INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Cloud Computing with Google Cloud & Docker

AI Frameworks

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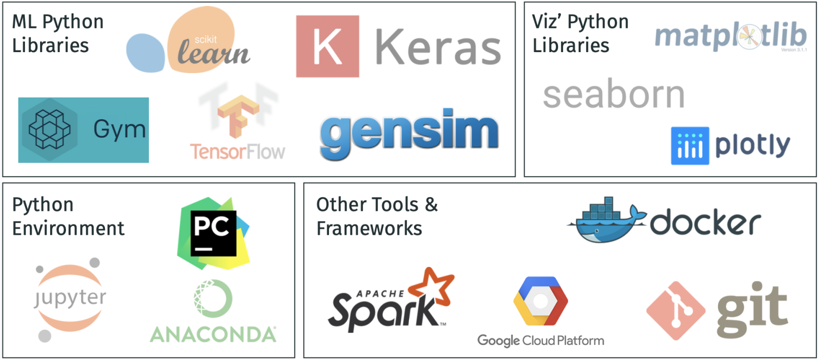
November 2th, 2019

Institut National des Sciences Appliquées

Introduction

IA Frameworks - Tools



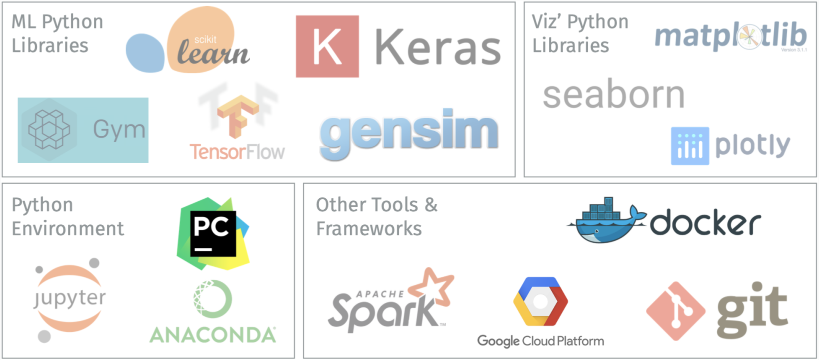
ML Python Libraries

Viz' Python Libraries

Python Environment

Other Tools & Frameworks

IA Frameworks - Tools



ML Python Libraries

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Pipeline d’execution

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Python Script

Why using script?

Jupyter limits :

- it’s an exploration tool
    - but cloud machine are accounted on an hourly base.
- Non-linear workflow.
    - Easy to write messy code.
- Not designed to handle large-scale experiment.
- Not designed for production.
    - Can’t be run from terminal, no test procedure.

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$\Longrightarrow$ Exploration work : *Jupyter*.

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- Not designed for production.
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$\Longrightarrow$ Exploration work : *Jupyter*.

$\Longrightarrow$ Large-scale/production work : Write *Script* !

Script execution

File *script.py*

```python
a = 5
b = 3
c = a + b
print("The answer is %d" %c)
```

Terminal

```
bguillou $> python script.py
bguillou $> The answer is 8
```

TP - First Part

Write two scripts :

- **learning.py :** to learn a model, save it in the *model* directory, save results in the *results* directory and
- **prediction.py :** to generate prediction ans save it in the *results* directory

on *CatsVsDogs* data.

$\Longrightarrow$ Ensure that the **complete workflow is working** locally before pushing the code on the instance.

Librairie *Argparse*

File *script.py*

```python
import argparse

parser = argparse.ArgumentParser()
parser.add_argument('--a', type=int, default=5)
parser.add_argument('--b', type=int, default=3)

args = parser.parse_args()

c= args.a + args.b
print("The answer is %d" %c)
```

Terminal

```
bguillou $> python script.py
bguillou $> The answer is 8
bguillou $> python script.py —a 4
bguillou $> The answer is 7
bguillou $> python script.py —a 4 —b 2
bguillou $> The answer is 7
```

Librairie *pickle*

File *learning.py*

```
import pickle
...
results = {"learning_time" : lt, "accuracy" : acc}
pickle.dump(results, open("/User/bguillouet/data/results.pkl","wb"))
```

File *explore_results.py*

```
import pickle
results = pickle.load(open("/User/bguillouet/data/results.pkl","rb"))
print(results)
```

Terminal

```
bguillou $> ls data/
bguillou $>
bguillou $> python learning.py
bguillou $> ls data/
bguillou $> results.pkl
bguillou $> python explore_results.py
bguillou $> {"learning_time" : lt, "accuracy" : acc}
```

Librairie *hashlib*

python *script.py*

```
import argparse
import hashlib
import pickle

parser = argparse.ArgumentParser()
parser.add_argument('--a', type=int, default=5)
parser.add_argument('--b', type=int, default=3)
parser.add_argument('--type_op', type =str, default="addition")

args = parser.parse_args()

if args.type_op == "addition":
    c= args.a + args.b
else:
    c= args.a * args.b

results = var(args)
print("Argument dictionary: "+ str(results))
results.update({"results" : c})
print("Argument dictionary with score: "+ str(results))

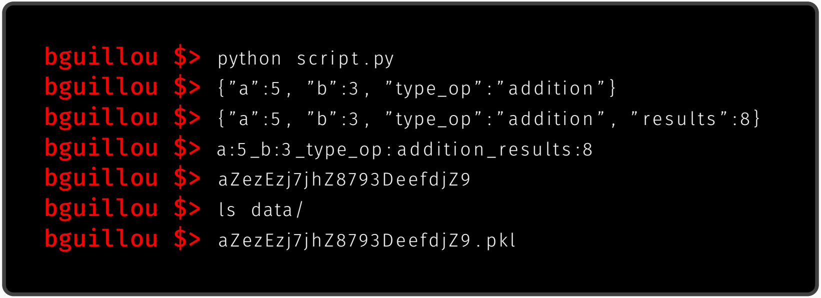

args_str = "_".join([k + ":" + str(v) for k, v in sorted(results.items(), key=lambda x : x[0])])
print("Argument string: "+ args_str)

id_str = hashlib.md5(args_str.encode("utf8")).hexdigest()
print(id_str)

result_file = "/User/bguillouet/data/" + id_str + ".pkl"

pickle.dump(results, open(results_file, "wb"))
```

Librairie *hashlib*



```
bguillou $> python script.py
bguillou $> {”a”:5, ”b”:3, ”type_op”:”addition”}
bguillou $> {”a”:5, ”b”:3, ”type_op”:”addition”, ”results”:8}
bguillou $> a:5_b:3_type_op:addition_results:8
bguillou $> aZezEzj7jhZ8793DeefdjZ9
bguillou $> ls data/
bguillou $> aZezEzj7jhZ8793DeefdjZ9.pkl
```

Google Cloud

Google Cloud

Suite of cloud computing services with more than 90 products.

- Power computation , Database, AI, Networking, Security *etc.*.

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    - $\Longrightarrow$ Google Cloud Engine

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Why not IA tools ?

- *AutoML* or *ML Engine* are tools that provide solution for non-expert.

Google Cloud

Suite of cloud computing services with more than 90 products.

- **Power computation**, Database, AI, Networking, Security *etc.*.
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Why not IA tools ?

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What do I need to know to use Google CLoud Engine ?

- Basic knowledge of Google cloud interface.
- Basic use of terminal command (no graphic interface).
- *gcloud SDK.* https ://cloud.google.com/sdk/docs/quickstart-debian-ubuntu

Gcloud - Command

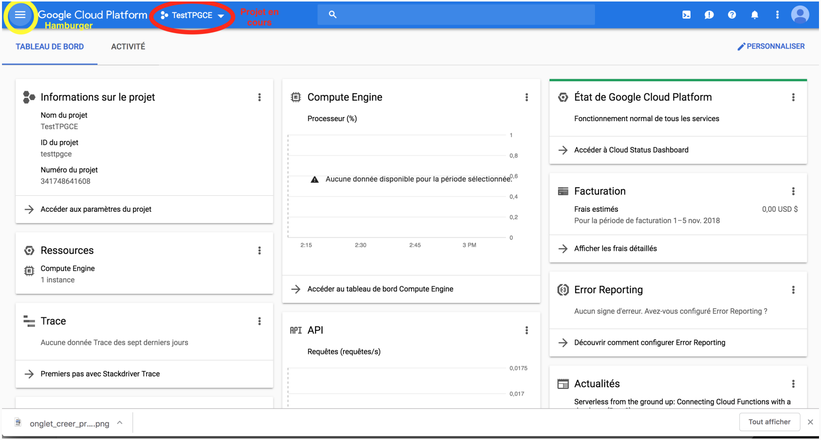
Command line tool which allow to manage VM instance.

- ***gcloud init***. To be used at first utilization.
- ***gcloud compute instances start/stop/delete instance_name***. To start/stop/remove instance.
- ***gcloud compute scp --recurse CopyFrom CopyTo***
    - *--recurse* (optional) : To be used if directory is copied.
    - *CopyFrom* : Location of the file or directory to be copied.
    - *CopyTo* : Location of the directory were the file or directory will be copied.
    - *Syntax :* [[[USER@]INSTANCE :]DIR] . To send file on the instance.

Gcloud - Command

- *gcloud compute ssh --ssh-key-file LocationOfSShKey --zone europe-west1-b*. To set ssh-connection to the instance.
- *gcloud compute ssh --command 'COMMAND'*. To execute command on the instance.
    - *gcloud compute ssh --command 'mkdir data'*
    - *gcloud compute ssh --command 'python learning.py'*

GCE : Home Page



Informations sur le projet

Nom du projet
TestTPGCE

ID du projet
testtpgce

Numéro du projet
341748641608

→ Accéder aux paramètres du projet

Ressources

Compute Engine
1 instance

Trace

Aucune donnée Trace des sept derniers jours

→ Premiers pas avec Stackdriver Trace

Compute Engine

Processeur (%)

Aucune donnée disponible pour la période sélectionnée.

→ Accéder au tableau de bord Compute Engine

API

Requêtes (requêtes/s)

État de Google Cloud Platform

Fonctionnement normal de tous les services

→ Accéder à Cloud Status Dashboard

Facturation

Frais estimés 0,00 USD $
Pour la période de facturation 1–5 nov. 2018

→ Afficher les frais détaillés

Error Reporting

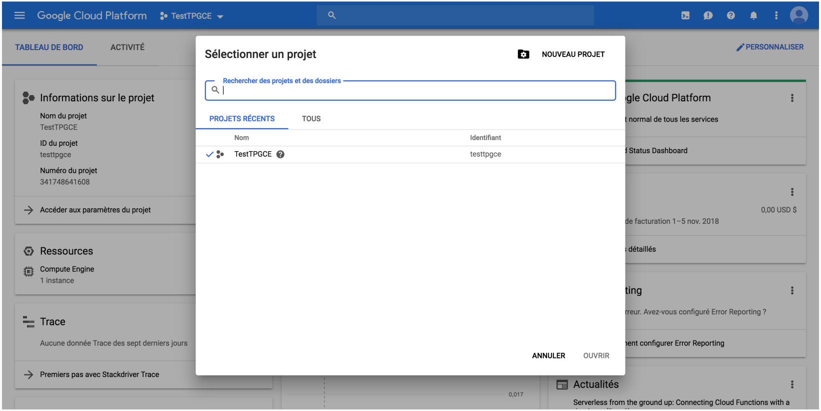
Aucun signe d'erreur. Avez-vous configuré Error Reporting ?

→ Découvrir comment configurer Error Reporting

Actualités

Serverless from the ground up: Connecting Cloud Functions with a

GCE : Select a project



Google Cloud Platform · TestTPGCE

TABLEAU DE BORD · ACTIVITÉ · PERSONNALISER

Informations sur le projet

Nom du projet
TestTPGCE

ID du projet
testtpgce

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341748641608

Accéder aux paramètres du projet

Ressources

Compute Engine
1 instance

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Aucune donnée Trace des sept derniers jours

Premiers pas avec Stackdriver Trace

Sélectionner un projet

NOUVEAU PROJET

Rechercher des projets et des dossiers

PROJETS RÉCENTS · TOUS

	Nom	Identifiant
✓	TestTPGCE	testtpgce

ANNULER · OUVRIR

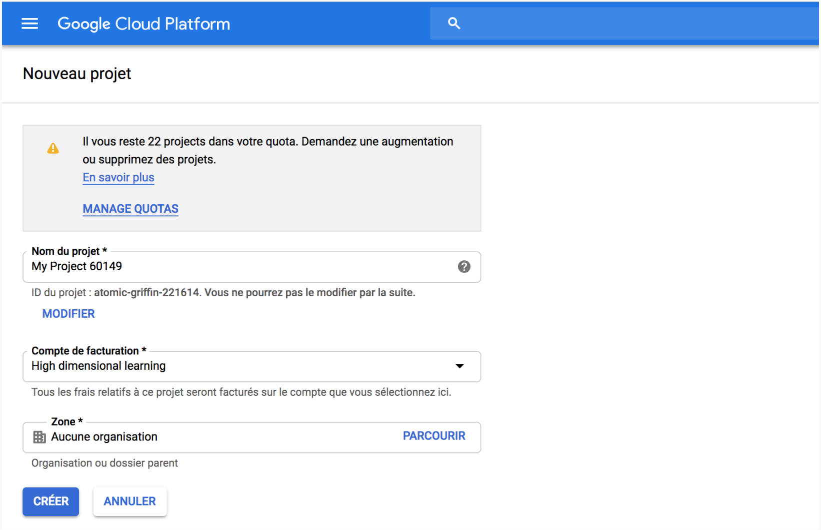
gle Cloud Platform
t normal de tous les services
Status Dashboard

0,00 USD $
de facturation 1–5 nov. 2018
détaillés

ting
rreur. Avez-vous configuré Error Reporting ?
nent configurer Error Reporting

Actualités
Serverless from the ground up: Connecting Cloud Functions with a

GCE : A New project



Nouveau projet

Il vous reste 22 projects dans votre quota. Demandez une augmentation ou supprimez des projets.

En savoir plus

MANAGE QUOTAS

Nom du projet *
My Project 60149

ID du projet : atomic-griffin-221614. Vous ne pourrez pas le modifier par la suite.

MODIFIER

Compte de facturation *
High dimensional learning

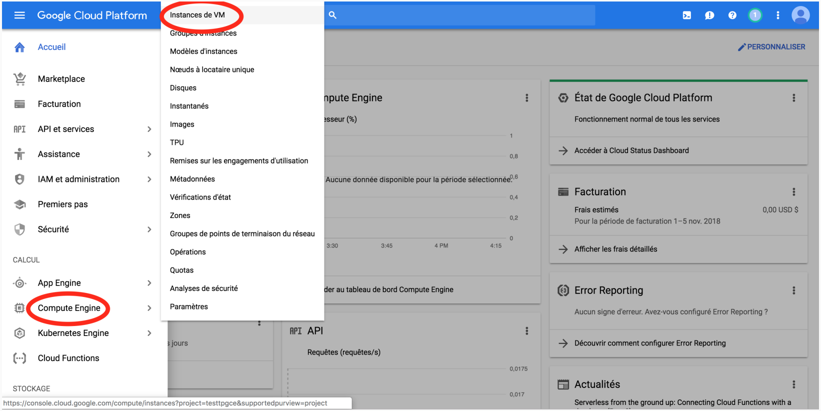
Tous les frais relatifs à ce projet seront facturés sur le compte que vous sélectionnez ici.

Zone *
Aucune organisation

PARCOURIR

Organisation ou dossier parent

GCE : Main Menu (Hamburger)



Aucune donnée disponible pour la période sélectionnée.

Fonctionnement normal de tous les services

Frais estimés 0,00 USD $

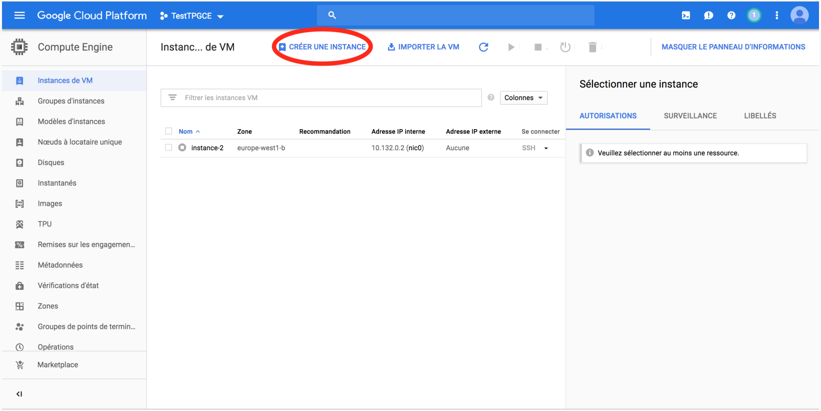
Pour la période de facturation 1–5 nov. 2018

Aucun signe d'erreur. Avez-vous configuré Error Reporting ?

Serverless from the ground up: Connecting Cloud Functions with a

https://console.cloud.google.com/compute/instances?project=testtpgce&supportedpurview=project

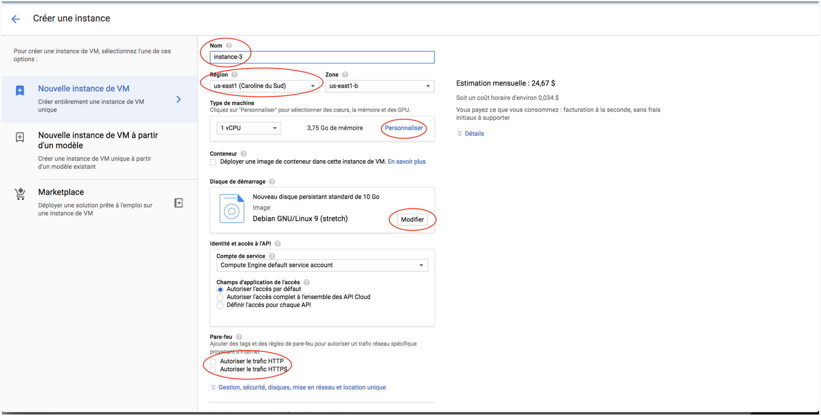
GCE : VM Instance



Nom	Zone	Recommandation	Adresse IP interne	Adresse IP externe	Se connecter
instance-2	europe-west1-b		10.132.0.2 (nic0)	Aucune	SSH

Veuillez sélectionner au moins une ressource.

GCE : Create a VM instance



Créer une instance

Pour créer une instance de VM, sélectionnez l'une de ces options :

Nouvelle instance de VM
Créer entièrement une instance de VM unique

Nouvelle instance de VM à partir d'un modèle
Créer une instance de VM unique à partir d'un modèle existant

Marketplace
Déployer une solution prête à l'emploi sur une instance de VM

Nom: instance-3

Région: us-east1 (Caroline du Sud)

Zone: us-east1-b

Type de machine
Cliquez sur "Personnaliser" pour sélectionner des cœurs, la mémoire et des GPU.

1 vCPU — 3,75 Go de mémoire — Personnaliser

Conteneur
□ Déployer une image de conteneur dans cette instance de VM. En savoir plus

Disque de démarrage
Nouveau disque persistant standard de 10 Go
Image
Debian GNU/Linux 9 (stretch)
Modifier

Identité et accès à l'API

Compte de service: Compute Engine default service account

Champs d'application de l'accès
● Autoriser l'accès par défaut
○ Autoriser l'accès complet à l'ensemble des API Cloud
○ Définir l'accès pour chaque API

Pare-feu
Ajouter des tags et des règles de pare-feu pour autoriser un trafic réseau spécifique provenant d'internet
□ Autoriser le trafic HTTP
□ Autoriser le trafic HTTPS

Gestion, sécurité, disques, mise en réseau et location unique

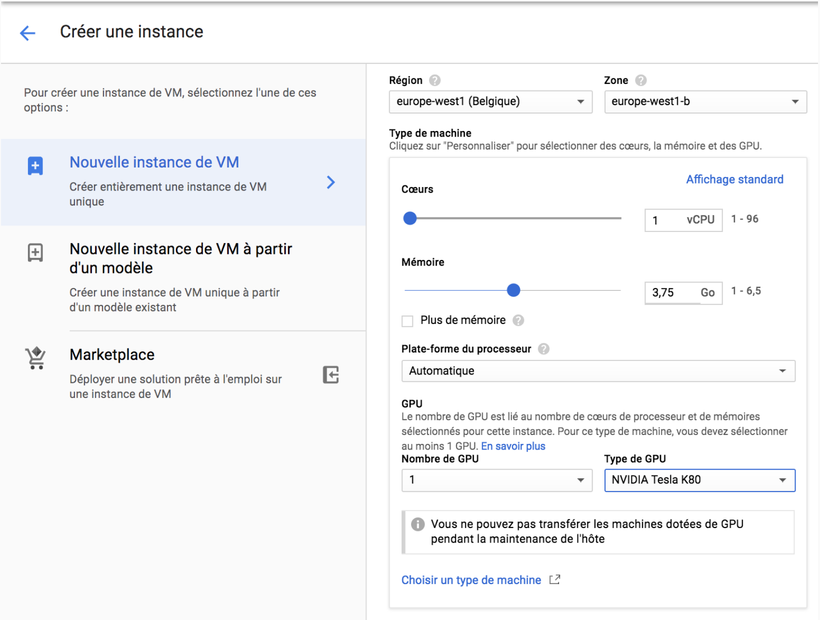
Estimation mensuelle : 24,67 $

Soit un coût horaire d'environ 0,034 $

Vous payez ce que vous consommez : facturation à la seconde, sans frais initiaux à supporter

Détails

GCE : VM configuration



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Marketplace

Déployer une solution prête à l'emploi sur une instance de VM

Région: europe-west1 (Belgique)

Zone: europe-west1-b

Type de machine

Cliquez sur "Personnaliser" pour sélectionner des cœurs, la mémoire et des GPU.

Affichage standard

Cœurs: 1 vCPU 1 - 96

Mémoire: 3,75 Go 1 - 6,5

□ Plus de mémoire

Plate-forme du processeur: Automatique

GPU

Le nombre de GPU est lié au nombre de cœurs de processeur et de mémoires sélectionnés pour cette instance. Pour ce type de machine, vous devez sélectionner au moins 1 GPU. En savoir plus

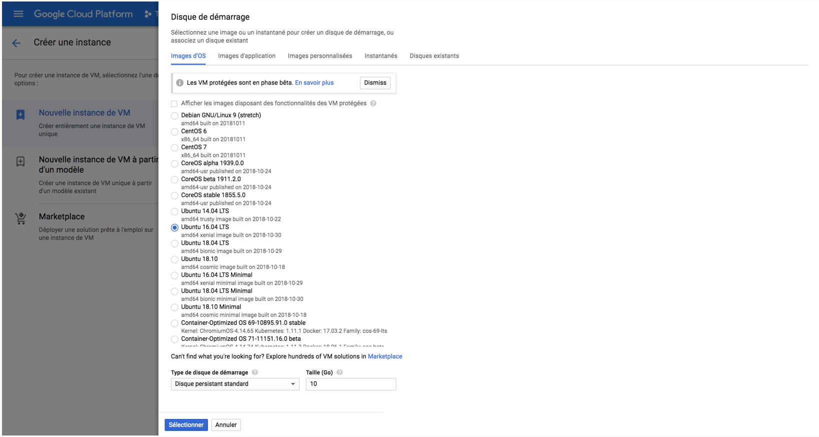
Nombre de GPU: 1

Type de GPU: NVIDIA Tesla K80

Vous ne pouvez pas transférer les machines dotées de GPU pendant la maintenance de l'hôte

Choisir un type de machine

GCE : Start disk



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Créer entièrement une instance de VM unique

Créer une instance de VM unique à partir d'un modèle existant

Déployer une solution prête à l'emploi sur une instance de VM

Disque de démarrage

Sélectionnez une image ou un instantané pour créer un disque de démarrage, ou associez un disque existant

Les VM protégées sont en phase bêta. En savoir plus

□ Afficher les images disposant des fonctionnalités des VM protégées

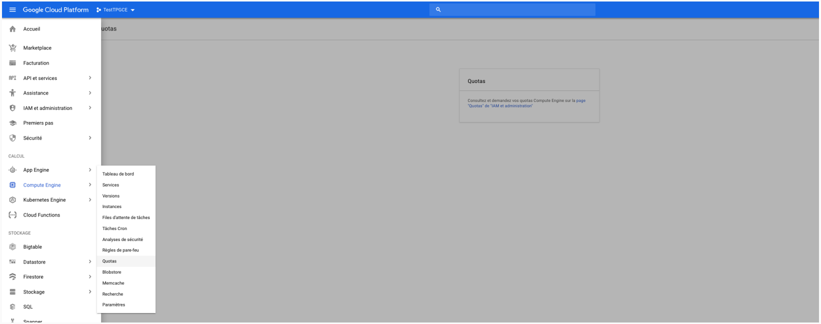
- ○ Debian GNU/Linux 9 (stretch)
  amd64 built on 20181011
- ○ CentOS 6
  x86_64 built on 20181011
- ○ CentOS 7
  x86_64 built on 20181011
- ○ CoreOS alpha 1939.0.0
  amd64-usr published on 2018-10-24
- ○ CoreOS beta 1911.2.0
  amd64-usr published on 2018-10-24
- ○ CoreOS stable 1855.5.0
  amd64-usr published on 2018-10-24
- ○ Ubuntu 14.04 LTS
  amd64 trusty image built on 2018-10-22
- ● Ubuntu 16.04 LTS
  amd64 xenial image built on 2018-10-30
- ○ Ubuntu 18.04 LTS
  amd64 bionic image built on 2018-10-29
- ○ Ubuntu 18.10
  amd64 cosmic image built on 2018-10-18
- ○ Ubuntu 16.04 LTS Minimal
  amd64 xenial minimal image built on 2018-10-29
- ○ Ubuntu 18.04 LTS Minimal
  amd64 bionic minimal image built on 2018-10-30
- ○ Ubuntu 18.10 Minimal
  amd64 cosmic minimal image built on 2018-10-18
- ○ Container-Optimized OS 69-10895.91.0 stable
  Kernel: ChromiumOS-4.14.65 Kubernetes: 1.11.1 Docker: 17.03.2 Family: cos-69-lts
- ○ Container-Optimized OS 71-11151.16.0 beta
  Kernel: ChromiumOS-4.14.74 Kubernetes: 1.11.3 Docker: 18.06.1 Family: cos-beta

Can't find what you're looking for? Explore hundreds of VM solutions in Marketplace

Type de disque de démarrage: Disque persistant standard

Taille (Go): 10

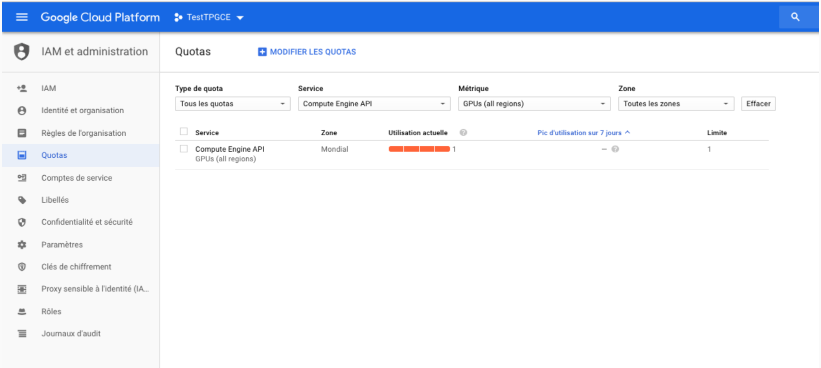
GCE : Quotas



Quotas

Consultez et demandez vos quotas Compute Engine sur la page "Quotas" de "IAM et administration"

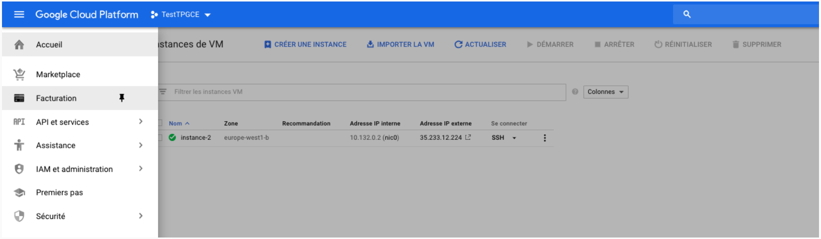
GCE : Quotas



Type de quota	Service	Métrique	Zone
Tous les quotas	Compute Engine API	GPUs (all regions)	Toutes les zones

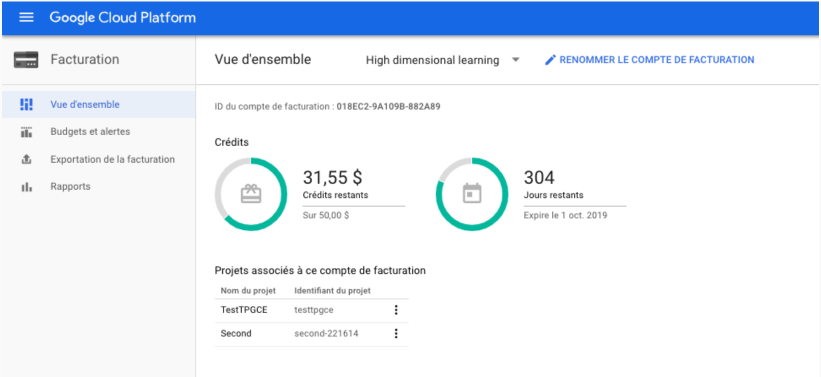
□	Service	Zone	Utilisation actuelle	Pic d'utilisation sur 7 jours	Limite
□	Compute Engine API GPUs (all regions)	Mondial	1	—	1

GCE : Billing



Nom	Zone	Recommandation	Adresse IP interne	Adresse IP externe	Se connecter
instance-2	europe-west1-b		10.132.0.2 (nic0)	35.233.12.224	SSH

GCE : Billing



Google Cloud Platform

Facturation

- Vue d'ensemble
- Budgets et alertes
- Exportation de la facturation
- Rapports

Vue d'ensemble   High dimensional learning   RENOMMER LE COMPTE DE FACTURATION

ID du compte de facturation : 018EC2-9A109B-882A89

Crédits

31,55 $
Crédits restants
Sur 50,00 $

304
Jours restants
Expire le 1 oct. 2019

Projets associés à ce compte de facturation

Nom du projet	Identifiant du projet
TestTPGCE	testtpgce
Second	second-221614

- Delayed Bill.
- 1 bill per project.
- 1 GPU max per project.

Install framework

- Python
- Cuda
- Docker
- Nvidia-docker

bash_script for installation in *utils/bash_utils_on_gpu*.

Pipeline d'execution

Pipeline in practice

1. Write script in your *local* machine.
2. Turn you *instance on*.
3. Build environment(if first used).
4. Send latest version of your code to the instance.
5. Send data to the instance.

7. Run the script on the instance.
8. Copy the results you want to analyze from the instance to your local machine.

10. Turn your instance off.

Pipeline in practice

1. Write script in your *local* machine.
2. Turn you *instance on*.
3. Build environment(if first used).
4. Send latest version of your code to the instance.
5. Send data to the instance.
6. Run container.
7. Run the script on the instance.
8. Copy the results you want to analyze from the instance to your local machine.
9. Stop and remove container.
10. Turn your instance off.

Pipeline - Command

1. Write script in your *local* machine.
2. *gcloud compute instances start ..*
3. *gcloud compute ssh --command ’mkdir data’*
4. *gcloud compute scp script.py bguillou@instance-gpu :/home/*
5. *gcloud compute scp --recurse data bguillou@instance-gpu :/home/*

7. *gcloud compute ssh --command ’python script.py –a 3’*
8. *gcloud compute scp --recurse bguillou@instance-gpu :/home/results/ /home/*

10. *gcloud compute instances stop ..*

Pipeline - Command

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5. *gcloud compute scp --recurse data bguillou@instance-gpu :/home/*
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Pipeline - Command

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Too many possibility to make a mistake.

Pipeline - Command

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10. *gcloud compute instances stop ..*

Too many possibility to make a mistake.

$\Longrightarrow$ Pipeline

Pipeline

We wille use a tools compose of 3 *python script* and a *.yml* file :

- **conf.yml** : This file works like a dictionary which contain global variables such as location of directory.
- **instances.py** : This script defines a Python class *InstanceManager* which encapsulate calls to *gcloud*. For exemple *list()* function of this class call this command in terminal :

  ```
      gcloud compute instances list
  ```

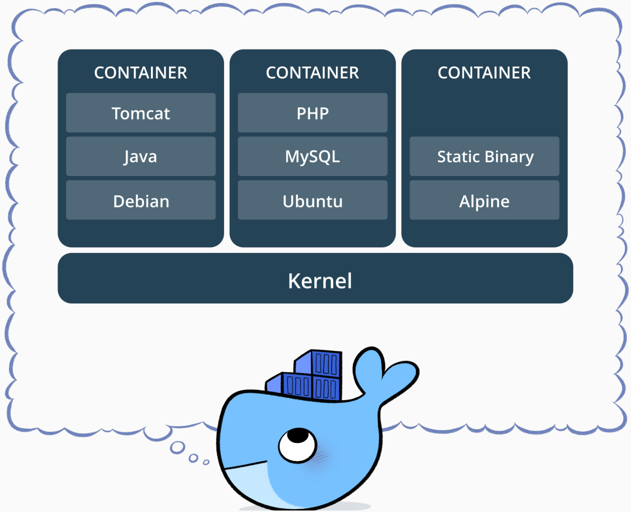
- **project.py** This script defines a Python class *ProjectManager* which contains specific functions to manage your project.

  For example, the *update_data(self, zip_file)* function allows to send a *zip_file* from your *data* directory from your local machine to the *data* directory on your instance.
- **main.py** This is a python script which contains all the command to execute your pipeline.

Docker

What is Docker?

Docker enables to build Virtual machines which are easy to re-create on different compute environment.



CONTAINER

Tomcat

Java

Debian

CONTAINER

PHP

MySQL

Ubuntu

CONTAINER

Static Binary

Alpine

Kernel

Why should I use docker AS A DATA SCIENTIST?

- Reproducibility : wrapping all you environment in a Docker container ensure the possibility to recreate your environment and makes your work more accessible.
- Portability of your compute environment To move your code and your model easily on machine with more computational power.
- Enlarge your possibility : being comfortable with Docker can allow you to use various solution available with docker.

Docker terminology

- **Image** : Its like a turned-off VM which contains the tools you want. Ex : Ubuntu + TensorFlow with Nvidia Drivers and a running Jupyter Server.
- **Container** : Is an instantiation of an image. You can have multiple copies of the same image running.
- **Dockerfile** : Recipe for creating an Image.
- **DockerHub / Image Registry** : Place where people/organization can post public (or private) docker images to facilitate collaboration and sharing.

https ://hub.docker.com/

What we'll do in this TP

- Write a *Dockerfile* which is based on the official *Tensorflow Dockerfile* available on *DockerHub*.
- Use the *Dockerfile* to build a *image*.
- Launch *container* with different option from the build *image*.

Dockerfile

Dockerfile of the image we'll build :

```
FROM tensorflow/tensorflow:latest-devel-gpu-py3
RUN apt-get update && apt-get install -y
python-opencv python-tk vim
RUN pip install h5py keras pytest scikit-image
seaborn tqdm  gensim
```

- FROM : Specifies the base image you want to build on top of. Docker will look in your local environment for the image you called and if it cannot find it locally it will search it in *DockerHub*.
- RUN : Is followed by normal commands that would be directly run on terminal to install librairies or framework.

Build Image

Run the BUILD command in order to build your IMAGE.

```
docker build -t ImageName -f /Docker/Dockerfile /Docker/
```

Build Image

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Name of
the image

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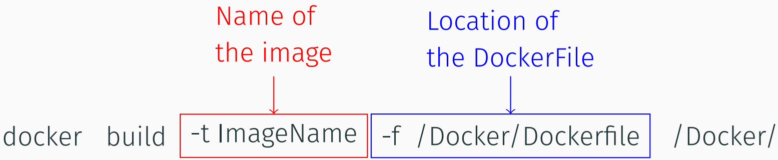

Name of the image

Location of the DockerFile

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docker build -t ImageName -f /Docker/Dockerfile /Docker/
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Build Image

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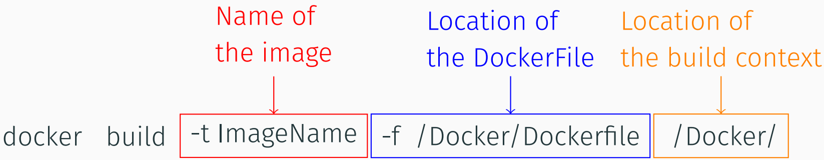

Name of the image

Location of the DockerFile

Location of the build context

```
docker build -t ImageName -f /Docker/Dockerfile /Docker/
```

The buid context is the location of the folder to which the **ADD** statement will reference. This means that all external files require by the *Dockerfile* will be located here.

Run Container

Run the RUN command in order to run your CONTAINER.

```
docker run -it –gpus all -name ContainerName
-v ~/CatsVsDogs/ :/root/CatsVsDogs ImageName
```

Run Container

Run the RUN command in order to run your **CONTAINER**.

Mode in which
the container
wil be launched

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docker run -it –gpus all -name ContainerName
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Mode of the container could be :

- -it : interactive mode,
- -dt : detached mode.

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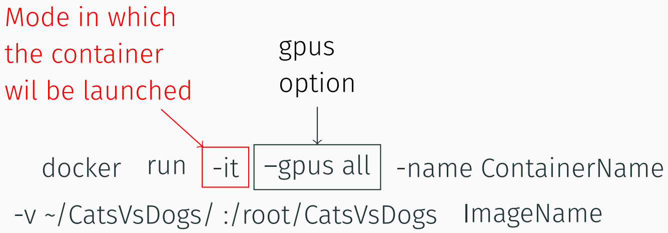

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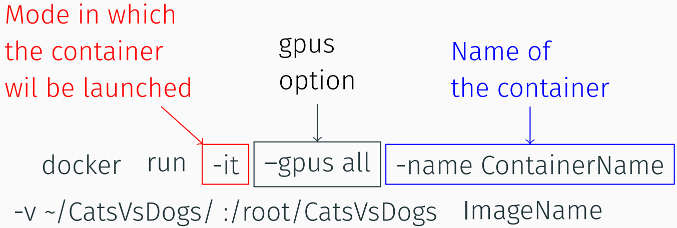

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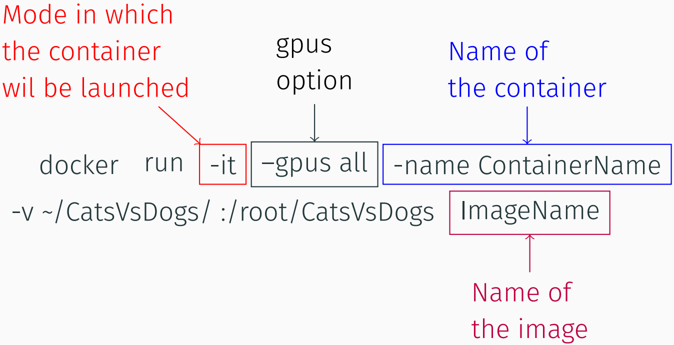

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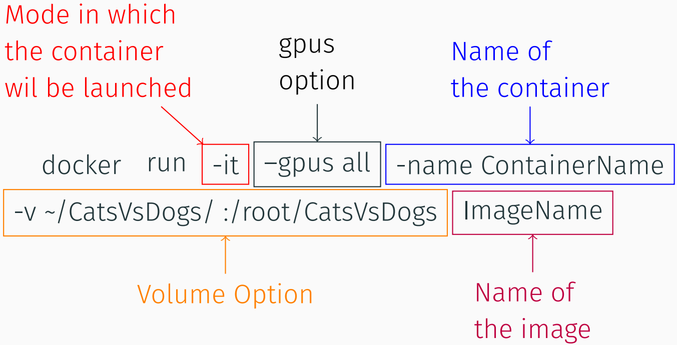

Mode in which the container wil be launched

gpus option

Name of the container

```
docker   run -it –gpus all -name ContainerName
-v ~/CatsVsDogs/ :/root/CatsVsDogs ImageName
```

Volume Option

Name of the image

Mode of the container could be :

- -it : interactive mode,
- -dt : detached mode.

Mounted Volume

The *-v* option allow you to use some date you have in yout machine within a container.

```
-v  ~/CatsVsDogs/ :/root/CatsVsDogs
```

Mounted Volume

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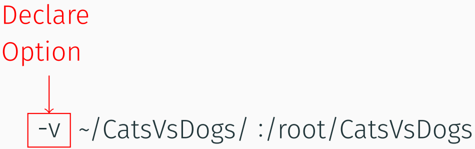

Declare Option

-v ~/CatsVsDogs/ :/root/CatsVsDogs

Mounted Volume

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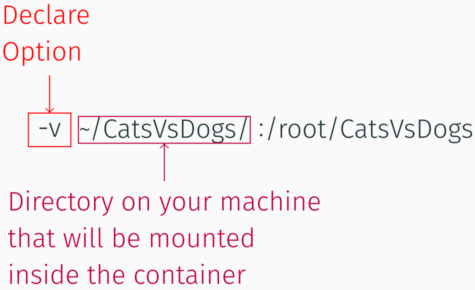

Declare Option

```
-v ~/CatsVsDogs/ :/root/CatsVsDogs
```

Directory on your machine that will be mounted inside the container

Mounted Volume

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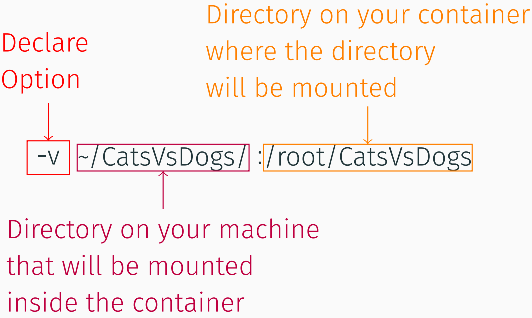

Declare Option

Directory on your container where the directory will be mounted

```
-v ~/CatsVsDogs/ :/root/CatsVsDogs
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Directory on your machine that will be mounted inside the container

Util Command

- sudo docker image ls -a
- sudo docker container ls -a
- sudo docker start/stop/rm container_name -a
- sudo docker exec container_name ’Command to execute in container’ -a

Other possibilities

- Use Jupyter on the instance (via ssh connection)
- Google Colab
- Image Gcloud

Reference

https ://towardsdatascience.com / how-docker-can-help-you-become-a-more-effective-data-scientist-7fc048ef91d5

References I

Références