AERIAL IMAGE RETRIEVAL

...

Juhi Deshpande A20430435
Sonali Deshpande A20428066
Monishaa Arulalan A20432700

CONTENTS

GOAL

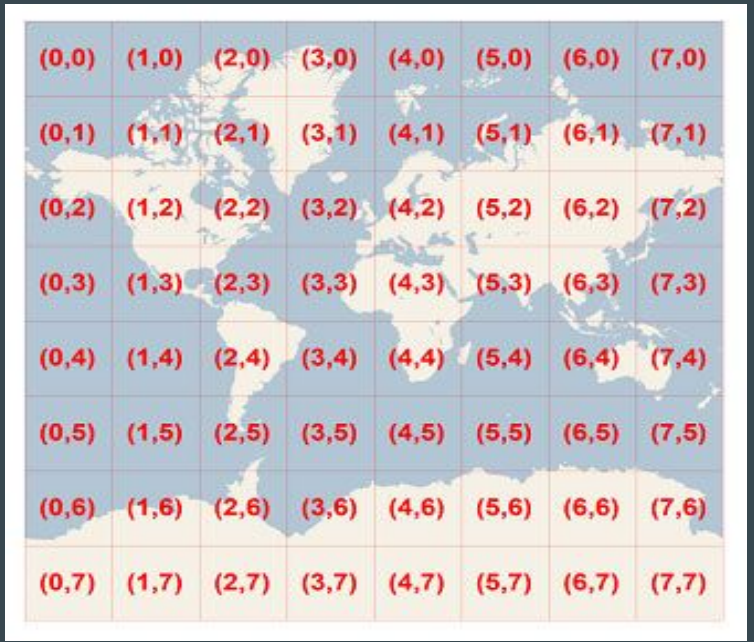
Our aim is to automatically download the aerial imagery with high resolution for given latitude and longitude using Bing Maps Tile System.

BING MAPS TILE SYSTEM

- Bing Maps provides a world map that users can directly manipulate to pan and zoom.
- To make this interaction as fast and responsive as possible, we chose to pre-render the map at many different levels of detail, and to cut each map into tiles for quick retrieval and display.
- Bing Maps makes use of Mercator projection which significantly distorts scale and area (particularly near the poles), but it has two important properties: conformal projection and cylindrical projection.

- To optimize the performance of map retrieval and display, the rendered map is cut into tiles of 256 x 256 pixels each. As the number of pixels differs at each level of detail, so does the number of tiles:
  map width = map height = 2 level tiles

- Given a pair of pixel XY coordinates, you can easily determine the tile XY coordinates of the tile containing that pixel:
  tileX = floor(pixelX / 256)
  tileY = floor(pixelY / 256)



- To optimize the indexing and storage of tiles, the two-dimensional tile XY coordinates are combined into one-dimensional strings called quadtree keys, or “quadkeys” for short.
- Each quadkey uniquely identifies a single tile at a particular level of detail, and it can be used as an key in common database B-tree indexes.
- To convert tile coordinates into a quadkey, the bits of the Y and X coordinates are interleaved, and the result is interpreted as a base-4 number (with leading zeros maintained) and converted into a string.
- ***Our key:***
  Akk7WP-w0TJrlJV0Kl5JO9gutSR1_ox5BEqIgs3iDdFdp4KZB7UlJp5FcEo2BTMW

ALGORITHM

1. Determine the lowest acceptable level by all bounding box area within one tile.
2. Determine the final best level by filtering out from fine to coarse iteratively.
3. Query each tile image and paste.
    i. Convert lat/lon to pixel coordinates.
    ii. Convert pixel coordinates to tile coordinates.
    iii. Query tile image from Bing Server.
4. Refine and crop the generated image by pixel granularity.

APPROACH

Given below are the steps followed to obtain the aerial image :

1. Obtaining the queried aerial tile image from the Bing Map Tile System.
2. Creating bounding box of the aerial image.
    a. Create a “Base” tile
    b. Create “finest” tile.
    c. Crop the finest tile to obtain the required aerial image.

STEP 1 : Query an image tile from Bing Maps tile system

- ➔ Use the Bing Map license key to access the Bing map API.
  - ◆ Key used : Akk7WP-w0TJrlJV0Kl5JO9gutSR1_ox5BEqIgs3iDdFdp4KZB7UlJp5FcEo2BTMW
- ➔ Create a URL to query the required image
  - ◆ http://ho.ortho.tiles.virtualearth.net/tiles/h*#quadkey*.jpeg?g=131&key=*#license_key*
  - ◆ ***Quadkey:*** is obtained by converting a pair of latitude and longitude which is taken as input from the user.
  - ◆ ***license key:*** is the key mentioned in the previous step.
- ➔ Using this extract the required tile image from Bing maps tile system.

STEP 2.A : CREATE THE BASE TILE

- After obtaining the image from Bing Map tile system, we find the smallest tile that boundes everything in this tile.
- Obtain the input of pair of latitudes and longitude : latitudeOne (x1) , longitudeOne (y1), latitudeTwo (x2), longitudeTwo (y2)
- Using the MaximumResolution set to 23. Search from level 1 to 23 if :
  - $|x1 - x2| \leq 1$ *and* $|y1 - y2| \leq 1$
  - We obtain our base tile.
- Output : Return this tile which is obtained after the iteration.

STEP 2B : CREATE THE FINEST TILE

- ➔ Using the inputs of tile coordinates : x1, y1, x2, y2 and tile level.
- ➔ Parsing from level 23 (MaximumResolution) to base tile level (previous step coordinates) :
  - ◆ If we can query all tile images in this level using the common zoom levels,
  - ◆ Return all tile images inside base tile.
- ➔ Stitch tile images obtained together to generate “finest” tile image.
- ➔ Output : Return finest tile image.

STEP 2C : CROPPING TO OBTAIN AERIAL IMAGE

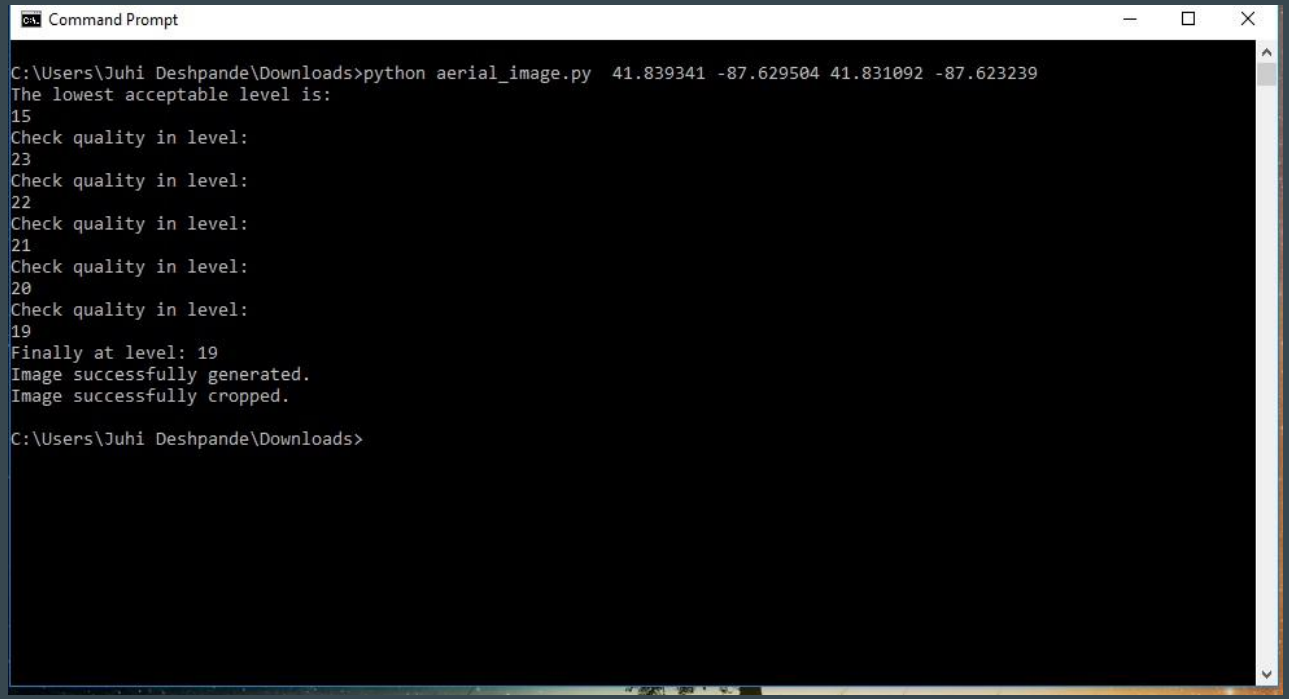
- ➔ Input : Using the finest tile image and the input pair of latitude and longitude.
- ➔ Converting these points into pixels coordinates of the finest image obtained in the previous step.
- ➔ Using the pixel coordinates of the finest tile image, crop them and obtain the required bounding box of aerial image.
- ➔ Output : Return the bounding box image obtained in the last step.

RESULTS

1) *IIT Campus*

Top Left Corner:
Latitude: 41.839341
Longitude: -87.629504

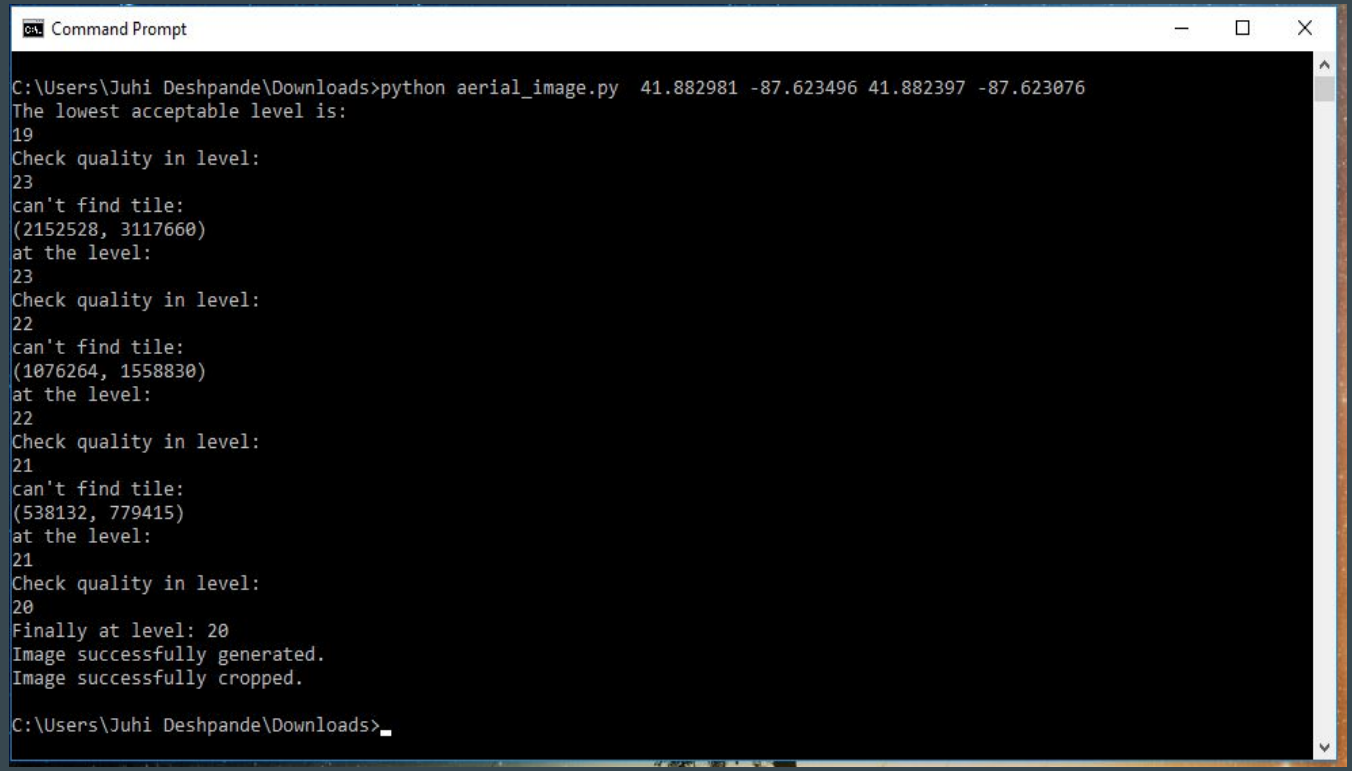
Bottom Right Corner:
Latitude: 41.831092
Longitude: -87.623239



2) ***Cloud Gate***

Top Left Corner:
Latitude: 41.882981
Longitude: -87.623496

Bottom Right Corner:
Latitude: 41.882397
Longitude: -87.623076



REFERENCES

1. Rbrundritt. (n.d.). Bing Maps Tile System - Bing Maps. Retrieved from http://msdn.microsoft.com/en-us/library/bb259689.aspx
2. Rbrundritt. (n.d.). Getting a Bing Maps Key - Bing Maps. Retrieved from https://docs.microsoft.com/en-us/bingmaps/getting-started/bing-maps-dev-center-help/getting-a-bing-maps-key
3. Rbrundritt. (n.d.). Bing Maps Tile System - Bing Maps. Retrieved from https://docs.microsoft.com/en-us/bingmaps/articles/bing-maps-tile-system

THANK YOU!