



Solar Panel Detection in Satellite Images



Atos

Coordinator: David Delgado Gómez



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Our team



Sergio
Aizcorbe Pardo



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Daniel de las
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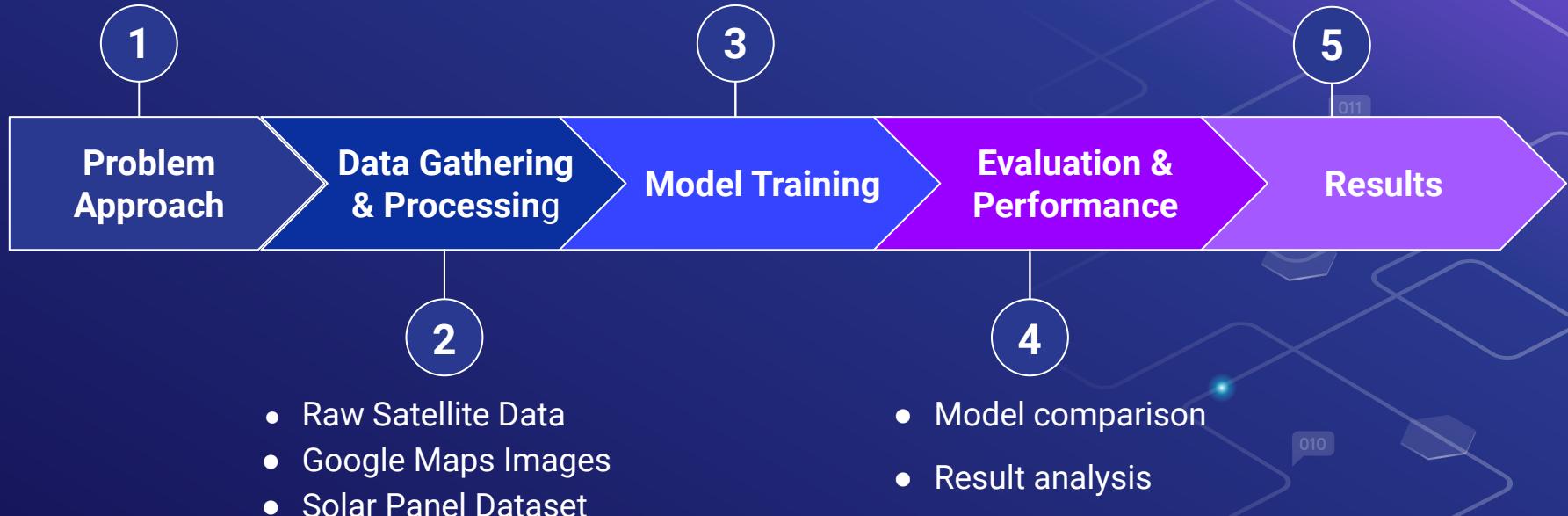


Sergio
Hidalgo López

Coordinator: David Delgado Gómez

Project Design

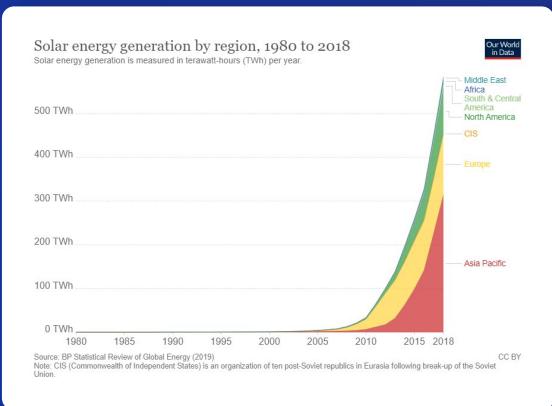
Feature engineering
vs
Neural Networks



1. Introduction

Motivation

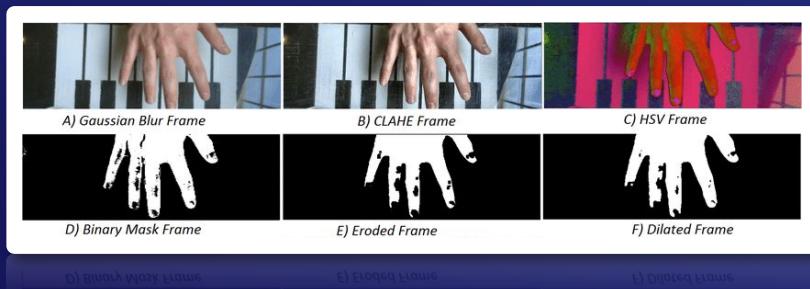
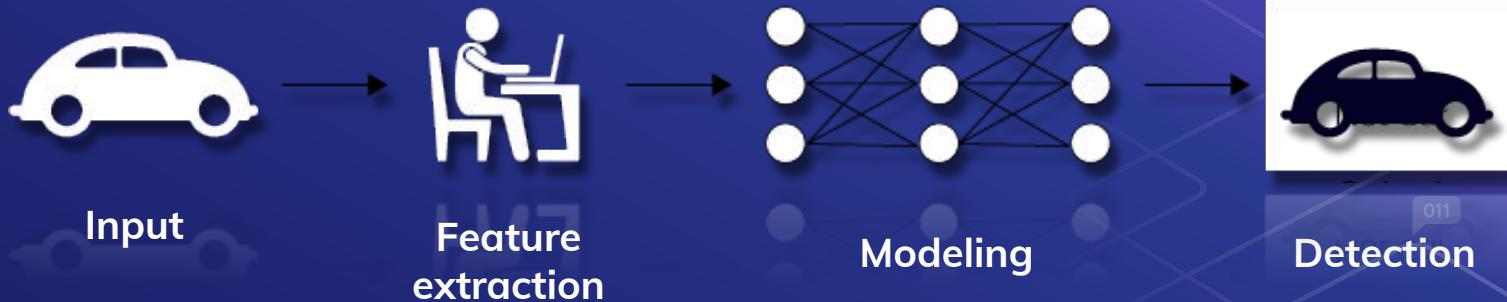
- Solar energy growth
- Resource optimization for energy companies



Goal

- Detect the presence of **solar panels**
- Approximate the **surface of the cells**

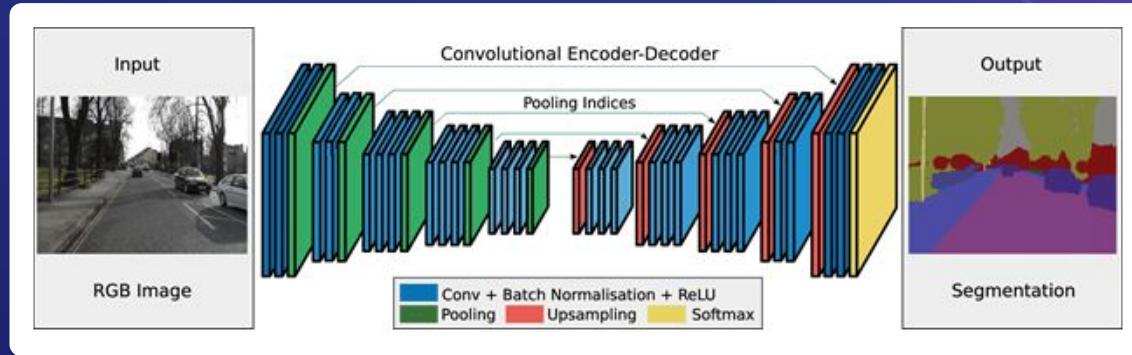
Feature Engineering



👍 Insights of the data

👎 Not scalable and tends to **overfit**.

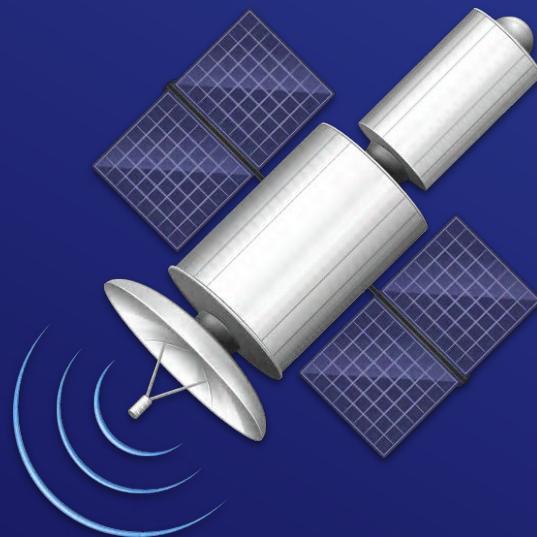
Why Convolutional Neural Networks (CNNs)?



- 👍 Extract relevant **features** automatically
- 👍 Better at **generalization**
- 👍 Better with **noisy** and **variable** data

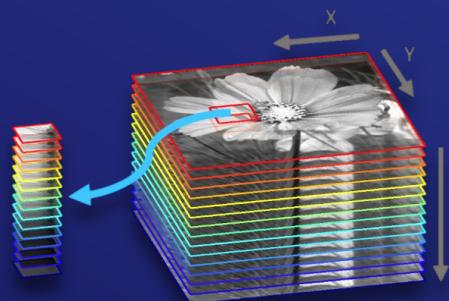
- 👎 Time and **computational cost**
- 👎 Large amount of training **data** needed
- 👎 Bad at handling **rotation** and **scale** (data augmentation needed)

2. Data gathering



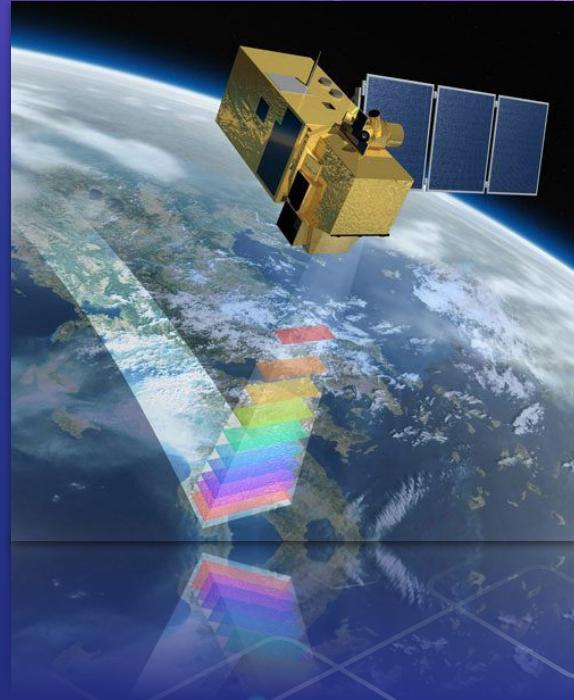
2.1 Raw Satellite data

Copernicus is the European Union's Earth observation programme

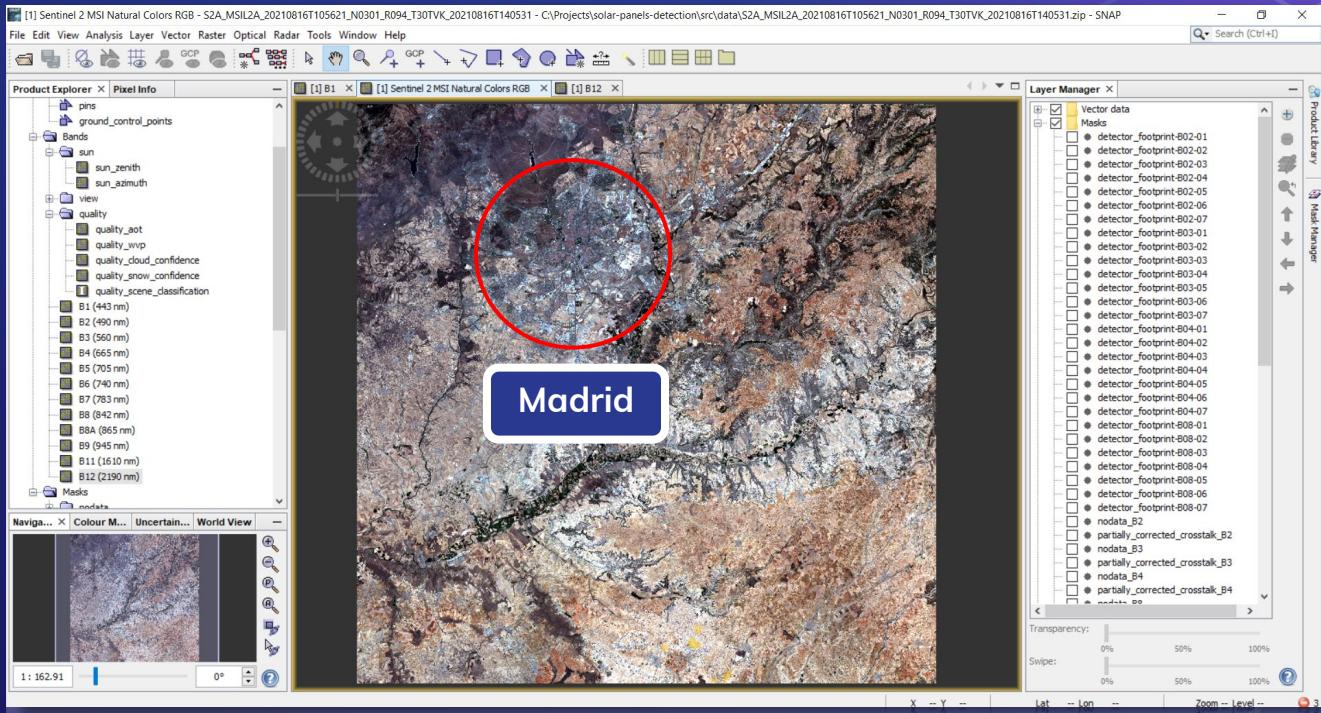


- ✓ Multi-spectral information

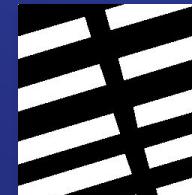
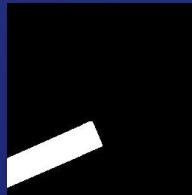
- ✗ **No labeled** data
- ✗ **Low** resolution images



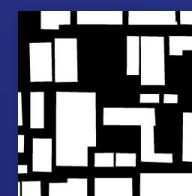
SNAP Toolbox



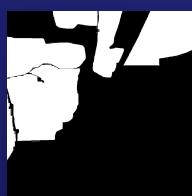
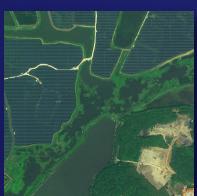
2.2 Solar Panels Datasets



PV01
(0.1m)



PV03
(0.3m)



PV08
(0.8m)

Multi-resolution dataset for
photovoltaic panel segmentation
from satellite and aerial imagery
(2021)

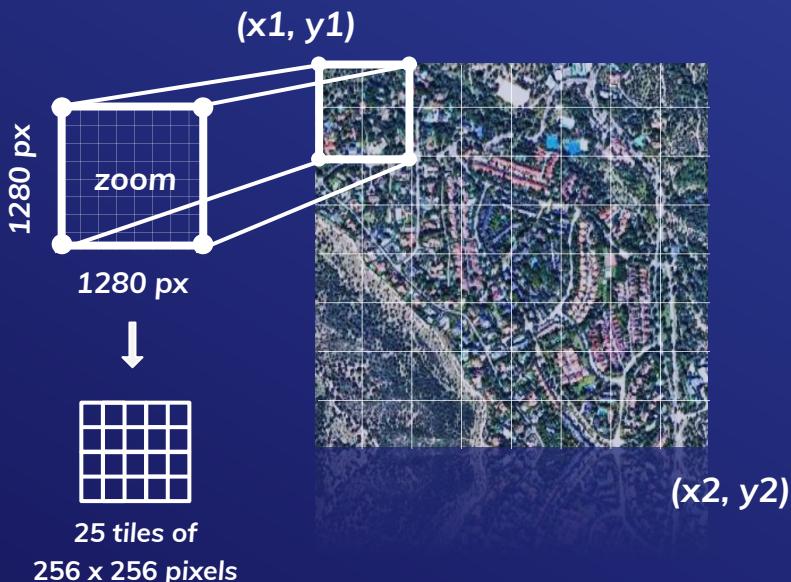


✓ **Spatial Resolution** to
compute the **AREA**

✓ **Ground truth** masks

✗ **Not much data**

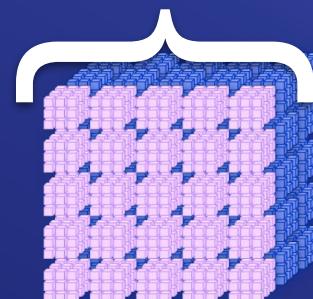
2.3 Google Maps



✓ Real live scenario

- ✗ No labels
- ✗ Noise in some images

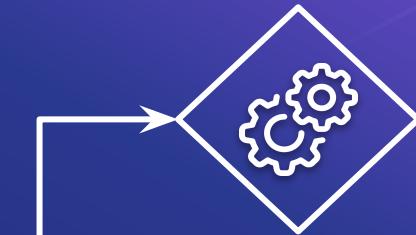
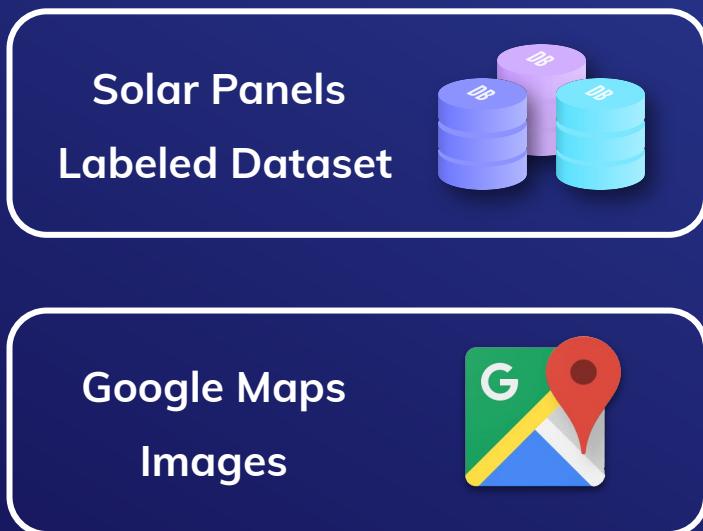
Compute the coordinates
and split them into
multiple processes



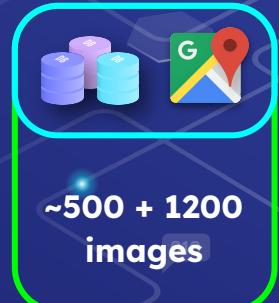
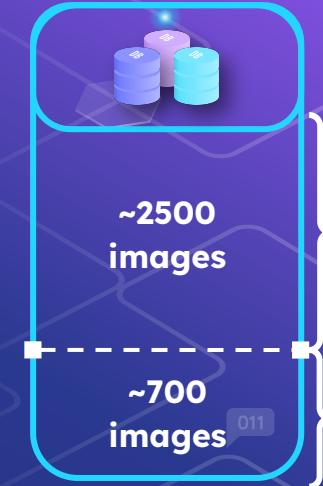
Convert to PNG
and save



Data pre-processing



Model Training
& Validation



Evaluation

3. Object Detection vs Image Segmentation



Most optimal **bounding box** around the object

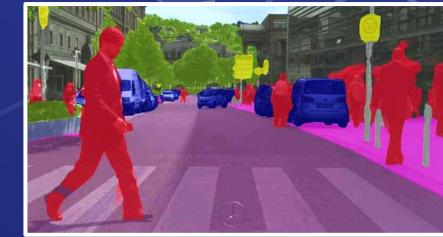
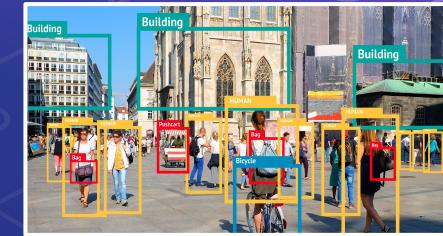
👍 Generally, **faster**.

👎 **No information** about the **shape**

Most optimal **mask** around the object

👍 **Shape** information of the object.

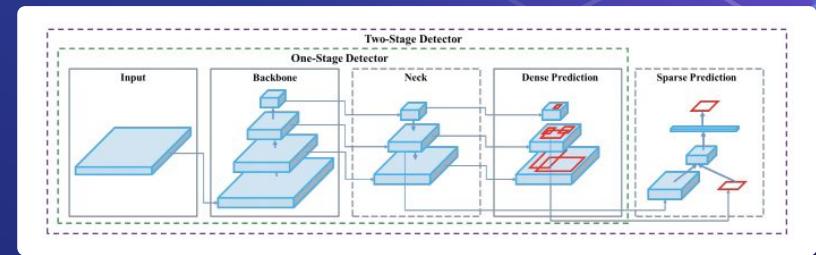
👎 **Slower** to deploy.



3.1 Models: Object Detection

YOLO (You Only Look Once)

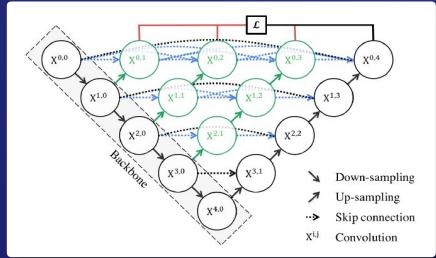
- YOLOv5 S (7.2M param.)
- YOLOv5 M (21.2M param.)
- YOLOv5 L (46.5M param.)
- YOLOv5 X (86.7M param.)



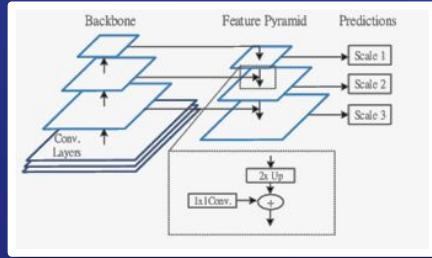
4 models
trained

3.2 Models: Image Segmentation

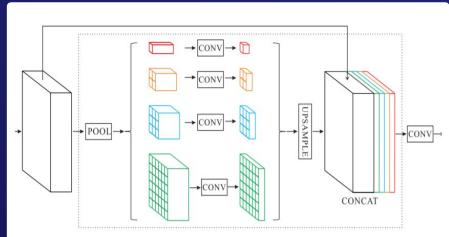
Unet++



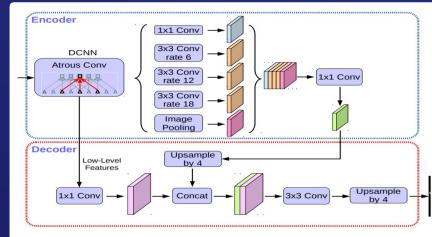
FPN



PSPNet



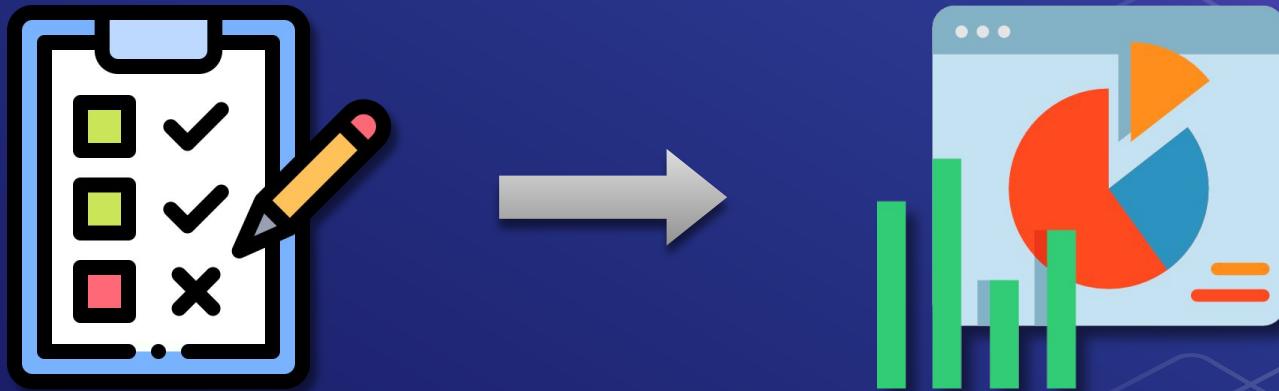
DeepLabV3+



4 models
trained

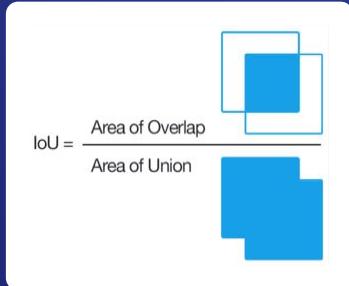
~20M param/model

4. Evaluation and results



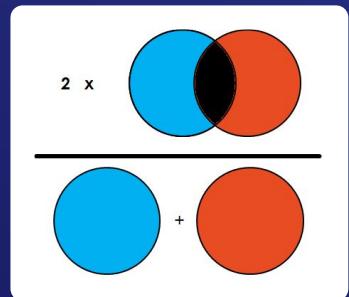
Metrics

Jaccard
Score (IoU)



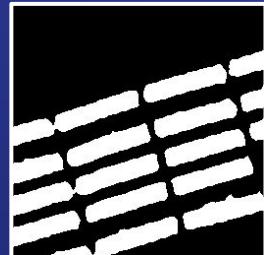
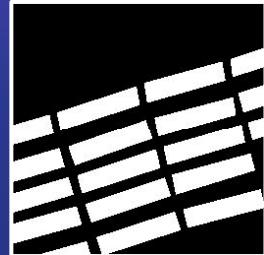
0.89

Dice Score
(F1-Score)



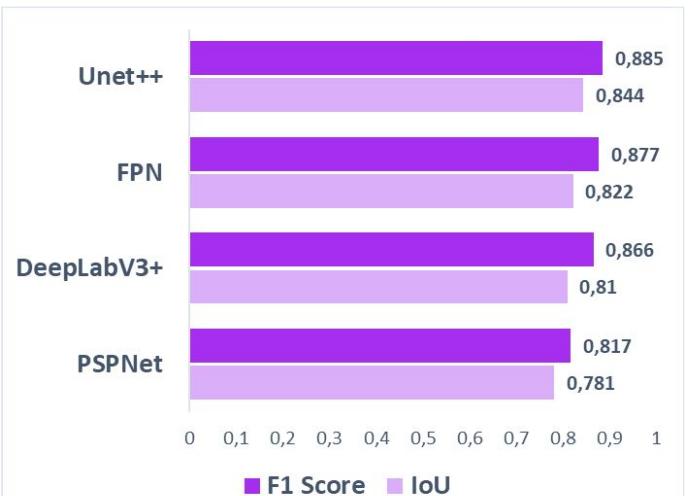
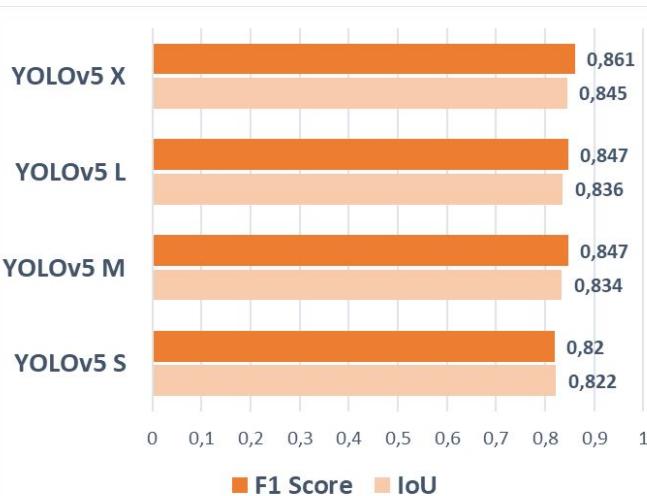
0.94

Image
Ground Truth
Prediction



Object Detection

Image Segmentation

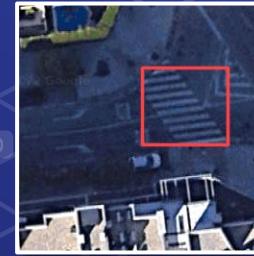




False Negatives



False Positives



- **Unseen** types of solar panels
- **Noise patterns** in images

- **Zebra crossings w/ shadows**
- **Tennis courts**

5. Streamlit Live Demo

Drag and drop file here
Limit 200MB per file • PNG

Browse files

Use an image from our test set

Select an image

PV01_325192_1204159.png (Zenodo)

Select the model you want to use for prediction

Select a model (architecture+backbone)

UNET++Resnet50d

Developers:

- Sergio Alzcorbe Pardo
- Ricardo Chavez Torres
- Daniel De Las Cuevas Turel
- Sergio Hidalgo López
- Zijun He

Solar Panel Detection

Detect solar panels from satellite images with just one click!

You could upload your own image!

Visualize Image

Display options: Show original image



Image Selected

Model Prediction Masks

Display options: Show predicted mask

Mask options: Show mask in binary



Predicted Mask

Model performance

IoU score: 0.87

Pixelwise accuracy: 0.973

Dice Coefficient (F1 Score): 0.932

Other information

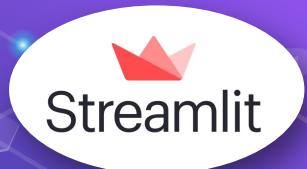
Enter the spatial resolution of the image: how long is one pixel

0.1

Area predicted: 140.98 meters squared, which represents 21.51% of the image (655.36 meters squared)

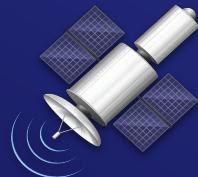
Coordinates:

B. Box	Top Left	Top Right	Bottom Left	Bottom Right
1	(173, 234)	(236, 234)	(173, 256)	(236, 256)
2	(158, 170)	(219, 170)	(158, 201)	(219, 201)
3	(16, 72)	(98, 72)	(16, 110)	(98, 110)



Future improvements

Raw
Satellite Data

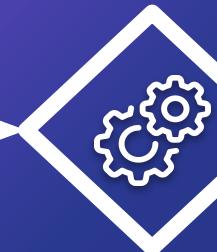


Specific models
for each panel



Gathering
more data





Model Training
& Validation

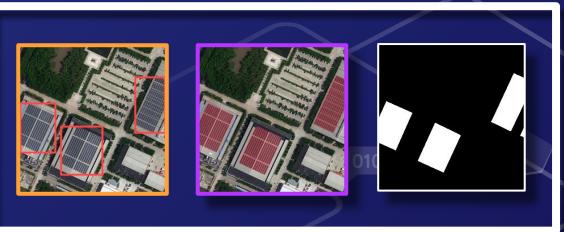
Evaluation

Detección de Objetos

YOLOv5 (S, M, L, X)

Segm. de Imágenes

Unet++, FPN, DLV3+, PSPNet



THANK YOU!



Atos