Segmentation and Clustering

"Group Similar things"

"Clustering is the problem of grouping similar data points (and represent them with a single token)"

↳ Important for Image processing & Image understanding.

Goal: Break up the image into similar regions without training data.

* Key Challenges

- What makes two points/images/patches similar?
- How do we compute an overall grouping from Pairwise similarities?

Segmentation → Separate the image into different regions

* Techniques for clustering

- Region growing
- Agglomerative clustering
- K-means
- Mean-shift clustering

* Fast Approach for Image Segmentation:

- Segment / partition the image.
- Group homogeneous regions according to some similarity measure.

* Possible Measure 1: Variance of the Intensities

- Variance smaller than a threshold

$$h_1 = \sigma_g^2 = G_\sigma * [(g - G_\sigma * g)^2] \leq T_1$$

- Using the box filter for smoothing and multiplication with $\frac{M}{M-1}$ yields the variance of the intensities:

* Possible Measure 2: Variance of the Gradients

- Variance of the gradient should be smaller than a threshold.

$$h_2 = \sigma_{g'}^2 = G_\sigma * (\nabla G_\tau * g) \leq T_2$$

- If we choose ∇G_τ as the gradient filter and G_σ as the box filter, we obtain:

$$h_2 = \frac{1}{M} \sum_m f_{im}^2 + f_{im}^2$$

* Region Growing

1. Select a random pixel.
2. Select a neighbor that fulfills the selected measure and merge it.
3. Repeat recursively
4. Goto 1 until image is fully segmented.

Problem: Small violations of the model assumptions lead to segmentation errors.

* Agglomerative Clustering

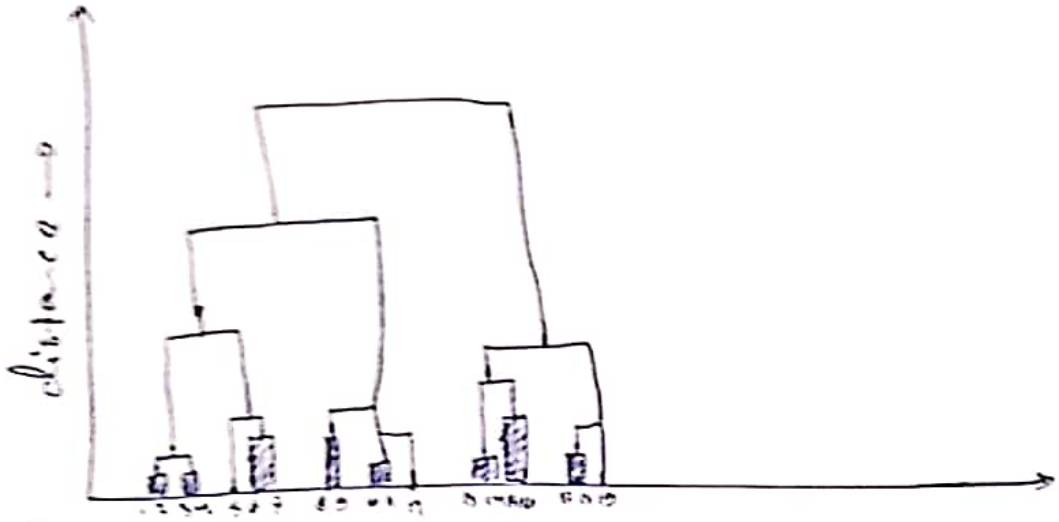
1. Say "Every point is its own cluster"
2. Find "most similar" pair of clusters.
3. Merge it into a parent cluster
4. Repeat.

How to define cluster similarity?

- Average distance
- Maximum distance
- minimum distance
- Distance between means or medoids

* How many clusters?

- Clustering creates a dendrogram (a tree)
- Threshold based on max number of clusters or based on distance between merges.



= Pros

- Simple to implement.
- Clusters have adaptive shapes
- Provides a hierarchy of clusters

* Cons

- May have imbalanced cluster
- Still have to choose number of clusters or threshold.
- Good metric needed to get a meaningful hierarchy.