SITARE University

Artificial Intelligence

Assignment 1: A* Search – Optimality and Heuristics

Duration: 1 Week

Learning Goals:

- Understand admissible and consistent heuristics
- Analyze why both conditions are important
- Build and test counterexamples
- Apply A* search in maze problems

Part A – Conceptual Questions (Short Answer)

1. Define admissible heuristic. Give one example of an admissible heuristic and one example of a non-admissible heuristic in a grid-world maze.

2. Define consistent heuristic. Explain how it is related to the triangle inequality.

3. Can a heuristic be admissible but not consistent? Provide reasoning.

4. Why is admissibility necessary for A* to be optimal? Why is consistency necessary?

Part B – Worked Examples (Paper/Pencil)

1. Consider the following graph:

A --2--> B --2--> C (goal)
A --5--> C

- With h(A)=3, h(B)=1, h(C)=0, show that A* finds the optimal path.

- With h(A)=5, h(B)=5, h(C)=0, show step-by-step how A* fails to find the optimal path.

2. For the same graph, test consistency:
   - Case 1: h(A)=3, h(B)=1, h(C)=0.
   - Case 2: h(A)=4, h(B)=5, h(C)=0.
   Identify which violates the consistency condition.

Part C – Programming Task (Python / Jupyter Notebook)

1. Implement A* search on a maze (given as a 2D matrix where 1=wall, 0=path, A=start, B=goal).

- Use Manhattan distance as heuristic.
- Visualize the path found.

2. Modify the heuristic:

- Case 1: Multiply Manhattan distance by 1.5 (check if it is admissible).

- Case 2: Define heuristic so that for one edge it violates consistency.

3. For each case, run A* and record:

- Path found
- Cost of path
- Whether the path is optimal

Part D – Critical Thinking (Write-up)

Explain in your own words:

1. Why A* is guaranteed optimal if both admissibility and consistency hold.

2. Construct your own maze example where admissibility fails and show A* produces a non-optimal result.

3. Construct another where consistency fails and show how A* may expand nodes incorrectly.

4. Also, Construct one example which is admissible but inconsistent.

Deliverables (Due in 1 Week)

1. PDF with answers to Part A, Part B, Part D

2. Jupyter Notebook with code and experiments for Part C

3. A short conclusion paragraph: “What I learned about admissibility and consistency in A* search.”