Master Course Description for EE-517

Title: Introduction to Large Language Models

Credits: 3

Course Catalog Entry:

EE 517: Introduction to Large Language Models is an introduction to the principles, theoretical foundations, and applications of large language models (LLMs) with a focus on electrical and computer engineering contexts. Topics include architecture design, training and fine-tuning methods, evaluation metrics, information-theoretic and scaling law analyses, ethical considerations, and applications to engineering domains. Prerequisites: EE 344 or EE 345 or equivalent class in machine learning, and EE 241 or CSE 163b or equivalent class in python.

Coordinator: Banghua Zhu, Assistant Professor of Electrical and Computer Engineering

Goals

To provide students with a foundational understanding of large language models, including their architecture, training methods, and applications, with an emphasis on engineering-related tasks. To equip students with practical skills for working with LLMs and prepare them for advanced research or industry roles in electrical and computer engineering and generative AI.

Learning Objectives

At the end of this course, students will be able to:

1. Explain the key components of large language models.
2. Describe how LLMs are trained, fine-tuned, and adapted to specific tasks.
3. Implement and experiment with pre-trained LLMs using modern frameworks.
4. Evaluate the performance and limitations of LLMs using established benchmarks.
5. Understand the information-theoretic perspectives of LLMs.
6. Identify and analyze ethical concerns related to bias, fairness, and misinformation in LLMs.
7. Apply LLMs to real-world tasks such as document AI, agentic tasks, and other engineering domains.

Textbook

No single textbook; course materials will be drawn from research papers, online resources, and instructor-provided notes.

Prerequisites by Topic

1. Fundamentals of machine learning and deep learning.
2. Linear algebra, probability, and optimization.

3. Proficiency in Python.

Prerequisites by Course

1. Machine Learning: EE 344 or EE 345 or equivalent.
2. Python: EE 241 or CSE 163 or equivalent.

Topics

1. Introduction to language models and self-supervised learning.
2. The transformer architecture and self-attention mechanism.
3. Pre-training, fine-tuning, and prompt engineering.
4. Optimization methods for pre-training and post-training.
5. Evaluation metrics and benchmarking for LLMs.
6. Information-theoretic perspectives, scaling laws and emergent properties of large models.
7. Efficiency techniques (quantization, distillation, retrieval-augmented generation).
8. Applications: text generation, translation, summarization, question-answering, coding assistants.
9. Ethical considerations: bias, fairness, misinformation, and environmental impact.
10. LLM deployment and real-world considerations.
11. Future directions and open challenges in LLM research for electrical and computer engineering applications.

Course Structure

Class meets twice per week for 80-minute lectures. The grading scheme in any particular offering is the prerogative of the instructor. Homework assignments include conceptual, coding exercises and a final project. The project topics could include literature review, exploration on pre-training, post-training, agent applications, development of new evaluation benchmarks and contribution to existing LLM systems / open source projects.

Grading

- Homework (30%)
- Course project (60%)
- In-class team exercises (10%)

Computer Resources

Students will require access to GPUs for assignments and projects. Cloud-based or department-provided resources will be available.

Laboratory Resources

Not required.

Religious Accommodations Policy

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious

Accommodations Policy. Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form.

Accommodations and Access

If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or disability.uw.edu. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between the student, instructor, and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

Academic Integrity

Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, adhere to the College of Engineering Statement of Principles. Any student in this course suspected of academic misconduct (e.g., cheating, plagiarism, or falsification) will be reported to the College of Engineering Dean's Office and the University's Office of Community Standards and Student Conduct to initiate the student conduct process.

Title IX

UW, through numerous policies, prohibits sex- and gender-based violence and harassment, and we expect students, faculty, and staff to act professionally and respectfully in all work, learning, and research environments. For support, resources, and reporting options related to sex- and gender-based violence or harassment, visit UW Title IX's webpage (https://www.washington.edu/titleix/), specifically the Know Your Rights & Resources guide (https://www.washington.edu/titleix/files/2020/08/KYRR-guide-8-10-2020-LINKED.pdf).

If you choose to disclose information to me about sex- or gender-based violence or harassment, I will connect you (or the person who experienced the conduct) with resources and individuals who can best provide support and options. You can also access those resources directly:

- Confidential: Confidential advocates (https://www.washington.edu/sexualassault/support/advocacy/) will not share information with others unless given express permission by the person who has experienced the harm or when required by law.
- Private and/or anonymous: SafeCampus (https://www.washington.edu/safecampus/) provides consultation and support and can connect you with additional resources if you want them. You can contact SafeCampus anonymously or share limited information when you call

Please note that some senior leaders and other specified employees have been identified as "Officials Required to Report." (https://www.washington.edu/titleix/title-ix-officials-required-to-report/) If an Official Required to Report learns of possible sex- or gender-based violence or harassment, they are required to call SafeCampus and report all the details they have in order to ensure that the person who

experienced harm is offered support and reporting options (https://www.washington.edu/titleix/resources/)."

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