Departmental Final Exam for MATH 2300 - Fall 2013
Version A
Part I

Please answer all 40 multiple choice questions in part I. Each question is worth 2 points. For each question in this part I of the exam, only the correct answer matters(A, B, C, D, or E), and no partial credit will be given. Please follow the instructions of your teacher as to where to report your final answers.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Find the requested value.

1) A researcher for a car insurance company wishes to estimate the mean annual premium that men aged 20-24 pay for their car insurance. A random sample of 16 men aged between 20 and 24 yields the following annual premiums, in dollars. 1) _____

812	913	908	901
601	926	742	591
905	420	580	725
856	610	720	985

Use the data to obtain a point estimate of the mean annual premium for all men aged between 20 and 24. Round your answer to the nearest dollar.

A) $753 B) $744 C) $739 D) $762

A sample mean, sample standard deviation, and sample size are given. Use the one-mean t-test to perform the required hypothesis test about the mean, μ, of the population from which the sample was drawn. Use the critical-value approach.

2) $\bar{x} = 3.16$, $s = 0.51$, $n = 9$, $H_0: \mu = 2.85$, $H_a: \mu > 2.85$, $\alpha = 0.01$ 2) _____

A) Test statistic: t = 1.82. Critical value: t = 2.821. Do not reject H_0. There is not sufficient evidence to support the claim that the mean is greater than 2.85.

B) Test statistic: t = 1.82. Critical value: t = 2.33. Do not reject H_0. There is not sufficient evidence to support the claim that the mean is greater than 2.85.

C) Test statistic: t = 1.82. Critical value: t = 2.896. Do not reject H_0. There is not sufficient evidence to support the claim that the mean is greater than 2.85.

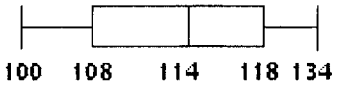
D) Test statistic: t = 1.82. Critical value: t = 2.896. Reject H_0. There is sufficient evidence to support the claim that the mean is greater than 2.85.

Construct and interpret a boxplot or a modified boxplot as specified.

3) The highest temperatures ever recorded (in °F) in 32 different U.S. states are shown below. Construct a boxplot for the data. 3) _____

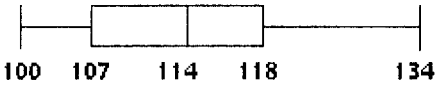
100	100	105	105	106	106	107	107
109	110	110	112	112	112	113	113
115	115	116	117	118	118	118	118
118	119	120	121	122	125	128	134

A)



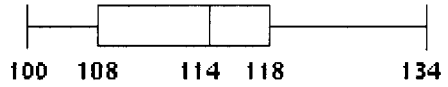
The data is fairly symmetrical.

B)



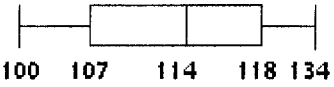
The data is slightly right-skewed.

C)



The data is slightly right-skewed.

D)



The data is fairly symmetrical.

Use a table of areas for the standard normal curve to find the required z-score.

4) Find the z-score for having area 0.07 to its right under the standard normal curve, that is, find $z_{0.07}$. 4) _____

A) 1.48 B) 1.45 C) 1.39 D) 1.26

Identify potential outliers, if any, for the given data.

5) The National Education Association collects data on the number of years of teaching experience of high-school teachers. A sample taken this year of 19 high-school teachers yielded the following data on number of years of teaching experience. 5) _____

16	27	1	33	15
6	18	7	20	14
17	19	16	10	21
30	14	39	18	

A) 33, 39 B) 1, 39 C) 1, 33, 39 D) None

Find the sample standard deviation for the given data. Round your final answer to one more decimal place than that used for the observations.

6) To get the best deal on a CD player, Tom called eight appliance stores and asked the cost of a specific model. The prices he was quoted are listed below: 6) _____

$426 $123 $181 $406 $307 $336 $226 $301

A) $304.0 B) $664,704.5 C) $105.8 D) $743,024.0

Compute the specified sum of squares.

7) The regression equation for the data below is $\hat{y} = 3.000x$. 7) _____

x	2	4	5	6
y	7	11	13	20

SSR

A) 78.75 B) 10.00 C) 72.45 D) 88.75

8) The regression equation for the data below is $\hat{y} = 3.000x$. 8) _____

x	2	4	5	6
y	7	11	13	20

SST

A) 10.00 B) 78.75 C) 92.25 D) 88.75

Find the indicated probability.

9) If two balanced die are rolled, the possible outcomes can be represented as follows. 9) _____

(1, 1) (2, 1) (3, 1) (4, 1) (5, 1) (6, 1)
(1, 2) (2, 2) (3, 2) (4, 2) (5, 2) (6, 2)
(1, 3) (2, 3) (3, 3) (4, 3) (5, 3) (6, 3)
(1, 4) (2, 4) (3, 4) (4, 4) (5, 4) (6, 4)
(1, 5) (2, 5) (3, 5) (4, 5) (5, 5) (6, 5)
(1, 6) (2, 6) (3, 6) (4, 6) (5, 6) (6, 6)

Determine the probability that the sum of the dice is 7.

A) $\frac{5}{36}$ B) $\frac{7}{36}$ C) $\frac{2}{9}$ D) $\frac{1}{6}$

Provide an appropriate response.

10) Find the value of α that corresponds to a confidence level of 84%. 10) _____

A) 0.016 B) 16 C) 0.84 D) 0.16

11) What generally happens to the sampling error as the sample size is decreased? 11) _____

A) It gets larger.
B) It gets less predictable.
C) It gets more predictable.
D) It gets smaller.

12) Suppose you have obtained a 95% confidence interval for μ. Which of the following statements is/are true regarding the relationship between precision and confidence level? Assume that the sample size is fixed. 12) _____

A. Increasing the confidence level to 99% will result in a narrower interval.
B. Decreasing the confidence level to 90% will result in greater precision.
C. Decreasing the precision will result in a higher confidence level.
D. Increasing the precision will result in a higher confidence level.

A) B and D B) A and C C) A and D D) B and C

13) The amount of money, in dollars, that an employee of a bank spent on lunch on six randomly selected days yielded the following data set: 13) _____

8, 13, 14, 12, 6, 16

Compute $\left(\sum x_i\right)^2$ and $\sum x_i^2$. Explain the difference between the two quantities.

A) 4761 and 865; $\left(\sum x_i\right)^2$ is the square of the sum of the data, whereas $\sum x_i^2$ represents the sum of the squares of the data.

B) 4624 and 69; $\left(\sum x_i\right)^2$ is the square of the sum of the data, whereas $\sum x_i^2$ represents the sum of the squares of the data.

C) 865 and 4761 ; $\left(\sum x_i\right)^2$ is the sum of the squares of the data, whereas $\sum x_i^2$ represents the square of the sum of the data.

D) 69 and 4761 ; $\left(\sum x_i\right)^2$ is the sum of the squares of the data, whereas $\sum x_i^2$ represents the square of the sum of the data.

14) Thirty of the 198 students enrolled in Statistics 101 were asked if they wanted Exam II to be a take-home or an in-class assessment. Twenty, or about 67%, of the students polled indicated a preference for an in-class exam. The professor concluded that the majority of students in Statistics 101 would prefer an in-class examination for the second assessment. Did the professor perform a descriptive study or an inferential study? 14) _____

A) Descriptive B) Inferential

15) Which of the following could not possibly be probabilities? 15) _____

A. -0.74
B. $\frac{11}{7}$
C. 0
D. 0.36

A) B and C B) A and B C) A and C D) A and D

16) The following table gives the top five movies at the box office this week. 16) _____

Rank	Last week	Movie title	Studio	Box office sales ($ millions)
1	N/A	Pirate Adventure	Movie Giant	35.2
2	2	Secret Agent Files	G.M.G.	19.5
3	1	Epic Super Hero Team	21st Century	14.3
4	5	Reptile Ride	Movie Giant	10.1
5	4	Must Love Cats	Dreamboat	9.9

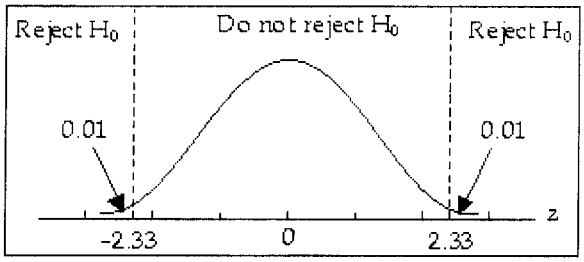
What kind of data is provided by the information in the first column ?

A) Qualitative B) Quantitative and discrete

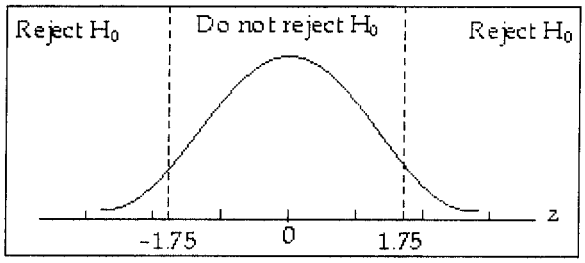
Determine the critical value(s) for a one-mean z-test.

17) Find the critical value(s) for a two-tailed test with $\alpha = 0.02$ and draw a graph that illustrates your answer. 17) _____

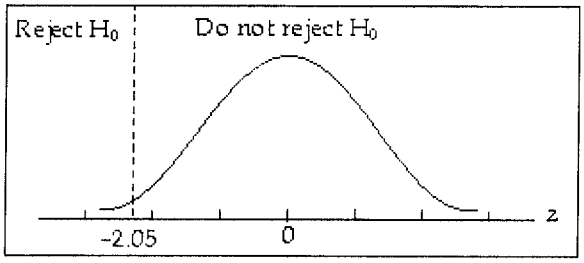
A) -2.33, 2.33



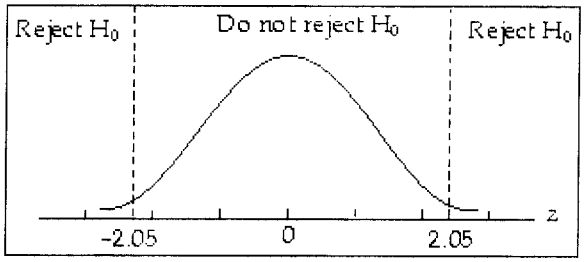
B) -1.75, 1.75



C) -2.05



D) -2.05, 2.05



18) The data in the following table show the results of a survey of college students asking which vacation destination they would choose given the eight choices shown. Determine the value that should be entered in the relative frequency column for California. 18) _____

Destination	Frequency	Relative frequency
Florida	34	
Mexico	80	
Belize	18	
Puerto Rico	26	
Alaska	4	
California	20	
Colorado	12	
Arizona	6	

A) 0.003 B) 0.06 C) 0.03 D) 0.1

Identify the distribution of the sample mean. In particular, state whether the distribution of $\bar{x}$ is normal or approximately normal and give its mean and standard deviation.

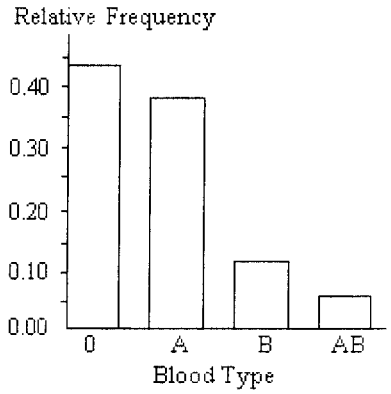
19) The heights of people in a certain population are normally distributed with a mean of 68 inches and a standard deviation of 3.1 inches. Determine the sampling distribution of the mean for samples of size 44. 19) _____

A) Normal, mean = 68 inches, standard deviation = 0.47 inches
B) Normal, mean = 68 inches, standard deviation = 3.1 inches
C) Approximately normal, mean = 68 inches, standard deviation = 0.07 inches
D) Normal, mean = 68 inches, standard deviation = 0.07 inches

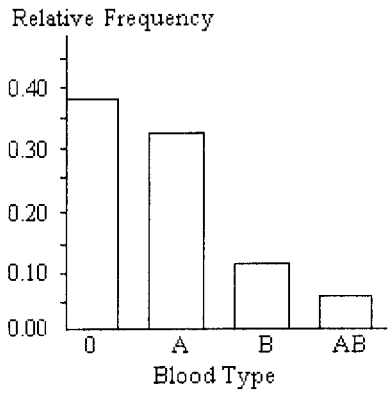
20) Construct a bar graph for the relative frequencies given. 20) _____

Blood type	Frequency	Relative frequency
O	22	0.44
A	19	0.38
B	6	0.12
AB	3	0.06

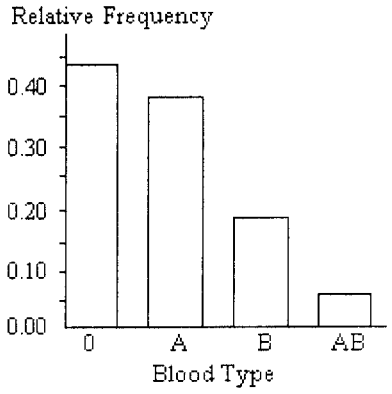
A)



B)



C)



A hypothesis test is to be performed. Determine the null and alternative hypotheses.

21) In the past, the mean running time for a certain type of flashlight battery has been 9.0 hours. The manufacturer has introduced a change in the production method and wants to perform a hypothesis test to determine whether the mean running time has changed as a result. 21) _____

A) $H_0 : \mu \geq 9.0$ hours
$H_a : \mu = 9.0$ hours

B) $H_0 : \mu = 9.0$ hours
$H_a : \mu > 9.0$ hours

C) $H_0 : \mu = 9.0$ hours
$H_a : \mu \neq 9.0$ hours

D) $H_0 : \mu \neq 9.0$ hours
$H_a : \mu = 9.0$ hours

Compute the coefficient of determination. Round your answer to four decimal places.

22) A regression equation is obtained for a set of data points. It is found that the total sum of squares is 138.7, the regression sum of squares is 81.8, and the error sum of squares is 56.9. 22) _____

A) 0.6956 B) 1.6956 C) 0.4102 D) 0.5898

Assume that you wish to estimate a population proportion, p. For the given margin of error and confidence level, determine the sample size required.

23) You wish to estimate the proportion of shoppers that use credit cards. Obtain a sample size that will ensure a margin of error of at most 0.04 for a 95% confidence interval. It is deemed reasonable to presume that of those sampled, the percentage using credit cards will be at least 54%. 23) _____

A) 597 B) 1297 C) 1030 D) 537

The significance level and P-value of a hypothesis test are given. Decide whether the null hypothesis should be rejected.

24) $\alpha = 0.01$, P-value = 0.005 24) _____

A) Reject the null hypothesis. B) Do not reject the null hypothesis.

List all possible samples from the specified population.

25) Given a group of students: Allen (A), Brenda (B), Chad (C), Dorothy (D), and Eric (E), list all of the possible samples (without replacement) of size four that can be obtained from the group. 25) _____

A) A,B,C,D A,B,C,E A,C,D,E A,D,E,B B,C,D,E B,C,E,A B,D,E,A
C,A,B,D C,E,D,B D,A,C,E

B) A,B,C,D A,B,C,E A,C,D,E A,D,E,B

C) A,B,C,D

D) A,B,C,D A,B,C,E A,C,D,E A,D,E,B B,C,D,E

A sample mean, sample size, and population standard deviation are given. Use the one-mean z-test to perform the required hypothesis test at the given significance level. Use the P-value approach.

26) $\bar{x} = 21$, $n = 18$, $\sigma = 7$, $H_0: \mu = 24$, $H_a: \mu < 24$, $\alpha = 0.05$ 26) _____

A) z = -1.82; P-value = 0.0344; reject H_0

B) z = -0.43; P-value = 0.3336; do not reject H_0

C) z = -1.82; P-value = 0.0688; do not reject H_0

D) z = -0.43; P-value = 0.0336; reject H_0

Find the indicated probability by using the complementation rule.

27) A percentage distribution is given below for the size of families in one U.S. city. 27) _____

Size	Percentage
2	43.3
3	22.7
4	19.8
5	8.6
6	4.0
7+	1.6

A family is selected at random. Find the probability that the size of the family is less than 6. Round results to three decimal places.

A) 0.984 B) 0.040 C) 0.944 D) 0.056

Find the median for the given sample data.

28) The normal monthly precipitation (in inches) for August is listed for 20 different U.S. cities. 28) _____

3.5	1.6	2.4	3.7	4.1
3.9	1.0	3.6	4.2	3.4
3.7	2.2	1.5	4.2	3.4
2.7	0.4	3.7	2.0	3.6

A) 3.45 in. B) 2.94 in. C) 3.40 in. D) 3.50 in.

A hypothesis test is to be performed for a population proportion. For the given sample data and null hypothesis, compute the value of the test statistic, $z = \frac{\hat{p} - p_0}{\sqrt{p_0(1 - p_0)/n}}$

29) Out of 187 observations, 57% were successes. H_0: $p = 0.55$. 29) _____

A) 0.001 B) 1.723 C) 0.550 D) 1.291

Find the indicated probability by using the general addition rule.

30) Of the 72 people who answered "yes" to a question, 11 were male. Of the 86 people who answered "no" to the question, 12 were male. If one person is selected at random from the group, what is the probability that the person answered "yes" or was male? 30) _____

A) 0.146 B) 0.153 C) 0.601 D) 0.595

Find the necessary sample size.

31) Scores on a certain test are normally distributed with a variance of 100. A researcher wishes to estimate the mean score achieved by all adults on the test. Find the sample size needed to assure with 95 percent confidence that the sample mean will not differ from the population mean by more than 4 units. 31) _____

A) 2401 B) 25 C) 97 D) 10

Solve the problem.

32) A sample of 44 washing machines yields a mean replacement time of 10.4 years. Assuming that $\sigma = 2.5$ years, find the margin of error in estimating μ at the 90% level of confidence. 32) _____

A) 0.6 years B) 0.5 years C) 2.6 years D) 0.1 years

33) The mean of a set of data is 242.80 and its standard deviation is 84.09. Find the z-score for a value of 317.75. Round your final answer to two decimal places. 33) _____

A) 0.89 B) 1.19 C) 0.98 D) 0.80

Determine the number of outcomes that comprise the specified event.

34) The age distribution of students at a community college is given below. 34) _____

Age (years)	Number of students (f)
Under 21	2189
21-25	2031
26-30	1073
31-35	853
Over 35	221

A student from the community college is selected at random. The event A is defined as follows.

A = event the student is between 26 and 35 inclusive.

Determine the number of outcomes that comprise the event (not A).

A) 4441 B) 1926 C) 5294 D) 4220

Find the indicated probability or percentage for the normally distributed variable.

35) A bank's loan officer rates applicants for credit. The ratings are normally distributed with a mean of 200 and a standard deviation of 50. If an applicant is randomly selected, find the probability of a rating that is between 200 and 275. 35) _____

A) 0.9332 B) 0.4332 C) 0.5 D) 0.0668

Determine the possible values of the random variable.

36) The following frequency distribution analyzes the scores on a math test. For a randomly selected score between 40 and 99, let Y denote the number of students with that score on the test. What are the possible values of the random variable Y? 36) _____

Scores	Number of students
40-59	2
60-75	4
76-82	6
83-94	15
95-99	5

A) 2, 4, 6, 15, 5 B) 2, 4, 6, 5 C) 32 D) 2, 4, 6, 15

Determine the regression equation for the data. Round the final values to three significant digits, if necessary.

37)

x	0	3	4	5	12
y	8	2	6	9	12

37) _____

A) $\hat{y} = 4.98 + 0.425x$ B) $\hat{y} = 4.88 + 0.625x$

C) $\hat{y} = 4.98 + 0.725x$ D) $\hat{y} = 4.88 + 0.525x$

You are given information about a straight line. Determine whether the line slopes upward, slopes downward, or is horizontal.

38) The equation of the line is $y = 6$. 38) _____

A) Slopes upward B) Is horizontal C) Slopes downward

Find the indicated margin of error.

39) In a survey of 2800 T.V. viewers, 1120 said they watch network news programs. Find the margin of error for the 99% confidence interval used to estimate the population proportion. 39) _____

A) 0.0208 B) 0.0136 C) 0.0181 D) 0.0238

Answer the question.

40) An employee at the local ice cream parlor asks three customers if they like chocolate ice cream. Identify the sample and population. 40) _____

A) Sample: the 3 selected customers; population: the customers who like chocolate ice cream

B) Sample: the 3 selected customers; population: all customers

C) Sample: the customers who like chocolate ice cream; population: all customers

D) Sample: all customers; population: the 3 selected customers

MATH 2300 Final Exam (Version A) - Part II - FALL 2013

INSTRUCTIONS: There are 5 questions in part II, 5 points per question. You must do ONLY 4 questions in order to get full credit. If you do all the questions in part II, only the first 4 will be graded. Show ALL your work and give precise answers.

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

1) A researcher is investigating the average height of male students in TTU, and 15 students are ranomly selected from campus and their heights are measureed as below (in meter):
1.80, 1.89, 1.67, 1.90, 1.95, 1.88, 1.80, 1.81, 1.85, 1.80, 1.77, 1.78, 1.99, 1.97, 1.90.
Answer the following questions (round two decimal places).

(a) Compare the mode, median and mean of this sample.Which one is not resistent with respect to outliers?
(b) What's the standard deviation of this sample? Is it a statistic or parameter?

Determine the regression equation for the data. Round the final values to three significant digits, if necessary.

2)

x	3	5	7	15	16
y	8	11	7	14	20

Provide an appropriate response.

3) Suppose that scores on a test are normally distributed with a mean of 80 and a standard deviation of 8. Read the two questions below.

(a) What is the 90th percentile?
(b) What percentage of students score less than 90?
(c) Explain the difference between the two questions. Describe how the method for solving A would differ from the the method for solving B. Be sure to include in your explanation a description of how the table of areas would be used in each case.

Find the confidence interval specified. Assume that the population is normally distributed.

4) A questionnaire of spending habits was given to a random sample of college students. Each student was asked to record and report the amount of money they spent on textbooks in a semester. The sample of 130 students resulted in an average of $422 with standard deviation of $57(Assume that $57 is also the value of the population standard deviation.).

(a) Give a 90% confidence interval for the mean amount of money spent by college students on textbooks.
(b) What is the margin of error for the 90% confidence interval?
(c) How many students should you sample if you want a margin of error of $5 for a 90% confidence interval?

Use the one-proportion z-test to perform the required hypothesis test. Use the critical-value approach.

5) A poll of 1,068 adult Americans reveals that 48% of the voters surveyed prefer the Democratic candidate for the presidency. At the 0.05 level of significance, do the data provide sufficient evidence that the percentage of all voters who prefer the Democrat is less than 50%?(State clearly: null and alternate hypothesis, test statistic, critical values, conclusion.)

Notation

n = sample size	Q_j = jth quartile	σ = population stdev	p = population proportion
$\bar{x}$ = sample mean	N = population size	d = paired difference	O = observed frequency
s = sample stdev	μ = population mean	$\hat{p}$ = sample proportion	E = expected frequency

Chapter 3 Descriptive Measures

- Sample mean: $\bar{x} = \dfrac{\Sigma x_i}{n}$
- Range: Range = Max − Min
- Sample standard deviation:

$$s = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}} \quad \text{or} \quad s = \sqrt{\frac{\Sigma x_i^2 - (\Sigma x_i)^2/n}{n-1}}$$

- Interquartile range: IQR = $Q_3 - Q_1$
- Lower limit = $Q_1 - 1.5 \cdot \text{IQR}$, Upper limit = $Q_3 + 1.5 \cdot \text{IQR}$
- Population mean (mean of a variable): $\mu = \dfrac{\Sigma x_i}{N}$
- Population standard deviation (standard deviation of a variable):

$$\sigma = \sqrt{\frac{\Sigma(x_i - \mu)^2}{N}} \quad \text{or} \quad \sigma = \sqrt{\frac{\Sigma x_i^2}{N} - \mu^2}$$

- Standardized variable: $z = \dfrac{x - \mu}{\sigma}$

Chapter 4 Descriptive Methods in Regression and Correlation

- S_{xx}, S_{xy}, and S_{yy}:

$$S_{xx} = \Sigma(x_i - \bar{x})^2 = \Sigma x_i^2 - (\Sigma x_i)^2/n$$
$$S_{xy} = \Sigma(x_i - \bar{x})(y_i - \bar{y}) = \Sigma x_i y_i - (\Sigma x_i)(\Sigma y_i)/n$$
$$S_{yy} = \Sigma(y_i - \bar{y})^2 = \Sigma y_i^2 - (\Sigma y_i)^2/n$$

- Regression equation: $\hat{y} = b_0 + b_1 x$, where

$$b_1 = \frac{S_{xy}}{S_{xx}} \quad \text{and} \quad b_0 = \frac{1}{n}(\Sigma y_i - b_1 \Sigma x_i) = \bar{y} - b_1 \bar{x}$$

- Total sum of squares: $SST = \Sigma(y_i - \bar{y})^2 = S_{yy}$
- Regression sum of squares: $SSR = \Sigma(\hat{y}_i - \bar{y})^2 = S_{xy}^2/S_{xx}$
- Error sum of squares: $SSE = \Sigma(y_i - \hat{y}_i)^2 = S_{yy} - S_{xy}^2/S_{xx}$
- Regression identity: $SST = SSR + SSE$
- Coefficient of determination: $r^2 = \dfrac{SSR}{SST}$
- Linear correlation coefficient:

$$r = \frac{\frac{1}{n-1}\Sigma(x_i - \bar{x})(y_i - \bar{y})}{s_x s_y} \quad \text{or} \quad r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$$

Chapter 5 Probability and Random Variables

- Probability for equally likely outcomes:

$$P(E) = \frac{f}{N}$$

where f denotes the number of ways event E can occur and N denotes the total number of outcomes possible.

- Special addition rule:

$$P(A \text{ or } B \text{ or } C \text{ or } \cdots) = P(A) + P(B) + P(C) + \cdots$$

(A, B, C, ... mutually exclusive)

- Complementation rule: $P(E) = 1 - P(\text{not } E)$
- General addition rule: $P(A \text{ or } B) = P(A) + P(B) - P(A \,\&\, B)$
- Mean of a discrete random variable X: $\mu = \Sigma x P(X = x)$
- Standard deviation of a discrete random variable X:

$$\sigma = \sqrt{\Sigma(x-\mu)^2 P(X=x)} \quad \text{or} \quad \sigma = \sqrt{\Sigma x^2 P(X=x) - \mu^2}$$

- Factorial: $k! = k(k-1)\cdots 2 \cdot 1$
- Binomial coefficient: $\dbinom{n}{x} = \dfrac{n!}{x!(n-x)!}$
- Binomial probability formula:

$$P(X = x) = \binom{n}{x} p^x (1-p)^{n-x}$$

where n denotes the number of trials and p denotes the success probability.

- Mean of a binomial random variable: $\mu = np$
- Standard deviation of a binomial random variable:

$$\sigma = \sqrt{np(1-p)}$$

Chapter 6 The Normal Distribution

- z-score for an x-value: $z = \dfrac{x - \mu}{\sigma}$
- x-value for a z-score: $x = \mu + z \cdot \sigma$

Chapter 7 The Sampling Distribution of the Sample Mean

- Mean of the variable $\bar{x}$: $\mu_{\bar{x}} = \mu$
- Standard deviation of the variable x: $\sigma_{\bar{x}} = \sigma/\sqrt{n}$

Chapter 8 Confidence Intervals for One Population Mean

- Standardized version of the variable $\bar{x}$:

$$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$$

- z-interval for μ (σ known, normal population or large sample):

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

- Margin of error for the estimate of μ: $E = z_{\alpha/2} \cdot \dfrac{\sigma}{\sqrt{n}}$

- Sample size for estimating μ:

$$n = \left(\frac{z_{\alpha/2} \cdot \sigma}{E}\right)^2$$

rounded up to the nearest whole number.

- Studentized version of the variable $\bar{x}$:

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$

- t-interval for μ (σ unknown, normal population or large sample):

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

with df $= n - 1$.

Chapter 9 Hypothesis Tests for One Population Mean

- z-test statistic for H_0: $\mu = \mu_0$ (σ known, normal population or large sample):

$$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$$

- t-test statistic for H_0: $\mu = \mu_0$ (σ unknown, normal population or large sample):

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

with df $= n - 1$.

Chapter 10 Inferences for Two Population Means

- Pooled sample standard deviation:

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

- Pooled t-test statistic for H_0: $\mu_1 = \mu_2$ (independent samples, normal populations or large samples, and equal population standard deviations):

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_p\sqrt{(1/n_1) + (1/n_2)}}$$

with df $= n_1 + n_2 - 2$.

- Pooled t-interval for $\mu_1 - \mu_2$ (independent samples, normal populations or large samples, and equal population standard deviations):

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2} \cdot s_p\sqrt{(1/n_1) + (1/n_2)}$$

with df $= n_1 + n_2 - 2$.

- Degrees of freedom for nonpooled t-procedures:

$$\Delta = \frac{[(s_1^2/n_1) + (s_2^2/n_2)]^2}{\dfrac{(s_1^2/n_1)^2}{n_1 - 1} + \dfrac{(s_2^2/n_2)^2}{n_2 - 1}}$$

rounded down to the nearest integer.

- Nonpooled t-test statistic for H_0: $\mu_1 = \mu_2$ (independent samples, and normal populations or large samples):

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(s_1^2/n_1) + (s_2^2/n_2)}}$$

with df $= \Delta$.

- Nonpooled t-interval for $\mu_1 - \mu_2$ (independent samples, and normal populations or large samples):

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2} \cdot \sqrt{(s_1^2/n_1) + (s_2^2/n_2)}$$

with df $= \Delta$.

- Paired t-test statistic for H_0: $\mu_1 = \mu_2$ (paired sample, and normal differences or large sample):

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

with df $= n - 1$.

- Paired t-interval for $\mu_1 - \mu_2$ (paired sample, and normal differences or large sample):

$$\bar{d} \pm t_{\alpha/2} \cdot \frac{s_d}{\sqrt{n}}$$

with df $= n - 1$.

Chapter 11 Inferences for Population Proportions

- Sample proportion: $\hat{p} = x/n$, where x denotes the number of members in the sample that have the specified attribute.

- z-interval for p:

$$\hat{p} \pm z_{\alpha/2} \cdot \sqrt{\hat{p}(1 - \hat{p})/n}$$

(*Assumption:* both x and $n - x$ are 5 or greater)

- Margin of error for the estimate of p:

$$E = z_{\alpha/2} \cdot \sqrt{\hat{p}(1 - \hat{p})/n}$$

- Sample size for estimating p:

$$n = 0.25\left(\frac{z_{\alpha/2}}{E}\right)^2 \quad \text{or} \quad n = \hat{p}_g(1 - \hat{p}_g)\left(\frac{z_{\alpha/2}}{E}\right)^2$$

rounded up to the nearest whole number (g = "educated guess")

- z-test statistic for H_0: $p = p_0$:

$$z = \frac{\hat{p} - p_0}{\sqrt{p_0(1 - p_0)/n}}$$

(*Assumption:* both np_0 and $n(1 - p_0)$ are 5 or greater)

- Pooled sample proportion: $\hat{p}_p = \dfrac{x_1 + x_2}{n_1 + n_2}$
- z-test statistic for H_0: $p_1 = p_2$:

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}_p(1 - \hat{p}_p)}\sqrt{(1/n_1) + (1/n_2)}}$$

(*Assumptions:* independent samples; x_1, $n_1 - x_1$, x_2, $n_2 - x_2$ are all 5 or greater)

- z-interval for $p_1 - p_2$:

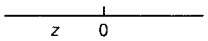
$$(\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2} \cdot \sqrt{\hat{p}_1(1 - \hat{p}_1)/n_1 + \hat{p}_2(1 - \hat{p}_2)/n_2}$$

(*Assumptions:* independent samples; x_1, $n_1 - x_1$, x_2, $n_2 - x_2$ are all 5 or greater)

- Margin of error for the estimate of $p_1 - p_2$:

$$E = z_{\alpha/2} \cdot \sqrt{\hat{p}_1(1 - \hat{p}_1)/n_1 + \hat{p}_2(1 - \hat{p}_2)/n_2}$$

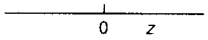
TABLE II
Areas under the standard normal curve



Second decimal place in z										
0.09	*0.08*	*0.07*	*0.06*	*0.05*	*0.04*	*0.03*	*0.02*	*0.01*	*0.00*	z
									0.0000†	*−3.9*
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	*−3.8*
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	*−3.7*
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	*−3.6*
0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	*−3.5*
0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	*−3.4*
0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005	*−3.3*
0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	*−3.2*
0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010	*−3.1*
0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	*−3.0*
0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019	*−2.9*
0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026	*−2.8*
0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035	*−2.7*
0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047	*−2.6*
0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062	*−2.5*
0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082	*−2.4*
0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107	*−2.3*
0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139	*−2.2*
0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179	*−2.1*
0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228	*−2.0*
0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287	*−1.9*
0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359	*−1.8*
0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446	*−1.7*
0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548	*−1.6*
0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668	*−1.5*
0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808	*−1.4*
0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968	*−1.3*
0.0985	0.1003	0.1020	0.1038	0.1056	0.1075	0.1093	0.1112	0.1131	0.1151	*−1.2*
0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357	*−1.1*
0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587	*−1.0*
0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841	*−0.9*
0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119	*−0.8*
0.2148	0.2177	0.2206	0.2236	0.2266	0.2296	0.2327	0.2358	0.2389	0.2420	*−0.7*
0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743	*−0.6*
0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085	*−0.5*
0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446	*−0.4*
0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821	*−0.3*
0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207	*−0.2*
0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602	*−0.1*
0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000	*−0.0*

† For $z \leq -3.90$, the areas are 0.0000 to four decimal places.

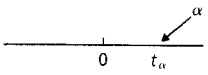
TABLE II (cont.)
Areas under the standard normal curve



	Second decimal place in z									
z	*0.00*	*0.01*	*0.02*	*0.03*	*0.04*	*0.05*	*0.06*	*0.07*	*0.08*	*0.09*
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.9	1.0000*									

* For $z \geq 3.90$, the areas are 1.0000 to four decimal places.

TABLE IV
Values of t_α



df	$t_{0.10}$	$t_{0.05}$	$t_{0.025}$	$t_{0.01}$	$t_{0.005}$	df
1	3.078	6.314	12.706	31.821	63.657	1
2	1.886	2.920	4.303	6.965	9.925	2
3	1.638	2.353	3.182	4.541	5.841	3
4	1.533	2.132	2.776	3.747	4.604	4
5	1.476	2.015	2.571	3.365	4.032	5
6	1.440	1.943	2.447	3.143	3.707	6
7	1.415	1.895	2.365	2.998	3.499	7
8	1.397	1.860	2.306	2.896	3.355	8
9	1.383	1.833	2.262	2.821	3.250	9
10	1.372	1.812	2.228	2.764	3.169	10
11	1.363	1.796	2.201	2.718	3.106	11
12	1.356	1.782	2.179	2.681	3.055	12
13	1.350	1.771	2.160	2.650	3.012	13
14	1.345	1.761	2.145	2.624	2.977	14
15	1.341	1.753	2.131	2.602	2.947	15
16	1.337	1.746	2.120	2.583	2.921	16
17	1.333	1.740	2.110	2.567	2.898	17
18	1.330	1.734	2.101	2.552	2.878	18
19	1.328	1.729	2.093	2.539	2.861	19
20	1.325	1.725	2.086	2.528	2.845	20
21	1.323	1.721	2.080	2.518	2.831	21
22	1.321	1.717	2.074	2.508	2.819	22
23	1.319	1.714	2.069	2.500	2.807	23
24	1.318	1.711	2.064	2.492	2.797	24
25	1.316	1.708	2.060	2.485	2.787	25
26	1.315	1.706	2.056	2.479	2.779	26
27	1.314	1.703	2.052	2.473	2.771	27
28	1.313	1.701	2.048	2.467	2.763	28
29	1.311	1.699	2.045	2.462	2.756	29
30	1.310	1.697	2.042	2.457	2.750	30
31	1.309	1.696	2.040	2.453	2.744	31
32	1.309	1.694	2.037	2.449	2.738	32
33	1.308	1.692	2.035	2.445	2.733	33
34	1.307	1.691	2.032	2.441	2.728	34
35	1.306	1.690	2.030	2.438	2.724	35
36	1.306	1.688	2.028	2.434	2.719	36
37	1.305	1.687	2.026	2.431	2.715	37
38	1.304	1.686	2.024	2.429	2.712	38
39	1.304	1.685	2.023	2.426	2.708	39
40	1.303	1.684	2.021	2.423	2.704	40
41	1.303	1.683	2.020	2.421	2.701	41
42	1.302	1.682	2.018	2.418	2.698	42
43	1.302	1.681	2.017	2.416	2.695	43
44	1.301	1.680	2.015	2.414	2.692	44
45	1.301	1.679	2.014	2.412	2.690	45
46	1.300	1.679	2.013	2.410	2.687	46
47	1.300	1.678	2.012	2.408	2.685	47
48	1.299	1.677	2.011	2.407	2.682	48
49	1.299	1.677	2.010	2.405	2.680	49

TABLE IV (cont.)
Values of t_α

df	$t_{0.10}$	$t_{0.05}$	$t_{0.025}$	$t_{0.01}$	$t_{0.005}$	df
50	1.299	1.676	2.009	2.403	2.678	50
51	1.298	1.675	2.008	2.402	2.676	51
52	1.298	1.675	2.007	2.400	2.674	52
53	1.298	1.674	2.006	2.399	2.672	53
54	1.297	1.674	2.005	2.397	2.670	54
55	1.297	1.673	2.004	2.396	2.668	55
56	1.297	1.673	2.003	2.395	2.667	56
57	1.297	1.672	2.002	2.394	2.665	57
58	1.296	1.672	2.002	2.392	2.663	58
59	1.296	1.671	2.001	2.391	2.662	59
60	1.296	1.671	2.000	2.390	2.660	60
61	1.296	1.670	2.000	2.389	2.659	61
62	1.295	1.670	1.999	2.388	2.657	62
63	1.295	1.669	1.998	2.387	2.656	63
64	1.295	1.669	1.998	2.386	2.655	64
65	1.295	1.669	1.997	2.385	2.654	65
66	1.295	1.668	1.997	2.384	2.652	66
67	1.294	1.668	1.996	2.383	2.651	67
68	1.294	1.668	1.995	2.382	2.650	68
69	1.294	1.667	1.995	2.382	2.649	69
70	1.294	1.667	1.994	2.381	2.648	70
71	1.294	1.667	1.994	2.380	2.647	71
72	1.293	1.666	1.993	2.379	2.646	72
73	1.293	1.666	1.993	2.379	2.645	73
74	1.293	1.666	1.993	2.378	2.644	74
75	1.293	1.665	1.992	2.377	2.643	75
80	1.292	1.664	1.990	2.374	2.639	80
85	1.292	1.663	1.988	2.371	2.635	85
90	1.291	1.662	1.987	2.368	2.632	90
95	1.291	1.661	1.985	2.366	2.629	95
100	1.290	1.660	1.984	2.364	2.626	100
200	1.286	1.653	1.972	2.345	2.601	200
300	1.284	1.650	1.968	2.339	2.592	300
400	1.284	1.649	1.966	2.336	2.588	400
500	1.283	1.648	1.965	2.334	2.586	500
600	1.283	1.647	1.964	2.333	2.584	600
700	1.283	1.647	1.963	2.332	2.583	700
800	1.283	1.647	1.963	2.331	2.582	800
900	1.282	1.647	1.963	2.330	2.581	900
1000	1.282	1.646	1.962	2.330	2.581	1000
2000	1.282	1.646	1.961	2.328	2.578	2000
	1.282	1.645	1.960	2.326	2.576	
	$z_{0.10}$	$z_{0.05}$	$z_{0.025}$	$z_{0.01}$	$z_{0.005}$	