Course: COMP 440/COMP 557
Term: Fall 2015
Room: DH 1064
Class: TTh, 9:25-10:40

Instructor Contact Information

Instructor: Devika Subramanian
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Office Hours: TTh 10:45-12:00

Course Objectives and Learning Outcomes

No subject unleashes the spirit of innovation like artificial intelligence and machine learning. Think of Google, Facebook, Twitter, eBay, Wikipedia, Stanley, Roomba, WoW, Farecast, NOAA's hurricane prediction, and Microsoft's surprise modeling, each of which is less than a decade old, and each of which embodies core algorithms in artificial intelligence. **comp440/comp557** is a foundational course in artificial intelligence, the discipline of designing intelligent computer systems. We will learn to design and analyze autonomous agents that do the right thing in the face of limited computational resources and limited information. The main questions we will study are

- how agents can effectively make decisions in fully observable, partially observable and adversarial environments, and
- how agents can adapt their actions by learning from experience.

The course draws on material from computer science, probability theory, decision theory and game theory. We will study interesting examples of intelligent agents including self-driving cars, face and handwriting recognizers, game playing programs, package delivery robots, schedulers, spam detectors, named entity recognizers, and speech recognition systems. The course assumes good knowledge of algorithms, discrete mathematics, linear algebra, probability and statistics, as well as considerable proficiency in Python and Java. **comp440/comp557** can be taken as part of a general education in computer science, as grounding for future research in artificial intelligence, or to gain familiarity with recent artificial intelligence algorithms for application in other fields.

Required Texts and Materials

The required textbook for the class is Artificial Intelligence: A Modern approach, 3rd edition. We will also draw on material from online sources. I will provide URLs to all the online resources we draw upon in the **Modules** section of the course website at http://www.clear.rice.edu/comp440. Lecture material (PDFs of powerpoint slides used in class) is available on the class website. Assignments and quizzes will be posted under **Assignments** and linked to Owlspace.

Exams and Papers

The purpose of the assignments is to train you to solve problems and to help deepen your understanding of concepts introduced in class.

- There will be eight assignments through the semester. Assignments include both written problem sets as well as programming exercises. Due dates and times for the assignments are specified in the course schedule.
- All work is to be turned in on Owlspace before the due date/time. Work is worth full credit when turned in on time.
- Because each of you will probably come upon some time during the semester where so much work piles up that you need a little extra time, every student begins the semester with **two** free "late days." After your two late days are exhausted, assignments that come in late (up to a maximum of three days) will be assessed a late penalty of 10% of your score per late day.
- You should think of the two free "late days" as extensions you have been granted ahead of time, and use them when you might have otherwise tried to ask for an extension. As a result, getting an extension beyond the two free "late days" will generally **not** be granted. In very special circumstances for which you can provide official documentation (primarily extended medical problems or other emergencies), extensions may be granted beyond the late days. All extension requests must be directed to me (devika@rice.edu), no later than 24 hours before the assignment is due.
- Graded work will be returned a week after the official due date. No submissions will be accepted one week after the due date.

The role of the weekly quizzes is to give you rapid feedback on your understanding of the concepts covered that week. Many of the quizzes are timed and typically range from 30 minutes to an hour.

Grade Policies

For comp440, your course grade will be based on assignments (30%), two exams (20% each), term project (15%), and in-class participation and quizzes (15%).
For comp557, your course grade will be based on assignments (20%), two exams (20% each), term project (15%), in-class participation and quizzes (15%), and reports on assigned papers (10%).
The term project, Pacwar is an exciting problem and has always been the highlight of the comp440/comp557 experience at Rice. We have a reigning pacmite champion (which was created in 2000) and I hope you will all create mites that give this long-reigning champion a run for the money! All resources for the Pacwar project are available from the **Assignments** tab on the course website. There will be two in-class examinations: the midterm and the final. The midterm examination will be held on

October 8, 2015 from 7 pm to 10 pm. If you have a conflict with that time or day, you can take the exam earlier on October 7 during a three hour period between 9 am and 4 pm. The final exam will be held at a time and place scheduled by the registrar during the finals period. It will be a three hour examination.

Absence Policies

You must attend the TTh lectures at 9:25 am. Help outside of class hours is available on piazza. You should expect to work about 8-10 hours per week for this class, including lecture time.

Rice Honor Code

> In this course, all students will be held to the standards of the Rice Honor Code, a code that you pledged to honor when you matriculated at this institution. If you are unfamiliar with the details of this code and how it is administered, you should consult the Honor System Handbook at http://honor.rice.edu/honor-system-handbook/. This handbook outlines the University's expectations for the integrity of your academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process.

We take the Honor Code very seriously. The work you submit for this class is expected to be the result of your own work or work with your partner for homeworks and programming assignments. Attempting to take credit for someone else's work by turning it in as your own constitutes plagiarism, as defined by our own Honor Code.

- You are allowed to discuss course material and general approaches to problems with your other classmates, the teaching assistant and the professor, but you should never misrepresent someone else's work as your own.
- You must indicate at the top of your homework submission any assistance you have received. Name the people you received help from, and indicate what kind of help you received. It is your responsibility to make sure that the assistance you receive does not cross the boundary into having someone else write code for you.
- If you use any material from online sources, you must provide the URL as well as an explanation of the value you have added to the referenced work. More on how to provide proper attribution to online work is shown here. Also see Rice University's policy on citing sources.
- You must not share code with others. In particular, you should not ask anyone to give you a copy of their code or, conversely, give your code to another student who asks you for it. Similarly, you should not discuss your strategies to such an extent that you and your collaborators end up turning in exactly the same code. Discuss ideas together, but do the coding on your own.
- You must not look at solution sets or code from other years or semesters. Here is the reason for this rule. Developing a good programming assignment often takes years. When a new assignment is created, it invariably has problems that require a certain amount of polishing. To make sure that the assignments are as

good as they can be, we, like most other schools in the country, reuse assignments over the years, incorporating changes each time to make them more effective. Submitting code that solves last year's assignment perfectly while failing to solve the current one would be a particularly damaging situation for you.

- Whenever you seek help on an assignment, your goal should be to improve your level of understanding and not simply getting your code to work. Suppose, for example, that someone responds to your request for help by showing you a couple of lines of code that do the job. Don't fall into the trap of thinking about that code as if it were a magical incantation—something you simply include in your solution and don't have to understand. By doing so, you will be in no position to solve similar problems on exams. You should be prepared to explain any part of your assignment to your teaching assistant or professor.

PIAZZA

All course related discussions and questions should be posted on piazza. Please do not send personal email to me or to the TAs — piazza is the fastest way to get a response from us and from the class community. Piazza allows you to ask questions in private as well as anonymously. We request you not to post code or answers to homework or programming assignments on piazza. If you are having difficulty with a programming assignment and need to show the teaching assistants your code, please make your piazza post on it private.

DISABILITY SUPPORT SERVICES

If you have a documented disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Disability Support Services (Allen Center, Room 111 / adarice@rice.edu / x5841) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

SYLLABUS

Week 1: Introduction and search (8/24-8/28)

- Lectures:
  - Introduction What can AI do for you?
    - Read Chapter 1.1-1.5, 2.1-2.3
  - Search 1 Problem solving as path finding
    - Read Chapter 2.4-2.5, 3.1-3.4
    - basic search algorithms

- Term project (due 4 December)
- Assignment 1 (due 4 September, 8 pm on Owlspace)
- Quiz 1 (due 28 August at 8 pm on Owlspace)

Week 2: Heuristic search and local search (8/31-9/4)

- Lectures:
  - Search 2 Algorithms for path finding in graphs: UCS, A*
    - Read Chapter 3.5-3.7
  - Search 3 Local search: HC, GSAT and GAs
    - Read Chapter 4.1-4.2, 4.5
- Assignment 1 (due 4 September, 8 pm on Owlspace)
- Assignment 2 (due 15 September, 8 pm on Owlspace)
- Quiz 2 (due 4 September at 8 pm on Owlspace)

Week 3: Adversarial search and game playing (9/7-9/11)

- Lectures:
  - Games 1 Adversarial search, minimax and alpha-beta pruning
    - Read Chapter 5.1-5.3
  - Games 2 Stochastic adversaries, expectimax,evaluation function learning
    - Read Chapter 5.4-5.5, 5.7-5.9
- Assignment 2 (due 15 September, 8 pm on Owlspace)
- Term project Pacwar blog 1 (due 11 September, 8 pm at blogs.rice.edu)
- Quiz 3 (due 16 September, 8 pm on Owlspace)

Week 4: Game theory and MDPs (9/14-9/18)

- Lectures:
  - Games 3 Game theory, Nash equilibria, mechanism design
    - Read Chapter 17.5-17.6
  - MDP 1 Markov decision processes
    - Read Chapter 17.1-17.2
- Assignment 2 (due 15 September, 8 pm on Owlspace)
- Assignment 3 (due 28 September, 8 pm on Owlspace)
- Quiz 4 (due 21 September, 8 pm on Owlspace)

Week 5: Markov decision processes (9/21-9/25)

- Lectures:
  - MDP 2 Policy evaluation, policy improvement
    - Read Chapter 17.2-17.3
  - MDP 3 Policy iteration, value iteration
    - Read Chapter 17.2-17.3
- Assignment 3 (due 28 September, 8 pm on Owlspace)
- Quiz 5 (due 25 September, 8 pm on Owlspace)

Week 6: Constraint satisfaction (9/28-10/2)

- Lectures:
  - CSP 1 Modeling problems as CSPs, backtracking search
    - Read Chapter 6.1-6.3

- CSP 2 Dynamic variable and value ordering
  - Read Chapter 6.3-6.4
- Assignment 4 (due 6 October, 8 pm on Owlspace)
- Term project Pacwar blog 2 (due 2 October, 8 pm at blogs.rice.edu)
- Quiz 6 (due 2 October, 8 pm on Owlspace)

Week 7: Bayesian networks (10/5-10/9)

- Lectures:
  - BN 0 Introduction to probability
    - Read Chapter 6.3-6.5
  - BN 1 Bayesian networks, Conditional independence
    - Read Chapter 14.1-14.4
- Assignment 4 (due 6 October, 8 pm on Owlspace)
- Assignment 5 (due 19 October, 8 pm on Owlspace)
- Midterm on 8 October 7pm-10pm, location TBA

Week 8: BNs and probabilistic reasoning (10/12-10/16)

- Lectures:
  - BN 2 Approximate inference, Gibbs sampling
    - Read Chapter 14.5
  - BN 3 Utility theory and decision networks
    - Read Chapter 16.1-16.6
- Assignment 5 (due 19 October, 8 pm on Owlspace)
- Quiz 7 (due 16 October, 8 pm on Owlspace)

Week 9: Temporal models and HMMs (10/19-10/23)

- Lectures:
  - HMM 1 Sequential models, exact inference in HMMs
    - Read Chapter 15.1-15.3
  - HMM 2 Approximate inference in HMMs: Particle filtering
    - Read Chapter 15.4-15.6
- Assignment 5 (due 19 October, 8 pm on Owlspace)
- Assignment 6 (due 30 October, 8 pm on Owlspace)
- Term project Pacwar blog 3 (due 23 October, 8 pm at blogs.rice.edu)
- Quiz 8 (due 23 October, 8 pm on Owlspace)

Week 10: HMMs and supervised learning (10/26-10/30)

- Lectures:
  - HMM 3 Estimating HMMs from data
    - Read Chapter 20.2-20.3
  - SL 1 Supervised learning: linear classification, perceptrons, naive Bayes
    - Read Chapter 18.1, 18.6-18.7
- Assignment 6 (due 30 October, 8 pm on Owlspace)
- Assignment 7 (due 9 November, 8 pm on Owlspace)
- Quiz 9 (due 30 October, 8 pm on Owlspace)

Week 11: Supervised learning (11/2-11/6)

- Lectures:
  - SL 2 Nearest neighbors, kernel methods
    - Read Chapter 18.6-18.8
  - SL 3 Decision trees, MLPs
    - Read Chapter 18.4, 18.7
- Assignment 7 (due 9 November, 8 pm on Owlspace)
- Quiz 10 (due 6 November, 8 pm on Owlspace)

Week 12: Unsupervised learning (11/9-11/13)

- Lectures:
  - SL 4 Generalization, bias/variance tradeoff, loss functions
    - Read Chapter 18.4-18.5
  - UL 1 Unsupervised learning, k-means algorithm
    - Read Chapter 18.11
- Assignment 7 (due 9 November, 8 pm on Owlspace)
- Assignment 8 (due 20 November, 8 pm on Owlspace)
- Term project Pacwar blog 4 (due 13 November, 8 pm at blogs.rice.edu)
- Quiz 11 (due 13 November, 8 pm on Owlspace)

Week 13: Reinforcement learning (11/16-11/20)

- Lectures:
  - RL1 Active and passive reinforcement learning
    - Read Chapter 21.1-21.3
  - RL 2 Function approximation, exploration/exploitation, policy search
    - Read Chapter 21.4-21.6
- Assignment 8 (due 20 November, 8 pm on Owlspace)
- Quiz 12 (due 20 November, 8 pm on Owlspace)

Week 14: AI Applications (11/23-11/27)

- Lectures:
  - App 1 IBM Watson: text understanding, question-answering
    - Read Chapter 22
  - No class, Thanksgiving break
- Term project Draft of final report (due 25 November, 8 pm on Owlspace)

Week 15: More applications and wrap-up (11/30-12/4)

- Lectures:
  - App 2 Self-driving cars: integrating vision, planning and robotics
    - Read Chapter 24, 25
  - Wrap Review of course
    - Read Chapter 27
- Term project Pacmite due (due 2 December, 12 noon to devika@rice.edu)
- Term project PacWar tournament (2 December, 7 pm at McMurtry)

Term project PacWar final report (4 December, 8 pm on Owlspace)

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