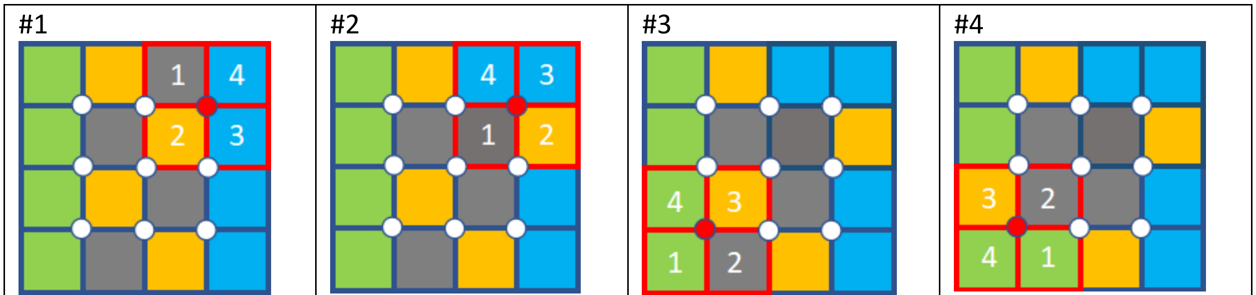
Task 1 Individual Project: **2x2Madness**

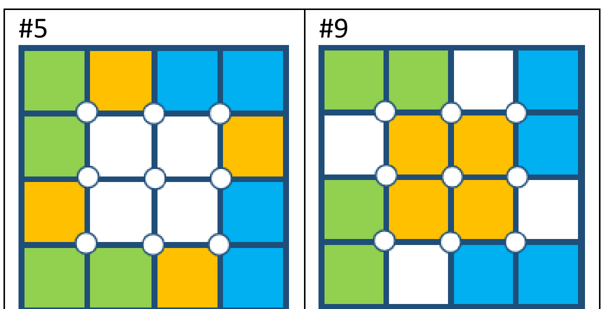
In the solitaire **2x2Madness** puzzle, an N x N square grid contains squares that may have a color. In the board below, four colors appear repeated four times: **orange**, **gray**, **blue** and **green**. Within the board there are $(N-1)^2$ small circles, each at the center of a 2x2 **group** of squares. Exactly one of these groups can be selected at any time. When a group is selected, the four squares in the group are drawn with red borders and the inner circle is filled with red.



Select top right group | **Rotate Counterclockwise** | **Select bottom left group** | **Rotate Counterclockwise**

The player can rotate the colors in a selected group, either **clockwise** or **counterclockwise**. In the example above, you can see how the player selects the top right group and then rotates its colors counterclockwise within the 2x2 group of squares. The affected squares are labeled '1' to '4' for clarity. Next, the player selects the bottom left group and similarly rotates its colors counterclockwise to result in the last board state **#4** on the right. Again, the squares are labeled so you an more easily see the updated squares.

The goal of **2x2Madness** is to remove all colors from the board. The only way to remove colors from the board is to select a 2x2 group whose colors are all the same, which removes those colors from the board.



Select middle group removes colors | **Next opportunity to remove colors**

Given board state #4 above, the colors in the middle 2x2 group are all the same **gray** color. When the player requests to select this middle 2x2 group, all colors are removed from the four squares and the middle group is automatically deselected.

Whenever the four squares in a 2x2 group contain no colors, the group cannot be selected. Attempts by the player to select the middle 2x2 group in board state **#5** should be ignored, because none of its four squares has a color.

From board state #5, the player can rotate four different 2x2 groups to produce board state **#9**. When the player selects the middle group, these four colors will be removed, leaving two additional colors that need to removed. Can you that with six further rotations, you can move the blue and green colors into 2x2 squares that you can then remove. Once all colors are removed, the puzzle is solved.

A valid initial board consists of an NxN grid of squares, where N is either 4, 5 or 6. You can assume that in each initial state, there are four colored squares for each color found on the board. This means for a 4x4 board there will be four colors used, on a 5x5 board there will be six distinct colors used and one empty square, and on a 6x6 board there will be nine colors used (and no empty colors).

Move Counts

2x2Madness records the total number of moves that a player makes while solving a puzzle. When a player rotates the colors in a 2x2 group, the number of moves increases by one. When a player selects a 2x2 group containing the same color, which removes these four colors from the board, the number of moves increases by one. Once the puzzle is solved, no more moves are allowed, since all colors have been removed. When a player resets a puzzle to its initial state, the number of moves is reset to zero.

Use Cases

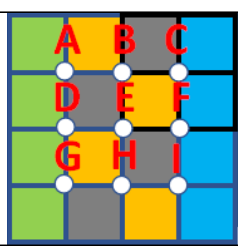
1. Choose Configuration
2. Select Group
3. Rotate Group
4. Remove Group
5. Reset Configuration
6. Solve Configuration

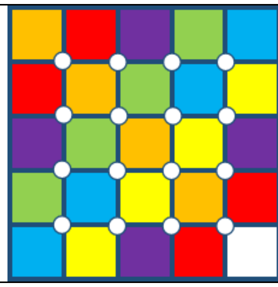
StoryBoards

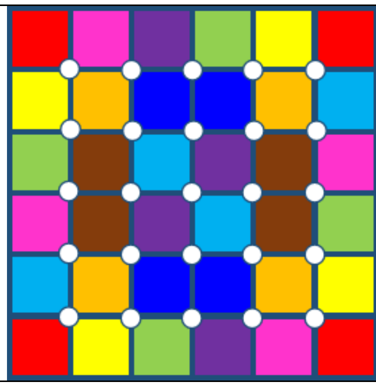
Mock-up some sample GUIs images to visualize the experience from the point of view of the player, showing a sample board state, the number of moves so far, and controls that the player will interact with when making moves. When a player has completed a valid initial configuration, a congratulatory message must appear in some form and the puzzle will become inactive until the player chooses a configuration to play.

Initial Configurations

No configuration can be larger than 6 x 6. There will always be exactly four colored squares for each color, which means that the 5x5 board will have one empty square. These are the three configurations that you must allow the player to choose from and you can assume that for each configuration there is a sequence of moves that will allow the player to solve the puzzle.

Config #1		
4 x 4	**Sample Solution in sixteen moves** C-ccw, G-ccw, E-clear, A-cw, C-cw, I-cw, A-cw, E-clear A-cw, A-cw, G-cw, D-clear, C-cw, I-cw, I-cw, F-clear	

Config #2	
5x5	How many moves?

Config #3	
6 x 6	How many moves?

Challenge Questions (NOT GRADED. JUST CURIOUS)

1. Construct a 4x4 board that requires the most number of moves to eliminate all colors. What is this number of moves? Do the same for the 5x5 and 6x6 grid.
2. If we generalized this problem to any **even** $N \geq 4$, can you identify a formula $F(N)$ that computes the minimum number of moves? For these initial boards, N^2 is always a multiple of 4. Set the base case for N=4 to be $F(4) = 1$, since there would be one 2x2 square with all colors being the same, which requires just one move to remove all.

Change Log

1. 6/6/2023 – Initial definition
2. 8/23/2023—Final Preparation
3.