CNN-based seismic facies classification from 3D seismic data

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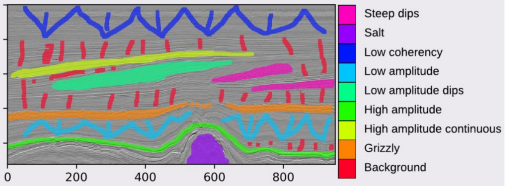
Motivation & Objective

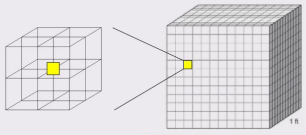
- Traditional seismic facies classification demands tremendous human labor and time with less-controlled quality check
- Develop a 3D Convolutional Neural Network (CNN) model to accurately classify seismic facies from 3D seismic data

Dataset

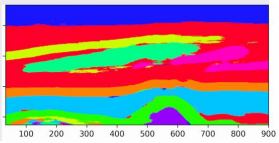
- 3D seismic data (size = 651x951x452) from the Netherlands Offshore F3 block
- Labels on one inline section



- Input data are sub-cubes of size 65x65x65 around labeled central voxel

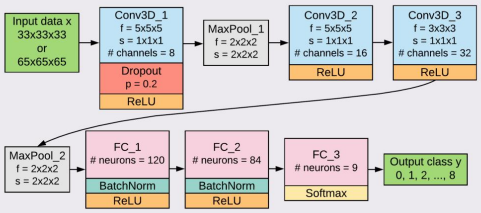


- Predictions on the same inline section using trained CNN model

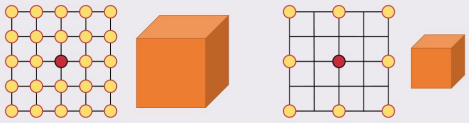


Methodology

- Modified LeNet-5 3D CNN design



- Sparse sampling scheme for input sub-cubes



Old = (65x65x65) New = (33x33x33)

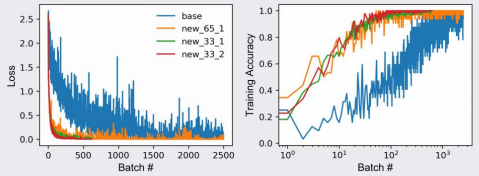
- 40,000 training, 10,000 validation, and 10,000 test samples
- Learning rate of 0.001 except base case
- 2 epochs w/ mini-batch size of 32 or 128
- Cross-entropy loss w/ Adam optimizer

Conclusions

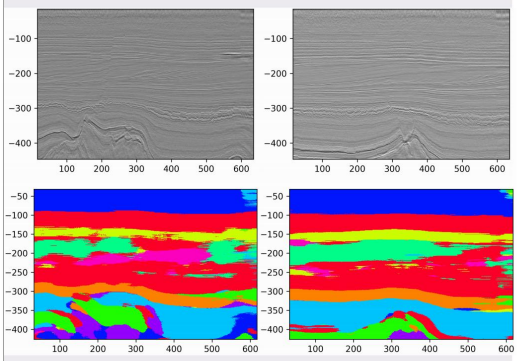
- CNN model gives geologically reasonable and consistent predictions.
- New CNN design significantly improves training accuracy in early training stage.
- New CNN + sparse sampling cuts running time by 50%, and boosts test accuracy to 0.9977.

Results

- Trained 4 models on 8 GPUs



- Predicted on two xline sections



- Metrics of 4 CNN models

Model	Sub-cube size	Step size	Mini-batch size	# of para.	Running time	Train'g acc	Val. acc	Test acc
Base	65^3	1	32	297,697	7min16s	0.9736	0.9857	0.9855
"LeNet-5"	65^3	1	32	8,478,817	29min28s	0.9974	0.9854	0.9853
"LeNet-5"	33^3	1	128	522,337	167s	0.9959	0.9488	0.9455
"LeNet-5"	**33^3**	**2**	**128**	**522,337**	**187s**	**0.9990**	**0.9961**	**0.9977**

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