Ira A. Fulton Schools of Engineering
Arizona State University
Engineering | School of Computing, Informatics, and Decision Systems Engineering

Course Syllabus - Fall B 2019

Artificial Intelligence (CSE 571)

Course Description

The field of Artificial Intelligence (AI) develops the principles and processes for designing autonomous agents. This course addresses the core concepts in designing autonomous agents that can reason, learn, and act to achieve user-given objectives and prepares students to address emerging technical and ethical challenges using a principled approach to the field. Main topics include principles and algorithms that empower modern applications and future technology development for self-driving vehicles, personal digital assistants, decision support systems, speech recognition and natural language processing, autonomous game playing agents and household robots.

Specific topics covered include:

- Neural Networks
- Classical Planning
- Modeling & Reasoning
- Reinforcement Learning
- Markov Decision Processes (MDPs)
- Partially Observable Markov Decision Processes (POMDPs)
- Bayesian Networks
- Sensors for Perception
- Perception based Recognition
- Real-world Applications
- Robotics

Learning Outcomes

Learners completing this course will be able to:

- Apply logical reasoning and programming to produce solutions for real-world problems.
- Use probabilistic inference to navigate uncertain information efficiently.
- Determine appropriate machine learning methods for a given scenario or dataset.
- Evaluate the challenges in perception systems for AI.
- Utilize sensors to execute perception tasks and their applications in intelligent systems.
- Apply algorithms to train an image classifier.
- Design an agent that can plan and act to achieve given objectives using noisy sensors and actuators.

Estimated Workload/ Time Commitment Per Week

Average of 15-20 hours per week

Required Prior Knowledge and Skills

- Proficient mathematical skills: Algebra, Linear Algebra, Probability and Statistics
- Experience using digital drawing tools (e.g. for constructing Parse Trees), Microsoft's Office 365, installing software
- Strong Python and ROS skills

Technology Requirements

Hardware

- Personal computer with 8 GB RAM or higher

Software and Other

Reliable WiFi

Software and Other (programs, platforms, services, etc.)

- Matlab
- Ubuntu 16.04
- ROS Kinetic
- Turtlebot3 packages
- PyTorch
- GProlog 1.4.5
- Cygwin (Windows Users)
- Linux (Windows users may install virtual machines)
- Pip and Pgmpy
- Python 3.4 or higher
- Microsoft Office 365

Course Content

Instruction

Video Lectures and In-Video Questions
Demonstration Videos
Live Events (e.g. Live Sessions hosted by the faculty and Virtual Office Hours hosted by Teaching Assistants)

Assessments

In-Video Questions (ungraded, auto-feedback)
Knowledge Check Questions (ungraded, auto-feedback)
Assignments (graded, auto-graded and course team-graded)
Individual Projects (graded, auto-graded)
Practice Unit Quizzes (ungraded, auto-feedback)
Unit Quizzes (graded, auto-graded)
Practice Exams (ungraded, auto-feedback)
Final Exam (graded, auto-graded, proctored)

Details of the main instructional and assessment elements this course:

Lecture videos: The concepts you need to know will be presented through a collection of video lectures. You may stream these videos for playback within the browser by clicking on their titles or download the videos. You may also download the slides that are used in the videos. The lecture slides, where available, are provided with the video.

In-Video Questions and Knowledge Checks: Designed to support your learning, in-video questions and knowledge checks are short ungraded quizzes to test your knowledge of the concepts presented in the lecture videos. You may take your time, review your notes, and learn at your own pace because knowledge checks are untimed. You may retake these as often as you would like at any point in the course. You are encouraged to read the feedback, review your answer choices, and compare them to the correct answers. *With the feedback as your guide, you may use these as opportunities to study for other assessments and tasks in the course.*

Discussion Forums: Discussion forums are present each week in the course. Although the course team is engaged in these discussions, the forums are spaces to clarify, support, and enrich student-to-student communication and learning.

Practice Quizzes: To help you prepare for other assessments in the course, you will have practice quizzes prior to taking graded quizzes and the proctored final exam. You may engage with your peers in the discussion forums to address questions, share resources and strategies, and provide feedback to help one another learn. You are encouraged to submit questions in the discussion forum for the course team to address during live events.

Graded Quizzes: Timed graded quizzes are included at the end of each week to assess you on each week's content. They *typically* include 10 multiple choice questions. You will have 30 minutes to complete each quiz. Once you open the quiz, your testing session begins and you

must complete it in a single session. You will be allowed one (1) attempt to take and complete each quiz. *There is a 15% grade penalty for each day late past the deadline.*

Proctored Final Exam: You will have one (1) proctored exam, which is a cumulative final exam (covering content from Weeks 1, 2, 3, 4, 5, 6, and 7). You have 120 minutes to complete the exam. Once you open the exam, your testing session begins and you must complete it in a single session. You will be allowed one (1) attempt to take and complete the exam. Students are to take the exam in a single session without leaving the testing space (e.g. no bathroom or water breaks).Students are allowed a calculator and no more than 6 pieces of hard copy, handwritten notes on standard A-4 paper as a reference during the exam. Students may have scratch paper and writing utensils (e.g. pens and/or pencils) and eraser(s). *No late exams will be permitted.*

ProctorU is an online proctoring service that allows students to take exams online while ensuring the integrity of the exam for the institution. Additional information and instructions are provided in the *Welcome and Start Here* section of the course. You *must* setup your proctoring 72 hours prior to taking your exams, so complete this early.

Assignments and Projects: This course includes two (2) individual assignments and four (4) projects. Both are provided to students in the first week of the course, so you can review what is expected and design your own learning schedules to complete these on time. At the beginning of specific weeks when they are due, they will be re-introduced and included on your weekly task list at the beginning of each week. Projects and assignments are due at the end of the second week, third week, fifth week, and seventh week of the course. A submission area is provided at the end of these weeks. There are specified late penalties per assignment and project. Please review these carefully:

- Week 2 Assignment: Derivation of Logic Proofs - *10% grade penalty for each day late.*
- Week 3 Assignment: Inference in Bayesian Networks - *10% grade penalty for each day late.*
- Week 3 Project: Bayesian Networks - *15% grade penalty for each day late.*
- Week 5 Project: Neural Network for Collision Prediction - *15% grade penalty for each day late.*
- Week 7 Project: Tools for Sequential Decision-Making*33% grade penalty for each day late.*

Course Grade Breakdown

Course Work	Quantity	Percentage of Grade
Individual, Timed Unit Quizzes	8	32%
Individual Assignments	2	6%
Individual Projects	3	32%
Individual, Timed, Proctored Final Exam	1	30%

Grade Scale

NOTE: You must earn a cumulative grade of 70% to earn a “C” in this course.

A+	97% - 100%
A	90% - 96%
B+	87% - 89%
B	80% - 86%
C+	77% - 79%
C	70% - 76%
D	60% - 69%
E	<60%

Course Schedule

Live Events - Weekly
Live Events are a valuable part of the learning experience because students can meet with the course instructor and fellow classmates to learn more about course topics and discuss coursework. The official weekly schedule for these events will be announced once the course starts. If you are able to attend these Live Events, you are strongly encouraged to do so.

Live Events hosted by the faculty will be recorded and uploaded to the course.

Virtual Office Hours - Weekly
Virtual Office Hours offer a chance for students to get their questions answered from the course instructor and/or teaching assistants. The official weekly schedule for these office hours will be announced once the course starts.*Virtual office hours are recorded, but not uploaded into the course.*

Week/Module	Begin Date	End Date
Week 1: Introduction to Artificial Intelligence	10/16	10/20
Week 2: Modeling	10/21	10/27
Week 3: Reasoning	10/28	11/3
Week 4: Machine Learning Part 1	11/4	11/10
Week 5: Machine Learning Part 2	11/11	11/17
Week 6: Perception	11/18	11/24
Week 7: Sequential Decision-Making	11/25	12/1
Final Exam	11/29	12/2
Week 8: Course Wrap-Up	12/2	12/6

**Grades are due December 9th, 2019 (Please see the ASU Academic Calendar for additional information.)*

Assignment Deadlines

Unless otherwise noted, all graded work is due on Sundays at 11:59 PM Arizona time for the week it is assigned.

Course Outline with Assignments

Week 1/Module 1: Introduction to Artificial Intelligence

Lesson 1: Overview of Artificial Intelligence

Lesson 2: Probability Basics
Lesson 3: Knowledge Representation Foundations
Lesson 4: Machine Learning Essentials
Lesson 5: Sequential Decision-Making Fundamentals

Assignments

- ❑ In-Video Questions
- ❑ Knowledge Checks
- ❑ Practice Quiz
- ❑ Graded Quiz

Week 2/Module 2: Modeling

Lesson 1: Logic Reasoning

Assignments

- ❑ In-Video Questions
- ❑ Knowledge Checks
- ❑ Practice Quiz
- ❑ Graded Quiz
- ❑ Graded Assignment (Due by 10/27 at 11:59 PM AZ time)

Week 3/Module 3: Reasoning

Lesson 1: Reasoning

Assignments

- ❑ In-Video Questions
- ❑ Knowledge Checks
- ❑ Practice Quiz
- ❑ Graded Quiz
- ❑ Graded Assignment (Due by 11/3 at 11:59 PM AZ time)
- ❑ Graded Project (Due by 11/3 at 11:59 PM AZ time)

Week 4/Module 4: Machine Learning Part 1

Lesson 1: Introduction to Machine Learning
Lesson 2: Neural Networks
Lesson 3: Applications of PyTorch

Assignments

- ❑ In-Video Questions

- ❏ Knowledge Checks
- ❏ Practice Quiz
- ❏ Graded Quiz

Week 5/Module 5: Machine Learning Part 2

Lesson 1: Recurrent Neural Networks
Lesson 2: Dropout and Uncertainty
Lesson 3: Introduction to Convolutional Neural Networks
Lesson 4: Recent Advances in Machine Learning

Assignments

- ❏ In-Video Questions
- ❏ Knowledge Checks
- ❏ Practice Quiz
- ❏ Graded Quiz
- ❏ Graded Project (Due by 11/17 at 11:59 PM AZ time)

Week 6/Module 6: Perception

Lesson 1: Camera Geometry
Lesson 2: Multi-View Geometry
Lesson 3: Feature Representation
Lesson 4: Machine Recognition

Assignments

- ❏ In-Video Questions
- ❏ Knowledge Checks
- ❏ Practice Quiz
- ❏ Graded Quiz

Week 7/Module 7: Sequential Decision-Making

Lesson 1: Deterministic Planning
Lesson 2: Planning Under Uncertainty

Assignments

- ❏ In-Video Questions
- ❏ Knowledge Checks
- ❏ Practice Quiz
- ❏ Graded Quiz
- ❏ Graded Project (Due by 12/1 at 11:59 PM AZ time)

Final Exam

Assignments

- ❏ Final Exam - Proctored
  - Available from 11/29 at 12:01 AM - 12/2 11:59 PM AZ time

Week 8/Module 8: Course Wrap-Up

Lesson 1: Recap of Critical Concepts in Artificial Intelligence
Lesson 2: Recent Trends and Future Work
Lesson 3: Exciting Applications of Artificial Intelligence

Assignments

- ❏ Practice Quiz
- ❏ Graded Quiz
- ❏ Optional: Portfolio Inclusion Report for ASU MCS Degree
- ❏ Course Survey

Policies

Please note that the course syllabus is subject to change without advance notice at the discretion of the faculty.

All ASU and Coursera policies will be enforced during this course. For policy details, please consult the MCS Graduate Handbook 2018 - 2019 and/or the MCS Onboarding Course.

Academic Integrity

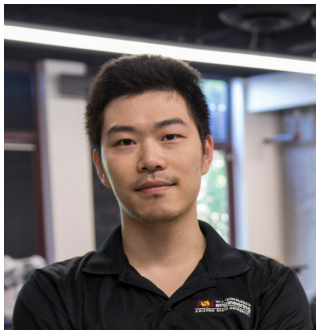
Students in this class must adhere to ASU's academic integrity policy, which can be found at https://provost.asu.edu/academic-integrity/policy). Students are responsible for reviewing this policy and understanding each of the areas in which academic dishonesty can occur. In addition, all engineering students are expected to adhere to both the ASU Academic Integrity Honor Code and the Fulton Schools of Engineering Honor Code. All academic integrity violations will be reported to the Fulton Schools of Engineering Academic Integrity Office (AIO). The AIO maintains records of all violations and has access to academic integrity violations committed in all other ASU college/schools.

Course Faculty

Drs. Heni Ben Amor, Siddharth Srivastava, Yezhou Yang, and Yu "Tony" Zhang collaborated in the design of this course.

Dr. Heni Ben Amor

Heni Ben Amor, Ph.D. is an Assistant Professor at Arizona State University (ASU) where he leads the ASU Interactive Robotics Laboratory. He studied Computer Science at the University of Koblenz-Landau (GER) and earned a Ph.D in robotics from the Technical University Freiberg and the University of Osaka in 2010 where he worked with Hiroshi Ishiguro and Minoru Asada. He received the NSF CAREER Award as well as the Outstanding Assistant Professor Award in 2018. Prior to that, he was a Research Scientist at the Institute for Robotics and Intelligent Machines at GeorgiaTech in Atlanta. Heni's research topics focus on artificial intelligence, machine learning, human-robot interaction, robot vision, and automatic motor skill acquisition. He received the highly competitive Daimler-and-Benz Fellowship as well as several "Best Paper" awards at major robotics and AI conferences. He is also on the program committee of various AI and robotics conferences such as RSS, AAAI, IJCAI, IROS, and ICRA.



Dr. Yezhou Yang

Yezhou Yang, Ph.D. is an Assistant Professor at the School of Computing, Informatics, and Decision Systems Engineering (CIDSE), Arizona State University (ASU), directing the Active Perception Group (APG). He received his M.S. and Ph.D. degrees in Computer Science from

the University of Maryland at College Park in 2013 and 2015 respectively. Prior to that, he obtained a B.Eng. degree in Computer Science and Engineering from Zhejiang University, China. His primary research focus is in Computer Vision and Robot Vision, especially exploring visual primitives in interpreting peoples' actions and the scene's geometry from visual input, grounding them by natural language as well as high-level reasoning over the primitives for intelligent systems. His research mainly focuses on solutions to visual learning, which significantly reduces the time to program intelligent agents. He is a recipient of Qualcomm Innovation Fellowship 2011, Verisk AI faculty award, and the NSF CAREER award in 2018.

Dr. Siddharth Srivastava

Siddharth Srivastava, Ph.D. is an Assistant Professor of Computer Science in the School of Computing, Informatics, and Decision Systems Engineering (CIDSE) at Arizona State University (ASU). Prof. Srivastava was a Staff Scientist at the United Technologies Research Center in Berkeley. Prior to that, he was a postdoctoral researcher in the RUGS group at the University of California Berkeley. He received his Ph.D. in Computer Science from the University of Massachusetts Amherst. His research interests include robotics and AI, with a focus on reasoning, planning, and acting under uncertainty. His work on integrated task and motion planning for household robotics has received coverage from international news media. His dissertation work received a "Best Paper" award at the International Conference on Automated Planning and Scheduling (ICAPS) and an Outstanding Dissertation award from the Department of Computer Science at UMass Amherst.

Dr. Yu "Tony" Zhang

Yu (“Tony”) Zhang, Ph.D. is an Assistant Professor at Arizona State University (ASU), where he directs the Cooperative Robotic Systems (CRS) laboratory. He graduated with a Ph.D. degree in Computer Science from the University of Tennessee, Knoxville in 2012. His research interests include the intersection of artificial intelligence (AI) and robotics. The focuses are innovating and applying AI and machine learning methods to human-robot teaming, multi-agent systems, distributed robotic systems, and more generally, human-in-the-loop AI systems. His research has been funded by federal governments and agencies, such as the National Science Foundation (NSF), National Aeronautics and Space Foundation (NASA) and Air Force of Scientific Research(AFOSR). Zhang has been highlighted with “Best Paper” Awards in premier robotics conferences. He is also a member/senior member of the program committees of major AI and robotics conferences, such as AAAI, IJCAI, IROS, and ICRA.