CSCI-561 Foundations of Artificial Intelligence – USC – Spring 2024 Syllabus and Schedule

Lectures: Prof. Laurent Itti, Mon & Wed, 3:00pm – 4:50pm, SGM-123

Textbook: Artificial Intelligence: A Modern Approach, 4th Ed. (AIMA)
Optional Reading: Autonomous Learning from the Environment (ALFE)

Date	Topic	Reading
Mon Jan 8	1. Welcome – Introduction. Why study AI? What is AI? The Turing test. Rationality. Branches of AI. Brief history of AI. Challenges for the future. What is an intelligent agent? Doing the right thing (rational action). Performance measure. Autonomy. Environment and agent design. Structure of agents. Agent types.	AIMA 1, 2 (ALFE 1)
Wed Jan 10	2. Problem Solving & Search – Types of problems. Example problems. Basic idea behind search algorithms. Complexity. Combinatorial explosion and NP completeness. Polynomial hierarchy.	AIMA 3 (ALFE 2, 6)
Mon Jan 15	**Martin Luther King's Birthday – NO CLASS**	
Wed Jan 17	3. Uninformed Search – Depth-first. Breadth-first. Uniform-cost. Depth-limited. Iterative deepening. Examples. Properties.	AIMA 3 HW1 out
Mon Jan 22	4. Informed search – Best-first. A* search. Heuristics. Hill climbing. Problem of local extrema. Simulated annealing. Genetic Algorithms.	AIMA 3, 4 (ALFE 6)
Wed Jan 24	5. Game Playing – The minimax algorithm. Resource limitations. Alpha-beta pruning. Chance and non-deterministic games.	AIMA 5
Mon Jan 29	6. Continue game Playing – The minimax algorithm. Resource limitations. Alpha-beta pruning. Chance and non-deterministic games.	AIMA 5
Wed Jan 31	7. Constraint satisfaction – Node, arc, path, and k-consistency. Backtracking search. Local search using min-conflicts.	AIMA 6 (ALFE 6)
Mon Feb 5	8. Agents that reason logically – Knowledge-based agents. Logic and representation. Propositional (boolean) logic. Inference in propositional logic. Syntax. Semantics. Examples.	AIMA 7 (ALFE 3) HW1 due
Wed Feb 7	9. First-order logic – Syntax. Semantics. Atomic sentences. Complex sentences. Quantifiers. Examples. FOL knowledge base. Situation calculus. Describing actions. Planning. Action sequences.	AIMA 8, AIMA 10 HW2 out
Mon Feb 12	**Midterm exam 1 – in classroom – 3:00pm - 4:50pm SGM-123**	
Wed Feb 14	10. Inference in first-order logic – Proofs. Unification. Generalized modus ponens. Forward and backward chaining. Resolution. Proof by contradiction.	AIMA 9
Mon Feb 19	**President's day – NO CLASS**	
Wed Feb 21	11. Logical reasoning systems – Indexing, retrieval and unification. The Prolog language. Theorem provers. Frame systems and semantic networks.	AIMA 9
Mon Feb 26	12. Planning – Definition and goals. Basic representations for planning. Situation space and plan space. Examples.	AIMA 11 (ALFE 6)
Wed Feb 28	13. Fuzzy logic – concepts, fuzzy inference, aggregation, defuzzyfication. Examples.	Handout

Mon Mar 4	14. Learning from examples – supervised learning, training / validation / test sets, cross-validation, learning decision trees, support vector machines.	AIMA 19 + handout (ALFE 4)
Wed Mar 6	15. Learning with neural networks – bio-inspired models, integrate and fire models, perceptrons, backpropagation algorithm, Hopfield networks. How to size a network? What can neural networks achieve?	Handout + AIMA 21 HW2 due
Mon Mar 11	**Spring Recess – NO CLASS**	
Wed Mar 13	**Spring Recess – NO CLASS**	
Mon Mar 18	16. Advanced concepts in neural networks – convnets, deep learning, autoencoders, applications and state of the art.	Handout HW3 out
Wed Mar 20	17. Continue advanced concepts in neural networks – generative models, generative adversarial networks, recurrent networks, transformers, foundation models.	Handout
Mon Mar 25	**Midterm exam 2 – in classroom – 3:00pm - 4:50pm SGM-123**	
Wed Mar 27	18. Neural networks applications, issues of fairness and bias.	AIMA 27
Mon Apr 1	19. Reasoning under uncertainty – probabilities, conditional independence, Markov blanket, Bayes nets.	AIMA 12, 13
Wed Apr 3	20. Continue Reasoning under uncertainty – Probabilistic inference, enumeration, variable elimination, approximate inference by stochastic simulation, Markov chain Monte Carlo, Gibbs sampling.	AIMA 13, 14 (ALFE 5)
Mon Apr 8	21. Probabilistic decision making – utility theory, decision networks, value iteration, policy iteration, Markov decision processes (MDP), partially observable MDP (POMDP).	AIMA 17, 18 (ALFE 5)
Wed Apr 10	22. Reinforcement learning – RL task formulation, Q learning, deep Q-networks, policy gradients, imitation learning.	AIMA 22
Mon Apr 15	23. AI for machine vision – physics of image formation, image processing, classes of computer vision algorithms, deep learning approaches.	AIMA 25 HW3 due
Wed Apr 17	24. AI for natural language processing – parsing and syntax, similarity measures, clustering, topic analysis, machine translation, dialogue systems, language generation, vision/language models.	AIMA 23, 24
Mon Apr 22	25. AI for robotics – Basic robotics concepts, locomotion, manipulation, Monte-Carlo localization, simultaneous localization and mapping (SLAM), deep learning for robotic control.	AIMA 26
Wed Apr 24	26. General outlook and conclusions.	AIMA 27, 28

Midterm 1: Monday February 12, 3:00pm – 4:50pm, SGM-123
Midterm 2: Monday March 25, 3:00pm – 4:50pm, SGM-123
Final exam: Friday May 3, 2:00pm – 4:00pm, room TBA

All exams are closed-book (no books, notes, or electronic devices allowed – only bring your student ID and a pen or pencil).

Grades: 20% for midterm 1, 20% for midterm 2, 30% for final exam, 10% for each of the 3 homeworks, bonus extra 5% for attendance (maximum score capped at 100%).

Homeworks: These are programming assignments, you will program some A.I. agents for search, game playing, and neural networks, from scratch. Good programming knowledge is necessary. We will use vocareum.com where you can edit, compile, and test your code in

the cloud. Supported languages are C++11, Java, and Python.

For each homework, you will be given detailed instructions about what your agent should achieve. Your agent should parse a file named input.txt containing a problem definition, and produce a file named output.txt containing the results. The formats for input.txt and output.txt will be specified precisely for each homework. For example, for HW2 (game playing), the homework text will define which game we will play and its rules (e.g., chess, or checkers, etc), then input.txt may contain a representation of the current state of the game (e.g., current positions of pieces on a game board), and output.txt should contain your selected move. You will be given sample input.txt and output.txt files for debugging purposes. Grading will then test your agent against 50 pairs of input.txt/output.txt files.

Homeworks should be solved individually, and will be graded individually.

The use of ChatGPT and other AIs is allowed for homeworks. Beware, however, that these agents may produce counterfactual or otherwise incorrect outputs (as we will study in class). Thus, you should use at your own risk.

Tentative homework topics (subject to change):

HW1 search
HW2 game playing
HW3 neural networks

Grading is absolute and according to the following scale:
90 or more: A+; 80 or more: A; 75 or more: A-; 70 or more: B+; 60 or more: B; 55 or more: B-; 50 or more: C+; 40 or more: C; 35 or more: C-; less than 35: F.