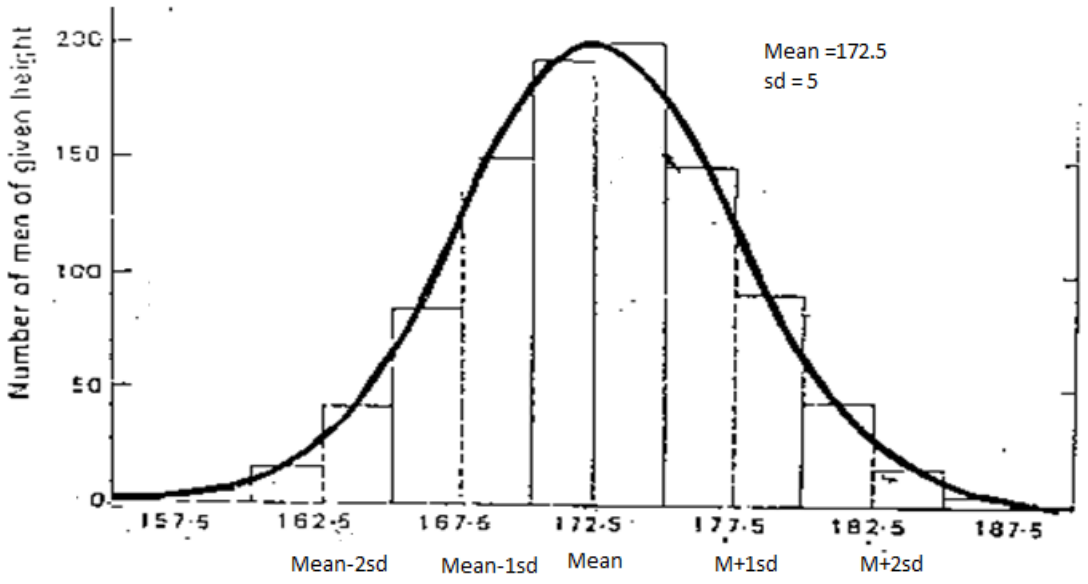
CMD **305 - COURSE**
(RESEARCH METHODOLOGY & BIOSTATISTICS)

TUTORIAL TOPIC: **NORMAL DISTRIBUTION**

Q1) using the NORMAL curve shown below, answer the following questions:

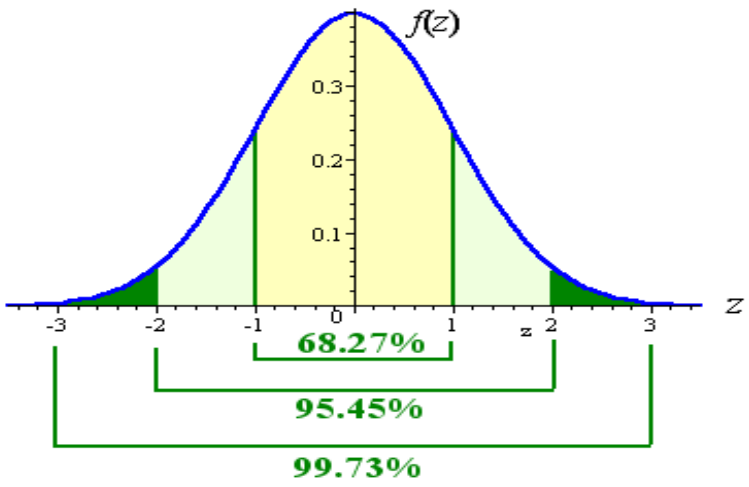


a) The normal curve is a bell shaped curve.
b) The total area under the curve is equal to 1
c) 68% of the area lies between (mean-sd) and (mean+sd)
d) 95% of the area lies between (mean-2sd) and (mean+2sd).
e) 99% of the area lies between (mean-3sd) and (mean+3sd)
f) Normal distribution can be standardized in terms of a quantity called

$$Z = \frac{\text{Observation - Mean}}{\textbf{Standard deviation}}$$

what do you call this Z: standard normal deviate

Q2) standardized normal curve (mean 0 and variance 1) is shown below



Looking at the graph, fill up the following:

a) What is the area lies between $-1 \le Z \le 1$? 68.27%

b) What is the area lies between $-2 \le Z \le 2$? 95.45%

c) What is the area lies between $-3 \le Z \le 3$? 99.73%

Q3) To find the shaded area under normal curve from mean to z value 1.45 using z tables.

Solution: 0.4265

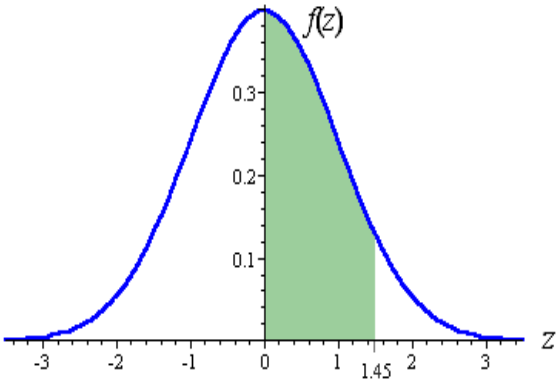


Table: Standard Normal Distribution – Area from 0 to Z value

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3304	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999

Q4) If the distribution of heights of persons in a city has mean height 65" and sd 2"

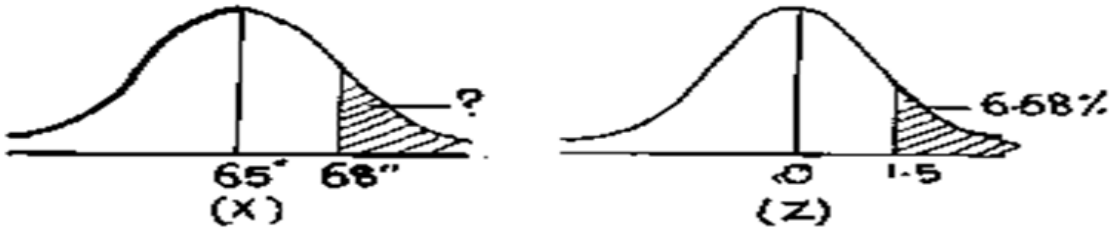
a) Find the Proportion of persons whose height exceeds 68"

Solution: Normal deviate = Z = (X- mean)/sd = (68-65)/2 = 1.5

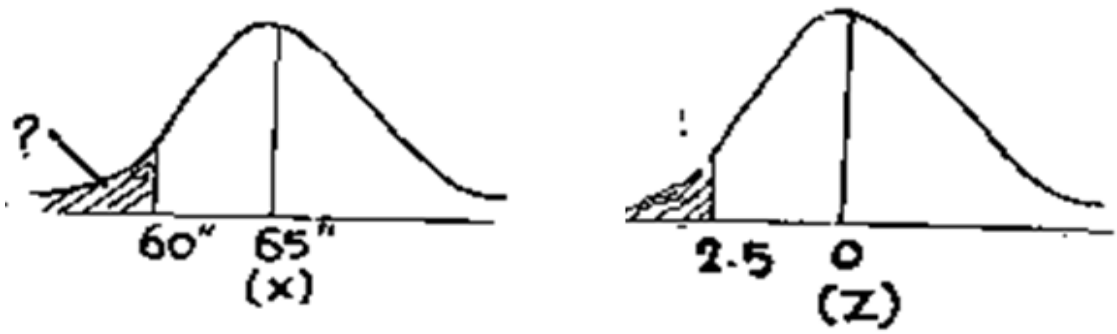
The z table gives areas from 0 to z. But, now we want the area from z to infinity. This gives us proportion of persons whose height exceeds 68'.

We know the area from 0 to infinity is 0.5. so, if we subtract area of 0 to 1.5 from 0.5, we get the area from z to infinity.

Area from 1.5 to infinity = (0 to infinity) – (0 to 1.5)
= 0.5 – 0.4332
=0.0668= 6.68%
That is, there are nearly 7% of persons whose height exceeds 68"



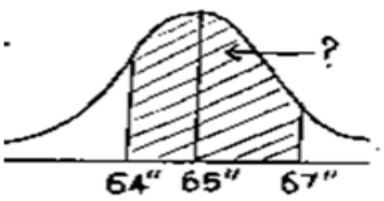
b) Find the proportion of persons whose height is less than 60"
Solution: compute Normal deviate = Z = (X- mean) /sd
= (60-65)/2 = -2.5
We want the area from - ∝ to –2.5 because we want proportion of persons whose height is less than 60".
We know that area from - ∝ to –z to from z to + ∝
The z tables give areas from 0 to z
We know the area from 0 to infinity is 0.5. So, if we subtract value of 0 to 2.5 from 0.5, we get the area from z to infinity.
Area from 2.5 to infinity = (0 to infinity) – (0 to 2.5) = 0.5 - 0.4938 = 0.0062 = 0.6 %
There are nearly 0.6% of persons whose height is <60"

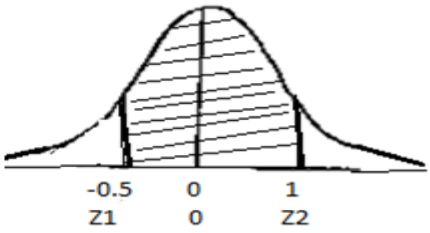


c) Proportion of persons whose height is in between 64 " & 67”

Solution:

First, find Normal deviate for 64” Z1 = (64 – 65)/2=-0.5
Next, find Normal deviate for 67” Z2 = (67 – 65)/2=1
We want the area from -0.5 to 1
Z table gives area from 0 to z.
We know area from -0.5 to 0 is same as area from 0 to 0.5
Hence, answer to the problem is to add the areas
From 0 to 0.5 and from 0 to 1
Area from 0 to 0.5 = 0.1915
Area from 0 to 1 = 0.3413
Area from -0.5 to1 = 0.5328 = 53.28%
There will be 53% of persons whose height is in between 64 " & 67”





Q5) suppose cholesterol level in a healthy population follows normal distribution with mean cholesterol = 160 mg/dl and; S.D. = 25 mg/dl

a) <u>What percentage of population is likely to have a level more than 210 mg/dl?</u>

Solution: first we draw rough normal curve showing which area we want to find. Next we want area from 210 to the end and we find the z value corresponding to 210 mg/dl and find the area from this z to the end.

z= (x-mean)/sd = (210-160)/25 = 50/25=2
Area from 2 to end = 0.5 – area from 0 to 2 (from the tables)
= 0.5 – 0.4772 = 0.0228 = 2.3%
<u>2.3% population is likely to have a level more than 210 mg/dl</u>

b) <u>What percentage of population is likely to have a level between 110 and 210 mg/dl?</u>

<u>Solution:</u> here also draw rough normal curve and shade the area from 110 and 210 mg/dl and then find the z values corresponding to 110 and 210 find the area from the z tables.

Let z1= (x- mean)/sd = (110-160)/25 = -50/25= -2

Let z2= (x- mean)/sd = (210-160)/25 = 50/25= 2

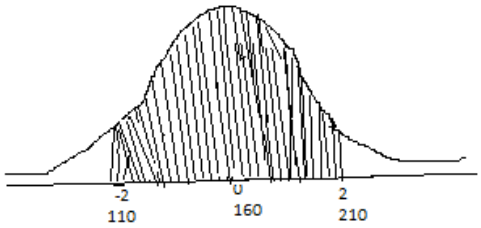
Area from -2 to 2 = (area from -2 to 0) + (area from 0 to 2)

Area from -2 to 0 = area 0 to 2 because of symmetry,

Area from -2 to 2 = 0.4772+0.4772

= 0.9554 = 95.54%

96% of the population is likely to have a level between 110 and 210 mg/dl



c) <u>What percentage of population is likely to have a level below 160mg/dl?</u>

<u>Solution:</u> here also first draw rough normal curve and shade the area up to 160mg/dl and find z value corresponding to 160.

Let z= (x- mean)/sd = (160-160)/25 = 0

Area up to 0 = 0.5 = 50%

50% of population is likely to have a level below 160mg/dl.

(NB: without calculation z itself, we can tell because 50% lie below mean value 160 mg/dl)