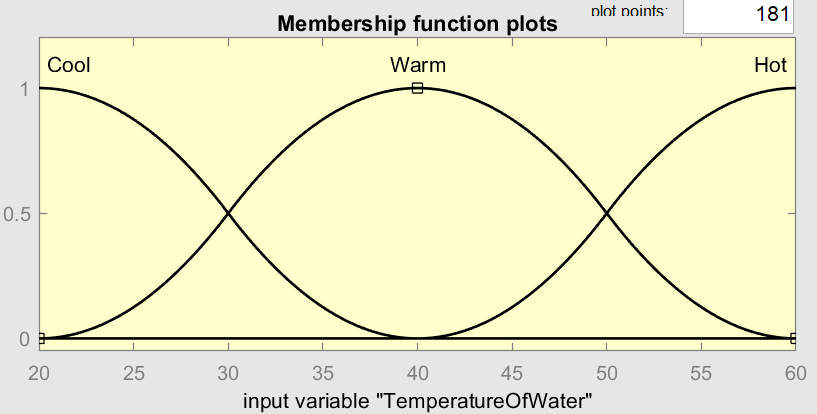


Figure 7Membership function:TemperatureOfWater

Base on the senesce of hotter water dissolve greasy is easier, some rules is add to the fuzzy logic controller. Rules are list down below