Deep Learning for Multimedia Pattern Recognition, Summer 2016
Exercise Sheet 1

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1 The Perceptron: A Single Neuron

Based on the linear regression example, we train a single neuron in TensorFlow.

- Go through the steps of the linear regression example and try comprehending them.
- Modify a copy of the linear regression example so that the function y is replaced by the function of a neuron:

  $$y(x) := g(w^\top x)$$

  You can use the function `tf.nn.sigmoid` to realise the activation function g.
- Create 20 randomly perturbed versions of the following data as training data:
  - $x^1 = (-2, 1)$, $y^1 = -1$.
  - $x^2 = (-1, -2)$, $y^2 = -1$.
  - $x^3 = (-1, 2)$, $y^3 = +1$.
  - $x^4 = (1, 1)$, $y^4 = +1$.
- Train the neuron using `tf.train.GradientDescentOptimizer` as in the linear regression example with the same cost function.

? What is a good test set? How does the neuron perform on the test set?

2 A Neural Network

We solve the XOR problem using a neural network with a hidden layer. Use three neurons in the hidden layer.

- Set up the neural network in TensorFlow. Use matrices for the weights and `tf.matmul` for matrix multiplication.
- Set up the training data similar to the last exercise, using random pertubations of the following data:
  - $x^1 = (0, 0)$, $y^1 = -1$.
  - $x^2 = (0, 1)$, $y^2 = +1$.
  - $x^3 = (1, 0)$, $y^3 = +1$.
  - $x^4 = (1, 1)$, $y^4 = -1$.
- Train the network using `tf.train.GradientDescentOptimizer` as in the linear regression example with the same cost function.

? What is a good test set? How does the neuron perform on the test set?

3 Visualisation *(Optional)*

- Visualise the training data, the test data, and the decision boundary of the neuron from the first exercise in the input space.
- Visualise the training data, the test data, and the decision boundaries of the neural network above in the input space.
- Fix the threshold of the neuron from the first exercise (to the value found in the training) and run the training again for random values of the other weights. Visualise the gradient descent steps together with a contour plot of the loss function.