



DECUS

PROGRAM LIBRARY

DECUS NO.	FOCAL8-236
TITLE	POLYNOMIAL CURVE FITTING (STREAMLINED PROGRAMS)
AUTHOR	Dr. J. H. Battocletti
COMPANY	Medical College of Wisconsin Milwaukee, Wisconsin
DATE	April 3, 1972
SOURCE LANGUAGE	FOCAL 1969

POLYNOMIAL CURVE FITTING (STREAMLINED PROGRAMS)

DECUS Program Library Write-up

DECUS NO. FOCAL8-236

WRITE-UP

The polynomial curve-fitting FOCAL programs described below have been written for the Pdp-8 user who has only 4k storage, but who wants to be able to use as many data points and as large an order polynomial as possible. To do this, near-ultimate streamlining has been accomplished, particularly by various techniques of minimizing the number of variables, pages, lines, and alphanumeric characters.

For the normal polynomial programs, no extended functions are needed; for the Chebyshev polynomial, only the SINE and COSINE extended functions are required.

The principal reference used is "Numerical Methods and Computers" by Shan S. Kuo, Addison-Wesley, 1965, Chapter 11. Example 11.3, page 233, is used as a sample program. Other references are: FOCAL8-37, FOCAL8-61, and the write-up, "Chebyshev Polynomial Approximation by FOCAL", by Chi-Whe Koo, DECUSCOPE pages 13-14, volume 10, No. 3.

CAPABILITIES

Number of data points and order of polynomial capabilities are given in terms of algebraic equations, which are given in the accompanying table, together with typical values of N (number of data points) and m (order of polynomial).

Order of Polynomial m	Number of Data Points.....N		
	Normal Polynomial $k_0 \neq 0$ $(m+2)^2 + 2N = 111$	Normal Polynomial $k_0 = 0$ $(m+1)^2 + 2N = 124$	Chebyshev Polynomial $k_0 \neq 0$ $2N + 3m = 41$
1	51	60	19
2	47	57	18
3	43	54	16
4	37	49	15
5	31	44	13
6	23	37	12
7	15	30	10
8	5	21	9
9	--	12	--

Normal Polynomial, with $k_0 \neq 0$

```

*
*C-FOCAL,1969
*
*01.02 A N,M;F I=1,N;A X(I),Y(I)
*01.14 F I=1,M*M+3*M+1;S A(I)=0
*01.18 S A(0)=N
*01.22 S A(0)=N;F I=1,M;F J=1,N;S A(I)=A(I)+X(J)+I
*01.26 S L=1;S K=M
*01.30 F I=L,M+L;F J=1,N;S A(K+I)=A(K+I)+X(J)+I
*01.34 S L=L+1;S K=K+M;I (L-M-1)1.3
*01.42 F I=1,N;S A((M+1)+2)=A((M+1)+2)+Y(I)
*01.46 F I=1,M;F J=1,N;S A((N+1)+2+I)=A((M+1)+2+I)+Y(J)*X(J)+I
*01.58 S L=M+1;S I=-1;F K=0,M;S R(K)=K+1
*01.60 S B=1E-6;F J=0,M;F K=0,M;D 6
*01.72 S R(P)=0
*01.76 F K=0,L;S A(P+L*K)=A(P+L*K)/B
*01.80 F J=0,M;D 5
*01.84 S I=I+1;I (I-M)1.6,1.9,1.6
*01.90 F J=0,M;F K=0,M;D 7
*01.94 S P=0;F J=1,N;S D=R(0);D 9
*01.97 T FSQT(P/(N-1)),!;S N=M+1;G 1.14

```

```

*
*05.10 I (J-P)5.3,5.4
*05.30 S D=A(J+L*Q);F K=0,L;S A(J+L*K)=A(J+L*K)-A(P+L*K)*D
*05.40 R

```

```

*
*06.10 I (R(J))0,6.3;I (FABS(A(J+L*K))-FABS(B))6.3
*06.20 S B=A(J+L*K);S P=J;S Q=K
*06.30 R

```

```

*
*07.10 I (1E-6-FABS(A(J+L*K)))7.2;R
*07.20 S R(K)=A(J+L*L);T %2,K,%16.16,R(K),!

```

```

*
*09.02 F I=1,M;S D=D+R(I)*X(J)+I
*09.04 T %6.03,X(J),Y(J),D,Y(J)-D,!;S P=P+(Y(J)-D)+2

```

```

G
:10 :2
:1 :2
:2 :5
:3 :7
:4 :8
:5 :10
:6 :11
:7 :11
:8 :10
:9 :9
:10 :8

```

```

= 0=-1.2998300000000000
= 1= 3.5650700000000000
= 2=-0.2651440000000000
= # 1.000= 2.000= 2.000=- 0.000
= 2.000= 5.000= 4.770= 0.230
= 3.000= 7.000= 7.009=- 0.009
= 4.000= 8.000= 8.718=- 0.718
= 5.000= 10.000= 9.897= 0.103
= 6.000= 11.000= 10.545= 0.455
= # 7.000= 11.000= 10.664= 0.337
= 8.000= 10.000= 10.252=- 0.252
= 9.000= 9.000= 9.309=- 0.309
= # 10.000= 8.000= 7.837= 0.164
= 0.347

```


NORMAL POLYNOMIAL, with $k_0 = 0$

W A
C-FOCAL, 1969

01.06 A N,M;F I=1,N;A X(I),Y(I)
01.14 S L=0;S K=0;F I=0,M*M+M-1;S A(I)=0
01.30 F I=L,M-1+L;F J=1,N;S A(K+I)=A(K+I)+X(J)+(I+2)
01.34 S L=L+1;S K=K+M-1;I (L-M)1.3
01.46 F I=1,M;F J=1,N;S A(M+2+I-1)=A(M+2+I-1)+Y(J)*X(J)+I
01.58 S L=M-1;S I=-1;F K=0,L;S R(K)=K+1
01.60 S B=1E-6;F J=0,L;F K=0,L;D 6
01.76 S R(P)=0;F K=0,M;S A(P+M*K)=A(P+M*K)/B
01.80 F J=0,L;D 5
01.84 S I=I+1;I (I-L)1.6,1.9,1.6
01.90 F J=0,L;F K=0,L;D 7
01.94 S P=0;F J=1,N;S D=0;D 9
01.97 T FSQT(P/(N-1)),!;S M=M+1;G 1.14

05.10 I (J-P)5.3,5.4
05.30 S D=A(J+M*Q);F K=0,N;S A(J+M*K)=A(J+M*K)-A(P+M*K)*D
05.40 R

06.10 I (R(J))0,6.3;I (FABS(A(J+M*K))-FABS(B))6.3
06.20 S B=A(J+M*K);S P=J;S Q=K
06.30 R

07.10 I (1E-6-FABS(A(J+M*K)))7.2;R
07.20 S R(K)=A(J+M*M);T %2,K+1,%16.16,R(K),!

09.02 F I=1,M;S D=D+R(I-1)*X(J)+I
09.04 T %6.03,X(J),Y(J),D,Y(J)-D,!;S P=P+(Y(J)-D)+2

*

*G

:10 :2
:1 :2
:2 :5
:3 :7
:4 :8
:5 :10
:6 :11
:7 :11
:8 :10
:9 :9
:10 :8

= 1 = 3.0717600000000000
= 2 = -0.2259930000000000
= 1.000 = 2.000 = 2.846 = - 0.846
= 2.000 = 5.000 = 5.240 = - 0.240
= 3.000 = 7.000 = 7.181 = - 0.181
= 4.000 = 8.000 = 8.671 = - 0.671
= 5.000 = 10.000 = 9.709 = 0.291
= 6.000 = 11.000 = 10.295 = 0.705
= 7.000 = 11.000 = 10.429 = 0.571
= 8.000 = 10.000 = 10.111 = - 0.111
= 9.000 = 9.000 = 9.341 = - 0.341
= 10.000 = 8.000 = 8.118 = - 0.118
= 0.506



Chebyshev Polynomial, with $k_0 \neq 0$

C-FOCAL, 1969

```

01.04 A N,M;S P=3.14159;A X,D;F I=1,N;A Y(I)
01.16 S N=M+1;F I=1,M;S A(M+1-I)=FCOS(P*(I-.5)/M)
01.24 S V(1)=-1;F I=1,N-1;S V(I+1)=V(I)+2/(N-1)
01.28 S I=1;F L=1,N;D 3
01.30 F I=1,M;D 4;S C(I)=2*S/M
01.48 S C(1)=C(1)/2;S W(1)=C(1);S W(2)=C(2);I (M-3)1.64
01.56 F K=1,M;S V(K)=0;S A(K)=0
01.60 S V(2)=1;F K=3,M;S W(K)=0;D 6
01.64 S A(1)=W(1);F K=2,M;S A(K)=0
01.68 F K=2,M;D 8
01.72 F K=1,M;T !,%2,K-1,%17.15,A(K)
01.76 S S=0;F J=1,N;D 10
01.80 T !,FSQT(S/(N-1)),!;G 1.16

03.04 I (V(L)-A(I))3.4
03.08 S U=(A(I)-V(L-1))/(V(L)-V(L-1));I (L-2)3.1,3.1;I (L-N)3.2
03.10 S W(I)=U*Y(L)+Y(L-1)*(1-U);G 3.3
03.20 S W(I)=-U*(U-2)*((U-1)*Y(L-2)/3+(U+1)*Y(L))/2
03.28 S W(I)=W(I)+(U*U-1)*((U-2)*Y(L-1)+U*Y(L+1)/3)/2
03.30 S I=I+1;I (I-M-1)3.04;S L=N+1
03.40 R

04.04 S S=0;I (2-I)4.24,4.16;F J=1,M;S S=S+W(J)
04.12 R
04.16 F J=1,M;S S=S+A(J)*W(J)
04.20 R
04.24 S V(1)=1;F J=1,M;S V(2)=A(J);D 5;S S=S+W(J)*V(I)

05.04 F K=3,I;S V(K)=2*A(J)*V(K-1)-V(K-2)

06.04 S A(1)=FCOS(P*(K-1)/2);F J=2,K;S A(J)=2*V(J-1)-A(J)
06.12 F J=1,K;S W(J)=W(J)+C(K)*A(J);S U=V(J);S V(J)=A(J);S A(J)=U

08.04 S L=K-1;S C(1)=X+(N-1)*D/2;S C(2)=(N-1)*D/2;S S=1;S U=1
08.08 S A(K)=A(K)+W(K)/C(2)+L;F J=1,L;S S=S*J;S U=U*(K-J);D 9

09.08 S A(K-J)=A(K-J)+U*C(1)+J*(-1)+J*W(K)/S/C(2)+L

10.04 S K=A(1);S U=X+(J-1)*D;F I=2,M;S K=K+A(I)*U+(I-1)
10.08 T %8.05,! ,U,Y(J),K,Y(J)-K;S S=S+(Y(J)-K)+2

```

```

*
*G
:10 :2
:1 :1
:2 :5 :7 :8 :10 :11 :11 :10 :9 :8

```

```

= 0=- 1.5601800000000000
= 1= 3.8158800000000000
= 2=- 0.2909800000000000
= 1.000000= 2.000000= 1.96472= 0.03528
= 2.000000= 5.000000= 4.90766= 0.09234
= 3.000000= 7.000000= 7.26864=- 0.26864
= 4.000000= 8.000000= 9.04766=- 1.04766
= 5.000000= 10.000000= 10.24470=- 0.24471
= 6.000000= 11.000000= 10.85980= 0.14019
= 7.000000= 11.000000= 10.89300= 0.10705
= 8.000000= 10.000000= 10.34410=- 0.34413
= 9.000000= 9.000000= 9.21335=- 0.21335
= 10.000000= 8.000000= 7.50060= 0.49940
= 0.43255

```

