NightVision: Generating Nighttime Satellite Imagery from Infra-Red Observations

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Motivation

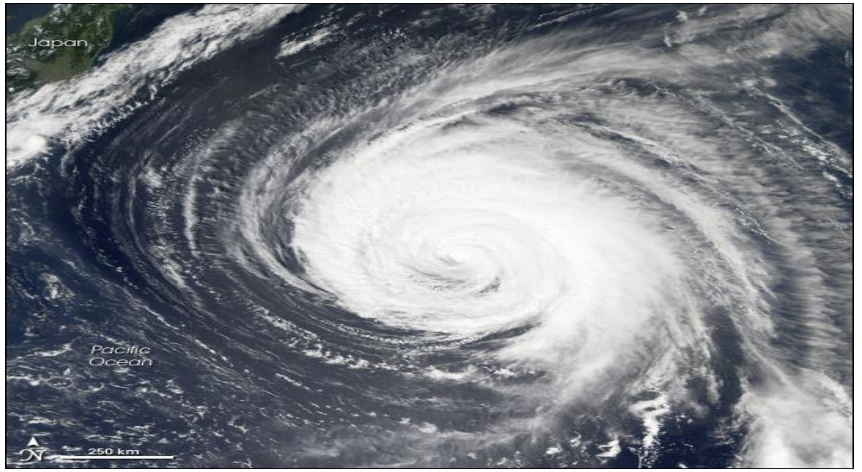
Why could it be useful to generate satellite imagery during the night?

Recent explosion of applying machine learning to satellite imagery

Existing algorithms often depend on daylight imagery

Examples:

- Storm tracking
- Cloud property analysis
- Pollution detection



https://earthobservatory.nasa.gov/images/17252/tropical-storm-ioke

Setup

Methods developed during the hackathon at Climate Informatics Conference 2020

Using GOES-16 data from a single side for years 2018 and 2019

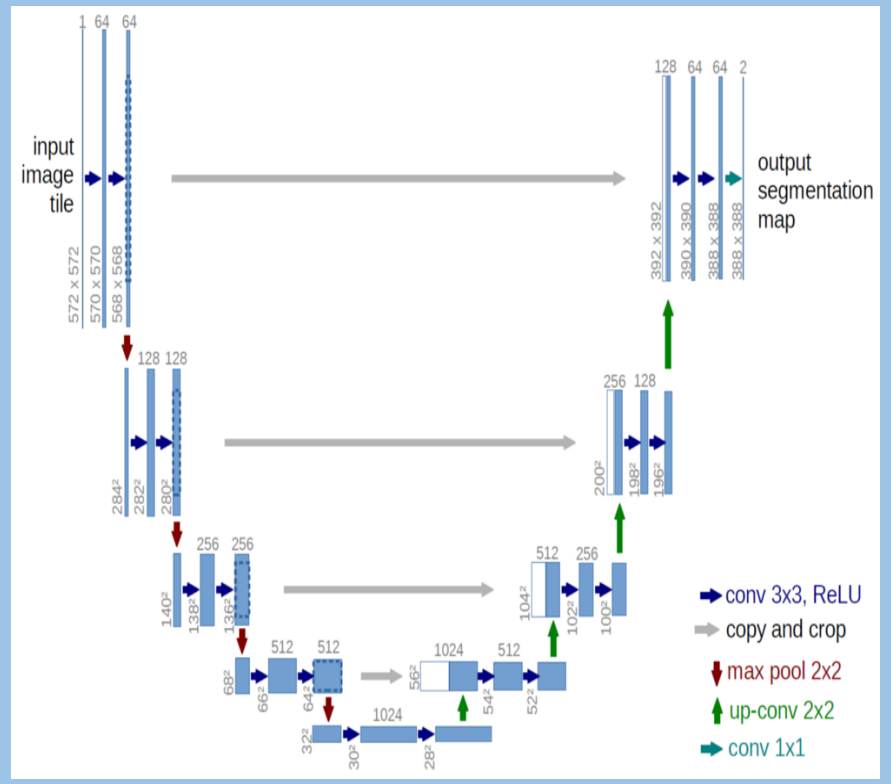
About 4,300 pairs of infra-red and visible spectrum imagery during day (Assumption: Infra-Red during day and night similar), completely black images sorted out

Scoring function: Structural similarity index measure (SSIM)

$$\mathrm{SSIM}(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

Methods

All three winning methods used the U-Net, a convolutional neural network developed for biomedical image analysis

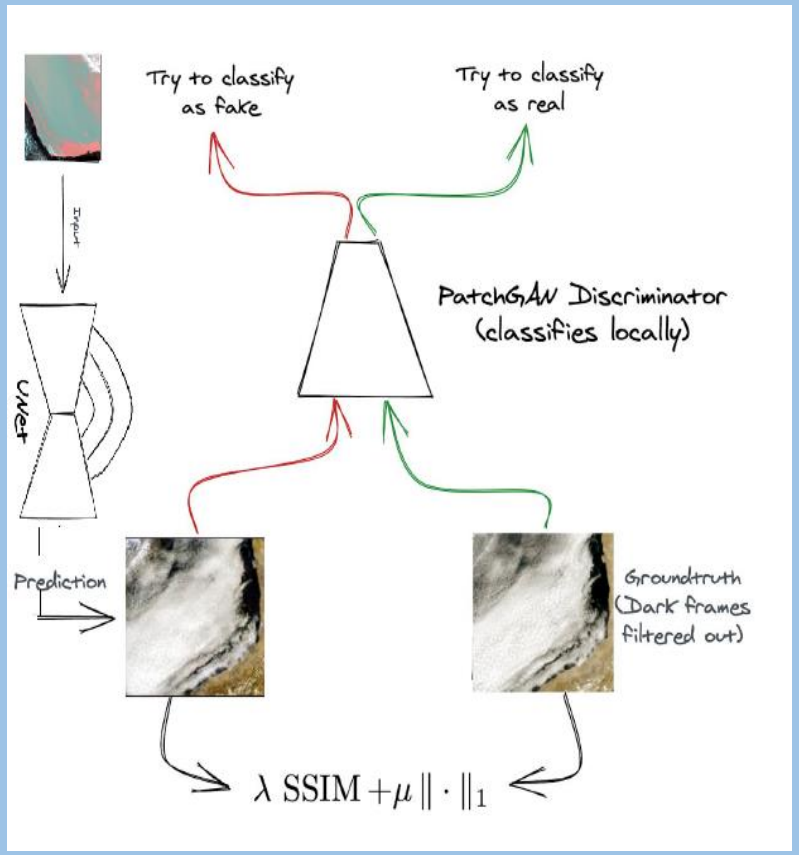


https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/

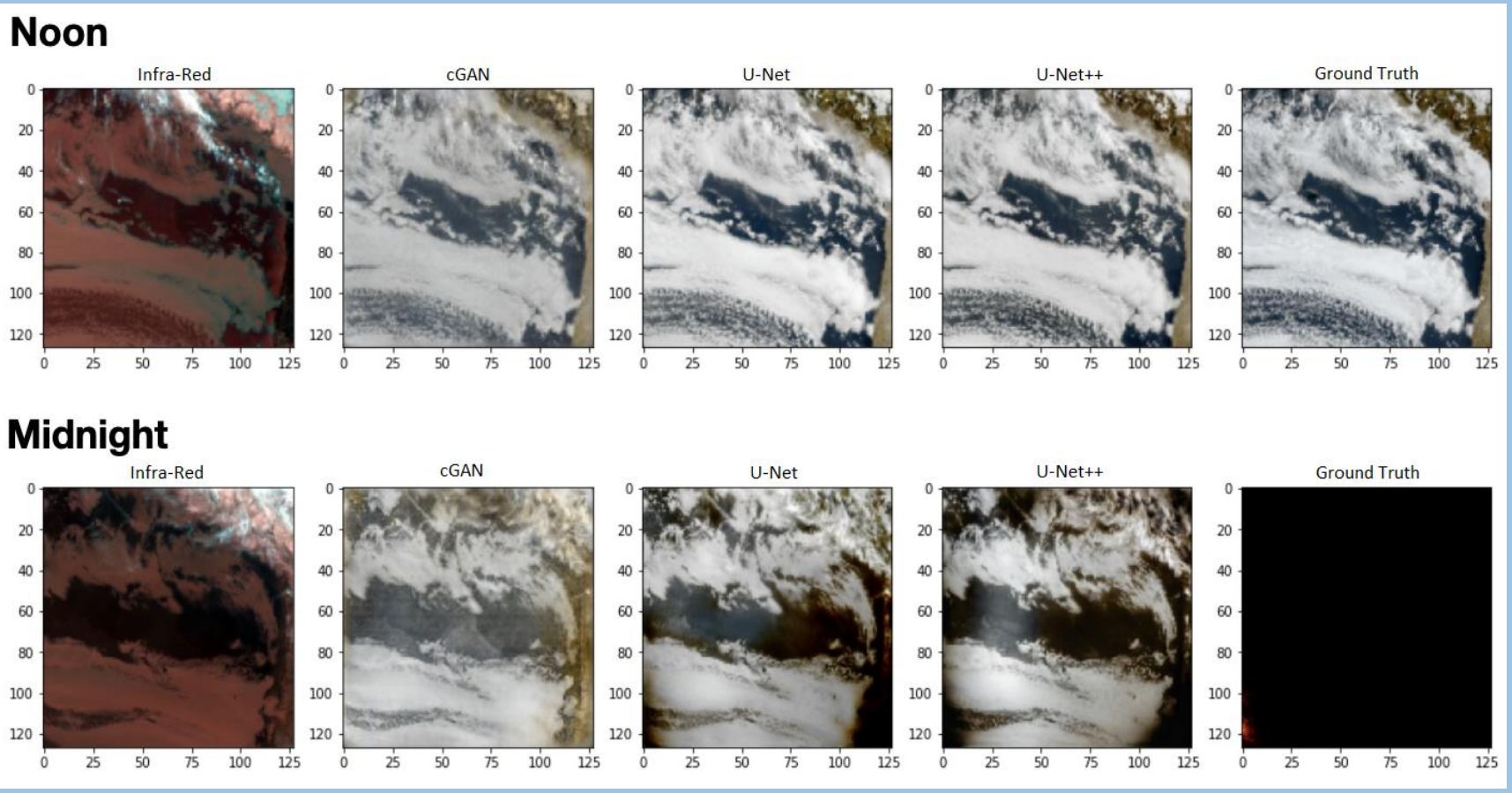
U-Net++: Advanced U-Net with enhanced skip connections

Generative adversarial network (GAN):

1. Generator which tries to generate an image like the groundtruth
2. Discriminator which tries to disguish generated and real



Results



CGAN method performs a little worse on the daylight examples, but better colouring for the night

Table 1: Accuracy scores for the different methods

Method	SSIM	RSME
Method 1: cGAN	0.77	0.11
Method 2: U-Net	0.85	0.09
Method 3: U-Net++	0.86	0.07

Non-GAN approaches show better SSIM scores, but suffer from black spots for nighttime observation

Future work

Analyse difference between infra-red during night and day

Detailed analysis of existing methods

Explore more approaches

Hackathon is public now, everyone is welcome to participate: https://competitions.codalab.org/competitions/26644


Thank you for your attention!