Comparison of Convolutional Neural Networks for Remote Sensing

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Abstract

The goal of this project was to investigate how deep learning compares to non-deep learning, and ultimately to compare how 3 separate Remote Sensing tools perform during 5 fold cross validation. The three techniques chosen for comparison are: Shallow Convolutional Network, Deep Convolutional Network, and a Deep Residual Network. Two datasets were used for experimentation, one being a 3 class problem and the other being the UC Merced Benchmark Dataset [1], which is comprised of 21 classes with 100 training examples each.

Method

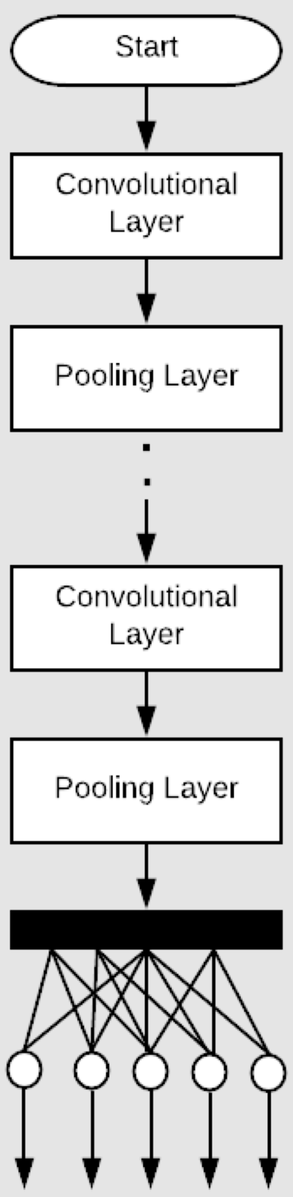
Training

- Train each method on both datasets for 10, 20, 30, 40, and 50 epochs with a batch size of 16, using SGD optimizer and categorical cross-entropy loss

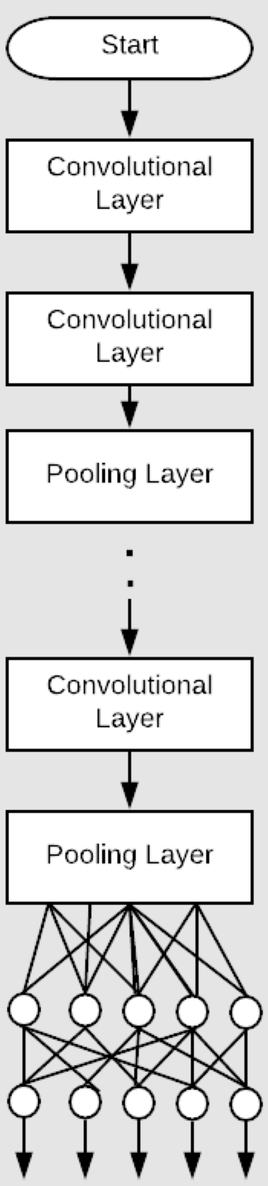
Model Configuration

- Shallow CNN: 5 Conv. Layers, 5 pooling layers, 32 filters, 3x3 Kernel, 2x2 Max Pooling with 1 fully connected softmax layer
- DeepCNN: VGG19 [2], which has 16 convolutional layers with Max Pooling and 3 fully connected layers, the last of which being a softmax layer
- DeepRNN: ResNet50 [3], which has 50 residual layers with Max Pooling and 1 fully connected softmax layer

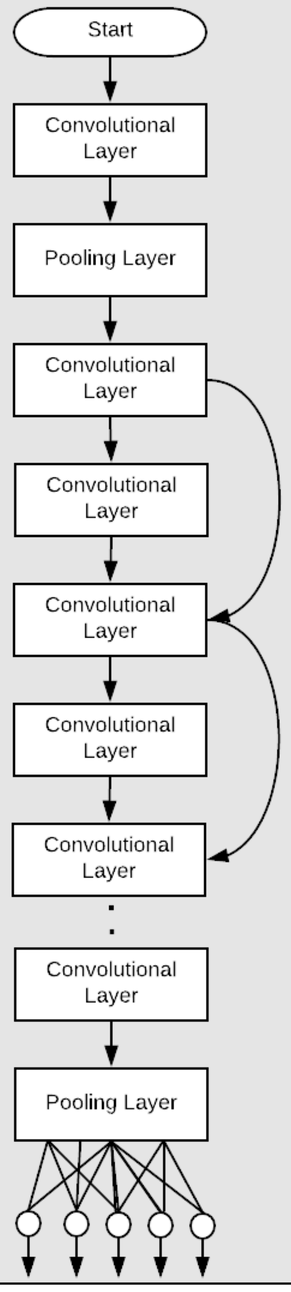
Shallow CNN



VGG19



ResNet50



UC Merced Dataset

Tech Stack

Keras

TensorFlow

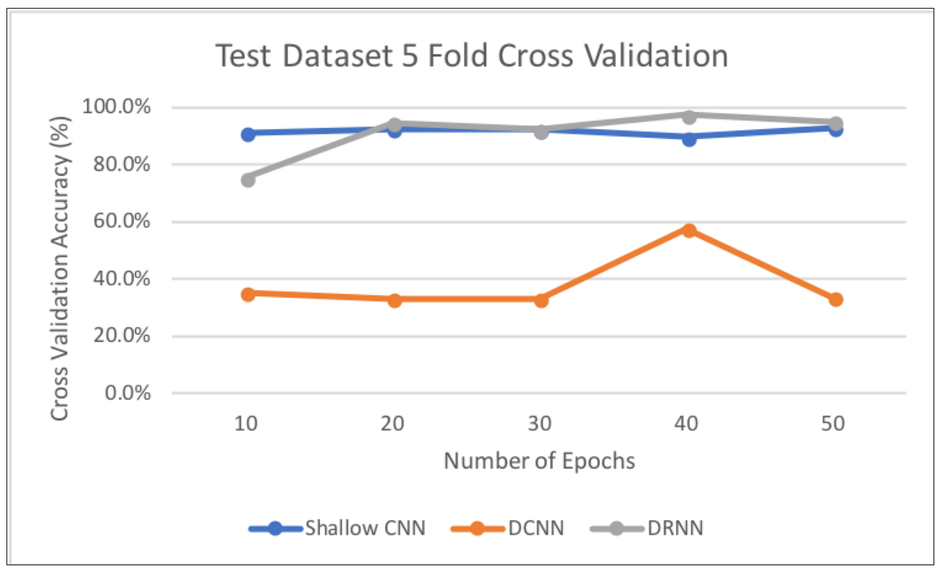
NVIDIA

cuDNN

Results

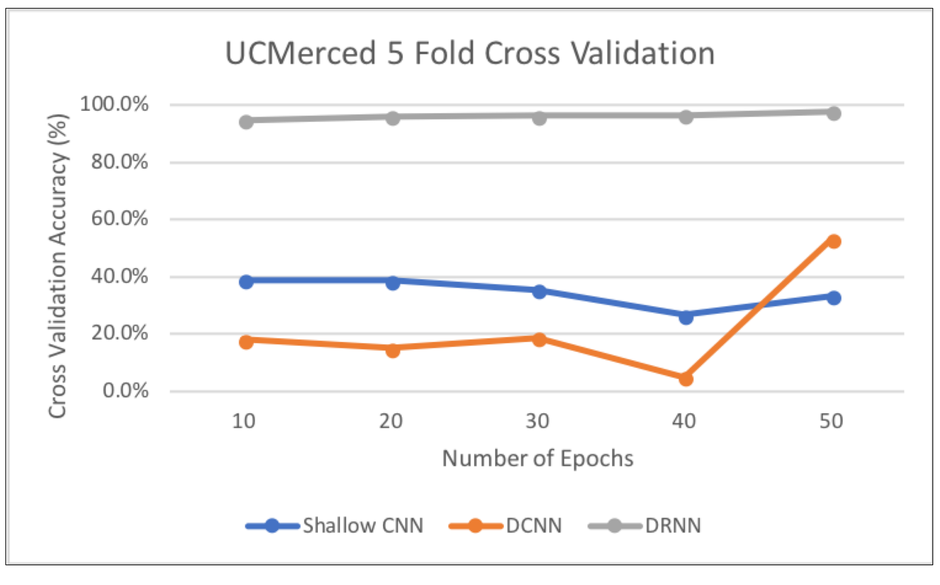
Test Dataset

Method	10	20	30	40	50
Shallow CNN	91.2%	92.5%	92.2%	89.7%	92.8%
Deep CNN	35.1%	33.1%	33.1%	57.7%	33.5%
Deep RNN	75.5%	94.5%	92.3%	97.3%	94.9%



UCMerced Dataset

Method	10	20	30	40	50
Shallow CNN	38.9%	38.6%	35.3%	26.6%	33.2%
Deep CNN	17.9%	15.1%	18.6%	4.9%	53.1%
Deep RNN	94.8%	96.2%	96.2%	96.4%	97.8%



References

[1] Y. Yang and S. Newsam, “Bag-of-visual-words and spatial extensions for land-use classification,” 2010, p. 270.

[2] K. Simonyan and A. Zisserman, “Very Deep Convolutional Networks for Large-Scale Image Recognition,” *arXiv:1409.1556 [cs]*, Sep. 2014.

[3] K. He, X. Zhang, S. Ren, and J. Sun, “Deep Residual Learning for Image Recognition,” *arXiv:1512.03385 [cs]*, Dec. 2015.