ASSIGNMENT 1

Search-Based Problem Solving

Deadline: Tuesday, 18/02/25

Assignment Guidelines(READ CAREFULLY)

Many students immediately look for solutions online or ask AI tools like ChatGPT to solve problems. However, in real-world AI and research, **the most important skill is problem-solving, not memorizing answers**. This assignment is designed to help you think deeply, struggle, and develop your own approach first before using any external help.By following this method, you will **develop strong problem-solving skills** that are essential in AI.

Grading Criteria

- **50% Marks:** Awarded based on demonstrated struggle and effort that you spend with each problem at least 1 hour, even if the final solution is incorrect.
- **50% Marks:** Awarded based on presenting a correct solution in the viva session and submitting correct solution sheet with Brainstorm sheet.
- **Independent Thinking Required:** Attempt each problem for at least **1 hour** without any external assistance, including ChatGPT or the internet.
- **Seeking External Help:** After 1 hour of dedicated effort, if you are still unable to find a solution, you may use external resources such as ChatGPT.
- **Struggle Sheet Submission:** You must submit a rough sheet of your struggle (brainstorming sheet) along with the final solution on A4 page, even if your attempts or answers are incorrect. **Failure to submit the struggle sheet will result in a 50% mark deduction.**
- **Viva Requirement:** During the demonstration session, you must explain your struggle, regardless of whether your final solution is correct or incorrect.
- **Partial Marks for Struggle:** If your final solution is incorrect but you honestly explain your struggle of at least 1 hour for each problem, you will receive **5 marks**.
- **Penalty for Missing Struggle Sheet:** If you fail to submit your **1-hour brainstorming sheet** for each problem, you will face a **5-mark deduction**.
- **Submission Guidelines:** Submit hard copy (struggle-sheet+final-solution) as well as soft copy only the solution part in **soft copy (PDF format)**. The assignment file name must follow this format: `P22_1234_Tayyab_RIAZ.pdf` (replace with your own details).

Problem 1: FAST Eid Escape Mission

Scenario:

Eid holidays are just around the corner, and you are stuck at Fast University.Your mission is to get to Lahore Adda as quickly as possible to catch your bus home. However, there's a twist.Your super-kind teachers have given you three 'precious gifts' to take with you:

- A pet golden fox(Dr.Waqas says it symbolizes your "cunning problem-solving skills").
- A pet blue hen (Apparently, it's a "reward" for all your hard work in AI class).
- A bushel of blue corn (No one knows why, but it was given by the Data Structures professor Sir Fazle-Basit, so you better take it).

Challenges:

- The BRT Service is unreliable and allows only one pet or item at a time.
- The bus driver will not allow you to carry anything else when taking the corn.
- Your fox will eat the hen if left alone.
- The hen will eat the corn if left alone.
- The fox and corn are best friends and can be left together safely.

Your Task:

Formulate this as a **search problem**.

Define:

1. **States:** Represent the locations of each entity (You, Fox, Hen, Corn).
2. **Operators:** List valid moves that follow the given rules.
3. **Goal Test:** Ensure all entities reach Lahore Adda safely.
4. **Path Costs:** Each bus trip costs the same.

Analysis Questions:

1. Draw the search tree for the chosen algorithm (no redundant expansions).
2. Which search algorithm (BFS or DFS) guarantees the shortest solution when not checking repeated states?

Problem 2: Word Transformer Game

Problem Statement:

You are given two three-letter English words: **"SUN"** (starting word) and **"MAP"** (goal word). Your task is to transform **"SUN"** into **"MAP"** by changing **one letter at a time**, ensuring each intermediate word is a valid English word.

Game Rules:

1. You may **only change one letter** at a time.
2. Each intermediate word **must be valid**.
3. The transformation must be completed in the **fewest steps**.
4. **Cost Function:**
   - Replacing a letter with a vowel (A, E, I, O, U) costs **3 points**.
   - Replacing a letter with a consonant costs **1 point**.
   - Returning to a previous word adds **2 extra points**.

Part 1: Formulating as a Search Problem

1. Define the **State Representation**.
2. Define the **Initial State**.
3. Define the **Successor Function**.
4. Define the **Goal Test**.
5. Define the **Path Cost Function**.

Part 2: Constructing the Search Tree

1. Draw a tree representation where:
   - Root node = "SUN".
   - Each branch = valid one-letter transformation.
   - Goal node = "MAP".
2. Expand the tree **until "MAP" is reached**.

Part 3: Applying Uninformed Search Algorithms

1. **Breadth-First Search (BFS)**
    - How does BFS explore the tree?
    - Does BFS guarantee the shortest path?
2. **Depth-First Search (DFS)**
    - How does DFS explore the tree?
    - Can DFS get stuck in loops?
3. **Uniform Cost Search (UCS)**
    - Does UCS always find the optimal path?
    - Compare UCS path cost with BFS path length.

Good luck! Be prepared for viva sessions!