Symmetry puzzles

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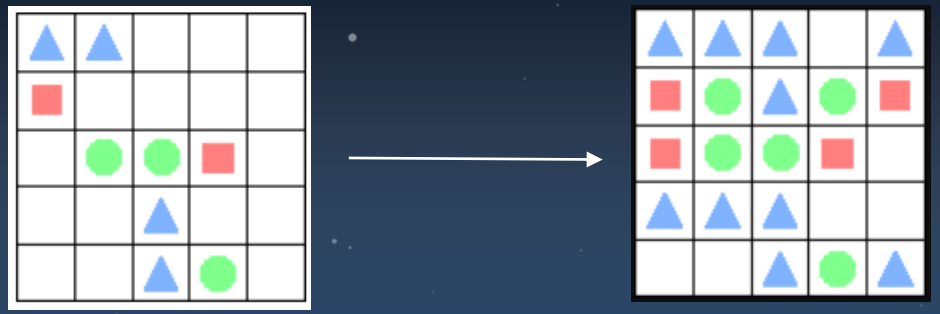
Specification of the work

- In this project we will address One-player solitaire games, most specifically the Symmetry puzzle, in which the objective is to form palindromes both in each column and row. Each one of the puzzles has a unique solution.
- The rules are simple: either we add one of tree geometrical figures(circle, triangle or square), or leave the space empty, in order to create a palindrome.



Related work

Palindromic sentence building puzzle: https://www.itprotoday.com/sql-server/palindromes-puzzle-solutions

```
with c as
(
  select
    n as words, cast(n as bigint) as sentences,
    cast(n as bigint) as v, n-1 as i
  from nums -- auxiliary table of numbers
  where n = 1
)
select words, sentences
from c where i = 0
order by words;
```

words	sentences
1	1
2	4
3	15
4	64
5	325
6	1956
7	13699
8	109600
9	986409
10	9864100
11	108505111
12	1302061344
13	16926797485
14	236975164804
15	3554627472075
16	56874039553216
17	966858672404689
18	17403456103284420
19	330655665962403999
20	6613313319248080000

Finding maximal 2 dimensional palindromes: https://drops.dagstuhl.de/opus/volltexte/2016/6075/pdf/LIPIcs-CPM-2016-19.pdf

Table 2 Text T (left) and $d = 0$'s *pals* array (right), at the point where the algorithm will calculate the value for $T[6,6]$ in $pals[6]$.

	1	2	3	4	5	6	7	8	9	10
1	a	b	b	b	b	a	a	b	b	e
2	b	c	c	c	b	c	c	c	b	e
3	b	c	c	c	b	c	c	c	a	e
4	b	c	c	c	b	c	c	c	a	e
5	b	b	b	b	a	b	b	b	b	a
6	a	c	c	c	b	c	c	c	b	c
7	a	c	c	c	b	c	c	c	b	c
8	b	c	c	c	b	c	c	c	b	c
9	b	b	a	a	b	b	b	b	a	b
10	e	e	e	e	a	c	c	c	b	c

Table 4 Shown on the left is a text that contains a cubic number of maximal *rect2DP*. The *'s indicate unique, unused characters. On the right is a partial table with counts, which are the exact number of *rect2DP* that are centered at the corresponding text positions.

	1	2	3	4	5	6	7	8	9	0	1	2	3
1	*	*	*	*	*	*	0	*	*	*	*	*	*
2	*	*	*	*	*	0	0	0	*	*	*	*	*
3	*	*	*	*	0	0	0	0	0	*	*	*	*
4	*	*	*	0	0	0	0	0	0	0	*	*	*
5	*	*	0	0	0	0	0	0	0	0	0	*	*
6	*	0	0	0	0	0	0	0	0	0	0	0	*
7	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	*
9	*	*	0	0	0	0	0	0	0	0	0	*	*
0	*	*	*	0	0	0	0	0	0	0	*	*	*
1	*	*	*	*	0	0	0	0	0	*	*	*	*
2	*	*	*	*	*	0	0	0	*	*	*	*	*
3	*	*	*	*	*	*	0	*	*	*	*	*	*

	1	2	3	4	5	6	7	8	9	0	1	2	3
1							1						
2							1	2					
3							1	2	3				
4						1	2	3	4				
5					1	2	3	4	5				
6				1	2	3	4	5	6				
7	1	2	3	4	5	6	7	6	5	4	3	2	1
8							6						
9							5						
0							4						
1							3						
2							2						
3							1						

Formulation of the problem

State Representation

Single state problema (deterministic and accessible environment)

Initial State

Puzzle initial pieces laid in a board represented by a matrix

Objective test

Checks whether the state corresponds to the objective state.

Operators

Leave empty

Precondition: Matrix position must be empty
Effect: Position remains empty
Cost: 1

Add a Circle

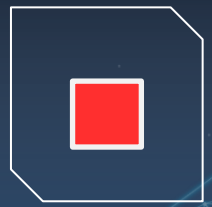
Precondition: Matrix position must be empty
Effect: New state where the position is filled with a circle
Cost: 1

Add a Triangle

Precondition: Matrix position must be empty
Effect: New state where the position is filled with a triangle
Cost: 1

Add a Square

Precondition: Matrix position must be empty
Effect: New state where the position is filled with a square
Cost: 1



Heuristics

Score

The score heuristic helps us find the best available next state, as palindrome formation would bump the value of this heuristic up

Central Pieces

Given different board sizes we can approach a solution faster if we search for lines which have a middle piece (for uneven sizes) as these provide a solid footing for future states