Problem Set 02
Importing Data and Plotting
Problems

Instructions:

1. This problem set contains paired programming and individual programming problems. Each problem has a set of deliverables that needs to be submitted. You are responsible for following the appropriate guidelines and instructions below. Create appropriately-named files as instructed.
2. Save all files to your Purdue career account in a folder specific to PS02.
3. Compress all deliverables into one zip folder named **PS02_yourlogin.zip**. Submit the zip file to the Blackboard drop box for PS02 before the due date. *REMEMBER*:
   - Only include deliverables. Do not include the problem document, blank templates, etc.
   - Only compress files into a .zip folder. No other compression format will be accepted.

Problem Set Deliverables

Item	Type	Deliverable
Problem 1: Matrix Manipulation II	Paired	PS02_matrix_manipulation_*yourlogin1*_*yourlogin2*.m PS02_matrix_manipulation_*yourlogin1*_*yourlogin2*_report.pdf
Problem 2: Airfares & Fuel Costs	Paired	PS02_costs_*yourlogin*_*yourlogin2*.m PS02_costs_*yourlogin*_*yourlogin2*_report.pdf All data files that are loaded into your m-file
Problem 3: Air Travel	Individual	PS02_airtravel_*yourlogin*.m PS02_airtravel_*yourlogin*_report.pdf All data files that are loaded into your m-file

Publishing MATLAB Scripts

Starting with PS02, you will publish your MATLAB m-files to a PDF file. Read the instructions for publishing scripts that is in the "Publishing MATLAB Code" item in the Problem Set folder on Blackboard to learn how to format your code and how to publish.

Programming Standards

You are responsible for following all course Programming Standards guidelines, which you will need to know for this and all subsequent assignments. You can find the guidelines on Blackboard via **Course Info** (on the left-hand navigation bar) / **Course Resources** > **MATLAB Resources**.

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Problem 1: Matrix Manipulation II

Paired Programming

Document, Test, Debug, and Finalize Your Code

- Comment your code **while you are coding, not afterwards**. It is easy to forget what each line of code represents if you delay commenting, and waiting until the end to add comments increases the time you will spend on commenting.
- Re-save, run, and debug your code often, preferably after each new line or closely related 2-5 new lines of code are added. This allows you to identify the true location of problems more easily. MATLAB identifies the first line of code that fails, but the actual error could be on any previous line.
- Suppress printing of code that is functioning properly. Only formatted displays should be printed in the Command Window once your code is functional.

Problem Background

This problem will introduce you to Paired Programming and will review Matrix Manipulation concepts. Be sure to follow the Paired Programming guidelines presented in class.

Problem Steps

1. Download the script **PS02_matrix_manipulation_template.m** file.
2. Open template and complete the header information.
    a. Add the problem set number (e.g. PS02), your name, and your section-team number.
    b. Declare your partner in the paired programming area.
    c. List any additional contributors who work with you and your paired partner.
3. Save your script with the name **PS02_matrix_manipulation_*yourlogin1*_*yourlogin2*.m**, where *yourloginX* are yours and your paired partner's Purdue Career Account logins.
4. Use MATLAB to learn what these built-in functions do: `ones` and `sum`.
5. In the `INITIALIZATION---` section of your script file, create a matrix A in the following manner.
    a. Use the built-in MATLAB function `ones` to create a 7x7 matrix filled with 10s.

```
A =

    10    10    10    10    10    10    10
    10    10    10    10    10    10    10
    10    10    10    10    10    10    10
    10    10    10    10    10    10    10
    10    10    10    10    10    10    10
    10    10    10    10    10    10    10
    10    10    10    10    10    10    10
```

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b. Using matrix manipulations, replace the inner 5x5 matrix with 9s.

```
A =

    10    10    10    10    10    10    10
    10     9     9     9     9     9    10
    10     9     9     9     9     9    10
    10     9     9     9     9     9    10
    10     9     9     9     9     9    10
    10     9     9     9     9     9    10
    10    10    10    10    10    10    10
```

c. Using matrix manipulations, replace the inner 3x3 matrix with 8s.

d. Using matrix manipulations, replace the innermost value with a 7.

```
A =

    10    10    10    10    10    10    10
    10     9     9     9     9     9    10
    10     9     8     8     8     9    10
    10     9     8     7     8     9    10
    10     9     8     8     8     9    10
    10     9     9     9     9     9    10
    10    10    10    10    10    10    10
```

6. In the `COPY VECTORS` section of your script file, perform the following:

   Note: Do not hardcode assignments unless told to do so.

   a. Copy from A, a 4-element row vector that counts up from 7 to 10 and assign it to B.

   b. Copy from A, a 3-element row vector that counts down from 9 to 7 and assign it to C.

   c. Copy from A, a 4-element column vector that counts up from 7 to 10 and assign it to D

   d. Copy from A, a 3-element column vector that counts down from 9 to 7 and assign it to E.

7. In the `REPLACE MATRIX ELEMENTS` section of your script file, perform the following:

   a. Use only vectors B-E, as appropriate, to replace the first row of A as shown below. Continue to use only vectors B-E, as appropriate, to replace the first column of A, the last row of A, and the last column of A as shown below.

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```
A =

     7     8     9    10     9     8     7
     8     9     9     9     9     9     8
     9     9     8     8     8     9     9
    10     9     8     7     8     9    10
     9     9     8     8     8     9     9
     8     9     9     9     9     9     8
     7     8     9    10     9     8     7
```

b. In the top left corner of A, replace the 7 with the sum of the three values adjacent to it using *array indexing*. See PS01, Problem 5 "Useful MATLAB Commands" in the green box for help with array indexing.

   Repeat for the top right corner of A, the bottom right corner of A, and the bottom left corner of A.

c. Replace the center value of A with the sum of the eight surrounding values.

8. In the `CONCATENATION` section of your script file, perform the following:

   a. Create a vector X that contains the sums of the columns of A.

   b. Concatenate vector X to the bottom of matrix A (from Step 7.c) to create a new matrix, B. Concatenation requires the use of square brackets.

   c. Create a vector Y that contains the sums of the rows of B.

   d. Concatenate vector Y to the right of matrix B (from Step 8.b) to create a new matrix, C. Concatenation requires the use of square brackets.

9. In the `DISPLAY` section of your script file, use three **`fprintf`** statements to display your results as shown:

   Note: Do not hardcode the numerical values within your **`fprintf`** statements; use array indexing of A to identify the appropriate values of A to display.

```
After doing step 7.c, the value in the center of A is ___.

After doing step 8.d, the value in the upper left of C is ___,
and the value in the upper right of C is ___.

After doing step 8.d, the value in the lower left of C is ___,
and the value in lower right of C is ___.
```

10. Publish your script as **PS02_matrix_manipulation_*yourlogin1*_*yourlogin2*_report.pdf**.

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Problem 2: Airfare & Fuel Costs

Paired Programming

Creating Plots of Data

- When analyzing bivariate (two variables) data, you must determine which is the independent variable and which is the dependent variable.
- A common way to phrase a request for a plot is to say, "Plot variable 1 versus variable 2." Variable 1 refers to the y-axis variable; variable 2 refers to the x-axis variable.
- When formatting plots of data, data markers are used for each data point but no line is used to connect those points. A line implies a relationship between the independent and dependent variable is known or modeled.

Creating Plots of Models

- When plotting models, lines are used with no data markers. The points used to generate the plot are selected for convenience and do not refer to actual data.
- Models may be presented with the raw data plot on the same plot. The model is a line with no data markers. The raw data are shown with data markers and no connecting line.

Testing and Debugging Plot Code

- **Always close all figure windows before re-running your code.** Otherwise, your code will add or remove things from the existing plot displays. This will appear to be random acts that may or may not reflecting the presence of any coding problems.

Problem Setup

Air travel is a complex system with many factors that determine costs for airlines and passengers. Up to 30% of an airline's operating expense goes to fuel costs, which can be affected by many things. Airfares contribute to airlines' revenues, but airfare prices fluctuate over time and can affect passengers' decisions to fly or to use other transportation.

You are to examine some airline data to look for trends concerning what affects fuel costs and airfares. You will need two data files for this problem. The file named **Data_US_airlines.csv** contains annual information for **all** domestic US flights. The file **Data_adj_airfare.txt** contains annual US domestic flight fare averages that have been adjusted for inflation.

You will create plots to help answer these questions:

- Do fuel costs reflect fuel prices?
- Have airfare prices been increasing or decreasing over the past 15 years?

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Problem Steps

A. Initialize your script:

1. Download the **PS02_costs_template.m** file.
2. Open the template and complete the header information.
3. Save your script with the name **PS02_costs_*yourlogin1*_*yourlogin2*.m**, where *yourloginX* are yours and your paired partner's Purdue Career Account logins.
4. Open **Data_US_airlines.csv** and review the information it contains. Open **Data_adj_airfare.txt** and review the information it contains.
5. In the `INITIALIZATION` section of your script, write the code to:
    a. Import all the data from both data files using the appropriate MATLAB built-in functions for the provided data file formats (i.e. .csv, .txt).
    b. Extract each data column into separate vectors. Use descriptive variable names and add comments to explain each variable. Include units in the comments, where applicable.

B. Examine airline fuel cost:

6. In the `FUEL COST PLOT` section of your script, write the code to:
    a. Create a scatter plot that you can use to determine what effect fuel price has on fuel costs.
    b. Format the plot with a descriptive title, useful axes labels with units, and gridlines.

C. Examine airline fares over time

You have been provided with airfares (both nominal average airfare and adjusted-for-inflation airfare) in the two data files. You want to see how the fares have changed over time. If each year is converted to a year count (Year 2000 = Year 1, Year 2001 = Year 2, etc.), then the fare data can be modeled using the following two equations:

$$A_{nom} = 0.623c^2 - 5.832c + 330.57$$

$$A_{adj} = 0.956c^2 - 19.841c + 469.5$$

Where A_{nom} is the modeled annual average airfare (dollars), A_{adj} is the average airfare adjusted for inflation (dollars), and c is the year count.

7. In the `AIRFARE MODEL CALCULATIONS` section of your script, write the code to:
    a. Calculate the modelled average airfare for each year (by count).
    b. Calculate the modelled adjusted airfare for each year (by count).
8. In the `AIRFARE DATA & MODEL PLOT` section of your script, write the code to:
    a. Create a second figure that contains a single plot with both models.
    b. Overlay the actual average airfare and inflation-adjusted airfare provide in the data files.

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c. Format the plot with a descriptive title, useful axes labels with units, and gridlines. Each model must be a different style and color. Each set of data points must be a different marker style but match the color of its model. Add a legend and label the models and data sets appropriately.

D. Answer questions about the data and plots:

9. In the `ANALYSIS` section of your script, answer the following questions.

   Q1: In Problem 2, Figure 1, what type of trend do you see in the plot? Does fuel cost reflect fuel price?

   Q2: In Problem 2, Figure 2, what is happening to airfare prices from 2000-2015? Refer to both the average fares and the inflation-adjusted fares in your answer.

E. Publish your script:

10. Publish your script as **PS02_costs_*yourlogin1*_*yourlogin2*_report.pdf**.

References:
http://www.rita.dot.gov/bts/data_and_statistics/index.html
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EER_EPJK_PF4_RGC_DPG&f=A
http://www.rita.dot.gov/bts/airfares/programs/economics_and_finance/air_travel_price_index/html/AnnualFares.html

Problem 3: Air Travel

Individual Programming

Problem Setup

Continue using the data from Problem 2 to create an individual script that will allow you to answer the following questions. You will create additional plots to help answer these questions:

- Has there been an increase in the number of flights and passengers over the past 15 years?
- Do airfare prices reflect fuel costs?

Problem Steps

A. Create and initialize your script:

1. Download the **PS02_airtravel_template.m** file.
2. Open the template and complete the header information.
3. Save your script with the name **PS02_airtravel_*yourlogin*.m**, where *yourlogin* is your Purdue Career Account login.
4. In the `INITIALIZATION` section of your script, write the code to:

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a. Import all the data from both data files using the appropriate MATLAB built-in functions for the provided data file formats (i.e. .csv, .txt), just as you did in Problem 2.

b. Extract each data column into separate vectors, just as you did in Problem 2. Use descriptive variable names and add comments to explain each variable. Include units in the comments, where applicable.

B. Compare travel data & airfare and fuel costs:

5. In the `TRAVEL & AIRFARE PLOTS` section of your script, write the code to:

a. Create a figure that contains a 2x2 arrangement of subplots. You will use the two subregions in the left column and only the top subregion in the right column, as follows:

Subplot A	Subplot C
Subplot B	

b. Subplot A must be a scatter plot that shows the number of passengers each year (i.e., 2000-2015).

c. Subplot B must be a scatter plot that shows the number of flights each year.

d. Subplot C must be a scatter plot that allows you to determine if fuel costs affect the average airfare price.

e. Format each subplot with a descriptive title, useful axes labels with units, and gridlines.

C. Answer questions about the data and plots:

6. In the `ANALYSIS` section of your script, answer the following questions.

Q1: Examine Problem 3, Figure 1, subplots A and B. Has there been an increase in flights and/or passengers over time? What can you say about how the number of flights relates to the number of passengers? Justify your answers.

Q2: Based on Problem 3, Figure 1, subplot C, is airline fuel cost a good indicator of airfare price? Justify your answer.

D. Publish your script:

7. Publish your script as **PS02_airtravel_*yourlogin*_report.pdf**.