escape

GraphQL Vulnerabilities in the Wild

What scanning real-life GraphQL apps told us
about exploiting GraphQL in Production

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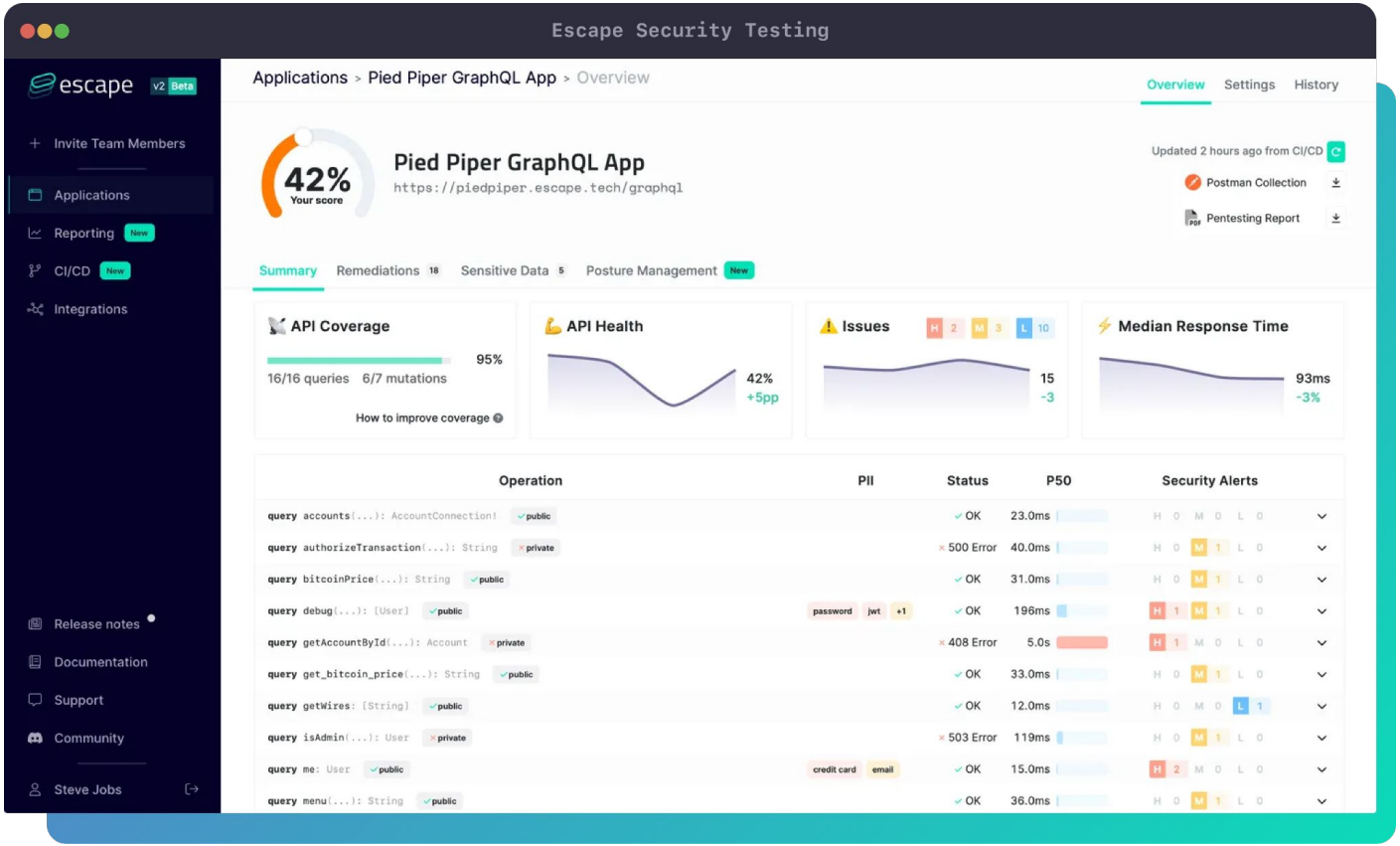
About Escape.tech

First automated Security Testing platform (DAST) able to test the business logic of APIs and GraphQL.



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1599

production APIs scanned

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1599

production APIs scanned

416

cumulative scan hours

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1599

production APIs scanned

416

cumulative scan hours

46,809

security alerts found

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30

Security alerts per GraphQL app on average

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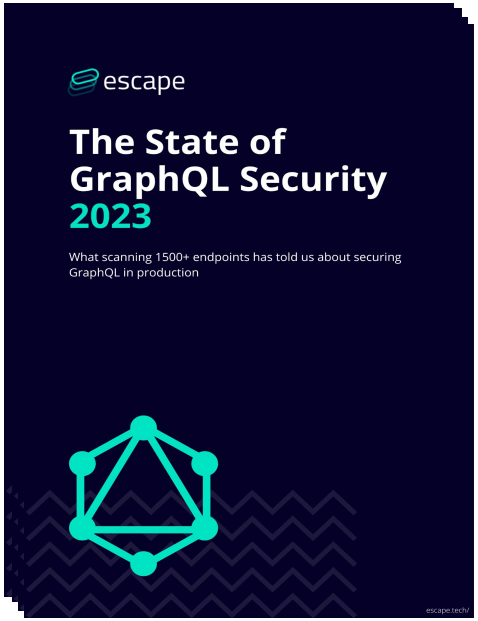

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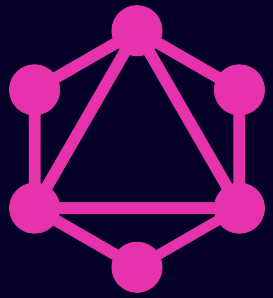

Why is GraphQL vulnerable?

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GraphQL is a query language for APIs

PELOTON NETFLIX The New York Times Walmart PayPal

nerdwallet expedia group glassdoor priceline

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Why is GraphQL vulnerable?

1 – GraphQL is a full-featured language...

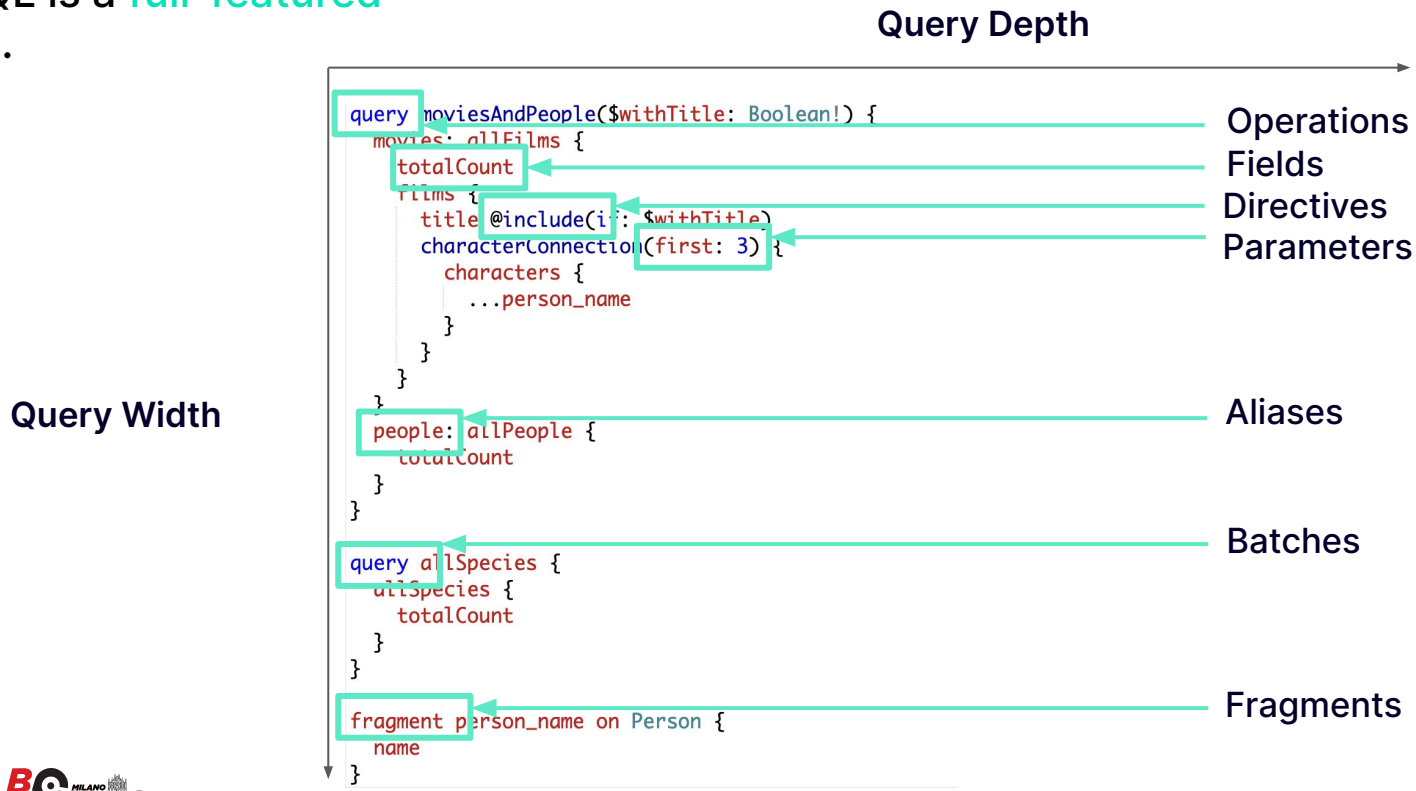
```
query moviesAndPeople($withTitle: Boolean!) {
  movies: allFilms {
    totalCount
    films {
      title @include(if: $withTitle)
      characterConnection(first: 3) {
        characters {
          ...person_name
        }
      }
    }
  }
  people: allPeople {
    totalCount
  }
}

query allSpecies {
  allSpecies {
    totalCount
  }
}

fragment person_name on Person {
  name
}
```

Why is GraphQL vulnerable?

1 – GraphQL is a full-featured language...



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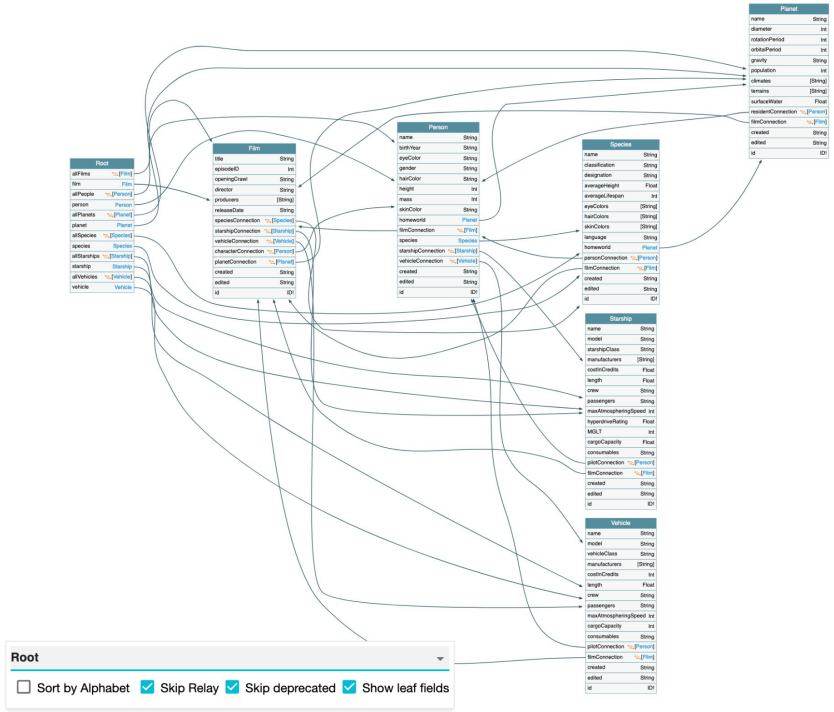
Why is GraphQL vulnerable?

2 - GraphQL is a graph... with a lot of different paths leading to the same resource



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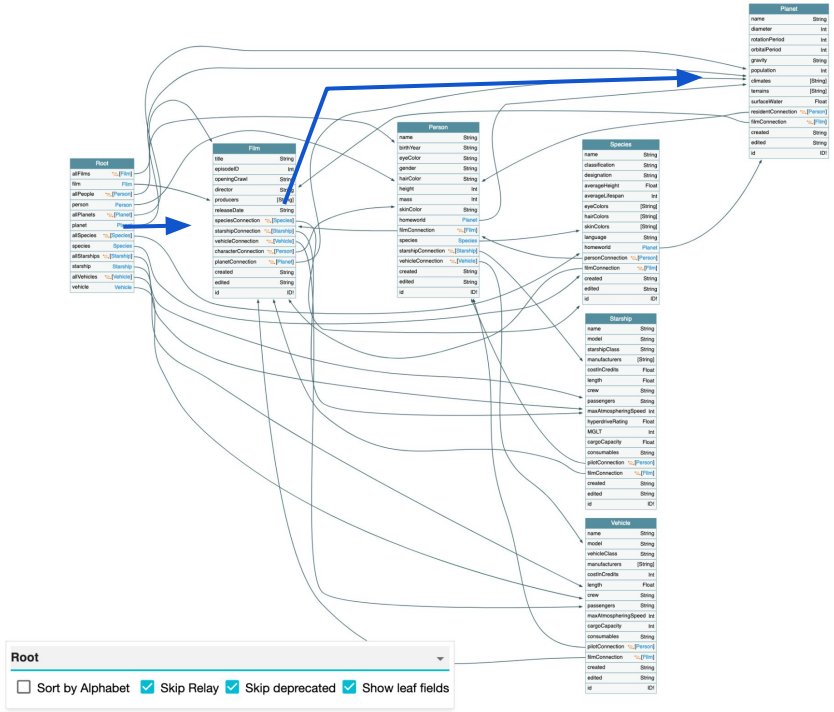

1. stripe_token

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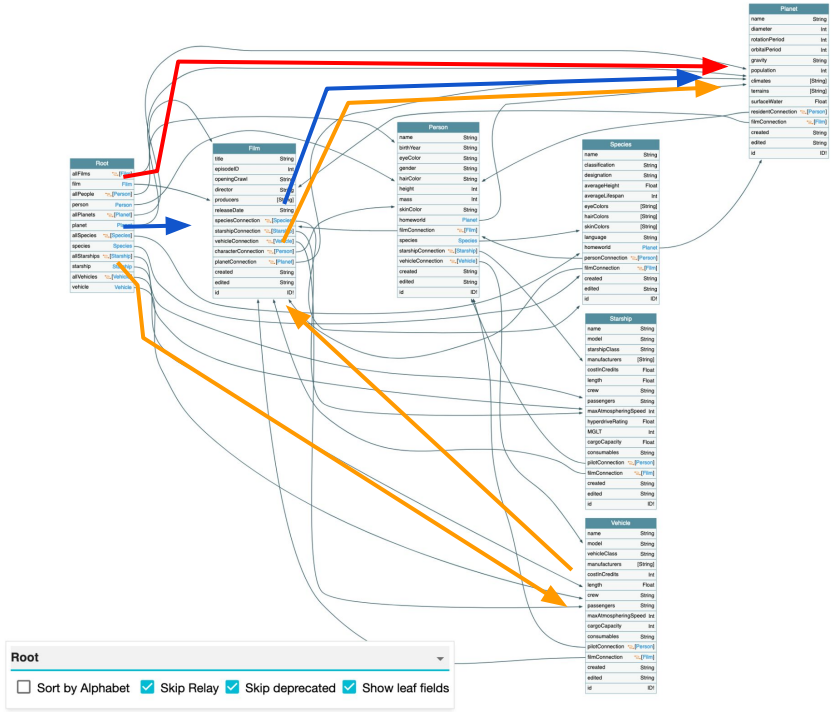

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Why is GraphQL vulnerable?

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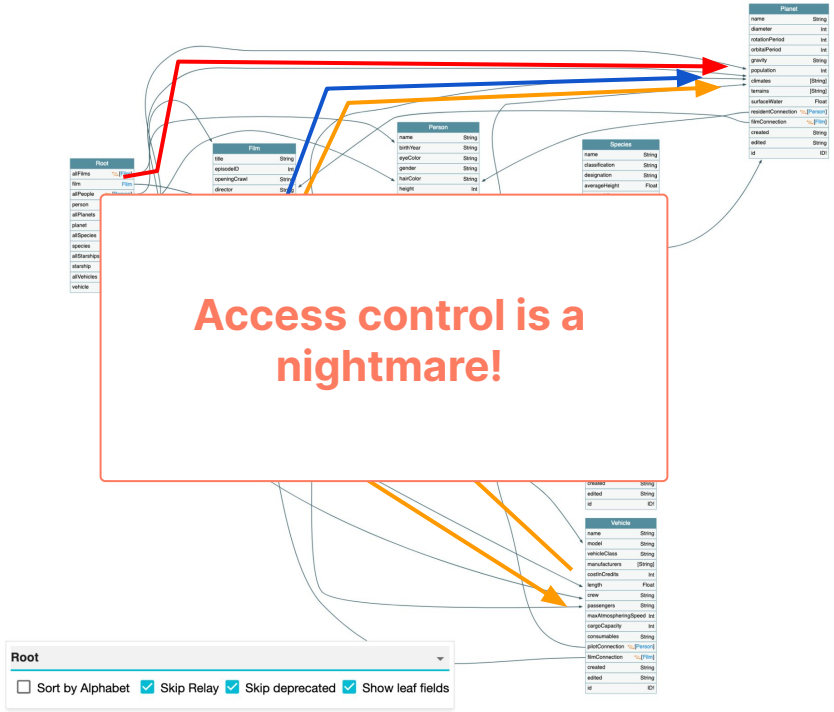

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Why is is hard to test production GraphQL apps?

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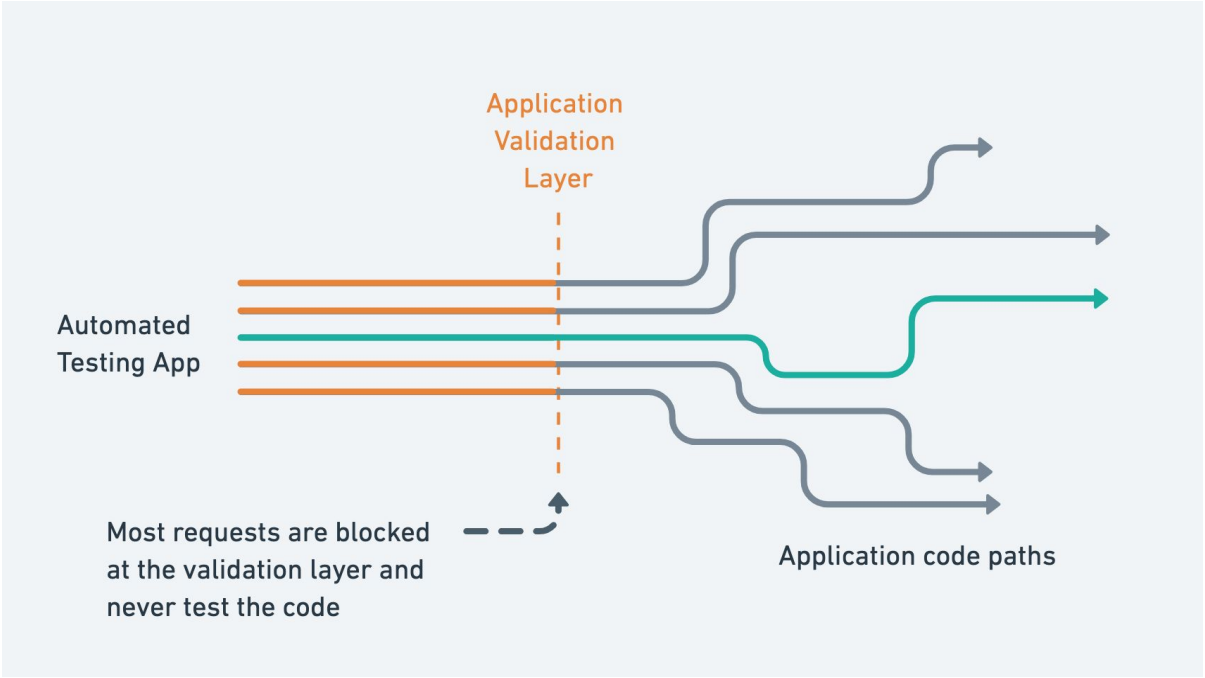
The two problems when testing GraphQL APIs

Problem 1 : Classic testing cannot assess the business logic of APIs



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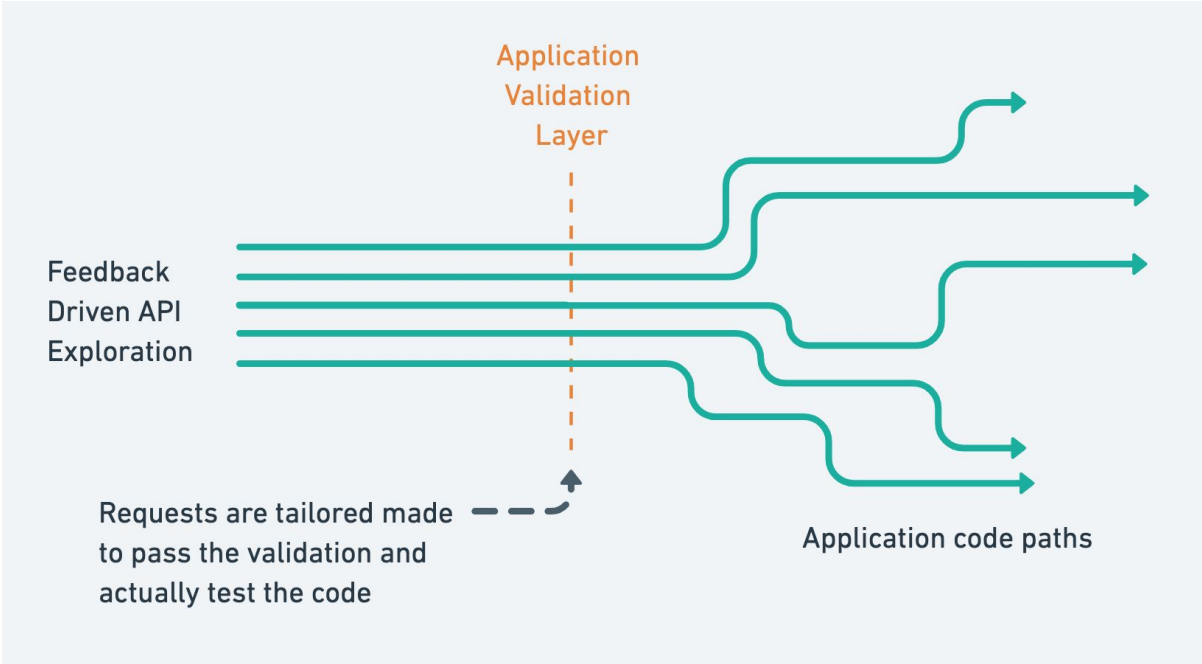
The two problems when testing GraphQL APIs

Solution 1 : Feedback-Driven API Exploration



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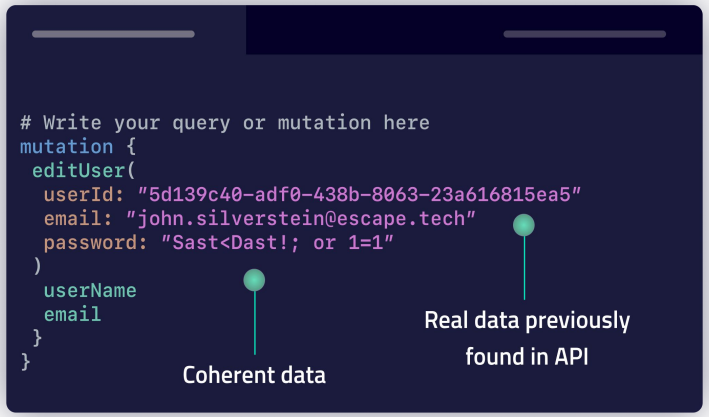
The two problems when testing GraphQL APIs

Solution 1 : Feedback-Driven API Exploration

Regular API Testing



Feedback Driven API Exploration

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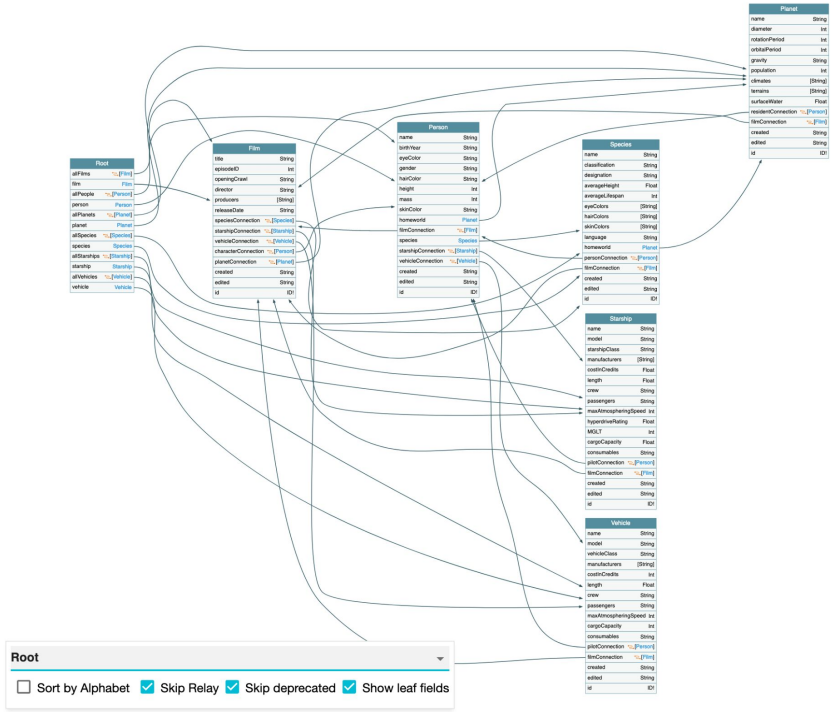
The two problems when testing GraphQL APIs

Problem 2 : GraphQL is a Graph...



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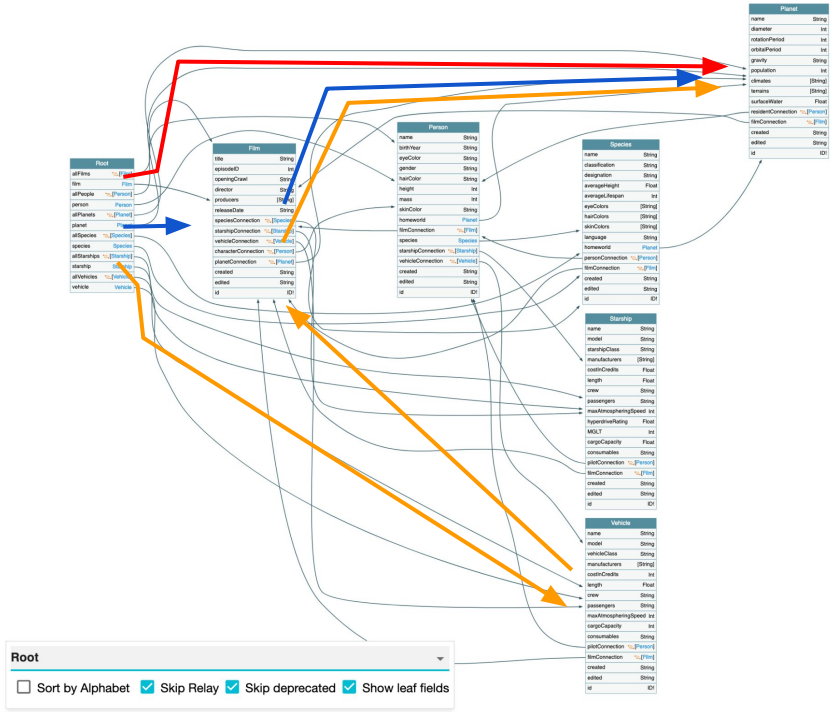
The two problems when testing GraphQL APIs

Solution 2 : Recursively explore all paths in the graph



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The findings

46,809

Security alerts found

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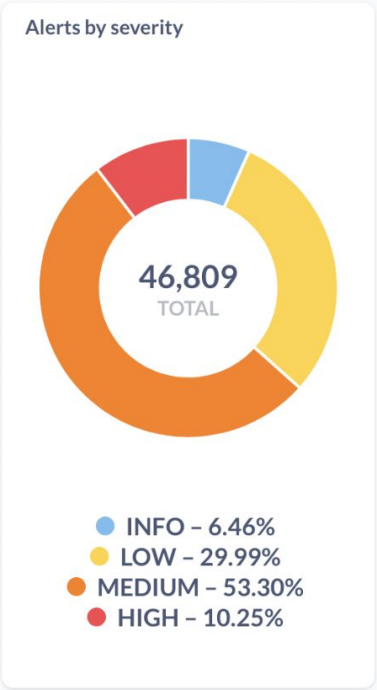
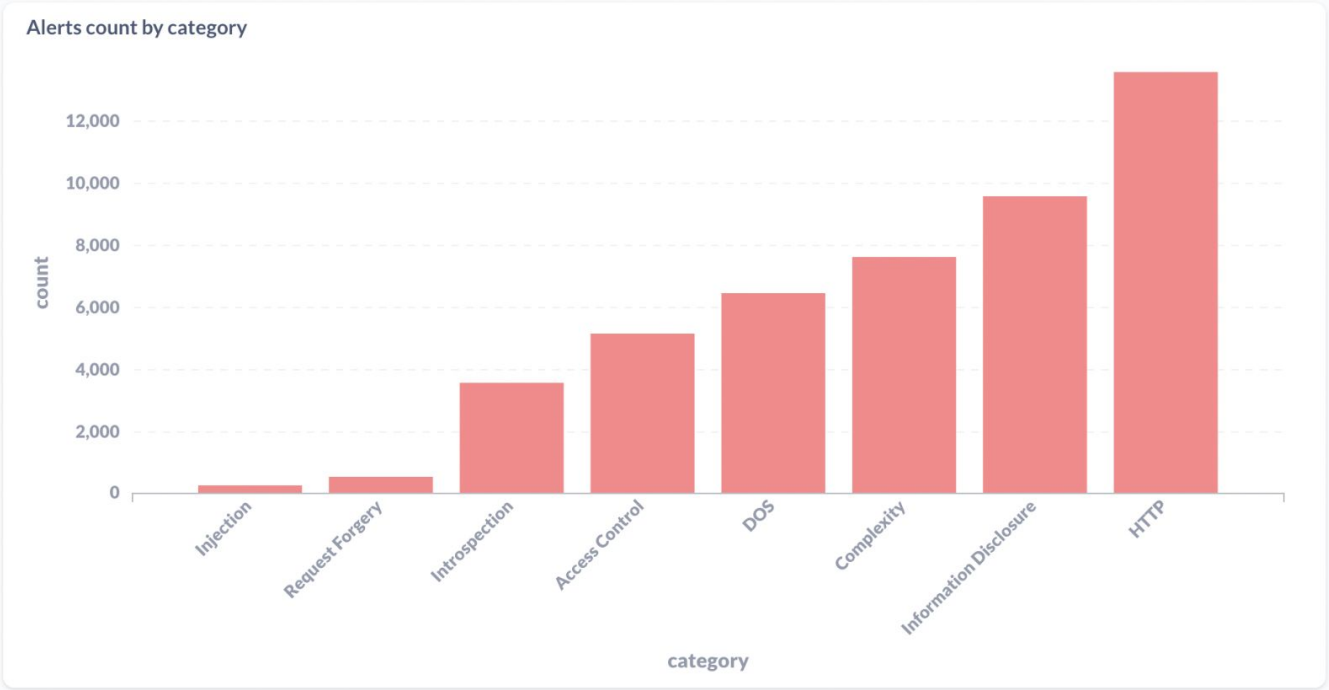
Which severity and category?





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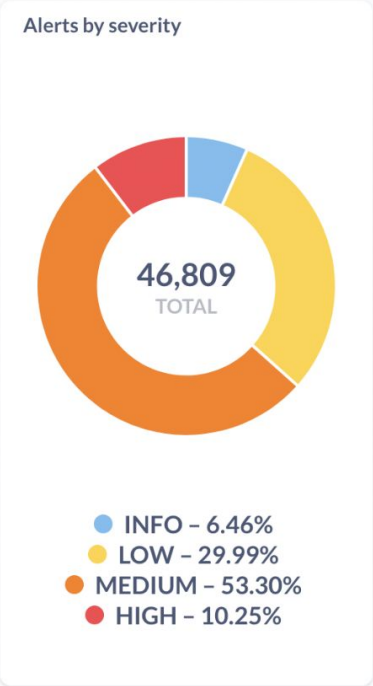
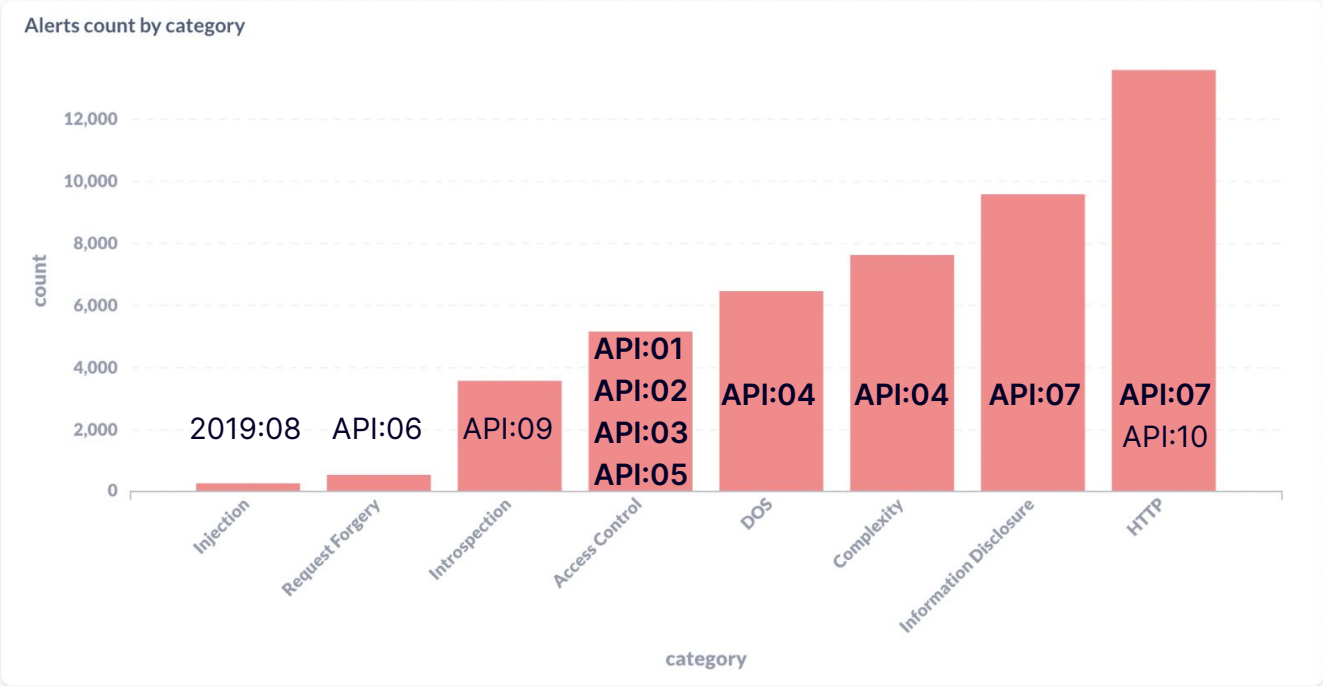
Which severity and category?





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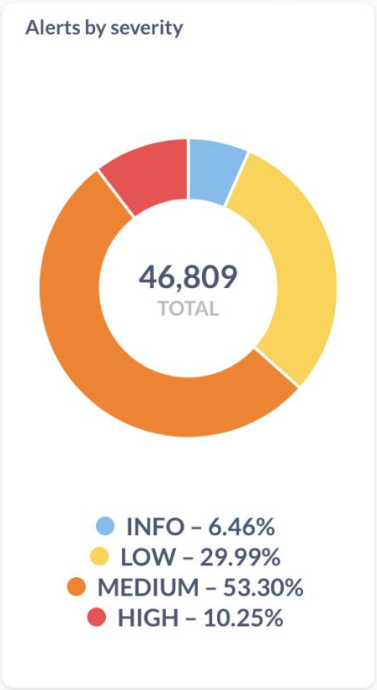
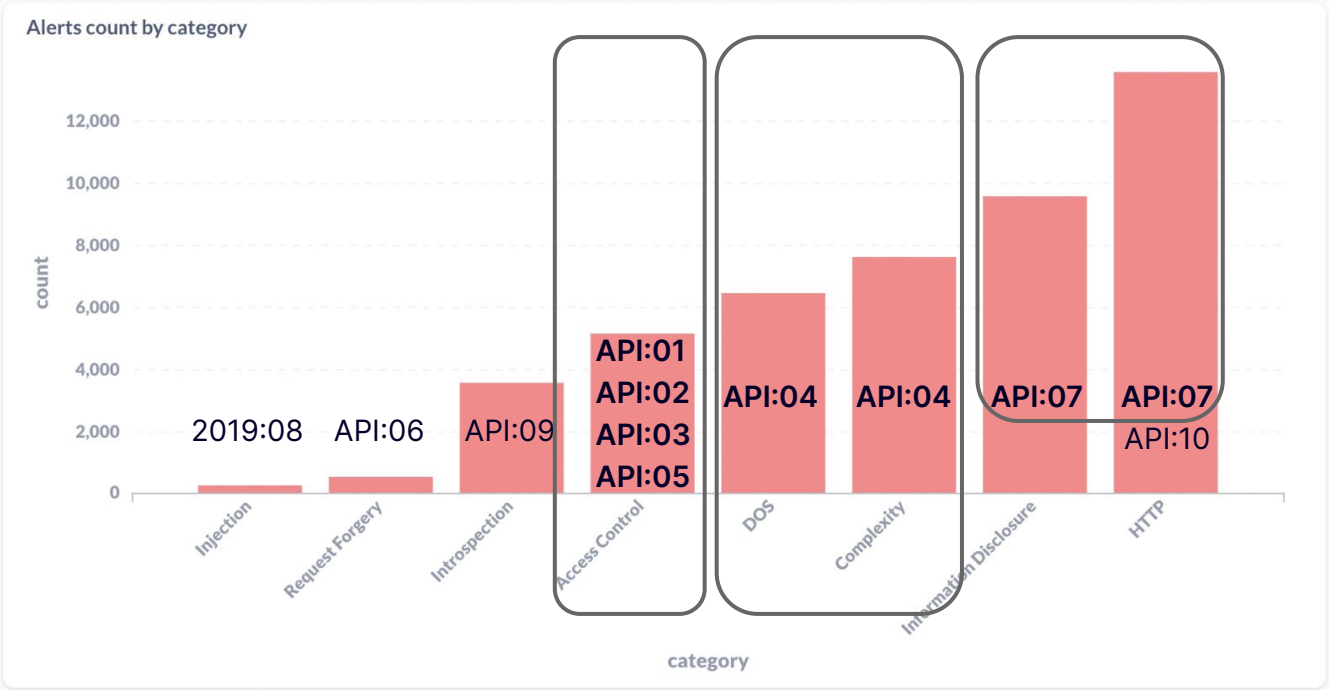
Which severity and category?





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A lot are GraphQL-specific

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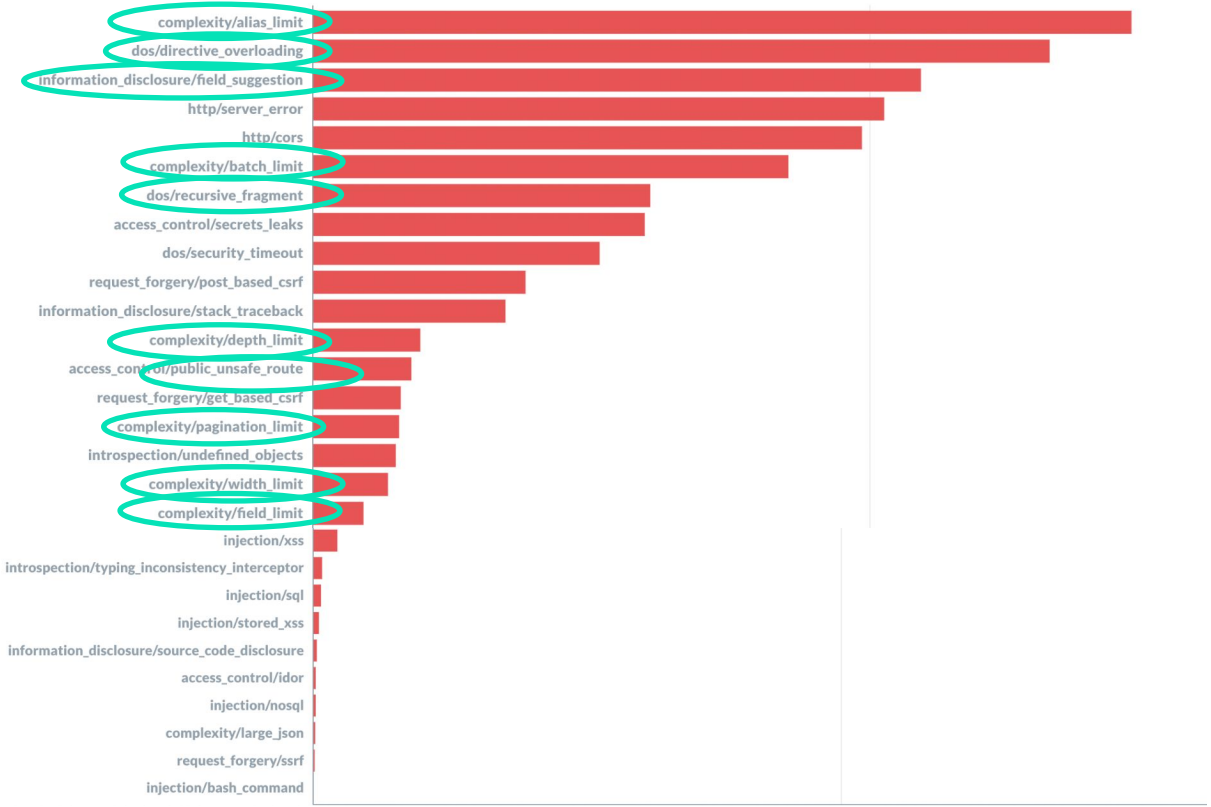
GraphQL-specific Vulnerabilities come first



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Top vulnerability 1: Bruteforcing API requests (API:04)

Batching: Multiple GraphQL Queries in one HTTP Request

```
query Hero {
  hero {
    name
  }
}

query Vilain {
  vilain {
    name
  }
}
```

Aliasing: The same fields multiple times with aliases

```
{
  empireHero: hero(episode: EMPIRE) {
    name
  }
  jediHero: hero(episode: JEDI) {
    name
  }
}
```

Top vulnerability 1: Bruteforcing API requests (API:04)

The problem: can be used to bypass rate limiting on login mutations = Bruteforce attack

```
{
  login1: login(email: user0@graphql.org, password: "password1") {
    username
    jwt
  }
  login2: login(email: user0@graphql.org, password: "password22") {
    username
    jwt
  }
  login3: login(email: user0@graphql.org, password: "password2211") {
    username
    jwt
  }
}
...
```


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Top vulnerability 2: Denial of Service (API:04)

Fragments: a piece of logic that can be shared between multiple queries

```
fragment NameParts on Person {
  firstName
  lastName
}
```

Top vulnerability 2: Denial of Service (API:04)

The problem: What if a fragment calls itself? Oops, you get an infinite recursion loop.

```
{
  ...X
}

fragment X on Query {
  ...Y
}

fragment Y on Query {
  ...X
}
```

```
{
  "errors": [
    {
      "message": "Maximum call stack size exceeded",
      "extensions": {
        "code": "INTERNAL_SERVER_ERROR",
        "exception": {
          "stacktrace": [
            "RangeError: Maximum call stack size exceeded",
            "    at Map.get (<anonymous>)",
            "    at getReferencedFieldsAndFragmentNames (/usr/s
/app/node_modules/graphql/validation/rules
/OverlappingFieldsCanBeMergedRule.js:468:45)",
```


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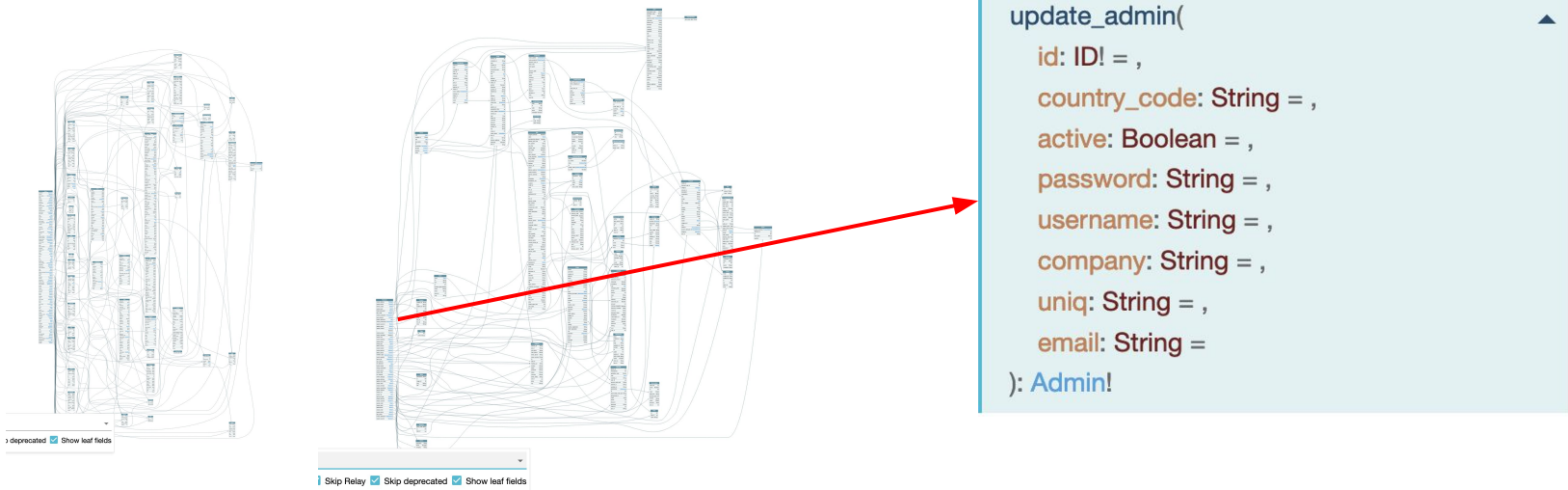
Top vulnerability 3: Internal API Schema Leak (API:07)

The problem: Endpoints with disabled introspection still leaks underlying schema through field suggestion using

```
{
  "errors": [
    {
      "message": "Cannot query field \"createSesion\" on
        type \"RootMutation\". Did you mean
        \"createSession\", \"createUser\",
        \"createFile\", or \"createImage\"?",
      "category": "graphql"
    }
  ]
}
```

Top vulnerability 3: Internal API Schema Leak (API:07)

The problem: Endpoints with disabled introspection still leaks underlying API Schema through field suggestion using open source tool Clairvoyance, anybody can build back the full Schema.



Classic API vulnerabilities are still there

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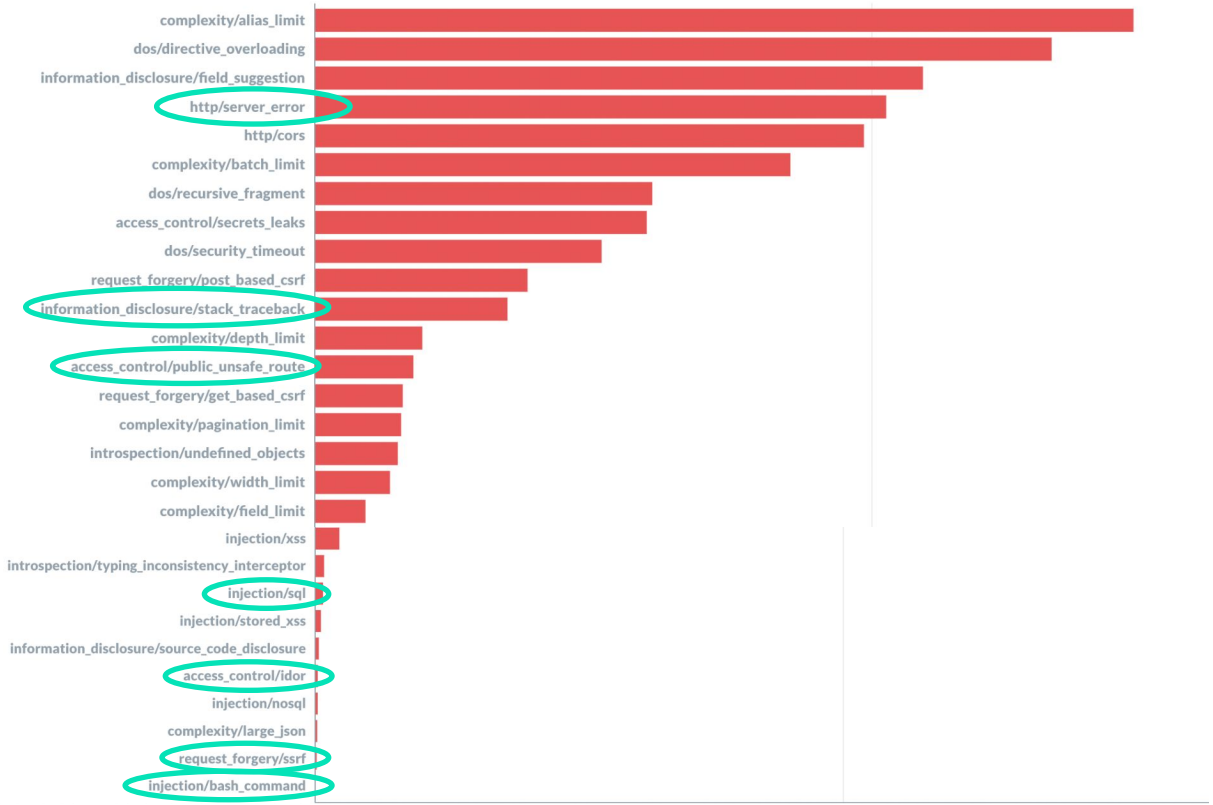
HTTP Errors, Access Control Issues, Injections



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API Errors and Stacktraces disclosing internal data (API:07)

The problem: Stack Traces give too much information on what's vulnerable in your app 👀

```
      "extensions": {
        "code": "GRAPHQL_VALIDATION_FAILED",
        "exception": {
          "stacktrace": [
            "GraphQLError: Boolean cannot represent a non
boolean value: \"'\"",
            "    at GraphQLScalarType.parseLiteral
(/usr/local/app/common/temp/node_modules/.pnpm/@apollo
/gateway@0.6.1/node_modules/graphql
/type/scalars.js:271:13)",
            "    at isValidValueNode (/usr/local/app/common
/temp/node_modules/.pnpm/graphql@16.5.0/node_modules
```

Prototype Pollution In

@Apollo/gateway

HIGH 7.3

Updated at: 11 months ago

Published: 3 years ago

Package: **@apollo/gateway** (npm)
Affected Version: **< 0.6.2**
Patch Version: **0.6.2**

(12% endpoints misconfigured)

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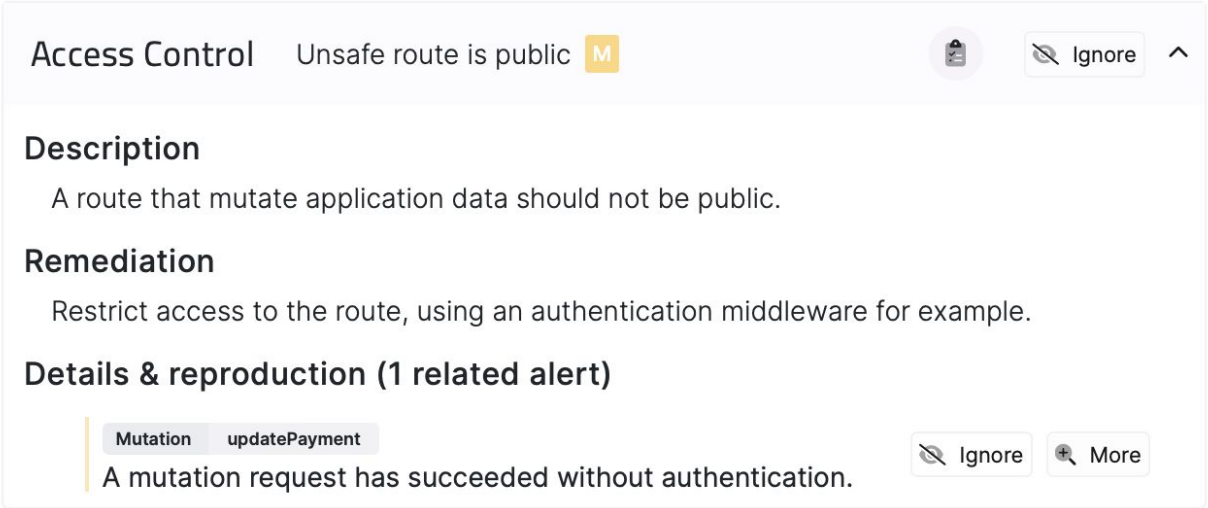
Access Control issues (API:01,02,03,05)

The problem: Most routes writing data (mutations) are not supposed to be accessible without authentication



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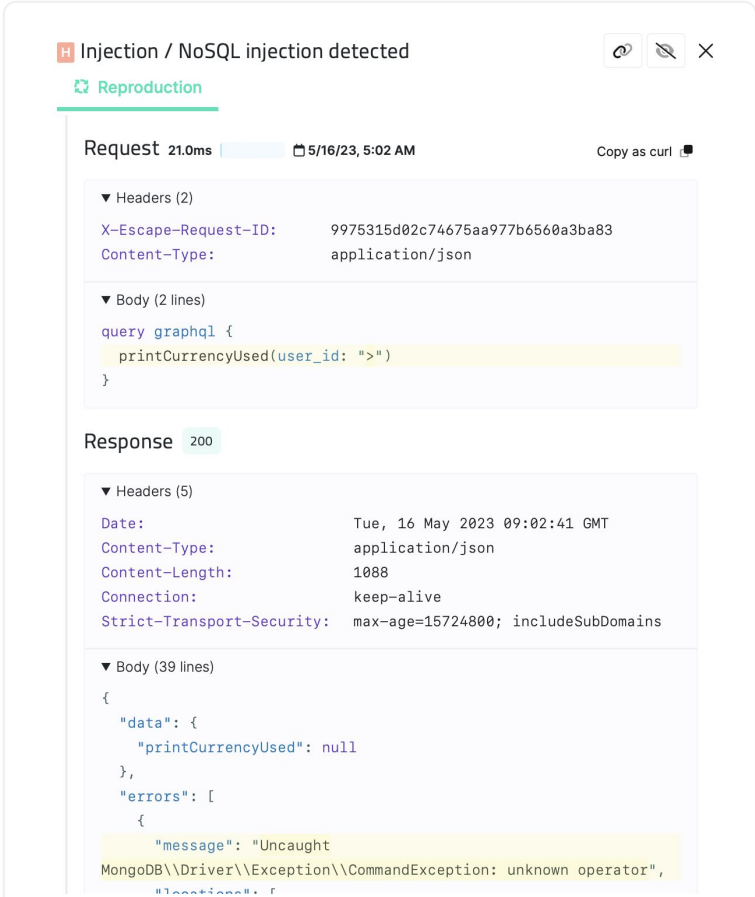
Injections are still there (API 2019:08)

- 16 SQL or NoSQL injections
- 1 bash command injection
- 3 Server Side Request Forgery



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Sensitive data made public!

4,493 potential PII and token leaks found.

- Email
- Secret
- Phone Number
- MD5 hash
- Generic API Key
- Password
- AWS
- JSON Web Token
- IPv4 address
- Passport Number
- Plaid Client ID
- Adobe Client ID (OAuth Web)
- Asana Client ID
- US Bank Account Number
- EasyPost API token
- Ethereum address
- IPv6 address
- bCrypt hash
- Credit Card Verification Value
- GCP API key
- Slack token
- EasyPost test API token
- Kucoin Access Token
- Private Key
- SendGrid API token
- GitHub OAuth Access Token
- International Bank Account Number
- Netlify Access Token

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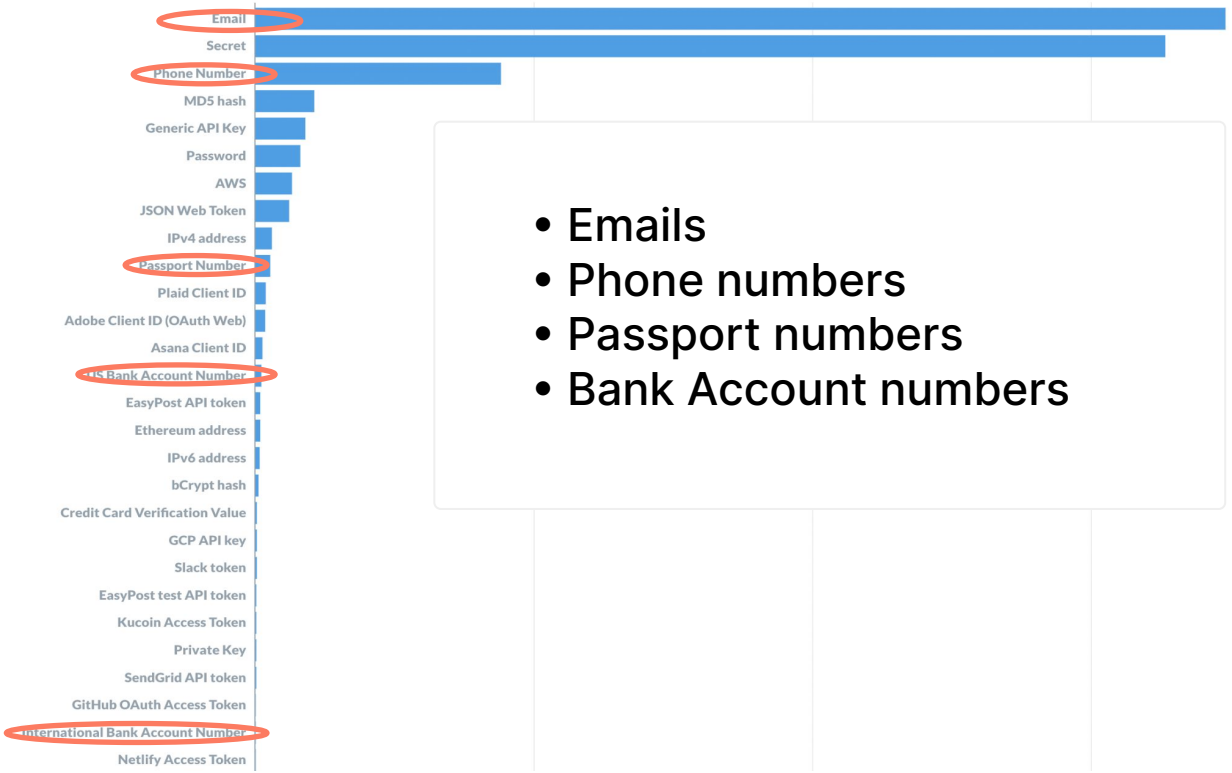
4,493 potential PII and token leaks found.



- Emails
- Phone numbers
- Passport numbers
- Bank Account numbers

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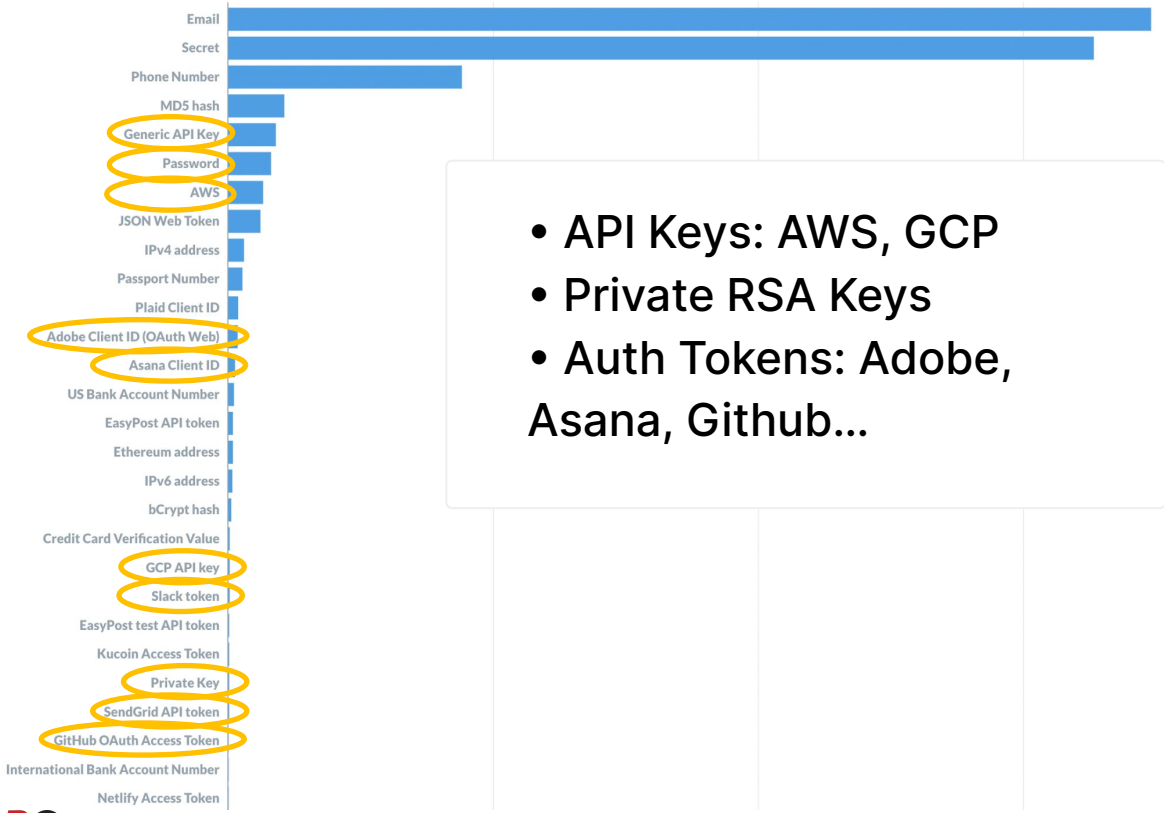
4,493 potential PII and token leaks found.



- API Keys: AWS, GCP
- Private RSA Keys
- Auth Tokens: Adobe, Asana, Github...

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How does OWASP TOP 10 reflect in prod-ready GraphQL apps?

DOS & Complexity issues
Due to GraphQL-specific features

API:04: Unrestricted Resource Consumption

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How does OWASP TOP 10 reflect in prod-ready GraphQL apps?

DOS & Complexity issues

Due to GraphQL-specific features

→ **API:04**: Unrestricted Resource Consumption

Access Control, Authentication and Authorization:

Very common because of the graph nature of GraphQL

→ **API:01**: Broken Object Level Authorization (BOLA)
API:02: Broken Authentication
API:03: Broken Object Property Level Authorization (BOPLA)
API:05: Broken Function Level Authorization (BFLA)

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How does OWASP TOP 10 reflect in prod-ready GraphQL apps?

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Security Misconfiguration and Information Disclosure

By default in GraphQL Server Engines

→ **API:07**: Security Misconfiguration

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Conclusion, using only unauthenticated API calls:

- We found 130k+ public GraphQL APIs into the wild and scanned **1599** of them
- Highlighted numerous vulnerabilities, most frequently GraphQL Specific, but not only
- **Access control flaws** and **secret leaks** are *very* frequent in GraphQL

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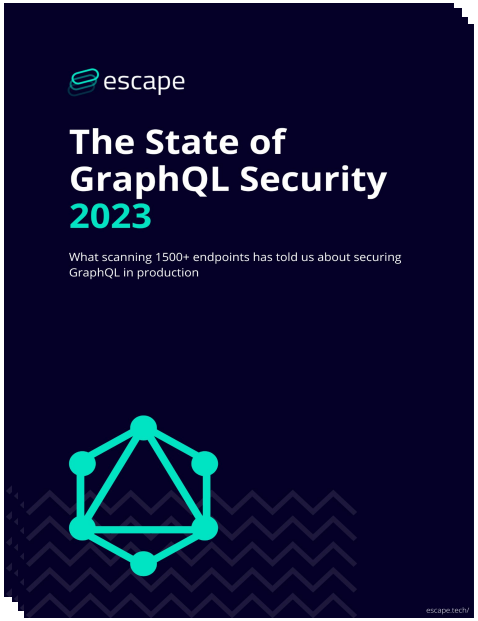

https://escape.tech/resources/state-of-graphql-security-2023/

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Two more things...

GraphQL Armor

The missing free & open source security middleware for GraphQL applications

escape.tech/graphql-armor

Provides out-of-the-box security best practices:

- Aliases Limit
- Character Limit
- Cost Limit
- Depth Limit
- Directives Limit
- Field Suggestion

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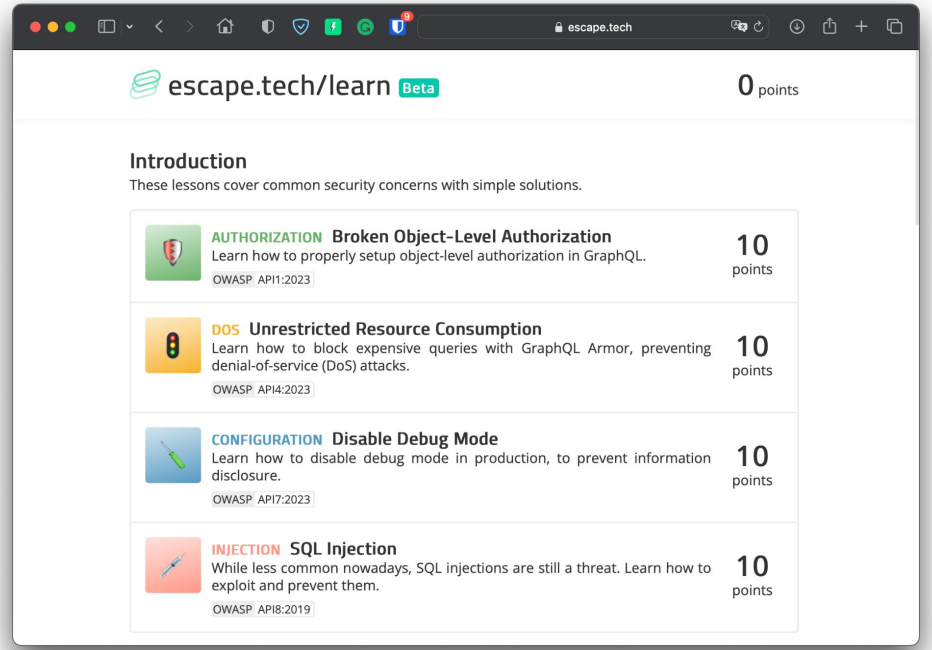
Escape learning center

The first free & open-source security learning platform dedicated to GraphQL developers.



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to make DAST cool again.

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Thank you

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to bring cybersecurity into all developers' hands.

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