WEAKLY-SUPERVISED LEARNING OF PIXEL-LEVEL LABELLING FOR SEISMIC STRUCTURES

ACSE 9 - Independent Research Project

Internship at Ovation Data Ltd

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Content

- Motivation and aim: Labelling seismic structures at pixel-level
- Experimental data: LANDMASS
- Method: Non-negative Matrix factorization(with sparseness)
- Software workflow
- Results
- Conclusion

Motivation and Aim

- Motivation: To reduce manual labelling workload of Ovation Data
- Aim：Given labelled bounding box to label pixels

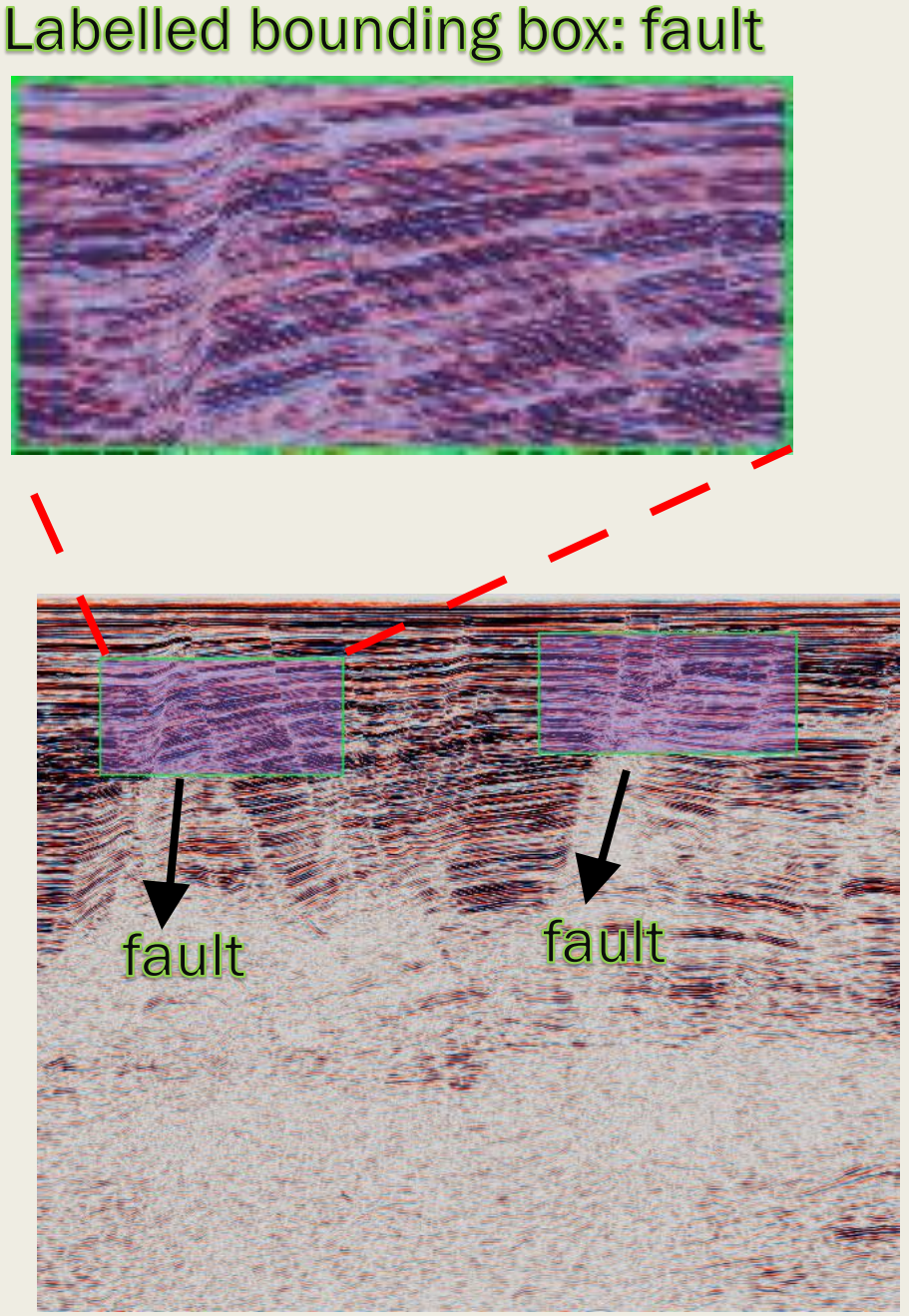
  → Weakly-supervised learning

- Tasks:

I. Selecting the bounding boxes to label

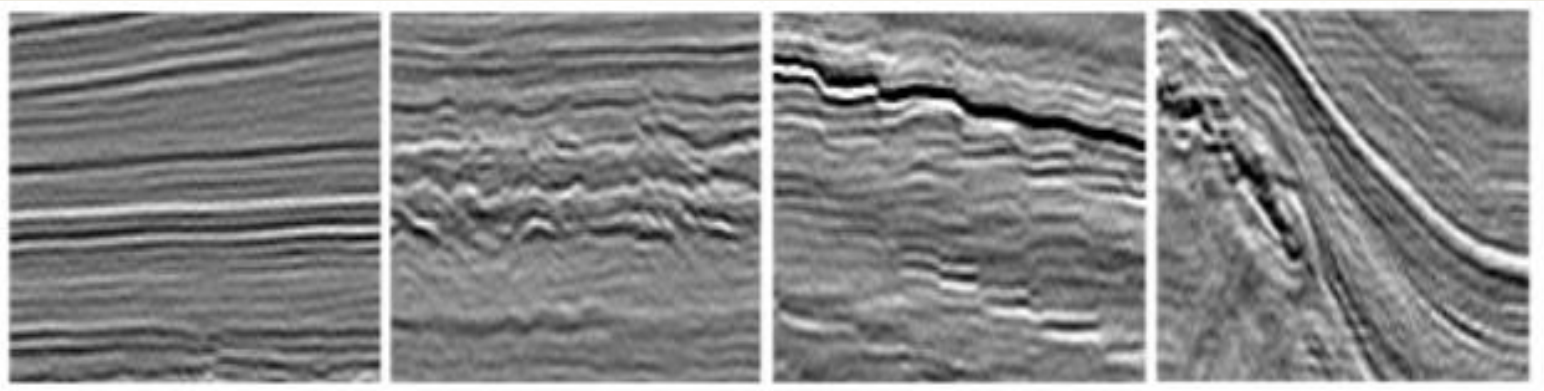
II. Train a machine learning classifier to classify pixels

III. Output binary masks for bounding boxes into local machine



Bounding boxes labelling from Ovation Data

Data for experiment:
LANDMASS, offshore data from the Netherland



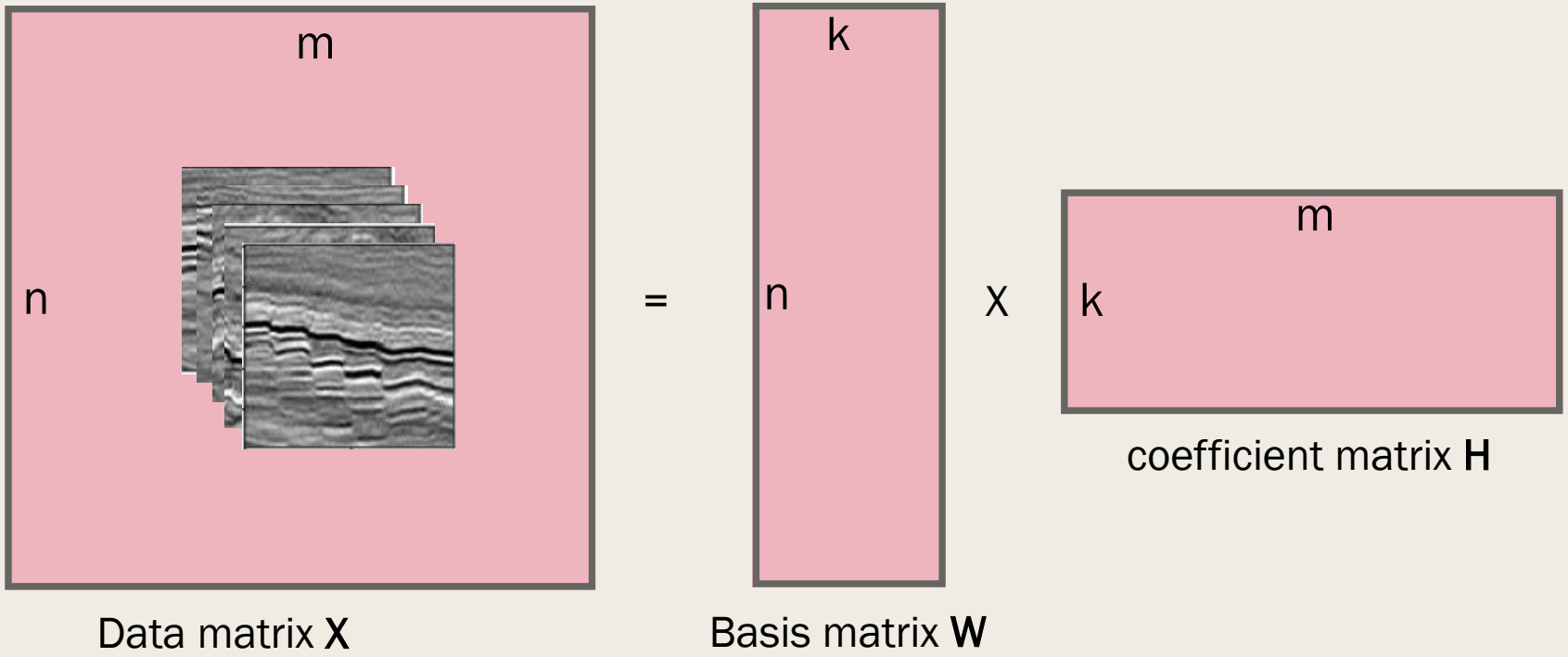
Unknown Chaotic Fault Salt dome

- Cleaned bounding boxes: Highly similar in texture for each class
- Four classes are input for training the weakly-supervised classifier
- No pixel-level labels for input

LANDMASS: http://cegp.ece.gatech.edu/codedata/landmass/

Approach: Non-negative Matrix factorization(NMF) with sparseness constraints

Classic NMF:



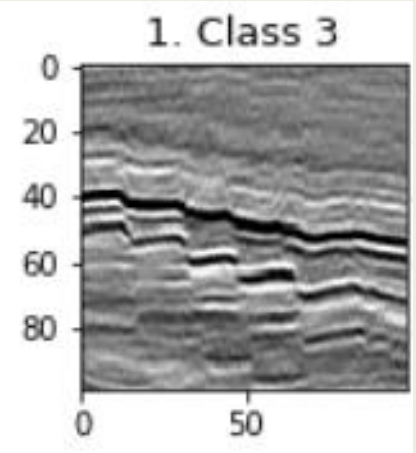
X consists of all the images selected for labelling

Image representation is obtained by the product: $X = WH$

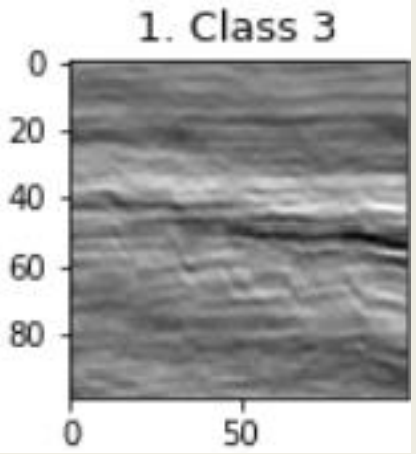
NMF solves $\min_{W,H} \|X - WH\|^2$

NMF with sparseness constraints

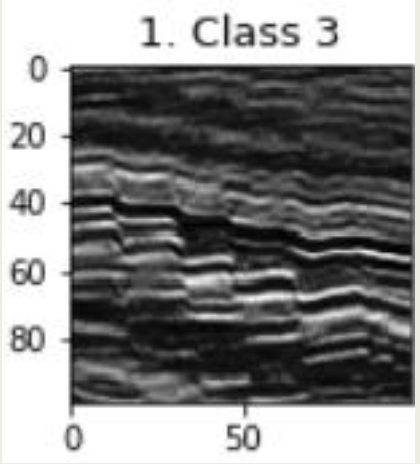
Original fault image



Plot NMF representation



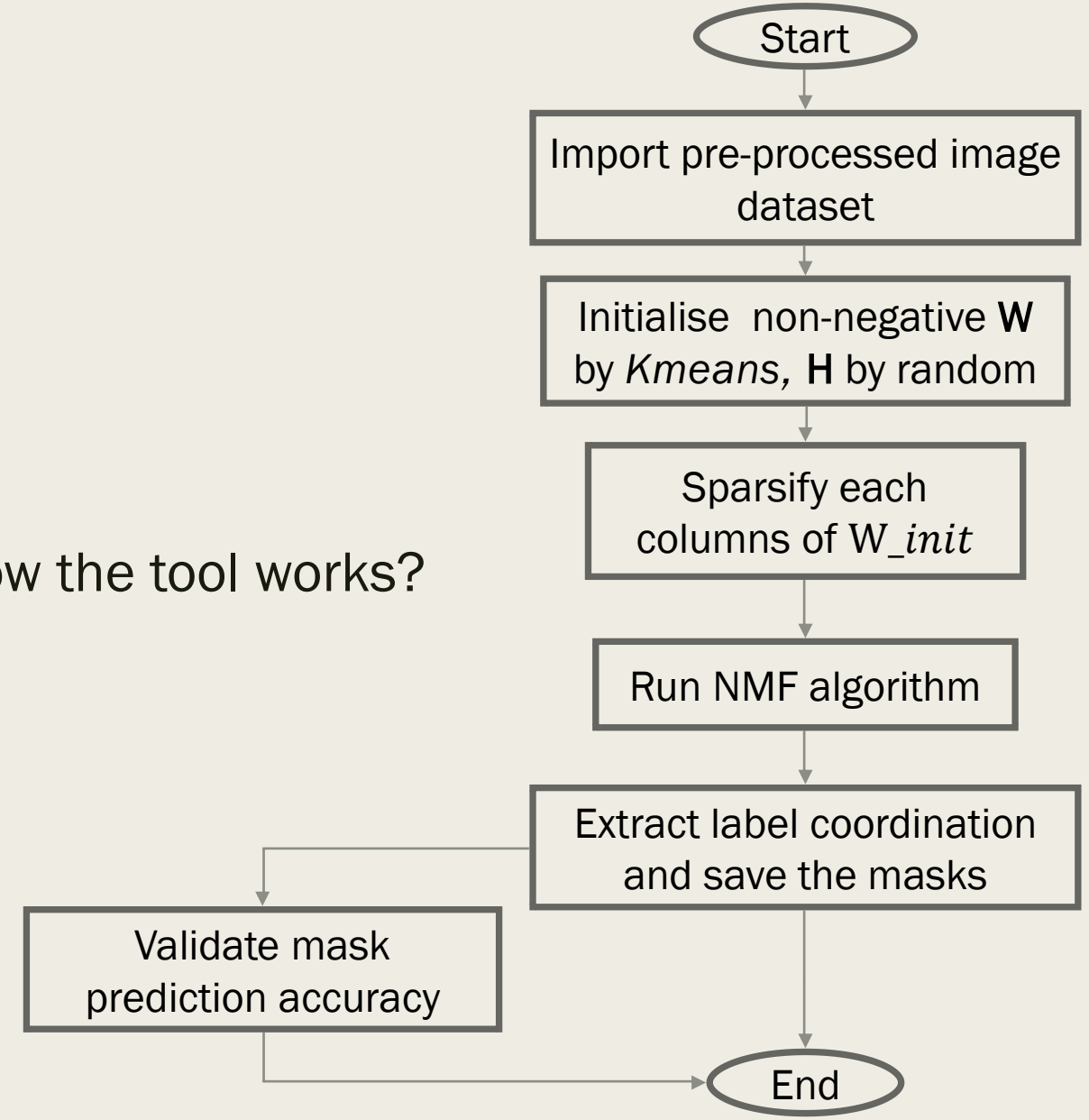
No sparsity control



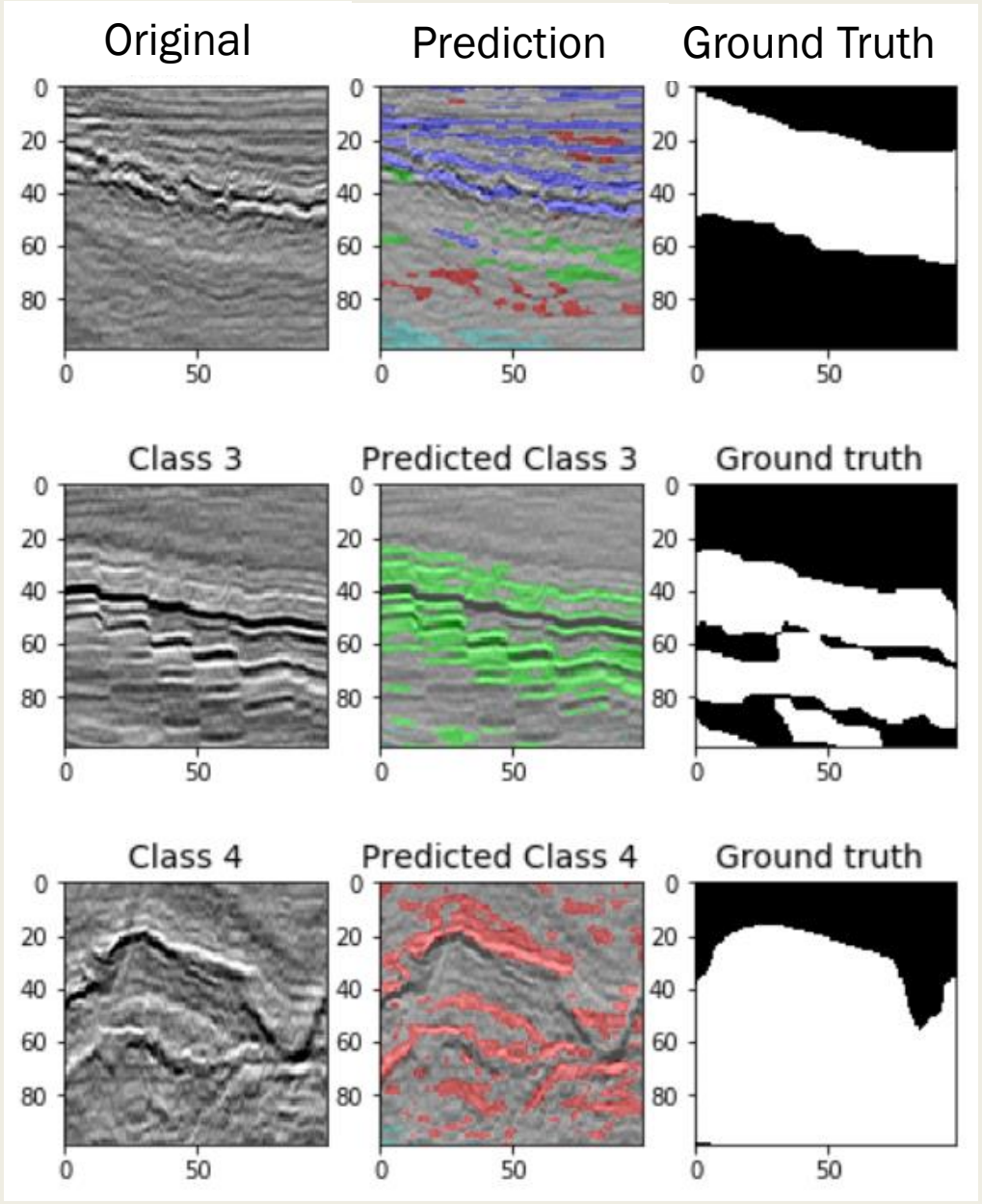
With sparsity control

- Sparseness keeps significant feature active, and make unimportant features 0.
- Experiment on fault class with sparseness constraints.
- By controlling sparsity level, we can obtain more informative representation from NMF.

Software workflow: How the tool works?



Results



- The result of labelling chaotic, fault and salt domes.
- Structures boundaries are highlighted in colours.
- Good match for **fault** and **salt** with original images, but not **chaotic**
- Accuracy rate: ~40%

Blue: Chaotic

Green: fault

Red: salt

Light blue: unknown

Results Illustration for LANDMASS

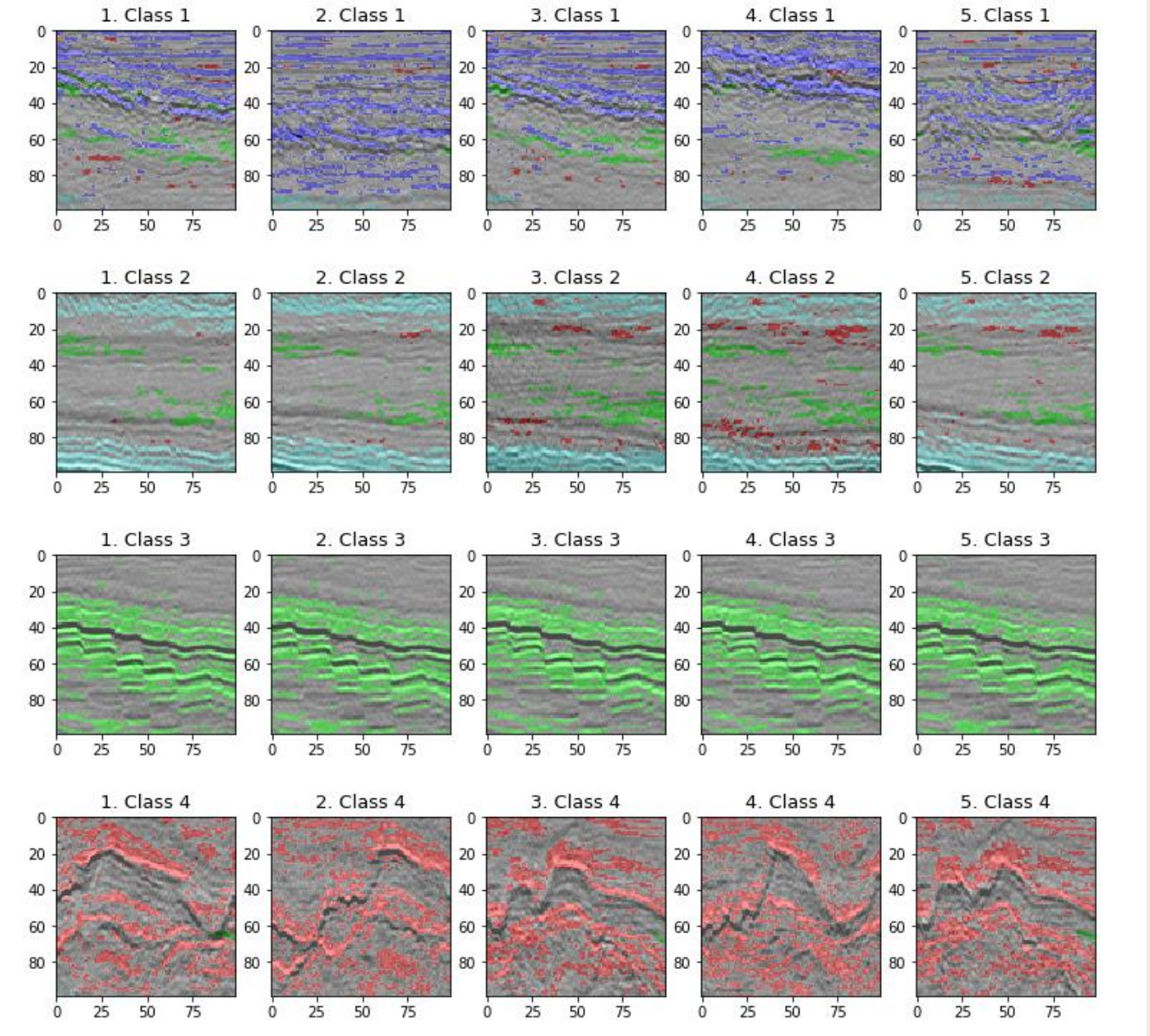
chaotic

unknown

fault

salt

Color masks Result



Conclusion

- Developed a pixel-level labelling tool using NMF with sparsity control
- The masks output ought to assist supervised model training

- Strength: Handle multi-classes at once
- Challenges:

I. Require a similarity-based data cleaning scheme

II. How to quantify the effectiveness of the approach objectively ?

Future work

- Deploy the weakly-supervised model on Ovation's dataset.

I. Map bounding boxes with the entire image after classification

- Model scalability and portability testing:

I. Input more data at once to test the maximum load accepted by the by classifier

II. Deploy the model on different datasets.

Thank you

Q&A

Appendix A
Binary masks

chaotic

unknown

fault

salt