

CS1112 Spring 2011 Project 1 due Thursday 2/3 at 11pm

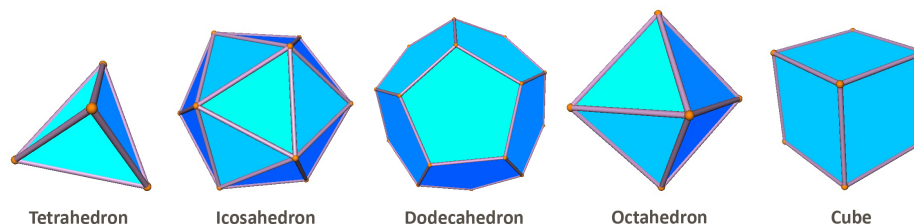
You must work either on your own or with one partner. If you work with a partner you must first register as a group in CMS and then submit your work as a group. *Adhere to the Code of Academic Integrity.* For a group, “you” below refers to “your group.” You may discuss background issues and general strategies 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 Which Platonic Solid is Most Spherical? Surprise, surprise ...

A solid is a *Platonic solid* if each face is identical in size and shape. There are only five:



The number of faces for the solids range from four—the tetrahedron—to twenty—the icosahedron. Exercise **P1.1.5** in *Insight* (page 13) gives more details on Platonic solids.

First let’s consider the two-dimensional case. Suppose I ask which regular polygon is more circular, the square or the hexagon? Likely you would say the hexagon, and you can draw a circle with an inscribed square and an inscribed hexagon showing that the hexagon’s area is bigger than that of the square (and therefore is closer to the circle and therefore is “more circular”).

Going to three dimensions, we can answer the question “which Platonic solid is most spherical?” by comparing the volume of inscribed Platonic solids. Using some of the formulae from Exercise **P1.1.5** in *Insight*, write a script `pSolids.m` to print a table showing the volumes of the five Platonic solids when *inscribed* in a unit sphere (a sphere with radius one). To print a “table” simply use `fprintf` with an appropriate format sequence so that the values line up neatly. In your script, write the following comment and fill in the blank based on your observation:

```
% Comparing the inscribed Platonic solids, I think the _____ is most spherical!
```

Does the result match your intuition? Let’s try another criterion for comparison. Add more code to `pSolids.m` to calculate and print the volumes of the Platonic solids that *circumscribe* a unit sphere. You can print a separate table or organize your code to print just one table. Write the following comment and fill in the blank based on your observation:

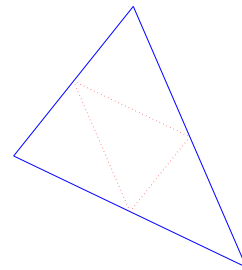
```
% Comparing the circumscribed Platonic solids, I think the _____ is most spherical!
```

I hope you have fun thinking about these observations!

Errata: In the example below the table of formulae in *Insight* p.13, the divisor for calculating `Vol20` should be 12, not 4, i.e., `Vol20 = ((15 + 5*sqrt(5))/12)*E^3`; Later please look at the *Insight* page on the course website to see the erratum list for the rest of the book.

2 Triangles

Given a triangle, one can partition it into two triangles of equal area by connecting one vertex to the midpoint of the opposite side. A partition into four triangles of equal area can be made by connect the midpoints of the three sides. You will modify a given script to draw a triangle and possibly partition it based on its area.



Download the file `triangles.m` and run it. A graphics window showing two points connected by one line 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 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,'ko')` draws a marker at the point (x,y) with the format "black circle"; `plot([x3 x2],[y3 y2],'b:')` draws a line from the point $(x3,y3)$ to $(x2,y2)$ with the format "blue dotted line." Other formats are explained in the program comments. The statement `[x3,y3]=ginput(1)` accepts one mouse click by the user and stores the x - and y -coordinates of the click in the variables `x3` and `y3`, 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:

1. Change the fixed locations of the second point (see the comments in the code) to randomly generated coordinates within the interval $(1,9)$ for both x and y . *Hint:* The statement `v = rand(1)` assigns to variable `v` a random number in the range of 0 to 1. Note that the 1 in the parentheses indicates that *one number* is to be generated—it has nothing to do with the range, which is always 0 to 1. So how do you get a random number within a different range? First, the statement `v = rand(1)` 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.
2. After accepting and drawing the user's mouse click, connect the three points (x_1, y_1) , (x_2, y_2) , and (x_3, y_3) with solid lines to draw a triangle. Use one color of your choice for all three lines of the triangle. Remove the markers at the vertices.
3. Compute the area of the triangle. (Forgot the distance and area formulae? See Appendix B in *Insight*, p.413.)
4. To partition or not to partition ... Based on the area of the triangle, the program should perform one of these three actions:
 - (a) If the area is strictly less than 5 units squared, display the message "Triangle is small!" in the title area of the graphic.
 - (b) If the area is strictly greater than 15, partition into four triangles of equal area by connecting the midpoints of the original triangle. Use dotted lines in a color of your choice. Note that the midpoint on a line with endpoints (x_1, y_1) and (x_2, y_2) is

$$\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2} \right).$$

- (c) Otherwise partition into two triangles of equal area. Draw one solid line in a color of your choice between a vertex and the midpoint of the opposite side. You can choose which vertex to use.

Submit your files `pSolids.m` and `triangles.m` in CMS.