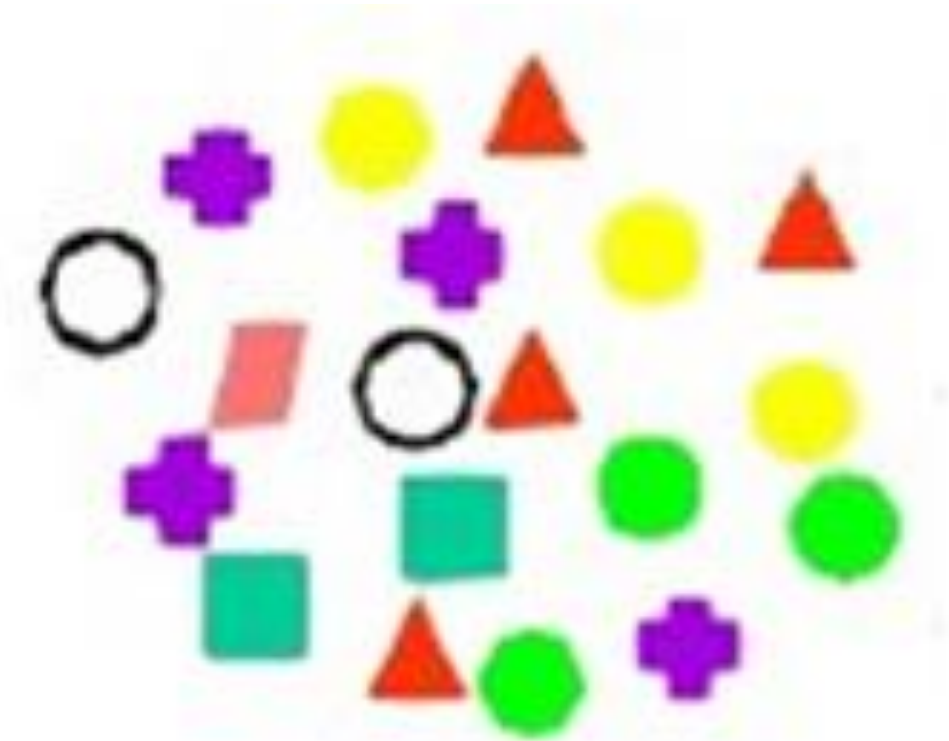
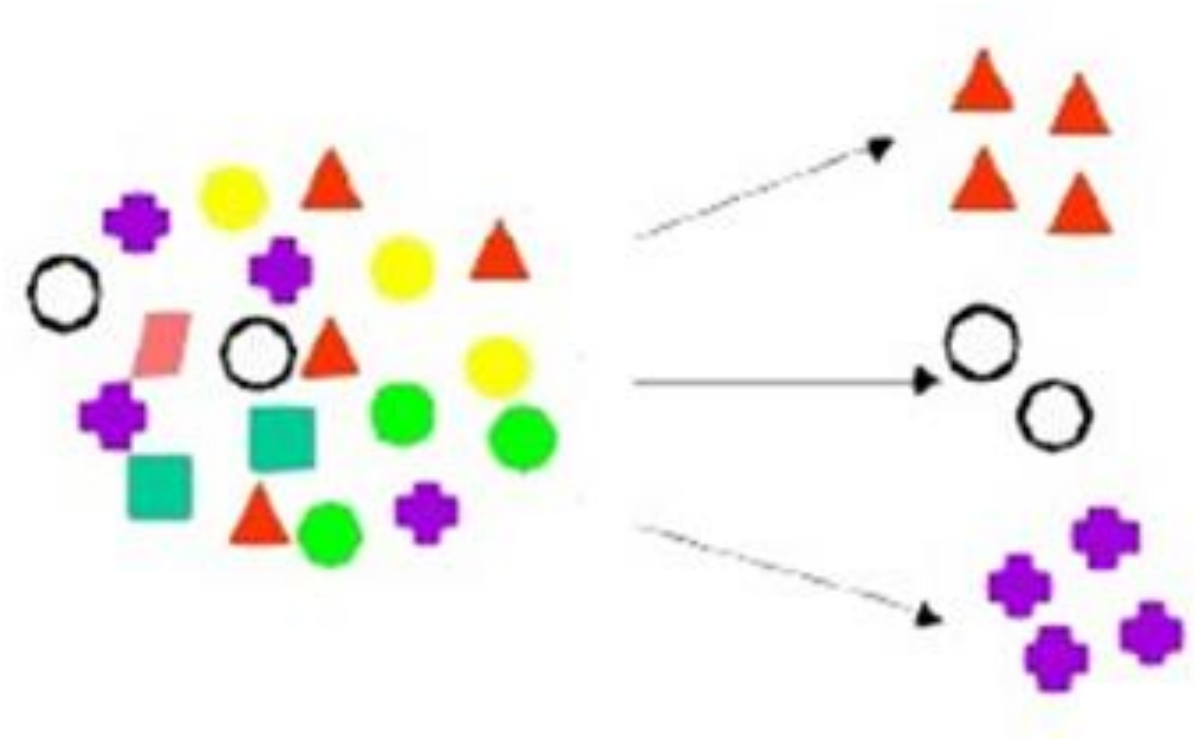
Computational Intelligence

Unit # 6-2

Know your data!



Know your data!



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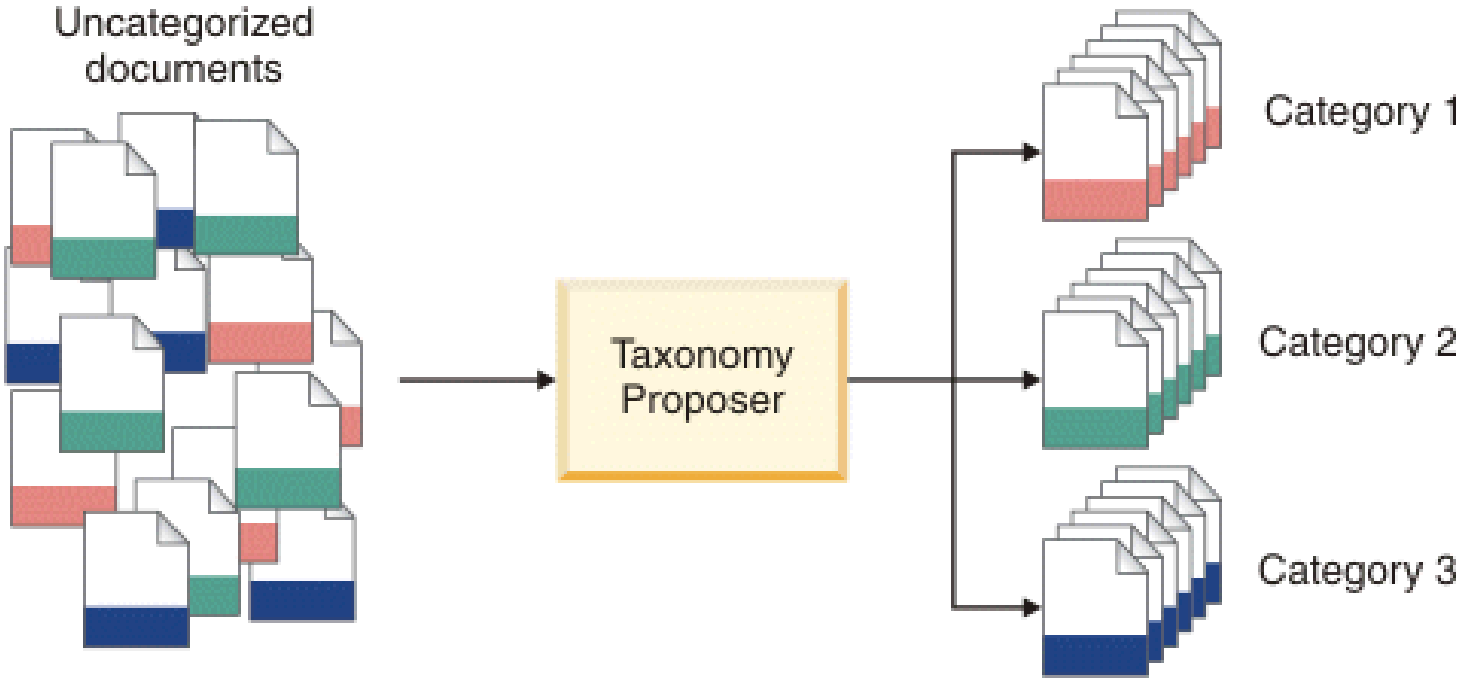
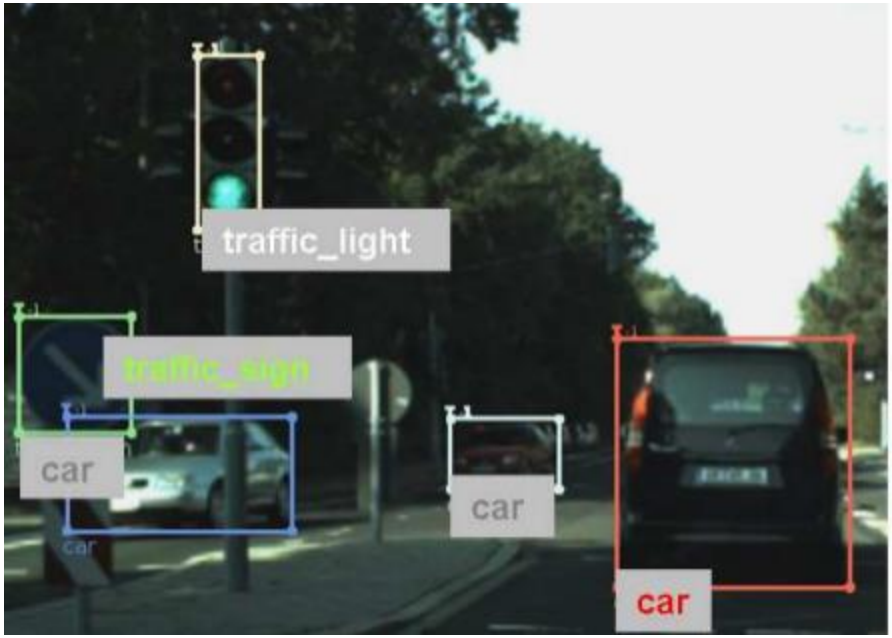
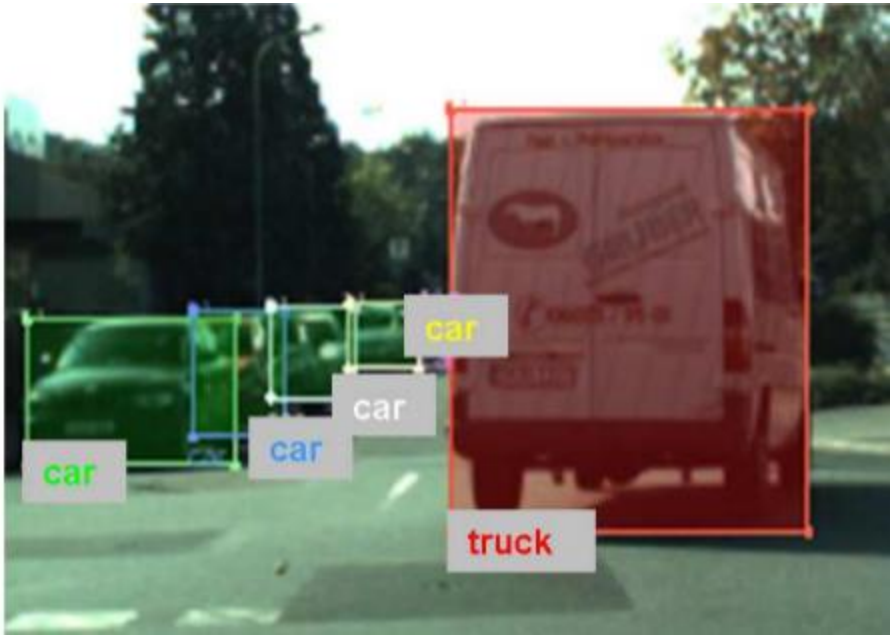
Documents Sorting



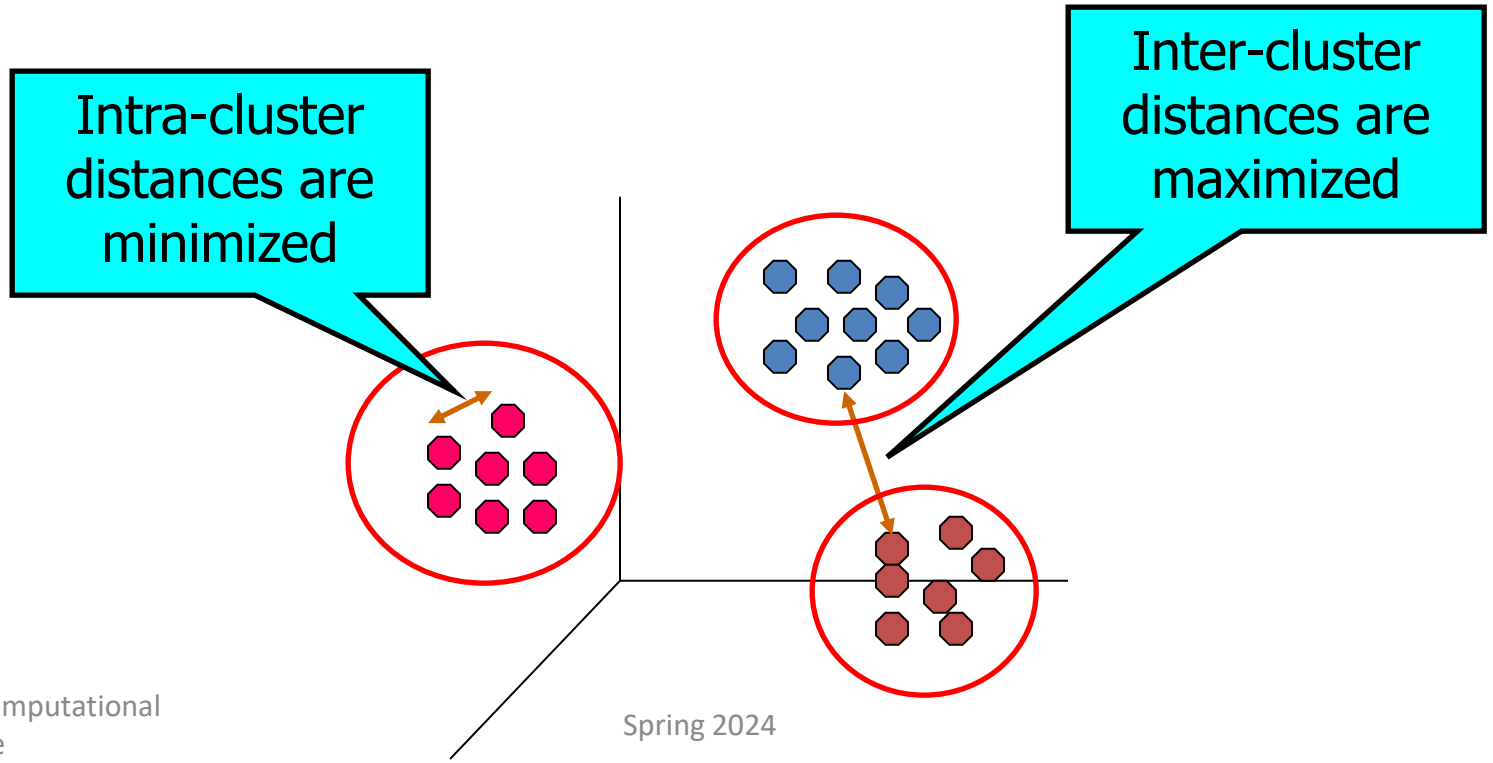
Object Detection





Cluster Analysis

- Finding groups of objects such that the objects in a group will be similar (or related) to one another and different from (or unrelated to) the objects in other groups



Some Applications

- Recommendation engines
- Market segmentation
- Social network analysis
- Search result grouping
- Medical imaging
- Image segmentation
- Anomaly detection
- Portfolio Analysis

Ant Clustering

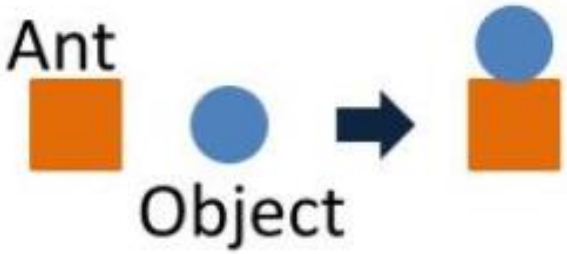
Ant Clustering in Nature

- Several species of ants cluster corpses to form a “cemetery”, or sort their larvae into several piles.
- This behavior is still not fully understood, but a simple model, in which ants move randomly in space and pick up and deposit items on the basis of local information, may account for some of the characteristic features of clustering and sorting in ants.

Ant Clustering Algorithm (ACA)

- General idea is that isolated items should be picked up and dropped at some other location where more items of that type are present.
- Here are some basic rules that ants follow:
  - If not carrying a corpse, and a single corpse (or quite small cluster of corpses) is encountered, pick it up.
  - If carrying a corpse, and a relatively large cluster of corpses is encountered, put it down.

ACA – Picking up and dropping off Objects



Probability of picking up $= \left(\frac{a}{a+f}\right)^2$

a is a constant

f is the perceived fraction of objects nearby

Probability of placing $= \left(\frac{f}{b+f}\right)^2$

b is a constant

Assuming the ant moves randomly and it has enough time to explore the entire area, you could expect all of the objects to be clustered together.

ACA – Picking up

- Let us assume that there is only one type of item in the environment. The probability P_p for a randomly moving, unladen agent to pick up an item is given by:

$$P_p = \left(\frac{k_1}{k_1+f}\right)^2$$

- Where,
  - f is the perceived fraction of items in the neighborhood of the agent,
  - k_1 is a constant
- When there are not many objects in the agent's neighborhood, that is $f \ll k_1$, then P_p approaches 1; hence, objects have a high probability of being picked up.
- On the other hand, if the agent observes many objects $f >> k_1$), P_p approaches 0, and the probability that the agent will pick an object is small.

ACA – Dropping off

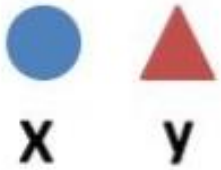
- The probability P_d for a randomly moving loaded agent to deposit an item is given by:

$$P_d = \left(\frac{f}{k_2 + f}\right)^2$$

- where:
  - k_2 is another threshold constant
- If the agent observes a large number of objects in its neighborhood (*f* » k_2*),* then pd approaches 1, and the probability of dropping the object is high. If f<< k_2, then *p<I* approaches 0.

ACA – Perceived Objects Nearby

f is the perceived fraction of objects nearby



$$f(x) = \begin{cases} \frac{1}{s^2} \sum_{y \in (s*s)} \left[1 - \frac{d(x,y)}{\alpha}\right] & \text{when } f > 0 \\ 0 & \text{otherwise} \end{cases}$$

f(x) is now a measure of the **similarity** of object x to object y in the area around object x

α is a scale factor for dissimilarity.

Where $d(x, y)$is a dissimilarity function.

When the objects are the **same**:

$$d(x, y) = 0$$

When the objects are **different**:

$$d(x, y) = 1$$

Basic Algorithm

```
0 /*Initialization*/
1 for every object x do
2       place x randomly on grid
3 end for
4 for all ants do
5       Place ant at randomly selected site
6 end for
7 {*main loop*}
8 for all ants do
9    For t = 1 to t_max do
10       If ((ant no object) and (site occupied by
         object) then
11          Compute f(x) and probability of picking
         up
12          Draw random real number R
13          if (R ≤ Prob) then
14              pick up object
15       end if
16       else
17          if (ant w/object) and (empty site) then
18             compute f(x) and probability of
         dropping
19             draw random real number R
20             if (R ≤ Prob) then
21                drop object
22             end if
23          end if
24       end if
25       move to randomly selected  ant free
         adjacent site
26    end for
27       end for
28    Print location of objects
```

[Ant Inspired Data Mining]

References

- Computational Intelligence, An Introduction By Andries P. Engelbrecht
- PPT - Ant Inspired Data Mining PowerPoint Presentation, free download - ID:2387411 (slideserve.com)

Thanks