Make sure to grab the handouts!
Go ahead and start with question 1.

Mathematical Tiling and Organization

Central Washington University

Dr. Brandy Wiegers
Central Washington University

Math Circle Promise

I solemnly swear

that if I already know the answer

to the math problem

I will not yell it out loud

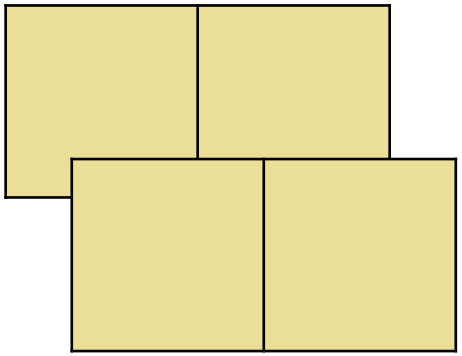
so those around me

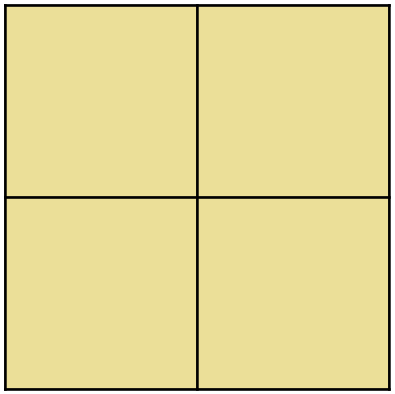
can experience the joy of learning.

WHAT IS A MATHEMATICAL TILING?

WHAT IS A MATHEMATICAL TILING?

- Like your bathroom tiles…
  - All the tiles sit next to each other, sides touching

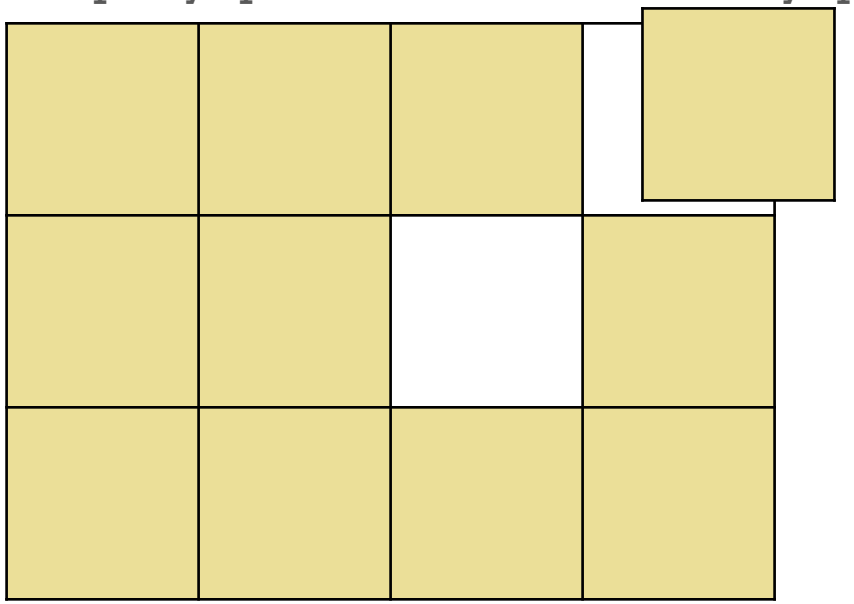




  - Can't skip any spaces- need to cover every spot

WHAT IS A MATHEMATICAL TILING?

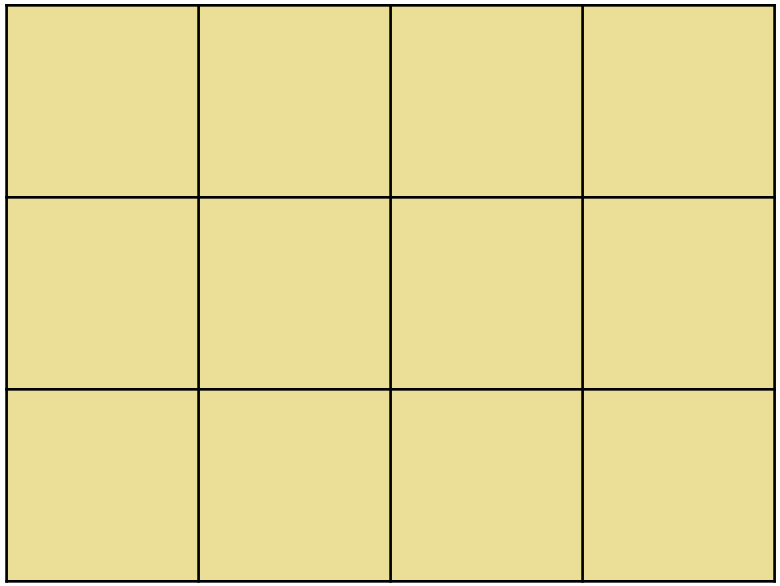
- Like your bathroom tiles…
  - All the tiles sit next to each other, sides touching
  - Can't skip any spaces- need to cover every spot on the "board"



- But sometimes we can add holes in our "board"

WHAT IS A MATHEMATICAL TILING?

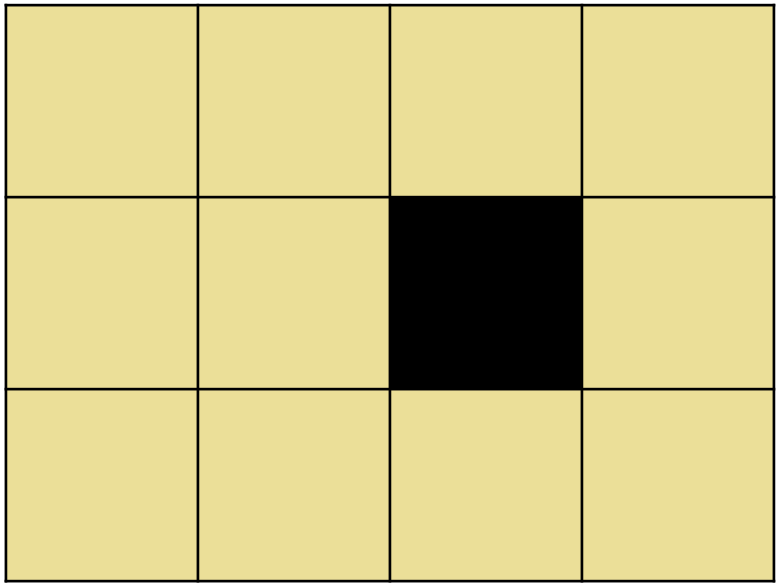
- Like your bathroom tiles…
  - All the tiles sit next to each other, sides touching
  - Can't skip any spaces- need to cover every spot on the "board"



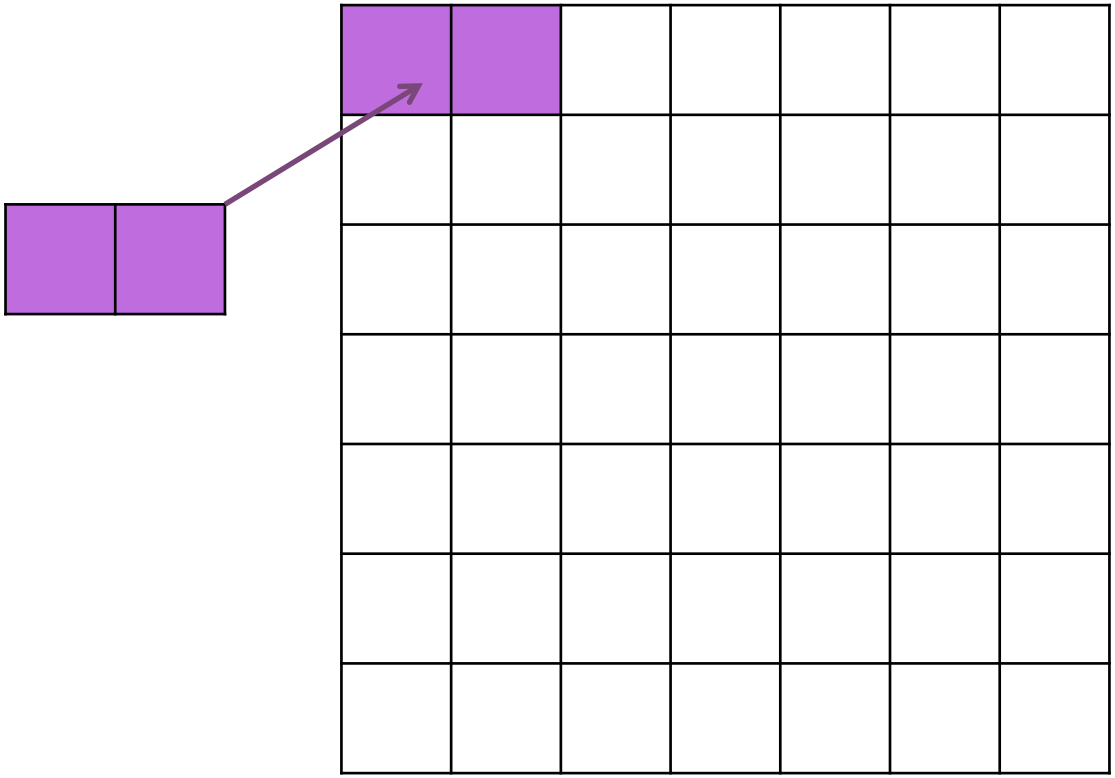
- But sometimes we can add holes in our "board"

WHAT IS A MATHEMATICAL TILING?

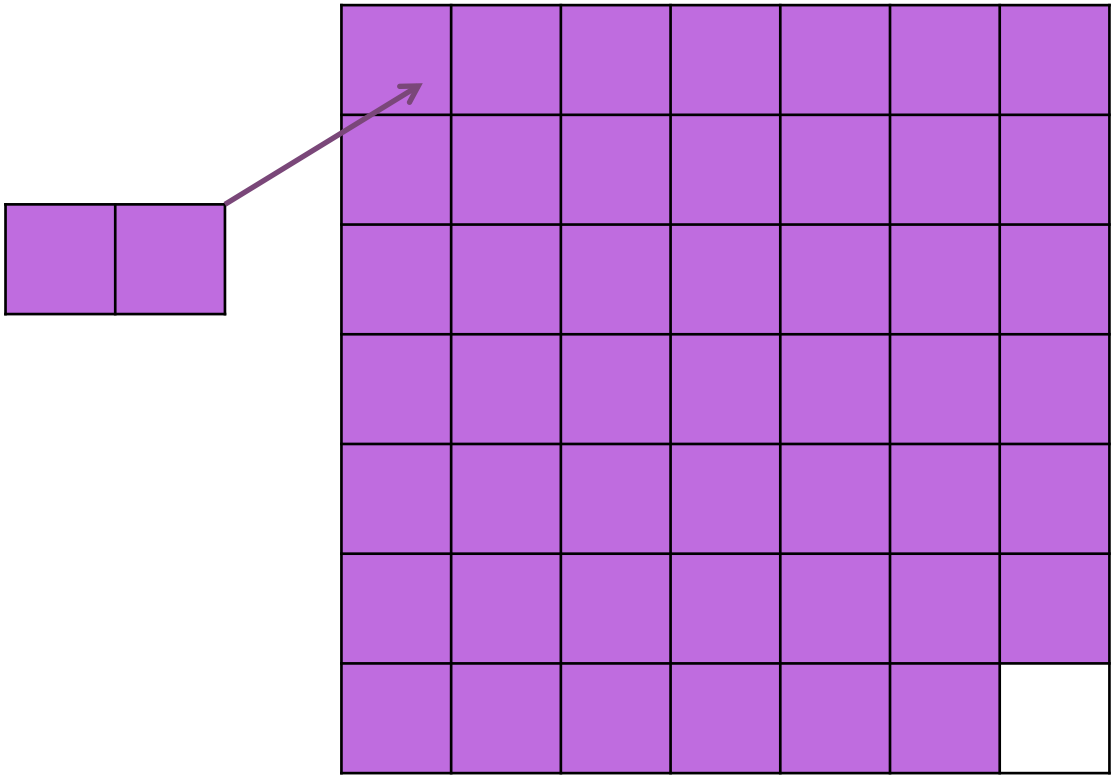
- Like your bathroom tiles…
  - All the tiles sit next to each other, sides touching
  - Can't skip any spaces- need to cover every spot on the "board"
  - But sometimes we can add holes in our "board"



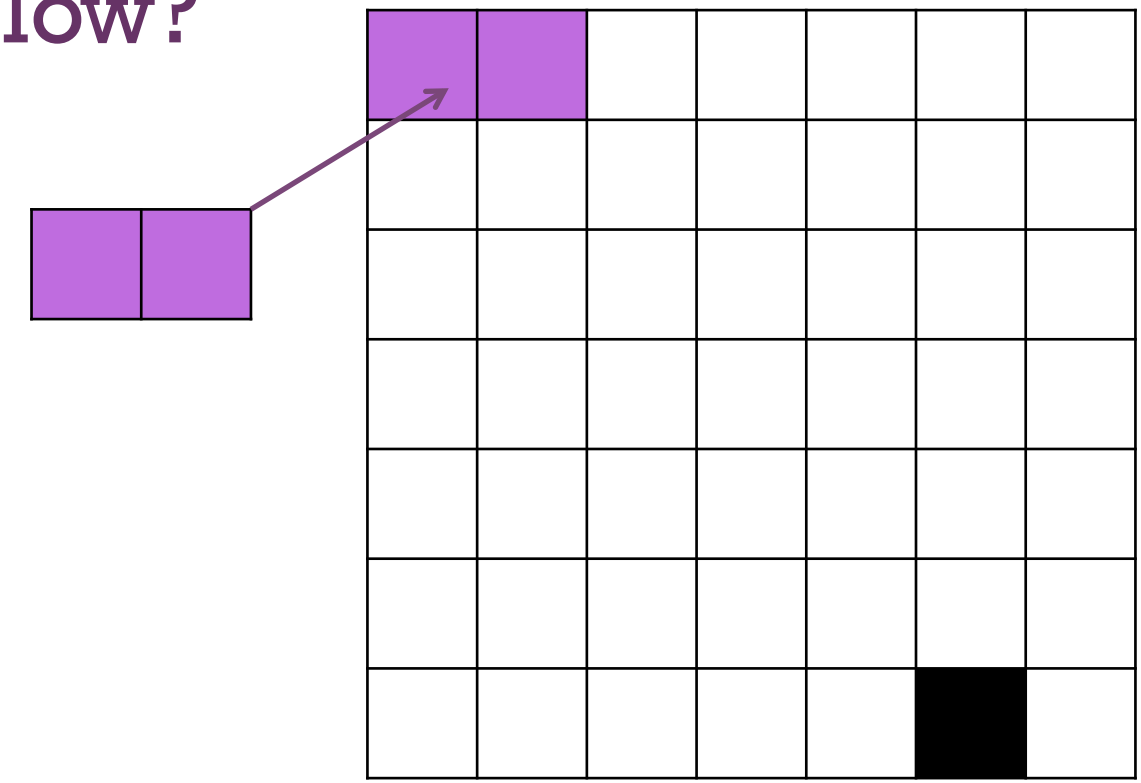
Question 1: Is it possible to tile a 7x7 board with 2x1 tiles?



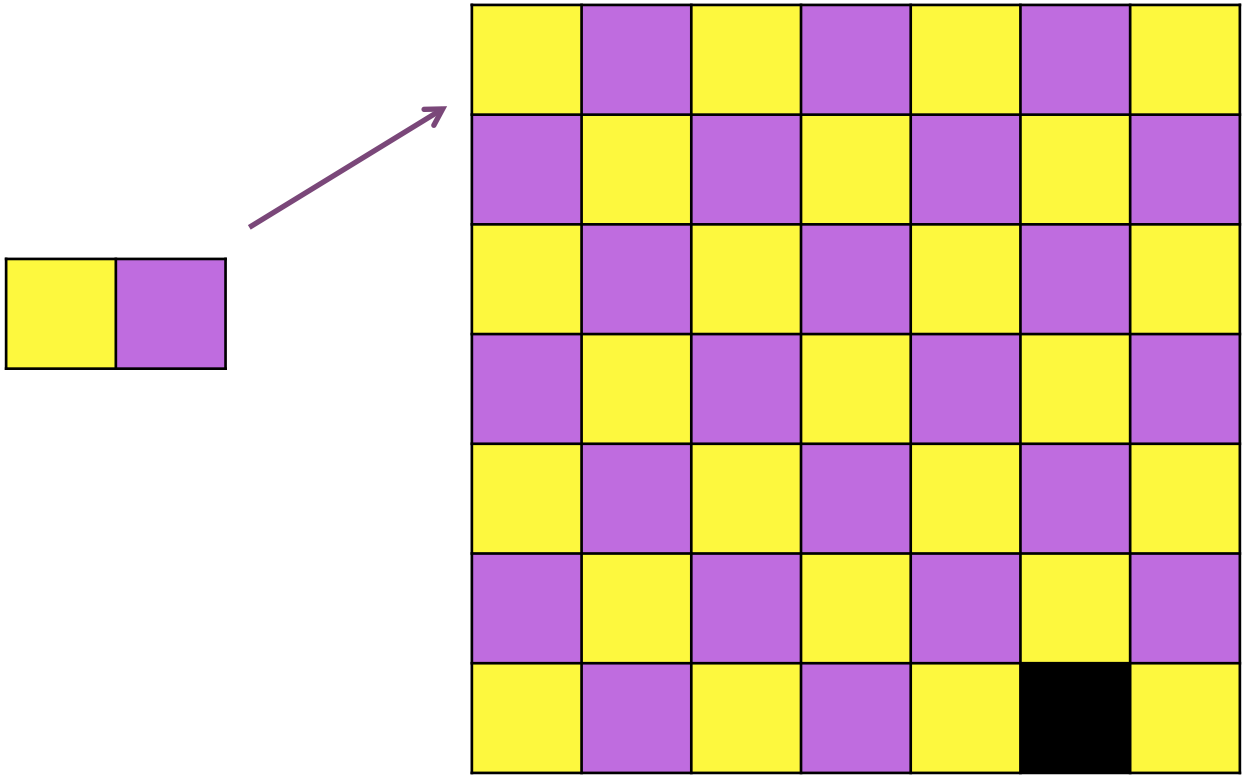
Question 1: Is it possible to tile a 7x7 board with 2x1 tiles?



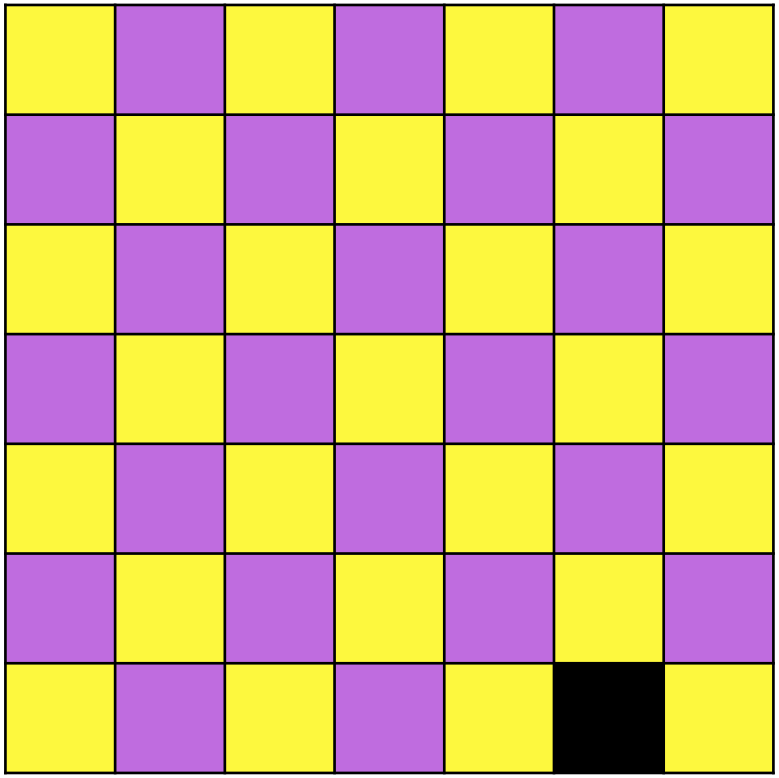
- Question 1.5: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?



Question 1.5: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?



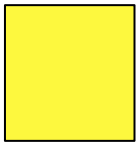
Question 1.5: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?



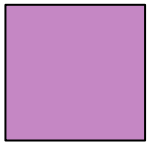
How many yellow boxes are there in a domino?

How many purple boxes are there in a domino?

How many yellow boxes are there in the grid?



How many purple boxes are there in the grid?



Question 1.5: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?

1	1	2	2	3	3	4
4	5	5	6	6	7	7
8	8	9	9	10	10	11
11	12	12	13	13	14	14
15	15	16	16	17	17	18
18	19	19	20	20	21	21
22	22	23	23	24		25

How many yellow boxes are there in a domino?

How many purple boxes are there in a domino?

How many yellow boxes are there in the grid?

25

How many purple boxes are there in the grid?

23

How many dominoes can we place on the 7x7 grid with this hole?

Question 1.5: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?

1	1	2	2	3	3	4
4	5	5	6	6	7	7
8	8	9	9	10	10	11
11	12	12	13	13	14	14
15	15	16	16	17	17	18
18	19	19	20	20	21	21
22	22	23	23	24		25

How many yellow boxes are there in a domino?

How many purple boxes are there in a domino?

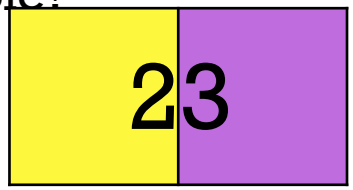
How many yellow boxes are there in the grid?

25

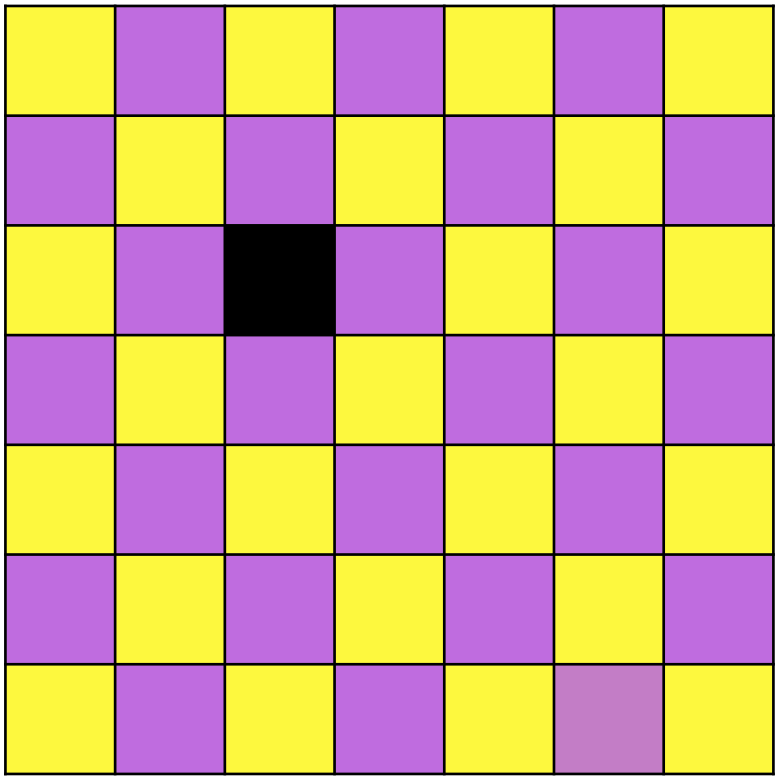
How many purple boxes are there in the grid?

23

How many dominoes can we place on the 7x7 grid with this hole?



Question 1.75: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?



Can we cover the entire 7x7 board with this hole?

Question 1.75: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?

1	1	2	2	3	3	4
4	5	5	6	6	7	7
8	8		9	9	10	10
11	11	12	12	13	13	14
14	15	15	16	16	17	17
18	18	19	19	20	20	21
21	22	22	23	23	24	24

How many yellow boxes are there in a domino?

How many purple boxes are there in a domino?

How many yellow boxes are there in the grid?

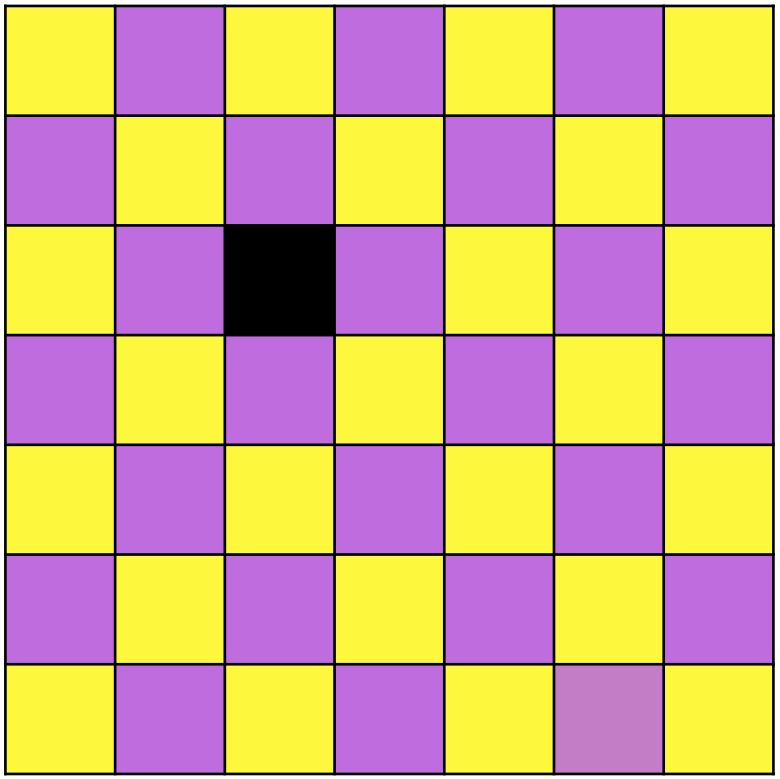
24

How many purple boxes are there in the grid?

24

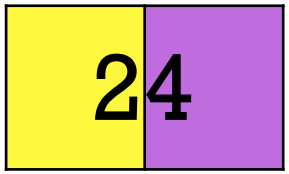
How many dominoes can we place on the 7x7 grid with this hole?

Question 1.75: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?

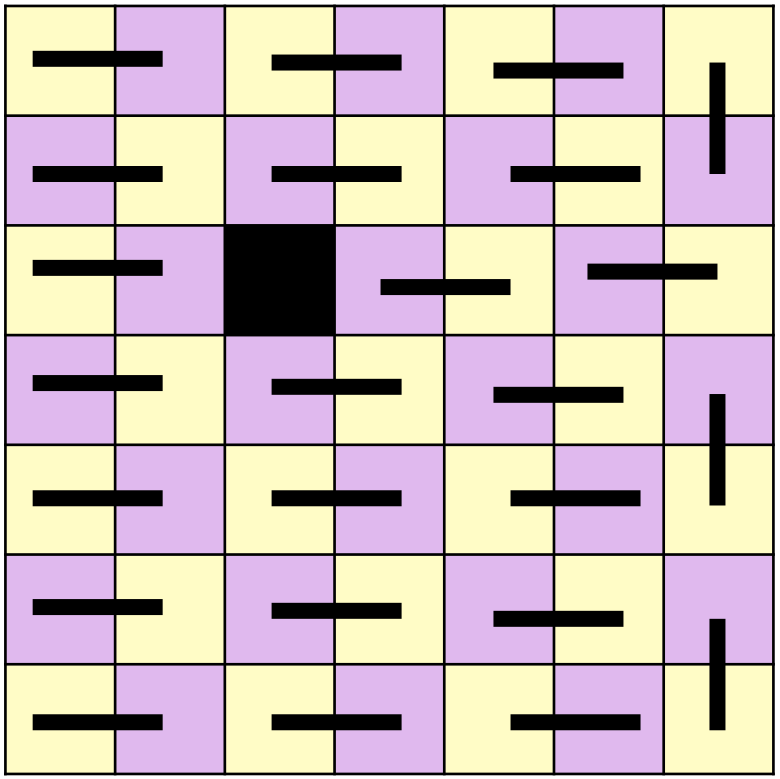


Can we cover the entire 7x7 board with this hole?

YES!

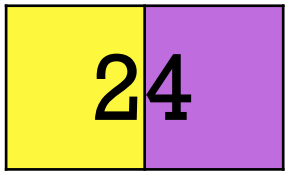


Question 1.75: Is it possible to tile a 7x7 board with 2x1 tiles given the 1 hole in the board at the spot below?

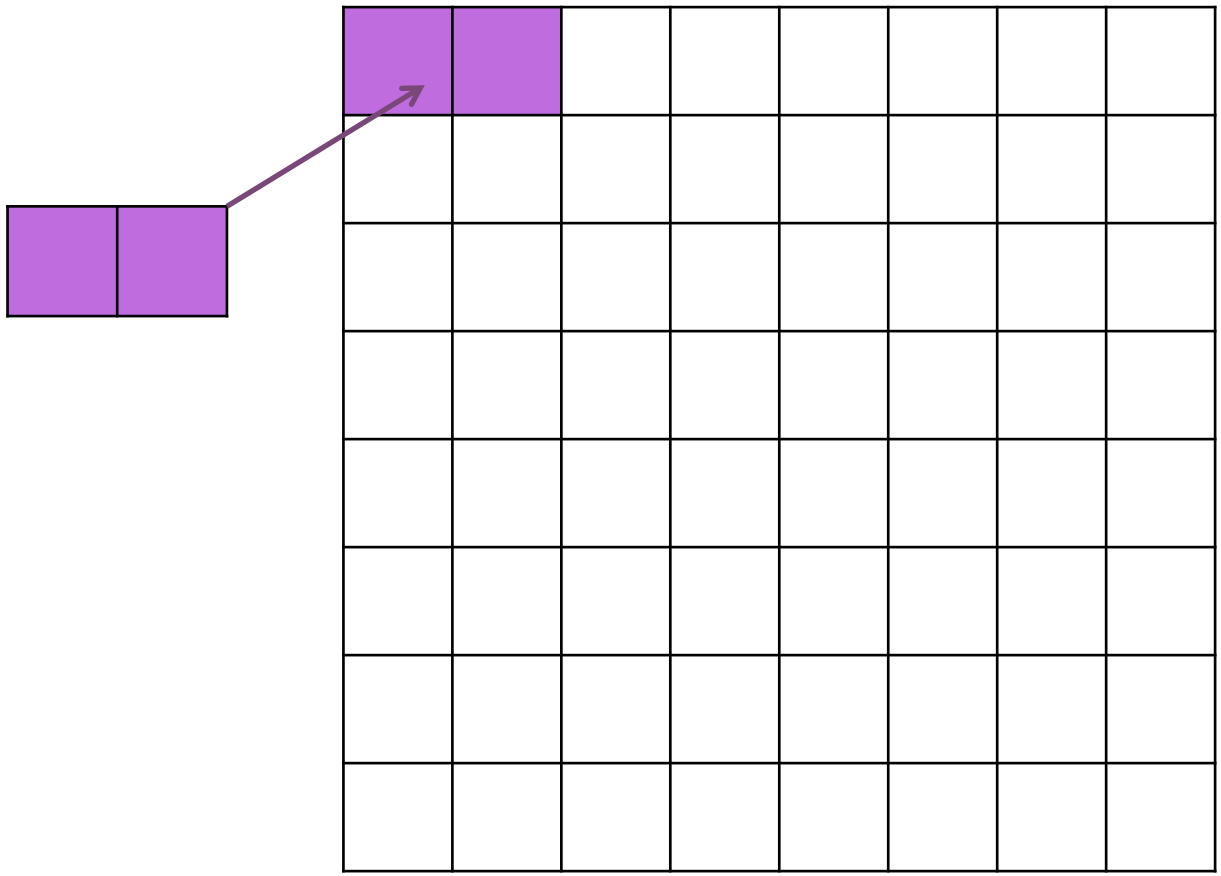


Can we cover the entire 7x7 board with this hole?

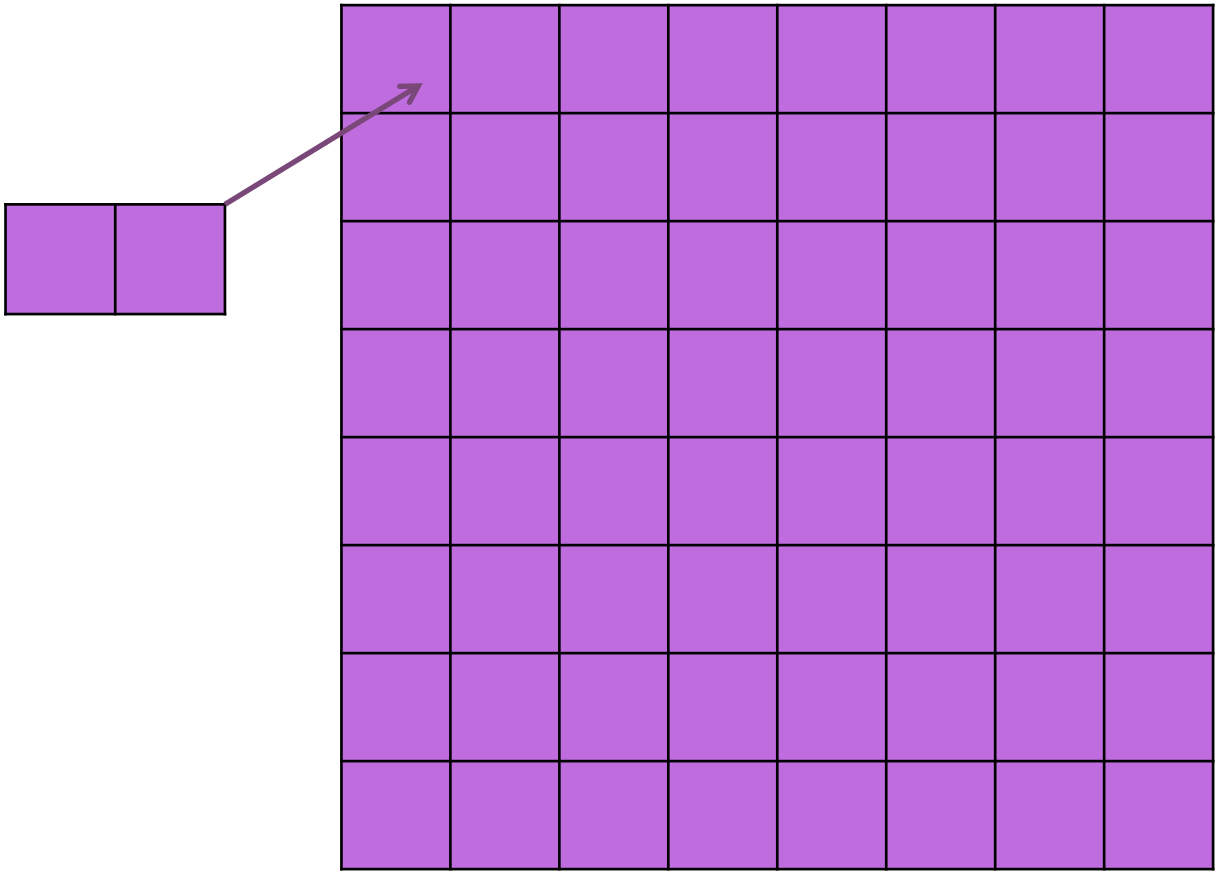
YES!



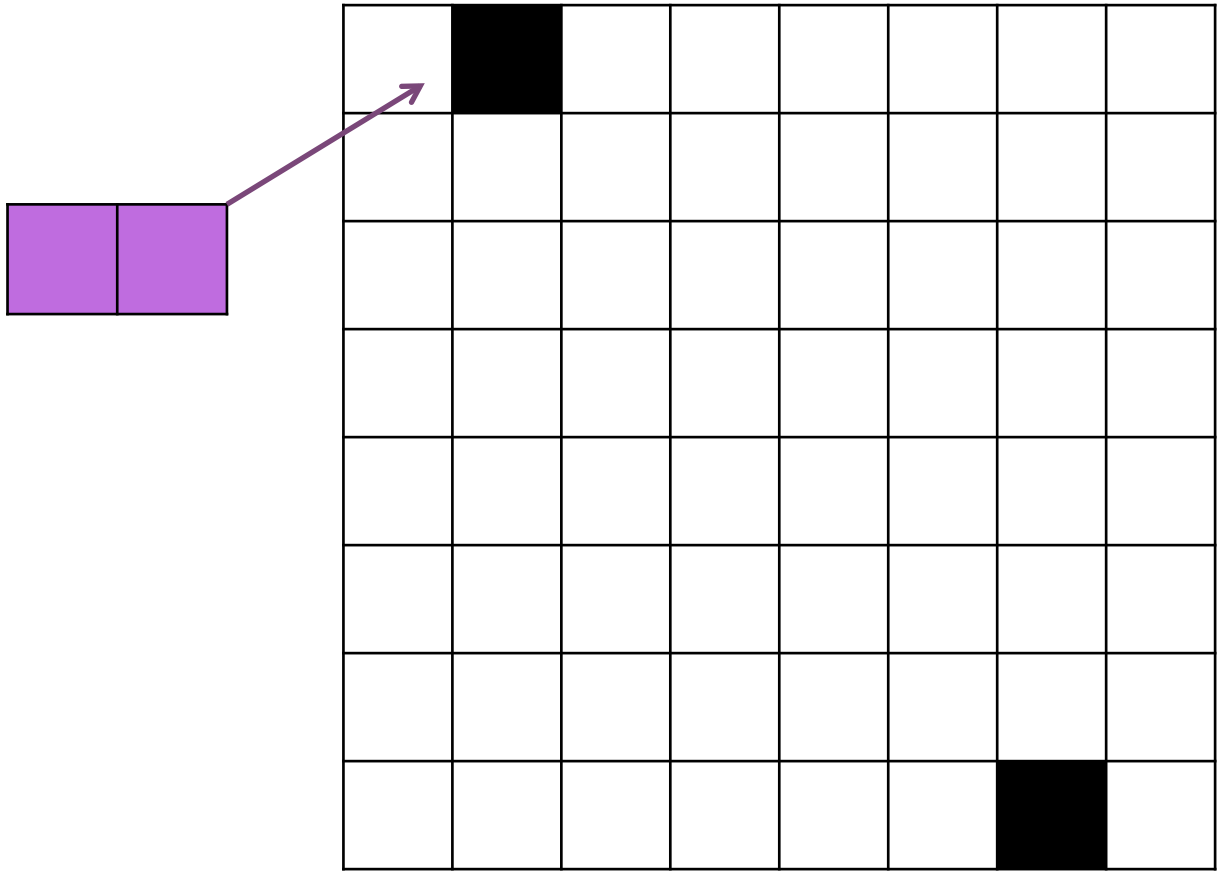
Question 2: Is it possible to tile a 8x8 board with 2x1 tiles?



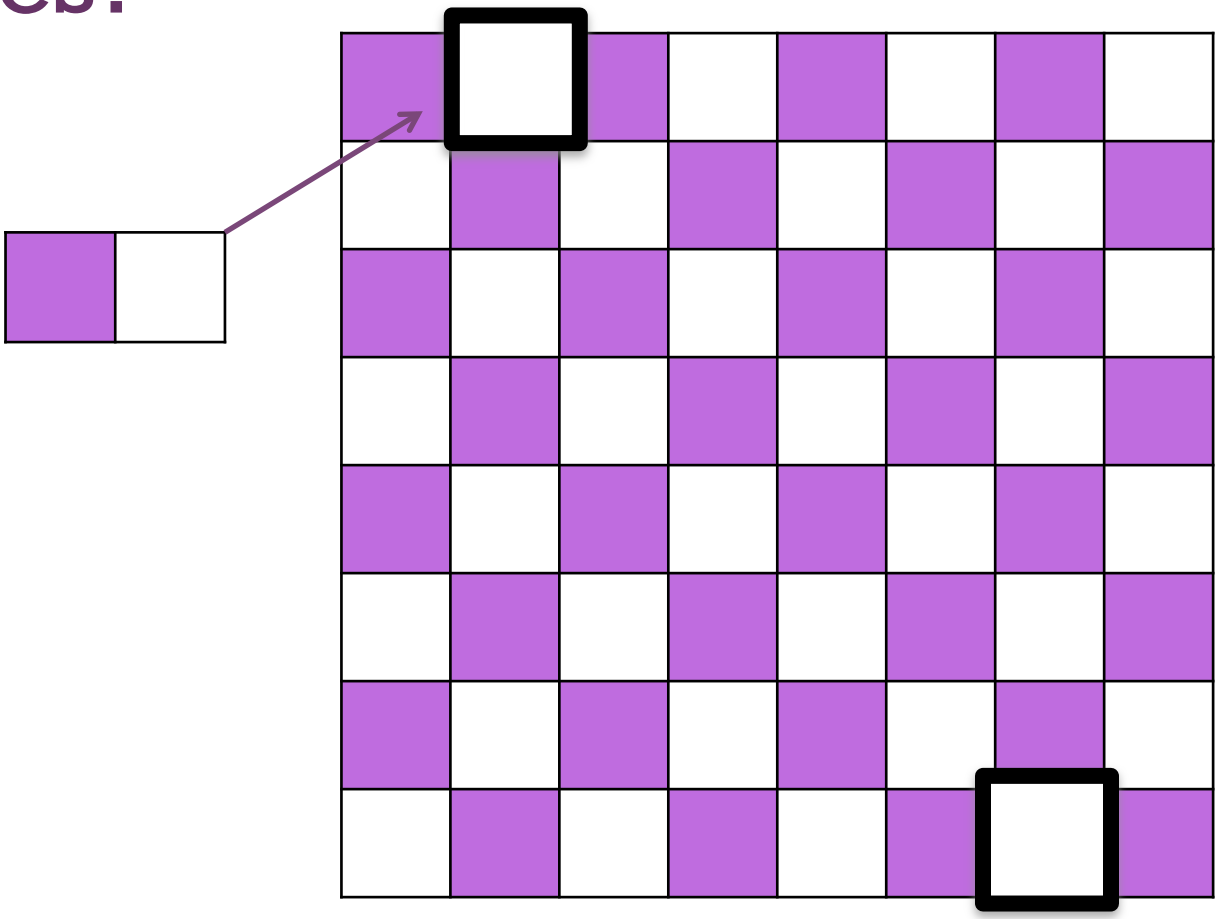
Question 2: Is it possible to tile a 8x8 board with 2x1 tiles?



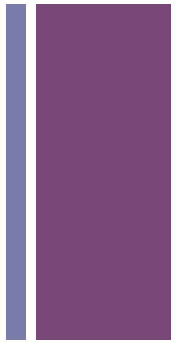
Question 2.5: Is it possible to tile a 8x8 board with 2x1 tiles and 2 holes?



Question 2.5: Is it possible to tile a 8x8 board with 2x1 tiles and 2 holes?

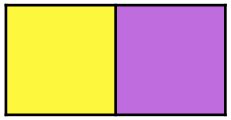


What's the next question?



- 7x7 board
- 8x8 board
- ??

What's the next question?



- Q: In general, is it possible to tile an nxn board with 2x1 tiles? If so, which boards can you tile and why?
- Q: In general, if n is odd, is it possible to tile an nxn board with 2x1 tiles if one square is covered with a 1x1 tile? Does it matter which square is covered?
- Q: In general, if n is even, is it possible to tile an nxn board with 2x1 tiles if two squares are removed? Does it matter which two squares are removed?

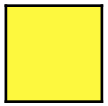
What's the next question?

What if instead of focusing on domino problems we change our tile shapes?

What's the next question?

What if instead of focusing on domino problems we change our tile shapes?

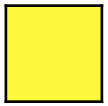
- Monominoes



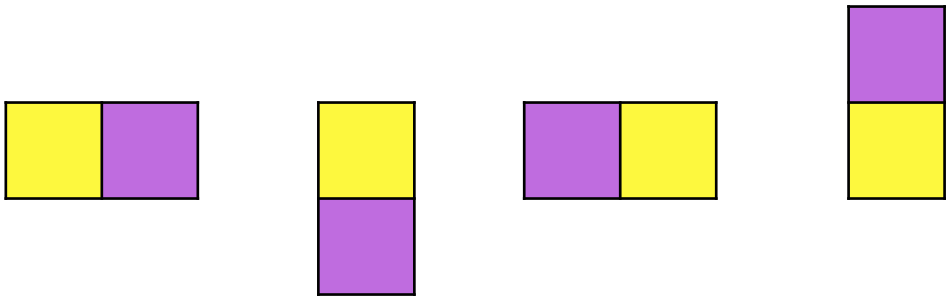
What's the next question?

What if instead of focusing on domino problems we change our tile shapes?

- Monominoes



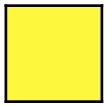
- Dominoes:



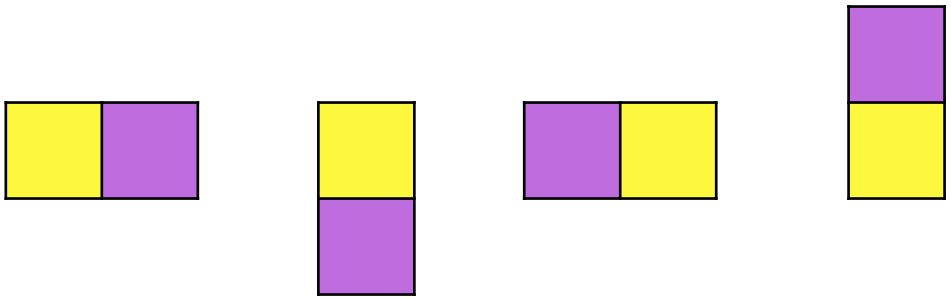
What's the next question?

What if instead of focusing on domino problems we change our tile shapes?

- Monominoes

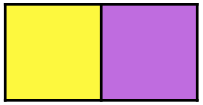


- Dominoes:



- But all of these are the same tile, rotated around.

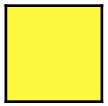
There is just 1 tile with 2 squares



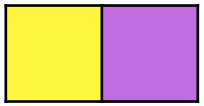
What's the next question?

What if instead of focusing on domino problems we change our tile shapes

- Monominoes



- Dominoes:



- Trominoes:

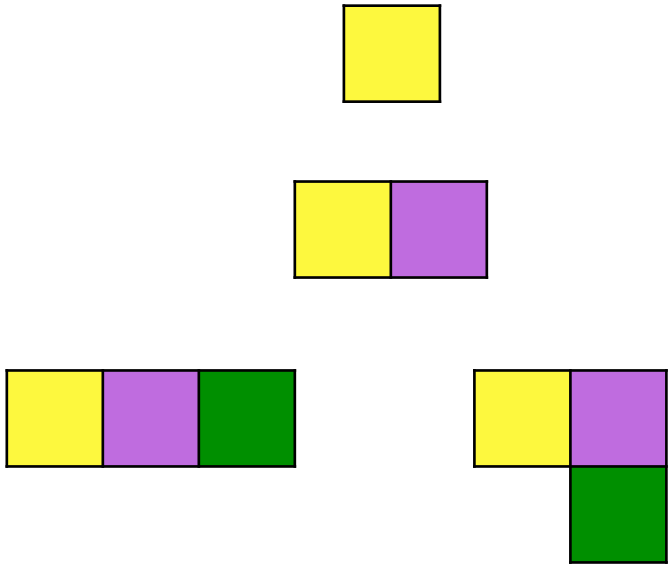
Q: How many Trominoes are there?

*Not counting rotations/ reflections of the same tile

What's the next question?

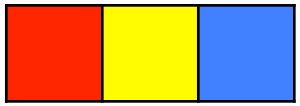
What if instead of focusing on domino problems we change our tile shapes

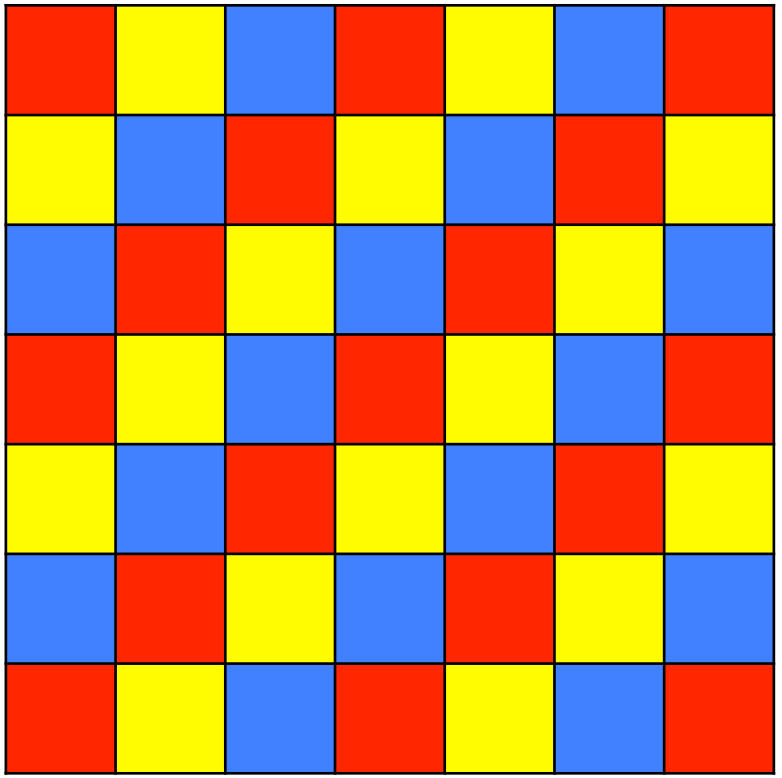
- Monominoes
- Dominoes:
- Trominoes:



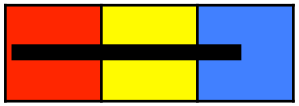
* colors indicate where we added the extra tiles.

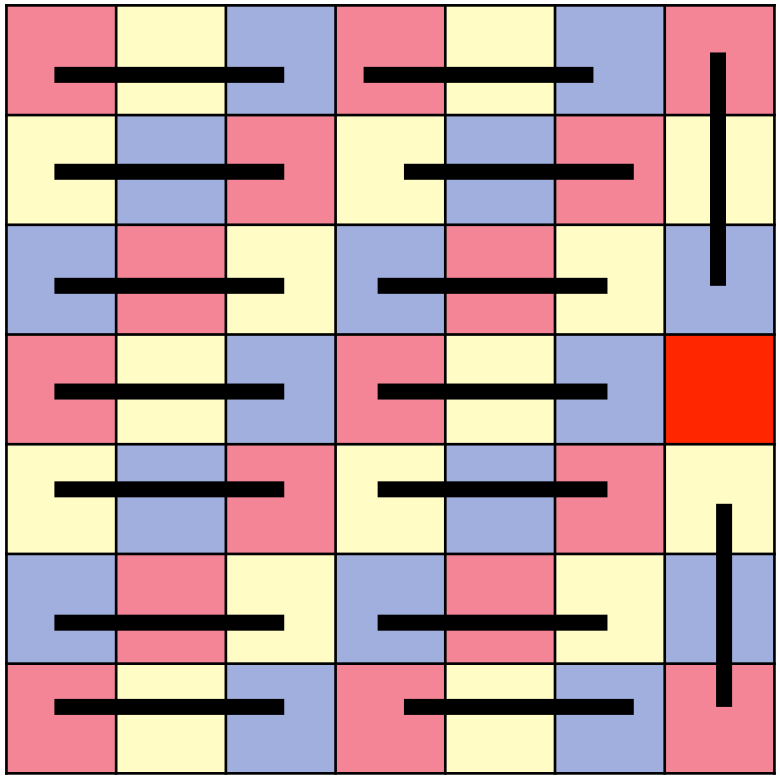
Q3: Is it possible to tile an 7x7 board with 16 3x1 tiles and 1 hole?



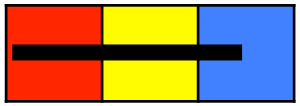


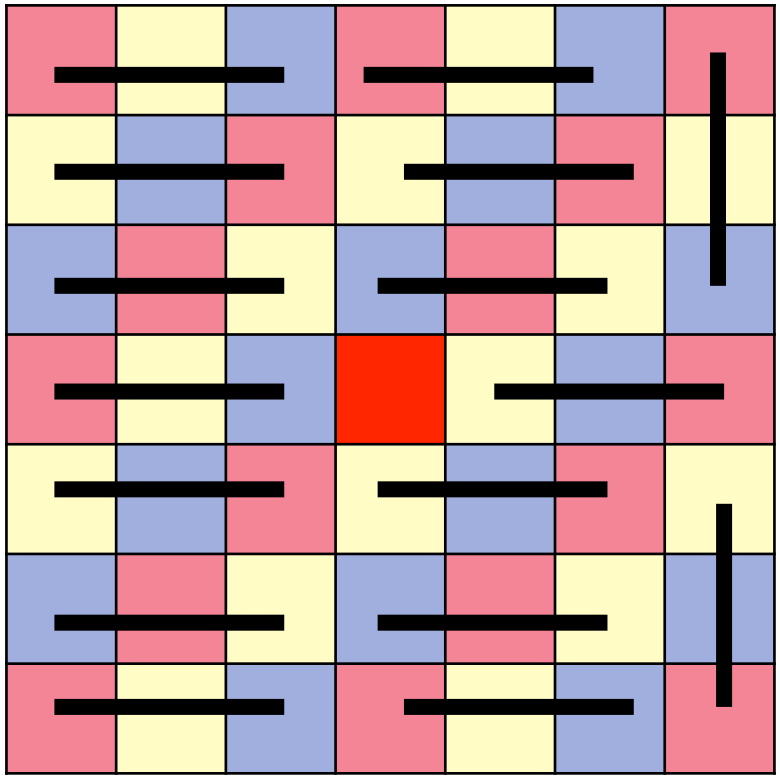
Q3: Is it possible to tile an 7x7 board with 21 3x1 tiles and 1 hole?



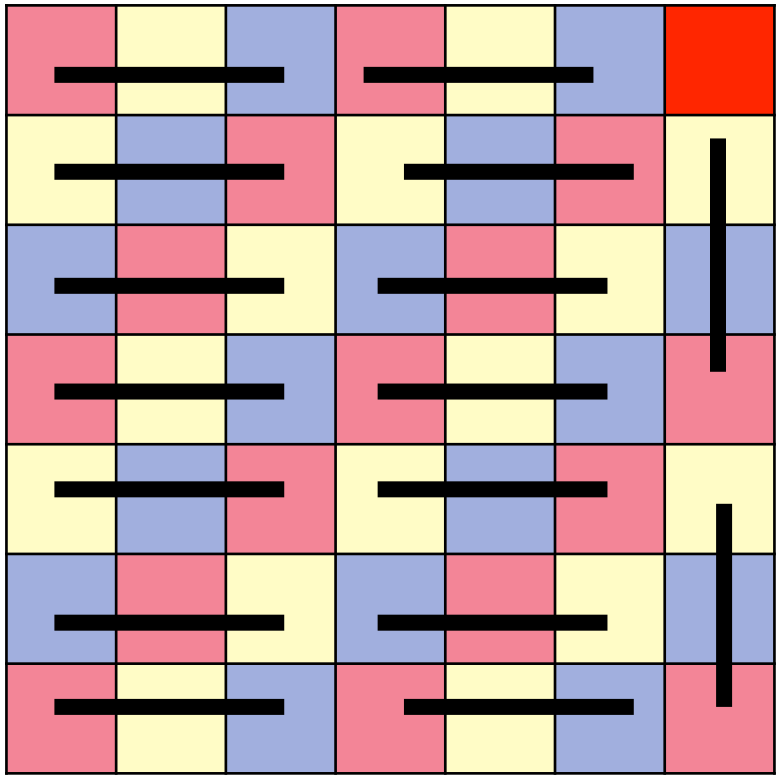


Q3: Is it possible to tile an 7x7 board with 21 3x1 tiles and 1 hole?

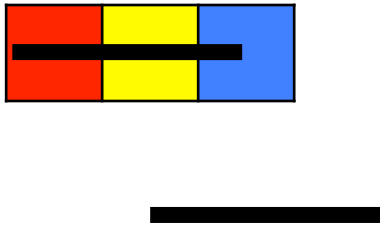




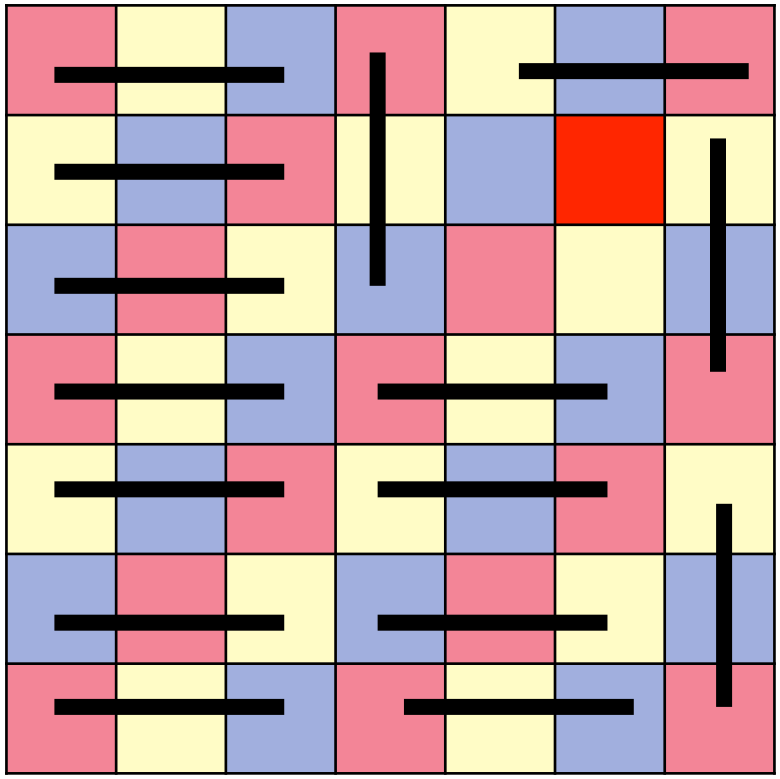
Q3: Is it possible to tile an 7x7 board with 21 3x1 tiles and 1 hole?



Q3: Is it possible to tile an 7x7 board with 21 3x1 tiles and 1 hole?

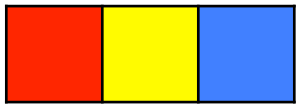


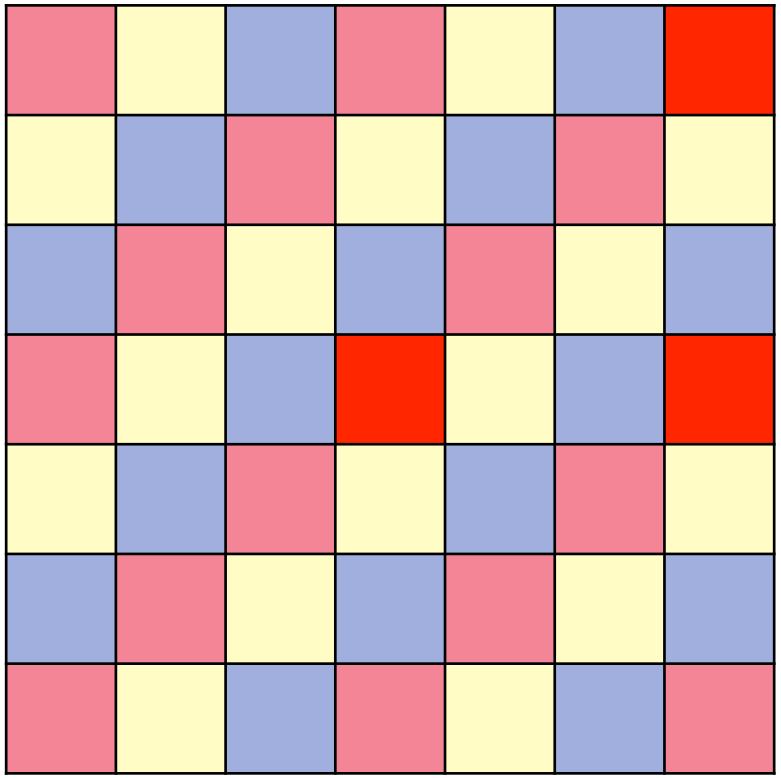
?



Q3: Is it possible to tile an 7x7 board with 16 3x1 tiles and 1 hole?

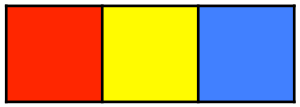
- I know that these 3 work

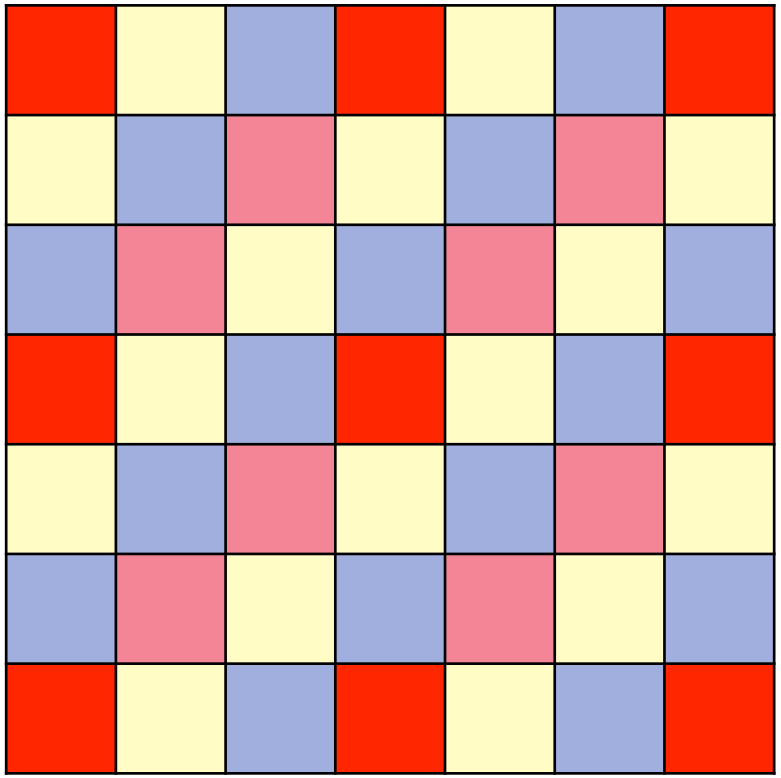




Q3: Is it possible to tile an 7x7 board with 16 3x1 tiles and 1 hole?

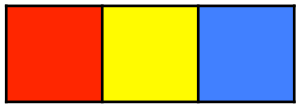
- I can then rotate the board and make a rotation argument for these same spots in the other corners/ sides



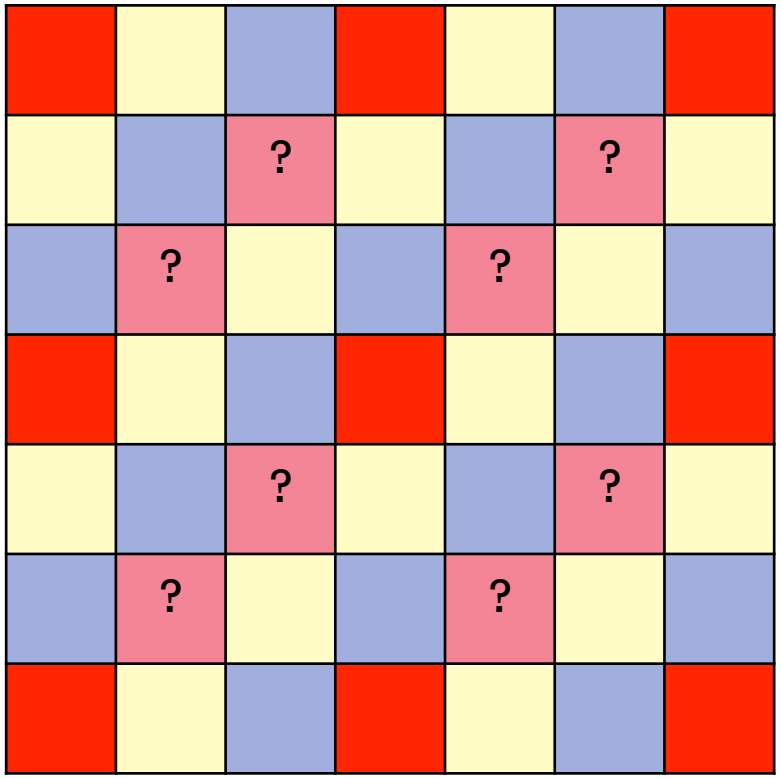


Q3: Is it possible to tile an 7x7 board with 16 3x1 tiles and 1 hole?

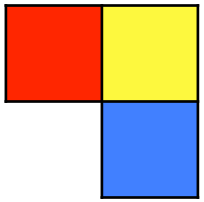
- I'm going to leave it to you to discover if the other inside points work

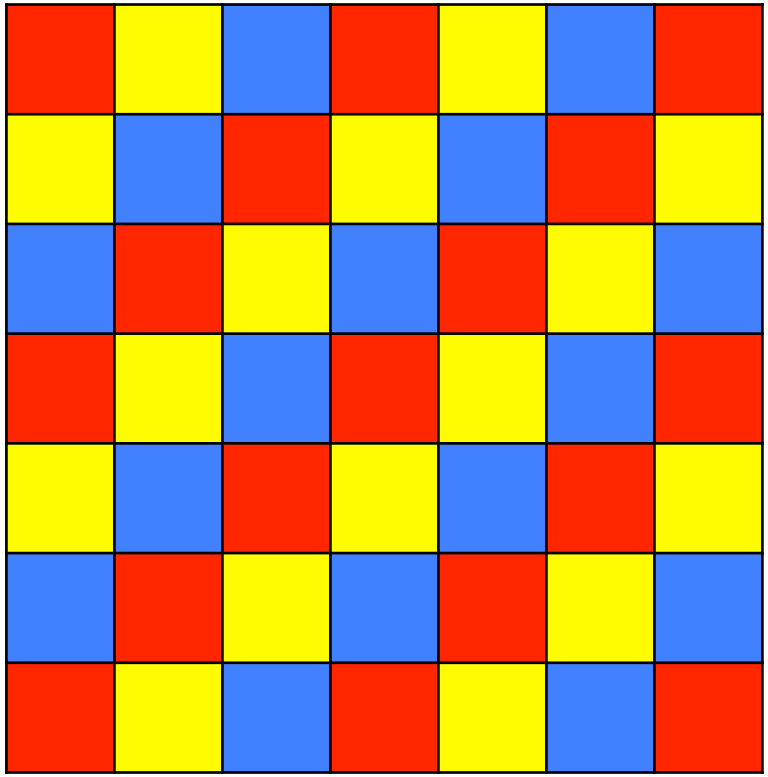


?

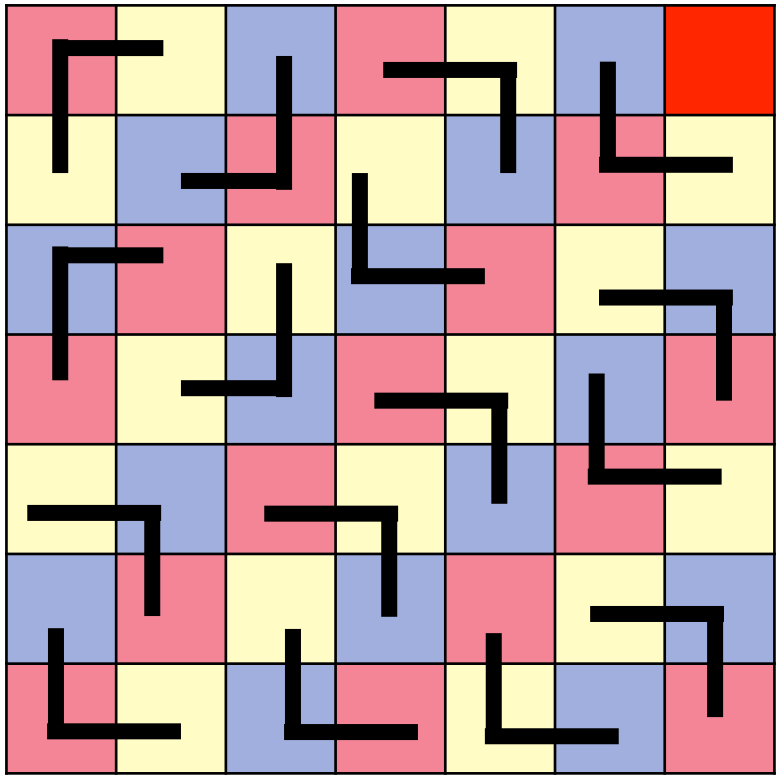


Q3.5 : Is it possible to tile an 7x7 board with 21 L-shaped trominoes and 1 hole?

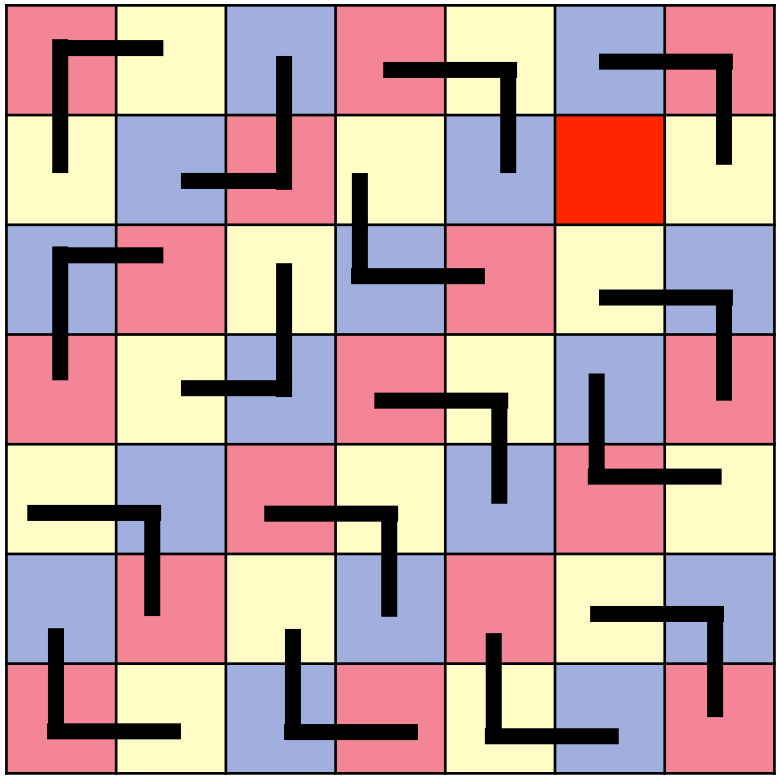




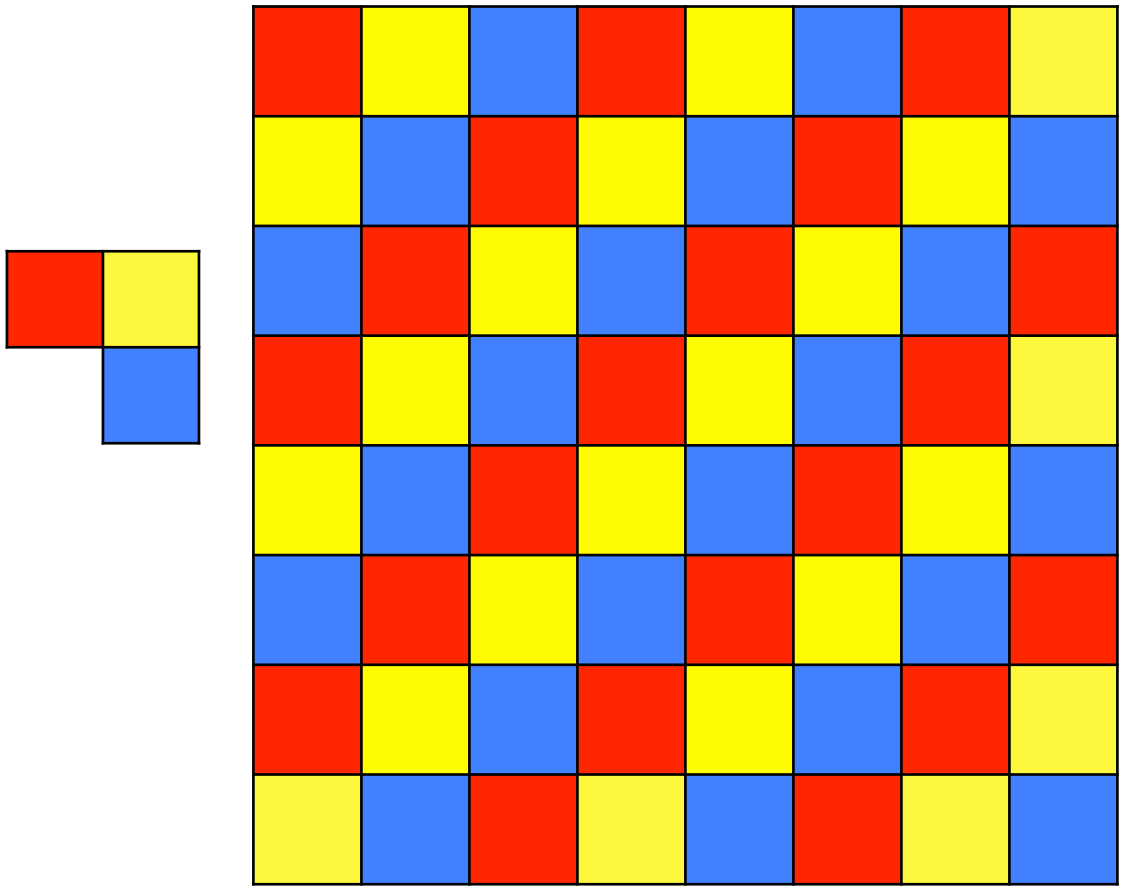
Q3.5 : Is it possible to tile an 7x7 board with 21 L-shaped trominoes and 1 hole?



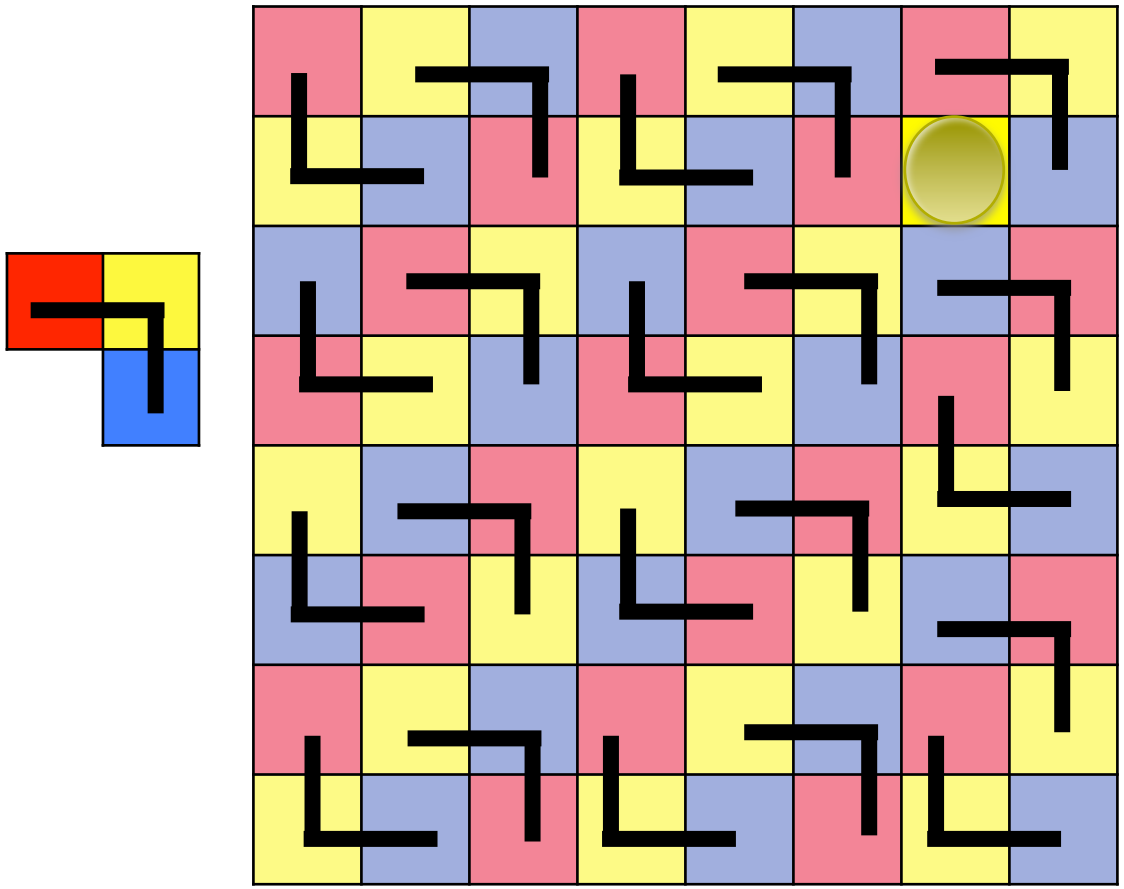
Q3.5 : Is it possible to tile an 7x7 board with 21 L-shaped trominoes and 1 hole?



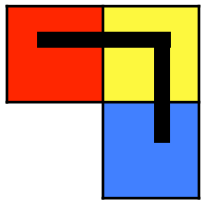
Q4: Is it possible to tile an 8x8 board with 21 "L-shaped" tiles of three squares and one hole?

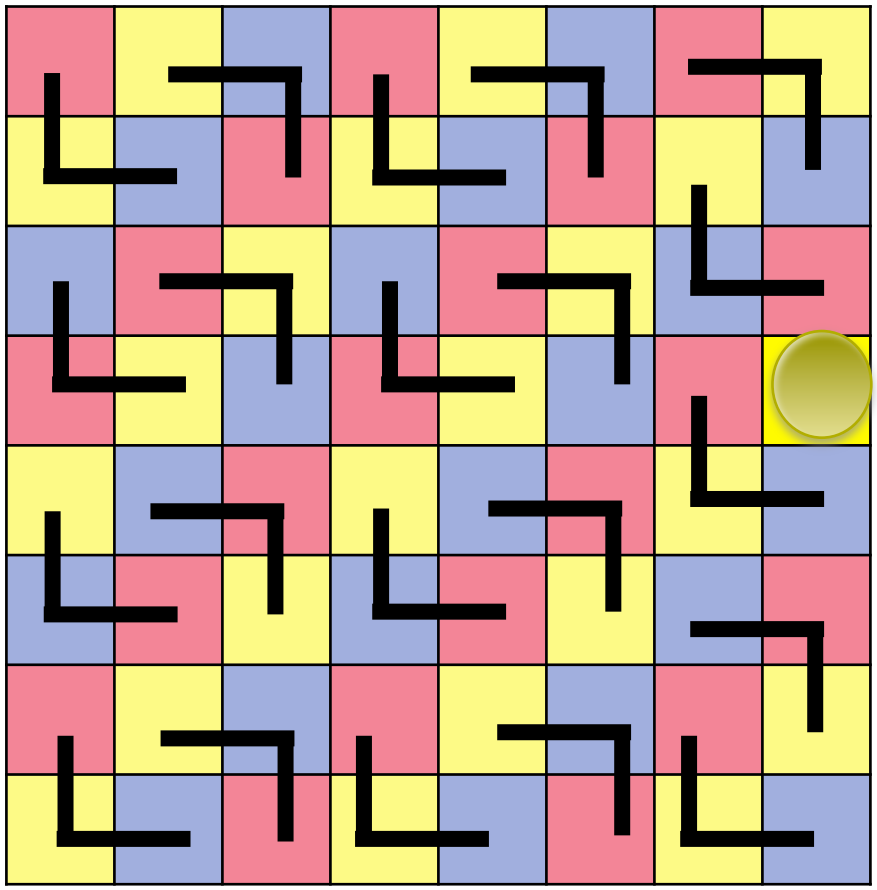


Q4: Is it possible to tile an 8x8 board with 21 "L-shaped" tiles of three squares and one hole?

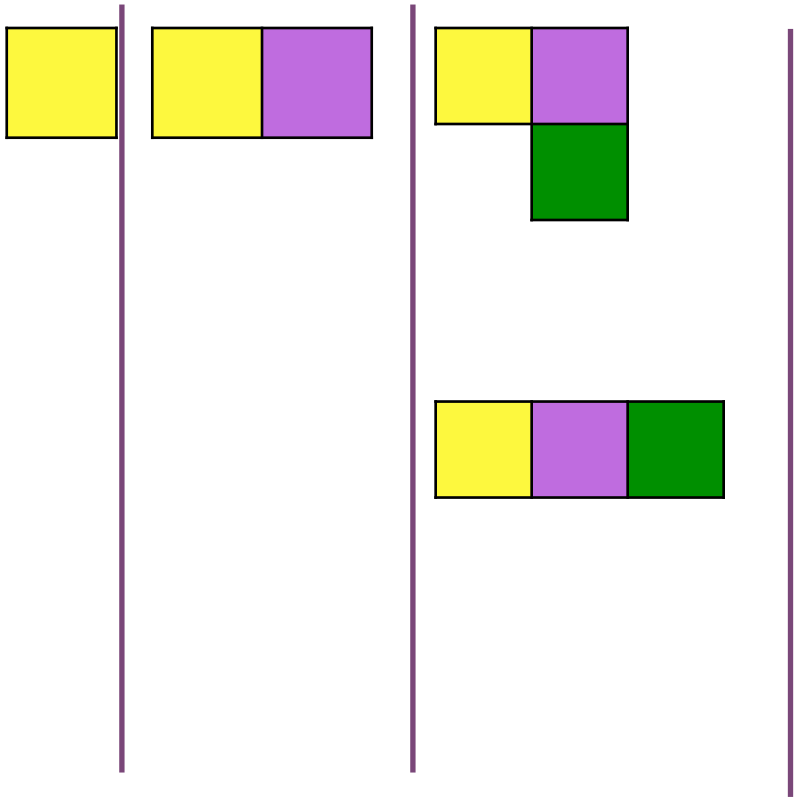


Q4: Is it possible to tile an 8x8 board with 21 "L-shaped" tiles of three squares and one hole?

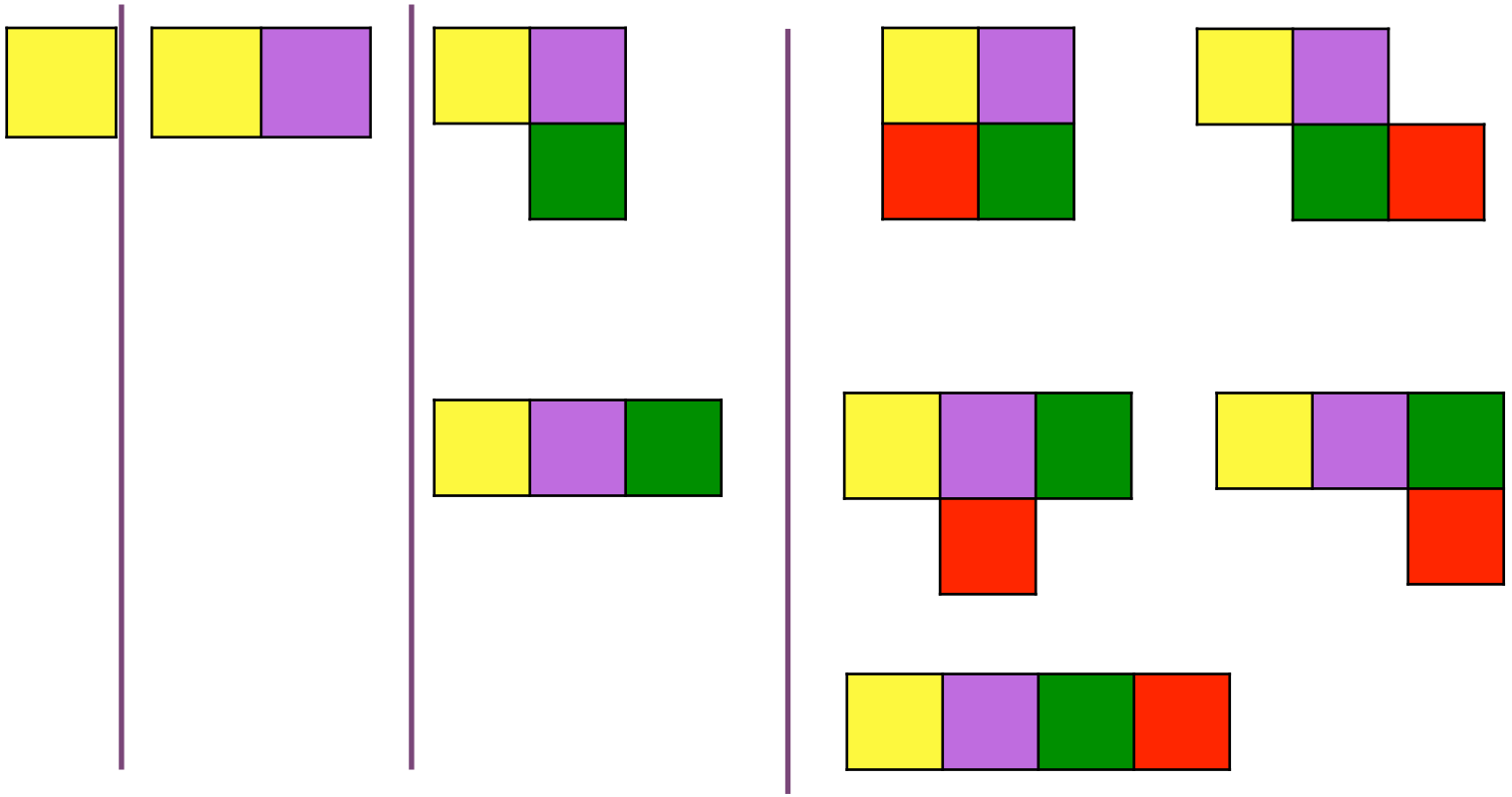




Other Questions to think about…
What other polyominoes are there?



Other Questions to think about…
What other polyominoes are there?



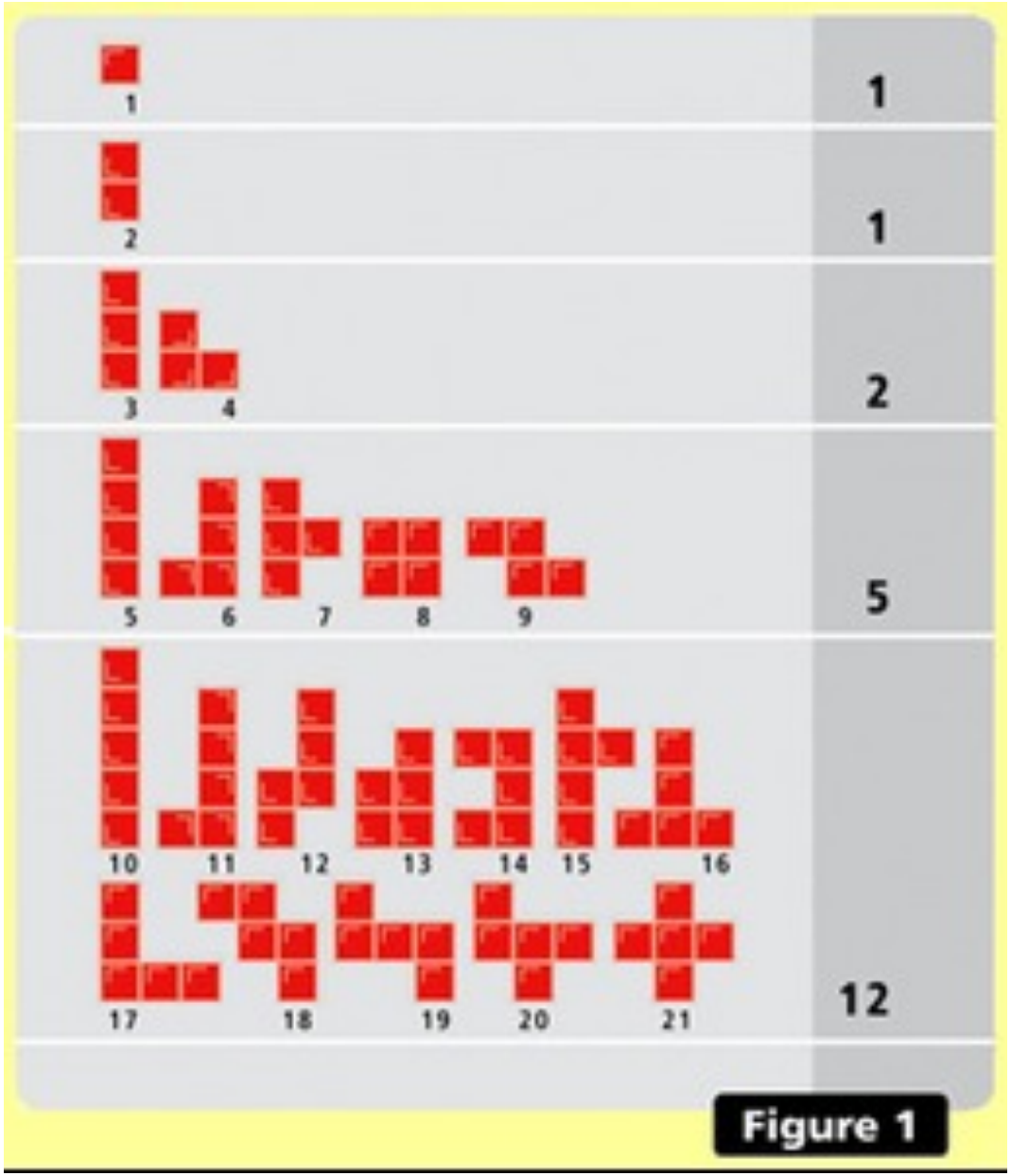
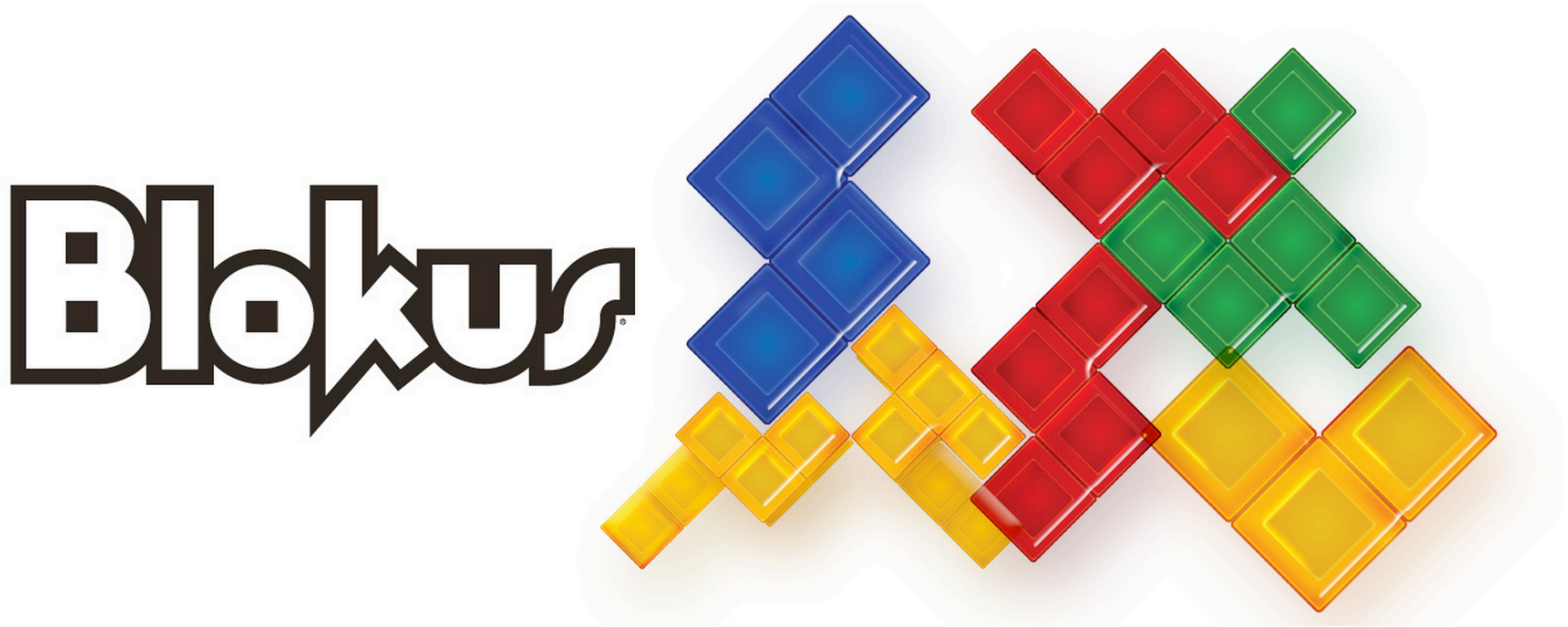


Image from: http://seshil4324jp.sugo-roku.com/newgame/blokus

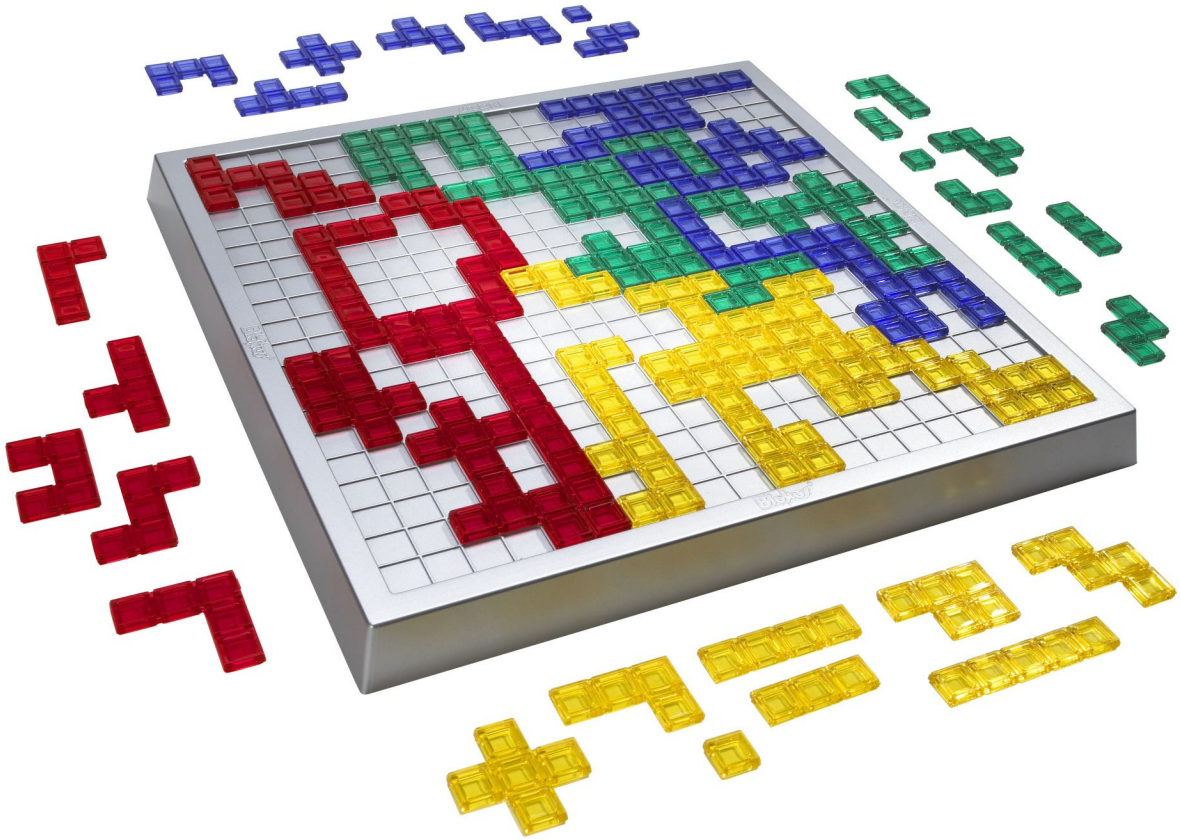
Blokus!

http://mattelgames.com/en-us/blokus



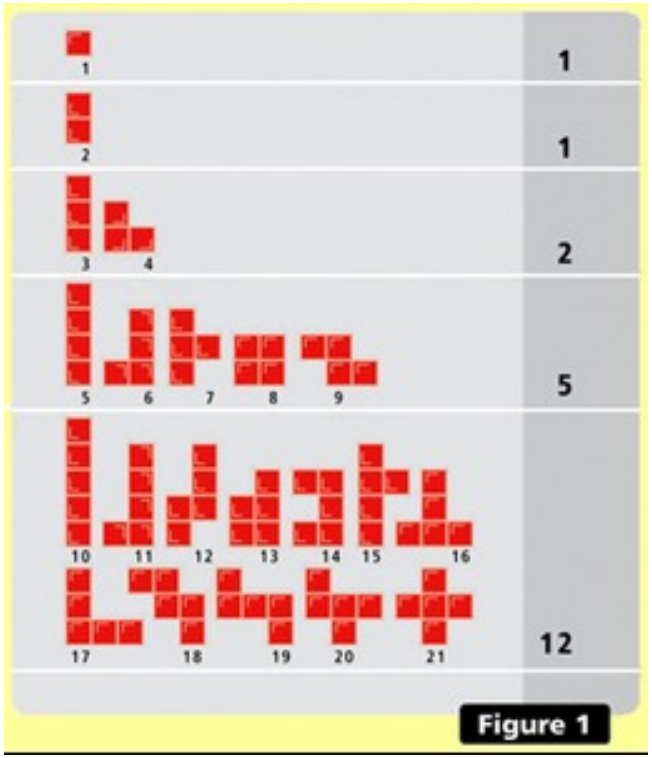
Blokus!

http://mattelgames.com/en-us/blokus



Other Questions to think about…

Can you tile all the 1through 5 polyominoes into 1 rectangle?



Polyominoes of Order 1 through 6

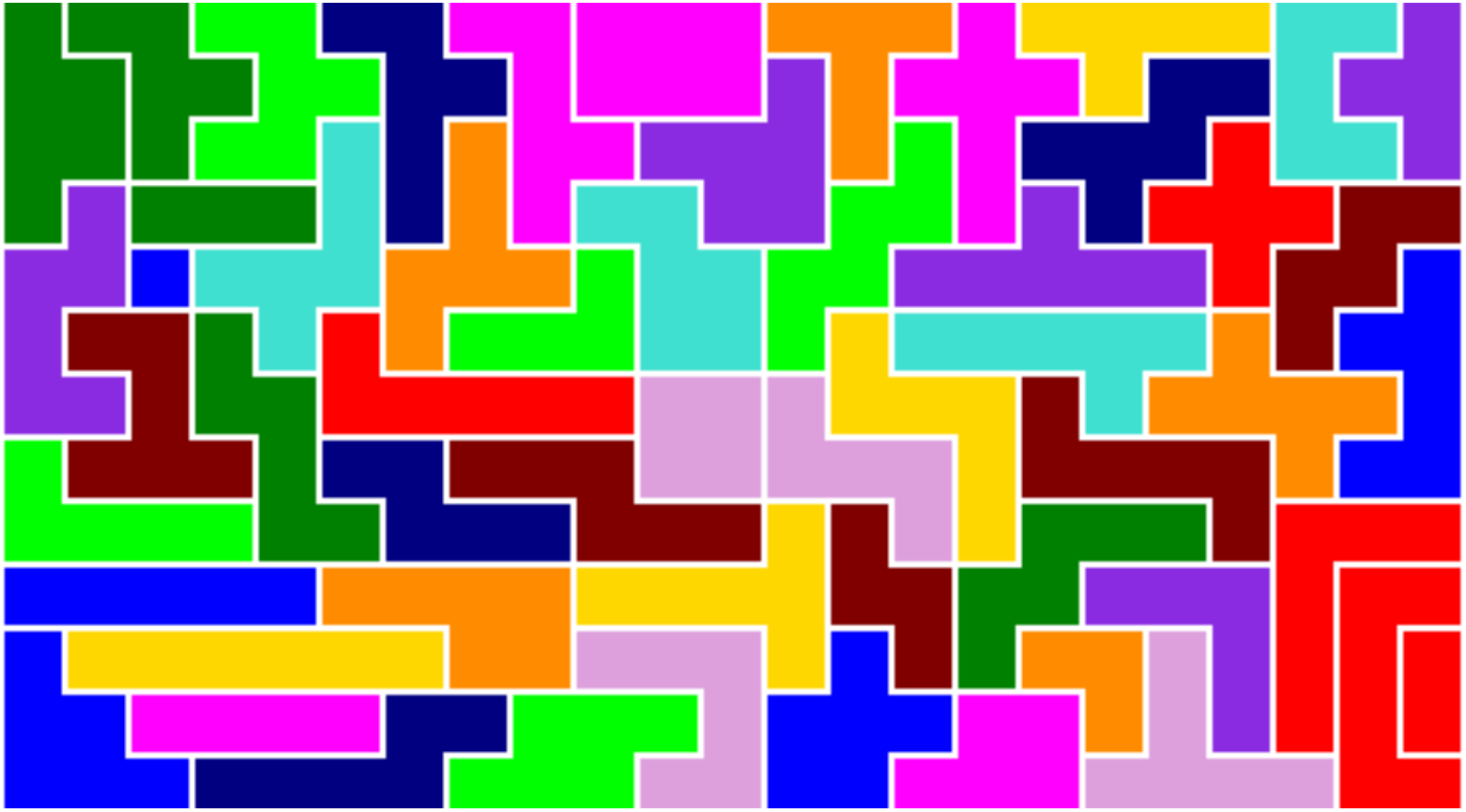
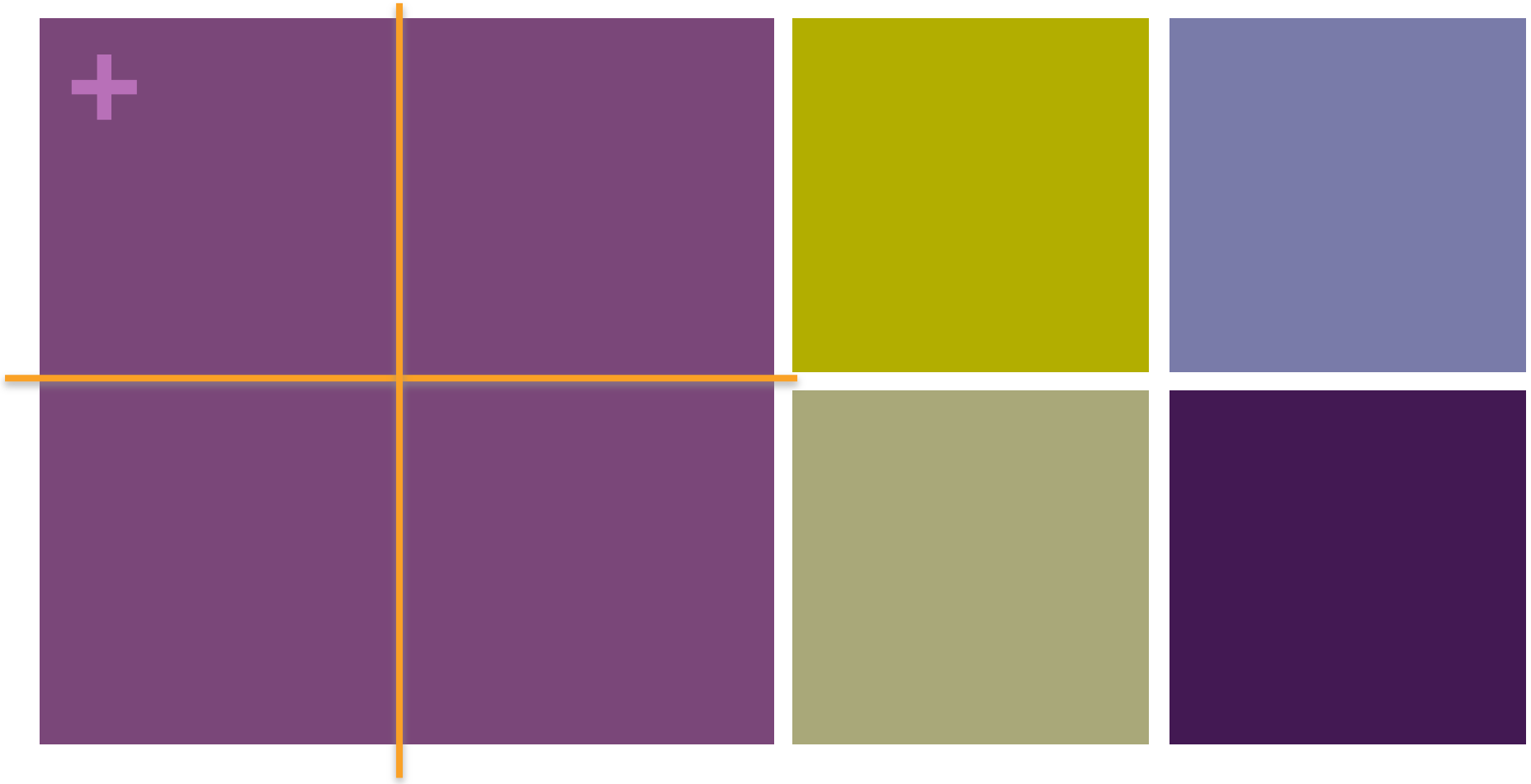


Image from http://puzzler.sourceforge.net/docs/polyominoes.html

Other Questions to think about…
What if your tiles have to be squares of 2^n length?
What shapes can you tile then?

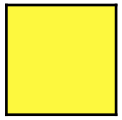
Mathematical Tiling and Organization

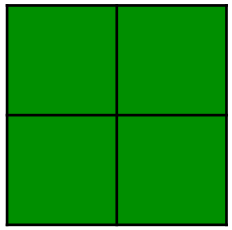
Central Washington University
Dr. Brandy Wiegers
Central Washington University

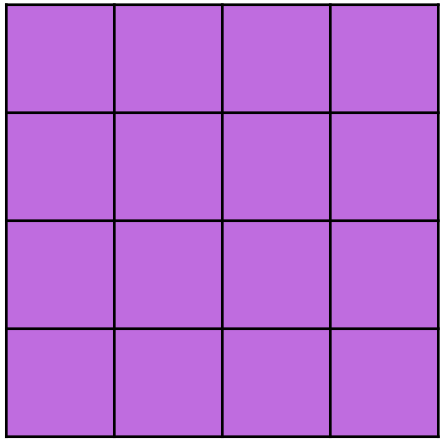


Other Questions to think about…
What if your tiles have to be squares of 2^n length?
What shapes can you tile then?

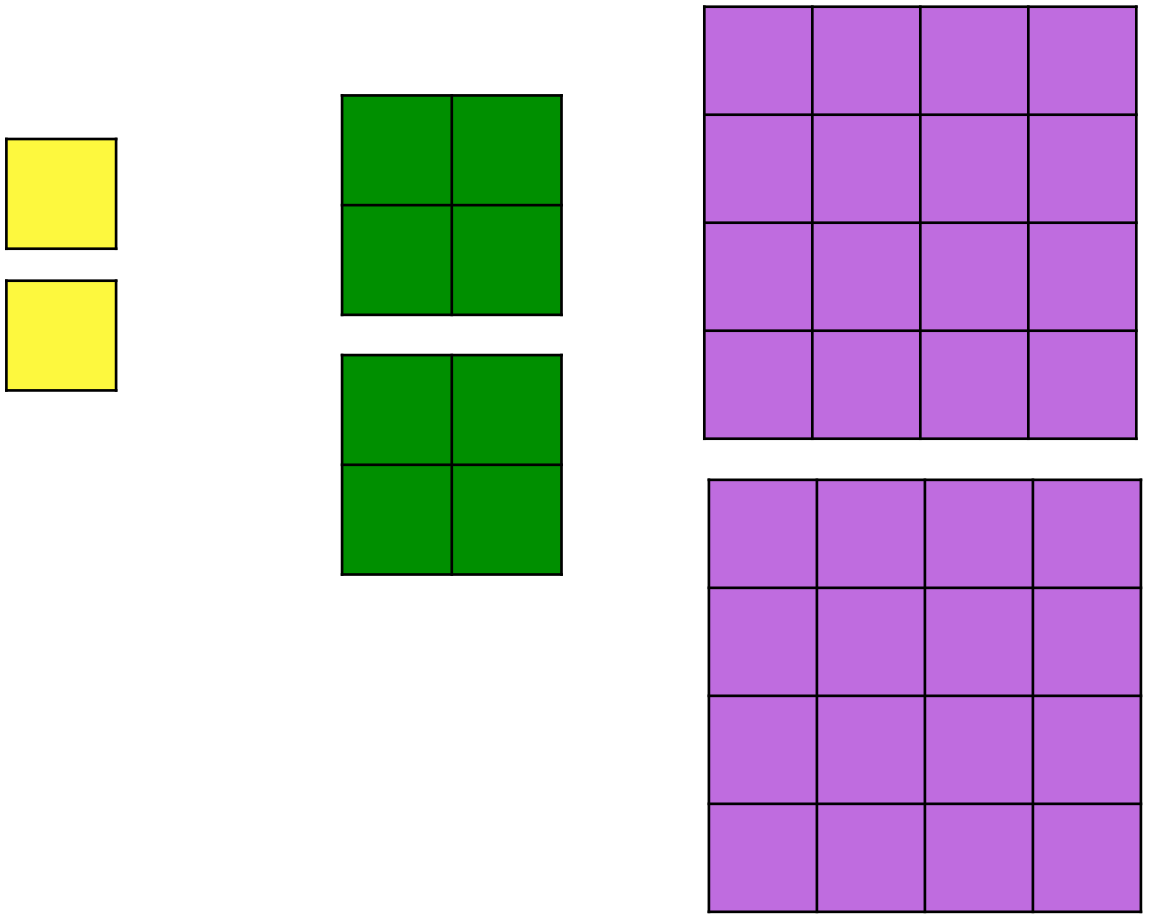
Q: What if your tiles have to be squares of 2^n length? What shapes can you tile if you can only use 1 tile of each length?

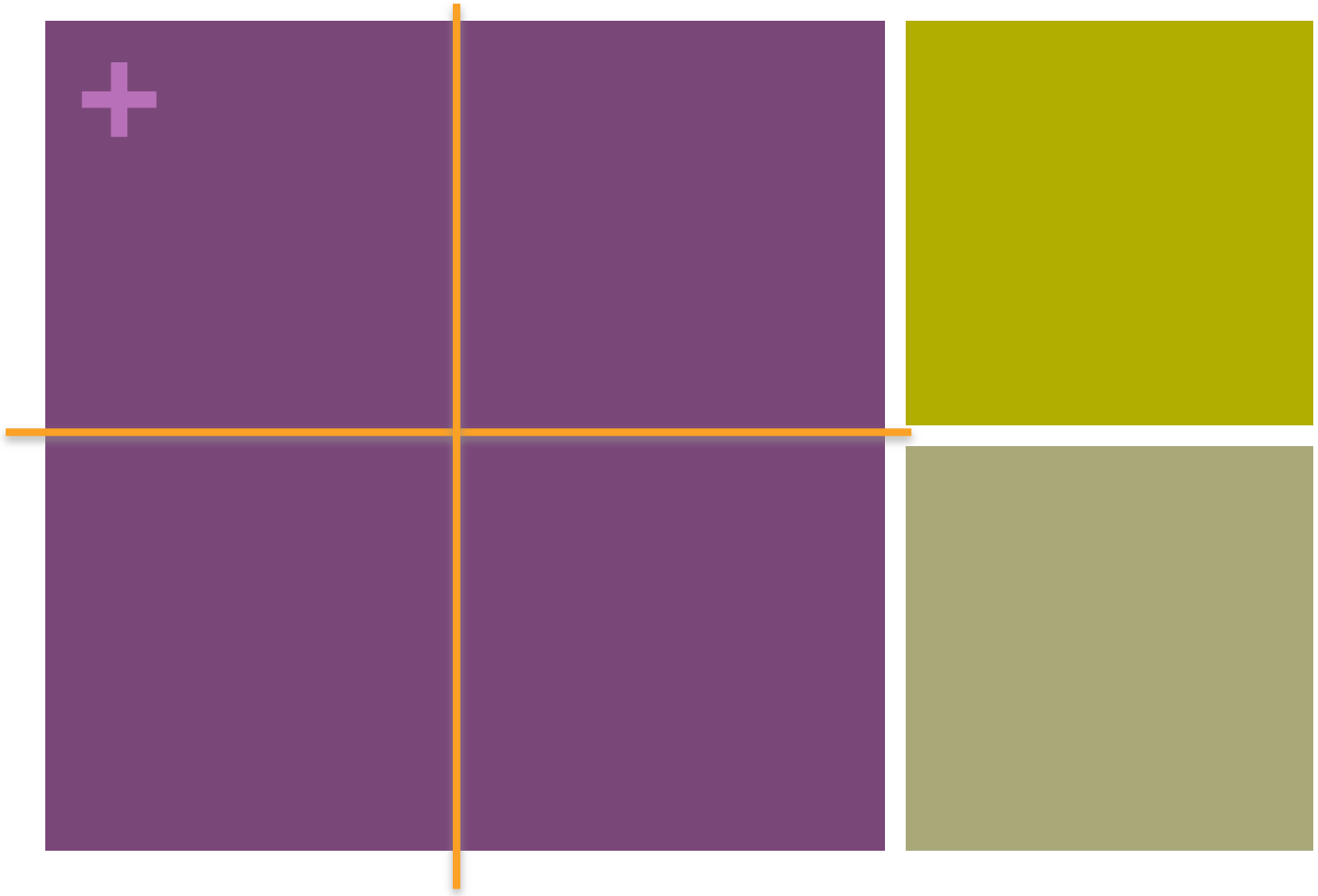






Q: What if your tiles have to be squares of 2^n length? What shapes can you tile if you can only use 2 tiles of each length?



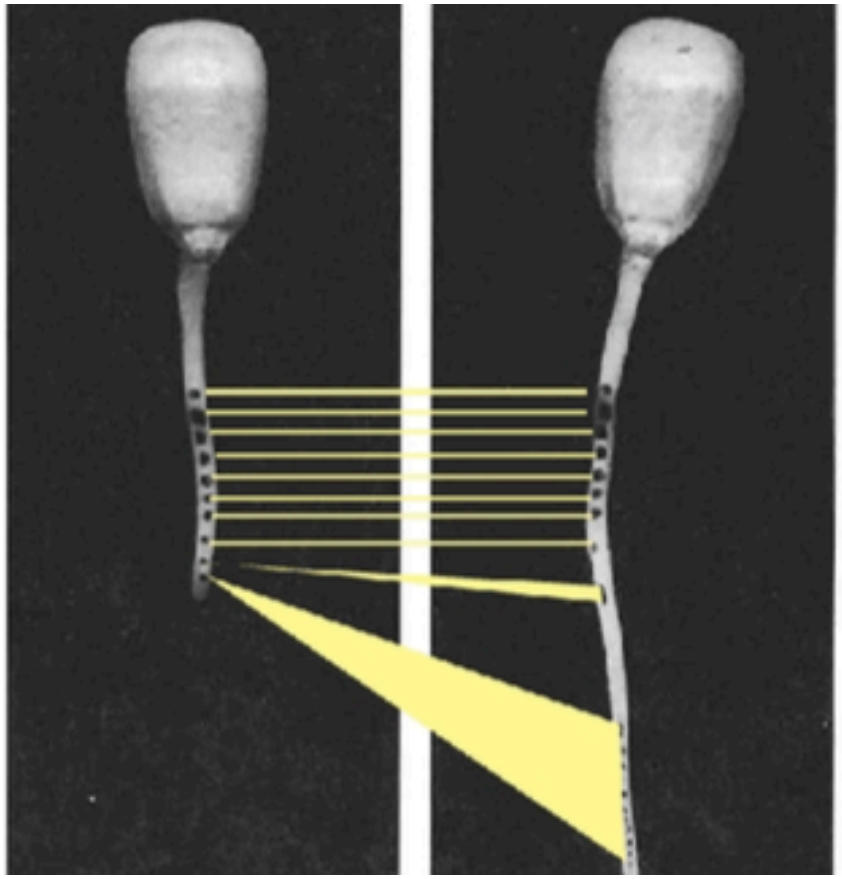


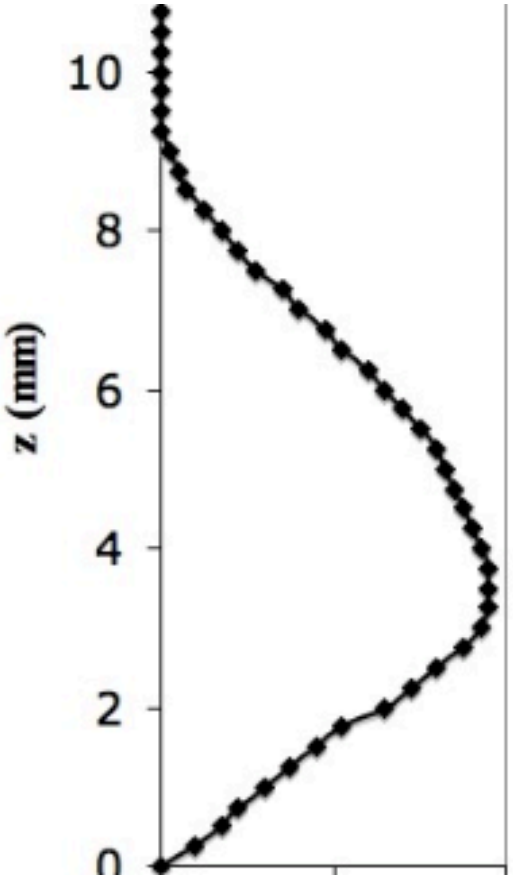
Q: What if your tiles have to be squares of 2^n length? What shapes can you tile if you can only use 2 tiles of each length?

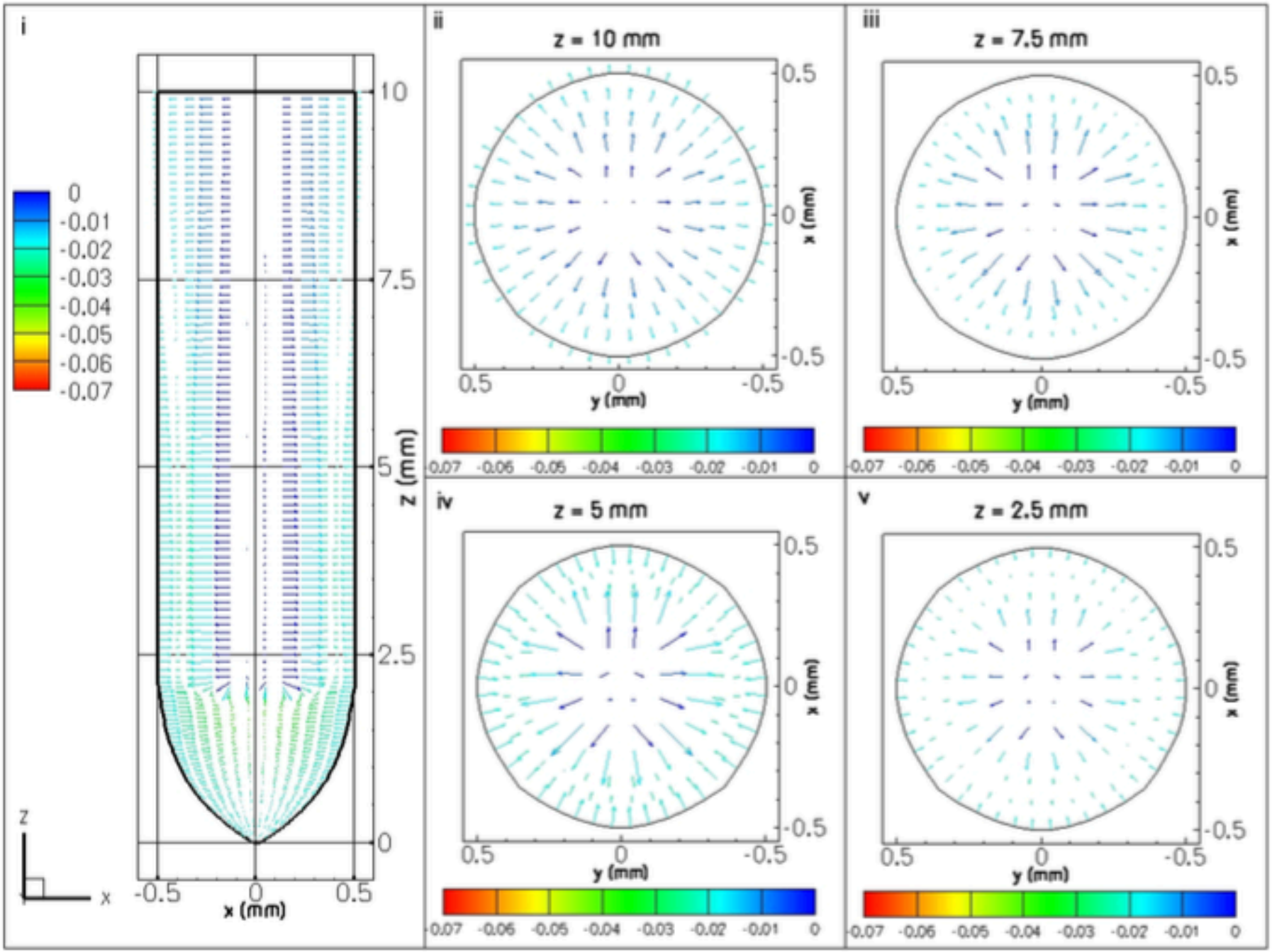
Problem Solving Skills

- Mathematical Play
- Using Organization!
  - Starting smaller
  - Recording Data
  - Designing systems to find repeats
  - Coloring

My Ph.D.






i
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
10
7.5
5
2.5
0
z (mm)
z
x
-0.5
0
0.5
x (mm)
ii
z = 10 mm
iii
z = 7.5 mm
iv
z = 5 mm
v
z = 2.5 mm
0.5
0
-0.5
y (mm)
x (mm)
0.07 -0.06 -0.05 -0.04 -0.03 -0.02 -0.01 0

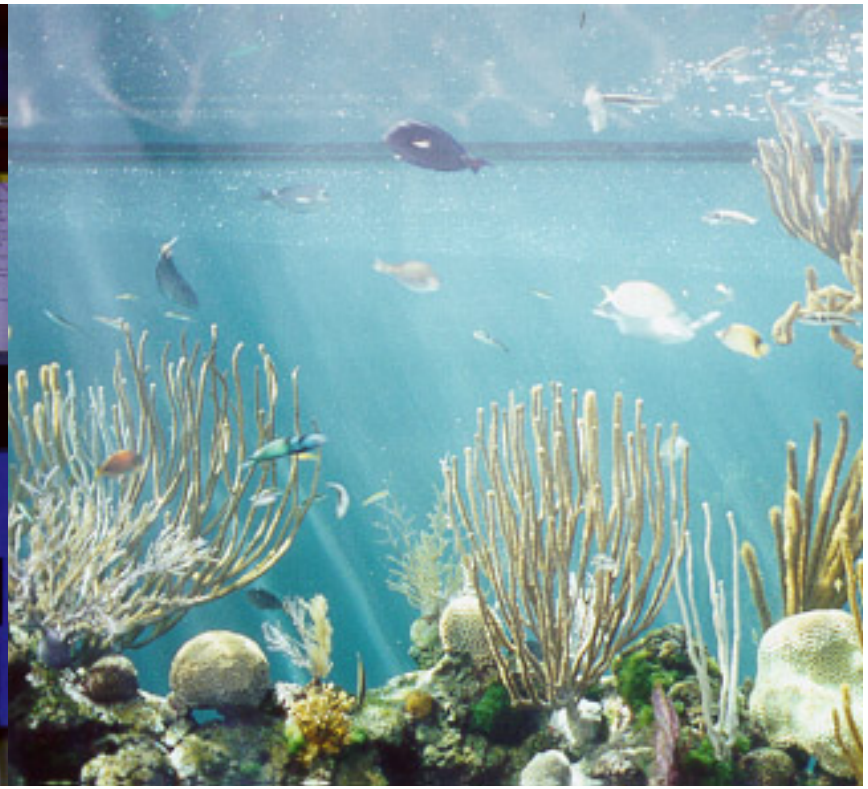
Greenland
Iceland
Finland
Sweden
Norway
Russia
Canada
Poland
Germany
Ukraine
France
Spain
Italy
Turkey
Kazakhstan
Mongolia
China
South Korea
Afghanistan
Iran
Iraq
Pakistan
India
Thailand
Saudi Arabia
Egypt
Libya
Algeria
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Kenya
DR Congo
Tanzania
Angola
Namibia
Botswana
South Africa
Madagascar
Indonesia
Australia
Mexico
Venezuela
Colombia
Brazil
Peru
Bolivia
Chile
Argentina
North Atlantic Ocean
South Atlantic Ocean
South Pacific Ocean
Indian Ocean
Southern Ocean
P
N
Q
D
V
Z
U
S
c
d
O
B
b
Y
I
H
L

Winnipeg
Vancouver
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
OREGON
IDAHO
WYOMING
NEBRASKA
IOWA
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
United States
CALIFORNIA
Las Vegas
Los Angeles
ARIZONA
NEW MEXICO
OKLAHOMA
Phoenix
San Diego
Dallas
TEXAS
San Antonio
Houston
LOUISIANA
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
Gulf of California
Gulf of Mexico
Monterrey
Mexico
Guadalajara
Mexico City
Havana
Cuba
Dominican Republic
Guatemala
Honduras
Nicaragua
Caribbean Sea
Chicago
MICHIGAN
ILLINOIS
INDIANA
OHIO
WEST VIRGINIA
KENTUCKY
TENNESSEE
Ottawa
Montreal
Toronto
NEW YORK
PENNSYLVANIA
NJ
DE
MAINE
VT
NEW BRUNSWICK
NOVA
NORTH CAROLINA
SOUTH CAROLINA
VIRGINIA
P
E
N
K
Q
D
V
W
Z
R
A
C
S
U
a
c
X
G
J
B
d
T
O
b

Julia Robinson Math Festival – April 4th (1-5pm), UW HUB

Julia Robinson Mathematics Festival

http://mathforlove.com/julia-robinson-festival/

Any questions?

Dr. Brandy Wiegers **wiegersb@cwu.edu**