DigitalHouse >

DATA SCIENCE

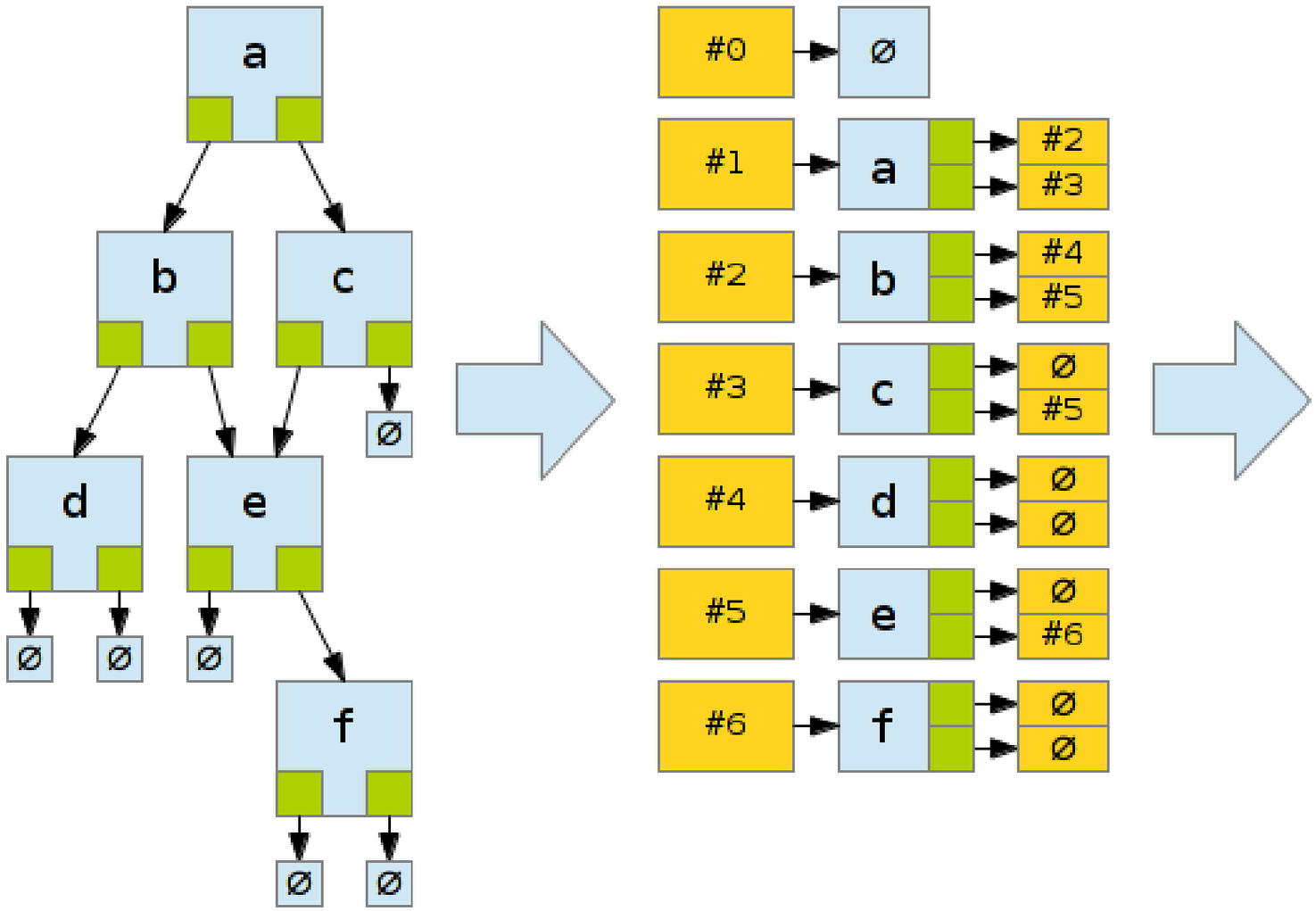
Machine Learning – Modelos em Produção

PERSISTÊNCIA DE MODELOS

https://docs.python.org/3/library/pickle.html

O Pickle é uma biblioteca de SERIALIZAÇÃO de objetos do Python. Pode ser utilizado para gravar estruturas de dados, modelos preditivos, etc

Input Data

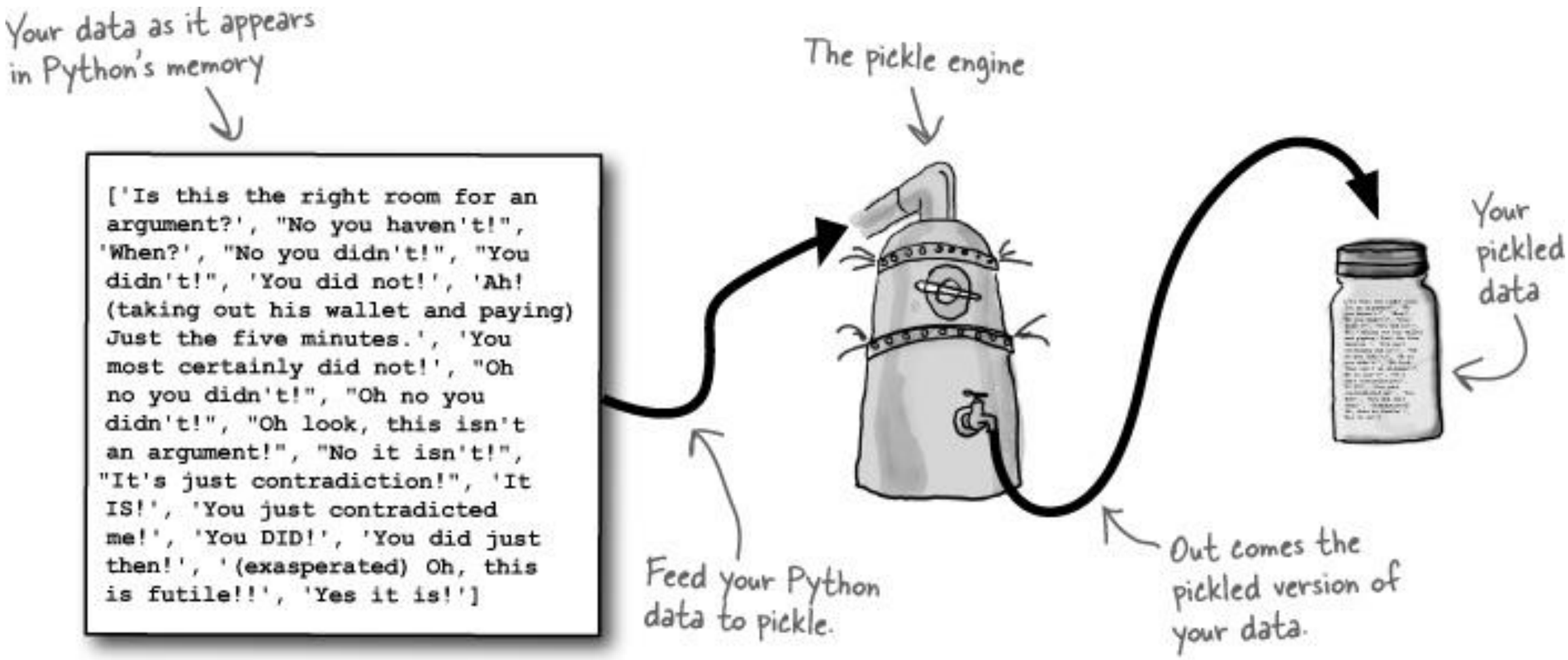


ser_ialize()

Output Format

```
node #1 { letter 'a';
   left #2; right #3; }

node #2 { letter 'b';
   left #4; right #5; }

node #3 { letter 'c';
   left #5; right NULL; }

node #4 { letter 'd';
   left NULL; right NULL; }

node #5 { letter 'e';
   left NULL; right #6; }

node #6 { letter 'f';
   left NULL; right NULL; }
```

PYTHON PICKLE



https://www.oreilly.com/library/view/head-first-python/9781449397524/ch04.html

python™

pickle exploitation

TL;DR: Never unpickle data from sources you don't trust. Otherwise you open your app up to a relatively simple way of remote code execution.

intoli

HOME FEATURES PRICING TEAM BLOG CONTACT

DANGEROUS PICKLES — MALICIOUS PYTHON SERIALIZATION

BY EVAN SANGALINE | OCTOBER 17, 2017

Follow @sangaline 283 Star 205

What's so dangerous about pickles?

> Those pickles are very dangerous pickles. I literally can't begin to tell you how really dangerous they are. You have to trust me on that. It's important, Ok?
>
> – *"Explosive Disorder" by Pan Telare*

Before we get elbow deep in opcodes here, let's cover a little background. The Python standard library has a module called pickle that is

SEARCH

Search

TAGS

PYTHON (19)

BROWSE ALL TAGS

https://intoli.com/blog/dangerous-pickles/

Joblib: running Python functions as pipeline jobs

Introduction

Joblib is a set of tools to provide **lightweight pipelining in Python**. In particular:

1. transparent disk-caching of functions and lazy re-evaluation (memoize pattern)
2. easy simple parallel computing

Joblib is optimized to be **fast** and **robust** on large data in particular and has specific optimizations for *numpy* arrays. It is **BSD-licensed**.

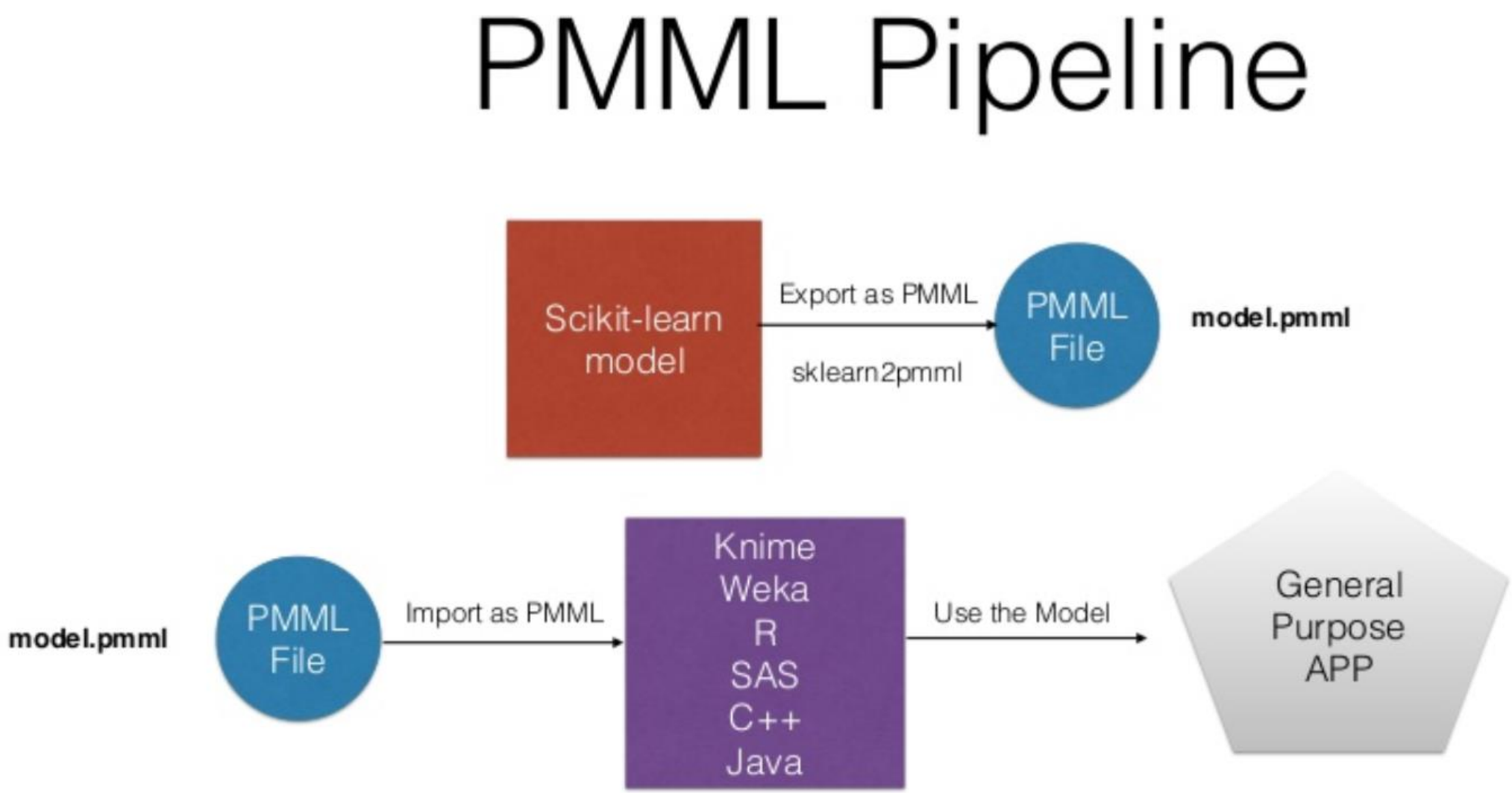
Documentation:	https://joblib.readthedocs.io
Download:	https://pypi.python.org/pypi/joblib#downloads
Source code:	https://github.com/joblib/joblib
Report issues:	https://github.com/joblib/joblib/issues

https://joblib.readthedocs.io/en/latest/

O Joblib também oferece funcionalidades de persistência e serialização de dados, além de ser excelente para a paralelização de tarefas e montagem de pipelines complexos.

Pmml XML File

```
<Node recordCount="0" score="Iris-virginica">CRLF
  <True/>CRLF
  <ScoreDistribution confidence="0.3333333333333333" recordCount="50" value="Iris-virginica"/>CRLF
  <ScoreDistribution confidence="0.3333333333333333" recordCount="50" value="Iris-setosa"/>CRLF
  <ScoreDistribution confidence="0.3333333333333333" recordCount="50" value="Iris-versicolor"/>CRLF
  <Node recordCount="0" score="Iris-virginica">CRLF
    <SimplePredicate field="a3" operator="greaterThan" value="2.450"/>CRLF
    <ScoreDistribution confidence="0.5" recordCount="50" value="Iris-virginica"/>CRLF
<ScoreDistribution confidence="0.0" recordCount="0" value="Iris-setosa"/>CRLF
<ScoreDistribution confidence="0.5" recordCount="50" value="Iris-versicolor"/>CRLF
<Node recordCount="34" score="Iris-virginica">CRLF
  <SimplePredicate field="a3" operator="greaterThan" value="5.150"/>CRLF
  <ScoreDistribution confidence="1.0" recordCount="34" value="Iris-virginica"/>CRLF
  <ScoreDistribution confidence="0.0" recordCount="0" value="Iris-setosa"/>CRLF
  <ScoreDistribution confidence="0.0" recordCount="0" value="Iris-versicolor"/>CRLF
</Node>CRLF
<Node recordCount="0" score="Iris-versicolor">CRLF
  <SimplePredicate field="a3" operator="lessOrEqual" value="5.150"/>CRLF
  <ScoreDistribution confidence="0.24242424242424243" recordCount="16" value="Iris-virginica"/>CRLF
  <ScoreDistribution confidence="0.0" recordCount="0" value="Iris-setosa"/>CRLF
  <ScoreDistribution confidence="0.7575757575757576" recordCount="50" value="Iris-versicolor"/>CRLF
  <Node recordCount="8" score="Iris-virginica">CRLF
    <SimplePredicate field="a4" operator="greaterThan" value="1.850"/>CRLF
    <ScoreDistribution confidence="1.0" recordCount="8" value="Iris-virginica"/>CRLF
```



https://www.slideshare.net/AnassBensrhirDatasci/deploying-machine-learning-models-to-production

Search projects

Help Sponsor Log in Register

sklearn-pmml-model 0.0.14.1

Latest version

```
pip install sklearn-pmml-model
```

Released: Mar 26, 2020

A library to parse PMML models into Scikit-learn estimators.

Navigation

- Project description
- Release history
- Download files

Project links

Project description

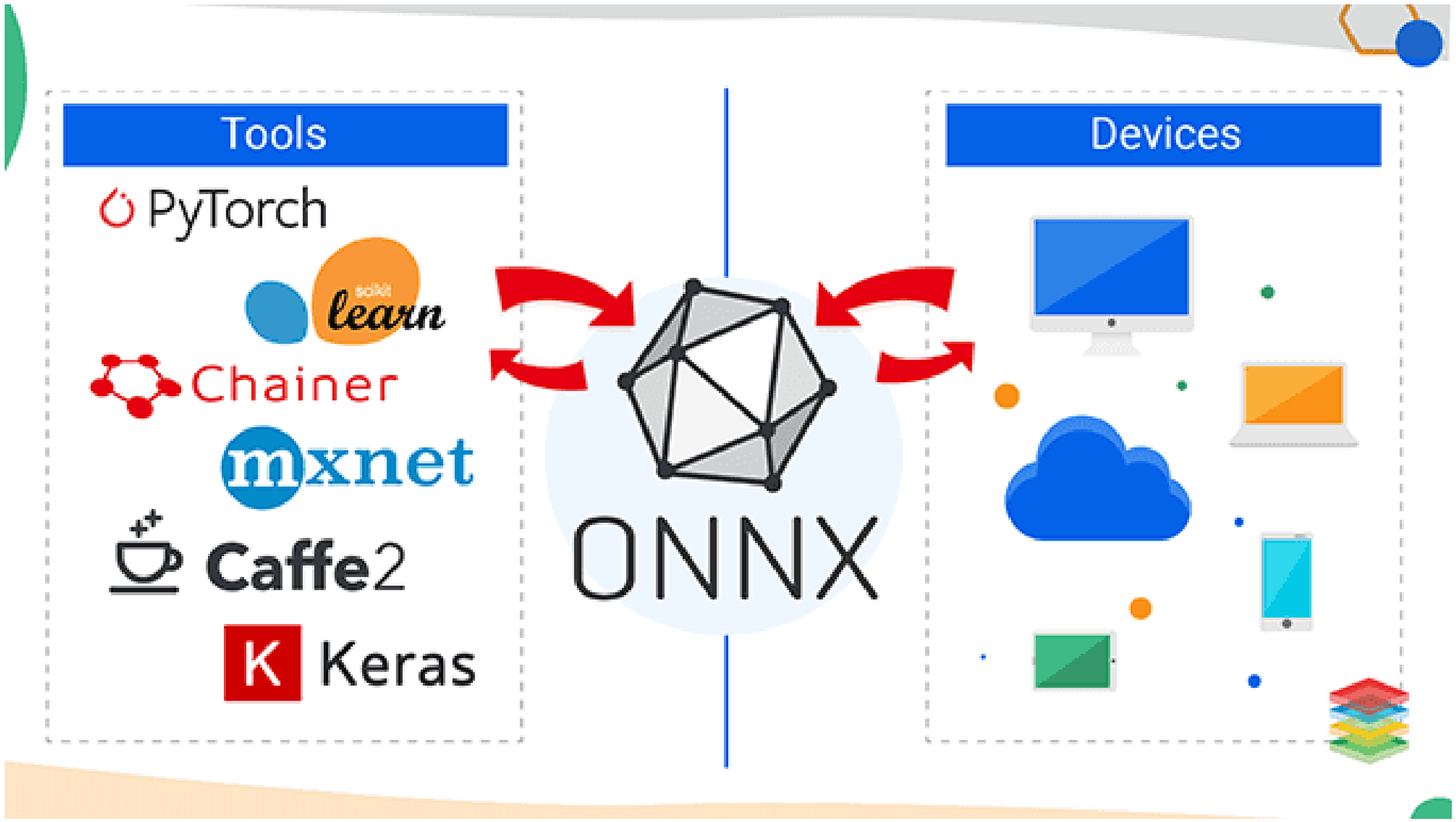
scikit learn + PMML Predictive Model Markup Language

sklearn-pmml-model

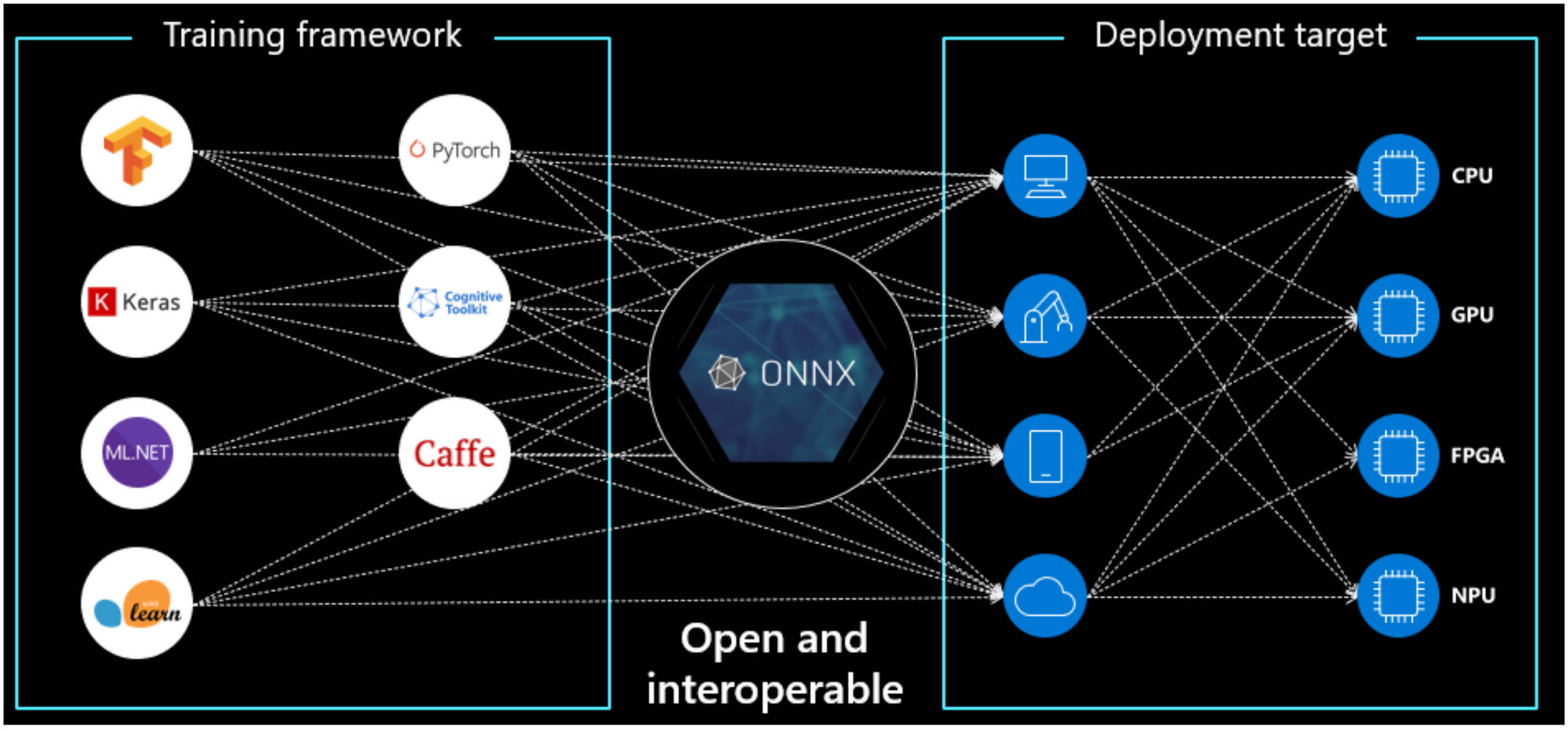
pypi package 0.0.14.1 | circleci failing | codecov 100% | docs passing

https://pypi.org/project/sklearn-pmml-model/

ONNX – OPEN NEURAL NETWORK EXCHANGE



https://www.xenonstack.com/blog/onnx/



https://microsoft.github.io/ai-at-edge/docs/onnx/

EXERCÍCIO

- Vamos rodar o o Notebook **SklearnPipelines_persistence_vf.ipynb** para vermos o Pickle e Joblib em ação.

VAMOS COLOCAR UM WEB APP EM PRODUÇÃO (NA INTERNET)

Streamlit

Streamlit.
The fastest way to build data apps

Streamlit's open-source app framework is the easiest way for data scientists and machine learning engineers to create beautiful, performant apps in only a few hours! All in pure Python. All for free.

https://www.streamlit.io/

```
pip install streamlit
```

Observação – poderá ser necessário colocar o caminho do streamlit.exe no PATH (Windows)

C:\Users\[**USUÁRIO**]\AppData\Roaming\Python\Python37\Scripts

```
(base) C:\streamlit>streamlit hello

  Welcome to Streamlit. Check out our demo in your browser.

  Local URL: http://localhost:8501
  Network URL: http://192.168.0.10:8501

  Ready to create your own Python apps super quickly?
  Just head over to https://docs.streamlit.io

  May you create awesome apps!
```

Vamos rodar o “Hello World” do Streamlit no prompt e ver o resultado no Browser:

- `> streamlit hello`

Depois iremos rodar também:

```
> streamlit run tutorial.py
> streamlit run bandrec-streamlit.py
```

HEROKU

Streamlit

Recomendação de Bandas

Escolha o país

- (•) Estados Unidos
- ( ) Reino Unido
- ( ) Brasil

Digite o nome da Banda / Artista

megadeth

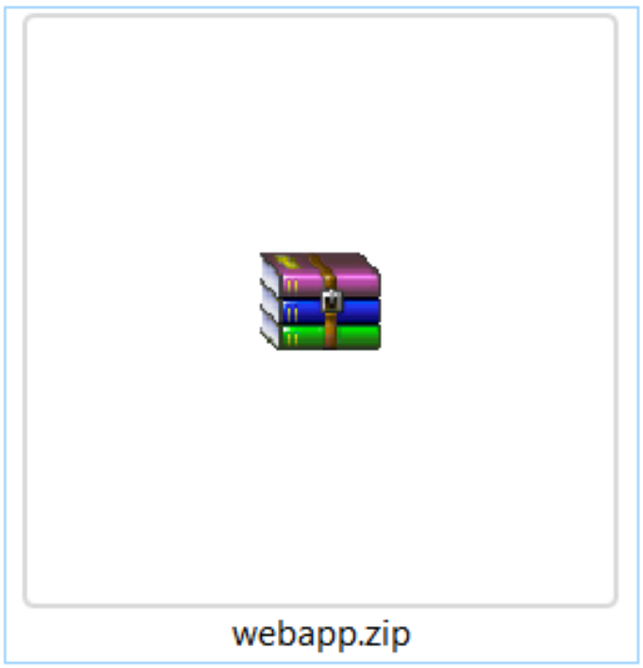
Submeter

Recommendations for megadeth:

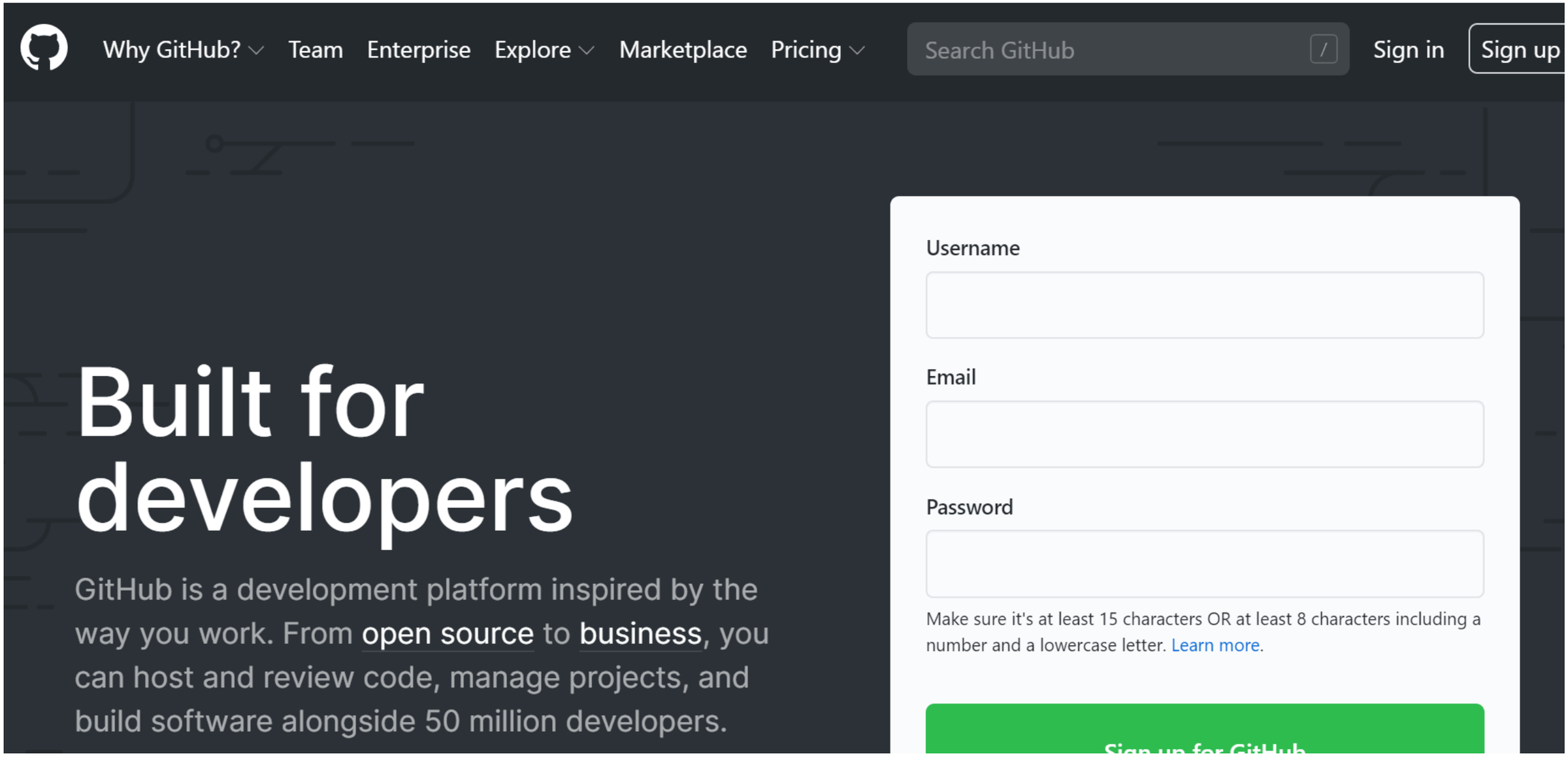
1: black sabbath, with distance of 0.3221987029536757:

2: koЯn, with distance of 0.3742111519629977:

3: slipknot, with distance of 0.37701311363710077:



Descompactar arquivos recebidos do pacote webapp.zip



https://github.com/

Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere?
Import a repository.

Owner

gitaulasdh /

Repository name *

Great repository names are short and memorable. Need inspiration? How about **ubiquitous-pancake**?

Description (optional)

Public
Anyone on the internet can see this repository. You choose who can commit.

Private
You choose who can see and commit to this repository.

Create repository

gitaulasdh / **webapp**

Unwatch 1 | Star 0 | Fork 0

Quick setup — if you've done this kind of thing before

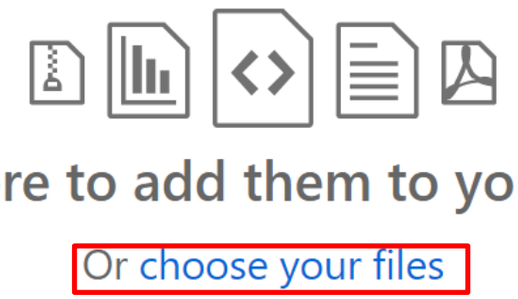
Set up in Desktop or HTTPS SSH `https://github.com/gitaulasdh/webapp.git`

Get started by creating a new file or uploading an existing file. We recommend every repository include a README, LICENSE, and .gitignore.

...or create a new repository on the command line

```
echo "# webapp" >> README.md
git init
git add README.md
git commit -m "first commit"
git remote add origin https://github.com/gitaulasdh/webapp.git
```

webapp /



Drag files here to add them to your repository

Or choose your files

Subir todos arquivos que estavam no webapp.zip, descompactados previamente

bandrec-streamlit.py

Procfile

requirements.txt

setup.sh

usersha1-artmbid-artname-plays_1.tsv

usersha1-profile.tsv

Commit changes

Carga inicial dos arquivos

Add an optional extended description...

Commit changes | Cancel

E nesta mesma tela dar “commit changes”.

gitaulasdh / **webapp**

Unwatch 1 | Star 0 | Fork 0

Branch: master | Go to file | Add file | Clone

gitaulasdh committed b25299e now ... | 1 commits | 1 branch | 0 tags

Procfile	Carga inicial dos arquivos	now
bandrec-streamlit.py	Carga inicial dos arquivos	now
requirements.txt	Carga inicial dos arquivos	now
setup.sh	Carga inicial dos arquivos	now
usersha1-artmbid-artname-pla...	Carga inicial dos arquivos	now
usersha1-profile.tsv	Carga inicial dos arquivos	now

About

No description, website, or topics provided.

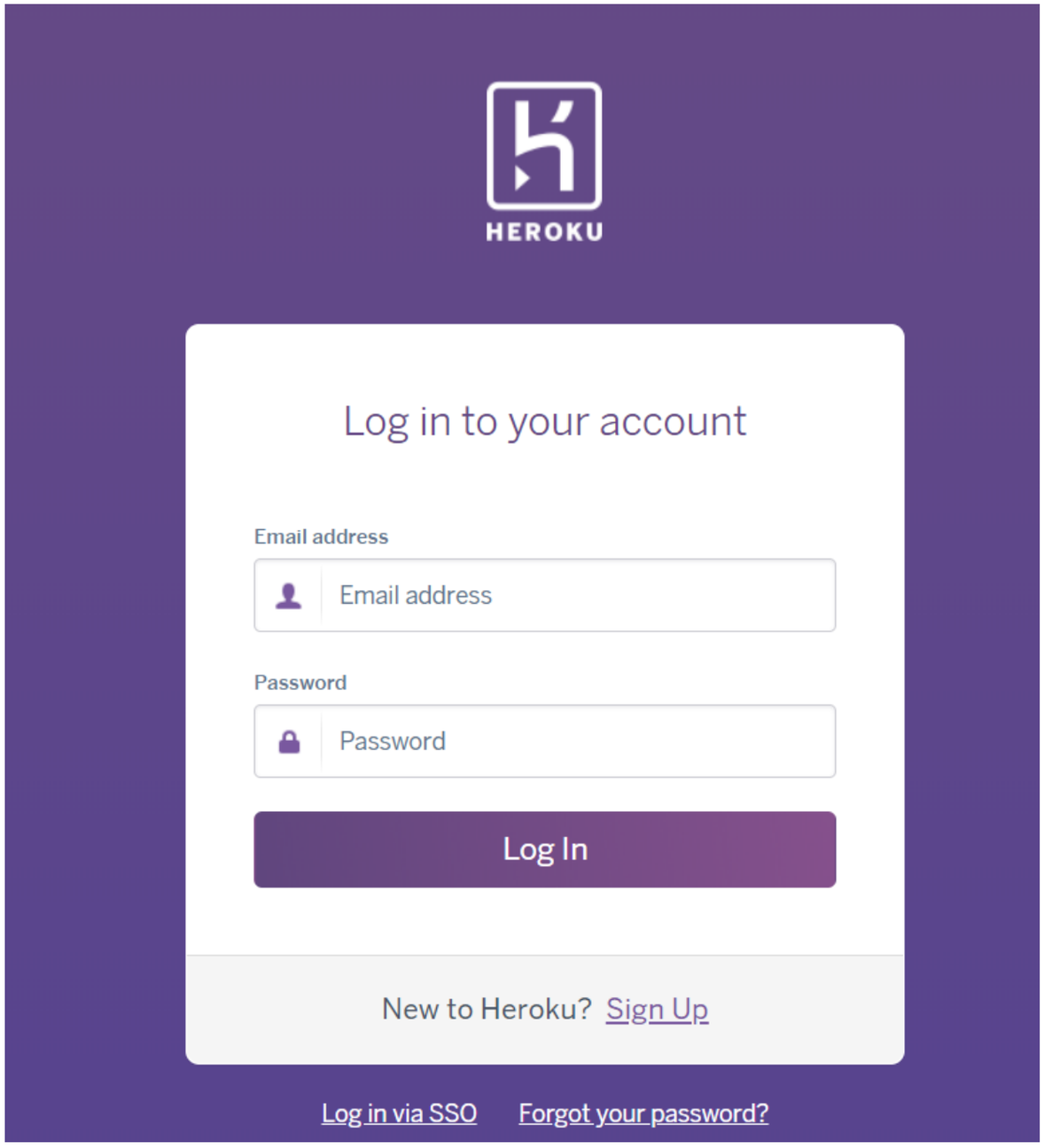
Releases

No releases published

Create a new release

Packages

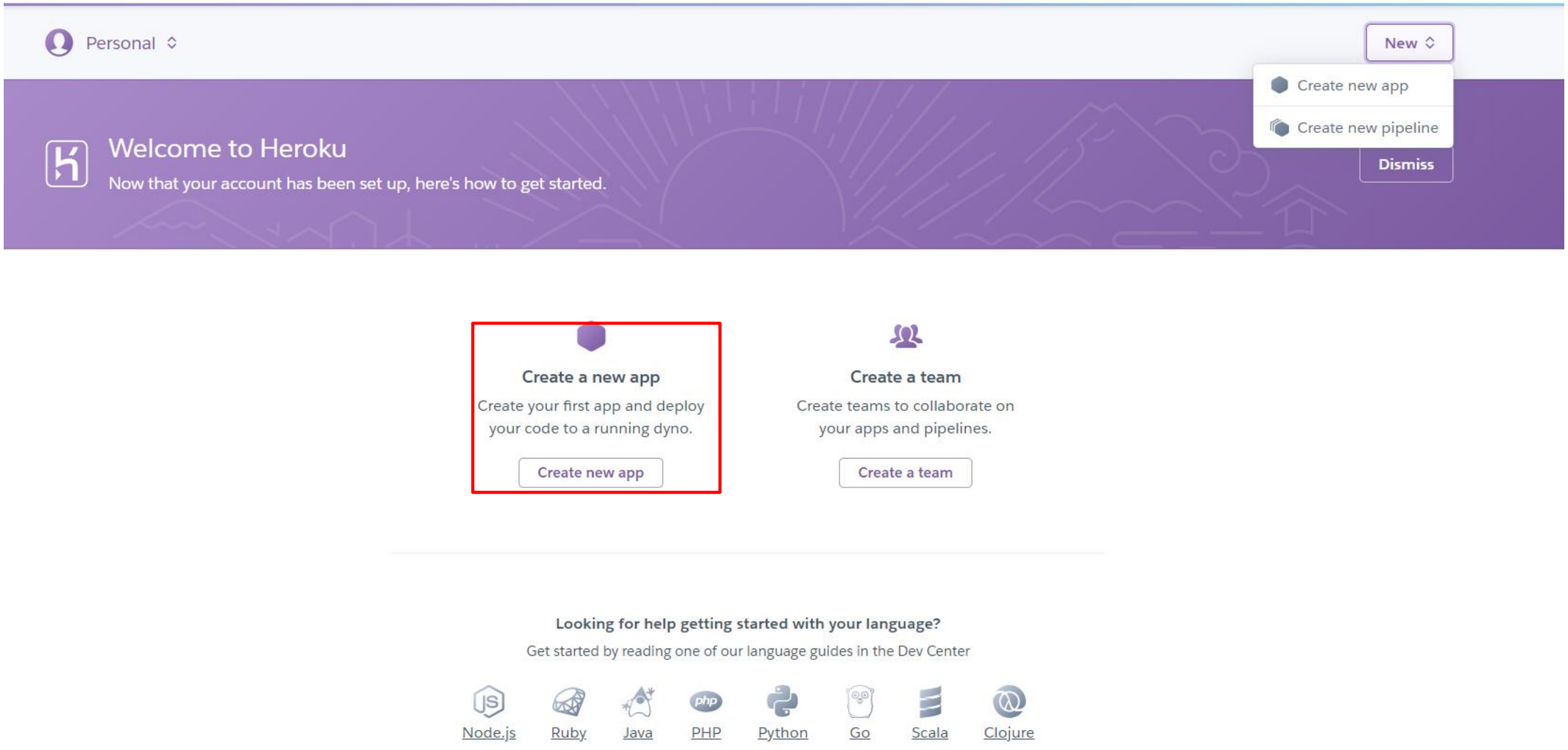
HEROKU – ONDE COLOCAREMOS NOSSO WEBSERVICE



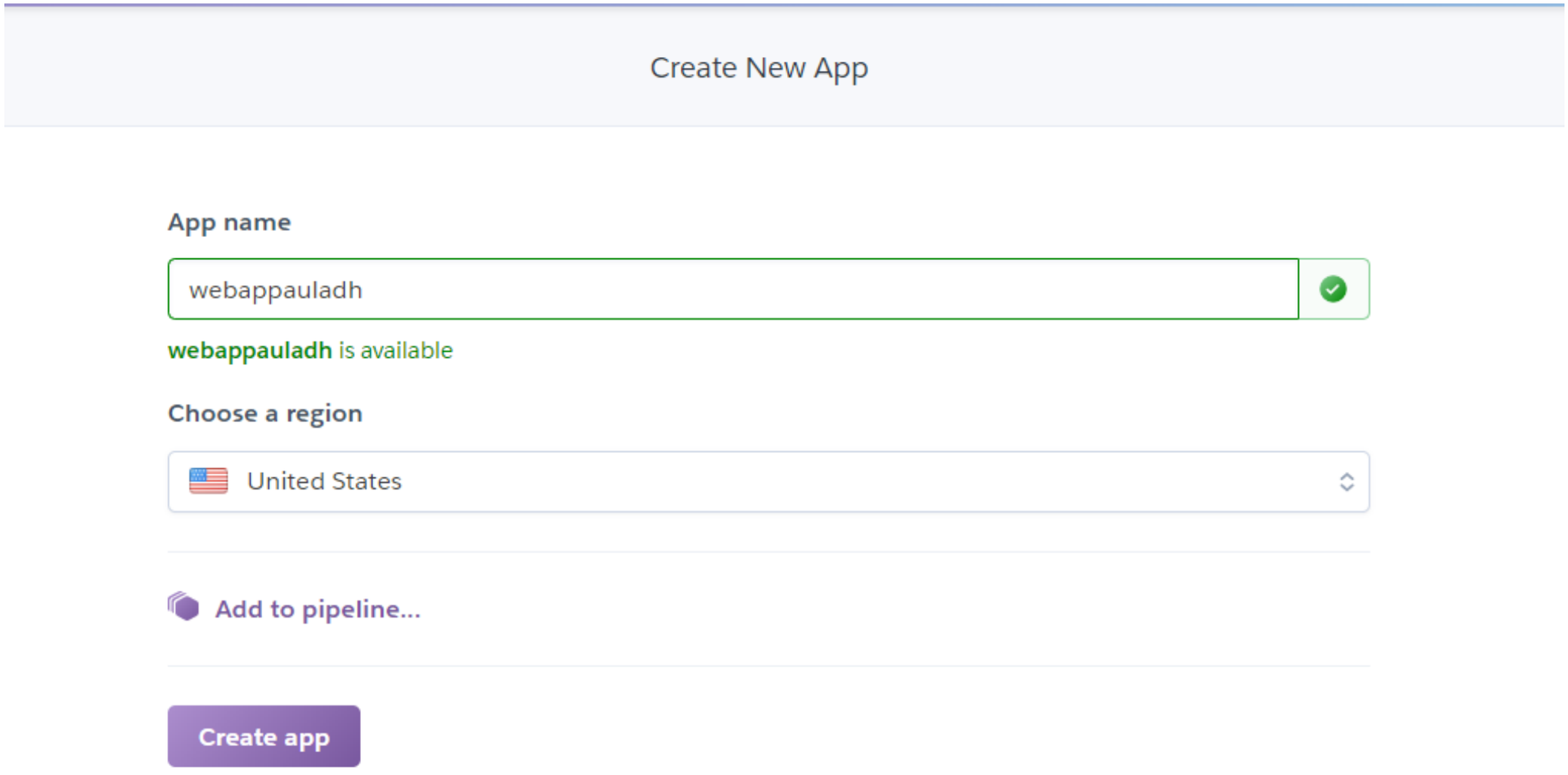
https://www.heroku.com/

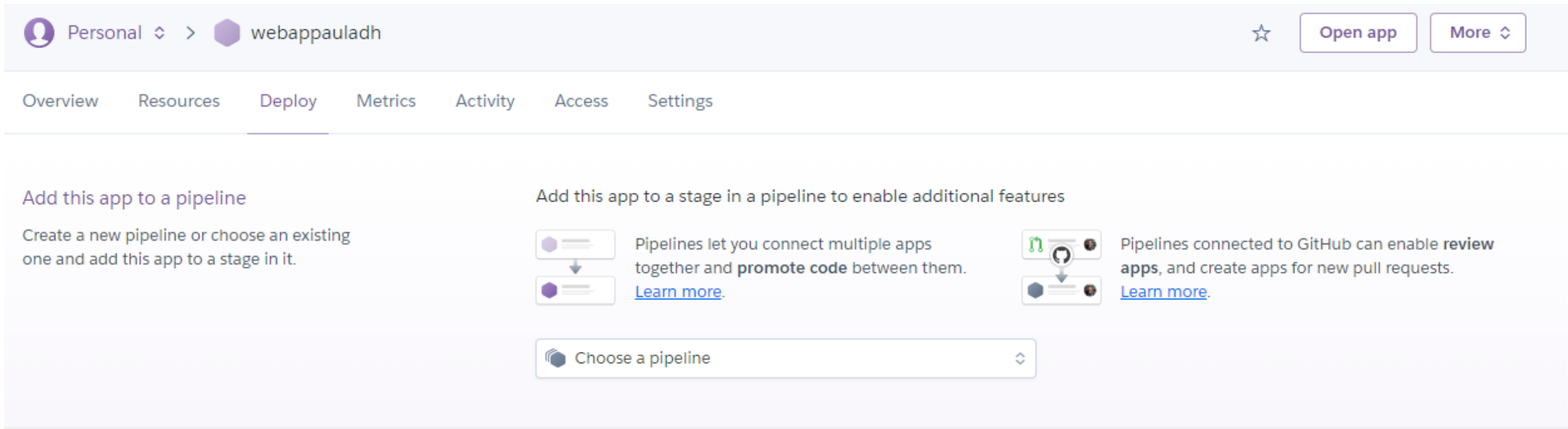
Selecionar “Sign Up”, preencher todos os dados e confirmar a inscrição no e-mail enviado

CREATE A NEW APP

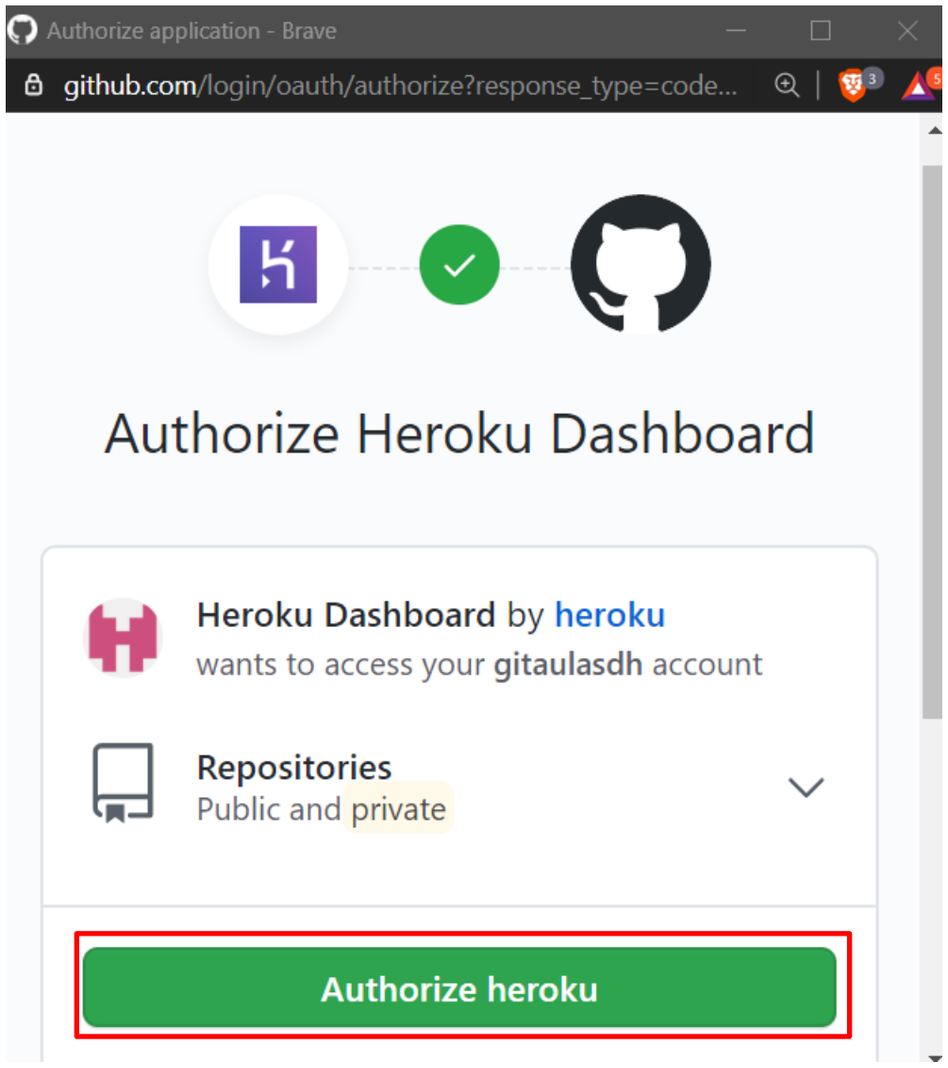


ESCOLHER UM NOME PARA O WEB APP




Personal
webappauladh
Open app
More
Overview
Resources
Deploy
Metrics
Activity
Access
Settings
Add this app to a pipeline
Create a new pipeline or choose an existing one and add this app to a stage in it.
Add this app to a stage in a pipeline to enable additional features
Pipelines let you connect multiple apps together and promote code between them.
Learn more.
Pipelines connected to GitHub can enable review apps, and create apps for new pull requests.
Learn more.
Choose a pipeline
Deployment method
Heroku Git
Use Heroku CLI
GitHub
Connect to GitHub
Container Registry
Use Heroku CLI
Connect to GitHub
Connect this app to GitHub to enable code diffs and deploys.
View your code diffs on GitHub
Connect your app to a GitHub repository to see commit diffs in the activity log.
Deploy changes with GitHub
Connecting to a repository will allow you to deploy a branch to your app.
Automatic deploys from GitHub
Select a branch to deploy automatically whenever it is pushed to.
Create review apps in pipelines
Pipelines connected to GitHub can enable review apps, and create apps for new pull requests. Learn more.
Connect to GitHub

AUTORIZAR A CONEXÃO



INFORMAR REPO CRIADO NO GITHUB E DAR CONNECT

Personal > webappauladh ☆ Open app More

Overview Resources Deploy Metrics Activity Access Settings

Add this app to a pipeline

Create a new pipeline or choose an existing one and add this app to a stage in it.

Add this app to a stage in a pipeline to enable additional features

Pipelines let you connect multiple apps together and **promote code** between them. Learn more.

Pipelines connected to GitHub can enable **review apps**, and create apps for new pull requests. Learn more.

Choose a pipeline

Deployment method

Heroku Git
Use Heroku CLI

GitHub
Connect to GitHub

Container Registry
Use Heroku CLI

Connect to GitHub

Connect this app to GitHub to enable code diffs and deploys.

Search for a repository to connect to

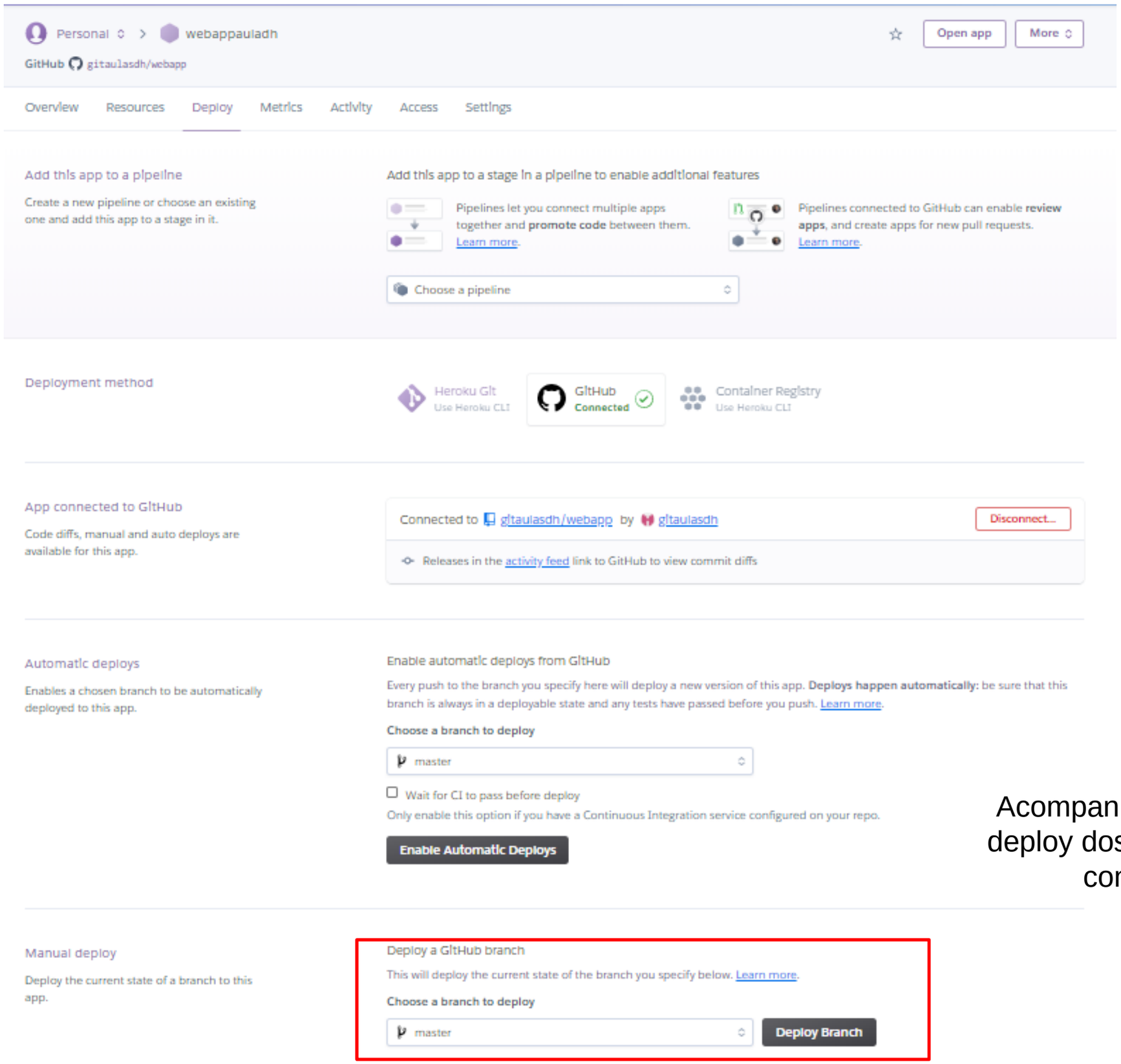
gitaulasdh | webapp | Search

Missing a GitHub organization? Ensure Heroku Dashboard has team access.

gitaulasdh/webapp Connect

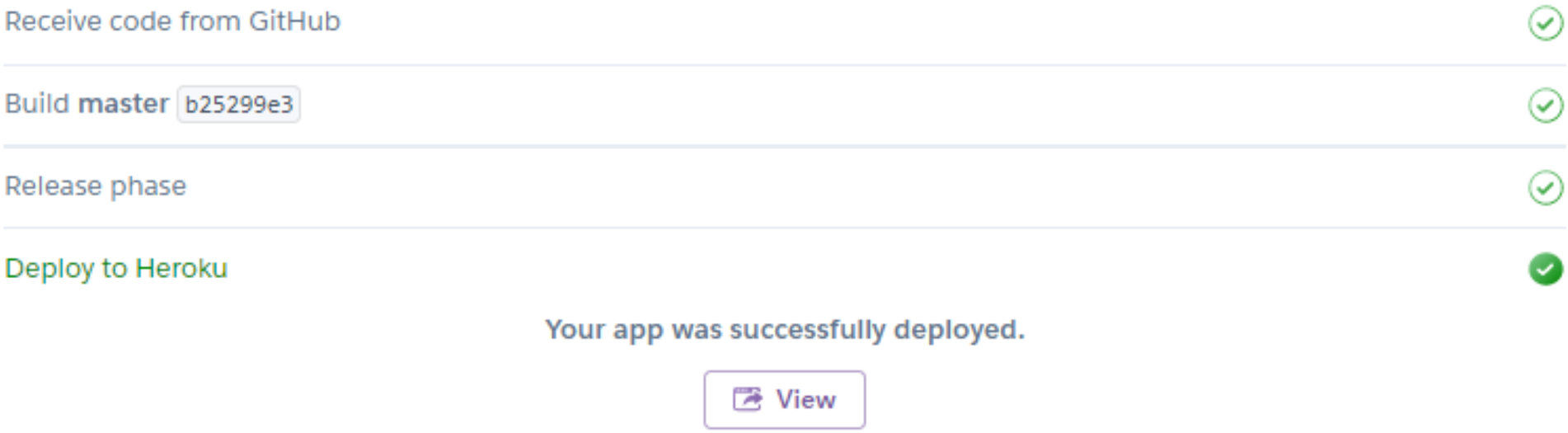
Aguardar alguns segundos para que seja feita a conexão / download do repo ou dê reload na página

CLIQUE EM “DEPLOY BRANCH”

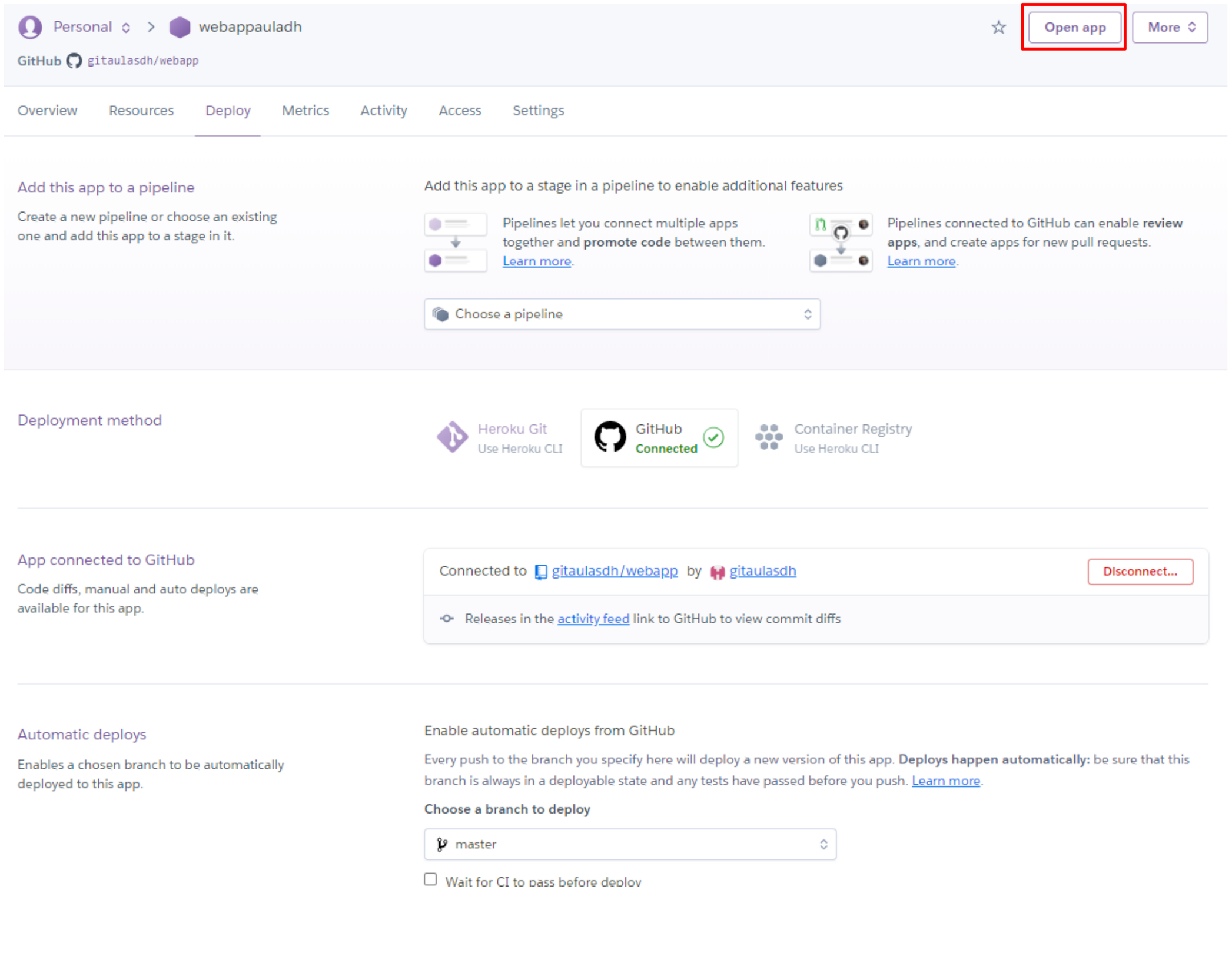


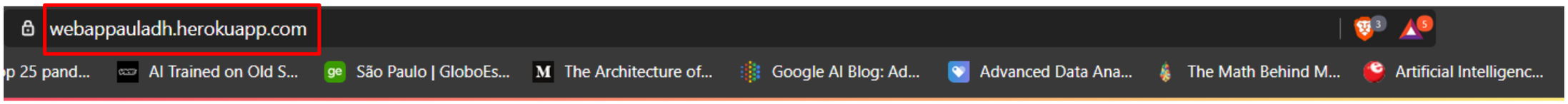
Acompanhar para ver se o deploy dos arquivos foi feito com sucesso

CLIQUE EM “DEPLOY BRANCH”



CLIQUE EM “OPEN APP”





Recomendação de Bandas

Escolha o país

- (•) Estados Unidos
- ( ) Reino Unido
- ( ) Brasil

Digite o nome da Banda / Artista

megadeth

Submeter

Recommendations for megadeth:

1: black sabbath, with distance of 0.3221987029536757:

2: koЯn, with distance of 0.3742111519629977:

3: slipknot, with distance of 0.37701311363710077:

ARQUIVOS IMPORTANTES – STREAMLIT - HEROKU

Procfile

```
web: sh setup.sh && streamlit run --server.port $PORT bandrec-streamlit.py

```

Procfile – indica os comandos que vão ser executados

requirements.txt

```
numpy==1.17.3
pandas==1.0.5
streamlit==0.62.0
scipy==1.4.1
fuzzywuzzy==0.18.0
sklearn

```

requirements.txt – libs a serem instaladas

setup.sh

```
mkdir -p ~/.streamlit/

echo "\
[server]\n\
headless = true\n\
port = $PORT\n\
enableCORS = false\n\
\n\
" > ~/.streamlit/config.toml
```

setup.sh – preparação e configuração do ambiente

VAMOS COLOCAR UM WEB SERVICE EM PRODUÇÃO (NA INTERNET)

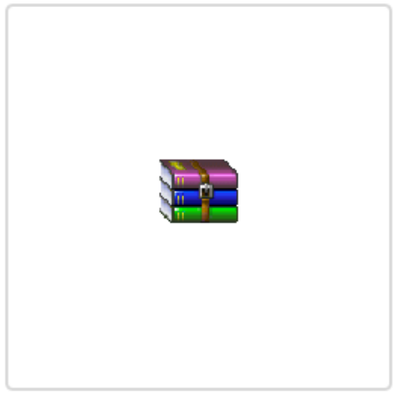
EXERCÍCIO

- Vamos rodar o o Notebook **titanic_api_heroku_vf.ipynb**

para vermos a utilização de APIs com um modelo persistido com o pickle – localmente e no Heroku.

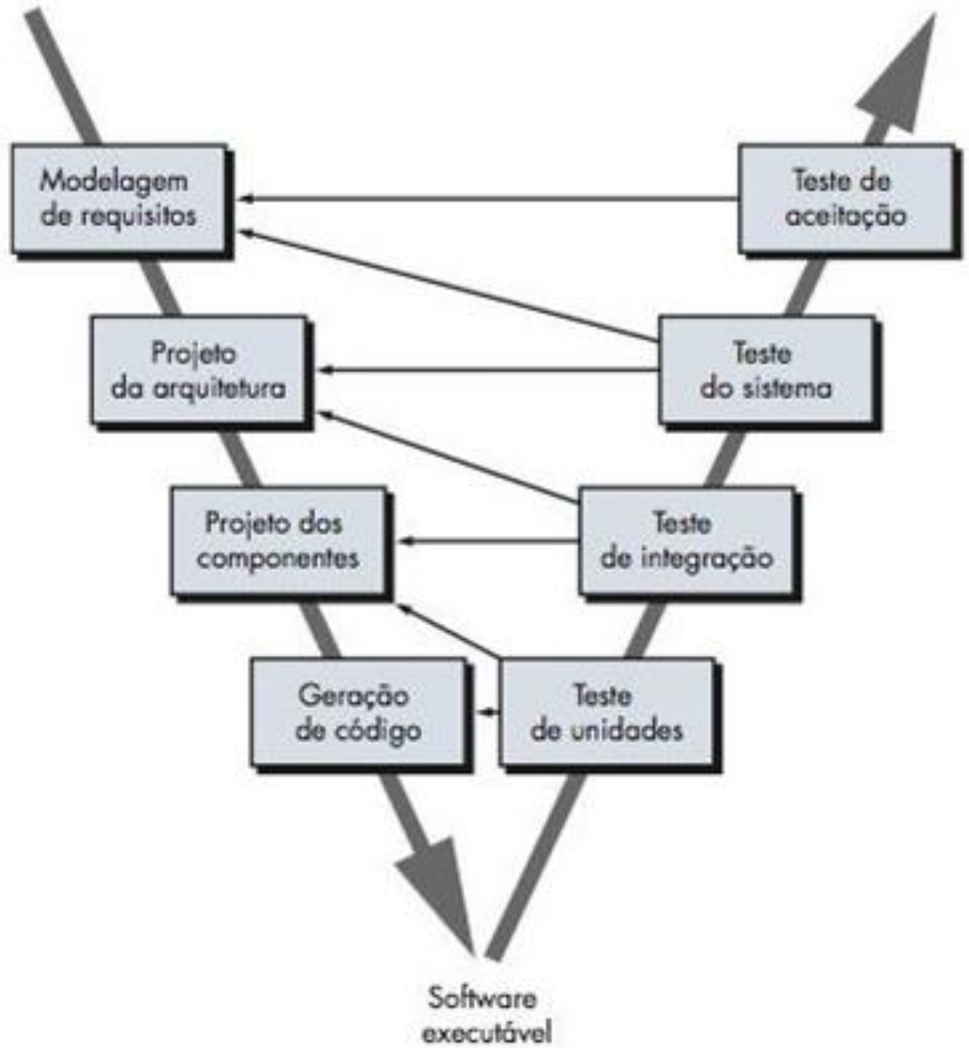
Agora vamos criar um webservice com o Flask e fazer o deploy do mesmo no Heroku.

DESCOMPACTAR ARQUIVOS DO PACOTE



Descompactar arquivos em webservice.zip e abrir o notebook **deploy_api_heroku_v1**.ipynb no Jupyter.

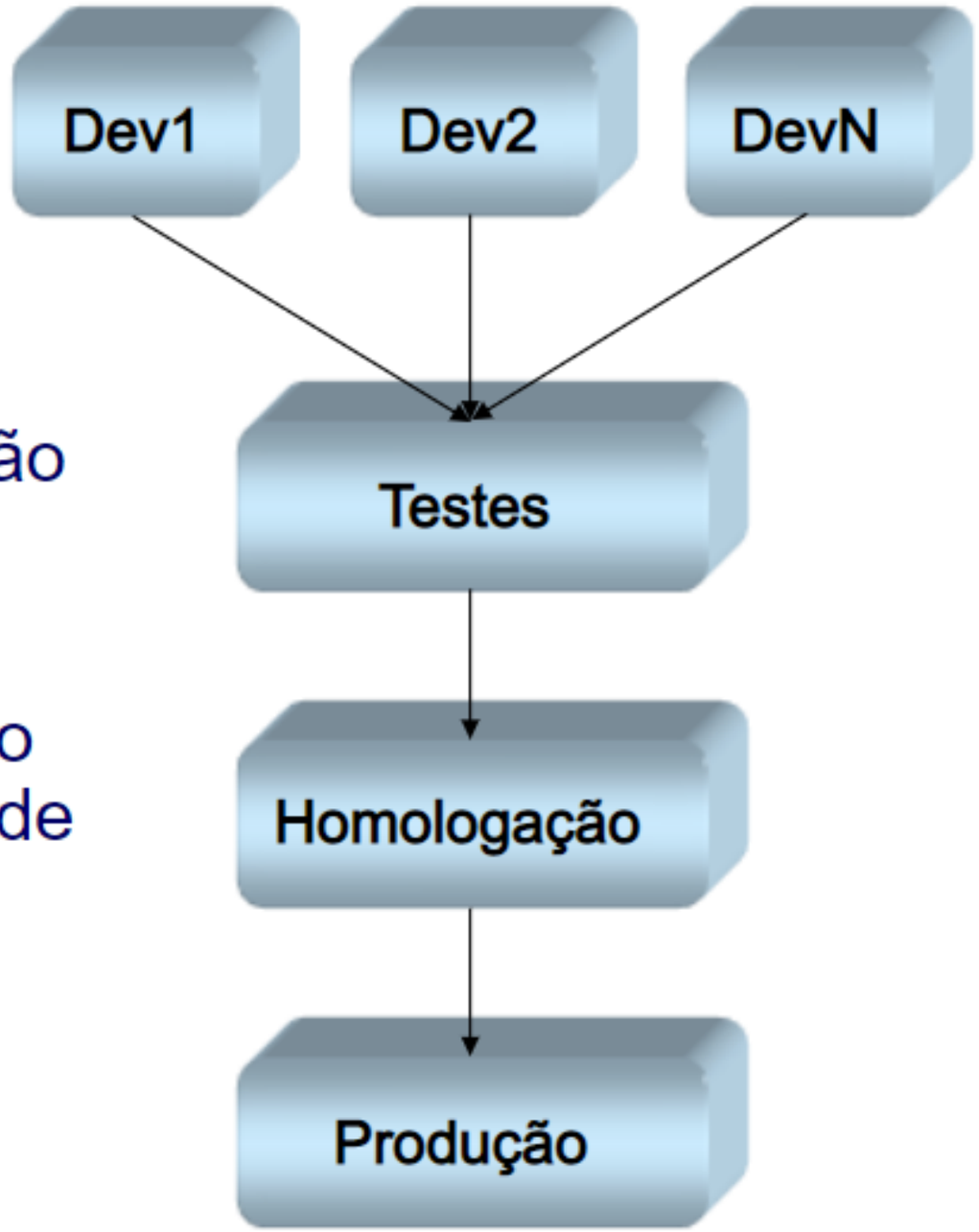
COMO O SOFTWARE CHEGA AO AMBIENTE PRODUTIVO?

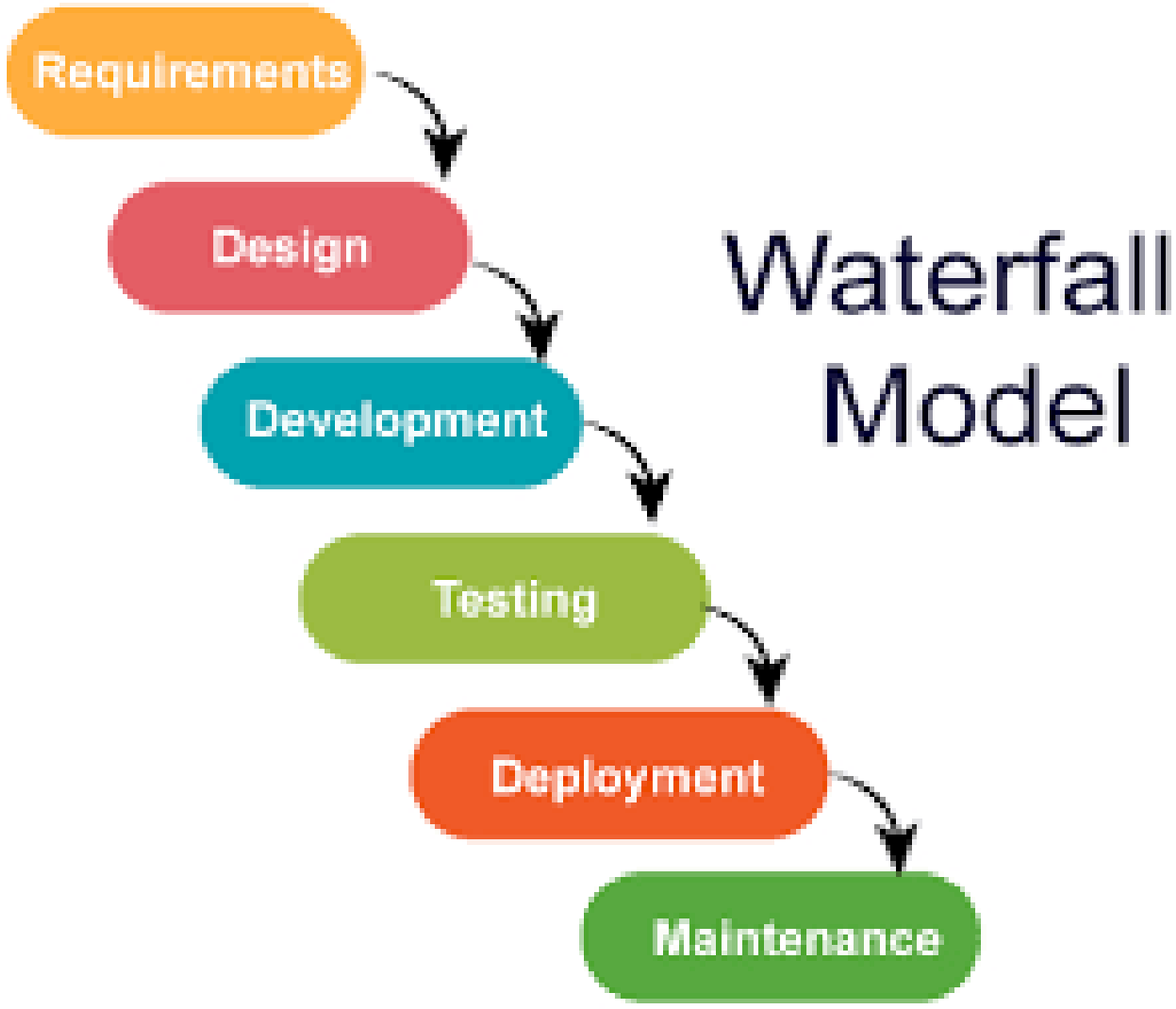


https://www.devmedia.com.br/introducao-ao-modelo-cascata/29843

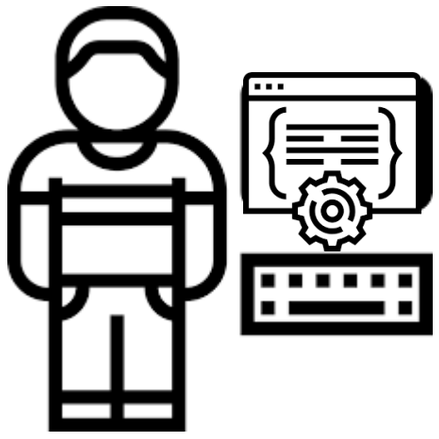
Importante lembrarmos do modelo mais tradicional de desenvolvimento de software – o "**V Model**" para entendermos sua evolução e o estágio atual dos conceitos de entrega e desenvolvimento de software.

- Desenvolvimento
  - Estação de trabalho dos desenvolvedores
- Testes
  - Ambiente para testar a integração das unidades desenvolvidas
- Homologação
  - Ambiente similar ao de produção utilizado para realizar os testes de aceitação
- Produção
  - Ambiente real de produção da aplicação

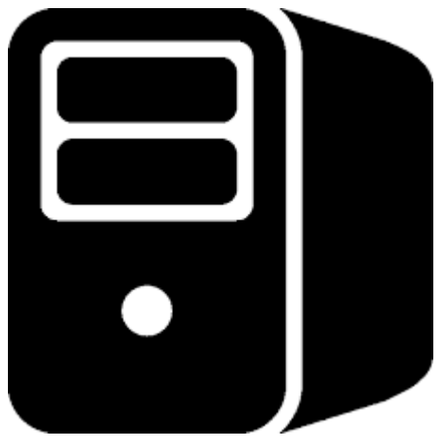




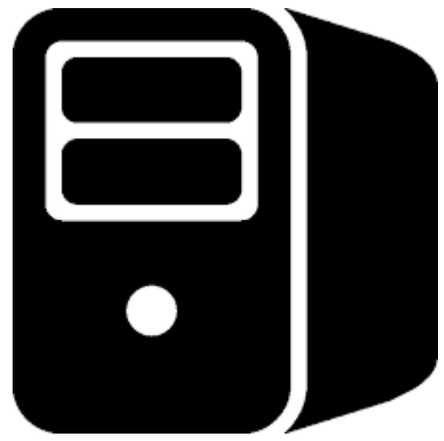
Outra denonimação muito comum para o modelo tradicional de desenvolvimento de software é ***Waterfall*** ou Cascata em português.



DESENV.



PROVAS

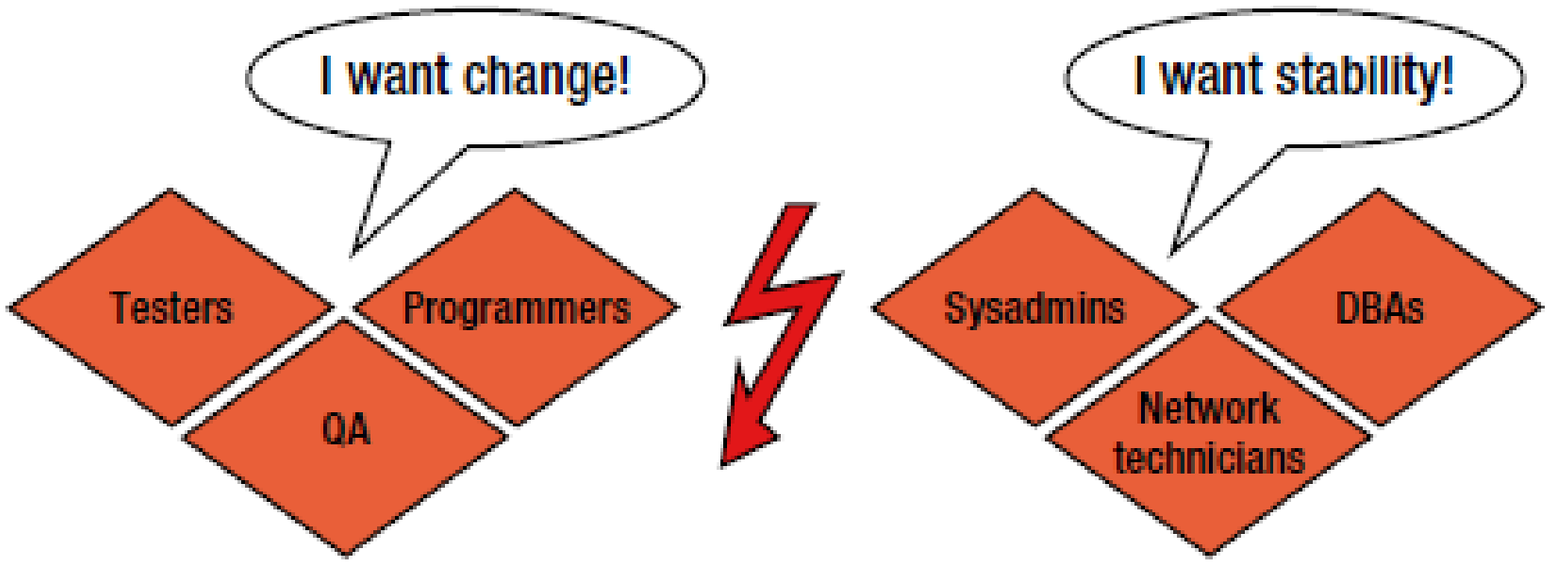


HOMOLOGAÇÃO

PRODUÇÃO

No modelo tradicional de desevolvimento o programador faz o ***Build*** de seu programa e entrega o executável produzido para a equipe de Operações. Esta equipe faz a **Movimentação** do programa entre os ambientes.

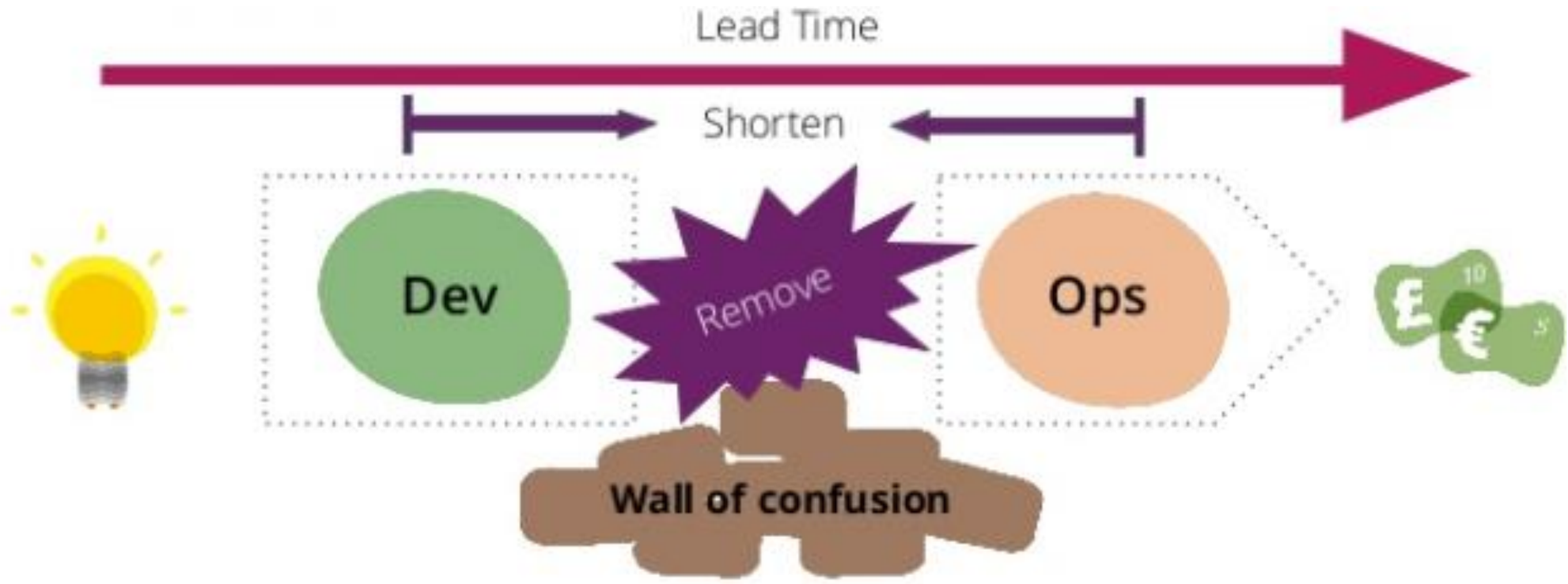
DEV x OPS – OBJETIVOS DISTINTOS



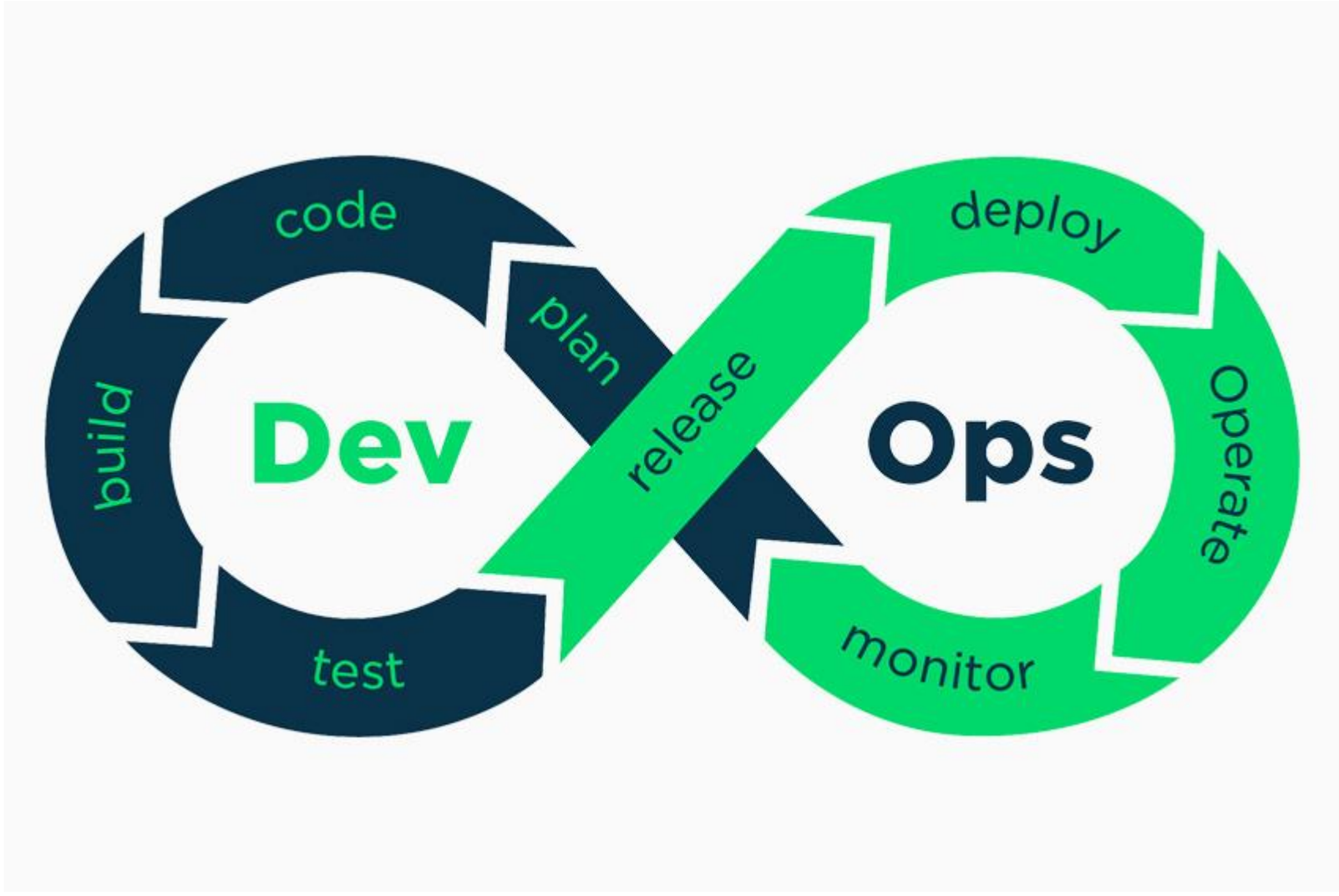
No modelo tradicional de desenvolvimento tínhamos uma divisão clara e distinta entre as equipes de **Desenvolvimento** e **Operações**. Hoje é consenso que havia entre os dois um "**Muro de Confusão**" causando uma série de problemas.

https://pt.slideshare.net/jallspaw/10-deploys-per-day-dev-and-ops-cooperation-at-flickr

Porém em 2009 John Allspaw e Paul Hammond fizeram a apresentação "*10 deploys per day – Dev & Ops cooperation at Flickr*" – introduzindo o conceito de **DevOps**.



O conceito de DevOps propõe então eliminar esta barreira entre as duas equipes – principalmente através da **Automatização** dos processos de entrega de software ao ambiente produtivo.



E junto com a automação, além da maior integração entre as equipes, a ideia é que o processo de entrega de software com valor ao cliente possa ocorrer com uma frequência bem maior – baseada em um processo iterativo.

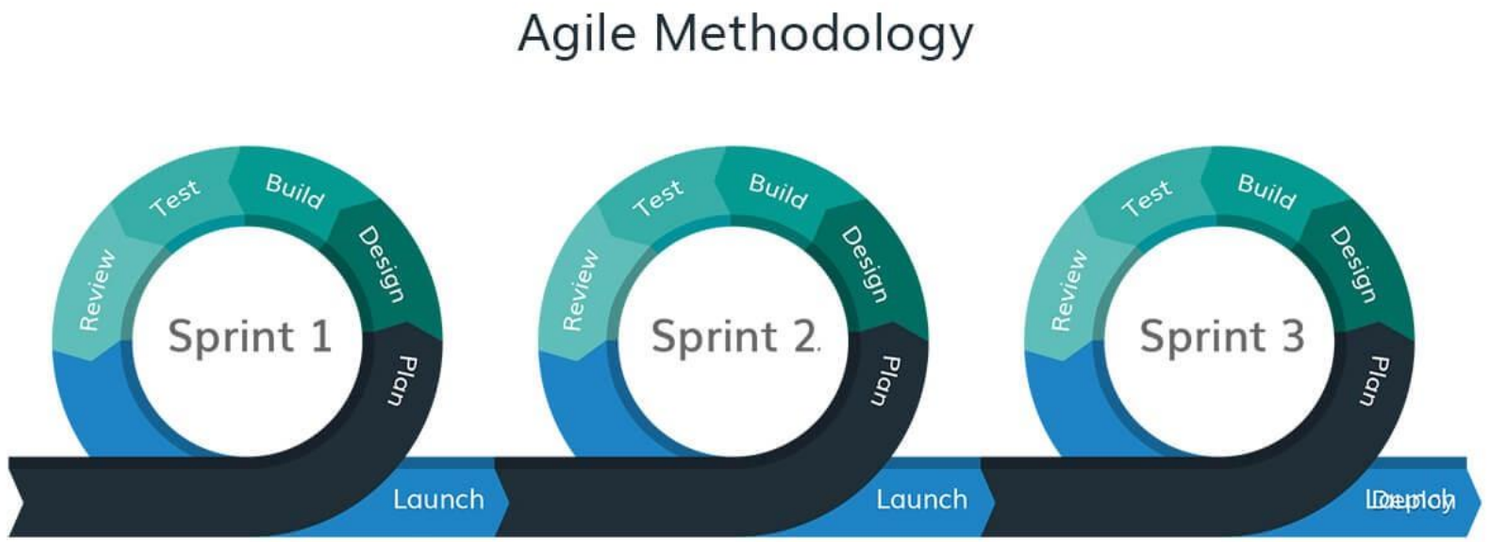
Agile Manifesto

We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

Individuals and interactions	Over	processes and tools
Working software	Over	comprehensive documentation
Customer collaboration	Over	contract negotiation
Responding to change	Over	following a plan

That is, while there is value in the items on the right, we value the items on the left more.

Essa nova maneira de entregar software foi impulsionada também pelo advento das metodologias ágeis (**Agile**) de desenvolvimento de software – que também propôs a entrega de software com valor em intervalos menores – num processo iterativo.



Data Scientist

also known as Data Managers, statisticians.

A data scientist will be able to take data science projects from end to end. They can help store large amounts of data, create predictive modelling processes and present the findings.

Skills: Mathematics, Programming, Communication

Will use programmes such as:

SQL, Python, R

Data Engineers

also known as database administrators and data architects.

They are versatile generalists who use computer science to help process large datasets. They typically focus on coding, cleaning up data sets, and implementing requests that come from data scientists.

Skills: Programming, Mathematics, Big data

Will use programmes such as:

Hadoop, NoSQL, and Python

Data Analysts

also known as business Analysts.

They typically help people from across the company understand specific queries with charts.

Skills: Statistics, Communication, Business knowledge

Will use programmes such as:

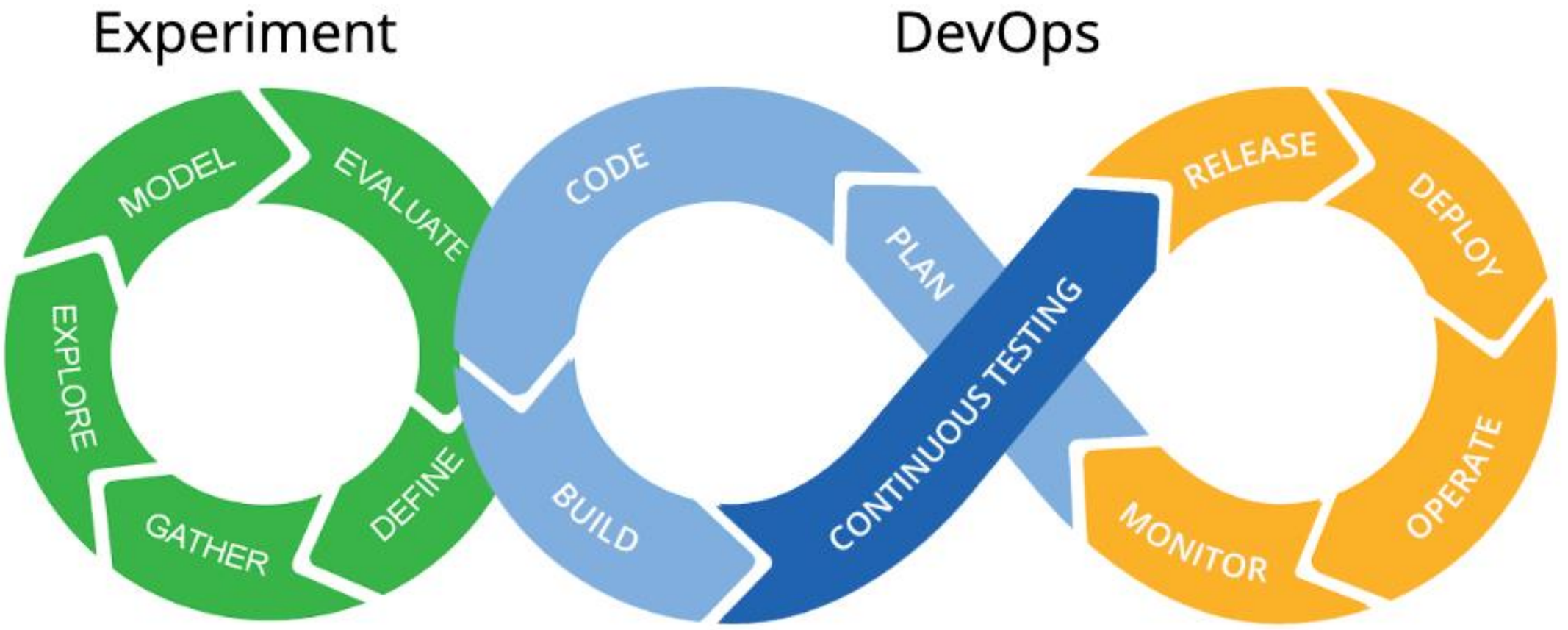
Excel, Tableau, SQL

DEV **OPS**

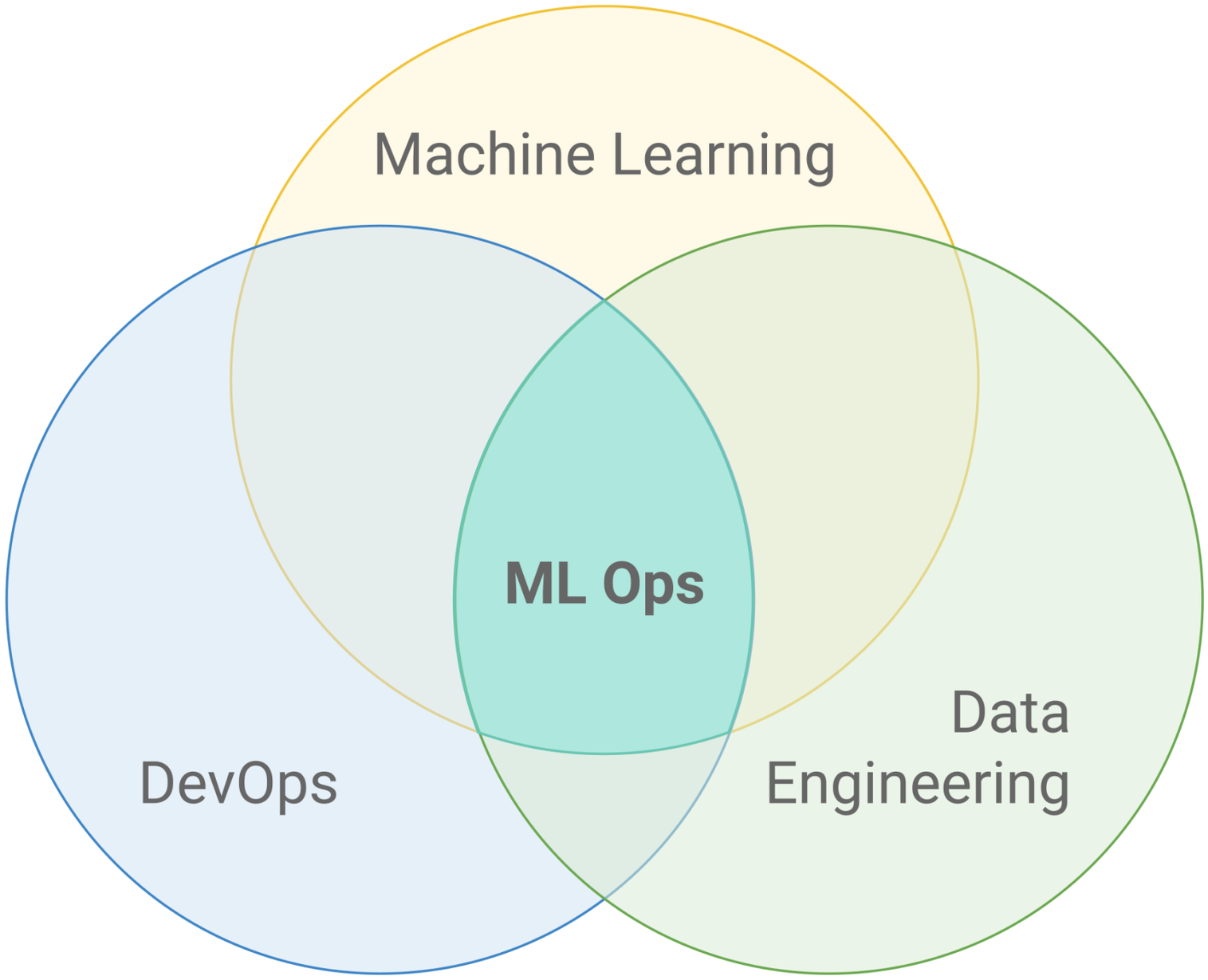
"It has been said that a data scientist is someone who is better at statistics than any software engineer, and better at software engineering than any statistician"

MACHINE LEARNING OPERATIONS

ML - OPS



https://blog.jdriven.com/2019/10/machine-learning-systems-require-paradigm-shift-in-software-engineering/



https://medium.com/@cbreuel/ml-ops-machine-learning-como-disciplina-de-engenharia-a058770b93dc

O ML Ops é um conjunto de práticas que combina Machine Learning, DevOps e Engenharia de Dados, que visa implantar e manter sistemas de ML em produção de maneira confiável e eficiente.

Prática	DevOps	Engenharia de Dados	ML Ops
Controle de versões	Versionamento de código	Versionamento de código Linhagem de dados	**Versionamento de código + dados + modelos (conectados)**
Pipeline	n/a	Pipeline de dados/ETL	**Pipeline ML de treinamento, Pipeline ML de predição**
Validação de comportamento	Testes unitários	Testes unitários	**Validação de modelo**
CI/CD	Implanta código em produção	Implanta código do pipeline de dados	**Implanta código dos pipelines de ML**
Validação de dados	n/a	Validação de negócio e formato	**Validação estatística**
Monitoramento	Baseado em SLOs	Baseado em SLOs	**SLOs + monitoramento diferencial e estatístico, em fatias**

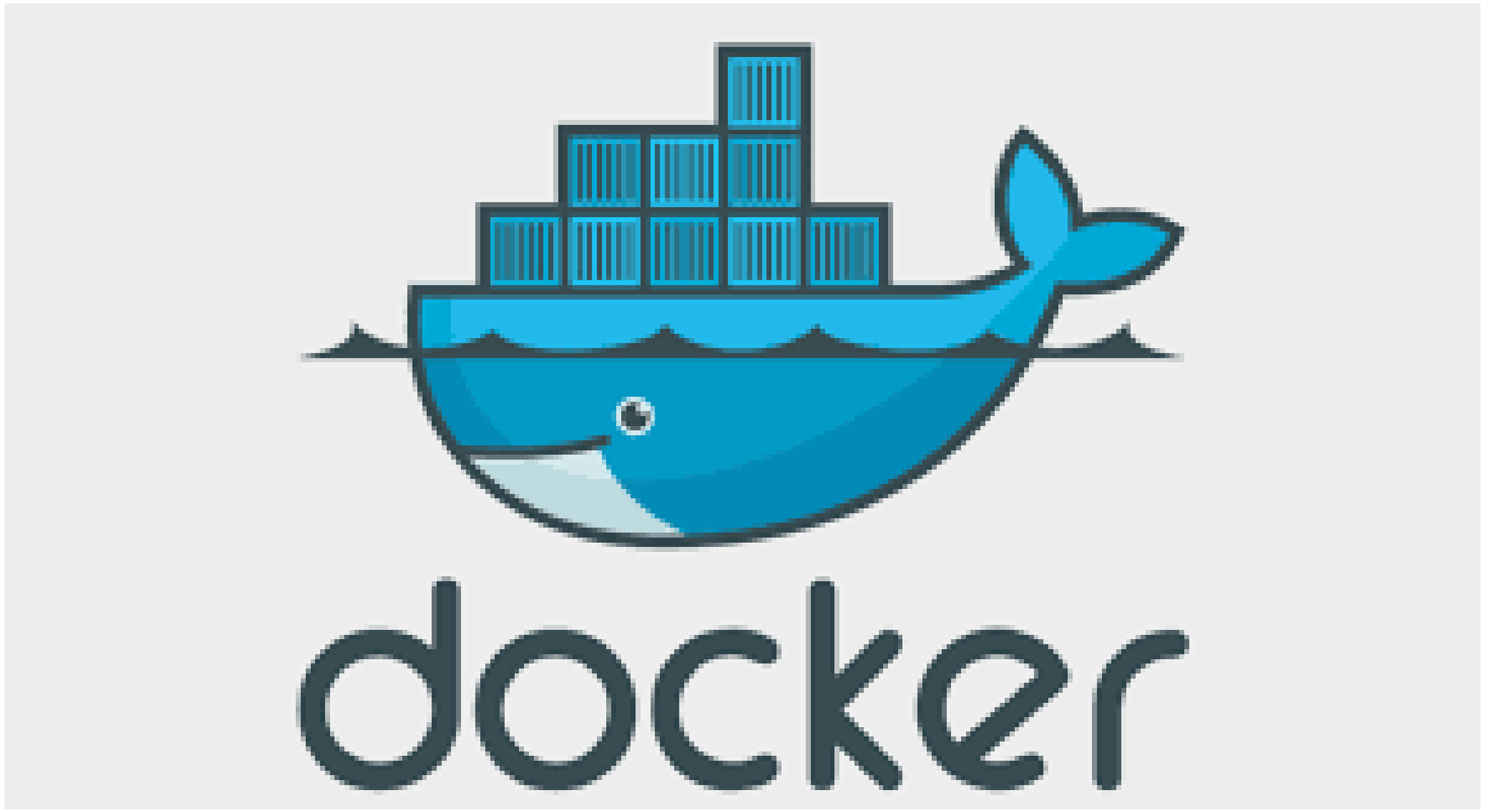
https://medium.com/@cbreuel/ml-ops-machine-learning-como-disciplina-de-engenharia-a058770b93dc

Como uma diferença fundamental em relação ao modelo de DevOps observamos que em ML também precisamos fazer o deploy adicional de **Dados** e **Modelos** para funcionamento e Validação da solução preditiva.

FERRAMENTAS ENVOLVIDAS

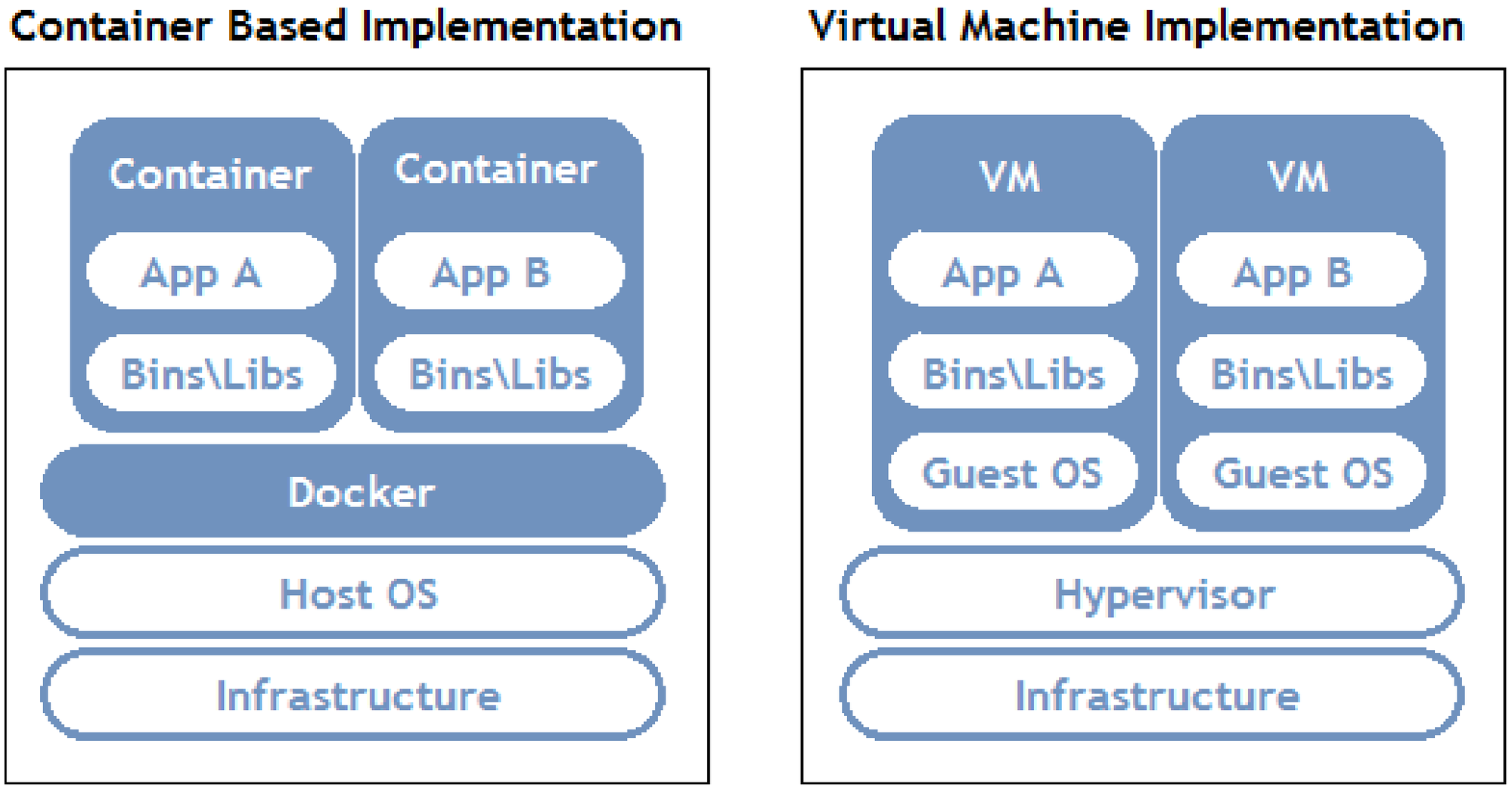
ML - OPS

DOCKER

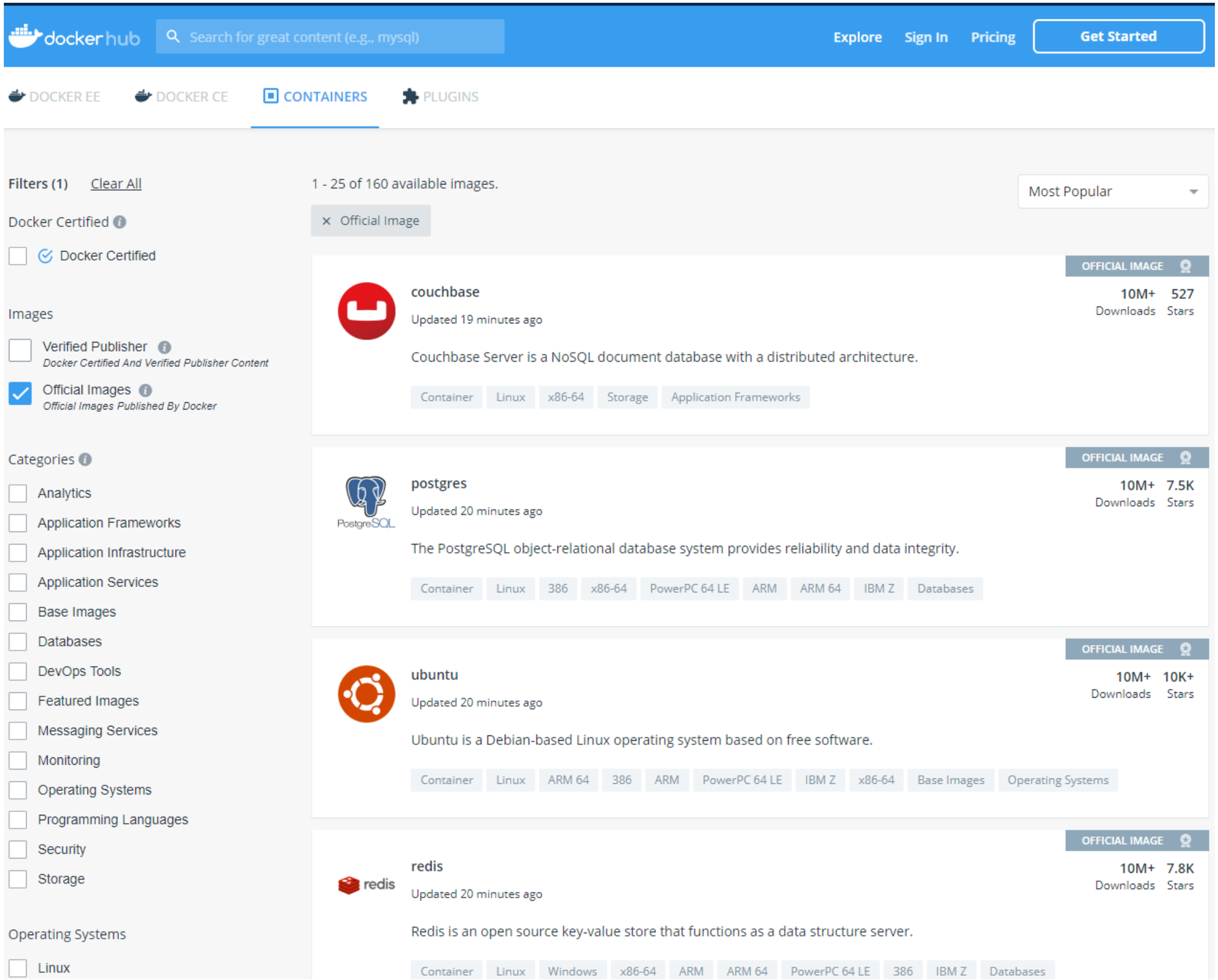


https://stack.desenvolvedor.expert/appendix/docker/oquee.html

Docker é uma plataforma aberta, criada com o objetivo de facilitar o desenvolvimento, a implantação e a execução de aplicações em ambientes isolados. Foi desenhada especialmente para disponibilizar uma aplicação da forma mais rápida possível – com a possibilidade de escalonamento horizontal quase que imediato.



O Docker se diferencia por trabalhar com **CONTEINERS** que podem ser entendidos como mini-máquinas virtuais - muito leves e simples que podem ser instanciadas com diferentes imagens (bases de dados, sistemas operacionais, etc). Por serem leves e diretamente conectadas ao kernel do sistema operacional elas podem rapidamente ser criadas e destruídas, otimizando a utilização do hardware.



https://hub.docker.com/search?image_filter=official&type=image

KUBERNETES

https://www.concrete.com.br/2018/02/22/tudo-o-que-voce-precisa-saber-sobre-kubernetes/

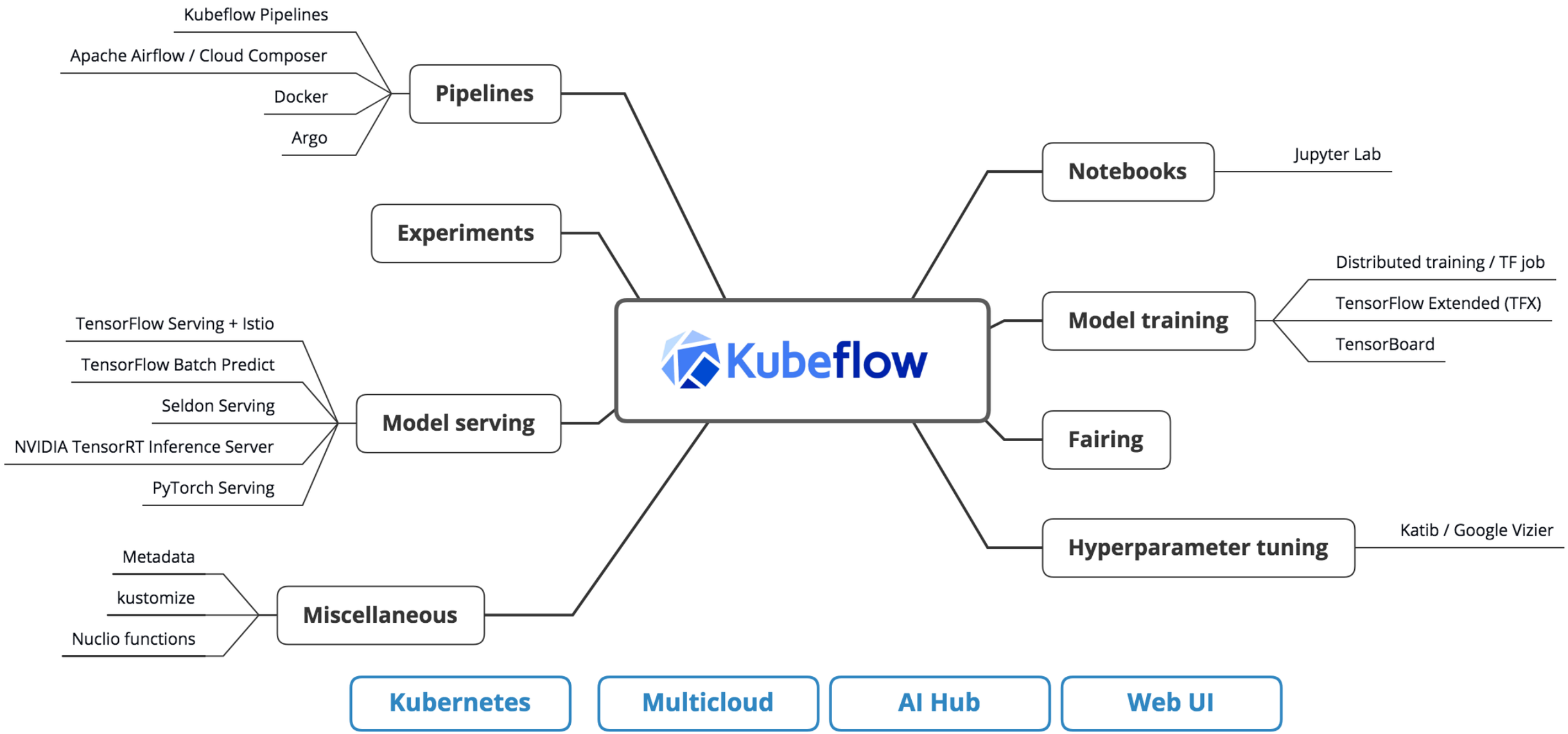
O Kubernetes é uma ferramenta que faz o **Gerenciamento de Conteiners** gerados por aplicaçoes com o Docker.

https://www.slideshare.net/renatogroff1/docker-kubernetes-orquestrando-containers-e-escalando-rapidamente-suas-aplicaes-devops-professionals-setembro2018

Docker + Kubernetes: Orquestrando containers e escalando rapidamente suas aplicações - DevOps Professionals - Setembro-2018

KUBEFLOW

KUBEFLOW

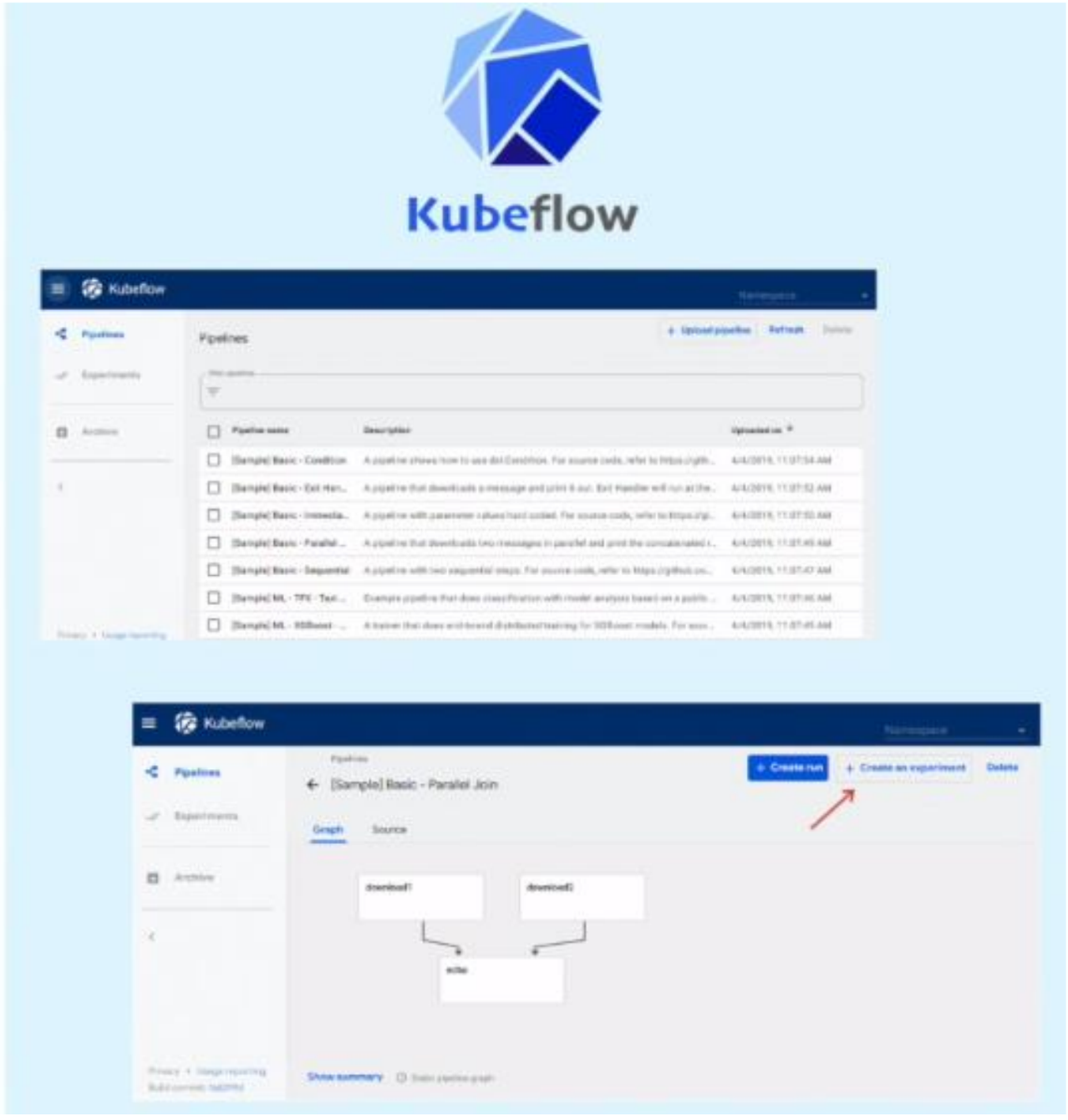


Version 1.1 20190807 @MichalBrys

Kubeflow Pipelines

Kubeflow Pipelines is a platform for building and deploying portable, scalable machine learning (ML) workflows based on Docker containers.

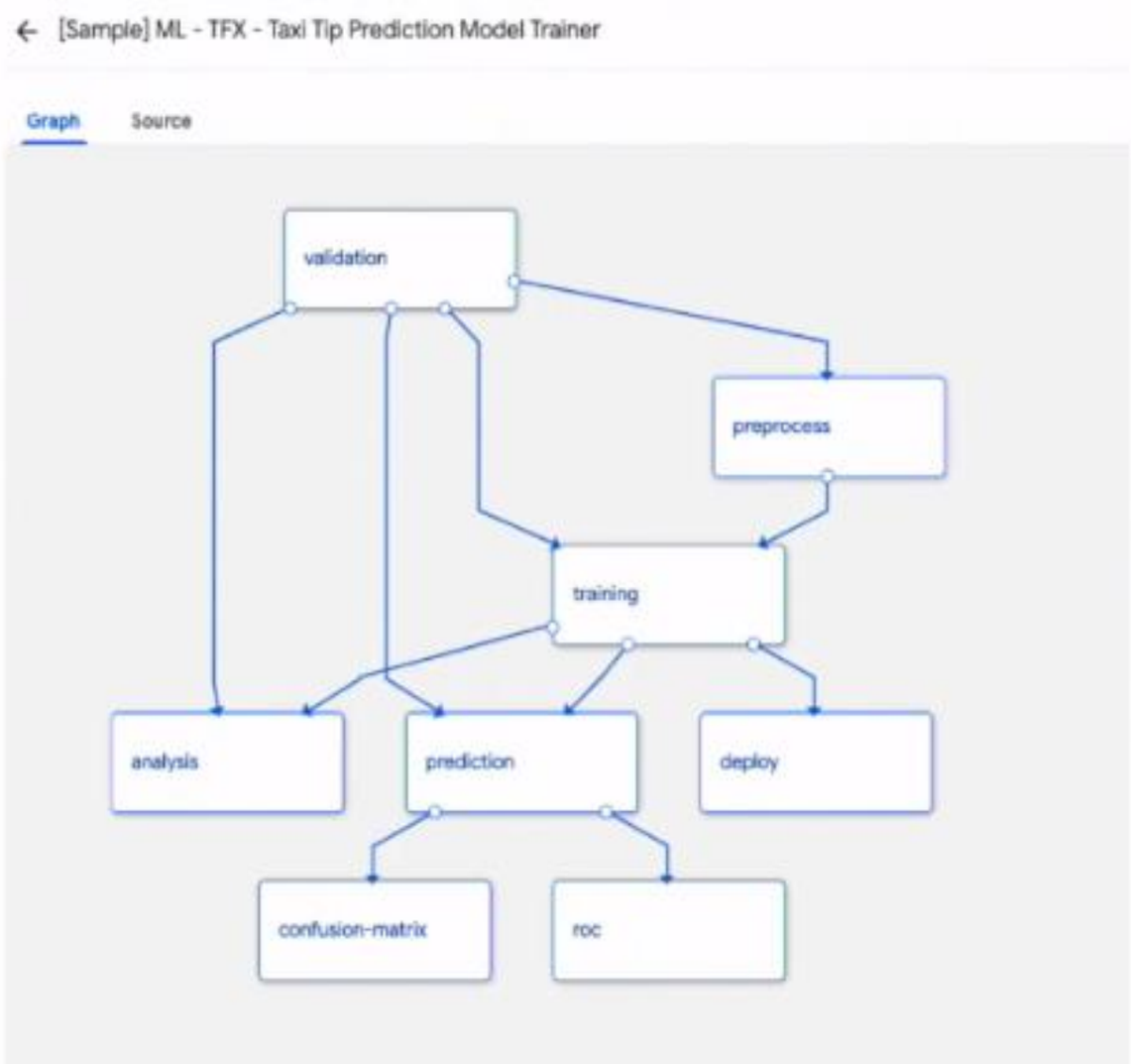
- End-to-end orchestration: enabling and simplifying the orchestration of machine learning pipelines.
- Easy experimentation: making it easy for you to try numerous ideas and techniques and manage your various trials/experiments.
- Easy re-use: enabling you to re-use components and pipelines to quickly create end-to-end solutions without having to rebuild each time.



Kubeflow Pipelines

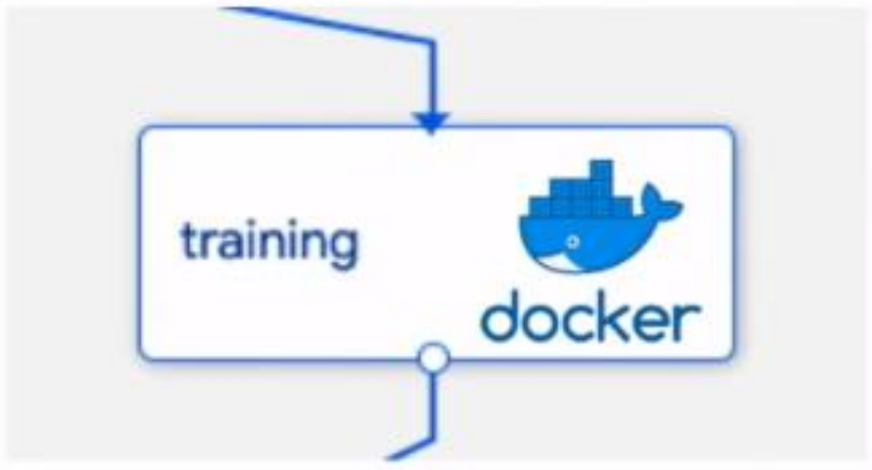
Two key takeaways : A Pipeline and a Pipeline Component

A *pipeline* is a description of a machine learning (ML) workflow, including all of the components of the workflow and how they work together.



Kubeflow Pipelines

Each pipeline *component* is a container that contains a program to perform the task required for that particular step of your workflow.



MODELOS NA *CLOUD*

IBM | Cloud | Cloud Paks | Produtos | Soluções | Precificação | Parceiros | Documentos | Suporte | Search | Conectar-se/Efetuar Log-in na cloud

Entenda os modelos de serviço IaaS, PaaS e SaaS do IBM Cloud

Qual a diferença entre IaaS, PaaS e SaaS?

A diferença principal está no tipo de serviço que está sendo oferecido. Veja:

Infraestrutura como serviço (IaaS)

Um fornecedor oferece aos clientes o acesso pago por utilização ao armazenamento, à rede, aos servidores e a outros recursos computacionais em cloud.

Plataforma como serviço (PaaS)

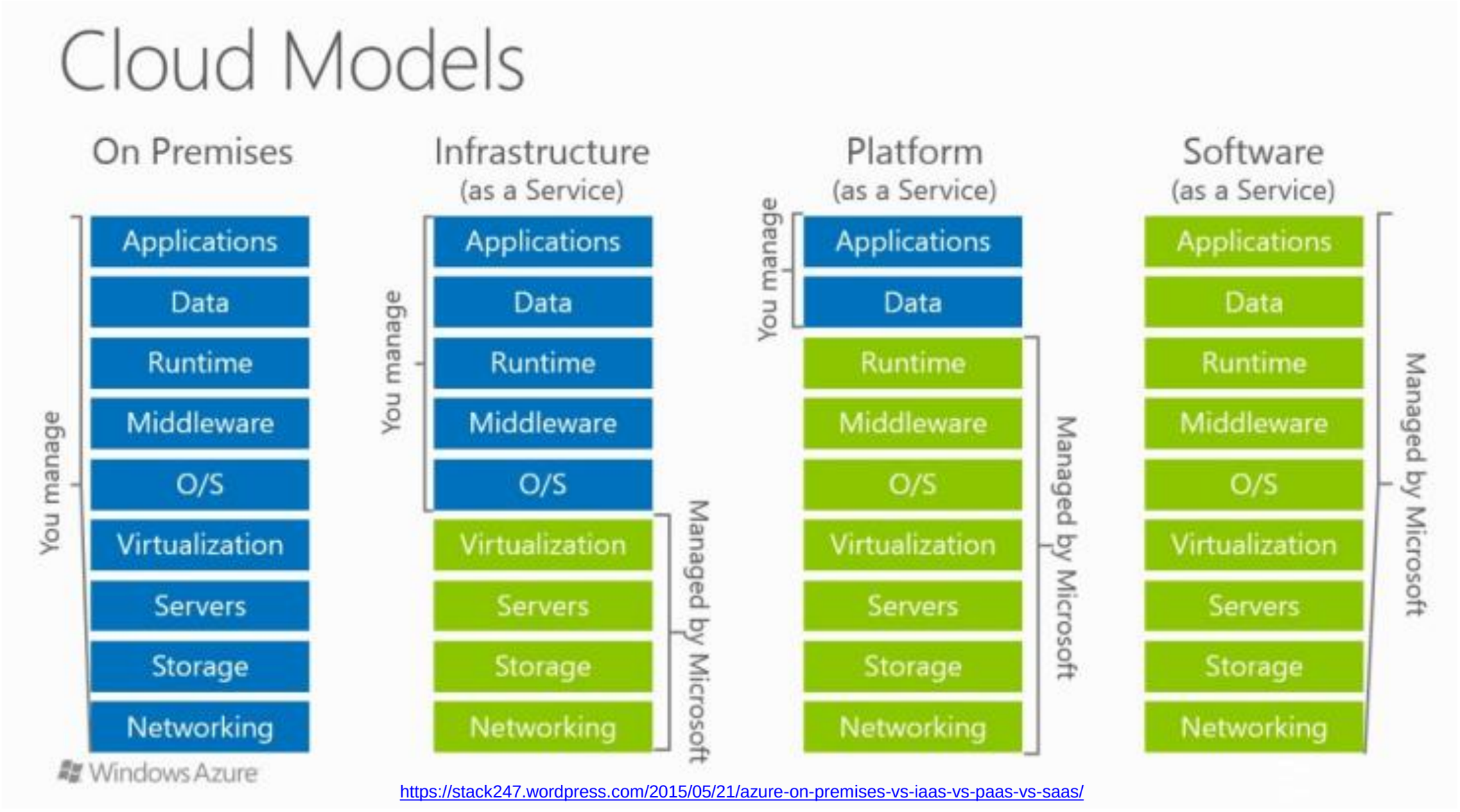
Um provedor de serviços oferece acesso a um ambiente baseado em cloud no qual os usuários podem construir e fornecer aplicativos. O provedor fornece infraestrutura subjacente.

Software como serviço (SaaS)

Um provedor de serviços oferece software e aplicativos por meio da Internet. Os usuários subscrevem ao software e o acessam por meio da web ou de APIs do fabricante.

https://www.ibm.com/br-pt/cloud/learn/iaas-paas-saas

On Premise x IaaS x PaaS x SaaS



https://stack247.wordpress.com/2015/05/21/azure-on-premises-vs-iaas-vs-paas-vs-saas/

IBM Watson

Google Cloud AutoML Vision

IBM Cloud

HEROKU

Google Cloud

Amazon SageMaker

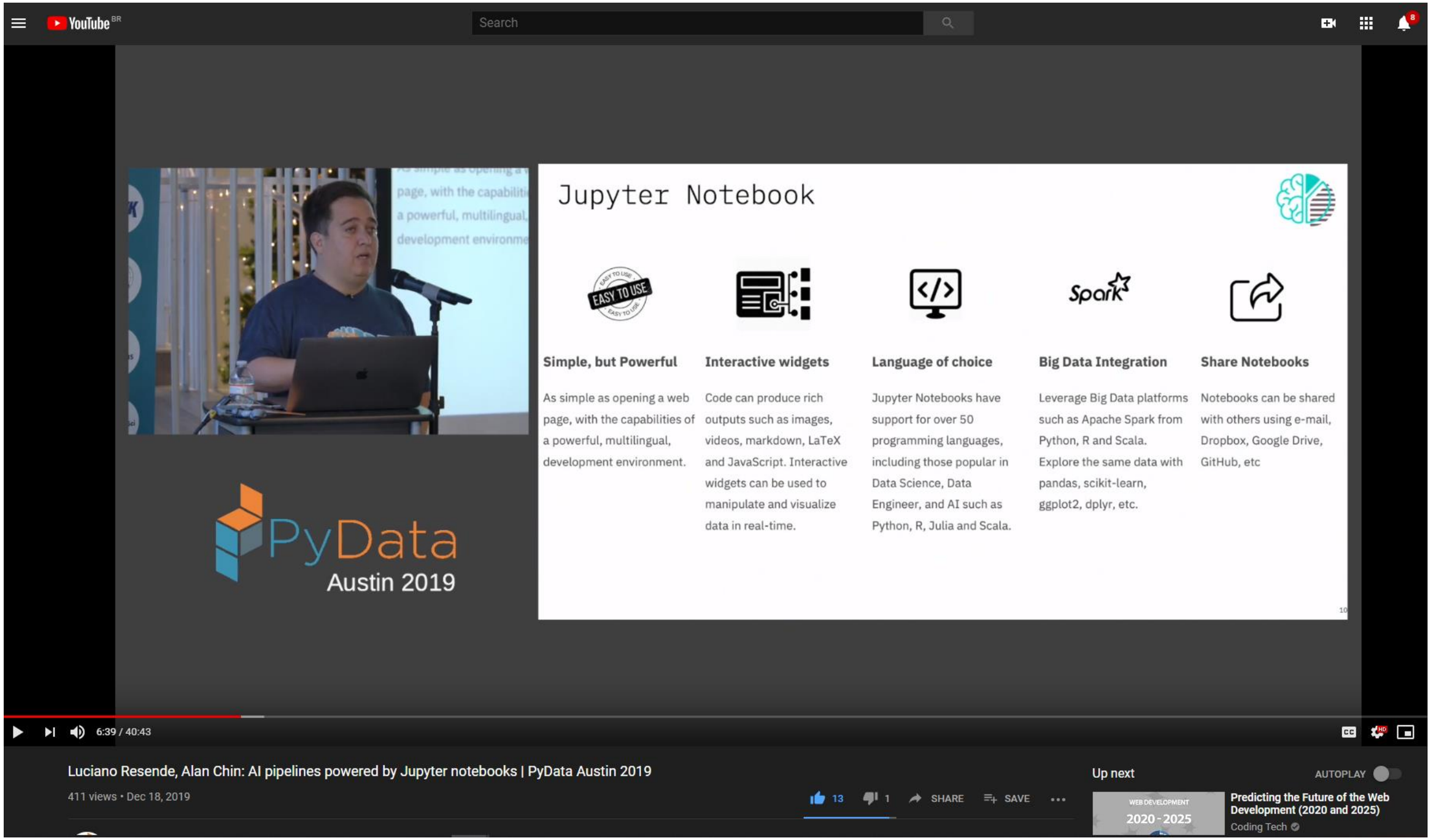
Azure Machine Learning

amazon web services™

Microsoft Azure

JUPYTER NOTEBOOKS
EM PRODUÇÃO

JUPYTER NOTEBOOKS EM PRODUÇÃO!



https://youtu.be/XJAx9dS0k7I

Search projects

Help Donate Log in Register

nbconvert 5.6.1

```
pip install nbconvert
```

Latest version

Released: Oct 24, 2019

Converting Jupyter Notebooks

Navigation

- Project description
- Release history
- Download files

Project links

- Homepage
- Tracker
- Source
- Funding
- Documentation

Project description

nbconvert

Jupyter Notebook Conversion

Google Group | build failing | docs passing | docs passing | codecov 92% | PASSED

The **nbconvert** tool, `jupyter nbconvert`, converts notebooks to various other formats via Jinja templates. The nbconvert tool allows you to convert an `.ipynb` notebook file into various static formats including:

- HTML
- LaTeX
- PDF
- Reveal JS
- Markdown (md)
- ReStructured Text (rst)
- executable script

https://pypi.org/project/nbconvert/

Notebook Pipelines using NBConvert

Jupyter NBConvert enables executing and converting notebooks to different file formats.

Advantages

– Support notebook chaining

– Convert results to immutable formats

Limitations

– No support for parameters

Jupyter NBConvert

https://nbconvert.readthedocs.io/en/latest/

```
$ pip install nbconvert

$ jupyter nbconvert --to html --execute overview_with_run.ipynb
[NbConvertApp] Converting notebook overview_with_run.ipynb to html
[NbConvertApp] Executing notebook with kernel: python3
[NbConvertApp] Writing 300558 bytes to overview_with_run.html

$ open overview_with_run.html
```

Papermill

Papermill is an open source tool contributed by Netflix which enables parameterizing, executing, and analyzing Jupyter Notebooks.

Papermill lets you:

- Parameterize notebooks
- Execute notebooks

DigitalHouse >

DATA SCIENCE

Machine Learning – Modelos em Produção