

Units: 4

Instructor: Mohammad Reza Rajati, PhD

PHE 412

rajati@usc.edu – Include CSCI 360 in subject

Office Hours: After class, by appointment

TA(s): TBD

tbd@usc.edu – Include CSCI 360 in subject

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Grader(s):

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Lecture: Monday, Wednesday, 12:00 pm –1:50 pm, THH 201

Webpages: [Piazza Class Page](#) for everything except grades
and [USC Blackboard Class Page](#) for grades
and [GitHub](#) for code submission

Prerequisite: – All HWs, handouts, solutions will be posted in PDF format
CSCI 104L, CSCI 170. Prior courses in calculus, linear algebra,
probability, and statistics will immensely help.

Other Requirements: Computer programming skills.
Using Python is mandatory.

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

Letter Grade Distribution:

≥ 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+	≤ 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. Private Piazza posts to the whole instructor team should be used to contact 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 CSCI 561 rather than CSCI 360.

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:** Monday March 6, 12:00-1:50 PM, In Class.
- **Final Exam:** Friday, May 5, 11:00 AM- 1:0 PM, 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, 2021. (ISLR)
Available at https://web.stanford.edu/~hastie/ISLRv2_website.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 competitive basis *at the discretion of the instructor*.

• Homework Policy

- Homework is assigned on an approximately weekly basis. Homework due dates are mentioned in the course outline, so mark your calendars. A three-day grace period can be used for each homework with 10% penalty per day. Any change in homework after the deadline makes it a late submission. *Absolutely no late homework will be accepted after the grace period. A late assignment results in a zero grade.*
- Late Days: No late homework will be accepted after the three day grace period. One second after the deadline is considered late. However, students are allowed to use *six* late days for homework for any reason (including sickness, family emergencies, overwhelming workload, exams, etc) *without incurring the 10% penalty.* Beyond that, no individual extension will be granted to anyone for any reason whatsoever.

Example: A student can submit six assignments, one day late each, without any penalty. Or three assignments, two days late each, without penalty, or two assignments three days late each. A student cannot use four late days for one assignment, and two late days for another assignment. An assignment submitted four days late will receive a zero grade, although its grade will be dropped as the lowest homework grade, according to the above grading policies.
- Use your six late days strategically and only if you absolutely need them. Always remember that later in the semester, you might become sick or have heavy workload in other courses and might need to use your late days.
- Assignments are *project-style*; therefore, *we do not provide solutions to the assignments.* This is a firm rule.
- 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 is graded based on *when it was submitted, not when it was finished.*
- Homework solutions and simulation results should be typed or *scanned* using scanners or mobile scanner applications like CamScanner 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.

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
<div style="display: flex; justify-content: space-between;"> Jan 9th 1 </div> Introduction and History of AI (AIMA Ch. 1)	<div style="display: flex; justify-content: space-between;"> 11th 2 </div> Intelligent Agents (AIMA Ch. 2)
<div style="display: flex; justify-content: space-between;"> 16th </div> Martin Luther King Day	<div style="display: flex; justify-content: space-between;"> 18th 3 </div> Problem Solving via Search (AIMA Ch. 3.1-3.3) Problem Formulation Examples Search Algorithms Best-first Search
<div style="display: flex; justify-content: space-between;"> 23rd 4 </div> Problem Solving via Search (AIMA Ch. 3.3-3.4) Uninformed Search Depth-First Search Breadth-First Search Uniform Cost Search	<div style="display: flex; justify-content: space-between;"> 25th 5 </div> Search in Complex Environments (AIMA Ch. 3.5-3.6) Informed Search Greedy best-first search A* Search Heuristic Functions
<div style="display: flex; justify-content: space-between;"> 30th 6 </div> Search in Complex Environments (AIMA Ch. 4.1-4.2) Local Search and Optimization Hill Climbing Evolutionary Algorithms Simulated Annealing* Particle Swarm Optimization*	<div style="display: flex; justify-content: space-between;"> Feb 1st 7 </div> Adversarial Search and Games (AIMA Ch. 5.1-5.3) Game Theory Optimal Decisions and Min-Max Alpha-Beta Pruning
<div style="display: flex; justify-content: space-between;"> 6th 8 </div> 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	<div style="display: flex; justify-content: space-between;"> 8th 9 </div> Decision Theory (AIMA Ch. 16.1-16.5) Utility Theory Rational Preferences Utility Functions Decision Networks*

MONDAY	WEDNESDAY
13th 10 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!	15th 11 Classification (AIMA Ch. 19.7.3) Bayes' Optimal Classifiers and KNN Logistic Regression*
20th President's Day	22nd 12 Classification (AIMA Ch. 12.6) Bayesian Learning and Naïve Bayes' Learning Text Classification
27th 13 Regression (AIMA Ch. 19.6.1-19.6.3, 19.7.4) Minimum Mean-Squared Error Regression KNN Regression Linear Regression	Mar 1st 14 Decision Trees (AIMA Ch. 19.3) Regression and Classification Trees
6th 15 Midterm	8th 16 Agents that Think Humanly Fuzzy Sets Fuzzy Inference Interpretable Learning Using Fuzzy Rule-Based Systems
13th Spring Recess	15th Spring Recess
20th 17 Supervised Hebbian Learning Perceptron Learning Rule Hopfield Neural Networks	22nd 18 Neural Networks and Deep Learning (AIMA Ch. 21) Feedforward Neural Networks Backpropagation and Gradient Descent Overfitting Regularization

MONDAY		WEDNESDAY	
27th	19	29th	20
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		Unsupervised Learning K-Means Clustering Hierarchical Clustering Competitive Learning and Self-Organizing Maps*	
Apr 3rd	21	5th	22
Logical Agents (AIMA Ch. 7.1-7.3) Knowledge-Based Agents Logic		Propositional Logic (AIMA Ch. 7.4-7.5) Aristotelian Logic Inference Theorem Proving Forward and Backward Chaining	
10th	23	12th	24
First-Order Logic (AIMA Ch. 8.1-8.4) Knowledge Representation via Logic Syntax and Semantics Existential and Universal Quantification Applications Knowledge Engineering*		Inference in First-Order Logic (AIMA Ch. 9.1-9.2) Inference	
17th	25	19th	26
Knowledge-Based Systems (AIMA Ch. 9.3-9.4) Forward and Backward Chaining		Search-Based Planning* (AIMA Ch. 11.1-11.4) Classical Planning Formulation Automated Planning Algorithms	
24th	27	26th	28
Search-Based Planning* (AIMA Ch. 11.1-11.4) Heuristics Hierarchical Planning		The Future of AI*, Ethics in AI*, Review and Wrapup (AIMA Chs. 27, 28)	

- Items marked by * will be covered only if time permits.

Homework Due Dates & Exams

FRIDAY	
Jan 13th -	1
20th -	2
27th Lab 0 Due (not graded)	3
Feb 3rd PS 1 Due	4
10th Lab 1 Due	5
17th PS 2 Due	6
24th Lab 2 Due	7
Mar 3rd PS 3 Due	8
10th PS 4 Due	9
17th Spring Recess	10
24th Lab 3 Due	11
31st PS 5 Due	12
Apr 7th Lab 4 Due	13
14th PS 6 Due	14
21st Lab 5 Due	15
28th PS 7 Due	16

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on [Research and Scholarship Misconduct](#).

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University’s educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

studenthealth.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call

suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call

studenthealth.usc.edu/sexual-assault

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086

eeotix.usc.edu

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors,

and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298

usc-advocate.symplicity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776

osas.usc.edu

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 821-4710

campussupport.usc.edu

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101

diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

ombuds.usc.edu

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-3340 or otfp@med.usc.edu

chan.usc.edu/otfp

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.