PASS
Data Community
SUMMIT
2023

Postgres

Extensions Shape the Future

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bringing you data

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PASS Data Community SUMMIT 2023

Databases over time

- Postgres (2011)
- MS SQL (2008)
- Oracle (2008)
- MySQL (early 2000s)

Agenda

- What are Extensions?
- History of Postgres Extensions
- Tour of Extensions
- How Extensions are Built

This session should have been titled...

What can your database do for you?

What are Postgres Extensions?

“PostgreSQL stores much **more information in its catalogs**: not only information about tables and columns, but also **information about data types, functions, access methods**, and so on. These tables **can be modified by the user**, and since PostgreSQL bases its operation on these tables, this means that PostgreSQL can be extended by users.”

https://www.postgresql.org/docs/current/extend-how.html

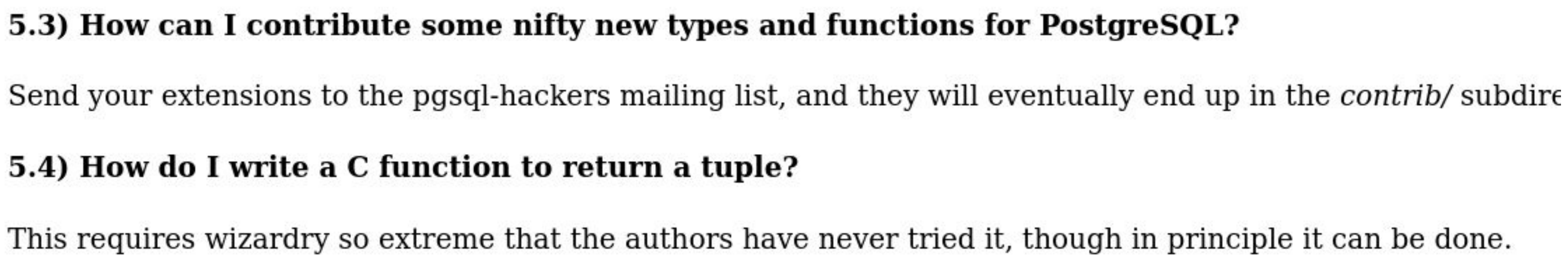
What are Postgres Extensions?

- Extensions customize Postgres
- Created in a database
- Some are included by default
- Some need installed (OS)

History of Extensions in Postgres

2000, circa Postgres 6.5.2

- Documentation had section for "Extending PostgreSQL"



5.3) How can I contribute some nifty new types and functions for PostgreSQL?

Send your extensions to the pgsql-hackers mailing list, and they will eventually end up in the *contrib/* subdire

5.4) How do I write a C function to return a tuple?

This requires wizardry so extreme that the authors have never tried it, though in principle it can be done.

http://web.archive.org/web/20000301082427fw_/http://www.postgresql.org/docs/faq-english.html

2000, circa Postgres 6.5.2

5.4) How do I write a C function to return a tuple?

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2001, circa Postgres 7.1

PostGIS enters the scene

> "Our most sophisticated developer, Dave Blasby, who had actually studied computer science, was unafraid of low-level languages"
>
> -- Paul Ramsey

https://blog.cleverelephant.ca/2021/05/postgis-20-years.html

2008: Postgres 8.3

- Extensions continued to grow in popularity
- 34 modules in Contrib
- Installed through `psql -f extension.sql`

https://www.postgresql.org/docs/8.3/contrib.html

2008: Postgres 8.3

- Extensions included:
  - dblink
  - fuzzystrmatch
  - hstore
  - pgcrypto

2011, Postgres 9.1

New Syntax!

```
CREATE EXTENSION postgis;
```

https://www.postgresql.org/docs/current/sql-createextension.html

https://wiki.postgresql.org/wiki/Extensions

2011-2013

- I migrated all MySQL databases to Postgres
- PostGIS was the catalyst

50 extensions available in Postgres 16

Included in `contrib/`

- auto_explain
- pg_stat_statements
- pg_prewarm
- file_fdw

https://www.postgresql.org/docs/16/contrib.html

Not all extensions included by default

- Extension has to be installed before you can create it!
- Often available via apt/yum
- May have to download package
- ... or Install from source
- Some have dependencies

```
sudo apt install postgresql-16-postgis-3
```

Tour of Extensions

What can your database do for you today?

Tour of Extensions

- 3rd party
- Not in Contrib
- Need to be Installed

PostGIS

- Data types
- Indexes
- Nearest neighbor
- Spatial analysis

https://postgis.net/

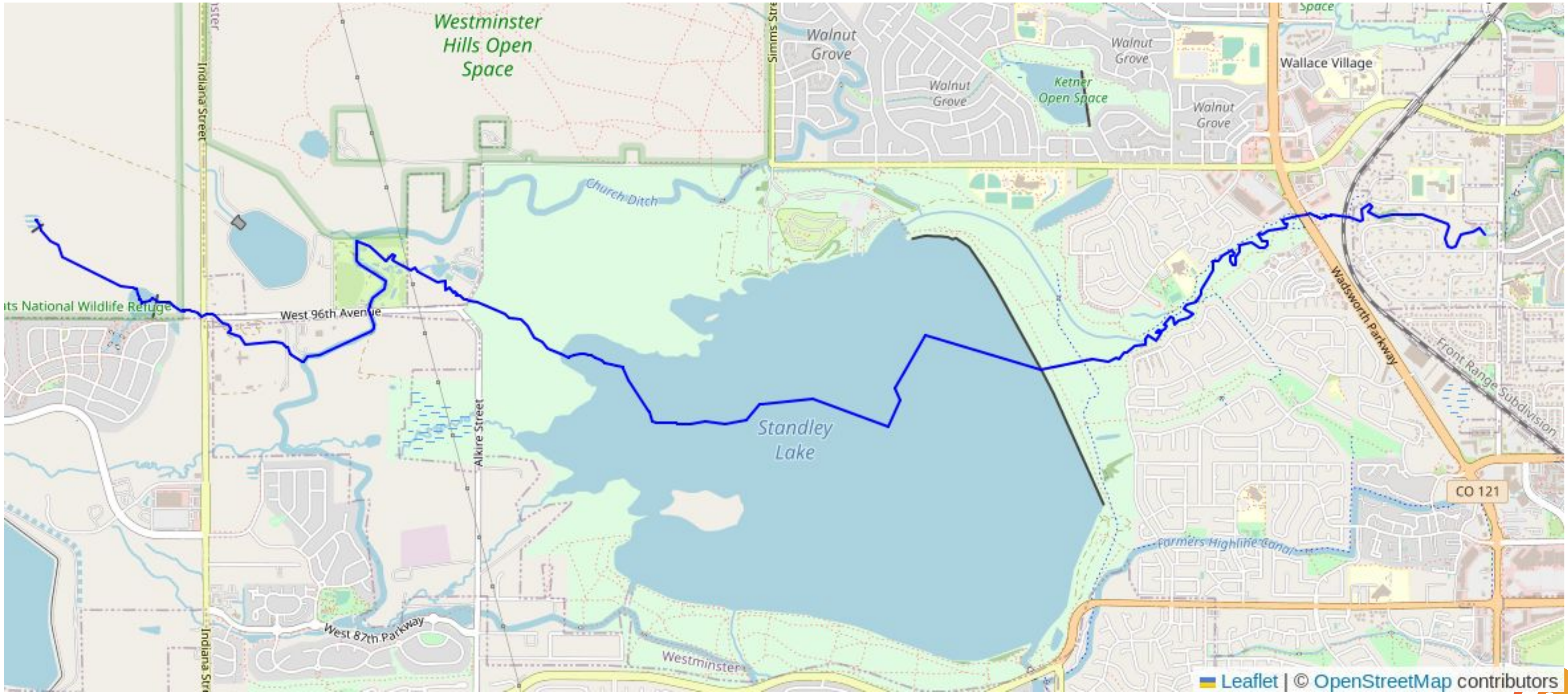
https://blog.rustprooflabs.com/category/postgis

PostGIS is a dependency for other extensions

- pgRouting
- MobilityDB
- h3-pg

https://blog.rustprooflabs.com/2022/11/route-the-interesting-things-postgis-day2022
https://blog.rustprooflabs.com/2023/08/postgis-mobility-db
https://blog.rustprooflabs.com/2023/05/postgis-h3-v4-refresh

PostGIS and pgRouting



TimescaleDB

- Focus on Timeseries data
- Partitioning (with automated management)
- Compression
- Continuous Aggregates

https://www.timescale.com/
https://blog.rustprooflabs.com/2021/08/timescale-compression-openstreetmap-tags

Foreign data wrappers (FDWs)

- Remote CSV files over internet
- SQLite databases

```
CREATE EXTENSION file_fdw;

CREATE EXTENSION sqlite_fdw;
```

https://blog.rustprooflabs.com/2021/02/postgresql-sqlite-fdw-pihole

https://blog.rustprooflabs.com/2020/03/postgresql-fdw-remote-file

More FDWs
(It doesn't matter where your data lives)

- ogr_fdw
- Supabase's Wrappers

https://www.crunchydata.com/blog/remote-access-anything-from-postgres

https://supabase.github.io/wrappers/

ZomboDB

- Full text search
- Indexes backed by ElasticSearch

https://www.zombodb.com/

Citus

- Sharding
- Distributed queries
- Columnar compression

https://www.citusdata.com/blog/2017/10/25/what-it-means-to-be-a-postgresql-extension/

https://www.citusdata.com/blog/2016/03/24/citus-unforks-goes-open-source/

How Extensions are Built

Any extension maintainers here?

👍 🤔 👎

How Extensions are Built

- Raw SQL
- C
- pgrx

Extensions in Raw SQL

- Not trivial to get started
- Not expert level either
- Lot of boilerplate code

Extensions in Raw SQL

- 2nd iteration of PgDD
- Clone & make install
- Challenging to support multiple Postgres versions

https://blog.rustprooflabs.com/2019/11/pgdd-now-postgresql-extension

Extensions in C

- Power-extensions were generally in C

__However...__

- Need to be good at C
- Need to understand Postgres' flavor of C
- Easy to crash Postgres

Extensions in C

"I just want to make stuff work, and I do ***not*** want to crash Postgres with my simple extension."

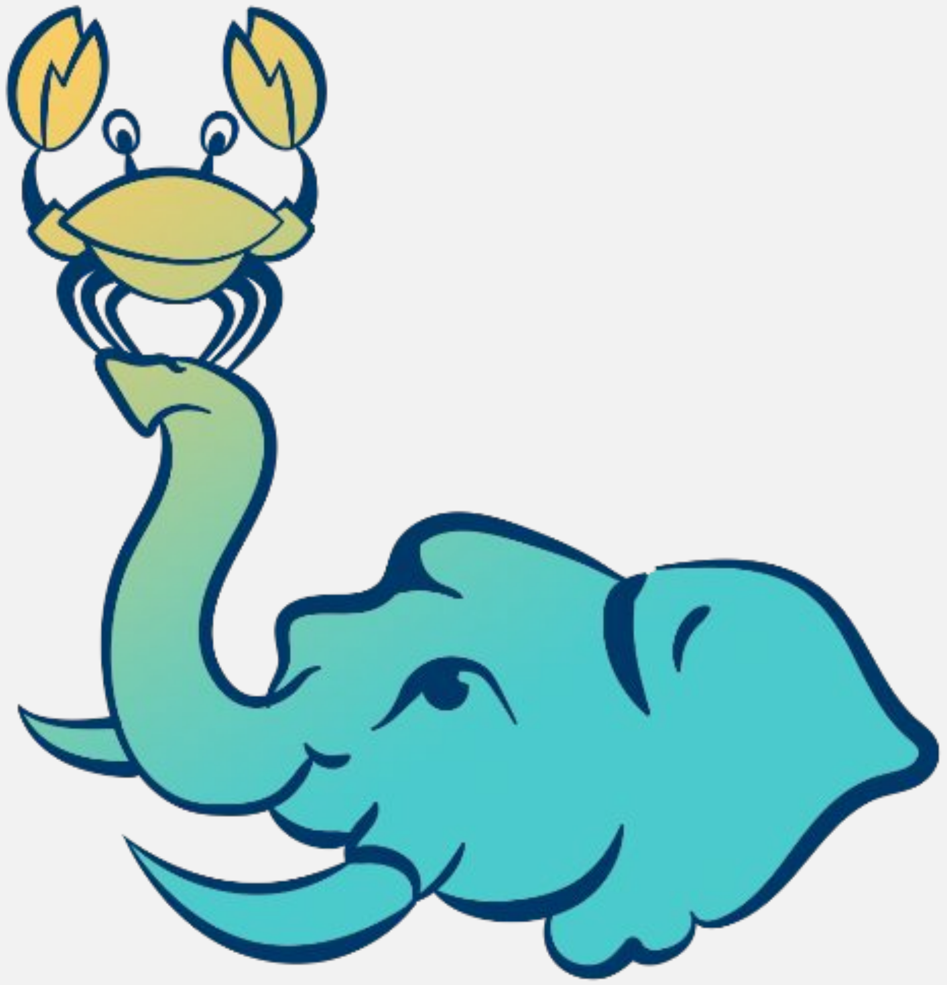
-- Me

https://blog.rustprooflabs.com/2021/10/pgdd-extension-using-pgx-rust

Extensions using `pgrx` framework

`pgrx` **framework**

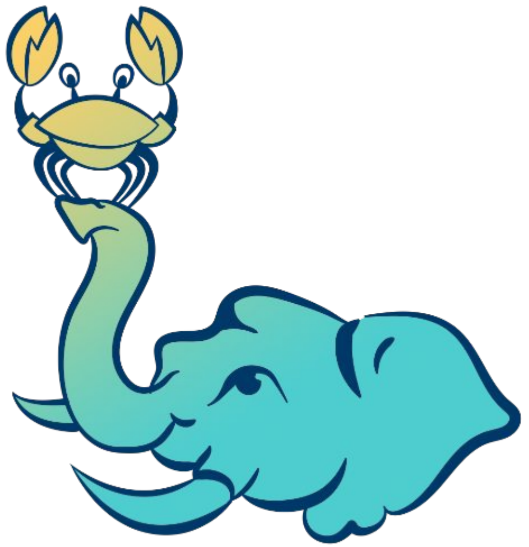
Use Rust in your database



https://github.com/pgcentralfoundation/pgrx

pgrx

- Automates boilerplate
- Encourages ideation and prototyping
- Feature flags for Postgres versions



```
cargo pgrx new
cargo pgrx run pg16
cargo pgrx test
```

pgrx

- Easy to make production ready

```
cargo pgrx package \
    --pg-config /usr/lib/postgresql/16/bin/pg_config
```

https://tcdioss.tcdi.com/blog/install-pgx-extensions

pgrx in the Wild

PostgresML

“SQL along with the most advanced machine learning algorithms and pretrained models in a high performance database.”

https://postgresml.org/

PostgresML 2.0 built on pgrx

“The more data we're dealing with, the bigger the improvement we see in Rust.”

“... Rust is about 10x faster than native SQL, embedded PL/pgSQL, and pure Python.”

https://postgresml.org/blog/postgresml-is-moving-to-rust-for-our-2.0-release

pgrx in the Wild

PL/Rust

“PL/Rust include writing natively-compiled functions to achieve the absolute best performance, access to Rust's large development ecosystem, and Rust's compile-time safety guarantees”

https://github.com/tcdi/plrust

PL/Rust

PL/Rust is available on AWS RDS!

> “... with performance benefits that are comparable to writing code in C without the risk of unsafe memory access.”

https://aws.amazon.com/blogs/database/build-high-performance-functions-in-rust-on-amazon-rds-for-postgresql/

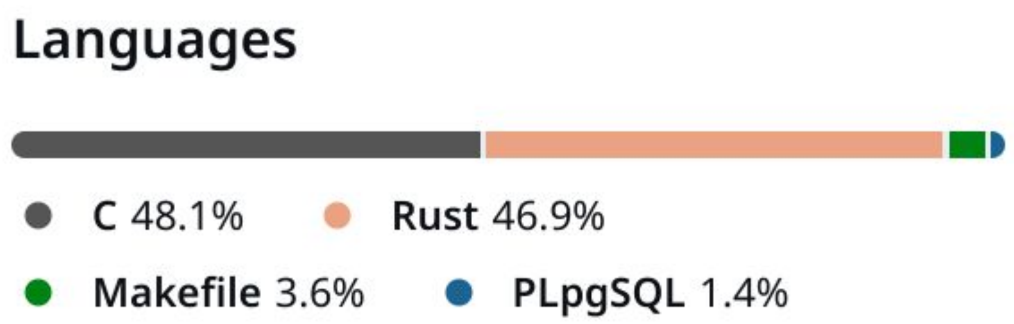
Why PL/Rust on RDS matters

- Limited extensions on RDS
- PL/Rust is built on pgrx
- AWS appears to trust the stack

pgrx in the Wild

pg_subxact_counters

- Extension written in C
- And pgrx!



https://bdrouvot.github.io/2023/07/30/rusting-a-new-postgres-c-extension-that-records-subtransactions-counters/

pgrx in the Wild

Supabase pg_graphql

- SQL schema to GraphQL
- One Function (to use)

https://supabase.github.io/pg_graphql/

“Little extensions”

“What I like to see are people using pgrx to solve a problem they have with their application. They need to talk to an S3 bucket so they put together a little pgrx extension for that.” – Eric Ridge, October 2023

https://open.spotify.com/episode/2s1wiM2S1zJVVCCJ4mduUt?si=441d4ea82922401b

My pgrx extensions

- PgDD 2021
- Convert 2022
- QR 2022 (Bad Idea)
- pgFaker 2023

PgDD moved to pgrx

PgDD moved to pgrx

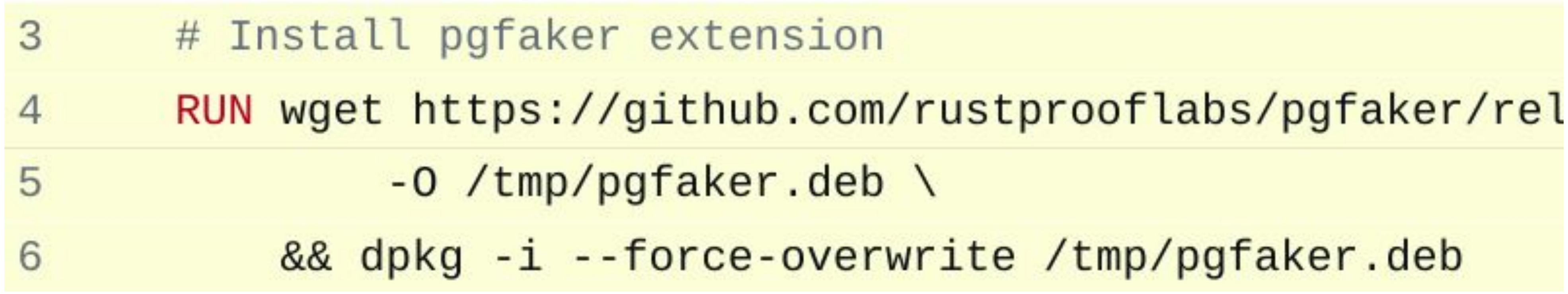
- Started experimenting
- ~~pgx~~ pgrx 0.0.14

> *"the team's obvious focus on making it easy to create Postgres extensions"*

https://blog.rustprooflabs.com/2021/10/pgdd-extension-using-pgx-rust

pgFaker

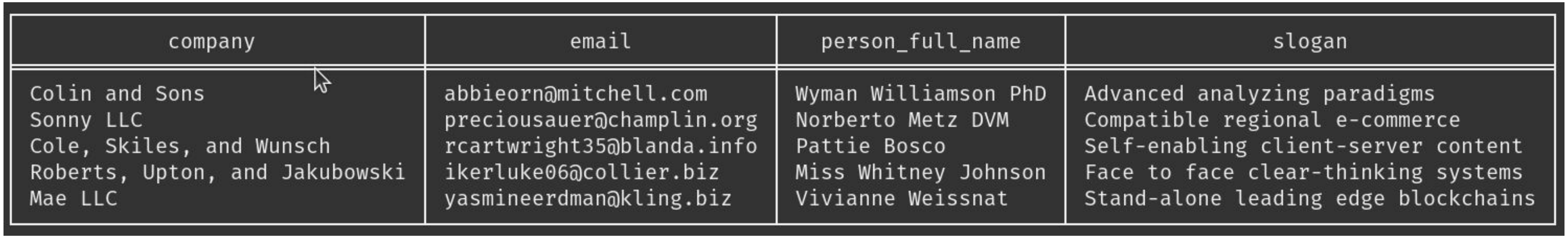
- Create fake text data
- Built to use in GeoFaker
  - https://github.com/rustprooflabs/geofaker/
- Easy to install



```
# Install pgfaker extension
RUN wget https://github.com/rustprooflabs/pgfaker/rel
        -O /tmp/pgfaker.deb \
    && dpkg -i --force-overwrite /tmp/pgfaker.deb
```

pgFaker

```
SELECT pgfaker.company(),
    pgfaker.email(), pgfaker.person_full_name(),
    pgfaker.slogan()
  FROM generate_series(1, 5);
```



```
            company            |            email            |   person_full_name   |              slogan
-------------------------------+-----------------------------+----------------------+------------------------------------
 Colin and Sons                | abbieorn@mitchell.com       | Wyman Williamson PhD | Advanced analyzing paradigms
 Sonny LLC                     | preciousauer@champlin.org   | Norberto Metz DVM    | Compatible regional e-commerce
 Cole, Skiles, and Wunsch      | rcartwright35@blanda.info   | Pattie Bosco         | Self-enabling client-server content
 Roberts, Upton, and Jakubowski| ikerluke06@collier.biz      | Miss Whitney Johnson | Face to face clear-thinking systems
 Mae LLC                       | yasmineerdman@kling.biz     | Vivianne Weissnat    | Stand-alone leading edge blockchains
```

Convert extension

- Common Conversions
  - Area - `convert.area_acre_to_mi2()`
  - Distance - `convert.dist_km_to_mi()`
  - Speed - `convert.speed_m_s_to_mph()`
  - Time to Travel - `convert.ttt_meters_m_s()`
  - Power - `convert.power_dbm_to_watts()`

Does it justify an extension?

Does it justify an extension?

- PgDD and Convert could both be implemented in pure SQL code
- Other Faker options exist
- In-DB QR code generation is just a bad idea

- Why make an extension?

QR codes in Postgres

It started with a phone call…

QR codes in Postgres

It turned into an extension!

```
CREATE EXTENSION qr;

SELECT qr.generate_qr(

  'https://localhost', 'product', '1'

  );
```

https://github.com/rustprooflabs/qr

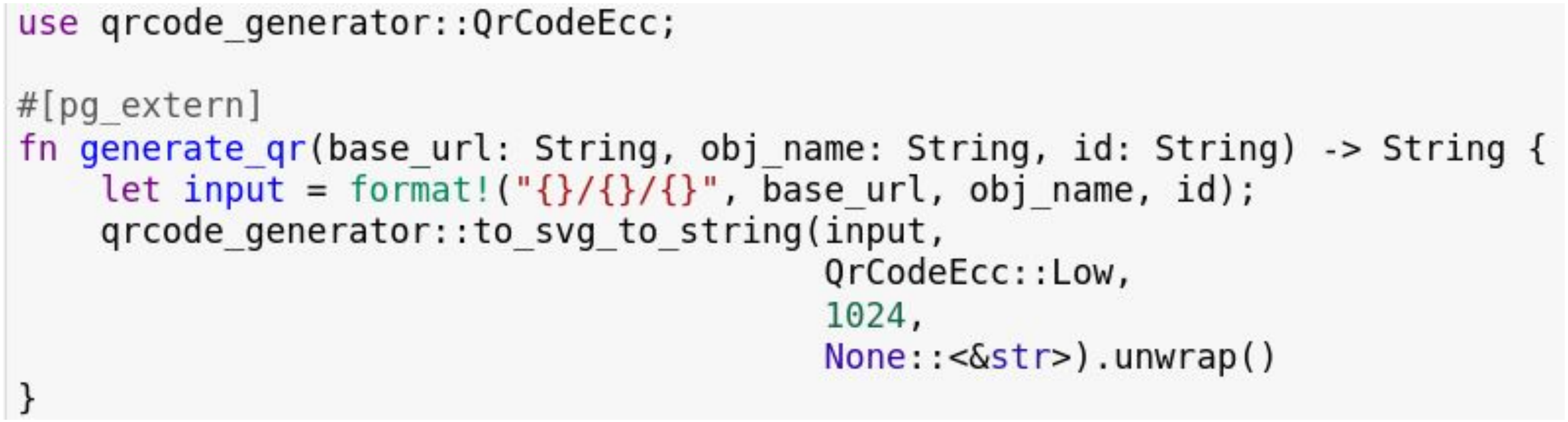
Creating qr extension

- Used `pgrx`
- Took roughly an hour

Compare against 2000: “extreme wizardry” to return a tuple!

lib.rs

This is the entirety of the custom code!



```rust
use qrcode_generator::QrCodeEcc;

#[pg_extern]
fn generate_qr(base_url: String, obj_name: String, id: String) -> String {
    let input = format!("{}/{}/{}", base_url, obj_name, id);
    qrcode_generator::to_svg_to_string(input,
                                       QrCodeEcc::Low,
                                       1024,
                                       None::<&str>).unwrap()
}
```

Does it justify an extension?

If the QR code extension turned out to be "the right solution", it was easy to make it production ready.

https://tcdioss.tcdi.com/blog/install-pgx-extensions

Does it Justify an extension?

- The `qr` extension is a generally bad idea!
- I did it anyway
- Development cost with `pgrx` is tiny!

Cost versus Benefit

- We're curious people
- Silly ideas are worth playing with

Some “silly ideas” turn out to be pretty great

Error handling

“If the result is `Err`, then pgrx will automatically raise a Postgres `ERROR`. A pgrx `ErrorReport` can include a specific SQL error code, detail, hint, and context message.”

https://tcdioss.tcdi.com/blog/pgx-0-7-0-spi-changes

What will your database do for you tomorrow?

New in past 2 years

Powerful new(ish) extensions

- PL/Rust (2023)
- PostgresML (2022)
- Supabase Wrappers (2022)
- Timescale-DB Toolkit (2021)

https://github.com/pgcentralfoundation/pgrx/network/dependents

What will the next 2 years bring?

What will you build?

- Boilerplate automated
- Built-in safety
- Performance of Compiled

Session evaluation

Your feedback is important to us

Evaluate this session at:

www.PASSDataComminitySummit.com/evaluation

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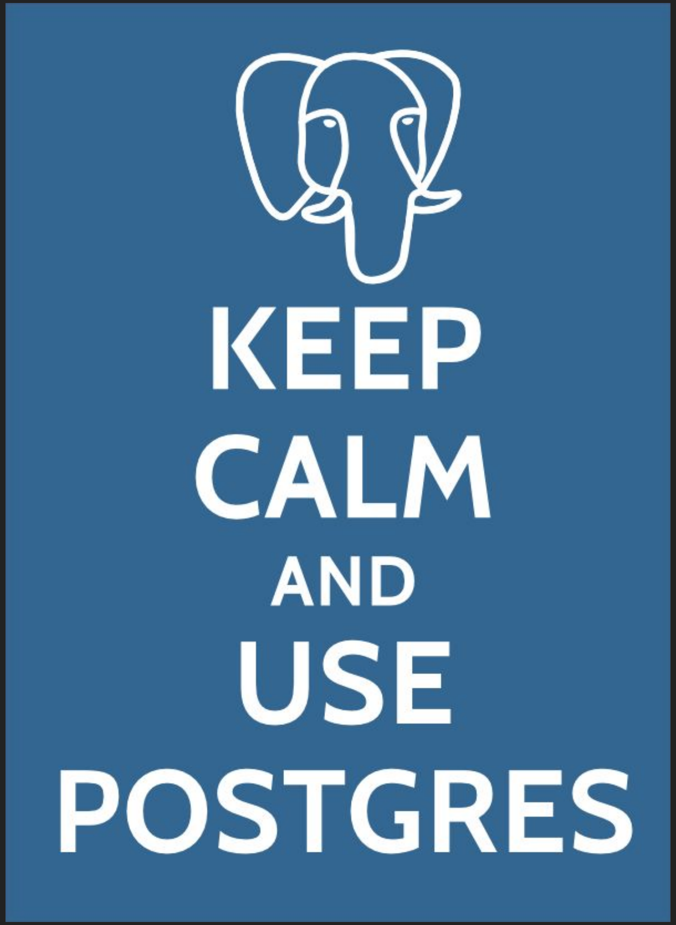
Thank you



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