Engineering 13300 – HW 11 MA 3
MATLAB 3 – Individual Tasks

Guidelines for Tasks 6-7:

1. Tasks 6-7 are individual tasks. You may seek help from classmates, the instructional team or others but the work you submit should be your own. If you collaborate with others and use information developed together or by someone else, ALWAYS document and reference that material.
2. Each student is responsible for submitting their own assignment to gradescope
3. Draw a flowchart or diagram to every task in this section and save it as `Ma3_Ind_flowchart_username.pdf`

Individual Task 6 (of 7) LiDAR

Image 1 –LiDAR equipment on vehicle

Background

LiDAR, light detection and ranging, is a surveying system that measures distance by illuminating a target with laser light. Once data is obtained it is used to generate 3D point clouds of the objects or areas surveyed (see images 2a and 2b). LiDAR can be used for many applications, one of which is to measure lane widths in construction work zones. To collect lane width data, LiDAR equipment is mounted on top of a vehicle (see image 1) and driven through construction areas.

A traffic study was performed on a portion of interstate where construction was taking place. Lane width (obtained by LiDAR data) and the traffic speed data along I-74 from milepost 146 to 145 (the driving direction is from milepost 146 to 145) was obtained. Traffic speed data was collected from approximately 6:15 am to 5:45 pm, from the 1^{st} to the 7^{th} day, which adds up to approximately 80 hours in total. The data shows the lane width as well as the number of hours (within the 80 hours) that the traffic travels at different speed intervals at each mile marker location.

In this problem you will be looking at the affect lane width has on traffic speed. The research observed that when lanes are narrowed it affects vehicle speed. Reduced vehicle speed will affect traffic flow capacity and might lead to congestion, which would increase the drivers' stress as well as the probability of traffic accidents.

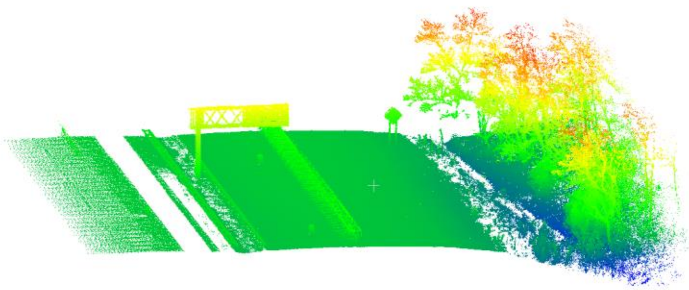

Image 2a – LiDAR data colored by height

Image 2b –corresponding image

Problem Steps

1. Observe the data file to see what each column represents before you remove the headers.
   Hint 1: *Consider ways to parse the loaded data into useful pieces.*
   Hint 2: *Some useful functions that may or may not be needed are:* ***min(), max(), find(), numel(), sum(), disp()****. If you have any questions about what these are for or how to use them, look them up within MATLAB help or on MATLAB's website.*
2. Load the data (***Lanewidth_TrafficSpeed.csv***) with the MATLAB `csvread` command into the script file to be saved as ***Ma3_Task6_ConstrolSys_username.m.*** Modify the template file – **ENGR133_MATLAB_Template.m**. as a start for the script.
3. In the CALCULATIONS section, use relational and logical operators and associated built-in functions, as appropriate, to answer these three questions:
   a. Find the maximum and minimum lane width, and the corresponding mile markers.
   b. Find the mile marker range where the lane width is less than 10 ft. Let P represent the first mile marker in this range, and Q represent the last mile marker in this range. Show P and Q.
   c. Using your results from question B, calculate the average number of hours for different speed intervals based on the following mile marker ranges: 145 to P, P to Q, and Q to 146. Show these averages.
   d. Create a plot of lane width versus mile markers. Notice that within your PQ range, it looks like the width may go above 10 feet a couple times. Do you think this is a problem?
   e. To find out exactly how much of the PQ range is above 10 feet, make a vector that is composed only of the lane width data points between P and Q. Use logic statements, commands, and (if necessary) additional vectors to figure out how many of the data

points between P and Q have lane widths above 10 feet. Use that result to calculate the percentage of data points between P and Q which are greater than 10 feet.

f. Now that you have a more precise indicator of how many times the lane width is greater than 10 feet between P and Q, does this change the answer that you provided in Part D? Why or why not? Type a comment in your code with the answer to this question.

4. Write `fprintf` commands to print the results of the above question. Make sure you frame your results as sentences, not just the numbers. Your `fprintf` commands should include the following:
   a. Your lane min and lane max as well as their corresponding mile markers
   b. The mile markers for both P and Q.
   c. Average number of hours in each speed range based on the mile marker ranges: 145 to P, P to Q, and Q to 146.
   d. The percentage of data points between P and Q where the lane width is greater than 10.
5. Publish your script as a PDF and name it Ma3_Task6_ControlSys_username.pdf.

Task 6 files to submit:

- `Ma3_Ind_flowchart_username.pdf`
- `Ma3_Task6_ControlSys_username.m`
- `Ma3_Task6_ControlSys_username.pdf (published file)`

Individual Task 7 (of 7) Launch vehicle tracking

Problem statement
You are testing a new propellant for space flight using a model rocket. On board the rocket is an R-DAS (Rocket Data Acquisition System) that measures the rocket's altitude and acceleration over the course of the fight. Your goal is use that information to find the velocity of the rocket. One data file is available: Data_RDAS.csv contains time of the flight in seconds and the acceleration of the rocket in g's (Remember 1 g = 32.2 ft/s^2).
To determine the velocity throughout the flight, you will need the area under the acceleration curve. The Trapezoidal Rule gives a formula to find a graphical approximation of that area:

$$V = \int_{t_0}^{t_f} a(t)dt \approx \sum_{k=2}^{N} \left(\frac{a_k + a_{k-1}}{2}\right)(t_k - t_{k-1})$$

Where N is the number of data points, a is the acceleration of the rocket, and t is the flight time.

Part A
Open launchVel_tracking_template.m and write a script that does the following:

- Imports the data and assigns the columns to unique variables.
- Uses a for loop to create a vector of the approximated velocity for each time entry in the data set.
    - Hint: you will need to initialize the velocity value to 0 ft/s for the first time entry.
    - Hint: notice the initial value of k in the summation is 2.
- Creates one figure with 3 subplots. The subplots must be in one column, with acceleration (in ft/s^2) as the top plot, velocity (in ft/s) as the middle plot, and altitude (in ft) as the bottom plot. All three plots must be plotted with respect to time. Format for technical presentation.
- Displays the maximum launch velocity (i.e., not falling) and the time it occurs to the Command Window using professional formatting.

Part B
Follow instructions in Ma3_launchVel_tracking_template.docx to complete the tracking table. Save the file as Ma3_Ind_Task7_username.pdf. Does your tracking table result match your script result? Debug your script and/or tracking table as necessary.

Publish your script as a PDF and name it Ma3_Task7_launchVel_tracking_username.pdf.

Task 7 files to submit:

- `Ma3_Ind_flowchart_username.pdf`
- `Ma3_Ind_Task7_username.pdf`
- `Ma3_Task7_launchVel_tracking_username.m`
- `Ma3_Task7_launchVel_tracking_username.pdf (published file)`