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

Program Title
Programmtitel / Titre du programme / Titolo del programma: Logit

Category No. Kategorie Nr. / Catégorie N° / Categoria N°: 304 716
Name Rubrik / Rubrique / Nome della categoria: curve fitting / regression
Radio immuno essay

No. of program lines Anzahl Programmzeilen / Nombre de lignes de programme / N° di linee di programma: 308

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

Recommended HP 41C System configuration
Empfohlene System-Konfiguration / Configuration recommandée / Configurazione raccomandata
Port # 1: memory module Port # 2:
Port # 3: Port # 4:

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:

HP 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 logit function (log y-c/d-y = a log x + b)
is an exelent function for fitting sigmoid and
half sigmoid curves. The program seeks for a d
(= y max) that gives the best correlation.
With a detailed explanation of the program you are shown
how to fit the program to your problem. Error corrector for
false data input is provided. Also a control of the curve
fitting. x → y and y → x , a, b, correlation- & y' are given
The calculation of a straight line is also possible
n = number of x,y pairs times 2

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ACKNOWLEDGMENT AND AGREEMENT
Erklärung und Ermächtigung / Déclaration et Autorisation / Dichiarazione e Autorizzazione

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Date Datum / Date / Data: 10/4/01
Signature Unterschrift / Signature / Firma: C Nieuwenhuys

PROGRAM DESCRIPTION I
PROGRAMMBESCHREIBUNG I
DESCRIPTION DU PROGRAMME I
DESCRIZIONE DEL PROGRAMMA I

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

$$\log \frac{y-c}{D-y} = a \log x + b$$

c = y minimal

D = y maximal

Correlation $r = \dfrac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\sqrt{\left[\Sigma x^2 - \frac{(\Sigma x)^2}{n}\right] \cdot \left[\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right]}}$ $\quad \dfrac{S_{xy}}{\sqrt{S_x \cdot S_y}}$

$tg\,\alpha \quad a = \dfrac{\Sigma xy - \Sigma x \Sigma y / n}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$ where x = log entered x

$y = \dfrac{\text{entered } y - c}{D - \text{entered } y}$

Intercept $b = -a\frac{\Sigma x}{n} + \frac{\Sigma y}{n}$

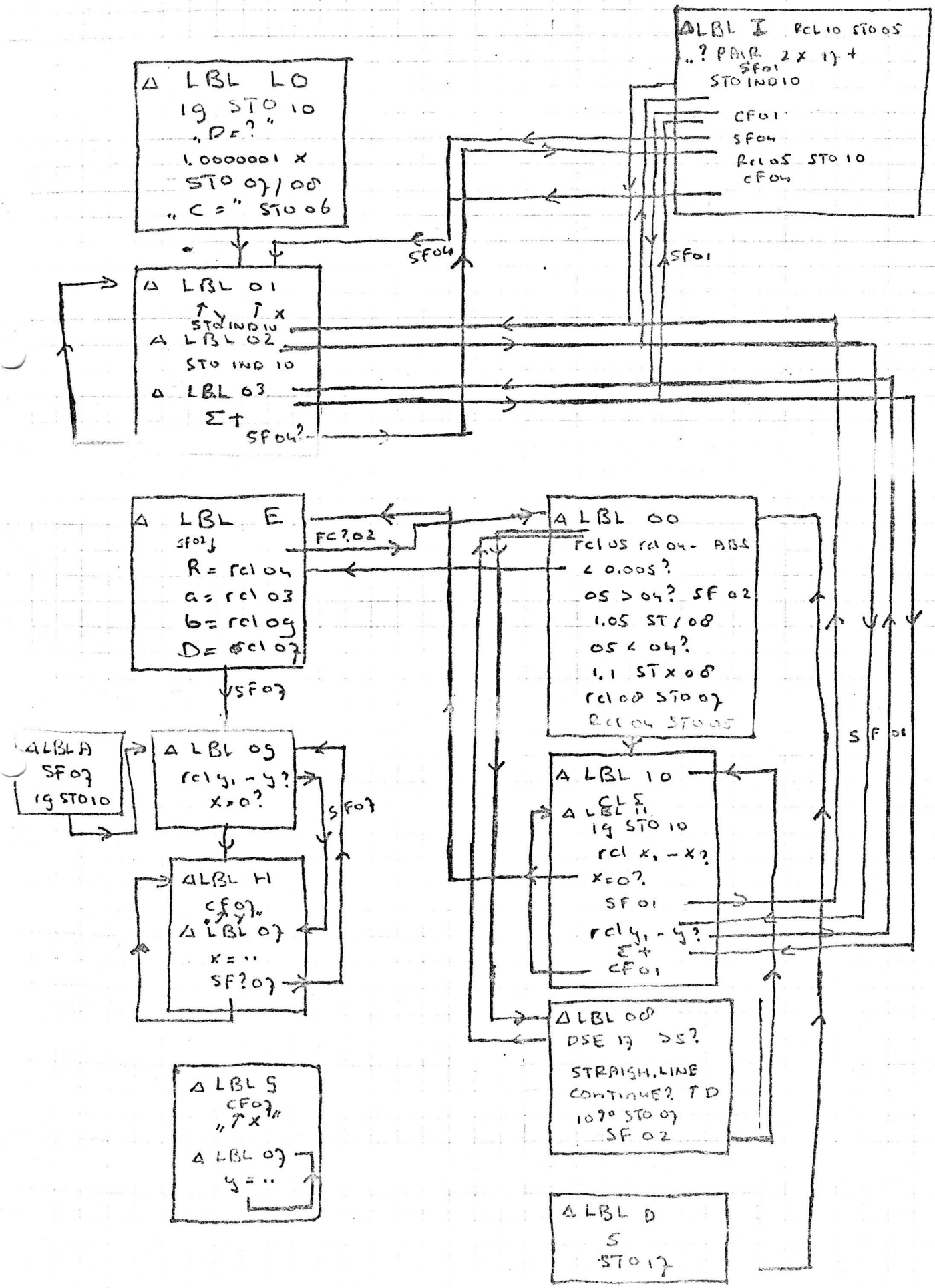
$$y = \frac{16^{a \log x + b} \cdot D + c}{10^{a \log x + b} + 1}$$

$$x = 10^{\left(\frac{\log \frac{y-c}{D-y} - b}{a}\right)}$$

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

Input of x=0 or y=0 gives a DATA ERROR (log 0 of dividing by zero)

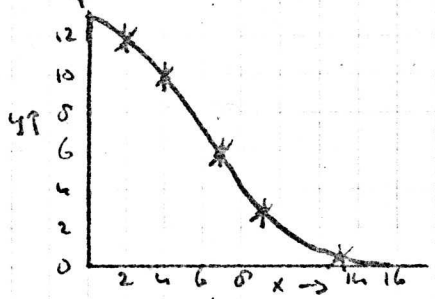
After five D increases it is assumed that the x,y pairs are on a straight line. The program stops and gives „STRAIGHT LINE". If you don't believe this, press D to continue. i Memory 17 is the counter of the loops


Δ LBL LO
19 STO 10
„D=?"
1.0000001 x
STO 07 / 08
„C=" STO 06
Δ LBL 01
↑ STO IND 10 ↑ x
Δ LBL 02
STO IND 10
Δ LBL 03
Σ+
SF04?
ΔLBL I RCL 10 STO 05
„?" PAUSE 2 x 17 +
SF01
STO IND 10
CF01
SF04
RCL 05 STO 10
CF04
SF04
SF01
Δ LBL E
SF02
R = rcl 04
a = rcl 03
b = rcl 09
D = rcl 07
FC?02
Δ LBL 00
rcl 05 rcl 04 - ABS
< 0.005?
05 > 04? SF 02
1.05 ST / 08
05 < 04?
1.1 ST x 08
rcl 08 STO 07
RCL 04 STO 05
SF01
ΔLBL A
SF07
19 STO 10
Δ LBL 05
rcl y1 - y?
x>0?
SF07
Δ LBL 10
CL Σ
Δ LBL 11
19 STO 10
rcl x1 - x?
x=0?
SF 01
rcl y1 - y?
Σ+
CF01
ΔLBL H1
CF07
↑ x
Δ LBL 07
x = ..
SF?07
Δ LBL 08
DSE 17 >5?
STRAIGH. LINE
CONTINUE? TO
10?0 STO 07
SF 02
Δ LBL S
CF07
„↑ x"
Δ LBL 07
y = ..
Δ LBL D
5
STO 17

Start program logit.

The following curve is put in

y	x
12	2
10	4
6	7
3	9
0.5	13



The display shows „D=?" Enter ymax 12 R/S „C=?" C is zero, just press R/S. „Ty Tx" is shown. Enter the pairs. Oh, Instead of y=6 and x=7 you entered 6 y=6 x=8. Press I. „? PAIR" This means which pair went wrong. Press 3 R/S „Ty Tx" is asked. Enter the right pair.

This can also be done in a later stadium. You have to enter the correct pair. This is controlled by flag 4. After entering the pairs, press E. The display shows the calculated correlation. The line has a negative tangens, so the correlation is also negative

The display shows „-0.9093" „-0.9653" „-0.9440."

The correlation lowers, D is decreased by 5%. (Note flag 2) and the looping stops. „R=-0.9537"

press R/S „a=-2.61" R/S „b=1.82" R/S „D=13.83" R/S

The display shows you the X you entered „2.00" and the calculated X' „X=2.42", R/S, „4.00", „X=3.45" and so on

After all the pairs have been shown „Ty" comes in the display to calculate X. Enter a value and press R/S.

(When you want to calculate y press g. „Tx" is in the display. Enter a x and press R/S.

PROGRAM DESCRIPTION III

When you forget one of the results, press C.
Press A to see back the x and x'
When you want to continue the looping, thus increasing D again by 10%, because you think the calculation could maybe be better, press D. The display shows you the old correlation „-0.9537" The new one „-0.9363" which is worse so it decreases D by 5% and stops „R=-0.9444". If you want to correct an eventual damage (this one) press B, enter the old D (is 13.03 here) press R/S, enter the old C (is zero here) and press R/S and not E, after the display shows „ȳ, x̄" When the display shows the old correlation „-0.9537" stop the programming and press C
When you press E at the point „ȳ, x̄, D is increased by 10% and this is too high for an optimal correlation
So press A: to see x and x' back
B: to enter another D or the old one
C: To see back the results
D: To continue the increasing of b
E: To start calculating
G: To calculate y
H: To calculate x
I: To correct a wrong pair

This is a common program. When you always have the same sort curve, you can change some controls in the program to get better results. With some examples I will show you what to change.

In the logit formula $\log \frac{y-c}{D-y} = a \log x + b$

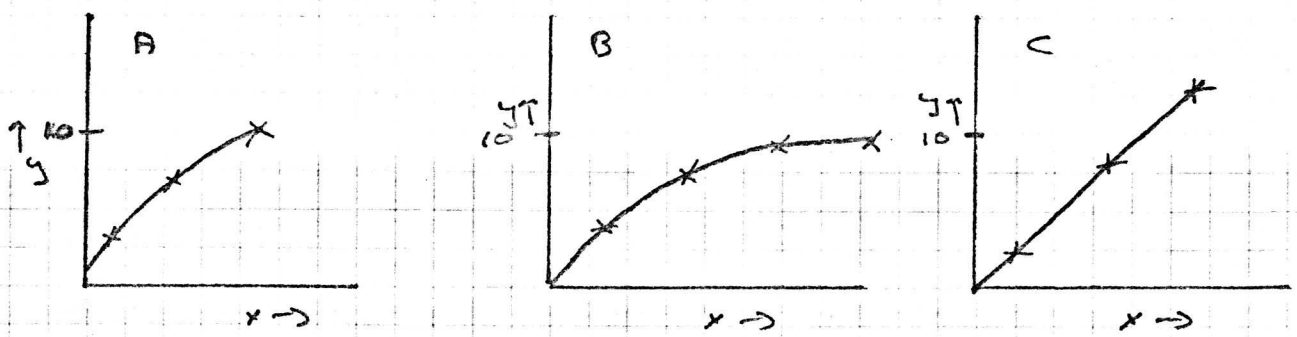
D is ymax and C is ymin or the blanco

The program is finding such a D that the correlation is optimal.

Every loop the program makes D is increased by 10%, when the correlation lowers, D is lowered by 5% and the correlation corresponding with that D is given.

When the change in correlation is smaller than 0.005 the last correlation is given

There are three sorts of (half sigmoid) curves you can enter



Curve A:

After input of the x,y pairs and D=10 C=0 the program will take more than five loops to find the real ymax (D)

So a few things can be changed. The increase of D can be made bigger say 50%. This won't give an optimal correlation.

Making more loops by putting say 20 in STO 17 will cause long execution times.

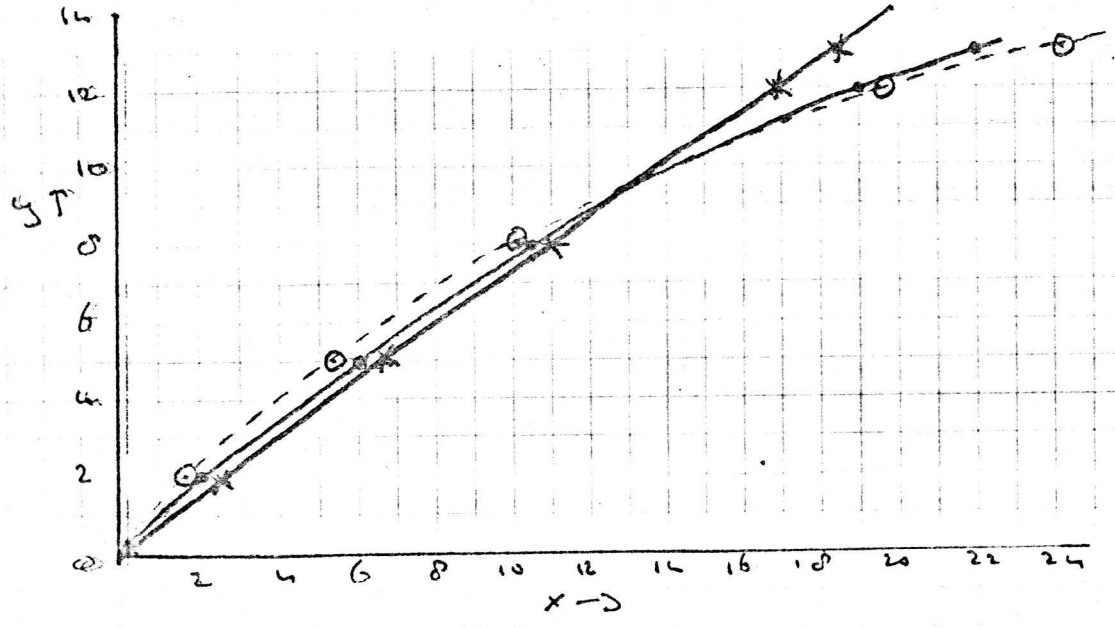
Starting with a high D can give a bad correlation when this was to high. It is difficult to say what the real D will be in a curve like this one.

These curves are the most difficult ones.

curve B:
This curve won't give many problems.
When working with these curves I would lower the correlation change control in step 194

curve C
This will give „STRAIGHT.LINE" and it is for you to decide if you will go on by pressing D or make a straight line of it by pressing R/S so D will be 10^{90}.

Now I will give the practical examples.



y	x	x'
0.01	0.01	0.01
2	2	2.53
5	6	6.68
8	10.5	11.00
12	19	16.92
13	22	18.42
		(x)

D=13
C=0

↑ calculated back

DISPLAY
0.6650
0.9886
0.9941
0.9971
0.9985
STRAIGHLINE
CONTINUE? / D
R/S R=0.9986
a=0.94
b=-90.08
D=1.00 E90

We see that the correlation difference is very small between the calculated D after five loops and when $D=10^{90}$. So it was maybe better to continue

We will do it again and now continuing
PRESS B D=13 C=0 and after „Ty Tx", R/S

y	x	x'
0.01	0.01	0.01
2	2	1.91
5	6	5.35
8	10.5	10.14
12	19	20.27
13	22	24.01
		(0)

↑ calculated back

DISPLAY
0.6658
0.9866
0.9941
0.9971
0.9905
STRAIGHT. LINE
CONTINUE? ↑ D
„D" 0.9993
R = 0.9997
a = 1.03
b = -1.31
D = 23.03

The program stopped because the correlation increase was smaller than 0.0005 now we will change that in 0,0005 (step 1/54)

PRESS B D=23 C=0 R/S we know D > 20

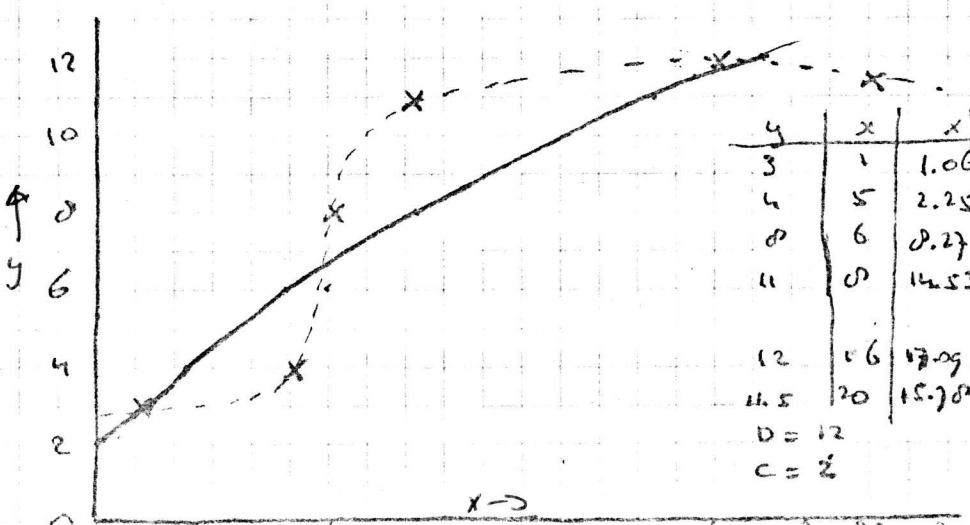
x	x'
0.01	0.01
2	2.06
6	5.75
10.5	10.46
19	19.24
22	22.10

↑ calculated back

DISPLAY
0.9990
0.9995
0.9998
0.9999
1.0000
R = 1.0000 correlation change < 0.00005
a = 1.01
b = -1.45
D = 29.20

When we change the correlation change control in zero (1/54) we will see that the correlation will get higher (fix 5)

Now an example of a sigmoid curve with not so good correlating points.



y	x	x'
3	1	1.06
4	5	2.25
8	6	8.27
11	8	14.53
12	16	17.09
11.5	20	15.78
D = 12		
C = 2		

DISPLAY
0.6099
0.9068
0.9089
0.9096
0.9100 STRAIGHT. LINE
„D" 0.9104
0.9106
0.9108
0.9110
0.9112 STRAIGHT. LINE
„C" stop the calculating
R = 0.9113
a = 0.97

PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

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	ΔLBL LO		51	←RTN	
	∘CF02			RCL 18	
	CLRG			STOP	
	ΔLBL B			STO IND 10	
05	19		55	X<>Y	
	STO 10			RDN	
	6			ΔLBL 03	
	STO 17			LOG	
	"D=?"			∘FS?01	
10	"PROMPT		60	← RTN	
	1.00000001			FS?C 04	
	STO 06			← RTN	
	X			Σ+	
	STO 07			CLA	
15	STO 08		65	ARCL 18	
	0			+/-	
	STO 05			ARCL IND 10	
	"C=?"			AVIEW	
	"PROMPT			1	
20	RCL 06		70	ST+10	
	/			GO TO 01→	
	STO 06			ΔLBL E	
	ΔLBL 01			RCL 15	
	∘CF01			RCL 11	
25	∘CF22		75	RCL 13	
	FIX 0			X	
	CLA			RCL 16	
	RCL 16			/	
	1			−	
30	+		80	STO 00	
	ARCL X			RCL 12	
	"+1/Ty Tx"			RCL 11	
	"PROMPT			x^2	
	FIX 2			RCL 16	
35	FC? 22		85	/	
	GO TO 10→			−	
	STO IND 10			STO 01	
	ΔLBL 02			RCL 14	
	STO 18			RCL 13	
40	RCL 06		90	x^2	
	−			RCL 16	
	RCL 07			/	
	RCL 18			−	
	−			STO 02	
45	/		95	RCL 00	
	LOG			RCL 01	
	1			/	
	ST+10			STO 03	
	X<>Y			RCL 00	
50	∘FS?01		100	RCL 01	

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PROGRAM LISTING

PROGRAMMAUFLISTUNG
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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
001	RCL 02		051	ENTER↑	
	x			RCL 07	
	√			x	
	1/x			RCL 06	
005	STO 04		055	+	
	• FC? C 02			x<>y	
	XEQ 00 ⇄			1	
	Δ LBL C			+	
	FIX 4			1/x	
010	"R="		060	CLA	
	ARCL 04			ARCL 05	
	PROMPT			"+1/y="	
	FIX 2			ARCL x	
	RCL 11			PROMPT	
015	RCL 16		065	GO TO 06 →	
	1/x			Δ LBL 10	
	RCL 03			CLΣ	
	x			1g	
	CHS			STO 10	
020	RCL 13		070	Δ LBL 11	
	RCL 16			RCL IND 10	
	1/x			x=0?	
	+			GO TO E →	
	STO 09			• SF 01	
025	"a="		075	XEQ 02 ⇄	
	ARCL 03			ENTER↑	
	PROMPT			RCL IND 10	
	"b="			XEQ 03 ⇄	
	ARCL 09			Σ+	
030	PROMPT		080	1	
	"D="			ST+10	
	ARCL 07			• CF 01	
	PROMPT			GO TO 11 →	
	• SF 07			Δ LBL 00	
035	20		085	XEQ 00 ⇄	
	STO 10			FIX 4	
	GO TO 09 →			CLA	
	Δ LBL 5			ARCL 04	
	• CF 07			AVIEW	
040	"Tx"		090	RCL 05	
	PROMPT			RCL 04	
	Δ LBL 06			−	
	STO 05			ABS	
	LOG			0.0005	
045	RCL 03		095	x>y?	
	x			GO TO C →	
	RCL 09			RCL 05	
	+			ABS	
	10^x			RCL 04	
050	ENTER↑		100	ABS	

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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
001	x<=y?		251	•SF02	
	•SF02			GO TO 10 →	
	1.05			ΔLBL 09	
	•FS?02			•SF25	
05	ST 100		55	CLA	
	1.1			RCL IND 10	
	•FC?02			x=0?	
	ST x 08			GO TO 4 →	
	RCL 08			FC?C 25	
10	STO 07		60	GO TO 4 →	
	RCL 04			ARCL IND 10	
	STO 05			AVIEW	
	GO TO 10 →			1	
	Δ LBL 4			ST-10	
	•CF07		65	RCL IND 10	
	"y"			3	
	"PROMPT			ST+10	
	Δ LBL 07			x<>y	
	STO 05			GO TO 07 →	
20	RCL 06		70	Δ LBL A	
	−			•SF07	
	RCL 07			.20	
	RCL 05			STO 10	
	−			GO TO 09 →	
25	/		75	Δ LBL D	
	LOG			6	
	RCL 09			STO 17	
	−			CLA	
	RCL 03			ARCL 04	
30	/		80	AVIEW	
	10^x			GO TO 00 →	
	CLA			Δ LBL I	
	ARCL 05			RCL 10	
	"+/x="			STO 05	
35	ARCL X		85	"?PAIR"	
	PROMPT			PROMPT	
	•FS?07			2	
	GO TO 09 →			x	
	GO TO 07 →			17	
40	Δ LBL 08		90	+	
	DSE 17			STO 10	
	← RTN			•SF01	
	CLA			RCL IND 10	
	"STRAIGHT.LINE"			XEQ 02 ⇄	
45	AVIEW		95	RCL IND 10	
	PSE			XEQ 03 ⇄	
	"CONTINUE? 1 0			Σ−	
	PROMPT			•CF01	
	1 E 50			1	
250	STO 07		300	ST-10	

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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
3 01	• SF 04		51		
	XEQ 01 ⇄				
	RCL 05				
	STO 10				
05	0		55		
	STO 05				
	GO TO 01 →				
308	END				
10			60		
15			65		
20			70		
25			75		
30			80		
35			85		
40			90		
45			95		
50			00		

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REGISTERS, STATUS, FLAGS

REGISTERBELEGUNG, FLAGS, BETRIEBSARTEN
REGISTRES, INDICATEURS, MODES OPÉRATOIRES
REGISTRI, MODI OPERATIVI, FLAGS

Registers
Datenspeicher
Registres de données
Registri

00	$\Sigma xy - \Sigma x \frac{\Sigma y}{n}$	50	
	$\Sigma x^2 - \frac{(\Sigma x)^2}{n}$		
	$\Sigma y^2 - \frac{(\Sigma y)^2}{n}$		
	a		
	R		
05	x or y → y' or x'	55	
	C		
	D actual		
	D		
	b		
10	pair counter +1	60	
	Σx		
	Σx^2		
	Σy		
	Σy^2		
	Σx^2	65	
	n		
	loop counter		
	Y		
	$\begin{cases} y_1 \\ x_1 \end{cases}$		
20		70	
	$\begin{cases} y_2 \\ x_2 \end{cases}$		
	$\begin{cases} y_3 \\ x_3 \end{cases}$		
25	↓ ...s.o.	75	
30		80	
35		85	
40		90	
45		95	
		99	

Status
Betriebsart
Modes opératoires
Modi operativi

Size 1g + n **Total Reg.** _____ **User Mode**

Eng ☐ Fix ☐ Sci ☐ On ☒

Deg ☐ Rad ☐ Grad ☐ Off ☐

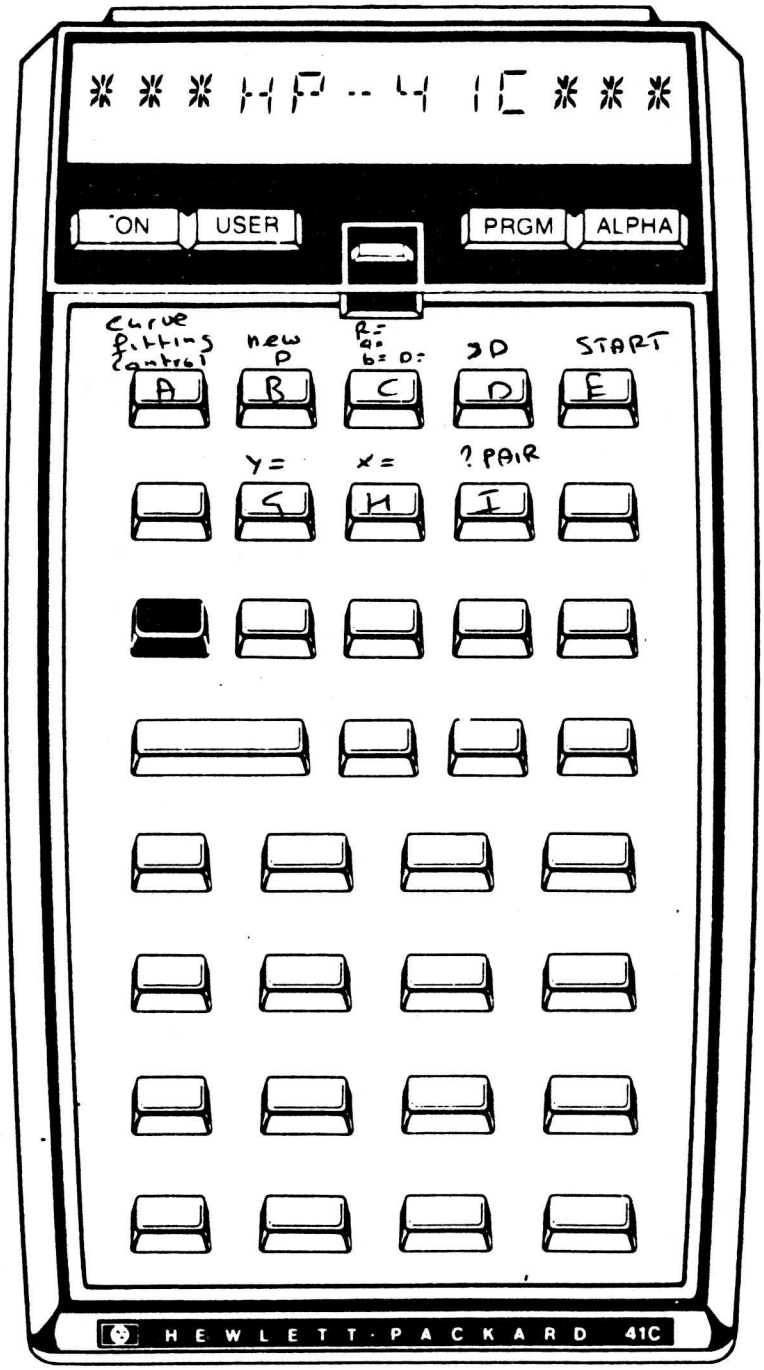
Flags

	Purpose (Bedeutung / Signification / Scopo)	SET	CLEAR	
00				
01	Calling x,y pairs	x		
02	Decrease D by 5%	x	x	Increase D by 10%
03				
04	Wrong data input	x		
05				
06				
07	curve fitting control	x		
08				
09				
10				
11	Audio execute			
12				
13				
14				
15				
16				
17				
18				
19				
20				
21	Printer Enable			
22	Number Input	x		
23	Alpha Input			
24	Range Ignore			
25	Error Ignore	x		
26	Audio Enable			
27	User Mode			
28	Decimal Point			
29	Digit Grouping			

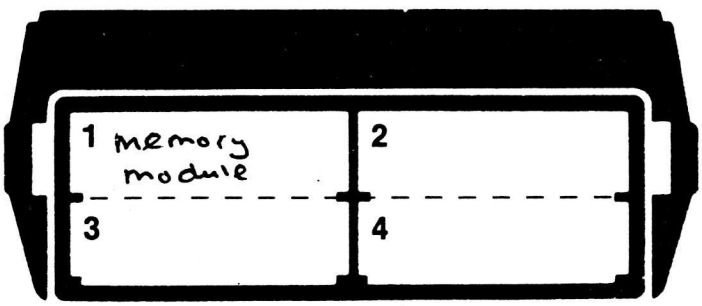
Assignments
Tastenbelegung / Assignations / Assegnamenti

Function (Funktion / Fonction / Funzione)	Key (Taste / Touche / Tasto)	Function (Funktion / Fonction / Funzione)	Key (Taste / Touche / Tasto)
curve fitting control	A	To correct data	T
Enter new D	B	LO	F
See back R, a, b, D	C		
continue increasing D	D		
Start calculating	E		
To calculate y	J		
To calculate x	H		

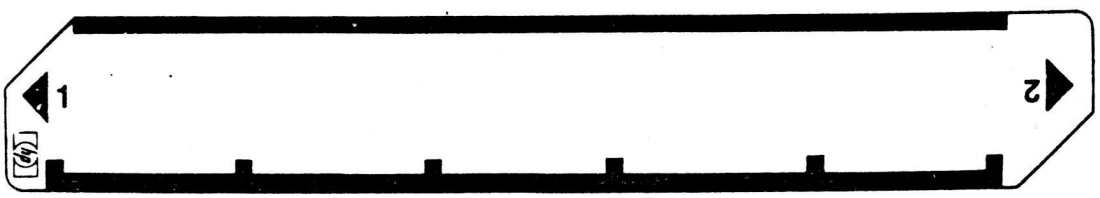
SYSTEM CONFIGURATION
CONFIGURAZIONE DEL SISTEMA



Assignments
Belegungen
Affectations
Assegnamenti



Configuration
Belegung
Configuration
Configurazione



Magnetic card
Magnetkarte
Carte magnétique
Scheda magnetica