

Deep Generative Models

Chapter 0: Logistics and Course Overview

Ali Bereyhi

ali.bereyhi@utoronto.ca

Department of Electrical and Computer Engineering
University of Toronto

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Welcome to GenAI!

Happy to see you in

Deep Generative Models

Instructor: Ali Bereyhi

- *Office:* BA 7208 at Bahen Centre for Information Technology
- *Email:* ali.bereyhi@utoronto.ca

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
 - likun.cai@mail.utoronto.ca
- Mohammadreza Safavi – *Tutorials and Assignments*
 - ECE Department
 - mohammadreza.safavi@mail.utoronto.ca
- Amir Hossein Mobasher – *Project Supervision and Assignments*
 - ECE Department
 - amir.mobasher@mail.utoronto.ca
- Amir Hosein Rostami – *Project Supervision and Assignments*
 - CS Department
 - amirhosein.rostami@mail.utoronto.ca

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



A news article thumbnail from "AI research" dated "Mar 12, 2025". The headline reads "AI-generated paper passes peer review before planned withdrawal". The thumbnail image shows a robotic hand holding a piece of paper with dense text on it.

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**

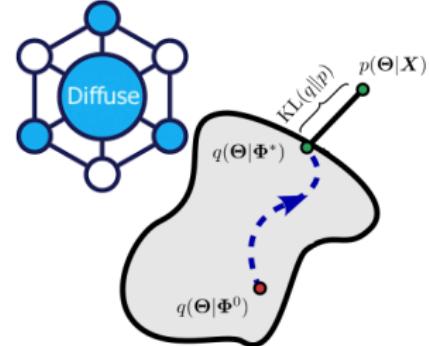
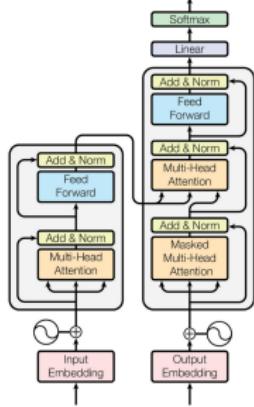
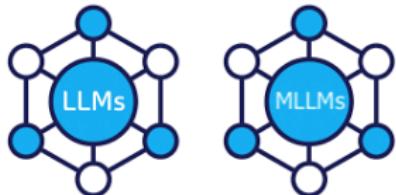
This course deals with these superheros in two respects

- 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 ↵ **Attention:** We don't get into NLP domain!
 - ↳ Context-Aware LMs ↵ 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 ≡ 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!*



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

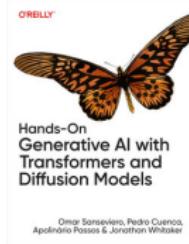
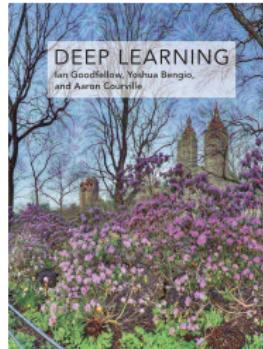
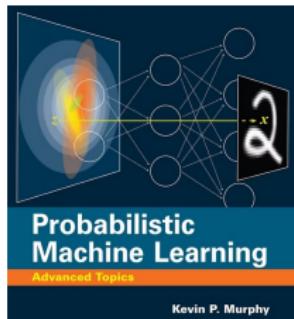
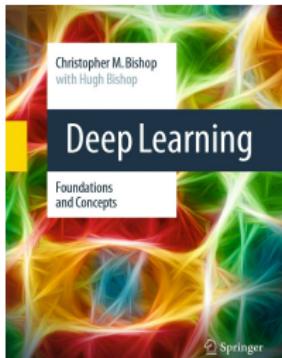
- ↳ a **good understanding** of fundamentals **notions in ML** is needed
- ↳ **basic notions in probability and statistics**

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? ☺