CS 1571 Introduction to AI
Review

Midterm review

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Midterm

- **October 23, 2007**
- **In-class**
- **Closed book**
- **Cover material on:**
  - Search
  - Propositional logic
  - First order logic (excluding inferences in FOL)
- **Study material:**
  - Lecture notes
  - Russel and Norvig textbook
  - Homework assignments

Search

- **Basic definition of the search problem**
  - Search space, operators, initial state, goal condition
- **Formulation of a problem:**
  - We have some control over the complexity of the **search space size**
- **Two types:**
  - Path vs. configuration search

Search

- **Methods for searching the search space:**
- **Search trace captured by the search tree**
- **Search methods properties :**
  - Completeness, Optimality, Space and time complexity.
- **Complexities**
  - measured in terms of a branching factor (*b*), depth of the optimal solution (*d*), maximum depth of the state space (*m*)

Search

- **Uninformed methods:**
  - Breadth first search, Depth first search, Iterative deepening, Bi-directional search, Uniform cost search (for the weighted path search)
- **Informed methods:**
  - **Heuristic function** (h): potential of a state to reach the goal
  - **Evaluation function (f) :** desirability of a state to be expanded next
  - **Best first search:**
    - Greedy $f(n) = h(n)$
    - A*: $f(n) = g(n) + h(n)$

      the role of admissible heuristics, optimality

Search

- **Constraint satisfaction problem (CSP)**
  - Variables, constraints on values (reflect the goal)
  - Formulation of a CSP as search
  - Methods and heuristics for CSP search
    - Backtracking, constraint propagation, most constrained variable, least constrained value
- **Complex configuration searches. Use iterative algorithms:**
  - **Methods:** Hill climbing, Simulated annealing, Genetic algorithms
  - **Advantage**: **memory !! Useful for very large optimization problems.**

Search

- **Adversarial search (game playing)**
  - Specifics of a game search, game problem formulation
  - rational opponent
- **Algorithms:**
  - **Minimax algorithm**
    - Complexity bottleneck for large games
  - **Alpha-Beta pruning**: prunes branches not affecting the decision of players
  - **Cutoff** of the search tree and heuristics

KR and logic

- **Knowledge representation:**
  - **Syntax** (how sentences are build), **Semantics** (meaning of sentences), **Computational aspect** (how sentences are manipulated)
- **Logic:**
  - A formal language for expressing knowledge and ways of reasoning
  - **Three components:**
    - A set of sentences
    - A set of interpretations
    - The valuation (meaning) function

Propositional logic

- A language for symbolic reasoning
- **Language:**
  - Syntax, Semantics
- **Satisfiability** of a sentence: at least one interpretation under which the sentence can evaluate to ***True***.
- **Entailment:**

$KB \models \alpha$ is true in all worlds in which KB is true

- **Inference procedure**
  - Soundness If $KB \vdash_i \alpha$ then $KB \models \alpha$
  - Completeness If $KB \models \alpha$ then $KB \vdash_i \alpha$

Propositional logic

- **Logical inference problem:** $KB \models \alpha$?
  - Does KB entail the sentence α ?
- Logical inference problem for the propositional logic is **decidable**.
  - A procedure (program) that stops in finite time exists
- **Approaches:**
  - Truth table approach
  - Inference rule approach
  - Resolution refutation

$KB \models \alpha$	if and only if
$(KB \wedge \neg \alpha)$	is **unsatisfiable**

- **Normal forms**: DNF, CNF, Horn NF (conversions)

First order logic

- Deficiencies of propositional logic
- **First order logic (FOL):**
  allows us to represent objects, their properties, relations and statements about them
  - Variables, predicates, functions, quantifiers
  - Syntax and semantics of the sentences in FOL
- Translation of English sentences to FOL