Problem Set 03 · Relational & Logical Operators

Instructions:

1. Each problem in this problem set has a set of deliverables for you to submit. 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 PS03.
3. Compress all deliverables into one zip file named **PS03_yourlogin.zip**. Submit the zip file to the Blackboard drop box for PS03 before the due date. *REMEMBER*:
   - Only include deliverables. Do not include the problem document, blank templates, etc.
   - Only compress files into a .zip file. No other compression format will be accepted.

Deliverables List

Item	Type	Deliverable
Problem 1: Flight Time Departures	Paired	PS02_flightdelays_*yourlogin1_yourlogin2*.m PS02_flightdelays_*yourlogin1_yourlogin2*_report.pdf All data files that are loaded into your m-file
Problem 2: Sunrise Sorting	Individual	PS03_2018sunrise_*yourlogin*.m PS03_2018sunrise_*yourlogin*_report.pdf Any data files that are loaded into your m-file
Problem 3: Truth Tables	Individual	PS03_truthtables_yourlogin.docx

Truth Table Answer Sheet

You must use the truth table answer sheet that is provided in the Assignment Files. Be sure to fill out the header information. Follow any additional instructions that appear in the answer sheet. Submit your completed answer sheet with the rest of your deliverables.

`find` Command in the MATLAB Editor

If you use the find command and edit your code within the MATLAB editor, you may find that MATLAB produces a warning on the lines with the find command. MATLAB may suggest that you use logical indexing, which allows you to use logical 1s and 0s to identify which values in a vector correspond to the 'true' condition. You can use either method, `find` or logical indexing, on this assignment. You should know how the `find` command works for exams.

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Problem 1: Flight Time Departures

Paired Programming

Learning Objectives

Below are learning objectives that may be used when assessing your work on this problem. Learning objectives from past assignments may also be used to assess your work. Use the links to find the full evidence lists for each topic.

Scripts	04.00 Create and execute a script
Variables	02.00 Assign and manage variables
Arrays	03.00 Manipulate arrays (vectors or matrices)
Text Display	05.00 Manage text output
Import Data	06.00 Import numeric data stored in .csv and .txt files
Relational & Logical Operators	14.00 Perform and evaluate relational and logical operations
	14.02 Employ relational operators with arrays (scalars, vectors, matrices)
	14.03 Employ order of operations to perform calculations, comparisons, and logical operations
	14.05 Employ comparison functions with vectors and matrices: find
	14.06 Employ logical operations with arrays (scalars, vectors, matrices)

Problem Setup

You work for Boiler Aeronautical Consulting Systems (BACS) as a flight systems engineer, and you design systems to optimize the efficiency of commercial airplane departures. You are currently interested in evaluating the performance of the flight departure system your team designed.

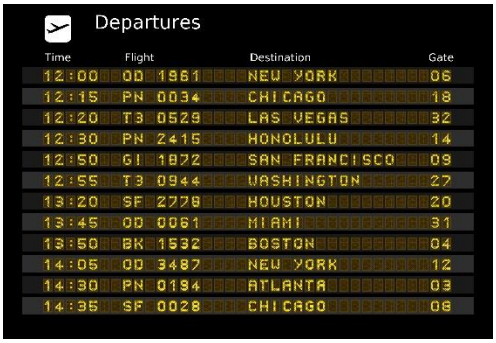

Figure 1: Sample Flight Departure Board.

BACS's goal in designing the system is to maximize the number of on-time flights based on industry standards. A flight's departure time is the time when the aircraft leaves the gate. A flight is considered on-time (OT) if the actual departure time is less than or equal to 5 minutes from the scheduled departure time (either early or late). A flight is considered delayed (DEL) if its actual departure is later than 15 minutes or more from its scheduled departure time (late only). A flight is considered acceptably off-schedule (AOS) if its actual departure is between 5 minutes and 15 minutes from its scheduled departure (either early or late).

Your company has pilot-tested its system across four airports with similar numbers of daily domestic flights [Boston (BOS), Minneapolis-St Paul (MSP), Orlando (MCO), and Las Vegas (LAS)], consisting of 500 different flights, and your goal is to produce reports that will help your team determine the efficiency of your flight departure system.

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One data file is available:

- **flight_times.csv** contains the departure airport code with its city and state (columns 1-3) as well as the delay in departure (column 4) determined as the actual arrival time minus the scheduled departure time measured in minutes. Negative values for the delay in departure correspond with an early departure.

Your task is to create a script that will use relational and logical operators and MATLAB built-in functions to answer the following questions about the data:

A. What are the total number of on-time, acceptably off-schedule, and delayed flights?

B. Which airport has the largest average departure delay and which has the smallest average departure delay.

C. What is the number of excessively off-schedule departures (i.e., the departure is more than 90 minutes late or more than 15 minutes early) for each airport?

Learn about the following built-in MATLAB commands, which might be useful in your solution:

```
min, max, mean, sort, length
```

Problem Steps

1. Open the script **PS03_flightdelays_template.m** file. Complete the header information. Save your script with the name format required by the deliverables list.
2. Write a script that allows to you answer the questions in the Problem Setup.
3. In the `FORMATTED TEXT DISPLAYS` section, display your answers to questions A, B, and C in the Command Window using professionally formatted text displays. Do not hardcode any values in your fprintf statements.
4. In the `ANALYSIS` section, answer the following question:

   Q1: The US Department of Transportation monitors on-time performance for US airlines and displays annual statistics here. Examine the average annual delayed percentage and compare that to your flight system's data. How well do you think the system is performing?

5. Publish your script as a PDF and name it as required in the Deliverables List.

Reference

Image source: http://blog.rmi.org/Content/Images/departureboard.jpg

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Problem 2: Sunrise Sorting

Individual Programming

Learning Objectives

Below are learning objectives that may be used when assessing your work on this problem. Learning objectives from past assignments may also be used to assess your work. Use the links to find the full evidence lists for each topic.

Scripts	04.00 Create and execute a script
Variables	02.00 Assign and manage variables
Arrays	03.00 Manipulate arrays (vectors or matrices)
Text Display	05.00 Manage text output
Import Data	06.00 Import numeric data stored in .csv and .txt files
Relational & Logical Operators	14.00 Perform and evaluate relational and logical operations
	14.02 Employ relational operators with arrays (scalars, vectors, matrices)
	14.03 Employ order of operations to perform calculations, comparisons, and logical operations
	14.05 Employ comparison functions with vectors and matrices: find
	14.06 Employ logical operations with arrays (scalars, vectors, matrices)

Problem Setup

You are a Purdue engineering student who is considering a 7:30am class in either Tuesday/Thursday in Spring 2018 or Monday/Wednesday/Friday in Fall 2018. You want to know how many days you will have to walk to class in the dark versus in daylight.

You have been provided with a data set, **Data_westlafayette_sun_2018.csv**, that contains the 2018 sunrise and sunset times for West Lafayette. Review the data file.

You plan to start walking to class at 7:00 am and will arrive at your classroom at 7:20am. Assume that daylight starts when the sun rises. Use the data to answer the following questions:

A. Spring 2018 Semester:

1. How many days will you walk in total darkness (i.e., the sun does not rise until after you arrive at your classroom)?
2. How many days will the sun rise during your walk (i.e., the sun rises between 7:00 am and 7:20 am, including both times)?
3. How many days will you walk in full daylight (i.e., the sun rises before you leave)?
4. What is the last day-of-year (DOY) you will walk in full darkness?
5. What is the first DOY you will walk in full daylight?

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B. Fall 2018 Semester:

1. How many days will you walk in total darkness (i.e., the sun does not rise until after you arrive at your classroom)?
2. How many days will the sun rise during your walk (i.e., the sun rises between 7:00 am and 7:20 am, including both times)?
3. How many days will you walk in full daylight (i.e., the sun rises before you leave)?
4. What is the last DOY you will walk in full daylight?
5. What is the first DOY you will walk in full darkness?

Learn about the following built-in MATLAB commands, which might be useful in your solution:

`min, max, sum, length, size`

You can find Purdue's academic schedules here. Remember that Spring 2018 and Fall 2018 are in different academic years. Do not include finals week. Ignore university holidays.

Problem Steps

1. Open the script **PS03_2018sunrise_template.m** file. Complete the header information. Save your script with the name format required by the deliverables list.
2. Import the data into MATLAB using appropriate commands.
3. Initialize variables for the start time of your walk, the time you arrive at the classroom, the day-of-year (DOY) for the first class and last class of each semester, and the numerical representations of the days of week. **Do not hard code any other values**.
4. Write the code to answer the questions in the Problem Setup.
    a. Use **only** relational and logical operations, along with any of the built-in functions listed in the Problem Setup, to determine the answers to the questions.
    b. Place code in the appropriate sections. Do not forget to comment all new variable assignments and code blocks in your code to make it readable to others. A code block is a group of code lines that program an intermediate step or steps within your script.
5. Print the results to the Command Window, replacing <num> with the appropriate variable value calculated by your code:

```
Spring 2018:
You will walk <num> days in darkness, <num> days in partial daylight,
and <num> days in full daylight. Your last walk in full darkness is
on DOY <num> and your first walk in full daylight is on DOY <num>.

Fall 2018:
You will walk <num> days in full daylight, <num> days in partial daylight,
and <num> days in darkness. Your last walk in full daylight is
on DOY <num> and your first walk in full darkness is on DOY <num>.
```

Note: Be sure to leave a space between the Spring and Fall information. It is acceptable to have a blank space for <num> instead of a value in the display if the variable used to display it is a blank vector.

6. Publish your script as a PDF and name it as required in the Deliverables List.

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Problem 3: Truth Tables

Individual Analysis

Learning Objectives

Below are learning objectives that may be used when assessing your work on this problem. Learning objectives from past assignments may also be used to assess your work. Use the links to find the full evidence lists for each topic.

Relational & Logical Operators	14.00 Perform and evaluate relational and logical operations
	14.01 Construct relational and logical statements from English statements
	14.02 Employ relational operators with arrays (scalars, vectors, matrices)
	14.03 Employ order of operations to perform calculations, comparisons, and logical operations
	14.06 Employ logical operations with arrays (scalars, vectors, matrices)
	14.07 Construct truth tables to evaluate logical expressions

Problem Setup

In logic, a true statement is assigned the value 1, and a false statement is assigned the value 0.

When writing and evaluating logical statements using truth tables, the following MATLAB operators are used as symbols:

Symbol	Logic Meaning
|	OR
&	AND
~	NOT

For example, for the statement **A & ~xor(B,C),** the truth table would be:

	B=0		B=1	
	C=0	C=1	C=0	C=1
A=0	0 & ~xor(0,0) → 0 & ~0 → 0 & 1 → 0	0 & ~xor(0,1) 0 & ~1 → 0 & 0 → 0	0 & ~xor(1,0) → 0 & ~1 → 0 & 0 → 0	0 & ~xor(1,1) → 0 & ~0 → 0 & 1 → 0
A=1	1 & ~xor(0,0) → 1 & ~0 → 1 & 1 → 1	1 &~ xor(0,1) → 1 & ~1 → 1 & 0 → 0	1 & ~xor(1,0) → 1 & ~1 → 1 & 0 → 0	1 & ~xor(1,1) → 1 & ~0 → 1 & 1 → 1

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The order of precedence is important when using truth tables. Remember MATLAB's order of precedence when creating and evaluating logical statements. In the absence of parentheses, operators at the same level are read left to right.

DESCRIPTION	OPERATORS	
Parentheses	( )	Highest Priority
Transpose and Exponentiation	.' .^ ' ^	
Negation and Logical Negation	- ~	
Multiplication and Division	.* ./ .\ * / \	
Addition and Subtraction	+ -	
Relational Operators	< <= > >= == ~=	
Logical AND	&	
Logical OR	|	
Logical Short-Circuit AND	&&	
Logical Short-Circuit OR	||	Lowest Priority

Problem Steps

1. Open *PS03_truthtable_template.docx*. Complete the header, and save the file as **PS03_truthtables_*yourlogin*.docx**. This is where you will complete all the parts to this problem.
2. **To receive full credit, you must show the intermediate steps needed to reach the final answer for each location in each truth table—even if you see opportunities for short cuts**. See the example above.

   Note: you do not have to provide an answer for any greyed-out boxes within a table.
3. On your Word answer sheet, do the following:
   a. Complete the truth table for the logic statement **xor(B,A) | A & B**
   b. Complete the truth table for the logic statement **F & ~xor(G,F) < H ~=K**
   c. Construct the truth table and then complete it for the logic statement **~C == D | E > C < (D & C)**
4. The following English-language logic statement needs to be translated into MATLAB logic statements.

   The statement is true if R is true and Q is false. The statement is true if P or R are true but not both. All other conditions are false.

   To translate English statements, follow these steps on your answer sheet:

   - Use the English language logic to determine the pattern of 1's and 0's in the truth table that must result from the statement.
   - Use the pattern to create the MATLAB logic statement.
   - Verify the MATLAB logic statement by completing the truth table.