

# Lab 7

Basic Image Processing Algorithms  
Fall 2016

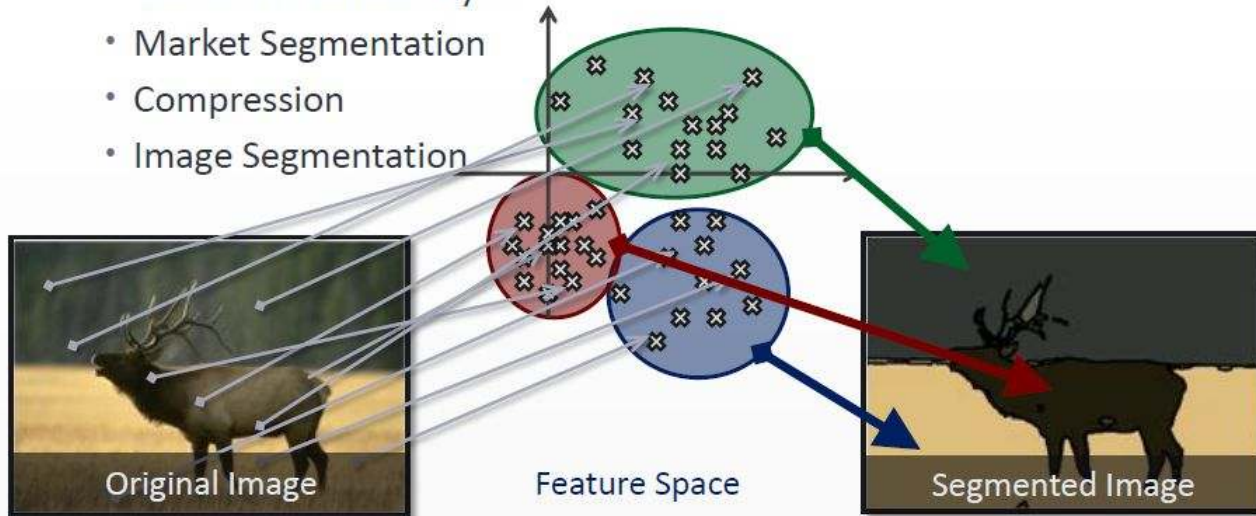
# Lab 7: Image segmentation with k-means clustering

- deadline (if you do not finish until the end of the lab): **23:59, 02/11/2016**;  
please send it to: [bipa2016fall@gmail.com](mailto:bipa2016fall@gmail.com)  
with the subject: **LAB7**

# Machine Learning Algorithms

## ○ Unsupervised Learning

- The goal is to find meaningful structure in the data.
- Applications:
  - Social Network Analysis
  - Market Segmentation
  - Compression
  - Image Segmentation



Source of the Images: [http://ivrgwww.epfl.ch/supplementary\\_material/RK\\_CVPR09/](http://ivrgwww.epfl.ch/supplementary_material/RK_CVPR09/)

# K-Means Clustering

- ◉ It aims to partition the data samples into  $k$  clusters.
- ◉ Each sample will belong to the cluster with the nearest mean.
- ◉ The objective is to minimize the within-cluster sum of squares:

$$\operatorname{argmin}_S \sum_{i=1}^k \sum_{x \in S_i} \|x - \mu_i\|^2$$

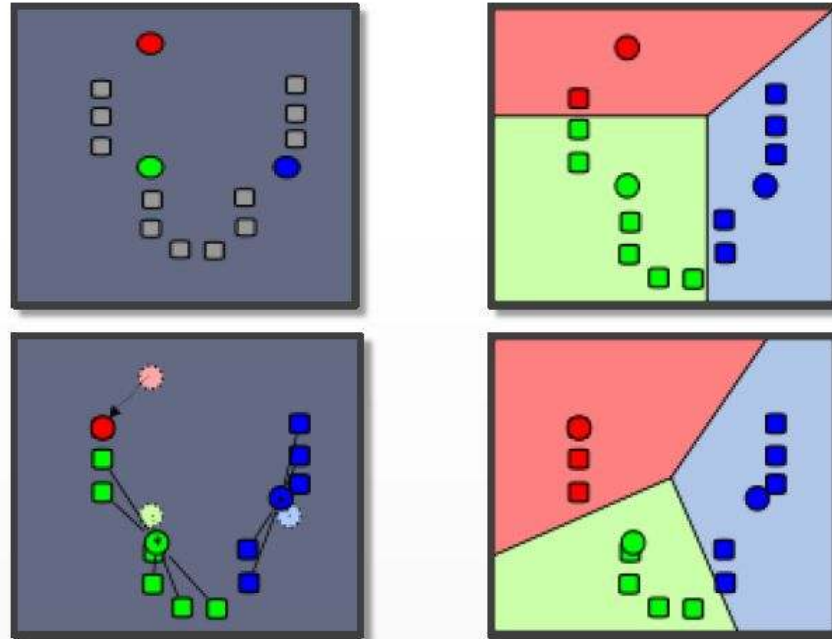
where  $x_1, x_2, \dots, x_n$  are the data samples,  $\mu_i$  is the mean (prototype) of the points in the cluster  $S_i (i=1 \dots k)$ .

- ◉ There is an iterative heuristic method for k-means clustering:
  1. Initialize the  $k$  cluster means
  2. **Assignment step**: assign each sample to the nearest mean
  3. **Update step**: calculate the new mean for each cluster

$$\mu_i^{(t+1)} = \frac{1}{|S_i^{(t)}|} \sum_{x_j \in S_i^{(t)}} x_j$$

# K-Means Clustering

- Illustration of k-means iteration:

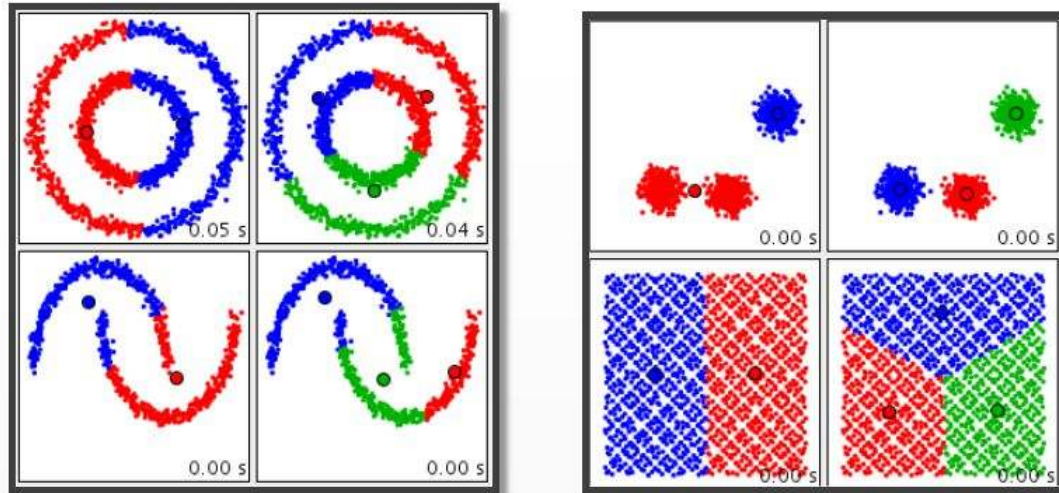


Source of the images: [http://en.wikipedia.org/wiki/K-means\\_clustering](http://en.wikipedia.org/wiki/K-means_clustering)

# K-Means Clustering

## ⦿ Limitation of k-means:

- Number of clusters has to be known a priori
- Spherical cluster shapes
- Could stuck in a local minimum



Source of the images: <http://commons.apache.org/proper/commons-math/userguide/ml.html>

# Preparation of your environment - vlfeat library

- original source:  
<http://www.vlfeat.org/>
- for your convenience, please download **only this**:  
<http://users.itk.ppke.hu/~kolmi/bipa/vlfeat-0.9.20.zip>
- to add vlfeat to the path:
  - call from command window 'run ./vlfeat-0.9.20/toolbox/vl\_setup.m' then save the path in Ribbon->Home->SetPath->SAVE
  - the order of the subdirs is important, that's why we are not going to add the vlfeat lib manually
- today's hot-topic: [http://www.vlfeat.org/matlab/vl\\_kmeans.html](http://www.vlfeat.org/matlab/vl_kmeans.html)

# Preparation of your environment - vlfeat library

- today's hot-topic: [http://www.vlfeat.org/matlab/vl\\_kmeans.html](http://www.vlfeat.org/matlab/vl_kmeans.html)

`[C, A] = VL_KMEANS(X, NUMCENTERS)`

- clusters the columns of the matrix X
- in NUMCENTERS centers C
- using k-means.
- X may be either SINGLE or DOUBLE.
- C has the same number of rows of X and NUMCENTER columns, with one column per center.
- A is a UINT32 row vector specifying the assignments of the data X to the NUMCENTER centers.

*data transformation figure/description on the table*

# Exercises for today

- first exercise: please create a script:
  - load *market.jpg*
  - check whether is it color (today we would like to work with color images!)
  - convert it to the necessary data-format
  - use `v1_kmeans` to cluster the datapoints, in the beginning to **30** different clusters
  - convert back the result data to a normal image
  - display it
- second exercise: divide your original script to a function and a script
  - the function
    - *input parameter*: original image; *output parameter*: segmented image
    - converts the image to the necessary data-format
    - calls `v1_kmeans`
    - converts back the result to a normal image
  - the script
    - loads the image
    - check whether is it color
    - calls your function
    - displays the result with the original image

original

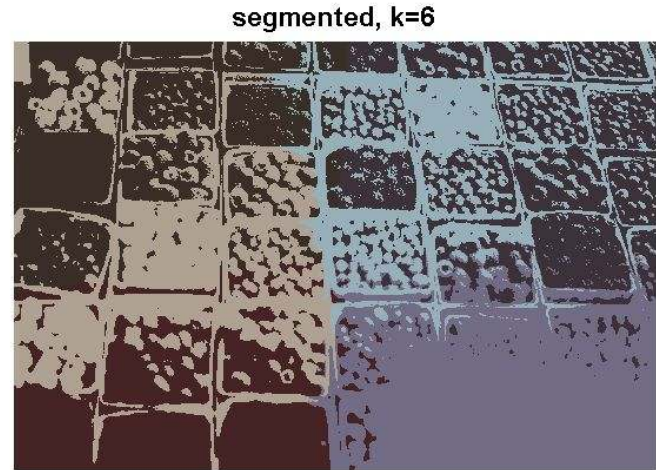


segmented, k=30



# Exercise #3

1. Extend your script with a new call of your original function, but with  $k=6$ . What happens?



# Exercise #3

1. Extend your script with a new call of your original function, but with  $k=6$ .  
What happens?
2. Create a new function (a slightly-different version of your original function):  
in this version please do the clustering on the basis of the RGB channels only.

