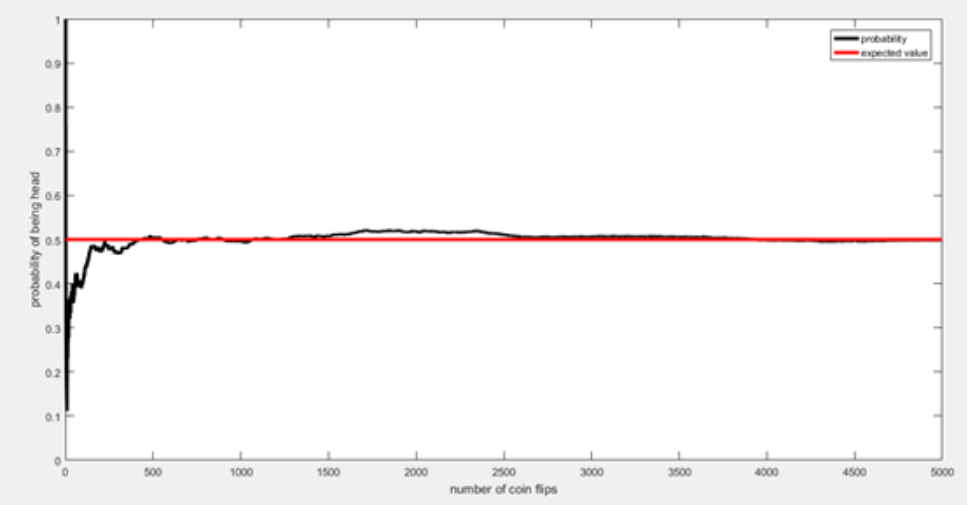
Hands-on Exercise 4

This exercise is designed to give you practice with more advanced and specific Matlab functionality, like advanced data structures, images, and animation. As before, the names of helpful functions are provided in **bold** where needed. Exercise report must be submitted on the website(超星学习通) before the end of the course.

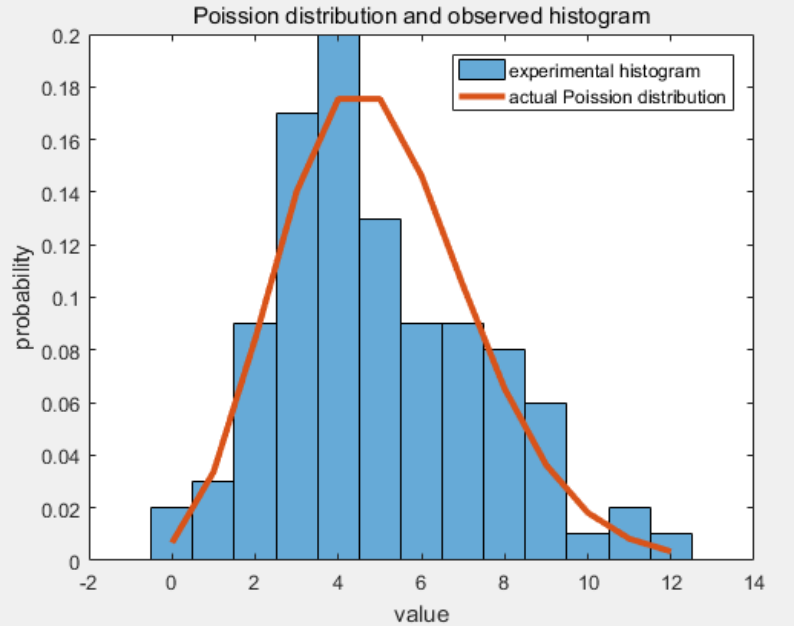
What to turn in: Copy the text from your scripts and paste it into a document(use Matlabo报告模板.docx). If a question asks you to plot or display something to the screen, also include the plot and screen output your code generates. Submit either a *.doc or *.pdf file. **Name it as "学号-姓名-第4次实验报告"**. Keep all your code in scripts/functions. If a specific name is not mentioned in the problem statement, you can choose your own script names.

1. **Random variables.** Make a vector of 500 random numbers from a Normal distribution with mean 2 and standard deviation 5 (**randn**). After you generate the vector, verify that the sample mean and standard deviation of the vector are close to 2 and 5 respectively (**mean**, **std**).

2. **Flipping a coin.** Write a script called `coinTest.m` to simulate sequentially flipping a coin 5000 times. Keep track of every time you get 'heads' and plot the running estimate of the probability of getting 'heads' with this coin. Plot this running estimate along with a horizontal line at the expected value of 0.5, as below. This is most easily done without a loop (useful functions: **rand**, **round**, **cumsum**).



3. **Histogram.** Generate 1000 Poisson distributed random numbers with parameter $\lambda = 5$ (**poissrnd**). Get the histogram of the data and normalize the counts so that the histogram sums to 1 (**histogram**). Plot the normalized histogram. Hold on and also plot the actual Poisson probability mass function with $\lambda = 5$ as a line (**poisspdf**). You can try doing this with more than 1000 samples from the Poisson distribution to get better agreement between the two.



4. **Practice with cells.** Usually, cells are most useful for storing strings, because the length of each string can be unique.
    a. Make a 3x3 cell where the first column contains the names: 'Joe', 'Sarah', and 'Pat', the second column contains their last names: 'Smith', 'Brown', 'Jackson', and the third column contains their salaries: $30,000, $150,000, and $120,000. Display the cell using **disp**.
    b. Sarah gets married and decides to change her last name to 'Meyers'. Make this change in the cell you made in a. Display the cell using **disp**.
    c. Pat gets promoted and gets a raise of $50,000. Change his salary by adding this amount to his current salary. Display the cell using **disp**.

    The output to parts a-c should look like this:

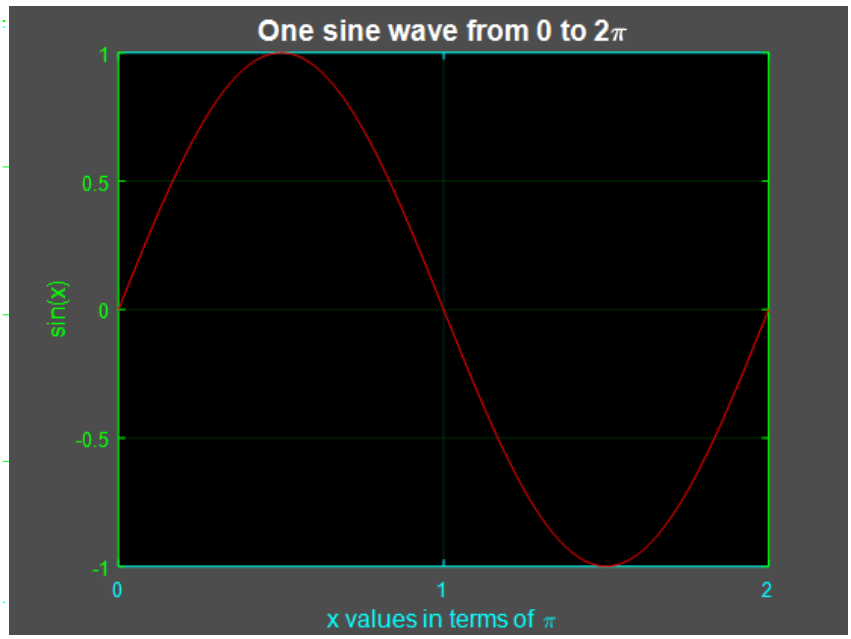
```
>> cellProblem
    'Joe'       'Smith'       [ 30000]
    'Sarah'     'Brown'       [150000]
    'Pat'       'Jackson'     [120000]

    'Joe'       'Smith'       [ 30000]
    'Sarah'     'Meyers'      [150000]
    'Pat'       'Jackson'     [120000]

    'Joe'       'Smith'       [ 30000]
    'Sarah'     'Meyers'      [150000]
    'Pat'       'Jackson'     [170000]
```

5. **Using Structs**. Structs are useful in many situations when dealing with diverse data. For example, get the contents of your current directory by typing `a=dir;`
    a. `a` is a struct array. What is its size? What are the names of the fields in `a`?
    b. Write a loop to go through all the elements of a, and if the element is not a directory, display the following sentence 'File *filename* contains X bytes', where *filename* is the name of the file and X is the number of bytes.
    c. Write a function called `displayDir.m`, which will display the sizes of the files in the current directory when run, as below. Your output may have different filenames.

```
>> displayDir
File brown2D.m contains 417 bytes.
File coinTest.m contains 524 bytes.
File displayDir.m contains 304 bytes.
File plotPoisson.m contains 543 bytes.
File someData.txt contains 66 bytes.
```

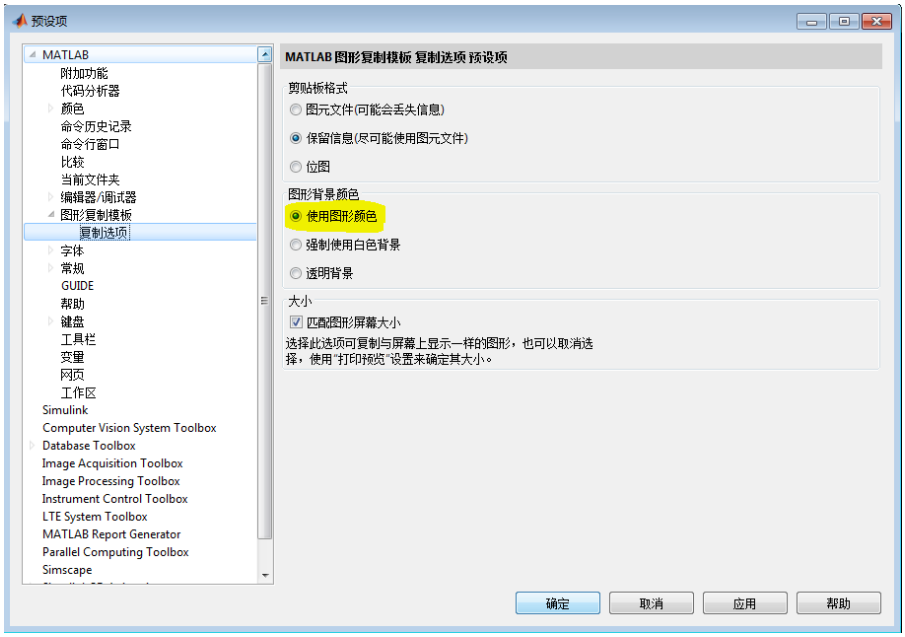
Optional Homework Assignments

6. **Handles.** We'll use handles to set various properties of a figure in order to make it look like this:



a. Do all the following in a script named `handlesPractice.m`
b. First, make a variable `x` that goes from 0 to 2π, and then make `y=sin(x)`.
c. Make a new `figure` and do `plot(x,y,'r')`
d. Set the x limit to go from 0 to 2π (**xlim**)
e. Set the `xtick` property of the axis to be just the values `[0 pi 2*pi]`, and set `xticklabel` to be `{'0','1','2'}`. Use **set** and **gca**
f. Set the `ytick` property of the axis to be just the values `-1:.5:1`. Use **set** and **gca**
g. Turn on the grid by doing `grid on`.
h. Set the `ycolor` property of the axis to green, the `xcolor` property to cyan, and the `color` property to black (use **set** and **gca**)
i. Set the `color` property of the figure to a dark gray (I used [.3 .3 .3]). Use **set** and **gcf**
j. Add a title that says 'One sine wave from 0 to 2π' with `fontsize` 14, `fontweight` bold, and `color` white. Hint: to get the π to display properly, use \pi in your string. Matlab uses a Tex or Latex interpreter in xlabel, ylabel, and title. You can do all this just by using **title**, no need for handles.
k. Add the appropriate x and y labels (make sure the π shows up that way in the x label) using a `fontsize` of 12 and `color` cyan for x and green for y. Use **xlabel** and **ylabel**

l. Before you copy the figure to paste it into word, look at copy options (in the figure's Edit menu) and under 'figure background color' select 'use figure color'.



7. **Image processing**. Write a function to display a color image, as well as its red, green, and blue layers separately. The function declaration should be `im=displayRGB(filename)`. `filename` should be the name of the image . `im` should be the final image returned as a matrix. To test the function, you should put an image file into the same directory as the function and run it with the filename (include the extension, for example `im=displayRGB('testImage.jpg')`). You can use any picture you like, from your files or off the internet. Useful functions: **imread**, **meshgrid**, **interp2**, **uint8**, **image**, **axis equal**, **axis tight**.
    a. To make the program work efficiently with all image sizes, first interpolate each color layer of the original image so that the larger dimension ends up with 800 pixels. The smaller dimension should be appropriately scaled so that the length:width ratio stays the same. Use **interp2** with cubic interpolation to resample the image. **Hint:** The image is an MxNx3 matrix; you need to interpolate each of the 3 color layers separately. **Note:** If you have difficulty doing this section, try part (b) first. (But if you get part (b) working, try to do this and use the interpolated image for part (b).)
    b. Create a composite image that is 2 times as tall as the original, and 2 times as wide. Place the original image in the top left, the red layer in the top right, the green layer in the bottom left, and the blue layer in the bottom right parts of this composite image. The function should return the composite image matrix in case you want to save it as a jpg again (before displaying or returning, convert the values to unsigned 8-bit integers using **uint8**). **Hint:** To get just a single color layer, all you have to do is set the other two layers to zero. For example if `X` is an MxNx3 image, then `X(:,:,2)=0; X(:,:,3)=0;` will retain just the red layer. Include your code and the final image in your homework writeup. It should look something like this: