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Knots from Puzzle Pieces

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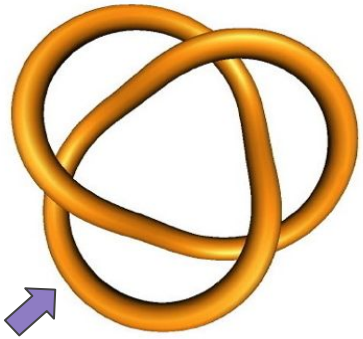
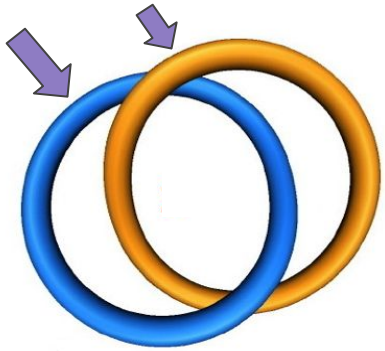
Background



➔ **Knot**

- A **knot** is a closed loop in space, in which there are no loose ends and no beginning and ending points.

Components

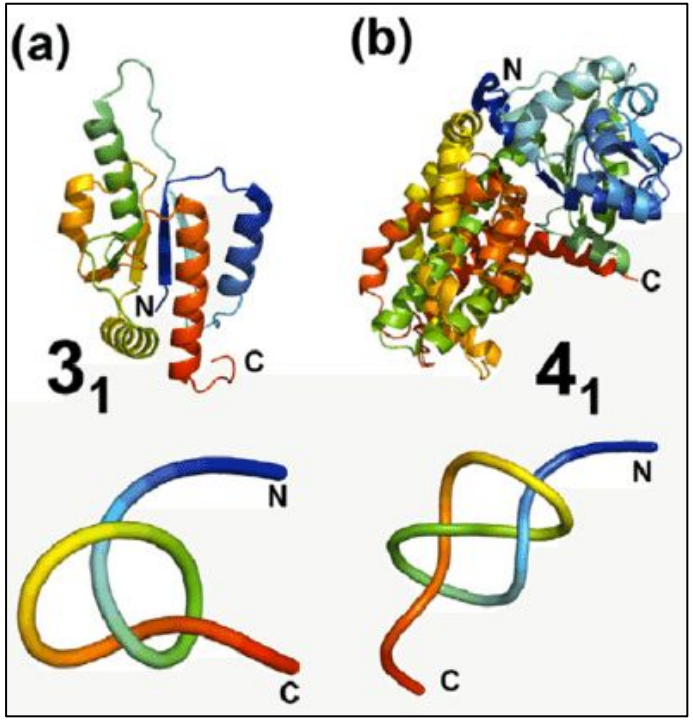


➔ **Link**

- A **link** is a collection of closed loops in space.

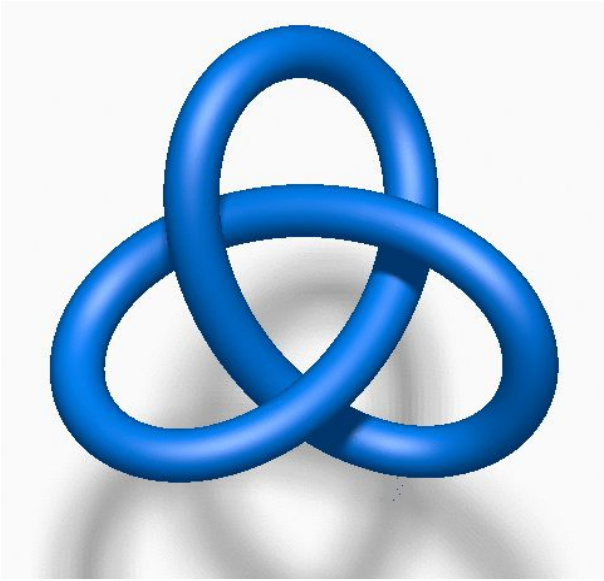
Goal

- Understand Knots in Nature
  - Proteins, Enzymes, DNA, & RNA
- Use Random Knot Models

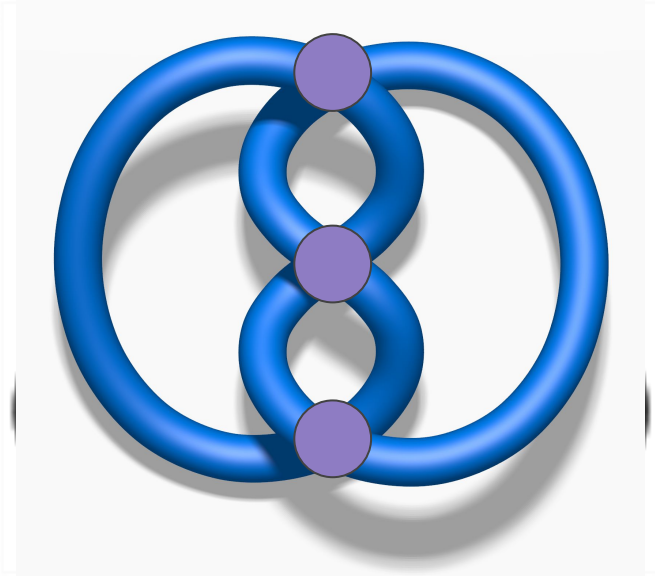


Via: Lim, Nicole & Jackson, Sophie. (2015). Molecular Knots in Biology and Chemistry. Journal of physics. Condensed matter : an Institute of Physics journal. 27. 10.1088/0953-8984/27/35/354101.

Trefoil Knot

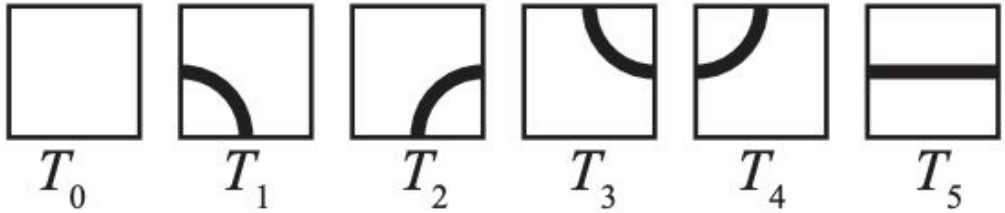


3_2

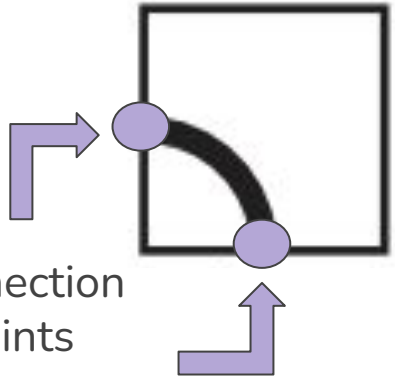


Crossing Point

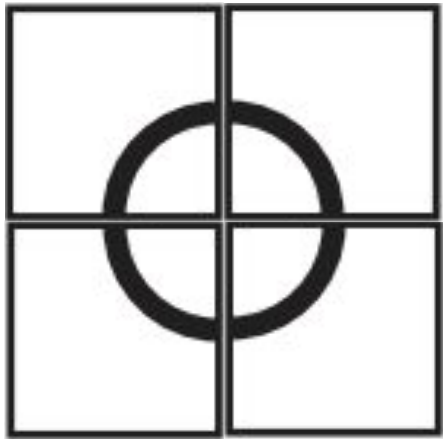
Knot Mosaic Tiles



Crossing tiles



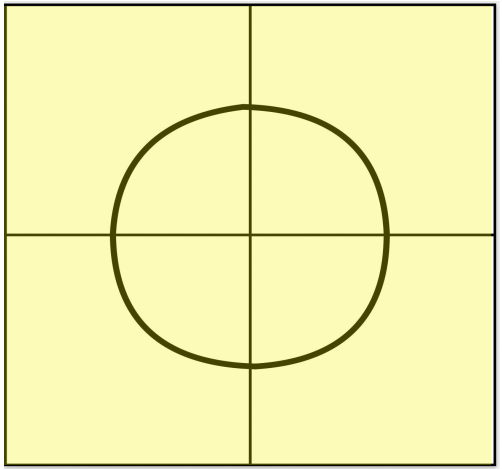
Connection points



Unknot, 0_1

0_1

2 x 2

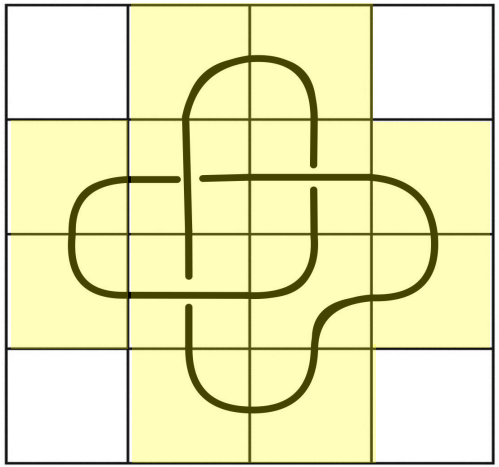


$m(0_1) = 2$

$t(0_1) = 4$

3_1

4 x 4

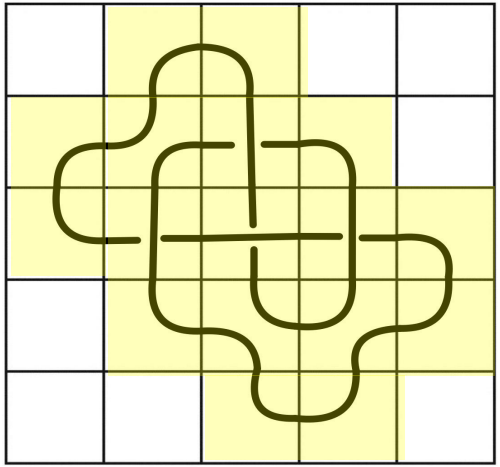


$m(3_1) = 4$

$t(3_1) = 12$

4_1

5 x 5

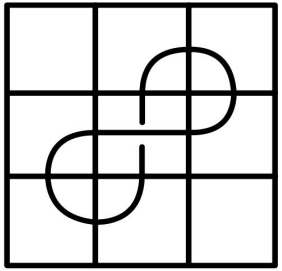


$m(4_1) = 5$

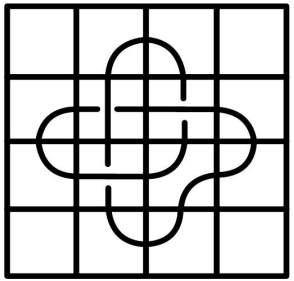
$t(4_1) = 17$

Mosaic & Tile Numbers

Reduced & Space Efficient Knots

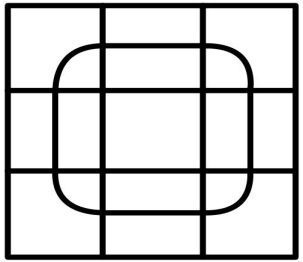


Not Reduced

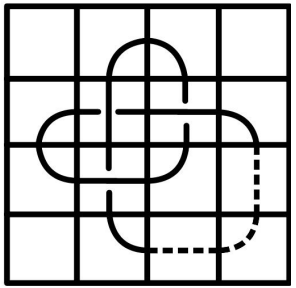


$t(3_1) = 12$

Space Efficient



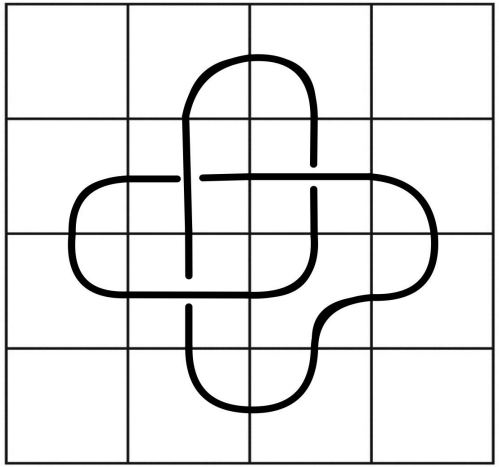
Reduced

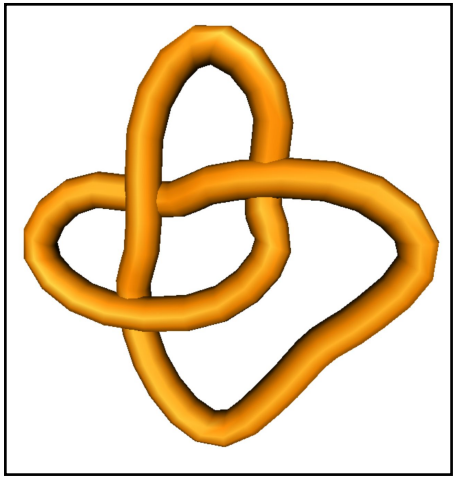


$t(3_2) = 13$

Not Space Efficient

Mosaic Progress

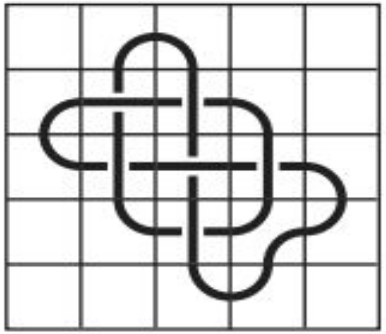




Knot type:
Trefoil, 3_1

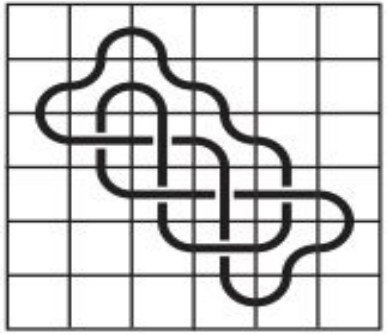
Issues with Mosaics

- Begin to tilt diagonally



6_2

- Extra, unused space



6_3

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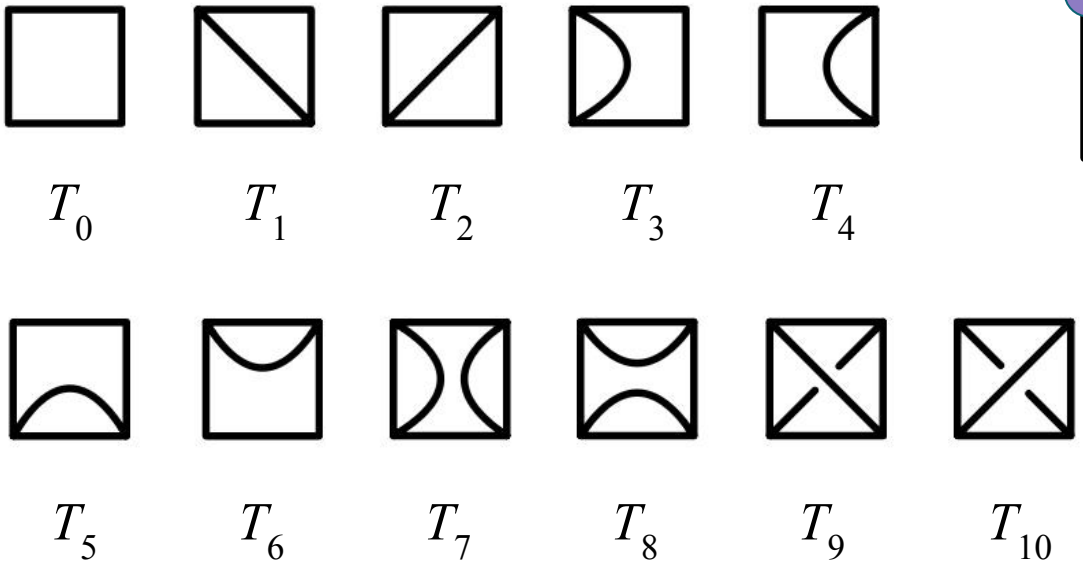
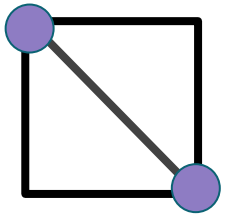
Move to Bro-saic Tiles



Crossing tiles



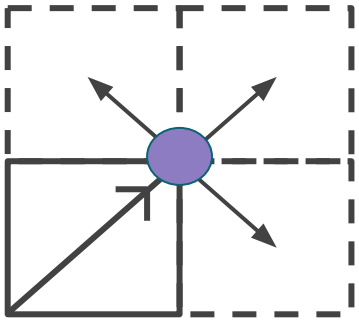
Connection Point

Bro-saic Tiles

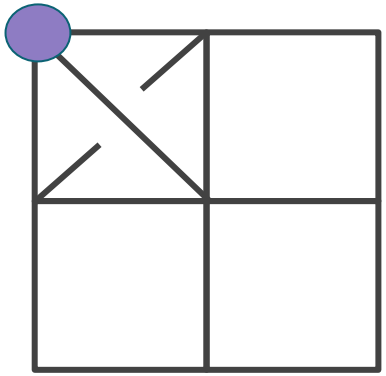
Brosaic Observations

In a properly connected brosaic board,

- Each tile must be *suitably connected*

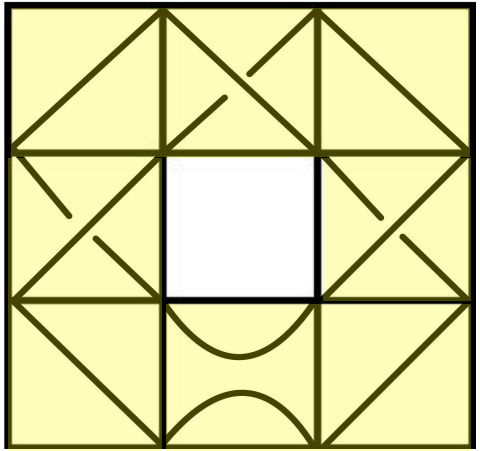


- Corner tiles of the brosaic board cannot be crossing tiles



3_1

3 x 3

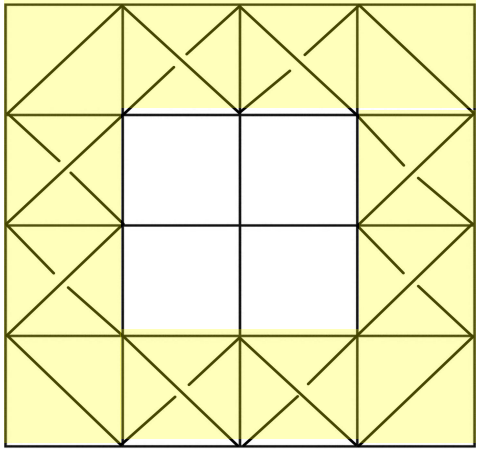


$m(3_1) = 4$ $b(3_1) = 3$

$t_m(3_1) = 12$ $t_b(3_1) = 8$

8_1

4 x 4

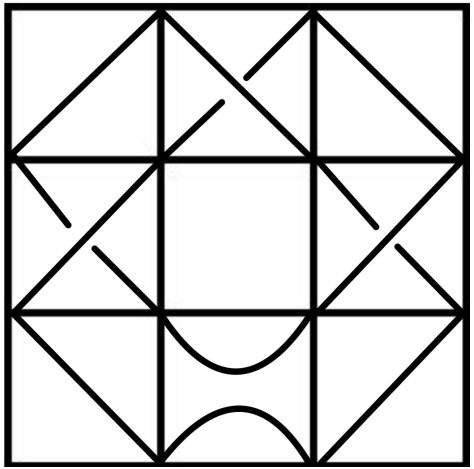


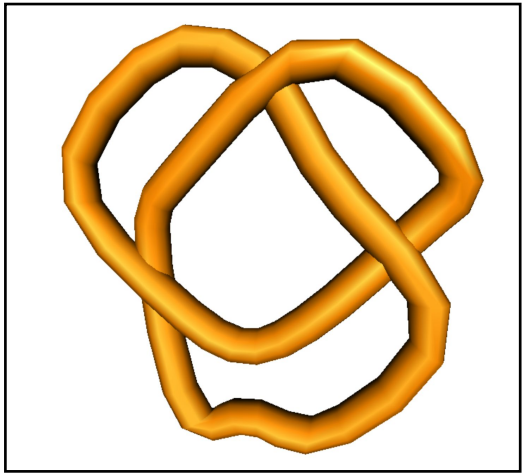
$m(8_1) = 6$ $b(8_1) = 4$

$t_m(8_1) = 22$ $t_b(8_1) = 12$

Brosaic and Tile Numbers

Brosaic Coding

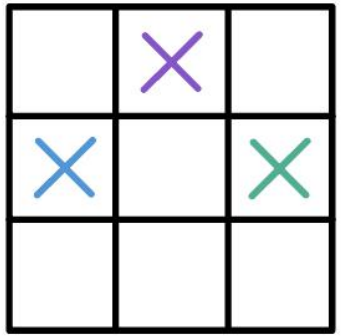




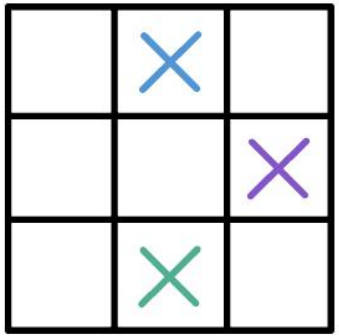
Knot type:
Trefoil, 3_1

Brosaic Combinations

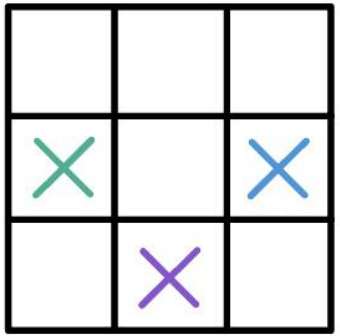
0°



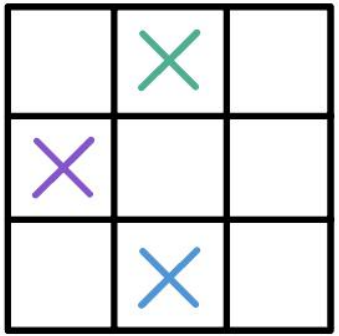
90°



180°



270°



Equation: $({}_xC_y) \times (2)^y$

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	X	X	
X			X
X			X
	X	X	

Equation: $({}_xC_y) \times (2)^y$

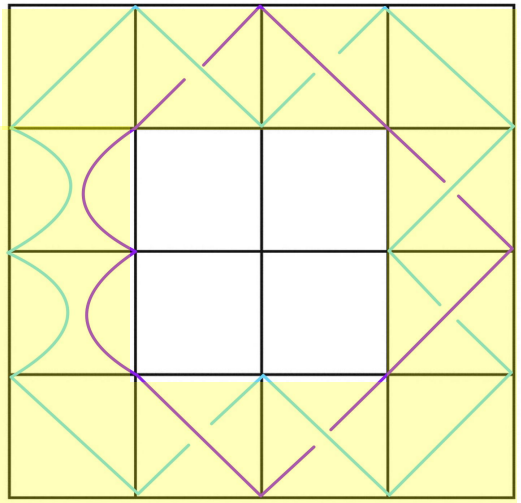
1. y = 6, x = 8 → $({}_8C_6)$

2. $(2)^y = (2)^6$

3. $({}_8C_6) \times (2)^6 = 1792$

Brosaic Combinations

Brosaic Links on *m* x *n* Matrices

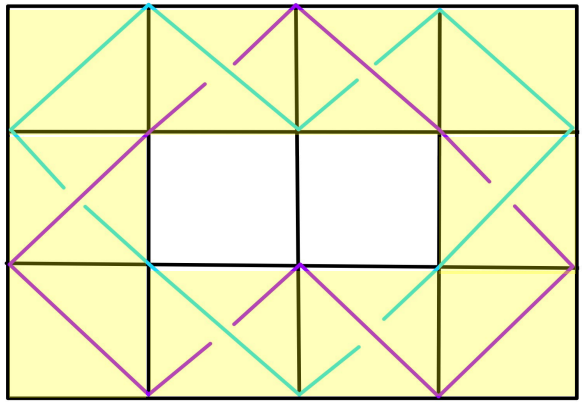


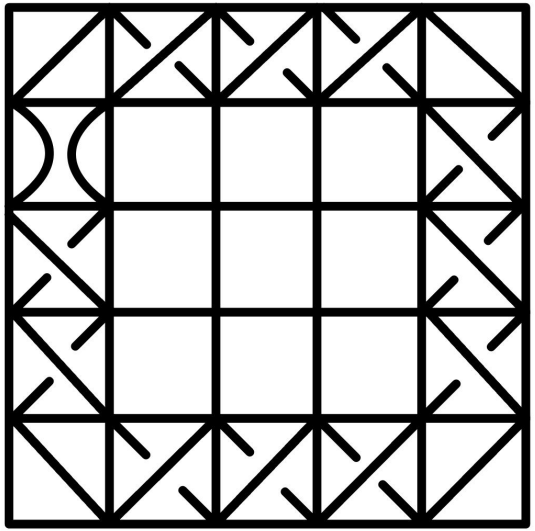
n x n = 4 x 4

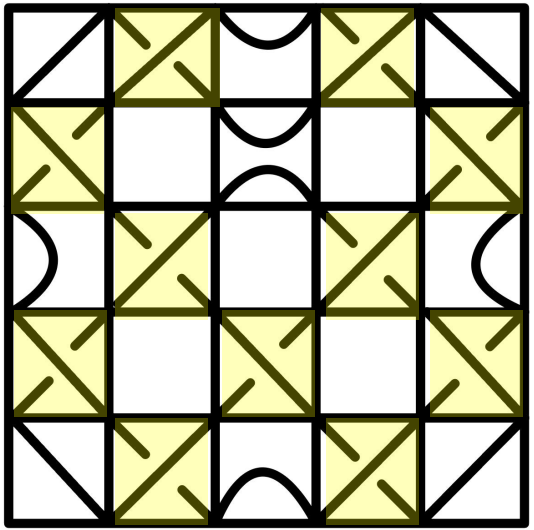
$t(6_1^2) = 12$

m x n = 3 x 4

$t(6_2^2) = 10$







Other Brosaic Patterns

Concluding Thoughts