

UNIVERSITY OF MAINE
COS 470/570: INTRODUCTION TO COMPUTER SCIENCE
SPRING 2021

SYLLABUS

Time: 2–3:15 TTh	Instructor: Roy M. Turner
Location: Zoom 841 5680 1740	Contact: rturner.maine.edu

Instructor: Roy M. Turner, Associate Professor of Computer Science

Office: Zoom ID 142 037 329 (<https://maine.zoom.us/j/142037329>)

Office hours: TTh 1–2 or by appointment

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Teaching assistant: Mark Royer (mark.royer@maine.edu)

Static class information: MaineSAIL.umcs.maine.edu/COS470

Announcements, grades, slides, etc. [BrightSpace \(courses.maine.edu\)](http://courses.maine.edu)

Class meetings: Zoom ID 841 5680 1740 (<https://maine.zoom.us/j/84156801740>)

Class discussions (asynchronous): UMaine 470/570 Discord server (invitations to be sent)

Textbook (required): *AI: A Modern Approach* (4rd ed.), Stuart Russell & Peter Norvig. Available at the UMaine Bookstore & Amazon [buy or rent]; online version for rent at VitalSource (much, much cheaper). (Note: you need the 4th edition; the 3rd will not be sufficient.)

Course description: It seems as if it is impossible to pick up a magazine, newspaper, or technical journal recently without stumbling upon some article referencing artificial intelligence (AI). It is arguably the fastest-growing area of science/technology at the moment, thanks in large part to the research and development efforts of some of the largest and best-known corporations in the world. Image recognition, personal digital assistants, self-driving cars, human-level performance in extremely computationally-hard games such as Go, machine translation, natural language processing, planning space missions, deep learning, data mining, and, of course, web search,¹ are all AI applications that either are or that will soon be common in our everyday lives. AI technology is already economically important, and it will be a dominant feature of the economy for the foreseeable future. And, of course, it is a staple of science fiction books and movies, from *Forbidden Planet* to *2001: A Space Odyssey* to *Ex Machina*.

But what *is* AI? One way to define AI is as the part of computer science concerned primarily with giving computer programs abilities similar to those human abilities that require intelligence. Examples include: playing games, proving theorems, planning courses of action, and solving problems. Another definition is that AI is concerned with providing computer

¹Indeed, it can be argued that Google is and always has been essentially an AI company; in fact, one of the authors of the textbook is Research Director at Google.

programs with abilities that, while they may be simple for humans or even other animals, are extraordinarily difficult to achieve using standard computer science techniques. Examples include understanding and generating a natural language (e.g., English), recognizing an image, commonsense reasoning, and learning. Still third definition is that AI is the field seeking to create non-biological human-level (or above) intelligence. These “definitions” of AI are really closer to aims of the field or goals of researchers in the field. Another part of AI has to do with examining, through the use of computers, intelligence itself.

Course goals: AI is an extremely broad and diverse field—far too broad to cover completely in a semester-long course such as this one. Consequently, the overall goal of this course is to give the student an overview of the field in general while at the same time providing depth in the most fundamental areas. The course aims to prepare you to understand what AI is and how it is used in its expanding areas of application. It will help you prepare you to understand how AI can be used in your own work, to take advanced courses in the field, and to begin working on AI research projects. It is a hands-on course; there is some sentiment in the field that to truly understand AI techniques, one must implement them. Thus, you will have both the chance to program a variety of AI techniques as well as to concentrate on a semester project.

Instructional objectives: By the end of the course, you should have a general knowledge of the field of AI. You should be able to recognize when AI techniques are necessary to solve a problem. You should be able to apply standard AI techniques to solve problems. You should be able to evaluate new techniques you encounter. You should be knowledgeable enough to take an advanced course in AI or one of AI’s subfields. You will also be fluent in using Lisp to write simple AI programs and Tensorflow/Keras to specify introductory-level networks for deep learning. At least as important, you will be prepared to understand the “brave new world” that is likely to be permeated by AI technology in the coming years.

ABET student outcomes addressed:

- SO 1: Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.
- SO 2: Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of computer science.
- SO 3: Communicate effectively in a variety of professional contexts.
- SO 6: Apply computer science theory and software development fundamentals to produce computing-based solutions.

Assignments for all students: Programming and written assignments, semester project, journal. The purpose of the programming and written assignments is to increase and deepen your understanding of the concepts covered in class and to give you a better understanding of the unique challenges and techniques of AI programming and knowledge representation. The semester project will give you a chance to delve into some area of AI in depth. The project will be described in class. It is possible to do the project by yourself or with other students. Journal assignments will be given from time to time to give you a chance to think more deeply about what is being covered and to give feedback about the course.

Assignments for COS 570 students: In addition to the assignments for all students, COS 570 students will have additional assignments. These will typically be either additional programming assignments, exercises from the book, assignments to read a scientific paper or a chapter

in the text and prepare a report on it, and so forth. In addition, if you are a COS 570 student, your work is expected to be of higher quality and to have more depth than 470 students, and you will be graded accordingly.

Grading: Grades will be assigned based on written homeworks, programming assignments, the course project, your blog, and the tests. Grades will be assigned based on the following percentages:

Homework, journal, programming assignments:	25%
Project:	25%
Prelim I:	15%
Prelim II:	15%
Final exam:	20%

Grades will be assigned in the usual manner: 90–100 is an A, 80–89 a B, etc., with anything below 60 being an F. Plus and minus grades will be used, and grades will be assigned based on the guidelines published in UMaine’s *Handbook for the Faculty of Instruction*, paraphrased here:

A: Top-quality work. A definite encouragement to the advanced student that he or she is potentially a very good prospect for graduate work insofar as ability to master material, but not necessarily to pursue research, is concerned. A is given to students who excel in many ways in meeting the course objectives.

B: Indicates that the student has excelled in meeting the course objectives in some way, such as exhibiting superior insight into and mastery of the material or taking the initiative in going beyond what the instructor suggests for satisfactory work. A student should find it necessary to achieve a B rather than merely to receive it as an average student. B is a grade for students who stand out above those in the C group. B means that the student’s work is particularly commendable and praiseworthy.

C: A respectable grade for any undergraduate student in any course. It implies that the student has been successful in meeting the course objectives. It implies approval by the University of the student’s progress toward graduation. It represents a satisfactory level of work for both non-major and major students. [Note that a C is *not* a satisfactory grade for a graduate student!]

D: Low-level passing work for any undergraduate student. It should warn the student that he or she will be unlikely to achieve success in the next course of a sequence unless greater effort is forthcoming. D indicates that the course objectives have been poorly met as a result of lack of work or insufficient ability. The D grade warns the student that unsatisfactory progress is being made toward a college degree. The D grade is a failing grade for graduate students.

F: A failing grade for all students.

A word about how I grade on tests is in order, especially if this is your first class with me. In an effort to grant more partial credit, I grade each question on tests qualitatively, using the following grades, where n equals the points possible for a question:

Grade	Points	Grade	Points
✓ or ok	n	C+:	0.78n
A+:	0.98n	C:	0.75n
A:	0.95n	C-:	0.72n
A-:	0.92n	C/D:	0.70n
A/B:	0.90n	D+:	0.68n
B+:	0.88n	D:	0.65n
B:	0.85n	D-:	0.62n
B-:	0.82n	F:	0.60n
B/C:	0.80n	A number x:	x

Class structure: Unfortunately, the format of the synchronous classes will be much more lecture-like than active learning-like, given the necessity of teaching online. I will still try to foster as much interactivity and discussion as possible, however, since the subject matter definitely benefits from it. As an AI colleague of mine once said, with AI there's no one right answer, but there are a whole lot of wrong ones!

We will also use a Discord server for outside-of-class discussions. If you do not have a Discord account, you can create one by going to discord.com. I will send an invitation to you the first week of class. I will regularly check there and try to respond to your questions in as timely a fashion as possible. (I have used Slack in the past, but we have enough different programs to keep track of these days, and most of you likely already use Discord.) It will also be a great place for you to get help, discuss things with your classmates, commiserate, etc.

Note that the School has a discord server as well with a "cos470" channel where you can discuss the class and perhaps even get help from people who've had the class before. The server also hosts virtual lab hours and office hours for TAs. It can be a great resource, and also a way to keep in touch with others in the major during this odd time. Please keep in mind, though, that unlike the class server, the School's server and channel are not limited to just our class, so anything of a personal or sensitive nature that you want to talk about should be done via a more secure channel.

Absences (yours): It is in your best interest to attend classes, as that way you can participate in discussions and ask questions when you don't understand something. However, the lectures will all be recorded and available on BrightSpace, along with the slides should you need to miss a class. I will not take attendance unless attendance becomes a problem.

Absences (mine): If I cannot attend a class session for any reason, I will either reschedule or (most likely) record a lecture that you can watch asynchronously.

Programming: Two languages will be used for programming assignments in this course, Lisp and Python. There are two reasons for this. First, historically, symbolic artificial intelligence has been done predominantly in the Lisp programming language. Although it is the second oldest programming language in use, it remains the premier language for symbolic and functional programming. Consequently, all programming assignments in the symbolic AI portions of the course will be done in Common Lisp. The second reason to use Lisp in the course is to help achieve a goal of the School to expose students to a range of programming languages. I will not devote class time to Lisp, but I will schedule or record a help/review session early in the semester to summarize the features of the language. There are very good textbooks

available, both online and in hardcopy form (some free),² and there are also online tutorials. In addition, Guy Steele's *Common Lisp: The Language*, which is the definition document for Common Lisp, is available online as well, although this should be used as a reference book, *not* a textbook.

You may use any Common Lisp you like. The Lisp you use, however, must be compliant with Guy Steele's *Common Lisp: The Language* (2nd edition). If you are uncertain about whether a Lisp you have access to is a Common Lisp, ask me. Lisp interpreters (and/or compilers) and integrated development environments are available free online. I suggest using either Franz, Inc.'s free version of Allegro Common Lisp (ACL) or Steel Bank Common Lisp (SBCL). A separate information packet I'll make available discusses in more detail how to acquire and use Lisp.

With respect to which integrated development environment (IDE) to use, I *strongly* suggest using GNU Emacs with Slime (for SCBL) or some other interface package (Franz's ELI for ACL, e.g.). Though the learning curve can be somewhat steep, it will be well worth your time; Emacs and Lisp have a very long history together (Emacs is mainly programmed in a version of Lisp, and Lisp's first IDE [and one of the very first IDEs, as a matter of fact] was a version of Emacs), and consequently they play nice with each other. Besides, Emacs is awesome, especially for programmers. I would *not* recommend Eclipse or VI or VIM for Lisp; I certainly would not suggest *not* using an IDE; and never, ever write your code in a word processor (but you knew that already, right?).

You will use Python for the material having to do with neural networks/deep learning. You will be using TensorFlow and Keras. I will provide more information later about setting up your Python environment to use them. If you want to jump ahead, I would suggest using Anaconda (www.anaconda.com/products/individual), which makes it simple to install different Python environments for different uses, and it provides a very easy-to-use package manager as well. For a Python IDE, Anaconda provides access to both PyCharm and Jupyter notebooks (or the newer Jupyter Lab). Emacs also functions as a good Python IDE with minimal effort to set it up.

Plagiarism and cheating: Plagiarism and cheating are violations of UMaine's Student Conduct Code and will not be tolerated in this class. Such behavior will result in *at least* the penalty of a zero for the affected assignment/test, and possibly an F in the course. In addition, such an offense may be reported to the appropriate office for disciplinary action (which can include expulsion from the University).

I realize that it is sometimes a fine line between collaboration that is acceptable (or even desired) on a programming project or homework and cheating. I encourage students to talk together about the course and the course assignments. However, all work turned in, with the exception of group projects or group assignments (if any) should be your own. If you feel that the ideas behind some portion of an assignment are due to another student, you should note that in the assignment you turn in. If you have a question about what constitutes cheating, you should talk to me in advance of turning in the assignment.

And, of course, no collaborative work is permissible on prelims or the final exam!

Reading: This class will move **fast** and there will be a lot of reading. (Don't worry though; we won't cover all 1000+ pages of the text!) If at all possible, you should read the assigned

²I highly recommend Paul Graham's *ANSI Common Lisp* or Peter Seibel's *Practical Common Lisp*, which is available for free at www.gigamonkeys.com/book.

readings before coming to class. Readings also may be the subject of test questions. I will try to remember to assign readings as we go; however, it should be fairly obvious which readings go with which classes.

Late policy: The due date for each assignment will be announced when assigned. Assignments will be turned in via BrightSpace and will usually be due at midnight (well, 11:59 pm) on the due date. Late penalties, unless otherwise announced, will be a **letter grade a day**, and assignments will not be accepted more than 5 days late. Saturdays, Sundays, and holidays **do** count as days late.

If you feel you need an extension on an assignment for a valid reason, you must contact me as soon as possible about it.

Civility: You are expected to conduct yourself in a manner that is civil and respectful to the other students and to me. If not, I may ask you to leave class.

Schedule of topics: This is a tentative list of the topics to be covered and in which order; I may provide a more detailed schedule as we see how fast the class progresses—this is the first time I have taught it online, so... Programming assignments (for all students) are listed with the topics they are associated with; other homework assignments may also be assigned, and additional programming assignments may be assigned to COS 570 students.

- Part 1: Introduction
 - What is AI? (*Assignment 1: Learn Lisp*)
 - Intelligent agents
- Part 2: Search
 - State-space search (*Assignment 2: Search*)
 - Heuristic search & heuristics
 - Local & online search
 - Constraint-satisfaction
 - Neural networks: Searching to create *agents* (*Assignment 3: Neural networks*)
 - Adversarial search (*Assignment 4: α - β Minimax*)
- Part 3: Knowledge and its use
 - Knowledge representation
 - First-order logic and theorem proving (*Assignment 5: Resolution theorem proving*)
 - Rules and rule-based reasoning
 - Structured knowledge representation
 - Description logics and ontologies
- Part 4: Planning and acting
 - Automated planning
 - Handling uncertainty
 - Decision making with utilities
- Part 5: Machine learning
 - Symbolic ML
 - Going beyond MLPs (*Assignment 6: Convolutional Neural Networks*)

- Reinforcement learning
- Part 6: Interacting with others
 - Natural language processing
 - Multiagent systems

Important dates:

Date	Class event	Other
1/25	First class; project assigned	
1/31		Last day to add classes
2/7		Last day to drop classes for refund
2/11	Project pre-proposal due	
2/15		President’s Day
2/24		Last day to drop without it showing on transcript
2/25	PRELIM 1	
3/2	Project proposal due	
3/24		March “mini-break
4/1	PRELIM 2	
4/16		UMaine Student Symposium
4/28		Maine Day
4/29	Last class; PROJECT DUE	
5/6	Final exam , 10:30-2:30	

Campus policies

Academic Honesty Statement: Academic honesty is very important. It is dishonest to cheat on exams, to copy term papers, to submit papers written by another person, to fake experimental results, or to copy or reword parts of books or articles into your own papers without appropriately citing the source. Students committing or aiding in any of these violations may be given failing grades for an assignment or for an entire course, at the discretion of the instructor. In addition to any academic action taken by an instructor, these violations are also subject to action under the University of Maine Student Conduct Code. The maximum possible sanction under the student conduct code is dismissal from the University.

Students with disabilities statement: If you have a disability for which you may be requesting an accommodation, please contact Student Accessibility Services, 121 East Annex, 581.2319, as early as possible in the term. Students who have already been approved for accommodations by SAS and have a current accommodation letter should meet with me privately as soon as possible.

Course Schedule Disclaimer (Disruption Clause): In the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

Observance of Religious Holidays/Events: The University of Maine recognizes that when students are observing significant religious holidays, some may be unable to attend classes

or labs, study, take tests, or work on other assignments. If they provide adequate notice (at least one week and longer if at all possible), these students are allowed to make up course requirements as long as this effort does not create an unreasonable burden upon the instructor, department or University. At the discretion of the instructor, such coursework could be due before or after the examination or assignment. No adverse or prejudicial effects shall result to a student's grade for the examination, study, or course requirement on the day of religious observance. The student shall not be marked absent from the class due to observing a significant religious holiday. In the case of an internship or clinical, students should refer to the applicable policy in place by the employer or site.

Sexual Discrimination Reporting: The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell a teacher about an experience of **sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination** involving members of the campus, **your teacher is required to report** this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity.

If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

For *confidential resources on campus:* Counseling Center: 207-581-1392 or Cutler Health Center: at 207-581-4000. For *confidential resources off campus:* Rape Response Services: 1-800-871-7741 or Spruce Run: 1-800-863-9909.

Other resources: The resources listed below can offer support but may have to report the incident to others who can help:

For *support services on campus:* Office of Sexual Assault & Violence Prevention: 207-581-1406, Office of Community Standards: 207-581-1409, University of Maine Police: 207-581-4040 or 911. Or see the OSAVP website for a complete list of services at <http://www.umaine.edu/osavp/>