Git for Data Lakes

How lakeFS Scales Data Versioning to Billions of Objects

Amit Kesarwani
Director of Solution Engineering

lakeFS


38
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Amit Kesarwani: Solutions Architect

github.com/kesarwam

@AmitKesarwani

github.com/treeverse/lakeFS

@lakeFS

axolotl

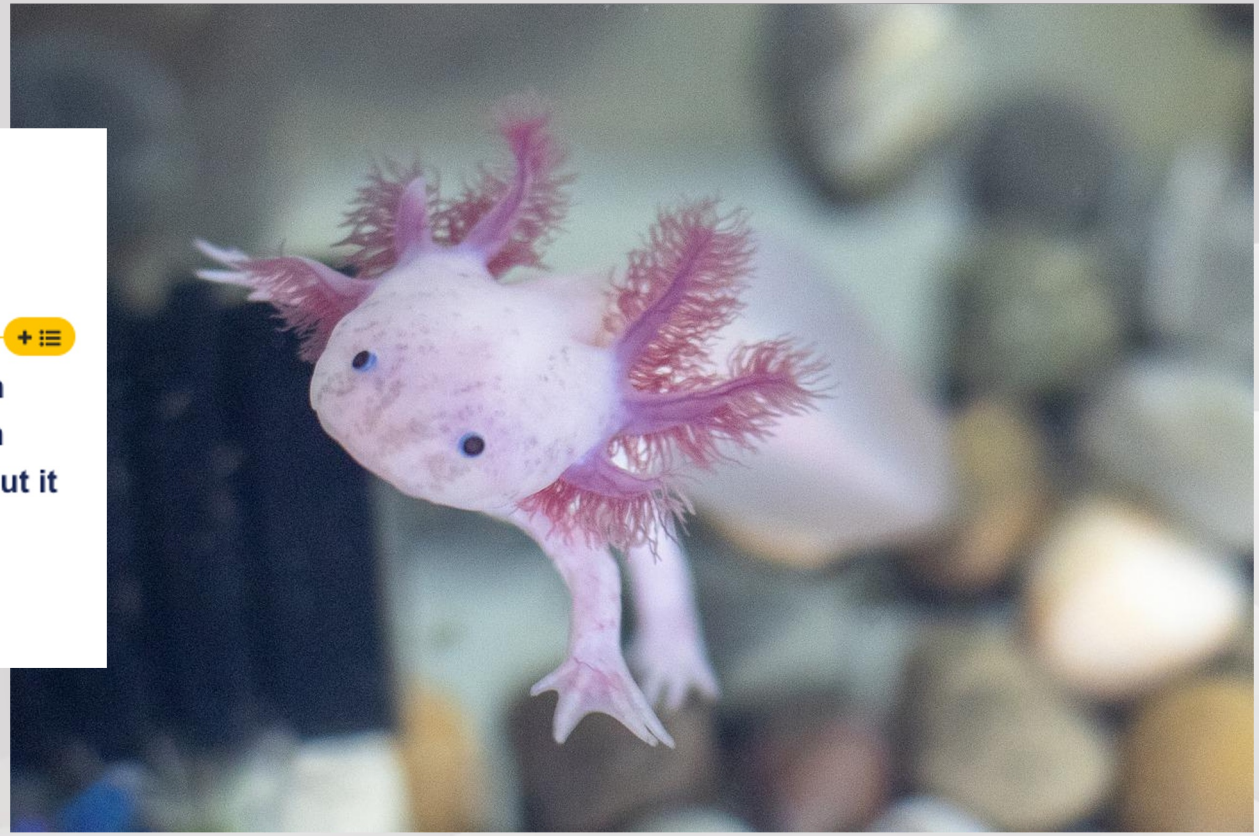
noun [C]

UK /ˈæk.sə.lɒt.ᵊl/ US /ˈæk.sə.lɑː.ɾᵊl/

a small animal that lives in water and looks like a fish with four legs. An axolotl is a type of amphibian (= an animal that usually lives both on land and in water) but it only lives in water.

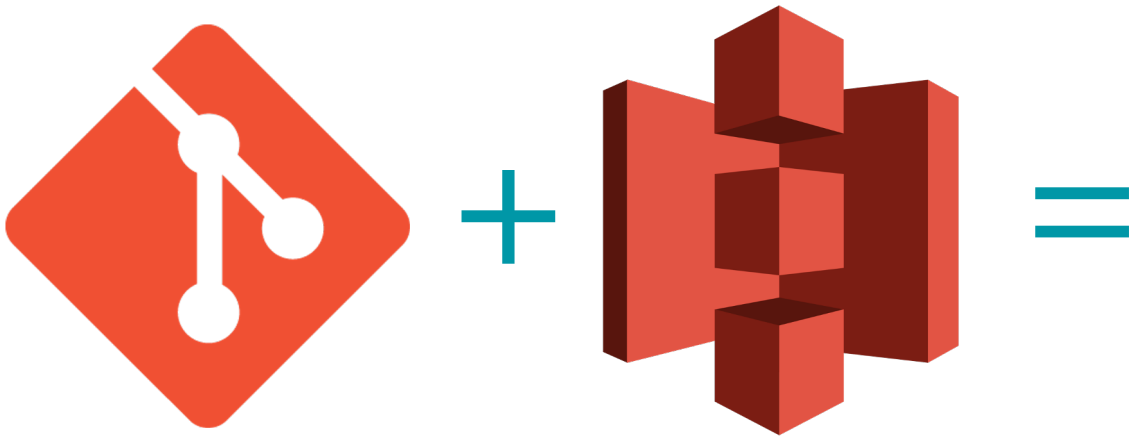
GlobalP/iStock / Getty Images Plus/GettyImages

https://dictionary.cambridge.org/dictionary/english/axolotl



What if we had Git?

But, you know, that scales to S3 sizes?



What if we had Git?

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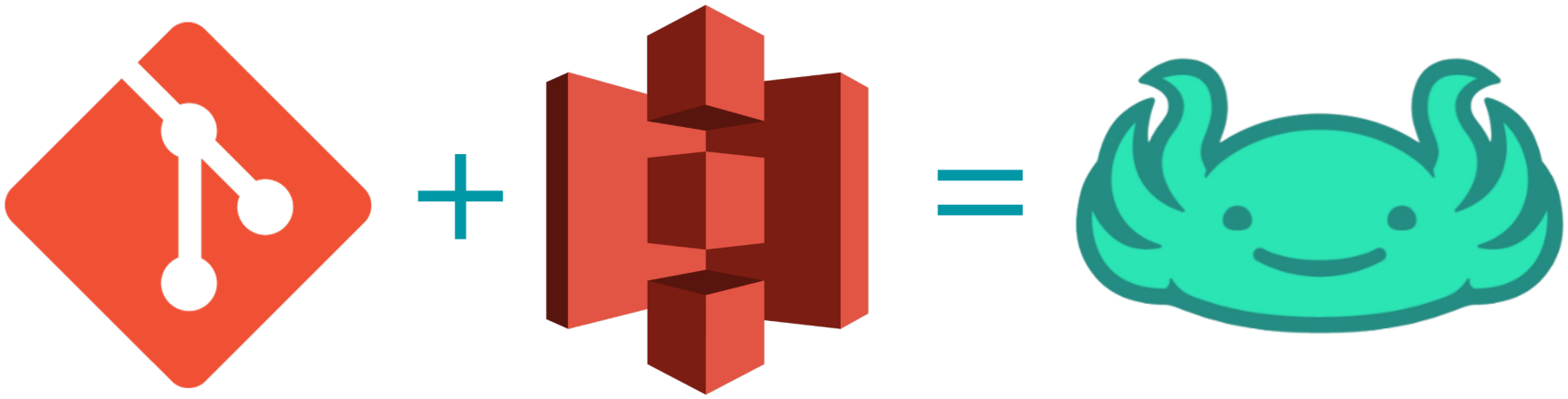


Wishlist

Sometimes referred to as “requirements”

- Cheap, CoW Branching
- Fast
- Efficient diffing/merging
- ~~Intuitive~~ Familiar branching committing and merging semantics

OK, so how do you scale the Git model to billions of objects?

Attempt #1

Let’s use Git!

Metadata (pointers to objects)

Data (objects)

Attempt #1

Let’s use Git!

Metadata (pointers to objects)

Data (objects)

```
root tree - e8d7621521

100644 blob f45a79533c   README.md
040000 tree b5df52155c   events
040000 tree 9fadcccbbc   marketing-data
040000 tree 01ffd0da88   sales-data
040000 tree 5cc330844a   raw-events
```

```
tree - b5df52155c

040000 tree f45a79537f   country=US
040000 tree 7bdf5217a2   country=IT
040000 tree f9adcec9ee   country=IL
040000 tree 18ffd0d216   country=UK
040000 tree d8c33089c1   country=NL
```

```
tree - 01ffd0da88

040000 tree 40218ea9e4 year=1995
040000 tree 76d4e36205 year=1996
040000 tree 54d483d269 year=1997
040000 tree f0c3bfe2a3 year=1998
040000 tree 70e3e07f8a year=1999
040000 tree 80430d4c57 year=2000
040000 tree 1b2d99146a year=2001
040000 tree d5203bd4b1 year=2002
040000 tree f4203a7b5e year=2003
040000 tree 059496b48f year=2004
040000 tree 43893289a2 year=2005
040000 tree 60a6a68b57 year=2006
040000 tree 8a243ccd59 year=2007
040000 tree 0d9f60fa7a year=2008
040000 tree cb692970d7 year=2009
040000 tree bbf9bfef4b year=2010
040000 tree 0325a8040b year=2011
040000 tree d84c7b4646 year=2012
```

Attempt #1

Let’s use Git!

Metadata (pointers to objects)

Data (objects)

- ✓ Cheap, CoW branching
- ✗ Fast
- ✗ Efficient diffing/merging
- ✓ ~~Intuitive~~ Familiar branching committing and merging semantics

Attempt #2

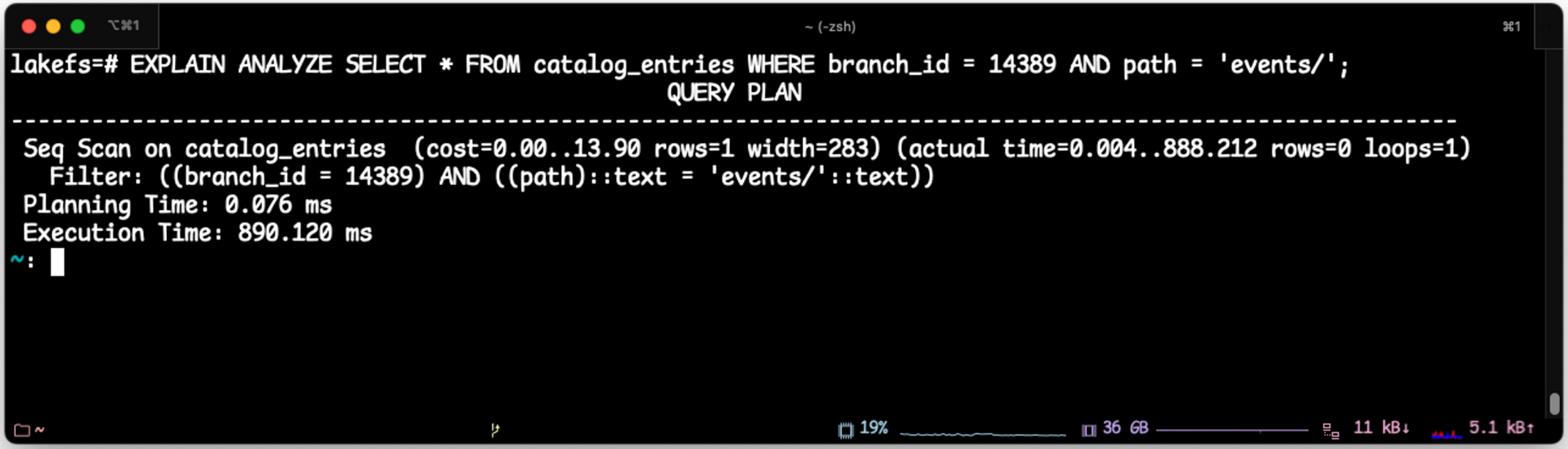
Let’s use a database!

Metadata (pointers to objects)

Data (objects)

Attempt #2

Let’s use a database!



Attempt #2

Let’s use a database!

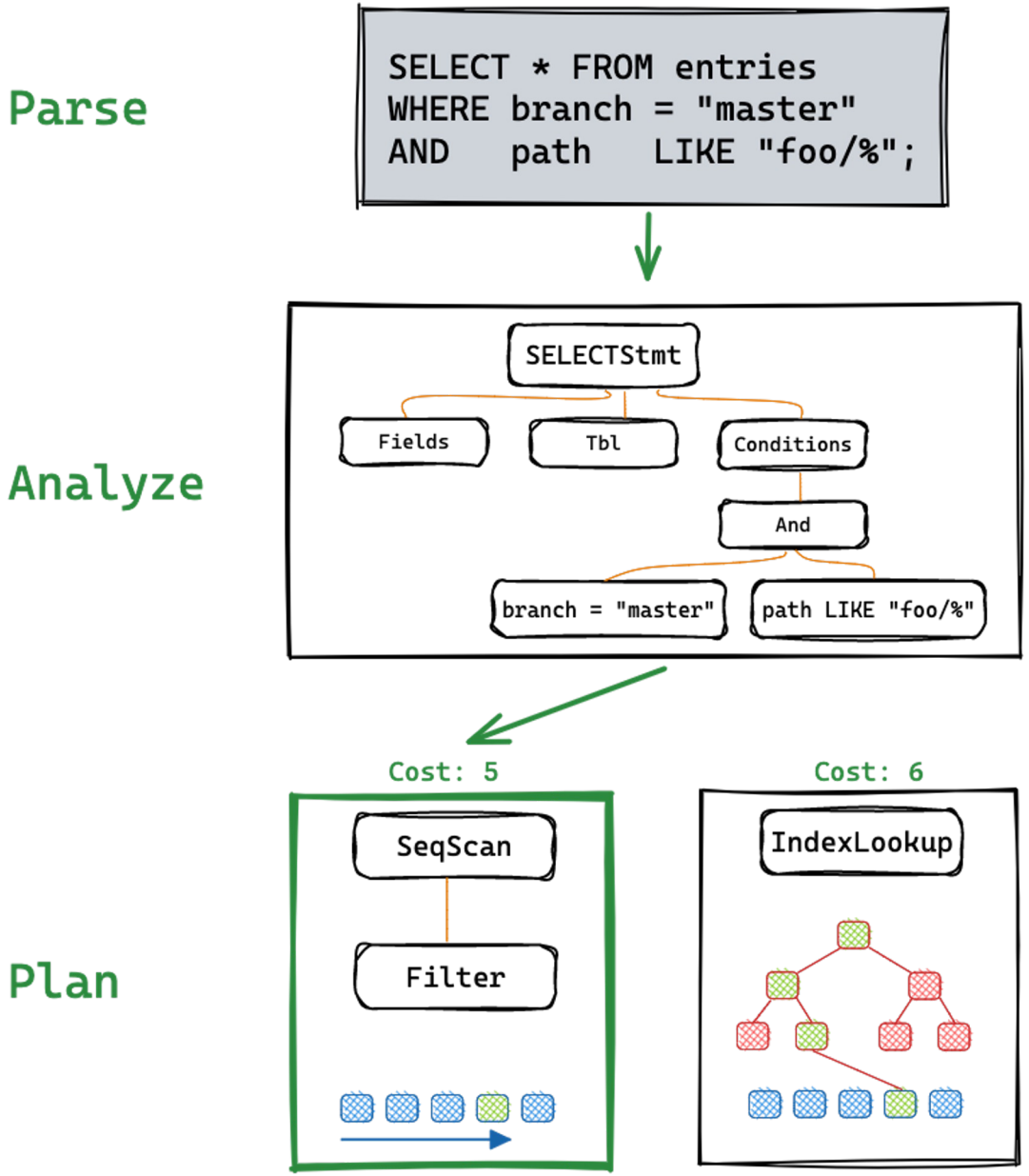
```
lakefs=# EXPLAIN ANALYZE SELECT * FROM catalog_entries WHERE branch_id = 14389 AND path = 'events/';
                                                        QUERY PLAN
---------------------------------------------------------------------------------------------------------------------------
 Seq Scan on catalog_entries  (cost=0.00..13.90 rows=1 width=283) (actual time=0.004..888.212 rows=0 loops=1)
   Filter: ((branch_id = 14389) AND ((path)::text = 'events/'::text))
 Planning Time: 0.076 ms
 Execution Time: 890.120 ms
~:
```

Attempt #2

Let’s use a database!

Cost Based Optimization

- Mostly based on table statistics
- Won’t always use the index
- Bad when growing/shrinking 1000x



Attempt #2

Let’s use a database!

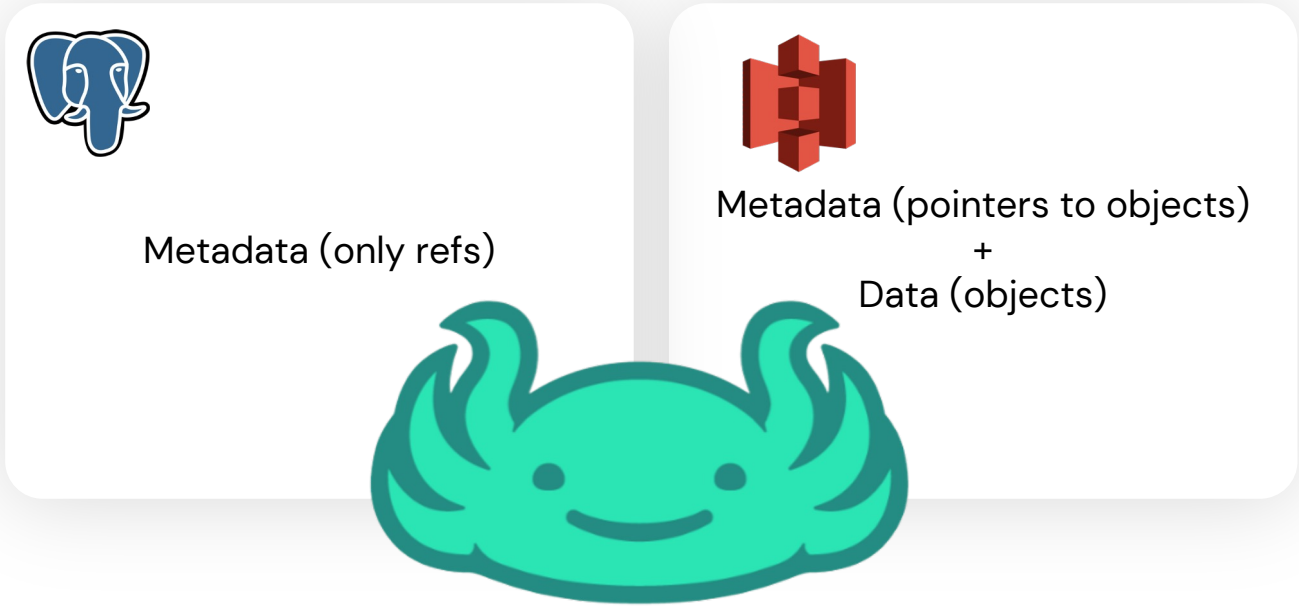
Metadata (pointers to objects)

Data (objects)

- ✓ Cheap, CoW branching
- ✗ Fast
- ✗ Efficient diffing/merging
- ✓ ~~Intuitive~~ Familiar branching committing and merging semantics
- ✗ Predictable behavior
- ✗ Easy to extend and maintain

Attempt #3

Let’s not use a database!*



* Almost.

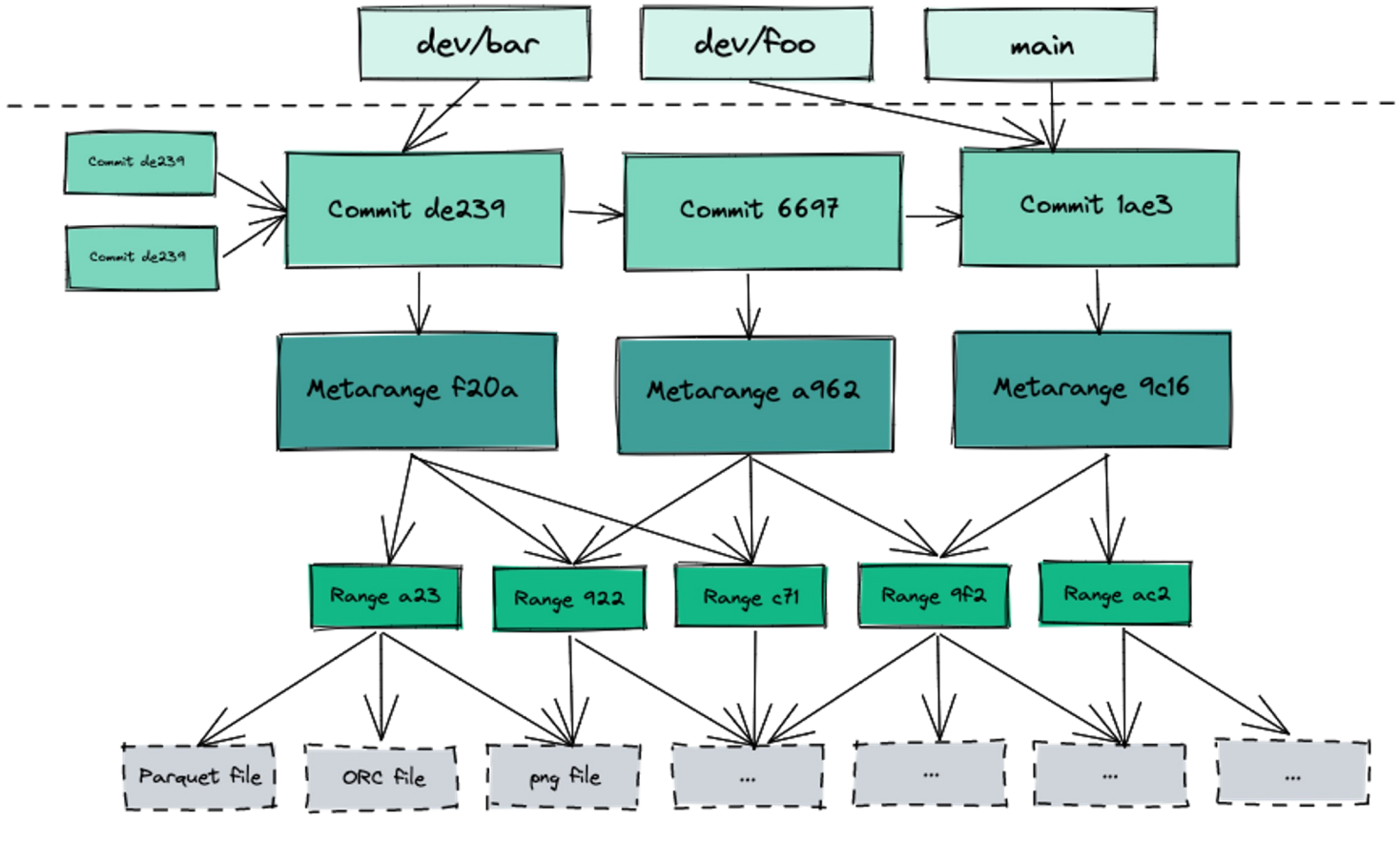
Attempt #3

Let’s not use a database!

Metadata (refs only)

Metadata (pointers to objects)

Data (Objects)



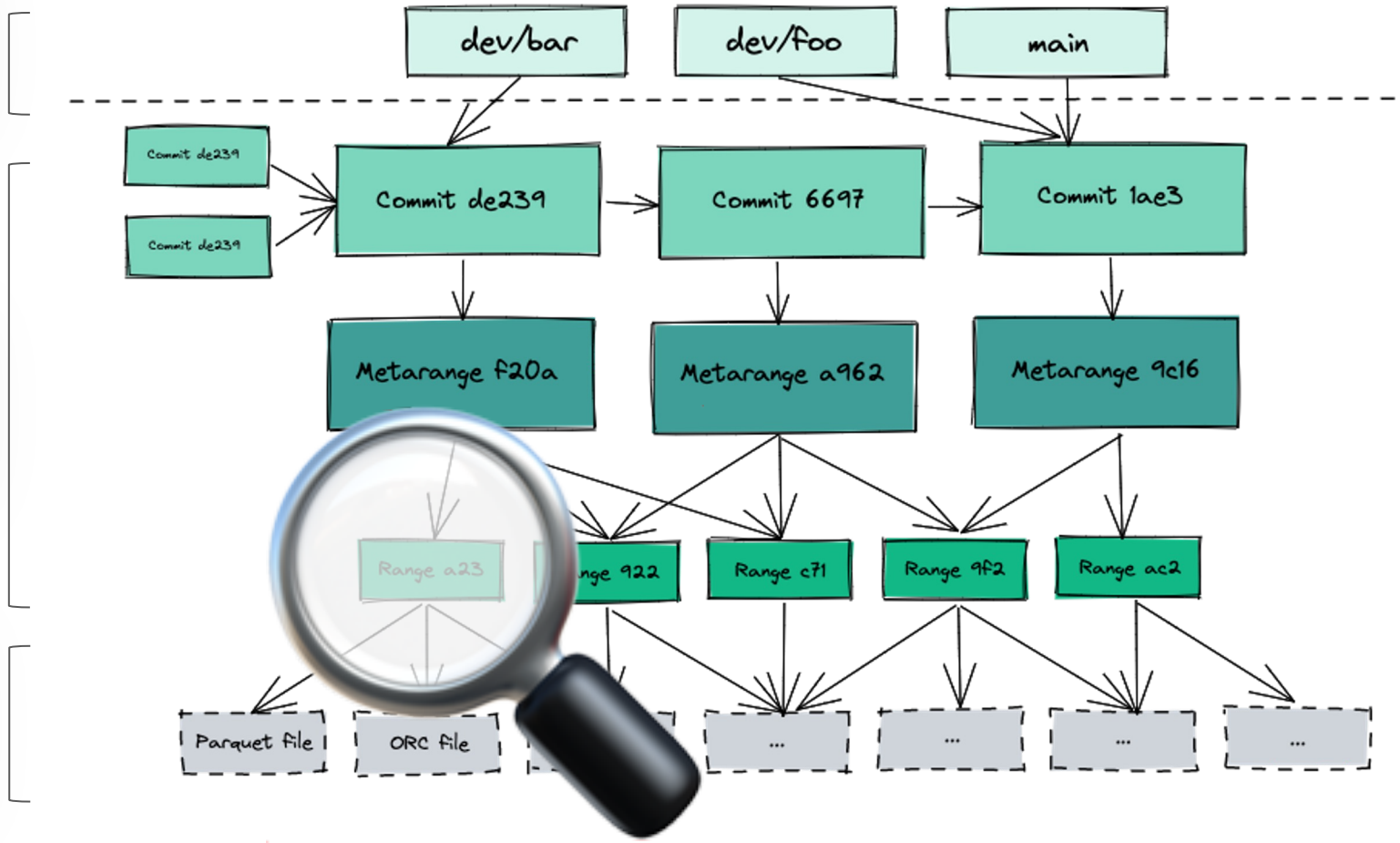
Attempt #3

Let’s not use a database!

Metadata (refs only)

Metadata (pointers to objects)

Data (Objects)

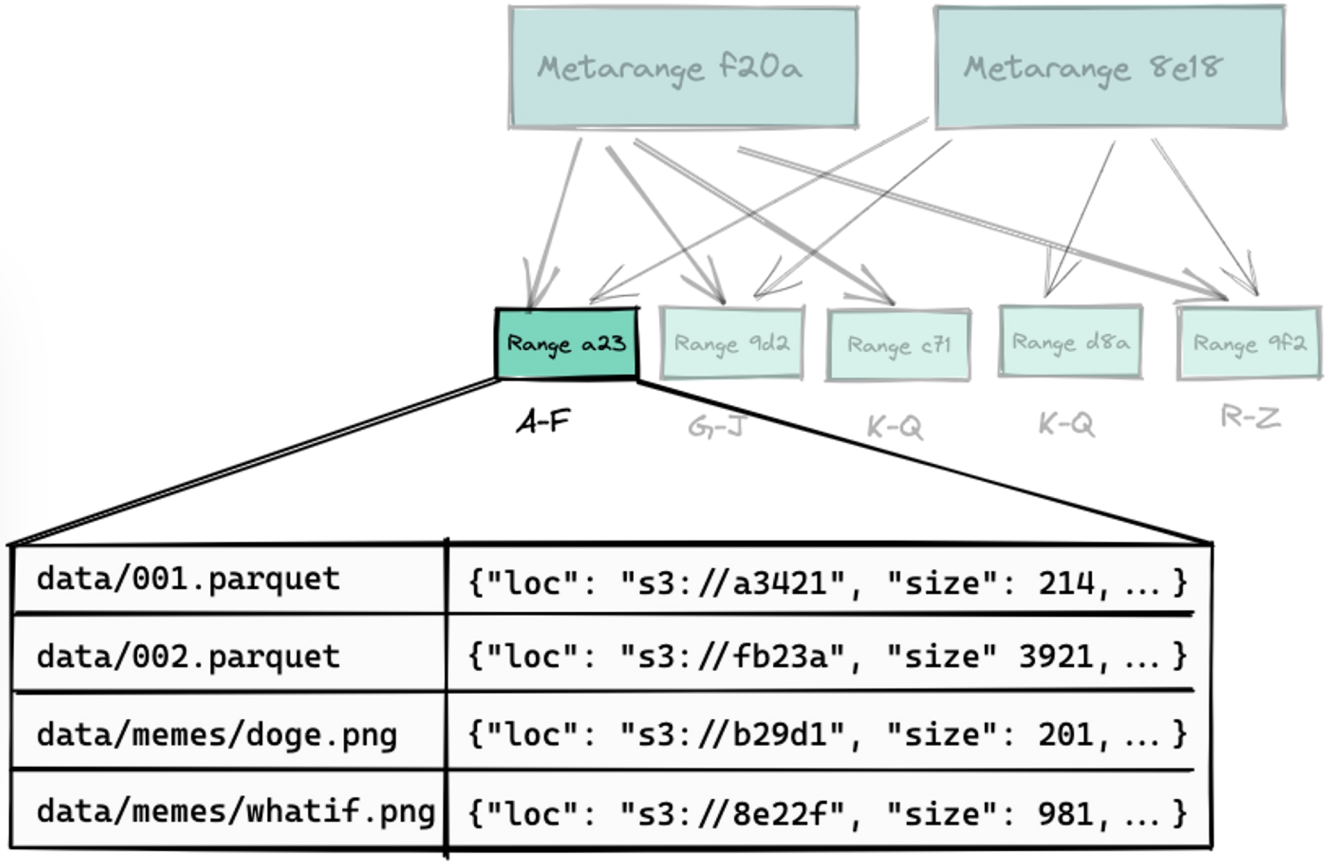


Attempt #3

Let’s not use a database!

Ranges

- Key/value pairs
- Lexicographically sorted paths
- Balancing throughput and latency:
  1-8 MB in size
- Immutable, hash addressed



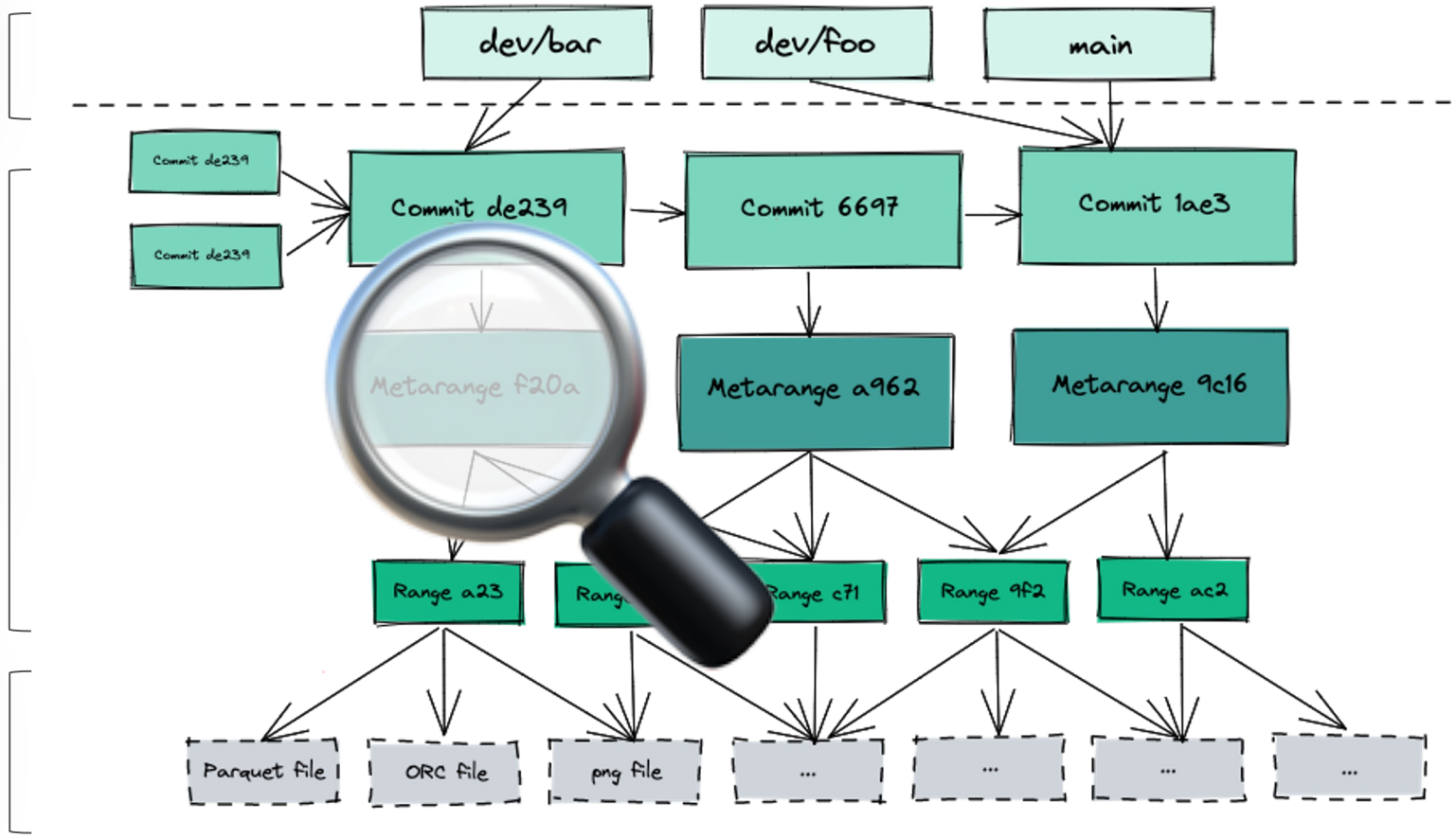
Attempt #3

Let’s not use a database!

Metadata (refs only)

Metadata (pointers to objects)

Data (Objects)

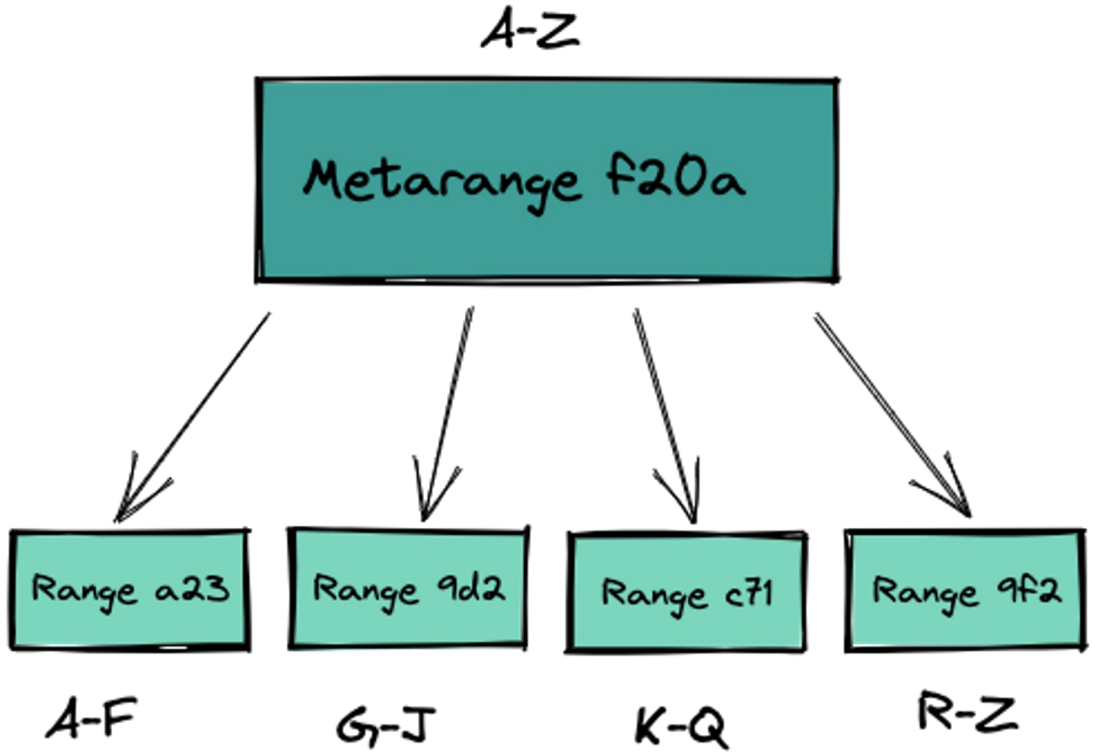


Attempt #3

Let’s not use a database!

Metaranges

- Are ranges!
- That point to ranges!
- These ranges do not overlap

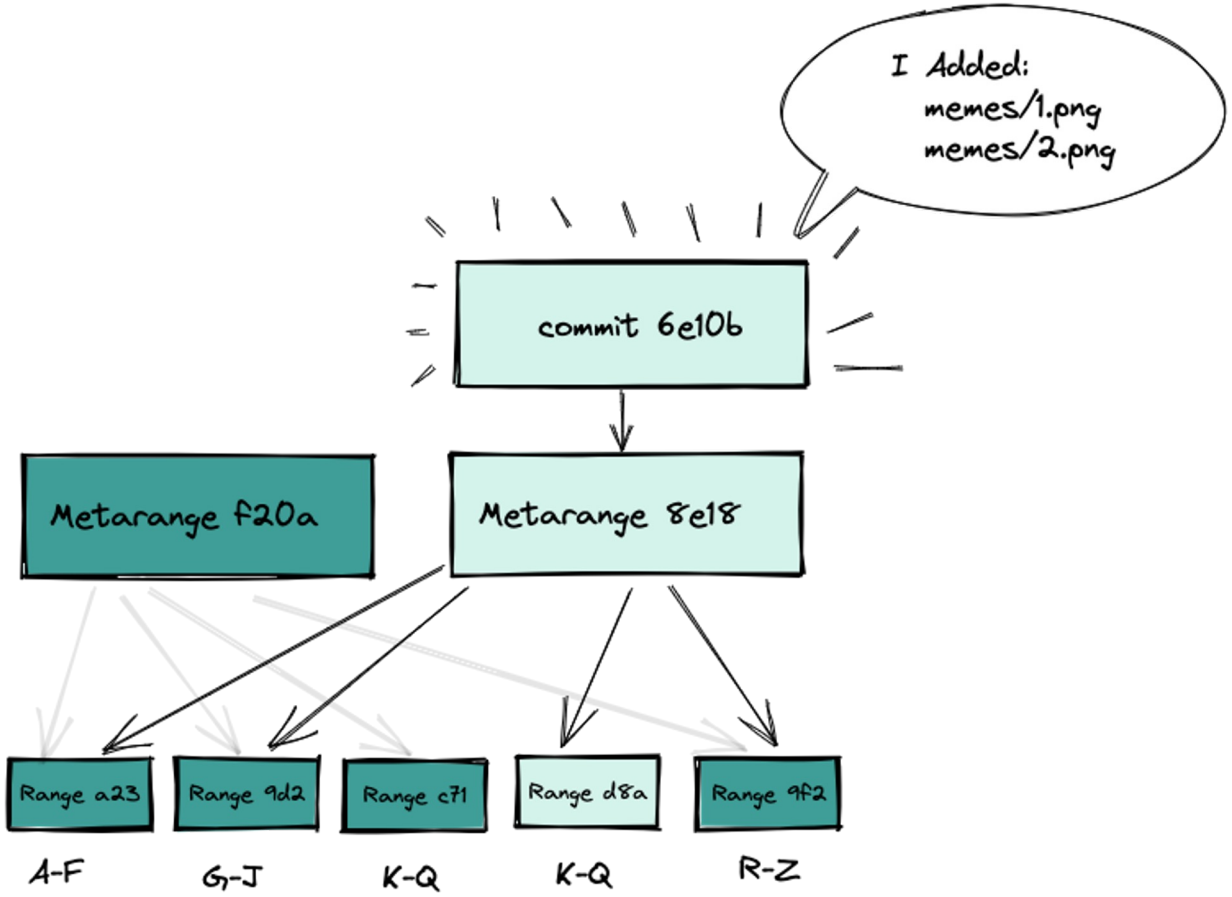


Attempt #3

Let’s not use a database!

Commits

- Are pointers to metaranges
- Space = O(diff)

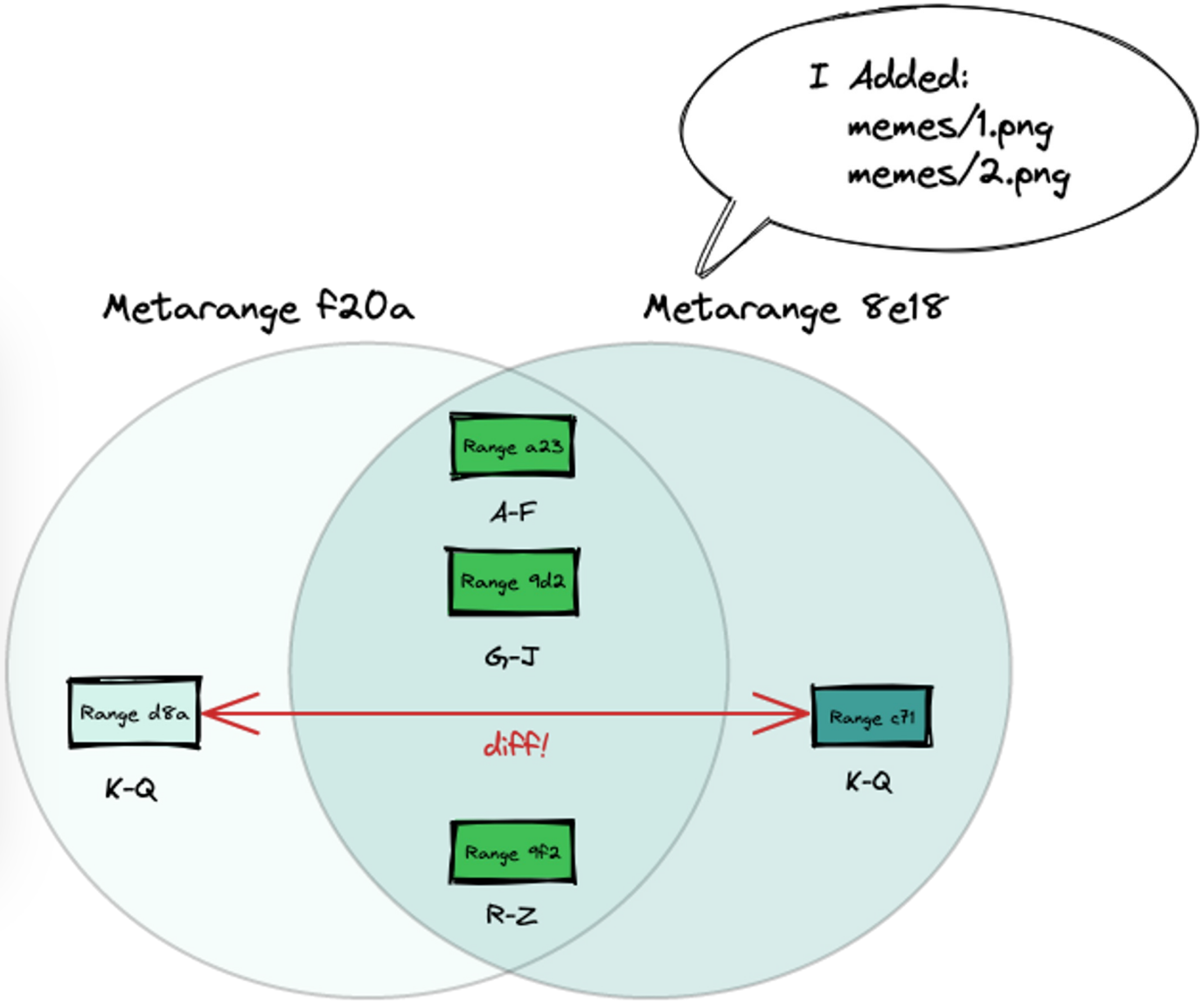


Attempt #3

Let’s not use a database!

Diffing and Merging

- Are efficient!
- Time = O(diff)



Attempt #3

Let’s not use a database!

Metadata (only refs)

Metadata (pointers to objects)
+
Data (objects)

- Cheap, CoW branching
- Fast…? 🤷
- Efficient diffing/merging
- ~~Intuitive~~ Familiar branching committing and merging semantics

Attempt #3

Let’s not use a database!

Metadata (only refs)

Metadata (pointers to objects)
+
Data (objects)

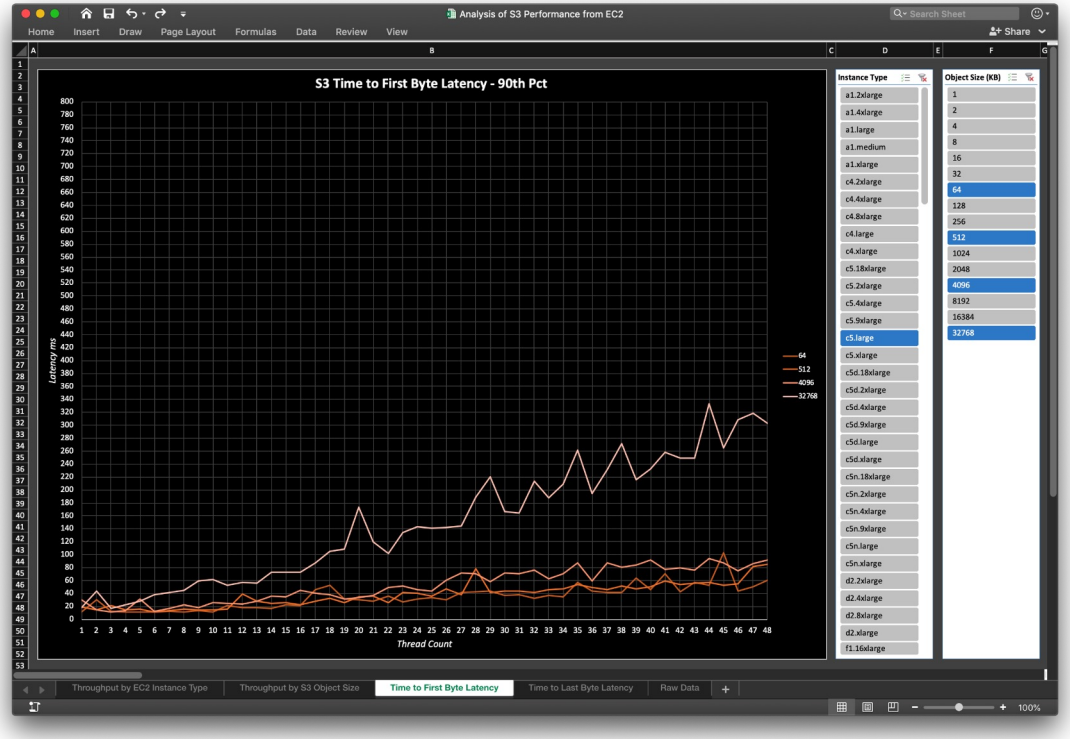
- ✓ Cheap, CoW branching
- ✗ Fast 😢
- ✓ Efficient diffing/merging
- ✓ ~~Intuitive~~ Familiar branching committing and merging semantics

Attempt #3

Let’s not use a database!

Object store != Key Value Store

- TTFB is *high* (tens of ms)
- Gets worse at higher percentiles



https://github.com/dvassallo/s3-benchmark

Attempt #3.5

Caching!

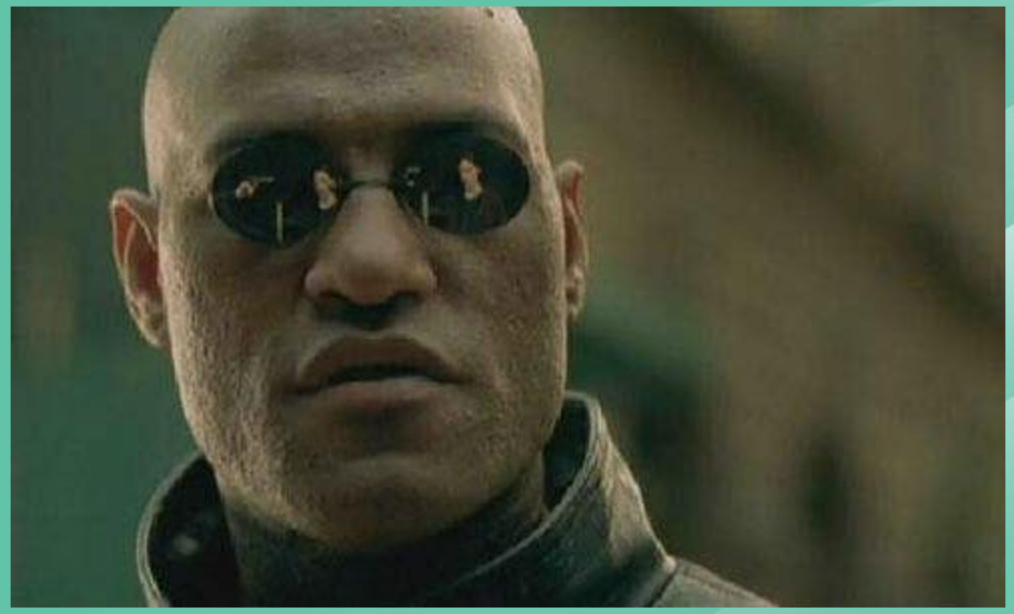
Metadata (only refs)

Metadata (pointers to objects)
+
Data (objects)

- ✓ Cheap, CoW branching
- ✓ Fast!
- ✓ Efficient diffing/merging
- ✓ ~~Intuitive~~ Familiar branching committing and merging semantics

*“There are only two hard things in Computer Science: **cache invalidation** and naming things.”*

— Phil Karlton



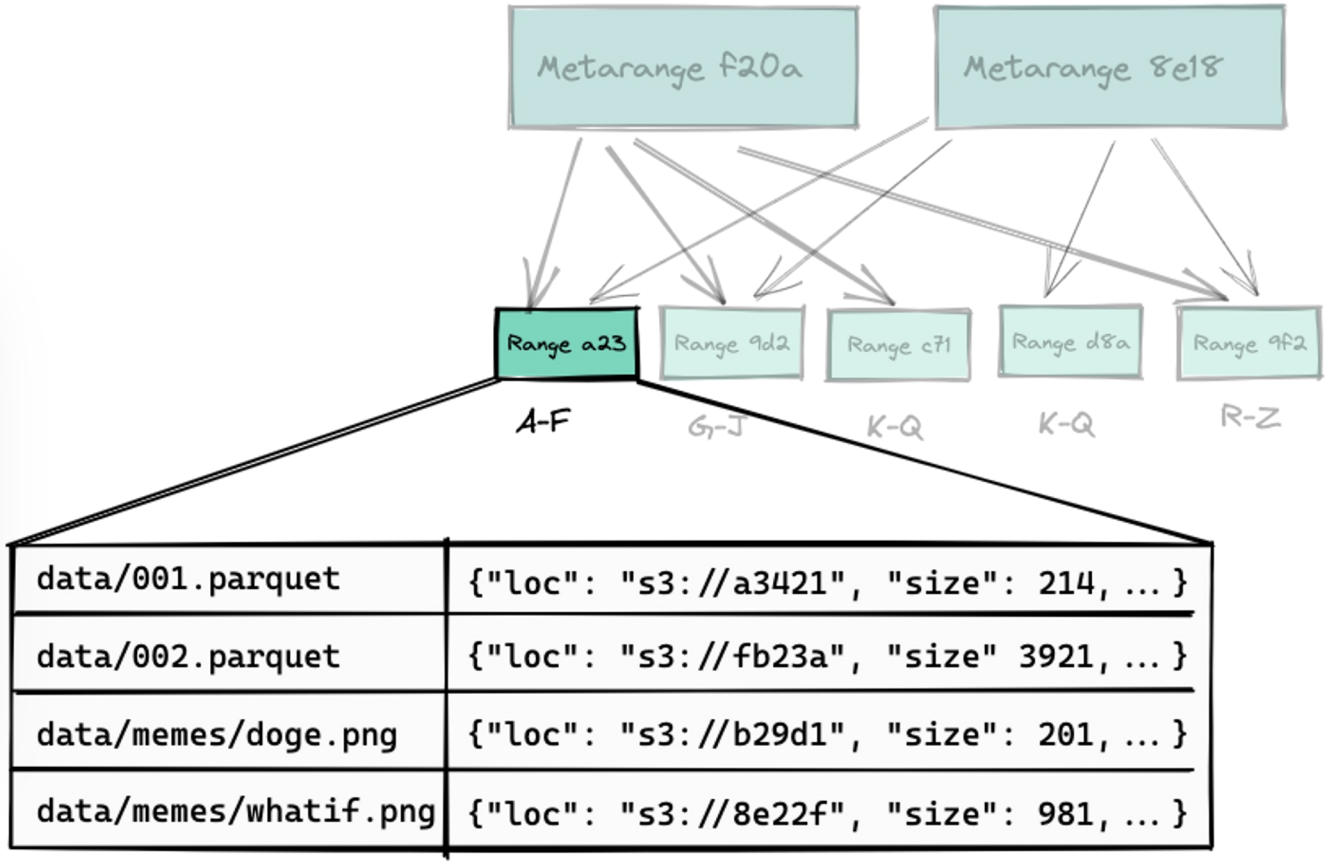
Attempt #3.5

Caching

Ranges

- Key/value pairs
- Lexicographically sorted paths
- Balancing throughput and latency:
  1-8 MB in size
- **Immutable, hash addressed**

So no invalidation necessary



Attempt #3.5

Caching!

Metadata (only refs)

Metadata (pointers to objects)
+
Data (objects)

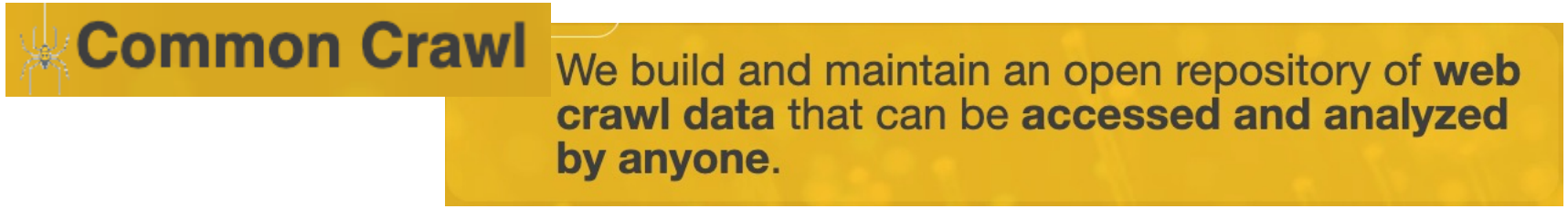
- Cheap, CoW branching
- **Fast!**
- Efficient diffing/merging
- ~~Intuitive~~ Familiar branching committing and merging semantics

Demo Time

Demo: Use Case

Cleaning the internet with lakeFS and Spark

https://commoncrawl.org/



https://www.kaggle.com/datasets/taruntiwarihp/phishing-site-urls

Delete phishing sites from Common Crawl's data

What can we learn from this?

Some key points

- Define constraints early
- You cannot predict your next bottleneck
- **Choosing a correct data model is 80% of the work**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Learn More

https://lakeFS.io/

github.com/treeverse/lakeFS

https://lakefs.io/community

Thanks!

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Director of Solution Engineering

amit.kesarwani@treeverse.io