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10 REM UNIVARIATE CURVE FIT
20 CLS : PRINT TAB(8); "UNIVARIATE CURVE FITTING"
30 PRINT TAB(7); "BY METHOD OF LEAST SQUARES"
40 PRINT TAB(7); "BY STEVEN BROWN - VERSION 1.5 - 1982"
50 PRINT : PRINT "THIS PROGRAM USES THE METHD OF LEAST SQUARRES TO FIT"
60 PRINT "THE FOLLEDOING FUNCTIONS TO A SERIES OF UP TO 100 DATA POINTS" : PRINT
70 PRINT "<1> - POWER FUNCTION"
80 PRINT "<2> - EXPONENTIAL FUNCTION"
90 PRINT "<3> - LOGARITHMIC FUNCTION"
100 PRINT "<4> - POLYNOMIAL OF SPECIFIED ORDER"
110 PRINT : PRINT "THE OPTIMAL CURVE FIT IS THEN SELECTED"
120 PRINT "VIA THE LEAST SQUARES NORM. THE MAXIMUM ERROR OVER THE"
130 PRINT "INPUT DATA AND THE INPUT ON WHICH THIS ERROR OCCURS"
140 PRINT "IS ALSO FOUND."
150 PRINT : PRINT : INPUT "HIT RETURN TO CONTINUE", T$
160 DIM X(100), Y(100), WX(100), WY(100), XM(99,20), S(20,20), A(20)
170 GOSUB 750 : REM GET DATASET TITLE
180 CLS : PRINT TAB(10); "INITIALIZE DATA"
190 PRINT TAB(10); "<1> - ENTER NEW DATA"
200 PRINT TAB(10); "<2> - RECALL DISK DATA"
210 PRINT : PRINT TAB(10); : INPUT "OPTION: ", T$
220 T=VAL(T$) : IF T<1 OR T>2 THEN GOTO 180
230 ON T GOSUB 580,2970
240 REM MAIN PROGRAM MENU
250 CLS
260 PRINT TAB(10); "UNIVARIATE CURVE FIT"
270 PRINT TAB(10); "<1> - DATA EDITOR"
280 PRINT TAB(10); "<2> - DISK I/O"
290 PRINT TAB(10); "<3> - FIT CURVE"
300 PRINT TAB(10); "<4> - CALCULATOR"
310 PRINT TAB(10); "<5> - QUIT"
320 PRINT : PRINT TAB(10); : INPUT "OPTION: ", T$
330 T=VAL(T$) : IF T<1 OR T>5 THEN GOTO 320
340 IF T=5 THEN END
350 ON T GOSUB 370,2750, 910, 3100
360 GOTO 240
370 REM DATA EDITOR MENU
380 CLS
390 PRINT TAB(10); "UNIVARIATE EDITOR"
400 PRINT TAB(10); "<1> - DISPLAY DATA TABLE"
410 PRINT TAB(10); "<2> - ADD DATA TO TABLE"
420 PRINT TAB(10); "<3> - CHANGE DATA TABLE"
430 PRINT TAB(10); "<4> - DELETE DATA FROM TABLE"
440 PRINT TAB(10); "<5> - CHANGE DATASET TITLE"
450 PRINT TAB(10); "<6> - RETURN TO MAIN MENU"
460 PRINT : PRINT TAB(10); : INPUT "OPTION: ", T$
470 T=VAL(T$) : IF T<1 OR T>6 THEN GOTO 460
480 IF T=6 THEN RETURN
490 ON T GOSUB 780, 580, 510, 650, 750
500 GOTO 370
510 REM CHANGE DATA
520 CLS : PRINT "Q TO QUIT"
530 INPUT "EDIT WHICH POINT "; T$ : T=VAL(T$) : IF T$="Q" THEN RETURN
540 IF T<1 OR T>N THEN GOTO 510
550 PRINT "X("; T; ")="; X(T); TAB(20) : INPUT "", T$ : IF T$<>" THEN X(T)=VAL(T$)
560 PRINT "Y("; T; ")="; Y(T); TAB(20) : INPUT "", T$ : IF T$<>" THEN Y(T)=VAL(T$)
570 GOTO 510
580 REM ADD DATA TO TABLE
590 CLS : PRINT "INPUT DATA POINT - Q TO QUIT"
600 PRINT "PT"; TAB(5); "X-VALUE"; TAB(17); "Y-VALUE"
610 PRINT N+1; TAB(5); : INPUT "", T$ : X(N+1)=VAL(T$) : IF T$="Q" THEN RETURN
620 PRINT TAB(17); : INPUT "", T$ : Y(N+1)=VAL(T$) : IF T$="Q" THEN RETURN
630 N=N+1 : IF N=100 THEN RETURN
640 GOTO 610
650 REM DELETE DATA FROM TABLE

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660 CLS: PRINT "Q TO QUIT"

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670 INPUT "DELETE WHICH POINT ".T$: T=VAL(T$): IF T$="Q" THEN RETURN
680 IF T<1 OR T>N THEN GOTO 650
690 IF T=N THEN GOTO 730
700 FOR I=T TO N-1
710 X(I)=X(I+1) : Y(I)=Y(I+1)
720 NEXT I
730 N=N-1 : IF N=0 THEN RETURN
GOTO 650
750 REM GET DATASET TITLE
760 CLS : INPUT "TITLE OF INPUT DATASET ",TI$
770 RETURN
780 REM DATA DISPLAYER
790 T1=1
800 T2=T1+21
810 IF T2>N THEN T2=N
820 GOSUB 850
830 IF T2=N THEN RETURN
840 T1=T2+1 : GOTO 800
850 CLS
860 PRINT "PT"; TAB(5); "X-VALUE"; TAB(17); "Y-VALUE"
870 FOR I=T1 TO T2
880 PRINT I; TAB(5); X(I); TAB(17); Y(I)
890 NEXT I
900 INPUT "HIT RETURN TO CONTINUE ",T$: RETURN
910 REM **** GET POLYNOMIAL ORDER ****
920 FUNC=0
930 CLS : INPUT "DESIRED POLYNOMIAL ORDER: ";T$
940 M=VAL(T$) : IF M<1 OR M>20 THEN GOTO 930
950 REM CHECK FOR SUFFICIENT DATA
960 IF N<(L+1)*(M+1) THEN CLS : PRINT "INSUFFICIENT DATA" : FOR I=1 TO 2000 : NE
XT I : L=0 : RETURN
970 REM **** FIT CURVES TO DATA ****
REM SET NEGATIVE FLAGS
970 X$="P" : Y$="P"
1000 FOR I=1 TO N
1010 IF X(I)<=0 THEN X$="N"
1020 IF Y(I)<=0 THEN Y$="N"
1030 NEXT I
1040 REM FIT POWER FUNCTION
1050 IF X$="N" OR Y$="N" THEN GOTO 1110
1060 FOR I=1 TO N
1070 WX(I)=LOG(X(I)) : WY(I)=LOG(Y(I))
1080 NEXT I
1090 GOSUB 2670 : REM LEAST SQUARES
1100 A1=EXP(A) : B1=B
1110 REM FIT EXPONENTIAL FUNCTION
1120 IF Y$="N" THEN GOTO 1180
1130 FOR I=1 TO N
1140 WX(I)=X(I) : WY(I)=LOG(Y(I))
1150 NEXT I
1160 GOSUB 2670 : REM LEAST SQUARES
1170 A2=EXP(A) : B2=B
1180 REM FIT LOGARITHMIC FUNCTION
1190 IF X$="N" THEN GOTO 1250
1200 FOR I=1 TO N
1210 WX(I)=LOG(X(I)) : WY(I)=Y(I)
1220 NEXT I
1230 GOSUB 2670 : REM LEAST SQUARES
1240 A3=B : B3=EXP(A/B)
1250 REM POLYNOMIAL FIT
1260 REM FIND SCALE AND RANGE FACTORS
1270 MAX=X(1) : MIN=X(1)
1280 FOR I=2 TO N
1290 IF X(I)>MAX THEN MAX=X(I)
1300 IF X(I)<MIN THEN MIN=X(I)
1310 NEXT I

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1320 XC=(MAX+MIN)/2 : XR=(MAX-MIN)/2
1330 REM COMPUTE XM MATRIX
1340 FOR I=1 TO N : T=(X(I)-XC)/XR
1350 XM(I-1,0)=1 : FOR J=1 TO M
1360 XM(I-1,J)=XM(I-1,J-1)*T
1370 NEXT J : NEXT I
1380 IF M>1 THEN GOTO 1450
1390 FOR I=1 TO N
1400 WX(I)=XM(I-1,1) : WY(I)=Y(I)
1410 NEXT I
1420 GOSUB 2670 : REM LEAST SQUARES
1430 A(0)=A : A(1)=B
1440 GOTO 1650 : REM CHOOSE OPTIMAL
1450 REM COMPUTE TRANS(XM)*XM MATRIX
1460 FOR I=0 TO M : FOR J=0 TO I
1470 T=0
1480 FOR K=0 TO N-1
1490 T=T+XM(K,I)*XM(K,J)
1500 NEXT K : S(J,I)=T
1510 NEXT J : NEXT I
1520 L=M : GOSUB 3260 : REM COMPUTE S=INV(S)
1530 REM COMPUTE A=INV(S)*TRANS(XM)*Y
1540 FOR I=0 TO M : T=0
1550 FOR J=0 TO N-1
1560 T=T+XM(J,I)*Y(J+1)
1570 NEXT J
1580 XM(I,0)=T : NEXT I
1590 REM COMPUTE S*XM(I,0)
1600 FOR I=0 TO M : T=0
1610 FOR J=0 TO M
1620 T=T+S(I,J)*XM(J,0)
1630 NEXT J
1640 A(I)=T : NEXT I
1650 REM **** CHOOSE OPTIMAL MODEL ****
1660 REM SUM OF SQUARED ERROR
1670 DEF FNA(X)=A1*X^B1
1680 DEF FNB(X)=A2*EXP(B2*X)
1690 DEF FNC(X)=A3*LOG(B3*X)
1700 REM POLYNOMIAL IMPLEMENTED LATER
1710 REM **** POWER FUNCTION ****
1720 IF X#="N" OR Y#="N" THEN GOTO 1770
1730 T=0
1740 FOR I=1 TO N
1750 T=T+(Y(I)-FNA(X(I)))^2
1760 NEXT I : EROR(1)=T
1770 REM **** EXPONENTIAL ERROR ****
1780 IF Y#="N" THEN GOTO 1820
1790 T=0 : FOR I=1 TO N
1800 T=T+(Y(I)-FNB(X(I)))^2
1810 NEXT I : EROR(2)=T
1820 REM LOGARTHIMIC ERROR ****
1830 IF X#="N" THEN GOTO 1870
1840 T=0 : FOR I=1 TO N
1850 T=T+(Y(I)-FNC(X(I)))^2
1860 NEXT I : EROR(3)=T
1870 REM **** POLYNOMIAL ERROR ****
1880 T=0 : FOR I=1 TO N
1890 T1=A(0) : FOR J=1 TO M
1900 T1=T1+XM(I-1,J)*A(J)
1910 NEXT J
1920 T=T+(Y(I)-T1)^2
1930 NEXT I : EROR(4)=T
1940 REM **** FIND MAX MODEL ERROR ****
1950 T=EROR(1) : FOR I=2 TO 4
1960 IF EROR(I)>T THEN T=EROR(I)
1970 NEXT I

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1980 REM SET ERROR ON UNUSED FUNCTIONS TO MAXERR+1
1990 IF X#="N" THEN EROR(1)=T+1 : EROR(3)=T+1
2000 IF Y#="N" THEN EROR(1)=T+1 : EROR(2)=T+1
2010 REM **** FIND OPTIMAL FUNCTION ****
2020 T=EROR(1) : FUNC=1
2030 FOR I=2 TO 4
2040 IF EROR(I)<T THEN T=EROR(I) : FUNC=I
2050 NEXT I
2060 REM FIND MAX ERROR ****
2070 ME=0 : REM INITIALIZE MAX ERROR
2080 FOR I=1 TO N
2090 ON FUNC GOTO 2100,2110,2120,2130
2100 T=Y(I)-FNA(X(I)) : GOTO 2160
2110 T=Y(I)-FNB(X(I)) : GOTO 2160
2120 T=Y(I)-FNC(X(I)) : GOTO 2160
2130 T=A(0) : FOR J=1 TO M
2140 T=T+XM(I-1,J)*A(J)
2150 NEXT J : T=Y(I)-T
2160 IF ABS(T)>ME THEN ME=ABS(T) : MP=I
2170 NEXT I
2180 GOTO 2400
2190 REM READJUST SCALE
2200 T=XR
2210 FOR I=1 TO M
2220 A(I)=A(I)/T : T=T*XR
2230 NEXT I
2240 REM READJUST RANGE (HORNER SHIFT)
2250 A(0)=A(0)-XC*A(1)
2260 IF M=1 THEN GOTO 2380
2270 WX(0)=-XC : WX(1)=1
2280 FOR I=2 TO L
2290 WX(I)=WX(I-1)
2300 FOR J=I-1 TO 1 STEP -1
2310 WX(J)=WX(J-1)-XC*WX(J)
2320 NEXT J
2330 WX(0)=-XC*WX(0)
2340 FOR J=0 TO I-1
2350 A(J)=A(J)+WX(J)*A(I)
2360 NEXT J
2370 NEXT I
2380 IF T#="Y" THEN GOTO 3850
2390 GOTO 2580
2400 REM OUTPUT RESULTS
2410 CLS : INPUT " IS HARD COPY DESIRED (Y/N)? ",T#
2420 IF T#<>"Y" AND T#<>"N" THEN GOTO 2410
2430 CLS : IF T#="N" THEN PRINT TI# ELSE GOTO 3730
2440 REM
2450 REM PRINT DATA TABLE
2460 PRINT "PT"; TAB(5);"X-VALUE"; TAB(17);"Y-VALUE"
2470 FOR I=1 TO N
2480 PRINT I; TAB(5);X(I); TAB(17);Y(I)
2490 NEXT I : PRINT : PRINT
2500 PRINT "THE OPTIMAL CURVE FIT: "
2510 ON FUNC GOTO 2520,2540,2560,2190
2520 PRINT "Y=";A1;"*X^";B1 : GOTO 2640
2540 PRINT "Y=";A2;"*EXP(";B2;"*X)" : GOTO 2640
2560 PRINT "Y=";A3;"*LOG(";B3;"*X)" : GOTO 2640
2580 PRINT "Y=";A(0);"+(";A(1);"*X)" : IF M=1 THEN GOTO 2640
2590 I=1
2600 I=I+1 : PRINT TAB(3); "+(";A(I);"*X^";I;")"
2610 IF I=M THEN GOTO 2640
2620 I=I+1 : PRINT "+(";A(I);"*X^";I;")"
2630 IF I<M GOTO 2600
2640 PRINT : PRINT "THE MAXIMUM ERROR IS: ";ME
2650 PRINT "THIS ERROR OCCURS AT POINT: ";MP
2660 INPUT "HIT RETURN TO CONTINUE ":T# : RETURN

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2670 REM **** LEAST SQUARES ****
2680 X=0 : Y=0 : X2=0 : XY=0
2690 FOR I=1 TO N
2700 X=X+WX(I) : Y=Y+WY(I) : X2=X2+WX(I)*WX(I) : XY=XY+WX(I)*WY(I)
2710 NEXT I
2720 T=N*X2-X*X
2730 A=(Y*X2-X*XY)/T : B=(N*XY-X*Y)/T
2740 RETURN
2750 REM DISK INPUT/OUTPUT ROUTINES
2760 REM DISK MENU
2770 CLS
2780 PRINT : PRINT :PRINT TAB(10);"UNIVARIATE DISK I/O"
2790 PRINT TAB(10); "<1> - SAVE DATA TO DISK"
2800 PRINT TAB(10); "<2> - RECALL DATA FROM DISK"
2810 PRINT TAB(10); "<3> - RETURN TO MAIN MENU"
2820 PRINT : PRINT TAB(10); : INPUT "OPTION: ";T$
2830 T=VAL(T$) : IF T<1 OR T>3 THEN GOTO 2820
2840 IF T=3 THEN RETURN
2850 ON T GOSUB 2870, 2970
2860 RETURN
2870 REM SAVE DATA TO DISK
2880 OPEN "O",#1,TI$+".UNI"
2890 ON ERROR GOTO 3050
2900 WRITE #1,N
2910 FOR I=1 TO N
2920 WRITE #1,X(I);Y(I)
2930 NEXT I
2940 CLOSE #1
2950 ON ERROR GOTO 0
2960 RETURN
2970 REM RECALL DATA FROM DISK
2980 OPEN "I", #1, TI$+".UNI"
2990 INPUT #1,N
3000 FOR I=1 TO N
3010 INPUT #1,X(I),Y(I)
3020 NEXT I
3030 CLOSE #1
3040 RETURN
3050 REM HANDLE INPUT ERRORS
3060 CLS : PRINT "UNABLE TO WRITE DATA TO FILE"
3070 PRINT "ERR= ";ERR;"ERL= ";ERL
3080 ON ERROR GOTO 0
3090 RETURN
3100 CLS : PRINT "UNIVARIATE CALCULATOR - Q TO QUIT"
3110 IF FUNC=0 THEN RETURN
3120 PRINT TAB(5);"X-VALUE"; TAB(17);"Y-VALUE"
3130 PRINT TAB(5); : INPUT;"",T$ : X=VAL(T$) : IF T$="Q" THEN RETURN
3140 ON FUNC GOTO 3150,3160,3170,3190
3150 Y=FNA(X) : GOTO 3240
3160 Y=FNB(X) : GOTO 3240
3170 IF (B3*X)<0 THEN GOTO 3210
3180 Y=FNC(X) : GOTO 3240
3190 Y=0
3200 FOR I=M TO 1 STEP -1
3210 Y=(Y+A(I))*X
3220 NEXT I
3230 Y=Y+A(0)
3240 PRINT TAB(17); Y
3250 GOTO 3130
3260 REM
3270 REM GUASSUAN ELIMINATIN ON S
3280 DET =1
3290 FOR I=0 TO L-1
3300 DET=DET*S(I,I)
3310 IF S(I,I)=0 THEN S$="Y" : I=L-1 : GOTO 3370
3320 FOR J=I+1 TO L

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3330 T=S(I,J)/S(I,I) : S(J,I)=T
3340 FOR K=J TO L
3350 S(J,K)=S(J,K)-T*S(I,K)
3360 NEXT K : NEXT J : S$="N"
3370 NEXT I
3380 DET=DET*S(L,L)
3390 IF S$="Y" THEN GOTO 3700 : REM SINGULARITY
3400 REM COMPUTE INV(L) - FORWARD SUBSTITUTION
3410 FOR I=0 TO L-2
3420 S(I+1,I)=-S(I+1,I)
3430 FOR J=I+2 TO L
3440 T=-S(J,I)
3450 FOR K=I+1 TO J-1
3460 T=T-S(J,K)*S(K,I)
3470 NEXT K
3480 S(J,I)=T
3490 NEXT J
3500 NEXT I
3510 S(L,L-1)=-S(L,L-1)
3520 REM COMPUTE INV(U)
3530 FOR I=0 TO L-1 : FOR J=I+1 TO L
3540 S(I,J)=S(J,I)
3550 NEXT J : NEXT I
3560 S(0,0)=1/S(0,0)
3570 FOR I=1 TO L
3580 T=1/S(I,I) : S(I,I)=T
3590 FOR J=0 TO I-1
3600 S(J,I)=S(J,I)*T
3610 NEXT J : NEXT I
3620 REM COMPUTE INV(U)*INV(L)
3630 FOR I=0 TO L-1
3640 T=S(I,I)
3650 FOR K=I+1 TO L : T=T+S(I,K)*S(K,I) : NEXT K
3660 S(I,I)=T
3670 FOR J=I+1 TO L
3680 T=0 : FOR K=J TO L : T=T+S(J,K)*S(K,I) : NEXT K
3690 S(J,I)=T : NEXT J : NEXT I
3700 FOR I=0 TO L-1 : FOR J=I+1 TO L
3710 S(I,J)=S(J,I) : NEXT : NEXT
3720 RETURN
3730 REM PRINTED OUTPUT
3735 LPRINT TI$
3740 LPRINT "PT"; TAB(5); "X-VALUE"; TAB(17); "Y-VALUE"
3750 FOR I=1 TO N
3760 LPRINT I; TAB(5); X(I); TAB(17); Y(I)
3770 NEXT
3780 LPRINT
3790 LPRINT
3800 LPRINT "THE OPTIMAL CURVE FIT: "
3810 ON FUNC GOTO 3820,3830,3840,2190
3820 LPRINT "Y=";A1;"*X^";B1 : GOTO 3910
3830 LPRINT "Y=";A2;"*EXP(";B2;"*X)": GOTO 3910
3840 LPRINT "Y=";A3;"*LOG(";B3;"*X)": GOTO 3910
3850 LPRINT "Y=";A(0);"+(";A(1);"*X)" : IF M=1 THEN GOTO 3910
3860 I=1
3870 I=I+1 : LPRINT TAB(3);"+(";A(I);"*X^";I;)"
3880 IF I=M THEN GOTO 3910
3890 I=I+1 : LPRINT "+(";A(I);"*X^";I;)"
3900 IF I<M GOTO 3870
3910 LPRINT : LPRINT "THE MAXIMUM ERROR IS : ";ME
3920 LPRINT "THIS ERROR OCCURS AT POINT : ";MP
3930 INPUT "HIT RETURN TO CONTINUE ";T$ : RETURN

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