Problem:

The attached file (two columns X and Y) contains data (Y) in irregular intervals of X. Write a program to generate at regular interval of 0.5 in X. Use piece-wise linear interpolation and cubic spline interpolation.

Solution with Code:

Program for linear interpolation:

```
PROGRAM LINEAR_INTERPOLATION
IMPLICIT NONE
INTEGER :: I,J,N ,M1, M
REAL :: A, B
REAL, DIMENSION(:), ALLOCATABLE :: X, Y, XO, YO
OPEN(1,file='data_exer1_30.txt')
WRITE(*,*)'ENTER THE NO OF ORIGINAL DATA POINTS'
READ*,N
ALLOCATE(X(1:N))
ALLOCATE(Y(1:N))
      DO I = 1, N
READ (1,*)X(I),Y(I)
      END DO
M1=INT(MAXVAL(X))
M=2*M1-1
ALLOCATE(XO(1:M))
ALLOCATE(YO(1:M))
XO(1)=1.0
DO I=1,M-1
XO(I+1)=XO(I)+0.5
END DO
DO I=1,M-1
DO J=1,N-1
YO(M)=Y(N)
IF(XO(I)>=X(J).AND.XO(I)<X(J+1))THEN
A=(X(J+1)-XO(I))/(X(J+1)-X(J))
B=(XO(I)-X(J))/(X(J+1)-X(J))
YO(I)=A*Y(J)+B*Y(J+1)
END IF
END DO
END DO
OPEN(2,file='OUTPUT1.dat')
DO I=1,M
WRITE(2,*) XO(I), YO(I)
END DO
END
```

Program for Spline interpolation:

```
       PROGRAM SPLINE_INTERPOLATION
      IMPLICIT NONE
      INTEGER :: I, K ,N ,M, M1
      REAL :: XO, YO, DX, H, ALPHA, BETA, GAMMA, ETA
      REAL, DIMENSION(:), ALLOCATABLE :: XI, YI, P2
      OPEN(1,file='data_exer1_30.txt')
      WRITE(*,*)'ENTER THE NO OF ORIGINAL DATA POINTS  - 1'
      READ*,N
      ALLOCATE(XI(1:(N+1)))
      ALLOCATE(YI(1:(N+1)))
      ALLOCATE(P2(1:(N+1)))
            DO I = 1, N+1
      READ (1,*)XI(I),YI(I)
            END DO
      ! XI & YI IS THE X & Y VALUE OF ORIGINAL DATA
      M1=INT(MAXVAL(XI))
      M=2*M1
      CALL CUBIC_SPLINE(N, XI, YI, P2)
      H = 0.5
      XO = XI(1)
        DO I = 1, M-1
      K = 1
      DX = XO-XI(1)
        DO WHILE (DX >= 0)
      K = K + 1
      DX = XO-XI(K)
        END DO
      K = K - 1
      DX = XI(K+1) - XI(K)
      ALPHA = P2(K+1)/(6*DX)
      BETA = -P2(K)/(6*DX)
      GAMMA = YI(K+1)/DX - DX*P2(K+1)/6
      ETA = DX*P2(K)/6 - YI(K)/DX
      YO = ALPHA*(XO-XI(K))*(XO-XI(K))*(XO-XI(K)) &
        +BETA*(XO-XI(K+1))*(XO-XI(K+1))*(XO-XI(K+1)) &
        +GAMMA*(XO-XI(K))+ETA*(XO-XI(K+1))
      OPEN(2,FILE='RESULT.dat')
      IF(XO==50)THEN
      YO=YI(N)
      END IF
      WRITE(2,*)XO,YO
      XO = XO + H
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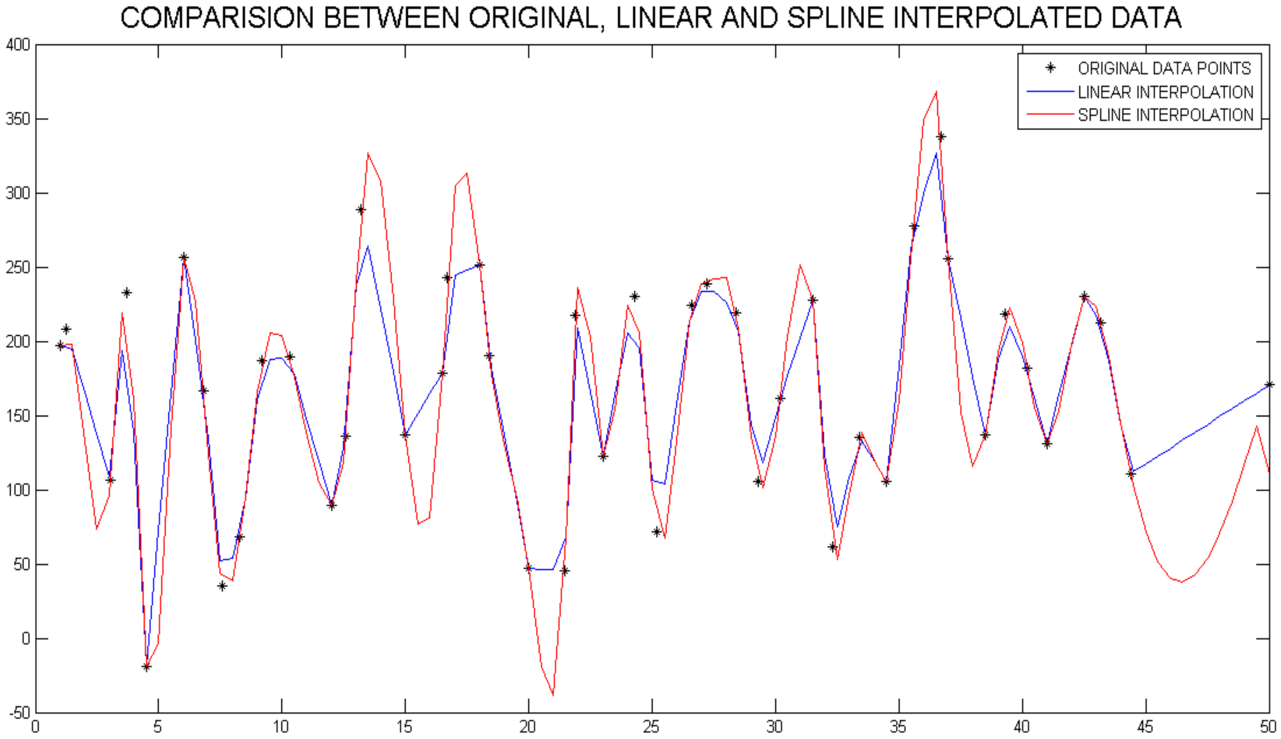
```
! XO & YO IS THE X & Y VALUE OF INTERPOLATED DATA
  END DO
END PROGRAM SPLINE_INTERPOLATION

SUBROUTINE CUBIC_SPLINE (N, XI, FI, P2)
INTEGER :: I
INTEGER, INTENT (IN) :: N
REAL, INTENT (IN), DIMENSION (N+1):: XI, FI
REAL, INTENT (OUT), DIMENSION (N+1):: P2
REAL, DIMENSION (N):: G, H
REAL, DIMENSION (N-1):: D, B, C
  DO I = 1, N
H(I) = XI(I+1) - XI(I)
G(I) = FI(I+1) - FI(I)
  END DO
  DO I = 1, N-1
D(I) = 2*(H(I+1)+H(I))
B(I) = 6*(G(I+1)/H(I+1)-G(I)/H(I))
C(I) = H(I+1)
  END DO
CALL TRIDIAGONAL_INVERSION(N-1, D, C, C, B, G)
P2(1) = 0
P2(N+1) = 0
  DO I = 2, N
P2(I) = G(I-1)
  END DO
END SUBROUTINE CUBIC_SPLINE

SUBROUTINE TRIDIAGONAL_INVERSION (L, D, E, C, B, Z)
INTEGER, INTENT (IN) :: L
INTEGER :: I
REAL, INTENT (IN), DIMENSION (L):: D, E, C, B
REAL, INTENT (OUT), DIMENSION (L):: Z
REAL, DIMENSION (L):: Y, W
REAL, DIMENSION (L-1):: V, T
W(1) = D(1)
V(1)  = C(1)
T(1)  = E(1)/W(1)
  DO I = 2, L - 1
W(I) = D(I)-V(I-1)*T(I-1)
V(I) = C(I)
T(I) = E(I)/W(I)
  END DO
W(L) = D(L)-V(L-1)*T(L-1)
```

```
Y(1) = B(1)/W(1)
DO I = 2, L
Y(I) = (B(I)-V(I-1)*Y(I-1))/W(I)
  END DO
Z(L) = Y(L)
  DO I = L-1, 1, -1
Z(I) = Y(I) - T(I)*Z(I+1)
  END DO
END SUBROUTINE TRIDIAGONAL_INVERSION
```

Result:


COMPARISION BETWEEN ORIGINAL, LINEAR AND SPLINE INTERPOLATED DATA
ORIGINAL DATA POINTS
LINEAR INTERPOLATION
SPLINE INTERPOLATION