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          PROGRAM D10R9
C         DRIVER FOR ROUTINE FRPRMN
          PARAMETER(NDIM=3,FTOL=1.0E-6,PIO2=1.5707963)
          DIMENSION P(NDIM)
          WRITE(*,'(/1X,A)') 'PROGRAM FINDS THE MINIMUM OF A FUNCTION'
          WRITE(*,'(1X,A)') 'WITH DIFFERENT TRIAL STARTING VECTORS.'
          WRITE(*,'(1X,A)') 'TRUE MINIMUM IS (0.5,0.5,0.5)'
          DO 11 K=0,4
             ANGL=PIO2*K/4.0
             P(1)=2.0*COS(ANGL)
             P(2)=2.0*SIN(ANGL)
             P(3)=0.0
             WRITE(*,'(/1X,A,3(F6.4,A))') 'STARTING VECTOR: (' ,
*           P(1),',',P(2),',',P(3),')'
             CALL FRPRMN(P,NDIM,FTOL,ITER,FRET)
             WRITE(*,'(1X,A,I3)') 'ITERATIONS:',ITER
             WRITE(*,'(1X,A,3(F6.4,A))') 'SOLUTION VECTOR: (' ,
*           P(1),',',P(2),',',P(3),')'
             WRITE(*,'(1X,A,E14.6)') 'FUNC. VALUE AT SOLUTION',FRET
11        CONTINUE
          PAUSE
          END

          FUNCTION FUNC(X)
          DIMENSION X(3)
          FUNC=1.0-BESSJ0(X(1)-0.5)*BESSJ0(X(2)-0.5)*BESSJ0(X(3)-0.5)
          END

          SUBROUTINE DFUNC(X,DF)
          PARAMETER (NMAX=50)
          DIMENSION X(3),DF(NMAX)
          DF(1)=BESSJ1(X(1)-0.5)*BESSJ0(X(2)-0.5)*BESSJ0(X(3)-0.5)
          DF(2)=BESSJ0(X(1)-0.5)*BESSJ1(X(2)-0.5)*BESSJ0(X(3)-0.5)
          DF(3)=BESSJ0(X(1)-0.5)*BESSJ0(X(2)-0.5)*BESSJ1(X(3)-0.5)
          RETURN
          END

          SUBROUTINE FRPRMN(P,N,FTOL,ITER,FRET)
          PARAMETER (NMAX=50,ITMAX=200,EPS=1.E-10)
          DIMENSION P(N),G(NMAX),H(NMAX),XI(NMAX)
          FP=FUNC(P)
          CALL DFUNC(P,XI)
          DO 11 J=1,N
             G(J)=-XI(J)
             H(J)=G(J)
             XI(J)=H(J)
11        CONTINUE
          DO 14 ITS=1,ITMAX
             ITER=ITS
             CALL LINMIN(P,XI,N,FRET)
             IF(2.*ABS(FRET-FP).LE.FTOL*(ABS(FRET)+ABS(FP)+EPS))RETURN
             FP=FUNC(P)
             CALL DFUNC(P,XI)
             GG=0.
             DGG=0.
             DO 12 J=1,N

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      GG=GG+G(J)**2
C      DGG=DGG+XI(J)**2
      DGG=DGG+(XI(J)+G(J))*XI(J)
12     CONTINUE
      IF(GG.EQ.0.)RETURN
      GAM=DGG/GG
      DO 13 J=1,N
          G(J)=-XI(J)
          H(J)=G(J)+GAM*H(J)
          XI(J)=H(J)
13     CONTINUE
14     CONTINUE
      PAUSE 'FRPR MAXIMUM ITERATIONS EXCEEDED'
      RETURN
      END
      SUBROUTINE LINMIN(P,XI,N,FRET)
      PARAMETER (NMAX=50,TOL=1.E-4)
      EXTERNAL F1DIM
      DIMENSION P(N),XI(N)
      COMMON /F1COM/ NCOM,PCOM(NMAX),XICOM(NMAX)
      NCOM=N
      DO 11 J=1,N
          PCOM(J)=P(J)
          XICOM(J)=XI(J)
11     CONTINUE
      AX=0.
      XX=1.
      BX=2.
      CALL MNBRAK(AX,XX,BX,FA,FX,FB,F1DIM)
      FRET=BRENT(AX,XX,BX,F1DIM,TOL,XMIN)
      DO 12 J=1,N
          XI(J)=XMIN*XI(J)
          P(J)=P(J)+XI(J)
12     CONTINUE
      RETURN
      END
      SUBROUTINE MNBRAK(AX,BX,CX,FA,FB,FC,FUNC)
      PARAMETER (GOLD=1.618034, GLIMIT=100., TINY=1.E-20)
      FA=FUNC(AX)
      FB=FUNC(BX)
      IF(FB.GT.FA)THEN
          DUM=AX
          AX=BX
          BX=DUM
          DUM=FB
          FB=FA
          FA=DUM
      ENDIF
      CX=BX+GOLD*(BX-AX)
      FC=FUNC(CX)
1     IF(FB.GE.FC)THEN
          R=(BX-AX)*(FB-FC)
          Q=(BX-CX)*(FB-FA)
          U=BX-((BX-CX)*Q-(BX-AX)*R)/(2.*SIGN(MAX(ABS(Q-R),TINY),Q-
1          R))
          ULIM=BX+GLIMIT*(CX-BX)
          IF((BX-U)*(U-CX).GT.0.)THEN

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FU=FUNC(U)
IF(FU.LT.FC)THEN
  AX=BX
  FA=FB
  BX=U
  FB=FU
  GO TO 1
ELSE IF(FU.GT.FB)THEN
  CX=U
  FC=FU
  GO TO 1
ENDIF
U=CX+GOLD*(CX-BX)
FU=FUNC(U)
ELSE IF((CX-U)*(U-ULIM).GT.0.)THEN
  FU=FUNC(U)
  IF(FU.LT.FC)THEN
    BX=CX
    CX=U
    U=CX+GOLD*(CX-BX)
    FB=FC
    FC=FU
    FU=FUNC(U)
  ENDIF
ELSE IF((U-ULIM)*(ULIM-CX).GE.0.)THEN
  U=ULIM
  FU=FUNC(U)
ELSE
  U=CX+GOLD*(CX-BX)
  FU=FUNC(U)
ENDIF
AX=BX
BX=CX
CX=U
FA=FB
FB=FC
FC=FU
GO TO 1
ENDIF
RETURN
END

FUNCTION BESSJ0(X)
REAL*8 Y,P1,P2,P3,P4,P5,Q1,Q2,Q3,Q4,Q5,R1,R2,R3,R4,R5,R6,
* S1,S2,S3,S4,S5,S6
DATA P1,P2,P3,P4,P5/1.D0,-.1098628627D-2,.2734510407D-4,
* -.2073370639D-5,.2093887211D-6/, Q1,Q2,Q3,Q4,Q5/-.1562499995D-
*1,
* .1430488765D-3,-.6911147651D-5,.7621095161D-6,-.934945152D-7/
DATA R1,R2,R3,R4,R5,R6/57568490574.D0,-13362590354.D0,651619640.7D
*0,
* -11214424.18D0,77392.33017D0,-184.9052456D0/,
* S1,S2,S3,S4,S5,S6/57568490411.D0,1029532985.D0,
* 9494680.718D0,59272.64853D0,267.8532712D0,1.D0/
IF(ABS(X).LT.8.)THEN
  Y=X**2
  BESSJ0=(R1+Y*(R2+Y*(R3+Y*(R4+Y*(R5+Y*R6))))))
* /((S1+Y*(S2+Y*(S3+Y*(S4+Y*(S5+Y*S6))))))

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ELSE
  AX=ABS(X)
  Z=8./AX
  Y=Z**2
  XX=AX-.785398164

  BESSJ0=SQRT(.636619772/AX)*(COS(XX)*(P1+Y*(P2+Y*(P3+Y*(P4+Y
*      *P5))))-Z*SIN(XX)*(Q1+Y*(Q2+Y*(Q3+Y*(Q4+Y*Q5))))))
  ENDIF
  RETURN
  END
  FUNCTION BESSJ1(X)
  REAL*8 Y,P1,P2,P3,P4,P5,Q1,Q2,Q3,Q4,Q5,R1,R2,R3,R4,R5,R6,
*      S1,S2,S3,S4,S5,S6
  DATA R1,R2,R3,R4,R5,R6/72362614232.D0,-7895059235.D0,242396853.1D0
*,
*      -2972611.439D0,15704.48260D0,-30.16036606D0/,
*      S1,S2,S3,S4,S5,S6/144725228442.D0,2300535178.D0,
*      18583304.74D0,99447.43394D0,376.9991397D0,1.D0/
  DATA P1,P2,P3,P4,P5/1.D0,.183105D-2,-.3516396496D-4,.2457520174D-5
*,
*      -.240337019D-6/, Q1,Q2,Q3,Q4,Q5/.04687499995D0,-.2002690873D-3
*,
*      .8449199096D-5,-.88228987D-6,.105787412D-6/
  IF(ABS(X).LT.8.)THEN
    Y=X**2
    BESSJ1=X*(R1+Y*(R2+Y*(R3+Y*(R4+Y*(R5+Y*R6))))
*      /(S1+Y*(S2+Y*(S3+Y*(S4+Y*(S5+Y*S6))))
  ELSE
    AX=ABS(X)
    Z=8./AX
    Y=Z**2
    XX=AX-2.356194491

    BESSJ1=SQRT(.636619772/AX)*(COS(XX)*(P1+Y*(P2+Y*(P3+Y*(P4+Y
*      *P5))))-Z*SIN(XX)*(Q1+Y*(Q2+Y*(Q3+Y*(Q4+Y*Q5))))
*      *SIGN(1.,X)
  ENDIF
  RETURN
  END
  FUNCTION BRENT(AX,BX,CX,F,TOL,XMIN)
  PARAMETER (ITMAX=100,CGOLD=.3819660,ZEPS=1.0E-10)
  A=MIN(AX,CX)
  B=MAX(AX,CX)
  V=BX
  W=V
  X=V
  E=0.
  FX=F(X)
  FV=FX
  FW=FX
  DO 11 ITER=1,ITMAX
    XM=0.5*(A+B)
    TOL1=TOL*ABS(X)+ZEPS
    TOL2=2.*TOL1
    IF(ABS(X-XM).LE.(TOL2-.5*(B-A))) GOTO 3
    IF(ABS(E).GT.TOL1) THEN

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R=(X-W)*(FX-FV)
Q=(X-V)*(FX-FW)
P=(X-V)*Q-(X-W)*R
Q=2.*(Q-R)
IF(Q.GT.0.) P=-P
Q=ABS(Q)
ETEMP=E
E=D
IF(ABS(P).GE.ABS(.5*Q*ETEMP).OR.P.LE.Q*(A-X).OR.
*   P.GE.Q*(B-X)) GOTO 1
D=P/Q
U=X+D
IF(U-A.LT.TOL2 .OR. B-U.LT.TOL2) D=SIGN(TOL1,XM-X)
GOTO 2
ENDIF
1 IF(X.GE.XM) THEN
E=A-X
ELSE
E=B-X
ENDIF
D=CGOLD*E
2 IF(ABS(D).GE.TOL1) THEN
U=X+D
ELSE
U=X+SIGN(TOL1,D)
ENDIF
FU=F(U)
IF(FU.LE.FX) THEN
IF(U.GE.X) THEN
A=X
ELSE
B=X
ENDIF
V=W
FV=FW
W=X
FW=FX
X=U
FX=FU
ELSE
IF(U.LT.X) THEN
A=U
ELSE
B=U
ENDIF
IF(FU.LE.FW .OR. W.EQ.X) THEN
V=W
FV=FW
W=U
FW=FU
ELSE IF(FU.LE.FV .OR. V.EQ.X .OR. V.EQ.W) THEN
V=U
FV=FU
ENDIF
ENDIF
11 CONTINUE
PAUSE 'BRENT EXCEED MAXIMUM ITERATIONS.'

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3      XMIN=X
      BRENT=FX
      RETURN
      END
      FUNCTION F1DIM(X)
      PARAMETER (NMAX=50)
      COMMON /F1COM/ NCOM,PCOM(NMAX),XICOM(NMAX)
      DIMENSION XT(NMAX)
      DO 11 J=1,NCOM
          XT(J)=PCOM(J)+X*XICOM(J)
11     CONTINUE
      F1DIM=FUNC(XT)
      RETURN
      END
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