Python-Powered Machine Learning

Carrie Gardner, PTOH `23

Special Thanks:

Data Analytics Club

A Little Background on Me

Carrie Gardner

- Member of the Technical Staff @ AI Division, Software Engineering Institute, CMU
  - Cultivating the interdisciplinary engineering discipline of AI Engineering ☺
- Social Science & Information Science Education
- 7+ years using python and working on analytics projects
- Proud Python Evangelist 😁

Workshop Roadmap

- Logistics
- What is Machine Learning?
- How is ML Performed?
- Why Python?
- Interactive Tutorial
  1. Tooling & Data Wrangling
  2. Price Prediction w/Scikit-Learn
  3. Natural Language Processing

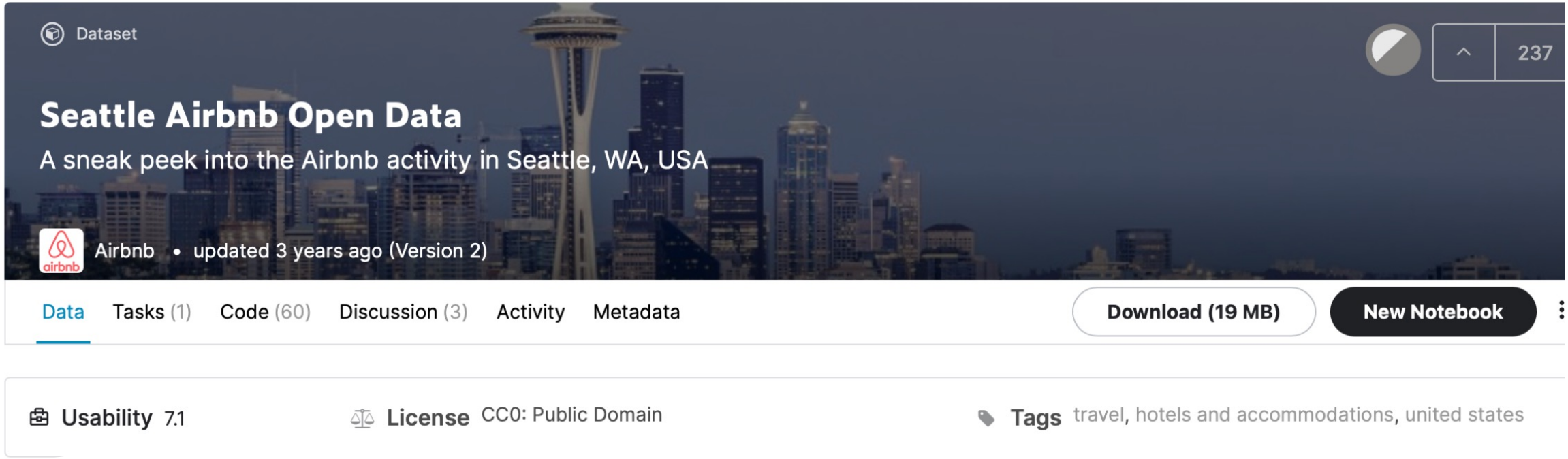
Timing:
~30 Minutes Lecture
~5-10 Minute Break
~70 Minutes
Interactive Coding

Logistics

- This workshop assumes
  - Attendees have little-no experience with machine learning
  - Attendees have little-no experience using python
  - **Everyone** can learn to code (no CS background required!)
- **PLEASE raise your hand and ask questions!**
- Takeaways:
  - **Confidence** to start machine learning with python
  - **Knowledge** of ML and data analytics capabilities with python
  - **Scaffolding** to jump-start a python-powered analytics project

What is Machine Learning?

Let’s Frame the Opportunity

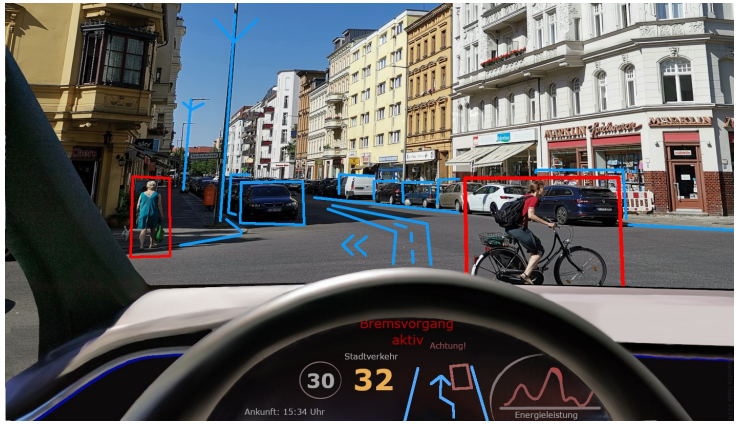


- Can we **forecast** and **predict** prices?
- Can we **parse** and **glean insights** from reviews?
- Can we **segment** listings into groups?

kaggle

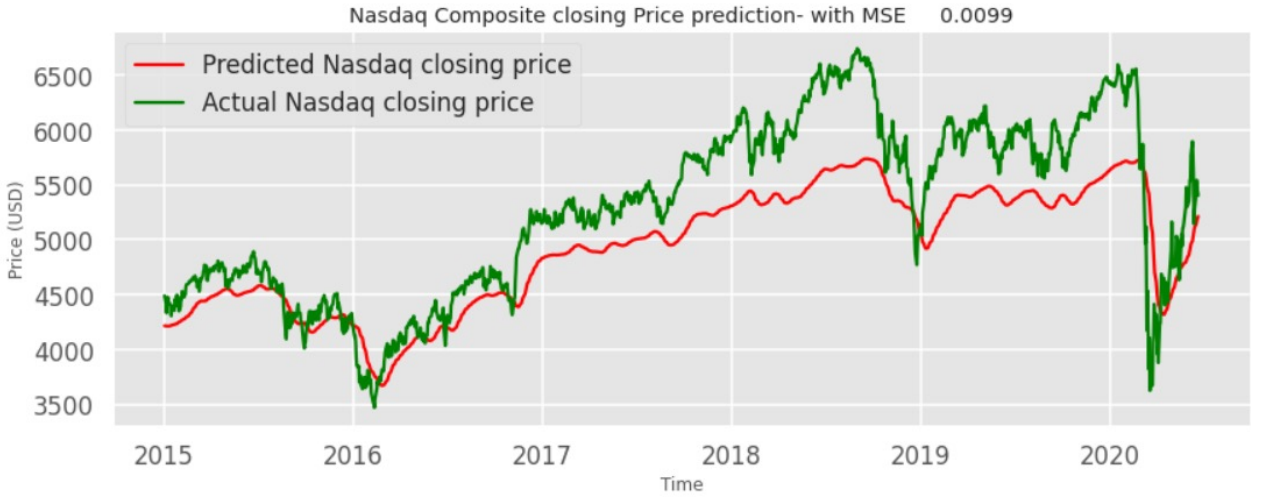
What is Machine Learning?

Machine Learning (ML) is a data science technique that learns from existing data to forecast future behaviors, outcomes, and trends



Forms

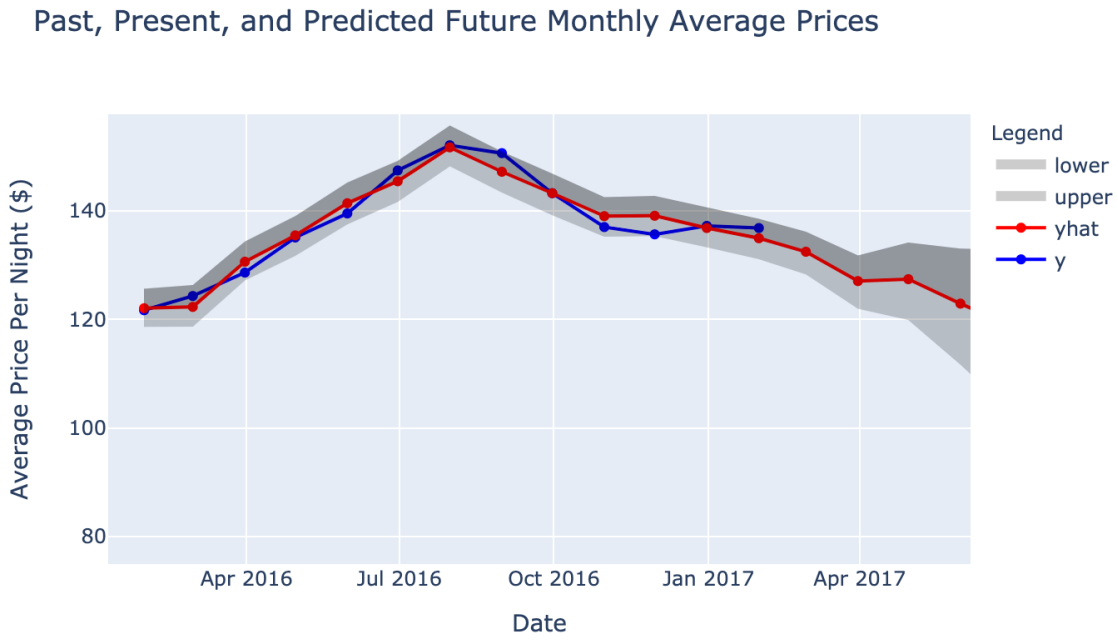
- **Supervised**
- **Unsupervised**
- Semi-supervised
- Reinforcement/Active



Supervised Learning

Supervised ML models are developed by training algorithms on *labeled* data to understand the relationship between the features and the label

- Classification
- **Regression**



Forecast Daily Listing Prices

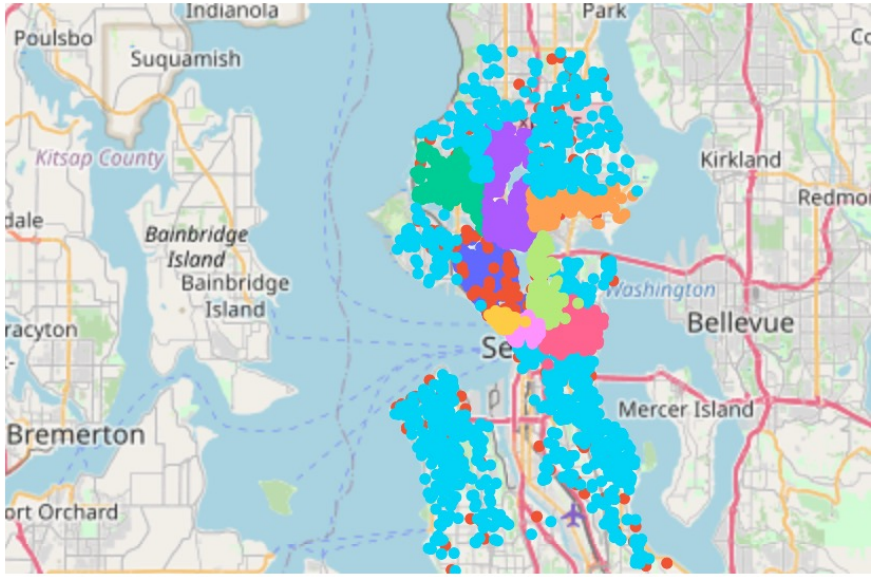
- Modeling using FB's Prophet Library
- Visualization using Plotly

Unsupervised Learning

Unsupervised ML models are developed by training algorithms on *unlabeled* data to find relationships amongst variables

- **Clustering**
- Association

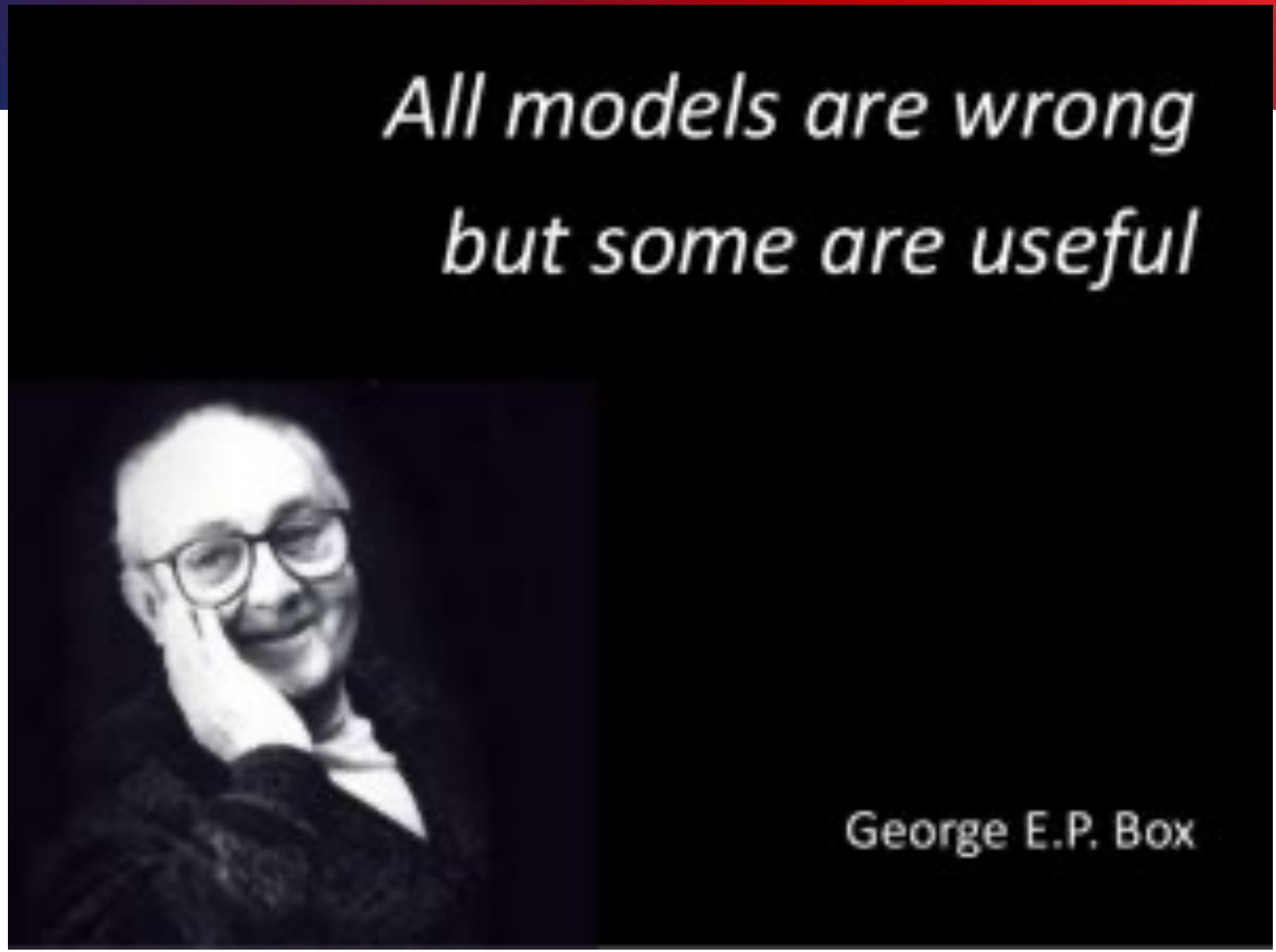
K-Means Clustering of AirBnB Spaces



Cluster Listings into Neighborhoods

- Modeling using Scikit-Learn
- Visualization using Plotly

Remember:
a machine learning model is designed to represent the problem you are studying, and it is not a perfect reflection of the problem



More Business Use Cases

Predictive Maintenance	Optimal Price Selection	Personalized Ads	Fraud Detection
Market Forecasting	Sentiment Analysis	Document Workflow Automation	Supplier Selection
Route Optimization	Credit Scoring	Algorithmic Trading	...

How is Machine Learning Performed?

ML Workflow: Simple

BLUF

- What is the goal?
- What's the expected operational context?
- What's the expected deployment state?
- What's our operational plan to fulfill this?

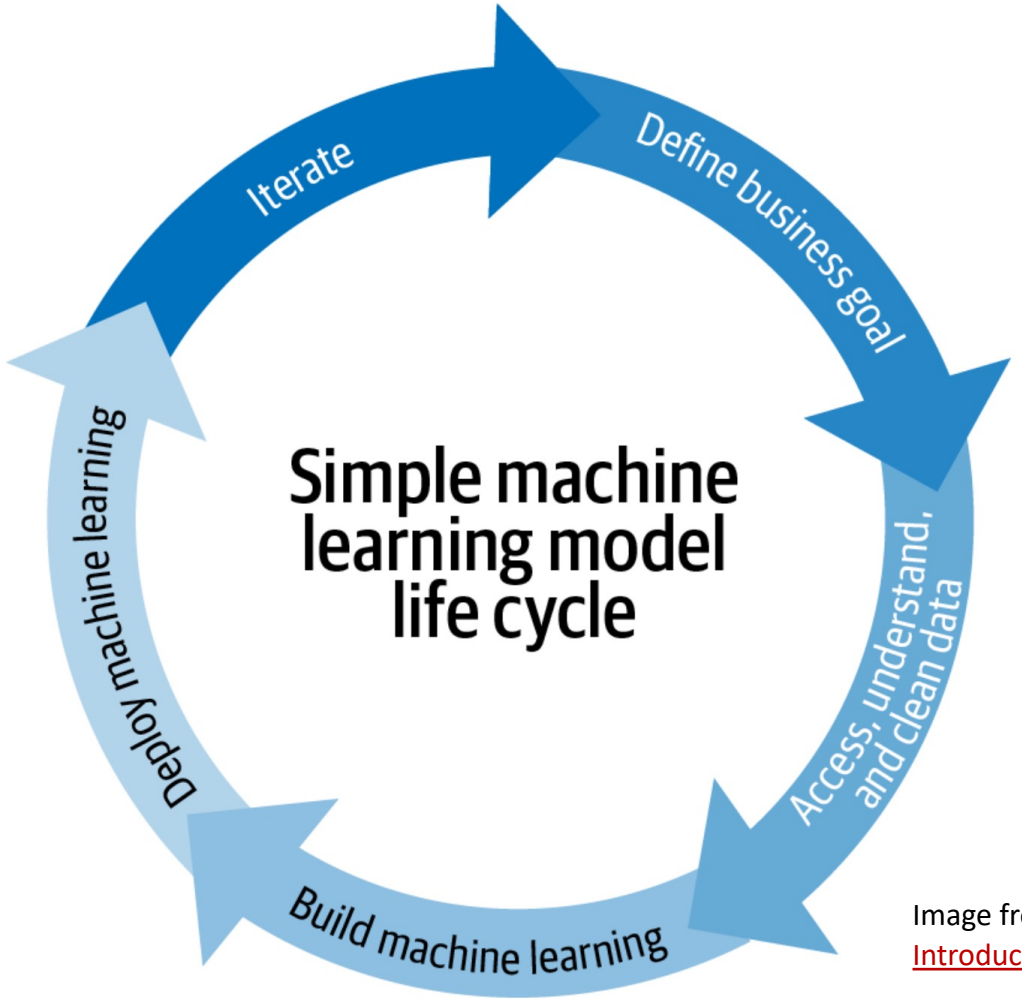


Image from Introducing MLOps

Figure 1-2. A simple representation of the machine learning model life cycle, which often underplays the need for MLOps, compared to Figure 1-3

ML Workflow: Complex

Questions

- What are product integration needs?
- How might this need to scale?
- What's the post-deployment maintenance plan?

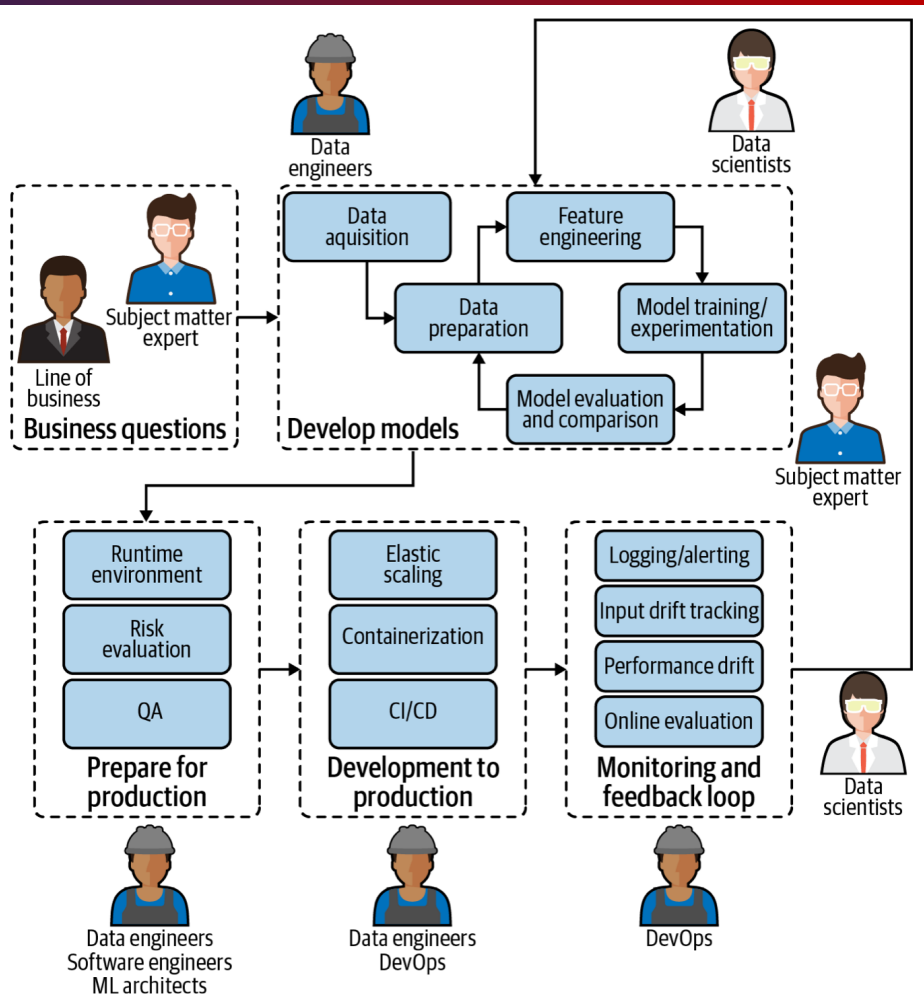


Figure 1-3. The realistic picture of a machine learning model life cycle inside an average organization today, which involves many different people with completely different skill sets and who are often using entirely different tools.

An "MLOps" perspective

Image from Introducing MLOps

ML Workflow: Roles & Responsibilities

	Role	Responsibility
	Subject Matter Experts	Provide business use case and KPIs Provide expertise on data and inference context Manage ML project performance
ML Engineer	Data Scientists	Design and prototype models that address business use case Iteratively test modeling approaches (e.g., neural nets versus decision trees) Conduct exploratory data analysis (EDA) Identify ML risk concerns
	Data Engineers	Conduct exploratory data analysis (EDA) Perform Extend Transform Load (ETL) activities to prepare data Design and develop data “pipelines” and storage capabilities Deploy ”dataOps” capabilities to manage state of data
	DevOps	Design and develop microservice architecture (e.g., using AWS services) Design and develop microservice containers Develop CI/CD infrastructure for automated deployment (e.g., automated logging and testing)
	Software Engineers	Translate and develop production software code from the prototype model Select and design software libraries

High-Level ML Workflow

BLUF

- What is the purpose?
- What is the end state goal?
- What are the requirements vs. the requests?

Problem Formation
- What is the goal?
- What are the requirements?

Data Curation
- Collect Data
- Preprocess

Exploratory Analysis
- Learn basic features
- Visualize and discern patterns

Modeling
- Select techniques per Problem Formation
- Train and fit ML pipeline model

Testing & Evaluation
- Iteratively test and evaluate ML model for appropriateness of fit / tune parameters

Integration
- Validate model meets specifications
- Deploy ML tool into production

Considerations

- Product Integration?
- Decision Support Tool or Fully Autonomous?
- Risk Tolerance Requirements ☺

Building Model

Train

Inference

It is often easiest to visualize a pipeline as a flowchart, such as the one depicted for Figure 2-5.

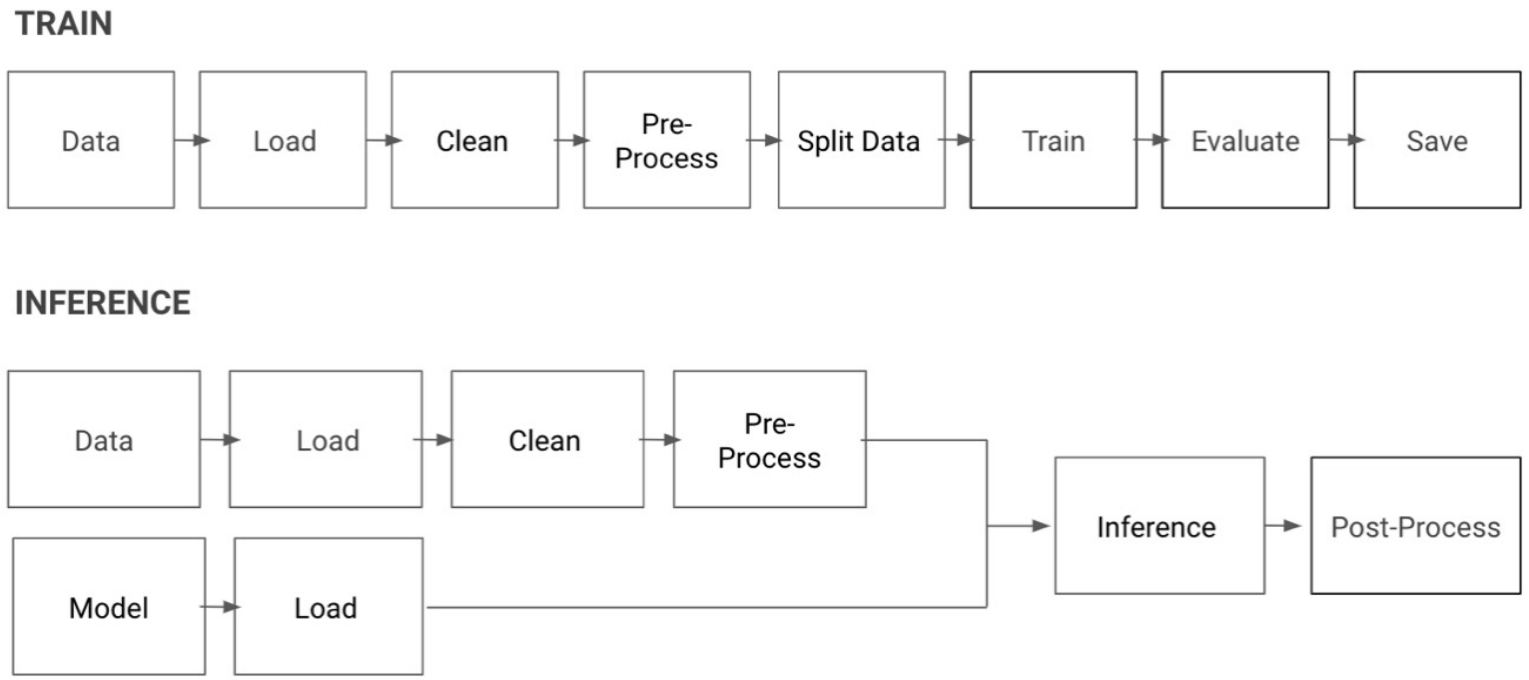


Figure 2-5. Pipelines for the editor

Image from Building Machine Learning Powered Applications

Deploying Model

- Deploy Streaming Model Service

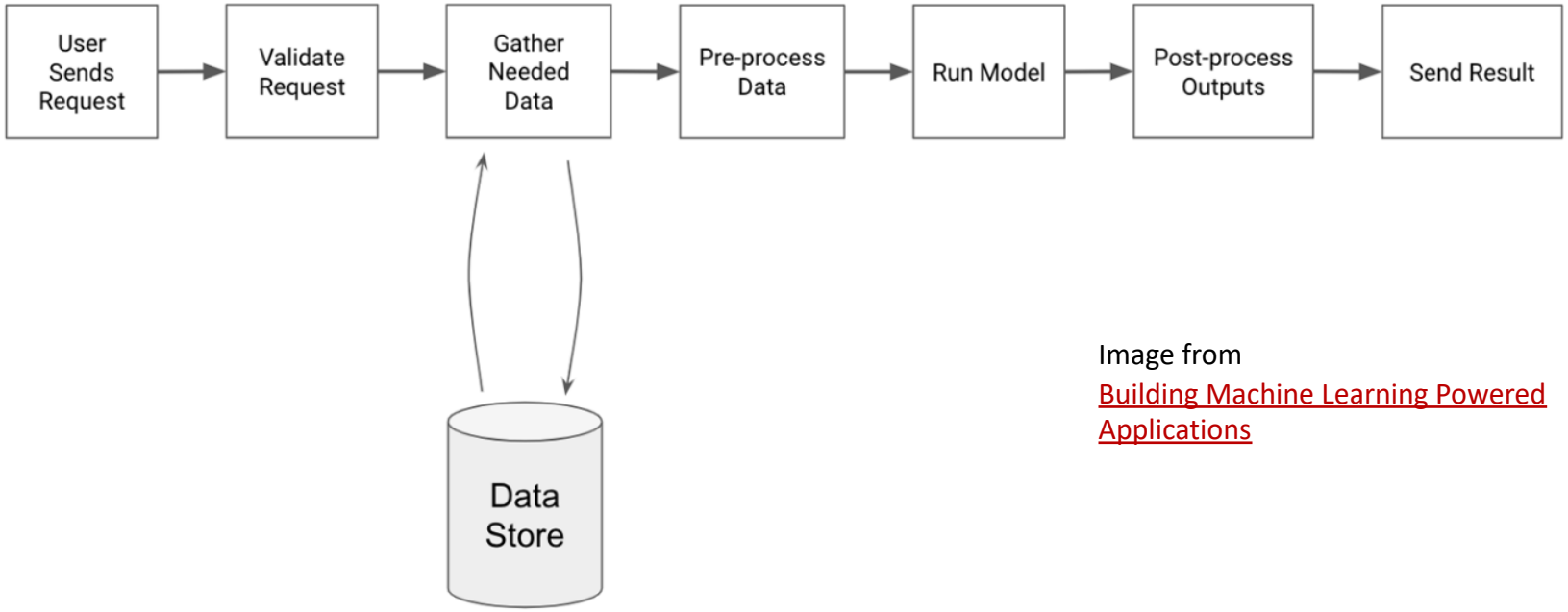


Figure 9-1. Streaming API workflow

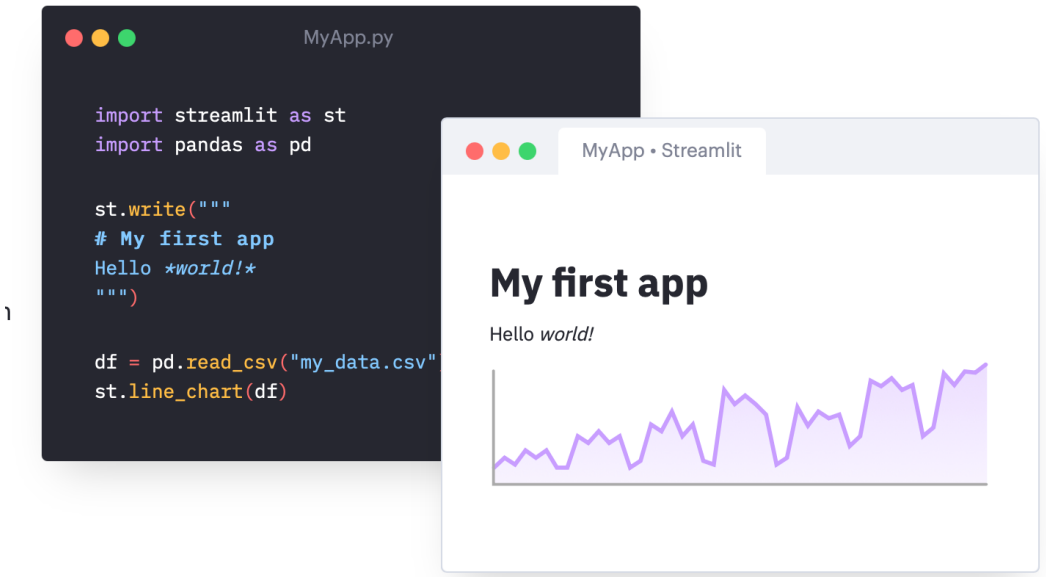
Image from
Building Machine Learning Powered Applications

Why Python?

Why Python?

Python is “an interpreted, high-level and general-purpose programming language”

- Versatility
- Code readability
- General and specialized libraries
- Object-oriented design
- **Full data lifecycle support – from Exploratory Analysis to Data Product Development**



Python-Powered Applications

- Web Development
- Embedded Systems
- Desktop Applications
- Command Line Interfaces (CLI)
- Data Analytics & Machine Learning
- Scripting

spaCy

neo4j

Keras

statsmodels

pandas

TensorFlow

plotly | Dash

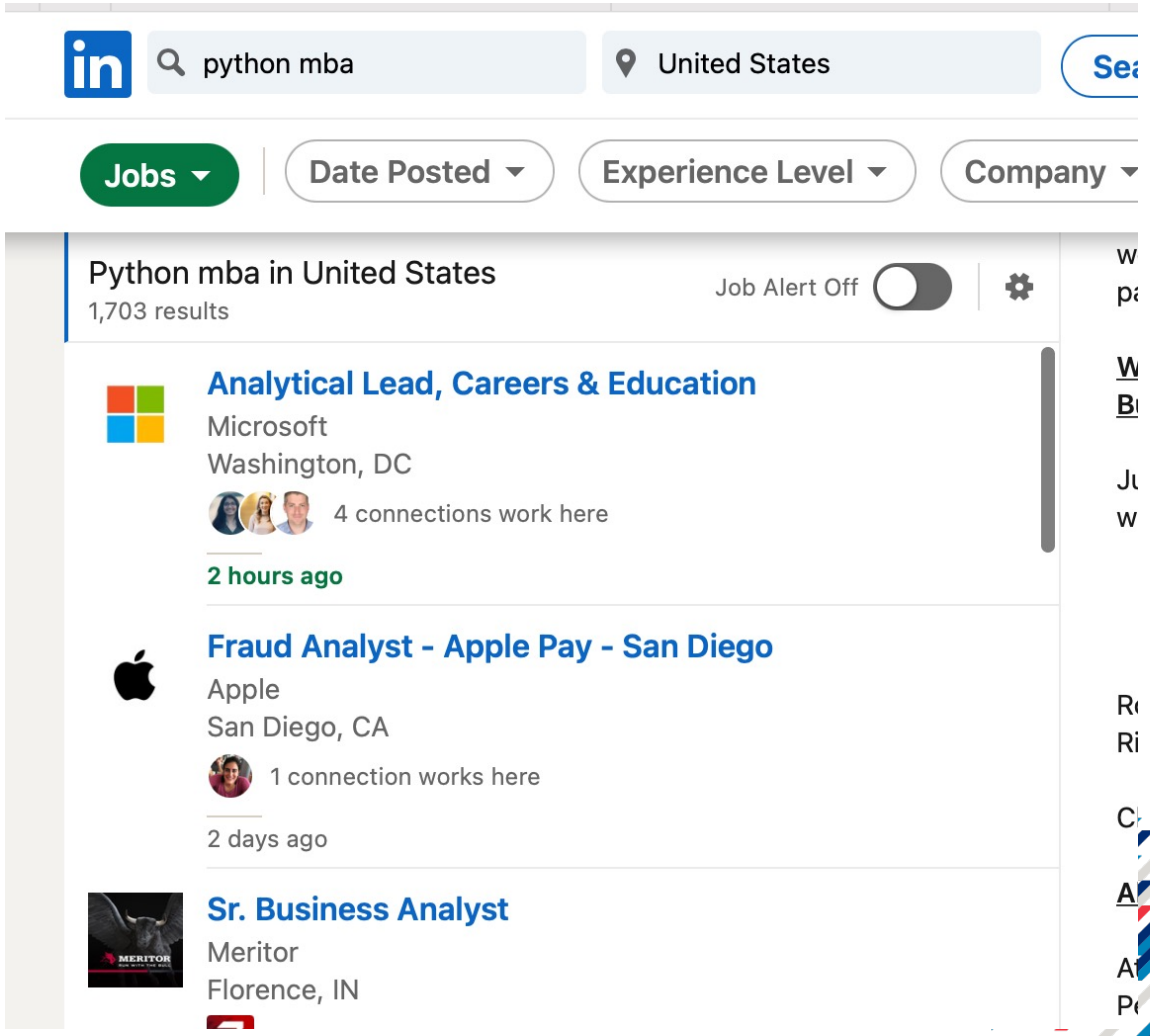
Companies that Rely Upon Python

- Google
  - "Python has been an important part of Google since the beginning, and remains so as the system grows and evolves. Today dozens of Google engineers use Python, and we're looking for more people with skills in this language." - Peter Norvig, director of search quality at Google, Inc.
- Facebook
- Instagram (a Django app!)
- Spotify
- Netflix (super Jupyter proponents)
- Dropbox
- Pinterest (Django)
- Goldman Sachs
- Paypal
- DHS
- DoD

JOBS

Appreciation of Python + MBA is a powerful combo…

- Business Intel Analyst
- Analytics Lead
- Data Scientist
- People Analytics
- Product Manager
- …



Python-Powered ML Tech Stack

Analytics

- Scikit-Learn
- Plotly
- spaCy, keras, tensorflow, torch, etc…

Data Manipulation

- Pandas
- Numpy

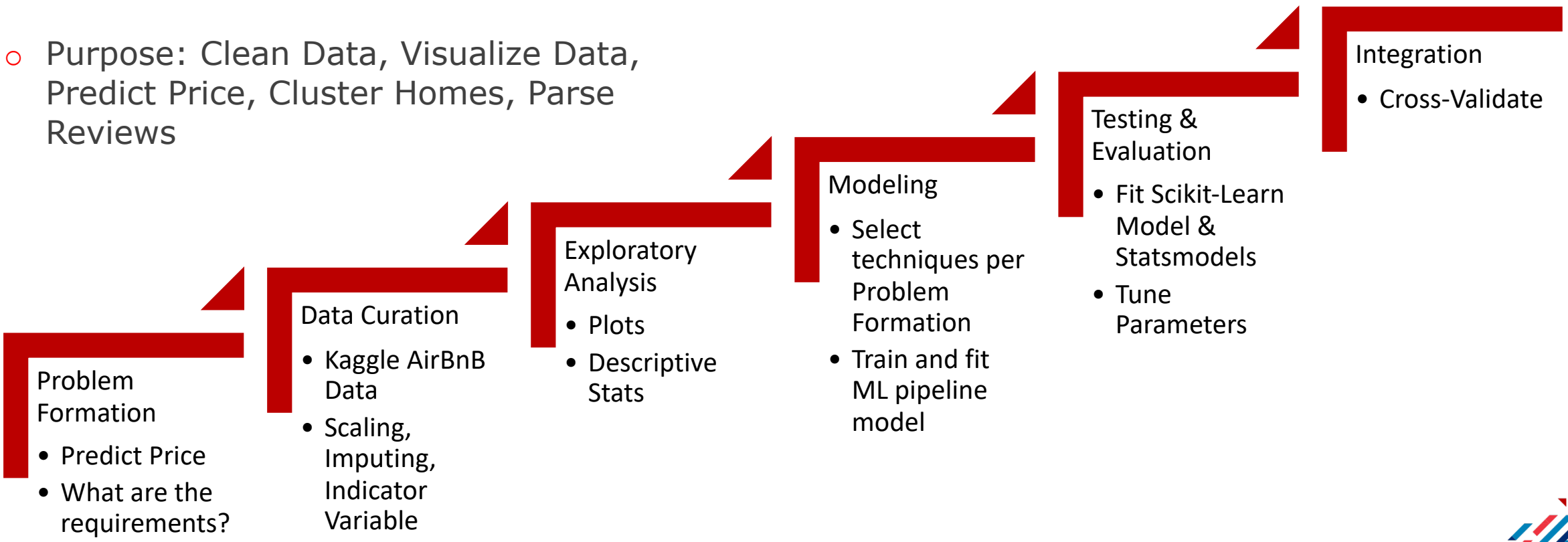
Code & Documentation

- Colab
- Jupyter

Generating Insights for AirBnB

BLUF

- Purpose: Clean Data, Visualize Data, Predict Price, Cluster Homes, Parse Reviews



Let's Apply a Little Python + ML to the AirBnB Dataset with an *Interactive Tutorial*

Time to Code!

GitHub

Github Project Link:
https://github.com/carriegardner428/ML-with-Python-Tepper-CY22-Mini4

colab

Colab Link:
https://colab.research.google.com/github/carriegardner428/ML-with-Python-Tepper-CY22-Mini4/blob/main/

Parting Thoughts

- Thank you for your attention!
  - If you liked this workshop, please endorse one of my skills on LinkedIn
- Please reach out if you want to…
  - Learn more on these topics
  - Get more hands-on python and analytics experience (e.g., collaborative coding events)
  - Share your knowledge and experience on these topics
- Again: You can do this! 😀

Resources

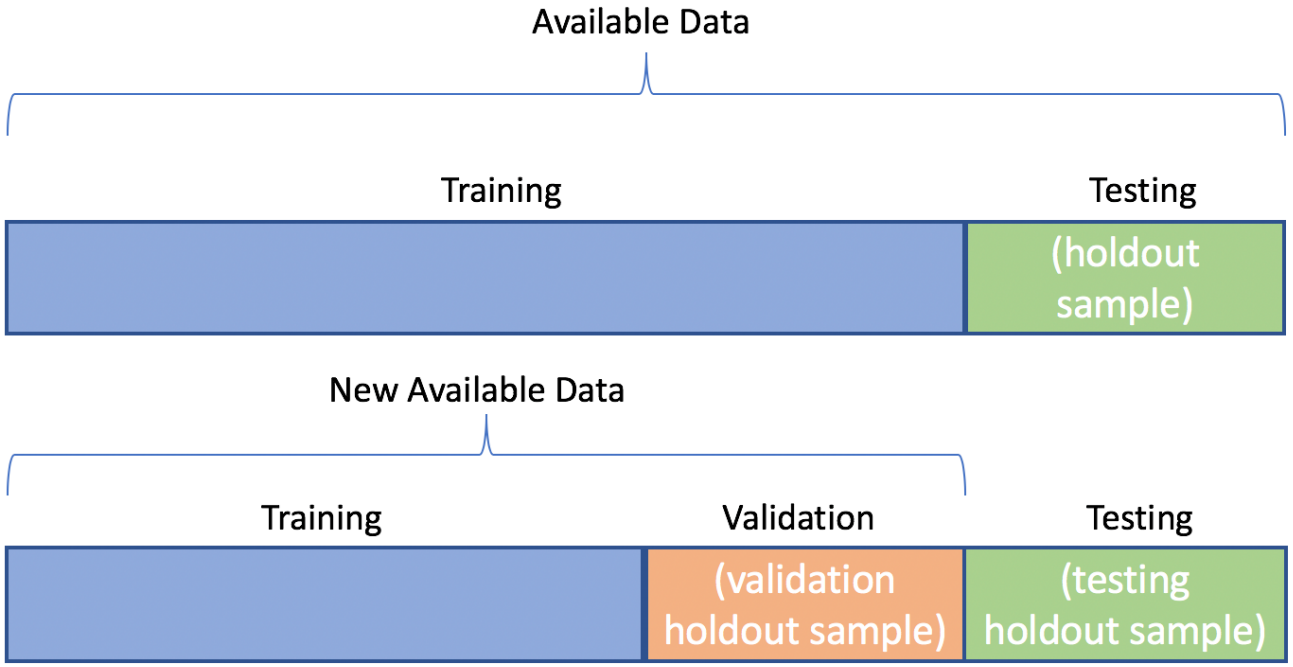
- Hands-on Machine Learning with Scikit-Learn, Keras, & TensorFlow (Book)
- ML Design Patterns (Book)
- Introducing MLOps (Book)
- Building Machine Learning Powered Applications (Book)

Backup Slides

Model Training & Evaluation

Training & Evaluation (T&E)

- Training: data used to fit (train) the model (typically accounts for 70-90% of all data)
- Evaluation (Test): data used to at the end of fitting to measure how robust the model is to handling other data
- Holdout (Validation): data used to assess the performance of the model after the model has been fitted, tested, and is ready for deployment



General Tasks

- Clean Data
- Visualize Data
- Predict Labels
- Presence Detection
- Predict Numerical Values
- Detect Topics in Text
- Detect Sentiment
- Summarize Text
- Infer Absolute and Relative Risk
- Find Clusters
- Real-Time Decisions
- Automate Processes
- …