# EART119 – In Class Assignment – Week 1
# – First Calculations and Functions-

1. Consider two satellites at different velocities but the same orbit around earth. Let's assume their positions as a function of time can be described by two discrete functions f(t) and g(t) with:
   $f(t) = c^* (t - t_0)^2$, with $t_0 = 2.5$, $c = 1.1$
   $g(t) = A^*t + t_0$ with $A = 5$, and $-10 \leq t \leq 10$
   Write a program that finds the approximate crossover point at which f(t) ~ g(t) (remember we are dealing with discrete functions). Evaluate the function values of g(t) and f(t) for *N* = 1000, equally spaced point within the given interval (use: np.linspace). The criteria for the detection of the crossover point is:
   $$|f(t) - g(t)| < \varepsilon, \text{for} -10 \leq t \leq 10, \text{and } \varepsilon = 0.1$$
   a. What are t, g(t) and f(t) at the crossover point?
   b. Solve this using a "for loop" structure and then vectorize the problem to eliminate the loop for faster processing.
   c. Do the same problem for $g(t) = A^*t + t_0$ using the vectorized solution. Return all cross-over points!
   d. Find the minimum of the difference between the two discrete functions:
      i. $\min|f(t) - g(t)|$

Look at matlab_to_python.pdf reference sheet before starting the following assignement.

2. Compute the average and standard deviation of a matrix of downhole well pressures using matrix operations. Specifically, you can use the following:
   $$mean = \frac{1}{n}\sum_{i=1}^{n} D_i$$
   In matrix notation:
   $$\overline{mean} = \boldsymbol{D}^{m\times n} \cdot \overline{1^{n\times 1}} \,/\, n$$

*m* – are the number of wells,
*n* – are the number of pressure measurements in each well

Where ***D*** is the data matrix with dimensions m x n, $\bar{1}$ is the unity vector of dimension 1 x n and n is the total number of measurements. And the standard deviation is given by:

$$std = \left(\sum_{i=1}^{n}(D_i - mean)^2/n\right)^{1/2}$$

In matrix notation:

$$\overline{std} = \left\{\left[\left(\boldsymbol{D}^{m\times n} - \overline{mean}^{m\times 1} \cdot \overline{1^{1\times n}}\right)\right] ** 2 \cdot \overline{\overline{1^{n\times 1}}} \,/\, m\right\}^{1/2}$$

3. Solve the following linear system of equations:

[1] $3x_0 + x_1 = 9$
[2] $x_0 + 2x_1 = 8$, Use np.linalg.solve!