# Concordia University
# SOEN 691 – Engineering AI-based Software Systems
# Fall 2024
# Course Outline

| Section | Instructor | E-mail | Office |
|---|---|---|---|
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## Background

The field of Artificial Intelligence (AI) has seen significant demand and growth due to the recent explosion in datasets and breakthroughs in Machine Learning (ML) such as deep learning and reinforcement learning. Many organizations are leveraging the benefits of AI in real-world applications across numerous domains such as healthcare, finance, retail, security, and education.

The development, deployment and servicing of AI-based systems requires specialized training since such systems tend to have fundamental differences compared to traditional software systems. For example, traditional software systems are written to implement a specific behaviour that is expected of the system, whereas, AI-based systems infer their behaviour from training data. In such cases, technical aspects such as debugging if something is wrong becomes much harder since there is no 'expected output'. The goal of the course is to provide graduate students with the basic and fundamental technical background while exercising SE concepts in the context of an AI-based software system.

## Reference Material

The course reference textbook for the course is:

1. Building Intelligent Systems: A Guide to Machine Learning Engineering, 2018. Geoff Hulten

Also, reading materials (i.e., research papers) will be assigned and provided.

## Course Outline

This course introduces key concepts related to the engineering of AI-based software systems. Topics include requirements and architectures of AI-based software systems, data validation and management, model selection, quality assurance, deployment and continuous delivery of AI-based software systems. Additionally, special topics on interpreting and monitoring models, and operations in large-scale AI-based system will be included. A course project involving a real-world open source AI-based software system will be required.

A tentative list of the topics that will be covered in this course is given in the tentative schedule section at the end of this document.

## Web Page

Many resources for the course (lecture slides, assigned readings, example projects, etc.) will be available on the course Moodle page.

## Class Participation

Students are expected to attend **all** classes. In each class, we will have discussions based on the assigned readings. Students are expected to participate and **make meaningful contributions** to these discussions.

## Paper Critiques

We will have two assigned research papers (or chapters) on most weeks. Each student is expected to send a critique of one of the papers that are being presented. The critique should include **a brief summary of the paper, at least three strengths of the paper and at least three weaknesses of the paper**. For the other paper, each student is required to submit a summary of the paper. The critiques and paper summaries are due at noon on Mondays. The paper critiques will be graded in detail.

## Research Proposal and Project

A large portion of the course deliverables is a course research project. You are expected to work on the course project in groups. Each group is expected to write a research paper by the end of the semester. The topic is to be determined with the instructor. Examples include a new contribution on a specific related topic, a survey paper of a related topic (typically involves surveying 30 – 60 papers), or building a tool to support the engineering of AI-based software systems.

**The first deliverable of the course project is a project proposal**. The project proposal should be 3 pages in length (plus references). The project proposal should be submitted by the end of week 6. A project progress presentation will be held in week 6. The final project will be presented in week 12 and the final project report (10 pages in length) should be submitted by the end of week 12. The final submission is expected to be of publishable quality. All project-related documents (i.e., project proposal and project report) should use the IEEE conference publication format.

If the paper is deemed publishable, the instructor will work with the students to make appropriate changes to the final report and submit the paper for publication.

## Evaluation Scheme

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|---|---|
| Class participation | 10% |
| Paper critiques & activities | 20% |
| Project proposal | 10% |
| Research project | 40% |
| Quizzes and exams | 20% |

1. You must pass the quizzes and the course project to pass the course.
2. There is no standard relationship between percentages and letter grades assigned.
3. All students should become familiar with the University's Code of Conduct located at https://www.concordia.ca/conduct/academic-integrity.html In cases where cheating or plagiarism is suspected, the case will be forwarded directly to the appropriate university office.

## Tentative Schedule

The table below provides a summary of the material that will be covered during the course as well as a *tentative* schedule. Please check the course web page for any changes.

| Week | Date | Topic |
|---|---|---|
| 1 | Sep. 3 | Introduction & overview |
| 2 | Sep. 10 | AI for Software Engineers |
| 3 | Sep. 17 | Software requirements and architectures for AI-based systems |
| 4 | Sep. 24 | Data validation and management |
| 5 | Oct. 1 | Interpretation vs. Explanation |
| 6 | Oct. 8 | **Project updates (student presentations)** |
| 7 | Oct. 22 | Deployment and testing (MLOps) – Dr. Adams |
| 8 | Oct. 29 | Technical Debt in AI-based systems |
| 9 | Nov. 5 | LLMs in AI-based systems |
| 10 | Nov. 12 | Continuous delivery – Dr. Mujahid |
| 11 | Nov. 19 | **Quiz** |
| 12 | Nov. 26 | **Project presentations (student presentations)** |