In theory, data points that are in the same group should have similar properties and/or features, while data points in different groups should have highly dissimilar properties and/or features. Clustering is a method of unsupervised learning and is a common technique for statistical data analysis used in many fields.

Reliable intraoperative delineation of tumor from healthy brain tissue is essentially based on the neurosurgeon's visual aspect and tactile impression 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. 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)].

1)
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.