File Format Description for Unsolvable Boards for CSPLib

Written by: Moshe Rubin (Mountain Vista Software)
17 December 2005

Overview

This file describes the file format of the text file containing Solitaire Battleship boards that the current Fathom It! built-in solver could not solve. This makes the boards extremely difficult to solve. These boards are provided to CSPLib as fodder for constraint programmers' efforts.

File Format Description

The text file containing unsolvable boards is a simple ASCII file. The boards are separated from each other by a line of '=' characters:

```
===================================================

Board ID: 113
Nodes: 583567
Solutions: 70
START-NEW-BOARD        10 10
Hint: 6 9 Circle 67
Hint: 0 5 Water 2
PLACESHIP     4 1 1 S
PLACESHIP     3 1 3 E
PLACESHIP     3 5 5 E
PLACESHIP     2 0 7 E
PLACESHIP     2 2 7 E
PLACESHIP     2 3 4 E
PLACESHIP     1 7 1 S
PLACESHIP     1 4 9 S
PLACESHIP     1 5 3 S
PLACESHIP     1 6 9 S

Row tallies:     2 4 3 3 2 4 1 1 0 0
Column tallies:  0 5 0 2 2 3 1 3 2 2

DisplayBoardASCII: After generating a board

.....W.lr. 2
.t.lmr.... 4
.m.....lr. 3
.m..lr.... 3
.b.......c 2
...c.lmr.. 4
.........C 1
.c........ 1
.......... 0
.......... 0
0502231322
```

```
==================================================

Board ID: 123
Nodes: 661850
Solutions: 2222
START-NEW-BOARD         10 10
Hint: 5 2 Circle 2120
Hint: 4 6 Circle 98
Hint: 5 8 Water 3
PLACESHIP      4 9 3 E
PLACESHIP      3 7 8 S
PLACESHIP      3 7 1 E
PLACESHIP      2 0 0 S
PLACESHIP      2 0 2 E
PLACESHIP      2 2 2 S
PLACESHIP      1 5 2 S
PLACESHIP      1 1 8 S
PLACESHIP      1 5 4 S
PLACESHIP      1 4 6 S

Row tallies:      3  2  1  1  1  2  0  4  1  5
Column tallies:   2  1  5  3  2  1  2  0  4  0

DisplayBoardASCII: After generating a board

t.lr...... 3
b.......c. 2
..t....... 1
..b....... 1
......C... 1
..C.c...W. 2
.......... 0
.lmr....t. 4
........m. 1
...lmmr.b. 5
2153212040

==================================================
```

Each board stands by itself. Let's examine the board file format.

Board ID

```
Board ID: 113
```

This is the seed value used to generate this board. It has no value to anyone other than a means of identifying the board.

Nodes

```
Nodes: 583567
```

The Fathom It! board generator traverses an internal "board tree" to determine all possible solutions. The nodes line states how many internal nodes were processed before determining all possible solutions for the given row and column tally vectors.

Solutions

```
Solutions: 70
```

This means that, given the row and column tally vectors and no square hinting, there are 70 possible solutions. It is the hinting that provides one, unique solution for the puzzle.

START_NEW_BOARD

```
START-NEW-BOARD       10 10
```

This states that a new 10x10 puzzle is about to be generated.

Hint

```
Hint: 6 9 Circle 67
Hint: 0 5 Water 2
```

This board needed two hints to disambiguate the puzzle. The hint line is read as follows:

```
    Hint: <row> <column> <hint value> <# of ambiguous boards removed>
```

Row and column values are zero-based starting in the upper left-hand cell. The hints in the example here mean the following:

- A hint of a 'circle' (or submarine) should be placed at (row,column)=(6,9). This hint rules out 67 other solutions.
- A hint of 'water' placed at (row,column)=(0,5) rules out two other solutions.

Since there were 70 possible solutions, and out two hints rules out 69 solutions, the board with the two hints has a unique solution.

Together with the row and column tallies, this is what the starting puzzle will look like with the hints:
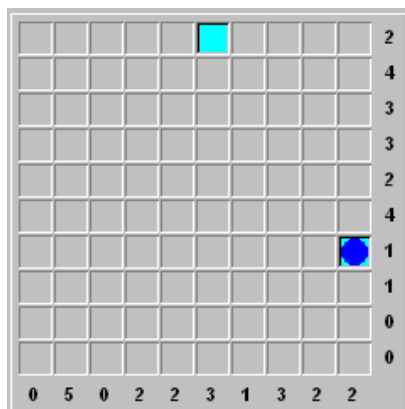
PLACESHIP

```
PLACESHIP     4 1 1 S
PLACESHIP     3 1 3 E
PLACESHIP     3 5 5 E
PLACESHIP     2 0 7 E
PLACESHIP     2 2 7 E
PLACESHIP     2 3 4 E
PLACESHIP     1 7 1 S
PLACESHIP     1 4 9 S
PLACESHIP     1 5 3 S
PLACESHIP     1 6 9 S
```

These lines list where the ten ships comprising a 10x10 Solitaire Battleship puzzle should be placed. A PLACESHIP line is read as follows:

PLACESHIP <ship length> <row> <column> <direction/orientation>

In the example above:

- a ship of length four (i.e., a battleship) should be placed at (1,1) going south (i.e., downwards)
- a ship of length three (i.e., a cruiser) should be placed at (1,3) going east (i.e., left-to-right)

Here's what the solution would look like:
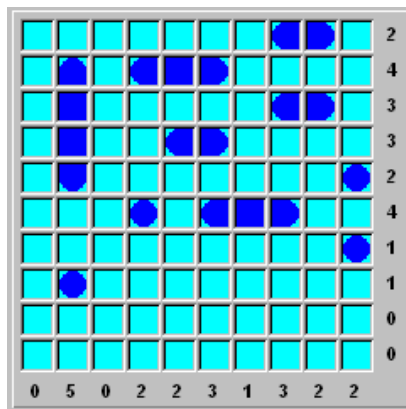
Row Tallies

```
Row tallies:     2  4  3  3  2  4  1  1  0  0
```

You can see this is the vector of row counts in the above example.

Column Tallies

```
Column tallies:  2  1  5  3  2  1  2  0  4  0
```

You can see this is the vector of column counts in the above example.

ASCII diagram of the board

```
DisplayBoardASCII: After generating a board

.....W.lr. 2
.t.lmr.... 4
.m.....lr. 3
.m..lr.... 3
.b.......c 2
...c.lmr.. 4
.........C 1
.c........ 1
.......... 0
.......... 0
0502231322
```

This is an ASCII representation of the starting board and its solution:

- The row and column tallies are given
- The uppercase letters, if there are any, denote hints.
- The lowercase letters denote ship segments that are part of the solution but are not displayed in the original puzzle.