



# Machine Learning & Causal Inference A Practical Approach using Python

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## Requirements:

- Undergraduate Statistics & Econometrics.
- Python-capable machine.
- Ideally, agent-based IDE for coding (e.g., Cursor, Claude Code).

## Recommended Readings:

- Intro to Causal Inference w/ examples in Python: [Causal Inference for The Brave and True](#). Matheus Facure
- Causal Inference Theory: [Causal Inference: A Statistical Learning Approach](#). Stefan Wager
- Machine Learning Theory: [The Elements of Statistical Learning](#). Hastie, Tibshirani, Friedman
- Some resources on Prompt Engineering:
  - [Prompt Engineering Guide by Google](#)
  - [Context Engineering for AI Agents by Anthropic](#)

## Content:

### Lecture 1: 18-Feb. Basic Elements of Coding

1. Python. Virtual environments. Basic libraries. Data loading.
2. Basic programming logic: “for”, “while” loops. “if” conditions.
3. User-defined functions. Classes.
4. Scripts vs notebooks.

5. Version control: Github.
6. AI Agents. Prompts. Good practices.

## **Lecture 2: 20-Feb. Treatment Effects & Randomized Controlled Trials (RCT)**

1. Fundamental Problem of Causal Inference.
2. Data simulations. Seeds for reproducibility. Visualizations.
3. RCTs. Difference in means estimator.
4. Variance reduction. [Lin \(2013\)](#) adjustment.

## **Lecture 3: 23-Feb. Treatment Effect Estimation under Unconfoundedness**

1. Unconfoundedness assumption.
2. Stratified estimator.
3. Propensity score.
4. Inverse-Propensity Weighting (IPW) estimator.
5. Bootstrap.
6. Balance checks.

## **Lecture 4: 24-Feb. Machine Learning for Treatment Effects I**

1. Introduction to Supervised Learning.
2. Regression vs Classification.
3. Linear models. Logistic Regression.
4. Decision trees.

## **Lecture 5: 26-Feb. Machine Learning for Treatment Effects II**

1. Evaluation of Machine Learning Models
2. Bias-variance tradeoff
3. Overfitting. Training and test sets.
4. Regularization. Model Selection.
5. Hyperparameter tuning and Cross-Validation.
6. Random Forests
7. Feature Importance and Partial Dependence Plots.