CS 4100 artificial intelligence

T, F | 9:50-11:30 am (Richards 458), 1:35-3:15 pm (Hurtig 130), 3:25-5:05 pm (Hurtig 130)

Instructor: Raj Venkat
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Course Webpage: venkat.prof/CS4100
24/7 Q&A: Campuswire (group join code 3161)
Submissions: Gradescope (See individual HW instructions)

Contents

1 Overview

1.1 Course Description

Computers are incredibly dumb. However, they can be programmed to appear incredibly clever using fancy mathematics. This introductory course on Artificial Intelligence covers: a) search, planning, constraint-satisfaction problems, and games; b) how to work with uncertainty in the environment; c) foundations of ML, reinforcement learning, NLP, and recent developments; d) ethical questions about the use of AI.

1.2 Required Background

Students are expected to have strong programming foundations, preferably in Python 3, which will be extensively used in this course. Prior formal coursework in algorithms is advisable. We will also rely on the fundamentals of linear algebra, probability, and some preliminary calculus. While these are not formal prerequisites, students without prior experience should expect to spend additional time outside of lectures/assignments to build these foundations within the first 2 weeks, with the help of provided resources.

1.3 Attendance Policies

I do not normally record attendance. However, attendance will be mandatory for a mid-term exam on Feb 20, the last 3 lectures of the semester before finals week, which will be devoted to in-class final project presentations, and the final exam. For Spring 26, presentations will be held on Apr 10, 14 and 17. Attendance is mandatory for all students on these dates; it will be recorded and will impact your grade. Please plan all your travel and other commitments accordingly. Travel plans for any of these dates that were booked prior to the start of the semester are not a valid reason to request an exemption to this policy; if such travel is unavoidable, students are advised to take this course in a later semester, when they are able to be present in Boston for the entire duration of the course. Exceptions will only be granted for genuine and unforeseen emergencies.

1.4 Rigor, Engagement & Support

The material presented in this course is inherently mathematical and often quite complex. The best way to learn is to engage with me during lectures and take detailed notes. While I do not record attendance for most of the semester, students are strongly advised to attend class regularly. Past iterations of this course have shown that students who regularly attend lectures and office hours and engage deeply with the final project achieve positive outcomes in terms of course performance and satisfaction, as well as offers for internships or co-ops in AI/ML related roles.

In addition to being your instructor, I hope you also think of me as an advisor/mentor with whom you can freely talk for any reason[1]. I am open to questions about anything that relates to your education, even if it does not strictly fall within the scope of CS4100. I strive to foster a nonjudgmental learning environment at all times, and I am never inconvenienced by a student reaching out for support.

[1] You should be aware that faculty are mandatory reporters at Northeastern. See section 4.2.

1.5 Time Management, Grading, Regrade Requests

A college degree is as challenging as it is rewarding. You are bound to have conflicting deadlines from multiple courses and co-op related activities, but a crucial part of your learning experience is figuring out a time-management strategy that allows you to deliver on all fronts. University education also places significant emphasis on the precision of writing and a student's ability to meet all expectations communicated through assignment instructions.

Requests for extensions to submissions due to poor time management will be denied. Choosing to prioritize a different course, co-op applications, interviews, etc., is your prerogative; however, you do so with the understanding that no additional flexibility will be provided outside of course policies, except in genuine emergency situations. I also expect students to read and adhere to any provided assignment instructions and stay up to date with course announcements made throughout the semester on Campuswire.

Regrade requests are intended to address potential grading errors, not to serve as an avenue for negotiation. Rubrics are designed with expected outputs and writing quality in mind, and are developed in close collaboration with the TA team to reflect both course standards and student perspectives. These rubrics are applied fairly and consistently across the class. While effort is valuable, it is inherently subjective and varies greatly among students. There is no way for me to evaluate effort objectively. If you believe there was an oversight in grading - such as missing points for a rubric item that your answer addressed, or if something was overlooked - please feel free to submit a regrade request.

Please note that submitting a regrade request may result in the entire question being regraded from scratch by me. While I strive for fairness and consistency, my experience often allows me to identify more nuanced mistakes that may have been overlooked during the initial grading by the TA team. As a result, a regrade could lead to an increase in your score, but it could also result in a decrease if additional errors are found. I encourage you to carefully review your submission and the rubric before deciding to request a regrade.

1.6 Late Joiners

Please note that by joining the course late, you knowingly accept the responsibility of catching up on missed material and should not expect any preferential treatment or adjustments to deadlines[2]. For any assignments due before the add deadline, you will have 5 days from your join date to submit them. For any assignments released on or after the add date, no additional extensions will be provided. You will need to work on multiple submissions in parallel if you join late.

Please stop by my office hours, or book an appointment with me, and I will be more than happy to briefly review content (provided you go over the relevant class notes first) and point you to the right resources. TA office hours will prioritize assignment-related questions over content review for late joiners.

[2] If you are an international student whose visa process was delayed due to recent events, please follow University guidance closely. Note that certain interactions with course material (such as submitting any assignments/quizzes on Canvas) prior to your arrival in Boston may constitute a violation of your visa status.

1.7 Textbook(s)

This course does not have a *required* textbook, and my course content is curated from several different sources, many of them not textbooks. However, you will find the following texts useful. Except for the first book in this list, the remaining are made freely available online by the respective authors.

- Artificial Intelligence: A Modern Approach, Pearson
- Artificial Intelligence 2E: Foundations of Computational Agents, Cambridge University Press
- Mathematics for Machine Learning, Cambridge University Press
- Dive into Deep Learning, Forthcoming at Cambridge University Press

1.8 Tentative Lecture Plan

For an updated list of topics, slides, readings, and notes, please visit the course website. Topics are subject to change, depending on class progress, latest happenings, popular demand, etc. If there is a specific topic you would like me to cover, please reach out to me, and I would be happy to try and devote some time to it towards the end of the semester.

1.9 Software

We will use Python 3 for all programming assignments. These resources may be useful:

- Prof Felix Muzny's Computational Thinking in Python
- Learn Python 3
- GitHub Quickstart

If you have limited or no Python or GitHub experience, please reach out to the TAs or the instructor early in the semester. This will enable us to work with you and provide additional guidance in a timely manner.

1.10 Components & Grading

- **Group Project: 20%**
  (presentation (5%), project tracking and summary sheet (5%), modular, documented code in GitHub repo (5%), proposal + check-in (3%), presentation attendance (2%))
- **Programming Assignments: 30%**
  (PA1: 35 points, PA2 & PA3: 45 points each) - total normalized to 30%
- **Problem Sets: 20%**
  (PS1: 35 points, PS2 & PS3: 45 points each) - total normalized to 20%
- **Assignment 0 + Labs: 5%**
  (graded on completion)
- **Exams: 25%**
  (Midterm: 10%, Final: 15%)

i. Group Project Expectations

The aim of the final project is to allow you to pick one topic in AI to pursue in more depth than course assignments permit, and build something cool related to it from the ground up. The project should be interesting (and hopefully useful to someone) - but you should also consider feasibility when proposing a project. You might start looking for ideas in your daily life - look for problems that you might want to solve using techniques covered in this course. If you can turn your solution into something that lasts and is used actively beyond the course, that would be a fantastic outcome! Please note that I caution against waiting to start working on projects until the relevant material is covered in class. The project component requires you to read ahead of class material somewhat independently, and start working on an initial implementation fairly early on. The TA team and I will be glad to assist, should you find yourself stuck at any point.

To help keep project groups functioning smoothly, each group will maintain a project progress tracker as part of their GitHub repository, which must be updated regularly throughout the semester. Guidelines and a template will be shared with the class along with detailed project instructions and requirements. Each team will also be required to complete a check-in with a TA during the week after Spring break, where significant progress is expected.

All students are expected to regularly and meaningfully contribute to their final project by: a) being punctual to and participating in group discussions, b) actively contributing to ideation and end-to-end framework-design, c) actively contributing original source code *pertaining to the project's AI methods* to the repository, d) staying up to date with each other's contributions, and e) contributing to the creation/writing of slides and the final report.

If a group member does not meet the above expectations, the rest of the group may raise a concern to me through a form available on Canvas, or by reaching out to me or the TA team via email/Campuswire. Provided this report is made early enough in the semester, I will reach out to the non-performing member (or the entire group, depending on the situation) to schedule a meeting. This meeting is not meant to be punitive; the goal of this meeting is only to allow me to take stock of the situation, and to offer the right resources to help the team deal with present circumstances. At the end of the semester, each student will receive a score proportional to their contributions to the project (established using the project tracker, Git commits and peer evaluations), and can be as low as a 0 on the entire project component of the course. This has happened before.

Most stressful situations in group project work can be avoided by having an honest conversation with your peers about the challenges you are facing. This includes anything from personal issues or conflicting deadlines to a member's prolonged absence, lack of responses in group forums, or lack of meaningful code contributions. While communication is key, I am also sensitive to the fact that such conversations are hard and uncomfortable. Should such a situation arise, please remember that the TA team and I are always happy to help mediate these conversations, and that it does not have to be done at the cost of the group dynamic. Working with team members who have differing opinions, schedules, and constraints, is a vital part of your development as an upcoming professional in your field.

ii. Alternative (Research) Pathway

With the instructor's permission, students have the option to substitute the course final project requirement with a research-intensive evaluation worth 20%, consisting of two parts: **a)** a research paper implementation and accompanying seminar-style presentation worth 15%, and **b)** a *viva voce* - a one-on-one, whiteboard-interview-style oral examination including, but not limited to, lecture content and provided materials, worth the remaining 5%.

For part (a), you will select an existing research paper published in a top AI/ML conference or journal and submit it for approval in the beginning of the semester (to check for scope, relevance, feasibility, etc.). You will then re-implement the method(s) presented in the paper, where the core contribution must be programmed from scratch. Feel free to discuss which Python packages may be used in your implementation with me. You will then (attempt to) reproduce the results presented in the paper using the original dataset and your code, as well as try replicating the study on a different but similar dataset to test for generalizability (we can discuss cases where the latter approach may not be applicable).

Your 15-minute seminar-style presentation should consist of a brief literature survey (covering 3-5 relevant papers), contextualize the chosen paper within that literature, present the main methods, and then present and compare the results obtained using your implementation to the authors' results. The presentations for the research pathway from all three of my CS4100 sections will be held in a single combined session, to be scheduled *outside lecture time*, during the last 1-2 weeks of classes before finals (depending on everyone's availability).

For part (b), while you will not be expected to know every latest AI technique or ML model in existence, the oral exam will test your ability to apply known concepts to novel and unseen scenarios, and learn and adapt new techniques on the fly. A breadth of knowledge beyond course content and a strong grasp of foundational mathematics is likely to give you an advantage in the oral exam. The oral exam must be completed before **Apr 17** by first-come-first-served appointment. That said, please try to schedule these much earlier (preferably the first week of Apr), since my availability thereafter will be very scarce due to multiple MS theses advising and College-level commitments.

This pathway is designed to be significantly more challenging, and will require reading broadly beyond provided course materials in preparation. This pathway is intended to serve students considering or interested in pursuing a Ph.D. in the future, but is open to anyone up for a challenge! Successfully completing the research pathway will allow me to write a very strong letter of recommendation for you, should you choose to apply to graduate programs.

iii. Final Grades and Rounding Scheme

Final grades will be assigned based on the following scale (note open and closed intervals). Natural rounding will be used, i.e., percentages $\geq x.5$ get rounded up to the next integer, $x + 1$ (94.5 becomes 95, 94.4 does not).

A	[93, 100]
A-	[90, 93)
B+	[87, 90)
B	[82, 87)
B-	[80, 82)
C+	[77, 80)
C	[72, 77)
C-	[70, 72)
D+	[67, 70)
D	[62, 67)
D-	[60, 62)
F	[0, 60)

2 Class Policies

2.1 Homework Submissions & Grading

- All homework submissions and labs must be uploaded to Gradescope by 6:00 pm Eastern on the due date. Written submissions must be in PDF format.
- All written solutions **must** be typed (i.e., no scans of handwritten assignments will be accepted). Scanned figures are only permitted where explicitly specified in the assignment instructions. Any such figures must be clear and perfectly legible.
- The use of LaTeX to typeset mathematical equations is highly encouraged. Overleaf is an excellent browser-based LaTeX editor with real-time compilation capabilities. Overleaf Professional is free to all Northeastern students.
- It is encouraged that you collaborate with your classmates to review course content, notes and other reading material. However, any such collaborations must be kept strictly conceptual, and not involve any actual assignment problems. I recommend re-using examples from lecture, or reaching out to the instructor/TAs if in doubt.
- **If you do discuss any concepts with a classmate, you must list all such collaborators on your submission. You must write all solutions by yourself, in your own words, and are strictly forbidden from sharing written solutions or code.**
- The TAs and instructors reserve the right to ask you to explain your solutions, and inability to do so may result in academic penalties (sec. 2.2, 2.3).
- **Grading**: All grades will be released via Gradescope.
- **Regrade Requests**: All regrade requests must be submitted within 1 week of receiving your grade. Requests for all submissions must be submitted from within Gradescope. Requests submitted via email will almost certainly be missed.

2.2 Policy on the use of Generative AI

- For programming submissions (except assignment 0), students may use any AI tool available to them, as long as they are appropriately cited (a code comment will suffice). While the same policy applies to labs, I advise against using AI for these.
- Students may **not** use generative AI to complete problem sets in any capacity. These are intended to test students' ability to demonstrate mastery of techniques learnt in the course by a) presenting sound and rigorous theoretical analysis, and b) critically analyzing code. Any indication of the use of AI tools in the written submissions will constitute a violation of academic integrity, and be subject to academic penalties (see sec 2.3).
- The TAs and I reserve the right to refuse help with debugging code that was found online or generated by AI tools, if you cannot sufficiently explain it.
- The use of AI solely to rephrase sentences and improve writing clarity, etc. - while an acceptable use case - makes it difficult for instructors to discern whether the entire answer was AI-generated. Therefore, if AI is used in this manner, students are **required** to submit an additional appendix at the end of their submission with their corresponding originally written answers. Failure to include such an appendix will be treated as an academic integrity violation.
- The appendix is aimed only at helping me understand the usage patterns of AI tools. Points will **not** be taken off for using AI to improve writing when disclosed as per the policies above. Please feel free to clarify policies with me when in doubt.

2.3 Academic Integrity

- Please familiarize yourself with Northeastern University's Academic Integrity Policy.
- Sharing or discussing assignment solutions or code in any form is strictly forbidden. Searching for solutions online is okay, but must be clearly and appropriately cited. Any conceptual discussions held with classmates must be clearly disclosed in the assignment submission by all parties.
- Any violation of academic integrity (as outlined by all homework policies above) will result in the following penalties:
  - Academic penalties up to, and including, a grade of **F** for the course.
  - A report of the violation will be filed with OSCCR, where outcomes can range from warnings or academic probation to dismissal from the University.
  - International students should note that they do not have the option to withdraw from the course upon receiving an F grade due to F-1 visa credit requirements. Dismissal may also cause the student to be in violation of their visa status.

- Recognize that most violations are easily avoided by simply acknowledging any difficulties you may be having with the course and seeking help from your professor in a timely fashion. We're here to help you learn.
- International students often report suffering from cultural shock, homesickness, and being overwhelmed by a new education system. However, cheating is never the right solution. I want to assure you that I will never be inconvenienced by a student reaching out for help, or think poorly of a student for asking me lots of questions.

  I was in your shoes not that long ago, and I am happy to talk to you about any of these issues and offer you my support and guidance. However, it is imperative that this conversation happens in the absence of an academic integrity violation. Once a violation is identified, I will have no choice but to report it in the interest of fairness.

2.4 Late Policy

- Homework deadlines will typically be on Fridays at 8:00 pm Eastern. Students will receive an automatic extension until Sunday 8:00 pm, without penalty. Deadlines for any submissions related to the final project are absolute, and no extensions will be provided for these deliverables.
- Treat the automatic extensions to problem sets/programming assignments as a fallback for genuine emergencies - assignments in this course take a significant amount of time to complete. **No office hours are offered during the extension period.**
- Requests to submit assignments after the late deadline due to last-minute difficulties will be ignored. It is your responsibility to ensure that the correct files are properly uploaded, submitted, and reflected in Gradescope well in advance of the deadline.
- Beyond the automatic late deadline, I will not grant further extensions, except in the case of limited and verifiable emergency situations, or University and DAS-sanctioned accommodations. It is imperative that you communicate with me (or the TA team) early on when circumstances permit.
- In case you are close to the late deadline, and feel that you will be unable to submit an assignment in time, please reach out to me. Depending on your circumstances, I may not be able to give you an extension, but I will certainly offer you the right resources to help you make the most of your assignment.
- Do not succumb to the temptation to copy from a classmate (or use AI where prohibited) in order to salvage your grade close to a deadline - while it may seem like an easy way out at the time, doing so will only result in a much worse, irreversible outcome for all parties. Reach out to the TAs or me instead!

2.5 Classroom Environment

- Digital devices are permitted for note-taking purposes and to engage with course material such as lecture slides, or in-class activities as instructed. However, any use of laptops/tablets must not be disruptive to your classmates. No phones please.

- To create and preserve a healthy classroom atmosphere that facilitates teaching and learning, all participants share a responsibility in creating a civil, nonjudgmental, and non-disruptive forum for the discussion of ideas. Students are expected to conduct themselves at all times in a manner that does not disrupt teaching or learning.
- Your comments to others should be constructive and free from any harassing or disrespectful statements. You are welcome to disagree with other students and the instructor, but such disagreements need to be respectful, and based on facts, evidence and documentation (rather than prejudices and personalities).
- The instructor reserves the right to interrupt conversations that deviate from these expectations. Repeated unprofessional or disrespectful conduct will be treated as a violation of the Code of Student Conduct.

3 Office Hours & the TA Team

Campuswire is a Piazza alternative that we will be using as the class forum, and for online support. All course announcements will be posted on Campuswire. TAs offer a mix of in-person and online office hours. Check the course website for TA office hours timings.

Instructor - Raj

- In-person, Meserve 303, Wednesdays, 10:00 am - 12:00 pm.
- If you have a conflict, you may also schedule meetings with me through my website.
- If you decide to swing by on a whim and my office door is open, feel free to bug me.

Teaching Assistants

- Andrei Biswas, (biswas.and@northeastern.edu)
- Esakkivel Esakkiraja, (esakkiraja.e@northeastern.edu)
- Justin Feldman, (feldman.jus@northeastern.edu)
- Brent Garey, (garey.b@northeastern.edu)
- Arzoo Jiwani, (jiwani.a@northeastern.edu)
- Sabine Laurence, (laurence.s@northeastern.edu)
- Grace Mackin, (mackin.g@northeastern.edu)
- Ben Marler, (marler.b@northeastern.edu)
- Micah Marshall, (marshall.mica@northeastern.edu)
- Haig Shirozian, (shirozian.h@northeastern.edu)
- Rishi Srikaanth, (srikaanth.r@northeastern.edu)

4 Campus Resources

4.1 Healthcare, Counseling, and Wellness

Your health and well-being are paramount, above any and all course deliverables. There is a wide range of support services on campus to ensure your success, and I encourage you to reach out to these resources as appropriate. If I can help connect you, please don't hesitate to reach out to me!

- University Health and Counseling Services
- Find@Northeastern
- WeCare
- Support Groups and Workshops

4.2 Title IX

- Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender identity, in educational programs and activities that receive federal financial assistance.
- Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including students, faculty, and staff of all genders.
- If you or someone you know has been a survivor of a Prohibited Offense, confidential support and guidance can be found through University Health and Counseling Services staff and Center for Spiritual Dialogue and Service clergy members. By law, those employees are not required to report allegations of sex or gender-based discrimination to the University.
- Alleged violations can be reported non-confidentially to the Title IX Coordinator within The Office for University Equity and Compliance (OUEC) by either filling out the Discrimination Complaint Form, via email to the OUEC (this is a less secure option) at titleix@northeastern.edu and/or through NUPD (Emergency 617-373-3333; Non-Emergency 617-373-2121). Reporting Prohibited Offenses to NUPD does NOT commit the victim/affected party to future legal action.
- Faculty members are considered "responsible employees" at Northeastern, i.e., they are **required** to report all allegations of sex or gender-based discrimination to the Title IX Coordinator. Note that faculty are mandatory reporters, but not arbiters of situations that may arise. In case of an emergency, please call NUPD's emergency line (617-373-3333) or 911 as appropriate. Please visit the Title IX webpage for a complete list of reporting options and resources both on-campus and off-campus.

4.3 Disability Accessibility Services

Students with disabilities who wish to receive academic services and/or accommodations should visit Disability Accessibility Services at 20 Dodge Hall, or call 617-373-2675. If you have not already done so, please have the accommodations letter sent to me early in the semester so that I can best serve your needs.