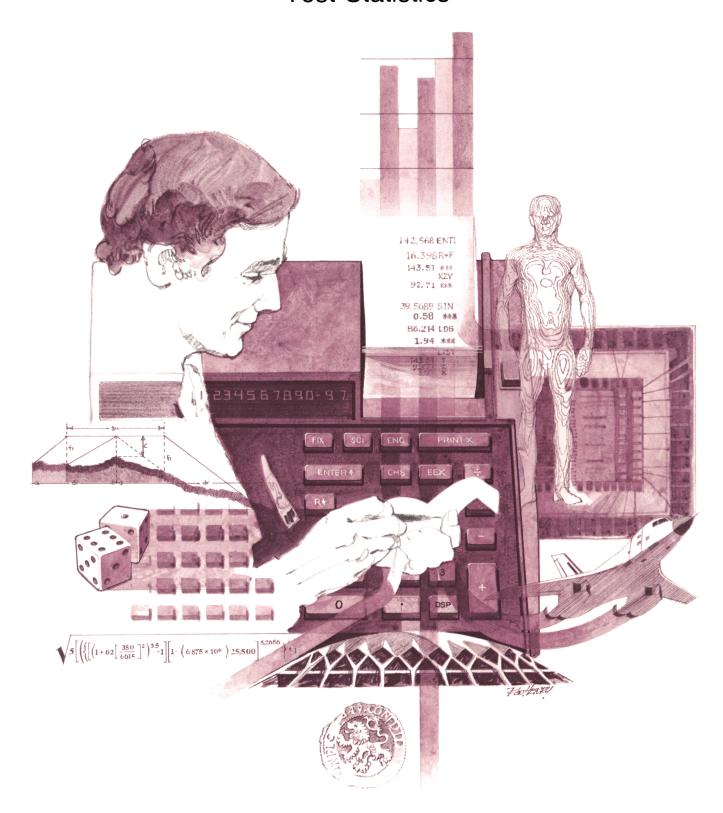
HEWLETT-PACKARD

HP-67/HP-97

Users' Library Solutions Test Statistics



INTRODUCTION

In an effort to provide continued value to it's customers, Hewlett-Packard is introducing a unique service for the HP fully programmable calculator user. This service is designed to save you time and programming effort. As users are aware, Programmable Calculators are capable of delivering tremendous problem solving potential in terms of power and flexibility, but the real genie in the bottle is program solutions. HP's introduction of the first handheld programmable calculator in 1974 immediately led to a request for program solutions — hence the beginning of the HP-65 Users' Library. In order to save HP calculator customers time, users wrote their own programs and sent them to the Library for the benefit of other program users. In a short period of time over 5,000 programs were accepted and made available. This overwhelming response indicated the value of the program library and a Users' Library was then established for the HP-67/97 users.

To extend the value of the Users' Library, Hewlett-Packard is introducing a unique service—a service designed to save you time and money. The Users' Library has collected the best programs in the most popular categories from the HP-67/97 and HP-65 Libraries. These programs have been packaged into a series of low-cost books, resulting in substantial savings for our valued HP-67/97 users.

We feel this new software service will extend the capabilities of our programmable calculators and provide a great benefit to our HP-67/97 users.

A WORD ABOUT PROGRAM USAGE

Each program contained herein is reproduced on the standard forms used by the Users' Library. Magnetic cards are not included. The Program Description I page gives a basic description of the program. The Program Description II page provides a sample problem and the keystrokes used to solve it. The User Instructions page contains a description of the keystrokes used to solve problems in general and the options which are available to the user. The Program Listing I and Program Listing II pages list the program steps necessary to operate the calculator. The comments, listed next to the steps, describe the reason for a step or group of steps. Other pertinent information about data register contents, uses of labels and flags and the initial calculator status mode is also found on these pages. Following the directions in your HP-67 or HP-97 **Owners' Handbook and Program Listing I** and Program Listing I and Program Listing indicates on which calculator the program was written (HP-67 or HP-97). If the calculator indicated differs from the calculator you will be using, consult Appendix E of your **Owner's Handbook** for the corresponding keycodes and keystrokes converting HP-67 to HP-97 keycodes and vice versa. No program conversion is necessary. The HP-67 and HP-97 are totally compatible, but some differences do occur in the keycodes used to represent some of the functions.

A program loaded into the HP-67 or HP-97 is not permanent—once the calculator is turned off, the program will not be retained. You can, however, permanently save any program by recording it on a blank magnetic card, several of which were provided in the Standard Pac that was shipped with your calculator. Consult your **Owner's Handbook** for full instructions. A few points to remember:

The Set Status section indicates the status of flags, angular mode, and display setting. After keying in your program, review the status section and set the conditions as indicated before using or permanently recording the program.

REMEMBER! To save the program permanently, **clip** the corners of the magnetic card once you have recorded the program. This simple step will protect the magnetic card and keep the program from being inadvertently erased.

As a part of HP's continuing effort to provide value to our customers, we hope you will enjoy our newest concept.

TABLE OF CONTENTS

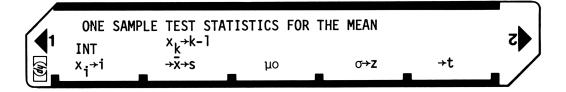
- KRUSKAL-WALLIS STATISTIC The Kruskal-Wallis statistic can be used to test if the independent random samples come from identical continuous population

rogram Title	ONE SAMPLE TEST ST FOR THE MEAN			
ontributor's Name	Hewlett-Packard			
ddress	1000 N.E. Circle Blvd.			
ty Cor	vallis	State Oregon	Zip Code	97330
ogram Descripti	on, Equations, Variables			
	Suppose $\{x_1, x_2,, x_n\}$ is a sample from known variance σ^2 and unknown the hypothesis	om a normal population with a mean μ . A test of the null		
	$H_0: \mu = \mu$	D		
	is based on the z statistic which has a	standard normal distribution		
	If the variance σ^2 is unknown then distribution with $n - 1$ degrees of free	the t statistic, which has the t dom, is used instead.	t	
	Equations:			
	$z = \frac{\sqrt{n}(\overline{x} - \sigma)}{\sigma}$	· µ ₀)		
	$t = \frac{\sqrt{n} (\bar{x} - s)}{s}$	(μ_0)		
	where $\overline{\mathbf{x}}$ and s are sample mean and sa	mple standard deviation.		
	•	-		
n a na tin n t insite a	ad Mauria as			
perating Limits a	na warnings			
	Remark:			
Antonio	n>1.			

This program has been verified only with respect to the numerical example given in *Program Description II*. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

NEITHER HP NOR THE CONTRIBUTOR MAKES ANY EXPRESS OR IMPLIED WARRANTY OF ANY KIND WITH REGARD TO THIS PROGRAM MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. NEITHER HP NOR THE CONTRIBUTOR SHALL BE LIABLE FOR INCIDENTAL OR CONSEQUEN-TIAL DAMAGES IN CONNECTION WITH OR ARISING OUT OF THE FURNISHING, USE OR PERFORMANCE OF THIS PROGRAM MATERIAL.

Sample Problem(s)	Example: Compute the z and the t statistics f	or the following set of data if	
	$\mu_0 = 2$ and $\sigma = 1$.	-	
	{2.73, 0.45, 2.52, 1.19, 3.51, 2.75, 1.74, 1.92, 1.24, 2.68}	1.79, 1.83, 1, 0.87, 1.9, 1.62,	
	Keystrokes:		
	[f] [A] —————		
	2.73 A .45 A 2.68 A	▶ 16.00	
	В		
	В	→ 0.82 (s)	
	2 C ———	→ 2.00	
	1 D	→ -0.57 (z)	
	▣	→ -0.69 (t)	
Solution(s)			
Reference(s) This	program is a translation of	the HP-65 Stat Pac 2 progra	am.



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	If $\overline{\mathbf{x}}$ and s are known, go to 8			
3	Initialize		RTN R/S	0.00
4	Perform 4 for i = 1, 2,, n	× _i	A	i
5	Optional-delete erroneous			
	data x _k (k≠1)	× _k	f A	
6	Compute $\bar{\mathbf{x}}$ and s		В	x
		-	В	S
7	Go to 9			
8	Store $\overline{\mathbf{x}}$ and s	x	STO 2	
		S	STO 5	
9	Input μ_0	μ_0	С	
10	Input σ and compute z	σ	D	z
	or			
	Compute t		E	t
11	For a new case, go to 2			

Program Listing I

epsile $n_{n_{n_{n_{n_{n_{n_{n_{n_{n_{n_{n_{n_{n$	4							
#elt. 21.6 11 Initialize B57 45 $\bar{x} - \mu_0$ B02 CLCR 165 45 $\bar{x} - \mu_0$ $\bar{y} - \mu_0$ B03 RTM 24 B58 $x^2 - y^2 - 45$ $\bar{y} - \mu_0$ B05 RCL2 36 62 $\bar{y} - \mu_0$ $\bar{y} - \mu_0$ $\bar{y} - \mu_0$ B05 RCL2 36 62 $\bar{x} - 24$ $\bar{y} - \mu_0$ $\bar{y} - \mu_0$ B05 RCL2 36 62 $\bar{x} - 24$ $\bar{y} - \mu_0$ $\bar{y} - \mu_0$ B05 RCL2 36 62 $\bar{y} - 24$ $\bar{y} - \mu_0$ $\bar{y} - \mu_0$ B05 RCL1 36 61 $\bar{y} - 24$ $\bar{y} - 24$ $\bar{y} - 24$ $\bar{y} - 24$ B05 RC11 36 64 $RLE 2$ 21 $\bar{y} - 24$ $\bar{y} - 24$ $\bar{y} - 24$ B16 24 $\bar{y} - 24$ B17 R11 -21 $\bar{y} - 24$		KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
add ALLE Line 165-53 Initialize BSS $M2Y$ -41 $\bar{x} - \mu_0$ B23 RTN 24 B55 $M2Y$ -41 $\bar{x} - \mu_0$ $\bar{B}55$ $\bar{H}55$ $\bar{H}56$ \bar	Inn1	1	4 4 5 4 4		857	· _	-45	1
egg trip 121 interaction egg trip -24 100 egg trip 110 211 egg trip 221 100				T				=
Bit				Initialize				x- μ ₀
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bit RCL4 36 d+ IDF Circ Bit and and deviation B24 LEE 21 15 B03 RCL1 36 d+ Ide standard deviation B24 LEE 21 15 24 LEE 21 15 16 17 16 17 17 17 16 17 17 16 16 17 17 17 16 17 17 16 17 16 17 16 17 16 16 17 16 17 16 16 17 16 16 17 16 16 16 16 16	00	6 -						Display z
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e13 ENT+ -21 065° -24 e14 EVT+ -21 070° RCL1 36 01 e15 RCL4 36 04 071° RCL 36 01 e16 r.t -55 073° RTM 24 e17 ENT+ -21 073° RTM 24 e18 RC11 -21 073° RTM 24 e19 RC12 36 01 073° RTM 24 e20 + -55 075° RTM 24 -22 e21 STV1 126 01 075° RTM 24 -22 e25 sTV1 36 01 075° RTM 24 -22 e26 R4 -31 075° 886 23 11 060° -22 e325 sTV1 35 01 000° -22 075° 87 070° 070								
eff EVC1 36 Bit Sci								
e15 $PCL4$ 36 37							36 01	
Pic - -55 Pic Tit -24 817 ENT1 -21 873 RTN 24 818 ENT1 -21 875 RTN 24 819 RCL2 26.62 875 RCL1 26.01 Delete data 823 - 55 876 CMS 22 Pit Delete data 823 - 55 876 RH 31 Pit Delete data 823 - 55 876 RH 31 Delete data 824 - - - 883 R/S 51 825 ST04 35 883 R/S 51 826 R -31 -35 -35 -36 828 RCL1 36 36 -35 -36 -36 828 RCL1 36 36 -35 -36 -36 834 ST01 35 960 -35 -36 -36 844 RCL3 36 631 <							54	
e17 ENT1 -21 67.3 KIK 21 Delete data e13 ENT1 -21 67.3 KIK 21 16 12 e13 ENT1 -21 67.5 RCL1 36 61.1 36 KIK 22 97.5 RCL1 36 16 16 16 16 17.5 16 16 17.5 16 17.5 16 17.5 16 17.5 16 17.5 16 17.5 16 17.5 18					072	X	-35	Display t
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B19 RCL1 36 01 Delete data B19 RCL2 36 01 Delete data B20 + -55 B75 CH1 36 01 Delete data B21 B70 RCL1 36 01 Delete data B22 LSTM 16-53 B75 R4 -31 B22 LSTM 16-53 B77 STD1 35 01 B25 STO1 36 01 B78 R4 -31 B24 - -45 B88 R/S 51 B25 STO4 36 01 B88 R/S 51 B26 R4 -35 B88 R 51 B27 $x - 35$ B88 16 31 B88 R 24 B38 RTM 24 B39 Store s Set status Set status B44 RCL3 36 03 Compute the standard deviation Set status B19 B24 B19 B26 Store s Set status B45 1 60 Store s Set status Set status <th< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th<>								
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224 5734 35 44 825 $R14$ -35 -35 827 x -35 -35 828 $RCL1$ 36 01 829 y -35 -35 828 $RCL1$ 36 01 824 575 -55 823 4 -55 823 $A85$ 16 824 $ST01$ 35 000 827 $RCL1$ 36 01 828 RTN 24 080 000 827 $RCL1$ 36 01 000 828 $8TN$ 24 015 000 828 $8TN$ 24 010 000 844 $RCL2$ 36 01 000 844 RCL 2112 000 000 844 RCL 2114 200 000 000 000 000 000 000 000								
026 R4 -31 027 x -35 028 $RCL1$ 360 -35 028 $RCL1$ 360 -35 028 $RCL1$ 360 -35 023 $16-31$ 000 -35 031 $LSTX$ $16-63$ 000 -36 033 $LSTX$ $16-63$ 000 -36 033 RST 25 000 -36 033 RST 25 000 -36 033 RST 24 000 -36 033 RST 24 000 -36 044 $RCL1$ 3663 $Compute$ the standard deviation -36 000					000	Nº O	1	
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047 Koll 1 Standard deviation Image: constraint of the standard deviation 045 1 01 standard deviation Image: constraint of the standard deviation 045 - -45 Image: constraint of the standard deviation Image: constraint of the standard deviation 047 ÷ -24 Image: constraint of the standard deviation Image: constraint of the standard deviation 048 JX 54 54 Image: constraint of the standard deviation Image: constraint of the standard deviation 049 ST05 35.05 Store s Image: constraint of the standard deviation Image: constraint of the standard deviation 050 RTN 24 Store s Image: constraint of the standard deviation Image: constraint of the standard deviation Image: constraint of the standard deviation 052 ST06 35.06 Store point Image: constraint of the standard deviation Image: constraint of the standard deviation Image: constraint of the standard deviation 052 ST06 35.06 Store point Image: constraint of the standard deviation Image: constraint of the standard deviation Image: constraint of the standard deviation 053 RTH 24				Compute the	100			4
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$ \frac{1}{n(or-n)} \frac{2 \text{ running }}{mean} \frac{3 \text{ sum of }}{\text{squares}} \frac{4 \text{ Used }}{5 \text{ s}} \frac{5 \text{ s}}{6 \mu_0} \frac{7}{7} \frac{8}{8} \frac{9}{9} \frac{9}{100000000000000000000000000000000000$	05		36 06					
n(07-n) mean Squares S0 S1 S2 S3 S4 S5 S6 S7 S8 S9	0	11	12 nunning	g ³ sum of ⁴ Used	⁵ S	⁶ μ₀	7	8 9
			n) mean	squares	05		67	
A B C D E I	S0	S1	52	53 54	55	50	3/	30 39
A B C D E I	<u> </u>		<u></u>		<u> </u>			
	Α		в	С	υ		LF.	ľ

Program Title	TEST STATISTICS FOR CORRELATION COEFFIC		
Contributor's Name	Hewlett-Packard		
Address	1000 N.E. Circle Blvd.		
City	Corvallis	State Oregon	Zip Code 97330

ogram Descriptio	n, Equations, Variables	
	Under the assumptions of normal correlation analysis, the t statistic,	
	which has the t distribution with $n - 2$ degrees of freedom, can be	
	used to test the null hypothesis that the true correlation coefficient	
	$\rho = 0.$	
	To test the null humothesis $a = a$, where a is a sinen number the a	
	To test the null hypothesis $\rho = \rho_0$, where ρ_0 is a given number, the z statistic is used. z has approximately the standard normal distribution.	
	statistic is used. 2 has approximately the standard normal distribution.	
	Equations:	
	•	
	$r\sqrt{n-2}$	
	$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$	
	$VI - r^2$	
Annual 2011 (2011) (201	$\sqrt{n-3}$ $\left[(1+r)(1-2r) \right]$	
	$z = \frac{\sqrt{n-3}}{2} \ln \left[\frac{(1+r)(1-\rho_0)}{(1-r)(1+\rho_0)} \right]$	
	where r is an estimate (based on a sample of size n) of the correlation	
	coefficient ρ .	
1. 1993 COM. And Designation and exception of the state and the state of the sta		
erating Limits ar	nd Warnings	
	Remarks:	
	1. This program requires that $n > 3$, $ r < 1$ and $ \rho_0 < 1$; other-	scattors come and come
	wise, flashing zeros will result.	
	2. Usually, the z statistic is used when the sample size is large.	

This program has been verified only with respect to the numerical example given in *Program Description II*. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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C		
Sketch(es)		
Sample Problem(s)		
	Example:	
	Given $r = 0.12$, $n = 31$, and $\rho_0 = 0$, find t and	Z
	Keystrokes:	
	.12 A 31 B C	
	0 D E	→ 0.64 (z)
Solution(s)		
Reference(s)]. Hogg ar	nd Craig, Introduction to Mathema	
Macmil1	an Co., 1970.	tercar statistics,
2. J. Frei	nd, <u>Mathematical Statistic</u> s, Pre	ntice-Hall, 1971.
3. This pr	ogram is a translation of the HP	-65 Stat Pac 2 program
•		

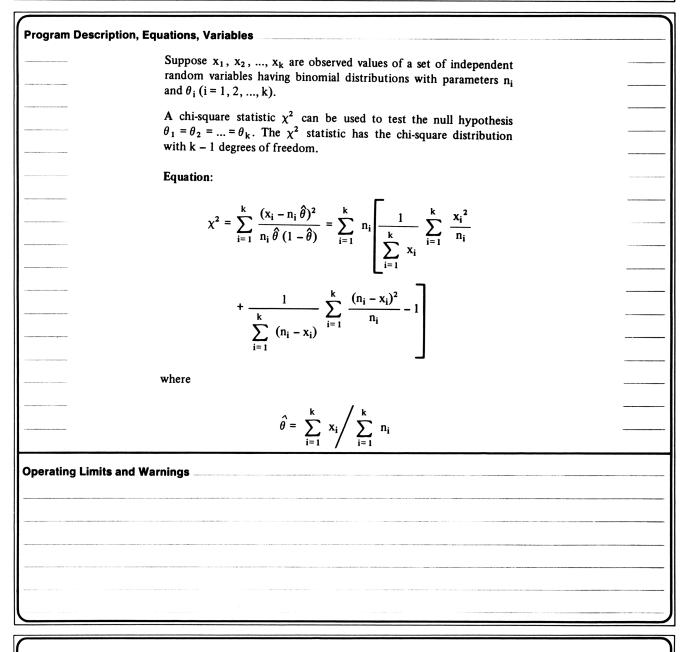
TES CORI	T STATISTIC: RELATION CO	s for the Defficient	r		
r	n	►t	۴ <mark>₀</mark>	►Z	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Input r and n in any order	r	A	
		n	В	
3	Compute t		С	t
	or			
	Input $ ho_0$ and compute z	ρ ₀	D	
			E	Z
4	For a new case, go to 2			

Program Listing I

8			97 Program	LIS	ung I		
STEP	KEY ENŤRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
601	*LBLA	21 11		057	· ÷	-24	
802	STC1	35 01	Store r	058		24	.
003	*LBLC	21 00		060	·····		
004	ABS	16 31	Test if a sure has				
005	1	01	Test if r or ρ_0 has				
00 <i>6</i>	X≠Y	-41	absolute value less than or equal to l				
007	X>Y?	16-34	I than of equal to I				
008	GTO9	22 09					
009	LSTX	16-63					
010	RTN	24					
011 012	*LBLB STO2	21 12 35 02					
012 013	3102	33 02 03	Store n				
013 014	X≠Y	-41		070			
015	X <u>¥</u> Y?	16-35	Test if n > 3				
015	GTO9	22 09					
017	RTN	24					
018	*LBLC	21 13	Compute t				
019	RCL2	36 02					
820	2	02					
021	- ,	-45	n-2				
022 007		01 74 01	1				
023 024	RCL1 X2	36 01 53		080			
024 025	-	-45	$(n-2)/(1-r^2)$				
025 026	÷	-24	1				
020 027	JX	54	4				
028	RCL1	36 01	4				
029	X	-35	4				
030	RTN	24	4				
031	*LBLD	21 14	1				
832	STO3	35 03	Store po				
833	GTO0	22 00	1	090			
034 075	*LBLE RCL1	21 15 36 01	Test if $ \rho_0 < 1$				
035 035	RULI 1	36 Ø1 Ø1	. Compute z				
033 037	+	-55	1				1
038	1	Ū1	4				4
039	RCL1	36 01					
040	-	-45	(1+4)/(1-r)				
841	÷	-24	1				
042	1	Ø1	1				
043	RCL3	36 03	1	100			
844	-	-45]				
045 046	× 1	-35 01]				
048 047	RCLJ	3E 03	4				4
0 48	+	-55	4				4
049	÷	-24	4				SET STATUS
050	LN	32	1				TRIG DISP
051	RCL2	36 02	1.			ON OFF	
852	3	03] n-3				DEG 🗹 FIX 🗹
053 054	-	-45	4	110			
054 055	1 X	54 - 75	4				RAD 🗆 ENG 🗆 n2
055 . 056	x 2	-35 02		STERS			
0	1	2	3 4	5	6	7	8 9
Ľ	r	n	ρ ₀				
S0	S1	S2	S3 S4	S5	S6	S7	S8 S9
A	I	I B		D		E	I

Program Title	DIFFERENCES	AMONG PROPORTIONS	
Contributor's Name	Hewlett-Packard		
Address	1000 N.E. Circle	Blvd.	
City	Corvallis	State Oregon	Zip Code 97330



This program has been verified only with respect to the numerical example given in *Program Description II*. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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Sketch(es)			
Skelch(es)			
Comple Droblem(c)			
Sample Problem(s)			
	Example:		
	-		
		n _i x _i	
	Sample 1	400 232	
	Sample 2	500 260	
	Sample 3	400 197	
	Keystrokes:		
	A 400 (+ 232 B 500 (+ 26	0 ₿ 400 🛉 197 ₿ → 3.00	(lr)
			(K)
		► 6.47	(x ²)
	D	2 00	(46)
	G	→ 0.53	() (-)
		0.53	(0)
Solution(s)			
Solution(s)		tistics, Prentice-Hal	1, 1971.
Reference (s) 1. J. Free	und, <u>Mathematical Sta</u>		
Reference (s) 1. J. Free	und, <u>Mathematical Sta</u>	<u>utistics</u> , Prentice-Hal	
Reference (s) 1. J. Free	und, <u>Mathematical Sta</u>		
Reference (s) 1. J. Free	und, <u>Mathematical Sta</u>		
Reference (s) 1. J. Free	und, <u>Mathematical Sta</u>		
Reference(s) 1. J. Free	und, <u>Mathematical Sta</u>		



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Initialize		A	0.00
3	Perform 3 for i = 1, 2,, k	n _i		
		×i	В	i
4	Compute χ^2 statistic		С	χ ²
5	Compute df		D	df
6	Compute $\hat{ heta}$		E	ô
7	For a new case, go to 2			

Program Listing I

12							
STEP		RY KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11					
002		16-53	Initialize				
003		ŨŨ		060			
004		24			+		
00:		21 12					4
000		35-55 01	Accumulate sums				4
007		-45					
00		35 04	n _i -x _i				4
00		35-55 02					4 1
010		15-63			· · · ·	, 	
01		-55					
01		16-63	x.				
01		-21	[×] i				1
01.		-35	n i	070			
01: 01:		-41					
61. 61.		-24	x _i ²				
			2/2				
81) 81)		35-55 05 16-67	x _i ² /n _i]
01) 01)		16-63	n _i]
011		36 04 1			I]
021 02		-21	$(n_i - x_i)^2$]
02. 82		-35	l ı ,]
02:		-41	1		1		1
023		-24	1	080			1
02·		35-55 06	1				1
B2:		01					1 1
Ø2(36 03		1			1 1
021		-55	1				1
020		35 03	4		+		4
Ø2:		24					1 1
031		21 13	Compute χ^2				4 1
03.		36 05					4
03:		36 01					
63.		-24	1	090		ł	4
Ø3:		36 06	1				4
03:		36 02	4				4
631		-24	-				4
031	7 +	-55	4				4
03:		Øİ					· · · · · · · · · · · · · · · · · · ·
833	9 -	-45	4				4
841		36 01	4				4
04.		36 02	1			l	4
84:		-55	1			 	4
043		-35	1			l	4
64-		24	1	100			4 1
043		21 14	Compute df				4 1
044		36 03	1				4
841		Ø1	1				4
04:		-45	1				4
64		24	1				
051		21 15	Compute 0				SET STATUS
05		36 01	Compute 0			FLAGS	TRIG DISP
05		36 01	1				
05		36 02	4	110			
05-		-55	4	110			GRAD SCI RAD ENG
05		-24	4				
05: 05:		24	L		L		
		······································				$\frac{12}{n}$ [7]	8 9
0	1 Σ>	<i <sup="">2 Σ(n_i-x)</i>	i) ³ k ^h i-xi	⁵ Σ(x _i ²	/n _i) ⁶ Σ(n _i -:	x _i) ² /n _i /'	9
S0	S1	S2	S3 S4	S5	S6	S7	S8 S9
30	31	52	00 04			-	
A		B		D		E	I
l^		ľ	Ĭ			-	
L							

Program Title	BEHRENS-FISHER \$	STATISTIC		
Contributor's Address	Name Hewlett-Packard 1000 N.E. Circle Blvd.			
City	Corvallis	State	Oregon	Zip Code _97330

Suppose $\{x_1, x_2, ..., x_{n_1}\}$ and $\{y_1, y_2, ..., y_{n_2}\}$ are independent random samples from two normal populations having means μ_1, μ_2 (unknown). If the variances σ_1^2, σ_2^2 cannot be assumed equal, then the Behrens-Fisher statistic d is used instead of the t statistic to test the null hypothesis

 $\mathbf{H_0}: \boldsymbol{\mu_1} - \boldsymbol{\mu_2} = \mathbf{D}.$

Equation:

$$d = \frac{\overline{x} - \overline{y} - D}{\sqrt{\frac{{s_1}^2}{n_1} + \frac{{s_2}^2}{n_2}}}$$

where \overline{x} , \overline{y} and s_1^2 , s_2^2 are sample means and variances.

Critical values of this test are tabulated in the Fisher-Yates Tables for various values of n_1 , n_2 , α and θ , where α is the level of significance and

$$\theta = \tan^{-1}\left(\frac{s_1}{s_2}\sqrt{\frac{n_2}{n_1}}\right).$$

Operating Limits and Warnings

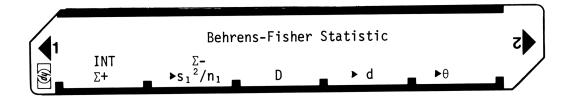
Remark:

 $n_1 > 1, n_2 > 1.$

This program has been verified only with respect to the numerical example given in *Program Description II*. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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Sample Problem(s)	
	Example:
	Compute the Behrens-Fisher statistic for $D = 0$.
	x: 79, 84, 108, 114, 120, 103, 122, 120 y: 91, 103, 90, 113, 108, 87, 100, 80, 99, 54
	Keystrokes:
	[f] [A] 79 A 84 A 120 A → 8.00 (n ₁)
	$B \longrightarrow 34.60 (s_1^2/n_1)$
	$ \begin{bmatrix} f \end{bmatrix} \begin{bmatrix} A \end{bmatrix} 91 \begin{bmatrix} A \end{bmatrix} 103 \begin{bmatrix} A \end{bmatrix} \dots 54 \begin{bmatrix} A \end{bmatrix} \longrightarrow 10.00 (n_2) $ $ 0 \begin{bmatrix} D \end{bmatrix} \longrightarrow 1.73 (d) $
	E 47.88° (θ)
	or 0.84 radians
	or 53.20 grads
Solution(s)	
Medica	r and Yates, <u>Statistical Tables for Biological. Agricultural and</u> <u>1 Research</u> , Hafner, Publishing Co., 1970. program is a translation of the HP-65 Stat Pac 2 program.



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	If \overline{x} , \overline{y} and s_1 , s_2 are known, go			
	to 11			
3	Initialize		f A	0.00
4	Perform 4 for i = 1, 2,, n ₁	× _i	A	i
5	Optional-delete erroneous x _k	× _k	f B	
	(k ≠ 1)			
6	Compute and store \overline{x} , s_1^2/n_1		В	s ₁ ² /n ₁
7	Initialize		F A	0.00
8	Perform 8 for i = 1, 2,, n ₂	Уi	A	i
9	Optional—delete erroneous y _h	Уh	f B	
	(h ≠ 1)			
10	Go to 12			
11	Store \overline{x} , \overline{y} and s_1^2/n_1 , s_2^2/n_2			
	in any order	x	STO 5	
		s_1^2/n_1	STO 6	
		ÿ	STO 2	
		s_2^2/n_2	STO 3	
12	Input D	D	С	
13	Compute d and $ heta$		D	d
			E	θ
14	Optional-recall means		RCL 5	x
			RCL 2	ÿ
15	For a different D, go to 12			
16	For a new case, go to 2			

97 Program Listing I

16			9/ Program	LÌS	ting I		
STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLa 21	16 11		057	' RTN	24	
002	6	00	-	058	*LBLD	21 14	
003	ST01	35 01 -	Initialize	059	RCL5	36 05	Compute d
004	STC2	35 02	iniciarize	868	RCL2	36 02	
005		35 03		061	-	-45	
006		35 04		062	RCL7	36 07	
007		24		063		-45	
008		21 11		064		36 03	
009		36 82	Accumulate sums	065		36 01	
010		-45		866		Ūİ	
011	RCL4	36 64		867		-45	
012		-45		068		-24	
012 013		36 01		069		36 01	
013 014		01	1	070		-24	
014 015	1 +	-55		071		35 08	Stans a 2/m
			1	072		35 08 36 06	Store s_2^2/n_2
016		-24		673			
017		-21				-55	
018		-21 -	1	074		54	
019		36 04	1	075 075		-24	
020		-55	1	076		24	
021	ENT†	-21		077		21 15	Compute 0
022		-21		079		36 Ø6	Compute θ
023		36 02		079		36 08	
824	+	-55		080		-24	
825	ST02	35 02		. 081		54	
026	LSTX	16-63		. 082		16 43	
027	-	-45		083	RTH	24	
0 28	-	-45		084	*LBLk	21 16 12	
<i>029</i>	ST04	35 04		085	RCL1	36 01	Delete ennemente
030		-31		086	CHS	-22	Delete erroneous
031	X	-35		087		35 01	data
032		36 61		088		-31	
033		-35		089		22 11	
034		B 1		090			J
035		16-63					
835		-55]
Ø37		16 31					1 1
033	ST01	35 01					1
039	3701 X	-35					1
03 <i>5</i> 040		i-55 03					1
040 041	RCL1 33	-55 03 36 01				1	1
						1	1
042 847	RTN	24				1	1
043 044		21 12 76 90	Store x	100		+	1
044 045		36 02 75 of					1
045		35 05 36 03				1	1
846		36 03				+	· · · · · · · · · · · · · · · · · · ·
847	RCL1	36 01					1 1
648		01	n _i -l				ł I
849		-45	'			+-1	SET STATUS
650		-24					
051	RCL 1	36 01				FLAGS	TRIG DISP
Ø52		-24	Store s_1^2/n_1				DEG 🗹 FIX 🗹
053		35 06		110			GRAD GRAD
054		24					RAD D ENG D
055		21 13	Store D				RAD ENG n_2
056	ST07	35 07	Store D REGIS				
0	11	2		5 x	6	7	8 9
ľ	l' n	² runnin Mean	g ³ sum of ⁴ Used squares	X	[°] s ₁ ² /n		s_{2}^{2}/n_{2}
S0	S1	S2	S3 S4	S5	S6	S7	S8 S9
l	-	-					
A	l I		С	D		E	I I
	-						

Program Title	KRUSKAL-WALLIS STATISTIC	
Contributor's Name	Hewlett-Packard N.E. Circle Blvd.	
City Corvall	is <u>State</u> Oregon Zip Code	97330
Program Description, E	quations, Variables	
	Suppose we want to test the null hypothesis that k independent random samples of sizes n_1 , n_2 ,, n_k come from identical continuous populations.	-
	Arrange all values from k samples jointly (as if they were one sample) in an increasing order of magnitude. Let R_{ij} (i = 1, 2,, k, j = 1, 2,, n _i) be the rank of the j th value in the i th sample.	-
	The Kruskal-Wallis statistic H can be used to test the null hypothesis.	
	When all sample sizes are large (> 5), H is distributed approximately as the chi-square with $k - 1$ degrees of freedom. For small samples, the test is based on special tables.	-
	Equation:	-
	$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{\left(\sum_{j=1}^{n_i} R_{ij}\right)^2}{n_i} - 3(N+1)$	-
	where	-
	$N = \sum_{i=1}^{k} n_i$	-
Operating Limits and W	'arnings	

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Program Title	KRUSKAL-WALLIS STATISTIC									
Contributor's Name	Hewlett-Packard									
Address	1000 N.E. Circle									
City	Corvallis	State	Oregon	Zip Code 97330						

Program Description, Equations, Variables							
	Table for small samples (k = 3):						
	Alexander and Quade, On the Kruskal-Wallis Three Sample H- statistic, University of North Carolina, Department of Biostatistics, Inst. Statistics Mimeo Ser. 602, 1968.						
Operating Limits and Warning	8						

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iketch(es)													
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	 	 								Ì			
	 		**			 •			•				
					••••••••••	 ••••	•••• •••••		• • • •		•		

	Example:												
	j					Rank	cs R _{ii}						
	i	1	2	3	4	5	6	7	8	9	10		1.1984
	1	29	5	26	10	33	30						-
	2	11	12	9	7	20	18	19	21				
	3	14	28	8	25	17	15	32	4	2			
	4	6	27	3	16	24	13	1	31	22	23		
	Keystroke	s:											
	А 29 В 5	В.	. 30 🛙	3					► 6.	00			
	С ———												
	11 B 12												
	14 B 28												
	6 В 27 В			_									-
	D								► 2.	29 (H)		
olution(s)	Ε								→ 3.	00 (d i	f)		
······································													
												 	'

2. This program is a translation of the HP-65 Stat Pac 2 program.

	Kruskal- R _{ih} ⊳h-1	Wallis Stat	tistic		7
INT	n R _{ij} ≻j	►i	► H	► df	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1.	Enter program			
2.	Initialize			0.00
3.	Perform 3-6 for i-1,2,,k			
4.	Perform 4 for j-1,2,n	R _{ij}	B	j
			f B	
5.	Optional-delete erroneous R _{ih}	R _{jh}		
6.	End of the ith sample			i
				••
7.	Compute H statistic		D	Н
				16
8.	Compute df			df
9.	Optional-recall N		RCL 5	N
<u> </u>				
10.	For a new case, go to 2			
	·			
		·		

$\left(\right)$	•KRUS	KAL-WALLIS	STATISTI	C		
	INIT	R _{ij} ⊳j	►i	►H	►df	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Initialize		A	0.00
3	Perform 3-6 for i = 1, 2,, k			
4	Perform 4 for j = 1, 2,, n _i	R _{ij}	В	j
5	Optional-delete erroneous R _{ih}	R _{ih}	GTO 1	
			R/S	
6	End of the ith sample		С	i
7	Compute H statistic		D	н
8	Compute df		E	df
9	Optional-recall N		RCL 5	N
10	For a new case, go to 2			

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22							
STEP	KEY ENTR	Y KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
601	*LBLA	21 11					
			Initialize				1
002	CLRG	16-53	Inicialize				1
003	Ø	00		060			1
004	RTN	24					1
005	*LBLB	21 12	Accumulate sums				
006	ST+2	35-55 02					4
007	RCL1	36 01					4 1
008	1	Ū l					4
009	÷	-55					
010	ST01	35 01					
011	RTN	24					1
012	*LBLC	21 13	Duamana fan a nav				1
			Prepare for a new				1
013	RCL1	36 B1	sample	070			1
014		35-55 05					1
015	RCL2	36 02					4
016	χ2	53	$(\Sigma R_{ij})^2$				4
017	X‡Y	-41	i ij'				4
018	÷	-24					4
019	ST+3	35-55 03					1
020	RCL4	36 04					4
621	1	00 0 1 01					J I
022	+	-55]
022 023	3T04	35 04	Reinitialize regist-]
				080			1
024	Ū	00 75 04	ers R ₁ ,R ₂				1
025	ST01	35 01	Display sample				1
026	STO2	35 02	number				4
027	RCL4	36 Ø4					4
0 28	RTN	24					4
0 29	*LBLD	21 14	Compute H				4
030	RCL3	36 03					4
031	4	64					1 1
032	x	-35					
033	RCL5	36 05]
634	÷	-24		090			1
	RCL5						1
035 074		36 05					1
036	1	01 55					1 1
037	+	-55					†
038	÷	-24					1
839	LSTX	16-63	N + 1				4
840	-	-45					4
041	3	03	}				4
042	X	-35					4
843	RTN	24					4
044	*LBLE	21 15	Compute df	100			4 1
845	RCL4	36 04	Compute df				1
040 046	I	01 01]
040 047		-45					j l
047 048	RTN	-40]
	*LBLb						
049 050		21 16 12 75 45 60	Delete erroneous				SET STATUS
050	ST-2	35-45 02	data			FLAGS	TRIG DISP
051	RCL1	36 01					
0 52	1	01					DEG 🗹 FIX 🗹
6 53	-	-45		110			GRAD C SCI
054	ST01	35 01					
055	RTN	24	•				n
		I		STERS	I		44
0	1	2 50		5	6	7	8 9
ľ	' n _i	² ΣR _{ij}	³ Σ[(ΣR _{ij}) ³ /4 k	⁵ N	ľ		
S0	S1	S2	n _i] ⁵	S5	S6	S7	S8 S9
1			''i'	-			
A	I	B	С	D	T	E	I
		-	-				

Program Title	MEAN-SQUARE SUCCESSIVE DIFFERENCE	
Contributor's Name	Hewlett-Packard	
	00 N.E. Circle Blvd.	- On out of the second seco
City Corva	Illis State Oregon Zip Code	97330
Program Description	n, Equations, Variables	
	When test and estimation techniques are used, the method of drawing the sample from the population is specified to be random in most	
	cases. If observations are chosen in sequence $x_1, x_2,, x_n$, the mean- square successive difference η can be used to test for randomness.	-
	If the sample size n is large (say, greater than 20) and the population is normal, then a z statistic has approximately the standard normal	
	distribution. Long trends are associated with large positive values of z and short oscillations with large negative values.	
	Equations:	
	- / n	
	$\eta = \sum_{i=2}^{n} (x_i - x_{i-1})^2 \left/ \sum_{i=1}^{n} (x_i - \overline{x})^2 \right.$	
	$= \sum_{i=2}^{n} (x_i - x_{i-1})^2 \left \sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n} \right $	
	$= \sum_{i=2} (x_i - x_{i-1})^2 / \left[\sum_{\underline{i}=1}^{n} x_i^2 - \frac{x_i^2 - x_i^2}{n} \right]$	
- Marca and Antonio and Antonio	$z = \frac{1 - \eta/2}{\sqrt{\frac{n-2}{n^2-1}}}$	
	$\sqrt{n^2 - 1}$	
Operating Limits and	d Warnings	
\frown		

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<u></u>						
Sketch(es)						
Sketch(es)						
Sample Problem(s)						
	F					
	Example:					
	Find the mean-square succes	essive difference for	or the following	ng set of		
	data:			J ·		
	{0.53, 0.52, 0.39, 0.49, 0.9	.97, 0.29, 0.65, 0	.30, 0.40, 0.0	06, 0.14,		
	0.16, 0.68, 0.22, 0.68, 0.08,	,0.52, 0.50, 0.63.	0.20, 0.67, 0.	44,0.64.		
	0.40, 0.97, 0.03, 0.73, 0.24	4,0.57.0.35}	,, . ,	; - · - · ;		
		·, · · · , · · · · ,		ture wave		
	Keystrokes:					
	А .53 В ———		→ 1.00			
	.52 C .39 C35 C		> 30.00			
	D		→ 2.81 (*	n)		
	.E			(7)		
				(-)		
Solution(s)						
						-
		111-111-11-11-111-1111-1111-11-11-11-11				
Reference(s) 1. This	s program is a transla	tion of the	HP-65 Sta	t Pac 2 pr	ogram.	
2. Dix(on and Massey, Introduc	ction to Sta	tistical A	Analysis, I	1cGraw-Hill	,
1969	2.					
1						
ί.						

\langle	SUC	MEAN-SQ CESSIVE DI	UARE FFERENCE)
	INIT	× ₁	× _i ⊳i	⊳η	►Z	J

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Initialize		A	0.00
3	Input x ₁	x ₁	В	1.00
4	Perform 4 for i = 2, 3,, n	×i	С	i
5	Compute η		D	η
6	Compute z		E	z
7	For a new case, go to 2			

Program Listing I

26								
STEP	KEY ENTRY			INTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	-					
002	CLRG	16-53	Tuddda 1d.					1
003	Ø	<i>30</i>	Initiali:	ze				1
004	RTN	24			060			1
005	*LBLB	21 12						4
			Channel	- 1				4
006	ST05	35 05	Store x1	and				4
007		35-55 02	accumulat	te sums				4
00 8	ENT↑	-21	× 2					
009	Х	-35	× 1 2					
010	ST+3	35-55 03]
011	RCL1	36 01						1
012	1	01						1
013	+	-55						1
014	ST01	35 01			070			4
								-
015	RTN	24						4
B16	*LBLC	21 13	Store x _i					-
017	RCL5	<i>36 0</i> 5	1					
018	X≠Y	-41						1
019	ST05	35 05						1
020	-	-45	×i-×i-l					1
021	ENTŤ	-21	1 1-1					1
021 022	X	-35						1
								4
023		35-55 04			080			-
024	RCL5	36 05			080			4
025	GTOB	22 12						
026	*LBLD	21 14	Compute					
627	RCL4	36 04	Compute r)				1
028	RCL3	36 03						1
029	RCL2	36 02						1
02.) 030	ENTT	-21						4
		-21	(∑x;)²					4
031	X	-35	(=)					4
032	RCL1	36 01						4
033	÷	-24						
034	-	-45			090			
035	÷	-24	η					1
036	ST05	35 05	''					1
037	RTN	24						
038 038	*LBLE	21 15	Compute z					4
								4
039	1	01						4
040	RCL5	36 05		· · · · · · · · · · · · · · · · · · ·			LABE	
041	2	02		A	В	Y. C	LABE ID	F
042	÷	-24		Î INT	D	x1 C	Xi D	η Έ Ζ
043	-	-45		a	b	С	d	
644	RCL1	36 01						
045	2	<i>02</i>		0	1	2	3	4
846	-	-45		5	6	7		9
040	RCL1	36 01				<u>l</u> ′	°	
047 048	ENT†							
		-21			 +	FLAGS		SET STATUS
049	×	-35			├ ───┤	0		
050	1	Ø1			├ ──┤	-	FLAGS	TRIG DISP
051	-	-45				1	ON OFF	
052	÷	-24			├ ───┤	2		DEG 🗹 🛛 FIX 🗹
053	٩X	54						
054	÷	-24	Z		110	3		RAD ENG n_2
055	RTN	24	-			_L	3 🗆 🗹	
				REGI	STERS			
0	1	2	3 _ 2 4	1		6	7	8 9
	n	ΣΧι	Σx_i^2	$\Sigma(x_i - x_{i-1})$) ² Xi,	n		
S0	S1	S2		54	S5	S6	S7	S8 S9
A		В	l c		D	I	k	I
		-	Ĭ		[⁻	ľ	-	1
		L			l			l

Program Title	THE RUN TEST FOR RANDOMNESS		
Audress	Hewlett-Packard N.E. Circle Blvd.	-	
City Corvall	s State Oregon	Zip Code	97330
Program Description, E	quations, Variables		
	Consider a sequence of symbols such that the symbols are of two types only. A run is a continuous string of identical symbols preceded and followed by a different symbol or no symbol at all. For example, the sequence 1110100011 has five runs.		
	Let the total number of runs in a given sequence be u, and let n_1 and n_2 represent the number of symbols of type 1 and type 2 respectively. If the sample sizes are large (say, n_1 and n_2 are both greater than 10), then the randomness of the sequence may be tested using a z statistic which has the standard normal distribution.		
	Equations: The sample distribution of the run has the mean μ and the standard deviation σ .		
	$\mu = \frac{2 n_1 n_2}{n_1 + n_2} + 1$ $\sigma = \sqrt{\frac{2 n_1 n_2 (2 n_1 n_2 - n_1 - n_2)}{(n_1 + n_2)^2 (n_1 + n_2 - 1)}}$		
	The test is based on the statistic		
	$z = \frac{u - \mu}{\sigma}$		
Operating Limits and W	arnings		
this program material AT upon any representation NEITHER HP NOR THE C PROGRAM MATERIAL, IN FOR A PARTICULAR PUI	crified only with respect to the numerical example given in <i>Program Descript</i> HIS OWN RISK, in reliance solely upon his own inspection of the program for description concerning the program material. ONTRIBUTOR MAKES ANY EXPRESS OR IMPLIED WARRANTY OF ANY K ICLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERC RPOSE. NEITHER HP NOR THE CONTRIBUTOR SHALL BE LIABLE FOR IN IECTION WITH OR ARISING OUT OF THE FURNISHING, USE OR PERFOR	material and KIND WITH RE HANTABILITY ICIDENTAL OF	GARD TO THIS AND FITNESS CONSEQUEN-

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Program Titl	le	THE RUN TEST FOR		
Contributor's	s Name	Hewlett-Packard		
Address	R	1000 N.E. Circle Blvd.		
City	Corva	llis	State Oregon	Zip Code 97330

Remarks:

- 1. For small samples, the test is based on special tables.
- 2. This program can also be used for other tests involving runs. For example, one might want to test runs of scores above and below the median based on the order in which the scores were obtained. In this case, a sequence could be constructed in which each score would be replaced by a 1 if it was above the median or a 0, if below the median.
 - The run test for randomness can then be applied to the sequence of 0's and 1's.
 - Another use might be for Wald-Wolfowitz run test, which tests the null hypothesis that two random samples have been drawn from identical populations. The data from both groups are combined into one sequence according to magnitude. Each value may be assigned a 0 or 1 depending on which population it came from, and the run test for randomness then performed on the resulting sequence.

Operating Limits and Warnings

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Sketch(es)			
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		· · · · · · · · · · · · · · · · · · ·	
		· · · · · · · · · · · · · · · · · · ·	
Sample Problem(s)			
	Example:		
		oulette table one night in a Las Vegas	
	casino, suspiciously watching	g the house rake in stake upon stake. To	
		the sequence of numbers is random, the owing sequence of red (\mathbf{R}) and black (\mathbf{R})	
	statistician observes the follo numbers (ignoring 0 and 00):	owing sequence of red (R) and black (B)	
	IIUIIIOEIs (Buoring - ana).		
	RRRR B RRR B	BBBBB RR BBB RR BB RRR	
		s, 11B's, and a total of 9 runs. Find the	
	mean and standard deviatior statistic.	n of the sampling distribution and the z	
	statistic.		
	Keystrokes:		
	14 🕂 11 A 9 B C	► 13.32 (µ)	
· · · · · · · · · · · · · · · · · · ·		→ 2.41 (<i>a</i>)	
	E	→ -1.79 (z)	
	(His suspicion is not entirely	unjustified.)	
Solution(s)			
			· · · · · · · · · · · · · · · · · · ·
		ionany/Autlino of Bacic Static	tico MoGnaw_
		<u>ionary/Outline of Basic Statist</u>	11CS, MCuraw-
	11, 1966.		
2. Thi	is program is a transla	tion of the HP-65 Stat Pac 2 pr	rogram.
			-
			AN ADDRESS OF A COMPACT OFFICE AND ADDRESS OF ADDRESS OF ADDRESS OF ADDRESS OF ADDRESS OF ADDRESS OF ADDRESS OF

THE RUN TEST FOR RANDOMNESS										
S n₁ŧn₂	u	►μ	⊳σ	►Z						

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS	
1	Enter program				
2	Input				
	number of symbols of type 1	n ₁	†		
	number of symbols of type 2	n ₂	A	n ₁	
3	Input number of runs	u	В	u	
4	Compute the mean		С	μ	
5	Compute the standard de-				
	viation		D	σ	
6	Compute the z statistic		E	Z	
7	For a new case, go to 2				

			97 Progran	n Lis	sting I			21
STEP	KEY ENTRY		COMMENTS	STEP		KEY CODE	COM	31 Ments
001	*LBLA	21 11						
002 807	STO2	35 0 2	Store n_2				-	
003 004	R↓ STO1	-31		060	<u>+</u>		1	
004	RTN	35-01 24	Store n_1				1	
005	*LBLE	21 12					1	
007	ST03	35 03	Store u				1	
008	RTN	24	Store u				1	
003	*LBLC	21 13						
010	RCL1	36 01	Compute the mean					
011	RCL2	36 02					1	
012	×	-35					4	
013 814	2	02 25		070			4	
014 015	× sto7	-35 35 07		0/0			1	
015 016	RCL1	35 07 36 01					1	
017	RCL2	36 02					1	
018	+	-55					1	
019	STOS	35 08					J	
628	÷	-24						
021	1	01					4	
022	+	-55					4	
023 024	ST04	35 84 .		080			{	
024 025	RTN	24					4	
825 825	*LBLD RCL7	21 14 36 07	Compute the				1	
023 027	RCL8	36 08	Compute the standard deviatio	n	1		1	
023	-	-45	Stanuaru ueviatio	"			1	
029	RCL7	36 07]	
030	X	-35	(n ₁ +n ₂) ²					
031	RCL8	36-08	(¹ 1 ²)				ļ	
8 32	ENT†	-21 .					4	
033	× -	-35 .		090			-	
034 075	RCL8	3608.		090	+		1	
035 036	1	81 -45	n ₁ +n ₂ -1				1	
037	X	-35	-				1	
0 38	÷	-24					ţ	
039	JΧ	54]	
040	ST05	35 05 .						
041	RTN	24					4	
042	*LBLE	21 15 _	Compute the z				-	
043 844	RCL3	36 03 _ 36 03 _	statistic	100	+		1	
044 045	RCL4 -	36 04 - -45 -			+		1	
045 046	RCL5	-45 _ 36 05 _		 			1	
047	÷	-24]	
048	ST06	35 06			FLAGS	1] SET STATUS	
049	RTN	24						
Δ	В	C	LABELS D			FLAGS ON OFF	TRIG	DISP
$n_1 n_2$		u j	μ σ	Z		0 □ ☑,	DEG 🗹	FIX 🗹
а	b	с	d e		2			SCI □ ENG □
0	1	2	3 4		3	2 🗆 🗹 3 🗆 🗹	RAD 🗆	
5	6	7	8 9				L	
				SISTERS	I	•	<u>.</u>	
0	¹ n ₁	² n ₂	3 u 4 μ	5 σ	⁶ Z	Zn ₁ n ₂	⁸ n ₁ +n ₂	9
S0	- S1	S2	S3 S4	S5	S6	S7	S8	S9
A		В		D	I	E	I	L
<u> </u>			Ĭ					

Program Title	INTRACLAS	s co	RRELAT		EFFICIE	NT		
Audress	00 N.E. Circle							07000
City Corval	lis	-		State	Oregon		Zip Code	97330
Brogram Descripti	ion, Equations, Varia	blae						
	The intraclass ciation among	correlati				ree of asso-		
	-			Observati	ons			
		1	x ₁₁	x ₁₂		x _{1n}		
		2	x ₂₁	X22		x _{2n}		
	Groups	•						
		•	· ·	•		•		
		k	x _{k1}	$\mathbf{x_{k_2}}$		x _{kn}		
	The coefficien	t is most	ansily calcu	lated using	the analysis	ofvariance		
	techniques. r _I	The coefficient is most easily calculated using the analysis of variance techniques. r_I is the sample estimate of the population intraclass						
		correlation coefficient ρ_I . If we can assume that the individuals within groups are random samples from normal populations with the same variance, then the hypothesis $\rho_I = 0$ can be tested using the F						
	same variance,							
	statistic.							
	Equations:							
	1. Sums		n					
	Group	Ti		i = 1, 2,	., k			
			j=1					
	Total		ו T = ג					
Operating Li	Total		$T = \sum_{i=1}^{n}$	= 1				
	2. Sums of	squares						
	Mean	squares						
			MSS =	T²/k n				
						and a constant of the second second second second second second second second second second second second second	Ann	

This program has been verified only with respect to the numerical example given in *Program Description II*. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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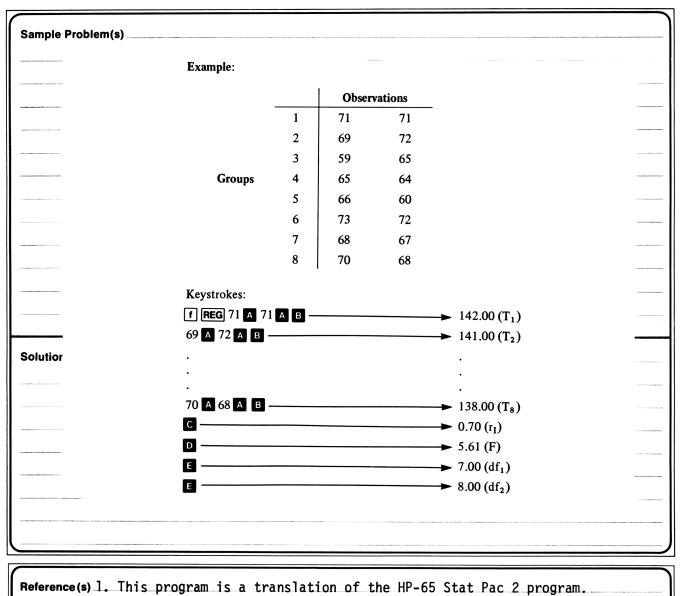
Drognam Decemintion

rogram Title	INTRACLASS CORRELATION COEF	FICIENT	
ontributor's Name	Hewlett-Packard		
ddress 1000 l	I.E. Circle Blvd.		
ity Corvall	S State	Oregon	Zip Code 97330
rogram Description,	Equations, Variables		
	Among groups		
	k = 2 / 2 /		
	ASS = $\sum_{i=1}^{k} T_i^2 / n - M_i^2$	22	-
NUMPERATURE TO A LOCAL DIST.	Within groups		_
	WSS = $\sum_{i=1}^{k} \sum_{j=1}^{n} x_{ij}^{2} - MSS$	S – ASS	
	3. Intraclass correlation coefficient		_
	$r_{I} = \left(\frac{ASS}{k-1} - \frac{WSS}{k(n-1)}\right) / \left(\frac{A}{k}\right)$	$\left(\frac{SS}{-1} + \frac{WSS}{k}\right)$	-
	4. F statistic		_
	$F = \frac{ASS}{k-1} / \frac{WSS}{k(n-1)}$	1)	
	with $df_1 = k - 1$ and $df_2 = k (n - 1)$	degrees of freedom	 I.
ne a de alteres en la Necessaria de la composición de la composición de la composición de la composición de la			
perating Limits and N	Varnings		
	2		

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2. B. Ostle, Statistics, in Research, Iowa State University Press, 1972.

\mathcal{L}	CORR	•INTRACL	ASS DEFFICIENT			٦
	× _{ij} ⊳j	►Ti	►r	►F	►df ₁ ►df ₂	J

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Initialize		f REG	
3	Perform 3-5 for i = 1, 2,, k			
4	Perform 4 for j = 1, 2,, n	× _{ij}	A	j
5	Compute the group mean		В	Тi
6	Compute the coefficient		С	۲I
7	Compute the F statistic		D	F
8	Compute the degrees of freedom		E	df1
			E	df ₂
9	For a new case, go to 2			

36			<i>//</i>				
STEP	KEY ENT	RY KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11		05	7 RCL8	36 08	
				050		-55	Dicplay r
002		35-55 06	× _{ij}	05		-24	Display r _l
003		53					
664	\$ ST+5	35-55 05		061		24	
005	5 1	<i>01</i>		06.		2i 14	
00E		36 01	Increase counter	062	2 RCL7	36 07	Compute F
			Increase counter	063		36 0 8	
007		-55		06-		36 01	
003		35 Ø1					
009	RTN	24		063		-24	
010		21 12	Compute group sum	066		-24	
611		36 06	compute group sum	061	7 RTN	24	
				068		21 15	
012		35 08		069		36 02	Compute degrees of
013	3 ST+3	35- 55 03					freedom
014	4 X2	53		070		Ū1	
015		35-55 04		07:	1 –	-45	
		36 01		072	2 R/S	51	
016				07.		21 15	
017		35 07					
018	30	00		074		36 Ø1	
019		35 01	Reinitialize	075		36 Ø2	
020		35 06		076	5 X	-35	
				077		24	
020		Ø1				1	1
022		36 02					
023	3 +	-55					
024		35 02		080			
02:		36 08	Display sum				
			Display Sum				1
Ø20		24					
021	7 *LBLC	21 13					
Ø23	8 RCL4	36 04	Compute coefficient				
023		36 03					
		53					
031							
03.		36 02					
032	2 ÷	-24					
03		-45					
03-		36 07	Acc /1 1	090			
			ASS/k-1				
03:		35 01					
630		-24					
031	7 RCL2	36 02					4
030		01					
03:		-45					
			1			1	1
041		-24	1	 	- FLAGS		SET STATUS
04.		35 07	ł		-0	FLAGS	TRIG DISP
042	2 RCL5	36 05	1				
04:		36 04	J		Ll'	0 □ 12	DEG 🗹 FIX 🗹
04		36 01	1	100	2		GRAD C SCI C
			1				
04		-24	1	 	3		RAD 🗆 ENG 🗆
04:		-45	1		┝┨	3 🗆 🗹	
047	7 RCL2	3 6 02	4	L	_		
04(-24]	1		LABE	<u> </u>
045		3 5 08		1-	I		
			Α Σ +	В	T;	Y ₁	F $[df_1, df_2]$
050		36 01		b	- 'i c	_ d	
05:		Ø1	a	^o	C C	ľ	ř
053	2 -	-45	0	1	2	3	4
05		35 01					
05-		-24	5	6	7	8	9
05		-45					
050	6 RCL7	36 07		STERS	L	•	
L					2 6 T	7	8 9
0	1	n-1 ² k	3 ΣT , 4 ΣT , 2	⁵ Σ × i	$\mathbf{j}^{2} \mid \mathbf{f} \mathbf{T}_{\mathbf{i}}$	ľ ASS/k-	-1 ⁸ T, WSS/k ⁹ 0
						S7	
S0	S1	S2	S3 S4	S5	S6	5/	30 39
A		В	c	D		E	I
1							
				1			

Program Title	FISHER'S EXACT TEST FOR A 2 x 2 CONTINGENCY TABLE
Contributor's Name	Hewlett-Packard
Address	1000 N.E. Circle Blvd.
City Corva	Illis State Oregon Zip Code 97330
Program Description, I	Equations, Variables
	Fisher's exact probability test is used for analyzing a 2×2 contin- gency table when the two independent samples are small in size.
	a b
	c d
	Suppose a, b, c, d are the frequencies and a is the smallest frequency,
	this program computes the following:
	1. The exact probability p_0 of observing the given frequencies in a 2 x 2 table, when the marginal totals are regarded as fixed.
	2. The exact probability p _i (i = 1, 2,, a) of each more extreme table having the same marginal totals.
	3. The sum S _i of the probabilities of the first i + 1 tables.
	4. The sum S of the probabilities of all tables with the same margins (i.e., S = S _a).
	Equations:
	_
	1. $p_0 = \frac{(a+b)! (c+d)! (a+c)! (b+d)!}{N! a! b! c! d!}$
	where
	N = a + b + c + d.
Operating Limits and W	/arnings
· · · · · · · · · · · · · · · · · · ·	
this program material A upon any representation NEITHER HP NOR THE PROGRAM MATERIAL, FOR A PARTICULAR PL TIAL DAMAGES IN CON	verified only with respect to the numerical example given in <i>Program Description II.</i> User accepts and uses T HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance or description concerning the program material. CONTRIBUTOR MAKES ANY EXPRESS OR IMPLIED WARRANTY OF ANY KIND WITH REGARD TO THIS INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS JRPOSE. NEITHER HP NOR THE CONTRIBUTOR SHALL BE LIABLE FOR INCIDENTAL OR CONSEQUEN- INECTION WITH OR ARISING OUT OF THE FURNISHING, USE OR PERFORMANCE OF THIS PROGRAM
MATERIAL.	

Program Title	FISHER'S EX FOR A 2 x 2 CONTIL			
Contributor's Name Hewlett	-Packard			
Address 1000 N.E. Circl	e Blvd.			
City Corvallis	Sta	te Oregon	Zip Code	97330
Program Description, Equations, V	/ariables			
2.	For the more extreme table (with the same margir	ns)	
	a – i	b + i		
	c + i	d – i		
	$p_{i} = \frac{(a+b)! (c+d)!}{N! (a-i)! (b+i)!}$	$\frac{(a + c)!(b + d)!}{(c + i)!(d - i)!}$		
where				
	i can be 1, 2, or a			
3.	$S_n = \sum_{i=1}^{n} p_i$			
	$S_n = \sum_{i=0}^{n} p_i$			
where				
wildle	n can be 1, 2,, a			
4.	а			
т.	$S = \sum_{i=0}^{a} p_i$			
	1=0			
Operating Limits and Warnings				
				- PERMIT AND ADDRESS AND ADDRESS
Remarks:				
	ust be the smallest among the if necessary.	frequencies. Rearran	nge the	
2. This	program requires N ≤ 69. Ho	wever, Fisher's exact	t test is	
	hally used for $N \leq 30$.			
)

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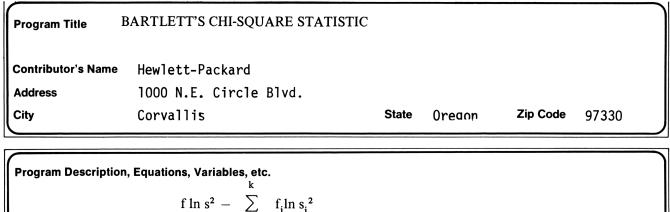
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6					
Sketch(es)					
			•		
Sample Problem(s)					
	Example				
administrative -	Example:	_			
	Compute p_0, p_1	$1, p_2, S_4$ and S for	the following ta	ble	
Logistic IN	,	~	10		
1972 (1977 (1986 A		7	10		
		8	5		
xantuudinaan.					
*******	Note:				
	The table must	be rearranged as			
		-		-	
MMM410400011		5	8		
Accession and Acce		10	7		
Monte and Annual Control of Contr	Keystrokes:				
40.000 0000000.] 7 A ———		$\rightarrow 0.16 (p_0)$	
19880000019949	В			→ 0.00 (p ₁)	
Sol	В В С —			→ 0.23 (S₄)	
	D			→ 0.23 (S)	
and generalized on the					
Reference (s)					
	1. S. Siegel, No	onparametric Statis	tics. McGraw-Hi	ill, 1956.	
		Fisher, Statistical	Methods for Re	search Workers,	
	Oliver and B	loyd, 1950.			
Thic marine -	• • • • • • • • •				
This program is	s a translati	on of the HP-	-65 Stat Pa	c 2 program.	

FISHER'S EXACT TEST FOR A 2×2 CONTINGENCY TABLE a4b4 € c4d⊧Po ⊧Pi ⊧Si ►S

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Enter frequencies and compute			
	P ₀	а		
		b		
		С	↑	
		d	A	p ₀
3*	Optional—perform 3 or 3-4 for			
	i = 1, 2,, a		В	p _i
4	Optional—recall current S _i		С	Si
5	Compute the sum of all			
	probabilities		D	S
6	For a new case, go to 2			
	* It is not necessary to com-			
	plete the loop of 3 and 4. Go to			
	5 for S when desired.			

							41
STEP	KEY ENTR	Y KEY CODE	COMMENTS	STEP	KEY ENTR	Y KEY CODE	COMMENTS
001	*LBLA	21 11		057		35-55 03 -	
002	ST04	35 04		058 058		35-45 04 -	4
003	R↓	-31	Stored, c,b,a	030 059		35-45 08	4
004	ST03	35 03				36 07	4
005		-31		060			4 1
				861		22 00	
006	ST02	35 02		062		21 13	Recall the sum S _n
007	XZY	-4 İ		063		36 0 5]
008	ST01	35 01		064		51]
00 9	STO8	<i>35 08</i>		065	5 ★LBLD	21 14	Compute the sum C
010	÷	-55		06 6		36 08	Compute the sum S
011	ST05	35 05		067		00	1 1
612	R↓	-31		068		16-33	
613	+	-55		069		23 01	
014	ST06	35 06		076		23 12	
015	N.	16 52	(c+d)!	071		22 14	
016	RCL5	36 05				21 01	
017	N!	16 52		07:		36 05	
018	X	-35	(a+b)!	07		50 55	
				07			
019	RCL5	36 05 36 05		67	5 RTN	24	
020	RCL6	36 06					
021	+	-55					
022	N !	16 52] [
023	÷	-24					
024	RCLi	36 01		080			1 1
025	RCL3	36 03					1 1
0 26	÷	-55	(a+c)!				1 1
027	Ν!	16 52					4 1
028	X	-35					1 1
029	PCL2	36 02					4 1
020 030	RCL4	36 02 36 04					4
031	+	-55	(4 1
<i>0</i> 32	N !	16 52	(b+d)!				4 1
033	X	-35					
634	ST07	35 07		090			1
635	e	00					
036	STC5	35 05					
037	R↓	-31					1 1
6 38	*LBL0	21 00					1
039	RCL 1	36 01	Loop for computing				1
040	N!	16 52	probability				1
041	÷	-24	probability				1
042	RCL2	.36 02					1 1
043	N!	16 52		 			1 1
040 044	÷.	-24		100			1 1
045	RCL3	36 03		+			1 1
045 046	NULS NI	16 52		\vdash			4 I
646 647	n: ÷	-24		├ ──┤			4 1
		-24 36 04		├ ───┤			4
048 049	RCL4			├ ───┤	FLAG	s	SET STATUS
049 859	N !	16 52		├├			
050 051	÷	-24 35 55 05	Accumulate the sum	├ ──┤	_Ľ	FLAGS	TRIG DISP
051	ST+5	35-55 05	Display ρ_0		1	ON OFF	DEG 🗹 FIX 🗹
052	RTN	24	e e e	├ ──┤	2		GRAD SCI
053	*LBLB	21 12	Compute $ ho_{i}$ for				
054	1	01	more extreme	110	_3	$\begin{array}{c c} 2 & \Box & Q \\ 3 & \Box & Q \end{array}$	RAD \square ENG \square n_2
055	ST-1	35-45 01	tables	├			
056	ST+2	35-55 02					
		I		STERS		7	8 9
0	1	2	3 4	5 a+b lle	$ad \begin{bmatrix} 6 \\ c \end{bmatrix}$		1 1
<u>C0</u>	S1	S2	S3 S4	a+b Us S5	ed c+	d Used	S8 S9
S0	51	52	55 54	33	00		
A		B		D		E	I
~			Ĭ				
						1	



 $x^{2} = \frac{\sum_{i=1}^{i=1} \frac{1}{1 + \frac{1}{3(k-1)} \left[\left(\sum_{i=1}^{k} \frac{1}{f_{i}} \right)^{i} - \frac{1}{f} \right]}$ where $s_{i}^{2} = \text{sample variance of the } i^{\text{th}} \text{ sample}$ $f_{i} = \text{degrees of freedom associated } s_{i}^{2}$ i = 1, 2, ..., k k = number of samples $s^{2} = \frac{\sum_{i=1}^{k} f_{i} s_{i}^{2}}{f}$ $f = \sum_{i=1}^{k} f_{i}$ This χ^{2} has a chi-square distribution (approximately) with k - 1 degrees of freedom which can be used to test the null hypothesis that $s_{i}^{2}, s_{2}^{2}, ..., s_{k}^{2}$ are all estimates of the same population variance σ^{2} ; i.e. H_{0} : Each of $s_{i}^{2}, s_{2}^{2}, ..., s_{k}^{2}$ is an estimate of σ^{2} .
Note: Erroneous data can be corrected by using the \boxed{D} key.

Operating Limits and Warnings

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Sketch(es)												
								•				
Sample Prot	olem(s)											
		Apply	the prog	gram to	the follo	owing d	ata:					
			i	1	2	3	4	5	6			
		509000v	s _i ²	5.5	5.1	5.2	4.7	4.8	4.3			
			f _i	10	20	17	18	8	15			
Solution(s)	Keystroke	es:										
	[A] 5.5[ENT+]] 10ГВ]	. 5.1[ENT+];	20ГВ].		•					
	4.3[ENT+]] 15[B]										
	[C] [R/S]											
	[K/3]							/	5.00	\UI		
Reference (s							-					
		istical		y with	Engin	eering	Appli	<u>cation</u>	<u>s</u> , A.	Hald,	John W	liley
		Sons, 1 progra		trans	lation	of th	e HP-6	5 Stat	Pac 1	progr	am	

	Bartlett's Chi-Square Statist	ic	7	
	$ INT \Sigma^+ \chi^2 \Sigma^- $			
STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Initialize		A	
3	Perform 3 for i = 1, 2,, k	s _i ²		
		fi	В	i
	(Correct erroneous data s _m ² , f _m)	s _m ²		
		f _m		
4				<u>x</u> ²
5			R/S	df

			JI TIUSIA		ung i			45
STEP	KEY ENTR	Y KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS	
681	*LBLA	21 11		057		-31		
602		16-53	Initialize	058		-21		
003		00	Inicialize	059		-21		
004		24	Clear storage	060		36 Ø1		
005		21 12	registers	861		-35		
005		35 01	Accumulate sums	062		35-45 08		
007		35-55 03	Accumulate sums	063		-41		
008		52		064		32		
009		35-55 04		065		36 01		
010		-31		066		-35		
011	ENT†	-21		067		35-45 07		
612		-21		068		36 05		
013		36 01		069		01		
014		-35		070		-45		
015		35-55 08		071		35 05		
016		-41		672		24		
017		32					1	
018		36 01						
019		-35						
020		35-55 07						
021	RCL5	36 05						
622	1	Ø1						
023	÷	-55		000				
024	ST05	35 Ø5	,	080				
025	RTN	24						
025	*LBLC	21 13	Compute chi-squar	∿e				
027	RCL8	36 08		Ŭ				
028	RCL3	36 03		+				
029	÷	-24		+			4	
030		32		+			4	
031	RCL3	36 03		+			+	
032		-35					4	
633	RCL7	36 07		090			•	
034	-	-45		090			•	
035		36 04					•	
036	RCL3	36 03					•	
037	17X	52					4	
038		-45					4	
039		36 05					4	
040		61					•	
041	-	-45					4	
042		35 02		+		1	1	
043		03		100		<u> </u>	1	
044	X	-35		+			1	
045 045		-24					1	
046 047	1	Ø) -55]	
047 040	+	-55 - 34]	
848 848		-24	Display chi-squar	e			l	
049 050		51 36 02		-			SET STATUS	
050 051	RTN	36 02 24				FLAGS	TRIG DISP	
051 052		24 21 14				ON OFF	, , , , , , , , , , , , , , , , , , , ,	
052 053		21 14 35 01	Error corrector			0 🗆 🗹		
053 054	3701 ST-3	35 01 35-45 03		110	an ann an tha an tha an tha an tha an tha an tha an tha an tha an tha an tha an tha an tha an tha an tha an tha		GRAD C SCI C RAD C ENG C	
054 055		33-43 83 52				$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	RAD ENG n_2	_
655 656		35-45 04						
1					6 0	75.6 -	2 8 9 0	
0	¹ f	i ² df	$^{3}\Sigma f_{i}$ $^{4}\Sigma l/f_{i}$	⁵ k	⁶ 0	$^{7\Sigma}f_{i}Ins_{i}$		
S0	S1	S2	S3 S4	S5	S6	S7	S8 S9	
A		В		D	I	E	I	
Î		ľ						

Program Title MANN-WHITNEY STATISTIC

Contributor's Name Hewlett-Packard

Corvalli

Address

City

Program Description, Equations, Variables, etc.

This program computes the Mann-Whitney test statistic on two independent samples of equal or unequal sizes. This test is designed for testing the null hypothesis of no difference between two populations.

Mann-Whitney test statistic is defined as

$$U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - \sum_{i=1}^{n_1} R_i$$

1000 N.E. Circle Blvd.

where n_1 and n_2 are the sizes of the two samples. Arrange all values from both samples jointly (as if they were one sample) in an increasing order of magnitude, let R_i (i = 1, 2, ..., n_1) be the ranks assigned to the values of the first sample (it is immaterial which sample is referred to as the "first").

When n_1 and n_2 are small, the Mann-Whitney test bases on the exact distribution of U and specially constructed tables. When n_1 and n_2 are both large (say, greater than 8) then

$$z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{n_1 n_2 (n_1 + n_2 + 1)/12}}$$

is approximately a random variable having the standard normal distribution.

Operating Limits and Warnings

For small samples (say, less than or equal to 8) the specially constructed tables should be used. For example:

Handbook of Statistical Tables, D. B. Owen, Addison-Wesley, 1962

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Address

State Oregon

Zip Code 97330

Sketch(es)

	U and Z for the Sample 1	14.9	11.3	13.2	16.6	17	14.1	15.4	13	16.9		
	Rank R _i	7	1	4	12	14	5	10	3	13	-	
	Sample 2	15.2	19.8	14.7	18.3	16.2	21.1	18.9	1	2.2	15.3	19.4
	Rank	8	18	6	15	11	19	16		2	9	17
olution(s)	Keystrokes: 10[A] 7[B] 3[B] 13[B] [C]							>		00 (l		
olution(s)	10[A] 7[B] 3[B] 13[B]							>	66.			

		Mann-Whi	tney	Stat	istic			5
n₂	_	Σ +		U		z	Σ -	

STEP	INSTRUCTIONS	INPUT DATA/UNITS		KE	YS	OUTPUT DATA/UNITS
1	Enter program		[
2		n ₂	[А		
3	Perform 3 for i = 1, 2,, n ₁	R _i	[В		i
	(Correct erroneous data R _k)	R _k	[E		
4	Compute U		[С		U
5	Compute z		[D		z
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STEP								49
-	KEY ENTF		COMMENTS	STEP	KEY ENTRY	KEY CODE	СОММ	ENTS
881	*LBLA	21 11					4	
002	ST02	35 02	$n_2 \rightarrow R_2$				4	
003	Ø	08		060	ł		4	
004	ST01	35 01	Store O in R_1, R_3				4	
005	STC3	35 03					-	
005	RTN	24						
007	*LBLB	21 12					1	
008	ST+3	35-5 5 03	Accumulate sums				-	
009 019	RCL1	36 01 01					1	
010 011	i +	01 -55	1				1	
011 012	s701	-33 35 01	1				1	
012	RTN	30 01 24	1				1	
013 014	*LBLC	21 13		070			1	
015	RCL2	36 02	Compute U				1	
016	RCL1	36 01					1	
017	1	Ø1]	
018	÷	-55]	
019	2	02						
020	÷	-24						
021	÷	-55						
022	Х	-35					1	
023	RCL3	36 03	Display U				4	
624	-	-45	Display	080			4	
025	RTN	24					4	
026	*LBLD	21 14	Compute z				4	
027	RCL1	36 01					4	
023	RCL2	36 02					-	
B 29	X	-35					4	
030	2	82					-	
031	÷	-24					•	
832	-	-45					4	
033	RCL1	36 01 76 00		090		+	1	
034 075	RCL2	36 02 FF						
035 074	÷	-55 01						
036 037	1 +	-55						
037 038		36 Ø1					1	
039 039	X	-35]	
040 040	RCL2	36 02						
041	X	-35						
642	1	Ø1						
843	2	02						
644	÷	-24		100			4	
045	1%	54						
646	÷	-24	Display z				4	
047	RTN	24					4	
048	*LELE	21 15	Error corrector		 	 	ł	
649	ST-3	35-45 03					SET STATUS	{
050 051	RCL1	36 Ø1				++		
051 050	1	Ŭ1 -45				ON OFF		DISP
052 057	- 9701	-45 35 01					DEG 🗹	FIX 🗹
053 054	STO1 RTN	30 01 24		110		L 1 □ Ø	GRAD 🗆	SCI 🗆
во4 	7 (N		4				RAD 🗆	ENG
						3 🗆 🗖		n
					6	7	8	9
0	l ¹ n	$1 \frac{2}{n_2}$	3 ΣR_{1} 4	5	o	· /		,
SO	S1	S2		S5	S6	S7	S8 5	59
A		в	С	D		E	I	

KENDALL'S COEFFICIENT OF CONCORDANCE **Program Title**

Hewlett-Packard Contril

Circle Blvd. Address

Corvallis City

Oregon State

97330 Zip Code

Program Description, Equations, Variables, etc.

Suppose n individuals are ranked from 1 to n according to some specified characteristic by k observers, the coefficient of concordance W measures the agreement between observers (or concordance between rankings).

$$W = \frac{12 \sum_{i=1}^{n} \left(\sum_{j=1}^{k} R_{ij}\right)^{2}}{k^{2} n(n^{2} - 1)} - \frac{3(n+1)}{n-1}$$

Where R_{ii} is the rank assigned to the ith individual by the jth observer.

W varies from 0 (no community of preference) to 1 (perfect agreement). The null hypothesis that the observers have no community of preference may be tested using special tables, or if n > 7, by computing

$$\chi^2 = k (n-1) W$$

which has approximately the chi-square distribution with n - 1 degrees of freedom (df).

Operating Limits and Warnings

For small samples (say, less than or equal to 7) the specially constructed tables should be used. For example:

> Rank Correlation Methods, M.G. Kendall, Hafner Publishing Co., 1962

This program has been verified only with respect to the numerical example given in Program Description II. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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Dutor's	Name	
	1000	N.E.

Sketch(es)						
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	•	ана са се се се се се се се се се се се се се		,	· · · · · · · · · · · · · · · · · · ·	•
				ana ana a sa akana sa mana ana aga sana a sa manageren kena		
		· · · · · · · · · · · · · · · · · · ·				
				189 H H H H +		
				a an an an an an an an an an an an an an		
			· · · · · · · · · · · · · · · · · · ·	an a sa sa sa sa ara a sa sa sa sa sa sa sa sa sa sa sa sa		
			·			
Sample Problem(s) 1. Find	W, χ^2 , and	l df for the foll	lowing data:			
	× 1	Table for R _{ii}	(n = 10, k	= 3)		
	j	-	-			
	i	1	2	3		
	1	6	7	3		
	$\frac{1}{2}$	1	, 4	2		
	3	9	3	5		
	4	2	6	1		
	5	10	8	9		
	6	3	2	6		
	7	5	9	8		
	8	4	1	4		
	9	8	10	10		
	10	7	5	7		1 - 19 - 1 - 19 - 19 - 19 - 19 - 19 - 1
Solution(s) Keystrokes:						
[f] [CL REG]						
6[A] 7[A] 3[A] [B],						
1[A] 4[A] 2[A] [B]						an an an an an an an an an an an an an a
7[A] 5[A] 7[A] [B]						
					<u> </u>	····
[0]						
[D]						
[R/S]					-> 9.00	(df)
Reference (s)						
Reference(s) 1. <u>Nonparametric Sta</u>	+istica]	Inforence.	יח Gibł	McGr	u;1]	ודחי
I. NUTPATAMENTO COM						1971.
	· · · · · · · · · · · · · · · · · · ·			• · · · · ·	coursm	
2. This program is a	transla	tion of the	HP-05 STE	at Pac I p	rogram.	
	transla	tion of the	HP-65 STA	at Pac I p	r ograin.	

Kendall	's Coefficie	ent of Cor	cordance		7
Σ+	ΣΣ +	W	χ^2 ,df	Σ -	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program			
2	Initialize		f CL REG	
3	Perform 3-5 for i = 1, 2,, n			
4	Perform 4 for j = 1, 2,, k	R _{ij}	A	j
	(Correct erroneous data R _{im})		E	
5			В	i
6	Compute W		С	W
7	Compute χ^2 and df		D	χ^2
8			R/S	df
	(For a new case, go to 2.)			
				1

							53
STEP	KEY ENT	RY \sim Key code	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
801	*LBLA	21 11		057	7 RCL4	36 04	
002		35-55 02		058		38 04 01	
003		36 01	Accumulate sums	059		-45	
003	1	01	(i is fixed)				
005		-55		860		24	
005 006				061		21 15	Error corrector
		35 01	Display current j	062		35-45 02	(i is fixed)
087		24		063		36 01	
003		21 12	Accumulate sum	064		Ø1	
009		36 01 35 05	over i	065		-45	
010		35 05		066		35 01	
011	RCL2	36 82		067	r RTN	24	_
012		53					_
013		35-5 5 03					_
014	RCL4	36 04		070			_
015		Ø1					
016	÷	-55					
017	STC4	35 04					
018		ŨŨ	Deductiolize D D				
019		35 Ø1	Reinitialize R ₁ ,R ₂				1
020		35 02					1
021	RCL4	36 04	Display current i] . !
022		24					1
022 023		21 13	Compute W			1	1
023 024		36 03		080			1
							-
025 006	1	Ø1 82 -				+	-
026		02 - 75					-
027		-35		├ ───┤		+	-
028		36 05		├ ───┤			-
029		53		├ ───┤			4
030		-24				+	4
031	RCL4	36 04					4
032		-24		+			4
033		36 04					4
034		53		090			4
035	1	Ø1					_
036	-	-45					
037		-24]
038		35 Ø4]
039	1	Ø1					
640		-55					1
041	3	03					1
042		-35					1
042		36 Ø4					1
043 044	1	01		100			1
044 045	-	-45					1
045		-24				1	1
	-	-45		├ ───┤			1 . !
047 042	- рти	-40 24	Display answer W	 +		+	1
043 043			2				4
049 050		21 14 76 05	Compute χ^2 and df	├ ───┤		+	SET STATUS
050		36 05 75	k	├ ───┤		+ +	
051 052	X	-35		├ ───┤		FLAGS	TRIG DISP
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NOTES

Hewlett-Packard Software

In terms of power and flexibility, the problem-solving potential of the Hewlett-Packard line of fully programmable calculators is nearly limitless. And in order to see the practical side of this potential, we have several different types of software to help save you time and programming effort. Every one of our software solutions has been carefully selected to effectively increase your problem-solving potential. Chances are, we already have the solutions you're looking for.

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10	
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EE (Lab)	Games
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Beams and Columns	Calendars
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TEST STATISTICS

Test Statistics includes many of the non-parametric tests and others.

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