National College of Ireland

# National College of Ireland

## H9AIDM: AI Driven Decision Making

**(MSCAI1, MSCAI1B)**

**Release Date: Monday, 3 March 2025 at 09:00**

**Submission Deadline:**
**Monday, 14 April 2025 at 23:55**

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## Continuous Assessment (CA) Type: Project

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**Weight:** The assignment will be marked out of 100. This CA is worth 60% of the overall marks for this module.

**Task:** Create an Index Fund Using AI-Driven Decision-Making Approaches a team of 2 participants.

### Project Description:

The purpose of this project is to construct an index fund that will track the S&P 100 (https://en.wikipedia.org/wiki/S%26P_100 ). The idea is to use less than 100 stocks and still have a performance as similar as possible to that of S&P 100 across 1 quarter, 2 quarters, 3 quarters and 4 quarters. You should:

a) select the value of $q$, which is the number of stocks that will form your index fund, as a parameter.
b) Once you have selected the $q$ assets you want, define the amount that will be invested in each one.

1) Formulate this problem as an optimisation problem and solve it using AMPL. In order to test how well your index fund tracks the S&P 100, you will need to define a metric that says, “I am closely following the benchmark”. Correlation is a good metric to use. Estimate the performance of your index over periods ranging from 3 months to 1 year.

2) Implement another decision-making approach of your choice and compare its performance to the approach used in 1) above.

Historical stock data can be downloaded using the *yfinance* Python package, or any other similar package.

**Deliverables:**

1. **Project Report:** A comprehensive report detailing the following:
    - **Introduction:** Overview of the theories and models relevant to AI-driven approaches in index fund construction and portfolio optimisation.
    - **Problem Definition:** Detailed formulation of the optimisation problem(s).
    - **Methodology:** Description of the selected decision-making approaches, including justification for their selection and implementation details.
    - **Evaluation:** A discussion on the best values of $q$ to construct an index fund. A discussion on the quality of the approximation as the estimation horizon gets larger. A comparison and critical evaluation of the alternative algorithms applied to the problem, including performance metrics and analysis.
    - **Conclusion:** Summary of findings, discussion of the effectiveness of the implemented solutions, and suggestions for future improvements.

2. **Code Submission:** All code developed for the project should be submitted in a well-documented format, ensuring reproducibility of results.

3. **Presentations:** Presentations should be recorded and should not be more than 10 minutes long. The whole team should coordinate and plan the presentation. Each team member should present at least one of the major aspects of the project.

4. **Distribution of Work:** An overview of the contribution of each team member to the project should be submitted as part of the report.

## Submission Instructions

Students must submit their work using the module's Moodle page.

- Report
  The report should be submitted in PDF format. The report should be up to 8 pages in length (excluding list of references).

- Code, Data and Presentation
  A zip file containing code, any additional data, the presentation (in PowerPoint or PDF or similar format) and a link to the video recording of the presentation should also be submitted.

## Report Style Guidelines

The report style should comply with the presentation style of this module and use the Microsoft Word or LATEX document preparation system. The report templates are provided on Moodle page of the module.

**IMPORTANT: It is your responsibility to avoid plagiarism. Please read the comprehensive guidelines on academic honesty and academic integrity, and how to avoid plagiarism made available by the NCI Library** (https://libguides.ncirl.ie/referencingandavoidingplagiarism ).
**NOTE: YOU ARE NOT ALLOWED TO PUBLISH THIS ASSIGNMENT BRIEF OR A PART THEREOF ON ANY WEBSITES. YOU ARE NOT ALLOWED TO PUBLISH/SHARE YOUR SOLUTION WITH OTHERS. All work submitted should be your own.**
**Note that all submissions will be electronically screened (via Turnitin) for evidence of academic misconduct (i.e., plagiarism and collusion).**

## Marking Scheme

This project is worth 60% of the final grade awarded, and will be graded using the rubric below:

| Grade<br>Criterion | Solid H1<br>> 80% | H1<br>> 70% | H2.1<br>> 60% | H2.2<br>> 50% | PASS<br>> 40% | FAIL<br>< 40% |
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| **Basic Structure (10%)** | All elements of project requirements have been thoroughly addressed. | All elements of the project requirements have been thoroughly addressed. | Some minor requirements missing from project. | Multiple omissions from the project. | Major parts of the project are missing. | The solution bears no resemblance to the project requirements at all. |
| **Optimisation Approach (25%)** | Elegant formulations of the optimisation problems. Objective function is correct, and maximum or minimum value is correct.<br><br>Variables and constraints are fully correct and justified.<br><br>Effort exceeds the requirements of the module. | Objective function is correct, and maximum or minimum value is correct.<br><br>Variables and constraints are fully correct and justified. | Objective function is correct, and maximum or minimum value is correct.<br><br>Variables and constraints are correct and justified. | Objective function, variables and constraints have slight errors. | Some logical errors exist in the objective function, variables and constraints. | No objective function present. No variables or constraints. |
| **Alternative Approach (15%)** | An alternative modelling or solution approach such as metaheuristics, genetic algorithms, fuzzy approaches, reinforcement learning, deep learning, etc., are included.<br><br>Effort exceeds the requirements of the module. | An alternative modelling or solution approach such as metaheuristics, genetic algorithms, fuzzy approaches, reinforcement learning, deep learning, etc., are included.<br><br>Implementation is done to a high standard. | An alternative solution approach such is considered and implemented well. | A good attempt is made at including an alternative approach. There may be some implementation errors. | An attempt is made at including an alternative approach. | No alternative solution approach is considered or implemented. |
| **Code Format/Style (20%)** | Code is fully commented. There are no syntax or logic errors, and no excess code used.<br><br>The implementation significantly exceeds the module requirements | Code is fully commented. There are no syntax or logic errors, and no excess code used. | Code is partially commented. There are few syntax or logic errors, and a minimal amount of excess code used. | Code is partially commented. There are several syntax or logic errors, and use of excess code. | Code is poorly commented. There are many syntax or logic errors, and excess use of unnecessary code. | Code is barely commented. There are many syntax or logic errors, and excess use of much unnecessary code. |
| **Evaluation & Results (10%)** | Models are completely and thoroughly evaluated. Results are presented and thoroughly discussed.<br><br>There is significant reflection on the challenges faced in this project. | Models are fully evaluated. Results are presented and thoroughly discussed.<br><br>There is significant reflection on the challenges faced in this project. | Models are evaluated. Results are presented and thoroughly discussed.<br><br>There is very good reflection on the challenges faced in this project. | Models and results are presented and appropriately discussed.<br><br>There is good reflection on the challenges faced in this project. | Cursory evaluation of models. Cursory discussion of results.<br><br>There is some reflection on the challenges faced in this project. | Little to no evaluation of model. Little to no discussion of results.<br><br>There is no reflection on the challenges faced in this project |
| **Quality of Writing (10%)** | Very well written, with no language errors. All figures are well conceived and read-able. Report is sufficiently | Well written, with no (large) language errors. All figures are well conceived and read-able. Report is sufficiently | Main document has a few language and/or style errors. Figures are well presented. Report is sufficiently | Main document has a few language and/or style errors. Some figures may be hard to read. Report has adequate | Main document is readable with some language and/or style errors. Figures may be hard to read or presented in a | Littered with typos, and/or poor use of English. Poor report with very little content/detail. Figures may |

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| | detailed. References are appropriately and correctly used. | detailed. References are appropriately and correctly used. | detailed. References are complete and correctly used. | detail. References are complete and correctly used. | suboptimal manner. Report is scant on detail. References are mostly complete and correctly used. | be hard to read. References (if any) are probably incomplete. |
| **Video Presentation (10%)** | The presentation clearly outlined the project argument. Slides were error-free and logically presented. The speaker was poised and enthusiastic. Questions were excellently answered. | The presentation clearly outlined the project argument. Slides were error-free and logically presented. The speaker was poised and enthusiastic. Questions were excellently answered. | The presentation somewhat clearly outlined the project argument. Slides were somewhat error-free and somewhat logically presented. The speaker was poised and enthusiastic. Questions were very well answered. | The presentation outlined the project argument. Slides were mostly error-free and mostly logically presented. The speaker was poised and enthusiastic. Questions were well answered. | The presentation provided a limited outline of the project argument. Slides were not error-free and not logically presented. The speaker was poised and enthusiastic. Questions were reasonably well answered. | The presentation is unorganised and unclear. Questions were unanswered/poorly answered. |