[Lab 5]

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Link github: Data_Mining/Week5 at main · Shu2301/Data_Mining (github.com)

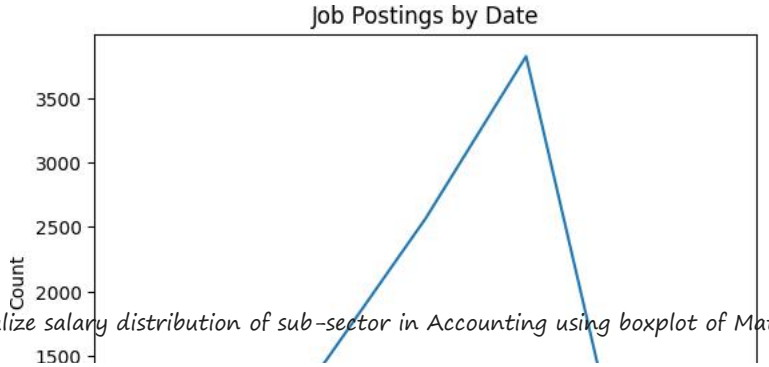
```
# This Python 3 environment comes with many helpful analytics libraries installed
# It is defined by the kaggle/python Docker image: https://github.com/kaggle/docker-python
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list all files under the input directory

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that gets preserved as output when you create a version using "Save & # You can also write temporary files to /kaggle/temp/, but they won't be saved outside of the current session
```

In this workshop, you will continue using Matplotlib, Seaborn and Plotly to explore the data. Filter from the dataset all the "Accounting" job and visualize the total job postings of each sub-sectors.

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

import plotly.express as px

df = pd.read_csv("/kaggle/input/shu/job-market.csv")

accounting_jobs = df[df['Classification'] == 'Accounting']

subsector_counts = accounting_jobs['SubClassification'].value_counts()

fig = px.bar(x=subsector_counts.index, y=subsector_counts.values, labels={'x':'Sub-sector', 'y':'Count'}, color=subsector_counts.index)
fig.update_layout(title='Accounting')
fig.show()
```

Count the job postings by month and visualize in line graph using Matplotlib, Seaborn and Plotly

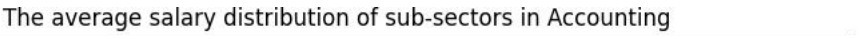
```
import matplotlib.pyplot as plt

# Convert the 'Date' column to datetime format
df['Date'] = pd.to_datetime(df['Date'])

# Filter the data for the month of October 2018
df = df[(df['Date'] >= '2018-10-01') & (df['Date'] <= '2018-10-31')]

# Group the data by day and count the job postings
job_postings_by_day = df.groupby(pd.Grouper(key='Date', freq='D'))['Title'].count()

# Create a line graph of the job postings by day using Matplotlib
plt.plot(job_postings_by_day.index, job_postings_by_day.values)
plt.xticks(job_postings_by_day.index, [d.strftime('%d.%b') for d in job_postings_by_day.index], rotation=45)
plt.xlabel('Label')
plt.ylabel('Count')
plt.title('Job Postings by Date')
plt.show()
```



Visualize salary distribution of sub-sector in Accounting using boxplot of Matplotlib, Seaborn and Plotly.

```
import seaborn as sns

accounting_jobs = df[df['Classification'] == 'Accounting']
plt.figure(figsize=(10,8))
sns.boxplot(x=accounting_jobs['SubClassification'], y=accounting_jobs['LowestSalary'])
plt.xlabel('Sub-sector')
plt.ylabel('Average Salary')
plt.title('The average salary distribution of sub-sectors in Accounting')
plt.xticks(rotation=90)
plt.show()
```

```
/opt/conda/lib/python3.10/site-packages/scipy/__init__.py:146: UserWarning:

A NumPy version >=1.16.5 and <1.23.0 is required for this version of SciPy (detected version 1.23.5
```



Section 2: Moving Beyond Static Visualizations

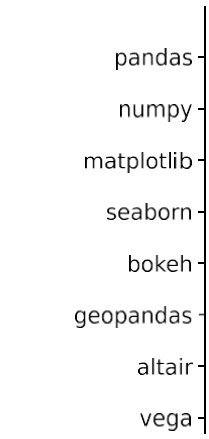
Animating cumulative values over time

```
import pandas as pd

questions_per_library = pd.read_csv(
    "/kaggle/input/shu/stackoverflow/stackoverflow.csv", parse_dates=True, index_col = 'creation_date'
).loc[:,'pandas':'bokeh'].resample('1M').sum().cumsum().reindex(
    pd.date_range('2008-08', '2021-10', freq='M')
).fillna(0)
questions_per_library.tail()
```

	pandas	matplotlib	numpy	seaborn	geopandas	geoviews	altair	yellowbrick	vega	holoviews	hvplot	bokeh
2021-05-31	200734.0	57853.0	89812.0	6855.0	1456.0	57.0	716.0	46.0	532.0	513.0	84.0	4270.0
2021-06-30	205065.0	58602.0	91026.0	7021.0	1522.0	57.0	760.0	48.0	557.0	521.0	88.0	4308.0
2021-07-31	209235.0	59428.0	92254.0	7174.0	1579.0	62.0	781.0	50.0	572.0	528.0	89.0	4341.0
2021-08-31	213410.0	60250.0	93349.0	7344.0	1631.0	62.0	797.0	52.0	589.0	541.0	92.0	4372.0
2021-09-30	214919.0	60554.0	93797.0	7414.0	1652.0	63.0	804.0	54.0	598.0	542.0	92.0	4386.0

```
from matplotlib.animation import FuncAnimation


import matplotlib.pyplot as plt
from matplotlib import ticker

def bar_plot(data):
  fig, ax = plt.subplots(figsize=(8, 6))
  sort_order = data.last('1M').squeeze().sort_values().index
  bars = [
      bar.set_label(label) for label, bar in
      zip(sort_order, ax.barh(sort_order, [0] * data.shape[1]))
  ]

  ax.set_xlabel('total questions', fontweight='bold')
  ax.set_xlim(0, 250_000)
  ax.xaxis.set_major_formatter(ticker.EngFormatter())
  ax.xaxis.set_tick_params(labelsize=12)
  ax.yaxis.set_tick_params(labelsize=12)

  for spine in ['top', 'right']:
    ax.spines[spine].set_visible(False)

  fig.tight_layout()

  return fig, ax


%config InlineBackend.figure_formats = ['svg']
%matplotlib inline
bar_plot(questions_per_library)
```

```
(<Figure size 800x600 with 1 Axes>, <AxesSubplot: xlabel='total questions'>)
```




```
def generate_plot_text(ax):
    annotations =
        [ ax.annotate(
            "", xy=(0, bar.get_y() + bar.get_height()/2),
            ha='left', va='center'
        ) for bar in ax.patches
    ]

    time_text = ax.text(
        0.9, 0.1, "", transform = ax.transAxes,
        fontsize=15, ha='center', va='center'
    )
    return annotations, time_text


def update(frame, *, ax, df, annotations, time_text):
    data = df.loc[frame, :]

    # update bars
    for rect, text in zip(ax.patches, annotations):
        col = rect.get_label()
        if data[col]:
            rect.set_width(data[col])
            text.set_x(data[col])
            text.set_text(f" {data[col]:,.0f}")

    # update time
    time_text.set_text(frame.strftime('%b\n%Y'))


from pandas.core.strings.base import annotations
from functools import partial

def bar_plot_init(questions_per_library):
    fig, ax = bar_plot(questions_per_library)
    annotations, time_text = generate_plot_text(ax)

    bar_plot_update = partial(
        update, ax=ax, df=questions_per_library,
        annotations = annotations, time_text = time_text
    )

    return fig, bar_plot_update


from numpy import repeat
fig, update_func = bar_plot_init(questions_per_library)

ani = FuncAnimation(
    fig, update_func, frames=questions_per_library.index, repeat=False
)
ani.save(
    'stackoverflow_questions.mp4',
    writer='ffmpeg', fps=10, bitrate=100, dpi=300
)
plt.close()
```

```
from IPython import display

display.Video(
    '/kaggle/working/stackoverflow_questions.mp4', width=600, height=400,
    embed=True, html_attributes='controls muted autoplay'
)
```

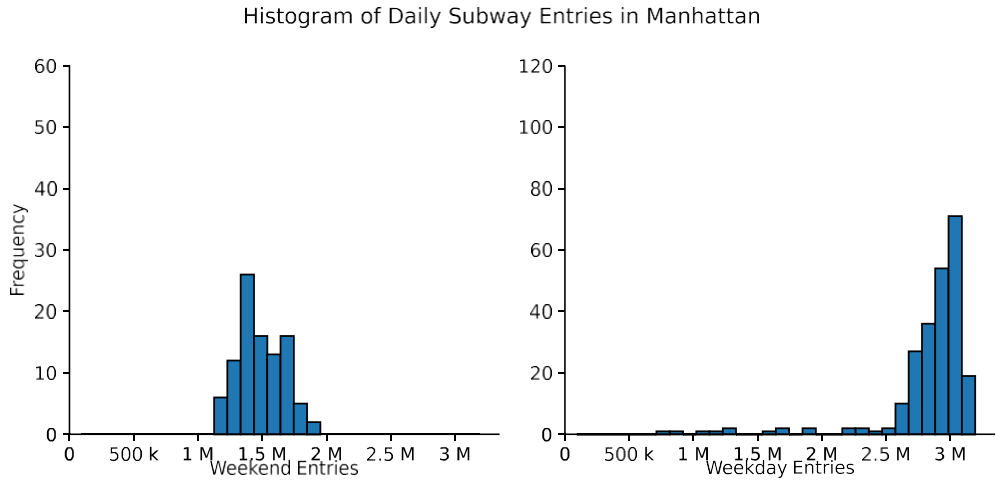
Animating distributions over time

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.animation import FuncAnimation
from matplotlib import ticker
from functools import partial

subway = pd.read_csv(
    "/kaggle/input/shu/NYC_subway_daily.csv", parse_dates=['Datetime'],
    index_col=['Borough', 'Datetime']
)
subway_daily = subway.unstack(0)
subway_daily.head()
```

	Entries				Exits			
Borough	**Bk**	**Bx**	**M**	**Q**	**Bk**	**Bx**	**M**	**Q**
Datetime								
2017-02-04	617650.0	247539.0	1390496.0	408736.0	417449.0	148237.0	1225689.0	279699.0
2017-02-05	542667.0	199078.0	1232537.0	339716.0	405607.0	139856.0	1033610.0	268626.0
2017-02-06	1184916.0	472846.0	2774016.0	787206.0	761166.0	267991.0	2240027.0	537780.0
2017-02-07	1192638.0	470573.0	2892462.0	790557.0	763653.0	270007.0	2325024.0	544828.0
2017-02-08	1243658.0	497412.0	2998897.0	825679.0	788356.0	275695.0	2389534.0	559639.0

```
manhattan_entries = subway_daily['Entries']['M']
count_per_bin, bin_ranges = np.histogram(manhattan_entries, bins=30)


def subway_histogram(data, bins, date_range):
    _, bin_ranges = np.histogram(data, bins=bins)

    weekday_mask = data.index.weekday < 5
    configs = [
        {'label': 'Weekend', 'mask': ~weekday_mask, 'ymax': 60},
        {'label': 'Weekday', 'mask': weekday_mask, 'ymax': 120}
    ]

    fig, axes = plt.subplots(1, 2, figsize=(8, 4), sharex=True)
    for ax, config in zip(axes, configs):
```

```
        _, _, config['hist'] = ax.hist(
            data[config['mask']].loc[date_range], bin_ranges, ec='black'
        )
        ax.xaxis.set_major_formatter(ticker.EngFormatter())
        ax.set(
            xlim=(0, None), ylim=(0, config['ymax']),
            xlabel=f"{config["label"]} Entries'
        )
        for spine in ['top', 'right']:
            ax.spines[spine].set_visible(False)

    axes[0].set_ylabel('Frequency')
    fig.suptitle('Histogram of Daily Subway Entries in Manhattan')
    fig.tight_layout()

    return fig, axes, bin_ranges, configs


_ = subway_histogram(manhattan_entries, bins=30, date_range='2017')
```




```
def add_time_text(ax):
    time_text = ax.text(
        0.15, 0.9, '', transform=ax.transAxes,
        fontsize=15, ha='center', va='center'
    )
    return time_text


def update(frame, *, data, configs, time_text, bin_ranges):
    artists = []

    time = frame.strftime('%b\n%Y')
    if time != time_text.get_text():
        time_text.set_text(time)
        artists.append(time_text)

    for config in configs:
        time_frame_mask = \
            (data.index > frame - pd.Timedelta(days=365)) & (data.index <= frame)
        counts, _ = np.histogram(
            data[time_frame_mask & config['mask']],
            bin_ranges
        )
        for count, rect in zip(counts, config['hist'].patches):
            if count != rect.get_height():
                rect.set_height(count)
                artists.append(rect)

    return artists


def histogram_init(data, bins, initial_date_range):
    fig, axes, bin_ranges, configs = subway_histogram(data, bins, initial_date_range)

    update_func = partial(
        update, data=data, configs=configs,
```

```
        time_text=add_time_text(axes[0]),
        bin_ranges=bin_ranges
    )

    return fig, update_func


fig, update_func = histogram_init(
    manhattan_entries, bins=30, initial_date_range=slice('2017', '2019-07')
)

ani = FuncAnimation(
    fig, update_func, frames=manhattan_entries['2019-08':'2021'].index,
    repeat=False, blit=True
)

ani.save(
    'subway_entries_subplots.mp4',
    writer='ffmpeg', fps=30, bitrate=500, dpi=300
)
plt.close()


from IPython import display

display.Video(
    '/kaggle/working/subway_entries_subplots.mp4', width=600, height=400,
    embed=True, html_attributes='controls muted autoplay'
)
```

Animating geospatial data with HoloViz

```
import pandas as pd
import geopandas as gpd

earthquakes = gpd.read_file("
    /kaggle/input/shu/earthquakes.geojson").assign( time = lambda x:
    pd.to_datetime(x.time, unit='ms'),
    month = lambda x: x.time.dt.month
)[['geometry', 'mag', 'time', 'month']]

earthquakes.shape
```

```
(188527, 4)
```

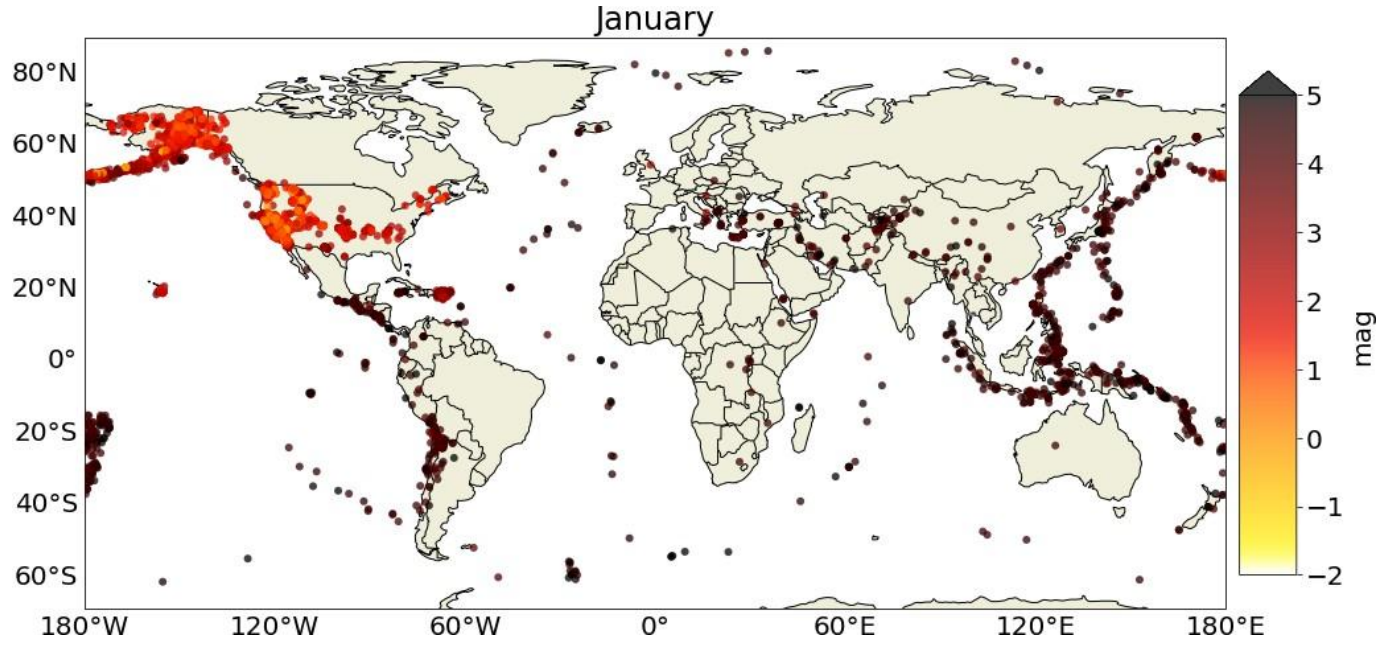
```
earthquakes.head()
```

	geometry	mag	time	month
0	POINT Z (-67.12750 19.21750 12.00000)	2.75	2020-01-01 00:01:56.590	1

```
import geoviews as gv
import geoviews.feature as gf
import holoviews as hv

gv.extension('matplotlib')
```

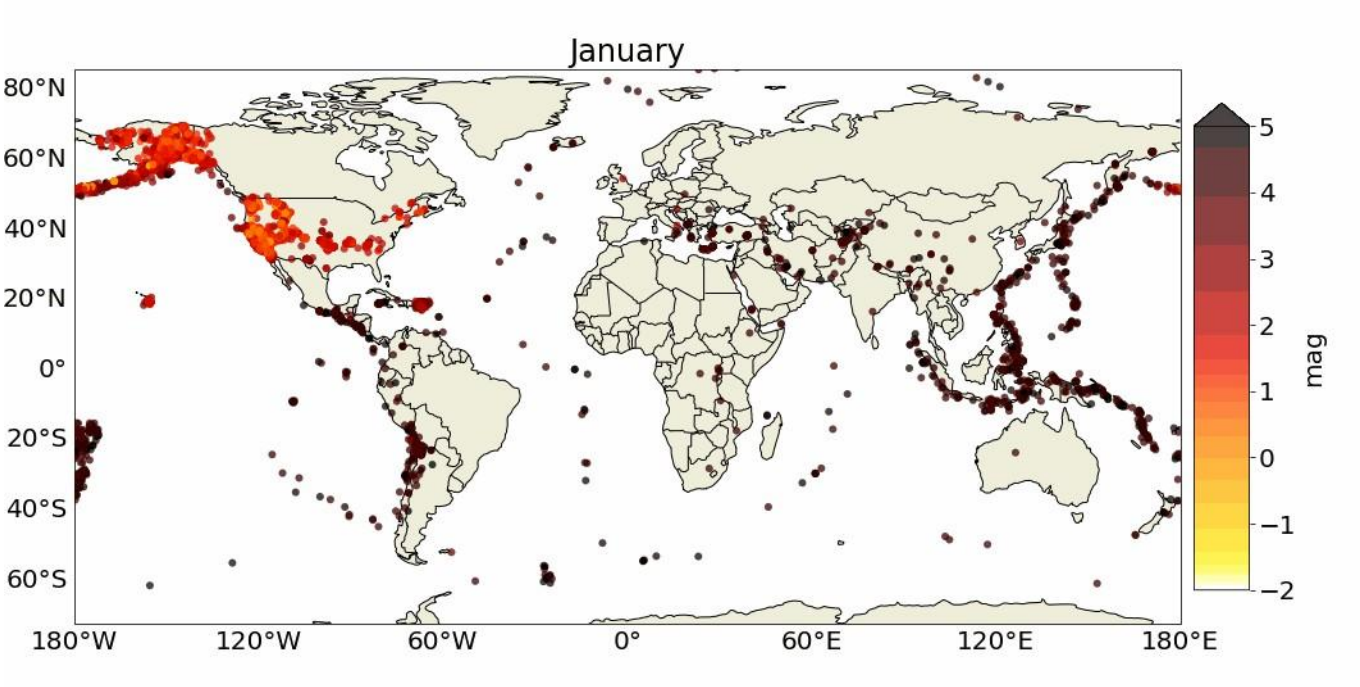
```
import calendar

def plot_earthquakes(data, month_num):
    points = gv.Points(
        data.query(f'month == {month_num}'),
        kdims = ['longitude', 'latitude'],
        vdims = ['mag']
    ).redim.range(mag=(-2, 5), latitude=(-45,45))

    overlay = gf.land * gf.coastline * gf.borders * points

    return overlay.opts(
        gv.opts.Points(color='mag', cmap='fire_r', colorbar=True, alpha=0.75),
        gv.opts.Overlay(
            global_extent=False, title=f"{calendar.month_name[month_num]}", fontscale=2
        )
    )


plot_earthquakes(earthquakes, 1).opts(
    fig_inches=(6,3), aspect=2, fig_size=250, fig_bounds=(0.07, 0.05, 0.87, 0.95)
)
```

```
/opt/conda/lib/python3.10/site-packages/cartopy/io/__init__.py:241: DownloadWarning:

Downloading: https://naturalearth.s3.amazonaws.com/110m_physical/ne_110m_land.zip

/opt/conda/lib/python3.10/site-packages/cartopy/io/__init__.py:241: DownloadWarning:

Downloading: https://naturalearth.s3.amazonaws.com/110m_physical/ne_110m_coastline.zip

/opt/conda/lib/python3.10/site-packages/cartopy/io/__init__.py:241: DownloadWarning:

Downloading: https://naturalearth.s3.amazonaws.com/110m_cultural/ne_110m_admin_0_boundary_lines_land.zip
```




```
frames = {
    month_num: plot_earthquakes(earthquakes, month_num)
```

```
    for month_num in range(1, 13)
}
holomap = hv.HoloMap(frames)


hv.output(
    holomap.opts(
        fig_inches=(6,3), aspect=2, fig_size=250,
        fig_bounds=(0.07, 0.05, 0.87, 0.95)
    ), holomap='gif', fps = 5
)
```




```
hv.save(
    holomap.opts(
        fig_inches=(6,3), aspect=2, fig_size=250,
        fig_bounds=(0.07, 0.05, 0.87, 0.95)
    ), 'earthquakes.gif', fps=5
)
```

Up Next: Building interactive Visualizations for Data

ExplorationExcercises Excercises

1. *Modify the animation of subway entries from this section to show both the weekday and weekend histograms on the same subplot*

2. *Modify the earthquake animation to show earthquakes per day in April 2020.*

Section 3: Building interactive visualizations for data exploration

```
import pandas as pd
```

```
import geopandas as gpd

earthquakes =
    gpd.read_file('/kaggle/input/shu/earthquakes.geojson').assign( time =
    lambda x: pd.to_datetime(x.time, unit='ms'),
    month = lambda x: x.time.dt.month
```

```
).dropna()

earthquakes.head()
```

	mag	place	time	tsunami	magType	geometry	month
0	2.75	80 km N of Isabela, Puerto Rico	2020-01-01 00:01:56.590	0	md	POINT Z (-67.12750 19.21750 12.00000)	1
1	2.55	64 km N of Isabela, Puerto Rico	2020-01-01 00:03:38.210	0	md	POINT Z (-67.09010 19.07660 6.00000)	1
2	1.81	12 km SSE of Maria Antonia, Puerto Rico	2020-01-01 00:05:09.440	0	md	POINT Z (-66.85410 17.87050 6.00000)	1
3	1.84	9 km SSE of Maria Antonia, Puerto Rico	2020-01-01 00:05:36.930	0	md	POINT Z (-66.86360 17.89930 8.00000)	1
4	1.64	8 km SSE of Maria Antonia, Puerto Rico	2020-01-01 00:09:20.060	0	md	POINT Z (-66.86850 17.90660 8.00000)	1

```
from cartopy import crs
import geoviews as gv
import geoviews.feature as gf

gv.extension('bokeh')
```

```
points =
    gv.Points( earthqua
    kes,
    kdims = ['longitude', 'latitude'],
    vdims = ['month', 'place', 'tsunami', 'mag', 'magType']
)

points = points.redim.range(
    mag=(-2,10), longitude=(-180,180), latitude=(-90,90)
)

overlay = gf.land * gf.coastline * gf.borders * points.groupby('month')

interactive_map = overlay.opts(
    gv.opts.Feature(projection=crs.PlateCarree()),
    gv.opts.Overlay(width=700, height=450),
    gv.opts.Points(color='mag', cmap='fire_r', colorbar=True, tools=['hover'])
)

import panel as pn
earthquake_viz = pn.panel(interactive_map, widget_location='bottom')

earthquake_viz.embed()
```

Linking plots

```
january_earthquakes = earthquakes.query('month ==
    1').assign( longitude = lambda x: x.geometry.x,
    latitude = lambda x:  x.geometry.y
).drop(columns=['month', 'geometry'])

import hvplot.pandas

geo = january_earthquakes.hvplot(
    x='longitude', y='latitude', kind='points',
    color='mag', cmap='fire_r', clim=(-2,10),
    titles='CartoLight', geo=True, global_extent=True,
    xlabel='Longitude', ylabel='Latitude', title='January 2020 Earthquakes',
    frame_height=450
)
```

```
WARNING:param.main: titles option not found for points plot with bokeh; similar options include: ['title', 'tiles']
```

```
table = january_earthquakes.sort_values(['longitude',
    'latitude']).hvplot( kind='table', width=650, height=450, title='Raw
    Data'
```

)

```
layout = geo + table

selection = hv.link_selections.instance()
map_and_table_tabs = selection(layout).opts(tabs=True)

map_and_table_tabs
```

```
selection.filter(january_earthquakes).nlargest(3, 'mag')
```

	mag	place	time	tsunami	magType	longitude	latitude
15154	7.7	123 km NNW of Lucea, Jamaica	2020-01-28 19:10:24.918	1	mww	-78.7560	19.4193
13296	6.7	13 km N of Do?anyol, Turkey	2020-01-24 17:55:14.147	0	mww	39.0609	38.4312
4062	6.4	13 km SSE of Maria Antonia, Puerto Rico	2020-01-07 08:24:25.262	1	mww	-66.8266	17.8686

Additional plot types

```
import pandas as pd
import numpy as np

flight_stats = pd.read_csv(
    "/kaggle/input/shu/T100_MARKET_ALL_CARRIER/865214564_T_T100_MARKET_ALL_CARRIER.csv",
    usecols=[
        'CLASS', 'REGION', 'UNIQUE_CARRIER_NAME', 'ORIGIN_CITY_NAME', 'ORIGIN',
        'DEST_CITY_NAME', 'DEST', 'PASSENGERS', 'FREIGHT', 'MAIL'
    ]
).rename(lambda x: x.lower(),
    axis=1).assign( region=lambda x:
    x.region.replace({
        'D': 'Domestic', 'I': 'International', 'A':'Atlantic',
        'L': 'Latin America', 'P': 'Pacific', 'S':'System'
    }),
    route=lambda x:
        np.where( x.origin <
        x.dest,
        x.origin + '-' + x.dest,
        x.dest + '-' + x.origin
    )
)
```

```
flight_stats.head()
```

	passengers	freight	mail	unique_carrier_name	region	origin	origin_city_name	dest	dest_city_name	class	route
0	0.0	53185.0	0.0	Emirates	International	DXB	Dubai, United Arab Emirates	IAH	Houston, TX	G	DXB-IAH
1	0.0	9002.0	0.0	Emirates	International	DXB	Dubai, United Arab Emirates	JFK	New York, NY	G	DXB-JFK
2	0.0	2220750.0	0.0	Emirates	International	DXB	Dubai, United Arab Emirates	ORD	Chicago, IL	G	DXB-ORD
									Dubai, United Arab		DXB-

```
cities = [
    'Atlanta, GA', 'Chicago, IL', 'New York, NY', 'Los Angeles, CA',
    'Dallas/Fort Worth, TX', 'Denver, CO', 'Houston, TX',
    'San Francisco, CA', 'Seattle, WA', 'Orlando, FL'
]

top_airlines = [
    'American Airlines Inc.', 'Delta Air Lines Inc.', 'JetBlue Airways',
    'Southwest Airlines Co.', 'United Air Lines Inc.'
]
```

Chord diagram

```
total_flight_stats = flight_stats.query(
      f`class` == "F" and origin_city_name != dest_city_name'
```

```
    f' and origin_city_name.isin({cities}) and dest_city_name.isin({cities})'
).groupby([
    'origin', 'origin_city_name', 'dest', 'dest_city_name'
])[['passengers', 'freight', 'mail']].sum().reset_index().query('passengers > 0')


total_flight_stats.sample(10, random_state=1)
```

	origin	origin_city_name	dest	dest_city_name	passengers	freight	mail
78	LGA	New York, NY	DEN	Denver, CO	589190.0	506023.0	293108.0
117	ORD	Chicago, IL	SEA	Seattle, WA	810594.0	1063463.0	2627325.0
31	DFW	Dallas/Fort Worth, TX	MCO	Orlando, FL	683700.0	187672.0	95570.0
5	ATL	Atlanta, GA	LAX	Los Angeles, CA	1121378.0	8707125.0	3267077.0
126	SEA	Seattle, WA	LGA	New York, NY	24.0	0.0	0.0
45	IAH	Houston, TX	ATL	Atlanta, GA	566369.0	367543.0	726670.0
14	DEN	Denver, CO	HOU	Houston, TX	305193.0	363119.0	0.0
44	HOU	Houston, TX	SFO	San Francisco, CA	1843.0	5523.0	0.0
73	LAX	Los Angeles, CA	MDW	Chicago, IL	277226.0	2022416.0	0.0
89	MCO	Orlando, FL	DEN	Denver, CO	594878.0	368516.0	138811.0

```
import holoviews as hv

chord = hv.Chord(
    total_flight_stats,
    kdims=['origin', 'dest'],
    vdims=['passengers', 'origin_city_name', 'dest_city_name', 'mail', 'freight']
)


from bokeh.models import HoverTool

tooltips = {
    'Source': '@origin_city_name (@origin)',
    'Target': '@dest_city_name (@dest)',
    'Passengers': '@passengers{0,.},',
    'Mail': '@mail{0,.} lbs.',
    'Freight': '@freight{0,.} lbs.',
}
hover = HoverTool(tooltips=tooltips)
```

Sankey plot

```
top_cities = cities[:5]

domestic_passenger_travel = flight_stats.query(
    'region == "Domestic" and `class` == "F" and origin_city_name != dest_city_name '
    f'and origin_city_name.isin({top_cities}) and dest_city_name.isin({top_cities})'
).groupby([
    'region', 'unique_carrier_name', 'route',
    'origin_city_name', 'dest_city_name'
]).passengers.sum().reset_index()

domestic_passenger_travel.head()
```

	region	unique_carrier_name	route	origin_city_name	dest_city_name	passengers
0	Domestic	Air Wisconsin Airlines Corp	ATL-ORD	Atlanta, GA	Chicago, IL	915.0
1	Domestic	Air Wisconsin Airlines Corp	ATL-ORD	Chicago, IL	Atlanta, GA	556.0
2	Domestic	Alaska Airlines Inc.	JFK-LAX	Los Angeles, CA	New York, NY	265307.0
			JFK-			

```
domestic_passenger_travel.unique_carrier_name.replace( '^(?
    !' + '|'.join(top_airlines) + ').*$',
```

```
    'Other Airlines',
    regex=True, inplace=True
)

domestic_passenger_travel.groupby('unique_carrier_name').passengers.sum().div( domestic_p
    assenger_travel.passengers.sum()
)
```

```
unique_carrier_name
American Airlines Inc.    0.337186
Delta Air Lines Inc.      0.312187
JetBlue Airways           0.049500
Other Airlines            0.120544
Southwest Airlines Co.    0.079074
United Air Lines Inc.     0.101509
Name: passengers, dtype: float64
```

```
def get_edges(data, *, source_col, target_col):
    aggregated = data.groupby([source_col, target_col]).passengers.sum()
    return aggregated.reset_index().rename(
        columns={source_col: 'source', target_col: 'target'}
    ).query('passengers > 0')


carrier_edges = get_edges(
    domestic_passenger_travel,
    source_col='region',
    target_col='unique_carrier_name'
).replace('Domestic', 'Top Routes')

carrier_edges
```

	source	target	passengers
0	Top Routes	American Airlines Inc.	9426060.0
1	Top Routes	Delta Air Lines Inc.	8727210.0
2	Top Routes	JetBlue Airways	1383776.0
3	Top Routes	Other Airlines	3369815.0
4	Top Routes	Southwest Airlines Co.	2210533.0
5	Top Routes	United Air Lines Inc.	2837682.0

```
carrier_to_route_edges =
    get_edges( domestic_passenger_travel,
    source_col='unique_carrier_name',
    target_col='route'
)

carrier_to_route_edges.sample(10, random_state=1)
```

	source	target	passengers
39	Other Airlines	DFW-LGA	157366.0
41	Other Airlines	JFK-LAX	523222.0
2	American Airlines Inc.	ATL-LAX	294304.0
48	Southwest Airlines Co.	ATL-MDW	498481.0
50	Southwest Airlines Co.	LAX-MDW	558574.0
44	Other Airlines	LAX-ORD	378552.0
33	Other Airlines	ATL-LAX	146882.0
35	Other Airlines	ATL-MDW	1201.0
40	Other Airlines	DFW-ORD	241147.0
27	JetBlue Airways	DFW-JFK	140.0

```
all_edges = pd.concat([carrier_edges,
    carrier_to_route_edges]).assign( passengers=lambda x: x.passengers /
    1e6
)
```

```
import holoviews as hv
hv.extension('bokeh')

sankey =
    hv.Sankey( all_edge
    s,
    kdims=['source', 'target'],
    vdims=hv.Dimension('passengers', unit='M')
).opts(
    labels='index', label_position='right', cmap='Set1',
    edge_color='lightgray',
    width=750, height=600,
    title='Travel Between the Top 5 Cities in 2019'
)
```

sankey

Exercises

1. *For the 10 carriers that transported the most freight, create a bar plot showing total freight transported per carrier.*

```
import matplotlib.pyplot as plt

# Group by carrier and sum the freight
top_10_carriers = flight_stats.groupby('unique_carrier_name')['freight'].sum().nlargest(10)

# Create a bar plot
plt.bar(top_10_carriers.index, top_10_carriers.values)

# Set labels and title
plt.xlabel('Carrier')
plt.ylabel('Total Freight (in millions)')
plt.title('Total Freight Transported by Top 10 Carriers')

# Rotate x-axis labels diagonally for better visibility
plt.xticks(rotation=45, ha='right')

# Show the plot
plt.show()
```

```
import pandas as pd
import geopandas as gpd
from bokeh.plotting import figure, show
from bokeh.models import HoverTool

# Load earthquake data into a geopandas DataFrame
earthquakes = gpd.read_file('/kaggle/input/shu/earthquakes.geojson')

# Convert the 'time' column to a datetime object
earthquakes['time'] = pd.to_datetime(earthquakes['time'], unit='ms')

# Group by day and count the number of earthquakes
earthquakes_per_day = earthquakes.groupby(pd.Grouper(key='time', freq='D')).size()

# Create a line plot with tooltips
p = figure(
    title='Total Earthquakes per Day',
    x_axis_label='Date',
    y_axis_label='Total Earthquakes',
    x_axis_type='datetime',
    tools='hover',
    tooltips=[('Date', '@time{%F}'), ('Total Earthquakes', '@value')],
    sizing_mode="stretch_both"
)
p.line(
    x=earthquakes_per_day.index,
    y=earthquakes_per_day.values,
```

```
    line_width=2,
)
```

```
# Format the hover tooltip to show the date in YYYY-MM-DD format
p.hover.formatters = {'@time': 'datetime'}

# Show the plot
show(p)
```

3. Make histograms of earthquake magnitude (mag) for each magnitude type (magType) with a dropdown to select the magnitude type.

```
import pandas as pd
import geopandas as gpd
from bokeh.layouts import column
from bokeh.plotting import figure, show
from bokeh.models import ColumnDataSource, Select

# Load earthquake data into a geopandas DataFrame
earthquakes = gpd.read_file('/kaggle/input/shu/earthquakes.geojson')

# Filter out NaN values from the magType column
earthquakes = earthquakes.dropna(subset=['magType'])

# Create a ColumnDataSource for the histograms
source = ColumnDataSource(data=dict(mag=[], magType=[]))

# Create a histogram plot
p = figure(
    title='Histogram of Earthquake Magnitude',
    x_axis_label='Magnitude',
    y_axis_label='Count',
    tools='box_select, lasso_select',
    sizing_mode="stretch_both"
)
hist, edges = np.histogram([], bins=50)
p.quad(
    top=hist,
    bottom=0,
    left=edges[:-1],
    right=edges[1:],
    fill_color='navy',
    line_color='white',
    alpha=0.5
)

# Create a dropdown menu to select the magnitude type (sorted by magnitude type)
magTypes = sorted(earthquakes.magType.unique().tolist())
magType_menu = Select(
    title='Magnitude Type',
    options=magTypes,
    value=magTypes[0]
)

# Define a callback function to update the histogram when the magnitude type is changed
def update_hist(attr, old, new):
    selected_data = earthquakes[earthquakes.magType == magType_menu.value]
    hist, edges = np.histogram(selected_data.mag, bins=50)
    source.data = dict(mag=selected_data.mag, magType=[magType_menu.value] * len(selected_data))
    p.title.text = f'Histogram of Earthquake Magnitude ({magType_menu.value})'
    p.quad(
        top=hist,
        bottom=0,
        left=edges[:-1],
        right=edges[1:],
        fill_color='navy',
        line_color='white',
        alpha=0.5
    )

# Attach the update_hist callback function to the magnitude type dropdown
magType_menu.on_change('value', update_hist)

# Create a layout with the histogram plot and the magnitude type dropdown
layout = column(magType_menu, p)
```

```
# Show the plot
update_hist(None, None, magType_menu.value)
show(layout)
```

0 giây hoàn thành lúc