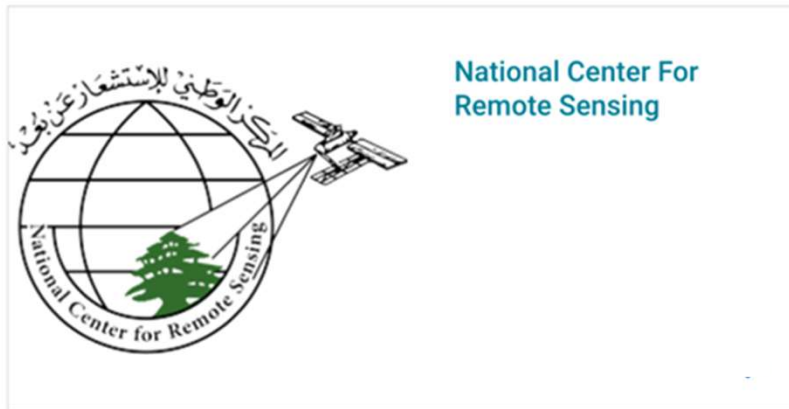# How SAM would revolutionize geospatial applications?
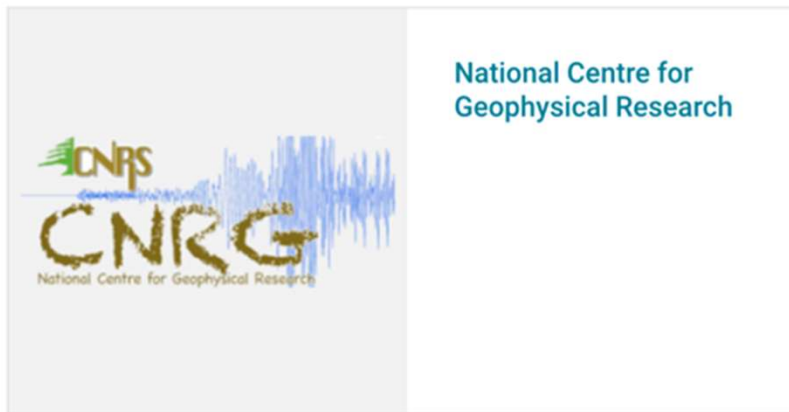
Ali Ghandour, PhD
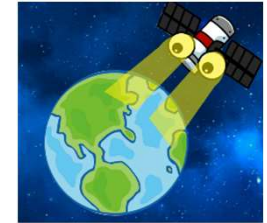
26 May 2023

CNRS-L Research Centers

National Centre for Geophysical Research
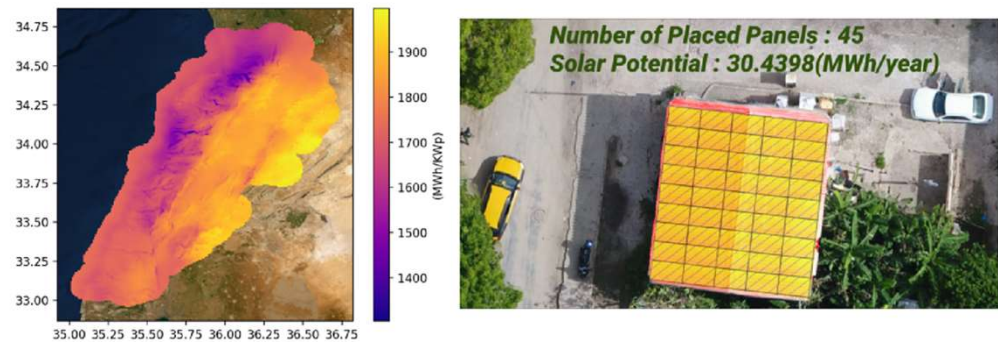

National Centre for Marine Sciences

National Center For Remote Sensing

Lebanese Atomic Energy Commission

GEOspatial Artificial Intelligence (GEOAI)
www.geogroup.ai

Urban-AI Mapping

720K buildings

First Lebanese Urban Map
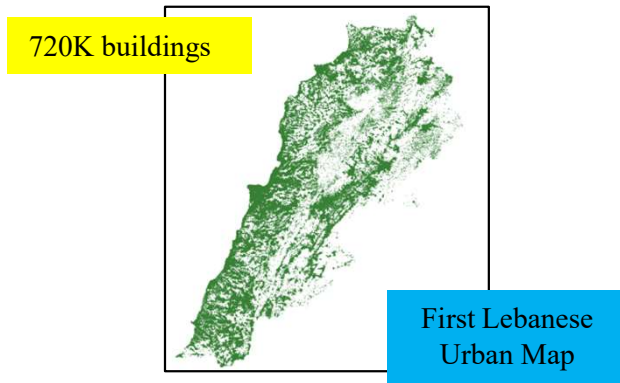
Solar rooftop potential map

Number of Placed Panels : 45
Solar Potential : 30.4398(MWh/year)

Road Crashes Observatory
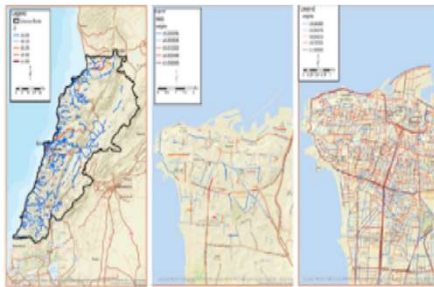
Water Body Monitoring

Crop Monitoring

The idea and practice of looking down at the Earth's surface emerged in the 1840s

- Cameras secured to tethered **balloons** for purposes of topographic mapping
- **Pigeon fleet** as a novel platform that operated in Europe
- Cameras mounted on **airplanes** for aerial large views (military reconnaissance)
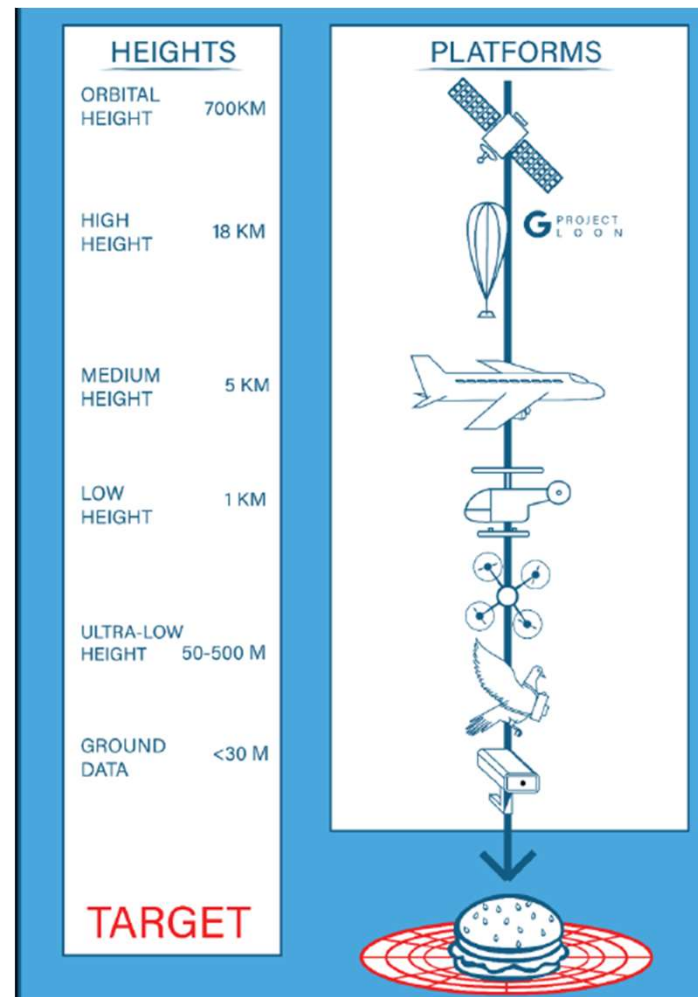

Balloons (1868)   Pigeons (1903)   Airplane (1909)

source: https://www.gabriele-cavallaro.com/teaching/parallel-and-scalable-machine-learning-for-remote-sensing-big-data-ws-2020-2021
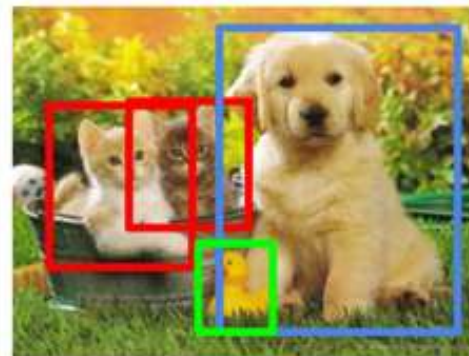
RS Platforms

source: https://www.gabriele-cavallaro.com/teaching/parallel-and-scalable-machine-learning-for-remote-sensing-big-data-ws-2020-2021

"How SAM would revolutionize geospatial applications?", Dr. Ali J. GHANDOUR, 26 May 2023
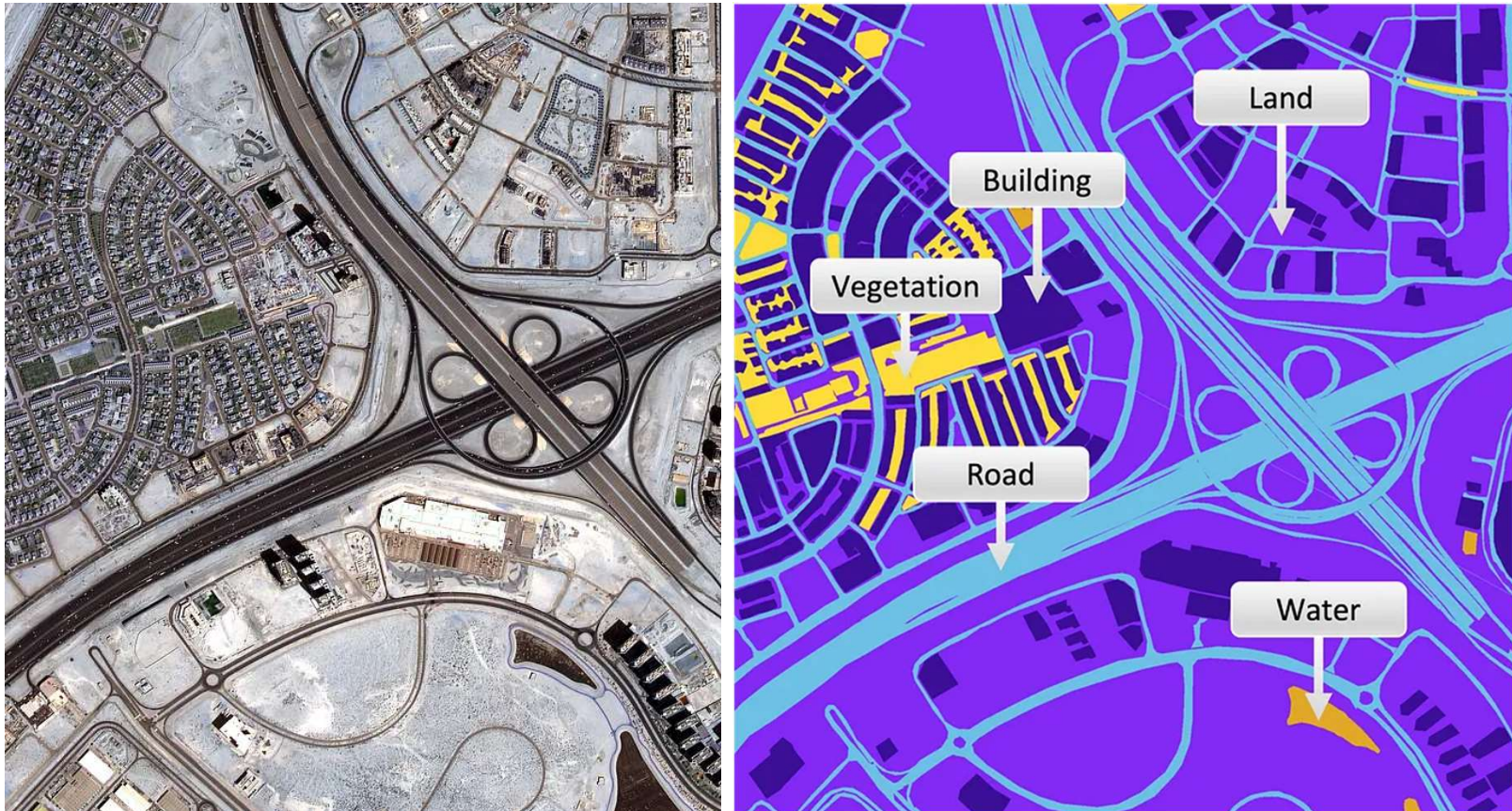
■ **Classification:**

source: https://www.geeksforgeeks.org/object-detection-vs-object-recognition-vs-image-segmentation/
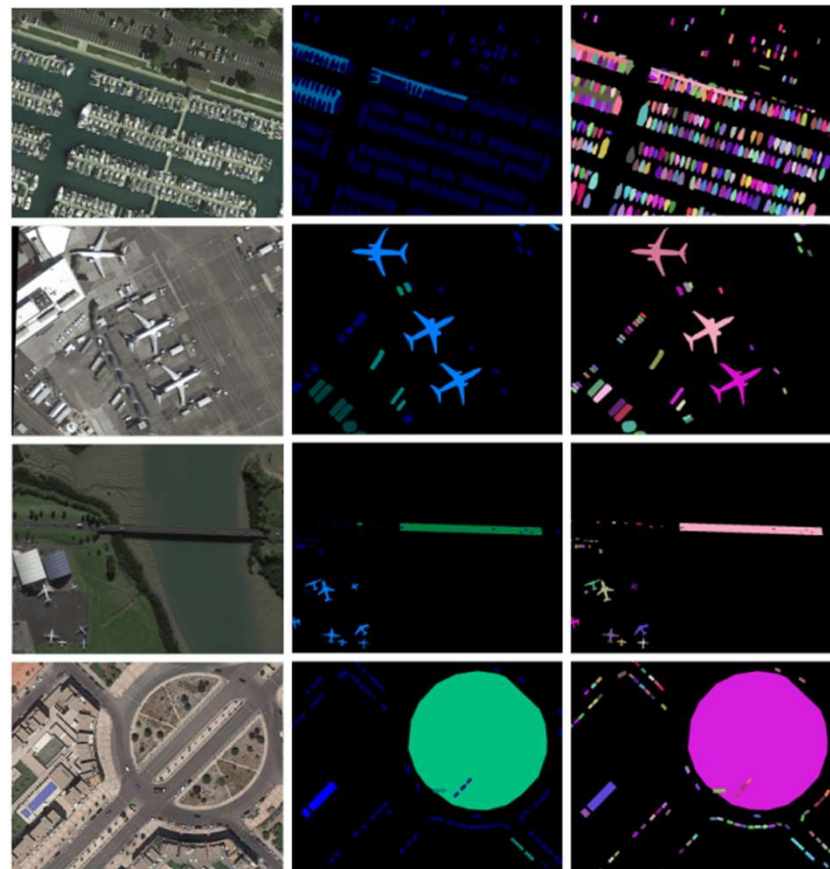
■ **Detection:**

CAT, DOG, DUCK

■ **(Semantic) Segmentation:**

Source: https://towardsdatascience.com/semantic-segmentation-of-aerial-imagery-using-u-net-in-python-552705238514
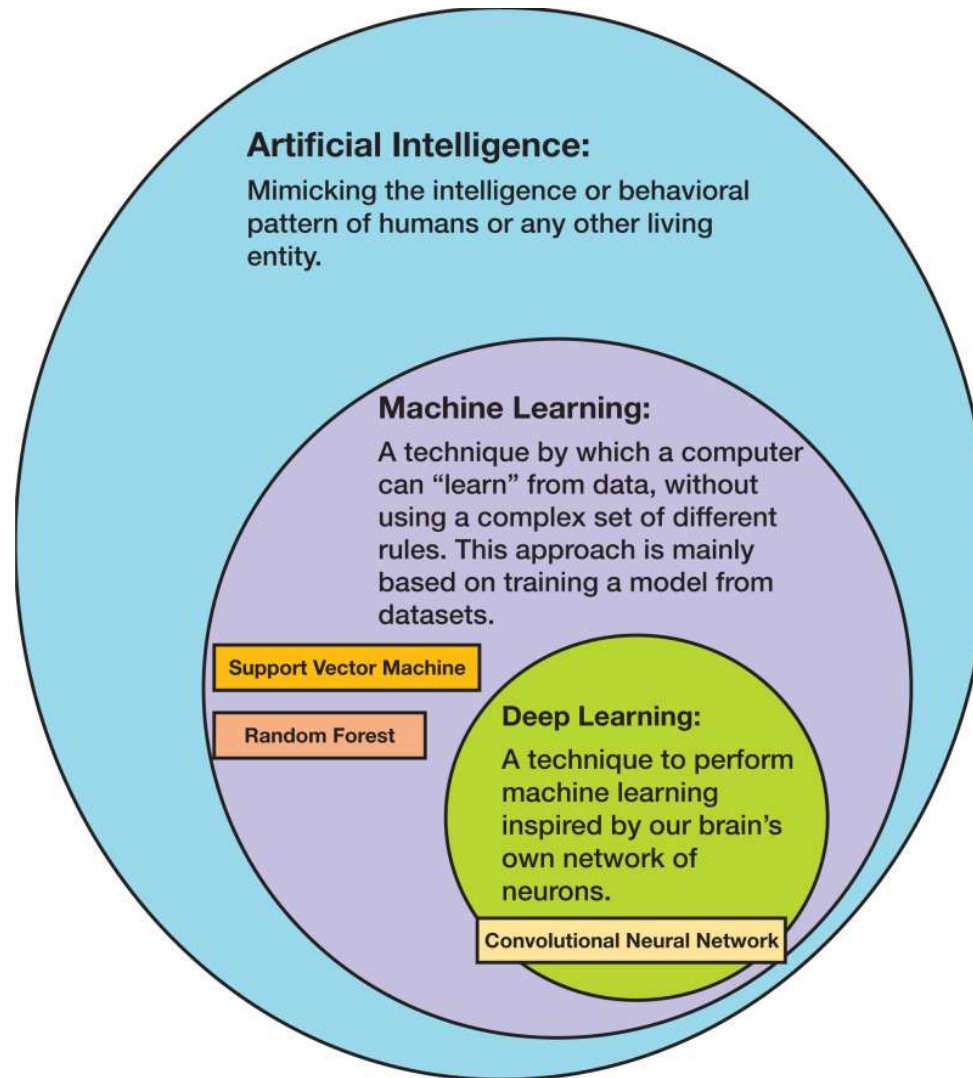
- ## (Instance) Segmentation:

(a) Original image   (b) SS maps   (c) IS maps

Source: https://arxiv.org/pdf/1905.12886.pdf

AI

Source: https://www.ncbi.nlm.nih.gov/books/NBK570711/

Deep Learning

- model extracts the feature set by itself without supervision (XAI field):
  - ❑ faster
  - ❑ more accurate.

- Training set
- Validation set
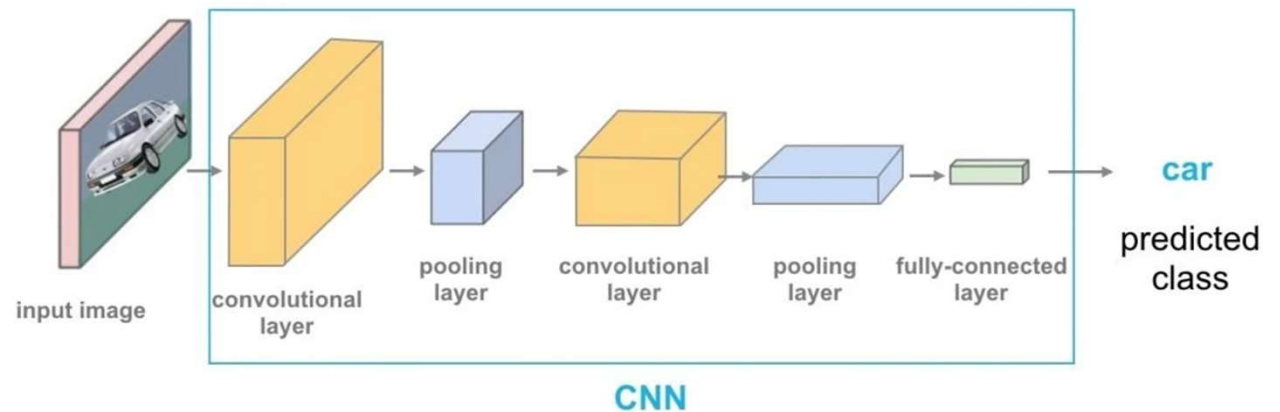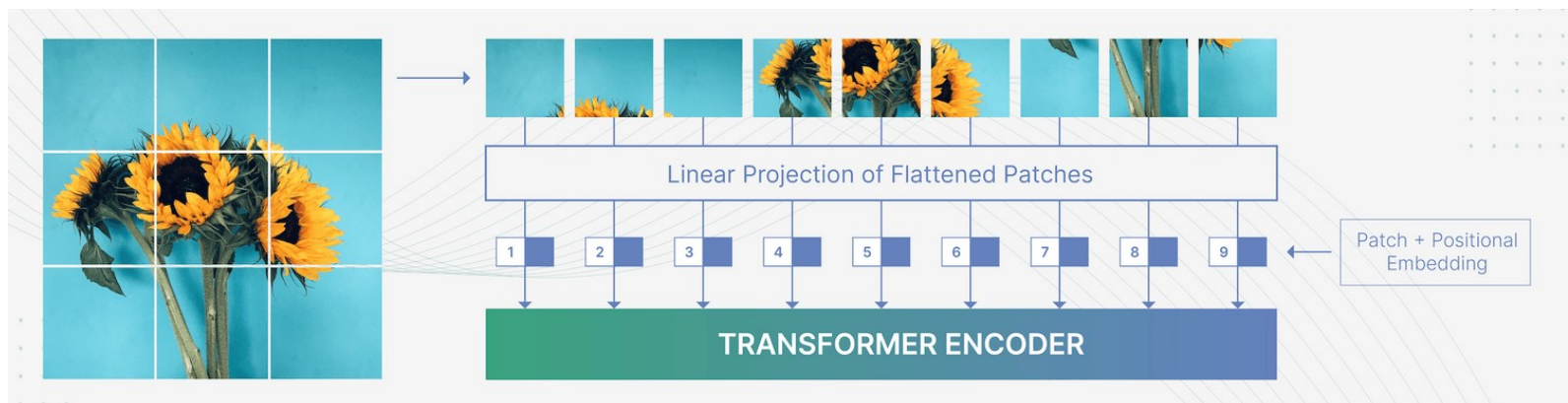- Test set

Deep Learning – *cont.*

- **model extracts the feature set by itself without supervision (XAI field):**
  - ❑ faster
  - ❑ more accurate.

- Training set
- Validation set
- Test set

Source: https://www.ncbi.nlm.nih.gov/books/NBK570711/

Deep Learning – *cont.*

■ **CNN:**

Source: https://viso.ai/deep-learning/vision-transformer-vit/

■ **Transformers:**

Source: https://www.picsellia.com/post/are-transformers-replacing-cnns-in-object-detection/

OOD Generalization

- **Out-of-Distribution Generalization:**
  - ❑ testing distribution is unknown and different from the training

source: https://www.gabriele-cavallaro.com/teaching/parallel-and-scalable-machine-learning-for-remote-sensing-big-data-ws-2020-2021

Foundation Models

- **coined in July 2022:**

  ❑ https://arxiv.org/pdf/2108.07258.pdf

  ❑ Large (deep neural network) model

  ❑ trained on broad data (generally using self-supervision at scale)

  ❑ usually multimodal

  ❑ can be adapted to a wide range of downstream tasks

- **transformer model on a large scale.**

- **widely used in NLP: Large Language Models (LLMs)**

- **human brain:**
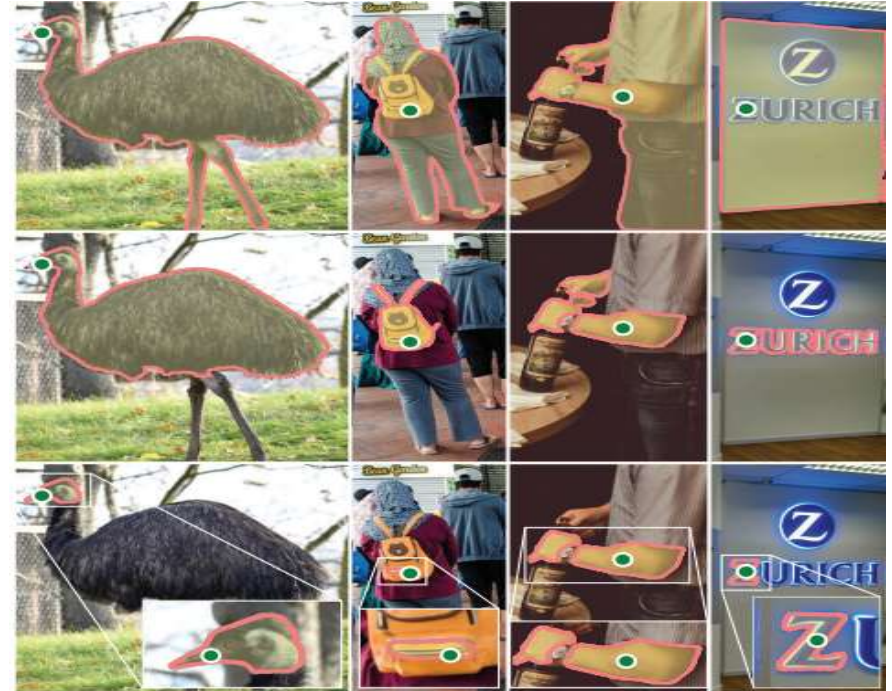 - ❑ ~86 billion neurons
  - ❑ 100 trillion synapses

Source: https://huggingface.co/blog/large-language-models/

SAM
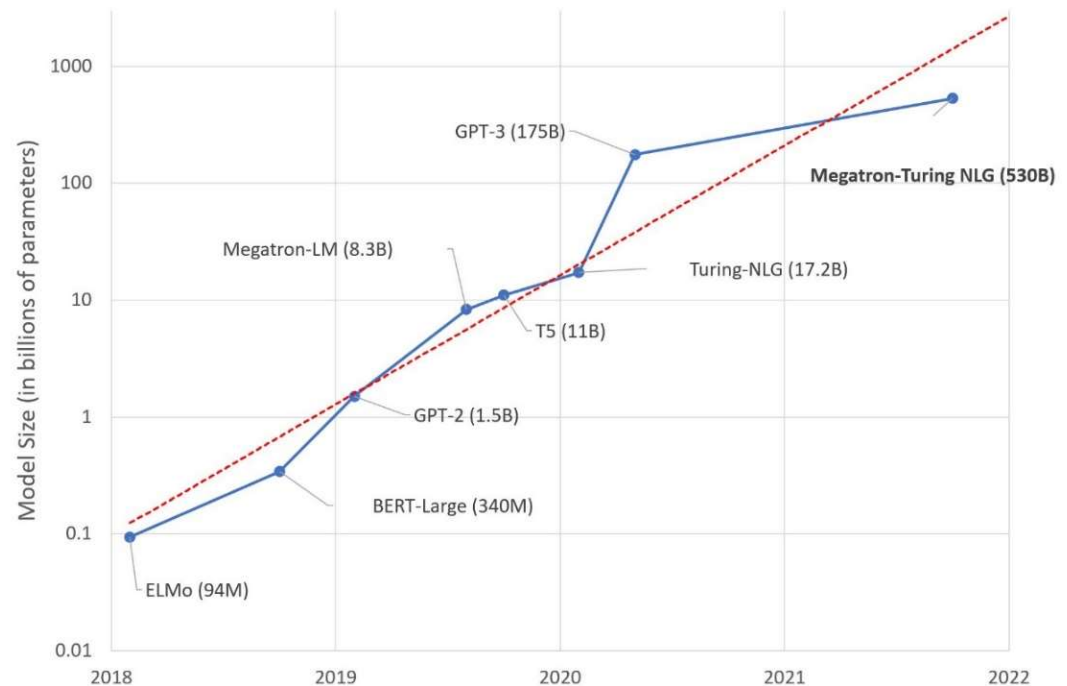
- **new model from Meta AI: April 2023**
  - ❏ https://arxiv.org/pdf/2304.02643.pdf

- **effectively segment any object in any image, without the need for additional task-specific or dataset-specific training**

- **various input prompts:**
  - ❑ points
  - ❑ bounding boxes
  - ❑ masks

- **Ambiguity-Aware Design:**
  - ❑ handle ambiguous situations
  - ❑ multiple masks for a single prompt

SA-1B Dataset Overview

- **Dataset Composition:**
  - ❑ 11M diverse, high-res images (3300x4950 pixels)
  - ❑ 1.1B segmentation masks (99.1% auto-generated)
  - ❑ High-quality masks
  - ❑ Significantly larger than any segmentation datasets

Zero-Shot Edge Detection

Figure 10: Zero-shot edge prediction on BSDS500. SAM was not trained to predict edge maps nor did it have access to BSDS images or annotations during training.
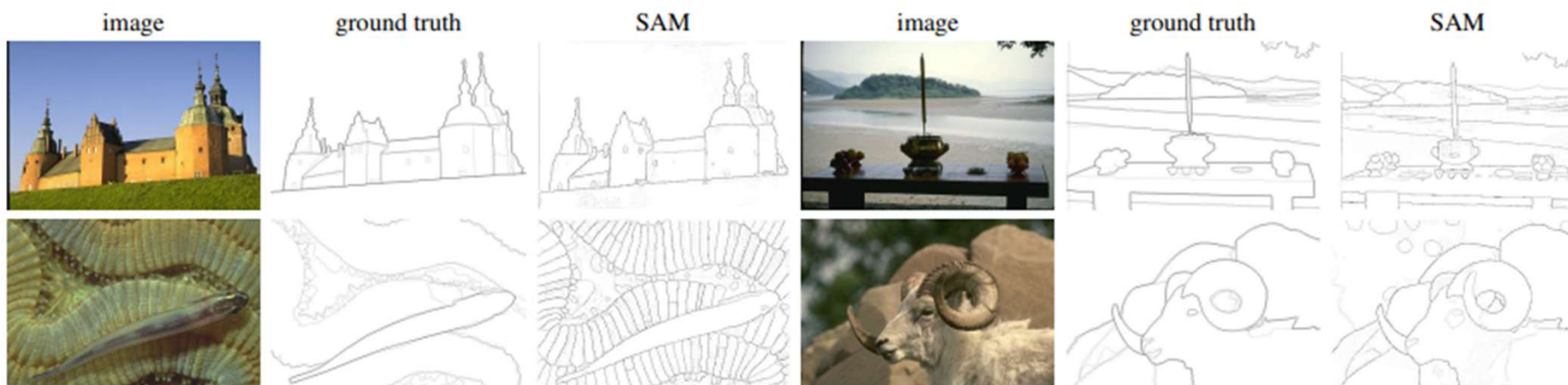

Figure 15: Additional visualizations of zero-shot edge predictions on BSDS500. Recall that SAM was not trained to predict edge maps and did not have access to BSDS images and annotations during training.
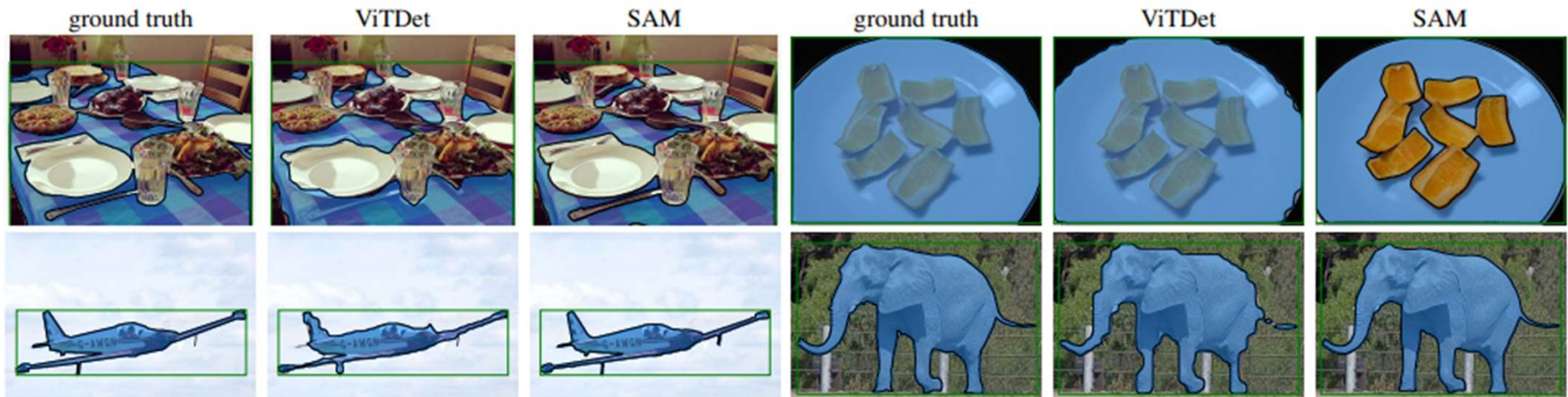
Zero-Shot Instance Segmentation

Figure 16: Zero-shot instance segmentation on LVIS v1. SAM produces higher quality masks than ViTDet. As a zero-shot model, SAM does not have the opportunity to learn specific training data biases; see top-right as an example where SAM makes a modal prediction, whereas the ground truth in LVIS is amodal given that mask annotations in LVIS have no holes.
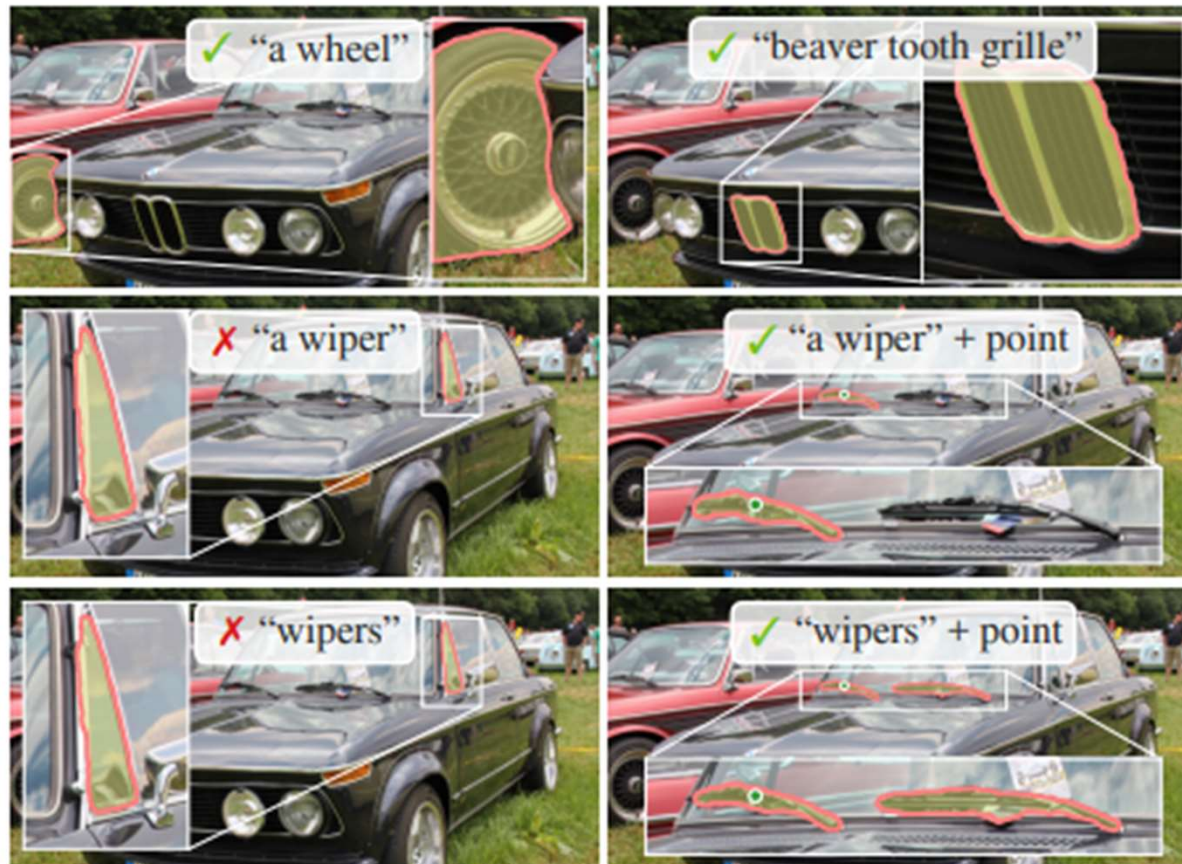
Zero-Shot Text-to-Mask

Figure 12: Zero-shot text-to-mask. SAM can work with simple and nuanced text prompts. When SAM fails to make a correct prediction, an additional point prompt can help.
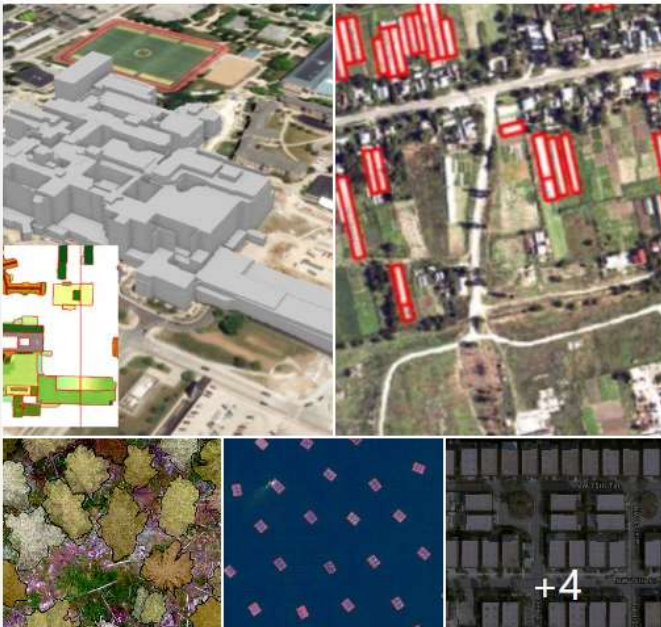
Adaptation

Annotation Business

James Gallagher • 1st
Computer Vision | Technical Marketer @ Roboflow
3d • Edited • 🌐

Trying out the new SAM Annotation feature in Roboflow Annotate on aerial imagery
⬜

To use:

1. Hover over an item of interest
2. Click to focus
3. Refine your annotation by clicking on any missed regions of interest
4. Press enter to save your annotation

Picterra   + Follow •••
5,352 followers
2d • 🌐

BREAKING: Picterra is thrilled to announce that we are the FIRST geospatial company to integrate the groundbreaking Segment Anything Model (SAM) by Meta AI into its platform! Read on for more details about this industry-first release.

- What is SAM? 🤔

Launched just last week, SAM is a new AI model from Meta AI that can "cut out" any object, in any image, with a single click. The model is already making big waves in the tech industry & we're excited to be the first to bring it to the #geospatial realm.

- How does the integration with Picterra work? 🔧

As our users know, annotating objects in the Picterra platform is already quick, thanks to our easy-to-use & efficient drawing tools. Integrating #SAM gives our users a supercharged AI magic wand⬜ to make annotating complex objects in #EarthObservation imagery possible with just a single click.
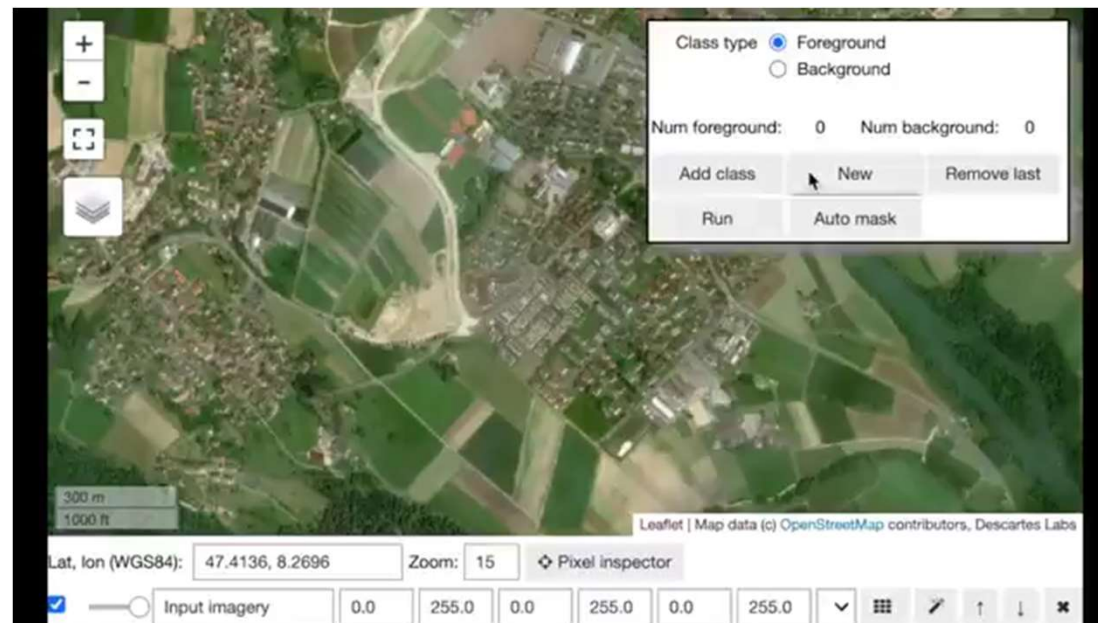
Annotation Business- *cont.*
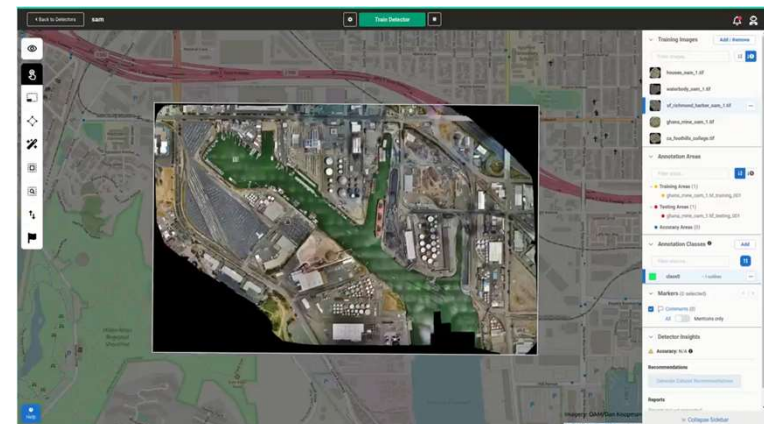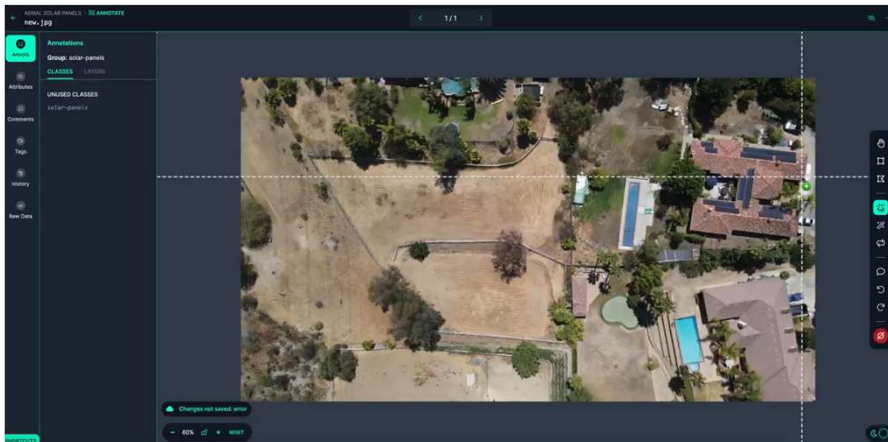
Descartes Labs
@DescartesLabs

Video of the Descartes Labs technology incorporating the Segment Anything Model (SAM), showing fast prototyping leveraging SAM powered by the Descartes Labs platform to retrieve imagery & display vectorized output in an interactive way.

- **TrackSAM:**

Live Demo!

- Ali: graduate student at GEOAI group
- Hasan: research engineer at GEOAI group

Thank you!