

# THE GAME

## [ai] explore!



The game [ai] explore! was created within the project SciMaG- Science&Math educational games from preschool to university. The project is co-funded by the Erasmus+ Program of the European Union, KA220-SCH – Cooperation partnerships in school education(023-1-HR01-KA220-SCH-000165485).



Co-funded by  
the European Union

## The origin of the game

The popular science exhibition [ai] explore! presents visualisations of engineering problems from the field of civil engineering as well as some computationally demanding scientific research examples. The visualisation was inspired by mathematical algorithm HEDAC, and the exhibits show the process by which the algorithm learns to recognise objects and explore their shape. The algorithm successfully explores and reproduces real works of art.

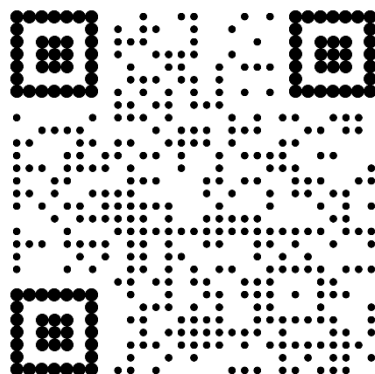
The game is inspired with the scientific work:

S. Ivić, B. Crnković and I. Mezić, "Ergodicity-Based Cooperative Multiagent Area Coverage via a Potential Field," in IEEE Transactions on Cybernetics, vol. 47, no. 8, pp. 1983-1993, Aug. 2017

The applications of the algorithm are numerous, and we list only some of them: exploration and search in unknown space, painting, planning of agricultural spraying, scanning of 3D objects, etc.

The exhibits were created in interdisciplinary collaboration between employees of the Faculty of Mathematics and the Faculty of Civil Engineering at the University of Rijeka. The authors of the exhibition are Bojan Crnković, Vedrana Mikulić Crnković, Ivona Traunkar from the Faculty of Mathematics of the University of Rijeka and Nina Čeh, Edita Papa Dukić from the Faculty of Civil Engineering of the University of Rijeka.

The exhibition was presented on the outdoor exhibition panels in the Trsat University Campus in Rijeka (Croatia), on the exhibition panels on the main promenade Korzo in the city centre of Rijeka (Croatia) and in the Moise Palace in Cres (island of Cres, Croatia). You can still experience the exhibition by taking a virtual walk. You can find out more about the exhibition [ai] explore! and the virtual tour prepared for VR headsets at



To complement the exhibition, the educational game [ai] explore! was developed. The authors of the game are Bojan Crnković, Vedrana Mikulić Crnković, Ivona Traunkar.




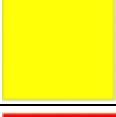

## How to play [ai] explore! game?

### Moving around the board

You can move step by step, but in such a way that each step brings you closer to the goal (a step can be one move from rectangle to rectangle, to the right or down). You can't move diagonally!

### Rules of the game

- The path starts in the upper left corner of the board and ends in the lower right corner of the board.
- Each rectangle has its own colour, and each colour that you find on your path carries a certain number of points, depending on its warmth (the warmest - red carries 5 points, yellow 4 points, green 3 points, blue 2 points and the coldest - purple 1 point).

COLOURS	POINTS
	1
	2
	3
	4
	5

**The goal** is to find the optimal path: the shortest path from the start to the goal that brings the most points. When you find it, mark it with a pencil and calculate how many points you have collected!

## How to check your solution?

The booklet in front of you contains 30 games of different levels: researcher beginner, researcher, experienced researcher. For each level, 10 games are given, and after these 10 games, their solutions are also given (one of the optimal paths and the maximal number of points). Although there are many almost optimal solutions, optimal solutions are only a few and, in most cases, only one solution.

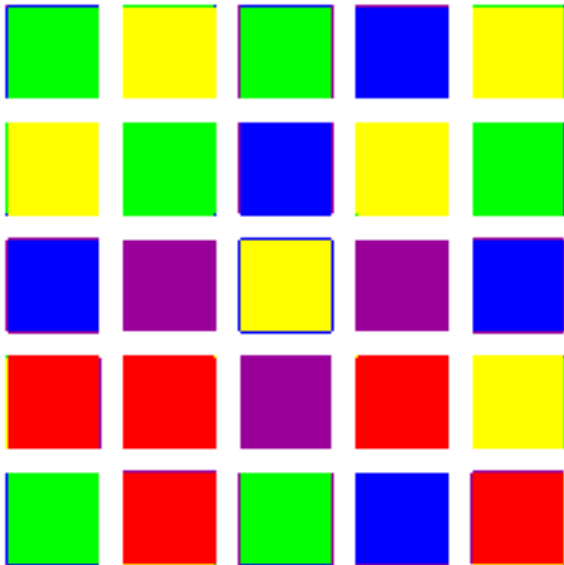
## How to generate more games?

If these 30 games we have prepared are not enough for you, no problem! You can just generate more than 300 more games. How?

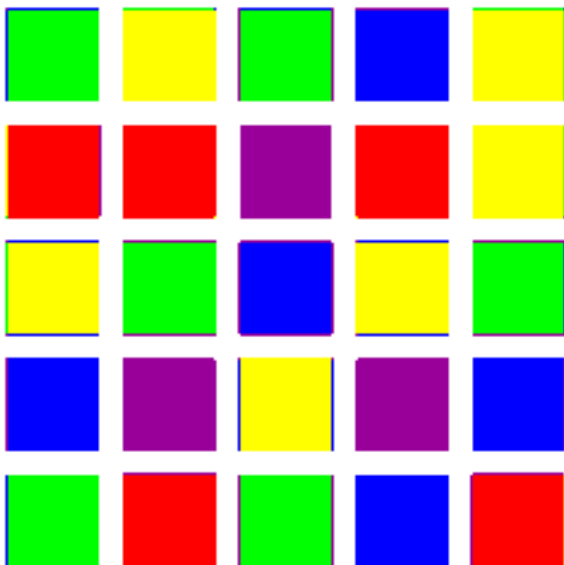
After the solution table, you can find everything you need to generate a new game (individual rows, instructions for composing a new game by composing individual rows). After you have composed a new game and played it, check the solution in the table that follows.

# GAMES (LEVEL: researcher beginner)

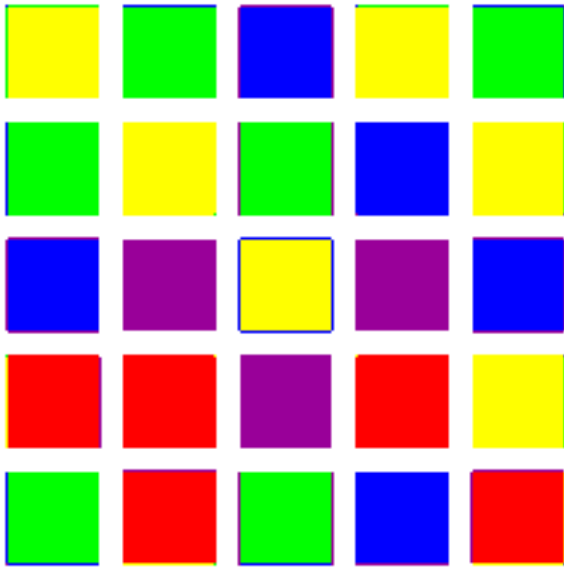
## GAME B1



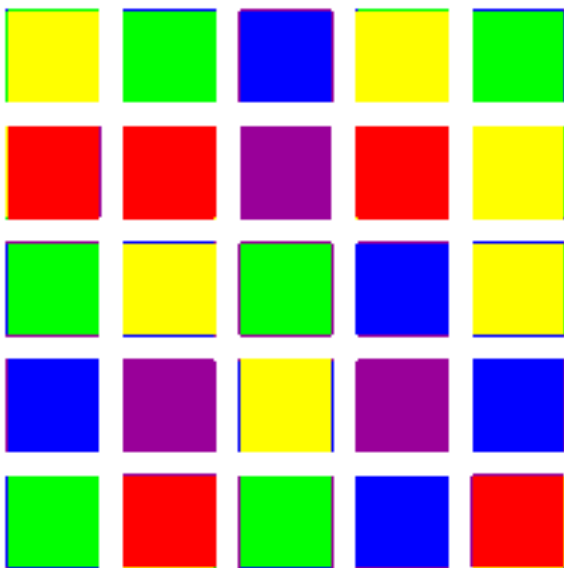
## GAME B2



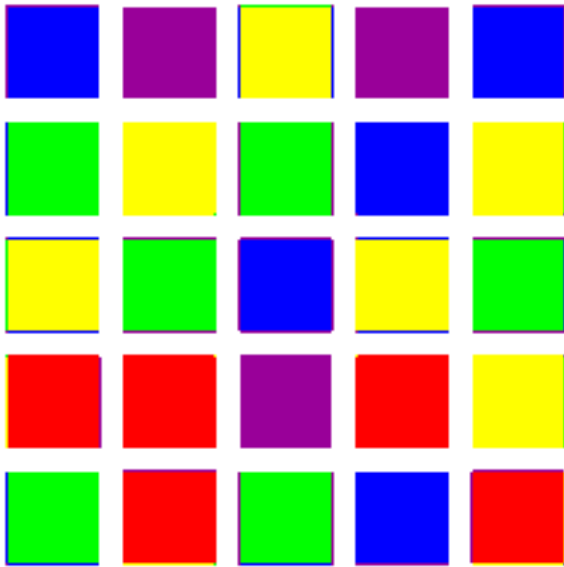
GAME B3



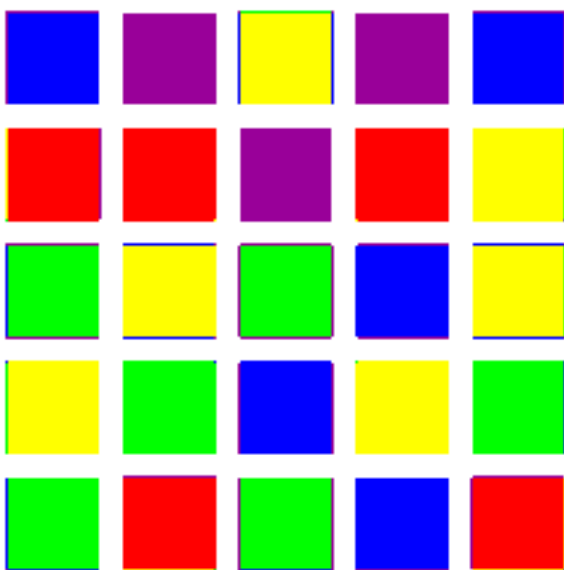
GAME B4



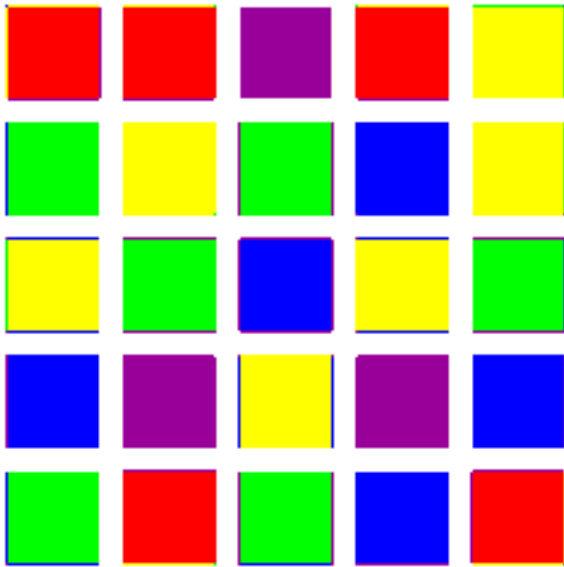
**GAME B5**



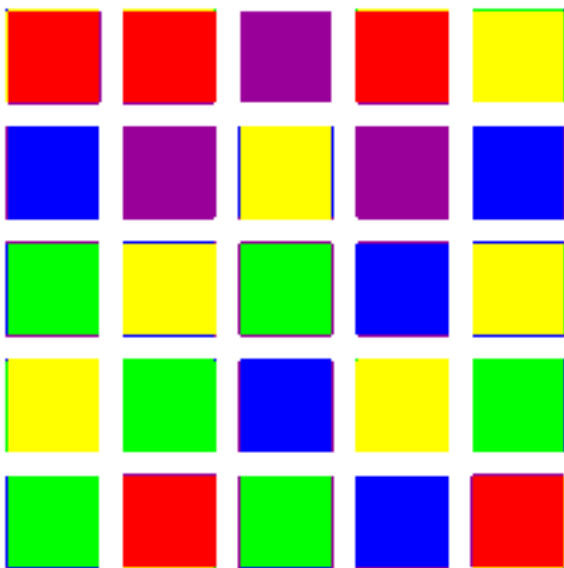
**GAME B6**



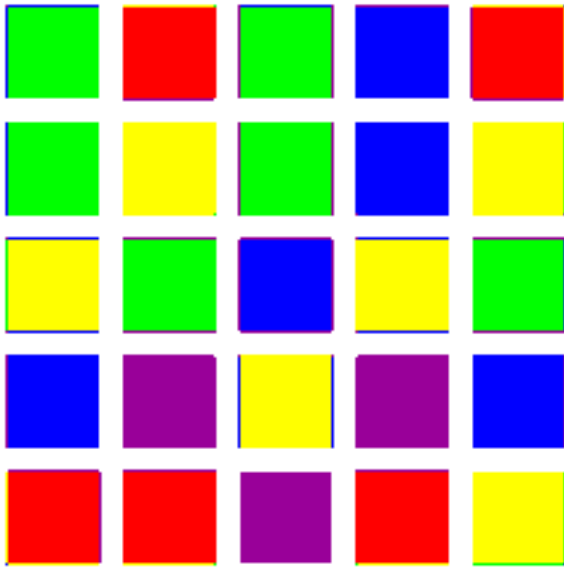
GAME B7



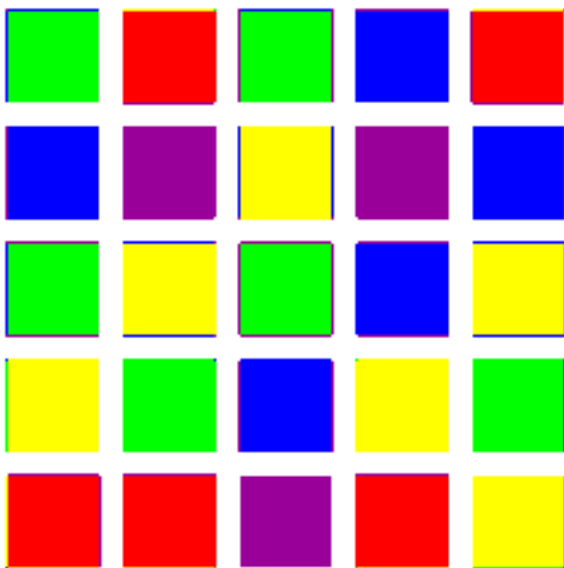
GAME B8



GAME B9



GAME B10

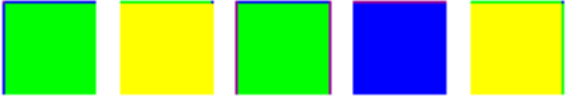



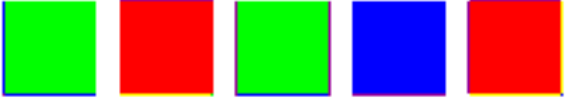


## SOLUTIONS (LEVEL: researcher beginner)

<b>GAME B1</b>	<b>GAME B2</b>	<b>GAME B3</b>	<b>GAME B4</b>	<b>GAME B5</b>
34	33	34	35	34
<b>GAME B6</b>	<b>GAME B7</b>	<b>GAME B8</b>	<b>GAME B9</b>	<b>GAME B10</b>
34	34	34	32	33

# ADDITIONAL GAMES AND SOLUTIONS

(LEVEL: researcher beginner)

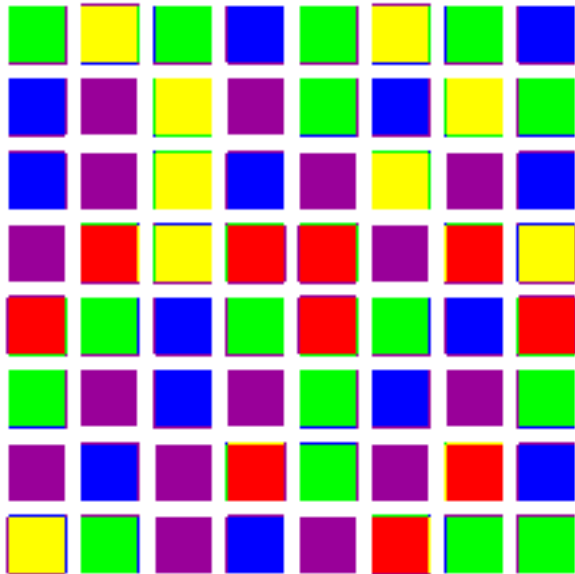
ROW 0	
ROW 1	
ROW 2	
ROW 3	
ROW 4	

<b>GAME</b>	<b>PERMUTATION</b>	<b>GAME</b>	<b>PERMUTATION</b>	<b>GAME</b>	<b>PERMUTATION</b>
<b>B11</b>	0, 1, 2, 4, 3	<b>B51</b>	1, 3, 4, 2, 0	<b>B91</b>	3, 1, 2, 4, 0
<b>B12</b>	0, 1, 3, 2, 4	<b>B52</b>	1, 4, 0, 2, 3	<b>B92</b>	3, 1, 4, 0, 2
<b>B13</b>	0, 1, 3, 4, 2	<b>B53</b>	1, 4, 0, 3, 2	<b>B93</b>	3, 1, 4, 2, 0
<b>B14</b>	0, 1, 4, 2, 3	<b>B54</b>	1, 4, 2, 0, 3	<b>B94</b>	3, 2, 0, 1, 4
<b>B15</b>	0, 1, 4, 3, 2	<b>B55</b>	1, 4, 2, 3, 0	<b>B95</b>	3, 2, 0, 4, 1
<b>B16</b>	0, 2, 1, 3, 4	<b>B56</b>	1, 4, 3, 0, 2	<b>B96</b>	3, 2, 1, 0, 4
<b>B17</b>	0, 2, 1, 4, 3	<b>B57</b>	1, 4, 3, 2, 0	<b>B97</b>	3, 2, 1, 4, 0
<b>B18</b>	0, 2, 3, 1, 4	<b>B58</b>	2, 0, 1, 3, 4	<b>B98</b>	3, 2, 4, 0, 1
<b>B19</b>	0, 2, 3, 4, 1	<b>B59</b>	2, 0, 1, 4, 3	<b>B99</b>	3, 2, 4, 1, 0
<b>B20</b>	0, 2, 4, 1, 3	<b>B60</b>	2, 0, 3, 1, 4	<b>B100</b>	3, 4, 0, 1, 2
<b>B21</b>	0, 2, 4, 3, 1	<b>B61</b>	2, 0, 3, 4, 1	<b>B101</b>	3, 4, 0, 2, 1
<b>B22</b>	0, 3, 1, 2, 4	<b>B62</b>	2, 0, 4, 1, 3	<b>B102</b>	3, 4, 1, 0, 2
<b>B23</b>	0, 3, 1, 4, 2	<b>B63</b>	2, 0, 4, 3, 1	<b>B103</b>	3, 4, 1, 2, 0
<b>B24</b>	0, 3, 2, 1, 4	<b>B64</b>	2, 1, 0, 3, 4	<b>B104</b>	3, 4, 2, 0, 1
<b>B25</b>	0, 3, 2, 4, 1	<b>B65</b>	2, 1, 0, 4, 3	<b>B105</b>	3, 4, 2, 1, 0
<b>B26</b>	0, 3, 4, 1, 2	<b>B66</b>	2, 1, 3, 0, 4	<b>B106</b>	4, 0, 1, 2, 3
<b>B27</b>	0, 3, 4, 2, 1	<b>B67</b>	2, 1, 3, 4, 0	<b>B107</b>	4, 0, 1, 3, 2
<b>B28</b>	0, 4, 1, 2, 3	<b>B68</b>	2, 1, 4, 0, 3	<b>B108</b>	4, 0, 2, 1, 3
<b>B29</b>	0, 4, 1, 3, 2	<b>B69</b>	2, 1, 4, 3, 0	<b>B109</b>	4, 0, 2, 3, 1
<b>B30</b>	0, 4, 2, 1, 3	<b>B70</b>	2, 3, 0, 1, 4	<b>B110</b>	4, 0, 3, 1, 2
<b>B31</b>	0, 4, 2, 3, 1	<b>B71</b>	2, 3, 0, 4, 1	<b>B111</b>	4, 0, 3, 2, 1
<b>B32</b>	0, 4, 3, 1, 2	<b>B72</b>	2, 3, 1, 0, 4	<b>B112</b>	4, 1, 0, 2, 3
<b>B33</b>	0, 4, 3, 2, 1	<b>B73</b>	2, 3, 1, 4, 0	<b>B113</b>	4, 1, 0, 3, 2
<b>B34</b>	1, 0, 2, 3, 4	<b>B74</b>	2, 3, 4, 0, 1	<b>B114</b>	4, 1, 2, 0, 3
<b>B35</b>	1, 0, 2, 4, 3	<b>B75</b>	2, 3, 4, 1, 0	<b>B115</b>	4, 1, 2, 3, 0
<b>B36</b>	1, 0, 3, 2, 4	<b>B76</b>	2, 4, 0, 1, 3	<b>B116</b>	4, 1, 3, 0, 2
<b>B37</b>	1, 0, 3, 4, 2	<b>B77</b>	2, 4, 0, 3, 1	<b>B117</b>	4, 1, 3, 2, 0
<b>B38</b>	1, 0, 4, 2, 3	<b>B78</b>	2, 4, 1, 0, 3	<b>B118</b>	4, 2, 0, 1, 3
<b>B39</b>	1, 0, 4, 3, 2	<b>B79</b>	2, 4, 1, 3, 0	<b>B119</b>	4, 2, 0, 3, 1
<b>B40</b>	1, 2, 0, 3, 4	<b>B80</b>	2, 4, 3, 0, 1	<b>B120</b>	4, 2, 1, 0, 3
<b>B41</b>	1, 2, 0, 4, 3	<b>B81</b>	2, 4, 3, 1, 0	<b>B121</b>	4, 2, 1, 3, 0
<b>B42</b>	1, 2, 3, 0, 4	<b>B82</b>	3, 0, 1, 2, 4	<b>B122</b>	4, 2, 3, 0, 1
<b>B43</b>	1, 2, 3, 4, 0	<b>B83</b>	3, 0, 1, 4, 2	<b>B123</b>	4, 2, 3, 1, 0
<b>B44</b>	1, 2, 4, 0, 3	<b>B84</b>	3, 0, 2, 1, 4	<b>B124</b>	4, 3, 0, 1, 2
<b>B45</b>	1, 2, 4, 3, 0	<b>B85</b>	3, 0, 2, 4, 1	<b>B125</b>	4, 3, 0, 2, 1
<b>B46</b>	1, 3, 0, 2, 4	<b>B86</b>	3, 0, 4, 1, 2	<b>B126</b>	4, 3, 1, 0, 2
<b>B47</b>	1, 3, 0, 4, 2	<b>B87</b>	3, 0, 4, 2, 1	<b>B127</b>	4, 3, 1, 2, 0
<b>B48</b>	1, 3, 2, 0, 4	<b>B88</b>	3, 1, 0, 2, 4	<b>B128</b>	4, 3, 2, 0, 1
<b>B49</b>	1, 3, 2, 4, 0	<b>B89</b>	3, 1, 0, 4, 2	<b>B129</b>	4, 3, 2, 1, 0
<b>B50</b>	1, 3, 4, 0, 2	<b>B90</b>	3, 1, 2, 0, 4		

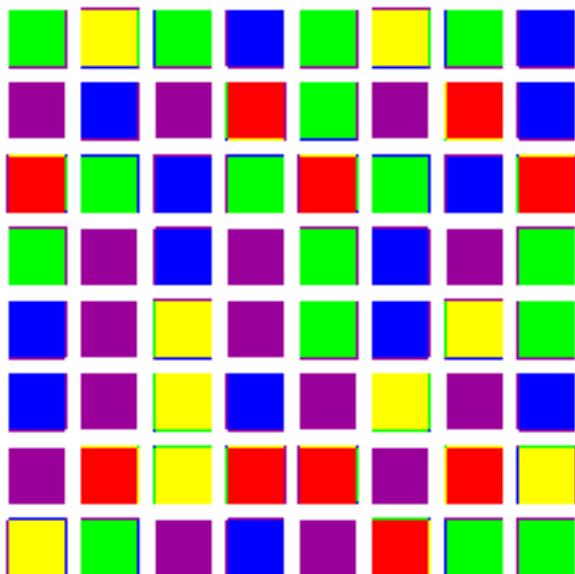
<b>GAME</b>	<b>SOLUTION</b>	<b>GAME</b>	<b>SOLUTION</b>	<b>GAME</b>	<b>SOLUTION</b>
<b>B11</b>	32	<b>B51</b>	35	<b>B91</b>	34
<b>B12</b>	34	<b>B52</b>	33	<b>B92</b>	34
<b>B13</b>	34	<b>B53</b>	33	<b>B93</b>	34
<b>B14</b>	32	<b>B54</b>	33	<b>B94</b>	34
<b>B15</b>	32	<b>B55</b>	33	<b>B95</b>	34
<b>B16</b>	34	<b>B56</b>	33	<b>B96</b>	34
<b>B17</b>	32	<b>B57</b>	33	<b>B97</b>	34
<b>B18</b>	33	<b>B58</b>	34	<b>B98</b>	34
<b>B19</b>	33	<b>B59</b>	32	<b>B99</b>	34
<b>B20</b>	32	<b>B60</b>	33	<b>B100</b>	34
<b>B21</b>	31	<b>B61</b>	33	<b>B101</b>	35
<b>B22</b>	33	<b>B62</b>	32	<b>B102</b>	34
<b>B23</b>	33	<b>B63</b>	32	<b>B103</b>	34
<b>B24</b>	33	<b>B64</b>	34	<b>B104</b>	34
<b>B25</b>	33	<b>B65</b>	33	<b>B105</b>	35
<b>B26</b>	33	<b>B66</b>	35	<b>B106</b>	32
<b>B27</b>	34	<b>B67</b>	35	<b>B107</b>	32
<b>B28</b>	32	<b>B68</b>	33	<b>B108</b>	34
<b>B29</b>	32	<b>B69</b>	33	<b>B109</b>	32
<b>B30</b>	34	<b>B70</b>	34	<b>B110</b>	32
<b>B31</b>	32	<b>B71</b>	34	<b>B111</b>	32
<b>B32</b>	32	<b>B72</b>	34	<b>B112</b>	32
<b>B33</b>	32	<b>B73</b>	34	<b>B113</b>	32
<b>B34</b>	34	<b>B74</b>	34	<b>B114</b>	32
<b>B35</b>	32	<b>B75</b>	34	<b>B115</b>	33
<b>B36</b>	34	<b>B76</b>	32	<b>B116</b>	33
<b>B37</b>	34	<b>B77</b>	32	<b>B117</b>	33
<b>B38</b>	33	<b>B78</b>	32	<b>B118</b>	33
<b>B39</b>	33	<b>B79</b>	33	<b>B119</b>	32
<b>B40</b>	34	<b>B80</b>	32	<b>B120</b>	32
<b>B41</b>	33	<b>B81</b>	32	<b>B121</b>	34
<b>B42</b>	35	<b>B82</b>	34	<b>B122</b>	32
<b>B43</b>	35	<b>B83</b>	34	<b>B123</b>	32
<b>B44</b>	33	<b>B84</b>	35	<b>B124</b>	32
<b>B45</b>	33	<b>B85</b>	34	<b>B125</b>	33
<b>B46</b>	35	<b>B86</b>	34	<b>B126</b>	32
<b>B47</b>	35	<b>B87</b>	35	<b>B127</b>	32
<b>B48</b>	35	<b>B88</b>	34	<b>B128</b>	32
<b>B49</b>	35	<b>B89</b>	34	<b>B129</b>	32
<b>B50</b>	35	<b>B90</b>	34		

# GAMES (LEVEL: researcher)

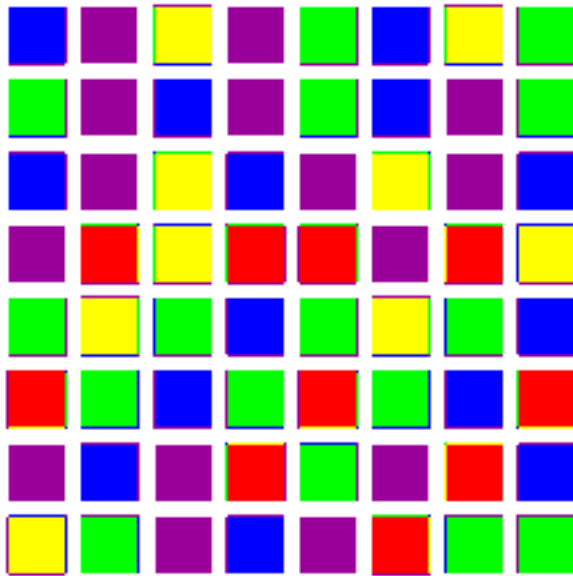
## GAME R1



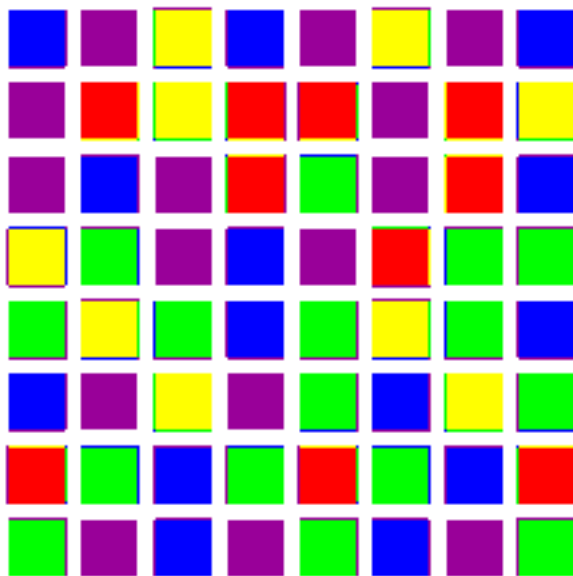
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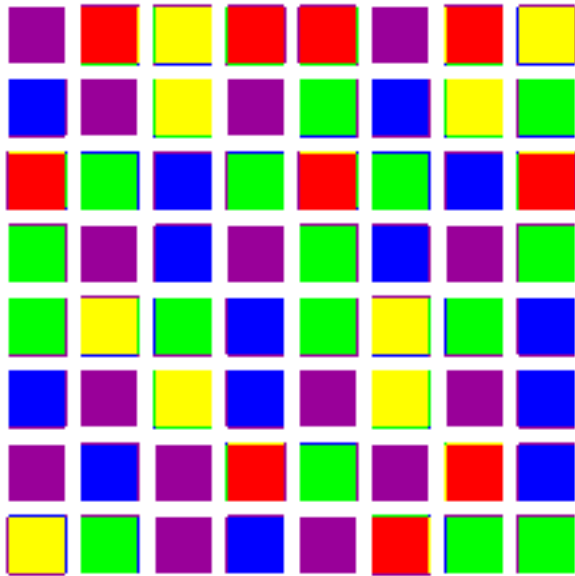
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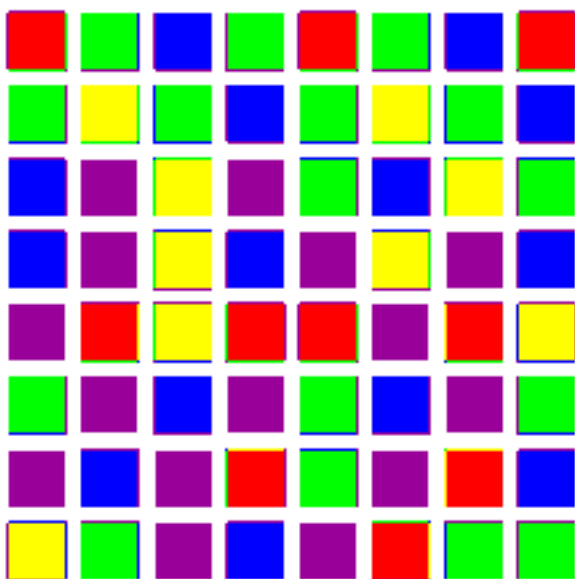
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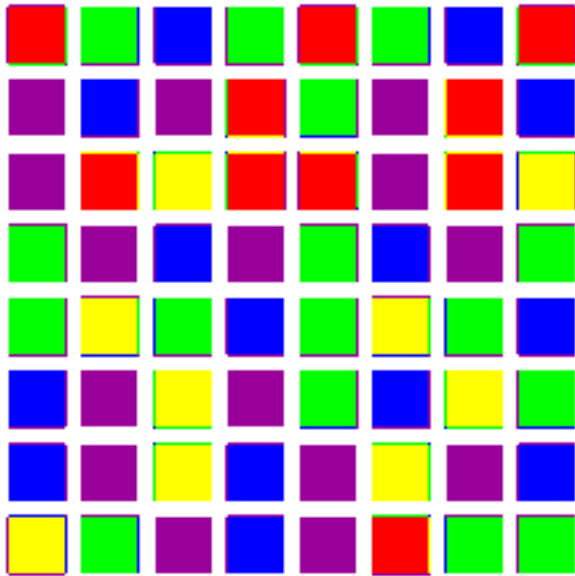
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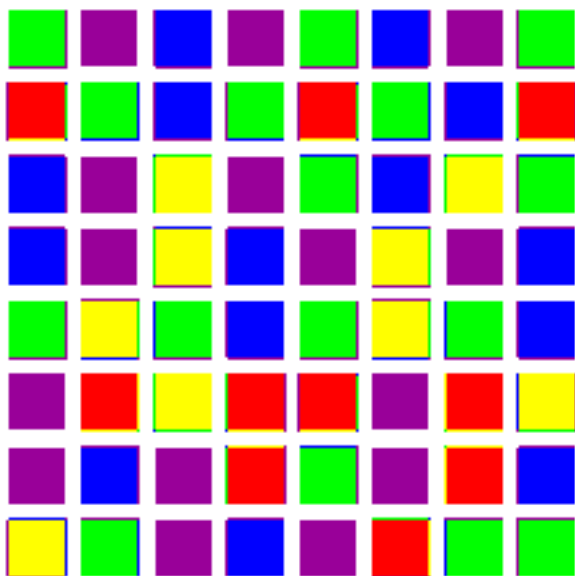
### GAME R6



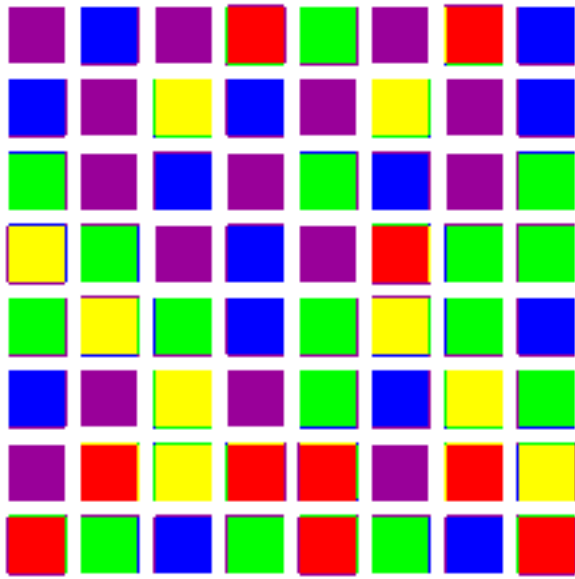
GAME R7



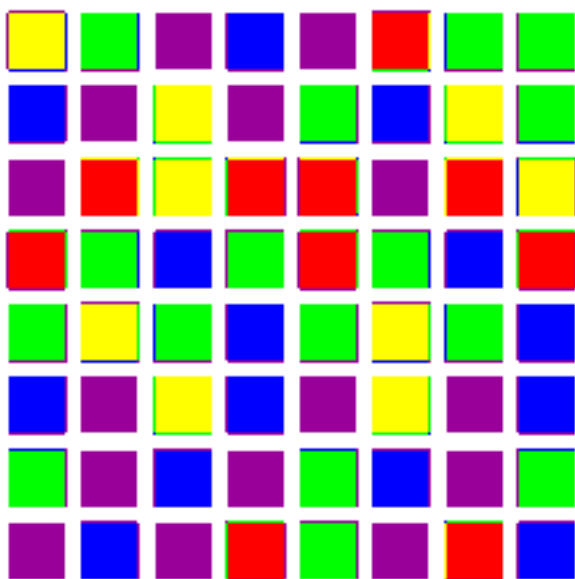
GAME R8



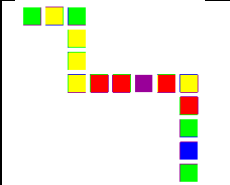

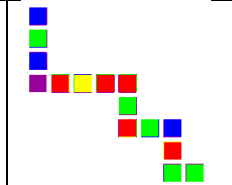
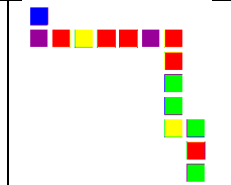
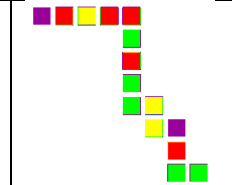
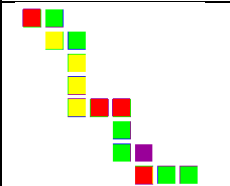
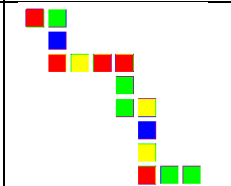
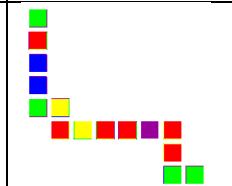
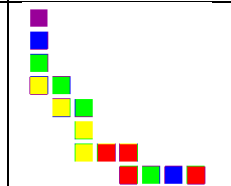
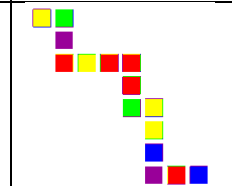
### GAME R9



### GAME R10











## SOLUTIONS (LEVEL: researcher)

<b>GAME R1</b>	<b>GAME R2</b>	<b>GAME R3</b>	<b>GAME R4</b>	<b>GAME R5</b>
				
55	51	51	54	54
<b>GAME R6</b>	<b>GAME R7</b>	<b>GAME R8</b>	<b>GAME R9</b>	<b>GAME R10</b>
				
55	56	55	53	53

# ADDITIONA GAMES AND SOLUTIONS

(LEVEL: researcher)

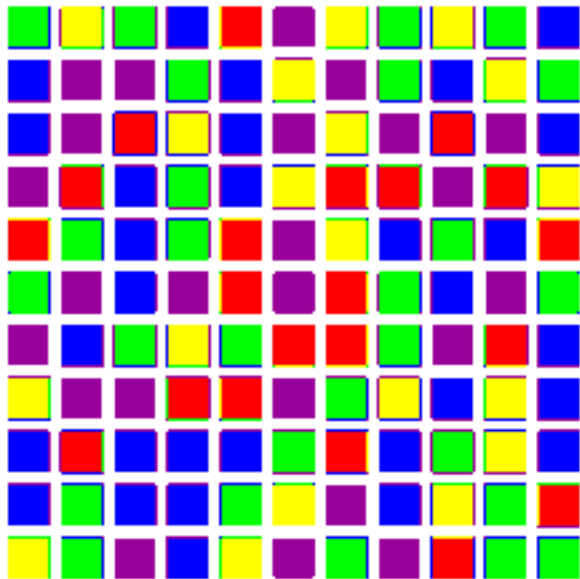
ROW 0	
ROW 1	
ROW 2	
ROW 3	
ROW 4	
ROW 5	
ROW 6	
ROW 7	

GAME	PERMUTATION	GAME	PERMUTATION	GAME	PERMUTATION
R11	0, 1, 2, 3, 4, 5, 7, 6	R45	2, 6, 0, 1, 7, 5, 4, 3	R79	5, 3, 0, 2, 7, 4, 6, 1
R12	0, 1, 5, 3, 7, 4, 2, 6	R46	2, 6, 4, 3, 7, 0, 1, 5	R80	5, 3, 4, 6, 2, 7, 0, 1
R13	0, 2, 1, 6, 5, 4, 7, 3	R47	2, 7, 0, 6, 4, 1, 5, 3	R81	5, 4, 1, 0, 3, 7, 6, 2
R14	0, 2, 6, 1, 4, 7, 3, 5	R48	2, 7, 5, 1, 3, 4, 0, 6	R82	5, 4, 6, 2, 1, 0, 3, 7
R15	0, 3, 2, 5, 1, 7, 6, 4	R49	3, 0, 2, 6, 1, 5, 7, 4	R83	5, 6, 1, 7, 0, 2, 4, 3
R16	0, 3, 6, 7, 1, 2, 4, 5	R50	3, 0, 6, 7, 5, 4, 1, 2	R84	5, 6, 7, 0, 4, 2, 1, 3
R17	0, 4, 3, 1, 7, 2, 6, 5	R51	3, 1, 4, 2, 6, 7, 5, 0	R85	5, 7, 2, 3, 4, 1, 6, 0
R18	0, 4, 7, 3, 5, 2, 1, 6	R52	3, 1, 7, 5, 4, 0, 2, 6	R86	5, 7, 6, 4, 1, 3, 0, 2
R19	0, 5, 3, 7, 2, 4, 6, 1	R53	3, 2, 5, 0, 4, 1, 7, 6	R87	6, 0, 4, 2, 1, 7, 5, 3
R20	0, 6, 1, 3, 2, 7, 4, 5	R54	3, 4, 0, 5, 1, 6, 2, 7	R88	6, 1, 0, 5, 2, 3, 4, 7
R21	0, 6, 4, 3, 7, 5, 2, 1	R55	3, 4, 5, 6, 7, 1, 2, 0	R89	6, 1, 4, 7, 5, 0, 3, 2
R22	0, 7, 1, 6, 5, 2, 3, 4	R56	3, 5, 1, 0, 6, 7, 2, 4	R90	6, 2, 1, 3, 5, 4, 0, 7
R23	0, 7, 5, 2, 4, 1, 6, 3	R57	3, 5, 6, 2, 1, 7, 4, 0	R91	6, 2, 5, 4, 1, 3, 7, 0
R24	1, 0, 3, 6, 4, 5, 2, 7	R58	3, 6, 1, 7, 2, 0, 4, 5	R92	6, 3, 2, 0, 1, 7, 4, 5
R25	1, 0, 7, 2, 3, 5, 6, 4	R59	3, 6, 7, 1, 0, 2, 5, 4	R93	6, 3, 7, 1, 5, 4, 2, 0
R26	1, 2, 4, 3, 7, 6, 0, 5	R60	3, 7, 2, 4, 6, 1, 0, 5	R94	6, 4, 2, 5, 7, 0, 1, 3
R27	1, 2, 7, 5, 4, 6, 3, 0	R61	3, 7, 6, 5, 2, 1, 4, 0	R95	6, 5, 0, 1, 4, 2, 7, 3
R28	1, 3, 5, 0, 6, 2, 4, 7	R62	4, 0, 5, 2, 3, 7, 1, 6	R96	6, 5, 3, 2, 1, 4, 0, 7
R29	1, 4, 0, 5, 3, 2, 7, 6	R63	4, 1, 0, 6, 2, 7, 5, 3	R97	6, 7, 0, 5, 1, 3, 4, 2
R30	1, 4, 5, 7, 0, 3, 2, 6	R64	4, 1, 6, 0, 2, 3, 5, 7	R98	6, 7, 4, 0, 5, 3, 1, 2
R31	1, 5, 2, 0, 7, 4, 6, 3	R65	4, 2, 1, 3, 7, 0, 6, 5	R99	7, 0, 2, 4, 5, 6, 3, 1
R32	1, 5, 6, 3, 4, 7, 0, 2	R66	4, 2, 6, 5, 3, 1, 0, 7	R100	7, 0, 5, 6, 3, 1, 2, 4
R33	1, 6, 2, 7, 3, 5, 4, 0	R67	4, 3, 2, 0, 5, 6, 7, 1	R101	7, 1, 3, 2, 4, 0, 6, 5
R34	1, 6, 7, 2, 3, 0, 4, 5	R68	4, 3, 7, 2, 0, 6, 1, 5	R102	7, 1, 6, 4, 0, 3, 2, 5
R35	1, 7, 3, 5, 0, 2, 6, 4	R69	4, 5, 2, 6, 7, 3, 1, 0	R103	7, 2, 3, 6, 5, 1, 4, 0
R36	1, 7, 6, 5, 4, 2, 0, 3	R70	4, 6, 0, 1, 7, 2, 3, 5	R104	7, 3, 0, 2, 5, 6, 1, 4
R37	2, 0, 5, 3, 6, 4, 7, 1	R71	4, 6, 3, 2, 5, 0, 7, 1	R105	7, 3, 4, 5, 1, 6, 2, 0
R38	2, 1, 0, 6, 4, 7, 3, 5	R72	4, 7, 0, 6, 2, 3, 1, 5	R106	7, 4, 1, 0, 3, 2, 5, 6
R39	2, 1, 6, 0, 3, 7, 5, 4	R73	4, 7, 5, 1, 0, 3, 6, 2	R107	7, 4, 5, 2, 0, 1, 6, 3
R40	2, 3, 1, 5, 0, 4, 6, 7	R74	5, 0, 2, 4, 7, 6, 1, 3	R108	7, 5, 1, 4, 6, 2, 0, 3
R41	2, 3, 6, 5, 7, 0, 4, 1	R75	5, 0, 6, 7, 3, 4, 2, 1	R109	7, 5, 6, 0, 3, 2, 4, 1
R42	2, 4, 3, 0, 6, 5, 1, 7	R76	5, 1, 3, 2, 6, 0, 4, 7	R110	7, 6, 2, 3, 1, 5, 0, 4
R43	2, 4, 7, 3, 1, 5, 6, 0	R77	5, 1, 7, 4, 2, 0, 6, 3	R111	7, 6, 5, 4, 0, 3, 2, 1
R44	2, 5, 3, 7, 0, 6, 1, 4	R78	5, 2, 4, 0, 1, 6, 3, 7		

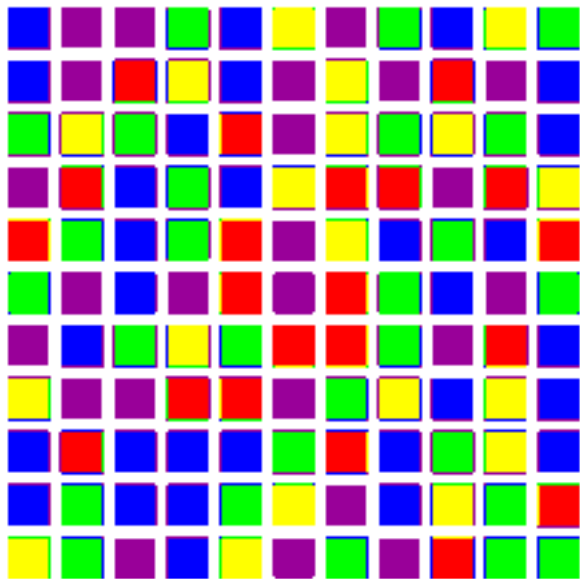
<b>GAME</b>	<b>SOLUTION</b>	<b>GAME</b>	<b>SOLUTION</b>	<b>GAME</b>	<b>SOLUTION</b>
<b>R11</b>	57	<b>R45</b>	52	<b>R79</b>	56
<b>R12</b>	52	<b>R46</b>	53	<b>R80</b>	55
<b>R13</b>	55	<b>R47</b>	52	<b>R81</b>	54
<b>R14</b>	55	<b>R48</b>	53	<b>R82</b>	52
<b>R15</b>	55	<b>R49</b>	55	<b>R83</b>	52
<b>R16</b>	57	<b>R50</b>	54	<b>R84</b>	53
<b>R17</b>	55	<b>R51</b>	52	<b>R85</b>	54
<b>R18</b>	56	<b>R52</b>	51	<b>R86</b>	50
<b>R19</b>	54	<b>R53</b>	52	<b>R87</b>	50
<b>R20</b>	53	<b>R54</b>	53	<b>R88</b>	52
<b>R21</b>	52	<b>R55</b>	52	<b>R89</b>	53
<b>R22</b>	52	<b>R56</b>	54	<b>R90</b>	52
<b>R23</b>	53	<b>R57</b>	51	<b>R91</b>	49
<b>R24</b>	56	<b>R58</b>	54	<b>R92</b>	52
<b>R25</b>	53	<b>R59</b>	53	<b>R93</b>	50
<b>R26</b>	53	<b>R60</b>	52	<b>R94</b>	53
<b>R27</b>	52	<b>R61</b>	51	<b>R95</b>	52
<b>R28</b>	52	<b>R62</b>	55	<b>R96</b>	51
<b>R29</b>	54	<b>R63</b>	51	<b>R97</b>	52
<b>R30</b>	54	<b>R64</b>	52	<b>R98</b>	52
<b>R31</b>	53	<b>R65</b>	55	<b>R99</b>	52
<b>R32</b>	51	<b>R66</b>	53	<b>R100</b>	53
<b>R33</b>	51	<b>R67</b>	55	<b>R101</b>	53
<b>R34</b>	51	<b>R68</b>	59	<b>R102</b>	53
<b>R35</b>	55	<b>R69</b>	52	<b>R103</b>	53
<b>R36</b>	53	<b>R70</b>	53	<b>R104</b>	57
<b>R37</b>	55	<b>R71</b>	55	<b>R105</b>	54
<b>R38</b>	52	<b>R72</b>	54	<b>R106</b>	54
<b>R39</b>	52	<b>R73</b>	55	<b>R107</b>	56
<b>R40</b>	52	<b>R74</b>	56	<b>R108</b>	53
<b>R41</b>	52	<b>R75</b>	55	<b>R109</b>	54
<b>R42</b>	55	<b>R76</b>	52	<b>R110</b>	53
<b>R43</b>	54	<b>R77</b>	55	<b>R111</b>	54
<b>R44</b>	55	<b>R78</b>	54		

# GAMES (LEVEL: experienced researcher)

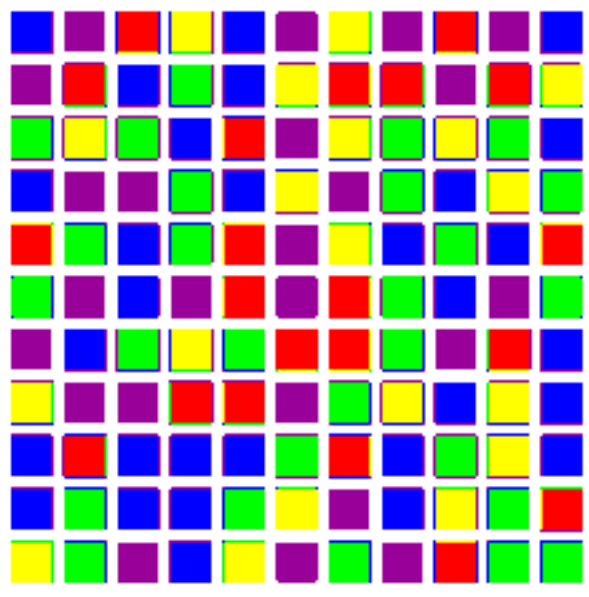
## GAME E1



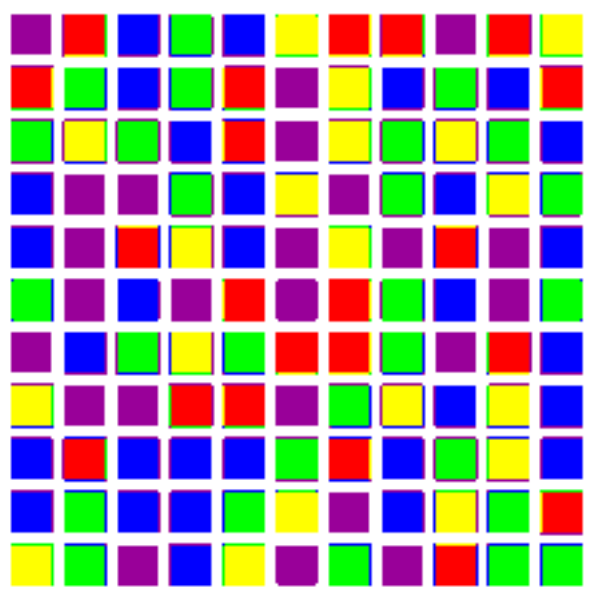
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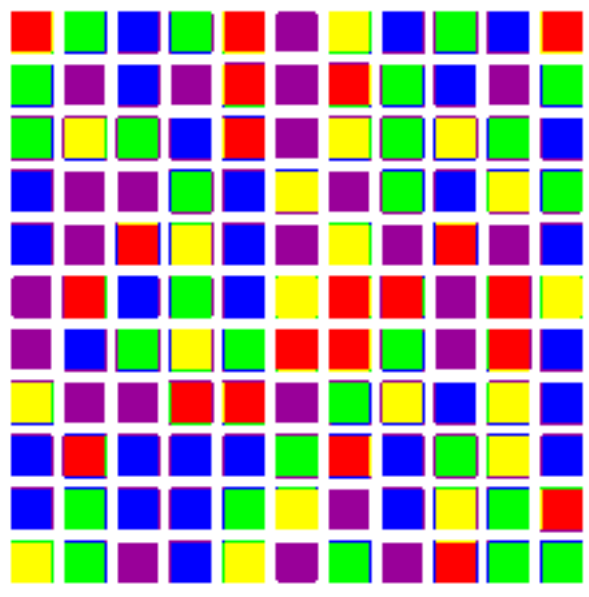
GAME E3



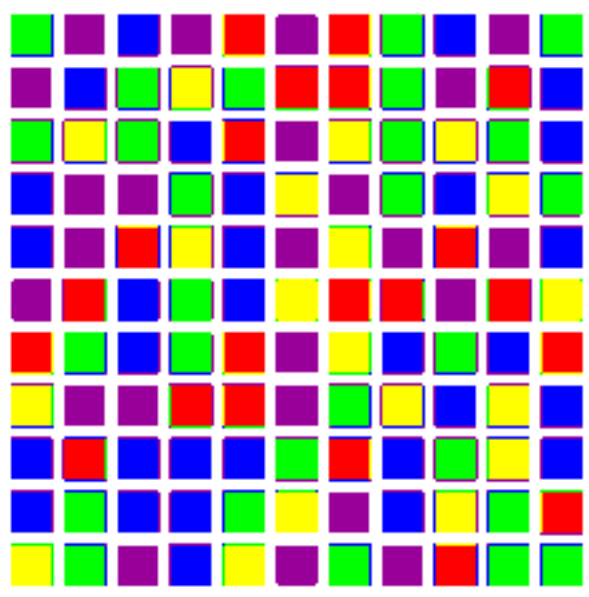
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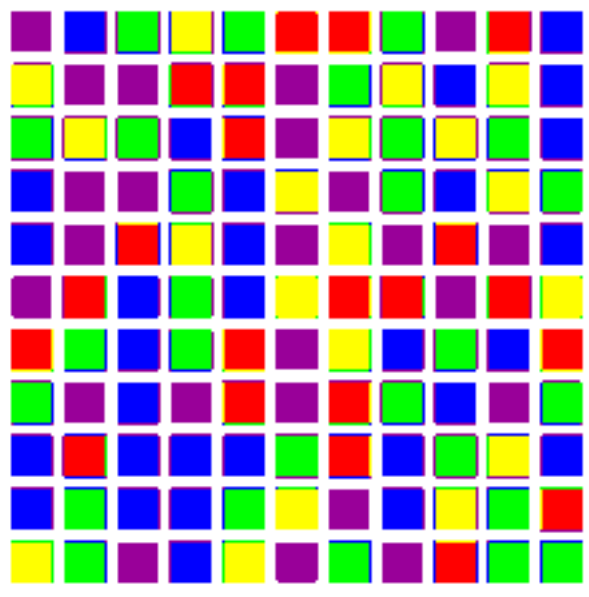
GAME E5



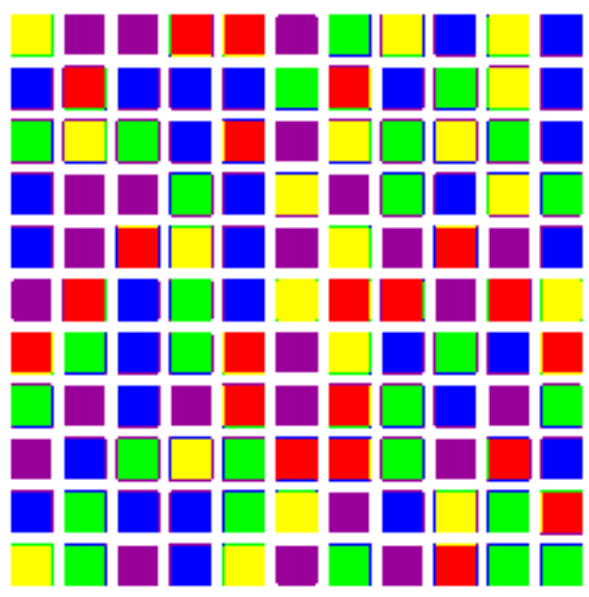
GAME E6



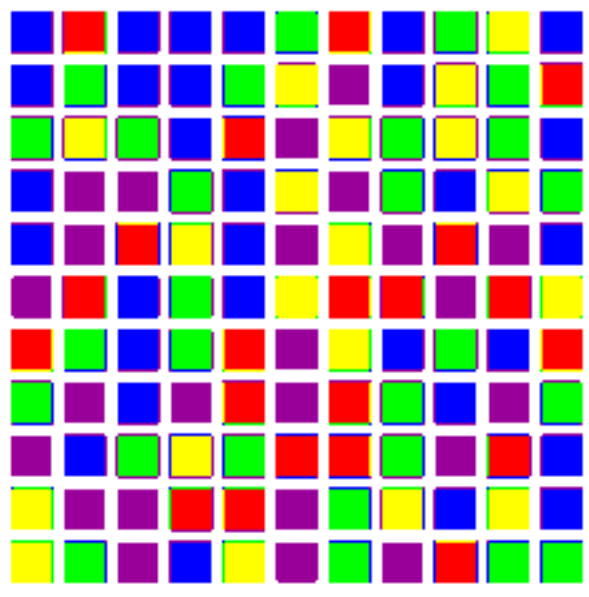
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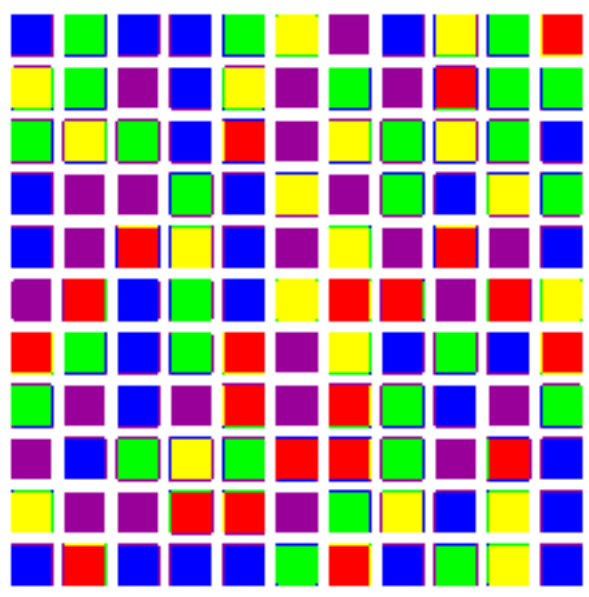
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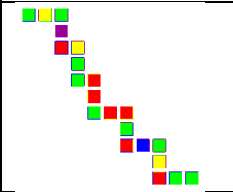
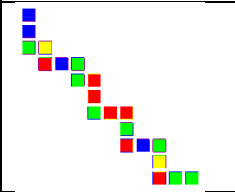
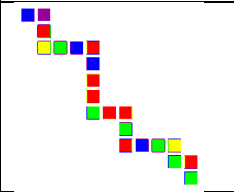
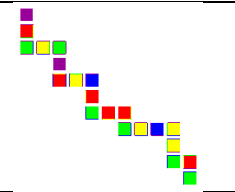
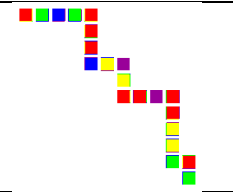
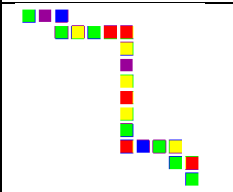

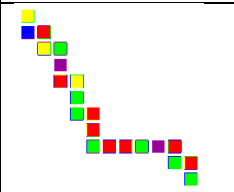
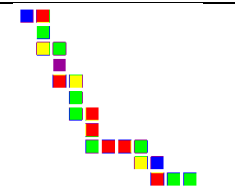
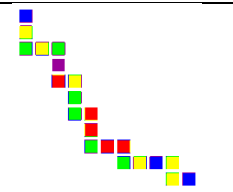
GAME E9



GAME E10



## SOLUTIONS (LEVEL: experienced researcher)

<b>GAME E1</b>	<b>GAME E2</b>	<b>GAME E3</b>	<b>GAME E4</b>	<b>GAME E5</b>
				
77	75	75	74	79
<b>GAME E6</b>	<b>GAME E7</b>	<b>GAME E8</b>	<b>GAME E9</b>	<b>GAME E10</b>
				
72	75	77	76	74

# ADDITIONAL GAMES AND SOLUTIONS

(LEVEL: experienced researcher)

ROW 0	
ROW 1	
ROW 2	
ROW 3	
ROW 4	
ROW 5	
ROW 6	
ROW 7	
ROW 8	
ROW 9	
ROW 10	

<b>GAME</b>	<b>PERMUTATION</b>	<b>GAME</b>	<b>PERMUTATION</b>	<b>GAME</b>	<b>PERMUTATION</b>
<b>E11</b>	0, 1, 2, 3, 4, 5, 6, 7, 8, 10, 9	<b>E45</b>	3, 8, 4, 6, 9, 5, 7, 0, 1, 10, 2	<b>E79</b>	7, 4, 9, 1, 6, 2, 3, 0, 5, 10, 8
<b>E12</b>	0, 2, 1, 10, 4, 6, 7, 3, 5, 9, 8	<b>E46</b>	3, 9, 5, 6, 0, 1, 2, 4, 7, 10, 8	<b>E80</b>	7, 5, 10, 0, 8, 4, 6, 1, 2, 9, 3
<b>E13</b>	0, 3, 2, 9, 5, 8, 10, 1, 4, 7, 6	<b>E47</b>	3, 10, 6, 4, 1, 5, 7, 0, 2, 9, 8	<b>E81</b>	7, 8, 0, 1, 2, 3, 4, 5, 6, 10, 9
<b>E14</b>	0, 4, 3, 8, 7, 2, 5, 1, 6, 10, 9	<b>E48</b>	4, 0, 8, 3, 5, 9, 10, 1, 2, 7, 6	<b>E82</b>	7, 9, 0, 10, 2, 4, 5, 1, 3, 8, 6
<b>E15</b>	0, 5, 4, 7, 9, 6, 8, 1, 2, 10, 3	<b>E49</b>	4, 1, 9, 2, 7, 3, 5, 0, 6, 10, 8	<b>E83</b>	7, 10, 1, 8, 3, 6, 9, 0, 2, 5, 4
<b>E16</b>	0, 6, 5, 7, 1, 2, 3, 4, 8, 10, 9	<b>E50</b>	4, 2, 10, 0, 8, 6, 7, 1, 3, 9, 5	<b>E84</b>	8, 0, 3, 7, 6, 2, 4, 1, 5, 10, 9
<b>E17</b>	0, 7, 6, 4, 2, 5, 8, 1, 3, 10, 9	<b>E51</b>	4, 5, 0, 1, 2, 3, 6, 7, 8, 10, 9	<b>E85</b>	8, 1, 4, 6, 9, 5, 7, 0, 2, 10, 3
<b>E18</b>	0, 8, 7, 3, 4, 9, 10, 1, 2, 6, 5	<b>E52</b>	4, 6, 0, 10, 2, 5, 7, 1, 3, 9, 8	<b>E86</b>	8, 2, 5, 6, 0, 1, 3, 4, 7, 10, 9
<b>E19</b>	0, 9, 8, 2, 6, 3, 4, 1, 5, 10, 7	<b>E53</b>	4, 7, 1, 9, 3, 8, 10, 0, 2, 6, 5	<b>E87</b>	8, 3, 6, 4, 1, 5, 7, 0, 2, 10, 9
<b>E20</b>	0, 10, 9, 1, 7, 5, 6, 2, 3, 8, 4	<b>E54</b>	4, 8, 2, 7, 6, 1, 3, 0, 5, 10, 9	<b>E88</b>	8, 4, 7, 2, 3, 9, 10, 0, 1, 6, 5
<b>E21</b>	1, 2, 0, 3, 4, 5, 6, 7, 8, 10, 9	<b>E55</b>	4, 9, 3, 6, 8, 5, 7, 0, 1, 10, 2	<b>E89</b>	8, 5, 9, 1, 6, 2, 3, 0, 4, 10, 7
<b>E22</b>	1, 3, 0, 10, 4, 6, 7, 2, 5, 9, 8	<b>E56</b>	4, 10, 5, 6, 0, 1, 2, 3, 7, 9, 8	<b>E90</b>	8, 6, 10, 0, 7, 4, 5, 1, 2, 9, 3
<b>E23</b>	1, 4, 2, 9, 5, 8, 10, 0, 3, 7, 6	<b>E57</b>	5, 0, 7, 4, 2, 6, 8, 1, 3, 10, 9	<b>E91</b>	8, 9, 0, 1, 2, 3, 4, 5, 6, 10, 7
<b>E24</b>	1, 5, 3, 8, 7, 2, 4, 0, 6, 10, 9	<b>E58</b>	5, 1, 8, 3, 4, 9, 10, 0, 2, 7, 6	<b>E92</b>	8, 10, 0, 9, 2, 4, 5, 1, 3, 7, 6
<b>E25</b>	1, 6, 4, 7, 9, 5, 8, 0, 2, 10, 3	<b>E59</b>	5, 2, 9, 1, 7, 3, 4, 0, 6, 10, 8	<b>E93</b>	9, 0, 2, 8, 4, 7, 10, 1, 3, 6, 5
<b>E26</b>	1, 7, 5, 6, 0, 2, 3, 4, 8, 10, 9	<b>E60</b>	5, 3, 10, 0, 8, 6, 7, 1, 2, 9, 4	<b>E94</b>	9, 1, 3, 7, 6, 2, 4, 0, 5, 10, 8
<b>E27</b>	1, 8, 6, 4, 2, 5, 7, 0, 3, 10, 9	<b>E61</b>	5, 6, 0, 1, 2, 3, 4, 7, 8, 10, 9	<b>E95</b>	9, 2, 4, 6, 8, 5, 7, 0, 1, 10, 3
<b>E28</b>	1, 9, 7, 3, 4, 8, 10, 0, 2, 6, 5	<b>E62</b>	5, 7, 0, 10, 2, 4, 6, 1, 3, 9, 8	<b>E96</b>	9, 3, 5, 6, 0, 1, 2, 4, 7, 10, 8
<b>E29</b>	1, 10, 8, 2, 6, 3, 4, 0, 5, 9, 7	<b>E63</b>	5, 8, 1, 9, 3, 7, 10, 0, 2, 6, 4	<b>E97</b>	9, 4, 6, 3, 1, 5, 7, 0, 2, 10, 8
<b>E30</b>	2, 0, 10, 1, 8, 6, 7, 3, 4, 9, 5	<b>E64</b>	5, 9, 2, 7, 6, 1, 3, 0, 4, 10, 8	<b>E98</b>	9, 5, 7, 2, 3, 8, 10, 0, 1, 6, 4
<b>E31</b>	2, 3, 0, 1, 4, 5, 6, 7, 8, 10, 9	<b>E65</b>	5, 10, 3, 6, 8, 4, 7, 0, 1, 9, 2	<b>E99</b>	9, 6, 8, 1, 5, 2, 3, 0, 4, 10, 7
<b>E32</b>	2, 4, 0, 10, 3, 6, 7, 1, 5, 9, 8	<b>E66</b>	6, 0, 5, 7, 1, 2, 3, 4, 8, 10, 9	<b>E100</b>	9, 7, 10, 0, 6, 4, 5, 1, 2, 8, 3
<b>E33</b>	2, 5, 1, 9, 4, 8, 10, 0, 3, 7, 6	<b>E67</b>	6, 1, 7, 4, 2, 5, 8, 0, 3, 10, 9	<b>E101</b>	9, 10, 0, 1, 2, 3, 4, 5, 6, 8, 7
<b>E34</b>	2, 6, 3, 8, 7, 1, 4, 0, 5, 10, 9	<b>E68</b>	6, 2, 8, 3, 4, 9, 10, 0, 1, 7, 5	<b>E102</b>	10, 0, 1, 9, 3, 5, 6, 2, 4, 8, 7
<b>E35</b>	2, 7, 4, 6, 9, 5, 8, 0, 1, 10, 3	<b>E69</b>	6, 3, 9, 1, 7, 2, 4, 0, 5, 10, 8	<b>E103</b>	10, 1, 2, 8, 4, 7, 9, 0, 3, 6, 5
<b>E36</b>	2, 8, 5, 6, 0, 1, 3, 4, 7, 10, 9	<b>E70</b>	6, 4, 10, 0, 8, 5, 7, 1, 2, 9, 3	<b>E104</b>	10, 2, 3, 7, 6, 1, 4, 0, 5, 9, 8
<b>E37</b>	2, 9, 6, 4, 1, 5, 7, 0, 3, 10, 8	<b>E71</b>	6, 7, 0, 1, 2, 3, 4, 5, 8, 10, 9	<b>E105</b>	10, 3, 4, 6, 8, 5, 7, 0, 1, 9, 2
<b>E38</b>	2, 10, 7, 3, 4, 8, 9, 0, 1, 6, 5	<b>E72</b>	6, 8, 0, 10, 2, 4, 5, 1, 3, 9, 7	<b>E106</b>	10, 4, 5, 6, 0, 1, 2, 3, 7, 9, 8
<b>E39</b>	3, 0, 9, 2, 7, 4, 5, 1, 6, 10, 8	<b>E73</b>	6, 9, 1, 8, 3, 7, 10, 0, 2, 5, 4	<b>E107</b>	10, 5, 6, 3, 1, 4, 7, 0, 2, 9, 8
<b>E40</b>	3, 1, 10, 0, 8, 6, 7, 2, 4, 9, 5	<b>E74</b>	6, 10, 2, 7, 5, 1, 3, 0, 4, 9, 8	<b>E108</b>	10, 6, 7, 2, 3, 8, 9, 0, 1, 5, 4
<b>E41</b>	3, 4, 0, 1, 2, 5, 6, 7, 8, 10, 9	<b>E75</b>	7, 0, 4, 6, 9, 5, 8, 1, 2, 10, 3	<b>E109</b>	10, 7, 8, 1, 5, 2, 3, 0, 4, 9, 6
<b>E42</b>	3, 5, 0, 10, 2, 6, 7, 1, 4, 9, 8	<b>E76</b>	7, 1, 5, 6, 0, 2, 3, 4, 8, 10, 9	<b>E110</b>	10, 8, 9, 0, 6, 4, 5, 1, 2, 7, 3
<b>E43</b>	3, 6, 1, 9, 4, 8, 10, 0, 2, 7, 5	<b>E77</b>	7, 2, 6, 4, 1, 5, 8, 0, 3, 10, 9		
<b>E44</b>	3, 7, 2, 8, 6, 1, 4, 0, 5, 10, 9	<b>E78</b>	7, 3, 8, 2, 4, 9, 10, 0, 1, 6, 5		

<b>GAME</b>	<b>SOLUTION</b>	<b>GAME</b>	<b>SOLUTION</b>	<b>GAME</b>	<b>SOLUTION</b>
<b>E11</b>	79	<b>E45</b>	72	<b>E79</b>	80
<b>E12</b>	79	<b>E46</b>	71	<b>E80</b>	79
<b>E13</b>	75	<b>E47</b>	74	<b>E81</b>	78
<b>E14</b>	79	<b>E48</b>	77	<b>E82</b>	77
<b>E15</b>	83	<b>E49</b>	77	<b>E83</b>	75
<b>E16</b>	79	<b>E50</b>	80	<b>E84</b>	80
<b>E17</b>	83	<b>E51</b>	79	<b>E85</b>	77
<b>E18</b>	75	<b>E52</b>	80	<b>E86</b>	80
<b>E19</b>	79	<b>E53</b>	77	<b>E87</b>	80
<b>E20</b>	80	<b>E54</b>	86	<b>E88</b>	75
<b>E21</b>	77	<b>E55</b>	78	<b>E89</b>	77
<b>E22</b>	75	<b>E56</b>	79	<b>E90</b>	78
<b>E23</b>	76	<b>E57</b>	81	<b>E91</b>	74
<b>E24</b>	76	<b>E58</b>	76	<b>E92</b>	78
<b>E25</b>	78	<b>E59</b>	74	<b>E93</b>	76
<b>E26</b>	80	<b>E60</b>	77	<b>E94</b>	75
<b>E27</b>	79	<b>E61</b>	74	<b>E95</b>	80
<b>E28</b>	72	<b>E62</b>	78	<b>E96</b>	73
<b>E29</b>	79	<b>E63</b>	74	<b>E97</b>	79
<b>E30</b>	78	<b>E64</b>	79	<b>E98</b>	73
<b>E31</b>	77	<b>E65</b>	77	<b>E99</b>	76
<b>E32</b>	77	<b>E66</b>	76	<b>E100</b>	80
<b>E33</b>	73	<b>E67</b>	79	<b>E101</b>	75
<b>E34</b>	78	<b>E68</b>	76	<b>E102</b>	78
<b>E35</b>	81	<b>E69</b>	72	<b>E103</b>	73
<b>E36</b>	76	<b>E70</b>	77	<b>E104</b>	76
<b>E37</b>	74	<b>E71</b>	77	<b>E105</b>	79
<b>E38</b>	74	<b>E72</b>	76	<b>E106</b>	79
<b>E39</b>	79	<b>E73</b>	76	<b>E107</b>	77
<b>E40</b>	74	<b>E74</b>	77	<b>E108</b>	77
<b>E41</b>	76	<b>E75</b>	79	<b>E109</b>	74
<b>E42</b>	77	<b>E76</b>	80	<b>E110</b>	79
<b>E43</b>	71	<b>E77</b>	80		
<b>E44</b>	75	<b>E78</b>	76		

## [ai] explore in the maze

### Motivation

Labyrinths were first mentioned in Greek mythology and continue to fascinate and entertain us to this day. A labyrinth is a complex structure consisting of multiple interwoven passages (corridors, edges) that connect multiple given points in space. A labyrinth can have multiple entrances and exits, and the path from the entrance to the exit is not always unique.

Over time, many problems associated with labyrinths have emerged, as have many algorithms based on scientific research to solve these problems. Here are some problems: determining the shortest path from the entrance to the exit in a labyrinth, discovering how to get around all points in a labyrinth with the fewest steps, devising a way for multiple people to share the work of searching a labyrinth, ...

Many methods for solving the above problems are based on mathematical models and we solve them using results from various areas of mathematics.

Before exploring our labyrinth, read the Labyrinth Story and help Mislav!

### The story of the labyrinth



#### Labyrinth

In the heart of the forgotten kingdom of Slavor, a deadly plague ravaged the villages, leaving the land silent and sick. The only hope lay in a cure whispered about in ancient scrolls - an elixir made from rare herbs that grew only in the Thorny Labyrinth, a labyrinth so twisted and enchanted that no one who entered it ever returned. Meet Mislav, a young herbalist with a brave heart and a mind sharpened by years of study. Armed with his bag of tools, a map half-burnt by time, and long coils of enchanted rope given to him by a wise old man, Mislav set out to collect herbs to save his neighbours and friends.



#### Start of the journey

As Mislav entered the labyrinth, the walls of thorny vines closed in behind him. He tied one end of the rope to a stone marker at the entrance and let it unwind behind him as he walked. The rope shimmered faintly, pulsing with magic—it would guide him back, but only if he didn't let it snap. Inside, the labyrinth was alive. Paths changed. Whispers echoed. Illusions danced in the corners of his vision. But Mislav pressed on, using his

knowledge to identify the gleaming Moonleaf, the elusive Whisper Root, and the fiery Flame Flower, each hidden in pockets of danger.

## Trials in the labyrinth

At one turn, Mislav faced an abyss guarded by poisonous vines. He used a rope to swing across it, barely escaping their grip. In another room, he came across a mirror that showed him a false exit. He almost cut the rope to follow it—but he remembered the wise old man's warning: "The rope is your truth. Never cut it." As he dared to go deeper, the rope tightened. He reached the limit. With his bag full and his heart pounding, Mislav turned back, following the rope through the shifting maze. The vines tried to confuse him, but the rope held firm, glowing brighter with each step toward freedom.


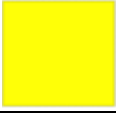
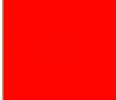
## Drug

Mislav emerged from the labyrinth at dawn, exhausted but triumphant. The herbs were crushed, boiled, and mixed into a shimmering potion. Within days, the plague began to fade, and Slavora flourished again. Mislav became a legend - not only for his courage, but also for his wisdom. And the rope, now frayed and faded, hung in the village square as a symbol of hope, reminding everyone that sometimes even the simplest thread can lead you out of the darkest places.

## Game rules

GOAL and RULES OF THE GAME:

You need to go through the maze from start to finish, using the shortest route, in order to collect as many points as possible. Each field has a colour code with a numerical value for points (red 3 points, yellow 2 points, green 1 point).

COLOURS	POINTS
	1 POINT
	2 POINTS
	3 POINTS

## SINGLE PLAYER GAME

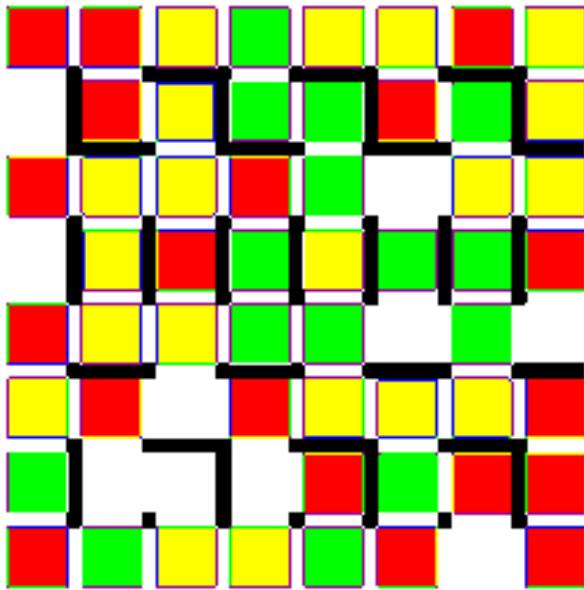
The game is played by one player who moves a piece that leaves a rope in its path, thus leaving a trace of where it has been. The goal is to get through the maze in the shortest possible way from the entrance to the exit, thus collecting as many points as possible.

## TWO PLAYER GAME

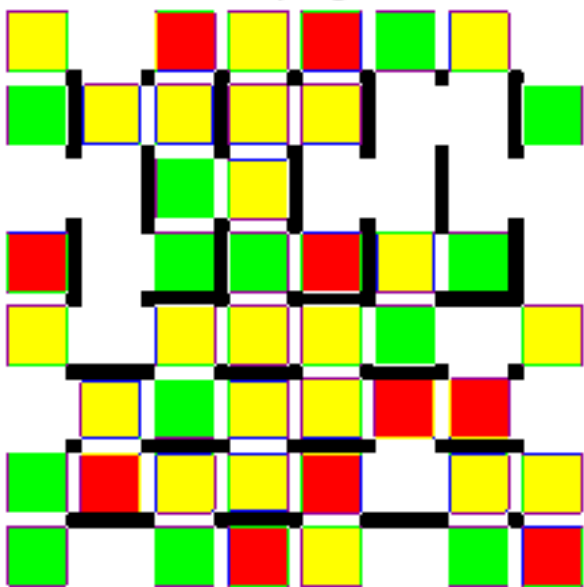
The game can be played by two players. In this case, the players start from diagonally opposite entrances and each of them has the task of finding the shortest path from the entrance to the exit. However, the players collect points together and the goal is to collect as many points as possible (points are only added once for a field that both players have passed through).

# GAMES

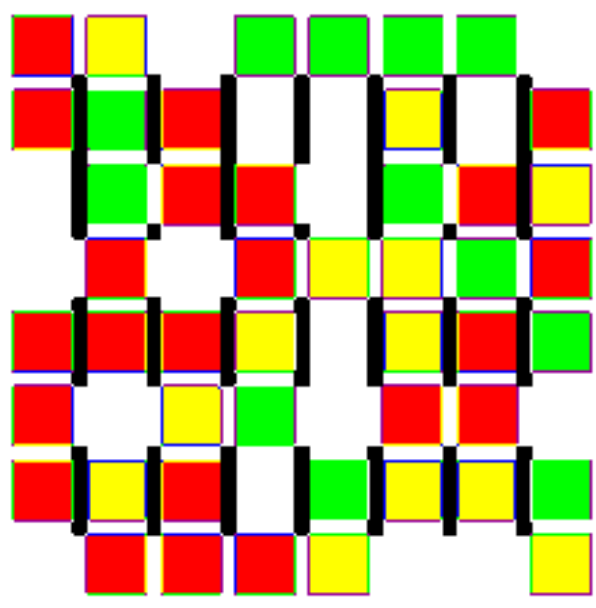
## GAME L1



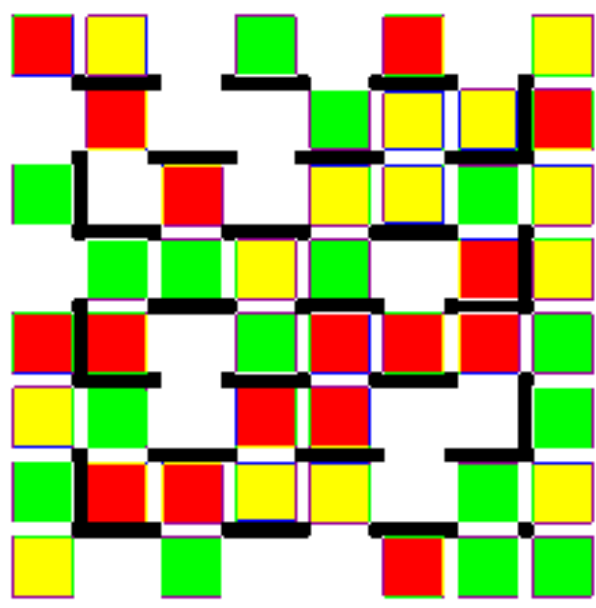
## GAME L2



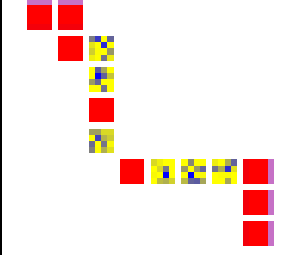
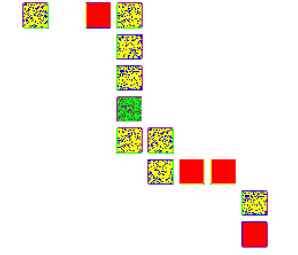
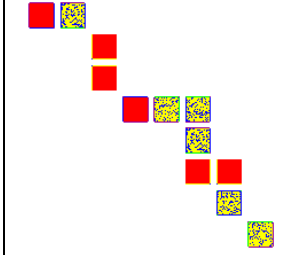
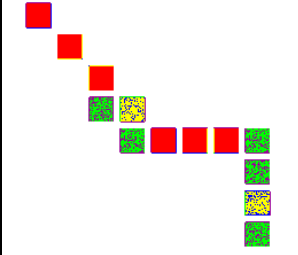
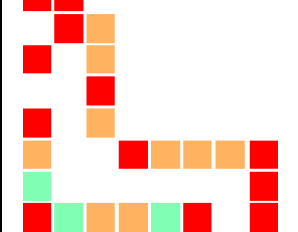
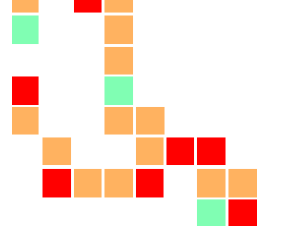
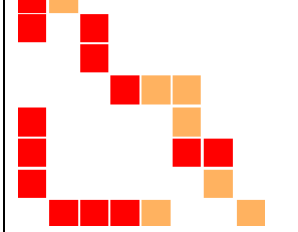
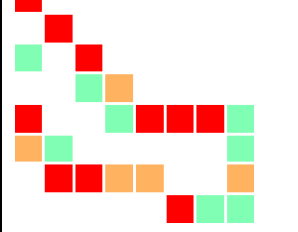
**GAME L3**



**GAME L4**



# SOLUTIONS

<b>GAME L1</b> (one player)	<b>GAME L2</b> (one player)	<b>GAME L3</b> (one player)	<b>GAME L4</b> (one player)
			
32	29	30	29
<b>GAME L1</b> (two players)	<b>GAME L2</b> (two players)	<b>GAME L3</b> (two players)	<b>GAME L4</b> (two players)
			
57	50	53	48