

SOCI 326

Quantitative Methods in Social Research

Session 2 – Normal Distribution

Lecturer: Dr. Rabiu K. B. Asante, Sociology Dept
Contact Information: rkbasante@ug.edu.gh



UNIVERSITY OF GHANA

College of Education

School of Continuing and Distance Education

2014/2015 – 2016/2017

Session Overview

This session introduces students to the concept of the normal curve and the standard normal curve. It also focuses on helping students to make the link between the variables we observe and how we can use the normal curve to assess these variables. The concept of the normal curve is one of the fundamental tools used to understand inferential statistics. Students are therefore advised to be patient with themselves to go through this session to allow them to build the needed knowledge to help them understand the subsequent chapters.

Session Outline

This session will introduce students to the normal curve by doing the following:

- Identifying the characteristics of the normal curve
- Using the Z-table to explain the distribution under the standard normal curve
- Convert observations into Z-distributions and plotting on the standard normal curve

Reading List

- Healey, J. F. (2010). ***Statistics: A Tool for Social Research.*** Wadsworth: CA, , pg 117 -130

Topic One

THE NORMAL CURVE

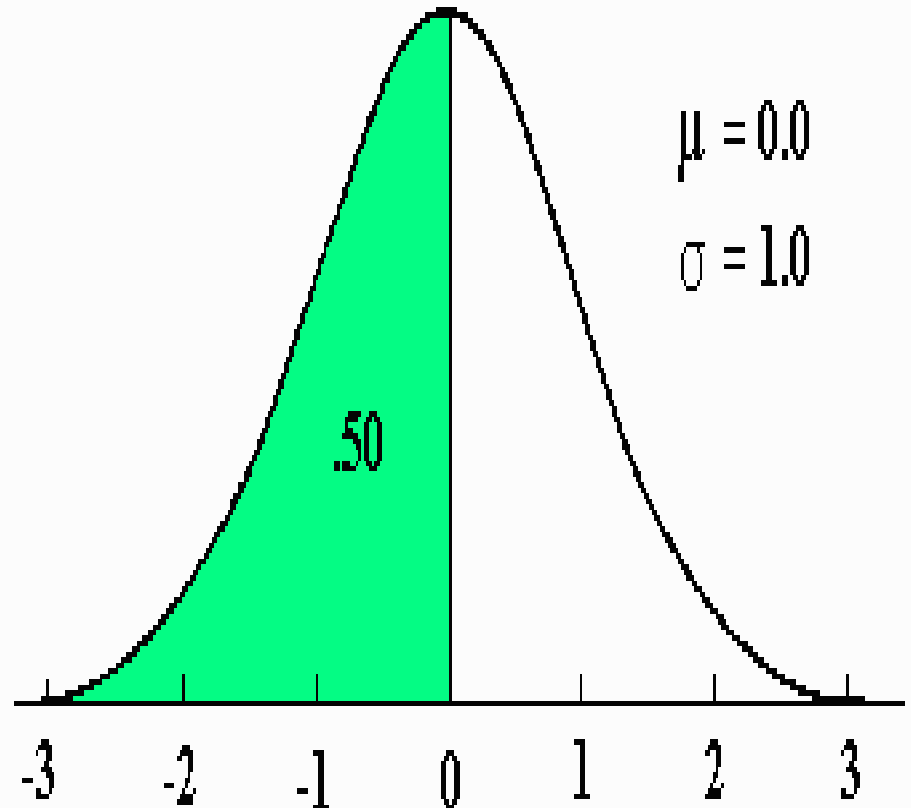


The normal curve

- The normal curve 'is a symmetrical distribution of scores with an equal number of scores above and below the midpoint of the abscissa (the horizontal axis, or 'x-axis', for the curve)

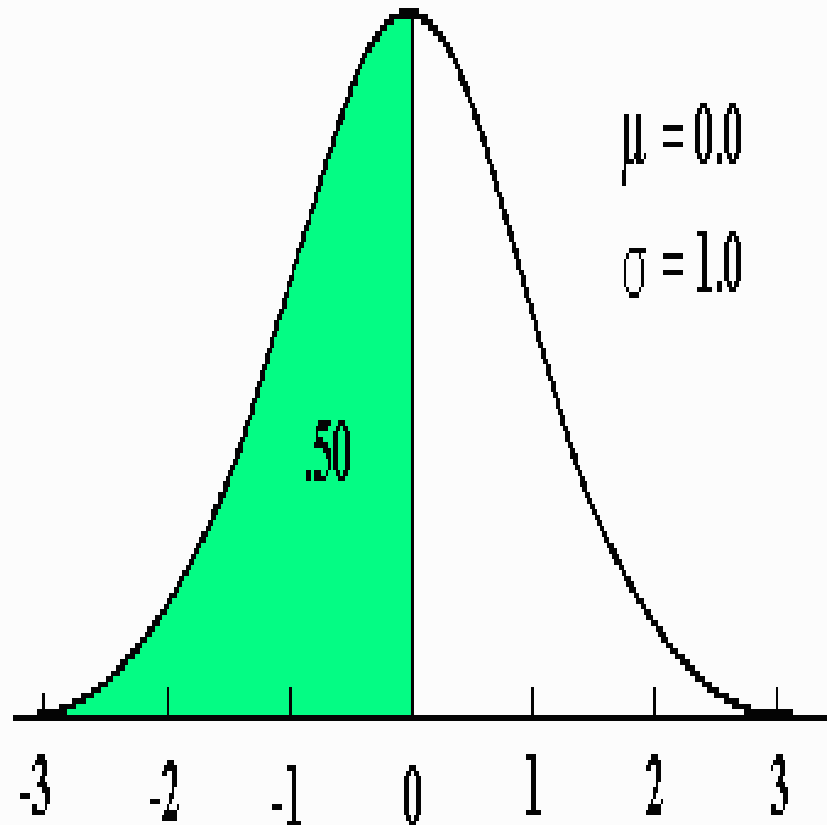
Characteristics of the normal curve

1. Unimodal (i.e., has a single mode, or peak)
2. Symmetrical (unskewed), so its mean, median, and mode are all exactly the same value
3. It is bell shaped
4. Its tail extends infinitely in both directions



...continuation

- The normal curve always has a mean of 0 and a standard deviation of 1
- In combination with the mean and standard deviation, the normal curve can be used to construct precise descriptive statements about empirical distributions
- The **X-axis** on a standard normal curve is often relabelled and called **Z scores**



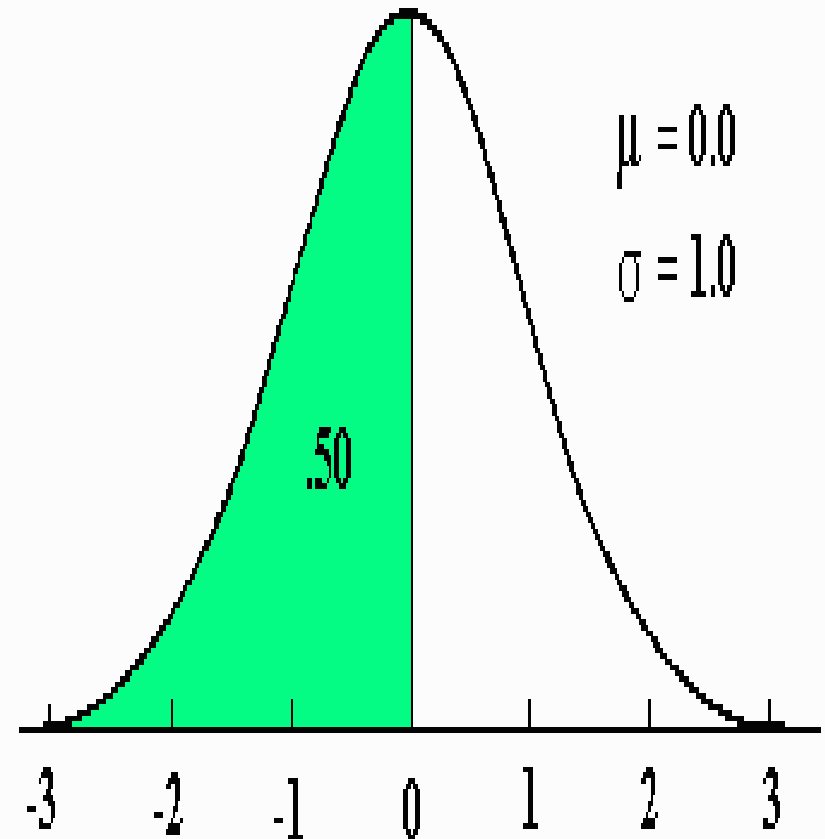
Topic Two

AREAS UNDER THE NORMAL CURVE

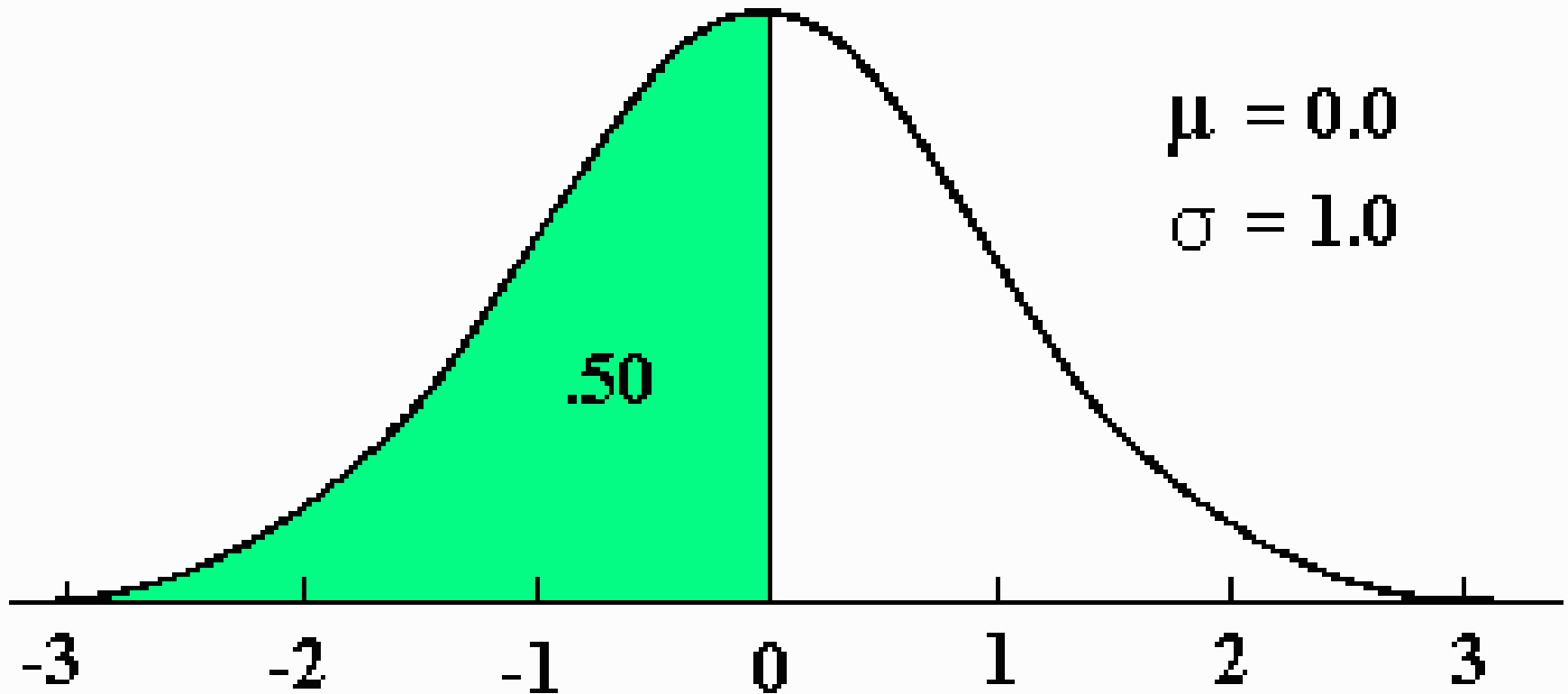


Three Areas on a Standard Normal Curve

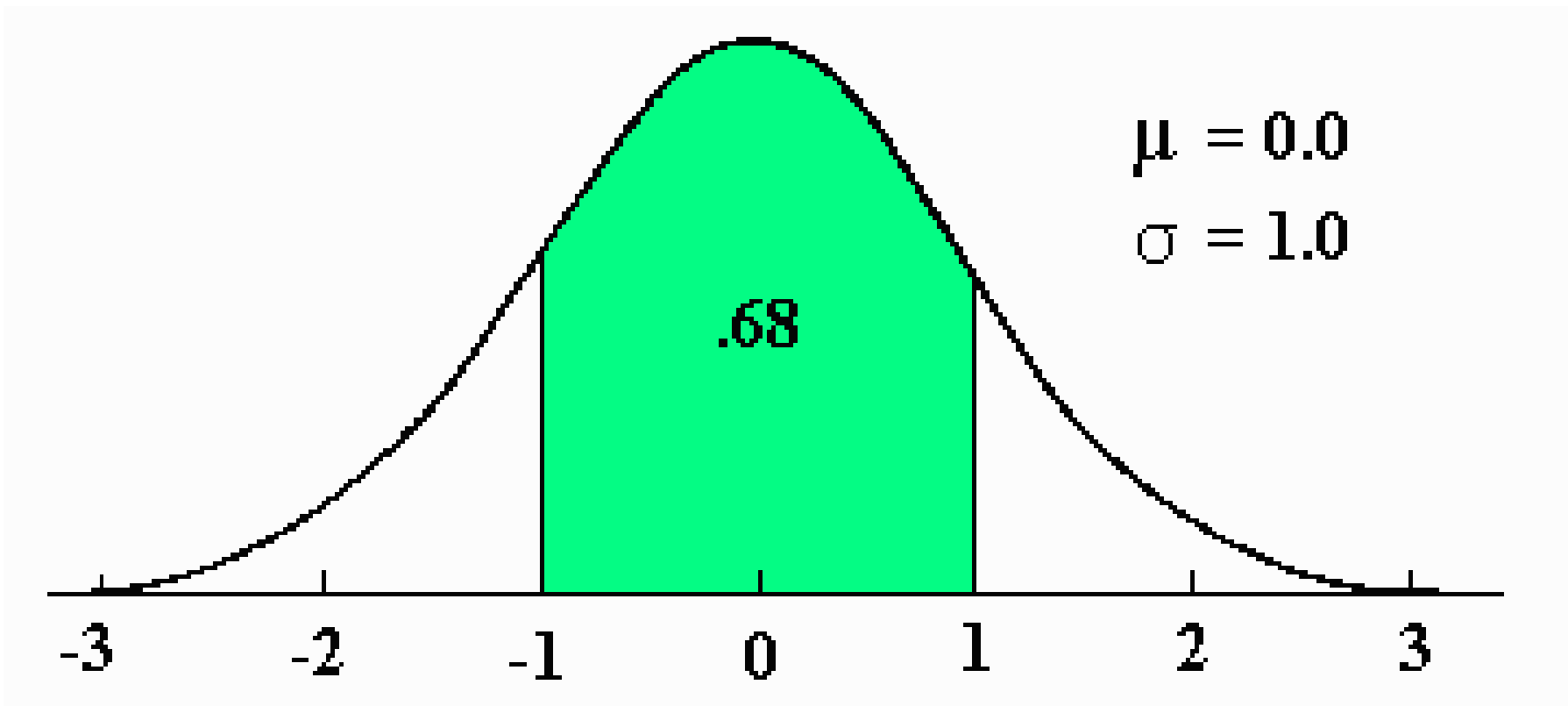
1. The total area below 0.0 is .50 (i.e. the total area below the value of mu is 0.50)
2. The area between Z-scores of -1.00 and +1.00. It is 0.68 or 68%
3. The third area is between Z-scores of -2.00 and +2.00 and is 0.95 or 95%



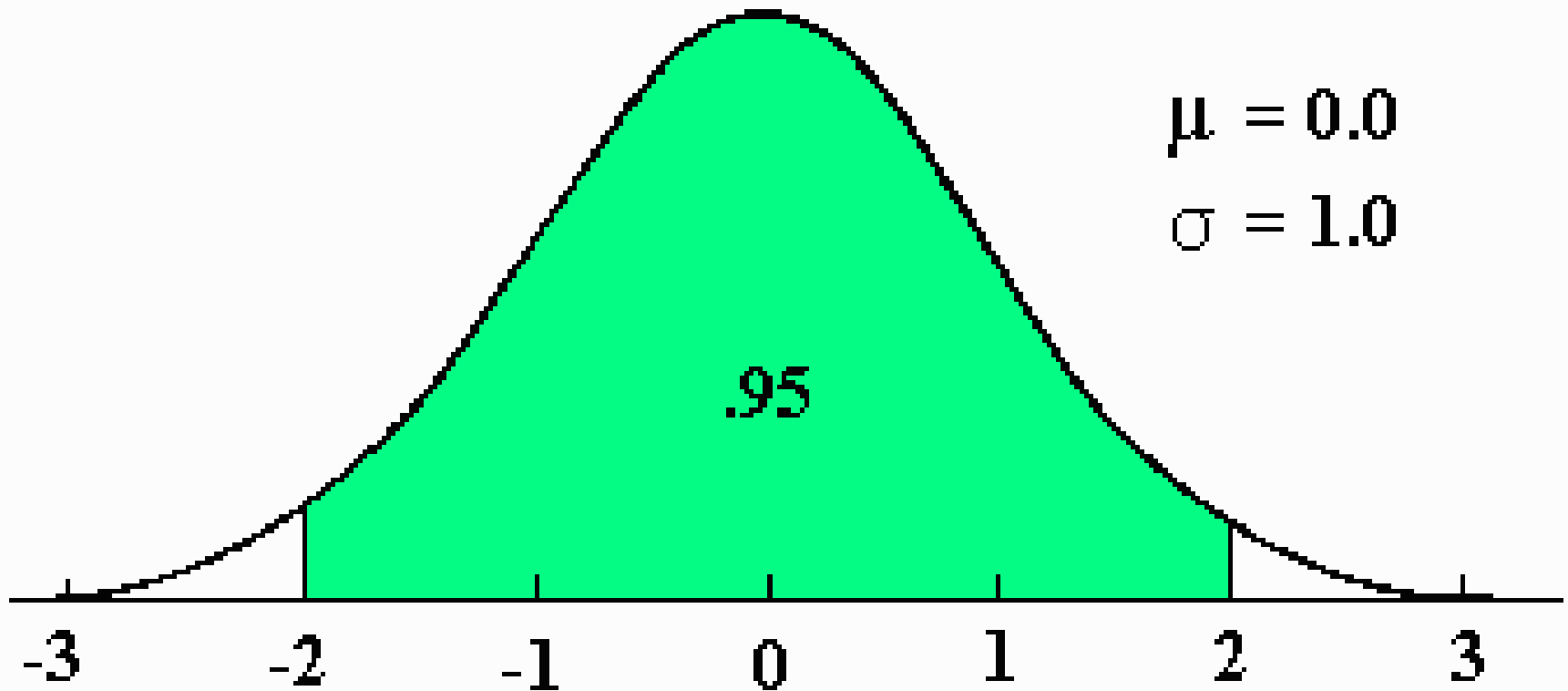
1. The total area below 0.0 is 0.50 (i.e. the total area below the value of mu is 0.50)



2. The total area between Z-scores of -1.00 and +1.00 is 0.68 or 68%



3. The total Area between Z-scores of -2.00 and +2.00 is 0.95 or 95%



Topic Three

READING THE Z TABLE



Features of the Z-table

- Note the following features:
- The column circled **red** is the Z- scores column Click on the link below for table
- The **blue column** is the proportion of the Area between the mean and a specific Z- score
- The **green column** is the proportion of the Area beyond a specific positive Z- score or Areas in the tails
- To read for a specific Z-score,
- Locate the score in the Z column then trace to the corresponding column (area between or area beyond)

Area Under the Normal Curve

Column (a) lists Z scores from 0.00 to 4.00. Only positive scores are displayed, but, since the normal curve is symmetrical, the areas for negative scores will be exactly the same as areas for positive scores. Column (b) lists the proportion of the total area between the Z score and the mean. Figure A.1 displays areas of this type. Column (c) lists the proportion of the area beyond the Z score, and Figure A.2 displays this type of area.

FIGURE A.1 AREA BETWEEN MEAN AND Z



(a) Z	(b) Area Between Mean and Z	(c) Area Beyond Z
0.00	0.0000	0.5000
0.01	0.0040	0.4960
0.02	0.0080	0.4920
0.03	0.0120	0.4880
0.04	0.0160	0.4840
0.05	0.0199	0.4801
0.06	0.0239	0.4761
0.07	0.0279	0.4721
0.08	0.0319	0.4681
0.09	0.0359	0.4641
0.10	0.0398	0.4602
0.11	0.0438	0.4562
0.12	0.0478	0.4522
0.13	0.0517	0.4483
0.14	0.0557	0.4443
0.15	0.0596	0.4404
0.16	0.0636	0.4364
0.17	0.0675	0.4325
0.18	0.0714	0.4286
0.19	0.0753	0.4247
0.20	0.0793	0.4207

FIGURE A.2 AREA BEYOND Z



(a) Z	(b) Area Between Mean and Z	(c) Area Beyond Z
0.21	0.0832	0.4168
0.22	0.0871	0.4129
0.23	0.0910	0.4090
0.24	0.0948	0.4052
0.25	0.0987	0.4013
0.26	0.1026	0.3974
0.27	0.1064	0.3936
0.28	0.1103	0.3897
0.29	0.1141	0.3859
0.30	0.1179	0.3821
0.31	0.1217	0.3783
0.32	0.1255	0.3745
0.33	0.1293	0.3707
0.34	0.1331	0.3669
0.35	0.1368	0.3632
0.36	0.1406	0.3594
0.37	0.1443	0.3557
0.38	0.1480	0.3520
0.39	0.1517	0.3483
0.40	0.1554	0.3446

Last page of the Z-table

(a) Z	(b) Area Between Mean and Z	(c) Area Beyond Z	(a) Z	(b) Area Between Mean and Z	(c) Area Beyond Z
2.61	0.4955	0.0045	3.11	0.4991	0.0009
2.62	0.4956	0.0044	3.12	0.4991	0.0009
2.63	0.4957	0.0043	3.13	0.4991	0.0009
2.64	0.4959	0.0041	3.14	0.4992	0.0008
2.65	0.4960	0.0040	3.15	0.4992	0.0008
2.66	0.4961	0.0039	3.16	0.4992	0.0008
2.67	0.4962	0.0038	3.17	0.4993	0.0007
2.68	0.4963	0.0037	3.18	0.4993	0.0007
2.69	0.4964	0.0036	3.19	0.4993	0.0007
2.70	0.4965	0.0035	3.20	0.4993	0.0007
2.71	0.4966	0.0034	3.21	0.4993	0.0007
2.72	0.4967	0.0033	3.22	0.4994	0.0006
2.73	0.4968	0.0032	3.23	0.4994	0.0006
2.74	0.4969	0.0031	3.24	0.4994	0.0006
2.75	0.4970	0.0030	3.25	0.4994	0.0006
2.76	0.4971	0.0029	3.26	0.4994	0.0006
2.77	0.4972	0.0028	3.27	0.4995	0.0005
2.78	0.4973	0.0027	3.28	0.4995	0.0005
2.79	0.4974	0.0026	3.29	0.4995	0.0005
2.80	0.4974	0.0026	3.30	0.4995	0.0005
2.81	0.4975	0.0025	3.31	0.4995	0.0005
2.82	0.4976	0.0024	3.32	0.4995	0.0005
2.83	0.4977	0.0023	3.33	0.4996	0.0004
2.84	0.4977	0.0023	3.34	0.4996	0.0004
2.85	0.4978	0.0022	3.35	0.4996	0.0004
2.86	0.4979	0.0021	3.36	0.4996	0.0004
2.87	0.4979	0.0021	3.37	0.4996	0.0004
2.88	0.4980	0.0020	3.38	0.4996	0.0004
2.89	0.4981	0.0019	3.39	0.4997	0.0003
2.90	0.4981	0.0019	3.40	0.4997	0.0003
2.91	0.4982	0.0018	3.41	0.4997	0.0003
2.92	0.4982	0.0018	3.42	0.4997	0.0003
2.93	0.4983	0.0017	3.43	0.4997	0.0003
2.94	0.4984	0.0016	3.44	0.4997	0.0003
2.95	0.4984	0.0016	3.45	0.4997	0.0003
2.96	0.4985	0.0015	3.46	0.4997	0.0003
2.97	0.4985	0.0015	3.47	0.4997	0.0003
2.98	0.4986	0.0014	3.48	0.4997	0.0003
2.99	0.4986	0.0014	3.49	0.4998	0.0002
3.00	0.4986	0.0014	3.50	0.4998	0.0002
3.01	0.4987	0.0013	3.60	0.4998	0.0002
3.02	0.4987	0.0013	3.70	0.4999	0.0001
3.03	0.4988	0.0012	3.80	0.4999	0.0001
3.04	0.4988	0.0012	3.90	0.4999	<0.0001
3.05	0.4989	0.0011	4.00	0.4999	<0.0001
3.06	0.4989	0.0011			
3.07	0.4989	0.0011			
3.08	0.4990	0.0010			
3.09	0.4990	0.0010			
3.10	0.4990	0.0010			

Some Examples

- Knowing these areas allow computation of additional areas
- For example, the area between a Z-score of 0.0 and 1.0 may be found by taking $1/2$ the area between Z-scores of -1.0 and 1.0
- Because the distribution is symmetrical between those two points. The answer in this case is **0.34 or 34%**
- A similar logic and answer is found for the area between 0.0 and -1.0
- Because the standard normal distribution is symmetrical around the value of 0.0

Topic Three

COMPUTING THE AREAS UNDER THE NORMAL CURVE USING THE Z TABLE



Computing the Area below and Above a Z-score

- Compute the area below a Z-score of 1.0
- The area below a Z-score of 1.0 may be computed by adding 0.34 and 0.50 to get **0.84**
- **Observe the sketch**
- Compute the area above a Z-score of 1.0
- The area above a Z-score of 1.0 may now be computed by subtracting the area just obtained from the total area under the distribution (1.00)
- Giving a result of $1.00 - 0.84 = 0.16$ or **16%**
- **Observe the sketch**

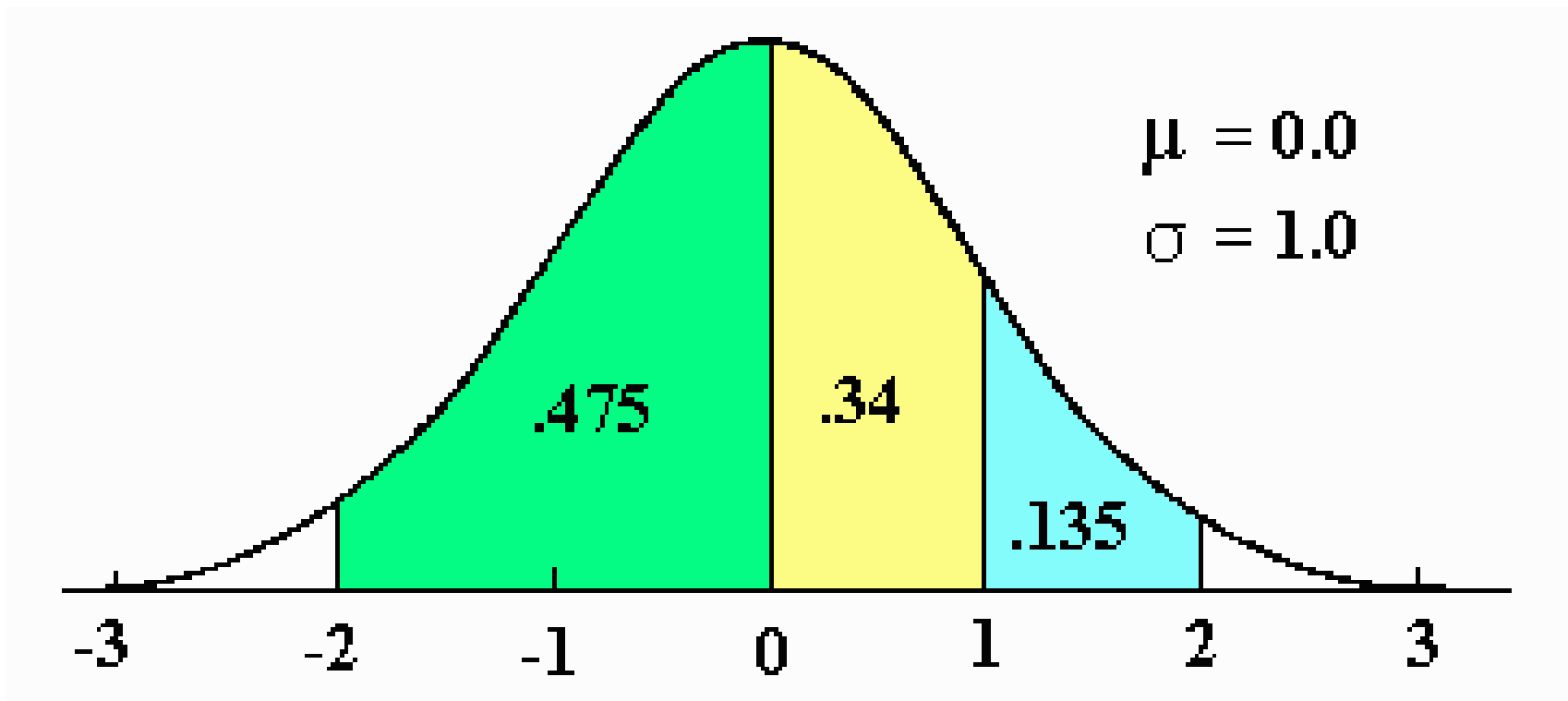
Computing Areas between Z-scores

- To compute for the area between 2.0 and 1.0 follow the steps below;
 1. Compute the area between 0.0 and 2.0 (this is $1/2$ of $0.95 = 0.475$).
 2. Because the 0.475 includes too much area, the area between 0.0 and 1.0 (0.34) must be subtracted in order to obtain the desired result.
- The correct answer is $0.475 - 0.34 = 0.135$

Observe the sketch

The correct answer is...

$$0.475 - 0.34 = 0.135$$



Topic Four

CONVERTING ANY RAW SCORE TO A Z SCORE

Z-scores

Z-scores can be calculated for any value (x). They are a means of standardizing values (s) that are measured on different scales by showing these values just in terms of the number of standard deviations (s) away from the mean (\bar{x}) they fall.

Z-scores are calculated by subtracting the mean from any value and dividing it by the standard deviation.

$$Z = \frac{x - (\bar{x})}{s}$$

Z-scores will always have:

a mean of 0 and standard deviation of 1



Exercise

- Scores on a quiz were normally distributed and had a mean of 10 and a standard deviation of 3. for each score below find the z score and the percentage of area between mean and z, above and below the score.

X	Z score	Between mean and Z	% area below Z	% area above Z
8				
9				
11				
12				
14				





Sample Question

- Complete the exercise by doing using the following information:
- Scores on a quiz were normally distributed and had a mean of 10.4 and a standard deviation of 2. for each score below find the z score and the percentage of area between mean and z, above and below the score.

References

- Healey, J. F. (2010). *Statistics: A Tool for Social Research*. Wadsworth: CA

