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After reading the project instructions, I knew that I would have to use vectors to calculate the number of bounces, so I started off with making four methods that involved vectors. These methods were: addVect, subtractVect, scalarMultiple, and dotProduct. The function of each of these methods is fairly self-explanatory. After this, I made four more methods dealing with the reflection and intersection of the ball on the circles. Reflect took in three parameters and calculate the reflection as detailed in the instructional document. Intersect took in four parameters and found the time of intersection as detailed in the instructional document. The next two methods took a bit of intuition to code. The method isIntercept will see if an intercept occurred and if none did it returns false. The final method before the main method determines what circle each intercept occurred at. The final method in the Pinball.java file is the main method, which contains a for loop to iterate through all the trials. The loop put each circle at the given coordinates in the instructional file and used the other methods in other files to sort the number of bounces and angles into a list.

The Circle.java file creates a circle with a given radius and an array of coordinates. The Score.java file holds all the data in the trials and the List.java file takes the top 10 hits and sorts them into a list to be easily read by the user.

Question 1

Each method is 1,000,000 trials

Random Method -

Amount of Bounces	Number of Bounces	Relative Frequency
0	719,979	72%
1	224,175	22.4%
2	45,523	4.55%
3	8,396	.84%
4	1,579	.00158%
5	282	.000282%
6	52	.000052%
7	13	.000013%
8	1	.000001%
9	0	0%
10	0	0%

Systematic Method -

Amount of Bounces	Number of Bounces	Relative Frequency
0	720,355	72%
1	223,813	22.3%
2	45,566	4.56%
3	8,388	.00839%
4	1,534	.001534%
5	282	.000282%
6	52	.000052%
7	8	.000008%
8	0	0%
9	2	.000002%
10	0	0%

The systematic method came up with the greater amount of bounces with 9, while the random method came up with 8. However, since the random method is random, it could have yielded a higher amount of bounces.

Random Top 10 –

(3.5702951993370076 radians, 8 bounces, Circle 2, Circle 3, Circle 2, Circle 1, Circle 2, Circle 1, Circle 2, Circle 3)

(5.662948598421166 radians, 7 bounces, Circle 1, Circle 2, Circle 1, Circle 2, Circle 1, Circle 2, Circle 3)

(3.760231274224797 radians, 7 bounces, Circle 2, Circle 1, Circle 2, Circle 3, Circle 1, Circle 3, Circle 1)

(1.4743308951146807 radians, 7 bounces, Circle 3, Circle 1, Circle 3, Circle 1, Circle 2, Circle 1, Circle 3)

(3.586000314930564 radians, 7 bounces, Circle 2, Circle 3, Circle 1, Circle 3, Circle 2, Circle 3, Circle 2)

(5.838633564775854 radians, 7 bounces, Circle 1, Circle 3, Circle 2, Circle 3, Circle 2, Circle 3, Circle 2)

(5.838766011705514 radians, 7 bounces, Circle 1, Circle 3, Circle 2, Circle 3, Circle 1, Circle 2, Circle 1)

(3.570295405302805 radians, 7 bounces, Circle 2, Circle 3, Circle 2, Circle 1, Circle 2, Circle 1, Circle 2)

(5.6645590671255075 radians, 7 bounces, Circle 1, Circle 2, Circle 1, Circle 3, Circle 2, Circle 1, Circle 2)

(5.664548006563563 radians, 7 bounces, Circle 1, Circle 2, Circle 1, Circle 3, Circle 2, Circle 3, Circle 1)

Systematic Top 10 –

(5.680538107290963 radians, 8 bounces, Circle 1, Circle 2, Circle 3, Circle 2, Circle 3, Circle 2, Circle 1, Circle 2)

(5.679179679218077 radians, 8 bounces, Circle 1, Circle 2, Circle 3, Circle 1, Circle 2, Circle 3, Circle 1, Circle 2)

(5.854625133076361 radians, 7 bounces, Circle 1, Circle 3, Circle 1, Circle 2, Circle 3, Circle 2, Circle 1)

(5.839983610421338 radians, 7 bounces, Circle 1, Circle 3, Circle 2, Circle 1, Circle 3, Circle 1, Circle 3)

(5.679063789284301 radians, 7 bounces, Circle 1, Circle 2, Circle 3, Circle 1, Circle 3, Circle 1, Circle 3)

(1.6672602543892998 radians, 7 bounces, Circle 3, Circle 2, Circle 3, Circle 2, Circle 1, Circle 2, Circle 1)

(5.856064885914201 radians, 7 bounces, Circle 1, Circle 3, Circle 1, Circle 3, Circle 2, Circle 1, Circle 2)

(1.6498576642096072 radians, 7 bounces, Circle 3, Circle 2, Circle 1, Circle 2, Circle 1, Circle 3, Circle 1)

(5.856050460466514 radians, 7 bounces, Circle 1, Circle 3, Circle 1, Circle 3, Circle 2, Circle 3, Circle 2)

(1.6656939004637914 radians, 7 bounces, Circle 3, Circle 2, Circle 3, Circle 1, Circle 3, Circle 1, Circle 2)