

What are numbers?

Sept. 12, 2017

Take out a piece of paper

Work silently & alone for the next minute

Without sharing or looking at anyone else's paper

Show me seven

No questions



7

ce n'est pas sept

The Big Question

If we were going to design a new system for representing numbers, what features would this system need to have?

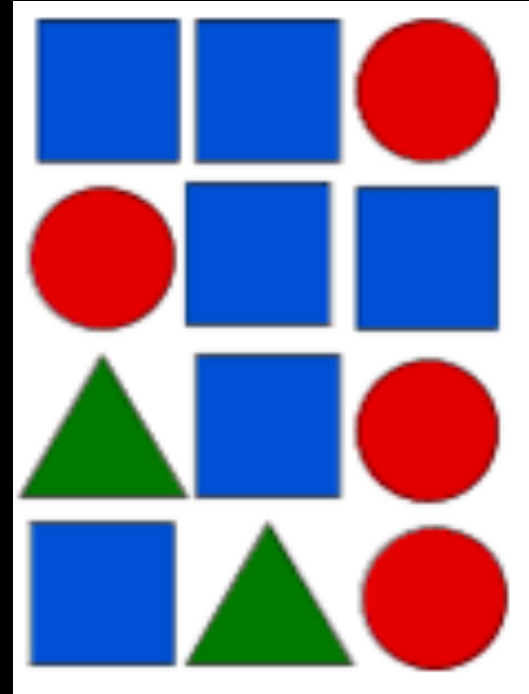
Your Challenge

In your group, figure out how many possible combinations you can make with these three shapes:

A Circle

A Triangle

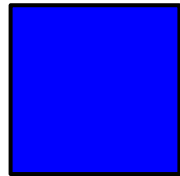
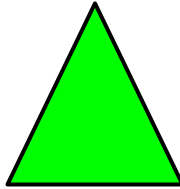
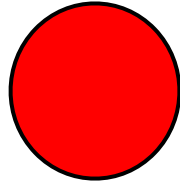
A Square





Previously on CSP....

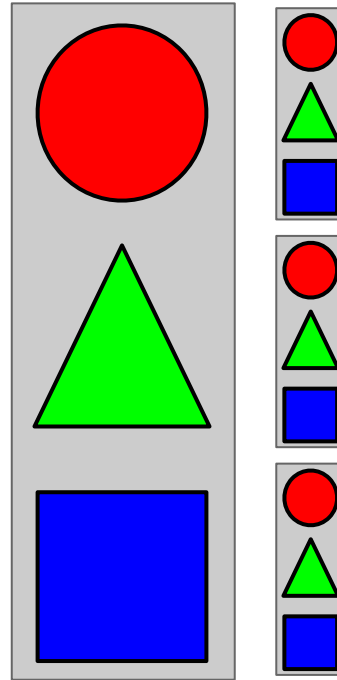
1 place = 3, 1-shape patterns





Previously on CSP....

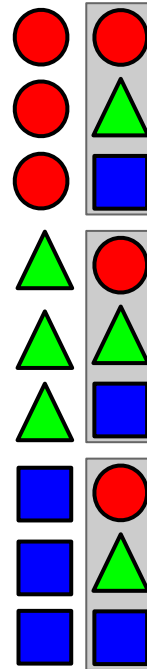
2 places = 9, 2-shape patterns





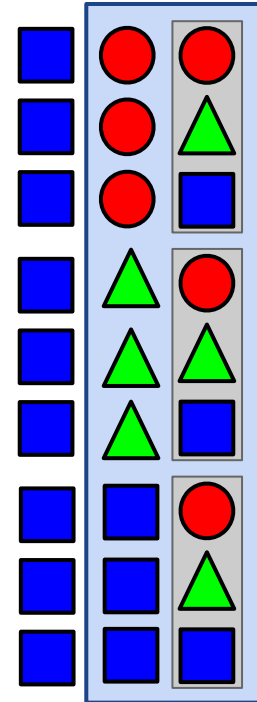
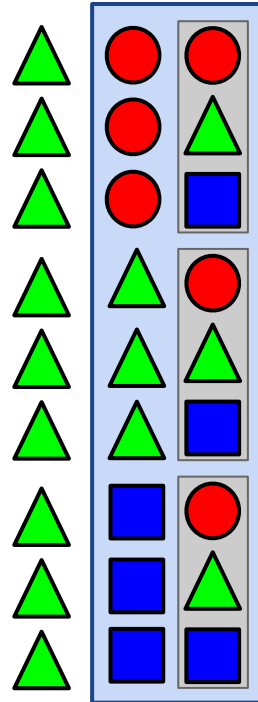
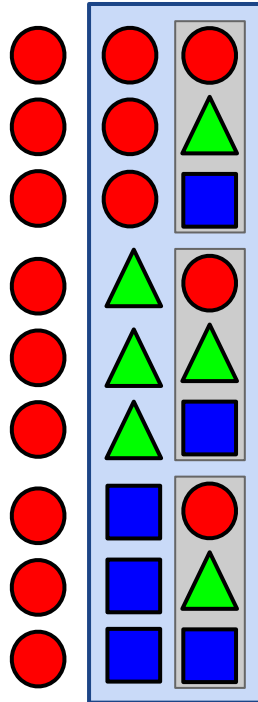
Previously on CSP....

2 places = 9, 2-shape patterns



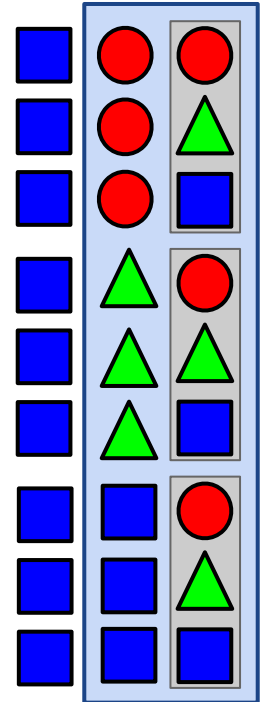
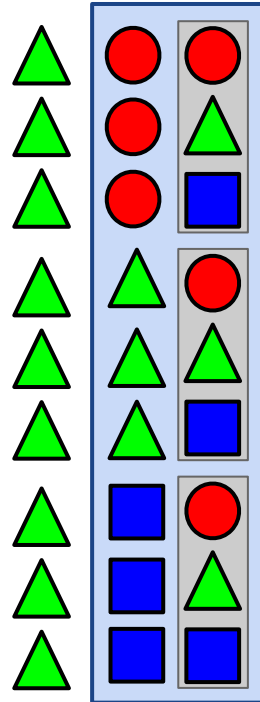
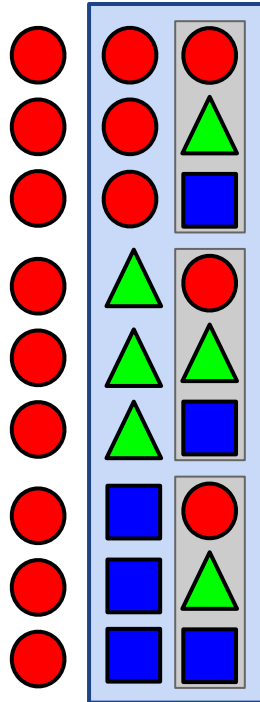


3 places = 27, 3-shape patterns





3 places = 27, 3-shape patterns





Previously on CSP....

Number each pattern to make a shape -> number mapping

	0
	1
	2
	3
	4
	5
	6
	7
	8

	9
	10
	11
	12
	13
	14
	15
	16
	17

	18
	19
	20
	21
	22
	23
	24
	25
	26



What if we had 10 shapes?



1 place = Ten 1-shape patterns

0
1
2
3
4
5
6
7
8
9

← These are just shapes!



Quiz: What comes next?

*Ten
shapes*

0			
1	0	9	9
2	<u> </u>	<u> </u>	<u> </u>
3			
4			
5			
6	<u> </u>	<u> </u>	<u> </u>
7			
8			
9			



Quiz: What comes next?

*Ten
shapes*

0			
1	<u>0</u>	<u>9</u>	<u>9</u>
2			
3			
4			
5	<u>1</u>	<u>0</u>	<u>0</u>
6			
7			
8			
9			



Previously on CSP....

Place Values...



Place Values...

With Ten “shapes” every time you add a place, you multiply by 10 the number of numbers...

_____ 10 possibilities (0 - 9)

_____ _____ 100 possibilities (00 - 99)

_____ _____ _____ 1000 possibilities (000 - 999)



Place Values...

With Three “shapes” every time you add a place, you multiply by 3 the number of numbers...

_____ 3 possibilities (● ▲ ■)

_____ _____ 9 possibilities (●● - ■■)

_____ _____ _____ 27 possibilities (●●● - ■■■)



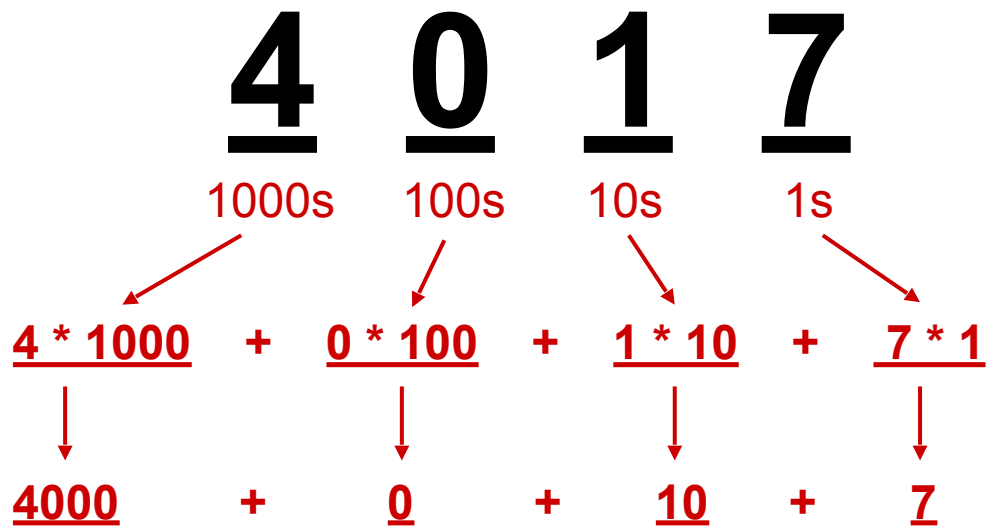
Previously on CSP....

Write the number...

Four thousand and seventeen



Place Values...Remember what it means?





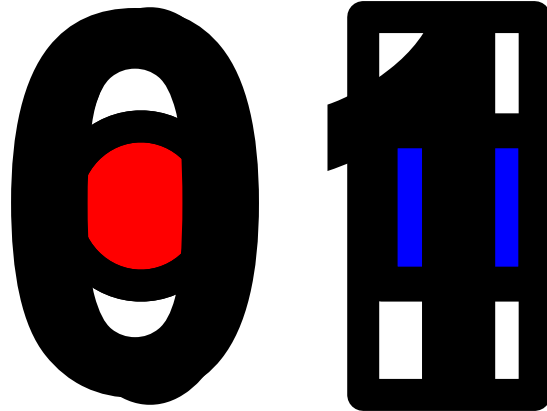
Where is this heading?

...binary...



Previously on CSP....

“Binary” is a number system with 2 shapes...





The pattern holds...

With two “shapes” every time you add a place, you **multiply by 2** the number of numbers...

_____ 2 possibilities (0 1)

_____ _____ 4 possibilities (00 - 11)

_____ _____ _____ 8 possibilities (000 - 111)

_____ _____ _____ _____ 16 possibilities (0000 - 1111)



Place Values...powers of 2

$$\begin{array}{cccc} \mathbf{1} & \mathbf{1} & \mathbf{0} & \mathbf{1} \\ \mathbf{8s} & \mathbf{4s} & \mathbf{2s} & \mathbf{1s} \\ \mathbf{1 * 8} & + & \mathbf{1 * 4} & + & \mathbf{0 * 2} & + & \mathbf{1 * 1} \\ \downarrow & & \downarrow & & \downarrow & & \downarrow \\ \mathbf{8} & + & \mathbf{4} & + & \mathbf{0} & + & \mathbf{1} = 13 \end{array}$$



Constructing a binary number means figuring out which powers of 2 add up to the number you want

128 64 32 16 8 4 2 1



Constructing a binary number means figuring out which powers of 2 add up to the number you want

128	64	32	16	8	4	2	1
0	0	1	0	1	0	0	1
		32	+	8	+		1 = 41