Can a Neural Network replace a Numerical Solver?

UPPSALA UNIVERSITET

Project in Scientific Computing

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ML (Machine Learning)

TensorFlow

Keras

Tools: We used TensorFlow, Keras and Google Colab (free GPU + IT student = ML) to make our custom neural network and train it!

Size and number of layers are in the figure below. Activation functions are ReLu for all layers except output layer, which has linear activation function.

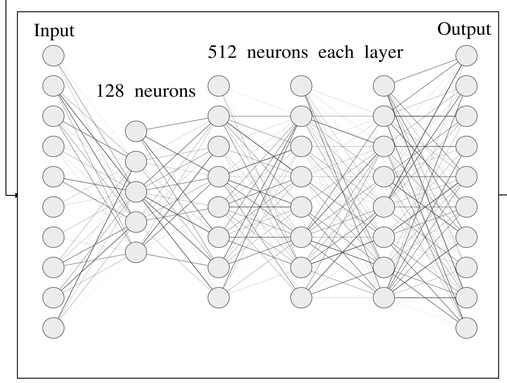

Figure 1. Our neural network architecture

ML Data

Aim of the project : Comparison of a neural network and numerical solution in geological events.

Conclusion: A neural network is less computationally expensive than a numerical solution and is capable of solving a geological event with reasonable accuracy. Added errors are in acceptable ranges and could be weighed against computation speed.

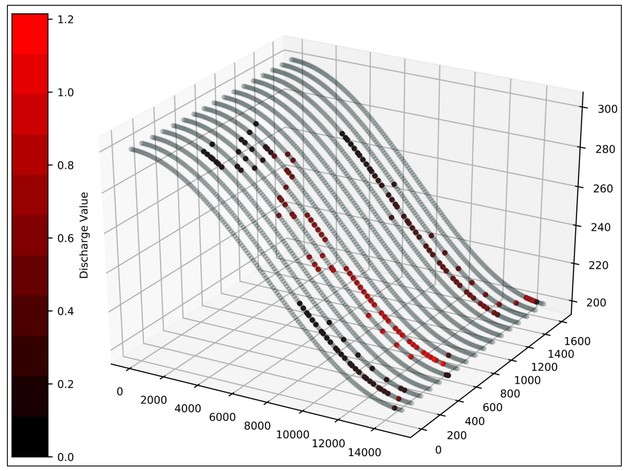

Figure 4. Output of a neural network simulation estimating a solution equal to Figure 3

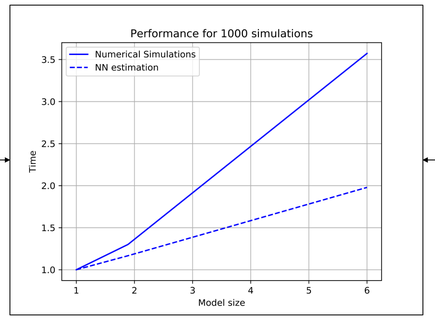

Figure 2. Computation cost of a neural network (NN) compared to a traditional numerical solution

Numerical Data

BADLANDS

Datasets: The data is taken from Badlands package which is a numerical solver for geological events on custom landscapes. We gather output data for water discharge value on each grid point of geometry's mesh.

Each precipitation value input to numerical solver (meters of rain per year), creates one data-set which is then used to train our ML model on.

In figure 3, a sample numerical simulation is presented, red dots present a river and the slope is a simple hill slope. This data is more accurate than the neural network, but takes longer computation time.

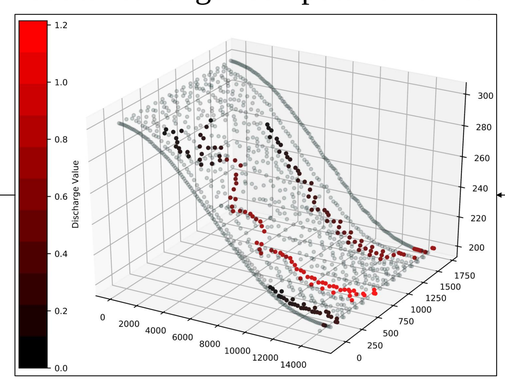

Figure 3. Numerical simulation of river creation due to rainfall