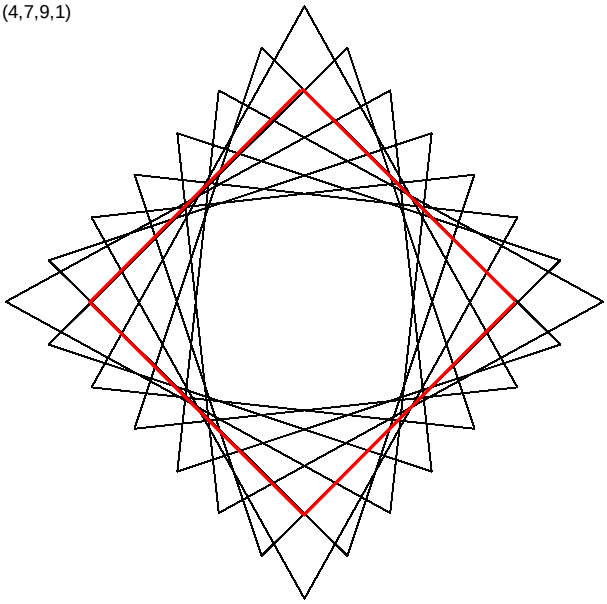
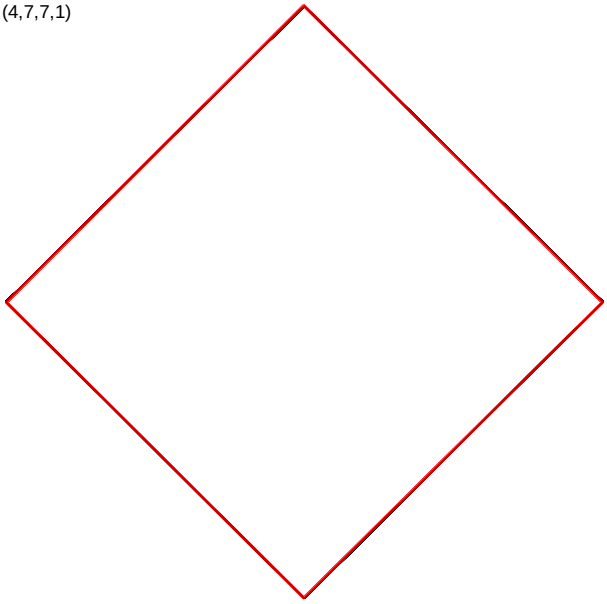
Calculating Areas of Squares in Modified Brunes Stars

Modified Brunes Stars occur if ***n*** = 4, ***J*** = 1 and 2 < ***S*** < ***P*** < 2***S*** with SCF = 1. The left image is an example.

(4,7,9,1)



(4,7,7,1)



The four corners of each image at vertices 0, 1, 2, and 3 are (0, 1), (1, 0), (0, -1) and (-1, 0).

1. Compare the areas of the two squares highlighted above.

a. Is the square on the left more or less than half the size of the one on the right?

b. Provide exact area calculations of each square in square units based on the coordinates above.

(Hint: This can be done without resorting to square roots.)

2. Consider the first line in the figure at left above, from vertex 0 to the second subdivision on the second segment of the vertex frame (since ***P*** = 9 = 7+2 = ***S***+2). There are two lines perpendicular to this line, one of which starts at the third vertex and ends at subdivision 2 on the first line of the vertex frame. This intersection appears below and to the right of the top red right angle in the left image.

a. Find equations for the two lines [it may help to use point-slope form of the line $y-y_0 = m(x-x_0)$].

b. Find the intersection point in (x, y) form using these equations.

c. Find the distance from this point to the center of the image using the *Pythagorean Theorem* [which is easy to do in this case since one of the points is (0, 0): $d = (x^2 + y^2)^{0.5}$].

d. Is the square you just found one vertex of larger or smaller than the one in red?

3. The largest internal square from Modified Brunes stars where ***S*** is odd occurs when ***P*** = ***S***+2 and the vertices of the internal square are on the axes (the image at left is an example given ***S*** = 7).

a. What is the smallest value of ***S*** that produces an internal square that is at least ¾ of the size of the square on the right above?

b. What is the smallest value of ***S*** that produces an internal square that is at least 90% of the size of the square on the right above?

HINT: This is easiest to do by modelling your answer in Excel. Think through the steps on paper, but then let Excel do the work for you.