

# CS1112 Fall 2014 Project 1 due Thursday 9/4 at 11pm

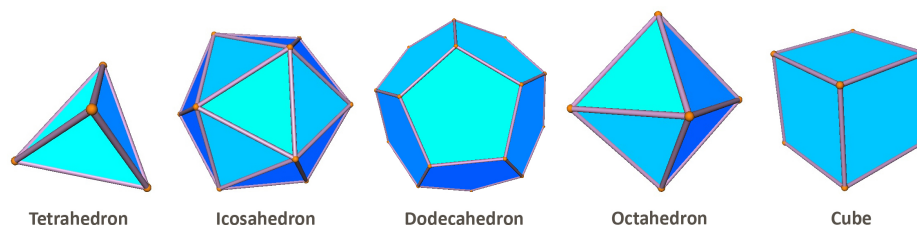
You must work either on your own or with one partner. If you work with a partner you must first register as a group in CMS and then submit your work as a group. *Adhere to the Code of Academic Integrity.* For a group, “you” below refers to “your group.” You may discuss background issues and general strategies with others and seek help from the course staff, but the work that you submit must be your own. In particular, you may discuss general ideas with others but you may not work out the detailed solutions with others. It is not OK for you to see or hear another student’s code and it is certainly not OK to copy code from another person or from published/Internet sources. If you feel that you cannot complete the assignment on your own, seek help from the course staff.

## Objectives

Completing this project will help you learn about MATLAB scripts, assignment statements, if-else statements, and some MATLAB built-in functions. You will also start to explore MATLAB graphics.

## 1 Kepler’s Model of Planetary Orbits

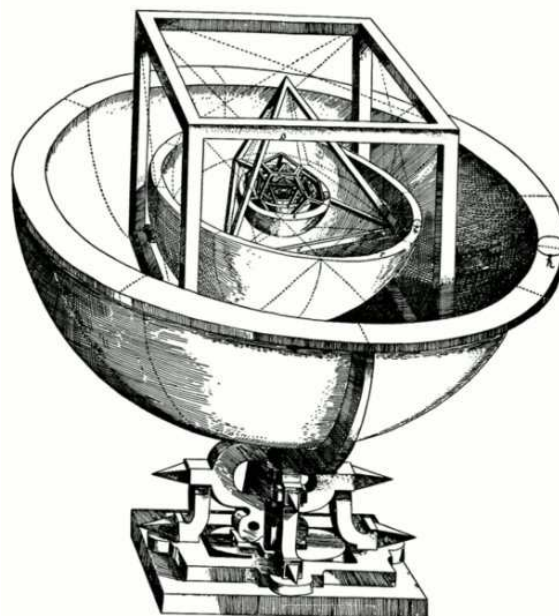
In the 16th century, Johannes Kepler tried to explain the orbits of the then six known planets by nesting the five Platonic solids:



By nesting alternately a sphere and a platonic solid in a particular order, Kepler obtained sphere sizes that were proportional to the sizes of the orbits of Mercury, Venus, Earth, Mars, Jupiter, and Saturn. The nesting order of the platonic solids, from outside to inside, is the cube, tetrahedron, dodecahedron, icosahedron, and octahedron. See Kepler’s model below. Since the nesting begins with a sphere and ends with a sphere, there are *six* spheres with the five platonic solids in between.

Write a script that calculates and prints the radii and circumferences of the six spheres in Kepler’s model, assuming that the outermost sphere is a unit sphere (i.e., radius one), the spheres have zero thickness, and the nesting is tight. Read Problem **P1.1.5** in *Insight Through Computing* to learn how to use the relevant formulas (but do not solve P1.1.5).

Be sure to do the calculations based on Kepler’s order for nesting the platonic solids—cube, tetrahedron, dodecahedron, icosahedron, and octahedron—not the nesting order in P1.1.5. Print the radii and circumferences neatly in a “table format,” i.e., the values should line up in columns and be printed through the 15th decimal place. To do this use `fprintf` with the appropriate format sequence. See, for example, scripts `Eg1_2` and `Eg1_1`. Save your script file as `kepModel.m` and submit it on CMS.



## 2 Almost Square

Download the file `almostSqr.m` and run it. A graphics window showing two points connected by two lines will pop up. The message near the top (the title area) says to click in the window. After you click, a black asterisk marks the clicked point and its coordinates are given in the title area.

Read the program to make sure that you understand what it does. Don't worry about the early commands to set up the figure window, but here's how the `plot` statement works: `plot(x,y,'bo')` draws a marker at the point  $(x,y)$  with the format "blue circle"; `plot([x1 x2],[y1 y2]','k:')` draws a line from the point  $(x_1,y_1)$  to  $(x_2,y_2)$  with the format "black dotted line." Other formats are explained in the program comments. The statement `[xu,yu]=ginput(1)` accepts one mouse click by the user and stores the  $x$ - and  $y$ -coordinates of the click in the variables `xu` and `yu`, respectively. A statement `title('hello there')` would display the text 'hello there' as the title of a figure. The `sprintf` statement works just like `fprintf` in formatting text, but instead of printing directly to the Command Window, `sprintf` allows the text to be saved under a variable name. Then this text (string) variable can be used in other statements, such as the `title` statement as shown in the program.

Now modify the program as specified below. After each modification, save and run your program before moving on to the next modification. This way you *debug*—check for and get rid of errors—along the way.

1. Change Point 1 (see the comments in the script) so that it gets the coordinates of a user-clicked point.
2. Change the fixed location of Point 2 to randomly generated coordinates within the interval  $(1,9)$  for both  $x$  and  $y$ . *Hint:* The statement `v = rand` assigns to variable `v` a random number in the range of 0 to 1. So how do you get a random number within a different range? First, the statement `v = rand` gets you a real number in the range of 0 to 1. Next, scale (think multiply) and shift (think add) the value `v` as necessary to get the range you need.
3. Remove the provided code that solicits and plots Point 3. The code that prints the coordinates of Point 3 should be removed as well, but you can use it as an example for completing the next task.
4. Treat Points 1 and 2 as the opposing corners of a rectangle with sides parallel to the axes. Let  $L$  and  $S$  be the length of the long and short sides of the rectangle, respectively. Add code to possibly make the rectangle more square before plotting it:
  - If  $L/S$  is less than 1.2, draw the rectangle as is. The original code plots two sides of the rectangle; you need to plot two more lines to complete the rectangle. Use any color/format that you like for the given and newly plotted lines. Keep the markers for Points 1 and 2. Display  $L/S$  to two decimal places in the title area of the plot.
  - If  $L/S$  is in the range of 1.2 to 2, inclusive, perform one averaging step as shown in Lecture 1. I.e., let the new width of the rectangle be  $w_{\text{new}} = (w + h)/2$  where  $w$  and  $h$  are the width and height, and then the new height is  $A/w_{\text{new}}$  where  $A$  is the area of the original rectangle. Draw this new rectangle instead of the original one centered in the figure window, at  $(5,5)$ . Display the *original* ratio  $L/S$  and the average value between the height and width of the *new* rectangle in the title area.
  - If  $L/S$  is greater than 2, perform two averaging steps and draw the final rectangle centered in the figure window. Display the *original* ratio  $L/S$  and the average value between the height and width of the *final* rectangle in the title area.

You may find the built-in functions `max` and `min` handy. E.g., the statement `v= max(pi,4)` assigns to variable `v` the value 4.

Sanity check: your final figure window should show a rectangle, two markers that may or may not be the opposing vertices of the plotted rectangle, and a message in the title area.

Submit your modified file `almostSqr.m` on CMS.