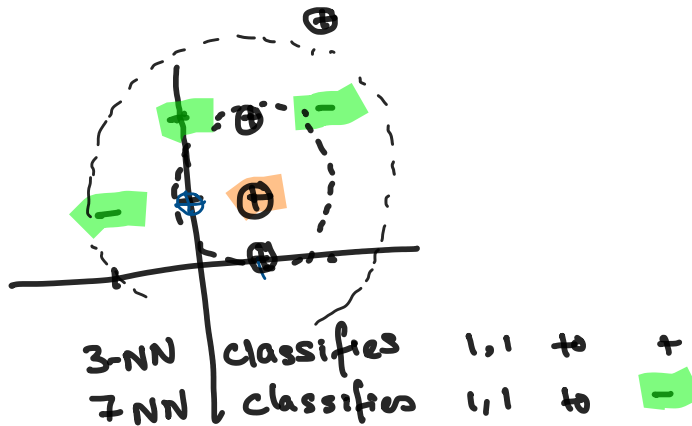


# In class review

Monday, February 24, 2020 12:09 PM

**Question.** Plot the following data points.  
Consider the new point 1,1. How should it be classified with 3-NN and 7-NN?

x	y	class
-1	1	-
0	1	+
0	2	-
1	-1	-
1	0	+
1	2	+
2	2	-
2	3	+



**Question:** Show that convolution is associative.

$$(a * b) * c = a * (b * c)$$

$$(a * b) * c [k] = \left\{ \sum_{m=-\infty}^{\infty} a[m] b[k-m] \right\} * c[k]$$

$$= \sum_{n=-\infty}^{\infty} \left\{ \sum_{m=-\infty}^{\infty} a[m] b[n-m] \right\} \cdot c[k-n]$$

$$= \sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} a[m] b[n-m] \cdot c[k-n]$$

$$= \sum_{m=-\infty}^{\infty} a[m] \sum_{n=-\infty}^{\infty} b[n-m] \underbrace{c[k-n]}_r$$

$$\underline{r = k - n}$$

$$n = k - r$$

$$n \rightarrow \infty \quad r \rightarrow -\infty$$

$$n \rightarrow -\infty \quad r \rightarrow \infty$$

$$= \sum_{m=-\infty}^{\infty} a[m] \sum_{r=-\infty}^{\infty} b[k-r-m] c[r]$$

$$\begin{aligned}
 & m = -\infty \qquad \overline{r} = \infty \\
 & \qquad \qquad \qquad \infty \\
 & = \sum_{m=-\infty}^{\infty} a[m] [b * c] [R-m] \\
 & \qquad \qquad \qquad m = -\infty \\
 & = a * (b * c) [R]
 \end{aligned}$$

**Question.** Each dataset is clustered using two different methods, and one of them is K-means. The distance measure used here is the Euclidean distance. Which one is using K-means?

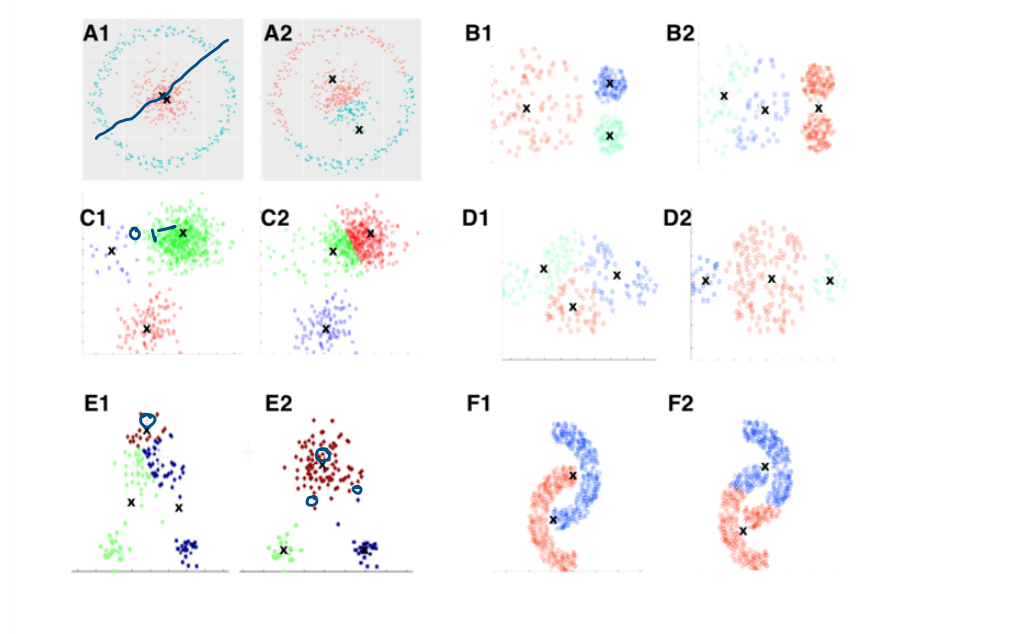


Figure 2: Clustered results for 6 datasets

**Question.** We are using k-means clustering to define “visual words” from a set of image patches.

(a) How is the size of the vocabulary (number of codewords) related to k? ↩

(b) How is the size of the feature vector ( $x_i$ ) representing an image related to k? ↩

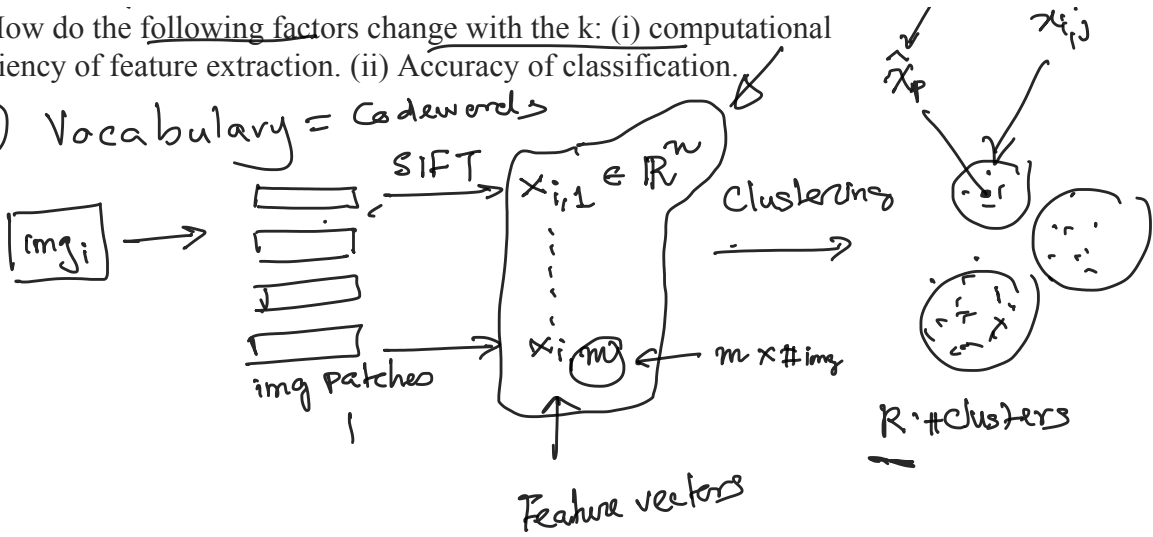
↪

—————

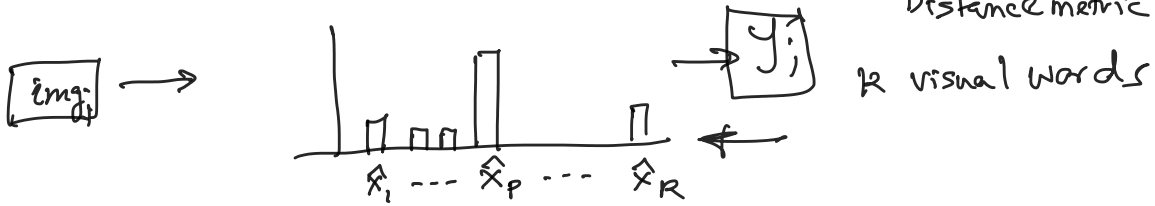
Visual words

(c) How do the following factors change with the  $k$ : (i) computational efficiency of feature extraction. (ii) Accuracy of classification.

① Vocabulary = Codewords



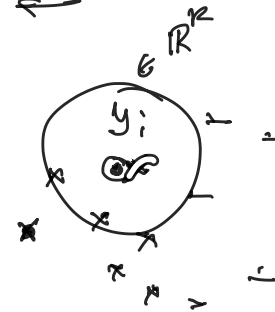
② Feature Extraction



③ Classification

(i) Feature Extraction complexity  $O(R)$

(ii) Accuracy of classification



**Question.** Consider an omni-directional robot controlled by a joystick. For each button press in the joystick, the robot moves 0.1m in the pushed direction **relative to its current orientation** (shown by the big red arrow).

Orientation is controlled with X and B buttons, for a 10-degree left and a 10-degree right turns. Assuming that the robot has started from the origin as shown in the figure. What is the

robot's position and orientation after the following commands  
in the global coordinates?

→ → → → ↑ ↑ ↑ B B B ↑ ↑ ↑ ↑ ← ← ← X X X X  
X X ↓ ↓

