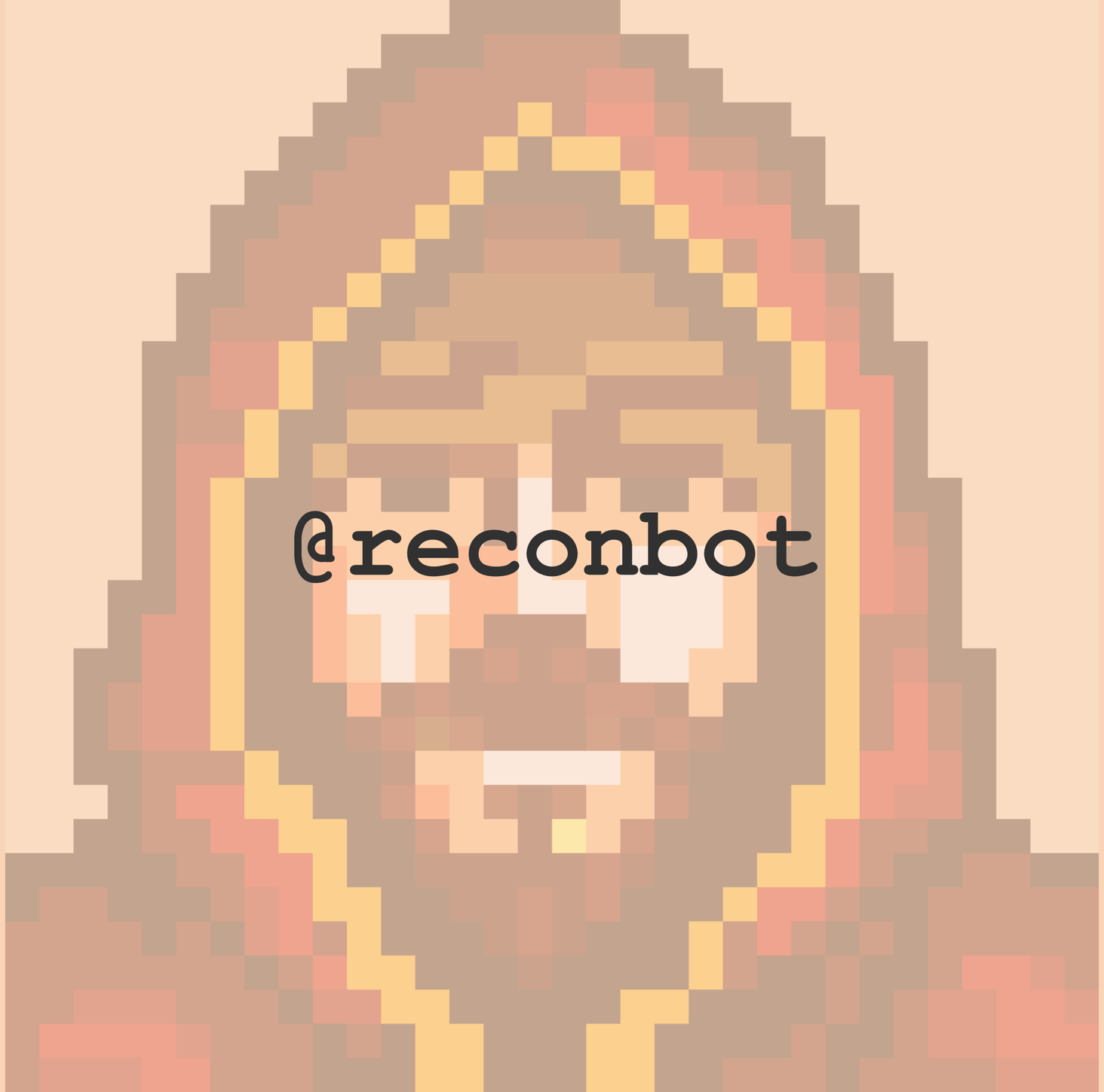
I 👋 Francis

I  BUSTLE


@reconbot

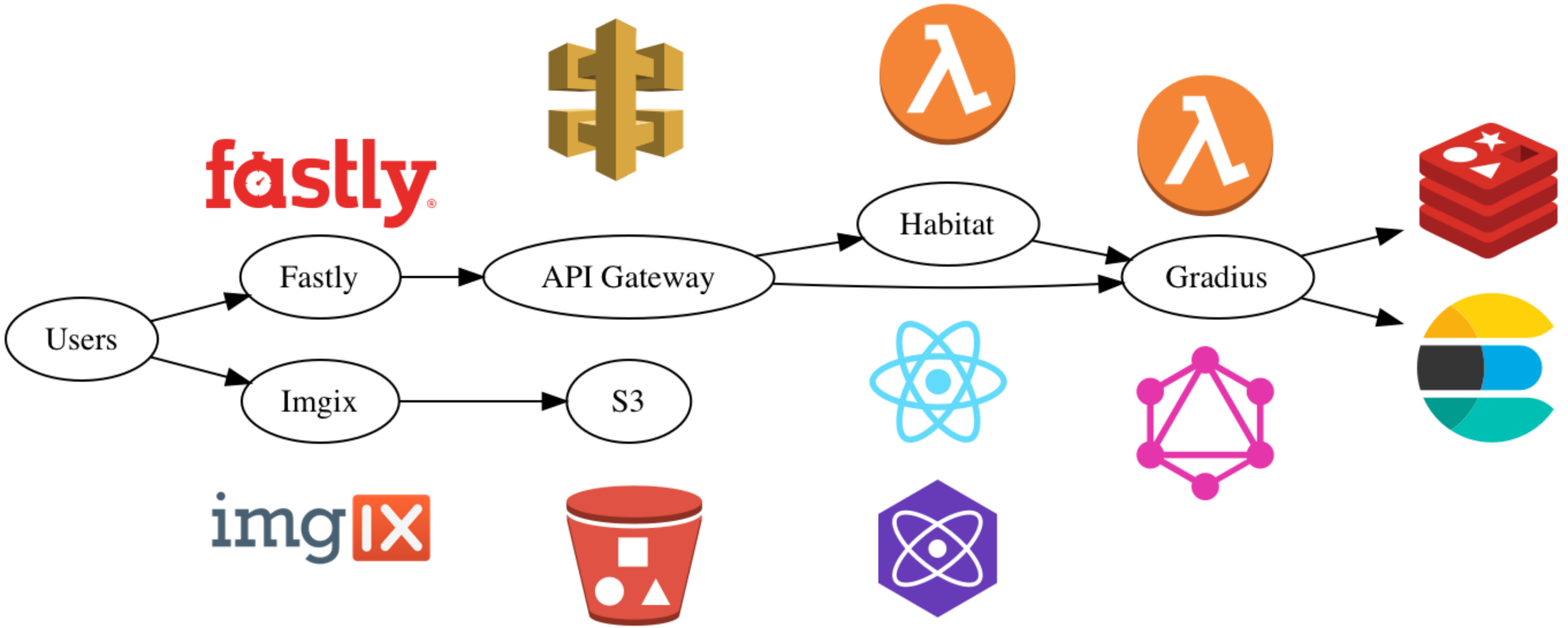
Hey Francis, How did everyone at Bustle make the website so fast?

— People

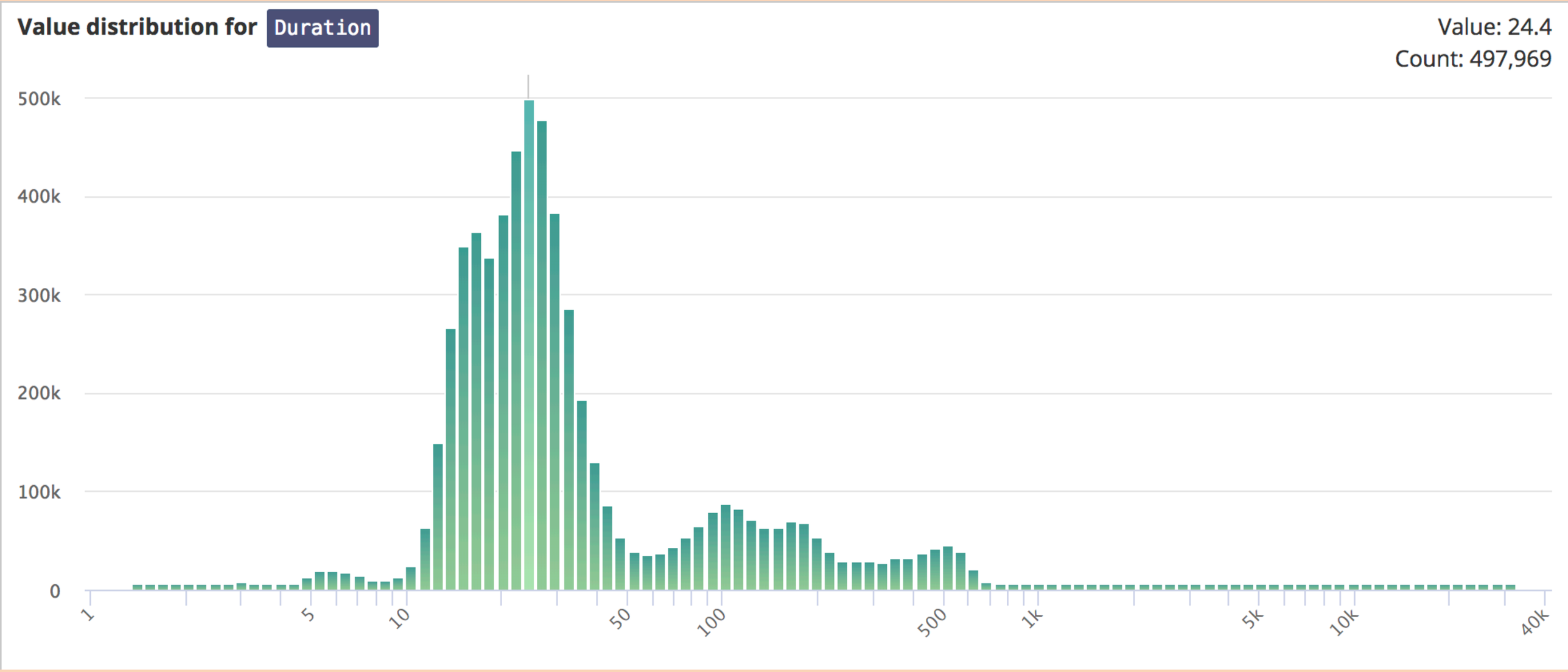
We put everything in Redis.

— Francis

We Live in Memory


fastly
Users
Fastly
Imgix
API Gateway
S3
Habitat
Gradius
imgIX

API Response Time


Value distribution for Duration
Value: 24.4
Count: 497,969
500k
400k
300k
200k
100k
0
1
5
10
50
100
500
1k
5k
10k
40k

Redis is our Primary Data Store

But that doesn't make it fast

*Redis is an **in-memory data structure store**, used as a database, cache and message broker. It supports data structures such as strings, hashes, lists, sets, sorted sets with range queries...*

— Redis.io(ish)

Hey Francis, isn't that really dangerous?

— 50/50 chance you'll say this

No

— 100% chance I'll say this

I don't believe you

– 100% chance you're thinking this

Redis Is our Primary Data Store

- 1s fsync of AOF
- 1 hour snapshot RDB
- Read replicas ready to take over really fast
- Good enough for Bustle's read heavy load

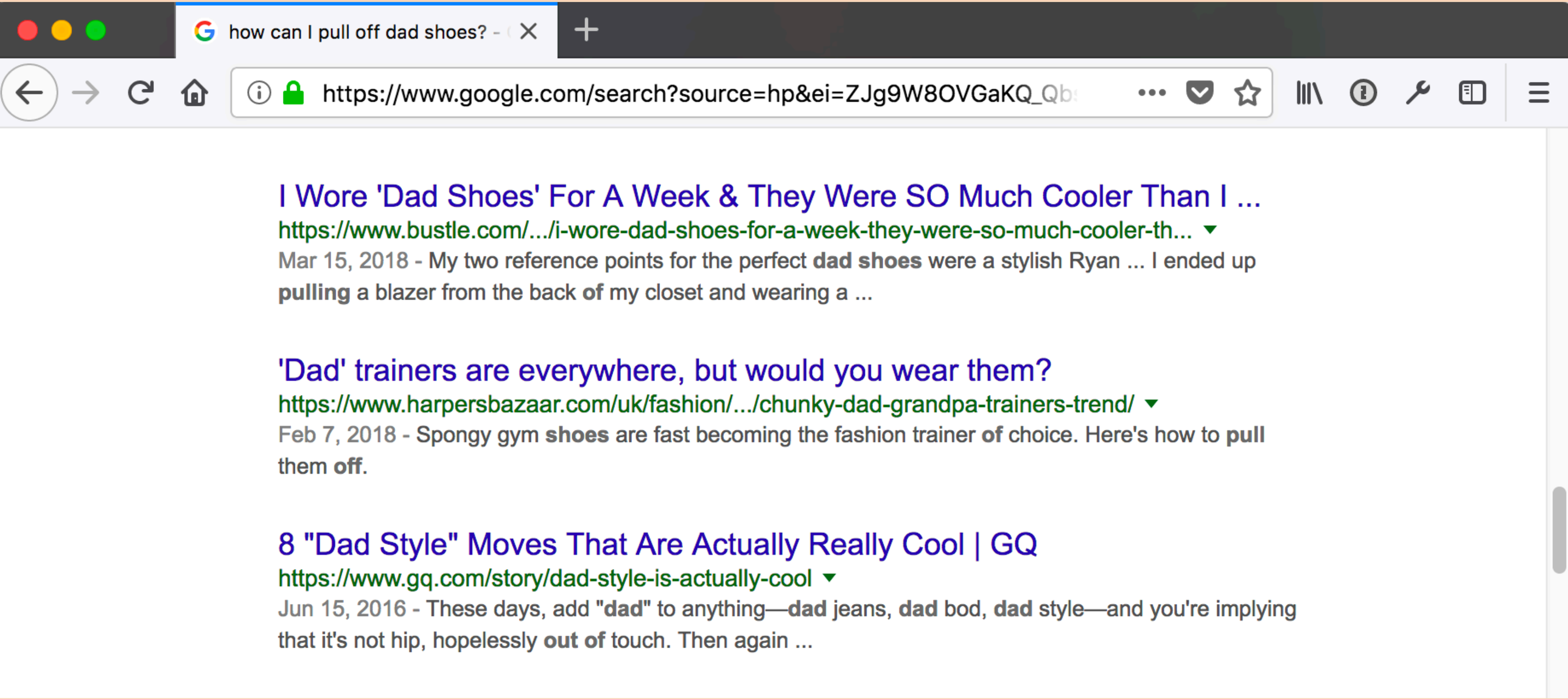
Modeling GraphQL data in a redis GraphDB

☝️ is why we're fast


MAN
HAT
TANjs

how can I pull off dad shoes?

Google Search I'm Feeling Lucky

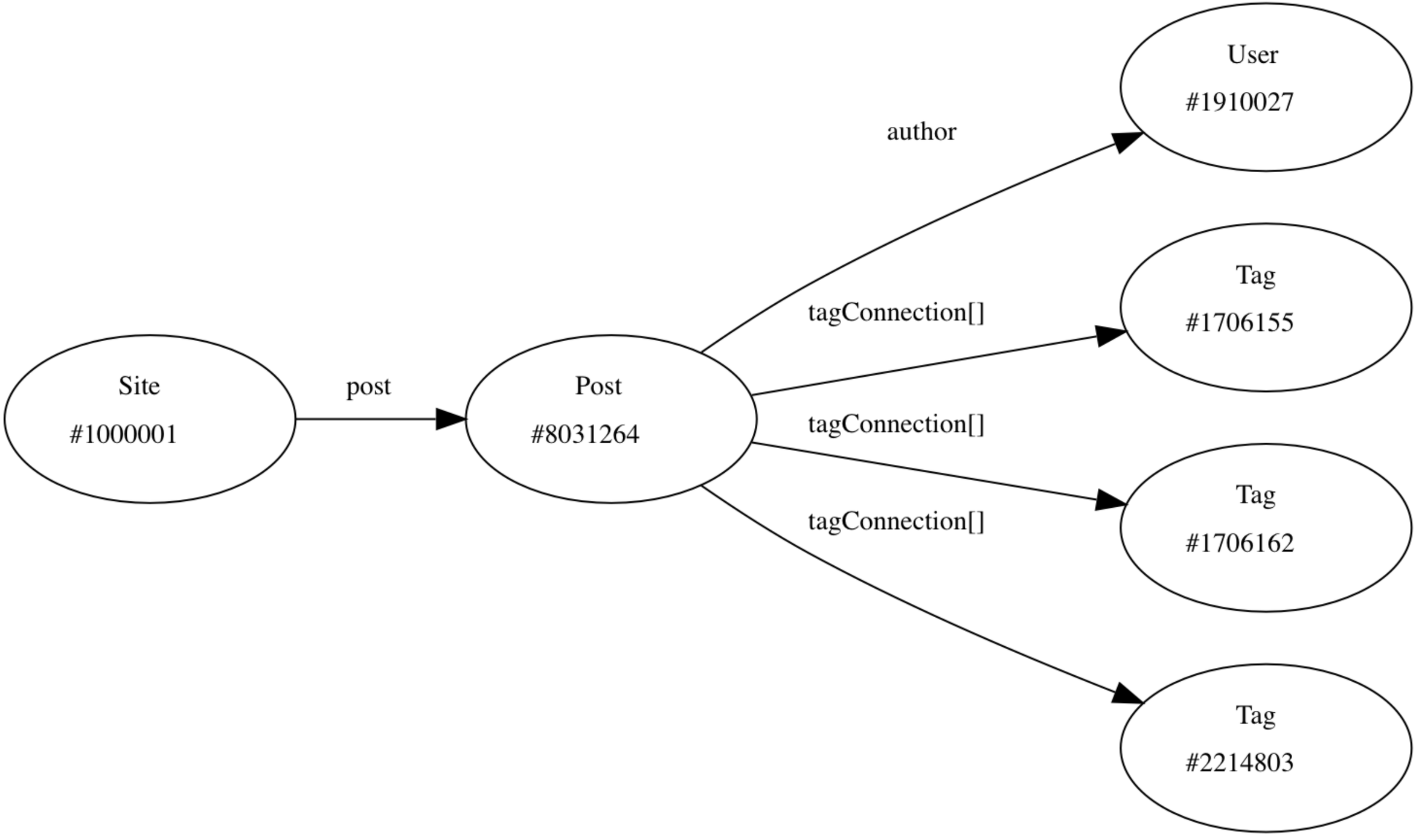

how can I pull off dad shoes? -
https://www.google.com/search?source=hp&ei=ZJg9W8OVGaKQ_Qb
I Wore 'Dad Shoes' For A Week & They Were SO Much Cooler Than I ...
https://www.bustle.com/.../i-wore-dad-shoes-for-a-week-they-were-so-much-cooler-th...
Mar 15, 2018 - My two reference points for the perfect dad shoes were a stylish Ryan ... I ended up pulling a blazer from the back of my closet and wearing a ...
'Dad' trainers are everywhere, but would you wear them?
https://www.harpersbazaar.com/uk/fashion/.../chunky-dad-grandpa-trainers-trend/
Feb 7, 2018 - Spongy gym shoes are fast becoming the fashion trainer of choice. Here's how to pull them off.
8 "Dad Style" Moves That Are Actually Really Cool | GQ
https://www.gq.com/story/dad-style-is-actually-cool
Jun 15, 2016 - These days, add "dad" to anything—dad jeans, dad bod, dad style—and you're implying that it's not hip, hopelessly out of touch. Then again ...

I Wore 'Dad Shoes' For A Week & They Were SO Much Cooler Than I Thought They'd Be

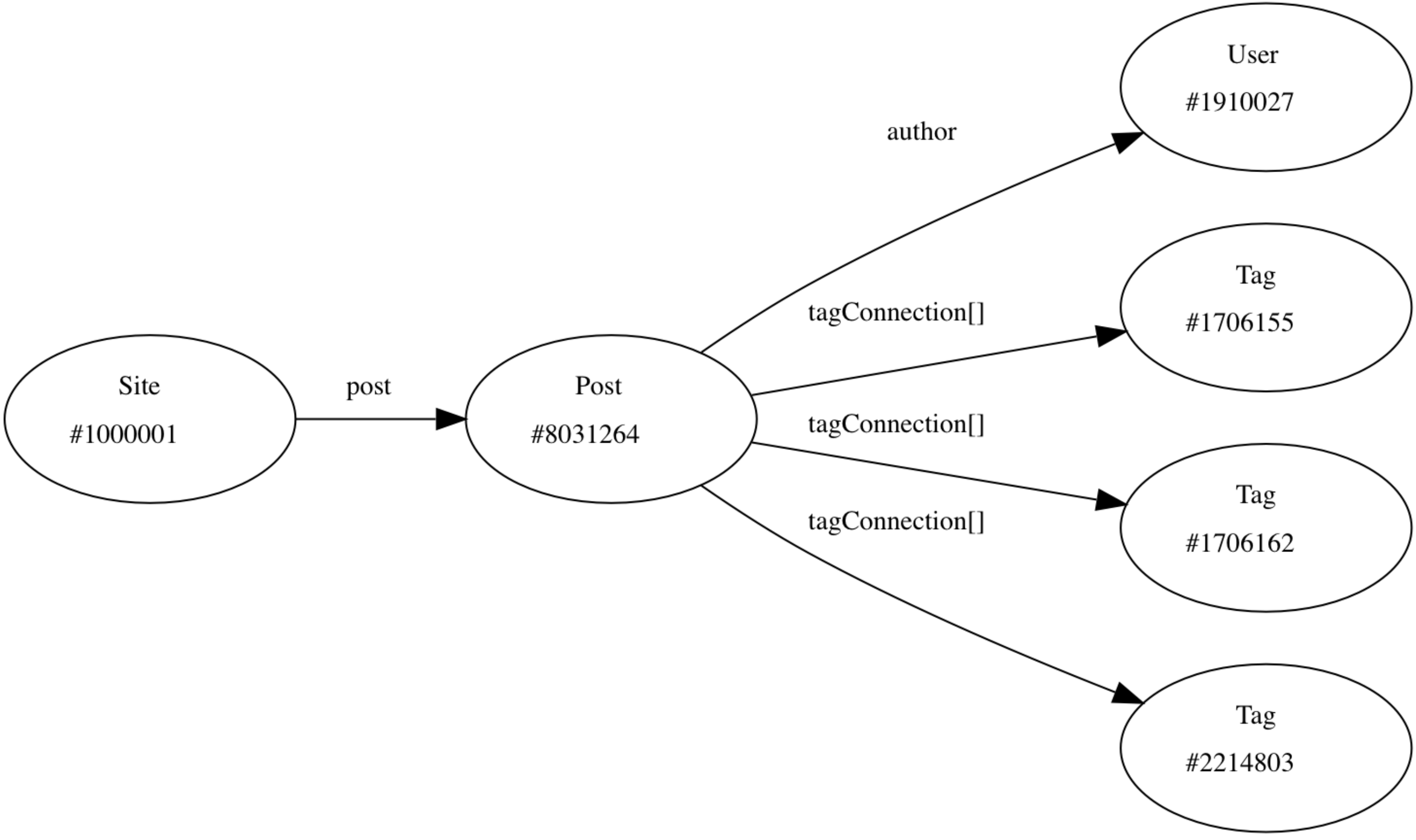
By DALE ARDEN CHONG | Mar 15 2018

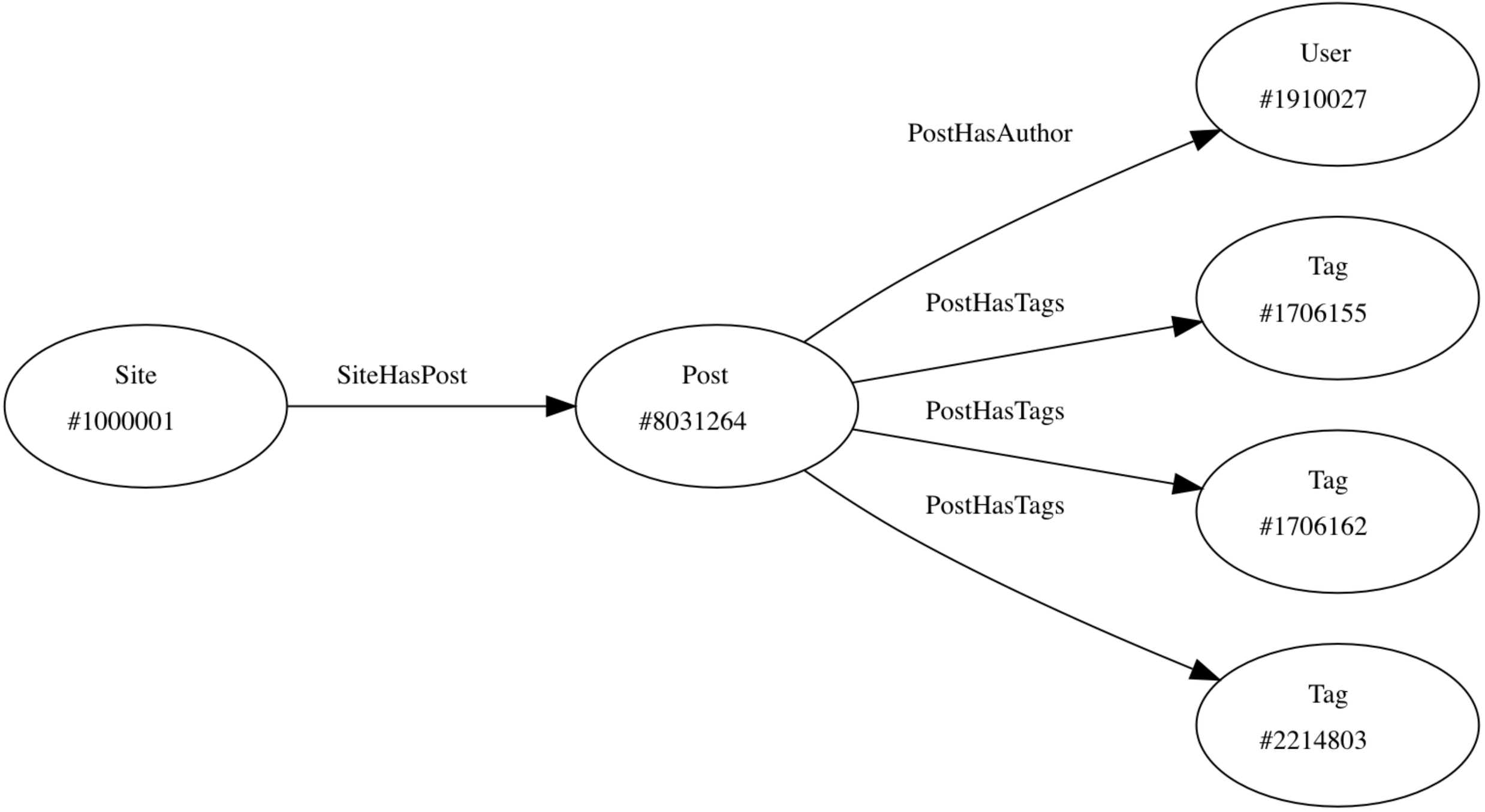
```
{
  "data": {
    "site": {
      "name": "BUSTLE",
      "post": {
        "id": "8031264",
        "__typename": "ArticlePost",
        "title": "I Wore 'Dad Shoes' For A Week & They Were SO Much Cooler Than I Thought They'd Be",
        "path": "/p/i-wore-dad-shoes-for-a-week-they-were-so-much-cooler-than-i-thought-theyd-be-8031264",
        "publishedAt": 1521160559405,
        "updatedAt": 1524672008862,
        "author": {
          "id": "1910027", "name": "Dale Arden Chong" },
        "tagConnection": {
          "nodes": [
            { "id": "1706155", "name": "homepage" },
            { "id": "1706162", "name": "fashion" },
            { "id": "2214803", "name": "Freelancer" }
          ]
        }
      }
    }
  }
}
```

```
{
  "data": {
    "site": {
      "id": "1000001",
      "__typename": "Site"
      "post": {
        "id": "8031264",
        "__typename": "ArticlePost"
        "author": { "id": "1910027", "__typename": "User" },
        "tagConnection": [
          { "id": "1706155", "__typename": "Tag" },
          { "id": "1706162", "__typename": "Tag" },
          { "id": "2214803", "__typename": "Tag" }
        ]
      }
    }
  }
}
```


Site
#1000001
post
Post
#8031264
author
User
#1910027
tagConnection[]
Tag
#1706155
tagConnection[]
Tag
#1706162
tagConnection[]
Tag
#2214803

GraphDB


Site
#1000001
post
Post
#8031264
author
User
#1910027
tagConnection[]
Tag
#1706155
tagConnection[]
Tag
#1706162
tagConnection[]
Tag
#2214803


Site
#1000001
SiteHasPost
Post
#8031264
PostHasAuthor
User
#1910027
PostHasTags
Tag
#1706155
PostHasTags
Tag
#1706162
PostHasTags
Tag
#2214803

Oh you mean, like Neo4j right?

– 99% of you

Sure, but it's faster and doesn't do any of the same things.

— Francis

Databases like trains aren't slow, the queries like the passengers are slow.

— Ikai (a DBA) who I guess never took the subway

They're complaining about the database being slow but it's their queries that are slow! They don't know how databases work! Where do they get off accusing the database servers!

Some database are slow, some queries are slow, it's all about tradeoffs

Bustle Traded Query Flexibility for Speed

No slow queries[1]

[1] Ok it's just very hard

Ok Francis, but how does it work?

— Get to it already

Nodes, Edges, and Indexes

Nodes (future)

- GUID (int32)
- Node Type
- **data** as a Compressed Protocol Buffer
- Redis Hash
  { id, data, updateclock, ...metadata }
- Update count with a Lua Script to prevent update clobbering

Nodes (now)

- GUID (int32)
- Node Type
- **JSON.stringify()** fields
- Redis Hash

  { id, ...data, ...metadata }
- **HGETALL, HMSET**

Node JSON

```
{
  id: 1,
  _nodeType: 'User',
  name: 'Ein',
  bigDeal: true,
  createdAt: 1531334120311,
  updatedAt: 1531334113447
}
```

Edges

- An edge is **Subject -> Predicate -> Object**
- An edge is **User -> UserHasPost -> Post**
- An edge can have weights

  User -> UserHasPost(42) -> Post

Edge JSON

```
{
  subject: 5001,
  predicate: 'UserHasPost',
  object: 40238,
  weight: 42
}
```

Sorted Sets

- Unique strings sorted by a score, then by member
- Think: hash with keys (members) sorted by their numeric values (scores) then by key
- Very fast read/write operations O(log(N))
- Can search by member or score

Edges Hexastore

- 1 big Sorted Set with each edge in 6 orderings
- Pick an ordering and use **zrangebylex** to search

```
ops:ObjectID:Predicate:SubjectID => 0
osp:ObjectID:SubjectID:Predicate => 0
pos:Predicate:ObjectID:SubjectID => 0
pso:Predicate:SubjectID:ObjectID => 0
sop:SubjectID:ObjectID:Predicate => 0
spo:SubjectID:Predicate:ObjectID => 0
```

```
★ gradius git:(master) redis-cli
127.0.0.1:6379> ZADD hexastore 0 "1:HasAuthor:2"
(integer) 1
127.0.0.1:6379> ZADD hexastore 0 "1:HasPost:3"
(integer) 1
127.0.0.1:6379> ZRANGEBYLEX hexastore "[1:HasAuthor" "[1:HasAuthor\xff"
1) "1:HasAuthor:2"
127.0.0.1:6379> ZRANGEBYLEX hexastore "[1:" "[1:\xff"
1) "1:HasAuthor:2"
2) "1:HasPost:3"
127.0.0.1:6379> _
```

Edges Hexastore

- 6 big Sorted Sets one for each ordering
- 4 bytes === 32bit GUID
- 4 bytes === sha256(predicate).slice(0, 4)
- 12 Byte Binary packed key **SSSSPPPPOOOO**
- Binary Packing saved 70% of memory
- still use **zrangebylex** to searching the members

Edges Weighted Store

- Can store a weight on an edge
- **Site -> HasPublishedPost(publishedAt) -> Post**
- Can only search **SP*** or **OP***
- Can search ranges of weights (eg, posts published today)
- Lots of tiny Sorted Sets
- Faster because of the smaller "n" in **O(log(n))**

Edges Weighted Store

Each edge is stored two different ways

Key	Member	Score
"edge:s:${subjectId}:${predicate}"	objectId	weight
"edge:o:${objectID}:${predicate}"	subjectId	weight

```
★ gradius git:(master) redis-cli
127.0.0.1:6379> ZADD "edge:s:1:HasAuthor" 42 2
(integer) 1
127.0.0.1:6379> ZADD "edge:o:2:HasAuthor" 42 1
(integer) 1
127.0.0.1:6379> ZRANGEBYSCORE "edge:s:1:HasAuthor" -Inf Inf WITHSCORES LIMIT 0 1
1) "2"
2) "42"
127.0.0.1:6379> _
```

Indexes

- **node:id** Sorted set of all node IDs
- **${type}:id** Sorted set of all node IDs of a type
- **${type}:${field}** Sorted set of unique values to ids

How fast is it?

– Me

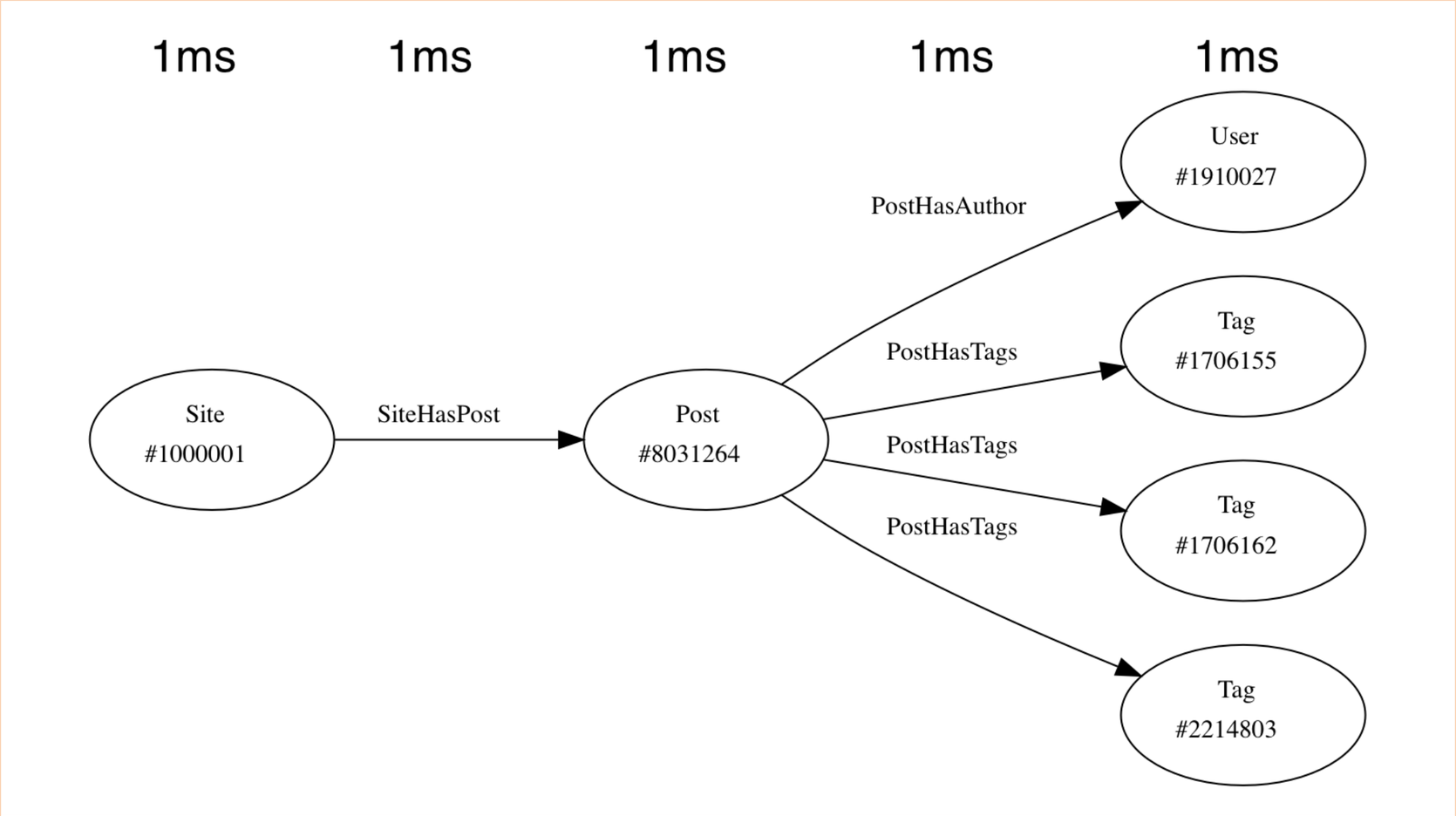
Loading Nodes is fast

```
while (true) {
  const start = Date.now()
  await graph.Site.find(1000001)
  console.log(`${Date.now() - start}ms`)
}
```

Loading all the nodes is fast

```
while (true) {
  const start = Date.now()
  await Promise.all([
    graph.Site.find(1000001),
    graph.Post.find(8031264),
    graph.User.find(1910027),
    graph.Tag.find(1706155),
    graph.Tag.find(1706162),
    graph.Tag.find(2214803)
  ])
  console.log(`${Date.now() - start}ms`)
}
```

Command Batching Makes Redis Fast



Not covered: ORM & Schemas

```
import { edge, Post, User } from './graph'
const ein = await User.create({ name: 'Ein the Dog', meta: {}})
const post = await Post.findBy('path', '/p/10-reasons-why-dogs-are-the-best')
await edge.create({
  subject: post,
  predicate: 'HasAuthor'
  object: ein
})

const authors = edge.makeIterator({ subject: post, predicate: 'HasAuthor'})
for await (author in authors) {
  await giveTreat(author)
}
```

Not covered:

- Interfaces and Mixin Inheritance
- Typed Edge validations
- Named Edges (unique text values between two nodes)
- The many different Failures and Bugs in production and how we mitigate them

In Conclusion

The secret of Dad shoes is a flowy skirt

Dale Arden Chong

On Day 5, I did a complete 180. With a newfound determination to make these sensible shoes look like Fashion with a capital F, I looked to Instagram to find new inspiration. What I found were looks juxtaposing the shoe's chunkiness with flowing skirts.

In Conclusion

- Don't make slow queries possible
- Round trip time is a killer so batch your requests
- Store your data in a way that matches your access patterns

Related Open Source

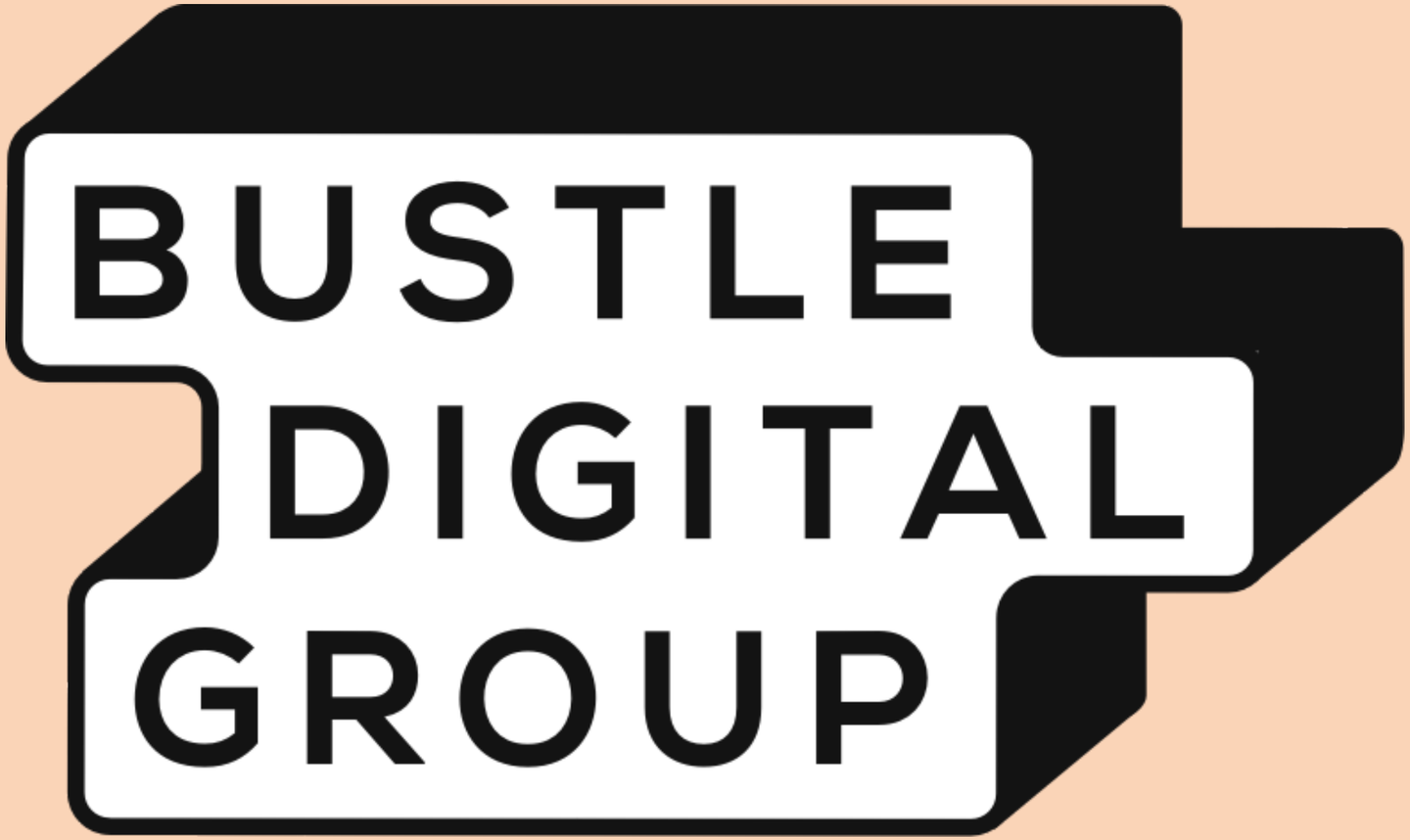
- **bluestream** Streams for Async functions
- **mobiledoc-kit** A toolkit for building WYSIWYG editors with Mobiledoc
- **SAMMIE** Serverless Application Model Made Infinitely Easier
- **shep** A framework for building JS Applications with AWS API Gateway and Lambda
- **streaming-iterables** Replace your streams with async iterators
- **redis-loader** An ioredis-like object that batches commands via dataloader

We Live In Memory

(a short story)

rbrtr.com/post/1911

Thanks 👏



We're hiring!