SQLGitHub

MANAGING GITHUB ORGANIZATION MADE EASIER

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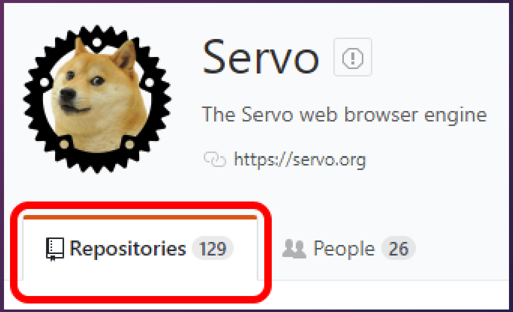
SQLGitHub – Motivation (I)

- There are very limited tools for managing GitHub organizations
- Open-source organizations are usually understaffed
- The Servo project on GitHub for example,
  contains 129 repositories
  managed by practically **1 person**.


Servo
The Servo web browser engine
https://servo.org

SQLGitHub – Background

Organization

Repository

- Commits
- Issues
- Pull Requests
- …

Repository

- Commits
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- Commits
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- …

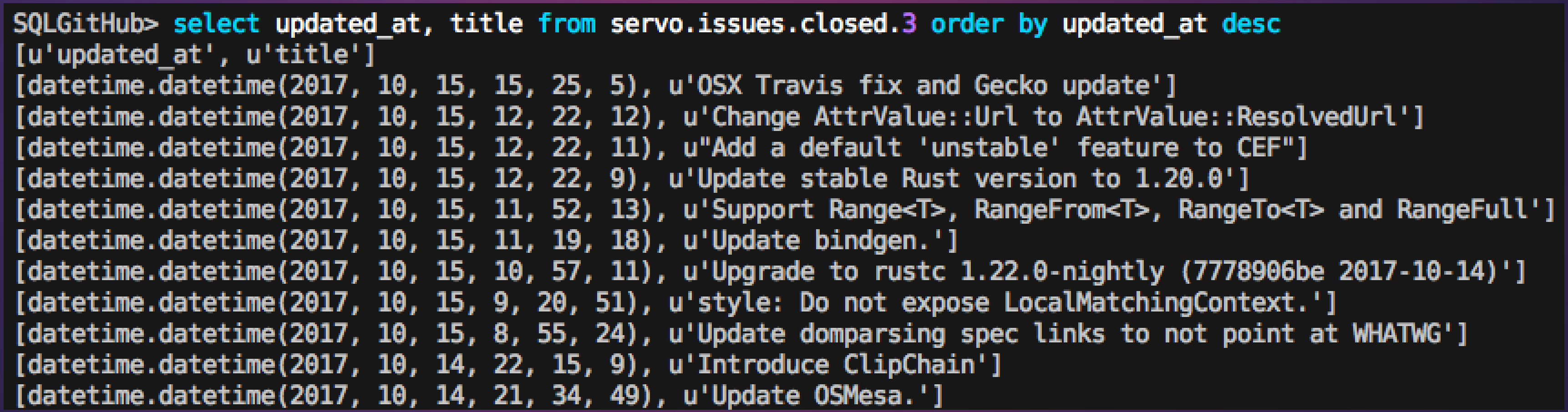
https://help.github.com/articles/github-glossary/

SQLGitHub – Motivation (II)

- Common tasks for an organization administrator usually involves obtaining certain metrics of the organization in human or machine-friendly format for post-processing. The specific tasks may include:
  - Get the current list of projects hosted on GitHub
  - List of the current repositories in the organization ordered by popularity
  - Get the list of issues closed (resolved) for the past 7 days
  - What are the critical issues that are still left open?
  - Who are the top contributors of the past month?
  - … endless possible questions

Abstract

- SQLGitHub features a SQL-like syntax that allows you to: **Query information about an organization as a whole**.
- You may also think of it as a better, enhanced frontend layer built on top of GitHub's RESTful API



```
SQLGitHub> select updated_at, title from servo.issues.closed.3 order by updated_at desc
[u'updated_at', u'title']
[datetime.datetime(2017, 10, 15, 15, 25, 5), u'OSX Travis fix and Gecko update']
[datetime.datetime(2017, 10, 15, 12, 22, 12), u'Change AttrValue::Url to AttrValue::ResolvedUrl']
[datetime.datetime(2017, 10, 15, 12, 22, 11), u"Add a default 'unstable' feature to CEF"]
[datetime.datetime(2017, 10, 15, 12, 22, 9), u'Update stable Rust version to 1.20.0']
[datetime.datetime(2017, 10, 15, 11, 52, 13), u'Support Range<T>, RangeFrom<T>, RangeTo<T> and RangeFull']
[datetime.datetime(2017, 10, 15, 11, 19, 18), u'Update bindgen.']
[datetime.datetime(2017, 10, 15, 10, 57, 11), u'Upgrade to rustc 1.22.0-nightly (7778906be 2017-10-14)']
[datetime.datetime(2017, 10, 15, 9, 20, 51), u'style: Do not expose LocalMatchingContext.']
[datetime.datetime(2017, 10, 15, 8, 55, 24), u'Update domparsing spec links to not point at WHATWG']
[datetime.datetime(2017, 10, 14, 22, 15, 9), u'Introduce ClipChain']
[datetime.datetime(2017, 10, 14, 21, 34, 49), u'Update OSMesa.']
```

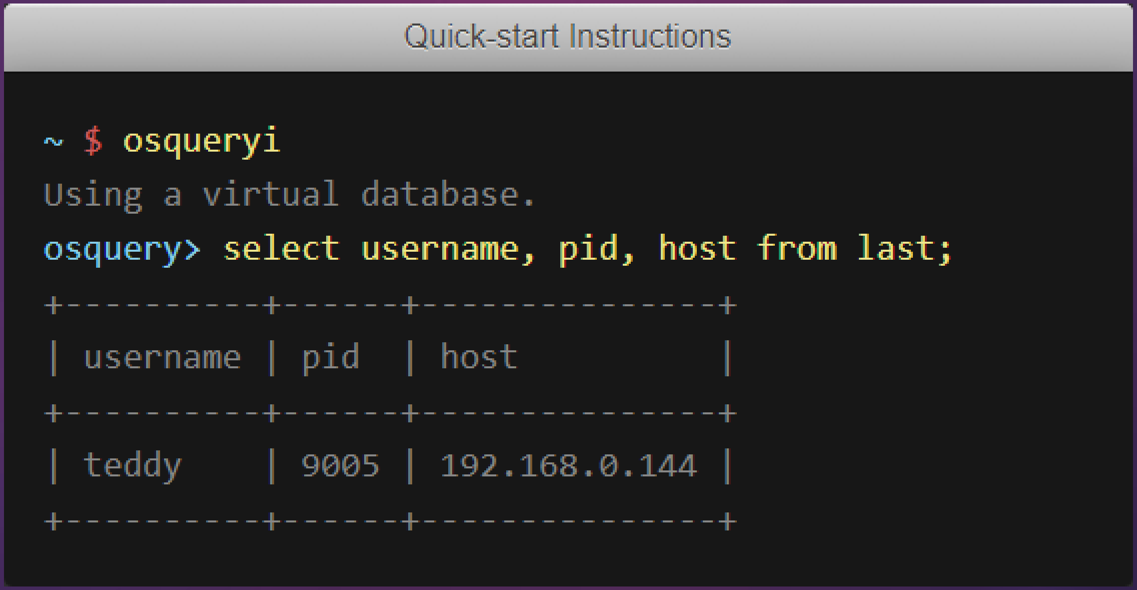
SQLGitHub – Motivation (III)

- For each of the listed tasks, it would take roughly the following steps:
  1. Utilize libraries for HTTP requests and JSON manipulation
  2. Obtain API key from GitHub
  3. Lookup API reference to find the needed API URIs
  4. Authenticate with obtained API key
  5. List all repositories within the organization
  6. For each repository, list all needed targets (e.g. Issues, commits …etc.)
  7. Navigate through the complex structure of targets to extract wanted information
  8. Aggregate extracted data
  9. Filter by hardcoded conditions
  10. Output information in friendly format
- The above steps would take roughly a week (2400 minutes) for an ordinary developer without experience with GitHub APIs.
- Using our tool SQLGitHub, the process would be simplified to something like this:
  1. Obtain API key from GitHub
  2. Lookup required information from the reference
  3. Launch SQLGitHub and enter SQL query
- The above steps would take less than 20 minutes for someone with knowledge of basic SQL (about 120x speedup).

Related Work

osquery

- SQL powered operating system instrumentation, monitoring, and analytics.


Quick-start Instructions

```
~ $ osqueryi
Using a virtual database.
osquery> select username, pid, host from last;
+----------+------+---------------+
| username | pid  | host          |
+----------+------+---------------+
| teddy    | 9005 | 192.168.0.144 |
+----------+------+---------------+
```

Introduction – Supported Schema

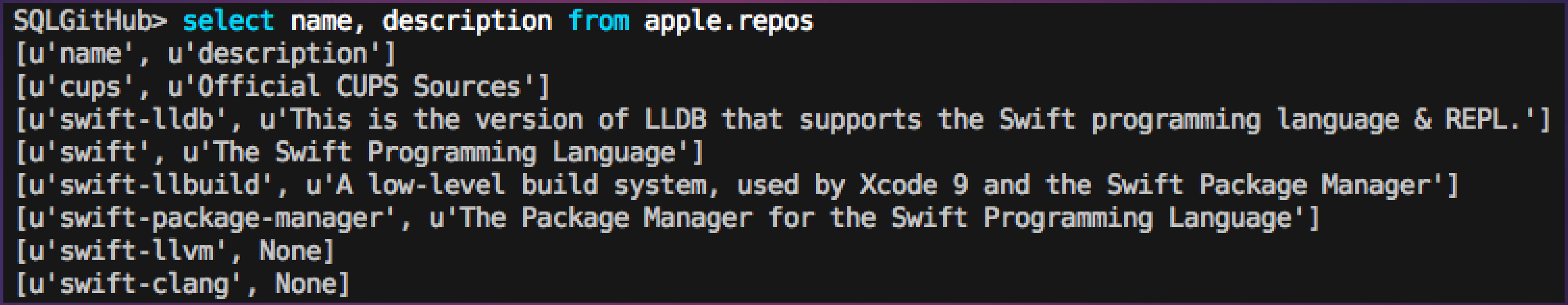
- **SELECT**
    select_expr [, select_expr ...]
    [**FROM** {org_name | org_name.{repos | issues | pulls | commits}}]
    [**WHERE** where_condition]
    [**GROUP BY** {col_name | expr} [ASC | DESC], ...]
    [**HAVING** where_condition]
    [**ORDER BY** {col_name | expr} [ASC | DESC], ...]
    [**LIMIT** row_count]

Introduction – Suppored Functions

- String Functions:
  - "concat", "concat_ws", "find_in_set", "insert", "instr", "length", "locate", "lcase", "lower", "left", "mid", "repeat", "right", "replace", "strcmp", "substr", "substring", "ucase", “upper"
- Numeric Functions:
  - "avg", "count", "max", "min", “sum", "abs", "ceil", "ceiling", "exp", "floor", "greatest", "least", "ln", "log", "pow", "power", "sign", "sqrt"
- Date & Advanced Functions:
  - "curdate", "current_date", "current_time", "current_timestamp", "curtime", "localtime", "localtimestamp", "now", “bin"

Introduction – Use Case (I)

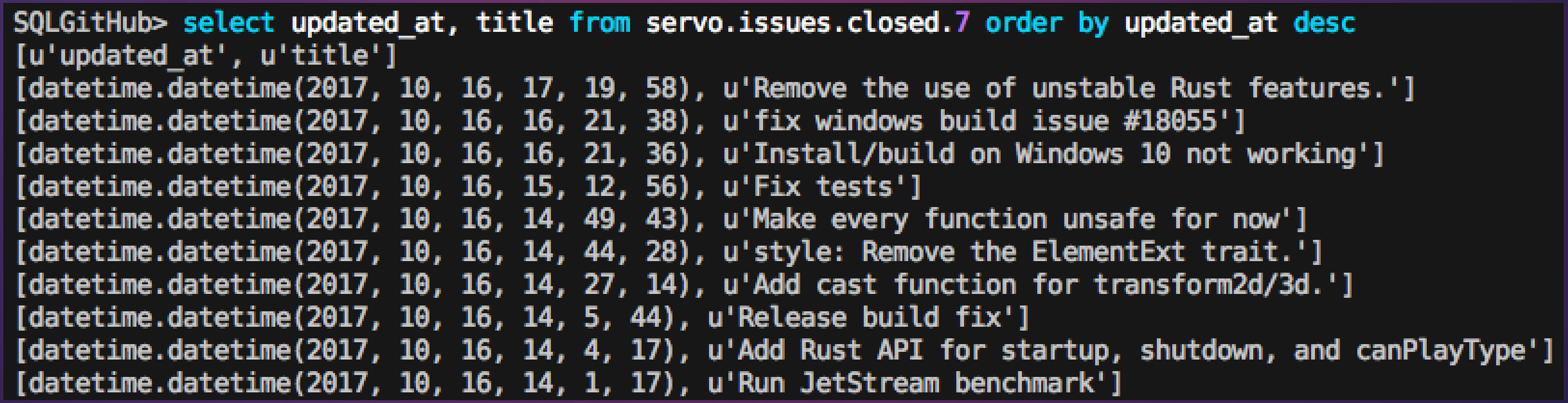
- Get name and description from all the repos in apple.
  - select name, description from apple.repos



```
SQLGitHub> select name, description from apple.repos
[u'name', u'description']
[u'cups', u'Official CUPS Sources']
[u'swift-lldb', u'This is the version of LLDB that supports the Swift programming language & REPL.']
[u'swift', u'The Swift Programming Language']
[u'swift-llbuild', u'A low-level build system, used by Xcode 9 and the Swift Package Manager']
[u'swift-package-manager', u'The Package Manager for the Swift Programming Language']
[u'swift-llvm', None]
[u'swift-clang', None]
```

Introduction – Use Case (II)

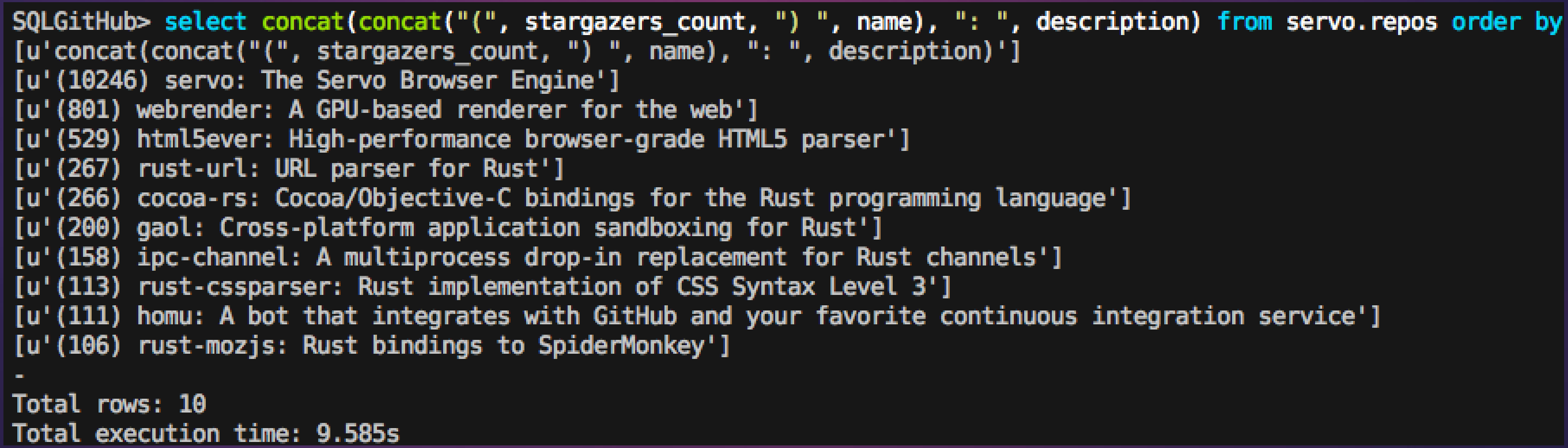
- Get last-updated time and title of the issues closed in the past week (7 days) in servo listed in descending order of last-updated time.
  - select updated_at, title from servo.issues.closed.7 order by updated_at desc



```
SQLGitHub> select updated_at, title from servo.issues.closed.7 order by updated_at desc
[u'updated_at', u'title']
[datetime.datetime(2017, 10, 16, 17, 19, 58), u'Remove the use of unstable Rust features.']
[datetime.datetime(2017, 10, 16, 16, 21, 38), u'fix windows build issue #18055']
[datetime.datetime(2017, 10, 16, 16, 21, 36), u'Install/build on Windows 10 not working']
[datetime.datetime(2017, 10, 16, 15, 12, 56), u'Fix tests']
[datetime.datetime(2017, 10, 16, 14, 49, 43), u'Make every function unsafe for now']
[datetime.datetime(2017, 10, 16, 14, 44, 28), u'style: Remove the ElementExt trait.']
[datetime.datetime(2017, 10, 16, 14, 27, 14), u'Add cast function for transform2d/3d.']
[datetime.datetime(2017, 10, 16, 14, 5, 44), u'Release build fix']
[datetime.datetime(2017, 10, 16, 14, 4, 17), u'Add Rust API for startup, shutdown, and canPlayType']
[datetime.datetime(2017, 10, 16, 14, 1, 17), u'Run JetStream benchmark']
```

Introduction – Use Case (III)

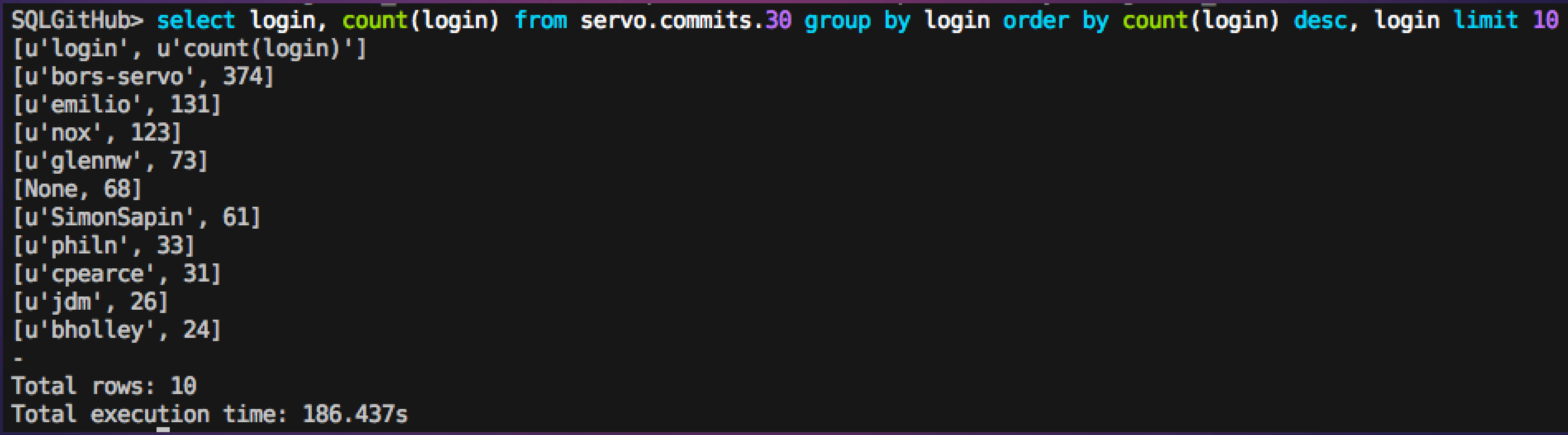
- Get top 10 most-starred repositories in servo.
  - select concat(concat("(", stargazers_count, ") ", name), ": ", description) from servo.repos order by stargazers_count desc, name limit 10



```
SQLGitHub> select concat(concat("(", stargazers_count, ") ", name), ": ", description) from servo.repos order by
[u'concat(concat("(", stargazers_count, ") ", name), ": ", description)']
[u'(10246) servo: The Servo Browser Engine']
[u'(801) webrender: A GPU-based renderer for the web']
[u'(529) html5ever: High-performance browser-grade HTML5 parser']
[u'(267) rust-url: URL parser for Rust']
[u'(266) cocoa-rs: Cocoa/Objective-C bindings for the Rust programming language']
[u'(200) gaol: Cross-platform application sandboxing for Rust']
[u'(158) ipc-channel: A multiprocess drop-in replacement for Rust channels']
[u'(113) rust-cssparser: Rust implementation of CSS Syntax Level 3']
[u'(111) homu: A bot that integrates with GitHub and your favorite continuous integration service']
[u'(106) rust-mozjs: Rust bindings to SpiderMonkey']
-
Total rows: 10
Total execution time: 9.585s
```

Introduction – Use Case (IV)

- Get top 10 contributors in servo for the past month (30 days) based on number of commits.
  - select login, count(login) from servo.commits.30 group by login order by count(login) desc, login limit 10



```
SQLGitHub> select login, count(login) from servo.commits.30 group by login order by count(login) desc, login limit 10
[u'login', u'count(login)']
[u'bors-servo', 374]
[u'emilio', 131]
[u'nox', 123]
[u'glennw', 73]
[None, 68]
[u'SimonSapin', 61]
[u'philn', 33]
[u'cpearce', 31]
[u'jdm', 26]
[u'bholley', 24]
-
Total rows: 10
Total execution time: 186.437s
```

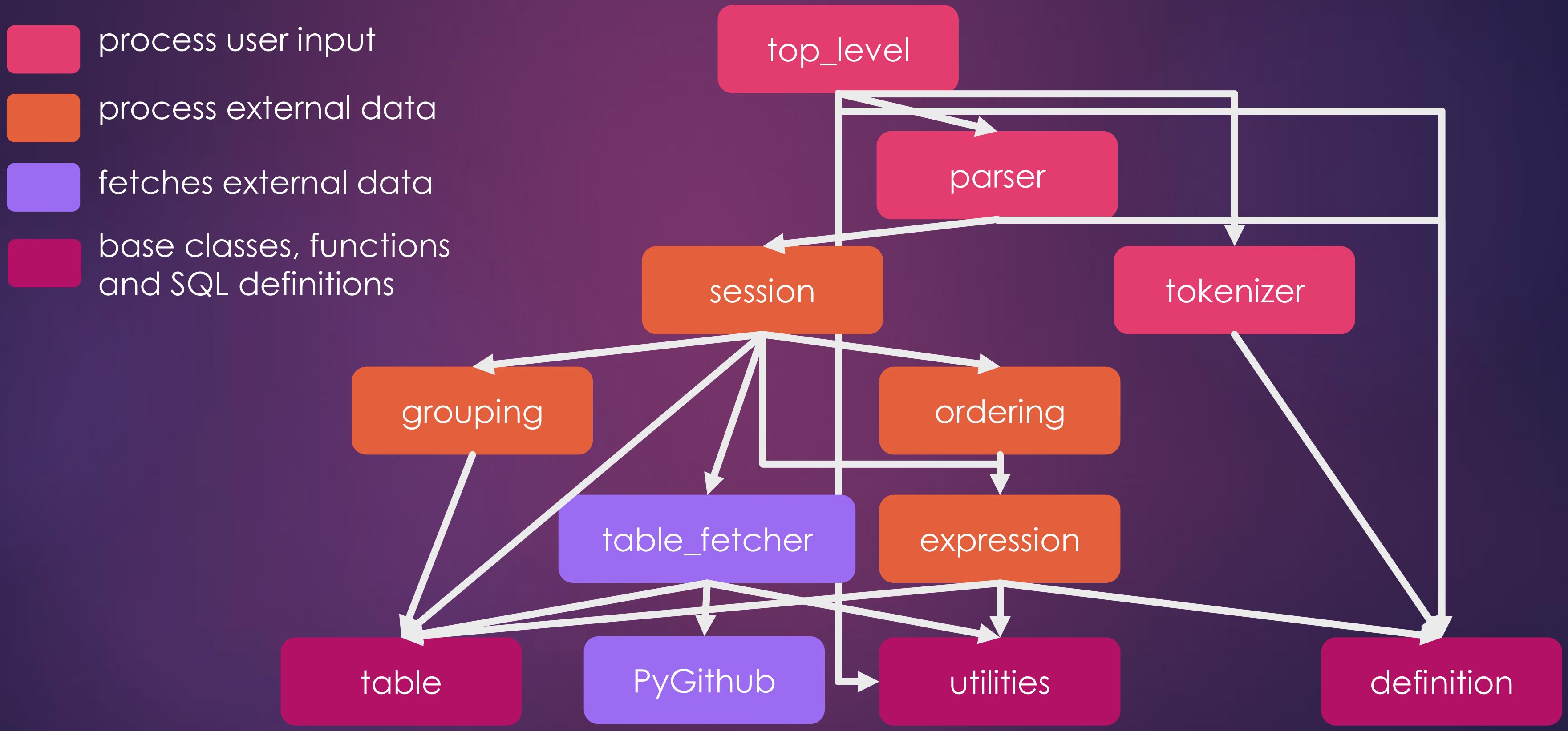
Introduction – Technology Stack

- **Python**
- **re** & **regex**, regular expression libraries
- **PyGithub** (patched), an unofficial client library for GitHub API
- prompt_toolkit, a library for building prompts
- pygments, a library for syntax highlighting

Introduction – (Simplified) Flow

Fetch data (**from**)	Fetch data with required fields from GitHub API
Filter by **where** conditions	Evaluate where conditions and filter fetched data
Evaluate partial exprs	Evaluate group exprs and other “field” exprs
Group by group exprs	Generate table groups by values of group exprs
Filter by **having** conditions	Evaluate having conditions and filter tables
Order by order exprs	Sort within and between tables
Evaluate **select** exprs	Evaluate select exprs

Introduction – Architecture



Introduction – Challenges (I)

- Algorithm of parsing is almost identical to that of expression evaluation → waste of time
- Lazy Parsing: Only parse **clauses** (eg. select, from, where) and **comma-separated fields**
- Comma-separated fields, strings and escape characters
  Evaluate this: `concat("[)\"Stars\"(: ", stargazers_count)`
- concat("[)\"Stars\"(: ", stargazers_count)
  concat("[)\"Stars\"(: ", stargazers_count)
- concat("[)\"Stars\"(: ", stargazers_count)

Introduction – Challenges (II)

- No local indexed stroe
- Need to extract all relevant fields from expressions to fetch at once
- select concat("[)\"-> avg(stargazers_count)\"(: ", **stargazers_count** - avg(**stargazers_count**), "] ", name) from apple.repos where **description** like "%library%" order by **id**
- Algorithm: for each expression,
  - Remove all literal strings. Use **r"\"(?:[^\\\"]|\\.)*\""** to match.
  - Find all possible tokens with **r"([a-zA-Z_]+)(?:[^\(a-zA-Z_]|$)"**.
  - For each token, check if it's a predefined token (ie. part of SQL).

Introduction – Challenges (III)

- Expression Evaluation is really complicated
  - Regular (eg. concat, floor) and Aggregate functions (eg. max, min)
    - Have to evaluate an entire table at once
  - Nested functions (eg. sum(avg(field_a) + avg(field_b)))
    - Use **recursive regex patterns** to extract tokens – r"**\((?:(?>[^\(\)]+|(?R))*)\)**"
    - Assign special precedence and insert extra logic in place
  - Operator Precedence
- **Modified 2-stack evaluation approach** +
- **Finite State Machine + One-token Lookahead**

Introduction – Challenges (IV)

- Python's built-in sort is not customizable:
  sorted(*iterable*, *, *key*=*None*, *reverse*=*False*)
- order by requires sorting with multiple keys each with potentially different reverse:
  order by field_a desc, field_b asc, field_c, desc
- Wrote **custom sort** that integrates better with the workflow

Results

- Significance
  - Useful for GitHub organization owners: Shortened the time needed for maintenance tasks by 120x
  - An easier-to-use, better and more versatile API frontend
  - High customizability thanks to good compatibility with SQL
  - Modularized, can be reused/integrated as a library
  - Better efficiency and security if integrated on servers
- Cons
  - Slow (information is retrieved over the internet + RESTful API) Migrate to GitHub API V4 (GraphQL backend) would help, but this would sacrifice functionalities as the new API is far from backwards-compatible to GitHub API V3.

Future Directions

- Improve it to production quality by refactoring code base and writing tests
- Promote to more GitHub organization owners
- Extend to end users not just organizations
- Implement an experimental GraphQL backend (GitHub API v4)
- Implement this concept directly on an API server end (better efficiency and perhaps better security!)

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