UNIVERSITY OF ZAGREB

Faculty of Electrical Engineering and Computing

Master Programme

Heuristic Optimization Methods

First lab assignment

Fantasy football draft problem

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Contents

1 Problem description....3
1.1 Problem instance....3
1.2 Problem formulations....4
1.3 Frequently asked questions (FAQ)....5
2 Tasks....6

1 Problem description

Fantasy football is a game where participants serve as managers of virtual football teams. In the Fantasy Premier League (https://fantasy.premierleague.com/) (FPL), you are given a task to pick a squad of real-life football players playing in the English Premier League, who score points for your team based on their performances in their own real matches. As a manager, you are given a budget of **100 million** in virtual currency, which can be spent on selecting a squad.

A squad has to have 15 players across four different positions: **goalkeepers (GK)**, **defenders (DEF)**, **midfielders (MID)**, and **forwards (FW)**. However, only 11 players will make it to the first team lineup, and 4 players have to serve as substitutes. Points can only be scored by players selected in the first team lineup. Given the list of players with their respective value (price), club, and points scored, your task is to draft a squad of 15 players, and pick the first team lineup, so as to **maximize the number of points scored by the selected eleven players** on the pitch. The following text describes the format of problem instances (input files), and formulates the objectives and constraints.

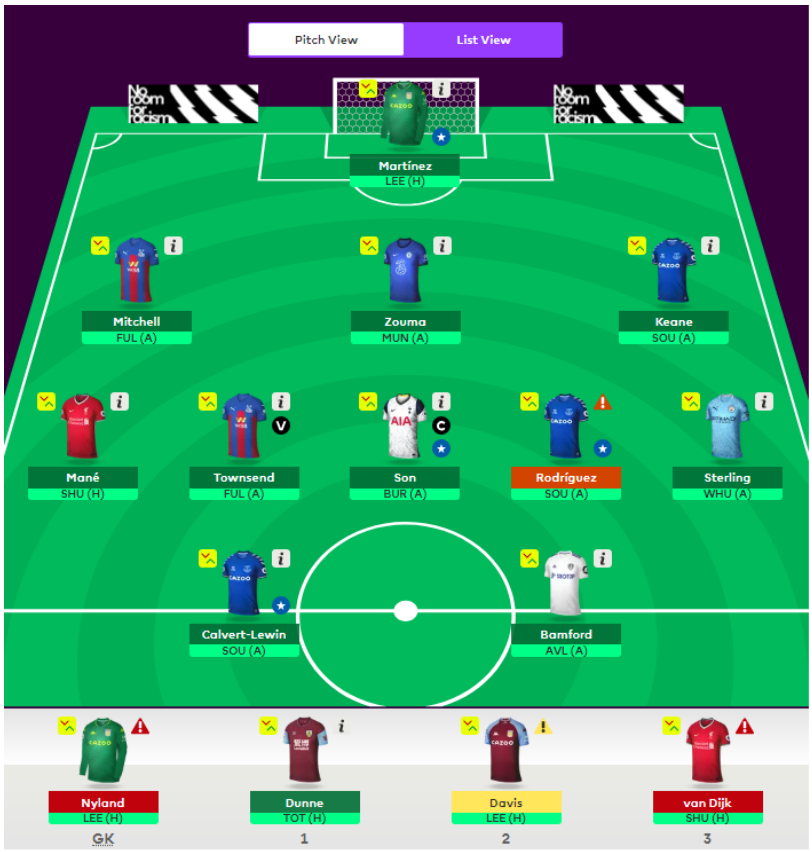

Figure 1. Example of a drafted fantasy squad on FPL

1.1 Problem instance

Problem instances define the list of players which are available for the draft. These instances were collected from various gameweeks during the course of previous and current football seasons. The data provided in each instance file is defined as follows:

- ID – unique integer representing each player
- Position – player's position on the pitch (e.g., GK, DEF, MID, or FW)
- Name – player's surname

- Club – player's club
- Points – points scored during that season (until the point of creating the instance)
- Price – player's cost in virtual currency (in millions)

ID	Position	Name	Club	Points	Price
1	GK	Ederson	Man City	13	6.0
2	GK	Alisson	Liverpool	17	5.9
3	GK	Pope	Burnley	15	5.5
...					
34	DEF	Alexander-Arnold	Liverpool	15	7.5
35	DEF	Robertson	Liverpool	25	7.1
36	DEF	van Dijk	Liverpool	15	6.4
...					
248	MID	Salah	Liverpool	48	12.3
249	MID	Mane	Liverpool	31	11.9
250	MID	Aubameyang	Arsenal	18	11.8
...					
485	FW	Kane	Spurs	60	10.8
486	FW	Agüero	Man City	2	10.4
...					

The player's ID, club, points, and price may vary from instance to instance. Additionaly, some players may be added or removed from the instances.

1.2 Problem formulations

The problem defines the following **constraints**:

1. Budget
    - A budget of **100 million** virtual currency is available for the draft.
    - Total cost of the drafted 15 players must not exceed the budget, but can be less than the budget.
2. Squad draft
    - A 15-player squad must be drafted, consisting of:
        - 2 goalkeepers
        - 5 defenders
        - 5 midfielders
        - 3 forwards

- A maximum of 3 players can be selected from a single club

3. First team lineup
    - From the 15-player squad, 11 players must be picked for the first team.
    - The players can play in any formation, providing:
        - 1 goalkeeper
        - At least 3 defenders
        - At least 1 forward
    - 4 players must be selected as substitutes
        - 1 goalkeeper must be a substitute
    - Players can only play in positions defined by the instance (i.e., goalkeepers can only play in a goalkeeper position, or sit on the bench)

The main objective is to maximize the sum of points from the players selected for the first team, and find the "best eleven" players in each instance. Points from players placed on the bench are not calculated in the overall score, however, their cost is deducted from the available budget. The solution consists of a list of (15) players drafted, a list of (11) players picked for the first team, the selected formation, and the overall score of the first team squad.

1.3 Frequently asked questions (FAQ)

1. I am not familiar with the rules of football. What are positions, formations, etc.?
   https://en.wikipedia.org/wiki/Association_football

2. FPL offers additional features when drafting your squad such as selecting the team captain. Does this matter for this problem?
   No.

3. If a player is injured, should he be drafted?
   Injuries are out of consideration for the purpose of this practical implementation.

4. Does the precise player position in the formation (left side, center, right side) matter?
   No.

5. Why is it relevant that we identify the substitute players? Is it not just straightforward that we select the 4 cheapest players, given that their points are not taken into consideration?

   According to fantasy football rules (https://fantasy.premierleague.com/help/rules), you must select 15 players and four of those players are required to be substitutes. While it makes sense to select four of the cheapest players, the question remains as to which players, in terms of player position, those will be (i.e., defenders are statistically cheapest players, however there are a lot of them with high number of points).

2 Tasks

1. Design and implement a greedy algorithm to find a solution to the given problem. During solution construction, once a decision variable is assigned a value (i.e., an element is added to the solution), there should be no backtracking. If your algorithm fails to construct a feasible solution, try with a different greedy selection heuristic.
2. Execute your algorithm for the given instances of the problem.
3. For each instance, save the value of the objective function (overall score for the "best eleven"), and the list of drafted players, as well as the list of players in the first team lineup.
4. Design and implement a *Greedy Randomized Adaptive Search Procedure* (GRASP) to solve the problem. During the construction phase, make sure to clarify how the Restricted Candidate List (RCL) is built. For the local search phase, make sure to clarify the solution neighborhood and how neighboring solutions are obtained. Set a chosen value of α (to determine RCL size) and run a maximum of 10 iterations of your GRASP algorithm. Repeat the previous step by tuning α → try with different values. Save the newly obtained solutions.
5. Write a report that describes your implemented algorithms and analyzes obtained results. The report should include the following:
    - Programming language used for the algorithm implementation.
    - Best obtained result for each instance: the value of the objective function, the list of drafted players, as well as the list of players in the first team lineup.
    - The pseudocode of the implemented algorithms.
    - A description of the implemented greedy and GRASP algorithms.
    - A discussion of potential limitations to your implemented algorithms and ways to improve search results.
6. The lab assignment is due on **November 11, 2022 at noon (strict deadline!)**. Additional information regarding the report and code submission will be provided on the course website.

    In addition to submitting your code and report via Moodle, you will be given a link to an online Google form to enter your best results per instance.