Heuristic Optimization Methods 2020/2021

Fantasy football draft problem – Report by Toma Petrač 0036493691

1. **Greedy algorithm**

Considering the fact that we want to maximize the points given only by players in the starting eleven, I first approached this problem by finding four players with the least value of all players in the database (so that we have as much budget as possible for the best eleven). I had to consider the number of these benched players, e.g. I had to include exactly one goalkeeper among these substitutes. Furthermore, we can't just take three defenders because of the constraints (5 defenders total, minimum 3 in the starting formation), so I had to keep track of benched players and their respective positions.

After we've chosen the least valuable players for the bench, we go with the greedy algorithm over the reduced search space, because if we don't reduce it, we won't be able to purchase eleven players. Search space is reduced here by slicing the list of players sorted by points by the slicing step (e.g. if the slicing step is 3, we will only consider each third player when going through the list of them all). Depending on the instance, I've tried different numbers of the slicing step, and it turned out that, for instance1, the best step is 17, and for instance2, it's 6. Additionally, we need to keep notion of those constraints (3 max per club, and positions). After we've selected our whole team, we only need to choose the best formation.

Pseudocode:

databases = [goalkeepers, defenders, midfielders, forwards]  
players\_by\_position = {'GK': 2, 'DEF': 5, 'MID': 5, 'FW': 3}

for pos\_no, database in zip(players\_by\_positions.values, databases):  
 player\_counter = 0  
 for player\_to\_add in sorted(database, key=points)[::slicin\_step]:  
 if constraints\_are\_met():  
 my\_team.add(player\_to\_add)  
 player\_counter += 1  
 update\_budget()  
 update\_club\_constraints()

1. **Local search**

Our current solution consists only of starting eleven players. Neighboring solutions are all solutions that are different from current solution by exactly one player. While there is a better neighboring solution, we will find it and replace it with the current one. This is implemented with a while(True) loop and a loop for each of our current player. We keep track of each possible replacement that would result in scoring more points that we currently have. In the end, if there is no better neighboring solution than the current, we break the loop and result is what we have saved last.

Pseudocode:

while True:  
 player\_replacements = []  
 for i in range(11):  
 player\_to\_remove = best\_eleven[i]  
 position = player\_to\_remove.pos  
   
 for player in sorted(all\_players\_dict[position],key=pnts):  
 if constraints\_are\_met:  
 player\_replacements.append((player\_to\_remove, player, point\_difference))  
 if len(player\_replacements) > 0:  
 player\_replacements.sort(key=point\_difference)  
 player\_to\_remove, player\_to\_add = player\_replacements[0]  
 my\_team.remove(player\_to\_remove)  
 my\_team.add(player\_to\_add)  
 update\_budget()  
 update\_club\_constraints()  
 else:  
 break

1. **Results**

**-** Instance1:

**Greedy algorithm**

**My team:**

{Alexander-Arnold DEF Liverpool 146.0 7.7, El Ghazi MID Aston Villa 72.0 5.5, Walker DEF Man City 60.0 5.7, Salah MID Liverpool 165.0 12.8, Henderson GK Sheffield Utd 113.0 5.1, Fleck MID Sheffield Utd 89.0 5.1, Dendoncker MID Wolves 62.0 4.4, Stearman DEF Sheffield Utd 0.0 3.9, Button GK Brighton 0.0 3.9, Deulofeu FW Watford 85.0 6.1, Azpilicueta DEF Chelsea 78.0 5.8, Vardy FW Leicester 152.0 9.8, Martinelli FW Arsenal 39.0 4.6, Gibson DEF Burnley 0.0 3.9, Elneny MID Arsenal 0.0 4.3}

Number of players in team: 15

Budget left: 11.399999999999991

Total points (whole team): 1061.0

Team by positions:

[Henderson GK Sheffield Utd 113.0 5.1, Button GK Brighton 0.0 3.9]

[Alexander-Arnold DEF Liverpool 146.0 7.7, Azpilicueta DEF Chelsea 78.0 5.8, Walker DEF Man City 60.0 5.7, Stearman DEF Sheffield Utd 0.0 3.9, Gibson DEF Burnley 0.0 3.9]

[Salah MID Liverpool 165.0 12.8, Fleck MID Sheffield Utd 89.0 5.1, El Ghazi MID Aston Villa 72.0 5.5, Dendoncker MID Wolves 62.0 4.4, Elneny MID Arsenal 0.0 4.3]

[Vardy FW Leicester 152.0 9.8, Deulofeu FW Watford 85.0 6.1, Martinelli FW Arsenal 39.0 4.6]

**Starting eleven points: 1061.0**  
**Starting formation (3-4-3):**

O O O

Martinelli Deulofeu Vardy

O O O O

Dendoncker El Ghazi Fleck Salah

O O O

Alexander-Arnold Azpilicueta Walker

O

Henderson

**Local search:**

1. Player Dendoncker MID Wolves 62.0 4.4 replaced by player De Bruyne MID Man City 161.0 10.8

**new\_points:** 1160.0

**new\_remaining\_budget:** 4.999999999999991

1. Player Martinelli FW Arsenal 39.0 4.6 replaced by player Rashford FW Man Utd 134.0 8.9

1255.0

0.6999999999999904

1. Player Walker DEF Man City 60.0 5.7 replaced by player Pereira DEF Leicester 107.0 6.3

1302.0

0.09999999999999076

1. Player El Ghazi MID Aston Villa 72.0 5.5 replaced by player Henderson MID Liverpool 92.0 5.5

1322.0

0.09999999999999076

1. Player Azpilicueta DEF Chelsea 78.0 5.8 replaced by player Evans DEF Leicester 90.0 5.2

1334.0

0.6999999999999904

1. Player Deulofeu FW Watford 85.0 6.1 replaced by player Pukki FW Norwich 119.0 6.5

1368.0

0.29999999999999005

1. Player Fleck MID Sheffield Utd 89.0 5.1 replaced by player Cantwell MID Norwich 92.0 4.9

1371.0

0.49999999999998934

1. Player Evans DEF Leicester 90.0 5.2 replaced by player Lundstram DEF Sheffield Utd 115.0 5.0

1396.0

0.6999999999999895

1. Player Henderson MID Liverpool 92.0 5.5 replaced by player Traoré MID Wolves 103.0 5.8

1407.0

0.3999999999999897

1. Player Pereira DEF Leicester 107.0 6.3 replaced by player van Dijk DEF Liverpool 127.0 6.5

1427.0

0.19999999999998952

**No more improving neighboring solutions! Local search has ended.**

**Final starting formation (3-4-3):**

O O O

Rashford Pukki Vardy

O O O O

De Bruyne Traoré Cantwell Salah

O O O

Alexander-Arnold Lundstram van Dijk

O

Henderson

10,71,130,73,280,434,343,283,542,556,546,274,273,70,520,**Total points: 1427.0**

- Instance2:

**Greedy algorithm**

**My team:**

{Stearman DEF Sheffield Utd 0.0 3.9, Pope GK Burnley 126.0 4.8, Tielemans MID Leicester 94.0 6.2, Traoré MID Wolves 107.0 5.8, Alexander-Arnold DEF Liverpool 164.0 7.8, Firmino FW Liverpool 128.0 9.6, Wood FW Burnley 100.0 6.1, Gibson DEF Burnley 0.0 3.9, Sterling MID Man City 116.0 11.7, O'Connell DEF Sheffield Utd 90.0 4.7, Button GK Brighton 0.0 3.9, Vardy FW Leicester 156.0 9.7, Elneny MID Arsenal 0.0 4.3, De Bruyne MID Man City 178.0 10.7, Baldock DEF Sheffield Utd 109.0 5.1}

Number of players in team: 15

Budget left: 1.7999999999999936

Total points (whole team): 1368.0

Team by positions:

[Pope GK Burnley 126.0 4.8, Button GK Brighton 0.0 3.9]

[Alexander-Arnold DEF Liverpool 164.0 7.8, Baldock DEF Sheffield Utd 109.0 5.1, O'Connell DEF Sheffield Utd 90.0 4.7, Stearman DEF Sheffield Utd 0.0 3.9, Gibson DEF Burnley 0.0 3.9]

[De Bruyne MID Man City 178.0 10.7, Sterling MID Man City 116.0 11.7, Traoré MID Wolves 107.0 5.8, Tielemans MID Leicester 94.0 6.2, Elneny MID Arsenal 0.0 4.3]

[Vardy FW Leicester 156.0 9.7, Firmino FW Liverpool 128.0 9.6, Wood FW Burnley 100.0 6.1]

**Starting eleven points: 1368.0  
Starting formation (3-4-3):**

O O O

Wood Firmino Vardy

O O O O

Tielemans Traoré Sterling De Bruyne

O O O

Alexander-Arnold Baldock O'Connell

O

Pope

**Local search:**

1. Player Sterling MID Man City 116.0 11.7 replaced by player Salah MID Liverpool 177.0 12.8

**new\_points:** 1429.0

**new\_remaining\_budget:** 0.6999999999999922

1. Player Wood FW Burnley 100.0 6.1 replaced by player Pukki FW Norwich 125.0 6.5

1454.0

0.29999999999999183

1. Player Firmino FW Liverpool 128.0 9.6 replaced by player Jiménez FW Wolves 145.0 8.0

1471.0

1.8999999999999915

1. Player O'Connell DEF Sheffield Utd 90.0 4.7 replaced by player Pereira DEF Leicester 117.0 6.3

1498.0

0.29999999999999183

1. Player Tielemans MID Leicester 94.0 6.2 replaced by player Mount MID Chelsea 105.0 6.1

1509.0

0.39999999999999236

1. Player Pereira DEF Leicester 117.0 6.3 replaced by player van Dijk DEF Liverpool 135.0 6.6

1527.0

0.09999999999999254

1. Player Baldock DEF Sheffield Utd 109.0 5.1 replaced by player Lundstram DEF Sheffield Utd 116.0 4.9

1534.0

0.29999999999999183

1. Player Mount MID Chelsea 105.0 6.1 replaced by player Pérez MID Leicester 110.0 6.2

1539.0

0.1999999999999913

**No more improving neighboring solutions! Local search has ended.**

**Final starting formation (3-4-3):**

O O O

Pukki Jiménez Vardy

O O O O

Pérez Traoré Salah De Bruyne

O O O

Alexander-Arnold Lundstram van Dijk

O

Pope

Player IDs: 16,72,139,74,285,282,344,326,545,551,559,272,521,271,70,**Total points: 1539.0**

1. Programming language used: **Python 3.7.1**