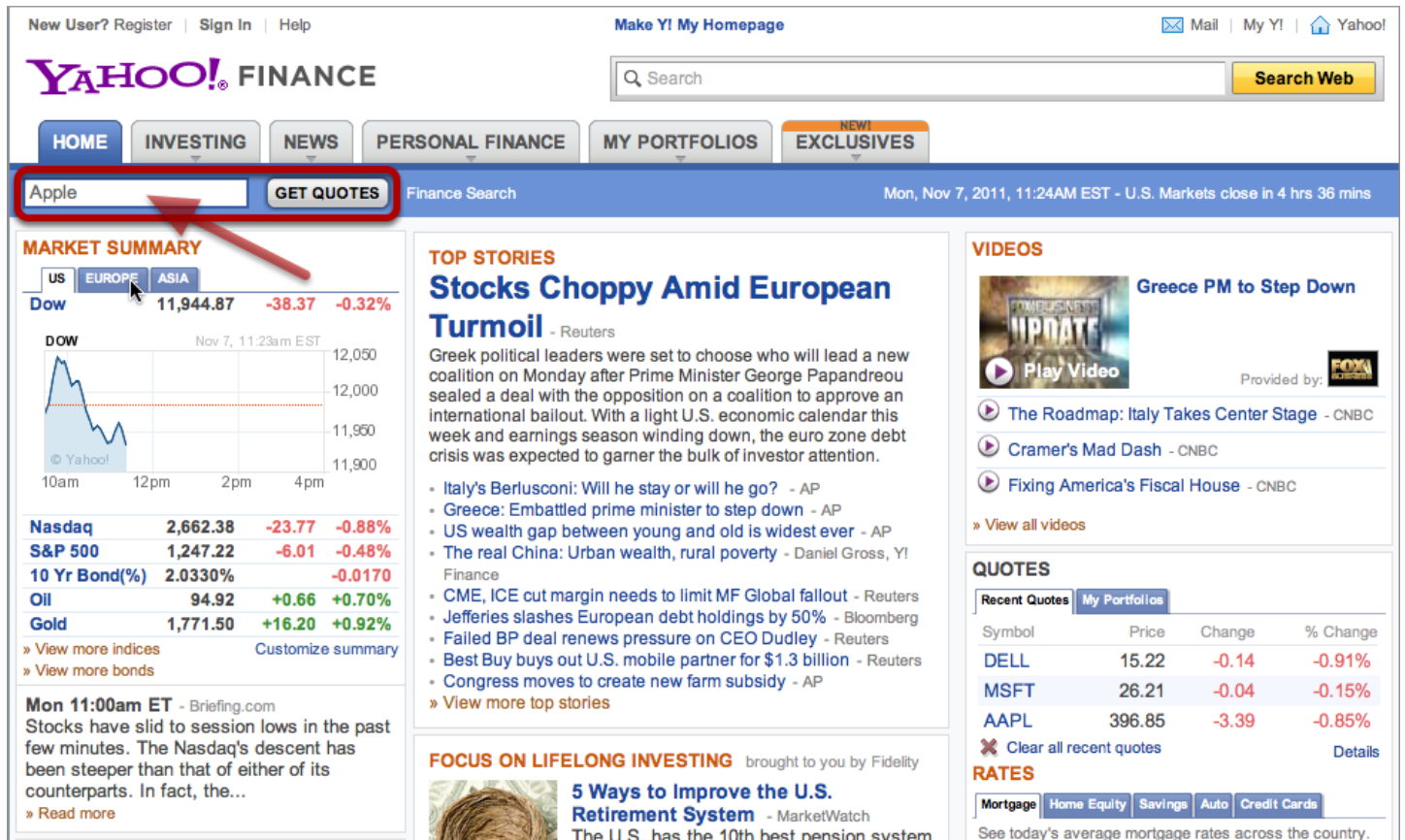# VaR: Historical Simulation

Assalamu 'aleykum, everybody,

Here we are going to explain the steps for portfolio VaR calculation, inshaAllah.

Step 1: Select a source for stock prices

Go to Yahoo Finance (www.finance.yahoo.com/)

Type in company name in highlighted window and Click Get Quotes.
For our example we will collect stock prices for three companies: Apple, Microsoft, and Dell.

Step 2: Get Historical Prices

Click on Historical Prices as shown above.

Step 3: Specify time range

Set Data Range and Click Get Prices.

In our case we have chosen Start Date as 07 November 2007 and End Date as 07 November 2011.

Number of observations: 1008 (07/11/2007 - 07/11/2011)

Step 4: Download data to Spreadsheet

Aug 29, 2011	388.18	391.50	386.00	389.97	14,473,900	389.97
Aug 26, 2011	371.17	383.80	370.80	383.58	22,909,900	383.58
Aug 25, 2011	365.08	375.45	365.00	373.72	31,119,500	373.72
Aug 24, 2011	373.47	378.96	370.60	376.18	22,366,700	376.18
Aug 23, 2011	360.30	373.64	357.00	373.60	23,458,400	373.60
Aug 22, 2011	364.51	364.88	355.09	356.44	19,118,400	356.44
Aug 19, 2011	362.17	367.00	356.00	356.03	27,710,300	356.03
Aug 18, 2011	370.84	372.65	361.37	366.05	30,408,400	366.05
Aug 17, 2011	382.31	384.52	378.00	380.44	15,787,900	380.44
Aug 16, 2011	381.52	383.37	376.06	380.48	17,812,500	380.48
Aug 15, 2011	379.63	384.97	378.09	383.41	16,448,000	383.41
Aug 12, 2011	378.07	379.64	374.23	376.99	18,879,800	376.99
Aug 11, 2011	370.52	375.45	364.72	373.70	26,498,900	373.70
Aug 10, 2011	371.15	374.65	362.50	363.69	31,380,600	363.69
Aug 9, 2011	361.30	374.61	355.00	374.01	38,663,700	374.01
Aug 8, 2011	361.69	367.77	353.02	353.21	40,851,200	353.21
Aug 5, 2011	380.44	383.50	362.57	373.62	43,021,100	373.62
Aug 4, 2011	389.41	391.32	377.35	377.37	31,121,700	377.37

* Close price adjusted for dividends and splits.

First | Previous | Next | Last

Download to Spreadsheet

Currency in USD.

Click on Download to Spreadsheet at the bottom of the page.

Or Right Click and Save File as...
The file will be in CSV format which can be opened using Excel.

Step 5: Repeat the same steps with other stocks

Repeat the same steps to get stock prices of Microsoft and Dell.

Step 6: Open downloaded files

	A	B	C	D	E	F	G	H
1	Date	Open	High	Low	Close	Volume	Adj Close	
2	04/11/2011	402.03	403.44	399.16	400.24	10772400	400.24	
3	03/11/2011	399.07	403.4	395.36	403.07	15763800	403.07	
4	02/11/2011	400.09	400.44	395.11	397.41	11691100	397.41	
5	01/11/2011	397.41	399.5	393.22	396.51	18974200	396.51	
6	31/10/2011	402.42	409.33	401.05	404.78	13767900	404.78	
7	28/10/2011	403	406.35	402.51	404.95	11515200	404.95	
8	27/10/2011	407.56	409	401.89	404.69	17666600	404.69	
9	26/10/2011	401.76	402.55	393.15	400.6	16279000	400.6	
10	25/10/2011	405.03	406.55	397.38	397.77	15372400	397.77	
11	24/10/2011	396.18	406.5	395.4	405.77	17933500	405.77	
12	21/10/2011	398.1	399.14	390.75	392.87	22161600	392.87	
13	20/10/2011	400	400.35	394.21	395.31	19616800	395.31	
14	19/10/2011	401.35	408.42	397.8	398.62	39407100	398.62	
15	18/10/2011	421.76	424.81	415.99	422.24	31232500	422.24	
16	17/10/2011	421.74	426.7	415.94	419.99	24478400	419.99	
17	14/10/2011	416.83	422	415.27	422	20450000	422	
18	13/10/2011	404.98	408.43	402.85	408.43	15177900	408.43	
19	12/10/2011	407.34	409.25	400.14	402.19	22206600	402.19	

Open downloaded spreadsheet.

You'll see seven columns as: Date, Open, High, Low, Close, Volume, and Adj.Close.
For our calculation of VaR, we are interested in the first and last columns only: Date and Adj.Close.
Other data will be deleted.

Step 7: Combine all stock prices into a table

	A	B	C	D	E
1	Date	APPLE	MICROSOFT	DELL	
2	04/11/2011	400.24	26.25	15.36	
3	03/11/2011	403.07	26.53	15.67	
4	02/11/2011	397.41	26.01	15.45	
5	01/11/2011	396.51	25.99	15.13	
6	31/10/2011	404.78	26.63	15.81	
7	28/10/2011	404.95	26.98	16.31	
8	27/10/2011	404.69	27.25	16.32	
9	26/10/2011	400.60	26.59	15.91	
10	25/10/2011	397.77	26.81	15.61	
11	24/10/2011	405.77	27.19	15.70	
12	21/10/2011	392.87	27.16	15.24	
13	20/10/2011	395.31	27.04	15.05	
14	19/10/2011	398.62	27.13	15.90	
15	18/10/2011	422.24	27.31	16.37	
16	17/10/2011	419.99	26.98	15.97	
17	14/10/2011	422.00	27.27	16.62	
18	13/10/2011	408.43	27.18	16.36	
19	12/10/2011	402.19	26.96	16.24	
20	11/10/2011	400.29	27.00	16.18	
21	10/10/2011	388.81	26.94	16.10	
22	07/10/2011	369.80	26.25	15.28	

Copy and Paste stock prices of three companies to one table as it is shown above.

Remember that we are interested in Adjusted Close Prices only.

Step 8: Calculate Stock Returns

| F3 | | | | fx | =LN(B3/B4) |

	A	B	C	D	E	F	G	H	I
1			STOCK PRICES				STOCK RETURNS		
2	Date	APPLE	MICROSOFT	DELL		APPLE	MICROSOFT	DELL	
3	04/11/2011	400.24	26.25	15.36		-0.70%	-1.06%	-2.00%	
4	03/11/2011	403.07	26.53	15.67		1.41%	1.98%	1.41%	
5	02/11/2011	397.41	26.01	15.45		0.23%	0.08%	2.09%	
6	01/11/2011	396.51	25.99	15.13		-2.06%	-2.43%	-4.40%	
7	31/10/2011	404.78	26.63	15.81		-0.04%	-1.31%	-3.11%	
8	28/10/2011	404.95	26.98	16.31		0.06%	-1.00%	-0.06%	
9	27/10/2011	404.69	27.25	16.32		1.02%	2.45%	2.54%	
10	26/10/2011	400.60	26.59	15.91		0.71%	-0.82%	1.90%	
11	25/10/2011	397.77	26.81	15.61		-1.99%	-1.41%	-0.57%	
12	24/10/2011	405.77	27.19	15.70		3.23%	0.11%	2.97%	
13	21/10/2011	392.87	27.16	15.24		-0.62%	0.44%	1.25%	
14	20/10/2011	395.31	27.04	15.05		-0.83%	-0.33%	-5.49%	
15	19/10/2011	398.62	27.13	15.90		-5.76%	-0.66%	-2.91%	
16	18/10/2011	422.24	27.31	16.37		0.53%	1.22%	2.47%	
17	17/10/2011	419.99	26.98	15.97		-0.48%	-1.07%	-3.99%	
18	14/10/2011	422.00	27.27	16.62		3.27%	0.33%	1.58%	
19	13/10/2011	408.43	27.18	16.36		1.54%	0.81%	0.74%	
20	12/10/2011	402.19	26.96	16.24		0.47%	-0.15%	0.37%	
21	11/10/2011	400.29	27.00	16.18		2.91%	0.22%	0.50%	
22	10/10/2011	388.81	26.94	16.10		5.01%	2.59%	5.23%	
23	07/10/2011	369.80	26.25	15.28		-2.03%	-0.34%	-1.75%	
24	06/10/2011	377.37	26.34	15.55		-0.23%	1.72%	1.10%	
25	05/10/2011	378.25	25.89	15.38		1.53%	2.15%	5.69%	
26	04/10/2011	372.50	25.34	14.53		-0.56%	3.25%	4.36%	
27	03/10/2011	374.60	24.53	13.91		-1.78%	-1.46%	-1.64%	

Create new table and Calculate Stock Returns using Lognormal formula in Excel.

Lognormal of Today price divided by Yesterday price.

Step 9: Calculate RM returns

	A	B	C	D	E	F	G	H				
1											**PORTFOLIO VALUE**	
2			**STOCK PRICES**				**STOCK RETURNS**		RM 100,000.00	RM 100,000.00	RM 100,000.00	
3	Date	APPLE	MICROSOFT	DELL		APPLE	MICROSOFT	DELL	APPLE	MICROSOFT		DELL
4	04/11/2011	400.24	26.25	15.36		-0.70%	-1.06%	-2.00%	-704.59	-1,061.02		-1,998.13
5	03/11/2011	403.07	26.53	15.67		1.41%	1.98%	1.41%	1,414.18	1,979.51		1,413.91
6	02/11/2011	397.41	26.01	15.45		0.23%	0.08%	2.09%	226.72	76.92		2,092.95
7	01/11/2011	396.51	25.99	15.13		-2.06%	-2.43%	-4.40%	-2,064.24	-2,432.66		-4,396.31
8	31/10/2011	404.78	26.63	15.81		-0.04%	-1.31%	-3.11%	-41.99	-1,305.75		-3,113.58
9	28/10/2011	404.95	26.98	16.31		0.06%	-1.00%	-0.06%	64.23	-995.77		-61.29
10	27/10/2011	404.69	27.25	16.32		1.02%	2.45%	2.54%	1,015.79	2,451.83		2,544.35
11	26/10/2011	400.60	26.59	15.91		0.71%	-0.82%	1.90%	708.95	-823.97		1,903.61
12	25/10/2011	397.77	26.81	15.61		-1.99%	-1.41%	-0.57%	-1,991.25	-1,407.43		-574.90
13	24/10/2011	405.77	27.19	15.70		3.23%	0.11%	2.97%	3,230.77	110.40		2,973.72
14	21/10/2011	392.87	27.16	15.24		-0.62%	0.44%	1.25%	-619.15	442.81		1,254.56
15	20/10/2011	395.31	27.04	15.05		-0.83%	-0.33%	-5.49%	-833.83	-332.29		-5,494.11
16	19/10/2011	398.62	27.13	15.90		-5.76%	-0.66%	-2.91%	-5,756.53	-661.28		-2,913.13
17	18/10/2011	422.24	27.31	16.37		0.53%	1.22%	2.47%	534.30	1,215.71		2,473.84
18	17/10/2011	419.99	26.98	15.97		-0.48%	-1.07%	-3.99%	-477.44	-1,069.13		-3,989.48
19	14/10/2011	422.00	27.27	16.62		3.27%	0.33%	1.58%	3,268.48	330.58		1,576.75
20	13/10/2011	408.43	27.18	16.36		1.54%	0.81%	0.74%	1,539.59	812.71		736.20
21	12/10/2011	402.19	26.96	16.24		0.47%	-0.15%	0.37%	473.53	-148.26		370.14
22	11/10/2011	400.29	27.00	16.18		2.91%	0.22%	0.50%	2,909.85	222.47		495.66
23	10/10/2011	388.81	26.94	16.10		5.01%	2.59%	5.23%	5,012.85	2,594.62		5,227.45
24	07/10/2011	369.80	26.25	15.28		-2.03%	-0.34%	-1.75%	-2,026.38	-342.27		-1,751.59
25	06/10/2011	377.37	26.34	15.55		-0.23%	1.72%	1.10%	-232.92	1,723.19		1,099.27
26	05/10/2011	378.25	25.89	15.38		1.53%	2.15%	5.69%	1,531.83	2,147.26		5,685.25
27	04/10/2011	372.50	25.34	14.53		-0.56%	3.25%	4.36%				

Calculate what would have been the result if we had invested RM100,000 in each stock 4 years ago.

Multiply 100,000 by each stock return.
For example:
100,000 x cell F4 (for Apple's stock),
100,000 x cell G4 (for Microsoft's stock),
100,000 x cell H4 (for Dell's stock).

Step 10: Calculate Portfolio returns

| | STOCK RETURNS | | | PORTFOLIO VALUE | | | | |
| | | | | RM 100,000.00 | RM 100,000.00 | RM 100,000.00 | | RM 300,000.00 |
APPLE	MICROSOFT	DELL		APPLE	MICROSOFT	DELL	PORTFOLIO (RM)	PORTFOLIO (%)
-0.70%	-1.06%	-2.00%		-704.59	-1,061.02	-1,998.13	-3,763.74	-1.25%
1.41%	1.98%	1.41%		1,414.18	1,979.51	1,413.91	4,807.59	1.60%
0.23%	0.08%	2.09%		226.72	76.92	2,092.95	2,396.59	0.80%
-2.06%	-2.43%	-4.40%		-2,064.24	-2,432.66	-4,396.31	-8,893.21	-2.96%
-0.04%	-1.31%	-3.11%		-41.99	-1,305.75	-3,113.58	-4,461.31	-1.49%
0.06%	-1.00%	-0.06%		64.23	-995.77	-61.29	-992.83	-0.33%
1.02%	2.45%	2.54%		1,015.79	2,451.83	2,544.35	6,011.97	2.00%
0.71%	-0.82%	1.90%		708.95	-823.97	1,903.61	1,788.58	0.60%
-1.99%	-1.41%	-0.57%		-1,991.25	-1,407.43	-574.90	-3,973.58	-1.32%
3.23%	0.11%	2.97%		3,230.77	110.40	2,973.72	6,314.88	2.10%
-0.62%	0.44%	1.25%		-619.15	442.81	1,254.56	1,078.21	0.36%
-0.83%	-0.33%	-5.49%		-833.83	-332.29	-5,494.11	-6,660.23	-2.22%
-5.76%	-0.66%	-2.91%		-5,756.53	-661.28	-2,913.13	-9,330.94	-3.11%
0.53%	1.22%	2.47%		534.30	1,215.71	2,473.84	4,223.85	1.41%
-0.48%	-1.07%	-3.99%		-477.44	-1,069.13	-3,989.48	-5,536.06	-1.85%
3.27%	0.33%	1.58%		3,268.48	330.58	1,576.75	5,175.80	1.73%
1.54%	0.81%	0.74%		1,539.59	812.71	736.20	3,088.50	1.03%
0.47%	-0.15%	0.37%		473.53	-148.26	370.14	695.42	0.23%
2.91%	0.22%	0.50%		2,909.85	222.47	495.66	3,627.98	1.21%
5.01%	2.59%	5.23%		5,012.85	2,594.62	5,227.45	12,834.91	4.28%
-2.03%	-0.34%	-1.75%		-2,026.38	-342.27	-1,751.59	-4,120.24	-1.37%
-0.23%	1.72%	1.10%		-232.92	1,723.19	1,099.27	2,589.54	0.86%
1.53%	2.15%	5.69%		1,531.83	2,147.26	5,685.25	9,364.34	3.12%
-0.56%	3.25%	4.36%		-562.18	3,248.73	4,360.75	7,047.30	2.35%
-1.78%	-1.46%	-1.64%		-1,778.01	-1,456.93	-1,639.97	-4,874.90	-1.62%
-2.40%	-2.22%	-5.03%		-2,396.83	-2,224.96	-5,033.81	-9,655.60	-3.22%
-1.64%	-0.51%	-0.20%		-1,635.43	-509.51	-201.55	-2,346.48	-0.78%
-0.57%	-0.35%	-1.80%		-565.14	-351.22	-1,795.86	-2,712.21	-0.90%
-0.97%	0.90%	2.81%		-974.55	900.03	2,807.67	2,733.15	0.91%
-0.28%	1.50%	2.40%		-279.89	1,504.98	2,401.49	3,626.58	1.21%

Sum up results from previous table to calculate daily portfolio returns in RM, and resulting percentage out RM300,000.
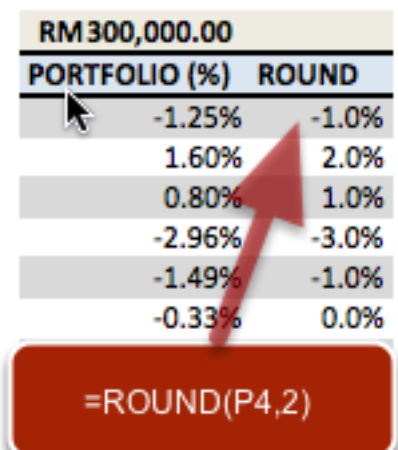
For example:
To calculate PORTFOLIO (RM), sum up cell J4 + cell K4 + cell L4.
To calculate PORTFOLIO (%), (cell N4 / 300,000)*100

Step 11: Round Portfolio returns

	P	Q
2	RM 300,000.00	
3	**PORTFOLIO (%)**	**ROUND**
4	-1.25%	-1.0%
5	1.60%	2.0%
6	0.80%	1.0%
7	-2.96%	-3.0%
8	-1.49%	-1.0%
9	-0.33%	0.0%
13	2.10%	2.0%
14	0.36%	0.0%
15	-2.22%	-2.0%
16	-3.11%	-3.0%
17	1.41%	1.0%
18	-1.85%	-2.0%
19	1.73%	2.0%
20	1.03%	1.0%
21	0.23%	0.0%

=ROUND(P4,2)

Round Portfolio returns using ROUND Excel formula.

For example,
in cell Q4 type "=" sign and type ROUND(P4,2).
Where,
P4 is cell P4.
2 is number of digits.

Step 12: Create bins and calculate frequency

	P	Q		S	T
1					
2	R|N300,000.00				
3	PORTFOLIO (%)	ROUND			
4	-1.25%	-1.0%			
5	1.60%	2.0%		=COUNTIF($Q$4:$Q$1010, S12)	
6	0.80%	1.0%			
7	-2.96%	-3.0%			
8	-1.49%	-1.0%			
9	-0.33%	0.0%			
10	2.00%	2.0%			
11	0.60%	1.0%		Bin	Frequency
12	-1.32%	-1.0%		-15%	0
13	2.10%	2.0%		-14%	0
14	0.36%	0.0%		-13%	1
15	-2.22%	-2.0%		-12%	0
16	-3.11%	-3.0%		-11%	0
17	1.41%	1.0%		-10%	0
18	-1.85%	-2.0%		-9%	1
19	1.73%	2.0%		-8%	2
20	1.03%	1.0%		-7%	1
21	0.23%	0.0%		-6%	6
22	1.21%	1.0%		-5%	12
23	4.28%	4.0%		-4%	28
24	-1.37%	-1.0%		-3%	48
25	0.86%	1.0%		-2%	88
26	3.12%	3.0%		-1%	156
27	2.35%	2.0%		0%	276
28	-1.62%	-2.0%		1%	200
29	-3.22%	-3.0%		2%	119
30	-0.78%	-1.0%		3%	36
31	-0.90%	-1.0%		4%	17

Create bins (range with 1% change) and calculate number of returns that fall within those bins.
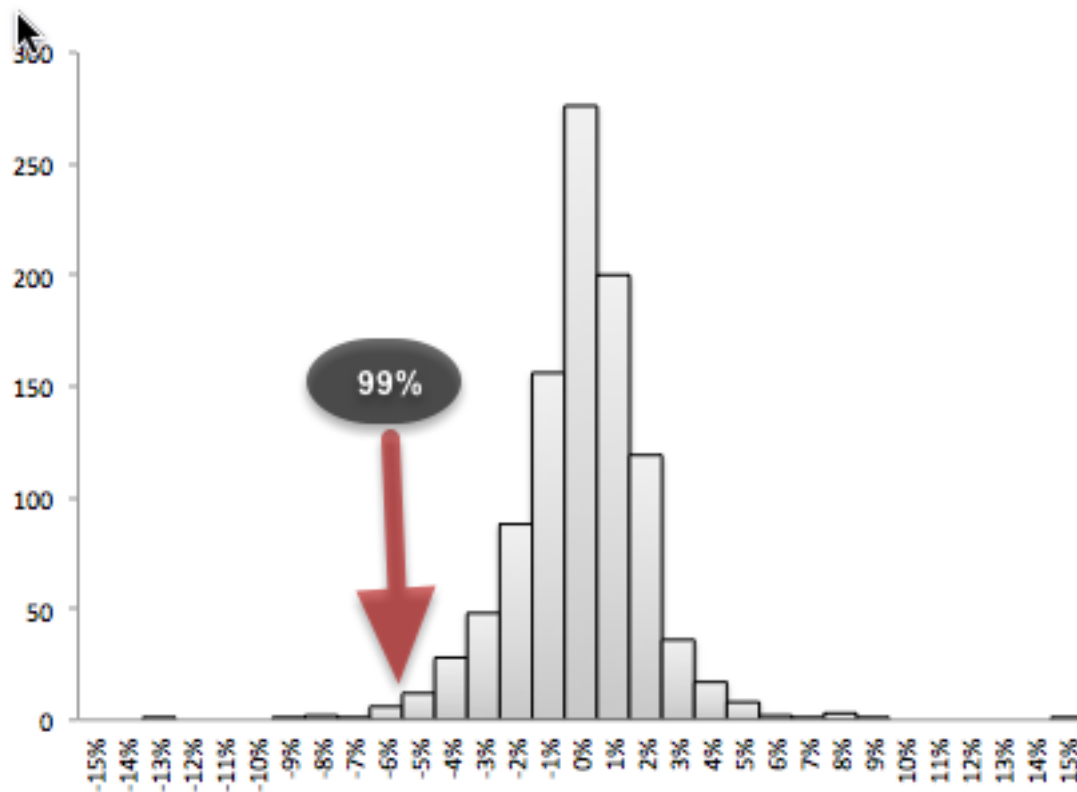
For example,
Our range falls between -15% and 15% with 1% value step.
Frequency (how many times each return is observed) can be calculated using Excel formula COUNTIF(range,bin).
i.e., COUNTIF($Q$4:$Q$1010, S12)

Step 13: Create Histogram

Using data from Step 12, create Histogram (Charts -> Column).

Returns are located on axis X, and Frequency - on axis Y.
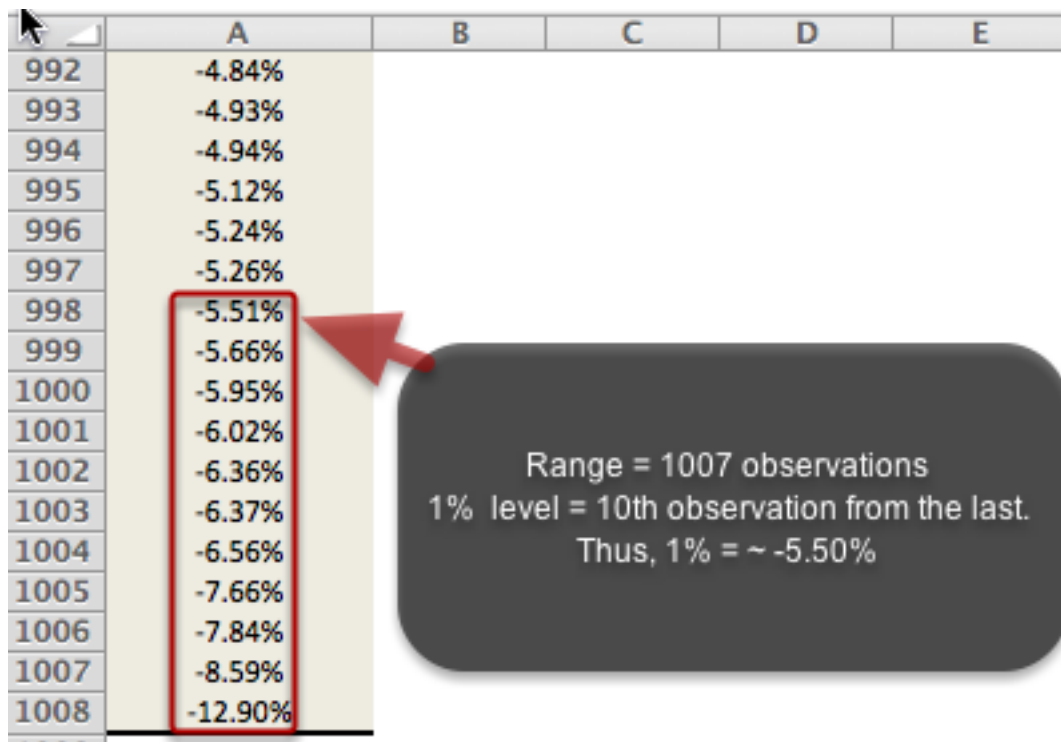
Step 14: Calculate Value at Risk

	RM	Returns
Mean	-9.89	-0.003%
St.Deviation	6,221.24	2.074%
Confidence level	99%	99%

VaR -16,492.24 -5.50%

Calculate VaR using Excel formula PERCENTILE.

Here, to calculate VaR with 99% of confidence level, we are using the following formula:
=PERCENTILE(RETURNS RANGE, 1%)

Step 15: Double check of the previous value

	A	B	C	D	E
992	-4.84%				
993	-4.93%				
994	-4.94%				
995	-5.12%				
996	-5.24%				
997	-5.26%				
998	-5.51%				
999	-5.66%				
1000	-5.95%				
1001	-6.02%				
1002	-6.36%				
1003	-6.37%				
1004	-6.56%				
1005	-7.66%				
1006	-7.84%				
1007	-8.59%				
1008	-12.90%				

Range = 1007 observations
1% level = 10th observation from the last.
Thus, 1% = ~ -5.50%

Arrange (sort) returns from best to worst, i.e. from highest positive to lowest negative, and pick 10th value from the end (1007 - 10 = 997),
which is 1 percentile of 1007 returns data = ~ -5.50%

Finally, VaR is 5.50% out of RM300,000 = -16,492.24 ringgits @ 99% confidence level.

GOOD LUCK!

Was-salamu 'aleykum wa rahmatullah!