Deep Convolutional Embedding for Digitized Painting Clustering

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Context

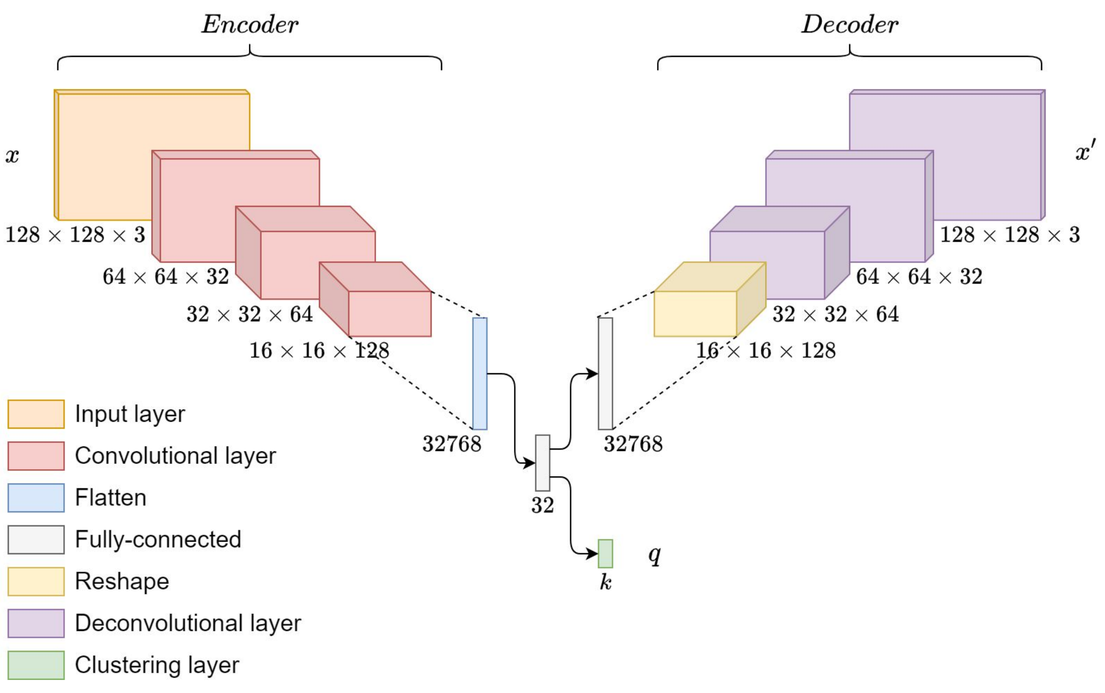
Cultural heritage, in particular visual arts, are of inestimable importance for the cultural, historical and economic growth of our societies. In recent years, due to technological improvements and the drastic drop in costs, a large scale digitization effort has been made which has led to an increasing availability of large digitized art collections. This availability, coupled with the recent advances in Pattern Recognition and Computer Vision, has opened new opportunities to computer science researchers to assist the art community with intelligent tools to analyze and further understand visual arts.

Motivations

Having a model that can cluster artworks based on their visual appearance, without the need to collect labels and metadata, can be useful for many applications: visual link retrieval, historical knowledge discovery, etc. Unfortunately, clustering artworks is difficult for several reasons. On the one hand, recognizing meaningful patterns according to domain knowledge and visual perception is extremely difficult. On the other hand, applying traditional clustering and feature reduction techniques to the highly dimensional pixel space can be ineffective.

Method

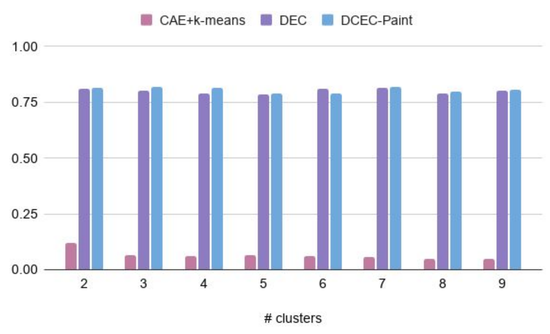
To address these issues, we propose to use a deep convolutional embedding clustering (DCEC) model, in which the task of mapping the raw input data to an abstract, latent space is jointly optimized with the task of finding a set of cluster centroids in this latent feature space.



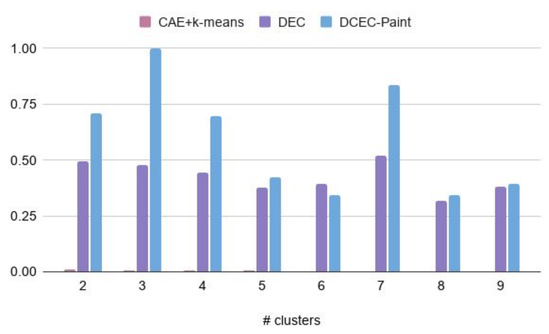
Experiment

To evaluate the effectiveness of the method, we used a database that collects paintings of 50 popular artists belonging to 9 art periods: Gothic, Renaissance, Baroque, Romanticism, Impressionism, etc. We fairly compared the proposed method with other deep clustering approaches: running k-means on the embedded features of the proposed pre-trained convolutional autoencoder (CAE+k-means) and the deep embedding clustering (DEC) method, in which the decoder is abandoned and only the clustering loss is minimized.

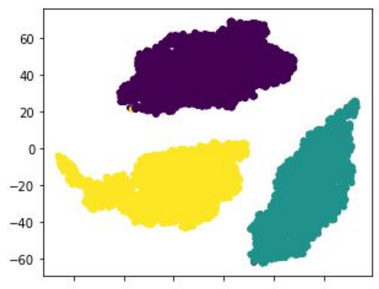
Silhouette coefficient



Calinski-Harabasz index



k= 3



Conclusion

Encouraging results have been obtained, which confirm the effectiveness of the deep clustering approach to address highly complex image domains, such as the artistic one. When the granularity of clustering is coarse, the model takes into account more general features, mainly related to the artistic style. When the granularity is finer, the model begins to use content features and tends to group works regardless of the corresponding painting school. In the future, we would like to discard traditional distance measures to find clusters in the feature space, relying on a metric learning approach.

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