



บรรณานุกรม

ภาษาไทย

หนังสือ

จุฬาลงกรณ์มหาวิทยาลัย. บัณฑิตวิทยาลัย. คู่มือการพิมพ์วิทยานิพนธ์. จุฬาลงกรณ์มหาวิทยาลัย.

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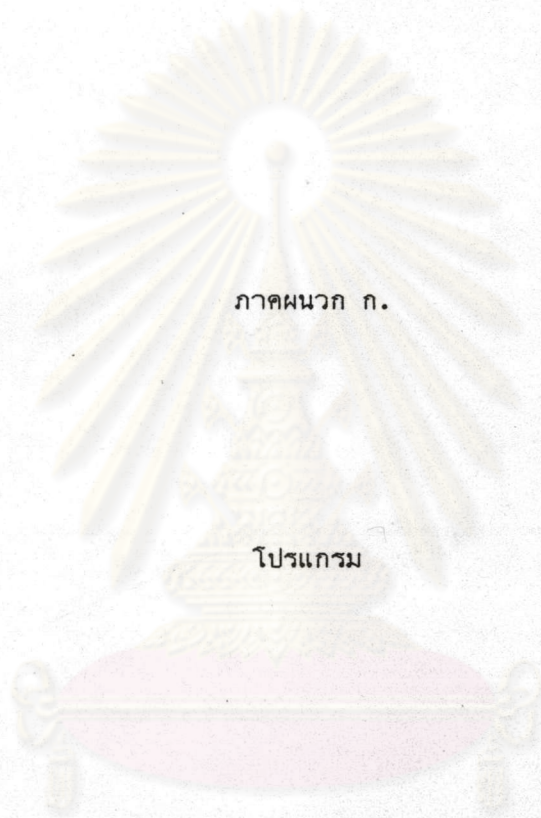
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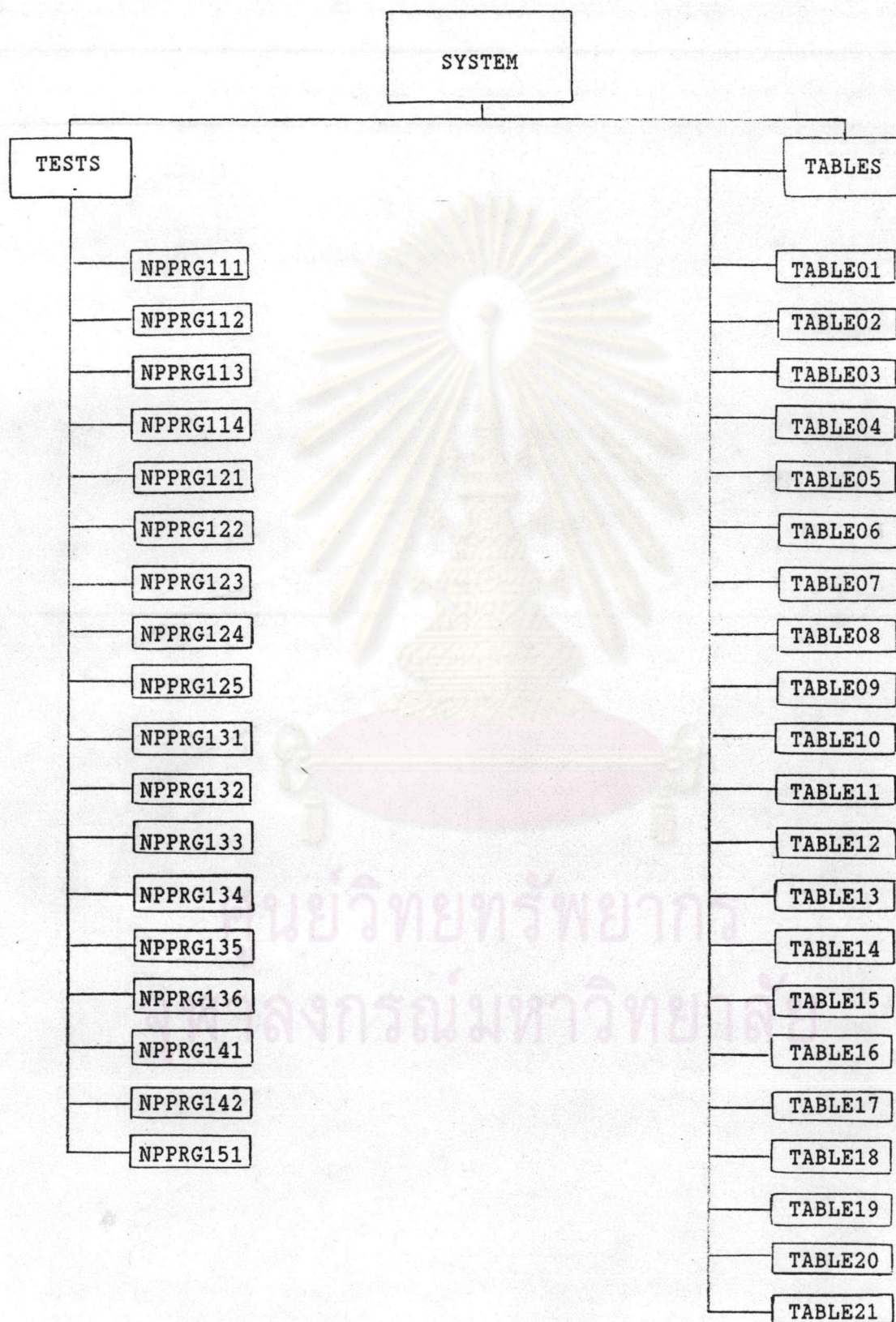
ศูนย์วิทยทรัพยากร  
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ภาคผนวก ก.

โปรแกรม

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ภาคผนวก ข.

แฟ้มข้อมูล

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

แฟ้มข้อมูลที่ใช้งานในโปรแกรมนี้ ประกอบด้วยแฟ้มข้อมูล 1 แฟ้มคือ

1. แฟ้มข้อมูลชื่อ DATA05.DBF

ประกอบด้วยรายการ 5 รายการ ดังต่อไปนี้คือ

	ชื่อรายการ	ชนิด	ความยาว (ตัวอักษร)
1.1	EN1	ตัวเลข	15,7
1.2	EN2	ตัวเลข	15,7
1.3	EN3	ตัวเลข	15,7
1.4	EN4	ตัวเลข	15,7
1.5	EN4	ตัวเลข	15,7

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ภาคผนวก ค.

ตารางสถิติ

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย







TABLE 2 TABLE OF CRITICAL VALUES OF  $t^*$

df	Level of significance for one-tailed test					
	.10	.05	.025	.01	.005	.0005
	Level of significance for two-tailed test					
	.20	.10	.05	.02	.01	.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	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
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	3.767
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
$\infty$	1.282	1.645	1.960	2.326	2.570	3.291

\* Table B is abridged from Table III of Fisher and Yates: *Statistical tables for biological, agricultural, and medical research*, published by Oliver and Boyd Ltd., Edinburgh, by permission of the authors and publishers.

TABLE 3 TABLE OF CRITICAL VALUES OF CHI SQUARE\*

df	Probability under $H_0$ that $\chi^2 \geq$ chi square													
	.99	.98	.95	.90	.80	.70	.50	.30	.20	.10	.05	.02	.01	.001
1	.00016	.00063	.0039	.016	.064	.15	.46	1.07	1.64	2.71	3.84	5.41	6.64	10.83
2	.02	.04	.10	.21	.45	.71	1.39	2.41	3.22	4.60	5.99	7.82	9.21	13.82
3	.12	.18	.35	.58	1.00	1.42	2.37	3.66	4.64	6.25	7.82	9.84	11.34	16.27
4	.30	.43	.71	1.06	1.65	2.20	3.36	4.88	5.99	7.78	9.49	11.67	13.28	18.46
5	.55	.75	1.14	1.61	2.34	3.00	4.35	6.06	7.29	9.24	11.07	13.39	15.09	20.52
6	.87	1.13	1.64	2.20	3.07	3.83	5.35	7.23	8.56	10.64	12.59	15.03	16.81	22.46
7	1.24	1.56	2.17	2.83	3.82	4.67	6.35	8.38	9.80	12.02	14.07	16.62	18.48	24.32
8	1.65	2.03	2.73	3.49	4.59	5.53	7.34	9.52	11.03	13.36	15.51	18.17	20.09	26.12
9	2.09	2.53	3.32	4.17	5.38	6.39	8.34	10.66	12.24	14.68	16.92	19.08	21.67	27.88
10	2.56	3.06	3.94	4.86	6.18	7.27	9.34	11.78	13.44	15.99	18.31	21.16	23.21	29.59
11	3.05	3.61	4.58	5.58	6.99	8.15	10.34	12.90	14.63	17.28	19.68	22.62	24.72	31.26
12	3.57	4.18	5.23	6.30	7.81	9.03	11.34	14.01	15.81	18.55	21.03	24.05	26.22	32.91
13	4.11	4.76	5.89	7.04	8.63	9.93	12.34	15.12	16.98	19.81	22.36	25.47	27.69	34.53
14	4.66	5.37	6.57	7.79	9.47	10.82	13.34	16.22	18.15	21.06	23.68	26.87	29.14	36.12
15	5.23	5.98	7.26	8.55	10.31	11.72	14.34	17.32	19.31	22.31	25.00	28.26	30.58	37.70
16	5.81	6.61	7.96	9.31	11.15	12.62	15.34	18.42	20.46	23.54	26.30	29.63	32.00	39.29
17	6.41	7.26	8.67	10.08	12.00	13.53	16.34	19.51	21.62	24.77	27.59	31.00	33.41	40.75
18	7.02	7.91	9.39	10.86	12.86	14.44	17.34	20.60	22.76	25.99	28.87	32.35	34.80	42.31
19	7.63	8.57	10.12	11.65	13.72	15.35	18.34	21.69	23.90	27.20	30.14	33.69	36.19	43.82
20	8.26	9.24	10.85	12.44	14.58	16.27	19.34	22.78	25.04	28.41	31.41	35.02	37.57	45.32
21	8.90	9.92	11.59	13.24	15.44	17.18	20.34	23.86	26.17	29.62	32.67	36.34	38.93	46.80
22	9.54	10.60	12.34	14.04	16.31	18.10	21.24	24.94	27.30	30.81	33.92	37.66	40.29	48.27
23	10.20	11.29	13.09	14.85	17.19	19.02	22.34	26.02	28.43	32.01	35.17	38.97	41.64	49.73
24	10.86	11.99	13.85	15.66	18.06	19.94	23.34	27.10	29.55	33.20	36.42	40.27	42.98	51.18
25	11.52	12.70	14.61	16.47	18.94	20.87	24.34	28.17	30.68	34.38	37.65	41.57	44.31	52.62
26	12.20	13.41	15.38	17.29	19.82	21.79	25.34	29.25	31.80	35.56	38.88	42.86	45.64	54.05
27	12.88	14.12	16.15	18.11	20.70	22.72	26.34	30.32	32.91	36.74	40.11	44.14	46.96	55.48
28	13.56	14.85	16.93	18.94	21.59	23.65	27.34	31.39	34.03	37.92	41.34	45.42	48.28	56.89
29	14.26	15.57	17.71	19.77	22.48	24.58	28.34	32.46	35.14	39.09	42.56	46.69	49.59	58.30
30	14.95	16.31	18.49	20.60	23.36	25.51	29.34	33.53	36.25	40.26	43.77	47.96	50.89	59.70

\* Table C is abridged from Table IV of Fisher and Yates: *Statistical tables for biological, agricultural, and medical research*, published by Oliver and Boyd Ltd., Edinburgh, by permission of the authors and publishers.

TABLE 4 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS SMALL AS OBSERVED VALUES OF  $x$  IN THE BINOMIAL TEST\*

Given in the body of this table are one-tailed probabilities under  $H_0$  for the binomial test when  $P = Q = \frac{1}{2}$ . To save space, decimal points are omitted in the  $p$ 's.

$N \backslash x$	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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	251	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	†	†				
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

\* Adapted from Table IV, B, of Walker, Helen, and Lev, J. 1953. *Statistical inference*. New York: Holt, p. 458, with the kind permission of the authors and publisher.

† 1.0 or approximately 1.0.

TABLE 5 TABLE OF CRITICAL VALUES OF  $D$  IN THE KOLMOGOROV-SMIRNOV ONE-SAMPLE TEST\*

Sample size ( $N$ )	Level of significance for $D = \text{maximum }  F_0(X) - S_N(X) $				
	.20	.15	.10	.05	.01
1	.900	.925	.950	.975	.995
2	.684	.726	.776	.842	.929
3	.565	.597	.642	.708	.828
4	.494	.525	.564	.624	.733
5	.446	.474	.510	.565	.669
6	.410	.436	.470	.521	.618
7	.381	.405	.438	.486	.577
8	.358	.381	.411	.457	.543
9	.339	.360	.388	.432	.514
10	.322	.342	.368	.410	.490
11	.307	.326	.352	.391	.468
12	.295	.313	.338	.375	.450
13	.284	.302	.325	.361	.433
14	.274	.292	.314	.349	.418
15	.266	.283	.304	.338	.404
16	.258	.274	.295	.328	.392
17	.250	.266	.286	.318	.381
18	.244	.259	.278	.309	.371
19	.237	.252	.272	.301	.363
20	.231	.246	.264	.294	.356
25	.21	.22	.24	.27	.32
30	.19	.20	.22	.24	.29
35	.18	.19	.21	.23	.27
Over 35	$\frac{1.07}{\sqrt{N}}$	$\frac{1.14}{\sqrt{N}}$	$\frac{1.22}{\sqrt{N}}$	$\frac{1.36}{\sqrt{N}}$	$\frac{1.63}{\sqrt{N}}$

\* Adapted from Massey, F. J., Jr. 1951. The Kolmogorov-Smirnov test for goodness of fit. *J. Amer. Statist. Ass.*, 46, 70, with the kind permission of the author and publisher.

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TABLE 6 TABLE OF CRITICAL VALUES OF  $r$  IN THE RUNS TEST\*

Given in the bodies of Table F<sub>I</sub> and Table F<sub>II</sub> are various critical values of  $r$  for various values of  $n_1$  and  $n_2$ . For the one-sample runs test, any value of  $r$  which is equal to or smaller than that shown in Table F<sub>I</sub> or equal to or larger than that shown in Table F<sub>II</sub> is significant at the .05 level. For the Wald-Wolfowitz two-sample runs test, any value of  $r$  which is equal to or smaller than that shown in Table F<sub>I</sub> is significant at the .05 level.

Table F<sub>I</sub>

$n_1 \backslash n_2$	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2											2	2	2	2	2	2	2	2	2
3					2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
4				2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4
5			2	2	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5
6		2	2	3	3	3	3	4	4	4	4	5	5	5	5	5	5	6	6
7		2	2	3	3	3	4	4	5	5	5	5	5	5	6	6	6	6	6
8		2	3	3	3	4	4	5	5	5	6	6	6	6	6	7	7	7	7
9		2	3	3	4	4	5	5	5	6	6	6	7	7	7	7	8	8	8
10		2	3	3	4	5	5	5	6	6	7	7	7	7	8	8	8	8	9
11		2	3	4	4	5	5	6	6	7	7	7	8	8	8	9	9	9	9
12	2	2	3	4	4	5	6	6	7	7	7	8	8	8	9	9	9	10	10
13	2	2	3	4	5	5	6	6	7	7	8	8	9	9	9	10	10	10	10
14	2	2	3	4	5	5	6	7	7	8	8	9	9	9	10	10	10	11	11
15	2	3	3	4	5	6	6	7	7	8	8	9	9	10	10	11	11	11	12
16	2	3	4	4	5	6	6	7	8	8	9	9	10	10	11	11	11	12	12
17	2	3	4	4	5	6	7	7	8	9	9	10	10	11	11	11	12	12	13
18	2	3	4	5	5	6	7	8	8	9	9	10	10	11	11	12	12	13	13
19	2	3	4	5	6	6	7	8	8	9	10	10	11	11	12	12	13	13	13
20	2	3	4	5	6	6	7	8	9	9	10	10	11	12	12	13	13	13	14

\* Adapted from Swed, Frieda S., and Eisenhart, C. 1943. Tables for testing randomness of grouping in a sequence of alternatives. *Ann. Math. Statist.*, 14, 83-86, with the kind permission of the authors and publisher.

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TABLE 6 TABLE OF CRITICAL VALUES OF  $r$  IN THE RUNS TEST\* (Continued)  
Table F<sub>II</sub>

$n_1 \backslash n_2$	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2																			
3																			
4				9	9														
5			9	10	10	11	11												
6			9	10	11	12	12	13	13	13	13								
7				11	12	13	13	14	14	14	14	15	15	15					
8				11	12	13	14	14	15	15	16	16	16	16	17	17	17	17	17
9					13	14	14	15	16	16	16	17	17	18	18	18	18	18	18
10					13	14	15	16	16	17	17	18	18	18	19	19	19	20	20
11					13	14	15	16	17	17	18	19	19	19	20	20	20	21	21
12					13	14	16	16	17	18	19	19	20	20	21	21	21	22	22
13						15	16	17	18	19	19	20	20	21	21	22	22	23	23
14						15	16	17	18	19	20	20	21	22	22	23	23	23	24
15							15	16	18	18	19	20	21	22	22	23	23	24	25
16								17	18	19	20	21	21	22	23	23	24	25	25
17									17	18	19	20	21	22	23	23	24	25	26
18										17	18	19	20	21	22	23	24	25	26
19											17	18	20	21	22	23	23	24	25
20												17	18	20	21	22	23	24	25

\* Adapted from Swed, Frieda S., and Eisenhart, C. 1943. Tables for testing randomness of grouping in a sequence of alternatives. *Ann. Math. Statist.*, 14, 83-86, with the kind permission of the authors and publisher.

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TABLE 7 TABLE OF CRITICAL VALUES OF  $T$  IN THE WILCOXON  
MATCHED-PAIRS SIGNED-RANKS TEST\*

N	Level of significance for one-tailed test		
	.025	.01	.005
	Level of significance for two-tailed test		
	.05	.02	.01
6	0	—	—
7	2	0	—
8	4	2	0
9	6	3	2
10	8	5	3
11	11	7	5
12	14	10	7
13	17	13	10
14	21	16	13
15	25	20	16
16	30	24	20
17	35	28	23
18	40	33	28
19	46	38	32
20	52	43	38
21	59	49	43
22	66	56	49
23	73	62	55
24	81	69	61
25	89	77	68

\* Adapted from Table I of Wilcoxon, F. 1949. *Some rapid approximate statistical procedures*. New York: American Cyanamid Company, p. 13, with the kind permission of the author and publisher.



TABLE 8 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS SMALL AS OBSERVED VALUES OF  $U$  IN THE MANN-WHITNEY TEST\*

$n_2 = 3$					$n_2 = 4$				
$U \backslash n_1$	1	2	3		$U \backslash n_1$	1	2	3	4
0	.250	.100	.050		0	.200	.067	.028	.014
1	.500	.200	.100		1	.400	.133	.057	.029
2	.750	.400	.200		2	.600	.267	.114	.057
3		.600	.350		3		.400	.200	.100
4			.500		4		.600	.314	.171
5			.650		5			.429	.243
					6			.571	.343
					7				.443
					8				.557

$n_2 = 5$						$n_2 = 6$						
$U \backslash n_1$	1	2	3	4	5	$U \backslash n_1$	1	2	3	4	5	6
0	.167	.047	.018	.008	.004	0	.143	.036	.012	.005	.002	.001
1	.333	.095	.036	.016	.008	1	.286	.071	.024	.010	.004	.002
2	.500	.190	.071	.032	.016	2	.428	.143	.048	.019	.009	.004
3	.667	.286	.125	.056	.028	3	.571	.214	.083	.033	.015	.008
4		.429	.196	.095	.048	4		.321	.131	.057	.026	.013
5		.571	.286	.143	.075	5		.429	.190	.086	.041	.021
6			.393	.206	.111	6		.571	.274	.129	.063	.032
7			.500	.278	.155	7			.357	.176	.089	.047
8			.607	.365	.210	8			.452	.238	.123	.066
9				.452	.274	9			.548	.305	.165	.090
10				.548	.345	10				.381	.214	.120
11					.421	11				.457	.268	.155
12					.500	12				.545	.331	.197
13					.579	13					.396	.242
						14					.465	.294
						15					.535	.350
						16						.409
						17						.469
						18						.531

\* Reproduced from Mann, H. B., and Whitney, D. R. 1947. On a test of whether one of two random variables is stochastically larger than the other. *Ann. Math. Statist.*, 18, 52-54, with the kind permission of the authors and the publisher.

TABLE 9 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS SMALL AS OBSERVED VALUES OF  $U$  IN THE MANN-WHITNEY TEST\* (Continued)

$n_1 = 7$

$U$	1	2	3	4	5	6	7
0	.125	.028	.008	.003	.001	.001	.000
1	.250	.056	.017	.006	.003	.001	.001
2	.375	.111	.033	.012	.005	.002	.001
3	.500	.167	.058	.021	.009	.004	.002
4	.625	.250	.092	.036	.015	.007	.003
5		.333	.133	.055	.024	.011	.006
6		.444	.192	.082	.037	.017	.009
7		.556	.258	.115	.053	.026	.013
8			.333	.158	.074	.037	.019
9			.417	.206	.101	.051	.027
10			.500	.264	.134	.069	.036
11			.583	.324	.172	.090	.049
12				.394	.216	.117	.064
13				.464	.265	.147	.082
14				.538	.319	.183	.104
15					.378	.223	.130
16					.438	.267	.159
17					.500	.314	.191
18					.562	.365	.228
19						.418	.267
20						.473	.310
21						.527	.355
22							.402
23							.451
24							.500
25							.549

\* Reproduced from Mann, H. B., and Whitney, D. R. 1947. On a test of whether one of two random variables is stochastically larger than the other. *Ann. Math. Statist.*, 18, 52-54, with the kind permission of the authors and the publisher.

TABLE 10 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS SMALL AS OBSERVED VALUES OF  $U$  IN THE MANN-WHITNEY TEST\* (Continued)

$n_2 = 8$

$n_1 \backslash U$	1	2	3	4	5	6	7	8	$t$	Normal
0	.111	.022	.006	.002	.001	.000	.000	.000	3.308	.001
1	.222	.044	.012	.004	.002	.001	.000	.000	3.203	.001
2	.333	.089	.024	.008	.003	.001	.001	.000	3.098	.001
3	.444	.133	.042	.014	.005	.002	.001	.001	2.993	.001
4	.556	.200	.067	.024	.009	.004	.002	.001	2.888	.002
5		.267	.097	.036	.015	.006	.003	.001	2.783	.003
6		.356	.139	.055	.023	.010	.005	.002	2.678	.004
7		.444	.188	.077	.033	.015	.007	.003	2.573	.005
8		.556	.248	.107	.047	.021	.010	.005	2.468	.007
9			.315	.141	.064	.030	.014	.007	2.363	.009
10			.387	.184	.085	.041	.020	.010	2.258	.012
11			.461	.230	.111	.054	.027	.014	2.153	.016
12			.539	.285	.142	.071	.036	.019	2.048	.020
13				.341	.177	.091	.047	.025	1.943	.026
14				.404	.217	.114	.060	.032	1.838	.033
15				.467	.262	.141	.076	.041	1.733	.041
16				.533	.311	.172	.095	.052	1.628	.052
17					.362	.207	.116	.065	1.523	.064
18					.416	.245	.140	.080	1.418	.078
19					.472	.286	.168	.097	1.313	.094
20					.528	.331	.198	.117	1.208	.113
21						.377	.232	.139	1.102	.135
22						.426	.268	.164	.998	.159
23						.475	.306	.191	.893	.185
24						.525	.347	.221	.788	.215
25							.389	.253	.683	.247
26							.433	.287	.578	.282
27							.478	.323	.473	.318
28							.522	.360	.368	.356
29								.399	.263	.396
30								.439	.158	.437
31								.480	.052	.481
32								.520		

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TABLE 11 TABLE OF CRITICAL VALUES OF  $U$  IN THE MANN-WHITNEY TEST\*  
 Table K1. Critical Values of  $U$  for a One-tailed Test at  $\alpha = .001$  or for a Two-tailed Test at  $\alpha = .002$

$n_1 \backslash n_2$	9	10	11	12	13	14	15	16	17	18	19	20
1												
2												
3									0	0	0	0
4		0	0	0	1	1	1	2	2	3	3	3
5	1	1	2	2	3	3	4	5	5	6	7	7
6	2	3	4	4	5	6	7	8	9	10	11	12
7	3	5	6	7	8	9	10	11	13	14	15	16
8	5	6	8	9	11	12	14	15	17	18	20	21
9	7	8	10	12	14	15	17	19	21	23	25	26
10	8	10	12	14	17	19	21	23	25	27	29	32
11	10	12	15	17	20	22	24	27	29	32	34	37
12	12	14	17	20	23	25	28	31	34	37	40	42
13	14	17	20	23	26	29	32	35	38	42	45	48
14	15	19	22	25	29	32	36	39	43	46	50	54
15	17	21	24	28	32	36	40	43	47	51	55	59
16	19	23	27	31	35	39	43	48	52	56	60	65
17	21	25	29	34	38	43	47	52	57	61	66	70
18	23	27	32	37	42	46	51	56	61	66	71	76
19	25	29	34	40	45	50	55	60	66	71	77	82
20	26	32	37	42	48	54	59	65	70	76	82	88

\* Adapted and abridged from Tables 1, 3, 5, and 7 of Auble, D. 1953. Extended tables for the Mann-Whitney statistic. *Bulletin of the Institute of Educational Research at Indiana University*, 1, No. 2, with the kind permission of the author and the publisher.

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TABLE 12 TABLE OF CRITICAL VALUES OF  $U$  IN THE MANN-WHITNEY TEST\* (Continued)

Table KII. Critical Values of  $U$  for a One-tailed Test at  $\alpha = .01$  or for a Two-tailed Test at  $\alpha = .02$

$n_2$	9	10	11	12	13	14	15	16	17	18	19	20
1												
2					0	0	0	0	0	0	1	1
3	1	1	1	2	2	2	3	3	4	4	4	5
4	3	3	4	5	5	6	7	7	8	9	9	10
5	5	6	7	8	9	10	11	12	13	14	15	16
6	7	8	9	11	12	13	15	16	18	19	20	22
7	9	11	12	14	16	17	19	21	23	24	26	28
8	11	13	15	17	20	22	24	26	28	30	32	34
9	14	16	18	21	23	26	28	31	33	36	38	40
10	16	19	22	24	27	30	33	36	38	41	44	47
11	18	22	25	28	31	34	37	41	44	47	50	53
12	21	24	28	31	35	38	42	46	49	53	56	60
13	23	27	31	35	39	43	47	51	55	59	63	67
14	26	30	34	38	43	47	51	56	60	65	69	73
15	28	33	37	42	47	51	56	61	66	70	75	80
16	31	36	41	46	51	56	61	66	71	76	82	87
17	33	38	44	49	55	60	66	71	77	82	88	93
18	36	41	47	53	59	65	70	76	82	88	94	100
19	38	44	50	56	63	69	75	82	88	94	101	107
20	40	47	53	60	67	73	80	87	93	100	107	114

\* Adapted and abridged from Tables 1, 3, 5, and 7 of Aule, D. 1953. Extended tables for the Mann-Whitney statistic. *Bulletin of the Institute of Educational Research at Indiana University*, 1, No. 2, with the kind permission of the author and the publisher.

TABLE 13 TABLE OF CRITICAL VALUES OF  $U$  IN THE MANN-WHITNEY TEST\* (Continued)

Table K<sub>III</sub>. Critical Values of  $U$  for a One-tailed Test at  $\alpha = .025$  or for a Two-tailed Test at  $\alpha = .05$

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

\* Adapted and abridged from Tables 1, 3, 5, and 7 of Aule, D. 1953. Extended tables for the Mann-Whitney statistic. *Bulletin of the Institute of Educational Research at Indiana University*, 1, No. 2, with the kind permission of the author and the publisher.

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TABLE 14 TABLE OF CRITICAL VALUES OF  $U$  IN THE MANN-WHITNEY  
TEST\* (Continued)

Table Kiv. Critical Values of  $U$  for a One-tailed Test at  $\alpha = .05$  or for a Two-tailed Test at  $\alpha = .10$

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

\* Adapted and abridged from Tables 1, 3, 5, and 7 of Aulsebrook, D. 1953. Extended tables for the Mann-Whitney statistic. *Bulletin of the Institute of Educational Research at Indiana University*, 1, No. 2, with the kind permission of the author and the publisher.

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TABLE 15 TABLE OF CRITICAL VALUES OF  $K_D$  IN THE KOLMOGOROV-SMIRNOV  
TWO-SAMPLE TEST  
(Small samples)

$N$	One-tailed test*		Two-tailed test†	
	$\alpha = .05$	$\alpha = .01$	$\alpha = .05$	$\alpha = .01$
3	3	—	—	—
4	4	—	4	—
5	4	5	5	5
6	5	6	5	6
7	5	6	6	6
8	5	6	6	7
9	6	7	6	7
10	6	7	7	8
11	6	8	7	8
12	6	8	7	8
13	7	8	7	9
14	7	8	8	9
15	7	9	8	9
16	7	9	8	10
17	8	9	8	10
18	8	10	9	10
19	8	10	9	10
20	8	10	9	11
21	8	10	9	11
22	9	11	9	11
23	9	11	10	11
24	9	11	10	12
25	9	11	10	12
26	9	11	10	12
27	9	12	10	12
28	10	12	11	13
29	10	12	11	13
30	10	12	11	13
35	11	13	12	13
40	11	14	13	13

\* Abridged from Goodman, L. A. 1954. Kolmogorov-Smirnov tests for psychological research. *Psychol. Bull.*, 51, 167, with the kind permission of the author and the American Psychological Association.

† Derived from Table 1 of Massey, F. J., Jr. 1951. The distribution of the maximum deviation between two sample cumulative step functions. *Ann. Math. Statist.*, 22, 126-127, with the kind permission of the author and the publisher.



TABLE 16 TABLE OF CRITICAL VALUES OF  $D$  IN THE KOLMOGOROV-SMIRNOV  
TWO-SAMPLE TEST  
(Large samples: two-tailed test)\*

Level of significance	Value of $D$ so large as to call for rejection of $H_0$ at the indicated level of significance, where $D = \text{maximum }  S_{n_1}(X) - S_{n_2}(X) $
.10	$1.22 \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$
.05	$1.36 \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$
.025	$1.48 \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$
.01	$1.63 \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$
.005	$1.73 \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$
.001	$1.95 \sqrt{\frac{n_1 + n_2}{n_1 n_2}}$

\* Adapted from Smirnov, N. 1948. Tables for estimating the goodness of fit of empirical distributions. *Ann. Math. Statist.*, 19, 280-281, with the kind permission of the publisher.

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TABLE 17 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS LARGE AS OBSERVED VALUES OF  $\chi_r^2$  IN THE FRIEDMAN TWO-WAY ANALYSIS OF VARIANCE BY RANKS\*

Table  $N_1, k = 3$

$N = 2$		$N = 3$		$N = 4$		$N = 5$	
$\chi_r^2$	$p$	$\chi_r^2$	$p$	$\chi_r^2$	$p$	$\chi_r^2$	$p$
0	1.000	.000	1.000	.0	1.000	.0	1.000
1	.833	.667	.944	.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
$N = 6$		$N = 7$		$N = 8$		$N = 9$	
$\chi_r^2$	$p$	$\chi_r^2$	$p$	$\chi_r^2$	$p$	$\chi_r^2$	$p$
.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
4.00	.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	.000006

\* Adapted from Friedman, M. 1937. The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *J. Amer. Statist. Ass.*, 32, 688-689, with the kind permission of the author and the publisher.

TABLE 18 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS LARGE AS OBSERVED VALUES OF  $\chi_r^2$  IN THE FRIEDMAN TWO-WAY ANALYSIS OF VARIANCE BY RANKS\* (Continued)

Table N<sub>II</sub>.  $k = 4$

$N = 2$		$N = 3$		$N = 4$			
$\chi_r^2$	$p$	$\chi_r^2$	$p$	$\chi_r^2$	$p$	$\chi_r^2$	$p$
.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

\* Adapted from Friedman, M. 1937. The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *J. Amer. Statist. Ass.*, 32, 688-689, with the kind permission of the author and the publisher.

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TABLE 19 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS LARGE AS OBSERVED VALUES OF  $H$  IN THE KRUSKAL-WALLIS ONE-WAY ANALYSIS OF VARIANCE BY RANKS\*

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	1	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
								6.7091	.013
3	2	1	4.2857	.100				5.7909	.046
			3.8571	.133				5.7273	.050
3	2	2	5.3572	.029				4.7091	.092
			4.7143	.048				4.7000	.101
			4.5000	.067	4	4	1	6.6667	.010
			4.4643	.105				6.1667	.022
3	3	1	5.1429	.043				4.9667	.048
			4.5714	.100				4.8667	.054
			4.0000	.129				4.1667	.082
								4.0667	.102
3	3	2	6.2500	.011	4	4	2	7.0364	.006
			5.3611	.032				6.8727	.011
			5.1389	.061				5.4545	.046
			4.5556	.100				5.2364	.052
			4.2500	.121				4.5545	.098
3	3	3	7.2000	.004				4.4455	.103
			6.4889	.011	4	4	3	7.1439	.010
			5.6889	.029				7.1364	.011
			5.6000	.059				5.5985	.049
			5.0667	.086				5.5758	.051
			4.6222	.100				4.5455	.099
4	1	1	3.5714	.200				4.4773	.102
4	2	1	4.8214	.057	4	4	4	7.6538	.008
			4.5000	.076				7.5385	.011
			4.0179	.114				5.6923	.049
4	2	2	6.0000	.014				5.6538	.054
			5.3333	.033				4.6539	.097
			5.1250	.052				4.5001	.104
			4.4583	.100	5	1	1	3.8571	.143
			4.1667	.105					
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

TABLE 19 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS LARGE AS OBSERVED VALUES OF  $H$  IN THE KRUSKAL-WALLIS ONE-WAY ANALYSIS OF VARIANCE BY RANKS\* (Continued)

Sample sizes			$H$	$p$	Sample sizes			$H$	$p$
$n_1$	$n_2$	$n_3$			$n_1$	$n_2$	$n_3$		
5	2	2	6.5333	.008	5	4	4	5.6308	.050
			6.1333	.013				4.5487	.099
			5.1600	.034				4.5231	.103
			5.0400	.056					
			4.3733	.090				7.7604	.009
			4.2933	.122				7.7440	.011
5	3	1					5.6571	.049	
			6.4000	.012	5.6176	.050			
			4.9600	.048	4.6187	.100			
			4.8711	.052	4.5527	.102			
			4.0178	.095					
5	3	2	3.8400	.123	5 5 1	7.3091	.009		
					6.8364	.011			
					5.1273	.046			
			6.9091	.009	4.9091	.053			
			6.8218	.010	4.1091	.086			
5	3	2	5.2509	.049		4.0364	.105		
			5.1055	.052					
			4.6509	.091	5 5 2	7.3385	.010		
			4.4945	.101	7.2692	.010			
					5.3385	.047			
5	3	3	7.0788	.009		5.2462	.051		
			6.9818	.011	4.6231	.097			
			5.6485	.049	4.5077	.100			
			5.5152	.051					
			4.5333	.097	5 5 3	7.5780	.010		
5	4	1	4.4121	.109		7.5429	.010		
					5.7055	.046			
			6.9545	.008	5.6264	.051			
			6.8400	.011	4.5451	.100			
			4.9855	.044	4.5363	.102			
5	4	2	4.8600	.056					
			3.9873	.098	5 5 4	7.8229	.010		
			3.9600	.102	7.7914	.010			
					5.6657	.049			
			7.2045	.009	5.6429	.050			
5	4	2	7.1182	.010		4.5229	.099		
			5.2727	.049	4.5200	.101			
			5.2682	.050					
			4.5409	.098	5 5 5	8.0000	.009		
			4.5182	.101	7.9800	.010			
5	4	3				5.7800	.049		
			7.4449	.010	5.6600	.051			
			7.3949	.011	4.5600	.100			
				4.5000	.102				

\* Adapted and abridged from Kruskal, W. H., and Wallis, W. A. 1952. Use of ranks in one-criterion variance analysis. *J. Amer. Statist. Ass.*, 47, 614-617, with the kind permission of the authors and the publisher. (The corrections to this table given by the authors in Errata, *J. Amer. Statist. Ass.*, 48, 910, have been incorporated.)

TABLE 20 TABLE OF CRITICAL VALUES OF  $r_s$ , THE SPEARMAN RANK CORRELATION COEFFICIENT\*

N	Significance level (one-tailed test)	
	.05	.01
4	1.000	
5	.900	1.000
6	.829	.943
7	.714	.893
8	.643	.833
9	.600	.783
10	.564	.746
12	.506	.712
14	.456	.645
16	.425	.601
18	.399	.564
20	.377	.534
22	.359	.508
24	.343	.485
26	.329	.465
28	.317	.448
30	.306	.432

\* Adapted from Olds, E. G. 1938. Distributions of sums of squares of rank differences for small numbers of individuals. *Ann. Math. Statist.*, 9, 133-148, and from Olds, E. G. 1949. The 5% significance levels for sums of squares of rank differences and a correction. *Ann. Math. Statist.*, 20, 117-118, with the kind permission of the author and the publisher.

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TABLE 21 TABLE OF PROBABILITIES ASSOCIATED WITH VALUES AS LARGE AS OBSERVED VALUES OF  $S$  IN THE KENDALL RANK CORRELATION COEFFICIENT

$S$	Values of $N$				$S$	Values of $N$		
	4	5	8	9		6	7	10
0	.625	.592	.548	.540	1	.500	.500	.500
2	.375	.408	.452	.460	3	.360	.386	.431
4	.167	.242	.360	.381	5	.235	.281	.364
6	.042	.117	.274	.306	7	.136	.191	.300
8		.042	.199	.238	9	.068	.119	.242
10		.0083	.133	.179	11	.028	.068	.190
12			.089	.130	13	.0083	.035	.146
14			.054	.090	15	.0014	.015	.108
16			.031	.060	17		.0054	.078
18			.016	.038	19		.0014	.054
20			.0071	.022	21		.00020	.036
22			.0028	.012	23			.023
24			.00087	.0063	25			.014
26			.00019	.0029	27			.0083
28			.000025	.0012	29			.0046
30				.00043	31			.0023
32				.00012	33			.0011
34				.000025	35			.00047
36				.0000028	37			.00018
					39			.000058
					41			.000015
					43			.0000028
					45			.00000028

\* Adapted by permission from Kendall, M. G., *Rank correlation methods*, Charles Griffin & Company, Ltd., London, 1948, Appendix Table 1 p. 141.

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ประวัติผู้เขียน

นางสาว พิไลวรรณ พุทธรังษล เกิดวันที่ 12 กุมภาพันธ์ 2506 ที่จังหวัดกาฬสินธุ์ สำเร็จการศึกษาปริญญาวิทยาศาสตรบัณฑิต (สถิติ) จากภาควิชาสถิติ มหาวิทยาลัยเชียงใหม่ พ.ศ. 2526 และเข้าศึกษาต่อในระดับปริญญาโทบัณฑิต ภาควิชาสถิติ คณะพาณิชยศาสตร์และการบัญชี จุฬาลงกรณ์มหาวิทยาลัย ในปี พ.ศ. 2529



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