INFO 7375
Prompt Engineering for Generative AI
Course Syllabus

Course Information

Professor: Nik Bear Brown
Email: ni.brown@neu.edu
Office: 505A Dana Hall
Office hours:
Through Zoom by Appointment

Note: I am also a master's student at Northeastern. Do not send e-mail to my student e-mail brown.ni@husky.neu.edu as I almost never read that e-mail.

All classes will be held on ground in Boston.

Course website: Canvas

Course Prerequisites

Python programming. A commitment to do independent research.

Course Description

Welcome to the world of Prompt Engineering and Fine-Tuning for Generative AI with Large Language Models (LLMs), where we delve deep into the art and science of crafting prompts that drive LLMs to create captivating and context-aware content. In this comprehensive course, you'll not only master the essential techniques for effective prompt engineering but also gain expertise in the fine-tuning and configuration of LLMs. This dual skill set will empower you to harness the full potential of AI-driven creativity and problem-solving across a wide range of domains.

Course Highlights

Prompt Engineering Mastery: Learn the principles of creating prompts that elicit desired responses from LLMs, whether you're generating text, code, or creative content.

Fine-Tuning Expertise: Explore the intricate process of fine-tuning LLMs, optimizing them for specific tasks, domains, and applications.

Real-World Applications: Apply your skills to real-world scenarios, from content creation and decision support to interactive media and beyond.

Ethical Considerations: Discuss the ethical implications of AI-generated content and responsible AI usage in media production.

Hands-On Experience: Engage in practical exercises, assignments, and projects to reinforce your learning and gain practical experience in prompt engineering and LLM fine-tuning.

By the end of this course, you will not only be proficient in the art of prompt engineering for generative AI but also equipped with the skills to configure and fine-tune LLMs, enabling you to unleash the power of AI-driven creativity and problem-solving across diverse domains. Join us on this transformative journey into the realm of AI-driven creativity and problem-solving.

Learning Objectives

Module 1: Introduction to LLMs and Prompting

- Unveiling Large Language Models (LLMs): Their capabilities, use cases, and historical context.
- Understanding randomness in LLM output and setting the stage for effective prompt engineering.
- Creating Your First Prompts: A hands-on initiation into the world of AI-powered content generation.

Module 2: The Art of Prompt Engineering

- Deciphering the Essence of a Prompt: What is a prompt, and how can it be tailored to your needs?
- Exploring Prompt Patterns: Unraveling the Persona Pattern, Question Refinement Pattern, Cognitive Verifier Pattern, Audience Persona Pattern, and more.
- Applying Prompt Patterns: Crafting prompts for various scenarios, including Few-shot Examples, Chain of Thought Prompting, and Game Play Patterns.

Module 3: Fine-Tuning and Configuring LLMs

- Pre-training Large Language Models: Unpacking the computational challenges, scaling laws, and domain-specific training.
- Instruction Fine-Tuning: Mastering single and multi-task instruction fine-tuning, scaling instruct models, and evaluating model performance.
- Reinforcement Learning and LLM-Powered Applications: Aligning models with human values, obtaining feedback, and optimizing for deployment.

Module 4: Beyond the Basics

- Interacting with External Applications: Integrating LLMs into real-world scenarios and applications.

- Program-Aided Language Models (PAL): Enhancing reasoning and action with LLMs.
- Model Application Architectures: Exploring advanced architectures for deploying LLMs in practical projects.

Weekly Schedule

Week 1: Introduction to Large Language Models

What are Large Language Models?
Randomness in Output
Creating Your First Prompts
What is a Prompt?
Prompt Patterns
The Persona Pattern
Reading a Prompt Pattern
Format of the Persona Pattern
Learn More About Prompt Patterns
Introducing New Information to the Large Language Model
Prompt Size Limitations

Week 2: Advanced Prompt Techniques

Prompts are a Tool for Repeated Use
Root Prompts
Question Refinement Pattern
Format of the Question Refinement Pattern
Cognitive Verifier Pattern
Format of the Cognitive Verifier Pattern
Audience Persona Pattern
Format of the Audience Persona Pattern
Flipped Interaction Pattern
Format of the Flipped Interaction Pattern
Applying Prompt Patterns I
Few-shot Examples
Few-shot Examples for Actions
Few-Shot Examples with Intermediate Steps
Writing Effective Few-Shot Examples

Week 3: Advanced Prompt Techniques Continued

Chain of Thought Prompting
ReAct Prompting
Using Large Language Models to Grade Each Other
Applying Few-Shot Examples Concepts
Game Play Pattern
Format of the Game Play Pattern

Template Pattern
Format of the Template Pattern
Meta Language Creation Pattern
Format of the Meta Language Creation Pattern
Recipe Pattern
Format of the Recipe Pattern
Alternative Approaches Pattern
Format of the Alternative Approaches Pattern
Ask for Input Pattern
Combining Patterns

Week 4: Further Prompt Techniques

Outline Expansion Pattern
Format of the Outline Expansion Pattern
Menu Actions Pattern
Format of the Menu Actions Pattern
Fact Check List Pattern
Format of the Fact Check List Pattern
Tail Generation Pattern
Format of the Tail Generation Pattern
Semantic Filter Pattern
Format of the Semantic Filter Pattern

Week 5: Understanding Large Language Models

Generative AI & LLMs
LLM use cases and tasks
Text generation before transformers
Transformers architecture
Generating text with transformers
Transformers: Attention is all you need
Prompting and prompt engineering
Generative configuration
Generative AI project lifecycle

Weeks 6 & 7: Training and Pre-training LLMs

Pre-training large language models
Computational challenges of training LLMs
Efficient multi-GPU compute strategies
Scaling laws and compute-optimal models
Pre-training for domain adaptation
Domain-specific training: BearBrownGPT

Weeks 8 & 9: Fine-tuning and Evaluation

Instruction fine-tuning

Fine-tuning on a single task
Multi-task instruction fine-tuning
Scaling instruct models
Model evaluation
Benchmarks
Parameter efficient fine-tuning (PEFT)
PEFT techniques 1: LoRA
PEFT techniques 2: Soft prompts

Weeks 10 & 11: Reinforcement Learning and LLM Applications

Reinforcement learning and LLM-powered applications
Aligning models with human values
Reinforcement learning from human feedback (RLHF)
RLHF: Obtaining feedback from humans
RLHF: Reward model
RLHF: Fine-tuning with reinforcement learning
Optional video: Proximal policy optimization
RLHF: Reward hacking
KL divergence
Scaling human feedback

Weeks 12 & 13: Deployment and Advanced Topics

Model optimizations for deployment
Generative AI Project Lifecycle Cheat Sheet
Using the LLM in applications
Interacting with external applications
Helping LLMs reason and plan with chain-of-thought
Program-aided language models (PAL)
ReAct: Combining reasoning and action
ReAct: Reasoning and action
LLM application architectures

Course Materials

Textbook

Title: "Prompt Engineering for Generative AI" by Nik Bear Brown (Free Online)
Publisher: Abecedarian, LLC
Publication Date: January 2023
ISBN: [ISBN]

Additional Readings

In addition to the textbook, you will also engage with academic papers, AI research reports, and articles specifically related to prompt engineering and fine-tuning techniques in prompt engineering and Generative AI.

By the end of this course, you will not only be proficient in prompt engineering for prompt engineering and Generative AI but also equipped with the skills to fine-tune LLMs, enabling you to harness the power of AI-driven creativity and problem-solving across diverse domains. Join us on this transformative journey into the realm of AI-driven content generation.

Course GitHub

The course GitHub (for all lectures, assignments and projects):

https://github.com/nikbearbrown/CSYE_7270

nikbearbrown YouTube channel

Over the course of the semester I'll be making and putting additional data science and machine learning related video's on my YouTube channel.

https://www.youtube.com/user/nikbearbrown

The purpose of these videos is to put additional advanced content as well as supplemental content to provide additional coverage of the material in the course. Suggestions for topics for additional videos are always welcome.

Teaching assistants

The Teaching assistants are:

Tanmay Dilip Zope <zope.t@northeastern.edu>

Programming questions should first go to the TA's. If they can't answer them then the TA's will forward the questions to the Professor.

Learning Assessment

Achievement of learning outcomes will be assessed and graded through:

● Quizzes

● Exams
● Completion of assignments
● Completion of term projects
● Partidipcation (Counts as a 100 point assingment) the TAs will keep track of meaningful contributions to the class and give a score between 0-100 at the end of finals.
● ATTENDANCE (Counts as a 100 point assingment) the TAs will keep track of whether you are in class Zoom attendance does not count as .attendance.

Reaching out for help

A student can always reach out for help to the Professor, Nik Bear Brown ni.brown@neu.edu. In an online course, it's important that a student reaches out early should he/she run into any issues.

Grading Policies

A point system is used. Everything that you are expected to turn in has points. Points can range from 1 point to 1000 points Assignments get a 10% deduction for each day they are late rounded up. Exams cannot be made up unless arraignments are made before the exam.

I expect to use the following as a rough grading scale at the end of the semester. You should not expect a curve to be applied; but I reserve the right to use one. The curve may go up or down. That is it is possible for a 95 to be an A-.

Score	Grade
93 – 100	A
90 – 92	A-
88 – 89	B+
83 – 87	B
80 – 82	B-
78 – 79	C+
73 – 77	C
70 – 72	C-
60 – 69	D
<60	F

Scores in-between grades. For example, 82.5 or 92.3 will be decided based on the exams.

* Note the score is calculated using the grading rubric and IS NOT the average of the assignments that is displayed by Canvas.

There will be two major projects due near the end of the semester worth approximately 50% of the total grade. A VFX assignment in Houdini and a game/real-time 3D assignment in either Unreal Engine or Unity 3D.

Canvas

You will submit your assignments via Canvas _and_ Github. Click the title of assignment (Canvas -> assignment -> <Title of Assignment>), to go to the submission page. You will know your score on an assignment, project or test via Canvas. Canvas only represents only the raw scores. Not normalized or curved grades. A jupyter notebook file ALONG with either a .DOC or .PDF rendering of that jupyter notebook file must be submitted with each assignment.

_Your name MUST be part of your submission, for example Sanchez_Rick_Assignment_1.zip_

Multiple files must be zipped. No .RAR, .bz, .7z or other extensions.

Assignment file names MUST start with students last name then first name OR the groups name and include the class number and assignment number.

Assignment MUST estimate the percentage of code written by the student and that which came from external sources.

Assignment MUST specify a license at the bottom of each notebook turned in.

All code must adhere to a style guide and state which guide was used.

Due dates

Due dates for assignments at midnight on due date of the assignment.

Five percent (i.e. 5%) is deducted for each day an assignment is late. Solutions will be posted the following Monday. Assignments will receive NO CREDIT if submitted after the solutions are posted. Any extensions MUST be granted via e-mail and with a specific new due date.

Course Materials

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Participation Policy

Participation in discussions is an important aspect on the class. It is important that both students and instructional staff help foster an environment in which students feel safe asking questions, posing their opinions, and sharing their work for critique. If at any time you feel this environment is being threatened—by other students, the TA, or the professor—speak up and make your concerns heard. If you feel uncomfortable broaching this topic with the professor, you should feel free to voice your concerns to the Dean's office.

Collaboration Policies

Students are strongly encouraged to collaborate through discussing strategies for completing assignments, talking about the readings before class, and studying for the exams. However, all work that you turn in to me with your name on it must be in your own words or coded in your own style. Directly copied code or text from any other source MUST be cited. In any case, you must write up your solutions, in your own words. Furthermore, if you did collaborate on any problem, you must clearly list all of the collaborators in your submission. Handing in the same work for more than one course without explicit permission is forbidden.

Feel free to discuss general strategies, but any written work or code should be your own, in your own words/style. If you have collaborated on ideas leading up to the final solution, give each other credit on what you turn in, clearly labeling who contributed what ideas. Individuals should be able to explain the function of every aspect of group-produced work. Not understanding what plagiarism is does not constitute an excuse for committing it. You should familiarize yourself with the University's policies on academic dishonesty at the beginning of the semester. If you have any doubts whatsoever about whether you are breaking the rules – ask!

Any submitted work violating the collaboration policies WILL BE GIVEN A ZERO even if "by mistake." Multiple mistakes *will be sent to OSCCR for disciplinary review.*

To reiterate: **plagiarism and cheating are strictly forbidden. No excuses, no exceptions***. All incidents of plagiarism and cheating will be sent to OSCCR for disciplinary review.*

Assignment Late Policy

Assignments are due by 11:59pm on the due date marked on the schedule. It is your responsibility to determine whether or not it is worth spending the extra time on an assignment vs. turning in incomplete work for partial credit without penalty. Any exceptions to this policy (e.g. long-term illness or family emergencies) must be approved by the professor.

Assignments will receive NO CREDIT if submitted after the solutions are posted. Any extensions MUST be granted via e-mail and with a specific new due date.

Only ONE extension will be granted per semester.

Student Resources

Special Accommodations/ADA: In accordance with the Americans with Disabilities Act (ADA 1990), Northeastern University seeks to provide equal access to its programs, services, and activities. If you will need accommodations in this class, please contact the Disability Resource Center (www.northeastern.edu/drc/) *as soon as possible* to make appropriate arrangements, and please provide the course instructors with any necessary documentation. The University requires that you provide documentation of your disabilities to the DRC so that they may identify what accommodations are required, and arrange with the instructor to provide those on your behalf, as needed.

Academic Integrity: All students must adhere to the university's Academic Integrity Policy, which can be found on the website of the Office of Student Conduct and Conflict Resolution (OSCCR), at http://www.northeastern.edu/osccr/academicintegrity/index.html. Please be particularly aware of the policy regarding plagiarism. As you probably know, plagiarism involves *representing anyone else's words or ideas as your own*. It doesn't matter where you got these ideas—from a book, on the web, from a fellow-student, from your mother. It doesn't matter whether you quote the source directly or paraphrase it; if you are not the originator of the words or ideas, *you must state clearly and specifically where they came from*. Please consult an instructor if you have any confusion or concerns when preparing any of the assignments so that together. You can also consult the guide "Avoiding Plagiarism" on the NU Library Website at http://www.lib.neu.edu/online_research/help/avoiding_plagiarism/. If an academic integrity concern arises, one of the instructors will speak with you about it; if the discussion does not resolve the concern, we will refer the matter to OSCCR.

Writing Center: The Northeastern University Writing Center, housed in the Department of English within the College of Social Sciences and Humanities, is open to any member of the Northeastern community and exists to help any level writer, from any academic discipline, become a better writer. You can book face-to-face, online, or same day appointments in two locations: 412 Holmes Hall and 136 Snell Library (behind Argo Tea). For more information or to book an appointment, please visit http://www.northeastern.edu/writingcenter/.