Project 1 Part 2 Analysis Worksheet

1. Create a table for each set of data from Part 1 with columns for trial, *x*, *y*. At the bottom, add two extra rows. In the first of these rows, type the label **Mean** in the trial column, and in the second of the rows type the label **Std Dev**. In the *x* and *y* column, include the corresponding value.

Set	Trial	X (cm)	Y (cm)
1	1	13.51	-24.13
1	2	2.37	21.35
1	3	-21.12	17.59
1	4	21.99	-10.11
1	5	23.58	-0.89
1	6	-9.51	-25.31
1	7	-15.77	3.81
1	8	17.66	24.15
1	9	13.97	8.35
1	10	-8.96	9.48
Mean	3.77	2.43	
St. Dev	16.53	17.60	

Set	Trial	X (cm)	Y (cm)
2	1	5.13	3.16
2	2	24.95	2.23
2	3	2.57	7.73
2	4	7.36	-8.48
2	5	0.81	4.45
2	6	8.03	-8.89
2	7	16.64	-8.09
2	8	-2.33	-1.51
2	9	-4.35	16.22
2	10	-18.55	28.67
Mean	4.03	3.55	
St. Dev	11.82	11.89	

Set	Trial	X (cm)	Y (cm)
3	1	18.43	11.09
3	2	2.63	9.56
3	3	-8.88	6.22
3	4	19.46	28.28
3	5	-2.65	26.54
3	6	-7.33	14.56
3	7	-5.97	4.05
3	8	-3.47	-1.60
3	9	-18.54	-6.21
3	10	1.36	-2.13
Mean	-0.50	9.03	
St. Dev	11.81	11.62	

Set	Trial	X (cm)	Y (cm)
4	1	5.67	19.03
4	2	7.54	-24.98
4	3	-2.88	-8.74
4	4	7.31	21.10
4	5	5.10	-14.83
4	6	-0.65	1.80
4	7	8.67	-2.17
4	8	15.03	-28.16
4	9	9.93	19.20
4	10	0.21	7.27
Mean	5.59	-1.05	
St. Dev	5.42	18.07	

Set	Trial	X (cm)	Y (cm)
5	1	-17.79	21.15
5	2	16.62	2.37
5	3	12.21	-6.79
5	4	-5.69	-10.05
5	5	7.59	-7.16
5	6	-27.51	11.29
5	7	-22.18	13.12
5	8	-5.59	-17.10
5	9	-0.92	28.95
5	10	29.59	18.66
Mean	-1.37	5.44	
St. Dev	18.16	15.40	

Set	Trial	X (cm)	Y (cm)
6	1	-9.86	-7.27
6	2	25.20	-18.68
6	3	14.21	-6.00
6	4	27.80	20.79
6	5	-3.02	-29.44
6	6	7.35	-5.73
6	7	12.55	1.98
6	8	-21.92	1.64
6	9	-29.83	14.85
6	10	3.38	19.01
Mean	2.59	-0.88	
St. Dev	18.98	16.16	

Set	Trial	X (cm)	Y (cm)
7	1	-1.54	-5.10
7	2	6.52	11.27
7	3	-27.40	7.57
7	4	8.19	-19.74
7	5	-8.04	-20.73
7	6	9.27	-5.59
7	7	28.86	-23.91
7	8	-16.83	-19.49
7	9	2.17	-7.12
7	10	6.55	1.50
Mean	0.77	-8.13	
St. Dev	15.53	12.49	

Set	Trial	X (cm)	Y (cm)
8	1	-24.61	15.26
8	2	24.48	-23.48
8	3	-11.97	6.52
8	4	23.93	-27.40
8	5	-29.58	8.19
8	6	-25.23	27.13
8	7	2.18	9.27
8	8	2.68	28.86
8	9	25.58	-16.83
8	10	10.81	-13.69
Mean	-0.17	1.38	
St. Dev	21.64	20.42	

2. Using a spreadsheet program, estimate the standard deviation of the mean (δ) for each of the x and y locations of the aim trials.

Set	Trial	X (cm)	Y (cm)
1	1	13.51	-24.13
1	2	2.37	21.35
1	3	-21.12	17.59
1	4	21.99	-10.11
1	5	23.58	-0.89
1	6	-9.51	-25.31
1	7	-15.77	3.81
1	8	17.66	24.15
1	9	13.97	8.35
1	10	-8.96	9.48
Mean	3.77	2.43	
St. Dev	16.5261	17.6049	
St. Dev (Mean)	5.22602	5.5671	

Set	Trial	X (cm)	Y (cm)
3	1	18.43	11.09
3	2	2.63	9.56
3	3	-8.88	6.22
3	4	19.46	28.28
3	5	-2.65	26.54
3	6	-7.33	14.56
3	7	-5.97	4.05
3	8	-3.47	-1.60
3	9	-18.54	-6.21
3	10	1.36	-2.13
Mean	-0.4966	9.0348	
St. Dev	11.8137	11.6189	
St. Dev (Mean)	3.7358	3.6742	

Set	Trial	X (cm)	Y (cm)
2	1	5.13	3.16
2	2	24.95	2.23
2	3	2.57	7.73
2	4	7.36	-8.48
2	5	0.81	4.45
2	6	8.03	-8.89
2	7	16.64	-8.09
2	8	-2.33	-1.51
2	9	-4.35	16.22
2	10	-18.55	28.67
Mean	4.0262	3.5481	
St. Dev	11.8215	11.8895	
St. Dev (Mean)	3.7383	3.7598	

Set	Trial	X (cm)	Y (cm)
4	1	5.67	19.03
4	2	7.54	-24.98
4	3	-2.88	-8.74
4	4	7.31	21.10
4	5	5.10	-14.83
4	6	-0.65	1.80
4	7	8.67	-2.17
4	8	15.03	-28.16
4	9	9.93	19.20
4	10	0.21	7.27
Mean	5.5928	-1.0464	
St. Dev	5.4164	18.0711	
St. Dev (Mean)	1.7128	5.7146	

Set	Trial	X (cm)	Y (cm)
5	1	-17.79	21.15
5	2	16.62	2.37
5	3	12.21	-6.79
5	4	-5.69	-10.05
5	5	7.59	-7.16
5	6	-27.51	11.29
5	7	-22.18	13.12
5	8	-5.59	-17.10
5	9	-0.92	28.95
5	10	29.59	18.66
Mean	-1.3672	5.4437	
St. Dev	18.1637	15.3974	
St. Dev (Mean)	5.7439	4.8691	

Set	Trial	X (cm)	Y (cm)
7	1	-1.54	-5.10
7	2	6.52	11.27
7	3	-27.40	7.57
7	4	8.19	-19.74
7	5	-8.04	-20.73
7	6	9.27	-5.59
7	7	28.86	-23.91
7	8	-16.83	-19.49
7	9	2.17	-7.12
7	10	6.55	1.50
Mean	0.7739	-8.1327	
St. Dev	15.5326	12.4902	
St. Dev (Mean)	4.9118	3.9498	

Set	Trial	X (cm)	Y (cm)
6	1	-9.86	-7.27
6	2	25.20	-18.68
6	3	14.21	-6.00
6	4	27.80	20.79
6	5	-3.02	-29.44
6	6	7.35	-5.73
6	7	12.55	1.98
6	8	-21.92	1.64
6	9	-29.83	14.85
6	10	3.38	19.01
Mean	2.5867	-0.8850	
St. Dev	18.9806	16.1585	
St. Dev (Mean)	6.0022	5.1098	

Set	Trial	X (cm)	Y (cm)
8	1	-24.61	15.26
8	2	24.48	-23.48
8	3	-11.97	6.52
8	4	23.93	-27.40
8	5	-29.58	8.19
8	6	-25.23	27.13
8	7	2.18	9.27
8	8	2.68	28.86
8	9	25.58	-16.83
8	10	10.81	-13.69
Mean	-0.1736	1.3821	
St. Dev	21.6419	20.4158	
St. Dev (Mean)	6.8438	6.4561	

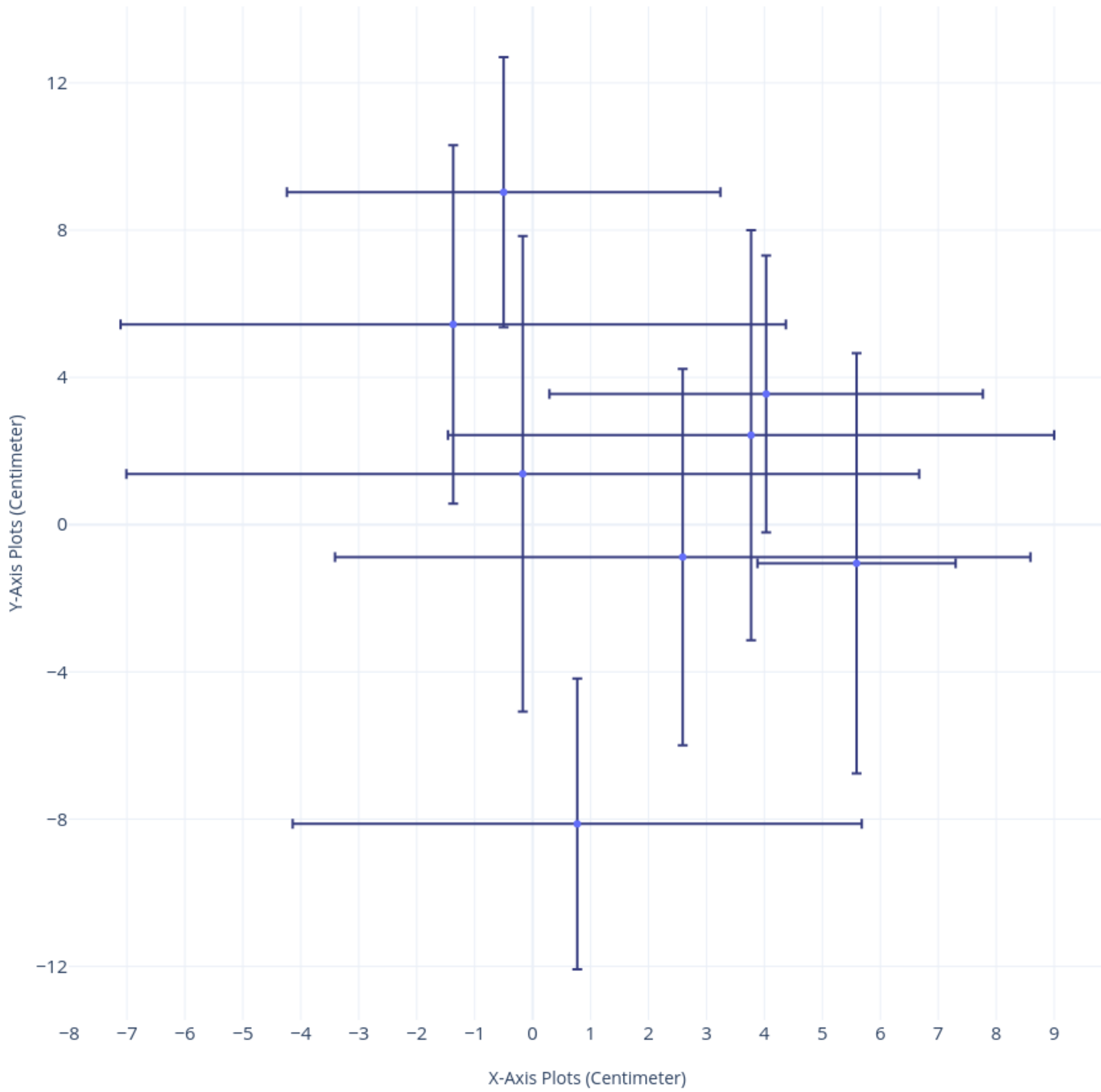
3. Create a table summarizing your results. You should have seven columns: set number, $\bar{x}$, σx,), $\bar{y}$, σy, δy.

	x avg ($\bar{x}$)	sigma x (σx)	delta x (δx)		y avg ($\bar{y}$)	sigma y (σy)	delta y (δy)
1	3.77	16.53	5.23		2.43	17.60	5.57
2	4.03	11.82	3.74		3.55	11.89	3.76
3	-0.50	11.81	3.74		9.03	11.62	3.67
4	5.59	5.42	1.71		-1.05	18.07	5.71
5	-1.37	18.16	5.74		5.44	15.40	4.87
6	2.59	18.98	6.00		-0.88	16.16	5.11
7	0.77	15.53	4.91		-8.13	12.49	3.95
8	-0.17	21.64	6.84		1.38	20.42	6.46

4. Use Plot.ly or Excel to create a scatter plot of your aim values for each trial, with the standard deviation of the mean (δx, δy) as your error bars.

Grid 0

	A	B	C	D	E	F	G
1	3.77	16.53	5.23	2.43	17.60	5.57	
2	4.03	11.82	3.74	3.55	11.89	3.76	
3	-0.50	11.81	3.74	9.03	11.62	3.67	
4	5.59	5.42	1.71	-1.05	18.07	5.71	
5	-1.37	18.16	5.74	5.44	15.40	4.87	
6	2.59	18.98	6.00	-0.88	16.16	5.11	
7	0.77	15.53	4.91	-8.13	12.49	3.95	
8	-0.17	21.64	6.84	1.38	20.42	6.46	
9							
10							



5. Calculate the overall mean ($\bar{X}$, $\bar{Y}$) and standard deviation of the means ($\sigma\bar{x}$, $\sigma\bar{y}$) from the mean values of the aim trials.

	x avg ($\bar{x}$)	sigma x (σx)	delta x (δx)		y avg ($\bar{y}$)	sigma y (σy)	delta y (δy)
1	3.77	16.53	5.23		2.43	17.60	5.57
2	4.03	11.82	3.74		3.55	11.89	3.76
3	-0.50	11.81	3.74		9.03	11.62	3.67
4	5.59	5.42	1.71		-1.05	18.07	5.71
5	-1.37	18.16	5.74		5.44	15.40	4.87
6	2.59	18.98	6.00		-0.88	16.16	5.11
7	0.77	15.53	4.91		-8.13	12.49	3.95
8	-0.17	21.64	6.84		1.38	20.42	6.46
Overall Mean x	1.8395			Overall Mean y	5.8863		
stdev Mean $\sigma\bar{x}$	2.5099			stdev Mean $\sigma\bar{y}$	5.1039		

// All Values are calculated in Centimeters.

Overall Mean ($\bar{x}$) = $\left[\dfrac{3.77 + 4.03 + (-0.50) + 5.59 + (-1.37 + 2.59) + 0.77 + (-0.17)}{8}\right]$ cm

= [using calculator] = 1.8395 cm

Standard Deviation of the mean values ($\sigma\bar{x}$) = $\sqrt{\left[\dfrac{\left\{(\text{mean values of } x)^2 - (\text{Overall mean of } x)\right\}^2}{8-1}\right]}$

$\boxed{\sigma_x = \sqrt{\dfrac{\Sigma(x-\bar{x})^2}{N-1}}}$

$= \sqrt{\left[\dfrac{(3.77-1.8)^2 + (4.03-1.8)^2 + (-0.5-1.8)^2 + (5.5-1.8)^2 + (2.59-1.8)^2 + (-1.37-1.8)^2 + (0.7-1.8)^2 + (-0.17-1.8)^2}{7}\right]}$

= 2.5099 cm $\approx$ 2.5 cm //

6. Perform a statistical test on the *x* and *y* aim, as compared to the ideal values.

// t testing : $\dfrac{(x_1 - x_2)}{\sqrt{\delta x_1^2 + \delta x_2^2}}$

$\approx \dfrac{x_1 - x_2}{\delta x_1}$

x_1 = Value found from experiment

x_2 = Expected value

δx_1 = Standard deviation of the values found.

In order to do t testing for the whole experiment, let's take x_1 as our values in each axis and x_2 as 0. From 8 sets of x_1 lets take the average

$\therefore (x_1 - x_2)$ = average mean value of all sets of x

= 1.84 cm

δx_1 = Standard deviation of the found mean values

= 2.5 cm.

t testing for x values = $\dfrac{1.84\ \cancel{cm}}{2.5\ \cancel{cm}}$ = 0.736

(Ans)

	x avg ($\bar{x}$)	sigma x (σx)	delta x (δx)		y avg ($\bar{y}$)	sigma y (σy)	delta y (δy)
1	3.77	16.53	5.23		2.43	17.60	5.57
2	4.03	11.82	3.74		3.55	11.89	3.76
3	-0.50	11.81	3.74		9.03	11.62	3.67
4	5.59	5.42	1.71		-1.05	18.07	5.71
5	-1.37	18.16	5.74		5.44	15.40	4.87
6	2.59	18.98	6.00		-0.88	16.16	5.11
7	0.77	15.53	4.91		-8.13	12.49	3.95
8	-0.17	21.64	6.84		1.38	20.42	6.46
Overall Mean x	1.8395			Overall Mean y	5.8863		
stdev Mean $\sigma\bar{x}$	2.5099			stdev Mean $\sigma\bar{y}$	5.1039		
t-test result	0.7329			t-test result	1.153294		

// All Values are calculated in Centimeters.

7. Respond to the following questions/instructions:

(a) Was the estimate of the precision of the experiment comparable to the value found from replication? Justify/support your answer.

Precision is the uncertainty of a value. Uncertainty of a set of data is measured with the help of standard deviation of that set, and generally taken as the uncertainty for each value in that set. In my experiment, I did 8 sets of flipping the coins on the floor, and I found that the precision of the sets (standard deviation) is comparable to the value found from replication. All the values are in the positive quadrant of the floor quad-section, and in between 12 c.m. to 18 c.m. for x axis values and between 13 c.m. to 18 c.m. for the y axis values.

(b) What numerical value represents the accuracy of the aim in the experiment? Is the aim in the experiment consistent with being “on target”?

The numerical value that represents the accuracy of the aim is the”t” from the t-testing of the experiment. We took the found values and expected values from the experiment and divided the sum of all the sets with the standard deviation (uncertainty value). We found the t value to be in range between -2.0 and +2.0, which means that our experiment values have been consistent with our finding from our experiment. The accuracy of the x-values in our data set seems to be more accurate than the accuracy we found in the data sets of y axis. We can say that the value of the t is small here because the precision of the values has not been perfect or accurate.

(c) By repeating the experiment, a thousand times, instead of twenty, what should happen to your estimations of your accuracy and precision?

From the data sets of 8, we can see that the uncertainty of our values is larger than 5 c.m. in some sets, and in others it was lower than 5 c.m. When we calculated the standard deviation of the mean values of all the sets, we found that the value of the mean has gotten lower with the number of sets. This can mean that the higher number of times the test will be performed and repeated, the test result might point to the correct value of the aim (precise value of the aim is {x: 0 c.m.} and {y: 0 c.m.} but the experiment result will show where the occurrence is higher on the floor). The same goes for the t testing as well, since the mean values of the average values will show the same result.

(d) Hypothetically, in one version of the experiment darts are used to hit a target on a wall, while in another version coins are tossed at a target on the floor. How should the use of coins affect the experiment versus the darts?

Though both experiments are governed by forces such as gravity, in dart game, the use of magnetic force and kinetic energy is used for giving a more precise aim of the dart to the circular target on the wall (in opposite to only gravity and potential energy). That’s why, the use of darts will give a more precise and accurate value for the aim in the circular dart board (if thrown with the current aim) and there’s no possibility of the darts to get bounced off as it happens with the coins on the floor. Therefore, using darts will give a more precise and accurate value of the aim on the wall in each set.