GIS with Python！

PyConJP2021 2021/10/15
Chomoku LLC: Hideyuki Ogawa
Translate with DEEPL

自己紹介

Name: Hideyuki Ogawa (@ogawahideyuki)

Company: Chomoku LLC (@hijichomoku)

Founder & CEO

CHOMOKU

We are hiring!!! Sorry we have no english site. (japanese site)

where: Kyoto

hobby: Jogging / Learn Chinese / BTS / No drinking

Talk: PyConJP2019, PyCon China Beijing 2019, PyCon mini HIroshima, PyConJP 2020 Tutorial

On PyConJP Blog

[Python Boot Camp in 京都を開催しました]

Thank you! PyConJP!!!

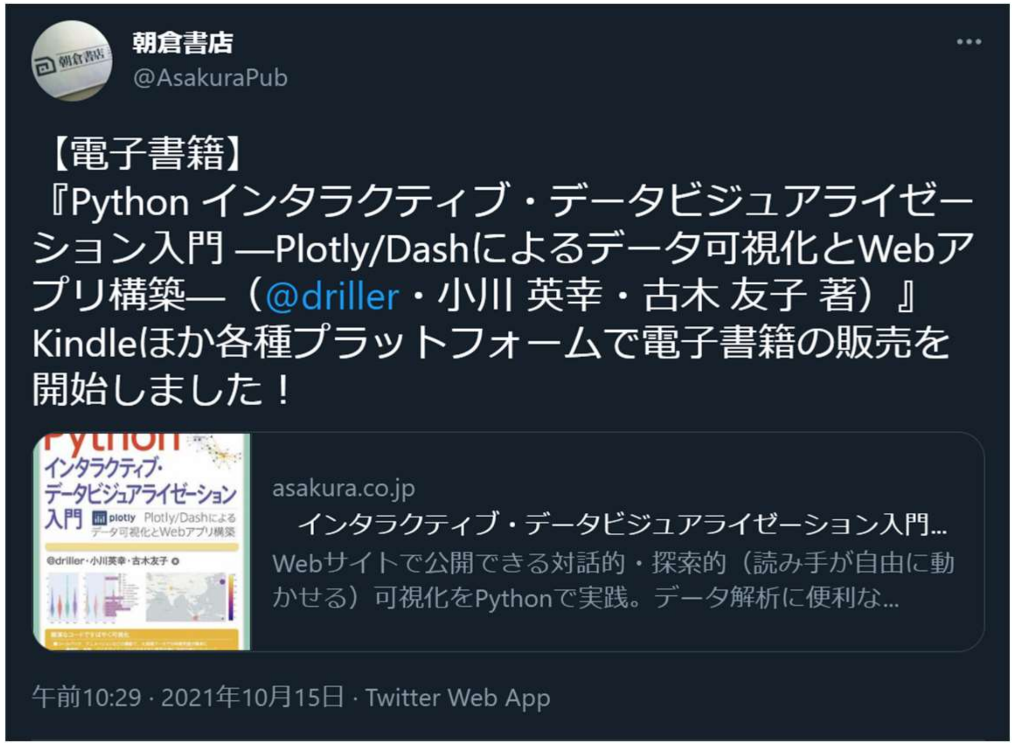
Writing

Webアプリケーション開発のためのプログラミング技術情報誌
FOR ALL WEB APPLICATION DEVELOPERS ウェブDBプレス
WEB+DB PRESS
評価制度
開発環境の整備
効果的な議論
vol. 118 2020
実践 オフィスに集まれない課題の解消方法
リモートワーク
Python ▶COVID-19 ▶家計調査 ▶財政データ
データ可視化
はじめての脆弱性調査
ツールで簡単!
Rails | nginx | サブドメイン | DB
速習 Googleスプレッドシート
教えて! 最新技術
ボタンのデザイン／JavaのOptional

Introduction to Interactive Data Visualization with Python
Python
インタラクティブ・データビジュアライゼーション入門
plotly
Plotly/Dashによる
データ可視化とWebアプリ構築
@driller・小川英幸・古木友子 著
朝倉書店

I write about Dash. Dash is plotly’s Web Framework.

Congrats on the ebook, more printings!

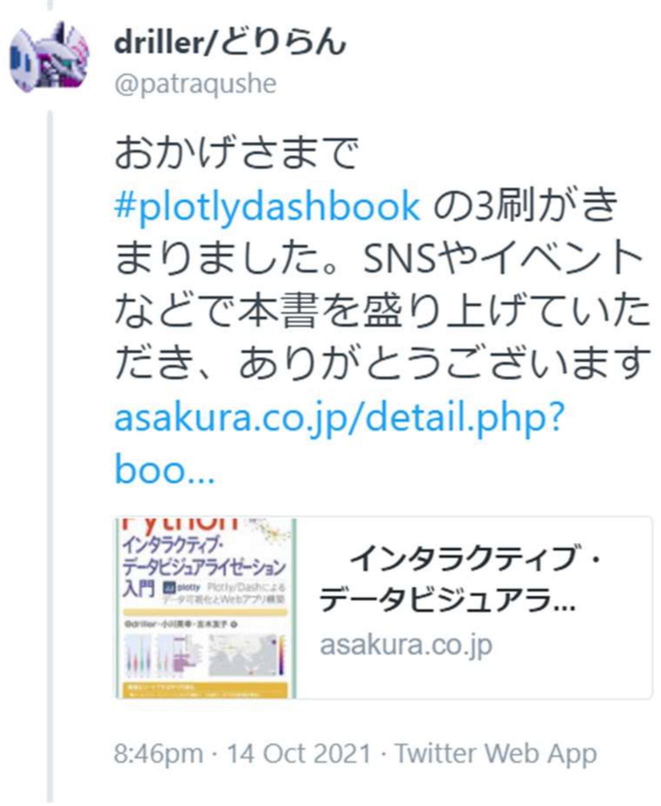


朝倉書店
@AsakuraPub

【電子書籍】
『Python インタラクティブ・データビジュアライゼーション入門 —Plotly/Dashによるデータ可視化とWebアプリ構築—（@driller・小川 英幸・古木 友子 著）』
Kindleほか各種プラットフォームで電子書籍の販売を開始しました！

asakura.co.jp
インタラクティブ・データビジュアライゼーション入門...
Webサイトで公開できる対話的・探索的（読み手が自由に動かせる）可視化をPythonで実践。データ解析に便利な...

午前10:29 · 2021年10月15日 · Twitter Web App



driller/どりらん
@patraqushe

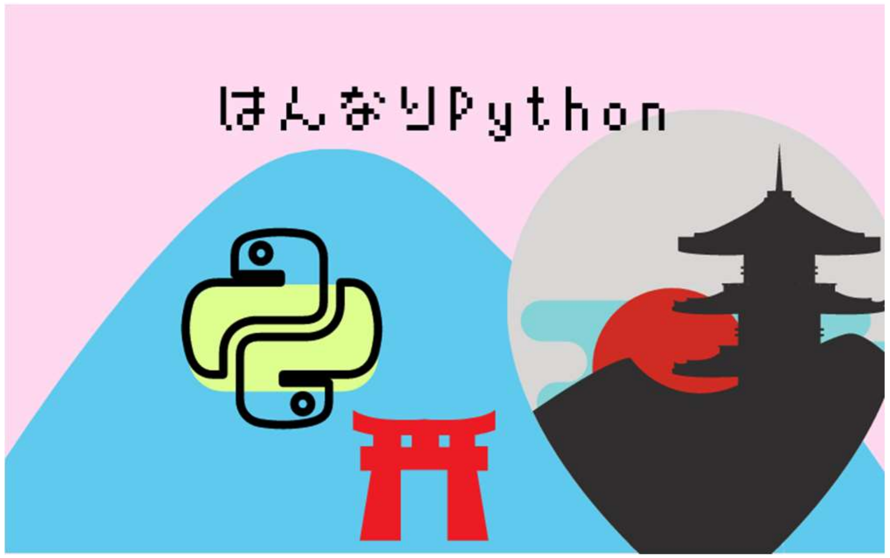
おかげさまで
#plotlydashbook の3刷ができました。SNSやイベントなどで本書を盛り上げていただき、ありがとうございます
asakura.co.jp/detail.php?boo...

インタラクティブ・データビジュアラ...
asakura.co.jp

8:46pm · 14 Oct 2021 · Twitter Web App

Hannari Python

- Python community in Kyoto
- Recently held Online!!!
- Once a week
- Social Tipping!!
- Donate
  - PyCharity
  - Red Cross
  - Japanese Student Service Organization
- https://hannari-python.connpass.com/



I appreciate before my talk.

To the medical community and all those who support society

Thank you!

Motivation for the talk.

- I dealt with a lot of location data at work.
- I realized the importance of location data in dealing with the real world we live in.
- On the other hand, the usage is rarely talked about (me too. according to me).
- Expectation that by talking, other people will start to talk about various things.
- I'll talk about the basics and how to use them.
- Also, there may be some mistakes, so if you notice any, please point them out to me!

Main Packages

- shapely
    - Handling geospatial information
- geopandas
    - Handling geospatial information as tabular data
- xarray
    - Handling multidimensional data
- folium / plotly / pydeck
    - Visualization of geospatial information

agenda

- Location data / Geospatial information
- File Formats
- How to use
  - Personal behavior data
  - National census
  - Himawari
  - Satellite Images

agenda

- **Location data / Geospatial information**
- File Formats
- How to use
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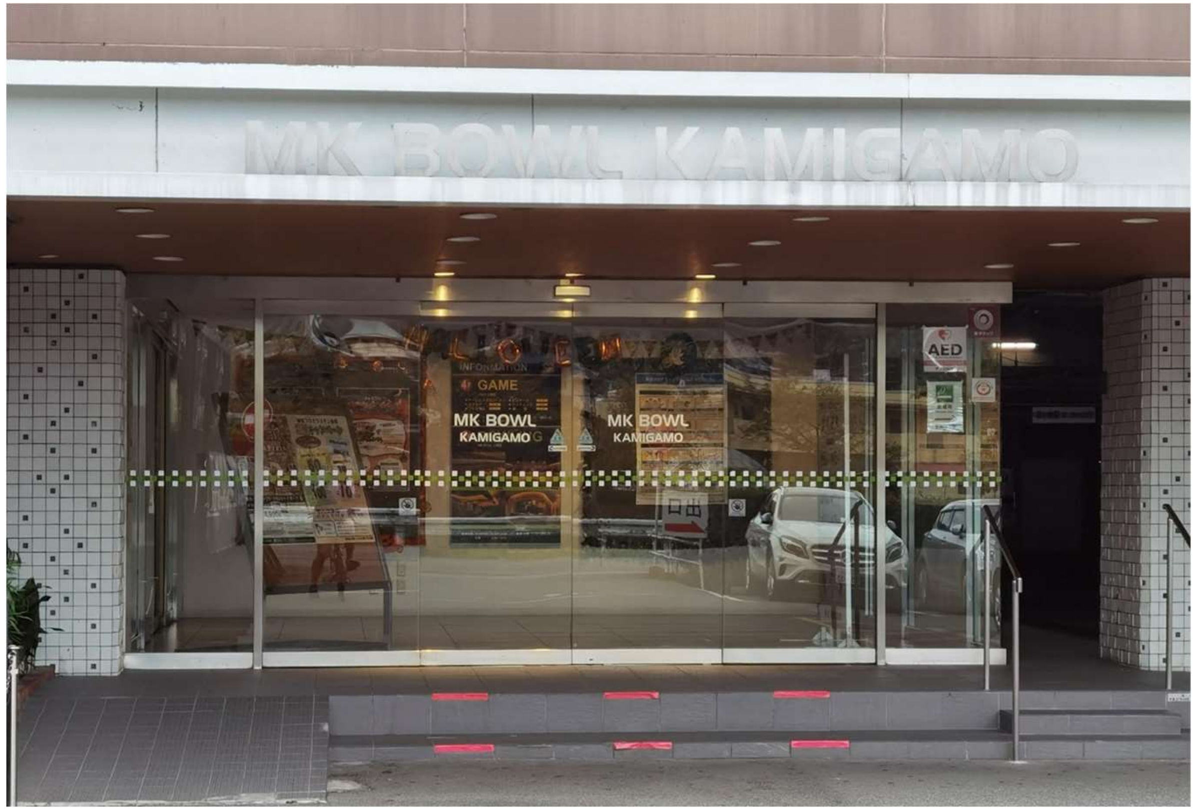
    - Himawari
    - Satellite Images

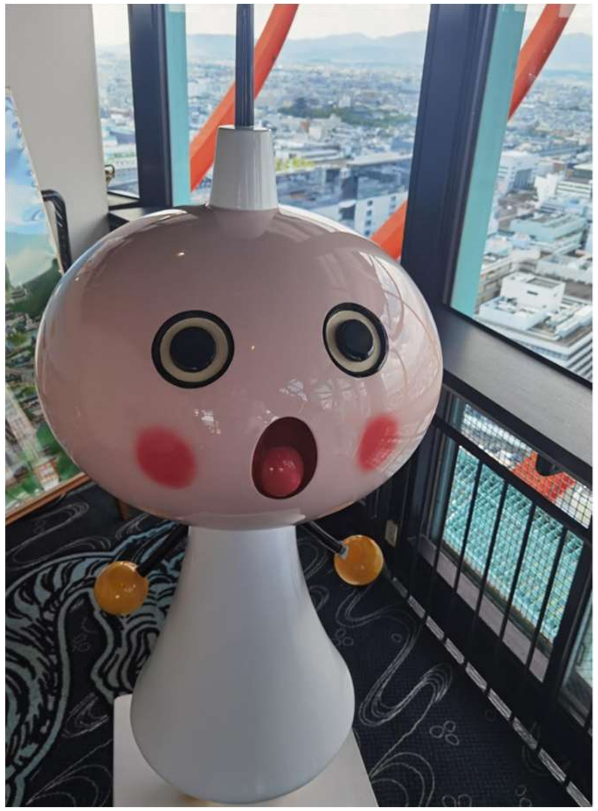
2020/2 〜 2021/10

- I can't go out.
- In 2019, I'd be at PyConJP in Tokyo in September, and PyCon China Beijing in October.
    - But these days….
- My area of activity（WFH : 2020/3 - 2021/10 99%）

North: MK BOWL KAMIGAMO

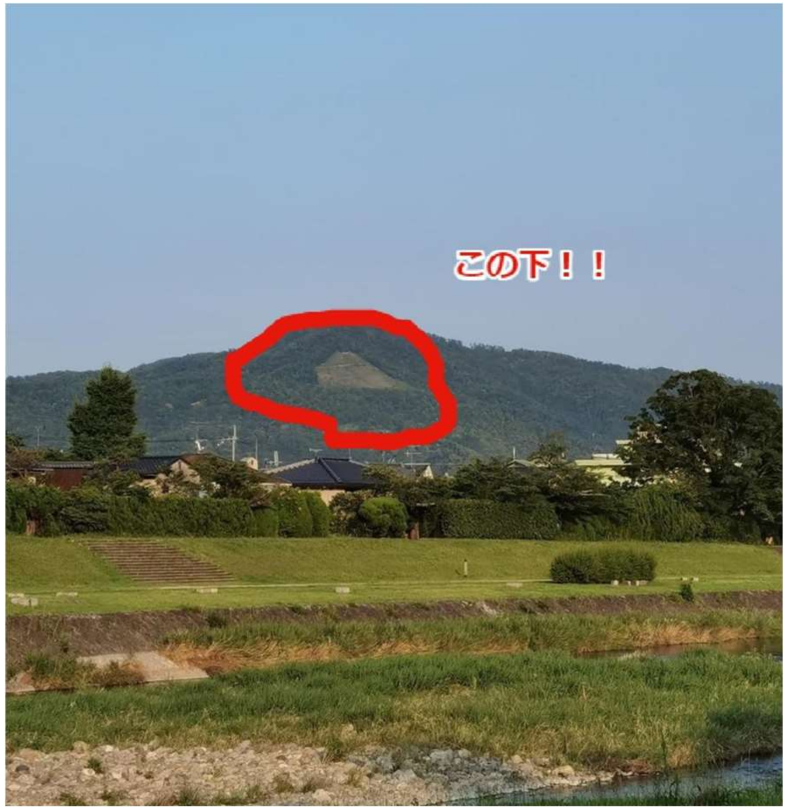


SOUTH: KYOTO STATION (KYOTO TOWER)



WEST: KINKAKUJI

EAST: GINKAKUJI

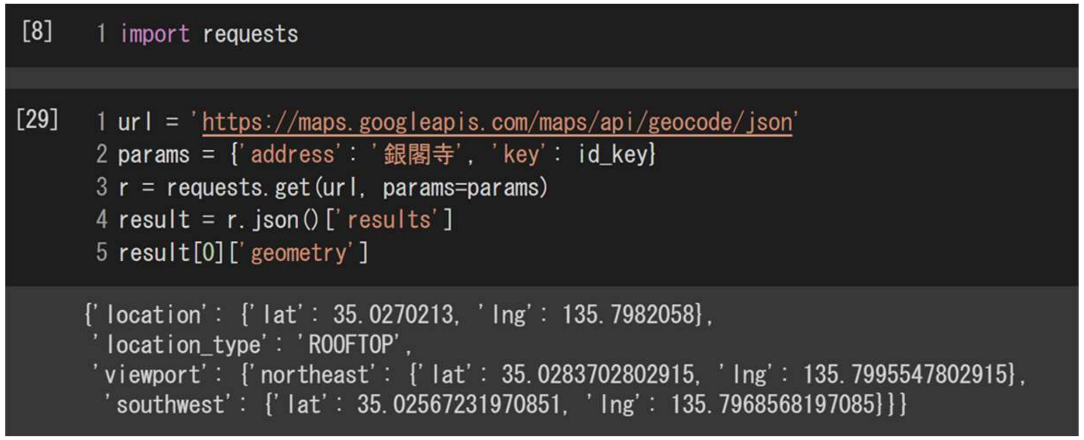


Use Google Map

- Only people in Kyoto would understand, so let's take a look on Google Maps!
  - Googlemap: My Place
  - https://goo.gl/maps/cFh66Zmg4j7cgfsG7
  - google is smart
- Google Maps plots the location by name.
  - ex. Ginkakuji
  - Address: 〒606-8402 京都府京都市左京区銀閣寺町2
  - Maybe it's plotted as place name -> address -> coordinates.
  - Search by GinkakujiCoordinates -> Latitude and Longitude: 35.0270° N, 135.7983° E

GeoCoding

- Don't pass addresses when plotting location data.
- Specify by coordinates such as latitude and longitude.
- Conversion from place names and addresses to latitude and longitude is called geocoding.
- Geocoding example (google's geocoding API: API_KEY required)



```
[8]   import requests
```

```
[29]  url = 'https://maps.googleapis.com/maps/api/geocode/json'
      params = {'address': '銀閣寺', 'key': id_key}
      r = requests.get(url, params=params)
      result = r.json()['results']
      result[0]['geometry']
```

```
{'location': {'lat': 35.0270213, 'lng': 135.7982058},
 'location_type': 'ROOFTOP',
 'viewport': {'northeast': {'lat': 35.0283702802915, 'lng': 135.7995547802915},
  'southwest': {'lat': 35.02567231970851, 'lng': 135.7968568197085}}}
```

Coordinates

- latitude and longitude
  - latitude
    - Represents north and south (up to 90 degrees)
    - 0 degrees from the equator
  - longitude
    - Representation of east and west (up to 180 degrees)
    - 0° prime meridian: 102.478m east of
    - Greenwich Observatory
- Sometimes expressed as decimals, but often expressed in degrees, minutes, and seconds, and the minutes and seconds must be divided by 60.
- Expressing latitude and longitude as numerical values can be used to identify locations.
- On the other hand, there are multiple expressions, and it is very difficult to

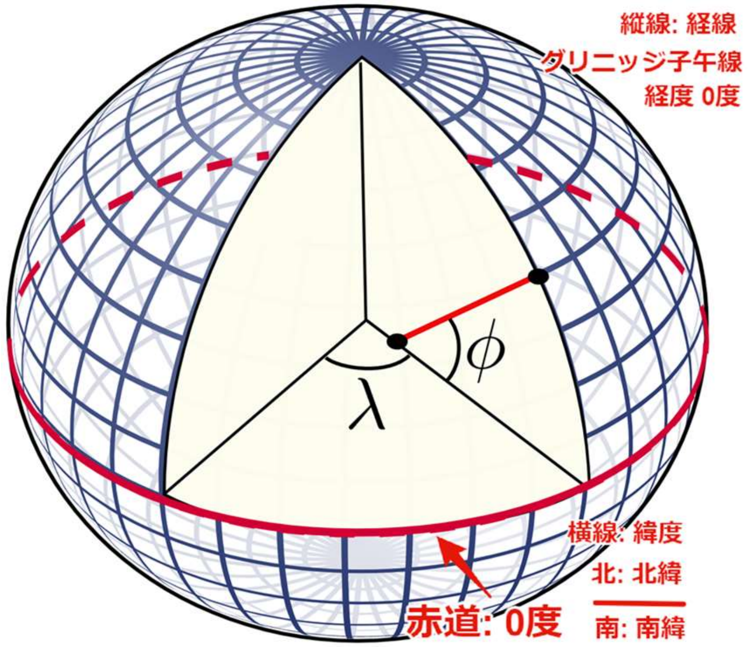


image: Peter Mercator, Public domain, from wikimedia commons

Coordinate Reference System（CRS）

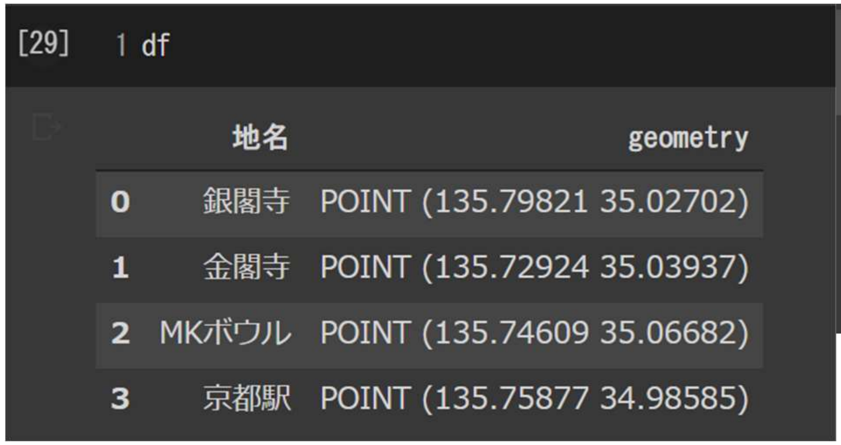
- There are multiple definitions for expressing position.
  - A geodesic system that defines what to do with a bumpy elliptical earth.
  - Representing the Earth as a Sphere? Coordinate system for planar representation.
  - A combination of many geodetic and coordinate systems => coordinate reference system
  - According to the GeoRepository site, there are 6547 CRSs.
    - It is run by The International Association of Oil & Gas Producers (IOGP).
  - If you don't pay attention to this, you won't be able to make use of the location data at all.
- Please refer to books and other sources for accurate information.

Shapely

- Use shapely to represent geospatial information
  - https://shapely.readthedocs.io/en/stable/
- Express space using Point, LineString, and Polygon
  - Pass numerical values in the order of x, y (longitude / latitude)
  - There is also Multi * that puts each together.
    - Point : MultiPoint
    - LineString : MultiString
    - Polygon : MultiPolygon
- Notebook Link
  - Colab: https://colab.research.google.com/drive/1CU8jzoLs8Hv0NNmHqES3gtYqneX_PvNJ?usp=sharing

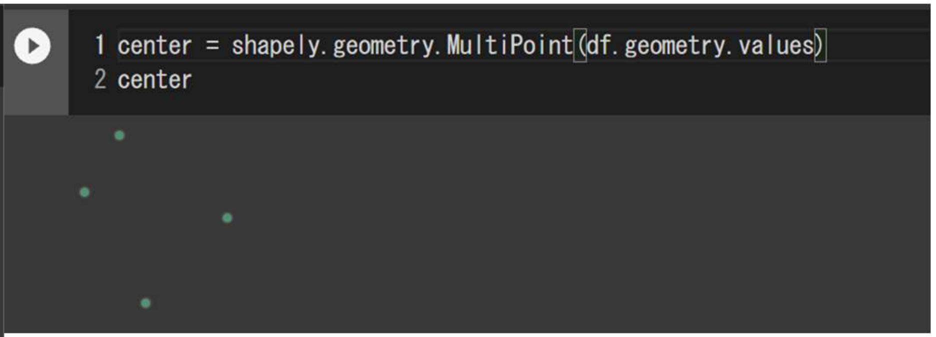
Express the area of my activity with Point

- Expressed in latitude and longitude
- When set to MultiPoint, it is displayed with 4 points



```
[29] df
```

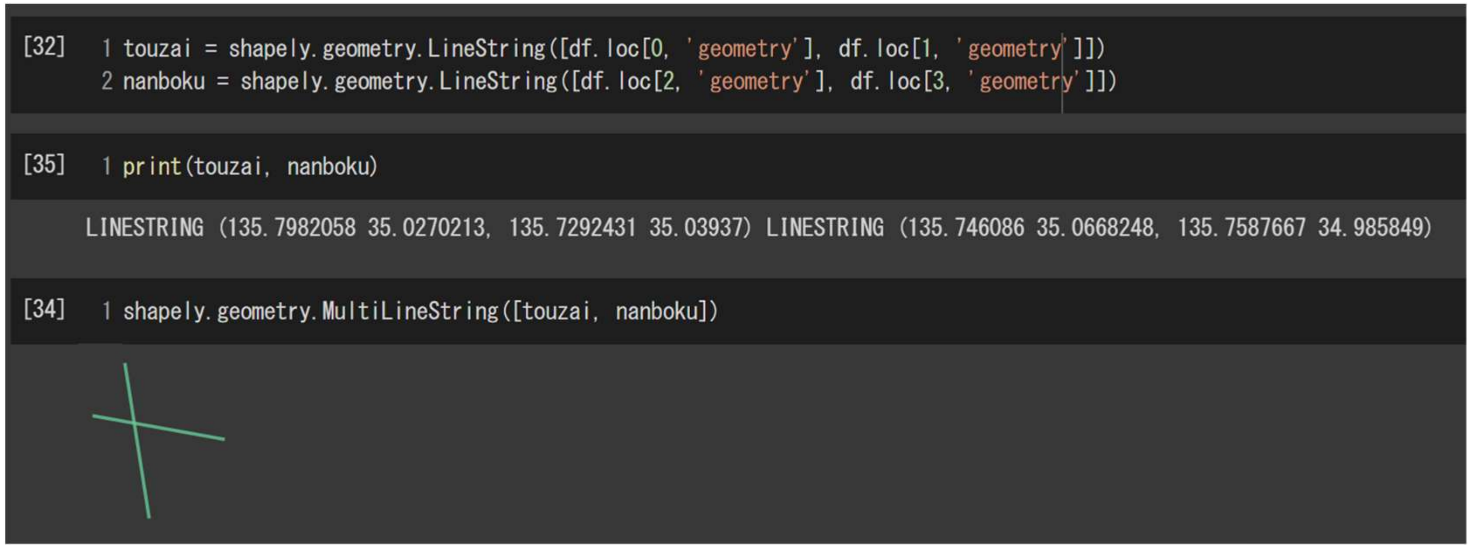
	地名	geometry
0	銀閣寺	POINT (135.79821 35.02702)
1	金閣寺	POINT (135.72924 35.03937)
2	MKボウル	POINT (135.74609 35.06682)
3	京都駅	POINT (135.75877 34.98585)



```
center = shapely.geometry.MultiPoint(df.geometry.values)
center
```

Express the area of my activity with LineString

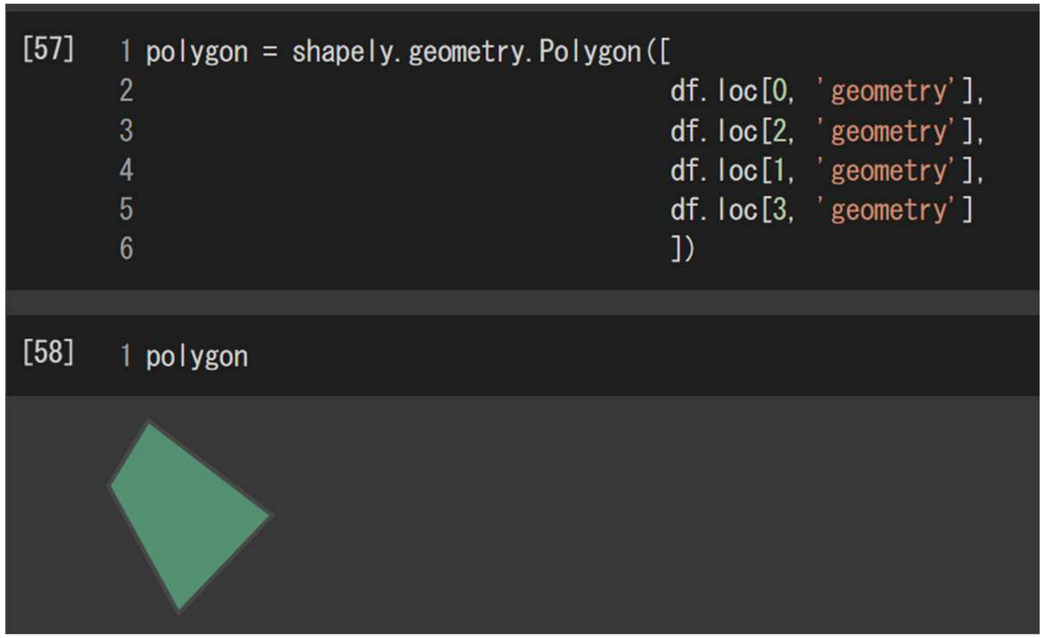
- If you pass a Point to multiple LineStrings, it will be represented by a line.
- Let's make a line between east and west, north and south.



```
[32]  touzai = shapely.geometry.LineString([df.loc[0, 'geometry'], df.loc[1, 'geometry']])
      nanboku = shapely.geometry.LineString([df.loc[2, 'geometry'], df.loc[3, 'geometry']])

[35]  print(touzai, nanboku)

LINESTRING (135.7982058 35.0270213, 135.7292431 35.03937) LINESTRING (135.746086 35.0668248, 135.7587667 34.985849)

[34]  shapely.geometry.MultiLineString([touzai, nanboku])
```

Express the area of my activity with Polygon

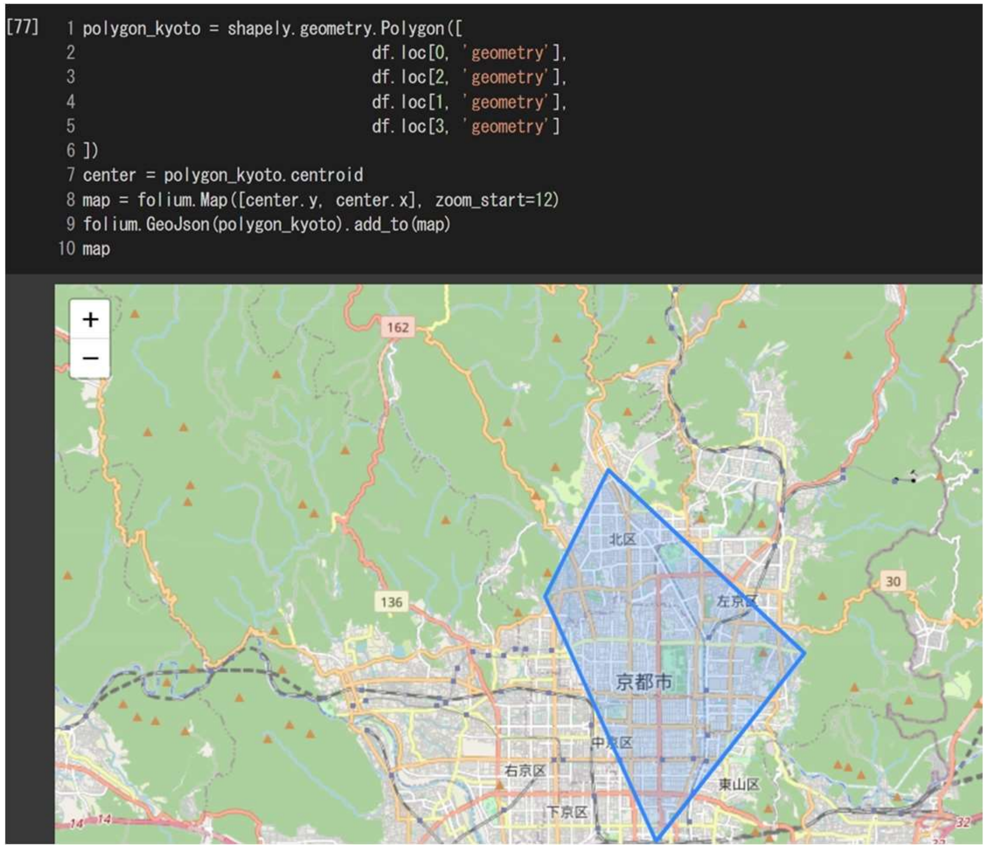
- When multiple Points are passed, they are represented as Polygon.
- Convert four points to a Polygon.



```
[57] polygon = shapely.geometry.Polygon([
                                            df.loc[0, 'geometry'],
                                            df.loc[2, 'geometry'],
                                            df.loc[1, 'geometry'],
                                            df.loc[3, 'geometry']
                                            ])

[58] polygon
```

Plotting

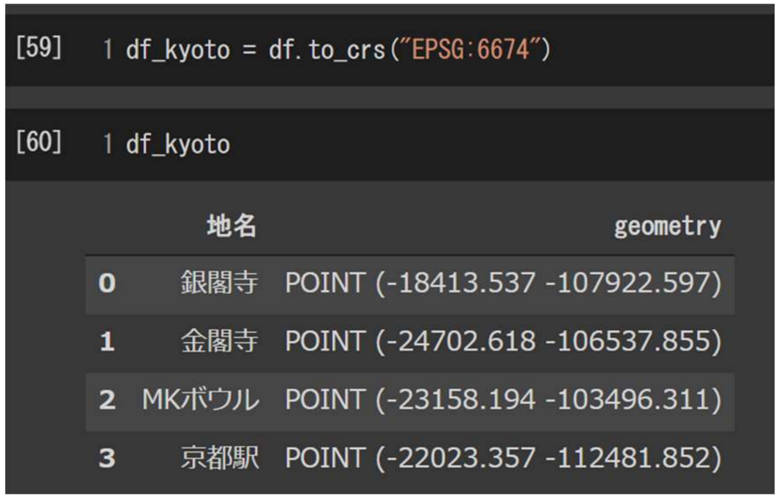
- Plotting with folium.



```
polygon_kyoto = shapely.geometry.Polygon([
                              df.loc[0, 'geometry'],
                              df.loc[2, 'geometry'],
                              df.loc[1, 'geometry'],
                              df.loc[3, 'geometry']
])
center = polygon_kyoto.centroid
map = folium.Map([center.y, center.x], zoom_start=12)
folium.GeoJson(polygon_kyoto).add_to(map)
map
```

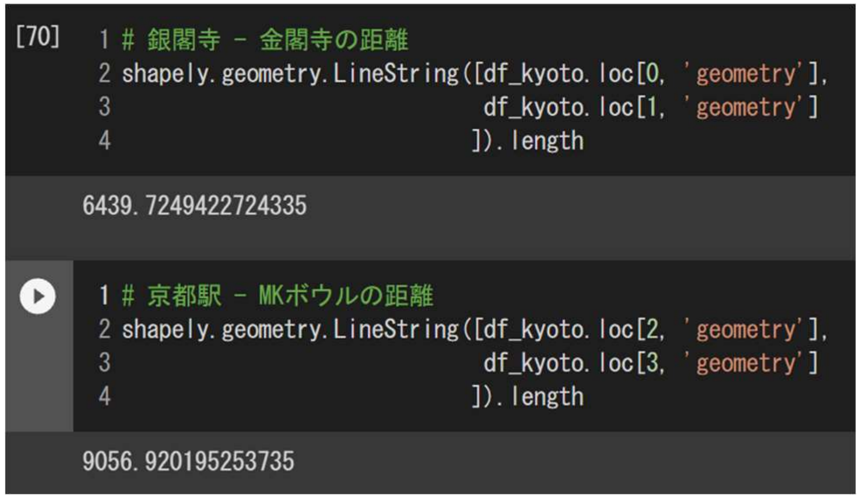
Measure distances by transforming the coordinate reference system.

- In this case, EPSG4326 => EPSG6674
- By doing so, we can measure the distance between line segments.
- There are various attributes.



```
[59] df_kyoto = df.to_crs("EPSG:6674")

[60] df_kyoto
```

	地名	geometry
0	銀閣寺	POINT (-18413.537 -107922.597)
1	金閣寺	POINT (-24702.618 -106537.855)
2	MKボウル	POINT (-23158.194 -103496.311)
3	京都駅	POINT (-22023.357 -112481.852)



```
[70] # 銀閣寺 - 金閣寺の距離
     shapely.geometry.LineString([df_kyoto.loc[0, 'geometry'],
                                  df_kyoto.loc[1, 'geometry']
                                 ]).length

     6439.7249422724335

     # 京都駅 - MKボウルの距離
     shapely.geometry.LineString([df_kyoto.loc[2, 'geometry'],
                                  df_kyoto.loc[3, 'geometry']
                                 ]).length

     9056.920195253735
```

agenda

- Location data / Geospatial information
- File Formats
- How to use
  - Personal behavior data
  - National census
  - Himawari
  - Satellite Images

agenda

- Location data / Geospatial information
- **File Formats**
- How to use
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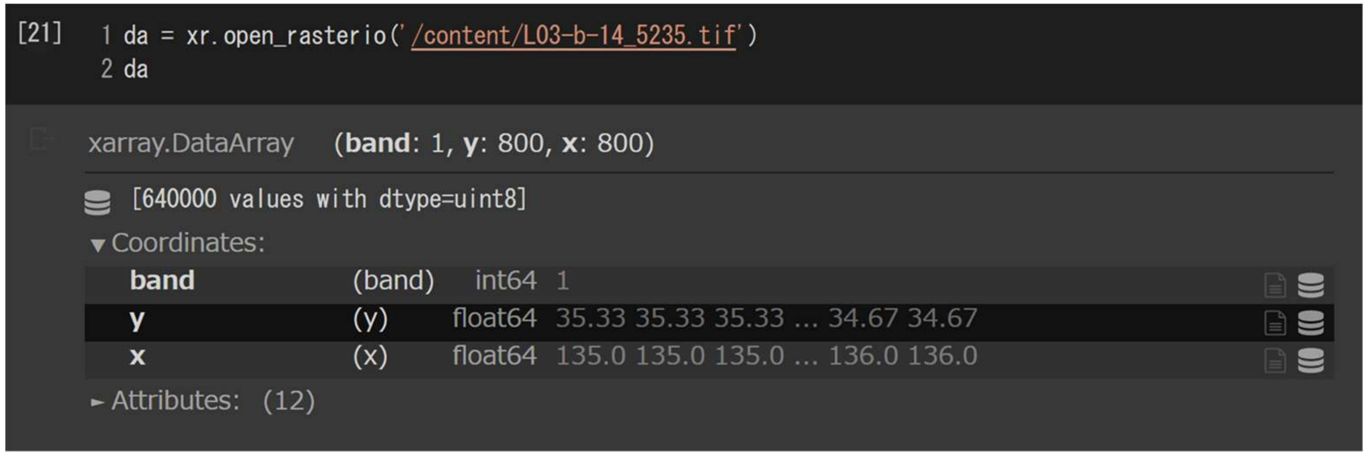
File Formats

- Raster Data
  - Data is stored in a grid.
  - File format: GeoTIFF, etc.
  - Packages: rasterio, **xarray**
- Vector Data
  - Data created from points, line strings, and polygons
  - File formats: Shape, GeoJSON, KML, etc.
    - Shapefile consists of about 3-5 files.
  - Packages: **geopandas**

Raster Data

- Data: National Land Information: Land use fine mesh (raster version)
  - https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-L03-b_r.html
  - Handling the Kyoto area: 5235
  - Unzip the zip and load the tif file with xarray's open_rasterio function.
  - The data are stored in 100m mesh at each location with the values of land cover classification.
  - Actual reading and objects.

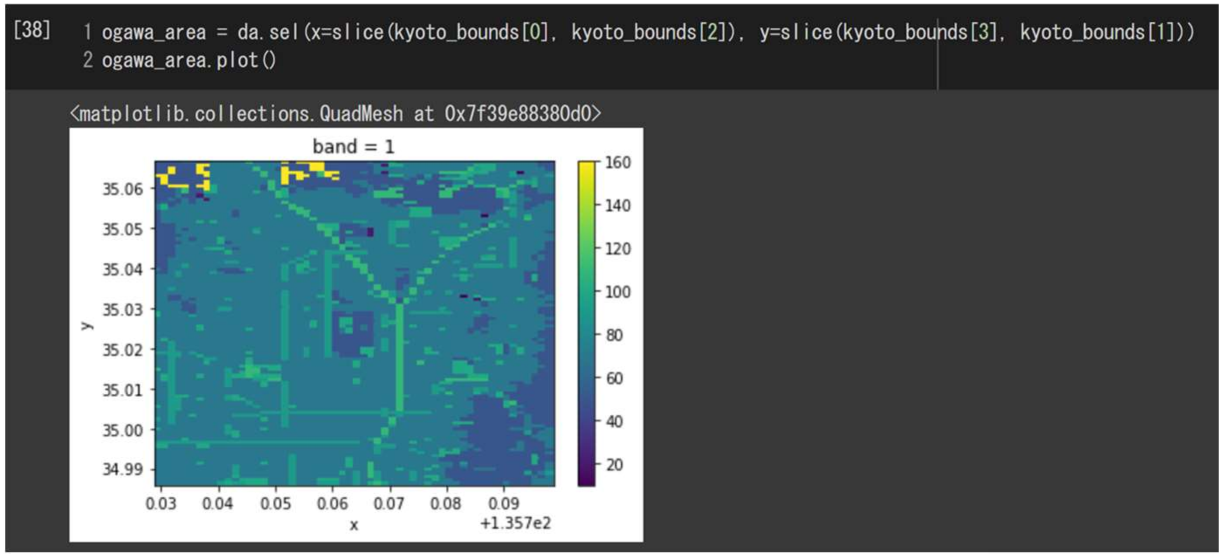


```
[21]  da = xr.open_rasterio('/content/L03-b-14_5235.tif')
      da
```

```
xarray.DataArray    (band: 1, y: 800, x: 800)

[640000 values with dtype=uint8]
▼Coordinates:
  band      (band)   int64  1
  y         (y)      float64  35.33 35.33 35.33 ... 34.67 34.67
  x         (x)      float64  135.0 135.0 135.0 ... 136.0 136.0
► Attributes:  (12)
```

Raster Data 2

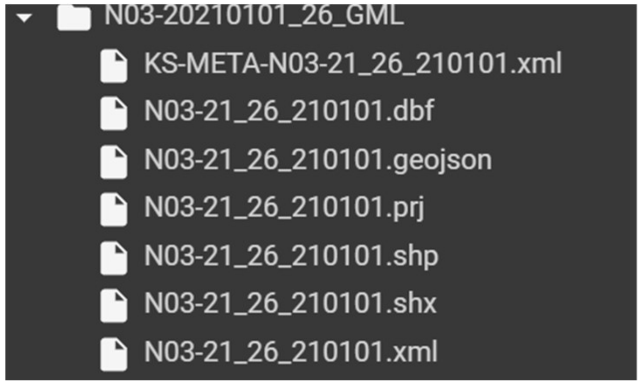
- Cut out area of my activity.
  - Can be visualized with the plot method.
  - Using xarray makes it easy to cut out data.



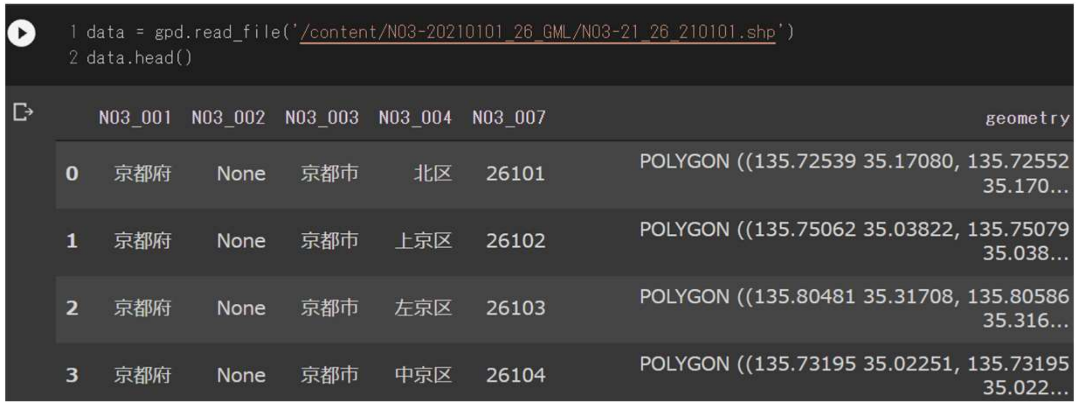
```
[38] ogawa_area = da.sel(x=slice(kyoto_bounds[0], kyoto_bounds[2]), y=slice(kyoto_bounds[3], kyoto_bounds[1]))
     ogawa_area.plot()

<matplotlib.collections.QuadMesh at 0x7f39e88380d0>
```

Vector Data

- Data used: National Land Data: Administrative Area Data
  - https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-N03-v3_0.html#!
  - As usual, kyoto data.
  - The ZIP contains both shape and geojson.



```
N03-20210101_26_GML
    KS-META-N03-21_26_210101.xml
    N03-21_26_210101.dbf
    N03-21_26_210101.geojson
    N03-21_26_210101.prj
    N03-21_26_210101.shp
    N03-21_26_210101.shx
    N03-21_26_210101.xml
```

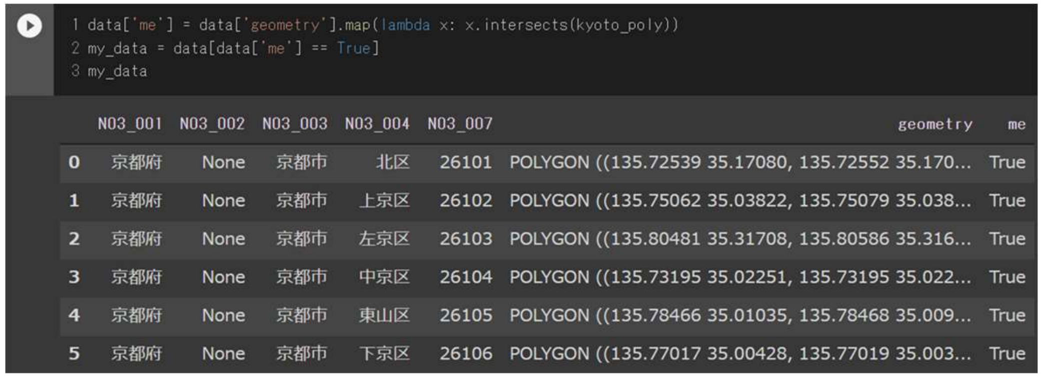


```python
data = gpd.read_file('/content/N03-20210101_26_GML/N03-21_26_210101.shp')
data.head()
```

```
   N03_001  N03_002  N03_003  N03_004  N03_007                                          geometry
0  京都府    None     京都市     北区     26101   POLYGON ((135.72539 35.17080, 135.72552 35.170...
1  京都府    None     京都市     上京区   26102   POLYGON ((135.75062 35.03822, 135.75079 35.038...
2  京都府    None     京都市     左京区   26103   POLYGON ((135.80481 35.31708, 135.80586 35.316...
3  京都府    None     京都市     中京区   26104   POLYGON ((135.73195 35.02251, 135.73195 35.022...
```

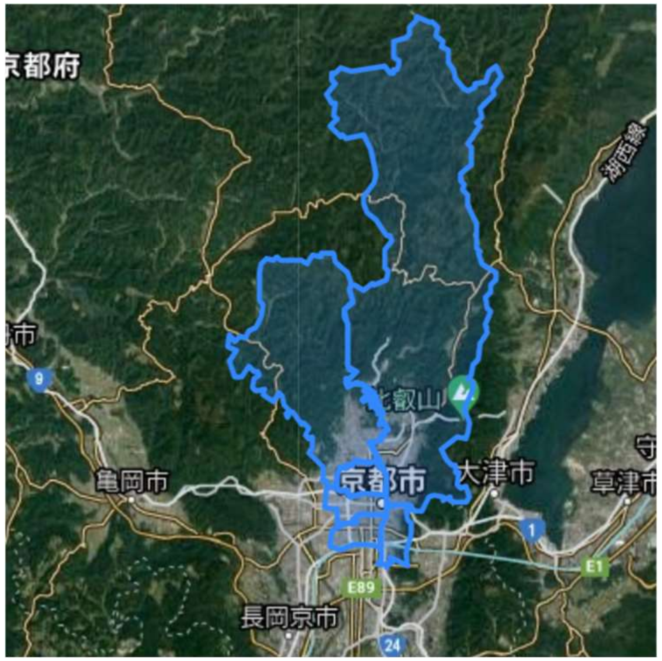
Vector Data 2

- Find out which wards are in my activity.
    - Use intersects method.
    - visualize with folium
    - The light blue area is vector data.
    - With google satellite data.
    - I was surprised by the length of Sakyo Ward.



```
data['me'] = data['geometry'].map(lambda x: x.intersects(kyoto_poly))
my_data = data[data['me'] == True]
my_data
```

	N03_001	N03_002	N03_003	N03_004	N03_007	geometry	me
0	京都府	None	京都市	北区	26101	POLYGON ((135.72539 35.17080, 135.72552 35.170...	True
1	京都府	None	京都市	上京区	26102	POLYGON ((135.75062 35.03822, 135.75079 35.038...	True
2	京都府	None	京都市	左京区	26103	POLYGON ((135.80481 35.31708, 135.80586 35.316...	True
3	京都府	None	京都市	中京区	26104	POLYGON ((135.73195 35.02251, 135.73195 35.022...	True
4	京都府	None	京都市	東山区	26105	POLYGON ((135.78466 35.01035, 135.78468 35.009...	True
5	京都府	None	京都市	下京区	26106	POLYGON ((135.77017 35.00428, 135.77019 35.003...	True



agenda

- Location data / Geospatial information
- File Formats
- How to use
    - Personal behavior data
    - National census
    - Himawari
    - Satellite Images

agenda

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- **How to use**
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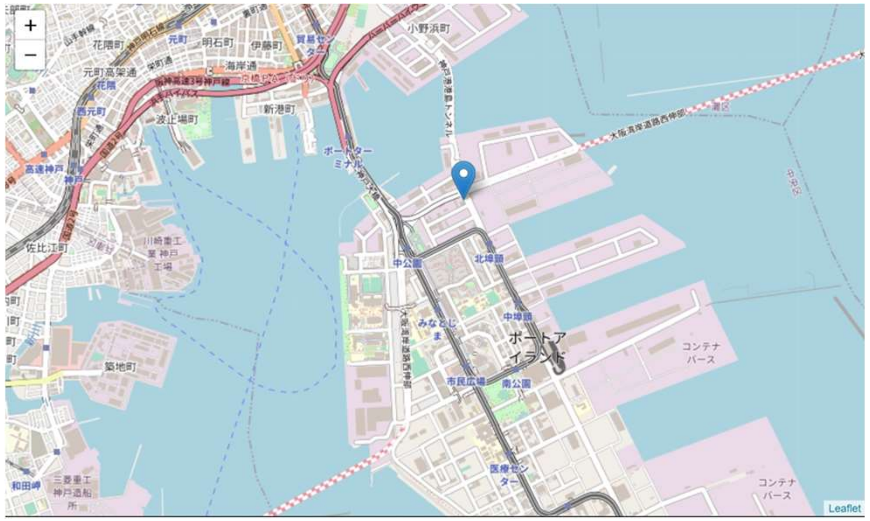
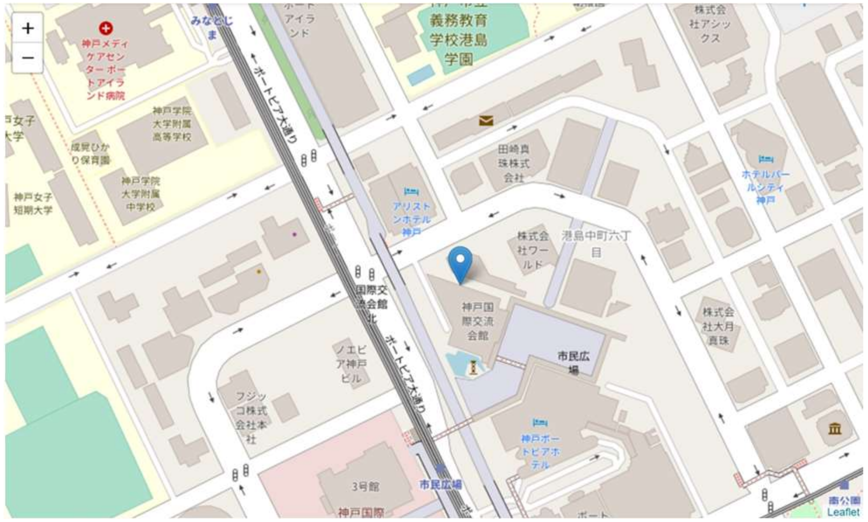
Personal behavior data

- Data: GPS trajectory linked data project
  - https://github.com/koujikozaki/GPS2LOD (CC4.0)
  - CSV file
  - Description: Behavior during a conference
  - We have time and location data, altitude, speed, etc.
  - I'll observe the data to see if everyone was acting seriously.
  - colab: https://colab.research.google.com/drive/1_LNM-AKdpcuJb-vOzPKJt3O81o1jOGia?usp=sharing
- data processing
  - We will use speed, location, and personal information.
  - Converted the data to every 30 minutes.
  - Point type for position information that exists as a float.
  - DataFrame => GeoDataFrame
  - CSV => GeoJson

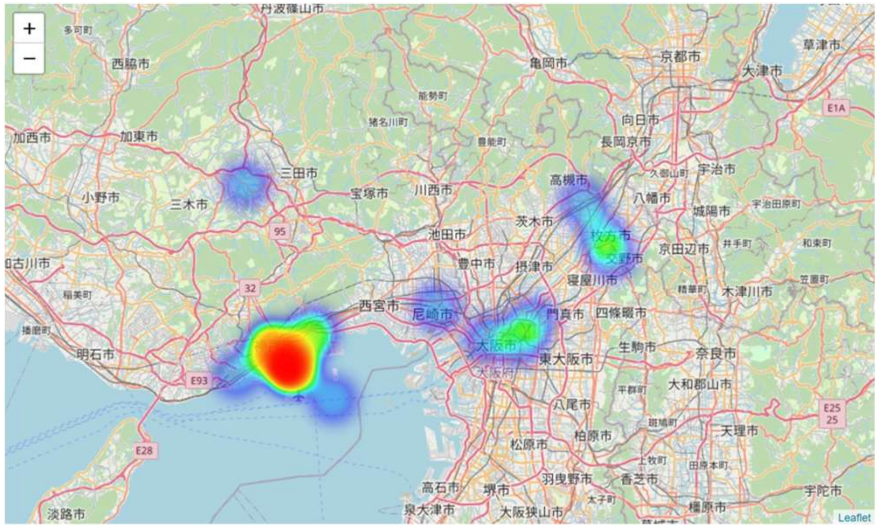
Personal behavior data 2

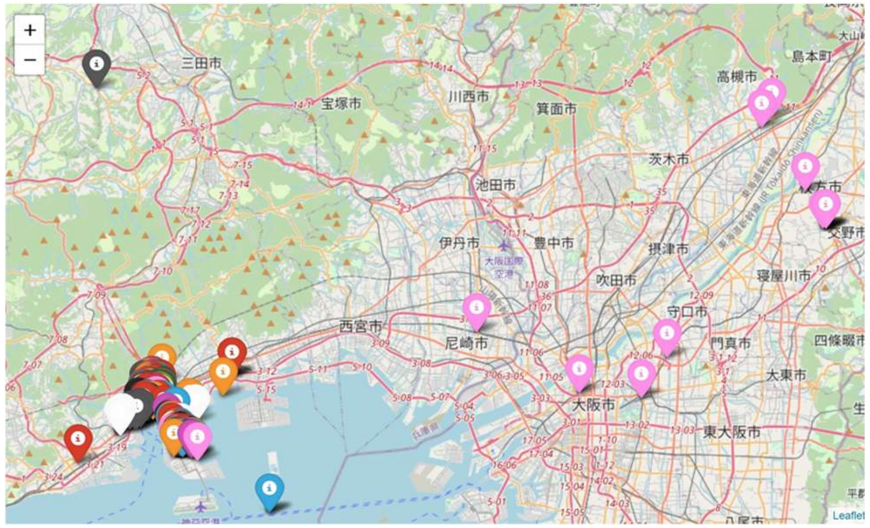
- What is the central point of everyone's actions?
  - It can be obtained with the centroid attribute of MultiPoint, but it is the center of movement... (left)
  - I created a median from position data that is a float (right): Bingo!

Personal behavior data 3

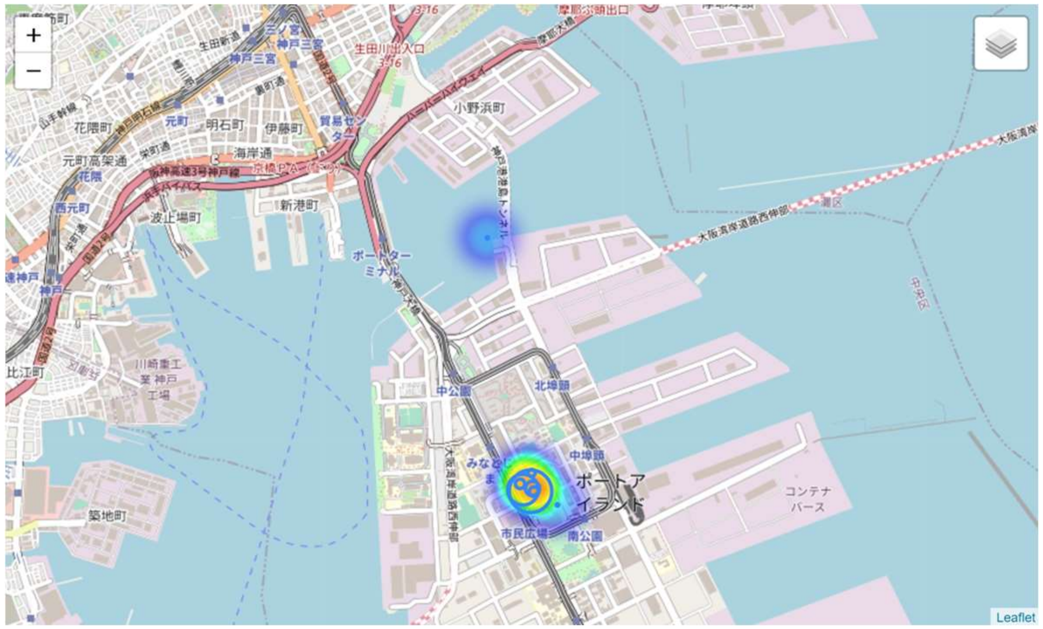
- Observe the behavior of all people.
- Use heat maps to observe where the frequency was highest.
- Observe each individual by separating them by color.





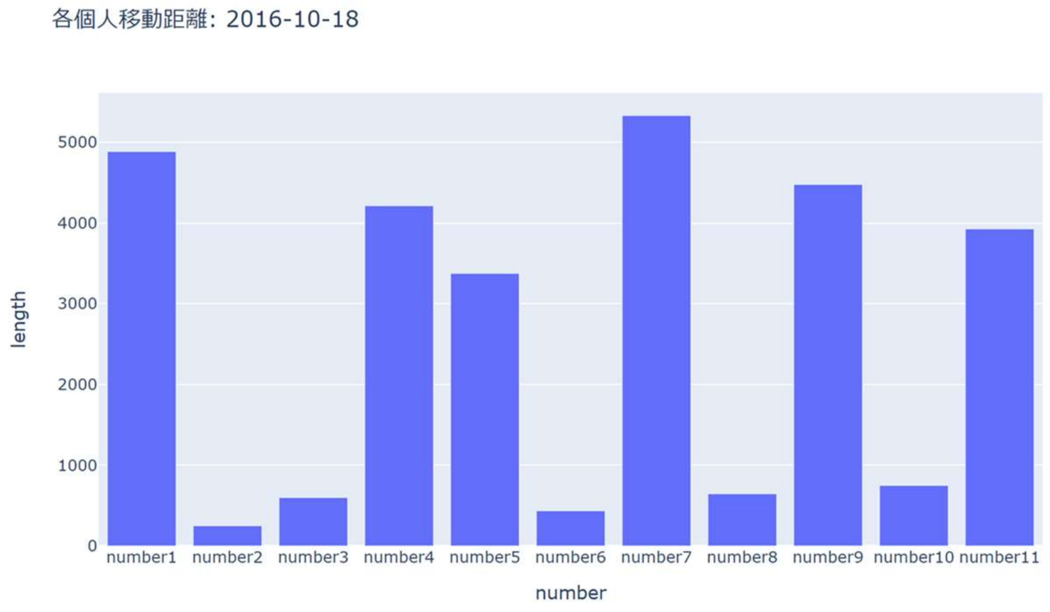
Personal behavior data 4

- The speed of each individual at a given point in time is represented by the size of the circle.
- Heat map representation of how many people are gathering.



Personal behavior data 4

- Compare the daily latitude distance for each individual
- Change the coordinate reference system to express in meters.（EPSG4326 => EPSG6673）



agenda

- Location data / Geospatial information
- File Formats
- How to use
    - Personal behavior data
    - National census
    - Himawari
    - Satellite Images

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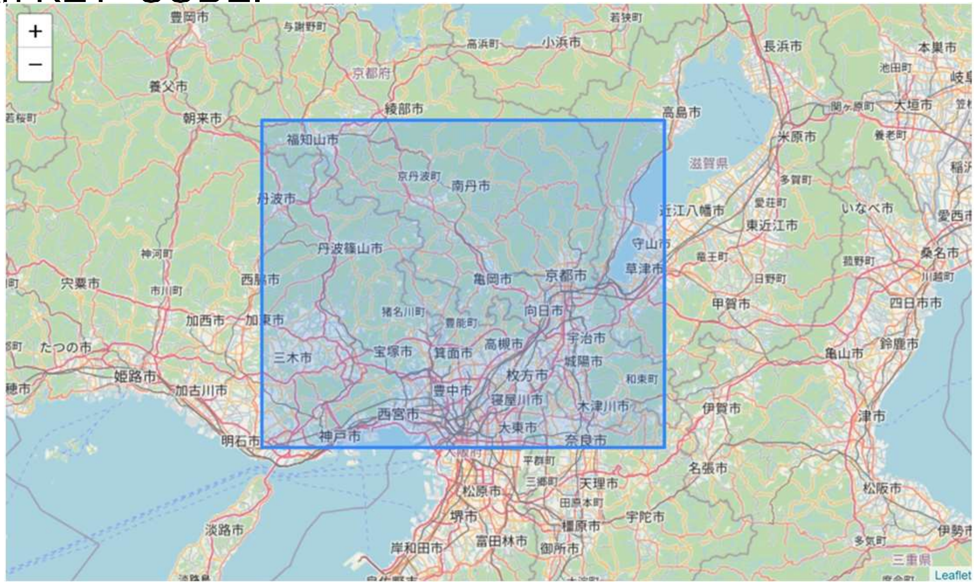
National census

- Census is the most important statistical survey of the country.
    - We can also get data on the number of people in each household, their ages, etc.
    - Nationwide, divided by town/character, data created by 1km, 500m, 250m mesh.
    - Statistical data and boundary data are kept separately, and regional data is created by merging the two.
    - Can be obtained in csv and shape file(zipped up).
    - https://www.e-stat.go.jp/gis
- In this article, we will show examples of marketing using basic statistics such as population.
    - Marketing to ages 0-14
    - Marketing to foreign residents
- Colab: https://colab.research.google.com/drive/1QspBpoW9BO_ofXmrLOX3a04YD5SE_3eH?usp=sharing

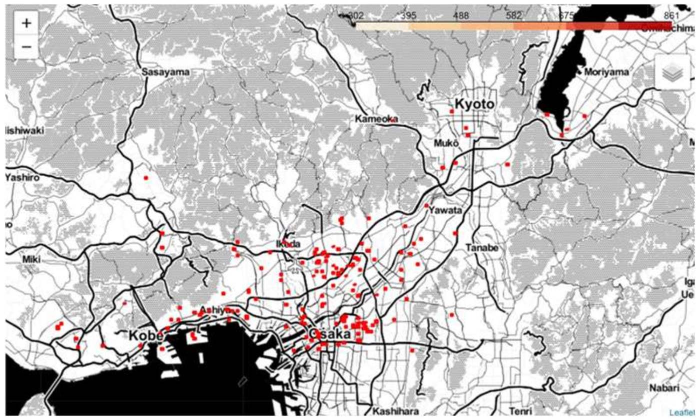
National census 2

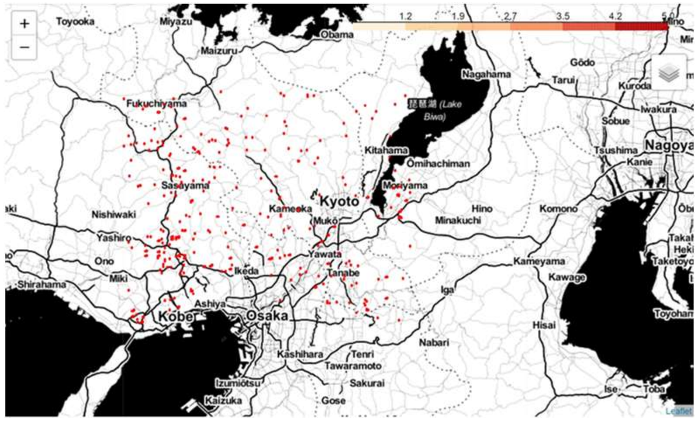
- We have created a data set that includes the central part of Kyoto.
  - Data on total population, sex ratio, age structure, number of households, etc. on a 250-meter mesh
  - Merged with KEY CODE.



National census 3

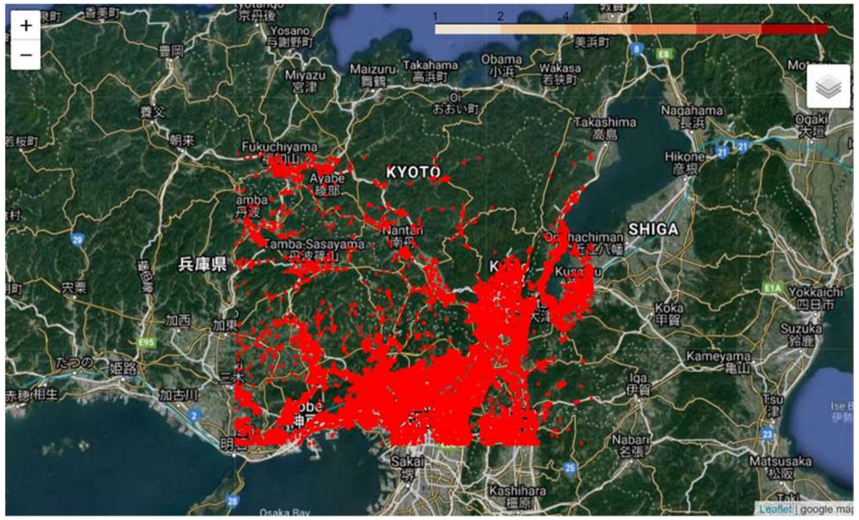
- Use the 0-14 year old population to find areas that are likely to have a younger population.
  - Separate by total number and ratio (300+, 40%)
  - This area can be created with Pandas-like processing.





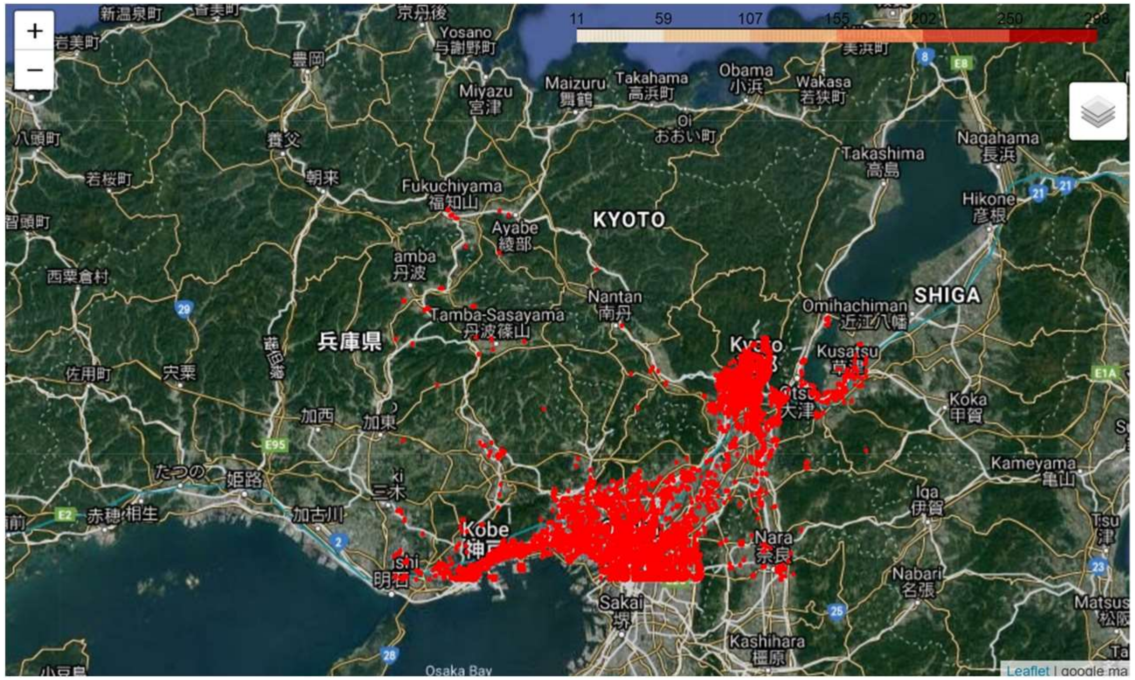
National census 4

- Delivering information to foreign residents.
- The less foreigners they have nearby, the more difficult it will be to get information.
- Find areas with less than 10 people on a 250 meter mesh.



National census 5

- There were more people under 10 than I expected, so I checked for people over 10.



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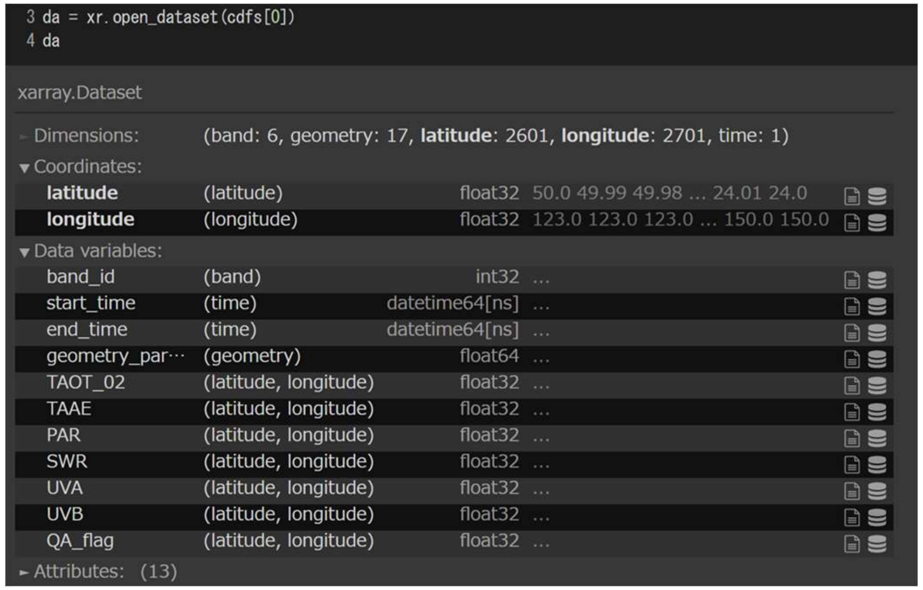
Meteorological data with xarray

- Data: PTree 「(c) JAXA・気象庁」
  - Colab: https://colab.research.google.com/drive/1J3QU3Hv2iO1EKYGKma96CkkFeVqqzzrD?usp=sharing
- Description https://www.eorc.jaxa.jp/ptree/userguide_j.html
  - Non-commercial use only.
  - Buy it if it's commercial use!
- Data is in NetCDF format
  - Multidimensional Array
  - Use xarray
- What to do
  - See how the amount of sunlight
  - changes over the of a day.



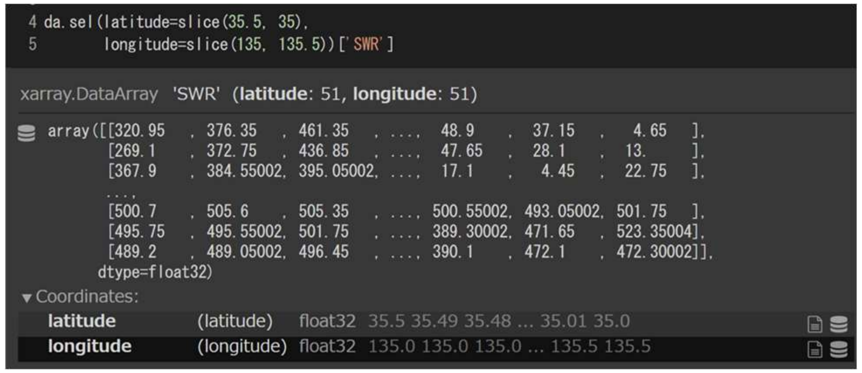
```python
da = xr.open_dataset(cdfs[0])
da
```

```
xarray.Dataset

► Dimensions:     (band: 6, geometry: 17, latitude: 2601, longitude: 2701, time: 1)
▼ Coordinates:
   latitude       (latitude)                     float32  50.0 49.99 49.98 ... 24.01 24.0
   longitude      (longitude)                    float32  123.0 123.0 123.0 ... 150.0 150.0
▼ Data variables:
   band_id        (band)                           int32  ...
   start_time     (time)                  datetime64[ns]  ...
   end_time       (time)                  datetime64[ns]  ...
   geometry_par…  (geometry)                     float64  ...
   TAOT_02        (latitude, longitude)          float32  ...
   TAAE           (latitude, longitude)          float32  ...
   PAR            (latitude, longitude)          float32  ...
   SWR            (latitude, longitude)          float32  ...
   UVA            (latitude, longitude)          float32  ...
   UVB            (latitude, longitude)          float32  ...
   QA_flag        (latitude, longitude)          float32  ...
► Attributes:  (13)
```

Meteorological data with xarray 2

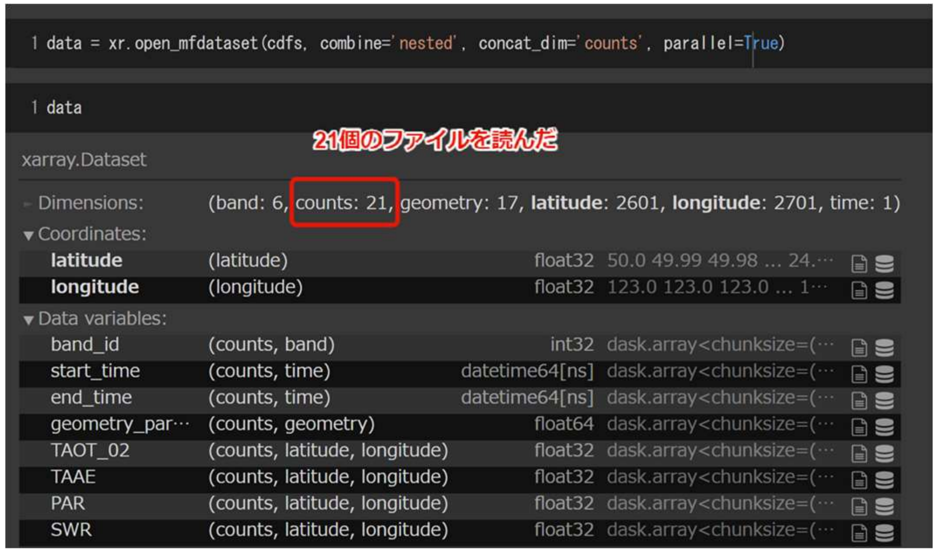
- Using xarray is intuitive and easy to understand.
  - I think I can get there if I can use pandas.
  - Files can be readed together.



```
da.sel(latitude=slice(35.5, 35),
       longitude=slice(135, 135.5))['SWR']
```

```
xarray.DataArray  'SWR'  (latitude: 51, longitude: 51)

array([[320.95    , 376.35    , 461.35    , ...,  48.9     ,  37.15    ,   4.65    ],
       [269.1     , 372.75    , 436.85    , ...,  47.65    ,  28.1     ,  13.      ],
       [367.9     , 384.55002, 395.05002, ...,  17.1     ,   4.45    ,  22.75    ],
       ...,
       [500.7     , 505.6     , 505.35    , ..., 500.55002, 493.05002, 501.75    ],
       [495.75    , 495.55002, 501.75    , ..., 389.30002, 471.65    , 523.35004],
       [489.2     , 489.05002, 496.45    , ..., 390.1     , 472.1     , 472.30002]],
      dtype=float32)
▾ Coordinates:
   latitude    (latitude)   float32  35.5 35.49 35.48 ... 35.01 35.0
   longitude   (longitude)  float32  135.0 135.0 135.0 ... 135.5 135.5
```



```
data = xr.open_mfdataset(cdfs, combine='nested', concat_dim='counts', parallel=True)
```

```
data
```

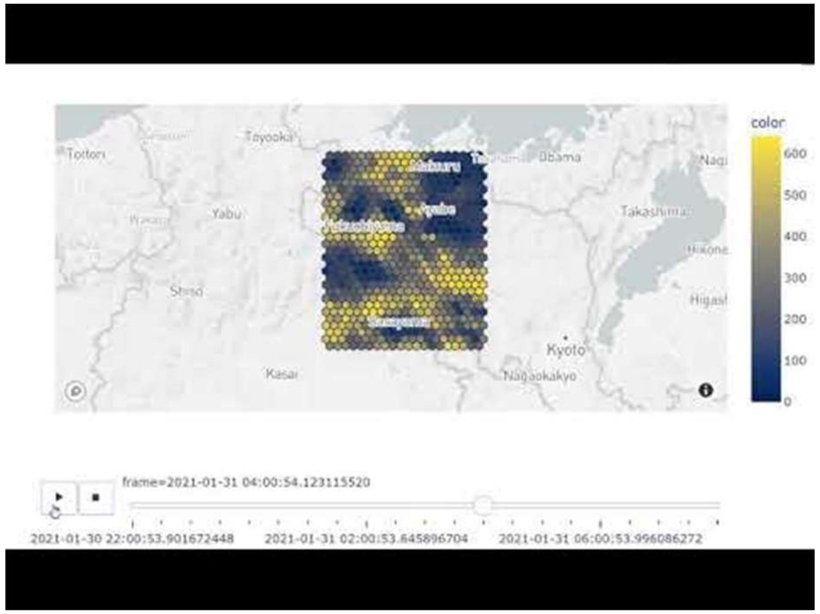
21個のファイルを読んだ

```
xarray.Dataset

Dimensions:     (band: 6, counts: 21, geometry: 17, latitude: 2601, longitude: 2701, time: 1)
▾ Coordinates:
   latitude       (latitude)                              float32  50.0 49.99 49.98 ... 24.⋯
   longitude      (longitude)                             float32  123.0 123.0 123.0 ... 1⋯
▾ Data variables:
   band_id        (counts, band)                          int32  dask.array<chunksize=(⋯
   start_time     (counts, time)                 datetime64[ns]  dask.array<chunksize=(⋯
   end_time       (counts, time)                 datetime64[ns]  dask.array<chunksize=(⋯
   geometry_par⋯  (counts, geometry)                      float64  dask.array<chunksize=(⋯
   TAOT_02        (counts, latitude, longitude)           float32  dask.array<chunksize=(⋯
   TAAE           (counts, latitude, longitude)           float32  dask.array<chunksize=(⋯
   PAR            (counts, latitude, longitude)           float32  dask.array<chunksize=(⋯
   SWR            (counts, latitude, longitude)           float32  dask.array<chunksize=(⋯
```

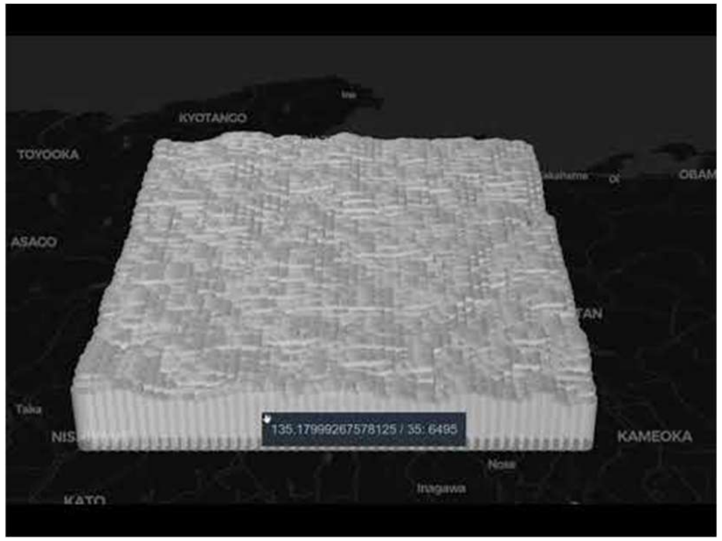
Meteorological data with xarray and plotly

- Using Plotly to visualize hourly data.
    - The more graph move, the more you feel!



Meteorological data with xarray and pydeck

- Express the total for the day.
  - Group by location and total for one day.
  - With pydeck.



135.17999267578125 / 35: 6495

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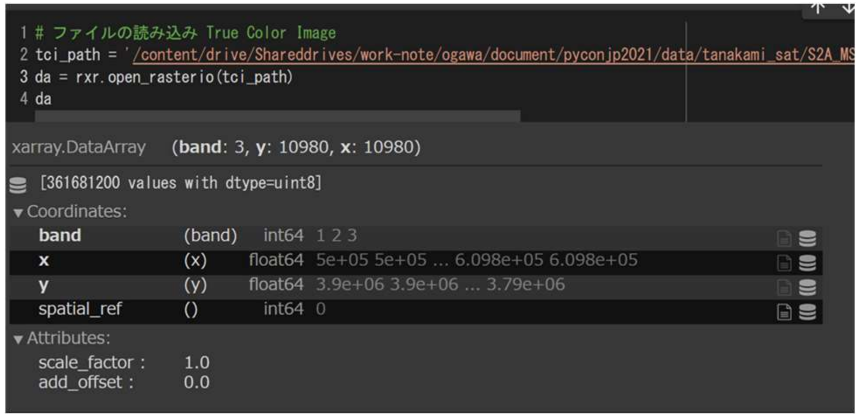
Satellite Images

- Data: Sentinel2
    - Colab: https://colab.research.google.com/drive/1hajaEIBbUwGWvm5JbnJ6y0WhsMDwc3Yi?usp=sharing
    - License Copernicus Open Access Hub (Link)
    - There are various files, but the raster data is in a jp2 file.
    - Read and process the file using rioxarray.
    - Read 1pixel / 10m TCI image
    - Observe the local Mt. Tanakami (I can only go back a year for convenience, so I will compare the two)



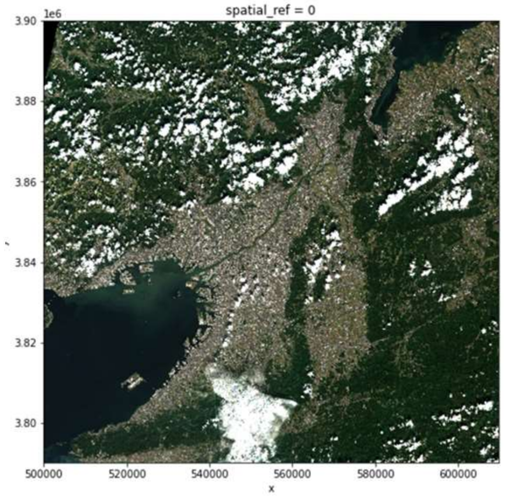
```
# ファイルの読み込み True Color Image
tci_path = '/content/drive/Shareddrives/work-note/ogawa/document/pyconjp2021/data/tanakami_sat/S2A_MS
da = rxr.open_rasterio(tci_path)
da
```

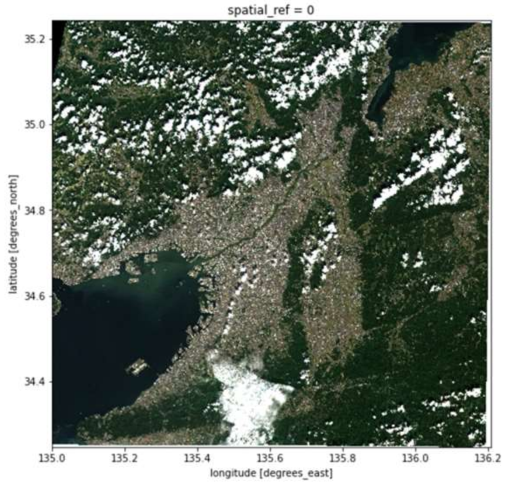
```
xarray.DataArray    (band: 3, y: 10980, x: 10980)

[361681200 values with dtype=uint8]
▾Coordinates:
   band          (band)    int64  1 2 3
   x             (x)     float64  5e+05 5e+05 ... 6.098e+05 6.098e+05
   y             (y)     float64  3.9e+06 3.9e+06 ... 3.79e+06
   spatial_ref   ()        int64  0
▾Attributes:
   scale_factor :    1.0
   add_offset :      0.0
```

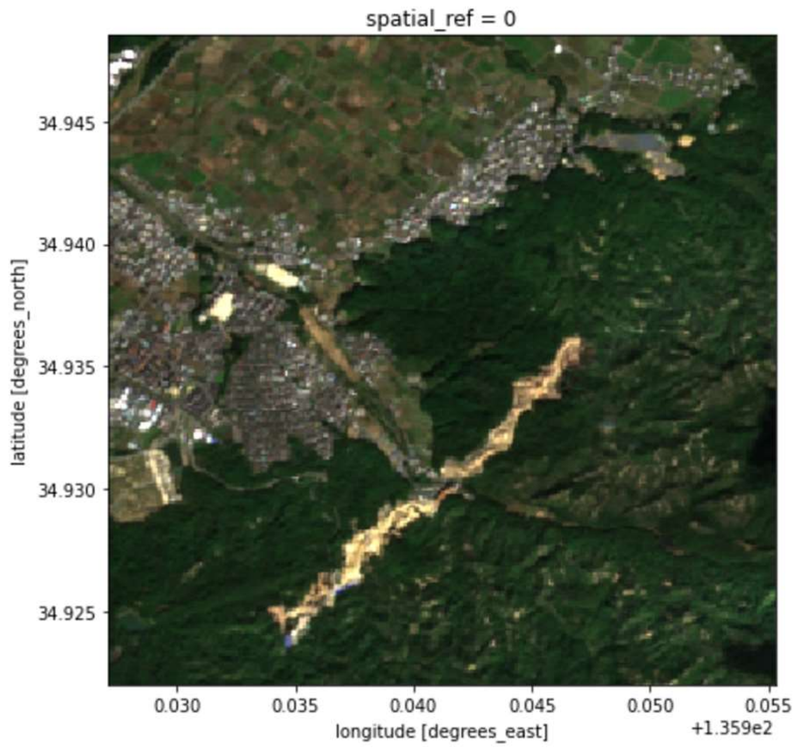
Satellite Images 2

- Visualization
  - Satellite images of Osaka, Kyoto, Nara, and Shiga
  - Changing the CRS（EPSG:32653 => EPSG:4326）
  - Call up the location data of the part of Mt. Tanakami you want to see that you prepared in advance, and cut it out.

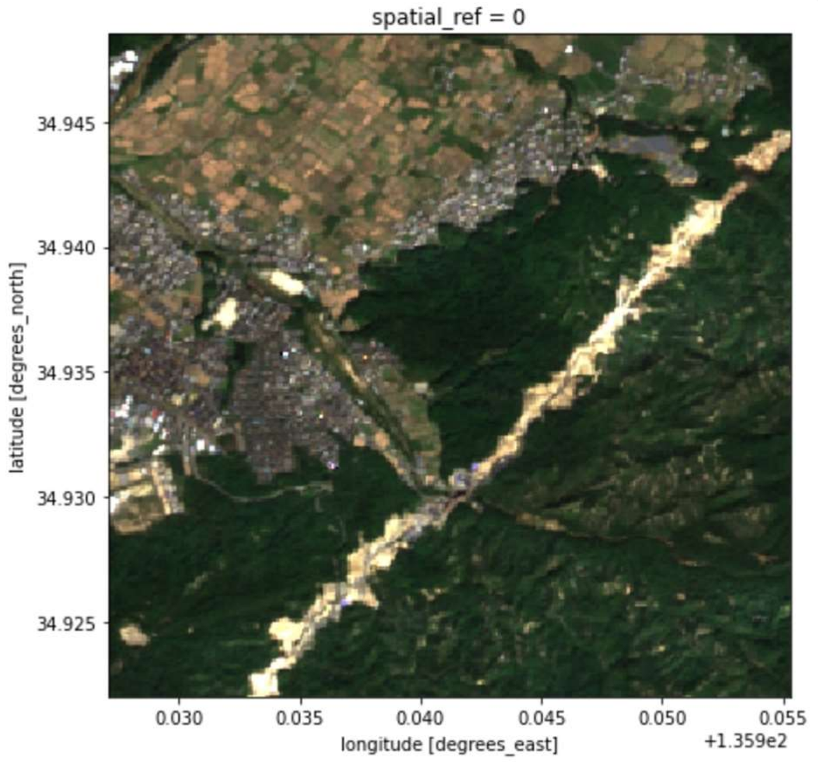




Satellite Images 3 : 2020/10/12



Satellite Images 4 : 2021/10/2



conclusion

- It's easy to make use of location data in Python.
- On the other hand, the exact knowledge is quite complex, and I'd like to work with an expert to touch this area.
- Once the data is in place, it will be possible to help solve social issues.
- "How do we act?" may be the challenge for those of us who can touch data or write code.

conclusion 2

from ghibli
https://www.ghibli.jp/works/mononoke/#frame

Thank you very much

参考資料

books(only japanese)

- 地図リテラシー入門　羽田康祐　ペレ出版
- その問題、デジタル地図が解決します　中島円　ペレ出版
- GIS地理情報システム　矢野桂司　創元社

for study

- GEO-PYTHON(University of Helsinki) Link

Packeges

- shapely
  - Document: https://shapely.readthedocs.io/en/stable/
- geopandas
  - Document: https://geopandas.org/
- xarray
  - Document: http://xarray.pydata.org/en/stable/
- folium
  - Document: https://python-visualization.github.io/folium/
- plotly
  - Document: https://plotly.com/python/
- pydeck
  - Document: https://deckgl.readthedocs.io/en/latest/

Data

- Behavior data of 11 people
  - GPS trajectory linked data project [Link]
- kokuse-chosa
  - eStat Statistics GIS https://www.e-stat.go.jp/gis
  - kokuse-chosa (2015) 250meter mesh
- Himawari
  - JAXA HIMAWARI MONITOR: Link
- Sentinel2
  - Copernicus Open Access Hub: Link