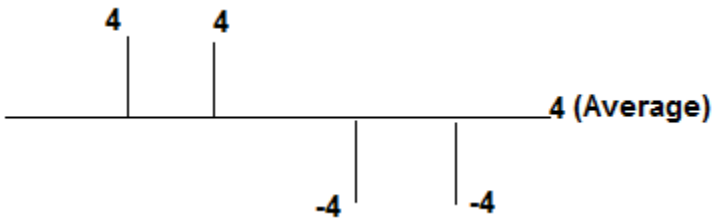
What is **Standard Deviation?** It is square of the difference between .....oh leave the definition lets get into practicality. And while doing so we will understand their their prominence in finance.

When you want to understand data, the first thing you will do is take average aka mean.

	A	B
1	0	-2
2	0	2
3	8	5
4	8	11

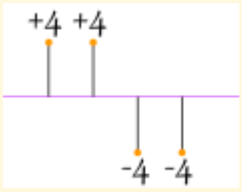
Check out two data sets A & B above. You can see that both of them have same average (4) but they are very much different. They are differently spread. (Data set A ranges from 0 to 8 whereas B ranges from -2 to 11). You now want to understand their spread.

- To measure the spread, you simply find out the difference between the data points and the mean of each set. Here is data set A.



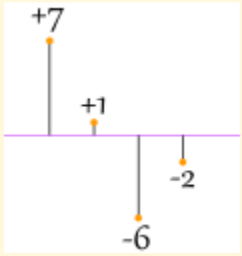
Two data points are 4 units above mean(8-4) and two data points are 4 units below mean (0-4). Good!! We got the mean differences of set A as (4+4-4-4)/4 =0. Oh no..... this metric is saying that their is no spread of data. It is not so useful metric. By the way the above metric is called **mean difference.**

- To avoid the flaw of the above metric let us take the absolute values of the differences.



$$\frac{|4| + |4| + |-4| + |-4|}{4} = \frac{4 + 4 + 4 + 4}{4} = 4$$

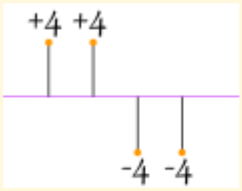
Beautiful.....now it is clearly showing that data is spread. Lets now check how is Data set B doing on this metric:



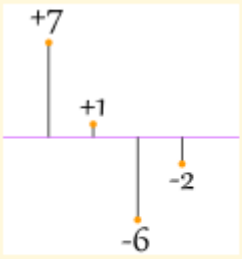
$$\frac{|7| + |1| + |-6| + |-2|}{4} = \frac{7 + 1 + 6 + 2}{4} = 4$$

Oh no.....though the set B is more spread, still this metric is showing the same spread. We need something better. By the way this measure is called **"mean absolute deviation".**

- What shall we do now? We know that if a number increases by one. Its square value increases by a greater degree. For example square of 3 is 9, square of 4 is 16 and square of 5 is 25. So when a smaller value increased by 1(3 increasing to 4) the affect on squares is lesser (16-9 = 7) but when a larger value increases by one (4 going to 5) the affect on squares is higher(25-16 = 9). Why not use this property. The extreme values will get more significance while measuring spread, so let us square the differences before averaging them.



$$\frac{4^2 + 4^2 + 4^2 + 4^2}{4} = \frac{64}{4} = \mathbf{16}$$



$$\frac{7^2 + 1^2 + 6^2 + 2^2}{4} = \frac{90}{4} = \mathbf{22.5}$$

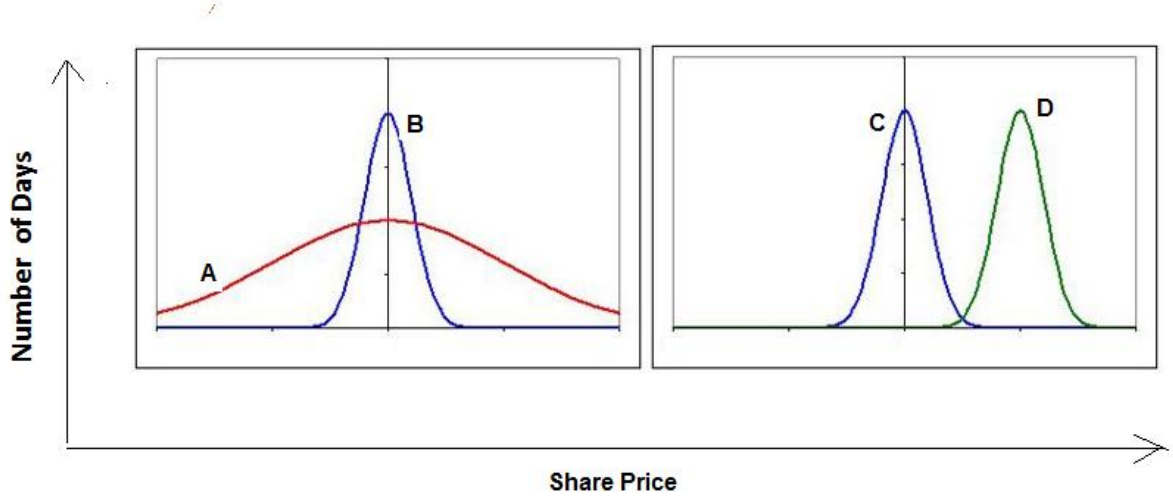
Wonderful!!! This metric is showing higher value when spread is higher. This is what we wanted. We will use it. By the way this metric is called as **"Variance"**

- But the above metric has a small issue. Suppose our data points were in Amperes then the above metric will be in Amperes^2. This may, at times, cause confusion. So we take a square root. This square root is called as **"Standard Deviation".**
- Covariance is not in the above league. It simply shows the manner in which two data sets change with respect to each other. It ranges from -1 to 1. If the two data sets change in perfect tandem the covariance is 1. If they change in exactly opposite direction (increase of one unit in one set causes decrease of one unit

in the other set) then the covariance is -1. If the data sets are not at all related the covariance is 0.

Now let us come to finance:

- Usually the portfolio managers and financial analysts use two metrics: standard deviation and co-variance.



- Let us consider that you have four shares(A, B, C & D) which you are tracking. Imagine that you drew the share price and the number of days that share price was held by the particular stock, for one year, in the manner above.
- You can see that the stocks A and B have same "average price". But the stock A is more riskier than stock B. It is highly spread. Since standard deviation(SD) of share price of A is higher than SD of B. So you should prefer stock B.
- Also, stock C and stock D have same amount of "risk" or Standard deviation. But stock D has higher average. So you should prefer stock D.
- Value at risk, VAR is one such metric in finance that makes the use of stock to understand "what can be my worst losses with a given probability" if I invest in a particular stock.
- **Co variance:** Co variance between stocks is calculated to find out whether the stocks are related or no. For example if you consider stocks of say Maruti and Tata Motors, they probably will rise and fall in tandem due to a government policy change in automobile sector. In short, they will have higher co-variance. Whereas say stocks of Tata consultancy services and Maruti will not be in tandom. Their covariance will be near to zero. Thus to avoid risk the investors "diversify" their equity investments by choosing those shares that have historically lower co-variance. (nearer to zero).