Assignment Five: Hill Climbing and Simulated Annealing

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**Question 1:** *What is a local search algorithm?*

Local search algorithms search from a start state to neighboring states without keeping track of paths or previously reached states, which makes them non-systematic. They might not explore parts of the search space where a solution could exist. However, these algorithms have two key advantages: they use minimal memory and can often find reasonable solutions in large or infinite state spaces where systematic algorithms are not suitable. (Artificial Intellligence: A Modern Approach, 2021, p. 110)

**Question 2:** *What is an optimization problem? Give an example for such a problem.*

An optimization problem involves finding the best solution from all possible solutions based on specific criteria. These problems seek to maximize or minimize an objective function under given constraints. For example, the Traveling Salesman Problem is an optimization problem where the goal is to find the shortest possible route that visits each city exactly once and returns to the starting point. (Artificial Intellligence: A Modern Approach, 2021, p. 110)

**Question 3a:** *Can you think of a situation in which hill-climbing will get stuck in this exploration task and never find a solution?*

Hill-climbing can get stuck in local optima, plateaus, or ridges, where no neighboring state offers a better cost (improvement). With the robo-vacuum exploration task, hill-climbing can get stuck if the robot is surrounded by previously visited cells (all cost = 1) and cannot move forward, even if there is an unexplored area nearby. For example, if the vacuum is in a corner or dead-end surrounded by obstacles or already visited cells, it may be unable to proceed further, failing to find a complete exploration solution. (Artificial Intellligence: A Modern Approach, 2021, pp. 113-115)

**Question 3b:**  *Can you then explain how simulated-annealing tries to overcome this problem?*

Simulated annealing is a probabilistic technique that allows the algorithm to explore worse states temporarily (higher cost states) to escape local optima. It introduces a temperature parameter that gradually decreases over time. When the temperature is high, the algorithm is more likely to accept worse moves, allowing it to explore a broader search space. As the temperature lowers, the probability of accepting worse moves decreases, refining the search towards an optimal solution. This flexibility helps the vacuum navigate out of dead-ends or suboptimal paths and explore unvisited areas, avoiding getting permanently stuck.(Artificial Intellligence: A Modern Approach, 2021, pp. 113-115)

# References

Artificial Intellligence: A Modern Approach. (2021). In S. Russell, & P. Norvig. Hoboken, NJ: Pearson.