CEE 3804: Computer Applications for CEE | Fall 2015

Quiz 2 (75 minutes)

Solution | Instructor: Trani

Open book and notes, use of computer is allowed

Your Name ____

Pledge ____

Use a Word processor of your choice to assemble your solutions. Include all screen captures of your Matlab scripts and plots created as outputs. Include all tables for Problem 2 in your solution as well. Create a single PDF file and send via email to: Moises Bobadilla (moisesbm@vt.edu) and to me (vuela@vt.edu).

Problem 1 (30 Points)

Your task is to analyze asset data for a construction company. The data is presented in a separate file called "Construction_assets_Rev.xlsx". The data has the following information:

Construction Site	Vehicle	Miles	Value ($)	Status
Salem	Cat 775F	98,345	123,450	Active
Galax	Cat 775F	112,340	179,642	Active
Richmond	Cat 725	172,645	118,900	Active
Galax	Cat 725	109,142	135,385	Active
Galax	Cat 775F	165,058	207,634	Active

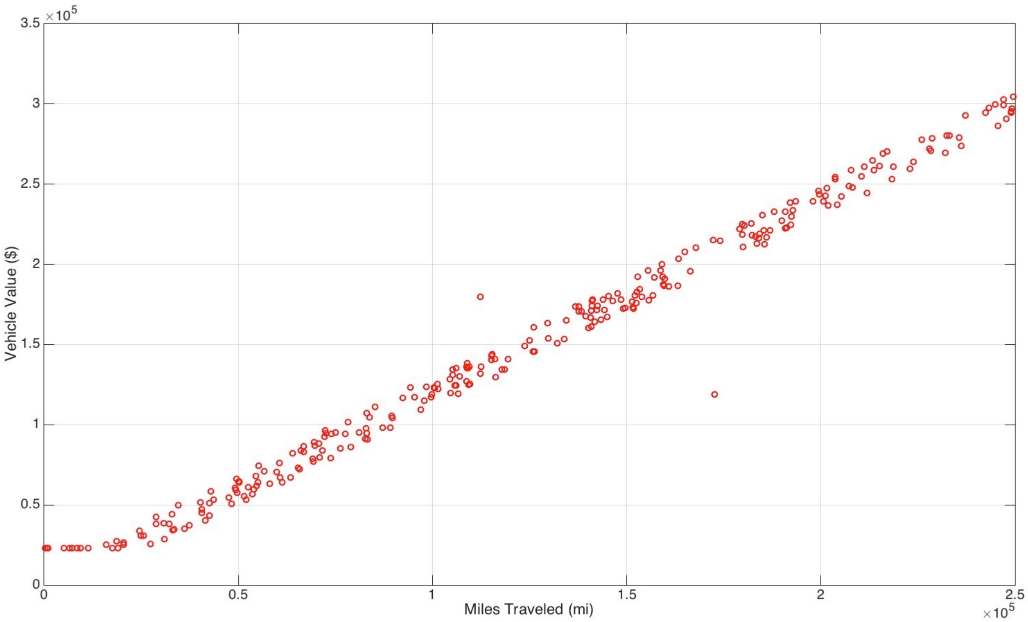
Task 1

Create a Matlab script to read the data (do not use the manual Matlab import procedure here). In your script create variables to store the information in every column individually. In the script you should plot the miles traveled against the vehicle cost. Comment on the trend observed on the plot.

```
% File to import Excel data (construction assets)
% A. Trani

clear

% Sample Excel data file

% Construction Site Vehicle Miles   Value ($)   Status
% Salem Cat 775F    98345   123450  Active
% Galax Cat 775F    112340  179642  Active
% Richmond  Cat 725 172645  118900  Active

% Read the complete Excel file

[num,txt,raw] = xlsread('Construction_assets_Rev-2.xlsx');

% Detect number of rows in the data file

noRows = length(raw);

% Rename variables of the problem

constructionSite    = raw(2:noRows,1);
vehicle              = raw(2:noRows,2);
miles               = num(:,1);
value               = num(:,2);
status              = raw(2:noRows,5);
```

```
% Plot miles traveled vs vehicle value

plot(miles,value,'or')
xlabel('Miles Traveled (mi)')
ylabel('Vehicle Value ($)')
grid
```

Task 2
Modify the script created in Task 1 to find all the vehicles of type Cat725 and then calculate the mean and standard deviation of the miles traveled by that type of vehicle only. Write the results to the Command Window.




```
% Task 2 - Find Cat 725 vehicles and compute mean and standard deviation of
% miles traveled

matchCat725     = strcmp(vehicle,'Cat 725');       % Finds matches for vehicle type (Cat 725)
indicesCat725   = find(matchCat725);               % Finds indices in original array with matches
                                                   % indicesCat725 is a pointer variable
cat725Miles      = miles(indicesCat725);           % Extracts the vector with Cat 725 vehicle miles

% Calculate mean and standard deviation

Cat725MeanMiles = mean(cat725Miles);               % Calculates the mean of Cat 725 vehicle miles
Cat725StdMiles    = std(cat725Miles);              % Finds the standard deviation of Cat 725 miles

% Display results to the Command Window
clc
disp(['Mean of Cat 725 Vehicle Miles  ', num2str(Cat725MeanMiles) , ' miles' ])
disp(['Std. Deviation of Cat 725 Vehicle Miles  ', num2str(Cat725StdMiles) , ' miles'  ])
```

Mean of Cat 725 Vehicle Miles 122160.4353 miles

Std. Deviation of Cat 725 Vehicle Miles 62664.7988 miles

Problem 2 (40 Points)

The following linear programming problem has been developed by a team in your company.

$$\text{Max } Z = 280x_1 + 180x_2$$
subject to:
$$x_2 \leq 1400$$
$$200x_1 + 350x_2 \leq 634000$$
$$x_1 \leq 2200$$

Task 1

Convert the problem shown above into standard form to be solved by hand using the Simplex Method. Write down the transformed equations and add slack and artificial variables as needed.

All constraints are of type $\geq$ therefore add a slack variable for each constraint equation.

$$Z - 280x_1 - 180x_2 = 0$$
subject to:
$$x_2 + x_3 = 1400$$
$$200x_1 + 350x_2 + x_4 = 634000$$
$$x_1 + x_5 = 2200$$

Task 2

Write the first two tables of the Simplex Method for this problem. Indicate the values of all the variables in every table. Indicate the value of the objective function Z in every table.

TABLE 1. INITIAL TABLE. PROBLEM HAS BEEN CONVERTED INTO STANDARD FORM. ADDED THREE SLACK VARIABLES.

Basic Variable	Z	x1	x2	x3	x4	x5	RHS
	1	-280	-180	0	0	0	0
x3	0	0	1	1	0	0	1400
x4	0	200	350	0	1	0	634000
x5	0	1	0	0	0	1	2200

Initial Basic Feasible Solution (IBFS) is: x1 = 0, x2 = 0, x3 = 1400, x4 = 634000 and x5 = 2200.

Value of Z = 0.

Steps:

1) Select Pivot column that containing Non-Basic variable x1. The coefficient of x1 in the Z-row is the most negative and hence improves the solution the most.
2) Take the ratio test. RHS/coefficients in Pivot column.

Basic Variable	Z	x1	x2	x3	x4	x5	RHS	Ratio
	1	-280	-180	0	0	0	0	
x3	0	0	1	1	0	0	1400	N/A
x4	0	200	350	0	1	0	634000	3170
x5	0	1	0	0	0	1	2200	2200

3) Select the lowest ratio. Variable x5 leaves the Basic Variable set and becomes zero in the next table.

4) Variable x1 enters the solution in the next table.

5) Perform row operations to eliminate all coefficients in Pivot Column.

a) Multiply row with variable x5 (3rd constraint equation) by 280and add to Z-row

b) Multiply row with variable x5 (3rd constraint equation) by (-200) and add to third row (second constraint equation)

6 Eliminate all coefficients in the Pivot column except for the unit value in the Pivot row (see Table 2).

TABLE 2. SECOND TABLE OF SIMPLEX METHOD.

Basic Variable	Z	x1	x2	x3	x4	x5	RHS
	1	0.00	-180	0	0	280	616000
x3	0	0	1	1	0	0	1400
x4	0.0	0.00	350.0	0.0	1.0	-200.0	194000.0
x1	0	1	0	0	0	1	2200

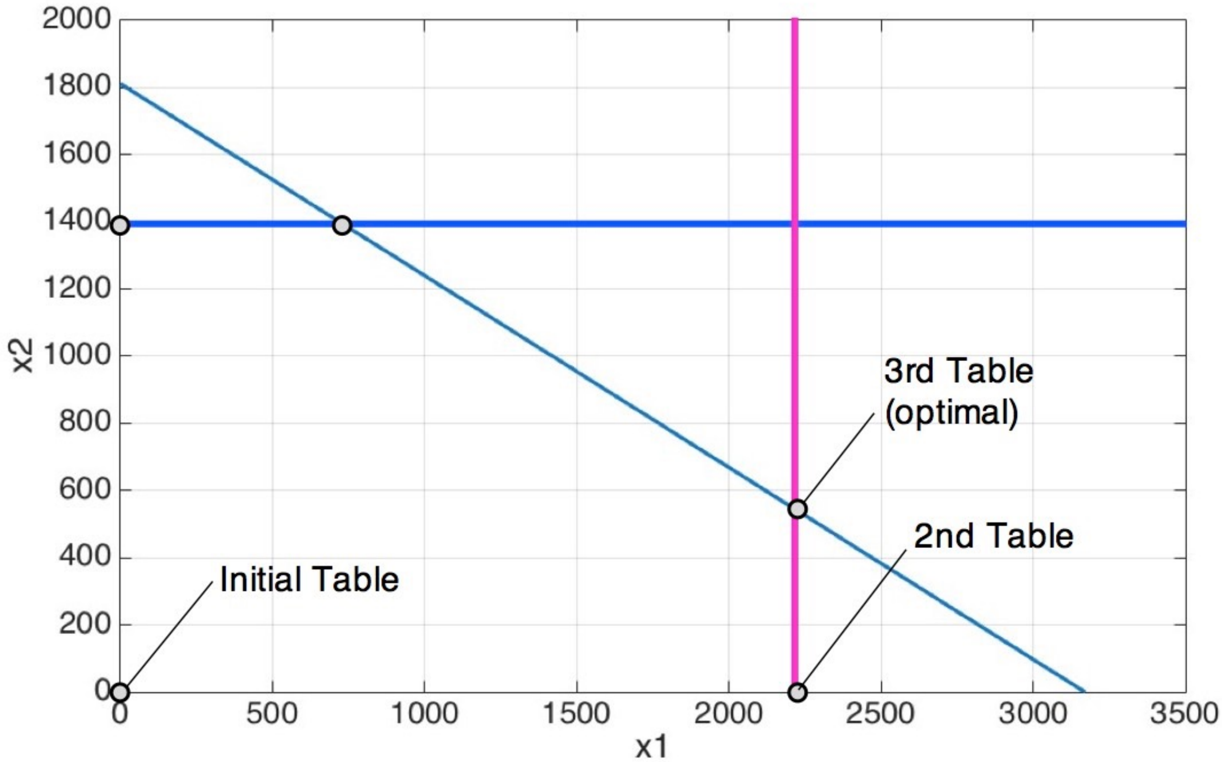
Current Solution (2nd Table) is: x1 = 2200, x2 = 0, x3 = 1400, x4 = 194000 and x5 = 0. Z = 616,000. Solution is not optimal yet.

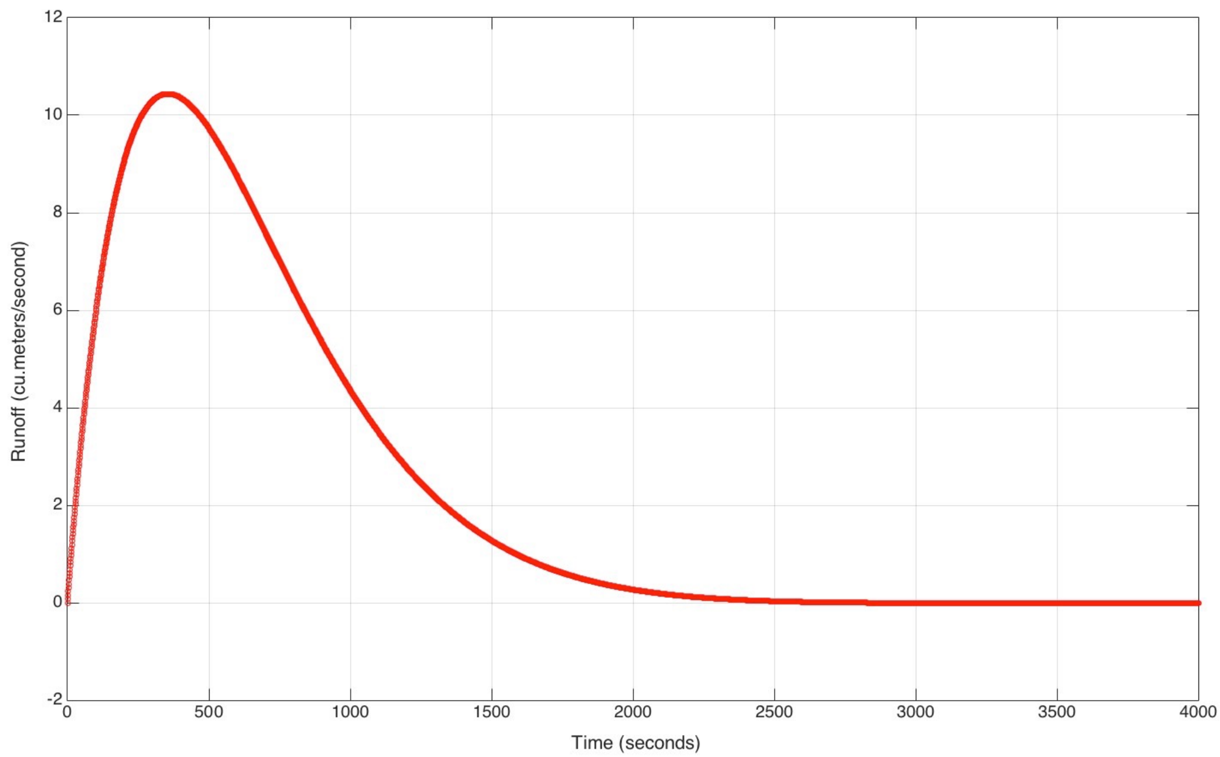
Basic Variable	Z	x1	x2	x3	x4	x5	RHS	Ratio
	1	0.00	-180	0	0	280	616,000	
x3	0	0	1	1	0	0	1,400	N/A
x4	0.0	0.00	350.0	0.0	1.0	-200.0	194,000.0	554.3
x1	0	1	0	0	0	1	2,200	N/A

TABLE 3. THIRD TABLE OF SIMPLEX METHOD. OPTIMAL SOLUTION.

Basic Variable	Z	x1	x2	x3	x4	x5	RHS
	1.00	0.00	0.00	0.00	0.51	177.14	715,771.43
x3	**0.00**	0.00	0.00	1.00	-0.00	0.57	845.71
x2	**0.0**	0.00	1.0	0.0	0.0	-0.6	554.3
x1	**0**	1	0	0	0	1	2200

Current Solution (3rd Table) is: x1 = 2200, x2 = 554.3, x3 = 845.71, x4 = 0 and x5 = 0. Z = 715771.43. Solution is optimal (all coefficients in Z-row are positive or zero).





Problem 3 (30 Points)

A civil engineer is designing a rainstorm water management system for a new Virginia Tech parking lot. During a severe thunderstorm, the water runoff generated by the large parking lot is approximated using the following equation:

$$runoff = k_2 + k_1 \sin(t / k_3) e^{(-t/k_4)}$$

Where *runoff* is the runoff volume (cubic meters per second) generated by the parking lot, *t* is the time (in seconds) after the thunderstorm starts and k_1 through k_4 are parameters to calculate the runoff.

Task 1

Create a Matlab script to calculate the runoff for values of time t ranging from 0 to 4000. The value of the parameters k1 through k4 for a 100 year storm are:

k1 = 56;
k2 = 1.25;
k3 = 900;
k4 = 375;

```
% Script to generate values for runoff calculations
% A. Trani

% Given a vector of time values (t) in seconds
% Given four coefficients k1, k2, k3 and k4

% Calculate runoff (cu. meters/second) using the following equation:
% runoff =k2 * k1*sin(t/k3) .* exp(-t/k4) ;

clear
clc

t=0:1:4000;                          % time vector (seconds)

% Define constants for the problem
k1 = 56;
k2 = 1.25;
k3 = 900;
k4 = 375;

runoff =k2 * k1*sin(t/k3) .* exp(-t/k4) ;   % runoff (cu.meters/second)
```

Task 2

Modify the Matlab script created in Task 1 and make a plot of the runoff as a function of time. Label accordingly. In your plot, make the markers of the plot red and the font size 20 for both axes.

```

plot(t,runoff,'o-r')
xlabel('Time (seconds)')
ylabel('Runoff (cu.feet/second)')
grid
```