

---

# Aerial Imagery and OSM Retrieval

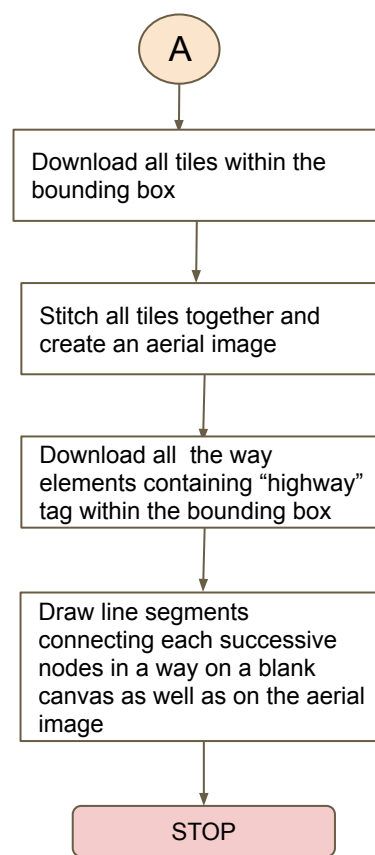
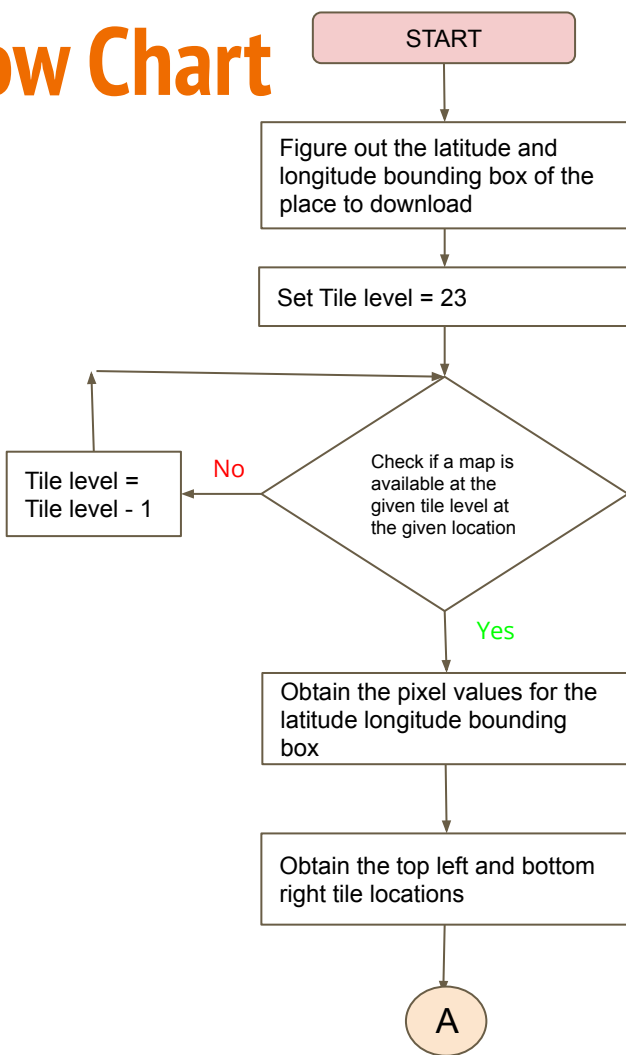
— Senthil Palanisamy —  
Jordan Zeeb

---

# Problem description

- Our first goal was to write a program using the Bing maps tile system to automatically download an aerial image, at the maximum resolution available, given the lat and long values for a bounding box (min\_lat, max\_lat, min\_long, max\_long).
- Then we were to use OpenStreetMap (OSM) API to retrieve the road network/map data for the bounding box. These were the “highway” values from OSM, specifically the “nodes and ways” which defined all the roads. With these, we could overlay the road map onto the satellite image.
- Finally, we were to use our map mapping algorithm to create a map for another cool place on earth.

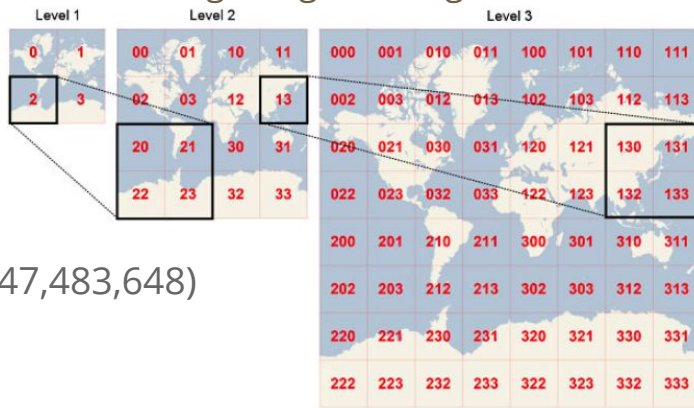
# Flow Chart



# Bing Maps Tile System

The Bing Maps Tile System breaks up the world map (Mercator projection) into smaller and smaller tiles which can be stored into a one-dimensional index key which has three interesting properties:

- 1: The number of digits equals the level of detail of corresponding tile
- 2: A tile always starts with the quadkey of its parent tile. As shown below, tile 2 is the parent of tiles 20 through 23.
- 3: Two tiles that have nearby XY coordinates usually have quadkeys that are relatively close together. This helps increase computer performance when getting tile images that are close together, like they usually are.

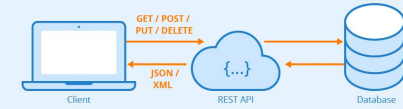


Pixels at each level range:

Level 1 = (512 x 512)

Level 23 = (2,147,483,648 x 2,147,483,648)

# Servers and REST API query



1. Both OSM data and BING data reside in their server database, both of which can be accessed through their REST APIs.
2. A get request is sent by the client (our system) to the data servers (Bing or OSM).
3. A get request is usually a url followed by a query i.e., This query is sent to the specific url to retrieve relevant data.
4. The server then sends the requested data to the client in XML / JSON format.

# Aerial Image download Procedure

1. Convert Min, max latitudes and longitudes into pixel values on bing map.
2. Find the maximum scale at which the map at the requested location is available (Max scale is 23).
3. Find the top left and bottom right tile of the bing map, that corresponds to these pixels (Each tile is about  $256 * 256$ ).
4. Get the quad key for each tile and use the bing api to download each tile with the quad key.
5. Stitch all tiles together to get the final aerial image.

# Aerial Image download Output

With this tile system, we can convert a lat/long bounding box into a group of quadkeys which we use to download the tiles. When these tiles are stitched together, can create the aerial image based on the highest resolution available for the given tiles.

Resolution:  
(8448 X 8960)

Nu Campus was only  
available at a scale of 20  
(Not at the maximum bing  
map scale of 23)



# OSM - Data Organisation basics

1. There are 3 kinds of elements in OSM
  - a. Node - A single point defined by a latitude and longitude.
  - b. Way - A shape defined by a sequence of nodes.
  - c. Relation - Specifies the relationship between different ways and nodes. Ex: NU campus can be specified by a combination of ways and nodes.
2. Each element may contain tags which specify attributes about the element
  - a. Each tag is a key-value pair that specifies information about the element.
  - b. Some examples of tags are highways, amenities etc.. If a way is specified with highway = trunk, it means that it is an important and heavily used roadway.



# Open Street Map API

- With Open Street Map (OSM), we are able to locate a wide variety of different physical features such as; buildings, railways, vegetation, ext.
- Luckily for us, they also store tags for roads which are saved as a group of “ways”, which are each their own group of nodes.
- Since each node has a lat/long associated with it, we can then map these nodes to our aerial image, as well as visualize each road (way) with their own color.

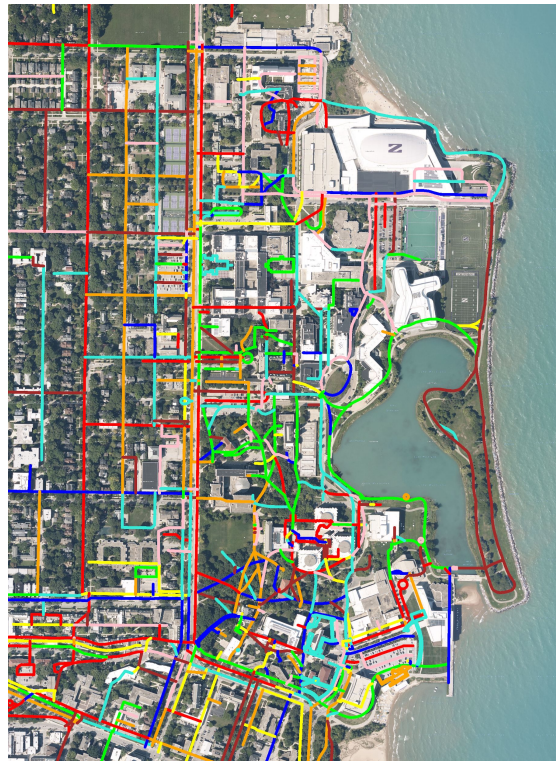
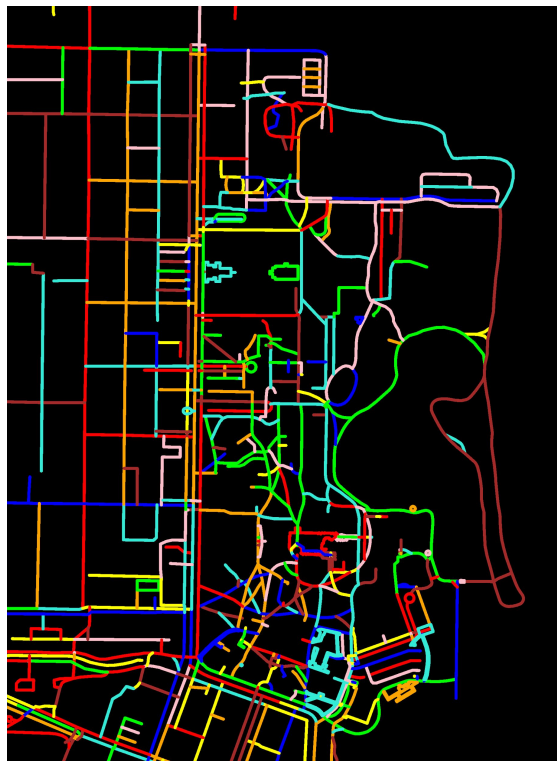
# Overpass and Query for retrieving data

1. Overpass is a convenient python library for retrieving OSM data
2. There are graphical tools available online to help users in generating a query for fetching the desired data. Ex: [overpass turbo](#)
3. This query can then be just sent through the overpass interfaces.

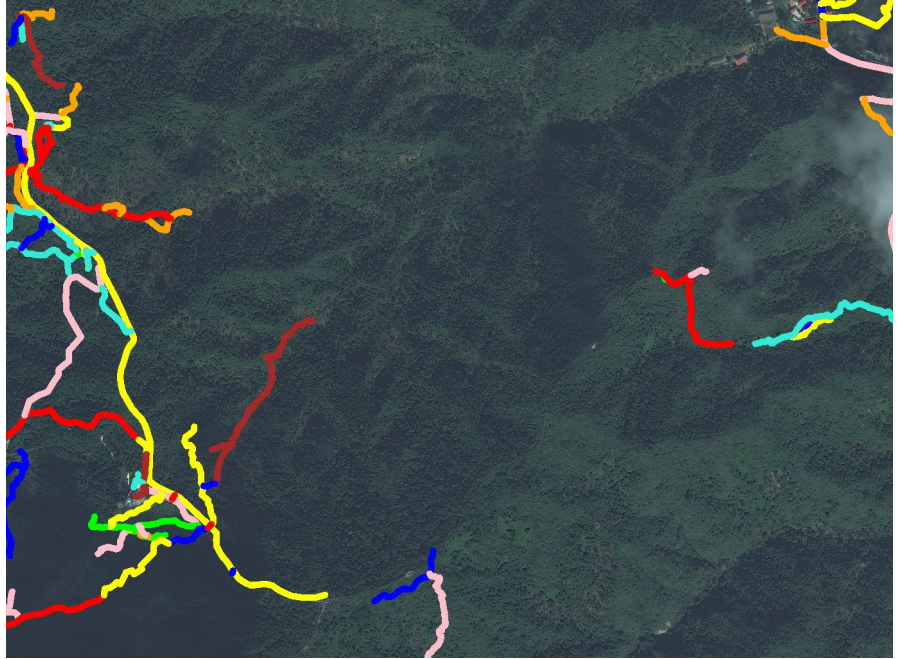
# Overlay OSM data on aerial imagery data

1. Use the min max latitude and longitude to query OSM about all the way elements that contain “highway” tag within the latitude, longitude bounding box.
2. Load the aerial image. Create an empty canvas that has the same size as the aerial image.
3. Since each way is composed of a sequence of nodes, draw line segments connecting each successive node.
4. Draw these line segments on the empty canvas as well as on the aerial image to obtain the final output. (The drawing on the empty canvas just shows a visualisation of the highway network while the drawing on the aerial image provides an output where the road network is aligned with the aerial image.)

# Results Northwestern campus



# Cool Place: Great Wall of China - lower bend



OSM search for "Highways" gives 77 ways for the image shown  
Resolution from aerial image: (6912 x 5120) Tile level -19 (Higher  
tile levels were not available)

# Problems and Findings

## OSM Data Problems:-

1. Due to its open source model, OSM depends heavily on volunteer contributions, which means there are patches of amazing data as well poor data.
2. As a consequence, OSM data is not up-to-date in many of these locations.

## How does BING map fare against competitors (google maps)?

1. For a mobile based solutions where higher accuracy is needed to provide a real time feedback, google maps wins the race due to its higher accuracy by virtue of using the huge probe data obtained from android user base.
2. For desktop applications like preplanning a trip for example, Bing stands as a decent competitor to google due to some of its unique feature. For example: A bird's eye satellite imagery feature supported by Bing.
3. The resolution is not super high. Even in urban places like NU campus, we cannot get to the highest resolution of tile level 23. Microsoft is focusing its effort to actively improve resolution and we should be able to access level 23 in major cities in the near future.



# Future Scope

- OSM is still a database of information and not a mapping service that's the easiest to use for a person with no geospatial expertise
- While OSM provides some very good information, it seems that turning it into an actual map would have been a common enough use case where functions could have been found to do this already.
- Perhaps a new library should be created that makes maps with OSM data in a similar way that we did, but with added features like including the names of ways on the map at appropriate scales.
- BING seems to be enjoying a surge in market share and is starting to challenge google's (and its allies) monopoly in the mapping space.