In [4]:
```
!pip install folium
```

```
Collecting folium
  Downloading folium-0.12.1.post1-py2.py3-none-any.whl (95 kB)
Requirement already satisfied: numpy in c:\users\e.daboner\anaconda3\lib\site-packages (from folium) (1.20.1)
Requirement already satisfied: jinja2>=2.9 in c:\users\e.daboner\anaconda3\lib\site-packages (from folium) (2.11.3)
Requirement already satisfied: requests in c:\users\e.daboner\anaconda3\lib\site-packages (from folium) (2.25.1)
Collecting branca>=0.3.0
  Downloading branca-0.5.0-py3-none-any.whl (24 kB)
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\e.daboner\anaconda3\lib\site-packages (from jinja2>=2.9->folium) (1.1.1)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\e.daboner\anaconda3\lib\site-packages (from requests->folium) (2020.12.5)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\e.daboner\anaconda3\lib\site-packages (from requests->folium) (1.26.4)
Requirement already satisfied: idna<3,>=2.5 in c:\users\e.daboner\anaconda3\lib\site-packages (from requests->folium) (2.10)
Requirement already satisfied: chardet<5,>=3.0.2 in c:\users\e.daboner\anaconda3\lib\site-packages (from requests->folium) (4.0.0)
Installing collected packages: branca, folium
Successfully installed branca-0.5.0 folium-0.12.1.post1
```

In [24]:
```
!pip install polyline
```

```
Collecting polyline
  Downloading polyline-1.4.0-py2.py3-none-any.whl (4.4 kB)
Requirement already satisfied: six>=1.8.0 in c:\users\e.daboner\anaconda3\lib\site-packages (from polyline) (1.15.0)
Installing collected packages: polyline
Successfully installed polyline-1.4.0
```

In [25]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
import folium
import requests
import polyline
dataFrame=pd.read_csv('c:/datasets/RAS2.csv')
```

In [2]:
```
dataFrame.head()
```

Out[2]:

	Time	UTC Time	Lap	GPS_Update	GPS_Delay	Latitude	Longitude	Altitude (m)	Altitude (ft)	Speed (Km/h)	Heading	Accuracy (m)	Accel X	Accel Y	Accel Z	Brake (calculated)	Barometric Pressure (kPa)	Pressure Altitude (m)
0	0.000	1659024166	0	1	0	9.051417	7.491423	485.6	1593	0.3	-1.0	5.3	0.56	-1.05	1.04	1	95.55	492.2
1	0.006	1659024166	0	0	0	9.051417	7.491423	485.6	1593	0.3	-1.0	5.3	0.53	-1.05	1.04	1	95.55	492.2
2	0.053	1659024166	0	0	0	9.051417	7.491423	485.6	1593	0.3	-1.0	5.3	0.56	-1.04	1.10	1	95.55	492.2
3	0.104	1659024166	0	0	0	9.051417	7.491423	485.6	1593	0.3	-1.0	5.3	0.56	-1.04	1.10	1	95.55	492.2
4	0.154	1659024166	0	0	0	9.051417	7.491423	485.6	1593	0.3	-1.0	5.3	0.59	-1.04	1.14	1	95.55	492.2

In [3]:
```
dataFrame.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 18246 entries, 0 to 18245
Data columns (total 18 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   Time                      18246 non-null  float64
 1   UTC Time                  18246 non-null  int64
 2   Lap                       18246 non-null  int64
 3   GPS_Update                18246 non-null  int64
 4   GPS_Delay                 18246 non-null  int64
```

```
 5   Latitude                  18246 non-null  float64
 6   Longitude                 18246 non-null  float64
 7   Altitude (m)              18246 non-null  float64
 8   Altitude (ft)             18246 non-null  int64
 9   Speed (Km/h)              18246 non-null  float64
 10  Heading                   18246 non-null  float64
 11  Accuracy (m)              18246 non-null  float64
 12  Accel X                   18246 non-null  float64
 13  Accel Y                   18246 non-null  float64
 14  Accel Z                   18246 non-null  float64
 15  Brake (calculated)        18246 non-null  int64
 16  Barometric Pressure (kPa) 18246 non-null  float64
 17  Pressure Altitude (m)     18246 non-null  float64
dtypes: float64(12), int64(6)
memory usage: 2.5 MB
```

In [4]:

```
newDf=dataFrame.drop(index=dataFrame.index[0::2])
newDf
newDf2=newDf.reset_index()
newDf3=newDf2.drop(index=newDf2.index[0::2])
newDf4=newDf3.reset_index()
newDf5=newDf4.drop(index=newDf4.index[0::2])
newDf5.head()
```

Out[4]:

	level_0	index	Time	UTC Time	Lap	GPS_Update	GPS_Delay	Latitude	Longitude	Altitude (m)	Altitude (ft)	Speed (Km/h)	Heading	Accuracy (m)	Accel X	Accel Y	Accel Z	Brake (calculated)	Barometric Pressure (kPa)	Pressure Altitude (m)
1	3	7	0.305	1659024166	0	0	0	9.051417	7.491423	485.6	1593	0.3	-1.0	5.3	0.59	-1.05	1.13	1	95.55	492.2
3	7	15	0.696	1659024167	0	0	0	9.051419	7.491430	485.5	1593	1.2	-1.0	5.2	0.59	-1.04	1.09	1	95.55	492.3
5	11	23	1.099	1659024167	0	0	0	9.051419	7.491430	485.5	1593	1.2	-1.0	5.2	0.55	-1.03	1.09	1	95.55	492.3
7	15	31	1.499	1659024167	0	0	0	9.051419	7.491430	485.5	1593	1.2	-1.0	5.2	0.56	-1.06	1.11	1	95.55	492.3
9	19	39	1.901	1659024168	0	0	0	9.051417	7.491431	485.4	1592	0.6	-1.0	5.1	0.56	-1.04	1.12	1	95.55	492.3

In [5]:

```
newDf5.shape
```

Out[5]:

```
(2280, 20)
```

In [6]:

```
locations=newDf5[["Latitude", "Longitude"]]
print(locations)

locationslist=locations.values.tolist()

print(len(locationslist))

print()
print(locationslist)

print(locationslist[9])
```

```
      Latitude  Longitude
1     9.051417   7.491423
3     9.051419   7.491430
5     9.051419   7.491430
7     9.051419   7.491430
9     9.051417   7.491431
...        ...        ...
4551  9.069009   7.446148
4553  9.069009   7.446148
4555  9.068983   7.446154
```

```
4557  9.068983   7.446154
4559  9.068983   7.446154

[2280 rows x 2 columns]
2280
```


[[9.0514168, 7.4914232], [9.0514185, 7.4914299], [9.0514185, 7.4914299], [9.0514185, 7.4914299], [9.0514175, 7.4914307], [9.0514175, 7.4914307], [9.051424, 7.4914326], [9.051424, 7.4914326], [9.05
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In [7]:

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location_details=newDf5[["UTC Time", 'Speed (Km/h)']]

locationdetailslist=location_details.values.tolist()
print(len(locationdetailslist))
print()
print(locationdetailslist)
print()
print(locationdetailslist[9])
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2280

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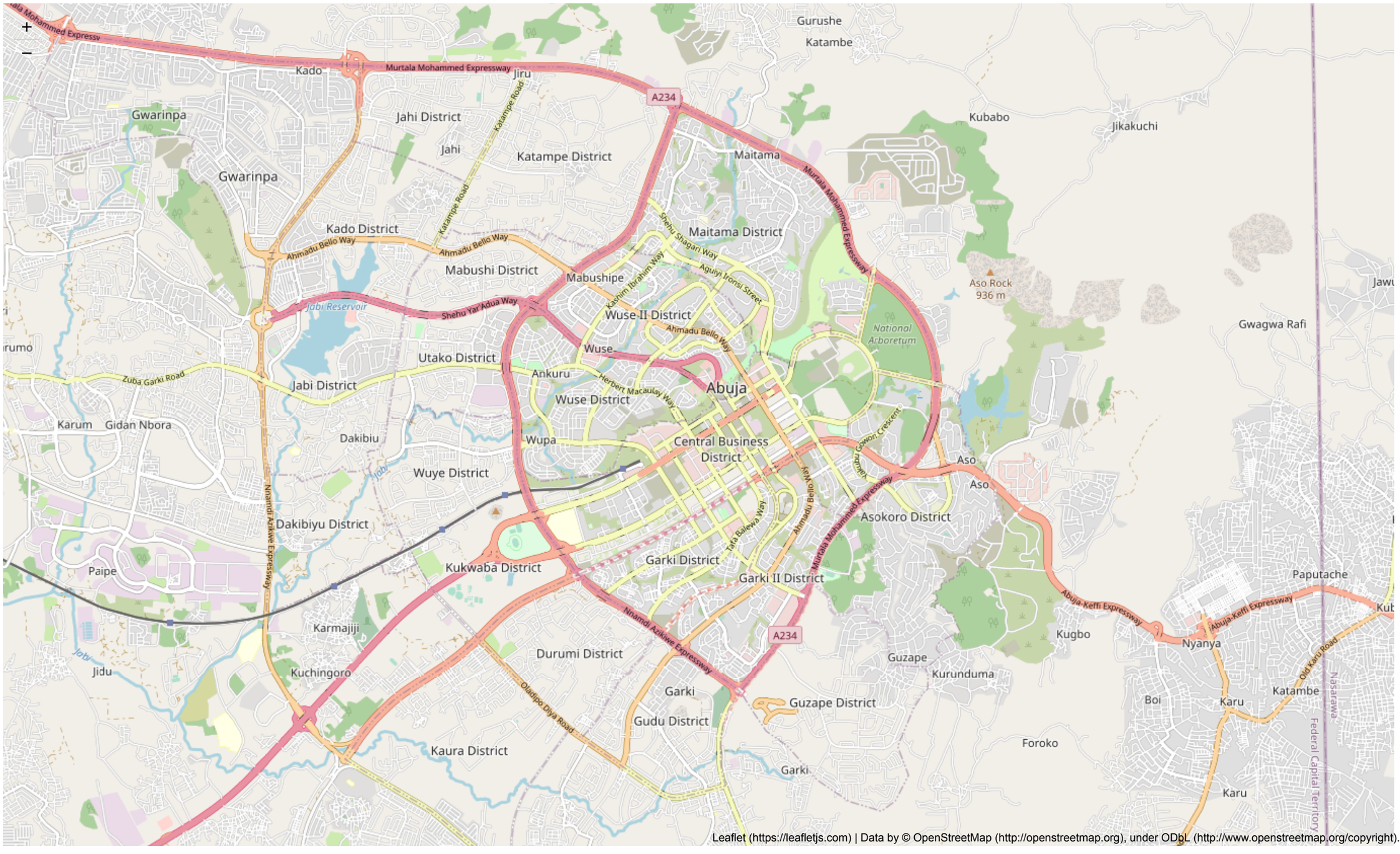
```

In [8]:

```
map = folium.Map(location=[locations.Latitude.mean(), locations.Longitude.mean()], zoom_start=13)
map
```

Out[8]:



In [9]:

```
#starting point
folium.Marker(locationslist[1], popup=locationdetailslist[1],icon=folium.Icon(color="darkpurple", icon_color='white', icon="twitter", prefix='fa')).add_to(map)
folium.PolyLine(locations = [locationslist[1], locationslist[2]],
                line_opacity = 0.2).add_to(map)
```

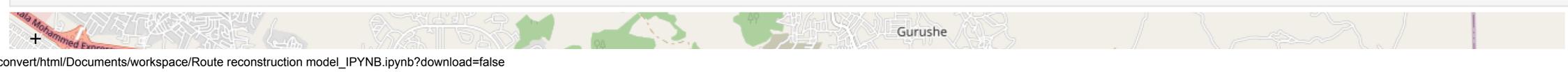
```
map
```

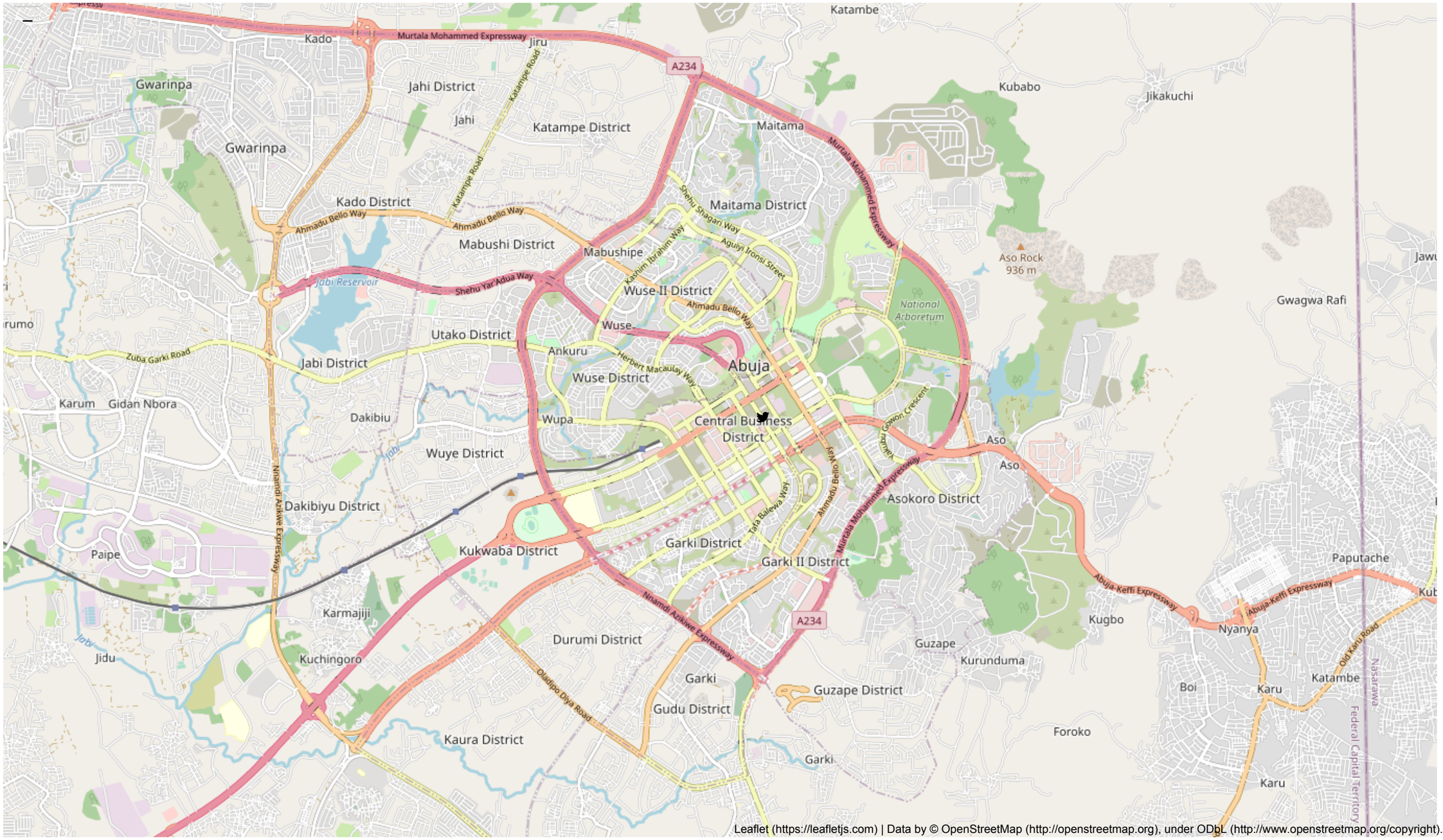
Out[9]:

In [10]:

```
#middle point
folium.CircleMarker(locationslist[100], radius=1, popup=locationdetailslist[100]).add_to(map)
#folium.PolyLine(locations = [locationslist[100], locationslist[101]],
#            line_opacity = 0.2).add_to(map)
map
```

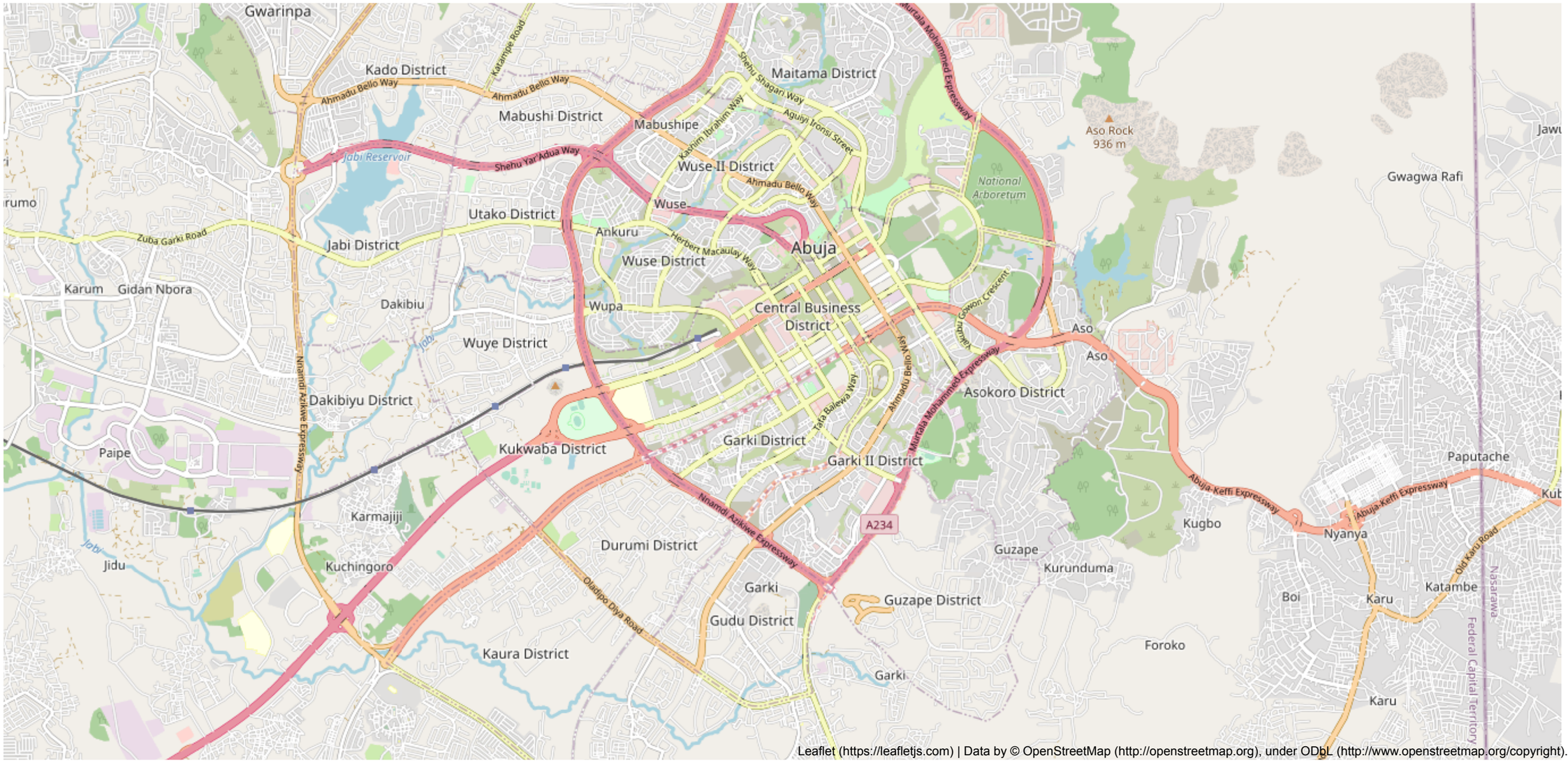
Out[10]:





In [11]:
```
map = folium.Map(location=[locations.Latitude.mean(), locations.Longitude.mean()], zoom_start=13)
map
```

Out[11]:



In [12]:

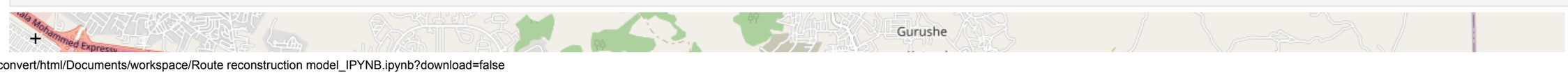
```
map = folium.Map(location=[locations.Latitude.mean(), locations.Longitude.mean()], zoom_start=13)

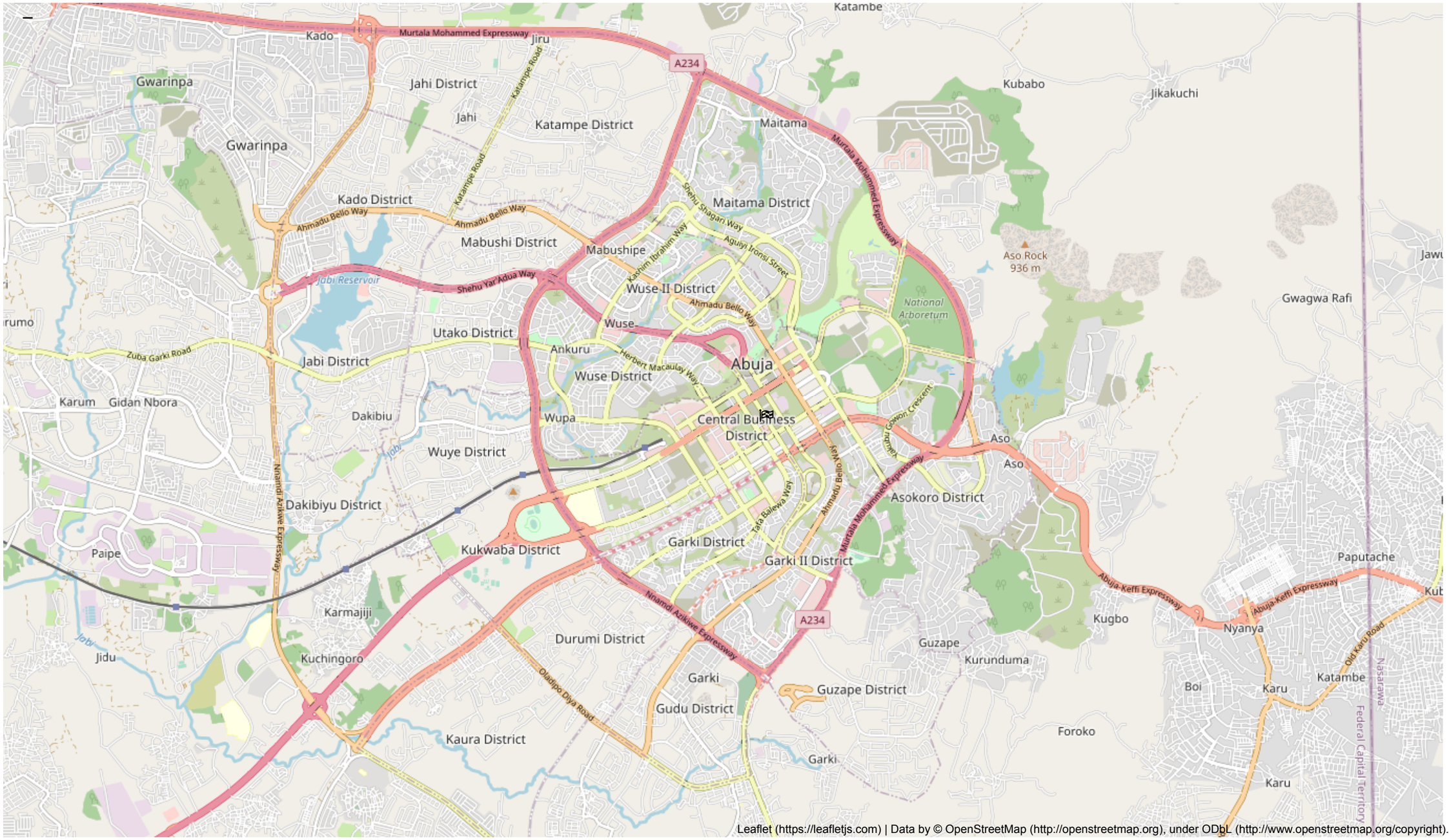
#starting point
folium.Marker(locationslist[1], popup=locationdetailslist[1],icon=folium.Icon(color="green", icon_color='white', icon="flag-checkered", prefix='fa')).add_to(map)
folium.PolyLine(locations = [locationslist[1], locationslist[2]],
                line_opacity = 0.2).add_to(map)

#middle points
for point in range(1, len(locationslist)-1):
    folium.CircleMarker(locationslist[point], radius=1, popup=locationdetailslist[point]).add_to(map)
    folium.PolyLine(locations = [locationslist[point], locationslist[point+1]],
                line_opacity = 0.2).add_to(map)

#Finish line
folium.Marker(locationslist[len(locationslist)-1], popup=locationdetailslist[len(locationslist)-1],icon=folium.Icon(color="red", icon_color='white', icon="flag-checkered", prefix='fa')).add_to(ma
folium.PolyLine(locations = [locationslist[len(locationslist)-2], locationslist[len(locationslist)-1]],
                line_opacity = 0.2).add_to(map)
map
```

Out[12]:





In [13]:
```
help(folium.Icon)
```

```
Help on class Icon in module folium.map:

class Icon(branca.element.MacroElement)
 |  Icon(color='blue', icon_color='white', icon='info-sign', angle=0, prefix='glyphicon', **kwargs)
 |
 |  Creates an Icon object that will be rendered
 |  using Leaflet.awesome-markers.
 |
 |  Parameters
 |  ----------
 |  color : str, default 'blue'
 |      The color of the marker. You can use:
```

```
|
|         ['red', 'blue', 'green', 'purple', 'orange', 'darkred',
|          'lightred', 'beige', 'darkblue', 'darkgreen', 'cadetblue',
|          'darkpurple', 'white', 'pink', 'lightblue', 'lightgreen',
|          'gray', 'black', 'lightgray']
|
|  icon_color : str, default 'white'
|      The color of the drawing on the marker. You can use colors above,
|      or an html color code.
|  icon : str, default 'info-sign'
|      The name of the marker sign.
|      See Font-Awesome website to choose yours.
|      Warning : depending on the icon you choose you may need to adapt
|      the `prefix` as well.
|  angle : int, default 0
|      The icon will be rotated by this amount of degrees.
|  prefix : str, default 'glyphicon'
|      The prefix states the source of the icon. 'fa' for font-awesome or
|      'glyphicon' for bootstrap 3.
|
|  https://github.com/lvoogdt/Leaflet.awesome-markers
|
|  Method resolution order:
|      Icon
|      branca.element.MacroElement
|      branca.element.Element
|      builtins.object
|
|  Methods defined here:
|
|  __init__(self, color='blue', icon_color='white', icon='info-sign', angle=0, prefix='glyphicon', **kwargs)
|      Initialize self.  See help(type(self)) for accurate signature.
|
|  ----------------------------------------------------------------------
|  Data and other attributes defined here:
|
|  color_options = {'beige', 'black', 'blue', 'cadetblue', 'darkblue', 'd...
|
|  ----------------------------------------------------------------------
|  Methods inherited from branca.element.MacroElement:
|
|  render(self, **kwargs)
|      Renders the HTML representation of the element.
|
|  ----------------------------------------------------------------------
|  Methods inherited from branca.element.Element:
|
|  add_child(self, child, name=None, index=None)
|      Add a child.
|
|  add_children(self, child, name=None, index=None)
|      Add a child.
|
|  add_to(self, parent, name=None, index=None)
|      Add element to a parent.
|
|  get_bounds(self)
|      Computes the bounds of the object and all it's children
|      in the form [[lat_min, lon_min], [lat_max, lon_max]].
|
|  get_name(self)
|      Returns a string representation of the object.
|      This string has to be unique and to be a python and
|      javascript-compatible
|      variable name.
|
|  get_root(self)
|      Returns the root of the elements tree.
|
```

```
|  save(self, outfile, close_file=True, **kwargs)
|      Saves an Element into a file.
|
|      Parameters
|      ----------
|      outfile : str or file object
|          The file (or filename) where you want to output the html.
|      close_file : bool, default True
|          Whether the file has to be closed after write.
|
|  to_dict(self, depth=-1, ordered=True, **kwargs)
|      Returns a dict representation of the object.
|
|  to_json(self, depth=-1, **kwargs)
|      Returns a JSON representation of the object.
|
|  ----------------------------------------------------------------------
|  Data descriptors inherited from branca.element.Element:
|
|  __dict__
|      dictionary for instance variables (if defined)
|
|  __weakref__
|      list of weak references to the object (if defined)
```

In [ ]:

In [14]:
```
help(folium.CircleMarker)
```

```
Help on class CircleMarker in module folium.vector_layers:

class CircleMarker(folium.map.Marker)
 |  CircleMarker(location=None, radius=10, popup=None, tooltip=None, **kwargs)
 |
 |  A circle of a fixed size with radius specified in pixels.
 |
 |  See :func:`folium.vector_layers.path_options` for the `Path` options.
 |
 |  Parameters
 |  ----------
 |  location: tuple[float, float]
 |      Latitude and Longitude pair (Northing, Easting)
 |  popup: string or folium.Popup, default None
 |      Input text or visualization for object displayed when clicking.
 |  tooltip: str or folium.Tooltip, default None
 |      Display a text when hovering over the object.
 |  radius: float, default 10
 |      Radius of the circle marker, in pixels.
 |  **kwargs
 |      Other valid (possibly inherited) options. See:
 |      https://leafletjs.com/reference-1.6.0.html#circlemarker
 |
 |  Method resolution order:
 |      CircleMarker
 |      folium.map.Marker
 |      branca.element.MacroElement
 |      branca.element.Element
 |      builtins.object
 |
 |  Methods defined here:
 |
 |  __init__(self, location=None, radius=10, popup=None, tooltip=None, **kwargs)
 |      Initialize self.  See help(type(self)) for accurate signature.
 |
 |  ----------------------------------------------------------------------
 |  Methods inherited from folium.map.Marker:
```

```
|
|  render(self)
|      Renders the HTML representation of the element.
|
|  ----------------------------------------------------------------------
|  Methods inherited from branca.element.Element:
|
|  add_child(self, child, name=None, index=None)
|      Add a child.
|
|  add_children(self, child, name=None, index=None)
|      Add a child.
|
|  add_to(self, parent, name=None, index=None)
|      Add element to a parent.
|
|  get_bounds(self)
|      Computes the bounds of the object and all it's children
|      in the form [[lat_min, lon_min], [lat_max, lon_max]].
|
|  get_name(self)
|      Returns a string representation of the object.
|      This string has to be unique and to be a python and
|      javascript-compatible
|      variable name.
|
|  get_root(self)
|      Returns the root of the elements tree.
|
|  save(self, outfile, close_file=True, **kwargs)
|      Saves an Element into a file.
|
|      Parameters
|      ----------
|      outfile : str or file object
|          The file (or filename) where you want to output the html.
|      close_file : bool, default True
|          Whether the file has to be closed after write.
|
|  to_dict(self, depth=-1, ordered=True, **kwargs)
|      Returns a dict representation of the object.
|
|  to_json(self, depth=-1, **kwargs)
|      Returns a JSON representation of the object.
|
|  ----------------------------------------------------------------------
|  Data descriptors inherited from branca.element.Element:
|
|  __dict__
|      dictionary for instance variables (if defined)
|
|  __weakref__
|      list of weak references to the object (if defined)
```

In [15]:
```
#OSRM
```

In [16]:
```
print(len(locationslist))
print(locationslist[0])
print(locationslist[2279])
```

```
2280
[9.0514168, 7.4914232]
[9.068983, 7.4461538]
```

In [ ]:
```
http://router.project-osrm.org/route/v1/driving/13.388860,52.517037;13.397634,52.529407;13.428555,52.523219?overview=false
```

In [19]:
```
url = "http://router.project-osrm.org/route/v1/driving/9.0514168,7.4914232;9.068983,7.4461538"
r = requests.get(url)
res = r.json()
res
```

Out[19]:
```
{'code': 'Ok',
 'routes': [{'geometry': 's~ul@u{gv@dPnBhU|FtZxKf^|EwCuR|@gAvEEeD}IeG_H{FoYpAmBfUeGrVq@hSdA`q@uk@fMkElGmFpJxC`d@|FnKrC',
   'legs': [{'steps': [],
     'summary': '',
     'weight': 1082,
     'duration': 1082,
     'distance': 7416}],
   'weight_name': 'routability',
   'weight': 1082,
   'duration': 1082,
   'distance': 7416}],
 'waypoints': [{'hint': '45nfgtAz5oNJAAAAdQAAAFkJAACiAgAAkhZKQn7SoEI9pM5E88_oQ0kAAAB1AAAAWQkAAKICAACZGgAA8jGKAMBLcgAZHYoAX09yAA0A3wsm41_Y',
   'distance': 597.956307,
   'name': '',
   'location': [9.056754, 7.490496]},
  {'hint': 'D5zfghU05oMAAAAAaQAAAJ8DAAD8BQAAAAAAAGygkEIDQyBE3EGERAAAAABpAAAAnwMAAPwFAACZGgAA3mmKAGmacQC3YYoAip5xAAIA_wEm41_Y',
   'distance': 258.347153,
   'name': '',
   'location': [9.07107, 7.445097]}]}
```

In [ ]:
```
'''
The trip has distance of 7416 meters and a travel time of 1082 seconds

'''
```

In [36]:
```
polyline.decode('s~ul@u{gv@dPnBhU|FtZxKf^|EwCuR|@gAvEEeD}IeG_H{FoYpAmBfUeGrVq@hSdA`q@uk@fMkElGmFpJxC`d@|FnKrC', precision=5, geojson=True)
```

Out[36]:
```
[(9.05675, 7.4905),
 (9.05619, 7.48775),
 (9.05492, 7.48418),
 (9.05287, 7.47975),
 (9.05176, 7.47475),
 (9.05491, 7.47551),
 (9.05527, 7.4752),
 (9.0553, 7.47412),
 (9.05705, 7.47495),
 (9.05849, 7.47626),
 (9.06273, 7.47752),
 (9.06328, 7.47711),
 (9.06459, 7.47355),
 (9.06484, 7.46977),
 (9.06449, 7.46652),
 (9.07164, 7.45851),
 (9.07266, 7.45623),
 (9.07385, 7.45488),
 (9.07308, 7.45303),
 (9.07181, 7.4471),
 (9.07107, 7.4451)]
```

In [45]:
```
def get_route(pickup_lat, pickup_lon, dropoff_lat, dropoff_lon):

    loc = "{},{};{},{}".format(pickup_lat, pickup_lon, dropoff_lat, dropoff_lon)
    url = "http://router.project-osrm.org/route/v1/driving/"
    r = requests.get(url + loc)
    if r.status_code!= 200:
        return {}
```

```
    res = r.json()
    routes = polyline.decode(res['routes'][0]['geometry'], precision=5, geojson=True)
    start_point = [res['waypoints'][0]['location'][0], res['waypoints'][0]['location'][1]]
    end_point = [res['waypoints'][1]['location'][0], res['waypoints'][1]['location'][1]]

    distance = res['routes'][0]['distance']

    out = {'route':routes,
           'start_point':start_point,
           'end_point':end_point,
           'distance':distance
          }

    return out
```

In [46]:

```
pickup_lat, pickup_lon, dropoff_lat, dropoff_lon = 9.0514168,7.4914232,9.068983,7.4461538
test_route = get_route(pickup_lat, pickup_lon, dropoff_lat, dropoff_lon)
test_route
```

Out[46]:

```
{'route': [(9.05675, 7.4905),
  (9.05619, 7.48775),
  (9.05492, 7.48418),
  (9.05287, 7.47975),
  (9.05176, 7.47475),
  (9.05491, 7.47551),
  (9.05527, 7.4752),
  (9.0553, 7.47412),
  (9.05705, 7.47495),
  (9.05849, 7.47626),
  (9.06273, 7.47752),
  (9.06328, 7.47711),
  (9.06459, 7.47355),
  (9.06484, 7.46977),
  (9.06449, 7.46652),
  (9.07164, 7.45851),
  (9.07266, 7.45623),
  (9.07385, 7.45488),
  (9.07308, 7.45303),
  (9.07181, 7.4471),
  (9.07107, 7.4451)],
 'start_point': [9.056754, 7.490496],
 'end_point': [9.07107, 7.445097],
 'distance': 7416}
```

In [65]:

```
def get_map(route):

    m = folium.Map(location=[(route['start_point'][0] + route['end_point'][0])/2,
                             (route['start_point'][1] + route['end_point'][1])/2],
                   zoom_start=13)

    folium.PolyLine(
        route['route'],
        weight=8,
        color='black',
        opacity=0.6
    ).add_to(m)

    folium.Marker(
        location=route['start_point'],
        icon=folium.Icon(color="green", icon_color='white', icon="flag-checkered", prefix='fa')
    ).add_to(m)

    folium.Marker(
```

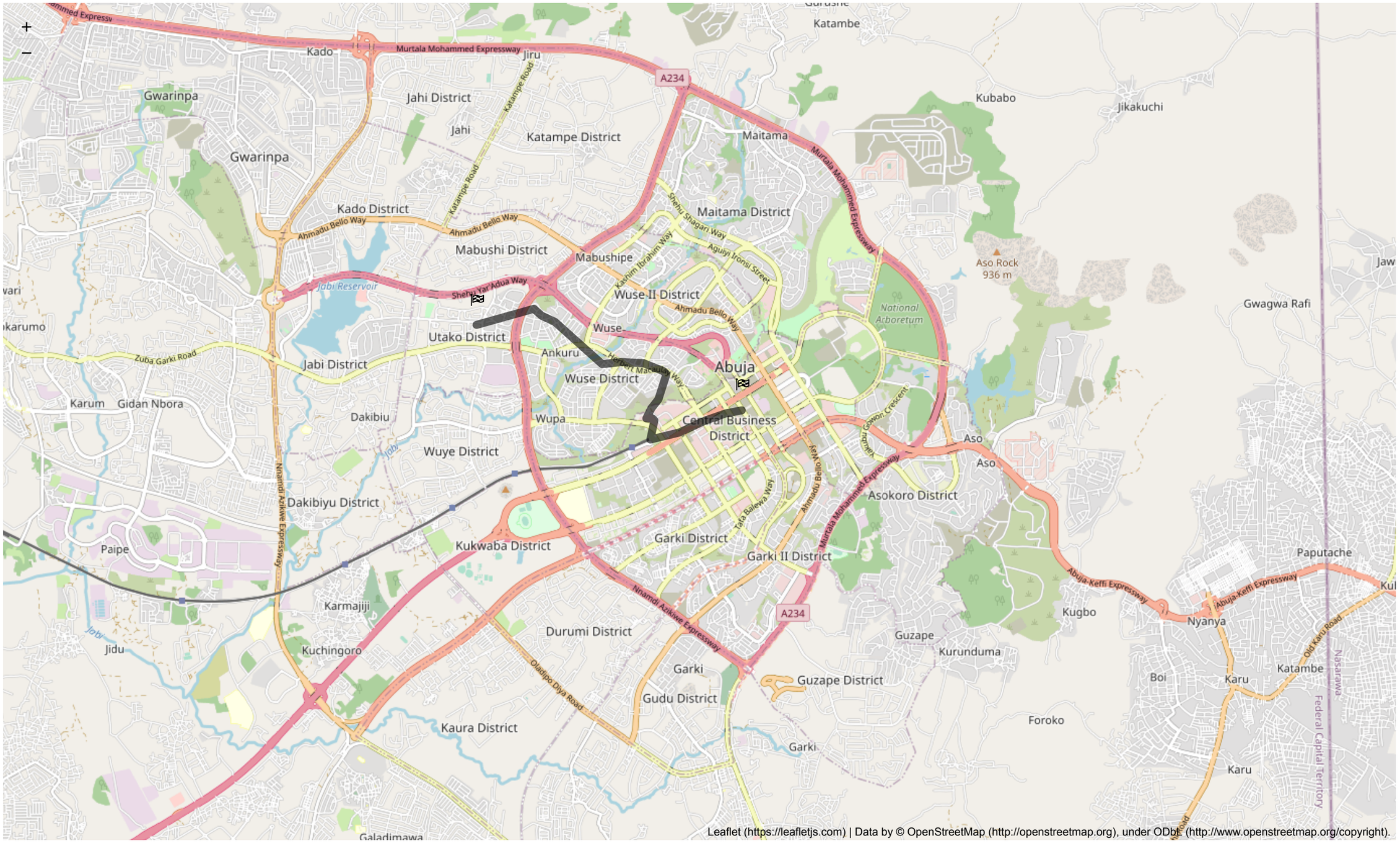
```
        location=route['end_point'],
        icon=folium.Icon(color="red", icon_color='white', icon="flag-checkered", prefix='fa')
    ).add_to(m)

    return m
```

In [66]:

```
# Route rendered using OSRM
get_map(test_route)
```

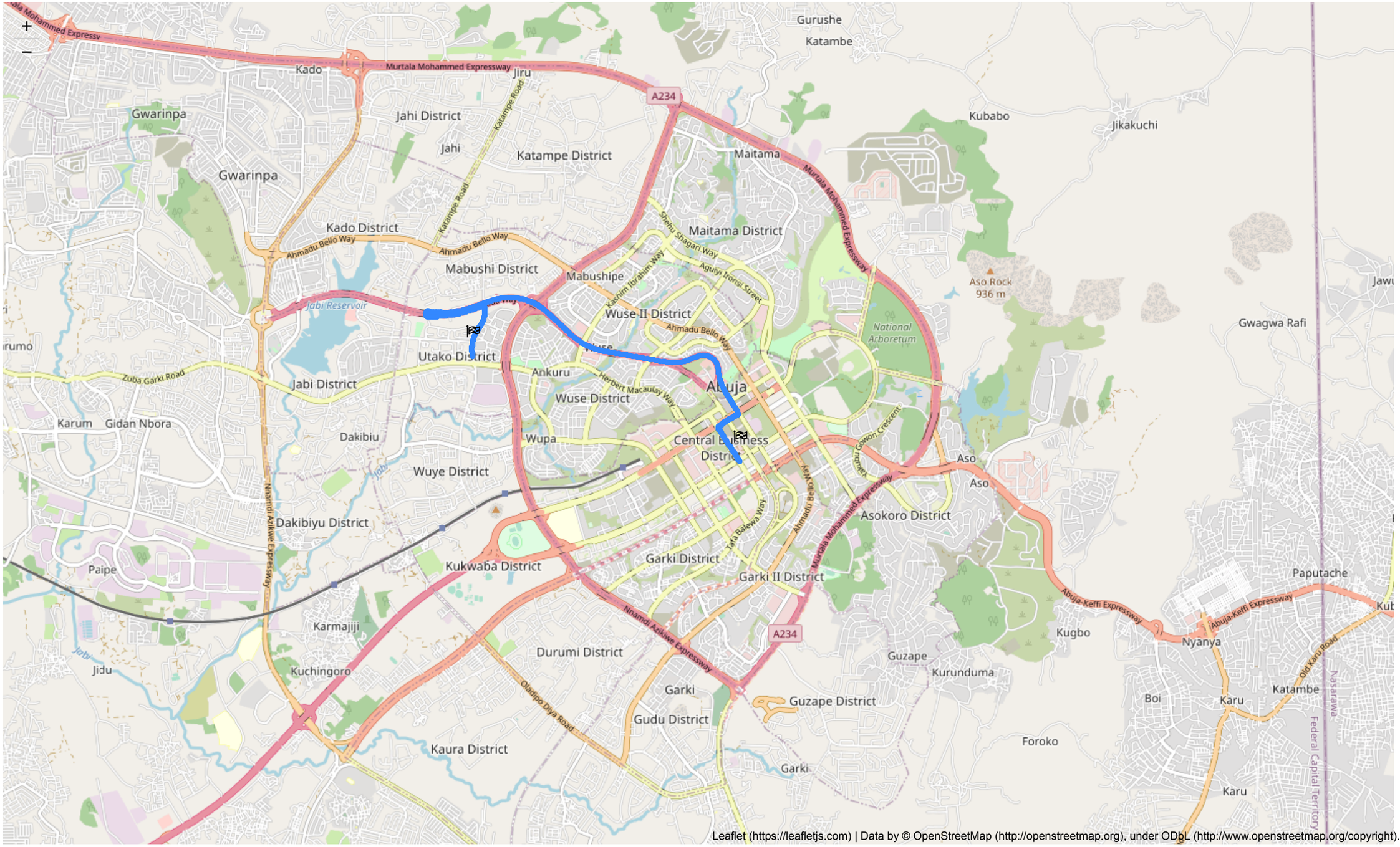
Out[66]:



In [32]:

```
# Route rendered by ploting all the coordinates using folium
map
```

Out[32]:



In [33]:

```
help(polyline.decode)
```

```
Help on function decode in module polyline:

decode(expression, precision=5, geojson=False)
    Decode a polyline string into a set of coordinates.

    :param expression: Polyline string, e.g. 'u{~vFvyys@fS]'.
```

```
    :param precision: Precision of the encoded coordinates. Google Maps uses 5, OpenStreetMap uses 6.
        The default value is 5.
    :param geojson: Set output of tuples to (lon, lat), as per https://tools.ietf.org/html/rfc7946#section-3.1.1
    :return: List of coordinate tuples in (lat, lon) order, unless geojson is set to True.
```

In [ ]:

In [ ]: