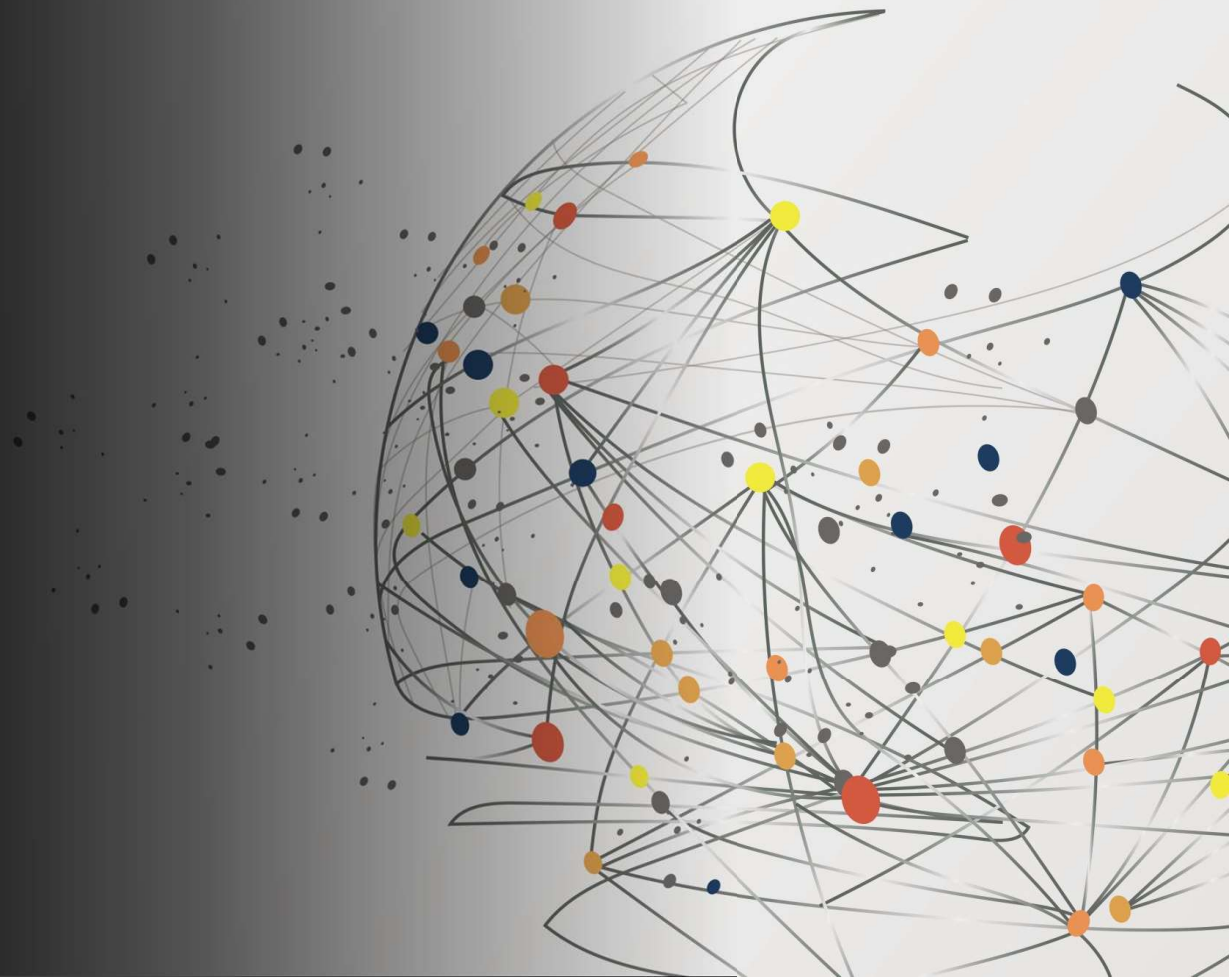
Flipping Pancakes

What is your favorite way to eat pancakes?



Pancakes!

- The chef at the local IHOP makes pancakes very quickly! But, because of this, her pancakes are all different sizes.
- The waiter delivering the pancakes wants to rearrange the stacks so that the biggest pancakes are on the bottom.
- The waiter holds the pancake plate on one hand, and a spatula on the other, and can only do one task: put the spatula in the middle of the stack and flip it

The challenge

- Sometimes, the stack of pancakes are already in order
- Other times, the stack is in a very bad order and needs many flips to get correct

- How many flips might we need to arrange a stack of pancakes?

No flips needed!

Just 1 flip!

Problem setup

- We want to know the “worst-case scenario” of the number of flips to properly arrange a stack of pancakes
- We call this number of flips the Pancake Number
- We will call this Pancake Number P_N, where N is the number of pancakes we have

Pancake Number P_N for some values of N

- Let's try it for some small values of N

- If there is only 1 pancake ($N = 1$), how many flips do we need?

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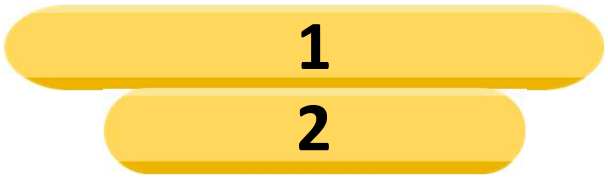
Pancake Number P_N for some values of N

- Let's try it for some small values of N

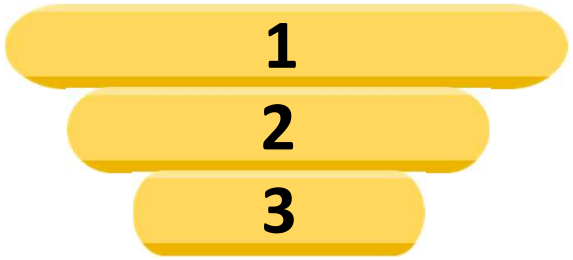
- If there are only 2 pancakes ($N = 2$), how many flips do we need?

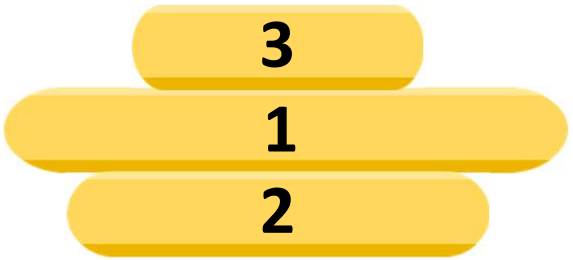


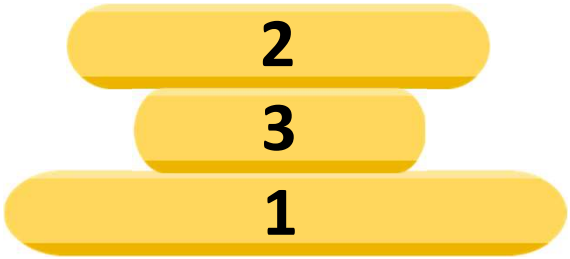
Breakout Rooms

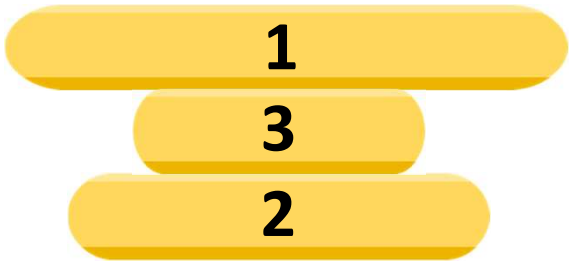
So, let's move to bigger numbers!

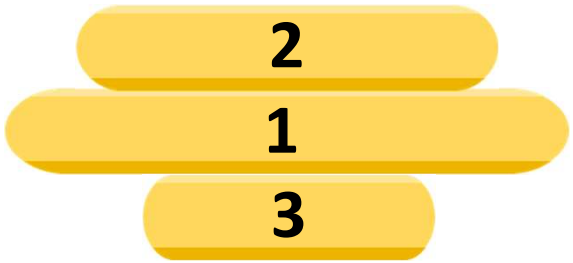
- Let's try it for $N = 3$

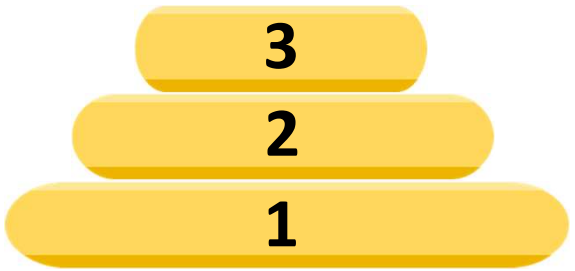






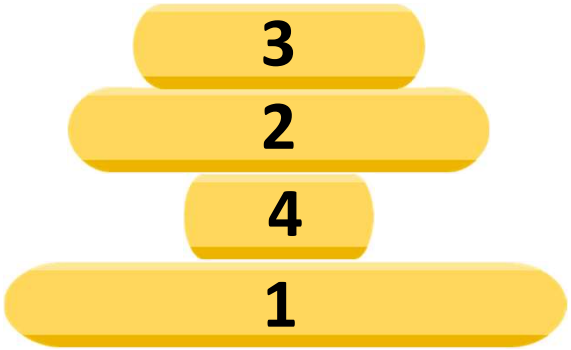






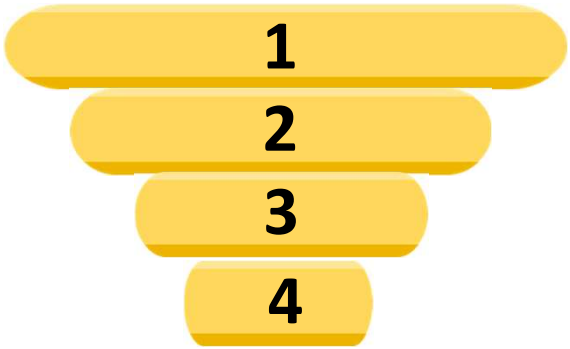
So, let's move to bigger numbers!

- Let's try it for $N = 4$ and we'll work backwards.
- Can you arrange the stack so you need just 1 flip to fix it?
- How many ways can you arrange the stack?



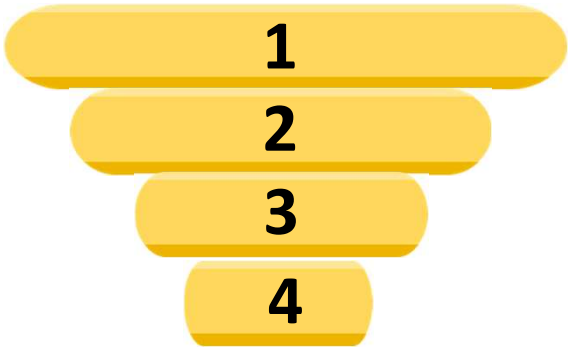
So, let's move to bigger numbers!

- Let's try it for $N = 4$ and we'll work backwards.
- Can you arrange the stack so you need just 2 flips to fix it?
- How many ways can you arrange the stack?



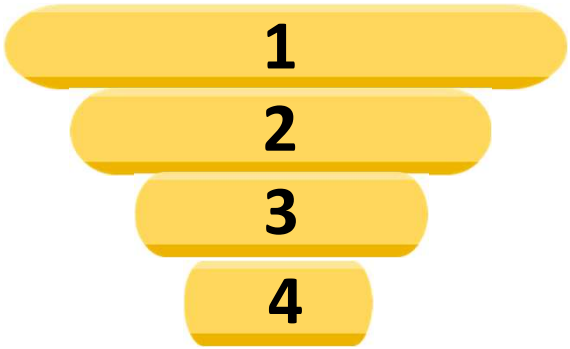
So, let's move to bigger numbers!

- Let's try it for $N = 4$ and we'll work backwards.
- Can you arrange the stack so you need 3 flips to fix it?
- How many ways can you arrange the stack?



So, let's move to bigger numbers!

- Let's try it for $N = 4$ and we'll work backwards.
- Can you arrange the stack so you need 4 flips to fix it?
- How many ways can you arrange the stack?

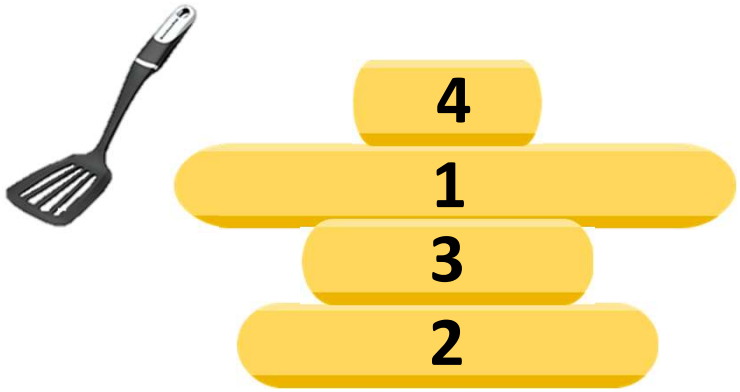


Can we find an algorithm?

- An algorithm is a general set of steps to solve a problem
- Can you find a simple algorithm for sorting pancakes?

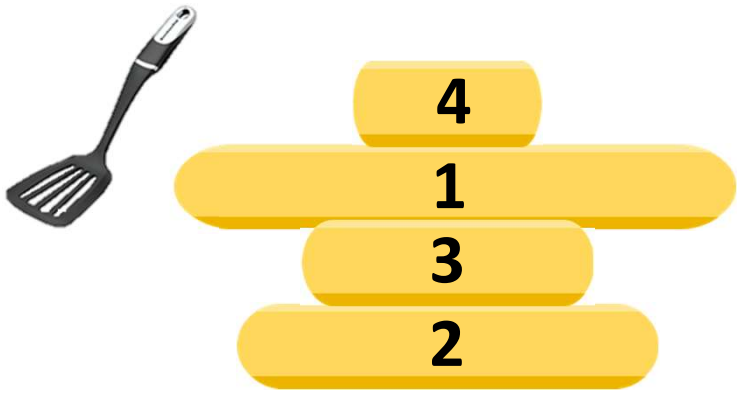
Let’s try a simple algorithm

- Step 1. Find the largest pancake. Put your spatula underneath this pancake and flip so the largest pancake is at the top
- Step 2. Flip the whole stack so the largest pancake is at the bottom
- Step 3. Repeat with the next largest pancake.



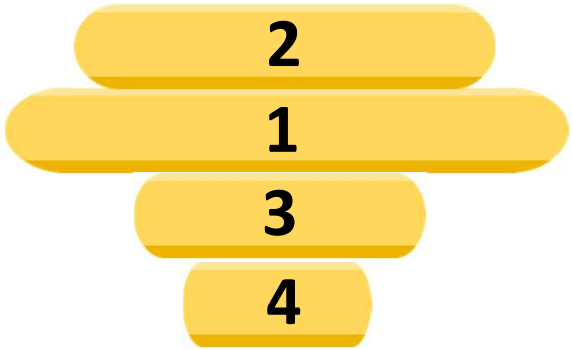
Let’s try a simple algorithm

- How long does it take?
- Let’s work it through: How many flips will each pancake take in the algorithm?



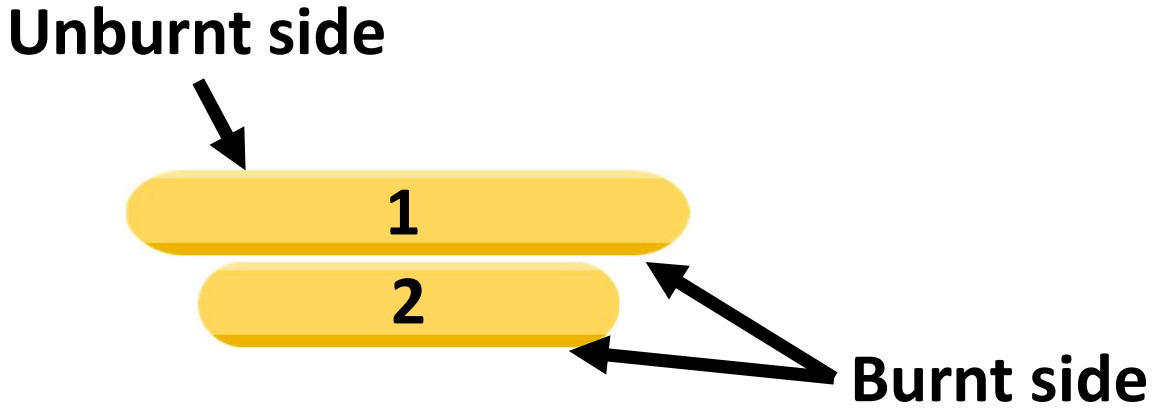
Can you come up with another algorithm?

- How long does your algorithm take?



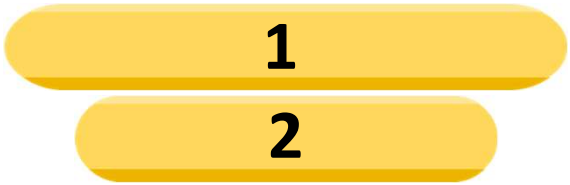
Challenge: Burnt Pancakes

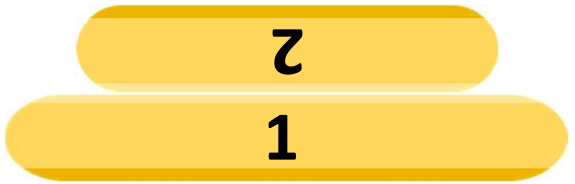
- Let's save our pancakes are burnt on one side
- When we finish our stack, all the pancakes should be unburnt side up and stacked with the largest pancakes at the bottom.



Challenge: Burnt Pancakes

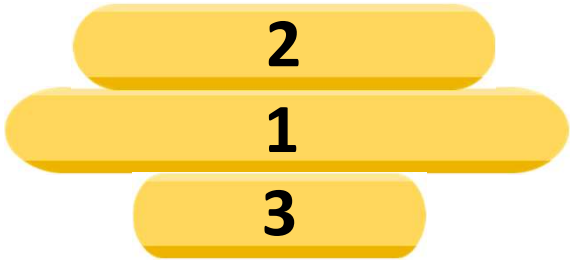
- How many flips for $N = 2$ pancakes?





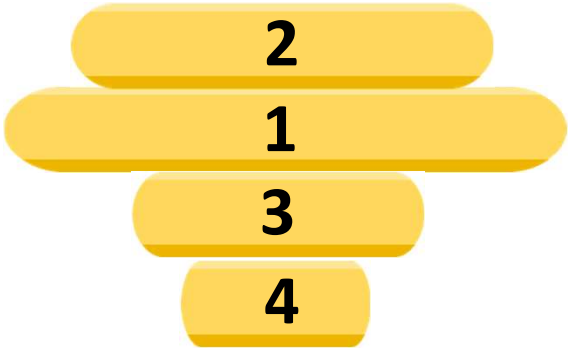
Challenge: Burnt Pancakes

- How many flips for $N = 3$ pancakes?

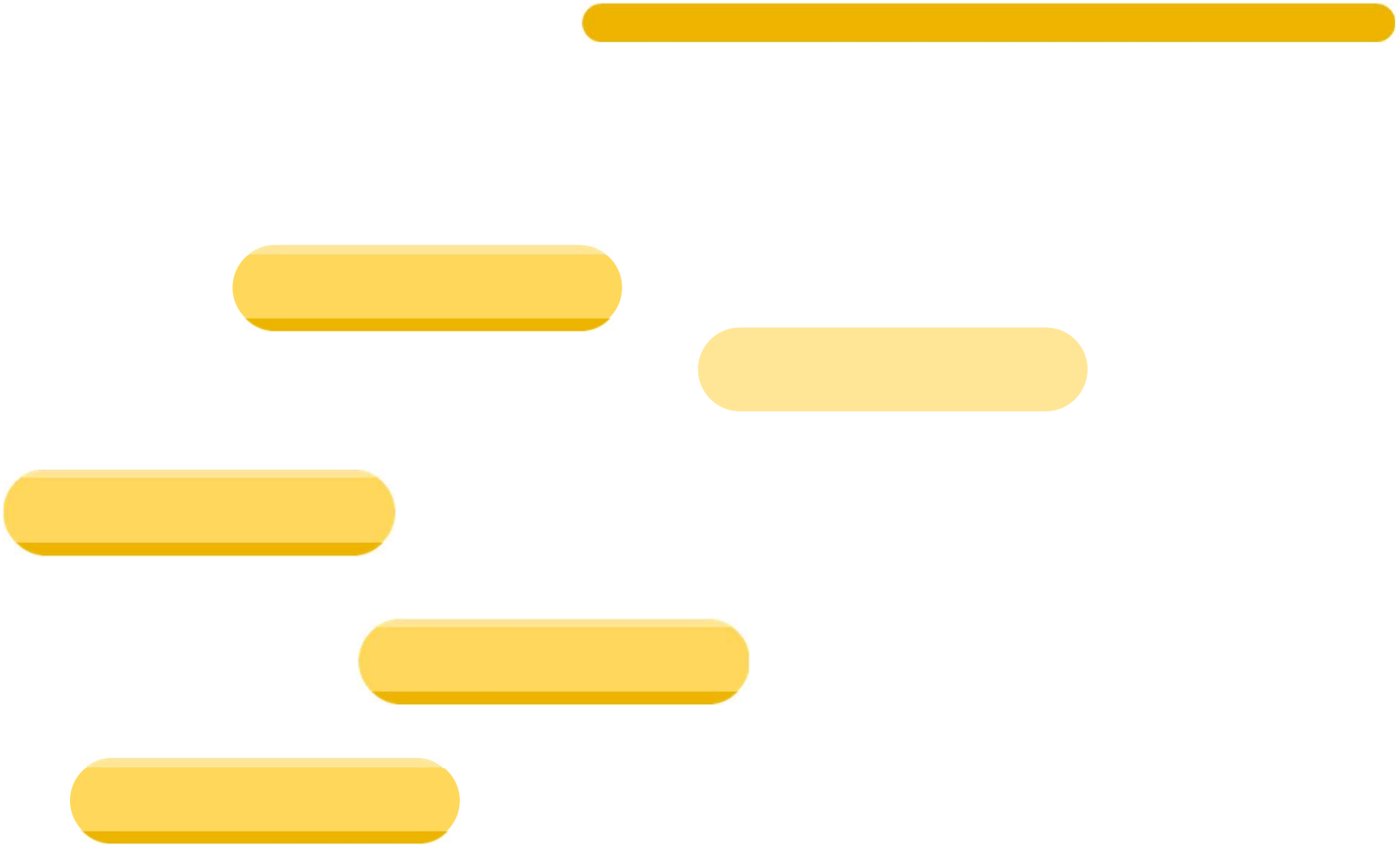


Challenge: Burnt Pancakes

- How many flips for $N = 4$ pancakes?



Some cool history

- The pancake sorting problem is used to solve many computer science problems (and DNA arrangement!)
- It was proposed by mathematician Jacob Goodman under a fake name: Harry Dweighter
  - Try saying that fast!
- Bill Gates and Christos Papadimitriou (a very cool computer scientist) proposed one solution to it

Thank you!