Frequently Used Statistics Formulas and Tables

Chapter 2

Class Width = $\dfrac{\text{highest value - lowest value}}{\text{number classes}}$ (increase to next integer)

Class Midpoint = $\dfrac{\text{upper limit + lower limit}}{2}$

Chapter 3

$n =$ sample size

$N =$ population size

$f =$ frequency

$\Sigma = sum$

$w = weight$

Sample mean: $\bar{x} = \dfrac{\sum x}{n}$

Population mean: $\mu = \dfrac{\sum x}{N}$

Weighted mean: $\bar{x} = \dfrac{\sum (w \bullet x)}{\sum w}$

Mean for frequency table: $\bar{x} = \dfrac{\sum (f \bullet x)}{\sum f}$

Midrange = $\dfrac{\text{highest value + lowest value}}{2}$

Range = Highest value - Lowest value

Sample standard deviation: $s = \sqrt{\dfrac{\sum (x-\bar{x})^2}{n-1}}$

Population standard deviation: $\sigma = \sqrt{\dfrac{\sum (x-\mu)^2}{N}}$

Sample variance: s^2

Population variance: σ^2

Chapter 3

Limits for Unusual Data

Below : μ - 2σ

Above: $\mu + 2\sigma$

Empirical Rule

About 68%: μ-σ to $\mu + \sigma$

About 95%: μ-2σ to $\mu + 2\sigma$

About 99.7%: μ-3σ to $\mu + 3\sigma$

Sample coefficient of variation: $CV = \dfrac{s}{\bar{x}} \bullet 100\%$

Population coefficient of variation: $CV = \dfrac{\sigma}{\mu} \bullet 100\%$

Sample standard deviation for frequency table:

$$s = \sqrt{\frac{n\,[\,\sum (f \bullet x^2)\,] - [\,\sum (f \bullet x)\,]^2}{n\,(n-1)}}$$

Sample z-score: $z = \dfrac{x - \bar{x}}{s}$

Population z-score: $z = \dfrac{x - \mu}{\sigma}$

Interquartile Range: (IQR) = $Q_3 - Q_1$

Modified Box Plot Outliers

lower limit: Q_1 - 1.5 (IQR)

upper limit: Q_3 + 1.5 (IQR)

Chapter 4

Probability of the complement of event A
$P(not\ A) = 1 - P(A)$

Multiplication rule for independent events
$P(A\ and\ B) = P(A) \bullet P(B)$

General multiplication rules
$P(A\ and\ B) = P(A) \bullet P(B,\ given\ A)$
$P(A\ and\ B) = P(A) \bullet P(A,\ given\ B)$

Addition rule for mutually exclusive events
$P(A\ or\ B) = P(A) + P(B)$

General addition rule
$P(A\ or\ B) = P(A) + P(B) - P(A\ and\ B)$

Permutation rule: $_nP_r = \dfrac{n!}{(n-r)!}$

Combination rule: $_nC_r = \dfrac{n!}{r!(n-r)!}$

<u>Permutation and Combination on TI 83/84</u>

n $\boxed{\text{Math}}$ $\boxed{\text{PRB}}$ $\boxed{\text{nPr}}$ $\boxed{\text{enter}}$ r

n $\boxed{\text{Math}}$ $\boxed{\text{PRB}}$ $\boxed{\text{nCr}}$ $\boxed{\text{enter}}$ r

Note: textbooks and formula sheets interchange "r" and "x" for number of successes

Chapter 5

Discrete Probability Distributions:

Mean of a discrete probability distribution:
$\mu = \sum[x \bullet P(x)]$

Standard deviation of a probability distribution:

$\sigma = \sqrt{\sum[x^2 \bullet P(x)] - \mu^2}$

Binomial Distributions

r = number of successes (or x)

p = probability of success

q = probability of failure

$q = 1 - p$ $\qquad$ $p + q = 1$

Binomial probability distribution
$P(r) = {}_nC_r\, p^r q^{n-r}$

Mean: $\mu = np$

Standard deviation: $\sigma = \sqrt{npq}$

Poisson Distributions

r = number of successes (or x)

μ = mean number of successes
(over a given interval)

Poisson probability distribution

$P(r) = \dfrac{e^{-\mu}\mu^r}{r!}$

$e \approx 2.71828$

$\mu = mean$ (over some interval)

$\sigma = \sqrt{\mu}$

$\sigma^2 = \mu$

Chapter 6

Normal Distributions

Raw score: $x = z\sigma + \mu$

Standard score: $z = \dfrac{x-\mu}{\sigma}$

Mean of $\overline{x}$ distribution: $\mu_{\overline{x}} = \mu$

Standard deviation of $\overline{x}$ distribtuion: $\sigma_{\overline{x}} = \dfrac{\sigma}{\sqrt{n}}$
(standard error)

Standard score for $\overline{x}$: $z = \dfrac{\overline{x}-\mu}{\sigma/\sqrt{n}}$

Chapter 7

One Sample Confidence Interval

for proportions (p): $(np > 5 \text{ and } nq > 5)$

$\hat{p} - E < p < \hat{p} + E$

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

$\hat{p} = \dfrac{r}{n}$

for means (μ) when σ is known:

$\overline{x} - E < \mu < \overline{x} + E$

where $E = z_{\alpha/2}\dfrac{\sigma}{\sqrt{n}}$

for means (μ) when σ is unknown:

$\overline{x} - E < \mu < \overline{x} + E$

where $E = t_{\alpha/2}\dfrac{s}{\sqrt{n}}$

with $d.f. = n-1$

for variance (σ^2): $\dfrac{(n-1)s^2}{\chi^2_R} < \sigma^2 < \dfrac{(n-1)s^2}{\chi^2_L}$

with $d.f. = n-1$

Chapter 7

Confidence Interval: Point estimate ± error

Point estimate = $\dfrac{\text{Upper limit + Lower limit}}{2}$

Error = $\dfrac{\text{Upper limit - Lower limit}}{2}$

Sample Size for Estimating

means:

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

proportions:

$$n = \hat{p}\hat{q}\left(\frac{z_{\alpha/2}}{E}\right)^2$$ with preliminary estimate for p

$$n = 0.25\left(\frac{z_{\alpha/2}}{E}\right)^2$$ without preliminary estimate for p

variance or standard deviation:
*see table 7-2 (last page of formula sheet)

Confidence Intervals

Level of Confidence	z-value $(z_{\alpha/2})$
70%	1.04
75%	1.15
80%	1.28
85%	1.44
90%	1.645
95%	1.96
98%	2.33
99%	2.58

Chapter 8

One Sample Hypothesis Testing

for p ($np > 5$ and $nq > 5$): $z = \dfrac{\hat{p} - p}{\sqrt{pq/n}}$

where $q = 1 - p$; $\hat{p} = r/n$

for μ (σ known): $z = \dfrac{\bar{x} - \mu}{\sigma/\sqrt{n}}$

for μ (σ unknown): $t = \dfrac{\bar{x} - \mu}{s/\sqrt{n}}$ with $d.f. = n - 1$

for σ^2: $\chi^2 = \dfrac{(n-1)s^2}{\sigma^2}$ with $d.f. = n - 1$

Chapter 9

Two Sample Confidence Intervals and Tests of Hypotheses

Difference of Proportions ($p_1 - p_2$)

Confidence Interval:

$$(\hat{p}_1 - \hat{p}_2) - E < (p_1 - p_2) < (\hat{p}_1 - \hat{p}_2) + E$$

where $E = z_{\alpha/2}\sqrt{\dfrac{\hat{p}_1\hat{q}_1}{n_1} + \dfrac{\hat{p}_2\hat{q}_2}{n_2}}$

$\hat{p}_1 = r_1/n_1$; $\hat{p}_2 = r_2/n_2$ and $\hat{q}_1 = 1 - \hat{p}_1$; $\hat{q}_2 = 1 - \hat{p}_2$

Hypothesis Test:

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\dfrac{\overline{pq}}{n_1} + \dfrac{\overline{pq}}{n_2}}}$$

where the pooled proportion is $\bar{p}$

$$\bar{p} = \frac{r_1 + r_2}{n_1 + n_2} \text{ and } \bar{q} = 1 - \bar{p}$$

$\hat{p}_1 = r_1/n_1$; $\hat{p}_2 = r_2/n_2$

Chapter 9

Difference of means μ_1-μ_2 (independent samples)

Confidence Interval when σ_1 and σ_2 are known

$$(\bar{x}_1 - \bar{x}_2) - E < (\mu_1 - \mu_2) < (\bar{x}_1 - \bar{x}_2) + E$$

where $E = z_{\alpha/2}\sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}$

Hypothesis Test when σ_1 and σ_2 are known

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}}$$

Confidence Interval when σ_1 and σ_2 are unknown

$$(\bar{x}_1 - \bar{x}_2) - E < (\mu_1 - \mu_2) < (\bar{x}_1 - \bar{x}_2) + E$$

$$E = t_{\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

with $d.f.$ = smaller of $n_1 - 1$ and $n_2 - 1$

Hypothesis Test when σ_1 and σ_2 are unknown

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}}$$

with $d.f.$ = smaller of $n_1 - 1$ and $n_2 - 1$

Matched pairs (dependent samples)

Confidence Interval

$$\bar{d} - E < \mu_{\bar{d}} < \bar{d} + E$$

where $E = t_{\alpha/2}\dfrac{s_d}{\sqrt{n}}$ with d.f. $= n - 1$

Hypothesis Test

$$t = \frac{\bar{d} - \mu_{\bar{d}}}{\dfrac{s_d}{\sqrt{n}}} \text{ with } d.f. = n - 1$$

Two Sample Variances

Confidence Interval for σ_1^2 and σ_2^2

$$\left(\frac{s_1^2}{s_2^2} \bullet \frac{1}{F_{right}}\right) < \frac{\sigma_1^2}{\sigma_2^2} < \left(\frac{s_1^2}{s_2^2} \bullet \frac{1}{F_{left}}\right)$$

Hypothesis Test Statistic: $F = \dfrac{s_1^2}{s_2^2}$ where $s_1^2 \ge s_2^2$

numerator $d.f. = n_1 - 1$ and denominator $d.f. = n_2 - 1$

Chapter 10

Regression and Correlation

Linear Correlation Coefficient (r)

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}\sqrt{n(\sum y^2) - (\sum y)^2}}$$

OR

$$r = \frac{\Sigma(z_x z_y)}{n-1} \quad \text{where } z_x = \text{ z score for x and } z_y = \text{ z score for y}$$

Coefficient of Determination: $r^2 = \dfrac{\text{explained variation}}{\text{total variation}}$

Standard Error of Estimate: $s_e = \sqrt{\dfrac{\Sigma(y-\hat{y})^2}{n-2}}$

or $s_e = \sqrt{\dfrac{\sum y^2 - b_0 \sum y - b_1 \sum xy}{n-2}}$

Prediction Interval: $\hat{y} - E < y < \hat{y} + E$

where $E = t_{\alpha/2}\ s_e \sqrt{1 + \dfrac{1}{n} + \dfrac{n(x_0 - \overline{x})^2}{n(\Sigma x^2) - (\Sigma x)^2}}$

Sample test statistic for r

$$t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}} \quad \text{with } d.f. = n-2$$

Least-Squares Line (Regression Line or Line of Best Fit)

$\hat{y} = b_0 + b_1 x$ note that b_0 is the y-intercept and b_1 is the slope

where $b_1 = \dfrac{n\sum xy - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$ or $b_1 = r\dfrac{s_y}{s_x}$

and

where $b_0 = \dfrac{(\sum y)(\sum x^2) - (\sum x)(\sum xy)}{n(\sum x^2) - (\sum x)^2}$ or $b_0 = \overline{y} - b_1\overline{x}$

Confidence interval for y-intercept β_0

$b_0 - E < \beta_0 < b_0 + E$

where E = $t_{\alpha/2}\ s_e \sqrt{\dfrac{1}{n} + \dfrac{\overline{x}^2}{\sum x^2 - \frac{(\sum x)^2}{n}}}$

Confidence interval for slope β_1

$b_1 - E < \beta_1 < b_1 + E$

where E = $t_{\alpha/2} \bullet \dfrac{s_e}{\sqrt{\sum x^2 - \frac{(\sum x)^2}{n}}}$

Chapter 11

$$\chi^2 = \sum \frac{(O-E)^2}{E} \quad \text{where } E = \frac{\text{(row total)(column total)}}{\text{sample size}}$$

Tests of Independence $d.f. = (R-1)(C-1)$

Goodness of fit $d.f. = \text{(number of categories)} - 1$

Chapter 12

One Way ANOVA

$k =$ number of groups; $N =$ total sample size

$$SS_{TOT} = \sum x_{TOT}^2 - \frac{(\sum x_{TOT})^2}{N}$$

$$SS_{BET} = \sum_{\text{all groups}} \left(\frac{(\sum x_i)^2}{n_i}\right) - \frac{(\sum x_{TOT})^2}{N}$$

$$SS_W = \sum_{\text{all groups}} \left(\sum x_i^2 - \frac{(\sum x_i)^2}{n_i}\right)$$

$$SS_{TOT} = SS_{BET} + SS_W$$

$$MS_{BET} = \frac{SS_{BET}}{d.f._{BET}} \quad \text{where } d.f._{BET} = k-1$$

$$MS_W = \frac{SS_W}{d.f._W} \quad \text{where } d.f._W = N-k$$

$F = \dfrac{MS_{BET}}{MS_W}$ where $d.f.$ numerator = $d.f._{BET} = k-1$

$d.f.$ denominator = $d.f._W = N-k$

Two-Way ANOVA

r = number of rows; c = number of columns

Row factor F : $\dfrac{MS \text{ row factor}}{MS \text{ error}}$

Column factor F : $\dfrac{MS \text{ column factor}}{MS \text{ error}}$

Interaction F : $\dfrac{MS \text{ interaction}}{MS \text{ error}}$

with degrees of freedom for

row factor = $r-1$

column factor = $c-1$

interaction = $(r-1)(c-1)$

error = $rc(n-1)$

NEGATIVE z Scores

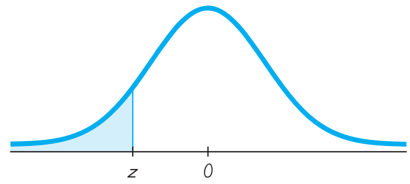
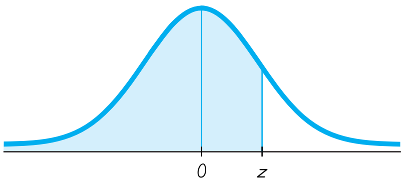


TABLE A-2 Standard Normal (z) Distribution: Cumulative Area from the LEFT

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.50 and lower	.0001									
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	* .0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	* .0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

NOTE: For values of z below −3.49, use 0.0001 for the area.
*Use these common values that result from interpolation:

z score	Area
−1.645	0.0500
−2.575	0.0050



POSITIVE *z* Scores

TABLE A-2 (*continued*) Cumulative Area from the LEFT

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495 *	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949 *	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998
3.50 and up	.9999									

NOTE: For values of *z* above 3.49, use 0.9999 for the area.

*Use these common values that result from interpolation:

z score	Area
1.645	0.9500
2.575	0.9950

Common Critical Values

Confidence Level	Critical Value
0.90	1.645
0.95	1.96
0.99	2.575

critical z-values for hypothesis testing

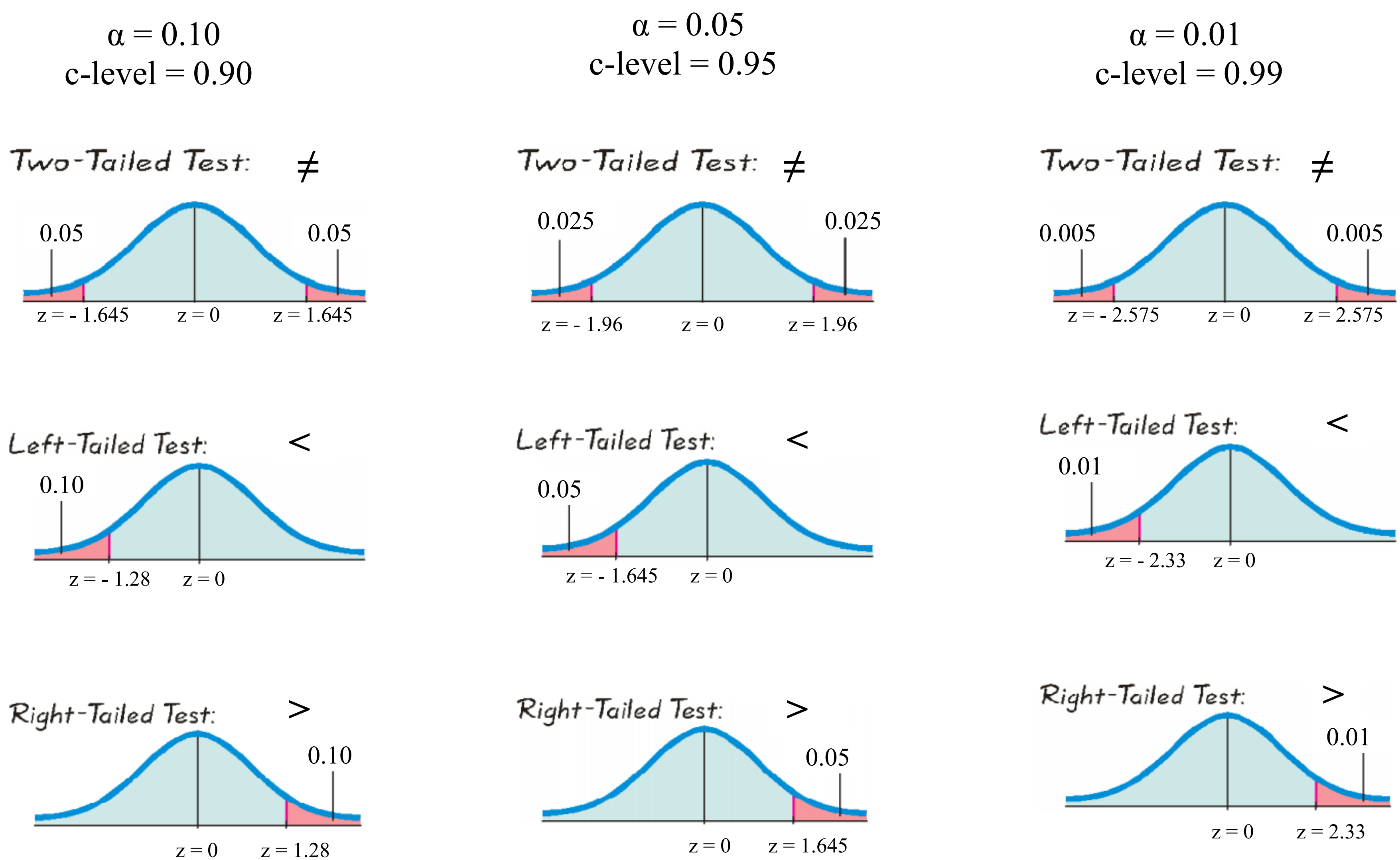


Figure 8.4

TABLE A-3 *t* Distribution: Critical *t* Values

	Area in One Tail				
	0.005	0.01	0.025	0.05	0.10
Degrees of Freedom	Area in Two Tails				
	0.01	0.02	0.05	0.10	0.20
1	**63.657**	31.821	**12.706**	6.314	3.078
2	**9.925**	6.965	**4.303**	2.920	1.886
3	**5.841**	4.541	**3.182**	2.353	1.638
4	**4.604**	3.747	**2.776**	2.132	1.533
5	**4.032**	3.365	**2.571**	2.015	1.476
6	**3.707**	3.143	**2.447**	1.943	1.440
7	**3.499**	2.998	**2.365**	1.895	1.415
8	**3.355**	2.896	**2.306**	1.860	1.397
9	**3.250**	2.821	**2.262**	1.833	1.383
10	**3.169**	2.764	**2.228**	1.812	1.372
11	**3.106**	2.718	**2.201**	1.796	1.363
12	**3.055**	2.681	**2.179**	1.782	1.356
13	**3.012**	2.650	**2.160**	1.771	1.350
14	**2.977**	2.624	**2.145**	1.761	1.345
15	**2.947**	2.602	**2.131**	1.753	1.341
16	**2.921**	2.583	**2.120**	1.746	1.337
17	**2.898**	2.567	**2.110**	1.740	1.333
18	**2.878**	2.552	**2.101**	1.734	1.330
19	**2.861**	2.539	**2.093**	1.729	1.328
20	**2.845**	2.528	**2.086**	1.725	1.325
21	**2.831**	2.518	**2.080**	1.721	1.323
22	**2.819**	2.508	**2.074**	1.717	1.321
23	**2.807**	2.500	**2.069**	1.714	1.319
24	**2.797**	2.492	**2.064**	1.711	1.318
25	**2.787**	2.485	**2.060**	1.708	1.316
26	**2.779**	2.479	**2.056**	1.706	1.315
27	**2.771**	2.473	**2.052**	1.703	1.314
28	**2.763**	2.467	**2.048**	1.701	1.313
29	**2.756**	2.462	**2.045**	1.699	1.311
30	**2.750**	2.457	**2.042**	1.697	1.310
31	**2.744**	2.453	**2.040**	1.696	1.309
32	**2.738**	2.449	**2.037**	1.694	1.309
33	**2.733**	2.445	**2.035**	1.692	1.308
34	**2.728**	2.441	**2.032**	1.691	1.307
35	**2.724**	2.438	**2.030**	1.690	1.306
36	**2.719**	2.434	**2.028**	1.688	1.306
37	**2.715**	2.431	**2.026**	1.687	1.305
38	**2.712**	2.429	**2.024**	1.686	1.304
39	**2.708**	2.426	**2.023**	1.685	1.304
40	**2.704**	2.423	**2.021**	1.684	1.303
45	**2.690**	2.412	**2.014**	1.679	1.301
50	**2.678**	2.403	**2.009**	1.676	1.299
60	**2.660**	2.390	**2.000**	1.671	1.296
70	**2.648**	2.381	**1.994**	1.667	1.294
80	**2.639**	2.374	**1.990**	1.664	1.292
90	**2.632**	2.368	**1.987**	1.662	1.291
100	**2.626**	2.364	**1.984**	1.660	1.290
200	**2.601**	2.345	**1.972**	1.653	1.286
300	**2.592**	2.339	**1.968**	1.650	1.284
400	**2.588**	2.336	**1.966**	1.649	1.284
500	**2.586**	2.334	**1.965**	1.648	1.283
1000	**2.581**	2.330	**1.962**	1.646	1.282
2000	**2.578**	2.328	**1.961**	1.646	1.282
Large	**2.576**	2.326	**1.960**	1.645	1.282

TABLE A-4 Chi-Square (χ^2) Distribution

Degrees of Freedom	Area to the Right of the Critical Value									
	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.299
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.042	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.194	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.257	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.954	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

From Donald B. Owen, *Handbook of Statistical Tables*, © 1962 Addison-Wesley Publishing Co., Reading, MA. Reprinted with permission of the publisher.

Degrees of Freedom

$n - 1$	for confidence intervals or hypothesis tests with a standard deviation or variance
$k - 1$	for goodness-of-fit with k categories
$(r - 1)(c - 1)$	for contingency tables with r rows and c columns
$k - 1$	for Kruskal-Wallis test with k samples

Determining Sample Size for Population Variance or Standard Deviation

Table 7-2

Sample Size for σ^2		Sample Size for σ	
To be 95% confident that s^2 is within	of the value of σ^2, the sample size n should be at least	To be 95% confident that s is within	of the value of σ, the sample size n should be at least
1%	77,208	1%	19,205
5%	3,149	5%	768
10%	806	10%	192
20%	211	20%	48
30%	98	30%	21
40%	57	40%	12
50%	38	50%	8
To be 99% confident that s^2 is within	of the value of σ^2, the sample size n should be at least	To be 99% confident that s is within	of the value of σ, the sample size n should be at least
1%	133,449	1%	33,218
5%	5,458	5%	1,336
10%	1,402	10%	336
20%	369	20%	85
30%	172	30%	38
40%	101	40%	22
50%	68	50%	14

(table 7-2 from page 390, Triola 4th edition)

TABLE A-6
Critical Values of the
Pearson Correlation Coefficient r

n	alpha = .05	alpha = .01
4	0.950	0.990
5	0.878	0.959
6	0.811	0.917
7	0.754	0.875
8	0.707	0.834
9	0.666	0.798
10	0.632	0.765
11	0.602	0.735
12	0.576	0.708
13	0.553	0.684
14	0.532	0.661
15	0.514	0.641
16	0.497	0.623
17	0.482	0.606
18	0.468	0.590
19	0.456	0.575
20	0.444	0.561
25	0.396	0.505
30	0.361	0.463
35	0.335	0.430
40	0.312	0.402
45	0.294	0.378
50	0.279	0.361
60	0.254	0.330
70	0.236	0.305
80	0.220	0.286
90	0.207	0.269
100	0.196	0.256

NOTE: To test H0: $\rho = 0$ against H1: $\rho \neq 0$, reject H0 if the absolute value of r is greater than the critical value in the table.

Greek Alphabet

Greek Letter		Name	Equivalent	Sound When Spoken
Α	α	Alpha	A	al-fah
Β	β	Beta	B	bay-tah
Γ	γ	Gamma	G	gam-ah
Δ	δ	Delta	D	del-tah
Ε	ε	Epsilon	E	ep-si-lon
Ζ	ζ	Zeta	Z	zay-tah
Η	η	Eta	E	ay-tay
Θ	θ	Theta	Th	thay-tah
Ι	ι	Iota	I	eye-o-tah
Κ	κ	Kappa	K	cap-ah
Λ	λ	Lambda	L	lamb-dah
Μ	μ	Mu	M	mew
Ν	ν	Nu	N	new
Ξ	ξ	Xi	X	zzEye
Ο	ο	Omicron	O	om-ah-cron
Π	π	Pi	P	pie
Ρ	ρ	Rho	R	row
Σ	σ	Sigma	S	sig-ma
Τ	τ	Tau	T	tawh
Υ	υ	Upsilon	U	oop-si-lon
Φ	φ	Phi	Ph	figh or fie
Χ	χ	Chi	Ch	kigh
Ψ	ψ	Psi	Ps	sigh
Ω	ω	Omega	O	o-may-gah

http://www.keyway.ca/htm2002/greekal.htm