## Syllabus Notes

- Next topics segmentation, grouping and fitting.
- We will do perhaps half each of §14, §15, and §16.

## Segmentation, Grouping, and Fitting

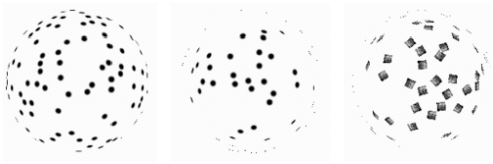
- Collect together tokens that belong together
- Gives a compact representation from an image/motion sequence/set of tokens that can be significantly easier to deal with
- What is the "right" group is often dependent on the application
- Broad theory is not known at present (and may not exist)
- These are general concepts--apply to many things, not just breaking images into regions of the same color.

## Segmentation, Grouping, and Fitting

- Terminology varies and the usage and the meaning of segmentation, grouping, and fitting overlap. However somewhat common usage:
  - Grouping (or clustering) is quite general sometimes suggest a relatively high level (group the black and white halves of a penguin together)
  - Segmentation is suggestive of the grouping is done at a low level and is quite spatially (or temporally coherent) given regions in time or space
  - Fitting when the focus is on a model associated with tokens. Issues:
    - which model?
    - which token goes to which element in the model (correspondence)?
    - how many elements in the model (how complex should it be)?

## General ideas

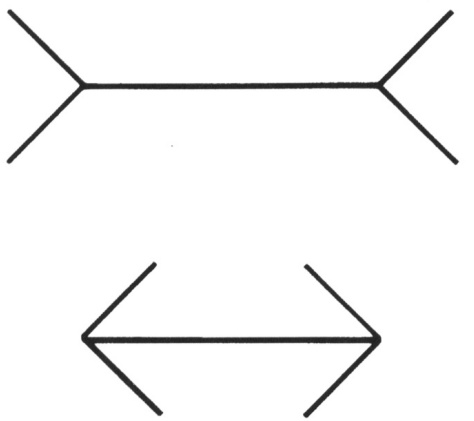
- Tokens
  - whatever we need to group (e.g. pixels, points, surface elements)
- Top down segmentation
  - tokens belong together because they lie on the same object
- Bottom up segmentation
  - tokens belong together because they are locally coherent
- These two are not mutually exclusive



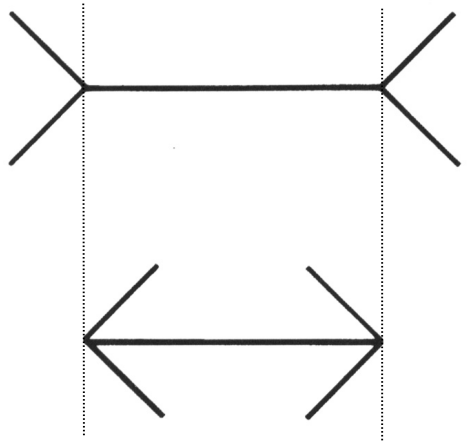
Why do these tokens belong together?

# Basic ideas of grouping in humans

- Figure-ground discrimination
  - grouping can be seen in terms of allocating some elements to a figure, some to ground (impoverished theory)
- Gestalt properties
  - Elements in a collection of elements can have properties that result from relationships (e.g. Muller-Lyer effect)
  - A series of factors affect whether elements should be grouped together
    - Gestalt factors



The Muller-Lyer illusion; the horizontal bar has properties that come only from its membership in a group



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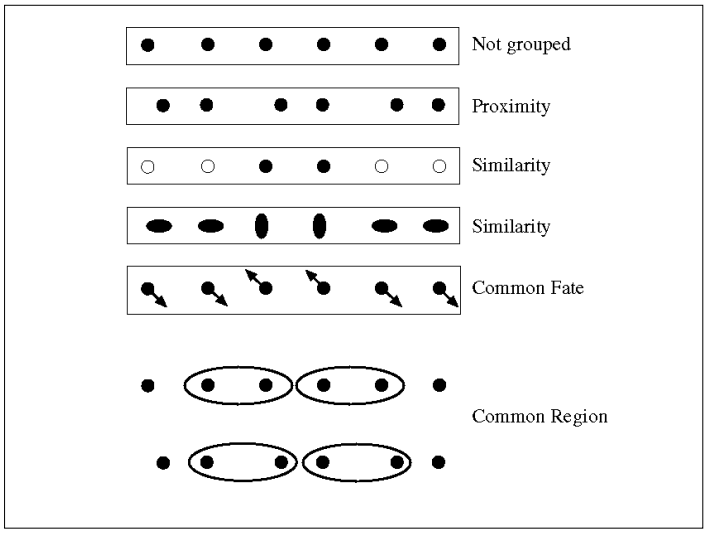
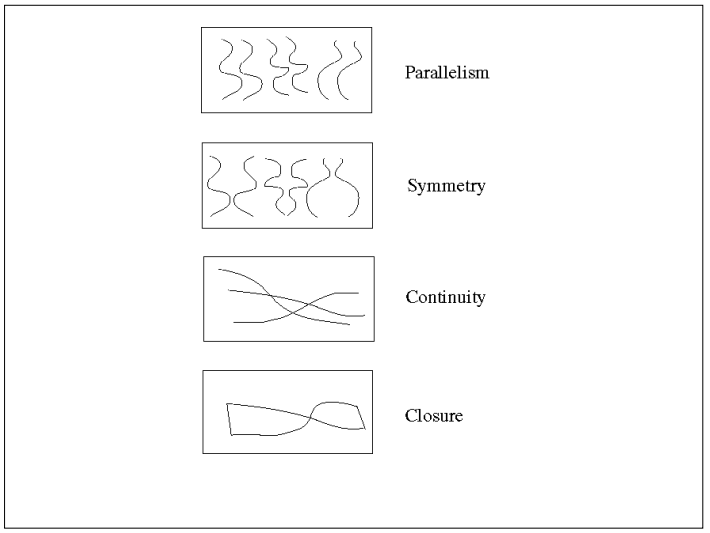
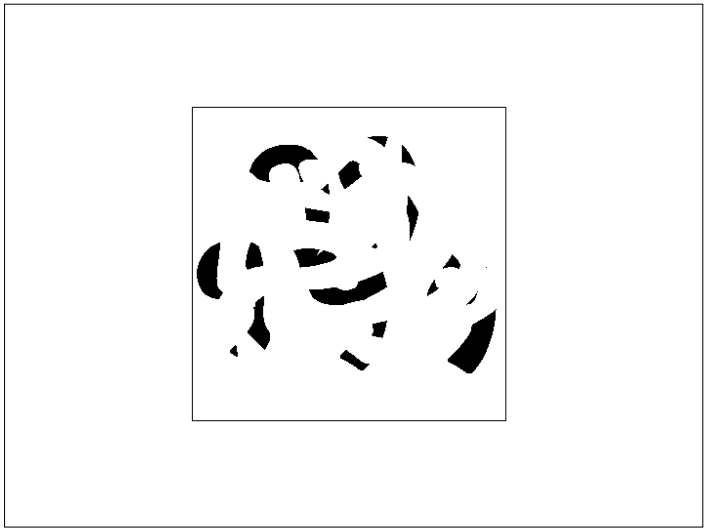
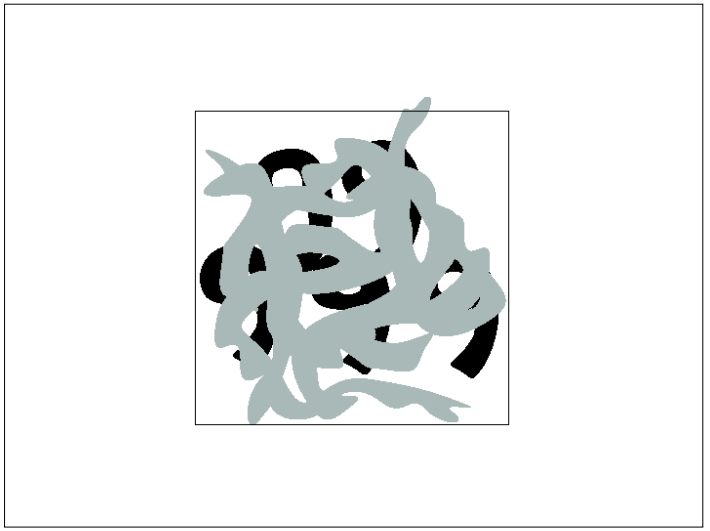
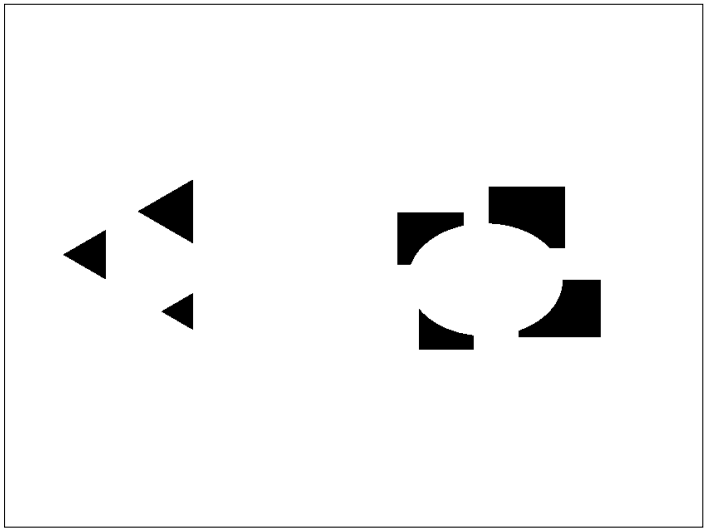

Not grouped
Proximity
Similarity
Similarity
Common Fate
Common Region


Parallelism
Symmetry
Continuity
Closure



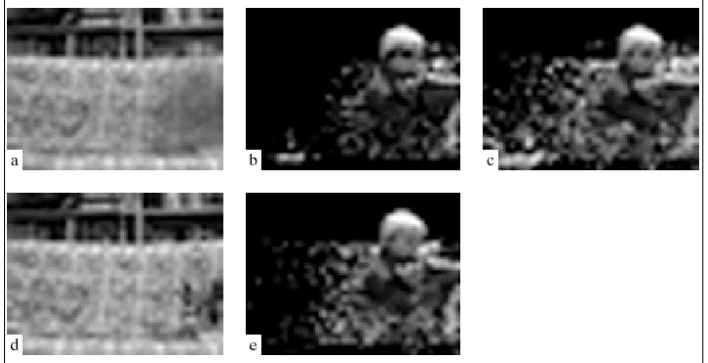




## Background Subtraction

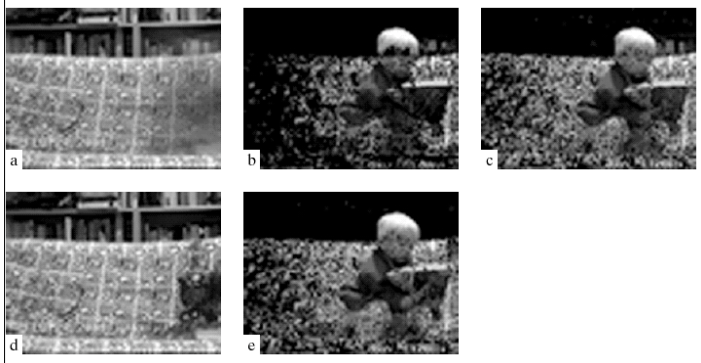
## Background Subtraction

- If we know what the background looks like, it is easy to identify “interesting bits”
- Applications
  - Person in an office
  - Tracking cars on a road
  - Surveillance
- Approach:
  - Use a moving average to estimate background image
  - Subtract from current frame
  - Large absolute values are interesting pixels
    - trick: use morphological operations to clean up pixels (remove “holes”)




a) average of sequence

b) difference from background > T1




Higher resolution version of previous

# Segmentation as clustering

- Cluster together (pixels, tokens, etc.) that belong together
- We assume that we can compute how close tokens are, or how close a token is to cluster.

# Why is clustering hard?

**Main reason**

- The number of possible clusterings is exponential in the number of data points

**Other issues**

- The number of clusters is usually **not** known
- A good distance function between points may not be known
- A good model explaining the existence of clusters is usually not available.
- High dimensionality