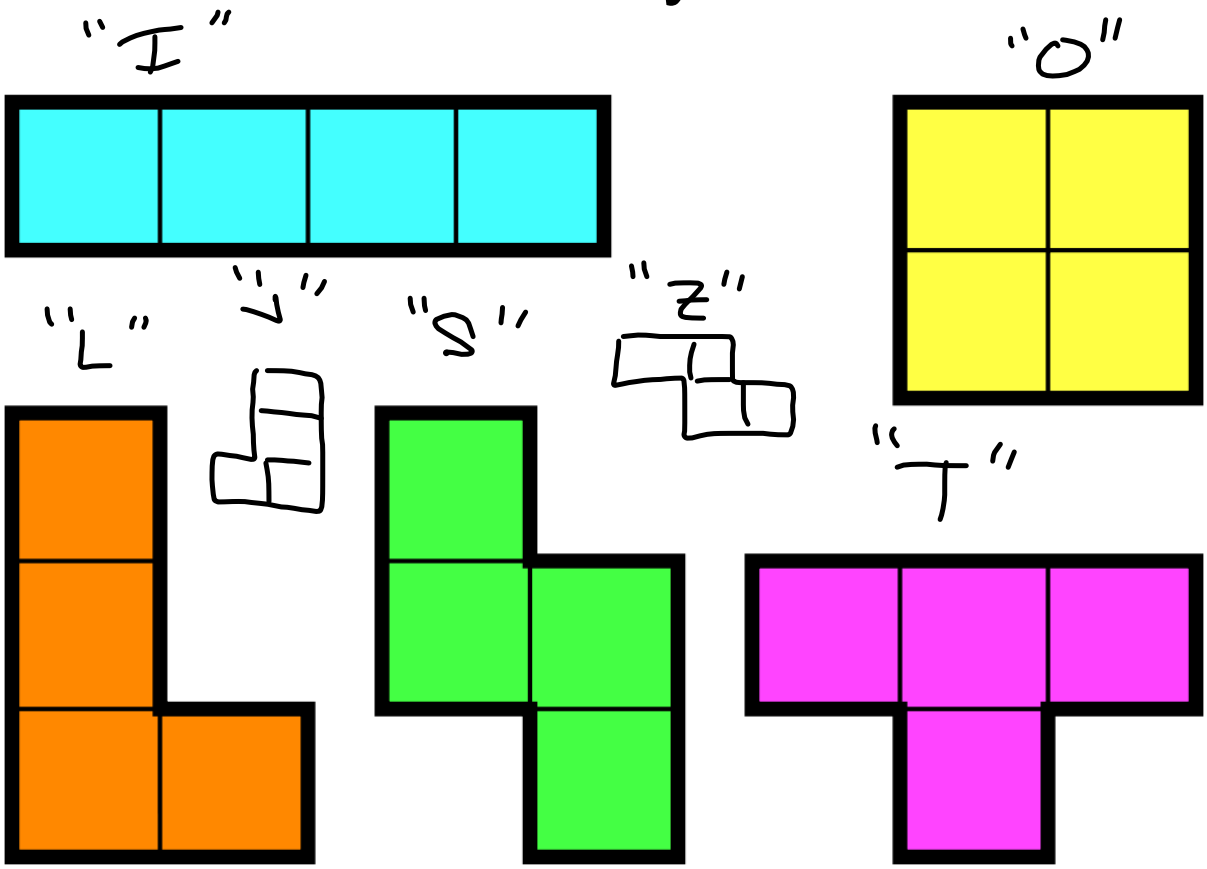
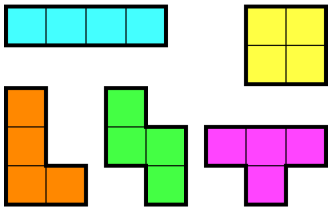
The Geometry of Tetris



Polyomino - is a plane geometric figure formed by joining one or more equal squares edge to edge.

Tetromino - A geometric shape composed of four squares, connected orthogonally. (A specific polyomino with four squares.)



Number of cells	Name
1	monomino
2	domino
3	tromino
4	tetromino
5	pentomino
6	hexomino
7	heptomino
8	octomino
9	nonomino
10	decomino
11	undecomino
12	dodecomino

Quick Review

Translations

Vector

<a,b> (x,y) --> (x+a, y+b)

Reflections

y-axis (x,y) --> (−x , y)

x-axis (x,y) --> (x , −y)

y = x (x,y) --> (y , x)

Rotations

90 CCW (0,0) (x,y) --> (−y , x)

180 CCW (0,0) (x,y) --> (−x , −y)

270 CCW (0,0) (x,y) --> (y , −x)

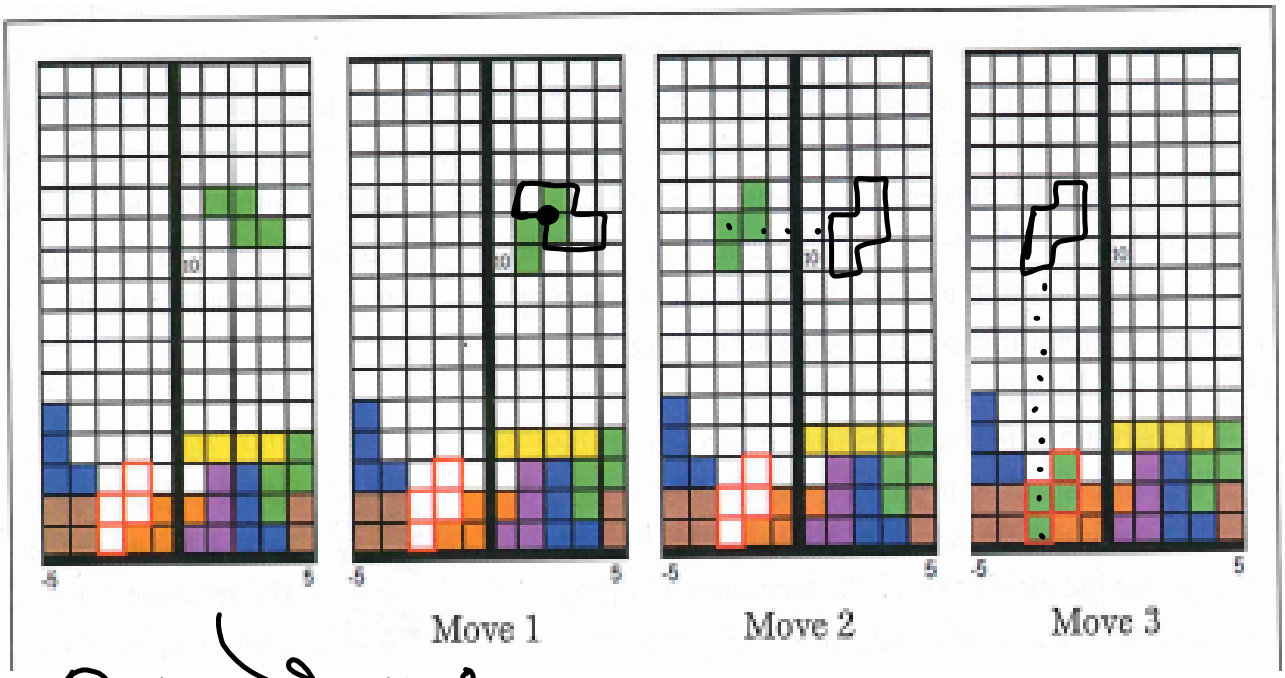
Compositions

A composition of rigid motions is a rigid motion.

What was our Composition Theorem?

Biconditional

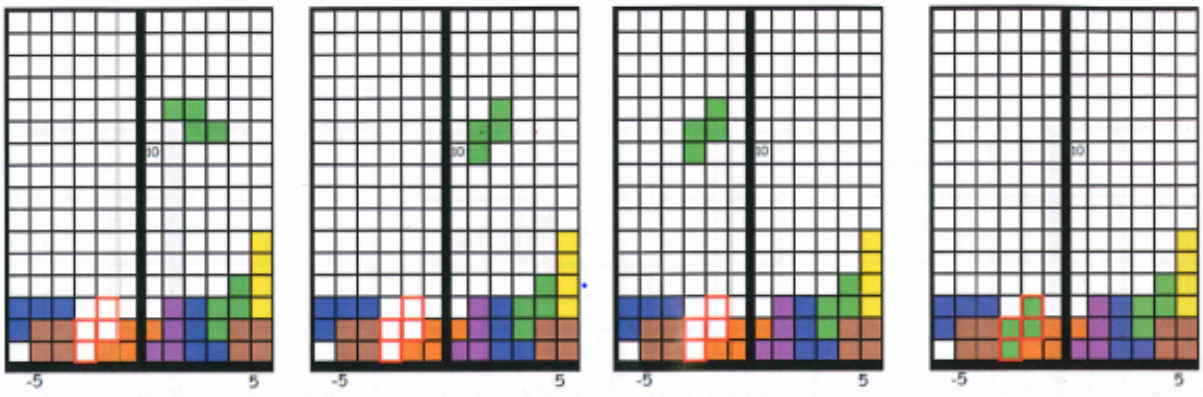
Glide reflection - composition of a reflection and a translation.



Rotation <90° cw (2,11)>
Translate <-4, 0>
Translate <0, -9>

The Geometry of Tetris

For the Tetris moves shown below, write the sequence of moves as a composition of isometries.

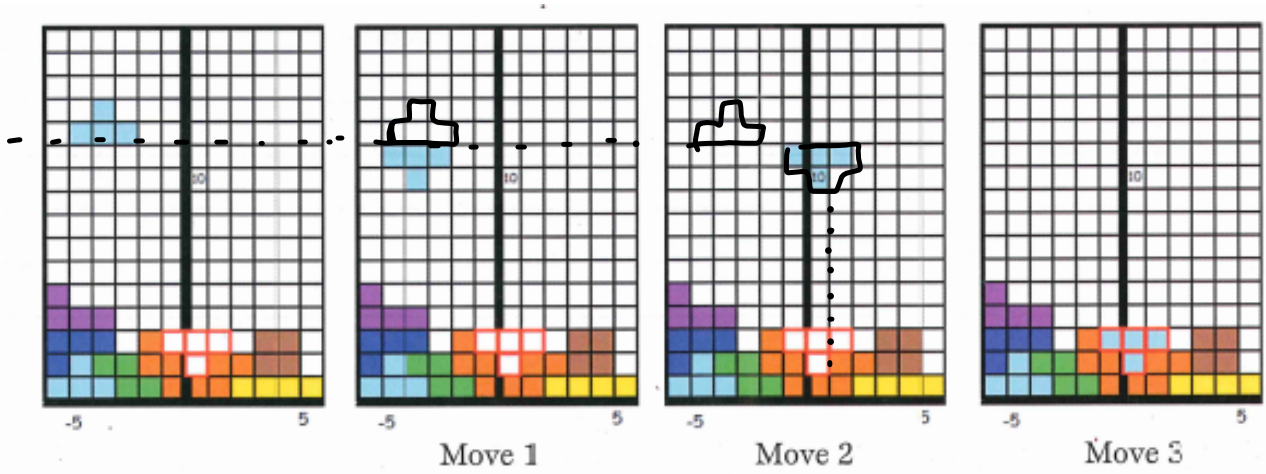


Move 1: _____

Move 2: _____

Move 3: _____

Composition: _____



Write the sequence of moves as a composition of isometries.

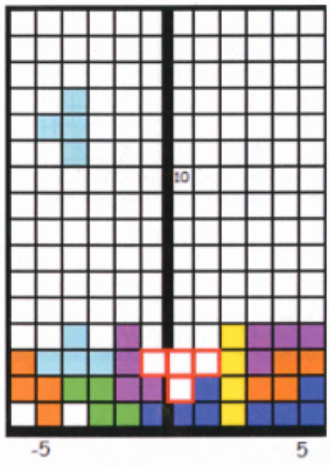
Move 1: Reflection $\langle y=11 \rangle$
Move 2: Translation $\langle 4, 0 \rangle$
Move 3: Translation $\langle 0, -8 \rangle$
Composition: _____

Translate $\langle 4, -8 \rangle \circ$ Reflect $\langle y=11 \rangle$

The Geometry of Tetris

For each of the four Tetris boards numbered here, write the sequence of moves required to move the piece into the desired location. Try to use the minimum number of moves possible. Then write the moves as a composition of isometries.

Board 1



Moves: _____

_____

_____

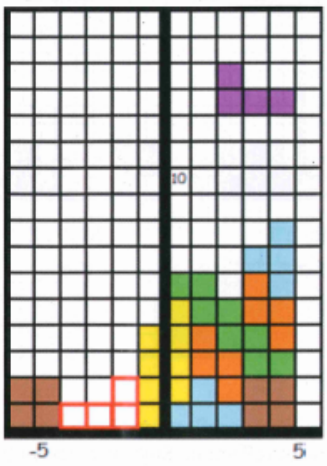
_____

_____

_____

Composition: _____

Board 2



Moves: _____

_____

_____

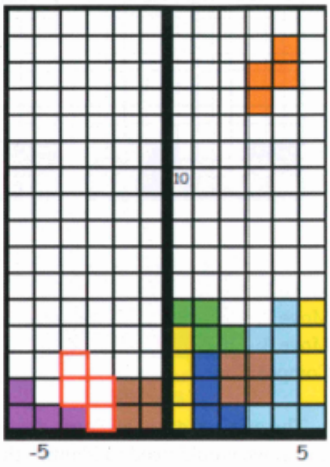
_____

_____

_____

Composition: _____

Board 3



Moves: _____

_____

_____

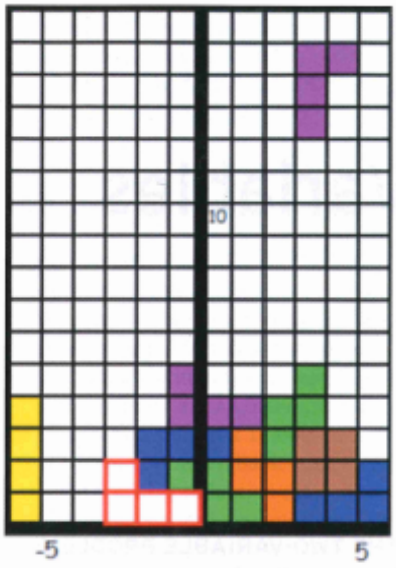
_____

_____

_____

Composition: _____

Board 4



Moves: _____

_____

_____

_____

_____

_____

Composition: _____

Questions

1. In the online version of Tetris, which keyboard commands (buttons) allow you to translate a game piece?

2. In the online version of Tetris, which keyboard commands (buttons) allow you to rotate a game piece? What is the measure of that rotation?

3. The original game of Tetris does not allow for reflections. If we allow reflections, which of the Tetris pieces are unnecessary? Explain. (Hint: A picture may be helpful.)

4. For which of the Tetris pieces would a rotation not be useful? Why not?

5. What other moves would you like to be able to carry out in a game of Tetris? Explain.

6. Your friend says that she would like to add a glide reflection command to the game. How could she achieve a glide reflection using rotations, reflections, and translations?

7. Instead of using Tetris shapes (four connected squares), how would the game change with pentominos (five connected squares)? How many game pieces would be possible, and what would they look like?