ΠΑΡΟΥΣΙΑΣΗ

ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ

ΗΜΕΡΟΜΗΝΙΑ: Τετάρτη, 22 Οκτωβρίου 2025

ΩΡΑ: 11.00 – 13:00

ΑΙΘΟΥΣΑ: Αίθουσα Σεμιναρίων ΤΜΗΥΠ

ΟΜΙΛΗΤΗΣ: Γεώργιος Βαρδάκας

Θ έ μ α

« Clustering Methods based on Deep Learning and Unimodality Testing »

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Π ε ρ ί λ η ψ η:

Data clustering is the process of partitioning a dataset into a finite set of groups, or clusters, such that data points within each cluster exhibit similarity, while

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those belonging to different clusters are dissimilar. This thesis concerns the development, implementation and evaluation of novel clustering methodologies.

At first, the global *k*-means++ algorithm is introduced to address the initialization challenges inherent in the standard *k*-means algorithm. The approach integrates the incremental strategy of global *k*-means with the probabilistic center selection mechanism of *k*-means++, effectively combining the strengths of both techniques. Furthermore, this concept is extended from Euclidean to kernel space by proposing global kernel *k*-means++, an algorithm specifically designed to overcome the initialization problem in kernel *k*-means.

Next the UniForCE clustering algorithm is proposed, that simultaneously partitions data and estimates the number of clusters. UniForCE introduces the notion of locally unimodal cluster, focusing on data unimodality at local regions rather than the entire cluster level. Starting from an overclustering of the dataset into subclusters, the method proceeds by first identifying unimodal pairs of neighboring subclusters and then by aggregating unimodal pairs into larger, statistically coherent structures via a unimodality graph. A statistical test is proposed to determine unimodal subcluster pairs and clustering is achieved by detecting the number of connected components in the unimodality graph. This flexible formulation enables the discovery of arbitrarily shaped clusters and automatically estimates the number of clusters.

The remaining part of the thesis focuses on deep clustering. At first the soft silhouette score is proposed that accommodates probabilistic cluster assignments to generalize the widely used silhouette criterion for clustering. By exploiting the differentiable nature of soft silhouette, an autoencoder-based deep clustering method is presented that guides the learned latent representations to form clusters that are both compact and well-separated.

Finally, another deep clustering method is proposed, the neural implicit maximum likelihood clustering algorithm, that frames clustering as a generative task within the Implicit Maximum Likelihood Estimation framework. By adapting ideas from GAN-based clustering, the method avoids several shortcomings while maintaining a simple and stable training objective. It performs particularly well on small datasets being capable of capturing diverse cluster geometries without hyperparameter tuning.

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