CSC 1002 Week 13

Machine Learning - kMeans & kNN

Q & A

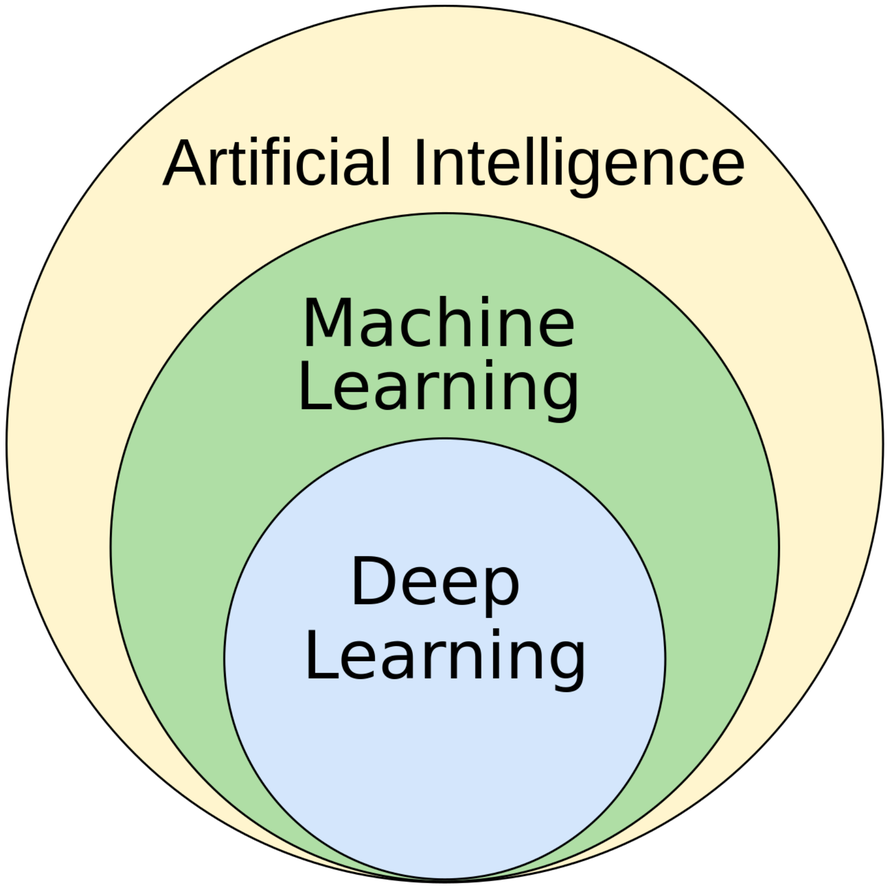
Assignment 3 - Snake

Machine Learning

kNN & kMeans

Machine Learning - Wikipedia

- “Wikipedia – …. ML gives computers the ability to perform tasks without explicit instructions …. using certain algorithms …”
- Popular Fields: Natural Language Processing (nlp), computer vision, speech recognition
- Approaches (high-level)
  - Supervised - learn from sample data and make prediction on new data. Ex: kNN
  - Unsupervised - learn on its own to discover trends and structures in the data. Ex: kMeans
  - Reinforcement - learn on feedback and rewards



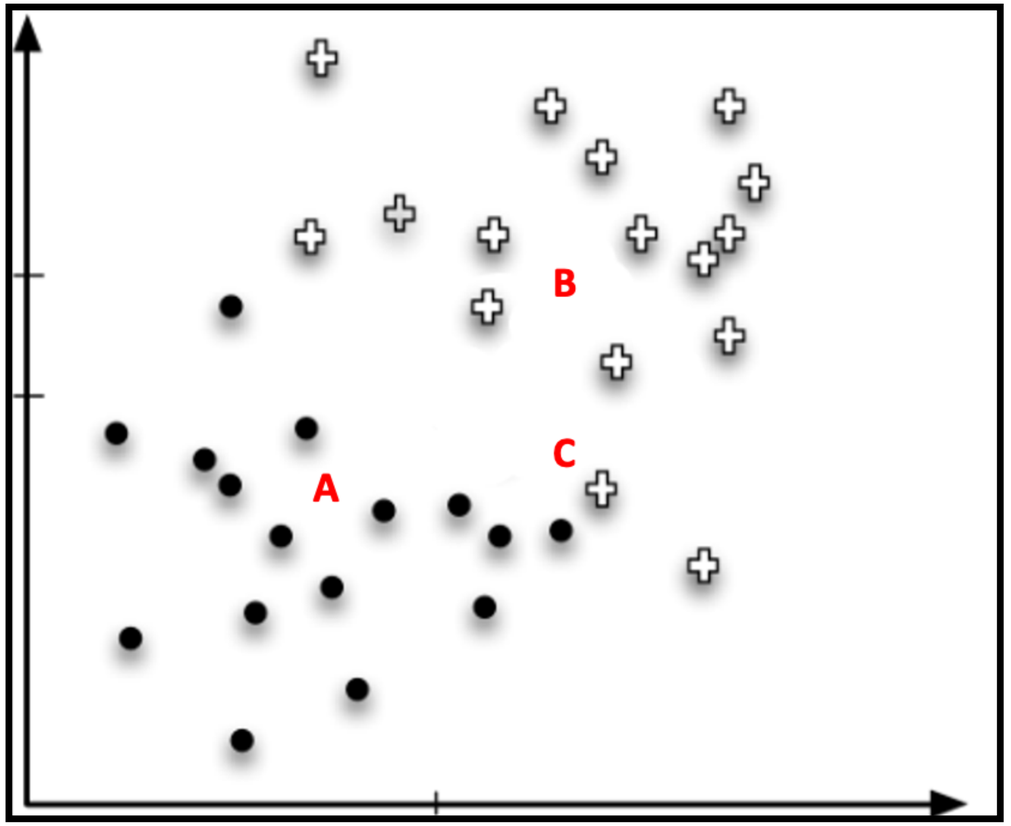
kNN

Supervised Learning

Supervised Learning

kNN - k Nearest Neighbors

- make a prediction based on neighbors
- find the k nearest neighbors
- neighbor is determined by simple notion of distance
- predict result based on majority vote of neighbors
- simple but expensive in computation

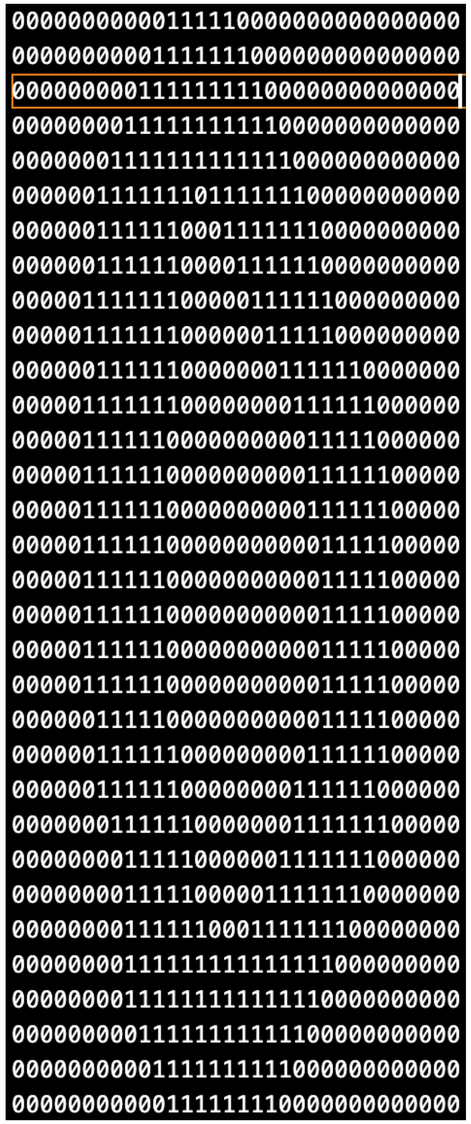


Supervised Learning - hand-written digit

kNN - k Nearest Neighbors

Online demo : https://henryjin.dev/demo/mnist/

Sample Data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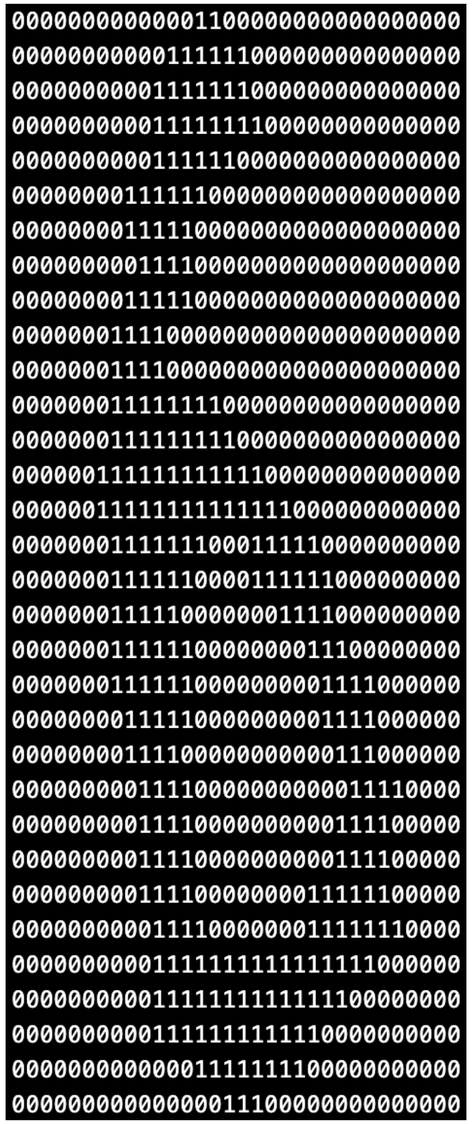
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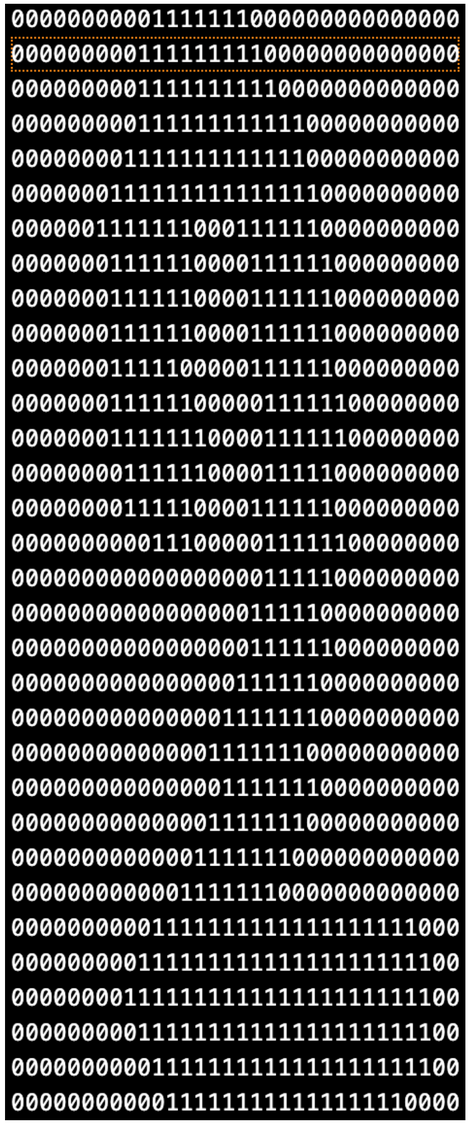
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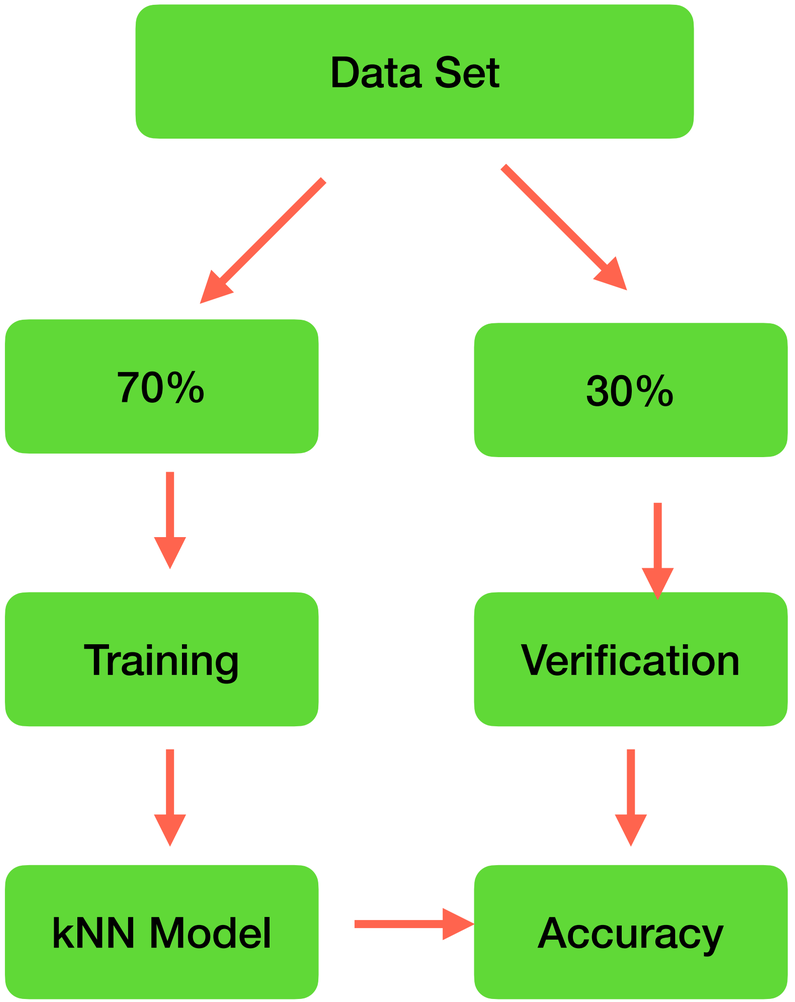
Supervised Learning - Training Data Set

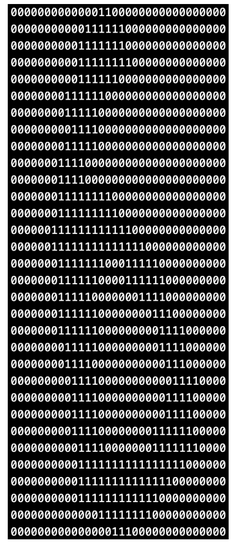
kNN - k Nearest Neighbors

Training




```
19  ----------------------------------------
20                Testing Info
21  ----------------------------------------
22                0 = 187,   2,  99%
23                1 = 192,   6,  97%
24                2 = 194,   1,  99%
25                3 = 197,   2,  99%
26                4 = 176,  10,  95%
27                5 = 177,  10,  95%
28                6 = 193,   2,  99%
29                7 = 198,   3,  99%
30                8 = 164,  16,  91%
31                9 = 181,  23,  89%
32  ----------------------------------------
33          Accuracy = 96.12%
34    Correct/Total = 1859/1934
35  ----------------------------------------
36  End of Training @ 2017-01-23 19:59:12
```

kNN - Prediction



Given Input

Find 10 closest

kNN Model

Predict

6

6 x 6 times, 5 x 4 times

Distance Computation

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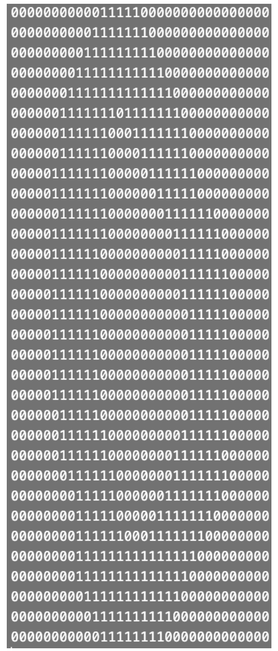
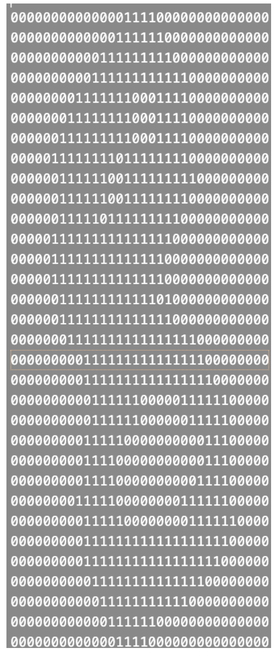
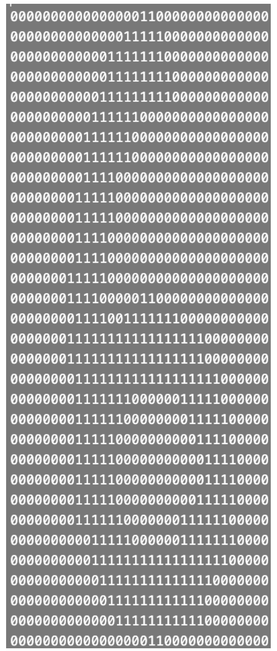
- Based on distance.
  - standard vector equation
  - XOR
- Based on overlapping image
  - And







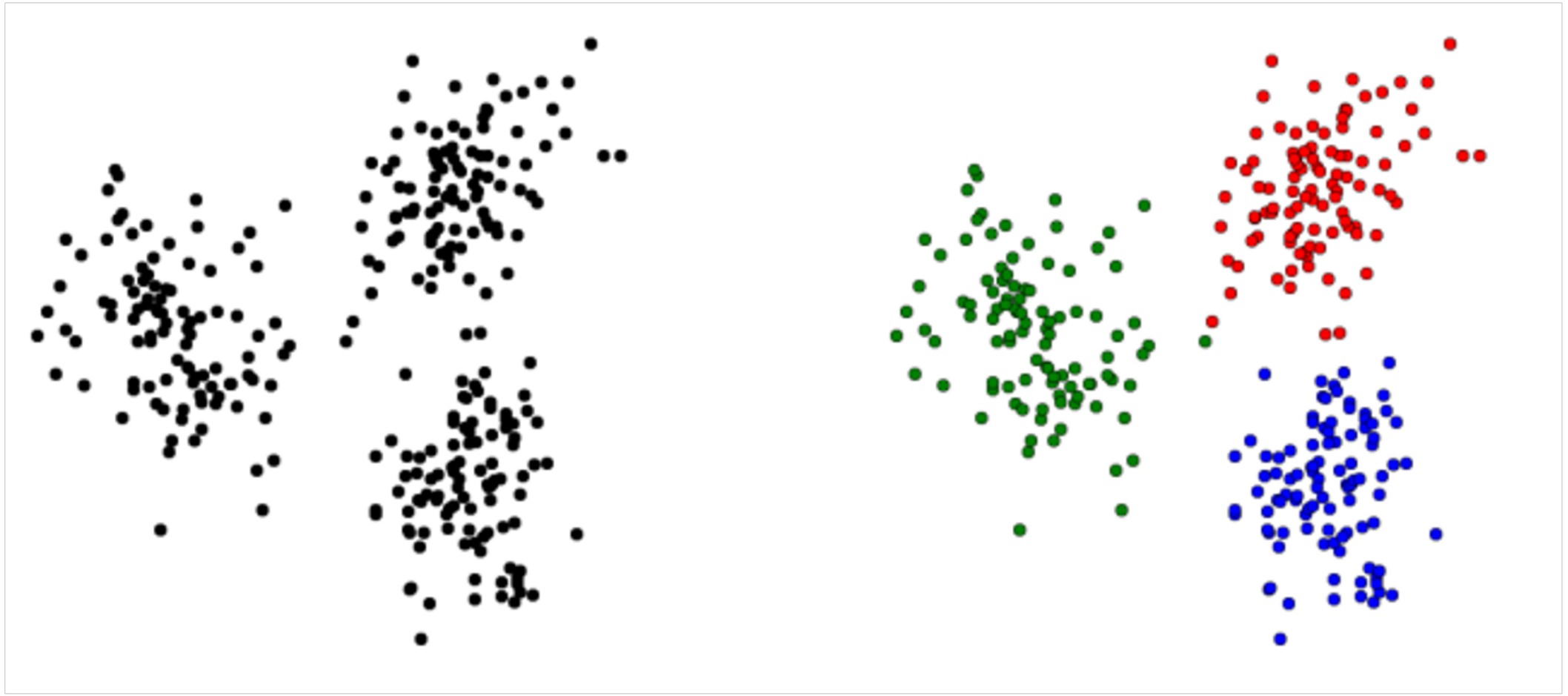
Show Demo with numbers

kMeans

Unsupervised Learning - Clustering

Unsupervised Learning - Clustering

kMeans - partition data into k groups based on similarities



kMeans - Definition

- K-means is an unsupervised learning algorithm for clustering data points
- The variable K represents the number of clusters that need to be created
- It classifies unlabeled data into K clusters based on similarities
- Clusters are non-overlapping
- The algorithm iteratively divides data points into clusters by minimizing the variance in each cluster
-

kMeans - Simple Example - 2 Clusters

Data Set = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Cluster	Data	Mean	Variance
1	1,2,3,4,5	3.0	2.5
2	6,7,8,9,10	8.0	2.5

Cluster	Data	Mean	Variance
1	1,2,3,9,10	5.0	17.5
2	4,5,6,7,8	6.0	2.5

Cluster	Data	Mean	Variance
1	1,3,5,7,9	5.0	10.0
2	2,4,6,8,10	6.0	10.0

kMeans - Image Compression

- kMeans can be used to reduce the size of an image file while maintaining its visual quality.
- This technique involves clustering the pixels in an image into a smaller number of groups
- Then representing each group by its mean color.
- The resulting image will have fewer colors, which reduces the file size, but the overall appearance of the image is still preserved.

kMeans - Image Compression

kMeans - Iterative Approach

- step 0: randomly pick “k” sample data as the initial mean points
- step 1: assign closest mean-point to each sample data
- step 3: if no changes of point assignment, stop and process is done
- step 4: update each group’s mean, and continue from step 1

kMeans - Simple Example - 2 Clusters

Data Set = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Iter	Mean 1	Group 1	Mean 2	Group 2
0	3	1,2,3,4	5	5,6,7,8,9,10
1	2.5	1,2,3,4,5	7.5	6,7,8,9,10
2	3.0	1,2,3,4,5	8.0	6,7,8,9,10

Iter	Mean 1	Group 1	Mean 2	Group 2
0	7	1,2,3,4,5,6,7	9	8,9,10
1	4.0	1,2,3,4,5,6	9.0	7,8,9,10
2	3.5	1,2,3,4,5	8.5	6,7,8,9,10
3	3.0	1,2,3,4,5	8.0	6,7,8,9,10

kMeans - Simple Example - 2 Clusters

Data Set = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Iter	Mean 1	Group 1	Mean 2	Group 2
0				
1				
2				

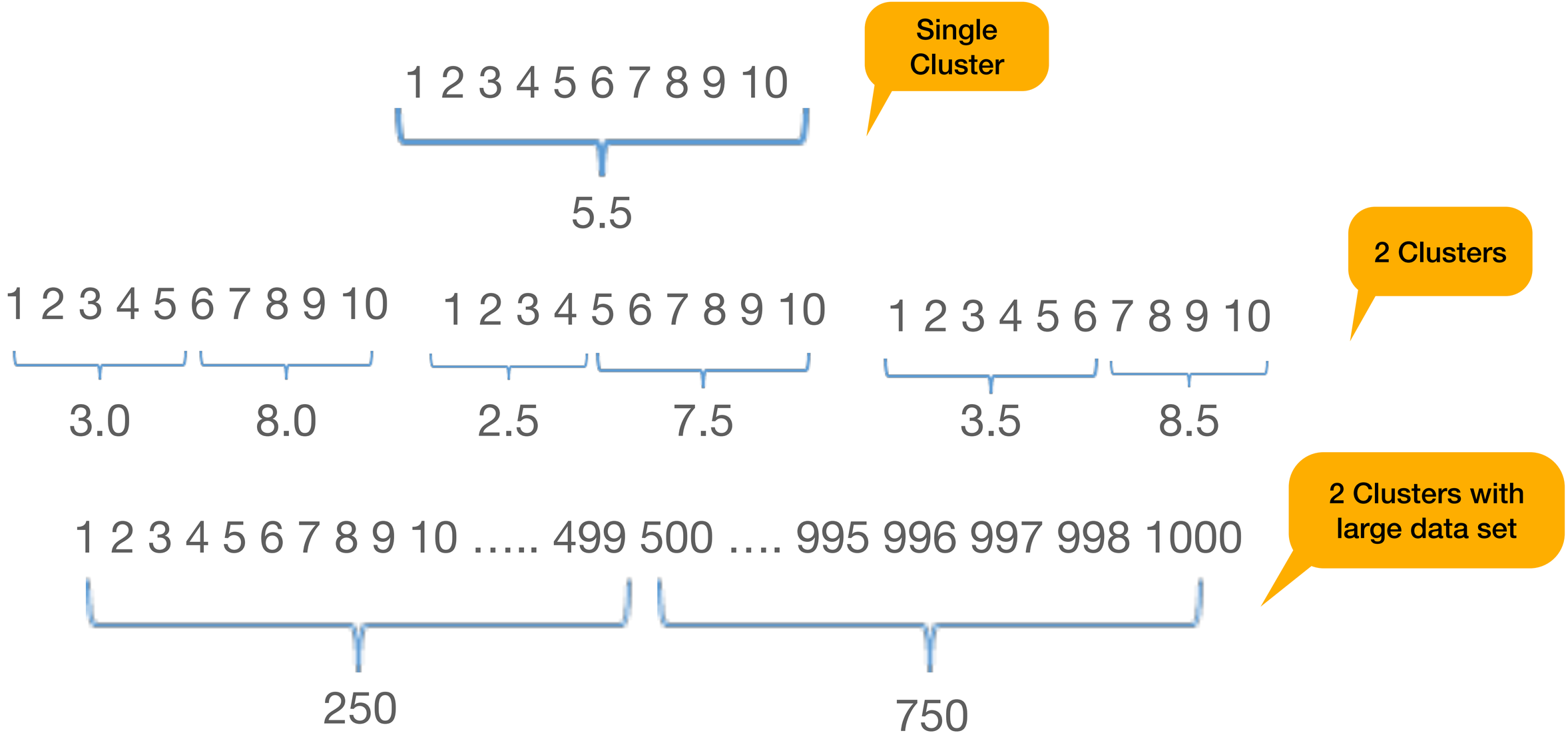
kMeans - Simple Example - 2 Clusters

Data Set = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 100

Iter	Mean 1	Group 1	Mean 2	Group 2
0	3	1,2,3,4	5	5,6,7,8,9,10,100
1	2.5	1,2,3,4,5,6,7,8,9,10	20.71	100
2	5.0	1,2,3,4,5,6,7,8,9,10	100.0	100

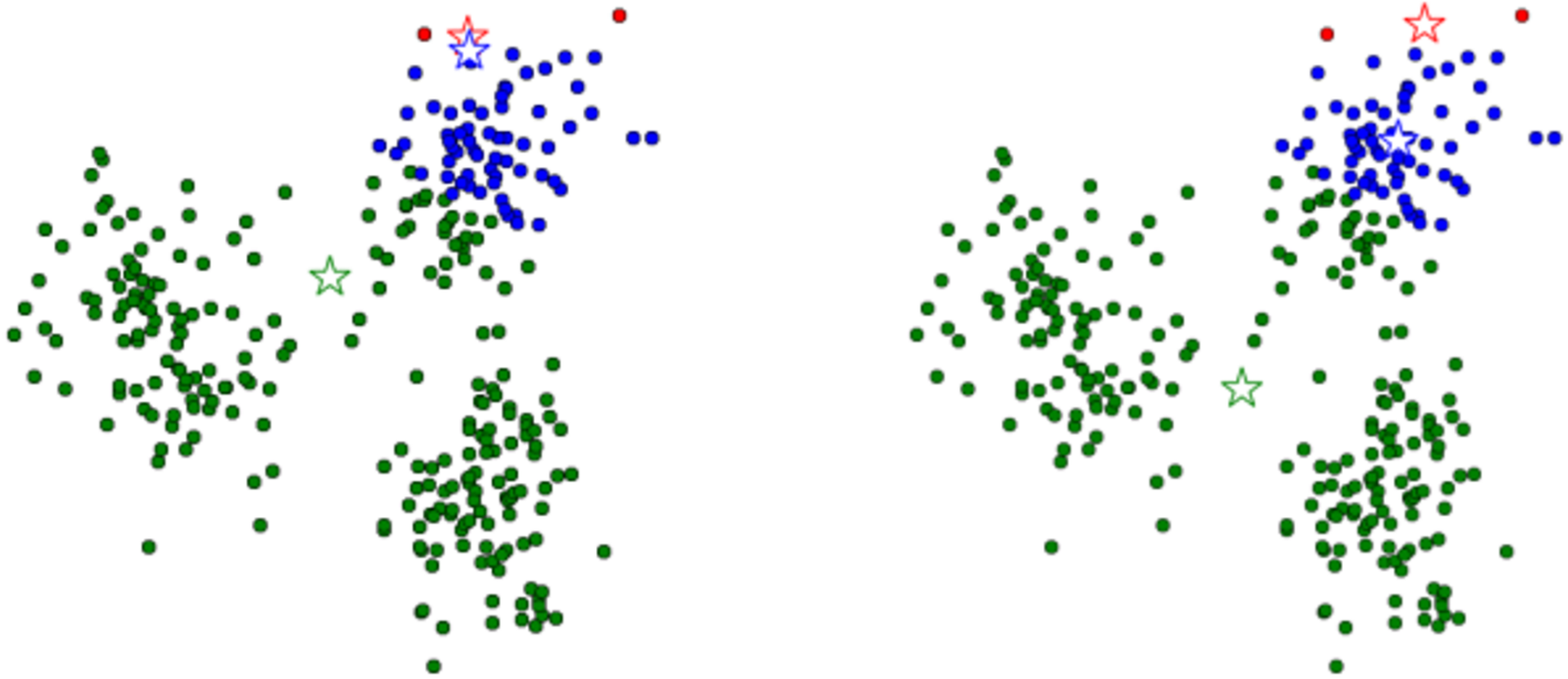
Show Demo with numbers

kMeans - Basic Example

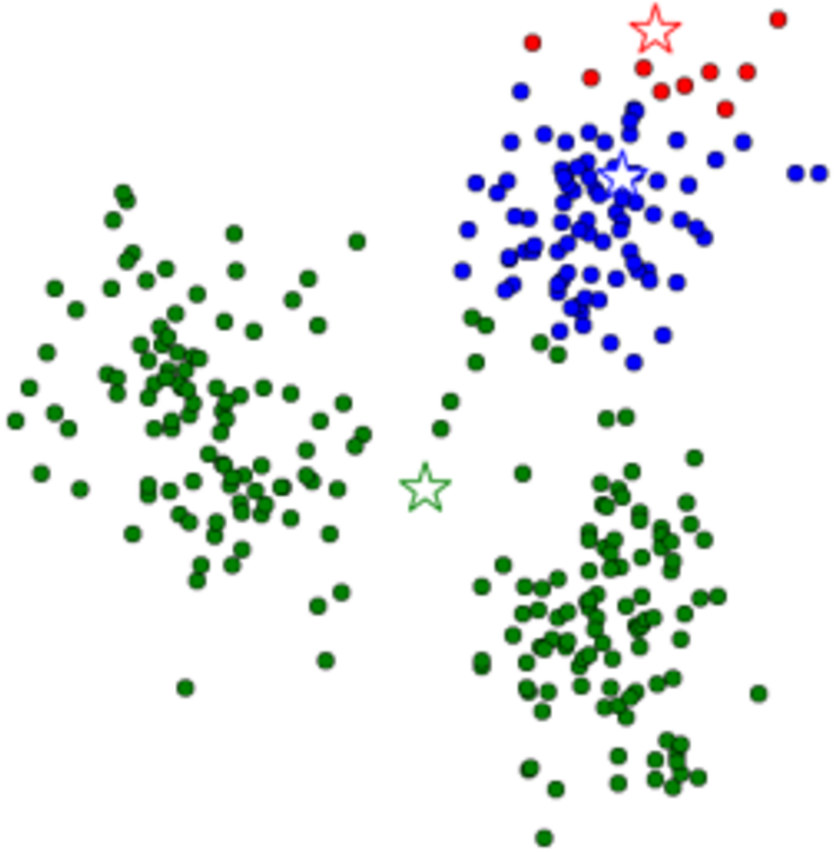


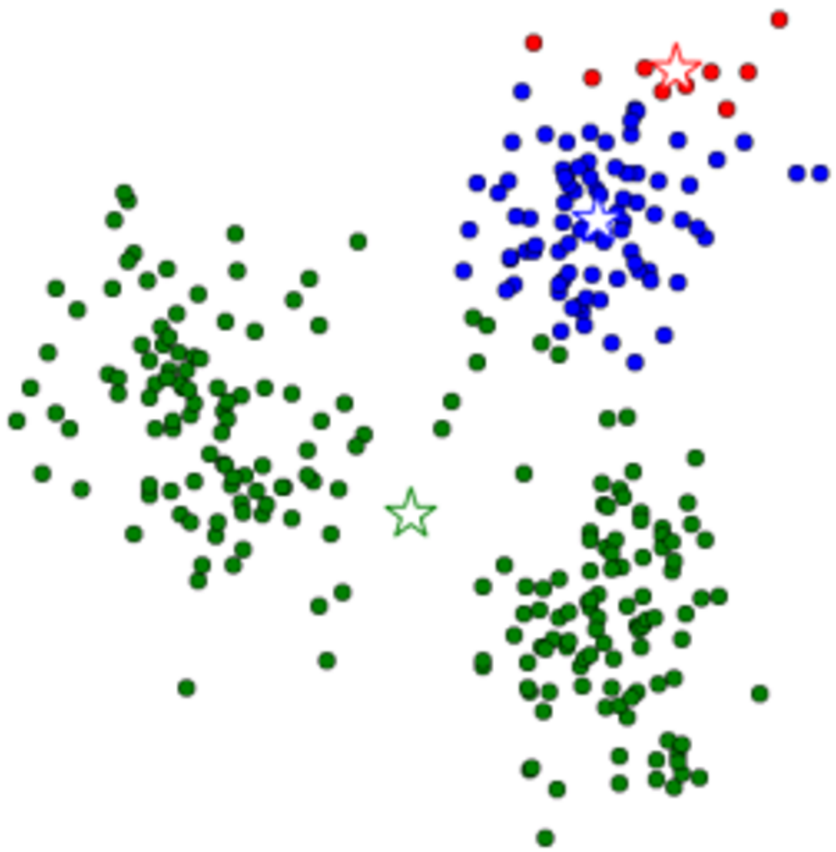
kMeans - Iteration 1 & 2

Initial Setup - Randomly pick 3 samples as the group mean

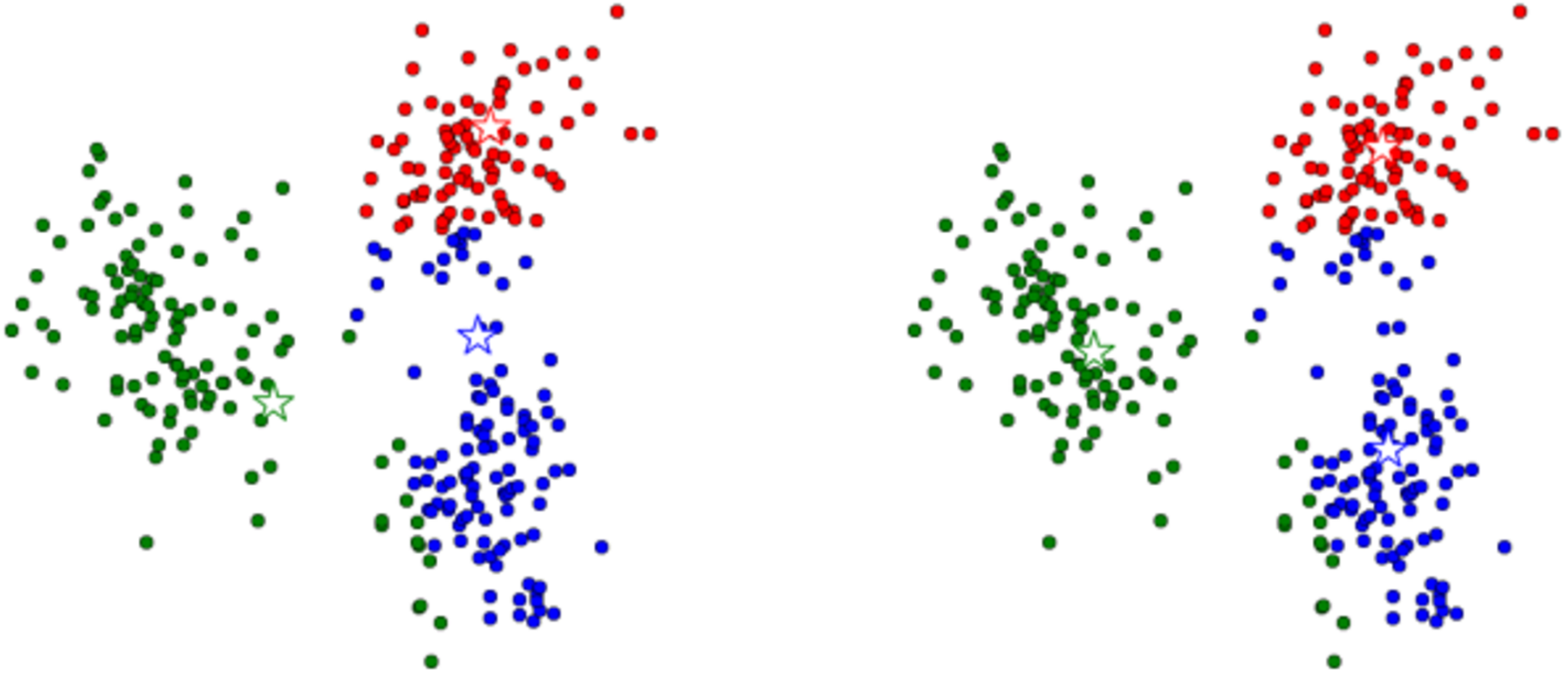


kMeans - Iteration 3 & 4





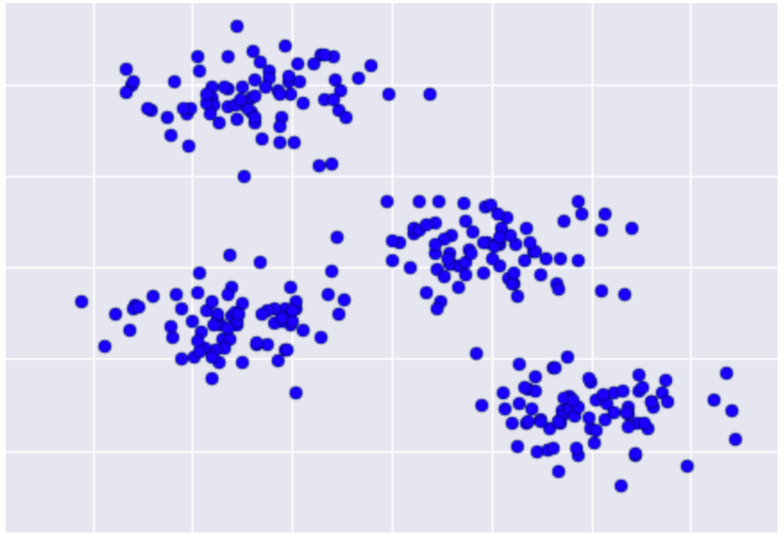
kMeans - Iteration 10

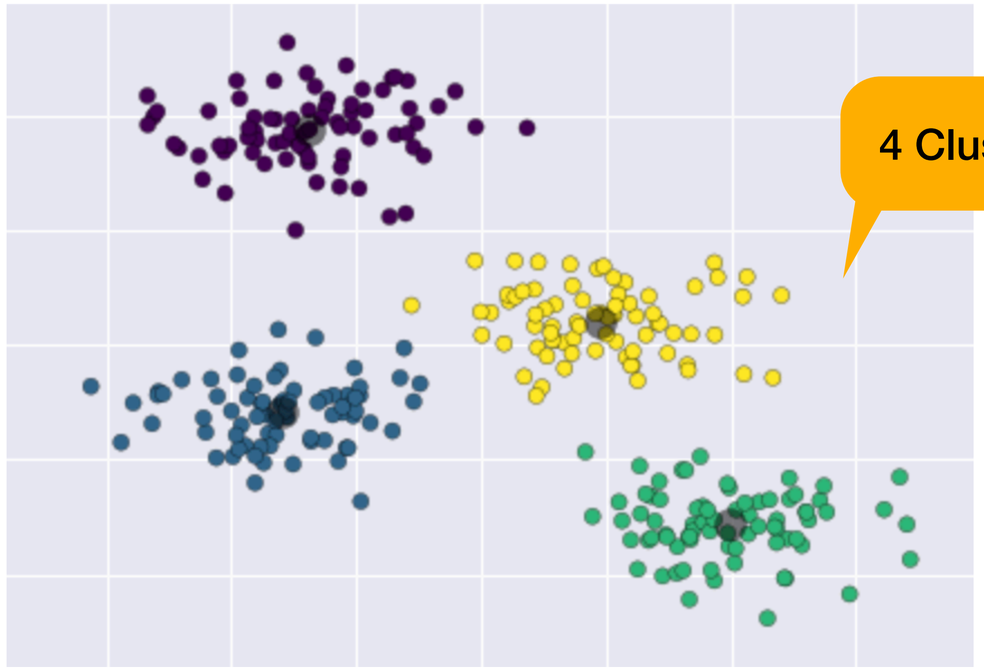


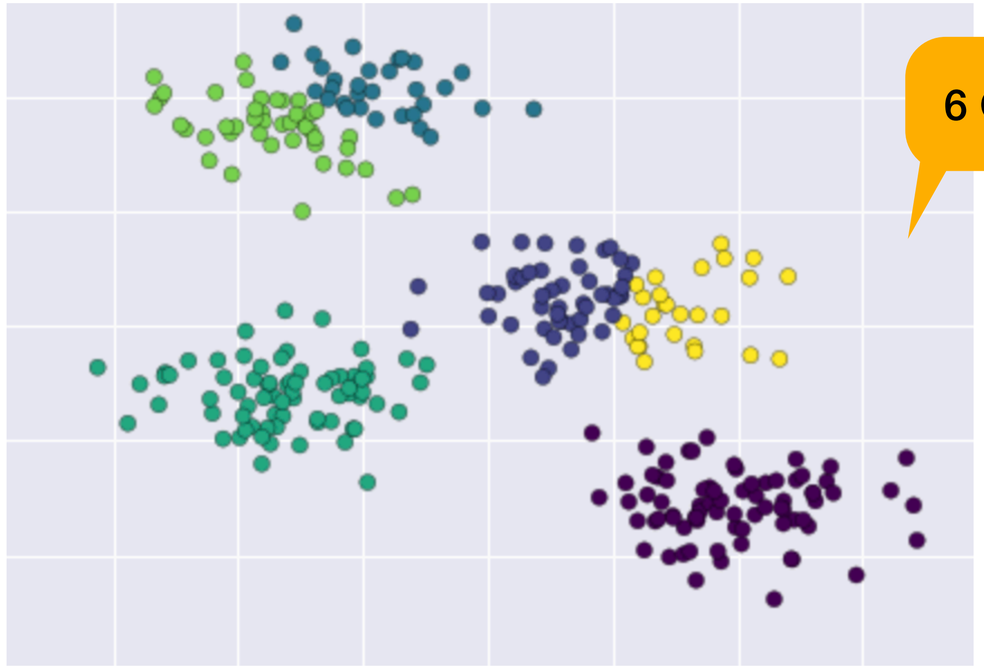
kMeans - Demo

kMeans - Limitation

Cluster Selection

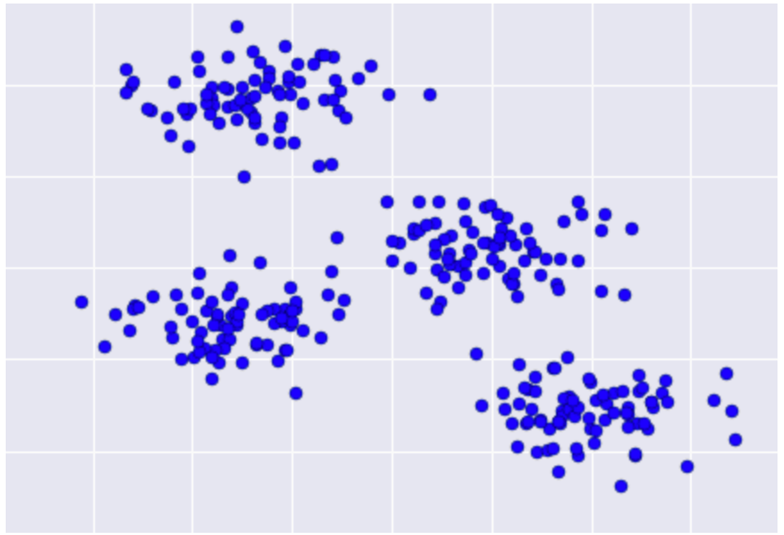


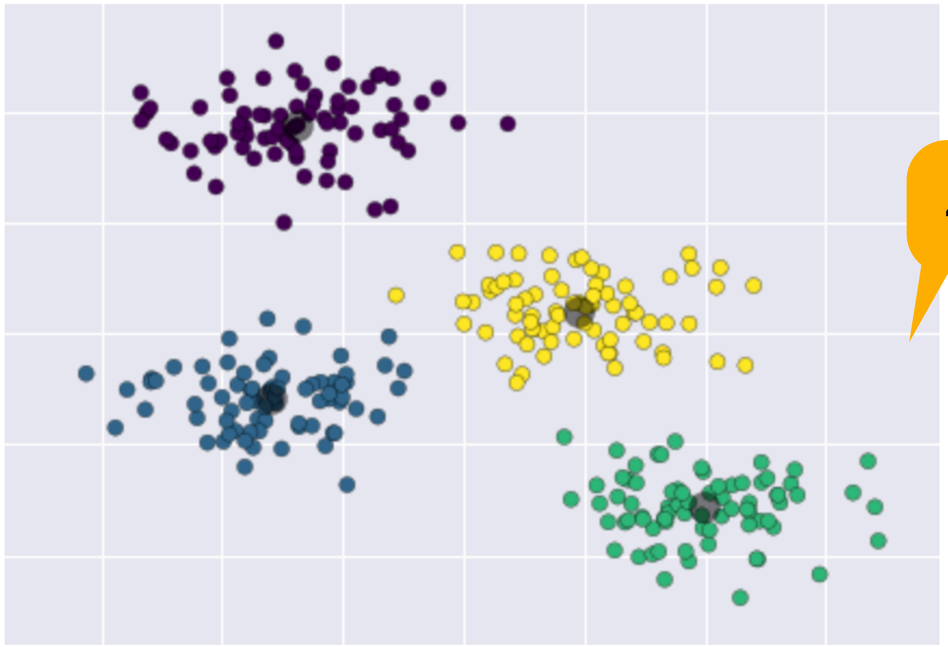




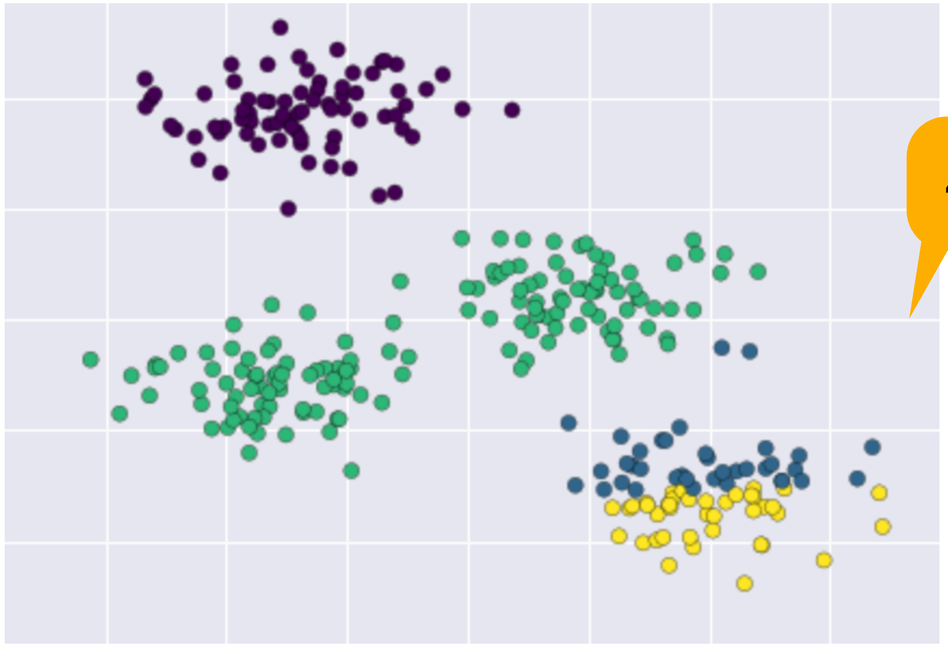
kMeans - Limitation

Globally Optimal Clusters





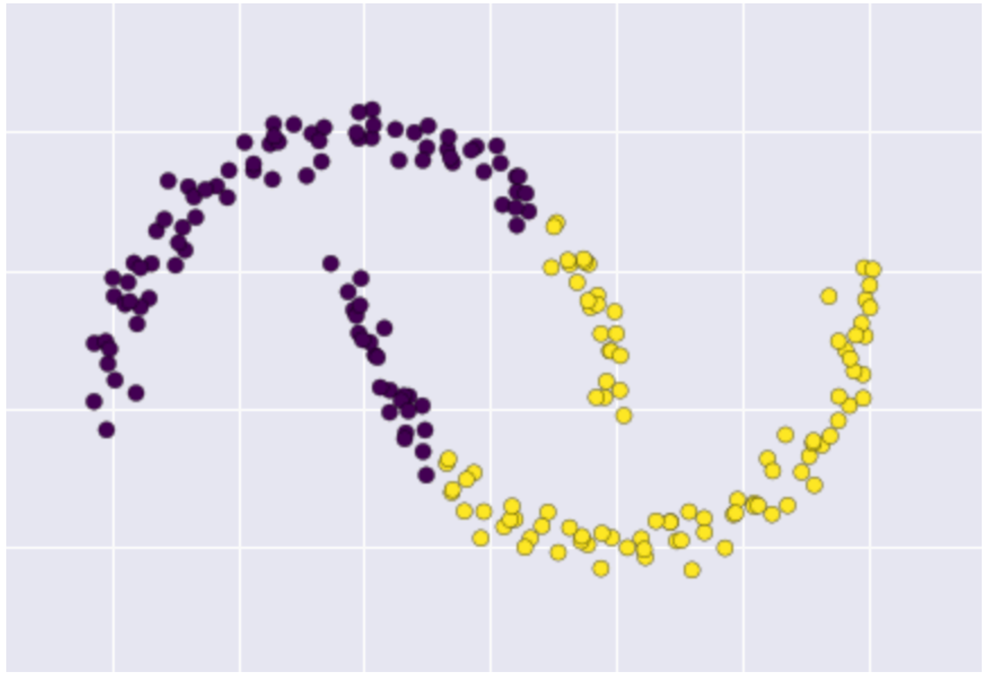
4 Clusters

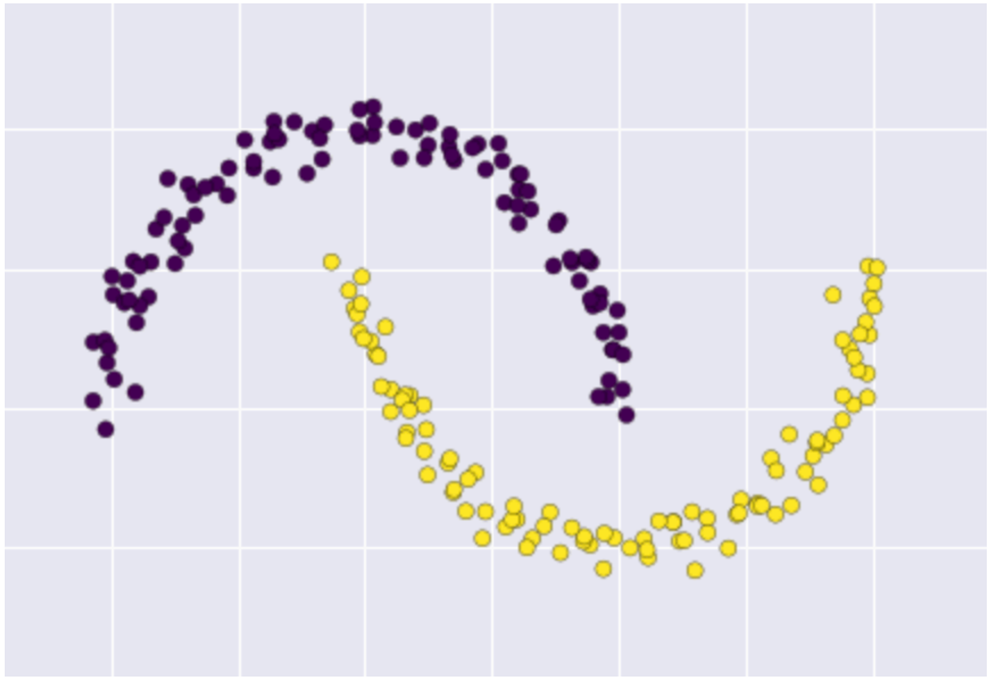


4 Clusters

kMeans - Limitation

Linear Boundaries





The End – Thank You & Good Bye