# Course Logistics

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# Course Overview

- This course aims to provide a comprehensive understanding of generative models, and to enhance the ability to implement these models.
- *Generative models* are machine learning methods for learning and synthesizing complex and large-scale data.
- Topics include (i) latent variable models, (ii) statistical distances used to learn distributions, and (iii) advanced applications such as temporal data analysis.
- **Office Hour:** Tuesday 3:00PM-5:00PM at WH C423 or by appointment.

# Lecture Topics

- Preliminary Knowledge
  1. Statistics
  2. Statistical Learning
  3. Python and PyTorch
- Transitions in generative model literature and statistical principles behind them
  1. Linear Method and Auto-regressive Model
  2. Energy-based Model
  3. Variational Autoencoders
  4. Generative Adversarial Networks
  5. Optimal Transport-based Method
  6. Score-based Method
- Implementation Lab (PyTorch)

# Coursework

- **Prerequisites:** There are no specific prerequisite courses. This course covers preliminary knowledge of Statistics, Statistical Learning, and PyTorch, a deep learning programming language.
- **Textbook:** There are no specific textbooks required, but the following may be helpful: Goodfellow, Ian. “Deep learning" (2016); available online for free at https://www.deeplearningbook.org/

# Coursework

- There is **one** group project, **one** personal project, and **four** assignments.
- **Group Project:** Study one of the listed agendas on the broader impacts of generative models:
  1. Introducing AI into peer-reviewing processes (e.g., Pre-peer review screening) (Checco et al., 2021)
  2. Utilizing generative AI for psychotherapy (e.g., helping mourners cope with grief) (Chowdhury, 2024; CBS News, 2024)
  3. Regularizing generative AI research until the establishment of safeguards against misuse (Bengio, 2023; The White House, 2023)

# Coursework

1. *Introducing AI into peer-reviewing processes:* Academia has focused on reducing the burden on peer reviewers while maintaining review quality. Machine learning conferences have strict review deadlines that raise concerns about review quality. Conversely, journals face increased desk-rejection rates and extended review periods.

   Generative models might offer alternatives, such as automating desk-rejections for formatting issues or summarizing submissions for reviewers. Additionally, AI reviewers could be considered when finding human reviewers is challenging. However, there can be concerns about AI's reliability and whether some aspects of peer-reviewing should remain human-led.

# Coursework


Figure: Virtual reality "reunites" a parent with deceased daughter. Ref: Youtube.

2. *Utilizing generative AI for psychotherapy:* Generative models can provide realistic virtual environments, potentially alleviating concerns about the stigma associated with seeking mental health services and offering personalized therapeutic experiences.

# Coursework


Figure: Virtual reality "reunites" a parent with deceased daughter. Ref: Youtube.

- Such experiences might provide relief, but there are concerns about the appropriateness of using such hallucinations in treatment and potential psychological rebounds due to the gap between the seemingly resolved issues in virtual environments and the unresolved realities in the actual world.

# Coursework

3. *Regularizing generative AI research until the establishment of safeguards against misuse:* As generative AIs have demonstrated notable performances, such as synthesizing text and voice indistinguishable from humans, there are growing concerns about their misuse or dangerous applications, such as voice phishing, deep fakes, and rapidly evolving high-performance weapons based on generative models.

   We may regulate AI development until a consensus on misuse prevention is reached. However, concerns about the feasibility of such regulations exist, especially given AI's relevance to national defense and economic power. There are also worries that these rules might widen gaps between entities with advanced generative models and those without, like developing countries. Additionally, it's debatable whether researchers should be responsible for AI's broader impacts.

# Coursework

- The purpose of the group project is to enhance the ability to think and critique agendas at more abstract and broader levels, and to communicate with other peer researchers to build consensus.
- Group members will be designated according to **Assignment I**, which involves writing position papers that present personal stances (pros and cons) on the agendas.
- Each group will study its assigned agenda, reach consensus on stances, present a 20-25 minute presentation on 03/13, and submit group project reports by 03/18.
- The group project report will include 3-4 pages summarizing the study, agreed-upon stances, and potential counterarguments with rebuttals. Additionally, one page per team member will be added for individual comments on the group part. Personal opinions opposing the group's consensus stance are permitted (and encouraged). For example, a report from a three-member team would total 6-7 pages.

# Coursework

- **Personal Project:** Conduct one of the following projects:
  1. Reviewing generative model papers related to students' research interests
  2. Modifying or extending existing theoretical results
  3. Applying existing algorithms to solve new research problems
- Repetitions of previous studies or mere summaries of existing review articles are not accepted.
- Each individual will give a 15-20 minute presentation on 04/22 and 04/24, and submit a 4-6 page personal project report by 05/01.

# Coursework

- **Assignment I:** Write a total of 2-page position papers on all three agendas discussed in the group project narrative (Due: 01/28). For each topic, state your opinion at one of four levels: Strongly Agree, Weakly Agree, Weakly Disagree, or Strongly Disagree.
- **Assignment II & IV:** Solve sets of problems to assess understanding of the main content. Most problems are examples and proofs presented in lectures (Due: 02/27 and 04/15).
- **Assignment III:** Write a review of learned papers and a meta-review of their peer-reviewing processes. Details will be provided later (Due: 04/01).
- Assignments will be graded as Pass or Resubmit (expected to be a rare situation).
- There is **Assignment 0** for preliminary knowledge, but it is neither submitted nor evaluated.

# Coursework

- **Course Evaluation:** Four assignments (10% each), personal project (20% for the presentation plus 20% for the report), and group project (10% for the presentation plus 10% for the report).

# References I

Bengio, Y. (2023). Slowing down development of ai systems passing the turing test. https://yoshuabengio.org/2023/04/05/slowing-down-development-of-ai-systems-passing-the-turing-test/. Accessed: 2024-12-16.

CBS News (2024). Ai grief bots and legacy technology. https://www.cbsnews.com/news/ai-grief-bots-legacy-technology/. Accessed: 2024-12-16.

Checco, A., Bracciale, L., Loreti, P., Pinfield, S., and Bianchi, G. (2021). Ai-assisted peer review. *Humanities and Social Sciences Communications*, 8(1):1–11.

Chowdhury, S. (2024). Managing grief with ai: Emerging evidence and ethical considerations. https://www.linkedin.com/pulse/managing-grief-ai-emerging-evidence-ethical-sibasish-chowdhury-rtdhc. Accessed: 2024-12-16.

# References II

The White House (2023). Executive order on the safe, secure, and trustworthy development and use of artificial intelligence. https://www.federalregister.gov/documents/2023/11/01/2023-24283/safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence. Accessed: 2025-01-21.