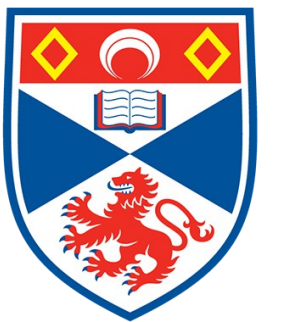


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# Solving European peg solitaire with constraint programming

by Niall Colfer

supervised by Prof Ian Miguel



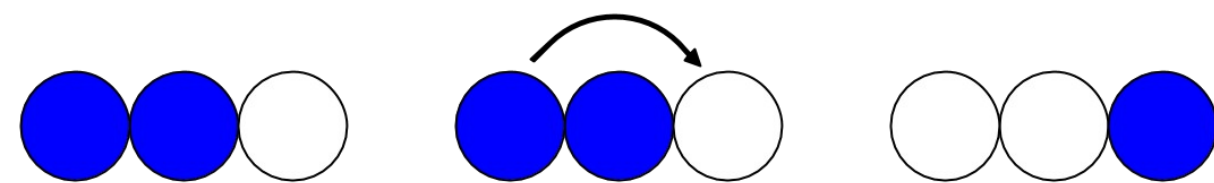
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## Peg Solitaire



A popular, one player board game that is played worldwide. Although the rules are simple, finding a solution can prove difficult.

Moves are performed as jumps, in a similar fashion to draughts. The goal is to reduce the board to a single peg.



This project aims to solve the European variation of the game (shown above), using a constraint programming approach.

## Essence'

A constraint programming language

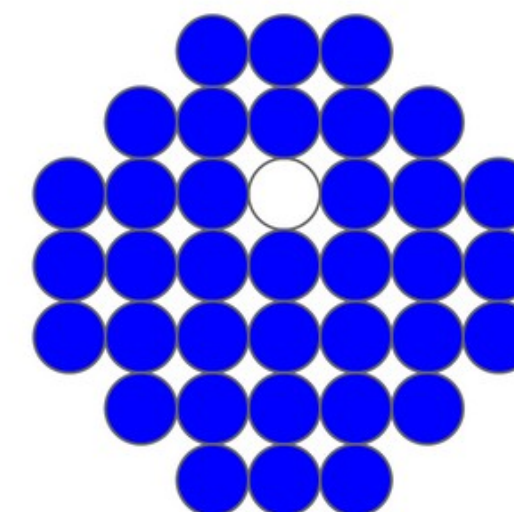
```
language ESSENCE' 1.0
```

```
letting n be 7  
find Boards : matrix indexed by i  
such that  
  forAll i : int(1..n) .
```

## Modelling peg solitaire as a constraint satisfaction problem

The model uses a representation of the state of the board, as seen below.

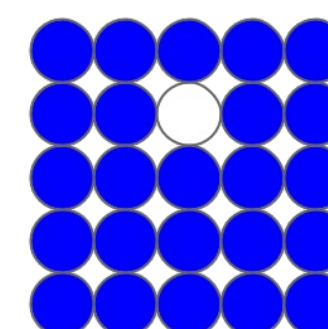
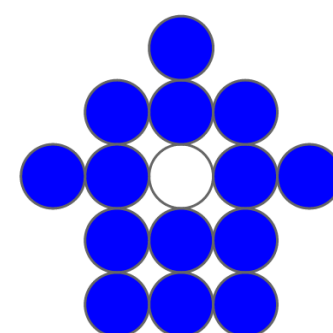
0	0	1	1	1	0	0
0	1	1	1	1	1	0
1	1	1	0	1	1	1
1	1	1	1	1	1	1
1	1	1	1	1	1	1
0	1	1	1	1	1	0
0	0	1	1	1	0	0



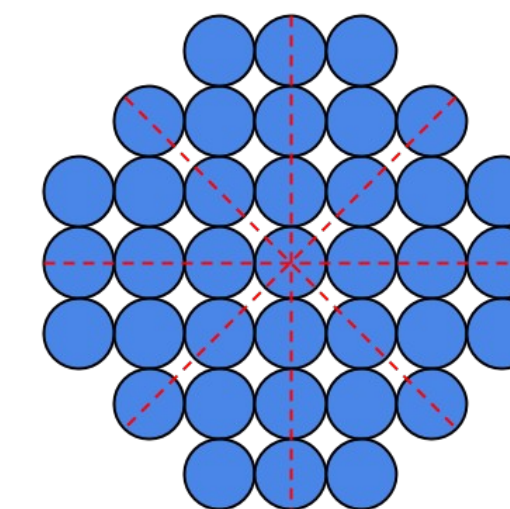
A sequence of these boards is sought, where constraints are used to ensure the transition from one board to another is performed with a legal peg solitaire move.

## Modelled as a class of CSPs

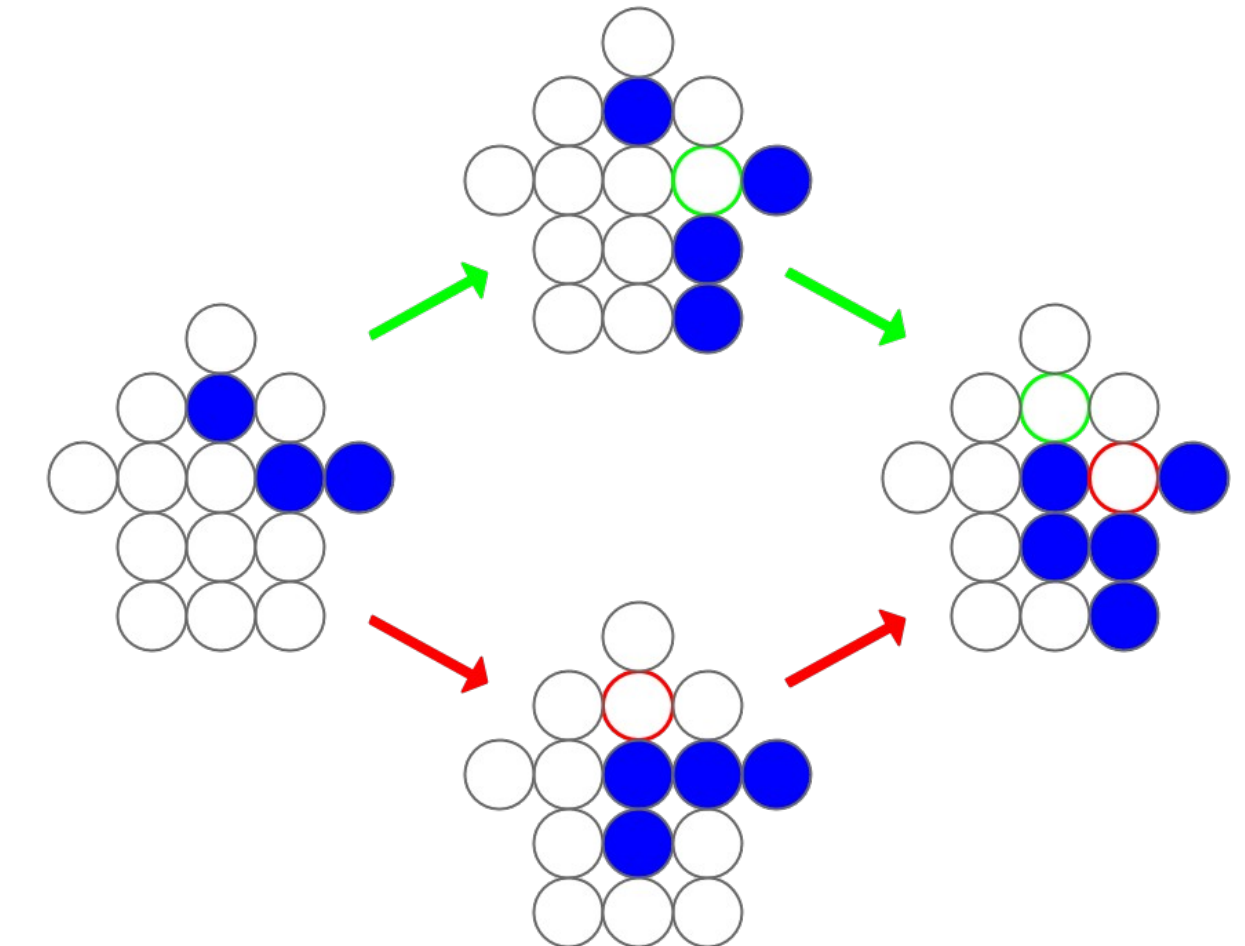
The class of solitaire game is modelled, so that alternate boards (as below) can also be modelled.



## Symmetry breaking



Symmetry in the game is broken to improve the solution, both along the axes of symmetry of the board (left) and in the choice of independent moves (below).



## Empirical evaluation

The model and symmetry breaking constraints are finally tested and evaluated to determine their effectiveness