The title of our project is the CNN-based seismic facies classification from 3D seismic data. My name is Iris. This is Wei. We are both grad students in Geophysics. Our objective here is to use the CNN techniques to efficiently interpret subsurface structures from seismic data.

We started from a publicly available github repo that provides a starting CNN framework and some labeled data. The seismic dataset is a 3D volume which is analogous to 3D CT scans in medical imaging. We only have labels on one of the 2D sections as shown here. There are 9 seismic facies to classify in total. Each input sample is a sub-cube of size 65x65x65 centered around the labeled voxel.

We ran the original code and found that the provided CNN architecture was not optimal, because the initial loss reduction and training accuracy gain were fairly slow, as you can see from the blue curves here. So we replaced their CNN design with a variant of the LeNet-5 architecture, and achieved significant improvement performance-wise in the early training stage, which are shown by the orange, green and red curves here. Basically, in the new design, we decreased the filter size, and increased the # of channels as the layers go deeper, and that we added two max-pooling layers in the NN. Additionally, we replaced the 2D filters in the original LeNet-5 with 3D filters, which now can do 3D convolution on the input sub-cubes.

To further improve the computational speed, we implemented a sparse sampling scheme around the central voxel when preprocessing the input sub-cubes, as you can see here. With this sampling scheme, the new sub-cubes are reduced by a factor of 8 in size, and still maintain the same receptive field as the old ones.

It turns out that the new CNN design combined with the sparse sampling scheme gives us the highest validation and test accuracies, which are over 0.99. It is also the second fastest model to train among the four models we tested.

The predicted results on the labeled section and two other unlabeled sections show fairly reasonable and consistent geological interpretation. To sum up, the CNN proves to be very promising and effective in classifying seismic facies from 3D seismic data. With trials and errors, our final CNN model is able to outperform the base model significantly in terms of the test accuracy, training time and the performance in the early training stage.