ASM PRESENTATION

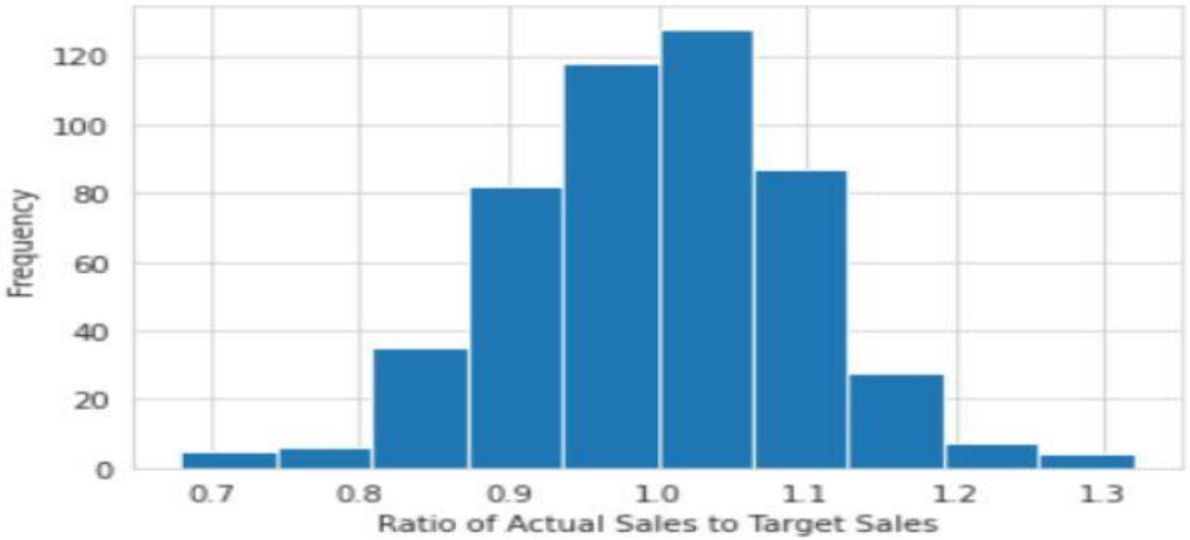
APPLICATION OF MONTE CARLO METHOD IN FINANCE

- Monte Carlo simulation offers numerous applications in finance. The most common applications of the model in finance include Stock-market valuation, portfolio valuation,Interest rate derivatives,risk assessments and other financial modellings.
- An example of application of monte carlo method in finance is to predict the range of potential values for a sales compensation budget.

Consider the Following example:

Sales Person	Sales Target (in Rupees)	Actual Sales (in Rupees)	Actual Sales/Sales Target	Commission Rate(Percentage)	Commission Amount (in Rupees)
1	100,000	88,000	0.88	2	1760
2	200,000	202,000	1.01	4	8080
3	75,000	90,000	1.2	4	3600
4	400,000	360,000	0.9	2	7200
5	500,000	350,000	0.7	2	7000

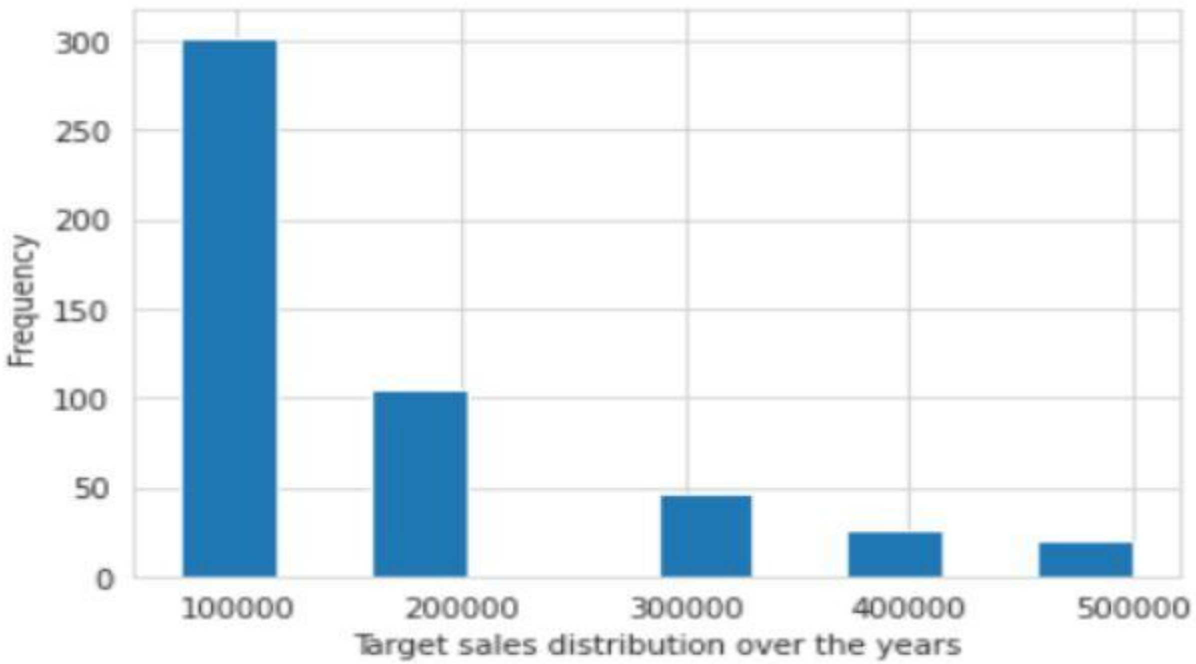
Based on the data from the previous years, the ratio of sales to Target is obtained as:



Commission Amount=Actual Sales * Commission Percentage

Commission Percentage depends on the ratio of actual sales to target sales.
If ratio >=1,commission rate is 4%
If ratio >0.9 and <1.0,commission rate is 3%
If ratio <=0.9,commission rate is 2%

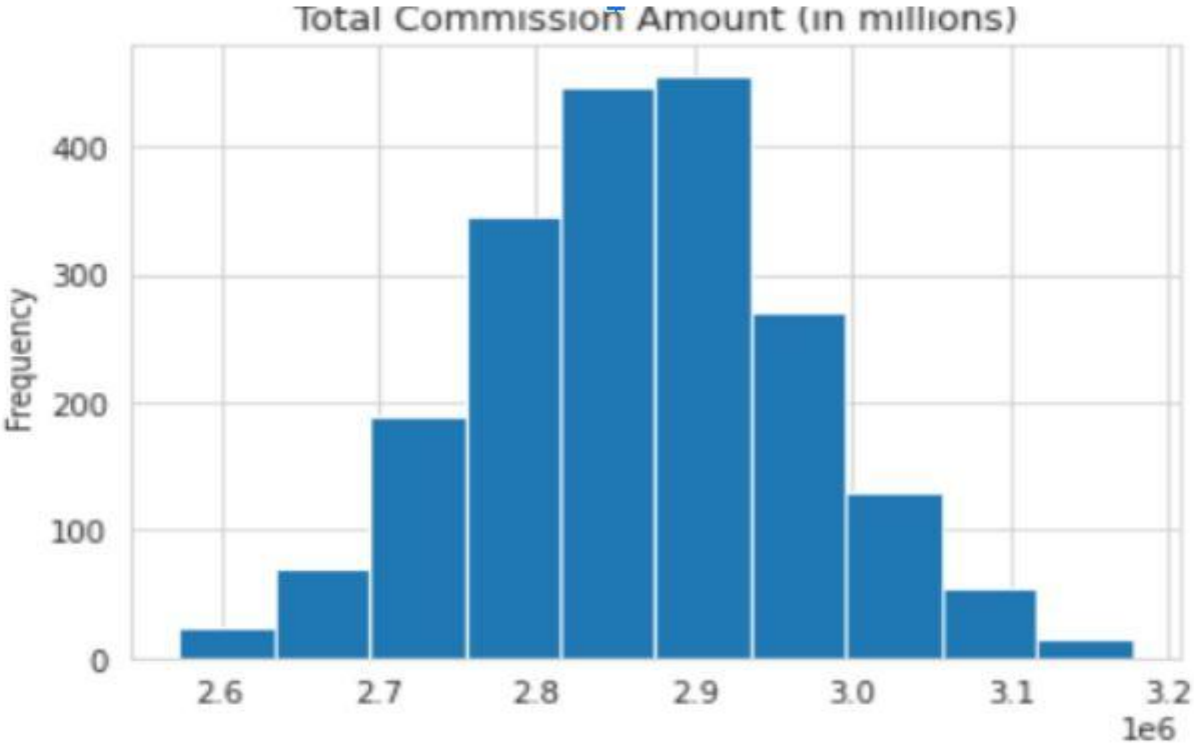
These values are based on a lot of uncertainties and their estimation for the future can be analyzed using monte carlo simulation. It involves running many scenarios with random inputs and summarizing the distribution of the results.

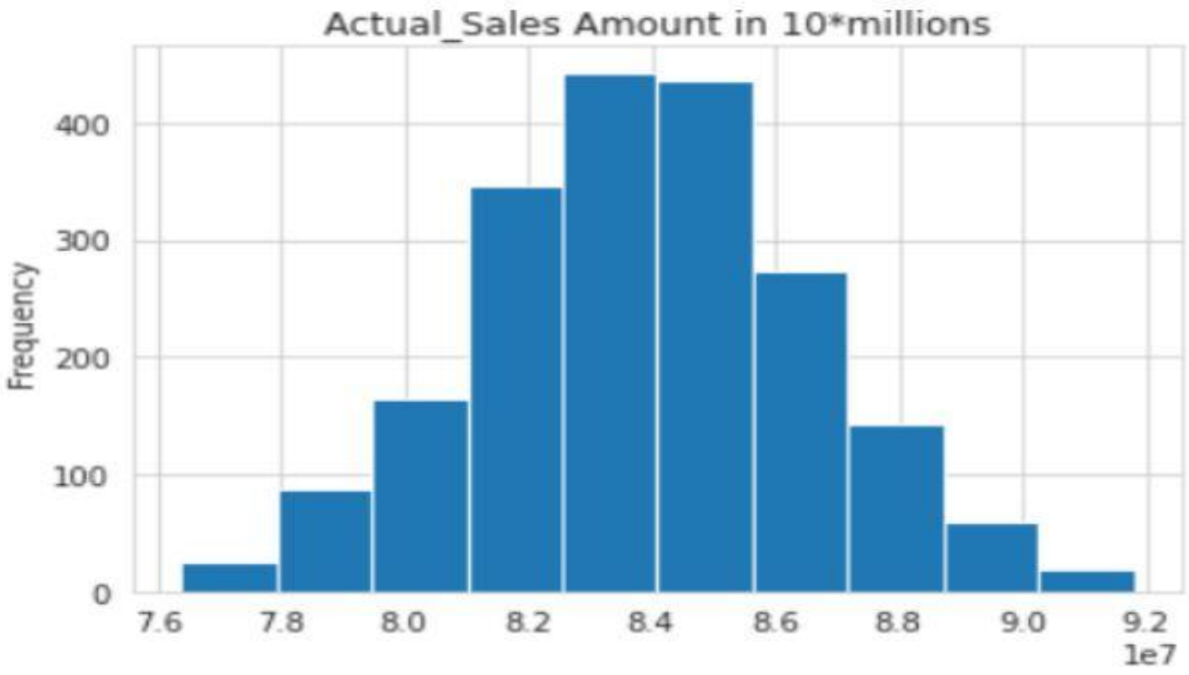


Frequency
300
250
200
150
100
50
0
100000
200000
300000
400000
500000
Target sales distribution over the years

- From the tables, it can be observed that the ratio of actual sales to target sales follows a Normal Distribution and the Mean is 1.0 with a standard deviation of 0.1
- It can also be observed that the target sales distribution over the years is most for Rs100,000 and Rs200,000 followed by Rs300,000 ,Rs 400,000 , Rs500,000

Actual Sales Amount	Probability
75,000	0.3
100,000	0.3
200,000	0.2
300,000	0.1
400,000	0.05
500,000	0.05

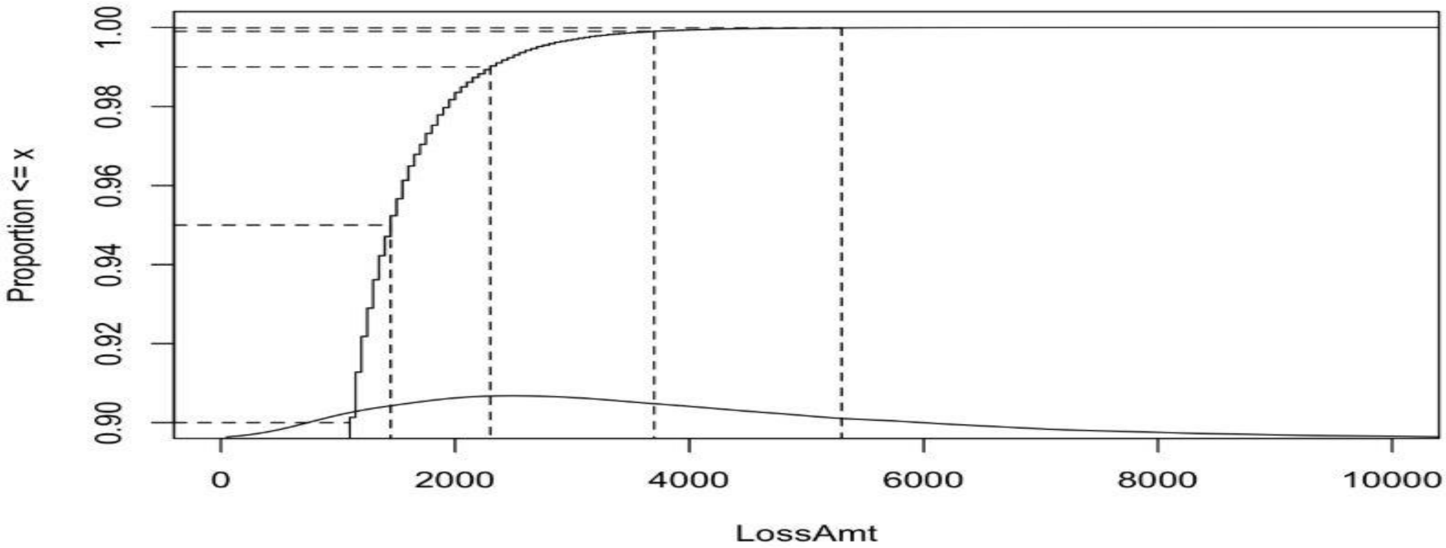

Total Commission Amount (in millions)
Frequency
0
100
200
300
400
2.6
2.7
2.8
2.9
3.0
3.1
3.2
1e6


Actual_Sales Amount in 10*millions
Frequency
0
100
200
300
400
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
9.2
1e7

Application of Importance Sampling to Simulate Portfolio Loss Distribution

- Credit risk mostly deals with tail cases as the portfolio can suffer an extreme credit even with less than 1%.
- In these cases, Naive Monte Carlo is inefficient as all scenarios are equally weighted which requires large number of simulations to reach convergence.
- Importance Sampling can improve the convergence by shifting the weight more on tails during simulation
- Instead of drawing simulations from a fixed mean=0, the simulations are drawn from a mean=-3 to draw which represents about 99.8% of loss.

- It can be noticed that Sampling Distribution is more concentrated at larger loss Amount.



Application of Markov Chain Monte Carlo Methods

- Data Mining and Machine Learning- They have various unusual and weird distributions that cannot be solved deterministically. Computer Vision makes heavy use of MCMC.
- Bayesian Methods require multiplication of prior distribution with some likelihood functions which may result in messy distributions. MCMC is used for them.
- Biological and Genetical Research: The Human genome is huge. So small samples are taken from them and combined at the end.

Simulated Annealing

- Simulated Annealing is a probabilistic technique for approximating the global optimum of a given function. Specifically, it is a metaheuristic to approximate global optimization in a large search space for an optimization problem.
- It is analogous to Annealing in Metallurgy where Metal is heated at high temperature and then cooled slowly to arrange all particles in the ground state.
- The Temperature T here implies the control parameter which starts at a high value and then lowered slowly depending on the chosen state.
- The Energy E implies the cost function which needs to be lowered.
- Annealing Schedules have to be changed depending on the state.

Travelling SalesMan Problem

- Given n cities and distance between them, we need to explore all the cities and return to the origin point.
- The problem doesn’t have a specific algorithm and it takes large amount of time to solve it by picking the best route of all the available routes.
- We can achieve a global optimal minimum using Simulated Annealing

Algorithm

1) Start with a Random Tour from the given cities.
2) Pick a new candidate tour at random from all neighbors of the existing tour.
3) If the candidate tour is better than the existing tour, then accept it as the new one
4) If the candidate tour is worse than the existing tour, we still need to accept it and assign a probability to it. The probability of accepting an inferior tour is a function of how much longer the candidate is compared to the current tour. A higher temperature makes you more likely to accept an inferior tour.
5) We need to iterate through the second step so many times till we are satisfied with our answer. After each iteration, the temperature is cooled. We need to change the cooling schedule if we are not satisfied with the result.

Though Simulated Annealing doesn't always guarantee of a global optimum everytime, it is better than the other Naive methods as the mean distance obtained by performing Simulated Annealing is less.

Scheduling Problem

- Simulated Annealing can also be used for scheduling and Time table purposes.
- An algorithm similar to the Travelling Sales Man Problem is used where we start off with a random partial solution and we can optimise it by choosing the next solution based on their Cost Functions and probabilities.