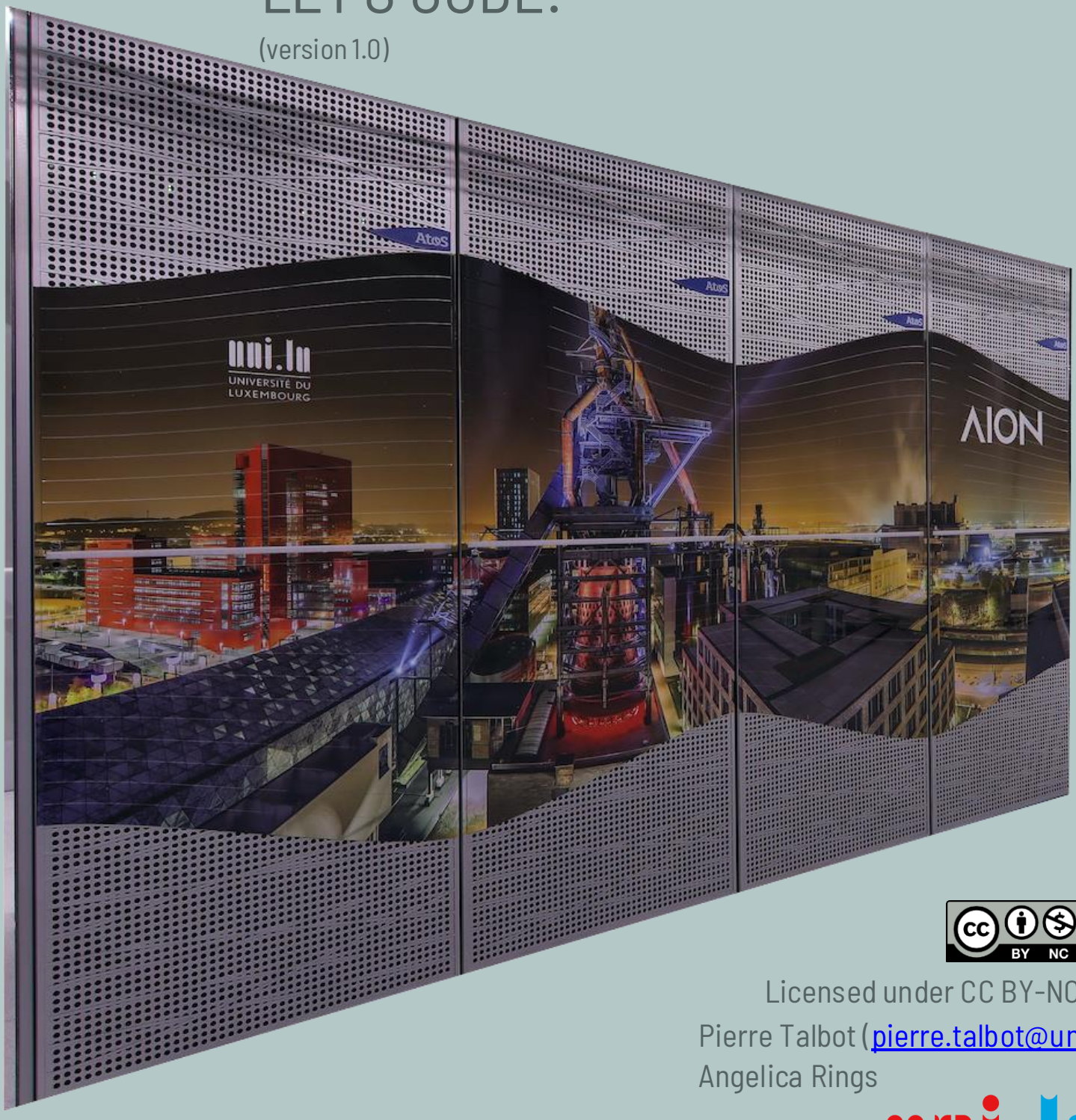
Supercomputer: Always Faster?

LET'S CODE!

(version 1.0)



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SCIENCE FESTIVAL 22-25 nov. 2025

Luxembourg National Research Fund

UNIVERSITY OF LUXEMBOURG

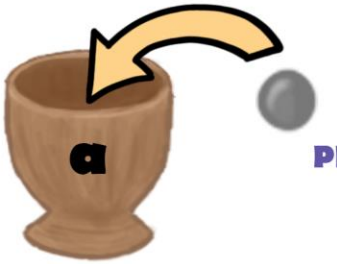
How to Code?

Follow the arrows with Stitch, and stop at each action

a <- 1

Nothing inside the bowl!

a <- 2

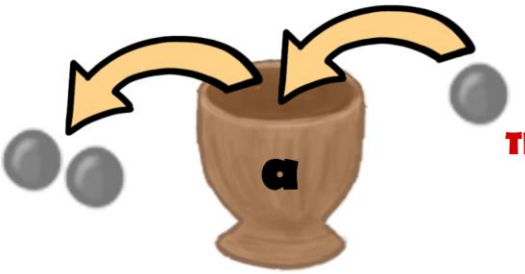


Place a ball

a <- a -1

Place 2 balls

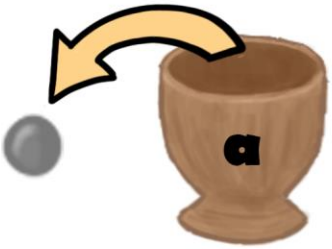
say (a)



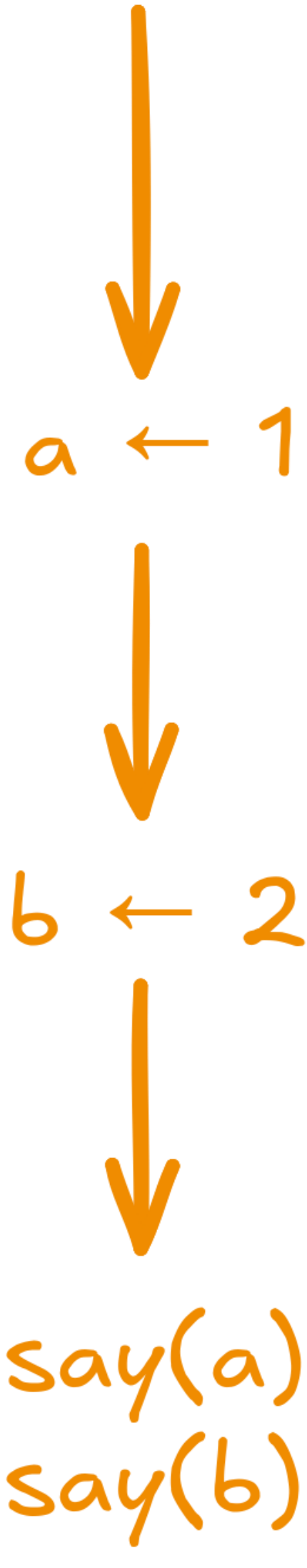
The arrow "<-" means replace, **NOT** add

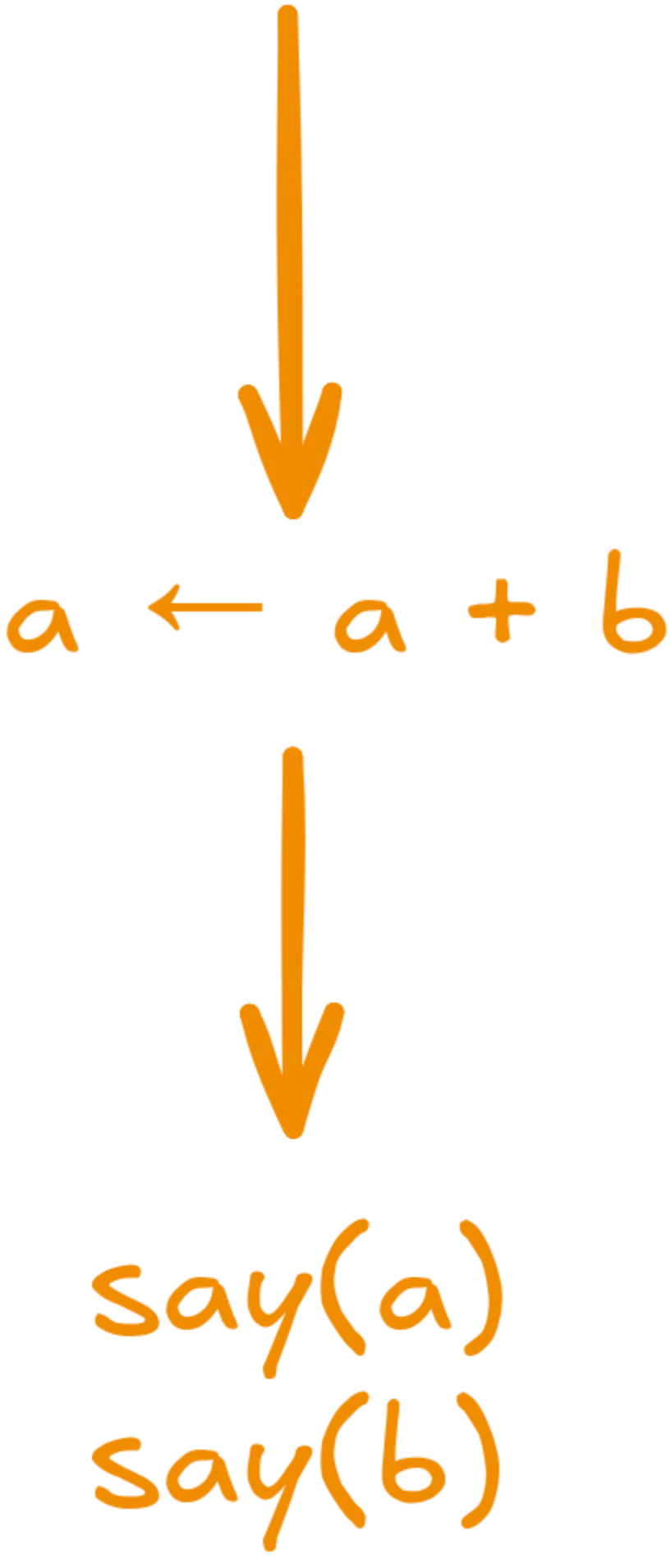
clean

Say out loud the number of balls in the bowl



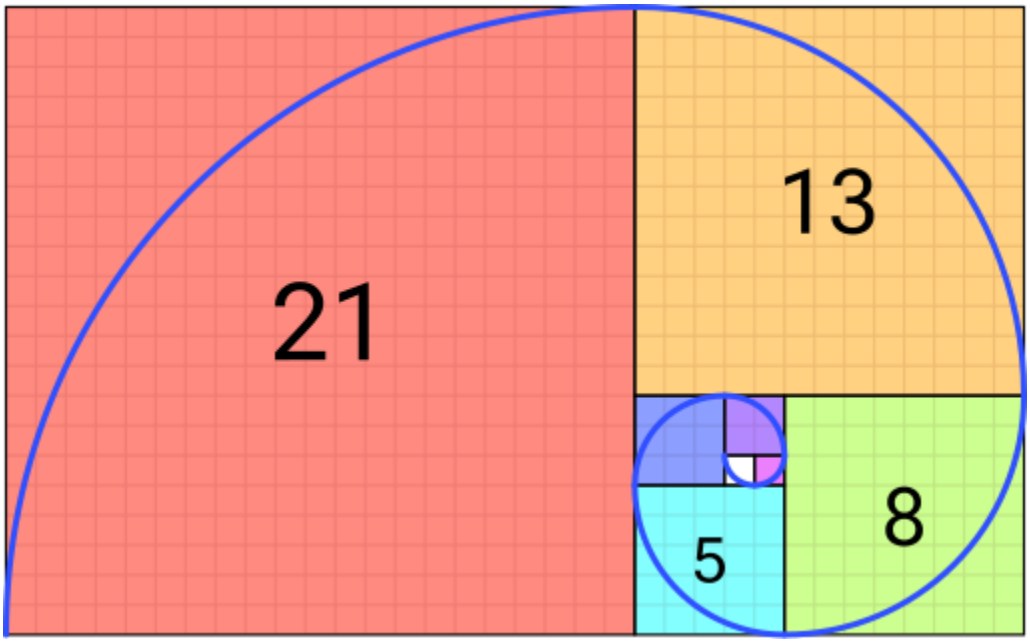
Remove all balls


a ← 1
b ← 2
say(a)
say(b)


a ← a + b
say(a)
say(b)

One famous problem

Fibonacci sequence



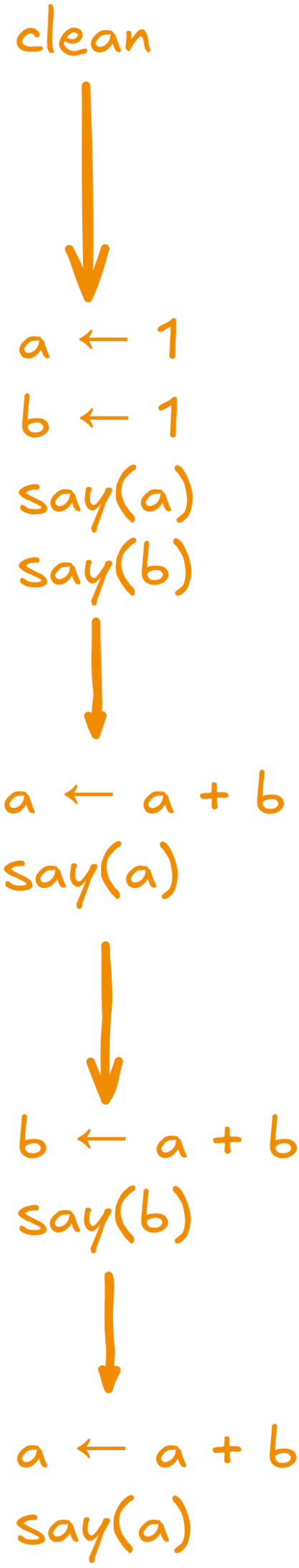
The Fibonacci sequence is a sequence in which each element is the sum of the two elements that precede it.

Can you compute the first 5 elements of the sequence?

Leonardo Bonacci (c. 1170 – c. 1240-50), aka. Fibonacci, was an Italian mathematician, considered to be "the most talented Western mathematician of the Middle Age".

Note that this sequence was already discovered in India by Pingala (200 BC.)

Credits: images and text from Wikipedia


clean
a ← 1
b ← 1
say(a)
say(b)
a ← a + b
say(a)
b ← a + b
say(b)
a ← a + b
say(a)

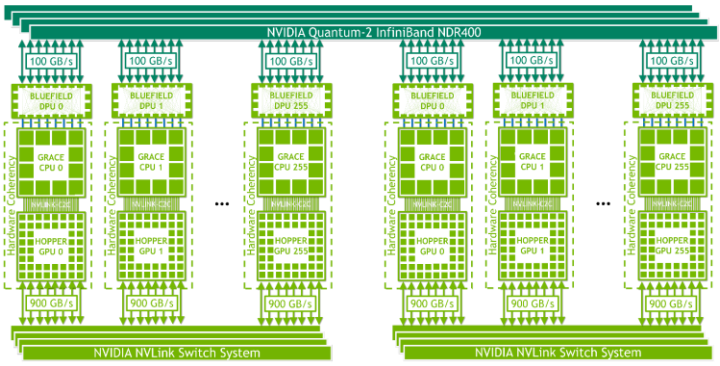
Supercomputer

The main difference between your phone and a supercomputer is that a supercomputer can do a lot of things at the same time (in parallel).

In artificial intelligence, we use graphics card (GPU) to process a lot of data in parallel.

Inside a GPU

A small square is called a **core.** Each core can run a program like the one we have written before. Because there are so many cores, the GPU can do a lot in parallel!

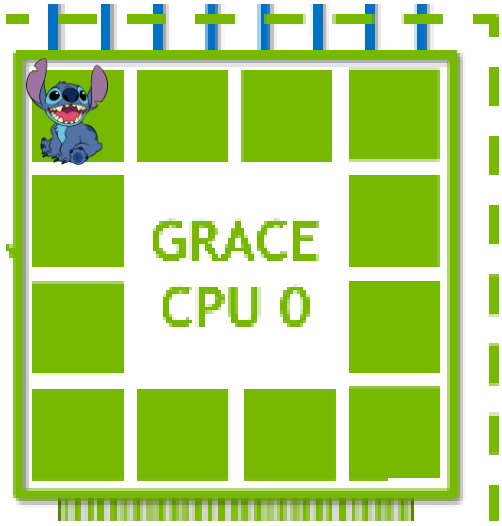


- **A modern GPU has 16000 cores.**
- **Modern supercomputers have thousands of GPUs.**

Credits: images from https://www.msi.com/Graphics-Card/NX8800GTST2D320EHDOC/Specification and https://developer.nvidia.com/blog/nvidia-grace-hopper-superchip-architecture-in-depth/

Cloning Stitch!

So far, we had a single Stitch to execute the instructions.

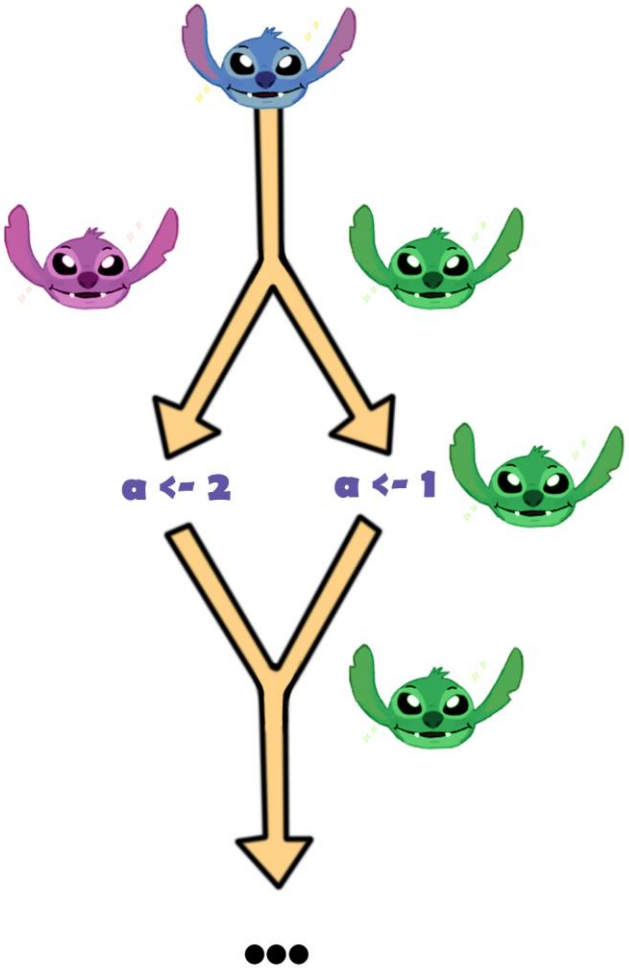


Multiple cores? Multiple Stitch!

Let's discover how to program multiple Stitch!
And why two Stitch are not always two times faster...

Credits: images from https://developer.nvidia.com/blog/nvidia-grace-hopper-superchip-architecture-in-depth/ and Wikipedia for Stitch.

How to Code?



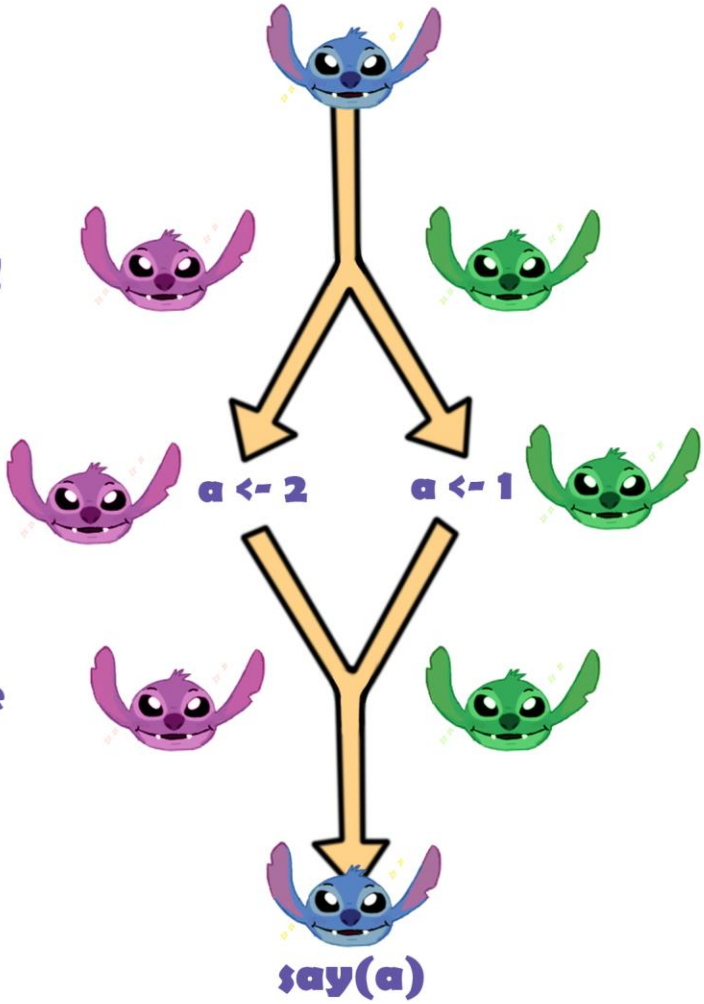
Duplicate your Stitch!

Move one of the Stitches

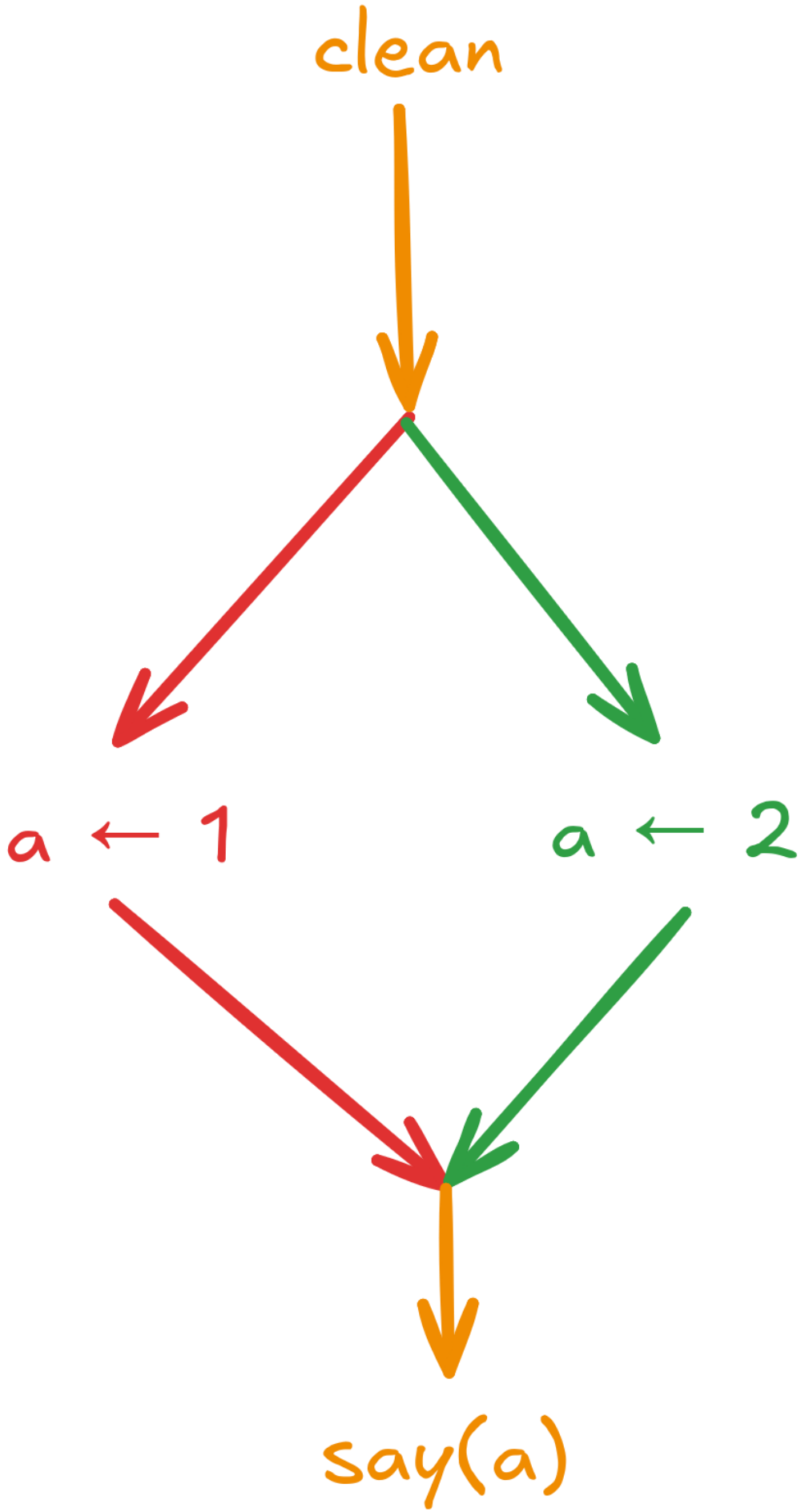
Oh! Green Stitch must wait for Pink Stitch to merge!

...

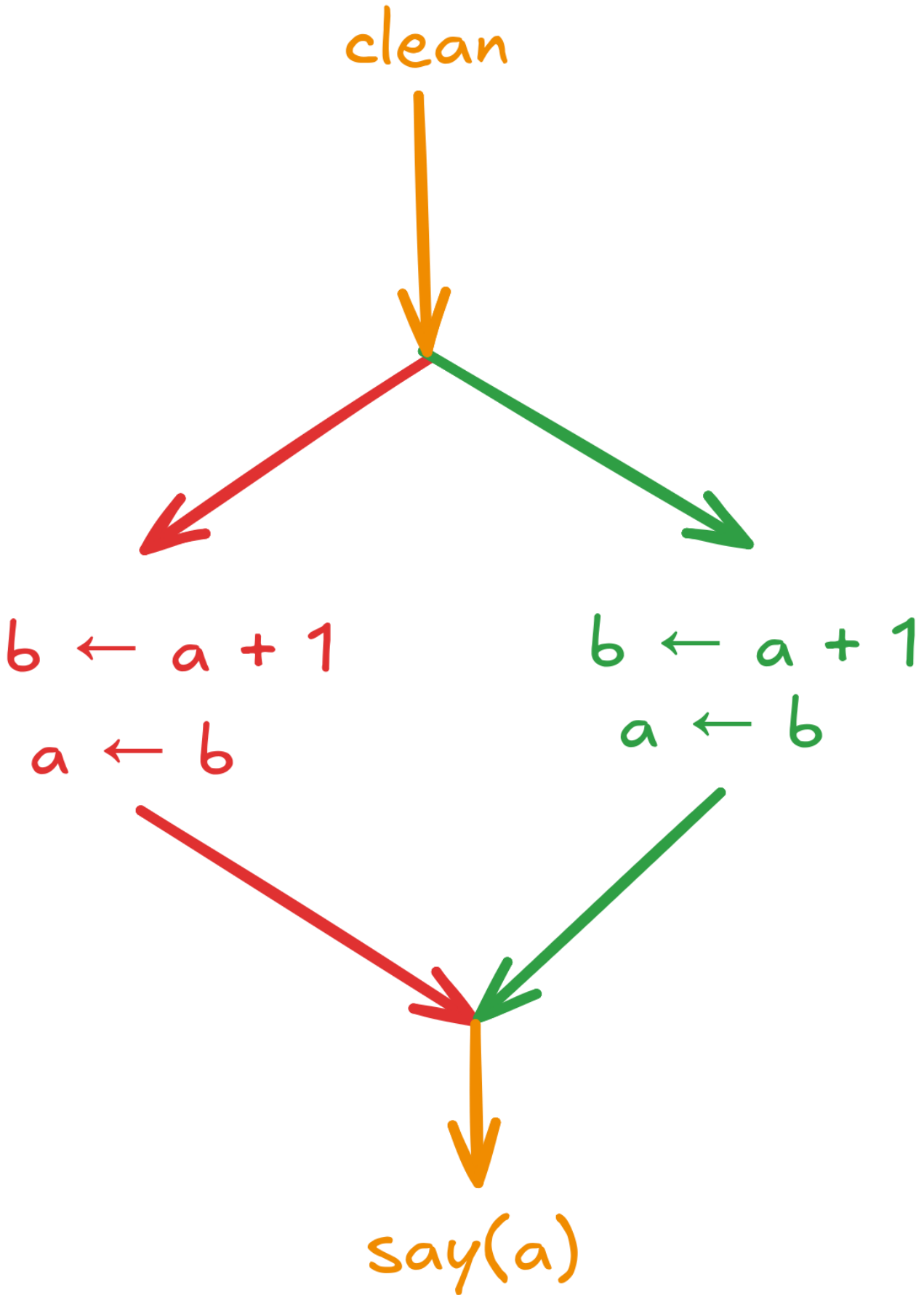
Let's move Pink Stitch now!



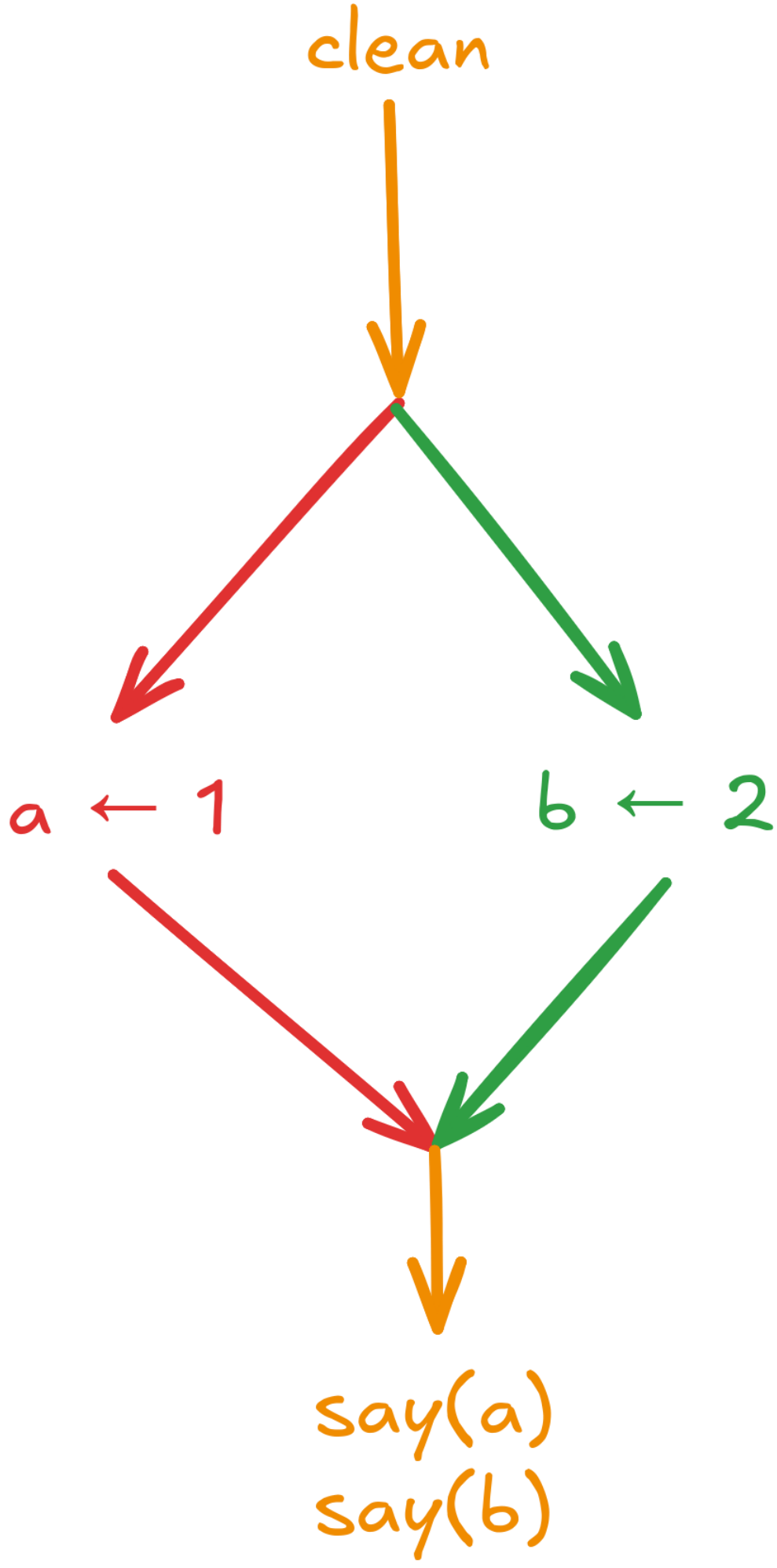
Once both arrive at the same point, they can merge!



What are the possible results?

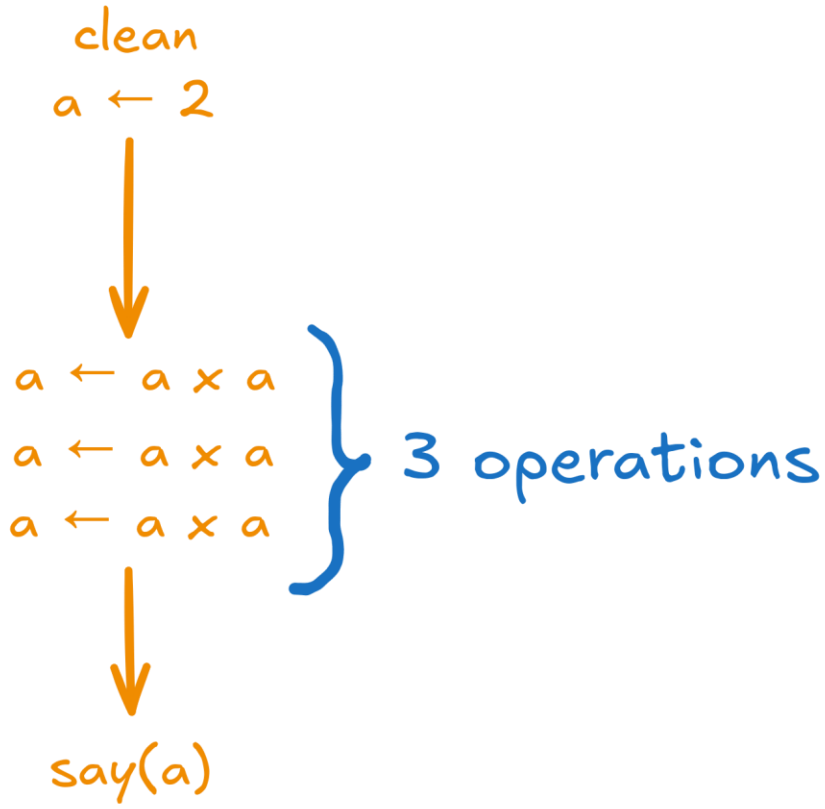


What are the possible results?



What are the possible results?

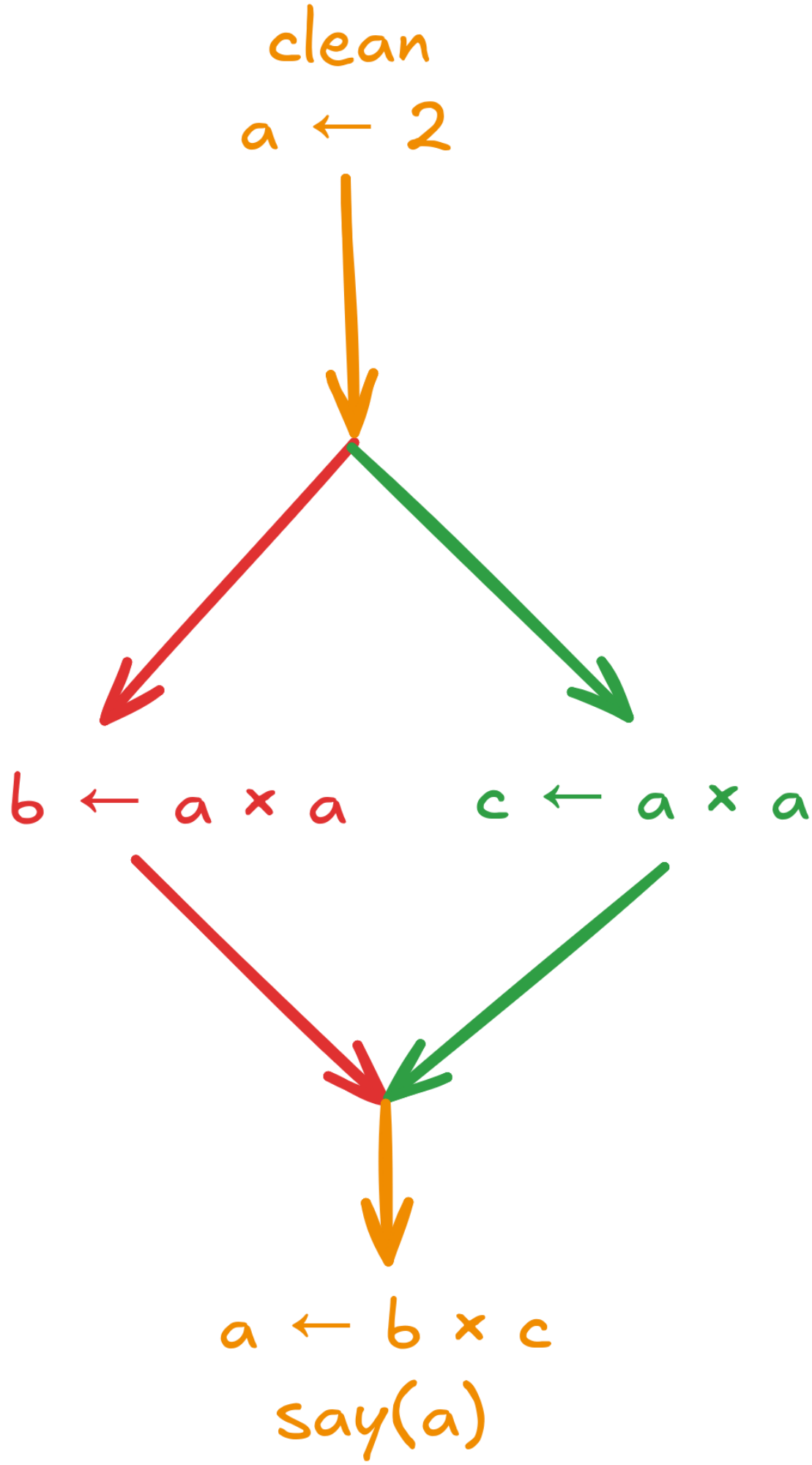
Compute 2 × 2 × 2 × 2



If each operation takes 1 second, it takes 3 seconds!

How long does it take with 2 Stitch?

What about three Stitch?



What are the possible results?