# Implementing Linear Regression

Lab Assignment 8

Due date: February 18, 2021

1. Single-variate Linear Regression

   In this lab, you are going to implement Linear Regression (Refer Lecture 17).

   Start with a 1-D case. Download the files 1-D_x.dat and 1-D_y.dat from google classroom. The files contain some example measurements of heights for various boys between the ages of two and eight. The y-values are the heights measured in meters, and the x-values are the ages of the boys corresponding to the heights. Each height and age tuple constitutes one training example $(x^i, y^i)$ in the dataset. There are 50 training examples, and you will use them to develop a linear regression model using gradient descent algorithm, based on which, one can predict the height given a new age value.

   i. Implement gradient descent using a learning rate of $\alpha = 0.07$. Initialize the parameters to $\theta = \mathbf{0}$ (i.e., $\theta_0 = \theta_1 = 0$), and run one iteration of gradient descent from this initial starting point. Display the value of $\theta_0$ and $\theta_1$ that you get after the first iteration.

   ii. Continue running gradient descent for more iterations until $\theta$ converges. After convergence, display the final values of $\theta_0$ and $\theta_1$ that you get, and plot the straight line fit from your algorithm on the same graph as your training data according to $\theta$.

   iii. Finally, make some predictions using the learned hypothesis. Use your model to predict the height for two boys of ages 3.5 and 7.

2. Multivariate Linear Regression

   Consider training data contains multiple features.

   Download the files 2-D_x.dat and 2-D_y.dat from the google classroom. This is a training set of housing prices in TVM where the outputs $y$'s are the prices (say in Lakhs) and the inputs $x$'s are the living area and the number of bedrooms. There are 47 training examples.

   Pick a good learning rate in the range $0.001 \leq \alpha \leq 10$. After making an initial selection, run gradient descent and observing the cost function, and adjust the learning rate accordingly. Run gradient descent for about 50 iterations at your initial learning rate. In each iteration, calculate $J(\theta)$ and store the result in a vector $J$. After the last iteration, plot the $J$ values against the number of the iteration.

i. Observe the changes in the cost function as the learning rate changes. What happens when the learning rate is too small? Too large?

ii. Using the best learning rate that you found, run gradient descent until convergence to find
    a. The final values of $\theta$.
    b. The predicted price of a house with 1650 square feet and 3 bedrooms.