

# New spaces

The background features a dark brown gradient on the right side, transitioning into a lighter orange gradient on the left. Several thin, light orange lines intersect in the lower-left quadrant, forming a series of overlapping triangles and quadrilaterals. A large, curved, light orange shape is positioned in the lower-right quadrant, partially overlapping the dark brown area.

# Tic-Tac-Toe

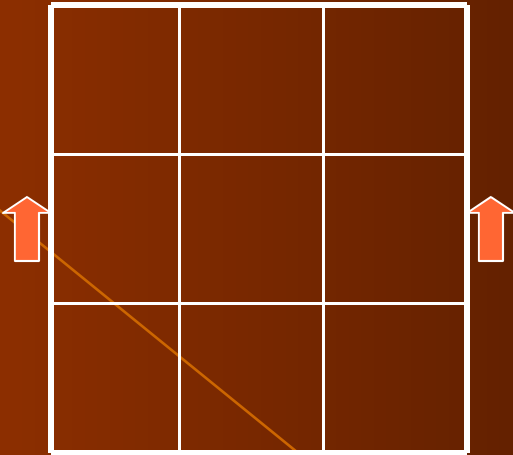
X	O	
O	X	
	X	O

Has anybody won here?

	X	O
	O	X
O		X

# “Gluing”

Instead of performing gluing in reality,  
we do it mentally!!!



The arrows indicate that we  
glue those sides together

# Exercise 1

Did any of the players win? If so, draw a line through the winning three.

	O	
O	X	X
X		O

X	O	O
O		X
	X	

O	X	O
		X
	O	X

X	O	
O	X	
	O	X

# Exercise 2

Mark X's best move. If it won, mark the winning three.

O		
X		
	X	O

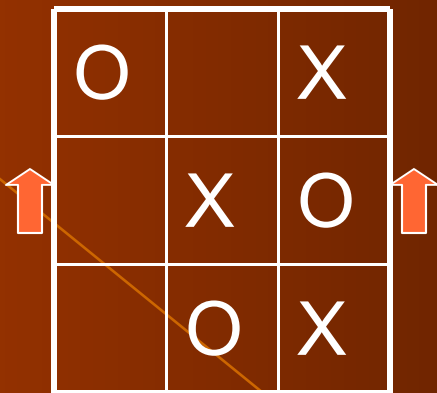
O	X	O
X		

X	X	O
O		

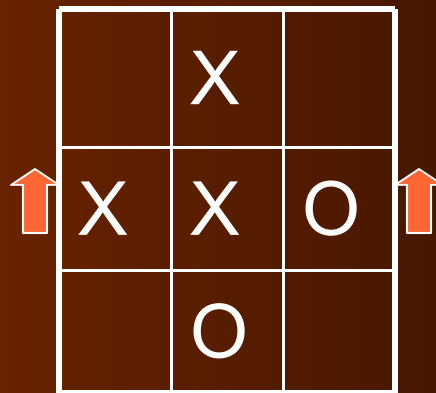
O	O	
X		X

# Same or different

Two games are equivalent if they yield the same game on a cylinder.



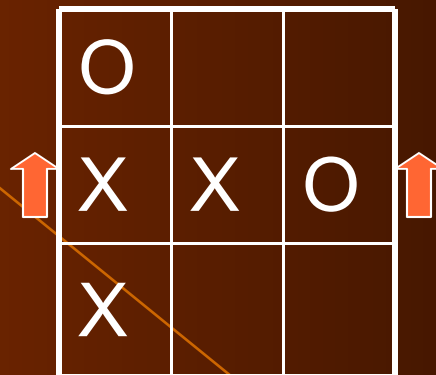
O		X
	X	O
	O	X



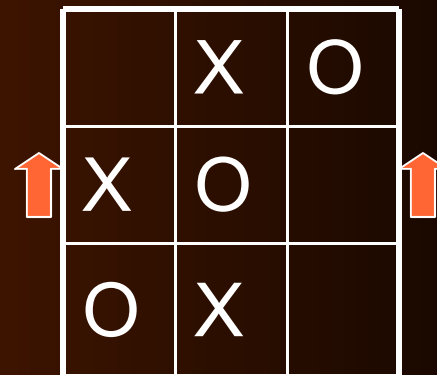
	X	
X	X	O
	O	

$$1 = 4$$

$$2 = 3$$



O		
X	X	O
X		




	X	O
X	O	
O	X	

# Exercise

Draw all cylindrical tic-tac-toe equivalent to this one

X	X	
	O	X
	O	O



# Food for thought

- In traditional tic-tac-toe two good players can always play to a draw. Is that true in cylindrical tic-tac-toe?
  - Why or why not?



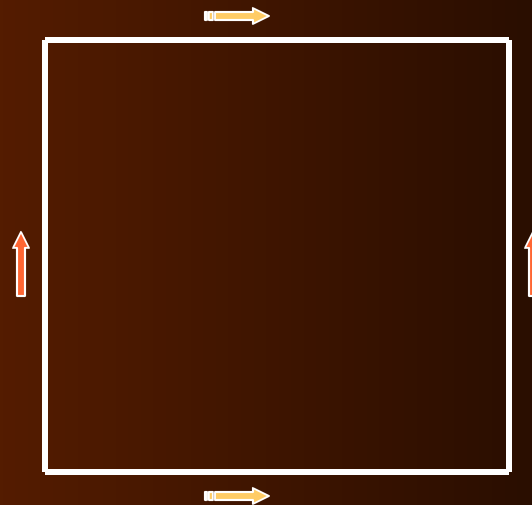
# Characteristics of a cylinder

- How many dimensions does it have?
  - 2
- Is it finite or infinite?
  - finite
- Does it have boundary?
  - yes

# New surface

- Living in a new surface

TORUS



# Characteristics of a torus

- How many dimensions does it have?
  - 2
- Is it finite or infinite?
  - finite
- Does it have boundary?
  - NO

# New games

- Maze
- Word Search
- Jigsaw
- Tic Tac Toe

# Torus Tic Tac Toe

- Does the first move matter in torus tic-tac-toe?
- If the first player takes the upper left corner, how many nonequivalent moves does the second player have?