**Exercise cpc-08: Example 5: Configuration of track indicators**

Graphical user interface, text, application, email

Description automatically generated

Text

Description automatically generated

Generic model (tracks.mzn):

enum Type = {A, B, C, D};

array[Type,Type] of 0..1: allows = [|

% A, B, C, D

0, 1, 0, 0 | % A

1, 0, 1, 0 | % B

0, 1, 0, 1 | % C

0, 0, 1, 0 % D

|];

int: NrSections;

set of int: Sections = 1..NrSections;

array[Sections,Sections] of 0..1: neighborship;

array[Sections] of var Type: indicators;

constraint forall (i,j in Sections where i<j)

(neighborship[i, j]==1 -> allows[indicators[i],indicators[j]] == 1);

solve satisfy;

Original Example (8 sections):

NrSections = 8;

% only upper half is used because of i<j constraint

neighborship = [|

% 1, 2, 3, 4, 5, 6, 7, 8

0, 1, 0, 0, 0, 0, 0, 0 | %1

0, 0, 1, 1, 0, 0, 0, 0 | %2

0, 0, 0, 0, 1, 1, 0, 0 | %3

0, 0, 0, 0, 1, 0, 0, 0 | %4

0, 0, 0, 0, 0, 0, 1, 0 | %5

0, 0, 0, 0, 0, 0, 1, 0 | %6

0, 0, 0, 0, 0, 0, 0, 1 | %7

0, 0, 0, 0, 0, 0, 0, 0 %8

|];

Output Sample:

|  |  |  |
| --- | --- | --- |
|  | Running tracks.mzn, sample8\_1.dzn | 169msec |

|  |
| --- |
| indicators = [A, B, A, A, B, B, A, B];  % time elapsed: 169msec  ----------  %%%mzn-stat: failures=0  %%%mzn-stat: initTime=0.00036  %%%mzn-stat: nodes=5  %%%mzn-stat: peakDepth=4  %%%mzn-stat: propagations=40  %%%mzn-stat: propagators=9  %%%mzn-stat: restarts=0  %%%mzn-stat: solutions=1  %%%mzn-stat: solveTime=9.3e-05  %%%mzn-stat: variables=8  %%%mzn-stat-end  Finished in 169msec. |

Unsatisfiable Example:

NrSections = 8;

% only upper half is used because of i<j constraint

neighborship = [|

% 1, 2, 3, 4, 5, 6, 7, 8

0, 1, 0, 0, 0, 0, 0, 0 | %1

0, 0, 1, 1, 0, 0, 0, 1 | %2

0, 0, 0, 0, 1, 1, 0, 0 | %3

0, 0, 0, 0, 1, 0, 0, 0 | %4

0, 0, 0, 0, 0, 0, 1, 0 | %5

0, 0, 0, 0, 0, 0, 1, 0 | %6

0, 0, 0, 0, 0, 0, 0, 1 | %7

0, 0, 0, 0, 0, 0, 0, 0 %8

|];

Output Sample:

|  |  |  |
| --- | --- | --- |
|  | Running tracks.mzn, sample8\_1\_unsatisfiable.dzn | 190msec |

|  |
| --- |
| =====UNSATISFIABLE=====  %%%mzn-stat: failures=4  %%%mzn-stat: initTime=0.000384  %%%mzn-stat: nodes=7  %%%mzn-stat: peakDepth=1  %%%mzn-stat: propagations=124  %%%mzn-stat: propagators=10  %%%mzn-stat: restarts=0  %%%mzn-stat: solutions=0  %%%mzn-stat: solveTime=0.000129  %%%mzn-stat: variables=8  %%%mzn-stat-end  Finished in 190msec. |

Double-sized Example:

NrSections = 16;

% only upper half is used because of i<j constraint

neighborship = [|

% 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 11 12 13 14 15 16

0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0 | %1

0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0 | %2

0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0 | %3

0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0 | %4

0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0 | %5

0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0 | %6

0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1 | %7

0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0 | %8

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 | %9

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 | %10

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0 | %11

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 | %12

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 | %13

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 | %14

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1 | %15

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 | %16

|];

Output Sample:

|  |  |  |
| --- | --- | --- |
|  | Running tracks.mzn, sample8\_1\_16t.dzn | 193msec |

|  |
| --- |
| indicators = [A, B, A, A, B, B, A, B, A, B, A, A, B, B, A, B];  % time elapsed: 161msec  ----------  %%%mzn-stat: failures=0  %%%mzn-stat: initTime=0.000436  %%%mzn-stat: nodes=9  %%%mzn-stat: peakDepth=8  %%%mzn-stat: propagations=98  %%%mzn-stat: propagators=21  %%%mzn-stat: restarts=0  %%%mzn-stat: solutions=1  %%%mzn-stat: solveTime=0.00013  %%%mzn-stat: variables=16  %%%mzn-stat-end  Finished in 193msec. |

Larger Example (32 sections):

NrSections = 32;

% only upper half is used because of i<j constraint

neighborship = [|

% 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0 | %1

0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0 | %2

0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0 | %3

0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0 | %4

0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0 | %5

0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0 | %6

0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1 | %7

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 | %8

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 | %9

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 | %10

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 | %11

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 | %12

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 | %13

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 | %14

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 | %15

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 | %16

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0 | %17

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 | %18

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 | %19

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 | %20

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 | %21

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 | %22

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 | %23

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 | %24

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 | %25

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 | %26

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 | %27

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, 1, 0, 0 | %28

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 | %29

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 | %30

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 | %31

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 | %32

|];

Output Sample:

|  |  |  |
| --- | --- | --- |
|  | Running tracks.mzn, sample8\_1\_16t copy.dzn | 197msec |

|  |
| --- |
| indicators = [A, B, A, A, B, B, A, B, A, B, A, A, B, B, A, B, A, B, A, A, B, B, A, B, B, B, A, A, B, B, A, B];  % time elapsed: 166msec  ----------  %%%mzn-stat: failures=0  %%%mzn-stat: initTime=0.00052  %%%mzn-stat: nodes=16  %%%mzn-stat: peakDepth=15  %%%mzn-stat: propagations=179  %%%mzn-stat: propagators=39  %%%mzn-stat: restarts=0  %%%mzn-stat: solutions=1  %%%mzn-stat: solveTime=0.000133  %%%mzn-stat: variables=32  %%%mzn-stat-end  Finished in 197msec. |

Solver Performance Comparison:

|  |  |  |
| --- | --- | --- |
| Size | Average solveTime | Avg. overall time |
| 8 | 0.000093 | 169ms |
| 16 | 0.000130 | 161ms |
| 32 | 0.000133 | 166ms |