SATELLITE/AERIAL IMAGE RETRIEVAL

SUBMITTED BY:

ANIMESHPATNI (A20403240)

ABHIJEET AMBEKAR(A20395747)

VAMSI K KOTHAPALLI(A20395942)

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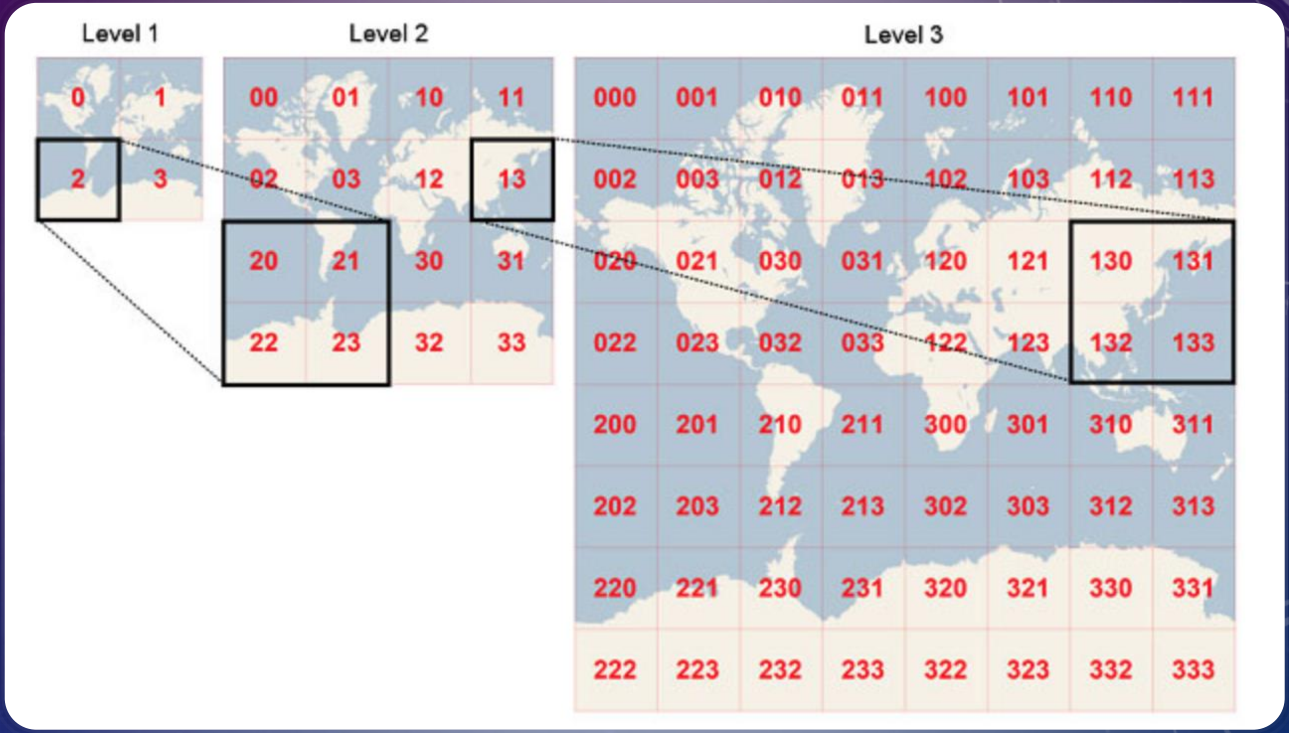
INTRODUCTION

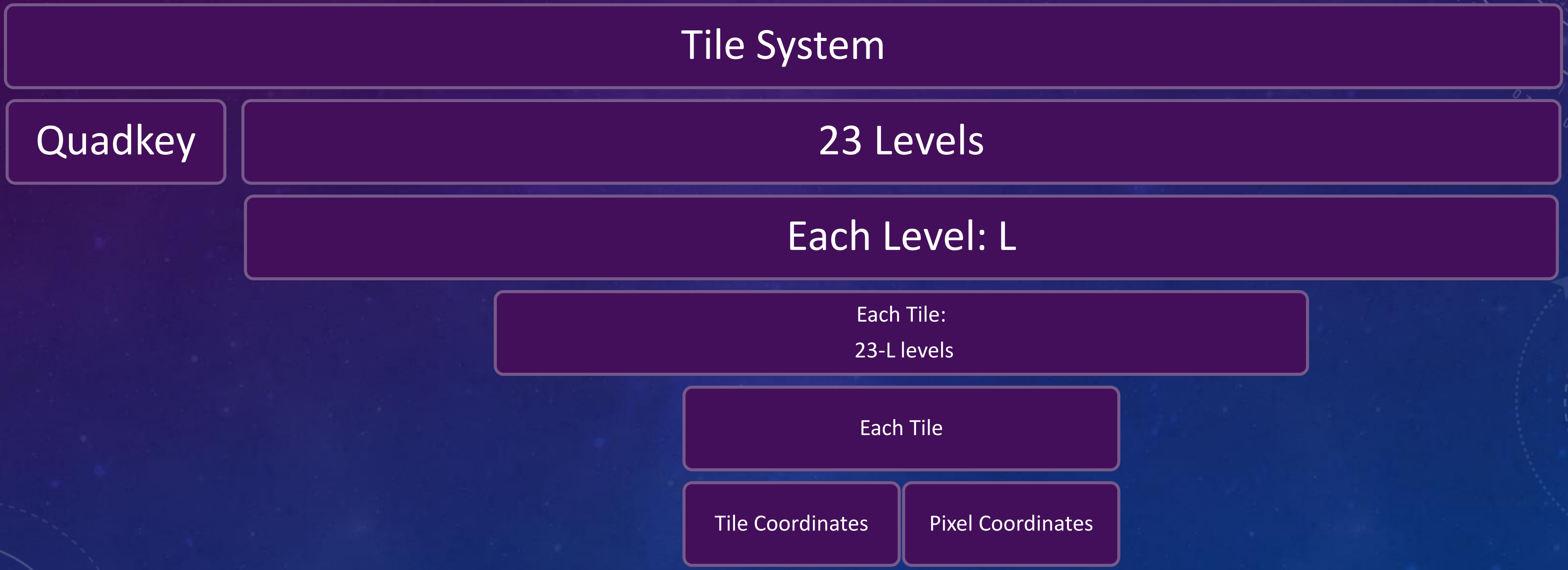
- Extract aerial imagery provided with latitude and longitude on the map of the bounding box using the Bing maps title system.
- Extracted image has to be on best possible zoom level to get best high resolution.

BING MAPS TILE SYSTEM

- In order to obtain high resolution aerial imagery project the world map to a square number of pixels. A bunch of pixels consist a tile orderly.
- In higher level, there are more pixels, bigger map size, more tiles, and finer ground resolution. There are 23 levels in total. Each tile in current level expand to 4 tiles in next finer level.



BING MAPS TILE SYSTEM



Tile System

Quadkey

23 Levels

Each Level: L

Each Tile:
23-L levels

Each Tile

Tile Coordinates

Pixel Coordinates

APPROACH

QUERY AERIAL IMAGE FROM BING MAP TILE SYSTEM

- Generating URL by quadkey :
  - *http://h0.ortho.tiles.virtualearth.net/tiles/h{quadkey}.jpeg?g=131"*
  - #quadkey: can be generated by converting a pair of latitude and longitude.
- Request the url and obtain the queried tile image.

SAMPLE QUERY OUTPUT:

- While extracting Aerial Image for Navy Pier, one of the many tiles with quadkey link:

•http://h0.ortho.tiles.virtualearth.net/tiles/h030222231031003300.jpeg?g=131

•Here 030222231031003300 is the calculated QuadKey Value.

GENERATE BOUNDING BOX OF AERIAL IMAGE

Base Tile

- Find the smallest tile which bounds everything of our bounding box.
- Inside this base tile, recursively find finest tiles.

Finest Tile

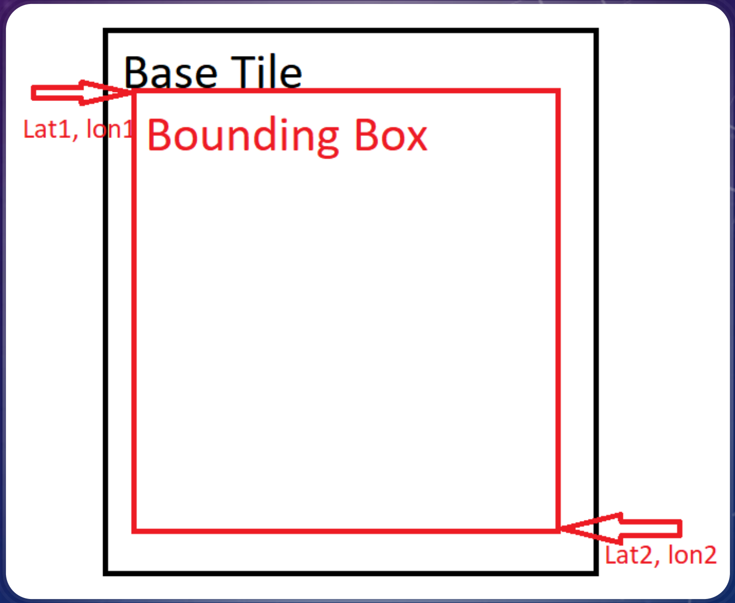
- From level 23 to lower levels, find the first non-null tile aerial images.
- Stitch these tiles together to generate a “finest tile”

Cropping

- Convert Longitudes and latitudes to pixel coordinates in the finest tile.
- Crop the finest tile to the bounding box of required aerial image.

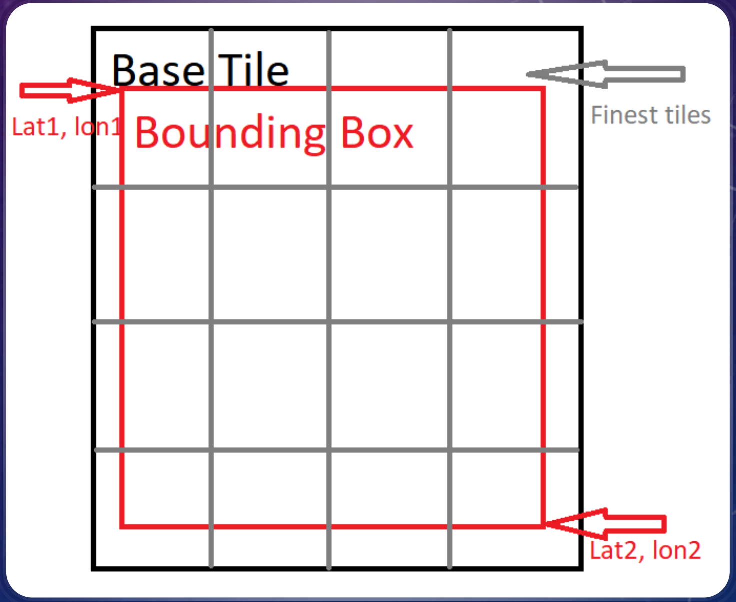
BASE TILE

- Input : lat1, lon1, lat2, lon2
- Find the coordinated for given latitude and longitude x1, y1, x2, y2.
- Search from level 23 to level 1 where each tile x1,x2,y1,y2 are:
  - If $|x1 - x2| \leq 1\ and\ |y1 - y2| \leq 1$
  - If the above condition is true then tile level is the base tile level
- Output : {tile level} and tile coordinate {x1, y1}



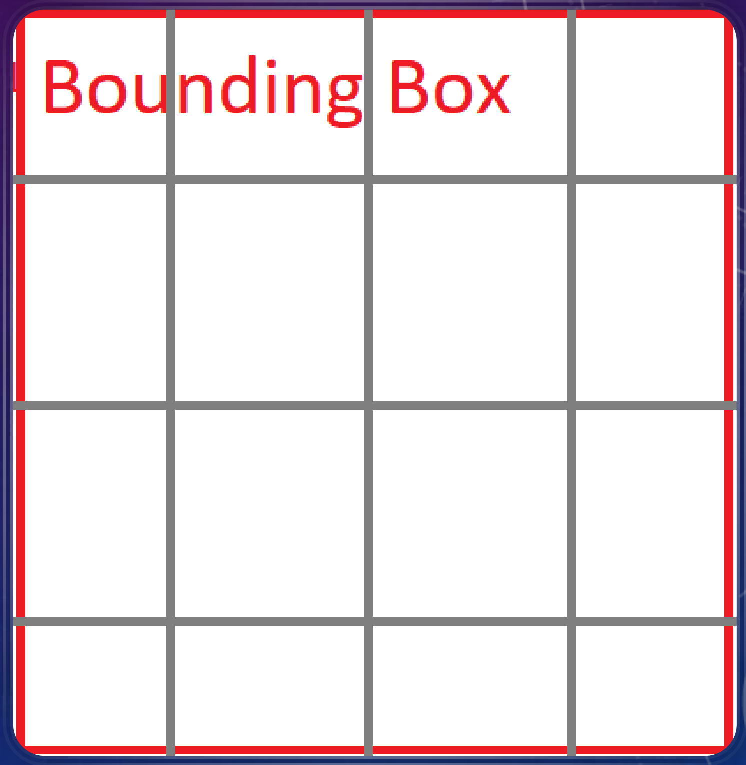
FINEST TILE

- Input : tile coordinates {x1, y1, x2, y2} and {tile level}.
- From level 23 to base tile level:
  - Querying all tile images in this level
  - Return all tile images inside base tile.
- Stitch up these tile images together to generate finest tile image.
- Output : Finest tile image produced after stiching up.



CROPPING

- Input: {lat1, lon1, lat2, lon2} and {finest tile image}.
- Convert latitudes and longitudes into pixel coordinates of finest tile.
- Cropping finest tile image by the pixel coordinates to generate required bounding box of aerial image.
- Output : final aerial image.



CODE OVERVIEW

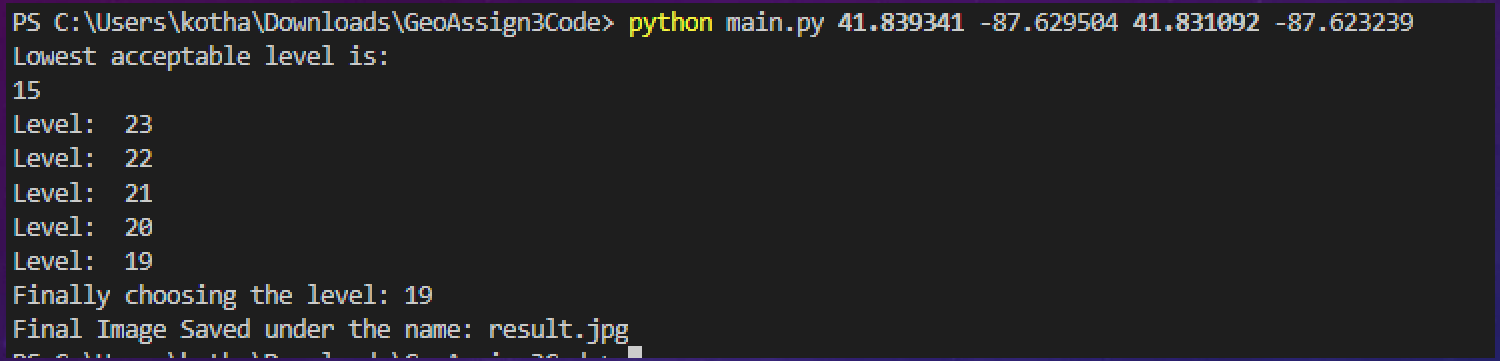
PROGRAM STRATEGY

- Get User input for location box (X1, Y1, X2, Y2) where X is latitude and Y is longitude
- Get Minimum Level
  - Get the lowest acceptable level given two points coordinates of bounding box
- Get Best Level by fetching User Input and Minimum Level data
  - Estimates the level with finest resolution without missing any information
- Acquire all Quad Keys and download tile images
- Combine all the tile images and form resultant image
- Save result image as result.png

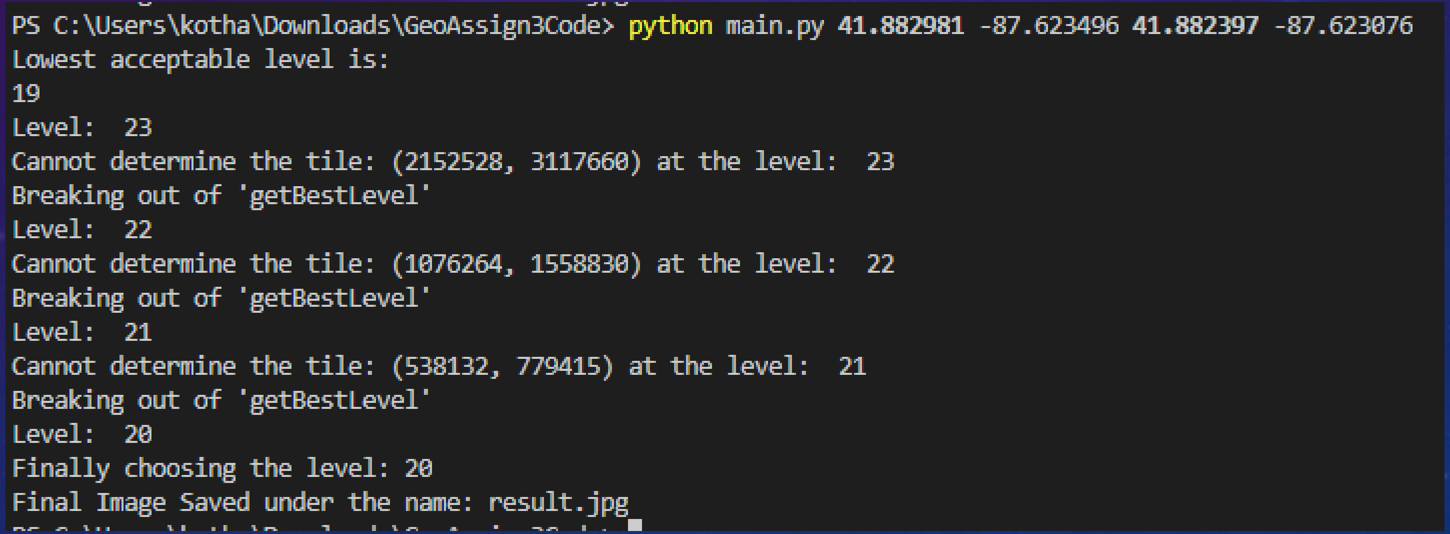
HOW TO RUN?

- Run the file main.py with two geo-points
  - Example python main.py -33.856098 151.214184 -33.858352 151.215814
- Please refer test_data.txt for other test examples
- Output will be generated as result.png

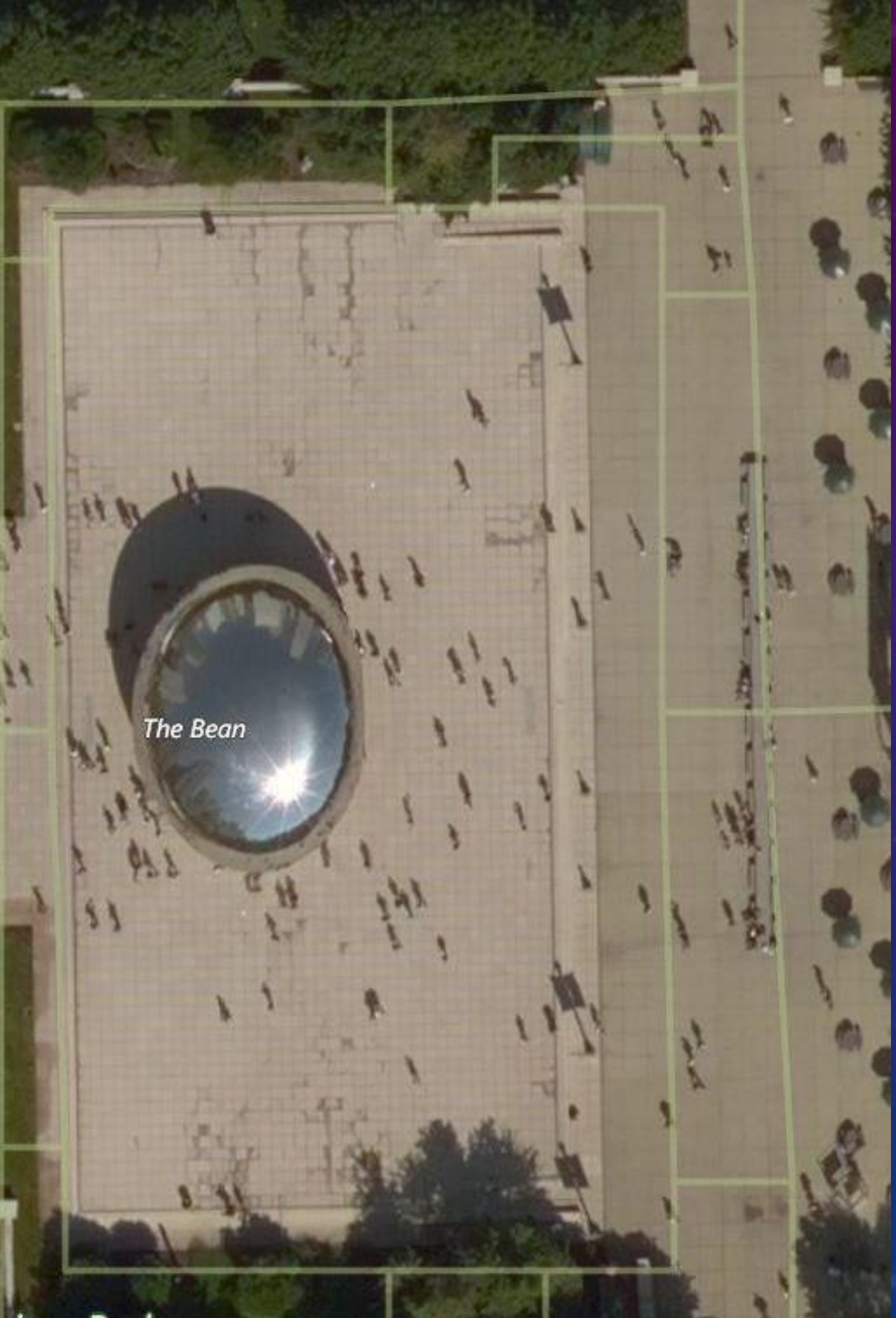
RESULTS



```
PS C:\Users\kotha\Downloads\GeoAssign3Code> python main.py 41.839341 -87.629504 41.831092 -87.623239
Lowest acceptable level is:
15
Level:  23
Level:  22
Level:  21
Level:  20
Level:  19
Finally choosing the level: 19
Final Image Saved under the name: result.jpg
```



```
PS C:\Users\kotha\Downloads\GeoAssign3Code> python main.py 41.882981 -87.623496 41.882397 -87.623076
Lowest acceptable level is:
19
Level:  23
Cannot determine the tile: (2152528, 3117660) at the level:  23
Breaking out of 'getBestLevel'
Level:  22
Cannot determine the tile: (1076264, 1558830) at the level:  22
Breaking out of 'getBestLevel'
Level:  21
Cannot determine the tile: (538132, 779415) at the level:  21
Breaking out of 'getBestLevel'
Level:  20
Finally choosing the level: 20
Final Image Saved under the name: result.jpg
```



AERIAL IMAGE OF THE BEAN

Bounding box

Top Left Corner

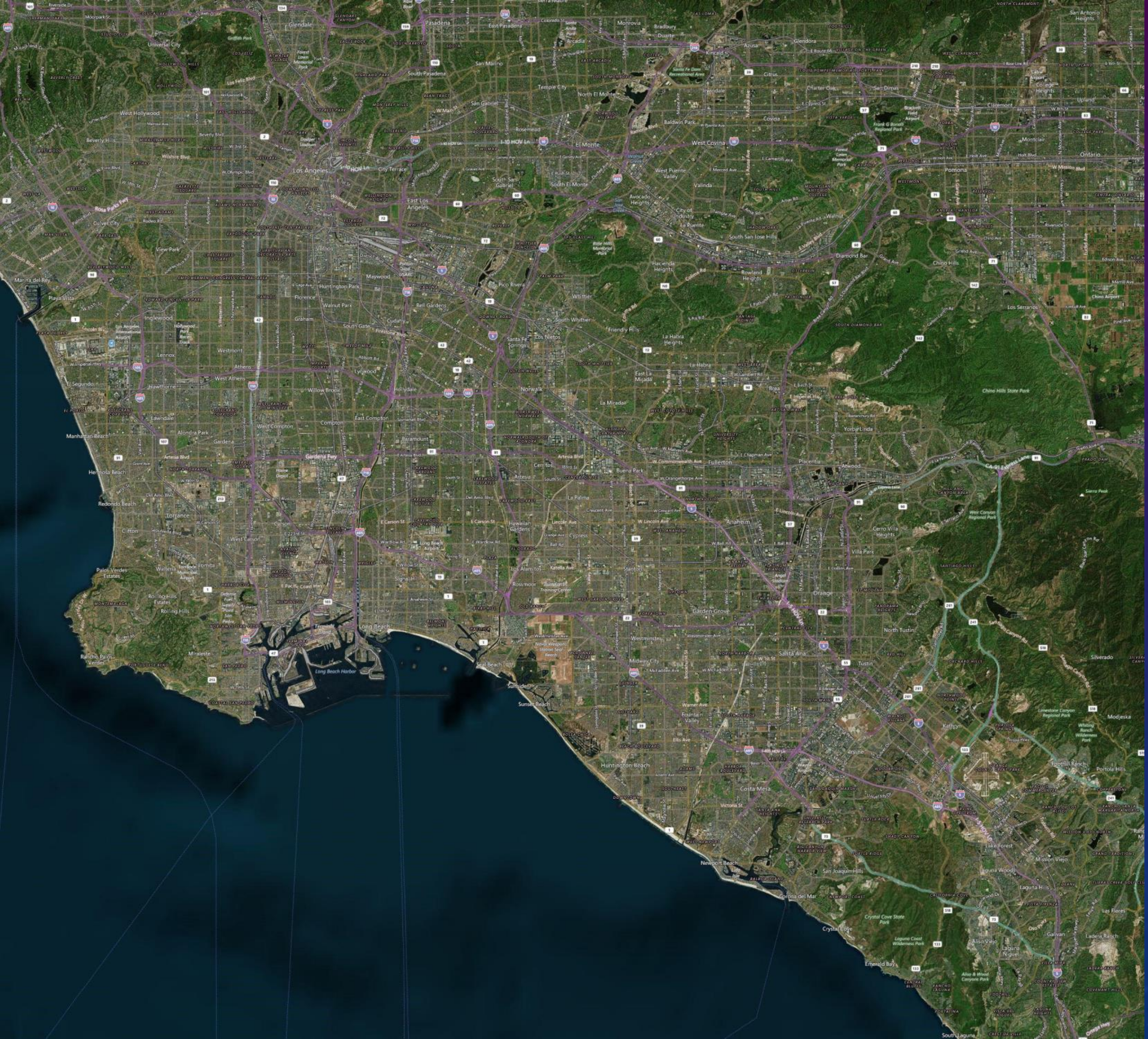
Latitude : 41.882981

Longitude : -87.623496

Bottom Right Corner

Latitude : 41.882397

Longitude : -87.623076



AERIAL IMAGE OF LOS ANGELES

Bounding box

Top Left Corner

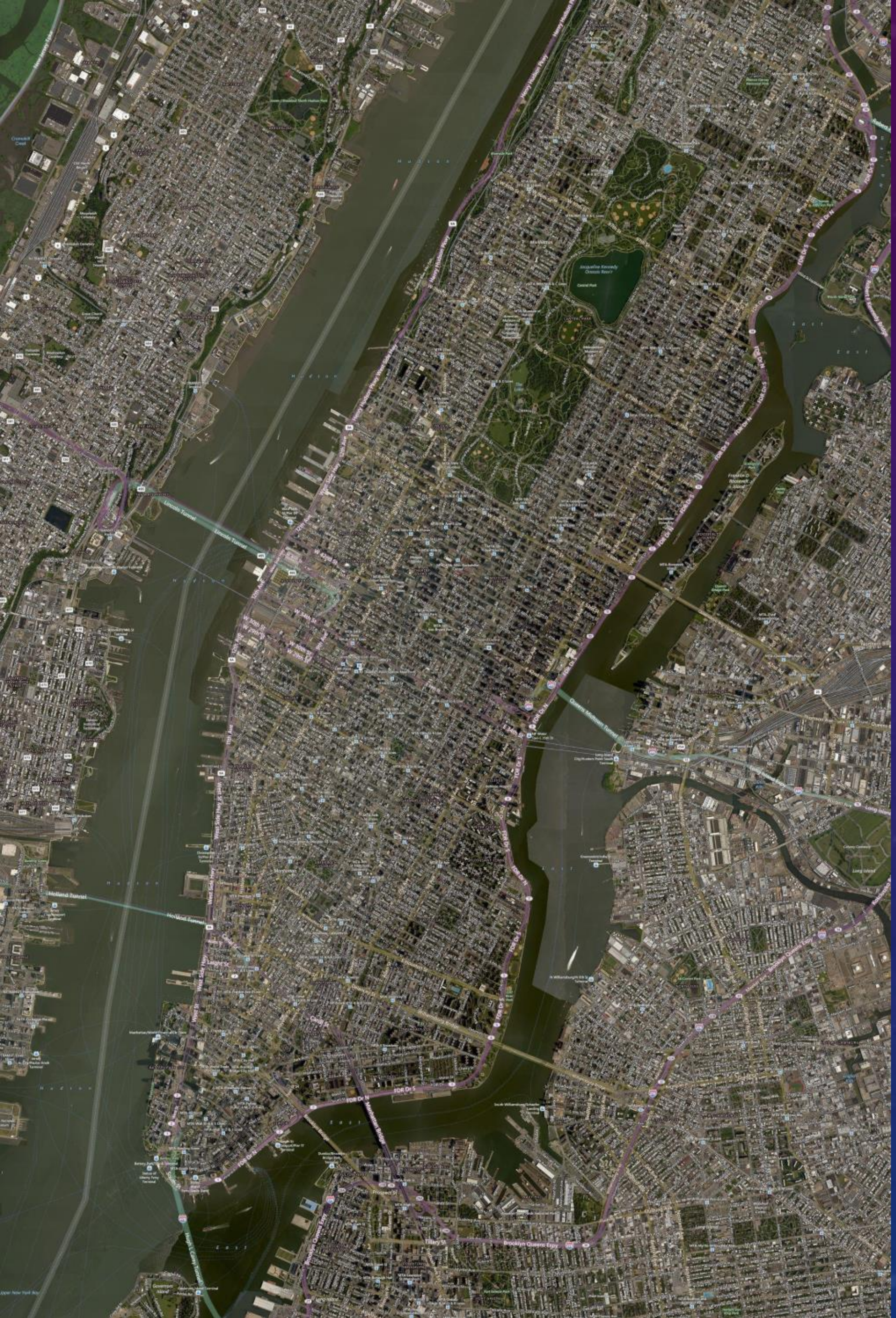
Latitude : 34.105290

Longitude : -118.656758

Bottom Right Corner

Latitude : 33.570656

Longitude : -117.580821



AERIAL IMAGE OF MANHATTAN

Bounding box

- Top Left Corner
  - Latitude : 40.811149
  - Longitude : -74.031106
- Bottom Right Corner
  - Latitude : 40.691880
  - Longitude : -73.929692

THANK YOU