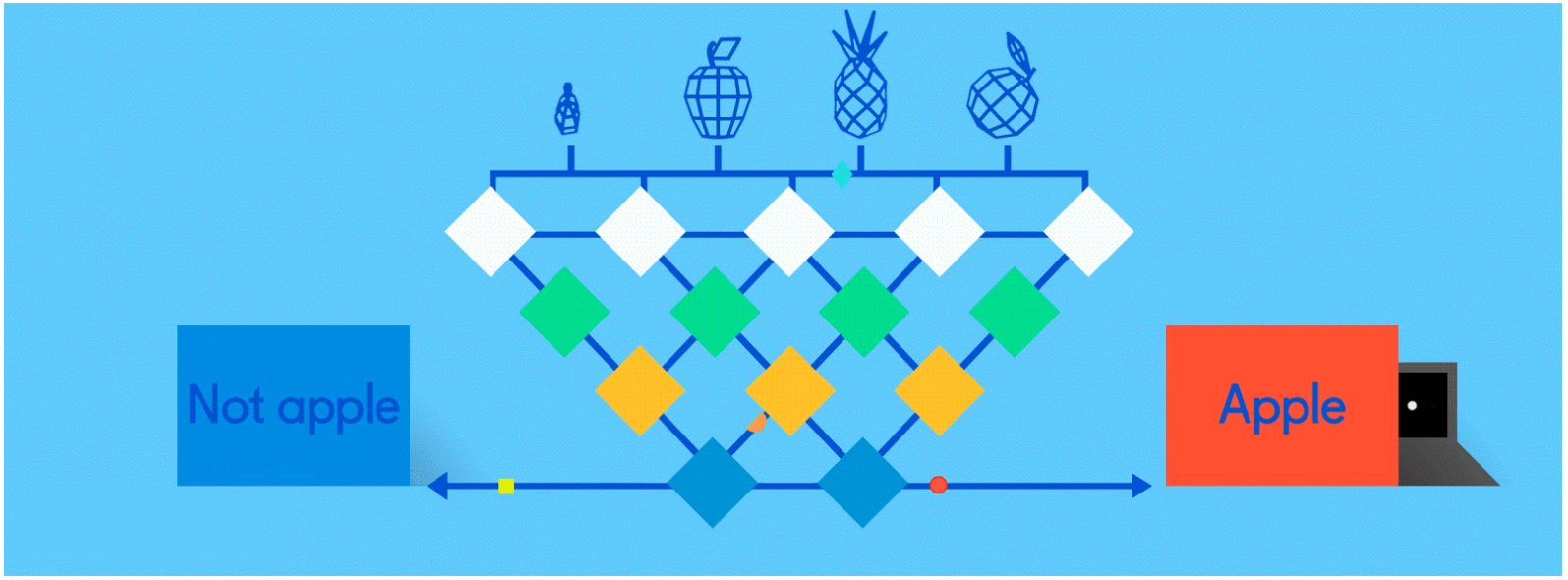
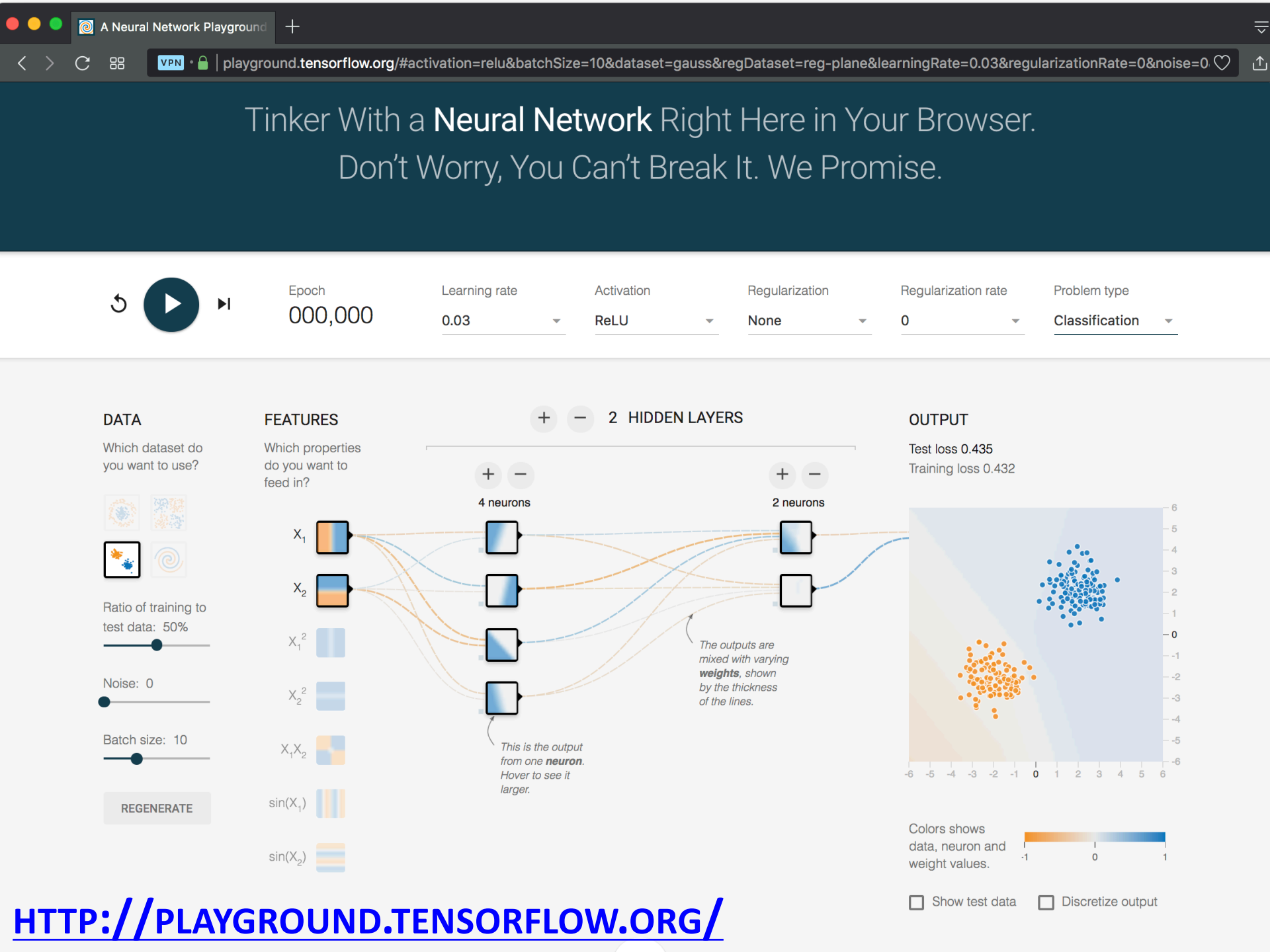
Neural Networks for Machine Learning

tensorflow playground

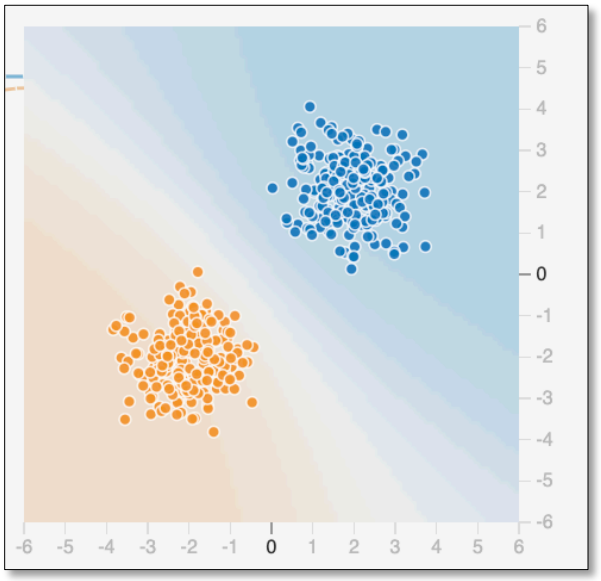


TensorFlow Playground

- Great javascript app demonstrating many basic neural network concepts
- 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


A Neural Network Playground
playground.tensorflow.org/#activation=relu&batchSize=10&dataset=gauss&regDataset=reg-plane&learningRate=0.03&regularizationRate=0&noise=0
Tinker With a Neural Network Right Here in Your Browser.
Don't Worry, You Can't Break It. We Promise.
Epoch
000,000
Learning rate
0.03
Activation
ReLU
Regularization
None
Regularization rate
0
Problem type
Classification
DATA
Which dataset do you want to use?
Ratio of training to test data: 50%
Noise: 0
Batch size: 10
REGENERATE
FEATURES
Which properties do you want to feed in?
X1
X2
X1²
X2²
X1X2
sin(X1)
sin(X2)
2 HIDDEN LAYERS
4 neurons
2 neurons
The outputs are mixed with varying weights, shown by the thickness of the lines.
This is the output from one neuron. Hover to see it larger.
OUTPUT
Test loss 0.435
Training loss 0.432
Colors shows data, neuron and weight values.
Show test data
Discretize output
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

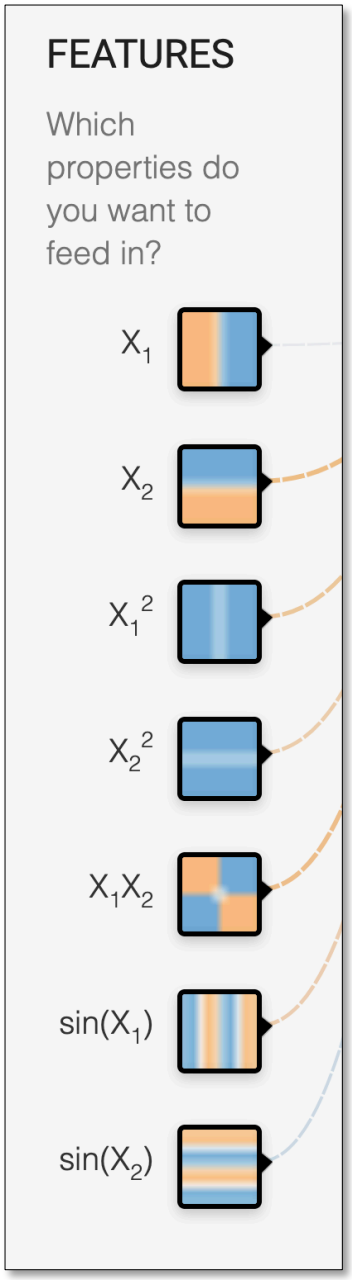
X_1^2 Point's x value squared

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

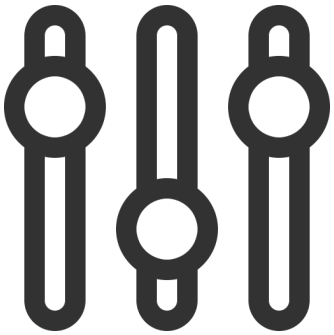
$\sin(X_2)$ Sine of point's y value



Typical Training Flow

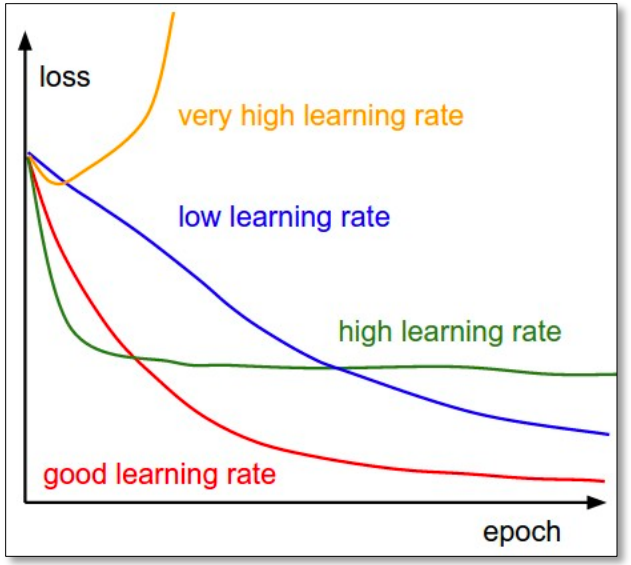
- Divide training data into batches of instances (e.g., batch size = 10)
- For each epoch:
  - For each batch:
    - Instances run through network, noting difference between predicted and actual value
    - Backpropagation used to adjust connection weights
  - Stop when training loss flatten out
- If 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



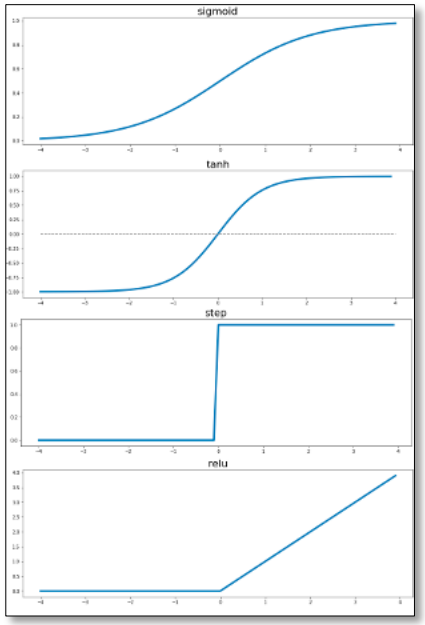
- Parameters whose values are set before the learning process begins
- Basic neural network hyperparameters
  - Learning rate
  - Activation function
  - Regularization
  - Regularization rate

Learning rate

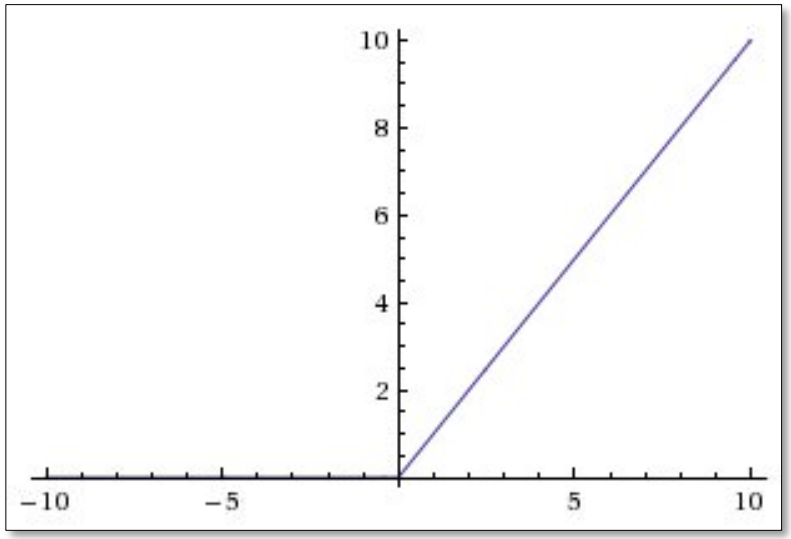


- Gradient descent used in backpropagation to adjust weights to minimize the loss function
- Learning rate determines how much weights are adjusted
- If too high, we may miss some or most minima
- If too low, learning will take too long

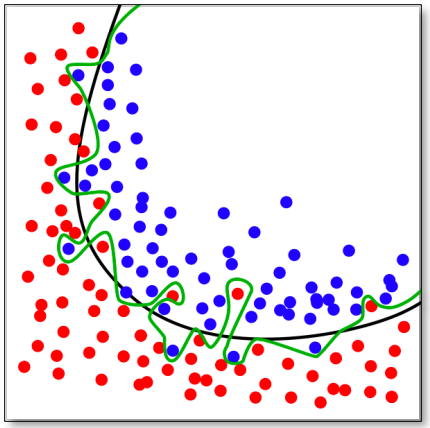
Activation Function



- 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 are temporarily removed