Running a Serverless Lucene Reverse Geocoder

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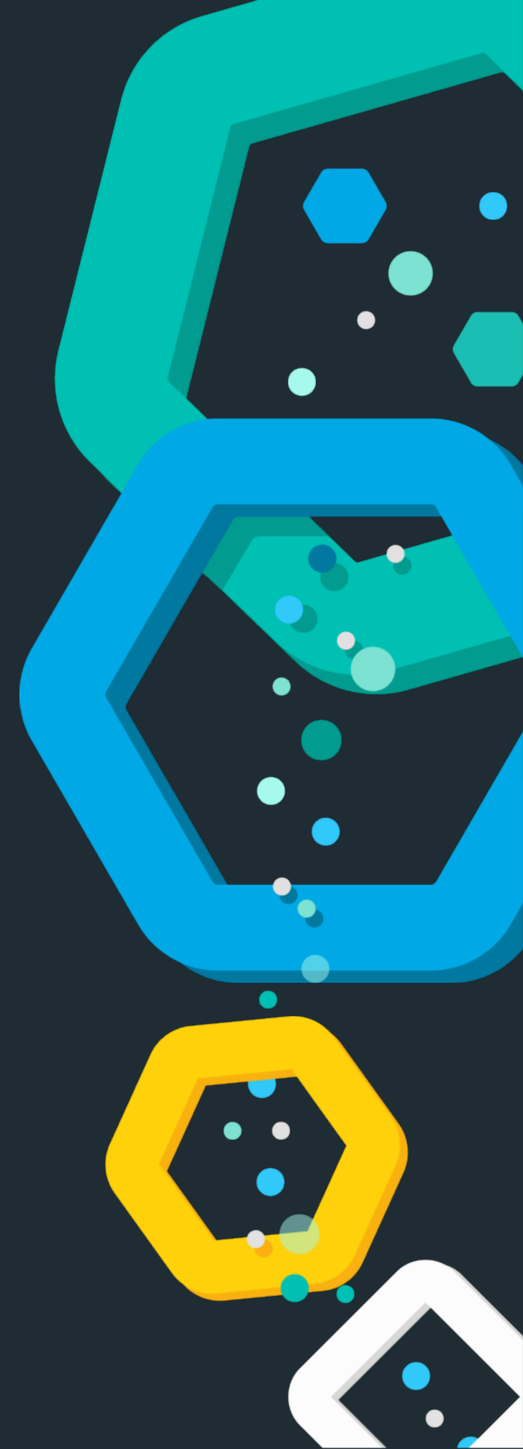
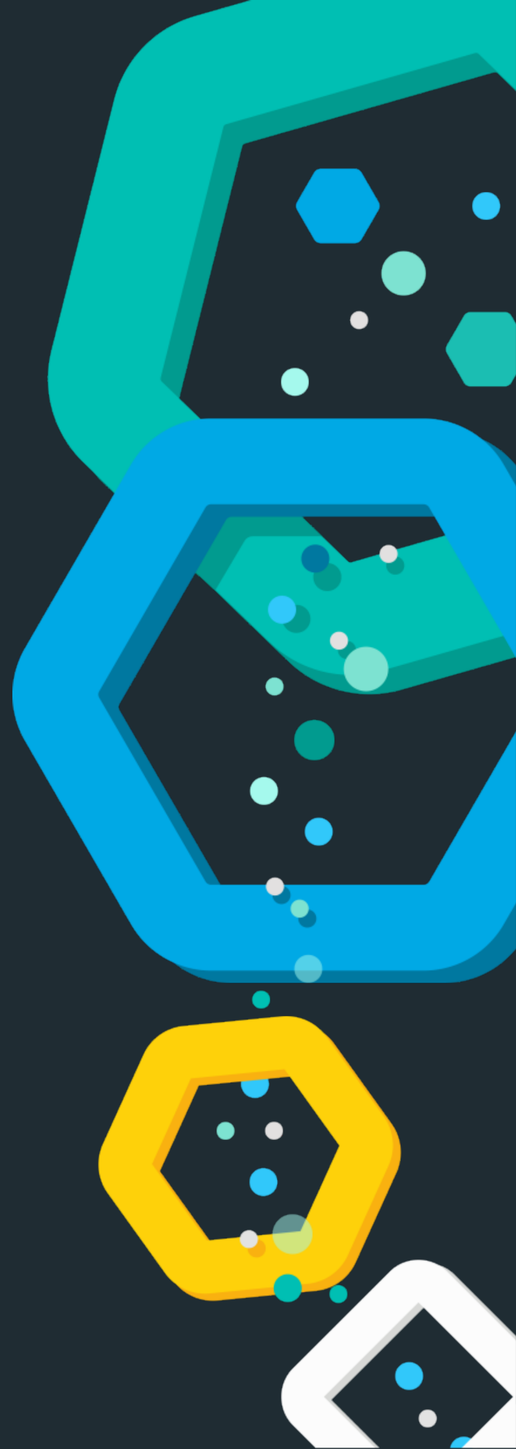
@spinscale

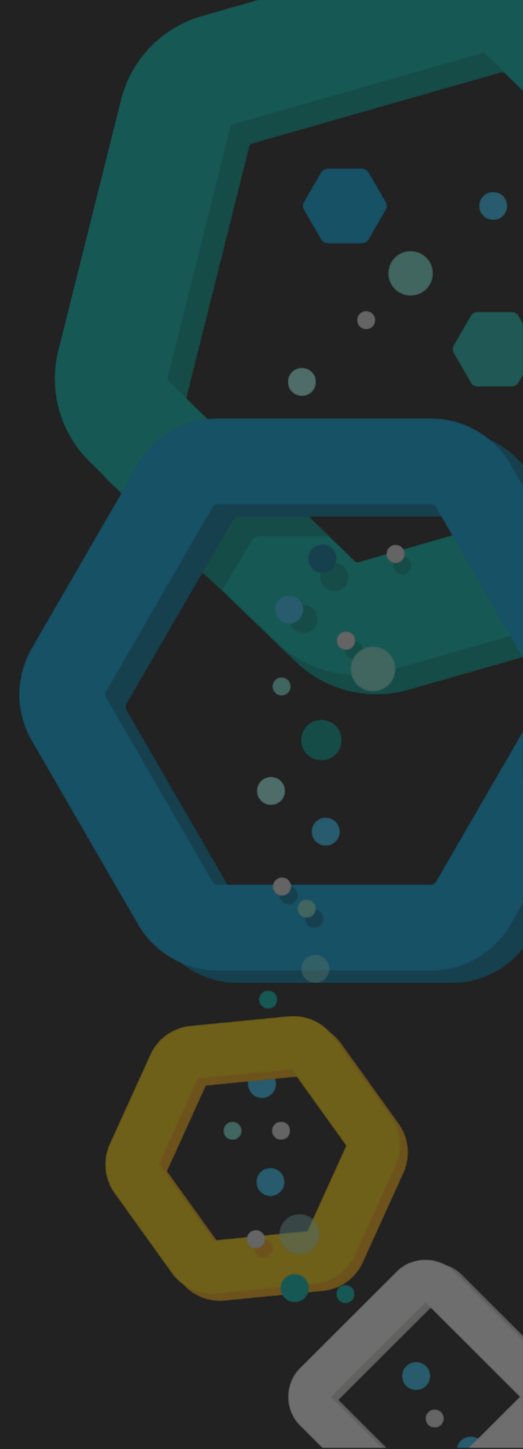


Agenda

- What is serverless?
- Searching for Locations
- Demo
- How to execute java code faster



Serverless?



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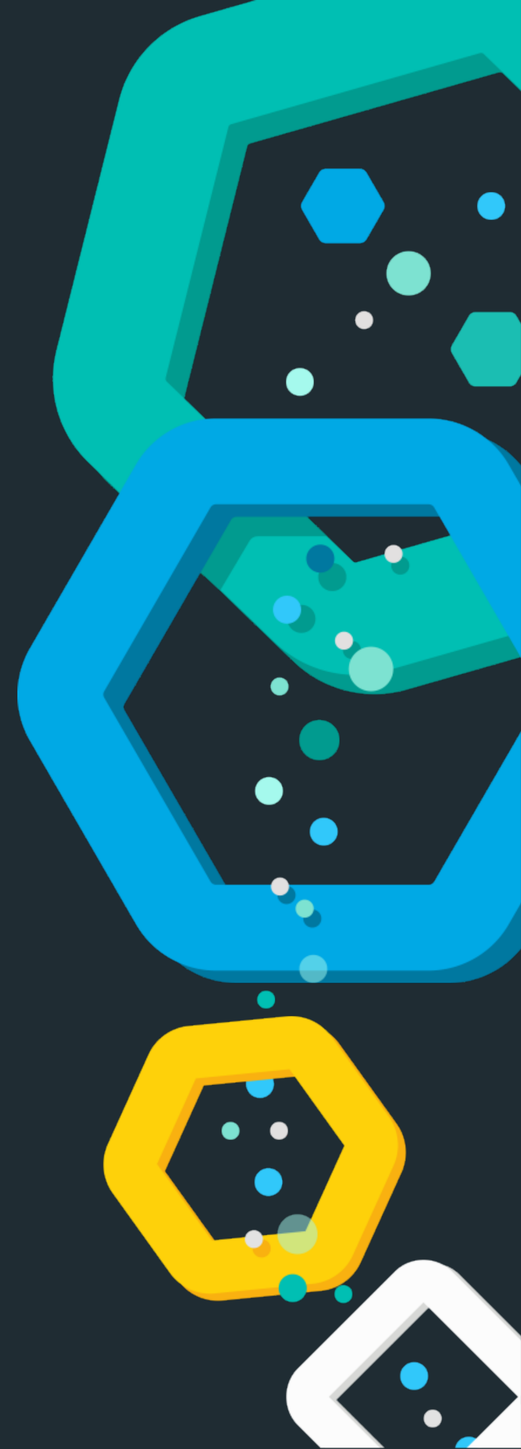
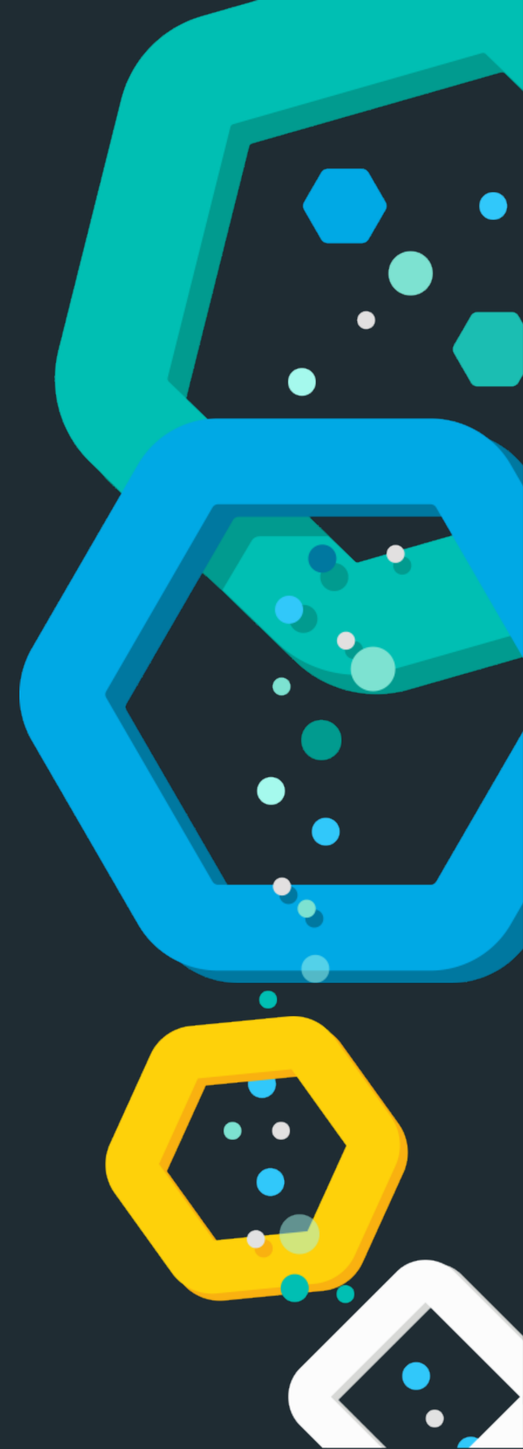
Serverless?

- FaaS (Function as a Service)
- Execution Environment as a Service
- Payment model: Pay per code runtime
- Not running? No bill!
- Configure memory size (also changes CPU power)
- Maximum function execution time
- Provider takes care of scaling functions



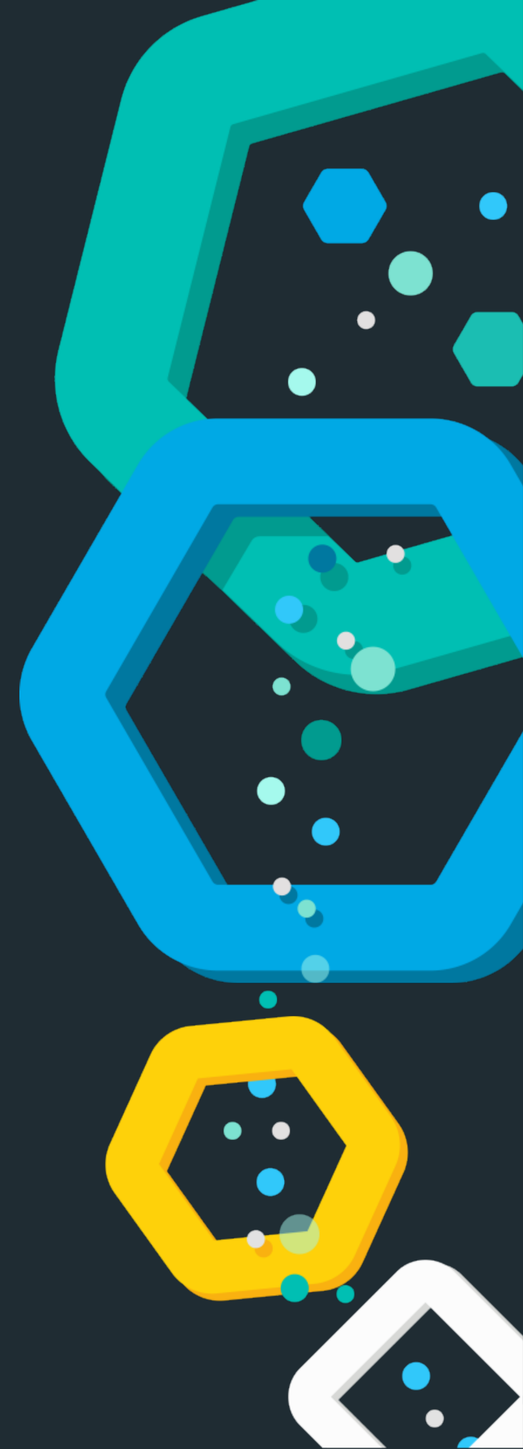
Examples

- Good: Short lived HTTP requests
- Good: Short running jobs
- Good: Event streaming & processing
- Good: Share nothing web applications
- Good: Parallelizable workloads
- Bad: Slack bots?



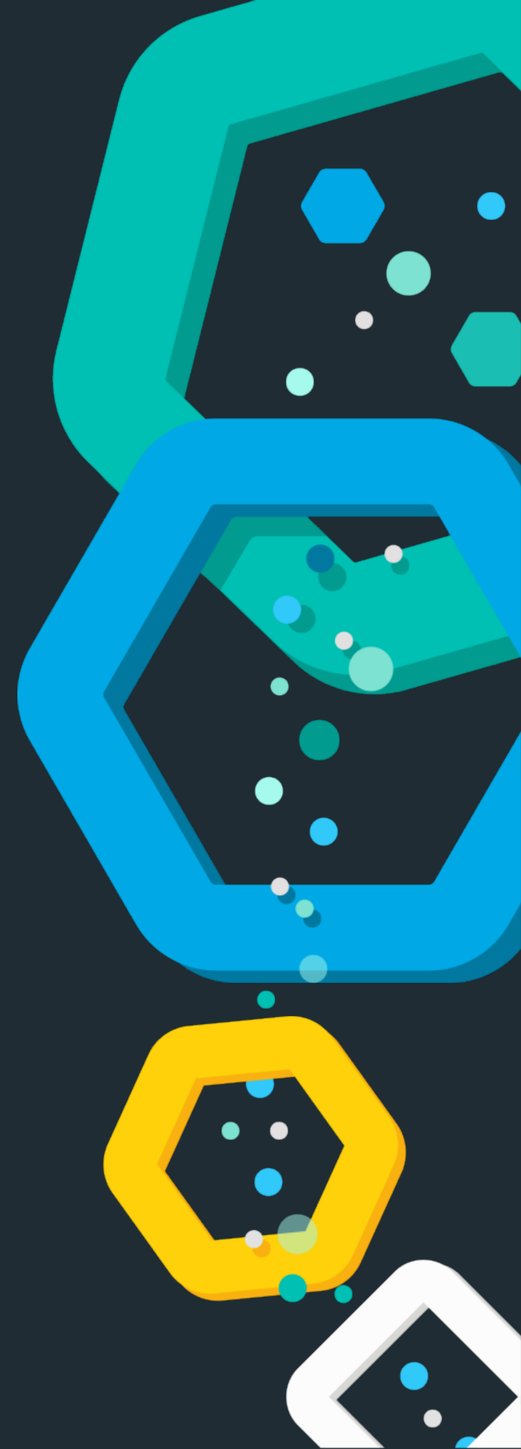
Providers?

- AWS Lambda, GCP Cloud Functions, Azure Cloud Functions, Cloudflare, IBM OpenWhisk, Google Cloud Run
- Faastruby, Binaris, Spotinst
- K8s: KNative, Fission, Kubeless, Nuclio, OpenFaas
- Docker: Fn, OpenFaas

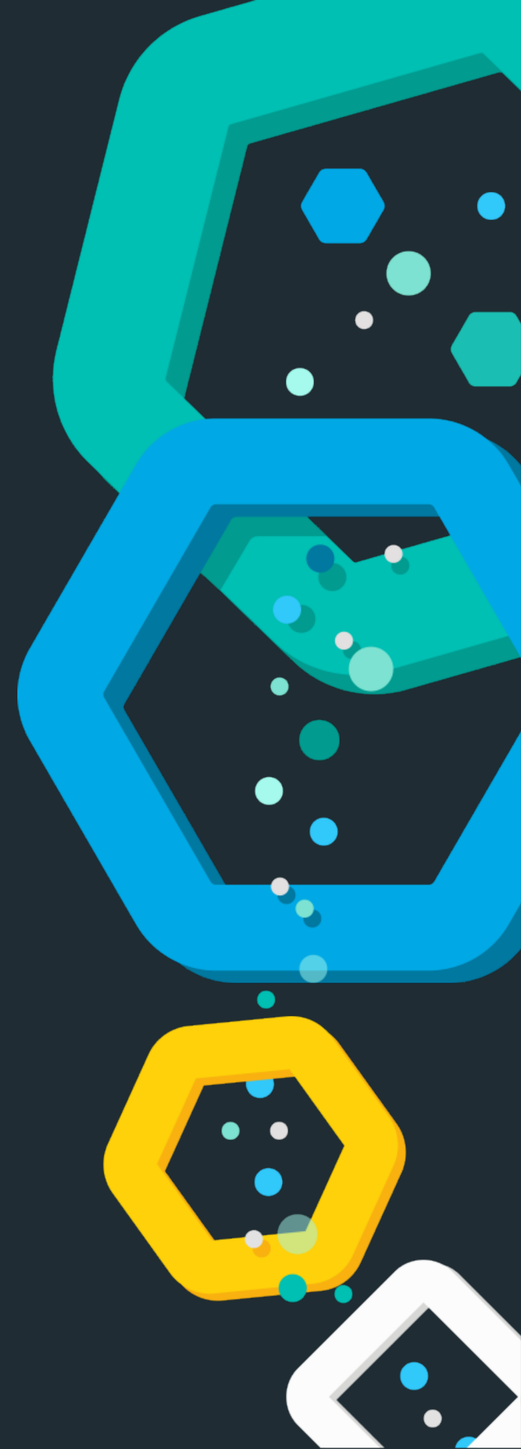


Java?

- Not too well suited for short lived tasks
- JVM startup time
- JIT compiler
- Dependency initialisation
- Application initialisation



Location Tracker:
Owntracks + Lambda + Kibana



kibana

- Discover
- Visualize
- Dashboard
- Timelion
- Canvas
- Maps
- Machine Learning
- Infrastructure
- Logs
- APM
- Uptime
- Graph
- Dev Tools
- Monitoring
- Management

Dashboard / Alr location

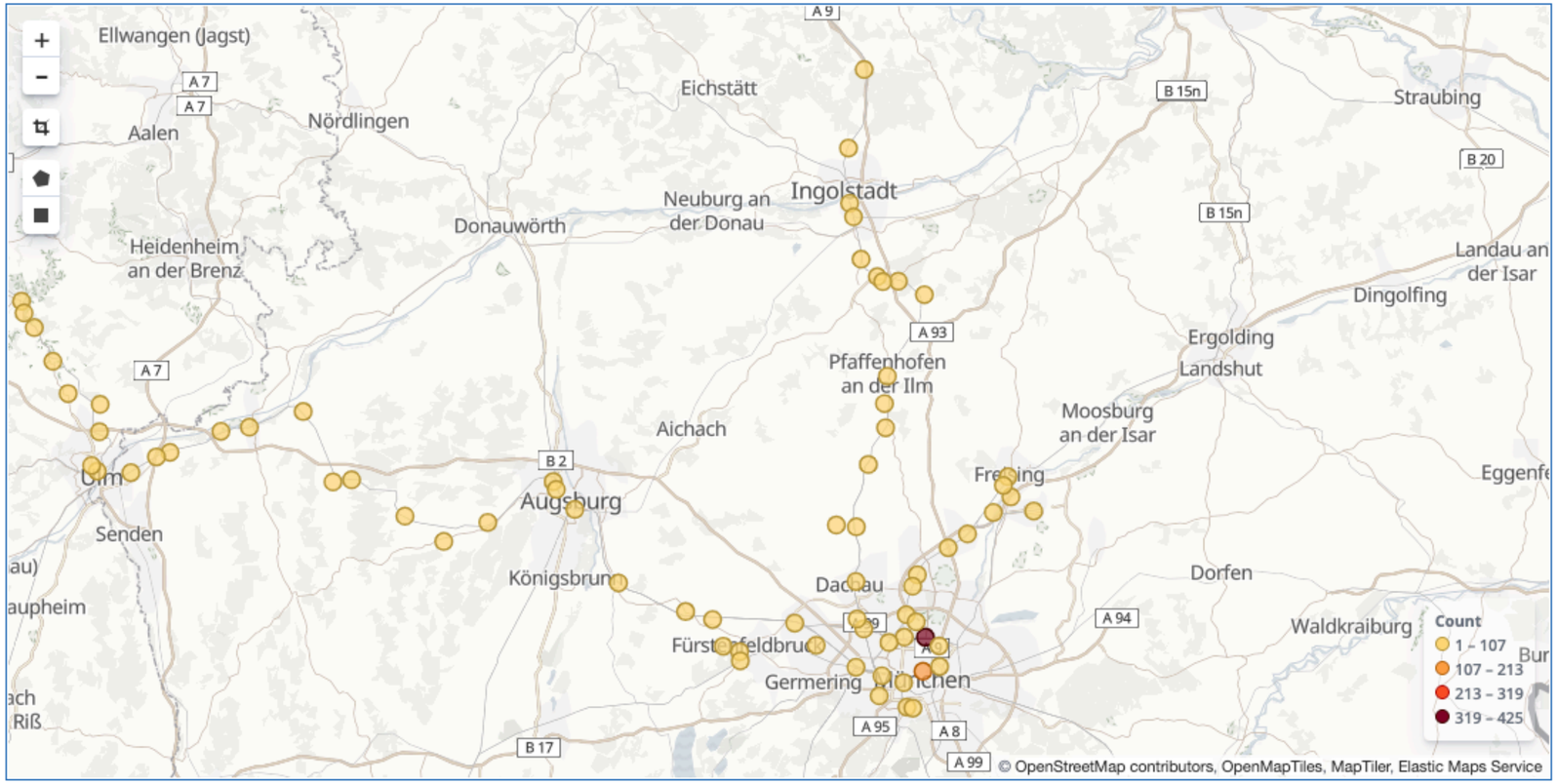
Full screen | Share | Clone | Edit | Documentation | Auto-refresh | Last 90 days

>_ *

Options | Update

Add a filter +

Last Positions

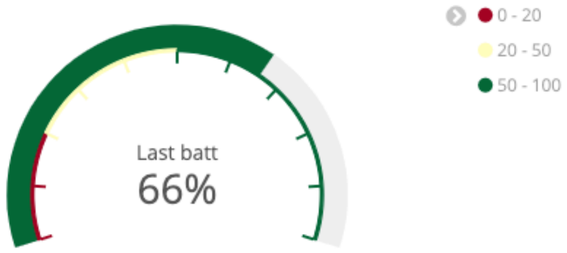


Last update

November 18th 2019, 09:19:47.000

Last update

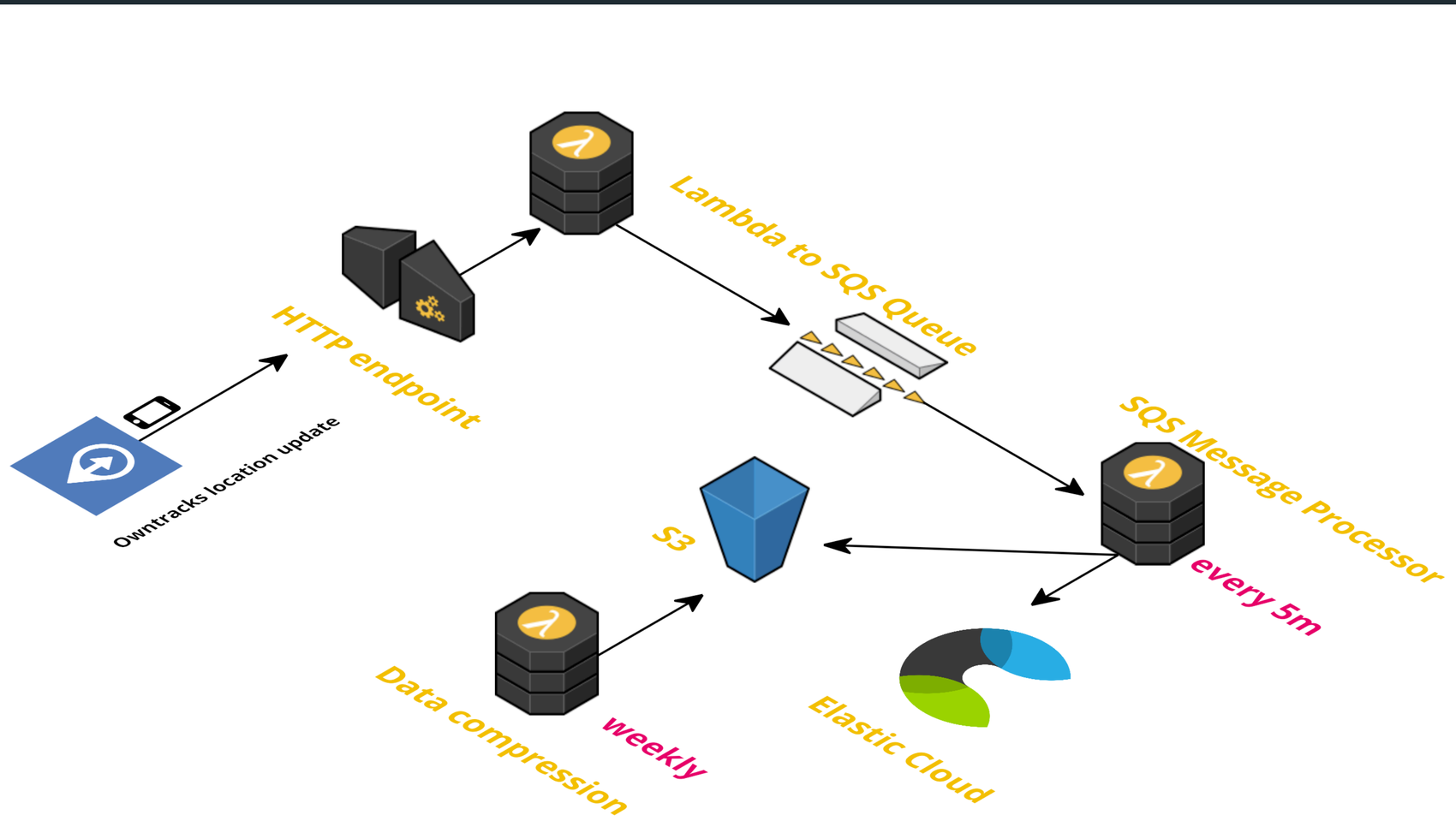
Last battery indicator



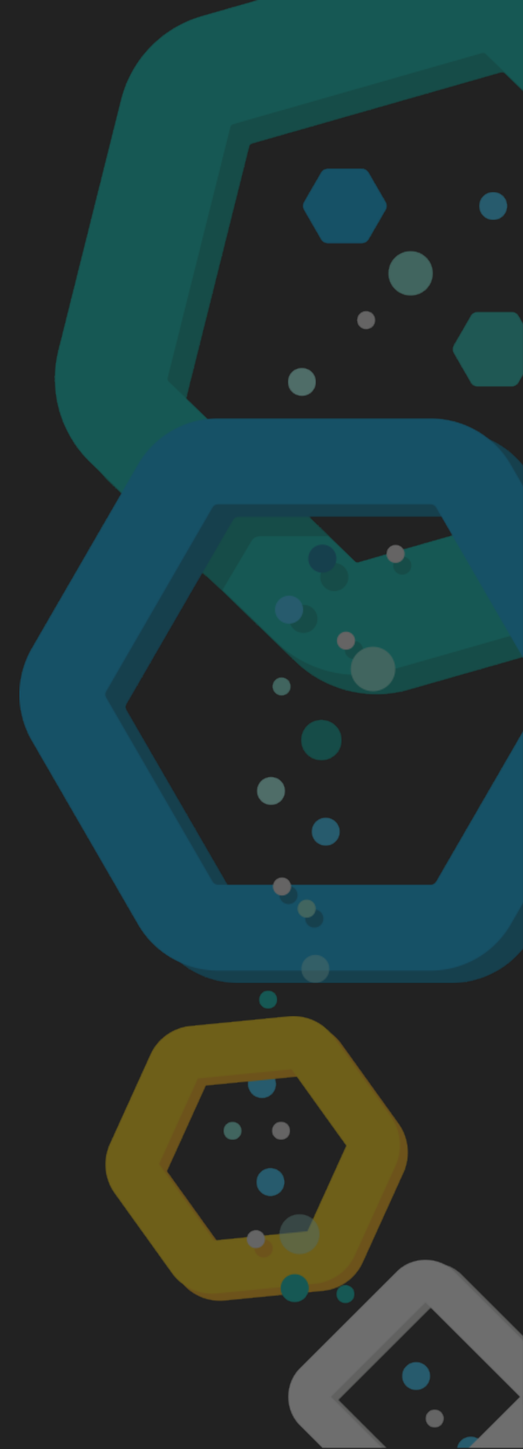
Battery over time

Last batt

https://github.com/spinscale/serverless-owntracks-kotlin



Location search



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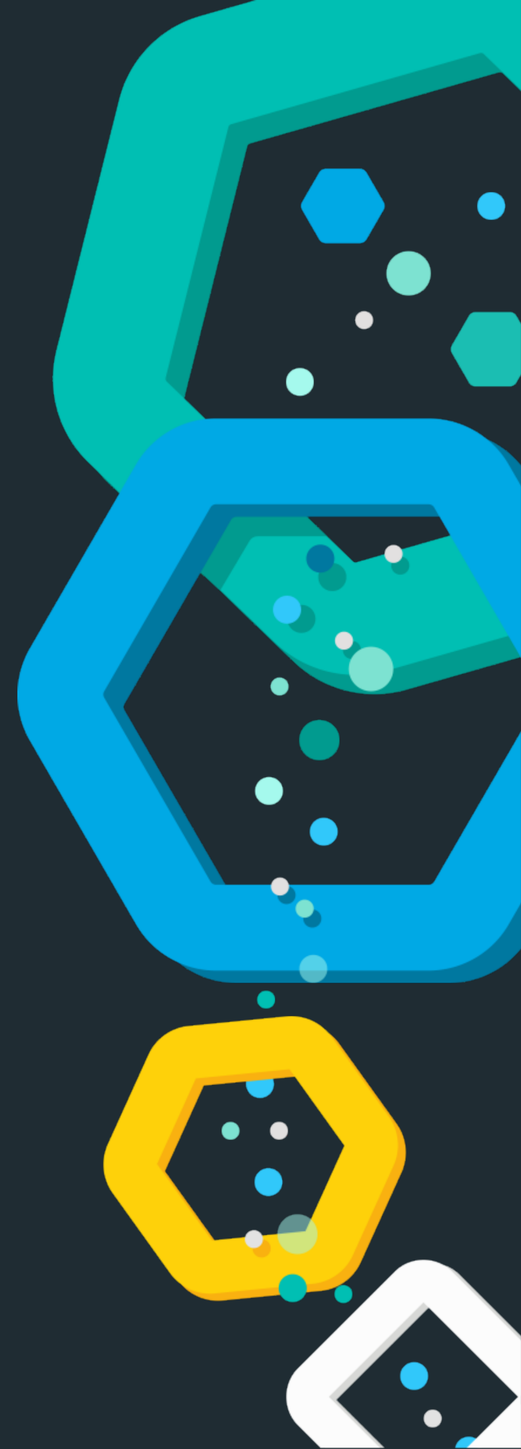
Reverse Geocoder

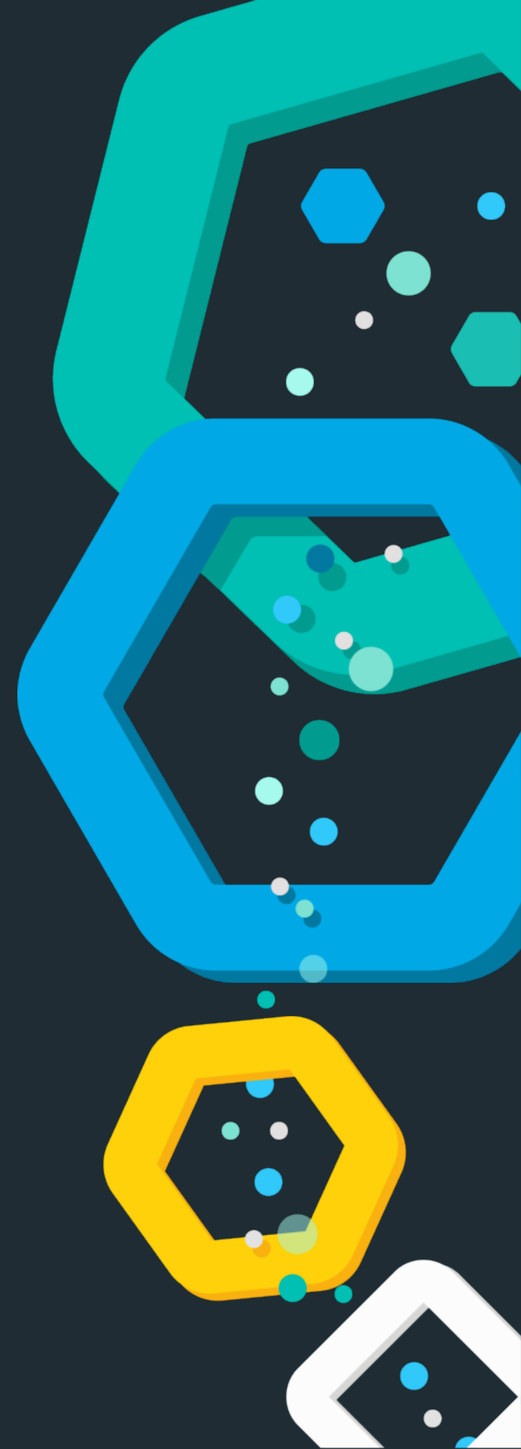
- Input: Latitude, Longitude
- Output: readable representation (City)



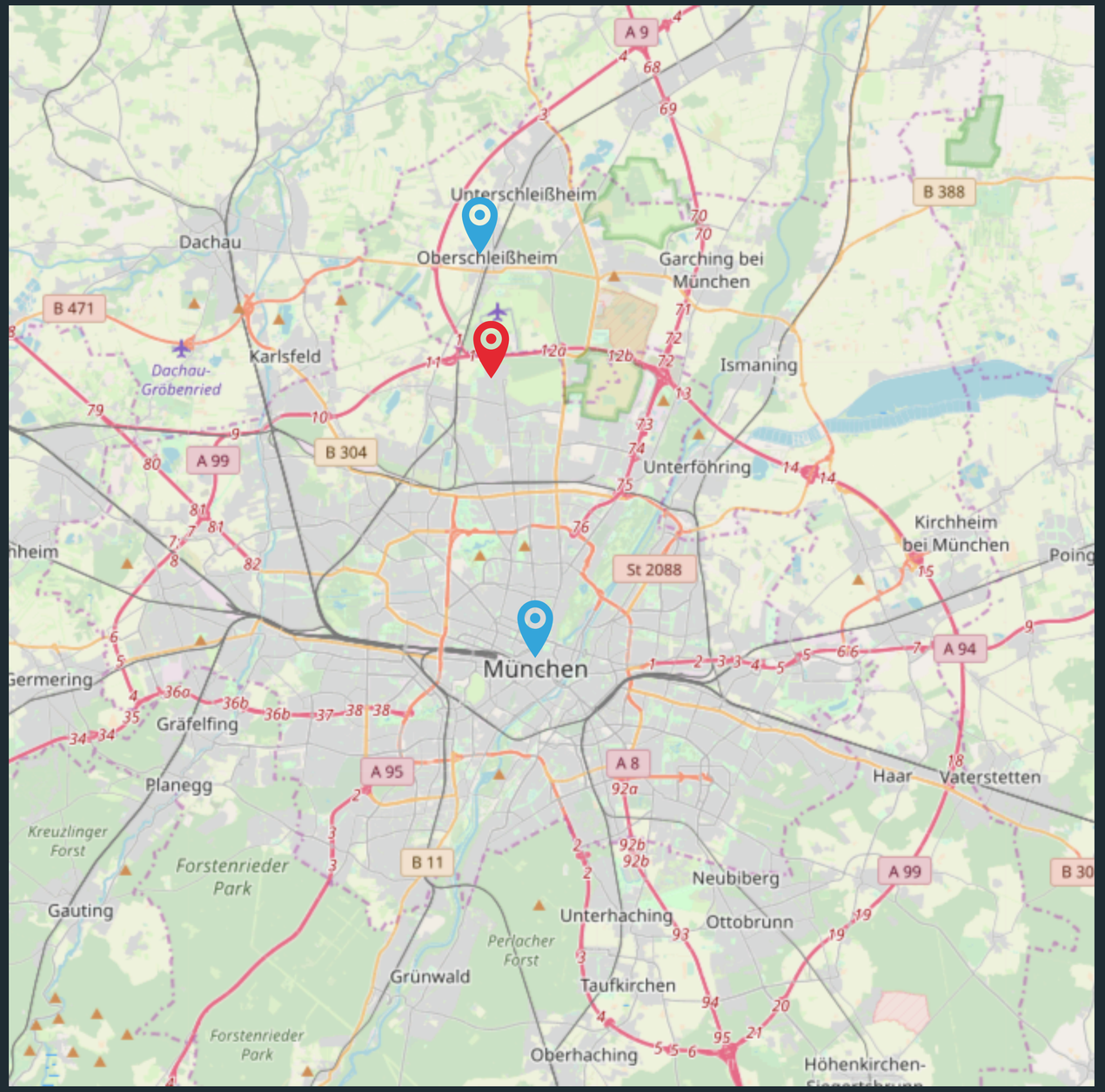
Search across points

- Each city gets indexed with a lat/lon pair
- Search for the next point to the supplied one

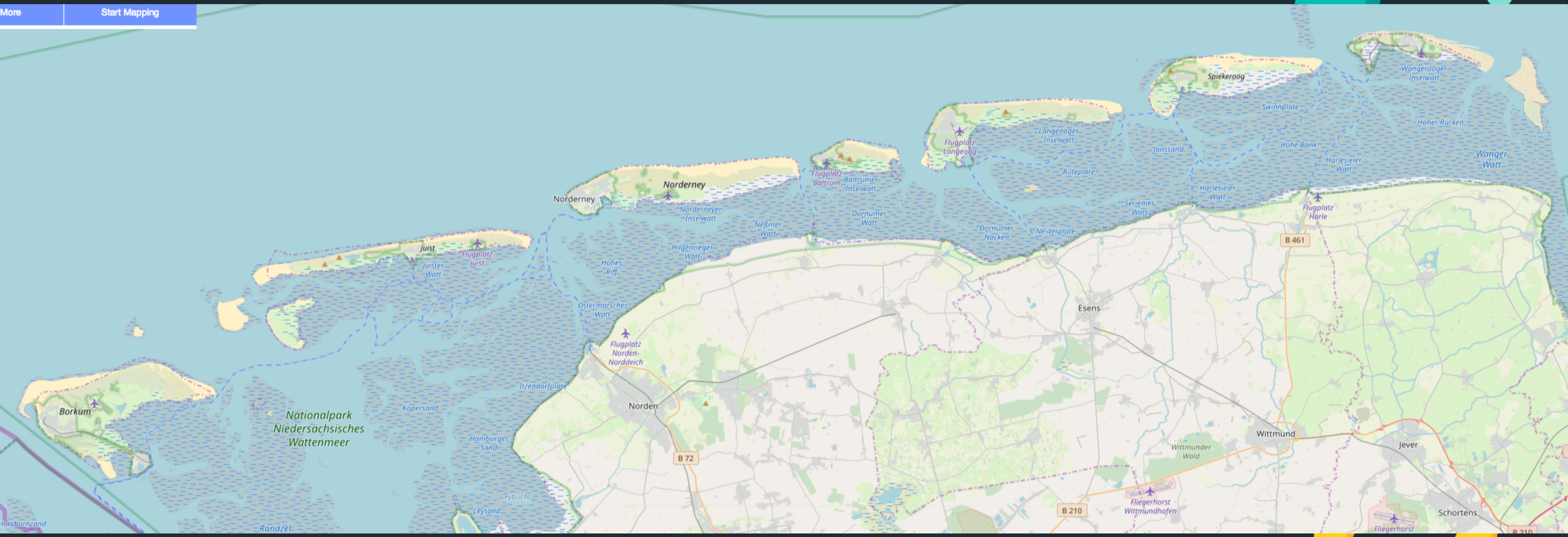
- Problem: Neighbours!



Point based search: Near neighbours



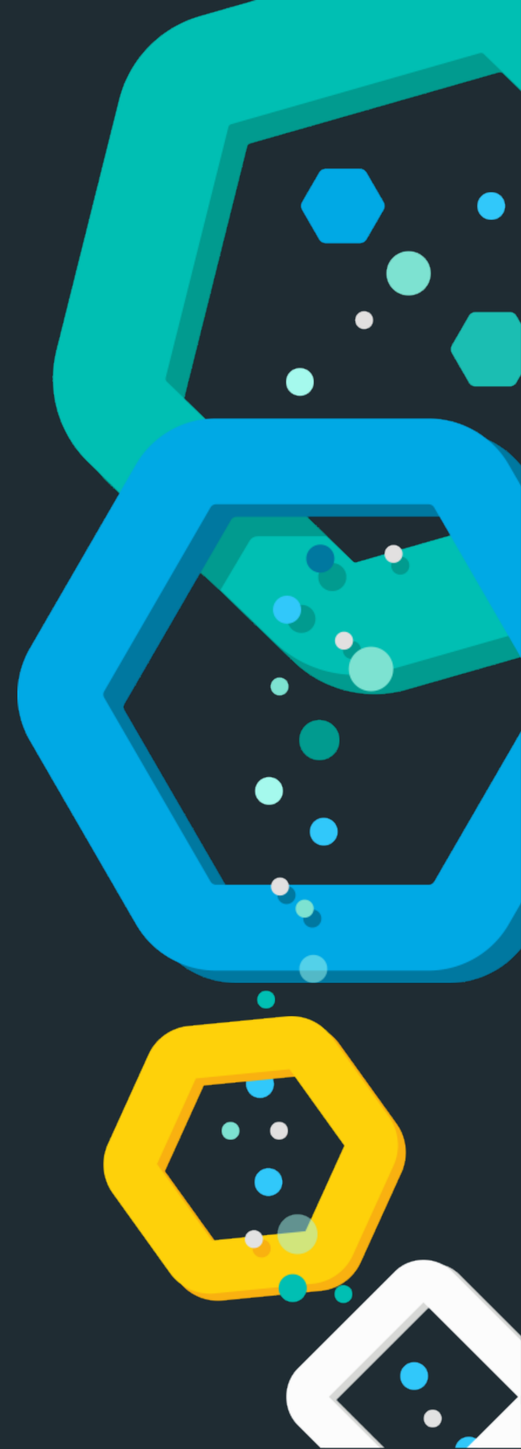
Point based search: Near neighbours



Search across shapes

- Each city gets indexed with a lat/lon pair
- Certain cities get indexed as a geoshape

- Run two searches:
  - Lat/Lon within any shape
  - Lat/Lon nearby any point

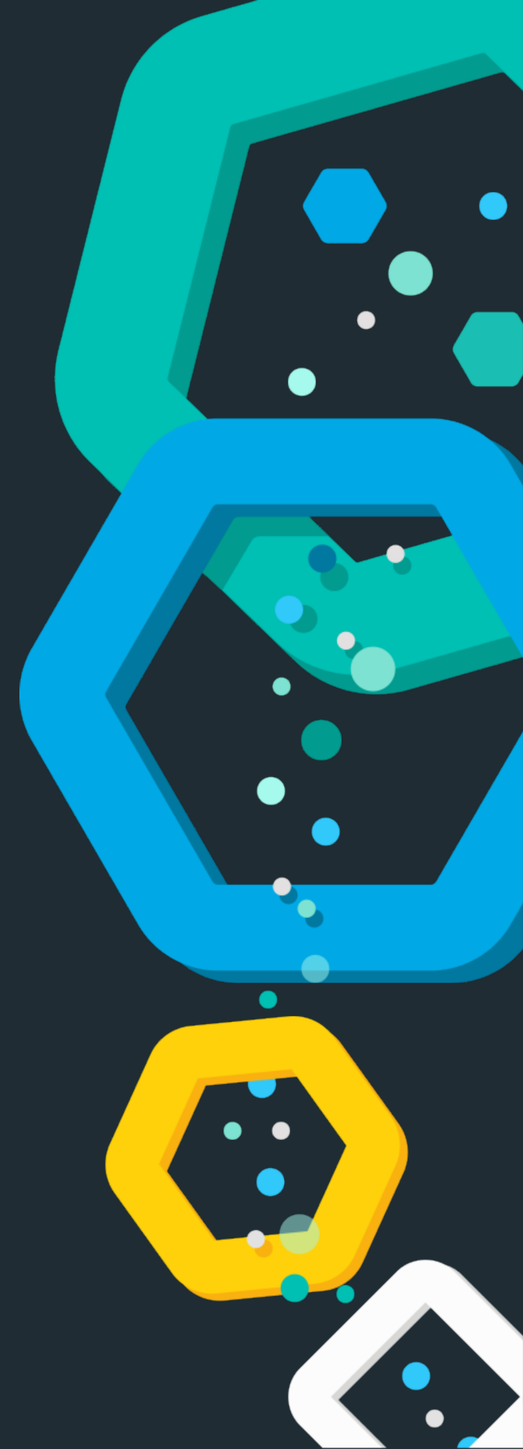


Geo and Lucene: BFF!

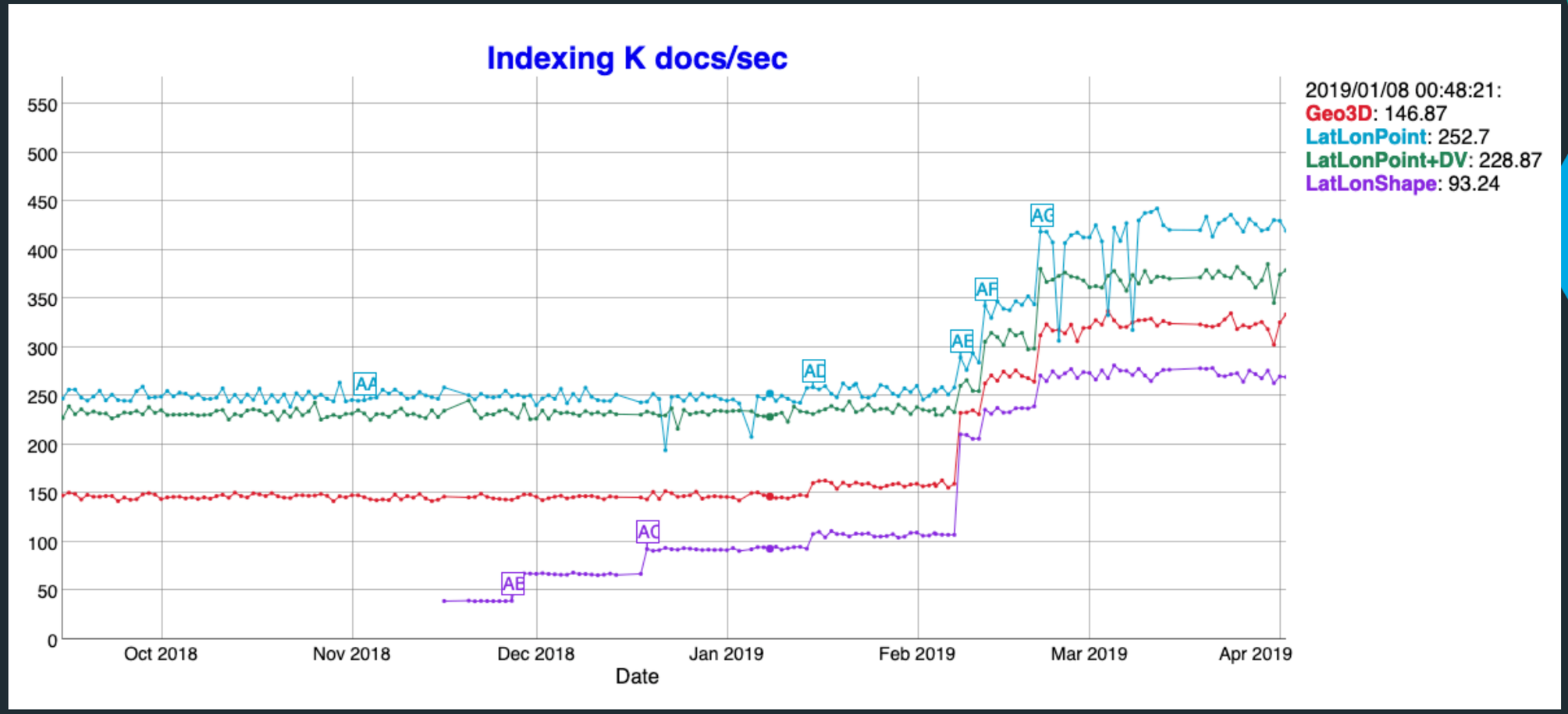
- **`LatLonPoint`**: two points, 4 bytes each
- **`LatLonShape`**: triangular mesh tesselation

Indexing approach edit

GeoShape types are indexed by decomposing the shape into a triangular mesh and indexing each triangle as a 7 dimension point in a BKD tree. This provides near perfect spatial resolution (down to 1e-7 decimal degree precision) since all spatial relations are computed using an encoded vector representation of the original shape instead of a raster-grid representation as used by the Prefix trees indexing approach. Performance of the tessellator primarily depends on the number of vertices that define the polygon/multi-polygon. While this is the default indexing technique prefix trees can still be used by setting the `tree` or `strategy` parameters according to the appropriate Mapping Options. Note that these parameters are now deprecated and will be removed in a future version.

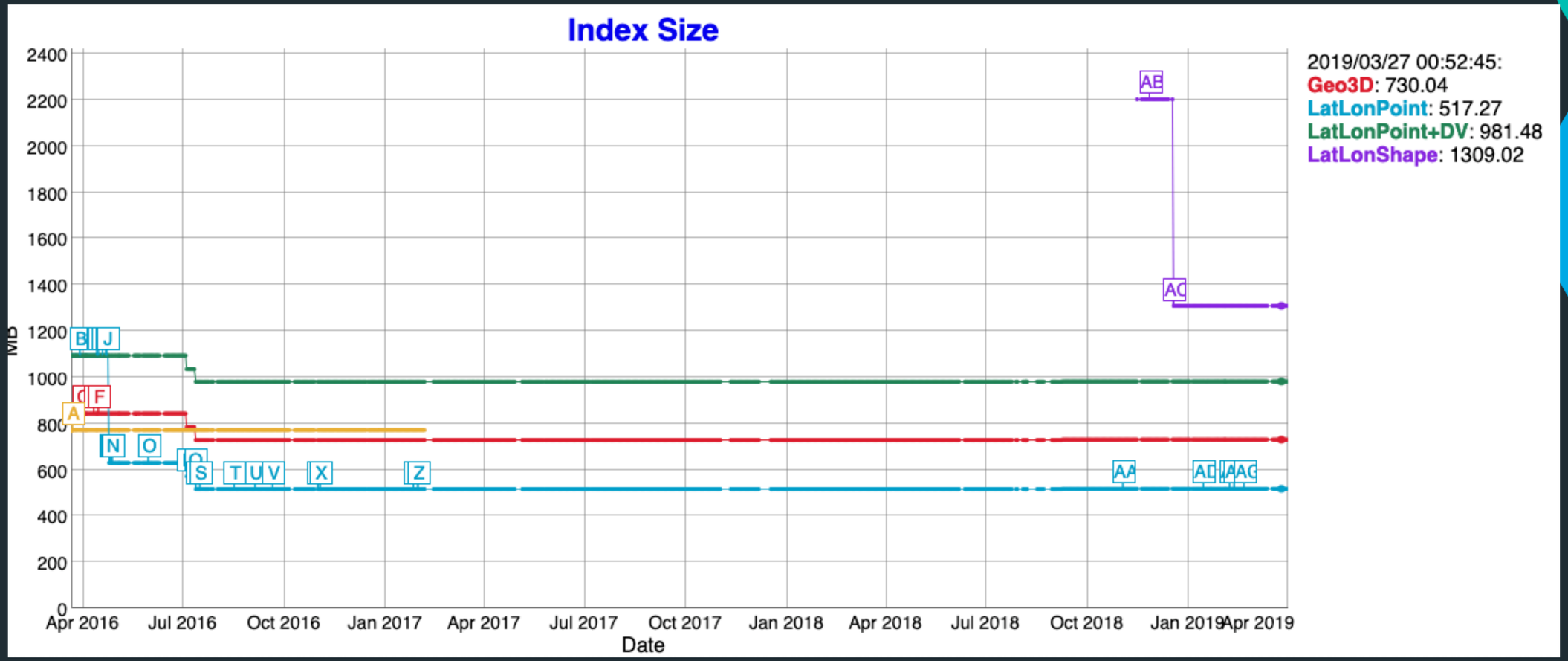


Geo and Lucene: BFF!



https://home.apache.org/~mikemccand/geobench.html

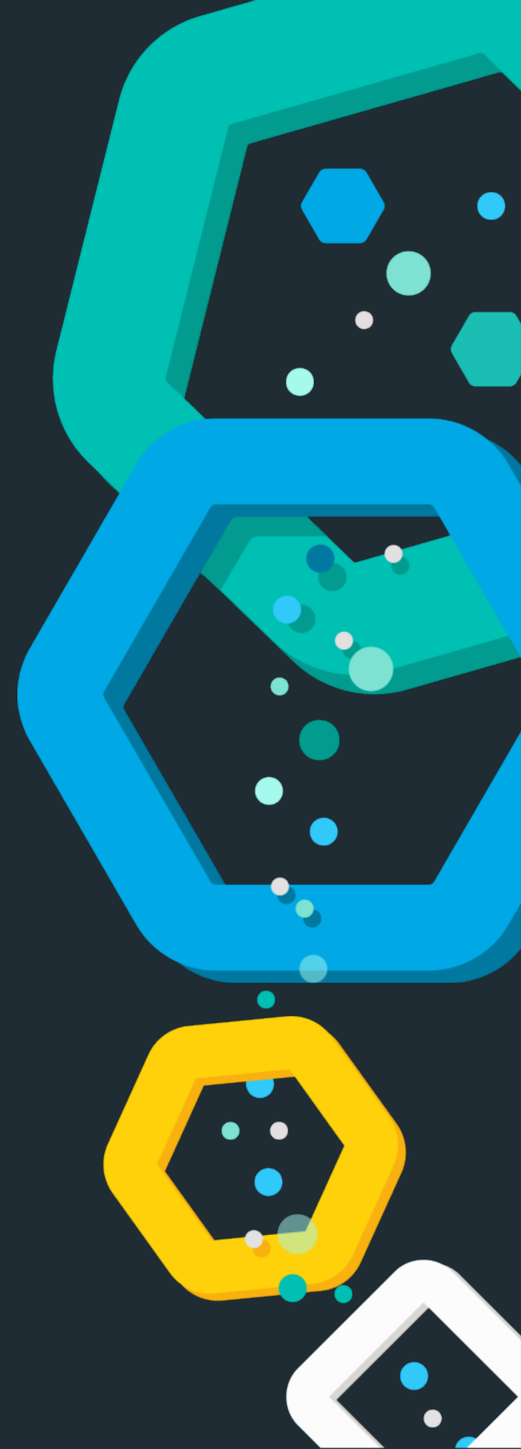
Geo and Lucene: BFF!



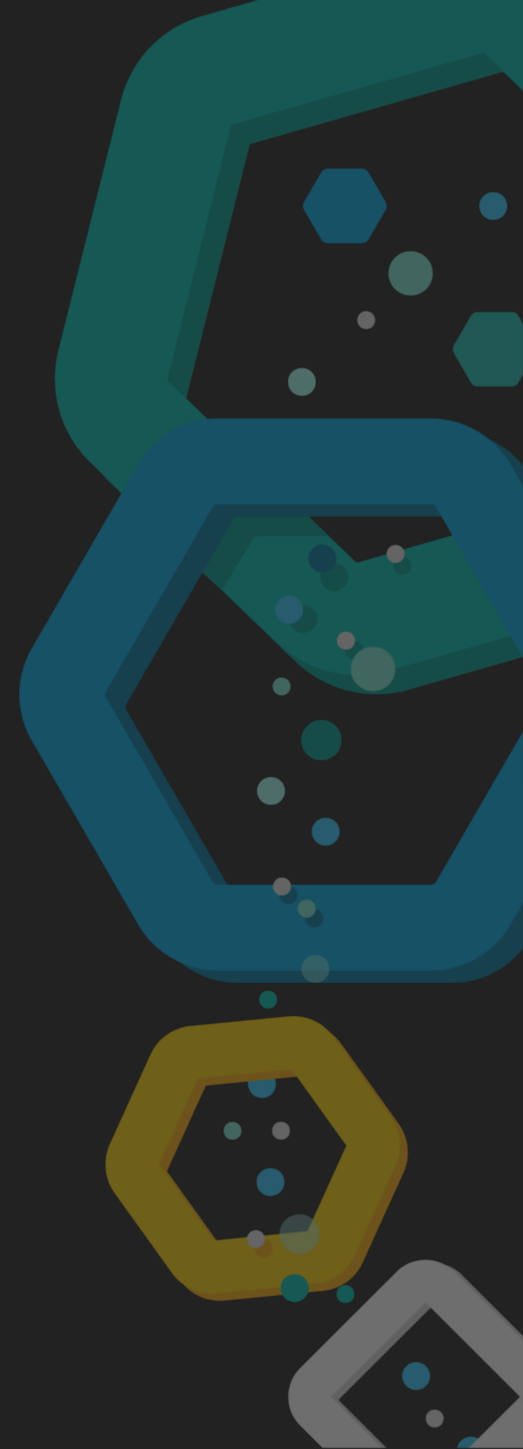
https://home.apache.org/~mikemccand/geobench.html

Serverless Lucene

- Local execution, index part of the package
- Offline index creation
- Packaging index into code
- Index needs to be unpacked, using Lucene via classpath resources is tricky



Demo



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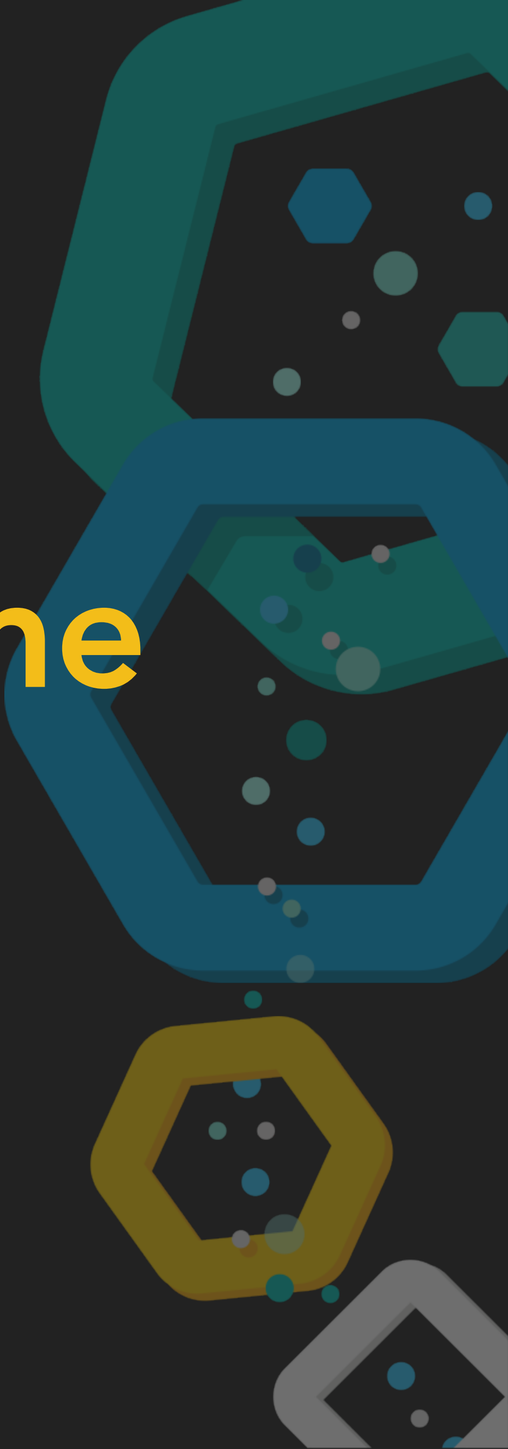
Summary

- Works!
- Problem: Data quality, getting accurate shape data
- Problem: First invocation (up to 2s)
  - JVM startup
  - Lucene index opening

Faster startup & runtime



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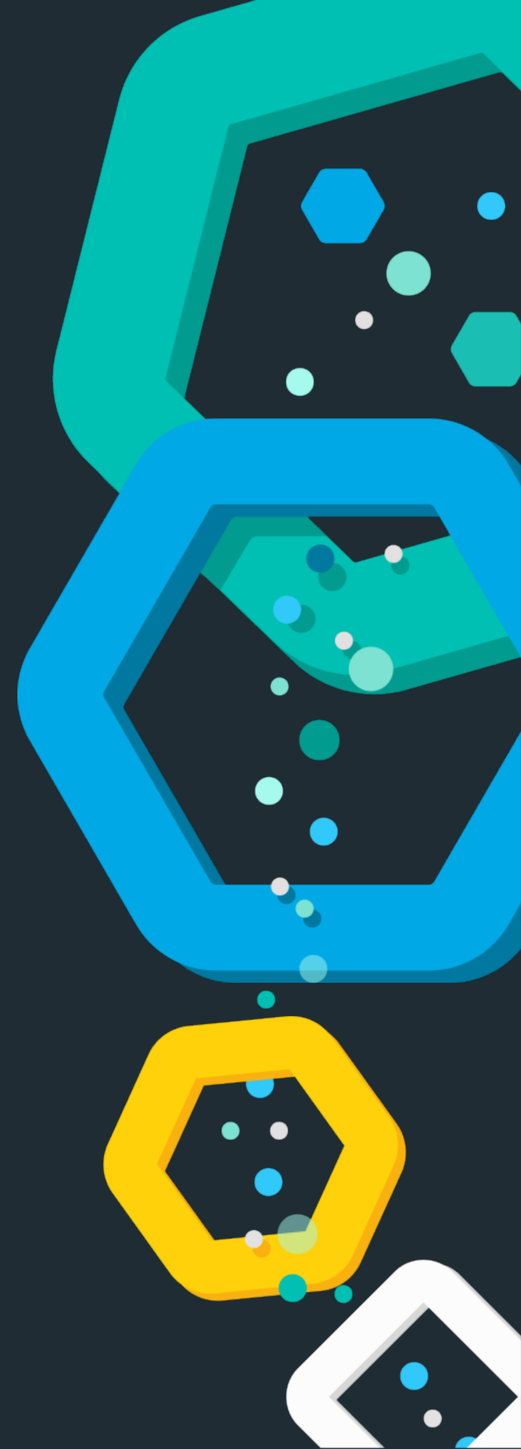
Enter GraalVM!

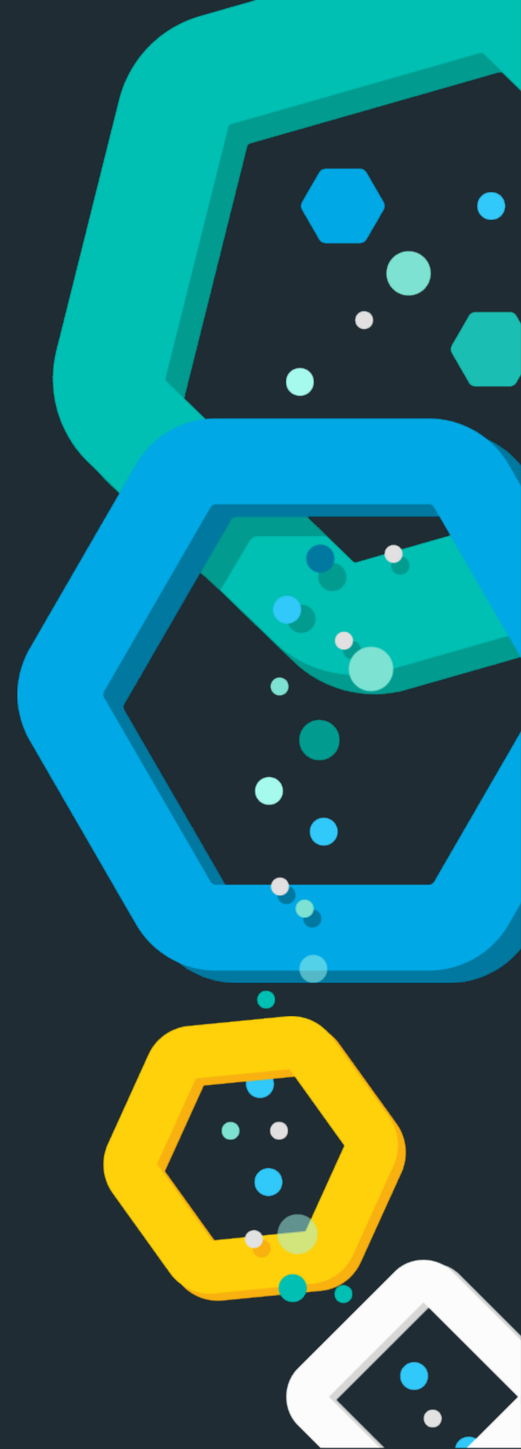
- A new compiler, supporting HotSpot and AOT compilation
- Graal compiler part of Java9 (experimental!)
- Graal JIT compiler part of Java10 (Linux 64bit only)
- Project Metropolis: Java-on-Java Hotspot implementation
- Truffle: Framework to implement other languages on top of graal (jruby replacement)



Enter GraalVM!

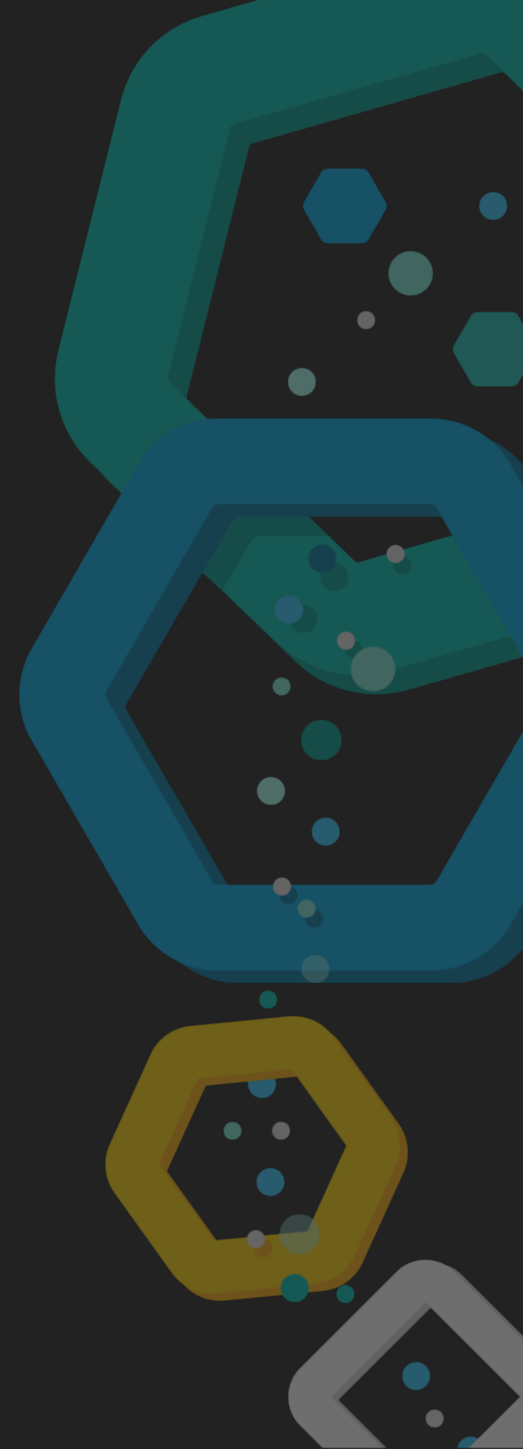
- AOT static compilation + SubstrateVM = executable binaries of java apps

- Using SubstrateVM
- Reflection!



```
devel/spinscale/aws-lambda-geohash  master ✘  hyperfine --warmup 3 'java -jar cli/build/libs/cli-all-0.1.jar cli/build/lucene 48.1374 11.5755' './cli/build/cli cli/build/lucene/ 48.1374 11.5755' --prepare 'sudo purge'
Benchmark #1: java -jar cli/build/libs/cli-all-0.1.jar cli/build/lucene 48.1374 11.5755
  Time (mean ± σ):     829.6 ms ±  20.1 ms    [User: 604.1 ms, System: 184.4 ms]
  Range (min … max):   804.1 ms … 862.1 ms    10 runs

Benchmark #2: ./cli/build/cli cli/build/lucene/ 48.1374 11.5755
  Time (mean ± σ):     100.0 ms ±   2.3 ms    [User: 3.5 ms, System: 25.5 ms]
  Range (min … max):    96.1 ms … 103.9 ms    11 runs

Summary
  './cli/build/cli cli/build/lucene/ 48.1374 11.5755' ran
    8.29 ± 0.27 times faster than 'java -jar cli/build/libs/cli-all-0.1.jar cli/build/lucene 48.1374 11.5755'
devel/spinscale/aws-lambda-geohash  master ✘  hyperfine --warmup 3 'java -jar cli/build/libs/cli-all-0.1.jar cli/build/lucene 48.1374 11.5755' './cli/build/cli cli/build/lucene/ 48.1374 11.5755'
Benchmark #1: java -jar cli/build/libs/cli-all-0.1.jar cli/build/lucene 48.1374 11.5755
  Time (mean ± σ):     291.3 ms ±   3.8 ms    [User: 549.9 ms, System: 53.7 ms]
  Range (min … max):   287.4 ms … 300.0 ms    10 runs

Benchmark #2: ./cli/build/cli cli/build/lucene/ 48.1374 11.5755
  Time (mean ± σ):     4.9 ms ±   0.6 ms    [User: 2.3 ms, System: 1.5 ms]
  Range (min … max):   4.3 ms …   7.6 ms    425 runs

  Warning: Command took less than 5 ms to complete. Results might be inaccurate.

Summary
  './cli/build/cli cli/build/lucene/ 48.1374 11.5755' ran
   59.01 ± 7.27 times faster than 'java -jar cli/build/libs/cli-all-0.1.jar cli/build/lucene 48.1374 11.5755'
devel/spinscale/aws-lambda-geohash  master ✘
```

Deployment model



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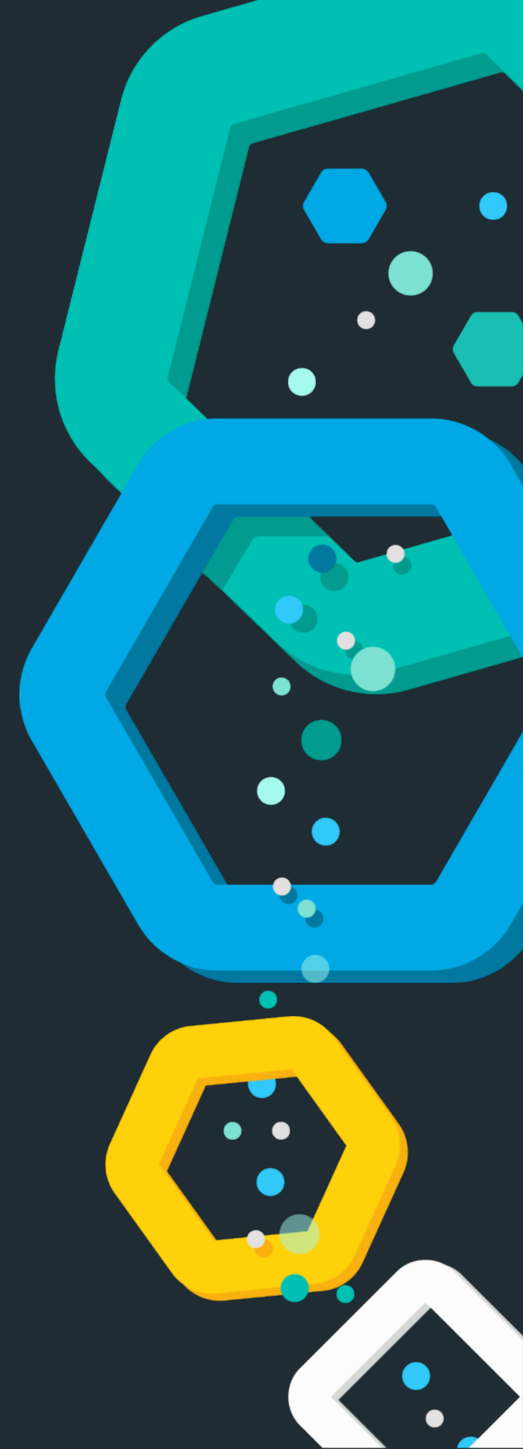
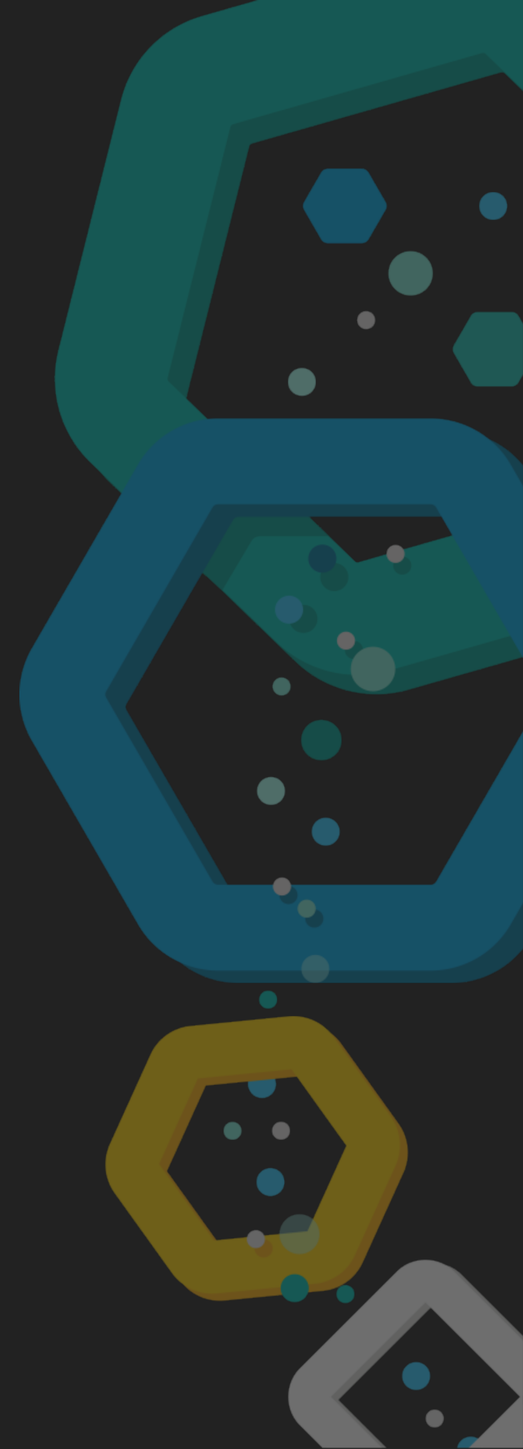
AWS Lambda

- Deployment model: Zip archive in S3 bucket
- Execution: Download zip archive & execute
- Requires regular java start (AWS reduced JVM startup time)
- GraalVM can only be used with custom runtime



runtime flow



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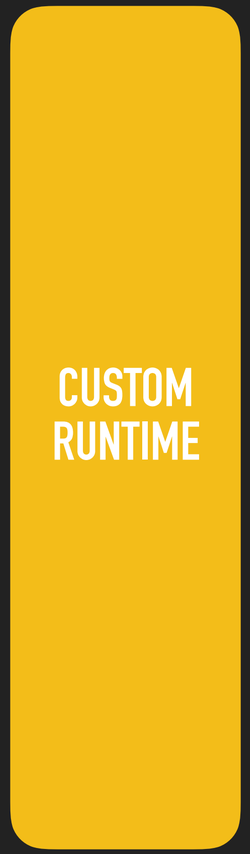
CUSTOM
RUNTIME

```
AWS_LAMBDA_RUNTIME_API=localhost:12345
_HANDLER="my_handler"

/bin/bootstrap
```



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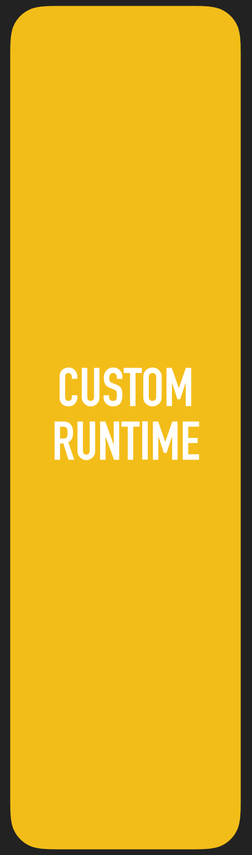

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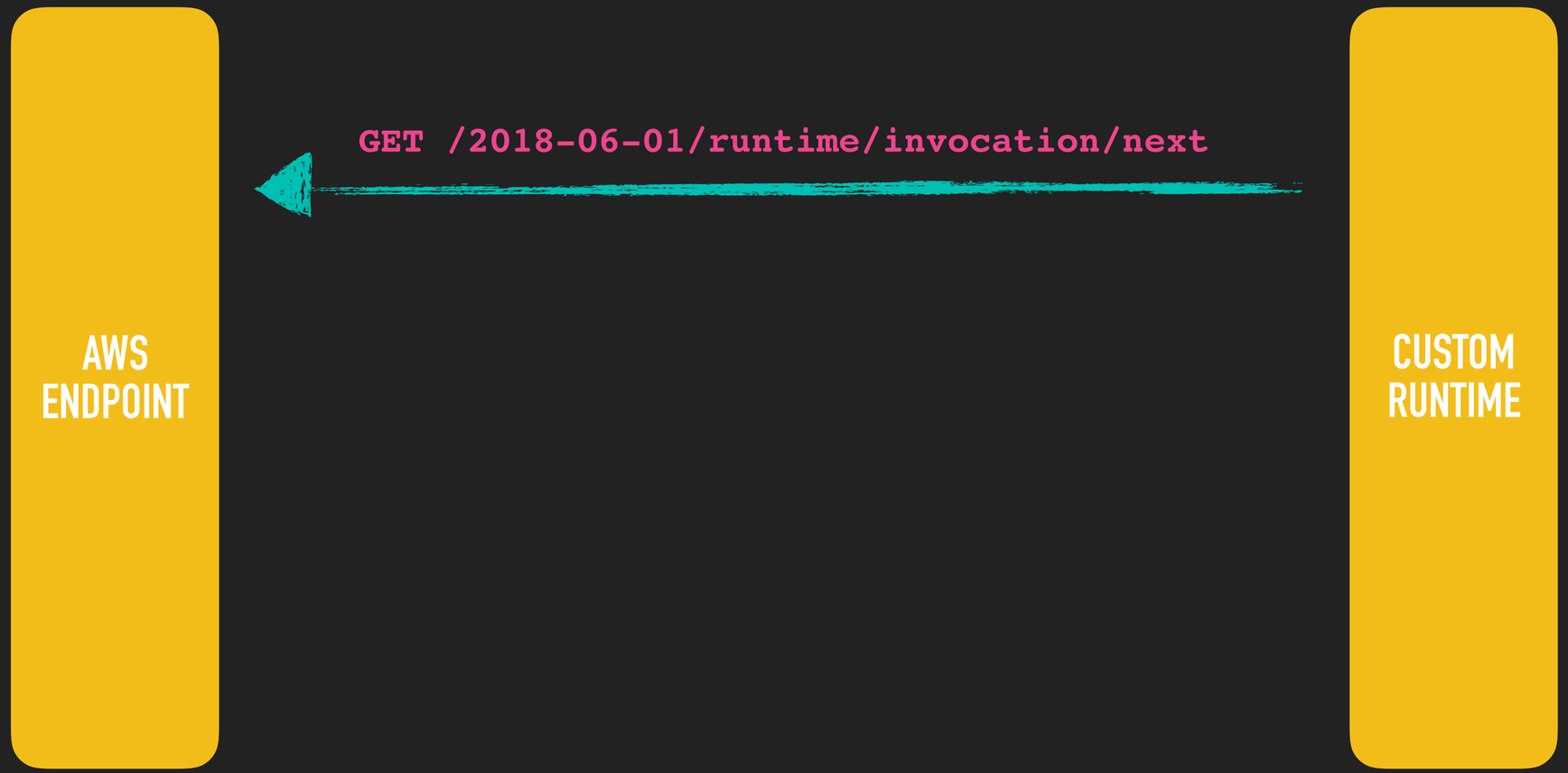

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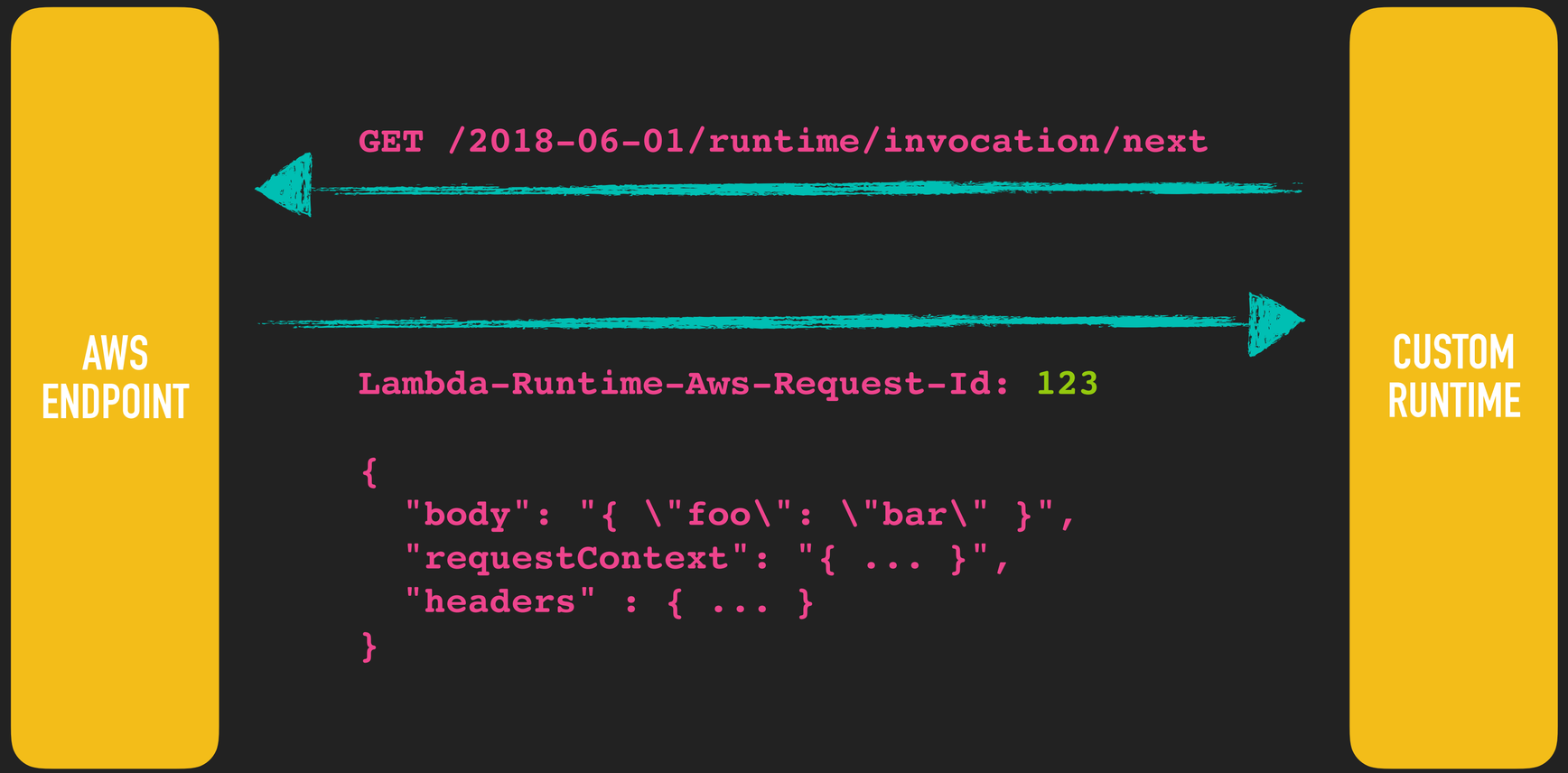

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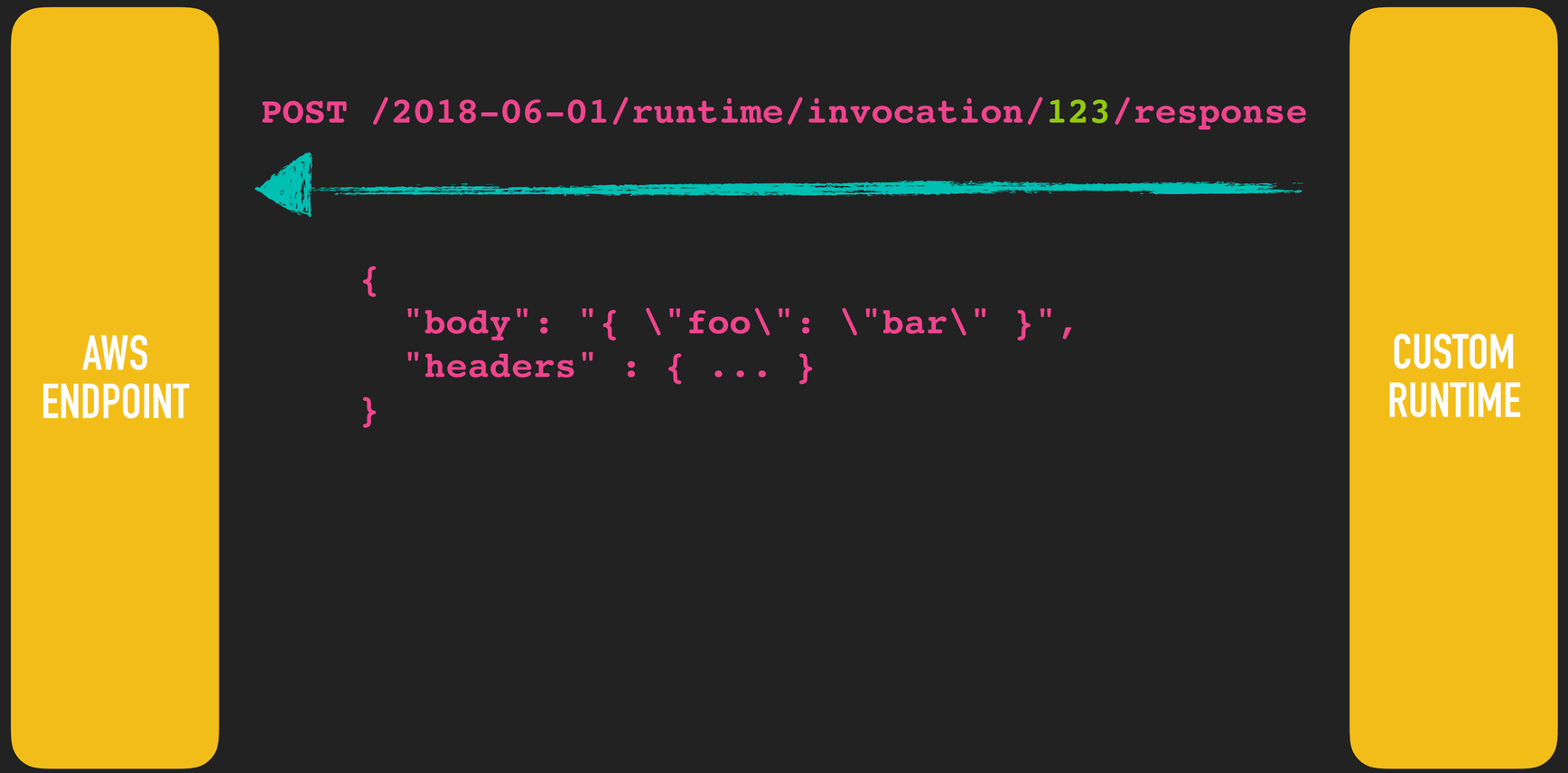

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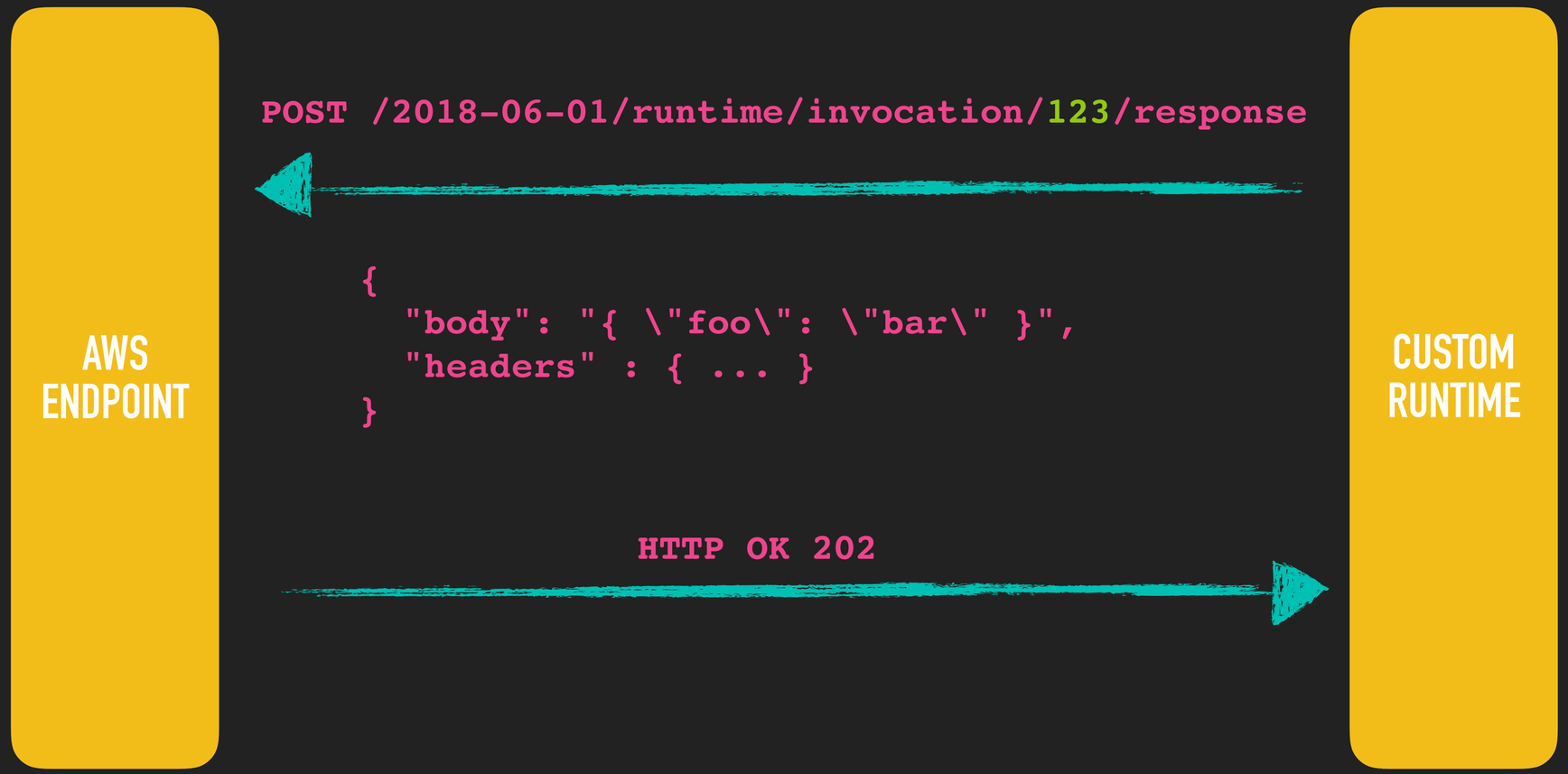

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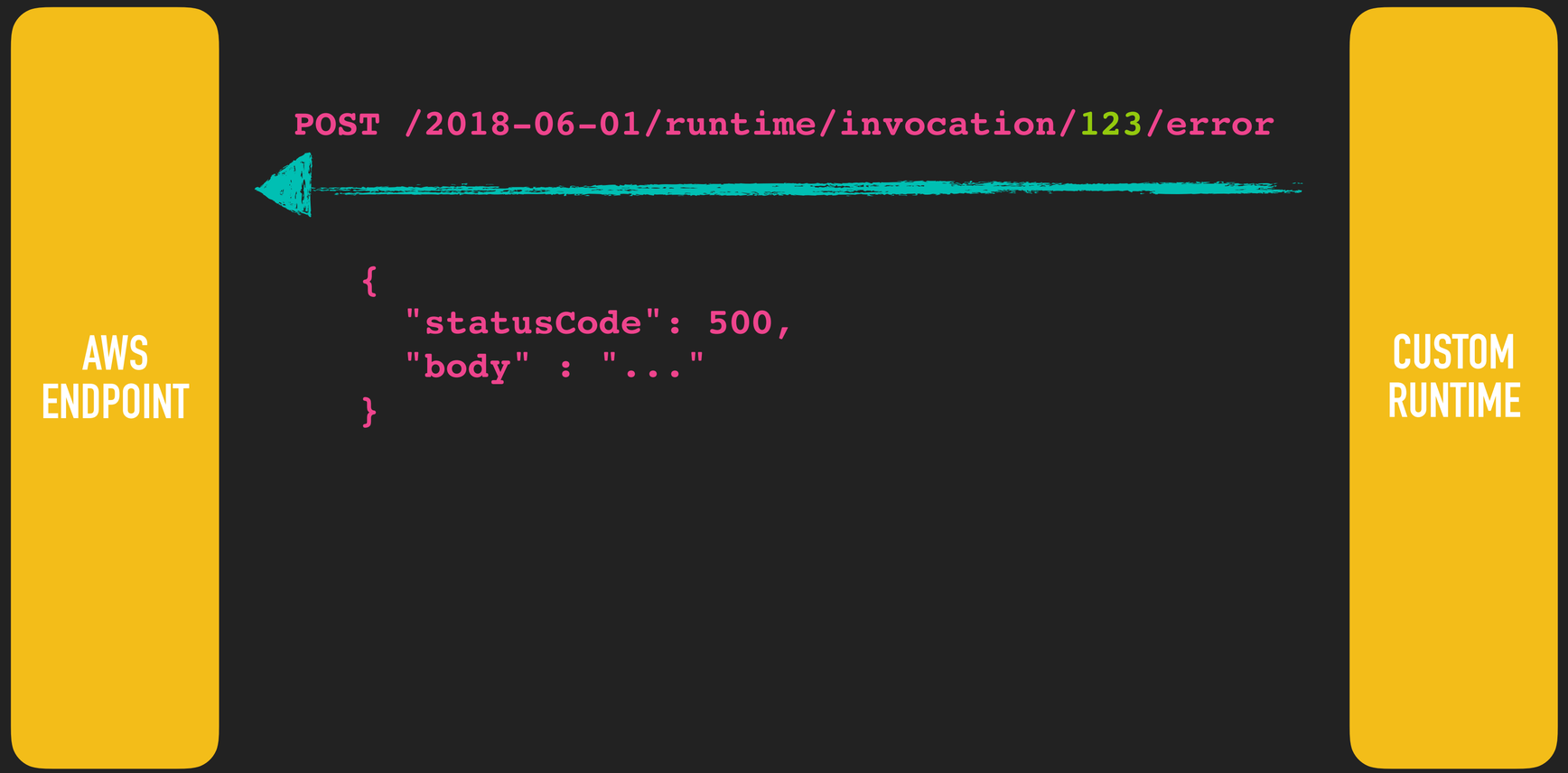

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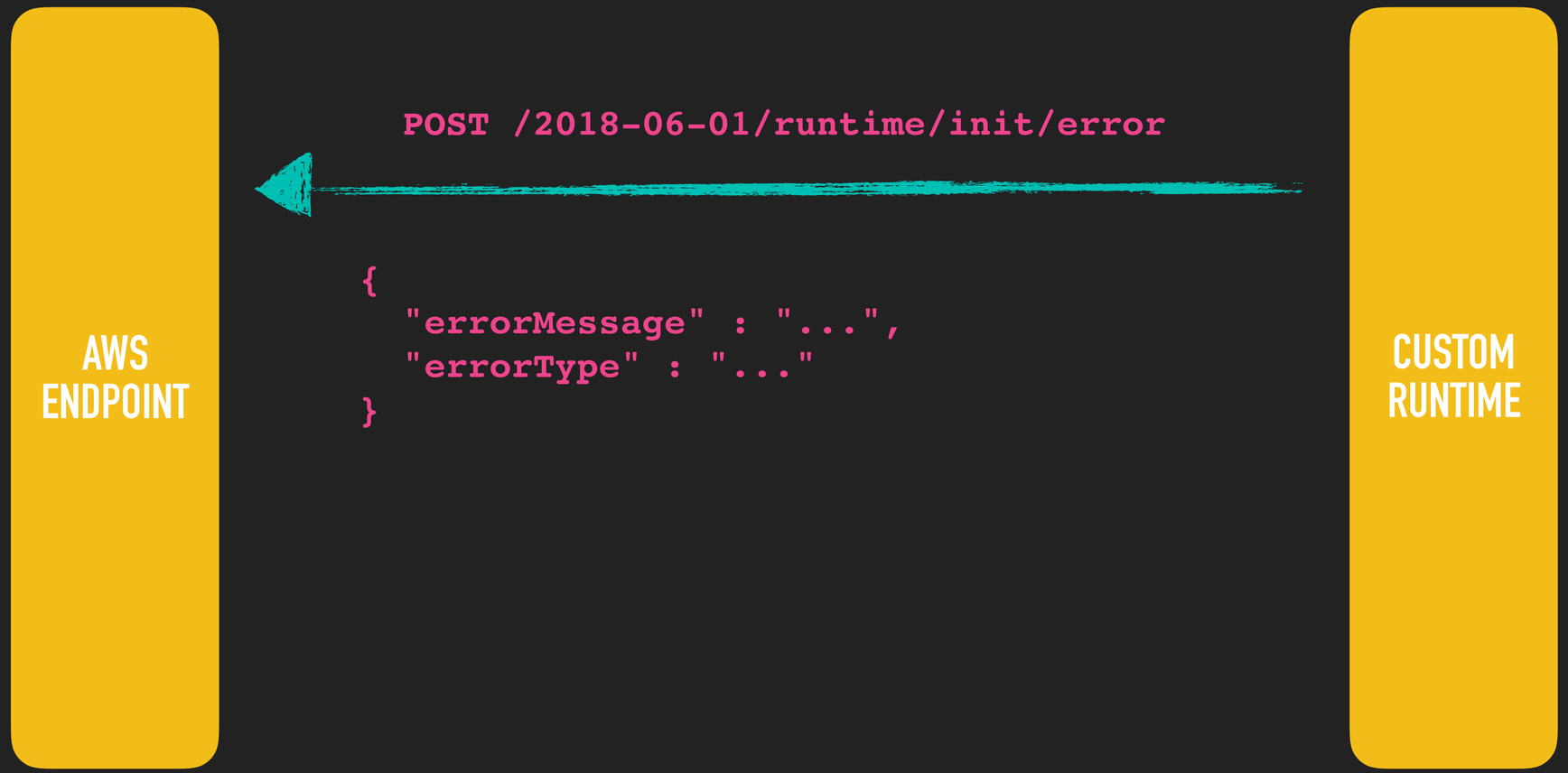
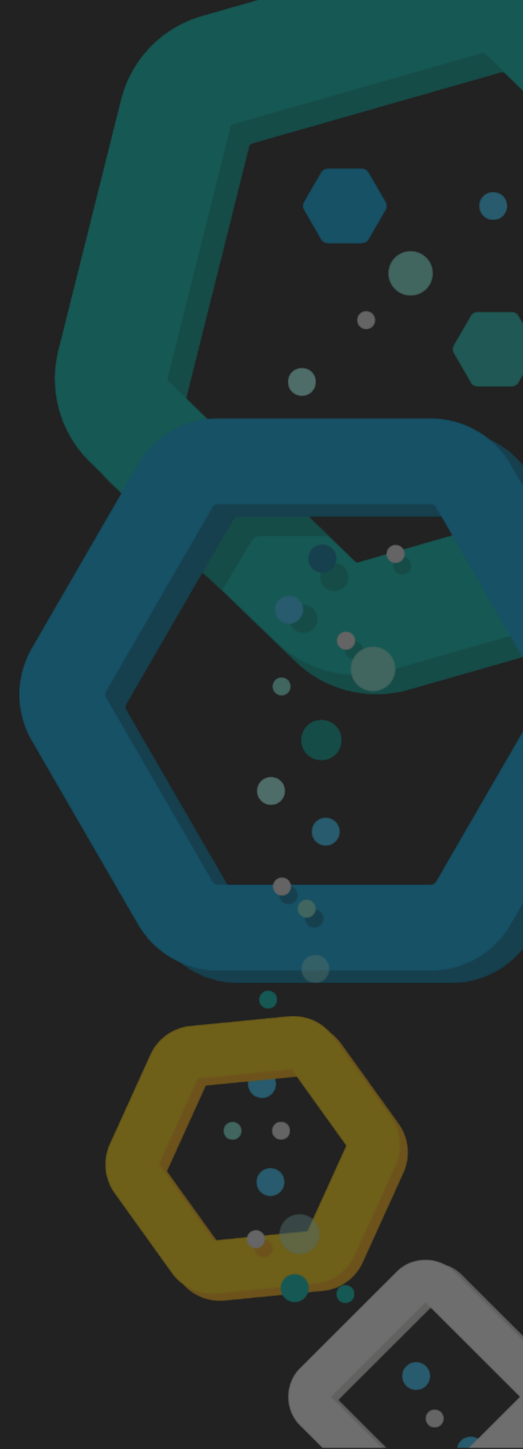


Google Cloud Run



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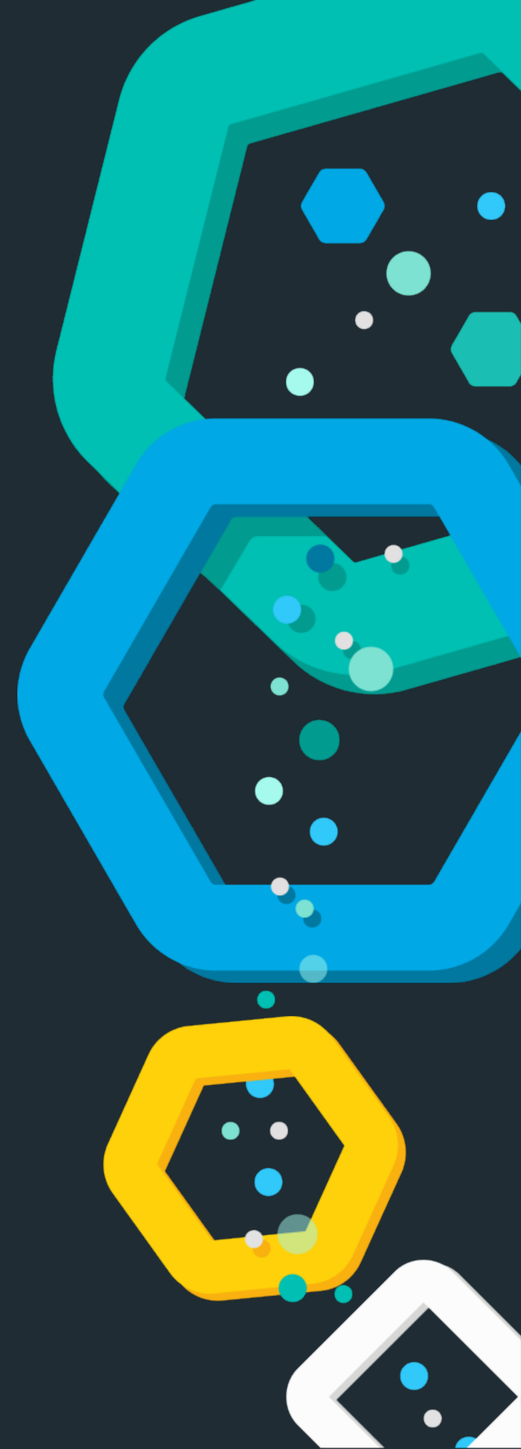
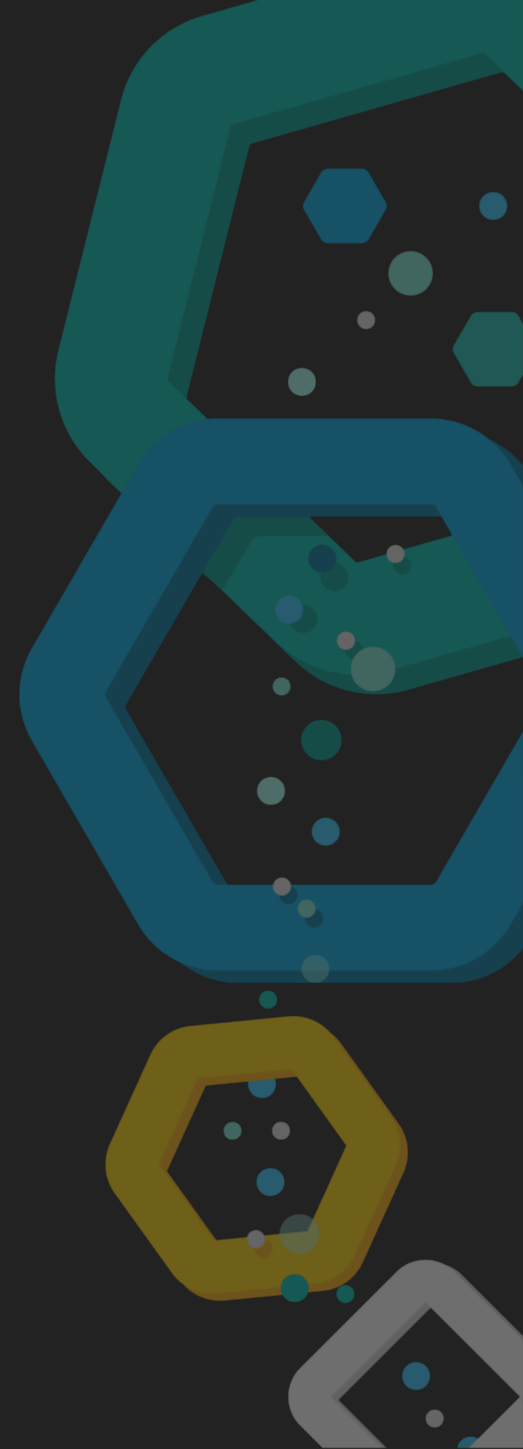
Google Cloud Run

- Serverless done 'right'?
- Docker container as a web application listening in $PORT
- Deployment model: **`docker push && gcloud beta run`**
- Easier to test
- Configurable concurrency
- Improved billing model due to concurrency



Demo



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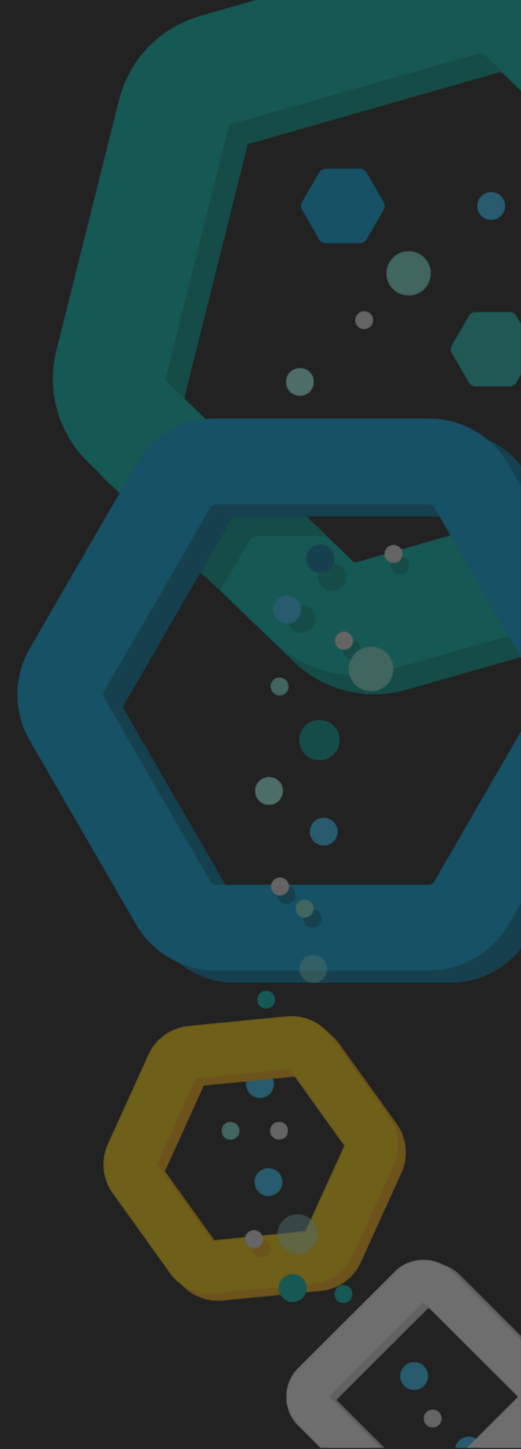
Summary



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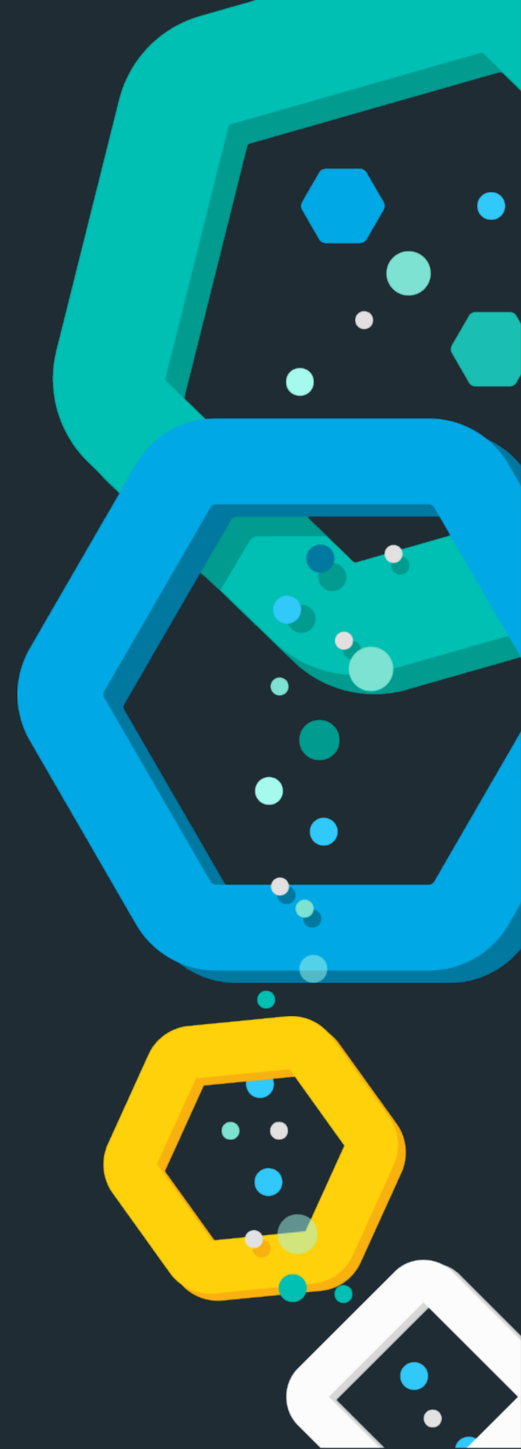
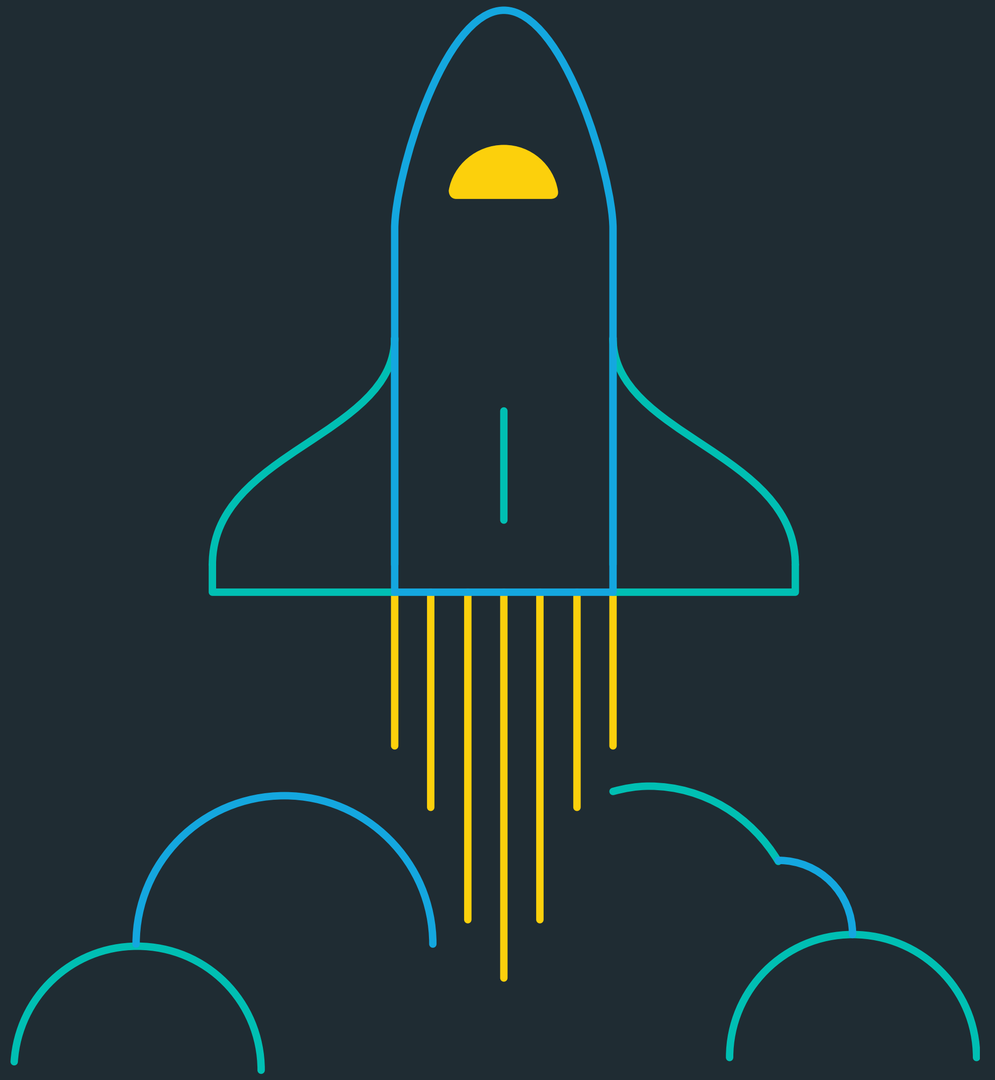
Summary

- Economics
  - Billing model
  - Runtime cost vs. development cost
  - Break even vs. non serverless model
- Development
  - Vendor lock-in
  - Deployment model is important
  - Cloud Run: Run serverless or as container
  - Scalability strategies, base load container, increased load serverless?
  - Observability



Discussion

… ask all the things!



Links

- https://serverless.com/framework/docs/
- https://www.openfaas.com
- https://cloud.google.com/knative/
- https://kubeless.io/
- https://fission.io/
- http://fnproject.io/
- https://nuclio.io
- https://openwhisk.incubator.apache.org/

- https://www.graalvm.org
- https://openjdk.java.net/projects/metropolis/
- https://github.com/oracle/graal/tree/master/substratevm

- https://en.wikipedia.org/wiki/Reverse_geocoding

https://noti.st/spinscale/ACCnKE/running-a-serverless-lucene-reverse-geocoder