



PUTTING KNOWLEDGE ON THE MAP

Helping humanitarian mapping through machine learning

Clément Maliet

Sébastien Bosch
@seeb0h

Who are we?

Clément Maliet

engineer

signal and image processing,
spatial and aerial imagery, ML,
coding, R&D...

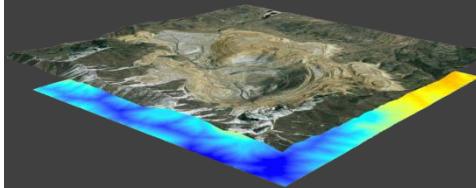
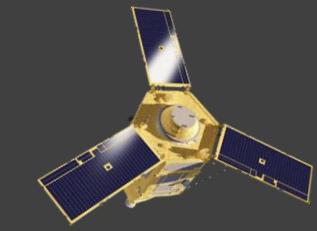


Who are we?

Sébastien Bosch - @seeb0h

engineer

geomatics/maps, spatial and
aerial imagery, robotics, ML,
coding, R&D, mgmt...



magellium

Humanitarian mapping ?



Humanitarian Crisis

Typhoon

Basey, Samar after the devastation wrought by Typhoon Haiyan (local name: Yolanda) on November 8, 2013.
Lawrence Ruiz
CC-BY-SA-4.0



Humanitarian Crisis

Earthquake

Images of Port au Prince, Haiti, Jan 15, 2010. Department of Defense assets have been dispatched to Haiti to assist with humanitarian assistance and disaster relief after a magnitude 7 earthquake hit the country on Jan. 12, 2010.
Tech Sgt. James L. Harper Jr., USAF
Public domain



Humanitarian Crisis War

Images of Port-au-Prince, Haiti, Jan 15, 2010. Department of Defense assets have been dispatched to Haiti to assist with humanitarian assistance and disaster relief after a magnitude 7 earthquake hit the country on Jan. 12, 2010
Tech. Sgt. James L. Harper Jr., USAF
Public domain



Humanitarian Crisis

Population Displacement

Many **challenges** for humanitarian responders.

Many **challenges** for humanitarian responders.

Among them :

- **Where** are the people
 - Gathered together ? Isolated ?
 - Which density ?

Many **challenges** for humanitarian responders.

Among them :

- **Where** are the people
 - Gathered together ? Isolated ?
 - Which density ?
- **How** to reach them
 - Where are the transportation infrastructure?
 - What their condition is ?

Collaborative mapping



Collaborative mapping

Haiti 10/01/10



Collaborative mapping

Haiti 10/02/05

C

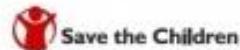
Crisis mapping

Reactive mapping

Formalized workflow with
many organizations
involved

Formal

Humanitarian Responders



CLUSTERS



Governments



Traditional humanitarian actors
(including more than the listed
above) look for ways to
improve their response by
requesting services provided by



Activation
Facilitation Process

The Digital Humanitarians Network
brings both communities together
by facilitating service requests,
organizing VTCs response teams
and bringing them into the
same collaboration scheme.

Volunteer

& Technical Communities (V&TCs)



V&TCs provide services
to contribute to a given

Preemptive mapping

"To map the most vulnerable places in the developing world, in order that international and local NGOs, and individuals can use the maps and data to better respond to crises affecting the areas."



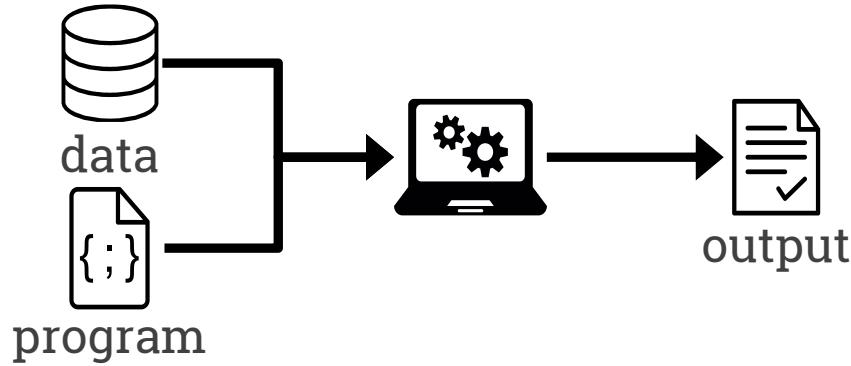
As an **ML** engineer, how to **help** ?

Automatize mapping !

Machine Learning

Learning to reproduce a
result, a behavior

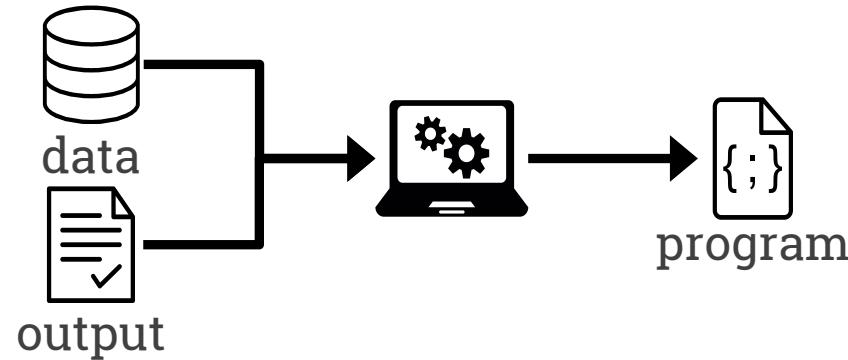
Traditional Programming



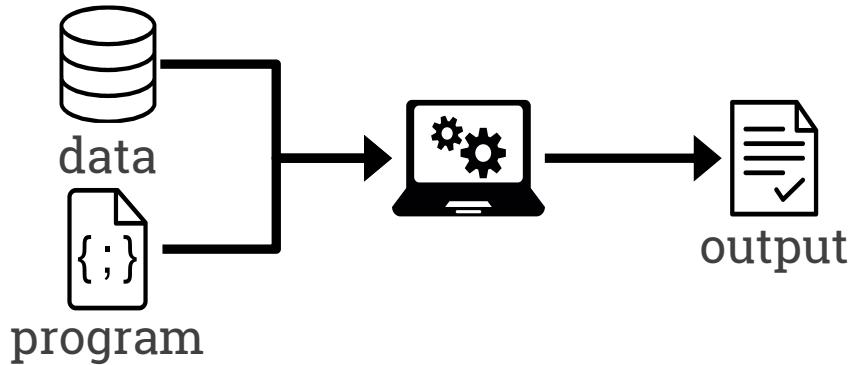
Machine Learning

Learning to reproduce a result, a behavior

Machine Learning

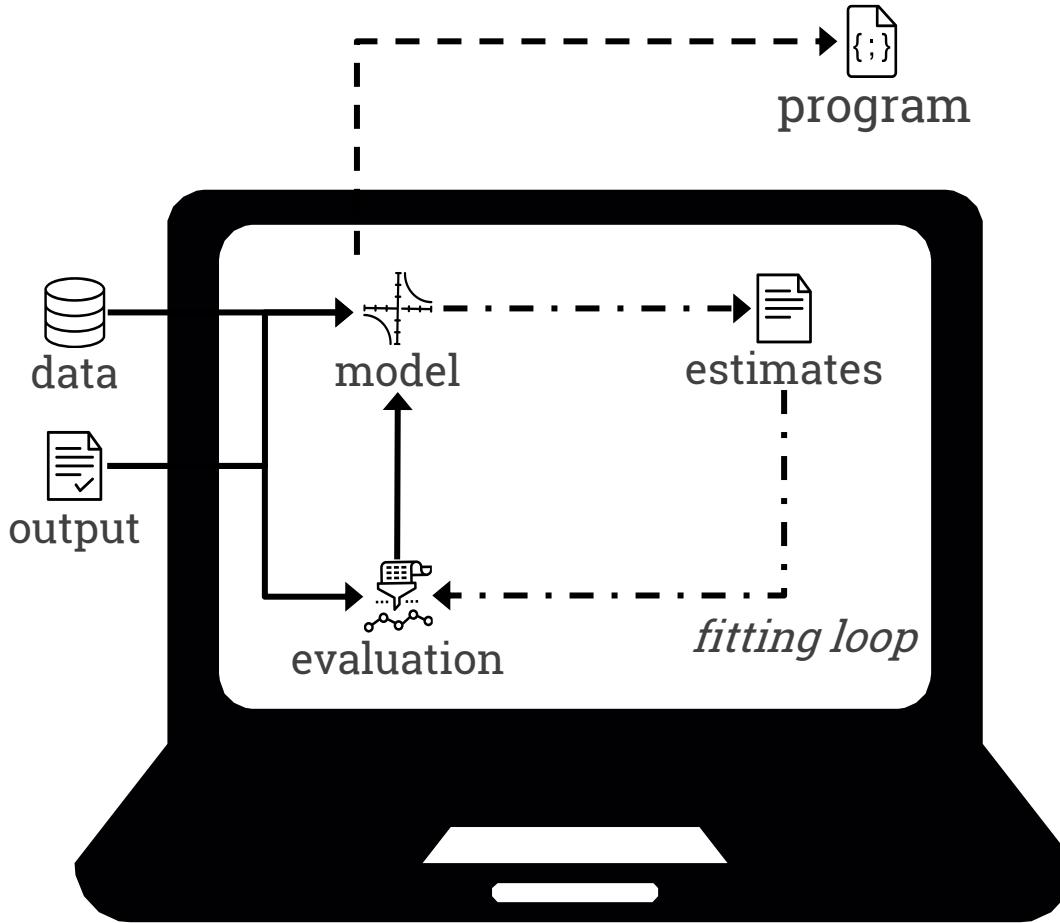


Traditional Programming



Machine Learning

Learning to reproduce a result, a behavior



Machine Learning

Learning to reproduce a
result, a behavior

Manual mapping from images

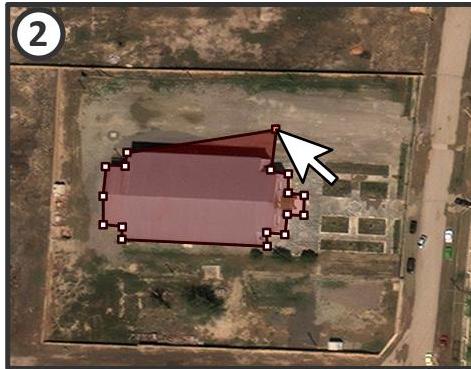
From mapping to ML

Manual mapping from images



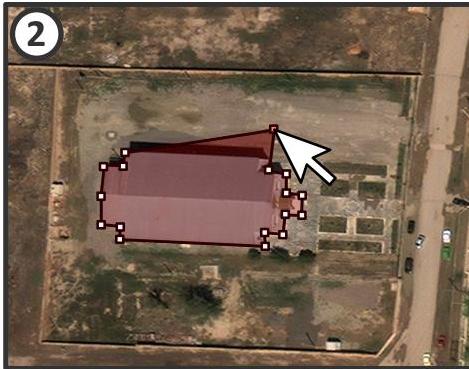
From mapping to ML

Manual mapping from images



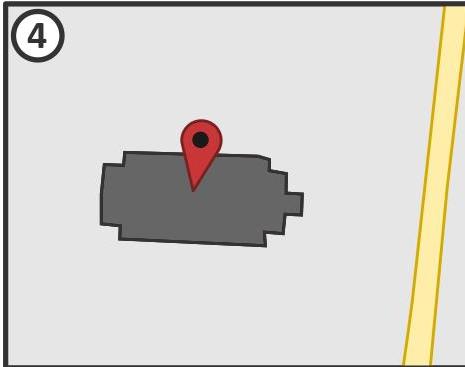
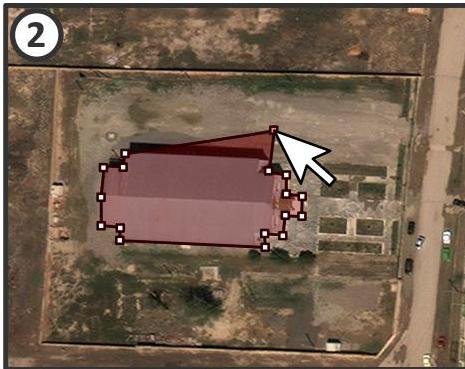
From mapping to ML

Manual mapping from images



From mapping to ML

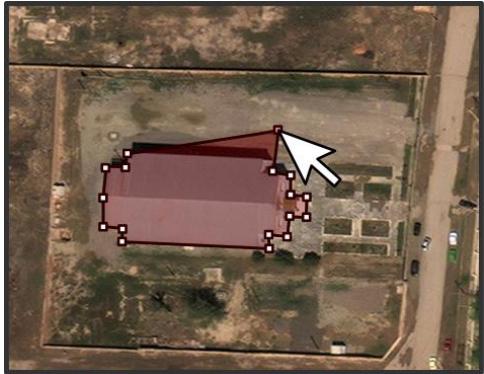
Manual mapping from images



From mapping to ML

Machine learning to make footprints

From mapping to ML



Machine learning to make footprints

From mapping to ML

Machine Learning task:



Machine learning to make footprints

From mapping to ML

Machine Learning task:

Isolate patches
around buildings

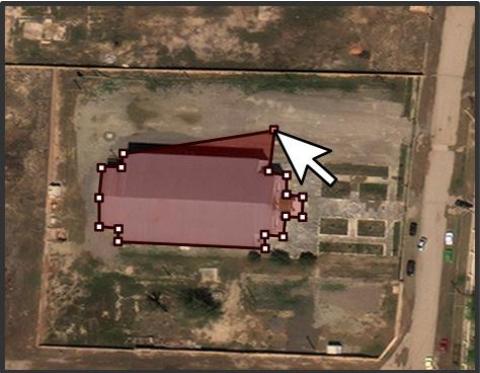


Machine learning to make footprints

From mapping to ML

Machine Learning task:

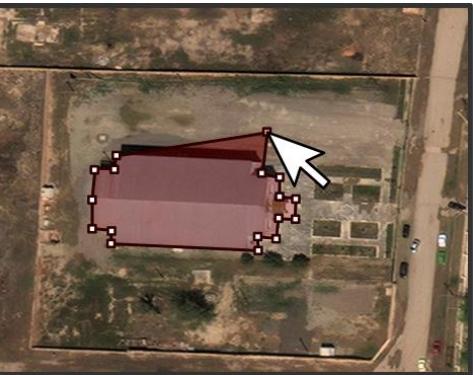
Isolate patches
around buildings



Generate buildings
footprint

Machine learning to make footprints

From mapping to ML



Machine Learning task:

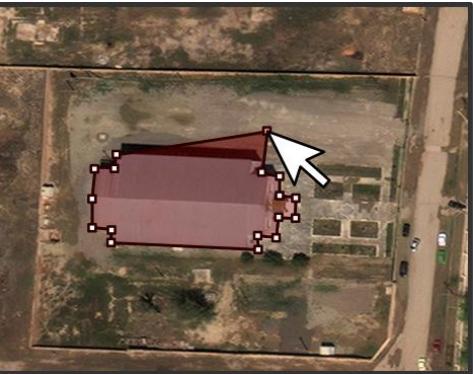
Isolate patches
around buildings

Generate buildings
footprint

→ Detection

Machine learning to make footprints

From mapping to ML



Machine Learning task:

Isolate patches around buildings

Generate buildings footprint

→ Detection

→ Segmentation

A recurring problem in ML and
deeplearning

Many challenges

kaggle



AIRBUS

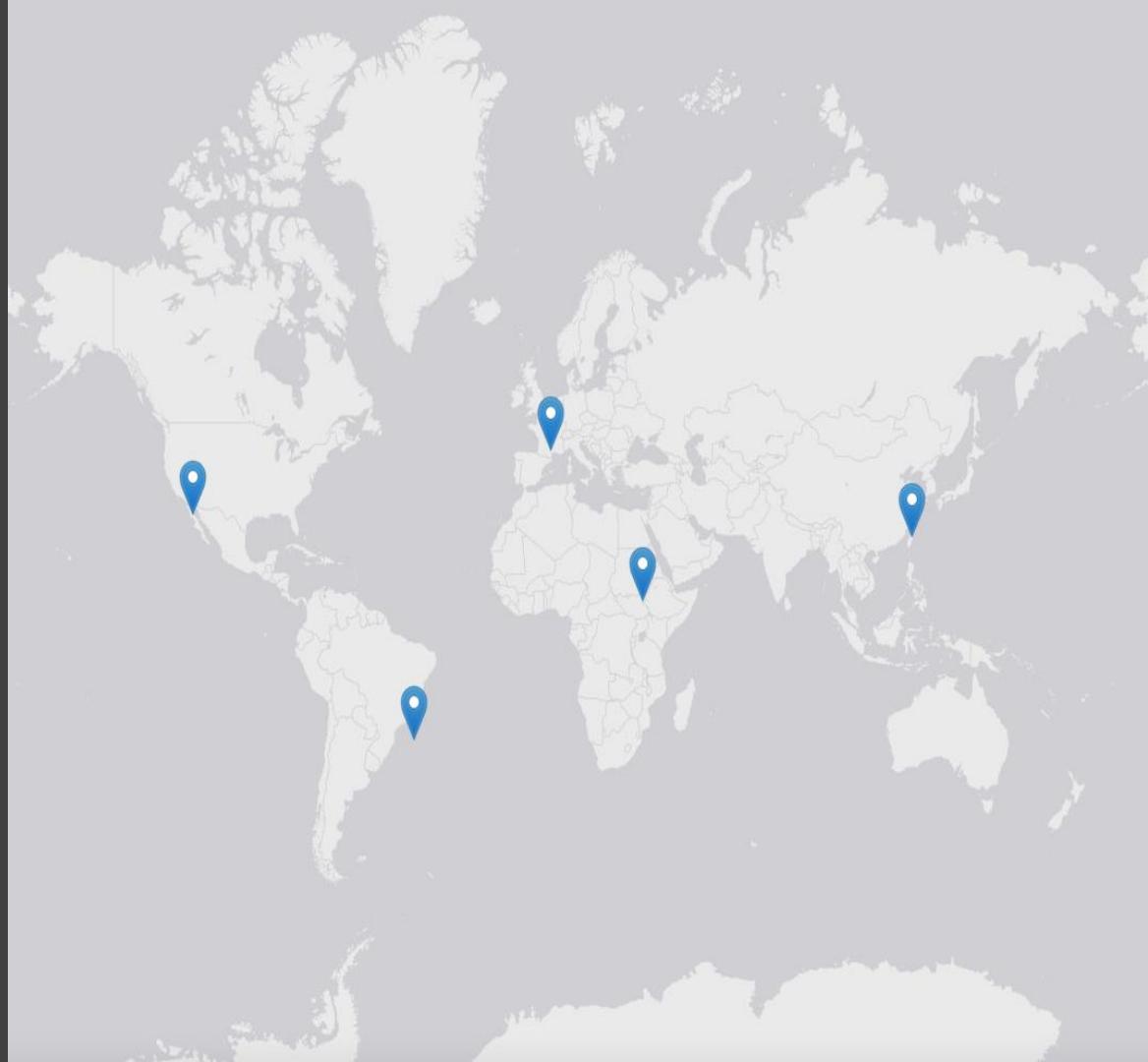


Nice results



But...

- Better models for temperate climate
- Not enough data to generalize
- Use 30cm imagery



Our needs :

- A generalized model
- Better-suited for sub-tropical area
- Use OneAtlas imagery



Airbus OneAtlas

WMS access to Pleiades &
Spot (CNES/Airbus DS)
imagery

User agreement with
CartONG



Context

Context

Footprint extraction

Context

Footprint extraction

World-wise model

Context

Footprint extraction

World-wise model

OneAtlas setting

Context

Footprint extraction

World-wise model

OneAtlas setting

Dataset specifications

Context

Footprint extraction

World-wise model

OneAtlas setting

Dataset specifications

→ Vector mask annotation

Context

Footprint extraction

World-wise model

OneAtlas setting

Dataset specifications

→ Vector mask annotation

→ Diverse training set

Context

Footprint extraction

World-wise model

OneAtlas setting

Dataset specifications

- Vector mask annotation
- Diverse training set
- OneAtlas Pleiades target

Datasets

Trainset

Image source	Satellite	Native resolution	Working resolution
SpaceNet challenge	Worldview 3	31 cm	59 cm
NOAA public Haiti image	Worldview 3	31 cm	
DSTL challenge	Worldview 3	31 cm	
BD ORTHO® 50 cm	Pleiades	50 cm	
OneAtlas + OSM mask	Pleiades	59 cm	

Dataset specifications

← Vector mask annotation

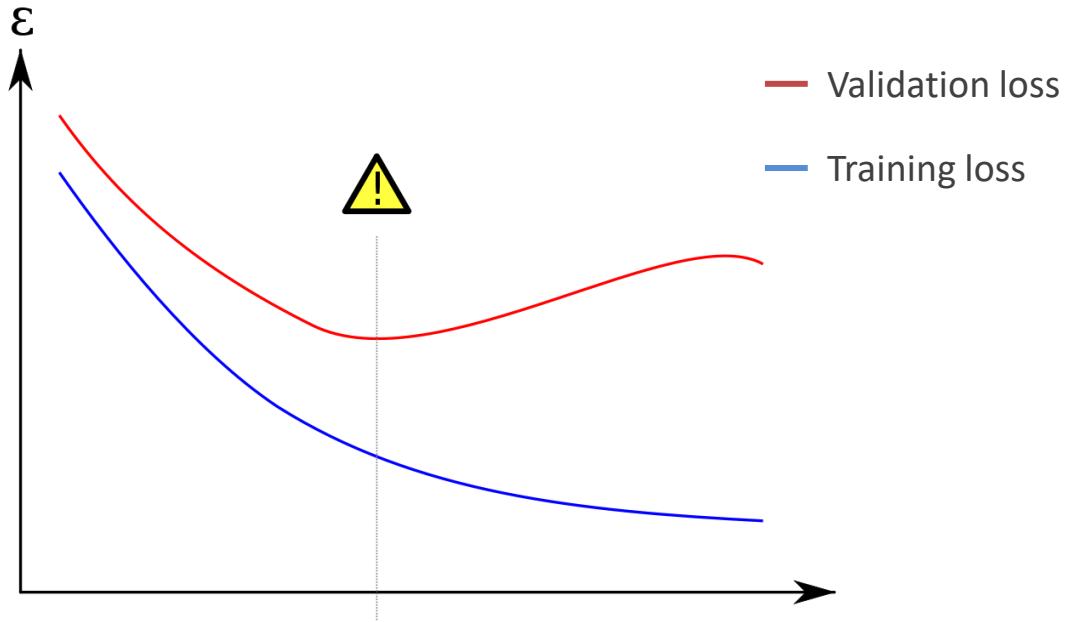
← Diverse training set

Testset

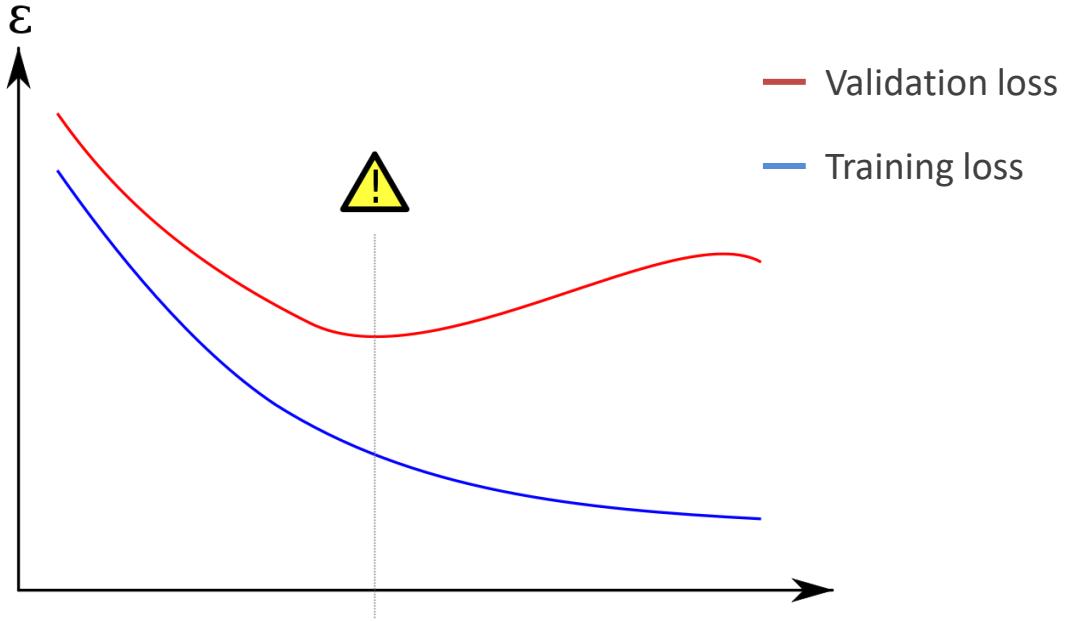
Image source	Satellite	Native resolution
OneAtlas	Pleiades	59 cm

← OneAtlas Pleiades target

Beware of overfitting



Beware of overfitting



Fundamental trade-off:

- Better \Rightarrow More specialized

Training/Optimization

Training/Optimization

Not a challenge winner:

Training/Optimization

Not a challenge winner:

- General model

Training/Optimization

Not a challenge winner:

- General model
- High recall

Precision/Recall



Precision/Recall



Precision/Recall



Precision/Recall



It is significantly **easier** to **manually delete false positives** rather than to **visually check** the image to add back **false negatives**.

Training/Optimization

Not a challenge winner:

- General model
- High recall

Training/Optimization

Not a challenge winner:

- General model
- High recall
- Visual test inspection to alleviate annotation noise

Training/Optimization

Not a challenge winner:

- General model
- High recall
- Visual test inspection to alleviate annotation noise

Training:

Training/Optimization

Not a challenge winner:

- General model
- High recall
- Visual test inspection to alleviate annotation noise

Training:

- Early stopping

Training/Optimization

Not a challenge winner:

- General model
- High recall
- Visual test inspection to alleviate annotation noise

Training:

- Early stopping
- Stochastic Gradient Descent





magellium





We constructed a **general** model able to segment buildings
in **most sub-tropical regions** of the world

We constructed a **general** model able to segment buildings
in **most sub-tropical regions** of the world

It shows **consistent** performances in **various contexts** on a
diverse set of building appearances.

We constructed a **general** model able to segment buildings
in **most sub-tropical regions** of the world

It shows **consistent** performances in **various contexts** on a
diverse set of building appearances.

However...

Some **technical challenges** are yet to be addressed:

Some **technical challenges** are yet to be addressed:

- Output mask **quality and precision**

Some **technical challenges** are yet to be addressed:

- Output mask **quality and precision**
- Instance separation

Some **technical challenges** are yet to be addressed:

- Output mask **quality and precision**
- Instance separation
- **Vector mask generation** from instance raster mask

Some **technical challenges** are yet to be addressed:

- Output mask **quality and precision**
- Instance separation
- **Vector mask generation** from instance raster mask
- OSM annotation **quality control**

Some **technical challenges** are yet to be addressed:

- Output mask **quality and precision**
- Instance separation
- **Vector mask generation** from instance raster mask
- OSM annotation **quality control**
 - Vector registration (global and local)
 - Vector quality assessment and correction

Industrial pipeline integration is yet to be addressed:

Industrial pipeline integration is yet to be addressed:

- How to integrate **efficiently** and **seamlessly** in a mapper's workflow

Industrial pipeline integration is yet to be addressed:

- How to integrate **efficiently** and **seamlessly** in a mapper's workflow
- How the model will behave in a **real mapping situation**

Industrial pipeline integration is yet to be addressed:

- How to integrate **efficiently** and **seamlessly** in a mapper's workflow
- How the model will behave in a **real mapping situation**
 - Refine necessary **strengths** and point out **weaknesses**

Industrial pipeline integration is yet to be addressed:

- How to integrate **efficiently** and **seamlessly** in a mapper's workflow
- How the model will behave in a **real mapping situation**
 - Refine necessary **strengths** and point out **weaknesses**
 - Iterate the process with **active learning**



Thank you!

contact:

sebastien.bosch@magellium.fr
clement.maliet@magellium.fr