Cloud Removal in Hyperspectral Satellite Images using Generative Adversarial Networks

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Cloudy is fuzzy

- Satellite imagery can be used to monitor the environment or predict disasters and enable quick responses.
- Clouds bring **uneven illumination**, **blurring** and **occlusion** of the target.

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Hyperspectral Satellite Images

- **Numerous wavelengths** including near-infrared
- Becoming more widely available

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Generative Adversarial Networks (GANs)

- Train 2 networks in **competition**: generator vs discriminator
- Among the most successful unsupervised techniques for **generating realistic images**.

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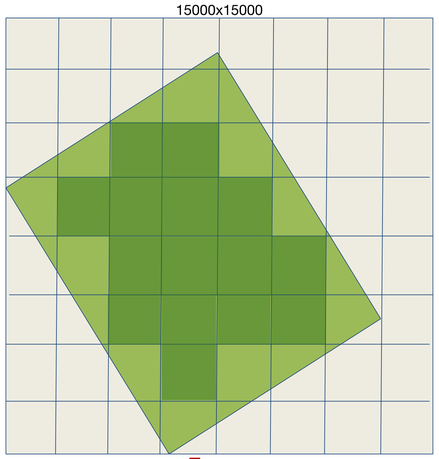
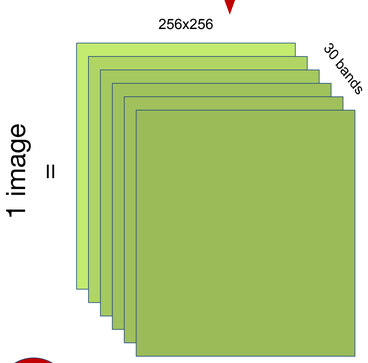
Apply GANs to hyperspectral satellite images in order to generate the missing patches from below the clouds

Data pipeline

1 Satellogic hyperspectral satellite images



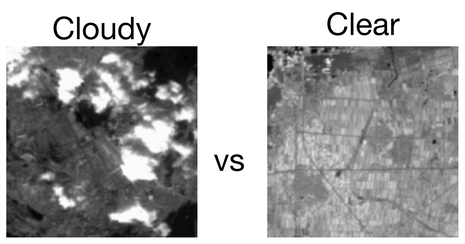
Extract patches



2 **Total:** ~ 15k images

Label a subset of patches

3 **Classification** with Convolutional Neural Networks (CNNs)



Select clear hyperspectral patches

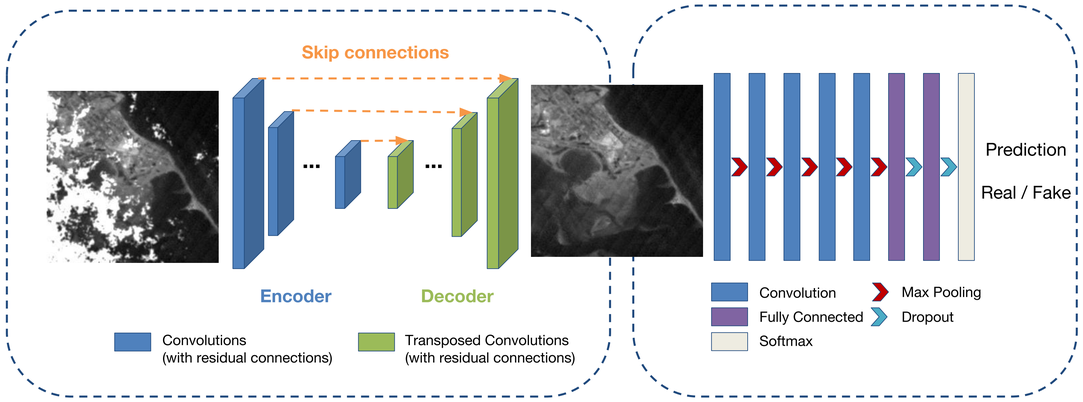
4 **Cloud synthesis** using Perlin noise

Example of real and fake clouds on hyperspectral satellite image - left = 452nm band, right = 827nm band.

Network Architecture

Generator = UResNet

Discriminator = VGG



Next Steps

- Explore several evaluation metrics
- Compare with other cloud removal methods
- Try different GAN architectures (e.g. cGAN)
- Refine the architecture:
  - Use Attention [2]
  - Shadow removal [3]

Acknowledgments & References

Data provided by Satellogic for Stanford Big Earth Hackathon

SATELLOGIC

[1] Enomoto, Kenji, et al. "Filmy Cloud Removal on Satellite Imagery with Multispectral Conditional Generative Adversarial Nets." *Computer Vision and Pattern Recognition Workshops (CVPRW), 2017 IEEE Conference on.* IEEE, 2017.
[2] Qian, Rui, et al. "Attentive Generative Adversarial Network for Raindrop Removal from a Single Image." *arXiv preprint arXiv:1711.10098* (2017).
[3] Wang, Jifeng, et al. "Stacked Conditional Generative Adversarial Networks for Jointly Learning Shadow Detection and Shadow Removal." *arXiv preprint arXiv:1712.02478* (2017).