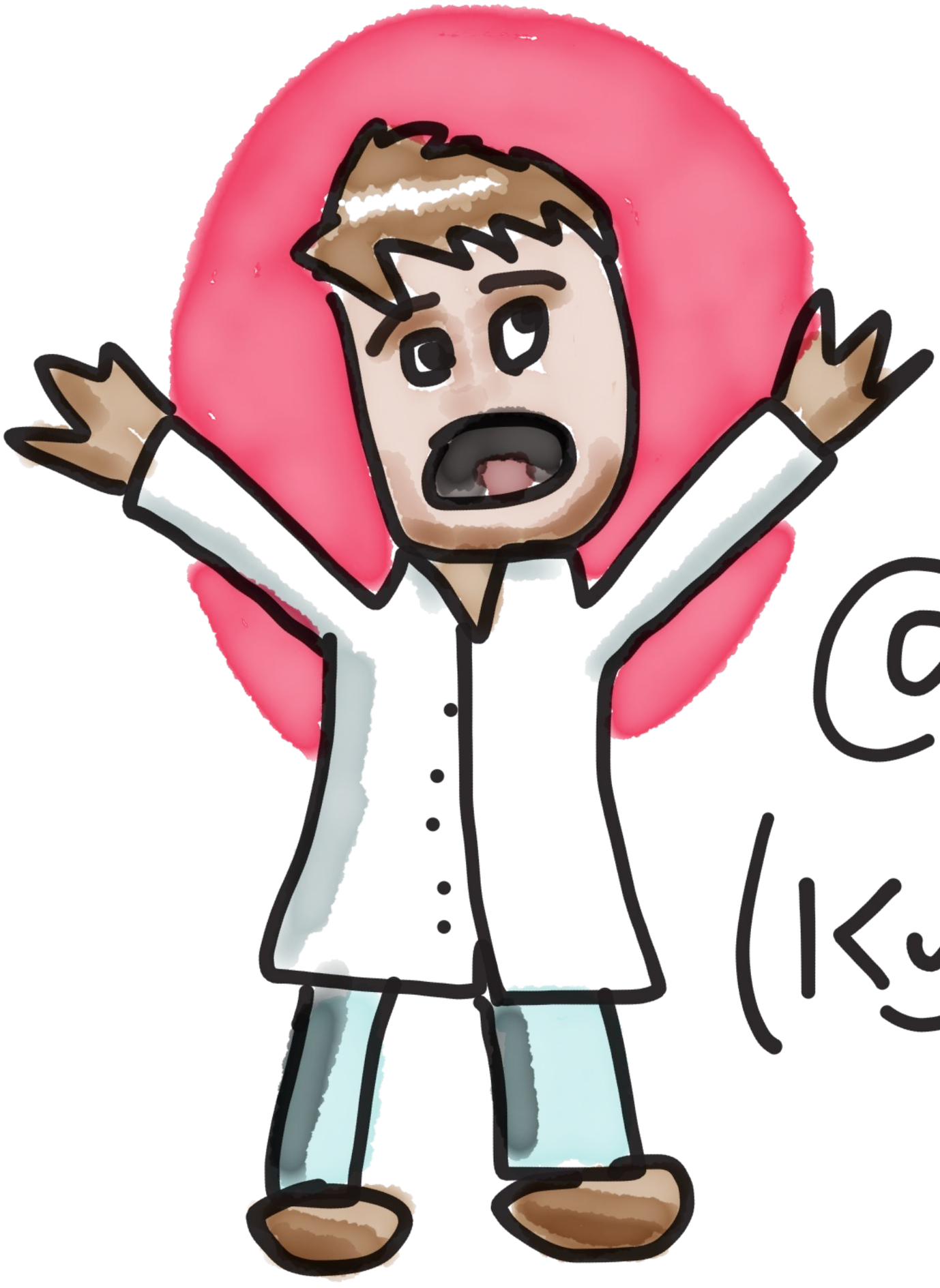
JEPSEN IV

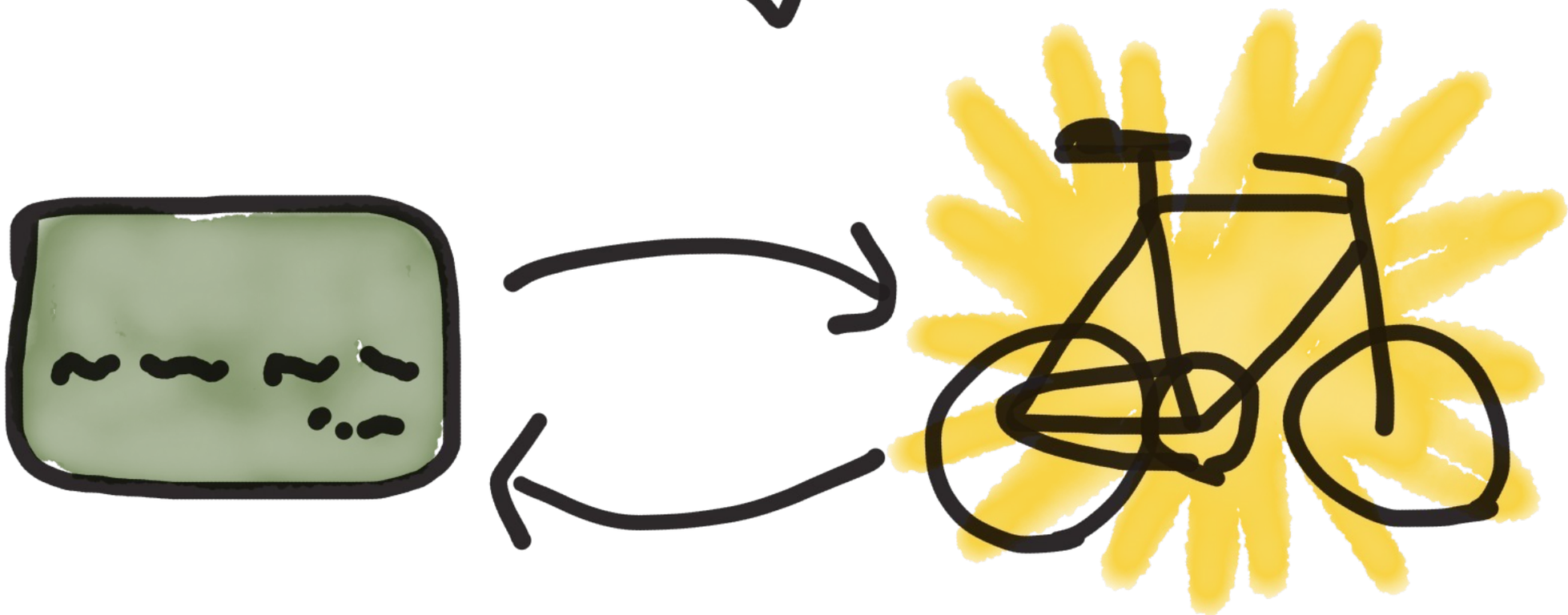
Hope Springs Eternal



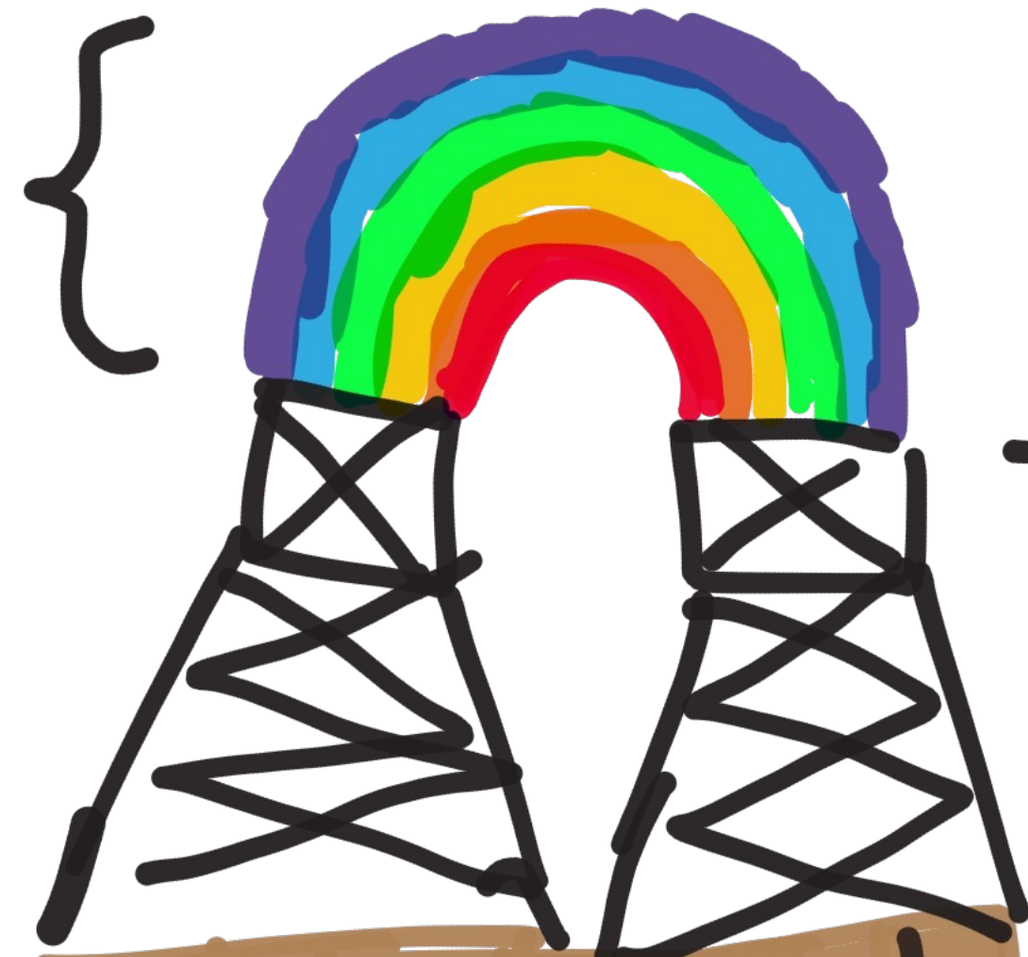
@aphyr

(Kyle Kingsbury)

str/pe



Public API {



} API code

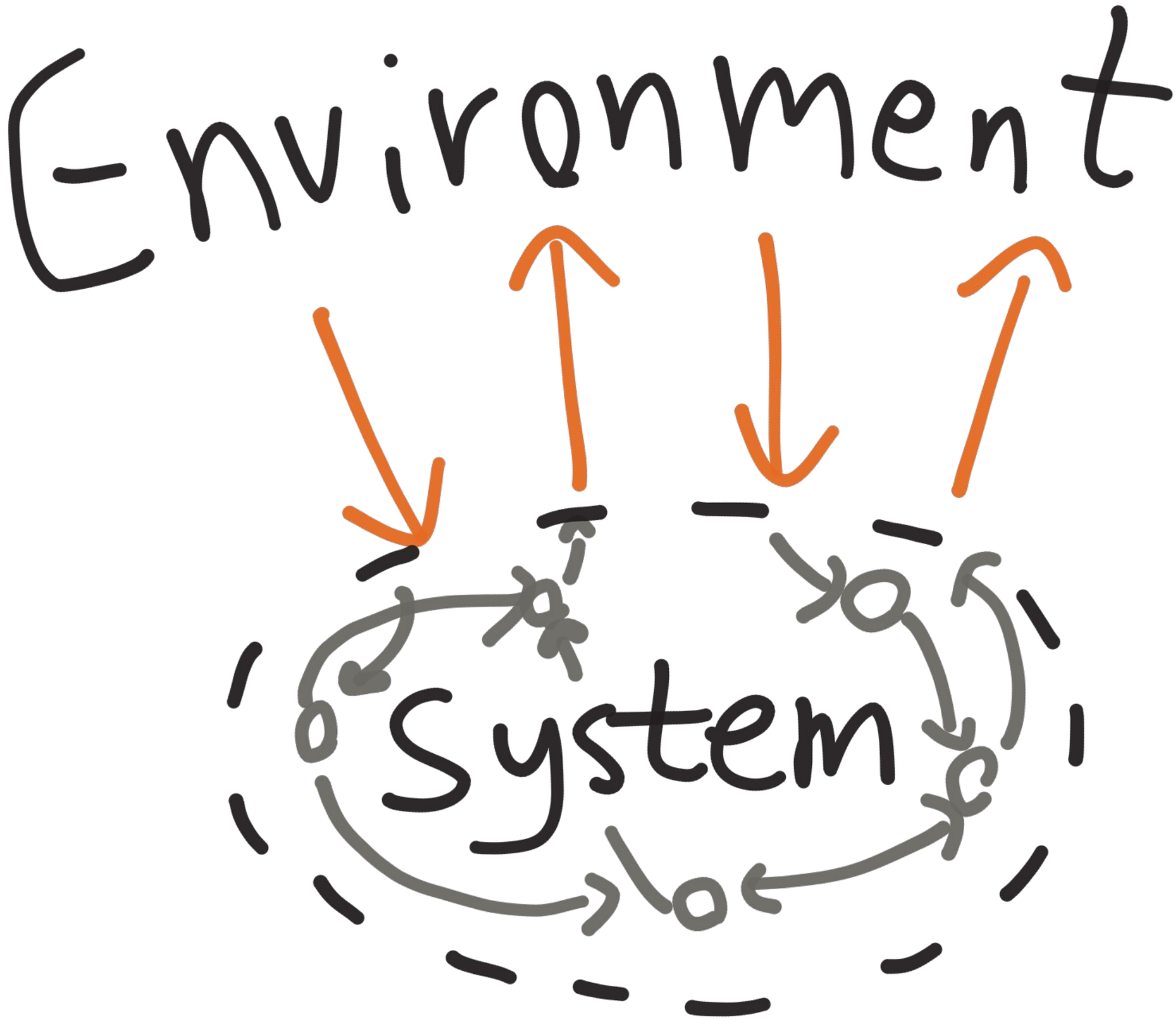
Ruby {

DBs

Every thing is fine!

Jepsen

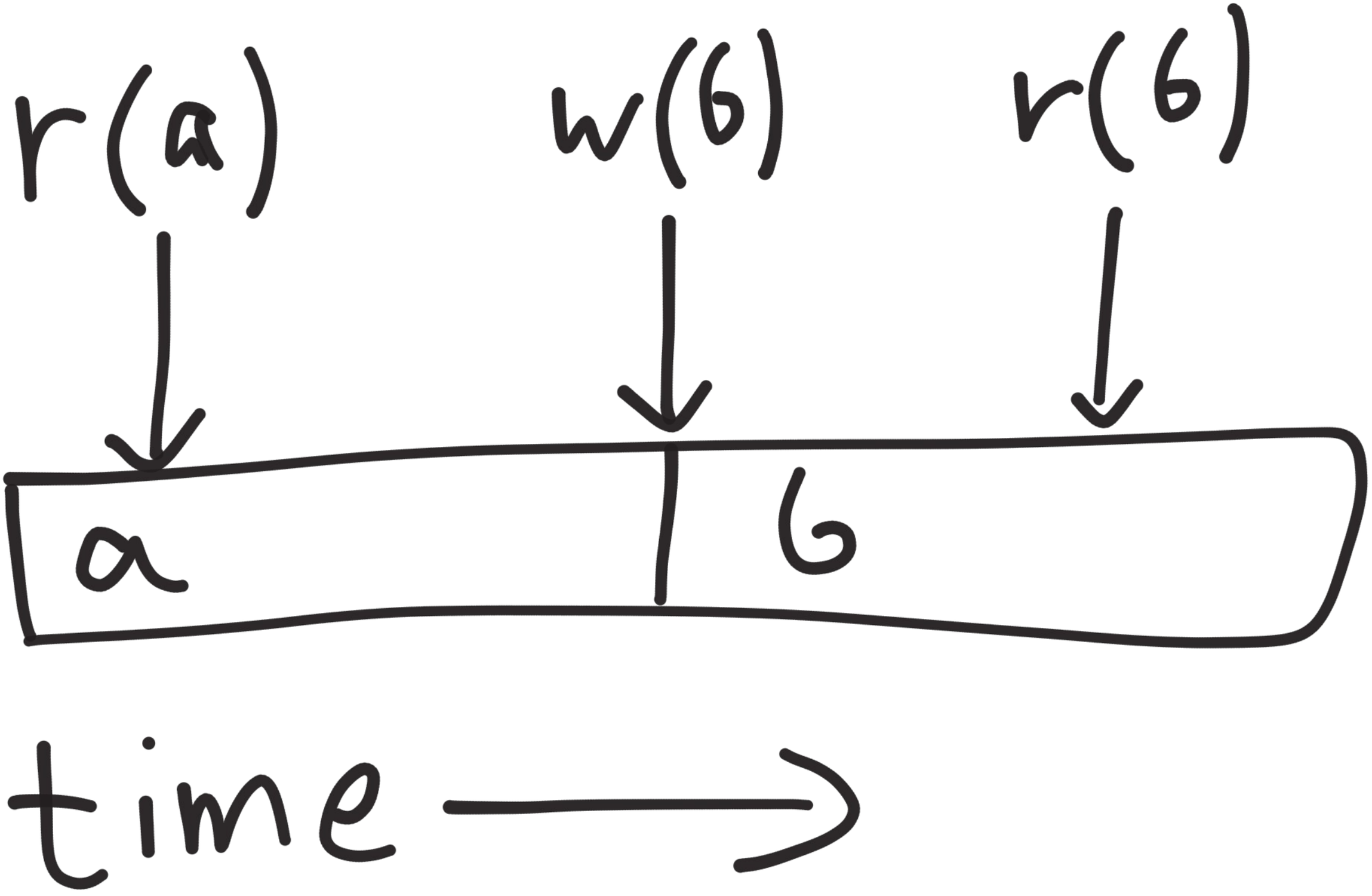
github.com/aphyr/jepsen

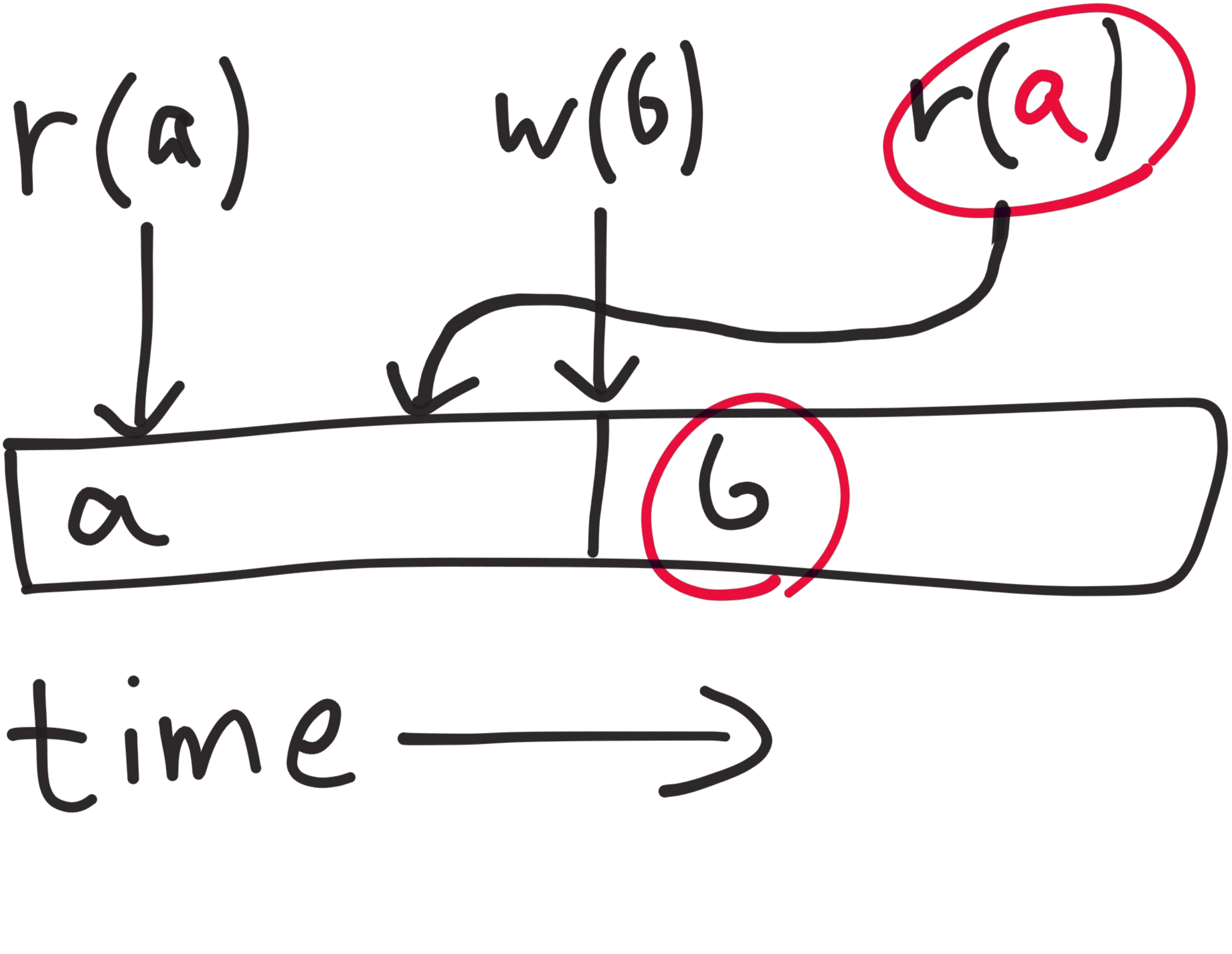

Environment
System

-INVARIANTS-

```
var x = a
print x
```

```
x = b
print x
```


r(a)
w(6)
r(6)
a
6
time


r(a)
w(b)
r(a)
a
b
time

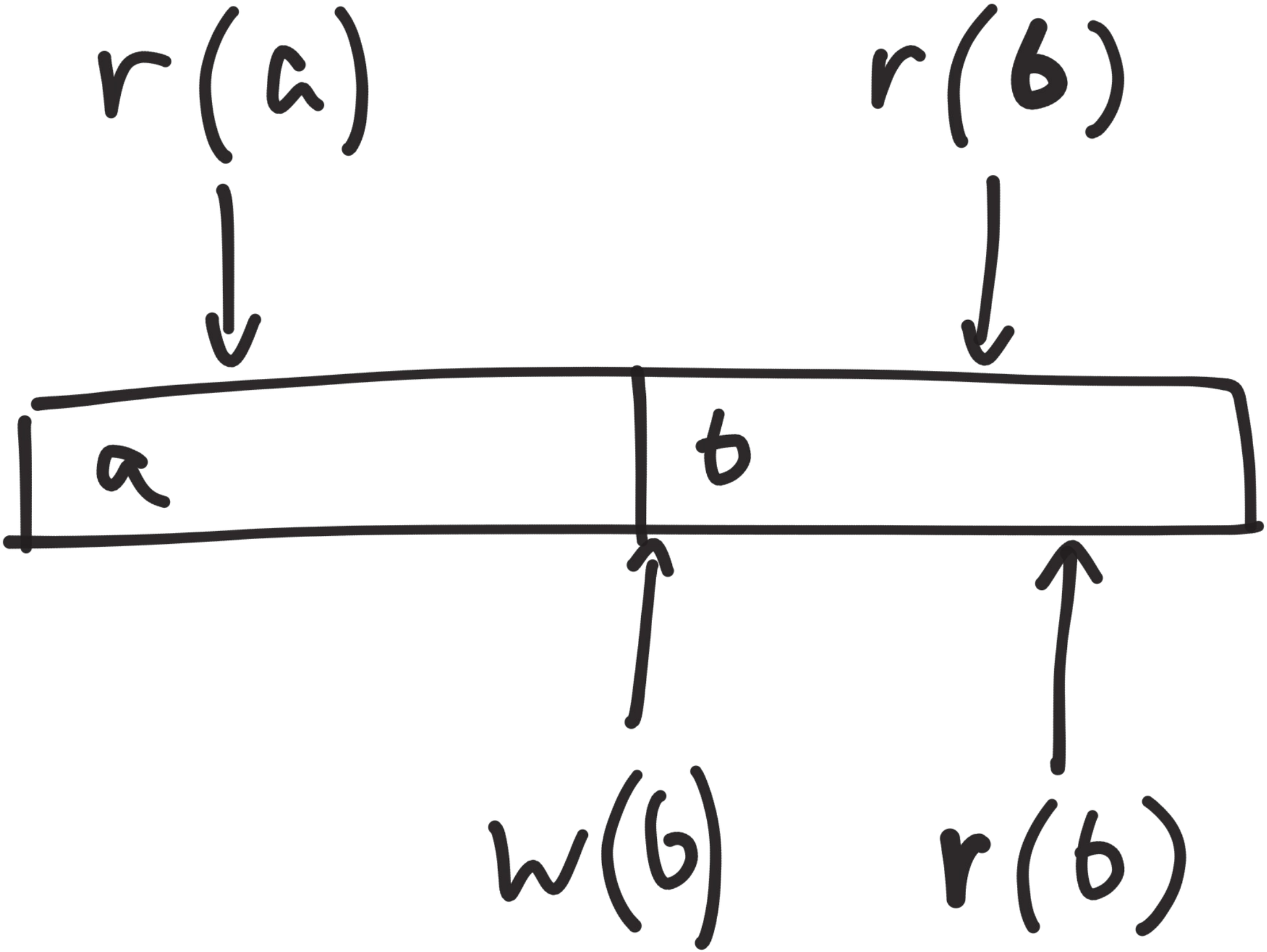
Invariants

Constrain

Histories

What about

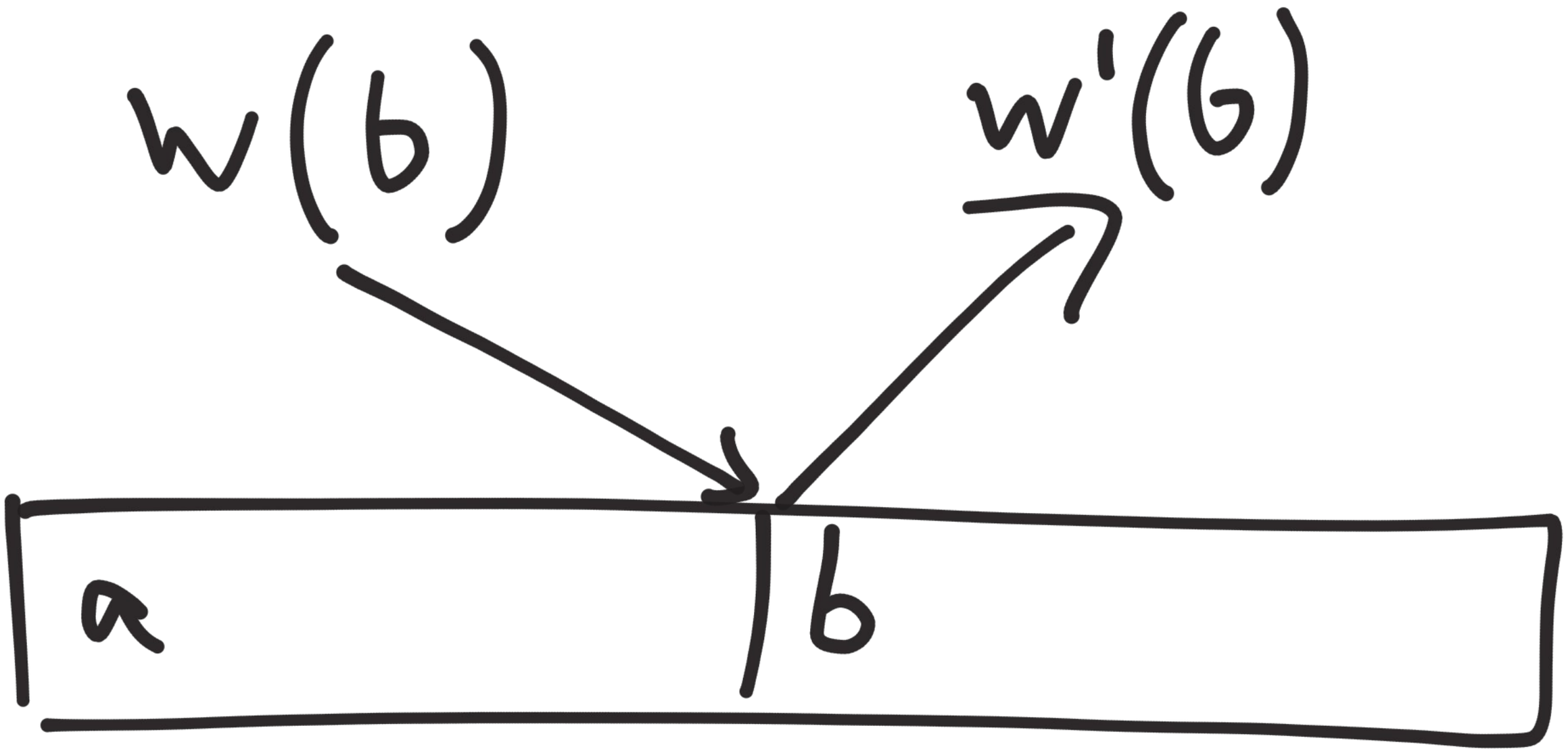
Concurrency?


r(a)
r(b)
a
b
w(b)
r(b)

Distributed

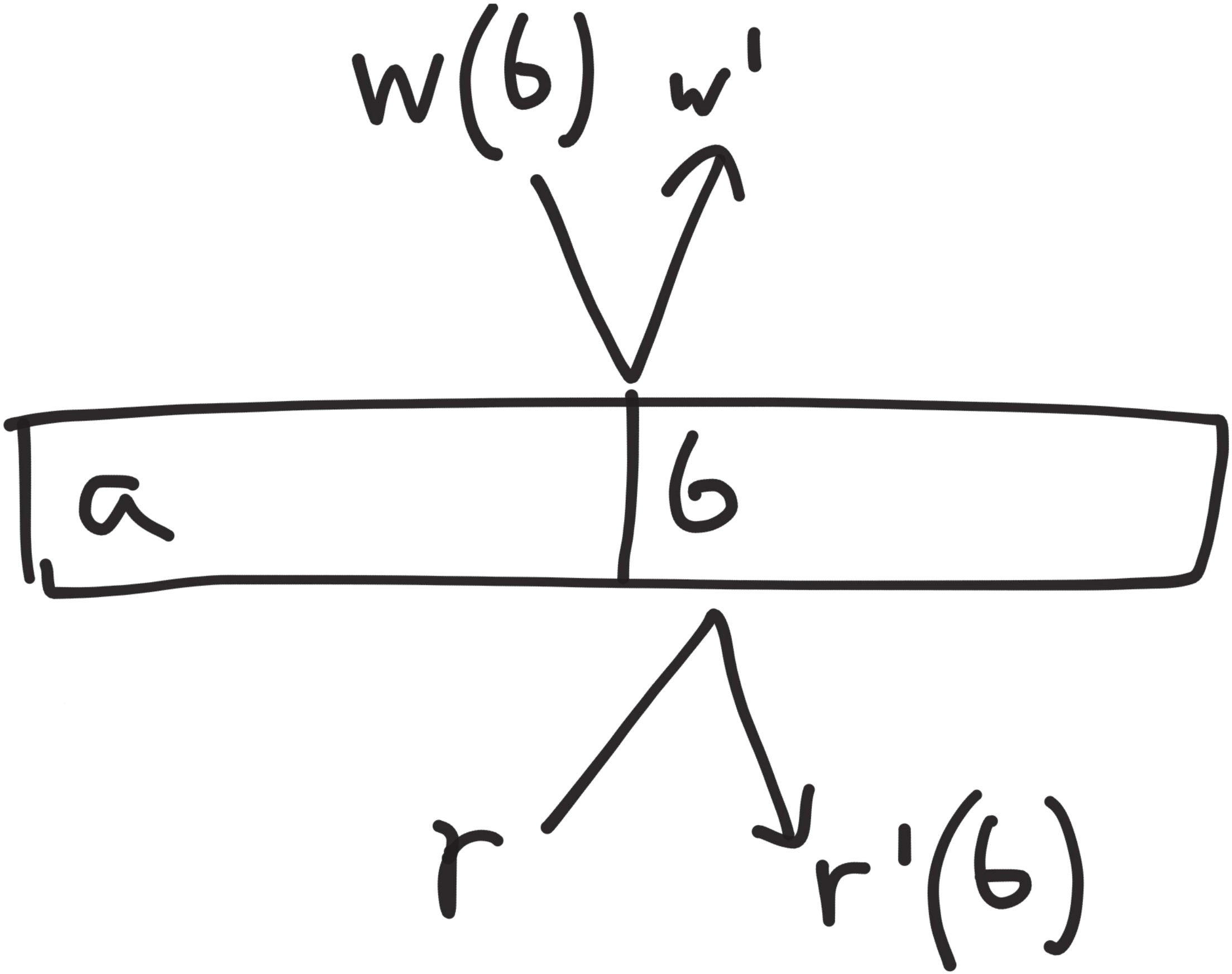
⇓

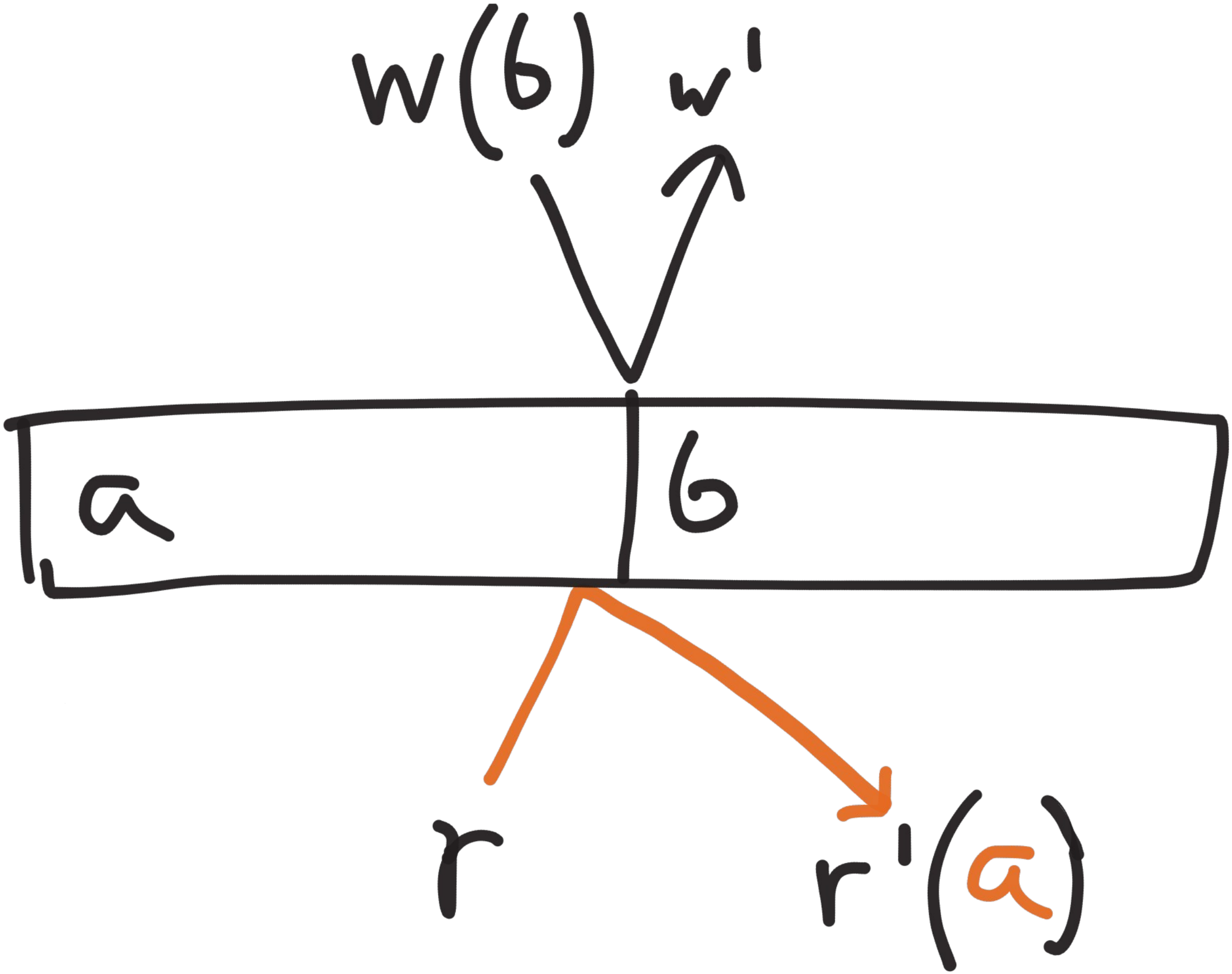
Distance



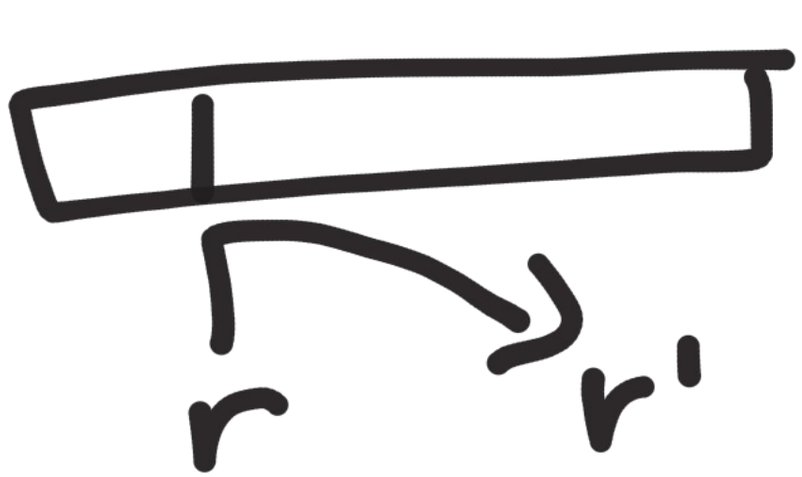
Messages take time

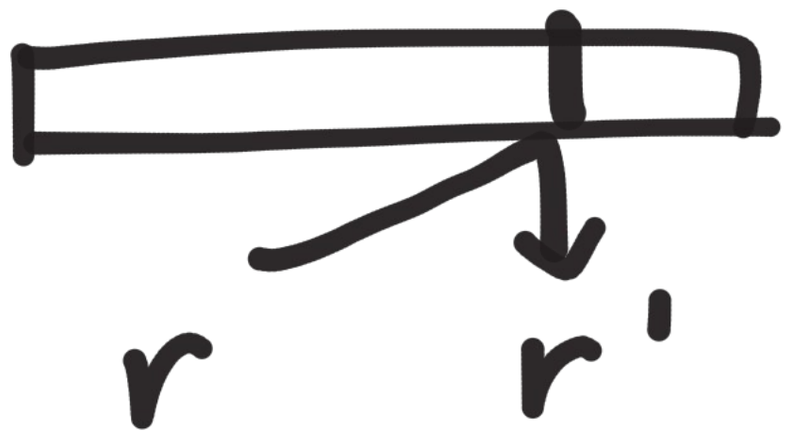
Delays imply ambiguous orders

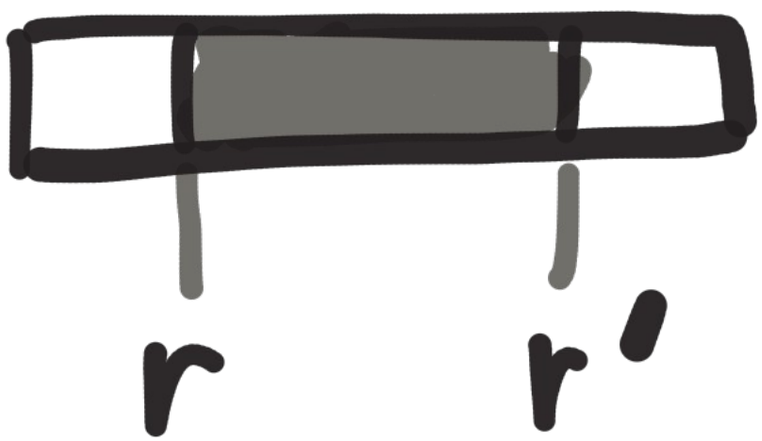

w(b)
w'
a
b
r
r'(b)


w(b)
w'
a
b
r
r'(a)

But there are finite bounds on ambiguity!

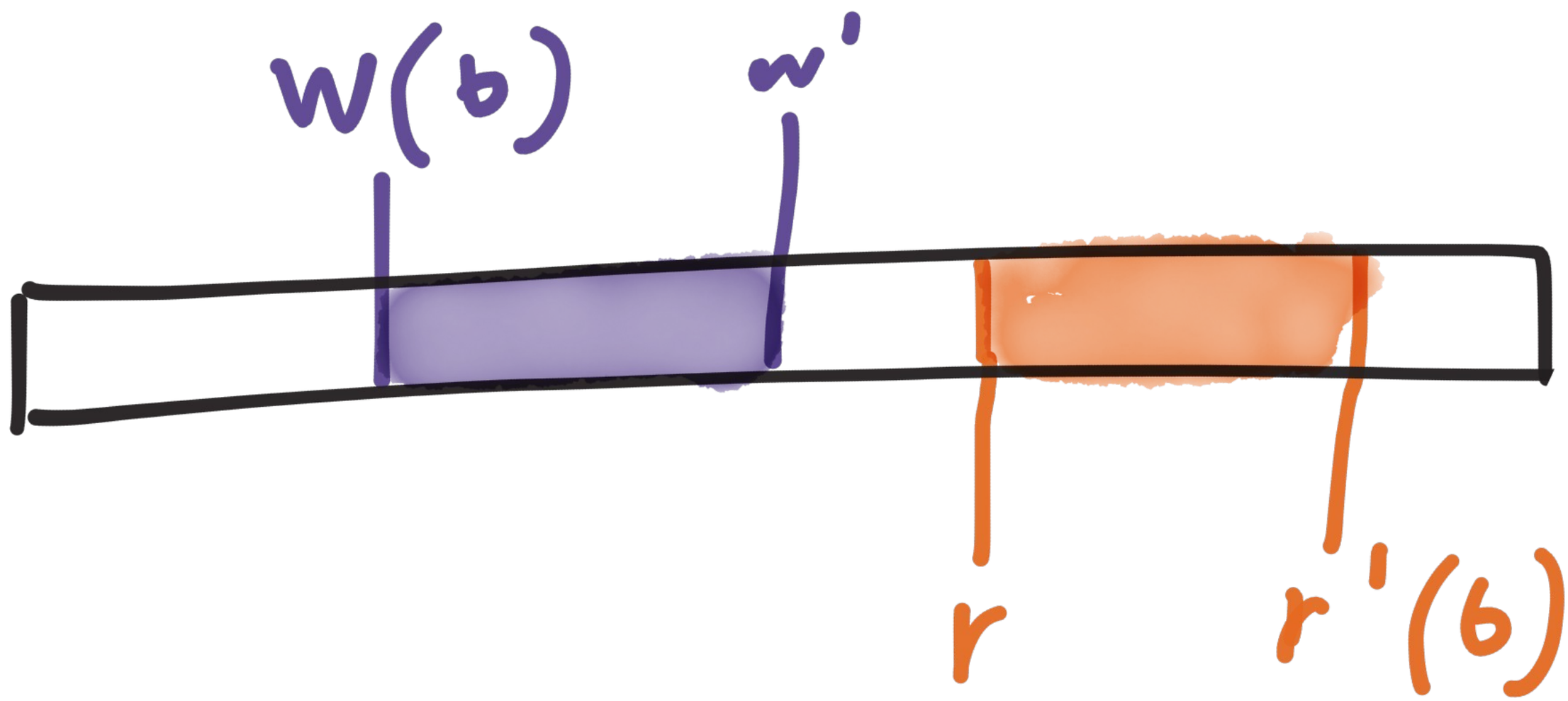




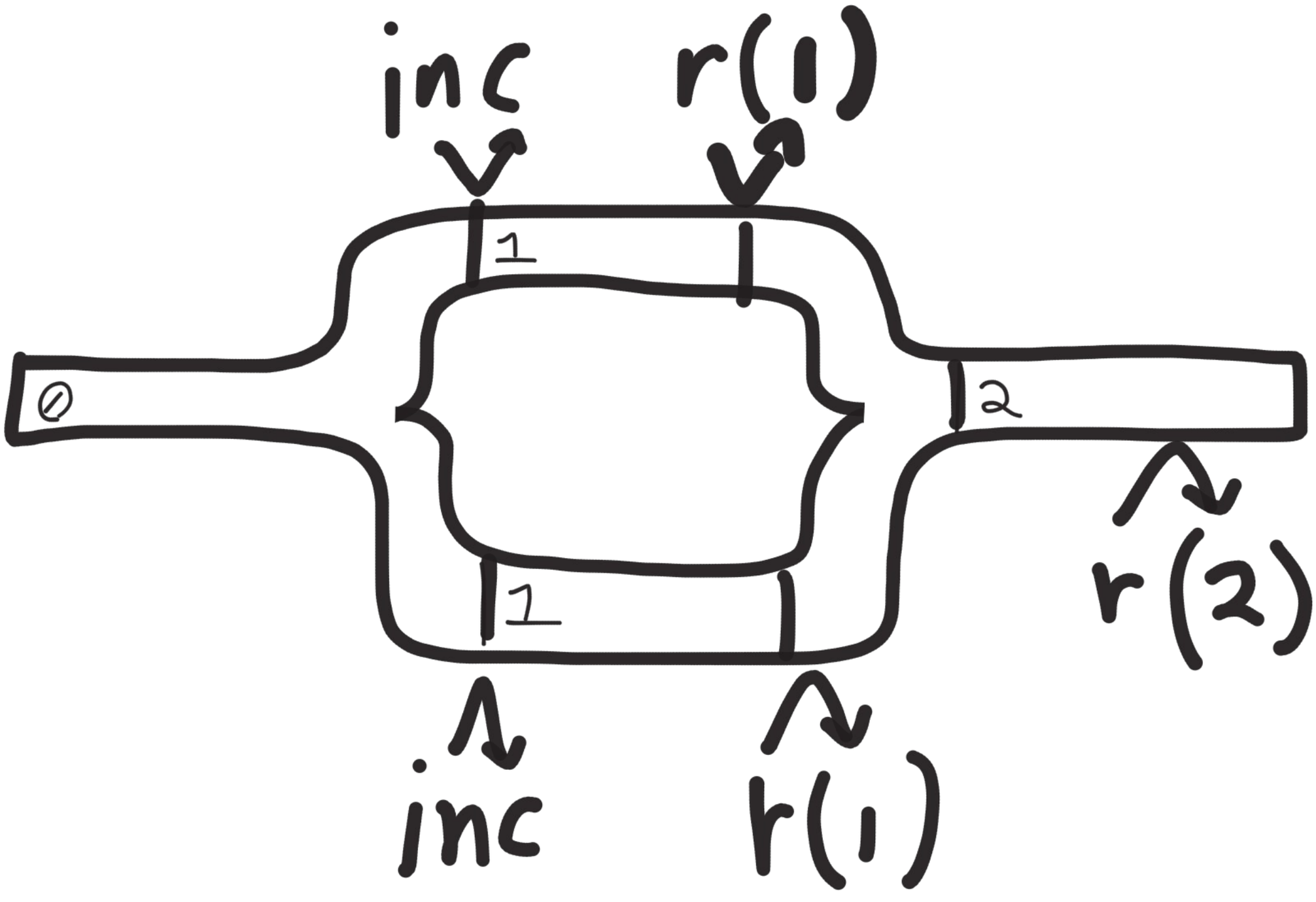


Linearizability

After op is complete, guaranteed visibility!



Eventual Consistency



strong

linearizable

sequential

causal

PRAM

RYW

MR

MW

WFR

serializable

serializable

RR

CS

SI

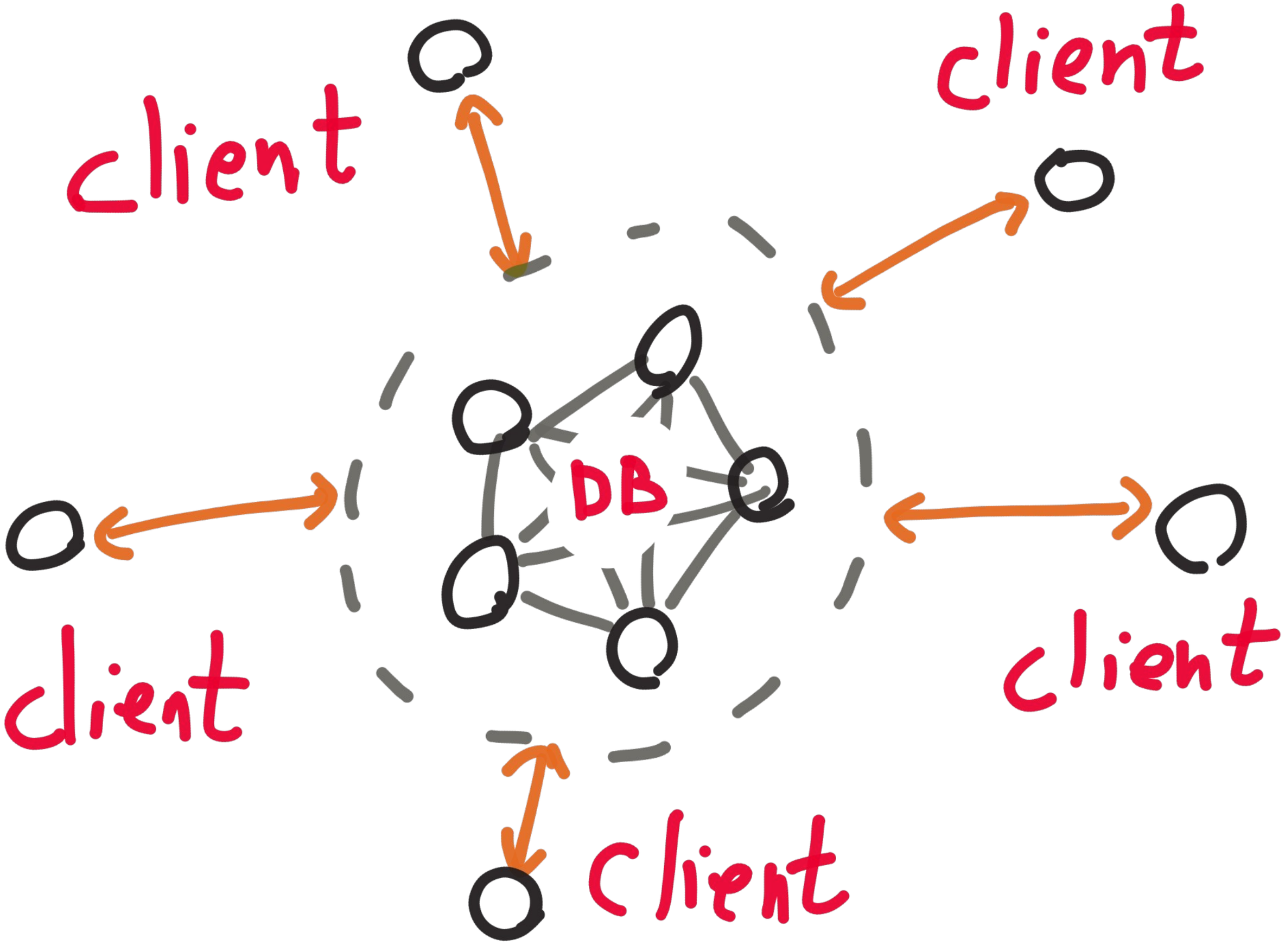
MAV

P-CI

RC

...

SO: Consistency models constrain the system-environment interactions.

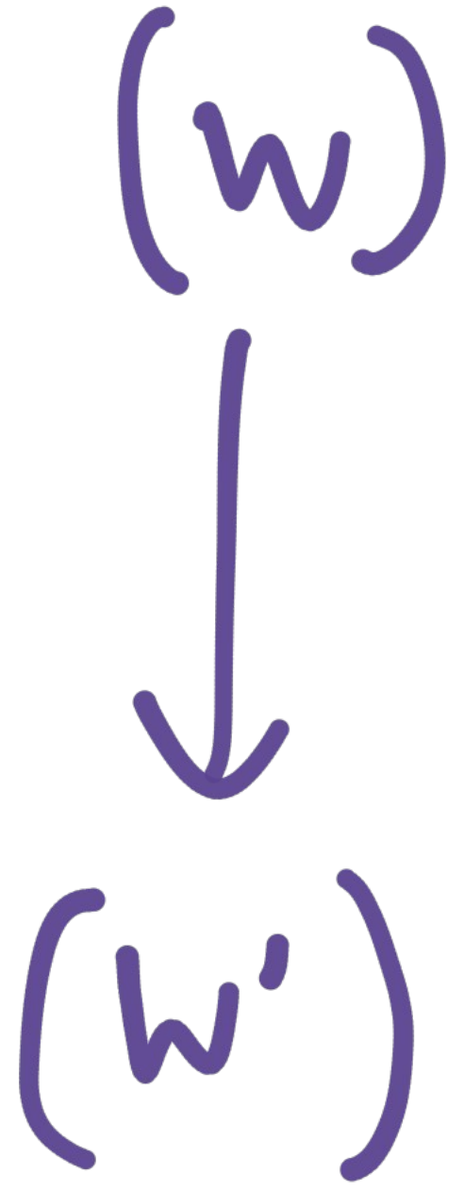

client
client
DB
client
client
client

client: w—w' r—r' w—w'

DB:

client : w —— w' w ——— - - -

Clients Generate random operations (w) and apply them to the system



invoke ok

invoke fail

invoke ? ? info ? ? ?

invoke ok

invoke fail

invoke ok

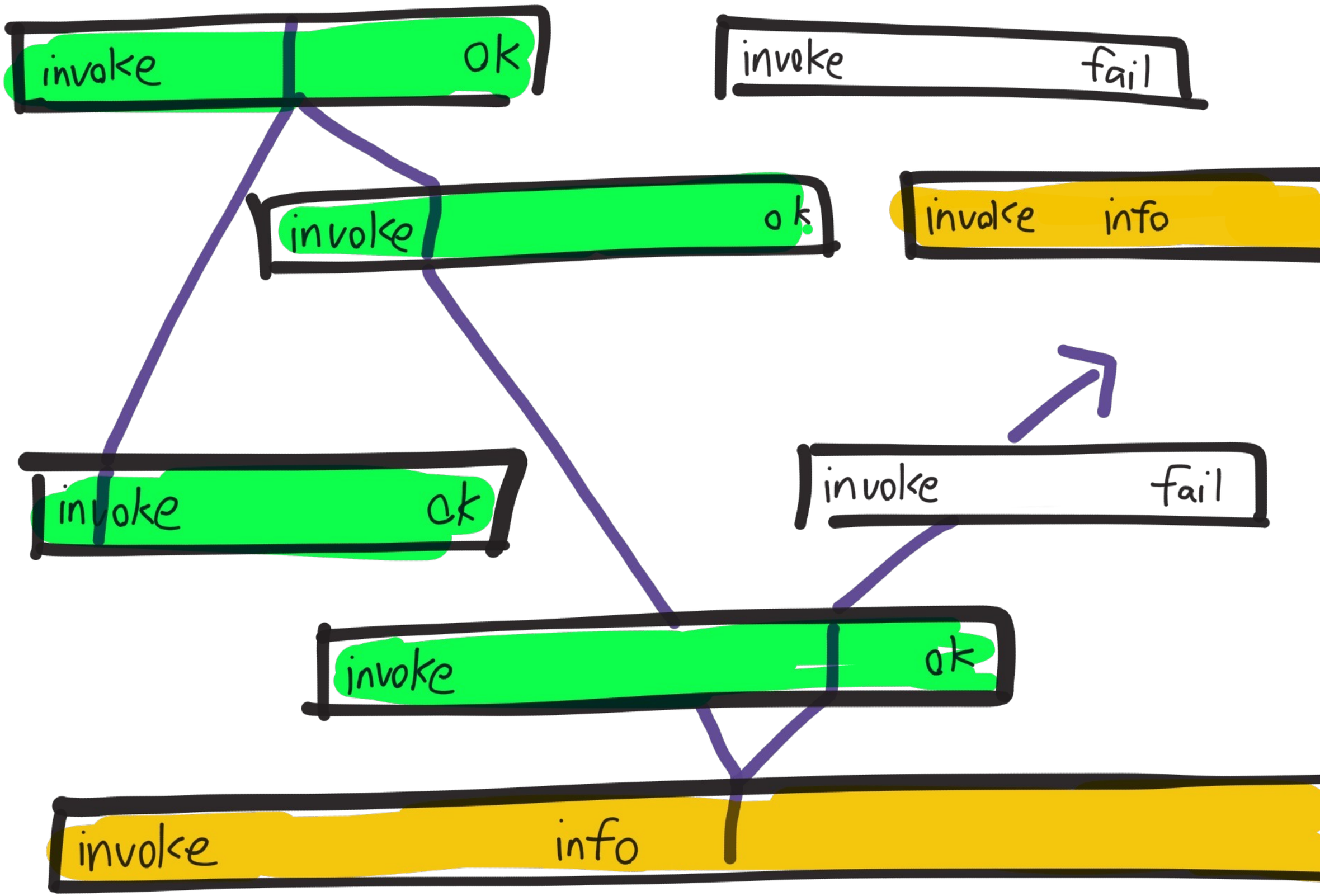
invoke info

invoke ok

invoke fail

invoke ok

invoke info


invoke
ok
invoke
fail
invoke
ok
invoke
info
invoke
ok
invoke
fail
invoke
ok
invoke
info

1. Generate ops

2. Record history

3. Verify history is consistent w/ model

“So, what have you found?”

2013

- Redis Sentinel
- Mongo D3
- Riak

2013

- Kafka
- NuoDB
- Cassandra

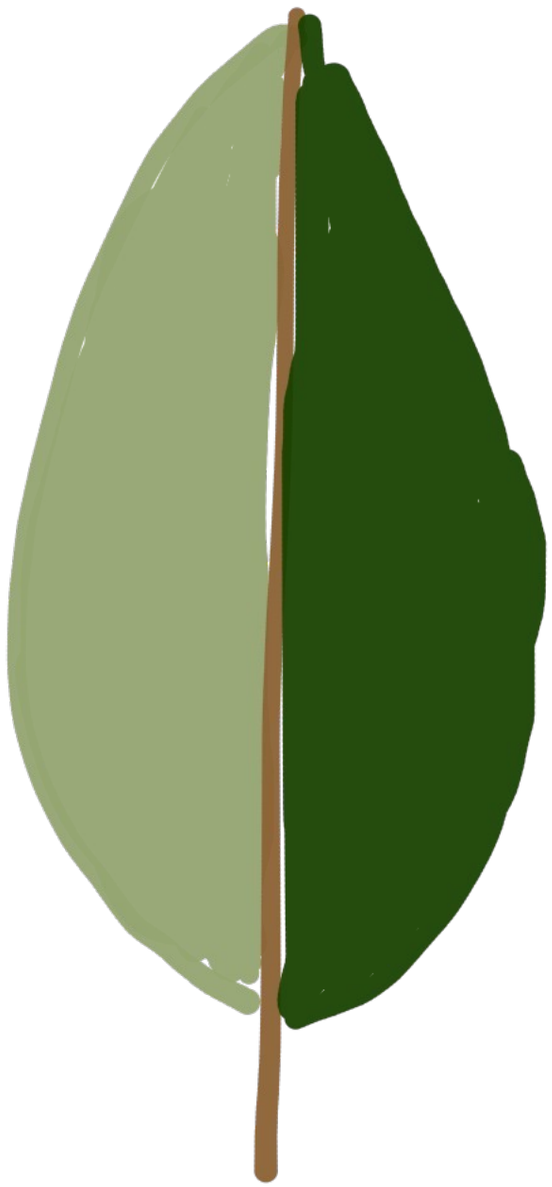
2014

- RabbitMQ
- etcd $ Consul
- Elasticsearch

And now, for something

COMPLETELY DIFFERENT

~~DIFFERENT~~ THE SAME



mongoDB

First Jepsen test in May 2013

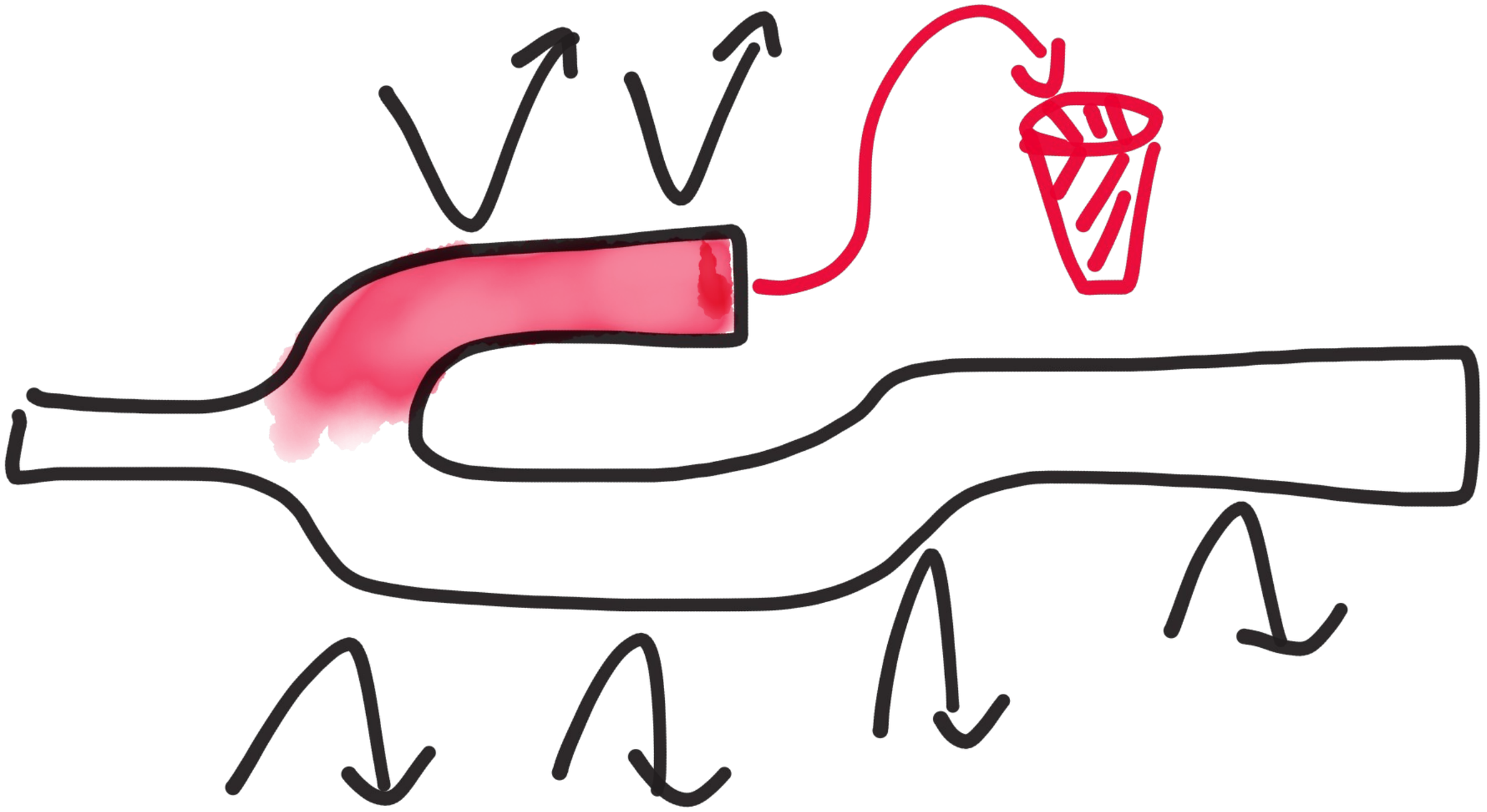
Data loss at all WriteConcern levels

Unsafe defaults

- Some clients didnt check for errors at all

Unsafe defaults

- Better clients only wait for 1 or nodes, instead of a majority!



Rollbacks

Even Majority unsafe!

Network failures were considered successful responses

But those bugs are fixed now!

Ok! Let's

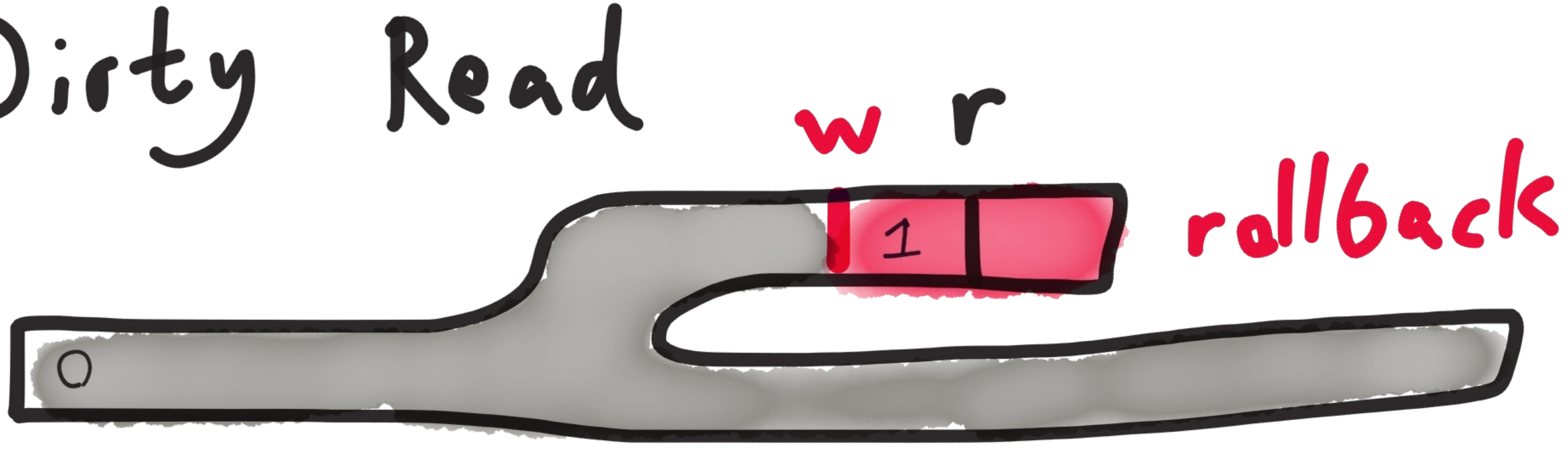
try 2.6.7

Linearizable

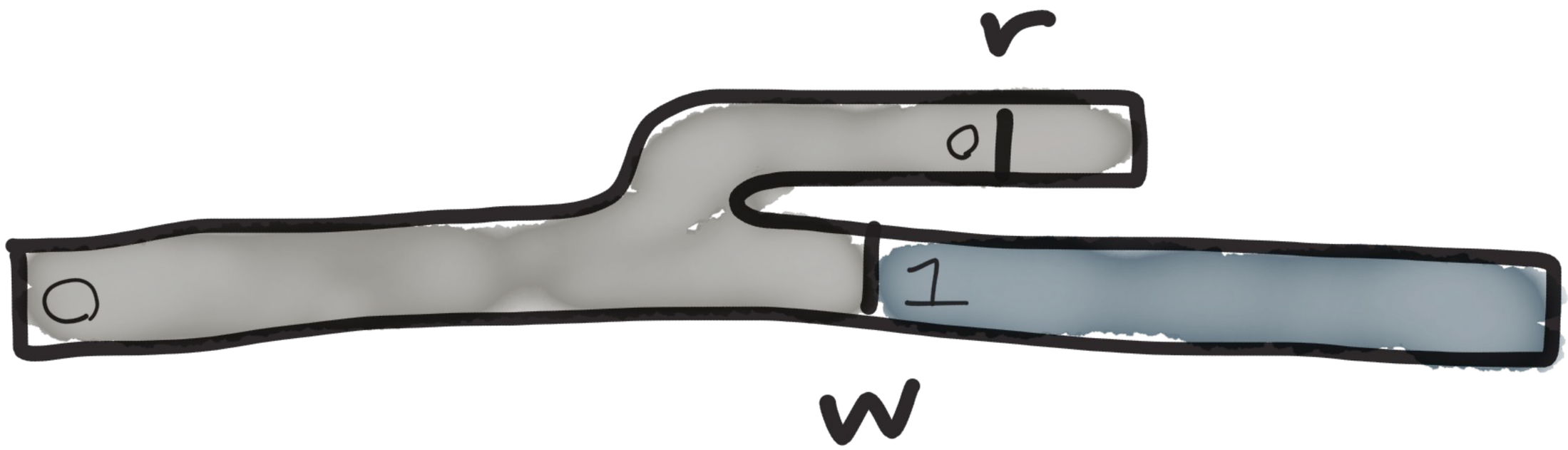
CaS Registers

An Anomaly Emerges!

Dirty Read



Stale Read



Server-17975

strong

serializable

linearizable

serializable

sequential

RR

SI

causal

CS

MAV

P-CI

PRAM

WFR

RC

RYW

MR

MW

strong

serializable

linearizable

sequential

causal

PRAM

RYW

MR

MW

WFR

RR

CS

RC

SI

MAV

P-CI

strong

serializable

linearizable

serializable

sequential

RR

SI

CS

causal

MAV

P-CI

PRAM

WFR

RC

RYW

MR

MW

RU

strong

serializable

linearizable

serializable

sequential

RR

SI

CS

causal

MAV

P-CI

PRAM

WFR

IRC

RYW

MR

MW

RU

Mongo

strong

serializable

linearizable

sequential

causal

PRAM

RYW

MR

MW

WFR

serializable

RR

CS

SI

MAV

P-CI

IRC

RU

Mongo vs. docs

Mongo Recommendations

- Plan for stale reads
- Use CaS to verify read values are legitimate

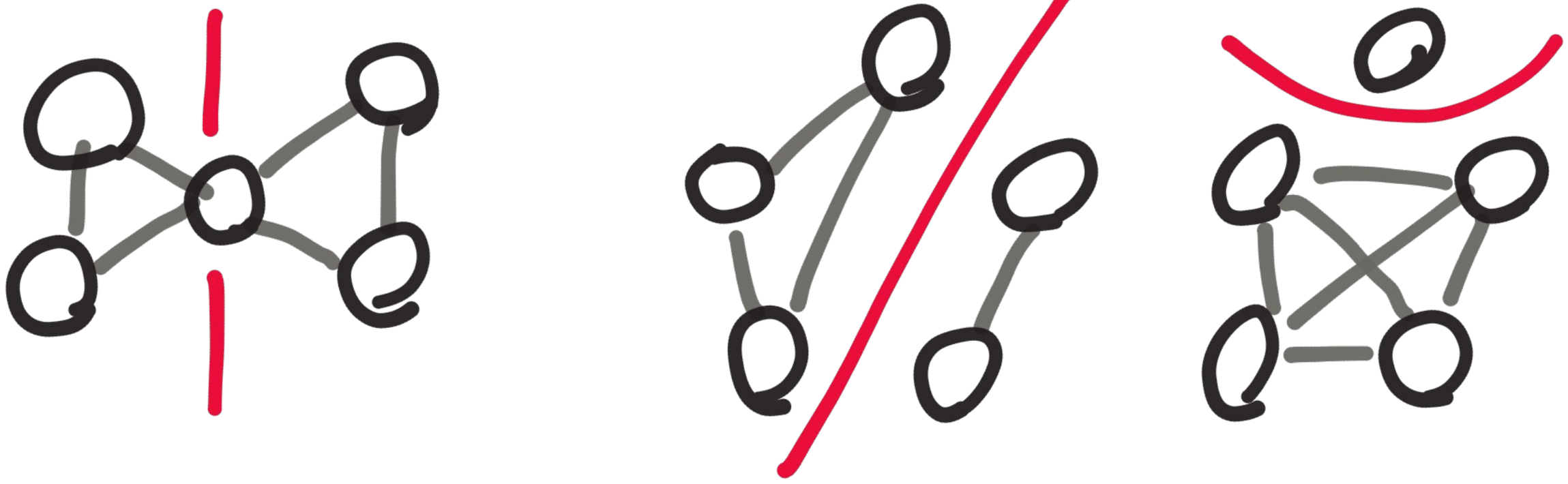
elastic

[search]

First Elasticsearch tests: June 2014

v1.1.0

Split Brain from



Massive data loss: 90%

- Cluster status lies
- 90 seconds for recovery
- Permanently wedged clusters

ES added a great page on safety issues

bleskes commented on Sep 1, 2014 Owner

I'm closing this issue, as it is solved, as specified, by the changes made in #7493. Of course, there is more work to be done and the effort continues.

Thx for all the input and discussion.

 **bleskes** closed this on Sep 1, 2014

AeroNotix commented on Sep 1, 2014

@bleskes so it's 100% fixed?

bleskes commented on Sep 1, 2014 Owner

this issue (partial network splits causing split brain) is fixed now, yes.

Folks are still referring to the last talk

Mark Walkom
@warkolm

Follow

@falican durability in ES isn't a major problem these days, take a look at elasticsearch.org/guide/en/elast… for info on our view

9:36 PM - 20 Feb 2015

Reply to @warkolm @falican

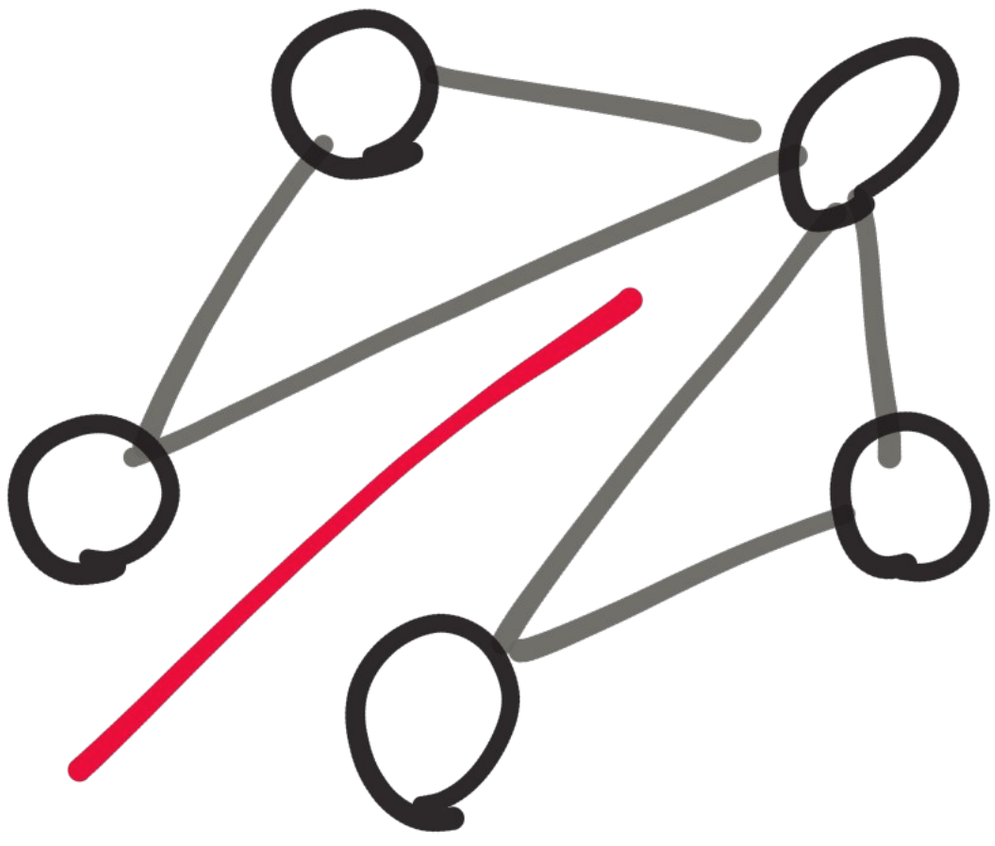
Rory Hart @falican · Feb 20
@warkolm yeah I've read through that, looks like you're all working very hard. I've got an abundance of caution today. Appreciate the time.

Mark Walkom @warkolm · Feb 20
@falican any time!

Mark Walkom @warkolm · Feb 20
@falican re-read that article, most of the complaints in it are pre 1.0 btw, given we're probably not far off 1.5, grains of salt needed ;)

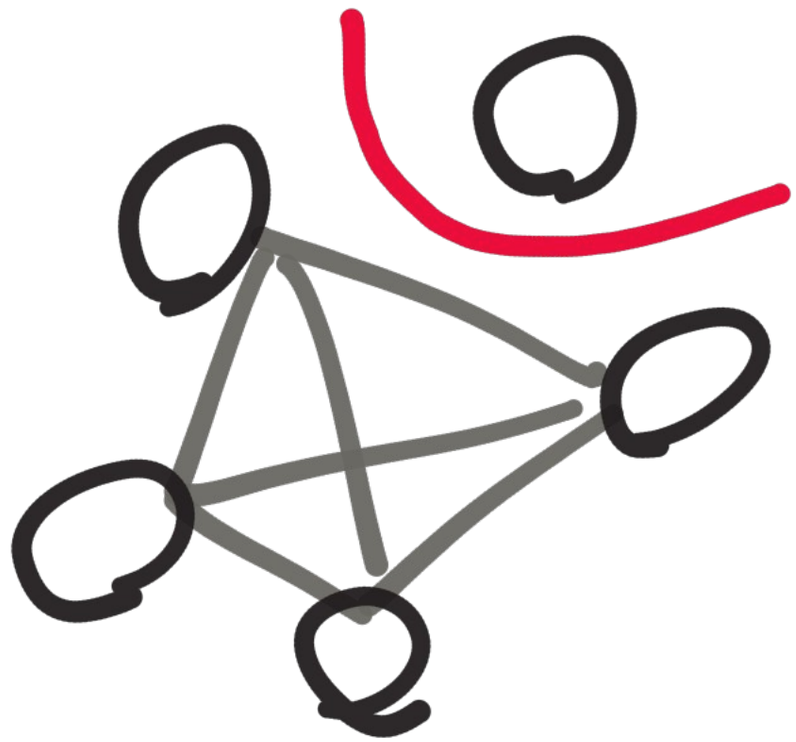
Retesting with ES 1.5.0

Intersecting partitions still cause data loss



Long-lived split-brain appears fixed, but docs are still last

Single node partition still cause data loss!



Electing a new primary still takes

~90 seconds

- Writes will stall

Elasticsearch is doing better, esp. with documentation!

Elastic Search Recommendations

- No longer catastrophic
- But, still loses data in all failure modes
- 


KEROSPIKE

RELIABILITY

100% Uptime
with strong consistency (ACID)

"No data loss. Row-level locking... immediate consistency (ACID), with synchronous replication"

"AS is by and large an AP system that provides high consistency"

"Aerospike provides read-committed isolation level using record locks to ensure isolation between [txns]"

strong

linearizable

sequential

causal

PRAM

RYW MR MW

WFR

serializable

serializable

RR

CS

SI

MAV

P-CI

RC

AP ✓

"for ops. on single keys with replication, Aerospike provides immediate consistency using synchronous writes to replicas"

"...read requests are guaranteed to find the newly written data..."

strong

linearizable

sequential

serializable

serializable

RR

SI

CS

causal

PRAM

RYW

MR

MW

WFR

MAV

RC

P-CI

"Virtually eliminate partition formation proven by years of deployment in DC and cloud environments."

"A key design point of As is to setup cluster nodes that are tightly coupled so that partitions are virtually impossible to create"

AEROSPIKE

Search

DISCOVER DOWNLOAD DEVELOP DEPLOY DOCUMENTATION
COMMUNITY

Get Started!

DEPLOY

TRAINING

RESOURCES

Aerospike is now available with Click-to-Deploy on Google Compute Engine

You can quickly spin up an Aerospike cluster for development or production.

Deploy Aerospike clusters easily in Amazon EC2

Learn how to install on EC2 instances, get tips on capacity planning, configuration, benchmarking and using bcache for faster persistent storage.

1M TPS on 1 Server

This can be achieved on a $5k commodity server. Don't believe it? Follow this easy, 4 step

So for a CaS

Register...

6

w2

7

w4

11

w0

4

r2

10

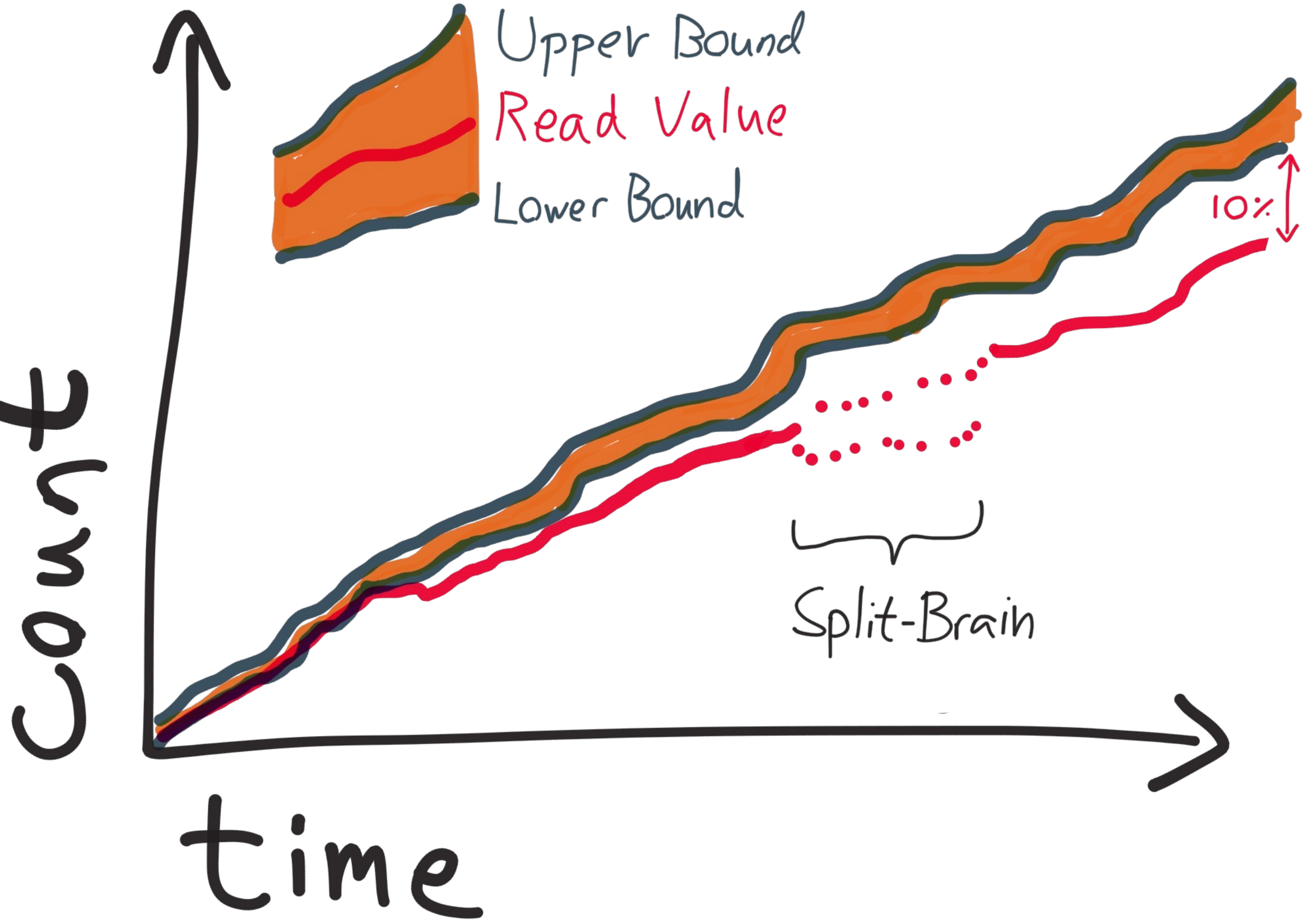
w4

12

r0

Cas 0→3

Counters will drop increments during a partition


Upper Bound
Read Value
Lower Bound
10%
Split-Brain
count
time

"Deployment modes
AP vs. CP"

CP is vaporware

Application Merge!

"Read... will return both versions, allowing the app. to resolve"

Like "CP mode"
this feature does
not exist.

No CRDTs for you!

LOST

UPDATES

strong

linearizable

sequential

causal

PRAM

RYW

MR

MW

WFR

serializable

serializable

RR

CS

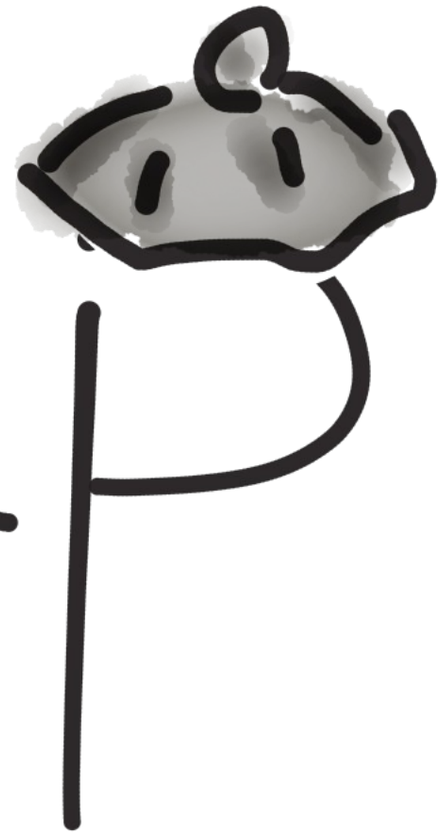
RC

SI

MAV

P-CI

Recap



Mongo ⅁ ES

have made

improvements!

Still Surprises

lurking in the

DEEP

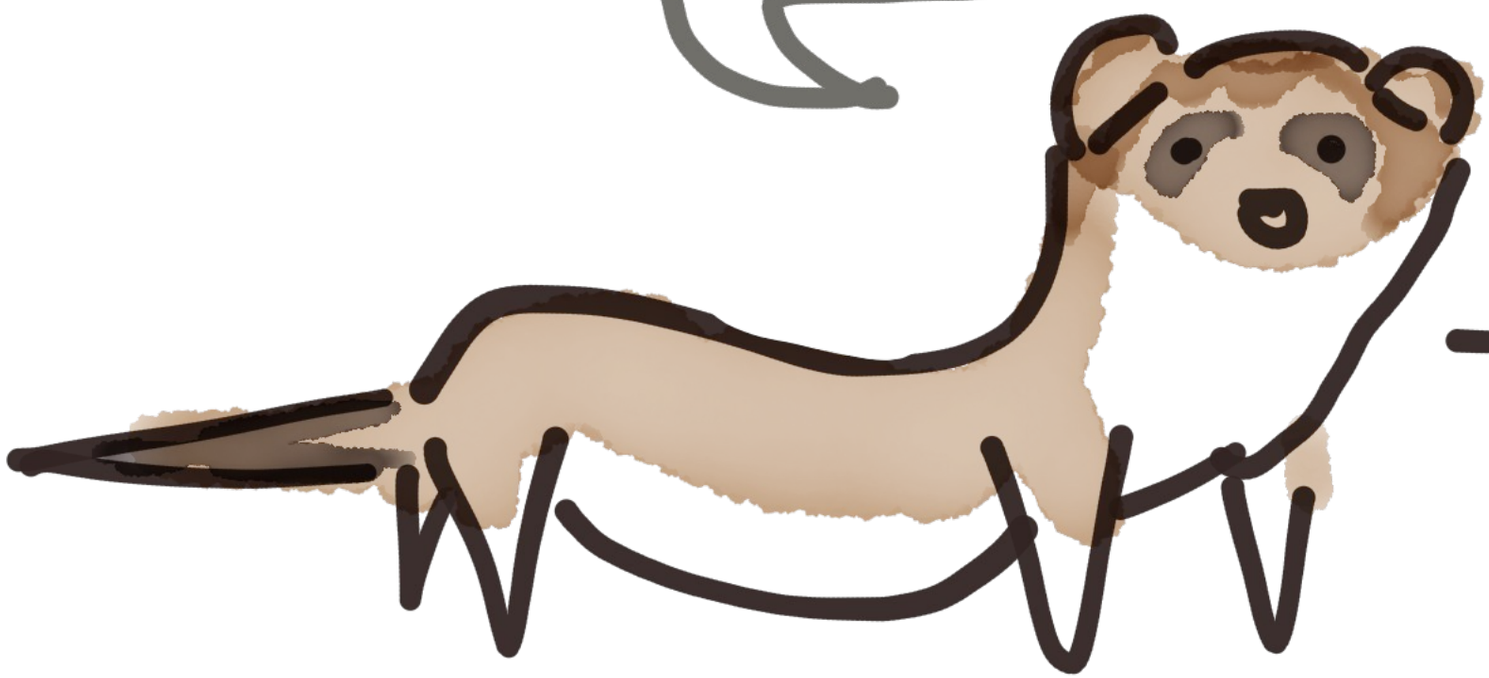
Read the docs!

CAREFULLY

"Strict"

"ACID"

"strong"



-WORDS

Figure out the invariants your system needs

How much

can you tolerate?

Then test it for YOURSELF

Consider your failure modes

Process Crash

```
#kill -9 1234
```

Node failure

- AWS terminate
- Physical power switch

Clock Skew

```
# date 10280000
# faketime ...
```

SC/IO Pause

```
# killall -s STOP foo
```

```
# killall -s CONT foo
```

Network Partition

```
# iptables -j DROP
```

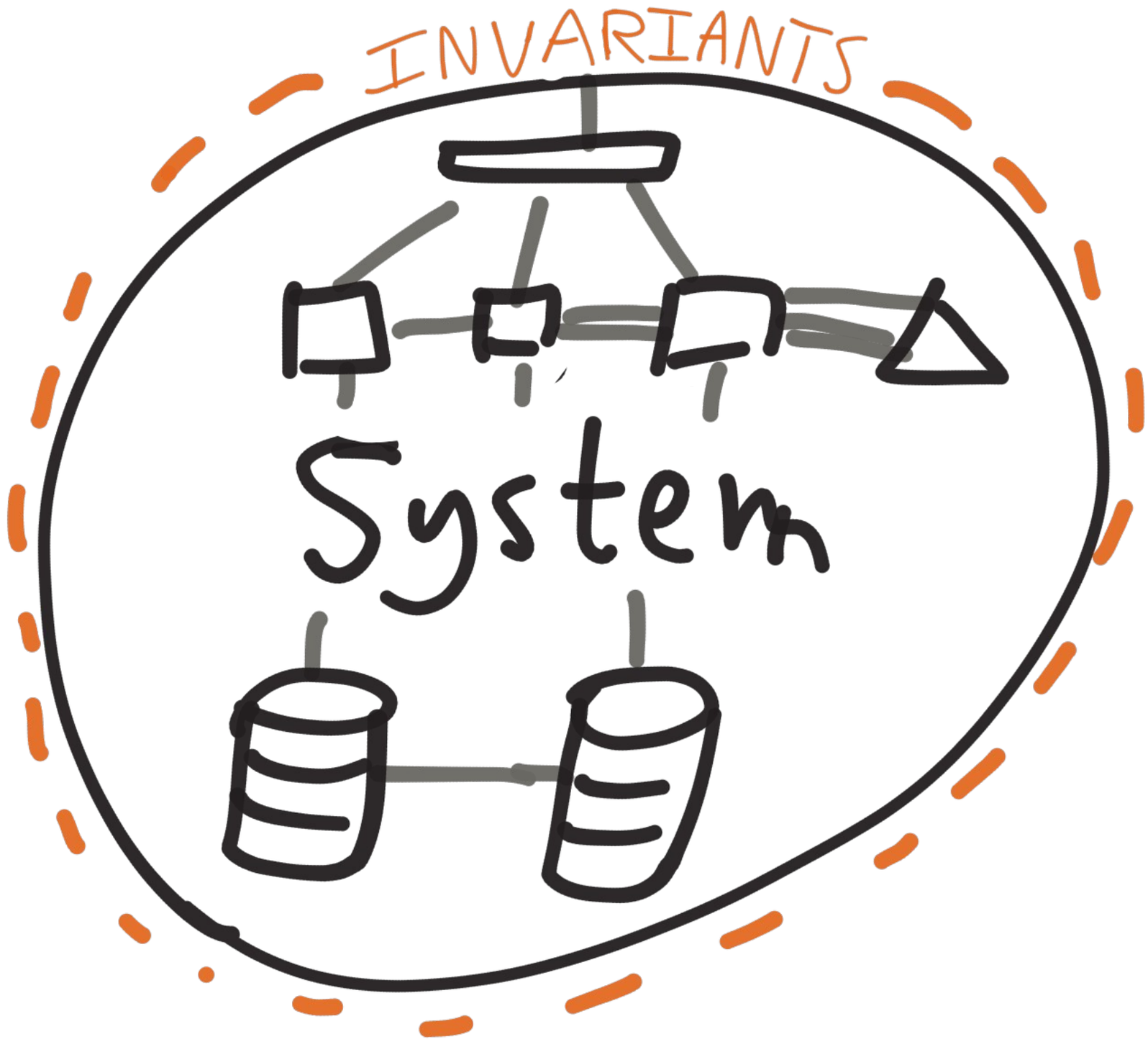
```
# tc qdisc ... delay ...
                drop ...
```

Test your

Systems

end ——— to ——→ end

vs.



- Property testing
- High-level invariants
- With distsys failure modes

Thanks!

Kevin Porter
Lucien Valmar
Stripe
Evan Broder
Boaz Leskes
Asya Kamsky
Lee Hinman
Kelly Stirman
Matt Kangas
Marc Hedlund

Jepsen

github.com/aphyr/jepsen