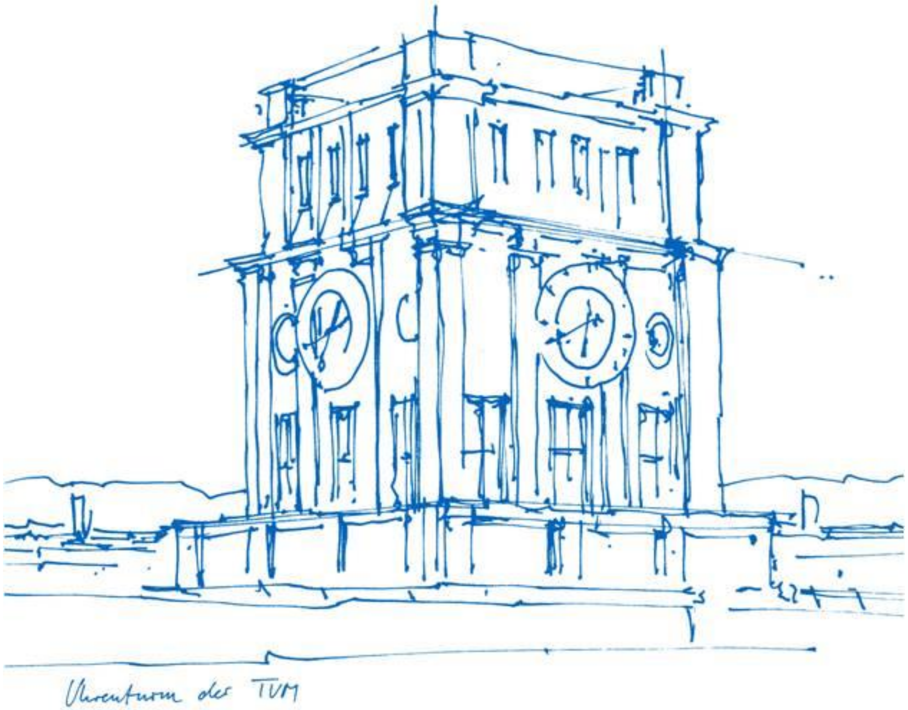
ClusterNet: unsupervised generic feature learning for fast interactive satellite image segmentation



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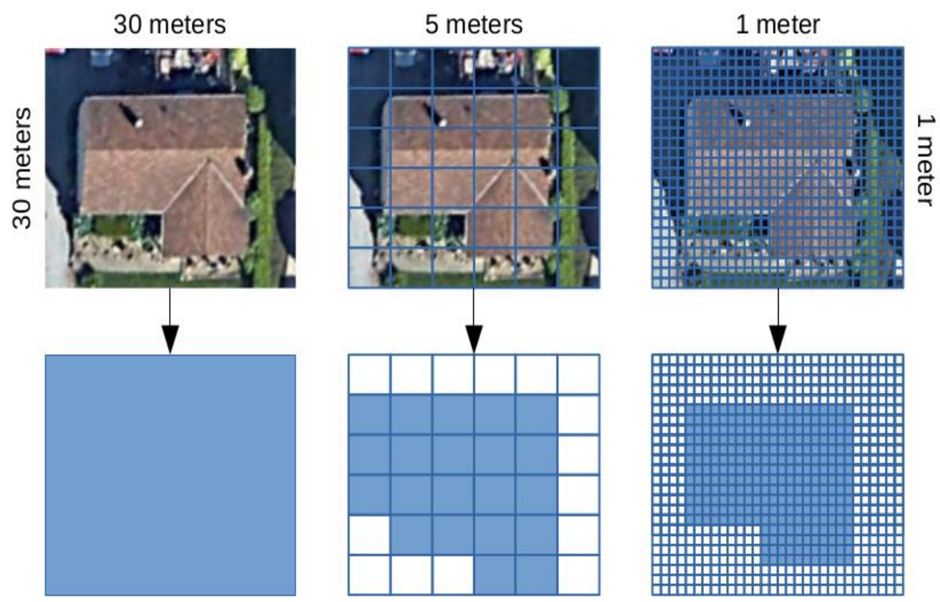
Agenda

1. Introduction
2. Related Work
3. Proposed Method
4. Future Work

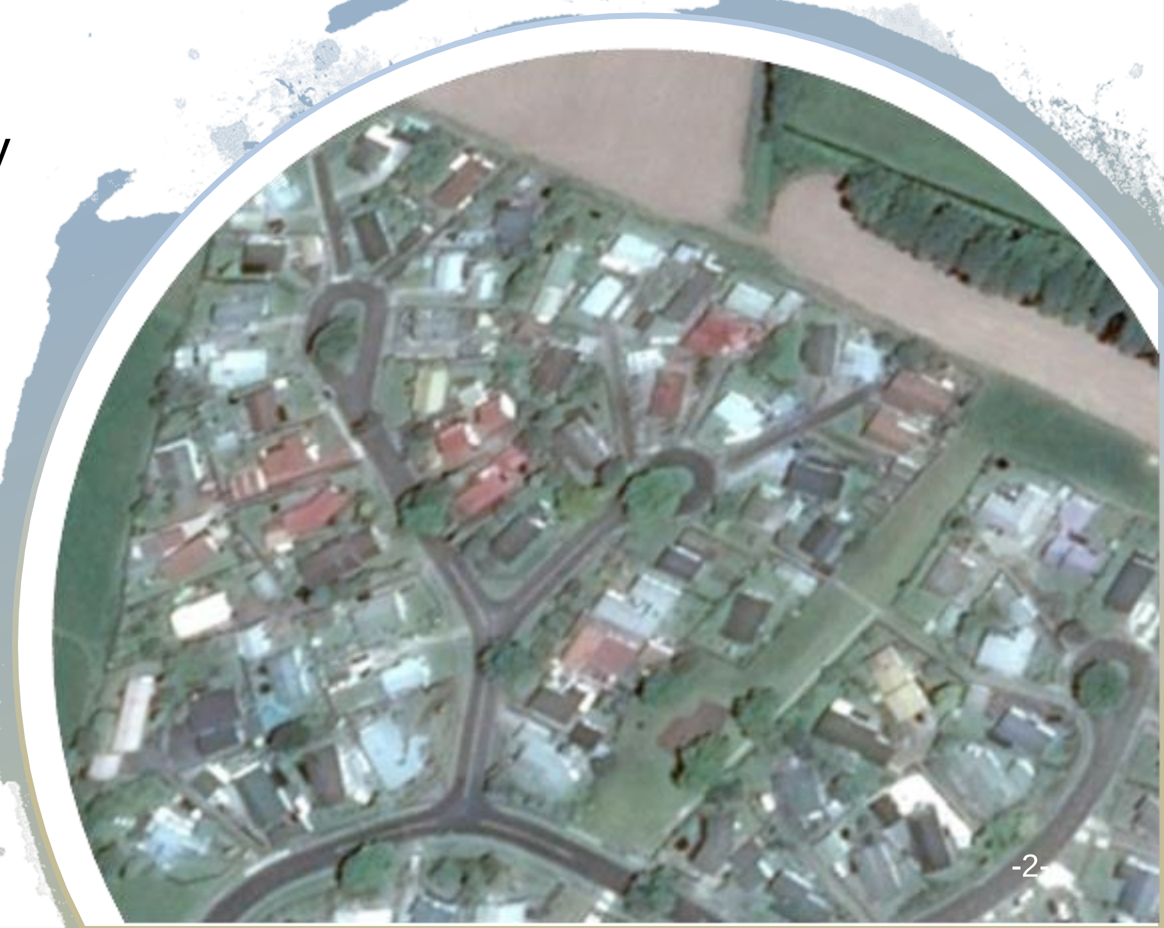
Introduction
Remote Sensing Data



- Aerial Images
  - high spatial resolution
  - expensive; a little of data
- **Satellite Images**
  - low spatial resolution
  - Cheap; a lot of data

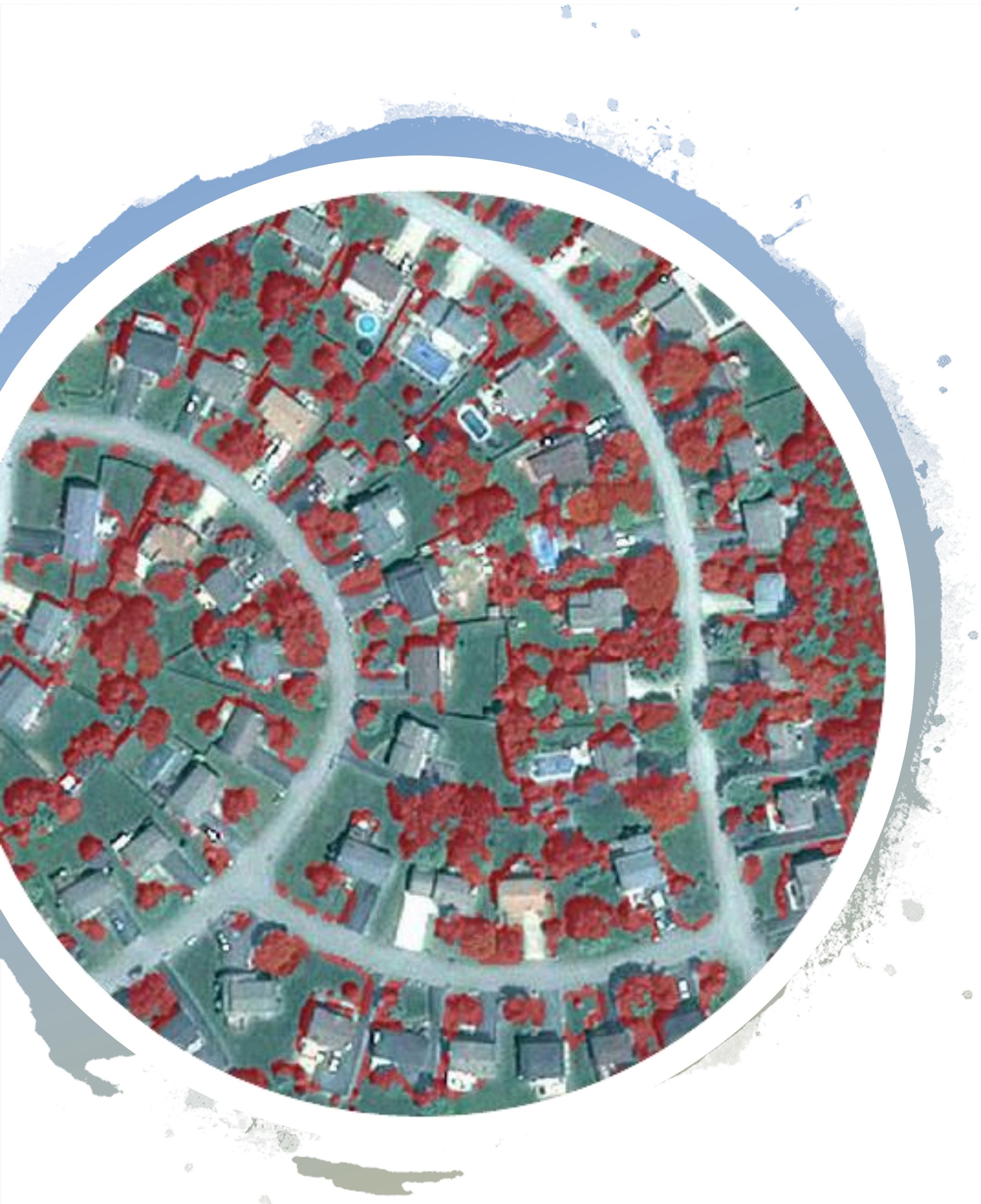
Introduction
Application

- Disaster Monitoring
- Estimating Urban Areas
- Autonomous Driving
- Agriculture planning
- Optimizing solar panel energy
- Others



Introduction
Task

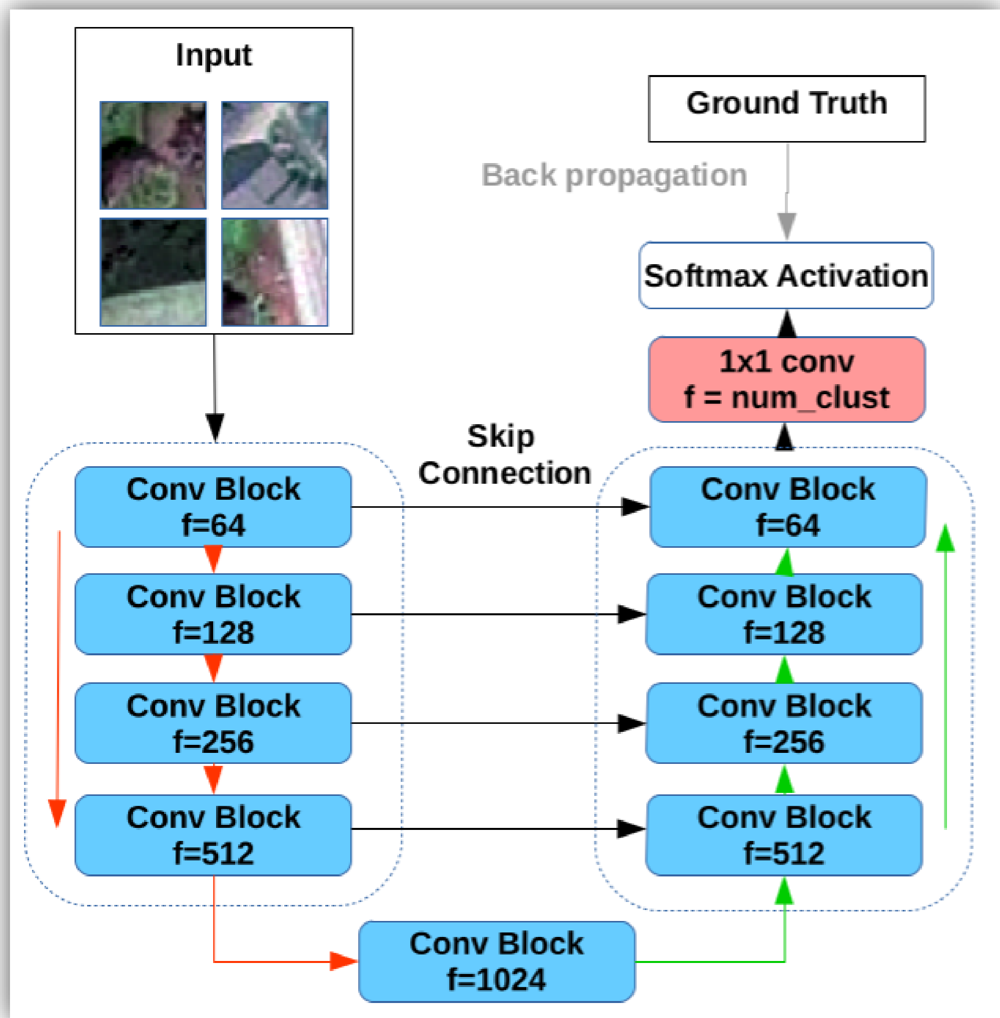
Automatically segment objects of interest (in our case trees) on satellite images preserving their geometric structure.



Introduction
Challenges

- Complicated Objects
- Low resolution
- Difference in data distribution
- **No ground-truth**
- **Bad ground-truth**

Related Work
Supervised U-Net*



Advantages:

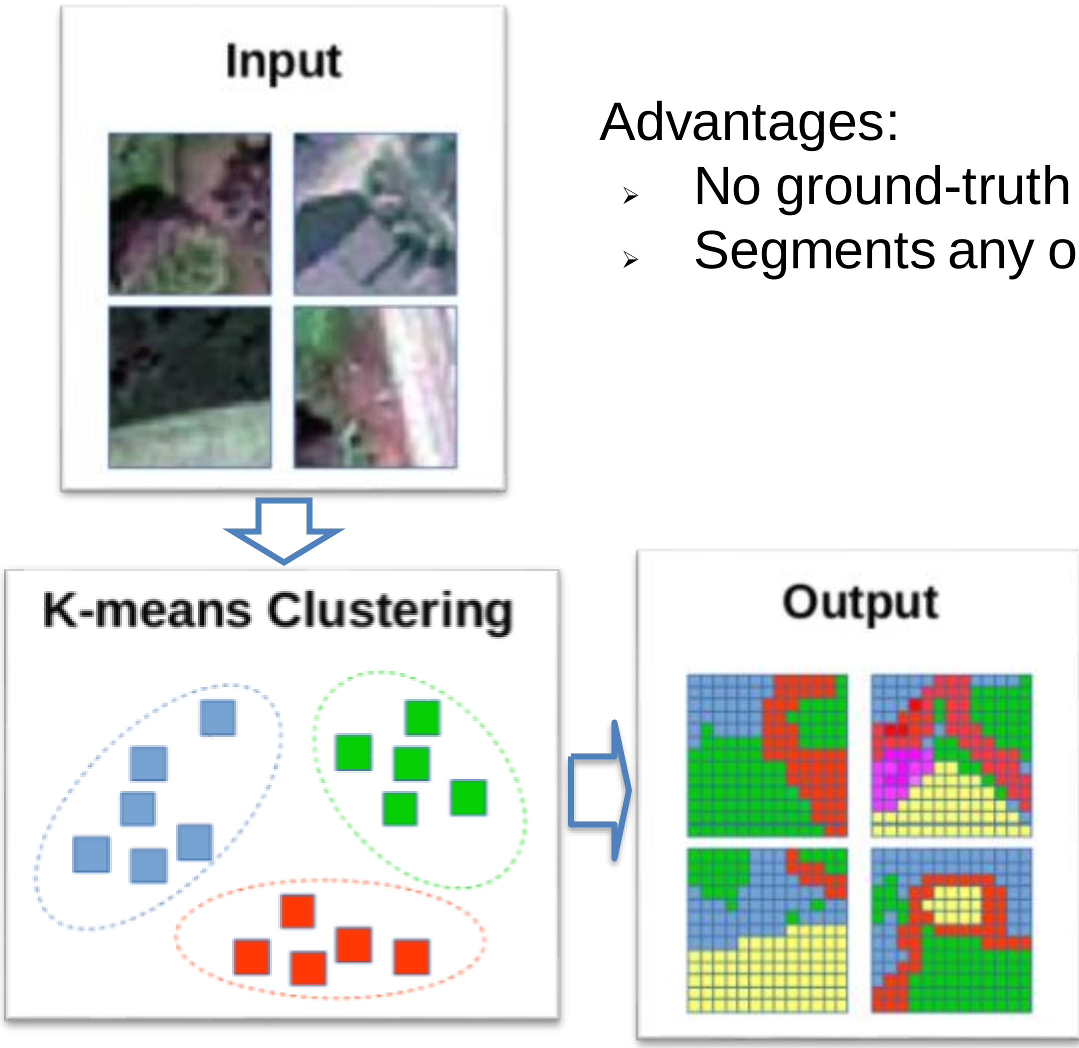
- State of the art performance

Disadvantages:

- Requires a lot of ground-truth
- Segments only the objects labeled by the ground-truth

* Olaf Ronneberger, Philipp Fischer, Thomas Brox. "U-Net: Convolutional Net-works for Biomedical Image Segmentation." In: arXiv:1505.04597 (2015).

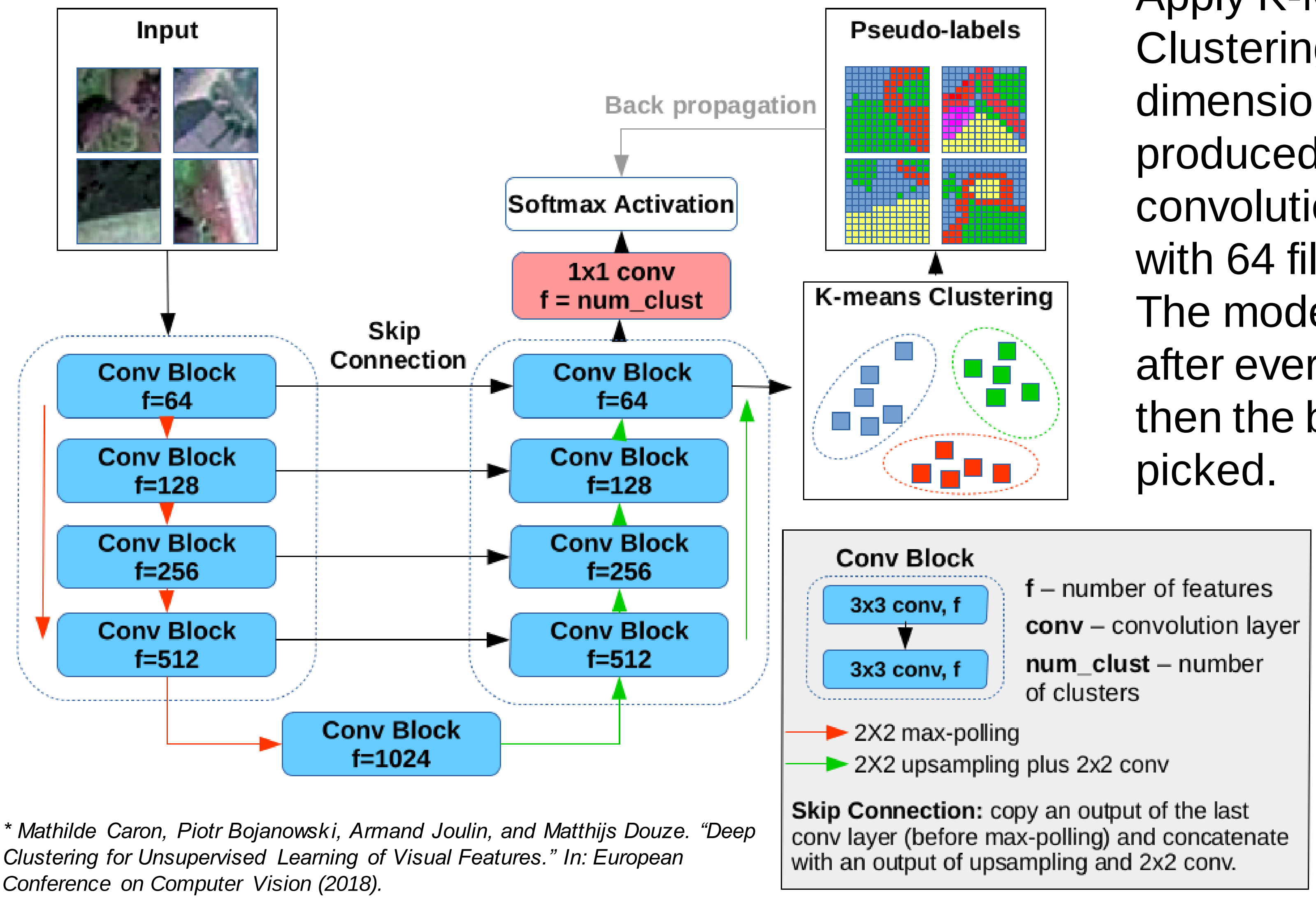
Related Work
Unsupervised K-Means



Advantages:
- No ground-truth required
- Segments any object

Disadvantages:
- Low performance
- Confuses different objects similar in color (trees – grass)
- Doesn’t account the geometric structure of an object
- Object class is unknown

Proposed Method
ClusterNet

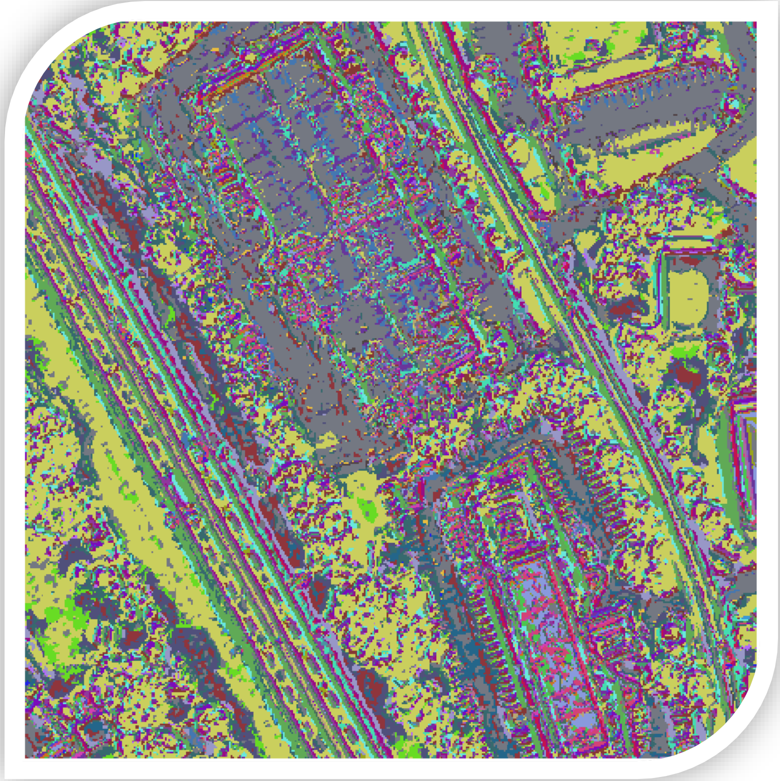


Apply K-Means Clustering to the high-dimensional features produced by the last convolutional layer with 64 filters.
The model is saved after every epoch, then the best one is picked.

* *Mathilde Caron, Piotr Bojanowski, Armand Joulin, and Matthijs Douze. "Deep Clustering for Unsupervised Learning of Visual Features." In: European Conference on Computer Vision (2018).*

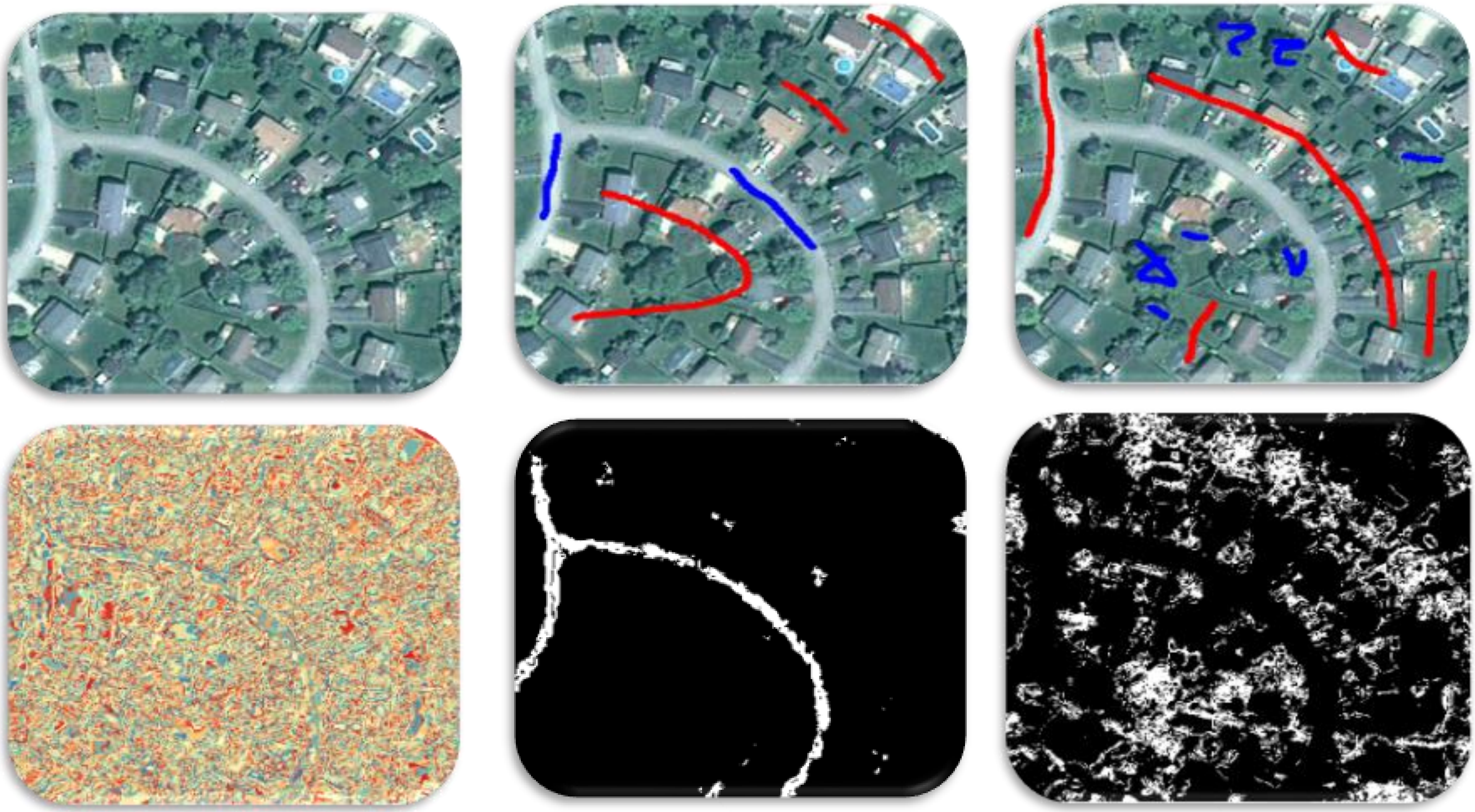
Proposed Method
Output

The output is a mask where every pixel is assigned to one of the possible clusters (a hyper-parameter chosen by user)



Proposed Method
Classes from Clusters

Draw Positive/Negative Strokes to identify foreground and background.
Clusters which overlap will be splited which makes the process interative.



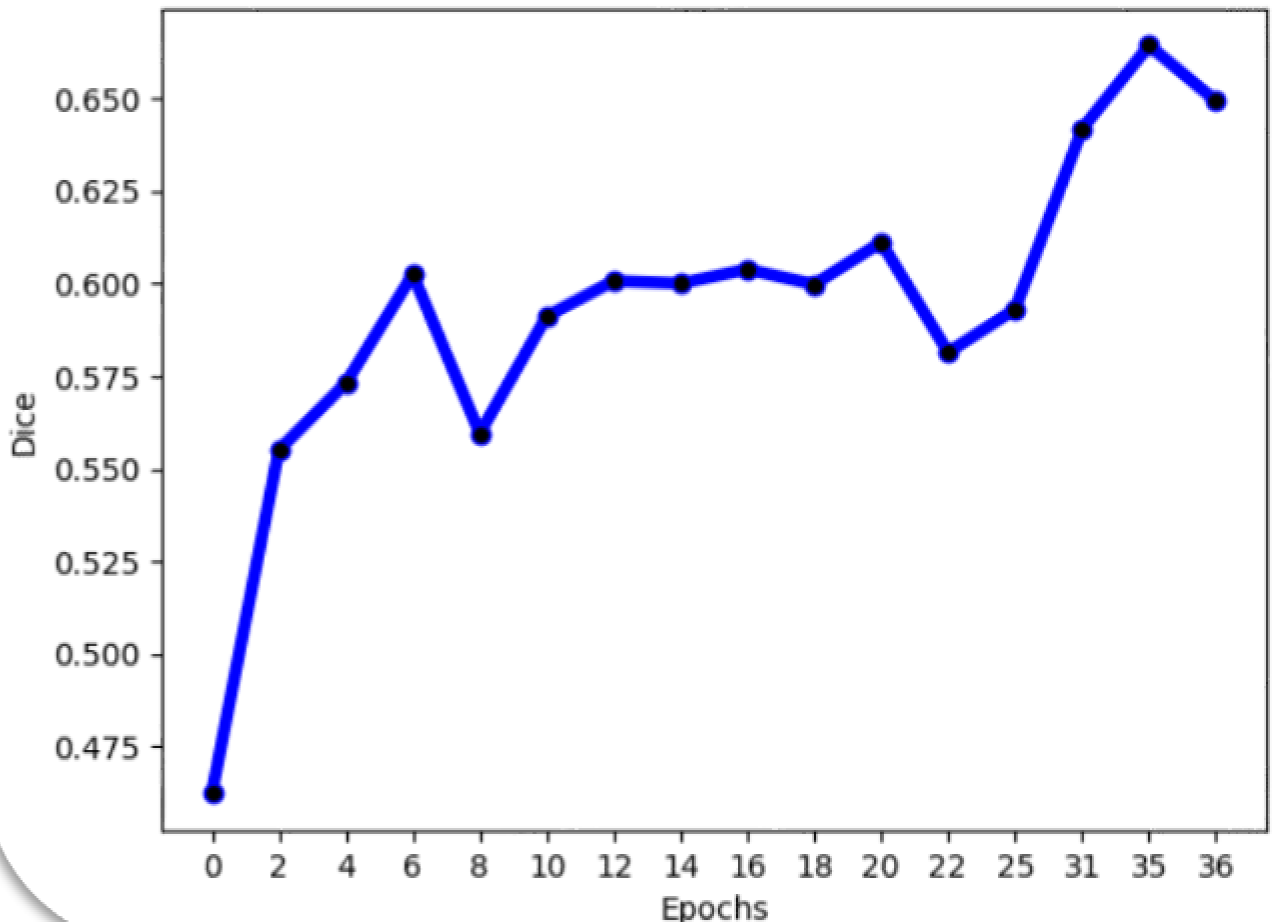
Proposed Method
Dataset & Evaluation

Data: LuxCarta sattelite images of 9 cities worldwide with 50 cm/pixel spatial resolution (721 patches for training, 24 patches for testing).

Evaluation: Dice similarity coefficient (DSC):

$$DSC = \frac{2|Prediction \cdot GroundTruth|}{|Prediction|^2 + |GroundTruth|^2}$$

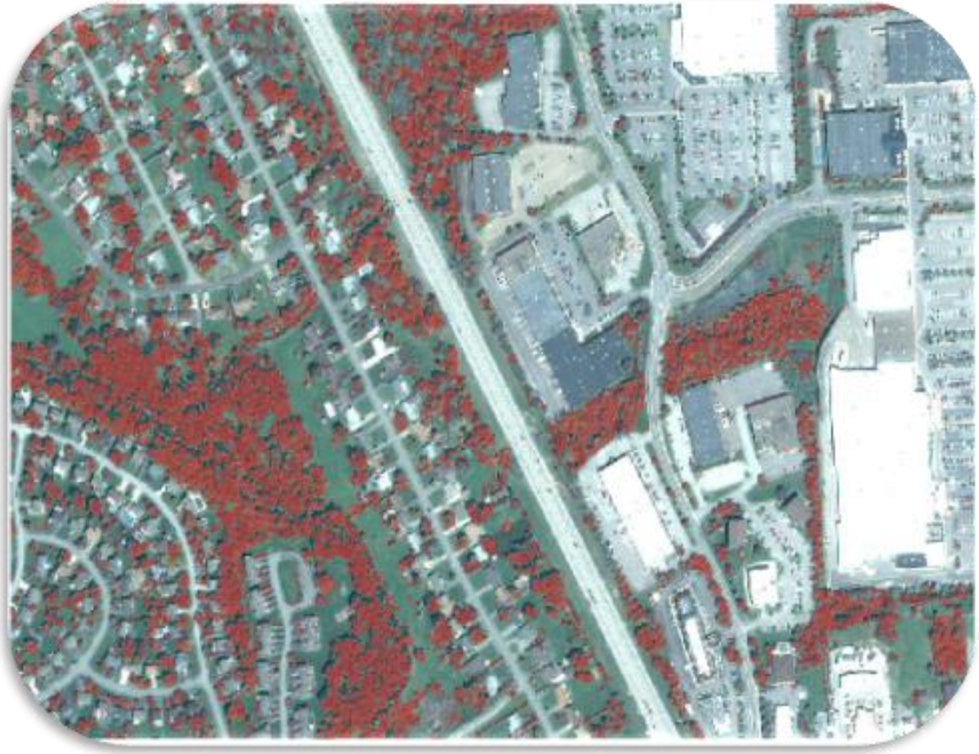
Proposed Method
Results



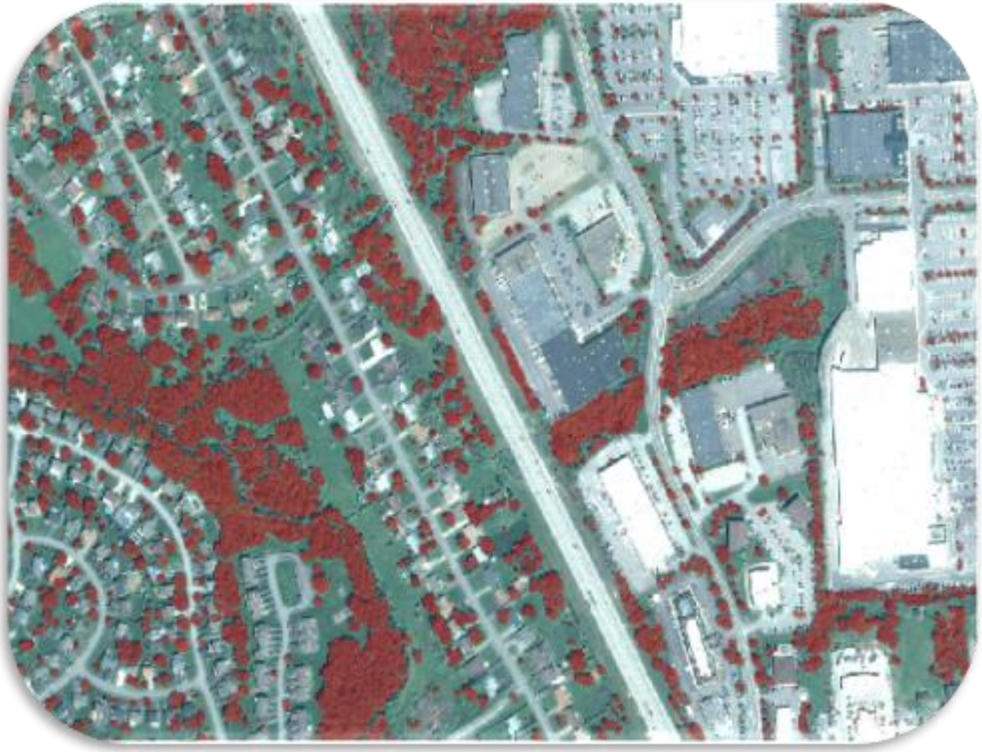
Performance is growing, hence training on pseudo-labels helps learning spatial information

Performance after the first epoch is close to the performance of K-Means applied to 3 channels

Proposed Method
Results



ClusterNet
66% Dice



Ground Truth

Proposed Method
Results

ClusterNet
66% Dice

Ground Truth

Proposed Method Comparison

	Dice	Accuracy
ClusterNet	**0.66**	**0.86**
Supervised U-Net	0.61	0.84
K-Means Clustering	0.48	0.76
SVM	0.18	0.69
SVM + GraphCut	0.19	0.71
SuperPixel GraphCut	0.37	0.68

Future Work

- Different clustering techniques
- Pretraining with Autoencoders
- Multitask Learning(clustering + autoencoders)
- Experiments on Data with higher spatial resolution

Thank You for Attention