

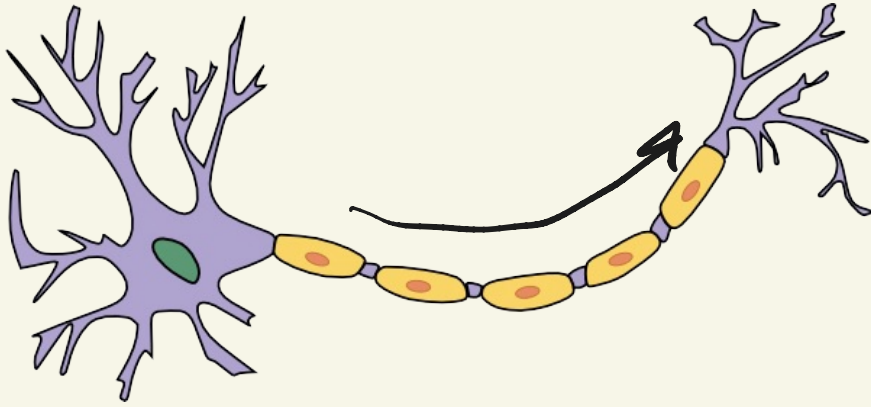
Neurons & Convexity

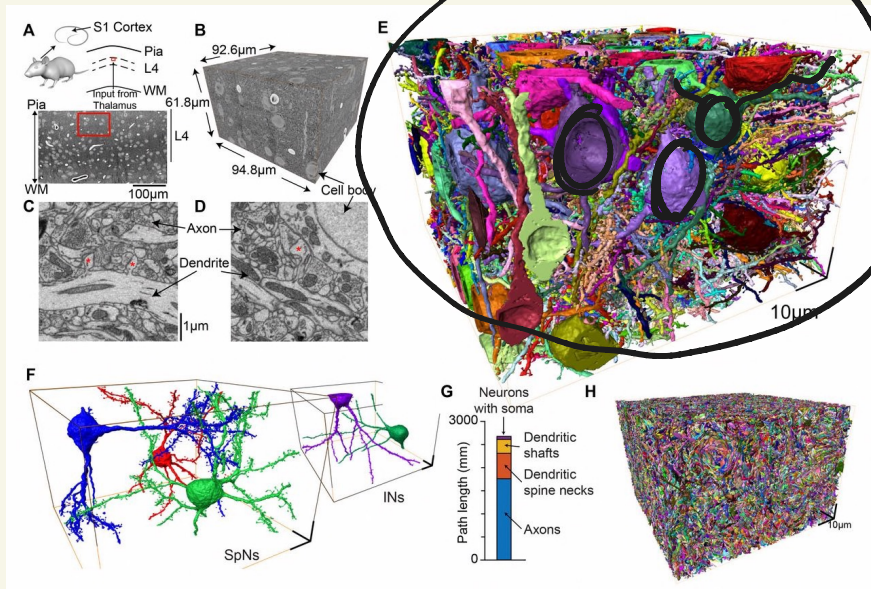
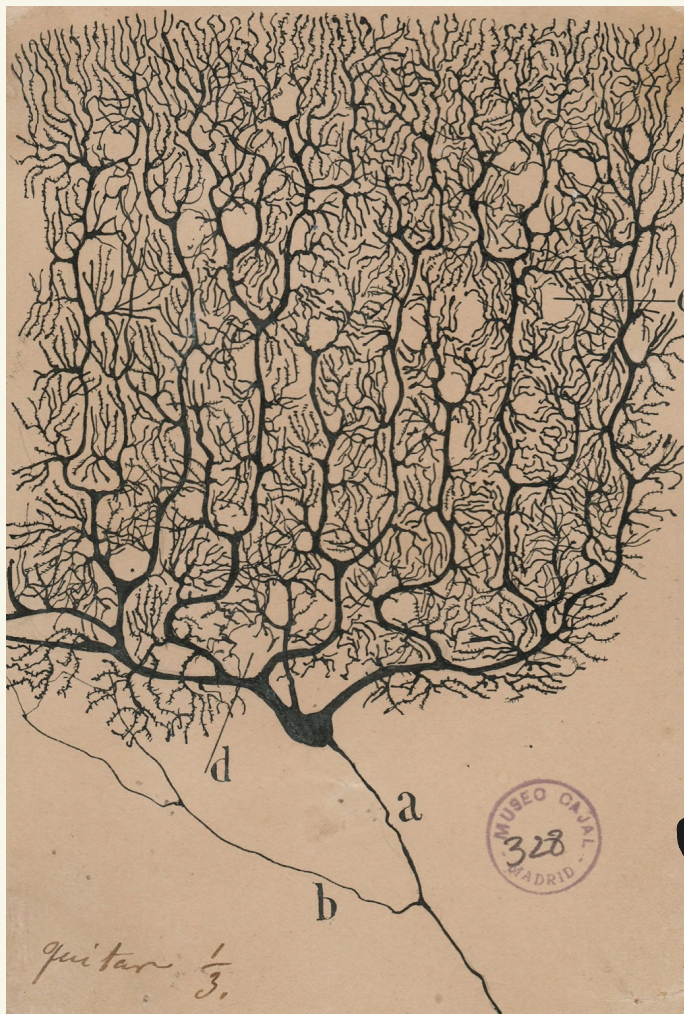
UW Math Hour

Neurons, navigation and convexity

Nora Youngs

What is a neuron?



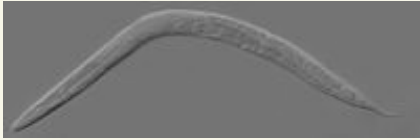




elephant or human?

who has more neurons?

jellyfish or worm — who has
fewest neurons?



302



5,600



250,000



71,000,000



500,000,000



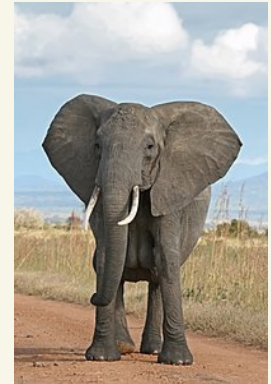
2,148,000,000



9,586,000,000



86,000,000,000



257,000,000,000



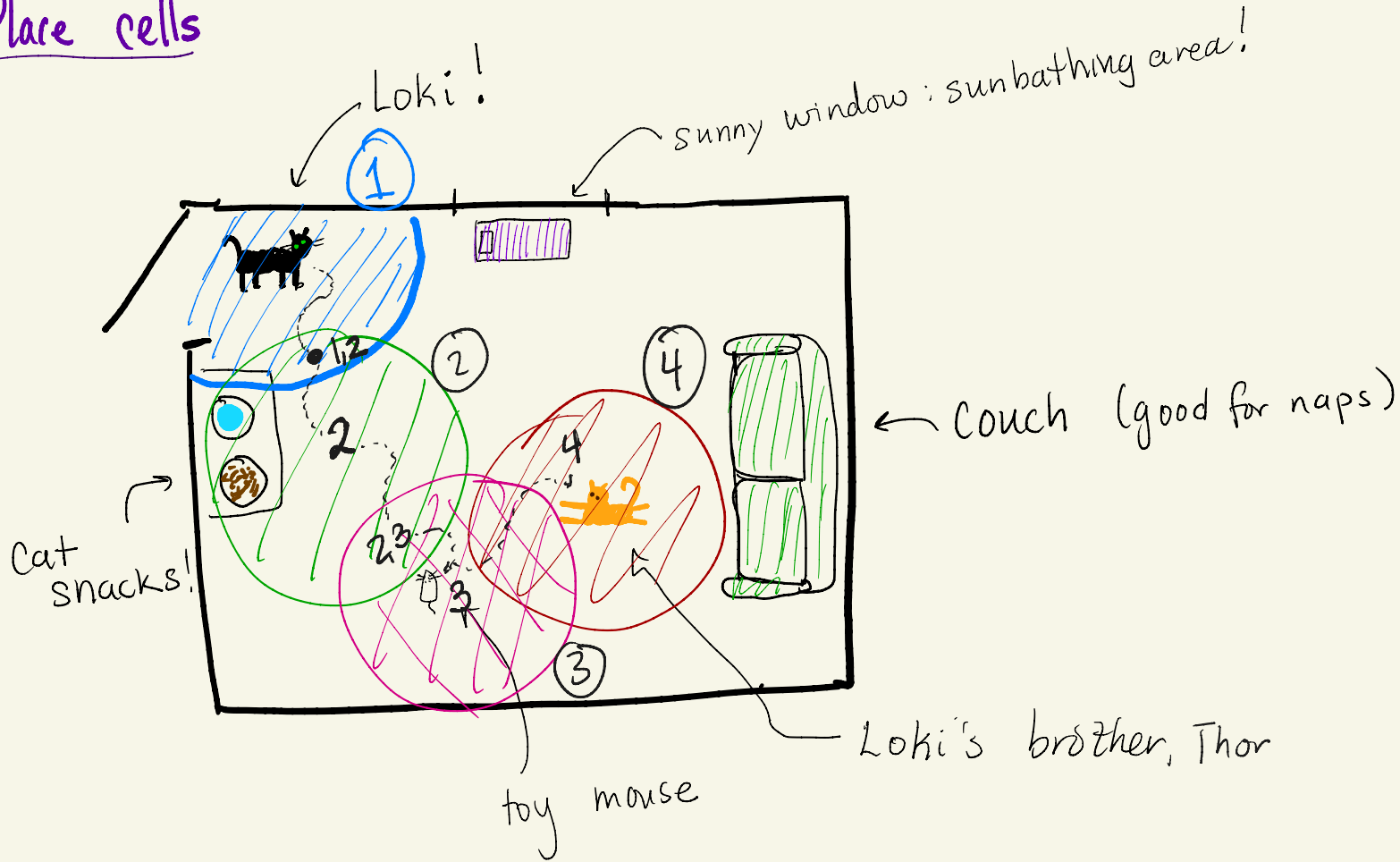
Loki



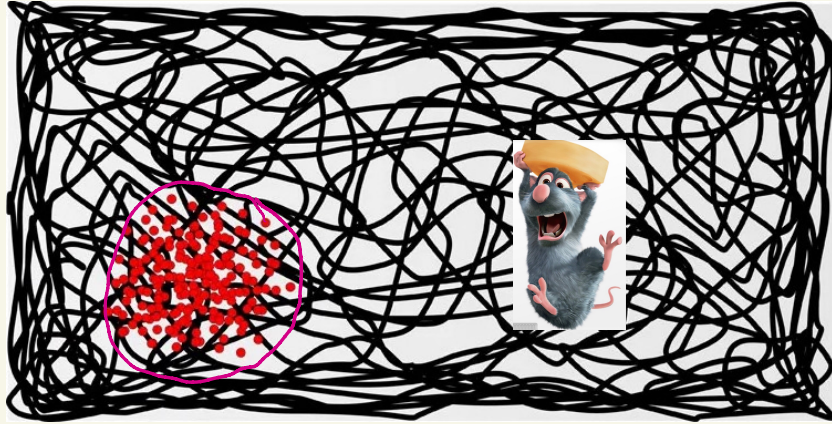
Thor



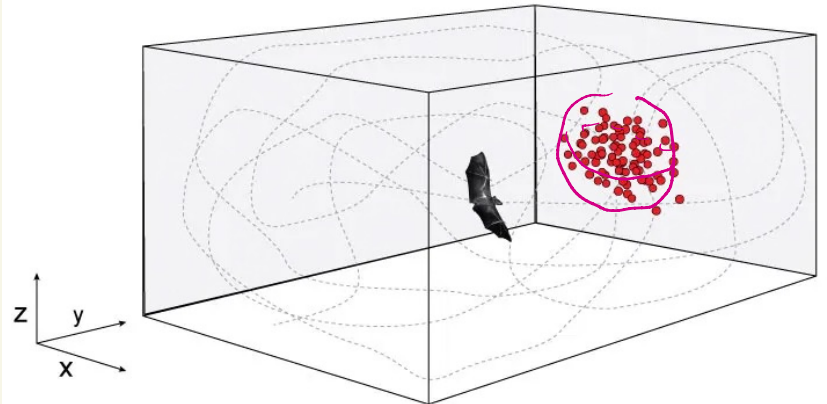
Place cells



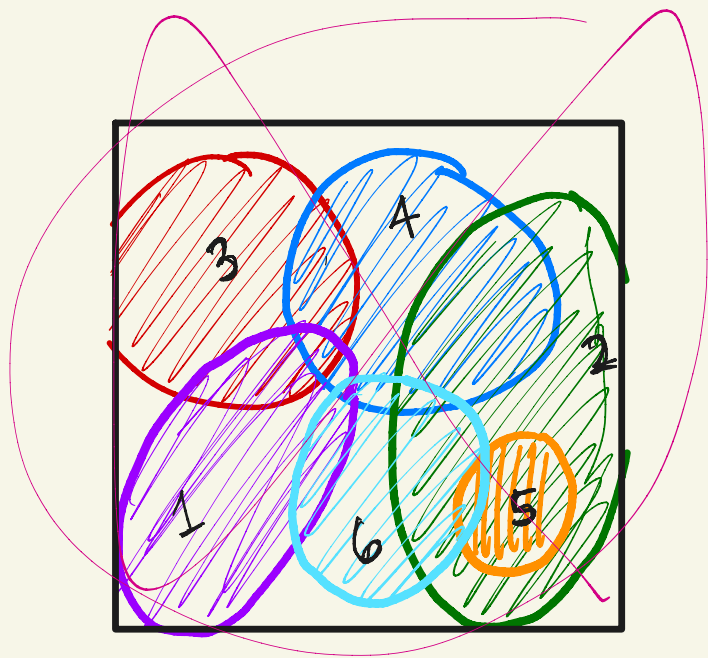
Place cells



Hippocampal place cell in 3D arena



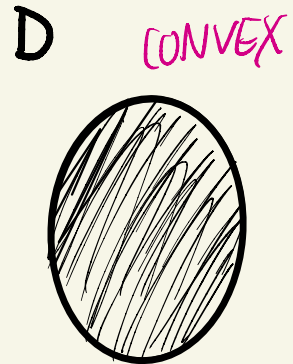
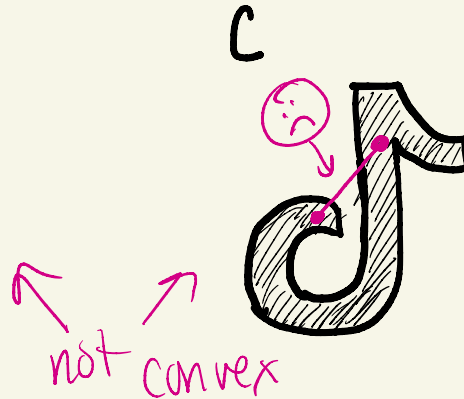
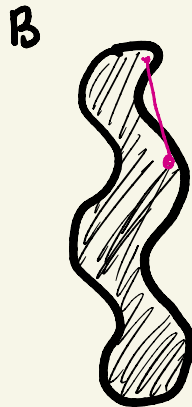
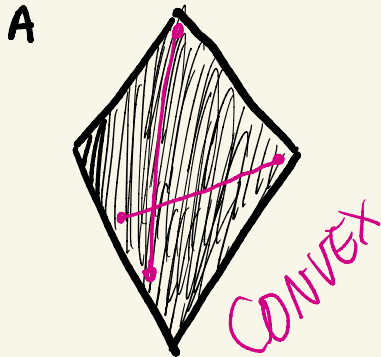
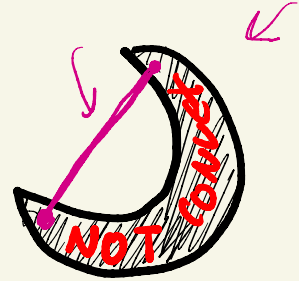
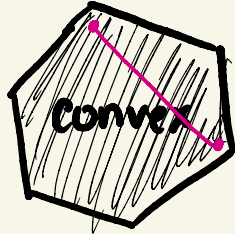
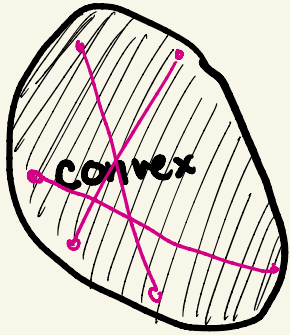
If we know where the place cell regions are,
we can list the possible combinations of
neurons.



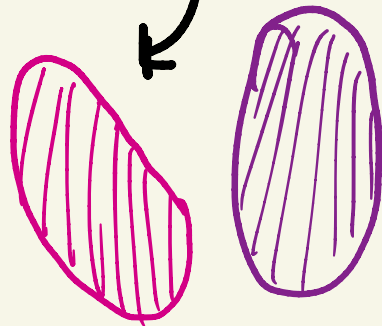
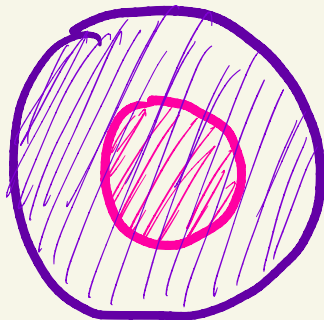
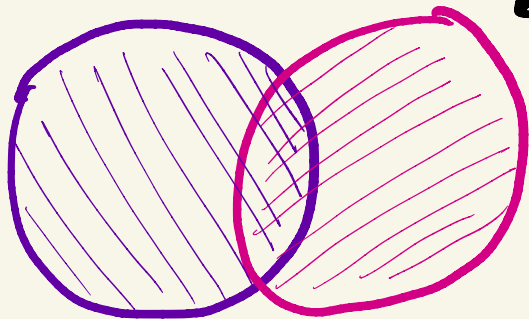
List:

- 1
- 1, 3
- 1, 3, 4
- ...
- ...
- ...

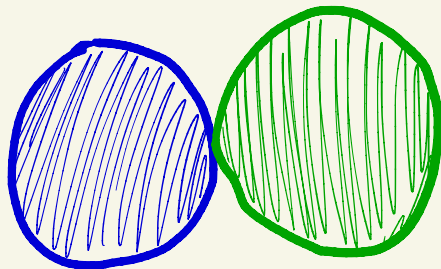
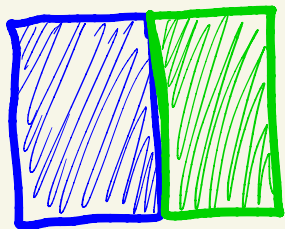
Rules: Place regions are convex: no indents or holes!



The regions can overlap, can be nested, or can be separate!

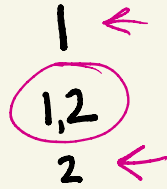


They can NOT be neighbors!

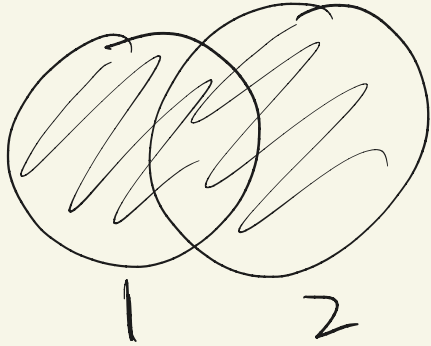


Draw a picture of place cell regions that go with these lists. Follow the rules!

Example :



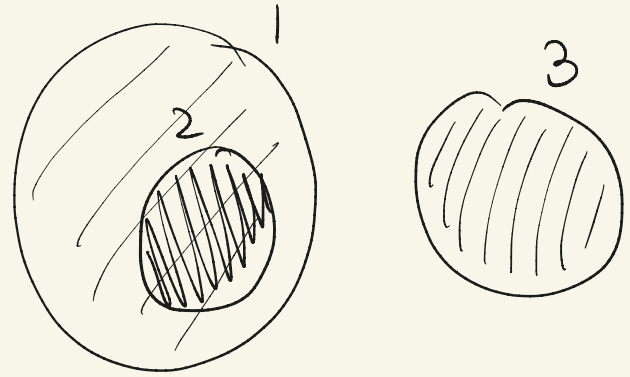
2 neurons



Example



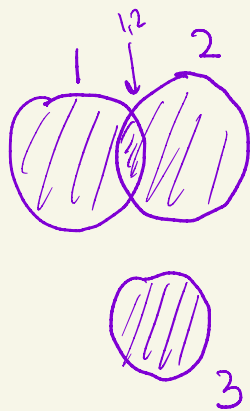
3 neurons



Can these lists come from convex pictures?

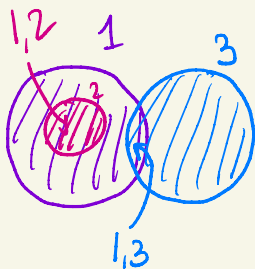
A

- 1
- 2
- 1, 2
- 3



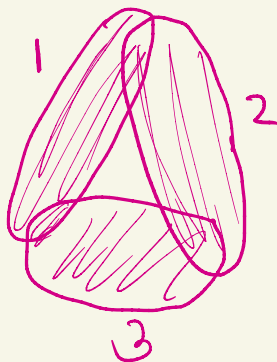
B

- 1
- 1, 2
- 3
- 1, 3



C

- 1
- 1, 2
- 2
- 2, 3
- 3
- 1, 3



D

- 1
- 1, 2
- 1, 2, 3
- 4



A

1
1,2
2
2,3
3
3,4
4
1,4

(4)

B

1
1,2
1,2,3
1,2,3,4

(1)

C

1
1,2
2
2,3
3
3,4
4
4,5
5

(5)

D

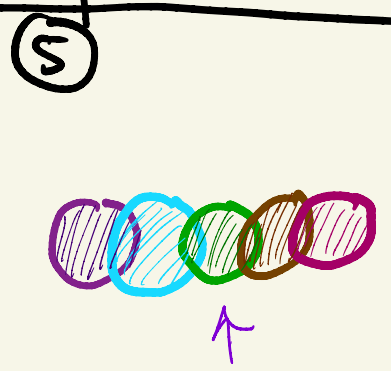
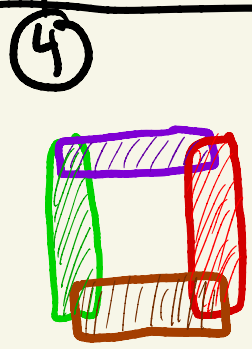
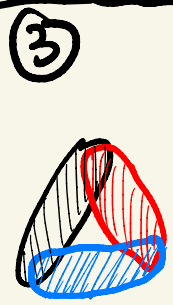
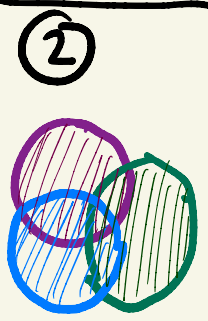
1
1,2
2
2,3
3
1,3

(3)

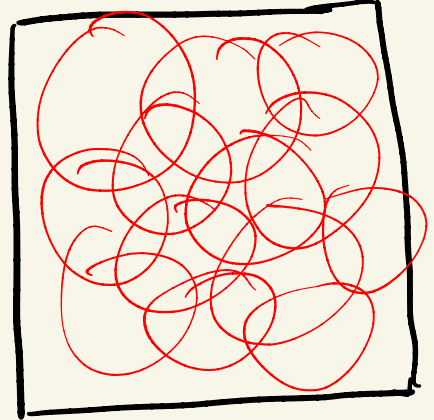
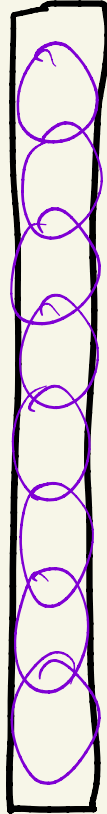
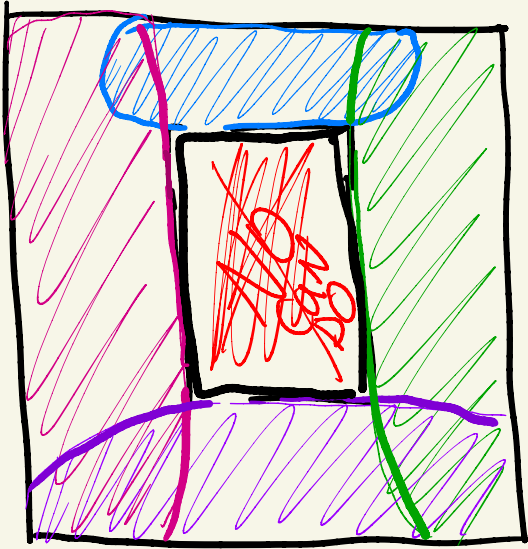
E

1
2
3
1,2
1,3
2,3
1,2,3

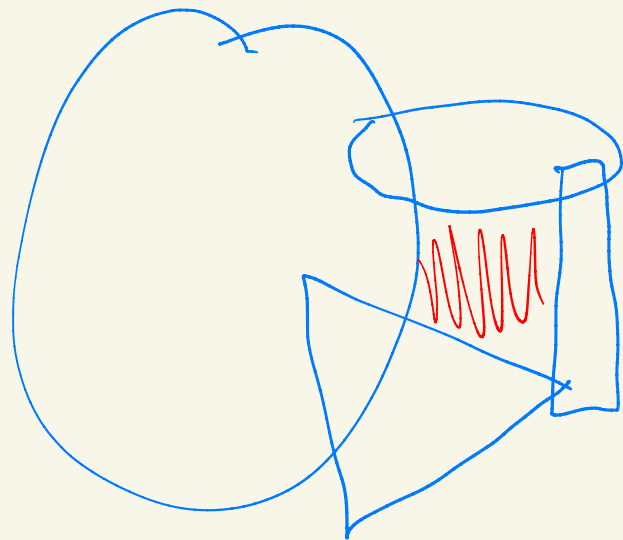
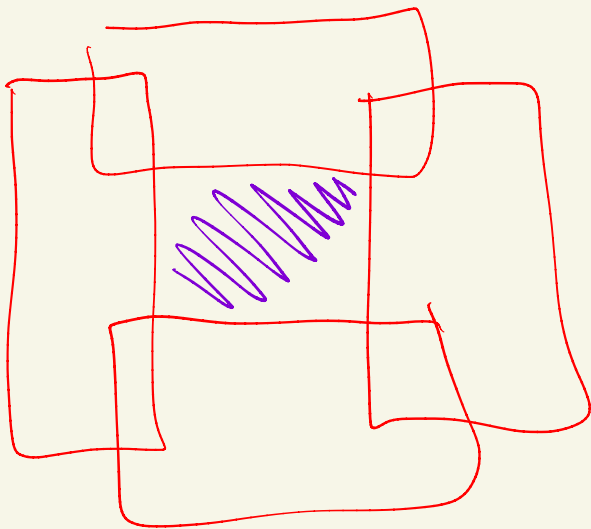
(2)



Different rooms, different data lists

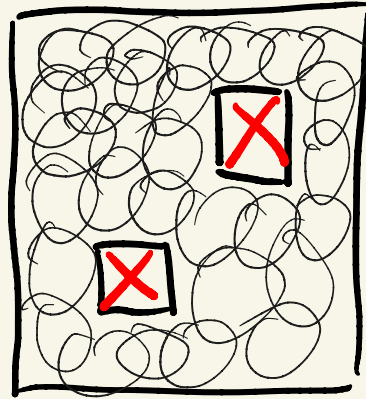
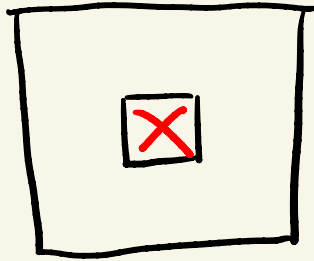


1
1,2
2
2,3
3
3,4
4
14



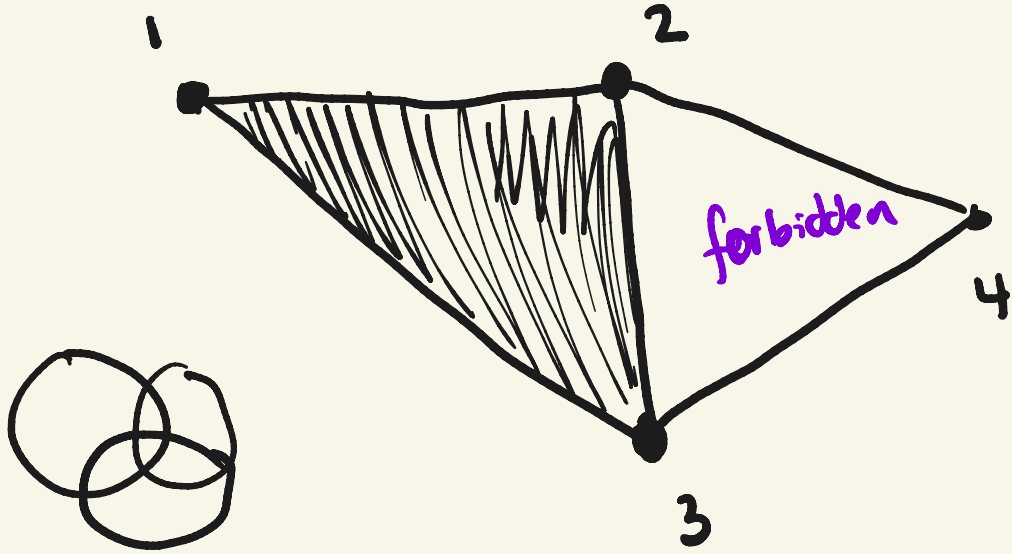
→ No matter how you draw these regions (with convex sets) we will see the gap!

For convex sets, the data list ALWAYS tells us how many "forbidden areas" we have
(if the whole room has been explored)



How do we tell?

- 1
- 2
- 3
- 4
- 1,2 ←
- 1,3 ←
- 2,3 ←
- 1,2,3 ←
- 2,4 ←
- 3,4 ←



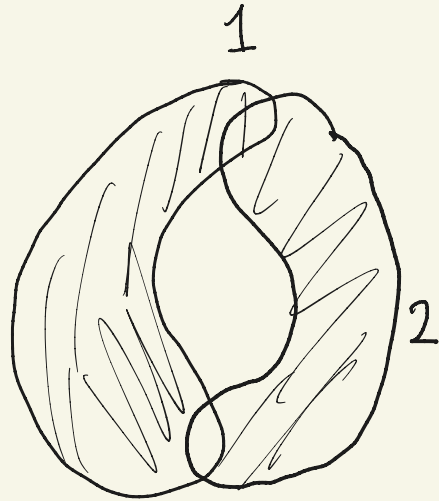
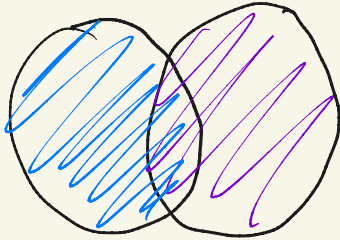
What if we do not use convex sets?

List:

1

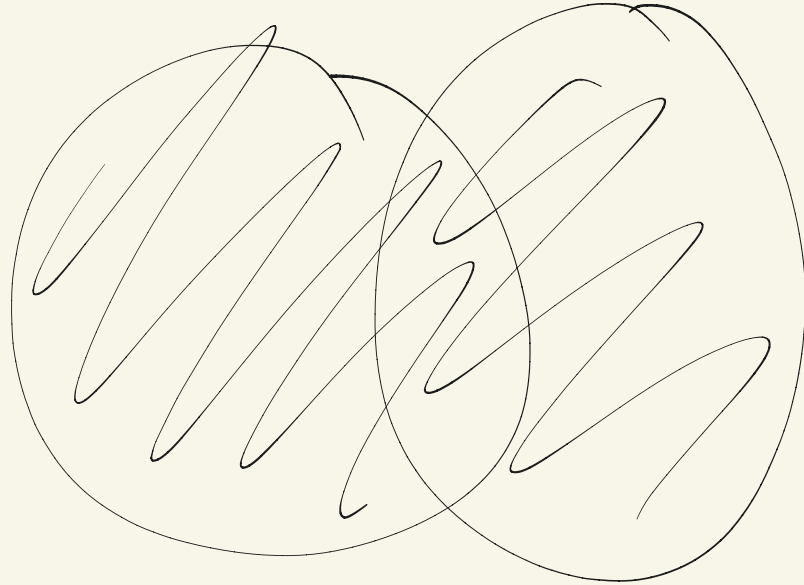
2

1,2

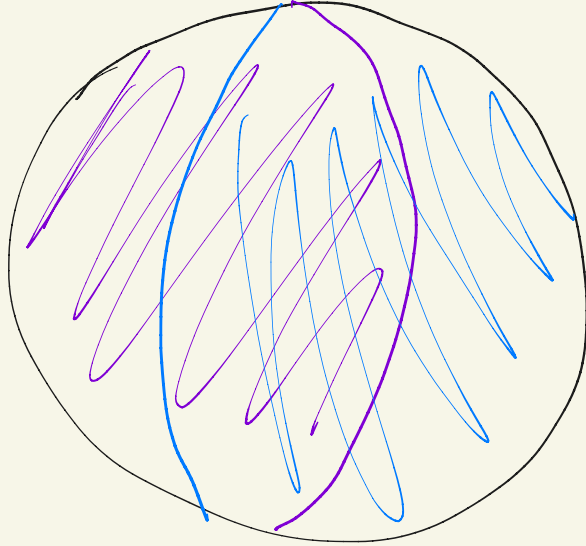


For some kinds of information, the list is not enough!

Example: Size

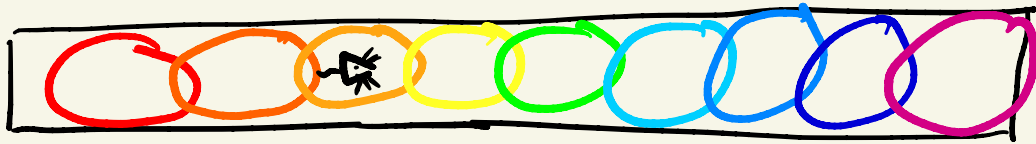


Example : Exact shape

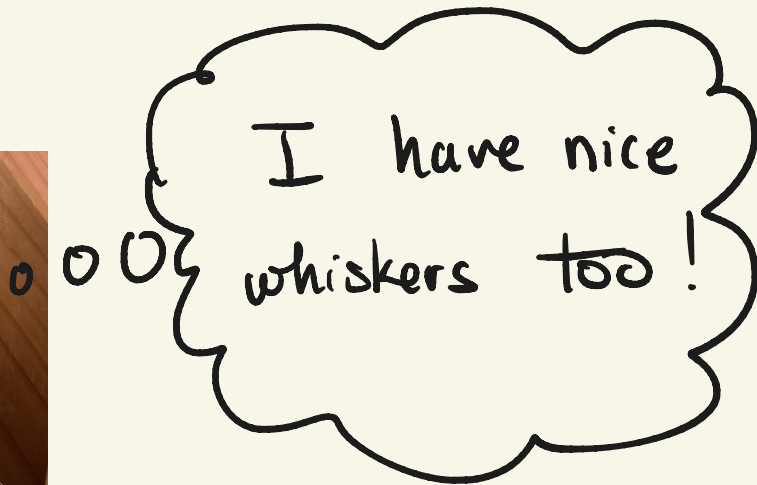


A few more fun rat facts:

- After a rat spends time walking along a hallway, it will "dream" about the sequence.



- Rats have a large chunk of their brain just for processing information from their whiskers!



Thank You!

Questions ?