Geospatial Data Analytics Projects undertaken by Ryan Watson Consulting, Melbourne, Australia

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Ryan Watson Consulting Pty Ltd

30 April 2024

Overview of Presentation

- Company profile
- Current importance of geospatial data analytics
- Victorian road accident data analysis project
- Road accident hotspot prediction using machine learning
- Canopy coverage analysis using 2D and 3D data
- Whitehorse City Council Project
- Conclusions

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Company Profile - Ryan Watson Consulting Pty Ltd

- Established in October 2020
- Based in eastern suburbs of Melbourne
- Built on research with Swinburne University in:
  - Internet of Things
  - Big Data
  - Smart Cities

- Open to collaboration with other universities

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Current Importance of Geospatial Data Analytics

- Using geospatial technologies to gather location information provides us with data that can give a deeper understanding of many issues. This spatial data can answer questions, help with predictions, analysis and decision making
- Spatial data can be combined with other data from various sources - weather data, census data, satellite imagery, aerial photography, social media data, etc
- Geospatial data can be used in a wide variety of different industries – urban planning, transportation, natural disasters, health care, agriculture, and many more

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Victorian Road Accident Data Analysis Project

- Victorian road accidents and fatalities datasets analysed using python spatial libraries
- Various statistical tests employed to establish spatial autocorrelation and distribution of road accidents
- Geospatial factors contributing to road accidents such as land use, built infrastructure, road characteristics and population density found from open datasets and their connection to road accidents established
- Street view images of road accident sites analysed and included in a machine learning model of road accident hotspots

Reference: Geospatial Factors Applied to Road Accidents: A Review

Journal of Advances in Information Technology, **15**, 3, March 2024

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Victorian Road Accident Data Analysis Project

- Data sources
  - Federal, state, local open geospatial data for Australia
  - Open Street Map, Google Earth for World
- Geospatial Analysis
  - Vector, raster and point cloud data
  - Spatial join, coordinate projection, etc
- Geospatial statistics
  - Kriging, Moran I, Kernel Density Estimation, Getis-Ord, Geographically Weighted Regression, etc
- Machine Learning
  - sklearn, keras, SHAP, etc
- Visualization
  - Maps, Choropleths, heatmaps, etc

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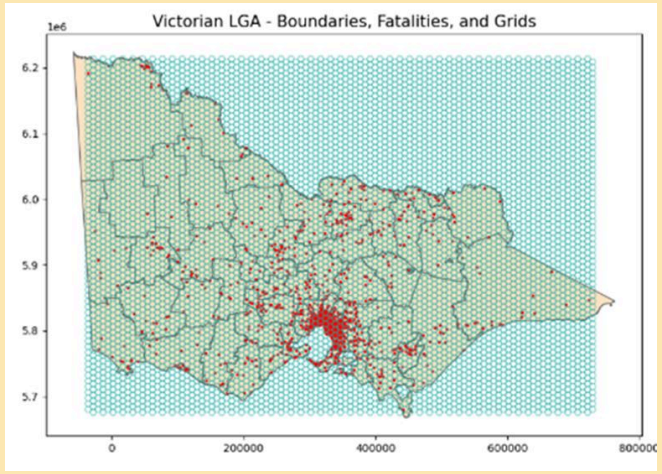
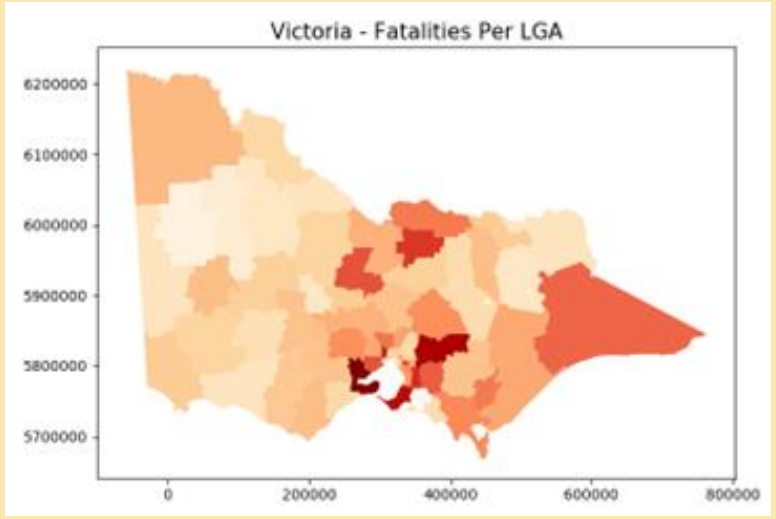
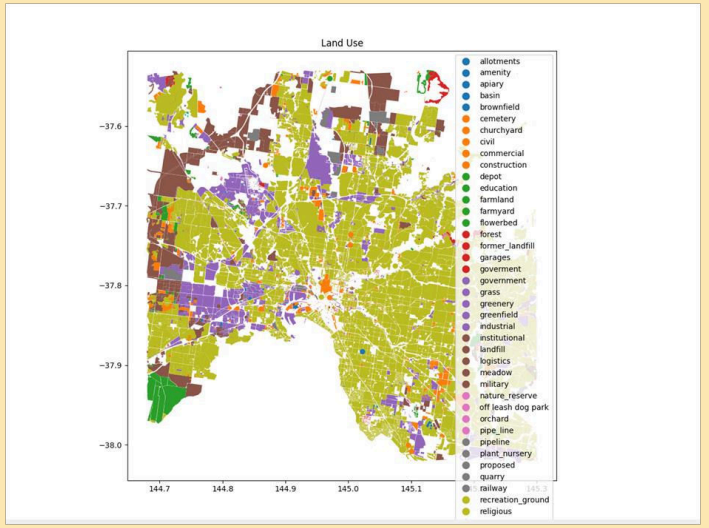
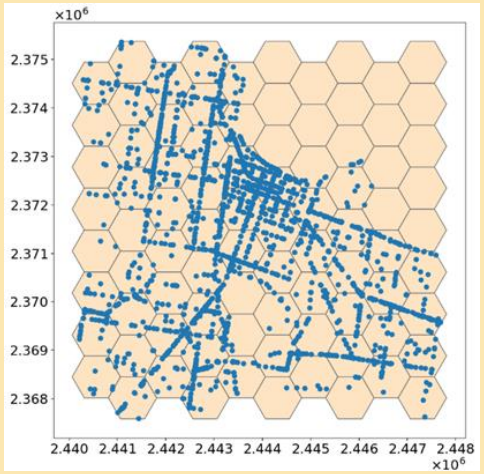
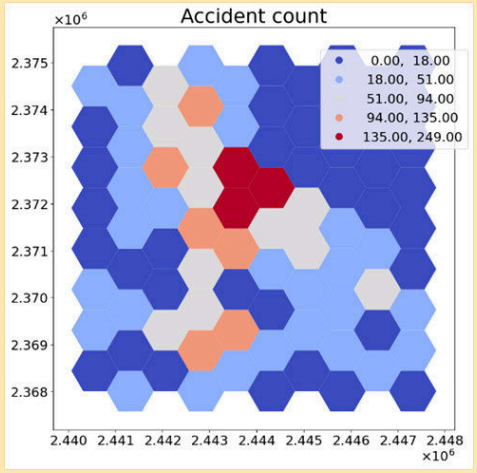
Victorian Road Accident Data Analysis Project











Some examples of data visualization from this project

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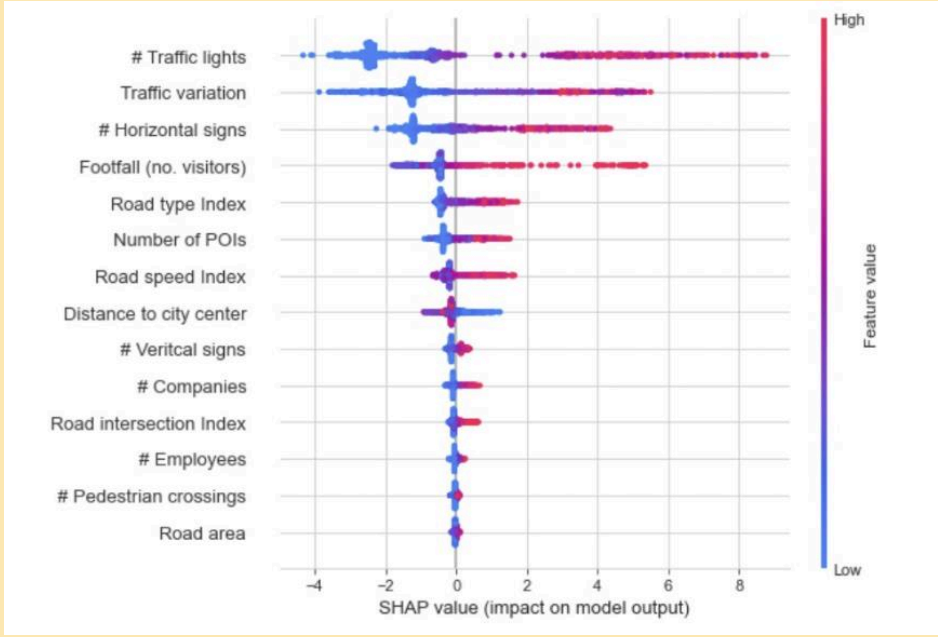
Road Accident Hotspot Prediction using Machine Learning

- It is important to understand the contributing factors of road accidents and their impacts in order to design safer roads
- Contributing factors can be categorised based on different characteristics such as road, vehicle, human, speed limit, and others
- Machine learning models use accident and geospatial environmental data to predict hotspots
- Model predictions need to be explained by techniques such as Shapley Additive Explanations (SHAP)



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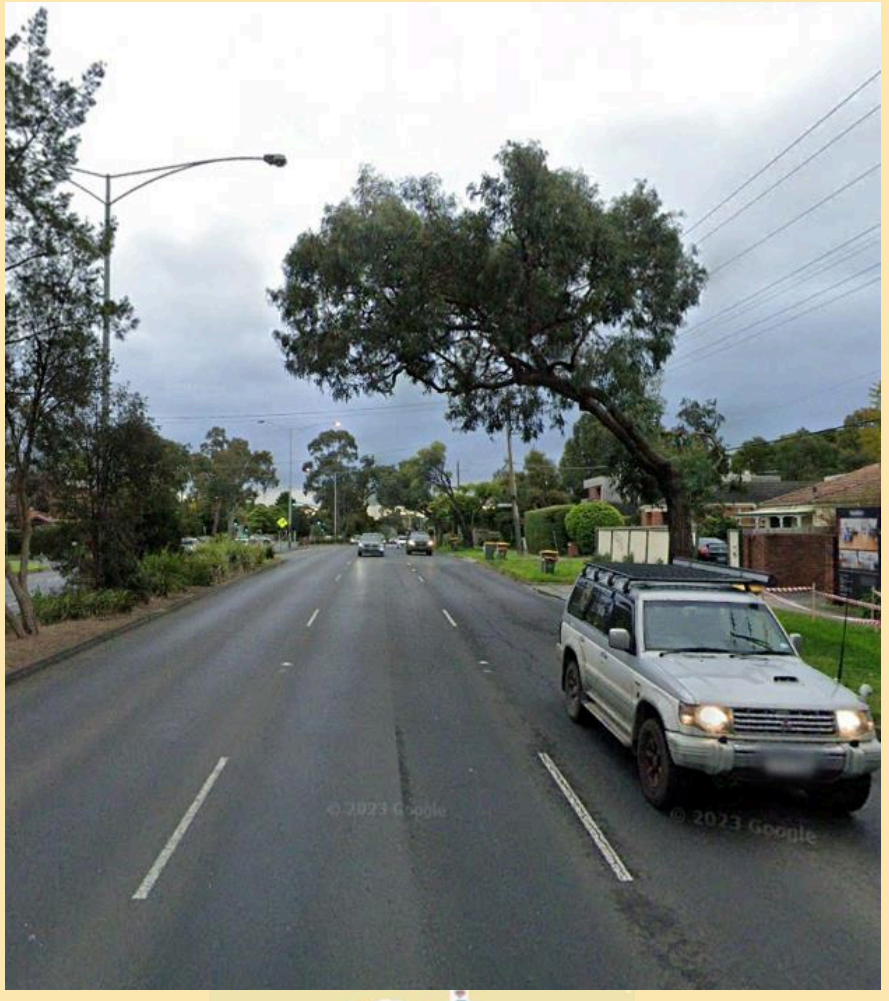
Environment and Road Accidents

- A road can also be defined in the form of its environment features such as presence of trees, open space, buildings, etc
- Identifying association between environmental factors and road crashes can be crucial for making roads safe
- Deep learning can be used to extract environmental features from street view images and feed these features along with other contributing features that lead to road accidents



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Environmental Features

- Street environmental features can be extracted using Semantic Image Segmentation such as PSPNet – A very popular architecture
- Segments in these images are obtained using Detectron2 – A system developed by Facebook AI Research which implements state-of-the-art object detection algorithms
- Segment information can be used for machine learning algorithms and feed these features

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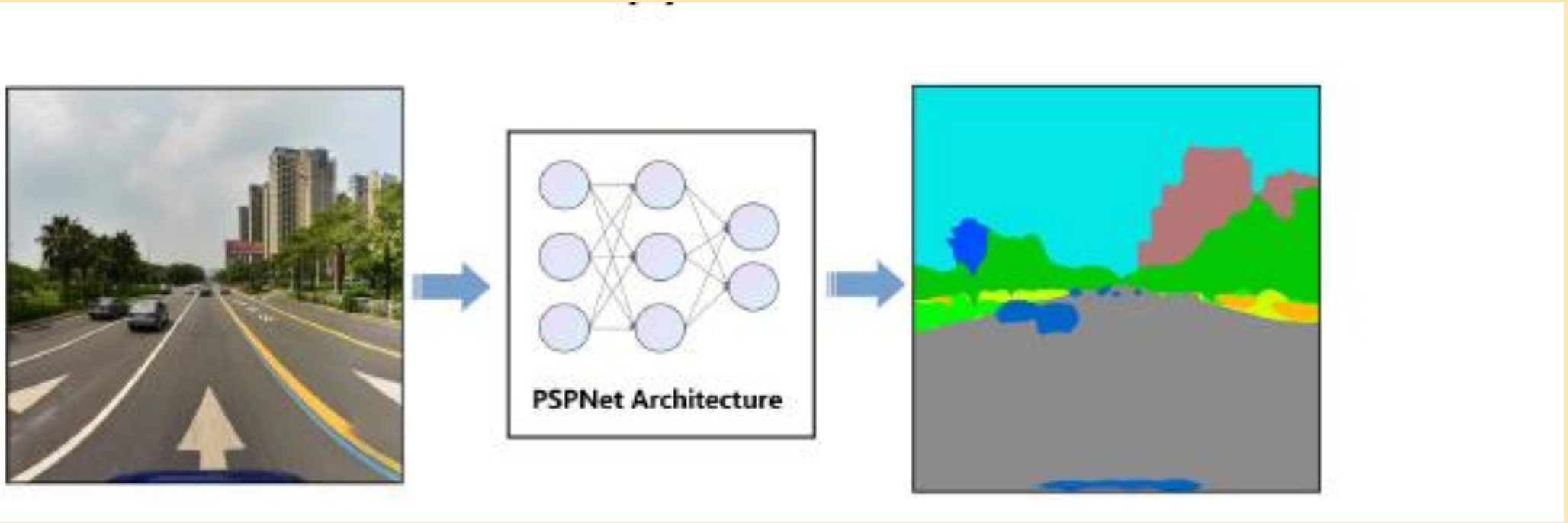
Feature Extraction



From: Uncovering the association between traffic crashes and street-level built-environment features using street view images, Sheng Hu et al, https://doi.org/10.1080/13658816.2023.2254362

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Feature Extraction

- Instance is the desired environmental feature
- Area is the number of pixels for each instance in that image

Image Name	Instance	Area
0016E5_05460.png	traffic light	0
0016E5_05460.png	car	0
0016E5_05460.png	person	0
0016E5_05460.png	road	63828
0016E5_05460.png	tree	7441
0016E5_05460.png	sky	18902
0016E5_05460.png	building	63200
0016E5_06570.png	car	0
0016E5_06570.png	road	50617
0016E5_06570.png	sky	14952
0016E5_06570.png	pavement	4865
0016E5_06570.png	building	82717

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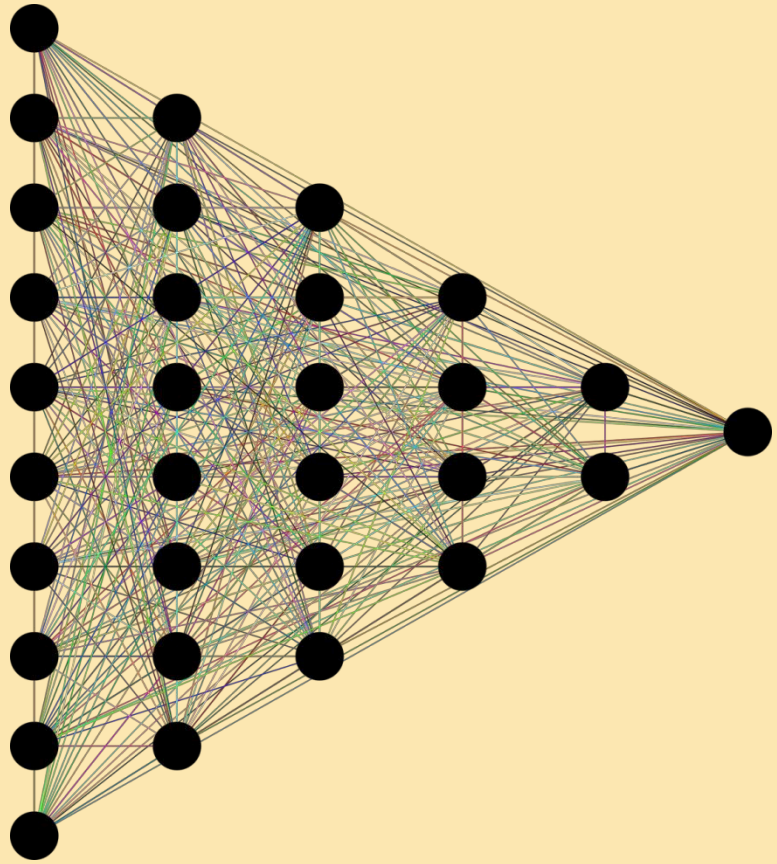
What Next?

Develop a small model to identify the relevance of environmental features in road crashes using Deep Neural Network



Limitations:

- Street View Images
- Relevance of captured Images
- Redesigned roads and developed areas

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Canopy coverage analysis using 2D and 3D data

- Local Councils are trying to increase tree canopy coverage to reduce urban heat islands
- 2D (RGB imagery) and 3D (lidar point cloud and stereo vision) data is being collected by remote sensing to monitor changes in canopy coverage over time
- Lidar point cloud data is obtained from 3D scanners that project light at objects and interpret the scattered ray
- It can be analysed to categorise objects using deep learning.
- Our Interns have been outplaced to Whitehorse City Council GIS Team to analyse RGB imagery and lidar datasets

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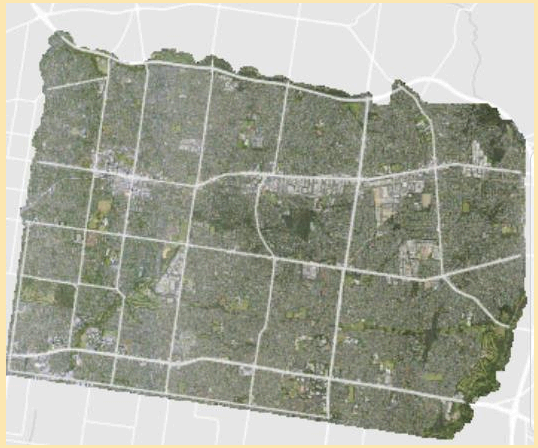
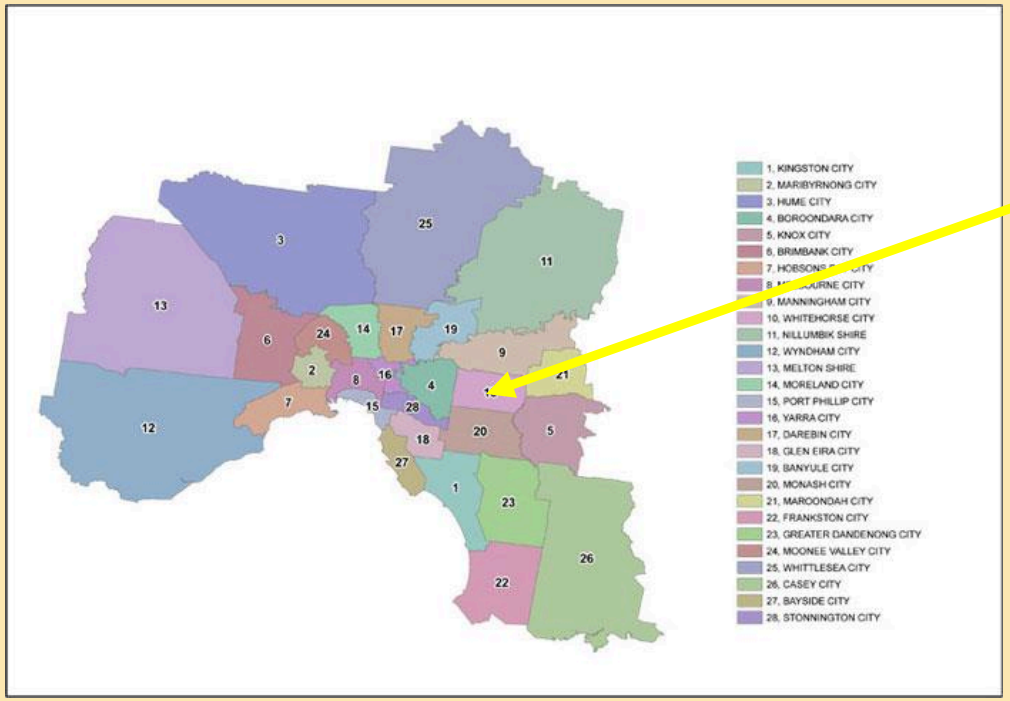
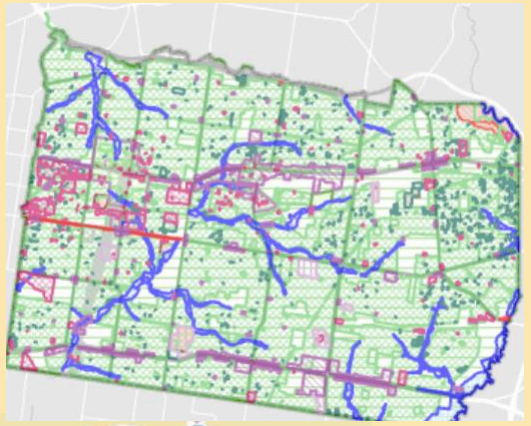
Whitehorse City Council Project

- Tree canopy cover
- Whitehorse - Local Government Area in Victoria
- Cooling and Greening Melbourne







https://map.whitehorse.vic.gov.au/index.html

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Background to Study

- Cooling and Greening Melbourne (2019)
  - https://www.planning.vic.gov.au/guides-and-resources/strategies-and-initiatives/plan-melbourne/cooling-and-greening-melbourne
- DELWP, RMIT University, CSIRO, Clean Air and Urban Landscapes Hub
  - supported by Melbourne Water
- CSIRO's Urban Monitor - create first high resolution map that records baseline of urban vegetation across Melbourne, mapping imagery in 2014 and 2018

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WCC Targets

- Cooling and Greening reported that canopy cover across Whitehorse was measured at 18%
- This represents a 2.3% canopy cover decrease from 2014
- Urban Forest Strategy Targets
  - Increase tree canopy to 27% by 2031
  - Increase tree canopy cover to 30% by 2050

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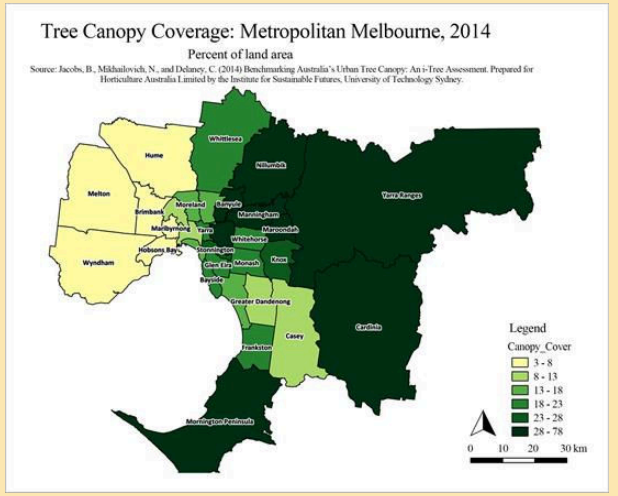
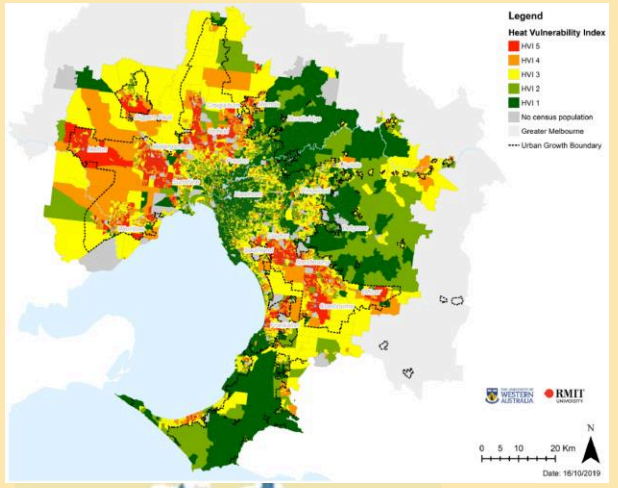
Project Deliverables

- Benchmarking tree cover change, urban heat and heat vulnerability
  - 2014 and 2018 tree cover
  - 2014 → 2018 tree cover change
  - 2018 urban heat
  - 2018 heat vulnerability index





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WCC Dataset

- LIDAR data from 2018
- Aerial Imagery
- 52.8 GB
- .las file format – 3D point cloud
- Over 100 .las files to cover WCC
  - Each >350MB

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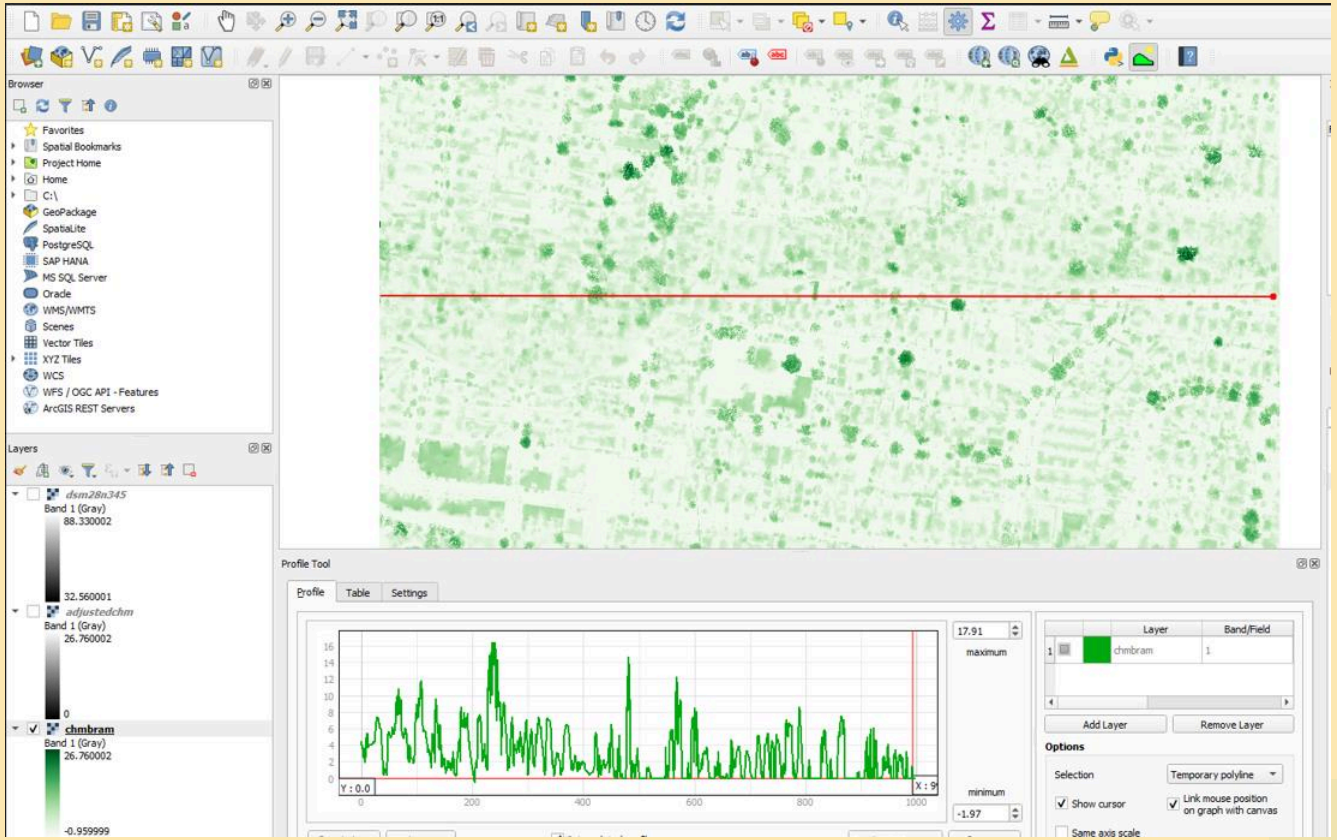
Analysis Techniques

- QGIS: open source, many plugins – eg LAS tools, Qgis2threejs
- Python libraries: *detectron2, detectree*



https://qgis.org

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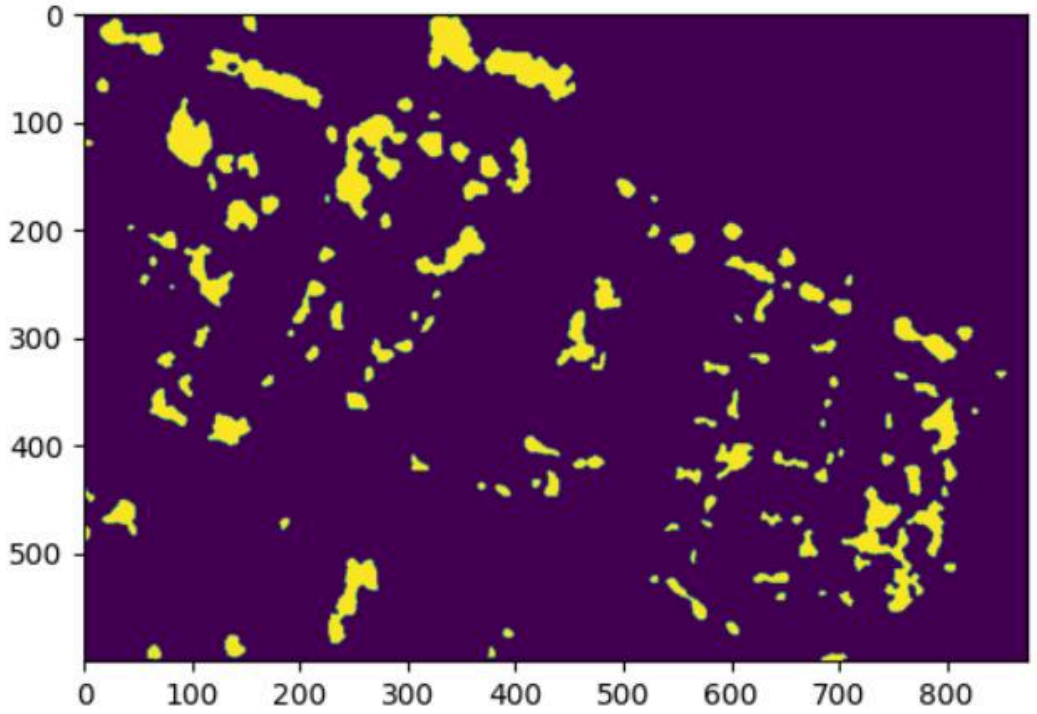
Python *detectree*



Bosch M. 2020. "DetecTree: Tree detection from aerial imagery in Python". *Journal of Open Source Software, 5(50), 2172.* doi.org/10.21105/joss.02172

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DEM, DTM, CHM for Canopy Cover

- **DSM: Digital Surface Model**
- **DTM: Digital Terrain Model**

- **CHM: Canopy Height Model**
  - **CHM = DSM - DTM**

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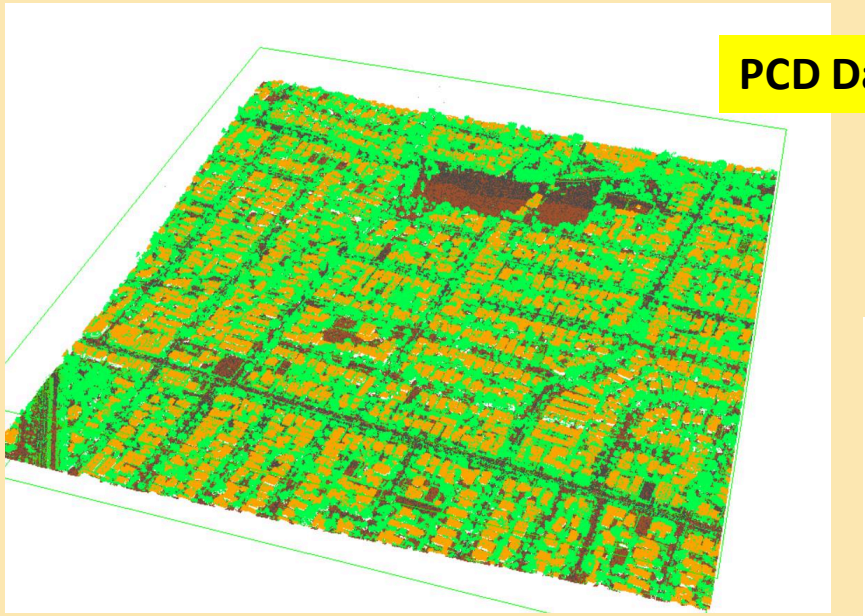
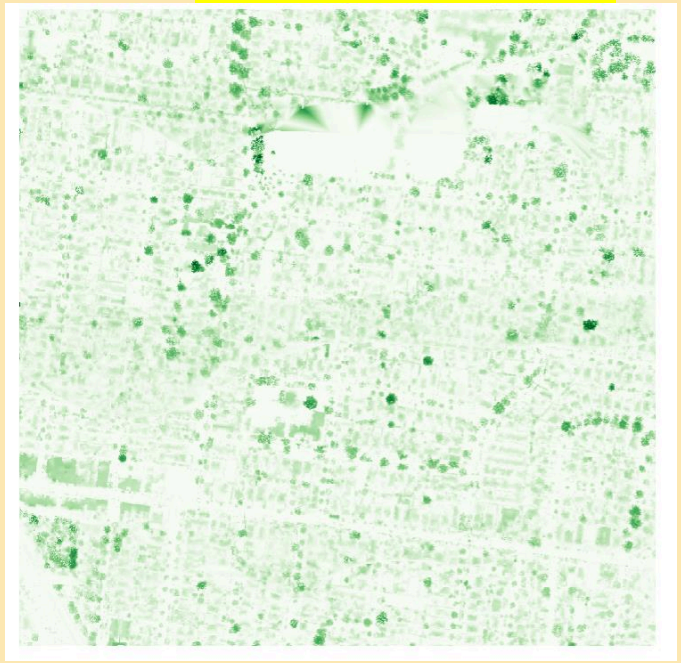
Canopy Height Analysis (QGIS)

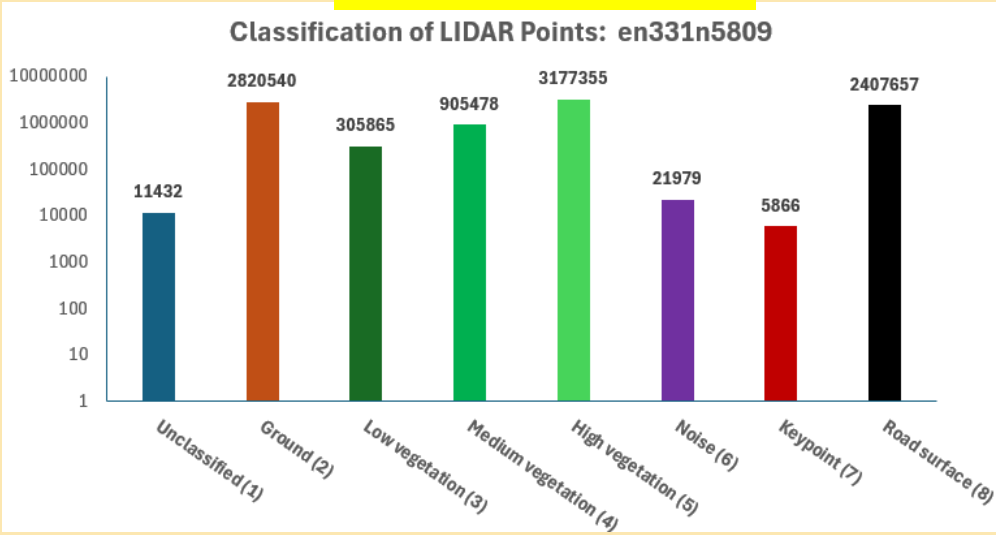


PCD Data from .LAS file

Canopy Height Model from LIDAR



Point Classification



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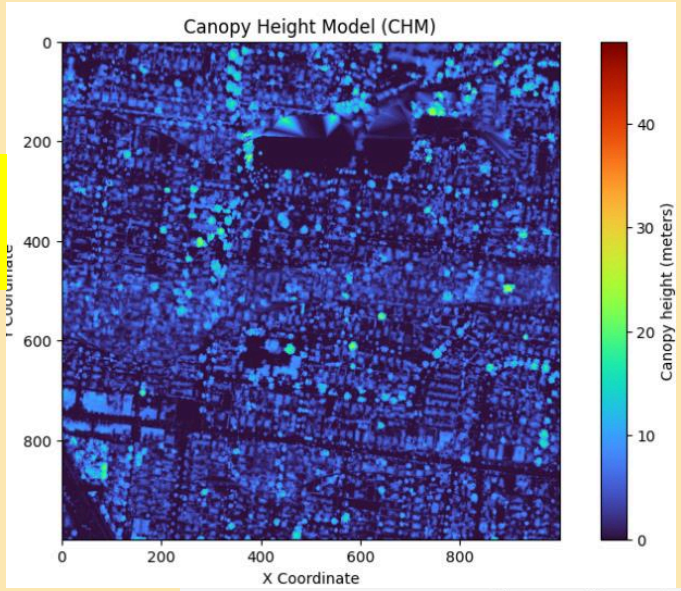
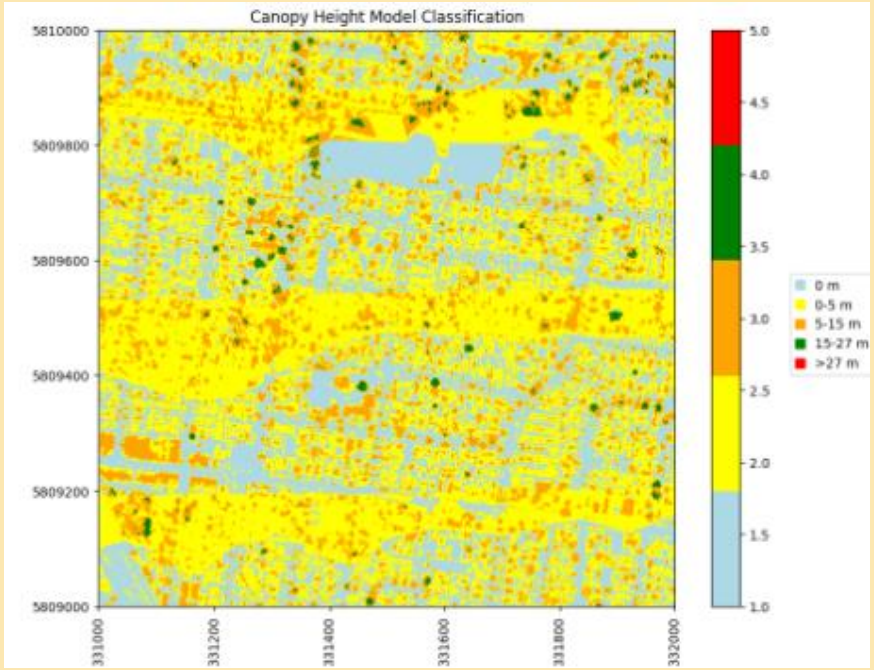
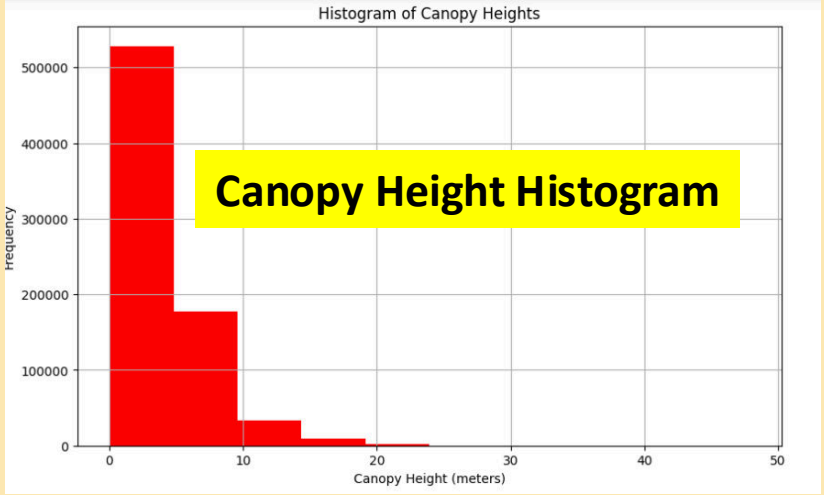
Canopy Height Analysis (Python)

Canopy Height Model



Canopy Height Model Classification





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Summary and Conclusions

- RWC registered in 2020 in Melbourne, Australia
- Focus on research into IoT, Smart Cities, Big Data – presented in conferences and journal papers
- Actively engaged in GIS projects
  - Road accident analysis and hotspot determination
  - Canopy cover to Victorian Local Government Area
- Collaboration with Swinburne University
- Open to collaboration with other universities

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Questions?

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