Multi-topic objectives

0a. Show knowledge of facts and concepts
0b. Summarize the semester’s learning
0c. Carry out documented research on AI
0d. Participate in class activities throughout the semester
0e. Solve problems as part of a team
0f. Present results in the classroom
Background concepts

0.1a Recognize basic concepts of precalculus*
0.1b Write the truth table for a propositional-logic formula or logic circuit*
0.2 Design a looping algorithm*
0.3a Find a path in a graph*
0.3b Explain the relation between the logarithm function and the heights of trees*
0.4 Explain basic notions of combinatorics*

Course plan

1. Cognition and computation
2. State-space search
3. Knowledge representation and inference
4. Uncertainty and probabilistic reasoning
5. Supervised learning and natural language
6. Reinforcement learning and adaptation
7. Distributed AI and multi-stream interaction
8. Philosophical considerations and future prospects
**Objectives for topics 1-4**

1. Compare human cognition with computational or agent models of perception-action
2. Explain how heuristics offer ways to pursue goals in exponentially large search spaces
3. Describe the representation and use of knowledge in inference-based problem solving
4. Apply probability theory to describe agents operating in uncertain environments

**Objectives for topics 5-8**

5. Describe different ways to supervise agents to learn and improve their behavior
6. Explain adaptive learning from the environment
7. Explain the relation between distributed artificial intelligence and emergent behavior
8. Defend a theory of mind, relating it to ethical issues raised by artificial cognitive systems
Summary objective

9. Distinguish stages in the development of artificial-intelligence research and applications

Stages in development of AI

1. Definition of field: phys. symb. system hypothesis
2. Goal-driven state-space search
3. Knowledge-based systems using inference
4. Planning under uncertainty using Bayesian reasoning and Markov models
5. Supervised learning via abduction, neural nets, and evolution
6. Adaptive learning from environment; robotics
7. Distributed (multi-agent) artificial intelligence
Final exam and summary quiz

- On final exam day, each student will be asked to present elements of her/his research or semester project
- During the last week of classes, we’ll have a summary quiz of multiple-choice questions and multi-topic problems
## Subtopic outcomes

1.1 Describe some concepts or problems in cognitive science
1.2 Describe the computational-representational understanding of mind*
1.3a Distinguish classes of agent environments
1.3b Describe a reflex agent within the rational-agent model of AI*
1.4 Contrast connectionist and automata-based models of computation

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### 2. State-space search

1. Constraint and optimization problems
2. Goal-driven search
3. Exhaustive search and intractability
4. Heuristics
Subtopic outcomes

2.1 Explain what constraint and optimization problems are
2.2a Explain goal-based state-space search*
2.2b Perform a goal-driven analysis of a problem with a game tree*
2.3 Apply the definition of intractability to a computational problem
2.4 Explain how heuristics are used to provide adequate solutions to hard search problems*

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3. Knowledge representation and inference

1. Knowledge, planning, and beliefs
2. Concepts and instances
3. Logical inference
4. Expert systems and resolution proof
Subtopic outcomes

3.1 Explain *knowledge-based* agents*
3.2 Describe methods of representing and using knowledge*
3.3a Explain a basic concept of logical inference*
3.3b Use inference in propositional or predicate logic
3.4 Describe how expert systems work

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4. Uncertainty and belief

1. Acting under uncertainty
2. Probability theory and belief
3. Bayesian inference
4. Markov models
5. Decision theory and expected utility
Subtopic outcomes

4.1  Describe ways to operate under conditions of *uncertain knowledge*

4.2  Apply probability theory

4.3  Derive belief from evidence using a belief network

4.4a Describe and construct a Markov model

4.4b Describe applications of Bayesian reasoning and Markov modeling

4.5  Describe and apply decision theory and bounded rationality*

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**5. Supervised learning and natural language**

1. Supervised learning
2. Symbol-based learning
3. Connectionist learning
4. Evolutionary computation
5. Natural-language processing
**Subtopic outcomes**

5.1 Explain what *learning* is*

5.2a Describe methods of symbol-based *supervised learning*

5.2b Apply the decision tree learning method to sample data

5.3a Describe the *connectionist* approach to AI*

5.3b Construct and train a perceptron

5.4 Describe evolutionary computation

5.5 Explain concepts of *natural-language processing*

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**6. Adaptation and reinforcement learning**

1. Interaction and intelligent behavior
2. POMDPs and reinforcement learning
3. Robotics and embodied intelligence
Subtopic outcomes

6.1 Identify problems that require interaction or adaptation*
6.2a Describe methods of reinforcement learning
6.2b Describe policy search methods in a sample environment
6.3 Explain features of robotic systems*

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7. Distributed AI

1. Multi-agent systems and distributed intelligence
2. Decentralized and self-organizing systems
Subtopic outcomes

7.1 Describe distributed AI*

7.2a Relate intelligence to self organization and emergent behavior*

7.2b Apply multi-agent concepts in a computer-based solution design or simulation

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8. Philosophical challenges

1. Theories of mind
2. Weak and strong AI claims
3. Future agent architectures
4. Future ethical issues
Subtopic outcomes

8.1 Explain two theories of mind*
8.2 Evaluate the weak and strong AI theses
8.3 Explain the notion of bounded optimality
8.4 Discuss ethical issues raised by future prospects for AI*