A DL approach for automated fracture tracing in 2D

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Introduction

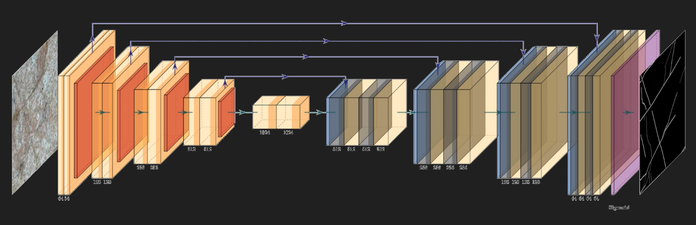
- Natural fractures create permeable fluid pathways crucial for geo-energy applications like CO2 sequestration and geothermal projects [1].
- Drone and LiDAR-based acquisition methods produce high-resolution 2D data, suitable for detailed fracture mapping [2].
- Manual and semi-automated fracture mapping is time-consuming and susceptible to interpreter bias [3].

Methods

MODELS:

All based on convolutions

* U-Net [4]
* DeepLabV3+ [5]
* PAN [6]!

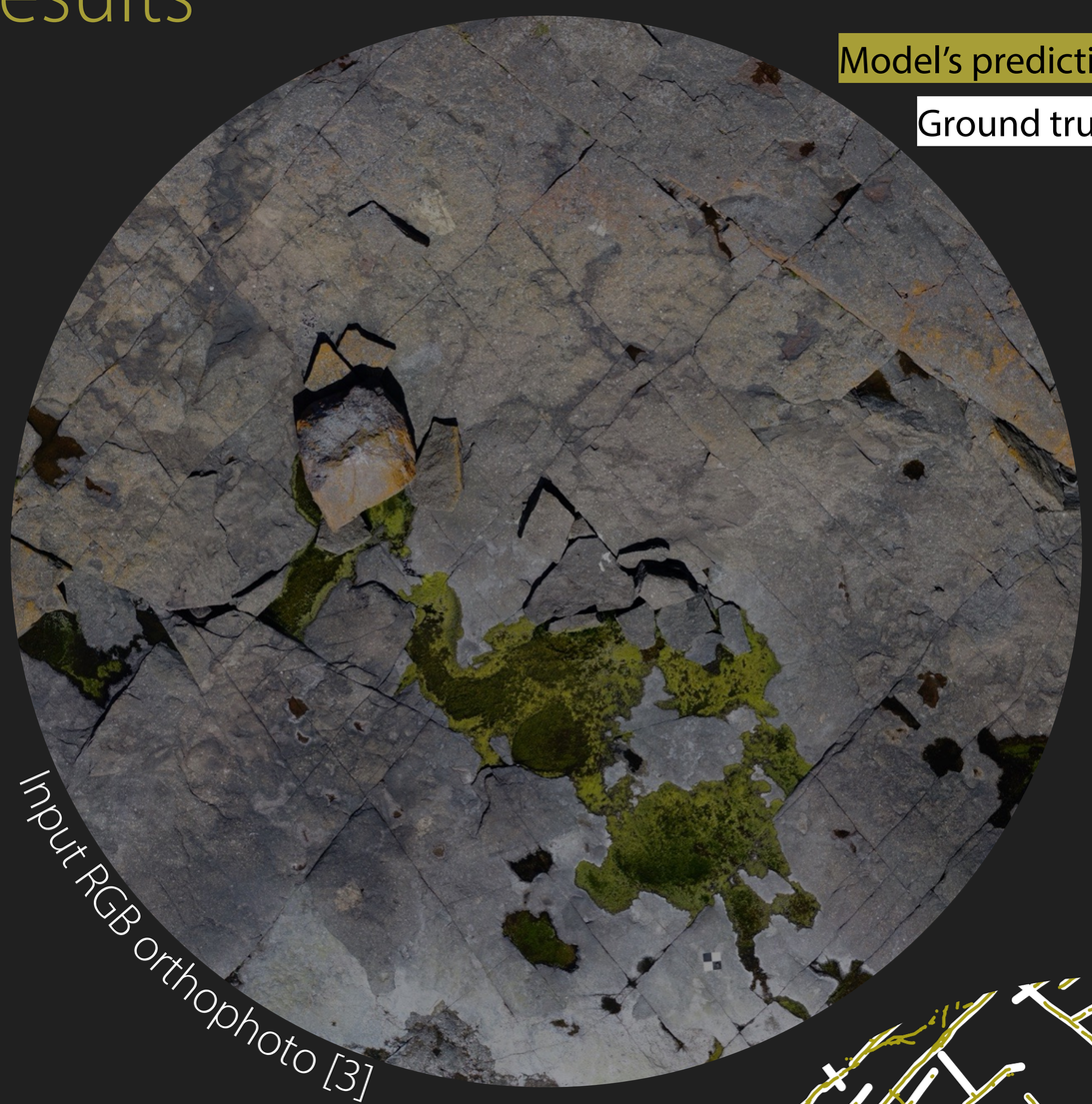


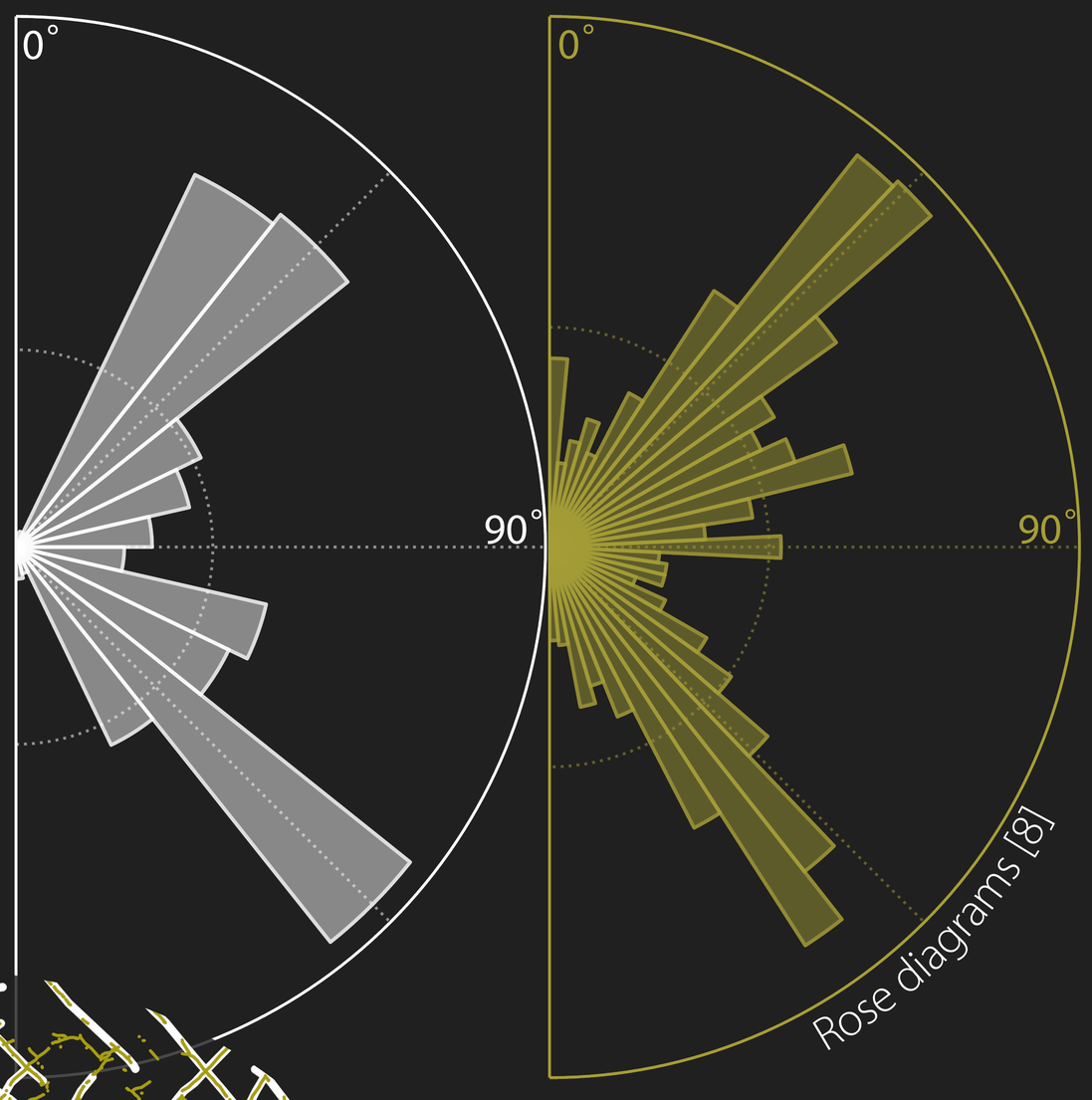
Post-processing: Thin ---> Smooth ---> Vectorize

Can we use DL to *automate* 2D fracture mapping for *quick* and *accurate* results?

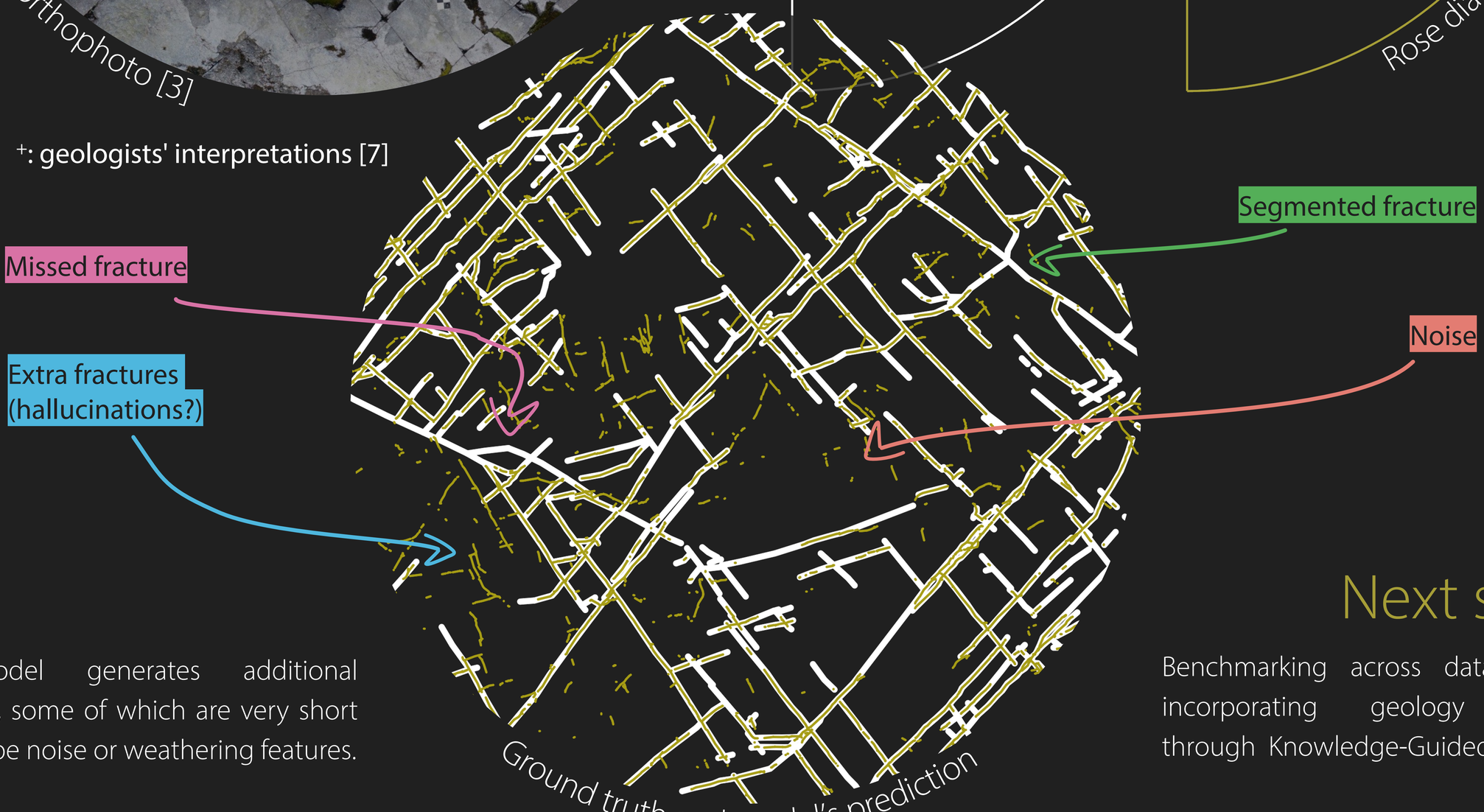
Automatic: No manual intervention required;
Accurate: Results closely match real fractures and unaffected by interpreter bias.

Results





+: geologists' interpretations [7]



The model generates additional segments, some of which are very short and may be noise or weathering features.

Next steps

Benchmarking across datasets and incorporating geology insights through Knowledge-Guided Learning

[1] Matthaï S., 2004, Geophysical Research Letters, Volume 31 – [2] Bemis S., 2014, Journal of Structural Geology – [3] Nordbäck N., 2022, zenodo.7077519 - [4] Ronneberger O., 2015, Lecture Notes in Computer Science, 9351 - [5] Chen L., 2018, arXiv: 1802.02611 - [6] Li H., 2018, arXiv: 1805.10180 - [7] Ovaskainen N., 2022, zenodo.7077846 - [8] Ovaskainen N., 2023, joss.05300