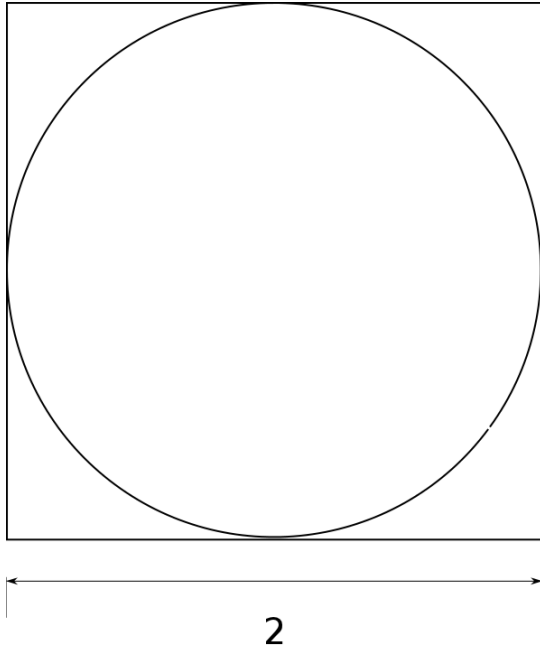


Name: _____ Date: _____

A Chance at Monte Carlo Activity — Monte Carlo Simulation Worksheet

Inscribed Circle

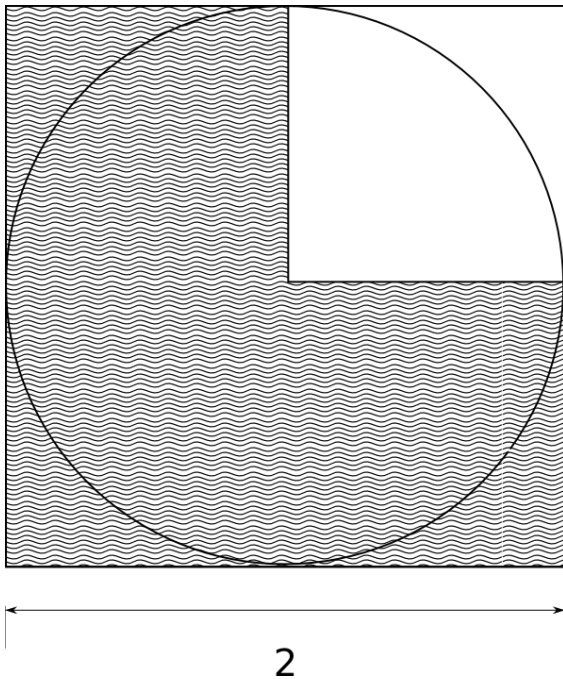


Area of the square: _____

Area of the circle: _____
(hint: find radius first)

Ratio of areas (circle to square): _____

Single Quadrant



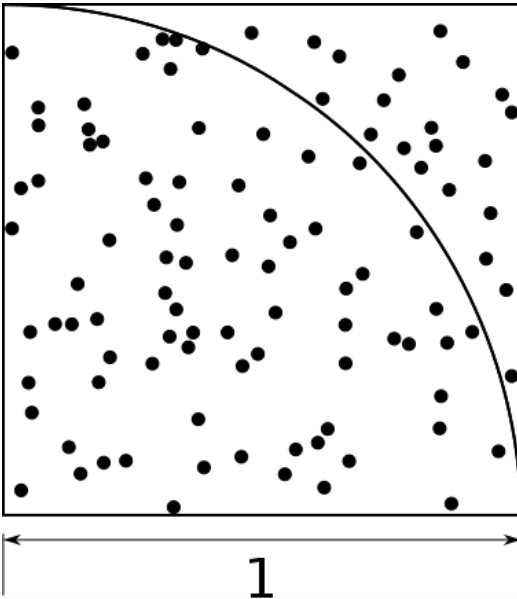
Both the area of the square and the area of the circle are divided by four.

What is the area of the un-shaded square?

What is the area of the quarter circle wedge?

Is the ratio the same as before? (YES or NO)

Estimating the Area



Find the number of points inside the wedge versus the total number of points (100).

Hint: it may help to count the points outside; for example: $N_{in} = 100 - N_{out}$

$$\text{If } \frac{N_{in}}{100} \approx \frac{\pi}{4}, \text{ then } \pi \approx \frac{4N_{in}}{100}$$

What is your estimate of π ? _____

Collecting Data

1. Use the **EV3** program to collect five estimates of pi from 100 simulated points:

_____, _____, _____, _____, _____

2. What is the average estimate \bar{x} : _____

3. Below are two ways to evaluate the quality of the estimate. Since we already have a “gold standard” for pi, we can compute the **percent error**:

$$100 \times \frac{|3.14159 - \bar{x}|}{3.14159}$$

The **standard error** is a better measure of quality when we do not have a gold standard (when we estimate an unknown quantity). The standard error measures how widely the different estimates differ from the average.

$$SE = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n(n-1)}} = \sqrt{\frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \dots + (x_5 - \bar{x})^2}{n(n-1)}}$$

What is the percent error? _____

What is the standard error? _____

4. Reset the **EV3** program to use 500 simulations.

_____, _____, _____, _____, _____

The average estimate is: _____

The percent error is: _____

The standard error is: _____

5. Repeat the experiment for 1000 and 4000 simulations.

1000 points	4000 points
The average estimate is: _____	The average estimate is: _____
The percent error is: _____	The percent error is: _____
The standard error is: _____	The standard error is: _____

Extra Credit

1. Plot the estimation errors versus simulated points.

