

Student ID Number: \_\_\_\_\_

## Psychology 216: Elementary Statistics

### Exam 1

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This exam consists of 25 multiple-choice questions and 5 essay / problem questions. For each multiple-choice question, circle the one letter that corresponds to the correct answer. Each multiple-choice question is worth 2 points. If you do not show your work in the essay / problem questions, you will not receive credit. Each of the essay / problem questions is worth 10 points. You have until 2:45 PM to finish the exam. Budget your time wisely.

1. Which of the following is a population parameter?
- A.  $\bar{X}$
  - B.  $s^2$
  - C.  $\mu$
  - D.  $\Sigma$

C – population parameters are represented by Greek letters. The only Greek letters here are  $\mu$  and  $\Sigma$ .  $\mu$  is the population mean (and therefore is a population parameter) and  $\Sigma$  is the summation operator (and therefore is not a population parameter.)

2. A study tested whether the consumption of alcohol slows reaction time. One group of randomly selected participants drank a placebo that tasted like, but did not contain alcohol, while another group drank just enough alcohol, given their body weight, to become legally drunk. After waiting a sufficient amount of time for the effects of the alcohol to occur, both groups pressed a button as soon as they could whenever a light turned on. How long it took the participants to press the button was recorded. All participants had normal vision. What is the dependent variable in this study?
- A. whether or not the participant drank alcohol
  - B. how long it took the participant to press the button when the light came on
  - C. all participants had normal vision
  - D. None of the above – this study is a correlational study and does not have a dependent variable.

B -- The dependent variable is the variable that is measured by the researcher. Its value should depend on the value of the independent variable. The time to respond is what is measured. Its value should depend on whether or not the participant consumed alcohol.

3. For the study in the previous question, what is the independent variable?
- A. whether or not the participant drank alcohol
  - B. how long it took the participant to press the button when the light came on
  - C. all participants had normal vision
  - D. None of the above – this study is a correlational study and does not have an independent variable.

A – The independent variable is the variable that is manipulated by the researcher. The researcher manipulated whether or not the participant consumed alcohol.

4. For the study in question 3, what is the control condition?
- A. not drinking alcohol
  - B. drinking alcohol
  - C. having normal vision
  - D. pressing the button when the light comes on

A – The control condition is the condition of the experiment that did not receive the treatment. The participants who did not drink alcohol are in the control condition.

5. Which of the following is a discrete variable?
- A. the amount of time remaining on this exam
  - B. the number of questions on this exam
  - C. the width of the paper that this exam is printed on
  - D. All of the above

B – Discrete variables can only take on certain values. The number of questions on a test can only take on integer values and therefore is discrete. The amount of time and width of the paper could take on a continuum of values and therefore are continuous.

6. A coffee shop wants to know the temperature of coffee that most people prefer. They brew coffee at the typical temperature for the shop and then ask customers “Do you prefer coffee to be at this temperature?” and record a yes or no answer for each customer. What is the level of measurement of the way they measured preferred temperature?
- A. nominal
  - B. ordinal
  - C. interval
  - D. ratio

A – This way of measuring results in two categories in no particular order. That is the hallmark of a nominally scaled variable.

7. The same coffee shop later repeats the study but this time they ask “Do you prefer coffee to be a lot colder, a little cooler, this temperature, a little warmer or a lot hotter?” and record the person’s response. Now, what is the level of measurement of the way they measured preferred temperature?
- A. nominal
  - B. ordinal
  - C. interval
  - D. ratio

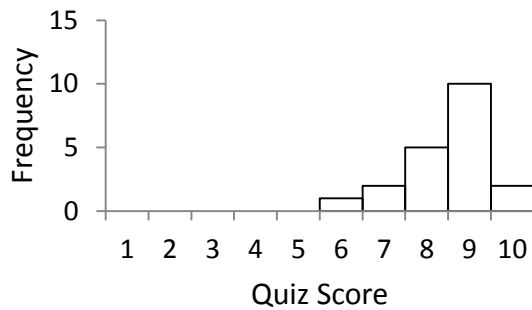
B – This way of measuring results in four categories which are in a particular order. However, the distance between adjacent categories (e.g. between lot colder and a little colder) are not the same between each adjacent pair of categories. This is the hallmark of an ordinally scaled variable.

8. Finally, the same coffee shop repeats the study but this time they brew the coffee at seven different temperatures, each one being exactly 5° C warmer than the previous cup. They have each customer sample all seven cups and indicate the cup that they think is at the perfect temperature. Now, what is the level of measurement of the way they measured preferred temperature?
- A. nominal
  - B. ordinal
  - C. interval or ratio

C – This way of measuring results in seven categories in a particular order. The distance between adjacent categories is always the same -- 5° C. If 0° C represents a complete absence of temperature (it does not), then this would be a ratio scale. Otherwise, it is an interval scale.

9. A standardized test of achievement yields scores between 300 and 700. If you were to create a grouped frequency distribution of the scores, what would be the most appropriate width for the class interval?
- A. 10
  - B. 20
  - C. 50
  - D. 100

C -- You want approximately 10 class intervals and the class width should be a simple number such as 2, 5, 10, 20, 50, or 100. The range of scores is  $700 - 300 = 400$ . Dividing the range by each of the listed class widths yields  $400 / 2 = 200$  (too many),  $400 / 5 = 80$  (too many),  $400 / 10 = 40$  (too many),  $400 / 20 = 20$  (too many),  $400 / 50 = 8$  (about right) and  $400 / 100 = 4$  (too few.) The class width should be 50.



10. The above distribution is
- A. symmetrical.
  - B. normal.
  - C. negatively skewed.
  - D. positively skewed.

C – The tail pointing to the negative end of the X axis more gradually goes toward 0 than the tail pointing to the positive end of the X axis. This implies a negative skew.

11. An honors society only accepts members whose GPA is very high. An applicant's GPA is at the 1<sup>st</sup> percentile. Should the honors society accept the applicant?
- A. Yes! Very few people have a GPA that is as large as or larger than his!
  - B. Yes! Very few people have a GPA that is larger than his!
  - C. No! Very few people have a GPA that is smaller than his!
  - D. No! Very few people have a GPA that is as small as or smaller than his!

D – The percentile is the percentage of scores at or below the given value. In this case, only 1% of the GPAs are at or below this applicant's GPA. Given their admission criterion, they should not accept the applicant.

12. The mean score on an exam is 73 points. The instructor adds 10 points to everyone's score. What is the mean score on the exam after the 10 points have been added?
- A. 73
  - B. 83
  - C. None of the above but I could calculate it given the information in the problem.
  - D. How should I know? You would have to tell us the exam scores, add ten points to each one, and then calculate the new mean.

B – Adding a constant to every score increases the mean by that constant.  $73 + 10 = 83$ .

13. An instructor records how long it takes students to finish a statistics test. If the times are normally distributed, which of the measures of central tendency would be most appropriate to use with this data?
- A. mode
  - B. median
  - C. mean
  - D. interquartile range

C – Time is a ratio scale variable (categories, in order, equal spacing, true 0 point.) Ratio scaled variables that are not skewed (this is normal which implies that the distribution is not skewed) should use the mean as the measure of central tendency.

14. An instructor found that the scores on the first exam in statistics had a pronounced negative skew. Which of the measures of central tendency would be most appropriate to use with this data?
- A. mode
  - B. median
  - C. mean
  - D. interquartile range

B – Scores on an exam are ratio scaled (categories, in order, equal spacing, true 0 point.) Ratio scaled variables that are highly skewed should use the median which is less sensitive to the extreme scores in the skewed tail of the distribution.

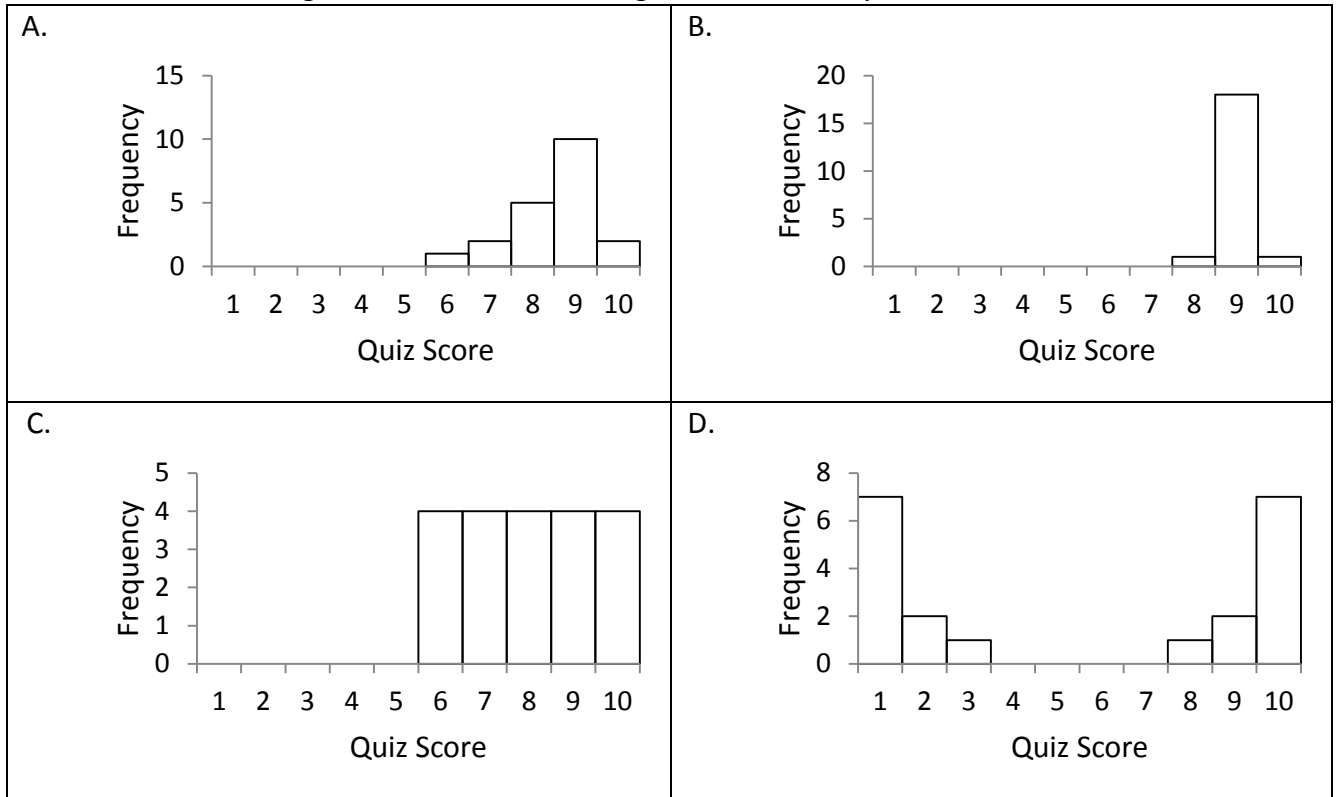
15. An instructor asked her students if they bought the assigned textbook. Which of the measures of central tendency would be most appropriate to use with this data?
- A. mode
  - B. median
  - C. mean
  - D. None of the above – there is no appropriate measure of central tendency to use with this data.

A – This variable is nominally scaled (categories in no particular order.) The only measure of central tendency defined for nominally scaled variables is the mode.

16. A researcher measures how long it takes students to press a button when a loud sound occurs. He calculates the mode, median and mean of the data and finds that the mode is less than the median which is less than the mean. Which of the following is most likely true about the distribution of scores?
- A. They are normally distributed.
  - B. They are symmetrically distributed, but not necessarily normally distributed.
  - C. They are negatively skewed.
  - D. They are positively skewed.

D – When the mean > median > mode, the scores are often positively skewed.

17. Which of the following distributions shows the greatest variability?



D – On average, the squared distance of the scores from the mean is larger in distribution D than in the other distributions.

18. Which of the following measures of dispersion would be most appropriate to use with a nominally scaled variable?

- A. range
- B. interquartile range
- C. standard deviation or variance
- D. None of the above

D – In order to talk about dispersion, distance must be defined. Distance is not defined for nominally scaled variables. Thus none of the measures are appropriate for nominally scaled variables.

19. For a particular set of data, the median is the most appropriate measure of central tendency. Which measure of variability would be most appropriate to use with this data?
- A. range
  - B. interquartile range
  - C. standard deviation or variance
  - D. None of the above

B – The interquartile range should be used when the median is used. Both are useful for ordinal scaled variables or interval / ratio scaled variables that are highly skewed.

20. Sample variance, especially when it is calculated from a sample that is small in size, tends to
- A. offer a precise estimate of the population variance.
  - B. offer an unbiased, but not necessarily precise estimate of the population variance.
  - C. under estimate the value of the population variance.
  - D. over estimate the value of the population variance.

C – Small samples often do not include the extreme scores that are in the population because those extreme scores often occur very infrequently in the population. Thus, the dispersion of the sample will often underestimate the dispersion of the population.

21. The variance of a population
- A. equals the mean of the squared deviation scores.
  - B. equals  $SS / df$ .
  - C. is represented by  $s^2$ .
  - D. All of the above are true.

A –  $\sigma^2 = SS / N$  which is the mean of the squared deviation scores.

22. A teacher gave an exam and found  $\mu = 75$  and  $\sigma = 10$ . She added 10 points to everyone's score. What is the value of  $\sigma$  after adding the 10 points?
- A.  $\sigma = 0$
  - B.  $\sigma = 10$
  - C.  $\sigma = 20$
  - D. None of the above

B – Adding or subtracting a constant from every score does not change the standard deviation of the scores.

23. Which of the following z scores is for a score that is just a little below the mean?
- A. -2
  - B. -0.1
  - C. 0
  - D. 2

B – Negative z scores are below the mean. The larger the magnitude (absolute value) of the z score, the farther the score is from the mean.

24. Heights of women are normally distributed with a mean of 163 cm and a standard deviation of 7 cm. What is the probability that a randomly selected woman will measure exactly 163 cm tall?
- A.  $p = 0$
  - B.  $p = .5$
  - C.  $p = 1$
  - D. None of the above

A or D – Heights are continuous. It does not make sense to ask about the probability of a particular value of a continuous variable.

25. The normal approximation to the binomial distribution can be used when
- A.  $n > 10$ .
  - B.  $n \cdot p > 10$  and  $n \cdot q > 10$ .
  - C. the distribution of scores is not skewed (either negatively or positively).
  - D. all the time.

B – The criteria for using the normal approximation to the binomial distribution is that both  $n \cdot p$  and  $n \cdot q$  must be larger than 10.



26. The following scores occurred on an exam:

75	72	66	72	75	46	55	98
43	78	63	96	73	71	86	92
52	56	85	100	84	90	79	56

- A. Create a frequency distribution, or if more appropriate, a grouped frequency distribution, of the exam scores.

The range of scores is  $100 - 43 = 57$ . That is too large for a frequency distribution. We want approximately 10 class intervals and the width should be a simple number such as 2, 5, or 10. A class interval width of 10 would yield  $57 / 10 \approx 6$  intervals. A class interval width of 5 would yield  $57 / 5 \approx 12$  intervals, which is close to 10. The smallest class interval should start at the integer multiple of the class width that is just smaller than the smallest value in the data set. That would be 40 ( $= 5 \times 8$  which is just smaller than 43).

Class Interval	Frequency
40-44	1
45-49	1
50-54	1
55-59	3
60-64	1
65-69	1
70-74	4
75-79	4
80-84	1
85-89	2
90-94	2
95-99	2
100-104	1

B. Create a stem and leaf plot of the exam scores.

We want approximately 7 stems. If we made the hundreds digit the stem, there would be only two stems. Making the hundreds and tens digits the stem, there are seven stems. Cut each score so the hundreds and tens digits are the stems, and the ones digit is the leaf. Organize the stems from low to high, discarding duplicate stems. To the right of each stem, write the leafs that correspond to that stem in ascending order, retaining duplicate leafs.

Stem	Leaf
4	36
5	2566
6	36
7	12235589
8	456
9	0268
10	0

27. Consider the following 10 IQ scores:

IQ	IQ <sup>2</sup>
97	9409
115	13225
111	12321
99	9801
114	12996
97	9409
105	11025
98	9604
105	11025
108	11664

$\Sigma$	1049	110479
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Calculate the following showing your work (no work = no credit):

A. Mode(s)

The number(s) that occur most frequently are 97 and 105. They are the modes.

B. Median

Sort the data. Find the index of the middle score:  $\text{index} = (n + 1) / 2 = (10 + 1) / 2 = 5.5$ .  
Because the index is not an integer, take the average of the scores in the sorted data set just above and just below the index:  $\text{Median} = (X_5 + X_6) / 2 = (105 + 105) / 2 = 105$ .

97  
97  
98  
99  
105  
105  
108  
111  
114  
115

C. Mean

$$M = \Sigma X / n = 1049 / 10 = 104.9$$

28. Consider the following heights (in inches) from a sample of five women:

Height	Height <sup>2</sup>	(Height - M)	(Height - M) <sup>2</sup>
65	4225	1	1
71	5041	7	49
63	3969	-1	1
59	3481	-5	25
62	3844	-2	4

Σ	320	20560	0	80
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- A. What is the variance of the *population* (show your work; it is ok to leave your answer as a fraction with or without a square root)?

$$\sigma^2 = \frac{\sum (X - \mu)^2}{n} = \frac{80}{5} = 16 \text{ in}^2$$

$$\sigma^2 = \frac{\sum X^2 - \frac{(\sum X)^2}{n}}{n} = \frac{20,560 - \frac{320^2}{5}}{5} = \frac{20,560 - 20480}{5} = 16 \text{ in}^2$$

- B. What is the standard deviation of the *sample* (show your work; it is ok to leave your answer as a fraction with or without a square root)?

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}} = \sqrt{\frac{80}{4}} = \sqrt{20} = 4.47 \text{ in}$$

$$s = \sqrt{\frac{\sum X^2 - \frac{(\sum X)^2}{n}}{n - 1}} = \sqrt{\frac{20,560 - \frac{320^2}{5}}{5 - 1}} = \sqrt{\frac{20,560 - 20480}{4}} = \sqrt{20} = 4.47 \text{ in}$$

- C. What is the range of the heights?

$$\text{Range} = X_{\text{Largest}} - X_{\text{Smallest}} = 71 - 59 = 12$$

29. Scores from the UCLA Loneliness Scale are normally distributed with  $\mu = 40$  and  $\sigma = 10$ . Showing your work, answer the following:

A. What is the z-score for a loneliness score of 55?

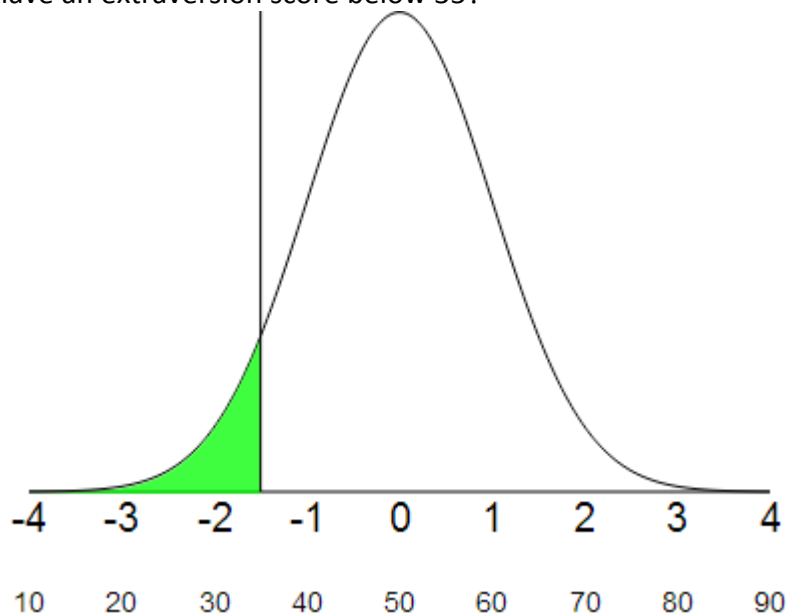
$$z = \frac{X - \mu}{\sigma} = \frac{55 - 40}{10} = 1.5$$

B. What is the loneliness score that corresponds to a z-score of -0.5?

$$\text{Raw score} = z \cdot \sigma + \mu = -0.5 \cdot 10 + 40 = 35$$

30. Consult the attached table of areas under the unit normal distribution to answer the following questions. Show your work.

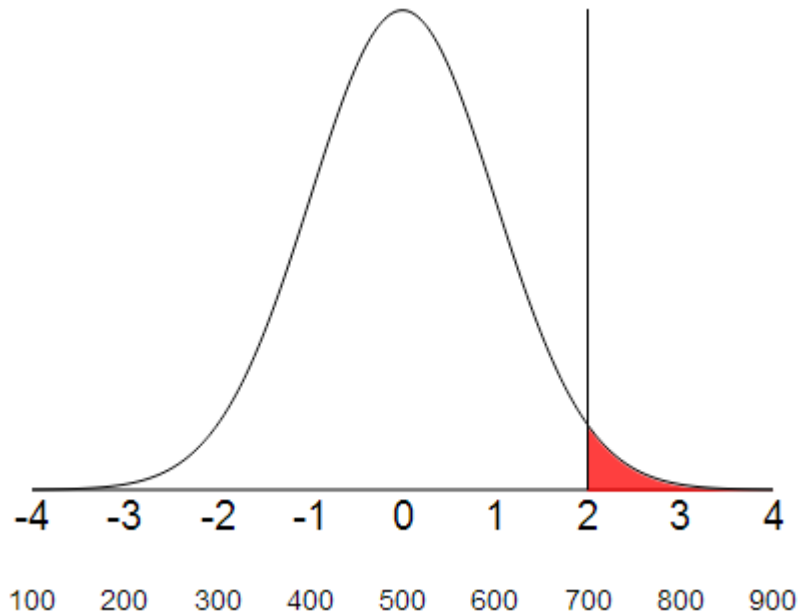
- A. A measure of extraversion is normally distributed in the population with  $\mu = 50$  and  $\sigma = 10$ . What is the probability that a randomly selected individual from the population will have an extraversion score below 35?



$$z = \frac{X - \mu}{\sigma} = \frac{35 - 50}{10} = -1.5$$

We want the area below  $z = -1.5$  in the unit normal distribution. Remember that the area below a negative  $z$  score is equal to the area above the same  $z$  score that is positive. From the table of areas under the unit normal distribution, that area is .067. Thus, the probability is .067.

- B. Assume that SAT math scores are normally distributed in the population with  $\mu = 500$  and  $\sigma = 100$ . What is the probability that a randomly selected individual from the population will have a SAT math score above 700?



$$z = \frac{X - \mu}{\sigma} = \frac{700 - 500}{100} = 2.0$$

We want the area above  $z = 2.0$  in the unit normal distribution. From the table of areas under the unit normal distribution, that area is .023. Thus, the probability is .023.

Areas Under the Unit Normal Distribution

<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>	<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>	<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>
0.00	0.500	0.500	0.000	0.40	0.655	0.345	0.155	0.80	0.788	0.212	0.288
0.01	0.504	0.496	0.004	0.41	0.659	0.341	0.159	0.81	0.791	0.209	0.291
0.02	0.508	0.492	0.008	0.42	0.663	0.337	0.163	0.82	0.794	0.206	0.294
0.03	0.512	0.488	0.012	0.43	0.666	0.334	0.166	0.83	0.797	0.203	0.297
0.04	0.516	0.484	0.016	0.44	0.670	0.330	0.170	0.84	0.800	0.200	0.300
0.05	0.520	0.480	0.020	0.45	0.674	0.326	0.174	0.85	0.802	0.198	0.302
0.06	0.524	0.476	0.024	0.46	0.677	0.323	0.177	0.86	0.805	0.195	0.305
0.07	0.528	0.472	0.028	0.47	0.681	0.319	0.181	0.87	0.808	0.192	0.308
0.08	0.532	0.468	0.032	0.48	0.684	0.316	0.184	0.88	0.811	0.189	0.311
0.09	0.536	0.464	0.036	0.49	0.688	0.312	0.188	0.89	0.813	0.187	0.313
0.10	0.540	0.460	0.040	0.50	0.691	0.309	0.191	0.90	0.816	0.184	0.316
0.11	0.544	0.456	0.044	0.51	0.695	0.305	0.195	0.91	0.819	0.181	0.319
0.12	0.548	0.452	0.048	0.52	0.698	0.302	0.198	0.92	0.821	0.179	0.321
0.13	0.552	0.448	0.052	0.53	0.702	0.298	0.202	0.93	0.824	0.176	0.324
0.14	0.556	0.444	0.056	0.54	0.705	0.295	0.205	0.94	0.826	0.174	0.326
0.15	0.560	0.440	0.060	0.55	0.709	0.291	0.209	0.95	0.829	0.171	0.329
0.16	0.564	0.436	0.064	0.56	0.712	0.288	0.212	0.96	0.831	0.169	0.331
0.17	0.567	0.433	0.067	0.57	0.716	0.284	0.216	0.97	0.834	0.166	0.334
0.18	0.571	0.429	0.071	0.58	0.719	0.281	0.219	0.98	0.836	0.164	0.336
0.19	0.575	0.425	0.075	0.59	0.722	0.278	0.222	0.99	0.839	0.161	0.339
0.20	0.579	0.421	0.079	0.60	0.726	0.274	0.226	1.00	0.841	0.159	0.341
0.21	0.583	0.417	0.083	0.61	0.729	0.271	0.229	1.01	0.844	0.156	0.344
0.22	0.587	0.413	0.087	0.62	0.732	0.268	0.232	1.02	0.846	0.154	0.346
0.23	0.591	0.409	0.091	0.63	0.736	0.264	0.236	1.03	0.848	0.152	0.348
0.24	0.595	0.405	0.095	0.64	0.739	0.261	0.239	1.04	0.851	0.149	0.351
0.25	0.599	0.401	0.099	0.65	0.742	0.258	0.242	1.05	0.853	0.147	0.353
0.26	0.603	0.397	0.103	0.66	0.745	0.255	0.245	1.06	0.855	0.145	0.355
0.27	0.606	0.394	0.106	0.67	0.749	0.251	0.249	1.07	0.858	0.142	0.358
0.28	0.610	0.390	0.110	0.68	0.752	0.248	0.252	1.08	0.860	0.140	0.360
0.29	0.614	0.386	0.114	0.69	0.755	0.245	0.255	1.09	0.862	0.138	0.362
0.30	0.618	0.382	0.118	0.70	0.758	0.242	0.258	1.10	0.864	0.136	0.364
0.31	0.622	0.378	0.122	0.71	0.761	0.239	0.261	1.11	0.867	0.133	0.367
0.32	0.626	0.374	0.126	0.72	0.764	0.236	0.264	1.12	0.869	0.131	0.369
0.33	0.629	0.371	0.129	0.73	0.767	0.233	0.267	1.13	0.871	0.129	0.371
0.34	0.633	0.367	0.133	0.74	0.770	0.230	0.270	1.14	0.873	0.127	0.373
0.35	0.637	0.363	0.137	0.75	0.773	0.227	0.273	1.15	0.875	0.125	0.375
0.36	0.641	0.359	0.141	0.76	0.776	0.224	0.276	1.16	0.877	0.123	0.377
0.37	0.644	0.356	0.144	0.77	0.779	0.221	0.279	1.17	0.879	0.121	0.379
0.38	0.648	0.352	0.148	0.78	0.782	0.218	0.282	1.18	0.881	0.119	0.381
0.39	0.652	0.348	0.152	0.79	0.785	0.215	0.285	1.19	0.883	0.117	0.383



<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>
1.20	0.885	0.115	0.385
1.21	0.887	0.113	0.387
1.22	0.889	0.111	0.389
1.23	0.891	0.109	0.391
1.24	0.893	0.107	0.393
1.25	0.894	0.106	0.394
1.26	0.896	0.104	0.396
1.27	0.898	0.102	0.398
1.28	0.900	0.100	0.400
1.29	0.901	0.099	0.401
1.30	0.903	0.097	0.403
1.31	0.905	0.095	0.405
1.32	0.907	0.093	0.407
1.33	0.908	0.092	0.408
1.34	0.910	0.090	0.410
1.35	0.911	0.089	0.411
1.36	0.913	0.087	0.413
1.37	0.915	0.085	0.415
1.38	0.916	0.084	0.416
1.39	0.918	0.082	0.418
1.40	0.919	0.081	0.419
1.41	0.921	0.079	0.421
1.42	0.922	0.078	0.422
1.43	0.924	0.076	0.424
1.44	0.925	0.075	0.425
1.45	0.926	0.074	0.426
1.46	0.928	0.072	0.428
1.47	0.929	0.071	0.429
1.48	0.931	0.069	0.431
1.49	0.932	0.068	0.432
1.50	0.933	0.067	0.433
1.51	0.934	0.066	0.434
1.52	0.936	0.064	0.436
1.53	0.937	0.063	0.437
1.54	0.938	0.062	0.438
1.55	0.939	0.061	0.439
1.56	0.941	0.059	0.441
1.57	0.942	0.058	0.442
1.58	0.943	0.057	0.443
1.59	0.944	0.056	0.444

<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>
1.60	0.945	0.055	0.445
1.61	0.946	0.054	0.446
1.62	0.947	0.053	0.447
1.63	0.948	0.052	0.448
1.64	0.949	0.051	0.449
1.65	0.951	0.049	0.451
1.66	0.952	0.048	0.452
1.67	0.953	0.047	0.453
1.68	0.954	0.046	0.454
1.69	0.954	0.046	0.454
1.70	0.955	0.045	0.455
1.71	0.956	0.044	0.456
1.72	0.957	0.043	0.457
1.73	0.958	0.042	0.458
1.74	0.959	0.041	0.459
1.75	0.960	0.040	0.460
1.76	0.961	0.039	0.461
1.77	0.962	0.038	0.462
1.78	0.962	0.038	0.462
1.79	0.963	0.037	0.463
1.80	0.964	0.036	0.464
1.81	0.965	0.035	0.465
1.82	0.966	0.034	0.466
1.83	0.966	0.034	0.466
1.84	0.967	0.033	0.467
1.85	0.968	0.032	0.468
1.86	0.969	0.031	0.469
1.87	0.969	0.031	0.469
1.88	0.970	0.030	0.470
1.89	0.971	0.029	0.471
1.90	0.971	0.029	0.471
1.91	0.972	0.028	0.472
1.92	0.973	0.027	0.473
1.93	0.973	0.027	0.473
1.94	0.974	0.026	0.474
1.95	0.974	0.026	0.474
1.96	0.975	0.025	0.475
1.97	0.976	0.024	0.476
1.98	0.976	0.024	0.476
1.99	0.977	0.023	0.477

<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>
2.00	0.977	0.023	0.477
2.01	0.978	0.022	0.478
2.02	0.978	0.022	0.478
2.03	0.979	0.021	0.479
2.04	0.979	0.021	0.479
2.05	0.980	0.020	0.480
2.06	0.980	0.020	0.480
2.07	0.981	0.019	0.481
2.08	0.981	0.019	0.481
2.09	0.982	0.018	0.482
2.10	0.982	0.018	0.482
2.11	0.983	0.017	0.483
2.12	0.983	0.017	0.483
2.13	0.983	0.017	0.483
2.14	0.984	0.016	0.484
2.15	0.984	0.016	0.484
2.16	0.985	0.015	0.485
2.17	0.985	0.015	0.485
2.18	0.985	0.015	0.485
2.19	0.986	0.014	0.486
2.20	0.986	0.014	0.486
2.21	0.986	0.014	0.486
2.22	0.987	0.013	0.487
2.23	0.987	0.013	0.487
2.24	0.987	0.013	0.487
2.25	0.988	0.012	0.488
2.26	0.988	0.012	0.488
2.27	0.988	0.012	0.488
2.28	0.989	0.011	0.489
2.29	0.989	0.011	0.489
2.30	0.989	0.011	0.489
2.31	0.990	0.010	0.490
2.32	0.990	0.010	0.490
2.33	0.990	0.010	0.490
2.34	0.990	0.010	0.490
2.35	0.991	0.009	0.491
2.36	0.991	0.009	0.491
2.37	0.991	0.009	0.491
2.38	0.991	0.009	0.491
2.39	0.992	0.008	0.492

<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>
2.40	0.992	0.008	0.492
2.41	0.992	0.008	0.492
2.42	0.992	0.008	0.492
2.43	0.992	0.008	0.492
2.44	0.993	0.007	0.493
2.45	0.993	0.007	0.493
2.46	0.993	0.007	0.493
2.47	0.993	0.007	0.493
2.48	0.993	0.007	0.493
2.49	0.994	0.006	0.494
2.50	0.994	0.006	0.494
2.51	0.994	0.006	0.494
2.52	0.994	0.006	0.494
2.53	0.994	0.006	0.494
2.54	0.994	0.006	0.494
2.55	0.995	0.005	0.495
2.56	0.995	0.005	0.495
2.57	0.995	0.005	0.495
2.58	0.995	0.005	0.495
2.59	0.995	0.005	0.495

<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>
2.60	0.995	0.005	0.495
2.61	0.995	0.005	0.495
2.62	0.996	0.004	0.496
2.63	0.996	0.004	0.496
2.64	0.996	0.004	0.496
2.65	0.996	0.004	0.496
2.66	0.996	0.004	0.496
2.67	0.996	0.004	0.496
2.68	0.996	0.004	0.496
2.69	0.996	0.004	0.496
2.70	0.997	0.003	0.497
2.71	0.997	0.003	0.497
2.72	0.997	0.003	0.497
2.73	0.997	0.003	0.497
2.74	0.997	0.003	0.497
2.75	0.997	0.003	0.497
2.76	0.997	0.003	0.497
2.77	0.997	0.003	0.497
2.78	0.997	0.003	0.497
2.79	0.997	0.003	0.497

<b>z</b>	<b>Area Below</b>	<b>Area Above</b>	<b>Area from M to z</b>
2.80	0.997	0.003	0.497
2.81	0.998	0.002	0.498
2.82	0.998	0.002	0.498
2.83	0.998	0.002	0.498
2.84	0.998	0.002	0.498
2.85	0.998	0.002	0.498
2.86	0.998	0.002	0.498
2.87	0.998	0.002	0.498
2.88	0.998	0.002	0.498
2.89	0.998	0.002	0.498
2.90	0.998	0.002	0.498
2.91	0.998	0.002	0.498
2.92	0.998	0.002	0.498
2.93	0.998	0.002	0.498
2.94	0.998	0.002	0.498
2.95	0.998	0.002	0.498
2.96	0.998	0.002	0.498
2.97	0.999	0.001	0.499
2.98	0.999	0.001	0.499
2.99	0.999	0.001	0.499

**Mean:**

$$\mu = \frac{\sum X}{n} \quad \bar{X} = \frac{\sum X}{n}$$

**Median:**

$$\text{Index of middle score} = \frac{n+1}{2}$$

**Range:**

$$\text{Range} = X_{\text{Largest}} - X_{\text{Smallest}}$$

**Interquartile range:**

$$\text{IR} = Q_3 - Q_1$$

**Percentiles:**

$$i = \frac{n \cdot p}{100} + 0.5$$

k = integer part of i

f = fractional part of i

$$(1-f) \cdot X_k + f \cdot X_{k+1}$$

**Variance of a population:**

$$\sigma^2 = \frac{SS}{n} = \frac{\sum (X - \mu)^2}{n} = \frac{\sum X^2 - \frac{(\sum X)^2}{n}}{n}$$

**Standard deviation of a population:**

$$\sigma = \sqrt{\sigma^2}$$

**Variance of a sample:**

$$s^2 = \frac{SS}{df} = \frac{\sum (X - \bar{X})^2}{n-1} = \frac{\sum X^2 - \frac{(\sum X)^2}{n}}{n-1}$$

**Standard deviation of a sample:**

$$s = \sqrt{s^2}$$

**z-score from a population:**

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

**z-score from a sample:**

$$z = \frac{X - \bar{X}}{s}$$

**Population raw score from a z-score:**

$$\text{Raw Score} = \mu + z \cdot \sigma$$

**Sample raw score from a z-score:**

$$\text{Raw Score} = \bar{X} + z \cdot s$$

**Normal Approximation to the Binomial Distribution:**

$$\mu = n \cdot p$$

$$\sigma = \sqrt{n \cdot p \cdot q}$$

$$z = \frac{X - \mu}{\sigma} = \frac{X - n \cdot p}{\sqrt{n \cdot p \cdot q}}$$