SET10121 AI for Optimisation

Optimisation of a Fantasy Football Team

Learning Outcomes Covered:	LO3, LO4, LO5
Assessment Type:	Report
Overall module assessment	75% coursework, 25% class Test
For this assessment:	75%
Assessment Limits:	6 page report + 1 page for Assessment Declaration
Submission Deadline:	Monday 8th December 9am
Submission Method:	Via Moodle
Turnitin on submissions:	Turnitin report not visible to students
Module Leader:	Emma Hart
Tutor with direct responsibility:	E Hart
Return of work and feedback:	Feedback on submissions will normally be provided within three working weeks from the submission date.
Notes:	• You are advised to keep a copy of your submitted assessment. • Please read and follow the 'Fit-to-Sit' guidance if you need to request an extension

Assessment regulations and academic integrity

The University rules on Academic Integrity apply to all submissions. The student academic integrity regulations contain a detailed definition of academic integrity breaches.

- You cannot knowingly permit another student to copy all or part of your work.
- You must not share your work with other students. This includes posting any of your work in any repository that is accessible to others (such as GitHub) and applies also after you have completed the course.
- Asking coursework-related questions in external online forums (such as Stackoverflow) is NOT permitted.

By submitting the report, you are confirming that:

- It is your own work except where explicit reference is made to the contribution of others.
- It has not been submitted for any module, programme or degree at Edinburgh Napier University or any other institution.
- If you have made use of generative Artificial Intelligence (AI) tools, you have done so only as allowed for this assessment, and have provided the relevant details in the coursework declaration.

Academic skills support: In advance of submission, you can access the support of the academic skills team. They can help you with any aspect of the assessment that you might struggle with, that is not content related. For example, they can help with time-management, effective reading and note-making, and any aspect of academic writing that you might struggle with. This support is provided through workshops and individual appointments which are bookable online via MyNapier: Improve your Academic & Study Skills (napier.ac.uk). You can also directly email the Academic Skills Adviser, Hannah Awcock, h.awcock@napier.ac.uk for any specific academic skills support you require.

Use of generative AI:

Please include the Assessment Declaration Cover Sheet as the first page of your submitted report (this does not count towards the 6 pages of the report. The cover sheet is provided on Moodle and below
Submissions must be accompanied by a declaration cover sheet to fulfil the requirements of the university Assessment Policy.

ASSESSMENT DECLARATION COVER SHEET

Please complete this cover sheet for each assessment submission. For group assessments, each group member must individually complete and submit a cover sheet.

STUDENT REGISTRATION NUMBER: Click or tap here to enter text.

MODULE TITLE: Click or tap here to enter text.

DATE OF SUBMISSION: Click or tap to enter a date.

I declare that, except where explicitly acknowledged*, this assessment is my own work and has not been submitted for any other module or degree programme at Edinburgh Napier University or any other institution. This declaration is made in compliance with Edinburgh Napier University's Academic Integrity Regulations.

***IMPORTANT**: Contributions from other sources include incorrectly cited quotations or content generated by Generative Artificial Intelligence (Gen AI) tools, such as ChatGPT. See Artificial Intelligence Tools and Your Learning for more information.

Note: It is also important to check the associated Assessment Brief to understand what is permissible. Unless stated in the Assessment Brief, use of Grammarly for checking spelling and grammar is allowable in this assessment, but it cannot be used to generate content.

Please declare here your use of such tools in this assessment submission:
(Select one of the two options below)

☐ Yes, I have used Gen AI tools for this submission, and I have described how below.

☐ No, I have not used Gen AI tools for this submission.

If you selected **Yes**, briefly describe (in less than 100 words) how you used these tools:

:

Use	Permitted?	Advice	How to acknowledge use
As a search engine	Yes	Cross reference AI output for factual accuracy in authoritative texts e.g. text books, reading lists, peer-reviewed publications	Acknowledgment not required
As an ideas generator/conversational partner/debating partner	Yes	Cross reference for accuracy as above AND check for bias, irrelevant or too generalised ideas.	On cover sheet: "I used [tool name] on [date] with the question [insert question/prompt used] to give me ideas, of which I used/adapted into [idea name] in this submission"
To suggest a submission structure	With caution	Consult the assessment brief first to ensure your structure follows the recommendations and meets the learning outcomes.	On cover sheet: "I used [tool name] on [date] with the question [insert question/prompt used] to get a submission structure, which I used/adapted into [part name] in this submission"
To make suggestions to improve your communication of your ideas	With caution	Always start with your own writing first to develop your own thinking. Use the AI tool to get quick feedback and use your judgement whether its advice is appropriate for your submission. Work on one paragraph at a time.	Acknowledgment not required *Or* On cover sheet: "I used [tool name] on [date] with the question [insert question/prompt used] on [section name(s)/whole submission] to get feedback on my writing, which I then improved based on its advice on [spelling/grammar/ vocabulary/etc.]
To generate content (example 1: not allowed)	No	Never ask an AI tool to generate parts of your submission from scratch. Do not input assessment brief or rubric into AI tools and ask it to generate your submission.	
To generate content (example 2: allowed)	With caution	Always put copied-and-pasted AI content in quotations marks (in the case of text) or label other media appropriately.	On cover sheet: "AI generated content is indicated in this submission [within quotation marks/labelled] which gives the prompt used, the tool name and date used"

Optimising a Fantasy Football Team

In the online game of Fantasy Football, players have to select a high-quality football team from a large pool of potential players, purchased using a fixed budget. Each player has a "points" score associated with them, derived from large numbers of statistics gathered from previous games (for example, goals scored, man of the match, 'clean-sheet', red cards, penalty scored/saved, etc). They also have a purchase cost. From a computational perspective, it's an NP-hard problem to select the optimum team in terms of the total number of points while remaining within the specified budget.

In addition to the constraint regarding the maximum budget that can be spent, there are several additional constraints that need to be satisfied. In fact, there are 7 constraints in total:

1. The total cost of the team must be less than or equal to **£100**
2. There must be exactly 11 players in the team
3. You can't pick the same player more than once (i.e. all players in a team are unique)
4. There must be exactly 1 goal-keeper (GK)
5. There must be at least 3 but no more than 5 defenders (DEF)
6. There must be at least 3 but no more than 5 midfielders (MID)
7. There must be at least 1 but no more than 3 strikers (STR)

Hence, the goal is to select a team that maximises the total points score of the team, remains within budget and satisfies all of the constraints.

What to do

Your goal is to write a stochastic search algorithm to find the best possible solution to this problem (i.e. a team that maximises the point score, remains within budget and does not break any constraints) using any meta-heuristic or local search algorithm (or a hybrid method). You can use any of the methods covered in the module, but you are also free to do some research and use another method if it falls under the category of a stochastic search algorithm*. If you want to use a method not covered in the lecture material, please check with Emma/Sarah before going ahead.*

You can implement your algorithm using the DEAP libraries using the knowledge you have learned in class, but if you prefer to write in another language then that is fine. Note there are no marks associated with the style of the code or for its efficiency or for choosing one language over another.

A data-file is provided that contains real information from a soccer season. The file contains cost, points and position information for 523 players from which you have to select the optimal 11.

You will have to design a representation to use with a stochastic search algorithm (or algorithms) of your choice. You might want to experiment with different representations, algorithms, and/or the parameters and operators of an algorithm. You will need to carefully consider how to deal with the constraints imposed by the problem.

You need to write a report that documents your approach and identifies the single best solution found by your method. The report will be evaluated according to the following criteria (the marks associated with each are also shown):

Approach (15 marks): Explain the representation(s) used to represent an individual solution, including a description of why you chose this. Also, explain the choice of algorithm(s) (EA, local search, hybrid) you will use to solve the problem. Clearly set out what your investigation covers, for example comparing operators/compare algorithms/etc.

Algorithm/Operator Design (25 marks): For the algorithm you chose, describe the algorithm and any operators used, highlighting any customisation you might have made to the algorithm chosen. Clearly describe any custom operators designed and the rationale behind their design. If you use the off-the-shelf operators provided in DEAP without modification you should state which ones used but you don't need to describe how they work. However, you should describe why you chose them.

Experimental Design & Analysis (25 marks) : describe any experiments conducted to test version(s) of your algorithm. Give sufficient detail that experiments could be reproduced, including parameter settings. Present results of experiments in an appropriate form using graphs and/or tables, use statistical significance testing where appropriate and give a commentary that highlights interesting findings.

Solution Quality (10 marks): you must include the points score of the best solution found, and the associated cost in your report. If it breaks any constraints, you must also state this in your report. *You must check the best solution found using the* ***constraint_checker()*** *function supplied and include a screenshot of the output from this as an appendix to your report. If you do not provide this, you will get 0 marks for this aspect*

Evaluation (15 marks): provide a reflective commentary on the results obtained and the approach taken, highlighting any strengths or weaknesses and making suggestions for future work.

Clarity/overall style (10 marks): the document should be written in a scientific style in the format of an academic paper. Be careful to label graphs/tables clearly (including axes on graphs) and use references where appropriate. The report should be a maximum of 6 pages, using Arial font, minimum size 11. **Do not** use any appendices other than the single one required with the screen shot of the checker function.

A marking rubric is included below

	<40	40-50	50-60	60-70	70+
Approach	Inappropriate choices; no explanation provided/explanation incorrect; no clear questions or plan defined	adequate choices of method and/or representation; some basic attempt at explanation but partially incorrect/choices that do not demonstrate understanding of ECO concepts	Good choice of algorithm/representation; good attempt at explanation but missing some depth or has some inaccuracies; choices demonstrate understanding of core material	Very good approach with explanations that demonstrate v. good understanding of material, but perhaps missing some detail or depth	Excellent approach, very clearly justified, demonstrating excellent understanding of core concepts of course, perhaps going beyond taught material
Algorithm and Operator design and customisation	No customisation beyond code provided or design shows lack of understanding of basic concepts	Uses off-the-shelf operators/algorithms with no attempt at developing any customisation to make methods suitable to solving the problem	Some attempt to provide customisation of at least one operator to enforce constraints	Very good attempt to adapt algorithm to problem taking account of constrained nature; may have customised multiple operators or shown very good insight into particular operator design	Excellent; bespoke customisations that demonstrate excellent understanding of the nature of the problem and deep insights into the algorithm; may draw on literature not covered in the course
Experimental design and analysis	Insufficient experiment; poor presentation of results, no analysis	Experimental design meets minimum requirements, but very limited in scope or ha some flaws; presentation adequate but lacks statistical analysis	Good design, that includes some experimentation of parameters/methods. Presentation could perhaps be improved; at least some attempt at basic statistical analysis provided	Very good design that covers a range of factors; results well presented, appropriate use of statistics	Excellent design, wide ranging or very thorough investigation; thoughtful presentation or results, thorough use of statistics, excellent analysis
Solution quality	No solution given	Solution provided but breaks most/all of the constraints	Solution provided but breaks a few constraints, at top end of this range, solutions are very close to being feasible	Solution doesn't break any constraints, good quality re total point score	Excellent quality of solution re total point score, does not break any constraints
Evaluation and future work	None provided or demonstrates significant misunderstandings	minimal reflection; suggestions for future work either minimal or flawed	Provides some reflection with some attempt to highlight strengths/weaknesses with at least one sensible suggestion for future work but perhaps not well linked to weaknesses	Very good and critical reflection that shows insight into domain and methods. Focused suggestions for future work linked to weaknesses	In-depth reflection, shows deep insights in both methods and the domain, with excellent suggestions for future work that address highlighted issues
Clarity/overall style	Below standard expected at this level	adequate	good	Very good	excellent

Technical Information

You are provided with a program in Python that has some basic functions:

- It reads in the data file and creates some useful arrays, such as lists of strikers/goalkeepers etc, as well as a constraint checker function.
- A very basic EA written using the DEAP libraries that is unlikely to provide a valid solution but can be used as a starting point.
- A *constraint_checker()* function:
    - The constraint checker function is passed a binary array of length 523,where each bit is set to 0 or 1 to indicate if the player at bit *i* is included in the team.
    - *You can represent a solution in any way you want in order to solve this problem. If not using a binary representation, you will need to write your own checker to suit your representation.*
    - You must convert your final solution to the form stated above in order to check the constraints of the final solution you produce and provide its output in your report. If you do not provide this, you will not get any marks for Solution Quality.

I may rerun the checker on your solution–therefore you should not sort the input file provided in any way as I will apply the checker to the data read from the file provided.