Changes in the Building Landscape of Central Christchurch

GeoNet Spider

University of Canterbury

TEAM MEMBERS

Ding Ning

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Computer Science

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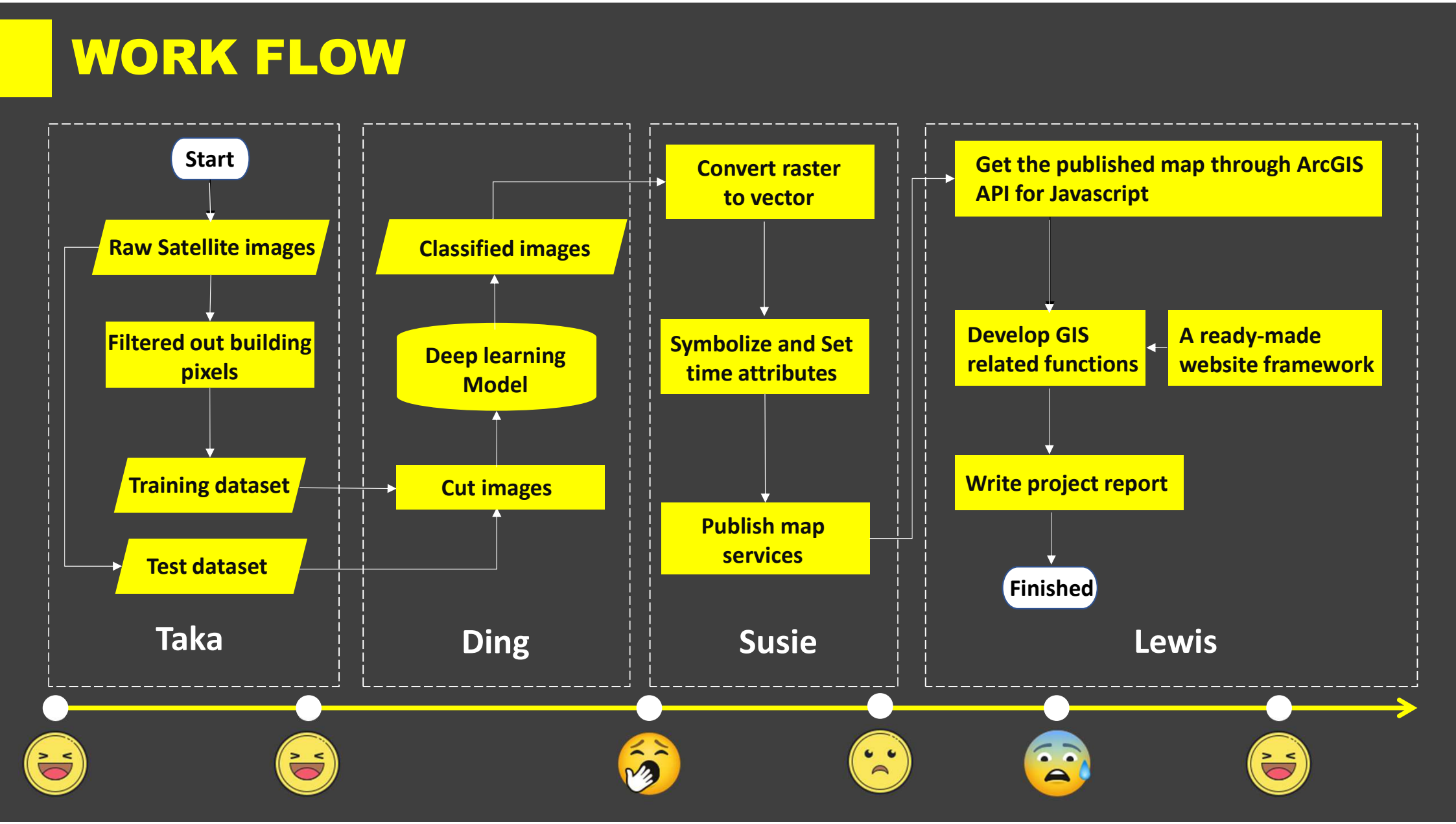
OBJECTIVES

Explore the feasibility of detecting **changes** in buildings in Central Christchurch **over time** from **high-resolution** satellite images using a **deep learning** approach.

Display the changes detected by a convolutional neural network on a **user-friendly** website

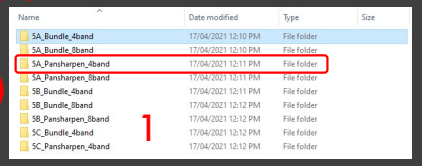
WORK FLOW

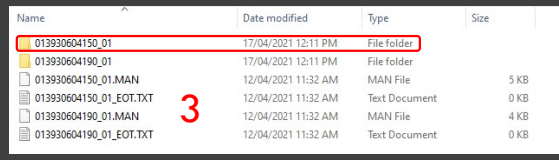

Start
Raw Satellite images
Filtered out building pixels
Training dataset
Test dataset
Taka
Classified images
Deep learning Model
Cut images
Ding
Convert raster to vector
Symbolize and Set time attributes
Publish map services
Susie
Get the published map through ArcGIS API for Javascript
Develop GIS related functions
A ready-made website framework
Write project report
Finished
Lewis

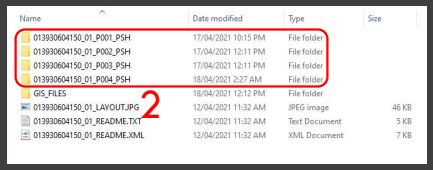
TOPIC AND DATA CHOICE

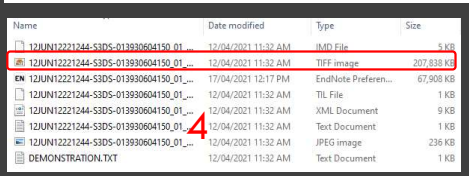
Area of Interest: Christchurch urban city

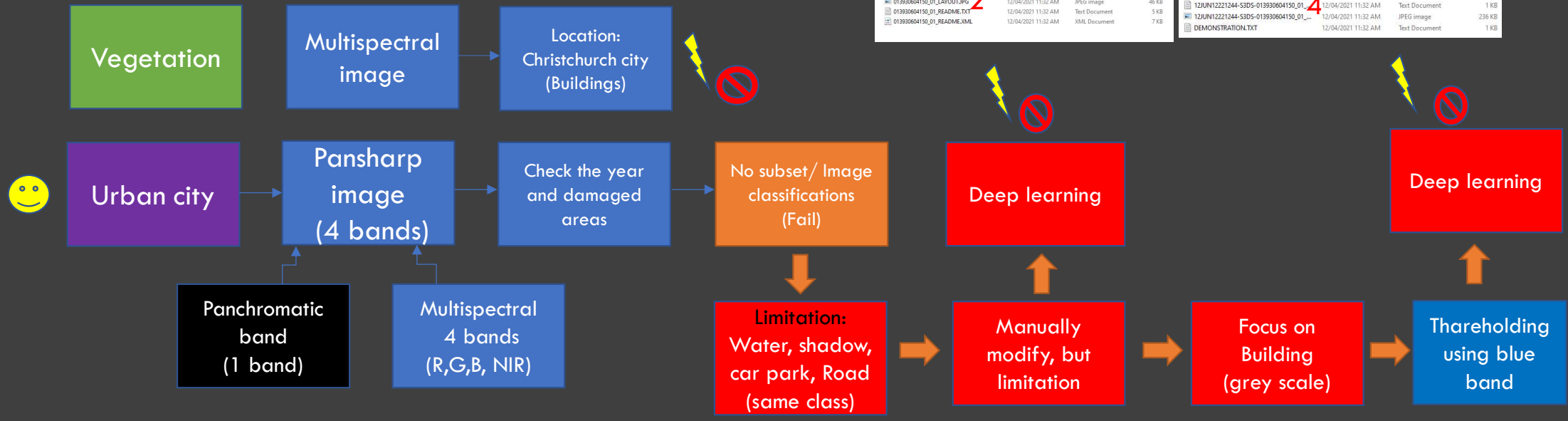
* Before/after the earthquake based on the spatial temporal analysis(Feb 2012, Jun 2012, Oct 2012, May 2013)
* Land cover changes: vegetation analysis or urban building analysis
* Image classification or object detection or sematic segmentation
* Multispectral(low resolution) or phan-sharpening(High resolution)
* 4 bands(channel) or 8 bands(channel)
* 4 geo-tiff files -->Labels: binary class (building or non-building)
* Resolution 6506 x 8025 (big)--> Grey scale(black and white)











Initial class: Green space, residential area, car parks, roads, industrial area, under developing area and water

What is Image classification or object detection or sematic segmentation

Figure: True colour(RGB) and label

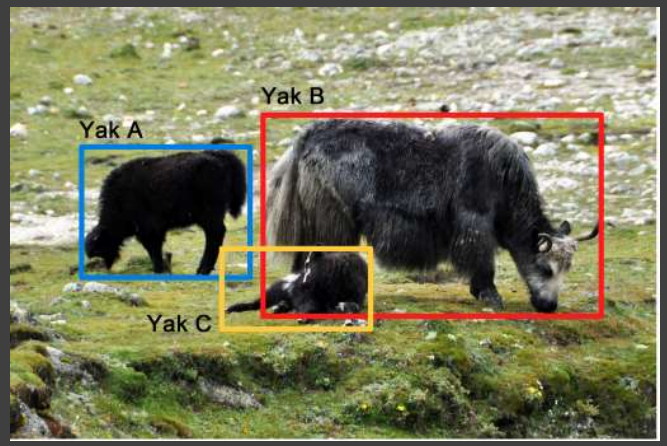


Figure: Object detection

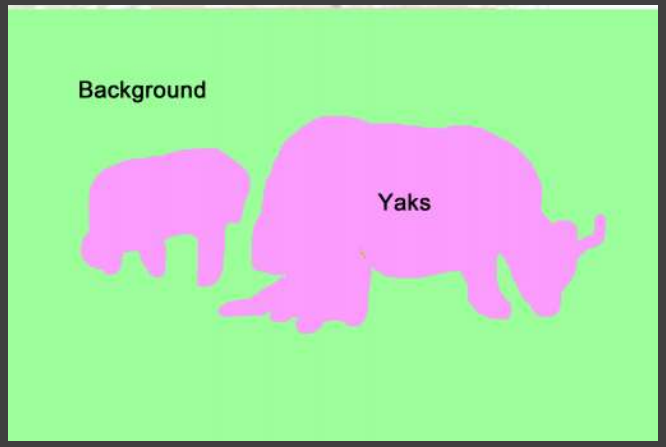


Figure: Sematic segmentation

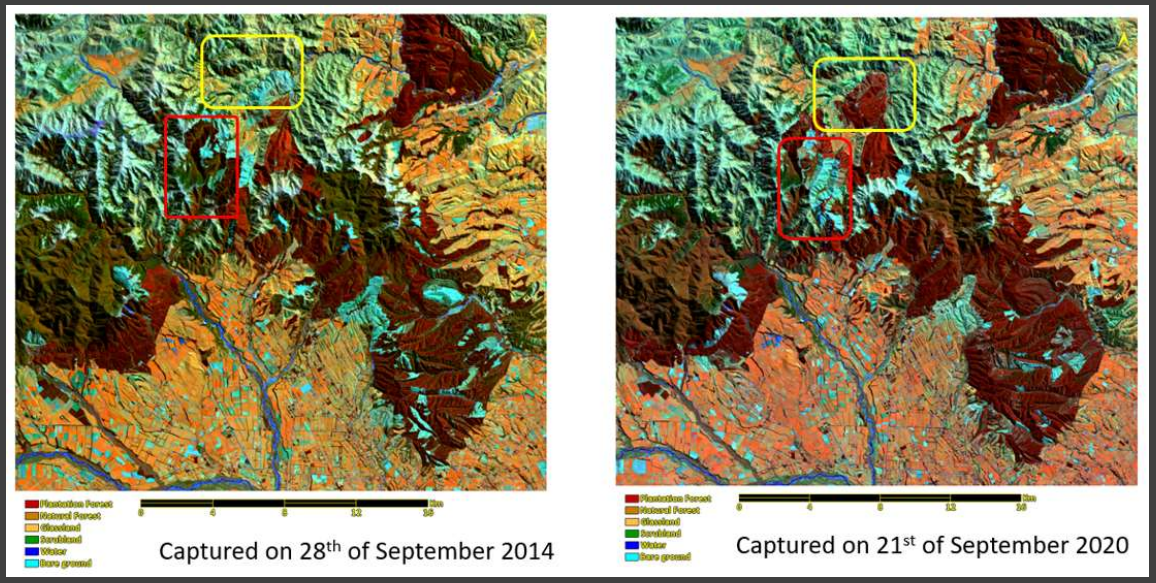


Figure: False colour (Healthy Vegetation) and label

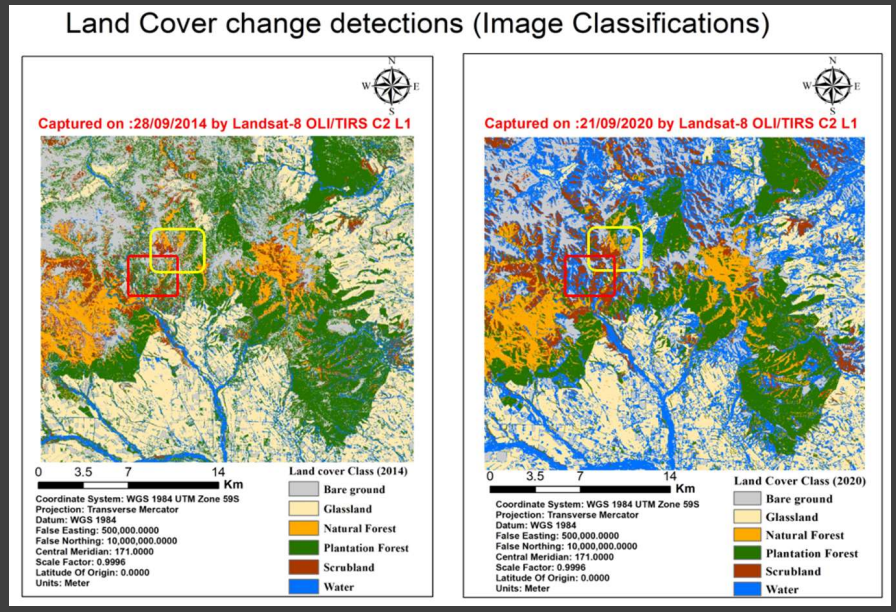
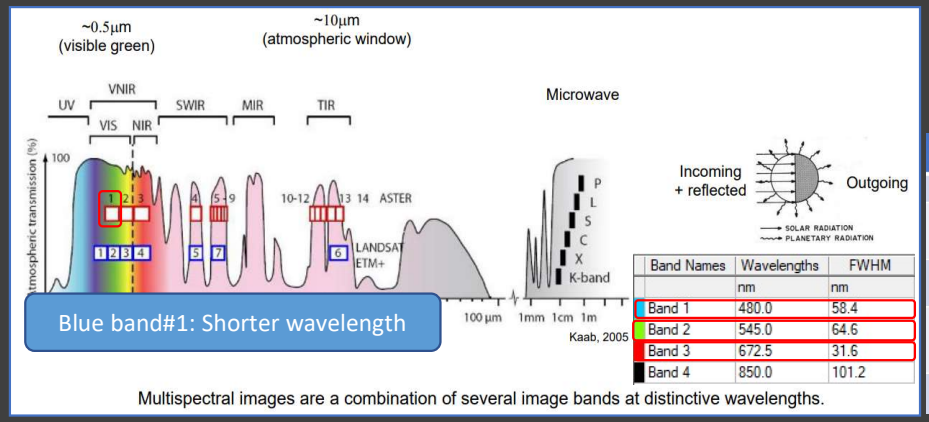


Figure: Image classification (supervised learning)

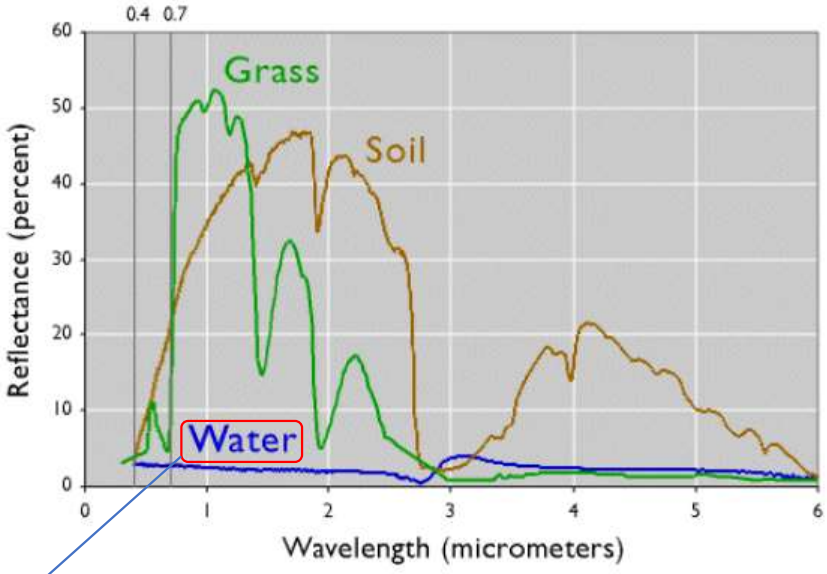
OBJECT DETECTION by Remote sensing



Band Names	Wavelengths	FWHM
	nm	nm
Band 1	480.0	58.4
Band 2	545.0	64.6
Band 3	672.5	31.6
Band 4	850.0	101.2

Multispectral images are a combination of several image bands at distinctive wavelengths.

Criteria	Data specification
Sensor type	GeoEye-1
Spatial temporal	(Feb 2011, Jun 2012, Oct 2012, May 2013)
Spatial resolution	0.5m x 0.5m
Spectral resolution	4 bands (Red, Green, Blue and Near Infra-Red)
Radiometric resolution	16bit



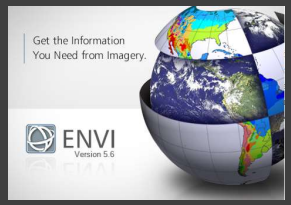
→ 1. select band#1(blue)
→ 2. check lowest pixels values on the building objects
→ 3. choose threshold parameters between 0 to 255
→ 4. manual check to investigate over the building objects that have been covered correctly or not.

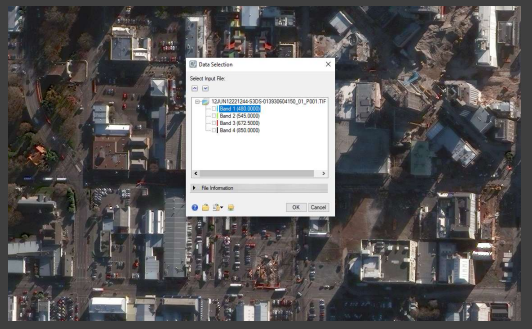
Lower pixel values detect higher object

Sensitive to Higher resolution/Higher radiometric resolution

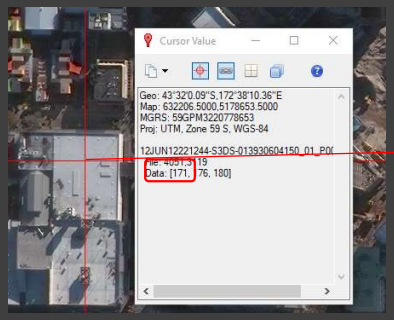
Buildings or Trees

Clean the attribute table by ArcGIS pro

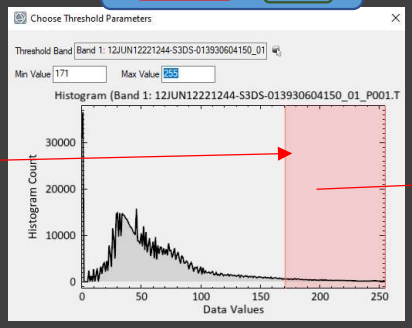




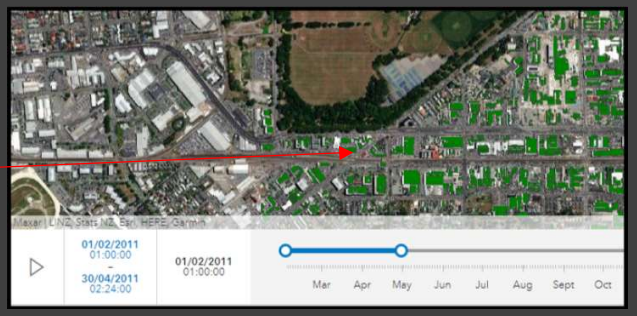
1



2



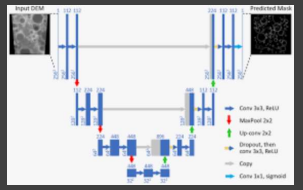
3



4

Computing Environment

- Platform and language: python + colab
- GPU: Tesla P100-PCIE 16GB
- RAM: 25 GB
- Storage: 70 GB approx.
- Framework: PyTorch
- Model Architecture: U-Net



matplotlib
PyTorch
OpenCV
NumPy
scikits learn
pillow

PRE - PROCESSING

- Cut the big image into piles and get 99 piles.
- Drop the edge piles and keep 80 813 x 802 complete piles.
- Resize the piles to 512 x 512.
- Split them into 70% for training and 30% for test.

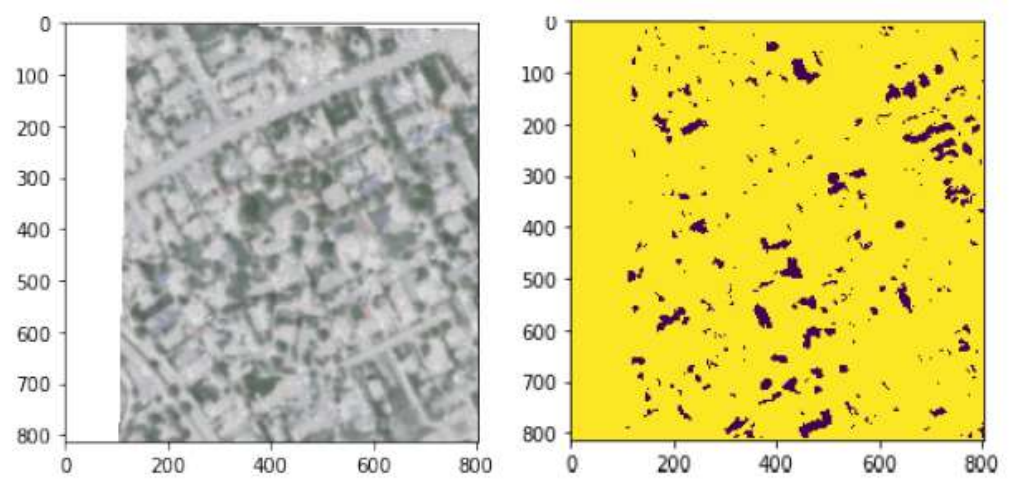


Figure: Image and label

MODEL ARCHITECTURE

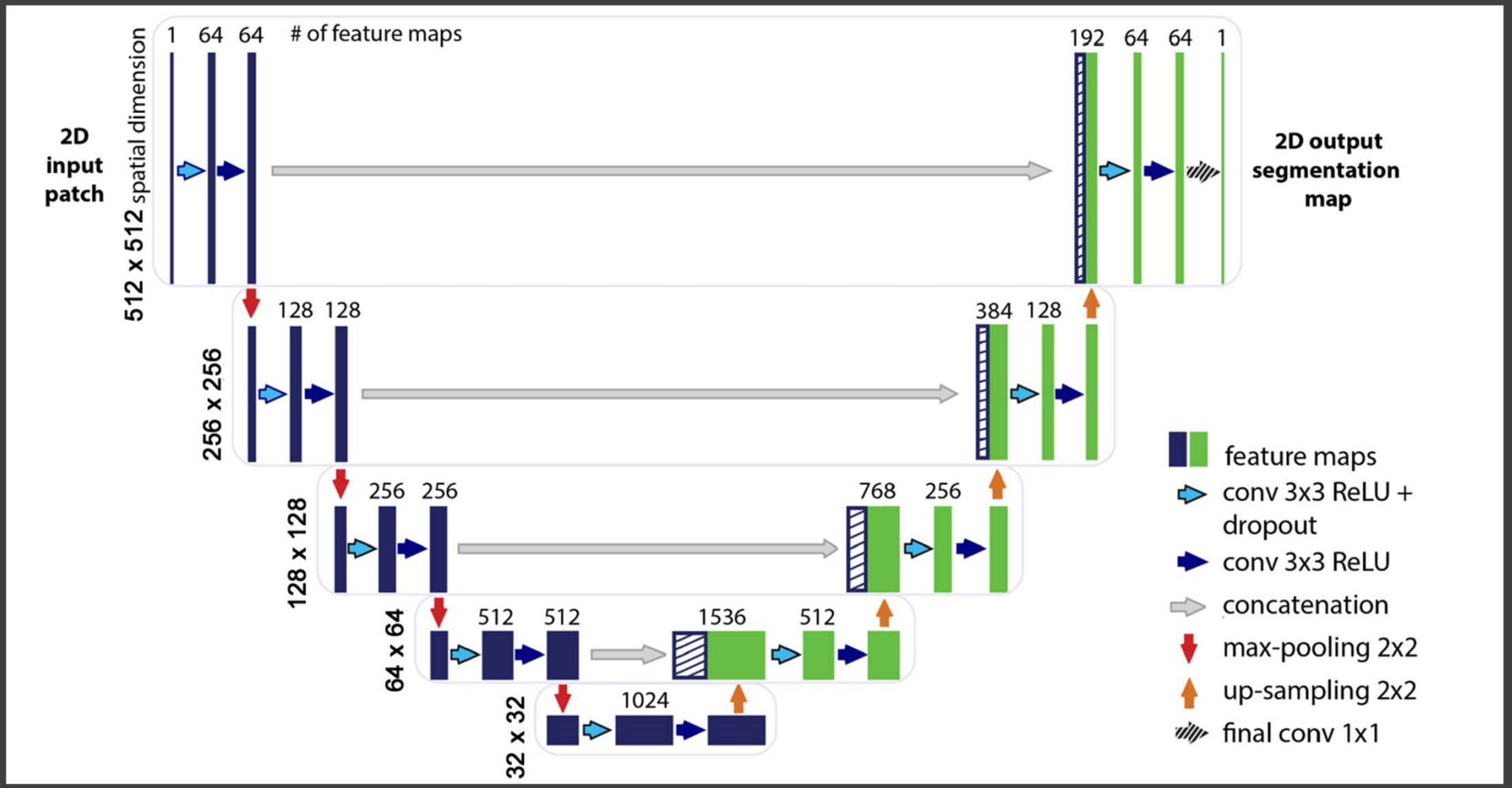
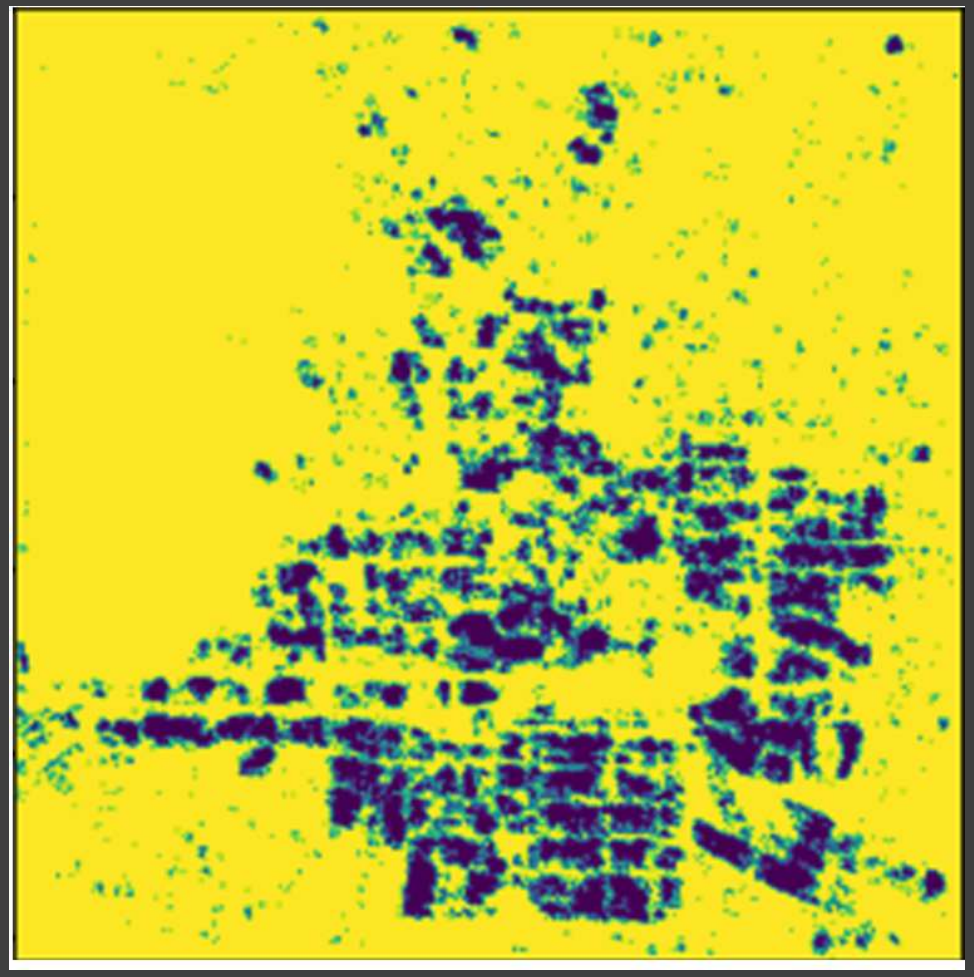


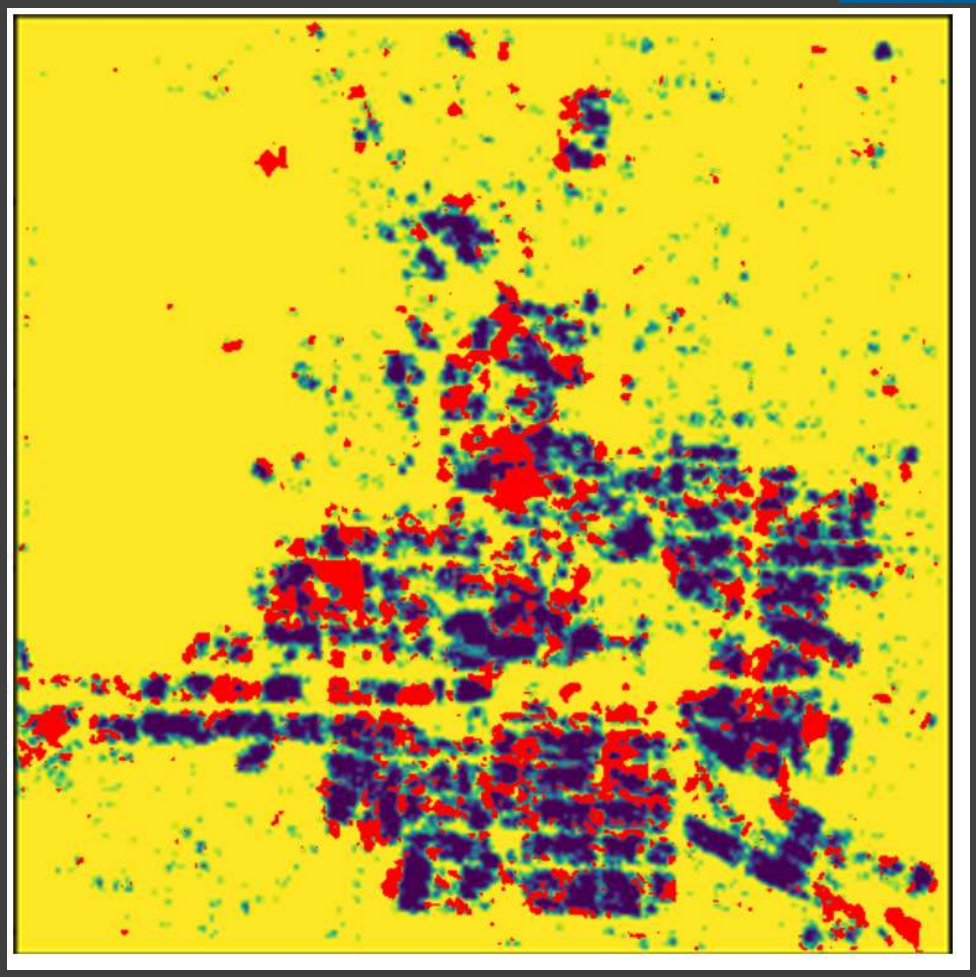
Figure: U-Net 2D, a convolutional autoencoder (CNN-AE)

RESULTS: SEMATIC SEGMENTATION (2012 - 2013)

PNG File with tiff file for georeferencing, using ArcGIS Pro



Buildings in 2012



2012 – 2013 changes

WEB DEVELOPMENT

Angular JS Framework

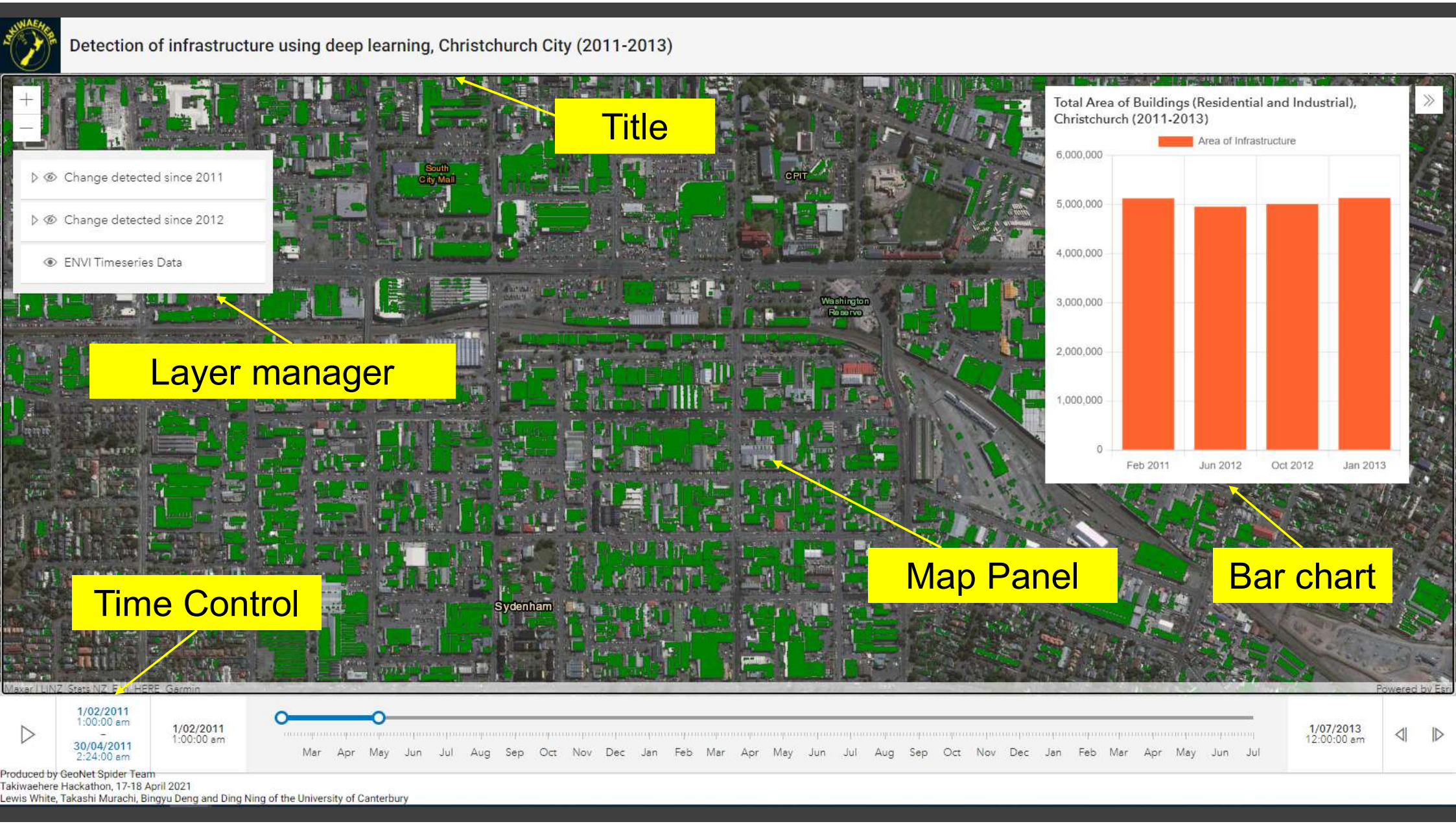
Jetbrains Webstorm IDE

ESRI – ArcGIS API for Javascript with Angular CLI

HIGHLIGHTS

Modular and Quick implementation

Adaptable to changes in project scope


Detection of infrastructure using deep learning, Christchurch City (2011-2013)
Title
Change detected since 2011
Change detected since 2012
ENVI Timeseries Data
Layer manager
Total Area of Buildings (Residential and Industrial), Christchurch (2011-2013)
Area of Infrastructure
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Feb 2011
Jun 2012
Oct 2012
Jan 2013
Map Panel
Bar chart
Time Control
1/02/2011 1:00:00 am
30/04/2011 2:24:00 am
1/02/2011 1:00:00 am
1/07/2013 12:00:00 am
Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
Produced by GeoNet Spider Team
Takiwaehere Hackathon, 17-18 April 2021
Lewis White, Takashi Murachi, Bingyu Deng and Ding Ning of the University of Canterbury


THANK YOU
Q & A