NeuralNetworks

December 20, 2017

1 Neural Networks

Manually creating a neural network

In [11]:
```
class Operation():
    """
    An Operation is a node in a "Graph".
    TensorFlow will also use this concept of a Graph.
    This Operation class will be inherited by other
    classes that actually compute the specific
    operation, such as adding or matrix multiplication.
    """
    def __init__(self, input_nodes = []):
        """
        Intialize an Operation
        """
        self.input_nodes = input_nodes # The list of input nodes
        self.output_nodes = [] # List of nodes consuming this node's output
        for node in input_nodes:
            node.output_nodes.append(self)
        _default_graph.operations.append(self)
    def compute(self):
        """
        This is a placeholder function. It will be
        overwritten by the actual specific operation
        that inherits from this class.
        """
        pass
```

In [26]:
```
class add(Operation):
    def __init__(self, x,y):
        super().__init__([x,y])
    def compute(self, x_var, y_var):
        self.inputs = [x_var,y_var]
        return x_var+y_var
```

In [13]:
```
class multiply(Operation):
    def __init__(self, a, b):
```

```
            super().__init__([a, b])
        def compute(self, a_var, b_var):
            self.inputs = [a_var, b_var]
            return a_var * b_var
```

```
In [14]: class matmul(Operation):
             def __init__(self, a, b):
                 super().__init__([a, b])
             def compute(self, a_mat, b_mat):
                 self.inputs = [a_mat, b_mat]
                 return a_mat.dot(b_mat)
```

```
In [15]: class Placeholder():
             """
             A placeholder is a node that needs to be provided a
             value for computing the output in the Graph.
             """
             def __init__(self):
                 self.output_nodes = []
                 _default_graph.placeholders.append(self)
```

```
In [16]: class Variable():
             def __init__(self, initial_value = None):
                 self.value = initial_value
                 self.output_nodes = []
                 _default_graph.variables.append(self)
```

```
In [22]: class Graph():
             def __init__(self):
                 self.operations = []
                 self.placeholders = []
                 self.variables = []
             def set_as_default(self):
                 """
                 Sets this Graph instance as the Global Default Graph
                 """
                 global _default_graph
                 _default_graph = self
```

```
In [27]: # z = Ax + b
         g = Graph()
         g.set_as_default()
         A = Variable(10)
         b = Variable(1)
         x = Placeholder()
         y = multiply(A,x)
         z = add(y,b)
```

Creating the session

In [29]:
```python
def traverse_postorder(operation):
    """
    PostOrder Traversal of Nodes. Basically makes sure
    computations are done in the correct order (Ax first,
    then Ax + b). Feel free to copy and paste this code.
    It is not super important for understanding the
    basic fundamentals of deep learning.
    """
    nodes_postorder = []
    def recurse(node):
        if isinstance(node, Operation):
            for input_node in node.input_nodes:
                recurse(input_node)
        nodes_postorder.append(node)
    recurse(operation)
    return nodes_postorder
```

In [43]:
```python
import numpy as np
class Session:
    def run(self, operation, feed_dict = {}):
        """
          operation: The operation to compute
          feed_dict: Dictionary mapping placeholders to
          input values (the data)
        """
        # Puts nodes in correct order
        nodes_postorder = traverse_postorder(operation)
        for node in nodes_postorder:
            if type(node) == Placeholder:
                node.output = feed_dict[node]
            elif type(node) == Variable:
                node.output = node.value
            else: # Operation
                node.inputs = [input_node.output for input_node in node.input_nodes]
                node.output = node.compute(*node.inputs)
            # Convert lists to numpy arrays
            if type(node.output) == list:
                node.output = np.array(node.output)
        # Return the requested node value
        return operation.output
```

In [32]:
```python
sess = Session()
```

In [33]:
```python
result = sess.run(operation=z,feed_dict={x:10})
```

In [35]:
```python
result #10*10+1=101
```

Out[35]: 101

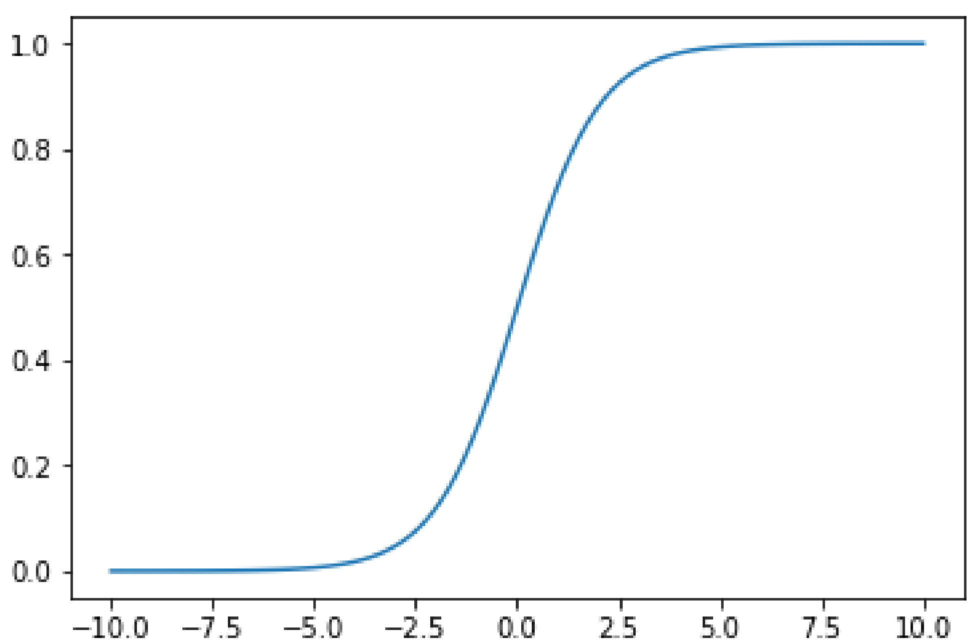
In [44]:
```
#Another example
g = Graph()
g.set_as_default()
A = Variable([[10,20],[30,40]])
b = Variable([1,1])
x = Placeholder()
y = matmul(A,x)
z = add(y,b)
sess = Session()
result = sess.run(operation=z,feed_dict={x:10})
result
```

Out[44]:
```
array([[101, 201],
       [301, 401]])
```

Activation Function

In [46]:
```
import matplotlib.pyplot as plt
%matplotlib inline
def sigmoid(z):
    return 1/(1+np.exp(-z))
sample_z = np.linspace(-10,10,100)
sample_a = sigmoid(sample_z)
plt.plot(sample_z,sample_a)
```

Out[46]:
```
[<matplotlib.lines.Line2D at 0x20c72cdd828>]
```

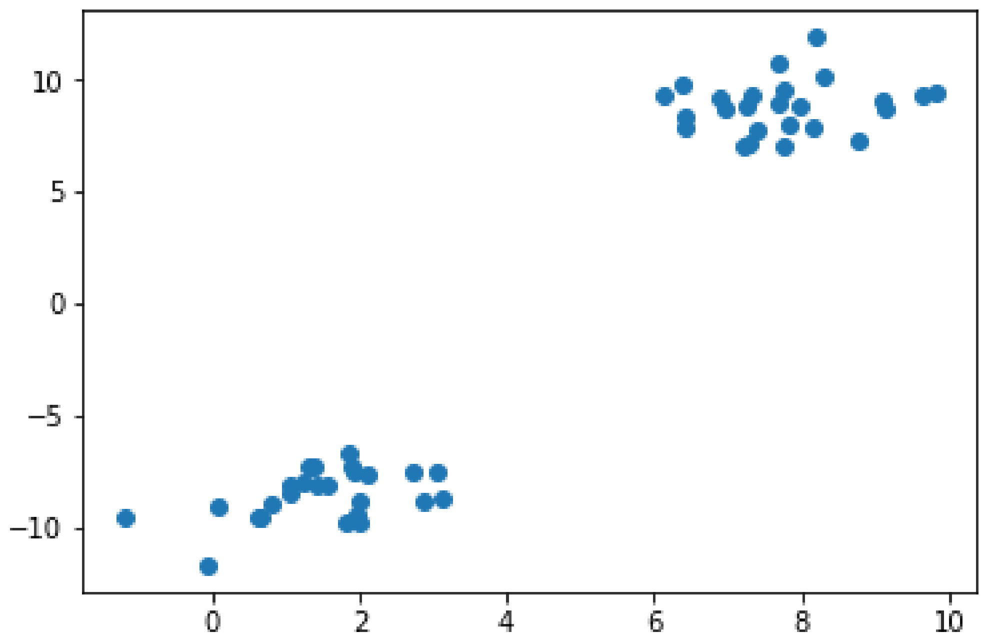


In [47]:
```python
class Sigmoid(Operation):
    def __init__(self, z):
        super().__init__([z])
    def compute(self, z_val):
        return 1/(1+np.exp(-z_val))
```

Classification

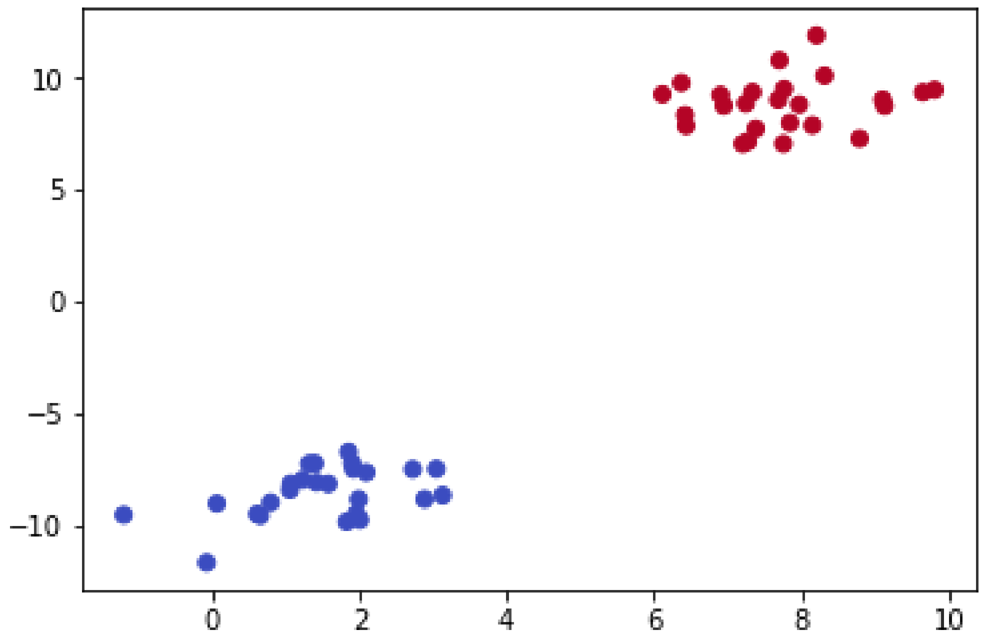
In [48]:
```python
from sklearn.datasets import make_blobs
data = make_blobs(n_samples = 50,n_features=2,centers=2,random_state=75)
features = data[0]
plt.scatter(features[:,0],features[:,1])
```

Out[48]: `<matplotlib.collections.PathCollection at 0x20c73b7fd68>`



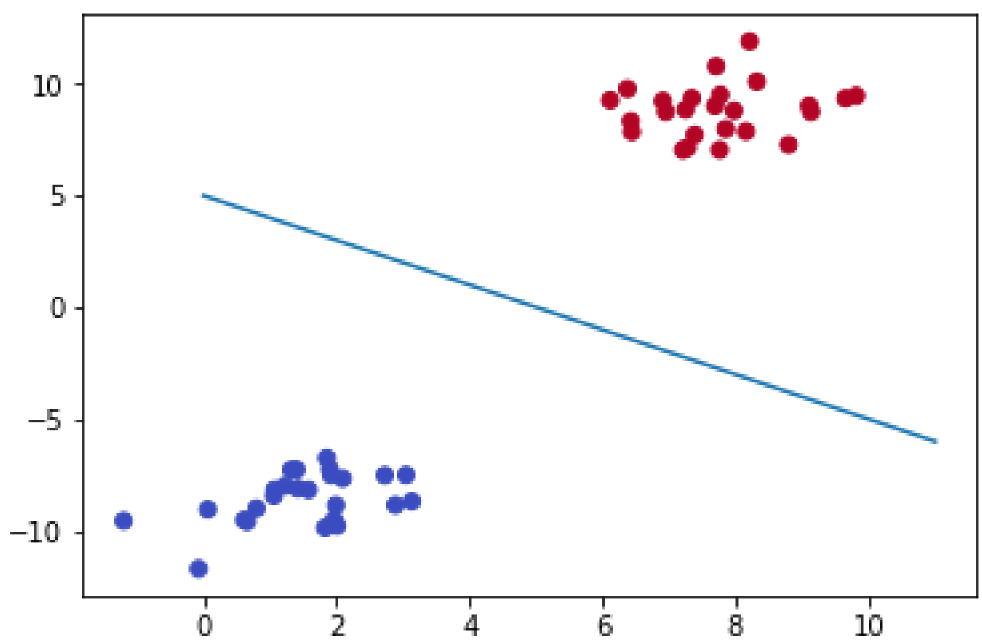
In [49]:
```python
labels = data[1]
plt.scatter(features[:,0],features[:,1],c=labels,cmap='coolwarm')
```

Out[49]: `<matplotlib.collections.PathCollection at 0x20c74bc75c0>`




```
In [50]: x = np.linspace(0,11,10)
         y = -x + 5
         plt.scatter(features[:,0],features[:,1],c=labels,cmap='coolwarm')
         plt.plot(x,y)
```

```
Out[50]: [<matplotlib.lines.Line2D at 0x20c73bd0048>]
```



Defining the Perceptron

$$y = mx + b$$

$$y = -x + 5$$

$$f1 = mf2 + b, m = 1$$

$$f1 = -f2 + 5$$

$$f1 + f2 - 5 = 0$$

Convert to a Matrix Representation of Features

$$w^T x + b = 0$$

$$\begin{pmatrix} 1, 1 \end{pmatrix} f - 5 = 0$$

Then if the result is > 0 its label 1, if it is less than 0, it is label=0

Example Point Let's say we have the point f1=2 , f2=2 otherwise stated as (8,10). Then we have:

$$(1, 1) \begin{pmatrix} 8 \\ 10 \end{pmatrix} + 5 =$$

```
In [53]: np.array([1, 1]).dot(np.array([[8],[10]])) - 5
```

```
Out[53]: array([13])
```

Using an Example Session Graph

```
In [55]: g = Graph()
         g.set_as_default()
         x = Placeholder()
         w = Variable([1,1])
         b = Variable(-5)
         z = add(matmul(w,x),b)
         a = Sigmoid(z)
         sess = Session()
         sess.run(operation=a,feed_dict={x:[8,10]})
```

```
Out[55]: 0.9999773967570205
```

```
In [56]: sess.run(operation=a,feed_dict={x:[0,-10]})
```

```
Out[56]: 3.059022269256247e-07
```