



Cairo University
Faculty of Computers and Artificial Intelligence



Term Project

Department: Operations Research and Decision Support

Course Name: Decision and Game Theory

Course Code: DS414/DS411

Instructor: Assoc. Prof. Ayman Ghoneim

Date: May 20th, 2022

Total Marks: 100

General Instructions to Students

- This is a group term project for up to three students per group.
- The only programming language allowed to be used in the project is Python.
- Submission schedule and procedure will be announced later.
- For the submitted deliverables, see the end of the document.
- The project has four parts, and the group must attempt all parts.
- In each part of the project, it will be stated clearly what implementation is required and/or what should be included in the report.
- Assessment will be on the report documentation and code implementation submitted based on the following criteria:
 - The correctness of the algorithms employed and implementation.
 - The quality/comprehensiveness of your experiments & documentation.
 - The correctness of your analysis.
- Academic Integrity: You can only submit your own work. Any student suspected of plagiarism will be subject to the procedures set out in by the Faculty/University (including failing the course entirely). Examples of behaviour that is 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, text books, etc.

Part I [20 Marks]

Game theory is widely applied in many areas, which includes warfare/conflicts, health, sports and telecommunication.

You are requested to choose one application area, then:

- A) Find three research papers (i.e., proper journals or conferences publications) which apply game theory to the area you chose, and write a summary (not less than 1000 words) of the game theory models presented in the papers. You will get bonus if you cover more papers in the same area. You need to state the references you used in writing your summary.
- B) Find a magazine article (published in a newspaper or a magazine) which discuss a strategic situation; however it doesn't treat the situation from a game-theoretic

perspective. You may check <http://www.gametheory.net/news/byindustry.html> as an example. You are requested to model the situation with a strategic game (or several strategic games) by defining the players and their strategies. You may use sequential games or simultaneous games (or both). Analyze the strategic game using one of the techniques you learned in the course (e.g., eliminate dominated strategies; Nash equilibria, backward induction ... etc). You need to state the reference or the link for the magazine article.

Part II [30 Marks]

Consider a simultaneous game between two players. Player 1 has n actions (i.e., n pure strategies), while player 2 has m actions. Thus the payoff matrix representing the game will be of size $n \times m$, where n and m are any arbitrary positive numbers. Write a code implementation that takes any arbitrary $n \times m$ payoff matrix as an input and does the following:

- A) Apply iterative elimination of strictly dominated strategies and print out the resulting payoff matrix, or the solution of the game.
- B) Apply iterative elimination of weakly dominated strategies and print out the resulting payoff matrix, or the solution of the game.
- C) Determine the pure Nash equilibria of the game.
- D) Determine the pure strict Nash equilibria of the game.
- E) Determine the expected payoff for each player when player 1 uses a mixed strategy x and player 2 uses a mixed strategy y .
- F) Determine the trembling hand perfect equilibria of the game.
- G) Apply positive affine transformation to the payoff matrix.
- H) Assume that the input payoff matrix represents a 2×2 symmetric game, find which category does the game belongs to.

In the report documentation, for each of the previous points (from A to H), you are requested to:

- 1- Explain the logic flow and steps of your program (you may use a flow chart).
- 2- Use at least two numerical examples to illustrate the output of your program (provide snapshots of your program input and output).

Part III [30 Marks]

Consider a sequential game between three players. Player 1 moves first (i.e., has one decision node), and has $n = 2$ actions. Player 2 has n decision nodes, and has $m = 2$ actions at each decision node. Player 3 moves last and has $n \times m$ decision nodes and has $k = 2$ actions at each

decision node. Write a code implementation that takes the previous description as an input and does the following:

- A) Implement a decision tree for this sequential game. You will get a bonus if the tree is implemented for any arbitrary number of actions (instead of 2 actions) at each decision node, and another bonus if the tree is implemented for any arbitrary number of players (instead of 3 players).
- B) Solve the sequential game using backward induction.
- C) Compute the subgame perfect equilibrium of the game.

In the report documentation, for each of the previous three points, you are requested to:

- 1- Explain the logic flow and steps of your program (you may use a flow chart).
- 2- Use at least three numerical examples to illustrate the output of your program (provide snapshots of your program input and output).

Part IV [20 Marks]

Consider the following games:

- Sprouts
- Hackenbush
- Domineering

Choose only one of the games mentioned above and address the following points in your report documentation:

- A) Learn about the game using an internet search (e.g., wikipedia), then explain the game using your own numerical examples (mention the references you used to read about and understand the game).
- B) Does Zeimelo theorem apply to the game? Why?
- C) Does the game have a winning or a tie strategy? Why?
- D) If your answer is yes to the previous point (C), think about that strategy of the game and which player have the moving advantage?

Deliverables

One compressed file which must include a report documentation (Word or PDF file) and Python code implementation files, following the below details.

- Report documentation including:
 - Cover Sheet: Includes the CU and FCAI logos, course code, course name, project title, student name and ID, course instructor.

- Table of Contents
 - Each part of the four parts and the required points mentioned above in each part. Your report must be organized following the same organization stated here in the research project document. For example, Part I (A), Part I (B) until Part I (H).
 - List of References.
- Code Implementation files, where each file is named after the part and the point it corresponds to. For example, PartI(A).py. The code file can be included in a folder if you are using input files.

Good Luck 😊