

SETS:

! Gymnast selection problem.

How best to select which candidates are part of a team,

and to which specialty each candidate is assigned.

A particular application is to selecting a gymnastics team;

!Refs:

Ellis, P. and R. Corn (1984), "Using bivalent integer programming to select teams for intercollegiate women's gymnastics competition," Interfaces, 14(3):41-46.

Eilon, S. and A. Land, (1986) "Note: Further Gymnastics," Interfaces, 16(2):69-71.

Land, A. and S. Powell (1985), "More gymnastics," Interfaces, 15(4):52-54;

! Keywords: Assignment, Corn, Eilon, Ellis, Gymnastics, Land, LINGO, Powell, Sports, Team;

Gymnast: Y;

Event;

GxE(Gymnast, Event): S, X, Z;

Endsets

Data:

!CaseAll; MAKINT = 1; ! = 1 if make variables integer, else 0;

!CaseAll; NPEVENT = 6; ! Number gymnasts assigned to each event;

!CaseAll; NALLRND = 4; ! Number of all rounders required;

!CaseAll; NCTOP = 5; ! Count only the NCTOP highest scores;

!CaseAll; Gymnast = NADIA1 BRUCE2 SIMONE3 DOUG4 MARYLU5 LINUS6 OLGA7 LIDA8 NASTIA9

LUCY10;

!CaseAll; Event =

VAULT BARS BEAM FLOOR;

! Case1

S = 9.3	9.3	9.2	9.5
9.1	9.0	8.8	8.7
9.2	9.0	9.2	9.0
9.0	8.6	8.6	8.65
8.8	8.7	8.5	8.5
8.7	7.5	7.5	8.7
8.5	8.8	8.7	8.5
9.1	9.0	9.0	9.2
9.2	7.0	7.0	9.1
8.9	8.9	9.1	8.7

;

! Case2

S = 9.5	9.5	9.5	9.5
9.5	9.5	9.5	9.5
9.2	9.2	8.6	8.6
8.6	8.6	9.2	9.2
9.0	9.1	8.6	8.6
9.1	7.5	7.5	8.7
8.6	8.6	9.1	9.1
9.2	9.2	8.6	8.6
8.6	8.6	9.2	9.2
8.9	8.9	8.9	8.9

;

! Case3;

S = 9.5	9.5	8.6	8.6
8.6	9.5	9.5	8.6
9.5	8.6	9.5	8.6
8.6	8.6	9.5	9.5
9.4	9.1	9.0	9.4
9.2	9.0	9.4	9.1
9.4	9.1	9.4	9.0
9.3	9.2	9.2	9.3
9.2	9.3	9.2	9.3
9.2	9.3	9.2	9.3

;

! To take data from an Excel spreadsheet,

1) replace a statement like MAKINT = 0, by MAKINT = @OLE(),

2) make sure the spreadsheet has range names matching the LINGO names,

3) make sure the only spreadsheet open is the desired one;

!CaseXcl MAKINT = @Ole(); ! = 1 if make variables integer, else 0;

!CaseXcl NPEVENT = @Ole(); ! Number gymnasts assigned to each event;

!CaseXcl NALLRND = @Ole(); ! Number of all rounders required;

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!CaseXcl      NCTOP = @Ole();      ! Count only the NCTOP highest scores;
!CaseXcl      Gymnast = @Ole();    ! Names of candidates;
!CaseXcl      Event = @Ole();      ! Names of events;
!CaseXcl      S = @OLE(, SCORE); ! Score matrix;
Enddata

Submodel HuDuzWat:
! Parameters:
    S( i, j) = expected score of gymnast i in event j;
! Variables:
    Y( i) = 1 if gymnast i is selected as all-rounder,
    X( i, j) = 1 if i participates in event j,
    Z( i, j) = 1 if score of gymnast i is counted for event j
    ;
    NEVENTS = @SIZE( EVENT); ! Number of events;
! Maximize expected score of team;
    MAX = @SUM( GxE( i, j): S( i, j) * Z( i, j));
! If Gymnast i selected as all-rounder, must participate in every event j;
    @For( GxE( i, j):
        X( i, j) >= Y( i);
    );

    @For( EVENT( j):
        @SUM( GYMNAST( i): Z( i, j)) <= NCTOP;    ! Count only the NCTOP highest scores;
    );

    @SUM( GYMNAST( i): Y( i)) >= NALLRND;    ! Must have enough All-rounders;

    @FOR( EVENT( j):
! Must have NPEVENT participants in each event;
        @Sum( GYMNAST( i): X( i, j)) = NPEVENT;
    );

    @For( GxE( i, j):
        Z( i, j) <= X( i, j);    ! Score of i counted implies i participated in event;
        @BND( 0, X( i, j), 1); ! Cannot count a gymnast more than once;
    );
! If MAKINT = 1, then make all X variables binary;
    @For( GxE( i, j) | MAKINT:
        @Bin( X( i, j));    ! (Perhaps) make X variables binary integer;
    );
Endsubmodel
Calc:
    @Solve( HuDuzWat);

! Display a simple report;
    @For( GYMNAST( i) | Y( i) #GT# 0:
        @Write( ' Gymnast ', @Format( GYMNAST( i),'8s'),' is an all-rounder      (',Y( i),')',
@NEWLINE( 1));
    );
    @Write( @NEWLINE( 1));
    @For( GxE( i, j) | X( i, j) #GT# 0:
        @Write( ' Gymnast ', @Format( GYMNAST( i),'8s'),' participates in ', Event( j),'
( ', X( i, j),')', @NEWLINE( 1));
    );
Endcalc

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