



3D HOUSES

TO MODEL A HOUSE IN 3D WITH
ONLY A HOME ADDRESS

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Mission & Objectives

Mission:

Consolidate the knowledge in Python, specifically in :

- NumPy
- Pandas
- Matplotlib

Objectives:

- to be able to search and implement new libraries
- to be able to read and use shapefiles
- to be able to read and use geoTIFFs
- to be able to render a 3D plot
- to be able to present a final product

3D HOUSES



Requirements

We are LIDAR PLANES , active in the Geospatial industry. We would like to use our data to launch a new branch in the insurance business. So, we need you to build a solution with our data to model a house in 3D with only a home address.

Must-have features

- 3D lookup of houses.

Nice-to-have features

- Optimize your solution to have the result as fast as possible.
- Features like the living area of the house in m², how many floors, if there is a pool, the vegetation in the neighbourhood, etc...
- Better visualization

Process flow

Research

Background info
Glossary
3D plot libraries

Data Collecting

DTM/DSM
Addresses csv

Data Cleaning

Pandas

Data Processing

geopy
Folium
Rasterio
pyproj
Rioarray

Data Visualisation

Matplotlib & numpy
Mayavi

Research

- Research and understand the term, concept and requirement of the project.
- Discover new libraries that can be used to render a 3D plot
 - glob - to search all file with the same extension
 - geopy - convert physical addresses to Geographic locations
 - folium - plot address on a map
 - rasterio - read and write GEOTIFF format file
 - pyproj - performs cartographic transformations and geodetic computations
 - rioarray - rasterio xarray extension (xarray - working with labelled multi-dimensional arrays)
 - imageio - interface to read and write a wide range of image data
 - matplotlib (mpl_toolkits.mplot3d Axes3D) - plot 3D objects on a 2D matplotlib figure
 - Mayavi - provide easy and interactive visualization of 3D data

Data Collecting

- DTM file for Flandre including Brussels: http://bit.ly/DTM_Flandre
- DSM file for Flandre including Brussels: http://bit.ly/DSM_Flandre
- DTM file for Wallonie: http://bit.ly/DTM_Walloine_2013-2014
- DSM file for Wallonie: http://bit.ly/DSM_Wallonie_2013-2014
- BeST: Geographical coordinates with addresses in Belgium:
 - <https://opendata.bosa.be/index.fr.html>
 - CSV Flandres - <https://opendata.bosa.be/download/best/openaddress-bevlg.zip>
 - CSV Région de Bruxelles - <https://opendata.bosa.be/download/best/openaddress-bebru.zip>
 - CSV Wallonie - <https://opendata.bosa.be/download/best/openaddress-bewal.zip>

Data Cleaning

- Create belgium houses addresses with coordinate from opendata.bosa.be website

df_flandre df_bru df_wal
2823783 rows × 20 columns 221443 rows × 20 columns 1488530 rows × 20 columns

df_address

Address	EPSG:31370_x	EPSG:31370_y	EPSG:4326_lat	EPSG:4326_lon	region_code
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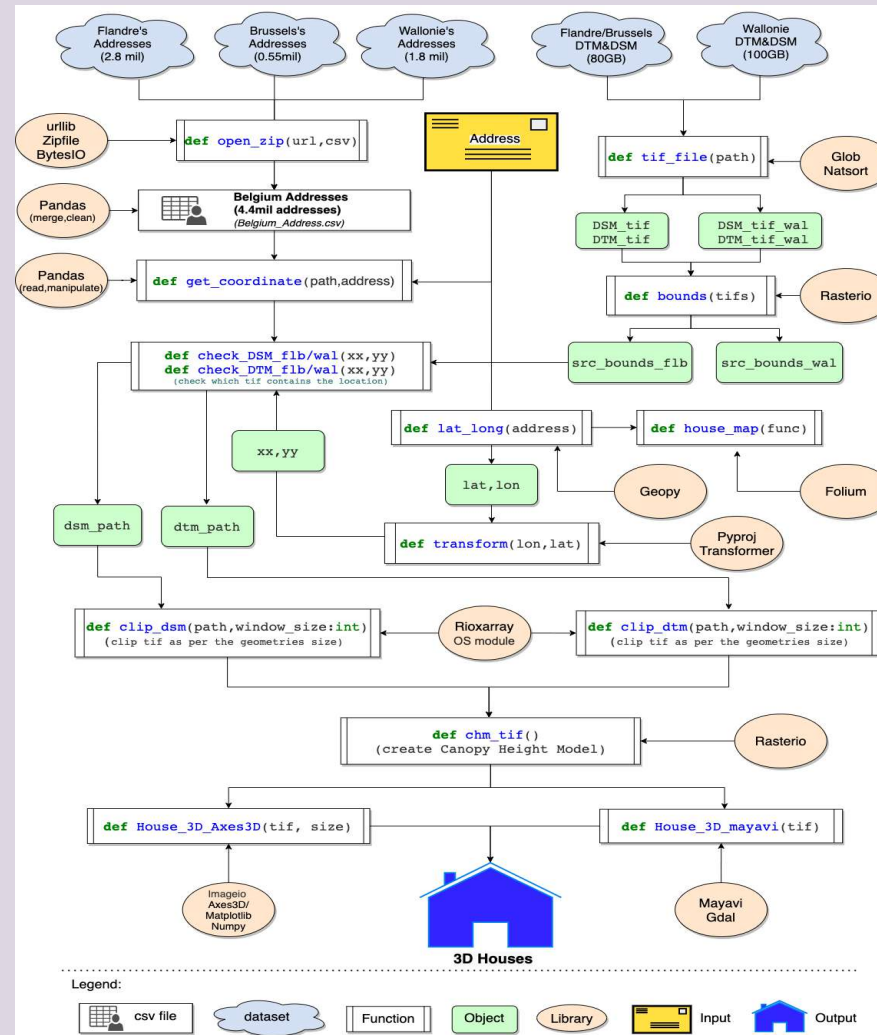
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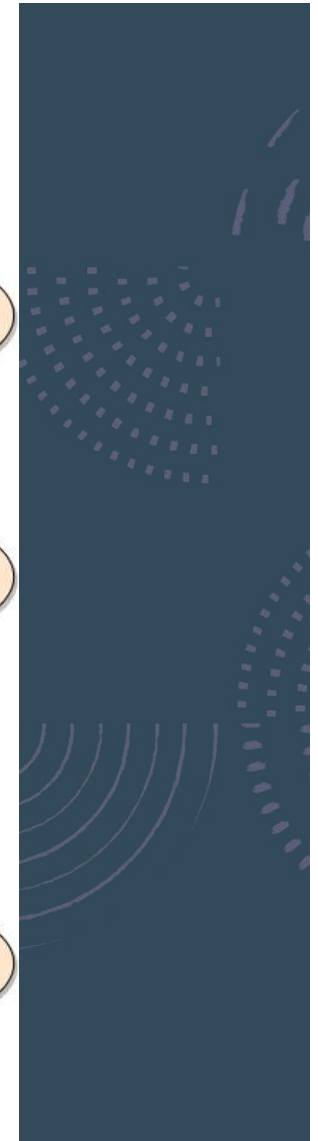
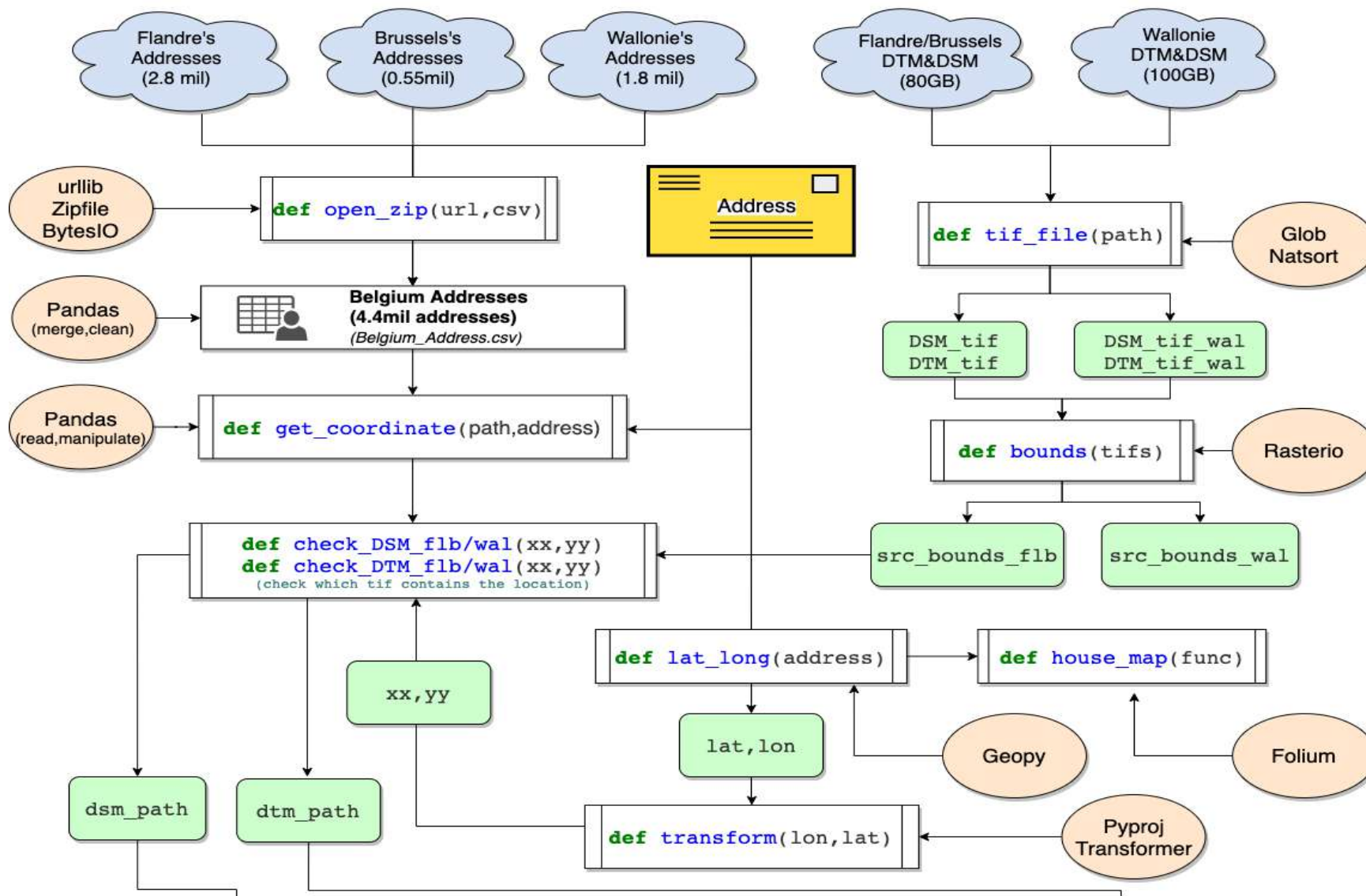
Result : http://bit.ly/Belgium_Addresses

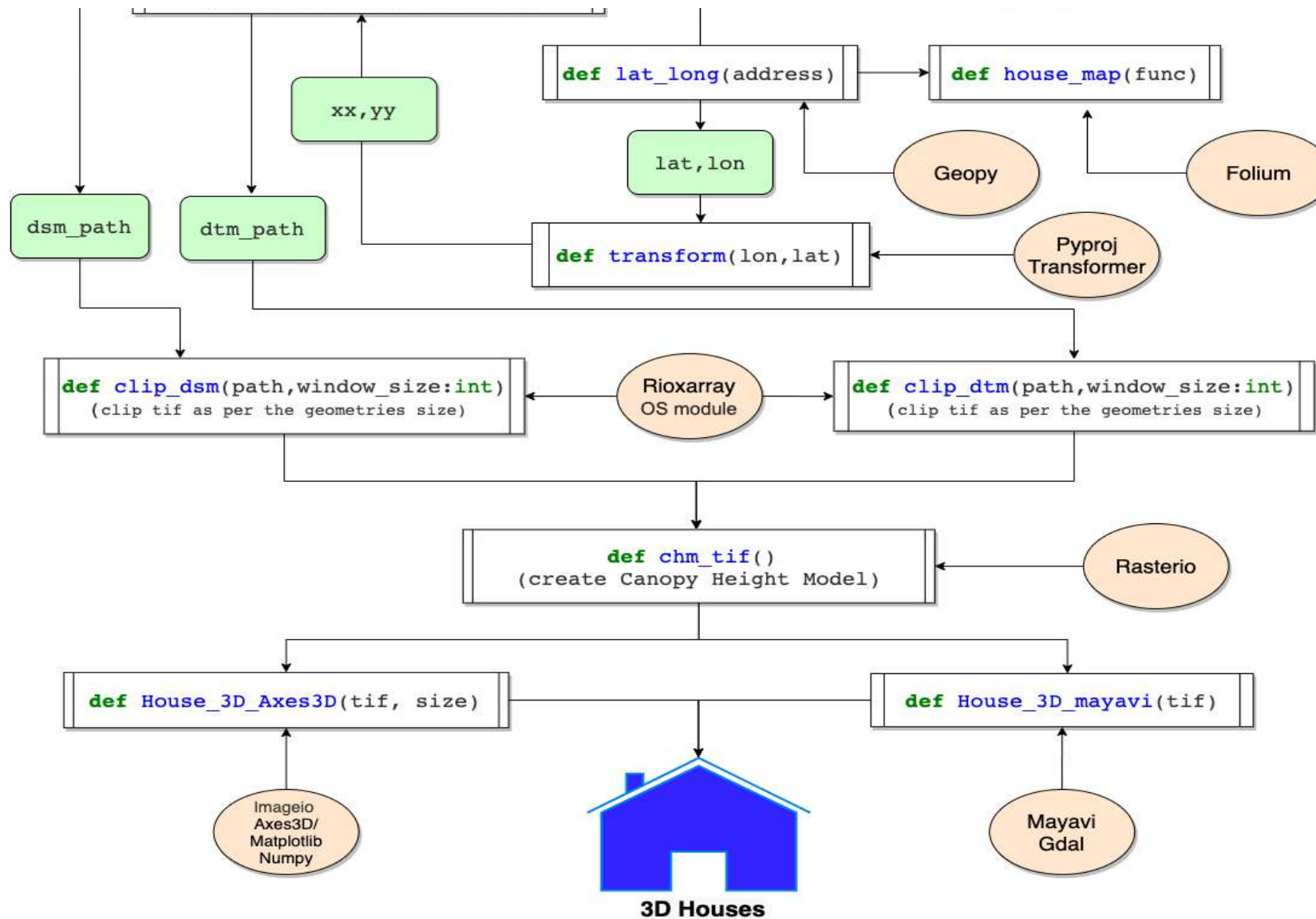
https://github.com/kaiyungtan/3D_houses/blob/main/2.Addresses/Belgium_Address_17.10.2020.ipynb

Diagram

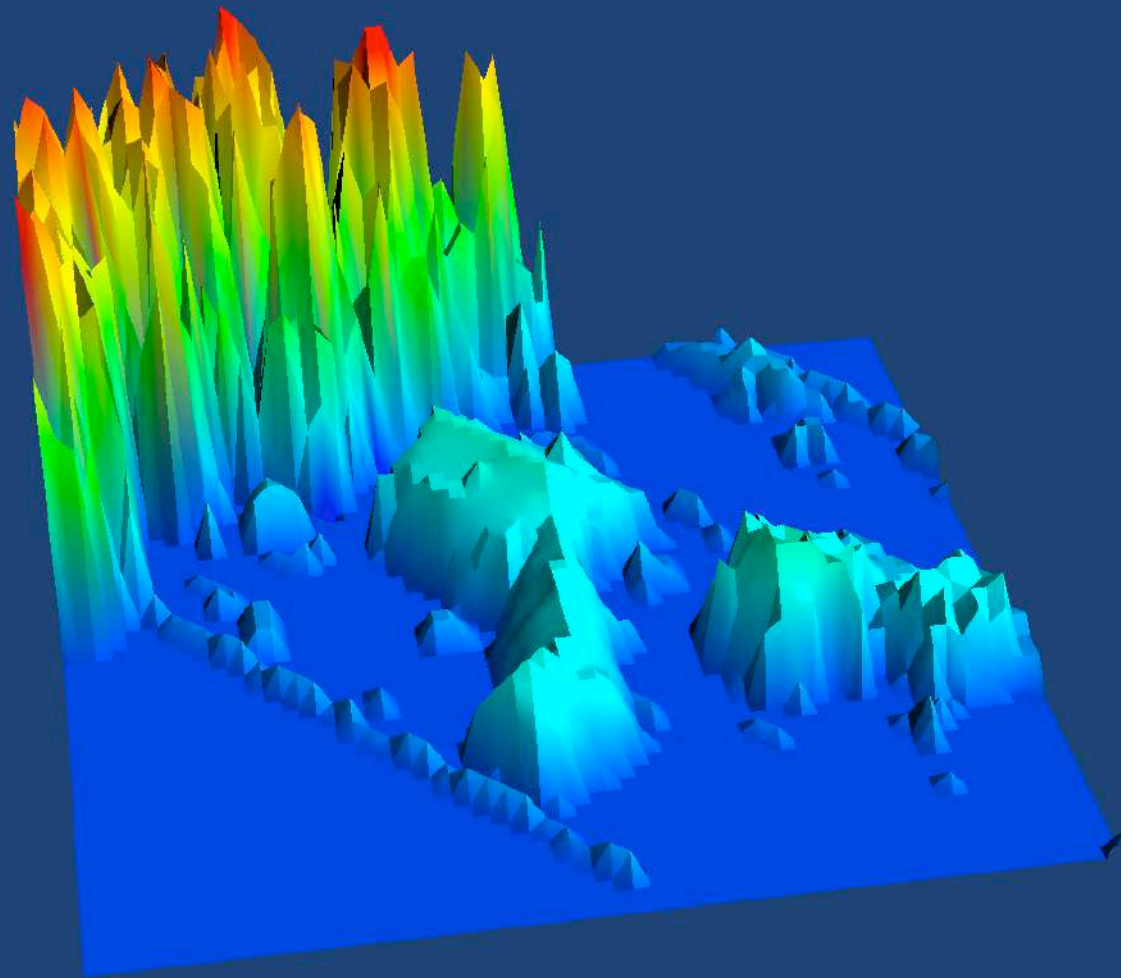
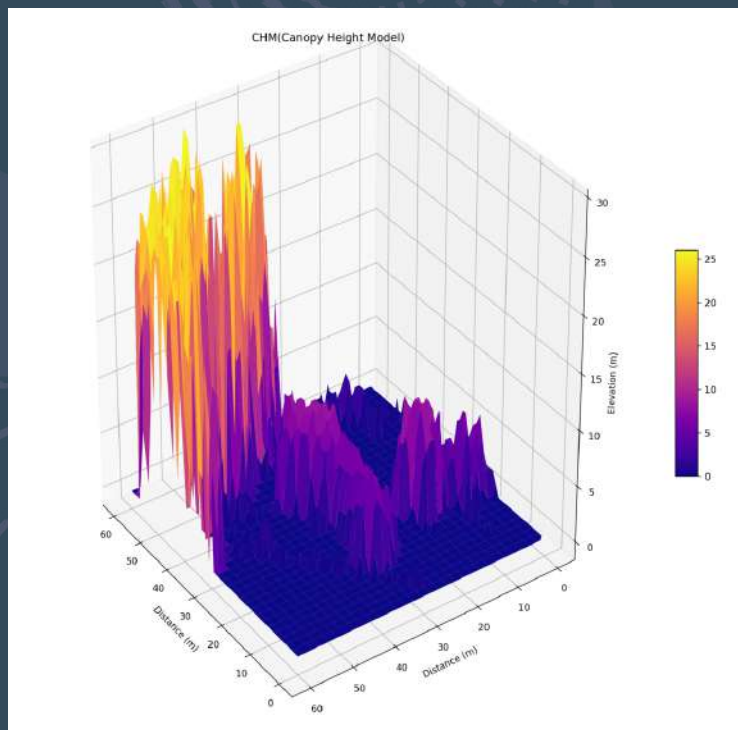
describe the flow of the process where the input is the address of the house and the output is the 3D plot of the house.



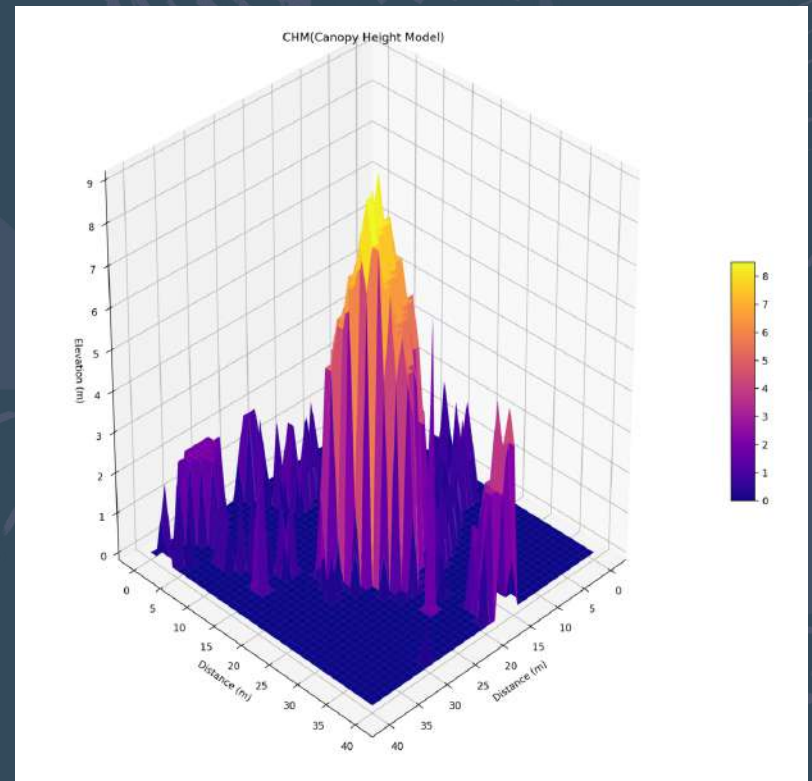
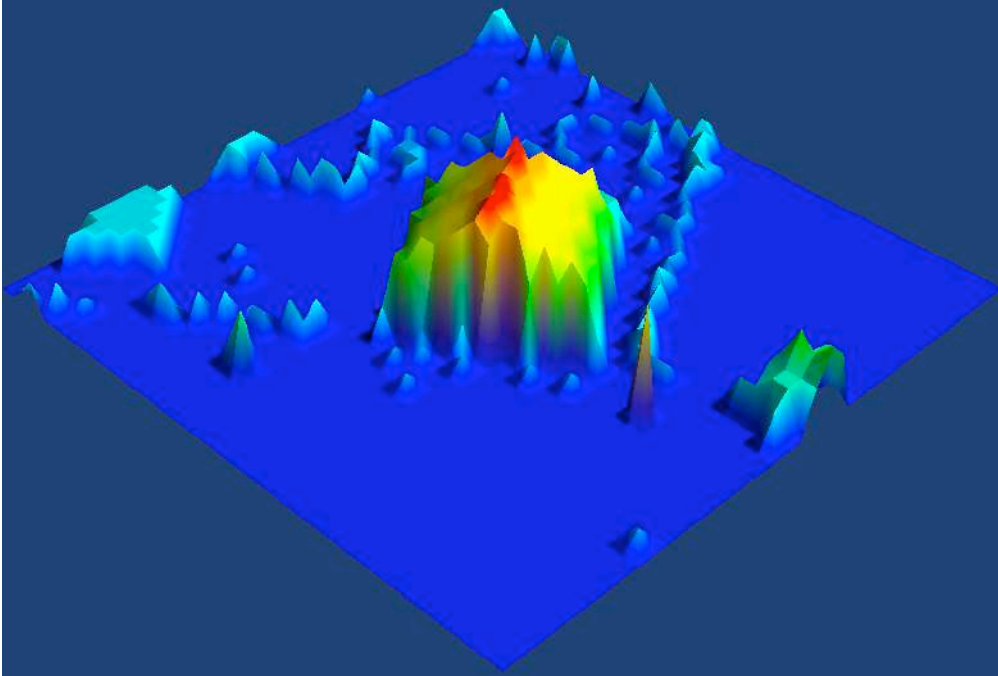




Data Visualization

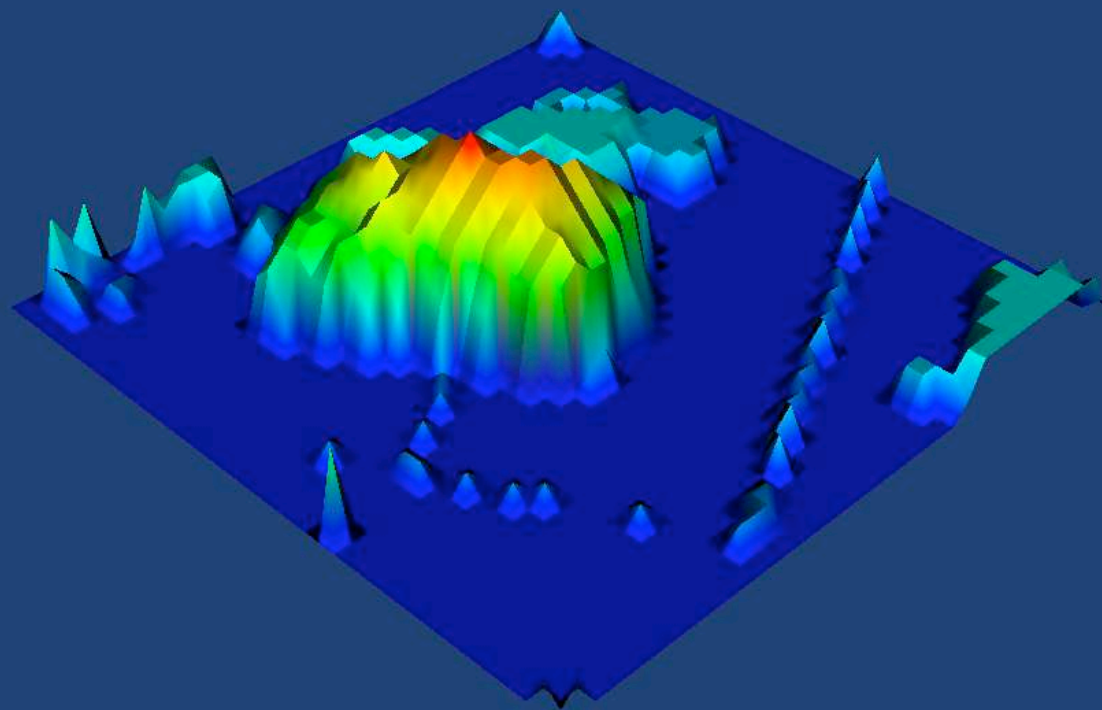
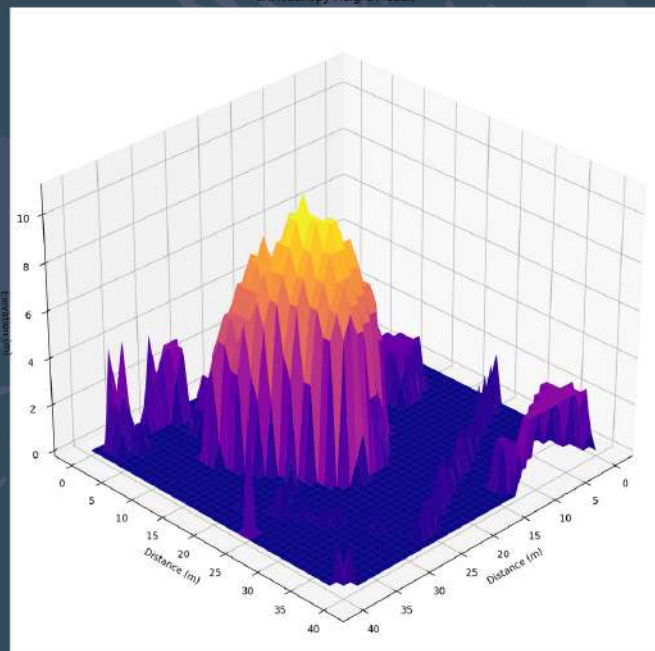


Data Visualization

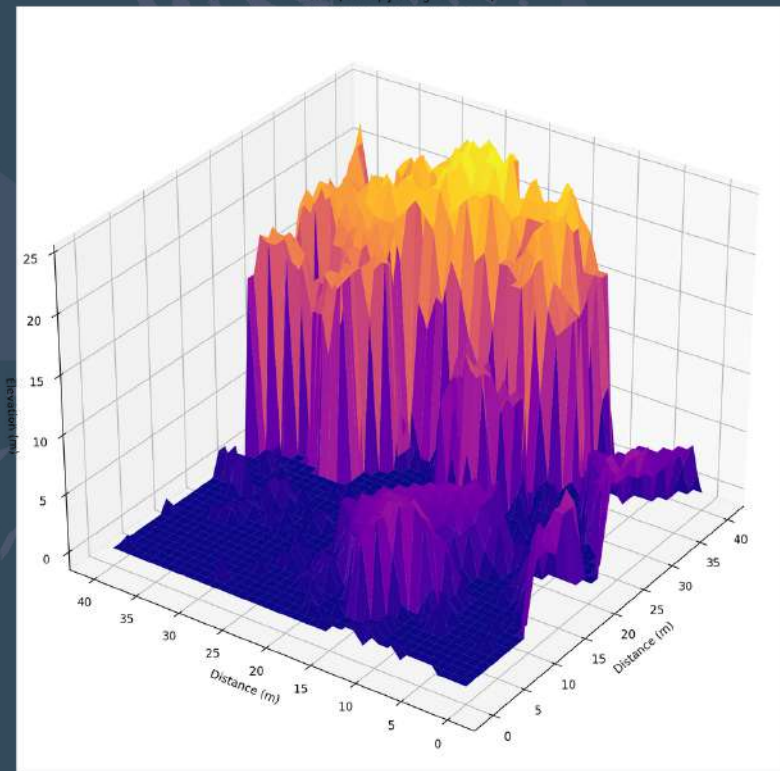
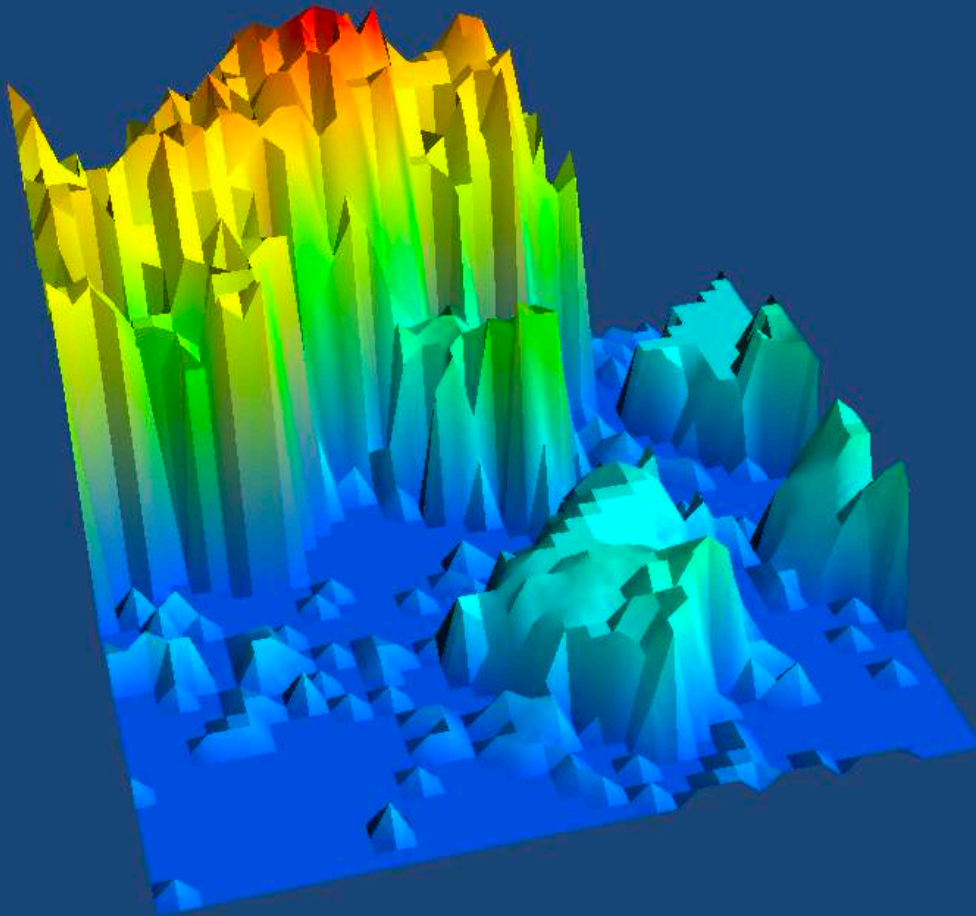


Data Visualization

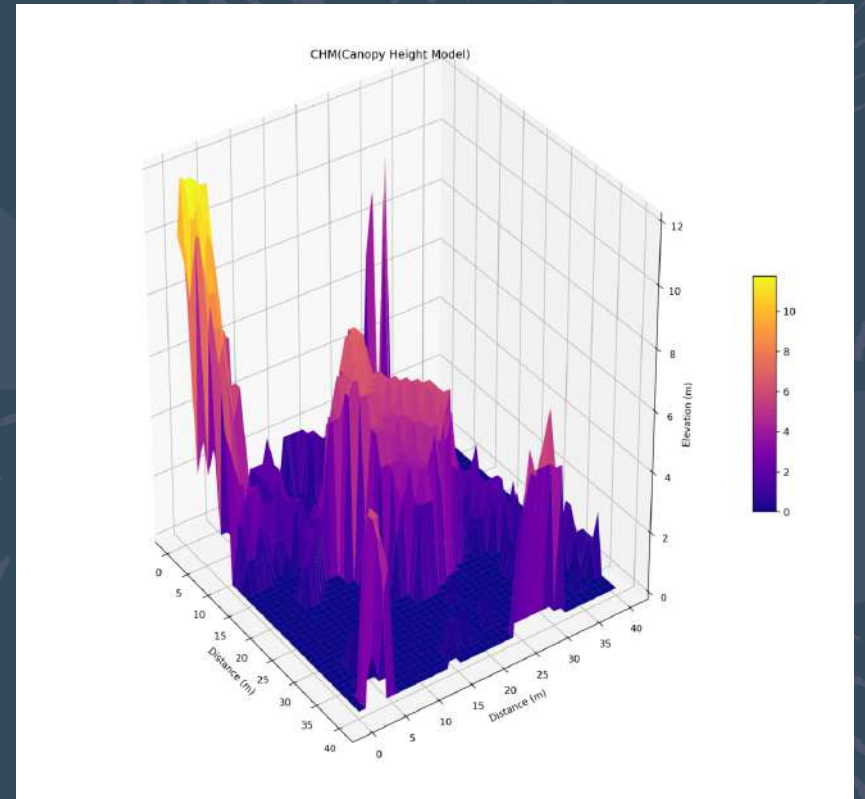
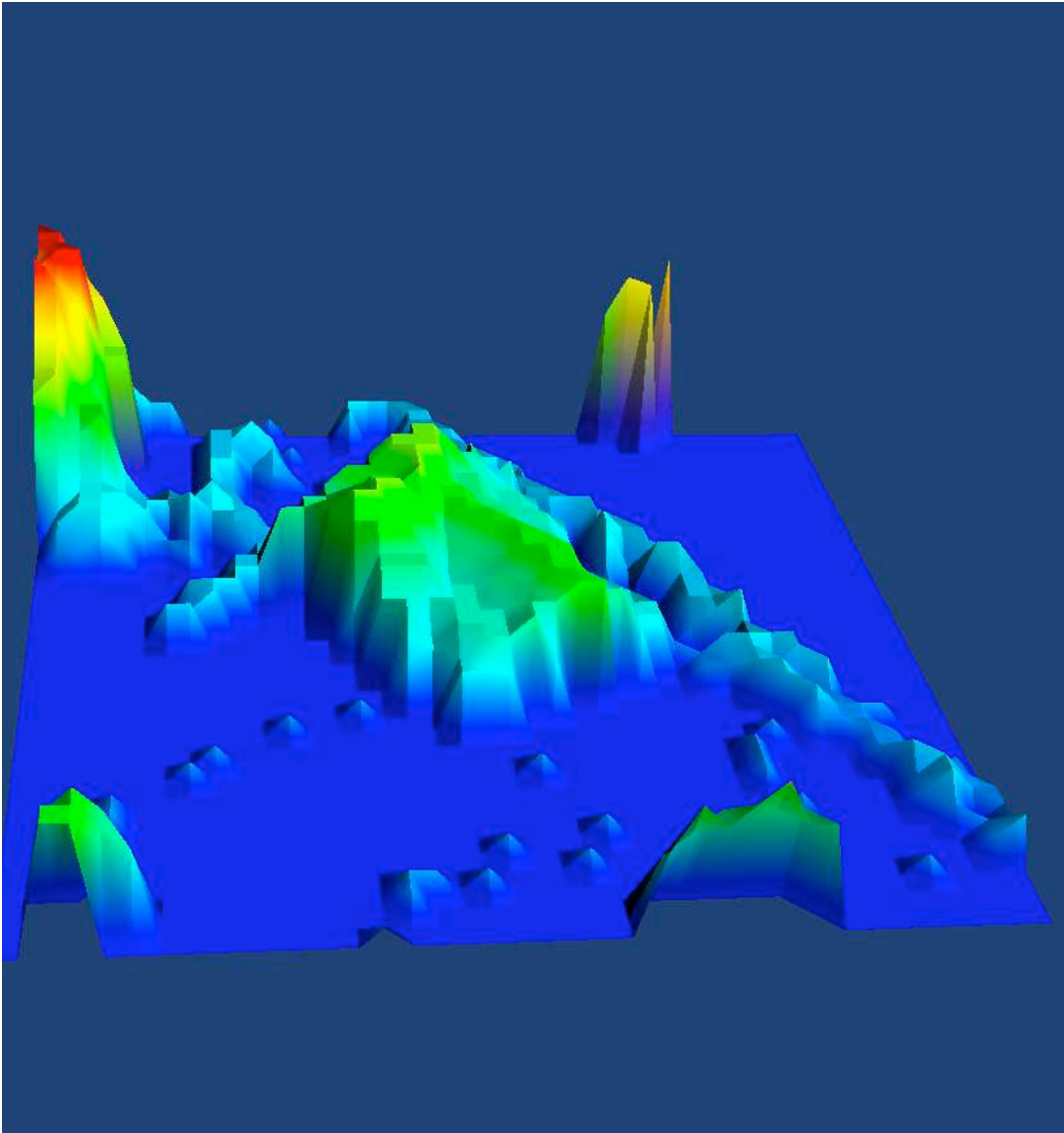
CHM(Canopy Height Model)

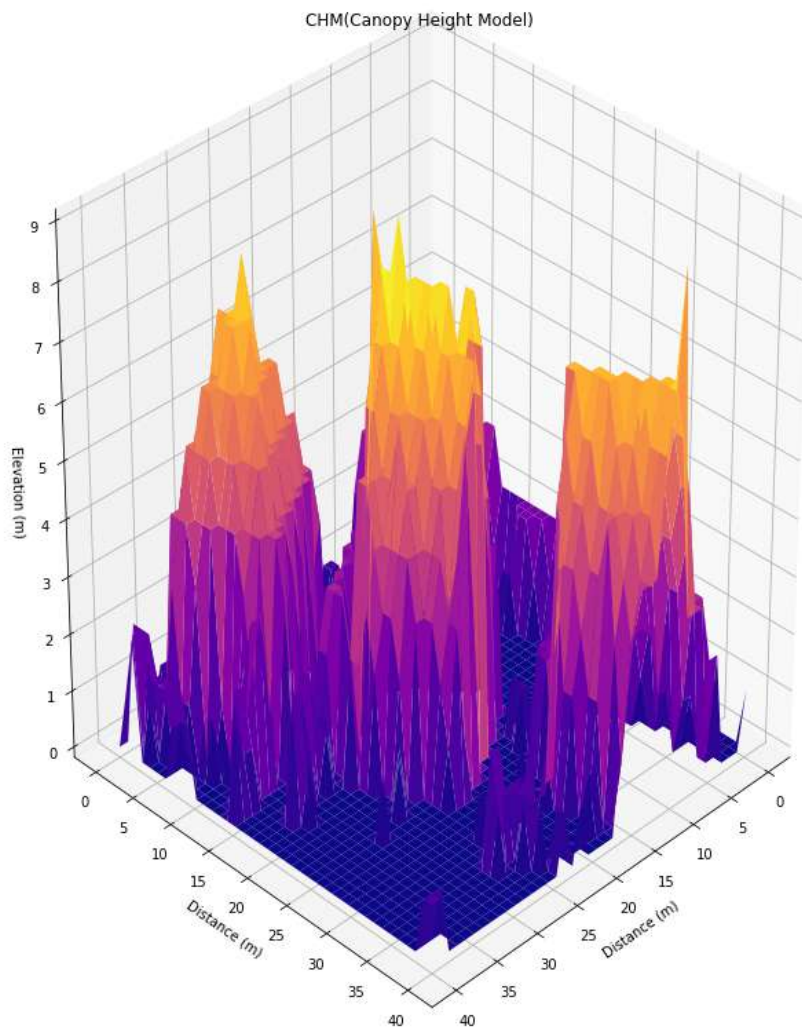


Data Visualization

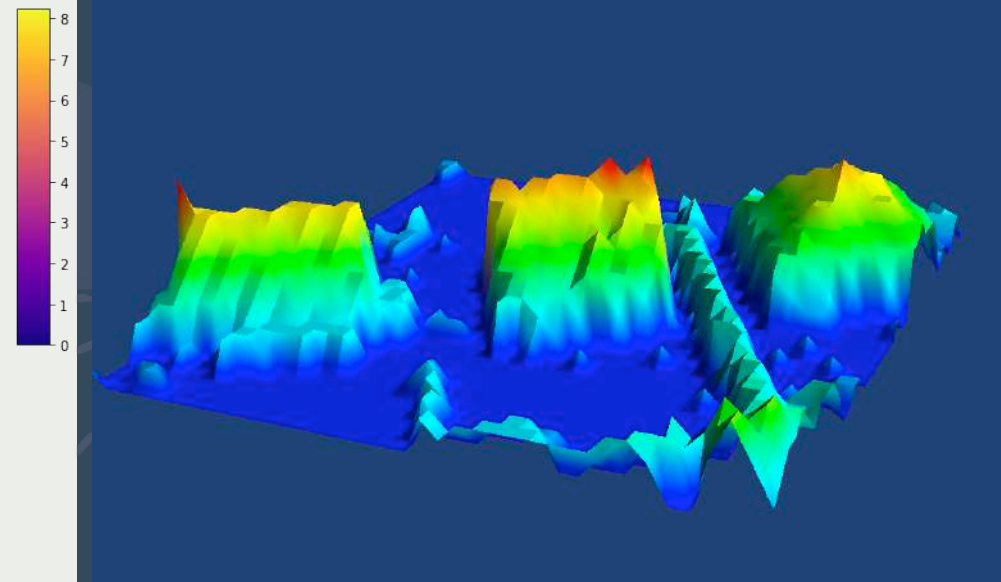


Data Visualization





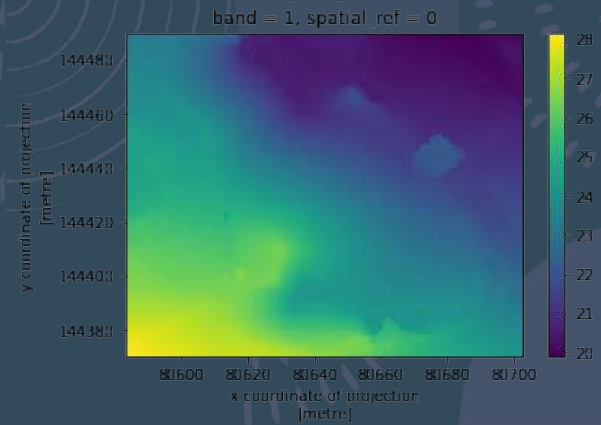
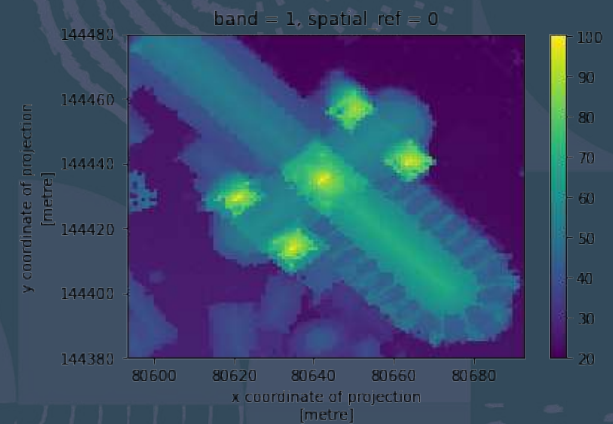
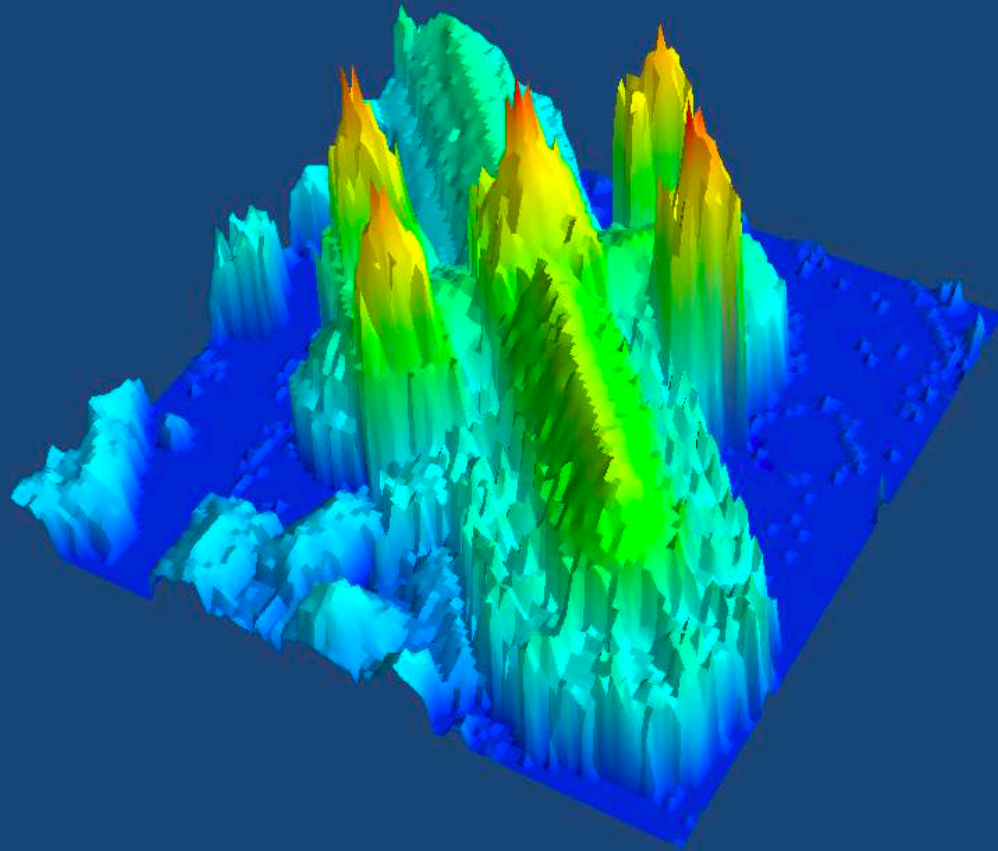
Data Visualization



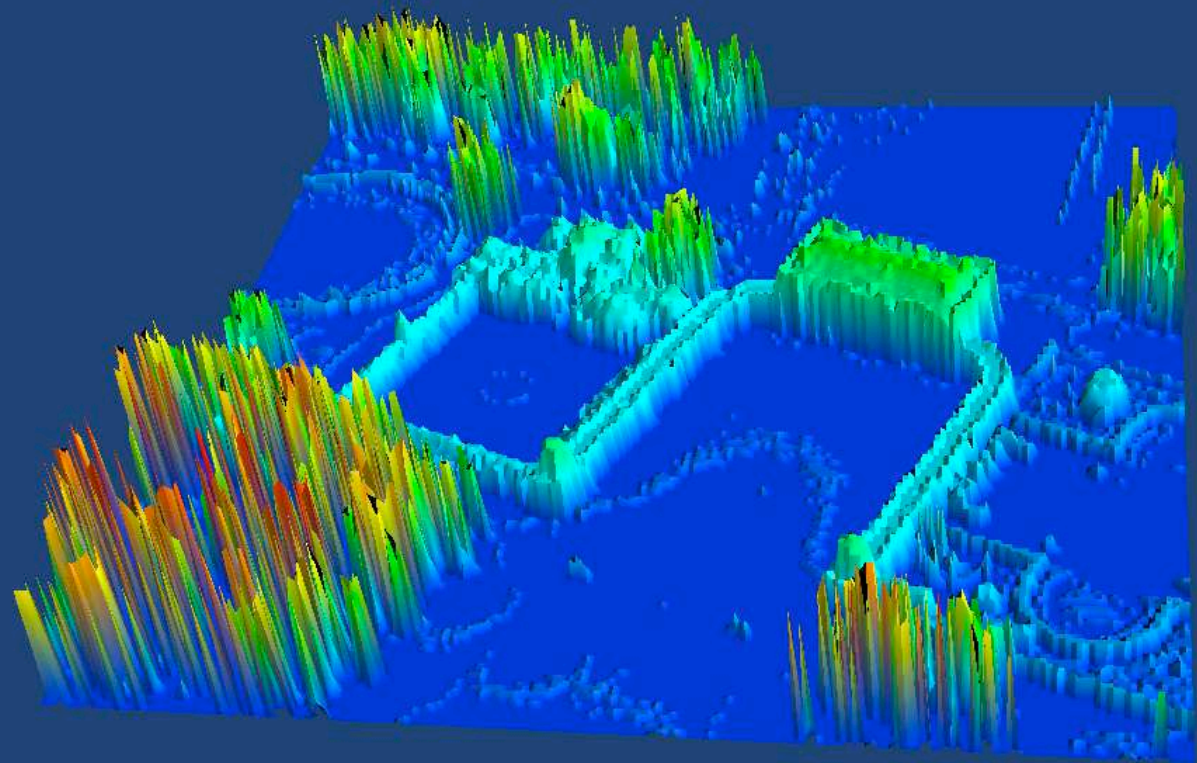
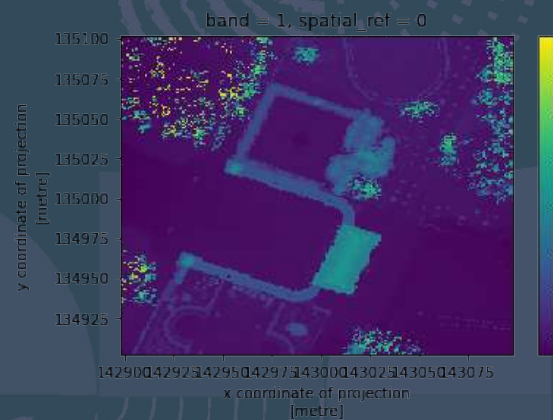
3D Plot

- **Plot 3D houses only with Flandres dataset**
 - https://kaiyungtan.github.io/3D_houses/Examples_Code_3D_houses/Project_3D_Houses_Flandre_Beernem.html
- **Plot 3D houses only with Wallonie dataset**
 - https://kaiyungtan.github.io/3D_houses/Examples_Code_3D_houses/Project_3D_Houses_Wallonie_Wavre.html
- **Plot 3D houses - Belgium**
 - https://kaiyungtan.github.io/3D_houses/Examples_Code_3D_houses/Project_3D_Houses_Belgium_Arlon.html
- **Plot 3D monuments in Belgium**
 - https://kaiyungtan.github.io/3D_houses/Examples_Code_3D_monuments/Project_3D_Monument_Royal_Palace_of_Brussels.html

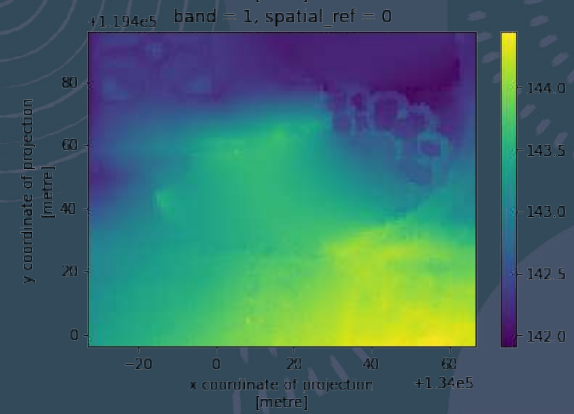
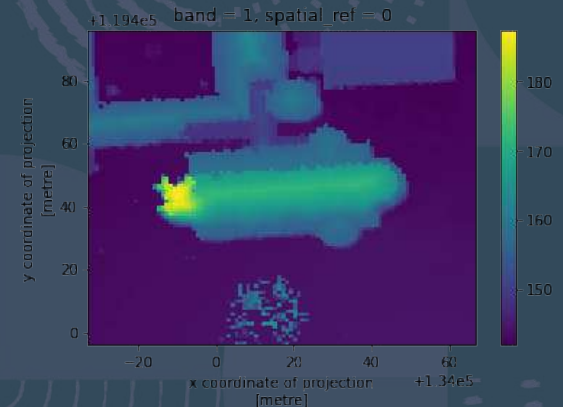
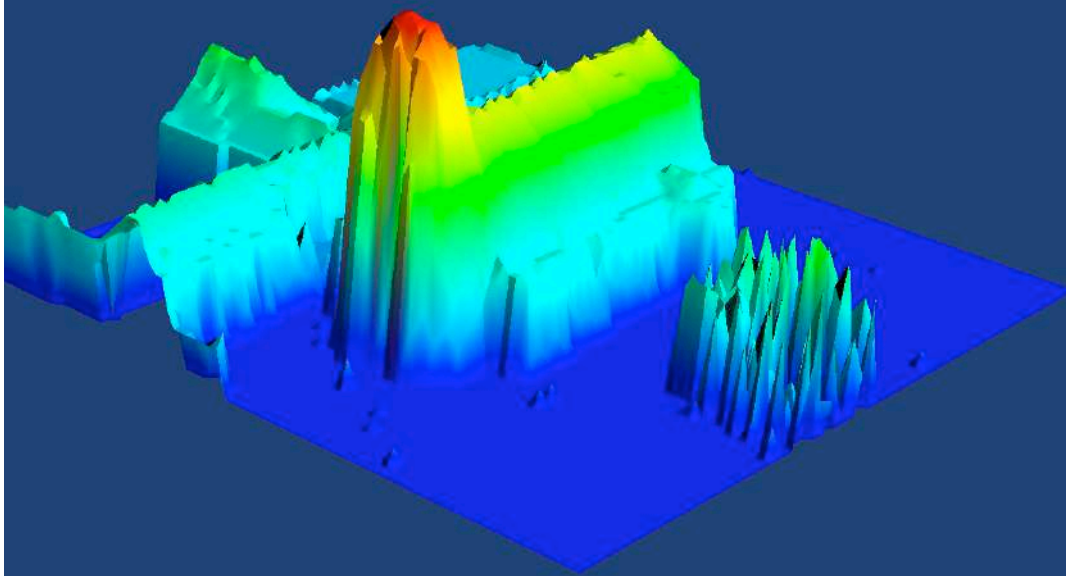
Data Visualization



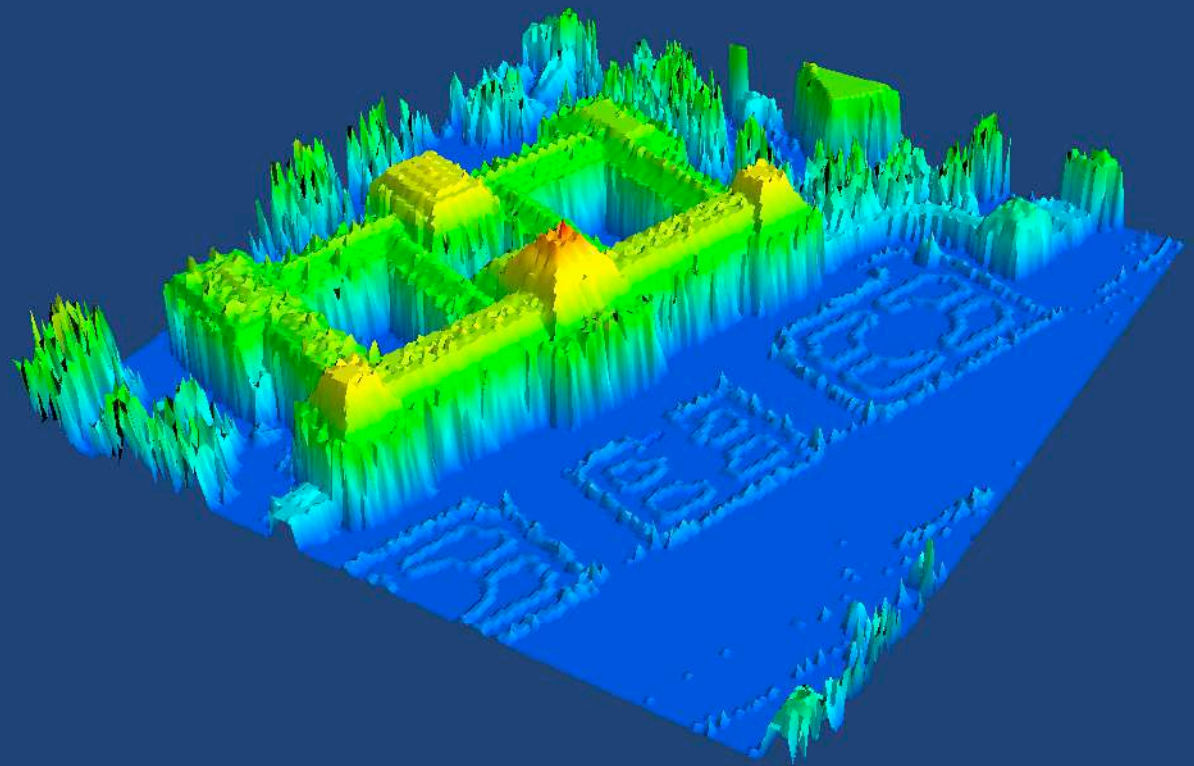
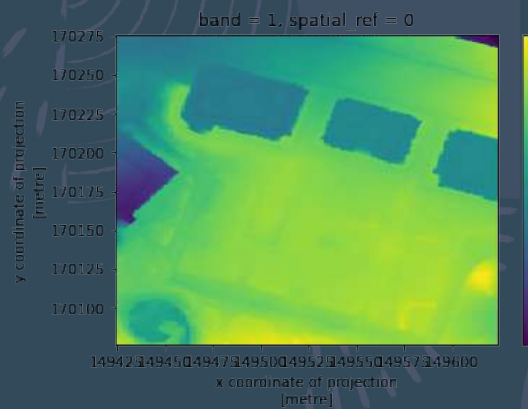
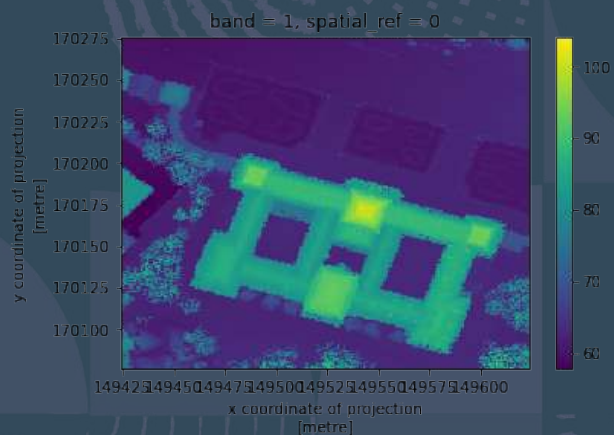
Data Visualization



Data Visualization



Data Visualization



Challenges

- to convert an address to a latitude,longitude coordinate
- to search the existing tif and determine which tif contain the coordinate
- to clip the tif with certain window size to allow rendering in 3D
- to use new libraries to render a 3D plot
- unable to host all the data - Flandre data (80GB) and Wallonie data (100GB) on the same place (due to limit of storage)
- after updating macOS Catalina version 10.15.7, Anaconda-Navigator did not work and have to reinstall Anaconda-Navigator and all libraries for this project.
- after reinstall mayavi , mayavi did not work on python 3.8. Upon investigating, found out that have to install vtk in order for mayavi to work.

Limitation

- due to the buffer zone of each tif file, some houses can be located on 2 tifs.
- geocoding of address to coordinates sometime did not give the correct location of the houses
- belgium addresses.csv may not be able to provide the coordinate for the address in question, due to the address provided may not actually be the same as indicated in the csv or address has been removed during the cleaning process of the data.
- new houses after 2014 are not shown on the tif due to the fact the tif was dated 2014.

Further Development

- to host the data on an online server.
- to develop web application allowing client to type in any address in Belgium to view 3D houses.
- to obtain latest LIDAR images so that new houses after 2014 can be rendered.
- to incorporate cadastral plan of each property in the 3D rendering so that only the requested house is rendered.
- to explore other 3D plotting libraries

Thank You

https://github.com/kaiyungtan/3D_houses