Critical Values P. 1

Appendix 1: Method for ranking data in statistical tests

1. Organize the data into ascending order of values (see specimen data below).
2. Allocate rank 1 to the lowest value.
3. Allocate ranks to the remaining values, averaging the ranks for any tied scores (see below).
4. A useful check that you have done this correctly is that the last rank value you use should be the same as N, unless, of course, it was tied.

Scores	Rank	Notes
10	1	Both scores of 12 are given the average rank of positions 2 and 3. Note that the next score is ranked 4, not 3.
12	2.5	
12	2.5	
15	4	
17	5	
18	7	The three scores of 18 are each given the average rank of positions 6, 7 and 8, i.e. 7. Note that the next score is rank 9, not 8.
18	7	
18	7	
20	9	
25	10	

Appendix 2: The critical values of *U*

Table 1: Critical values of *U* for a one-tailed test at $p = .005$; two-tailed test at $p = .01$ (Mann-Whitney)

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
3	-	-	-	-	-	-	-	-	0	0	0	1	1	1	2	2	2	2	3	3
4	-	-	-	-	-	0	0	1	1	2	2	3	3	4	5	5	6	6	7	8
5	-	-	-	-	0	1	1	2	3	4	5	6	7	7	8	9	10	11	12	13
6	-	-	-	0	1	2	3	4	5	6	7	9	10	11	12	13	15	16	17	19
7	-	-	-	0	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	24
8	-	-	-	1	2	4	6	7	9	11	13	15	17	18	20	22	24	26	28	30
9	-	-	0	1	3	5	7	9	11	13	16	18	20	22	24	27	29	31	33	36
10	-	-	0	2	4	6	9	11	13	16	18	21	24	26	29	31	34	37	39	42
11	-	-	0	2	5	7	10	13	16	18	21	24	27	30	33	36	39	42	45	48
12	-	-	1	3	6	9	12	15	18	21	24	27	31	34	37	41	44	47	51	54
13	-	-	1	3	7	10	13	17	20	24	27	31	34	38	42	45	49	53	56	60
14	-	-	1	4	7	11	15	18	22	26	30	34	38	42	46	50	54	58	63	67
15	-	-	2	5	8	12	16	20	24	29	33	37	42	46	51	55	60	64	69	73
16	-	-	2	5	9	13	18	22	27	31	36	41	45	50	55	60	65	70	74	79
17	-	-	2	6	10	15	19	24	29	34	39	44	49	54	60	65	70	75	81	86
18	-	-	2	6	11	16	21	26	31	37	42	47	53	58	64	70	75	81	87	92
19	-	0	3	7	12	17	22	28	33	39	45	51	56	63	69	74	81	87	93	99
20	-	0	3	8	13	18	24	30	36	42	48	54	60	67	73	79	86	92	99	105

*Dashes in the body of the table indicate that no decision is possible at the stated level of significance. For any N_1 and N_2, the observed value of *U* is significant at a given level of significance if it is equal to or less than the critical values shown.

Critical Values P. 2

Table 2: Critical values of U for a one-tailed test at $p = .01$; two-tailed test at $p = .02$* (Mann-Whitney)

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	0	0	1	1
3	-	-	-	-	-	-	0	0	1	1	1	2	2	2	3	3	4	4	4	5
4	-	-	-	-	0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10
5	-	-	-	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6	-	-	-	1	2	3	4	6	7	8	9	11	12	13	15	16	18	19	20	22
7	-	-	0	1	3	4	6	7	9	121	12	14	16	17	19	21	23	24	26	28
8	-	-	0	2	4	6	7	9	11	13	15	17	20	22	24	26	28	30	32	34
9	-	-	1	3	5	7	9	11	14	16	18	21	23	26	28	31	33	36	38	40
10	-	-	1	3	6	8	11	13	16	19	22	24	27	30	33	36	38	41	44	47
11	-	-	1	4	7	9	12	15	18	22	215	28	31	34	37	41	44	47	50	53
12	-	-	2	5	8	11	14	17	21	24	28	31	35	38	42	46	49	53	56	60
13	-	0	2	5	9	12	16	20	23	27	31	35	39	43	47	51	55	59	63	67
14	-	0	2	6	10	13	17	22	26	30	34	38	43	47	51	56	60	65	69	73
15	-	0	3	7	11	15	19	24	28	33	37	42	47	51	56	61	66	70	75	80
16	-	0	3	7	12	16	21	26	31	36	41	46	51	56	61	66	71	76	82	87
17	-	0	4	8	13	18	23	28	33	38	44	49	55	60	66	71	77	82	88	93
18	-	0	4	9	14	19	24	30	36	41	47	53	59	65	70	76	82	88	94	100
19	-	1	4	9	15	20	26	32	38	44	50	56	63	69	75	82	88	94	101	107
20	-	1	5	10	16	22	28	34	40	47	53	60	67	73	80	87	93	100	107	114

Table 3: Critical values of U for a one-tailed test at $p = .025$; two-tailed test at $p = .05$* (Mann-Whitney)

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	131	12	13	14	15	17	18	19	20
6	-	-	1	2	3	5	6	8	10	131	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	55	57	61	65	69
13	-	1	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	74	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	76	80	85	90
16	-	1	6	11	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
17	-	2	6	11	17	22	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	105	112	119	127

Critical Values P.3

P30

Table 4: Critical values of U for a one-tailed test at $p = .05$; two-tailed test at $p = .10$* (Mann-Whitney)

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	121	12	14	15	16	17	18
5	-	0	1	2	4	5	6	8	9	121	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	-	4	10	17	23	30	37	44	51	58	65	72	80	87	94	101	109	116	123	130
20	-	4	11	18	25	32	39	47	54	62	69	77	84	92	100	107	115	123	130	138

*Dashes in the body of the table indicate that no decision is possible at the stated level of significance. For any N_1 and N_2, the observed value of U is significant at a given level of significance if it is equal to or less than the critical values shown.
Source: Runyon and Haber (1976)

Appendix 3: The critical values of T for the Wilcoxon Matched Pairs Signed Ranks test

Level of significance for a one-tailed test	*.05*	*.025*	*.01*	*.005*
Level of significance for a two-tailed test	*.10*	*.05*	*.02*	*.002*
N				
5	0			
6	2	0		
7	3	2	0	
8	5	3	1	0
9	8	5	3	1
10	10	8	5	3
11	13	10	7	5
12	17	13	9	7
13	21	17	12	9
14	25	21	15	12
15	30	25	19	15
16	35	29	23	19
17	41	34	27	23
18	47	40	32	27
19	53	46	37	32
20	60	52	43	37
21	67	58	49	42
22	75	65	55	48
23	83	73	62	54
24	91	81	69	61
25	100	89	76	68

Value of T that is equal to or less than the tabled value is significant at or beyond the level indicated.
Source: Taken from Table 1 of McCormack (1965) *With permission of the publisher.*

Critical Values P. 4

Appendix 4: Critical values of Spearman's Rank Order Correlation Coefficient (r_s)

Level of significance for two-tailed test	.10	.05	.20	.01
Level of significance for one-tailed test				
N	*.05*	*.025*	*.01*	*.005*
4	1.000			
5	.900	1.000	1.000	
6	.829	.886	.943	1.000
7	714	786	.893	.929
8	643	738	.833	.881
9	.600	.700	.783	.833
10	.564	.648	.745	.794
11	.536	.618	.709	.755
12	.503	.587	.671	.727
13	.484	.560	.648	.703
14	.464	.538	.622	.675
15	.443	.521	.604	.654
16	.429	.503	.582	.635
17	.414	.485	.566	.615
18	.401	.472	.550	.600
19	.391	.460	.535	.584
20	.380	.447	.520	.570
21	.370	.435	.508	.556
22	.361	.425	.496	.544
23	.353	.415	.486	.532
24	.344	.406	.476	.521
25	.337	.398	.466	.511
26	.331	.390	.457	.501
27	.324	.382	.448	.491
28	.317	.375	.440	.483
29	.312	.368	.433	.475
30	.306	.362	.425	.467

Values of r_s that equal or exceed the tabled value are significant at or below the level indicated.
Source: Zar (1972)
With permission of the author and publisher

Critical Values p.5

Appendix 5: Critical values of χ^2 Chi-Squared

Level of significance for a one-tailed test						
df	*.10*	*.05*	*.025*	*.01*	*.005*	*.0005*
1	1.64	2.71	3.84	5.41	6.64	10.83
Level of significance for a two-tailed test						
df	*.20*	*.010*	*.05*	*.02*	*.01*	*.001*
1	1.64	2.71	3.84	5.41	6.64	10.83
2	3.22	4.60	5.99	7.82	9.21	13.82
3	4.64	6.25	7.82	9.84	11.34	16.27
4	5.99	7.78	9.49	11.67	13.28	18.46
5	7.29	9.24	11.07	13.39	15.09	20.52
6	8.56	10.64	12.59	15.03	16.81	22.46
7	9.80	12.02	14.07	16.62	18.48	24.32
8	11.03	13.36	15.51	18.17	20.09	26.12
9	12.24	14.68	16.92	19.68	21.67	27.88
10	13.44	15.99	18.31	21.16	23.21	29.59
11	14.63	17.28	19.68	22.62	24.72	31.26
12	15.81	18.55	21.03	24.05	26.22	32.91
13	16.98	19.81	22.36	25.47	27.69	34.53
14	18.15	21.06	23.68	26.87	29.14	36.12
15	19.31	22.31	25.00	28.26	30.58	37.70
16	20.46	23.54	26.30	29.63	32.00	39.29
17	21.62	24.77	27.59	31.00	33.41	40.75
18	22.76	25.99	28.87	32.35	34.80	42.31
19	23.90	27.20	30.14	33.69	36.19	43.82
20	25.04	28.41	31.41	35.02	37.57	45.32
21	26.17	29.62	32.67	36.34	38.93	46.80
22	27.30	30.81	33.92	37.66	40.29	48.27
23	28.43	32.01	35.17	38.97	41.64	49.73
24	29.55	33.20	36.42	40.27	42.98	51.18
25	30.68	34.38	37.65	41.57	44.31	52.62
26	31.80	35.56	38.88	42.86	45.64	54.05
27	32.91	36.74	40.11	44.14	46.96	55.48
28	34.03	37.92	41.34	45.42	48.28	56.89
29	35.14	39.09	42.69	46.69	49.59	58.30
30	36.25	40.26	43.77	47.96	50.89	59.70
32	38.47	42.59	46.19	50.49	53.49	62.49
34	40.68	44.90	48.60	53.00	56.06	65.25
36	42.88	47.21	51.00	55.49	58.62	67.99
38	45.08	49.51	53.38	57.97	61.16	70.70
40	47.27	51.81	55.76	60.44	63.69	73.40
44	51.64	56.37	60.48	65.48	68.71	78.75
48	55.99	60.91	65.17	70.20	73.68	84.04
52	60.33	65.42	69.83	75.02	78.62	89.27
56	64.66	69.92	74.47	79.82	83.51	94.46
60	68.97	74.40	79.08	84.58	88.38	99.61

Calculated value of χ^2 must equal or exceed the table (critical) values for significance at the level shown.
Source: abridged from Fisher and Yates (1974).

Critical values P.6

Table 7.15 Critical value tables for Pearson's product moment correlation test. The P value of Pearson's product is significant if it is equal to or greater than the table value. Degrees of freedom = pairs of scores minus 2

Level of significance	for a	one-tailed	(directional)	hypothesis
	0.02	0.025	0.005	0.0005
Level of significance	**for a**	**two-tailed**	**(non-directional)**	**hypothesis**
N	0.1	0.05	0.01	0.001
4	.9	.95	.99	.999
5	.805	.878	.959	.991
6	.729	.811	.917	.974
7	.669	.754	.875	.951
8	.621	.707	.834	.925
9	.582	.666	.798	.898
10	.549	.632	.765	.872
11	.521	.602	.735	.847
12	.497	.576	.708	.823
13	.476	.553	.684	.801
14	.458	.532	.661	.78
15	.441	.514	.641	.76
16	.426	.497	.623	.742
17	.412	.482	.606	.725
18	.4	.468	.59	.708
19	.389	.456	.575	.693
20	.378	.444	.561	.679
21	.369	.433	.549	.665
22	.36	.423	.537	.652
23	.352	.413	.526	.64
24	.344	.404	.515	.629
25	.337	.396	.505	.618
26	.33	.388	.496	.607
27	.323	.381	.487	.597
28	.317	.374	.479	.588
29	.311	.367	.471	.579
30	.306	.361	.463	.57

Critical Value P. 7

Table 7.16 Critical value table for the T-test (independent and related t-tests). To be significant T should be equal to or greater than the table value. Degrees of freedom (df) for a related T-test = N – 1. Degrees of freedom for an independent T – test = N1 + N2 – 2

Level of significance	for a one-tailed	(directional)	hypothesis
	.1	.05	.025
Level of significance	**for a two-tailed**	**(non-directional)**	**hypothesis**
df	.2	.1	.05
1	2.0	6.314	12.706
2	1.895	2.92	4.303
3	1.644	2.353	3.182
4	1.533	2.132	2.776
5	1.487	2.015	2.571
6	1.446	1.943	2.447
7	1.41	1.895	2.365
8	1.4	1.860	2.306
9	1.389	1.833	2.262
10	1.376	1.812	2.228
11	1.368	1.796	2.201
12	1.364	1.782	2.179
13	1.358	1.771	2.16
14	1.355	1.761	2.145
15	1.349	1.753	2.131
16	1.343	1.746	2.12
17	1.338	1.74	2.110
18	1.336	1.734	2.101
19	1.334	1.729	2.093
20	1.332	1.724	2.086
21	1.328	1.721	2.08
22	1.327	1.717	2.074
23	1.325	1.714	2.069
24	1.323	1.711	2.064
25	1.321	1.708	2.06
26	1.318	1.706	2.056
27	1.316	1.703	2.052
28	1.314	1.701	2.048
29	1.312	1.699	2.045
30	1.31	1.697	2.042