Deep Transfer Learning for Land Cover Classification

- **Objective**: develop **land cover classifier** trained on satellite images.
- **Method**: transfer learning with **Wide Residual Networks (50 CNNs) on the Land Cover (EuroSAT)** dataset.
- **Results**: **95%** accuracy with **0.03** loss on test data.
- **Optimizations**: boost efficiency with gradient clipping, adaptive learning rates, and data augmentation.
- **Dataset**: **27,000 labeled images** from Sentinel-2 satellite, data obtained via copernicus.eu (EU project).
- **Applications**: maps correction, urban planning, natural catastrophe prediction, precision agriculture.

Convolutional Neural Networks

How does CNNs for Image Recognition Work?

- Slice big picture into small pieces
- show small pictures to networks
- they **figure out color, tone, shape and orientation patterns** to “understand” what is depicted;
- as a result they output pictures’ classes.

Land Cover Example (think of a city photo from a satellite):

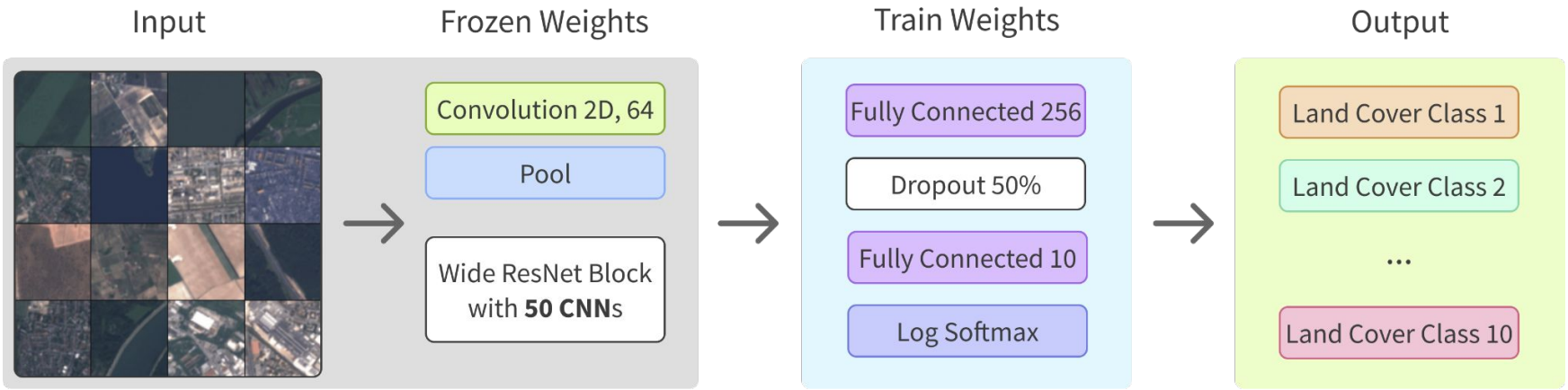
- CNNs sort it into residential or industrial areas, roads, parks and rivers.

Boosting Efficiency:

- **Gradient clipping: reduces overfitting** and **improves generalization**.
- **Adaptive learning rates:** make them learn at just the **right speed**.
- **Data augmentation:** show them more pictures from **different angles** for them to gain more **experience in classification**.

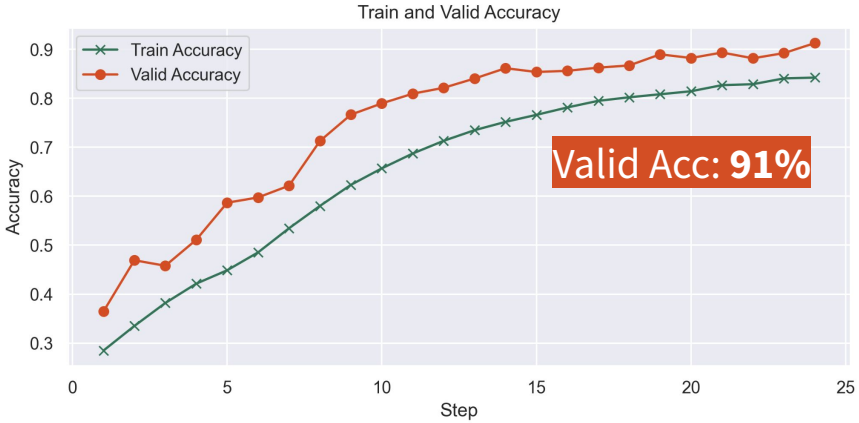
Transfer Learning

- Deep transfer learning **utilizes pre-trained neural networks**, adapting them for related tasks.
- Prior knowledge from one domain enhances another.
- It **saves time** and computational **resources**.



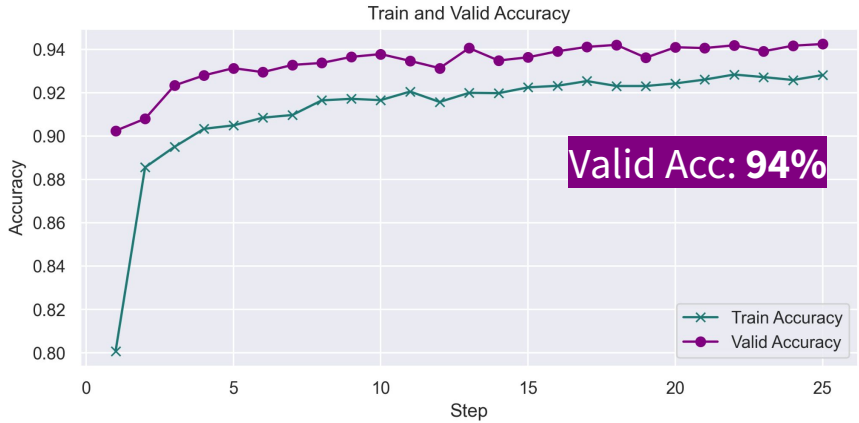
Baseline Classifier (**no** Pretrained Weights)

Train and validation time (GPU): **> 2.5 h** + **Excessive** Memory Consumption



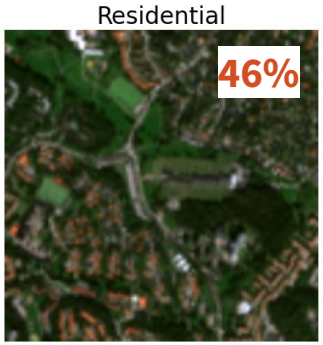
Improved Classifier (**with** Pretrained Weights)

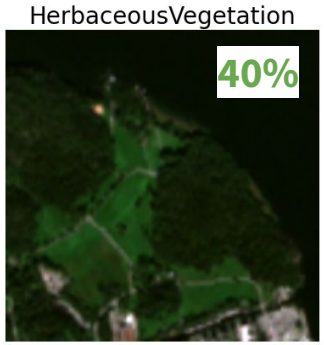
Train and validation time (GPU): **~ 1.5 h** + **Adequate** Memory Consumption

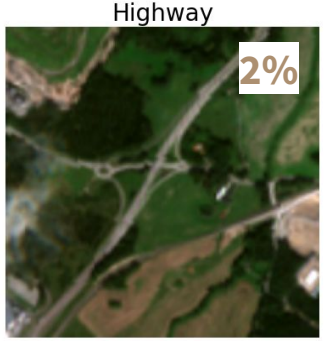


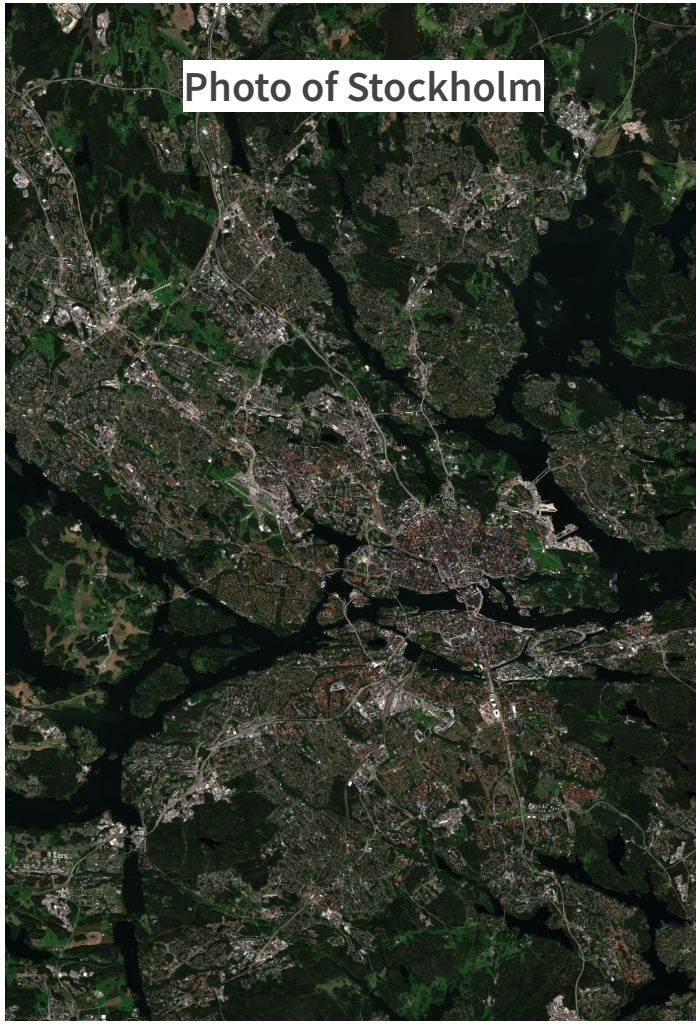
Improved Model in Action

Test accuracy: **95%**, test loss: **0.03**.









Main Findings:

- Even **without Transfer Learning** models are good **(91%)**, but **demanding**.
- **Wide Residual Networks** boost accuracy up to **94%**, (99% in some scientific papers), **save** computation **time and memory**.
- Land covers of **similar tone or shape** (Lakes and Forests) are **hard to differentiate**.

Main Challenges:

- Understanding the model and its parts is difficult.
- Powerful GPU and significant amount of memory are required.