Neural Networks for Machine Learning

tensorflow playground
TensorFlow Playground

• Great javascript app demonstrating many basic neural network concepts (e.g., MLPs)
• Doesn’t use TensorFlow software, but a lightweight js library
• Runs in a Web browser
• See http://playground.tensorflow.org/
• Code also available on GitHub
• Try the playground exercises in Google’s machine learning crash course
Tinker With a Neural Network Right Here in Your Browser.
Don’t Worry, You Can’t Break It. We Promise.

HTTP://PLAYGROUND.TENSORFLOW.ORG/
Datasets

• Six datasets, each with 500 \((x,y)\) points on a plane where \(x\) and \(y\) between -5 and +5

• Points have *labels* of positive (orange) or negative (blue)

• Two possible machine learning *tasks*:
  – Classification: Predict class of test points
  – Regression: find function to separate classes

• *Evaluation*: split dataset into training and test, e.g., 70% training, 30% test
Available Input features

$X_1$  Point’s x value
$X_2$  Point’s y value
$X_1^2$  Point’s x value squared
$X_2^2$  Point’s y value squared
$X_1X_2$  Product of point’s x & y values
$\sin(X_1)$  Sine of point’s x value
$\sin(X_2)$  Sine of point’s y value
Designing a neural network

• Simple NNs have just a few choices
  – What input features to use
  – How many hidden layers to have
    • How many neurons are in each layer
    • How each layer is connected to the one before and after it

• Complex NNs have more choices
  – E.g., CNNs, RNNs, etc.

• High-level interfaces (Keras, TensorFlow, PyTorch, ...) try to make this easier
Tinker With a **Neural Network** Right Here in Your Browser.
Don’t Worry, You Can’t Break It. We Promise.

---

**DATA**
Which dataset do you want to use?
- [ ] Choose options for dataset selection.

**FEATURES**
Which properties do you want to feed in?
- [ ] Choose options for feature selection.

**OUTPUT**
Test loss 0.435
Training loss 0.432

---

HTTP://PLAYGROUND.TENSORFLOW.ORG/
Training a Neural Network

• Neural networks are used for supervised machine learning and need to be trained

• The training process is broken done in a series of *epochs*

  In each epoch, all of the training data is run through the system to adjust the nn parameters

• Process ends after a fixed # of epochs or when error rate flattens or starts increasing
• Divide training data into batches of instances (e.g., batch size = 10)
• For each epoch:
  – For each batch:
    • Instances run through network, noting difference between predicted and actual value
    • Backpropagation used to adjust connection weights
  – Stop when training loss flatten out
• If test loss is high, then try
  – Adding additional hidden layers
  – Adding more features to inputs
  – Adjusting hyperparameters (e.g., learning rate)
  – Get more training data
Hyperparameters

• Parameters whose values are set before the learning process begins

• Basic neural network hyperparameters
  – Learning rate (e.g., 0.03)
  – Activation function (e.g., ReLU)
  – Regularization (e.g., L2)
  – Regularization rate (e.g., 0.1)
Learning rate

• **Gradient descent** used in backpropagation to adjust weights to minimize the loss function
• Learning rate determines how much weights are adjusted each time
• If too high, we may miss some or most minima
• If too low, learning will take too long
Gradient Descent

• Iterative process used in ML to find local minimum in our loss function measuring errors

• Moves in direction of steepest descent

• Step size decreases as with steepness to avoid missing minima

• Custom variants for NNs include Adam
Activation Function

• Determines a node’s output given its inputs
• The ReLu (rectified linear unit) is simple and a good choice for most networks
• Returns zero for negative values and its input for positive ones
  \[ f(x) = \max(0, x) \]
Regularization

• Parameter to control overfitting, i.e. when the model does well on training data but poorly on new, unseen data

• L2 regularization is the most common

• Using dropout is another common way of controlling overfitting in neural networks
  – At each training stage, some hidden nodes temporarily removed (dropped out)
Tinker With a **Neural Network** Right Here in Your Browser.
Don’t Worry, You Can’t Break It. We Promise.

HTTP://PLAYGROUND.TENSORFLOW.ORG/