**MST 698R – Data Science Mathematics** Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Session 3 – Analyzing Trends and Optimization**

**In-Class Exercise**

Instructions: Solve each problem. Show all work. Attach additional sheets as necessary. Unless otherwise stated, you may use Python or other tools to assist.

1. You have collected data on Chinese activity in the South China Sea that you believe are correlated. You suspect that the presence of Chinese submarines within the region is related to an increase in observed cyber activity.

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| --- | --- |
| Submarine Sightings | Cyber Activity Metric |
| 1 | 0.021025 |
| 2 | 0.022103 |
| 3 | 0.023237 |
| 4 | 0.024428 |
| 5 | 0.025681 |
| 6 | 0.026997 |
| 7 | 0.028381 |
| 8 | 0.029836 |
| 9 | 0.031366 |
| 10 | 0.032974 |

Answer the following:

* 1. Calculate the sample correlation coefficient.
  2. Calculate the parameters and .
  3. Does a linear relationship exist between these data sets? How do you know?
  4. Based on your calculations, is there a correlative relationship between cyber activity and submarines within the region?

1. You are developing a convolutional neural network for identifying Chinese military images on social media. Your loss function and gradient functions are:

Answer the following:

* 1. Using a learning rate of 0.1, calculate the first 5 gradient descent iterations, beginning at (1,5). Did your model converge?
  2. Increase the learning rate to 0.5, and repeat step a. Does your model converge?
  3. Explain the significance of the learning rate. Did it have an impact on the convergence of your model?