

AI from Space using Azure

Christos Charmatzis

@christoscharmatzis

<https://tageoforce.com>

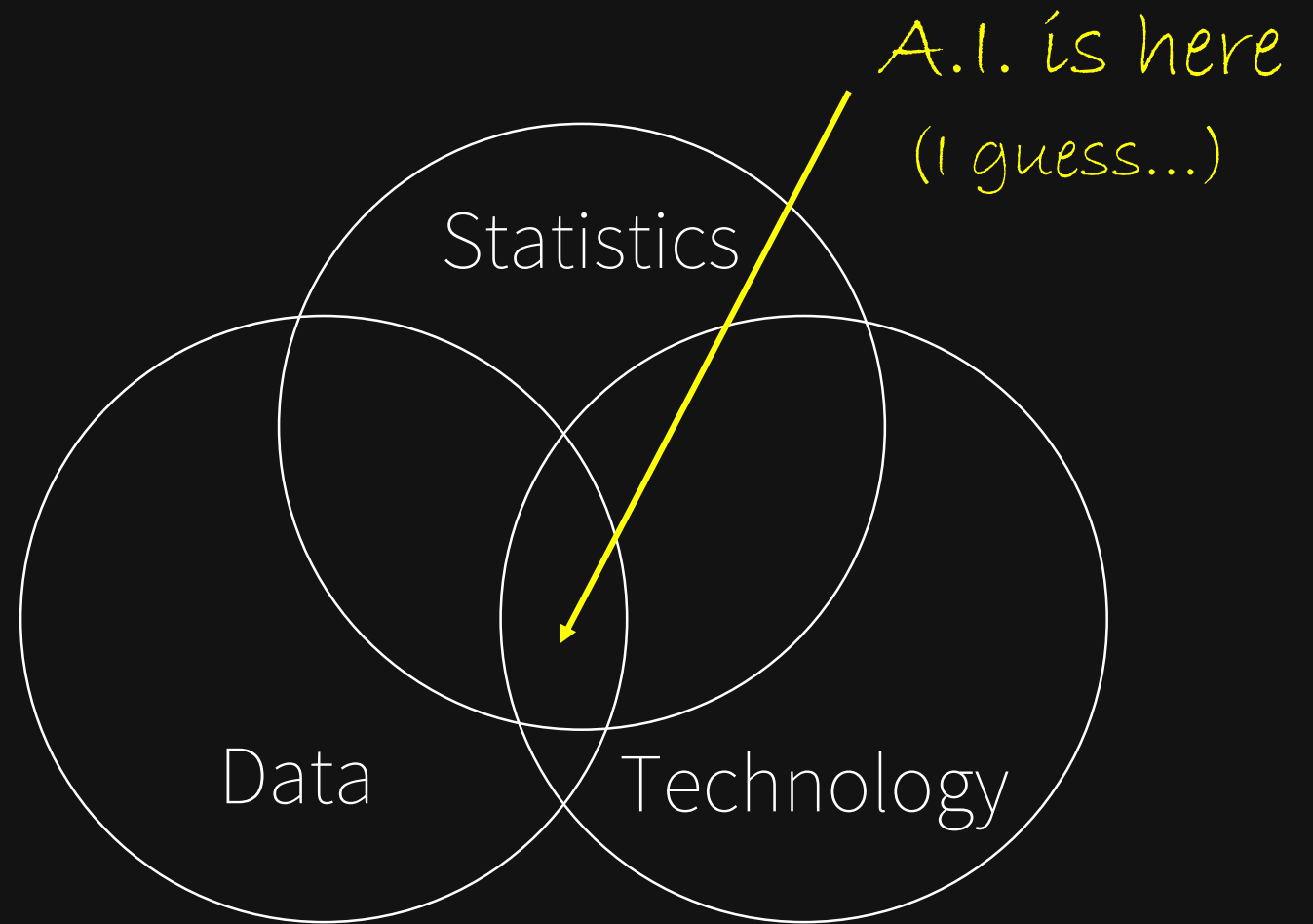
Few things about me

- Project manager @TA-Geoforce
- GIS Specialist 10+ years
- AI professional
- Open Source enthusiasm
- Piano player



Chopin – Heroic Polonaise
Source: youtube.com/Rouseau

What I used to
say



What's AI for
me



AI \equiv Knowledge

Data

All of us



Data from Space

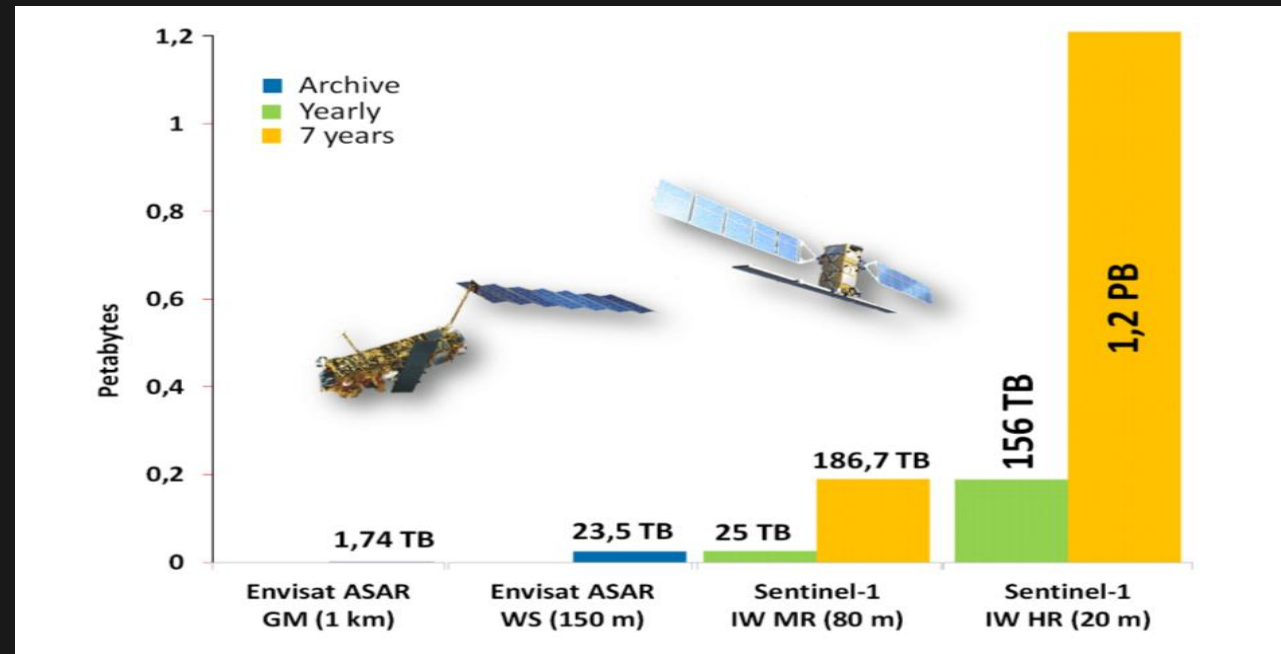
Refers to the massive spatio-temporal Earth and Space observation data collected by a variety of sensors - ranging from ground based to space-borne - and the synergy with data coming from other sources and communities.



Earth Observation Data

Only ESA satellites produces around 150 terabytes per day!!

(source:https://www.esa.int/Applications/Observing_the_Earth/Working_towards_AI_and_Earth_observation)



Growth of data volume from ENVISAT ASAR to Sentinel-1.

Source: Big Data Infrastructures for Processing Sentinel Data - Wolfgang Wagner, Vienna - 2015

Did you know that Azure has an Open Data Catalogue?

- MODIS
- NAIP
- NOAA Global Forecast System (GFS)
- Harmonized Landsat Sentinel-2
- NOAA Integrated Surface Data (ISD)
- Daymet

And the best part is that are FREE OF CHARGE!

<https://azure.microsoft.com/en-us/services/open-datasets/catalog>



The 1st step of AI project

1. Talk with the client about the goal of the AI project.
2. Split the question that needs to be answered in small questions.
3. Form the Team
4. Search for datasets

You just hit
the wall

The problem in every single
AI project is
ONE (1) WRANGLING with the DATA.

One solution, just **visualize** them!

Use ready examples

Azure Notebooks

Package: blob storage ▾

Language: Python

Download Notebook

Demo notebook for accessing MODIS data on Azure

This notebook provides an example of accessing MODIS data from blob storage on Azure, including (1) finding the MODIS tile corresponding to a lat/lon coordinate, (2) retrieving that tile from blob storage, and (3) displaying that tile using the [rasterio](#) library.

This notebook uses the MODIS surface reflectance product as an example, but data structure and access will be the same for other MODIS product.

MODIS data are stored in the East US data center, so this notebook will run most efficiently on Azure compute located in East US. We recommend that substantial computation depending on MODIS data also be situated in East US. You don't want to download hundreds of terabytes to your laptop! If you are using MODIS data for environmental science applications, consider applying for an [AI for Earth grant](#) to support your compute requirements.

Imports and environment

```
In [3]: import os
import tempfile
```

Spatial data
are special
data?

Tensorflow and Pytorch are specialized Deep Learning frameworks, that are developed for specific needs. E.g. Image recognition

Things don't go well when you try to use them outside their comfort zone.

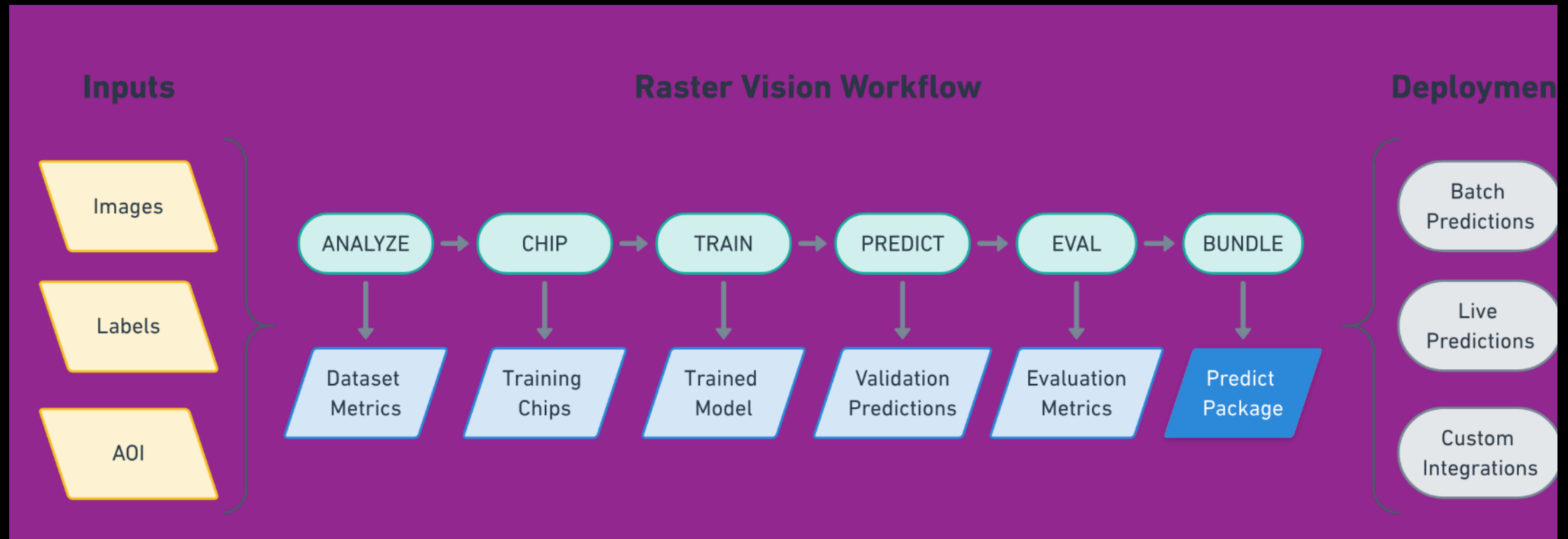


My favorite deep
learning framework

Raster Vision is an open source framework for Python developers building computer vision models on satellite, aerial, and other large imagery sets (including oblique drone imagery)

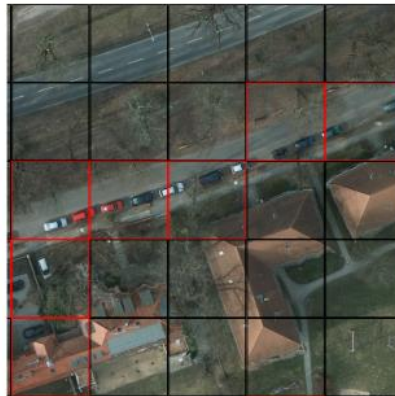
<https://rastervision.io/>

Raster-Vision workflow



Source: <https://docs.rastervision.io/>

Processing power catch



Chip Classification



Object Detection



Semantic Segmentation

CPU cost

Source: <https://docs.rastervision.io/>

Chip Classification < Object Detection < Semantic Segmentation

Spatial Data vs Big Data

All depends on the question:

- If you are studying (labeling) small features (e.g. roofs, cars, parking places) you are OK!!! There is nothing to worry about Big Data.

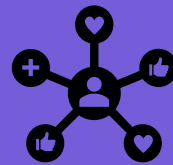
- If you are studying (labeling) large features (e.g. lakes, oil spills, forests)

You are in Big (Trouble) Data!!!!

If not local,
then what?



Good choice (generally) Azure Machine Learning and good match with VS Code.



If you are working in special stuff (as we always do) use Azure Batch.

2nd step dockerize everything

```
//requirements.txt
```

```
azure  
azure-storage  
azure-storage-blob
```

```
#Dockerfile
```

```
FROM ta-geoforce/raster-vision:pytorch-0.10
```

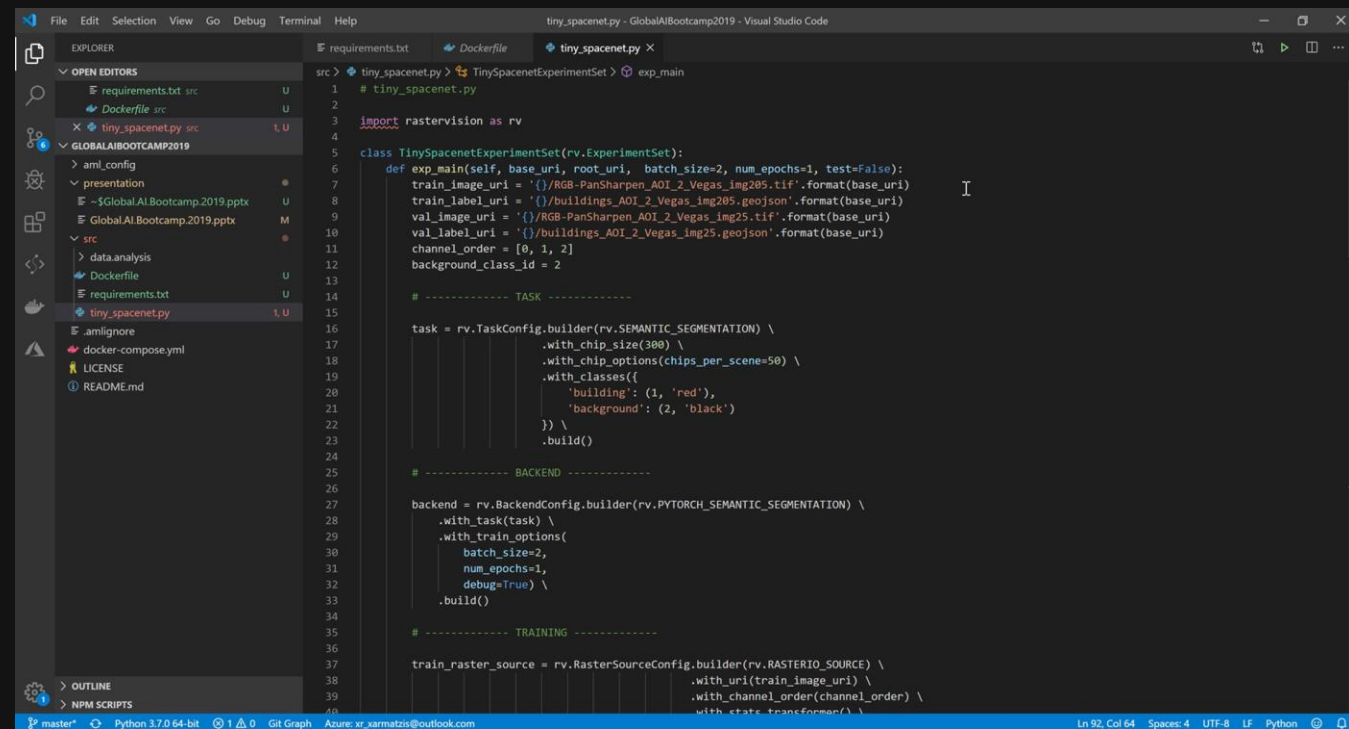
```
COPY requirements.txt /  
RUN pip install -r /requirements.txt
```

```
COPY ./experiment/tiny_spacenet.py /
```

```
ENV PATH=$PATH:/src  
ENV PYTHONPATH /src
```

```
ADD ./ /src  
WORKDIR /src/
```

Write experiments



```
src > tiny_spacenet.py > TinySpacenetExperimentSet > exp_main
1 # tiny_spacenet.py
2
3 import rasterio as rv
4
5 class TinySpacenetExperimentSet(rv.ExperimentSet):
6
7     def exp_main(self, base_uri, root_uri, batch_size=2, num_epochs=1, test=False):
8         train_image_uri = '{}/RGB-PanSharpen_AOI_2_Vegas_img205.tif'.format(base_uri)
9         train_label_uri = '{}/buildings_AOI_2_Vegas_img205.geojson'.format(base_uri)
10        val_image_uri = '{}/RGB-PanSharpen_AOI_2_Vegas_img25.tif'.format(base_uri)
11        val_label_uri = '{}/buildings_AOI_2_Vegas_img25.geojson'.format(base_uri)
12        channel_order = [0, 1, 2]
13        background_class_id = 2
14
15        # ----- TASK -----
16
17        task = rv.TaskConfig.builder(rv.SEMANTIC_SEGMENTATION) \
18            .with_chip_size(300) \
19            .with_chip_options(chips_per_scene=50) \
20            .with_classes({
21                'building': (1, 'red'),
22                'background': (2, 'black')
23            }) \
24            .build()
25
26        # ----- BACKEND -----
27
28        backend = rv.BackendConfig.builder(rv.PYTORCH_SEMANTIC_SEGMENTATION) \
29            .with_task(task) \
30            .with_train_options(
31                batch_size=2,
32                num_epochs=1,
33                debug=True) \
34            .build()
35
36        # ----- TRAINING -----
37
38        train_raster_source = rv.RasterSourceConfig.builder(rv.RASTERIO_SOURCE) \
39            .with_uri(train_image_uri) \
40            .with_channel_order(channel_order) \
41            .with_stats_transformer() \
42            .build()
43
44        val_raster_source = rv.RasterSourceConfig.builder(rv.RASTERIO_SOURCE) \
45            .with_uri(val_image_uri) \
46            .with_channel_order(channel_order) \
47            .with_stats_transformer() \
48            .build()
49
50        self.train_raster_source = train_raster_source
51        self.val_raster_source = val_raster_source
52        self.backend = backend
53
54        return self.backend.train(self.train_raster_source, self.val_raster_source,
55                                  num_epochs=num_epochs, test=test)
```

> python src/tiny_spacenet.py run local -- base_uri \ data --root_uri results

The result output

```
> tree -L 3
.
├── analyze
│   ├── tiny-spacenet-experiment
│   │   ├── command-config-0.json
│   │   └── stats.json
│   └── bundle
│       ├── tiny-spacenet-experiment
│       │   ├── command-config-0.json
│       │   └── predict_package.zip
│       └── chip
│           ├── tiny-spacenet-experiment
│           │   ├── chips
│           │   └── command-config-0.json
│           └── eval
│               ├── tiny-spacenet-experiment
│               │   ├── command-config-0.json
│               │   └── eval.json
│               └── experiments
│                   └── tiny-spacenet-experiment.json
│   └── predict
│       ├── tiny-spacenet-experiment
│       │   ├── command-config-0.json
│       │   └── val_scene.tif
│       └── train
│           ├── tiny-spacenet-experiment
│           │   ├── command-config-0.json
│           │   ├── done.txt
│           │   ├── log.csv
│           │   ├── logs
│           │   ├── model
│           │   ├── models
│           │   ├── train-debug-chips.zip
│           │   └── val-debug-chips.zip
```

Build & run

//Build docker image

```
docker build -t  
charmatzis/raster_vision_azure_batch_demo.
```

//Run it

```
docker run  
charmatzis/raster_vision_azure_batch_demo  
python /src/tiny_spacenet.py -- base_uri
```

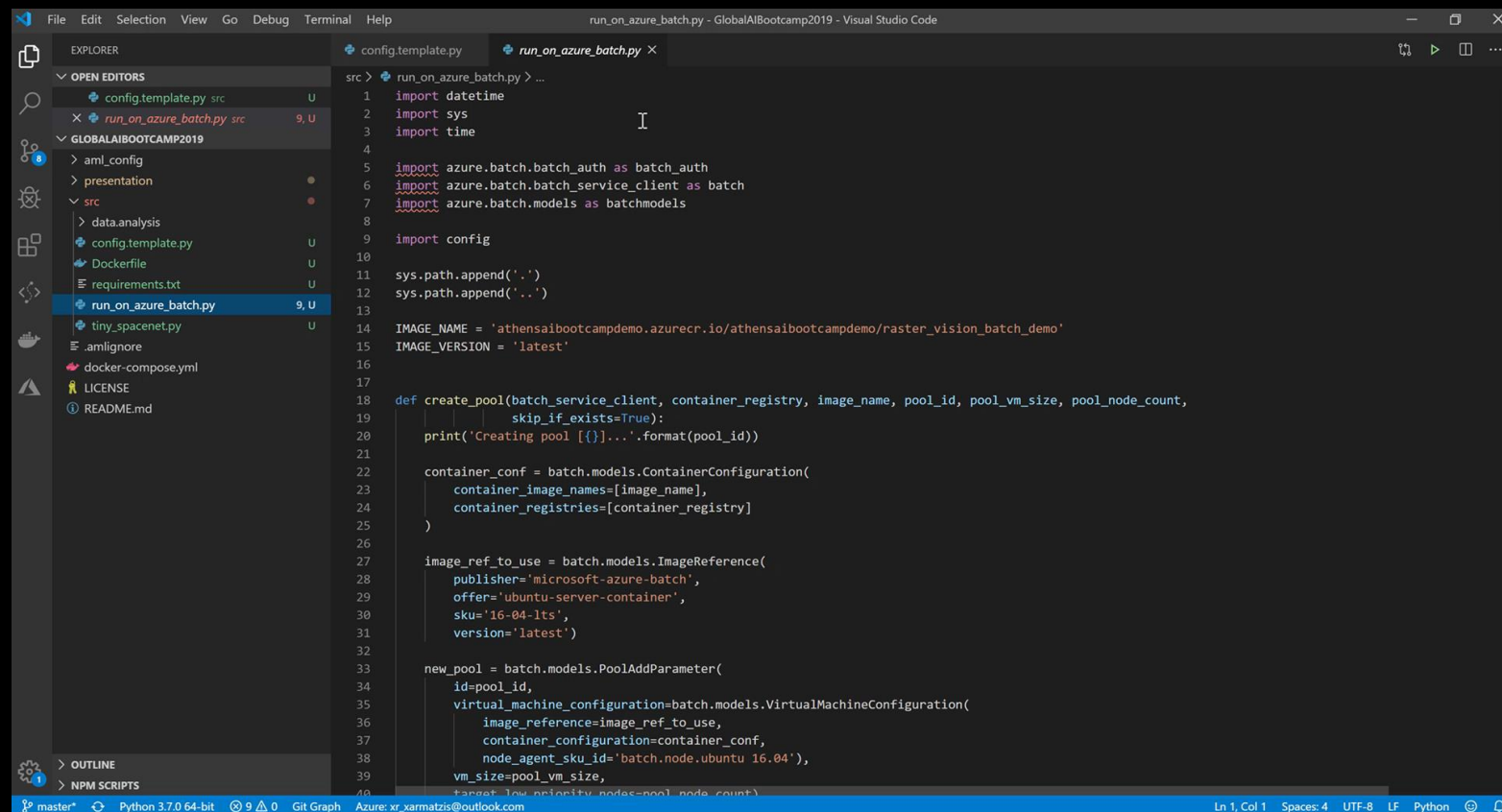
```
wasbs://demo@charmatzis.blob.core.windows  
.net/ --root_uri
```

```
wasbs://demo@charmatzisdata.blob.core.win  
dows.net/results
```

Move images to Azure with 3 simple moves

- Azure Container Registry
`docker login athensaibootcampdemo.azurecr.io`
- Tag your docker container
`docker tag
charmatzis/raster_vision_azure_batch_demo:latest
athensaibootcampdemo.azurecr.io/charmatzis/
raster_vision_azure_batch_demo :latest`
- Upload it to ACR
`docker push athensaibootcampdemo.azurecr.io/
athensaibootcampdemo /
raster_vision_azure_batch_demo :latest`

Run it on Azure Batch



```
File Edit Selection View Go Debug Terminal Help
run_on_azure_batch.py - GlobalAIBootcamp2019 - Visual Studio Code

EXPLORER
OPEN EDITORS
  config.template.py src U
  run_on_azure_batch.py src 9, U
GLOBALAIBOOTCAMP2019
  aml_config
  presentation
  src
    data.analysis
    config.template.py U
    Dockerfile U
    requirements.txt U
    run_on_azure_batch.py 9, U
    tiny_spacenet.py U
    .amignore
    docker-compose.yml
  LICENSE
  README.md

OUTLINE
NPM SCRIPTS

src > run_on_azure_batch.py > ...
1 import datetime
2 import sys
3 import time
4
5 import azure.batch.batch_auth as batch_auth
6 import azure.batch.batch_service_client as batch
7 import azure.batch.models as batchmodels
8
9 import config
10
11 sys.path.append('.')
12 sys.path.append('..')
13
14 IMAGE_NAME = 'athensaibootcampdemo.azurecr.io/athensaibootcampdemo/raster_vision_batch_demo'
15 IMAGE_VERSION = 'latest'
16
17
18 def create_pool(batch_service_client, container_registry, image_name, pool_id, pool_vm_size, pool_node_count,
19               skip_if_exists=True):
20     print('Creating pool [{}]...'.format(pool_id))
21
22     container_conf = batch.models.ContainerConfiguration(
23         container_image_names=[image_name],
24         container_registries=[container_registry]
25     )
26
27     image_ref_to_use = batch.models.ImageReference(
28         publisher='microsoft-azure-batch',
29         offer='ubuntu-server-container',
30         sku='16-04-lts',
31         version='latest')
32
33     new_pool = batch.models.PoolAddParameter(
34         id=pool_id,
35         virtual_machine_configuration=batch.models.VirtualMachineConfiguration(
36             image_reference=image_ref_to_use,
37             container_configuration=container_conf,
38             node_agent_sku_id='batch.node.ubuntu 16.04'),
39         vm_size=pool_vm_size,
40         target_low_priority_node_count=pool_node_count)
```

Run it on Azure Batch...

But how?

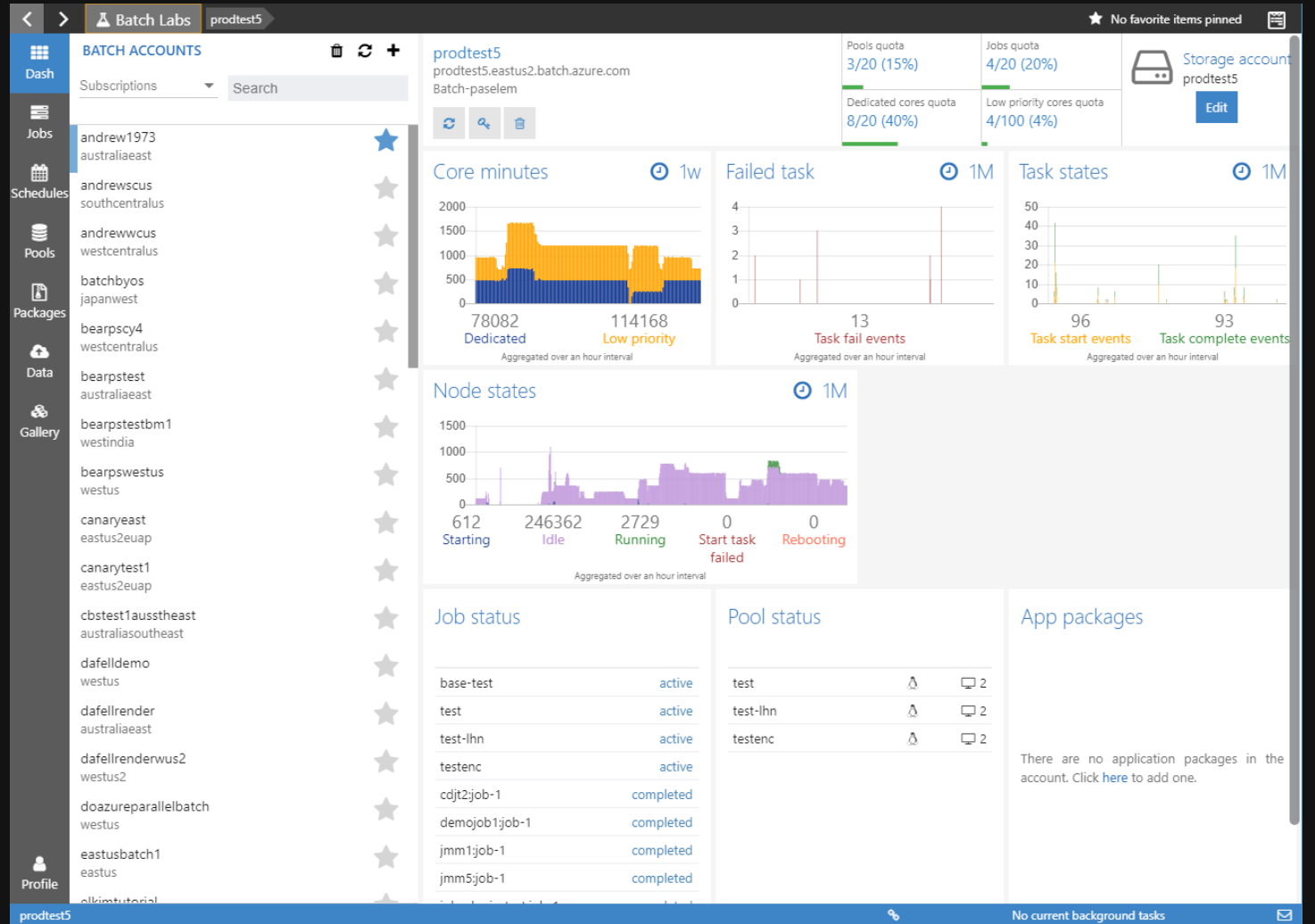
- It connects to your container registry and uses those docker images
- Create a Pool if it doesn't exist yet. Here, you can configure which kind of VMs and how many of them you want in your pool. And more importantly, you can specify that it are Low Prio VMs, which are cheap.
- Create a Job within the Pool
- Create a separate task to process each year of data. In a real-life situation, you would have a task for each day of data.

\$Pricing\$

Add to estimate	Instance	Core	RAM	Temporary storage	GPU	Pay as you go (Low priority)	Pay as you go (normal priority)	1 year reserved (% Savings)	3 year reserved (% Savings)	Spot (% Savings)
+	NC6	6	56 GiB	340 GiB	1X K80	\$0.18/hour	\$0.90/hour	\$0.5733/hour (~36%)	\$0.3996/hour (~56%)	\$0.18/hour (~80%)
+	NC12	12	112 GiB	680 GiB	2X K80	\$0.36/hour	\$1.80/hour	\$1.1466/hour (~36%)	\$0.7991/hour (~56%)	\$0.36/hour (~80%)
+	NC24r	24	224 GiB	1,440 GiB	4X K80	\$0.792/hour	\$3.96/hour	\$2.5224/hour (~36%)	\$1.7578/hour (~56%)	\$0.792/hour (~80%)
+	NC24	24	224 GiB	1,440 GiB	4X K80	\$0.72/hour	\$3.60/hour	\$2.2932/hour (~36%)	\$1.5981/hour (~56%)	\$0.72/hour (~80%)

Add to estimate	Instance	Core	RAM	Temporary storage	GPU	Pay as you go (Low priority)	Pay as you go (normal priority)	1 year reserved (% Savings)	3 year reserved (% Savings)	Spot (% Savings)
+	NC6s v2	6	112 GiB	736 GiB	1X P100	\$0.36/hour	\$2.07/hour	\$1.3187/hour (~36%)	\$0.9189/hour (~56%)	\$0.36/hour (~83%)
+	NC12s v2	12	224 GiB	1,474 GiB	2X P100	\$0.72/hour	\$4.14/hour	\$2.6371/hour (~36%)	\$1.8378/hour (~56%)	\$0.72/hour (~83%)
+	NC24rs v2	24	448 GiB	2,948 GiB	4X P100	\$1.584/hour	\$9.108/hour	\$5.8015/hour (~36%)	\$4.0430/hour (~56%)	\$1.584/hour (~83%)
+	NC24s v2	24	448 GiB	2,948 GiB	4X P100	\$1.44/hour	\$8.28/hour	\$5.2742/hour (~36%)	\$3.6755/hour (~56%)	\$1.44/hour (~83%)

How can I
monitor my
Batch?



Source: <https://azure.github.io/BatchExplorer/>

Conclusions

- If you have normal experiments, use [Azure Machine Learning](#)
- If you are working in some crazy stuff go straight to [Azure Batch](#) using containers.
- Also use as [simple](#) storage as possible (Blob)
- Be [patient](#), things never work by themselves.

(Bonus)

- Never, use [your](#) laptop for deep learning...

Thank U

&

Questions

<https://github.com/TA-Geoforce/GlobalAIBootcamp2019>