

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

Outline

Deep Learning Review

Midterm Review practice problems

Unsupervised learning

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

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

Question 1

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

$$\epsilon_t = \frac{1}{8} + \frac{1}{8} + \frac{1}{12} = \frac{1}{3}$$

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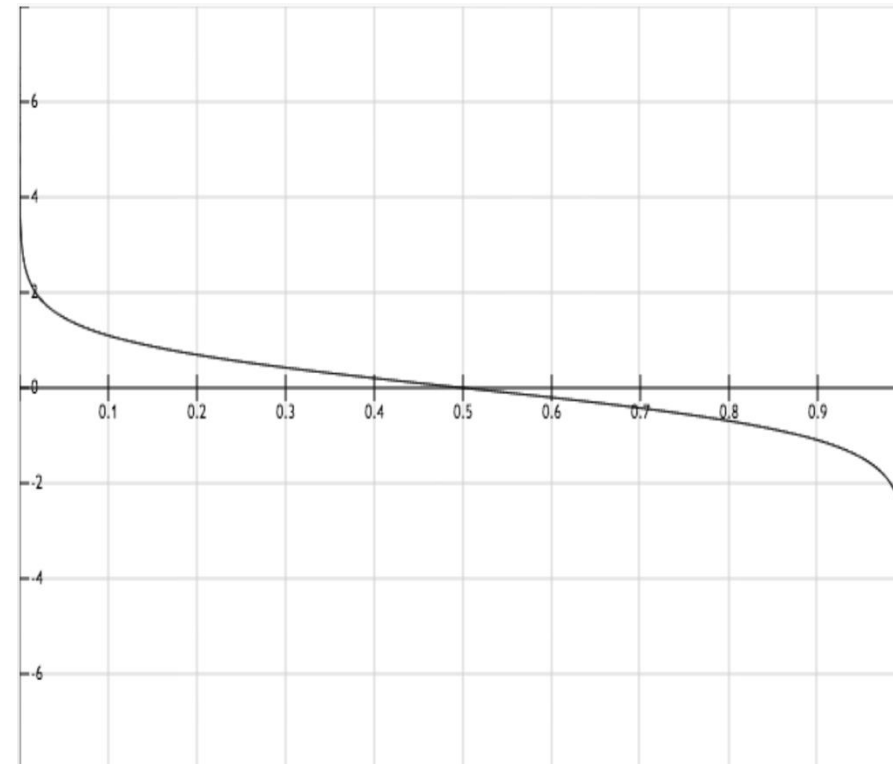
$$\epsilon_t = \frac{1}{8} + \frac{1}{8} + \frac{1}{12} = \frac{1}{3}$$

- 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:
- Fraction:
accuracy/error
- As error $\rightarrow 0$, score becomes high
- As error $\rightarrow \frac{1}{2}$, score goes to 0

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



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

Question 2

- This analysis assumed classifiers were independent!
- What if they are not? How did Random Forests help us decorrelate classifiers?

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- This analysis assumed classifiers were independent!
- 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: $TP / (TP + FN)$

Outline

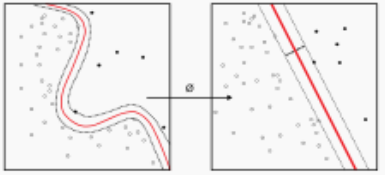
Deep Learning Review

Midterm Review practice problems

Unsupervised learning

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

Machine learning and data mining



Problems [show]

Supervised learning [hide]
(classification • regression)

Decision trees • Ensembles (Bagging, Boosting, Random forest) • *k*-NN • Linear regression • Naive Bayes • Neural networks • Logistic regression • Perceptron • Relevance vector machine (RVM) • Support vector machine (SVM)

Clustering [hide]
BIRCH • Hierarchical • *k*-means • Expectation-maximization (EM) • DBSCAN • OPTICS • Mean-shift

Dimensionality reduction [hide]
Factor analysis • CCA • ICA • LDA • NMF • PCA • t-SNE

Structured prediction [hide]
Graphical models (Bayes net, CRF, HMM)

Anomaly detection [hide]
k-NN • Local outlier factor

Neural nets [hide]
Autoencoder • Deep learning • Multilayer perceptron • RNN • Restricted Boltzmann machine • SOM • Convolutional neural network

Reinforcement Learning [hide]
Q-Learning • SARSA • Temporal Difference (TD)

Theory [show]

Machine learning venues [show]

Machine learning portal

CS383 - Lecture 28 - ML

V • T • E

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

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

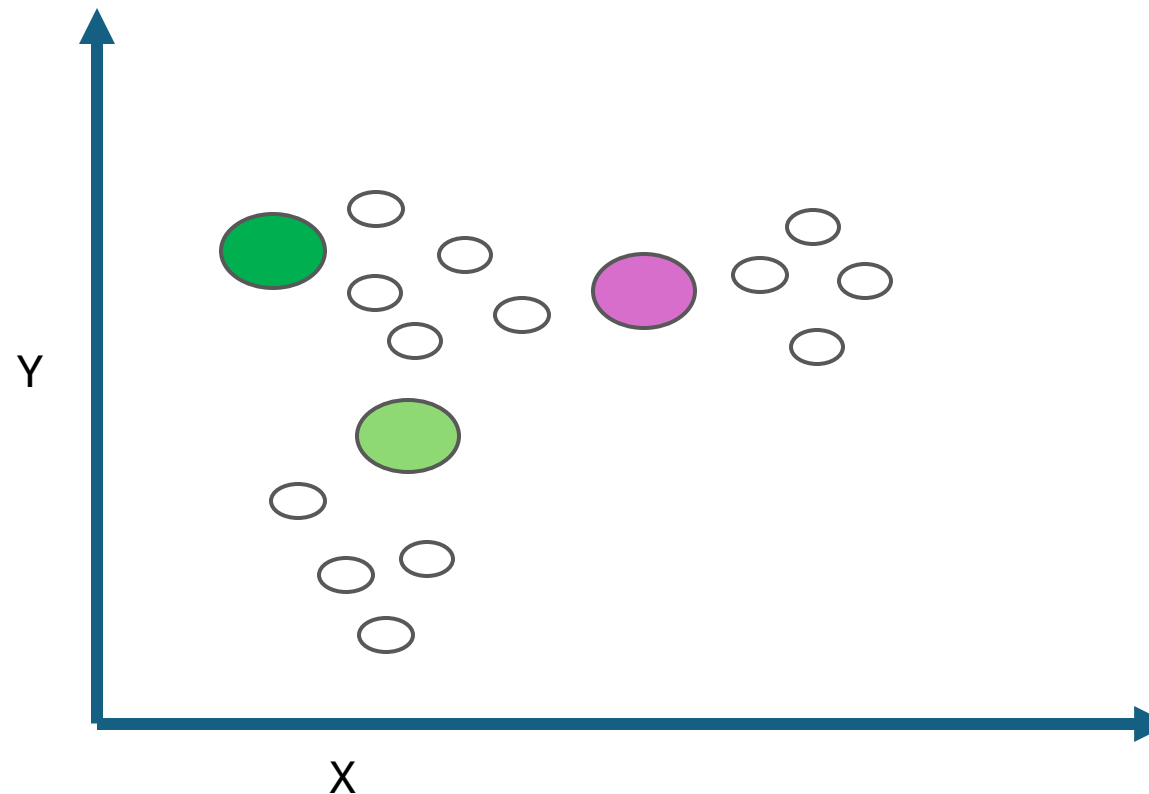
- K-means
- Gaussian Mixture Models (GMM)
- Principle Component Analysis (PCA)

K-means Algorithms

1. Initialize: Randomly pick K points as cluster centers

Randomly pick K points as centers

- Example: 2D point patterns

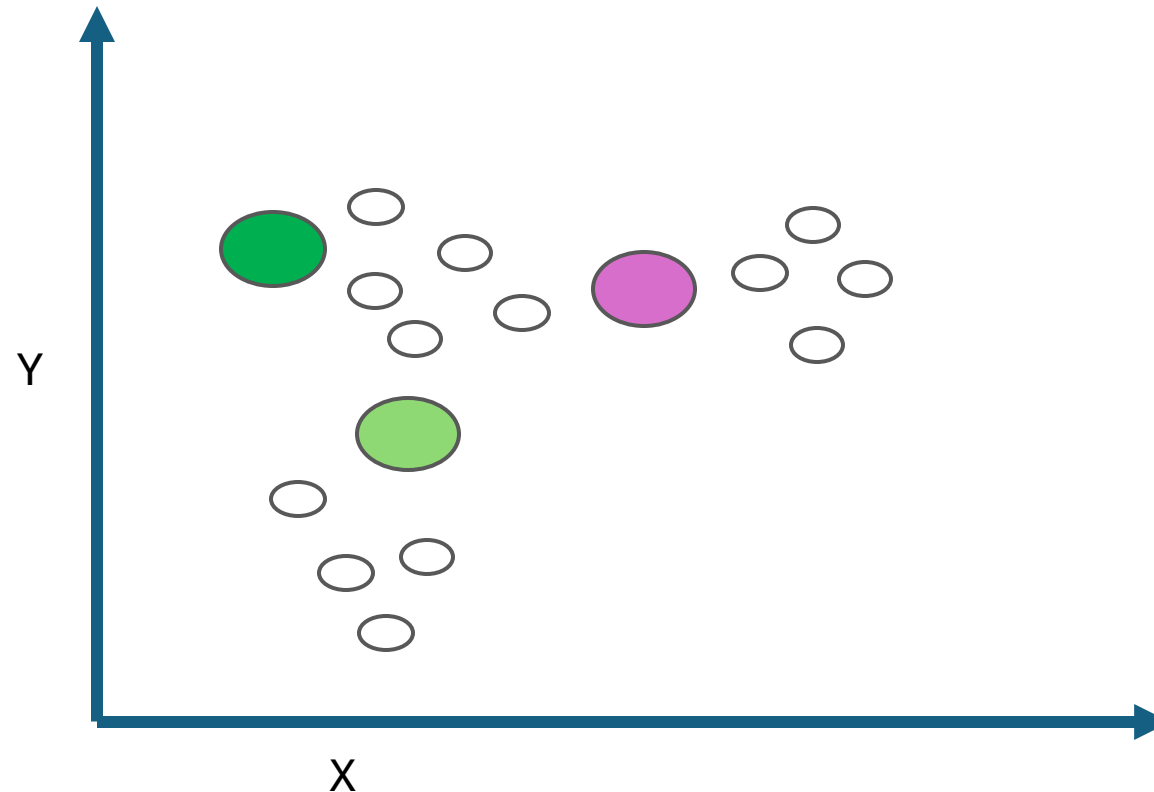


K-means Algorithms

1. Initialize: Randomly pick K points as cluster centers
2. Assign data points to each cluster
 1. Based on distance between point and cluster's center

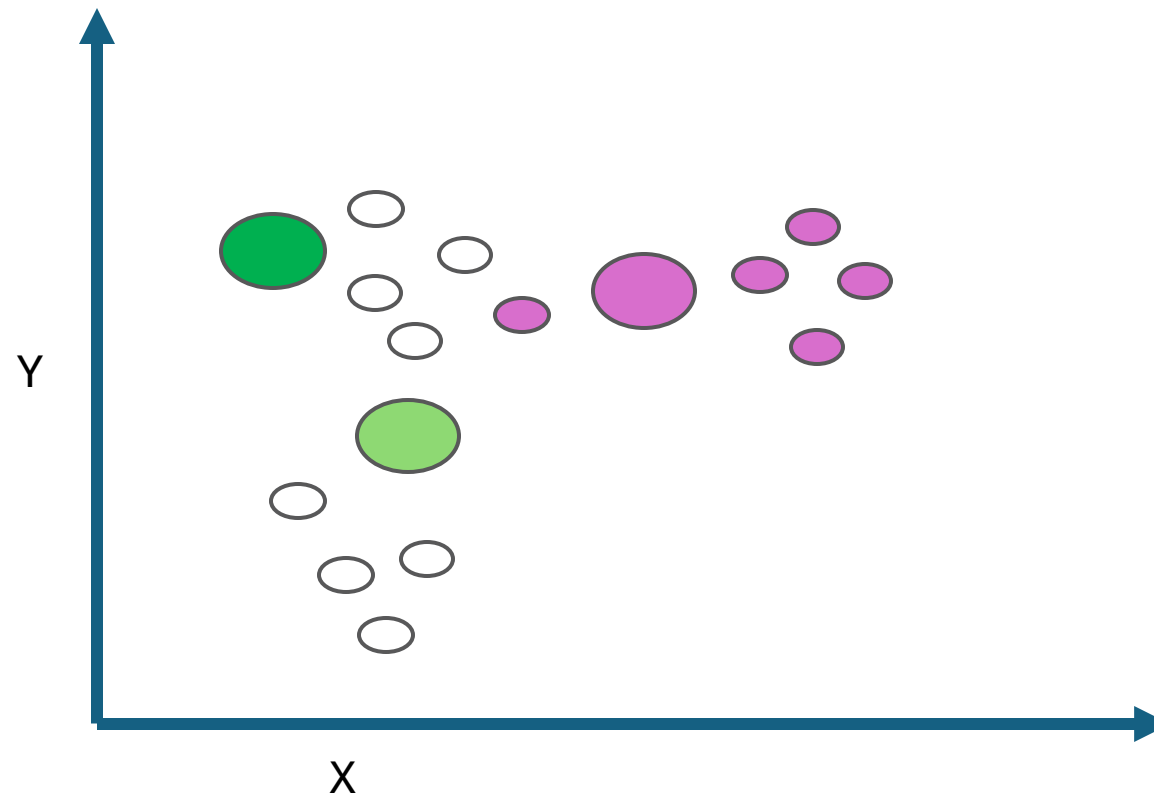
Assign data points to each cluster

- Example: 2D point patterns



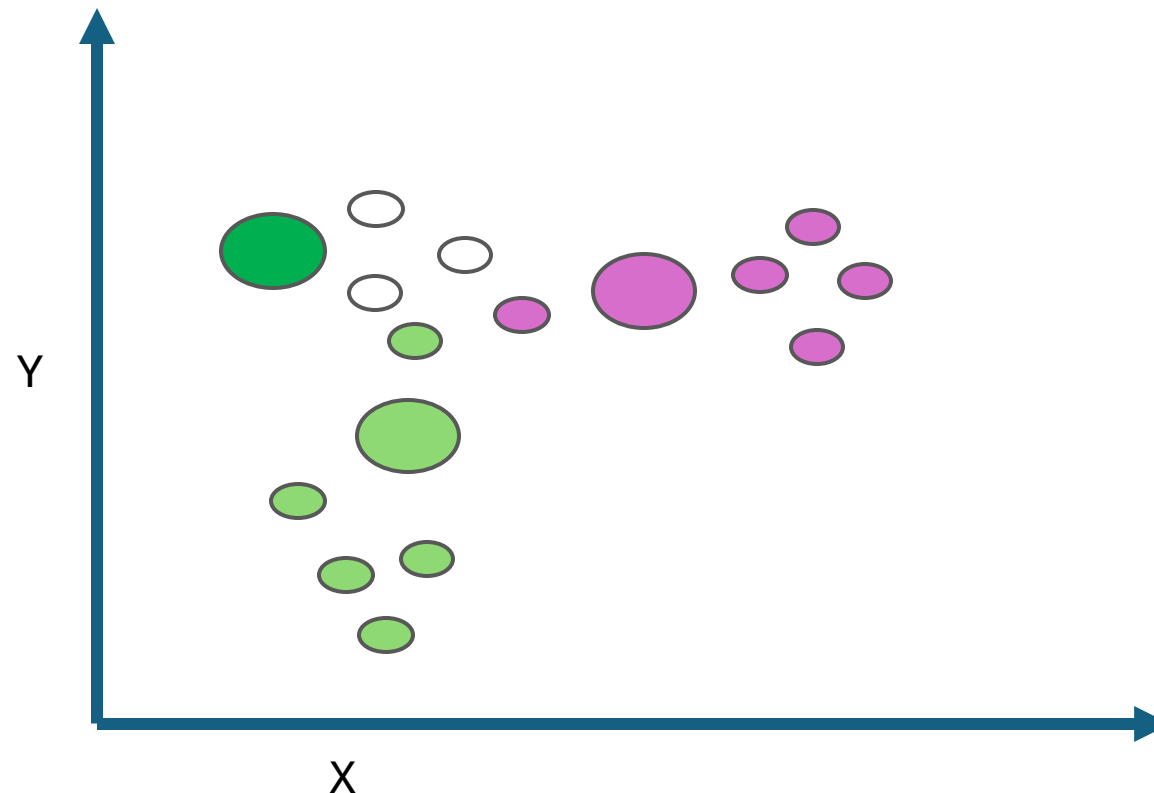
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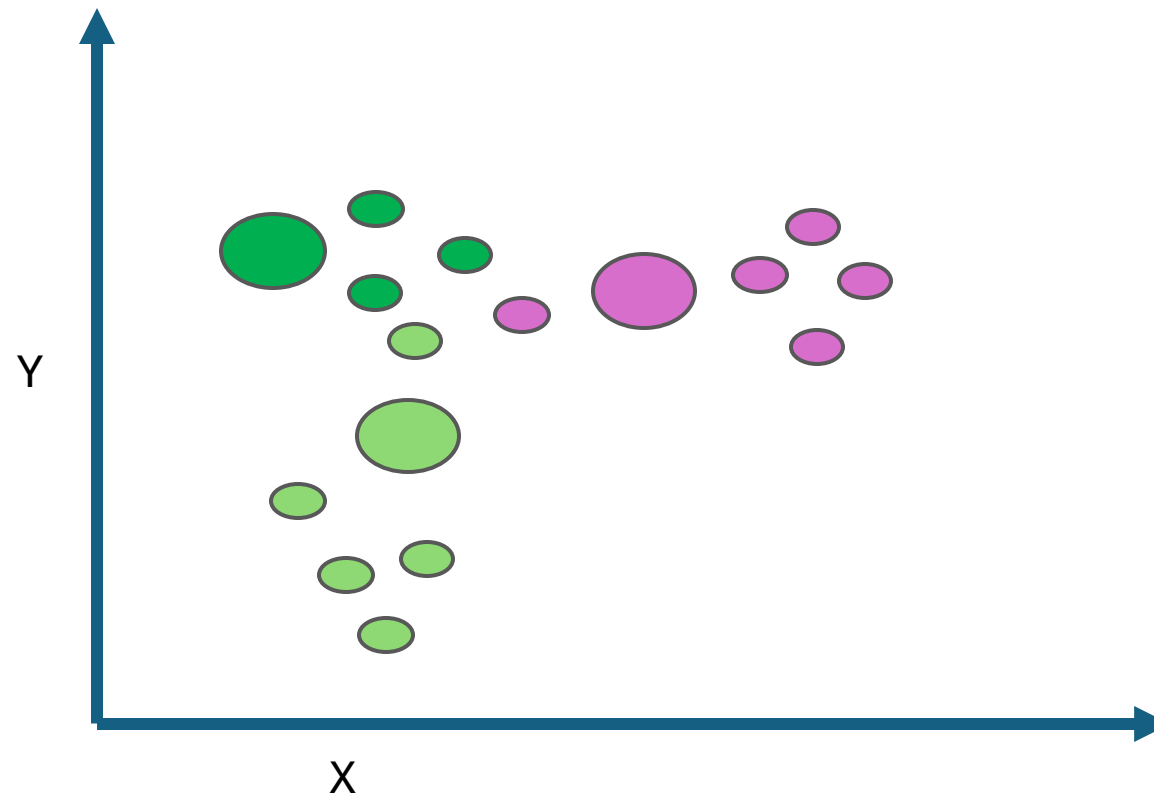
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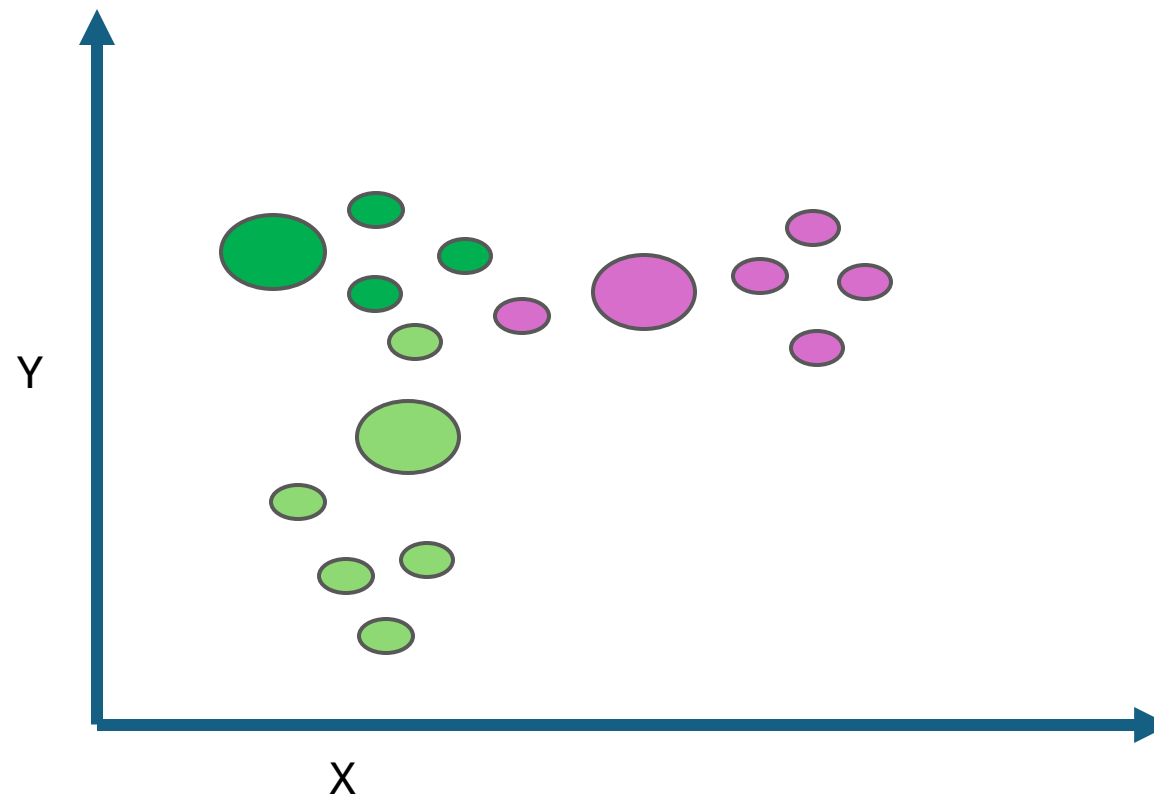


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 1. The average of its assigned points

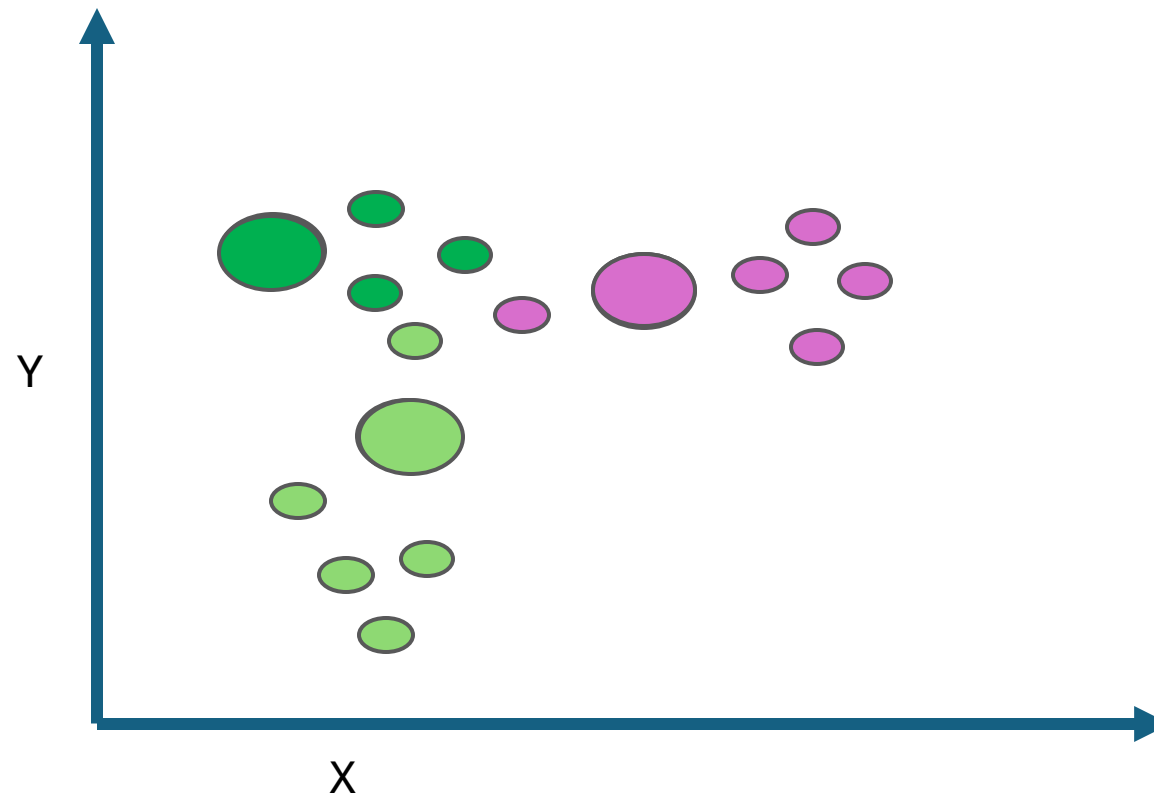
Update Centers

- Example: 2D point patterns



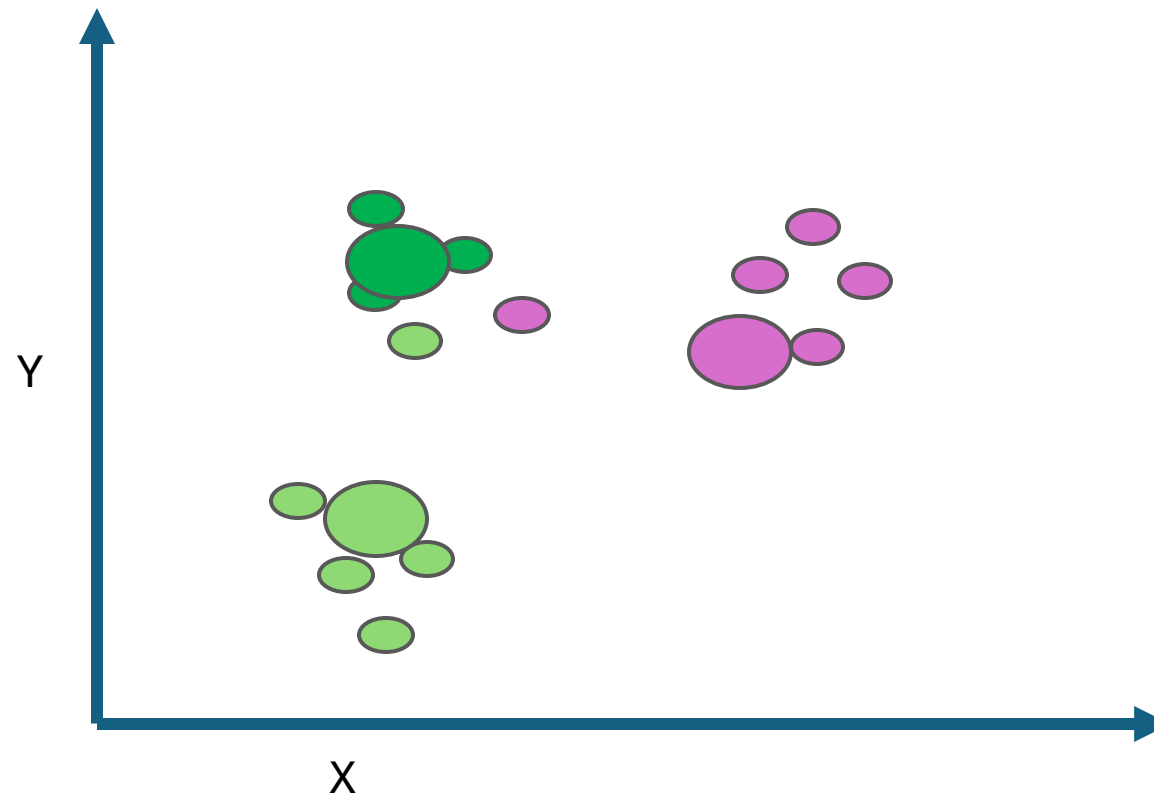
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Updated Centers

- Example: 2D point patterns

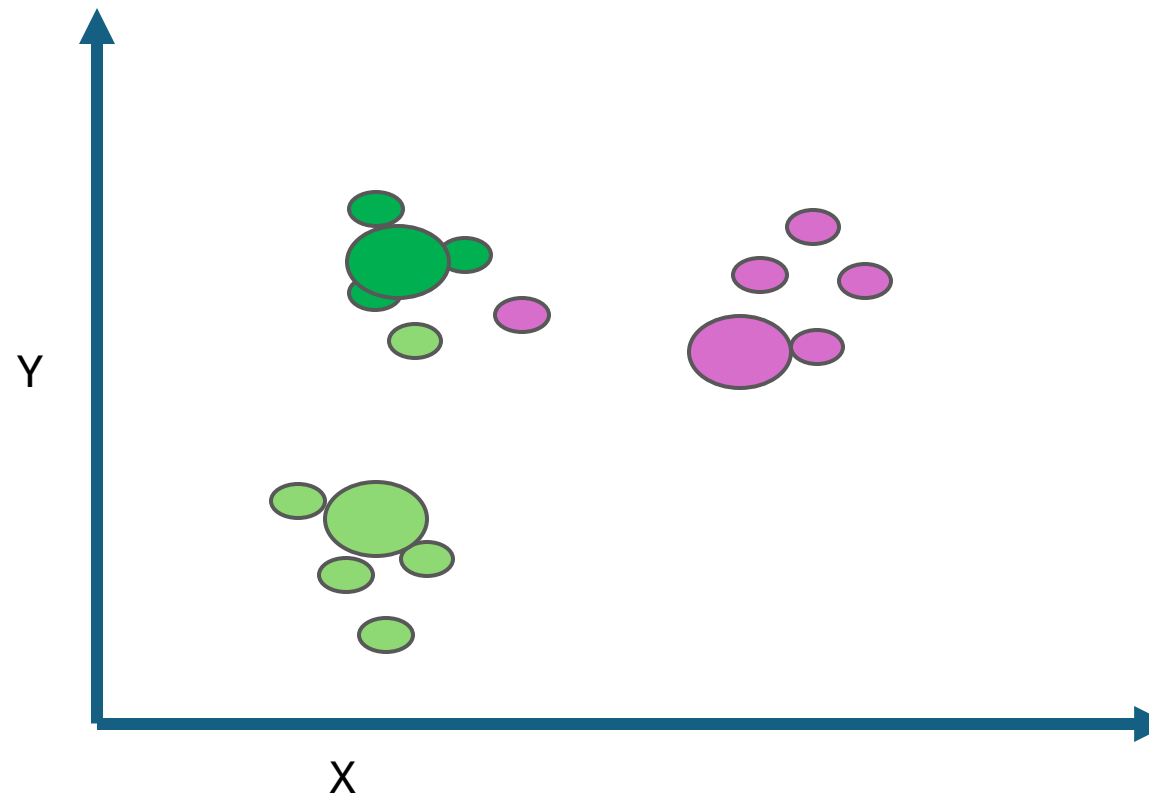


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4. Repeat 2 & 3 until the assignments stop changing

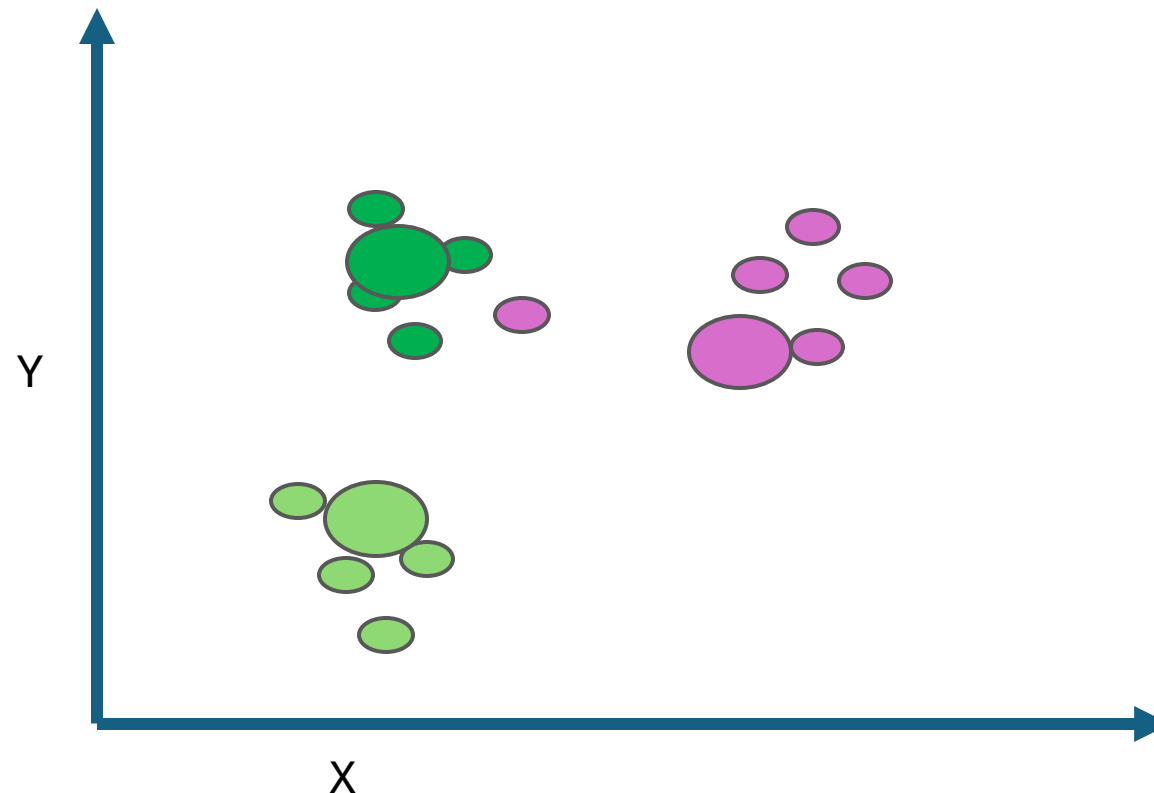
Reassign data points to each cluster

- Example: 2D point patterns



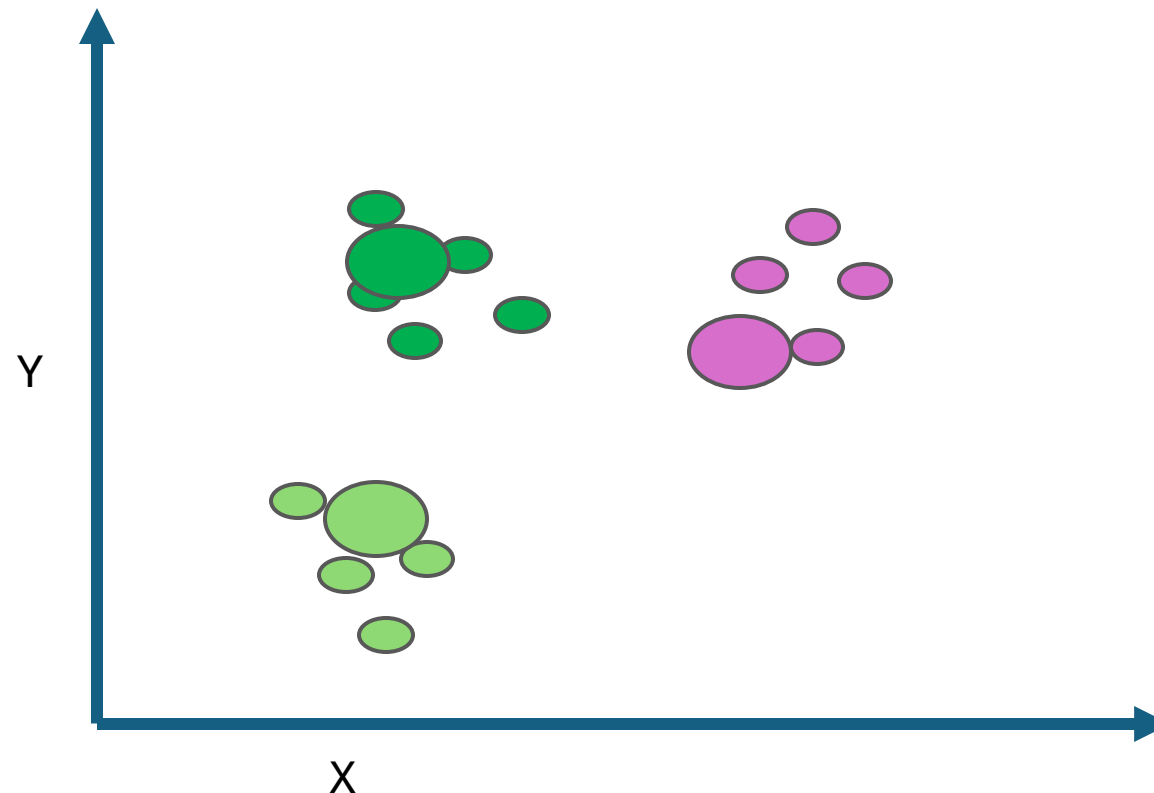
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