This folder contains python codes that implement the two fold-detection methods described in "Detecting geological structures from geological maps with machine learning" by Oakley, Loiselet, Coowar, Labbe, and Callot (submitted manuscript).

Folders

Neural_Network_Method: This folder contains the code for and the trained network weights for the U-NET based supervised learning method of fold detection.

The trained model that was used for the paper is saved in the folder "DetectAreasAndAxisModel" with its history in the file "DetectAreasAndAxisModel_history.npy". If you wish to recreate the training, first run the script "MakeRandomModels.py" in the "RandomModels" folder and then run the script "FitNeuralNetwork.py." However, since the trained model is provided, it is not necessary to recreate the training in order to run the rest of the scripts.

The scripts "Plot_Synthetic_Models" and "Plot_With_Sliding_Window" provide examples of applying the trained neural network to interpret the synthetic maps. The script "PlotLoss" plots the training and validation losses at each training epoch.

Synthetic_Maps: This folder contains the code to create the synthetic maps discussed in the paper as well as the resulting shapefile and raster maps.

To create these models run the scripts "MakeSyntheticModels_Vector.py" and "MakeSyntheticModels_Raster.py".

Synthetic_Model_Figures: This folder contains the code to recreate the figures in the paper that show the synthetic models and the results of the two methods as applied to them. You will need to first run the scripts in Synthetic_Maps and Unsupervised_Clustering_Method to create the files needed by these plotting scripts.

The scripts "PlotMapAndCrossSection.py" and "PlotSyntheticMaps.py" make plots using vector map data. The scripts "PlotClusteringProcess.py", "PlotMapsWithFoldAreas.py", and "PlotMapsWithFoldAxes.py" show results of the unsupervised clustering method. The scripts "PlotMapsUNET.py" and "PlotUNETProcess.py" show results of the neural network method.

Unsupervised_Clustering_Method: This folder contains the code for the unsupervised learning method of fold detection that uses hdbscan clustering.

To use this, run the script "main.py". Change options in the top section as desired. The script has options for running each of the maps in Synthetic_Maps, so you can uncomment the one you want to run and comment out the rest or comment out all of them and add your own in the same style.

Note: The real-world Lavelanet and Esternay maps used as examples in the text are not included in the above because they rely on data (shapefiles and digital elevation models) that we do not have permission to redistribute. If you are interested in working with that data, please contact the BRGM at contact@brgm.fr.

Python Packages

Due to package incompatibilities, two different python environments were used: one for scripts that require tensorflow, but not geopandas and one for those that require geopandas, but not tensorflow. The lists below give package versions in the two environments, with which all the scripts ran successfully. They may or may not run with other versions, but if you encounter errors, we suggest trying with these versions.

Environment 1 (Without Tensorflow, with Geopandas)

- geopandas 0.12.2
- hdbscan 0.8.33
- matplotlib 3.7.4
- numba 0.58.1
- numpy 1.26.2
- pandas 2.1.4
- pyogrio 0.7.2
- python 3.9.18
- regex 2023.10.3
- scikit-learn 1.3.2
- scipy 1.11.4
- shapely 2.0.2
- spyder 5.4.3

Environment 2 (With Tensorflow, without Geopandas):

- cudatoolkit 11.2.2
- cudnn 8.1.0.77
- imageio 2.31.4
- keras 2.10.0
- matplotlib 3.8.0
- numba 0.59.0
- python 3.9.18
- spyder 5.4.3
- tensorflow 2.10.1