CSCD84: Artificial Intelligence
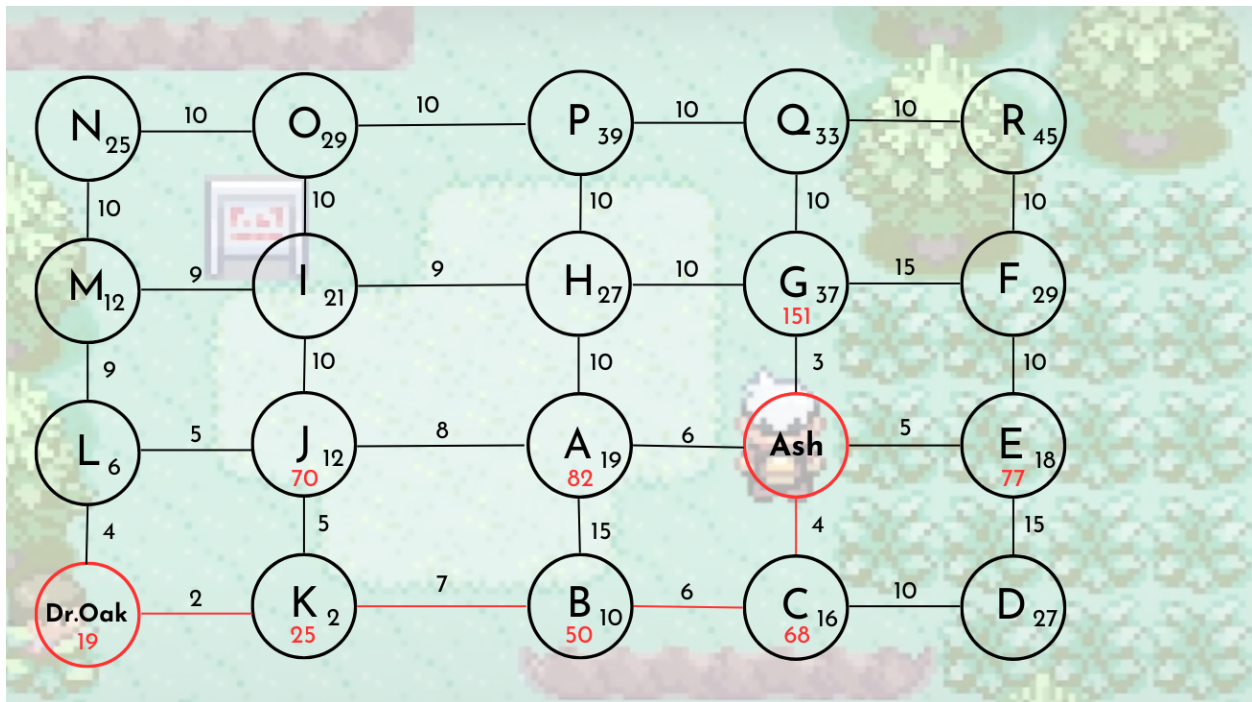## Problem Set 1 Solutions: Search
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Figure 1: Pokemon state space

Q1: Saving Pikachu with weighted A*

You are creating an AI for playing Pokemon Ruby on your Game Boy Advanced. At this stage of the game, Pikachu has low HP (health points) and Ash Ketchum needs to rush him to Dr.Oak. Each path Ash takes will cost his Pokemon more health points based on the number of wild Pokemon encounters he has. His Pokedex has provided you with a recommendation heuristic measure for the amount of health points his Pokemon will need to get from each node to the goal. Answer the following questions to help save Pikachu.

1. List the nodes *in the order they are expanded by weighted A**. Weighted A* is a method for finding the goal state faster at the cost of optimality. Weighted A* search uses the cost function $f(n) = g(n) + \epsilon h(n)$, where ϵ is a tunable parameter. Show the order of expansion with $\epsilon = 4$.

Q1: Solution

Ash → C → B → K → Dr.Oak (Cost = 19)

Q2: Comparing A* and weighted A*

1. Compared to regular A* search, weighted A* search will often find a more costly path. Let C be the cost of the solution found by weighted A* and C^* be the cost of the optimal solution, and suppose the heuristic is admissible. Prove that $C \leq \epsilon C^*$ [**HINT**: Recall the definition of the cost for A* and weighted A*. Consider the cost of the solution found by weighted A*, and that of the next unexpanded node along the path toward the optimal solution which was added to the expansion list by weighted A*.]

Q2: Solution

We know for the weighted A* algorithm,

$$f(n) = g(n) + \epsilon \cdot h(n)$$

where:

- $f(n)$ is the cost estimate of the path through node n.

- $g(n)$ is the cost to reach node n from the start node.

- $h(n)$ is the heuristic estimate of the cost to reach the goal from node n.

- ϵ is a weight factor applied to the heuristic function.

C is the cost of the solution found by weighted A*.
Thus, $C = f(G)$ where G is the goal at which A* terminates.
Let n be an ancestor of the optimal goal G^* that is discovered but not expanded.
Hence $f(G) \leq f(n)$.
Therefore,

$$
\begin{aligned}
C = f(G) & \\
\leq f(n) & \\
= g(n) + \epsilon h(n) & \\
\leq \epsilon(g(n) + h(n)) \quad & [\epsilon \geq 1] \\
\leq \epsilon C*
\end{aligned}
$$

Therefore, $C \leq \epsilon C^*$, which shows that the cost of the solution found by weighted A* is at most ϵ times the cost of the optimal solution, under the condition that the heuristic is admissible.