

NAG Library Routine Document

E04UDF/E04UDA

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of ***bold italicised*** terms and other implementation-dependent details.

1 Purpose

To supply optional parameters to E04UCF/E04UCA from an external file. More precisely, E04UDF must be used to supply optional parameters to E04UCF and E04UDA must be used to supply optional parameters to E04UCA.

E04UDA is a version of E04UDF that has additional parameters in order to make it safe for use in multithreaded applications (see Section 5). The initialization routine E04WBF **must** have been called before calling E04UDA.

E04UDF/E04UDA can also be used to supply optional parameters to E04UFF/E04UFA.

2 Specification

2.1 Specification for E04UDF

```
SUBROUTINE E04UDF(IOPTNS, INFORM)
  INTEGER          IOPTNS, INFORM
```

2.2 Specification for E04UDA

```
SUBROUTINE E04UDA(IOPTNS, LWSAV, IWSAV, RWSAV, INFORM)
  INTEGER          IOPTNS, IWSAV(610), INFORM
  double precision RWSAV(475)
  LOGICAL          LWSAV(120)
```

3 Description

E04UDF/E04UDA may be used to supply values for optional parameters to E04UCF/E04UCA. E04UDF/E04UDA reads an external file and each line of the file defines a single optional parameter. It is only necessary to supply values for those parameters whose values are to be different from their default values.

Each optional parameter is defined by a single character string, of up to 72 characters, consisting of one or more items. The items associated with a given option must be separated by spaces, or equals signs [=]. Alphabetic characters may be upper or lower case. The string

```
Print Level = 1
```

is an example of a string used to set an optional parameter. For each option the string contains one or more of the following items:

- a mandatory keyword;
- a phrase that qualifies the keyword;
- a number that specifies an INTEGER or **double precision** value. Such numbers may be up to 16 contiguous characters in Fortran's I, F, E or D formats, terminated by a space if this is not the last item on the line.

Blank strings and comments are ignored. A comment begins with an asterisk (*) and all subsequent characters in the string are regarded as part of the comment.

The file containing the options must start with `Begin` and must finish with `End`. An example of a valid options file is:

```
Begin * Example options file
  Print level = 5
End
```

For E04UDF each line of the file is normally printed as it is read, on the current advisory message unit (see X04ABF), but printing may be suppressed using the keyword `Nolist`. To suppress printing of `Begin`, `Nolist` must be the first option supplied as in the file:

```
Begin
  Nolist
  Print level = 5
End
```

Printing will automatically be turned on again after a call to E04UCF or E04UDF and may be turned on again at any time using the keyword `List`.

For E04UDA printing is turned off by default, but may be turned on at any time using the keyword `List`.

Optional parameter settings are preserved following a call to E04UCF/E04UCA and so the keyword `Defaults` is provided to allow you to reset all the optional parameters to their default values before a subsequent call to E04UCF/E04UCA.

A complete list of optional parameters, their abbreviations, synonyms and default values is given in Section 11 in E04UCF/E04UCA.

4 References

None.

5 Parameters

1: IOPTNS – INTEGER *Input*

On entry: the unit number of the options file to be read.

Constraint: $0 \leq \text{IOPTNS} \leq 99$.

2: INFORM – INTEGER *Output*

Note: for E04UDA, *INFORM* does not occur in this position in the parameter list. See the additional parameters described below.

On exit: contains zero if the options file has been successfully read and a value > 0 otherwise (see Section 6).

Note: the following are additional parameters for specific use with E04UDA. Users of E04UDF therefore need not read the remainder of this description.

2: LWSAV(120) – LOGICAL array *Communication Array*

3: IWSAV(610) – INTEGER array *Communication Array*

4: RWSAV(475) – *double precision* array *Communication Array*

The arrays LWSAV, IWSAV and RWSAV **must not** be altered between calls to any of the routines E04UDA, E04UCA, E04UEA or E04WBF.

5: INFORM – INTEGER *Output*

Note: see the parameter description for INFORM above.

6 Error Indicators and Warnings

Errors or warnings detected by the routine:

INFORM = 1

IOPTNS is not in the range [0,99].

INFORM = 2

Begin was found, but end-of-file was found before End was found.

INFORM = 3

end-of-file was found before Begin was found.

INFORM = 4

Not used.

INFORM = 5

One or more lines of the options file is invalid. Check that all keywords are neither ambiguous nor misspelt.

7 Accuracy

Not applicable.

8 Further Comments

E04UEF/E04UEA may also be used to supply optional parameters to E04UCF/E04UCA.

9 Example

This example solves the same problem as the example for E04UCF/E04UCA, but in addition illustrates the use of E04UDF/E04UDA and E04UEF/E04UEA to set optional parameters for E04UCF/E04UCA.

In this example the options file read by E04UDF/E04UDA is appended to the data file for the program (see Section 9.2). It would usually be more convenient in practice to keep the data file and the options file separate.

9.1 Program Text

Note: the following program illustrates the use of E04UDF. An equivalent program illustrating the use of E04UDA is available with the supplied Library and is also available from the NAG web site.

```
*      E04UDF Example Program Text
*      Mark 16 Release. NAG Copyright 1993.
*      .. Parameters ..
      INTEGER          NIN, NOUT
      PARAMETER        (NIN=5,NOUT=6)
      INTEGER          NMAX, NCLMAX, NCNMAX
      PARAMETER        (NMAX=10,NCLMAX=10,NCNMAX=10)
      INTEGER          LDA, LDCJ, LDR
      PARAMETER        (LDA=NCLMAX,LDCJ=NCNMAX,LDR=NMAX)
      INTEGER          LIWORK, LWORK
      PARAMETER        (LIWORK=100,LWORK=1000)
*      .. Local Scalars ..
      DOUBLE PRECISION OBJF
      INTEGER          I, IFAIL, INFORM, ITER, J, N, NCLIN, NCNLN,
+                     OUTCHN
*      .. Local Arrays ..
      DOUBLE PRECISION A(LDA,NMAX), BL(NMAX+NCLMAX+NCNMAX),
+                     BU(NMAX+NCLMAX+NCNMAX), C(NCNMAX),
```

```

+          CJAC(LDCJ,NMAX), CLAMDA(NMAX+NCLMAX+NCNMAX),
+          OBJGRD(NMAX), R(LDR,NMAX), USER(1), WORK(LWORK),
+          X(NMAX)
+    INTEGER      ISTATE(NMAX+NCLMAX+NCNMAX), IUSER(1),
+    IWORK(LIWORK)
*    .. External Subroutines ..
+    EXTERNAL      CONFUN, E04UCF, E04UDF, E04UEF, OBJFUN, X04ABF
*    .. Executable Statements ..
+    WRITE (NOUT,*) 'E04UDF Example Program Results'
+    OUTCHN = NOUT
*    Skip heading in data file
+    READ (NIN,*)
+    READ (NIN,*) N, NCLIN, NCNLN
+    IF (N.LE.NMAX .AND. NCLIN.LE.NCLMAX .AND. NCNLN.LE.NCNMAX) THEN
*
*        Read A, BL, BU and X from data file
*
+    IF (NCLIN.GT.0) READ (NIN,*) ((A(I,J),J=1,N),I=1,NCLIN)
+    READ (NIN,*) (BL(I),I=1,N+NCLIN+NCNLN)
+    READ (NIN,*) (BU(I),I=1,N+NCLIN+NCNLN)
+    READ (NIN,*) (X(I),I=1,N)
*
*    Set three options using E04UEF
*
+    CALL E04UEF(' Infinite Bound Size = 1.0D+25 ')
*
+    CALL E04UEF(' Print Level = 1 ')
*
+    CALL E04UEF(' Verify Level = -1 ')
*
*    Set the unit number for advisory messages to OUTCHN
*
+    CALL X04ABF(1,OUTCHN)
*
*    Read the options file for the remaining options
*
+    CALL E04UDF(NIN,INFORM)
*
+    IF (INFORM.NE.0) THEN
+        WRITE (NOUT,99999) ' ** E04UDF terminated with INFORM = ',
+        INFORM
+        GO TO 20
+    END IF
*
*    Solve the problem
*
+    IFAIL = 1
*
+    CALL E04UCF(N,NCLIN,NCNLN,LDA,LDCJ,LDR,A,BL,BU,CONFUN,OBJFUN,
+    ITER,ISTATE,C,CJAC,CLAMDA,OBJF,OBJGRD,R,X,IWORK,
+    LIWORK,WORK,LWORK,IUSER,USER,IFAIL)
*
+    IF (IFAIL.NE.0) THEN
+        WRITE (NOUT,99998) IFAIL
+    END IF
+    ELSE
+        WRITE (NOUT,99997)
+    END IF
+    20 CONTINUE
*
+    99999 FORMAT (1X,A,I3)
+    99998 FORMAT (1X,/' ** E04UCF returned with IFAIL = ',I5)
+    99997 FORMAT (1X,/' At least one of N, NCLIN or NCNLN is too large')
+    END
*
+    SUBROUTINE OBJFUN(MODE,N,X,OBJF,OBJGRD,NSTATE,IUSER,USER)
*    Routine to evaluate objective function and its 1st derivatives.
*    .. Parameters ..
+    DOUBLE PRECISION ONE, TWO
+    PARAMETER      (ONE=1.0D0,TWO=2.0D0)
*    .. Scalar Arguments ..

```

```

      DOUBLE PRECISION OBJF
      INTEGER          MODE, N, NSTATE
*
      .. Array Arguments ..
      DOUBLE PRECISION OBJGRD(N), USER(*), X(N)
      INTEGER          IUSER(*)
*
      .. Executable Statements ..
      IF (MODE.EQ.0 .OR. MODE.EQ.2) OBJF = X(1)*X(4)*(X(1)+X(2)+X(3)) +
+      X(3)
*
      IF (MODE.EQ.1 .OR. MODE.EQ.2) THEN
        OBJGRD(1) = X(4)*(TWO*X(1)+X(2)+X(3))
        OBJGRD(2) = X(1)*X(4)
        OBJGRD(3) = X(1)*X(4) + ONE
        OBJGRD(4) = X(1)*(X(1)+X(2)+X(3))
      END IF
*
      RETURN
      END
*
      SUBROUTINE CONFUN(MODE,NCNLN,N,LDCJ,NEEDC,X,C,CJAC,NSTATE,IUSER,
+      USER)
*
      Routine to evaluate the nonlinear constraints and their 1st
*
      derivatives.
*
      .. Parameters ..
      DOUBLE PRECISION ZERO, TWO
      PARAMETER      (ZERO=0.0D0,TWO=2.0D0)
*
      .. Scalar Arguments ..
      INTEGER          LDCJ, MODE, N, NCNLN, NSTATE
*
      .. Array Arguments ..
      DOUBLE PRECISION C(*), CJAC(LDCJ,*), USER(*), X(N)
      INTEGER          IUSER(*), NEEDC(*)
*
      .. Local Scalars ..
      INTEGER          I, J
*
      .. Executable Statements ..
      IF (NSTATE.EQ.1) THEN
*
        First call to CONFUN. Set all Jacobian elements to zero.
*
        Note that this will only work when 'Derivative Level = 3'
*
        (the default; see Section 11.2).
        DO 40 J = 1, N
          DO 20 I = 1, NCNLN
            CJAC(I,J) = ZERO
20          CONTINUE
40        CONTINUE
      END IF
*
      IF (NEEDC(1).GT.0) THEN
        IF (MODE.EQ.0 .OR. MODE.EQ.2) C(1) = X(1)**2 + X(2)**2 + X(3)
+      **2 + X(4)**2
        IF (MODE.EQ.1 .OR. MODE.EQ.2) THEN
          CJAC(1,1) = TWO*X(1)
          CJAC(1,2) = TWO*X(2)
          CJAC(1,3) = TWO*X(3)
          CJAC(1,4) = TWO*X(4)
        END IF
      END IF
*
      IF (NEEDC(2).GT.0) THEN
        IF (MODE.EQ.0 .OR. MODE.EQ.2) C(2) = X(1)*X(2)*X(3)*X(4)
        IF (MODE.EQ.1 .OR. MODE.EQ.2) THEN
          CJAC(2,1) = X(2)*X(3)*X(4)
          CJAC(2,2) = X(1)*X(3)*X(4)
          CJAC(2,3) = X(1)*X(2)*X(4)
          CJAC(2,4) = X(1)*X(2)*X(3)
        END IF
      END IF
*
      RETURN
      END

```

9.2 Program Data

E04UDF Example Program Data

```

4 1 2 :Values of N, NCLIN and NCNLN
1.0 1.0 1.0 1.0 :End of matrix A
1.0 1.0 1.0 1.0 -1.0E+25 -1.0E+25 25.0 :End of BL
5.0 5.0 5.0 5.0 20.0 40.0 1.0E+25 :End of BU
1.0 5.0 5.0 1.0 :End of X
Begin Example options file for E04UDF
Major Iteration Limit = 15 * (Default = 50)
Minor Iteration Limit = 10 * (Default = 50)
End
```

9.3 Program Results

E04UDF Example Program Results

Calls to E04UEF

```

Infinite Bound Size = 1.0D+25
Print Level = 1
Verify Level = -1
```

OPTIONS file

```

Begin Example options file for E04UDF
Major Iteration Limit = 15 * (Default = 50)
Minor Iteration Limit = 10 * (Default = 50)
End
```

*** E04UCF

Parameters

```

Linear constraints..... 1      Variables..... 4
Nonlinear constraints.. 2

Infinite bound size.... 1.00E+25  COLD start.....
Infinite step size.... 1.00E+25  EPS (machine precision) 1.11E-16
Step limit..... 2.00E+00  Hessian..... NO

Linear feasibility..... 1.05E-08  Crash tolerance..... 1.00E-02
Nonlinear feasibility.. 1.05E-08  Optimality tolerance... 3.26E-12
Line search tolerance.. 9.00E-01  Function precision..... 4.37E-15

Derivative level..... 3      Monitoring file..... -1
Verify level..... -1

Major iterations limit. 15      Major print level..... 1
Minor iterations limit. 10      Minor print level..... 0

Workspace provided is IWORK( 100), WORK( 1000).
To solve problem we need IWORK( 17), WORK( 185).

Exit from NP problem after 5 major iterations,
9 minor iterations.
```

Varbl	State	Value	Lower Bound	Upper Bound	Lagr Mult	Slack
V 1	LL	1.00000	1.00000	5.00000	1.088	.
V 2	FR	4.74300	1.00000	5.00000	.	0.2570
V 3	FR	3.82115	1.00000	5.00000	.	1.179
V 4	FR	1.37941	1.00000	5.00000	.	0.3794

L	Con	State	Value	Lower Bound	Upper Bound	Lagr Mult	Slack
L	1	FR	10.9436	None	20.0000	.	9.056

N	Con	State	Value	Lower Bound	Upper Bound	Lagr Mult	Slack
N	1	UL	40.0000	None	40.0000	-0.1615	-3.5264E-11
N	2	LL	25.0000	25.0000	None	0.5523	-2.8791E-11

Exit E04UCF - Optimal solution found.

Final objective value = 17.01402
