

Deep Generative Models

Chapter 0: Logistics and Course Overview

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Welcome to GenAI!

Happy to see you in

Deep Generative Models

Instructor: Ali Bereyhi

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Where and When?

- *Tuesdays* at **6:00 PM till 8:00 PM** at **BA 1170**
- *Thursdays* at **6:00 PM till 8:00 PM** at **BA 1190**

Tutorials: TBA

↳ *Tentative Time:* *Tuesdays* or *Thursday* at **5:00 PM till 6:00 PM**

Teaching Team

- Likun Cai – *Project Supervision* and *Assignments*
 - ECE Department
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 - CS Department
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Quercus and Piazza

Course Page

Course materials are shared over the [Course Page](#)

↳ This is not the [Quercus](#) page 😊

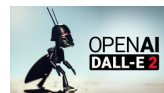
We got also [Quercus](#) page

- You have been automatically enrolled
- You get any logistic updates through [Quercus](#)
- Also you got registered at the [Piazza](#) page
 - ↳ You can login through the [Quercus](#) page

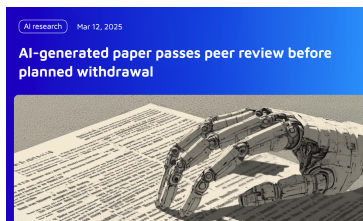
Please! Feel free to ask questions on Piazza!

Generative AI

Generative AI is nowadays *a thing* right!



Leonardo.Ai



Generative AI

Generative AI does pretty much anything!

- It writes **coherent texts** in response to our **prompts**
- It writes **efficient lines of code**
- It argues and mimics logical **thinking**
 - ↳ Does it?!
- It generates **images never seen before!**
- It generates **customized videos!**
- It writes **scientific text** and generates **data for experiments**

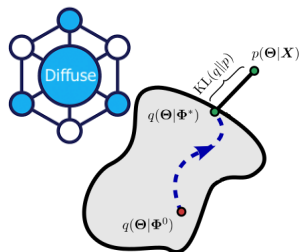
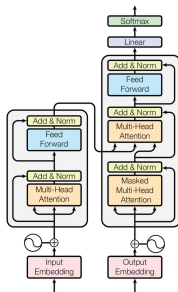
This course deals with these superheros in two respects

- ① **How** they really do what they do?!
- ② Are they really **capable** of all the things people say about them?!

Course Contents

When it comes to studying **generative models**, we get a bit **confused!**

+ Where should we start?! What should we learn?!



Complementary Viewpoints to ML

There two *major viewpoints* in learning and you have tried both

Computational Learning

- ✓ Represent a functional relation
- ! Computation is main paradigm
- 🔑 NNs are key tools

You have seen this viewpoint in

- ☰ Applied Deep Learning Course

Statistical Learning

- ✓ Infer statistical dependencies
- ! Inference is main paradigm
- 🔑 Statistical methods are used

You have seen this in courses

- ☰ Intro Machine Learning
- ☰ Information Theory

Note that . . .

These viewpoints are closely related and we need the both in this course

Course Contents: LLMs – Text Generation

Back to our challenge: *Where should we start?!*

- We start thinking **computationally** about data generation
 - ↳ We are more used to the computational notions
- We focus on text generation, namely **language models**
 - ↳ Basic LMs \rightsquigarrow **Attention:** We **don't** get into NLP domain!
 - ↳ Context-Aware LMs \rightsquigarrow Transformer-based LMs
- We **gradually** practice thinking **statistically**
 - ↳ What is the **language distribution**?!
 - ↳ What does **LMs** do **statistically**?
- We take deep look into **LLMs**

Prerequisite

Good understanding of NNs and training them is required

Course Contents: *Data Generation Framework*

In the next step, we extend our *statistical* viewpoint

- Data *generation* is essentially *distribution learning*
 - ↳ What is *data distribution*?
 - ↳ Data samples are *samples* of this *distribution*
 - ↳ How to learn it via *maximum likelihood* approach?

Prerequisite

A review on key notions in statistics and probability is helpful

Course Contents: *Deep Generative Models*

Learning distribution

- `</>` Conventional approach
- ✓ Maximum likelihood learning
- ✓ We learn distribution
- ✗ Complicated target
- ✗ Hard to sample

We see in this respect

- ☰ Auto-regressive models
- ☰ Flow & Energy-based models

Learn to sample

- ⚙ Latent-space approach
- ✓ More robust methods
- 🔑 Variational inference
- 🔑 Min-max game
- 🔑 Diffusion process

We see in this respect

- ☰ Generative Adversarial Nets
- ☰ Variational AEs
- ☰ Diffusion Models

Course Contents: *Advances*

By the end of the course . . .

*we make a solid understanding of trend **data generation frameworks***

We then take a look on a few advanced topics

- **Multimodal** LLMs and their challenges
- **Conditional** generative models
- . . .

Course Syllabus

Check detailed content on the [course page](#)

How Do We Get Trained?

There are three learning components in the course

- *Assignments*
 - ↳ We solve **three sets** of assignments
 - ↳ **No need to say** that they are the **best thing** to understand the course!
 - ↳ Please take a look at **Code of Honor**
 - ↳ Each assignment will be discussed in Tutorial **after the deadline**
 - ↳ Submission by **deadline at 11:59 PM**: **full mark**
 - ↳ Up to 2 days delay: **each day deducts 10%** – **Sorry! but no extension!**

Attention!

*Assignments make almost **half** of the **course mark**; so, they need effort! They are **a part** of the **learning process**, **not supplementary**!*

- Midterm Exam
- Final Project

How Do We Get Trained?

There are three learning components in the course

- Assignments
- Midterm Exam
 - ↳ One written exam in the middle of semester
 - ↳ Questions that *can be solved by hand*, so *no programming* in the exam
 - ↳ It evaluates *understanding* of *fundamental concepts*
 - ↳ Exam is on **June 24, 2025 at 6:00 - 9:00 PM**
- 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** of size **?**
 - ↳ **Each group** chooses a topic from the list
 - ↳ **!** Open-ended projects should **match** the **level & milestones**
 - ↳ **Each group** briefs us about the progress by **Week 10**
 - ↳ **Each group** accomplishes their project and submits final codes and paper
 - ↳ We meet all in a **seminar** where the groups present their projects

Final Project \equiv Final Evaluation

*Final project works as the final exam and you are professionally obligated to follow the **Code of Honor***

Course Calendar

| Week | Lecture Topics | Postings | Deliverable |
|---------|--|--|-------------------------------|
| Week 1 | Review on Language Models | | |
| Week 2 | LLMs and Data Generation Formulation | Assignment 1 Posted | |
| Week 3 | Learning Data Distribution | | |
| Week 4 | Auto-regressive and Flow-based Models | Project Documentations Posted | Assignment 1 Deadline |
| Week 5 | Generative Adversarial Networks | Assignment 2 Posted | |
| Week 6 | Variational Inference | | Project Topic Selection |
| Week 6 | Variational Auto-encoders | | Assignment 2 Deadline |
| Week 8 | No Lecture -- Midterm Exam | Midterm Exam on June 24, 2025 at 6:00 PM | |
| Week 9 | Diffusion Process | | |
| Week 10 | Forward and Reverse Processes | Assignment 3 Posted | Progress Briefing for Project |
| Week 11 | Diffusion Models Wrap-up of Standard Approaches | | |
| Week 12 | Advances I: Modality and Multimodal Models | | Assignment 3 Deadline |
| Week 13 | Advances II: Conditional Models and Available Trends | | |
| Week 14 | No Lecture -- Course Seminar | | Final Project Submission |

In Person Lectures!

The course is **in-person** and . . .

. . . *by Regulations the attendance is mandatory in in-person courses!*

attendance
MATTERS

Recording is uploaded after each lecture

- They are mainly for **recap** and/or **following some missed lectures**
- I **strongly** advise to **attend** the lectures
 - You don't want to miss my **performance** 😊
 - **Board and I** are **not** captured in videos, it's **only** the **slides and my voice**

Programming in Python

We deal a lot with programming in Python

- ↳ Good knowledge in Python is needed
 - ↳ An **overview** will be given in the **first tutorial**
- ↳ I extremely suggest **experimenting** by yourself
 - ↳ *Try to implement simple form of whatever we study*

Prerequisites: *Fundamentals of Deep Learning*

To follow the course

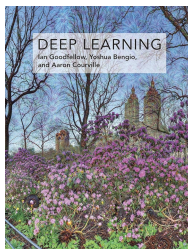
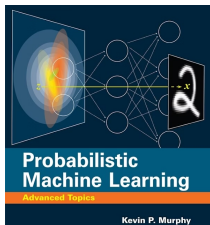
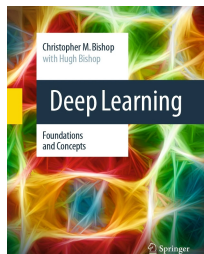
- ↳ a *good understanding* of fundamentals *notions in ML* is needed
- ↳ basic notions in *probability and statistics*

You do all fine if you had

- ECE1508: Applied Deep Learning
- ECE1513/ECE421: Introduction to Machine Learning
- Or any *equivalent* one

Review lectures are posted for those who want to *recap*

Textbooks



No specific textbook on Generative AI

- Bishop and Bishop, “Deep Learning: Foundations and Concepts”
- Murphy, “Probabilistic Machine Learning: Advanced Topics”
- Goodfellow et al., “*Deep Learning*”

Materials *are provided in the course*

- *Reading list* is completed through the semester

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.,

- + *You expect me to implement a LM?*
- *Sure! Let's try it!*

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



Challenge Me: *Please!*

This is the first time we teach GenAI as a course!



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? 😊