Author(s) : M. Gyr
Submitter : K.S. Kölbig
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Linear Optimization Using the Simplex Algorithm

Subroutine subprograms RSMPLX and DSMPLX calculate the quantities $x_1, x_2, \ldots, x_m$ for which the linear form, or objective function,

$$z = z_0 - \sum_{i=1}^{m} b_i x_i$$

assumes a *maximum* value subject to the n_1 inequality constraints

$$\sum_{i=1}^{m} a_{ik} x_i \le c_k \qquad (k = 1, 2, \ldots, n_1)$$

and the $n - n_1$ equality constraints

$$\sum_{i=1}^{m} a_{ik} x_i = c_k \qquad (k = n_1 + 1, n_1 + 2, \ldots, n).$$

A number $m_1 \le m$ of the variables $x_i,\ (i = 1, 2, \ldots, m_1)$ can be restricted to non-negative values ($x_i \ge 0$). The remaining $m - m_1$ variables $x_i,\ (i = m_1 + 1, \ldots, m)$ are then unrestricted ($-\infty < x_i < \infty$). In the case $m_1 = 0$, all variables x_i are unrestricted. These subprograms can also be used for the so-called degenerate case.

On computers other than CDC or Cray, only the double-precision version DSMPLX is available. On CDC and Cray computers, only the single precision version RSMPLX is available.

Structure:

SUBROUTINE subprograms
User Entry Names: RSMPLX, DSMPLX
Internal Entry Names: H101S1, H101S2
Files Referenced: Unit 6
External References: MTLMTR (N002), ABEND (Z035)

Usage:

For t = R (type REAL), t = D (type DOUBLE PRECISION),

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CALL tSMPLX(A,B,C,ZO,IDA,M,M1,N,N1,LW,IDW,W,X,Z,ITYPE)
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A (type according to t) Two-dimensional array of dimension (IDA, $\ge$ N). Contains, on entry, the coefficients $a_{i,k}$, $(i = 1, 2, \ldots, m;\ k = 1, 2, \ldots, n)$. Destroyed during execution.

B (type according to t) One-dimensional array of dimension $\ge$ M. Contains, on entry, the coefficients b_i, $(i = 1, 2, \ldots, m)$. Destroyed during execution.

C (type according to t) One-dimensional array of dimension $\ge$ N. Contains, on entry, the coefficients c_k, $(k = 1, 2, \ldots, n)$. Destroyed during execution.

ZO (type according to t) Contains, on entry, the initial value of the objective function.

IDA (INTEGER) Declared first dimension of A in the calling program (IDA $\ge$ M).

M (INTEGER) The total number m of variables x_i (M $\ge$ 0).

M1 (INTEGER) The number m_1 of restricted variables $x_i \geq 0$ ($0 \leq \mathtt{M1} \leq \mathtt{M}$).

N (INTEGER) The total number n of constraints ($\mathtt{N} \geq 0$).

N1 (INTEGER) The number n_1 of inequality constraints ($0 \leq \mathtt{N1} \leq \mathtt{N}$).

LW (INTEGER) Two-dimensional array of dimension ($\mathtt{IDW}, \geq 5$). Used as working space.

IDW (INTEGER) Declared first dimension of LW in the calling program ($\mathtt{IDW} \geq \mathtt{M} + 2 * \mathtt{N}$).

W (type according to t) One-dimensional array of dimension $\geq \mathtt{M} + \mathtt{N}$. Used as working space.

X (type according to t) One-dimensional array of dimension $\geq \mathtt{M} + \mathtt{N}$. If $\mathtt{ITYPE} = 1$ or $\mathtt{ITYPE} = 2$, its first m elements X(1), ... ,X(M) contain, on exit, the or a solution $x_1, \ldots, x_m$, respectively. The next n elements X(M+1), ... ,X(M+N) contain the values of the so-called slack variables $x_{m+1}, \ldots, x_{m+n}$. If $\mathtt{ITYPE} = 3$ or $\mathtt{ITYPE} = 4$, the elements $\mathtt{X}(1), \ldots, \mathtt{X}(\mathtt{M} + \mathtt{N})$ are undefined.

Z (type according to t) If $\mathtt{ITYPE} = 1$ or $\mathtt{ITYPE} = 2$, Z contains, on exit, the result z of the objective function. Undefined for $\mathtt{ITYPE} = 3$ and $\mathtt{ITYPE} = 4$.

ITYPE (INTEGER) Defines, on exit, the type of the result:

$= 1$: There is exactly one finite solution.

$= 2$: There is more than one solution.

$= 3$: There is no finite solution.

$= 4$: There is no feasable initial solution.

Method:

The method is described in Ref. 1 and Ref. 2.

Error handling:

Error H101.1: $\mathtt{M} \leq 0$ or $\mathtt{N} \leq 0$.
Error H101.2: $\mathtt{M1} < 0$ or $\mathtt{M1} > \mathtt{M}$ or $\mathtt{N1} < 0$ or $\mathtt{N1} > \mathtt{N}$.
In both cases, a message is written on Unit 6, unless subroutine MTLSET (N002) has been called.

References:

1. H.P. Künzi, H.G. Tzschach and C.A. Zehnder, Numerical methods of mathematical optimization, (Academic Press, New York 1968)
2. E. Stiefel, Einführung in die Numerische Mathematik, (B.G. Teubner, Stuttgart 1965)

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