Basic Statistics Formulas

Population Measures

$$Mean \mu = \frac{1}{n} \sum x_i \tag{1}$$

Variance
$$\sigma^2 = \frac{1}{n} \sum (x_i - \overline{x})^2$$
 (2)

Standard Deviation
$$\sigma = \sqrt{\frac{1}{n} \sum (x_i - \overline{x})^2}$$
 (3)

Sampling

Sample mean
$$\overline{x} = \frac{1}{n} \sum x_i$$
 (4)

Sample variance
$$s_x^2 = \frac{1}{n-1} \sum (x_i - \overline{x})^2$$
 (5)

Std. Deviation
$$s_x = \sqrt{\frac{1}{n-1} \sum (x_i - \overline{x})^2}$$
 (6)

z-score
$$z = \frac{x - \mu}{\sigma}$$
 (7)

Correlation r =

$$\frac{1}{n-1} \sum_{i=1}^{n} \left(\frac{(x_i - \overline{x})}{s_x} \right) \left(\frac{(y_i - \overline{y})}{s_y} \right) \tag{8}$$

Linear Regression

Line
$$\hat{y} = a + bx$$
 (9)

$$b = r \frac{s_y}{s_x}, a = \overline{y} - b\overline{x} \tag{10}$$

$$s = \sqrt{\frac{1}{n-2} \sum_{i=1}^{n} (y_i - \hat{y})^2}$$
 (11)

$$SE_b = \frac{s}{\sqrt{\sum_{i=1}^{n} (x_i - \overline{x})^2}}$$
 (12)

To test
$$H_0: b = 0$$
, use $t = \frac{b}{SE_b}$ (13)

$$CI = b \pm t^* S E_b \tag{14}$$

Probability

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$
 (15)

$$P(\text{not } A) = 1 - P(A) \tag{16}$$

$$P(A \text{ and } B) = P(A)P(B) \text{ (independent)}$$

$$P(B|A) = P(A \text{ and } B)/P(A) \tag{18}$$

$$0! = 1; n! = 1 \times 2 \times 3 \cdots \times (n-1) \times n \tag{19}$$

$$\binom{n}{k} = \frac{n!}{n!(n-k)!} \tag{20}$$

Binomial Distribution:

$$P(\mathcal{X} = k) = \binom{n}{k} p^k (1 - p)^{n - k} \tag{21}$$

$$\mu = np, \ \sigma = \sqrt{np(1-p)} \tag{22}$$

One-Sample z-statistic

To test
$$H_0: \mu = \mu_0 \text{ use } z = \frac{\overline{z} - \mu_0}{\sigma/\sqrt{n}}$$
 (23)

Confidence Interval for
$$\mu = \overline{x} \pm z^* \frac{\sigma}{\sqrt{n}}$$
 (24)

Margin of Error
$$ME = z^* \frac{\sigma}{\sqrt{n}}$$
 (25)

Minimum sample size
$$n \ge \left\lceil \frac{z^* \sigma}{ME} \right\rceil^2$$
 (26)

One-Sample t-statistic

$$SEM = \frac{s_x}{\sqrt{n}}, \ t = \frac{\overline{x} - \mu}{s_x/\sqrt{n}}$$
 (27)

Confidence Interval =
$$\overline{x} \pm t^* \frac{s_x}{\sqrt{n}}$$
 (28)

Two-Sample t-statistic

$$t = \frac{\overline{x}_1 - \overline{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \tag{29}$$

Conf. Interval =
$$(\overline{x}_1 - \overline{x}_2) \pm t^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$
 (30)

Sample Proportions

(17)

$$\mu_{\hat{p}} = p, \ \sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} \quad (31)$$

Conf. Int. =
$$\hat{p} \pm z^*(SE)$$
 (32)

$$SE = \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$
 (33)

sample size
$$n > \left[\frac{z^*}{ME}\right]^2 p^* (1 - p^*)$$
 (34)

To test
$$H_0: p = p_0$$
, use $z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}}$ (35)

Two-Sample Proportions

$$SE = \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$$
 (36)

$$CI = (\hat{p}_1 - \hat{p}_2) \pm z^*(SE)$$
 (37)

To test
$$H_0: p_1 = p_2$$
, use (38)

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$
(39)

$$\hat{p} = \frac{X_1 + X_2}{n_1 + n_2}, \ X_i = \text{ successes}$$
 (40)

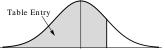
Chi-Square Statistic

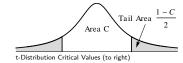
$$\chi^2 = \sum_{i=1}^n \frac{(o_i - e_i)^2}{e_i} \tag{41}$$

 $o_i = \text{observed}, e_i = \text{expected}$

Central Limit Theorem

$$s_{\overline{x}} \to \frac{\sigma}{\sqrt{n}} \text{ as } n \to \infty$$
 (42)





Standard Normal Cumulative Proportions (below)

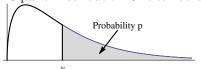
Standard Normal Cumulative Proportions

		Star				ulative	Propo			
	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1157	0.1131	0.1112	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.1	0.5000	0.4960	0.4920	0.4880	0.4840			0.4721	0.4681	0.4641
						0.4801				
						0.4801	0.4761			
	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0 0.5000	0.01 0.5040	0.02 0.5080	0.03 0.5120	0.04 0.5160	0.05 0.5199	0.06 0.5239	0.07 0.5279	0.08 0.5319	0.09 0.5359
0 0.1	0 0.5000 0.5398	0.01 0.5040 0.5438	0.02 0.5080 0.5478	0.03 0.5120 0.5517	0.04 0.5160 0.5557	0.05 0.5199 0.5596	0.06 0.5239 0.5636	0.07 0.5279 0.5675	0.08 0.5319 0.5714	0.09 0.5359 0.5753
0 0.1 0.2	0 0.5000 0.5398 0.5793	0.01 0.5040 0.5438 0.5832	0.02 0.5080 0.5478 0.5871	0.03 0.5120 0.5517 0.5910	0.04 0.5160 0.5557 0.5948	0.05 0.5199 0.5596 0.5987	0.06 0.5239 0.5636 0.6026	0.07 0.5279 0.5675 0.6064	0.08 0.5319 0.5714 0.6103	0.09 0.5359 0.5753 0.6141
0 0.1 0.2 0.3	0 0.5000 0.5398 0.5793 0.6179	0.01 0.5040 0.5438 0.5832 0.6217	0.02 0.5080 0.5478 0.5871 0.6255	0.03 0.5120 0.5517 0.5910 0.6293	0.04 0.5160 0.5557 0.5948 0.6331	0.05 0.5199 0.5596 0.5987 0.6368	0.06 0.5239 0.5636 0.6026 0.6406	0.07 0.5279 0.5675 0.6064 0.6443	0.08 0.5319 0.5714 0.6103 0.6480	0.09 0.5359 0.5753 0.6141 0.6517
0 0.1 0.2 0.3 0.4	0 0.5000 0.5398 0.5793 0.6179 0.6554	0.01 0.5040 0.5438 0.5832 0.6217 0.6591	0.02 0.5080 0.5478 0.5871 0.6255 0.6628	0.03 0.5120 0.5517 0.5910 0.6293 0.6664	0.04 0.5160 0.5557 0.5948 0.6331 0.6700	0.05 0.5199 0.5596 0.5987 0.6368 0.6736	0.06 0.5239 0.5636 0.6026 0.6406 0.6772	0.07 0.5279 0.5675 0.6064 0.6443 0.6808	0.08 0.5319 0.5714 0.6103 0.6480 0.6844	0.09 0.5359 0.5753 0.6141 0.6517 0.6879
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0 0.1 0.2 0.3 0.4 0.5 0.6	0 0.5000 0.5398 0.5793 0.6179 0.6554 0.6915 0.7257	0.01 0.5040 0.5438 0.5832 0.6217 0.6591 0.6950 0.7291	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.6985 0.7324	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7389	0.05 0.5199 0.5596 0.5987 0.6368 0.6736 0.7088 0.7422	0.06 0.5239 0.5636 0.6026 0.6406 0.6772 0.7123 0.7454	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7486	0.08 0.5319 0.5714 0.6103 0.6480 0.6844 0.7190 0.7517	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549
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0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1	0 0.5000 0.5398 0.5793 0.6179 0.6554 0.6915 0.7257 0.7580 0.7881 0.8159 0.8413 0.8643	0.01 0.5040 0.5438 0.5832 0.6217 0.65591 0.6950 0.7291 0.7611 0.7910 0.8186 0.8438 0.8665	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.6985 0.7324 0.7642 0.7939 0.8212 0.8461 0.8686	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7389 0.7704 0.7995 0.8264 0.8508 0.8729	0.05 0.5199 0.5596 0.5987 0.6368 0.6736 0.7088 0.7422 0.7734 0.8023 0.8289 0.8531 0.8749	0.06 0.5239 0.5636 0.6026 0.6406 0.6772 0.7123 0.7454 0.7764 0.8051 0.8315 0.8554 0.8770	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7486 0.7794 0.8078 0.8340 0.8577 0.8790	0.08 0.5319 0.5714 0.6103 0.6480 0.6844 0.7190 0.7517 0.7823 0.8106 0.8365 0.8599	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.7852 0.8133 0.8389 0.8621 0.8830
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1	0 0.5000 0.5398 0.5793 0.6179 0.6554 0.6915 0.7257 0.7580 0.7881 0.8159 0.8413 0.8643 0.8849	0.01 0.5040 0.5438 0.5832 0.6217 0.6591 0.6950 0.7291 0.7611 0.7910 0.8186 0.8438 0.8665 0.8869	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.7324 0.7642 0.7939 0.8212 0.8461 0.8686 0.8888	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7389 0.7704 0.7995 0.8264 0.8508 0.8729 0.8925	0.05 0.5199 0.5596 0.5987 0.6368 0.6736 0.7088 0.7422 0.7734 0.8023 0.8289 0.8531 0.8749	0.06 0.5239 0.5636 0.6026 0.6406 0.6772 0.7123 0.7454 0.8764 0.8051 0.8315 0.8554 0.8770 0.8962	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7486 0.7794 0.8078 0.8340 0.8577 0.8790 0.8980	0.08 0.5319 0.5714 0.6103 0.6480 0.6844 0.7190 0.7517 0.7823 0.8106 0.8365 0.8599 0.8810 0.8997	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.7852 0.8133 0.8389 0.8621 0.8830 0.9015
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2	0 0.5000 0.5398 0.5793 0.6179 0.6554 0.6915 0.7257 0.7580 0.7881 0.8159 0.8413 0.8643 0.8849	0.01 0.5040 0.5438 0.5832 0.6217 0.6591 0.6950 0.7291 0.7611 0.7910 0.8186 0.8438 0.8665 0.9049	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.7324 0.7642 0.7939 0.8212 0.8686 0.8888 0.9066	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907 0.9082	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7389 0.7704 0.7995 0.8264 0.8729 0.8925 0.9099	0.05 0.5199 0.5596 0.5987 0.6368 0.6736 0.7088 0.7422 0.7734 0.8023 0.8289 0.8531 0.8744 0.9115	0.06 0.5239 0.5636 0.6026 0.6406 0.6772 0.7123 0.7454 0.7764 0.8051 0.8315 0.8554 0.8770 0.8962	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7486 0.7794 0.8078 0.8340 0.8577 0.8980 0.9147	0.08 0.5319 0.5714 0.6103 0.6480 0.6844 0.7190 0.7517 0.7823 0.8106 0.8365 0.8599 0.8810 0.8997 0.9162	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.7852 0.8133 0.8389 0.8621 0.8830 0.9015
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3	0 0.5000 0.5398 0.5793 0.6179 0.6554 0.6915 0.7257 0.7580 0.7881 0.8159 0.8413 0.8643 0.8849 0.9032 0.9192	0.01 0.5040 0.5438 0.5832 0.6217 0.6591 0.6950 0.7291 0.7611 0.7910 0.8186 0.8438 0.8665 0.8869 0.9049 0.9207	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.6985 0.7324 0.7642 0.7939 0.8212 0.8461 0.8686 0.8888 0.9966 0.9222	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907 0.9082 0.9236	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7389 0.7704 0.8264 0.8508 0.8729 0.8925 0.9099 0.9251	0.05 0.5199 0.5596 0.5987 0.6368 0.6736 0.7088 0.7422 0.7734 0.8023 0.8289 0.8531 0.8749 0.8944 0.9115	0.06 0.5239 0.5636 0.6026 0.6406 0.6772 0.7123 0.7454 0.8051 0.8315 0.8554 0.8770 0.8962 0.9131	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7486 0.7794 0.8078 0.8340 0.8577 0.8790 0.8980 0.9147 0.9292	0.08 0.5319 0.5714 0.6103 0.6480 0.6844 0.7190 0.7517 0.7823 0.8106 0.8365 0.8599 0.8810 0.8997 0.9162 0.9306	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.7852 0.8133 0.8389 0.8621 0.830 0.9015 0.9117
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4	0 0.5000 0.5398 0.5793 0.6179 0.6554 0.6915 0.7257 0.7580 0.8815 0.8413 0.8643 0.8849 0.9032 0.9192	0.01 0.5040 0.5438 0.5832 0.6217 0.6591 0.7691 0.7611 0.7910 0.8438 0.8438 0.8665 0.8869 0.9049 0.9207	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.7324 0.7642 0.7939 0.8212 0.8461 0.8686 0.8888 0.9066 0.9222	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907 0.9082 0.9082 0.9082 0.9236 0.9370	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7389 0.7704 0.7995 0.8264 0.8508 0.8729 0.8925 0.9099 0.9251 0.9382	0.05 0.5199 0.5596 0.5987 0.6368 0.6736 0.7088 0.7422 0.7734 0.8023 0.8289 0.8531 0.8749 0.8944 0.9115 0.9265 0.9394	0.06 0.5239 0.5636 0.6026 0.6406 0.6772 0.7123 0.7454 0.8051 0.8315 0.8554 0.8770 0.8962 0.9131 0.9279 0.9406	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7486 0.7794 0.8078 0.8340 0.8577 0.8790 0.8980 0.9147 0.9292	0.08 0.5319 0.5714 0.6103 0.6480 0.6844 0.7190 0.7517 0.7823 0.8106 0.8365 0.8599 0.9306 0.9429	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.7852 0.8133 0.8389 0.8621 0.8621 0.9015 0.9015
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4	0 0.5000 0.5398 0.5793 0.6179 0.6915 0.7950 0.7860 0.7881 0.8413 0.8643 0.8849 0.9032 0.9192	0.01 0.5040 0.5438 0.5832 0.6217 0.6950 0.7291 0.7611 0.7910 0.8186 0.8438 0.8665 0.8695 0.9049 0.9049	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.7324 0.7642 0.7939 0.8212 0.8461 0.8686 0.8888 0.9066 0.9222	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907 0.9082 0.9236 0.9370 0.9484	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7995 0.8264 0.8729 0.8925 0.9099 0.9251	0.05 0.5199 0.55987 0.5987 0.6368 0.6736 0.7422 0.7734 0.8028 0.8289 0.8531 0.8749 0.8944 0.9115 0.9265 0.9394	0.06 0.5239 0.5636 0.6026 0.6026 0.6406 0.6772 0.7123 0.7454 0.8315 0.8315 0.83554 0.8770 0.8962 0.9131 0.9279	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7486 0.7794 0.8374 0.8377 0.8790 0.8980 0.9147 0.9292	0.08 0.5319 0.5714 0.6103 0.6480 0.7517 0.7823 0.8106 0.8365 0.8599 0.8810 0.8997 0.9162 0.9306 0.9429	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7559 0.8389 0.8621 0.8389 0.9015 0.9015 0.9177 0.9319
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0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7	0 0.5000 0.5000 0.5000 0.5793 0.6179 0.6554 0.6591 0.7580 0.7881 0.8143 0.8643 0.8849 0.9032 0.9192 0.9554 0.9554 0.9554	0.01 0.5040 0.5043 0.5832 0.6217 0.6950 0.7921 0.7910 0.8186 0.8438 0.8665 0.8669 0.9049 0.9207 0.9345 0.9463 0.9564	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.6985 0.7324 0.7642 0.7939 0.8212 0.8461 0.8686 0.8888 0.9066 0.9222 0.9357 0.9474	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907 0.9022 0.9236 0.9370 0.9484 0.9582 0.9664	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7389 0.7704 0.7995 0.8264 0.8508 0.8729 0.8925 0.9099 0.9251 0.9382 0.9495 0.9571	0.05 0.5199 0.5997 0.5987 0.6368 0.6736 0.7088 0.7422 0.8283 0.8233 0.8283 0.8749 0.9115 0.9264 0.9505 0.9505	0.06 0.5239 0.5636 0.6026 0.6026 0.6026 0.6406 0.7123 0.7454 0.7764 0.8051 0.8315 0.83554 0.8770 0.8962 0.9131 0.9279 0.9406 0.9515 0.9686	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7786 0.8778 0.8340 0.8340 0.8980 0.9147 0.9292 0.9418	0.08 0.5319 0.5714 0.6103 0.6480 0.6844 0.7517 0.7823 0.8106 0.8365 0.8599 0.8997 0.9162 0.9306 0.9429 0.9535 0.9625	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.7852 0.8133 0.8389 0.8621 0.8830 0.9015 0.9177 0.9319 0.9545 0.9633 0.9706
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0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8	0 0.5000 0.5398 0.5793 0.6179 0.6951 0.7257 0.7580 0.8159 0.8443 0.8643 0.8643 0.9192 0.9192 0.9332 0.9554 0.9554 0.9641 0.9772	0.01 0.5040 0.5438 0.5832 0.6217 0.6591 0.6950 0.7291 0.7611 0.8186 0.8468 0.8665 0.8665 0.8665 0.8690 0.9207 0.9345 0.9649 0.9649 0.9778	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.7939 0.8212 0.8461 0.8686 0.8888 0.9066 0.9222 0.9357 0.9474 0.9573 0.9556	0.03 0.5120 0.5517 0.5910 0.6293 0.6694 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907 0.9082 0.9236 0.9370 0.9484 0.9582 0.9664 0.9732	0.04 0.5160 0.55548 0.6331 0.6700 0.7054 0.7389 0.7704 0.7389 0.7704 0.8264 0.8508 0.8729 0.8925 0.9029 0.9251 0.9382 0.9495 0.9591 0.9671 0.9738	0.05 0.5199 0.5596 0.5987 0.5987 0.6368 0.6736 0.7088 0.7422 0.7734 0.8023 0.8289 0.8531 0.8749 0.9944 0.9105 0.9105 0.9394 0.9505 0.9509 0.9678 0.9798	0.06 0.5239 0.5636 0.6026 0.6026 0.6406 0.7123 0.7454 0.7764 0.8051 0.8315 0.8554 0.8776 0.8962 0.9131 0.9279 0.9406 0.9686 0.9686 0.9686	0.07 0.5279 0.5675 0.6064 0.6043 0.6808 0.7157 0.7486 0.8794 0.8340 0.8579 0.8790 0.9980 0.9147 0.9292 0.9418 0.9525 0.9663 0.9693	0.08 0.5319 0.5714 0.6103 0.6480 0.6849 0.7517 0.7823 0.8106 0.8365 0.85997 0.9162 0.9306 0.9429 0.9535 0.96699 0.9761	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.8133 0.8389 0.8621 0.9015 0.9017 0.9319 0.9441 0.9545 0.9633 0.9766 0.9766
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0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.1	0 0.5000 0.5398 0.5793 0.6179 0.6554 0.7580 0.8413 0.843 0.843 0.843 0.9032 0.9192 0.9332 0.9192 0.9554 0.9772 0.9661 0.9772 0.9861 0.9983 0.9993 0.9993	0.01 0.5040 0.5438 0.5832 0.6217 0.6591 0.7611 0.7910 0.8186 0.8438 0.8665 0.8488 0.9049 0.9207 0.9345 0.9649 0.9719 0.9778 0.9864 0.9896 0.9920 0.9982 0.9995	0.02 0.5080 0.5478 0.5871 0.6255 0.6628 0.6985 0.7324 0.7642 0.7939 0.8212 0.8461 0.8666 0.9222 0.9357 0.9573 0.9656 0.9726 0.9783 0.9830 0.9968 0.9989 0.9992 0.9941	0.03 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907 0.9982 0.9236 0.9370 0.9484 0.9582 0.9664 0.9732 0.9788 0.9834 0.9871 0.9901 0.9925 0.9943 0.9957 0.9968 0.99977 0.9983 0.9987	0.04 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7938 0.7704 0.7995 0.8264 0.8508 0.8729 0.8925 0.9099 0.9251 0.9382 0.9099 0.9251 0.9382 0.9099 0.99251 0.9099 0.9999 0.9999 0.9999 0.9999	0.05 0.5199 0.5596 0.5997 0.5987 0.6368 0.6736 0.7088 0.77422 0.7734 0.8023 0.8289 0.8531 0.8749 0.9944 0.915 0.9265 0.9599 0.9678 0.9960 0.9978 0.9960 0.9996	0.06 0.5239 0.5636 0.6026 0.6026 0.6026 0.6026 0.7723 0.7454 0.7764 0.8051 0.8315 0.8770 0.8962 0.9131 0.9279 0.9406 0.9515 0.9608 0.9680 0.9680 0.9750 0.9803 0.9846 0.9909 0.9931	0.07 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7794 0.8078 0.8374 0.8980 0.9147 0.9292 0.9418 0.9525 0.9616 0.9693 0.9786 0.9880 0.9880 0.9850 0.9880 0.9850 0.9980 0.99990	0.08 0.5319 0.5714 0.6103 0.6480 0.6844 0.7190 0.7517 0.7823 0.8106 0.8365 0.8599 0.9162 0.9306 0.9429 0.9523 0.9625 0.9699 0.9761 0.9812 0.9887 0.9913 0.9931 0.9963 0.9963 0.99980 0.99980 0.99980 0.99980	0.09 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.7852 0.8133 0.8389 0.9015 0.9917 0.9319 0.9441 0.9545 0.9633 0.9706 0.9767 0.9817 0.9887 0.9916 0.9995 0.9996 0.9996 0.9996

t-Distribution Cumulative Proportions

					Confide	nce Level C	1			
df	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.8%
1	1	1.376	1.963	3.078	6.314	12.706	15.895	31.821	63.657	318.309
2	0.816	1.061	1.386	1.886	2.92	4.303	4.849	6.965	9.925	22.327
3	0.765	0.978	1.25	1.638	2.353	3.182	3.482	4.541	5.841	10.215
4	0.741	0.941	1.19	1.533	2.132	2.776	2.999	3.747	4.604	7.173
5	0.727	0.92	1.156	1.476	2.015	2.571	2.757	3.365	4.032	5.893
6	0.718	0.906	1.134	1.44	1.943	2.447	2.612	3.143	3.707	5.208
7	0.711	0.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.785
8	0.706	0.889	1.108	1.397	1.86	2.306	2.449	2.896	3.355	4.501
9	0.703	0.883	1.1	1.383	1.833	2.262	2.398	2.821	3.25	4.297
10	0.7	0.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	4.144
11	0.697	0.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	4.025
12	0.695	0.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.93
13	0.694	0.87	1.079	1.35	1.771	2.16	2.282	2.65	3.012	3.852
14	0.692	0.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.787
15	0.691	0.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.733
16	0.69	0.865	1.071	1.337	1.746	2.12	2.235	2.583	2.921	3.686
17	0.689	0.863	1.069	1.333	1.74	2.11	2.224	2.567	2.898	3.646
18	0.688	0.862	1.067	1.33	1.734	2.101	2.214	2.552	2.878	3.61
19	0.688	0.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.579
20	0.687	0.86	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.552
21	0.686	0.859	1.063	1.323	1.721	2.08	2.189	2.518	2.831	3.527
22	0.686	0.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.505
23	0.685	0.858	1.06	1.319	1.714	2.069	2.177	2.5	2.807	3.485
24	0.685	0.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.467
25	0.684	0.856	1.058	1.316	1.708	2.06	2.167	2.485	2.787	3.45
30	0.683	0.854	1.055	1.31	1.697	2.042	2.147	2.457	2.75	3.385
40	0.681	0.851	1.05	1.303	1.684	2.021	2.123	2.423	2.704	3.307
50	0.679	0.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	3.261
60	0.679	0.848	1.045	1.296	1.671	2	2.099	2.39	2.66	3.232
80	0.678	0.846	1.043	1.292	1.664	1.99	2.088	2.374	2.639	3.195
100	0.677	0.845	1.042	1.29	1.66	1.984	2.081	2.364	2.626	3.174
1000	0.675	0.842	1.037	1.282	1.646	1.962	2.056	2.33	2.581	3.098
z*	0.674	0.842	1.036	1.282	1.645	1.960	2.054	2.326	2.576	3.090
1-Sided P	0.25	0.2	0.15	0.1	0.05	0.025	0.02	0.01	0.005	0.001
2-Sided P	0.5	0.4	0.3	0.2	0.1	0.05	0.04	0.02	0.01	0.002

Chi-Square Distribution Critical Values



				X						
						p				
df	0.25	0.20	0.10	0.05	0.025	0.02	0.01	0.005	0.0025	0.001
1	1.32	1.64	2.71	3.84	5.02	5.41	6.63	7.88	9.14	10.83
2	2.77	3.22	4.61	5.99	7.38	7.82	9.21	10.60	11.98	13.82
3	4.11	4.64	6.25	7.81	9.35	9.84	11.34	12.84	14.32	16.27
4	5.39	5.99	7.78	9.49	11.14	11.67	13.28	14.86	16.42	18.47
5	6.63	7.29	9.24	11.07	12.83	13.39	15.09	16.75	18.39	20.52
6	7.84	8.56	10.64	12.59	14.45	15.03	16.81	18.55	20.25	22.46
7	9.04	9.80	12.02	14.07	16.01	16.62	18.48	20.28	22.04	24.32
8	10.22	11.03	13.36	15.51	17.53	18.17	20.09	21.95	23.77	26.12
9	11.39	12.24	14.68	16.92	19.02	19.68	21.67	23.59	25.46	27.88
10	12.55	13.44	15.99	18.31	20.48	21.16	23.21	25.19	27.11	29.59
11	13.70	14.63	17.28	19.68	21.92	22.62	24.72	26.76	28.73	31.26
12	14.85	15.81	18.55	21.03	23.34	24.05	26.22	28.30	30.32	32.91
13	15.98	16.98	19.81	22.36	24.74	25.47	27.69	29.82	31.88	34.53
14	17.12	18.15	21.06	23.68	26.12	26.87	29.14	31.32	33.43	36.12
15	18.25	19.31	22.31	25.00	27.49	28.26	30.58	32.80	34.95	37.70
16	19.37	20.47	23.54	26.30	28.85	29.63	32.00	34.27	36.46	39.25
17	20.49	21.61	24.77	27.59	30.19	31.00	33.41	35.72	37.95	40.79
18	21.60	22.76	25.99	28.87	31.53	32.35	34.81	37.16	39.42	42.31
19	22.72	23.90	27.20	30.14	32.85	33.69	36.19	38.58	40.88	43.82
20	23.83	25.04	28.41	31.41	34.17	35.02	37.57	40.00	42.34	45.31
21	24.93	26.17	29.62	32.67	35.48	36.34	38.93	41.40	43.78	46.80
22	26.04	27.30	30.81	33.92	36.78	37.66	40.29	42.80	45.20	48.27
23	27.14	28.43	32.01	35.17	38.08	38.97	41.64	44.18	46.62	49.73
24	28.24	29.55	33.20	36.42	39.36	40.27	42.98	45.56	48.03	51.18
25	29.34	30.68	34.38	37.65	40.65	41.57	44.31	46.93	49.44	52.62
30	34.80	36.25	40.26	43.77	46.98	47.96	50.89	53.67	56.33	59.70
40	45.62	47.27	51.81	55.76	59.34	60.44	63.69	66.77	69.70	73.40
50	56.33	58.16	63.17	67.50	71.42	72.61	76.15	79.49	82.66	86.66
60	66.98	68.97	74.40	79.08	83.30	84.58	88.38	91.95	95.34	99.61
80	88.13	90.41	96.58	101.88	106.63	108.07	112.33	116.32	120.10	124.84
100	109.14	111.67	118.50	124.34	129.56	131.14	135.81	140.17	144.29	149.45