Artificial Intelligence: Week 2

1 Problem Solving by Searching

Goal formulation, based on the current situation and the agent's performance measure, is the first step in problem solving. **Problem formulation** is the process of deciding what actions and states to consider, given a goal. In general, *an agent with several immediate options of unknown value can decide what to do by first examining future actions that eventually lead to states of known value.* The process of looking for a sequence of actions that reaches the goal is called **search**. A search algorithm takes a problem as input and returns a **solution** in the form of an action sequence. Once a solution is found, the actions it recommends can be carried out. This is called the **execution** phase. Note while the agent is executing, it *ignores its percepts* when choosing its actions because it knows in advance what they will be.

Together, the **initial state, actions and transition model** implicitly define the **state space** of the problem - the set of all states reachable from the initial state by any sequence of actions. A **solution** to a problem is an action sequence that leads from the initial state to a goal state. Solution quality is measured by the path cost function, and an **optimal solution** has the lowest path cost among all solutions. The process of removing detail from a representation is called **abstraction**.

It is quite important to distinguish between a node and a state: a node is a bookkeeping data structure used to represent the search tree. A state corresponds to a configuration of the world. Furthermore, two different states can contain the same world state if that state is generated via two different search paths. We can evaluate the performance of an algorithm in four ways:

- **Completeness**: Is the algorithms guaranteed to find a solution if there is one?

- **Optimality**: Does the strategy find the optimal solution?

- **Time complexity**: How long does it take to find a solution?

- **Space complexity**: How much memory is needed to perform the search?

In AI, the graph is often represented implicitly by the initial state, actions and transition model and is frequently infinite. Complexity is expressed in terms of

three quantities: b, the **branching factor** or maximum number of successors of any node; d, the **depth** of the shallowest goal node; and m, the maximum length of any path in the state space.

1.1   Uniformed Search Strategies

1.1.1   Breadth-First Search