AI310/CS361 ARTIFICIAL INTELLIGENCE FALL 2025

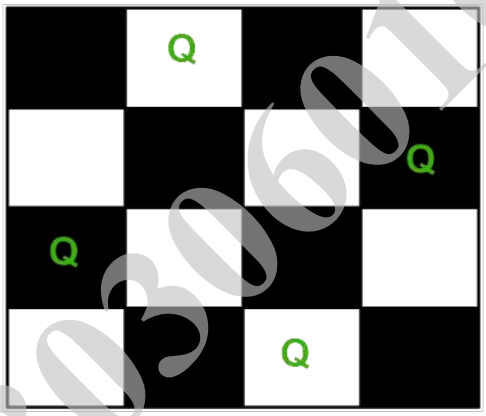
COURSE PROJECT INSTRUCTIONS

Instructions to Students:

- This is a group work project. Each group consists of **six students** ("Mainstream Programme") or **four to six** ("both Software Engineering & Medical Informatics Programmes"). *The Teaching Assistant must approve group members through registration*. Each group must develop the assigned idea using Python.
    - **Project Objectives:** The objectives of this project can be summarised as applying the main ideas, fundamental concepts, and basic algorithms in the fields of artificial intelligence and machine learning.
- **Submission:** Submission is done according to the following schedule:
    - **Week 12/13: Submission and Discussion of the** (1) **Project** and (2) **Documentation**. *The report should include the following: (1) Project idea in detail, (2) Main functionalities, (3) Similar applications in the market, (4) A literature review of Academic publications (papers) relevant to the idea (at least 4 to 6 papers, as per the number of team members), (5) the Dataset employed (preferably a publicly available dataset), (6) Details of the algorithm(s)/approach(es) used and the results of the experiments, and (7) Development platform.*
- **Assessment:** Assessment will be on the reports, code submitted, and discussions with team members. All team members must contribute across all phases, and each member's role must be clearly stated in each report.
    - The Project will be assessed based on the following criteria:
        - The complexity of the problem, & the correctness of the algorithms employed.
        - The quality/comprehensiveness of your experiments & documentation.
        - The correctness of your analysis and design diagrams.
        - Implementation correctness.
- **Feedback:** If requested, further details and feedback could be provided for each group through discussions with the teaching assistant(s) during the weekly-labs/office-hours.
- You can only submit your work. Any student suspected of plagiarism will be subject to the procedures set out by the Faculty/University (including failing the course entirely).
    - **Academic Integrity:** The University's policies on academic integrity will be enforced against students who violate the University's standards of academic integrity. Examples of behaviour that are not allowed are:
        - Copying all or part of someone else's work and submitting it as your own;
        - Giving another student in the class a copy of your work and
        - Copying parts from the internet, textbooks, etc.
        - If you have any questions concerning what is allowed, please don't hesitate to discuss them with me.
    - **We understand that you might positively refer to AI tools to support your research. Please note that, in case there are any concerns about AI-generated submission content, you will be invited for an opportunity to verify and defend your work.**

1) N-Queens Problem Solver (for different sizes – n should be selected by the user) using the Backtracking Search Algorithm, a Best-First Search, a Hill-Climbing Search, AND a Cultural Algorithm.

N-Queens Problem Solver Project Overview: The N-Queens Problem Solver project aims to develop an intelligent system capable of solving the N-Queens problem for various board sizes. The N-Queens problem is a classic chessboard puzzle in which the objective is to place N queens on an N×N chessboard in such a way that no two queens threaten each other. Threatening means no two queens share the same row, column, or diagonal. The value of N, representing the board size and the number of queens, can be chosen by the user. For example, the following is a solution for the 4 Queens problem:



Problem Description: In the N-Queens problem, the challenge is to arrange N queens on an N×N chessboard, ensuring that no two queens attack each other. The difficulty arises from the restrictive nature of queen movements: they can traverse horizontally, vertically, or diagonally. The project involves exploring multiple algorithms to efficiently find solutions to this puzzle.

Backtracking Search Algorithm: The Backtracking Search Algorithm is a systematic method for exploring potential solutions to a problem. In the context of the N-Queens problem, it involves placing queens on the board one by one and backtracking if a conflict is detected. This algorithm guarantees finding all possible solutions.

Best-First Search Algorithm: Best-First Search is an algorithm that intelligently selects the most promising path based on a heuristic evaluation. In the N-Queens context, this algorithm evaluates board configurations using a heuristic to guide the placement of queens, prioritising paths that seem most likely to lead to a solution.

Hill-Climbing Search Algorithm: Hill-Climbing is a local search algorithm that continually moves towards higher elevations in the solution space. Applied to the N-Queens problem, it involves iteratively adjusting queen placements to ascend towards a configuration with fewer conflicts. It may get stuck in local optima.

Cultural Algorithm: The Cultural Algorithm (CA) is an evolutionary computation technique (similar to the Genetic Algorithm) that mimics the dual inheritance found in human societies—where both genetic (population-

level) evolution and cultural (knowledge-based) evolution occur in tandem. In CA, two primary spaces are maintained:

- Population Space: This is similar to conventional evolutionary algorithms, where a set of candidate solutions (individuals) evolves using operators like selection, crossover, and mutation.

- Belief Space: This space stores accumulated knowledge (or "culture") from previous generations. It guides the search process by influencing how new candidates are generated.

User Interaction: The user has the flexibility to choose the size of the chessboard (N), making the project adaptable to different scenarios. The system will present solutions generated by each algorithm, allowing the user to compare their effectiveness and efficiency. Additionally, the project provides insights into the strengths and limitations of diverse search and optimisation techniques.

This project not only addresses the fundamental challenge of the N-Queens problem but also serves as an educational tool for understanding and comparing various search algorithms in artificial intelligence. It combines classic problem-solving techniques with contemporary optimisation strategies.