2022 ERAU REU: Ensemble Deep Learning

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Nevada National Security Site (NNSS)

protection

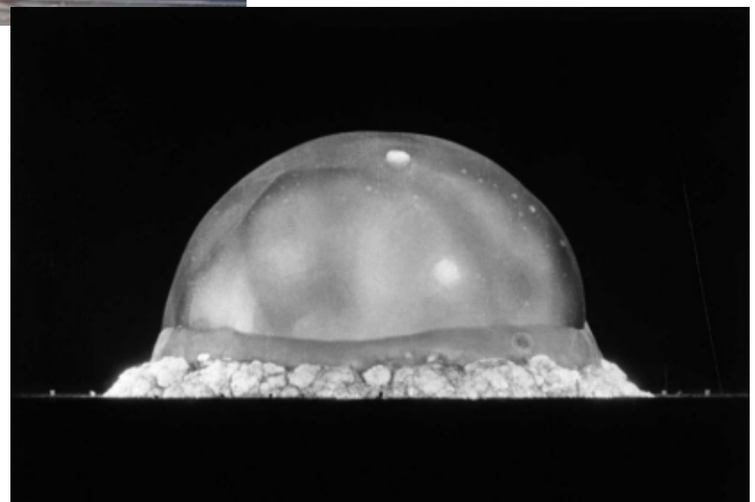
Nuclear weapons

National security programs

science Environmental

Problem Introduction

Radiographic image analysis using



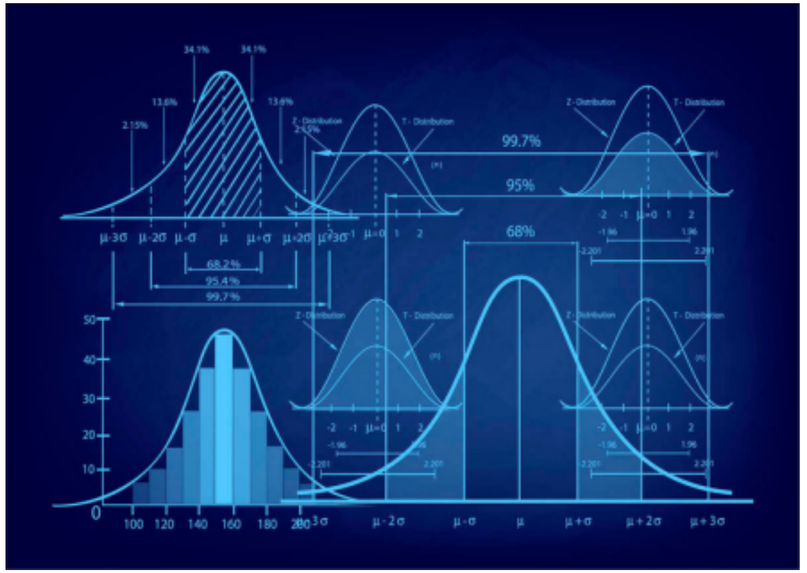
convolutional neural networks

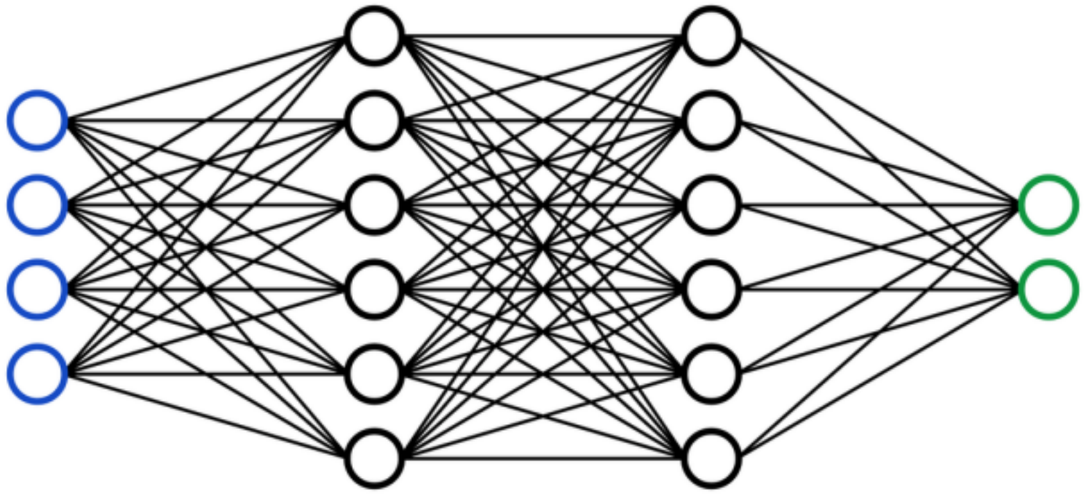
Aids in NNSS tests analysis

- National security
- Nuclear stockpile safety

Project Scope

Develop a network using Python and train it using image data Probability model and uncertainty quantification

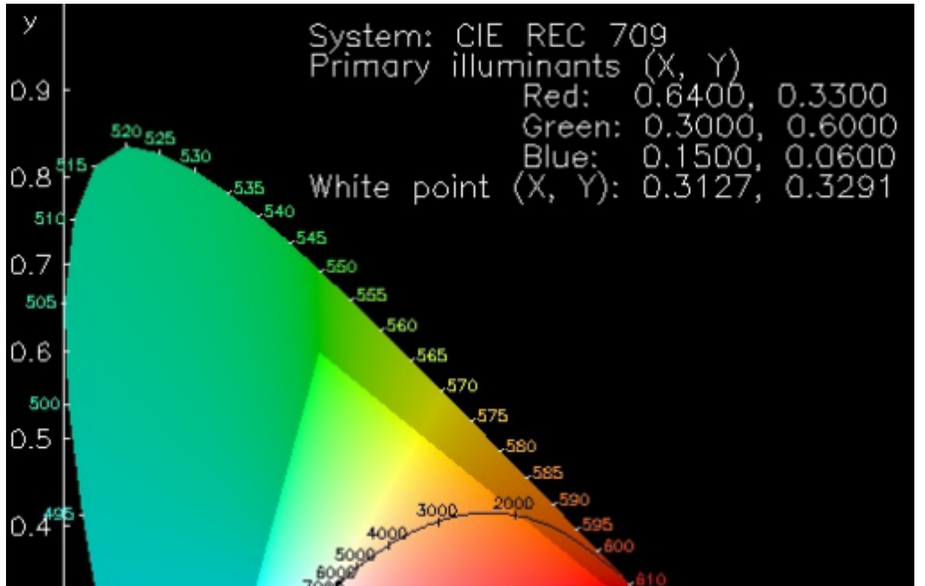




Initial Strategy

Develop neural networks and decide on an architecture

Create an ensemble and train the architecture *n* times



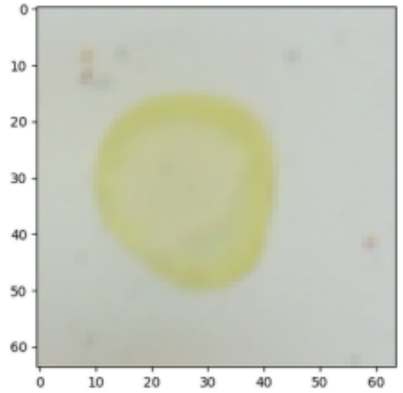
Start working on uncertainty quantification

Dataset: Absorption spectroscopy data for 179072 metal oxides

Image size: (64, 64, 3, 180902)

Channel values: RGB

Normalized: 0-1 for every channel

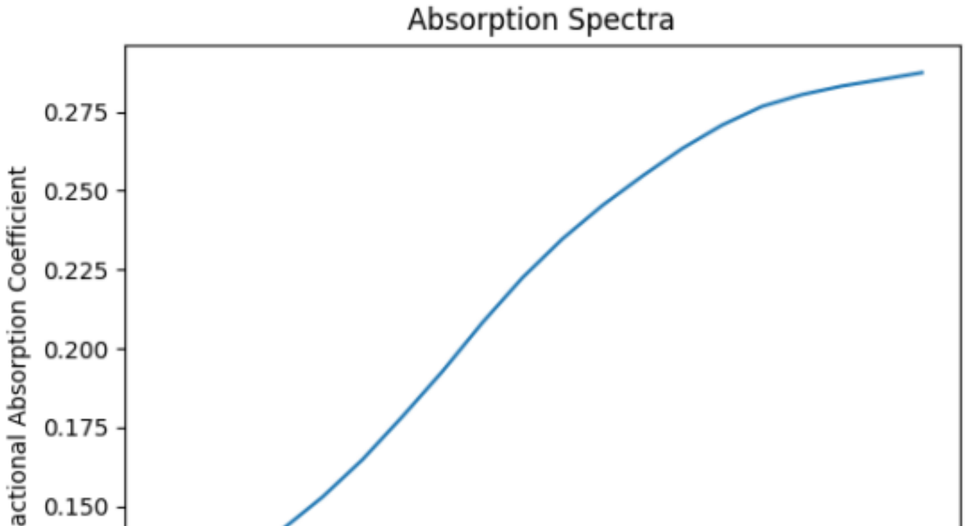


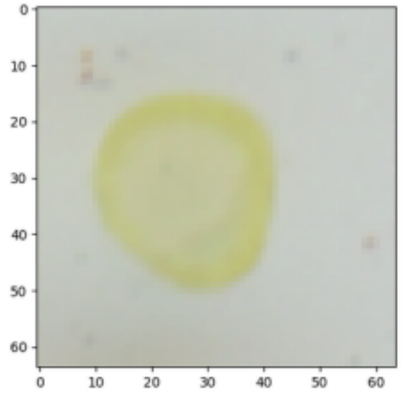
Stein, H. S., Soedarmadji, E., Newhouse, P. F., Guevarra, D. & Gregoire, J. M. Synthesis, optical imaging, and absorption spectroscopy data for 179072 metal oxides https://doi.org/10.6084/m9.fgshare.7502207 (2019).

Output

Spectra

Originally 220 values 20 values with linear interpolation between





ModelSummary

Layers:

1.

2. 3. 4. 5. 6. 7. 8.

Convolutional Dense

Max Pooling Dropout

Flatten

Dense

⚠

Training:

Dense

Dense

90,000 images 80%training

20%validation Batchsize: 32

Epochs: earlystop

Lossfunction: MSE

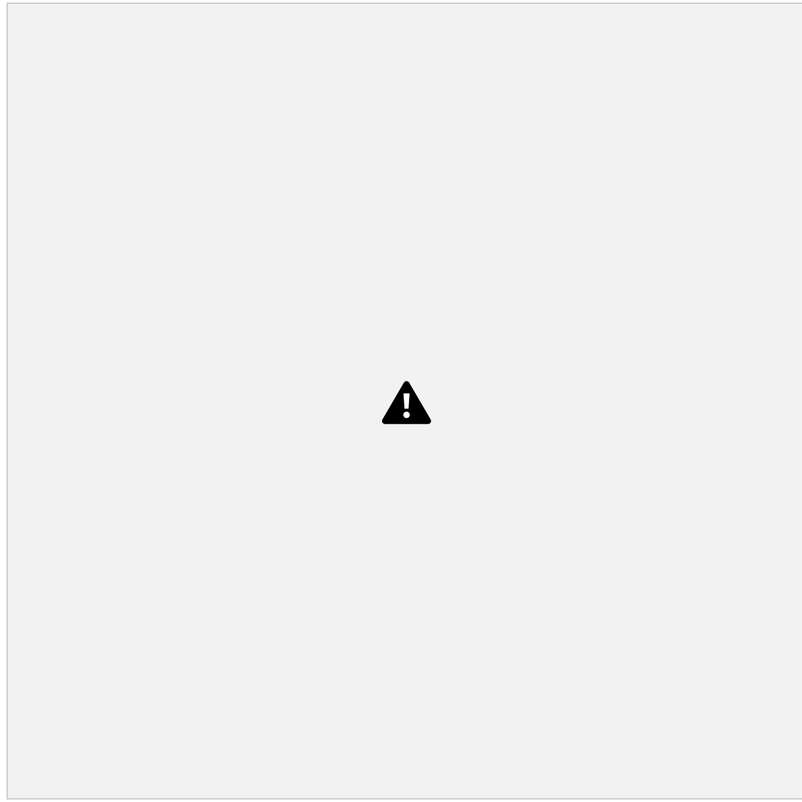
Ensemble Model Summary

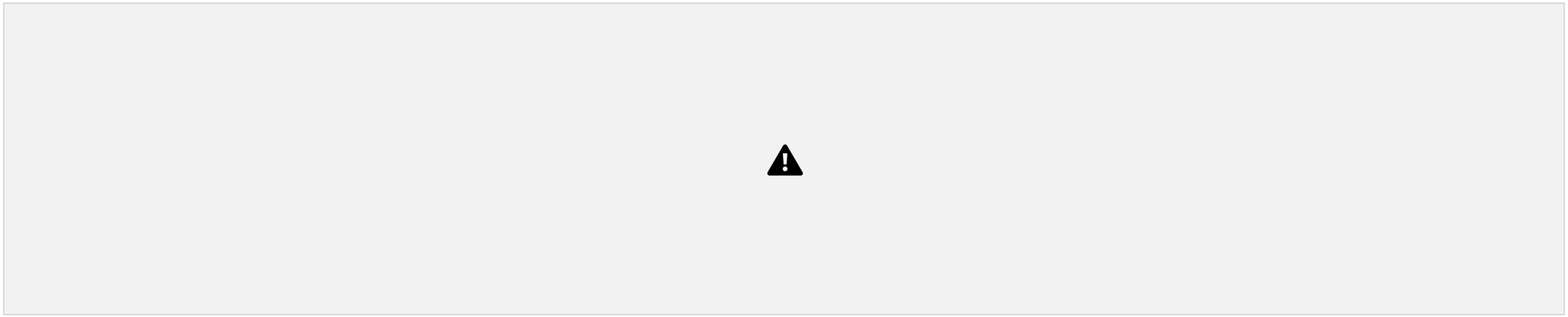
2 neural networks

Trained on 90,000 images

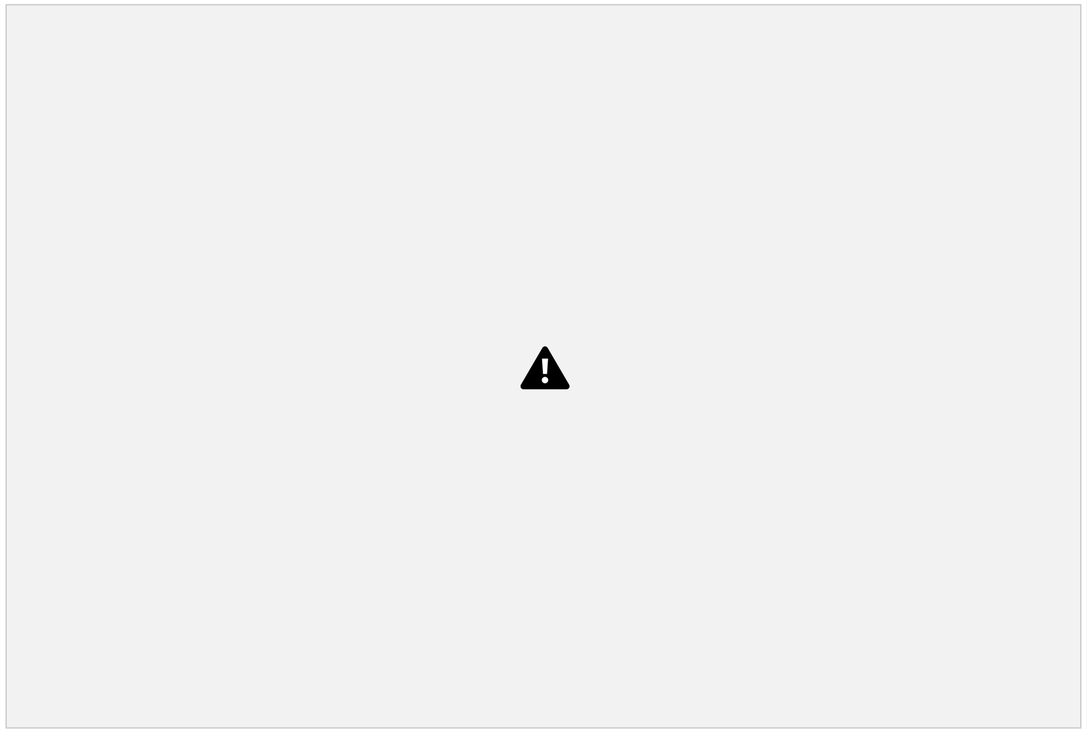
Batch size: 32

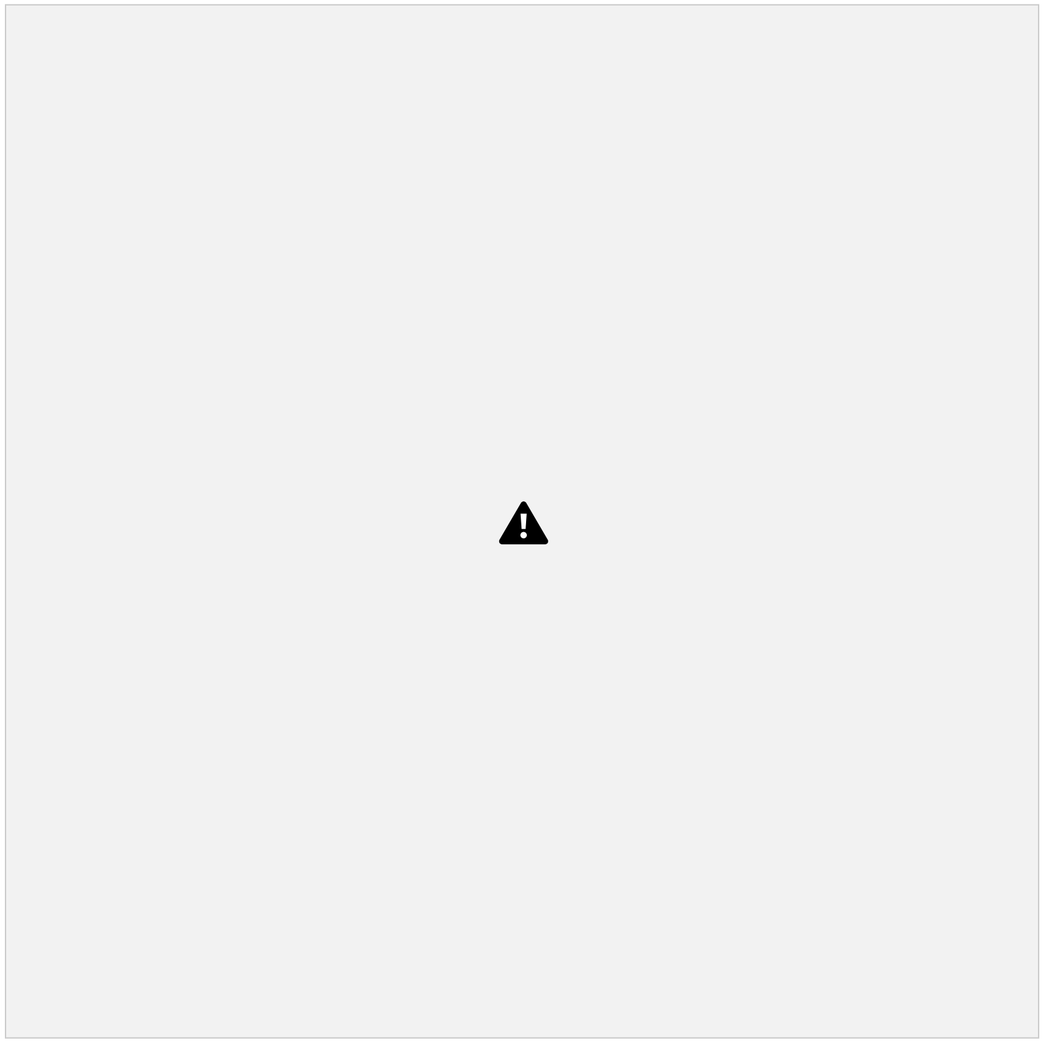
Epochs: early stop





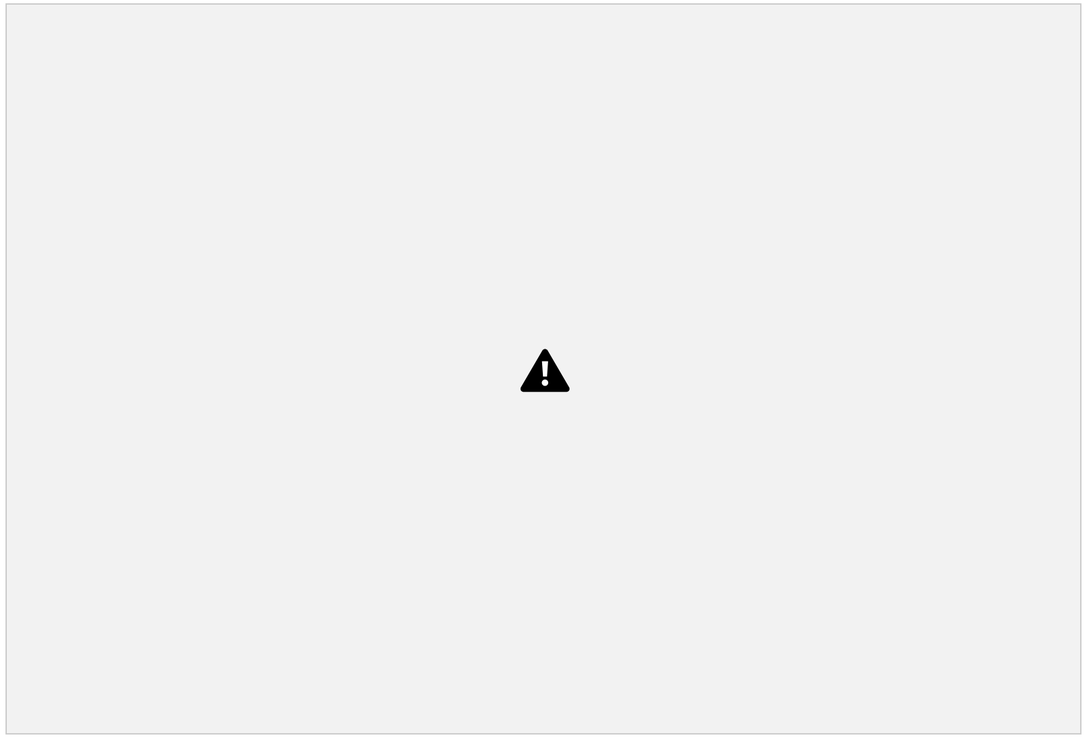
Ensemble vs. Single NN





Uncertainty Quantification:

Gaussian Process Regression Non-parametric, Bayesian regression approach Gives 95% confidence interval for prediction



Next Steps

Implement uncertainty quantification approach