

# CAP 5636 - Advanced Artificial Intelligence

Fall 2022

<b>Course description:</b>	Principles of artificial intelligence. Uninformed and informed search. Constraint satisfaction. AI for game playing. Probabilistic reasoning, Markov decision processes, hidden Markov models, Bayes nets. Neural networks and deep learning.
<b>Student learning outcomes:</b>	By the end of the semester the students will be able to: <ul style="list-style-type: none"><li>• understand the search and decision making techniques used in modern artificial intelligence</li><li>• apply artificial intelligence techniques in their own code</li><li>• understand the societal and ethical implications of artificial intelligence</li></ul>
<b>Instructor:</b>	<a href="#">Dr. Lotzi Bölöni</a>
<b>Office Location:</b>	HEC - 319
<b>Phone:</b>	(407) 823-2320 (on last resort)
<b>E-mail:</b>	<a href="mailto:Ladislau.Boloni@ucf.edu">Ladislau.Boloni@ucf.edu</a> (preferred means of communication)
<b>Grader:</b>	Karthiek Duggirala <a href="mailto:karthiek.duggirala@knights.ucf.edu">karthiek.duggirala@knights.ucf.edu</a>
<b>Web Site:</b>	<a href="http://www.cs.ucf.edu/~lboloni/Teaching/CAP5636_Fall2022/index.html">http://www.cs.ucf.edu/~lboloni/Teaching/CAP5636_Fall2022/index.html</a> The assignments and the other announcements will be posted on the course web site
<b>Classroom:</b>	HEC 103
<b>Class hours:</b>	Tue, Th 12:00PM - 1:15PM
<b>Office hours:</b>	Tue, Th 6:00PM - 7:30PM See webcourses announcement for Zoom link.
<b>Enrollment requirements:</b>	CAP 4630, or consent of instructor.
<b>Required texts:</b>	There is no required textbook.
<b>Recommended readings:</b>	<ul style="list-style-type: none"><li>• Stuart Russel and Peter Norvig, Artificial Intelligence - A Modern Approach, 4rd edition</li></ul>
<b>Grading methods:</b>	<ul style="list-style-type: none"><li>• Grading scale: Letter grades only (A,B,C and F)</li><li>• Point based grading. The points obtained in all exams are added up for the final score. The grade will be A for 90 and above, B for 80-89, C for 70-79, F for lower than 70.</li><li>• Points awarded: Midterm 1: 20 points, Midterm 2: 20 points, Homeworks/Projects: 30 points total, Final exam 30 points.</li><li>• Some midterms, exams and homeworks will have bonus points, but no curve will be applied.</li><li>• The exams will be administered through ProctorHub, and are open book, open notes.</li><li>• Make up exams will be given only in justified cases.</li></ul>
<b>Sample exams</b>	<a href="#">Sample Midterm 1</a> <a href="#">Sample Midterm 2</a>

## Sample Final Exam

Note: you should not expect that the new exams are just variations with different data.

### Verification of engagement:

As of Fall 2014, all faculty members are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete the following academic activity by the end of the first week of classes, or as soon as possible after adding the course, but no later than August 27. Failure to do so will result in a delay in the disbursement of your financial aid.

To satisfy this requirement, you must finish the first quiz posted online. Log in to Webcourses, choose CAP 5636, and submit your answers online.

### Academic integrity

Students should familiarize themselves with UCF's Rules of Conduct at . According to Section 1, "Academic Misconduct," students are prohibited from engaging in

1. Unauthorized assistance: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
4. Falsifying or misrepresenting the student's own academic work.
5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor.
7. Helping another violate academic behavior standards.
8. Soliciting assistance with academic coursework and/or degree requirements.

### Responses to Academic Dishonesty, Plagiarism, or Cheating

Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, The Golden Rule . UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and respond to academic misconduct when necessary. Penalties for violating rules, policies, and instructions within this course can range from a zero on the exercise to an "F" letter grade in the course. In addition, an Academic Misconduct report could be filed with the Office of Student Conduct, which could lead to disciplinary warning, disciplinary probation, or deferred suspension or separation from the University through suspension, dismissal, or expulsion with the addition of a "Z" designation on one's transcript. Being found in violation of academic conduct standards could result in a student having to disclose such behavior on a graduate school application, being removed from a leadership position

within a student organization, the recipient of scholarships, participation in University activities such as study abroad, internships, etc. Let's avoid all of this by demonstrating values of honesty, trust, and integrity. No grade is worth compromising your integrity and moving your moral compass. Stay true to doing the right thing: take the zero, not a shortcut.

**Unauthorized Use of Websites and Internet Resources** There are many websites claiming to offer study aids to students, but in using such websites, students could find themselves in violation of academic conduct guidelines. These websites include (but are not limited to) Quizlet, Course Hero, Chegg Study, and Clutch Prep. UCF does not endorse the use of these products in an unethical manner, which could lead to a violation of our University's Rules of Conduct. They encourage students to upload course materials, such as test questions, individual assignments, and examples of graded material. Such materials are the intellectual property of instructors, the university, or publishers and may not be distributed without prior authorization. Students who engage in such activity could be found in violation of academic conduct standards and could face course and/or University penalties. Please let me know if you are uncertain about the use of a website so I can determine its legitimacy.

**Unauthorized Distribution of Class Notes** Third parties may attempt to connect with you to sell your notes and other course information from this class. Distributing course materials to a third party without my authorization is a violation of our University's Rules of Conduct. Please be aware that such class materials that may have already been given to such third parties may contain errors, which could affect your performance or grade. Recommendations for success in this course include coming to class on a routine basis, visiting me during my office hours, connecting with the Teaching Assistant (TA), and making use of the Student Academic Resource Center (SARC), the University Writing Center (UWC), the Math Lab, etc. If a third party should contact you regarding such an offer, I would appreciate your bringing this to my attention. We all play a part in creating a course climate of integrity.

<b>In-class recording</b>	Students may, without prior notice, record video or audio of a class lecture for a class in which the student is enrolled for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach enrolled students about a particular subject. Recording class activities other than class lectures, including but not limited to lab sessions, student presentations (whether individually or part of a group), class discussion (except when incidental to and incorporated within a class lecture), clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, private conversations between students in the class or between a student and the faculty member, and invited guest speakers is prohibited. Recordings may not be used as a substitute for class participation and class attendance, and may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct as described in the Golden Rule.
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<b>Course accessibility:</b>	The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need access to course content due to course design limitations should contact the professor as soon as possible. Students should also connect with <a href="#">Student</a>
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[Accessibility Services](#) (Ferrell Commons 185, sas@ucf.edu, phone 407-823-2371). For students connected with SAS, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential course access and accommodations that might be necessary and reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SAS, faculty and the student may be warranted to ensure an accessible course experience.

<b>Campus safety statement:</b>	<p>Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.</p> <ul style="list-style-type: none"> <li>• In case of an emergency, dial 911 for assistance.</li> <li>• Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Students should make a note of the guide's physical location and review the online version at <a href="https://centralflorida-prod.modolabs.net/student/safety/index">https://centralflorida-prod.modolabs.net/student/safety/index</a>.</li> <li>• Students should know the evacuation routes from each of their classrooms and have a plan for finding safety in case of an emergency.</li> <li>• If there is a medical emergency during class, students may need to access a first-aid kit or AED (Automated External Defibrillator). To learn where those are located, see <a href="https://ehs.ucf.edu/automated-external-defibrillator-aed-locations">https://ehs.ucf.edu/automated-external-defibrillator-aed-locations</a>.</li> <li>• To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <a href="https://my.ucf.edu">https://my.ucf.edu</a> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK."</li> <li>• Students with special needs related to emergency situations should speak with their instructors outside of class.</li> <li>• To learn about how to manage an active-shooter situation on campus or elsewhere, consider viewing this video <a href="https://youtu.be/NIKYajEx4pk">https://youtu.be/NIKYajEx4pk</a>.</li> </ul>
<b>Deployed active duty military students</b>	<p>If you are a deployed active duty military student and feel that you may need a special accommodation due to that unique status, please contact your instructor to discuss your circumstances.</p>

## Syllabus

Date	Topic	Lecture Notes, Readings, Homeworks
Tue, Aug. 23	<p><b>History and positioning of AI</b></p> <ul style="list-style-type: none"> <li>• Motivating AI. Dangers of AI and AGI.</li> <li>• Early history</li> <li>• Expert systems</li> </ul>	<p><a href="#">[slides] History and positioning of AI</a></p>

Date	Topic	Lecture Notes, Readings, Homeworks
Thu, Aug. 25	<b>History and positioning of AI</b> <ul style="list-style-type: none"> <li>• Neural networks</li> <li>• The two intellectual traditions of logic vs neural networks</li> <li>• A melting pot of other ideas</li> <li>• The agent view of AI</li> </ul>	
Tue, Aug. 30	<b>Uninformed search</b> <ul style="list-style-type: none"> <li>• Reflex agents</li> <li>• Search problems</li> <li>• Depth first and breadth first search</li> <li>• Uniform cost search</li> </ul>	<a href="#">[slides] Uninformed search</a>
Thu, Sep. 1		
Tue, Sept. 6		
Thu, Sep. 8	<b>Informed search: A* search and heuristics</b> <ul style="list-style-type: none"> <li>• Informed search methods</li> <li>• Heuristics</li> <li>• Greedy search</li> <li>• A* search</li> <li>• Graph search</li> </ul>	<a href="#">[slides] Informed search</a>
Tue, Sep. 13	<b>Game playing and adversarial search</b> <ul style="list-style-type: none"> <li>• Types of games</li> <li>• Adversarial search, minimax</li> <li>• The problem of depth</li> <li>• Evaluation functions</li> <li>• Alpha Beta pruning</li> </ul>	<a href="#">[slides] Adversarial search</a>
Thu, Sep. 15	<b>Expectimax search and utilities</b> <ul style="list-style-type: none"> <li>• Expectimax search</li> <li>• Refresher about probabilities</li> <li>• Utilities and rationality</li> </ul>	<a href="#">[slides] Expectimax search and utilities</a>
Tue, Sep. 20	<b>Markov decision processes 1</b> <ul style="list-style-type: none"> <li>• Defining MDPs: policies and utilities</li> <li>• Optimal policy, value of state, value of Q-state</li> </ul>	<a href="#">[slides] Markov Decision Processes 1</a>
Thu, Sept. 22	<b>Midterm 1 - Introduction to Adversarial Search</b>	

Date	Topic	Lecture Notes, Readings, Homeworks
Tue, Sep. 27	<b>Markov decision processes 2</b> <ul style="list-style-type: none"> <li>• Policy iteration</li> </ul>	<a href="#">[slides] Markov Decision Processes 2</a>
Thu, Sept. 29	<b>Reinforcement learning 1</b> <ul style="list-style-type: none"> <li>• Reinforcement learning as a twist on MDPs</li> </ul>	<a href="#">[slides] Reinforcement learning 1</a>
Tue, Oct. 4	<ul style="list-style-type: none"> <li>• Model-based and model-free learning</li> <li>• Temporal difference learning</li> </ul>	
Thu, Oct. 6	<b>Reinforcement learning 2</b> <ul style="list-style-type: none"> <li>• Exploration vs. exploitation, regret</li> <li>• Generalization across states</li> <li>• Policy search</li> </ul>	<a href="#">[slides] Reinforcement learning 2</a>
Tue, Oct. 11	<b>Probability</b> <ul style="list-style-type: none"> <li>• Random variables</li> <li>• Joint and marginal distributions, conditional distribution</li> </ul>	<a href="#">[slides] Probability</a>
Thu, Oct. 13	<ul style="list-style-type: none"> <li>• Product rule, chain rule, Bayes' rule</li> <li>• Inference</li> <li>• Independence</li> </ul>	
Tue, Oct. 18	<b>Markov models</b> <ul style="list-style-type: none"> <li>• Markov chains</li> <li>• Conditional independence</li> <li>• Stationary distributions</li> </ul>	<a href="#">[slides] Markov models</a>
Thu, Oct. 20	<b>Hidden Markov models</b> <ul style="list-style-type: none"> <li>• Hidden Markov models</li> <li>• Example: robot localization</li> </ul>	<a href="#">[slides] Hidden Markov models</a>
Tue, Oct. 25	<ul style="list-style-type: none"> <li>• Most likely explanation</li> <li>• Speech recognition</li> </ul>	
Thu, Oct. 27		
Tue, Nov. 1	<b>Midterm 2 - from MDP to Markov Chains</b>	

Date	Topic	Lecture Notes, Readings, Homeworks
Thu, Nov. 3	<b>Particle filters and applications of HMMs</b> <ul style="list-style-type: none"> <li>• Particle filters</li> <li>• Robot localization with particle filters</li> <li>• Dynamic Bayes nets</li> </ul>	<a href="#">[slides] Particle filters and Applications of HMMs</a>
Tue, Nov. 8	<b>Classification, principles of machine learning, naive Bayes</b> <ul style="list-style-type: none"> <li>• Classification</li> <li>• Model-based classification</li> <li>• Naive Bayes</li> <li>• Spam filter example</li> <li>• Generalization and overfitting</li> <li>• Parameter estimation</li> </ul>	<a href="#">[slides] Classification and naive Bayes</a>
Thu, Nov. 10		
Tue, Nov. 15	<ul style="list-style-type: none"> <li>• Classification and machine learning cont'd</li> </ul>	
Thu, Nov. 17	<b>Neural networks</b> <ul style="list-style-type: none"> <li>• Perceptron</li> </ul>	<a href="#">[slides] Perceptrons</a>
Tue, Nov. 22	<b>Machine learning background of deep learning</b> <ul style="list-style-type: none"> <li>• History and impact</li> <li>• Machine learning background</li> <li>• Loss functions: squared, cross-entropy, softmax</li> <li>• Optimization, stochastic gradient descent</li> <li>• Backpropagation</li> </ul>	<a href="#">[slides] Neural Networks I</a>
Thu, Nov 24	<b>Thanksgiving break - no class</b>	
Tue, Nov. 29	<b>Feedforward neural networks</b> <ul style="list-style-type: none"> <li>• Feedforward networks</li> <li>• Stochastic gradient descent</li> </ul>	

Date	Topic	Lecture Notes, Readings, Homeworks
Thu, Dec. 1	<b>Convolutional neural networks</b> <ul style="list-style-type: none"><li>• Convolutions</li><li>• Convolutional filters in neural networks</li><li>• Pooling layers</li></ul>	<a href="#">[slides] Convolutional networks</a>
Thu, Dec. 9	<b>Final exam Thursday December 8, 2022 10:00 AM - 12:50 PM</b>	