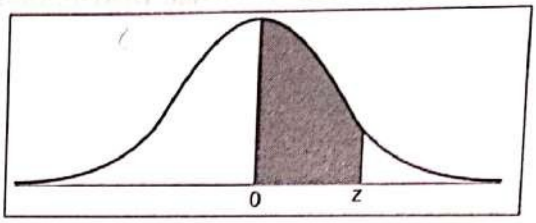
Areas of a Standard Normal Distribution



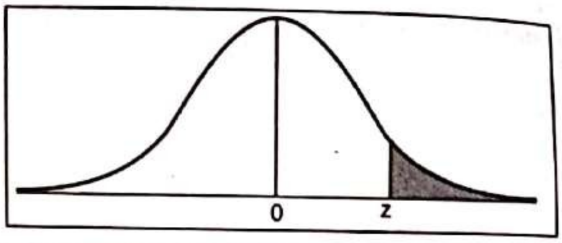
The table entries represent the area under the standard normal curve from 0 to the specified value of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998
3.6	.4998	.4998	.4998	.4999	.4999	.4999	.4999	.4999	.4999	.4999

Areas of a Standard Normal Distribution (Right)

$z = \frac{\bar{x}-\mu}{\sigma/\sqrt{n}}$; $t = \frac{\bar{x}_1-\bar{x}_2}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}$; $z=\frac{p-P}{\sqrt{\frac{PQ}{n}}}$, $z=\frac{p1-P2}{\sqrt{PQ(\frac{1}{n1}+\frac{1}{n2})}}$

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



The table entries represent the area under the standard normal curve more than specified value of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
3.5	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
3.6	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

s^2=(n1s1^2+n2s2^2)/n1+n2-2

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.0
-3.6	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.000
-3.5	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.000
-3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.000
-3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.000
-3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.000
-3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.000
-3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.001
-2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.001
-2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.001
-2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.002
-2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.003
-2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.004
-2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.006
-2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.008
-2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.011
-2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.014
-2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.018
-1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.023
-1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.029
-1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.036
-1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.045
-1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.055
-1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.068
-1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.082
-1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.098
-1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.117
-1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.137
-0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.161
-0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.186
-0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.214
-0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.245
-0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.277
-0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.312
-0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.348
-0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.385
-0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.424

Critical Values of Student's t-distribution

d.f.	Level of significance for one-tailed test					
	0.10	0.05	0.025	0.01	0.005	0.0005
	Level of significance for two-tailed test					
	0.20	0.10	0.05	0.02	0.01	0.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.599
3	1.638	2.353	3.182	4.541	5.841	12.924
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.869
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.408
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.768
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

Critical Values of Chi-Square

The values of χ^2 correspond to a specific right-tail area and specific number of degrees of freedom df.

Degree of Freedom	Level of Significance					
	0.2	0.1	0.05	0.02	0.01	0.001
1	1.642	2.706	3.841	5.412	6.635	10.828
2	3.219	4.605	5.991	7.824	9.210	13.816
3	4.642	6.251	7.815	9.837	11.345	16.266
4	5.989	7.779	9.488	11.668	13.277	18.467
5	7.289	9.236	11.070	13.388	15.086	20.515
6	8.558	10.645	12.592	15.033	16.812	22.458
7	9.803	12.017	14.067	16.622	18.475	24.322
8	11.030	13.362	15.507	18.168	20.090	26.124
9	12.242	14.684	16.919	19.679	21.666	27.877
10	13.442	15.987	18.307	21.161	23.209	29.588
11	14.631	17.275	19.675	22.618	24.725	31.264
12	15.812	18.549	21.026	24.054	26.217	32.909
13	16.985	19.812	22.362	25.472	27.688	34.528
14	18.151	21.064	23.685	26.873	29.141	36.123
15	19.311	22.307	24.996	28.259	30.578	37.697
16	20.465	23.542	26.296	29.633	32.000	39.252
17	21.615	24.769	27.587	30.995	33.409	40.790
18	22.760	25.989	28.869	32.346	34.805	42.312
19	23.900	27.204	30.144	33.687	36.191	43.820
20	25.038	28.412	31.410	35.020	37.566	45.315
21	26.171	29.615	32.671	36.343	38.932	46.797
22	27.301	30.813	33.924	37.659	40.289	48.268
23	28.429	32.007	35.172	38.968	41.638	49.728
24	29.553	33.196	36.415	40.270	42.980	51.179
25	30.675	34.382	37.652	41.566	44.314	52.620
26	31.795	35.563	38.885	42.856	45.642	54.052
27	32.912	36.741	40.113	44.140	46.963	55.476
28	34.027	37.916	41.337	45.419	48.278	56.892
29	35.139	39.087	42.557	46.693	49.588	58.301
30	36.250	40.256	43.773	47.962	50.892	59.703
40	47.269	51.805	55.758	60.436	63.691	73.402
60	68.972	74.397	79.082	84.580	88.379	99.607
120	132.806	140.233	146.567	153.918	158.950	173.617

Critical values of the Kolmogorov-Smirnov One Sample Test statistics D_n.
This table gives the values of $D^{+}_{n,\alpha}$ and $D^{-}_{n,\alpha}$ for which $\alpha \geq P\{D^{+}_n > D^{+}_{n,\alpha}\}$ and $\alpha \geq P\{D_n > D_{n,\alpha}\}$ for some selected values of n and α.

One-Sided Test:					
α =	.10	.05	.025	.01	.005
Two-Sided Test:					
α =	.20	.10	.05	.02	.01
n = 1	.900	.950	.975	.990	.995
2	.684	.776	.842	.900	.929
3	.565	.636	.708	.785	.829
4	.493	.565	.524	.689	.734
5	.447	.509	.563	.627	.669
6	.410	.468	.519	.577	.617
7	.381	.436	.483	.538	.576
8	.358	.410	.454	.507	.542
9	.339	.387	.430	.480	.513
10	.323	.369	.409	.457	.489
11	.308	.352	.391	.437	.468
12	.296	.338	.375	.419	.449
13	.285	.325	.361	.404	.432
14	.275	.314	.349	.390	.418
15	.266	.304	.338	.377	.404
16	.258	.295	.327	.366	.392
17	.250	.286	.318	.355	.381
18	.244	.279	.309	.346	.371
19	.237	.271	.301	.337	.361
20	.232	.265	.294	.329	.352
21	.226	.259	.287	.321	.344
22	.221	.253	.281	.314	.337
23	.216	.247	.275	.307	.330
24	.212	.242	.269	.301	.323
25	.208	.238	.264	.295	.317
26	.204	.233	.259	.290	.311
27	.200	.229	.254	.284	.305
28	.197	.225	.250	.279	.300
29	.193	.221	.246	.275	.295
30	.190	.218	.242	.270	.290
31	.187	.214	.238	.266	.285
32	.184	.211	.234	.262	.281
33	.182	.208	.231	.258	.277
34	.179	.205	.227	.254	.273
35	.177	.202	.224	.251	.269
[illegible]	[illegible]	.199	.221	.247	.265

Short Cut Key for Critical Values of Z

Critical Values (Z_α)	Level of significance (α)		
	1%	5%	10%
Two tailed test	$\lvert Z_\alpha \rvert = 2.575$	$\lvert Z_\alpha \rvert = 1.96$	$\lvert Z_\alpha \rvert = 1.645$
Right tailed test	$Z_\alpha = 2.33$	$Z_\alpha = 1.645$	$Z_\alpha = 1.28$
Left tailed test	$Z_\alpha = -2.33$	$Z_\alpha = -1.645$	$Z_\alpha = -1.28$

Critical values of the Kolmogorov-Smirnov. Test statistics for two samples of equal size

This table gives the values of $D^+_{n,n,\alpha}$ and $D_{n,n,\alpha}$ for which $\alpha \geq P\{D^+_{n,n} > D^+_{n,n,\alpha}\}$ and $\alpha \geq P\{D_{n,n} > D_{n,n,\alpha}\}$ for some selected values of n and α.

One-Sided Test:					
α =	.10	.05	.025	.01	.005
Two-Sided Test:					
α =	.20	.10	.05	.02	.01
n = 3	2/3	2/3			
4	3/4	3/4	3/4		
5	3/5	3/5	4/5	4/5	4/5
6	3/6	4/6	4/6	5/6	5/6
7	4/7	4/7	5/7	5/7	5/7
8	4/8	4/8	5/8	5/8	6/8
9	4/9	5/9	5/9	6/9	6/9
10	4/10	5/10	6/10	6/10	7/10
11	5/11	5/11	6/11	7/11	7/11
12	5/12	5/12	6/12	7/12	7/12
13	5/13	6/13	6/13	7/13	8/13
14	5/14	6/14	7/14	7/14	8/14
15	5/15	6/15	7/15	8/15	8/15
16	6/16	6/16	7/16	8/16	9/16
17	6/17	7/17	7/17	8/17	9/17
18	6/18	7/18	8/18	9/18	9/18
19	6/19	7/19	8/19	9/19	9/19
20	6/20	7/20	8/20	9/20	10/20
21	6/21	7/21	8/21	9/21	10/21
22	7/22	8/22	8/22	10/22	10/22
23	7/23	8/23	9/23	10/23	10/22
24	7/24	8/24	9/24	10/24	11/24
25	7/25	8/25	9/25	10/25	11/25
26	7/26	8/26	9/26	10/26	11/26
27	7/26	8/27	9/27	11/27	11/27
28	8/28	9/28	10/28	11/28	12/28
29	8/29	9/29	10/29	11/29	12/29
30	8/30	9/30	10/30	11/30	12/30
31	8/31	9/31	10/31	11/31	12/31
32	8/32	9/32	10/32	12/32	12/32
34	8/34	10/34	11/34	12/34	13/34
36	9/36	10/36	11/36	12/36	13/36
38	9/38	10/38	11/38	13/38	14/38
40	9/40	10/40	12/40	13/40	14/40
appro. for n > 40	$\frac{1.52}{\sqrt{n}}$	$\frac{1.73}{\sqrt{n}}$	$\frac{1.92}{\sqrt{n}}$	$\frac{2.15}{\sqrt{n}}$	$\frac{2.30}{\sqrt{n}}$

Two Sample Kolmogorov Smirnov Test:Small Sample test($n_1=n_2<40$,&$n_2\leq20$for$n_1 \neq n_2$):TS:D_0=maximum{$|F_x-F_y|$}

Large Sample Test($n_1=n_2>40$,&$n_2>20$for $n_1 \neq n_2$): Test Statistics; D_0=maximum{$|F(x)-F(y)|$} for two tail test

$X^2 = 4D_0^2\frac{n_1n_2}{n_1+n_2}$; Critical Value: $D_\alpha=1.36\sqrt{\frac{n_1+n_2}{n_1n_2}}$ for two tail with α = 5%

Critical values of the Kolmogorov-Smirnov Test Statistic for Two Samples of Unequal Size.
This table gives the values of $D^{+}_{n_1, n_2, \alpha}$ and $D_{n_1, n_2, \alpha}$ for which $\alpha \geq P\{D^{+}_{n_1, n_2} > D^{+}_{n_1, n_2, \alpha}\}$ and $\alpha \geq P\{D_{n_1, n_2} > D_{n_1, n_2}\}$ for some selected values of n_1 = smaller sample size n_2 = larger sample size, and α.

One-Sided Test:						
	α =	.10	.05	.025	.01	.005
Two-Sided Test:						
	α =	.20	.10	.05	.02	.01
$n_1 = 1$	$n_2 = 9$	17/18				
	10	9/10				
$n_1 = 2$	$n_2 = 3$	5/6				
	4	3/4				
	5	4/5	4/5			
	6	5/6	5/6			
	7	5/7	6/7			
	8	3/4	7/8	7/8		
	9	7/9	8/9	8/9		
	10	7/10	4/5	9/10		
$n_1 = 3$	$n_2 = 4$	3/4	3/4			
	5	2/3	4/5	4/5		
	6	2/3	2/3	5/6		
	7	2/3	5/7	6/7	6/7	
	8	5/8	3/4	3/4	7/8	
	9	2/3	2/3	7/9	8/9	8/9
	10	3/5	7/10	4/5	9/10	9/10
	12	7/12	2/3	3/4	5/6	11/12
$n_1 = 4$	$n_2 = 5$	3/5	3/4	4/5	4/5	
	6	7/12	2/3	3/4	5/6	5/6
	7	17/28	5/7	3/4	6/7	6/7
	8	5/8	5/8	3/4	7/8	7/8
	9	5/9	2/3	3/4	7/9	8/9
	10	11/20	13/20	7/10	4/5	4/5
	12	7/12	2/3	2/3	3/4	5/6
	16	9/16	5/8	11/16	3/4	13/16
$n_1 = 5$	$n_2 = 6$	3/5	2/3	2/3	5/6	5/6
	7	4/7	23/35	5/7	29/35	6/7
	8	11/20	5/8	27/40	4/5	4/5
	9	5/9	3/5	31/45	7/9	4/5
	10	1/2	3/5	7/10	7/10	4/5
	15	8/15	3/5	2/3	11/15	11/15
	20	1/2	11/20	3/5	7/10	3/4

$n_1 = 6$	$n_2 = 7$	23/42	4/7	29/42	5/7	5/6
	8	1/2	7/12	2/3	3/4	3/4
	9	1/2	5/9	2/3	13/18	7/9
	10	1/2	17/30	19/30	7/10	11/15
	12	1/2	7/12	7/12	2/3	3/4
	18	4/9	5/9	11/18	2/3	13/18
	24	11/24	1/2	7/12	5/8	2/3
$n_1 = 7$	$n_2 = 8$	27/56	33/56	5/8	41/56	3/4
	9	31/63	5/9	40/63	5/7	47/63
	10	33/70	39/70	43/70	7/10	5/7
	14	3/7	1/2	4/7	9/14	5/7
	28	3/7	13/28	15/28	17/28	9/14
$n_1 = 8$	$n_2 = 9$	4/9	13/24	5/8	2/3	¾
	10	19/40	21/40	23/40	27/40	7/10
	12	11/24	½	7/12	5/8	2/3
	16	7/16	½	9/16	5/8	5/8
	32	13/32	7/16	1/2	9/16	19/32
$n_1 = 9$	$n_2 = 10$	7/15	½	26/45	2/3	31/45
	12	4/9	½	5/9	11/18	2/3
	15	19/45	22/45	8/15	3/5	29/45
	18	7/18	4/9	½	5/9	11/18
	36	13/36	5/12	17/36	19/36	5/9
$n_1 = 10$	$n_2 = 15$	2/5	7/15	½	17/30	19/30
	20	2/5	9/20	½	11/20	3/5
	40	7/20	2/5	9/20	1/2	
$n_1 = 12$	$n_2 = 15$	23/60	9/20	½	11/20	7/12
	16	3/8	7/16	23/48	13/24	7/12
	18	11/36	5/12	17/36	19/36	5/9
	20	13/30	5/12	7/15	31/60	17/30
$n_1 = 15$	$n_2 = 20$	7/20	2/5	13/30	29/60	31/60
$n_1 = 16$	$n_2 = 20$	27/80	31/80	17/40	19/40	41/80
Large sample approx.		$1.07\sqrt{\frac{n_1+n_2}{n_1n_2}}$	$1.22\sqrt{\frac{n_1+n_2}{n_1n_2}}$	$1.36\sqrt{\frac{n_1+n_2}{n_1n_2}}$	$1.52\sqrt{\frac{n_1+n_2}{n_1n_2}}$	$1.63\sqrt{\frac{n_1+n_2}{n_1n_2}}$

Mann Whitey U Test: small sample size($n_1 \le 10, n_2 \le 10$) TS: $U_0 = \min\{U_1, U_2\}$; CV: $p = Prob(U \le U_0)$

U_1= $n_1n_2 + \frac{n_1(n_1+1)}{2} - R_1$ and **U_2**= $n_1n_2 + \frac{n_2(n_2+1)}{2} - R_2$ such that $n_1n_2 = U_1U_2$

mw

<u>Large sample size($n_1 > 10, n_2 > 10$)</u> variance $\sigma_u^2 = \frac{n_1n_2(n_1+n_2+1)}{12} = \frac{n_1n_2}{n(n-1)}\{\frac{n^3-n}{12} - \frac{\sum t_i^3 - ti}{12}\}$,TS:**Z**=$\frac{U_0-\mu_\alpha}{\sigma_n} = \frac{U_0 - \frac{n_1n_2}{2}}{\sqrt{\frac{n_1n_2(n_1+n_2+1}{12}}}$

Critical values for total number of runs 'r' at α = 0.05 for two tailed test.

The smaller critical value for a left-hand critical region, the larger for a right-hand critical region. For a one tailed test $\alpha = 0.025$ and use only-one of the critical values of r.

The Smaller of n_1 and n_2	The larger of n_1 and n_2: 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2								2, 6	2, 6	2, 6	2, 6	2, 6	2, 6	2, 6	2, 6	2, 6
3		2, 8	2, 8	2, 8	2, 8	2, 8	2, 8	2, 8	2, 8	2, 8	3, 8	3, 8	3, 8	3, 8	3, 8	3, 8
4	2, 9	2, 9	2, 10	3, 10	3, 10	3, 10	3, 10	3, 10	3, 10	3, 10	3, 10	4, 10	4, 10	4, 10	4, 10	4, 10
5	2, 10	3, 10	3, 11	3, 11	3, 12	3, 12	4, 12	4, 12	4, 12	4, 12	4, 12	4, 12	4, 12	5, 12	5, 12	5, 12
6		3, 11	3, 12	3, 12	4, 13	4, 13	4, 13	4, 13	5, 14	5, 14	5, 14	5, 14	5, 14	5, 14	6, 14	6, 14
7			3, 13	4, 13	4, 14	5, 14	5, 14	5, 14	5, 15	5, 15	6, 15	6, 16	6, 16	6, 16	6, 16	6, 16
8				4, 14	5, 14	5, 15	5, 15	6, 16	6, 16	6, 16	6, 16	6, 17	7, 17	7, 17	7, 17	7, 17
9					5, 15	5, 16	6, 16	6, 16	6, 17	7, 17	7, 18	7, 18	7, 18	7, 18	7, 18	7, 18
10						6, 16	6, 17	7, 17	7, 18	7, 18	7, 18	8, 19	8, 19	8, 19	8, 20	9, 20
11							7, 17	7, 18	7, 19	8, 19	8, 19	8, 20	9, 20	9, 20	9, 21	9, 21
12								7, 19	8, 19	8, 20	8, 20	9, 21	9, 21	9, 21	10, 22	10, 22
13									8, 20	9, 20	9, 21	9, 21	10, 22	10, 22	10, 23	10, 23
14										9, 21	9, 22	10, 22	10, 23	10, 23	11, 23	11, 24
15											10, 22	10, 23	11, 23	11, 24	11, 24	12, 25
16												11, 23	11, 24	11, 25	12, 25	12, 25
17													11, 25	12, 25	12, 26	13, 26
18														12, 26	13, 26	13, 27
19															13, 27	13, 27
20																14, 28

Distribution function of U i.e. $P(U \leq U_0) = p_0$, $n_1 \leq n_2$ and $3 \leq n_2 \leq 10$

The probabilities associated with the values as small as observed value of U in the Mann-Whitney test.

$n_2 = 3$

U_0	n_1 = 1	2	3
0	.25	.10	.05
1	.50	.20	.10
2		.40	.20
3		.60	.35
4			.50

$n_2 = 4$

U_0	n_1 = 1	2	3	4
0	.2000	.0667	.0286	.0143
1	.4000	.1333	.0571	.0286
2	.6000	.2667	.1143	.0571
3		.4000	.2000	.1000
4		.6000	.3143	.1714
5			.4286	.2429
6			.5714	.3429
7				.4429
8				.5571

$n_2 = 5$

U_0	n_1 = 1	2	3	4	5
0	.1667	.0476	.0179	.0079	.0040
1	.3333	.0952	.0357	.0159	.0079
2	.5000	.1905	.0714	.0317	.0159
3		.2857	.1250	.0556	.0278
4		.4286	.1964	.0952	.0476
5		.5714	.2857	.1429	.0754
6			.3929	.2063	.1111
7			.5000	.2778	.1548
8				.3651	.2103
9				.4524	.2738
10				.5476	.3452
11					.4206
12					.5000

For sample size (n_1 or $n_2 > 20$): in case of large sample size is approximately normally distributed with mean $\mu_r = \frac{2n_1n_2}{n_1+n_2} + 1$ And variance $\sigma_r^2 = \frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1+n_2)2\,(n_1+n_2-1)}$ **Test Statistics:** $z = \frac{r-\mu_r}{\sigma_r} \sim N(0,1)$; Md=$\frac{(n+1)}{2}$ *th item*

$n_2 = 6$

	n_1					
U_0	1	2	3	4	5	6
0	.1429	.0357	.0119	.0048	.0022	.0011
1	.2857	.0714	.0238	.0095	.0043	.0022
2	.4286	.1429	.0476	.0190	.0087	.0043
3	.5714	.2143	.0833	.0333	.0152	.0076
4		.3214	.1310	.0571	.0260	.0130
5		.4286	.1905	.0857	.0411	.0206
6		.5714	.2738	.1286	.0628	.0325
7			.3571	.1762	.0887	.0465
8			.4524	.2381	.1234	.0660
9			.5476	.3048	.1645	.0898
10				.3810	.2143	.1201
11				.4571	.2684	.1548
12				.5429	.3312	.1970
13					.3961	.2424
14					.4654	.2944
15					.5346	.3496
16						.4091
17						.4686
18						.5314

$n_2 = 7$

ANOVA Table Of Regression Analysis

Source of Variation	df	SS	MSS	F. ratio
due to regression	K(no. inde va	SSR	MSR=SSR/K	
due to error	n-k-1	SSE	MSE= SSE/(n-k-1)	F= MSR/MSE
Total	n-1	TSS		

When Y is dependent , X_1 and X_2 independent

$TSS = \sum(Y-\bar{Y})^2 = \sum Y^2 - n\,\bar{Y}^2$

$SSE = \sum(Y-\hat{Y})^2 = \sum Y^2 - b_0\sum Y - b_1\sum YX_1 - b_2\sum YX_2$

$SSR = TSS - SSE$

When X_1 is dependent, X_2 and X_3 independent

$TSS = \sum(X_1-\bar{X}_1)^2 = \sum X_1^2 - n\,\bar{X}_1^2$

$SSE = \sum(X_1-\hat{X}_1)^2 = \sum X_1^2 - a\sum X_1 - b_2\sum X_1X_2 - b_3\sum X_1X_3$

$SSR = TSS - SSE$

When Y is dependent , X_1 and X_2 independent

$TSS = \sum(X_1-\bar{X}_2)^2 = \sum X_2^2 - n\,\bar{X}_2^2$

$SSE = \sum(X_1-\hat{X}_2)^2 = \sum X_2^2 - a\sum X_2 - b_2\sum X_1X_2 - b_3\sum X_2X_3$

$SSR = TSS - SSE$

When X_1 is dependent, X_2 and X_3 independent

$TSS = \sum(X_1-\bar{X}_3)^2 = \sum X_3^2 - n\,\bar{X}_3^2$

$SSE = \sum(X_1-\hat{X}_3)^2 = \sum X_3^2 - a\sum X_3 - b_2\sum X_1X_3 - b_3\sum X_2X_3$

$SSR = TSS - SSE$

Standard Error of the Estimation

$S_e=\sqrt{MSE} = \sqrt{\frac{SSE}{n-k-1}}$; = no. of independent variable in RM

Coefficient of Determination

$R^2_{adjusted}(\bar{R})^2 = 1-\frac{(n-1)}{(n-k-1)}[1-R^2]$; $R^2=\frac{SSR}{TSS}$

Test of Significance for Regression Coefficients at α% level of significance:

Equation: $y = b_0 + b_1x_1 + b_2x_2$; **Test Statistics:** $t=\frac{b_1}{Sb_1}$; **Critical Value:** $t_{tabulated} = t_{\alpha/2(n-k-1)}$

Test of Overall Significance of the Regression Coefficients(independent variables):

Test Statistics $F=\frac{MSR}{MSE}$, $F=\frac{MSR}{MSE} = \frac{(n-k-1)}{k} * \frac{R^2}{1-R^2}$

$n_2 = 8$

U_0	n_1 = 1	2	3	4	5	6	7	8
0	.1111	.0222	.0061	.0020	.0008	.0003	.0002	.0001
1.	.2222	.0444	.0121	.0040	.0016	.0007	.0003	.0002
2.	.3333	.0889	.0242	.0081	.0031	.0013	.0006	.0003
3.	.4444	.1333	.0424	.0141	.0054	.0023	.0011	.0005
4.	.5556	.2000	.0667	.0242	.0093	.0040	.0019	.0009
5.		.2667	.0970	.0364	.0148	.0063	.0030	.0015
6.		.3556	.1394	.0545	.0225	.0100	.0047	.0023
7.		.4444	.1879	.0768	.0326	.0147	.0070	.0035
8.		.5556	.2485	.1071	.0466	.0213	.0103	.0052
9.			.3152	.1414	.0637	.0296	.0145	.0074
10.			.3879	.1838	.0855	.0406	.0200	.0103
11.			.4606	.2303	.1111	.0539	.0270	.0141
12.			.5394	.2848	.1422	.0709	.0361	.0190
13.				.3414	.1772	.0906	.0469	.0249
14.				.4040	.2176	.1142	.0603	.0325
15.				.4667	.2618	.1412	.0760	.0415
16.				.5333	.3108	.1725	.0946	.0524
17.					.3621	.2068	.1159	.0652
18.					.4165	.2454	.1405	.0803
19.					.4716	.2864	.1678	.0974
20.					.5284	.3310	.1984	.1172
21.						.3773	.2317	.1393
22.						.4259	.2679	.1641
23.						.4749	.3063	.1911
24.						.5251	.3472	.2209
25.							.3894	.2527
26.							.4333	.2869
27.							.4775	.3227
28.							.5225	.3605
29.								.3992
30.								.4392
31.								.4796
32.								.5204

$n_2 = 9$

Paired Sample Test:

1. Wilcoxon Matched Pair Signed Rank Test:

Small Sample size(n≤25):TS= min{S(+), S(-)}, Decision: Reject H_0 at level of significance if $T <= T_{\alpha, n}$ accept otherwise.

Large Sample size n>25: $\mu_T = \frac{n(n+1)}{4}$ and $\sigma_T^2 = \frac{n(n+1)(2n+1)}{24}$ **Test Statistic : Z =** $\frac{T-\mu_T}{\sigma_T} = \frac{T-\frac{n(n+1)}{4}}{\sqrt{\frac{n(n+1)(2n+1)}{24}}} \sim N(0,1)$

Cochran Q test:TS:Q=$\frac{(k-1)[K\sum R_i^2-(\sum R_i)^2]}{K\sum C_j-\sum C_j^2} \sim X^2$, **CV:** $X^2_{\alpha(k-1)}$;**Decision:**reject H_0 at α% level of sign, if Q>$X^2_{\alpha(k-1)}$

Kruskal Wallis H Test: TS:

$H=\frac{12}{n(n+1)}\sum\frac{R_i^2}{n_i} - 3(n+1) \sim X^2(k-1)$,

if tied occurs the corrected test Statistics is

$H=\frac{\frac{12}{n(n+1)}\sum\frac{R_i^2}{n_i}-3(n+1)}{1-\sum\frac{t_i^3-t_i}{n^3-n}}$, t_i=no.of times i^{th} rank is repeated

Friedman F test:

$H=\frac{12}{nk(k+1)}\sum_{i=1}^{k} R_i^2 - 3n(k+1)$

if tied occurs then corrected test statistics is

$H=\frac{\frac{12}{nk(k+1)}\sum_{i=1}^{k} R_i^2-3n(k+1)}{1-\sum\frac{t_i^3-t_i}{n(k^3-k)}}$,$t_i$= number of times ith rank is repeated.

10.			.3000	.1301	.0559	.0248	.0115	.0056	.0028
11.			.3636	.1650	.0734	.0332	.0156	.0076	.0039
12.			.4318	.2070	.0949	.0440	.0209	.0103	.0053
13.			.5000	.2517	.1199	.0567	.0274	.0137	.0071
14.				.3021	.1489	.0723	.0356	.0180	.0094
15.				.3552	.1818	.0905	.0454	.0232	.0122
16.				.4126	.2188	.1119	.0571	.0296	.0157
17.				.4699	.2592	.1361	.0708	.0372	.0200
18.				.5301	.3032	.1638	.0869	.0464	.0252
19.					.3497	.1942	.1052	.0570	.0313
20.					.3986	.2280	.1261	.0694	.0385
21.					.4491	.2643	.1496	.0836	.0470
22.					.5000	.3035	.1755	.0998	.0567
23.						.3445	.2039	.1179	.0680
24.						.3878	.2349	.1383	.0807
25.						.4320	.2680	.1606	.0951
26.						.4773	.3032	.1852	.1112
27.						.5227	.3403	.2117	.1290
28.							.3788	.2404	.1487
29.							.4185	.2707	.1701
30.							.4591	.3029	.1933
31.							.5000	.3365	.2181
32.								.3715	.2447
33.								.4074	.2729
34.								.4442	.3024
35.								.4813	.3332
36.								.5187	.3652
37.									.3981
38.									.4317
39.									.4657
40.									.5000

$n_2 = 10$

n_1		
8	9	10
0000	.0000	.0000
0000	.0000	.0000
0001	.0000	.0000
0002	.0001	.0000
0003	.0001	.0001
0004	.0002	.0001
0007	.0003	.0002
0010	.0005	.0002
0015	.0007	.0004
0022	.0011	.0005
0031	.0015	.0008
.0043	.0021	.0010

When $n_1 \le 20$ and $n_2 \le 20$, the test statistic for the runs test is ***G***, the number of runs.

When $n_1 > 20$ or $n_2 > 20$, the test statistic for the runs test is

$$z = \frac{G - \mu_G}{\sigma_G}$$

where

$$\mu_G = \frac{2n_1n_2}{n_1+n_2} + 1 \quad \text{and} \quad \sigma_G = \sqrt{\frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1+n_2)^2(n_1+n_2-1)}}$$

12.			.3462	.1518	.0646	.0280	.0125	.0058	.0028	.0014
13.			.4056	.1868	.0823	.0363	.0165	.0078	.0038	.0019
14.			.4685	.2268	.1032	.0467	.0215	.0103	.0051	.0026
15.			.5315	.2697	.1272	.0589	.0277	.0133	0.066	.0034
16.				.3177	.1548	.0736	.0351	.0171	.0086	.0045
17.				.3666	.1855	.0903	.0439	.0217	.0110	.0057
18.				.4196	.2198	.1099	.0544	.0273	.0140	.0073
19.				.4725	.2567	.1317	.0665	.0338	.0175	.0093
20.				.5275	.2970	.1566	.0806	.0416	.0217	.0116
21.					.3393	.1838	.0966	.0506	.0267	.0144
22.					.3839	.2139	.1148	.0610	.0326	.0177
23.					.4296	.2461	.1349	.0729	.0394	.0216
24.					.4765	.2811	.1574	.0864	.0474	.0262
25.					.5235	.3177	.1819	.1015	.0564	.0315
26.						.3564	.2087	.1185	.0667	.0376
27.						.3962	.2374	.1371	.0782	.0446
28.						.4374	.2681	.1577	.0912	.0526
29.						.4789	.3004	.1800	.1055	.0615
30.						.5211	.3345	.2041	.1214	.0716
31.							.3698	.2299	.1388	.0827
32.							.4063	.2574	.1577	.0952
33.							.4434	.2863	.1781	.1088
34.							.4811	.3167	.2001	.1237
35.							.5189	.3482	.2235	.1399
36.								.3809	.2483	.1575
37.								.4143	.2745	.1763
38.								.4484	.3019	.1965
39.								.4827	.3304	.2179
40.								.5173	.3598	.2406
41.									.3901	.2644
42.									.4211	.2894
43.									.4524	.3153
44.									.4841	.3421
45.									.5159	.3697
46.										.3980
47.										.4267
48.										.4559
49.										.4853
50.										.5147

Chi Square Test for Goodness of Fit: TS: $X^2=\sum_{i=0}^{k}\frac{(O_i-E_i)^2}{E_i}\sim X^2(k-1)$

Chi Square Test for Independence of Attributes: $X^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{ij}-E_{ij})^2}{E_{ij}}\sim X^2_{(r-1)(c-1)}$ $E_{ij}=(O_{i.} * O_{.j})/N$

Critical value of U in the Mann-Whitney Test

a. Critical values of U for a one-tailed test at 0.025 or for a two-tailed test at 0.05

n_2 \ n_1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
2								0	0	0	0	1	1	1	1	1	2	2	2	2
3					0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
4				0	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	13
5			0	1	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
6			1	2	3	5	6	8	10	11	13	14	16	17	19	21	22	24	25	27
7			1	3	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
8		0	2	4	6	8	10	13	15	17	19	22	24	26	29	31	34	36	38	41
9		0	2	4	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48
10		0	3	5	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
11		0	3	6	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
12		1	4	7	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
13		1	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
14		1	5	9	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
15		1	5	10	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
16		1	6	11	[illegible]	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
17		2	6	11	17	[illegible]	28	34	39	45	51	57	63	67	75	81	87	93	99	105
18		2	7	12	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
19		2	7	13	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
20		2	8	13	20	27	34	41	48	55	62	69	76	83	90	98	103	112	119	127

b. Critical values of U for a one-tailed test at 0.05 or for a two-tailed test at 0.10

n_2 \ n_1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																			0	0
2					0	0	0	1	1	1	1	2	2	2	3	3	3	4	4	4
3			0	0	1	2	2	3	3	4	5	5	6	7	7	8	9	9	10	11
4			0	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
5		0	1	2	4	5	6	8	9	11	12	13	15	16	18	19	20	22	23	25
6		0	2	3	5	7	8	10	12	14	16	17	19	21	23	25	26	28	30	32
7		0	2	4	6	8	11	13	15	17	19	21	24	26	28	30	33	35	37	39
8		1	3	5	8	10	13	15	18	20	23	26	28	31	33	36	39	41	44	47
9		1	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54
10		1	4	7	11	14	17	20	24	27	31	34	37	41	44	48	51	55	58	62
11		1	5	8	12	16	19	23	27	31	34	38	42	46	50	54	57	61	65	69
12		2	5	9	13	17	21	26	30	34	38	42	47	51	55	60	64	68	72	77
13		2	6	10	15	19	24	28	33	37	42	47	51	56	61	65	70	75	80	84
14		2	7	11	16	21	26	31	36	41	46	51	56	61	66	71	77	82	87	92
15		3	7	12	18	23	28	33	39	44	50	55	61	66	72	77	83	88	94	100
16		3	8	14	19	25	30	36	42	48	54	60	65	71	77	83	89	95	101	107
17		3	9	15	20	26	33	39	45	51	57	64	70	77	83	89	96	102	109	115
18		4	9	16	22	28	35	41	48	55	61	68	75	82	88	95	102	109	116	123
19	0	4	10	17	23	30	37	44	51	58	65	72	80	87	94	101	109	116	123	130
20	0	4	11	18	25	32	39	47	54	62	69	77	84	92	100	107	115	123	130	138

Probabilities associated with values as small as observed values of x in the binomial distribution with parameter n and p = ½

$$\text{i.e. } p_0 = P(X \le x) = \sum_{x=0}^{x=k} \binom{n}{x} \left(\frac{1}{2}\right)^n ; k = 0, 1, 2, \ldots (n-1).$$

n \ x	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	5	*														
2	250	500	*													
3	125	500	875	*												
4	063	313	688	938	*											
5	031	188	500	812	969	*										
6	016	109	344	656	891	984	*									
7	008	062	227	500	773	938	992	*								
8	004	035	145	363	637	855	965	996	*							
9	002	020	090	254	500	746	910	980	998	*						
10	001	011	055	172	377	623	828	945	989	999	*					
11		006	033	113	274	500	726	887	967	994	999	*				
12		003	019	073	194	387	613	806	927	981	997	*	*			
13		002	011	046	133	291	500	709	867	954	989	998	*	*		
14		001	006	029	090	212	395	605	788	910	971	994	999	*	*	
15			004	018	059	151	304	500	696	849	941	982	996	*	*	*
16			002	011	038	105	227	402	598	773	895	962	989	998	*	*
17			001	006	025	072	166	315	500	685	834	928	975	994	999	*
18			001	004	015	048	119	240	407	593	760	881	952	985	996	999
19				002	010	032	084	180	324	500	676	820	916	968	990	998
20				001	006	021	058	132	252	412	588	748	868	942	979	994
21				001	004	013	039	095	192	332	500	668	808	905	961	987
22					002	008	026	067	143	262	416	584	738	857	933	974
23					001	005	017	047	105	202	339	500	661	798	895	953
24					001	003	011	032	076	154	271	419	581	729	846	924
25						002	007	022	054	115	212	345	500	655	788	885

Note: To save space decimal points are omitted in the p's.
** = 1 or approximately 1.0*

Large Sample Size(n>25); test statistics

$Z = \frac{(x_0 \pm 0.5) - np}{\sqrt{npq}}$ use +0.5 if x_0<np & use -0.5 if x_0 >np

F Table for α = 0.10

Degree of Freedom for Numerator

df_2 \ df_1 (Degree of Freedom for Denumerator)	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	39.863	49.500	53.593	55.832	57.240	58.204	58.905	59.438	59.857	60.194	60.705	61.220	61.740	62.002	62.264	62.529	62.794	63.060	63.328
2	8.526	9.000	9.161	9.243	9.292	9.325	9.349	9.366	9.380	9.391	9.408	9.424	9.441	9.449	9.457	9.466	9.474	9.482	9.491
3	5.538	5.462	5.390	5.342	5.309	5.284	5.266	5.251	5.240	5.230	5.215	5.200	5.184	5.176	5.168	5.159	5.151	5.142	5.133
4	4.544	4.324	4.190	4.107	4.050	4.009	3.978	3.954	3.935	3.919	3.895	3.870	3.844	3.830	3.817	3.803	3.789	3.775	3.760
5	4.060	3.779	3.619	3.520	3.452	3.404	3.367	3.339	3.316	3.297	3.268	3.238	3.206	3.190	3.174	3.157	3.140	3.122	3.105
6	3.775	3.463	3.288	3.180	3.107	3.054	3.014	2.983	2.957	2.936	2.904	2.871	2.836	2.818	2.799	2.781	2.761	2.742	2.722
7	3.589	3.257	3.074	2.960	2.883	2.827	2.784	2.751	2.724	2.702	2.668	2.632	2.594	2.575	2.555	2.535	2.514	2.492	2.470
8	3.457	3.113	2.923	2.806	2.726	2.668	2.624	2.589	2.561	2.538	2.501	2.464	2.424	2.404	2.383	2.361	2.339	2.316	2.292
9	3.360	3.006	2.812	2.692	2.610	2.550	2.505	2.469	2.440	2.416	2.378	2.339	2.298	2.276	2.254	2.231	2.208	2.184	2.159
10	3.285	2.924	2.727	2.605	2.521	2.460	2.413	2.377	2.347	2.322	2.284	2.243	2.200	2.178	2.155	2.131	2.107	2.081	2.055
11	3.225	2.859	2.660	2.536	2.451	2.389	2.341	2.304	2.273	2.248	2.208	2.167	2.123	2.100	2.076	2.051	2.026	1.999	1.972
12	3.176	2.806	2.605	2.480	2.394	2.331	2.282	2.244	2.213	2.187	2.147	2.104	2.059	2.035	2.011	1.986	1.959	1.932	1.903
13	3.136	2.763	2.560	2.433	2.346	2.282	2.234	2.195	2.163	2.137	2.096	2.053	2.006	1.982	1.957	1.931	1.904	1.875	1.846
14	3.102	2.726	2.522	2.394	2.306	2.242	2.193	2.153	2.121	2.095	2.053	2.009	1.962	1.937	1.911	1.885	1.857	1.828	1.797
15	3.073	2.695	2.489	2.361	2.273	2.208	2.158	2.118	2.086	2.059	2.017	1.972	1.924	1.899	1.872	1.845	1.816	1.786	1.755
16	3.048	2.668	2.461	2.332	2.243	2.178	2.128	2.087	2.055	2.028	1.985	1.939	1.891	1.865	1.838	1.810	1.781	1.750	1.718
17	3.026	2.644	2.437	2.307	2.218	2.152	2.101	2.061	2.028	2.000	1.957	1.911	1.862	1.836	1.809	1.780	1.750	1.719	1.685
18	3.006	2.623	2.416	2.285	2.195	2.129	2.078	2.037	2.004	1.976	1.933	1.886	1.836	1.810	1.782	1.753	1.723	1.690	1.656
19	2.989	2.605	2.397	2.266	2.175	2.109	2.058	2.017	1.983	1.955	1.911	1.864	1.814	1.787	1.759	1.729	1.698	1.665	1.630
20	2.974	2.589	2.380	2.248	2.158	2.091	2.039	1.998	1.964	1.936	1.892	1.844	1.793	1.766	1.738	1.708	1.676	1.643	1.607
21	2.960	2.574	2.364	2.233	2.142	2.075	2.023	1.981	1.947	1.919	1.874	1.827	1.775	1.748	1.719	1.688	1.656	1.622	1.586
22	2.948	2.561	2.351	2.219	2.127	2.060	2.008	1.966	1.932	1.904	1.859	1.811	1.758	1.731	1.702	1.671	1.638	1.604	1.566
23	2.937	2.549	2.339	2.206	2.114	2.047	1.994	1.953	1.918	1.890	1.844	1.796	1.743	1.715	1.686	1.655	1.622	1.587	1.549
24	2.927	2.538	2.327	2.194	2.103	2.035	1.982	1.940	1.906	1.877	1.831	1.783	1.730	1.701	1.672	1.640	1.607	1.571	1.532
25	2.917	2.528	2.317	2.184	2.092	2.024	1.971	1.929	1.894	1.865	1.820	1.770	1.717	1.688	1.658	1.627	1.593	1.557	1.517
26	2.909	2.519	2.307	2.174	2.082	2.013	1.961	1.918	1.884	1.855	1.809	1.759	1.705	1.677	1.646	1.614	1.580	1.543	1.503
27	2.901	2.510	2.298	2.165	2.072	2.004	1.951	1.909	1.874	1.845	1.798	1.749	1.695	1.666	1.635	1.603	1.568	1.531	1.490
28	2.893	2.502	2.290	2.157	2.064	1.995	1.942	1.900	1.865	1.835	1.789	1.739	1.685	1.656	1.625	1.592	1.557	1.519	1.478
29	2.887	2.495	2.283	2.149	2.056	1.987	1.934	1.891	1.856	1.827	1.780	1.730	1.675	1.646	1.615	1.582	1.547	1.508	1.467
30	2.880	2.488	2.276	2.142	2.049	1.980	1.926	1.884	1.848	1.819	1.772	1.722	1.667	1.637	1.606	1.573	1.537	1.498	1.456
40	2.835	2.440	2.226	2.090	1.996	1.926	1.872	1.828	1.792	1.762	1.714	1.662	1.605	1.574	1.541	1.505	1.467	1.424	1.376
60	2.791	2.393	2.177	2.040	1.945	1.874	1.819	1.774	1.738	1.707	1.657	1.603	1.543	1.510	1.475	1.437	1.395	1.347	1.291
120	2.747	2.347	2.129	1.992	1.895	1.823	1.767	1.721	1.684	1.652	1.601	1.545	1.482	1.447	1.409	1.367	1.320	1.264	1.192
∞	2.705	2.302	2.083	1.944	1.847	1.774	1.716	1.670	1.631	1.598	1.545	1.487	1.420	1.383	1.341	1.295	1.239	1.168	1.000

F Table for $\alpha = 0.05$

Degree of Freedom for Numerator

Degree of Freedom for Denumerator

$df_2 \downarrow$ \ $df_1 \rightarrow$	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161.447	199.500	215.707	224.583	230.161	233.986	236.768	238.882	240.543	241.881	243.906	245.949	248.013	249.051	250.095	251.143	252.195	253.252	254.314
2	18.512	19.000	19.164	19.246	19.296	19.329	19.353	19.371	19.384	19.395	19.412	19.429	19.445	19.454	19.462	19.470	19.479	19.487	19.495
3	10.128	9.552	9.276	9.117	9.013	8.940	8.886	8.845	8.812	8.785	8.744	8.702	8.660	8.638	8.616	8.594	8.572	8.549	8.526
4	7.708	6.944	6.591	6.388	6.256	6.163	6.094	6.041	5.998	5.964	5.911	5.857	5.802	5.774	5.745	5.717	5.687	5.658	5.628
5	6.607	5.786	5.409	5.192	5.050	4.950	4.875	4.818	4.772	4.735	4.677	4.618	4.558	4.527	4.495	4.463	4.431	4.398	4.365
6	5.987	5.143	4.757	4.533	4.387	4.283	4.206	4.146	4.099	4.060	3.999	3.938	3.874	3.841	3.808	3.774	3.739	3.704	3.668
7	5.591	4.737	4.346	4.120	3.971	3.866	3.787	3.725	3.676	3.636	3.574	3.510	3.444	3.410	3.375	3.340	3.304	3.267	3.229
8	5.317	4.459	4.066	3.837	3.687	3.580	3.500	3.438	3.388	3.347	3.283	3.218	3.150	3.115	3.079	3.042	3.005	2.966	2.927
9	5.117	4.256	3.862	3.633	3.481	3.373	3.292	3.229	3.178	3.137	3.072	3.006	2.936	2.900	2.863	2.825	2.787	2.747	2.706
10	4.964	4.102	3.708	3.478	3.325	3.217	3.135	3.071	3.020	2.978	2.913	2.845	2.774	2.737	2.699	2.660	2.621	2.580	2.537
11	4.844	3.982	3.587	3.358	3.203	3.094	3.012	2.948	2.896	2.853	2.787	2.718	2.646	2.609	2.570	2.530	2.490	2.448	2.404
12	4.747	3.885	3.490	3.259	3.105	2.996	2.913	2.848	2.796	2.753	2.686	2.616	2.543	2.505	2.466	2.425	2.384	2.341	2.296
13	4.667	3.805	3.410	3.179	3.025	2.915	2.832	2.766	2.714	2.671	2.603	2.533	2.458	2.420	2.380	2.339	2.296	2.252	2.206
14	4.600	3.738	3.343	3.112	2.958	2.847	2.764	2.698	2.645	2.602	2.534	2.463	2.387	2.348	2.308	2.266	2.222	2.177	2.130
15	4.543	3.682	3.287	3.055	2.901	2.790	2.706	2.640	2.587	2.543	2.475	2.403	2.327	2.287	2.246	2.204	2.160	2.114	2.065
16	4.494	3.633	3.238	3.006	2.852	2.741	2.657	2.591	2.537	2.493	2.424	2.352	2.275	2.235	2.193	2.150	2.105	2.058	2.009
17	4.451	3.591	3.196	2.964	2.810	2.698	2.614	2.548	2.494	2.449	2.380	2.307	2.230	2.189	2.147	2.104	2.058	2.010	1.960
18	4.413	3.554	3.159	2.927	2.772	2.661	2.576	2.510	2.456	2.411	2.342	2.268	2.190	2.149	2.107	2.062	2.016	1.968	1.916
19	4.380	3.521	3.127	2.895	2.740	2.628	2.543	2.476	2.422	2.377	2.308	2.234	2.155	2.114	2.071	2.026	1.979	1.930	1.878
20	4.351	3.492	3.098	2.866	2.710	2.599	2.514	2.447	2.392	2.347	2.277	2.203	2.124	2.082	2.039	1.993	1.946	1.896	1.843
21	4.324	3.466	3.072	2.840	2.684	2.572	2.487	2.420	2.366	2.321	2.250	2.175	2.096	2.054	2.010	1.964	1.916	1.865	1.811
22	4.300	3.443	3.049	2.816	2.661	2.549	2.463	2.396	2.341	2.296	2.225	2.150	2.070	2.028	1.984	1.938	1.889	1.838	1.783
23	4.279	3.422	3.028	2.795	2.640	2.527	2.442	2.374	2.320	2.274	2.203	2.128	2.047	2.005	1.960	1.913	1.864	1.812	1.757
24	4.259	3.402	3.008	2.776	2.620	2.508	2.422	2.355	2.300	2.254	2.183	2.107	2.026	1.983	1.939	1.892	1.842	1.789	1.733
25	4.241	3.385	2.991	2.758	2.603	2.490	2.404	2.337	2.282	2.236	2.164	2.088	2.007	1.964	1.919	1.871	1.821	1.768	1.711
26	4.225	3.369	2.975	2.742	2.586	2.474	2.388	2.320	2.265	2.219	2.147	2.071	1.989	1.946	1.901	1.853	1.802	1.748	1.690
27	4.210	3.354	2.960	2.727	2.571	2.459	2.373	2.305	2.250	2.204	2.132	2.055	1.973	1.929	1.884	1.836	1.785	1.730	1.671
28	4.196	3.340	2.946	2.714	2.558	2.445	2.359	2.291	2.236	2.190	2.117	2.041	1.958	1.914	1.868	1.820	1.768	1.713	1.654
29	4.183	3.327	2.934	2.701	2.545	2.432	2.346	2.278	2.222	2.176	2.104	2.027	1.944	1.900	1.854	1.805	1.753	1.698	1.637
30	4.170	3.315	2.922	2.689	2.533	2.420	2.334	2.266	2.210	2.164	2.092	2.014	1.931	1.887	1.840	1.791	1.739	1.683	1.622
40	4.084	3.231	2.838	2.606	2.449	2.335	2.249	2.180	2.124	2.077	2.003	1.924	1.838	1.792	1.744	1.692	1.637	1.576	1.508
60	4.001	3.150	2.758	2.525	2.368	2.254	2.166	2.097	2.040	1.992	1.917	1.836	1.748	1.700	1.649	1.594	1.534	1.467	1.389
120	3.920	3.071	2.680	2.447	2.289	2.175	2.086	2.016	1.958	1.910	1.833	1.750	1.658	1.608	1.554	1.495	1.429	1.351	1.253
∞	3.841	2.995	2.604	2.371	2.214	2.098	2.009	1.938	1.879	1.830	1.752	1.666	1.570	1.517	1.459	1.394	1.318	1.221	1.000

F Table for $\alpha = 0.01$

Degree of Freedom for Numerator

Degree of Freedom for Denumerator

$df_2 \downarrow$ \ $df_1 \rightarrow$	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	4052.181	4999.500	5403.352	5624.583	5763.650	5858.986	5928.356	5981.070	6022.473	6055.847	6106.321	6157.285	6208.730	6234.631	6260.649	6286.782	6313.030	6339.391	6365.864
2	98.503	99.000	99.166	99.249	99.299	99.333	99.356	99.374	99.388	99.399	99.416	99.433	99.449	99.458	99.466	99.474	99.482	99.491	99.499
3	34.116	30.817	29.457	28.710	28.237	27.911	27.672	27.489	27.345	27.229	27.052	26.872	26.690	26.598	26.505	26.411	26.316	26.221	26.125
4	21.198	18.000	16.694	15.977	15.522	15.207	14.976	14.799	14.659	14.546	14.374	14.198	14.020	13.929	13.838	13.745	13.652	13.558	13.463
5	16.258	13.274	12.060	11.392	10.967	10.672	10.456	10.289	10.158	10.051	9.888	9.722	9.553	9.466	9.379	9.291	9.202	9.112	9.020
6	13.745	10.925	9.780	9.148	8.746	8.466	8.260	8.102	7.976	7.874	7.718	7.559	7.396	7.313	7.229	7.143	7.057	6.969	6.880
7	12.246	9.547	8.451	7.847	7.460	7.191	6.993	6.840	6.719	6.620	6.469	6.314	6.155	6.074	5.992	5.908	5.824	5.737	5.650
8	11.259	8.649	7.591	7.006	6.632	6.371	6.178	6.029	5.911	5.814	5.667	5.515	5.359	5.279	5.198	5.116	5.032	4.946	4.859
9	10.561	8.022	6.992	6.422	6.057	5.802	5.613	5.467	5.351	5.257	5.111	4.962	4.808	4.729	4.649	4.567	4.483	4.398	4.311
10	10.044	7.559	6.552	5.994	5.636	5.386	5.200	5.057	4.942	4.849	4.706	4.558	4.405	4.327	4.247	4.165	4.082	3.996	3.909
11	9.646	7.206	6.217	5.668	5.316	5.069	4.886	4.744	4.632	4.539	4.397	4.251	4.099	4.021	3.941	3.860	3.776	3.690	3.602
12	9.330	6.927	5.953	5.412	5.064	4.821	4.640	4.499	4.388	4.296	4.155	4.010	3.858	3.780	3.701	3.619	3.535	3.449	3.361
13	9.074	6.701	5.739	5.205	4.862	4.620	4.441	4.302	4.191	4.100	3.960	3.815	3.665	3.587	3.507	3.425	3.341	3.255	3.165
14	8.862	6.515	5.564	5.035	4.695	4.456	4.278	4.140	4.030	3.939	3.800	3.656	3.505	3.427	3.348	3.266	3.181	3.094	3.004
15	8.683	6.359	5.417	4.893	4.556	4.318	4.142	4.004	3.895	3.805	3.666	3.522	3.372	3.294	3.214	3.132	3.047	2.959	2.868
16	8.531	6.226	5.292	4.773	4.437	4.202	4.026	3.890	3.780	3.691	3.553	3.409	3.259	3.181	3.101	3.018	2.933	2.845	2.753
17	8.400	6.112	5.185	4.669	4.336	4.102	3.927	3.791	3.682	3.593	3.455	3.312	3.162	3.084	3.003	2.920	2.835	2.746	2.653
18	8.285	6.013	5.092	4.579	4.248	4.015	3.841	3.705	3.597	3.508	3.371	3.227	3.077	2.999	2.919	2.835	2.749	2.660	2.566
19	8.185	5.926	5.010	4.500	4.171	3.939	3.765	3.631	3.523	3.434	3.297	3.153	3.003	2.925	2.844	2.761	2.674	2.584	2.489
20	8.096	5.849	4.938	4.431	4.103	3.871	3.699	3.564	3.457	3.368	3.231	3.088	2.938	2.859	2.778	2.695	2.608	2.517	2.421
21	8.017	5.780	4.874	4.369	4.042	3.812	3.640	3.506	3.398	3.310	3.173	3.030	2.880	2.801	2.720	2.636	2.548	2.457	2.360
22	7.945	5.719	4.817	4.313	3.988	3.758	3.587	3.453	3.346	3.258	3.121	2.978	2.827	2.749	2.667	2.583	2.495	2.403	2.305
23	7.881	5.664	4.765	4.264	3.939	3.710	3.539	3.406	3.299	3.211	3.074	2.931	2.781	2.702	2.620	2.535	2.447	2.354	2.256
24	7.823	5.614	4.718	4.218	3.895	3.667	3.496	3.363	3.256	3.168	3.032	2.889	2.738	2.659	2.577	2.492	2.403	2.310	2.211
25	7.770	5.568	4.675	4.177	3.855	3.627	3.457	3.324	3.217	3.129	2.993	2.850	2.699	2.620	2.538	2.453	2.364	2.270	2.169
26	7.721	5.526	4.637	4.140	3.818	3.591	3.421	3.288	3.182	3.094	2.958	2.815	2.664	2.585	2.503	2.417	2.327	2.233	2.131
27	7.677	5.488	4.601	4.106	3.785	3.558	3.388	3.256	3.149	3.062	2.926	2.783	2.632	2.552	2.470	2.384	2.294	2.198	2.097
28	7.636	5.453	4.568	4.074	3.754	3.528	3.358	3.226	3.120	3.032	2.896	2.753	2.602	2.522	2.440	2.354	2.263	2.167	2.064
29	7.598	5.420	4.538	4.045	3.725	3.499	3.330	3.198	3.092	3.005	2.868	2.726	2.574	2.495	2.412	2.325	2.234	2.138	2.034
30	7.562	5.390	4.510	4.018	3.699	3.473	3.304	3.173	3.067	2.979	2.843	2.700	2.549	2.469	2.386	2.299	2.208	2.111	2.006
40	7.314	5.179	4.313	3.828	3.514	3.291	3.124	2.993	2.888	2.801	2.665	2.522	2.369	2.288	2.203	2.114	2.019	1.917	1.805
60	7.077	4.977	4.126	3.649	3.339	3.119	2.953	2.823	2.718	2.632	2.496	2.352	2.198	2.115	2.028	1.936	1.836	1.726	1.601
120	6.851	4.787	3.949	3.480	3.174	2.956	2.792	2.663	2.559	2.472	2.336	2.192	2.035	1.950	1.860	1.763	1.656	1.533	1.381
∞	6.635	4.605	3.782	3.319	3.017	2.802	2.639	2.511	2.407	2.321	2.185	2.039	1.878	1.791	1.696	1.592	1.473	1.325	1.000

Critical Values of T in the Wilcoxon Matched-Pairs Signed-Ranks Test.

n	Level of significance for one-tailed test			
	0.05	.025	.01	.005
	Level of significance for two-tailed test			
	0.10	.05	.02	.01
5	1	-	-	-
6	2	1	-	-
7	4	2	0	-
8	6	4	2	0
9	8	6	3	2
10	11	8	5	3
11	14	11	7	6
12	17	14	10	7
13	21	17	13	10
14	26	21	16	13
15	30	25	20	16
16	36	30	24	20
17	41	35	28	23
18	47	40	33	28
19	54	46	38	32
20	60	52	43	38
21	68	59	49	43
22	75	66	56	49
23	83	73	62	55
24	92	81	69	61
25	101	90	77	68

Two Independent Sample Test: 1. Median Test; TS: $\frac{c(n_1,a)c((n_2,k-a)}{c(n_1+n_2,k)} a = 0,1,2 \dots . \min(n_1,k) = \frac{n_1+n_2}{2} = \frac{n}{2}$

Large sample size($n_1>10$, $n_2>10$)

	No. of obs≤Md	No. of obs≤Md	Total
Sample x	a	C	a+c
Sample y	b	D	b+d
Total	a+b	c+d	N=a+b+c+d

Test Statistics:

$$X^2 = \frac{N(ab-bc)^2}{(a+c)(b+d)(a+b)(c+d)} \sim x^2(1)$$

if any cell frequency is less than 5 then

$$X^2 = \frac{N(|ad-bc|-\frac{N}{2})^2}{(a+c)(b+d)(a+b)(c+d)} \sim X^2(1)$$

Probabilities associated with values as large as observed values of Friedman Statistic F_r
i.e. $p_0 = P(F_r > F_r^*)$ where F_r^* is the calculated value of F_r.

Table for k = 3

n = 2		n = 3		n = 4		n = 5	
F_r	p	F_r	p	F_r	p	F_r	p
0	1.000	.000	1.000	.0	1.000	.0	1.000
1	.833	.667	.994	.5	.931	.4	.954
3	.500	2.000	.528	1.5	.653	1.2	.691
4	.167	2.667	.361	2.0	.431	1.6	.522
		4.667	.194	3.5	.273	2.8	.367
		6.000	.028	4.5	.125	3.6	.182
				6.0	.069	4.8	.124
				6.5	.042	5.2	.093
				8.0	.0046	6.4	.039
						7.6	.024
						8.4	.0085
						10.0	.00077

n = 6		n = 7		n = 8		n = 9	
F_r	p	F_r	p	F_r	p	F_r	p
.00	1.000	.000	1.000	.00	1.000	.000	1.000
.33	.956	.286	.964	.25	.967	.222	.971
1.00	.740	.857	.768	.75	.794	.667	.814
1.33	.570	1.143	.620	1.00	.654	.889	.865
2.33	.430	2.000	.486	1.75	.531	1.556	.569
3.00	.252	2.571	.305	2.25	.355	2.000	.398
4.20	.184	3.429	.237	3.00	.285	2.667	.328
4.33	.142	3.714	.192	3.25	.236	2.889	.278
5.33	.072	4.571	.112	4.00	.149	3.556	.187
6.33	.052	5.429	.085	4.75	.120	4.222	.154
7.00	.029	6.000	.052	5.25	.079	4.667	.107
8.33	.012	7.143	.027	6.25	.047	5.556	.069
9.00	.0081	7.714	.021	6.75	.038	6.000	.057
9.33	.0055	8.000	.016	7.00	.030	6.222	.048
10.33	.0017	8.857	.0084	7.75	.018	6.889	.031
12.00	.00013	10.286	.0036	9.00	.0099	8.000	.019
		10.571	.0027	9.25	.0080	8.222	.016
		11.143	.0012	9.75	.0048	8.667	.010
		12.286	.00032	10.75	.0024	9.556	.0060
		14.000	.000021	12.00	.0011	10.667	.0035
				12.25	.00086	10.889	.0029
				13.00	.00026	11.556	.0013
				14.25	.000061	12.667	.00066
				16.00	.0000036	13.556	.00035
						14.000	.00020
						14.222	.000097
						14.889	.000054
						16.222	.000011
						18.000	.0000006

Table for k = 4

n = 2		n = 3		n = 4		n = 5	
F_r	p	F_r	p	F_r	p	F_r	p
.0	1.000	.2	1.000	.0	1.000	5.7	.141
.6	.958	.6	.958	.3	.992	6.0	.105
1.2	.834	1.0	.910	.6	.928	6.3	.094
1.8	.792	1.8	.727	.9	.900	6.6	.077
2.4	.625	2.2	.608	1.2	.800	6.9	.068
3.0	.542	2.6	.524	1.5	.754	7.2	.054
3.6	.458	3.4	.446	1.8	.677	7.5	.052
4.2	.375	3.8	.342	2.1	.649	7.8	.036
4.8	.208	4.2	.300	2.4	.524	8.1	.033
5.4	.167	5.0	.207	2.7	.508	8.4	.019
6.0	.042	5.4	.175	3.0	.432	8.7	.014
		5.8	.148	3.3	.389	9.3	.012
		6.6	.075	3.6	.355	9.6	.0069
		7.0	.054	3.9	.324	9.9	.0062
		7.4	.033	4.5	.242	10.2	.0027
		8.2	.017	4.8	.200	10.8	.0016
		9.0	.0017	5.1	.190	11.1	.00094
				5.4	.158	12.0	.000072

Multiple Correlation and Multiple Regression

Partial Correlation Coefficient

$$r_{12.3}=\frac{r_{12}-r_{13}r_{23}}{\sqrt{1-r_{13}^2}\sqrt{1-r_{23}^2}}$$

Partial Correlation Coefficient

$$r_{13.2}=\frac{r_{13}-r_{12}r_{32}}{\sqrt{1-r_{12}^2}\sqrt{1-r_{32}^2}}$$

Partial Correlation Coefficient

$$r_{23.1}=\frac{r_{23}-r_{21}r_{31}}{\sqrt{1-r_{21}^2}\sqrt{1-r_{31}^2}}$$

Multiple Correlation

$$R_{1.23}=\sqrt{\frac{r_{12}^2+r_{13}^2-2r_{12}r_{13}r_{23}}{1-r_{23}^2}}$$

$0 \le R_{1.23} \le +1$

Multiple Correlation

$$R_{2.13}=\sqrt{\frac{r_{21}^2+r_{23}^2-2r_{21}r_{23}r_{13}}{1-r_{13}^2}}$$

$0 \le R_{2.13} \le +1$

Multiple Correlation

$$R_{12.3}=\sqrt{\frac{r_{31}^2+r_{32}^2-2r_{31}r_{32}r_{12}}{1-r_{12}^2}}$$

$0 \le R_{3.12} \le +1$

$$r_{12}=\frac{n\sum u_1u_2-\sum u_1\sum u_2}{\sqrt{n\sum u_{11}-(\sum u_1)^2\sum}\sqrt{n\sum u_{21}-(\sum u_1)^2}}$$

$$r_{13}=\frac{n\sum u_1u_3-\sum u_1\sum u_3}{\sqrt{n\sum u_{11}-(\sum u_1)^2\sum}\sqrt{n\sum u_{31}-(\sum u_3)^2}}$$

$$r_{23}=\frac{n\sum u_2u_3-\sum u_2\sum u_3}{\sqrt{n\sum u_{21}-(\sum u_2)^2\sum}\sqrt{n\sum u_{31}-(\sum u_3)^2}}$$

Multiple Linear Regression

$Y= b_0 + b_1x_1 + b_2x_2 + e$

Estimation of coff. in multiple Linear Regression: $y= b_0 + b_1x_1 + b_2x_2 + e_i$

$\sum y= nb_0+ b_1\sum X_1 + b_2\sum X_2$, $\sum X_1y = b_0\sum X_1+ b_1\sum X_1^2 + b_2\sum X_1X_3$

$\sum X_2y = b_0\sum X_1 + b_1\sum X_1X_2+ b_2\sum X_2^2$ where $b_0=\frac{D_1}{D}$, $b_1=\frac{D_2}{D}$, $b_2=\frac{D_3}{D}$

Design and Experiment

Completely randomized design:

S.V	d.f	S.S	M.S	F_{cal}	F_{tab}
Due to Treatment	t-1	SST	$MST = \frac{SST}{t-1}$	$F_T = \frac{MST}{MSE}$	$F_{\alpha\{(t-1),\, t(r-1)\}}$
Due to error	t(r-1)	SSE	$MSE = \frac{SSE}{t(r-1)}$		
Total	r t-1	TSS			

Calculation of completely randomized design: **SSE = TSS - SSE**

$$TSS = \sum_{i=1}^{t}\sum_{j=1}^{r} y_{ij}^2 - \frac{(T)^2}{n}\ ,\ SST = \frac{\sum_{i=1}^{t} Ti^2}{r} - CF\ ,\text{where } CF = \frac{(T_i)^2}{n}$$

Randomized block design:

S.V	d.f	S.S	M.S	F_{cal}	F_{tab}
Due to Treatment	t-1	SST	$MST = \frac{SST}{t-1}$	$F_T = \frac{MST}{MSE}$	$F_{\alpha\{(t-1),\, (t-1)(r-1)\}}$
Due to block	r-1	SSB	$MSB = \frac{SSB}{r-1}$	$F_B = \frac{MSB}{MSE}$	$F_{\alpha\{(r-1),\, (t-1)(r-1)\}}$
Due to error	(t-1) *(r-1)	SSE	$MSE = \frac{SSE}{(t-1)(r-1)}$		
Total	r t-1	TSS			

Calculation of randomized block design: **SSE = TSS – SST - SSB**

$$TSS = \sum_{i=1}^{t}\sum_{j=1}^{r} y_{ij}^2 - \frac{(T)^2}{n}\ ,\ SST = \frac{\sum_{i=1}^{t} Ti^2}{r} - CF,\text{where } CF = \frac{(T_i)^2}{n}\ ,\ SSB = \frac{\sum_{j=1}^{t} Tj^2}{r} - CF$$

Efficiency of RBD relative to CRD	Efficiency of LSD relative to CRD	Efficiency of LSD relative to RBD
$\frac{\delta_e'^2}{\delta_e^2} = \frac{r(t-1)*MSE + (r-1)*MSB}{(rt-1)*MSE}$	$\frac{\delta_e'^2}{\delta_e^2} = \frac{(m-1)*MSE + MSR + MSC}{(m+1)MSE}$	$\frac{\delta_e'^2}{\delta_e^2} = \frac{(m-1)*MSE + MSR}{m*MSE}$
$\frac{\delta_e'^2}{\delta_e^2} < 1$ => RBD is less efficient than CRD	$\frac{\delta_e'^2}{\delta_e^2} < 1$ => LSD is less efficient than CRD	$\frac{\delta_e'^2}{\delta_e^2} < 1$ => LSD is less efficient than RBD
$\frac{\delta_e'^2}{\delta_e^2} > 1$ => RBD is more efficient than CRD	$\frac{\delta_e'^2}{\delta_e^2} > 1$ => LSD is more efficient than CRD	$\frac{\delta_e'^2}{\delta_e^2} > 1$ => LSD is more efficient than RBD
$\frac{\delta_e'^2}{\delta_e^2} = 1$ => RBD and CRD are equally effective	$\frac{\delta_e'^2}{\delta_e^2} = 1$ => LSD and CRD are equally effective	$\frac{\delta_e'^2}{\delta_e^2} = 1$ => LSD and RBD are equally effective

Latin Square design:

Calculation of Latin square design: **SSE = TSS – SSR – SSC - SST**

$$TSS = \sum_{(i,j,k)} y_{ijk}2\ ,\ SSR = \frac{\sum_i T_{i..}^2}{m} - CF\ ,\text{where } CF = \frac{(T_i)^2}{n}\ ,\ SSC = \frac{\sum_j T_{.j.}^2}{m} - CF,\ SST = \frac{\sum_k T_{..k}^2}{m} - CF,$$

Reject H_{0R} at α% level of significance if $F_R > F_{\alpha\{(m-1),\,(m-1)(m-2)\}}$, accept otherwise.

Reject H_{0C} at α% level of significance if $F_C > F_{\alpha\{(m-1),\,(m-1)(m-2)\}}$, accept otherwise.

Reject H_{0T} at α% level of significance if $F_T > F_{\alpha\{(m-1),\,(m-1)(m-2)\}}$, accept otherwise.

$$sd = \sqrt{\frac{1}{n-1}\left(\sum d_i^2 - \frac{\left(\sum d_i\right)^2}{n}\right)}$$

$$sp^2 = \frac{\left(\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n_1}\right) + \left(\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n_2}\right)}{n_1 + n_2 - 2}$$

$$s_p^2 = \frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2} \qquad : t = \frac{\bar{X} - \mu}{s/\sqrt{n}} \qquad t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Probabilities associated with values as large as observed values of Kruskul-Wallis H Statistic. i.e. $p_0 = P(H > H^*)$ where $H^* = H_{cal}$.

Sample sizes			H	p	Sample sizes			H	p
n_1	n_2	n_3			n_1	n_2	n_3		
2	1	1	2.7000	.500	4	3	2	6.4444	.008
								6.3000	.011
2	2	2	3.6000	.200				5.4444	.046
								5.4000	.051
2	2	2	4.5714	.067				4.5111	.098
			3.7143	.200				4.4444	.102
3	1	1	3.2000	.300	4	3	3	6.7455	.010
								6.7455	.010
3	2	1	4.2857	.100				6.7091	.013
			3.8571	.100				5.7909	.046
3	2	2	5.3572	.029				4.7091	.092
			4.7143	.048				4.7000	.101
			4.5000	.067					
			4.4643	.105	4	4	1	6.6667	.010
								6.1667	.022
3	3	1	5.1429	.043				4.9667	.048
			4.5714	.100				4.8667	.054
			4.0000	.129				4.1667	.082
3	3	2	6.2500	.011				4.0667	.102
			5.3611	.032	4	4	2	7.0364	.006
			5.1389	.061				6.8727	.011
			4.5556	.100				5.4545	.046
			4.2500	.121				5.2364	.052
3	3	3	7.2000	.004				4.5545	.098
			6.4889	.011				4.4455	.103
			5.6889	.029	4	4	3	7.1439	.010
			5.6000	.050				7.1364	.011
			5.0667	.086				5.5985	.049
			4.6222	.100				5.5758	.051
4	1	1	3.5714	.200				4.5455	.099
4	2	1	4.8214	.057				4.4773	.102
			4.5000	.076	4	4	4	7.6538	.008
			4.0179	.114				7.5385	.011
4	2	2	6.0000	.014				5.6923	.049
			5.3333	.033				5.6538	.054
			5.1250	.052				4.6539	.097
			4.4583	.100				4.5001	.104
			4.1667	.105	5	1	1	3.8571	.143
4	3	1	5.8333	.021	5	2	1	5.2500	.036
			5.2083	.050				5.0000	.048
			5.0000	.057				4.4500	.071
			4.0556	.093				4.2000	.095

			3.8889	.129				4.0500	.119
5	2	2	6.5333	.008	5	4	4	7.7604	.009
			6.1333	.013				7.7440	.011
			5.1600	.034				5.6571	.049
			5.0400	.056				5.6176	.050
			4.3733	.090				4.6187	.100
			4.2933	.122				4.5527	.102
5	3	1	6.4000	.012	5	5	1	7.3091	.009
			4.9600	.048				6.8364	.011
			4.8711	.052				5.1273	.046
			4.0178	.095				4.9091	.53
			3.8400	.123				4.1091	.086
5	3	2	6.9091	.009				4.0364	.105
			6.8281	.010	5	5	2	7.3385	.010
			5.2509	.049				7.2692	.010
			5.1055	.052				5.3385	.047
			4.6509	.091				5.2464	.051
			4.4945	.101				4.6231	.097
5	3	3	7.0788	.009				4.5077	.100
			6.9818	.011	5	5	3	7.5780	.010
			5.6485	.049				7.5429	.010
			5.5152	.051				5.7055	.046
			4.5333	.097				5.6264	.051
			4.4121	.109				4.5451	.100
5	4	1	6.9545	.008				4.5363	.102
			6.8400	.011	5	5	4	7.8229	.010
			4.9855	.044				7.7914	.010
			4.8600	.056				5.6657	.049
			3.9873	.098				5.6429	.050
			3.9600	.102				4.5229	.099
5	4	2	7.2045	.009				4.5200	.101
			7.1182	.010	5	5	5	8.0000	.009
			5.2727	.049				7.9800	.010
			5.2682	.050				5.7800	.049
			4.5409	.098				5.6600	.051
			4.5182	.101				4.5600	.100
5	4	3	7.4449	.010				4.5000	.102
			7.3949	.011					
			5.6564	.049					
			5.6308	.050					
			4.5487	.099					
			4.5231	.103					