Advanced Topics of Machine Learning

Course Description

Author: Eng. Carlos Andrés Sierra, M.Sc.
cavirguezs@udistrital.edu.co

Full-time Adjunct Professor
Computer Engineering Program
School of Engineering
Universidad Distrital Francisco José de Caldas

2026-I

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Outline

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Academic Experience

- **Computer Engineer**, M.Sc. in Computer Engineering, and *researcher* for 16 years.
- 8 years as **full-time associate professor** at colleges, in Computer Engineering programs.
- 3 years as **lecturer professor** for both colleges and government STEM programs.
- Speaker at IEEE events and colleges in Colombia, Brazil, and Bolivia.

Non-academic Experience

- PyCon Colombia and Python Bogotá **co-organizer**.
- 3 years as **software engineer** for several tech companies in Colombia.
- 3 years as **Technical Leader** of Machine Learning and Data Science at a USA startup.
- 1.5 years as **MLOps Engineer** for a Fintech company in LATAM.
- Currently, **Senior Engineering Manager** of Data Engineering and Machine Learning at Blend 360.

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Overview

This course is designed to introduce undergraduate students to **advanced machine learning techniques** as part of the foundation for becoming an experienced *AI engineer* capable of developing *intelligent solutions*.

The course starts with a comprehensive study of **reinforcement learning** and **generative models**. Then, it transitions into **advanced unsupervised learning** and deep learning optimization techniques. Finally, we will focus on **online learning**, **transfer learning**, and **model interpretability** for both research and industry applications.

Classes will consist of theoretical lectures, **algorithm implementation sessions**, and cutting-edge research projects. Also, you must complete some readings from *advanced ML research papers* and *deep learning*. In addition, there will be a **semester-long research project**, one **final course test**, and four **practical challenges**.

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Goals

The main goal of this course is to provide students with **advanced concepts** and **cutting-edge techniques** for **intelligent systems design** capable of analyzing data, optimizing processes, and improving human-machine interactions.

At the end of this course you should be able to **implement** advanced ML models including reinforcement learning, generative models, and **transfer learning techniques**. Also, you should be able to **develop** complete AI solutions that solve real-world problems using **state-of-the-art algorithms** and optimization techniques.

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Prerequisites

This is an advanced course, so you must have some knowledge in:

- **Programming** in Python (advanced level), including libraries like NumPy, Pandas, and Scikit-learn.
- **Mathematics** fundamentals: linear algebra, **calculus**, and **probability theory**.
- **Statistics** and statistical inference: hypothesis testing, distributions, and regression analysis.
- **Basic Machine Learning** concepts: supervised/unsupervised learning, model evaluation, and cross-validation.
- **Git** usage, Jupyter Notebooks, and experience with ML frameworks like **TensorFlow** or **PyTorch**.
- **Recommended**: Experience with Docker containers and research paper reading.

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Syllabus

Period	Topic	Time
Period I	Introduction to Machine Learning	2 sessions
	Reinforcement Learning Fundamentals	7 sessions
	Generative and Probabilistic Models	5 sessions
	Advanced Unsupervised Learning I	3 sessions
	Course Project Catch-Up	2 sessions
Period II	Advanced Unsupervised Learning II	4 sessions
	Deep Learning	4 sessions
	Online Learning	2 sessions
	ML Interpretability Techniques	3 sessions
	Final Test	1 session
Period III	Project Dissertation	2 sessions

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Grades Percentages

Period	Item	Percentage
Period I	Mini-Projects	20%
	Project Catch-Up	15%
Period II	Mini-Projects	15%
	Course Test	20%
Period III	Paper + Poster	15%
	Report + Implementation	10%
	Presentation	5%

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Don't hate the player, hate the game

- All assignments must be submitted **on time**, and in **English**. Grammar and spelling will **not** be evaluated.
- Copying and pasting from the internet are **forbidden**. Please **develop** your own ideas and solutions.
- Class attendance is **not mandatory**. If you **miss** classes, you must study *independently*.
- No cell phones, smartwatches, WhatsApp, Tinder, or smart devices. **Just you and your brain**. Pay attention in class.
- Communication with me must be via **email** or **Slack**. I will **not** answer any questions via *WhatsApp*.

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Code of Conduct

- Always be **respectful** to your classmates and to me. You must be **kind** to everyone inside (*and outside*) the classroom.
- There is no best programming language, tool, or technology. There are only **better** or **worse** solutions.
- You must be **honest** with your work. If you don't know something, just **ask** me. I will be glad to help you.
- You must be **responsible** with your work. If you don't submit **on time**, please don't complain.
- You must not be **disruptive** or **negatively affect** the **classroom environment**. If you do, I will ask you to **leave** the classroom.

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Bibliography

Recommened bibliography:

- **Reinforcement Learning: An Introduction**, by Richard S. Sutton & Andrew G. Barto.
- **Deep Learning**, by Ian Goodfellow, Yoshua Bengio, & Aaron Courville.
- **Generative Deep Learning**, by David Foster.
- **Pattern Recognition and Machine Learning**, by Christopher M. Bishop.
- **The Elements of Statistical Learning**, by Trevor Hastie, Robert Tibshirani, & Jerome Friedman.
- **Interpretable Machine Learning**, by Christoph Molnar.
- **Online Learning and Online Convex Optimization**, by Shai Shalev-Shwartz.
- **Bayesian Reasoning and Machine Learning**, by David Barber.

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Thanks!

Questions?

My Profile: *www.linkedin.com/in/casierrav*