

Artificial Intelligence Algorithms MESIIN476023

Project statement : Technical interview



Table des matières

1 Preamble	1
2 Problem description	2
2.1 Benchmark	2
3 Project Objectives	3
4 Deliverables	3
5 Deadline	3
6 Project Guidelines and Rules	3

1 Preamble

This project is based on a topic given for a technical interview, aiming to secure a position as a Research Engineer in Data Science & Optimization. The candidate had four days to become acquainted with the problem, define it formally, and develop effective solutions. It is then required to present their findings and solutions, which are based on AI algorithms, during a technical interview in front of the company's technical experts. This project aims to replicate as closely as possible the information and resources made available to the candidate. No additional elements beyond those included in this project description were provided.

Can you effectively overcome the challenges of this recruitment phase and secure a position in this prestigious French company using the knowledge and skills acquired from the AI algorithms course ?

2 Problem description



A biscuit manufacturing factory is planning to produce a series of biscuits for Christmas. Using the same roll of dough, the factory aims to create various biscuits in different sizes and shapes. The goal is to maximize biscuit production from a single dough roll while ensuring the highest possible profit.

To achieve this goal, we have the following information :

- The roll of dough is of a predefined rectangular length, referred to as 'LENGTH', representing a one-dimensional problem.
- The roll may contain irregularities, referred to as defects. Each defect has
 - a position 'x'
 - and a class, which could be one of several types (e.g., 'a', 'b', 'c', ...).
- The factory aims to produce a set of biscuits. Each Biscuit can be produced an infinite number of times, and has :
 - a specific size (along the same dimension as the roll)
 - a value (price)
 - and a threshold for the maximum number of defects of each class it can contain (otherwise it cannot be marketed).

A solution is an assignment of biscuits on the roll. For an assignment to be valid, it needs to :

- be at integer positions
- Ensure no overlap in biscuit placement. For example, if you place a biscuit B1 of size 3 at position 'x=2', you cannot have any biscuit assigned at positions 'x=3' or 'x=4'.
- Ensure that each biscuit placed on the roll contains fewer defects (or an equal number) of each class than its thresholds permit. For example, a biscuit B1 of size 3 placed at 'x=2' includes all defects in the interval [2, 4]. If there are 3 defects of class 'a' in this interval, and B1's threshold for class 'a' is a maximum of 2 defects, then the assignment is invalid.
- Ensure that the sum of the sizes of the assigned biscuits does not exceed the length of the roll of dough.

The value of a solution is the sum of the values of the individual biscuits placed on it. Any part of the roll of dough without a biscuit assigned is considered to have a value of 0.

2.1 Benchmark

For this project, the following assumptions are made :

- The length of the roll of dough is set to 500 units.
- The roll has three classes of defects ('a', 'b', and 'c'). The set of defects and their positions on the roll are available in the 'defects.csv' file.
- The biscuit manufacturing factory aims to produce 4 types of biscuits, which are :
 - Biscuit 0 with a length of 4, a value 6, and maximum allowed defects as {'a' : 4, 'b' : 2, 'c' : 3}
 - Biscuit 1 with a length of 8, a value 12, and maximum allowed defects as {'a' : 5, 'b' : 4, 'c' : 4}
 - Biscuit 2 with a length of 2, a value 1, and maximum allowed defects as {'a' : 1, 'b' : 2, 'c' : 1}
 - Biscuit 3 with a length of 5, a value 8, and maximum allowed defects as {'a' : 2, 'b' : 3, 'c' : 2}

3 Project Objectives

This section outlines the primary goals of the project, focusing on a comprehensive understanding and effective addressing of the problem's challenges.

1. **Describe the problem and its challenges.**
 - Clearly articulate the problem at hand and identify the specific challenges it presents. This includes describing the problem, outlining the constraints and stating the goals of the project.
2. **Formulate and implement the problem using python.**
 - Detail the steps taken to translate the problem into a solvable format using Python. Explain the reasoning behind each step and the motivations for the choices made during implementation.
3. **Propose two alternative problem-solving approaches.**
 - Present two distinct methods for addressing the problem. **These could be the techniques discussed in class, such as Uninformed or Informed search solutions, heuristic methods, local search or constraint satisfaction problem techniques, or the approach introduced in your forum.** Provide justification for why each method was selected and how it is relevant for solving the problem.
 - You can provide heuristics or approaches that compute a feasible or optimal solution.
 - Compare the two proposed approaches in terms of performance (execution time, quality of the proposed solution, etc.)
4. **Conclusion and reflections :**
 - Summarize what this project has contributed to your learning experience. Discuss the challenges encountered during the project and how they were addressed. Reflect on any aspects of the project that were particularly insightful or noteworthy.

4 Deliverables

You are required to submit :

- **A final report in PDF format.** The report should not exceed 10 pages. It must comprehensively describe the problem, outline the proposed solutions, and detail the methodologies employed. The report should focus on explaining the approach and reasoning, referring to specific classes or functions from the notebook where necessary. It should not contain any code.
- And **a notebook** (Jupyter Notebook). This should contain the implementation of the proposed approaches and the obtained results.

5 Deadline

The candidate had four days to understand and propose a solution to the problem. You will have slightly more than a month to accomplish this (**deadline : December 22, 2023**). Can you secure the position at this well-known and prestigious French company ?

The project should be completed in groups of up to three people.

6 Project Guidelines and Rules

- **Submission Deadline :** All project materials must be submitted by the designated deadline. Late submissions will not be accepted.
- **Originality :** Each project must be the original work of the participant or team. Plagiarism or copying from other sources is strictly prohibited.
- **Unexplained Code Policy :** Any submitted code that lacks necessary explanations or comments will not be evaluated or graded. It's essential to provide clear documentation and rationale for your coding choices.