# Machine Learning in Practice

Rayid Ghani and Kit Rodolfa

Carnegie Mellon University

# What do you want/expect to learn from this class?

# Why does this class exist?

# What we want you to learn from this class

- How to responsibly and effectively solve real-world problems using ML
  - Understand the *entire* Machine Learning process (and get hands-on experience doing most of it)
  - Build (and use) reusable ML pipelines
  - Learn how to formulate ML problems, use, understand, evaluate, and communicate ML methods (that you have covered in earlier classes) in the context of a real problem

# How is this course different than typical ML classes you've taken before?

We'll assume everyone knows

- Methods/algorithms/models
- Assumptions behind them
- How to implement them

And focus on everything else that comes before the matrix and after the models are built (99% of the work done in a real-world project)

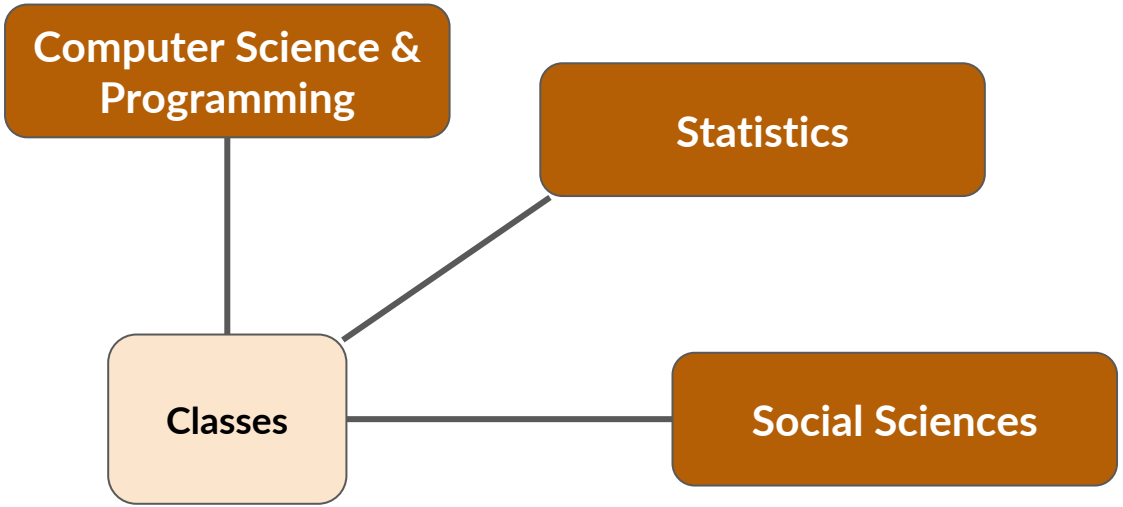
# Grading

- Pass/Fail
- We want the focus to be on learning and not on the grade.
- Levels of learning
  - Exposed to information covered in this course
  - Applying the information (correctly) covered to the class project
  - Generalizing to the next ML problem you tackle

# Pre-requisites

- Machine Learning (methods and overall process)
- Python (pandas, sklearn, tensorflow, matplotlib)
- Ideally: experience with SQL, command line (bash), git(hub), working on remote servers

# Skills needed to solve real-world problems (with ML)



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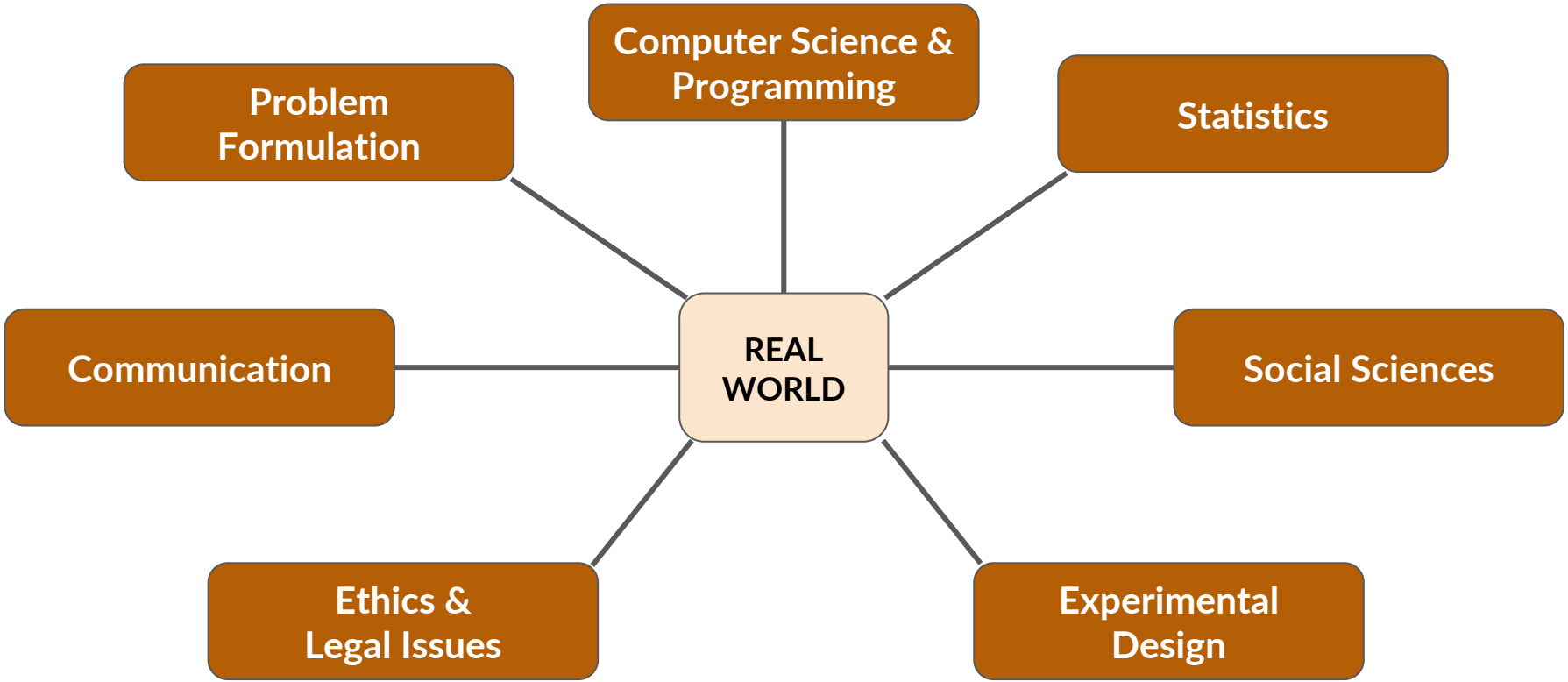

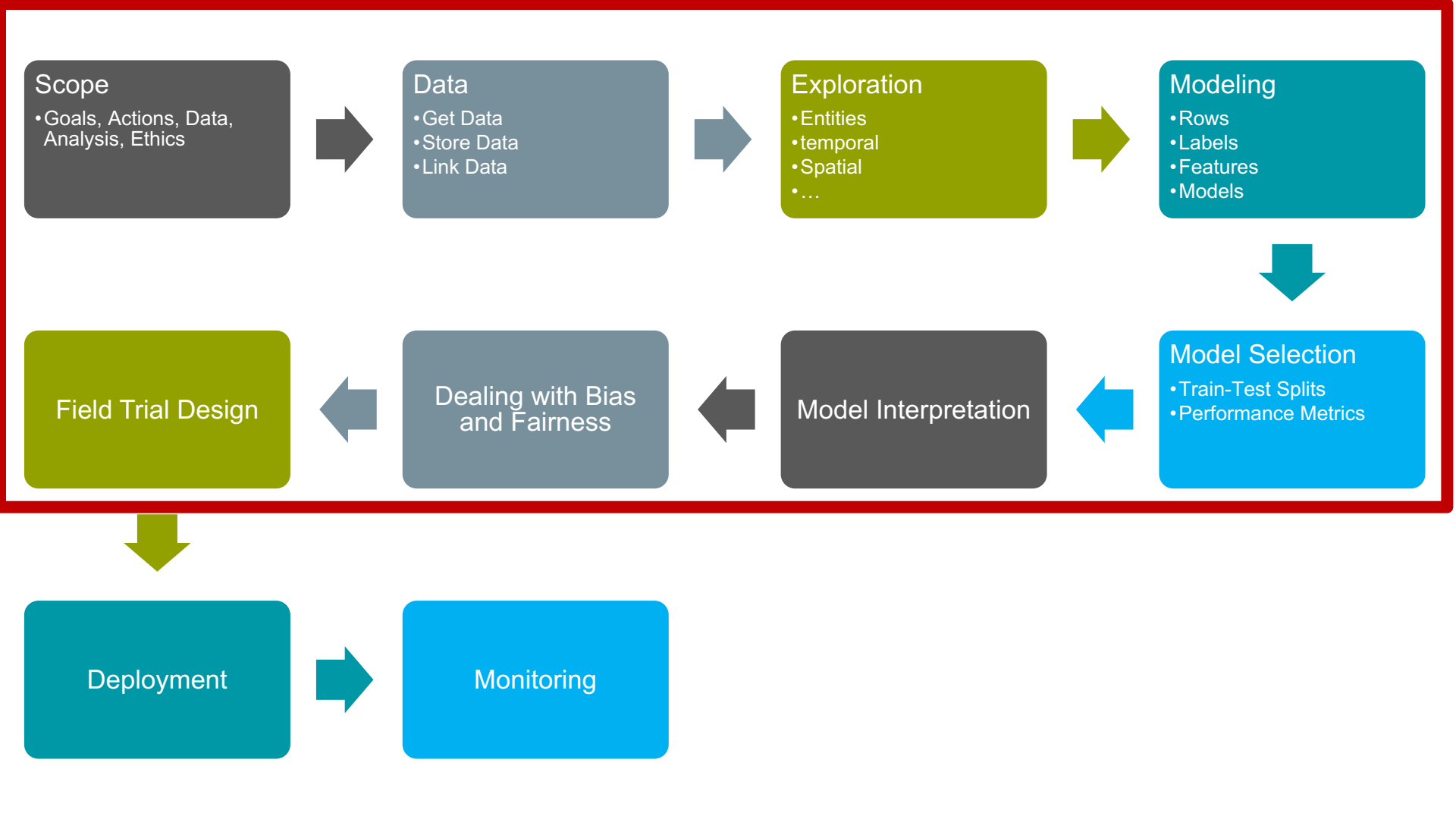
Scope
•Goals, Actions, Data, Analysis, Ethics
Data
•Get Data
•Store Data
•Link Data
Exploration
•Entities
•temporal
•Spatial
•…
Modeling
•Rows
•Labels
•Features
•Models
Model Selection
•Train-Test Splits
•Performance Metrics
Model Interpretation
Dealing with Bias and Fairness
Field Trial Design
Deployment
Monitoring

# Structure of the class

- Module 1: End-to-end ML Pipeline
  - Formulation, Modeling Setup, Features, Models, Model Selection
- Module 2: Model Interpretability
- Module 3: Fairness

# Class Schedule

| Week | Dates | Topic | Required Readings | Assignments |
|---|---|---|---|---|
| 1 | Tu: Aug 31 | Class Intro and Overview | | |
| 1 | Th: Sep 2 | ML Project Scoping | ML Project Scoping Guide | Project Team Selection |
| 2 | Tu: Sep 7 | Getting, Storing, and Linking Data | Optional readings on github | |
| 2 | Th: Sep 9 | Analytical Formulation / Baselines | List on github | |
| 3 | Tu: Sep 14 | Model Selection Methodology | | Project Assignment 1: Formulation and Baseline (due Monday) |
| 3 | Th: Sep 16 | Performance Metrics | | |
| 4 | Tu: Sep 21 | Feature Engineering and Imputation | | Project Assignment 2:<br>Validation set up<br>Initial pipeline with train and validation set(s) and baseline implemented (due Monday) |
| 4 | Th: Sep 23 | Hands-on Session for ML Pipeline review | | |
| 5 | Tu: Sep 28 | Models/hyperparameters in practice | | Project Assignment 3:<br>list of features and some subset implemented (due Monday) |
| 5 | Th: Sep 30 | Temporal Model Selection | | |
| 6 | Tu: Oct 5 | Module 1 Review: Applied ML - End to End Pipelines | | Project Assignment 4:<br>modeling results (due Monday) |
| 6 | Th: Oct 7 | Mid-term week - no class | | Mid-term exam due Friday |
| 7 | Tu: Oct 12 | Interpretability: Intro and Overview, taxonomy | | |
| 7 | Th: Oct 14 | No Class - Mid-semester break | | |

# Class Schedule

| Week | Dates | Topic | Required Readings | Assignments |
|---|---|---|---|---|
| 8 | Tu: Oct 19 | Understanding the Models | | |
| 8 | Th: Oct 21 | Interpretability Methods: Inherently Interpretable (GA2Ms, RiskSLIM, etc.) | | |
| 9 | Tu: Oct 26 | Interpretability Methods:: Post-Hoc Local/Feature-based (LIME, SHAP, MAPLE) | | |
| 9 | Th: Oct 28 | Interpretability Methods: Other methods (counterfactual, example-based, etc.) | | |
| 10 | Tu: Nov 2 | Module 2 Review: ML Interpretability | | |
| 10 | Th: Nov 4 | ML Ethics Issues Overview | | Interpretability Writeup Due on Friday |
| 11 | Tu: Nov 9 | Fairness in ML Overview | | |
| 11 | Th: Nov 11 | Fairness Methods: Pre-processing (removing sensitive attribute, sampling) | | |
| 12 | Tu: Nov 16 | Fairness Methods: In-processing (Zafar, Celis, fairlearn, etc.) | | |
| 12 | Th:Nov 18 | Post-Processing: Hardt, LA, etc | | |
| 13 | Tu: Nov 23 | Module 3 Review: ML Fairness | | |
| 13 | Th: Thanksgiving | Thanksgiving holiday | | |
| 14 | Tu: Nov 30 | Field Trials and Causality | | Bias Writeup Due |
| 14 | Th: Dec 2 | Wrap-Up | | |
| 15 | Tu: Dec 7 | No Class - Finals Week | | |
| 15 | Th: Dec 9 | No Class - Finals Week | | Final Research Writeup Due |

# Logistics

- Attendance (is not optional)
- Platforms:
  - Latest content will be on **github**
  - **Canvas** (for assignment submissions)
  - **Slack (and email)** for communications and project and teamwork
- Wednesday sessions
- Office hours
- TAs: to help manage and help access AWS infrastructure

# Project Teams

- Make sure to fill out the survey: We need your github username and  public SSH key

- You should create 5-person teams by the end of this week (and fill out the spreadsheet to let us know)

# Project

## Support a classroom.
## Build a future.

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# Tech Setup Options

- Get set up on github for your project
- Compute Infrastructure
  - Use your own laptop/machine for running things locally
  - Or use AWS resources we have set up to run larger jobs
- Data Infrastructure
  - Use CSVs on your own laptop/machine
  - **Or use Postgres database we have set up with data loaded**
- If you use AWS, make sure you have the following things set up:
  - ssh (to connect to the server) **server.mlinpractice.dssg.io**
  - dbeaver and psql (to connect to the database) **server.mlinpractice.dssg.io**

- Nice to have: get familiar with
  - Postgresql (to analyze and query data)
  - *nix command line
  - Remote server workflow

# Prep for next class

- Reading
  - Project Scoping guide
- Assignments
  - Survey (if you haven’t already): link from email
  - Project Team Selections: link in canvas
- No Wednesday Session This Week