Using Neural Networks to Identify Interest Points in Shoe Treads

Matthew Nissen, Gautham Venkatasubramanian
St. Olaf College, Iowa State University

Introduction

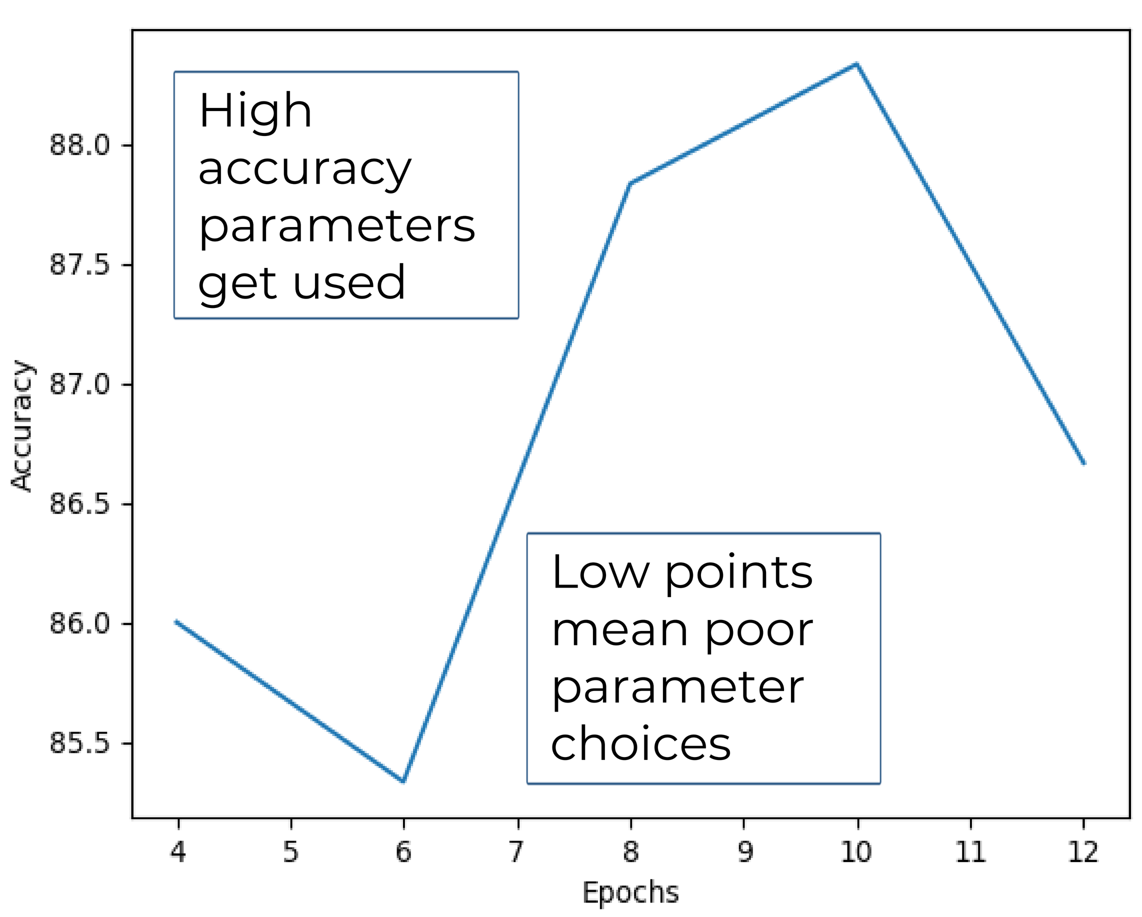
- The goal was to create a machine learning algorithm to detect interest points on pictures of shoe treads, starting with corners
- Current corner detection methods are only good at picking up on sharp, well defined corners which shoeprints rarely have
- In the future, this type of technique could be used to aid further analysis by mapping the corner points onto shoe treads before more advanced techniques could work

Methods

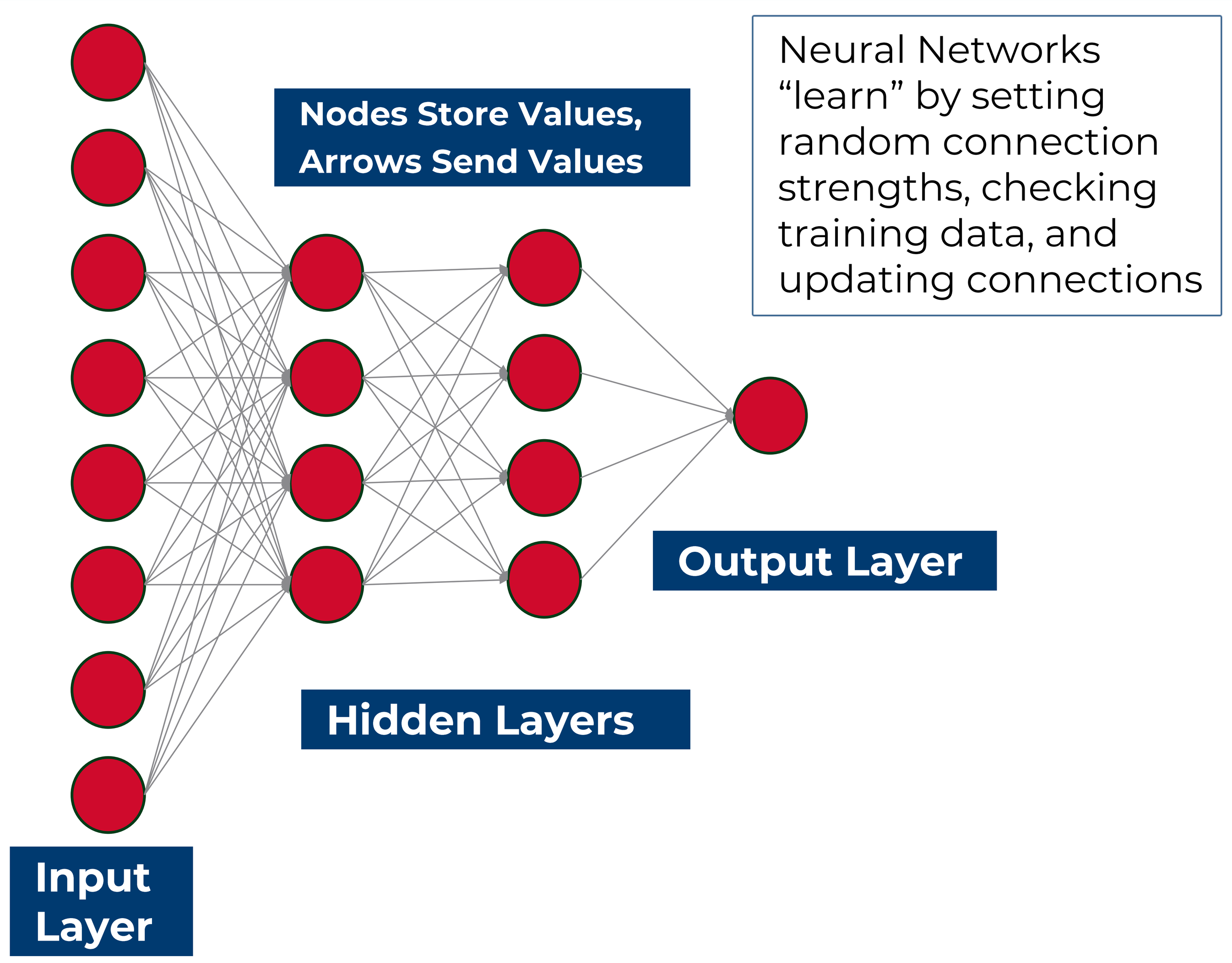
- We first manually marked shoeprint photos with dots on the corners, and sampled from these images to create our dataset of corner pixels and non-corner pixels
- Sampling involved taking pixels labeled corners, and the surrounding areas, and non corner pixels with surrounding area
- We then experimented with different neural network structures to optimize accuracy on testing data that the network hasn't seen
- Examples of hyperparameters we checked are learning rates, number of training cycles, image size, and layer numbers
- The network was constructed with Python code, and the PyTorch package

Example of a Marked Photo

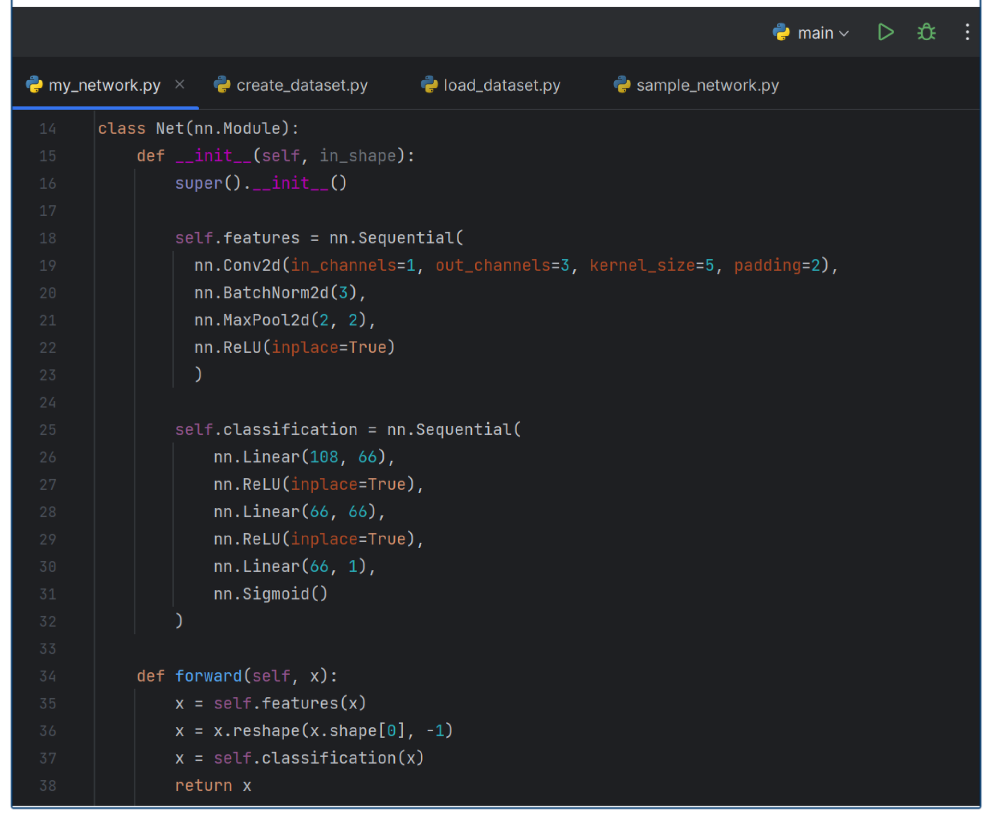
Parameter Data



What is a Neural Network?



Example Code



Results

- Largely successful, creating a model with 95% accuracy on data it had never seen before
- Simple models worked best overall, allowing for strong outcomes while preventing overfitting and speeding up computation times
- A single convolutional layer followed by 2 fully connected linear layers worked best

Conclusion

This model will need to be continuously improved, because shoeprint pictures contain thousands of pixels and marking even just 5% of them incorrectly means hundreds of wrong marks. What we have now will work as a powerful starting point for this future research.

After interest points can be quickly marked by a network, more advanced statistical comparisons can be made.

This work was funded (or partially funded) by the Center for Statistics and Applications in Forensic Evidence (CSAFE) through Cooperative Agreements 70NANB15H176 and 70NANB20H019 between NIST and Iowa State University, which includes activities carried out at Carnegie Mellon University, Duke University, University of California Irvine, University of Virginia, West Virginia University, University of Pennsylvania, Swarthmore College and University of Nebraska, Lincoln.