

ECE 1508: Reinforcement Learning

Course Logistics

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Welcome to ECE 1508!

Great pleasure to see you in ECE 1508

Special Topics in Communications: Reinforcement Learning

Instructor: Ali Bereyhi

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Teaching Assistants: TBA

- There will be *tutorial lectures*

Where and When?

- *Tuesdays* at **3:00 PM till 5:00 PM** at **MC-252**
- *Thursdays* at **3:00 PM till 5:00 PM** at **MC-252**

Quercus and Piazza

We got a *Quercus* page

- You have been automatically enrolled
- Also you got registered at the *Piazza* page
 - ↳ You can login through the *Quercus* page
- All course materials will be shared on *Quercus*

Please! Feel free to ask questions on Piazza!

What Do We Learn?

In nutshell: we learn **Reinforcement Learning**!

You may wonder how do we learn it? Well! in 3 steps

- **Step 1: Fundamentals of Reinforcement Learning**
 - We try to get understand the underlying framework
 - We understand what the main problem is
 - ↳ *We see that it's a sort of optimization problem*
 - We get to look at some simple example

By the end of this step, we know in theory

- What kind of problems we are dealing with in Reinforcement Learning
- What **methods** are available to solve these problems

What Do We Learn?

In nutshell: we learn **Reinforcement Learning**!

You may wonder how do we learn it? Well! in 3 steps

- **Step 2: Reinforcement Learning Methods**
 - Model-based Methods
 - *In some toy-scenarios, we can write the underlying problem analytically*
 - *This is not really the case in practice though!*
 - Model-free Methods
 - *In reality, we cannot write the problem analytically!*
 - *We need to solve the problem directly from data by efficient algorithms*

As we get over this part

- You have all background that you need on **Reinforcement Learning**
 - *You can formulate a Reinforcement Learning problem*
 - *You can specify at least one algorithms to solve it*

But! Your algorithm might take for ever to run! 😊

What Do We Learn?

In nutshell: we learn **Reinforcement Learning**!

You may wonder how do we learn it? Well! in 3 steps

- **Step 3: Deep Reinforcement Learning**
 - We now apply **deep learning** to solve those **hard** problems
 - We use neural networks to learn the solution from few samples
 - We look into **Deep Q-Learning** and **Policy Gradient Methods**

This is the major part of the course \approx 50%

- You need good background on Deep Learning, i.e., to be fairly familiar with neural networks

Checkout the course [syllabus at Quercus](#)

How Do We Get Trained?

There are three learning components in the course

- *Assignments*

- ↳ You get **three sets** of assignments
- ↳ **No need to say** that they are the **best thing** to understand the course!
- ↳ And, of course we do **lots of programming** in there!
 - ↳ Your code **should not return error!**
- ↳ Each assignment will be solved in Tutorial **after the deadline**
 - ↳ Submission by **deadline at 11:59 PM: full mark**
 - ↳ Up to 3 days delay is allowed: **each day deducts 10%**

*Feel free to get help, even from **ChatGPT!***

- Midterm Exam
- Final Project

How Do We Get Trained?

There are three learning components in the course

- Assignments
- *Midterm Exam*
 - ↳ We will have **one written exam** in the **middle of semester**
 - ↳ Questions that **can be solved by hand**, so **no programming** in the exam
 - ↳ It is after we are finished with **Part 2** \approx Week 7
 - ↳ It counts for 25% of the whole mark
- Final Project

How Do We Get Trained?

There are three learning components in the course

- Assignments
- Midterm Exam
- *Final Project*
 - ↳ The **most interesting** part of the course
 - ↳ We build **groups**
 - ↳ A list of predefined project topics is provided \approx Week 6
*Topics are all on **Deep Reinforcement Learning***
 - ↳ **Each group** chooses a topic
 - ↳ **Each group member** submits a progress report
 - ↳ **Each group** submits a final paper
 - ↳ **Each group** submits its implementation
 - ↳ **Each group** presents its poster in a poster session on last week

Lots of Programming in Python

We are going to do lots of programming in Python

- ↳ Basic knowledge in Python is necessary
- ↳ We use *PyTorch* and *NumPy* a lot
 - ↳ *Don't run away* if you *haven't* used them too much
 - ↳ *If you know Python* and have good programming skills, you're fine!
- ↳ It's important to mention *knowing Deep Learning is a must!*
 - ↳ You may follow without Deep Learning till midterm
 - ↳ After midterm we need to use deep learning
 - ↳ There will be *non-graded Quiz* this week
 - ↳ *This is only to make sure you know what you need to know*
- ↳ We will learn a new library
 - ↳ *Gymnasium*: standard API widely used for Reinforcement Learning

No Major Prerequisites

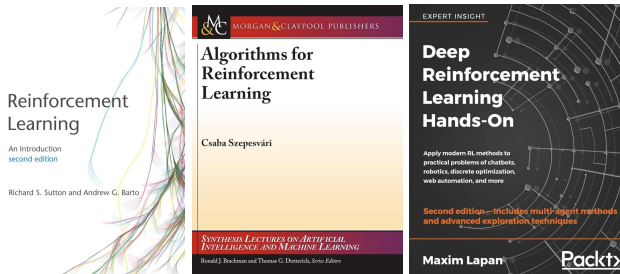
Except Deep Learning, the course is *self-containing* meaning that
you will learn *all other background*!

We assume that we all have some *basic math* in mind

↳ linear algebra, calculus, and probability theory

But we review *whatever we need* from these topics *whenever needed*!

Textbooks



All materials *are provided in the course*. It's however *good to know* some texts!

- Sutton and Barto can be accessed online [at this link](#)
- Szepesvári is available online [here](#)
- Lapan is a good source for Part 3

Terms and Conditions!



The instructor keeps the right reserved for himself to modify the slides

- *last minute before the lecture 😊*
- *after the lecture has been given*
 - *Typically happens due to typos*

The instructor keeps the right reserved for himself to deliver the lecture-notes

- *in form of mini-batches 😊*

Date and Signature

Introducing Glum

Glum does not buy my words! e.g.,

- + *Well! I know Deep Learning, you think you can teach me Reinforcement Learning!*
- *Sure! Let's try!*

So, please excuse me if I explain things sometimes in too much detail! I need to convince Glum!



No such thing as a stupid question!

Did you know that we got [a Wikipedia page](#) on this?

- ↳ Trust me! Your question will **never** sound stupid!
- ↳ **If you don't ask**; then, **I need to ask**!
 - ↳ **Interaction** is the best tool to avoid getting bored!

Any Questions? 😊