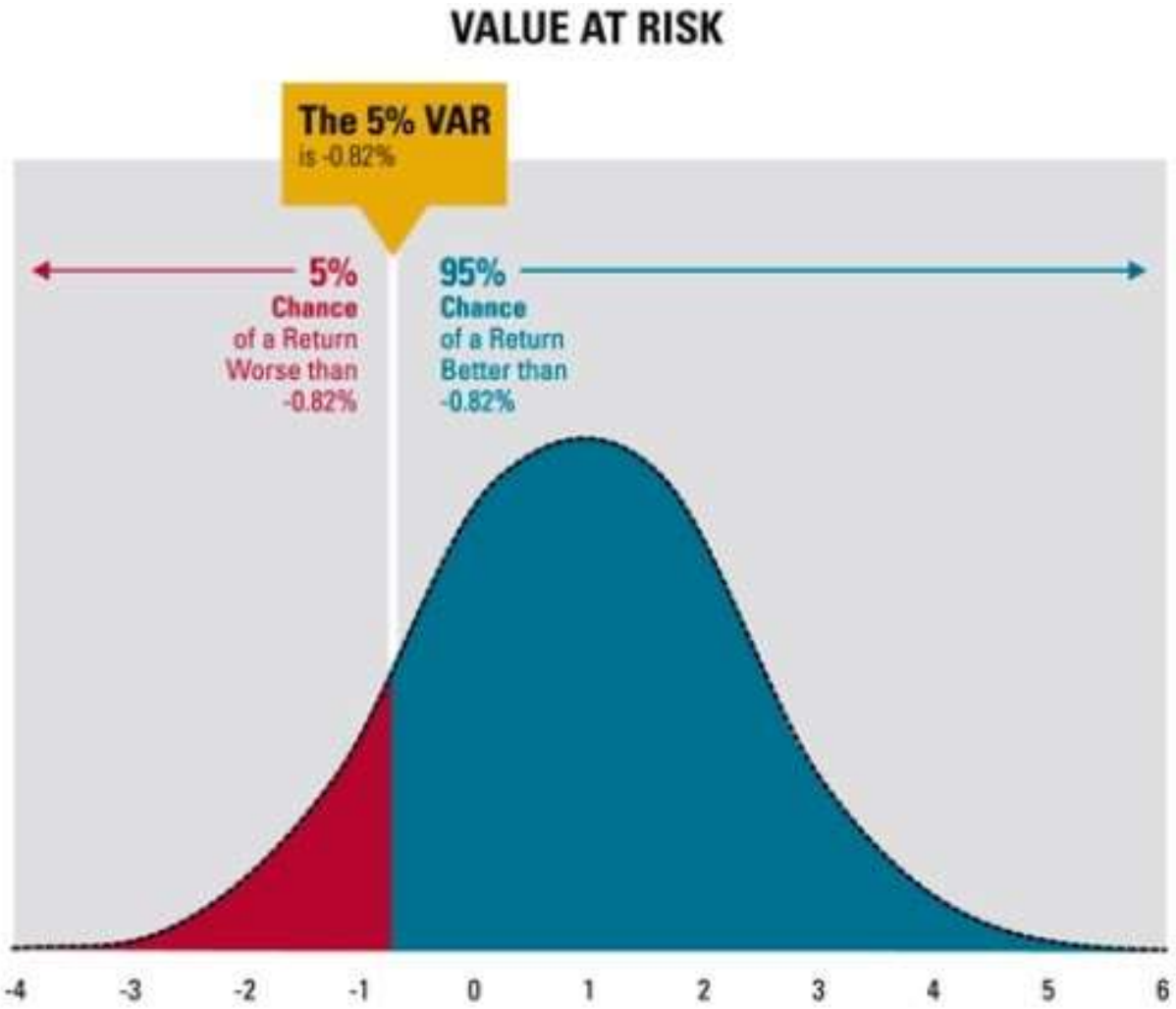
Value at Risk (VaR)

VaR

Value at Risk is the ***minimum loss*** that would be expected **a certain percentage of time** over **a certain period of time** given the assumed market conditions.



Example

In Percentage terms

5% Monthly VaR is 2.8%

In Dollar Terms or Amount

5% Monthly VaR is Rs. 100,000x2.8% = Rs. 2800 – 5%

Implies:

5% probability that the minimum loss is Rs. 2800 or 2.8% in a given month

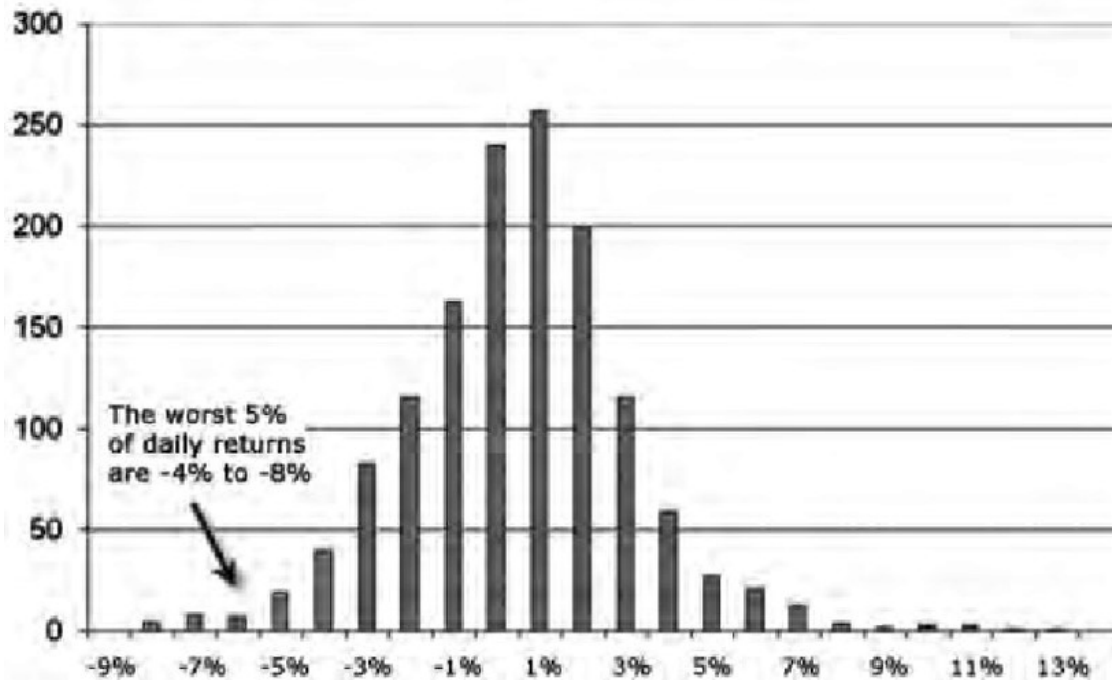
95% probability that maximum loss is Rs. 2800 in a given month

Back-testing to check if VaR is right

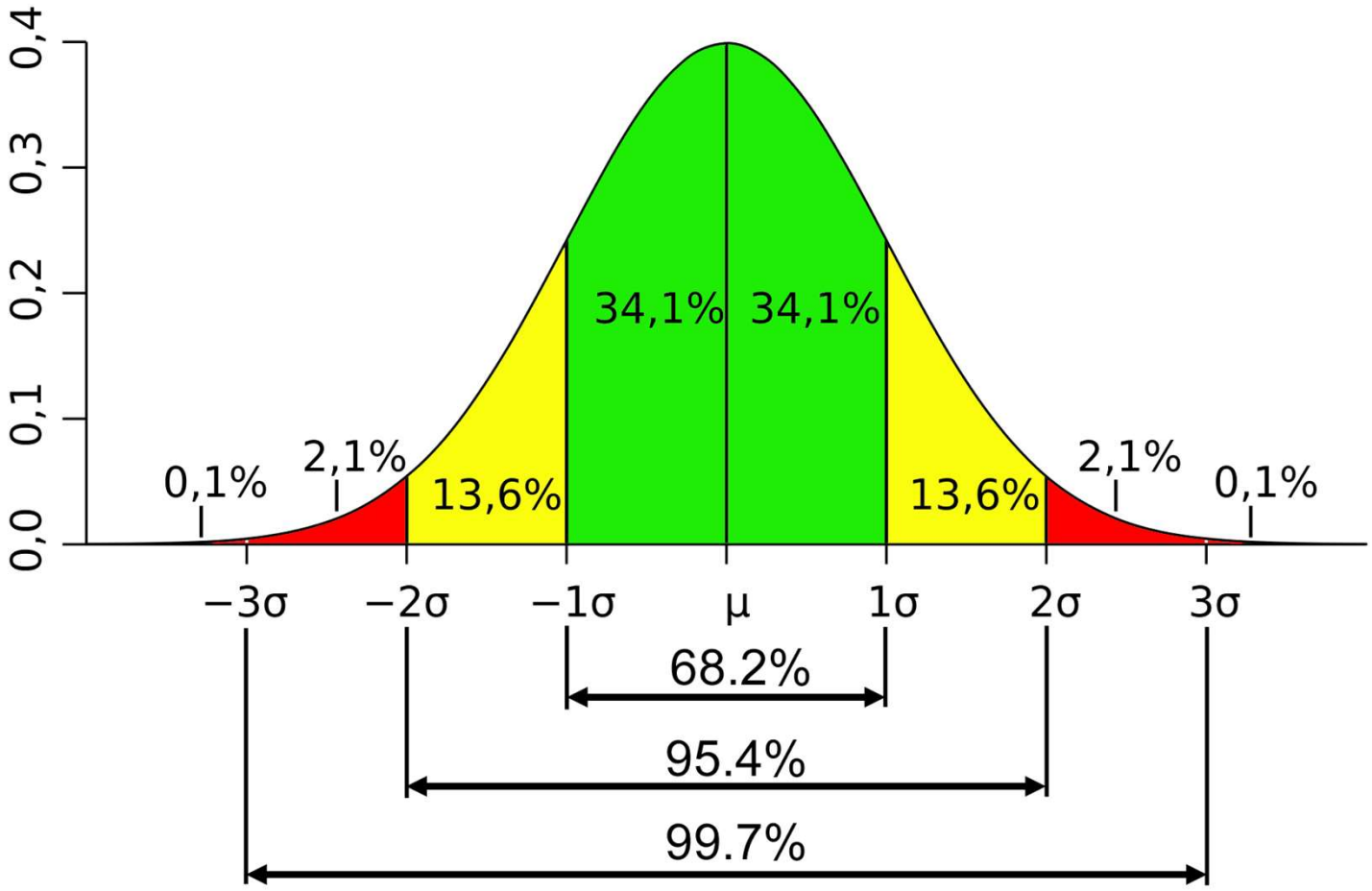
- In a 100 month data, if the loss greater than 2.8% / Rs. 2800 occurs more than 5 times it implies underestimation of VaR

- That implies Actual returns distributions have fatter tails compared to Normal Distribution

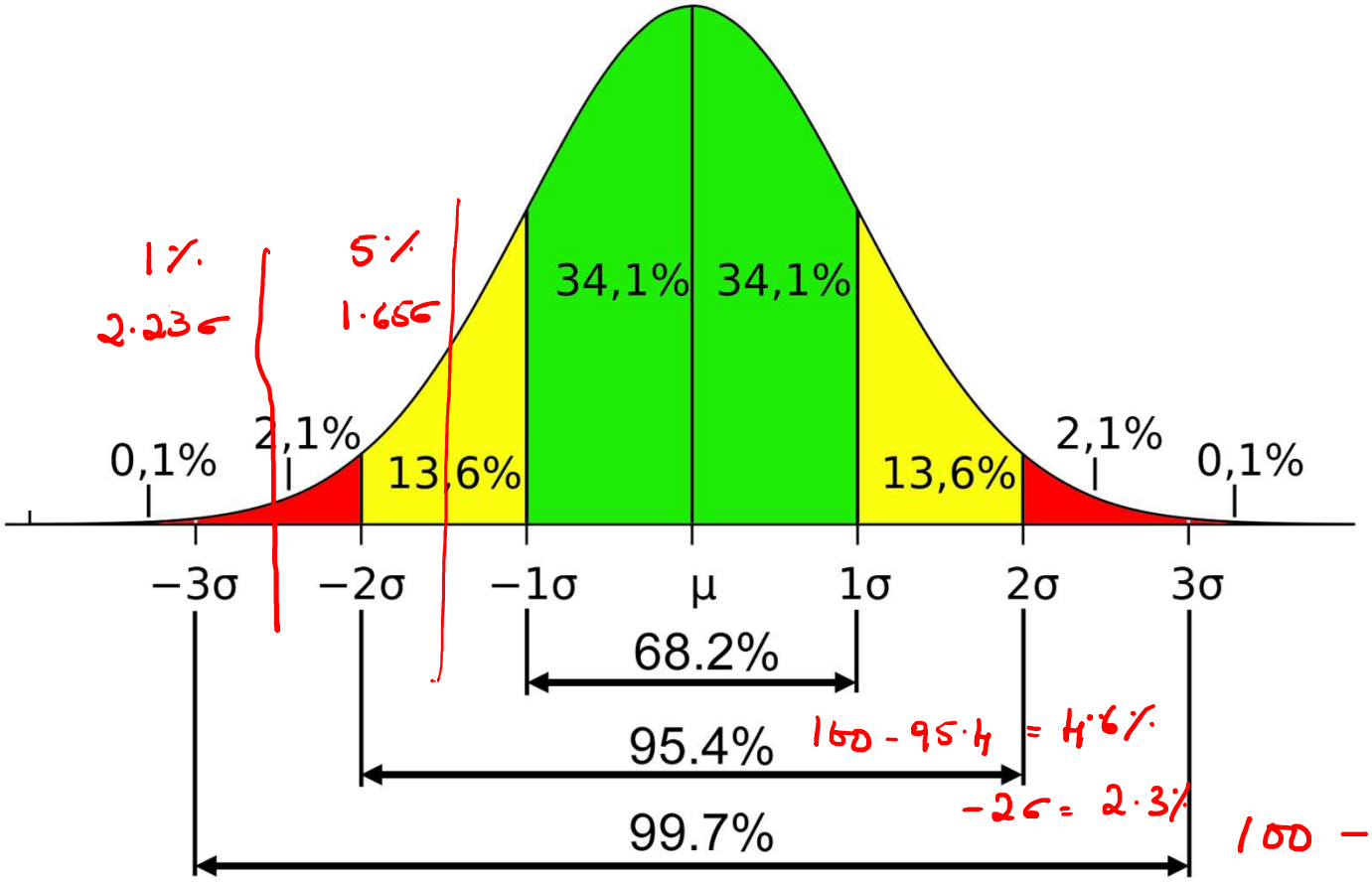
Estimating Value at Risk – Historical Simulation Method



- Collect data from historical lookback period
- Sort data from largest loss to greatest gain
- Choose the % based on the chosen confidence intervals


0,4
0,3
0,2
0,1
0,0
34,1%
34,1%
13,6%
13,6%
2,1%
2,1%
0,1%
0,1%
−3σ
−2σ
−1σ
μ
1σ
2σ
3σ
68.2%
95.4%
99.7%

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776


1%
2.23σ
5%
1.65σ
34,1%
34,1%
0,1%
2,1%
13,6%
13,6%
2,1%
0,1%
−3σ
−2σ
−1σ
μ
1σ
2σ
3σ
68.2%
95.4%
99.7%
100 - 95.4 = 4.6%
-2σ = 2.3%
100 - 99.7 = 0.3%
-3σ = 0.15%

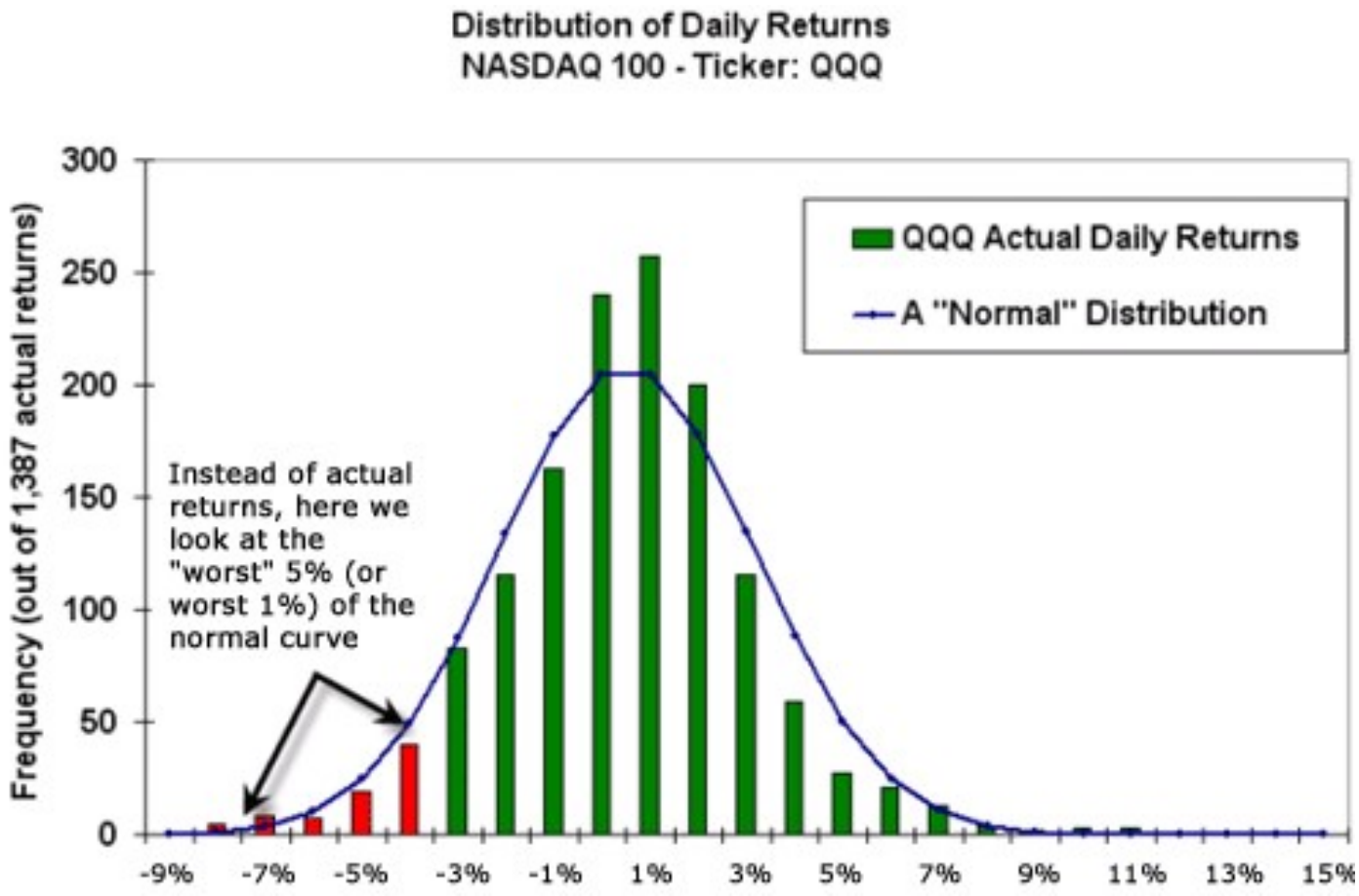
Estimating Value at Risk – Parametric Method / Variance –Covariance Method

- Collect data from historical lookback period
- Find the Mean & Standard Deviation
- Standardize the Normal Distribution

$$z = \frac{x - \mu}{\sigma}$$

μ = Mean

σ = Standard Deviation



Example

Portfolio Value = Rs. 100000

Monthly Return (mean) = 2%

Standard deviation monthly = 3%

Assumption: Normal Distribution

$$VaR = [EWR - (Z*STD)] * PV$$

- Where Var is the value at risk
- EWR is the expected weighted return of portfolio
- Z is the z score
- STD is the standard deviation
- PV is the portfolio value

Calculate VaR

Example Cont...

- **10 % Monthly VaR**
- Z value = 1.28
- VaR (%) = 2% - (3% x 1.28) = 1.84%
- VaR (amount) = 2% - (3% x 1.28) x 100000 = Rs. 1840

- **5 % Monthly VaR**
- Z value = 1.65
- VaR (%) = 2% - (3% x 1.65) = 2.95%
- VaR (amount) = 2% - (3% x 1.28) x 100000 = Rs. 2950

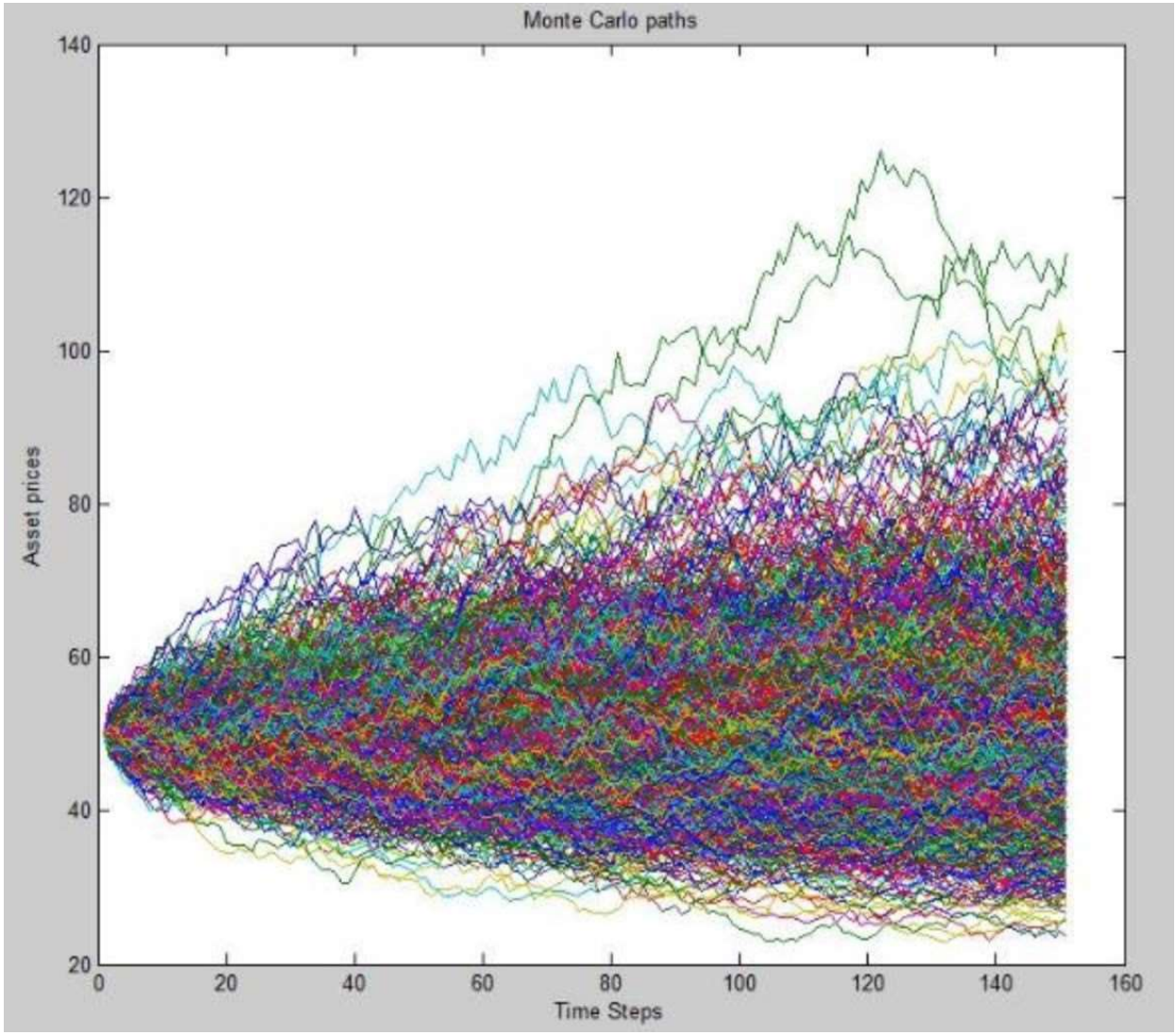
Example Cont...

- **1 % Monthly VaR**
- Z value = 2.33
- VaR (%) = 2% - (3% x 2.33) = 4.99%
- VaR (amount) = 2% - (3% x 2.33) x 100000 = Rs. 4990

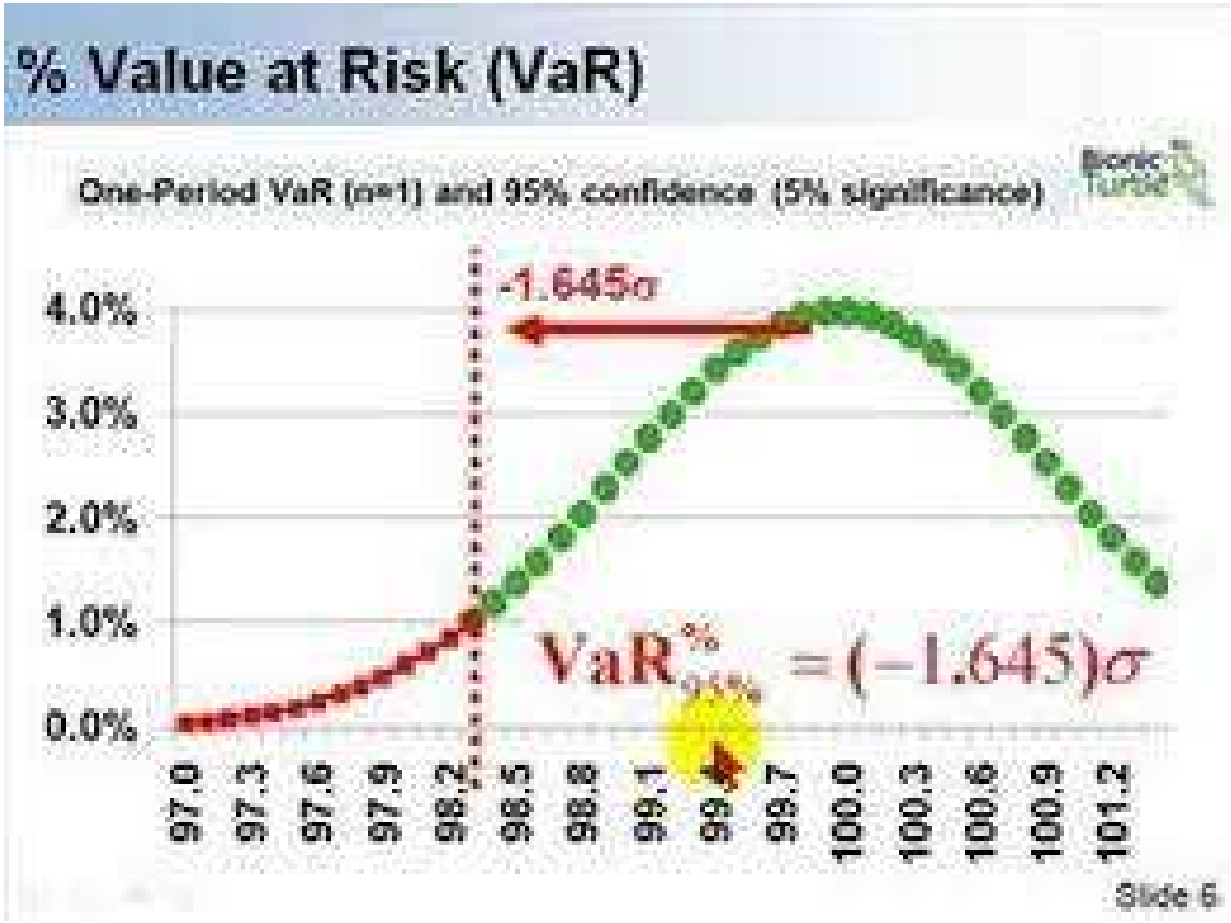
Monte Carlo Simulation Method

- No assumption of Normal Distribution
- Useful for large no of assets and risk factors
- Run 1000's of simulations to get the statistical characteristics
- Instead of using historical data, generate a random number that will be used to estimate the return

Monte Carol Simulation Method



% Value at Risk (VaR)



Confidence Level	The Maximum Loss--below the Expected or Average Return--as a Function of Standard Deviation (σ) and Time (T)
95% confidence	$-1.65 \times \sigma \times \sqrt{T}$
99% confidence	$-2.33 \times \sigma \times \sqrt{T}$