

Unsupervised learning

Inteligencia Artificial en los Sistemas de Control Autónomo
Máster en Ciencia y Tecnología desde el Espacio

Departamento de Automática

Objectives

1. Define Machine Learning (ML)
2. Delimit ML scope
3. Introduce the main ML tasks
4. Recognize problems as ML tasks

Bibliography

- Bishop, Christopher M. Pattern Recognition and Machine Learning. 2nd edition. Springer-Verlag. 2011
- Müller, Andreas C., Guido, Sarah. Introduction to Machine Learning with Python. O'Reilly. 2016

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Algorithms

K-means, GMM and PCA

Algorithms

K-means (I)

Clustering is a set of unsupervised techniques that identify groups of data (named **clusters**)

f_1	f_2	f_3	\dots	f_n
$a_{1,1}$	$a_{2,1}$	$a_{3,1}$	\dots	$a_{n,1}$
$a_{1,2}$	$a_{2,2}$	$a_{3,2}$	\dots	$a_{n,2}$
$a_{1,3}$	$a_{2,3}$	$a_{3,3}$	\dots	$a_{n,3}$
$a_{1,4}$	$a_{2,4}$	$a_{3,4}$	\dots	$a_{n,4}$
$a_{1,5}$	$a_{2,5}$	$a_{3,5}$	\dots	$a_{n,5}$

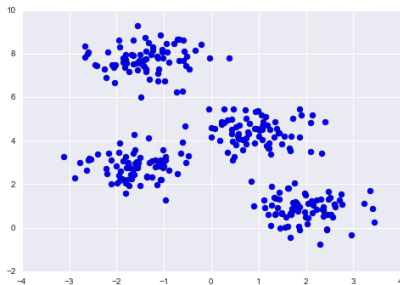
Main algorithms

- K-means
- DBScan
- Gaussian Mixture Models (GMM)
- Expectation Maximization (EM)
- ...

Algorithms

K-means (II)

Original data



(Source)

Clustered data



In k-means, clusters are identified by a centroid

Algorithms

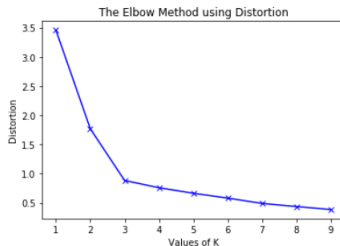
K-means (III)

K-means drawbacks

- Initial seed
- K election

Elbow method

1. Select $K = 1, \dots, n$
2. Visualize performance for each k
3. Choose K where metric stabilizes

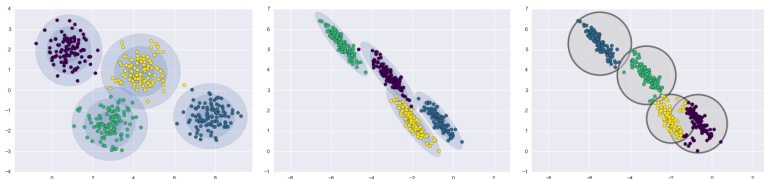


Algorithms

Gaussian Mixture Model (GMM)

GMM builds a probabilistic model of our data

- GMM is a generative clustering algorithm
- Assumes data coming from a set of multidimensional gaussian distributions
 - GMM fits a set $\{(\mu_i, \sigma_i)\}_{i=1,\dots,K}$
 - μ is a vector
 - σ is a covariance matrix



(Source)

Algorithms

Principal Components Analysis (I)

Dimensionality reduction transforms data into more convenient representations

- Reduce data dimensionality
- Visualize multidimensional data

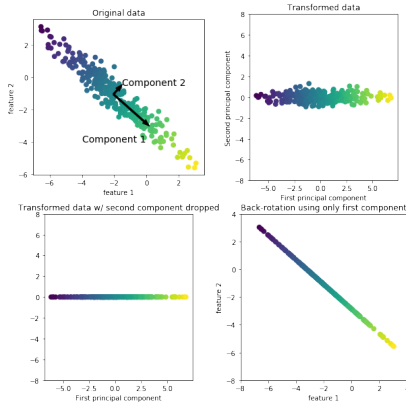
Main algorithms

- Isomap
- T-distributed Stochastic Neighbor Embedding (t-SNE)
- Principal Components Analysis (PCA)

Algorithms

Principal Components Analysis (II)

PCA maximizes data variance



(Source)

Algorithms

Principal Components Analysis (III)

Example: Hand-written digits recognition

- Images of hand-written digits
- 8x8 images (64 dimensions)
- 10 digits
- Classification problem

