CS344: Introduction to Artificial Intelligence

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Lecture 13– Search
Disciplines which form the core of AI - inner circle
Fields which draw from these disciplines - outer circle.
Search: Everywhere
Planning

- (a) which block to \textit{pick}, (b) which to \textit{stack}, (c) which to \textit{unstack}, (d) whether to \textit{stack} a block or (e) whether to \textit{unstack} an already stacked block. These options have to be searched in order to arrive at the right sequence of actions.
Vision

A search needs to be carried out to find which point in the image of $L$ corresponds to which point in $R$. Naively carried out, this can become an $O(n^2)$ process where $n$ is the number of points in the retinal images.
Robot Path Planning

- searching amongst the options of moving *Left*, *Right*, *Up* or *Down*. Additionally, each movement has an associated cost representing the relative difficulty of each movement. The search then will have to find the *optimal*, i.e., the *least cost* path.
Natural Language Processing

- search among many combinations of parts of speech on the way to deciphering the meaning. This applies to every level of processing- syntax, semantics, pragmatics and discourse.

```
The man would like to play.
```

```
Noun  Verb
   \   /  \
   PrepositionVerb  Noun
      \   /  \\
        Verb
```
Expert Systems

Search among rules, many of which can apply to a situation:

If-conditions
   * the infection is primary-bacteremia
   * AND the site of the culture is one of the sterile sites
   * AND the suspected portal of entry is the gastrointestinal tract

THEN
   * there is suggestive evidence (0.7) that infection is bacteroid

(from MYCIN)
Search building blocks

- State Space: Graph of states (Express constraints and parameters of the problem)
- Operators: Transformations applied to the states.
- Start state: $S_0$ (Search starts from here)
- Goal state: $\{G\}$ - Search terminates here.
- Cost: Effort involved in using an operator.
- Optimal path: Least cost path
Examples

Problem 1 : 8 – puzzle

<table>
<thead>
<tr>
<th>4</th>
<th>3</th>
<th>6</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>8</td>
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<tr>
<td>7</td>
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G

Tile movement represented as the movement of the blank space.

Operators:
L : Blank moves left
R : Blank moves right
U : Blank moves up
D : Blank moves down

\[ C(L) = C(R) = C(U) = C(D) = 1 \]
Problem 2: Missionaries and Cannibals

Constraints
- The boat can carry at most 2 people
- On no bank should the cannibals outnumber the missionaries
State: <#M, #C, P>
#M = Number of missionaries on bank L
#C = Number of cannibals on bank L
P = Position of the boat

S0 = <3, 3, L>
G = <0, 0, R>

Operations
M2 = Two missionaries take boat
M1 = One missionary takes boat
C2 = Two cannibals take boat
C1 = One cannibal takes boat
MC = One missionary and one cannibal takes boat
Partial search tree

Diagram:

```
<3,3,L>  <3,3,L>
   /     /
  C2     MC
 /       /
<3,1,R>   <2,2,R>
 /          /
<3,3,L>   <3,3,L>
```

---

Partial search tree
Problem 3

| B | B | B | W | W | W |

$G$: States where no $B$ is to the left of any $W$

Operators:
1) A tile jumps over another tile into a blank tile with cost 2
2) A tile translates into a blank space with cost 1

All the three problems mentioned above are to be solved using $A^*$