

ECE449

Lab 2

October 3rd, 2019

Cybera

- The cloud was down over Sunday
- **Back up your work!**

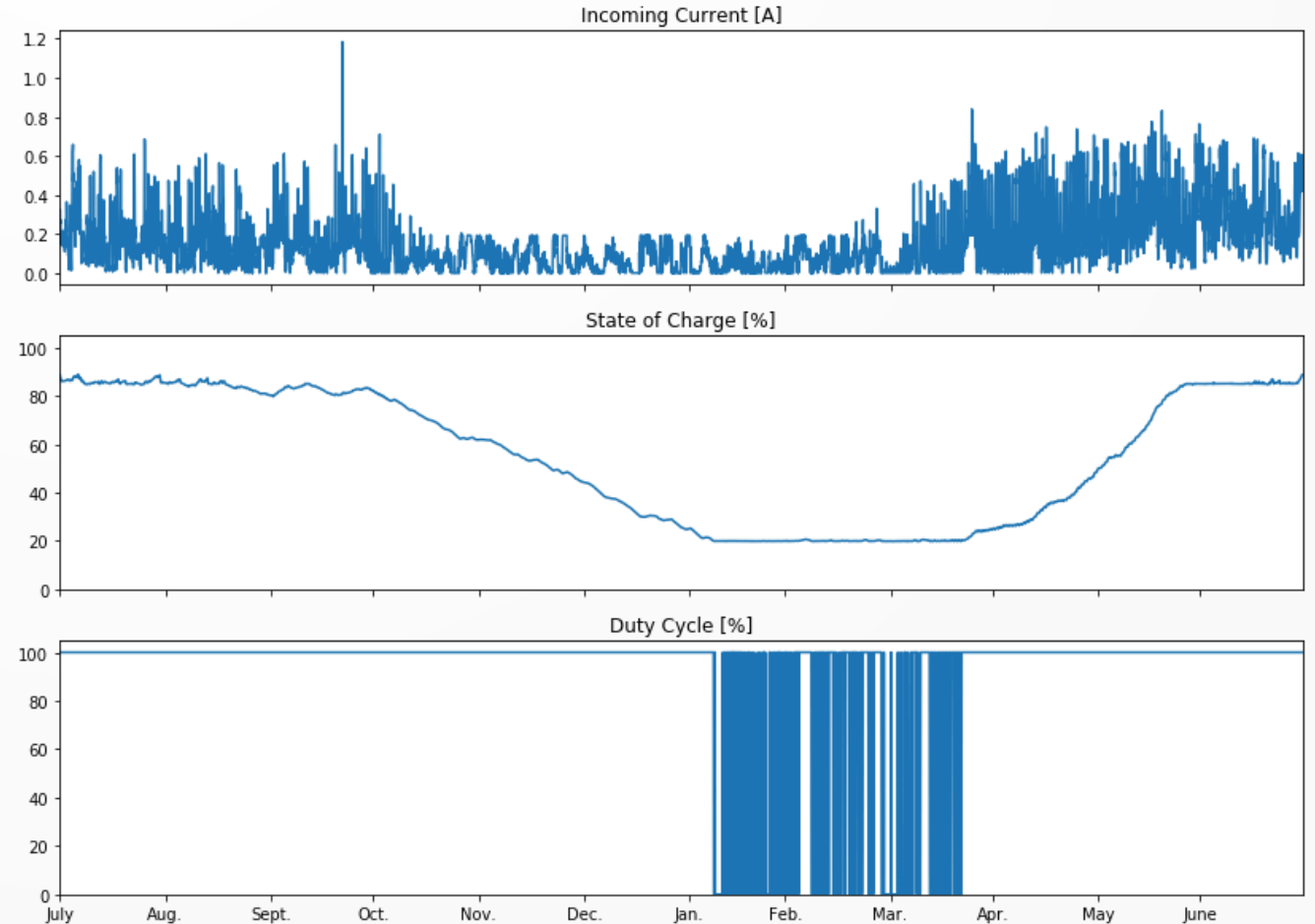
Lab 2

- Complete Fuzzy controller
- The simulated system:
 - Remote data logger
- Runs on a battery
 - taking periodic samples
- Consumes energy!
 - Solar panel
- Recharges the battery

Lab 2

.Naive control strategy

- Samples at full speed all the time
- .Data outages during the winter
- .Less samples is better than no samples at all

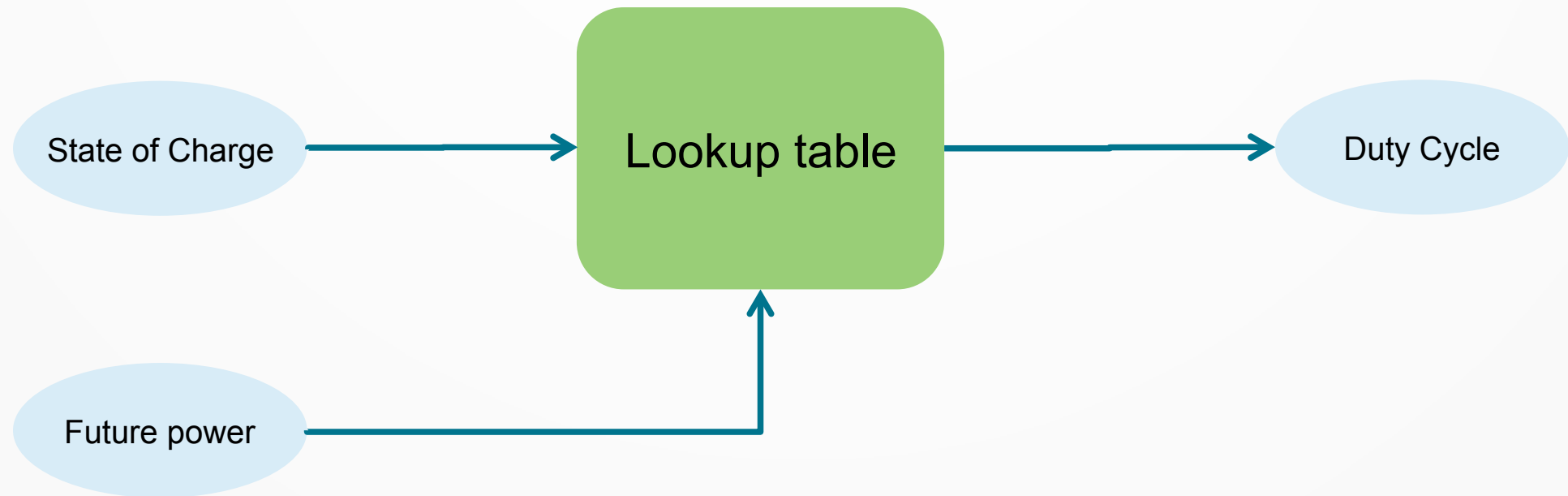


Lab 2

- The logging period can be controlled (duty cycle)
 - Thus the power consumption can be regulated
- Fuzzy controller
 - Inputs
 - State of Charge (SoC)
 - Future power (prediction of solar power)
 - Outputs
 - Duty cycle

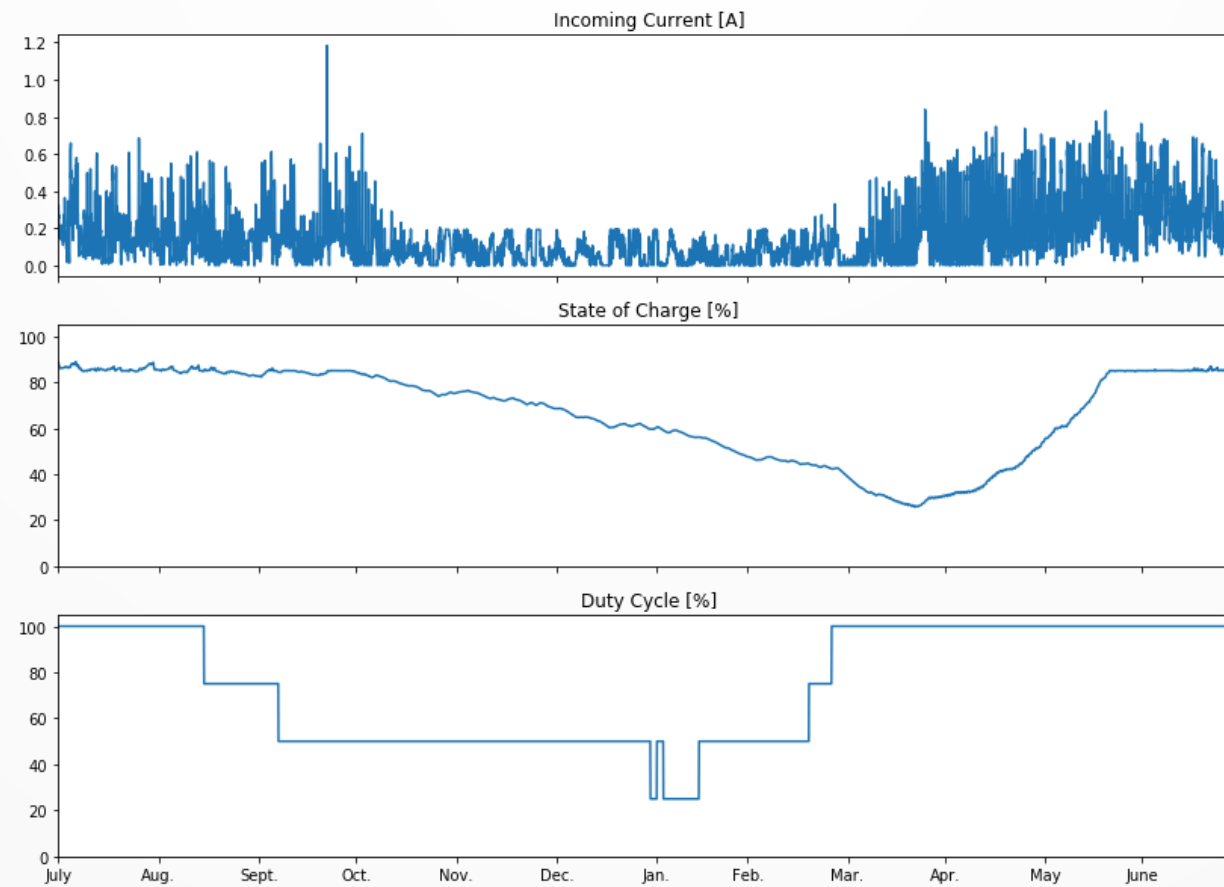
Lab 2

- The fuzzy controller:
 - Implemented as a Lookup Table (Decision Matrix)



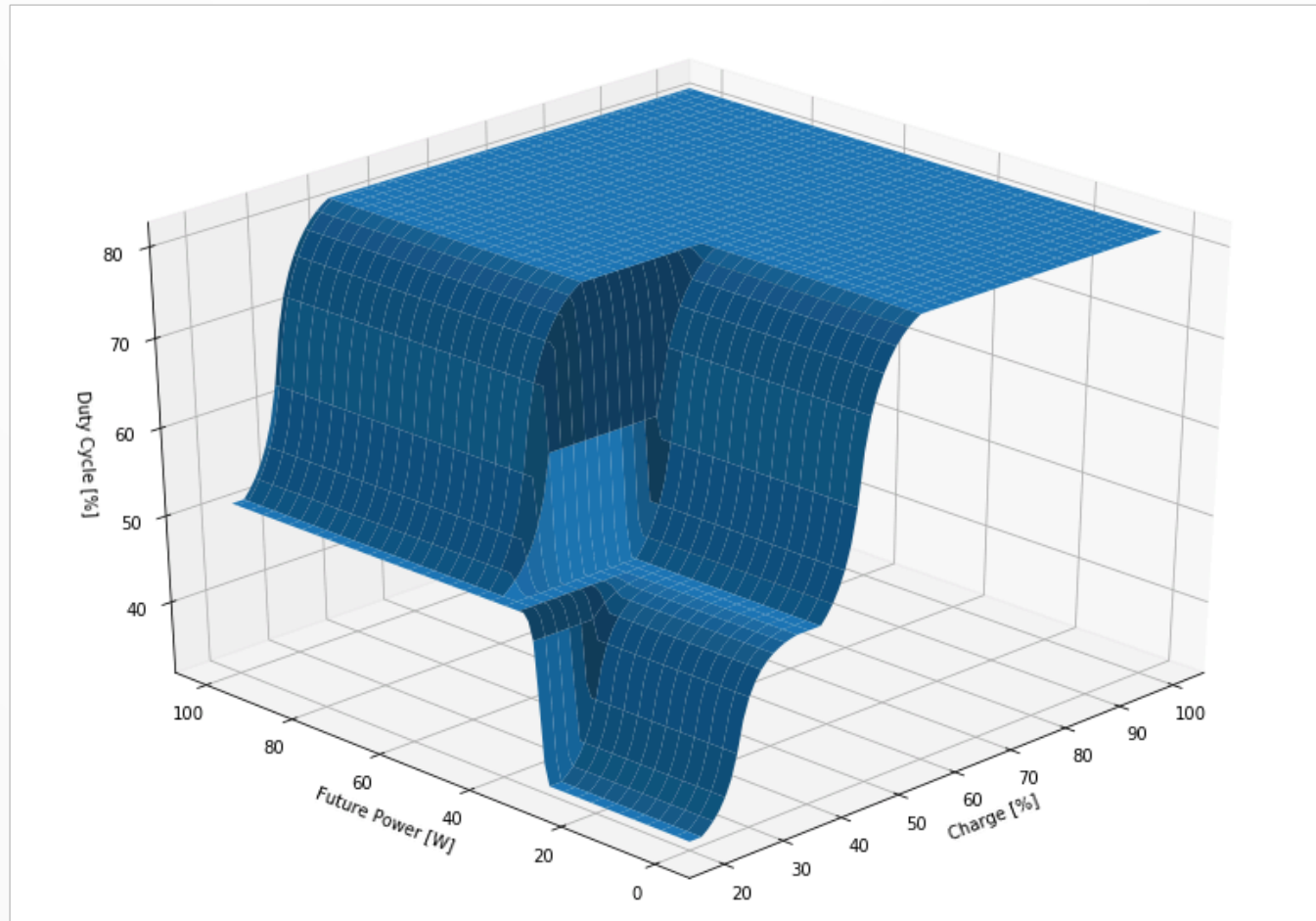
Lab 2

Data logger with the Fuzzy Controller



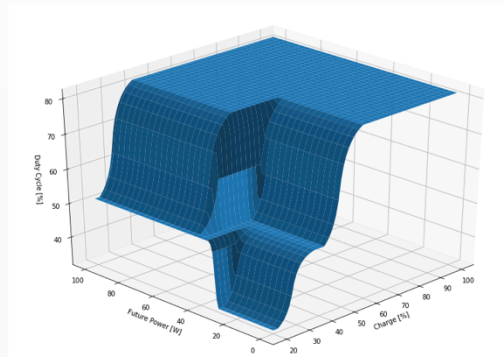
Lab 2

Lookup table



Exercise 2

Rule #	Rule
1	IF (SOC IS LOW AND power IS SCARCE) THEN duty cycle IS LOW ELSE
2	IF (SOC IS LOW AND power IS AVERAGE) THEN duty cycle IS MEDIUM ELSE
3	IF (SOC IS LOW AND power IS ABUNDANT) THEN duty cycle IS MEDIUM ELSE
4	IF (SOC IS MEDIUM AND power IS SCARCE) THEN duty cycle IS MEDIUM ELSE
5	IF (SOC IS MEDIUM AND power IS AVERAGE) THEN duty cycle IS MEDIUM ELSE
6	IF (SOC IS MEDIUM AND power IS ABUNDANT) THEN duty cycle IS HIGH ELSE
7	IF (SOC IS HIGH AND power IS SCARCE) THEN duty cycle IS HIGH ELSE
8	IF (SOC IS HIGH AND power IS AVERAGE) THEN duty cycle IS HIGH ELSE
9	IF (SOC IS HIGH AND power IS ABUNDANT) THEN duty cycle IS HIGH



Exercise 2

- Algorithm:
 - For every element of the lookup table
- Fuzzify *SoC* and *Future Power*
 - Using the membership functions
- Apply all 9 rules on the fuzzified values
 - Results in 9 membership functions
- “OR” these membership functions together
- Defuzzify
 - This is the result that goes to the lookup table

Exercise 2

•How to apply the rules?

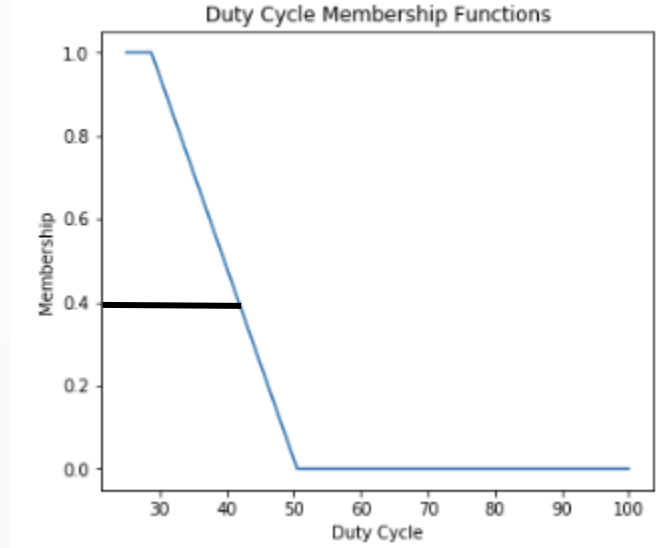
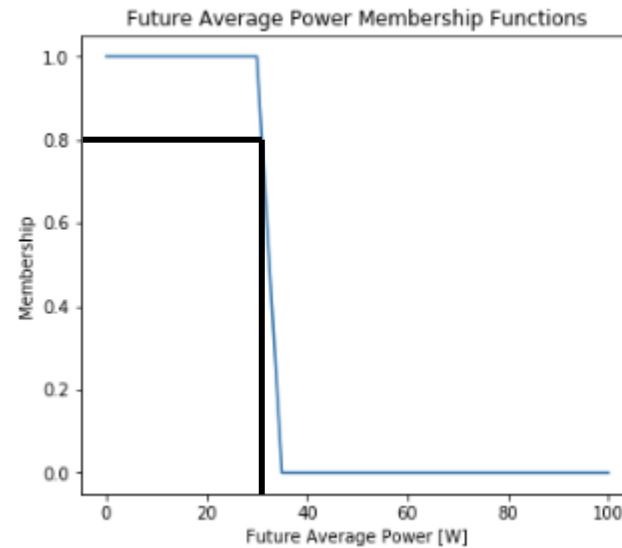
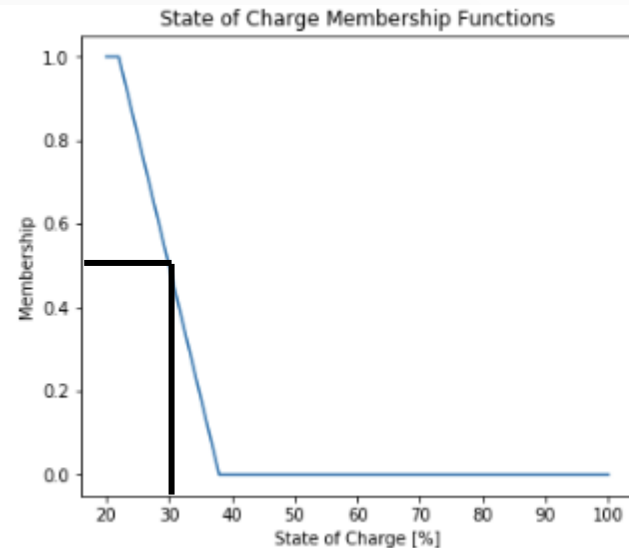
- | | |
|---|---|
| 1 | IF (<i>SOC IS LOW AND power IS SCARCE</i>) THEN <i>duty cycle IS LOW</i> ELSE |
| 5 | IF (<i>SOC IS MEDIUM AND power IS AVERAGE</i>) THEN <i>duty cycle IS MEDIUM</i> ELSE |
| 9 | IF (<i>SOC IS HIGH AND power IS ABUNDANT</i>) THEN <i>duty cycle IS HIGH</i> |

INPUTS: SOC = 30%; Future Power = 31W

Exercise 2

•How to apply the rules?

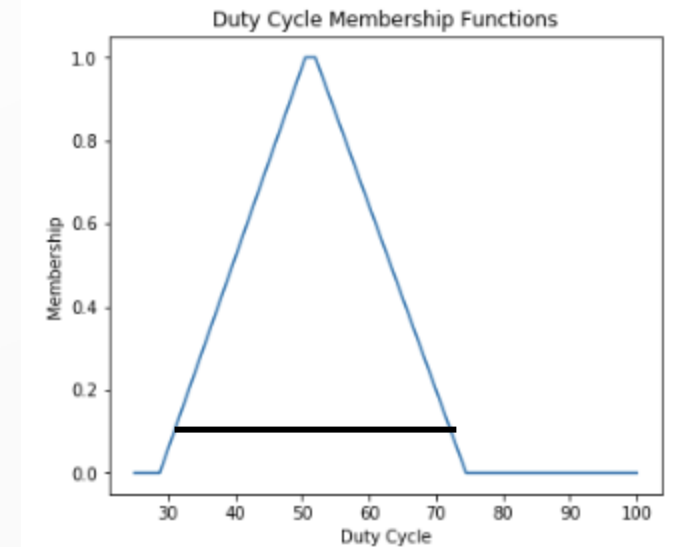
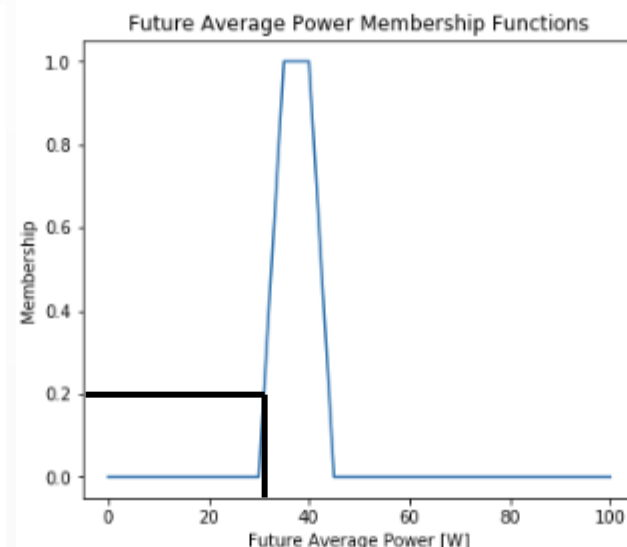
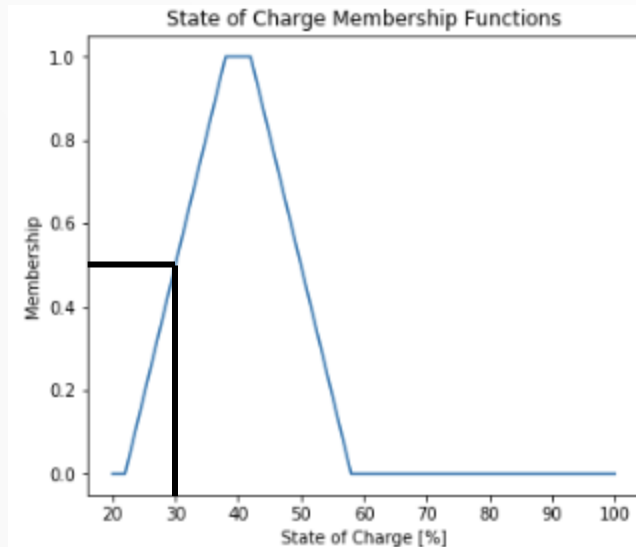
1 **IF** (*SOC IS LOW* **AND** *power IS SCARCE*) **THEN** *duty cycle IS LOW* **ELSE**



Exercise 2

•How to apply the rules?

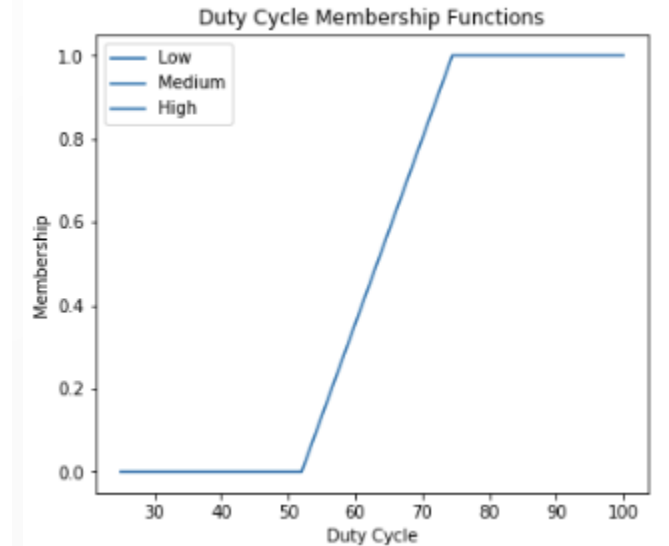
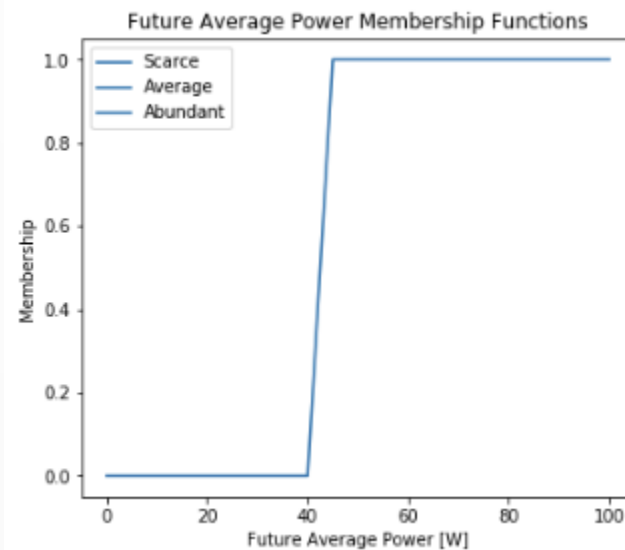
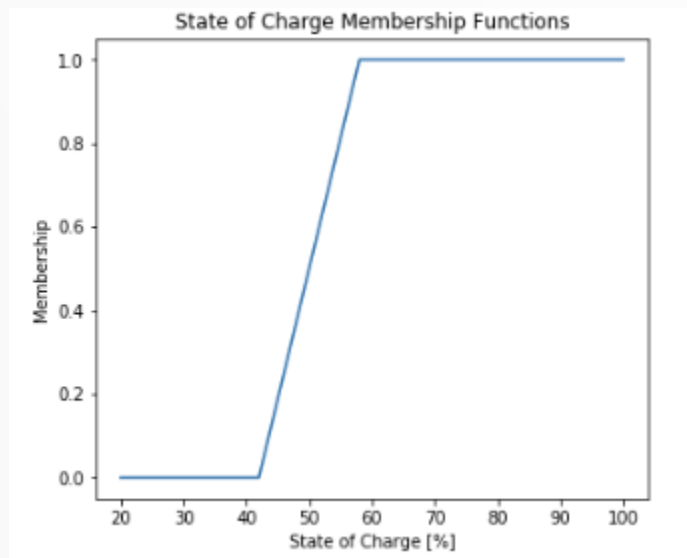
5 **IF** (*SOC IS MEDIUM* **AND** *power IS AVERAGE*) **THEN** *duty cycle IS MEDIUM* **ELSE**



Exercise 2

How to apply the rules?

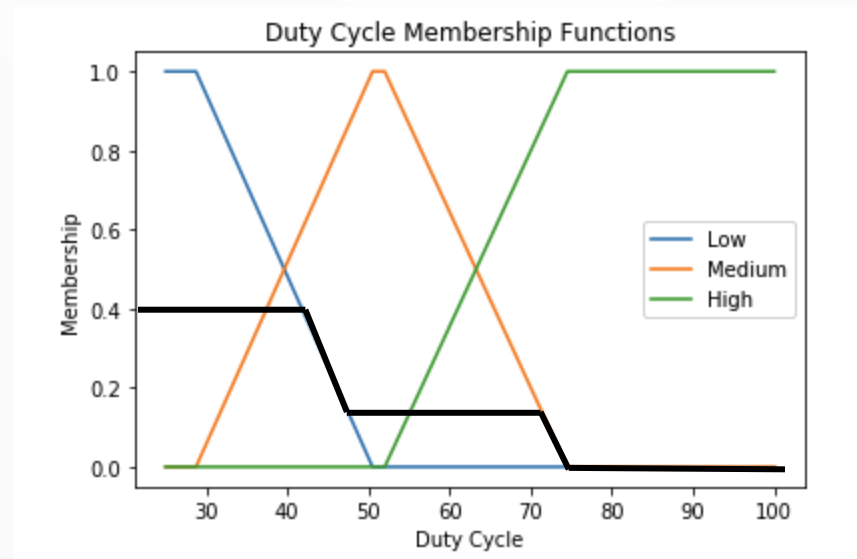
9 **IF (SOC IS HIGH AND power IS ABUNDANT) THEN duty cycle IS HIGH**



Exercise 2

•How to apply the rules?

- 1 **IF** (*SOC IS LOW AND power IS SCARCE*) **THEN** *duty cycle IS LOW ELSE*
- 5 **IF** (*SOC IS MEDIUM AND power IS AVERAGE*) **THEN** *duty cycle IS MEDIUM ELSE*
- 9 **IF** (*SOC IS HIGH AND power IS ABUNDANT*) **THEN** *duty cycle IS HIGH*



Aggregation of the rule consequents

Exercise 2

•How to apply the rules?

For each s in SOC

For each p in FuturePower

For each r in rules

$\text{dutyCycle}[r] = (\text{s in } ___\text{SOC}) * (\text{p in } ___\text{FP}) * ___\text{DC}$

$\text{dcMax} = \max(\text{dutyCycle})$

$\text{fuzzyLookupTable}[s, p] = \text{fuzz.defuzz}(\text{DC}, \text{dcMax}, \text{'bisector'})$

Exercise 3

- Use the lookup table to find the Duty Cycle