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Medizinische Fakultät Mannheim
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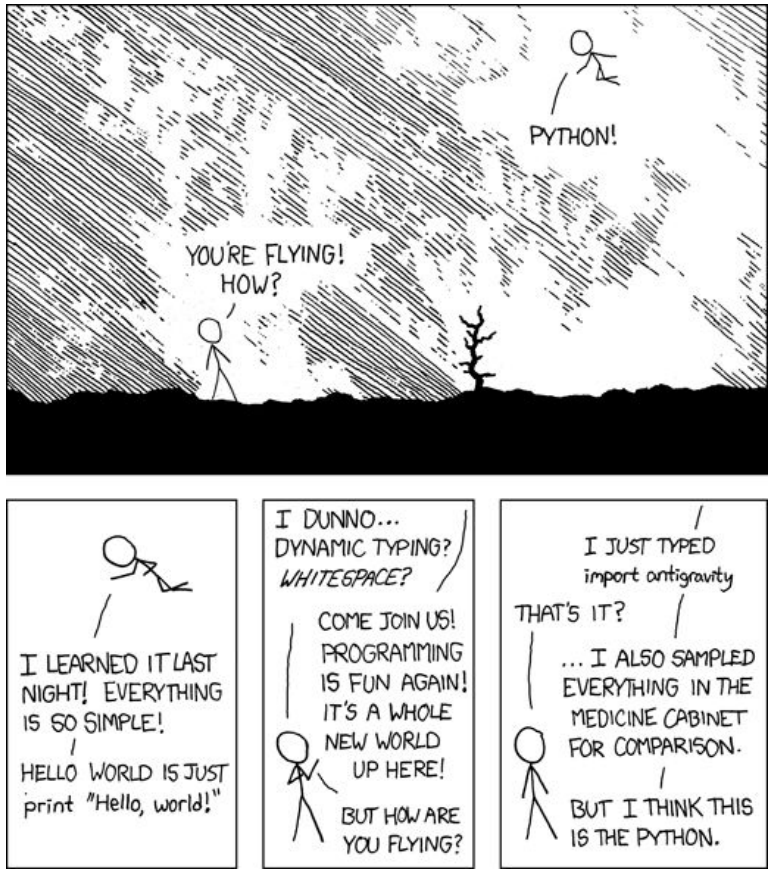
Python for Big Data Analysis



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Tutorial organization

Time	Topic
09:00 - 09:30	Set the scene
09:30 - 10:45	Data analysis and Data visualization
10:45 - 11:15	Break
11:15 - 12:15	**Machine Learning**
12:15 - 13:00	Python at Scale (PySpark)

Agenda

- Machine Learning
- Decision tree and demo
- Clustering and demo

"Machine learning is the field of study that gives computers the ability to learn without being explicitly programmed"

Arthur Samuel, 1959

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What is new in Machine Learning?

- Big data
  - A large volume of data
  - Distributed systems and databases
  - Distributed algorithms for machine learning
- Deep learning
  - Alexey Grigorevich Ivakhnenko published the first general, working learning algorithm for deep networks (Ivakhnenko and Lapa, 1965)
  - It is a learning method that involves more than one hidden layer of an Artificial Neural Networks (ANN)
  - It is a representation learning which is aspired to learn representations intrinsic in the data on its own, rather than manual feature engineering
  - Tools: Tensorflow, Keras, PyTorch and more (http://deeplearning.net/software_links)

Types of Machine Learning

- Supervised Learning
  - Learn **with** human guidance
  - It aims to predict a target value of unseen data from seen data by constructing a mathematical model from labeled data by means of correlating features in order to optimize an objective function
  - Examples: classification; regression
- Unsupervised Learning
  - Learn **without** human guidance
  - It infers a function to identify naturally occurring patterns (structure) in **unlabeled data**
  - Cluster algorithms have one or more hyper parameter that need to be set (e.g. the number of parameters k in k-means clustering); there are no known ways to set these to obtain optimal results (other than trial and error)
  - Examples: clustering; outlier detection

[Quiz] which of machine learning algorithms can be applied?

1. Type 2 diabetes **risk** forecasting
2. **Outlier detection** for patient monitoring and alerting
3. **Would this** patient readmission in 30 days?
4. **Segmentation** of brain tumor images
5. **How many** beds will be on demand today? / on a certain time?
6. **Mining** with rare disease cases

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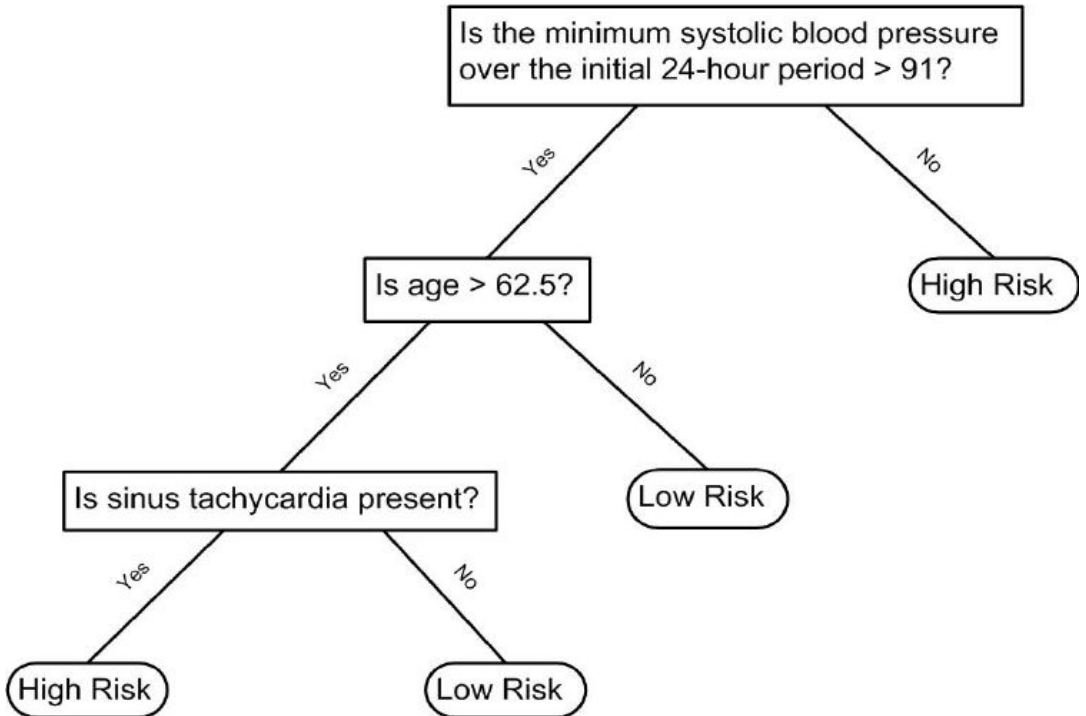
Supervised learning
Classification

- Decision Trees are a supervised learning method
- The model is built by learning decision rules inferred from the training data
- It is a tree of “Yes or No” questions, with questions of higher importance appearing earlier in the tree (e.g. feature importance is calculated based on information gain)
- Example tree that classifies the risk of sinus tachycardia



Supervised learning
Evaluation for classification algorithms

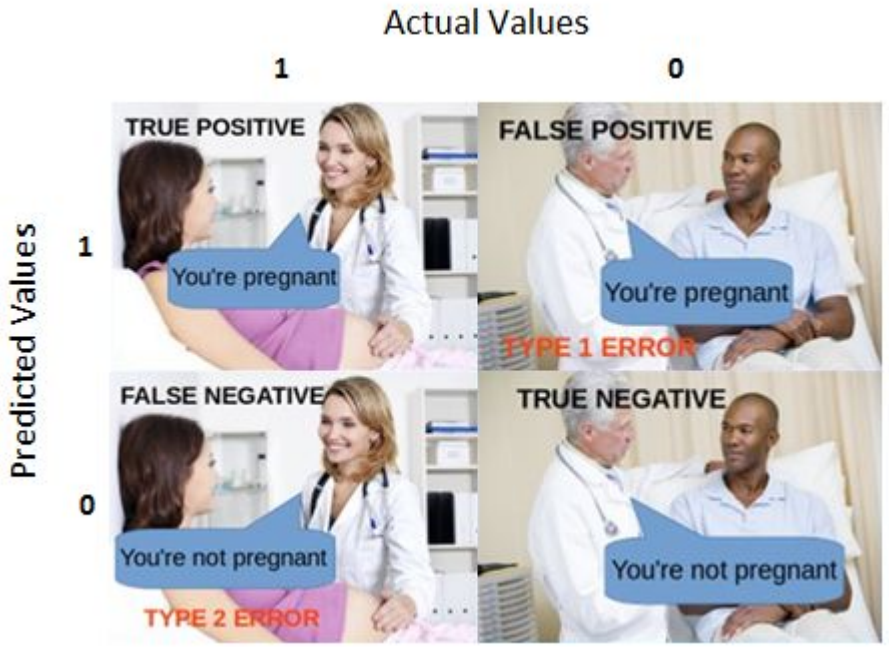
- A confusion matrix is a table that is used to describe the performance of a classification model (or “classifier”) on a set of test data.

		True condition	
		positive	negative
Predicted condition	positive	**True positive**	**False positive** Type I error
	negative	**False negative** Type II error	**True negative**

Precision

Recall/Sensitivity

Confusion matrix for a binary class problem (source: wikipedia)



[Demo] Decision Tree

- Predict the onset of diabetes based on diagnostic measures

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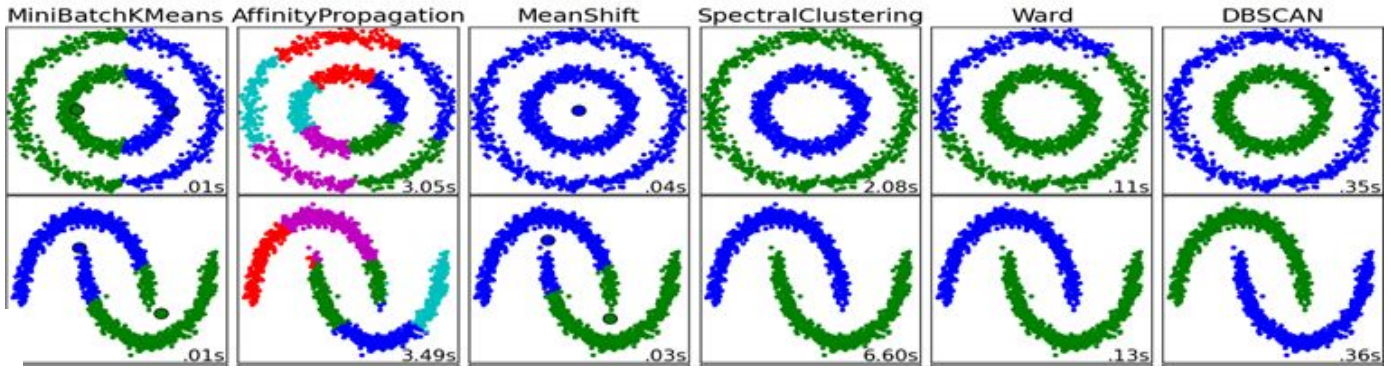
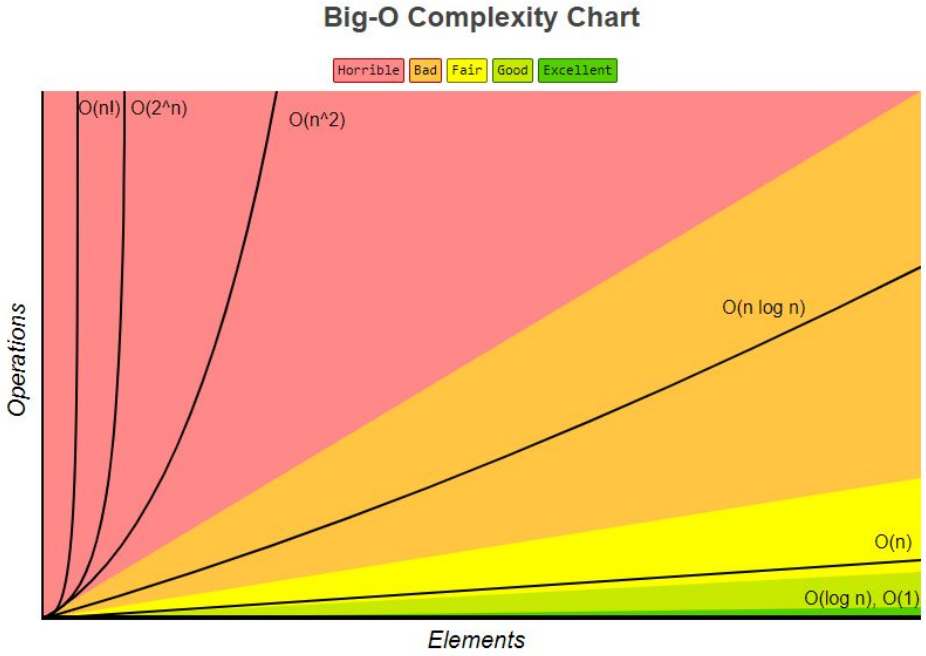
Clustering

- Methods to identify possible groupings in a data-set Induced by the similarity function
- cluster is a set of data points that share a sub-set of the overall properties
- Clustering Algorithms
  - k-means clustering
  - Hierarchical clustering
  - Density based clustering
  - and more



ikit-learn documentation and it demonstrates how the different clustering algorithms worked on a same input data

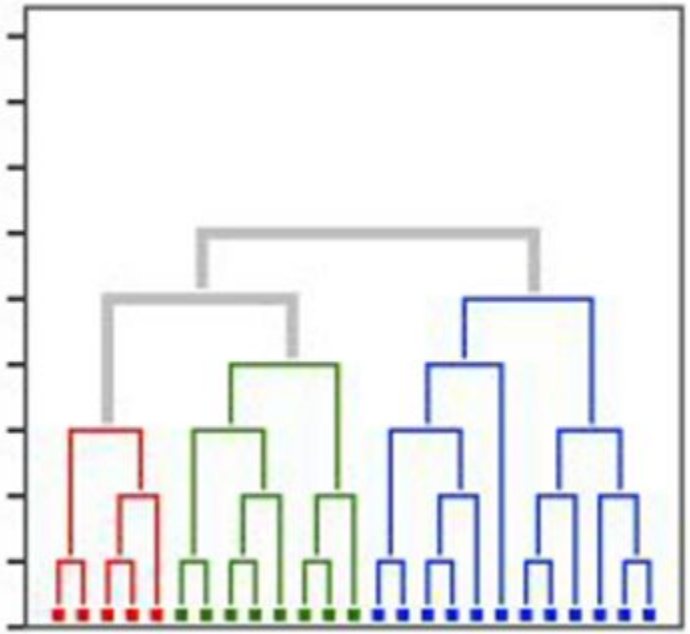


	KMeans	Hierarchical clustering	DBSCAN
time complexity	O(n^2)	O (n^3)	O (n^3)

- where n is the number of data points
- source: wikipedia

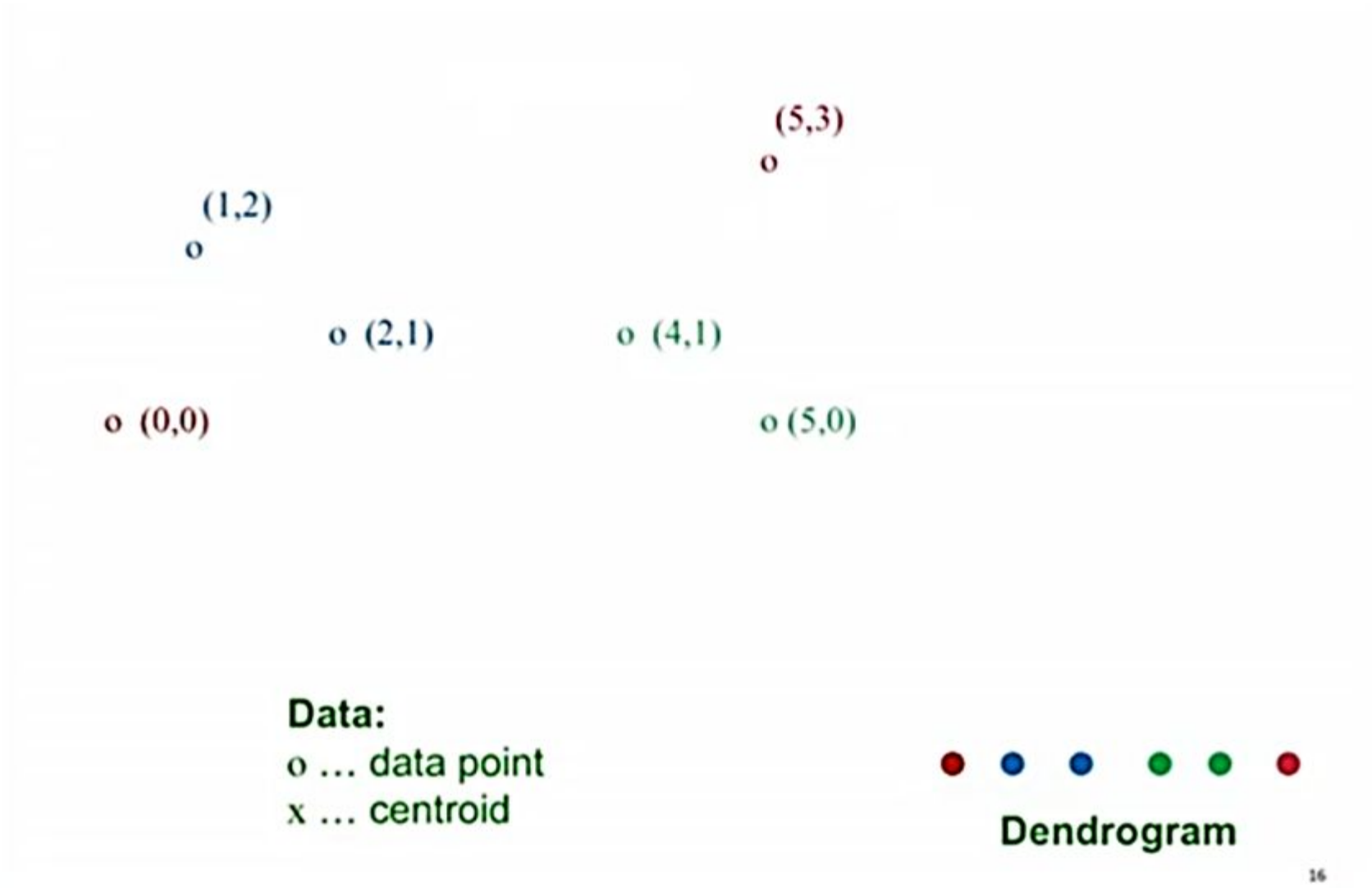
Hierarchical Clustering

- Easy to understand
- A dendrogram can be used to depict this hierarchical clustering process
- Bottom-up (=agglomerative) method: iterate over each data record
- Compare two data records using a similarity function, and join most similar pair



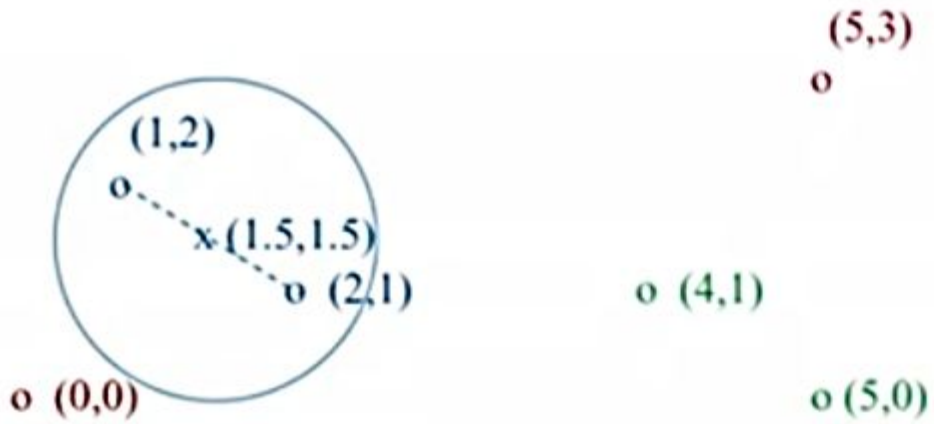
dendrogram

Hierarchical Clustering Demonstration (1/5)



Mining Massive Datasets - Stanford University

Hierarchical Clustering Demonstration (2/5)



Data:
o … data point
x … centroid

Dendrogram

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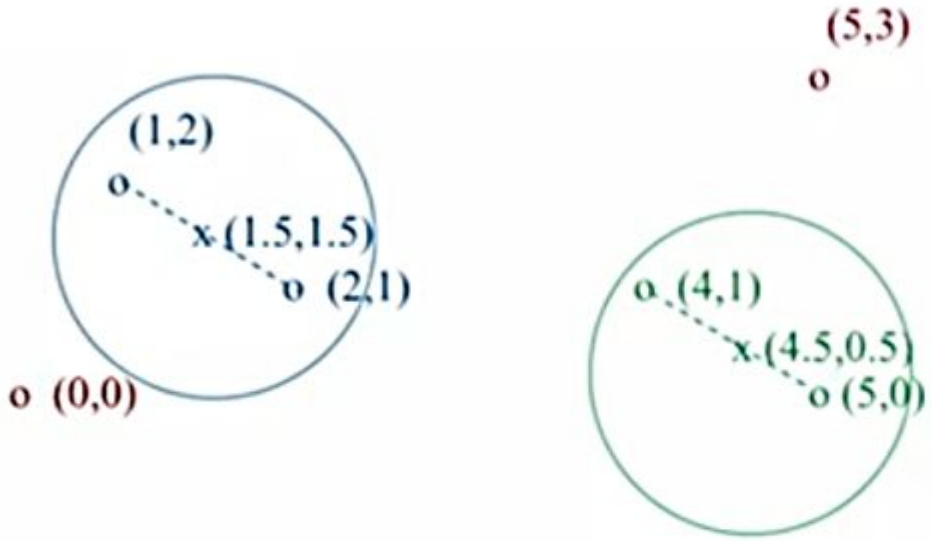
Hierarchical Clustering Demonstration (3/5)



Data:
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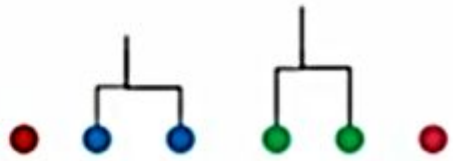
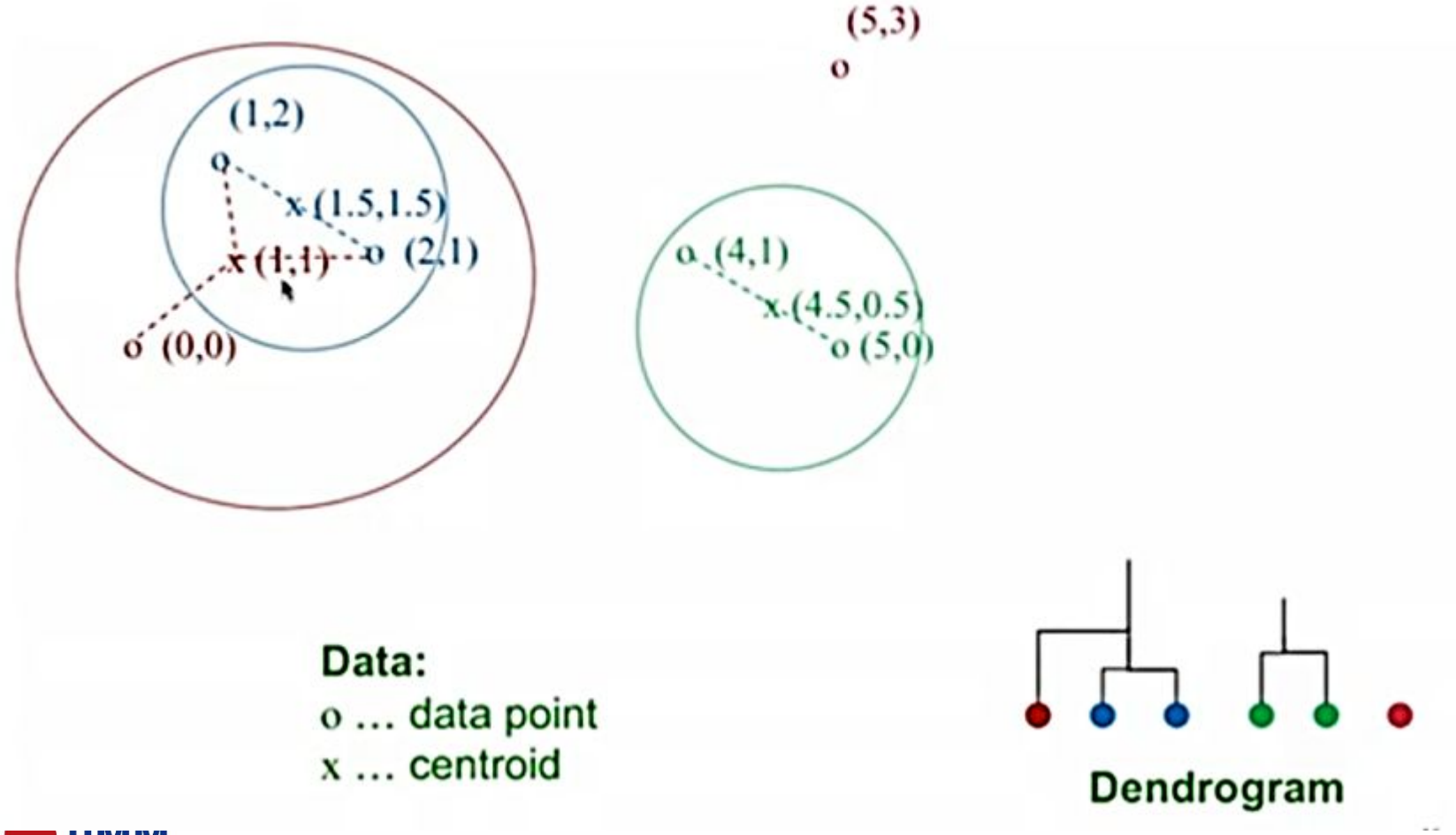
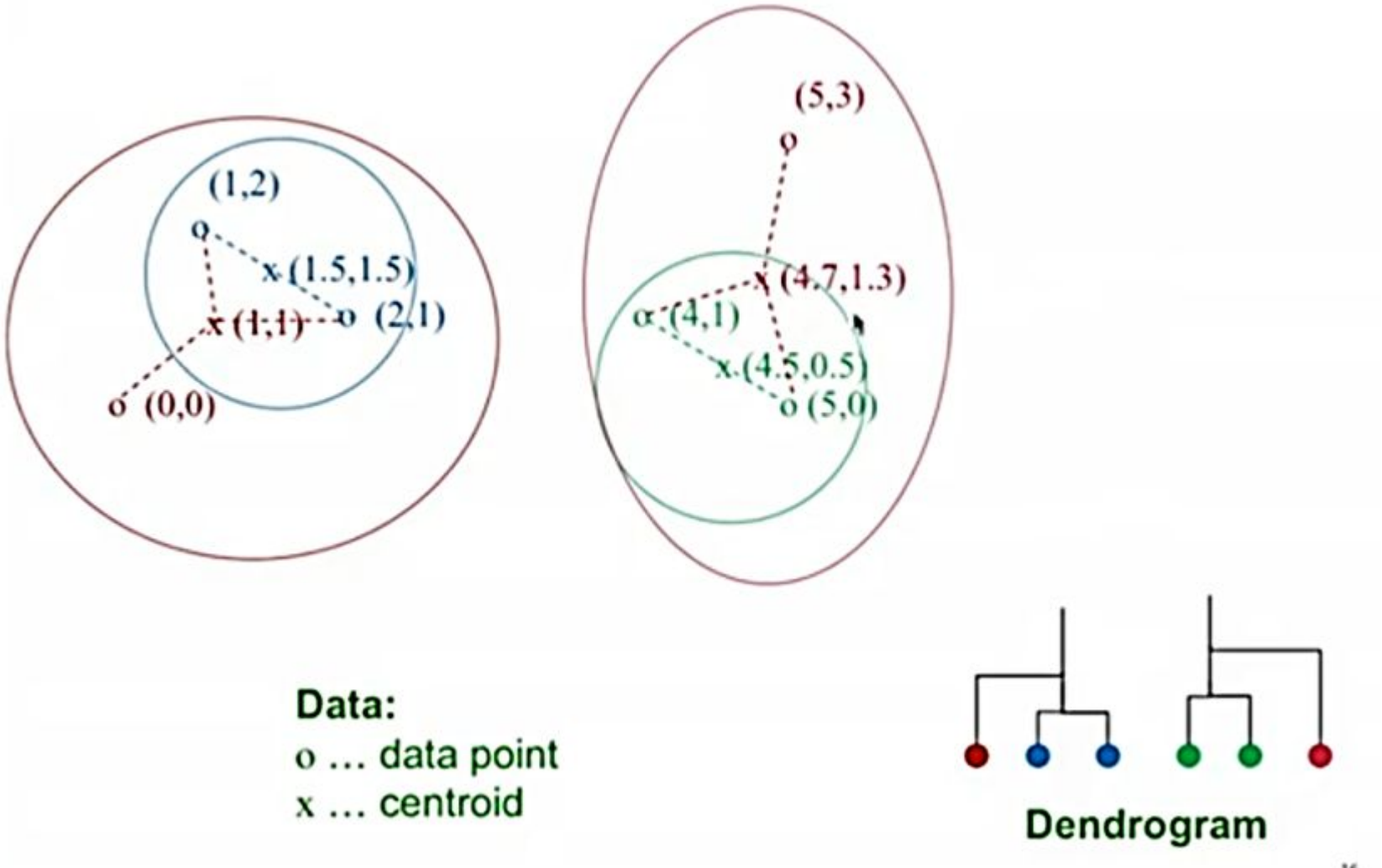


Dendrogram

Hierarchical Clustering Demonstration (4/5)



Hierarchical Clustering Demonstration (5/5)



k-means

- Simple and efficient; best known partitional clustering algorithm
- Maximize intracluster & minimize intercluster similarity
- **Sensitive to choice of seed clusters (initial centroids)**
- For every point in the dataset
  - Measure distance to each centroid
  - Assign point to centroid with lowest distance
- For every cluster
  - Calculate the mean position of all points
- Repeat until convergence criteria is met
  - No points change clusters
  - Centroid changes within a short distance
  - Fixed number of iterations

[Demo][Hands-on] Hierarchical Clustering

- Taxonomic classification of hemoglobin from different species

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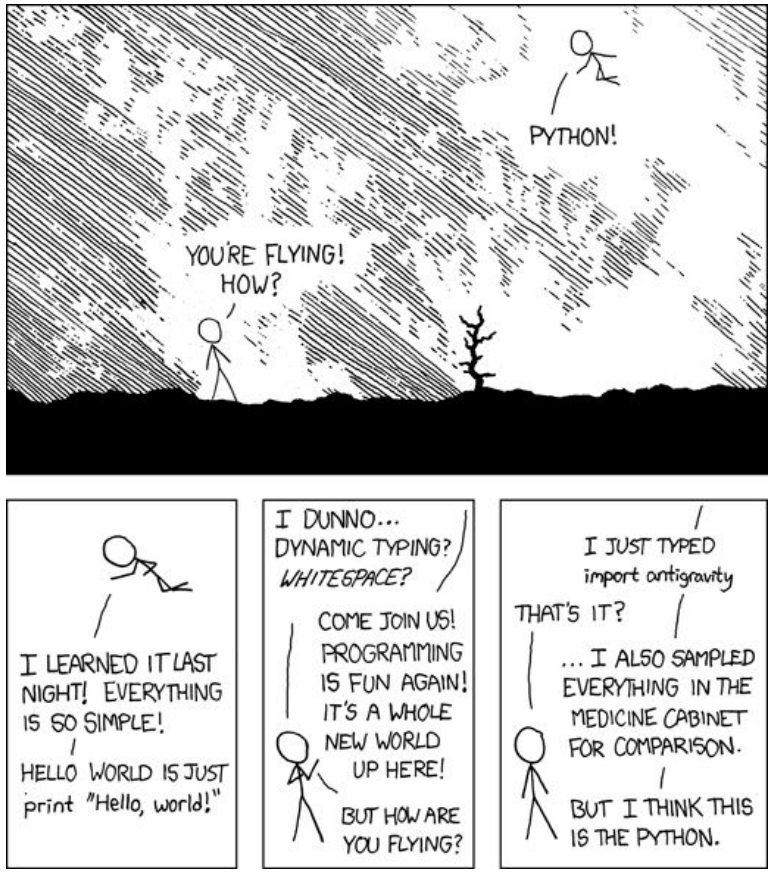
THANK YOU



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