DADS 7305 - Machine Learning Operations (MLOps)

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Course Description

Focuses on the integration of machine learning with production-level infrastructure, emphasizing the full lifecycle of model development, deployment, and monitoring. Highlights tools and best practices for scalable, reproducible, and automated ML operations. Covers continuous integration and delivery (CI/CD), containerization, orchestration, experiment tracking, and automated retraining using platforms such as TFX, MLflow, Airflow, Docker, Kubernetes, and Google Cloud Platform (GCP).

Prerequisites

- any of these courses: IE 7300, CS 6120 , CS 6140, CS 6180, CS 6220,CS 7140, CS 7150 with a minimum grade of C

Course Objectives

Upon completion of this course, students will be able to:

1. Explain the core principles and goals of MLOps, including reproducibility, automation, and scalability.
2. Develop and manage ML pipelines for model training, validation, and deployment.
3. Containerize ML models using Docker and orchestrate them with Kubernetes.
4. Monitor ML models in production, detect drift, and configure alerting systems.
5. Implement CI/CD workflows for ML using GitHub Actions, Jenkins, and Airflow.
6. Address compliance, governance, and security challenges in ML production environments.
7. Apply MLOps tools and techniques to deploy scalable, cloud-based ML systems.

Weekly Syllabus

Week	Topic	Description
1	Introduction to MLOps	Overview of MLOps, objectives, and key principles.
2, 3, 4, 5	Data Management	Data versioning, quality validation, and pipeline automation.
6, 7	Model Development	Experiment tracking, model validation, and hyperparameter tuning.
8, 9	Deployment Strategies	Containerization, orchestration with Kubernetes, and CI/CD for ML.
10, 11	Model Monitoring	Performance metrics, drift detection, and alerting.
12	Scaling ML Systems	Distributed training, cloud services, and cost optimization.
13	Security and Compliance	ML security best practices, governance, and ethical considerations.
14	Final Project Review	Project implementation, deployment, and presentation.

Course Evaluation

- **Labs Assignments:** 10%
- **Attendance:** 10%
- **Final Project:** 80% (Scoping - 10%, Data Pipeline - 20%, Model Pipeline - 25%, Deployment - 25%)

Lab Submission Requirements

Each student is required to complete and submit **six (6) labs** during the semester, chosen from the list of available labs in the course GitHub repository. Please follow the guidelines below:

1. **One Lab per Topic**
   You may submit only one lab per topic. For example, if you choose to complete a lab on *GitHub Actions*, you cannot submit another lab on that same topic.
2. **Follow Course Progression**
   Labs must be submitted in the order of the class content. This means you may only submit labs on topics that have already been covered in class. Labs on topics not yet discussed will not be accepted.
3. **Student Choice**
   You may choose any six labs, as long as they meet the above criteria and are selected from the official list in the course GitHub repository.

Attendance Policy

Attendance is **mandatory** for this course. Students are expected to attend and actively participate in all scheduled class sessions.

You may not miss more than **five (5) sessions** during the entire semester. Exceeding this limit may result in a reduction of your final grade or failure of the course, depending on the circumstances and instructor discretion.

Grading Scale

Grade	Percentage
A	100 – 94
A-	94 – 88
B+	88 – 82
B	82 – 76
B-	76 – 70
C+	70 – 64
C	64 – 58
C-	58 – 52
F	< 52

Table 2: Grading Scale

Software Requirements

Python >= 3.8, TensorFlow Extended (TFX), MLflow, Kubernetes, Docker, Airflow.

MLOps Innovation Expo

The **MLOps Innovation Expo** is a capstone event held at the end of each semester, where student teams present and demonstrate their production-grade ML systems in a public showcase. This event simulates a real-world product demo environment and is designed to:

- Provide a platform for students to communicate technical results to a broader audience, including industry experts, faculty, and peers.
- Celebrate the completion of a full MLOps lifecycle—from data ingestion and model training to deployment, monitoring, and CI/CD integration.
- Encourage students to receive feedback from external mentors and stakeholders, including judges from Google and other industry partners.
- Build students' confidence and skills in deploying and maintaining reliable, observable, and scalable ML services.

Each team is expected to present:

- A live demo of their deployed ML system (e.g., hosted on GCP with real-time telemetry)
- A technical walkthrough of the architecture, pipelines, and infrastructure
- Monitoring dashboards showing model performance, alerts, and retraining triggers
- CI/CD setup and deployment artifacts

Participation in the Expo is a required component of the final project grade, and performance will be assessed based on:

- Technical completeness and correctness
- System scalability, observability, and reproducibility
- Team collaboration and presentation clarity
- Innovation and relevance of the ML solution

Industry guests, Northeastern faculty, and partners from Google Cloud will be invited to attend the Expo, provide feedback, and evaluate selected projects for potential recognition and awards.

Academic Honesty

Plagiarism, cheating, and any form of unauthorized collaboration are strictly prohibited and will be handled in accordance with University policies as outlined in the Student Handbook. Penalties for academic dishonesty may include, but are not limited to, receiving zero credit on the assignment, being placed on probation, having judicial findings recorded in the student's permanent record, and risking the student's status in the Engineering Program. Acts of academic dishonesty will be referred to OSCCR (Office of Student Conduct and Conflict Resolution). Visit Northeastern University Academic Integrity Policy for additional information on the University's academic integrity policy.

Student Accommodations

Northeastern University and the Disability Resource Center (DRC) are committed to providing disability services that enable students who qualify under Section 504 of the Rehabilitation Act and the Americans with Disabilities Act Amendments Act (ADAAA) to participate fully in the activities of the university. To receive accommodations through the DRC, students must provide appropriate documentation that demonstrates a current, substantially limiting disability. For more information, visit the Northeastern DRC website.

Diversity and Inclusion

Northeastern University is committed to equal opportunity, affirmative action, diversity, and social justice while building a climate of inclusion on and beyond campus. In the classroom, members of the University community work to cultivate an inclusive environment that denounces discrimination through innovation, collaboration, and an awareness of global perspectives on social justice.
It is my intention that students from all backgrounds and perspectives will be well served by this course, and that the diversity students bring to this class will be viewed as an asset. I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, socioeconomic backgrounds, family education levels, abilities – and other visible and nonvisible differences.

All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class. Your suggestions are encouraged and appreciated.
Please visit the Northeastern University Diversity and Inclusion website for complete information on Diversity and Inclusion.

Title IX

Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender identity, in educational programs and activities that receive federal financial assistance. Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. This policy applies to the entire community, including male, female, and transgender students, as well as faculty and staff.
In case of an emergency, please call 911. For a complete list of reporting options and resources available both on- and off-campus, please visit the Northeastern Title IX website.

Guest Lecturers

- TBD

Contact

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- TAs Contact: TBD
- Github Repository