Penn CIS 5210- AI: A Modern Approach - Chapter 3

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This course investigates algorithms to implement resource-limited knowledge-based agents which sense and act in the world. Topics include, search, machine learning, probabilistic reasoning, natural language processing, knowledge representation and logic. After a brief introduction to the language, programming assignments will be in Python. — Description of CIS 4210/5210 in course catalog

1 Chapter Three: Solving Problems by Searching

1.1 3.0 introduction

Problem-Solving Agent is when the correct action to take is not offered by the greedy solution. **Searching** is now required.
Problem-Solving Agents use **atomic** representation. This means that A leads to B. **Planning agents** use factored or structured representation. A factored representation splits all the variables up in values. Think of this like an array of information. Two different factored reprensations might share certain elements, but be different vectors. More on that in chapter 2.
Let's briefly recap structured representation.
Structured reprensation is a bit like a relational database for storing data that interacts with each other.
Consequantiliasm is the idea that the agent flows through a series of states. The sequence of states is determined to be desirable based off the **performance measure.**

1.2 3.1 - Problem-Solving Agents

Unknown - In an unknown environment, the agent is forced engage in random behavior. **Goals** are very important to the agent. Clearly defined goals moreso. In the book, the author describes travelling

through Romania, specifically from arad to bucharest. Before taking any actions, the agent uses a **search** tree to find a solution. When a solution is found, the agent can ignore it's percepts and engage in the execution. This is called an **open-loop** system. Example might be driving from A -¿ B -¿ C. You don't really need to look at the map again. If there is a chance the road conditions may change, you might want to use a **closed-loop system**. This is more non-deterministic. The strategy could change depending on which precepts arrive.

1.3 3.2 - Search problems and solutions

Search problem can be formally defined as follows:

- States the environment can be in.
- Initial State the agent starts in.
- Goal states. There are can alternative states, sometimes the goal is defined by a property that applies to many states. If I write "goal", that could mean a variety of goal states.
- Actions available to the agents. ACTIONS(Arad) = (toSibiu,ToTimisoara,ToZerind)
- Transition Model. RESULT(Arad,ToZerind) = ToZerind
- Action Cost Function ACTIONCOST(Arad, Zerind, 3) where c(s,a,s') and s' is the cost of doing s-¿a.

Touring Problems are search problems. You can already see how they might need the states previously described. An example might be the **Travelling Salesman** problem. Examples of other solving problems through searching include VLSI layout, robot navigation, automatic assembly sequencing, and protein design.

1.4 3.3 - Search Algorithms

Search Algorithm takes a search problem as an input and returns a solution. Throughout this chapter, we investigate **search trees** over state space graph, forming various paths from the initial state, trying to find a path that reaches a goal state. The **state space** describes set of states in the world, and the actions that allow transitions from one to another. The **search tree** describes paths between these states, reaching towards the goal. **Child nodes** are nodes in a search that were generated from the parent node.

DECLARATIONS
function `Best-First-Search(problem, f)` **returns** a solution node or failure
Node (State = problem, initial)

frontier (a priority queue ordered by f, with node as an element)
reached (a look-up table, one entry with key problem. INITIAL and value NODE)

CODE while not IS-EMPTY (frontier) do
  if frontier is empty **then return** failure
  node ← remove the best node from frontier
  if node contains a goal state **then return** node
  frontier ← add all successors of node to frontier

That's a rough algorithm for best-first search. But let's figure out how to structure these. I want to try to construct one like I might construct a deterministic finite automata. Listed below is the structure of the search data.

Search Data Structures:

- node.State: the state to which the node corresponds
- node.Parent: the node in the tree that generated this node;
- node.Action: the action that was applied to the parents state to generate this node;
- node.PathCost: the total cost of the path from the initial state to this node. In math, we use g(node) as a synonym for the Path-Cost.

The frontier is typically stored in a queue. Three kinds of queues are typically used in search algorithms, priority, LIFO, FIFO. If a search tree has a loop or cycle, it is considered infinite.