VERVE

GraphQL in Python and Django

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Who am I

- **Patrick** Arminio
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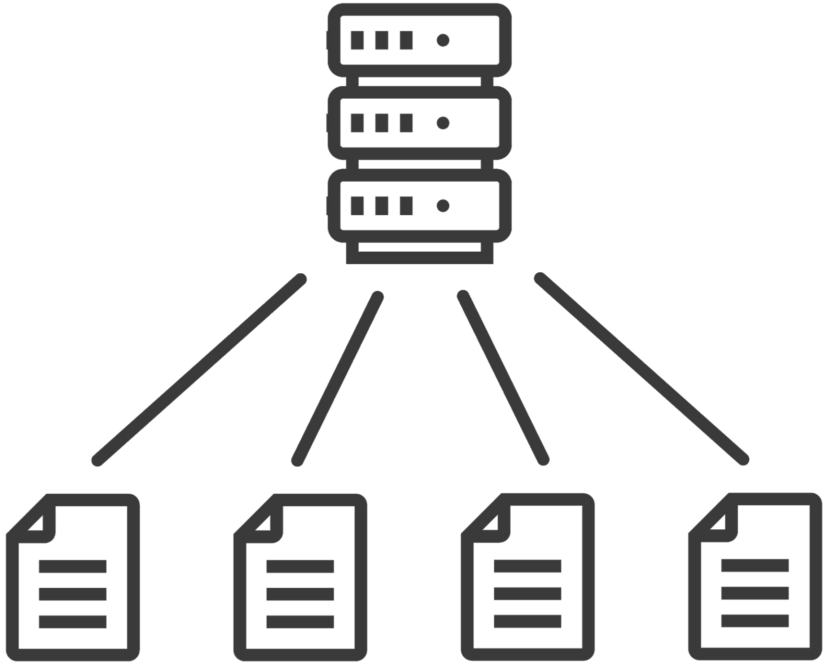
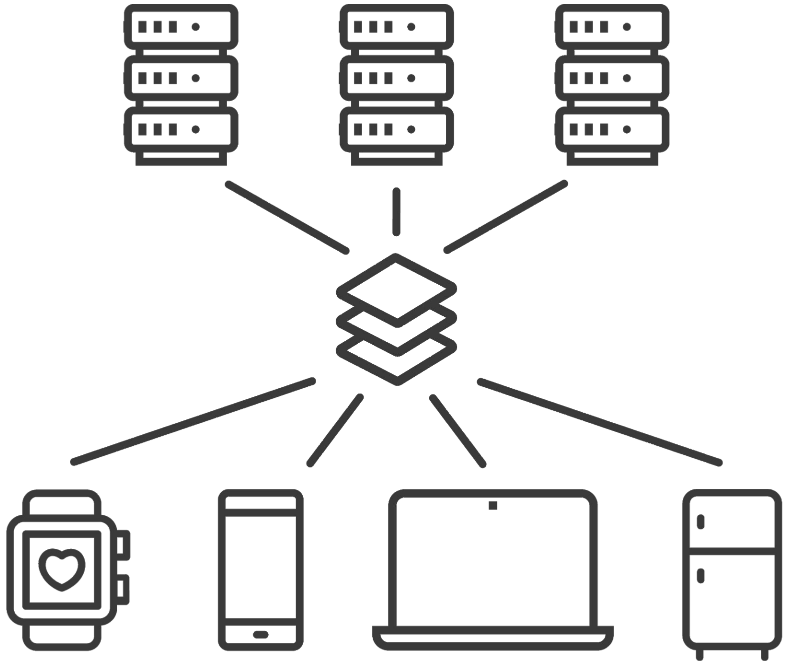
- **@patrick91** online

GraphQL?

WEB 1.0



WEB 2.0



REST APIs

While REST APIs are good, they have some shortcomings

Too many API calls (under-fetching)

```
http GET /user/1
```

```json
{
    "name": "Patrick",
    "friends": [
        "/users/2",
        "/users/3",
        "/users/4"
    ],
    "avatar": "/images/123"
}
```

```
http GET /user/2
http GET /user/3
http GET /user/4
http GET /user_with_friends/1
```

```json
{
    "name": "Patrick",
    "friends": [
        { "name": "Fiorella" },
        { "name": "Marco" },
        { "name": "Marta" }
    ],
    "avatar": "/images/123"
}
```

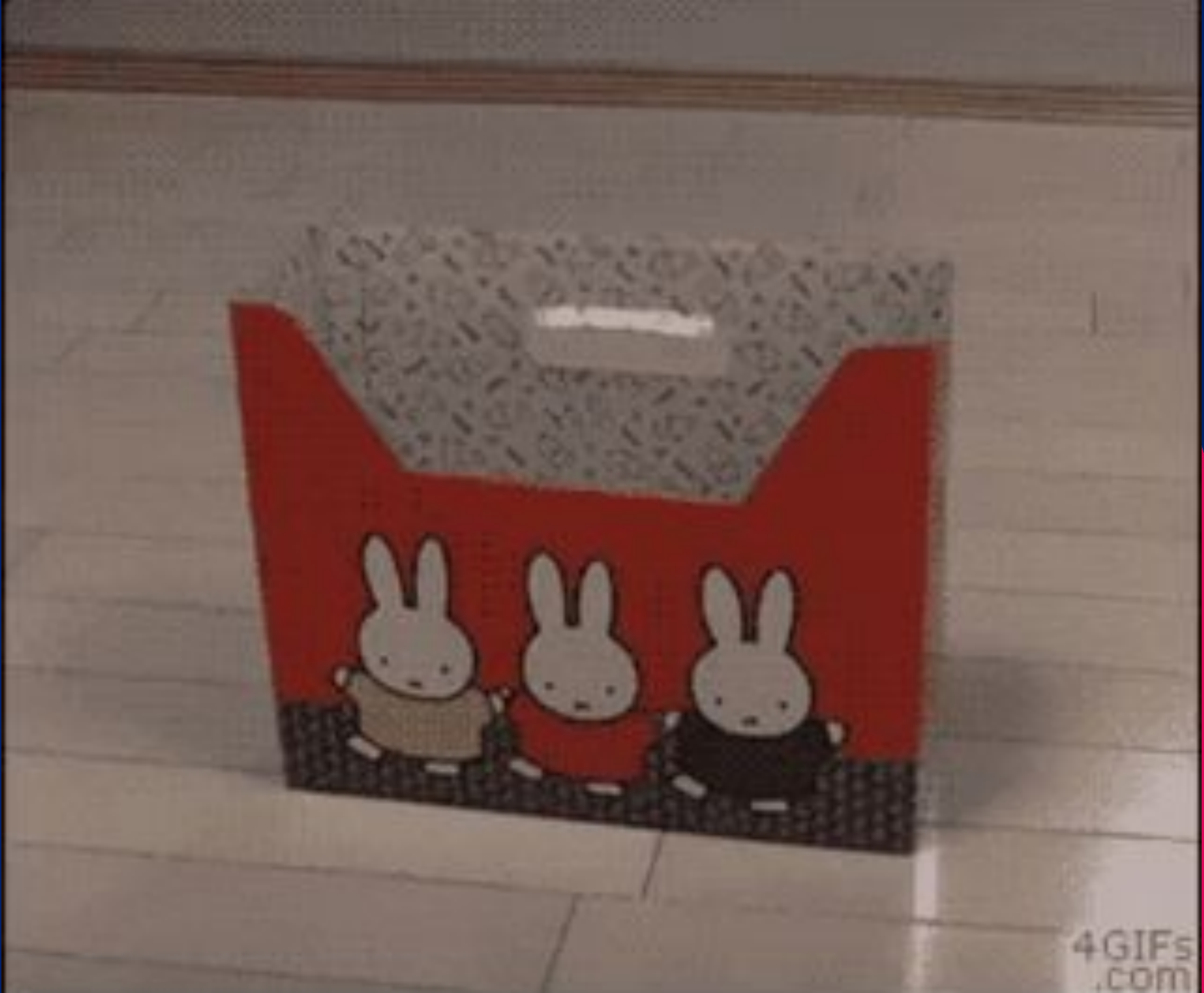
```
http GET /user_with_friends/1
http GET /user_with_friends/1
http GET /user_with_friends_and_avatar/1
http GET /user_with_friends/1
http GET /user_with_friends_and_avatar/1
http GET /user_with_avatar/1
http GET /user_with_friends/1
http GET /user_with_friends_and_avatar/1
http GET /user_with_avatar/1
http GET /user_with_small_avatar/1
http GET /user_with_friends/1
http GET /user_with_friends_and_avatar/1
http GET /user_with_avatar/1
http GET /user_with_small_avatar/1
http GET /user_with_small_avatar_and_friends/1
http GET /user_with_friends/1
http GET /user_with_friends_and_avatar/1
http GET /user_with_avatar/1
http GET /user_with_small_avatar/1
http GET /user_with_small_avatar_and_friends/1
http GET /page-1
http GET /user_with_friends/1
http GET /user_with_friends_and_avatar/1
http GET /user_with_avatar/1
http GET /user_with_small_avatar/1
http GET /user_with_small_avatar_and_friends/1
http GET /page-1
http GET /page-2
```

[...] At the time, we had over 1,000 different REST endpoints at Coursera (and now we have many more) [...]

Source: Coursera
https://dev-blog.apollodata.com/courseras-journey-to-graphql-a5ad3b77f39a

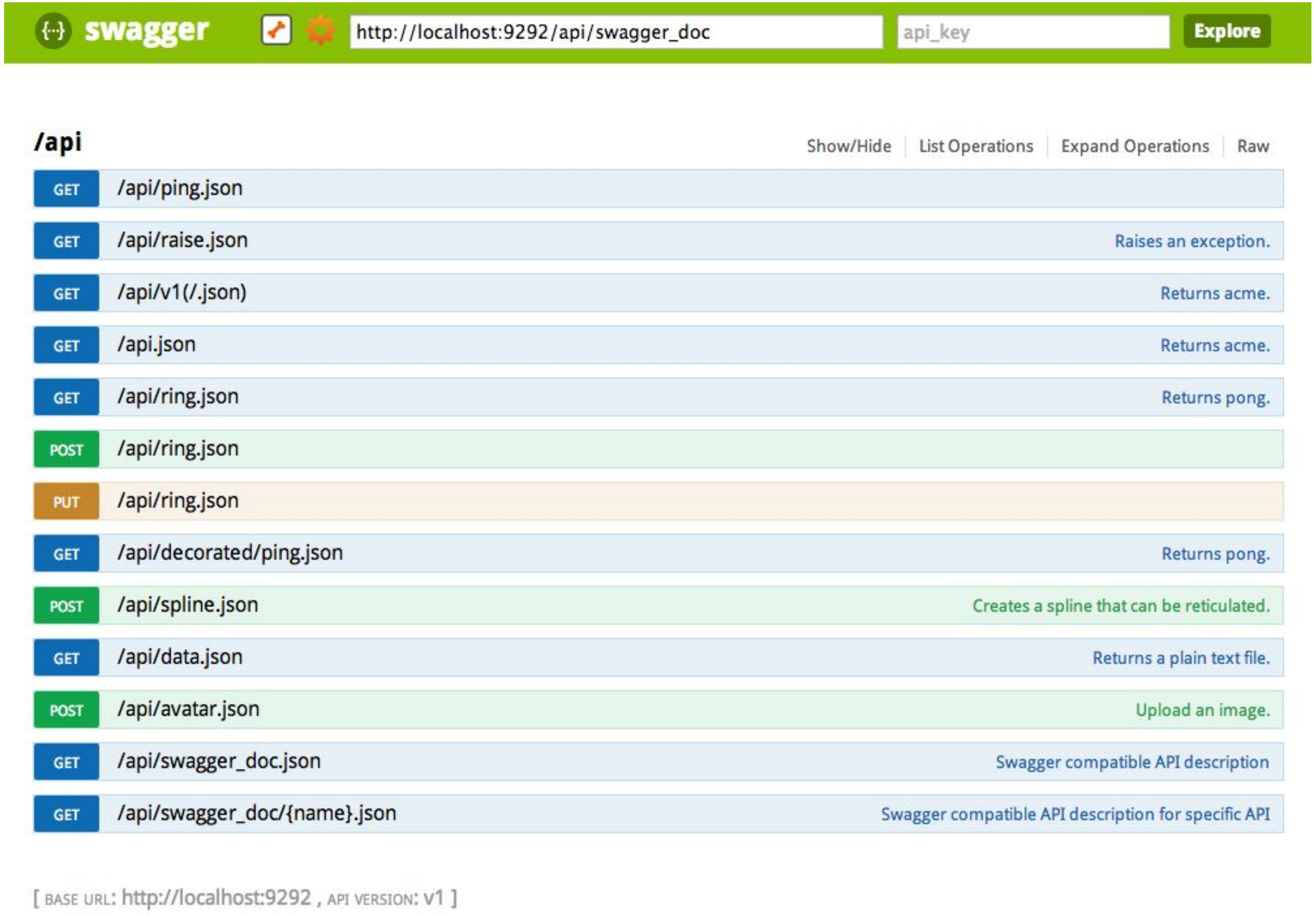
Too much data (over-fetching)

```
{
   "name": "Patrick",
   "friends": [{
           "name": "Ernesto",
           "friends": ["/users/2", "/users/3", "/users/4"],
           "avatar": {
               "url": "//cdn.x.com/123.jpg",
               "width": 400,
               "height": 300
           }
       },
       {
           "name": "Simone",
           "friends": ["/users/2", "/users/3", "/users/4"],
           "avatar": {
               "url": "//cdn.x.com/123.jpg",
               "width": 400,
               "height": 300
           }
       },
       {
           "name": "Marta",
           "friends": ["/users/2", "/users/3", "/users/4"],
           "avatar": {
               "url": "//cdn.x.com/123.jpg",
               "width": 400,
               "height": 300
```


4GIFs
.com

REST AND HYPERMEDIA LINKS ARE GREAT, BUT NOT ALWAYS THE BEST CHOICE WHEN BUILDING WEBSITES OR APPS.

Documentation



http://localhost:9292/api/swagger_doc

/api

GET	/api/ping.json	
GET	/api/raise.json	Raises an exception.
GET	/api/v1(/.json)	Returns acme.
GET	/api.json	Returns acme.
GET	/api/ring.json	Returns pong.
POST	/api/ring.json	
PUT	/api/ring.json	
GET	/api/decorated/ping.json	Returns pong.
POST	/api/spline.json	Creates a spline that can be reticulated.
GET	/api/data.json	Returns a plain text file.
POST	/api/avatar.json	Upload an image.
GET	/api/swagger_doc.json	Swagger compatible API description
GET	/api/swagger_doc/{name}.json	Swagger compatible API description for specific API

[BASE URL: http://localhost:9292 , API VERSION: v1]

Can we do better?

We could extend REST, but...

There won’t be a standard way

GraphQL!

GraphQL is a Query Language for APIs.

Source: https://graphql.org/

GraphQL is a specification

Single HTTP endpoint

```
http POST /graphql
```

```
{
 user(id: "1") {
   name
   friends {
     name
   }
   avatar
 }
}
```

```json
{
    "user": {
        "name": "Patrick",
        "friends": [
            { "name": "Fiorella" },
            { "name": "Marco" },
            { "name": "Marta" }
        ],
        "avatar": "/images/123"
    }
}
```

GraphQL is typed

```graphql
type Query {
   user(id: ID!): User
}

type User {
   name: String!
   friends: [Friend!]!
   avatar: String!
}

type Friend {
   name: String!
}
```

```
type Query {
  user(id: ID!): User
}

type User {
  name: String!
  friends: [Friend!]!
  avatar: String!
}

type Friend {
  name: String!
}
```

```graphql
type Query {
    user(id: ID!): User
}

type User {
    name: String!
    friends: [Friend!]!
    avatar: String!
}

type Friend {
    name: String!
}
```

```
type Query {
  user(id: ID!): User
}

type User {
  name: String!
  friends: [Friend!]!
  avatar: String!
}

type Friend {
  name: String!
}
```

```
type Query {
    user(id: ID!): User
}

type User {
    name: String!
    friends: [Friend!]!
    avatar: String!
}

type Friend {
    name: String!
}
```

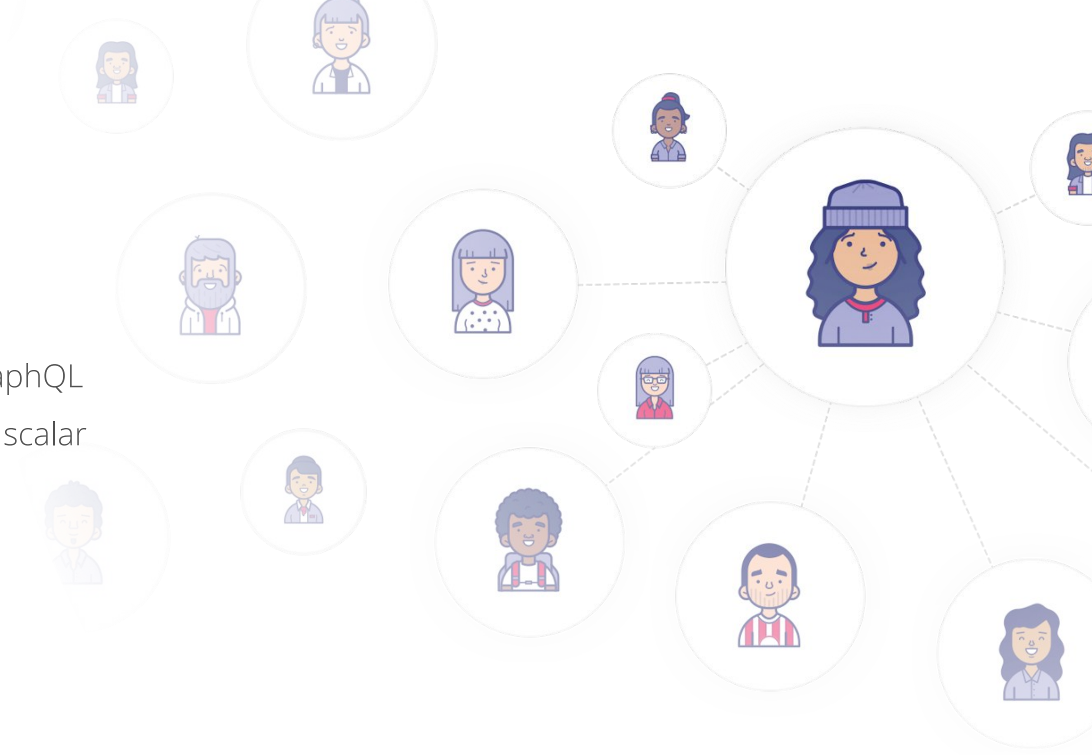
```
type Query {
  user(id: ID!): User
}

type User {
  name: String!
  friends: [Friend!]!
  avatar: String!
}

type Friend {
  name: String!
}
```

Scalar Types

- Int
- Float
- String
- Boolean
- Any user defined scalars (IE. datetime)

Object Types

Object Types are the objects defined in your GraphQL API. They are objects that have fields that can of scalar types or other object types.



Type “modifiers”

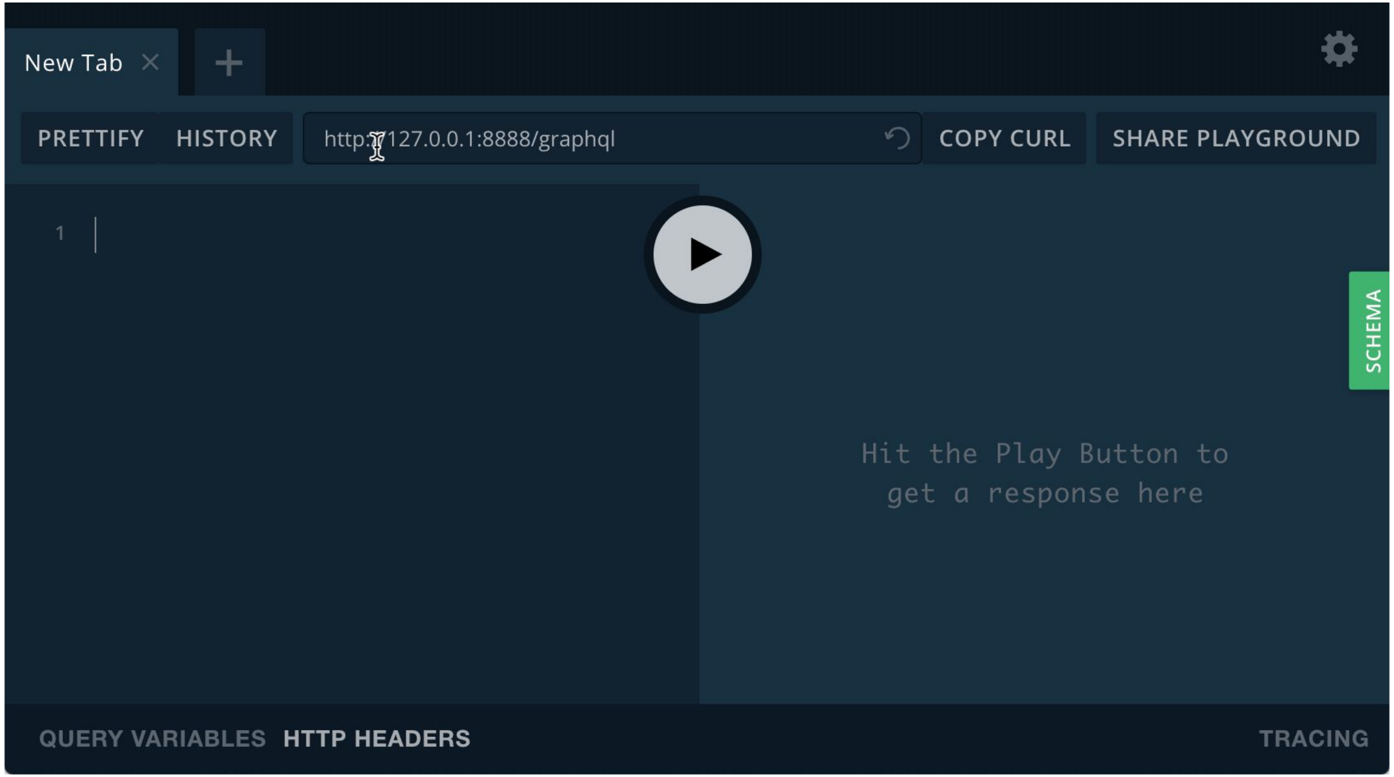
- List
- Non-nulls

Why is this important?

Static checking

Documentation and introspection

Let’s see an example



http://127.0.0.1:8888/graphql

Hit the Play Button to get a response here

Operations

3 Main operations

Query

Allows to request data from the server.

Subscription

Allows to subscribe to events, for example when a new user has been created.

Mutation

Allows you to modify/create data on the server. But it is not limited to data, can be used to run anything with side effects.

Query (shortcut)

```
{
    user(id: "1") {
        name
    }
}
```

Query

```
query QueryName($id: ID!) {
    user(id: $id) {
        name
    }
}
```

Mutation

```
mutation MutationName($input: CreateUserInput!) {
    createUser(input: $input) {
        ok
    }
}
```

Subscription

```
subscription SubscriptionName {
  onUserCreated {
      name
  }
}
```

Intermission

GraphQL in Python

2 libraries

Ariadne

https://github.com/mirumee/ariadne/

- Quite new
- Python 3.5+
- “Closer to GraphQL”

Graphene

https://graphene-python.org/

- Most popular
- Python 2.7+ and Python 3.5+
- Nice abstraction on top of GraphQL
- Support for Django and more frameworks

Let’s start with Ariadne

We need a schema

```
type Query {
   user(id: ID!): User
}

type User {
   name: String!
   friends: [Friend!]!
   avatar: String!
}

type Friend {
   name: String!
}
```

We need a schema

```
type Query {
  user(id: ID!): User
}

type User {
  name: String!
  friends: [Friend!]!
  avatar: String!
}

type Friend {
  name: String!
}
```

We need a schema

```
type Query {
   user(id: ID!): User
}

type User {
   name: String!
   friends: [Friend!]!
   avatar: String!
}

type Friend {
   name: String!
}
```

How do we link data to the fields?

Resolvers

Each field on each type is backed by a function called the **resolver** which is provided by the GraphQL server developer.

A simple resolver

```python
def resolve_user(_, info, id):
    return {
        "name": "Patrick",
        "friends": [
            {"name": "Fiorella"},
            {"name": "Marco"},
            {"name": "Marta"},
        ],
        "avatar": "/images/123",
    }
```

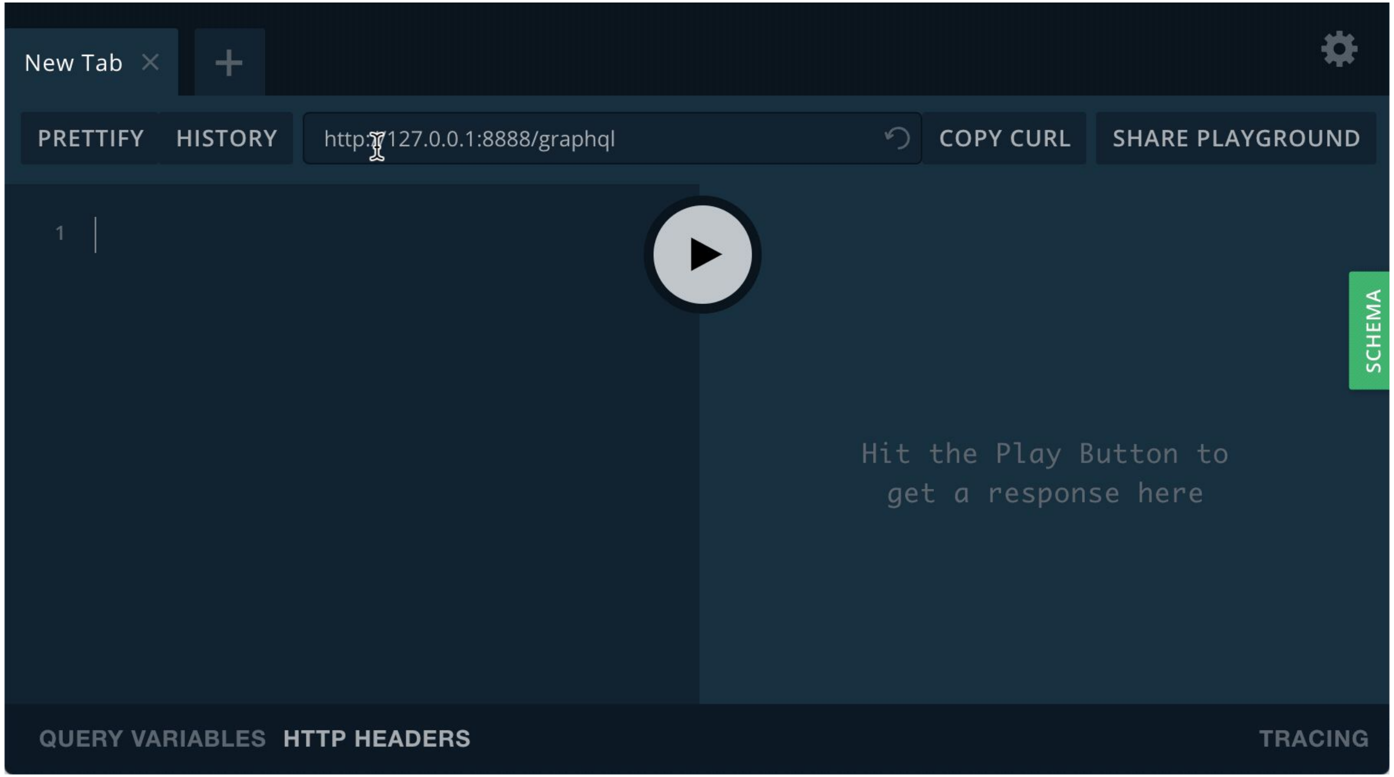
Attaching a resolver to a Type

```
resolvers = {
    "Query": {"user": resolve_user},
    "User": {"name": resolve_name},
}
```

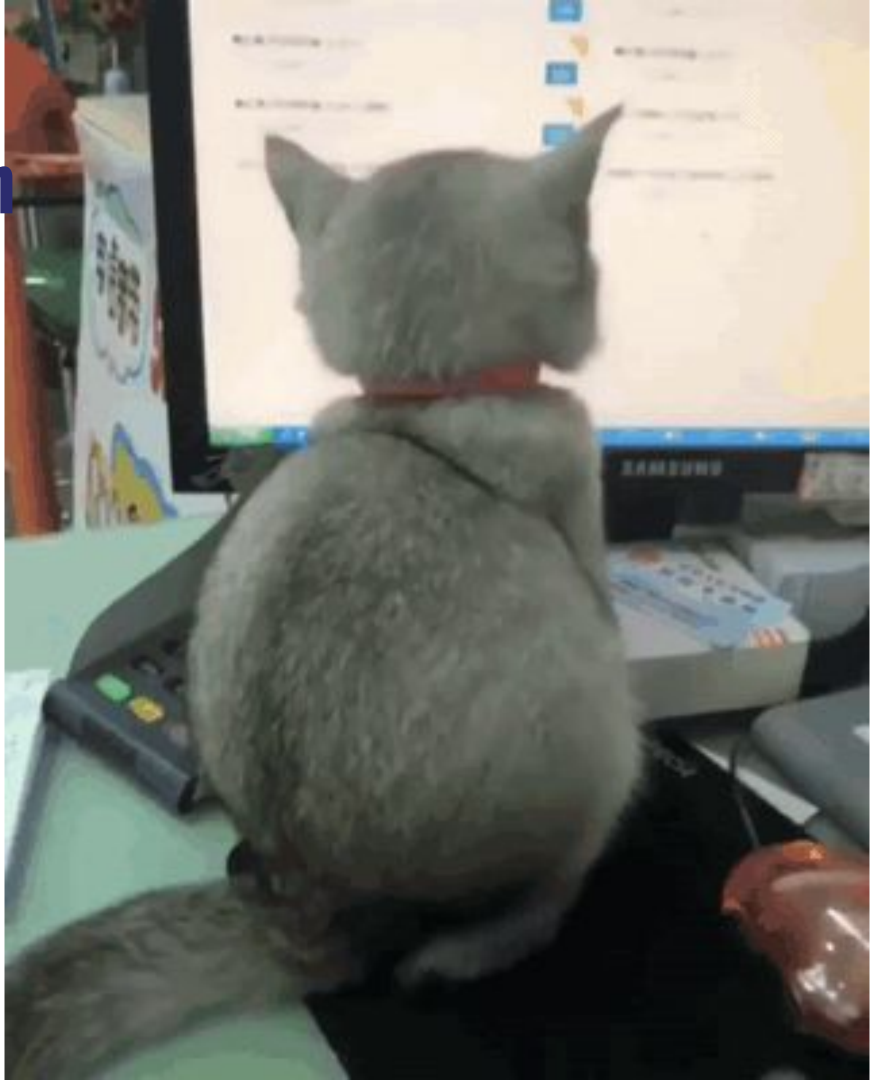
Creating and running the server

```
server = GraphQLMiddleware.make_simple_server(
    schema,
    resolvers
)

server.serve_forever()
```

Done!


New Tab
PRETTIFY
HISTORY
http://127.0.0.1:8888/graphql
COPY CURL
SHARE PLAYGROUND
SCHEMA
Hit the Play Button to get a response here
QUERY VARIABLES
HTTP HEADERS
TRACING

Intermission



Graphene

The schema is defined in Python

Our schema

```
type Friend {
   name: String!
}

type User {
   name: String!
   friends: [Friend!]!
   avatar: String!
}

type Query {
   user(id: ID!): User
}
```

Defining types with Graphene - Friend

```
class FriendType(graphene.ObjectType):
    name = graphene.String(required=True)
```

Types and resolvers live together*

* resolvers can also be external functions

Defining types with Graphene - User

```
class UserType(graphene.ObjectType):
   name = graphene.String(required=True)
   friends = graphene.List(graphene.NonNull(FriendType))
   avatar = graphene.String(required=True)

   def resolve_friends(self, info):
       return [
           FriendType(name="Marta"),
           FriendType(name="Marco"),
           FriendType(name="Fiorella"),
       ]
```

Defining types with Graphene - Query

```
class Query(graphene.ObjectType):
   user = graphene.Field(
       UserType,
       id=graphene.ID()
   )

   def resolve_user(self, info, id):
       return UserType(
           name="Patrick",
           avatar="/images/123"
       )
```

Finally, the schema

```
schema = graphene.Schema(query=Query)
```

Done!

Django Support

Graphene has support for Django, meaning that:

- Has a built in view
- It can create types from django models
- It can create mutations from Forms and DRF Serializers
- Has support for django filters

What about

Authentication

Authentication

When using GraphQL with HTTPs you have 3 options for authentication:

- Sessions
- HTTP Headers
- Field arguments

Sessions

Basically you rely on the browser sending cookies to your backend service, this works pretty well with Django.

Good when you an API that works only with your frontend and when you don’t have a mobile application.

Headers

You can use headers when you have third party clients accessing your API or when you have a mobile app.

Usually it is used in combination with JWT tokens.

Field params

This might be a good solution when you only have a few fields that require authentication. It could work like this:

```
{
   myBankStatement(token: "ABC123") {
       date
       amount
   }
}
```

Security

Quite easy to create “malicious” queries

```
{
 thread(id: "some-id") {
   messages(first: 99999) {
     thread {
       messages(first: 99999) {
         thread {
           messages(first: 99999) {
             thread {
               # ...repeat times 10000...
             }
           }
```

Solution for “malicious” queries

To prevent bad queries to happen we can adopt various solutions:

- Timeouts
- Limits on nested fields
- Query cost
- Static queries

Timeouts

Check how long a query is taking, if it is taking more than 1 second you can kill it.

- Prevents huge queries from DOS-ing your server
- Prevents long waiting time

Limit on nested fields

You can parse the incoming GraphQL request and deny queries that are requesting for fields that are too nested. For example you can only allow for maxing 3 levels of nesting and no more.

Easy solution when you don’t need complex checks.

Query costs

This is useful if you have third party clients and when you also want to limit their API usage.

The idea is to give each field a cost and calculate the cost of the query based on the number of fields requested.

This works extremely well with paginated data (where you know how much data you’re asking for)

Query costs - example query

```
query {
 viewer {
   repositories(first: 50) {
     issues(first: 10) {
       title
     }
   }
 }
}
```

Query costs - calculating the cost

```
50          = 50 repositories

+

50 x 10     = 500 repository issues


             = 550 total nodes
```

Static queries

Instead of allowing any query to be ran on your API you could allow only a predefined list of queries. You’d save those queries on a database and reference them by ID. So instead of doing a request passing the query to GraphQL you’d pass only the ID (and the variables if any).

```
http POST /graphql?id=123
```

Static queries

- Good to prevent unwanted queries
- Still allows to use all the advantages of GraphQL
- A bit cumbersome to deploy
- If you have third party you need a way for them to declare queries
- Potentially good for caching (see next slide)

```
http GET /graphql?id=123
```

Caching

Client Caching

Network Caching

Application Caching

Additional Things

Arguments and Inputs

```
{
 search(text: "an") {
   title
 }
}
```

```
{
 createUser(input: { … }) {
   user {
     name
   }
 }
}
```

Input Types

```graphql
input CreateUserInput {
 name: String!
 age: Int
}
```

Enums

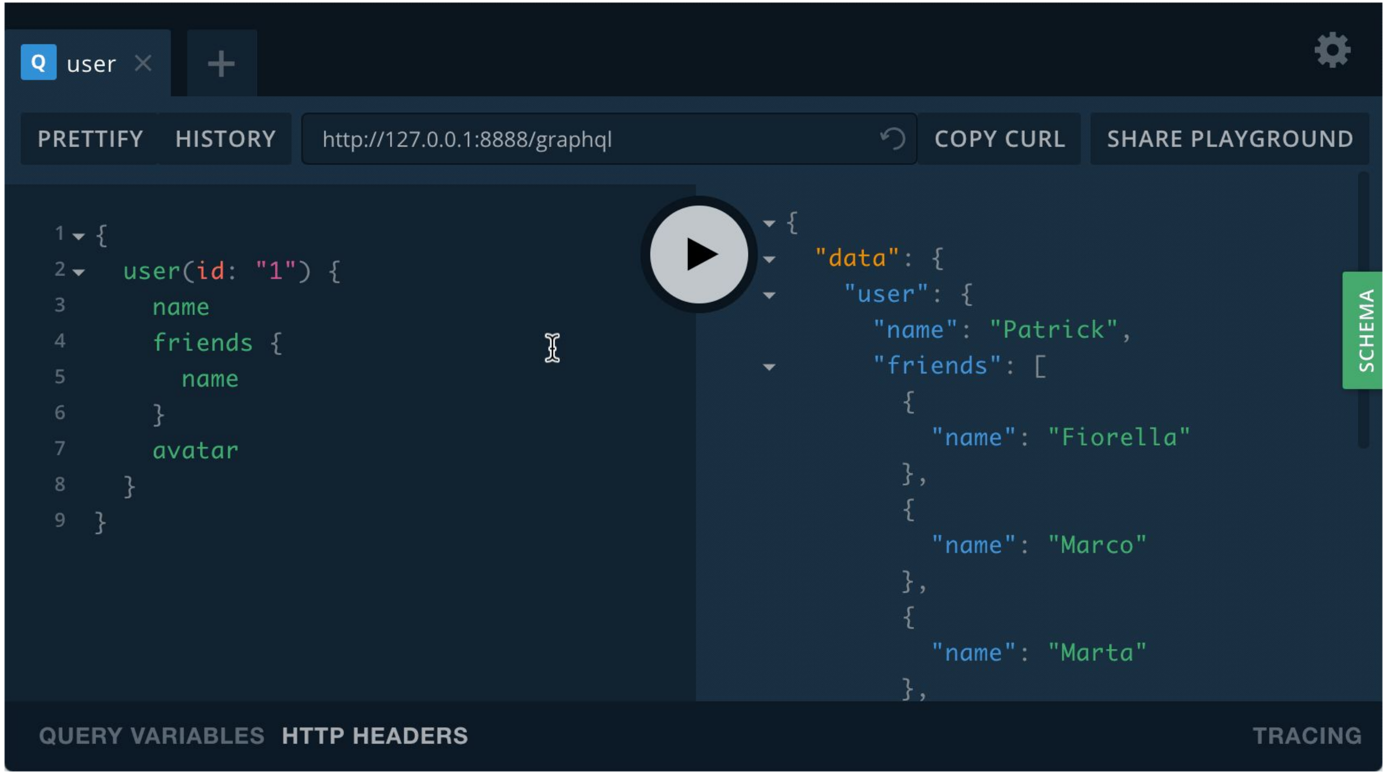
```
enum Conference {
 PYPARIS
 PYCONX
 PYCONUS
}
```

Interfaces

```
interface Character {
 id: ID!
 name: String!
}

type Human implements Character {
 id: ID!
 name: String!
 friends: [Character]
 starships: [Starship]
}
```

```
union SearchResult = Human | Droid

{
 search(text: "an") {
   ... on Human {
     name
     height
   }
   ... on Droid {
     name
     primaryFunction
   }
 }
}
```

Errors



```
{
  user(id: "1") {
    name
    friends {
      name
    }
    avatar
  }
}
```

```
{
  "data": {
    "user": {
      "name": "Patrick",
      "friends": [
        {
          "name": "Fiorella"
        },
        {
          "name": "Marco"
        },
        {
          "name": "Marta"
        },
```

And more

Frontend

Frontend developers benefit a lot from GraphQL, thanks to all the tooling available.

Relay

https://facebook.github.io/relay/

- Made by Facebook
- React Only

Apollo

https://www.apollographql.com/

- Supports many frameworks (React, Vue, etc)
- Big community
- Lots of tooling

Verve is Hiring 🎉

Want to work in an amazing company and use Python 3, GraphQL and Django?

https://verve.co/careers/

THANKS!

Patrick Arminio

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