

# Formulas

## (I) Descriptive Statistics

$$\bar{x} = \frac{\sum x_i}{n}$$

$$s_x = \sqrt{\frac{1}{n-1} \sum (x_i - \bar{x})^2}$$

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

$$\hat{y} = b_0 + b_1x$$

$$b_1 = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$$

$$b_0 = \bar{y} - b_1\bar{x}$$

$$r = \frac{1}{n-1} \sum \left( \frac{x_i - \bar{x}}{s_x} \right) \left( \frac{y_i - \bar{y}}{s_y} \right)$$

$$b_1 = r \frac{s_y}{s_x}$$

$$s_{b_1} = \frac{\sqrt{\frac{\sum (y_i - \hat{y}_i)^2}{n-2}}}{\sqrt{\sum (x_i - \bar{x})^2}}$$

## (II) Probability

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

$$E(X) = \mu_x = \sum x_i p_i$$

$$\text{Var}(X) = \sigma_x^2 = \sum (x_i - \mu_x)^2 p_i$$

If  $X$  has a binomial distribution with parameters  $n$  and  $p$ , then:

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

$$\mu_x = np$$

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

$$\mu_{\hat{p}} = p$$

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

If  $X$  has a normal distribution with mean  $\mu$  and standard deviation  $\sigma$ , then:

$$\mu_{\bar{x}} = \mu$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

## (III) Inferential Statistics

Standardized test statistic:  $\frac{\text{estimate} - \text{parameter}}{\text{standard deviation of estimate}}$

Confidence interval: estimate  $\pm$  (critical value)  $\cdot$  (standard deviation of estimate)

### Single-Sample

Statistic	Standard Deviation
Mean	$\frac{\sigma}{\sqrt{n}}$
Proportion	$\sqrt{\frac{p(1-p)}{n}}$

### Two-Sample

Statistic	Standard Deviation
Difference of means (unequal variances)	$\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$
Difference of means (equal variances)	$\sigma \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$
Difference of proportions (unequal variances)	$\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}$
Difference of proportions (equal variances)	$\sqrt{p(1-p)} \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$

$$\text{Chi-square test statistic} = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

Table entry for z is the probability lying below c

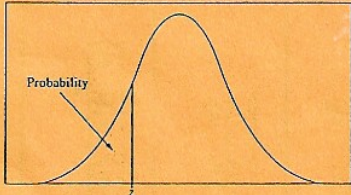


Table entry for z is the probability lying below c

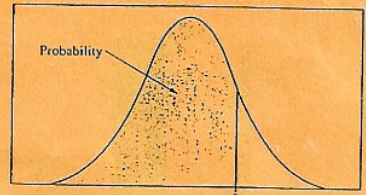


Table A Standard normal probabilities

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.4	.0001	.0003	.0007	.0013	.0020	.0028	.0038	.0050	.0064	.0081
-3.3	.0005	.0009	.0015	.0022	.0031	.0041	.0053	.0067	.0083	.0101
-3.2	.0007	.0011	.0017	.0025	.0034	.0045	.0058	.0073	.0089	.0108
-3.1	.0010	.0014	.0021	.0029	.0039	.0051	.0064	.0080	.0097	.0116
-3.0	.0013	.0017	.0025	.0034	.0044	.0056	.0070	.0086	.0103	.0121
-2.9	.0016	.0021	.0029	.0039	.0050	.0062	.0076	.0092	.0109	.0127
-2.8	.0019	.0025	.0034	.0044	.0056	.0069	.0083	.0100	.0117	.0135
-2.7	.0022	.0028	.0038	.0049	.0061	.0075	.0090	.0107	.0124	.0142
-2.6	.0025	.0031	.0042	.0053	.0065	.0080	.0095	.0112	.0129	.0146
-2.5	.0028	.0035	.0046	.0058	.0071	.0086	.0102	.0118	.0135	.0152
-2.4	.0031	.0038	.0050	.0062	.0076	.0091	.0107	.0124	.0141	.0158
-2.3	.0034	.0042	.0054	.0067	.0081	.0097	.0113	.0130	.0147	.0164
-2.2	.0037	.0045	.0058	.0071	.0086	.0102	.0118	.0135	.0152	.0169
-2.1	.0040	.0049	.0062	.0076	.0091	.0107	.0124	.0141	.0158	.0175
-2.0	.0044	.0053	.0066	.0081	.0096	.0113	.0129	.0146	.0163	.0180
-1.9	.0048	.0057	.0071	.0086	.0102	.0118	.0135	.0152	.0169	.0186
-1.8	.0052	.0061	.0075	.0091	.0107	.0124	.0141	.0158	.0175	.0192
-1.7	.0056	.0065	.0080	.0096	.0113	.0129	.0146	.0163	.0180	.0197
-1.6	.0060	.0069	.0084	.0101	.0117	.0134	.0151	.0168	.0185	.0202
-1.5	.0064	.0073	.0089	.0105	.0122	.0139	.0156	.0173	.0190	.0207
-1.4	.0068	.0077	.0093	.0110	.0127	.0144	.0161	.0178	.0195	.0212
-1.3	.0071	.0080	.0097	.0114	.0131	.0148	.0165	.0182	.0199	.0216
-1.2	.0075	.0084	.0101	.0118	.0135	.0152	.0169	.0186	.0203	.0220
-1.1	.0078	.0087	.0104	.0121	.0138	.0155	.0172	.0189	.0206	.0223
-1.0	.0081	.0090	.0107	.0124	.0141	.0158	.0175	.0192	.0209	.0226
-0.9	.0084	.0093	.0110	.0127	.0144	.0161	.0178	.0195	.0212	.0229
-0.8	.0087	.0096	.0113	.0130	.0147	.0164	.0181	.0198	.0215	.0232
-0.7	.0090	.0099	.0116	.0133	.0150	.0167	.0184	.0201	.0218	.0235
-0.6	.0093	.0102	.0119	.0136	.0153	.0170	.0187	.0204	.0221	.0238
-0.5	.0096	.0105	.0122	.0139	.0156	.0173	.0190	.0207	.0224	.0241
-0.4	.0099	.0108	.0125	.0142	.0159	.0176	.0193	.0210	.0227	.0244
-0.3	.0102	.0111	.0128	.0145	.0162	.0179	.0196	.0213	.0230	.0247
-0.2	.0105	.0114	.0131	.0148	.0165	.0182	.0199	.0216	.0233	.0250
-0.1	.0108	.0117	.0134	.0151	.0168	.0185	.0202	.0219	.0236	.0253
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359

Table A (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	.7122	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7421	.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	.8707	.8727	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8868	.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	.9685	.9692	.9699	.9706
1.9	.9713	.9719	.9725	.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	.9874	.9877	.9880	.9883	.9886	.9889
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	.9978	.9979	.9980	.9981	.9982	.9983
2.9	.9984	.9984	.9985	.9985	.9986	.9986	.9987	.9987	.9988	.9988
3.0	.9988	.9988	.9989	.9989	.9989	.9990	.9990	.9990	.9991	.9991
3.1	.9991	.9991	.9991	.9992	.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	.9997	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997

Table entry for p and c is the point z' with probability p lying above it and probability c lying between z' and z''

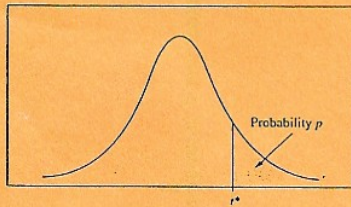


Table entry for p is the point (z') with probability p lying above it

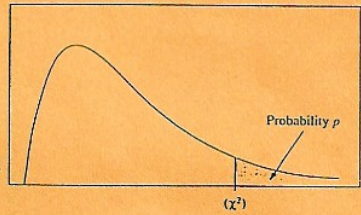


Table B t distribution critical values

df	Tail probability p											
	.25	.20	.15	.10	.05	.025	.02	.01	.005	.001		
1	1.000	1.376	1.963	3.078	6.315	12.71	15.89	31.82	63.68	127.3	318.3	636.6
2	1.16	1.064	1.186	1.886	2.924	4.303	4.849	6.965	9.925	15.99	31.82	63.66
3	1.65	1.25	1.25	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	1.74	1.29	1.19	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	1.75	1.29	1.19	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.859
6	1.76	1.29	1.19	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	1.77	1.29	1.19	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	1.77	1.29	1.19	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	1.78	1.29	1.19	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	1.78	1.29	1.19	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	1.78	1.29	1.19	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	1.78	1.29	1.19	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.313
13	1.78	1.29	1.19	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	1.78	1.29	1.19	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	1.78	1.29	1.19	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	1.78	1.29	1.19	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	1.78	1.29	1.19	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	1.78	1.29	1.19	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	1.78	1.29	1.19	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	1.78	1.29	1.19	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	1.78	1.29	1.19	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	1.78	1.29	1.19	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	1.78	1.29	1.19	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	1.78	1.29	1.19	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	1.78	1.29	1.19	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	1.78	1.29	1.19	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	1.78	1.29	1.19	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	1.78	1.29	1.19	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	1.78	1.29	1.19	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	1.78	1.29	1.19	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	1.78	1.29	1.19	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	1.78	1.29	1.19	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	