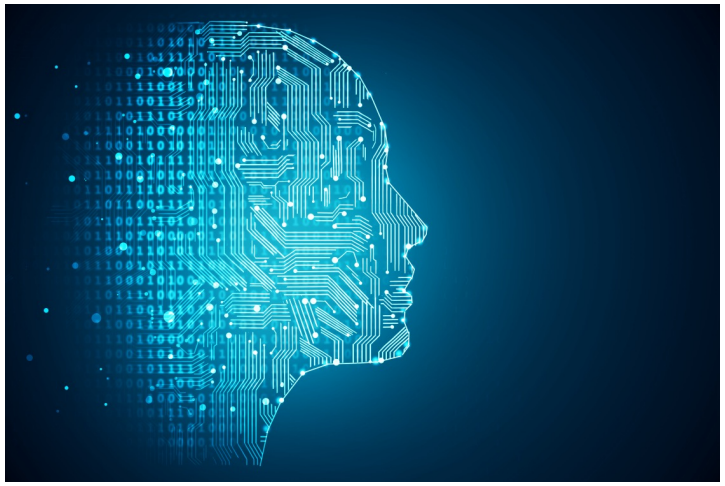
PRINCETON UNIVERSITY

CENTER FOR STATISTICS AND MACHINE LEARNING

Introduction to Machine Learning

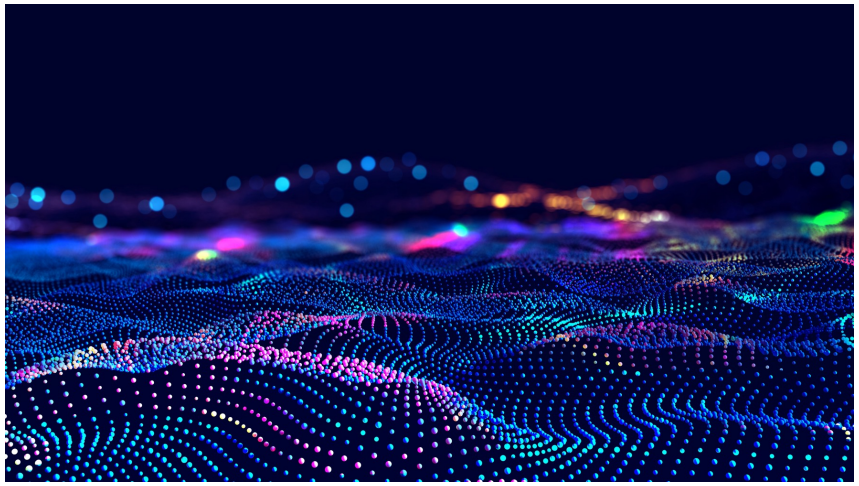


Wintersession 2024
Jan 16-18, 22-23

Gage DeZoort

Julian Gold

Jake Snell



With materials from:
Brian Arnold, Jonathan Halverson, Christina Peters, Savannah Thias, and Amy Winecoff

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Course Outline

Date	Instructor	Topic
Day 1 Tue. 1/16	Jake Snell	Machine Learning Overview and Simple Models
Day 2 Wed. 1/17	Jake Snell	Model Evaluation and Improving Performance
Day 3 Thu. 1/18	Julian Gold	Introduction to Neural Networks
Day 4 Mon. 1/22	Gage DeZoort	Survey of Neural Network Architectures
Day 5 Tue. 1/23	Gage DeZoort Julian Gold Jake Snell	Hackathon! • Computer Vision • Diffusion Models • Large Language Models

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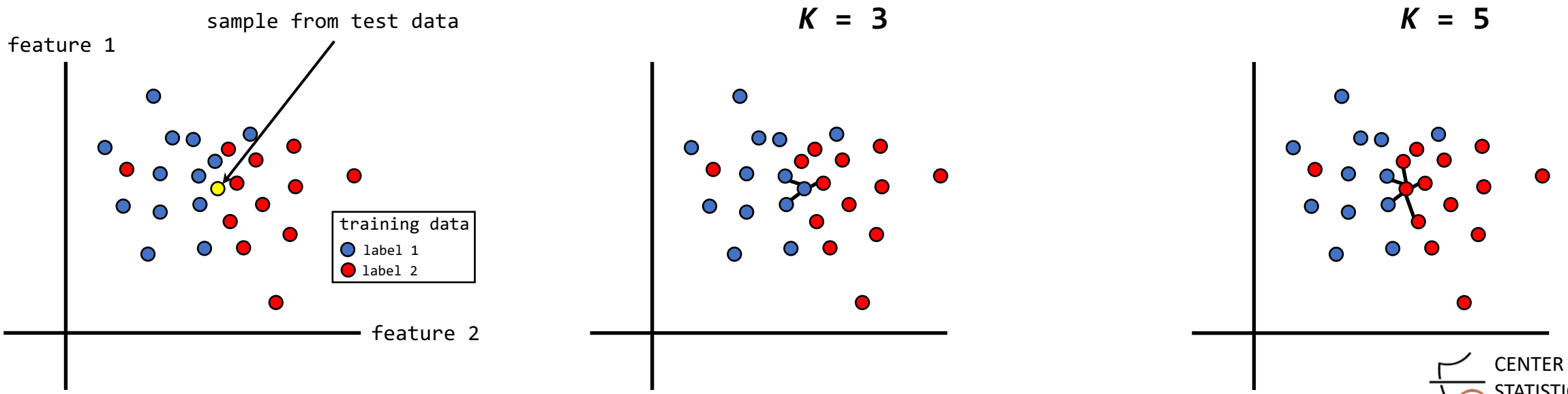
Agenda

- K-nearest Neighbors
  - Regression and classification
- Clustering with K-means
- Evaluation paradigms and improving performance

Intro to *K*-nearest neighbors (KNN)

- simple but powerful
- can be used for classification *or* regression!
- algorithm
  1. for a given test sample (yellow dot), find the *K* nearest training samples in feature space
  2a. for **classification**, assign label by majority vote
  2b. for **regression**, assign value by mean of neighbors

K is a tunable parameter!
- choose value that gives better predictions on test data



Coding in Python!

https://github.com/PrincetonUniversity/intro_machine_learning/tree/main/day2
https://jdh4.github.io/intro-ml

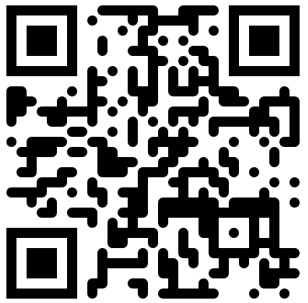
Google Colab

1. Open notebook (.ipynb):

2. Click “Open in Colab”:

JupyterLite

1. Download notebook (.ipynb) from left.
2. Open JupyterLite:



3. Upload the notebook and open:

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K-Means Clustering Visualization

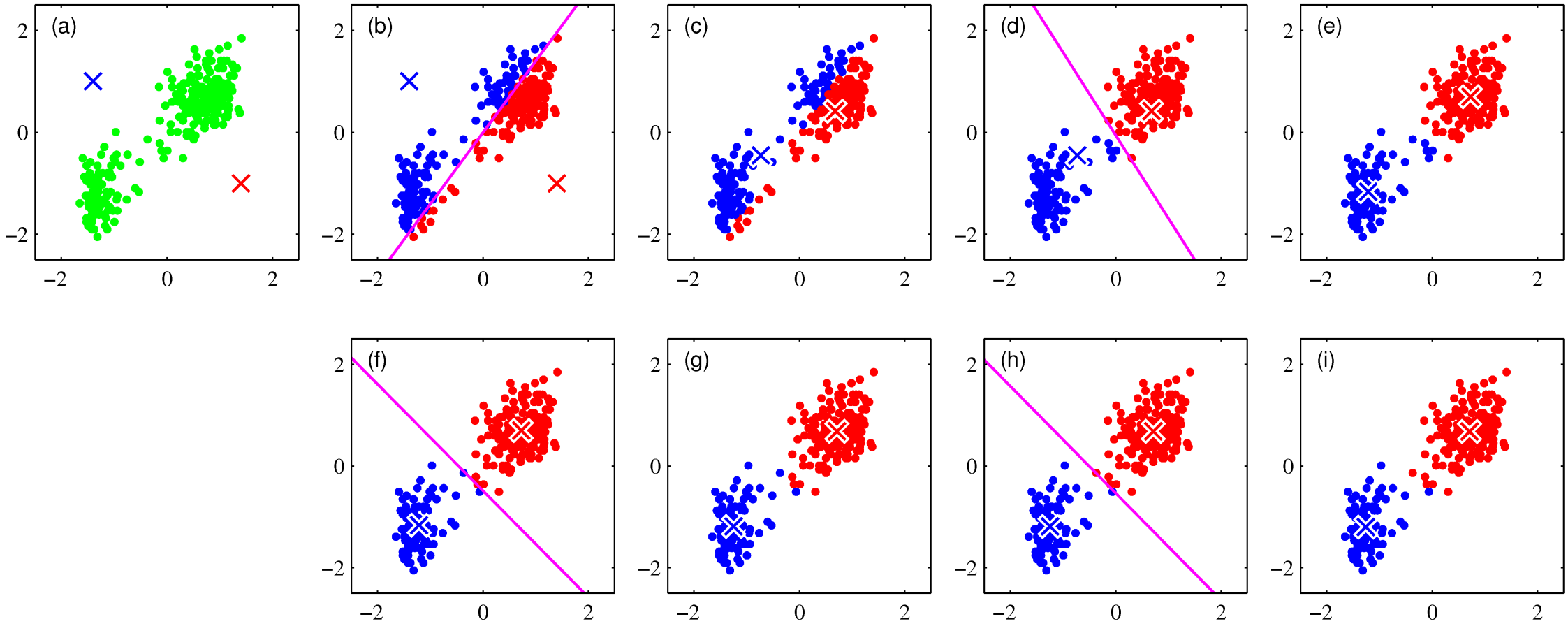


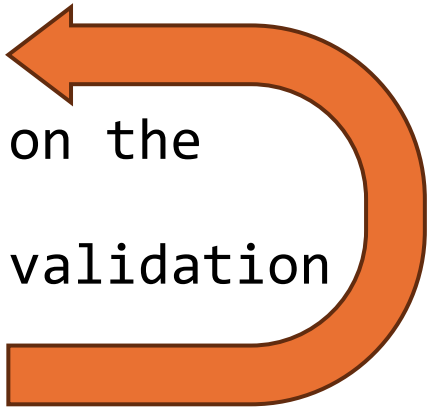
Figure credit: Bishop, Christopher M. 2006. *Pattern Recognition and Machine Learning*.

Overview of Machine Learning Process

1. Define the problem to be solved.

Datasets? Input features?
Targets? Evaluation metrics?

2. Split the data into train / validation / test.
3. Run the validation loop:
   a. Choose a set of models.
   b. Train each model by optimizing its parameters on the training set.
   c. Evaluate the performance of each model on the validation set.
   d. Repeat until performance is satisfactory.



4. Evaluate final performance on the test set.