# Homework 1
# AA 275: Navigation for Autonomous Systems

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Instructor: Prof. Grace Gao
gracegao@stanford.edu

Due date: 4:00 PM October 21, 2021, via Gradescope.
Total points: 55

## Problem 1 (10 points)

In class we learned how to acquire and analyze GNSS measurements using an Android device. Using the provided data file `gps_log_2017_03_06_sanfrancisco_L1L5.txt` (associated with the region shown at the end of demo slides), repeat the steps for analyzing GNSS measurements. Attach and comment (few lines each) on the nine generated plots. Some example prompts for the comments are listed here:

- How does the region where the data was collected influence the plot?
- How does the time of data collection influence the plot?
- What can you infer about Android GNSS logs from the plot?
- What different factors influencing GNSS measurements show up in the plot?

## Problem 2 (40 points)

In this problem, we will use the processed Android data provided in `hw1_data.csv` for positioning using GNSS pseudorange measurements. Some entries of interest in the dataset are explained in the demo slides. Some helper functions have been provided in `helper.py`, which you may modify if needed. Submit the code and generated plots along with the answers.

1. Separate the dataset into different measurement epochs, i.e., by `millisSinceGpsEpoch`. At the first measurement epoch, generate and attach a skyplot of the satellites using the satellite positions and the provided initial latitude and longitude values (in demo slides). [5 points]

2. Generate a skyplot using the entire dataset, i.e., all satellite paths using the initial position as reference. Comment on the observed paths. Why are some path longer than the others? [2 points]

3. Notice if there is a difference in the satellites observed in part 1 and part 2. Observing the environment around the initial position (in demo slides), comment on possible reasons for this difference. [2 points]

4. Next, we will estimate the receiver position and clock bias using the provided measurements. Implement the Newton-Raphson algorithm described in class. For initialization, use the provided initial position (converted to ECEF coordinates). Now set the initialization to center of the Earth (0,0,0,0). What can you say about the impact of initialization on the algorithm? [10 points]

5. Repeat the positioning process using ENU coordinates instead of ECEF. Convert the ECEF solution from the previous part to ENU. Does the choice of coordinate frame affect the final position? Why? [3 points]

6. Estimate the position using only 4, 5 and 6 satellites (randomly selected). Compare the estimated positions with those using the full set of satellites. Report your observations. [5 points]

7. Vary the groups of 4 satellites used for estimating the position. What do you infer from the different estimated positions at each measurement epoch? [3 points]

8. Using the estimated positions from part 4, compute and plot the absolute value of residuals (absolute difference between the measured and the expected pseudorange measurement). What do the spikes in the plot indicate? [5 points]

9. In this part, use weighted least-squares algorithm for positioning. You may use any information of your choice for creating the weight matrix at each measurement epoch, such as satellite elevation, pseudorange uncertainty or parameters estimated from the provided data. Report your experiments (at least 2 different ways of creating the weight matrix) and compare the performance with Newton-Raphson. [5 points]

# Problem 3 (5 points)

**(Self-Care)**

"The purpose of a storyteller is not to tell you how to think, but to give you questions to think upon." *–Brandon Sanderson*

Describe in a few sentences a story or a novel that was particularly interesting to you. Take a few moments to reflect on the story in the context of your everyday life. Alternatively, describe how you practiced self-care this week in any form or expression including but not limited to sketching, videos, and pictures.