1. **A Chance at Monte Carlo Activity —   
   Monte Carlo Simulation Worksheet**
2. **Inscribed Circle**

|  |  |
| --- | --- |
|  | Area of the square: \_\_\_\_\_\_\_\_\_\_\_\_\_\_  Area of the circle: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (hint: find radius first)  Ratio of areas (circle to square): \_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. **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) |

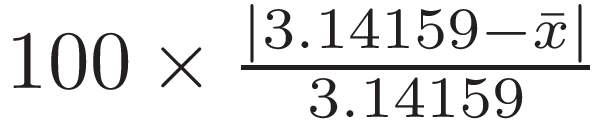
1. **Estimating the Area**

|  |  |
| --- | --- |
|  | 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: Nin = 100 - Nout*  *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*  If , then  What is your estimate of π? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

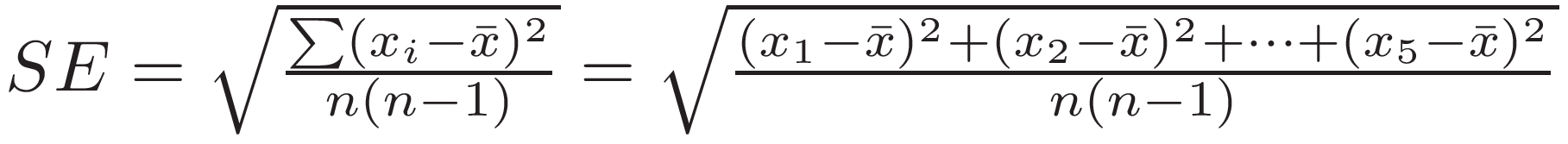
1. **Collecting Data**
2. Use the EV3 program to collect five estimates of pi from 100 simulated points:

\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_

1. What is the average estimate : \_\_\_\_\_\_\_\_\_\_
2. 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:**



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.



What is the percent error? \_\_\_\_\_\_\_\_\_\_ What is the standard error? \_\_\_\_\_\_\_\_\_\_

1. Reset the EV3 program to use 500 simulations.

\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_

The average estimate is: \_\_\_\_\_\_\_\_\_\_

The percent error is: \_\_\_\_\_\_\_\_\_\_ The standard error is: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Repeat the experiment for 1000 and 4000 simulations.

|  |  |
| --- | --- |
| 1000 points | 4000 points |
| The average estimate is: \_\_\_\_\_\_\_\_\_\_  The percent error is: \_\_\_\_\_\_\_\_\_\_  The standard error is: \_\_\_\_\_\_\_\_\_\_ | The average estimate is: \_\_\_\_\_\_\_\_\_\_  The percent error is: \_\_\_\_\_\_\_\_\_\_  The standard error is: \_\_\_\_\_\_\_\_\_\_ |

1. **Extra Credit**
2. Plot the estimation errors versus simulated points.

