Variational autoencoding of wood charcoal SEM images

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Description

The methods used by archaeobotanists to identify wood families from charcoal recovered from archaeological sites are based on a combination of several anatomical criteria. However, many families have very similar morphological characteristics that limit the identification of wood at the family level, especially when the wood pieces are not well preserved, broken or fragmentary. In this respect, machine and deep learning techniques can support the activity of the archaeobotanists by means of *unsupervised* classification aiming to detect latent similarities between families. This case study focuses on a family of deep generative models, the *variational autoencoders* (VAEs, Kingma and Welling, 2019) and the aim is twofold:

1. generate new, artificial wood charcoal images and

2. use the latent space representations to cluster the original images.

Based on a database of scanning electron microscopy (SEM) 2D images of wood charcoals, the students will be provided with a dataset counting about 1070 pre-processed images (80% used for training, 20% for validation) as the one in Figure 1. The aim of the case study is to test some variational autoencoder architectures (see https://github.com/AntixK/PyTorch-VAE for a non-extensive list), with a particular focus on the original VAE as well as on the recent NVAE (Vahdat and Kautz, 2020).
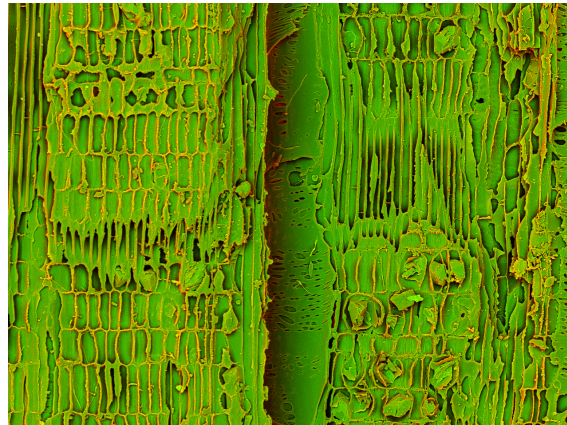

Figure 1: Example of a SEM image belonging to the class ANACARDIACEAE.

References

D. P. Kingma and M. Welling. An introduction to variational autoencoders. *arXiv preprint arXiv:1906.02691*, 2019.

A. Vahdat and J. Kautz. Nvae: A deep hierarchical variational autoencoder. *arXiv preprint arXiv:2007.03898*, 2020.