

Midterm Review

Some general advice

You should:

- Do the in-class exercises – they are there for a reason.
- Understand the assignments, even if you didn't do them, or didn't do well.
- Be able to *compare* strategies for representation and search. What are their strengths and weaknesses?
- Be able to write syntactically correct and functional basic LISP, and read more sophisticated code.
- Write your answers in full, grammatically correct sentences, using the terminology from the course.
- Not worry about memorizing formulae, but do know what they are for.

What is AI? Many answers.

- “The art of creating machines that perform functions that require intelligence when done by people.” (Kurzweil, 1990)
- Heuristic search, domain-specific reasoning
- Symbolic representation, qualitative vs. quantitative
- Sub-symbolic representation, (sometimes) mimicking the brain
- Problem-solving using inexact, missing or poorly defined information
- “Sufficient” answers, vs. exact, complete or optimal answers
- Meta-level knowledge, and reasoning about reasoning

What are the goals of AI? Many answers.

One or more of the following:

- To produce artificial humans/animals
- To build systems that exhibit human intelligence
- To learn more about human intelligence by trying to emulate it in a machine
- To build systems that behave (super-) intelligently
- To build systems which can do (boring, dangerous) tasks that (only?) humans now do
- To build useful machines using mechanisms inspired by human intelligence

What are the applications/subdomains of AI?

Many answers.

- Game playing
- Automated reasoning
- Expert systems
- Modeling humans
- Robotics
- Machine learning
- Intelligent interfaces

The Turing Test

- What is it, in its full form? What are some variations on the idea?
- Has a computer ever passed it?
- Why did Turing propose it?
- What are some criticisms of it?
- How did Turing (and others) respond to those criticisms?
- What is Searle's Chinese Room? How is it a response to the Turing Test? What point is it trying to make? What are some common responses to it?

Uninformed Search

You should understand Depth-First Search, Breadth-First Search and DFS With Iterative Deepening in detail.

- Given a state space, in what order will the nodes be searched?
- At any given point in the search, what is on the open and closed lists?
- What is a solution path (as opposed to the order in which the nodes are searched)?
- What are the pros/cons of each approach? (e.g. time/space complexity, shortest solution path)
- How can these be implemented in LISP?

Heuristics

The field of AI (and this course) uses the word “heuristic” in several different, but overlapping, ways.

- A rule of thumb
- The application of domain knowledge
- A domain-specific strategy
- A type of search (“heuristic search” is roughly the same as “best first search”)
- An estimate of the distance to a goal state (i.e. in A^*)

Good for problems without exact solutions, or those with exact solutions but with huge search spaces.

Downside: Fallible by their very nature! Horizon problem.

Informed Search

- Best-first search in general (ordering the open list by some sort of heuristic evaluation)
- A* in particular ($f(x)=g(x)+h(x)$)

What does it mean for a heuristic (with A*) to be:

- *Admissible*
- More *informed* than another heuristic

Competitive Search

In two-player games:

- How does minimax work with exhaustive search?
- How does it work to a fixed-ply depth?
- How does alpha-beta pruning improve minimax? Is there a cost?
- What *combination* of strengths/strategies allowed Deep Blue to beat Kasparov?

Propositional Logic

- What is the difference between propositional and predicate logic?
What advantages does the latter have over the former?
- Know how to use a truth table.

First-order predicate logic (FOPL)

- Know the syntax.
- Be able to translate English sentences into FOPL, and vice versa.
 - Note: Translating “Cosmo likes cheese” into something like “cosmo_likes_cheese().” is technically legal, but not recommended on the exam.
- Know how to use the existential and universal quantifiers.
- Why is it important to have some sort of interpretation or semantics?
- What does “first order” mean here?
- What is unification, and how does it work? [Note: this will be a LOT more important in the final exam]
- What are the strengths and weaknesses of predicate logic in the context of AI?

LISP

- Imperative vs. declarative, functional vs. logical, recursion vs. iteration – where does LISP fit?
- Know the syntax
- What do T and NIL really mean?
- Know how to use: CAR, CDR, QUOTE (or '), CONS etc. (everything in the slides). What do they return? When are they undefined? Don't worry about dotted pairs.
- Know how to use DEFUN and COND (including syntax). The midterm won't ask about other conditional forms – just COND.

Neural Networks

- *Symbolic vs Subsymbolic* representation
- Strengths and weaknesses, especially in comparison with symbolic systems.
- Roughly speaking, how does a human neuron work?
- How does an artificial neuron (TLU) work?
- No need to derive or remember any equations, but...
- For a given problem (e.g. image recognition), what are the inputs? What are the outputs? What is the training data? Why have cross-validation data (generalization, overfitting)?
- In general terms, how does the back propagation algorithm train a neural network?

Expert Systems

- The world knowledge problem. What is it? Can you give an example?
- General-purpose vs. domain-specific intelligence.
- Where do expert systems fall on procedural vs. declarative, quantitative vs. qualitative, domain specific vs general purpose (aka informed vs. uninformed)?
- What are the challenges in building an expert system? (e.g. getting knowledge out of an expert, estimating probability, handling incomplete knowledge, fuzziness, explanation, conflicts, maintenance/updates).
- What does a basic IF/THEN rule look like? What are its semantics?

Expert Systems 2

- IF/THEN rule structure
- AND/OR/NOT
- The structure of a rule-based system (knowledge base, database, inference engine, user interface)
- Forward vs backward chaining: examples of problems better/worse for each direction.
- Pros and cons of rule-based systems.

Probability in Expert Systems

- Where does uncertainty come from? Genuine randomness, weak implications, imprecise language, unknown data, differing experts.
- What are the pros and cons of Bayesian (classical) probability wrt expert systems? Humans poor at estimating conditional probability, good stats often not available, garbage in / garbage out – but rigorous, consistent, mathematically sound
- How do certainty factors work? Pros and cons
- Calculate how certainty factors propagate through a rule base.
- Remember: both facts (e.g. what the patient says) and the rules (i.e. what your expert(s) said) have CFs.
- Don't forget AND, OR and NOT!

Fuzzy ES

- Fuzzy logic vs. crisp logic: How are they different? Pros and cons.
- Two different approaches to defining membership functions for fuzzy sets. Practice using them. Given an item, calculate its membership.
- AND, OR, NOT and hedges (very, extremely, etc.). How are they used?
- Given a rule (e.g. “IF the wind is EXTREMELY strong and the rain is VERY heavy THEN weather is hurricane”) and membership values for the antecedent, how would you calculate the membership value for the consequent?
- Reasoning over multiple rules and defuzzification will not be covered on the midterm.

Breakdown

Roughly (no promises!) 20% each:

- High level: what AI is all about, philosophy, history
- Search
- Representation
- Comparing approaches
- LISP