The MibS Input Files

MibS requires two files:

1. a MPS file which includes data of the problem and,
2. a auxiliary (aux) file which includes the information necessary to separate the upper and lower level data.

The MPS File

To learn about the MPS file format see ILOG or Wikipedia.

The Auxiliary File

Each line in the auxiliary file begins with indicator letter(s) which specifies the purpose of the data that follows. The indicators and meaning of the data that follows are listed in Table 1.

Indicator	**Purpose**
N	specifics the number of lower level variables
M	specifies the number of lower level constraints
LC	specifies the index of a lower level variable *Note: variables are assumed to be in the order they appear in the mps file; indices start at 0*
LR	specifies the index of a lower level constraint *Note: constraints are assumed to be in the order they appear in the mps file; indices start at 0*
LO	specifies the the coefficients of the lower level objective function *Note: coefficients are assumed to be in the order of lower level variables*
OS	specifies the lower level objective sense (1=minimization, -1=maximization)

Table 1: Main indicators and their purpose

The Auxiliary File for Interdiction Problems

To solve interdiction problems the auxiliary file contains all indicators in Table 1 plus the additional indicators listed in Table 2. MibS also makes the following assumptions when reading the input files for interdiction problems:

- The variables listed in the MPS file are lower level variables.
- For each lower level variable a corresponding upper level binary variable is created. The upper level variables are indexed first and are matched to lower level variables based on their order.
- There is only one upper level constraint (budget constraint).
- The MPS and auxiliary file define the same lower level objective function. The upper level objective function is the negative of this expression.

Indicator	**Purpose**
IC	specifies the coefficients of budget constraint (the upper level constraint)
IB	specifies the interdiction budget (right hand side of upper level constraint)

Table 2: Interdiction indicators and their purpose

A General Example

The MPS file:

```
NAME          generalExample
ROWS
 L  R0
 L  R1
 L  R2
 L  R3
 N  R4
COLUMNS
    INT1      'MARKER'                 'INTORG'
    C0         R0     -3
    C0         R1     1
    C0         R2     2
    C0         R3     -2
    C0         R4     -1
    C1         R0     2
    C1         R1     2
    C1         R2     -1
    C1         R3     4
    C1         R4     -7
    INT1END   'MARKER'                 'INTEND'
RHS
    B         R0     12
    B         R1     20
    B         R2     7
    B         R3     16
BOUNDS
 UP BOUND     C0     10
 UP BOUND     C1     5
ENDATA
```

The auxiliary file:

```
N 1
M 2
LC 1
LR 2
LR 3
LO 1
OS 1
```

The model:

$$
\begin{aligned}
z = \min_{\mathrm{C}_0 \in \mathbb{Z}_+} \quad & -\mathrm{C}_0 - 7\mathrm{C}_1 \\
\text{s.t.} \quad & -3\mathrm{C}_0 + 2\mathrm{C}_1 \leq 12 \\
& \mathrm{C}_0 + 2\mathrm{C}_1 \leq 20 \\
& \mathrm{C}_0 \leq 10 \\
& \mathrm{C}_1 \in \arg\min_{\bar{\mathrm{C}}_1 \in \mathbb{Z}_+} \quad \bar{\mathrm{C}}_1 \\
& \quad \text{s.t.} \quad 2\bar{\mathrm{C}}_0 - \bar{\mathrm{C}}_1 \leq 7 \\
& \qquad -2\bar{\mathrm{C}}_0 + 4\bar{\mathrm{C}}_1 \leq 16 \\
& \qquad \bar{\mathrm{C}}_1 \leq 5
\end{aligned}
$$

Optimal solution: $\mathrm{C}_0 = 10, \mathrm{C}_1 = 5, z = -45$.

An Interdiction Example

The MPS file:

```
NAME          interdictionExample
ROWS
 N  OBJROW
 L  R1
COLUMNS
    C0  OBJROW     -8.          R0  11.
    C1  OBJROW     -12.         R0  4.
    C2  OBJROW     -3.          R0  6.
RHS
    RHS       R0  50.
BOUNDS
 BV BOUND     C0  3.
 BV BOUND     C1  2.
 BV BOUND     C2  4.
ENDATA
```

The auxiliary file:

```
N 3
M 4
LC 3
LC 4
LC 5
LR 1
LR 2
LR 3
LR 4
LO -8
LO -12
LO -3
OS -1
IC 7
IC 5
IC 2
IB 9
```

The model:

$$
\begin{aligned}
\min \quad & 8\mathrm{C}_0 + 12\mathrm{C}_1 + 3\mathrm{C}_2 \\
\text{s.t.} \quad & 7x_0 + 5x_1 + 2x_2 \leq 9 \\
& x_0, x_1, x_2 \in \{0,1\} \\
& \{\mathrm{C}_0, \mathrm{C}_1, \mathrm{C}_2\} \in \arg\min \quad -8\bar{\mathrm{C}}_0 - 12\bar{\mathrm{C}}_1 - 3\bar{\mathrm{C}}_2 \\
& \qquad \text{s.t. } 11\bar{\mathrm{C}}_0 + 4\bar{\mathrm{C}}_1 + 6\bar{\mathrm{C}}_2 \leq 50 \\
& \qquad\qquad \bar{\mathrm{C}}_0 \leq 3(1 - x_0) \\
& \qquad\qquad \bar{\mathrm{C}}_1 \leq 2(1 - x_1) \\
& \qquad\qquad \bar{\mathrm{C}}_2 \leq 4(1 - x_2) \\
& \qquad\qquad \bar{\mathrm{C}}_0, \bar{\mathrm{C}}_1, \bar{\mathrm{C}}_2 \in \mathbb{Z}_+
\end{aligned}
$$