Midterm Summary

Hantao Zhang

http://www.cs.uiowa.edu/~hzhang/c145

The University of Iowa
Department of Computer Science
Topics covered in the midterm

- General State Space Search
  - states, actions, initial state, goal testing
  - general search procedure: open and closed lists
- Uninformed Search
  - Depth-first search
  - Depth-limited search
  - Iterative deepening search
  - Breadth-first search
  - Bidirectional search
  - Uniform-cost search
Informed Search

- Heuristic functions
  - $h(n) = $ an estimated cost from node $n$ to a goal
  - $g(n) = $ the actual cost from the initial node to $n$

- Uniform-cost search: use $f(n) = g(n)$ to select a node to expand

- Best-first search: use $f(n) = h(n)$ (also called greedy best-first)

- Beam search: use $f(n) = h(n)$ and keep $m$ best nodes in memory

- $A^*$: use $f(n) = g(n) + h(n)$

- Iterative-deepening $A^*$: Iterative deepening search + $A^*$

- Simplified memory-bounded $A^*$: Beam search + $A^*$
Local Search

- Hill Climbing
  - Use actions to define a neighborhood
  - Use $h(n)$ (an estimated cost from node $n$ to a goal) to pick the best neighbor (or the first better neighbor) to replace $n$.

- Simulated Annealing (SA): Use a temperature function to accept worse neighbors

- Tabu Search: Keep a small list of recently explored nodes and accept worse neighbors (if it is the best among all neighbors).
Constraint Satisfaction Problems (CSP)

A model of specifying search problems with three components:

$(V, D, C)$

- $V$: set of variables
- $D$: domains for variables
- $C$: constraints over variables

The goal is to find an assignment $\sigma: V \rightarrow D$ so that $\sigma(C)$ is true.

Methods

- Local search
- Backtracking with a heuristic: Depth-first search and sort neighbors by a heuristic.
- Forward checking and Look ahead: get better heuristic values
- Constraint propagation: use constraints to remove unfeasible values and force some assignments
- Arc consistency: Keep a small set of variables consistent
Game Playing

- Minimax algorithm
- Alpha-beta pruning
Knowledge Representation

- Knowledge Representation via First-order logic
- Converting English statements into formulas
- Syntax and Semantics
- Converting formulas into clauses
- Unification
- Logic Programming
- Resolution and strategies
- Fuzzy Logic
Exercise Problem

List the nodes entering Open List and Closed List using the following strategies:

- Depth-first search
- Depth-limited search $d = 2$
- Iterative deepening search
- Breadth-first search
- Bidirectional search
Exercise Problem

Assume $h(n) =$ the minimal distance to one of $n$’s neighbor. List the nodes entering Open List and Closed List using the following strategies:

- **Uniform-cost search:** $f(n) = g(n)$
- **Best-first search:** $f(n) = h(n)$
- **Beam search:** $f(n) = h(n)$ and $m = 2$
- **$A^*$:** $f(n) = g(n) + h(n)$
- **Simplified memory-bounded $A^*$:** $m = 2$
Exercise Problem

Compute the value of the root node using alpha-beta pruning.
Exercise Problem

Let $\Phi$ be a set of the following clauses:

1. $p \lor q \lor r$
2. $p \lor \neg q$
3. $\neg q \lor r$
4. $\neg p \lor q \lor \neg r$
5. $\neg p \lor \neg q$

Suppose the initial assignment is $(p, q, r) = (1, 1, 0)$. You are asked to use the following strategies to find a model of the clauses.

- Hill Climbing
- Tabu Search $m = 3$
Represent each of the following sentences in both first-order logic and Prolog:

- A whale is a mammal.
- Jane loves John.
- John knows Jane’s father.
- If it’s raining, then the ground is wet.
- If the switch is on and the light is off then the light-bulb is broken.
- All computers have a processor.