Course Outline (November 2025)

Course Title and Code: **Machine Learning Deployment - ANA 680**

Course Prerequisites: ANA 675

Software/tools/cloud: **Open-source software and tools: Git/GitHub, FLASK web application framework, Jupyter notebook (Anaconda distribution, Google Colab), Heroku cloud platform account (about $5 per month, Docker containers and Docker Hub registry, AWS cloud services account (free for first time users).**

Suggested Textbook: There is not a single required textbook for this course. Readings in the class are assigned from selected chapters from multiple textbooks and Internet resources. All textbooks are available in digital form at NU library under O'Reilly textbooks.

1. **Gift. N and Deza. A. (2021).** ***Practical MLOps: Operationalizing Machine Learning Models.*** **1st edition. O'Reilly Media.**
2. **Mark Treveil, et al. (2021).** ***Introducing MLOps: How to Scale Machine Learning in the Enterprise.*** **1st edition, O'Reilly Media.**
3. ***Pramod Singh (2021). Deploy Machine Learning Models to Production: With Flask, Streamlit, Docker, and Kubernetes on Google Cloud Platform. 1st edition, Published by Apress.***
4. **Mark Treveil, et al. (2021).** ***Introducing MLOps: How to Scale Machine Learning in the Enterprise.*** **1st edition, O'Reilly Media.**
5. ***Gears. C (2022). Docker Fundamentals for Beginners. Packet publishing.***
6. **Emmanuel Raj (2021).** ***Engineering MLOps (O'Reilly).*** **Supplemental Textbook:**

To access O'Reilly books in the library. Login to your NU account, then go to the site: http://nu.libguides.com/oreilly

*You are encouraged to utilize any software, cloud service, or tools for your assignments and projects by providing justification for your choices. While we recommend certain software and tools for various stages of the machine learning lifecycle, you have the freedom to select the most appropriate tools for each stage.

Course Description: Examine all stages of Machine Learning (ML) application development lifecycle and the role of DevOps/MLOps in construction and deployment of ML applications in production. A study of the processes, tools and cloud services for continuous integration, delivery, deployment, and monitoring of ML models in production. Exposure to ML model optimizing for a variety of applications in industry.

Course Learning Outcomes:

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

2. Investigate the components of the ML lifecycle.
3. Compare and contrast ML deployment methods.
4. Deploy a ML model in the cloud.
5. Optimize the performance of the deployed model.

Material covered in this course also develops the following Program Learning Outcomes (PLOs):

PLO1: Use Python for AI and machine learning applications in data science

PLO2: Explore optimization methods and algorithms.

PLO3: Evaluate neural networks and deep learning models.

PLO4: Deploy machine learning models in the cloud.

Course Schedule, Topics, and Assignments:

In addition to successfully achieving the learning outcomes, students are expected to participate in all class activities, complete exams as scheduled, and turn in all assignments on time. Failure to do so will result in the loss of points.

All assignments for the week are due by MIDNIGHT SUNDAY Pacific Time. **Late submissions:** For each day after the due date the grade will be reduced by 10%. No assignments will be accepted after solutions have been posted, or after the assignment has been discussed in class or grades posted.

Week 1	**Topics/readings and chat schedules** **Module 1**: Machine Learning model training Lifecycle • ML Foundations and Lifecycle (PPT slides) • ML Operations MLOps and Workflows (PPT slides) • Machine Learning Modeling Algorithms (PPT slides) Online Class in Zoom 1: Tuesday, October 28, 4:30- 5:30 pm (PST) Introduction, review tools to be used in the class. Review ML lifecycle and activity 1. Online Class in Zoom 2: Thursday, October 30, 4:30- 5:30 pm (PST) ML algorithms and MLOps	**Tasks and Assignments** • Introduction to class • Read through PPT slides. • Complete Activity 1 • Respond to Discussions • Attend online class sessions in Zoom • Complete and submit week's assignment(s) • Take week 1 quiz **(will open on weekend)** **(Due Date:November 2)**
Week 2	**Module 2**: Deployment and Automation in ML pipelines • ML Production Deployment (PPT slides) • ML Model Deployment with FLASK APIs (PPT slides) • Continuous Integration and Deployment (PPT slides) Online Class in Zoom 1: Tuesday, November 4, 4:30- 5:30 pm (PST) Review of Git and GitHub Introductory HTML and FLASK Deployment to Heroku Online Class in Zoom 2: Thursday, November 6, 4:30- 5:30 pm (PST) FLASK/Heroku Continuous Integration and Deployment	• Read through PPT slides. • Complete Activities • Respond to Discussions • Attend online class sessions in Zoom • Complete and submit week's assignment(s) Take the midterm **(will open on weekend)** **(Due Date: November 9)**

Week 3	**Module 3**: Containerization and Cloud Services ML Development and Deployment • Container Technology and Docker (PPT slides) • Introduction to Cloud Services and AWS (PPT slides) • Deployment to AWS EC2 localhost (PPT slides) Online Class in Zoom 1: Tuesday, November 11, 4:30- 5:30 pm (PST) Docker Containers Docker hub Online Class in Zoom 2: Thursday, November 13, 4:30- 5:30 pm (PST) Introduction to AWS Deployment to AWS (EC2 local host)	• Read through PPT slides. • Respond to Discussions • Attend online class sessions in Zoom • Complete and submit week's assignment(s) Take the quiz **(will open on weekend)** **(Due Date: November 16)**
Week 4	**Module 4**: Monitoring Deployment and Deployment to AWS SageMaker • Monitoring Concepts and requirements (PPT slides) • AWS SageMaker example (PPT slides) Online Class in Zoom 1: Tuesday, November 18, 4:30- 5:30 pm (PST) AWS SageMaker Online Class in Zoom 2: Thursday, November 20, 4:30- 5:30 pm (PST) Monitoring concepts	• Read through PPT slides. • Respond to Discussions • Attend online class sessions in Zoom • Complete and submit the final project **(Due Date: November 23)**

Online Class in Zoom:

Will be each Week Tuesday and Thursday 4:30-5:30* pm (PST) in

https://nu.zoom.us/j/5527760565?omn=94190276140

*Please note that the meeting time may be subject to change based on student requests and convenience.

Course Grading:

Course grading will be a combination of objective and subjective measurements to evaluate student performance based on homework, quizzes, threaded discussions, an exam, and a project (***the final project is worth a minimum of 250points, with the potential to earn up to 300 additional points for exceptional work**)

*Threaded Discussion (30 points for each of the 4 weeks)	120
Quizzes (weeks 1, and 3) (75 each)	150
Homeworks (100 for each week 1,3,4, and 30 for week 2)	330
Midterm Exam (150 points)	150
Project*	250
Total Points	1000

*Course grading may change based on class progress or other conditions. Updates will be shared promptly

When answering essay questions on homework or exams, it is OK to refer to course material and other reference materials, but it is NOT OK to substantially copy the wording from these materials. **Answers to essay questions and threaded discussion posts must be written in your own words**. If an instructor judges that the answer is worded substantially the same as in the course or reference material or as submitted by another student, it may be considered academic dishonesty and subject to consequences described in the university catalog. For example, if textbook material is copied and pasted into the answer to a homework or exam question, a score of zero will be given for that question and a warning will be issued by the instructor. Repeat offenses may result in a score of zero given for the entire exam/quiz/homework/discussion, reporting of the incident to the NU Judicial Affairs Office, and a failing grade in the class.

Grades and Grading System:

A = 95-100%, A- = 90-94%, B+ = 87-89%, B = 84-86%,

B- = 80-83%, C+ = 77-79%, C = 74-76%, C- = 70-73%, D+ = 67-69%

D = 64%-66%, D- = 60-63%, F = < 60%

Grades that are in-between will be rounded up/down to the nearest whole number. For example, 94.4 and below will become 94%, while 94.5 and above will round up to 95%.

A Outstanding Achievement

B Commendable Achievement

C Marginal Achievement

D Unsatisfactory *

F Failing *

* Student receiving this grade in a course that is required for his/her degree program must repeat the course.

I: **Incomplete:** A grade given at the discretion of the instructor when a student who has completed **at least two-thirds of the course class sessions** and is unable to complete the requirements of the course because of *uncontrollable* and *unforeseen* circumstances. The student must convey these circumstances (preferably in writing) to the instructor prior to the final day of the course. If an instructor decides that an "Incomplete" is warranted, the instructor must convey the conditions for removal of the "Incomplete" to the student in writing. A copy must also be placed on file with the Office of the Registrar until the "Incomplete" is removed or the time limit for removal has passed. An "Incomplete" is not assigned when the only way the student could make up the work would be to attend a major portion of the class when next offered.

An "I" that is not removed within the stipulated time becomes an "U." No grade points are assigned.

W: ***Withdrawal****: Signifies that a student has withdrawn from a course after beginning the third class session. Students who wish to withdraw must notify their admissions advisor before the beginning of the sixth class session in the case of graduate courses. Instructors are not authorized to issue a "W" grade.*

Threaded Discussion (30 points per week; 120 points total)

The educational goal of the threaded discussion is to give students an opportunity to reflect on the conceptual material and the class discussions and synthesize this knowledge into understanding of the weekly course learning objectives. The threaded discussion assignments will be graded based on **Quality of information** and **Delivery of Information**. For moderate performance levels, students need to answer one of the questions in detail AND respond to one

other post. To receive maximum points in the high-performance levels, students should answer all the questions and respond in detail to at least two other posts.

Grading (On a scale of 0-30)	Quality of Information	Delivery of Information
0 -15 points = Low performance	Post is not related to the assignment; irrelevant remarks are made; no response to other posts.	Poor spelling and grammar, "hasty" appearance, professional vocabulary not used, and attitude negative or indifferent.
16 - 24 points = Moderate performance	Post is related to topic; supporting details or examples are not included in sufficient breadth or depth; the author simply restates concepts from others (textbook, instructor). One response to another post.	Few grammatical or spelling errors, professional vocabulary used most of the time, and positive attitude displayed frequently.
25 - 30 points = High performance	Supporting details and examples are both broad and deep; the author shows originality and does not just restate the textbook or instructor; multiple detailed responses to other posts.	Consistent grammatically correct posts with professional vocabulary, no misspellings, and positive attitude displayed throughout.

Homework Assignment (100 points for week 1,3,4 and 30 point week 2)

The educational goal of homework is to check analysis and synthesis of the class material and applications to analytical problem solving. The homework must be completed and submitted by midnight on Sunday of each week. Only submissions in Word or PDF will be accepted.

Please include your last name and the week number in the filename of your homework. For example: LastName_Week1 homework.pdf

Final Project (250 Points)

The educational goal of the final project is to apply the comprehensive set of skills learned throughout the course, encompassing the entire development cycle from inception to deployment. This involves utilizing various technologies and methodologies, including GitHub for version control, continuous integration and continuous deployment (CI/CD) pipelines for automated testing and deployment, and containerization for portability and scalability. Through this project, students gain hands-on experience in problem-solving with machine learning, data preprocessing, model training, and deployment using real-world datasets and industry-standard tools.

Quizzes and Exams

The educational goal of the quizzes and exams is to check understanding and synthesis of class material with classroom discussions and overall progress towards mastery of the Course Learning Objectives. Quizzes and exams will be open note, open book, and taken on-line through the course website.

Quizzes will be administered in weeks one and three. A midterm exam will be given in week 3.

National University Policies and Procedures

Please see the current policies and procedures in the catalog (https://www.nu.edu/catalog).