Ch 12.1, 12.4: Unsupervised Learning & Clustering

Lecture 32 - CMSE 381

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Mon, Nov 25, 2024

Announcements

Last time:

- Convolutional Neural Nets

This lecture:

- Clustering (Just hierarchical clustering)

Announcements:

- No more homework!
- Weds: Project office hours, zoom only, send a message on slack!
- Mon Dec 2: Review - Bring questions!
- Weds Dec 4: Exam
  - Content since 2nd Exam (Ch 7 and on)
  - One page (8.5x11) handwritten cheat sheet
  - Calculator if you want it

Lec #	Date			Reading	HW
21	Mon	10/28	Polynomial & Step Functions	7.1,7.2	
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32	Fri	11/22	CNN	10.3	HW #11 Due Sun 11/24
33	Mon	11/25	TBD: Unsupervised learning/clustering	12.1, 12.4?	
	Wed	11/27	Virtual: Project office hours		
	Fri	11/29	No class - Thanksgiving		
	Mon	12/2	Review		
	Wed	12/4	**Midterm #3**		
	Fri	12/6	No class - EGR Design Day		Project due

Section 1

Unsupervised learning

Supervised vs Unsupervised Learning

Supervised

Unupervised

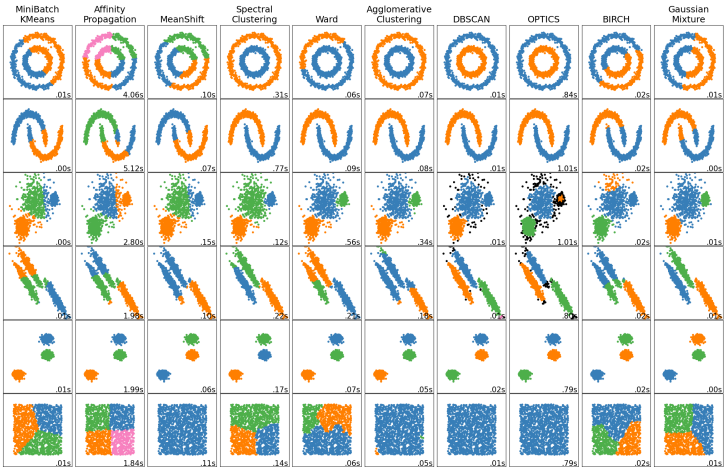
Some examples of unsupervised problems

- Assay gene expression levels in 100 patients with breast cancer, looking for subgroups with similar qualities
- Online shopping: find groups of shoppers with similar browsing and purchase histories and show relevant related products.
- Search engine picking results to show

Section 2

Clustering

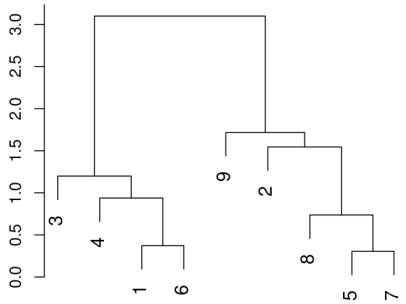
Big idea

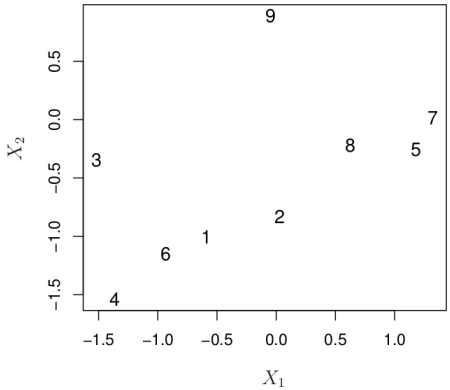

MiniBatch KMeans
Affinity Propagation
MeanShift
Spectral Clustering
Ward
Agglomerative Clustering
DBSCAN
OPTICS
BIRCH
Gaussian Mixture

Section 3

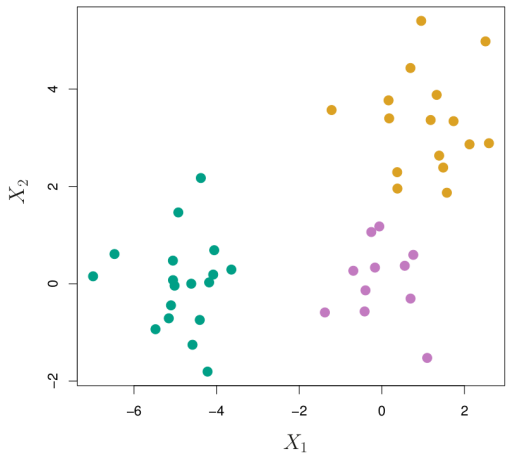
Hierarchical Clustering

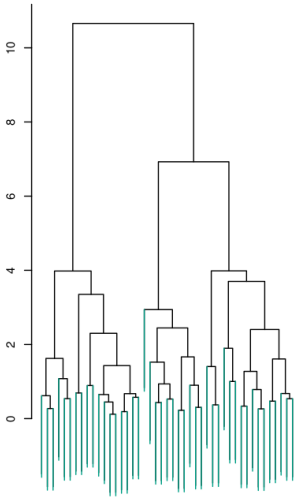
Dendrogram





A bigger example

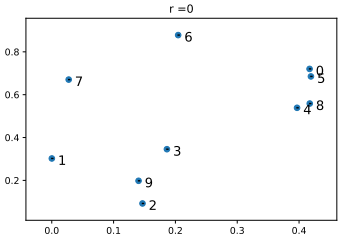


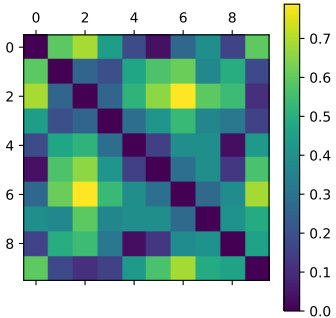


Single linkage

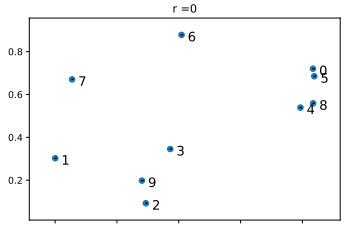
Distance between cluster A and cluster B:
Smallest distance between the points

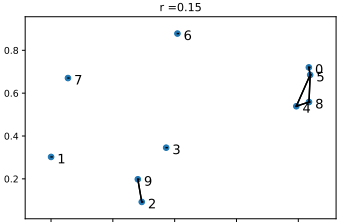
$$L(A, B) = \min_{a \in A, b \in B} \|a - b\|$$

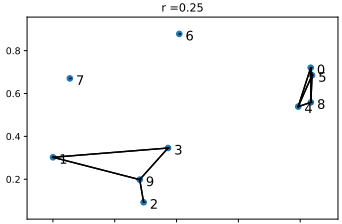


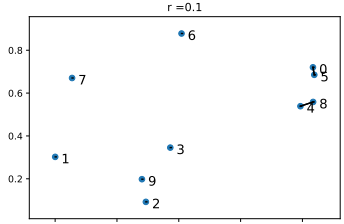


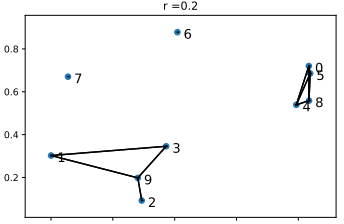
Building the dendrogram

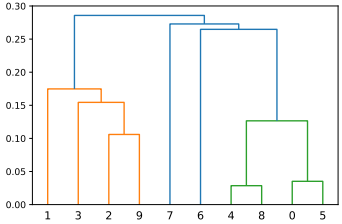




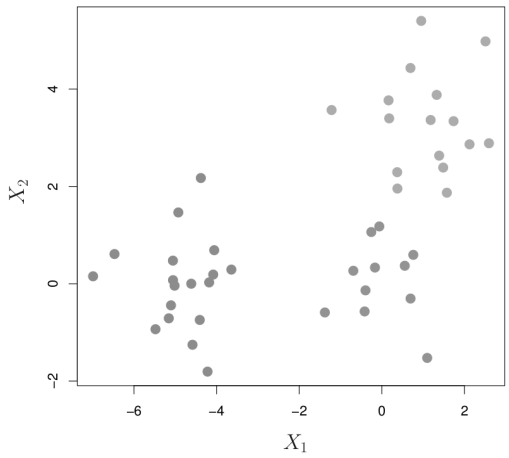


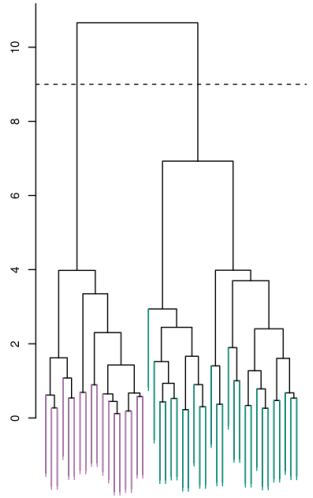




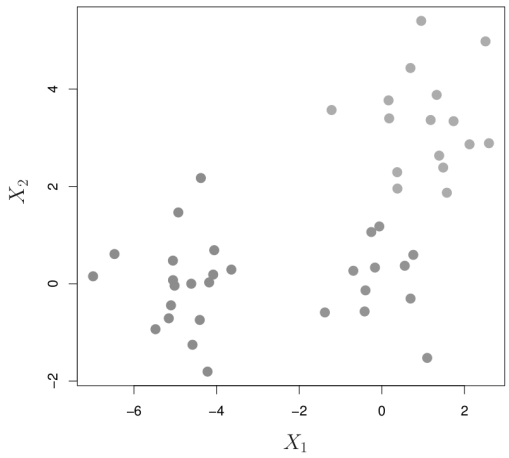


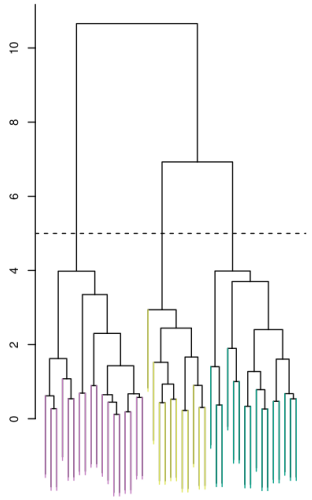
How to get clusters



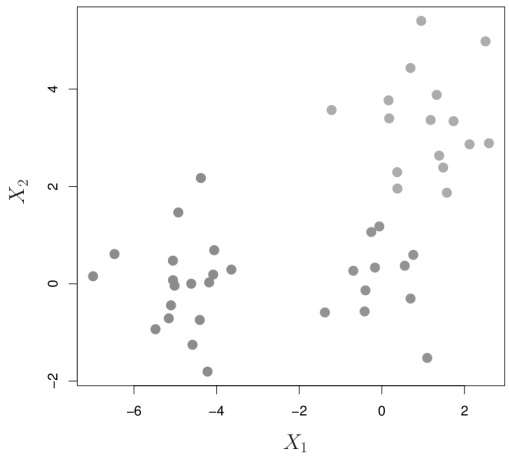


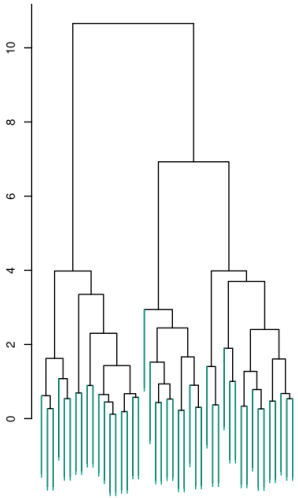
How to get different clusters





Can get any number of clusters

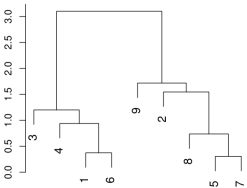




Linkage

Linkage	*Description*
Complete	Maximal intercluster dissimilarity. Compute all pairwise dissimilarities between the observations in cluster A and the observations in cluster B, and record the *largest* of these dissimilarities.
Single	Minimal intercluster dissimilarity. Compute all pairwise dissimilarities between the observations in cluster A and the observations in cluster B, and record the *smallest* of these dissimilarities. Single linkage can result in extended, trailing clusters in which single observations are fused one-at-a-time.
Average	Mean intercluster dissimilarity. Compute all pairwise dissimilarities between the observations in cluster A and the observations in cluster B, and record the *average* of these dissimilarities.
Centroid	Dissimilarity between the centroid for cluster A (a mean vector of length p) and the centroid for cluster B. Centroid linkage can result in undesirable *inversions*.

Example with complete linkage



Distance between cluster A and cluster B:
Largest distance between the points

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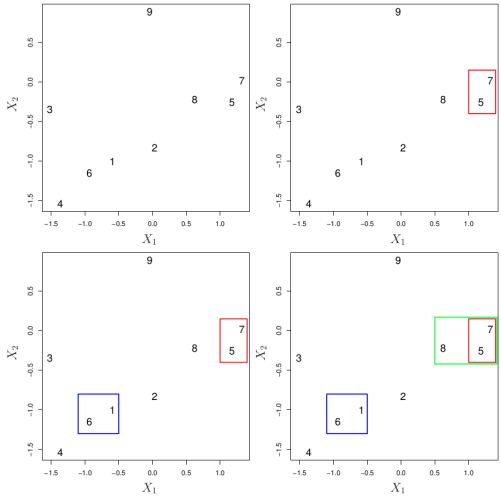
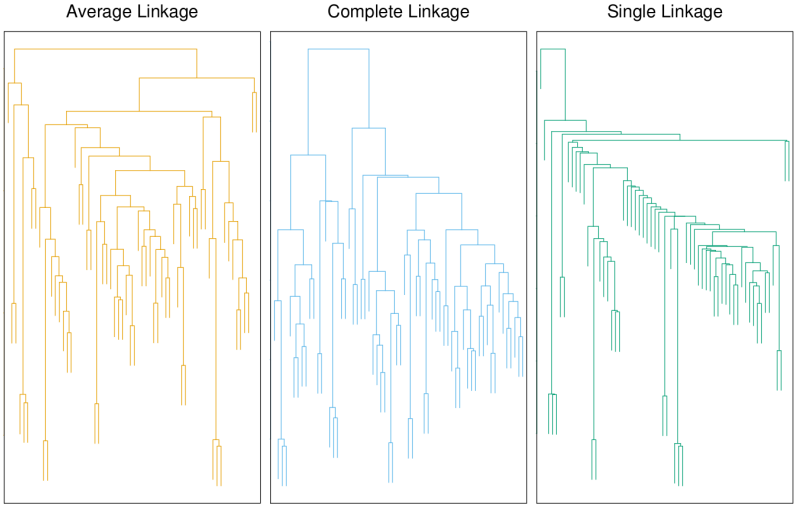


Examples of different linkage



Dependence on dissimilarity measure

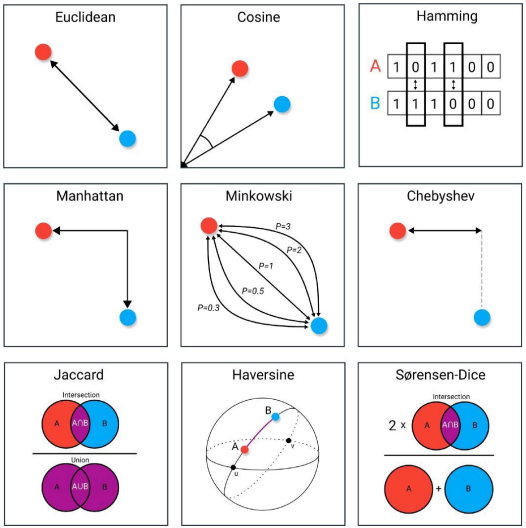


Photo Credit Link

Coding

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