**!**pip install pyserial

**!**pip install pynmea2

**!**pip install geopandas

**!**pip install contextily

**Save NMEA data from GPS receiver to file**

In [2]:

*# you need to connect GPS receiver to USB to run following code*

*# import serial*

*# import datetime*

*# ser = serial.Serial("/dev/cu.usbserial-0001", baudrate=9600)*

*# ser.flushInput()*

*# ser.flushOutput()*

*# idx = 0*

*# nmea\_data = b""*

*# # skip first line, since it could be incomplete*

*# ser.readline()*

*# while True:*

*# idx += 1*

*# nmea\_sentence = ser.readline()*

*# nmea\_data += nmea\_sentence*

*# if idx % 100 == 0:*

*# print(f"idx: {idx}")*

*# if idx % 2000 == 0:*

*# # save to file after 2000 sentences added*

*# filename = datetime.datetime.utcnow().strftime("data/gps\_data\_%Y%m%d-%H%M%S.nmea")*

*# f = open(filename, "ab")*

*# f.write(nmea\_data)*

*# f.close()*

*# nmea\_data = b""*

**Download example NMEA data**

In [3]:

**import** requests

**import** os

response **=** requests**.**get("https://raw.githubusercontent.com/maxim75/data-visualization/master/notebooks/data/geo/gps\_data\_20220215-070028.nmea")

**if** **not** os**.**path**.**exists("data"):

os**.**makedirs("data")

f **=** open("data/gps\_data.nmea", "a")

f**.**write(response**.**text)

f**.**close()

**Show first 10 message properties**

In [4]:

**import** pynmea2

nmea\_data **=** open("data/gps\_data.nmea", "rb")

**for** message\_bytes **in** nmea\_data**.**readlines()[:10]: *# read first 10 messages from file*

**try**:

message **=** message\_bytes**.**decode("utf-8")**.**replace("\n", "")**.**replace("\r", "")

parsed\_message **=** pynmea2**.**parse(message)

**except**:

*# skip invalid messages*

**continue**

print(f"message: {message}")

**for** field **in** parsed\_message**.**fields:

value **=** getattr(parsed\_message, field[1])

print(f"{field[0]:40} {field[1]:20} {value}")

print("\n")

message: $GNGSA,A,3,21,22,01,31,32,10,03,04,,,,,1.27,0.69,1.06\*17

Mode mode A

Mode fix type mode\_fix\_type 3

SV ID01 sv\_id01 21

SV ID02 sv\_id02 22

SV ID03 sv\_id03 01

SV ID04 sv\_id04 31

SV ID05 sv\_id05 32

SV ID06 sv\_id06 10

SV ID07 sv\_id07 03

SV ID08 sv\_id08 04

SV ID09 sv\_id09

SV ID10 sv\_id10

SV ID11 sv\_id11

SV ID12 sv\_id12

PDOP (Dilution of precision) pdop 1.27

HDOP (Horizontal DOP) hdop 0.69

VDOP (Vertical DOP) vdop 1.06

message: $GNGSA,A,3,71,86,73,72,87,74,85,,,,,,1.27,0.69,1.06\*18

Mode mode A

Mode fix type mode\_fix\_type 3

SV ID01 sv\_id01 71

SV ID02 sv\_id02 86

SV ID03 sv\_id03 73

SV ID04 sv\_id04 72

SV ID05 sv\_id05 87

SV ID06 sv\_id06 74

SV ID07 sv\_id07 85

SV ID08 sv\_id08

SV ID09 sv\_id09

SV ID10 sv\_id10

SV ID11 sv\_id11

SV ID12 sv\_id12

PDOP (Dilution of precision) pdop 1.27

HDOP (Horizontal DOP) hdop 0.69

VDOP (Vertical DOP) vdop 1.06

message: $GPGSV,4,1,13,01,51,248,13,03,26,229,16,04,16,283,13,08,01,322,\*7C

Number of messages of type in cycle num\_messages 4

Message Number msg\_num 1

Total number of SVs in view num\_sv\_in\_view 13

SV PRN number 1 sv\_prn\_num\_1 01

Elevation in degrees 1 elevation\_deg\_1 51

Azimuth, deg from true north 1 azimuth\_1 248

SNR 1 snr\_1 13

SV PRN number 2 sv\_prn\_num\_2 03

Elevation in degrees 2 elevation\_deg\_2 26

Azimuth, deg from true north 2 azimuth\_2 229

SNR 2 snr\_2 16

SV PRN number 3 sv\_prn\_num\_3 04

Elevation in degrees 3 elevation\_deg\_3 16

Azimuth, deg from true north 3 azimuth\_3 283

SNR 3 snr\_3 13

SV PRN number 4 sv\_prn\_num\_4 08

Elevation in degrees 4 elevation\_deg\_4 01

Azimuth, deg from true north 4 azimuth\_4 322

SNR 4 snr\_4

message: $GPGSV,4,2,13,10,15,069,20,17,00,223,,21,56,307,23,22,51,144,15\*74

Number of messages of type in cycle num\_messages 4

Message Number msg\_num 2

Total number of SVs in view num\_sv\_in\_view 13

SV PRN number 1 sv\_prn\_num\_1 10

Elevation in degrees 1 elevation\_deg\_1 15

Azimuth, deg from true north 1 azimuth\_1 069

SNR 1 snr\_1 20

SV PRN number 2 sv\_prn\_num\_2 17

Elevation in degrees 2 elevation\_deg\_2 00

Azimuth, deg from true north 2 azimuth\_2 223

SNR 2 snr\_2

SV PRN number 3 sv\_prn\_num\_3 21

Elevation in degrees 3 elevation\_deg\_3 56

Azimuth, deg from true north 3 azimuth\_3 307

SNR 3 snr\_3 23

SV PRN number 4 sv\_prn\_num\_4 22

Elevation in degrees 4 elevation\_deg\_4 51

Azimuth, deg from true north 4 azimuth\_4 144

SNR 4 snr\_4 15

message: $GPGSV,4,3,13,25,09,120,,26,12,038,07,31,67,081,28,32,34,129,22\*76

Number of messages of type in cycle num\_messages 4

Message Number msg\_num 3

Total number of SVs in view num\_sv\_in\_view 13

SV PRN number 1 sv\_prn\_num\_1 25

Elevation in degrees 1 elevation\_deg\_1 09

Azimuth, deg from true north 1 azimuth\_1 120

SNR 1 snr\_1

SV PRN number 2 sv\_prn\_num\_2 26

Elevation in degrees 2 elevation\_deg\_2 12

Azimuth, deg from true north 2 azimuth\_2 038

SNR 2 snr\_2 07

SV PRN number 3 sv\_prn\_num\_3 31

Elevation in degrees 3 elevation\_deg\_3 67

Azimuth, deg from true north 3 azimuth\_3 081

SNR 3 snr\_3 28

SV PRN number 4 sv\_prn\_num\_4 32

Elevation in degrees 4 elevation\_deg\_4 34

Azimuth, deg from true north 4 azimuth\_4 129

SNR 4 snr\_4 22

message: $GPGSV,4,4,13,50,43,321,\*49

Number of messages of type in cycle num\_messages 4

Message Number msg\_num 4

Total number of SVs in view num\_sv\_in\_view 13

SV PRN number 1 sv\_prn\_num\_1 50

Elevation in degrees 1 elevation\_deg\_1 43

Azimuth, deg from true north 1 azimuth\_1 321

SNR 1 snr\_1

SV PRN number 2 sv\_prn\_num\_2

Elevation in degrees 2 elevation\_deg\_2

Azimuth, deg from true north 2 azimuth\_2

SNR 2 snr\_2

SV PRN number 3 sv\_prn\_num\_3

Elevation in degrees 3 elevation\_deg\_3

Azimuth, deg from true north 3 azimuth\_3

SNR 3 snr\_3

SV PRN number 4 sv\_prn\_num\_4

Elevation in degrees 4 elevation\_deg\_4

Azimuth, deg from true north 4 azimuth\_4

SNR 4 snr\_4

message: $GLGSV,3,1,09,70,24,114,07,71,50,173,32,72,29,237,22,73,43,075,29\*69

Number of messages of type in cycle num\_messages 3

Message Number msg\_num 1

Total number of SVs in view num\_sv\_in\_view 09

SV PRN number 1 sv\_prn\_num\_1 70

Elevation in degrees 1 elevation\_deg\_1 24

Azimuth, deg from true north 1 azimuth\_1 114

SNR 1 snr\_1 07

SV PRN number 2 sv\_prn\_num\_2 71

Elevation in degrees 2 elevation\_deg\_2 50

Azimuth, deg from true north 2 azimuth\_2 173

SNR 2 snr\_2 32

SV PRN number 3 sv\_prn\_num\_3 72

Elevation in degrees 3 elevation\_deg\_3 29

Azimuth, deg from true north 3 azimuth\_3 237

SNR 3 snr\_3 22

SV PRN number 4 sv\_prn\_num\_4 73

Elevation in degrees 4 elevation\_deg\_4 43

Azimuth, deg from true north 4 azimuth\_4 075

SNR 4 snr\_4 29

message: $GLGSV,3,2,09,74,22,022,20,80,27,134,,85,09,346,09,86,37,304,17\*60

Number of messages of type in cycle num\_messages 3

Message Number msg\_num 2

Total number of SVs in view num\_sv\_in\_view 09

SV PRN number 1 sv\_prn\_num\_1 74

Elevation in degrees 1 elevation\_deg\_1 22

Azimuth, deg from true north 1 azimuth\_1 022

SNR 1 snr\_1 20

SV PRN number 2 sv\_prn\_num\_2 80

Elevation in degrees 2 elevation\_deg\_2 27

Azimuth, deg from true north 2 azimuth\_2 134

SNR 2 snr\_2

SV PRN number 3 sv\_prn\_num\_3 85

Elevation in degrees 3 elevation\_deg\_3 09

Azimuth, deg from true north 3 azimuth\_3 346

SNR 3 snr\_3 09

SV PRN number 4 sv\_prn\_num\_4 86

Elevation in degrees 4 elevation\_deg\_4 37

Azimuth, deg from true north 4 azimuth\_4 304

SNR 4 snr\_4 17

message: $GLGSV,3,3,09,87,28,227,19\*56

Number of messages of type in cycle num\_messages 3

Message Number msg\_num 3

Total number of SVs in view num\_sv\_in\_view 09

SV PRN number 1 sv\_prn\_num\_1 87

Elevation in degrees 1 elevation\_deg\_1 28

Azimuth, deg from true north 1 azimuth\_1 227

SNR 1 snr\_1 19

SV PRN number 2 sv\_prn\_num\_2

Elevation in degrees 2 elevation\_deg\_2

Azimuth, deg from true north 2 azimuth\_2

SNR 2 snr\_2

SV PRN number 3 sv\_prn\_num\_3

Elevation in degrees 3 elevation\_deg\_3

Azimuth, deg from true north 3 azimuth\_3

SNR 3 snr\_3

SV PRN number 4 sv\_prn\_num\_4

Elevation in degrees 4 elevation\_deg\_4

Azimuth, deg from true north 4 azimuth\_4

SNR 4 snr\_4

message: $GNGLL,3402.91780,S,15101.42526,E,064654.00,A,A\*6E

Latitude lat 3402.91780

Latitude Direction lat\_dir S

Longitude lon 15101.42526

Longitude Direction lon\_dir E

Timestamp timestamp 06:46:54

Status status A

FAA mode indicator faa\_mode A

**Extract data from parsed messages**

In [5]:

**import** pynmea2

nmea\_data **=** open("data/gps\_data.nmea", "rb")

coordinates\_data **=** []

**for** message\_bytes **in** nmea\_data**.**readlines():

**try**:

message **=** message\_bytes**.**decode("utf-8")**.**replace("\n", "")**.**replace("\r", "")

parsed\_message **=** pynmea2**.**parse(message)

**except**:

*# skip invalid sentences*

**continue**

cga\_data **=** {}

*# process only GGA messages*

**if** parsed\_message**.**sentence\_type **==** "GGA":

**for** attr **in** ["timestamp", "latitude", "longitude", "latitude", "horizontal\_dil", "num\_sats", "gps\_qual"]:

cga\_data[attr] **=** getattr(parsed\_message, attr)

coordinates\_data**.**append(cga\_data)

coordinates\_data[0]

Out[5]:

{'timestamp': datetime.time(6, 46, 55),

'latitude': -34.048630333333335,

'longitude': 151.02375633333332,

'horizontal\_dil': '0.62',

'num\_sats': '12',

'gps\_qual': 1}

**Create geo data frame**

In [6]:

**import** pandas **as** pd

**import** geopandas **as** gpd

df **=** pd**.**DataFrame(coordinates\_data)

gdf **=** gpd**.**GeoDataFrame(df, geometry**=**gpd**.**points\_from\_xy(df**.**longitude, df**.**latitude, crs**=**"EPSG:4326"))

gdf

/Users/z/code/data-visualization/env/lib/python3.9/site-packages/geopandas/\_compat.py:111: UserWarning: The Shapely GEOS version (3.8.0-CAPI-1.13.1 ) is incompatible with the GEOS version PyGEOS was compiled with (3.9.1-CAPI-1.14.2). Conversions between both will be slow.

warnings.warn(

Out[6]:

|  | **timestamp** | **latitude** | **longitude** | **horizontal\_dil** | **num\_sats** | **gps\_qual** | **geometry** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | 06:46:55 | -34.048630 | 151.023756 | 0.62 | 12 | 1 | POINT (151.02376 -34.04863) |
| **1** | 06:46:56 | -34.048630 | 151.023757 | 0.62 | 12 | 1 | POINT (151.02376 -34.04863) |
| **2** | 06:46:57 | -34.048623 | 151.023758 | 0.62 | 12 | 1 | POINT (151.02376 -34.04862) |
| **3** | 06:46:58 | -34.048609 | 151.023757 | 0.61 | 12 | 1 | POINT (151.02376 -34.04861) |
| **4** | 06:46:59 | -34.048588 | 151.023755 | 0.62 | 12 | 1 | POINT (151.02376 -34.04859) |
| **...** | ... | ... | ... | ... | ... | ... | ... |
| **1623** | 07:00:24 | -34.047688 | 151.022902 | 0.66 | 12 | 1 | POINT (151.02290 -34.04769) |
| **1624** | 07:00:25 | -34.047663 | 151.023005 | 0.66 | 12 | 1 | POINT (151.02301 -34.04766) |
| **1625** | 07:00:26 | -34.047636 | 151.023108 | 0.66 | 12 | 1 | POINT (151.02311 -34.04764) |
| **1626** | 07:00:27 | -34.047610 | 151.023211 | 0.66 | 12 | 1 | POINT (151.02321 -34.04761) |
| **1627** | 07:00:28 | -34.047583 | 151.023318 | 0.66 | 12 | 1 | POINT (151.02332 -34.04758) |

1628 rows × 7 columns

**Render map**

In [7]:

**import** matplotlib.pyplot **as** plt

**import** contextily **as** ctx

fig **=** plt**.**figure(figsize**=**(10,10))

ax **=** plt**.**axes()

gdf[gdf**.**gps\_qual **>** 0]**.**plot(ax**=**ax, alpha**=**.2, edgecolor**=**"#ffff", color**=**'red')

ctx**.**add\_basemap(ax, source**=**ctx**.**providers**.**Stamen**.**TonerLite, crs**=**"EPSG:4326", alpha**=**.3)