Introduction:

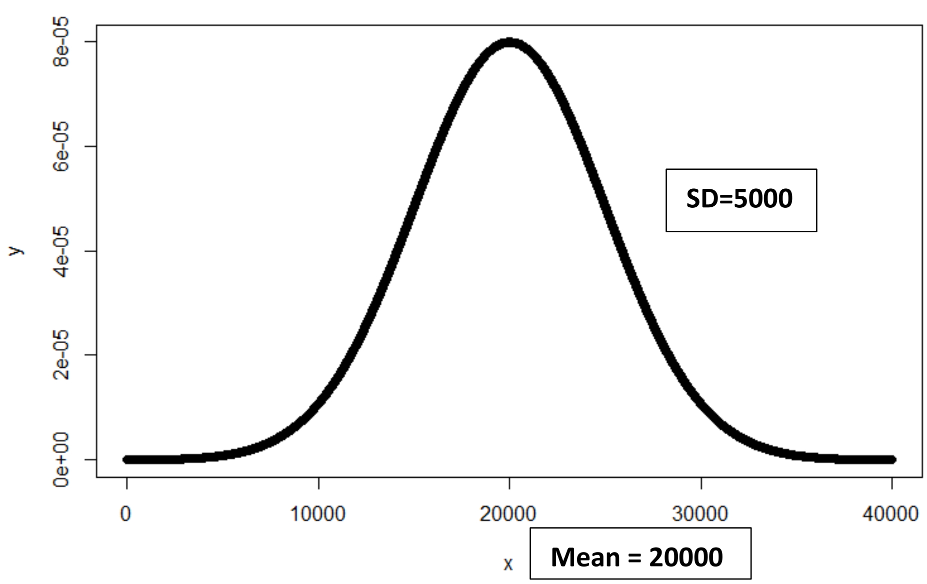
Specialty Toys, Inc., which sells a variety of children's toys, is planning to launch a new toy for the holiday season. However, the company is uncertain about the exact quantity to manufacture so that the profit will be maximum with low stockout probability. The management team have suggested different order quantities of 15000,18000,24000, 28000 units. The Specialty's senior sales forecaster has predicted an expected demand of 20,000 units with a .95 probability that the demand would be between 10,000 and 30,000 units. Taking these forecasts into consideration, we will compute the probability of stock-outs, profit margins for these suggested order quantities. Analyzing this data, we need to provide an estimate of the quantity to be ordered by Specialty Toys for the new product.

Question 1:

- According to forecasters prediction 95% values are predicted between 10000 and 30000.
- So, from empirical rule ,95% values are between ± 2 standard deviation of its mean

$$\boldsymbol{\mu - 2\sigma = 10000 \text{ and } \mu + 2\sigma = 30000}$$

- Solving these 2 equations we get the **mean(μ=20000)** and **standard deviation(σ=5000)**
- The mean value of 20000 also matches the expected demand as per the prediction
- Using these values, below is the normal probability distribution graph for demand distribution



Question 2:

- For stockout probability compute the z score value for each quantity. The area to the right of the z score value in the normal probability distribution gives the stockout probability

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

- Using the above formula and taking mean(μ=20000) and standard deviation(σ=5000)

1. For x=15000, z=-1
   So, p(z>-1) =1-0.1587 (From the Z score table we got p(z<-1)=0.1587)
   P(z>-1) = 0.8413

2. For x=18000, z= -0.4
   So, p(z>-0.4) =1-0.3446 (From the Z score table we got p(z<-0.4)=0.3446)
   P(z>-0.4) = 0.6554

3. For x=24000, z= 0.8
   So, p(z>0.8) =1-0.7881 (From the Z score table we got p(z<0.8)=0.7881)
   P(z>0.8) = 0.2119

4. For x=28000, z= 1.6
   So, p(z>1.6) =1-0.9452 (From the Z score table we got p(z<1.6)=0.9452)
   P(z>1.6) = 0.0548

Quantity	15000	18000	24000	28000
Stockout Probability	0.8413	0.6554	0.2119	0.0548

- The stockout probability decreases as the order quantity increases as inferred from the above table

Question 3:

- Computing the projected profits using suggested quantities and sales for different scenarios

  Case 1: suggested quantity = 15000, (Worst case) sales= 10000
  - Each unit is purchased for $16
    Total Cost Price (CP) = 15000*16

= 240000

- Sales during the holiday season will be sold at $24
  Selling Price 1 (SP1) = 10000*24
  = 240000
- Surplus inventory quantities will be sold at $5
  Selling Price 2 (SP2) = (Suggested quantity – sales quantity) * 5
  = (15000 – 10000) * 5
  = 25000
- Total Selling Price (SP) = SP1 + SP2
  = 265000
- Projected Profit = SP – CP

  Projected Profit = 25000

- Created a function in R to do above computation which returns the projected profit
- Similarly computed the projected profit for each quantity with each scenario in the table below

Quantity	15000	18000	24000	28000
Worst Case Profit	25000	-8000	-74000	-118000
Most likely Case Profit	120000	144000	116000	72000
Best Case Profit	120000	144000	192000	224000

- Negative values indicate loss

Question 4:

- Stockout probability should not be less than 30 percent
- So, for this need to find the z value that cuts of an area of 0.30 in the right tail of standard data distribution
- By looking at the complement of right tail area i.e.
  1-0.30 = 0.70 is z score table,
  the **z = 0.525**
- Quantity for this z value can be computed as:

$$\boldsymbol{Z = \frac{x - \mu}{\sigma}}$$

0.525=(x-20000)/5000

X = 22625

- The quantity order of **22625** will place the probability of stockout to less than 30 percent
- Computing projected profit for all three-case scenario using the method in Question 3

Quantity	22625
Worst case profit	-58875
Most likely case profit	131125
Best case profit	181000

Question 5:

- To find out the best possible order quantity, referring to the profits from Q3 and Q4
- The mean value of profits for all the scenarios are computed as below

Quantity	15000	18000	22625	24000	28000
Profit - Sum	265000	280000	253250	234000	178000
Profit - Mean	88333.33	93333.33	84416.66	78000	59333.33

- From the above table the maximum profit-mean lies between quantities 18000 to 22625
- Computing for the order quantity between these quantities

Quantity	18000	19000	20000	21000	22625
Worst case profit	-8000	-19000	-30000	-41000	-58875
Most likely case profit	144000	152000	160000	149000	131125
Best case profit	144000	152000	160000	168000	181000
Profit - Sum	280000	285000	**290000**	276000	253250
Profit - Mean	93333.33	95000	**96666.66**	92000	84416.66

- From the above table, the maximum profit-sum is for quantity 20000 and so is the maximum profit-mean
- Also, in real time scenario i.e., the most likely case the projected profit comes out to be maximum if order quantity is 20000 units