HW4 Report

Fundamentals of Computational Intelligence

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(Q1

date:

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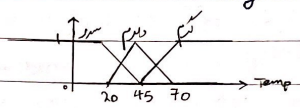
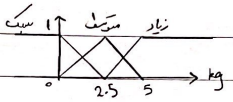
fuzzy controller 1

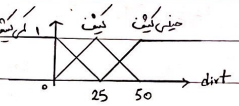
دمای آب : [20-70] → سرد - دلچسب - گرم



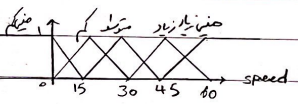
وزن ظرف : [0-5] → سبک - متوسط - زیاد



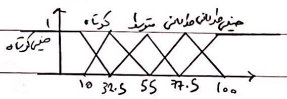
کثیفی : [0-50] → کم کثیف - متوسط کثیف - خیلی کثیف



سرعت چرخشی : [0-60] → خیلی کم - متوسط - زیاد - خیلی زیاد



زمان شستشو : [10-100] → خیلی کوتاه - کوتاه - متوسط - زیاد - خیلی زیاد



Inference system: Mandani Max-Min

Defuzzification method: MOM

Status: 4kg وزن - 45 کثیفی - 20 دمای آب

4kg وزن → $\frac{1}{2.5}=\frac{0.4}{1}$, 0.4 متوسط ; $\frac{1.5}{2.5}=\frac{0.6}{1}$, 0.6 زیاد

45 کثیفی → $\frac{5}{25}=\frac{0.2}{1}$, 0.2 کثیف ; $\frac{20}{25}=\frac{0.8}{1}$, 0.8 خیلی کثیف

20 دما → 1 سرد

- اگر ظرف خیلی کثیف و وزن زیاد و آب سرد باشد پس سرعت چرخش زیاد و زمان شستشو خیلی طولانی باشد.

وزن → 0.6 , کثیفی → 0.8 , دما → 1

⇒ $\min(0.6, 0.8) = 0.6$, $\min(0.6, 1) = 0.6$, $\min(0.8, 1) = 0.8$

max ⟹ $\max(0.6, 0.6, 0.8) = 0.8$

سرعت چرخش : $\frac{0.8}{1}=\frac{12}{15}$ → سرعت چرخش = 57 دور در دقیقه

زمان شستشو : $\frac{0.8}{1}=\frac{18}{22.5}$ → زمان شستشو = 95.5 دقیقه

(Q2

We start by declaring our fuzzy system and its terms which are triangle functions:

```
# Q2_graded
# Do not change the above line.

from simpful import *

FS = FuzzySystem()

player_price = AutoTriangle(6, terms=['very cheap', 'cheap', 'normal', 'expensive', 'very_expensive', 'extremely_expensive'], universe_of_discourse=[0,1000])
player_age = AutoTriangle(5, terms=['very_young', 'young', 'middle_age', 'old', 'very_old'], universe_of_discourse=[18,40])
last_5_matches = AutoTriangle(3, terms=['bad', 'medium', 'good'], universe_of_discourse=[0,5])

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\__ \ )( / \/ \ ) __/ ) _) ) \/ (/ (_/\
(____/(__)\_)(_/(__)  (__)  \____/\____/
```

Then we add our variables that are about our teams (their players and the history of the last 5 matches) so that our fuzzy system knows them.

```
FS.add_linguistic_variable("price_GoalKeeper_Sepahan", player_price)
FS.add_linguistic_variable("age_GoalKeeper_Sepahan", player_age)
FS.add_linguistic_variable("price_LeftDiffender_Sepahan", player_price)
FS.add_linguistic_variable("age_LeftDiffender_Sepahan", player_age)
FS.add_linguistic_variable("price_RightDiffender_Sepahan", player_price)
FS.add_linguistic_variable("age_RightDiffender_Sepahan", player_age)
FS.add_linguistic_variable("price_MidDiffender1_Sepahan", player_price)
FS.add_linguistic_variable("age_MidDiffender1_Sepahan", player_age)
FS.add_linguistic_variable("price_MidDiffender2_Sepahan", player_price)
FS.add_linguistic_variable("age_MidDiffender2_Sepahan", player_age)
FS.add_linguistic_variable("price_MidFielder1_Sepahan", player_price)
FS.add_linguistic_variable("age_MidFielder1_Sepahan", player_age)
FS.add_linguistic_variable("price_MidFielder2_Sepahan", player_price)
FS.add_linguistic_variable("age_MidFielder2_Sepahan", player_age)
FS.add_linguistic_variable("price_MidFielder3_Sepahan", player_price)
FS.add_linguistic_variable("age_MidFielder3_Sepahan", player_age)
FS.add_linguistic_variable("price_RightForward_Sepahan", player_price)
FS.add_linguistic_variable("age_RightForward_Sepahan", player_age)
FS.add_linguistic_variable("price_LeftForward_Sepahan", player_price)
FS.add_linguistic_variable("age_LeftForward_Sepahan", player_age)
FS.add_linguistic_variable("price_CenterForward_Sepahan", player_price)
FS.add_linguistic_variable("age_CenterForward_Sepahan", player_age)
```

Then we declare our rules:

```
Rules = [

        "IF (price_GoalKeeper_Sepahan IS expensive) THEN (result1 IS Sepahan_win)",
        "IF (price_GoalKeeper_Foolad IS cheap) THEN (result1 IS Sepahan_win)",
        "IF (age_GoalKeeper_Sepahan IS middle_age) THEN (result1 IS Sepahan_win)",
        "IF (age_GoalKeeper_Foolad IS very_old) THEN (result1 IS Sepahan_win)",
        "IF (price_GoalKeeper_Foolad IS expensive) THEN (result1 IS Foolad_win)",
        "IF (age_GoalKeeper_Sepahan IS very_old) THEN (result1 IS Foolad_win)",

        "IF (price_MidDiffender1_Sepahan IS expensive) THEN (result2 IS Sepahan_win)",
        "IF (price_MidDiffender1_Foolad IS cheap) THEN (result2 IS Sepahan_win)",
        "IF (age_MidDiffender1_Sepahan IS middle_age) THEN (result2 IS Sepahan_win)",
        "IF (age_MidDiffender1_Foolad IS very_old) THEN (result2 IS Sepahan_win)",
        "IF (price_MidDiffender2_Sepahan IS expensive) THEN (result2 IS Sepahan_win)",
        "IF (age_MidDiffender2_Sepahan IS middle_age) THEN (result2 IS Sepahan_win)",
        "IF (age_MidDiffender2_Foolad IS very_old) THEN (result2 IS Sepahan_win)",
        "IF (price_MidDiffender2_Foolad IS cheap) THEN (result2 IS Sepahan_win)",
        "IF (price_LeftDiffender_Sepahan IS expensive) THEN (result2 IS Sepahan_win)",
        "IF (age_LeftDiffender_Sepahan IS middle_age) THEN (result2 IS Sepahan_win)",
        "IF (age_LeftDiffender_Foolad IS very_old) THEN (result2 IS Sepahan_win)",
        "IF (price_LeftDiffender_Foolad IS cheap) THEN (result2 IS Sepahan_win)",
        "IF (price_RightDiffender_Sepahan IS expensive) THEN (result2 IS Sepahan_win)",
        "IF (age_RightDiffender_Sepahan IS middle_age) THEN (result2 IS Sepahan_win)",
        "IF (age_RightDiffender_Foolad IS very_old) THEN (result2 IS Sepahan_win)",
        "IF (price_RightDiffender_Foolad IS cheap) THEN (result2 IS Sepahan_win)",
        "IF (age_MidDiffender1_Foolad IS middle_age) THEN (result2 IS Foolad_win)",
```

Now, we set our previously declared variables to a number:

```
FS.set_variable("history_Sepahan", 4)
FS.set_variable("history_Foolad", 3)
FS.set_variable("price_GoalKeeper_Foolad", 270)
FS.set_variable("age_GoalKeeper_Foolad", 27)
FS.set_variable("price_LeftDiffender_Foolad", 338)
FS.set_variable("age_LeftDiffender_Foolad", 23)
FS.set_variable("price_RightDiffender_Foolad", 428)
FS.set_variable("age_RightDiffender_Foolad", 24)
FS.set_variable("price_MidDiffender1_Foolad", 405)
FS.set_variable("age_MidDiffender1_Foolad", 25)
FS.set_variable("price_MidDiffender2_Foolad", 383)
FS.set_variable("age_MidDiffender2_Foolad", 22)
FS.set_variable("price_MidFielder1_Foolad", 225)
FS.set_variable("age_MidFielder1_Foolad", 32)
FS.set_variable("price_MidFielder2_Foolad", 225)
FS.set_variable("age_MidFielder2_Foolad", 29)
FS.set_variable("price_MidFielder3_Foolad", 585)
FS.set_variable("age_MidFielder3_Foolad", 29)
FS.set_variable("price_RightForward_Foolad", 496)
FS.set_variable("age_RightForward_Foolad", 28)
FS.set_variable("price_LeftForward_Foolad", 405)
FS.set_variable("age_LeftForward_Foolad", 22)
FS.set_variable("price_CenterForward_Foolad", 405)
FS.set_variable("age_CenterForward_Foolad", 31)
```

Finally, based on our declared result function, the fuzzy system makes a prediction, which for me was Sepahan 3-0 Foolad:

```
result = AutoTriangle(3, terms=['Sepahan_win', 'tie', 'Foolad_win'], universe_of_discourse=[-10,10])
```

```
Sepahan_score = 0
Foolad_score = 0
score = FS.inference()

for i in range(1,5):
    if score[f"result{i}"] > 1:
        Foolad_score += 1
    elif score[f"result{i}"] < -1:
        Sepahan_score += 1

print(f"The prediction of the game is Sepahan {Sepahan_score}-{Foolad_score} Foolad")
```

```
The prediction of the game is Sepahan 3-0 Foolad
```

(Q3

3

very young = (0.81, 10), (0.64, 20), (0.25, 30), (0.04, 40), (0, 50)

very tall = (1, 1.9), (0.56, 1.8), (0.25, 1.7), (0.04, 1.6)

very tall \ very young	10	20	30	40	50
1.9	0.81	0.64	0.25	0.04	0
1.8	0.56	0.56	0.25	0.04	0
1.7	0.25	0.25	0.25	0.04	0
1.6	0.04	0.04	0.04	0.04	0

excellent = (1, 1.0), (1, 9), (0.7, 8), (0.5, 7), (0.3, 6)

→ max(0.81, 0.64, 0.25, 0.04, 0) = 0.81
max(0.56, 0.56, 0.25, 0.04, 0) = 0.56
max(0.25, 0.25, 0.25, 0.04, 0) = 0.25
max(0.04, 0.04, 0.04, 0.04, 0) = 0.04

⇝ excellent = (0.81, 0.56, 0.25, 0.04)

very shorts (1, 1.4), (0.86, 1.5), (0.7, 1.6), (0.5, 1.7)

old = (0.1, 40), (0.3, 50), (0.5, 60), (0.7, 70), (0.9, 80), (1, 90), (1, 100)

very short \ old	40	50	60	70	80	90	100
1.4	0.1	0.3	0.5	0.7	0.9	1	1
1.5	0.1	0.3	0.5	0.7	0.86	0.86	0.86
1.6	0.1	0.3	0.5	0.7	0.7	0.7	0.7
1.7	0.1	0.3	0.5	0.5	0.5	0.5	0.5

careful = (0.3, 4), (0.5, 3), (0.7, 2), (1, 0)

→ mean(0.1, 0.1, 0.1, 0.1) = 0.1
max(0.3, 0.3, 0.3, 0.3) = 0.3
max(0.3, 0.5, 0.5, 0.5) = 0.5
max(0.3, 0.5, 0.7, 0.5) = 0.7
max(0.3, 0.5, 0.7, 0.5) = 0.7
max(0.3, 0.5, 0.7, 0.5) = 0.7
max(0.3, 0.5, 0.7, 0.5) = 0.7

⇝ careful = (0.1, 0.3, 0.5, 0.7, 0.7, 0.7, 0.7)

(Q4

نمیتوان برای بازی XO یک کنترلگر فازی نوشت.

بازی XO به دلیل محدود بودن انواع حرکت و تعداد خانه ها، جایگشت ها و قوانین مشخصی دارد و تعداد حالت های مختلف بازی از آغاز تا پایان !۹ است. مثلا نمیتوان گفت که با حرکت در یکی از خانه ها چقدر احتمال برد/باخت وجود دارد. در نتیجه قوانین بازی برای برد و باخت بازیکنان ثابت است و نمیتوان آن ها را به فضا و قوانین فازی و احتمالاتی تبدیل کرد.

Resources:
https://github.com/aresio/simpful