CS-770-Generative AI
Fall 2024

Chapman University

Instructor: Arin Ghazarian
Email: arghazarian@chapman.edu
Course Schedule: Tuesday/Thursday 4PM-5:15PM
Course Location:
Virtual Office Hours: Appointment only
Onsite Office Hours: 5:15-6:15 Tuesdays (after class)

Description:

This course provides an overview of generative AI techniques and their application to different tasks such as computer vision and Natural Language Processing. You will learn both the theoretical and practical aspects of generative AI models. Python will be used for the demos and assignments.

Prerequisites

- Linear algebra and statistics, probability, math
- Python programming (Pandas, Sklearn, etc.)
- Machine Learning Basics
- Basics of Neural networks and deep learning

Units: 3

Topics:

1. Introduction and history
2. GMMs and HMMs as a generative model
3. Quick review of Neural Networks
4. VAEs
5. GANs
6. Attention Mechanism in sequence-to-sequence RNN models
7. Transformers, Self Attention, and LLMs
8. LLM Evaluation
    - 8.1. Metrics
    - 8.2. Benchmarks
9. RLHF
10. GPT API
11. Prompt engineering
    - 11.1. Zero, one, few shot
    - 11.2. Chain-of-Thought prompting
    - 11.3. Program-aided Language Models (PALs)
12. Fine Tuning
    - 12.1. Additive: Adapter layers, soft Prompts and prompt tuning

    12.2. Reparametrization: LORA
    12.3. Selective
    12.4. Instruction Fine Tuning: FLAN
13. Model Compression
    13.1. Quantization
    13.2. Knowledge distillation
    13.3. pruning
14. Hugging Face Library, Langchain and RAGs
    14.1. Open Models (LLAMA,BERT, Roberta, BLOOM, Mistral, BioMistral)
    14.2. ReAct
15. ViTs (Vision Transformers), Video Transformers, Multimodal Models
16. Diffusion Models
    16.1. DAll-E 2
17. Distributed Training
    17.1. DDP
    17.2. FSDP
    17.3. ZeRO
18. Responsible and Ethical Generative AI (Optional)
    18.1. Metrics of fairness in AI
    18.2. Toxicity
    18.3. Anti-Hallucination
    18.4. Bias and how to remove it
    18.5. Privacy
    18.6. Constitutional AI
19. MLOPs (Optional)
    19.1. Cloud based Generative AI
    19.2. Github actions, code spaces, copilot
    19.3. Containerization
    19.4. DVC
    19.5. Data distribution Shift
    19.6. MLFlow
    19.7. Model Portability: ONNX
    19.8. Feature stores
    19.9. Vector databases
    19.10. Rust
    19.11. Boltzmann Machine

Course materials

All course materials will be made available via the course site on Canvas when possible. Canvas will be used for all activities including submitting assignments, grading, communications, etc.

Grading

Evaluation Components	**Weight**
Assignments	25% Assignment1=8 % Assignment2=8 % Assignment3=9 %
Final Project	15%
Quizzes	10% The lowest grade will be dropped Quiz1=5% Quiz2=5% Quiz3=5%
Midterm Exam	25%
Final Exam	25%
Total	**100%**

Quizzes

There will be 3 quizzes. The quiz with the lowest grade will be dropped from the final grade calculation for each student.

Assignments

There will be 3 individual assignments.

Exams

There will be a midterm exam before the fall break. The final exam will include the topics covered during the second half of the semester.

Final Project

Each student will work on a final project. In this project, you will apply an advanced generative AI architecture/technique to solve a problem of their own choice. Students will present their work during the last week of the class.

How to Contact the Instructor

The best way to reach me is by email arghazarian@chapman.edu

Diversity and Equality

Chapman University is committed to ensuring equality and valuing diversity. Students and professors are reminded to show respect at all times as outlined in Chapman's Harassment and Discrimination Policy: http://tinyurl.com/CUHarassmentDiscrimination . Any violations of this policy should be discussed with the professor, the Dean of Students and/or otherwise reported in accordance with this policy.

Chapman University's Academic Integrity Policy

"Chapman University is a community of scholars that emphasizes the mutual responsibility of all members to seek knowledge honestly and in good faith. Students are responsible for doing their own work and academic dishonesty of any kind will be subject to sanction by the instructor/administrator and referral to the university Academic Integrity Committee, which may impose additional sanctions including expulsion. Please see the full description of Chapman University's policy on Academic Integrity at http://www.chapman.edu/academics/academicintegrity/index.aspx. "

Chapman University's Students with Disabilities Policy

"In compliance with ADA guidelines, students who have any condition, either permanent or temporary, that might affect their ability to perform in this class are encouraged to contact the Disability Services Office. If you will need to utilize your approved accommodations in this class, please follow the proper notification procedure for informing your professor(s). This notification process must occur more than a week before any accommodation can be utilized. Please contact Disability Services at (714) 516–4520 or visit:
http://www.chapman.edu/students/student-health-services/disabilityservices
if you have questions regarding this procedure or for information or to make an appointment to discuss and/or request potential accommodations based on documentation of your disability. Once formal approval of your need for an accommodation has been granted, you are encouraged to talk with your professor(s) about your accommodation options. The granting of any

accommodation will not be retroactive and cannot jeopardize the academic standards or integrity of the course."

Student Support at Chapman University

Over the course of the semester, you may experience a range of challenges that interfere with your learning, such as problems with friends, family, and other relationships; substance use; concerns about personal adequacy; feeling overwhelmed; or feeling sad or anxious without knowing why. These mental health concerns or stressful events may diminish your academic performance and/or reduce your ability to participate in daily activities. You can learn more about the resources available through Chapman University's Student Psychological Counseling Services here:
https://www.chapman.edu/students/health-and-safety/psychological-counseling/.
Fostering a community of care that supports the success of students is essential to the values of Chapman University. Occasionally, you may come across a student whose personal behavior concerns or worries you, either for the student's well-being or yours. In these instances, you are encouraged to contact the Chapman University Student Concern Intervention Team who can respond to these concerns and offer assistance:
https://www.chapman.edu/students/health-and-safety/student-concern/index.aspx . While it is preferred that you include your contact information so this team can follow up with you, you can submit a report.