GEOG 172: INTERMEDIATE GEOGRAPHICAL ANALYSIS

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About me

PhD candidate at UCSB Dept of Geography. I specialize in spatio-temporal visualizations that help exploratory spatial data analysis and data-driven knowledge discovery. In my day-to-day tasks I prefer using FOSS (free and open source) tools (e.g. Python, QGIS, GeoDa, R, PostGIS) that help make research more reproducible.

The outline of today's lecture

1. Course Introduction
    A. Syllabus
    B. Weekly Patterns
    C. Success tips
2. GIS versus Geographical Analysis

Course logistics

1. **GauchoSpace** - dropboxes for quizzes and labs + announcements
2. **JupyterBook course page** - Syllabus, course materials, lab instructions

Evaluation

1. Labs (40%) - the total of 8 labs. Lab 9 and 10 (as per Syllabus schedule) will be devoted to projects mostly.
2. Project (30%) - 4 deliverables.
    A. Data Report (5%)
    B. Interim Progress Report (5%)
    C. Presentation (10%)
    D. Final Report (10%)

1. Weekly quizzes (20%) - multiple choice and short answers. Lowest quiz will be dropped.
2. Participation (10%) - labs + lectures.

Labs

- In-person (M/T). Switching Policy.
- Python, GeoDa, ArcGIS / QGIS
- Due the following week before section!
- Late Policy: 1% for each hour late
- See schedule in the Syllabus

Why Project?

1. Projects mimic the on-the-job duties better.
2. Spatial data tasks:
    A. Acquire data (not part of this course)
    B. Process data (partly covered)
    C. Explore the data (covered)
    D. Generate hypotheses about the data
    E. Test hypothesis with statistics

Project structure

1. Data report. Find spatial data and describe in Python using code snippets learned in lab sections.
2. Interim data report. Utilize spatial statistics to characterize your data spatially.
3. Project presentation. Week 10. Sign-up for time either during lecture time or during lab time.
4. Final Report.

Quizzes

- Short answers and mulitple choice. Every Thursday: 8.00 - 23.00. Lowest score - dropped.

Participation

- Required for both labs and lectures

Wk	Date	Topics	Readings
1	09/26	Introduction/Review of Spatial Analysis	GIA Ch1
1	09/28	Review of Basic Statistics	TBD
2	10/3	Geographic Data	SD
2	10/5	Distance, adjacency and MAUP	GIA Ch1
3	10/10	Geovisualization	GIA Ch3
3	10/12	Point Pattern Analysis	GIA Ch5,6
3	10/16	**Data Report Due**	
4	10/17	Correlation and Covariance	
4	10/19	ANOVA	
5	10/24	Spatial Autocorrelation 1	GIA Ch7
5	10/26	Spatial Autocorrelation 2	

Wk	Date	Topics	Readings
6	10/31	LISA and Local Moran's I	GIA Ch8
6	11/2	Other Local Statistics	
6	11/6	**Interim Data Report Due**	⚠
7	11/7	Spatial Regression 1	SR
7	11/9	Spatial Regression 2	
8	11/14	Spatial Clustering/Regionalization 1	CR
8	11/16	Spatial Clustering/Regionalization 2	
9	11/21	Spatial Interpolation	GIA Ch9
9	11/23	Geostatistics	GIA Ch10
9	11/27	**Presentation slides due**	⚠
10	11/28	Presentations 1	
10	11/30	Presentations 2	
11	12/7	**Final Report Due**	⚠

Weekly Class Schedule

1. M/W: lectures (see Syllabus for readings)
2. M/T: lab sections (see Syllabus for lab schedule). Submit labs before the section the following week.
3. R: take a quiz

Questions  ?

Geographic Information Analysis

- Geographic information analysis
    - Concerned with investigating patterns that arise as processes that may be operating in space
    - Techniques and methods that enable the representation, description, measurement, comparison, and generation of spatial patterns

- What is a pattern?
    - Potential realization of a process
    - Provide clues to the cause of processes
- What is a process?
    - The underlying phenomenon that operates in space

Geographic Information Analysis

- Geographic Information Systems
- Remote Sensing
- Exploratory Spatial Data Analysis (ESDA)
- Statistics / Geostatistics
- Simulation / Agent-based Modeling / Cellular Automata
- Spatial Decision Support Systems
- Geovisualization

GIS

- System of hardware, software & procedures designed to support geographical decision making through the capture, management, manipulation, analysis, modeling and display of spatially referenced data
- Can handle geographic (spatially referenced) data or non-spatial attribute data
- Operations include:
    - Summary statistics, distance, intersection, buffer, map overlay, projection, transformation, etc.

Here is what GIS is (in Python words)

In [1]:

```
import geopandas as gpd
import osmnx as ox
import matplotlib.pyplot as plt
import contextily as cx
from IPython.display import Image
from pointpats import centrography
from matplotlib.patches import Ellipse
import numpy as np

ox.settings.use_cache = True
```

In [2]:

```
goleta = ox.geocode_to_gdf("Goleta, CA, USA") # get Goleta

go_graph = ox.graph_from_place('Goleta, CA, USA')
go_nodes, go_streets  = ox.graph_to_gdfs(go_graph)

tags = {'amenity': ['pub', 'bar', 'cafe', 'restaurant']} # used for parsing O
dist = 5000 # set search radius (in meters)

# download POIs
pois = ox.geometries.geometries_from_point(center_point = (goleta.lat[0],gole

go_proj = ox.project_gdf(goleta, to_crs='EPSG:3857') # re-project layers
go_streets_proj = ox.project_gdf(go_streets, to_crs='EPSG:3857')
pois_proj = ox.project_gdf(pois, to_crs='EPSG:3857')

# print to the output
print(f'There are {pois.shape} cafes/restaurants/bars/pubs in SB!')
pois.head(3)
```

```
There are (85, 58) cafes/restaurants/bars/pubs in SB!
```

Out[2]:

		amenity	brand	brand:wikidata	brand:wikipedia
element_type	**osmid**				
node	**448863565**	cafe	Starbucks	Q37158	en:Starbucks

		amenity	brand	brand:wikidata	brand:wikipedia
element_type	**osmid**				
	1341709739	restaurant	NaN	NaN	NaN
	1348747781	restaurant	NaN	NaN	NaN

3 rows × 58 columns

In [3]:
```
go_streets_proj.highway.value_counts()[:15]
```

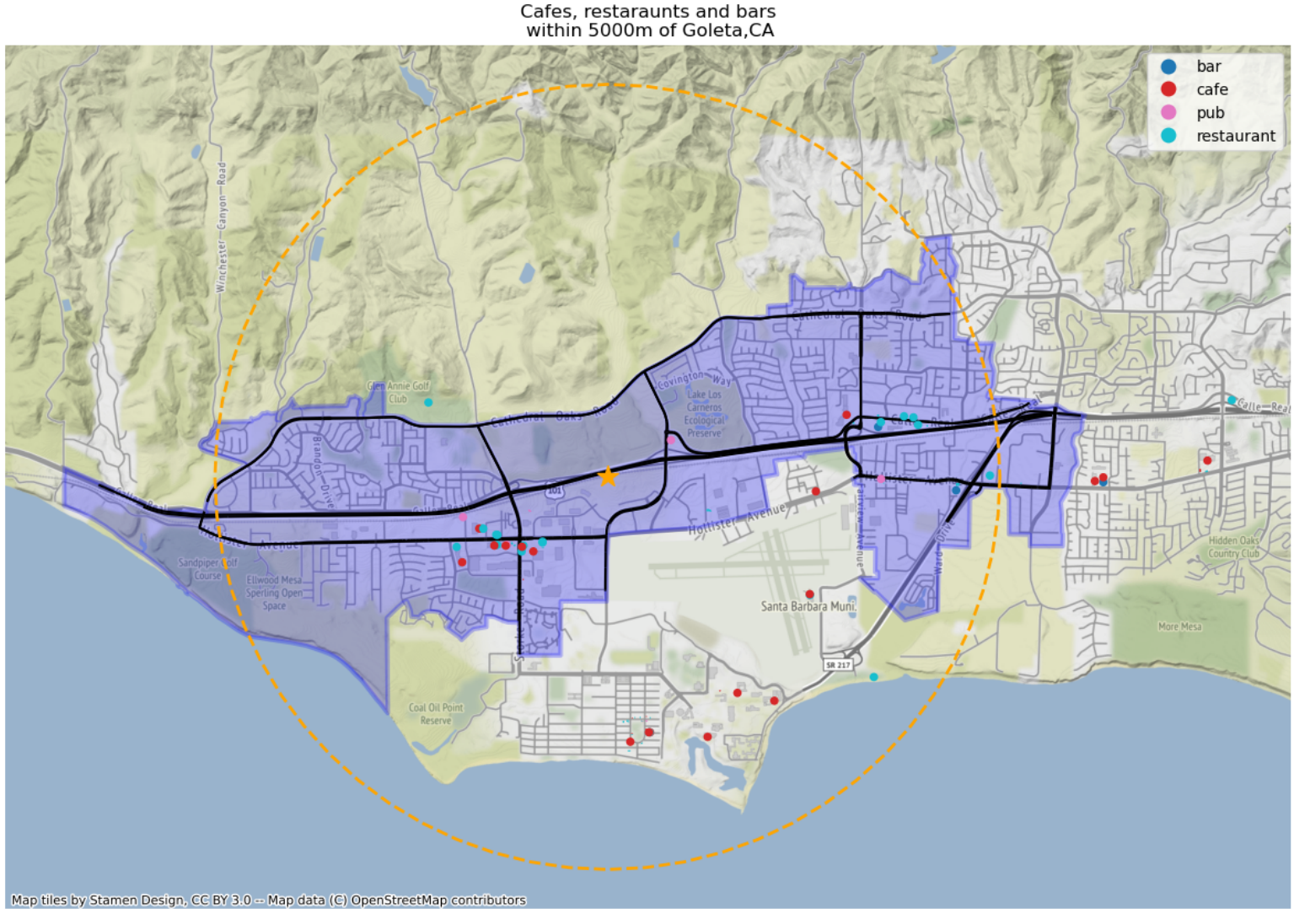
Out[3]:
```
service                  15890
footway                  12784
residential               7977
path                      1446
tertiary                   772
secondary                  644
unclassified               249
cycleway                   150
track                       84
[footway, service]          60
[footway, residential]      60
motorway_link               44
[footway, path]             30
motorway                    27
living_street               14
Name: highway, dtype: int64
```

In [20]:

```
fig, ax = plt.subplots(figsize=(15,15))

major_str = go_streets_proj.loc[(go_streets_proj.highway=='secondary')|(go_st

go_proj.plot(fc="blue", ec="blue", linewidth=3, alpha=.25, ax=ax, zorder=1, l
major_str.plot(color='k', ax=ax, zorder=2)
go_proj.centroid.plot(color='orange', markersize=200, marker='*', ax=ax, zord
go_proj.centroid.buffer(5000).plot(fc='none', ec='orange', linewidth=2, ax=ax
pois_proj.plot(column='amenity', markersize=20, ax=ax, categorical=True, lege
cx.add_basemap(ax=ax)

ax.set_title('Cafes, restaraunts and bars\n within 5000m of Goleta,CA')
_ = ax.axis("off")

fig.savefig('goleta_cafe.png', bbox_inches='tight')
plt.close()
```

In [21]:
```
Image(filename='goleta_cafe.png')
```

Out[21]:



What Geographic Analysis is

Centrography and Point Pattern Analysis

In [6]:

```
# create x and y for calculation with projected coords (meters)
pois = pois.to_crs('EPSG:3857')
pois['x'] = pois.geometry.centroid.x
pois['y'] = pois.geometry.centroid.y
```

In [7]:

```
mean_center = centrography.mean_center(pois[["x", "y"]])
med_center = centrography.euclidean_median(pois[["x", "y"]])
std_dist = centrography.std_distance(pois[["x", "y"]])
major, minor, rotation = centrography.ellipse(pois[["x", "y"]])

print(mean_center)
print(med_center)
print(std_dist)
```

```
[-13341454.75696344   4086141.85634311]
[-13342101.87019569   4085474.32197616]
2964.6474778578227
```

```
C:\Users\barguzin\anaconda3\envs\geo_env\lib\site-packages\pointpats
\geometry.py:22: DeprecationWarning: Please use `ConvexHull` from the
`scipy.spatial` namespace, the `scipy.spatial.qhull` namespace is dep
recated.
  spatial.qhull.ConvexHull,
C:\Users\barguzin\anaconda3\envs\geo_env\lib\site-packages\pointpats
\geometry.py:42: DeprecationWarning: Please use `ConvexHull` from the
`scipy.spatial` namespace, the `scipy.spatial.qhull` namespace is dep
recated.
  def _(shape: spatial.qhull.ConvexHull):
C:\Users\barguzin\anaconda3\envs\geo_env\lib\site-packages\pointpats
\geometry.py:85: DeprecationWarning: Please use `ConvexHull` from the
`scipy.spatial` namespace, the `scipy.spatial.qhull` namespace is dep
recated.
  def _(shape: spatial.qhull.ConvexHull):
C:\Users\barguzin\anaconda3\envs\geo_env\lib\site-packages\pointpats
\geometry.py:132: DeprecationWarning: Please use `ConvexHull` from th
```

```
e `scipy.spatial` namespace, the `scipy.spatial.qhull` namespace is d
eprecated.
  def _(shape: spatial.qhull.ConvexHull, x: float, y: float):
C:\Users\barguzin\anaconda3\envs\geo_env\lib\site-packages\pointpats
\geometry.py:174: DeprecationWarning: Please use `ConvexHull` from th
e `scipy.spatial` namespace, the `scipy.spatial.qhull` namespace is d
eprecated.
  def _(shape: spatial.qhull.ConvexHull):
```

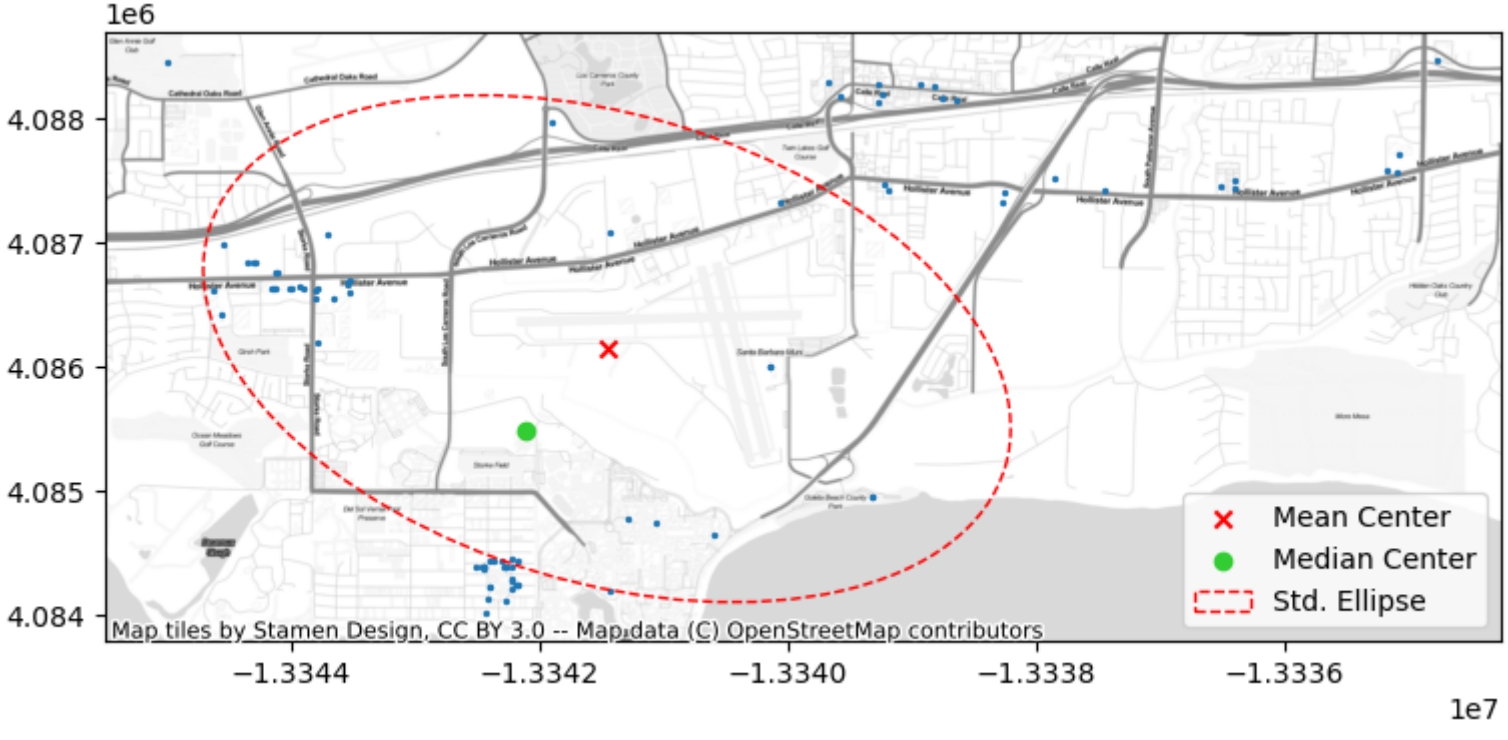
In [17]:

```
# Set up figure and axis
fig, ax = plt.subplots(1, figsize=(9, 9))
# Plot photograph points
ax.scatter(pois["x"], pois["y"], s=2)
ax.scatter(*mean_center, color="red", marker="x", label="Mean Center")
ax.scatter(
    *med_center, color="limegreen", marker="o", label="Median Center"
)

# Construct the standard ellipse using matplotlib
ellipse = Ellipse(
    xy=mean_center,  # center the ellipse on our mean center
    width=major * 2,  # centrography.ellipse only gives half the axis
    height=minor * 2,
    angle=np.rad2deg(
        rotation
    ),  # Angles for this are in degrees, not radians
    facecolor="none",
    edgecolor="red",
    linestyle="--",
    label="Std. Ellipse",
)
ax.add_patch(ellipse)

ax.legend()
# Display
# Add basemap
cx.add_basemap(
    ax, source=cx.providers.Stamen.TonerLite
    #ax, source=cx.providers.OpenStreetMap.Mapnik
```

```
)

fig.savefig('centro.png', bbox_inches='tight')
plt.close()
```

In [18]:
```
Image(filename='centro.png')
```

Out[18]:



Questions?

See you on Wednesday! Same time!

Do not forget to write down your name at attendance sheet!