Cloud segmentation for remote sensing imagery

Course: Computer Vision – TS. Nguyễn Thị Ngọc Diệp

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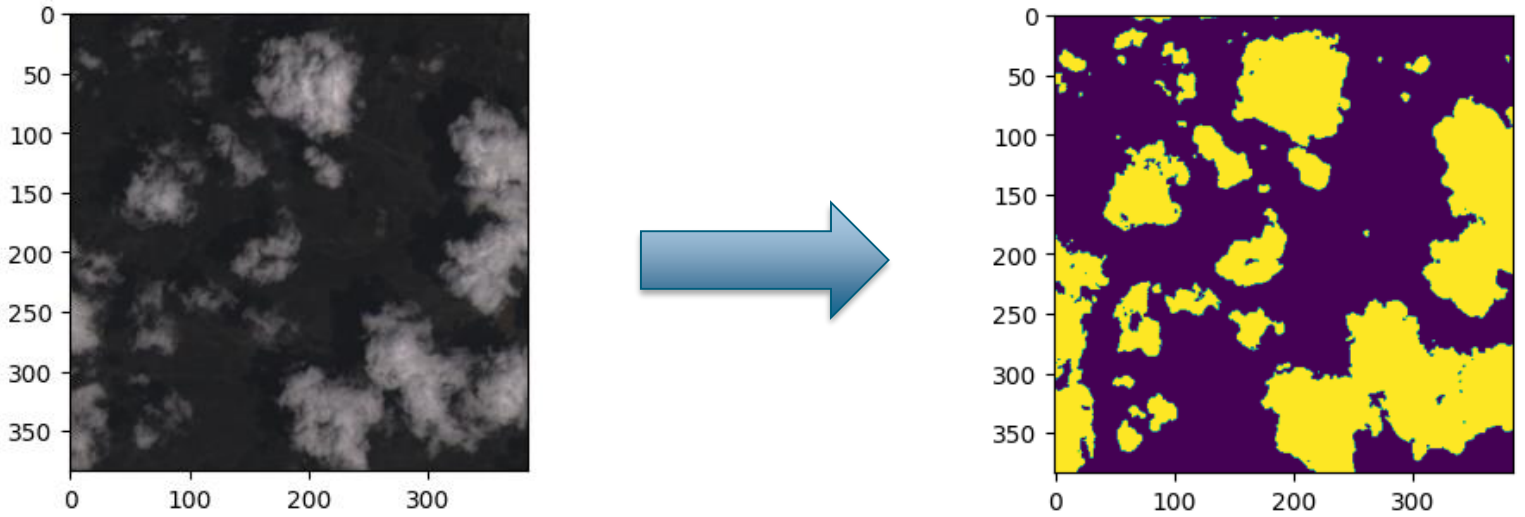
1. Introduction

- **Cloud segmentation problem**
  - Instance segmentation: identify cloud region in a image
  - Input: multi-spectral image
  - Output: probability map for the input

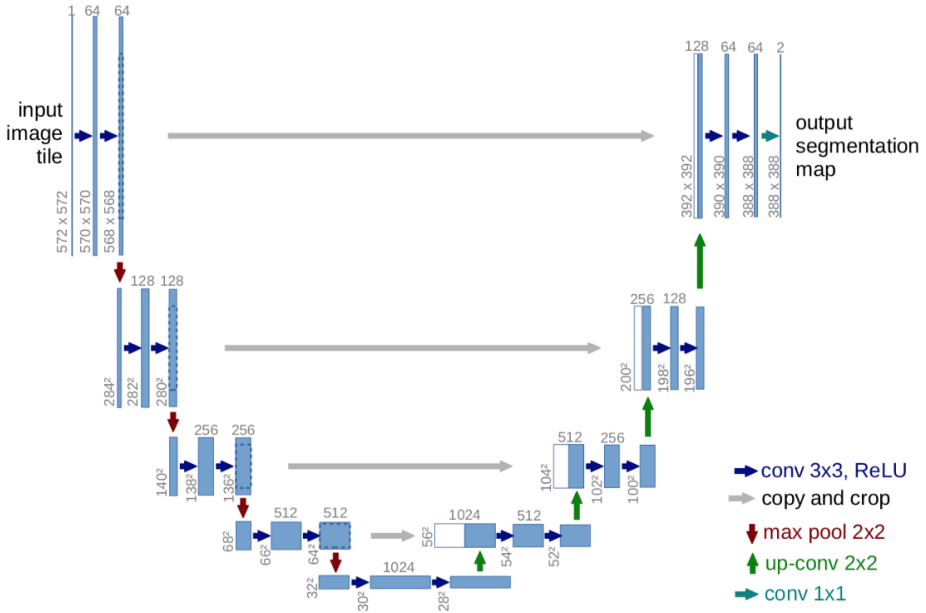


2. 38-Cloud Dataset

- Cropping 38 images from Landsat 8 dataset
- Each sample is 384 x 384, includes 4 bands: Red, Blue, Green, Near Infrared
- Training: 8400 patches; Testing: 9201 patches
- Label: ground truth of the entire Landsat 8 scenes
- 1/3 dataset are completely blank because of the black margin of the Landsat 8 images.

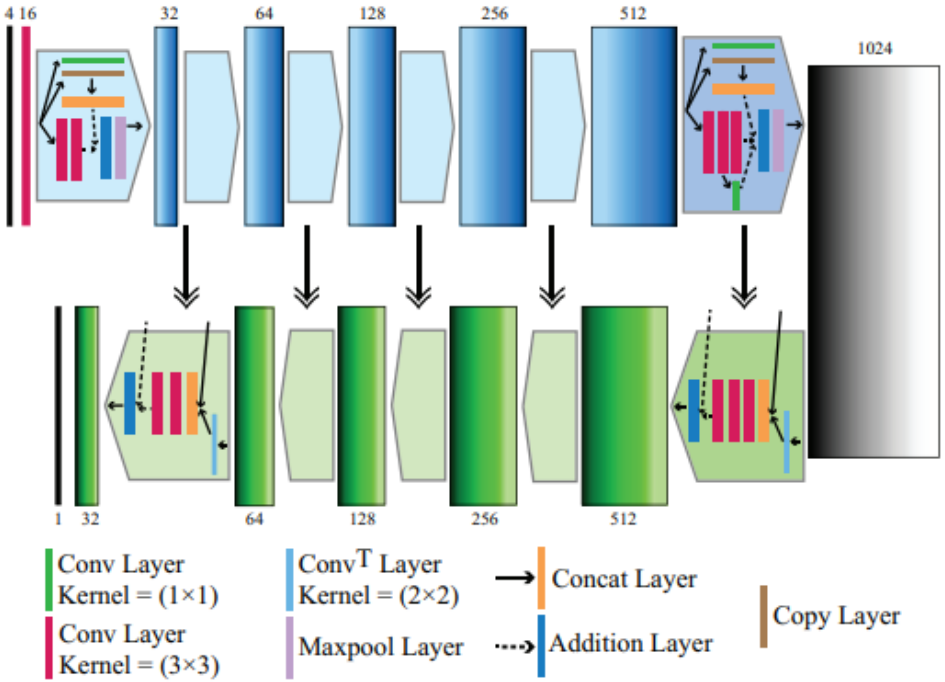
3. Method: U-Net

- Encoder-decoder architecture
- Encoder: feature extraction
- Decoder: increase the resolution of the output
- Skip-connection



3. Method: Cloud-Net

- Same architecture with U-Net
- Shortcut connections in **each block**
  - Concat, addition, copy layers
  - Preserved contexts from earlier layer
  - Prevent vanishing gradient



4. Experiment

- We implemented U-Net and Cloud-Net models
- Train set was split into train and validation set (8/2)
- Metrics
  - $\textbf{Jaccard Index} = \frac{\text{TP}}{\text{TP+FN+FP}}$
  - $\text{Precision} = \frac{\text{TP}}{\text{TP+FP}}$
  - $\text{Recall} = \frac{\text{TP}}{\text{TP+FN}}$
  - $\text{Accuracy} = \frac{\text{TP+TN}}{\text{TP+TN+FP+FN}}$

Authors [4] evaluation with 38-Cloud test dataset

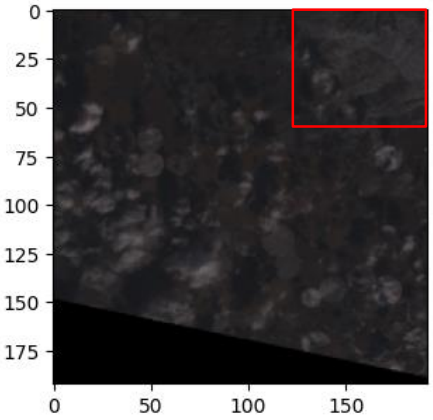
Method	Jaccard	Precision	Recall	Accuracy
U-Net	85.03	96.15	88.02	95.05
Cloud-Net	**87.32**	**97.60**	**89.23**	**95.86**

Our evaluation with 38-Cloud train dataset

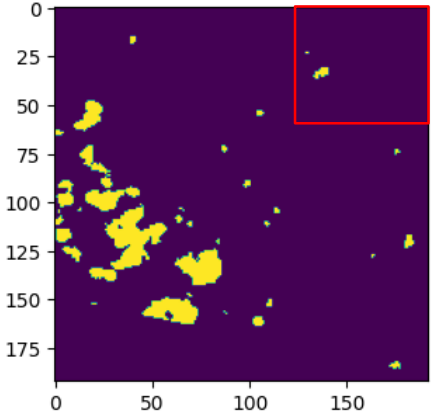
Method	Jaccard	Precision	Recall	Accuracy
U-Net	**85.47**	**93.94**	90.52	**93.27**
Cloud-Net	85.01	90.35	**93.57**	92.78

4. Experiment

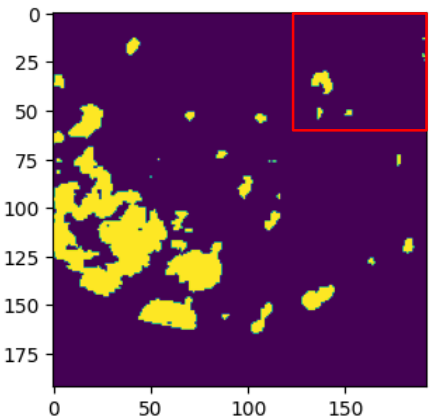
- Our code at: https://github.com/pypye/cloud_detection.git
- Input/output size: 192x192, Adam optimizer, 20 epochs, $lr = 1e - 4$
- Model outputs examples:



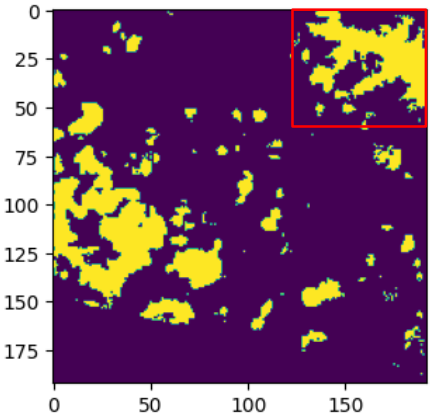
Input



Ground Truth



U-Net



Cloud-Net

5. Discussion

- We implemented and evaluated 2 models with 38-Cloud train dataset
- U-Net and Cloud-Net performances are quite good
- Can learn multi-scale information through the skip-connection operator
- Poor ability to distinguish clouds and factors (ice, snow, surface rivers, lakes,...)
- Cloud-Net uses 3x3 convolution layers so it increases the complexity of the model (36.4M parameters)

6. References

- [1] Dataset: https://github.com/SorourMo/38-Cloud-A-Cloud-Segmentation-Dataset#evaluation-over-38-cloud-dataset
- [2] Ronneberger, Olaf, Philipp Fischer, and Thomas Brox. "U-net: Convolutional networks for biomedical image segmentation." *International Conference on Medical image computing and computer-assisted intervention*. Springer, Cham, 2015.
- [3] Mohajerani, Sorour, and Parvaneh Saeedi. "Cloud-Net: An end-to-end cloud detection algorithm for Landsat 8 imagery." *IGARSS 2019-2019 IEEE International Geoscience and Remote Sensing Symposium*. IEEE, 2019.
- [4] Mohajerani, Sorour, and Parvaneh Saeedi. "Cloud and cloud shadow segmentation for remote sensing imagery via filtered jaccard loss function and parametric augmentation." *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* 14 (2021): 4254-4266.

Thanks for listening