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100

HP 41C PROGRAM SUBMITTAL FORM
PROGRAMMFORMBLATT/DOCUMENTATION DU PROGRAMME/GENERALITÀ SUL PROGRAMMA

Program Title
Programmtitel
Titre du programme
Titolo del programma

RANDOM NUMBER EVALUATOR

Category No.
Kategorie Nr.
Catégorie N°
Categoria N°

302

Name
Rubrik
Rubrique
Nome della categoria

PROBABILITY

No. of program lines
Anzahl Programmzeilen
Nombre de lignes de programme
N° di linee di programma

288

No. of data registers
Anzahl des benötigten Datenspeicher
Nombre de registres de données
N° di registri utilizzati

36

Recommended HP 41C System configuration

Empfohlene System-Konfiguration
Configuration recommandée
Configurazione raccomandata

Port # 1

MM

Port # 2

Port # 3

PR

Port # 4

(CR)

This program requires the following programs as subroutines:

Dieses Programm benutzt folgende Programme als Unterprogramme:

Ce programme utilise les programmes suivants comme sous-programmes:

Questo programma usa i seguenti programmi come subroutines:

F Applications ROM

HP Applikations ROM

ROM d'application HP

ROM di applicazione HP

Program Name:

Programm:

Nom du programme:

Programma:

Program Abstract
Kurzbeschreibung
Résumé
Breve descrizione
del programma

THE PROGRAM EXECUTES A USER-PROVIDED RANDOM NUMBER GENERATOR, AND CHECKS THE OUTPUT IN THE FOLLOWING WAYS: THE MEAN AND STANDARD DEVIATION OF A SEQUENCE ARE COMPUTED; THE CORRELATION BETWEEN X_i AND X_{i+1} IS CALCULATED; A RUNNING CHECK IS MADE TO DETERMINE WHEN THE GENERATOR ENTERS A CLOSED CYCLE (IF EVER); A HISTOGRAM IS PLOTTED; AND A CHI-SQUARED TEST OF UNIFORMITY IS CALCULATED. THE PROGRAM REQUIRES ONE MEMORY MODULE; A PRINTER IS RECOMMENDED.

Name
Name/Nom/Nome

L. H. GILBERT

Address
Strasse/Adresse/Indirizzo

DEPARTMENT OF PSYCHOLOGY, UNIVERSITY OF CAPE TOWN

City
Ort
Localité
Città

RONDE BOSCH

Postal Code
Postleitzahl
Code postal
C.A.P.

7700

Country
Land
Pays
Paese

SOUTH AFRICA.

ACKNOWLEDGMENT AND AGREEMENT

Erklärung und Ermächtigung/Déclaration et Autorisation/Dichiarazione e Autorizzazione

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Date
Datum
Date
Data

26.2.80

Signature
Unterschrift
Signature
Firma

En Content

Application, Equations, Variables
Anwendung, Gleichungen, Veränderliche
Application, Equations, Variables
Applicazione, Equazioni, Variabili

THE RANDOM NUMBER GENERATOR PRODUCES A
SEQUENCE OF (UNIFORM) NUMBERS, $X = \{X_i\}$,
 $i = 1 \dots N$.

- FOR EACH X_i , X_{2i} IS COMPUTED AND MATCHED; IF EQUAL, A CLOSED CYCLE OF NUMBERS HAS BEEN DETECTED.
- A HISTOGRAM OF 20 "BINS" ON THE INTERVAL 0-1 IS CONSTRUCTED, AND A COUNT MADE OF WHERE EACH X_i FALLS.
- THE EXPECTED COUNT PER BIN, $N/20$, IS EMPLOYED IN A χ^2 TEST:

$$\chi^2 = \sum_{f_e} (f_j - f_e)^2 \quad j = 1 \dots 20$$

f_j = EXPECTED COUNT
 $f_e = N/20$

AT THE 5% LEVEL OF SIGNIFICANCE, THE χ^2 SHOULD BE GREATER THAN 30 IN ORDER TO CONCLUDE THAT THE N RANDOM NUMBERS ARE NOT UNIFORMLY DISTRIBUTED.

Operating limits and Warnings
Grenzen und Einschränkungen
Limites et restrictions
Limiti operative e avvertenze

- THE PROGRAM IS DESIGNED TO EVALUATE
A GENERATOR OF UNIFORM RANDOM
NUMBERS, ON THE INTERVAL 0 $\leftrightarrow$ 1.

- USING ALL THE PROGRAM FACILITIES, EACH NUMBER TAKES ABOUT 3,6 SECONDS TO GENERATE AND EVALUATE; ABOUT 3,0 SECONDS WITH THE PRINTER SWITCHED OFF.
- PLACE THE RANDOM NUMBER GENERATOR INTO THE PROGRAM AT LABEL 00.

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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Dieses Programm wurde lediglich anhand des in der Programmbeschreibung II enthaltenen Zahlenbeispiels überprüft. Der Benutzer erhält und benutzt das Programmmaterial auf eigenes Risiko hin; er hat es deshalb - gleichgültig, ob es bereits anderweitig präsentiert oder beschrieben wurde - selbst zu untersuchen.

WEDER HP NOCH DER EINSENDER DES PROGRAMMS ÜBERNEHMEN FÜR DAS PROGRAMMATERIAL EINE IRGENDWIE GEARTETE GEWÄHRLEISTUNG ODER HAFTUNG, INSBESONDERE NICHT FÜR SEINE VERKÄUFLICHKEIT ODER SEINE VERWENDBARKEIT FÜR EINEN BESTIMMTEN ZWECK. HP UND DER EINSENDER HAFTEN AUCH NICHT FÜR INDIREKTE ODER FOLGESCHÄDEN.

Le présent programme n'a été vérifié qu'en ce qui concerne l'exemple numérique indiqué dans la description du programme II. L'utilisateur accepte et utilise le présent programme À SES PROPRES RISQUES et doit se fier uniquement à sa propre inspection dudit programme sans se référer à toute autre déclaration et description.

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Questo programma è stato verificato soltanto per quanto concerne l'esempio numerico indicato nella Descrizione del Programma II. L'utilizzatore accetta e utilizzerà il presente programma A SUO INTERO RISCHIO, fidandosi unicamente della propria verifica del programma e non basandosi su altre dichiarazioni o descrizioni.

NE LA SOCIETÀ NÉ L'AUTORE DANNO ALCUNA GARANZIA IMPLICITA O ESPlicitA CONCERNENTE IL PRESENTE PROGRAMMA, IN SPECIAL MODO RIGUARDO ALLA SUA COMMERCIALIZZAZIONE O ADATTABILITÀ AD UN USO PARTICOLARE. NÉ LA SOCIETÀ HP NÉ L'AUTORE ASSUMONO ALCUNA RESPONSABILITÀ PER DANNI IMMEDIATI O MEDIATI CAUSATI DALLA FORNITURA, UTILIZZAZIONE O FUNZIONAMENTO DEL PRESENTE PROGRAMMA.

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PROGRAM DESCRIPTION II

PROGRAMMBESCHREIBUNG II
DESCRIPTION DU PROGRAMME II
DESCRIZIONE DEL PROGRAMMA II

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Example
Beispiel
Exemple
Esempio

A SEQUENCE OF $N=100$ NUMBERS WAS GENERATED BY
THE FORMULA: $X_{i+1} \leftarrow [9821 * X_i + .271327]$

[]: TAKE FRACTIONAL PART.

THE INITIAL SEED WAS ,159753.

FOR THE FIRST 100 DIGITS:

FOR THE SECOND 100 DIGITS:

N=100
SEED(N)= 1.597530000E-01
SEED(2N)=1.597530000E-1
S= 0.5037 S= 0.2840
r=-0.0071 N= 100
E(f)= 5.0

	0	FREQ	12
0 7		x	
5 3	x		
10 5		x	
15 5		x	
20 6		x	
25 4	x		
30 5		x	
35 5		x	
40 2	x		
45 4		x	
50 8		x	
55 6		x	
60 4	x		
65 7		x	
70 10		x	
75 4	x		
80 4		x	
85 3	x		
90 2	x		
95 5		x	

CHI-SQ (5%:30) = 14.00

N=100
SEED(N)= 9.814530000E-01
SEED(2N)=2.031530000E-1
S= 0.4924 S= 0.2937
r=-0.1551 N= 100
E(f)= 5.0

	0	FREQ	12
0 6		x	
5 6		x	
10 6		x	
15 5		x	
20 2	x		
25 3	x		
30 2	x		
35 4	x		
40 4	x		
45 7		x	
50 4	x		
55 4	x		
60 8		x	
65 5		x	
70 8		x	
75 7		x	
80 5	x		
85 4	x		
90 3	x		
95 5		x	

CHI-SQ (5%:30) = 13.60

Sketch
Skizze
Dessin
Disegno

PROGRAM DESCRIPTION III

PROGRAMMBESCHREIBUNG III
DESCRIPTION DU PROGRAMME III
DESCRIZIONE DEL PROGRAMMA III

DESCRIPTION DEL PROGRAMMA III				
Data Input Dateneingabe Données Dati	Keystrokes Tasten Touches Tasti	Result Resultat Résultat Risultato	Comments Kommentare Commentaires Commenti	
	XEQ "EVAL"	"F: CLEAR/SET"	DISPLAY IS A HEADING FOR THE FOLLOWING REMINDERS ABOUT THE FLAG FUNCTIONS.	
		"0: STOP/CONT"	} SEE USER INSTRUCTIONS	
		"1: CLRG/ACCUM"		
		"2: XN=X2N/OMIT"		
		"3: HISTO/OMIT"		
		"4: /XN=2N ONLY"		
		SIZE=36/FLGS	HP47C HALTS TO ALLOW SIZE AND FLAGS TO BE SET.	
	R/S	SEED?	GIVE SEED AND	
	R/S	N?	SEQUENCE LENGTH.	
	R/S			
		N=100	} OUTPUT TO PRINTER	
		SEED<N>=.159357		
		SEED<2N>=.159357		
		"100"	COUNTDOWN AS EACH NUMBER IS GENERATED AND EVALUATED.	
		"99"		
		"98"		
				
		"3"	HP47C BEEPS AND HALTS AT END.	
		"2"		
		1 + BEEP		
	R/S	→ OUTPUT	ON PRINTER (SEE EXAMPLE).	
		14.00	HP47C HALTS WITH χ^2 DISPLAYED.	
	R/S	N=100	AND THE SECOND 100 NUMBERS	
			ARE GENERATED.	
				

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USER INSTRUCTIONS I

PROGRAMMABLAUF I
INSTRUCTIONS D'EMPLOI I
NORME OPERATIVE I

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Step Schnitt Pas Passo	Instructions Operation Instructions Istruzioni	Variables Dateneingabe Données Dati	Function(s) Taste(n) Touche(s) Tasti	Result Resultat Résultat Risultato
1.	BEGIN. (USER HAS ALREADY INSERTED HIS GENERATOR.) HEADING FOR FOLLOWING DISPLAYS: FOO: CLEAR = HALT AFTER N NUMBERS SO THAT THE PRINTER CAN BE SWITCHED ON. SET = NO HALT, PRINTER ALWAYS ON. FO1: CLEAR = EACH SEQUENCE OF N NUMBERS IS TREATED SEPARATELY. SET = THE DATA IS ACCUMULATED FOR EACH SUCCESSIVE SEQUENCE. FO2: CLEAR = CHECK FOR DUPLICATE NUMBERS. SET = NO CHECK (FASTER RUNNING TIME). FO3: CLEAR = PRINT HISTOGRAM. SET = DO NOT PRINT HISTOGRAM. FO4: CLEAR = DO COMPLETE EVALUATION. SET = ONLY CHECK FOR DUPLICATE NUMBERS. (ALL FLAGS ARE CLEAR INITIALLY.)		XEQ "EVAL"	"F: CLEAR/SET" "O: STOP/CONT" "1: CLRG/ACCUM" "2: XN=2N/OMIT" "3: HISTO/OMIT" "4: /XN=2N ONLY"
2.	SET SIZE AT 36, AND SET ANY FLAGS.			SIZE=36/FLGS
3.	INPUT THE SEED: INPUT THE DESIRED SEQUENCE LENGTH: (**)	X ₀ N	R/S R/S R/S	SEED? N?
	OUTPUT TO PRINTER {			N=N SEED < N > = X ₀ SEED < 2N > = X ₀
	COUNTDOWN DISPLAY: i = N ... 1 WHILE THE SEQUENCE IS GENERATED AND EVALUATED. (*) WHEN i = 1, HP 41C HALTS AND: (IF FOO IS SET, NO HALT OCCURS.)			"i" BEEP
4.	PROVIDE THE EVALUATION: (***) IF FO1 CLEAR, YYY = N, N, N, ... FO1 SET, YYY = N, 2N, 3N, ... IF FO3 SET, HISTOGRAM OUTPUT IS NOT PRINTED. TO PRINTER S ₁ = # OF NUMBERS BETWEEN 0 & 0.049 f ₂ = # OF NUMBERS BETWEEN 0.05 & 0.099 f ₂₀ = # OF NUMBERS BETWEEN 0.95 & 0.999 (IF FOO IS SET, NO HALT OCCURS HERE) THE NEXT N NUMBERS ARE GENERATED:		R/S	$\bar{X} = 0.XX$ $S = 0.XX$ $\gamma = 0.XX$ $N = YYY$ $E(f) = YYY/20$ LL FREQ UL 0 f ₁ 1 % 5 f ₂ 1 % 90 f ₁₉ 1 % 95 f ₂₀ 1 % CHI-SQ (5%:30) = χ^2
5.			R/S	

Step Schritt Pas Passo	Instructions Operation Instructions Istruzioni	Variables Dateneingabe Données Dati	Function(s) Taste(n) Touche(s) Tasti	Result Resultat Résultat Risultato
(*)	IF A DUPLICATE NUMBER IS DETECTED, HP 41C HALTS: TO CONTINUE WITH THE REMAINDER OF THE SEQUENCE:		SF 02 R/S	CYCLE AT i
(**)	IF FLAG 04 IS SET, THE PROGRAM IMMEDIATELY BEGINS THE SEARCH FOR A DUPLICATE RANDOM NUMBER, AND RUNS UNTIL HALTED BY THE USER. i = 1, 2, 3, ∞ THE VALUE OF N IS NOT REQUESTED.			"i"
(***)	IF THE PRINTER IS NOT CONNECTED, AN ERROR HALT OCCURS: CONNECT THE PRINTER, AND		R/S	NONEXISTANT

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PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

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Line Zeile Ligne Linea	Keystrokes Tastenfolge Touches Tasti	Comments Kommentar Commentaires Commenti	Line Zeile Ligne Linea	Key pressed Tastentolge Touches Tasti	Comments Kommentar Commentaires Commenti
01	01 *LBL "EVA	BEGIN.	5	51 SCI 9	PRINT VALUES
	L"			52 "SEED<N>	OF Xi AND
	02 CF 00			= "	X2i FOR
	03 CF 01	INITIALISE.		53 ACA	CURRENT
05	04 CF 02		5	54 ACX	SEQUENCE.
	05 CF 03			55 PRBUF	
	06 CF 04	REMINDER		56 "SEED<2N	
	07 "F: CLEA	MESSAGES.		>= "	
	R/SET"			57 ARCL 01	
	08 AON			58 ACA	
10	09 PSE		6	59 PRBUF	
	10 "0: STOP			60 16	IS: POINTER
	/CONT"			61 STO 15	TO BIN 1.
	11 PSE			62 CF 21	DISABLE PRINTER.
	12 "1: CLRG			63 FIX 0	
5	/ACCUM"		6	64 *LBL 02	
	13 PSE			65 VIEW 03	
	14 "2: XN=2			66 RCL 00	Xi
	N/OMIT"			67 RCL 00	
	15 PSE			68 XEQ 00	
20	16 "3: HIST		7	69 STO 00	Xi+1
	0/OMIT"			70 E+	
	17 PSE			71 CLX	
	18 "4: /XN=2			72 .05	COMPUTE BIN
	N ONLY"			73 /	#.
25	19 PSE			74 INT	
	20 AOFF		7	75 RCL 15	
	21 "SIZE=36			76 +	
	/FLGS"			77 1	ADD 1 TO BIN.
	22 PROMPT			78 ST+ IND	
	23 ZREG 09			Y	
30	24 CLRG		8	79 FC? 02	→ 04: CHECK
	25 "SEED?"			80 XEQ 04	Xi = X2i
	26 PROMPT	00: X ₀ , X ₁ , X ₂ , ...		81 DSE 03	
	27 STO 00			82 GTO 02	
	28 STO 01	01: X ₂ , X ₃ , X ₄ , ...		83 BEEP	
35	29 FS? 04		8	84 FC? 00	END OF
	30 GTO 03	→ 03: CHECK		85 STOP	SEQUENCE.
	31 "N?"	Xi = X2i ONLY.		86 FC? 55	
	32 PROMPT			87 PRBUF	ERROR HALT.
	33 STO 02			88 SF 21	ENABLE PRINTER.
	34 *LBL 01	GENERATE A		89 XEQ 05	→ 05: STAT.
40	35 RCL 00	SEQUENCE.	9	90 XEQ 06	→ 06: HISTO.
	36 RCL 01			91 FC? 00	
	37 RCL 02			92 STOP	
	38 FC? 01	ACCUMULATE		93 ADV	
	39 CLRG	DATA IF F01 SET.		94 ADV	NEXT SEQUENCE
45	40 FIX 0		9	95 GTO 01	
	41 "N="			96 *LBL 00	RANDOM
	42 ARCL X	PRINT SEQUENCE		97 "RAND"	NUMBER
	43 ACA	LENGTH.		98 "F NO"	GENERATOR.
	44 PRBUF			99 "F GEN"	
5	45 STO 02		10	100 "F GOES"	
	46 STO 03				
	47 RDN				
	48 STO 01				
	49 RDN				
	50 STO 00				

Please use
Bitte listen

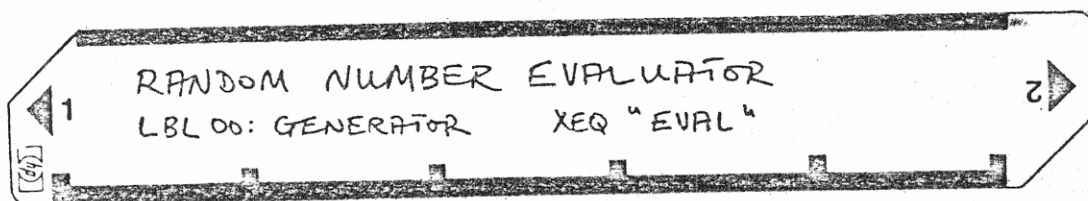
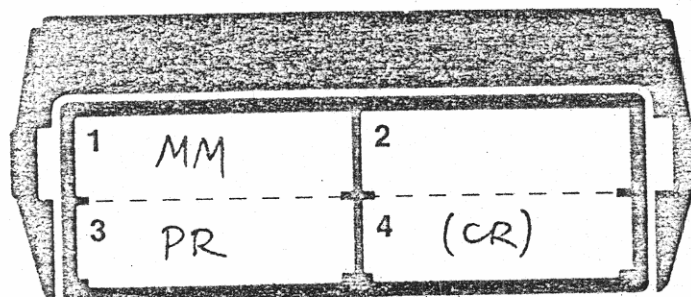
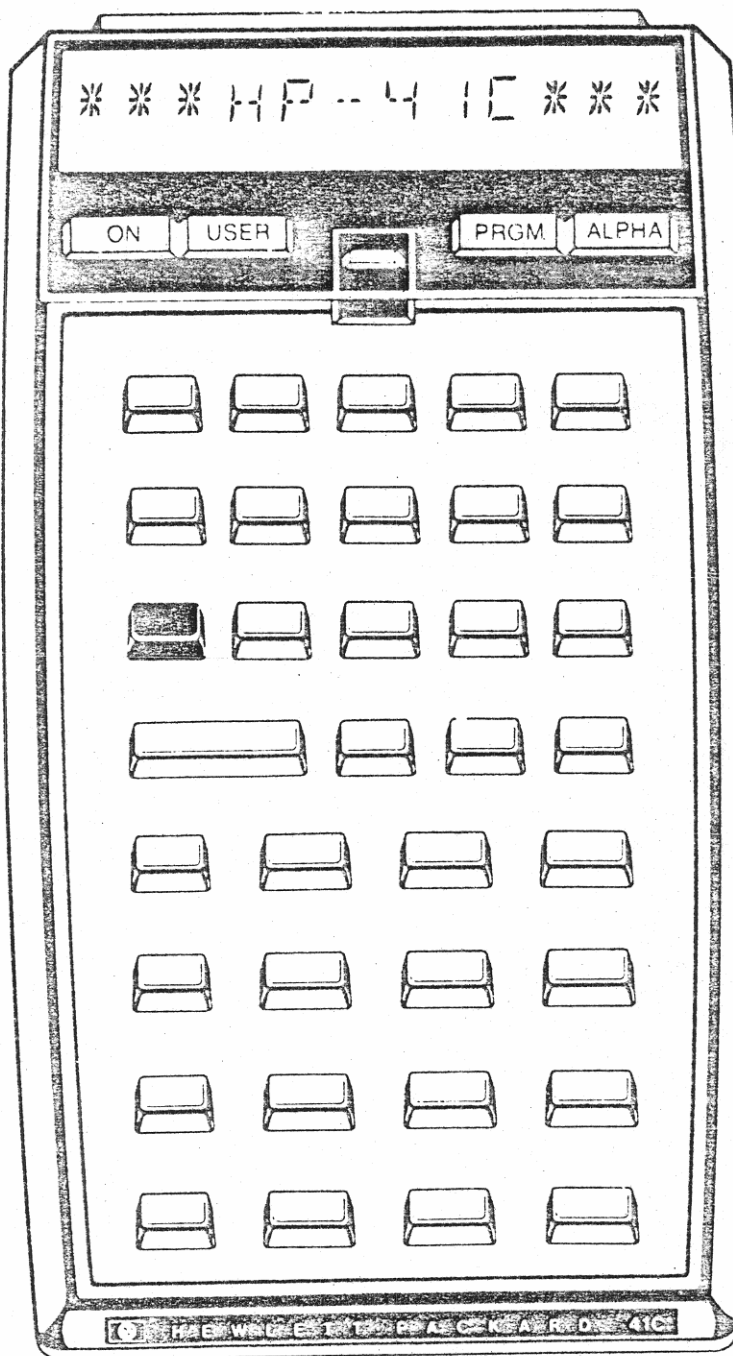
et
cichen!

S.V.P. utilisez de la colle à papier pour fixer les listings. Les rubans adhésifs peuvent altérer l'impression!
Per favore usare la colla per fissare i listati. Il nastro adesivo può alterare lo stampato!

Line Zeile Ligne Linea	Keystrokes Tastentolge Touches Tasti	Comments Kommentar Commentaires Commenti	Line Zeile Ligne Linea	Key pressed Tastentolge Touches Tasti	Comments Kommentar Commentaires Commenti
01	101 "F HERE"		5	151 RCL 14	
	102 RTN			152 /	
	103+LBL 03	CHECK		153 RCL 13	
	104 1	$X_i = X_{2i}$		154 -	
05	105 ST+ 03	ONLY.	5	155 CHS	
	106 VIEW 03			156 RCL 14	
	107 RCL 00			157 1	
	108 XEQ 00			158 -	
	109 STO 00	X_i		159 /	
	110 XEQ 04	-004: X_{2i}		160 $X < > Y$	
10	111 GTO 03		6	161 /	
	112+LBL 04			162 ACX	
	113 RCL 01	GENERATE		163 " N= "	N.
	114 XEQ 00	X_{2i}		164 FIX 0	
	115 XEQ 00			165 ARCL 14	
	116 STO 01	COMPARE	6	166 ACA	
	117 RCL 00	$X_i \neq X_{2i}$		167 PRBUF	
	118 $X=Y?$			168 RTN	
	119 RTN			169+LBL 06	HISTOGRAM.
	120 TONE 9	MESSAGE IF		170 CLX	
20	121 "CYCLE A	EQUAL.	7	171 STO 08	
	T "			172 RCL 15	
	122 ARCL 03			173 RCL 15	
	123 PROMPT			174 19	
	124 RTN			175 +	
	125+LBL 05	STATISTICS.		176 1 E3	
25	126 FIX 4		7	177 /	
	127 2	PRINT $\bar{X}$,		178 +	03: INDEX TO
	128 ACCHR			179 STO 03	BINS
	129 61			180 69	
	130 ACCHR			181 ACCHR	
30	131 MEAN		8	182 40	
	132 ACX			183 ACCHR	
	133 2			184 102	
	134 SKPCHR			185 ACCHR	
	135 115	S_i		186 41	
35	136 ACCHR		8	187 ACCHR	
	137 61			188 61	PRINT $E(f) =$
	138 ACCHR			189 ACCHR	
	139 SDEV			190 RCL 14	$f_e = N/20$
	140 ACX			191 20	PER BIN.
	141 PRBUF			192 /	
40	142 114	r ,	9	193 FIX 1	
	143 ACCHR			194 ACX	
	144 61			195 FIX 0	
	145 ACCHR			196 RND	07: f_e
	146 SDEV			197 STO 07	
45	147 *		9	198 STO 05	
	148 RCL 09			199 PRBUF	SKIP HISTOGRAM
	149 RCL 11			200 FS? 03	IF F03 SET.
	150 *				
5			(0)		

Line Zeile Ligne Linea	Keystrokes Tastenfolge Touches Tasti	Comments Kommentar Commentaires Commenti	Line Zeile Ligne Linea	Key pressed Tastenfolge Touches Tasti	Comments Kommentar Commentaires Commenti
01	201 GTO 08		5	251 ACA	
	202 RCL 14			252 RCL IND	
	203 2			03	
	204 /			253 RCL 07	
05	205 SORT		5	254 -	
	206 RND	05: UPPER		255 X+2	$08: \leq (f_i - f_e)^2$
	207 ST+ 05	LIMIT LABEL.		256 ST+ 08	
	208 -			257 RCL IND	X: f_i : FREQ.
	209 X<=0?			03	IN BIN i
	210 0			258 ACX	
10	211 STO 04	04: LOWER	6	259 RCL 04	
	212 ADV	LIMIT LABEL.		260 RCL 05	
	213 ACX			261 RCL 06	PLOT f_i .
	214 5	LABEL AND		262 STK PLOT	
	215 SKPCHR	PRINT Y		263 ISG 03	
	216 "FREQ"	AXIS.	6	264 GTO 07	
	217 ACA			265 *LBL 09	END OF
	218 4			266 ADV	HISTOGRAM.
	219 SKPCHR			267 RCL 07	
	220 RCL 05			268 ST/ 08	
20	221 ACX		7	269 FIX 2	PRINT VALUE
	222 ADV			270 "CHI-SQ	OF χ^2 .
	223 "-----"			"	
	224 "f-----"			271 "f<5%:30	
	-----"			> ="	
25	225 ACA		7	272 ACA	
	226 ADV			273 RCL 08	
	227 126	COMPUTE THE		274 ACX	
	228 RCL 05	COLUMN		275 PRBUF	
	229 RCL 04	SCALE FACTOR		276 ADV	
30	230 -	AND X-AXIS	8	277 RTN	
	231 /	POSITION		278 *LBL 08	IF HISTO. IS
	232 RCL 07	NNN. AAA		279 RCL IND	OMITTED,
	233 RCL 04	REQUIRED		03	CALCULATE
	234 -	BY STK PLOT.		280 ACX	χ^2 ANYWAY.
35	235 *		8	281 RCL 07	
	236 INT			282 -	
	237 1 E3			283 X+2	
	238 /			284 ST+ 08	
	239 126			285 ISG 03	
	240 +			286 GTO 08	
40	241 STO 06	06: NNN. AAA	9	287 GTO 09	
	242 *LBL 07	PRINT HISTO		288 .END.	
	243 RCL 03	LINE.			
	244 INT				
	245 RCL 15				
45	246 -		95		
	247 5	X: BIN LABEL			
	248 *				
	249 CLA				
	250 ARCL X				
5			00		

[illegible]



Assignments
Belegungen
Assignments
Assegnamenti

Configuration
Belegung
Configuration
Configurazione

Magnetic card
Magnetkarte
Carte magnetique
Scheda magnetica