Infrastructure as Code: "pip install" your environment

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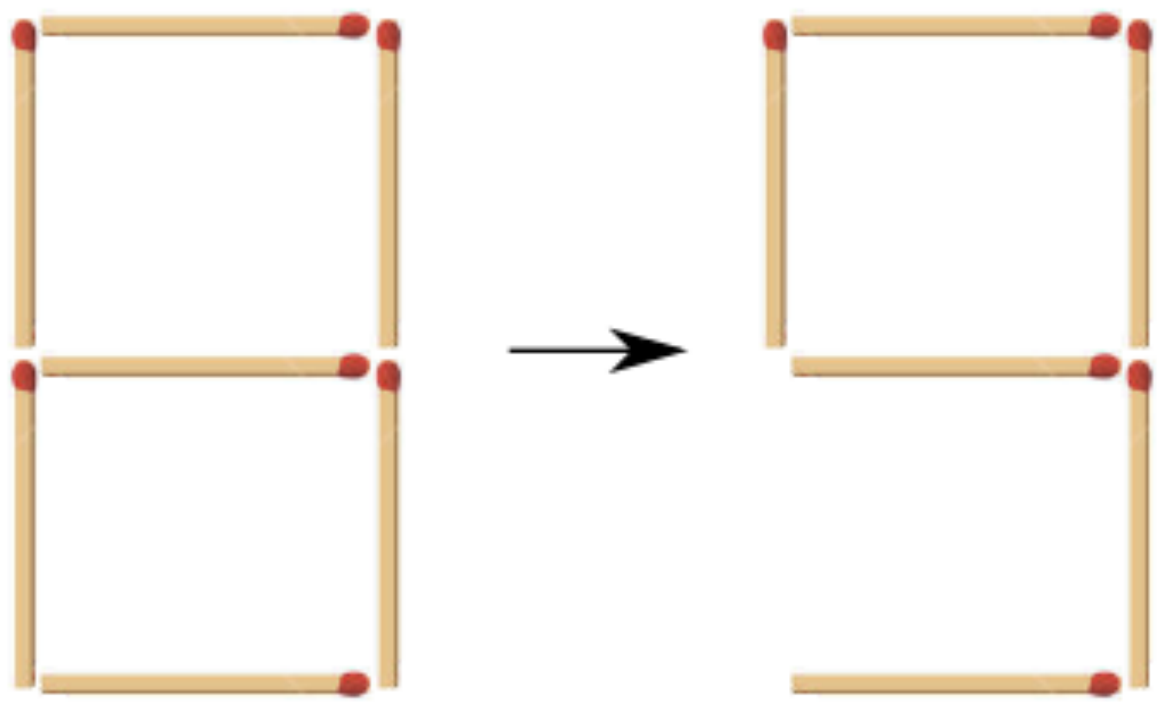
Outline

- What is **CRUD** and what has it to do with immutability?
- What is infrastructure as **code**?
- A real world example: **Postgraas** - PostgreSQL-as-a-service
- What **you** can do and where to start?
- Summary

What is CRUD?

- create, read, update, delete
- this simple set of operations is really powerful
- nearly everything can be implemented using these operations:
  - Blogs, todo app, ec2 instances, dictionaries, ldap users…
- If implemented with these, you get a REST api basically for free:
  - POST, GET, PUT, DELETE

What is immutability?



What do we have to do to come from left to right?

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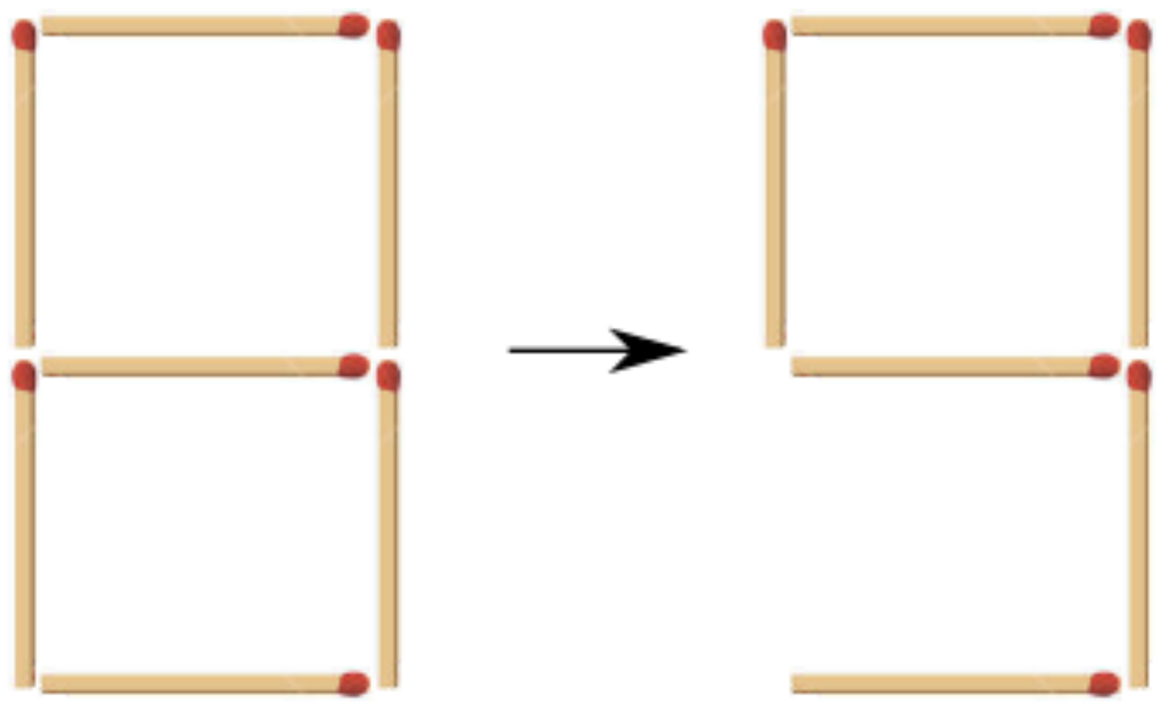
What is immutability?



How would a machine do it?

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What is immutability?

- An update can always be implemented by deleting and recreating
- deleting and recreating in the real world is often resource intensive:
    - building a house, writing a book, provision a server…
- making an update can be quite difficult and complex
    - add a room to a house, change the structure of a database, change the hair color of Mona Lisa…

What is immutability?

- Humans are lazy but intelligent

👉Update is most often the way to go

- Machines are eager but dumb

👉deleting and recreating is the preferred way to go

What is the current status of software infrastructure?

What is immutability?

„Immutability is a concept of how to change the state of a system“

What is immutability?

„Immutability is a concept of how to change the state of a system"

CR~~U~~D

API crash course: From CRUD to REST

- collection resource:
  - uri: /instances/
  - GET: list all instances
  - POST: create new instance
- instance resource:
  - uri: /instances/ID
  - GET: details of the instance
  - DELETE: delete instance
  - PUT: change the instance

what is infrastructure?

„Infrastructure is everything what brings your dead code to life“

what is infrastructure?

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Deploy

Object stores

Logging

Caches

Compute resources

Key-value stores

Middleware

Routing

Databases

Identity access

Network

Application Server

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What is infrastructure as code?

- …if we can access infrastructure in an automated fashion via machine consumable APIs:
    - no tickets
    - no screwdrivers
    - no admin ssh-terminal
    - no GUI
    - …

What is infrastructure-as-a-service?

- …if the application itself can consume the infrastructure it runs in:
    - self service
    - simple, machine consumable api
    - identity access management
    - no dependency to screwdrivers, admins or stackoverflow deploy instructions, …

What is immutable infrastructure?

What is immutable infrastructure?

CR~~U~~D

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Why is automation so important?

- automation means: machines do it
  - reduced human error
  - reproducibility
  - cheaper
  - faster
  - happier developers

Why is X-as-a-service so important?

„Now we can put the entire application, including infrastructure under version control“

Now let's get our hands dirty!

Let's build a PostgreSQL-as-a-service service together!

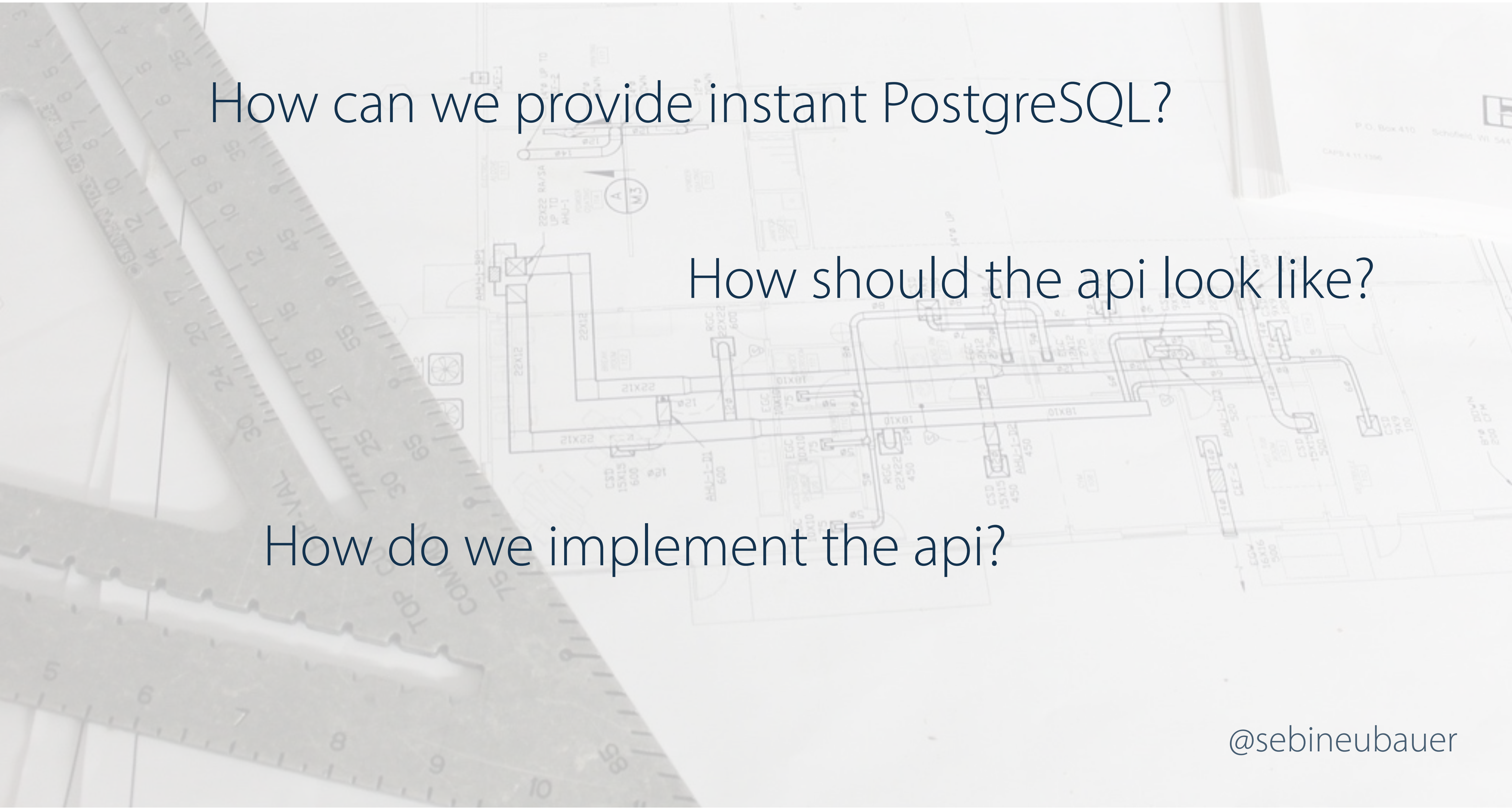
What should it do

- provide PostgreSQL instances-as-a-service
- isolate these instances as good as possible
- provide self service
- provide a simple, machine consumable API
- persist the status of the instances in a „meta db“
- be as simple as possible

First we need a name:

Hello
my name is
Postgraas

Brainstorm a possible implementation



How can we provide instant PostgreSQL?

How should the api look like?

How do we implement the api?

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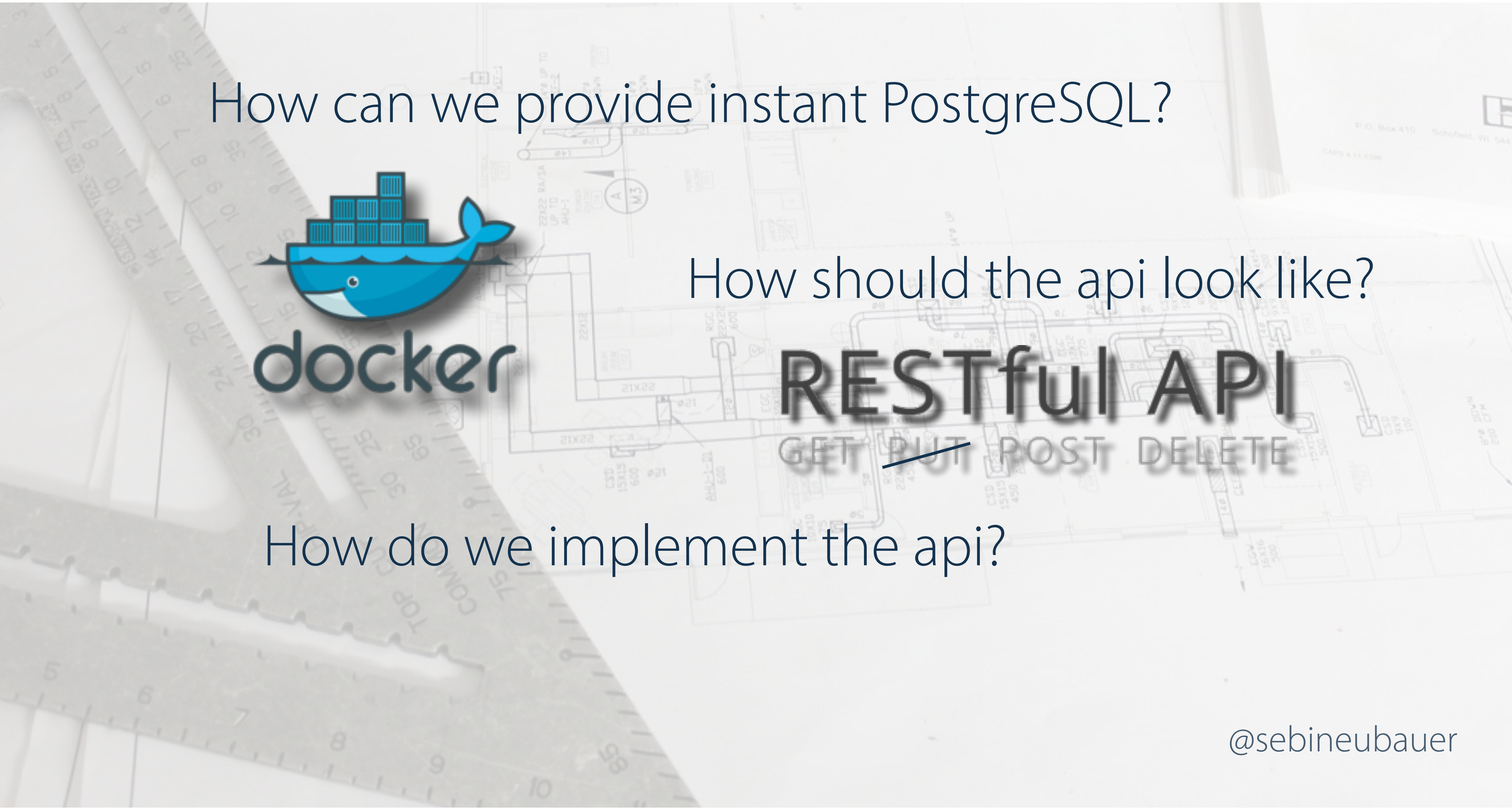

How can we provide instant PostgreSQL?

docker

How should the api look like?

RESTful API

GET ~~PUT~~ POST DELETE

How do we implement the api?

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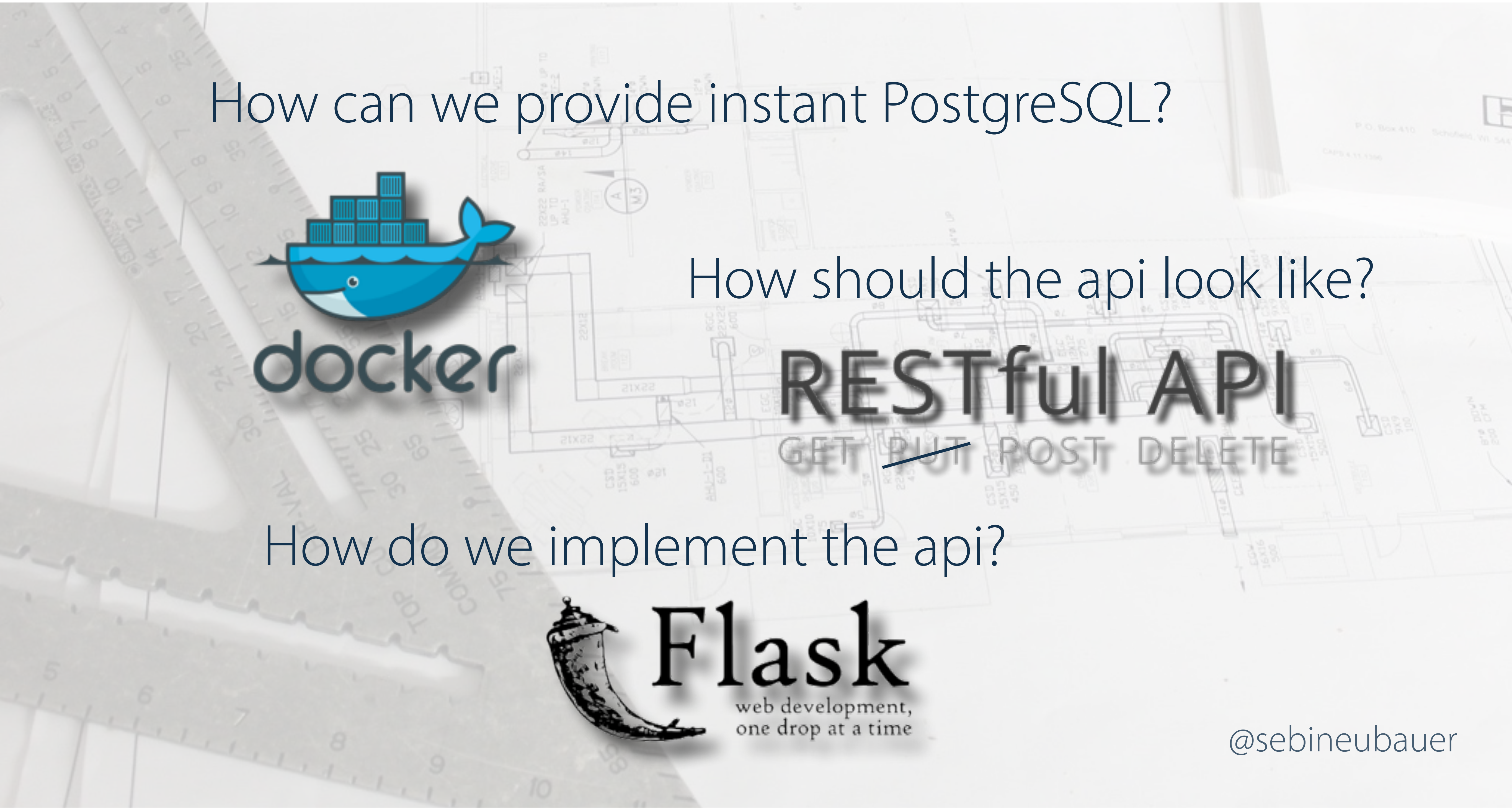
Brainstorm a possible implementation



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docker

How should the api look like?

RESTful API

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How do we implement the api?

Flask

web development, one drop at a time

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docker

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Managing docker from Python

- Easy with docker client library docker-py
- Nearly all features accessible from python
- Needs a running docker daemon to connect to:
  - remote or local
- Quite good quality (e.g. compared to the kafka python client)

Creating a PostgreSQL instance

```
def create_postgres_instance(postgraas_instance_name, connection_dict):
    c = docker.Client(base_url='unix://var/run/docker.sock')
    environment = {
        "POSTGRES_USER": connection_dict['db_username'],
        "POSTGRES_PASSWORD": connection_dict['db_pwd'],
        "POSTGRES_DB": connection_dict['db_name']
    }
    internal_port = 5432
    if check_container_exists(postgraas_instance_name):
        raise ValueError('Container exists already')
    image = 'postgres'
    container_info = c.create_container(image,
                                        name=postgraas_instance_name,
                                        ports=[internal_port],
                                        environment=environment,
                                        labels={"postgraas": image})
    container_id = container_info['Id']
    port_dict = {internal_port: connection_dict['port']}
    c.start(container_id, port_bindings=port_dict)
    return container_id
```

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Get details of an instance

```
def get_container_by_name(postgraas_instance_name):
    c = docker.Client(base_url='unix://var/run/docker.sock')
    containers = c.containers()
    for container in containers:
        for name in container['Names']:
            if postgraas_instance_name in name.replace("/", ""):
                return container
```

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Delete a PostgreSQL instance

(Yes, that is all we need…)

```
def delete_postgres_instance(container_id):
    c = docker.Client(base_url='unix://var/run/docker.sock')
    c.remove_container(container_id, force=True)
    return
```

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RESTful API

GET ~~PUT~~ POST DELETE

Design the API

…easy, we know already…

- Create an instance:
  - POST /postgraas_instances
  - parameters:
    - postgraas_name
    - db_name
    - db_username
    - db_pwd
  - returns: instanceID

Design the API

- List all instances:
  - GET /postgraas_instances
  - returns: list of all instances (or instanceID)
- Get an instance:
  - GET /postgraas_instances/<instanceID>
  - returns: instance details
- Delete an instance:
  - DELETE /postgraas_instances/<instanceID>
  - returns: success

Flask

web development,
one drop at a time

Implement REST in Python

- Really easy using the Flask extension flask-restful
- Define a resource by deriving from a `Resource` class
- Implement members `get`, `put`, `post` or `delete`
- set URI's for each defined resource
- Use SQLAlchemy for the meta data persistance

The Collection Resource

```
db_instance_marshaller = {
    'id': fields.Integer,
    'postgraas_instance_name': fields.String,
    'creation_timestamp': fields.DateTime(dt_format='iso8601'),
    'db_name': fields.String,
    'username': fields.String,
    'password': fields.String,
    'hostname': fields.String,
    'port': fields.String,
    'container_id': fields.String,
}

class DBInstanceCollectionResource(Resource):

    @marshal_with(db_instance_marshaller)
    def get(self):
        all = DBInstance.query.all()
        return all
```

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```python
def post(self):
    parser = reqparse.RequestParser()
    parser.add_argument('postgraas_name', required=True, type=str, help='name')
    parser.add_argument('db_name', required=True, type=str, help='name of the db')
    parser.add_argument('db_username', required=True, type=str, help='username of the db')
    parser.add_argument('db_pwd', required=True, type=str, help='pass of the db user')
    args = parser.parse_args()
    db_credentials = {
        "db_name": args['db_name'],
        "db_username": args['db_username'],
        "db_pwd": args['db_pwd'],
        "host": pg.get_hostname(),
        "port": pg.get_open_port()
    }
    if DBInstance.query.filter_by(postgraas_instance_name=args['postgraas_name']).first():
        return {'msg': "postgraas_name already exists {}".format(args['postgraas_name']) }
    try:
        db_credentials['container_id'] = pg.create_postgres_instance(args['postgraas_name'],
                                                                    db_credentials)
    except APIError as e:
        return {'msg': str(e)}
    db_entry = DBInstance(postgraas_instance_name=args['postgraas_name'],
                          db_name=args['db_name'],
                          username=args['db_username'],
                          password="",
                          hostname=db_credentials['host'],
                          port=db_credentials['port'],
                          container_id=db_credentials['container_id'])
    db.session.add(db_entry)
    db.session.commit()
    db_credentials["postgraas_instance_id"] = db_entry.id
    return db_credentials
```

The Instance Resource

```
class DBInstanceResource(Resource):

    @marshal_with(db_instance_marshaller)
    def get(self, id):
        entity = DBInstance.query.get(id)
        return entity
```

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```
def delete(self, id):
    c = docker.Client(base_url='unix://var/run/docker.sock',
                      version='auto',
                      timeout=10)
    entity = DBInstance.query.get(id)
    if entity:
        try:
            container_info = c.inspect_container(entity.container_id)
            print container_info
        except APIError as e:
            if e.response.status_code == 404:
                db.session.delete(entity)
                db.session.commit()
                return {'status': 'success', 'msg': 'deleted'}
        try:
            pg.delete_postgres_instance(entity.container_id)
        except APIError as e:
            return {'status': 'failed', 'msg': str(e)}
        db.session.delete(entity)
        db.session.commit()
        return {'status': 'success', 'msg': 'deleted postgraas instance'}
    else:
        return {'status': 'failed', 'msg': 'does not exist {}'.format(id)}
```

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Finally: set URIs for the Resources

```
from flask import Flask
from flask_restful import fields, Resource, marshal_with, Api, reqparse
from postgraas_server.management_resources import db
from postgraas_server.management_resources import DBInstanceResource,
DBInstanceCollectionResource
from postgraas_server.configuration import get_meta_db_config_path


def create_app(config):
    app = Flask(__name__)
    app.config['SQLALCHEMY_DATABASE_URI'] = get_meta_db_config_path(config)
    app.config['SQLALCHEMY_TRACK_MODIFICATIONS'] = False
    restful_api = Api(app)
    restful_api.add_resource(DBInstanceResource, "/postgraas_instances/<int:id>")
    restful_api.add_resource(DBInstanceCollectionResource, "/postgraas_instances")
    db.init_app(app)
    return app
```

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Done! We have all parts together…

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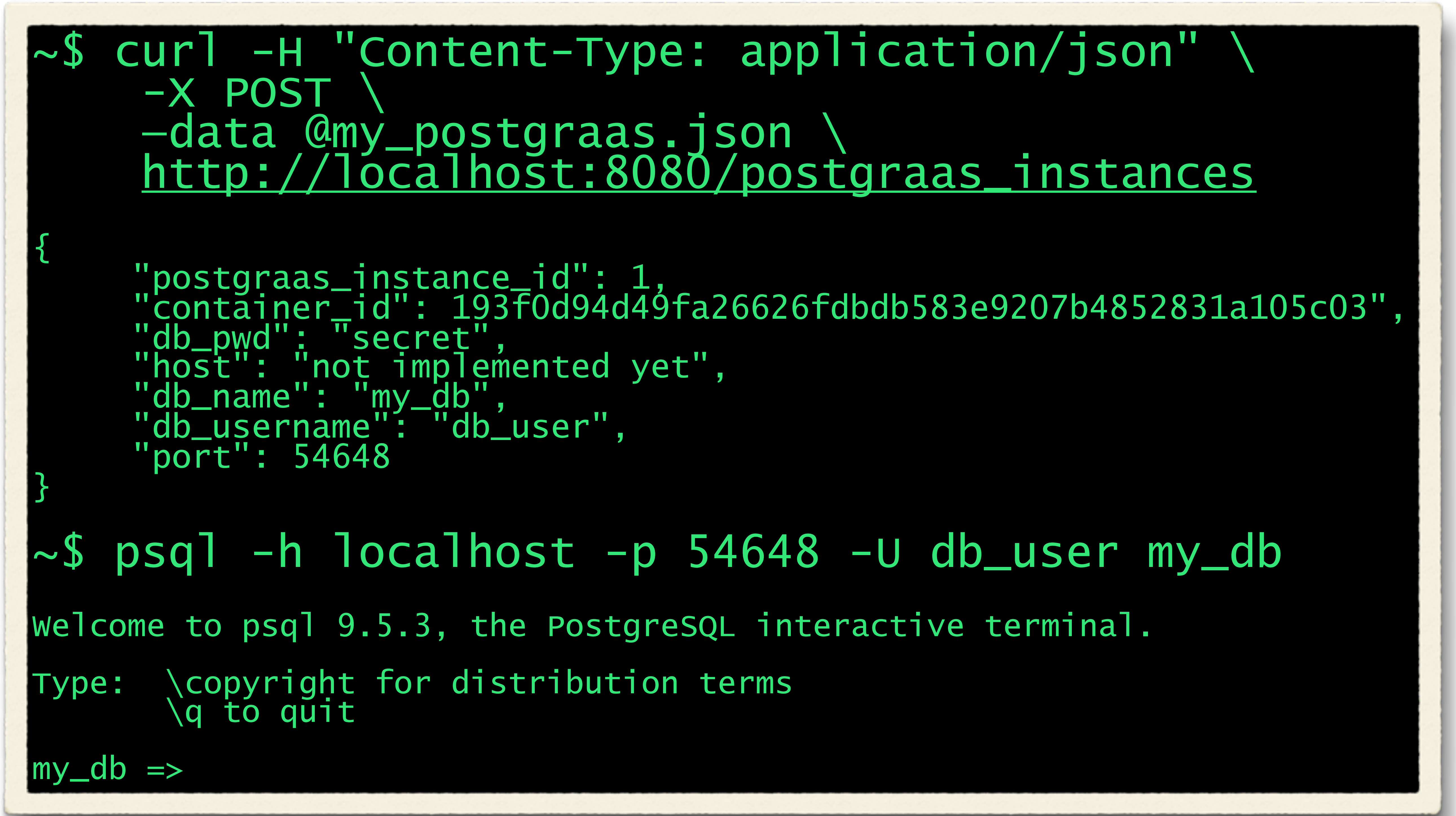
And does it work?

1. Starting Docker and pull the `postgres` image
2. Starting up the flask server (e.g. gunicorn)
3. Initialize the meta db
4. and then…

KEEP
CALM
AND
GET YOU A
POSTGRES

my_postgraas.json:

```
{
    "postgraas_name": "my_postgraas",
    "db_name": "my_db",
    "db_username": "db_user",
    "db_pwd": "secret"
}
```



```
~$ curl -H "Content-Type: application/json" \
    -X POST \
    –data @my_postgraas.json \
    http://localhost:8080/postgraas_instances

{
     "postgraas_instance_id": 1,
     "container_id": 193f0d94d49fa26626fdbdb583e9207b4852831a105c03",
     "db_pwd": "secret",
     "host": "not implemented yet",
     "db_name": "my_db",
     "db_username": "db_user",
     "port": 54648
}

~$ psql -h localhost -p 54648 -U db_user my_db

Welcome to psql 9.5.3, the PostgreSQL interactive terminal.

Type:  \copyright for distribution terms
       \q to quit

my_db =>
```

Postgraas Summary

- It is on github, contributions very welcome: https://github.com/blue-yonder/postgraas_server
- Running in our company since a year:
  - for integrations tests
  - for experiments
  - maybe soon for productive services
  - served over hundreds of postgres instances, 50 currently running

Now it is your turn…

- Take a manual step or a ticket in your delivery chain

  Example: A directory on a fileserver with some permissions
- Blueprint:
  - Flask with REST API
  - 'os.makedirs' and 'shutil.rmtree' for create and delete
- Design API:
  - Needed: name, linux user, permissions, quota?
- Implement:
  - Needed: A rainy Sunday afternoon!

Summary/TIL

- CRD is for machines, CRUD is for humans
- CRD is trivial to be implemented as REST API
- Most infrastructure can be expressed as CRD:
  - can be easily exposed via REST API
  - is immutable, so good for machines
  - can be consumed from applications as a self service
- Postgraas is a nice and useful example, that the above is true…

Thank You!