# Course Admin

EE-UY 4563/EL-GY 6143: INTRODUCTION TO MACHINE LEARNING

PROF. SUNDEEP RANGAN

# People

- Professor: Sundeep Rangan, srangan@nyu.edu
  - 370 Jay St, 9th floor
  - Office hours:  Wednesdays 16:00 to 17:00 (in my office or on zoom)
- Lecture:  Tuesdays 11:00-13:30, 370 Jay St, Room 202
  - All lectures will be on zoom
  - Attendance (in person or online) is OK.  Attendance is not mandatory
  - Bring your laptop.  We will do in class exercises
- Course Graders:
  - Tejdeep Chippa, Jay Doshi, Roshan Nayak, Akshat Singh, Sheetal Prasad, Raunak Choudhary
  - Ask for all questions regarding homeworks and labs

# Course Learning Objectives

- ❑ Formulate a task as a machine learning problem
  - Identify learning objectives, source of data, models, …
- ❑ Load, pre-process and extract features from common data sources
  - images, text, audio, …
- ❑ Mathematically describe simple models of the data
- ❑ Fit the models to data and use models for prediction and estimation
  - Use common tools
- ❑ Evaluate goodness of fit and refine models
- ❑ Evaluate the performance of methods using statistical techniques

# Grad vs Undergrad

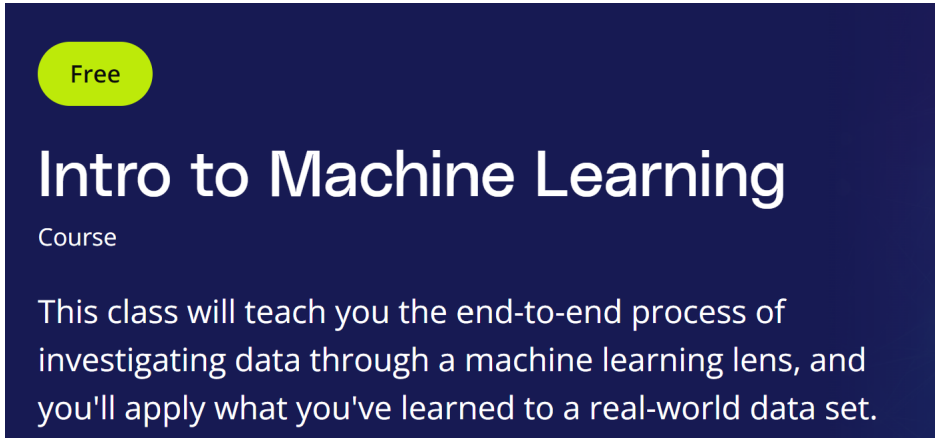
- Class is simultaneously offered at the graduate and undergraduate level
- Undergrad EE-UY/CSE-UY 4563: Intro to Machine Learning
  - Covers fundamental algorithms and some analysis
  - In depth coverage of software tools including python, Google Cloud, Tensorflow
  - Python-based lab exercises + mandatory project
- Grad EL-GY 6143: Intro to Machine Learning
  - More algorithms and more mathematical analysis. Faster paced.
  - Software tools must be learned at home. Less coverage in class
  - Python-based lab exercises + optional project
- Lecture notes are mostly common with supplementary material for grad students indicated
- Many labs are common

# Texts and Other Resources

- Undergrad: James, Witten, Hastie and Tibshirani, "An Introduction to Statistical Learning",
  - http://www-bcf.usc.edu/~gareth/ISL/ISLR%20First%20Printing.pdf
  - Very clear explanation of concepts.
  - But examples are in R. And there is no review of probability
- Grad: Hastie, Tibshirani, Friedman, "Elements of Statistical Learning"
  - https://web.stanford.edu/~hastie/Papers/ESLII.pdf
  - More advanced text with more analysis
- Tivandar Danka, Mathematics of Machine Learning
  - Nice background of all the mathematics you needd
- Bishop, "Pattern Recognition and Machine Learning" (more advanced)

# More Resources

- Many classes online
- Udacity
- Cornell CS4780
  - YouTube videos
- Berkeley Deep Learning
  - Deep learning specifically
- Andrew Ng's machine learning class:
  - https://www.coursera.org/learn/machine-learning
  - A little less mathematical than this class
- Many, many others online…



# Pre-Requisites

- Undergrad probability required for both UG and Grad version:
  - Basics of random variables, densities, Gaussian distributions, correlation, expectation, conditional densities, Bayes' theorem
  - Will provide a short review
  - NYU classes:  Data analysis or Intro Probability are sufficient
- Undergraduate calculus and linear algebra
  - Vectors, matrices, partial derivatives, gradients.
  - Again, we will provide a brief review
- No machine learning experience is necessary
  - If you have ML experience, do NOT take this class.
  - Take Graduate probability (Fall) then Advanced machine learning (Spring)

# Pre-Requisites Programming

- Python
  - All labs are in python, similar to object-oriented MATLAB, but many more libraries.
  - And free!
- What you need to know
  - You do not need to know python before class.  But we will go over it quickly.
  - You should have experience in some programming language (eg. MATLAB).
  - You should know or being willing to learn object-oriented programming
- Resources:
  - Installing python and ipython notebook (make sure you install Version 3.12) http://jupyter-notebook-beginner-guide.readthedocs.io/en/latest/index.html
  - Python tutorial:  https://docs.python.org/3/tutorial/
  - Numpy:  http://cs231n.github.io/python-numpy-tutorial/

# Grading: Undergraduate

- Midterm 1: 25%, Midterm 2: 25%, Labs, HW: 25%, Final project: 25%
- Labs: Simple python exercises
  - Given as jupyter notebook that you complete.
- Midterms
  - Each over approx. 3-4 weeks of material
  - Closed book with cheat sheet.
  - Follows homework and quiz problems + some very basic python questions
- Final project:
  - Use machine learning in some interesting way.
  - Must use data and python analysis.
  - Provide final report.

# Grading:  Graduate

- Midterm 35%, Final 35%, Labs / HW 30%
  - Optional project:  Up to 20%
- Labs:  Simple python exercises
  - Given as jupyter notebook that you complete.
- Midterms & final
  - Each over approx. 6-7 weeks
  - Open book but no electronic aids.
  - Follows homework and quiz problems + some very basic python questions
- Optional final project:
  - Use machine learning in some interesting way.
  - Must use data and python analysis.
  - Provide final report.

# Lecture Sequence

| Date | Prior Years | | Fall 2025 | |
|---|---|---|---|---|
| | Unit | Description | Unit | Description |
| 9/2/2025 | 1, 2 | Course Admin. What is ML? Multiple Linear Regression | 1, 2 | Course Admin. What is ML? Multiple Linear Regression |
| 9/9/2025 | 3 | Model Selection | 3 | Model Selection |
| 9/16/2025 | 4 | Regularization and LASSO | 4 | Regularization and LASSO |
| 9/23/2025 | 5 | Logistic Regression | 5 | Logistic Regression |
| 9/30/2025 | 6 | Nonlinear Optimization | 6 | Nonlinear Optimization |
| 10/7/2025 | | Midterm review | | Midterm review |
| 10/14/2025 | | No class: Spring break | | No class: Spring break |
| 10/21/2025 | | Midterm | | Midterm |
| 10/28/2025 | 7 | SVMs | 8 | Neural Networks |
| 11/4/2025 | 8 | Neural Networks | 9 | Convolutional neural networks |
| 11/11/2025 | 9 | Convolutional neural networks | 10 | PCA |
| 11/18/2025 | 10 | PCA | 11 | Word Embeddings and tokenization |
| 11/25/2025 | 11 | Clustering and K-means | 12 | Attention and LLMs |
| 12/2/2025 | | Final Exam Review / Make Up | 13 | Clustering and K-means [Modified] |
| 12/9/2025 | | Final Exam | | Final Exam |

# Machine Learning Project

- Perform an interesting machine learning task of your choice
- Many possible areas:
  - Machine vision, brain-computer interfaces, natural language processing, sentiment analysis, …
  - Anything that interests you
- Groups of 2 necessary
  - Submit all material as that group
- Use real data
  - write code
- Place all material in a github repo (including documentation) and submit only github repo

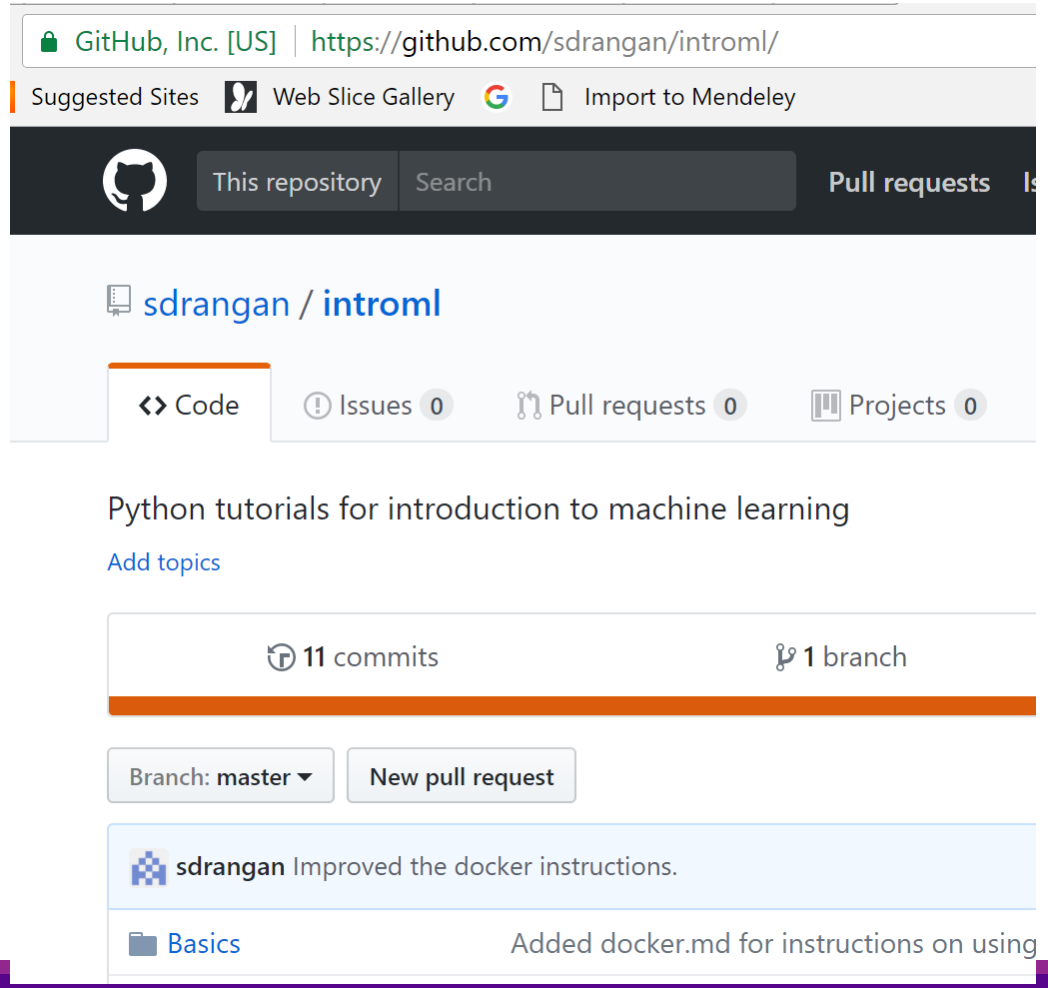
# Project Grading

- Formulation
  - How well did you formulate the problem?  Was it clear?  Was that tied to the right objective?
- Approach
  - Does your approach properly solve your problem?  Was that made clear?
- Evaluation and Interpretation
  - Did you comprehensively test the results?  How well did you select / create the data?
  - Did you test against alternative approaches?
- Presentation
  - Were the ideas clear?  Were all the details conveyed.  Did you highlight the main points?
  - You can select a number of formats.  Whatever makes sense.  A github page
- Bonus
  - Given for particularly hard / novel research

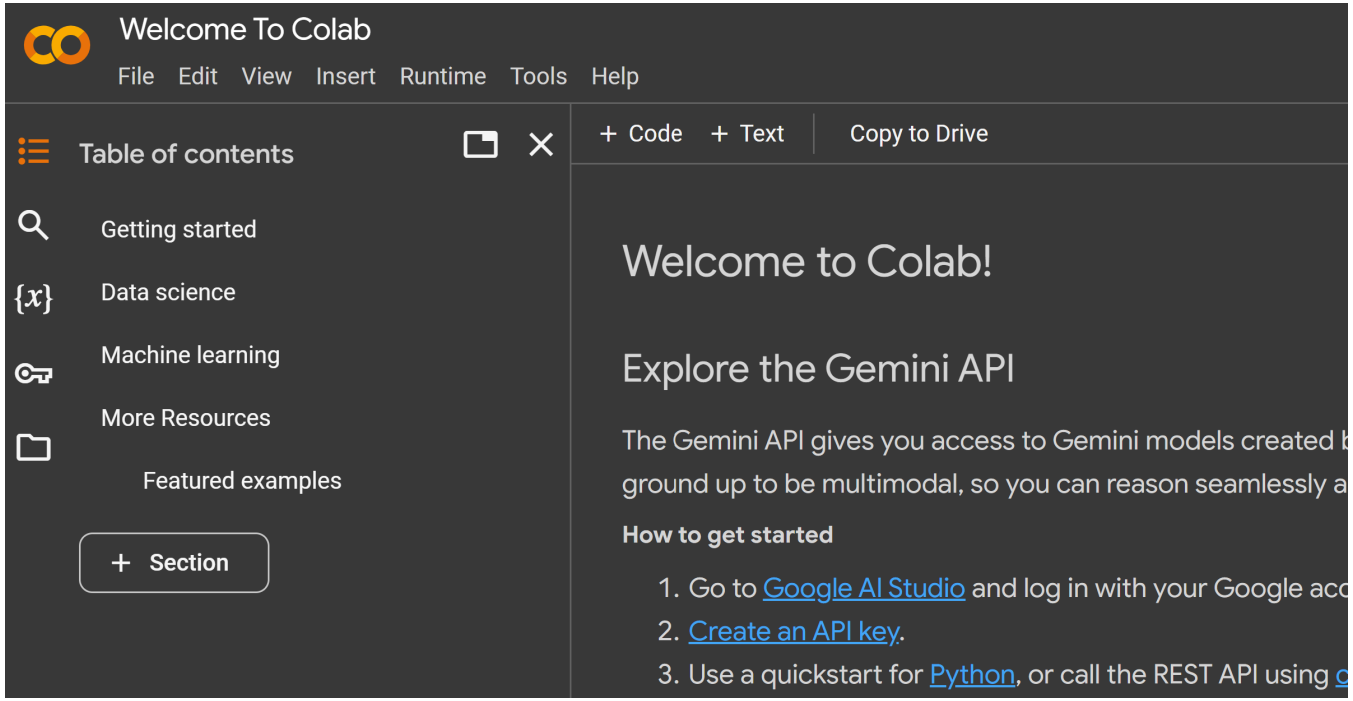
# Github

- Labs and demo posted on github
- https://github.com/sdrangan/introml/
- Also includes instruction for installing software

- Several tutorials of github on the web.
- Available on Windows, Mac and Unix.
- But, you can just clone the repo



# Google Colab




- Fully online python environment
- Many benefits
  - Free to use
  - Will work for all assignments and labs
  - No machine to set up
- But it may be a bit slow
  - Only matters for larger projects

# Software for Local Machine

- If you use your local machine, you will need to install several pieces of software:
- Python with various packages
  - Make sure you get 3.12
  - Anaconda
  - Jupyter notebook
  - See notes in NYU Classes
- Deep learning package
  - Either pytorch or Tensorflow
- Git hub
  - Guides: https://guides.github.com/
  - Available on Windows, Mac or Linux (including GCP instances)
  - All demos will be available on: https://github.com/sdrangan/introml.git