

FREQUENTLY USED FORMULAS

n = sample size N = population size f = frequency

Chapter 2

Class Width = $\frac{\text{high} - \text{low}}{\text{number classes}}$ (increase to next integer)

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

Lower boundary = lower boundary of previous class
+ class width

Chapter 3

Sample mean $\bar{x} = \frac{\sum x}{n}$

Population mean $\mu = \frac{\sum x}{N}$

Weighted average = $\frac{\sum xw}{\sum w}$

Range = largest data value - smallest data value

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

Computation formula $s = \sqrt{\frac{\sum x^2 - (\sum x)^2/n}{n - 1}}$

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

Sample variance s^2

Population variance σ^2

Sample Coefficient of Variation $CV = \frac{s}{\bar{x}} \cdot 100$

Sample mean for grouped data $\bar{x} = \frac{\sum xf}{n}$

Sample standard deviation for grouped data

$$s = \sqrt{\frac{\sum(x - \bar{x})^2 f}{n - 1}} = \sqrt{\frac{\sum x^2 f - (\sum xf)^2/n}{n - 1}}$$

Chapter 4

Regression and Correlation

Pearson product moment correlation coefficient

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

Least-squares line $\hat{y} = a + bx$

$$\text{where } b = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2}$$

$$a = \bar{y} - b\bar{x}$$

Coefficient of determination = r^2

Chapter 5

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

Multiplication rule for independent events
 $P(A \text{ and } B) = P(A) \cdot P(B)$

General multiplication rules
 $P(A \text{ and } B) = P(A) \cdot P(B, \text{ given } A)$
 $P(A \text{ and } B) = P(B) \cdot P(A, \text{ given } B)$

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

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

Permutation rule $P_{n,r} = \frac{n!}{(n - r)!}$

Combination rule $C_{n,r} = \frac{n!}{r!(n - r)!}$

Chapter 6

Mean of a discrete probability distribution $\mu = \sum xP(x)$

Standard deviation of a discrete probability distribution

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

For Binomial Distributions

r = number of successes; p = probability of success;
 $q = 1 - p$

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

Mean $\mu = np$

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

Chapter 7

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

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

Mean of \bar{x} distribution $\mu_{\bar{x}} = \mu$

Standard deviation of \bar{x} distribution $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$

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

Chapter 8

Confidence Interval

for μ

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

where $E = z_c \frac{\sigma}{\sqrt{n}}$ when σ is known

$$E = t_c \frac{s}{\sqrt{n}} \text{ when } \sigma \text{ is unknown}$$

with $d.f. = n - 1$

for p ($np > 5$ and $n(1-p) > 5$)

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

where $E = z_c \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

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

Sample Size for Estimating

means $n = \left(\frac{z_c \sigma}{E}\right)^2$

proportions

$n = p(1-p) \left(\frac{z_c}{E}\right)^2$ with preliminary estimate for p

$n = \frac{1}{4} \left(\frac{z_c}{E}\right)^2$ without preliminary estimate for p

Chapter 9

Sample Test Statistics for Tests of Hypotheses

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

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

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

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

Chapter 10

Sample Test Statistics for Tests of Hypotheses

for paired differences d $t = \frac{\bar{d} - \mu_{\bar{d}}}{s_d/\sqrt{n}}; d.f. = n - 1$

for difference of means, σ_1 and σ_2 known

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

for difference of means, σ_1 or σ_2 unknown

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

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

(Note: Software uses Satterthwaite's approximation for degrees of freedom $d.f.$)

for difference of proportions

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\frac{\hat{p}\hat{q}}{n_1} + \frac{\hat{p}\hat{q}}{n_2}}}$$

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

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

Confidence Interval

for $\mu_1 - \mu_2$ (independent samples)

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

where $E = z_c \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$ when σ_1 and σ_2 are known

$E = t_c \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ when σ_1 or σ_2 is unknown
with $d.f. =$ smaller of $n_1 - 1$ and $n_2 - 1$

(Note: Software uses Satterthwaite's approximation for degrees of freedom $d.f.$)

for difference of proportions $p_1 - p_2$

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

where $E = z_c \sqrt{\frac{\hat{p}_1 \hat{q}_1}{n_1} + \frac{\hat{p}_2 \hat{q}_2}{n_2}}$

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

$$\hat{q}_1 = 1 - \hat{p}_1; \hat{q}_2 = 1 - \hat{p}_2$$

Chapter 11

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

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

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

Sample test statistic for σ^2

$$\chi^2 = \frac{(n - 1)s^2}{\sigma^2} \text{ with } d.f. = n - 1$$

Linear Regression

Sample test statistic for r

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

$$\text{Standard error of estimate } S_e = \sqrt{\frac{\sum y^2 - a\sum y - b\sum xy}{n - 2}}$$

Confidence interval for y

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

$$\text{where } E = t_c S_e \sqrt{1 + \frac{1}{n} + \frac{n(x - \bar{x})^2}{n\sum x^2 - (\sum x)^2}}$$

with $d.f. = n - 2$

Sample test statistic for slope b

$$t = \frac{b}{S_e} \sqrt{\sum x^2 - \frac{1}{n}(\sum x)^2} \text{ with } d.f. = n - 2$$

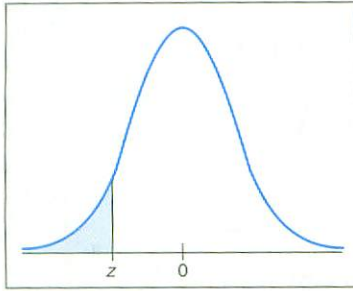


Table entry for z is the area to the left of z .

Areas of a Standard Normal Distribution

(a) Table of Areas to the Left of z

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-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

For values of z less than -3.49 , use 0.000 to approximate the area.

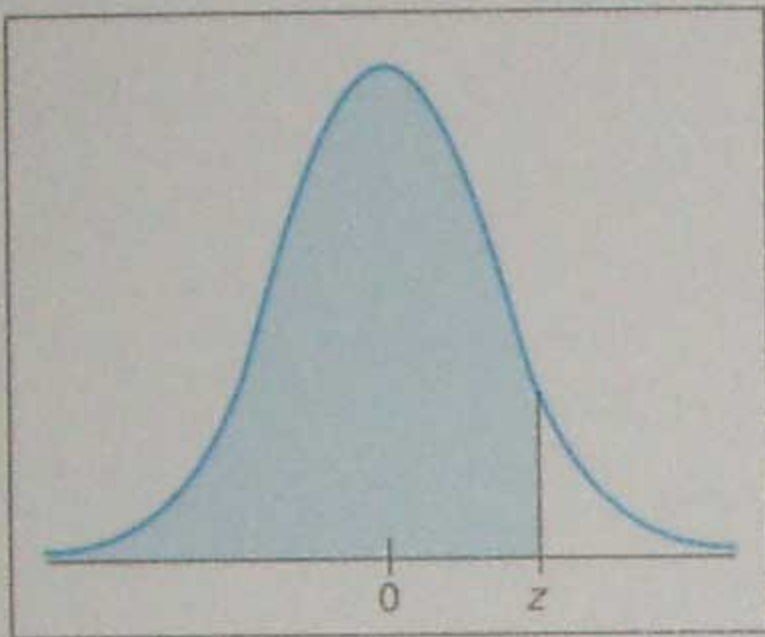


Table entry for z is the area to the left of z .

Areas of a Standard Normal Distribution *continued*

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

For z values greater than 3.49, use 1.000 to approximate the area.

Areas of a Standard Normal Distribution *continued*

(b) Confidence Interval Critical Values z_c	
Level of Confidence c	Critical Value z_c
0.70, or 70%	1.04
0.75, or 75%	1.15
0.80, or 80%	1.28
0.85, or 85%	1.44
0.90, or 90%	1.645
0.95, or 95%	1.96
0.98, or 98%	2.33
0.99, or 99%	2.58

Areas of a Standard Normal Distribution *continued*

(c) Hypothesis Testing, Critical Values z_0		
Level of Significance	$\alpha = 0.05$	$\alpha = 0.01$
Critical value z_0 for a left-tailed test	-1.645	-2.33
Critical value z_0 for a right-tailed test	1.645	2.33
Critical values $\pm z_0$ for a two-tailed test	± 1.96	± 2.58