Useful MATLAB Commands
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1. Purpose

These brief notes are intended to provide you with some help on MATLAB in order to proceed quickly with the assigned projects.

2. Useful Functions

2.1 Sum and cumulative Sum

sum(A): returns sums along different dimensions of an array.
Cumsum(A): returns the cumulative sum along different dimensions of an array.
Example:

```
A=[1 2 3 4 5]; sum(A)
ans =
   15
cumsum(A)
ans =
     1     3     6    10    15
```

2.2 Basic Random Numbers

rand(m,n): returns an m by n matrix each element of which is a pseudorandom, scalar value drawn from a uniform distribution on the unit interval.
randn(m,n): returns an m by n matrix each element of which is a pseudorandom, scalar value drawn from a normal distribution with mean 0 and standard deviation 1.

The commands rand or randn used alone return a pseudorandom, scalar value drawn from a uniform or normal distribution, respectively.

Initialization of the state of random number generators:

The functions rand and randn use random number generator algorithms. The outcomes of these algorithms depend on the state of the generator. It is possible to initialize the state of the generator to the state *s* using
rand(method,s) or
randn(method,s).

Depending on which random number generator algorithm is being used, method can be either 'state' or 'seed'. 'state' uses the Marsaglia's ziggurat algorithm (the default in MATLAB versions 5 and later) while 'seed' uses the polar algorithm (the default in MATLAB version 4). If method is set to 'state', then s must be a scalar integer value from 0 to 2^32-1. If method is set to 'seed', then *s* must be a scalar integer value from 0 to 2^31-2. To set the generator to its default initial state, set *s* equal to zero.

Note that the rand and randn generators each maintain their own internal state information. Initializing the state of one has no effect on the other.

3. Plotting

3.1 Plotting a single curve in a figure

plot(X,Y,*LineSpec*): plots the Y vector versus the X vector. *LineSpec* is a line specification that determines line type, marker symbol, and color of the plotted lines.
Line Style Specifiers:

Specifier	Line Style	Specifier	Line Style
-	Solid Line (Default)	:	Dotted Line
--	Dashed Line	-.	Dash-dot Line

Marker Specifiers:

Specifier	Marker Type	Specifier	Marker Type
+	Plys Sign	'diamond' or d	Diamond
O	Circle	^	Upward-pointing triangle
*	Asterisk	V	Downward-pointing triangle
.	Point	>	Right-pointing triangle
X	Cross	<	Left-pointing triangle
'square' or s	Square	'pentagram' or p	Pentagram

Color Specifiers:

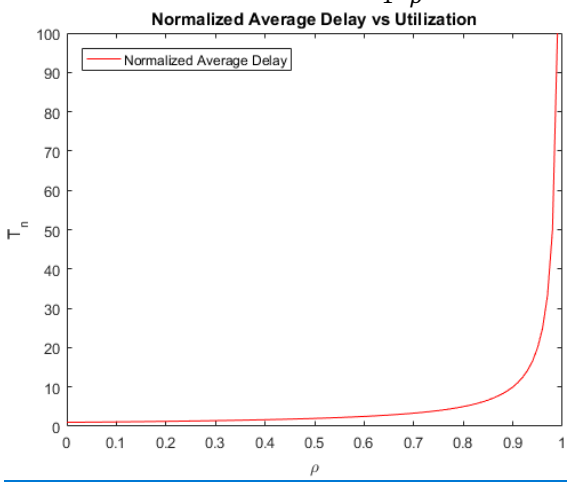
Specifier	Color	Specifier	Color
r	Red	m	Magneta
g	Green	y	Yellow
b	Blue	k	Black
c	Cyan	w	White

Title and Labeling:

title('string'): Outputs the string at the top and in the center of the current axes.
xlabel('string'): Labels the x-axis of the current axes.
ylabel('string'): Labels the y-axis of the current axes.

Example: Plot the normalized average delay versus the utilization factor ρ ($T_n = \frac{1}{1-\rho}$):

```
rho=0:.01:.99;
Tn=1./(1-rho);
plot(rho,Tn,'-r')
xlabel('\rho')
ylabel('T_n')
legend('Normalized Average
Delay','location','northwest')
title('Normalized Average Delay
vs Utilization')
```



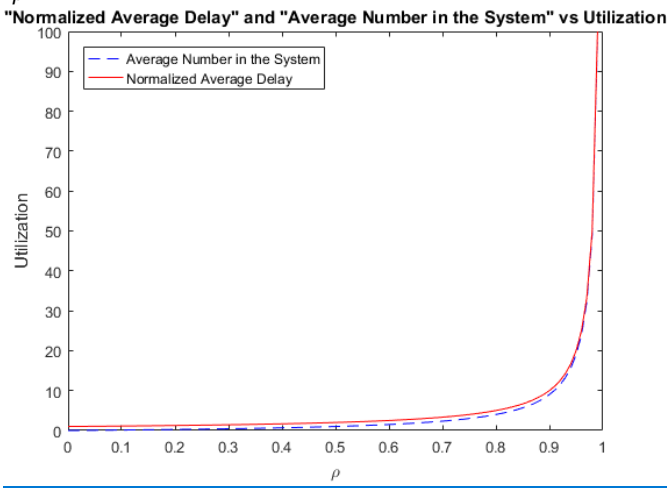
3.2 Plotting multiple curves in a figure

hold: The hold function determines whether new graphics objects are added to the graph or replace objects in the graph.
hold on: retains the current plot and certain axes properties so that subsequent graphing commands add to the existing graph.
hold off: resets axes properties to their defaults before drawing new plots. hold off is the default.
Legends:

legend('string1','string2',...): displays a legend in the current axes using the specified strings to label each set of data.

Example: Plot the normalized average delay versus the utilization factor ρ ($T_n = \frac{1}{1-\rho}$) and the average number of the customers in the system ($N = \frac{\rho}{1-\rho}$) in the same figure and use legends.

```
rho=0:.01:.99;
Tn=1./(1-rho);
N=rho./(1-rho);
plot(rho,N,'--b')
hold  on
plot(rho,Tn,'-r')
xlabel('\rho')
ylabel('Utilization')
legend('Average Number in the
System','Normalized Average
Delay','location','northwest')
title('"Normalized Average
Delay" and "Average Number in
the System" vs Utilization')
```

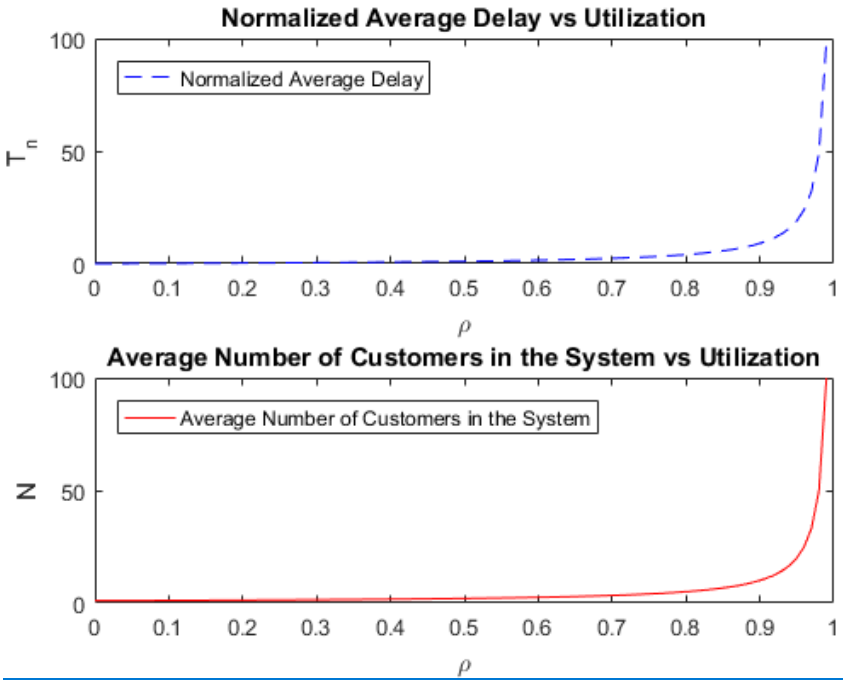


3.3 Plotting multiple graphs in a figure

subplot(m,n,p) or subplot(m,n,p): Breaks the figure window into an m-by-n matrix of small axes, selects the pth axes object for the current plot, and returns the axes handle. The axes are counted along the top row of the figure window, then the second row, etc.

Example: Plot the normalized average delay versus the utilization factor ρ ($T_n = \frac{1}{1-\rho}$) and the average number of the customers in the system ($N = \frac{\rho}{1-\rho}$) in the same figure and in two different graphs where the figure window is broken like a 2 by 1 matrix.

```
rho=0:.01:.99;
Tn=1./(1-rho);
N=rho./(1-rho);
subplot(2,1,1),plot(rho,N,'--b')
xlabel('\rho')
ylabel('T_n')
legend('Normalized Average Delay','location','northwest')
title('Normalized Average Delay vs Utilization')
subplot(2,1,2), plot(rho,Tn,'-r')
xlabel('\rho')
ylabel('N')
legend('Average Number of Customers in the System','location','northwest')
title('Average Number of Customers in the System vs Utilization')
```


Normalized Average Delay vs Utilization
Normalized Average Delay
T_n
100
50
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
ρ
Average Number of Customers in the System vs Utilization
Average Number of Customers in the System
N
100
50
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
ρ