Applied AI
Homework-II

Football Player Price Estimator Engine – Fuzzy Logic

Introduction:

This project aims at creating an engine to estimate the transfer value of a player in the current transfer market across Europe. Twice a year in Football (soccer) leagues across Europe FIFA lifts the transfer window open. During this period in Summer lasting from end of a league season's to beginning of next one and a month's duration in January, football clubs are allowed to sign the players from other teams participating in the same league or different league across Europe.

In recent times, we have observed how the football market has gone crazy with transfer fees for some players going as high as $150 Million Euros. We see that in every season the world record for the transfer fee is shattered for each of the player positions, which is unusual as defenders and goalkeepers were valued less as compared to forward more attacking players. However, that has changed in recent times. The major concern that these high transfer fee raises is whether it is a good business to buy players as such inflated costs because of inflation in the market.

In the current market of global recession where the football clubs are being run more like a business and less like a sports team, it becomes of prime importance for teams to scout the right player and estimate its accurate market value. This not only helps the club to carry out effective negotiations but also make sure that they can get the money invested in the right players by making a high probable bet to gain profits either from player's selling price some years later or through market value of a player.

* This document is built on the framework from the work done in previous assignment and is updated to accommodate the changes made for implementation of Fuzzy rules and its effect on the result.

Implementation:

There are many player attributes that could be considered while estimating price however sometimes only attributes are not enough to gauge a player's value. There are many organizations that provide statistics on players and ratings based on their on-pitch performances. These ratings are calculated using very robust and complicated methods and we

shall be using a few among these stats for the sake of simplicity and scope of the project. Following are the factors that we are using to gauge players estimate fees:

1. **Age**: rules are based on the age groups as age has a great influence on the price of the player. Young players with less experience are values less, similar to players who are more the 30 to 35 years old. Players who are young from 20 to 30 years of age are most valued in the transfer market.
2. **Player Position**: The forwards more attacking players have been valued a slightly higher than the players playing in more defensive roles. However, recently there have been some anomalies in this case as fees as high as $70 million were paid for defenders.
3. **Appearance**: More the appearance of a player will corelate to a higher value.
4. **Status in Squad**: If the player whose value is being estimated is an indispensable player for the current team he is in, he will come with a price tag slightly higher as compared a player with similar stats and attributes but with less important role in the team. This is because teams don't like their first team members leave easily, hence they have loftier transfer fees
5. Other attributes such as **pace, reflex, number of goals, interceptions made, assists score, dribbling score etc**., are considered based on the position of the player to calculate his rating and then factors such as if the player is in the **same league, same division etc.,** are also factored in to estimate the current transfer fees of the player.

a. Facts

Templates were created for the **player** and positions like, **midfielder, goalkeeper, forward and goalkeeper.**

One such template is:

```
;template for a goalkeeper
(deftemplate goalkeeper
    (slot clean-sheets)
    (slot reflex (type INTEGER))
    (slot handling (type INTEGER))
    (slot kicking (type INTEGER)))
```

b. Fuzzy Variables

To define fuzzy concepts we declared **five** fuzzy variables:

```
(defglobal ?*appearance* = (new nrc.fuzzy.FuzzyVariable "appearance" 0.0 999 "matches"))
(defglobal ?*age* = (new nrc.fuzzy.FuzzyVariable "age" 0 99 "years"))
(defglobal ?*cost* = (new nrc.fuzzy.FuzzyVariable "cost" 0 200 "millions"))
(defglobal ?*status* = (new nrc.fuzzy.FuzzyVariable "squad-status" 0 10 "score"))
(defglobal ?*speed* = (new nrc.fuzzy.FuzzyVariable "speed" 0 100 "score"))
```

The reason to take the first four attributes of a player as parameters for implementing fuzzy logic is that they can be represented better using the range as compared to binary values. Values such as appearance, age, cost and squad status don't have a definite boundary in general. **I found that if we evaluate the average cost based on calculations done in few or more categories to which we segregate the players will result in better estimation of a player's cost.**

c. Fuzzy Terms

We used at least 3 fuzzy sets per fuzzy variable in order to have a better vocabulary and extended reach for declaring the fuzzy concepts for the project. Defined under the **init** rule, an example for the Fuzzy terms declared for one of the above fuzzy variables is:

```
(?*age* addTerm "young" (new ZFuzzySet 16 20))
(?*age* addTerm "learning-age" (new TrapezoidFuzzySet 18 20 25 27))
(?*age* addTerm "peak-age" (new TrapezoidFuzzySet 23 25 30 32))
(?*age* addTerm "mature" (new TrapezoidFuzzySet 28 30 35 37))
(?*age* addTerm "old" (new SFuzzySet 35 40))
```

In this example for age Fuzzy Variable, we have associated 5 Fuzzy sets to the variable which helps us to calculate precise cost of the player.

d. Fuzzy Values:

We asserted the following fuzzy values to implement fuzzy logic for the project.

```
(assert (theAppearance (new nrc.fuzzy.FuzzyValue ?*appearance* (new SingletonFuzzySet ?*appearances*))))
(assert (theAge (new nrc.fuzzy.FuzzyValue ?*age* (new SingletonFuzzySet ?age))))
(assert (theStatus (new nrc.fuzzy.FuzzyValue ?*status* (new SingletonFuzzySet ?*squad-status*))))
(assert (thePace (new nrc.fuzzy.FuzzyValue ?*speed* (new SingletonFuzzySet ?*pace*))))
```

All the values were created for corresponding fuzzy variables using the **SingletonFuzzySet** based on the assumption that all the statistics of the player are recorded per match and have a method that is independent of error or approximation.

e. Rules

There are a total of **33 rules** that are being implemented for this project. They can be categorized as follows:

Rules1: Init - Adds all the fuzzy **terms** to the variables
Rule 2: Enter-Details - Takes the user **input** for a given player
Rule 3 to 7: Triggered for footballer playing at **Forward** position, segregated based on **age**
Rule 8 to 12: Triggered for footballer playing at **Midfield** position, segregated based on **age**
Rule 13 to 17: Triggered for footballer playing at **Defense** position, segregated based on **age**

Rule 18 to 22: Triggered for footballer playing as **Goalkeeper**, segregated based on **age**
Rule 23 to 26: Triggered to handle the **squad status** of the footballer
Rule 27 to 29: Triggered to handle the **appearances made** by footballer
Rule 30 to 32: Triggered to handle the **pace** of the footballer
Rule 33: Triggered to handle the **estimate cost** of the footballer

Except the first two rules all the other have Fuzzy Value based antecedents, for example belonging to a certain age group or some pace level. Most of the calculation for estimating a player's cost is implemented under these rules which also call few function for calculation of player rating belonging to individual positions.

f. Functions

Implementation is carried out using different functions to calculate ratings such as **gk-rating** etc. and take player position specific inputs like **enter-forward-props.**

Details on functionality

First, the attributes of the players are recorded by the program and then the system **asserts** the player and position to the fact. In addition to assertion of the player, Fuzzy Values of age, pace, squad status and appearances are also asserted into the system. Now we have the environment set up for execution of the fuzzy logic. **Age** is of prime importance while estimating the price of the player. In our implementation a player can belong to two age groups for example when he/she is 29. Now this will **calculate his estimate cost for both "prime-age" and "mature" group**. Our final price estimation will be an average of both the values carried out using the cost value.

Furthermore, we are considering values of **appearance and squad status** as well to segregate players and manipulate their final price based on these values.
For the scope of this project, we considered pace as one of the attributes of the player on which we can implement fuzzy logic, we could still implement the fuzzy logic for some of the other properties as well.

Example:

The below screenshot is included to show the internal working of the program. Notice how based on the earlier logic the player got segregated into two of the age groups, resulting in calculation of two costs for the player. These two costs are furthered modified based on pace, appearance and squad status before getting averaged to give us the final estimate result. Which when compared to initial values are much closer to practical value.

```
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This copy of Jess will expire in 1805 day(s).
f-0    (MAIN::initial-fact)
For a total of 1 facts in module MAIN.
Enter the footballer's Name:
Kante
Enter the footballer's Age:
29
Enter the footballer's Position: DEF MID FOR GK
MID
Does the footballer belong to same(1) or different league(0)?
1
In which division does the team he play for belong?
1
Enter the footballer's appearances:
289
Is the player important(1)or a backup(0) in his current team
10
Enter pace score:
97
Enter assists score:
78
Enter dribble score:
88
Enter passing score:
78
midfielder is at Peak age, rating:0.30000000000000004 estimated vale 24.000000000000004million Euros
midfielder has Matured, rating:0.30000000000000004 estimated vale 18.000000000000004million Euros
Player Estimated Cost before pace 42.000000000000001million Euros
Player Estimated Cost after pace 52.500000000000001million Euros
Player Estimated Cost before status 52.500000000000001million Euros
Player Estimated Cost after status 78.750000000000001million Euros
Player Estimated Cost before app 78.750000000000001million Euros
Player Estimated Cost after app 94.500000000000001million Euros
Player Estimated Cost is 47.250000000000001million Euros
```

For the sake of simplicity, all these values have been hidden and the final program displays the final estimated cost. These values can be visible on uncommenting the print statements associated with each rules.

All the attributes are factored in to estimate the player's current market transfer fees.

Test Cases:

1. Player Position: Forward Age: 23

```
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This copy of Jess will expire in 1804 day(s).
f-0    (MAIN::initial-fact)
For a total of 1 facts in module MAIN.
Enter the footballer's Name:

Werner
Enter the footballer's Age:
23
Enter the footballer's Position: DEF MID FOR GK
FOR
Does the footballer belong to same(1) or different league(0)?
0
In which division does the team he play for belong?
1
Enter the footballer's appearances:
128
Is the player important or a backup in his current team, Enter a score from 1(backup) to 10(very imp)
9
Enter pace score:
90
Enter goals score:
78
Enter shooting score:
86
Player Estimated Cost is 96.0million Euros
```

2. Player Position: Midfielder Age: 29

```
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This copy of Jess will expire in 1804 day(s).
f-0    (MAIN::initial-fact)
For a total of 1 facts in module MAIN.
Enter the footballer's Name:
Kante
Enter the footballer's Age:
29
Enter the footballer's Position: DEF MID FOR GK
MID
Does the footballer belong to same(1) or different league(0)?
1
In which division does the team he play for belong?
1
Enter the footballer's appearances:
298
Is the player important or a backup in his current team, Enter a score from 1(backup) to 10(very imp)
10
Enter pace score:
78
Enter assists score:
74
Enter dribble score:
88
Enter passing score:
89
midfielder is at Peak age, rating:0.6000000000000001 estimated vale 48.00000000000001million Euros
midfielder has Matured, rating:0.6000000000000001 estimated vale 36.00000000000001million Euros
Player Estimated Cost is 75.60000000000001million Euros
```

**for all midfielders old values are still visible

3. Player Position: Defender Age: 32

```
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This copy of Jess will expire in 1804 day(s).
f-0    (MAIN::initial-fact)
For a total of 1 facts in module MAIN.
Enter the footballer's Name:
Azpi
Enter the footballer's Age:
32
Enter the footballer's Position: DEF MID FOR GK
DEF
Does the footballer belong to same(1) or different league(0)?
1
In which division does the team he play for belong?
1
Enter the footballer's appearances:
250
Is the player important or a backup in his current team, Enter a score from 1(backup) to 10(very imp)
8
Enter pace score:
83
Enter interception score:
79
Enter tackle score:
82
Enter clearance score:
86
Enter marking score:
88
Player Estimated Cost is 42.0million Euros
```

4. Player Position: Goalkeeper Age: 19

```
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This copy of Jess will expire in 1804 day(s).
f-0    (MAIN::initial-fact)
For a total of 1 facts in module MAIN.
Enter the footballer's Name:
David
Enter the footballer's Age:
19
Enter the footballer's Position: DEF MID FOR GK
GK
Does the footballer belong to same(1) or different league(0)?
1
In which division does the team he play for belong?
2
Enter the footballer's appearances:
40
Is the player important or a backup in his current team, Enter a score from 1(backup) to 10(very imp)
7
Enter pace score:
33
Enter clean-sheets score:
76
Enter reflex score:
77
Enter handling score:
74
Enter kicking score:
78
Player Estimated Cost is 4.2374624999999995million Euros
```

Limitations:

With respect to the scope of the project, not all the contributing attributes of the player was considered, this could influence the transfer fee of the player. Only the topmost important were chosen here. And among that only pace attribute was considered for Fuzzy logic. We could further increase the precision of the code by adding fuzzy logic implementation for various stats of a player.

****Instruction for running the code:**

Download FuzzyJ-2.0 Jar and include in the project
Please load the program into the eclipse environment in that project
Once the environment is set, go to run as-> jess configuration (right click in the program pane)
Change the main class to: nrc.fuzzy.jess.FuzzyMain **and run the program**