Machine Learning for Geospatial Raster Data

Workshop #2 Please visit bit.ly/geoml-2

Presented by Juan Carrillo & Jaydeep Mistry

On behalf of the Geospatial Club - Winter 2019
In partnership with the University of Waterloo Geospatial Centre

Agenda

1. Why should we care about Machine Learning for Raster data?
2. Problem context: Understanding the Amazon from Space
3. Setup of the cloud-computing platform
4. Data exploration
5. Convolutional Neural Networks
6. Wrap-up

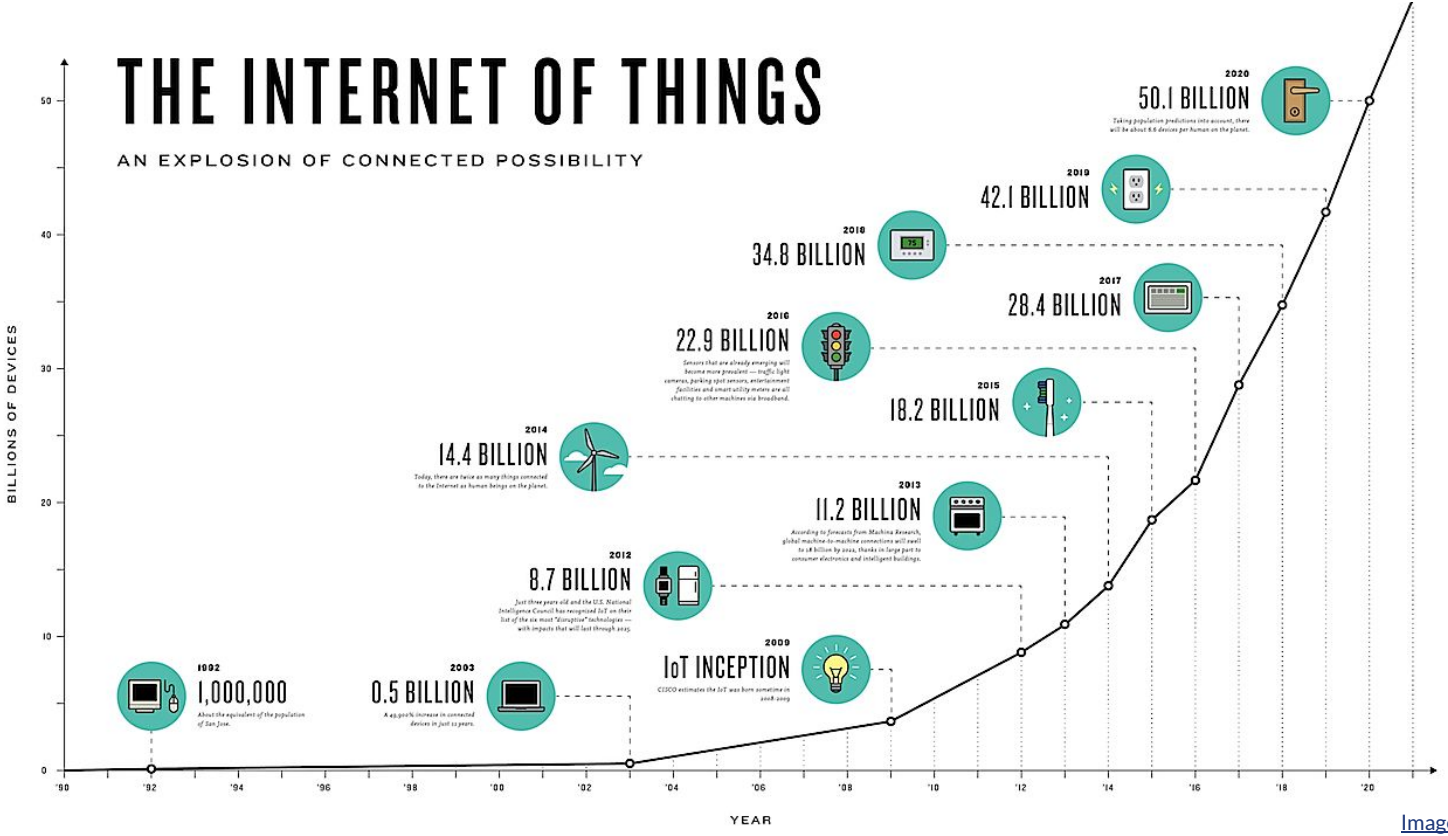
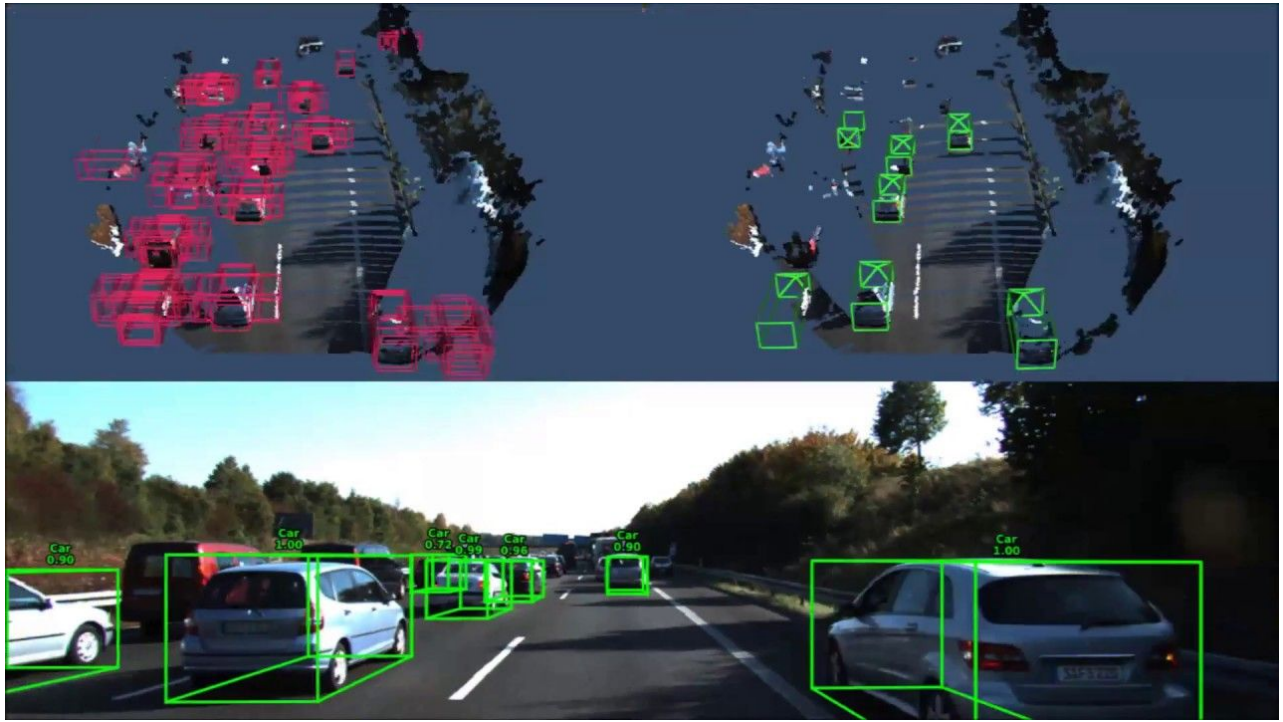


Image Source

Why does Machine Learning matter?



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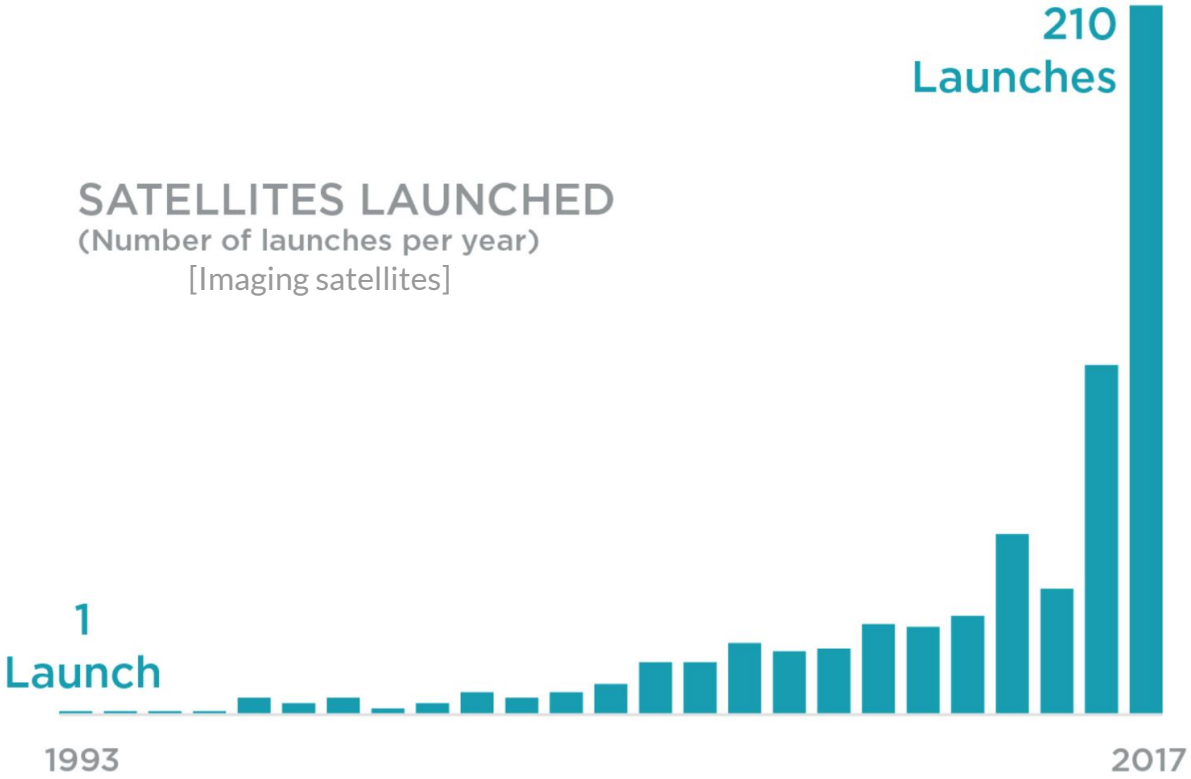
Common Computer Vision tasks



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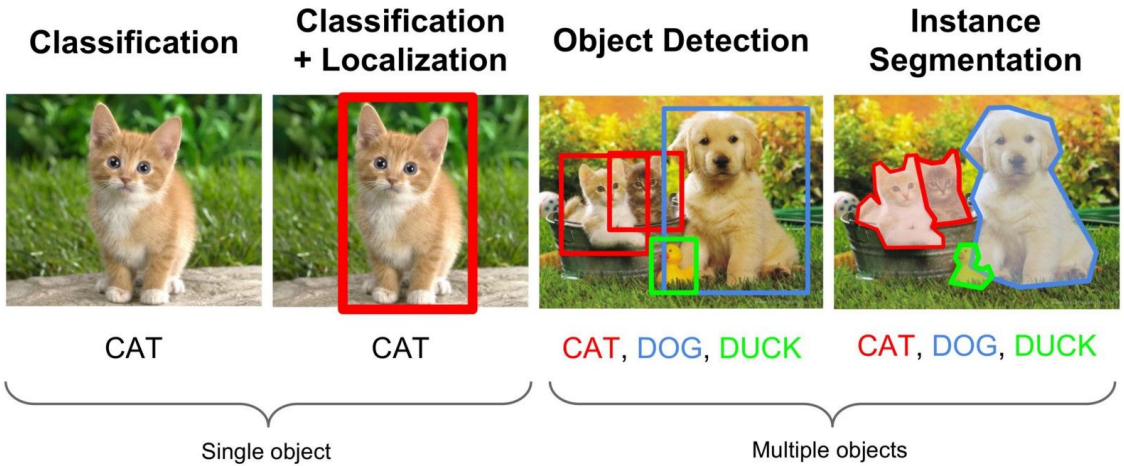
Why does Raster data matter?



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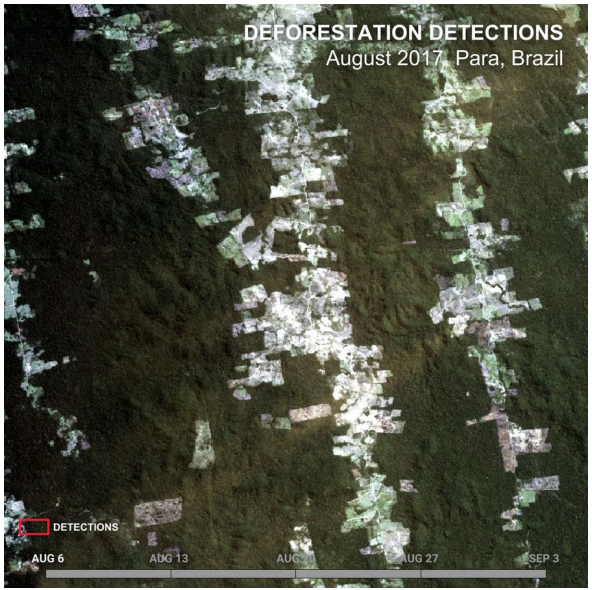

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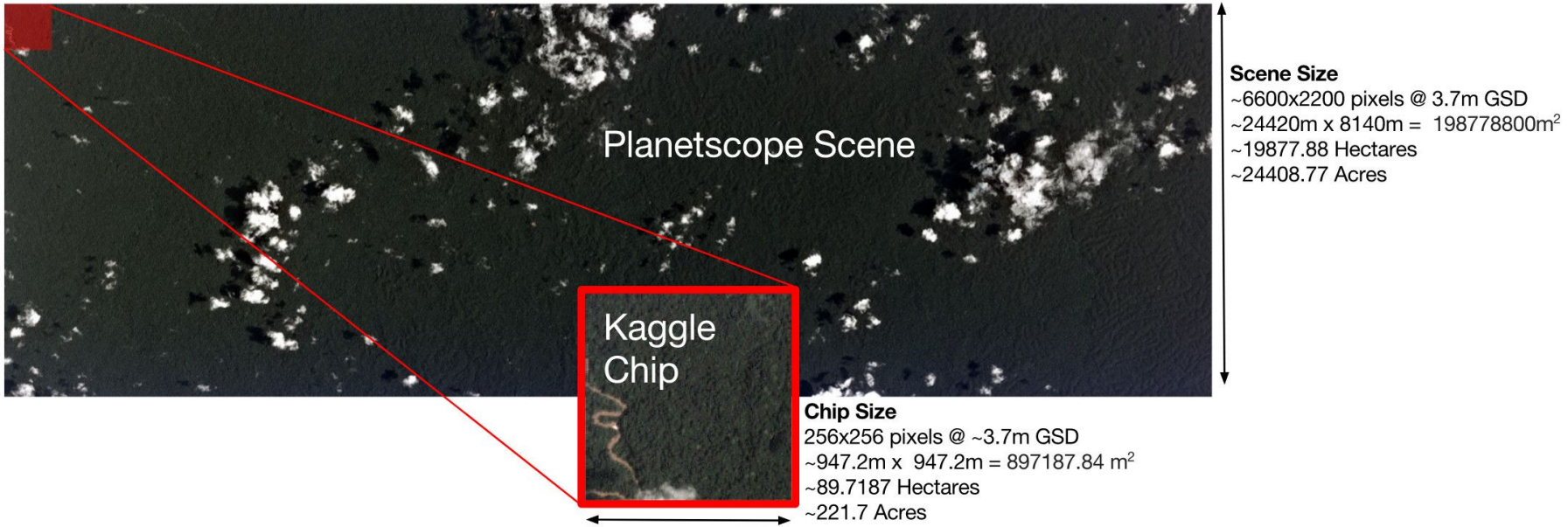
Common Computer Vision tasks

The Problem:
Identify Human Activity in the Amazon Rainforest

1. Use satellite data
2. Track human footprint in the Amazon rainforest
3. Popular Kaggle Competition for $60,000



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Dataset: 40,000+ Satellite Images

How to perform Machine Learning online?

- Free-to-use platform
- Designed for Data Science Competitions
- Full integration with **Python** and **R** for Cloud Computing

Optional: Google Colab, Earth Engine

Specs of a Kaggle Kernel virtual machine

16 Gigabytes of disk storage

4 CPU cores

17 Gigabytes of RAM

NVidia K80 GPU (12.5X speedup)

Source: Kaggle and BH seller

Let's get started!

- Dataset
- Notebook

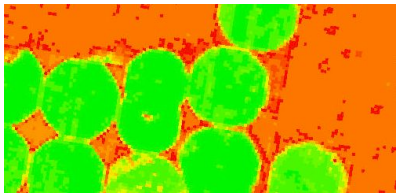
Image source

Normalized Differential Vegetation Index (NDVI)

- Quantifies vegetation by using difference between Near-Infrared and Red light

- Near-Infrared reflected by vegetation
- Red light absorbed by vegetation
- Ranges between -1 to +1

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$



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t-Distributed Stochastic Neighbor Embedding (t-SNE)

- For data dimensionality reduction
- Visualization of high dimensional datasets
- Uses t-Distribution to avoid having clusters group together

Creator; Visual Examples

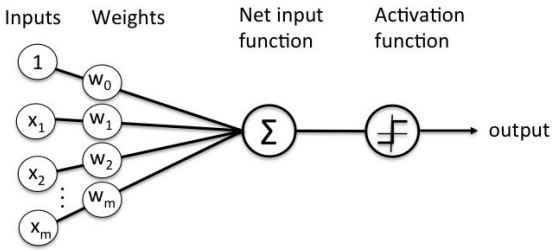
Why use this?

- Our Amazon rainforest dataset has
  - 40,000+ images
  - 256 x 256 pixels per image
  - Each image has 4 bands of data: Blue, Green, Red, Near-Infrared

Convolutional Neural Networks (CNN)

What are Neural Networks?

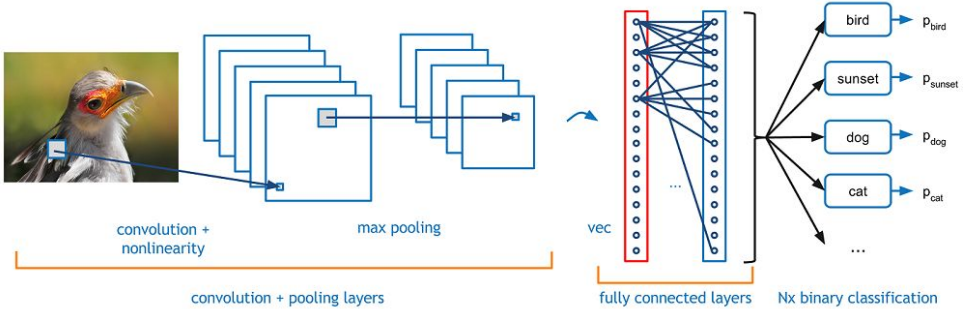
- System of connected ‘Neurons’ inspired by biological neural networks



Schematic of Rosenblatt’s perceptron.

What is CNN?

- Multi-layered system of Neurons, where the data gets Pooled to remove noise



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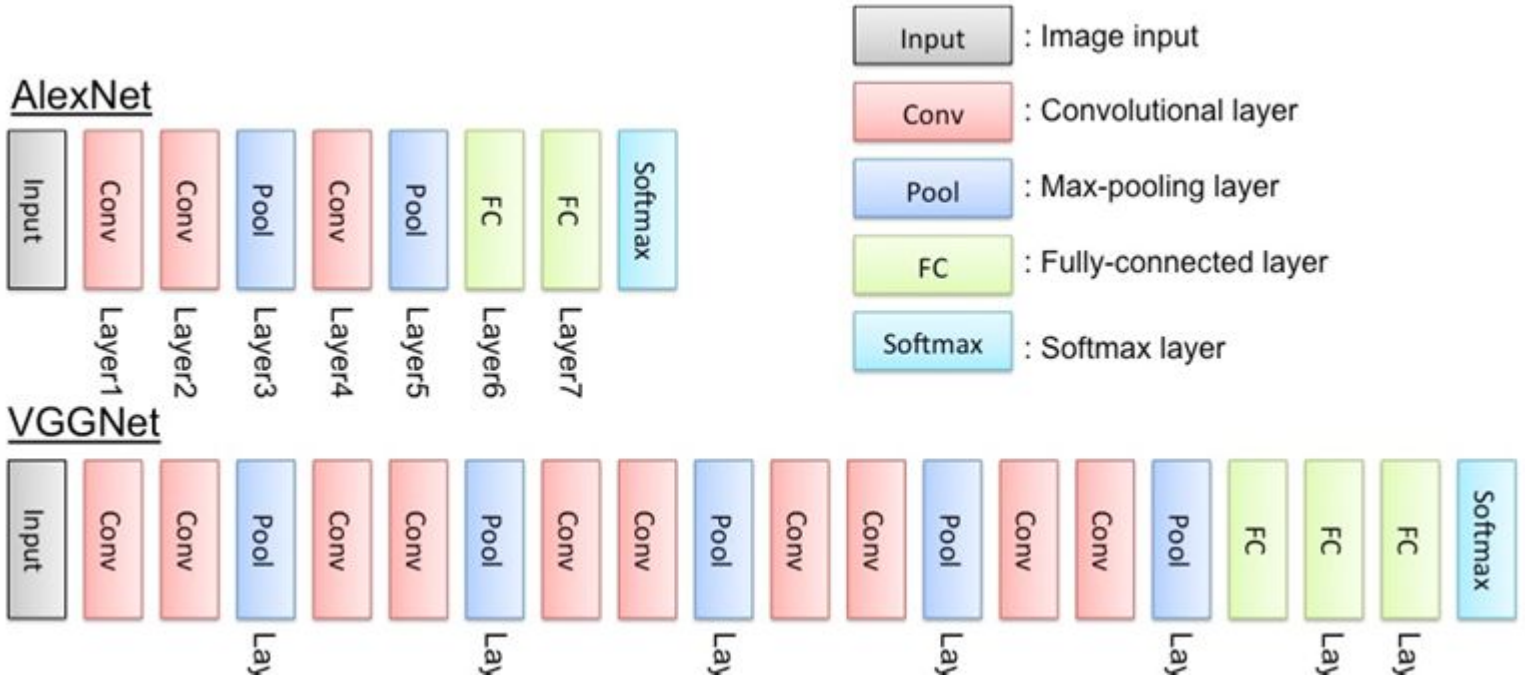
Convolutional Neural Networks (CNN)



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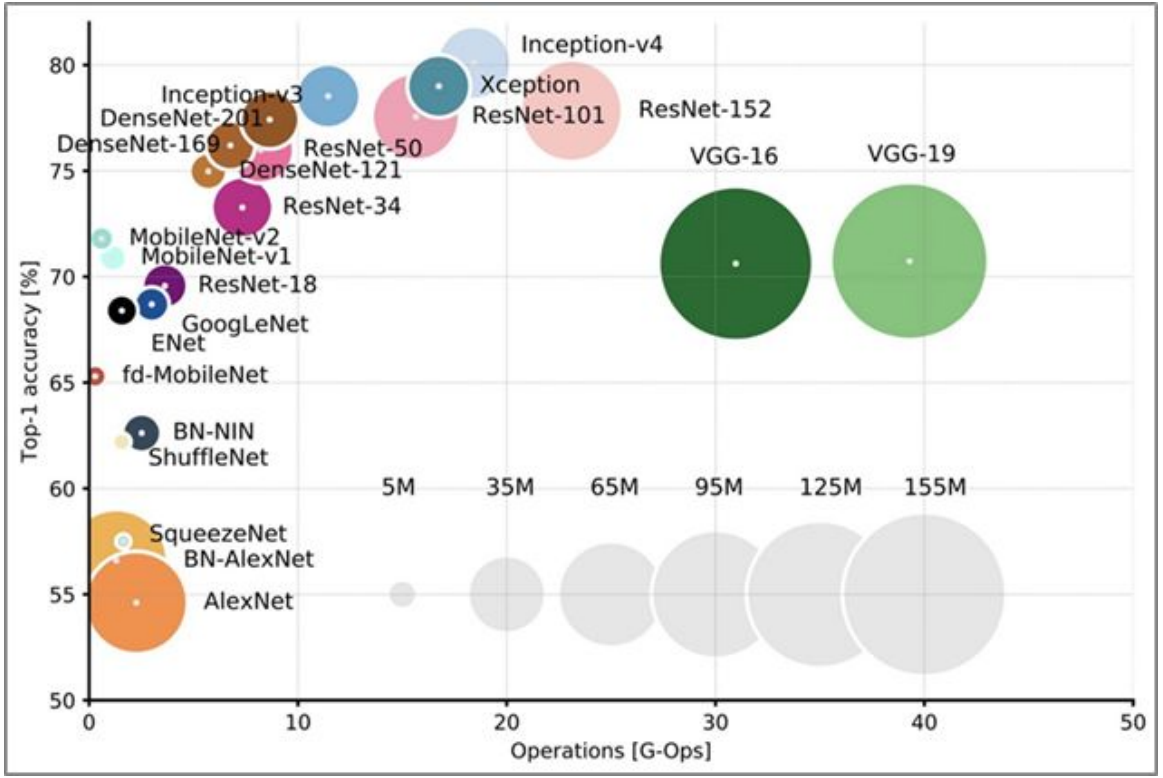
Deep Convolutional Neural Networks (CNN)



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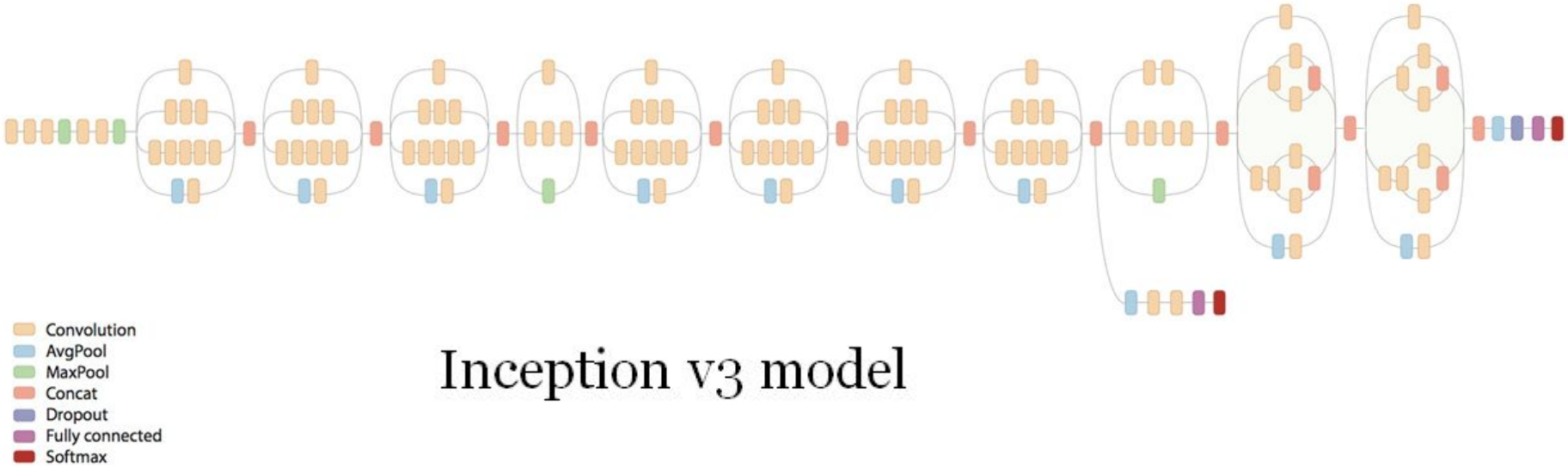
Deep Convolutional Neural Networks (CNN)



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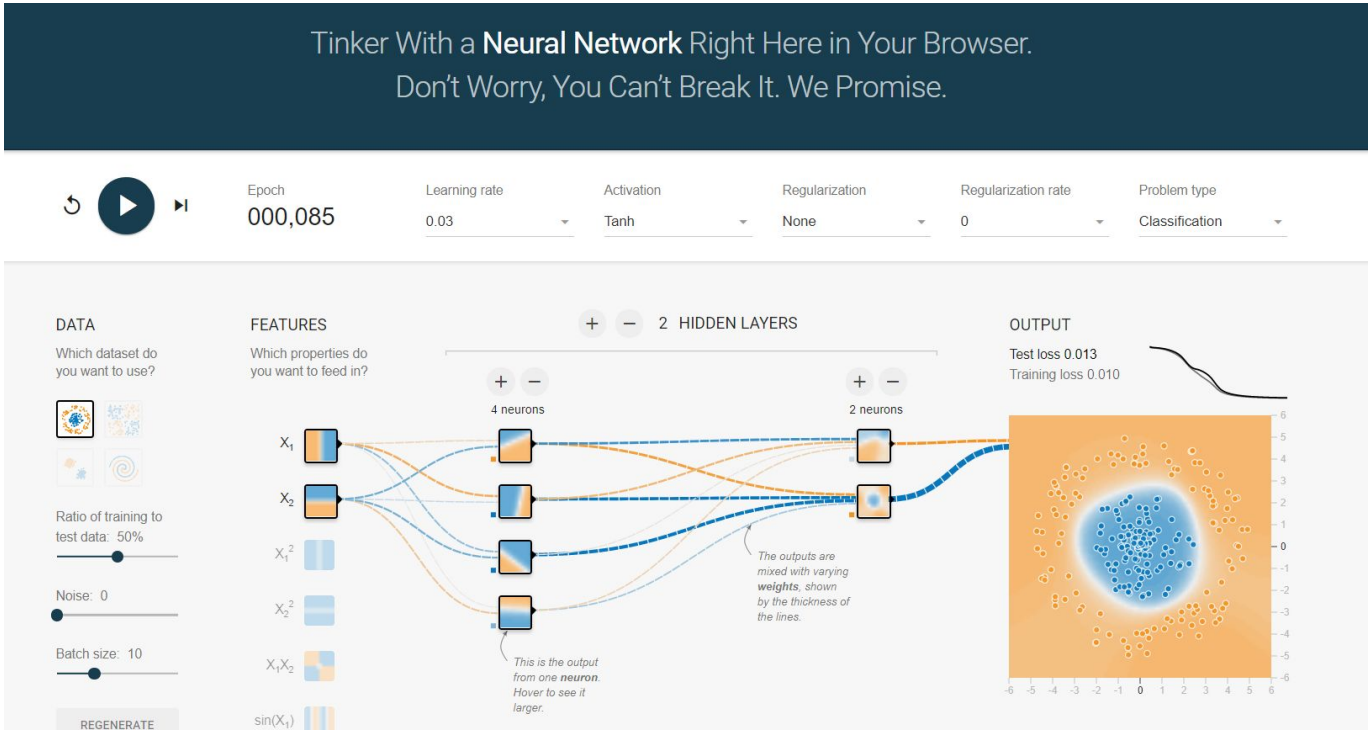
More on Neural Networks - online demo



[Try it here!]

Time to Train a basic CNN

Computing on CPU - 5-6 mins Avg

```
Train on 35000 samples, validate on 5479 samples
Epoch 1/4
35000/35000 [==============================] - 91s 3ms/step
Epoch 2/4
35000/35000 [==============================] - 90s 3ms/step
Epoch 3/4
35000/35000 [==============================] - 90s 3ms/step
Epoch 4/4
35000/35000 [==============================] - 90s 3ms/step
```

Computing on GPU - 30s Avg **(10x Faster)**

```
Train on 35000 samples, validate on 5479 samples
Epoch 1/4
35000/35000 [==============================] - 11s 309us/step
Epoch 2/4
35000/35000 [==============================] - 6s 172us/step -
Epoch 3/4
35000/35000 [==============================] - 6s 172us/step -
Epoch 4/4
35000/35000 [==============================] - 6s 173us/step -
```

Wrap-Up

Thank You to the Geospatial Centre for this collaboration!

Slide of this workshop: bit.ly/geoml-2

Please upvote Kernel and dataset :)

Contact us at:

https://www.facebook.com/uwgeospatial/

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