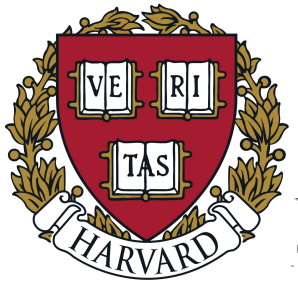
Small Synoptic Survey Telescopes

Matt George

AAS 2019

Image: Seattle - January 1, 2019

A bit about me



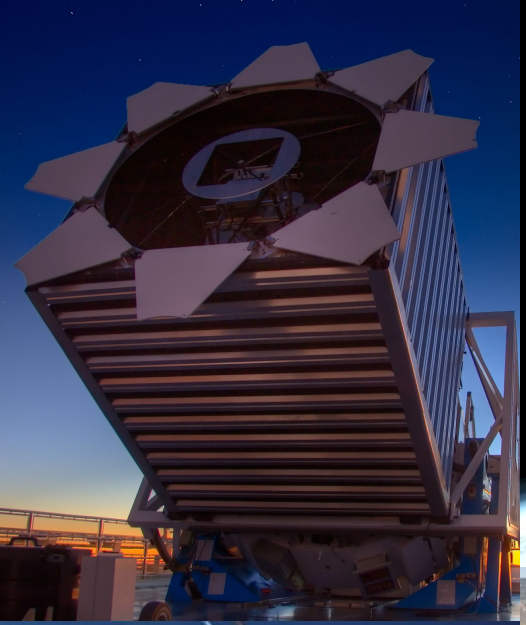
UNIVERSITY OF CAMBRIDGE

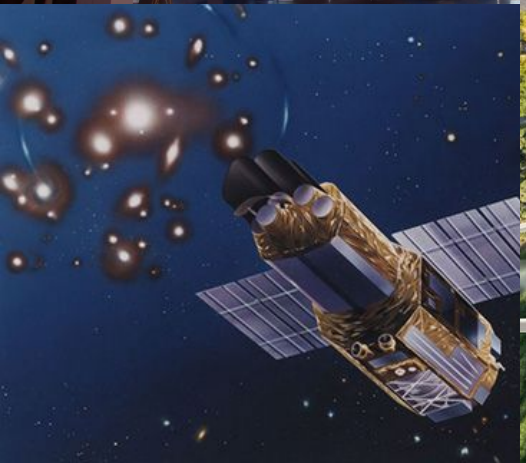
INSIGHT

Square

Airware

planet.





Overview

What: Constellations of satellites are collecting a torrent of new imagery of Earth.

Why: Researchers, companies, governments, and individuals are using this data to solve timely problems and understand change.

How: Machine learning is enabling analyses to extract useful information at scale.

Planet Dove Satellite

- Always-on, broad-area monitoring
- 3 meter resolution
- RGB and NIR bands

97° Orbital Inclination

Planet SkySat Satellite

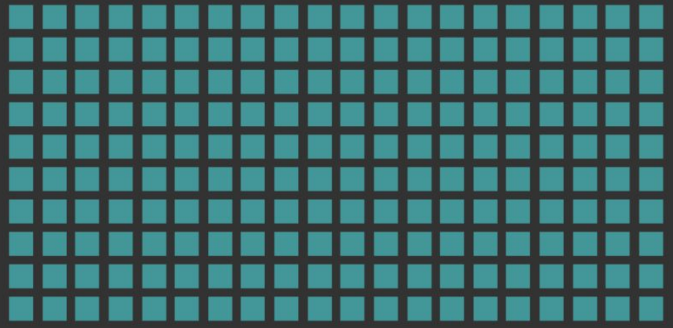
- Custom, targeted monitoring
- 72 centimeter resolution
- RGB, NIR, and Pan bands

OUR CONSTELLATIONS

Constellation	Dove (Planetscope)	RapidEye	SkySat
Orbit Altitude	475 km	630 km	500 km
Spacecraft #	130 +	5	13
Image capture capacity	346 million km^2/day	6 million km^2/day	500,000 km^2/day
GSD (Nadir)	3.9 m	6.5 m	0.72 m PAN
Pixel Resampled	3.125 m	5 m	1 m
Telescope and Camera	Bayer mask CCD sensor	Push broom imager	CMOS Frame Camera with Cassegrain telescope
Spectral Bands	RGB and NIR	RGB, Red Edge and NIR	RGB, PAN and NIR

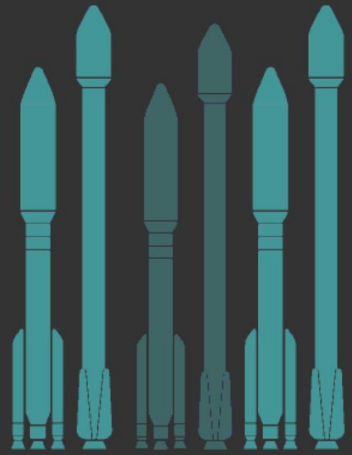
350 MILLION KM²/DAY

6 TERABYTES EACH DAY



150+ SATELLITES IN ORBIT

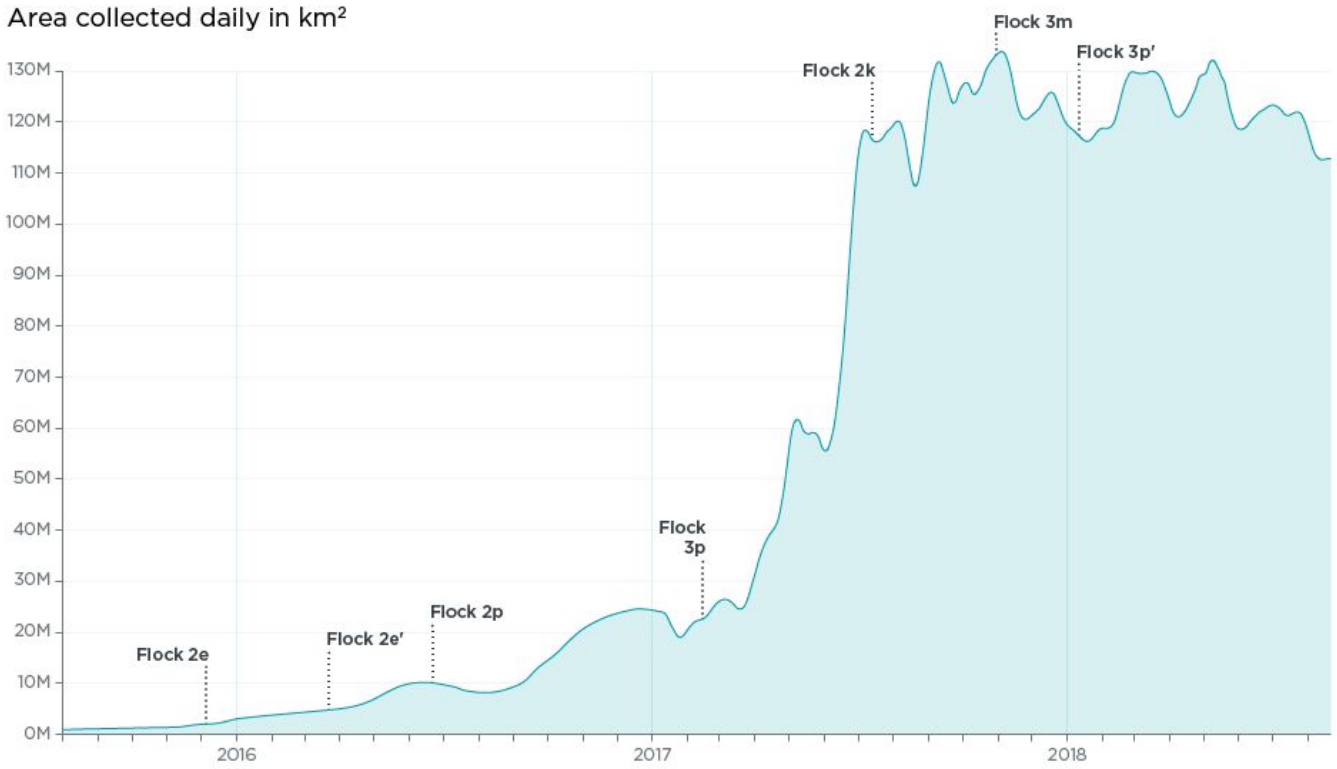
1.5 MILLION 29 MP IMAGES EVERY DAY



31 GROUND STATIONS

21 SUCCESSFUL LAUNCHES

REACHING A DAILY PICTURE OF EARTH



LSST is Not "Big Data"

David Schlegel

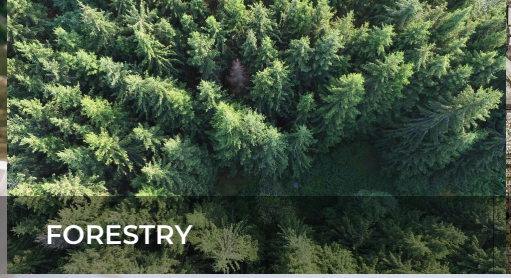
(Submitted on 3 Mar 2012)

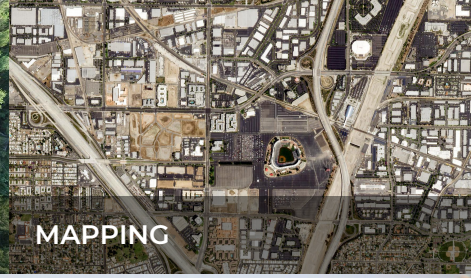
LSST promises to be the largest optical imaging survey of the sky. If we were fortunate enough to have the equivalent of LSST today, it would represent a "fire hose" of data that would be difficult to store, transfer, and analyze with available compute resources.
LSST parallels the SDSS compute task which was ambitious yet tractable. By almost any measure relative to computers that will be available (thanks to the steady progression of Moore's Law), LSST will be a small data set. LSST will never fill more than 22 hard drives. Individual investigators will be able to maintain their own data copies to analyze as they choose.

Comments: Letter submitted to the NSF Astronomy Portfolio Review
Subjects: **Instrumentation and Methods for Astrophysics (astro-ph.IM)**
Cite as: **arXiv:1203.0591 [astro-ph.IM]**


DEFENSE & INTELLIGENCE


EMERGENCY MANAGEMENT

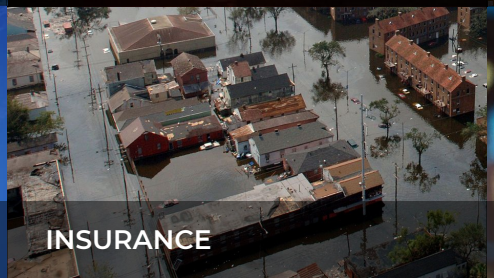

FORESTRY


MAPPING


ENERGY & INFRASTRUCTURE


AGRICULTURE

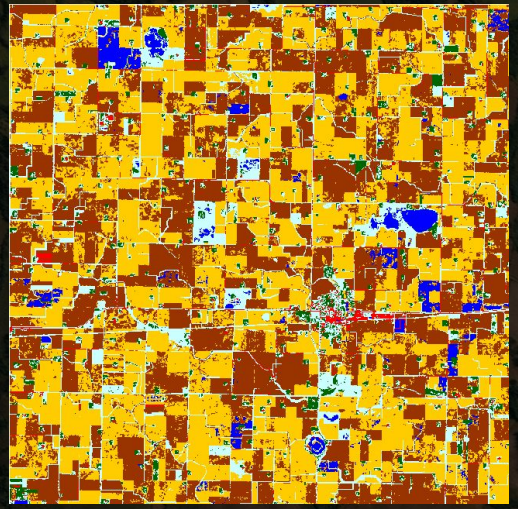

CIVIL GOVERNMENT


INSURANCE


FINANCE & BUSINESS INTELLIGENCE

Outcomes for Agriculture

Precise and Reliable Field-level Crop Information

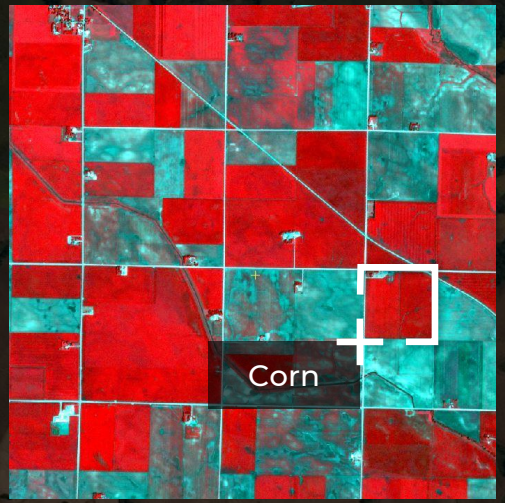


PREDICTING CROP YIELD

- SOY
- CORN
- BODIES OF WATER

MONITORING CROP HEALTH

With NDVI at 3 meter resolution, customers are able to detect crop anomalies and trends



CROP CLASSIFICATION

Planet's high-cadence visible & near-infrared data reveals patterns that help differentiate crop types early in the growing season

Outcomes for Economic Development

Urban/Rural Land Use, Monitor Infrastructure Development & Growth

DEFORESTATION

A real-time feed of forests and deforestation activity built on Planet's daily imagery set

PIPELINE MONITORING

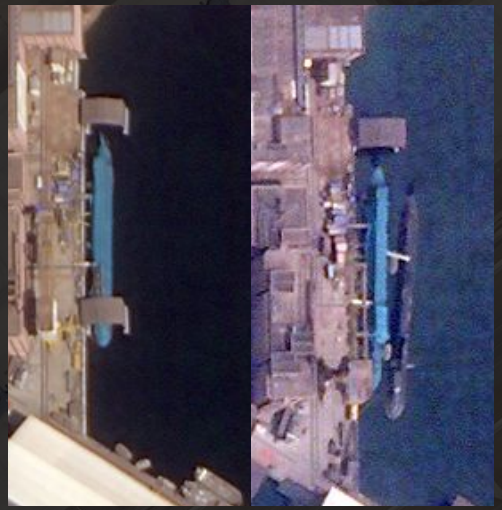
A critical part of pipeline planning involves knowing when multiple pipelines and operators exist in the same corridor.

INFRASTRUCTURE

Monitor strategic assets in remote areas as well as production indicators and global energy supply.

Outcomes for Defense & Intelligence

Gain Situational Awareness of Daily, Global Change



AIRCRAFT DETECTION

High-cadence coverage and rapid data delivery provide transparency into situational events as change occurs.

ASSET MONITORING

Frequent collection allows you to see change over time, and increases the likelihood of securing imagery of strategically important assets.

BORDER SECURITY

Planet's very high revisit rate, coupled with automated change detection, makes remote sensing valuable for any government.

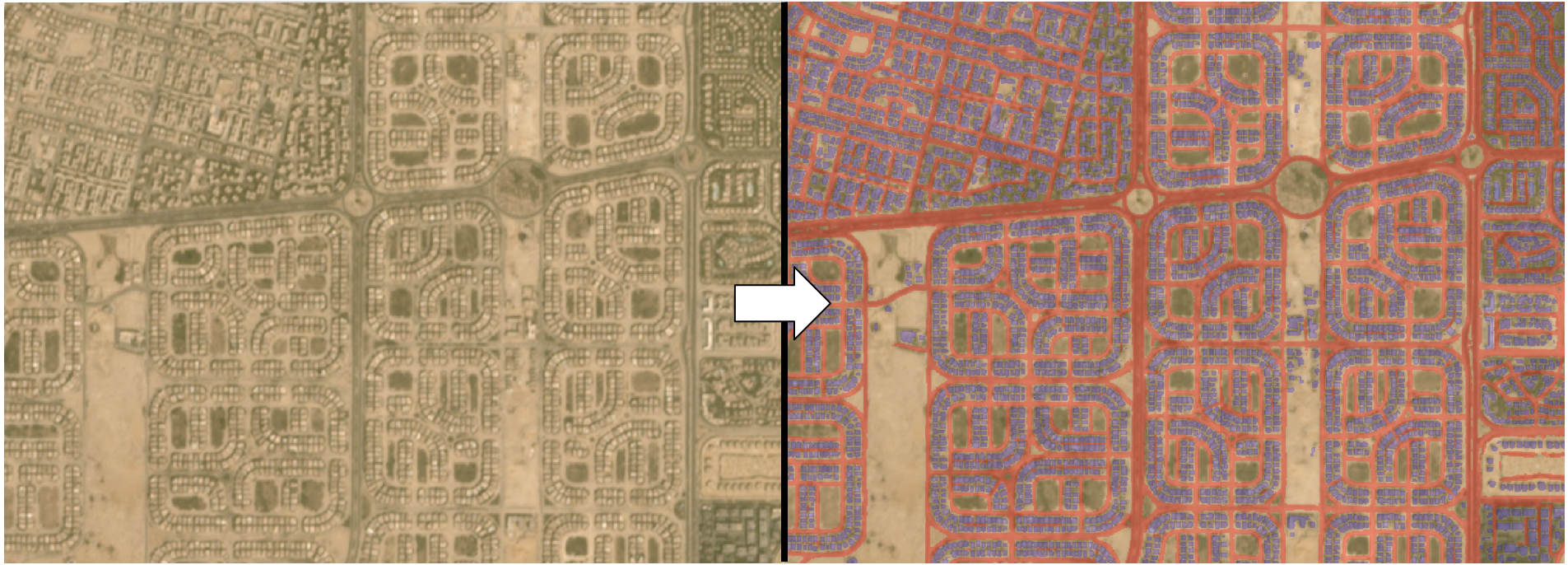
Overview

What: Constellations of satellites are collecting a torrent of new imagery of Earth.

Why: Researchers, companies, governments, and individuals are using this data to solve timely problems and understand change.

How: Machine learning is enabling analyses to extract useful information at scale.

Extracting Key Features from Imagery

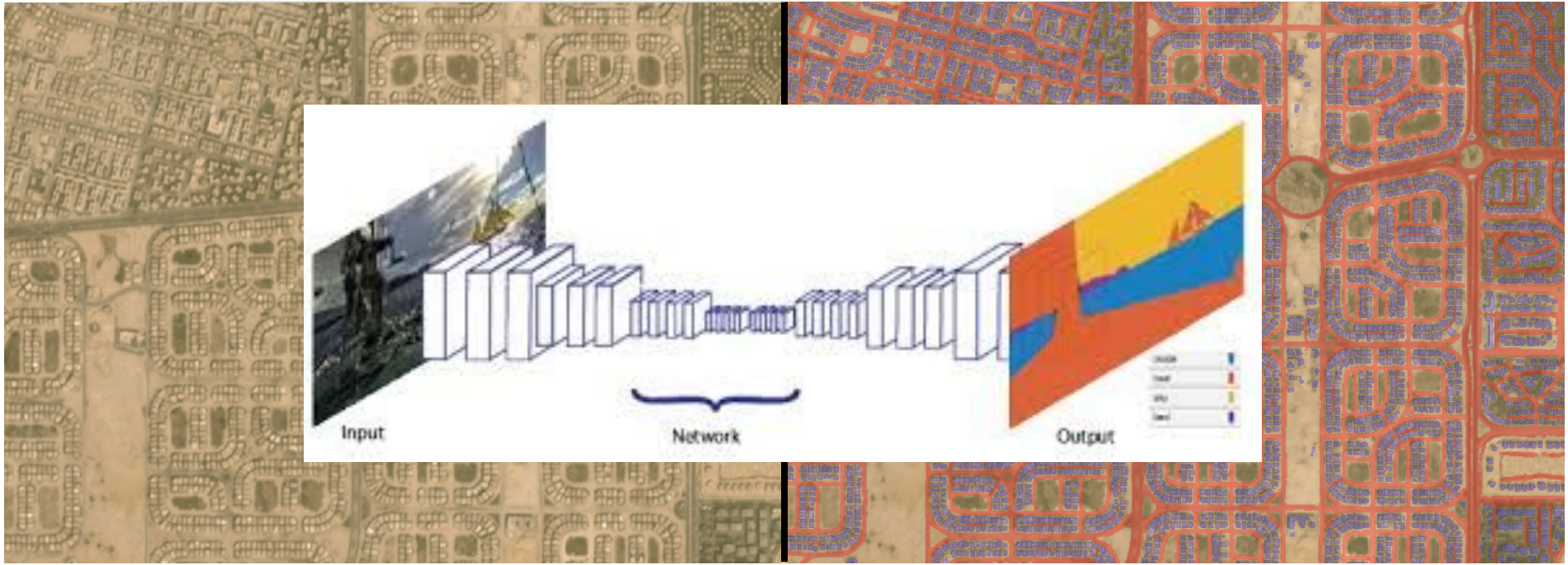


Input image

Output with roads & buildings labeled

Deep Learning for Semantic Segmentation

Goal is to learn a mapping from input pixels to output labels



Input image

Output with roads & buildings labeled

Deep Learning

Not magic, just curve-fitting

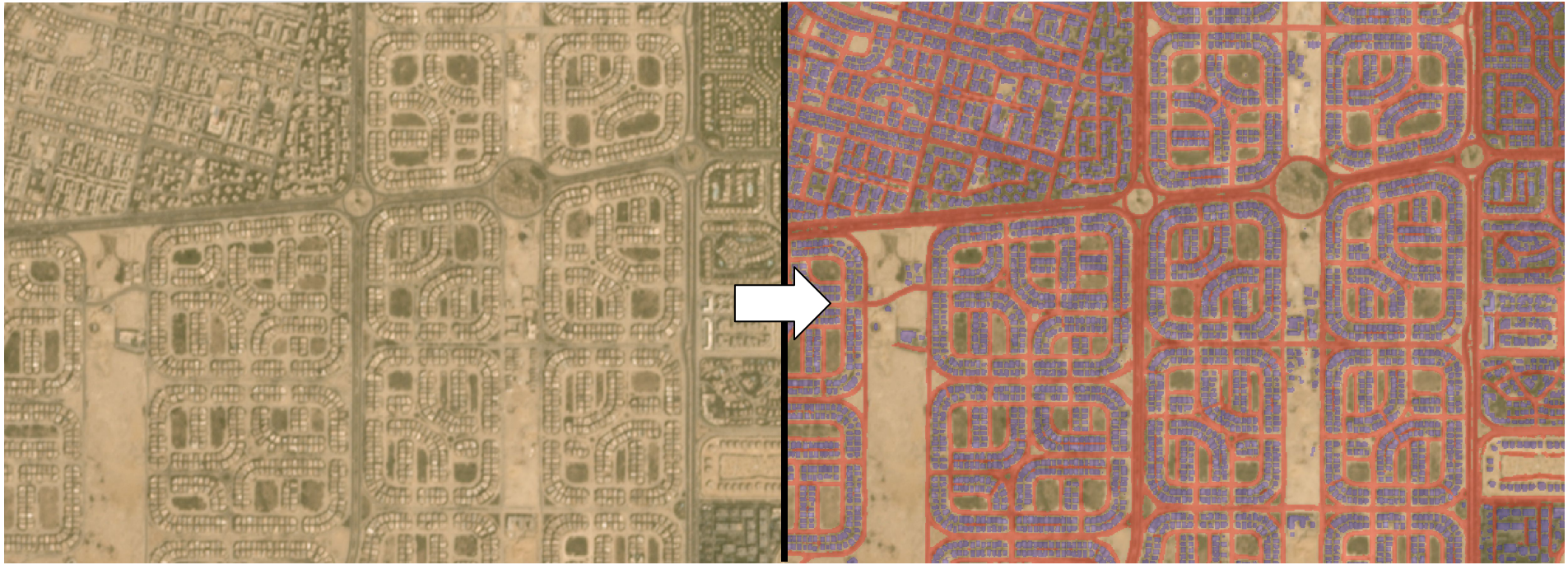
$f(x, w) \rightarrow y$

x: input pixel values
w: $O(>10^6)$ free parameters to fit, convnet architecture
y: target classification
→: optimization strategy like stochastic gradient descent

Overconstrained if $O(y) > O(w)$

Challenge is to generalize across widely varying samples

Deep Learning for Semantic Segmentation



Input image

Output with roads & buildings labeled

Demo


planet
2017.07.14
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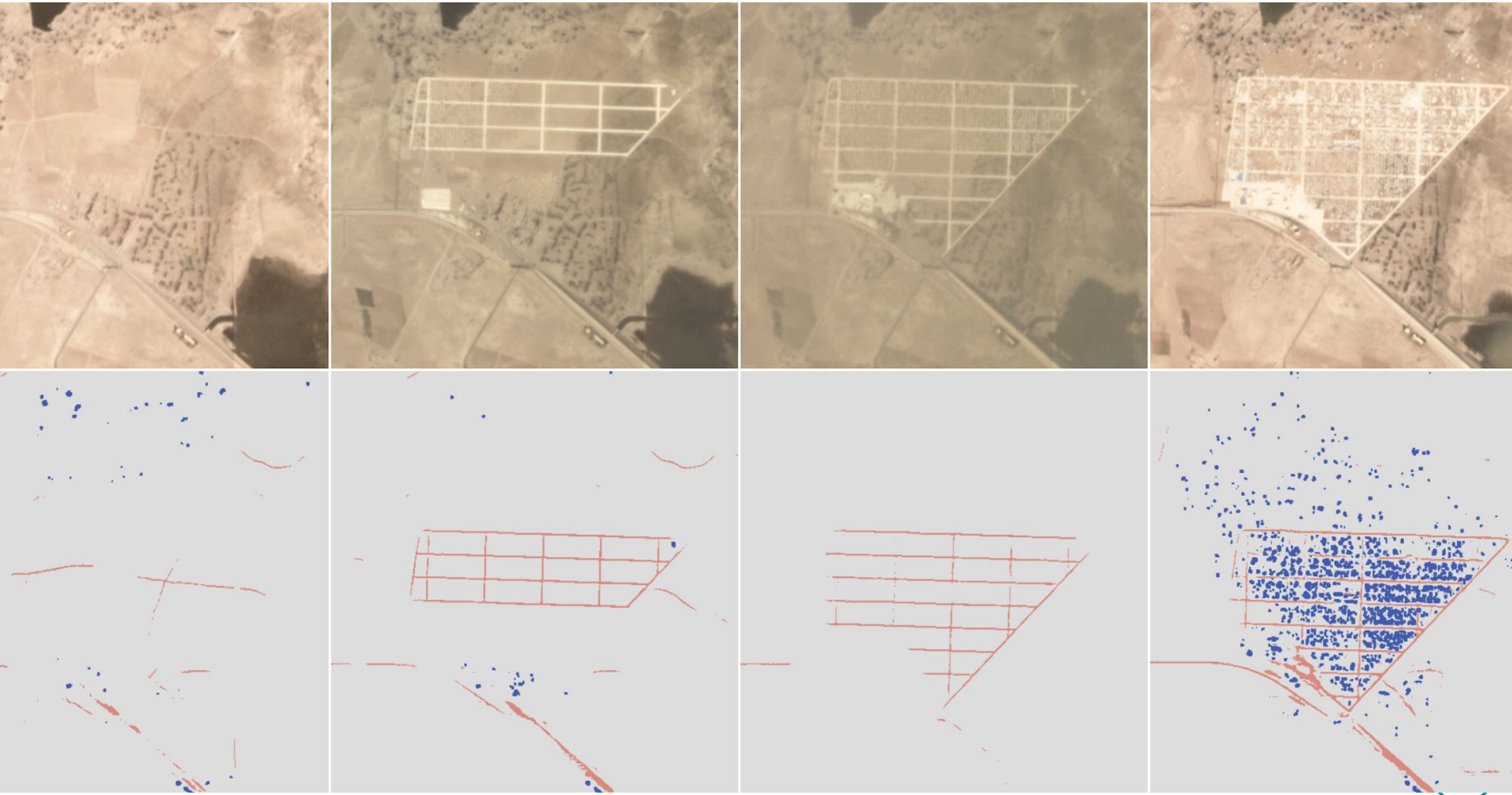
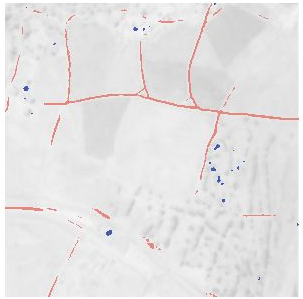
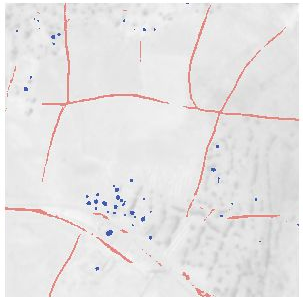


Roads & Buildings

IDP CAMP GROWTH IN SYRIA



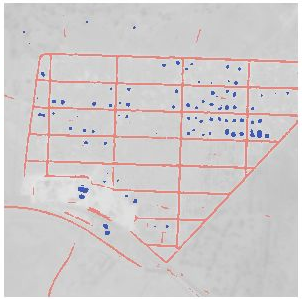
June 2017



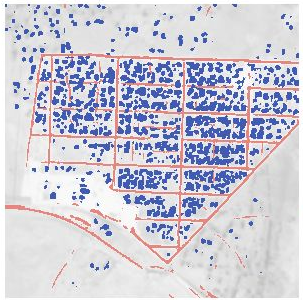
July 2017

August 2017

September 2017



October 2017



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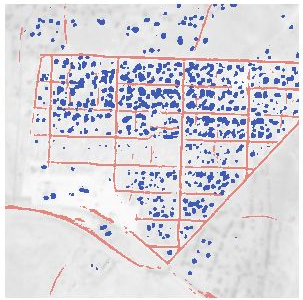
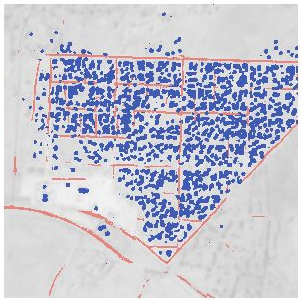


December 2017

January 2018



February 2018

ROADS

BUILDINGS


planet.
2018.11.20
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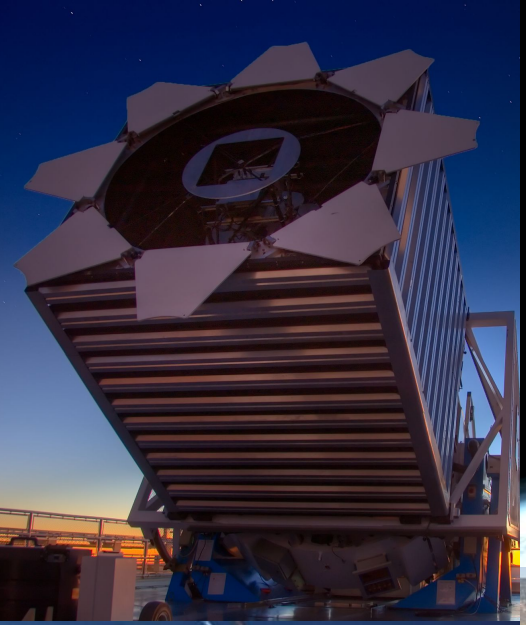

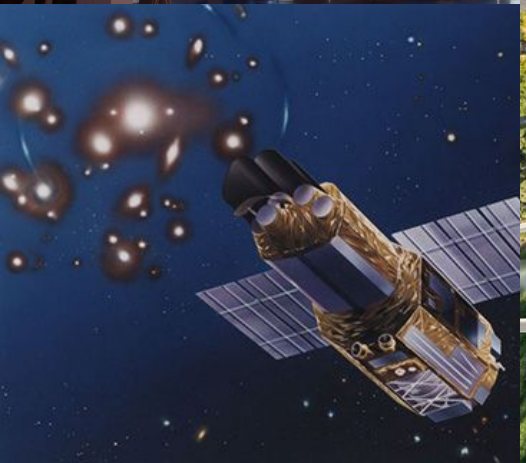

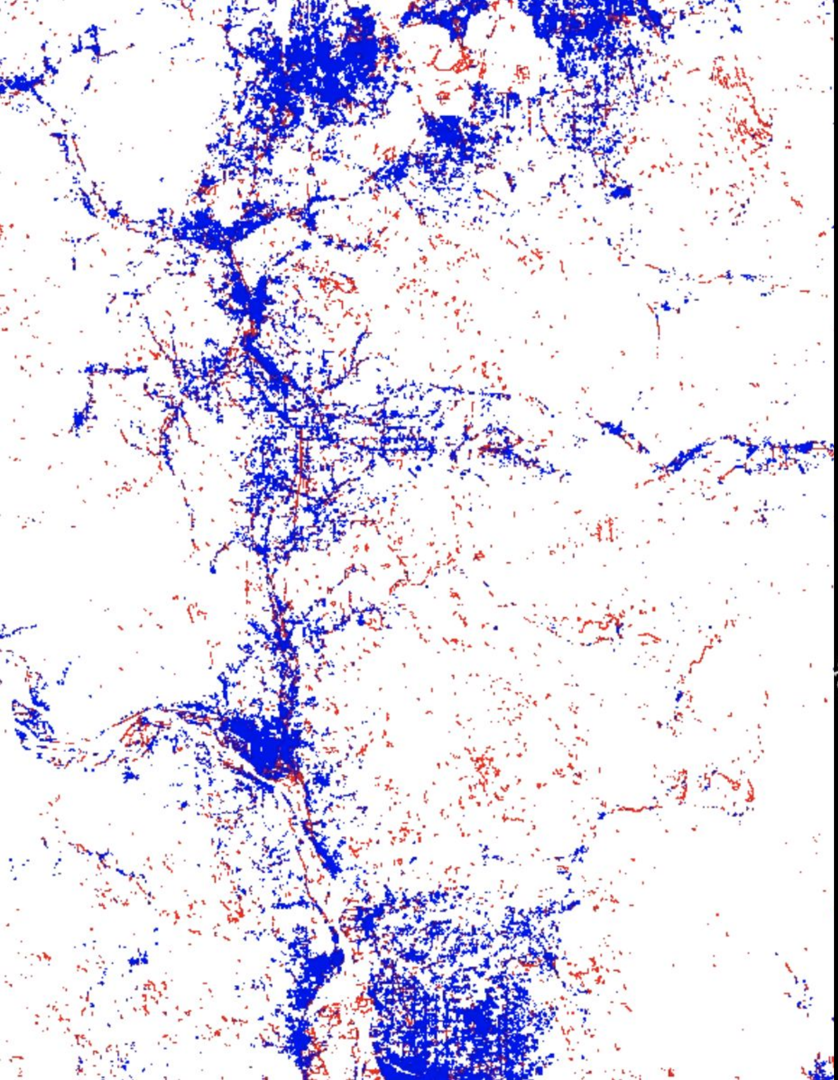

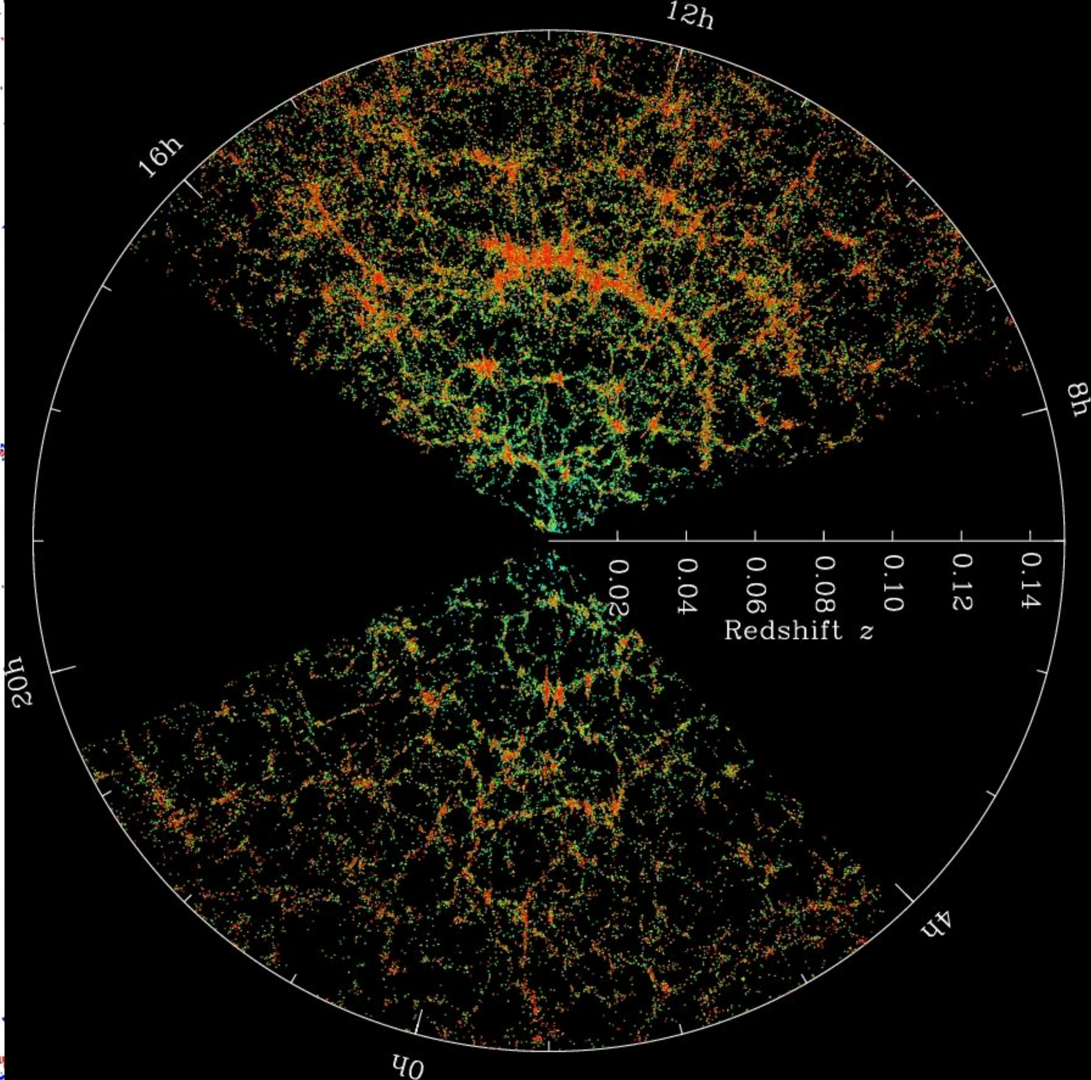
12h
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0.10
0.12
0.14
Redshift z

Thank you

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