ABOUT THE PORTABILITY OF THE DIDASS*-PACKAGE (AN IBM-IMPLEMENTATION)**

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*DIDASS - Dynamic Interactive Decision Analysis Supporting System

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1. INTRODUCTION

The aim of this paper is to point out the portability of the program package for linear multiple criteria reference point optimization. This should be understood as a step to improve the useroriented feature of software developed at IIASA and can be an example for further implementations of the software on other computer systems.

The actual reason for transferring the DIDASS-package to INSEE is the need for solving problems of medium- and long-term planning for the national economy of France which can be described by dynamic multiple-criteria linear programming models.

This paper is an initial note on implementation problems. As soon as there is substantive application in INSEE it will be reported.

We first describe the implementation problems, then the solutions and an hypothetical example to demonstrate the workability of the software.

2. IMPLEMENTATION PROBLEMS

The program package was transferred to a computer of the type IBM-3033 at the Institut National de la Statistique et des Etudes Economiques (Paris). Because the IBM-user-family is a big one the problems and solutions seem to be of broader interest. The above mentioned computer runs under OS/MVS-3.8, the interactive programming system is TSO and the used FORTRAN-version is FORTRAN-IV-G1; Release 2.0. It raises two main problems:

- equivalent IBM procedures should be developed for the statements of the command language "shell" of the UNIX-system,
- some modifications to the current IBM-FORTRAN-version ought to be done.

3. IBM-IMPLEMENTATION

For handling data in the interactive "editor" (lpmod) the following IBM-procedure was used:

```
00000010FREE F(FT03F001,FT04F001,FT08F001)
00000020ALLOC DA(LPSOLTMP.DATA) F(FT08F001) SHR
00000030ALLOC DA(OBJECT.DATA) F(FT03F001) SHR
00000040ALLOC DA(RFP.DATA) F(FT04F001) SHR
00000050CALL 'S90T3.LP.DATA(LPMOD2)'
00000060FREE F(FT03F001,FT04F001,FT08F001)
00000070END
```

The preprocessor (lpmulti) which converts the input model file into a single criteria equivalent has the following form in an IBM procedure:

```
00000010FREE F(FT01F001,FT02F001,FT03F001,FT04F001,FT12F001)
00000020ALLOC DA(NEWMODEL.DATA) F(FT01F001) SHR
00000030ALLOC DA(MODEL.DATA) F(FT02F001) SHR
00000040ALLOC DA(OBJECT.DATA) F(FT03F001) SHR
00000050ALLOC DA(RFP.DATA) F(FT04F001) SHR
00000055ALLOC DA(BUF.DATA) F(FT12F001) SHR
00000060CALL 'S90T3.LP.DATA(LPMLL2)'
00000070FREE F(FT01F001,FT02F001,FT03F001,FT04F001,FT12F001)
00000080COPY NEWMODEL.DATA FILE9.DATA NONUM
00000090END
```

The postprocessor (lpsol) which extracts the information from the LP system is:

```
00000010FREE F(FT01F001,FT02F001,FT03F001,FT04F001)
00000020ALLOC DA(FILE6.DATA) F(FT01F001) SHR
00000030ALLOC DA(LPSOLTMP.DATA) F(FT02F001) SHR
00000040ALLOC DA(OBJECT.DATA) F(FT03F001) SHR
00000050ALLOC DA(RFP.DATA) F(FT04F001) SHR
00000060CALL 'S90T3.LP.DATA(LPSOL)'
00000070FREE F(FT01F001,FT02F001,FT03F001,FT04F001)
00000080END
```

All the corresponding FORTRAN-programs are recompiled and linked. By this all CHARACTER-statements must be changed into REAL ones. For the use of an intermediate bufferfile a fixed one must be introduced.

In the next part the use of the IBM-implementation for the solution of a testexample will be demonstrated.

4. TESTEXAMPLE: (HYPOTH.1)

The three criteria-functions are:

$$\left.\begin{array}{rcl} x_1 + 2x_2 - x_3 + 3x_4 + 2x_5 + x_7 &=& obj1 \\ x_2 + x_3 + 2x_4 + 3x_5 + x_6 &=& obj2 \\ x_1 + x_3 - x_4 - x_6 - x_7 &=& obj3 \end{array}\right\} \rightarrow \max$$

subject to

$$\begin{array}{rcll} x_1 + 2x_2 + x_3 + x_4 + 2x_5 + x_6 + 2x_7 &\leq& 17 & (const1) \\ -2x_1 - x_2 + x_4 + 2x_5 + x_7 &\leq& 16 & (const2) \\ -x_1 + x_3 + 2x_5 - 2x_7 &\leq& 15 & (const3) \\ x_2 + 2x_3 - x_4 + x_5 - 2x_6 - x_7 &\leq& 14 & (const4) \end{array}$$

$$x_i \geq 0 \qquad i = 1,\ldots,7$$

The objective file for the above problem has the following form (format 2A4, A8, F15.0):

```
object.data
    OBJ1          +1.0
    OBJ2          +1.0
    OBJ3          +1.0
    ******
```

Its name is "object.data".

The reference point file containing the values of ρ, ε, and one reference point is:

```
RFP.DATA
   3.00
   .100E-06
   15.0
   20.0
   25.0
```

The MPS-input-file for the linear multiple criteria problem has the form:

```
NAME     HYPOTH.1
ROWS
 E  OBJ1
 E  OBJ2
 E  OBJ3
 L  CONST1
 L  CONST2
 L  CONST3
 L  CONST4
COLUMNS
    X1        OBJ1       1.0          OBJ3       1.0
    X1        CONST1     1.0          CONST2    -2.0
    X1        CONST3    -1.0
    X2        OBJ1       2.0          OBJ2       1.0
    X2        CONST1     2.0          CONST2    -1.0
    X2        CONST4     1.0
    X3        OBJ1      -1.0          OBJ2       1.0
    X3        OBJ3       1.0          CONST1     1.0
    X3        CONST3     1.0          CONST4     2.0
    X4        OBJ1       3.0          OBJ2       2.0
    X4        OBJ3      -1.0          CONST1     1.0
    X4        CONST2     1.0          CONST4    -1.0
    X5        OBJ1       2.0          OBJ2       3.0
    X5        CONST1     2.0          CONST2     2.0
    X5        CONST3     2.0          CONST4     1.0
    X6        OBJ2       1.0          OBJ3      -1.0
    X6        CONST1     1.0          CONST4    -2.0
    X7        OBJ1       1.0          OBJ3      -1.0
    X7        CONST1     2.0          CONST2     1.0
    X7        CONST3    -2.0          CONST4    -1.0
RHS
    RHS       CONST1    17.0
    RHS       CONST2    16.0
    RHS       CONST3    15.0
    RHS       CONST4    14.0
BOUNDS
 LO BND       X1         0.0
 LO BND       X2         0.0
 LO BND       X3         0.0
 LO BND       X4         0.0
 LO BND       X5         0.0
 LO BND       X6         0.0
 LO BND       X7         0.0
ENDATA
```

Using the preprocessor (lpmulti), this MPS multiple criteria file will be converted into an equivalent single-criterion linear programming problem extracting the information from the objective and reference point files.

The interactive procedure on the IBM-computer has the following sequence:

```
ex lpmulti l
 FREE F(FT01F001,FT02F001,FT03F001,FT04F001,FT12F001)
 FILE FT01F001 NOT FREED, IS NOT ALLOCATED
 FILE FT02F001 NOT FREED, IS NOT ALLOCATED
 FILE FT03F001 NOT FREED, IS NOT ALLOCATED
 FILE FT04F001 NOT FREED, IS NOT ALLOCATED
 FILE FT12F001 NOT FREED, IS NOT ALLOCATED
 ALLOC DA(NEWMODEL.DATA) F(FT01F001) SHR
 ALLOC DA(MODEL.DATA) F(FT02F001) SHR
 ALLOC DA(OBJECT.DATA) F(FT03F001) SHR
 ALLOC DA(RFP.DATA) F(FT04F001) SHR
 ALLOC DA(BUF.DATA) F(FT12F001) SHR
 CALL 'S90T3.LP.DATA(LPMUL2)'
  ENTER NAME OF RHS SET
rhs
     3  OBJECTIVES
  EPS      .100E-06
  RHO     3.00
  ENTER NAME OF BOUNDS SET
bnd
 FREE F(FT01F001,FT02F001,FT03F001,FT04F001,FT12F001)
 COPY NEWMODEL.DATA FILE9.DATA NONUM
 END
```

The result of running "lpmulti" is the modified MPS-input-file:

```
NAME     HYPOTH.1
ROWS
 N  MOCOBJ
 L  MOCV1000
 L  MOCV1001
 L  MOCV1002
 L  MOCV1003
 E  OBJ1
 E  OBJ2
 E  OBJ3
 L  CONST1
 L  CONST2
 L  CONST3
 L  CONST4
COLUMNS
    MOCW1001  MOCOBJ      -.100E-06   MOCV1000     -1.00
    MOCW1001  MOCV1001    -1.00       OBJ1         -1.00
    MOCW1002  MOCOBJ      -.100E-06   MOCV1000     -1.00
    MOCW1002  MOCV1002    -1.00       OBJ2         -1.00
    MOCW1003  MOCOBJ      -.100E-06   MOCV1000     -1.00
    MOCW1003  MOCV1003    -1.00       OBJ3         -1.00
    MOCY1001  MOCOBJ       1.00       MOCV1000     -1.00
    MOCY1001  MOCV1001    -.333
    MOCY1001  MOCV1002    -.333
    MOCY1001  MOCV1003    -.333
```

```
    X1        OBJ1       1.0          OBJ3       1.0
    X1        CONST1     1.0          CONST2    -2.0
    X1        CONST3    -1.0
    X2        OBJ1       2.0          OBJ2       1.0
    X2        CONST1     2.0          CONST2    -1.0
    X2        CONST4     1.0
    X3        OBJ1      -1.0          OBJ2       1.0
    X3        OBJ3       1.0          CONST1     1.0
    X3        CONST3     1.0          CONST4     2.0
    X4        OBJ1       3.0          OBJ2       2.0
    X4        OBJ3      -1.0          CONST1     1.0
    X4        CONST2     1.0          CONST4    -1.0
    X5        OBJ1       2.0          OBJ2       3.0
    X5        CONST1     2.0          CONST2     2.0
    X5        CONST3     2.0          CONST4     1.0
    X6        OBJ2       1.0          OBJ3      -1.0
    X6        CONST1     1.0          CONST4    -2.0
    X7        OBJ1       1.0          OBJ3      -1.0
    X7        CONST1     2.0          CONST2     1.0
    X7        CONST3    -2.0          CONST4    -1.0
RHS
    RHS       OBJ1          15.0
    RHS       OBJ2          20.0
    RHS       OBJ3          25.0
    RHS       CONST1     17.0
    RHS       CONST2     16.0
    RHS       CONST3     15.0
    RHS       CONST4     14.0
BOUNDS
 FR BND       MOCW1001
 FR BND       MOCW1002
 FR BND       MOCW1003
 FR BND       MOCY1001
 LO BND       X1          0.0
 LO BND       X2          0.0
 LO BND       X3          0.0
 LO BND       X4          0.0
 LO BND       X5          0.0
 LO BND       X6          0.0
 LO BND       X7          0.0
ENDATA
```

If we apply a standard LP-package to the solution of the problem formulated as the above-mentioned MPS-input-file the result is:

```
eps     0.100e-06
rho      3.00
 --obj--  ---objval---   ---refpt---  ----dif----  ---dual---
obj1          4.67          15.0         -10.3         0.501
obj2          9.67          20.0         -10.3          1.00
obj3          14.7          25.0         -10.3          1.50
```

5. CONCLUSIONS

In this paper we have implemented the package for linear multiple criteria reference point optimization (DIDASS) developed at IIASA on an IBM-computer. Modifications should be made according to the interactive programming language and the FORTRAN - version.

The solution of a hypothetical three-criteria-optimization problem proves the portability of the DIDASS - package.

Finally, it can be stated that the interactive command language "shell" and the f-77-FORTRAN - version used in the UNIX - system are more flexible and powerful than the corresponding IBM - versions.