DATA SOCIETY®

Advanced visualization in python

"One should look for what is and not what he thinks should be."
-Albert Einstein.

Module completion checklist

Objective	Complete
Introducing Bokeh and its applications	
Generate your first figure and add glyphs to it	
Transform Costa Rican data for visualizations	
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Save your graphs	

Directory settings

- In order to maximize the efficiency of your workflow, you should encode your directory structure into `variables`
- Let the `main_dir` be the variable corresponding to your `af-werx` folder

```
# Set `main_dir` to the location of your `af-werx` folder (for Linux).
main_dir = "/home/[username]/Desktop/af-werx"
```

```
# Set `main_dir` to the location of your `af-werx` folder (for Mac).
main_dir = '/Users/[username]/Desktop/af-werx'
```

```
# Set `main_dir` to the location of your `af-werx` folder (for Windows).
main_dir = "C:\\Users\\[username]\\Desktop\\af-werx"
```

```
# Make `data_dir` from the `main_dir` and
# remainder of the path to data directory.
data_dir = main_dir + "/data"
```

```
# Create a plot directory to save our plots
plot_dir = main_dir + "/plots"
```

Loading packages

- Load the packages we will be using

```
import pandas as pd
import numpy as np
import os
```

```
from bokeh.io import output_notebook
from bokeh.plotting import figure, output_file, show, output_notebook, save
from bokeh.transform import factor_cmap, factor_mark
from bokeh.layouts import column, row, gridplot
from bokeh.models import HoverTool, ColumnDataSource, NumeralTickFormatter, GroupFilter, CDSView
import ipywidgets as widgets
from ipywidgets import interact, interact_manual
```

Working directory

- Set working directory to `data_dir`

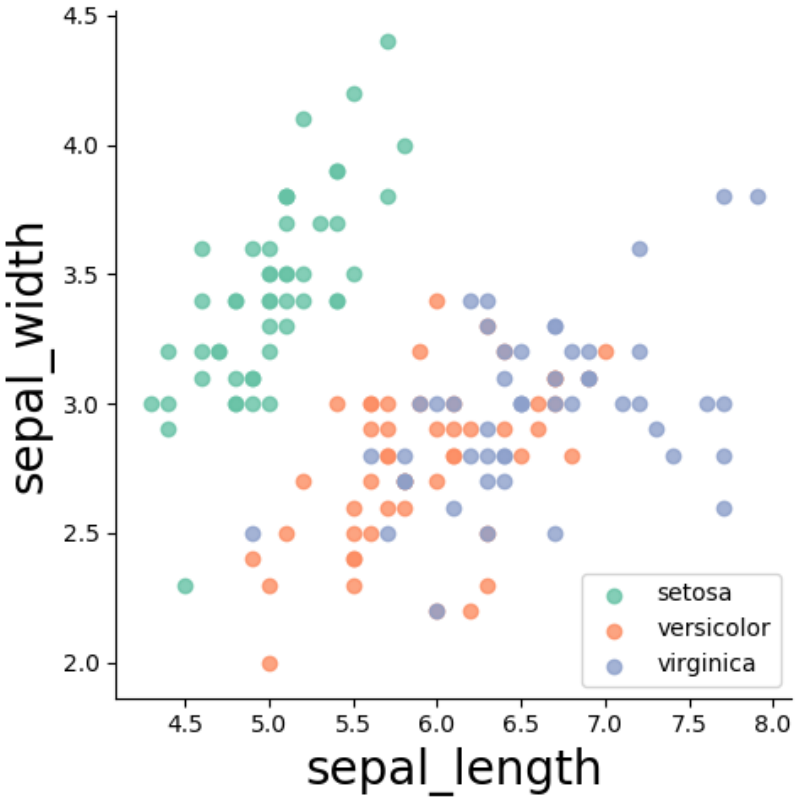
```
# Set working directory.
os.chdir(data_dir)
```

```
# Check working directory.
print(os.getcwd())
```

```
/home/[user-name]/Desktop/af-werx/data
```

Recap: why visualize data?

- To gain **insights on patterns, trends and correlations** that might not be detected otherwise
- Simple way to **convey concepts** and provide visual access to **large amounts of complex data**
- Python has multiple graphing libraries with a lot of great features!



Working with Costa Rica household poverty data

- Today we will:
  - Build simple plots on the dataset using Bokeh
  - Build interactive plots to analyze the data
  - Generate insights on the data by interpreting the plots

Dataset in your exercises

- Working with **Chicago census data**
  - Build simple plots to detect patterns in the data
  - Build complex plots to understand the socioeconomic indicators in the data

Visualizing data with Bokeh

- `bokeh` an interactive visualization library that targets modern web browsers for presentation
- Bokeh offers two interfaces to users:
  - `bokeh.models`: low-level interface with the most flexibility (most users will not use this level of interface to assemble plots directly)
  - `bokeh.plotting`: higher-level interface centered around composing visual glyphs
- The `bokeh.plotting` interface is handy when we need to customize the output more by adding more data series, glyphs, and so on

Plotting with Bokeh

- The basic steps to creating plots with the `bokeh.plotting` interface are:
- **Prepare some data:**
  - Could be numpy arrays or pandas series
- **Tell Bokeh where to generate output:**
  - In this case, it's `output_notebook()` for use in Jupyter notebooks
- **Call `figure()`**
  - This creates a plot with default options and easy customization of title, tools, and axes labels

Plotting with Bokeh

- **Add renderers**
  - We use functions specifying visual customizations like colors, legends, and widths
- **Ask Bokeh to `show()` or `save()` the results:**
  - These functions save the plot to an HTML file and optionally display it in a browser
- The last two steps can be repeated to create more than one plot

Output methods using Bokeh

- Common methods to view Bokeh plots are:
- `output_file()`
  - Generates HTML documents for Bokeh visualizations
- `output_notebook()`
  - Displays inline visualizations in Jupyter notebook

Using Bokeh with plotly

- The major concept of Bokeh is that graphs are built up **one layer at a time**
- **We start out by creating a figure**
- **Then we add elements, called glyphs, to the figure**
- Glyphs can take on many shapes depending on the desired use: circles, lines, patches, bars , arcs, and so on

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Bokeh: simple plot

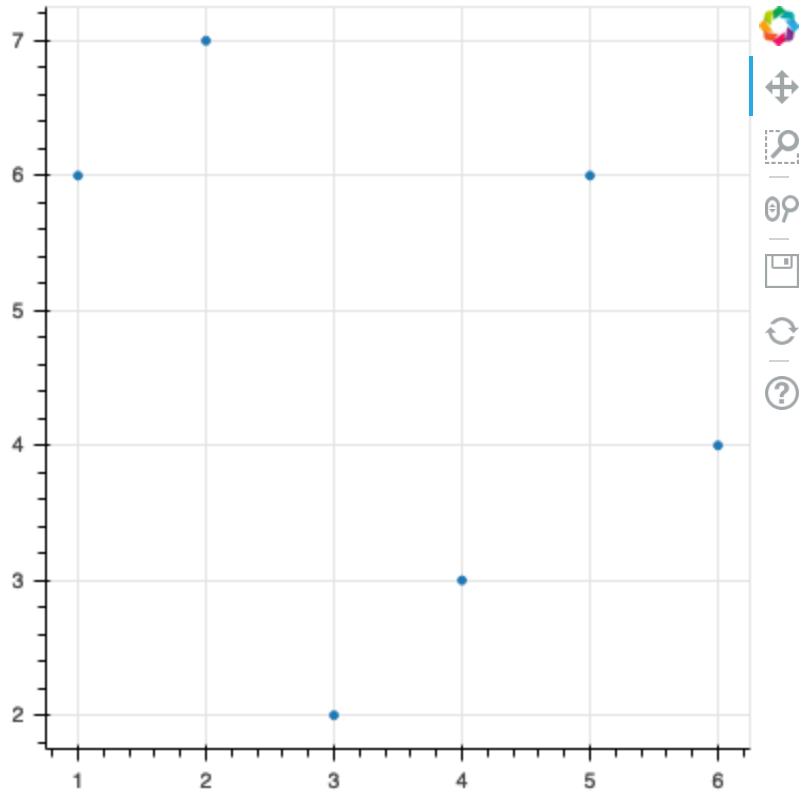
- We will create simple plots at first using data points assigned to variables `x_values` and `y_values`

```
# Input the sample data below.
x_values = [1, 2, 3, 4, 5, 6]
y_values = [6, 7, 2, 3, 6, 4]
```

Bokeh: simple plot

- First, we make a plot using the `figure()` method
- Then, we append our glyphs to the plot by calling the appropriate method and passing in data
- Finally, we show our plot

```
p = figure()
p.circle(x = x_values, y = y_values)
show(p)
```

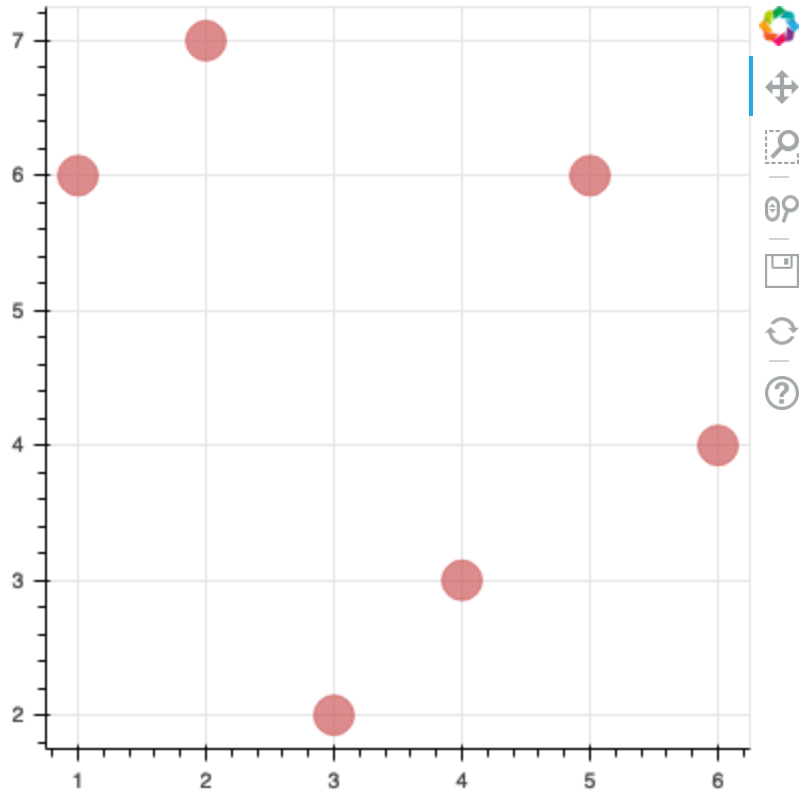


Bokeh: add size,color and opacity

- We can now create the same circle glyph with a size, color and alpha

```
# Create the blank plot.
p = figure(plot_width = 400, plot_height = 400)

# Add a circle glyph with a size, color, and
alpha.
p.circle(x_values,
         y_values,
         size = 20,
         color = "indianred",
         alpha = 0.7)
show(p)
```



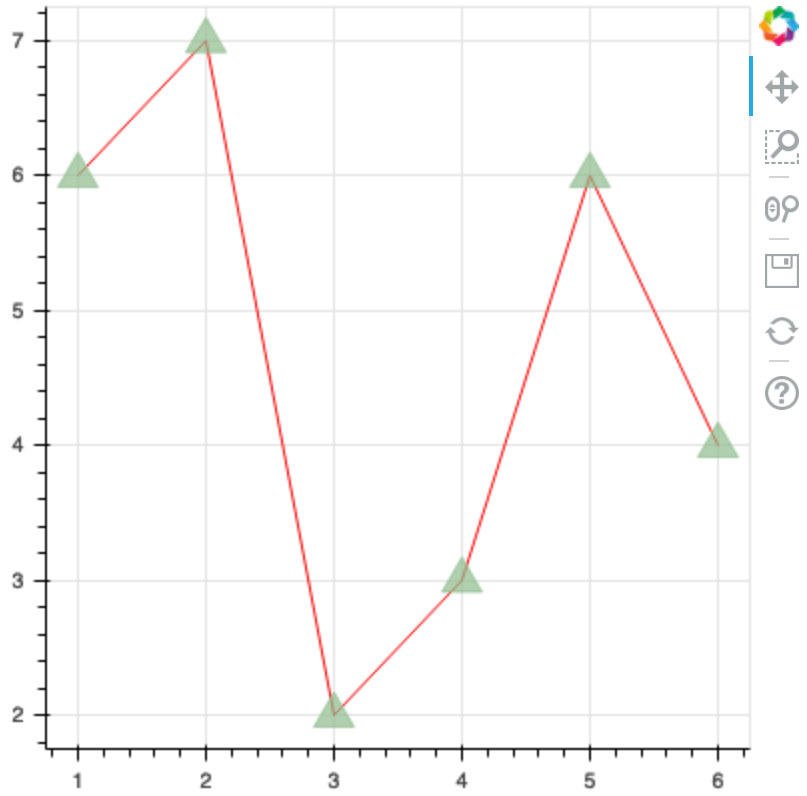
Bokeh: triangle glyph

- This time, two glyphs are added to the graph

```
p = figure(plot_width = 400, plot_height = 400)

p.line(x_values,
       y_values,
       color = 'red')

p.triangle(x_values,
           y_values,
           size = 20,
           color = "darkseagreen",
           alpha = 0.7)
show(p)
```



Bokeh: triangle glyph

- There are a lot more marker types you can try out
- You can see examples of plots with different markers ***here***

- `asterisk()`
- `circle()`
- `circle_cross()`
- `circle_x()`
- `cross()`
- `dash()`
- `diamond()`
- `diamond_cross()`
- `inverted_triangle()`
- `square()`
- `square_cross()`
- `square_x()`
- `triangle()`
- `x()`

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Load the dataset

- We will load in our Costa Rican poverty dataset as `household_poverty`
- Let's load the entire dataset
- For visualizations, we will be taking a specific subset
- We are now going to use the function `read_csv` to read in our `costa_rica_poverty` dataset

```
household_poverty = pd.read_csv("costa_rica_poverty.csv")
print(household_poverty.head())
```

```
  household_id        ind_id  rooms  ...  age  Target  monthly_rent
0    21eb7fcc1  ID_279628684      3  ...   43       4      190000.0
1    0e5d7a658  ID_f29eb3ddd      4  ...   67       4      135000.0
2    2c7317ea8  ID_68de51c94      8  ...   92       4           NaN
3    2b58d945f  ID_d671db89c      5  ...   17       4      180000.0
4    2b58d945f  ID_d56d6f5f5      5  ...   37       4      180000.0

[5 rows x 84 columns]
```

- The entire dataset consists of `9557` observations and `84` variables

Subsetting data

- Let's subset our data so that we have the variables we need
- Let's name this subset `costa_viz`

```
costa_viz = household_poverty[['household_id',
                               'ppl_total',
                               'dependency_rate',
                               'num_adults',
                               'rooms',
                               'age',
                               'monthly_rent',
                               'Target']]
print(costa_viz.head())
```

```
  household_id  ppl_total  dependency_rate  ...  age  monthly_rent  Target
0     21eb7fcc1          1               37  ...   43      190000.0       4
1     0e5d7a658          1               36  ...   67      135000.0       4
2     2c7317ea8          1               36  ...   92           NaN       4
3     2b58d945f          4               38  ...   17      180000.0       4
4     2b58d945f          4               38  ...   37      180000.0       4

[5 rows x 8 columns]
```

Remove labels

- Let's prepare the data for visualizations by removing any labels, removing the `household_id` variable, and keeping the remaining variables

```
costa_viz = costa_viz.drop('household_id', axis = 1)
print(costa_viz.head())
```

```
   ppl_total  dependency_rate  num_adults  rooms  age  monthly_rent  Target
0          1               37           1      3   43      190000.0       4
1          1               36           1      4   67      135000.0       4
2          1               36           1      8   92           NaN       4
3          4               38           2      5   17      180000.0       4
4          4               38           2      5   37      180000.0       4
```

Data prep: clean NAs

- Depending on **subject matter**, missing values might mean something
- Let's define how to handle **columns with NAs:**
  - Drop columns that contain any `NA`s
  - Drop columns with a certain % of `NA`s
  - Impute missing values
  - Convert column with missing values to categorical
- Let's look at the count of NAs by column first:

```
print(costa_viz.isnull().sum())
```

```
ppl_total              0
dependency_rate        0
num_adults             0
rooms                  0
age                    0
monthly_rent        6860
Target                 0
dtype: int64
```

Data cleaning: NAs

- We'll keep `monthly_rent` and impute missing values using the mean of the column

```
# Set the dataframe equal to the imputed dataset.
costa_viz = costa_viz.fillna(costa_viz.mean())
# Check how many values are null in monthly_rent.
print(costa_viz.isnull().sum())
```

```
ppl_total          0
dependency_rate    0
num_adults         0
rooms              0
age                0
monthly_rent       0
Target             0
dtype: int64
```

Converting the target variable

- Let's convert poverty to a target variable with two levels, which will help to balance it out
- The four original levels would also increase the complexity of the visualizations and the code
- For this reason, we will convert levels 1,2 and 3 to `vulnerable` and 4 to `non_vulnerable`
- The levels translate to 1, 2 and 3 as being **vulnerable** households
- Level 4 is **non vulnerable**

```
costa_viz['Target_class'] = np.where(costa_viz['Target'] <= 3, 'vulnerable','non_vulnerable')
```

```
print(costa_viz['Target_class'].head())
```

```
0    non_vulnerable
1    non_vulnerable
2    non_vulnerable
3    non_vulnerable
4    non_vulnerable
Name: Target_class, dtype: object
```

Knowledge check 1

Exercise 1

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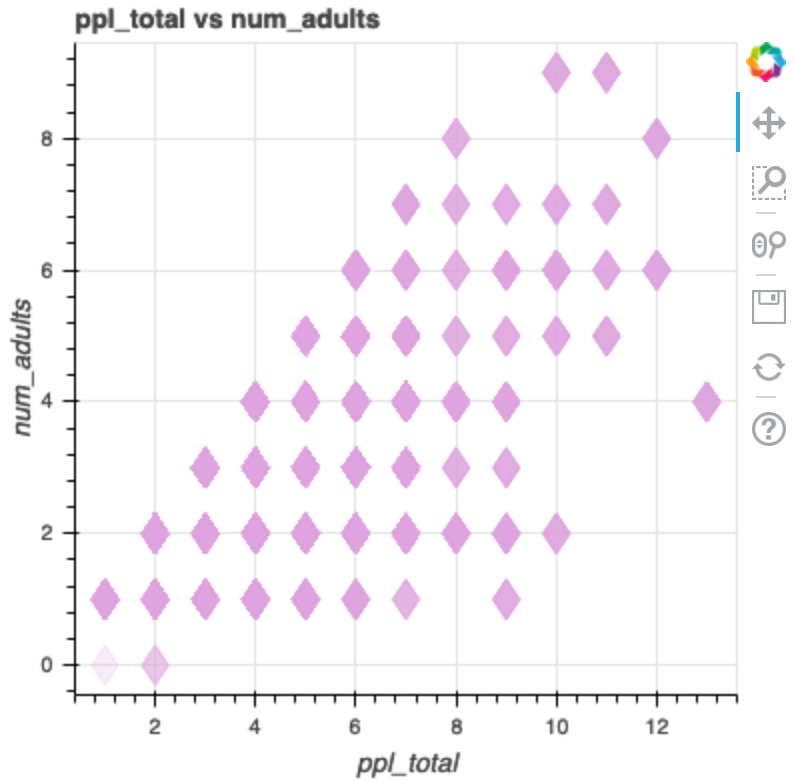
Use Costa Rican data for plots

- We're ready to create plots with `costa_viz`
- First, let's investigate the relationship between the total number of people and the number of adults

```
p = figure(title = "ppl_total vs num_adults",
           x_axis_label = 'ppl_total',
           y_axis_label = 'num_adults',
           plot_width = 400, plot_height = 400)

p.diamond(costa_viz['ppl_total'],
          costa_viz['num_adults'],
          size = 20,
          color = "plum",
          alpha = 0.2)
show(p)
```



vbar() and hbar()

- To see the count of the four levels, we will use the original `Target` variable

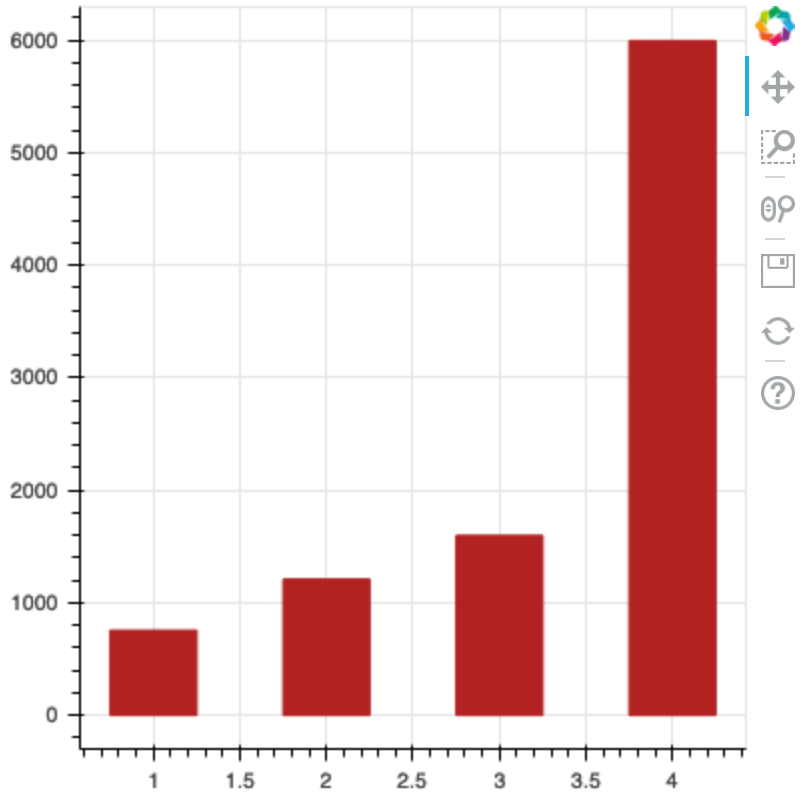
```
costa_viz.Target.value_counts()
```

```
4    5996
2    1597
3    1209
1     755
Name: Target, dtype: int64
```

```
p = figure(plot_width=400, plot_height=400)

p.vbar(x = [4, 3, 2, 1],
       width = 0.5,
       bottom = 0,
       top =
costa_viz.Target.value_counts(),
       color = "firebrick")

show(p)
```



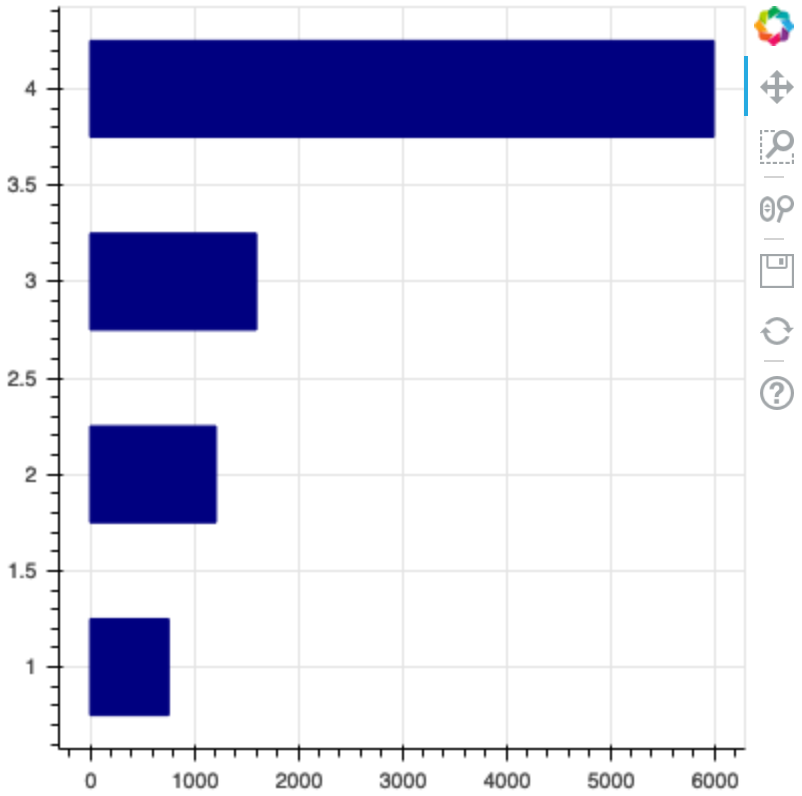
vbar() and hbar()

- Similarly, horizontal bar charts can be created using `.hbar()`
- Now, we can look at the distribution of levels, which is a best practice before analysis

```
p = figure(plot_width = 400, plot_height = 400)

p.hbar(y = [4, 3, 2, 1],
       height = 0.5,
       left = 0,
       right = costa_viz.Target.value_counts(),
       color = "navy")

show(p)
```



Markers for categorical data

- What if we want to see **three or more variables in one visualization**?
- We can map categorical data to marker types
- This example shows the use of `factor_mark()` to display different markers or different categories in the input data
- It also demonstrates the use of `factor_cmap()` to colormap those same categories

```
LEVELS = ['non_vulnerable', 'vulnerable']
MARKERS = ['triangle', 'hex']

p = figure(title = "Number of adults vs
dependency rate",
           x_axis_label = 'num_adults',
           y_axis_label = 'dependency_rate')
```

Markers for categorical data

```
p.scatter("num_adults", "dependency_rate",
          source = costa_viz,
          legend = "Target_class",
          fill_alpha = 0.1,
          size = 12,
          marker = factor_mark('Target_class',
                               MARKERS,
                               LEVELS),
          color = factor_cmap('Target_class',
                              'Category10_7',
                              LEVELS))

show(p)
```

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Laying out plots and plot tools

- Organize the layout when you wish to render multiple plots together by specifying `show()`
- Add the tools we wish to add in `figure()` as shown below
- The code also shows an alternate method to label the axes

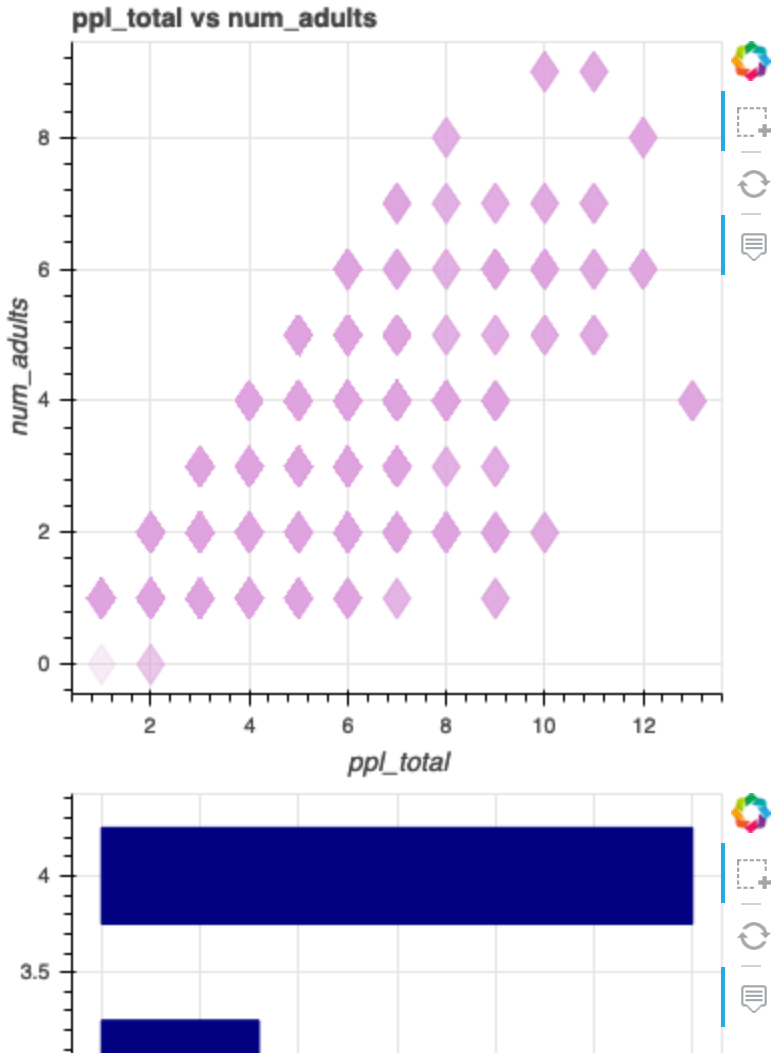
```
tools = ["box_select", "hover", "reset"]

# create a new plot
p1 = figure(title = "ppl_total vs num_adults",
           plot_width = 400, plot_height = 400,
           tools = tools)

p1.xaxis.axis_label = 'ppl_total'
p1.yaxis.axis_label = 'num_adults'

p1.diamond(costa_viz['ppl_total'],
           costa_viz['num_adults'],
           size = 20,
           color = "plum",
           alpha = 0.2)
```

Laying out plots and widgets

```
# Create another one.
p2 = figure(plot_width = 400, plot_height = 400, tools = tools)

p2.hbar(y=[4, 3, 2, 1],
        height = 0.5,
        left = 0,
       right = costa_viz.Target.value_counts(),
       color = "navy")

# Create another graph.
p3 = figure(title = "Number of adults vs dependency rate",
            plot_width = 400,
            plot_height = 400,
            tools = tools)

p3.xaxis.axis_label = 'num_adults'
p3.yaxis.axis_label = 'dependency_rate'

p3.scatter("num_adults", "dependency_rate",
            source = costa_viz,
            legend = "Target_class",
            fill_alpha = 0.1, size = 12,
            marker = factor_mark('Target_class',
                                 MARKERS, LEVELS),
            color = factor_cmap('Target_class',
                                'Category10_7',
                                 LEVELS))
```

Laying out plots and widgets

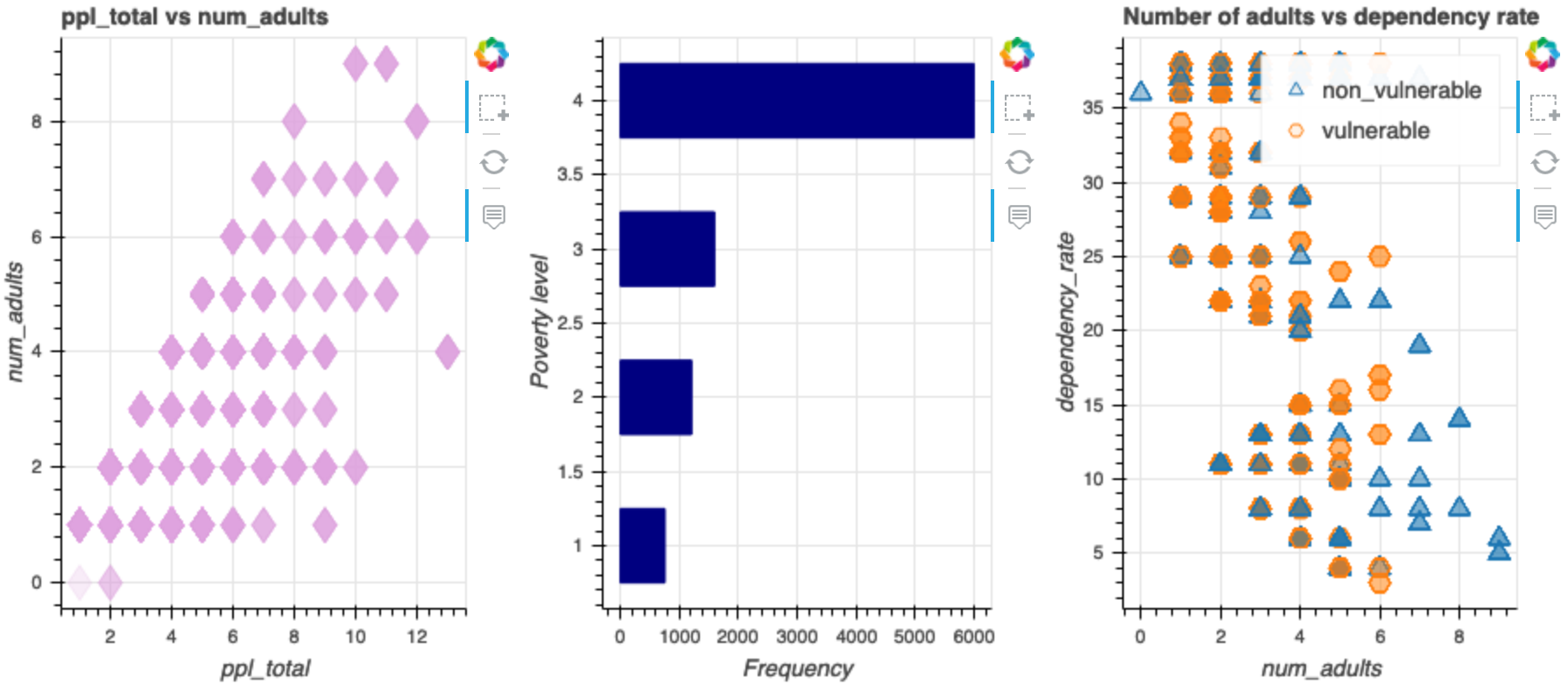
```
# Put the results in a column and show.
show(column(p1, p2, p3))
```



Laying out plots and widgets

- Row-wise layout

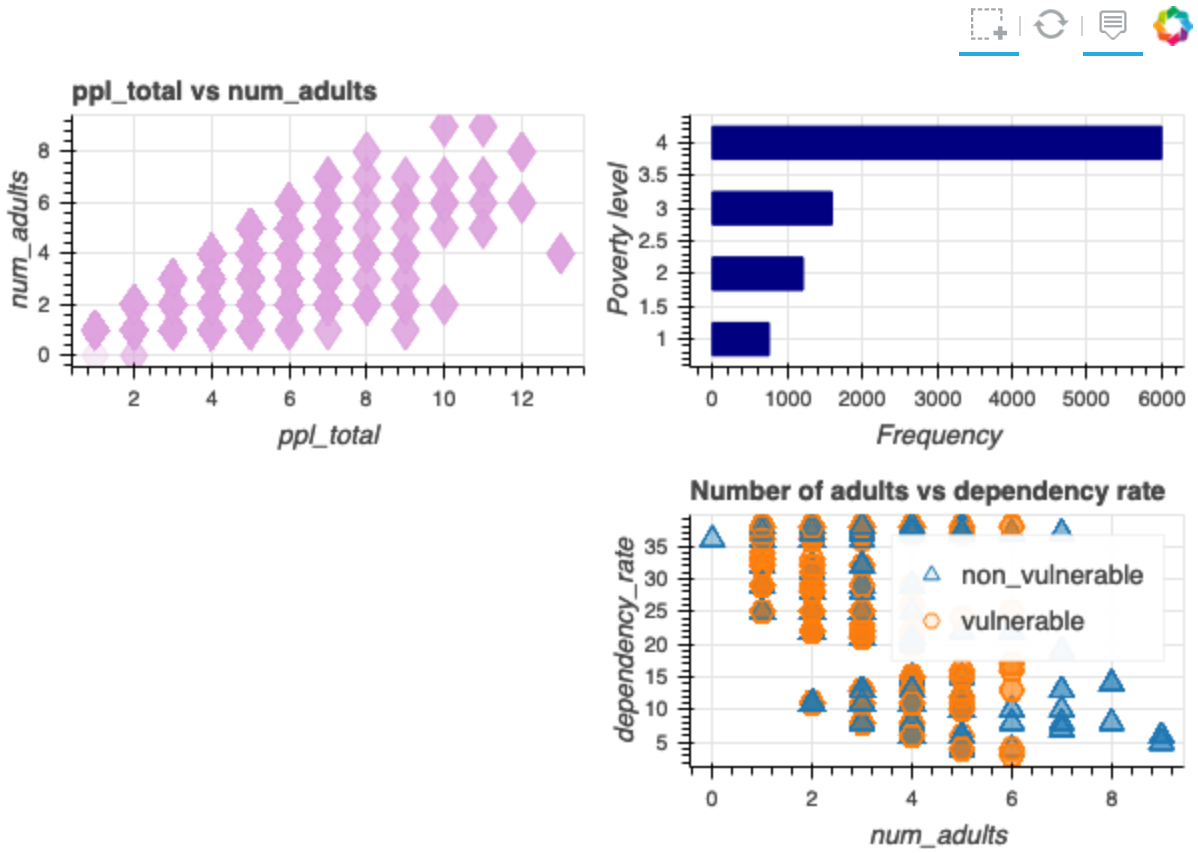
```
# Put the results in a row.
show(row(p1, p2, p3))
```



Laying out plots and widgets

- We can arrange graphs as subplots
- Notice that we have left the third quadrant empty

```
grid = gridplot([[p1, p2],
                 [None, p3]])

show(grid)
```



ColumnDataSource

- We can link our pandas dataframe to Bokeh using object **ColumnDataSource**
- It is specifically used for plotting with several methods, and allows us to **add annotations and interactivity to our graphs**
- After it is created, the ColumnDataSource can then be passed to glyph methods via the `source` parameter and other parameters (such as `x` and `y` axes)

```
# Import the ColumnDataSource class.
from bokeh.models import ColumnDataSource

# Convert dataframe to column data source.
src = ColumnDataSource(costa_viz)
```

Customizing Hovertool

```
# The Hovertool refers to our own data field using @ and
# a position on the graph using $.
hover = HoverTool(tooltips = [('Total number of people', '@ppl_total'),
                              ('Number of adults', '@num_adults'),
                              ('(x,y)', '($x, $y)')])

p = figure(title = "ppl_total vs num_adults",
           plot_width=400, plot_height=400,
           x_axis_label = 'ppl_total',
           y_axis_label = 'num_adults')

p.diamond('ppl_total',
          'num_adults',
          source = src,
          size = 20,
          color = "plum",
          alpha = 0.2)

# Add the hover tool to the graph.
p.add_tools(hover)
```

Customizing Hovertool

```
show(p)
```

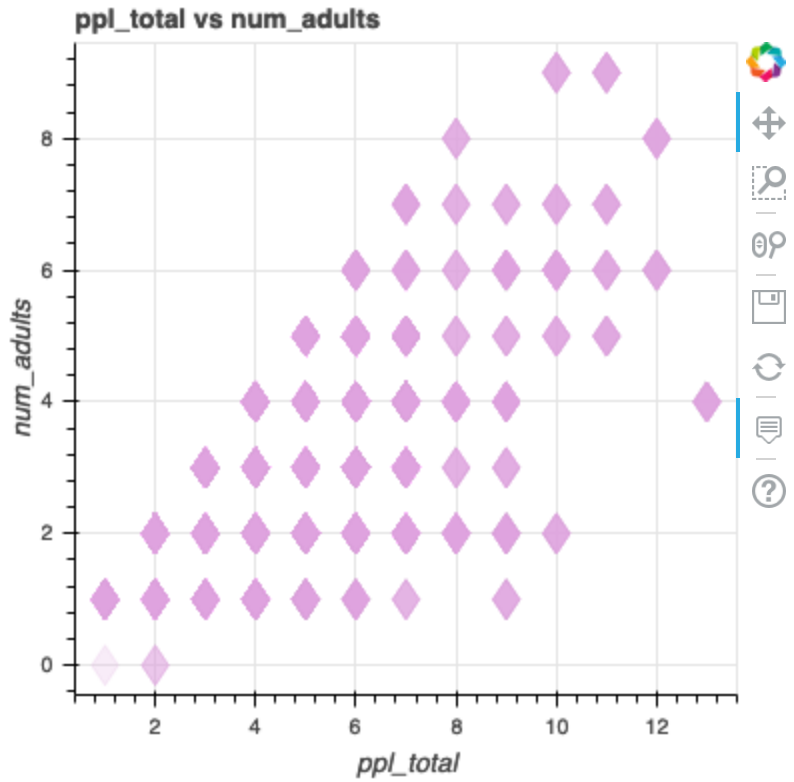
Customizing Hovertool

- Hover attributes can be customized in the glyphs as shown below
- The data point hovered over will change its color and opacity level

```
# Hover tool refers to our own data field using @ and
# a position on the graph using $.
hover = HoverTool(tooltips = [('Total number of people', '@ppl_total'),
                              ('Number of adults', '@num_adults'),
                              ('(x,y)', '($x, $y)')])

p = figure(title = "ppl_total vs num_adults",
           plot_width = 400, plot_height = 400,
           x_axis_label = 'ppl_total',
           y_axis_label = 'num_adults')


p.diamond('ppl_total','num_adults', source = src, size = 20, color = "plum", alpha = 0.2,
          hover_fill_alpha = 1.0, hover_fill_color = 'navy')

# Add the hover tool to the graph.
p.add_tools(hover)
```

Customizing Hovertool

```
show(p)
```



Knowledge check 2

Exercise 2

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Highlighting data using HoverTool()

- Using 'ColumnDataSource()' from your previous visualization can cause an error, so let's create a new one for each graph

```
# Store the data in a ColumnDataSource.
costa_cds = ColumnDataSource(costa_viz)
```

```
# Specify the selection tools to be made available.
select_tools = ['box_select', 'lasso_select', 'poly_select', 'tap', 'reset']

# Create the figure.
fig = figure(plot_height = 400,
             plot_width = 600,
             x_axis_label = 'ppl_total',
             y_axis_label = 'num_adults',
             title = 'Interactive scatterplot',
             toolbar_location = 'below',
             tools = select_tools)


# Add square representing each layer.
fig.square(x = 'ppl_total',
           y = 'num_adults',
           source = costa_cds,
           color = 'royalblue',
           selection_color = 'deepskyblue',
           nonselection_color = 'lightgray',
           nonselection_alpha = 0.3)
```

Customizing Hovertool

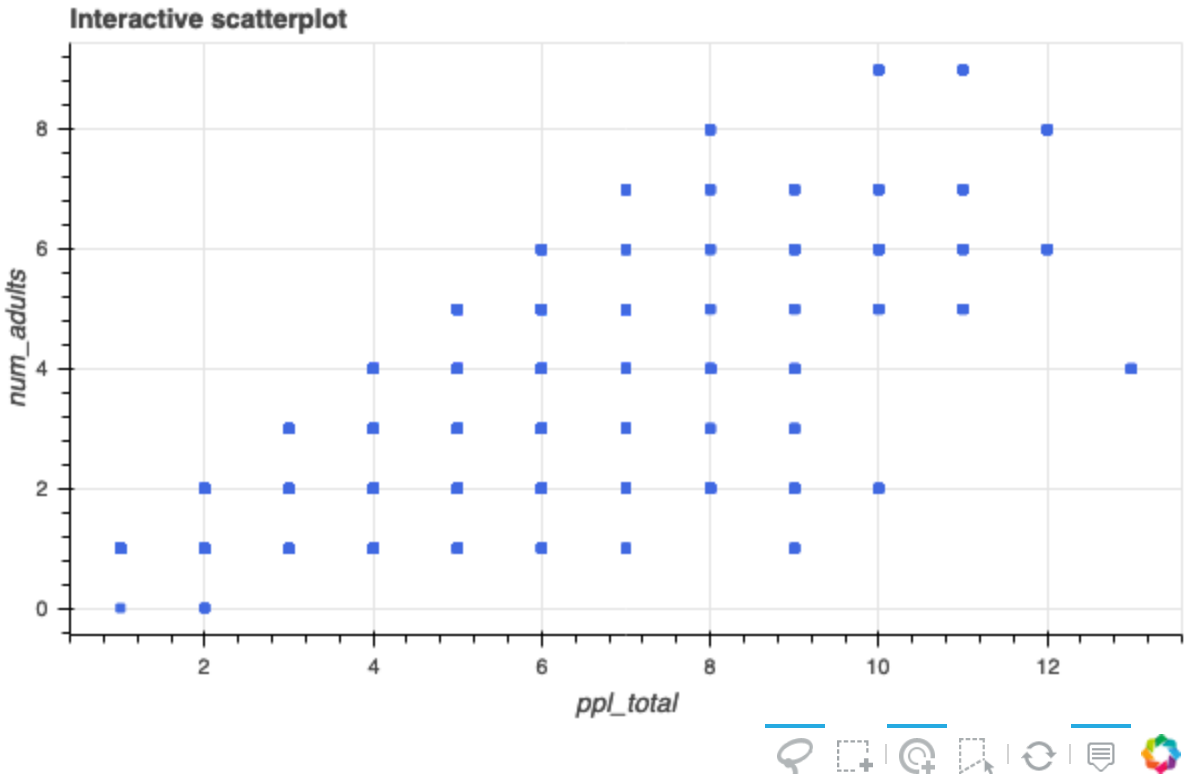
- `tooltips` from `HoverTool()` accepts input data and allows us to select data with the cursor

```
# Format the tooltip.
tooltips = [
            ('ppl_total','@ppl_total'),
            ('num_adults', '@num_adults')
           ]

# Add the HoverTool to the figure.
fig.add_tools(HoverTool(tooltips=tooltips))

# Visualize the graph.
show(fig)
```

Customizing Hovertool



Customizing Hovertool

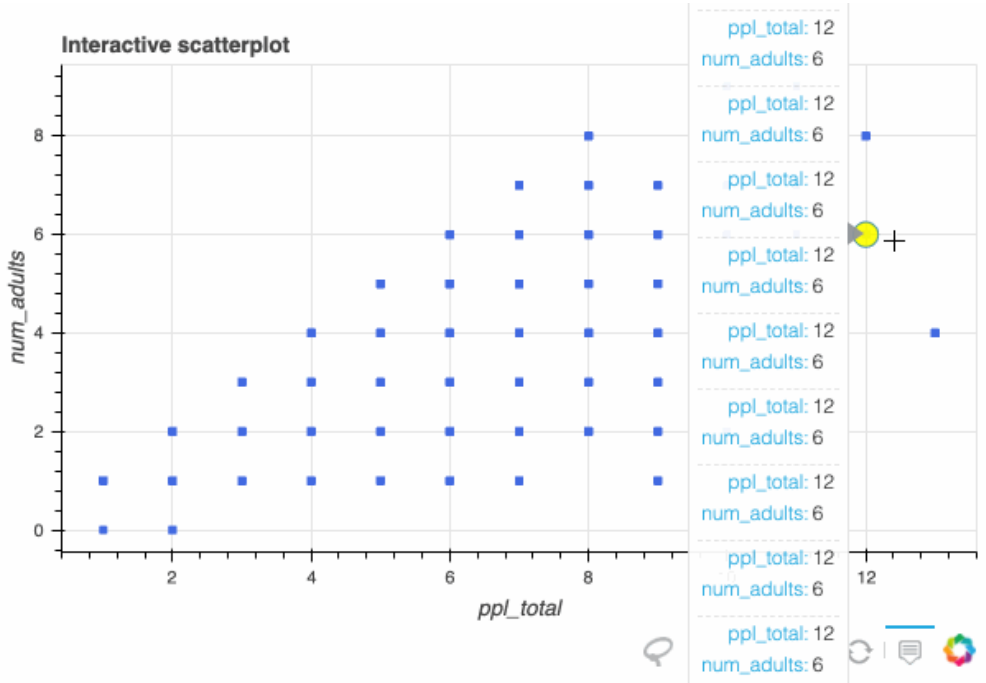
- Creating a new circle glyph named `hover_glyph` and adding it as `renderers` to `.add_tools()` will display the data point hovered over as a yellow circle instead

```
# Format the tooltip.
tooltips = [
            ('ppl_total','@ppl_total'),
            ('num_adults', '@num_adults')
           ]

hover_glyph = fig.circle(x = 'ppl_total', y =
'num_adults', source = costa_cds,
                         size = 15, alpha = 0,
                         hover_fill_color =
'yellow', hover_alpha = 0.2)

# Add the HoverTool to the figure.
fig.add_tools(HoverTool(tooltips = tooltips,
renderers = [hover_glyph]))

# Visualize the graph.
show(fig)
```



Highlighting data using labels

- We can select data points using the labels of `Target_class` by creating filters and views for both labels

```
costa_labels = ColumnDataSource(costa_viz)


# Create a view for each label.
vul_filters = [GroupFilter(column_name='Target_class', group = 'vulnerable')]

vul_view = CDSView(source = costa_labels,
                   filters = vul_filters)
```

```
# Create a view for each label.
nonvul_filters = [GroupFilter(column_name='Target_class', group = 'non_vulnerable')]

nonvul_view = CDSView(source = costa_labels,
                   filters = nonvul_filters)
```

Highlighting data using labels

- The common parameters used across the whole graph can be consolidated into dictionaries so we can reuse them later, instead of defining them every time

```
# Consolidate the common keyword arguments in dictionaries.
common_figure_kwargs = {
    'plot_width': 400,
    'x_axis_label': 'num_adults',
    'y_axis_label' : 'dependency_rate',
    'toolbar_location': None
}
common_circle_kwargs = {
    'x': 'ppl_total',
    'y': 'num_adults',
    'source': costa_labels,
    'size': 12,
    'alpha': 0.7,
}
common_vul_kwargs = {
    'view': vul_view,
    'color': '#002859',
    'legend': 'vulnerable'
}
common_non_kwargs = {
    'view': nonvul_view,
    'color': '#FFC324',
    'legend': 'non_vulnerable'
}
```

Highlighting data using labels

- Create the two figures and draw the data

```
hide_fig = figure(**common_figure_kwargs,
                  title = 'Click Legend to HIDE Data')
hide_fig.scatter(**common_circle_kwargs, **common_vul_kwargs)
```

```
hide_fig.scatter(**common_circle_kwargs, **common_non_kwargs)
```

```
mute_fig = figure(**common_figure_kwargs, title = 'Click Legend to MUTE Data')
mute_fig.circle(**common_circle_kwargs, **common_vul_kwargs,
                muted_alpha = 0.1)
```

```
mute_fig.circle(**common_circle_kwargs, **common_non_kwargs,
                muted_alpha = 0.1)
```

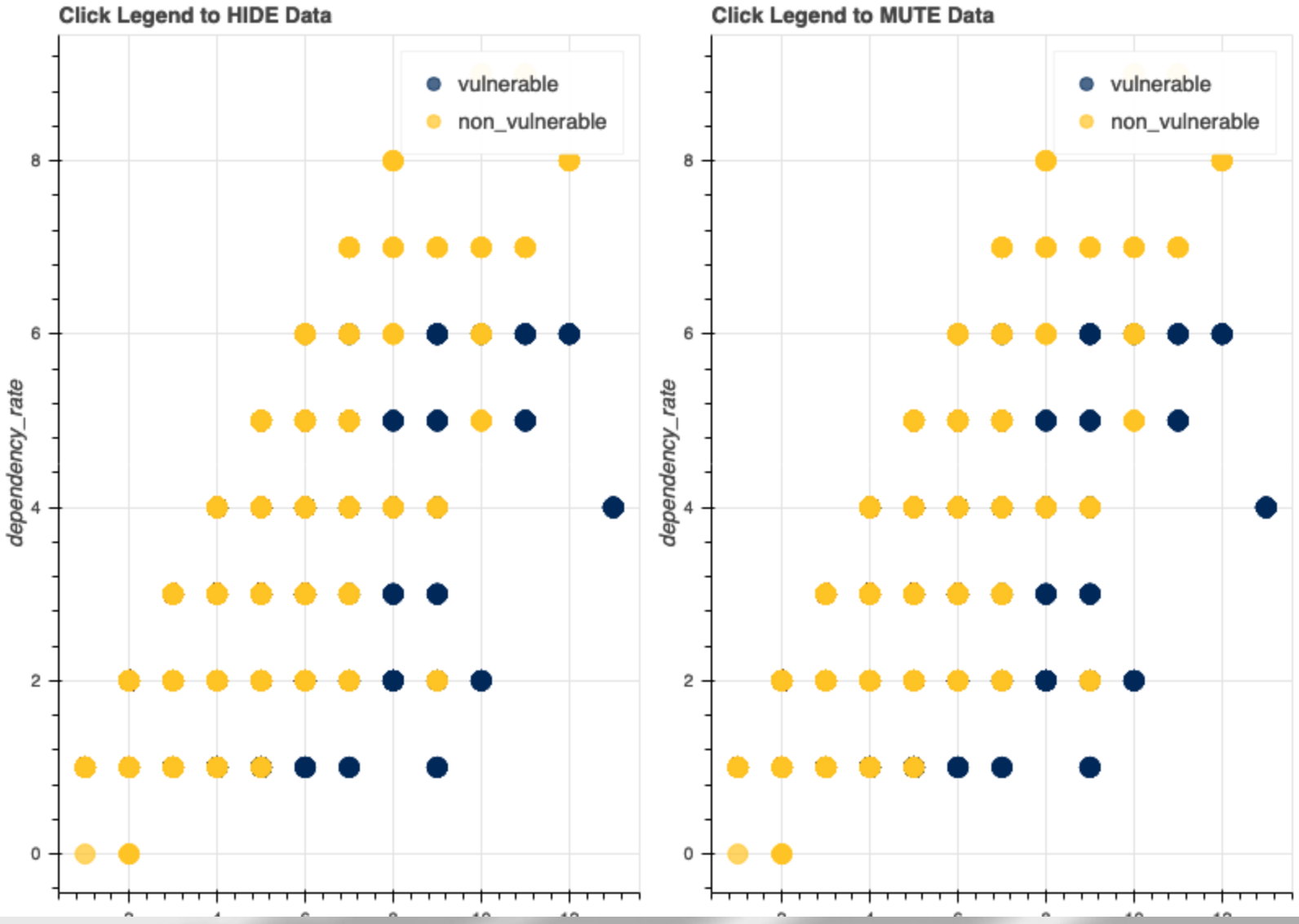
Highlighting data using labels

- Add interactivity to the legend

```
hide_fig.legend.click_policy = 'hide'
mute_fig.legend.click_policy = 'mute'

# Visualize the graph.
show(row(hide_fig, mute_fig))
```

Highlighting data using labels



Knowledge check 3

Exercise 3

Module completion checklist

Objective	Complete
Introducing Bokeh and its applications	✔
Generate your first figure and add glyphs to it	✔
Transform Costa Rican data for visualizations	✔
Create simple plots using Bokeh	✔
Organize multiple visualization with layouts and configure plot tools	✔
Add interactivity and highlight data using labels	✔
Integrate widgets to Bokeh and plotly graphs	
Save your graphs	

Adding widgets to graphs

- `ipywidgets` library allows us to turn Jupyter Notebooks from static documents into interactive dashboards
- Widgets are handy when we wish to **change inputs without needing to rewrite or rerun code**
- You can read the documentation on `ipywidgets` ***here***

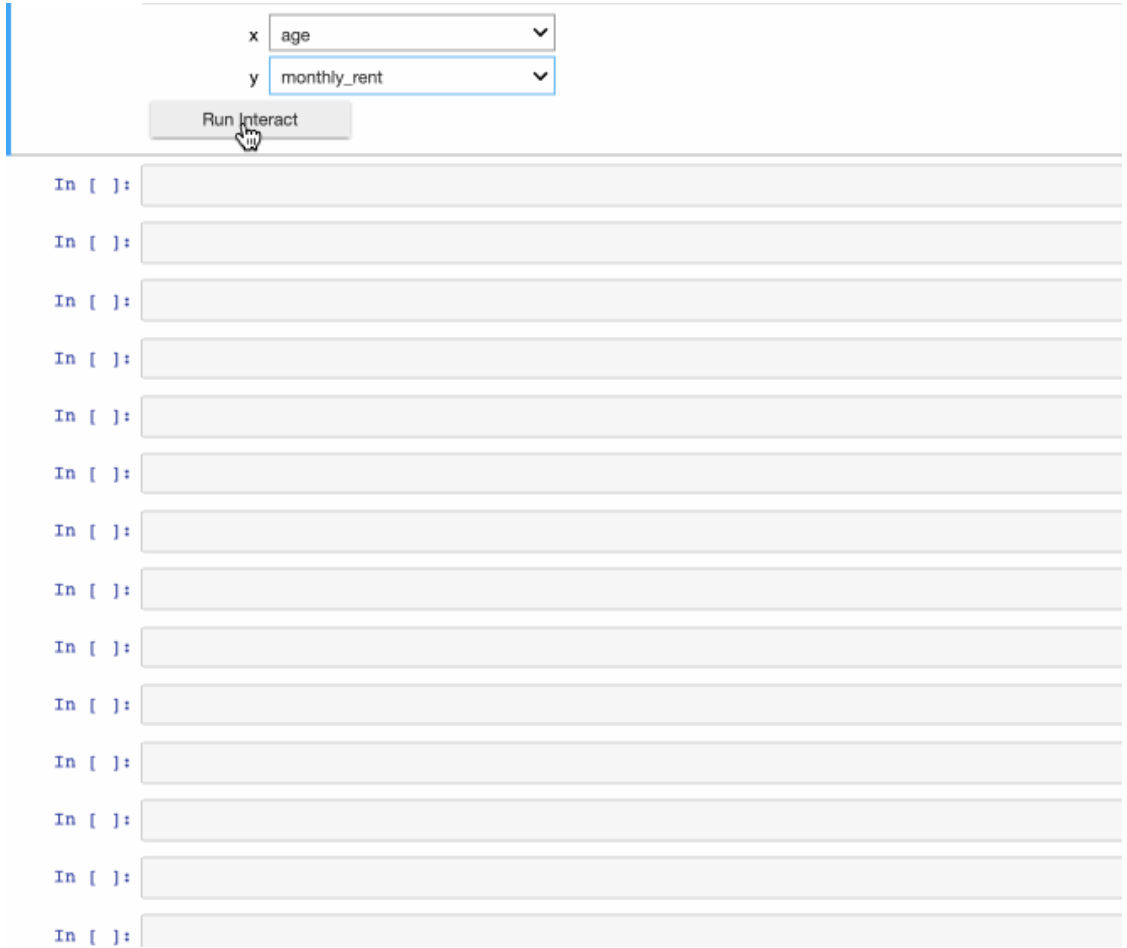
Adding widgets to graphs

- The Costa Rican dataset has many inputs which can slow the plot rendering, so let's subset the variables we wish to use

```
@interact_manual
def scatter_plot(x = list(costa_viz.columns),
                 y = list(costa_viz.columns)):
    p = figure(title = f'{x} vs {y}',
               x_axis_label = x,
               y_axis_label = y)

    p.circle(x = x,
             y = y,
             source = df,
             size = 20, color = "thistle", alpha = 0.2)
    show(p)
```

Adding widgets to graphs



Adding widgets to plotly graphs

- We can add `colorscale` and `themes` to our widget in cufflinks graphs
- First, we need to run the initialization steps for offline plotting

```
import plotly
import cufflinks as cf
from plotly.offline import download_plotlyjs, init_notebook_mode, plot, iplot
init_notebook_mode(connected=True)
cf.go_offline()
```

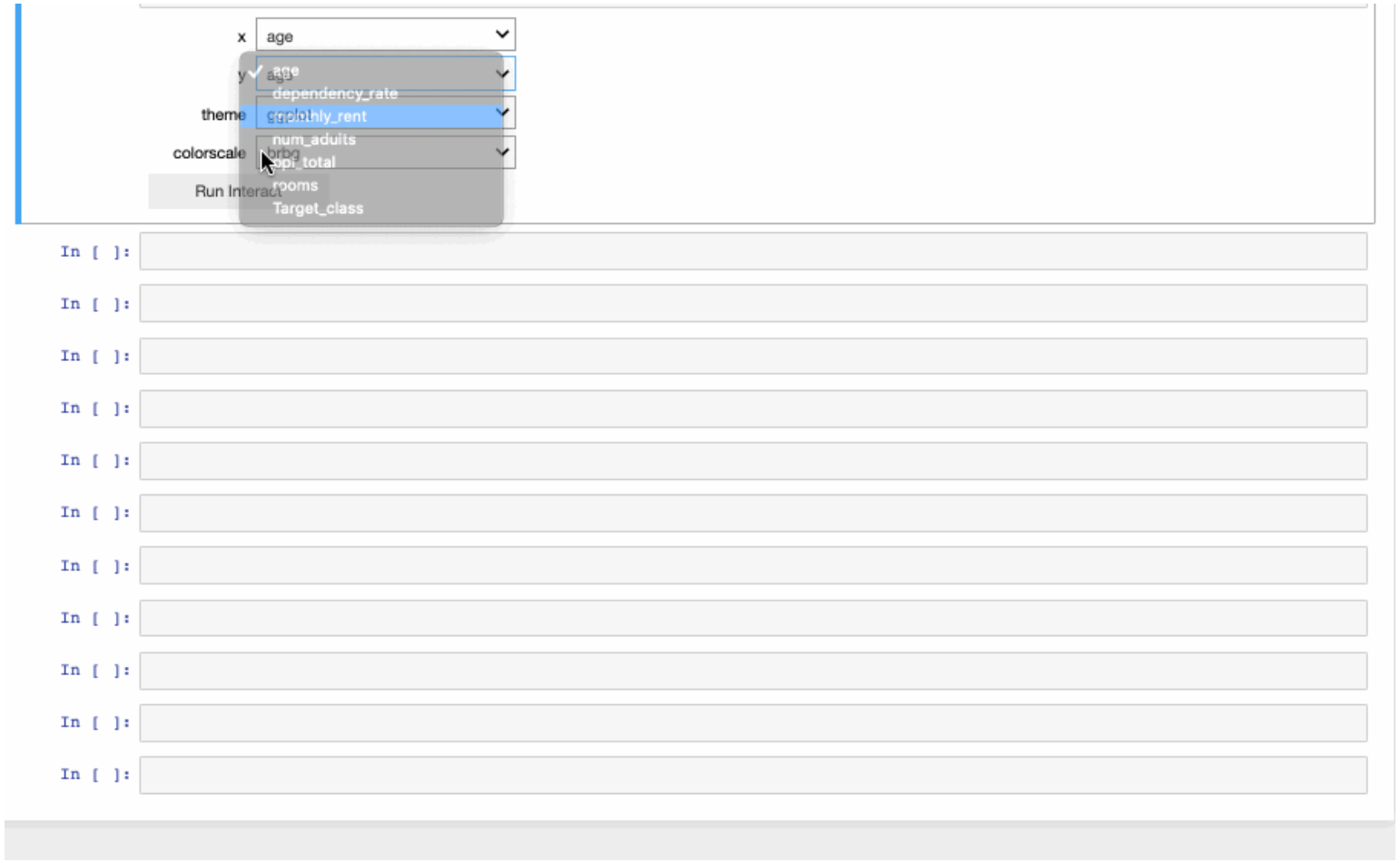
Adding widgets to plotly graphs

- `@interact` is another common method which will automatically output the widgets and the plot, but it may take longer to update
- We decided to use `@interact_manual` to prevent the notebook from freezing and to select all desired parameters before running the scatterplot

```
@interact_manual
def scatter_plot(x = list(costa_viz.columns),
                 y = list(costa_viz.columns),
                 theme = list(cf.themes.THEMES.keys()),
                 colorscale = list(cf.colors._scales_names.keys())):

    df.iplot(kind = 'scatter', x = x, y = y, mode='markers',
             categories = 'Target_class',
             xTitle = x, yTitle = y,
             title = f'{x} vs {y}',
             theme = theme, colorscale = colorscale)
```

Adding widgets to plotly graphs



Module completion checklist

Objective	Complete
Introducing Bokeh and its applications	✔
Generate your first figure and add glyphs to it	✔
Transform Costa Rican data for visualizations	✔
Create simple plots using Bokeh	✔
Organize multiple visualization with layouts and configure plot tools	✔
Add interactivity and highlight data using labels	✔
Integrate widgets to Bokeh and plotly graphs	✔
Save your graphs	

Saving your graph

- You will be saving all of your graphs as an `HTML` file in the plots folder
- Change your directory to `plot_dir` and save your `bokeh` plots as shown below:

```
os.chdir(plot_dir)
```

```
# Create figure.
p = figure(plot_width = 400, plot_height = 400)

# Add glyphs to it.
p.triangle(x_values, y_values, size = 20, color = "darkseagreen", alpha = 0.7)

# Save your plot.
output_file("bokeh-simple-plot.html", mode = 'inline')
save(p)
```

Plotly vs Bokeh

- **Bokeh is ideal to create charts with multiple glyphs and has various options for customization**
- But it undergoes a lot of development, hence the code we write today may change in future
- On the other hand, the **plotly syntax is also simple and can be embedded as an HTML in applications**
- The main limitation of plotly is that the online community version plots are public and there is a limit of plots which can be created per day
- Choosing an interactive visualization package depends on your personal preference and ease of use!

Knowledge check 4

Exercise 4

Module completion checklist

Objective	Complete
Introducing bokeh and its applications	✔
Generate your first figure and add glyphs to it	✔
Transform Costa Rican data for visualizations	✔
Create simple plots using Bokeh	✔
Organize multiple visualization with layouts and configure plot tools	✔
Add interactivity and highlight data using labels	✔
Integrate widgets to bokeh and plotly graphs	✔
Save your graphs	✔

Workshop: next steps!

- Workshops are to be completed in the afternoon either with a dataset for a capstone project or with another dataset of your choosing
- Make sure to annotate and comment your code so that it is easy for others to understand what you are doing
- This is an exploratory exercise to get you comfortable with the content we discussed today
- Today, you can try out the concepts covered in each module
  - Create basic plots using bokeh and then head on to plots with multiple metrics
  - Add interactions to your plots using `HoverTool()` and legends
  - Create widgets and run them with `bokeh` and `plotly` graphs
  - Save the above plots as a `.html` file in the `plots` folder

This completes our module

Congratulations!