# Clustering

see Biopsychosocial clustering

The task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense) to each other than to those in other groups (clusters). It is a main task of exploratory data mining, and a common technique for statistical data analysis, used in many fields, including machine learning, pattern recognition, image analysis, information retrieval, bioinformatics, data compression, and computer graphics.

Given a set of data points, we can use a cluster algorithm to classify each data point into a specific group.

Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense) to each other than to those in other groups (clusters).

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: These algorithms are used to group similar data points together based on their intrinsic properties. Common clustering algorithms include:

K-Means Clustering Hierarchical Clustering DBSCAN Gaussian Mixture Models (GMM) Dimensionality Reduction: These algorithms reduce the number of features in a dataset while retaining important information. Common dimensionality reduction techniques are:

Principal Component Analysis (PCA) t-Distributed Stochastic Neighbor Embedding (t-SNE) Linear Discriminant Analysis (LDA) Anomaly Detection: Anomaly detection algorithms identify unusual data points that do not conform to expected patterns. Algorithms in this category include:

Isolation Forest One-Class SVM Local Outlier Factor (LOF)

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Reliable intraoperative delineation of tumor from healthy brain tissue is essentially based on the neurosurgeon's visual aspect and tactile perception of the considered tissue, which is-due to inherent low brain consistency contrast-a challenging task. Development of an intelligent artificial intraoperative tactile perception will be a relevant task to improve the safety during surgery, especially when-as for neuroendoscopy-tactile perception will be damped or-as for surgical robotic applications-will not be a priori existent.

Stroop et al. from the Department of Neurosurgery, Academic Hospital Cologne-Merheim, Department of Engineering Technology (INDI), Vrije Universiteit Brussels, Belgium, presented the enhancements and the evaluation of a tactile sensor based on the use of a piezoelectric tactile sensor.

A robotic-driven piezoelectric bimorph sensor was excited using multisine to obtain the frequency response function of the contact between the sensor and fresh ex vivo porcine tissue probes. Based on load-depth, relaxation and creep response tests, viscoelastic parameters E1 and E2 for the elastic moduli and η for the viscosity coefficient have been obtained allowing tissue classification. Data analysis was performed by a multivariate cluster algorithm.

Cluster algorithm assigned five clusters for the assignment of white matter, basal ganglia and thalamus probes. Basal ganglia and white matter have been assigned to a common cluster, revealing a less discriminatory power for these tissue types, whereas thalamus was exclusively delineated; gray matter could even be separated in subclusters.

Bimorph-based, multisine-excited tactile sensors reveal a high sensitivity in ex vivo tissue-type differentiation. Although, the sensor principle has to be further evaluated, these data are promising [1)].

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Stroop R, Nakamura M, Schoukens J, Oliva Uribe D. Tactile sensor-based real-time clustering for tissue differentiation. Int J Comput Assist Radiol Surg. 2018 Oct 6. doi: 10.1007/s11548-018-1869-5. [Epub ahead of print] PubMed PMID: 30293172.