# Course DS 5004: Applied Reinforcement Learning
Syllabus: Fall 2025

## Course Information

**Course Start Date–End Date:** August 26–December 9, 2025
**Credit Hours:** 3
**Prerequisites:** At least one course in the following:

- Python coding
- Machine Learning
- Probability

**Catalog Description:** Formal description from the [University Registrar](#)
**Live Online Meeting Times:** Thursdays, 7:15 pm – 8:15 pm EST

## Instructor Information

Adam Tashman
Director of Data Science Capstone Program
Associate Professor
**Email:** apt4c@virginia.edu
**Office Hours:** Tuesday 8PM – 9PM on Zoom
**Office Location:** remote

## Course Overview

Reinforcement Learning (RL) is a dynamic, active area in machine learning. It is fundamentally different from supervised and unsupervised learning, as it allows the agent (a person, robot, self-driving car, etc.) to learn by interacting with its environment. This allows for learning when the ground truth is unavailable, which is often the case. Even when the ground truth is available, it often becomes outdated in a dynamic environment (think predicting Netflix usage before and during a pandemic).

You will develop an understanding of fundamental topics including the elements of RL, exploration strategies, k-armed bandits, Markov Decision Processes, value functions, Policy Gradients, Q-Learning, and deep Q-Learning. The focus will be on critical thinking and computation.

You will hone your ability to identify when RL may be a suitable method to solve a problem, frame the problem appropriately, and execute the right algorithm to solve it. The content will strengthen and integrate your knowledge and skills in probability, statistics, machine learning, and coding. Throughout the course, you will apply new knowledge to solve a problem in a team setting.

## Learning Outcomes

By the end of the semester, you will be able to:
1. Work effectively in a team setting to frame a real-world problem as a reinforcement learning problem and optimize its policy
2. Explain and implement exploration strategies, whereby agents select actions based on experience and by taking risk
3. Apply and contrast different methods for estimating value functions: dynamic programming, Monte Carlo simulation, temporal difference methods
4. Compare the value-based approach to the Policy Gradient approach, explaining when each is appropriate / not appropriate
5. Implement deep reinforcement learning techniques
6. Critically examine the safety of reinforcement learning approaches, and explain how to improve their safety

## Semester Schedule

The first class meeting and days when we will not meet for the Live Session will be announced on Canvas. Assignment due dates will be posted on Canvas and included in agendas shown at that the start of class and posted on the course GitHub repo.

## What to Expect in This Fully Online Course

This course is delivered in 12 learning modules through Canvas. Each course module consists of a live session.

Meetings (video and teleconference) for live sessions will be held on Zoom. We request that you have your camera turned on and actively participate in the discussions by asking questions and contributing.

The instructor will share what is necessary to prepare for each week's live activity. This may include reading passages or thinking about prompts.

The synchronous session will be used for a combination of walkthroughs, discussion of readings, and/or a Q&A period.

## Required Software

### Coding / Environment

All coding will be done in Python. It may be easiest to use Google Colab. For some activities, you might prefer an IDE of your choice (e.g., Spyder).

## Learning Resources

**Required Textbook**

1. Reinforcement Learning 2nd edition. RS Sutton & AG Barto.
Provides thorough detail for building conceptual understanding of the topics.

2. Mastering Reinforcement Learning with Python. E Bilgin.
Following the Sutton and Barto framework but the focus is very applied. Rich with code examples.
Freely available [online](online) at the UVA Library.

## Grading

### Grade Breakdown

| Assignment | Percentage of Overall Grade |
|------------|-----------------------------|
| Labs | 25% |
| Journaling | 15% |
| Quizzes | 20% |
| Attendance | 10% |
| Team Project | 30% |

### Grading Policies

#### Labs
Labs will include exercises in algorithms, simulation, and machine learning. The outline of the exercise will be sketched out by the instructor to some degree. You will fill in the code to run experiments and answer questions. **You may collaborate with your classmates but your code must your own.**

#### Journaling
The purpose of journaling is to track your learning and growth throughout this course. It's a useful tool for the instructor to understand your journey and learn of possible adjustments to the course. You will submit your journal over the course of the term, appending new entries.

#### Quizzes
All quizzes are multiple choice, with full points awarded for a correct answer, and no points awarded for an incorrect answer. Partial credit is given where appropriate. **Quizzes are closed book.**

#### Attendance
The weekly live sessions are a great opportunity to join the community, learn together, and share. Attendance is required. If you cannot attend a class, kindly notify the instructor, ideally at least 24 hours in advance.

Team Project
You will work in a team of 2-3 students to solve a problem using reinforcement learning. The project will consist of four components:

1. Project Proposal (5% of overall grade)
2. Code (5% of overall grade)
3. Presentation (10% of overall grade)
4. Paper (10% of overall grade)

Past students have worked on projects they found interesting and valuable, including:
- An algorithm to optimize batched inference on a server
- A model to control and monitor glucose for a diabetic patient
- A model for completing a March Madness Bracket, with near human-level performance
- A movie recommender system
- A model for playing Super Mario Bros and completing entire levels

Late Work Policy and Electronic Submission of Assignments
All assignments must be submitted electronically through Canvas by the specified due dates and times. It is crucial to complete all assigned work—failure to do so will likely result in failing the class. For late assignments, 10% of the total grade will be deducted per day, where the day means 11:59 p.m. Eastern time cutoff. After five days late, it will be marked as 0 points.

*Extenuating Circumstances*
If you need help, are falling behind and struggling to catch up, or if extenuating circumstances arise, the sooner you reach out for help, the more options there are to help and support you. The sooner your reach out to the instructor to make a plan, the better. Alternatively or in addition, you may choose to contact Kristy Simpkins, kms8k@virginia.edu, Assistant Director, Online Student Success and Engagement, if you are experiencing extenuating circumstances.

Accessing Grades and Feedback in Canvas
- All grades and feedback will be found on Canvas
- Quizzes will be autograded after submission
- Labs will be graded and feedback will be provided by the TA. We target a 7-10 day turnaround from the due date.
- The team project will be graded by the instructor. The project elements will be graded within 7 days of submission.

Grade Scale

According to the SDS Grading Policies, the standing of a graduate student in each course is indicated by one of the following grades: A+, A, A-; B+, B, B-; C+, C, C-; D+, D, D-; F.
*B- is the lowest satisfactory grade for graduate credit.* You will be graded according to the following markings:

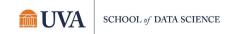| Online MSDS Grade Scale | |
| --- | --- |
| **Grade** | **Range** |
| A+ | > 97 |
| A | 93 - 97 |
| A- | 90 - 92.9 |
| B+ | 87- 89.9 |
| B | 83 – 86.9 |
| B- | 80 – 82.9 *Minimum passing grade* |
| C+ | 77 – 79.9 |
| C | 73 – 76.9 |
| C- | 70 – 72.9 |
| D+ | 67 – 69.9 |
| D | 63 – 66.9 |
| D- | 60 – 62.9 |
| F | 0 – 59.9 |

## Course Policies

Communication

### Zoom Expectations
Don't let Zoom keep you from being an active learner!

**You are required to have your camera on for the duration of our live class sessions.** Your virtual presence adds tremendous value to the course and program: it allows me as your instructor to gauge understanding; it helps you focus at a time when we know you are tired after working a long day; it creates connections with you and your peers.

**You may create a background** using the [Zoom Virtual Background Generator,](#) though it is not required. Distractions will happen – a needy child, wandering cat, messy pile – and I understand this as a working professional myself.

**Mute yourself unless you want to speak**. **Use the "Raise Hand" feature** if you wish to speak. Your questions and comments are valuable, and I encourage you to participate often.

**Set your name to what you would like to be called.** Update your profile with your preferred name. Be sure to log in with your UVA account.


## Recording of Live Zoom Class Sessions

Class sessions for this course will be recorded. Recordings will be available only to the instructor(s) and students enrolled in the class, including those who may miss a live session. Recordings will be deleted when no longer necessary. Recordings may not be reproduced, shared with those not enrolled in the class, or uploaded to other online environments. Students who are not comfortable with participating in a recorded discussion session should contact the instructor to request an alternate assessment activity. Students in the class are prohibited from recording of any kind unless authorization is obtained from the instructor.


## Communication and Student Response Time

Email or Teams message me or the TA whenever you want, and we will respond as soon as possible and generally within 24 hours. Email is the preferred mode of communication. Asking questions in front of others promotes discussion and reduces me having to repeat myself.

Questions containing personal information should be emailed to me. Throughout our time together, the sooner you inform me of any problem that may affect your attendance or performance, the better the chance we have of solving it together.


## Teams

The Teams link can be found on the Canvas Home page.


## Canvas

Canvas will be used for posting grades, announcements, viewing the overall flow and content of the course, and submitting assignments. The Canvas pages will have embedded links to GitHub which hosts the content of the course, including the syllabus, lab assignments, and lecture notes.


## Academic Integrity: Collaboration and Cheating

I encourage collaboration and you are welcome to discuss labs with other students, but the code needs to be yours. In general, the difference between collaboration and cheating comes down to intent. Cheating is trying to circumvent the learning process. Collaboration is trying to help yourself and your classmates learn the material more deeply. Use your own sense of right and wrong, but to help clarify the difference, here are **examples of cheating**:

1. Directly copying text/code from another student or generative AI tool
2. Sharing/showing code for the purpose of circumventing the learning process (for example, letting someone copy code because they are running up against the deadline)
3. Asking for help without doing anything to try to solve the problem first; asking someone to do the work for you
4. Making your homework freely available on GitHub or another website

5. Sharing answers to quizzes

## SDS Guidelines on AI Tools and Assistance

The use of generative AI tools and foundation models, (i.e. ChatGPT GPT, DALL-E, Stable Diffusion, Midjourney, GitHub Copilot, and similar tools) is permitted with the following activities in accordance with the stated guidelines at no penalty:

- Brainstorming and refining your ideas
- Fine tuning your research questions
- Finding information on your topic
- Drafting an outline to organize your thoughts
- Checking grammar and style

Students are responsible for

- Acknowledging that large language models tend to produce incorrect facts and fake citations
- Acknowledging that code generation models may produce inaccurate outputs
- Acknowledging that image generation models can occasionally come up with highly offensive products
- Taking responsibility for any inaccurate, biased, offensive, or otherwise unethical content submitted, regardless of the origin (i.e. student-generated or from a foundation model)
- Properly citing the contribution of the foundation model or other AI tools in submitted material
- The entirety of any information they submit, based on an AI query or AI assistance

The use of generative AI tools is NOT permitted for the following activities:

- Impersonating students in classroom contexts, such as by using the tool to compose discussion board prompts or content entered into a Zoom chat
- Completing group work assigned to a student, unless it is mutually agreed upon that they may utilize the tool
- Writing a draft of a writing assignment
- Writing entire sentences, paragraphs or papers to complete class assignments

**Students may be penalized for**

- Using a foundation model without including an acknowledgment
- Improperly citing the use of work by other human beings or the submission of work by other human beings as that of the student
- Violating intellectual property laws
- Submitting materials containing misinformation or unethical content

The use of AI tools must be properly cited (**for example, in your team project report**) to stay within university policies on academic honesty. Failure to adhere to these guidelines will result in a failing grade on the assignment or exam (a zero) and may be an honor code violation

depending on the context (to be determined at the instructor's discretion). Having said all these disclaimers, the use of foundation models is encouraged, as it may make it possible for you to submit assignments with higher quality, in less time.

## Technical Support

### Technical Support Contacts

- Login/Password: https://in.virginia.edu/helpdesk
- Canvas: Check the Help tab for resources

## School of Data Science Support and Policies

### Office of Student Affairs

The Office of Student Affairs is here to support your academic journey toward success. Their office provides resources to help you be authentic, healthy, successful, and engaged. If you need support resources related to student success or personal well-being, please reach out to the Office of Student Affairs directly at SDSStudentAffairs@virginia.edu.

Please also use the Student Affairs Community Portal for resources and information about career, academic support, engagement opportunities, funding, and more.

### Peer Tutors

The School of Data Science offers free, virtual, one-on-one tutoring with MSDS alumni. Our peer tutors provide personalized support tailored to your needs, whether you're struggling with a specific concept or want to deepen your understanding. They can clarify doubts, reinforce learning, and guide you toward success. Schedule your session at this Peer Tutoring scheduling link.

### Online MSDS Student Advisory Board (OSAB)

Online MSDS students have a student advisory board to help them navigate their online experience and engage with peers about opportunities and concerns related to online learning at the School of Data Science. You can contact them at SDS_OSAB@virginia.edu.

### Career Services

The School of Data Science Career Services Team provides a wealth of opportunities for you to learn, connect, and grow. These offerings are adapted to the needs of the cohort or the year and may take different forms as needs change.

Complete your profile and career interests, explore the Data Analytics Resource Card or make an appointment with Career Services at the School of Data Science by using your UVA Email to Login to Handshake.
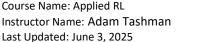
### Graduate Record

Visit the School of Data Science Graduate Record for policies and information about academic regulations, academic standing, financial assistance, and grades.

## University Policies

### University Email Policy

Students are expected to activate and then check their official UVA email addresses on a frequent and consistent basis to remain informed of University communications, as certain communications may be time sensitive. Students who fail to check their email on a regular basis are responsible for any resulting consequences.

## Academic Integrity and University of Virginia Honor System

The School of Data Science relies upon and cherishes its community of trust. We firmly endorse, uphold, and embrace the University's Honor principle that students will not lie, cheat, or steal, nor shall they tolerate those who do. We recognize that even one honor infraction can destroy an exemplary reputation that has taken years to build. Acting in a manner consistent with the principles of honor will benefit every member of the community both while enrolled in the School of Data Science and in the future. Students are expected to be familiar with the university honor code, including the section on academic fraud.

All work should be pledged in the spirit of the Honor System of the University of Virginia. The instructor will indicate which assignments and activities are to be done individually and which permit collaboration. Students who submit exams electronically acknowledge the Honor Pledge by agreeing to the following statement:

- "On my honor, I have neither given nor received aid on this examination, nor did I have prior knowledge of its contents."

For more information, please visit http://www.virginia.edu/honor/.

**Course Evaluations:** Student feedback is critical to the school, the instructor, and future students. Students are expected to complete anonymous and confidential course evaluations in a timely manner for each course at the end of each term.

## Discrimination/Harassment/Retaliation

UVA prohibits discrimination and harassment based on age, color, disability, family medical or genetic information, gender identity or expression, marital status, military status (which includes active duty service members, reserve service members, and dependents), national or ethnic origin, political affiliation, pregnancy (including childbirth and related conditions), race, religion, sex, sexual orientation, veteran status. UVA policy also prohibits retaliation. All faculty and TAs are also responsible employees for disclosures or reports of potential discrimination, harassment, and retaliation.

## Disability and Pregnancy Accommodations

If you anticipate or experience any barriers to learning in this course, please discuss your concerns with me. If you have a disability, or think you may have a disability,  contact the Student Disability Access Center ("SDAC") to request reasonable accommodation(s) for this course through their website. If you have accommodations through SDAC, send me your Faculty Notification Letter as soon as possible and meet with me so we can develop an implementation plan together.

Students may be entitled to reasonable accommodations for pregnancy, childbirth, or related medical issues.  Please contact SDAC for additional information. Pregnant and parenting students are encouraged to contact SDAC or EOCR to discuss plans and ensure ongoing access

to their academic courses and program.  Information for pregnant and parenting students is also available on EOCR's [Pregnancy and Parenting Resources webpage](#).

**Student Mental Health and Wellbeing**

The University of Virginia is committed to advancing the mental health and wellbeing of its students, while acknowledging that a variety of issues directly impacts students' academic performance. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, contact the CAPS Care Managers at [CAPSCareMgrs@virginia.edu](mailto:CAPSCareMgrs@virginia.edu).

For help finding a community therapist, visit the [Community Referrals page](#) through CAPS.

## Additional Resources

The School of Data Science Office of Student Affairs can help find resources for students experiencing Emergency Needs. Please contact them at [sdsstudentaffairs@virginia.edu.](mailto:sdsstudentaffairs@virginia.edu)