

# Course Syllabus for SIADS 644: Reinforcement Learning Algorithms

## Course Overview and Prerequisites

This course covers the basic principles of reinforcement learning and popular modern reinforcement learning algorithms. Students will develop familiarity with both model-based and model-free reinforcement learning algorithms, including Q-learning, Actor-Critic algorithms, policy-gradient, and Alpha-zero.

The prerequisites for SIADS 644 include:

- Math Methods for Data Science (502),
- Deep Learning (642)
- Data Mining II (632)

## Instructor and Course Assistants

### Instructor:

- Lei Ying - leiying@umich.edu Professor, Electrical Engineering and Computer Science, Michigan Engineering

### Course Assistants:

- Qining Zhang - qiningz@umich.edu

## How to Get Help

If you have questions concerning the degree program, encounter a technical issue with Coursera, or issues using Slack, please submit a report to the ticketing system at [umsimadshelp@umich.edu](mailto:umsimadshelp@umich.edu) [Opens in a new tab](#).

If you have an issue specific to the Coursera environment, you can receive support through the [Coursera Learner Help Center Opens in a new tab](#) (you may be asked to log in to your Coursera account). Live chat support is also available through the help center.

For questions regarding course content, refer to the **Communications Expectations** section below.

## Course Communication Expectations

Slack is the preferred communication tool for this course. If you have questions about course content (e.g. lecture videos or assignments), please make sure to use Slack. Instructor and course assistant response time to Slack messages will be within 24 hours.

Personal communication that may involve sensitive information may be emailed directly to the instructor or course assistant. If you email the instructor or course assistant, please include SIADS 644 in the email subject. Instructor and course assistant response time to email messages will be within 24 hours.

Instructor grading response time will be 4 days after assignments are submitted.

## Learning Outcomes

- Understand the principle of optimality and the Bellman equation
- Understand Q-function and model-free reinforcement learning.
- Program deep Q-learning algorithms for problems with discrete action spaces
- Program deep actor-critic algorithms for problems with continuous action spaces
- Program simple Alpha-zero

## Course Schedule

- **This course begins on November 21, 2023, and ends on December 18, 2023.**
- Weekly assignments will be **due on Mondays at 11:59 pm** (Ann Arbor, Michigan time; U.S. Eastern time zone).

**Week 1** focuses on the mathematical foundation of reinforcement learning. Students will learn dynamic programming and the principle of optimality. Students will focus on the Bellman equations for different types of reinforcement learning problems.

**Week 2** focuses on the algorithmic foundation. Students will learn value iteration and policy iteration algorithms. After that, model-free reinforcement learning algorithms such as Q-learning and SARSA will be introduced. Students will also learn linear function approximation for complex reinforcement learning problems. Students will be asked to use linear function approximation to play simple Tetris.

**Week 3** focuses on deep learning algorithms such as Q-learning, actor-critic algorithms, and deep policy gradient algorithms. Students will be asked to train a BipedalWalker in OpenAI Gym.

**Week 4** focuses on the exploration-exploitation tradeoff and the ideas behind Alpha-zero. Students will learn upper-confidence bound and Monte Carlo Tree Search. Students will be asked to program a simple Alpha-zero based on self-play.

## Weekly Office Hours via Zoom (Ann Arbor, Michigan time):

Your instructor will hold weekly, synchronous office hours using the video-conferencing tool, Zoom. The schedule of office hours can be found by clicking on the **Live Events** link in the left-hand navigation menu. Additionally, all office hours will be recorded and archived so that you can retrieve them at a later date. Office hour recordings will be available in the course. Password for all office hours will be 644 and take place in EST time.

## Grading

Course Item	Percentage of Final Grade	Due
Week 1 Homework - Part 1 - Part 2	25%	Monday, Nov 27, 2023 - 11:59pm (U.S. Eastern time)
Week 2 Homework - Part 1 - Part 2	25%	Monday, Dec 4, 2023 - 11:59pm (U.S. Eastern time)
Week 3 Homework - Part 1 - Part 2	25%	Monday, Dec 11, 2023 - 11:59pm (U.S. Eastern time)
Week 4 Homework	25%	Monday, Dec 18, 2023 - 11:59pm (U.S. Eastern time)
<b>Total</b>	<b>100%</b>	

Note: All assignments are required to earn credit for this course.

## Letter Grades, Course Grades, and Late Submission Policy

Late assignment submissions will be reduced by 25% per day for 3 days, then 0 points awarded after 4 days.

The grading scale for this course is as follows:

<b>A+ 95%</b>
A 90%
A- 85%
B+ 80%
B 75%
B- 70%
C+ 65%
C 60%
C- 55%
D+ 50%
D 45%
D- 40%

**A+ 95%**

**F 0%**

To get an A+, a student should not have any late homework submissions (with or without instructor's permission).

## **Academic Integrity/Code of Conduct**

Refer to the [Academic and Professional Integrity Opens in a new tab](#) section of the UMSI Student Handbook.

## **Accommodations**

Refer to the [Accommodations for Students with Disabilities Opens in a new tab](#) section of the UMSI Student Handbook. Use the Student Application Form in [Accommodate Opens in a new tab](#) to begin the process of working with the University's Office of Services for Students with Disabilities.

## **Accessibility**

Refer to the [Screen reader configuration for Jupyter Notebook Content Opens in a new tab](#) document to learn accessibility tips for Jupyter Notebooks.

## **Library Access**

Refer to the [U-M Library's information sheet Opens in a new tab](#) on accessing library resources from off-campus. For more information regarding library support services, please refer to the [U-M Library Resources Opens in a new tab](#) section of the UMSI Student Handbook (access to the Student Orientation course required).

## **Student Mental Health**

Refer to the University's [Resources for Stress and Mental Health website Opens in a new tab](#) for a listing of resources for students.

## **Student Services**

Refer to the [Introduction to UMSI Student Life Opens in a new tab](#) section of the UMSI Student Handbook (access to the Student Orientation course required).

## **Technology Tips**

- Recommended Technology
  - This program requires Jupyter Notebook for completion of problem sets and Adobe or other PDF viewer for reading articles.
- Working Offline

While the Coursera platform has an integrated Jupyter Notebook system, you can work offline on your own computer by installing Python 3.5+ and the Jupyter software packages, including pyspark. For more details, consult the [Jupyter Notebook FAQ Opens in a new tab](#).