GEO5017 A1
Linear Regression

Question 1. Basic model (20%)

Consider a linear regression model with basis functions $\phi(x)$ as presented in the lecture. Suppose we have observed N data points $\{x_i, t_i\}_{i=1...N}$, answer the following questions:

1) What do we need to estimate if we want to fit this model? (10%)

2) What would be the optimal solution in the sense of sum-of-squares error? (10%)

Question 2. Programming: quadrocopter (60%)

We are testing a tracking program and we evaluate it with the help of a quadrocopter. The quadrocopter sends estimates of its velocity and the tracking program estimates its global position with respect to the quadrocopter's initial position (before flying).

1) The tracker yields these tracked position estimates at a frequency of $1Hz$:

$$\mathcal{T} = \left\{ \begin{pmatrix} 2 \\ 0 \\ 1 \end{pmatrix} \begin{pmatrix} 1.08 \\ 1.68 \\ 2.38 \end{pmatrix} \begin{pmatrix} -0.83 \\ 1.82 \\ 2.49 \end{pmatrix} \begin{pmatrix} -1.97 \\ 0.28 \\ 2.15 \end{pmatrix} \begin{pmatrix} -1.31 \\ -1.51 \\ 2.59 \end{pmatrix} \begin{pmatrix} 0.57 \\ -1.91 \\ 4.32 \end{pmatrix} \right\}$$

   Plot the trajectory through these data points with your tool of choice. (10%)

2) Use the Polynomial Regression method introduced in the lecture to answer the following questions. You can choose your favorite programming language to formulate and solve the regression problems (10%), and your **must** use your own implementation of the Gradient Descent solver (10%).

   (a) Assuming the quadrocopter flies with constant speed, what speed does it have? What is the residual error of the estimation? (10%)

   (b) Now assume that the quadrocopter flies with constant acceleration. What is the residual error now? Is the error higher or lower? Why? (10%)

   (c) According to our last model, what is the quadrocopter's most likely position in the next second? Plot this position together with privious positions. (10%)

Submission (Due: Thursday, March 9th)

Please compress all the following into a single archive titled **GEO5017_A1_Group_X.zip** (where 'X' is your group ID and can be found here) and submit it to BrightSpace:

- **A report (max 2 pages) (20%)**
  - The report must contain the answers and necessary explainations.
  - The report must contain a short description of who did what.
- **Source code** (for Question 2)
  - The source code, archived in a 'code' subfolder. The code should build, run, and reproduce your results without changes.
    - Provide a 'ReadMe' file briefly explaining how to run the code (e.g., dependence of external libraries/packages, path to data, main script file in case of multiple Python source files) and reproduce the results.
  - [*optional*] Provide a link to the GitHub repository (only if you use GitHub) in the 'Experiment' section of your report. You are encouraged to collaborate with your teammates on GitHub.