USC Viterbi School of Engineering

CSCI 360: Introduction to Artificial Intelligence (Fall 2020)

Units: 4

Instructor: Mohammad Reza Rajati, PhD
PHE 412
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Office Hours: By appointment, ONLINE

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Grader(s):

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Lecture: Monday, Wednesday, 5:00 pm –6:50 pm ONLINE

Webpages: Piazza Class Page for everything except grades
and USC Blackboard Class Page for grades
and GitHub for code submission

– All HWs, handouts, solutions will be posted in PDF format

Prerequisite: CSCI 104L, CSCI 170. Prior courses in calculus, linear algebra, probability, and s

Other Requirements: Computer programming skills.
Using Python or C++ is mandatory. Using Python is highly encouraged.

Tentative Grading: Programming Assignments (Labs) 35%
Problem Sets 15%
Midterm Exam 20%
Final Exam 30%
Participation on Piazza* 5%

Letter Grade Distribution:

$\geq$ 93.00	A	73.00 - 76.99	C
90.00 - 92.99	A-	70.00 - 72.99	C-
87.00 - 89.99	B+	67.00 - 69.99	D+
83.00 - 86.99	B	63.00 - 66.99	D
80.00 - 82.99	B-	60.00 - 62.99	D-
77.00 - 79.99	C+	$\leq$ 59.99	F

Disclaimer: Although the instructor does not expect this syllabus to drastically change, he reserves every right to change this syllabus any time in the semester.

Note on e-mail vs. Piazza: If you have a question about the material or logistics of the class and wish to ask it electronically, please post it on the piazza page (not e-mail). You may post it anonymously if you wish. Often times, if one student has a question/comment, other also have a similar question/comment. Use e-mail with the professor, TA, graders only for issues that are specific to you individually (e.g., a scheduling issue or grade issue).

Catalogue Description: Concepts and algorithms underlying the understanding and construction of intelligent systems. Agents, problem solving, search, representation, reasoning, planning, machine learning.

Course Description: Artificial Intelligence (AI) seeks to understand the mechanisms underlying thought and intelligent behavior, with a particular focus on their embodiment in machines. Core topics include the integrating perspective of intelligent agents and how such systems can engage in: search and problem solving; symbolic and probabilistic knowledge representation and reasoning; planning; and machine learning. The course introduces both basic concepts and algorithms, and explores how to apply these in the construction of systems that can interact intelligently with complex environments. The course is intended for undergraduate students in computer science or closely related disciplines, usually in the junior year. Graduate students should take CSCI561 rather than CSCI360.

Course Objectives: Upon successful completion of this course a student will

- Broadly understand rationality and intelligence
- Understand problem solving via search
- Understand Uninformed and informed search algorithms
- Understand adversarial search and games
- Understand logical agents, logical inference, and knowledge-based systems
- Understand automated planning
- Understand decision theory
- Understand supervised and unsupervised learning .
- Understand classification and regression problems
- Understand decision trees and interpretable learning.
- Understand fuzzy sets and fuzzy rule mining
- Understand Hebbian learning in neural systems
- Understand feedforward neural networks and deep learning
- Understand Reinforcement Learning

Exam Dates:

- **Midterm Exam:** Wednesday Sep 30, 5:00-6:50 PM, ONLINE.
- **Final Exam:** Wednesday, Nov 18, 4:30 PM- 6:30 PM, ONLINE as set by the university

Textbooks:

- **Required Textbook:**

  1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson, 2020. (AIMA)

- **Recommended Textbooks:**

  1. Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, *An Introduction to Statistical Learning with Applications in R*, Springer, 2013. (ISLR)
     Available at http://faculty.marshall.usc.edu/gareth-james/ISL/ISLR%20Seventh%20Printing.pdf
  2. David L. Poole and Alan K. Mackworth, *Artificial Intelligence: Foundations of Computational Agents*, 2nd Edition, Cambridge University Press, 2017.
     Available at https://artint.info/2e/html/ArtInt2e.html
  3. *Neural Networks and Learning Machines*, 3rd Edition
     Author: Simon Haykin; Pearson; 2008. **ISBN-13:** 978-0131471399

Grading Policies:

- The letter grade distribution table guarantees the *minimum* grade each student will receive based on their final score. When appropriate, relative performance measures will be used to assign the final grade, at the discretion of the instructor.
  - Final grades are non-negotiable and are assigned at the discretion of the instructor. If you cannot accept this condition, you should not enroll in this course.
- Your lowest grade in problem sets and your lowest grade in programming assignments (Labs) will be dropped from the final grade.
- *Participation on Piazza has up to 5% extra credit, which is granted on a competetive basis *at the discretion of the instructor.*
- **Homework Policy**
  - Homework is assigned on an approximately weekly basis. A two-day grace period can be used for each homework with 10% penalty for each day the homework is late. *Absolutely no late homework will be accepted after the grace period. A late assignment results in a zero grade.*

  - Poor internet connection, failing to upload properly, or similar issues are NOT acceptable reasons for late submissions. If you want to make sure that you do not have such problems, submit homework eight hours earlier than the deadline. *Please do not ask the instructor to make individual exceptions.*
  - Homework solutions and simulation results should be typed or *scanned* using scanners or mobile scanner applications like CamScan and uploaded (photos taken by cell-phone cameras and in formats other than pdf will NOT be accepted). Programs and simulation results have to be uploaded on GitHub as well.
  - Students are encouraged to discuss homework problems with one another, but each student must do their own work and submit individual solutions written/ coded in their own hand. Copying the solutions or submitting identical homework sets is written evidence of cheating. The penalty ranges from F on the homework or exam, to an F in the course, to recommended expulsion.
  - Posting the homework assignments and their solutions to online forums or sharing them with other students is strictly prohibited and infringes the copyright of the instructor. Instances will be reported to USC officials as academic dishonesty for disciplinary action.

- **Exam Policy**
  - **Make-up Exams:** No make-up exams will be given. If you cannot make the above dates due to a class schedule conflict or personal matter, you must drop the class. In the case of a required business trip or a medical emergency, a signed letter from your manager or physician has to be submitted. This letter must include the contact of your physician or manager.
  - Midterm and final exams will be closed book and notes. Calculators may be allowed (this will be announced before the exam) but computers and cell-phones or any devices that have internet capability are not allowed. One letter size cheat sheet (back and front) is allowed for the midterm. Two letter size cheat sheets (back and front) are allowed for the final.
  - All exams are cumulative, with an emphasis on material presented since the last exam.

- **Attendance:**
  - Students are required to attend all the lectures and discussion sessions and actively participate in class discussions. Use of cellphones and laptops is prohibited in the classroom. If you need your electronic devices to take notes, you should discuss with the instructor at the beginning of the semester.

Important Notes:

- Textbooks are secondary to the lecture notes and homework assignments.
- Handouts and course material will be distributed.
- Please use your USC email to register on Piazza and to contact the instructor and TAs.

Tentative Course Outline

Monday	Wednesday
Aug 17th **1** **Introduction and History of AI** (AIMA Ch. 1)	19th **2** **Intelligent Agents** (AIMA Ch. 2)
24th **3** **Problem Solving via Search** (AIMA Ch. 3.1-3.3) Problem Formulation Examples Search Algorithms Best-first Search	26th **4** **Problem Solving via Search** (AIMA Ch. 3.3-3.4) Uninformed Search Depth-First Search Breadth-First Search Uniform Cost Search
31st **5** **Search in Complex Environments** (AIMA Ch. 3.5-3.6) Informed Search Greedy best-first search A* Search Heuristic Functions	Sep 2nd **6** **Search in Complex Environments** (AIMA Ch. 4.1-4.2) Local Search and Optimization Hill Climbing Evolutionary Algorithms Simulated Annealing* Particle Swarm Optimization*
7th **7** **Adversarial Search and Games** (AIMA Ch. 5.1-5.3) Game Theory Optimal Decisions and Min-Max Alpha-Beta Pruning **Labor Day**	9th **8** **Logical Agents** (AIMA Ch. 7.1-7.3) Knowledge-Based Agents Logic
14th **9** **Propositional Logic** (AIMA Ch. 7.4-7.5) Aristotelian Logic Inference Theorem Proving Forward and Backward Chaining	16th **10** **First-Order Logic** (AIMA Ch. 8.1-8.4) Knowledge Representation via Logic Syntax and Semantics Existential and Universal Quantification Applications Knowledge Engineering*
21st **11** **Inference in First-Order Logic** (AIMA Ch. 9.1-9.2) Inference	23rd **12** **Knowledge-Based Systems** (AIMA Ch. 9.3-9.4) Forward and Backward Chaining

Monday	Wednesday
28th **13** **Search-Based Planning** (AIMA Ch. 11.1-11.4) Classical Planning Formulation Automated Planning Algorithms Heuristics Hierarchical Planning	30th **14** **Review of Probability Theory** (AIMA Ch. 12.1-12.5) Quantifying Uncertainty Probability Axioms Events and Logic Probability Distributions Independence Total Probability and The Bayes' Rule
Oct 5th **15** **Decision Theory** (AIMA Ch. 16.1-16.5) Utility Theory Rational Preferences Utility Functions Decision Networks*	7th **16** **Agents that Learn from Experience and Data** (AIMA Ch. 19.1-19.2, 19.4, 19.9) What is Machine Learning? Supervised, Unsupervised, and Reinforcement Learning Regression and Classification The Bias-Variance Trade-off No Free Lunch!
12th **17** **Classification** (AIMA Ch. 19.7.3) Bayes' Optimal Classifiers and KNN Logistic Regression*	14th **18** **Classification** (AIMA Ch. 12.6) Bayesian Learning and Naïve Bayes' Learning Text Classification
19th **19** **Regression** (AIMA Ch. 19.6.1-19.6.3, 19.7.4) Minimum Mean-Squared Error Regression KNN Regression Linear Regression	21st **20** **Decision Trees** (AIMA Ch. 19.3) Regression and Classification Trees
26th **21** **Agents that Think Humanly** Fuzzy Sets Fuzzy Inference Interpretable Learning Using Fuzzy Rule-Based Systems	28th **22** **Supervised Hebbian Learning** Perceptron Learning Rule Hopfield Neural Networks

Monday	Wednesday
Nov 2nd **23** **Neural Networks and Deep Learning** (AIMA Ch. 21) Feedforward Neural Networks Backpropagation and Gradient Descent Overfitting Regularization	4th **24** **Reinforcement Learning*** (AIMA Ch. 22.3.3-22.5) Definitions Task-Reward-Policy Formulation Total Discounted Future Reward Optimal Policy Value Function Q-Function The Bellman Equation Q-Learning Exploration- Exploitation Extensions to Stochastic Environments and Rewards Deep Reinforcement Learning
9th **25** **Unsupervised Learning** K-Means Clustering Hierarchical Clustering Competitive Learning and Self-Organizing Maps*	11th **26** **The Future of AI*, Ethics in AI*, Review and Wrapup** (AIMA Chs. 27, 28)

Notes:

- This syllabus has two major parts: the first part is on topics that are called GOFAI (Good Old-Fashioned AI) and involves problem solving via search, game playing, logical agents, and knowledge-based systems. The second part involves Statistical Learning, or Machine Learning, which is arguably the major focus of AI nowadays.
- Items marked by * will be covered only if time permits.

Statement on Academic Integrity: USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A. See: http://scampus.usc.edu.

Emergency Preparedness/Course Continuity in a Crisis In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies. See the university's site on Campus Safety and Emergency Preparedness: http://preparedness.usc.edu

Statement for Students with Disabilities: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html

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