NAG Library Routine Document

E04NDF/E04NDA

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 E04NCF/E04NCA from an external file. More precisely, E04NDF must be used to supply optional parameters to E04NCF and E04NDA must be used to supply optional parameters to E04NCA.

E04NDA is a version of E04NDF that has additional arguments in order to make it safe for use in multithreaded applications (see Section 5). The initialization routine E04WBF **must** have been called before calling E04NDA.

2 Specification

2.1 Specification for E04NDF

```
SUBROUTINE E04NDF (IOPTNS, INFORM)
INTEGER IOPTNS, INFORM
```

2.2 Specification for E04NDA

```
SUBROUTINE E04NDA (IOPTNS, LWSAV, IWSAV, RWSAV, INFORM)
INTEGER            IOPTNS, IWSAV(610), INFORM
REAL (KIND=nag_wp) RWSAV(475)
LOGICAL            LWSAV(120)
```

3 Description

E04NDF/E04NDA may be used to supply values for optional parameters to E04NCF/E04NCA. E04NDF/E04NDA reads an external file and each line of the file defines a single optional parameter. It is only necessary to supply values for those arguments 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 real value. Such numbers may be up to 40 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 E04NDF 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 E04NCF or E04NDF and may be turned on again at any time using the keyword **List**.

For E04NDA 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 E04NCF/E04NCA 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 E04NCF/E04NCA.

A complete list of optional parameters, their abbreviations, synonyms and default values is given in Section 12 in E04NCF/E04NCA.

4 References

None.

5 Arguments

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 E04NDA, INFORM does not occur in this position in the argument list. See the additional arguments 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 arguments for specific use with E04NDA. Users of E04NDF therefore need not read the remainder of this description*.

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

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

5: RWSAV(475) – REAL (KIND=nag_wp) array *Communication Array*

The arrays LWSAV, IWSAV and RWSAV **must not** be altered between calls to any of the routines E04NDA, E04NCA, E04NEA or E04WBF.

6: INFORM – INTEGER *Output*

Note: see the argument description for INFORM above.

6 Error Indicators and Warnings

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 Parallelism and Performance

E04NDF/E04NDA is not threaded in any implementation.

9 Further Comments

E04NEF/E04NEA may also be used to supply optional parameters to E04NCF/E04NCA.

10 Example

This example minimizes the quadratic function $c^{\mathrm{T}}x + \frac{1}{2}x^{\mathrm{T}}Ax$, where

$$c = (-4.0, -1.0, -1.0, -1.0, -1.0, -1.0, -1.0, -0.1, -0.3)^{\mathrm{T}},$$

$$A = \begin{pmatrix} 2 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 2 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 2 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 2 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

subject to the bounds

$$\begin{aligned} -2 \leq x_1 \leq 2 \\ -2 \leq x_2 \leq 2 \\ -2 \leq x_3 \leq 2 \\ -2 \leq x_4 \leq 2 \\ -2 \leq x_5 \leq 2 \\ -2 \leq x_6 \leq 2 \\ -2 \leq x_7 \leq 2 \\ -2 \leq x_8 \leq 2 \\ -2 \leq x_9 \leq 2 \end{aligned}$$

and to the general constraints

$$-2.0 \leq x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + 4x_9 \leq 1.5$$
$$-2.0 \leq x_1 + 2x_2 + 3x_3 + 4x_4 - 2x_5 + x_6 + x_7 + x_8 + x_9 \leq 1.5$$
$$-2.0 \leq x_1 - x_2 + x_3 - x_4 + x_5 + x_6 + x_7 + x_8 + x_9 \leq 4.0$$

The initial point, which is feasible, is

$$x_0 = (0, 0, 0, 0, 0, 0, 0, 0, 0)^{\mathrm{T}},$$

and $F(x_0) = 0$.

The optimal solution (to five figures) is

$$x^* = (2.0, -0.23333, -0.26667, -0.3, -0.1, 2.0, 2.0, -1.7777, -0.45555)^{\mathrm{T}},$$

and $F(x^*) = -8.0678$. Three bound constraints and two general constraints are active at the solution. Note that, although the Hessian matrix is positive semidefinite, the point x^* is unique.

In this example the options file read by E04NDF/E04NDA is appended to the data file for the program (see Section 10.2). It would usually be more convenient in practice to keep the data file and the options file separate.

10.1 Program Text

the following program illustrates the use of E04NDF. An equivalent program illustrating the use of E04NDA is available with the supplied Library and is also available from the NAG web site.

```
    Program e04ndfe

!     E04NDF Example Program Text

!     Mark 26 Release. NAG Copyright 2016.

!     .. Use Statements ..
      Use nag_library, Only: e04ncf, e04ndf, e04nef, nag_wp, x04abf, x04acf
!     .. Implicit None Statement ..
      Implicit None
!     .. Parameters ..
      Integer, Parameter               :: iset = 1, nin = 5, ninopt = 7,       &
                                          nout = 6
      Character (*), Parameter         :: fname = 'e04ndfe.opt'
!     .. Local Scalars ..
      Real (Kind=nag_wp)               :: obj
      Integer                          :: i, ifail, inform, iter, lda, ldc,    &
                                          liwork, lwork, m, mode, n, nclin,    &
                                          outchn, sdc
!     .. Local Arrays ..
      Real (Kind=nag_wp), Allocatable  :: a(:,:), b(:), bl(:), bu(:), c(:,:),  &
                                          clamda(:), cvec(:), work(:), x(:)
      Integer, Allocatable             :: istate(:), iwork(:), kx(:)
!     .. Intrinsic Procedures ..
      Intrinsic                        :: max
!     .. Executable Statements ..
      Write (nout,99998) 'E04NDF Example Program Results'
      Flush (nout)

!     Skip heading in data file
      Read (nin,*)

      Read (nin,*) m, n, nclin
      liwork = n
      ldc = max(1,nclin)
      lda = max(1,m)

      If (nclin>0) Then
        sdc = n
      Else
        sdc = 1
      End If
```

```
!     This particular example problem is of type QP2, so we allocate
!     A(LDA,N), CVEC(N), B(1) and define LWORK as below

      If (nclin>0) Then
        lwork = 2*n**2 + 10*n + 6*nclin
      Else
        lwork = 10*n
      End If

      Allocate (istate(n+nclin),kx(n),iwork(liwork),c(ldc,sdc),bl(n+nclin),    &
        bu(n+nclin),cvec(n),x(n),a(lda,n),b(1),clamda(n+nclin),work(lwork))

      Read (nin,*) cvec(1:n)
      Read (nin,*)(a(i,1:n),i=1,m)
      Read (nin,*)(c(i,1:sdc),i=1,nclin)
      Read (nin,*) bl(1:(n+nclin))
      Read (nin,*)
      Read (nin,*) bu(1:(n+nclin))
      Read (nin,*)
      Read (nin,*) x(1:n)

!     Set the unit number for advisory messages to OUTCHN

      outchn = nout
      Call x04abf(iset,outchn)

!     Set one option using E04NEF

      Call e04nef(' Problem Type = QP2 ')

!     Open the options file for reading

      mode = 0

      ifail = 0
      Call x04acf(ninopt,fname,mode,ifail)

!     Read the options file for the remaining options

      Call e04ndf(ninopt,inform)

      If (inform/=0) Then
        Write (nout,99999) ' ** E04NDF terminated with INFORM =', inform
        Flush (nout)
        Go To 100
      End If

!     Solve the problem

      ifail = 0
      Call e04ncf(m,n,nclin,ldc,lda,c,bl,bu,cvec,istate,kx,x,a,b,iter,obj,     &
        clamda,iwork,liwork,work,lwork,ifail)

100   Continue

99999 Format (1X,A,I5)
99998 Format (1X,A)
    End Program e04ndfe
```

10.2 Program Data

```
Begin   Example options file for  E04NDF
   Iteration Limit   =  30      *  (Default =  90)
End
```

```
E04NDF Example Program Data
  9   9   3                                    :Values of M, N and NCLIN
 -4.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -0.1  -0.3        :End of CVEC
  2.0   1.0   1.0   1.0   1.0   0.0   0.0   0.0   0.0
  1.0   2.0   1.0   1.0   1.0   0.0   0.0   0.0   0.0
  1.0   1.0   2.0   1.0   1.0   0.0   0.0   0.0   0.0
  1.0   1.0   1.0   2.0   1.0   0.0   0.0   0.0   0.0
  1.0   1.0   1.0   1.0   2.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0        :End of matrix A
  1.0   1.0   1.0   1.0   1.0   1.0   1.0   1.0   4.0
  1.0   2.0   3.0   4.0  -2.0   1.0   1.0   1.0   1.0
  1.0  -1.0   1.0  -1.0   1.0   1.0   1.0   1.0   1.0        :End of matrix C
 -2.0  -2.0  -2.0  -2.0  -2.0  -2.0  -2.0  -2.0  -2.0  -2.0  -2.0  -2.0
                                                            :End of BL
  2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   1.5   1.5   4.0
                                                            :End of BU
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0        :End of X
```

10.3 Program Results

```
 E04NDF Example Program Results


 Calls to E04NEF
 ---------------

       Problem Type = QP2


 OPTIONS file
 ------------

      Begin   Example options file for  E04NDF
         Iteration Limit   =  30      *  (Default =  90)
      End

 *** E04NCF

 Parameters
 ----------

 Problem type...........       QP2       Hessian.................        NO

 Linear constraints.....         3       Feasibility tolerance..  1.05E-08
 Variables..............         9       Crash tolerance........  1.00E-02
 Objective matrix rows..         9       Rank tolerance.........  1.05E-07

 Infinite bound size....  1.00E+20       COLD start.............
 Infinite step size.....  1.00E+20       EPS (machine precision)  1.11E-16

 Print level............        10       Feasibility phase itns.        60
 Monitoring file........        -1       Optimality  phase itns.        30

 Workspace provided is     IWORK(       9),  WORK(     270).
 To solve problem we need  IWORK(       9),  WORK(     270).

 Rank of the objective function data matrix =     5


 Itn     Step Ninf Sinf/Objective  Norm Gz
   0  0.0E+00    0   0.000000E+00  4.5E+00
   1  7.5E-01    0  -4.375000E+00  5.0E-01
```

```
  2  1.0E+00    0  -4.400000E+00  2.8E-17
  3  3.0E-01    0  -4.700000E+00  8.9E-01
  4  1.0E+00    0  -5.100000E+00  2.4E-17
  5  5.4E-01    0  -6.055714E+00  1.7E+00
  6  1.1E-02    0  -6.113326E+00  1.6E+00
  7  1.1E-01    0  -6.215049E+00  1.2E+00
  8  1.0E+00    0  -6.538008E+00  1.8E-17
  9  6.5E-01    0  -7.428704E+00  7.2E-02
 10  1.0E+00    0  -7.429717E+00  1.8E-17
 11  1.0E+00    0  -8.067718E+00  1.8E-17
 12  1.0E+00    0  -8.067778E+00  1.8E-17

 Exit from QP problem after    12 iterations.


 Varbl State     Value       Lower Bound   Upper Bound    Lagr Mult   Slack

 V   1    UL    2.00000      -2.00000       2.00000     -0.8000         .
 V   2    FR  -0.233333      -2.00000       2.00000           .       1.767
 V   3    FR  -0.266667      -2.00000       2.00000           .       1.733
 V   4    FR  -0.300000      -2.00000       2.00000           .       1.700
 V   5    FR  -0.100000      -2.00000       2.00000           .       1.900
 V   6    UL    2.00000      -2.00000       2.00000     -0.9000         .
 V   7    UL    2.00000      -2.00000       2.00000     -0.9000         .
 V   8    FR   -1.77778      -2.00000       2.00000           .      0.2222
 V   9    FR  -0.455556      -2.00000       2.00000           .       1.544


 L Con State     Value       Lower Bound   Upper Bound    Lagr Mult   Slack

 L   1    UL    1.50000      -2.00000       1.50000     -6.6667E-02  1.1102E-15
 L   2    UL    1.50000      -2.00000       1.50000     -3.3333E-02 -4.4409E-16
 L   3    FR    3.93333      -2.00000       4.00000           .      6.6667E-02

 Exit E04NCF - Optimal QP solution.

 Final QP objective value =   -8.067778
```