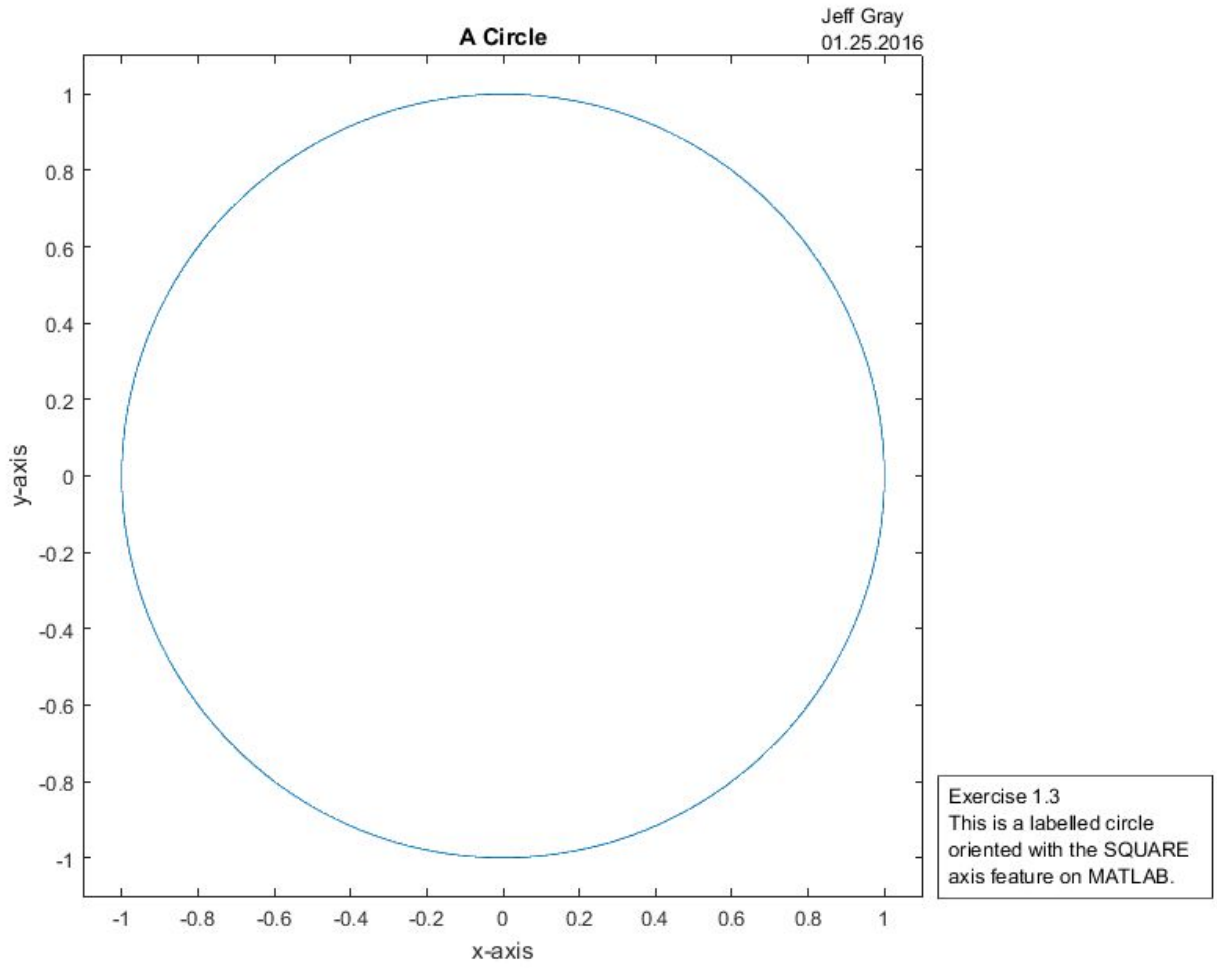
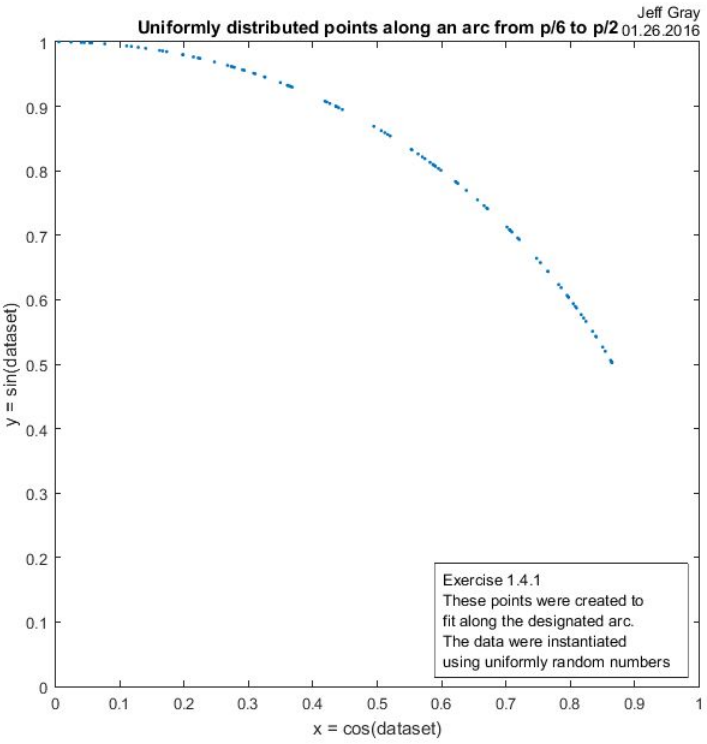
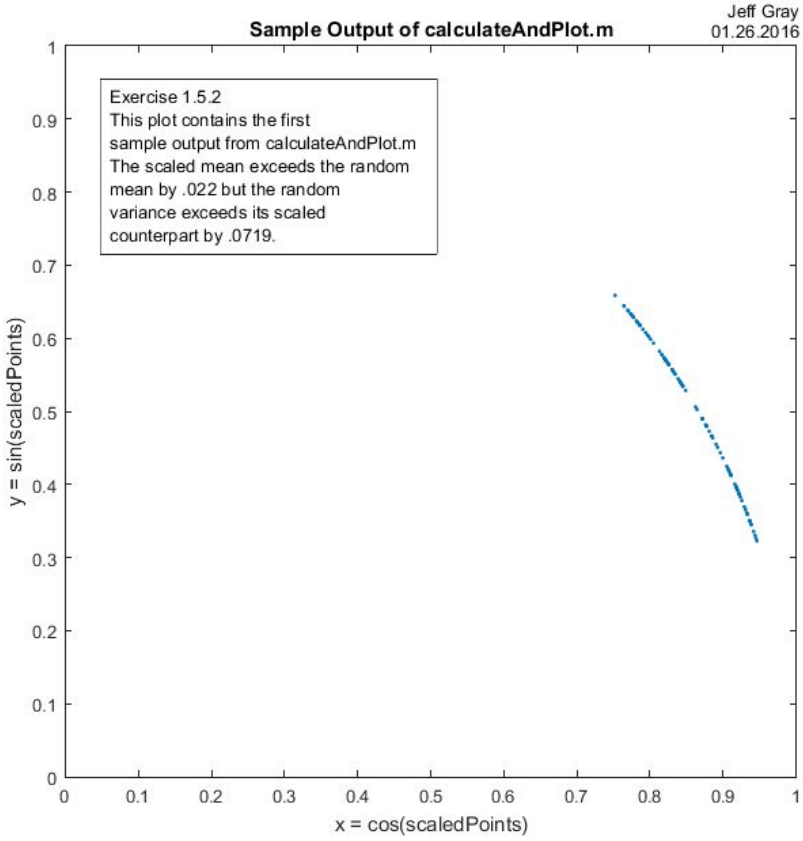
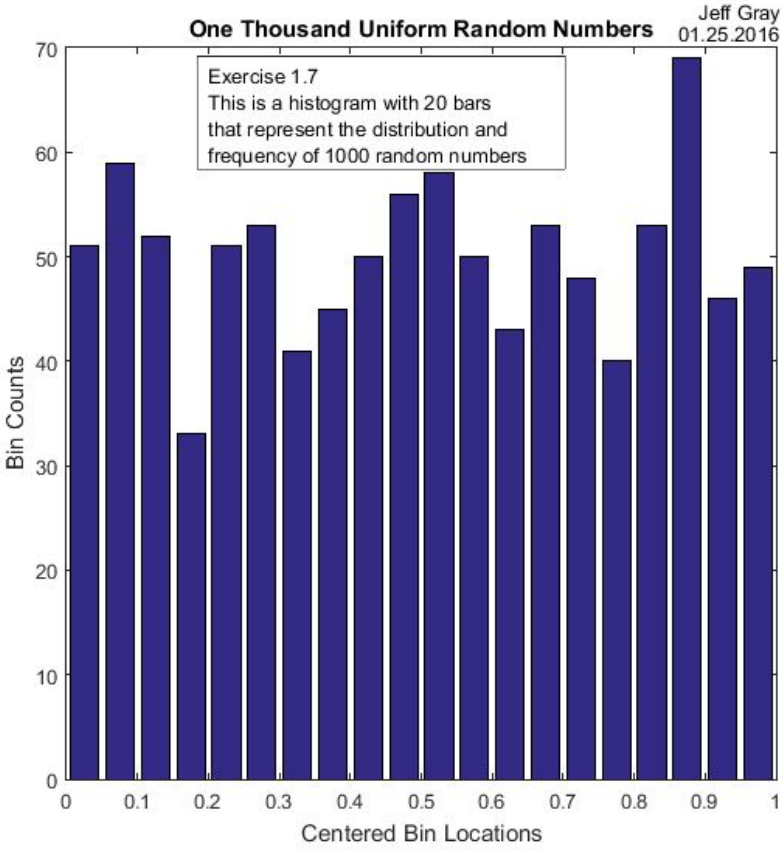
Jeff Gray
01.25.2016
NESC5330
Note: all lab1 figures available at
https://github.com/jeffreygray/nesc5330/tree/master/lab1/figures

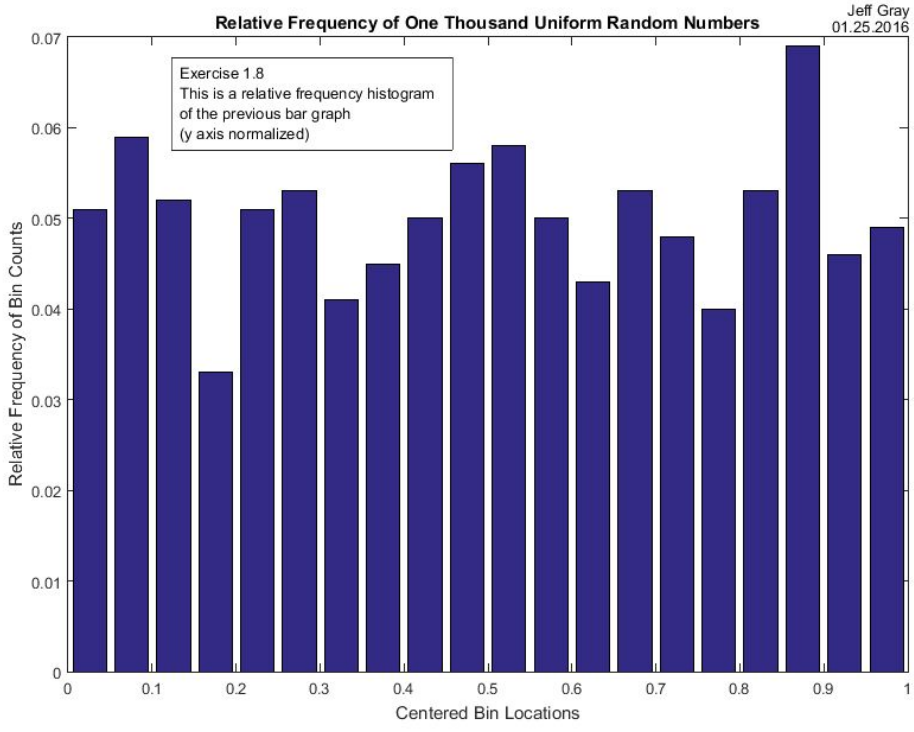
Lab 1 Plots




Jeff Gray
01.26.2016
Uniformly distributed points along an arc from p/6 to p/2
y = sin(dataset)
x = cos(dataset)
Exercise 1.4.1
These points were created to
fit along the designated arc.
The data were instantiated
using uniformly random numbers


Jeff Gray
01.26.2016
Sample Output of calculateAndPlot.m
y = sin(scaledPoints)
x = cos(scaledPoints)
Exercise 1.5.2
This plot contains the first
sample output from calculateAndPlot.m
The scaled mean exceeds the random
mean by .022 but the random
variance exceeds its scaled
counterpart by .0719.


One Thousand Uniform Random Numbers
Jeff Gray
01.25.2016
Exercise 1.7
This is a histogram with 20 bars
that represent the distribution and
frequency of 1000 random numbers
Bin Counts
Centered Bin Locations
0
10
20
30
40
50
60
70
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Relative Frequency of One Thousand Uniform Random Numbers
Jeff Gray
01.25.2016
Exercise 1.8
This is a relative frequency histogram
of the previous bar graph
(y axis normalized)
Relative Frequency of Bin Counts
Centered Bin Locations
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Comparing mean and variance of sample to theoretical population:

```
% set random number generator, clear variables
rng(9711963)
clear

sample = rand(1,1000); % populate vector sample
stats(sample) % call stats program created in this lab
% OUTPUT
% mean: .4913, var: .0865
```

After obtaining these statistics used in the creation of the histograms above in figures 1.7 and 1.8, I calculate the theoretical population mean and variance using the equations provided in the pdf.

On a range from [0,1) with an infinite number of samples,

```
mean  = (a + b) / 2
      = .5
var   = (b - a) ^ 2 / 12
      = .0833
```

Percent error between sample random and theoretical

```
mean  = 1.4%
var   = 3.8415%
```

With a sample size of 1000, the random data generated were fairly close to the theoretical population. If the sample size were to increase, the variance of the sample random data would decrease closer to the population variance and the mean would increase closer to the theoretical average.

Code

Note: all lab1 code available at
https://github.com/jeffreygray/nesc5330/tree/master/lab1

Circle 1.3

create_circle.m

```
%   jeff gray
%   01.24.2016
%   nesc5330
%   lab1
%   file: 'create_circle.m'
%   description: code used to plot

function create_circle()
% remove possibly conflicting data
clf
clear

% create figure
figure1 = figure;

% create axes
axes1 = axes('Parent',figure1);
xlim(axes1,[-1.1 1.1]);
ylim(axes1,[-1.1 1.1]);
box(axes1,'on');
hold(axes1,'on');

% instantiate data for plot
points = [0:2*pi/1000:2*pi];

% create plot
plot(cos(points), sin(points));

% add text
text('Parent',axes1,'String',{'Jeff Gray','01.25.2016'},...
    'Position',[0.70471609403255 1.21139240506329 0]);

% add xlabel
xlabel('x-axis','FontSize',11);

% add ylabel
ylabel('y-axis','FontSize',11);

% add title
title('A Circle','FontSize',11);

% add textbox
```

```
annotation(figure1,'textbox',...
    [0.667985284421925 0.108116067008524 0.0950054262120613 0.118902435935125],...
    'String',{'Exercise 1.3','This is a labelled circle','oriented with the
SQUARE','axis feature on MATLAB.'});

% set axis to square
axis('square')
```

arc problem 1.4.1

arcOne.m

```
%   jeff gray
%   01.24.2016
%   nesc5330
%   lab1
%   file: 'arcOne.m'

%   description: code used to plot

function arcOne
rng(9711973);
% create figure
figure1 = figure;

% set up axes
axes1 = axes('Parent',figure1);
xlim(axes1,[0 1]);
ylim(axes1,[0 1]);
box(axes1,'on');
hold(axes1,'on');

dataset = rand(1,100)*pi/3 + pi/6;


% draw plot
plot(cos(dataset), sin(dataset),'Marker','.','LineStyle','none');
axis('square')
axis([0,1,0,1])

% Create text
text('Parent',axes1,'String','Jeff Gray',...
    'Position',[0.904850746268657 1.04850746268657 0]);

% Create text
text('Parent',axes1,'String','01.26.2016',...
    'Position',[0.878731343283582 1.0205223880597 0]);
```

```
% Create xlabel
xlabel('x = cos(dataset)','FontSize',11);

% Create ylabel
ylabel('y = sin(dataset)','FontSize',11);

% Create title
title('Uniformly distributed points along an arc from p/6 to p/2',...
    'FontSize',11);

% Create textbox
annotation(figure1,'textbox',...
    [0.569096844396084 0.120882804464532 0.229597381947479 0.144596647590263],...
    'String',{'Exercise 1.4.1','These points were created to','fit along the designated
arc.','The data were instantiated','using uniformly random numbers'});
```

arc problem 1.5.2

code required to compute (calculateAndPlot.m)

```
%   jeff gray
%   01.24.2016
%   nesc5330
%   lab1
%   file: 'calculateAndPlot.m'

% function description:
% given a center and arclength in radians,
% create points along arc
% calculate mean and variance of original rand[0,1) and scaled/shifted points
% compare the two sets of statistics

function output = calculateAndPlot (centerX, centerY, arcLength)
    clf
    rng(9711963);

    radius = sqrt((centerX-0).^2 + (centerY-0).^2);  %   distance formula
    arcTheta = arcLength / radius;  %    full arclength in radians
    centerTheta = atan(centerY/centerX); %  radian pointing to arc center

    %finding new points that serve as boundaries
    x_1 = radius * cos(centerTheta - arcTheta/2);
    y_1 = radius * sin(centerTheta - arcTheta/2);
    x_2 = radius * cos(centerTheta + arcTheta/2);
    y_2 = radius * sin(centerTheta + arcTheta/2);

    randNums = rand(1,100);
    scaledPoints = randNums*arcLength + centerTheta - arcTheta/2; % scaling and
shifting random numbers
```

```
    % displaying output for comparison
    randMean = mean(randNums)
    randVar = var(randNums)
    scaledMean = mean(scaledPoints)
    scaledVar = var(scaledPoints)

    % plotting / formatting
    plot(cos(scaledPoints), sin(scaledPoints), '.')
    hold on
    axis ('square')
```

arc problem 1.5.2

code required to plot (controlledArc.m)

```
%   jeff gray
%   01.24.2016
%   nesc5330
%   lab1
%   file: 'controlledArc.m'

%   description: code used to plot

function controlledArc
clf
rng(9711963);
% Create figure
figure1 = figure;

% Create axes
axes1 = axes('Parent',figure1);
xlim(axes1,[0 1]);
ylim(axes1,[0 1]);
box(axes1,'on');
hold(axes1,'on');

centerX = sqrt(3)/2;
centerY = .5;
arcLength = pi/8;

radius = sqrt((centerX-0).^2 + (centerY-0).^2);  %   distance formula
    arcTheta = arcLength / radius;  %    full arclength in radians
    centerTheta = atan(centerY/centerX); %  radian pointing to arc center

    %finding new points that serve as boundaries
    x_1 = radius * cos(centerTheta - arcTheta/2);
    y_1 = radius * sin(centerTheta - arcTheta/2);
    x_2 = radius * cos(centerTheta + arcTheta/2);
```

```
    y_2 = radius * sin(centerTheta + arcTheta/2);

    randNums = rand(1,100);
    scaledPoints = randNums*arcLength + centerTheta - arcTheta/2;

% Create plot
plot(cos(scaledPoints), sin(scaledPoints),'Marker','.','LineStyle','none');

% Create text
text('Parent',axes1,'String','Jeff Gray',...
    'Position',[0.905204460966543 1.05018587360595 0]);

% Create text
text('Parent',axes1,'String','01.26.2016',...
    'Position',[0.882899628252788 1.02230483271375 0]);

% Create xlabel
xlabel({'x = cos(scaledPoints)'},'FontSize',11);

% Create ylabel
ylabel({'y = sin(scaledPoints)'},'FontSize',11);

% Create title
title({'Sample Output of calculateAndPlot.m'},'FontSize',11);

% Create textbox
annotation(figure1,'textbox',...
    [0.252448313384114 0.692375194472734 0.269858534175242 0.195158844861609],...
    'String',{'Exercise 1.5.2','This plot contains the first','sample output from
calculateAndPlot.m','The scaled mean exceeds the random','mean by .022 but the
random','variance exceeds its scaled','counterpart by .0719.'});
```

histogram tutorial p.27

```
%   jeff gray
%   01.24.2016
%   nesc5330
%   lab1
%   file: 'histogramTutorial.m'

%   description: copy of code used to walkthrough tutorial instructions

function histogramTutorial

data = rand(1,1000); %creating random values in 1D vector
[bin_values, bin_position] = hist(data, 20); %calling hist() to populate new variables
bar(bin_values); %create bar graph with bad x-labels
bar(.025: .05: .975, bin_values); %create bar with better x-labels and offset
```

```
total_count = sum(bin_values); %equals 1000!
bar(bin_position, bin_values/total_count); %relative frequency histogram
```

creating labelled histograms p.28

1.7 randHist.m

```
%   jeff gray
%   01.24.2016
%   nesc5330
%   lab1
%   file: 'randHist.m'

%   lab 1 exercise 1.7

function randHist
rng(9711963);
data = rand(1,1000);
[bin_values, bin_position] = hist(data, 20);

% assign figure
figure1 = figure;

% format axes
axes1 = axes('Parent',figure1);
xlim(axes1,[0 1]);
ylim(axes1,[0 70]);
box(axes1,'on');
hold(axes1,'on');

% Create bar
bar(bin_position, bin_values);

% add xlabel
xlabel('Centered Bin Locations','FontSize',11);

% add ylabel
ylabel('Bin Counts','FontSize',11);

% add title
title('One Thousand Uniform Random Numbers','FontSize',11);

% add textbox
annotation(figure1,'textbox',...
    [0.272921762926867 0.790294627383015 0.40169490378792 0.125802811657635],...
    'String',{'Exercise 1.7','This is a histogram with 20 bars','that represent the
distribution and','frequency of 1000 random numbers'},...
    'FitBoxToText','on');
```

creating histograms

1.8 relFreqHist.m

```
%   jeff gray
%   01.24.2016
%   nesc5330
%   lab1
%   file: 'relFreqHist.m'

%   lab 1 exercise 1.8

function relFreqHist
rng(9711963);
data = rand(1,1000);
[bin_values, bin_position] = hist(data, 20);

% assign figure
figure1 = figure;

% format axes
axes1 = axes('Parent',figure1);
xlim(axes1,[0 1]);
ylim(axes1,[0 70]);
box(axes1,'on');
hold(axes1,'on');

% create bar
bar(bin_position, bin_values);

% add xlabel
xlabel('Centered Bin Locations','FontSize',11);

% add ylabel
ylabel('Relative Frequency of Bin Counts','FontSize',11);

% add title
title('Relative Frequency of One Thousand Uniform Random Numbers','FontSize',11);

% add textbox
annotation(figure1,'textbox',...
    [0.272921762926867 0.790294627383015 0.40169490378792 0.125802811657635],...
    'String',{'Exercise 1.8','This is a relative frequency histogram', 'of the previous
bar graph','(y axis normalized)'},...
    'FitBoxToText','on');
```