CS 383: Machine Learning

Prof Adam Poliak

Fall 2024

11/26/2024

Lecture 28

Announcements – Remaining Assignments

HW07: due Wednesday 11/27

HW08: due Friday 12/06 (might extend this too)

No Project Presentations – due end of finals period

Outline

Deep Learning Review

Midterm Review practice problems

Unsupervised learning

Deep Learning

FNN

Solutions to fixed-length input problem

Attention/Self-Attention/Transformers

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Question 1

- First compute weighted leaf labels

$$P(+ \mid \text{sun}) = \frac{\frac{1}{3}}{\frac{1}{3} + \frac{1}{8} + \frac{1}{8}} = \frac{4}{7} \geq 0.5 \quad \Rightarrow +$$

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$$P(+ \mid \text{rain}) = \frac{\frac{1}{12}}{\frac{1}{12} + \frac{1}{6} + \frac{1}{6}} = \frac{1}{5} < 0.5 \quad \Rightarrow -$$

Question 1

- Based on these labels, we can say which training points are misclassified

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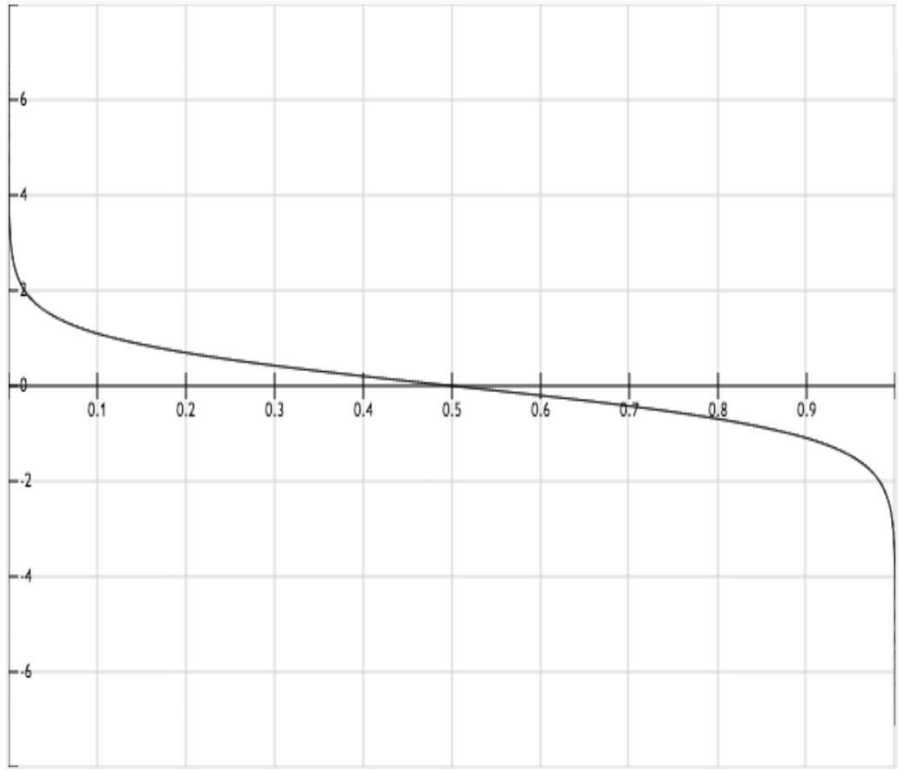
- Note if this was > 0.5, we should have chosen different leaf labels! So this “flipping” step should happen automatically
  - (exception for pathological cases)

Question 1

- Score function:

$$\alpha_t = \frac{1}{2} \ln \left(\frac{1-\epsilon_t}{\epsilon_t} \right)$$

- Fraction: accuracy/error
- As error -> 0, score becomes high
- As error -> ½, score goes to 0



Question 2

- r = 1/3, probability of one classifier being wrong
- T = 5, number of classifiers
- R = number of votes for the wrong class
- If R=3,4,5 then we will vote for the wrong class overall

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- What if they are not? How did Random Forests help us decorrelate classifiers?
- Note about Bagging: choosing *n* with resampling actually does produce a very different dataset
  - As *n* increases, roughly 0.37 not chosen each time

Question 3

- False Positive Rate: FP / (FP + TN)

- True Positive Rate: TP / (TP + FN)

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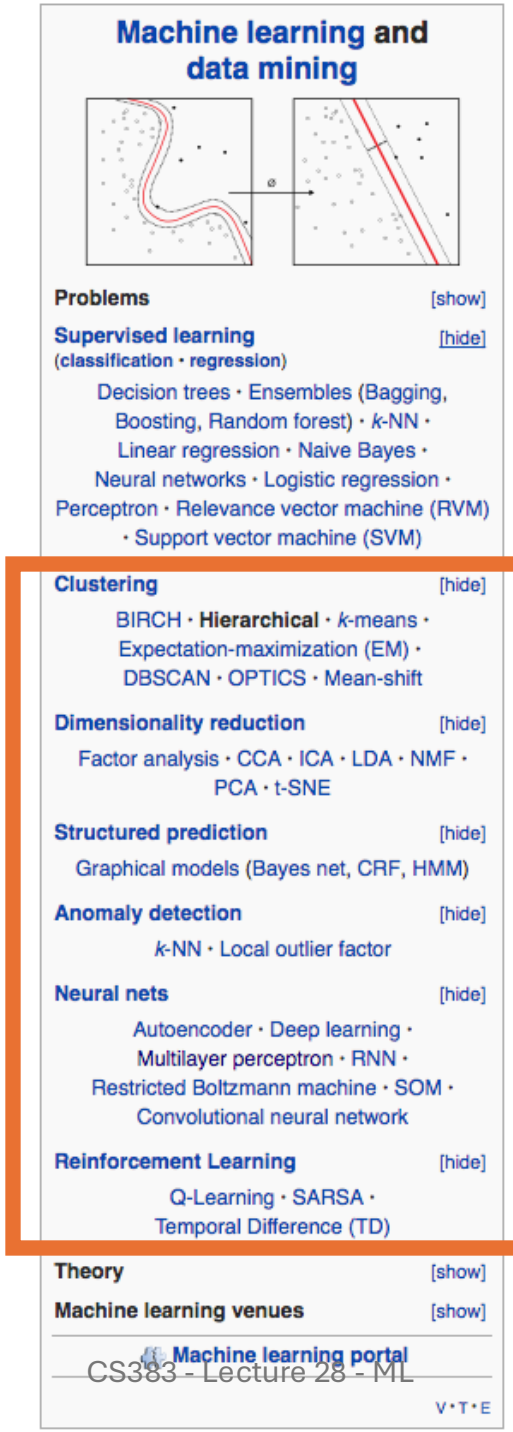
Supervised Learning:
makes use of examples where we know the underlying "truth" (label/output)



Unsupervised Learning:
Learn underlying structure or features without labeled training data

Image: wikipedia

Unsupervised learning: 3 main areas

1) Clustering: group data points into clusters based on features only

2) Dimensionality reduction: remove feature correlation, compress data, visualize data

3) Structured prediction: model latent variables (example: Hidden Markov Models)

Unsupervised Algorithms

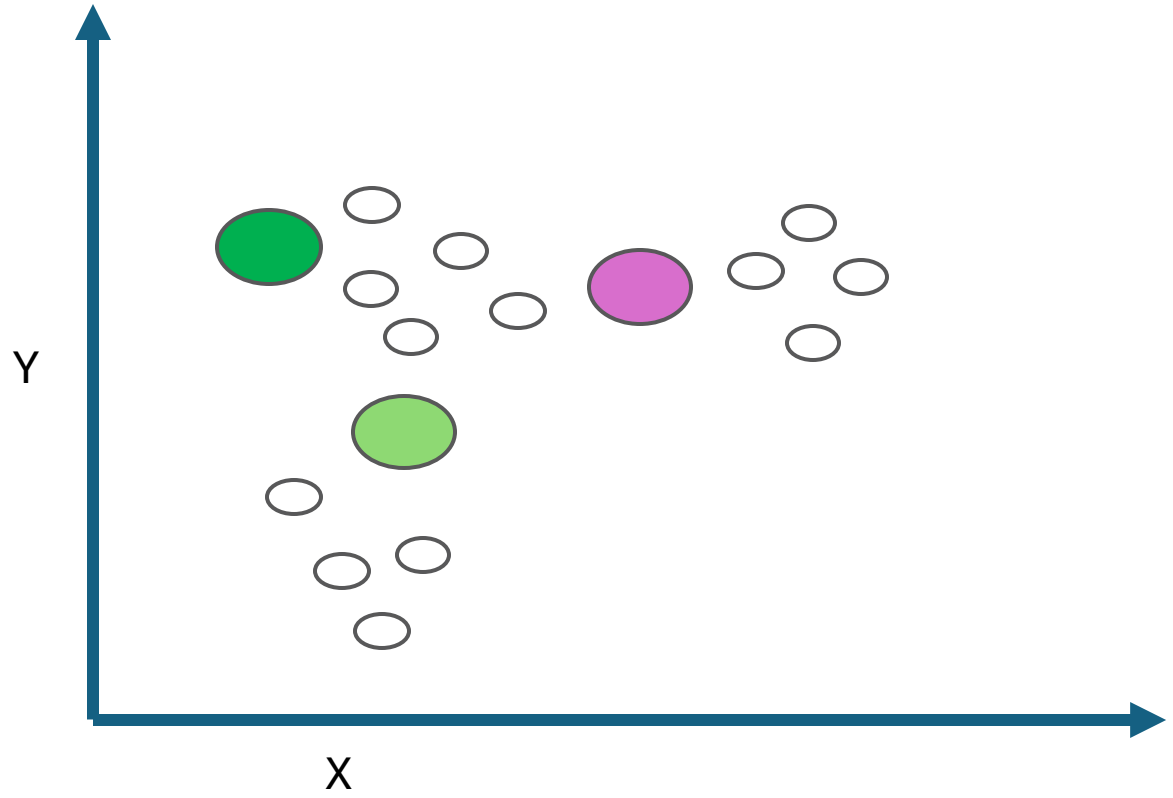
- K-means
- Gaussian Mixture Models (GMM)
- Principle Component Analysis (PCA)

K-means Algorithms

1. Initialize: Randomly pick K points as cluster centers

Randomly pick K points as centers

- Example: 2D point patterns



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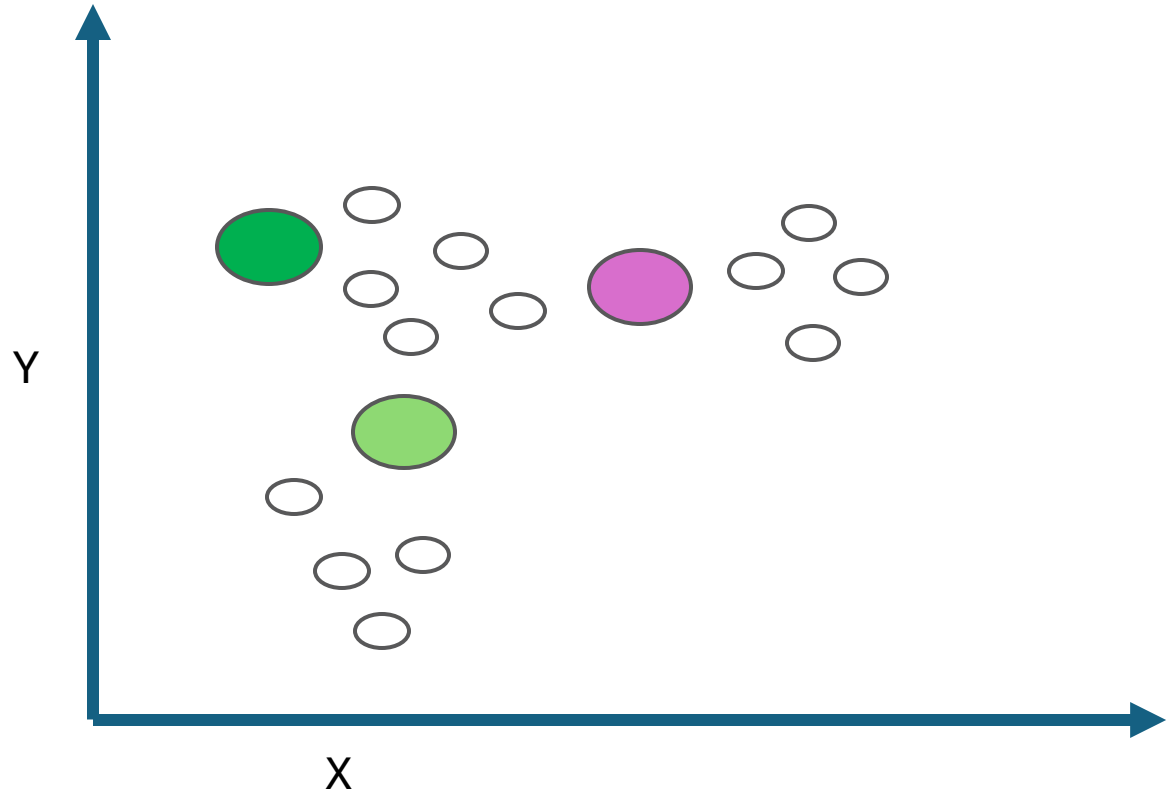
Assign data points to each cluster

- Example: 2D point patterns



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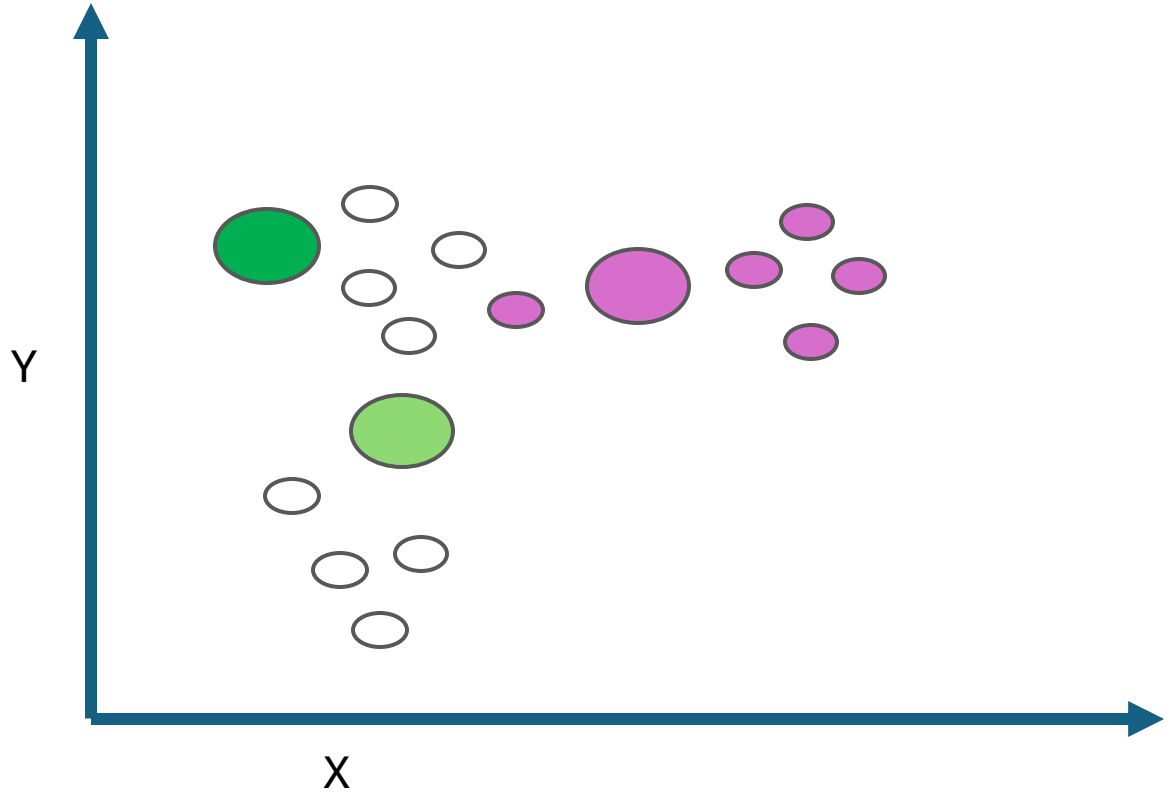

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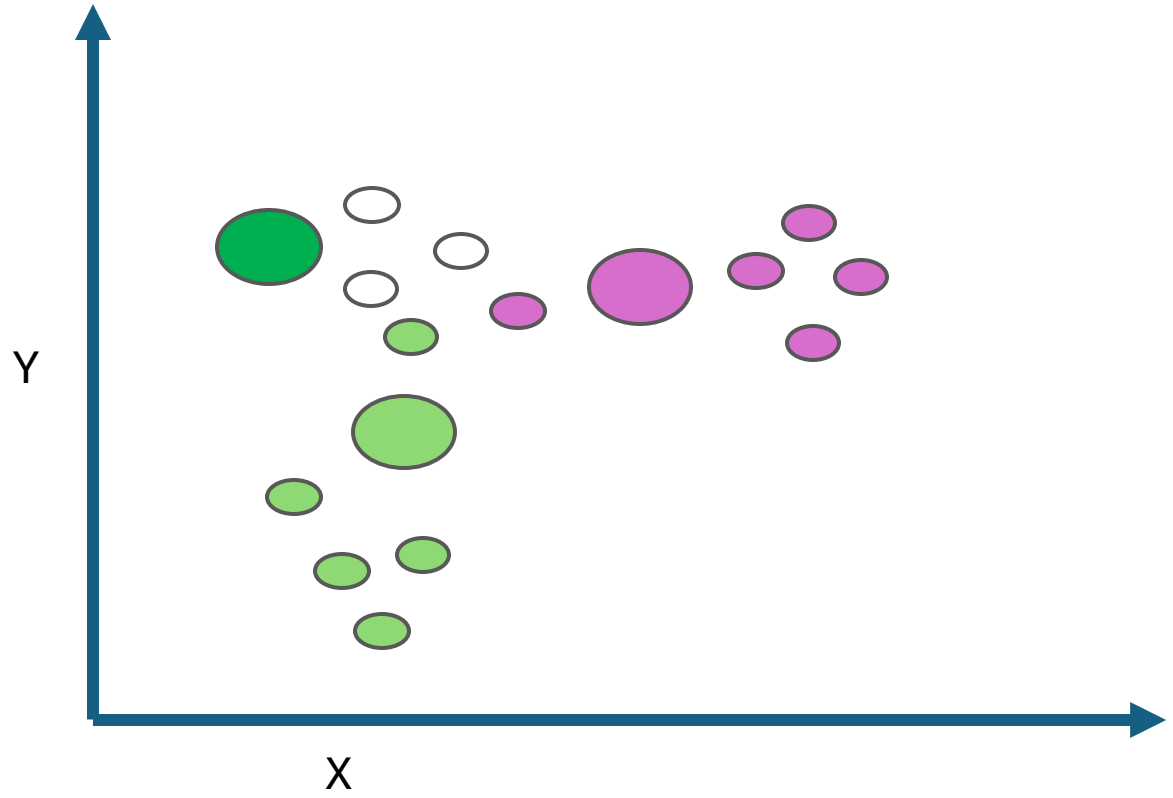

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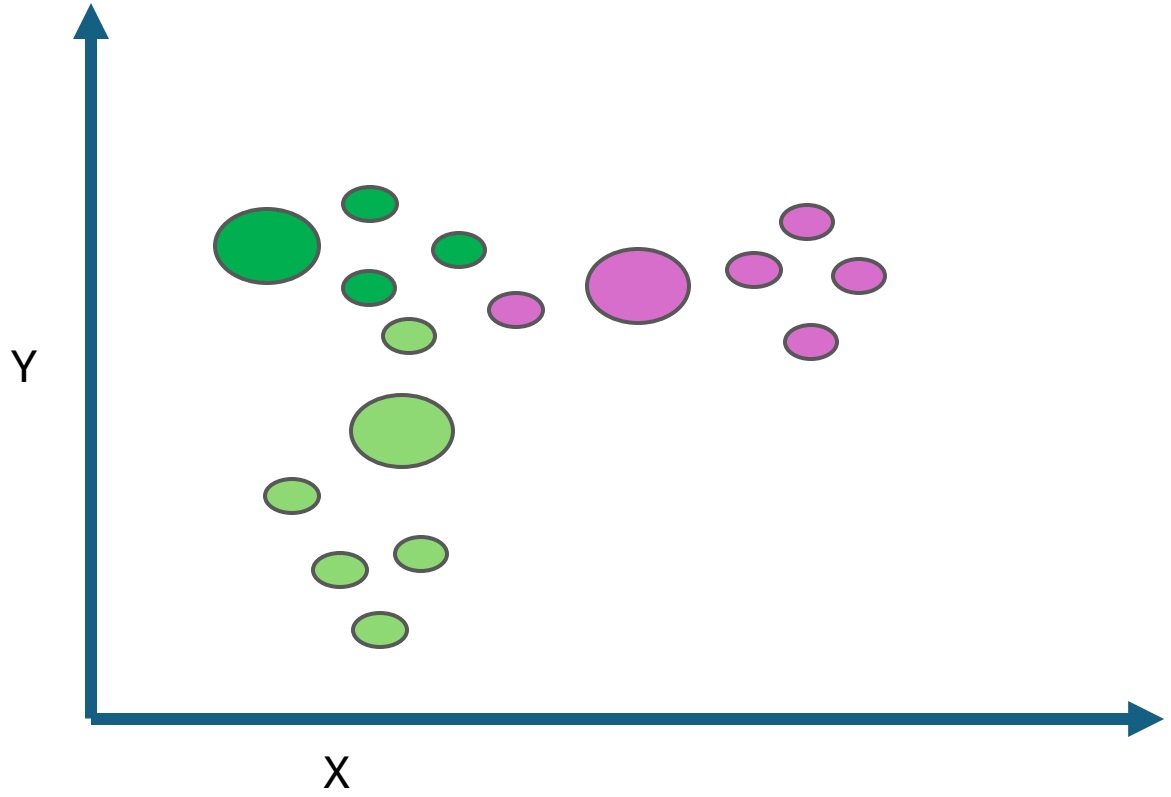

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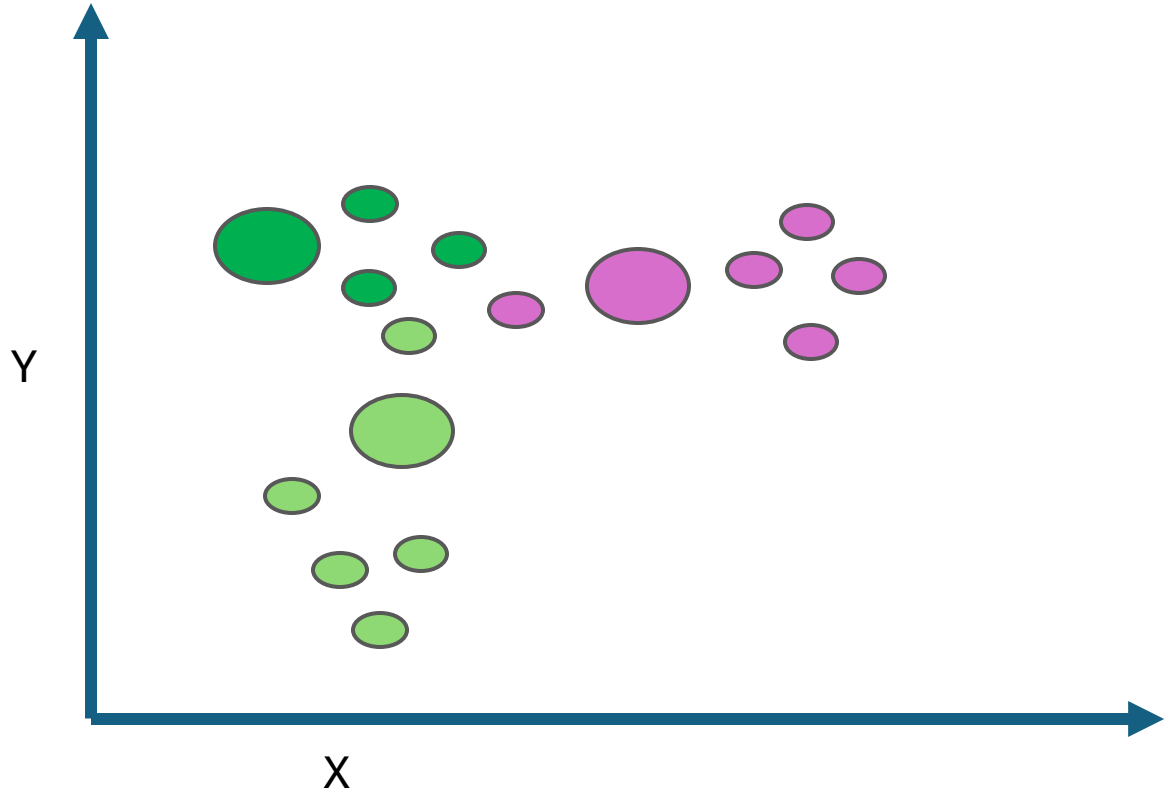
Update Centers

- Example: 2D point patterns



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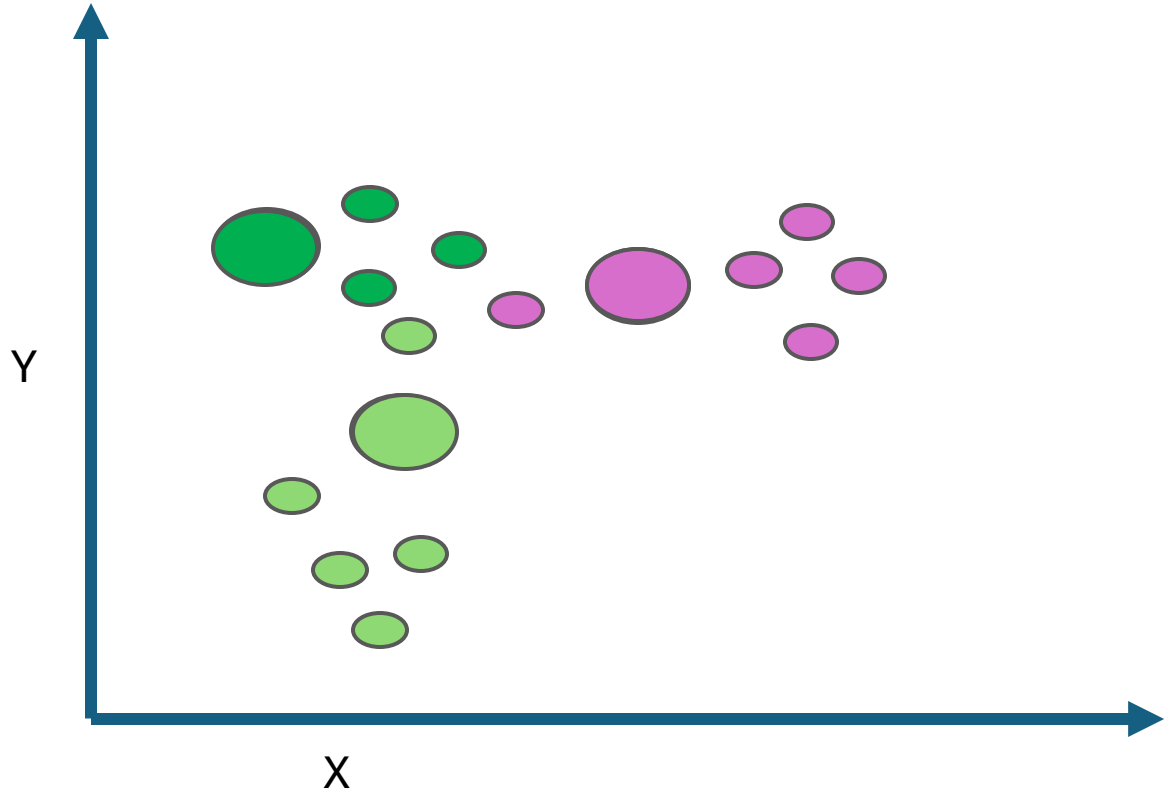

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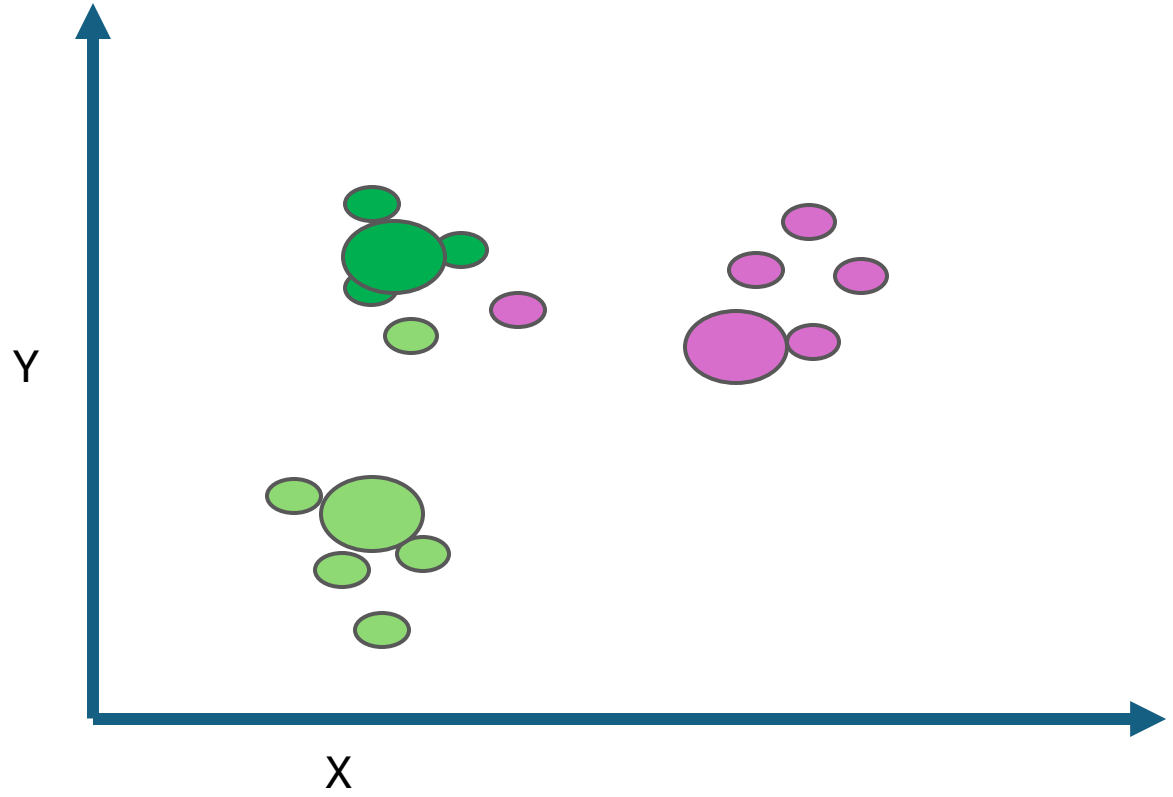

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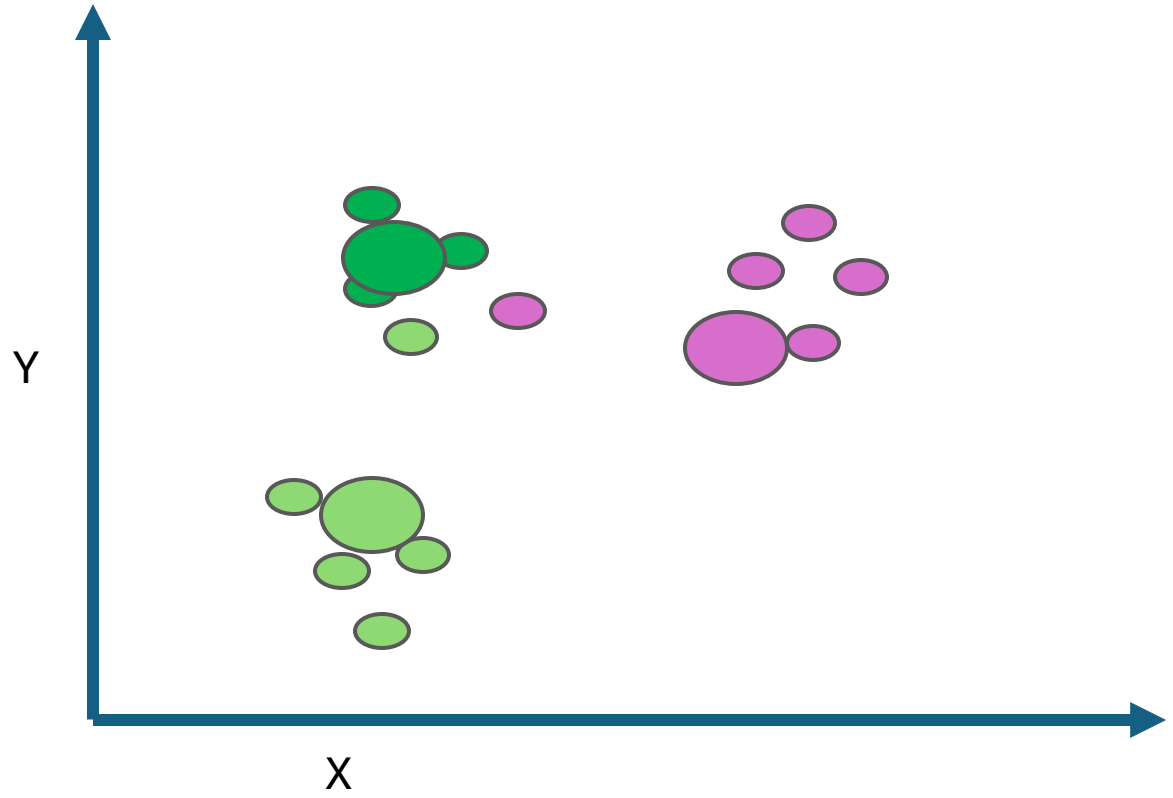

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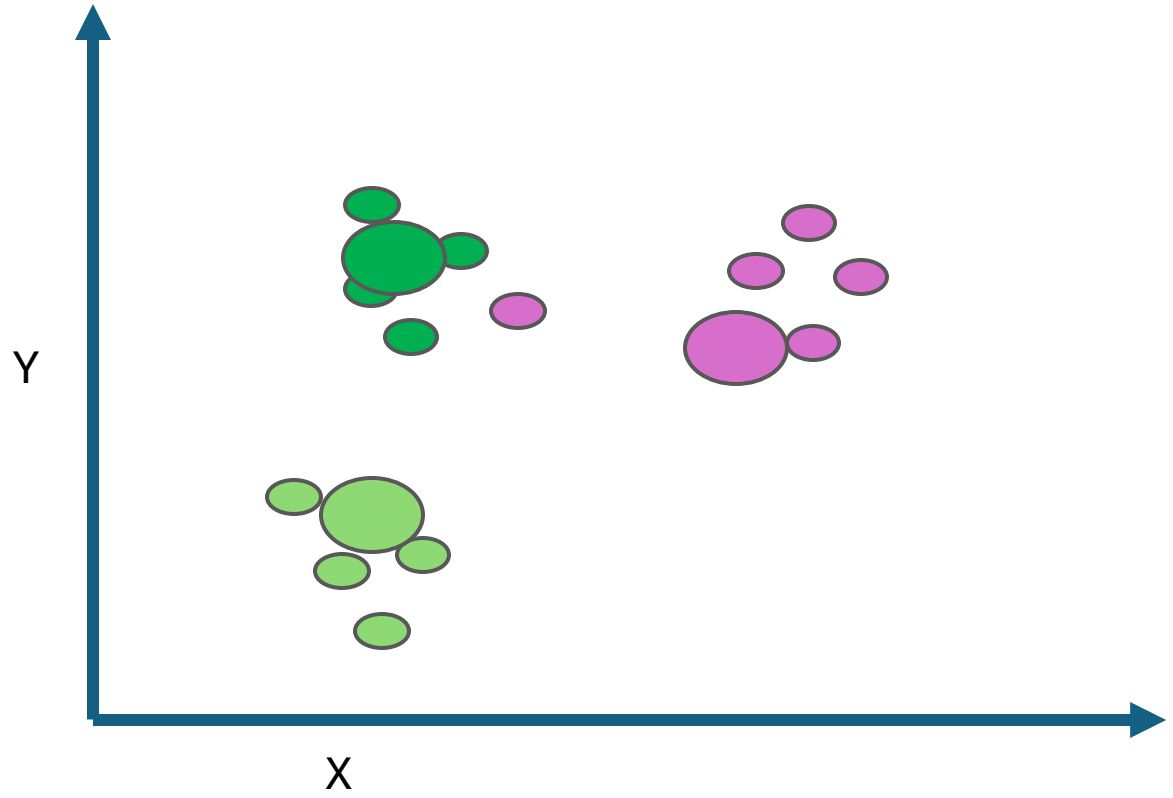

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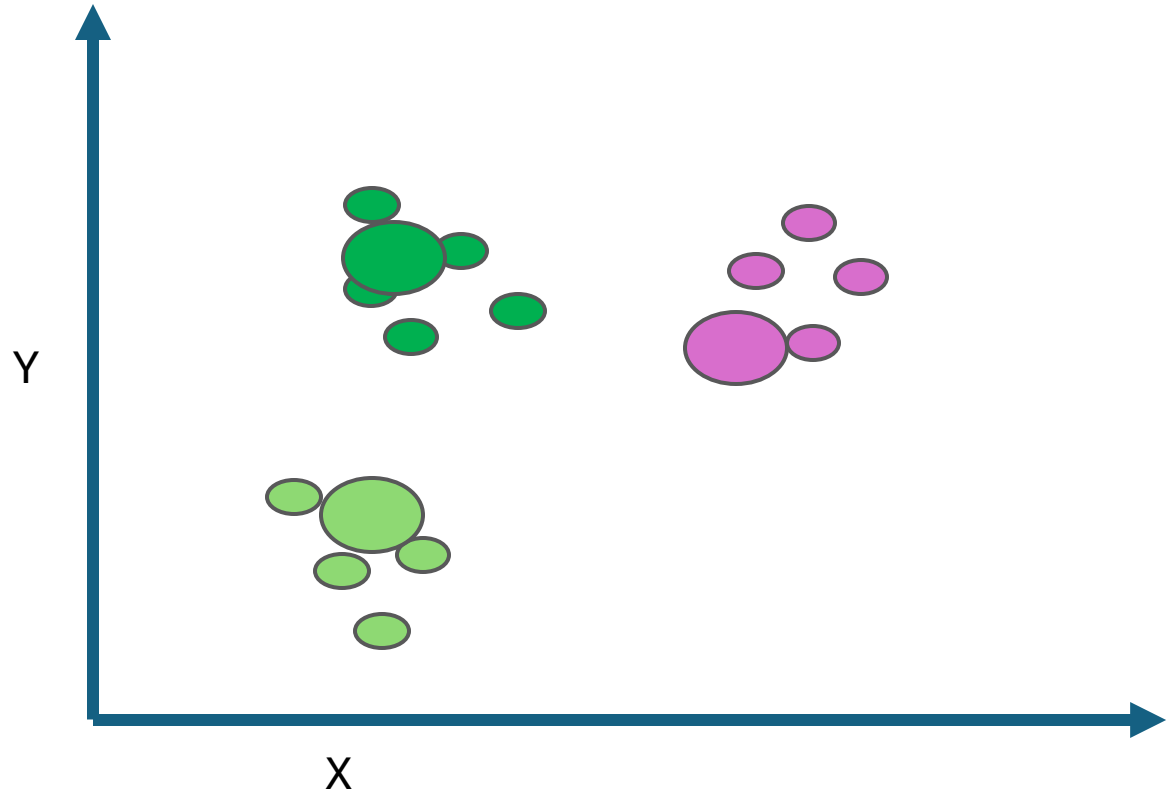

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