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Aim:

To design and implement a fuzzy controller for a given problem

Problem Statement:

Design a controller to determine the wash time of a domestic washing machine. Assume that input is dirt and grease on clothes. Use three descriptors for input variables and five descriptors for output variables. Derive set of rules for controller action and defuzzification. The design should be supported by figures wherever possible. Show that if the clothes are soiled to a larger degree the wash time will be more and vice-versa.

Tool/Language:

Programming language: Python (matplotlib, skfyzzy, numpy)

Code:

```
In [1]:  import numpy as np
         import skfuzzy.control as fuzzy
         import matplotlib.pyplot as plt
```

```
In [2]:  grease = fuzzy.Antecedent(np.arange(0, 60, 1), 'Grease')
         dirt = fuzzy.Antecedent(np.arange(0, 60, 1), 'Dirt')
         washingtime = fuzzy.Consequent(np.arange(0, 60, 1), 'Washing Time')
```

```
In [3]:  import skfuzzy as temp
```

```
In [4]:  grease['Low'] = temp.trimf(grease.universe, [ 0, 0, 30])
         grease['Medium'] = temp.trimf(grease.universe, [0, 30, 60])
         grease['High'] = temp.trimf(grease.universe, [30, 60, 60])
```

```
In [5]:  dirt['Low'] = temp.trimf(dirt.universe, [0, 0, 30])
         dirt['Medium'] = temp.trimf(dirt.universe, [0, 30,60])
         dirt['High'] = temp.trimf(dirt.universe, [30, 60, 60])
```

```
In [6]:  washingtime['Very Low'] = temp.trimf(washingtime.universe, [0, 0, 15])
         washingtime['Low'] = temp.trimf(washingtime.universe, [0, 15, 30])
         washingtime['Medium'] = temp.trimf(washingtime.universe, [15, 30, 45])
         washingtime['High'] = temp.trimf(washingtime.universe, [30, 45, 60])
         washingtime['Very High'] = temp.trimf(washingtime.universe, [45, 60, 60])
```

```
In [10]: dirt_array = ['Low','Medium','High']
         grease_array = ['Low','Medium','High']
```

```
In [11]: matrix = [['Very Low','Medium','High'],
                   ['Low','Medium','High'],
                   ['Medium','High','Very High']]
```

```
In [12]: logic = []
         for i,x in enumerate(dirt_array):
             for j,y in enumerate(grease_array):
                 rule = fuzzy.Rule(dirt[x] & grease[y], washingtime[matrix[i][j]])
                 logic.append(rule)
                 print(rule)
```

```
IF Dirt[Low] AND Grease[Low] THEN Washing Time[Very Low]
        AND aggregation function : fmin
        OR aggregation function  : fmax
IF Dirt[Low] AND Grease[Medium] THEN Washing Time[Medium]
        AND aggregation function : fmin
        OR aggregation function  : fmax
IF Dirt[Low] AND Grease[High] THEN Washing Time[High]
        AND aggregation function : fmin
        OR aggregation function  : fmax
IF Dirt[Medium] AND Grease[Low] THEN Washing Time[Low]
        AND aggregation function : fmin
        OR aggregation function  : fmax
IF Dirt[Medium] AND Grease[Medium] THEN Washing Time[Medium]
        AND aggregation function : fmin
        OR aggregation function  : fmax
IF Dirt[Medium] AND Grease[High] THEN Washing Time[High]
        AND aggregation function : fmin
        OR aggregation function  : fmax
IF Dirt[High] AND Grease[Low] THEN Washing Time[Medium]
        AND aggregation function : fmin
        OR aggregation function  : fmax
IF Dirt[High] AND Grease[Medium] THEN Washing Time[High]
        AND aggregation function : fmin
        OR aggregation function  : fmax
IF Dirt[High] AND Grease[High] THEN Washing Time[Very High]
        AND aggregation function : fmin
        OR aggregation function  : fmax
```

```
In [14]: fuzzysys = fuzzy.ControlSystem(logic)
         wt = fuzzy.ControlSystemSimulation(fuzzysys)
```
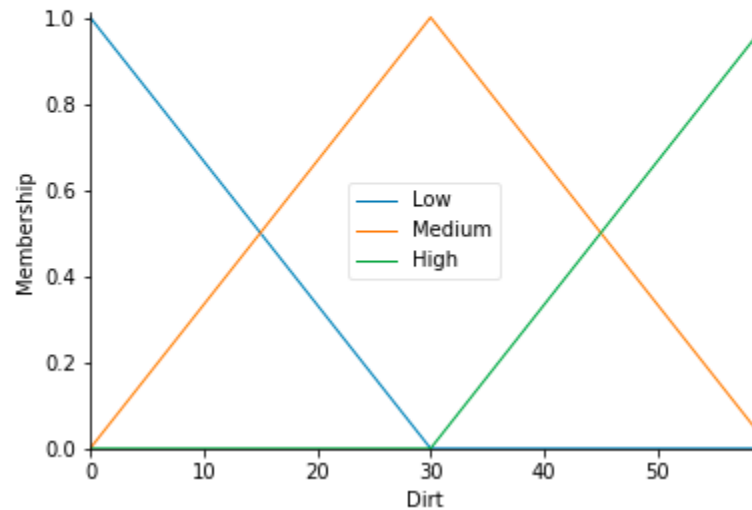
```
In [17]: wt.input['Dirt'] = 60
         wt.input['Grease'] = 15
         wt.compute()
         print("Wahing time by fuzzy system is:", round(wt.output['Washing Time'],2))

         Wahing time by fuzzy system is: 36.68
```

Results:

```
In [7]: dirt.view()

        C:\Users\Anu\Anaconda3\lib\site-packages\matplotlib\
        d, so cannot show the figure
          "matplotlib is currently using a non-GUI backend,
```
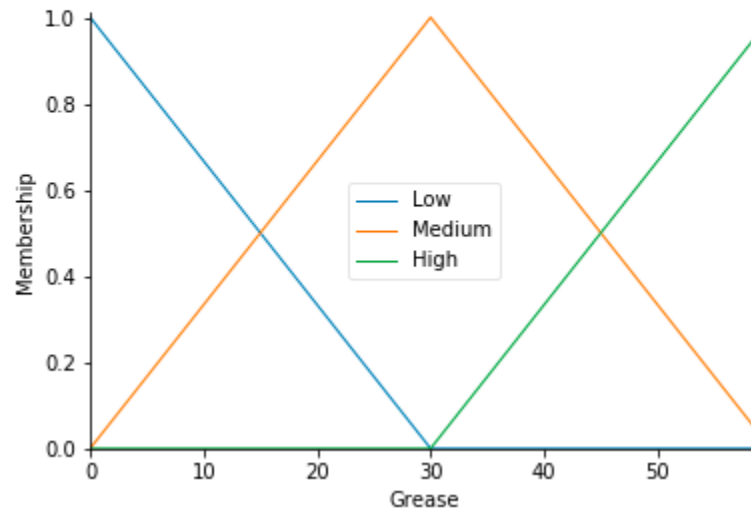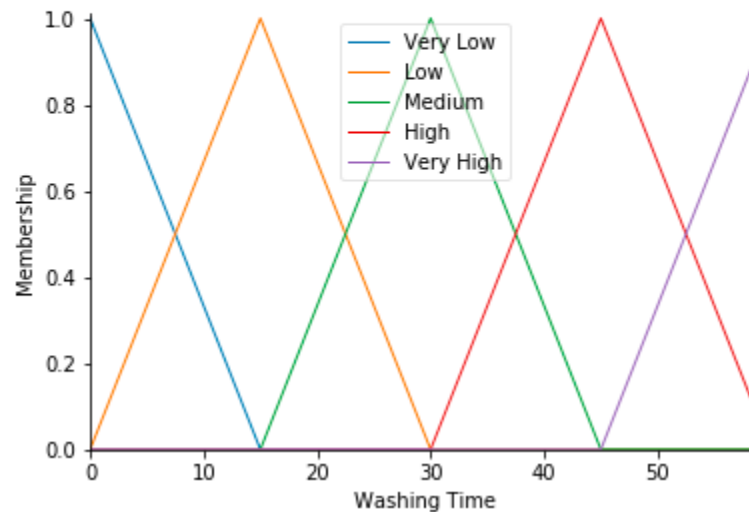
```
In [8]: grease.view()
```

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d, so cannot show the figure
  "matplotlib is currently using a non-GUI backend, "


```
In [9]: washingtime.view()
```

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```
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```
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```

```
In [16]: washingtime.view(wt = wt)
```

```
         C:\Users\Anu\Anaconda3\lib\site-packages\matplotlib\figure.p
         d, so cannot show the figure
           "matplotlib is currently using a non-GUI backend, "
```
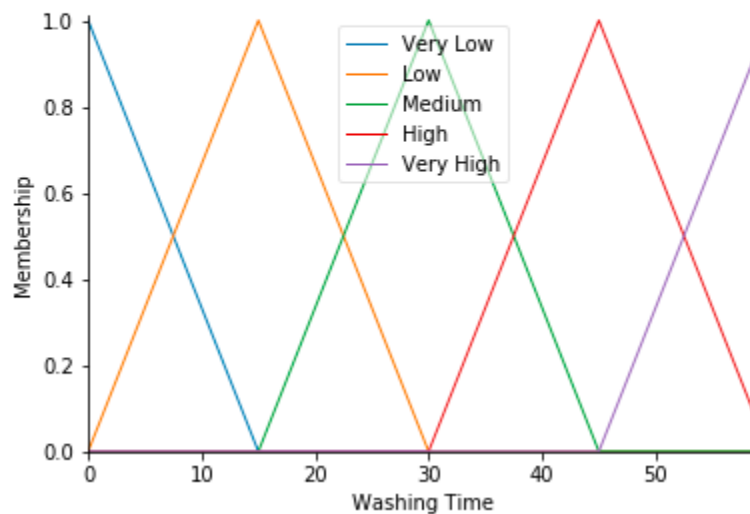

Conclusion:
Fuzzy Controller system for a washing machine was implemented and the time for low grease and high dirt was calculated.