

# Redefining Time

# Part 1: The Good Old Days

And why they weren't so good.

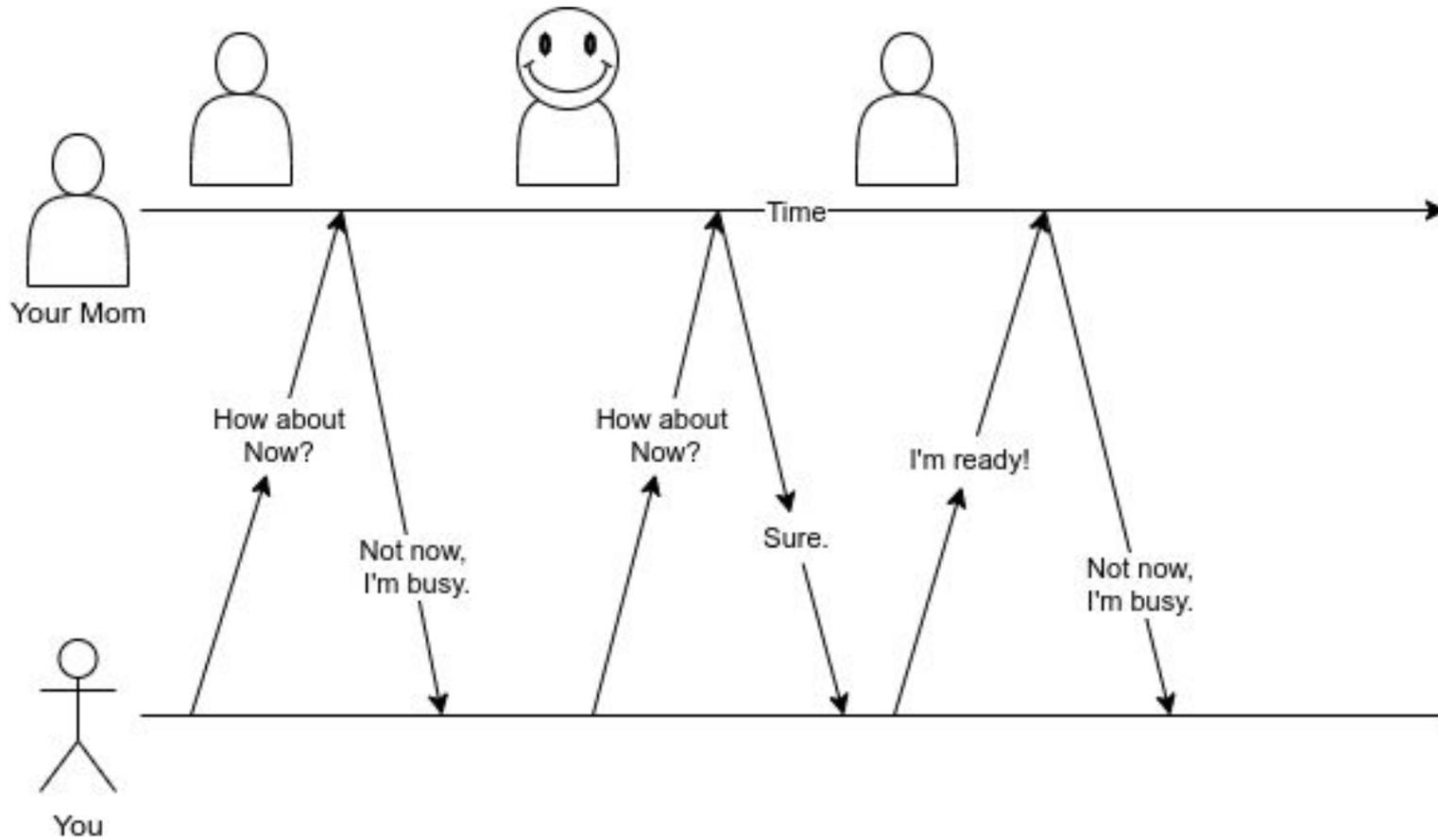
# Find the Bug

```
import os

if os.path.exists('shoopus.txt'):
    file = open('shoopus.txt', 'r')

    for line in file.readlines():
        print(line)

file.close()
```



Problems with External Actors

“It is often easier to ask for forgiveness  
than to ask for permission”

— Admiral Grace Hopper

# Idiomatic (under the hood)

```
import os

try:
    file = open('shoopus.txt', 'r')
    for line in file.readlines():
        print(line)
    file.close()
except FileNotFoundError:
    print("Oh no.")
```

# Idiomatic

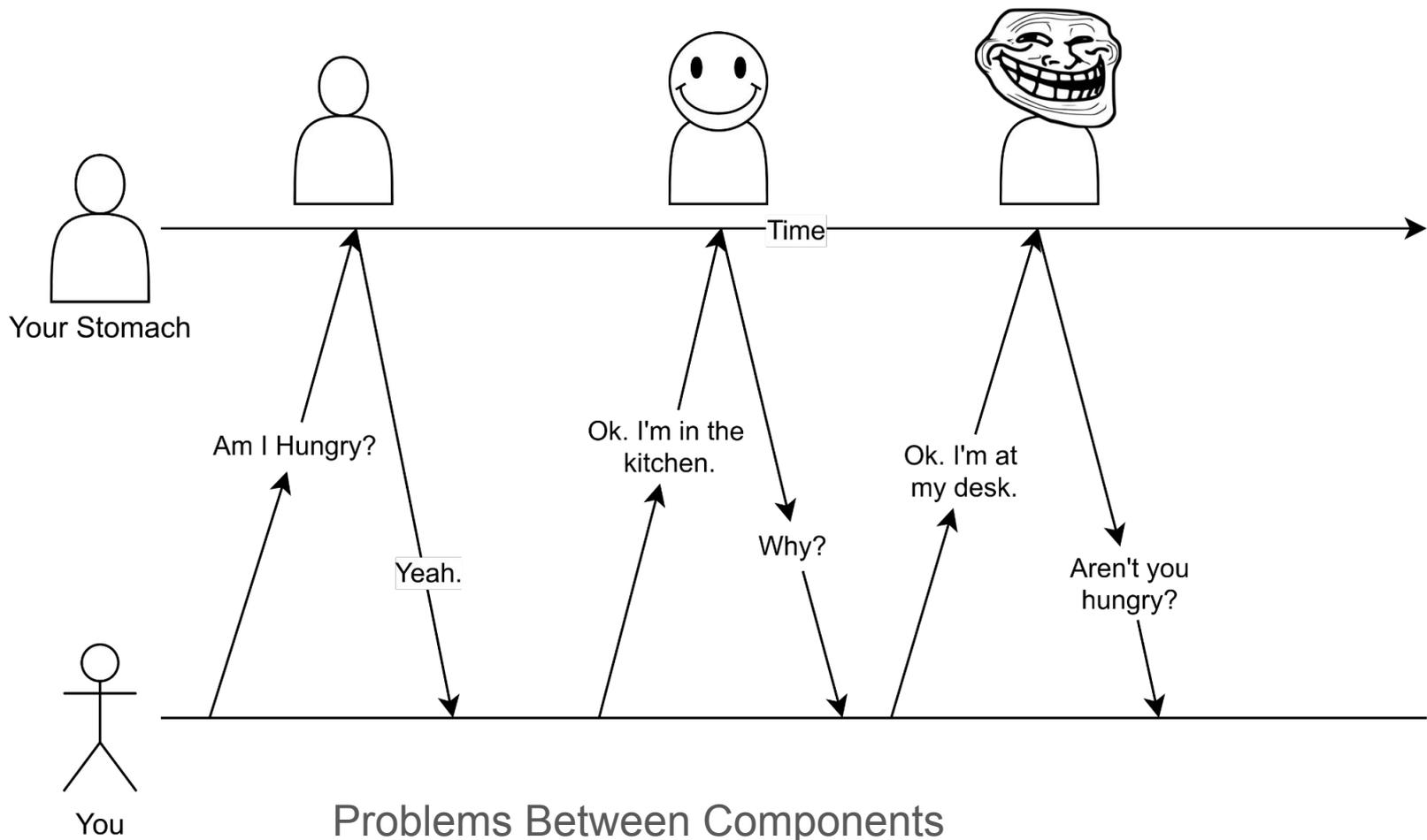
```
import os

with open('shoopus.txt') as file:
    for line in file.readlines():
        print(line)
```



Are we safe now?

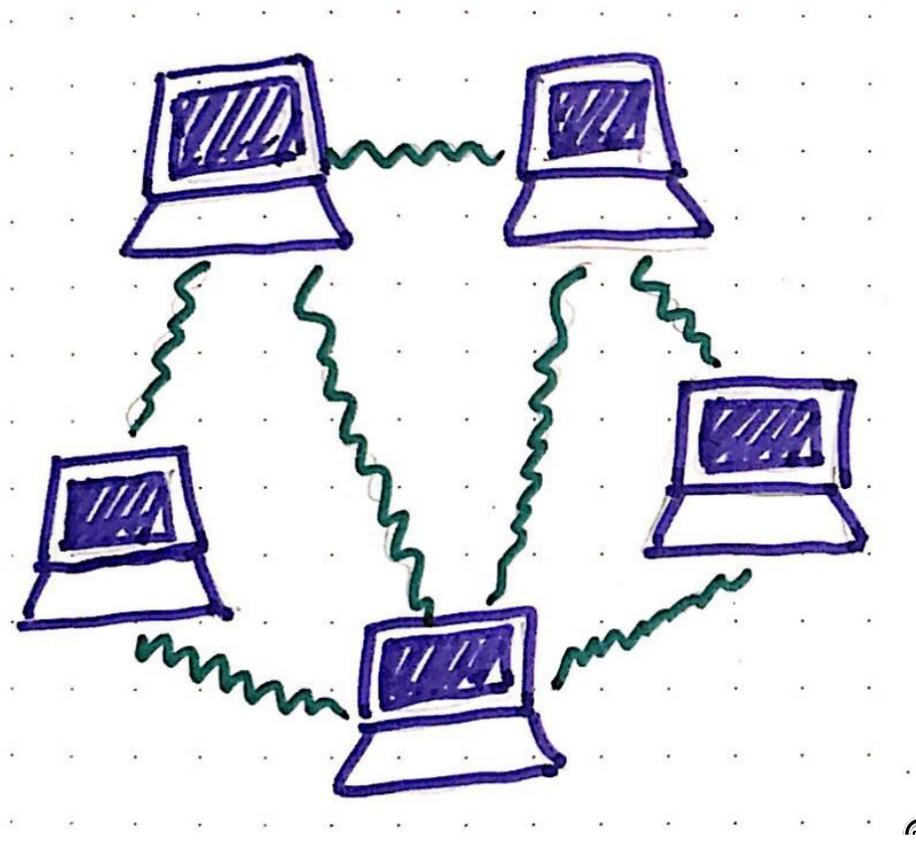
```
open(fd, O_EXCL)
```



Problems Between Components

# Part II: New Problems Approach

oh jeez they look complicated

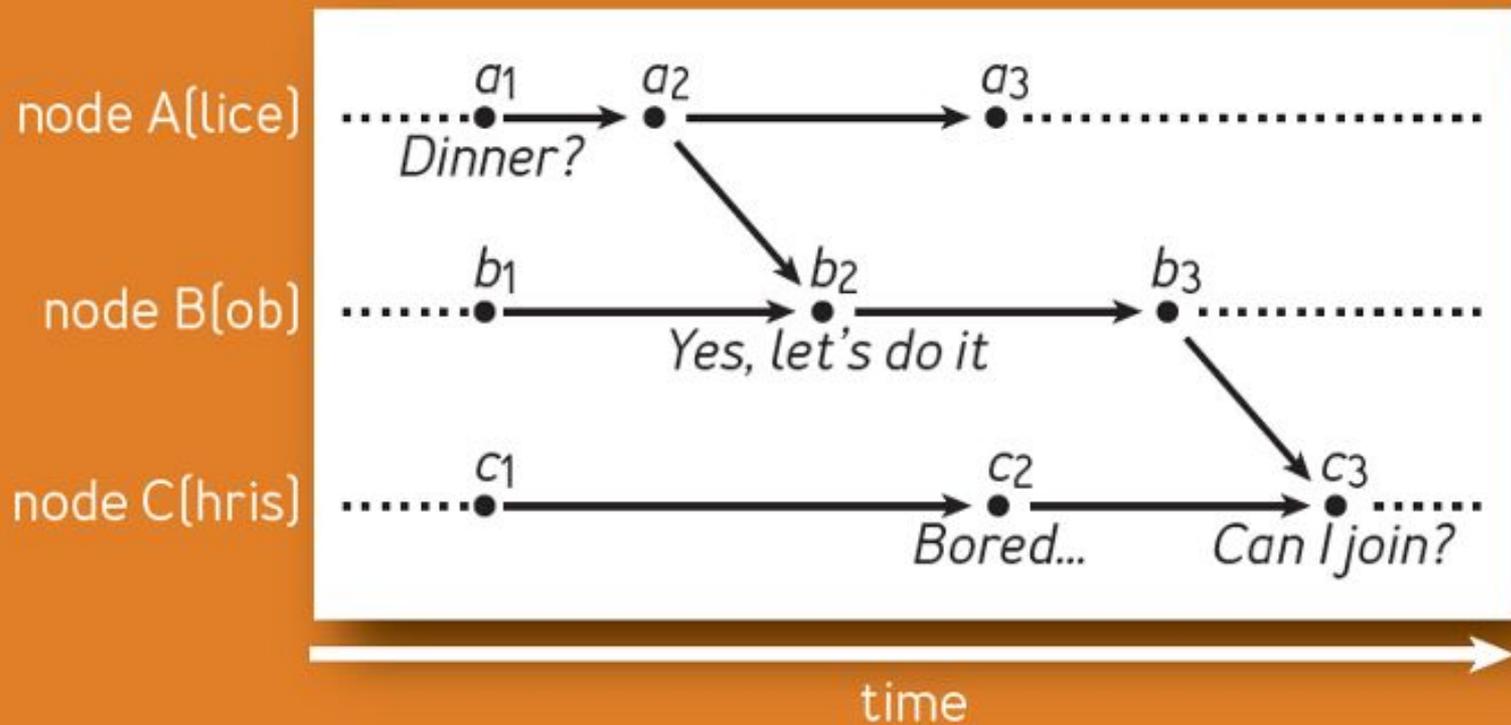


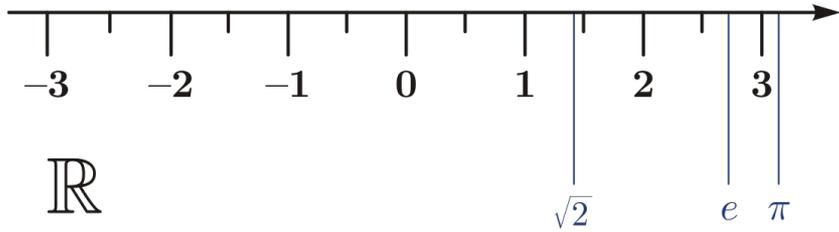


# Part III: Causal Consistency

Goal: Order Events

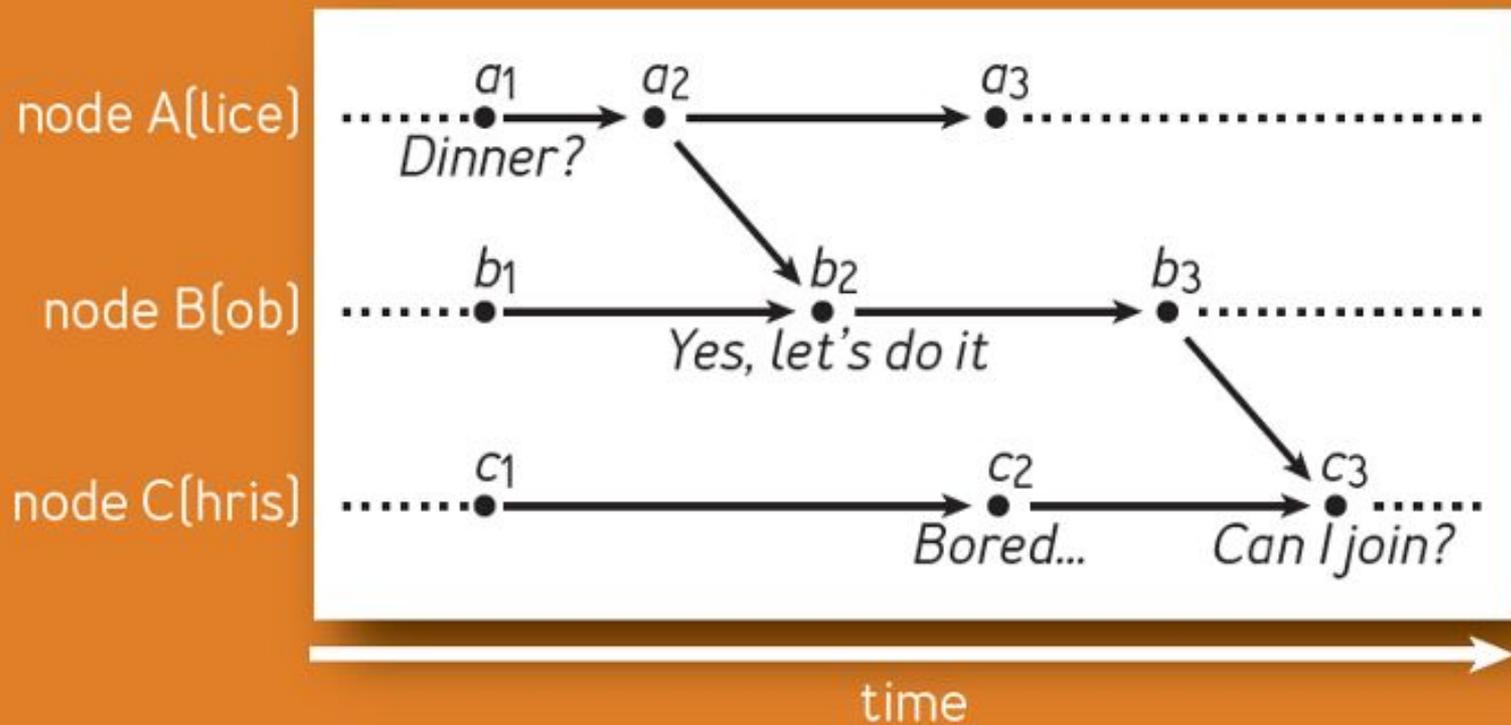
FIGURE 1: **HAPPENED-BEFORE RELATION**

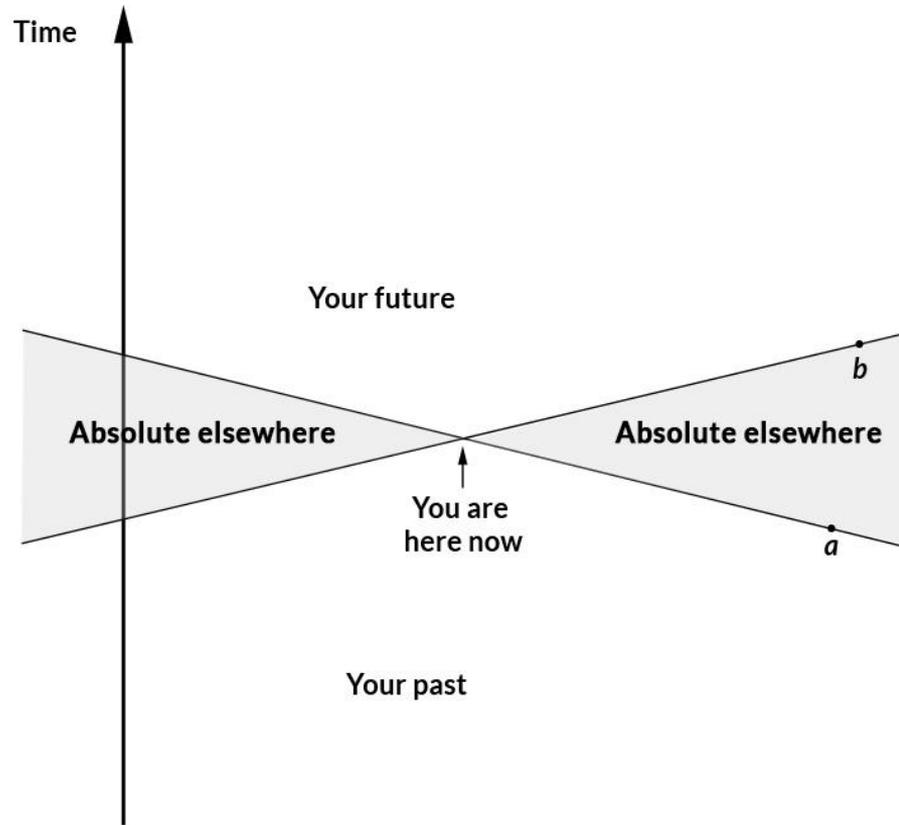




The preschooler's view of time.

FIGURE 1: **HAPPENED-BEFORE RELATION**





Causal Consistency: Technically Correct

# Lamport Clocks: A Demonstration

- Every time you do something, increment your clock.
- If you receive a message with clock value  $C$ :
  - If it's a bigger number than what you have now, set your clock to  $C+1$ .
  - If it's smaller than what you have now, just increment your clock like usual.

All causal events will now be ordered!