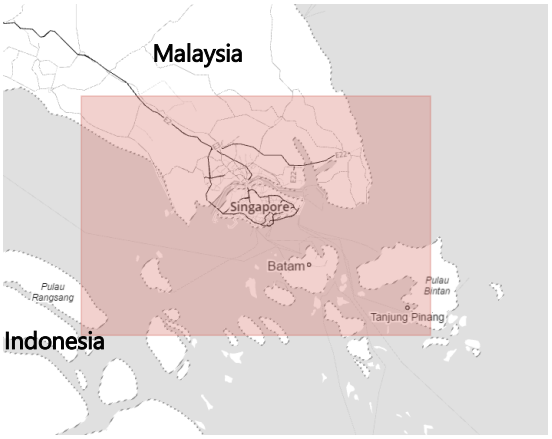
OpenStreetMap Data Case Study Using SQL

1. Map Area

For this case study, I picked Sinagapore. First of all I live here for 2 years so I think of it immediately. Besides, even it is a tiny city country (actually its nickname is 'little red dot') , I am overwhelmed by its complicated city planning and full-scale facilities. I am excited to check out the awaiting suprising facts hidden in this OpenStreetMap data!

NS（1.823,0.807）,EW(103.062,104.545)
https://s3.amazonaws.com/metro-extracts.mapzen.com/singapore.osm.bz2



Singapore Area Extracts Map

National University of Singapore Map

For sampling, I picked NUS campus area (National University of Singapore). Since I am very familiar with it.
NS（1.3094,1.2889）,EW(103.7702,103.7849)
https://www.openstreetmap.org/exPort#map=15/1.2991/103.7775&layers=HN

2.Problems Encoutered

First of all, to ease auditing and correcting, I converted raw sample data into csv format using quiz file *data.py*, during which I realized the processing is very slow, considering the actual dataset of interest is 65 as big as it, it is necessary to give progress report for processing monitoring:

- Process report

After importing the csv files into SQL, some short queries revealed problems such as

- inconsistent city names
- invalid postcodes

Below I show part of the most representative result with regards to the two problem:
sqlite>select value, count(*) from nodes_tags where key='city' group by value order by count(*) DESC ;
Singapore,1175
"Johor Bahru",60
Batam,35
"Ulu Tiram",9
Masai,6
Skudai,4
"Batam Kota",2
... ...

sqlite> select length(value),count(*) from nodes_tags where key='postcode' and length(value) !=6 group by length(value);
3,1
4,3
5,619
7,2
8,1
16,1

Situation for street names is bit complicated:
sqlite>select value from nodes_tags where key='street' ;
"Gopeng St"
"67, Ubi road 1, Oxley Biz Hub 1, #07-08"
Bukit Batok East Ave 5"
Tanjong Pagar Rd"
"Sin Min Ave"
"Libra Dr"
... ...

So I carried out an auditing on street name using ***audit.py***. After runing it aginst ways_tags.csv I noticed these following problems for street names:

- Abbreviations
- Inappropriate postfix
- Mixing house numbers
- Inconsistent title case

2.1 Progress Report
My laptop is very slow in executing data.py even aginst the sample dataset. To moniter the processing progress and secure control of work, I add a progress report functionality to data.py before running it against the whole 200 MB singapore map set, which takes me actually hours to finish.

2.2 Inconsistent City Names
Though the dataset I downloaded from metro-extracts names 'singapore', as we can see it actually is a rectanglar area which unavoidly involves its neighbouring areas like Johor Baru (Malaysisa), Batam (Indonesia), and so on. Therefore it's more accurate to address this case study as "OpenStreetMap Case Study of Singapore and Neighnoring Area". Realizing this, inconsistent city names are actually not problems. So just leave it as it is.

2.3 Invalid Postcodes
Valid Singapore postal code should be 6 digits ,with 2~3 digits for sector code and 3~4 digits for delivery point. I list these invalid postcodes as below:
5 digits: ... ... (Quite a lot. In total 619)
4 digits: 2424, 5901,2222
7 digits: S118556,S120517
16 digits: Singapore 408564
8 digits: S 278989
3 digits: 135

The four cases,"S 278989", "Singapore 408564", "S118556","S120517", are valid singapore postcodes. We just need to do little manual work to strip the prefix so that their format consistent: ***update nodes_tags set value="118556" where value="S118556";*** ... ...
After googling the neighboring area about their postcode format, I found Malaysia and Indonesia share the 5 digit format of postcodes. Most of the 619 5-digits must from the two country and thus should be valid. The 4 digits postcode, according to google, could be from Australia. But even AU is geographically near to Singapore I am skeptical about the possibility since I couldn't find any suspect AU cities/islands within the rectangular area above. To resolve this, I did a self.join query to look at their related tags:
sqlite> select a.id,a.key,a.value,b.key,b.value
...>from nodes_tags as a,nodes_tags as b
...>where a.id=b.id and a.value !=b.value and a.key='postcode' and length(a.value) =4 order by a.id;
3026819436|postcode|2424|bitcoin|yes
3026819436|postcode|2424|city|Singapore
3026819436|postcode|2424|housenumber|136
3026819436|postcode|2424|landuse|retail

3026819436|postcode|2424|name|Liana Medic Ltd
3026819436|postcode|2424|phone|+65 2424666
3026819436|postcode|2424|street|Orchard Road
3026819436|postcode|2424|website|http://www.lianamedic.com/
3756813987|postcode|5901|amenity|restaurant
3756813987|postcode|5901|city|Singapore
3756813987|postcode|5901|country|SG
3756813987|postcode|5901|housenumber|6
3756813987|postcode|5901|name|Wonderful Food and Beverage
3756813987|postcode|5901|phone|+65 9108 5572
3756813987|postcode|5901|street|Sago Street
4445039991|postcode|2222|housenumber|2156
4445039991|postcode|2222|shop|travel_agency
4445039991|postcode|2222|street|km 62

Surprisingly, all of the three postcodes are shown belong to singaporean location. According to wikipedia(https://en.wikipedia.org/wiki/Postal_codes_in_Singapore), Singapore used to use 4-digit post system. Nowadays they are used to refer to locations of properties for sale or rent. Therefore they are valid postcode in that sense.

2.3 Abbreviations in Street Names

After run the provided audit.py, I found abbreviations used in street names such as:

{Rd: set(['Bukit Timah Rd', 'Stockport Rd', 'Jupiter Rd', '31 Lower Kent Ridge Rd', 'Tanjong Pagar Rd']), Ave:set(["Sin Min Ave","Ubi Ave","70 Woodlans Ave","Clementi Ave","Ang Mo Kio Ave","1013 Geylang East Ave","Bukit Batok East Ave","Tampines Ave"]),
St:set(["Gopeng St"]),
Dr:set([""Libra Dr""]) }

Therefore I modified the ***mapping*** dictionary and wrote a ***mapping_update()*** function for ***class street*** to replace abbrevation with standard forms.

2.4 Inappropriate postfix

Such as: '' Taman Mediterania Tahap II Batam Center.'',''Zhong Shan Park,'', "Taman Impian Emas,"...

To deal with this, I wrote function ***strip()*** for in ***class_street.py***.

2.5 Mixing House Numbers

{...
1/5:set(['Jalan Bestari 1/5']),
29/7:set(['Jalan Indah 29/7']),
03-09:set(['East Coast Road #03-09']),
2/9:set(['Jalan Ros Merah 2/9']),
07-08:set(['67, Ubi road 1, Oxley Biz Hub 1, #07-08']),
01-02:set(['Rangoon Road #01-02']),
2/2:set(['Jalan Nb2 2/2']),
9-10:set(['Complex New Holiday Block A No. 9-10']),
01-23:set(['Ubi Road 1 #01-23']),
15/2:set(['Jalan Indah 15/2']),
D/99:set(['Perumahan Mekar Sari D/99']),
...}

It is a big problem. At lease hundreds of street names inappropriately include house numbers, rendering audit() results messy. I decide to split this kind of street names into street type part and house number part. To store the newly generated house number data I create a new DataFrame housenumber with the same "id" as the attr it comes from, and with "key"="housenumber", and "type"="addr"

2.6 Inconsistent Title case

To make street name more consistent, I simply add the standardizing function title() in strip() block, to turn strings such as "blk 168 bedok south ave 3" into title case "'Blk 168 Bedok South Ave 3'"

3 Data Overview

3.1 File Size

singapore.osm ---- 237MB
tags.csv ---- 18.3 MB

3.2 Records Counts

nodes.csv	86 MB	*sqlite> select count(*) from nodes;* *1048575*
ways.csv	9.2 MB	*sqlite> select count(*) from ways;* *159431*
nodes_tags.csv	3.4 MB	*sqlite> select count(*) from nodes_tags;* *89746*
ways_nodes.csv	31.5MB	*sqlite> select count(*) from ways_nodes;* *1048575*
ways_tags.csv	14.7MB	*sqlite> select count(*) from ways_tags;* *435565*

4. Additional Ideas

To make full advantage of the dataset, I combine "nodes_tags" and "ways_tags" into one "tags" table:

```
sqlite> create table tags (id integer, key text, value text, type text);
sqlite> insert into tags (id,key,value,type)
   ...>    select id,key,value,type from ways_tags;
sqlite> insert into tags (id,key,value,type)
   ...>    select id,key,value,type from nodes_tags;
```

(The queries below are all done against "tags" table.)

4.1 Economy, Religion, and Culture

It's very interesting to see how packed and efficient the "little red dot" (its nick name) is in land using: with only 700 km2 the island is home to all-scale amenities: two thousand of parking sites, more than one thousand restraunts, thousands of worship places … remember it's one of the greenest country in the world at the same time!

Besides, although dominated by Chinese, Singapore is a multi-cultural and multi-ethic country. The other two biggest ethics are Malay and Indian. Since majority of Chinese are non-believers, muslim ,the main religion of Malay, become the top religion. However, impacts from other religions are also there, such as Christianity, Hinduism, Taoism (native religion of Chinese). But overall, Singapore is not a religious country. Singaporeans are very busy and used to dine out. Here you can easily find food from every corner of the world, especially the best Asian cuisine: Chinese, Japanese, Korean, Indian, Malay...

4.1.1 Top 10 Appearing Amenities

```
sqlite> select value,count(*) from tags where key='amenity' group by value order by count(*) desc limit 10;
parking|2009
restaurant|1423
place_of_worship|943
school|699
cafe|344
fuel|342
taxi|336
fast_food|318
swimming_pool|285
toilets|220
```

4.1.2 Top 5 Dominating Religions

```
sqlite> select value, count(*) from tags where key="religion" group by value order by count(*) desc limit 5;
muslim|550
christian|202
buddhist|84
hindu|20
taoist|10
```

4.1.3 Top 10 Popular Cuisines

sqlite> select value, count(*) from tags where key="cuisine" group by value order by count(*) desc limit 10;
chinese|113
burger|71
japanese|53
coffee_shop|41
indian|38
chicken|37
italian|37
korean|37
asian|35

4.2 Editors, Contributors, Sources

98% of edits are done with JOSM, the an extensible editor for OpenStreetMap (OSM) ,Java 8;

28.3% of content come from the most active contributor is JaLooNz, who is a human user,
http://89-16-162-21.no-reverse-dns-set.bytemark.co.uk/user/JaLooNz
And so is the thrid active contributor, cboothroyd,
http://89-16-162-21.no-reverse-dns-set.bytemark.co.uk/user/cboothroyd
Indicating the high user involvement in this editing this area;

53% of the data are come from Bing Map, previous known as Microsoft Virtual Earth, is a platform making use of properiety dataset from thrid party providers, who now is a partner of OSM
http://wiki.openstreetmap.org/wiki/Bing_Maps,
24% of the data are from Batam Mapping Project,
http://wiki.openstreetmap.org/wiki/Mapping_projects
10% created by MapBox commercial mapping services,,
http://wiki.openstreetmap.org/wiki/Mapbox
The curious entry "HDB" brings 0.8% of the data. I am interested in it since it reminds me of Singapore "Health Promotion Board", who has same acronym with it. HDB is a government department which distributes free fit trackers annully to people. Since it is integrated with a multifunctional app for tracking and recording data from users it actually makes sense to link it with the entry.

4.2.1 Top 10 Sources

sqlite> Select count(*) from tags where key="source";
42003
sqlite> select value, count(*),(count(*)/(42003/100.0)) from tags where key="source" group by value order by count(*) desc limit 10;
Bing|22397|53.322381734638
Batam Mapping Project|10083|24.0054281837012
Mapbox|4381|10.4302073661405
Yahoo aerial images|2256|5.37104492536247
GPS & Yahoo aerial images|414|0.985643882579816
HDB|344|0.818989119824775
GPS|329|0.783277384948694
bing|325|0.773754255648406
NGA-GNS|186|0.442825512463396
US NGA Pub. 112. 2009-11-12.|107|0.254743708782706

4.2.2 Top Editors

sqlite> select count(*) from tags where key="created_by" ;
7166
sqlite> select value, count(*),(count(*)/(7166/100.0))
... >from tags where key="created_by" group by value
... >order by count(*) desc limit 10;
JOSM|7022|97.9905107451856
Potlatch 0.10f|124|1.73039352497907

Potlatch 0.7a|6|0.0837287189506001

4.2.3 Top 10 Contributors and Respective Contribution

sqlite> select user,count(*),(count(*)/(1048575/100.0)) from nodes group by user order by count(*) desc limit 10;

JaLooNz|297434|28.3655437140882
berjaya|103273|9.84889016045586
cboothroyd|69220|6.60133991369239
rene78|65405|6.23751281501085
kingrollo|37280|3.55530124216198
Sihabul Milah|30443|2.90327349021291
jaredc|27044|2.57911928092888
zomgvivian|20718|1.97582433302339
matx17|20057|1.91278640059128
singastreet|18080|1.72424480843049

5. Areas for Improvement

Overall, OpenStreetMap is an awesome platform for collaborative mapping, I especailly love the part that everyone could be the editor and its data is acessible to everybody. But of course there is always room for improvement. I have couple of suggestions towards data cleaness and project promotion.

First of all, to improve the cleanness of data, instead of accepting whatever is inputted and then wrangling, it's more efficient to reduce mess from its sources. For example, form conventions and consensus among users, give incentive educational tasks o newbies, and prompt reminder whenever user is trying to type in invalid characters or unexpected format, so on. And since all of these highlight responsibility of users as a editor, they will for sure hance the image of credibility and reliability of OpenStreetMap too.

Second, to better brand OSM and deepen its impact, cooperation with government departments could be a meaningful next step instead of just confining partners within industry. With advocate and help from government OpenStreetMap can win reputation and start its business much faster and more smoothly. Some government might be happy to help any open sources project improving public welfare, and some are not. But even so, it's always worthwhile to convince them.