

Reinforcement Learning

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Instructor

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Subject Area and Catalog Number: Data Science DS [NUMBER TBD]

Year and Term: Fall 2025

Class Title. Reinforcement Learning

Level: Graduate

Credit Type: Graded

Class Description

Reinforcement Learning is a dynamic, active area in machine learning. It is fundamentally different from supervised and unsupervised learning, as it allows an agent to learn by interacting with its environment. This allows for learning when the ground truth is unavailable, which is often the case. Even when ground truth is available, it often becomes outdated in a dynamic environment (think predicting Netflix usage before and during a pandemic). This course will introduce topics including the elements of RL, k-armed bandits, Markov Decision Processes, value functions, Policy Gradients, Q-Learning, and deep Q-Learning. The focus will be on computation and not theorem-proof (e.g., convergence guarantees).

Required Text

Reinforcement Learning 2nd edition. RS Sutton & AG Barto

Mastering Reinforcement Learning with Python. E Bilgin

Topic List (this list is subject to change)

- Foundations of Reinforcement Learning
- k-armed Bandit Problems
- Markov Decision Processes (MDPs)
- Approaches to solving MDPs:
 - > Dynamic Programming
 - > Monte Carlo
 - > Temporal-Difference Learning
- Q-Learning
- Deep Q-Learning (DQNs)
- Policy Gradients
- Safety in ML
- Reinforcement Learning with Human Feedback

Learning Outcomes

- Explain and implement methods that trade off exploration for exploitation
- Understand, compute, and improve value functions and policy gradients to optimize a policy
- Apply and contrast different methods for estimating value functions: dynamic programming, Monte Carlo simulation, temporal difference methods
- Explain how Q-Learning works and how it learns off policy
- Compare the value-based approach to the Policy Gradient approach
- Apply deep reinforcement learning techniques
- Explain methods for safely implementing reinforcement learning
- Explain methods for RL with human feedback

Delivery Mode Expectations

Weekly meetings and office hours on Zoom

Required Technical Resources and Technical Components

[VPN app: Cisco AnyConnect](#)

For coding, we will use Python. You might use tools like Anaconda and Google Colab.

Class Requirements

Prior to taking this course, you should meet the following course prerequisites:

- Python coding
- Machine Learning
- At least one course in Probability

Evaluation Standards and Assessments

Quizzes	Quizzes will assess student knowledge and application of topics covered in reading assignments, lecture notes, and labs.
Attendance	Student attendance is required.
Journaling	Students track their progress and learning in a Journal that is submitted to the instructor.
Labs	Labs will be implemented in Jupyter Notebooks and provide hands-on experience with concepts, RL environments, and coding.
Final Project	The final project is a large component of the course and it includes data collection, coding, algorithm use, visualization, and presentation.

Your final letter grade will be determined by the following scale:

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

Class Schedule

TBD

Communication & Student Response Time

Zoom:

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.

Teams: We will use a Teams channel for the course. This will be a place where students can reach out to peers and instructors to ask questions and provide comments related to content and technology.

Canvas: Class announcements will be made through Canvas. High-level notes (e.g., due dates) will be posted on the Canvas home page.

Email: For questions about assignment grading or assignment submission, please email the TA.

Response Time: The instructor and TA aim to provide a response within 24 hours.

Issues that may Arise: Throughout our time together, the sooner you inform the instructor of any problem (personal or academic) that may affect your attendance or performance, the better the chance we have of solving it together.

Assignments

Quizzes (20% of grade)

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 (5% of grade)

Student attendance is required. If a student cannot attend a class, the instructor needs to be notified in advance.

Journaling (15% of grade)

The purpose of journaling is to track student learning and growth throughout this course. The journal will be submitted over the course of the term, appending new entries.

Labs (30% of grade)

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. Students will fill in the code to run experiments and answer questions. **Students may collaborate with classmates but each student's code must be their own.**

Final Project (30% of grade)

The final project will have the student solve a problem using reinforcement learning, or dive deeper into an area of RL. Students can work individually or in small teams of 2 or 3. The project will consist of three components, each worth one-third of the final project grade:

1. Code
2. Presentation
3. Paper

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.

Technical Support

Technical Specifications: Computer Hardware

Operating system: Microsoft Windows 8.1 (64-bit) or Mac OS X 10.10
Minimum hard drive free space: 100 GB, SSD recommended
Minimum processor speed: Intel 4th Gen Core i5 or faster
Minimum RAM: 4 GB

For the computing work, options include your machine, Rivanna, and Google [Colab](#).

Technical Support Contacts

For issues with computing on Rivanna, please email UVA Research Computing at:
hpc-support@virginia.edu

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 utilize 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.](#)

Office of Equity and Inclusion

The [Office of Equity and Inclusion](#) is committed to diversity, equity, and inclusion as mission-central and integral to the institution's overall future success and has published its first Inclusive Excellence Plan (2023-2026).

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.

Attendance

Students are expected to attend all class sessions. Instructors establish attendance and participation requirements for each of their courses. Class requirements, regardless of delivery

mode, are not waived due to a student's absence from class. Instructors will require students to make up any missed coursework and may deny credit to any student whose absences are excessive. Instructors must keep an attendance record for each student enrolled in the course to document attendance and participation in the class.

University Email Policies

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.

End-of-Class Evaluations

Students are expected to complete the online end-of-class evaluation. As the semester comes to a close, students will receive an email with instructions for completing this. Student feedback will be very valuable to the school, the instructor, and future students. We ask that all students please complete these evaluations in a timely manner. Please be assured that the information you submit online will be anonymous and kept confidential.

University of Virginia Honor System

All work should be pledged in the spirit of the Honor System at the University of Virginia. The instructor will indicate which assignments and activities are to be done individually and which permit collaboration. The following pledge should be written out at the end of all quizzes, examinations, individual assignments and papers: "I pledge that I have neither given nor received help on this examination (quiz, assignment, etc.)." The pledge must be signed by the student. For more information, visit www.virginia.edu/honor.

Special Needs

It is my goal to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. Students with disabilities may also wish to work with the Student Disability Access Center to discuss a range of options to removing barriers in this course, including official accommodations. Please visit their website for information on this process and to apply for services online: sdac.studenthealth.virginia.edu. If you have already been approved for accommodations through SDAC, please send me your accommodation letter and meet with me so we can develop an implementation plan together.

Disability and Pregnancy Accommodations

If you anticipate or experience any barriers to learning in this course, please feel welcome to discuss your concerns with me. If you have a disability, or think you may have a disability, you may contact the Student Disability Access Center ("SDAC"), to request reasonable accommodation(s) for this course. You can find more information about SDAC, including how to apply for services online, through their [website](#). If you have already been approved for accommodations through SDAC, please make sure to 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

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.