Introduction to Seaborn

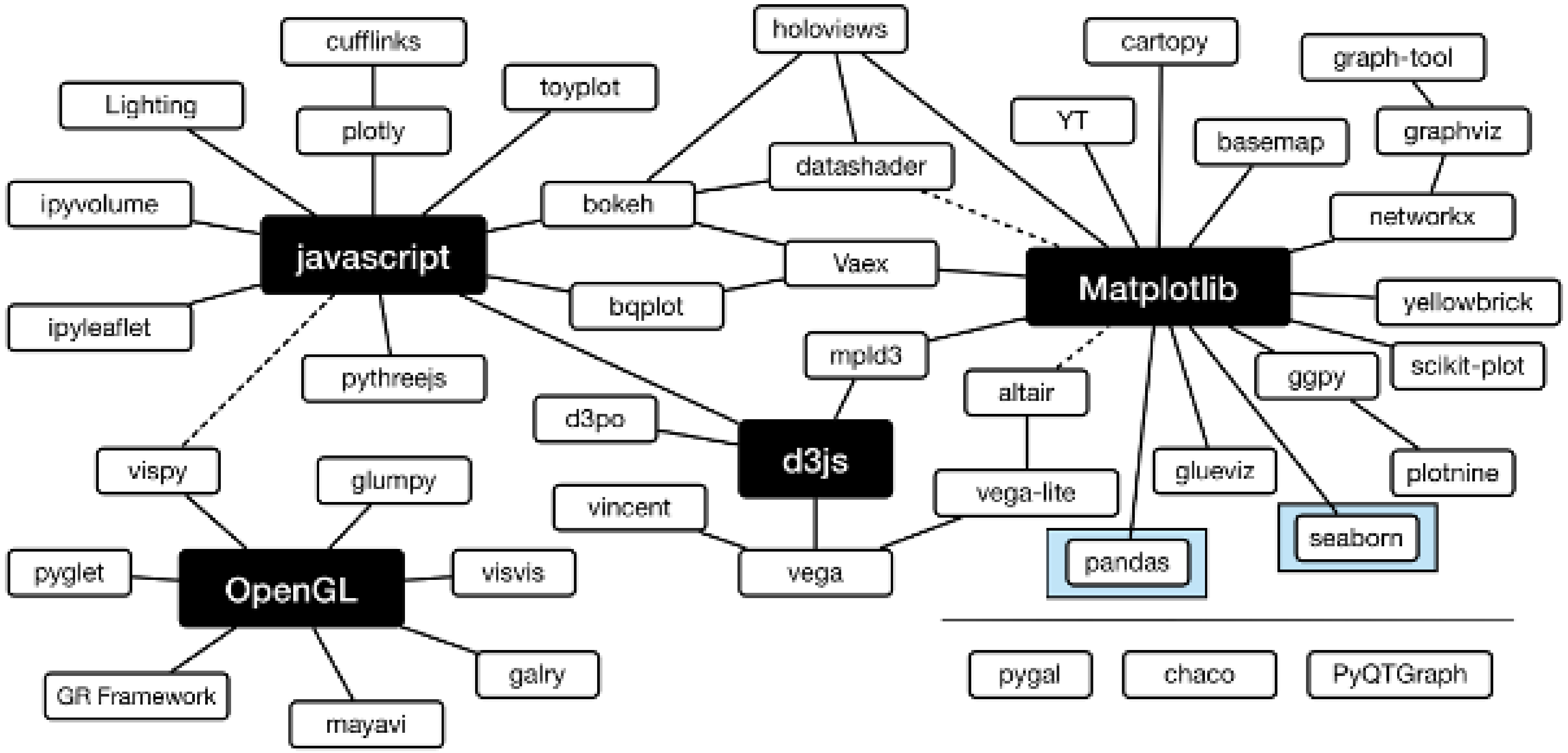
INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Chris Moffitt

Instructor

Python Visualization Landscape

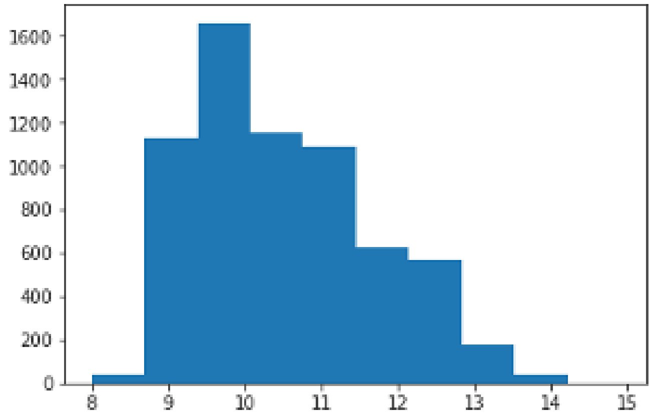
- The python visualization landscape is complex and can be overwhelming



Matplotlib

- `matplotlib` provides the raw building blocks for Seaborn's visualizations
- It can also be used on its own to plot data

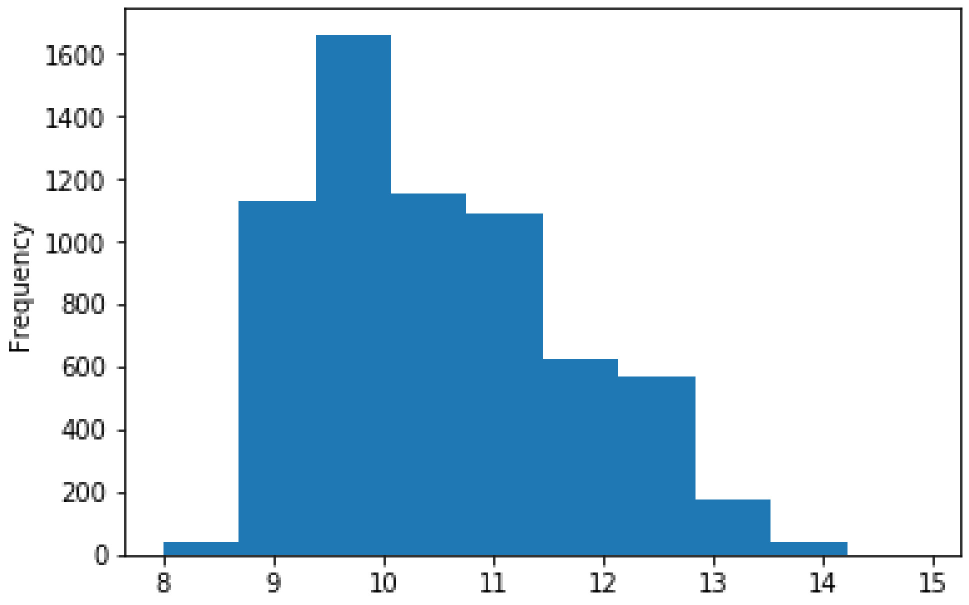
```
import matplotlib.pyplot as plt
import pandas as pd
df = pd.read_csv("wines.csv")
fig, ax = plt.subplots()
ax.hist(df['alcohol'])
```



Pandas

- `pandas` is a foundational library for analyzing data
- It also supports basic plotting capability

```python
import pandas as pd
df = pd.read_csv("wines.csv")
df['alcohol'].plot.hist()
```



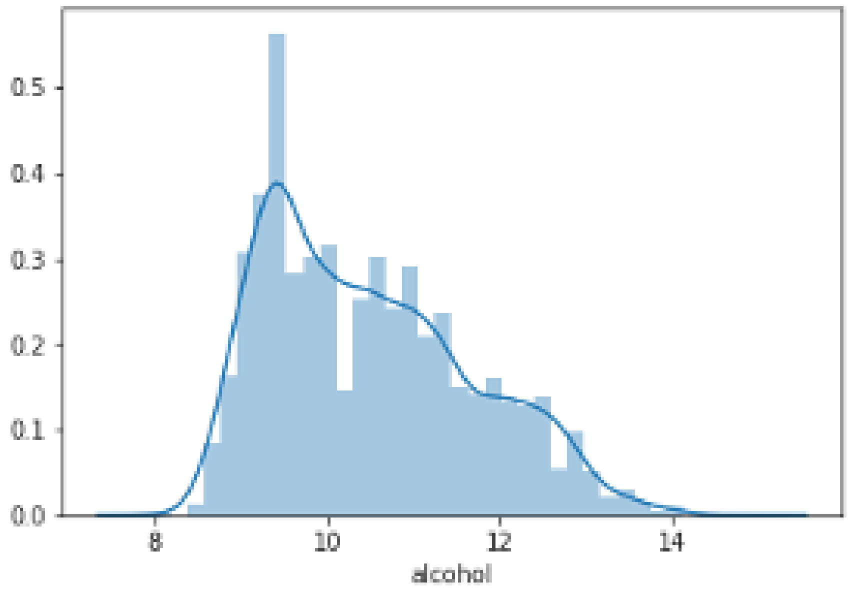
Seaborn

- Seaborn supports complex visualizations of data
- It is built on matplotlib and works best with pandas' dataframes

Seaborn

- The `distplot` is similar to the histogram shown in previous examples
- By default, generates a Gaussian Kernel Density Estimate (KDE)

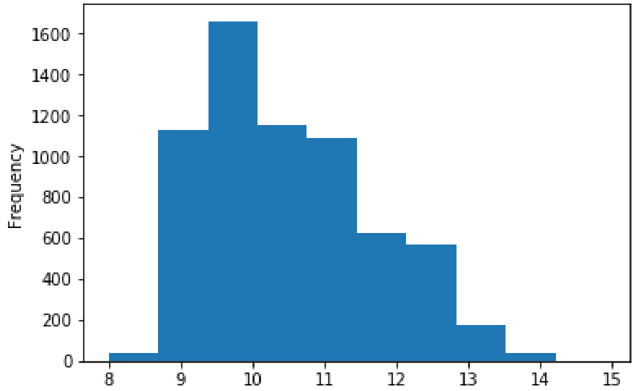
```
import seaborn as sns
sns.distplot(df['alcohol'])
```



Histogram vs. Distplot

- Pandas histogram

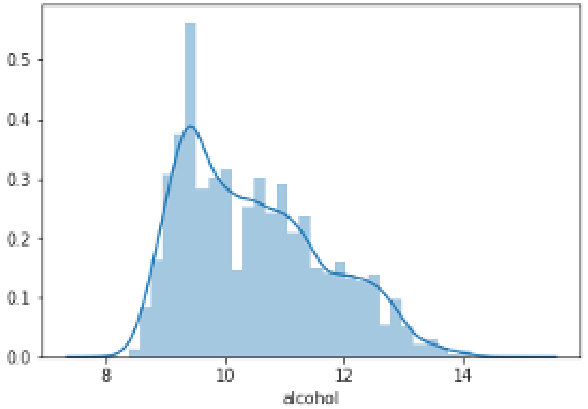
```
df['alcohol'].plot.hist()
```



  - Actual frequency of observations
  - No automatic labels
  - Wide bins

- Seaborn distplot

```
sns.distplot(df['alcohol'])
```



  - Automatic label on x axis
  - Muted color palette
  - KDE plot
  - Narrow bins

Let's practice!

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Using the distribution plot

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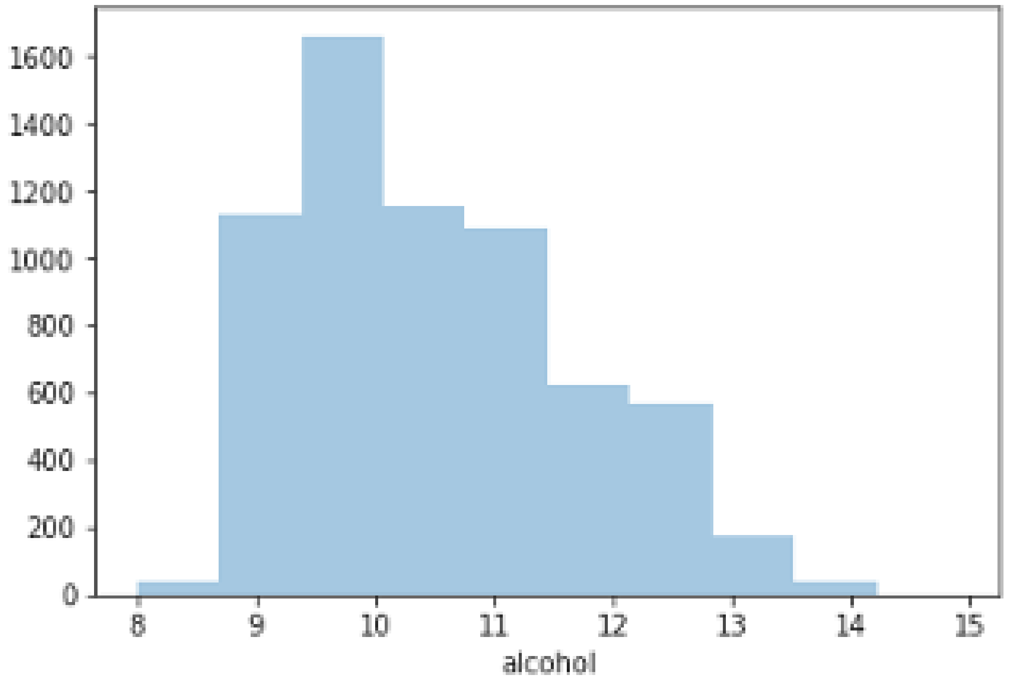
Creating a histogram

- Distplot function has multiple optional arguments
- In order to plot a simple histogram, you can disable the kde and specify the number of bins to use

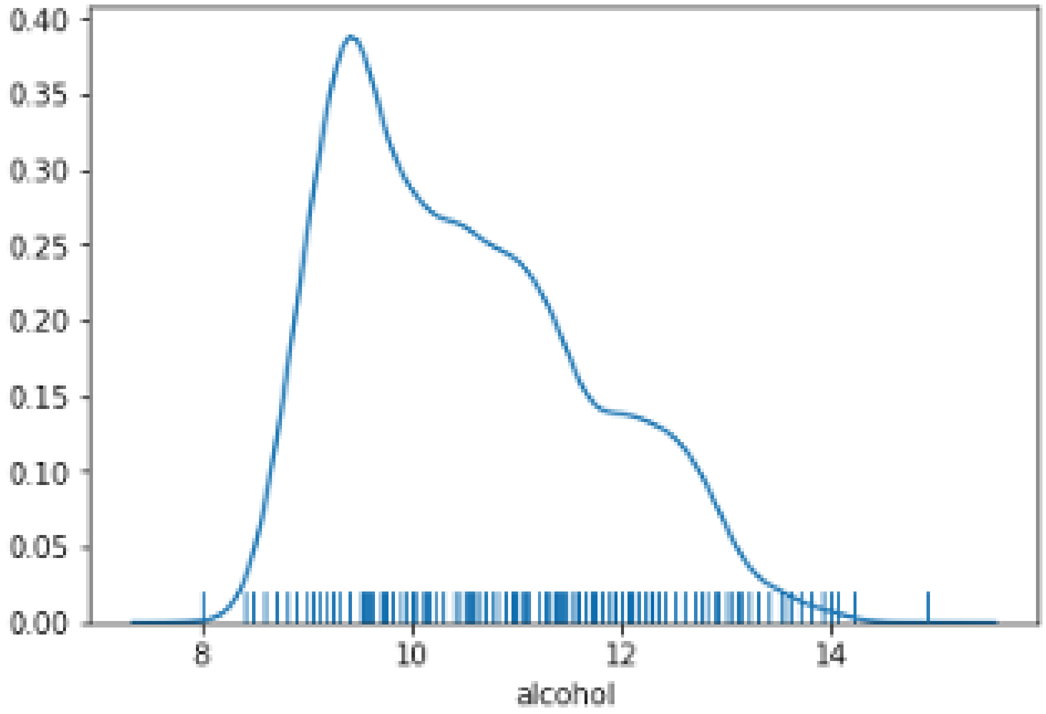
```
sns.distplot(df['alcohol'], kde=False, bins=10)
```



Alternative data distributions

- A rug plot is an alternative way to view the distribution of data
- A kde curve and rug plot can be combined

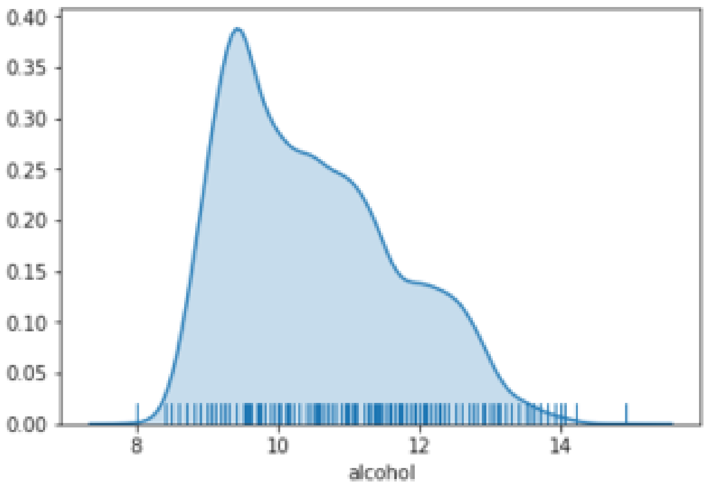
```
sns.distplot(df['alcohol'], hist=False, rug=True)
```



Further Customizations

- The `distplot` function uses several functions including `kdeplot` and `rugplot`
- It is possible to further customize a plot by passing arguments to the underlying function

```
sns.distplot(df['alcohol'], hist=False,
             rug=True, kde_kws={'shade':True})
```



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Regression Plots in Seaborn

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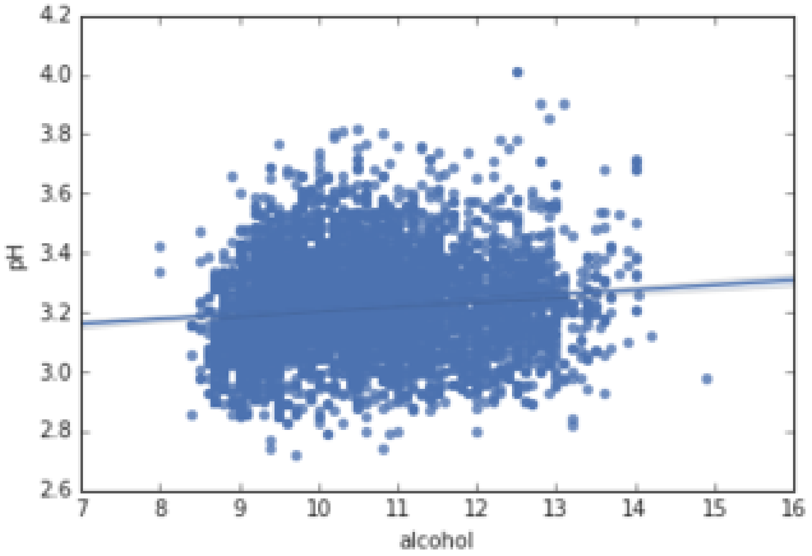
Introduction to regplot

- The `regplot` function generates a scatter plot with a regression line
- Usage is similar to the `distplot`
- The `data` and `x` and `y` variables must be defined

```
sns.regplot(x="alcohol", y="pH", data=df)
```

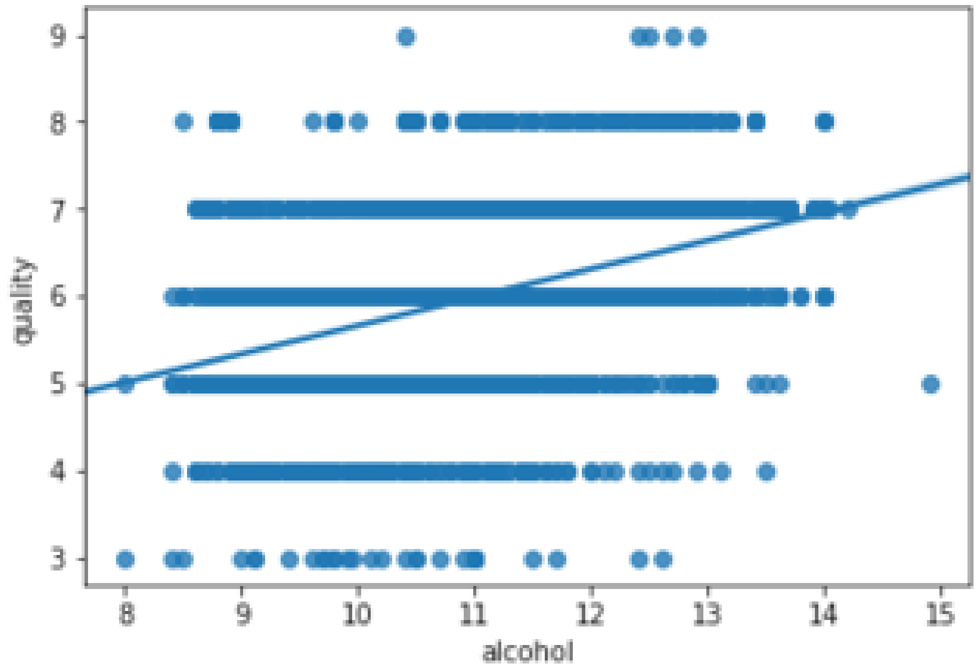


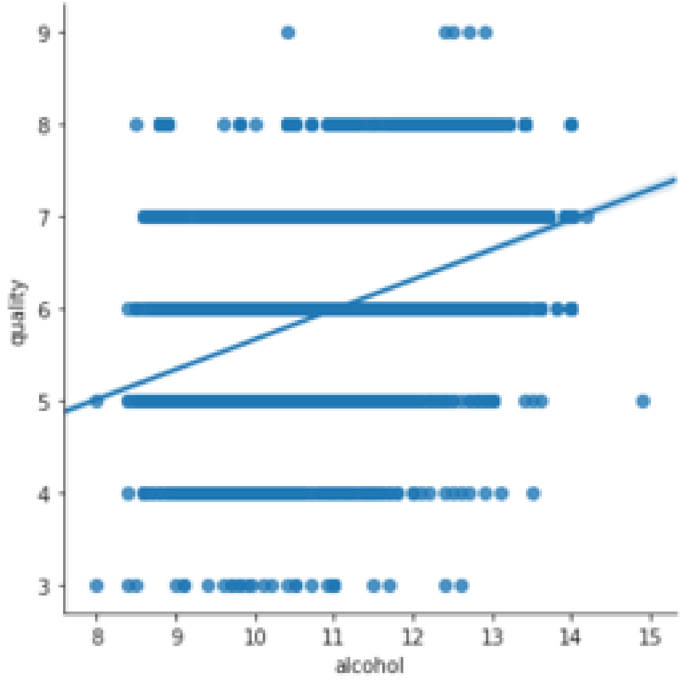
lmplot() builds on top of the base regplot()

- `regplot` - low level
- `lmplot` - high level

```
sns.regplot(x="alcohol",
            y="quality",
            data=df)
```

```
sns.lmplot(x="alcohol",
           y="quality",
           data=df)
```

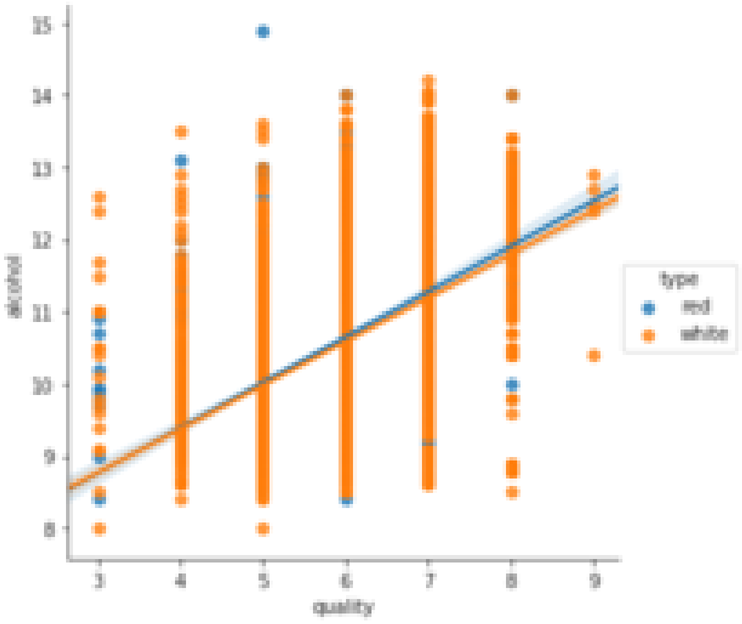




lmplot faceting

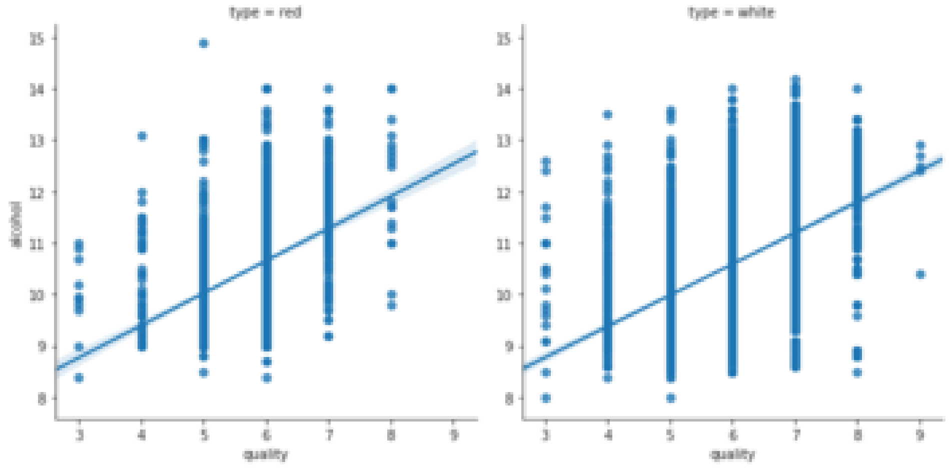
- Organize data by colors (`hue`)

```
sns.lmplot(x="quality",
           y="alcohol",
           data=df,
           hue="type")
```



- Organize data by columns (`col`)

```
sns.lmplot(x="quality",
           y="alcohol",
           data=df,
           col="type")
```



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Using Seaborn Styles

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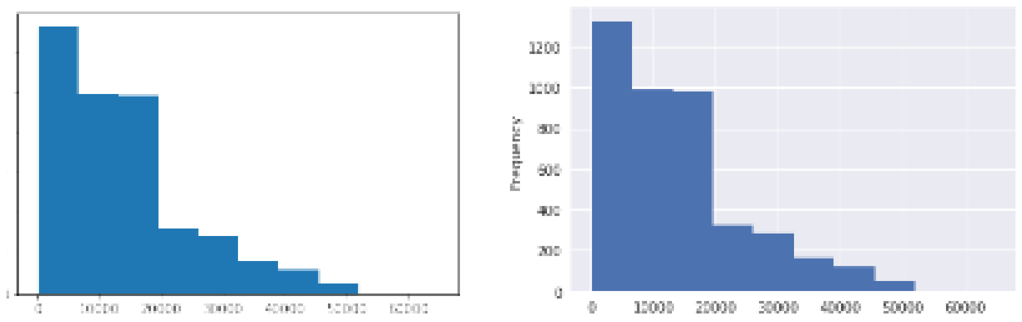
Setting Styles

- Seaborn has default configurations that can be applied with `sns.set()`
- These styles can override matplotlib and pandas plots as well

```
sns.set()
df['Tuition'].plot.hist()
```

Pandas histogram

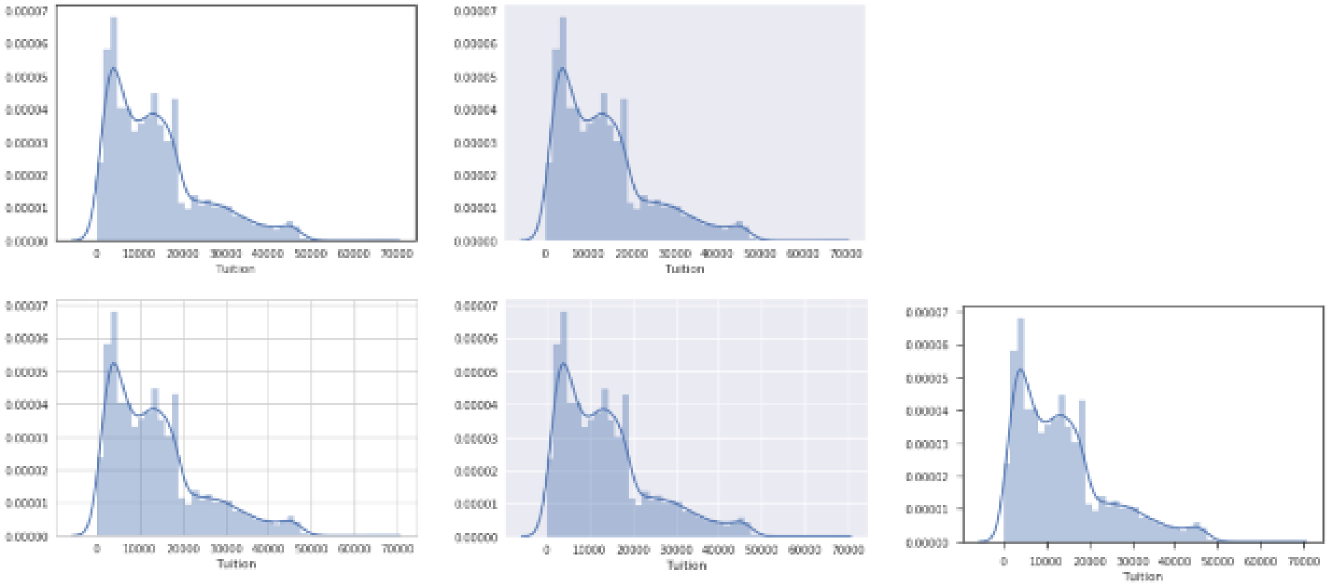


default

Seaborn style

Theme examples with sns.set_style()

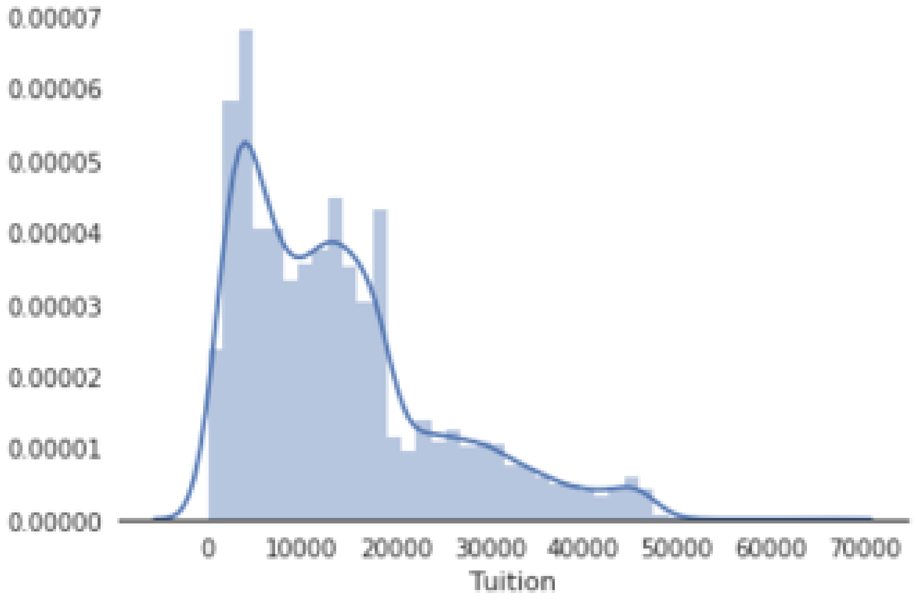
```
for style in ['white','dark','whitegrid','darkgrid',
              'ticks']:
    sns.set_style(style)
    sns.distplot(df['Tuition'])
    plt.show()
```



Removing axes with despine()

- Sometimes plots are improved by removing elements
- Seaborn contains a shortcut for removing the spines of a plot

```
sns.set_style('white')
sns.distplot(df['Tuition'])
sns.despine(left=True)
```



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Colors in Seaborn

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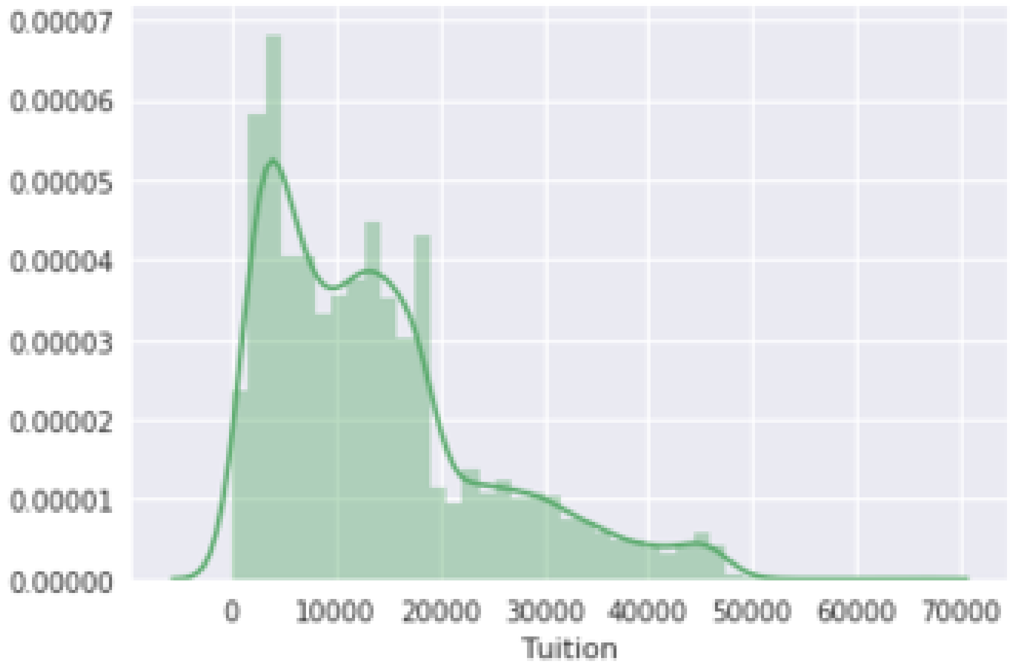
Defining a color for a plot

- Seaborn supports assigning colors to plots using `matplotlib` color codes

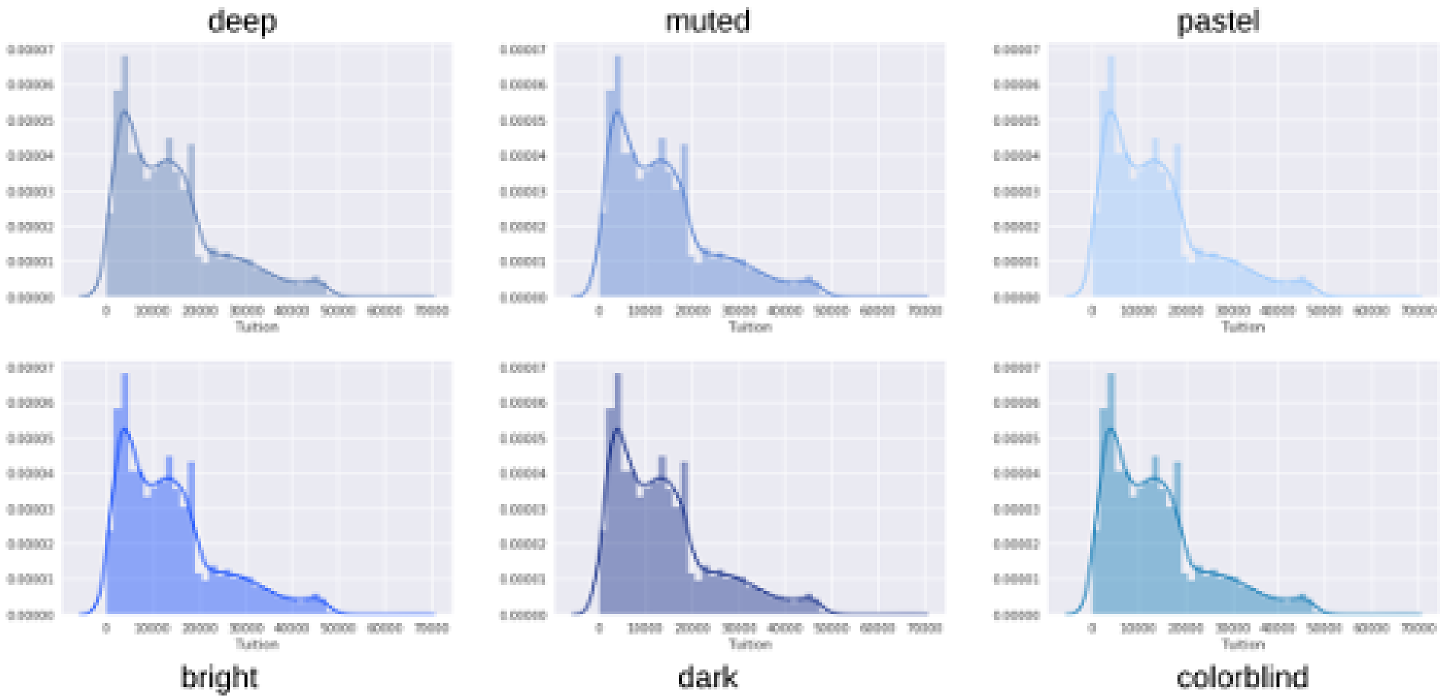
```
sns.set(color_codes=True)
sns.distplot(df['Tuition'], color='g')
```



Palettes

- Seaborn uses the `set_palette()` function to define a palette

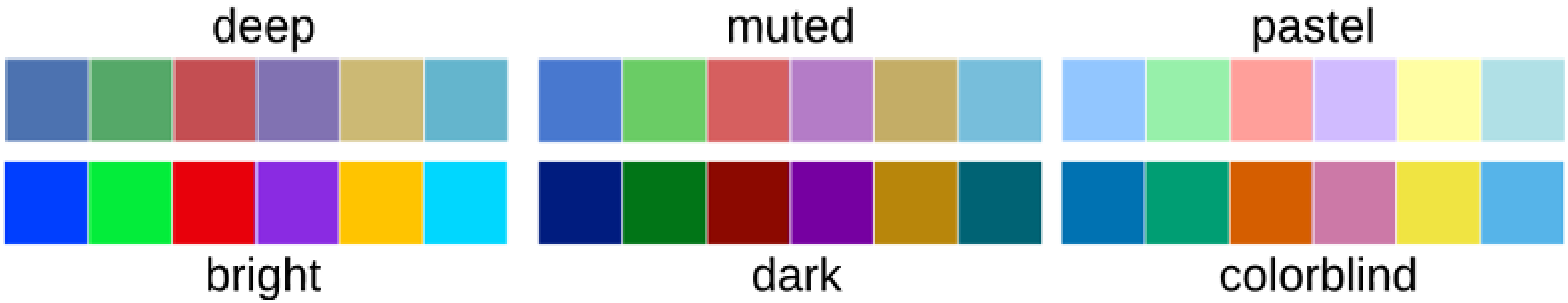
```
for p in sns.palettes.SEABORN_PALETTES:
    sns.set_palette(p)
    sns.distplot(df['Tuition'])
```



Displaying Palettes

- `sns.palplot()` function displays a palette
- `sns.color_palette()` returns the current palette

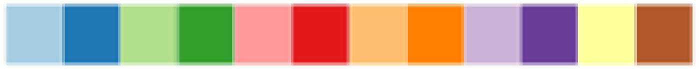
```
for p in sns.palettes.SEABORN_PALETTES:
    sns.set_palette(p)
    sns.palplot(sns.color_palette())
    plt.show()
```



Defining Custom Palettes

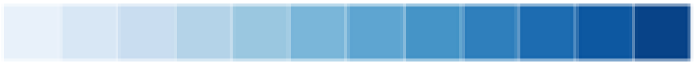
- Circular colors = when the data is not ordered

```
sns.palplot(sns.color_palette(
            "Paired", 12))
```



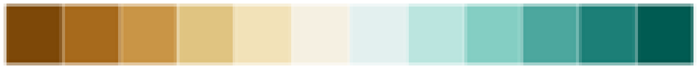
- Sequential colors = when the data has a consistent range from high to low

```
sns.palplot(sns.color_palette(
            "Blues", 12))
```



- Diverging colors = when both the low and high values are interesting

```
sns.palplot(sns.color_palette(
            "BrBG", 12))
```



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Customizing with matplotlib

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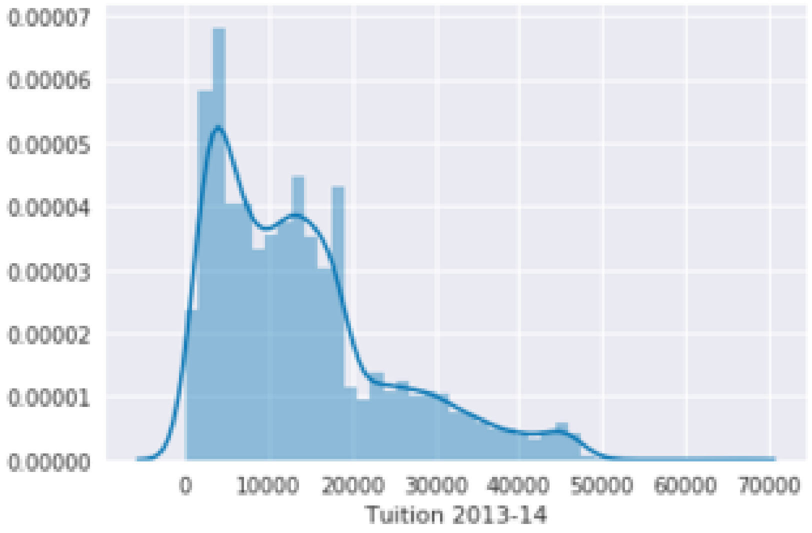
Matplotlib Axes

- Most customization available through `matplotlib` `Axes` objects
- `Axes` can be passed to seaborn functions

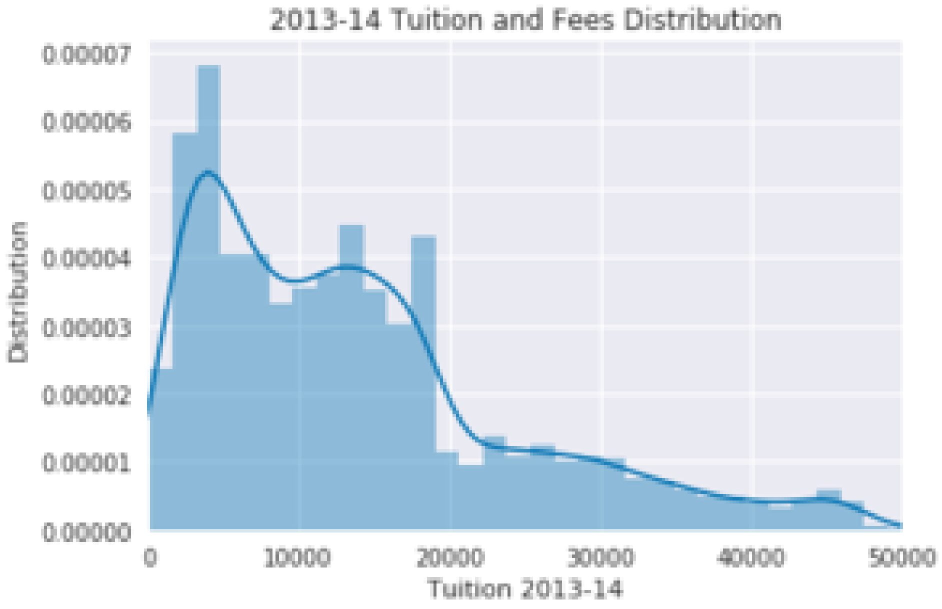
```
fig, ax = plt.subplots()
sns.distplot(df['Tuition'], ax=ax)
ax.set(xlabel="Tuition 2013-14")
```



Further Customizations

- The `axes` object supports many common customizations

```
fig, ax = plt.subplots()
sns.distplot(df['Tuition'], ax=ax)
ax.set(xlabel="Tuition 2013-14",
       ylabel="Distribution", xlim=(0, 50000),
title="2013-14 Tuition and Fees Distribution")
```



Combining Plots

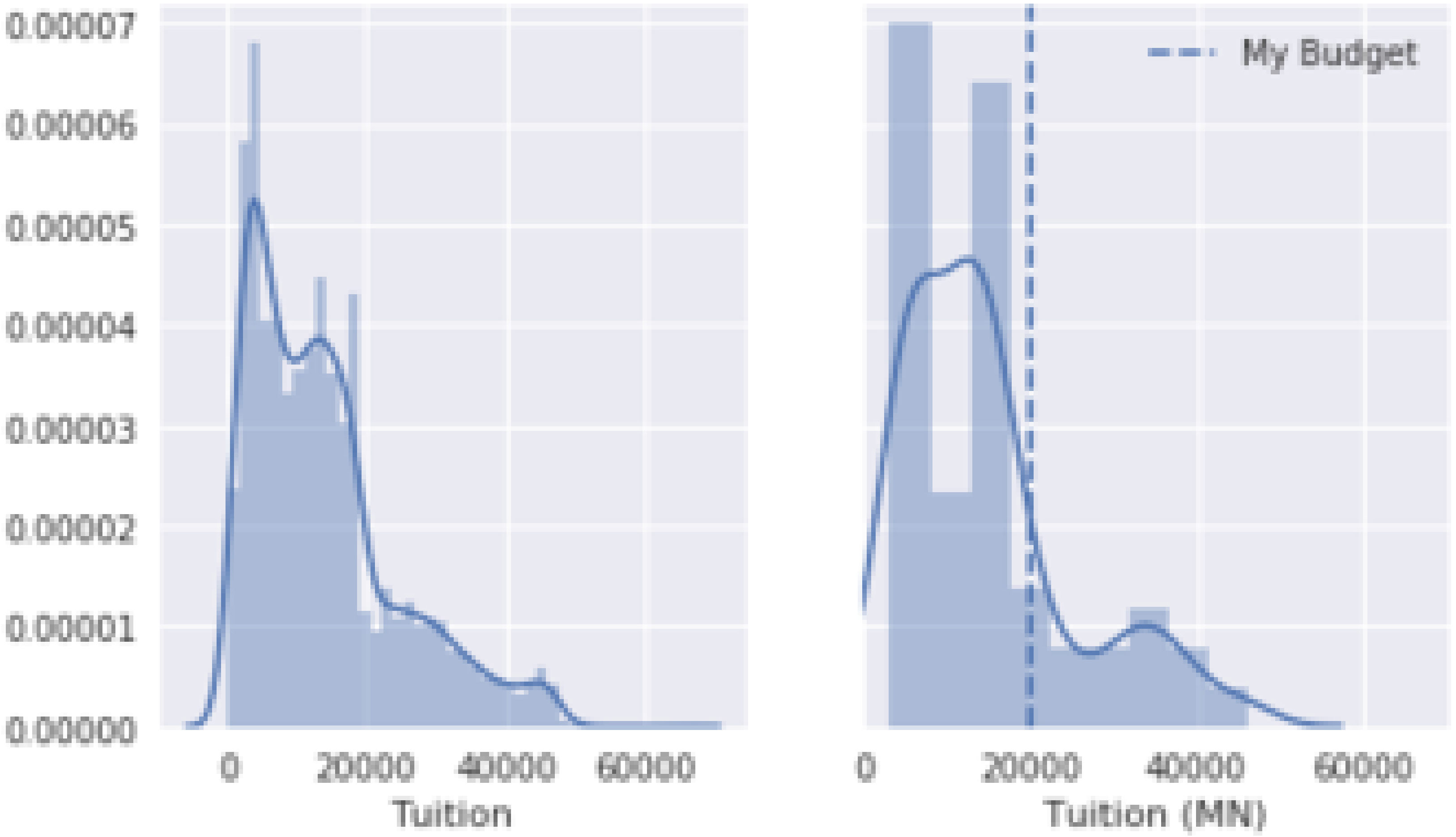
- It is possible to combine and configure multiple plots

```
fig, (ax0, ax1) = plt.subplots(
nrows=1,ncols=2, sharey=True, figsize=(7,4))

sns.distplot(df['Tuition'], ax=ax0)
sns.distplot(df.query(
'State == "MN"')['Tuition'], ax=ax1)

ax1.set(xlabel="Tuition (MN)", xlim=(0, 70000))
ax1.axvline(x=20000, label='My Budget', linestyle='--')
ax1.legend()
```

Combining Plots



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Categorical Plot Types

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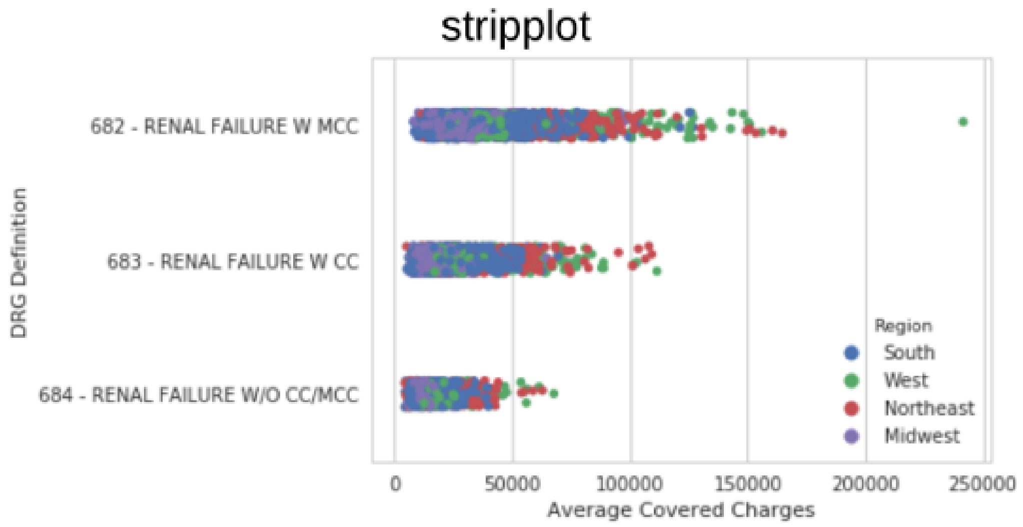
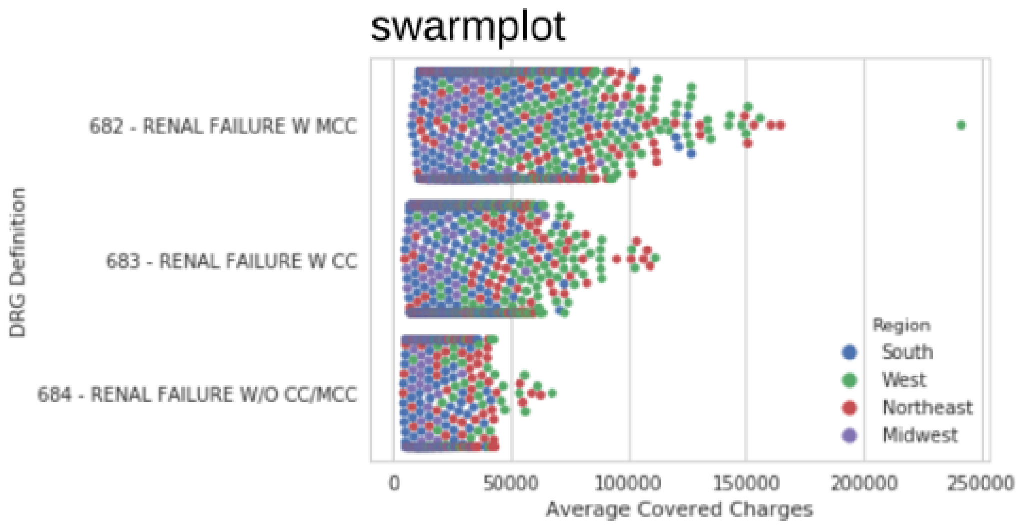
Categorical Data

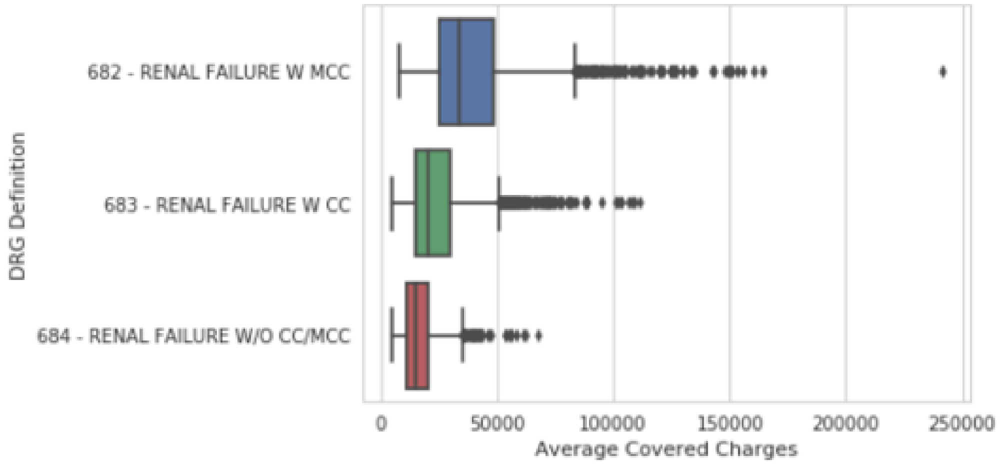
- Data which takes on a limited and fixed number of values
- Normally combined with numeric data
- Examples include:
    - Geography (country, state, region)
    - Gender
    - Ethnicity
    - Blood type
    - Eye color

Plot types - show each observation

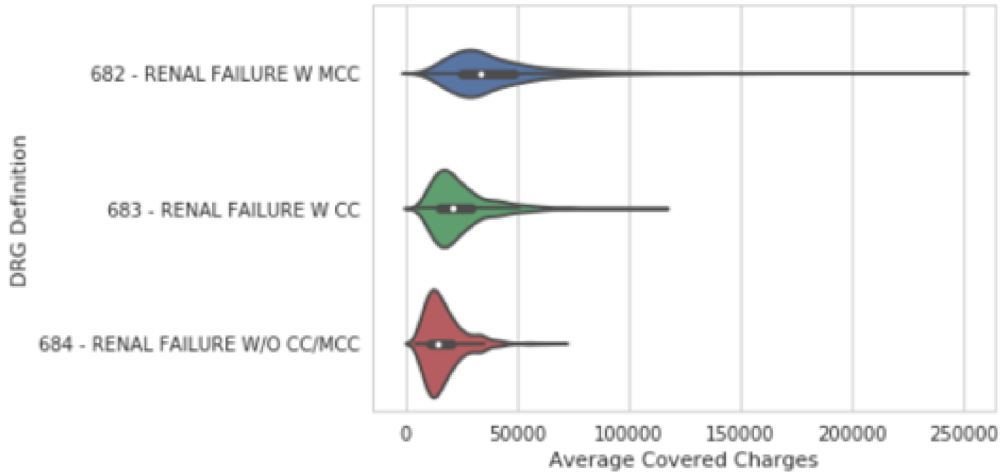




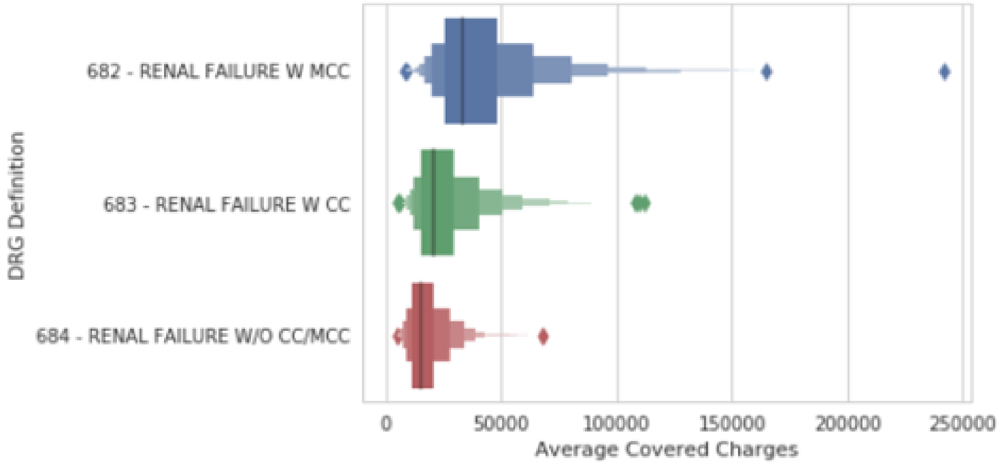
Plot types - abstract representations



boxplot



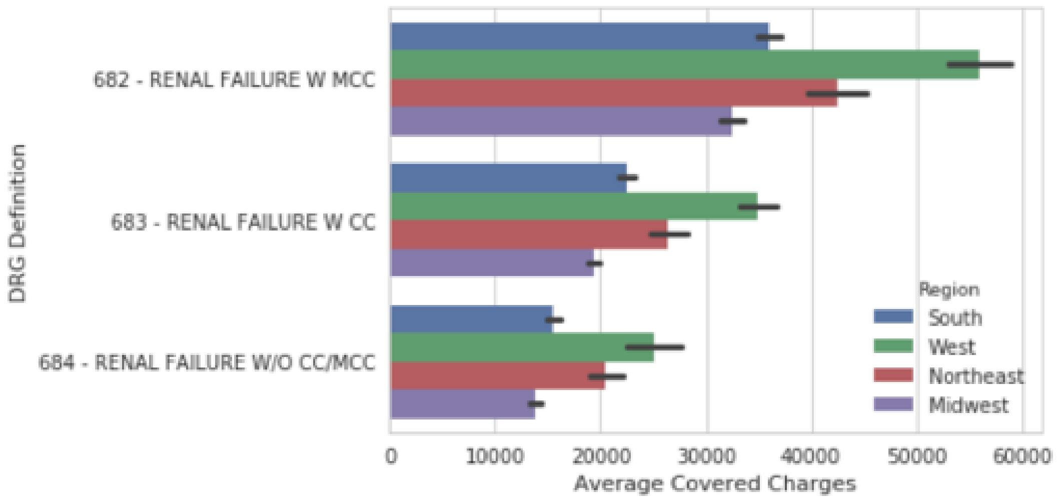
violinplot



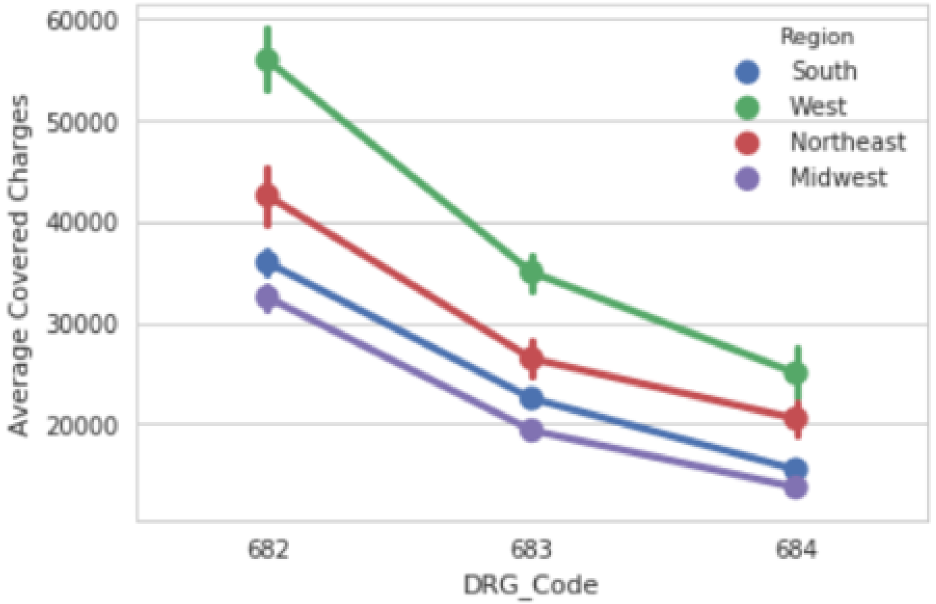
lvplot

Plot types - statistical estimates

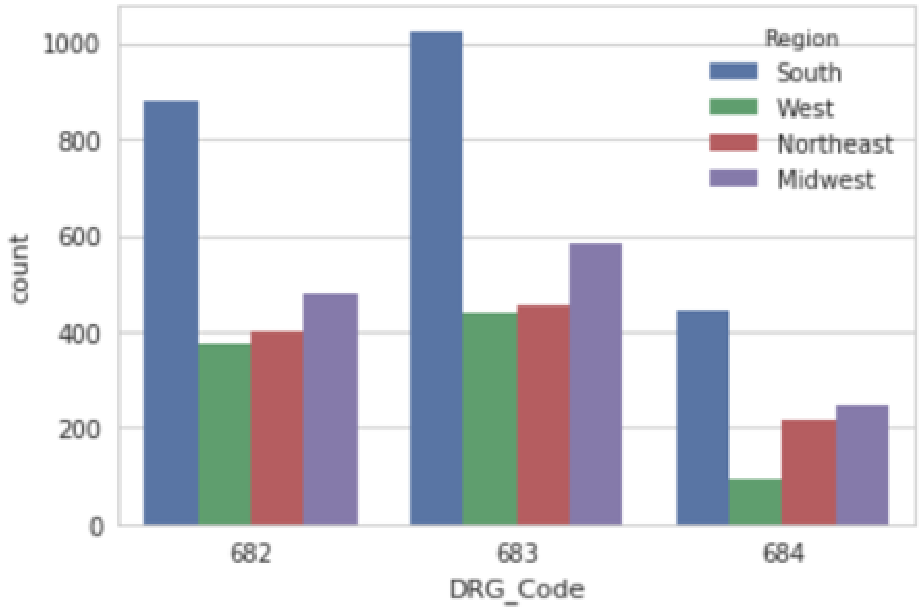
barplot



pointplot

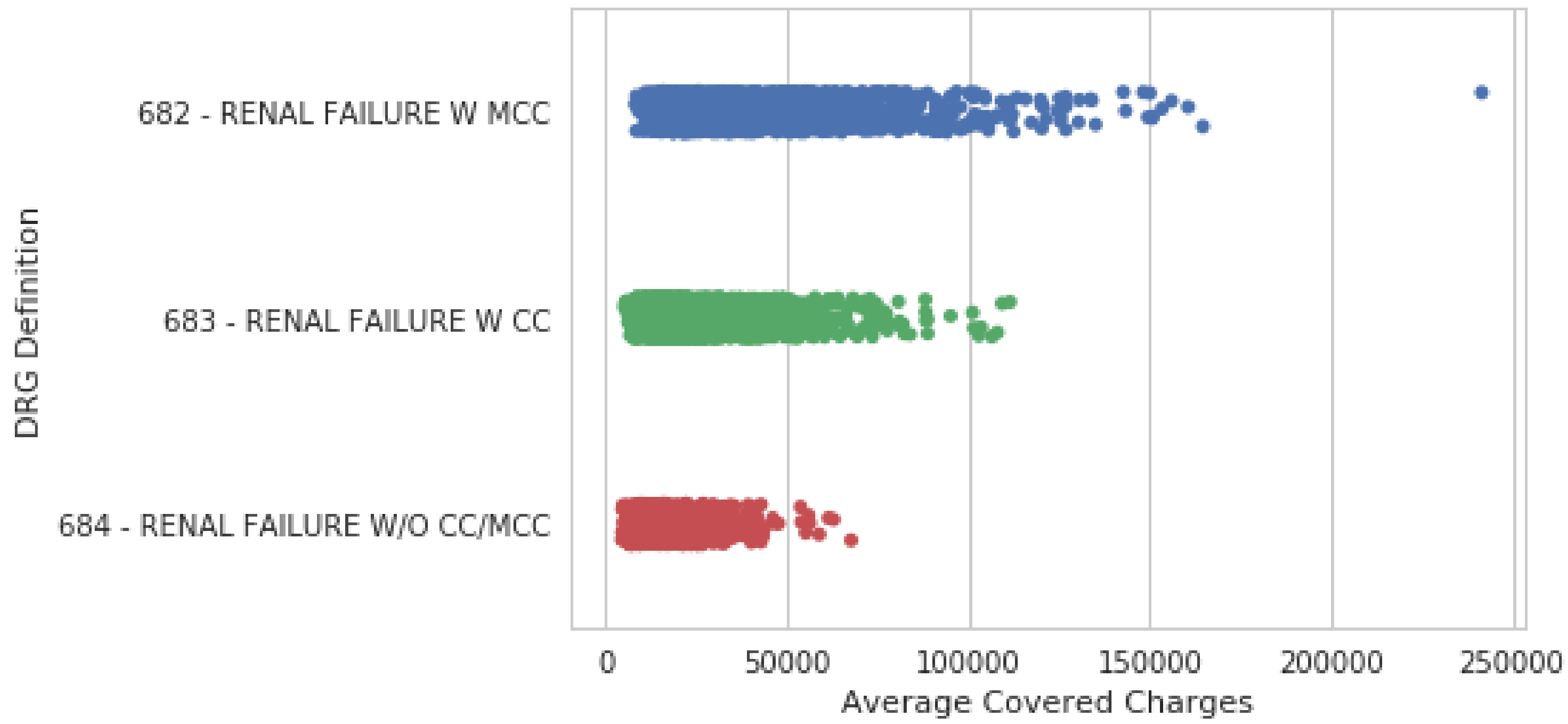


countplot



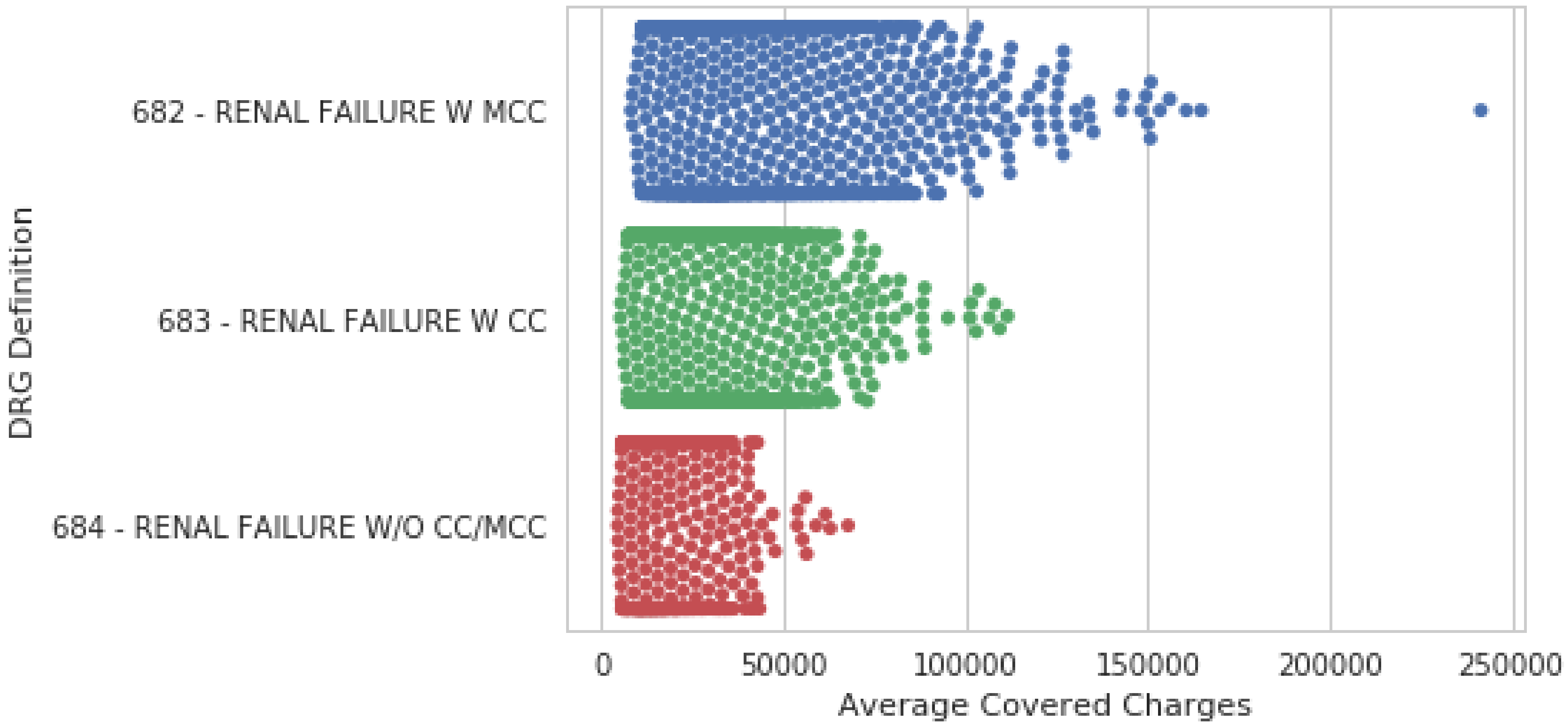
Plots of each observation - stripplot

```
sns.stripplot(data=df, y="DRG Definition",
              x="Average Covered Charges",
              jitter=True)
```



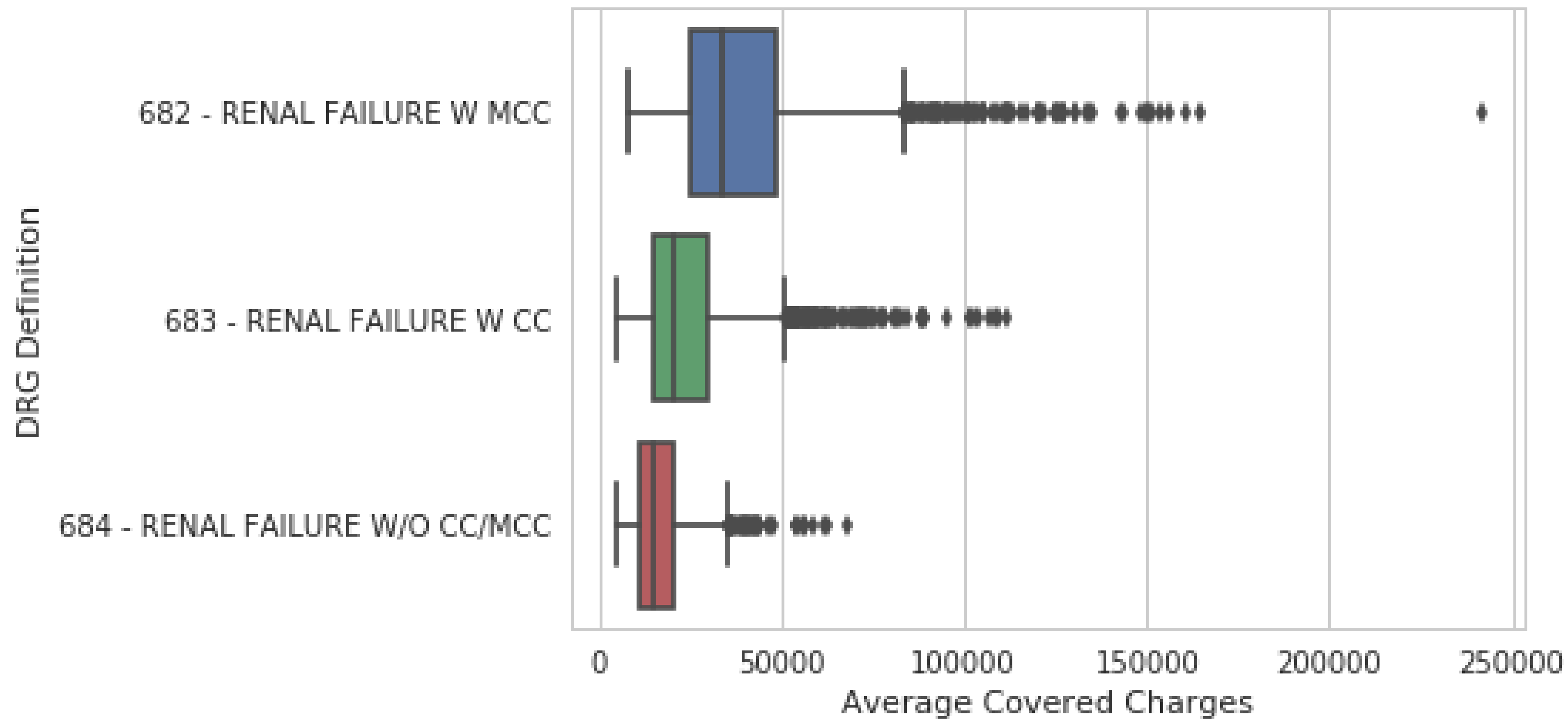
Plots of each observation - swarmplot

```
sns.swarmplot(data=df, y="DRG Definition",
                            x="Average Covered Charges")
```



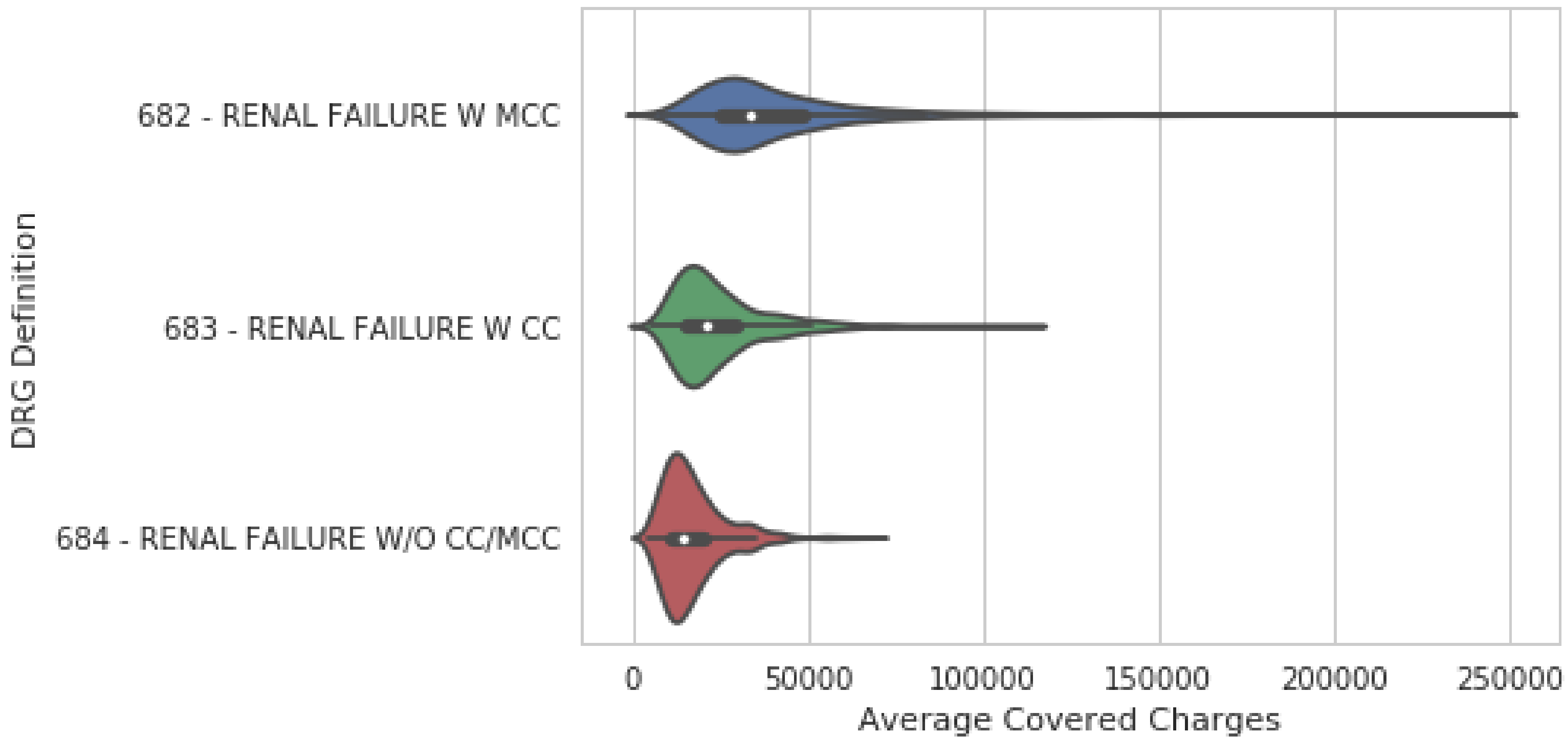
Abstract representations - boxplot

```
sns.boxplot(data=df, y="DRG Definition",
            x="Average Covered Charges")
```



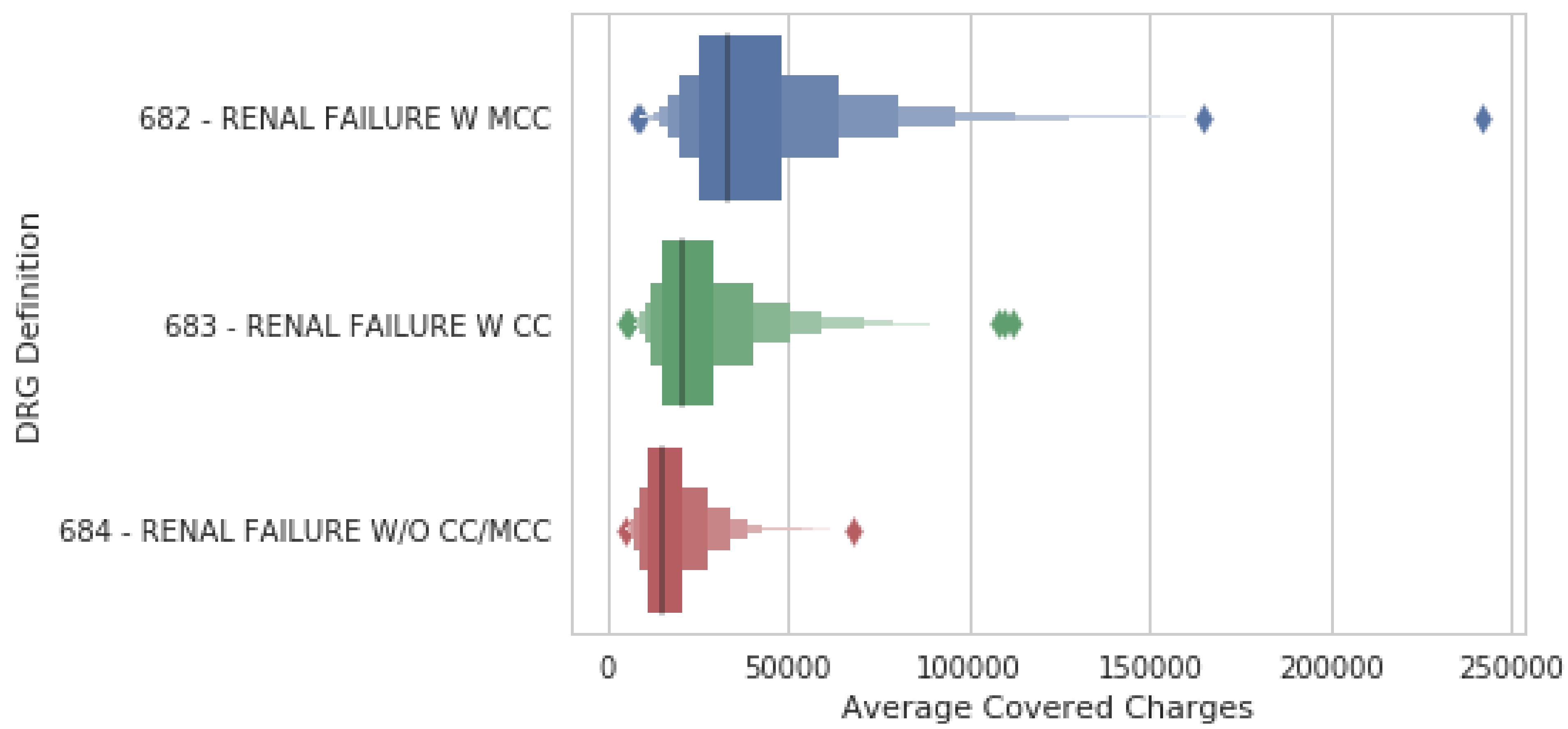
Abstract representation - violinplot

```
sns.violinplot(data=df, y="DRG Definition",
               x="Average Covered Charges")
```



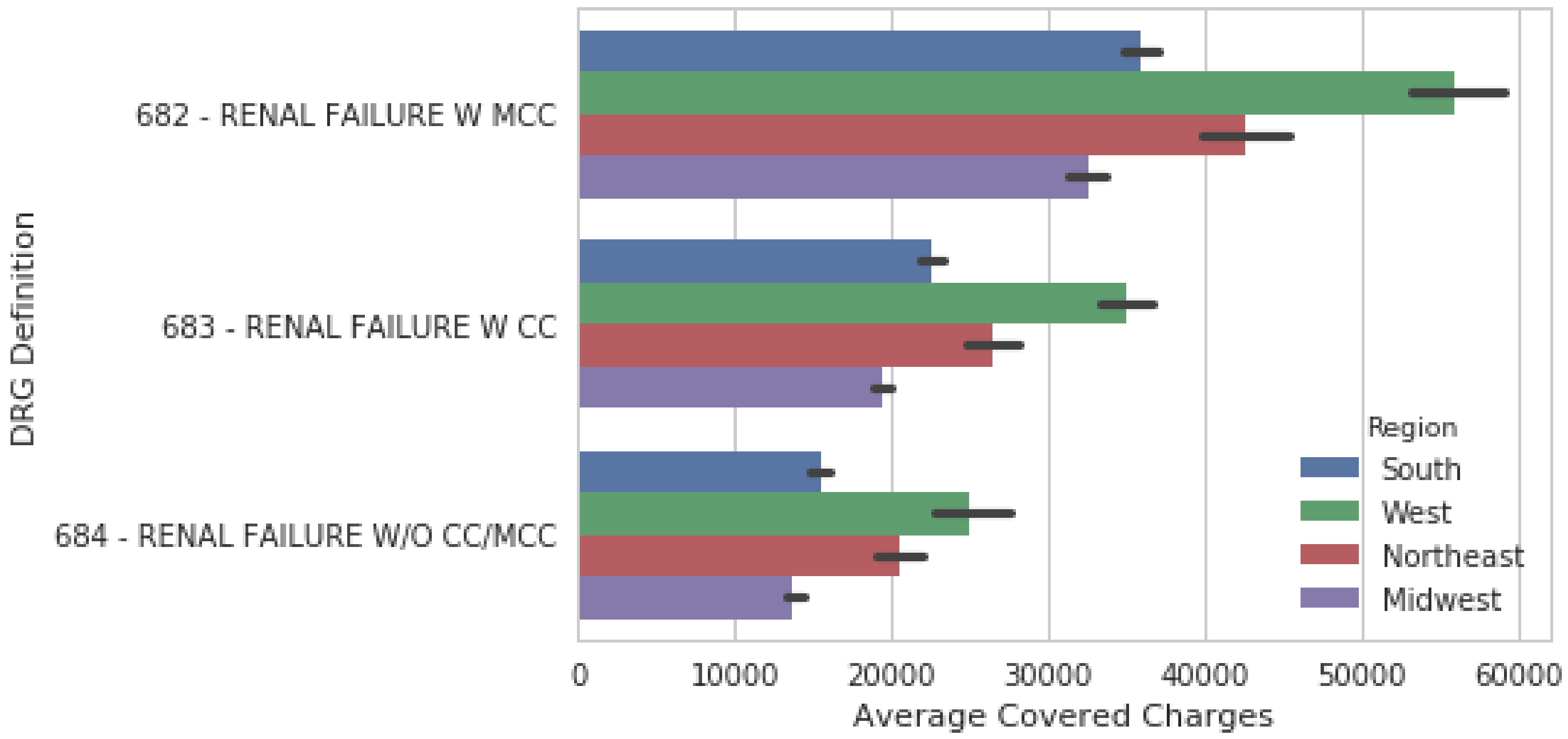
Abstract representation - lvplot

```
sns.lvplot(data=df, y="DRG Definition",
           x="Average Covered Charges")
```



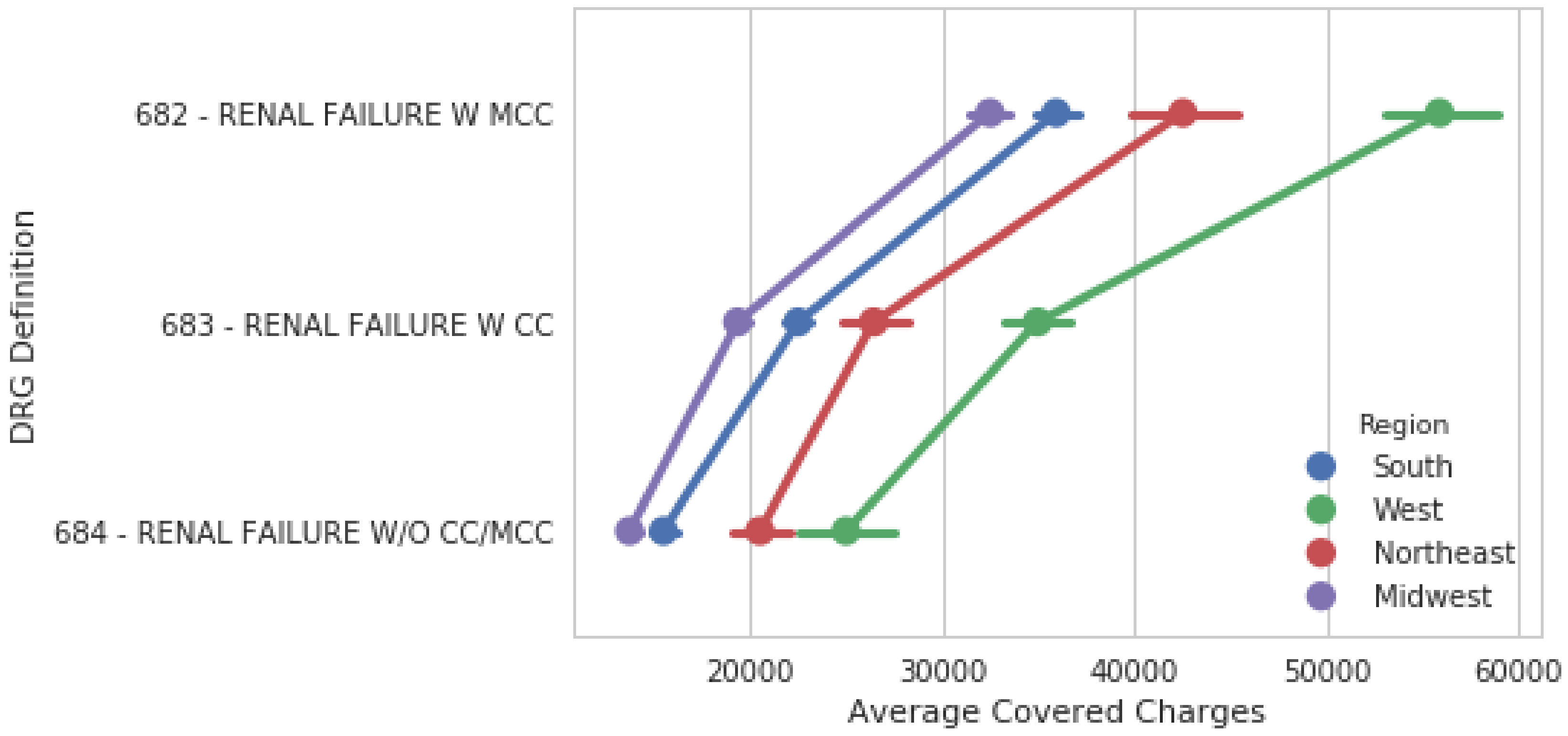
Statistical estimates - barplot

```
sns.barplot(data=df, y="DRG Definition",
            x="Average Covered Charges",
            hue="Region")
```



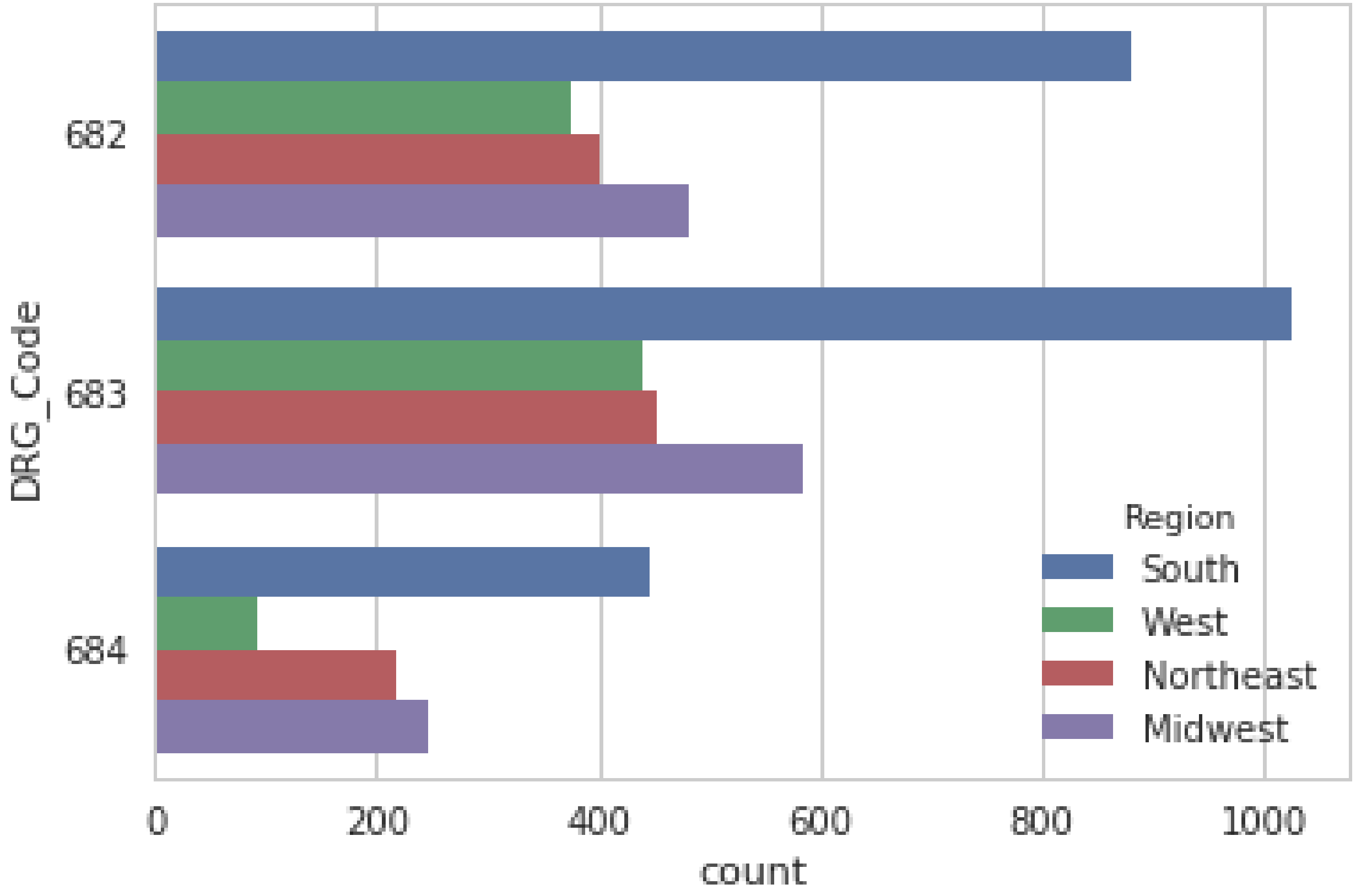
Statistical estimates - pointplot

```
sns.pointplot(data=df, y="DRG Definition",
              x="Average Covered Charges",
              hue="Region")
```



Statistical estimates - countplot

```
sns.countplot(data=df, y="DRG_Code", hue="Region")
```



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Regression Plots

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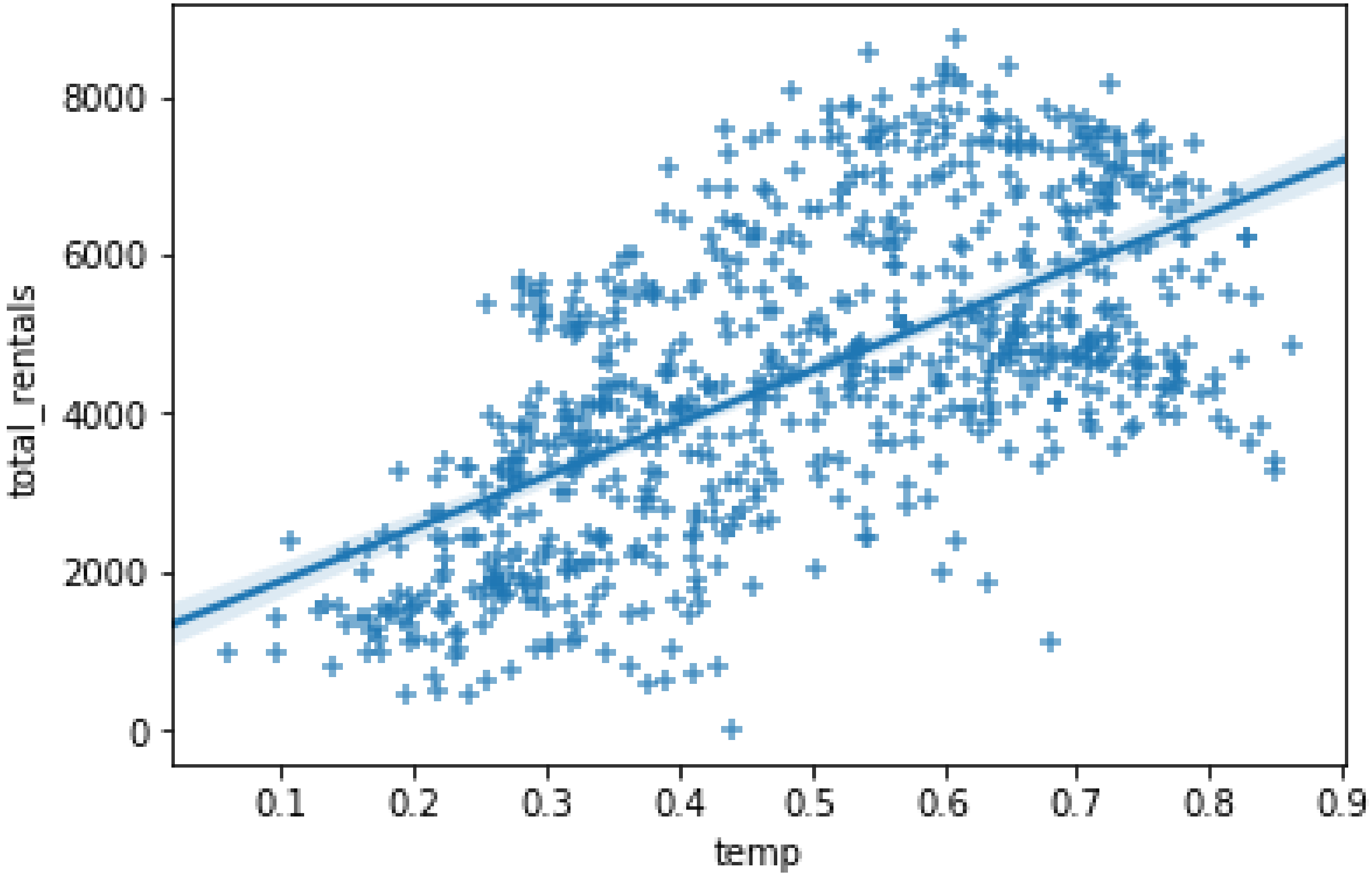
Bicycle Dataset

- Aggregated bicycle sharing data in Washington DC
- Data includes:
  - Rental amounts
  - Weather information
  - Calendar information
- Can we predict rental amounts?

Plotting with regplot()

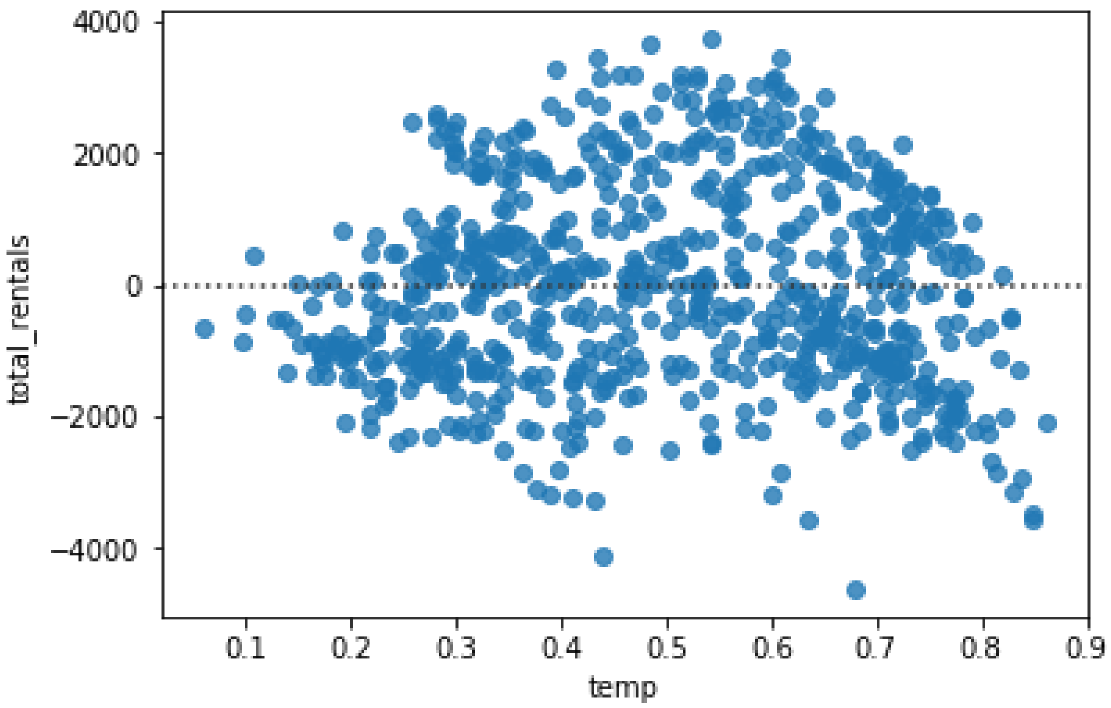
```
sns.regplot(data=df, x='temp',
            y='total_rentals', marker='+')
```



Evaluating regression with residplot()

- A residual plot is useful for evaluating the fit of a model
- Seaborn supports through `residplot` function

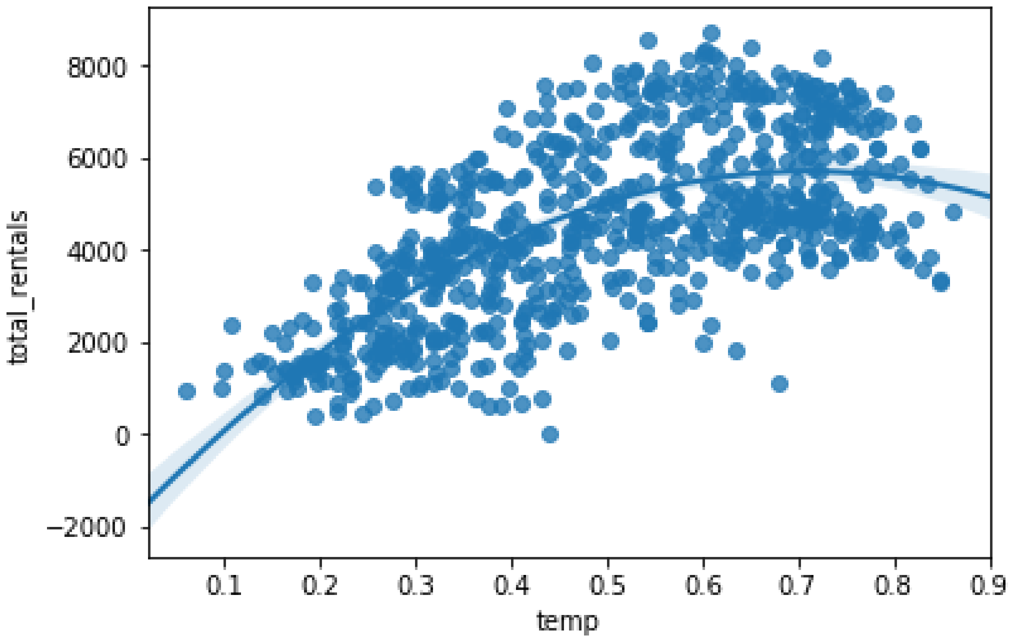
```
sns.residplot(data=df, x='temp', y='total_rentals')
```



Polynomial regression

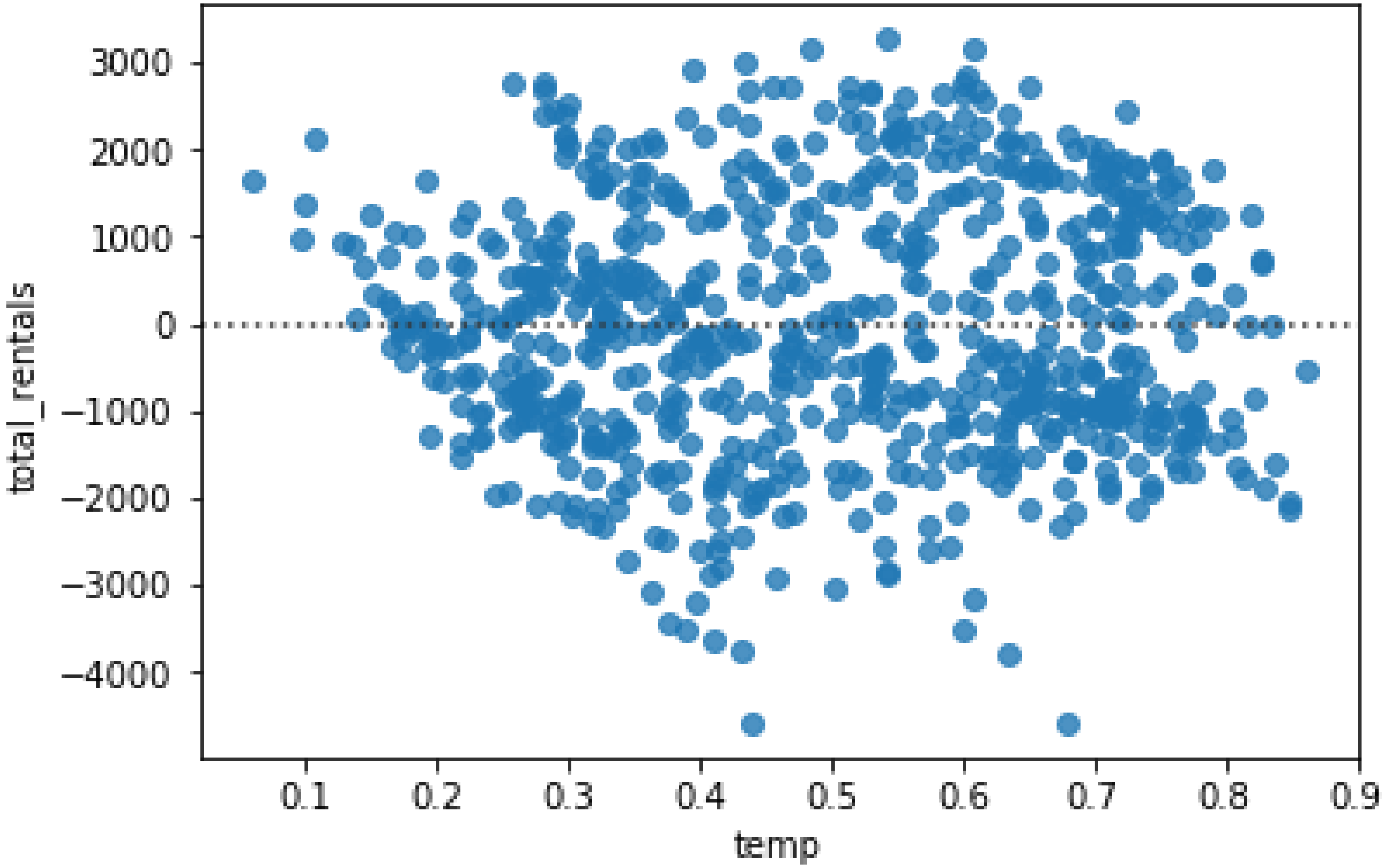
- Seaborn supports polynomial regression using the `order` parameter

```
sns.regplot(data=df, x='temp',
            y='total_rentals', order=2)
```



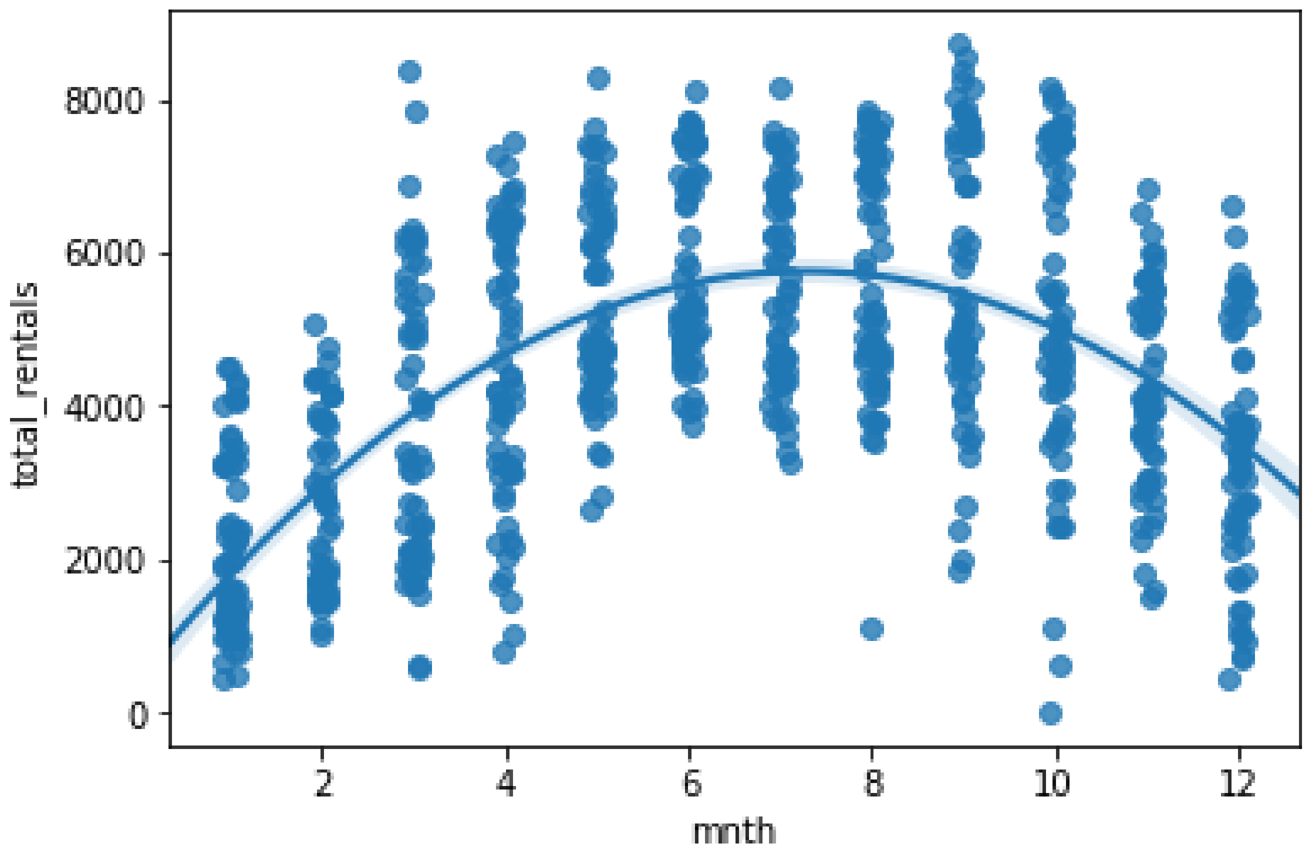
residplot with polynomial regression

```
sns.residplot(data=df, x='temp',
              y='total_rentals', order=2)
```



Categorical values

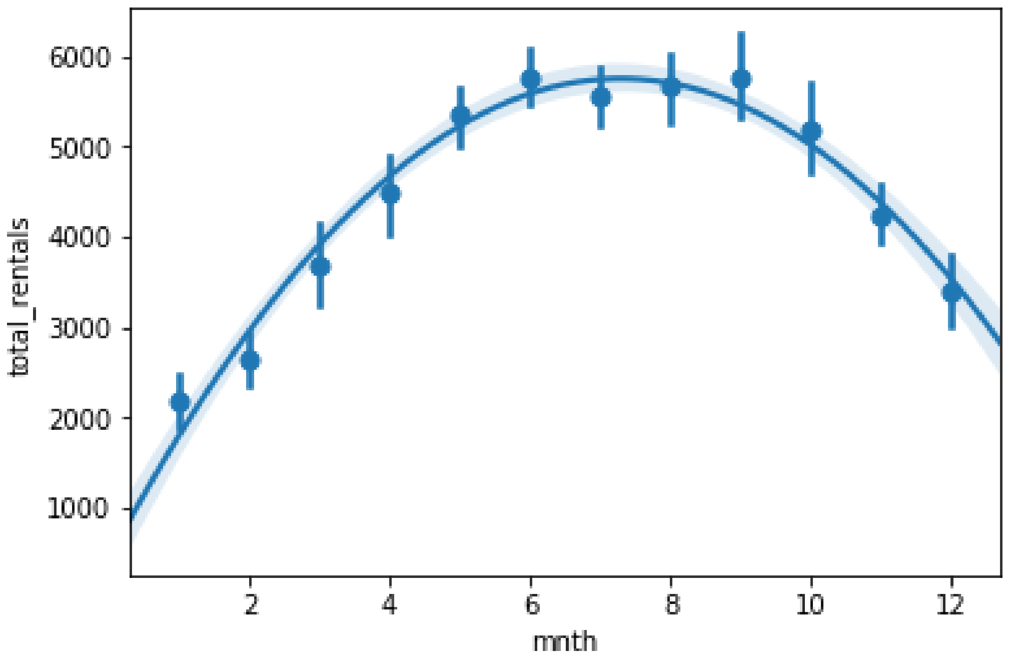
```
sns.regplot(data=df, x='mnth', y='total_rentals',
            x_jitter=.1, order=2)
```



Estimators

- In some cases, an `x_estimator` can be useful for highlighting trends

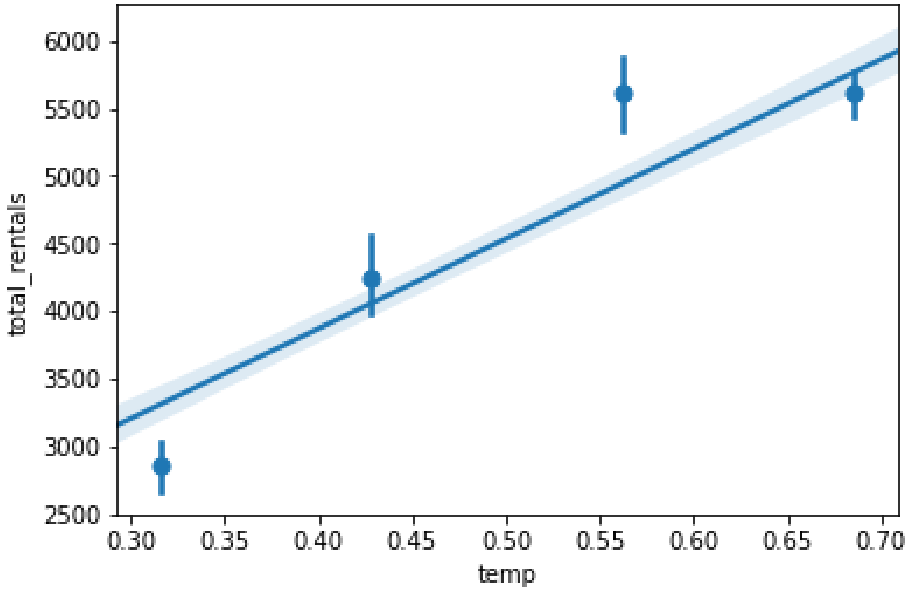
```
sns.regplot(data=df, x='mnth', y='total_rentals',
            x_estimator=np.mean, order=2)
```



Binning the data

- `x_bins` can be used to divide the data into discrete bins
- The regression line is still fit against all the data

```
sns.regplot(data=df,x='temp',y='total_rentals',
            x_bins=4)
```



Let's practice!

INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Matrix Plots

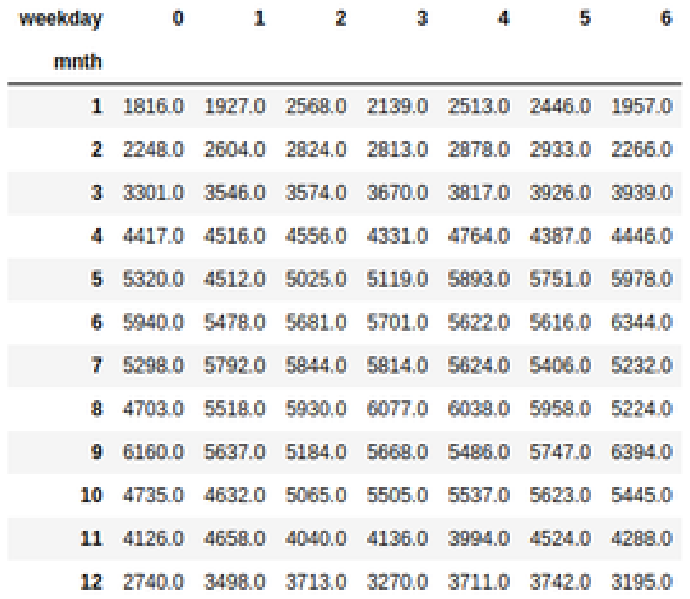
INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Chris Moffitt
Instructor

Getting data in the right format

- Seaborn's `heatmap()` function requires data to be in a grid format
- pandas `crosstab()` is frequently used to manipulate the data

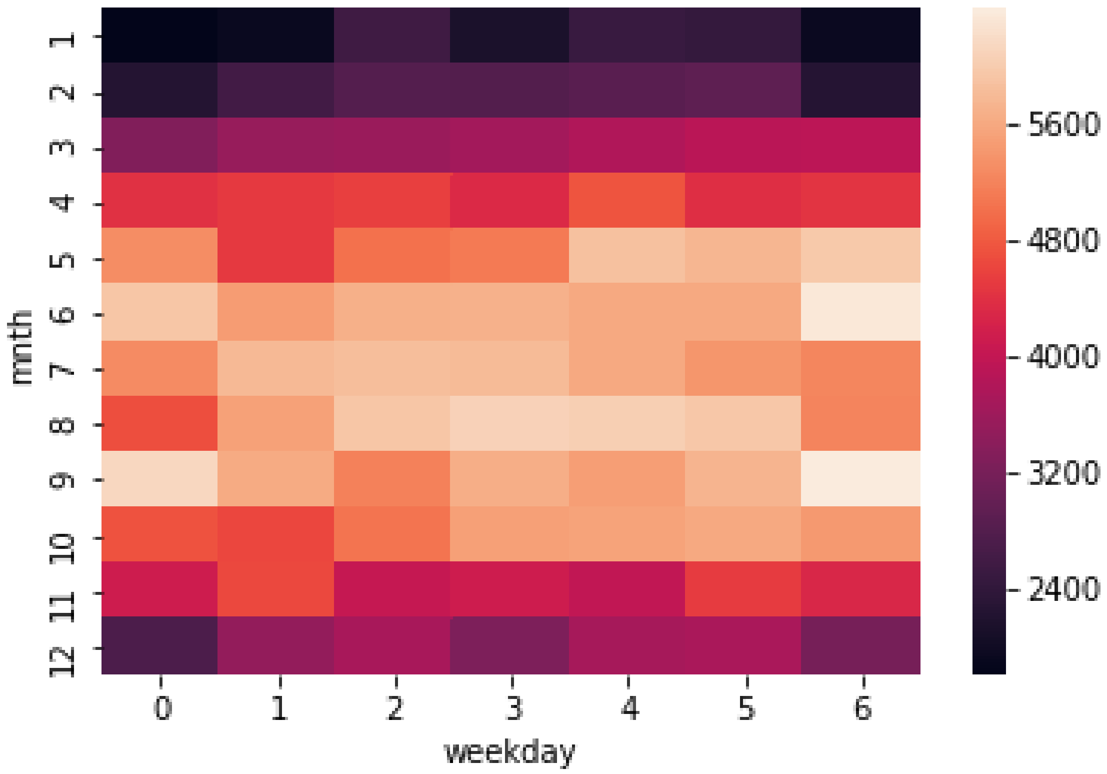
```
pd.crosstab(df["mnth"], df["weekday"],
values=df["total_rentals"],aggfunc='mean').round(0)
```



weekday	0	1	2	3	4	5	6
mnth							
1	1816.0	1927.0	2568.0	2139.0	2513.0	2446.0	1957.0
2	2248.0	2604.0	2824.0	2813.0	2878.0	2933.0	2266.0
3	3301.0	3546.0	3574.0	3670.0	3817.0	3926.0	3939.0
4	4417.0	4516.0	4556.0	4331.0	4764.0	4387.0	4446.0
5	5320.0	4512.0	5025.0	5119.0	5893.0	5751.0	5978.0
6	5940.0	5478.0	5681.0	5701.0	5622.0	5616.0	6344.0
7	5298.0	5792.0	5844.0	5814.0	5624.0	5406.0	5232.0
8	4703.0	5518.0	5930.0	6077.0	6038.0	5958.0	5224.0
9	6160.0	5637.0	5184.0	5668.0	5486.0	5747.0	6394.0
10	4735.0	4632.0	5065.0	5505.0	5537.0	5623.0	5445.0
11	4126.0	4658.0	4040.0	4136.0	3994.0	4524.0	4288.0
12	2740.0	3498.0	3713.0	3270.0	3711.0	3742.0	3195.0

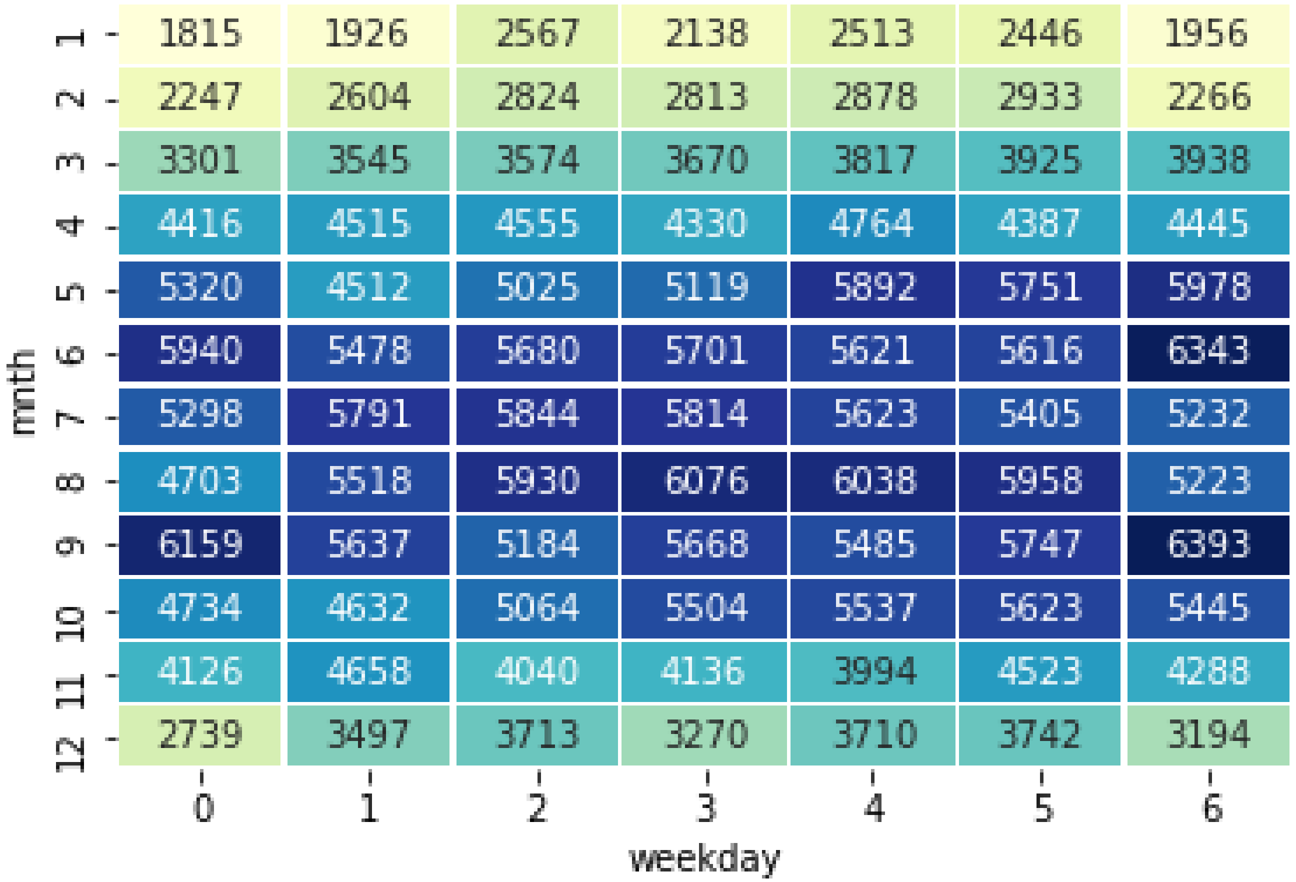
Build a heatmap

```
sns.heatmap(pd.crosstab(df["mnth"], df["weekday"],
            values=df["total_rentals"], aggfunc='mean')
)
```



Customize a heatmap

```
sns.heatmap(df_crosstab, annot=True, fmt="d",
            cmap="YlGnBu", cbar=False, linewidths=.5)
```

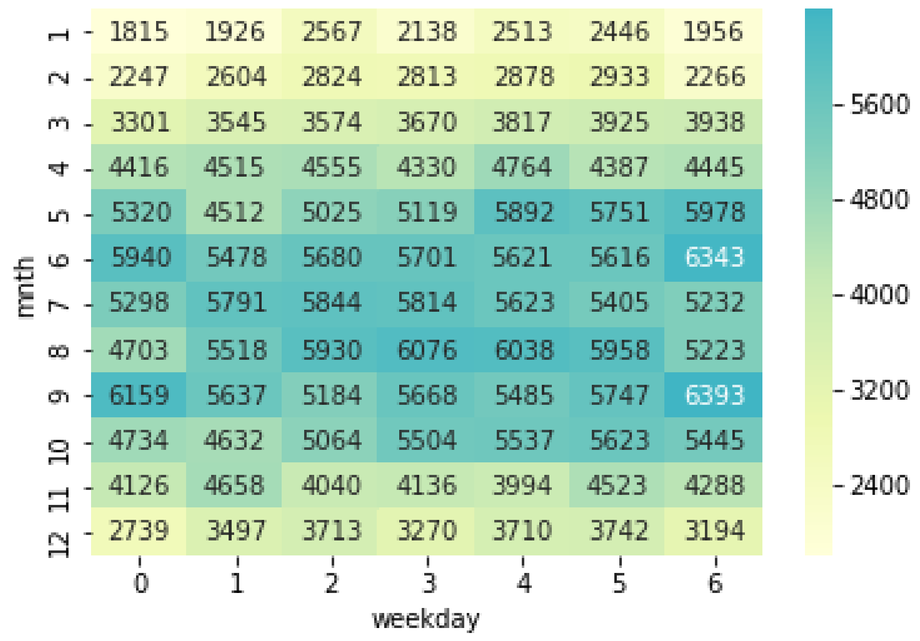


	0	1	2	3	4	5	6
1	1815	1926	2567	2138	2513	2446	1956
2	2247	2604	2824	2813	2878	2933	2266
3	3301	3545	3574	3670	3817	3925	3938
4	4416	4515	4555	4330	4764	4387	4445
5	5320	4512	5025	5119	5892	5751	5978
6	5940	5478	5680	5701	5621	5616	6343
7	5298	5791	5844	5814	5623	5405	5232
8	4703	5518	5930	6076	6038	5958	5223
9	6159	5637	5184	5668	5485	5747	6393
10	4734	4632	5064	5504	5537	5623	5445
11	4126	4658	4040	4136	3994	4523	4288
12	2739	3497	3713	3270	3710	3742	3194

Centering a heatmap

- Seaborn support centering the heatmap colors on a specific value

```
sns.heatmap(df_crosstab, annot=True, fmt="d",
            cmap="YlGnBu", cbar=True,
            center=df_crosstab.loc[9, 6])
```

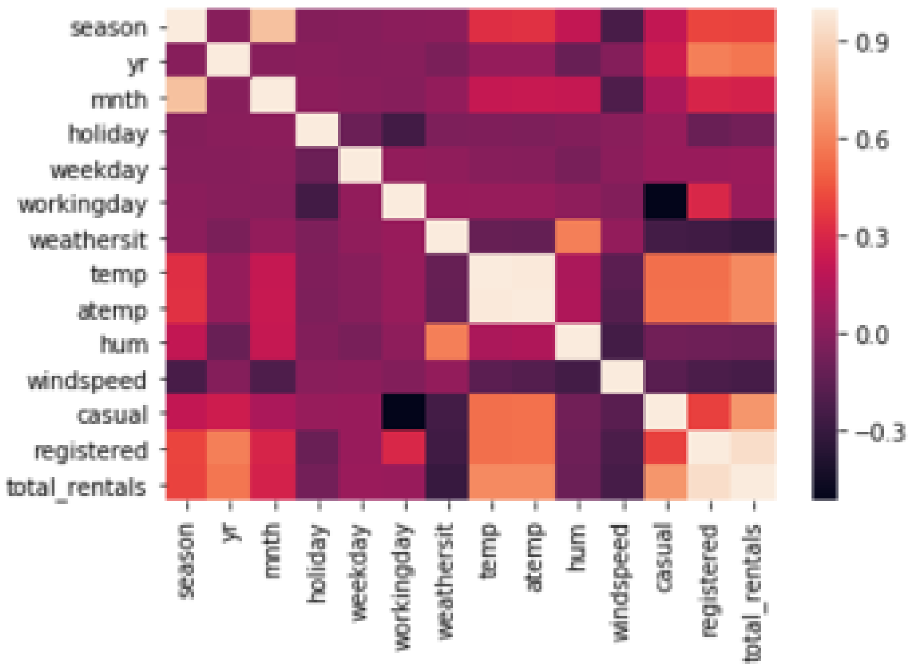


mnth	0	1	2	3	4	5	6
1	1815	1926	2567	2138	2513	2446	1956
2	2247	2604	2824	2813	2878	2933	2266
3	3301	3545	3574	3670	3817	3925	3938
4	4416	4515	4555	4330	4764	4387	4445
5	5320	4512	5025	5119	5892	5751	5978
6	5940	5478	5680	5701	5621	5616	6343
7	5298	5791	5844	5814	5623	5405	5232
8	4703	5518	5930	6076	6038	5958	5223
9	6159	5637	5184	5668	5485	5747	6393
10	4734	4632	5064	5504	5537	5623	5445
11	4126	4658	4040	4136	3994	4523	4288
12	2739	3497	3713	3270	3710	3742	3194

Plotting a correlation matrix

- Pandas `corr` function calculates correlations between columns in a dataframe
- The output can be converted to a heatmap with seaborn

```
sns.heatmap(df.corr())
```



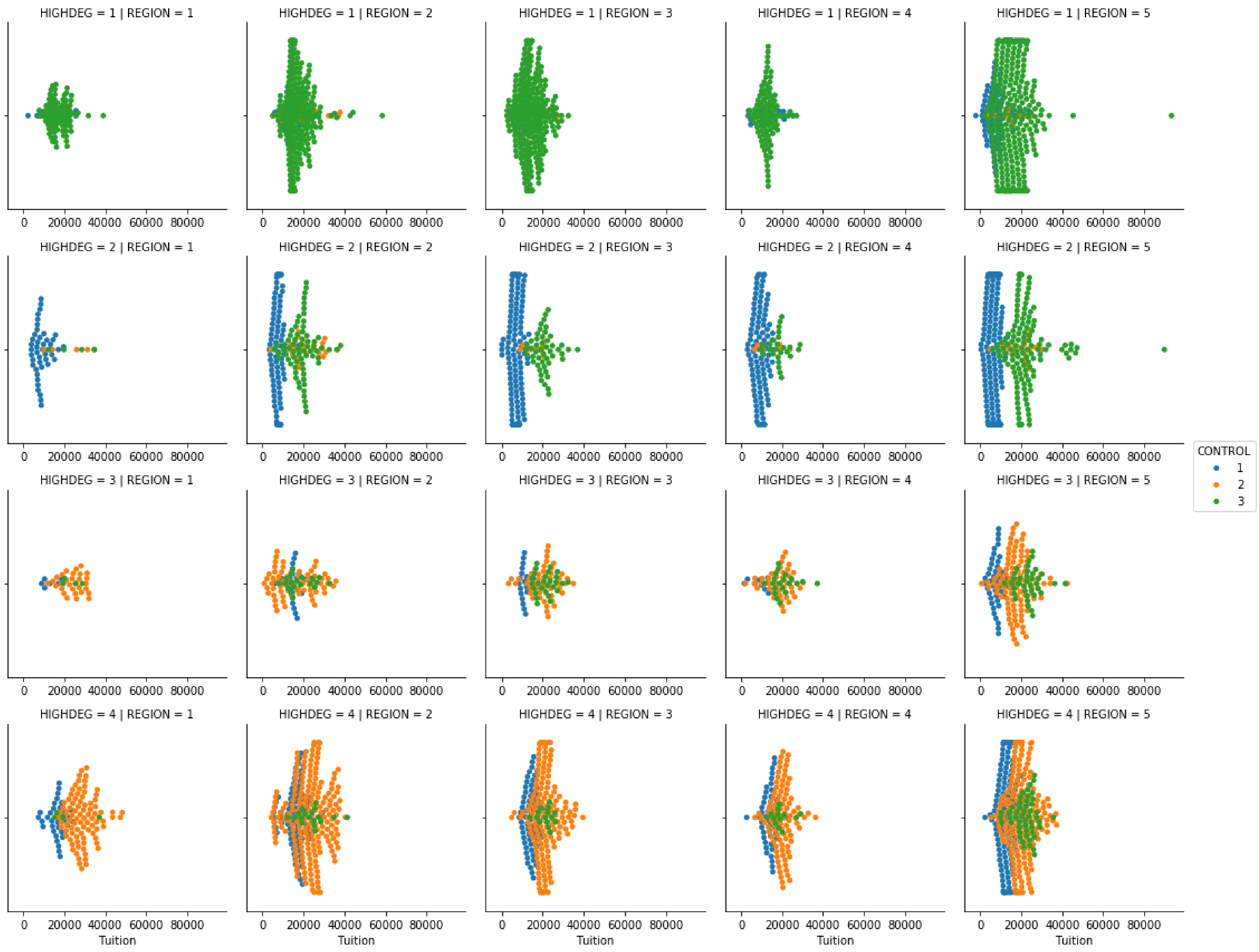
Let's practice!

INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Using FacetGrid, factorplot and lmplot

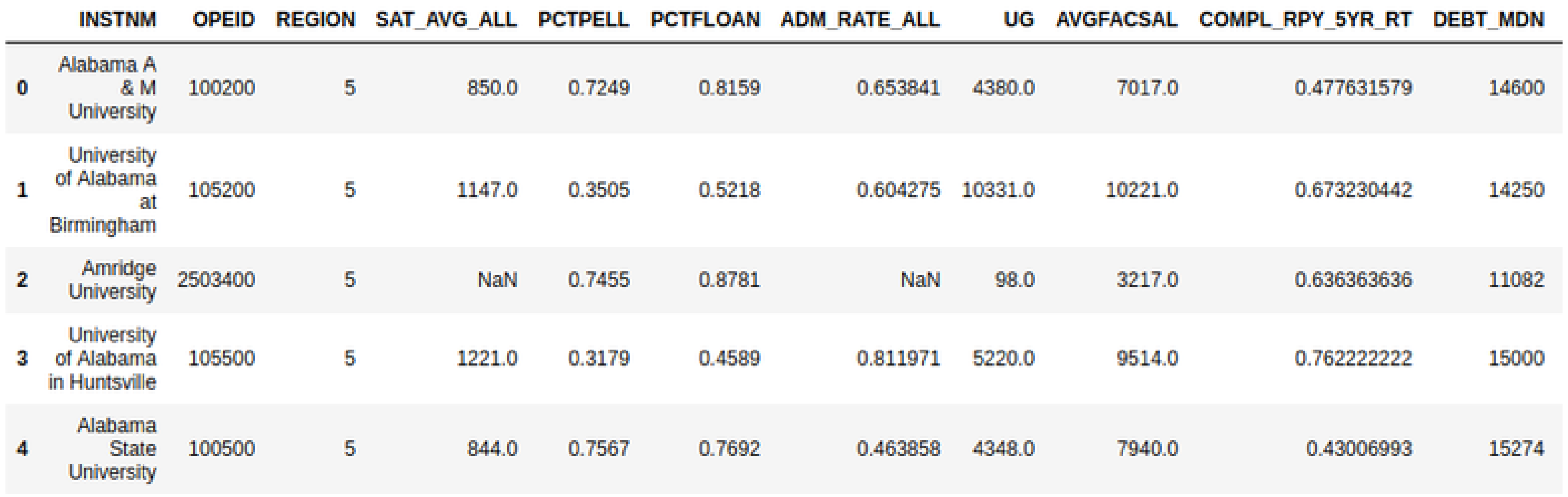
INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Chris Moffitt
Instructor


HIGHDEG = 1 | REGION = 1
HIGHDEG = 1 | REGION = 2
HIGHDEG = 1 | REGION = 3
HIGHDEG = 1 | REGION = 4
HIGHDEG = 1 | REGION = 5
HIGHDEG = 2 | REGION = 1
HIGHDEG = 2 | REGION = 2
HIGHDEG = 2 | REGION = 3
HIGHDEG = 2 | REGION = 4
HIGHDEG = 2 | REGION = 5
HIGHDEG = 3 | REGION = 1
HIGHDEG = 3 | REGION = 2
HIGHDEG = 3 | REGION = 3
HIGHDEG = 3 | REGION = 4
HIGHDEG = 3 | REGION = 5
HIGHDEG = 4 | REGION = 1
HIGHDEG = 4 | REGION = 2
HIGHDEG = 4 | REGION = 3
HIGHDEG = 4 | REGION = 4
HIGHDEG = 4 | REGION = 5
0
20000
40000
60000
80000
Tuition
CONTROL
1
2
3

Tidy data

- Seaborn's grid plots require data in "tidy format"
- One observation per row of data



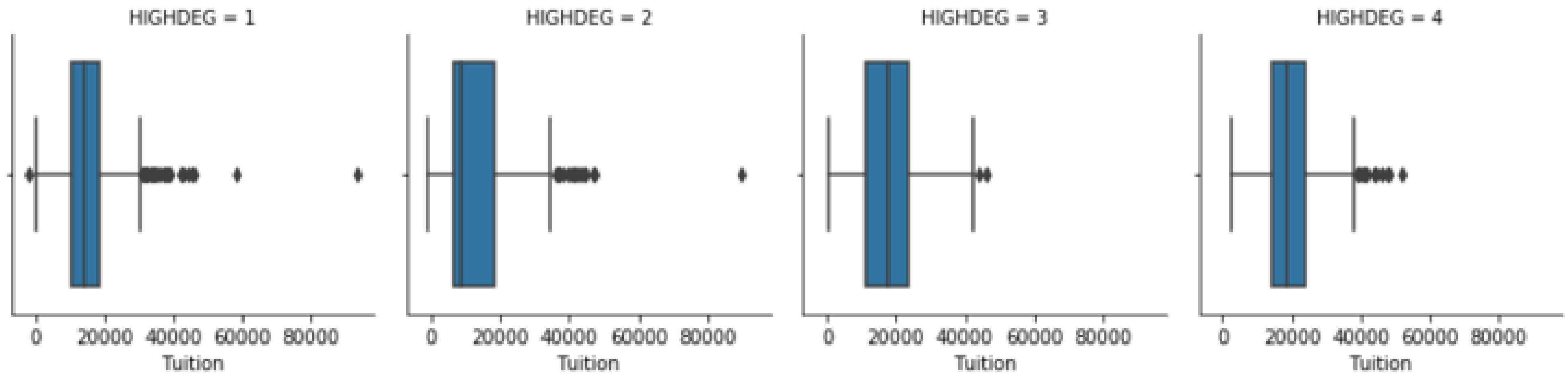
	INSTNM	OPEID	REGION	SAT_AVG_ALL	PCTPELL	PCTFLOAN	ADM_RATE_ALL	UG	AVGFACSAL	COMPL_RPY_5YR_RT	DEBT_MDN
0	Alabama A & M University	100200	5	850.0	0.7249	0.8159	0.653841	4380.0	7017.0	0.477631579	14600
1	University of Alabama at Birmingham	105200	5	1147.0	0.3505	0.5218	0.604275	10331.0	10221.0	0.673230442	14250
2	Amridge University	2503400	5	NaN	0.7455	0.8781	NaN	98.0	3217.0	0.636363636	11082
3	University of Alabama in Huntsville	105500	5	1221.0	0.3179	0.4589	0.811971	5220.0	9514.0	0.762222222	15000
4	Alabama State University	100500	5	844.0	0.7567	0.7692	0.463858	4348.0	7940.0	0.43006993	15274

FacetGrid

- The `FacetGrid` is foundational for many data aware grids
- It allows the user to control how data is distributed across columns, rows and hue
- Once a `FacetGrid` is created, the plot type must be mapped to the grid

FacetGrid Categorical Example

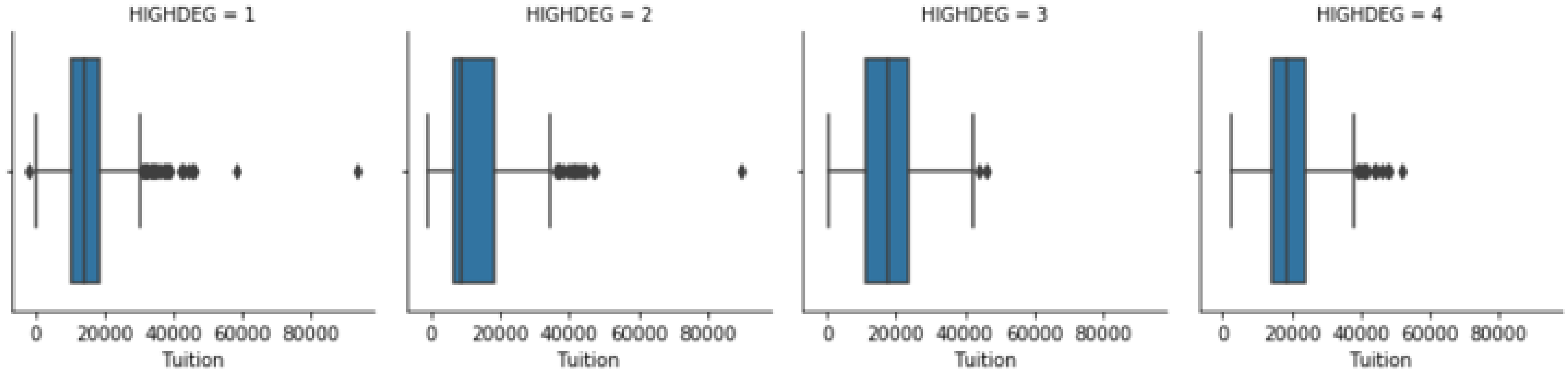
```
g = sns.FacetGrid(df, col="HIGHDEG")
g.map(sns.boxplot, 'Tuition',
      order=['1', '2', '3', '4'])
```



factorplot()

- The `factorplot` is a simpler way to use a `FacetGrid` for categorical data
- Combines the facetting and mapping process into 1 function

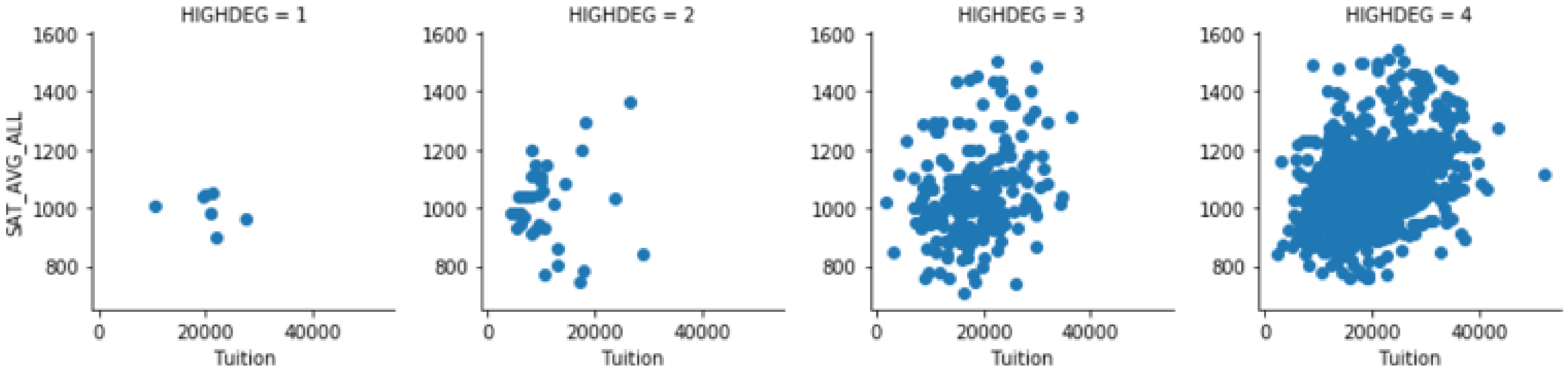
```
sns.factorplot(x="Tuition", data=df,
               col="HIGHDEG", kind='box')
```



FacetGrid for regression

- `FacetGrid()` can also be used for scatter or regression plots

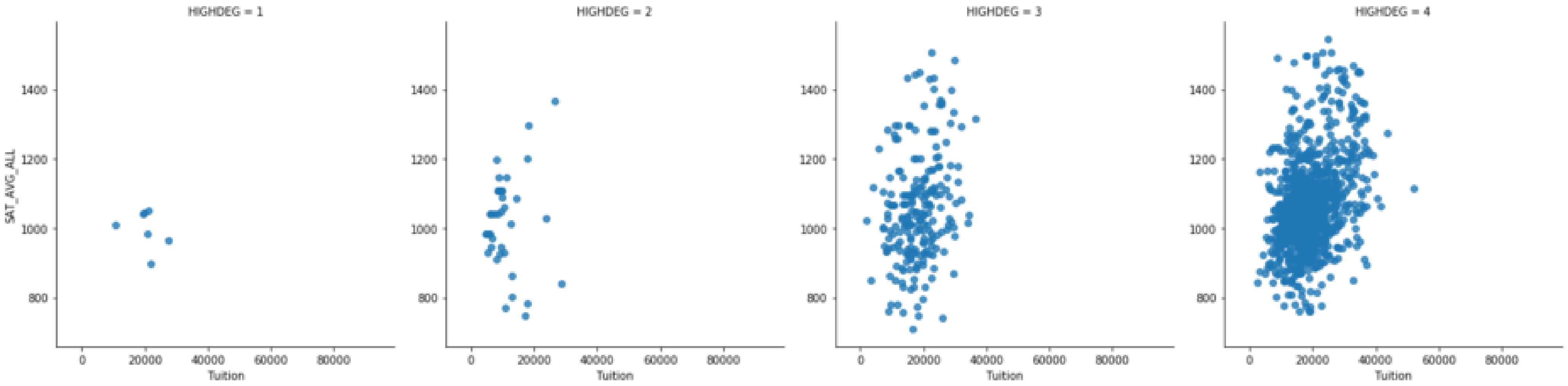
```
g = sns.FacetGrid(df, col="HIGHDEG")
g.map(plt.scatter, 'Tuition', 'SAT_AVG_ALL')
```



lmplot

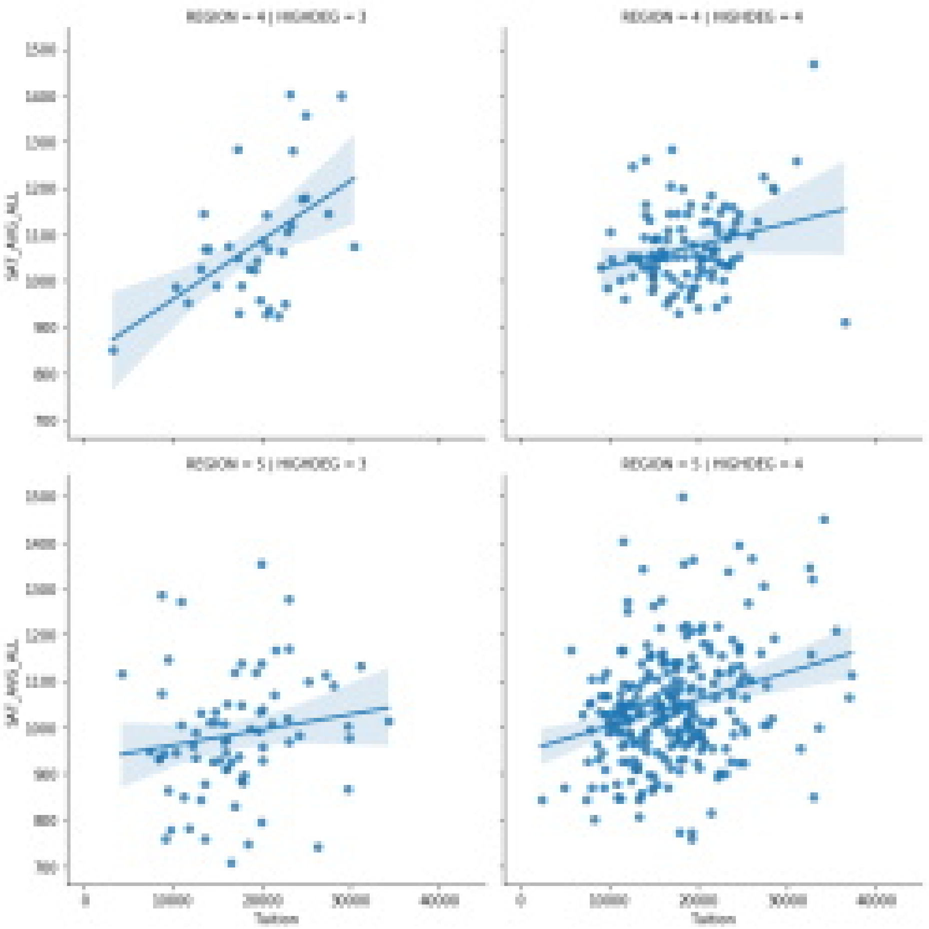
- `lmplot` plots scatter and regression plots on a `FacetGrid`

```
sns.lmplot(data=df, x="Tuition", y="SAT_AVG_ALL",
           col="HIGHDEG", fit_reg=False)
```



lmplot with regression

```
sns.lmplot(data=df, x="Tuition", y="SAT_AVG_ALL",
           col="HIGHDEG", row='REGION')
```



Let's practice!

INTERMEDIATE DATA VISUALIZATION WITH SEABORN

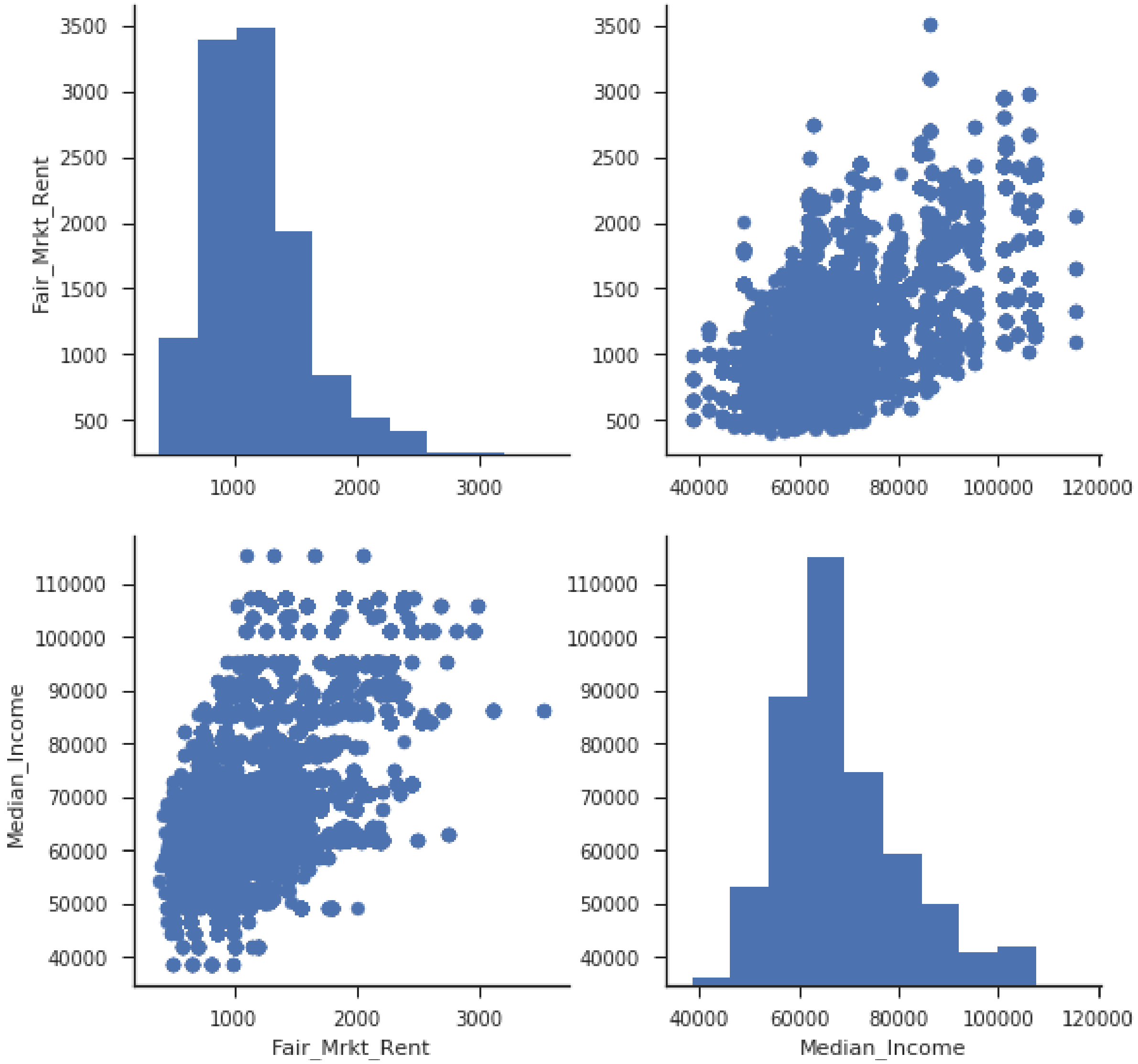
Using PairGrid and pairplot

INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Chris Moffitt
Instructor

Pairwise relationships

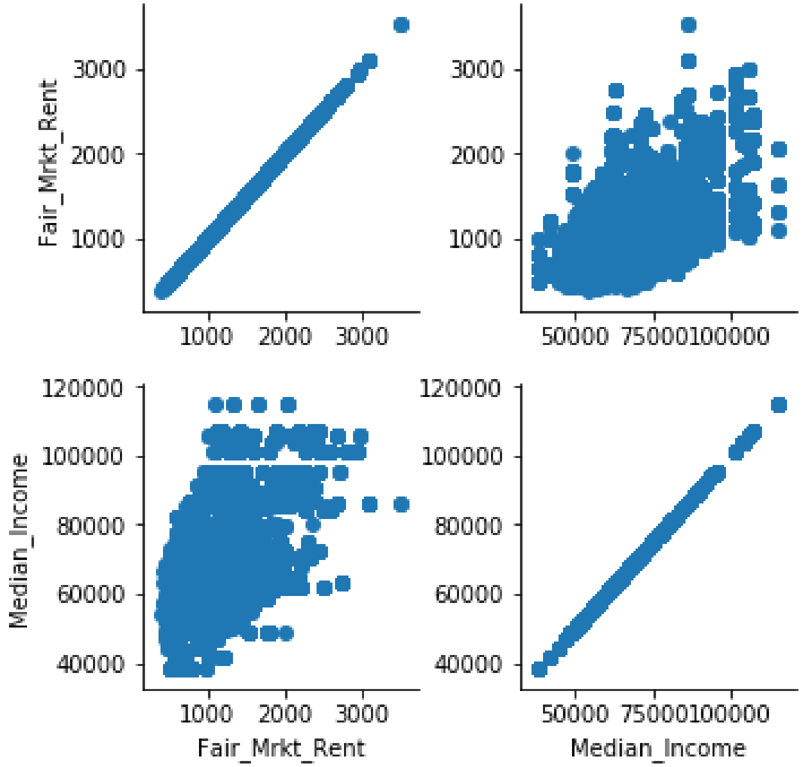
- `PairGrid` shows pairwise relationships between data elements



Creating a PairGrid

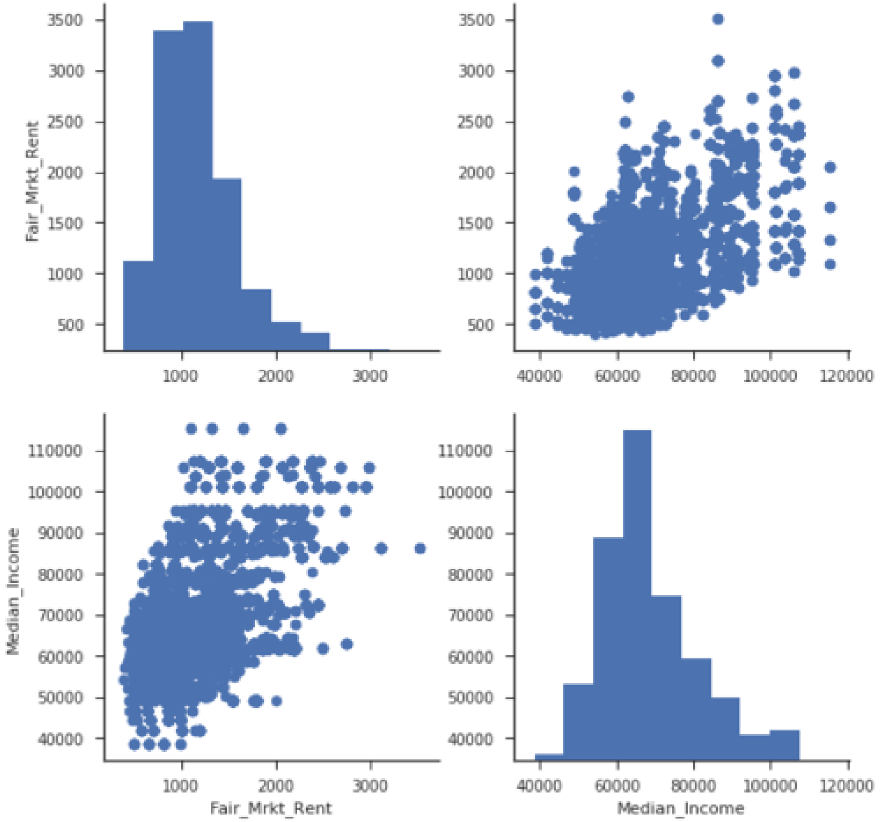
- The `PairGrid` follows similar API to FacetGrid

```
g = sns.PairGrid(df, vars=["Fair_Mrkt_Rent",
                 "Median_Income"])
g = g.map(plt.scatter)
```



Customizing the PairGrid diagonals

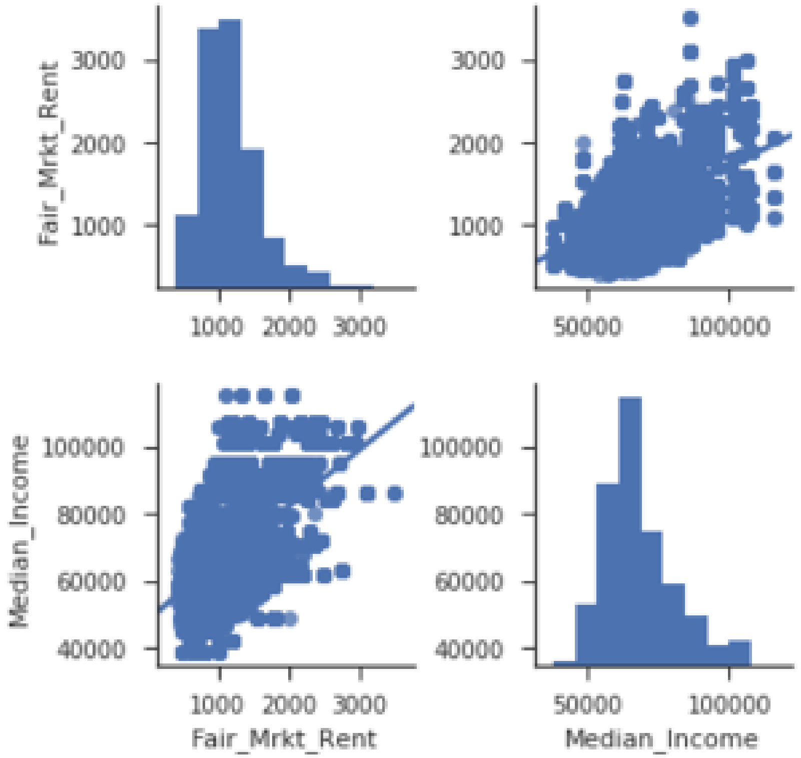
```
g = sns.PairGrid(df, vars=["Fair_Mrkt_Rent",
                 "Median_Income"])
g = g.map_diag(plt.hist)
g = g.map_offdiag(plt.scatter)
```



Pairplot

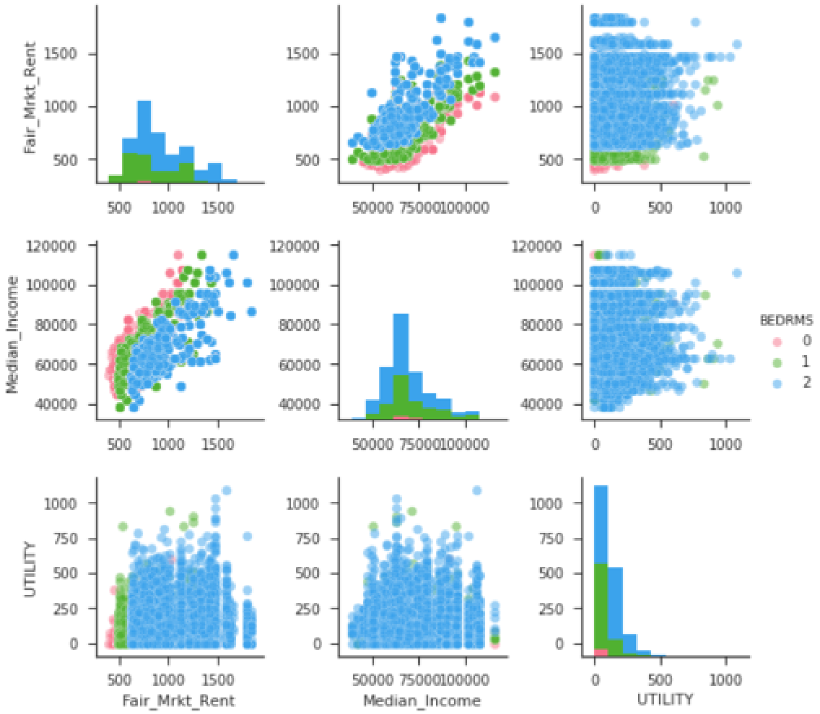
- `pairplot` is a shortcut for the `PairGrid`

```
sns.pairplot(df, vars=["Fair_Mrkt_Rent",
             "Median_Income"], kind='reg',
             diag_kind='hist')
```



Customizing a pairplot

```
sns.pairplot(df.query('BEDRMS < 3'),
             vars=["Fair_Mrkt_Rent",
             "Median_Income", "UTILITY"],
             hue='BEDRMS', palette='husl',
             plot_kws={'alpha': 0.5})
```



Let's practice!

INTERMEDIATE DATA VISUALIZATION WITH SEABORN

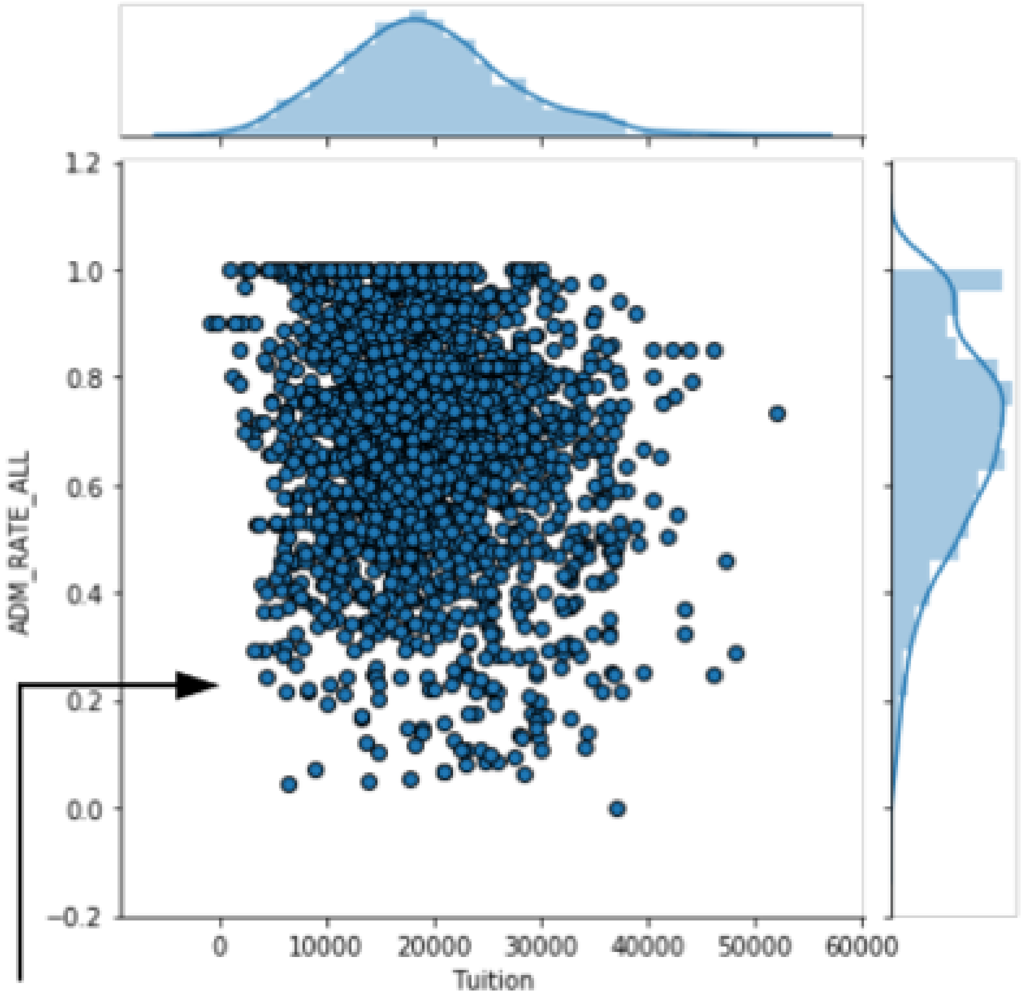
Using JointGrid and jointplot

INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Chris Moffitt
Instructor

JointGrid() Overview

Distribution of Tuition
(plot_marginal)

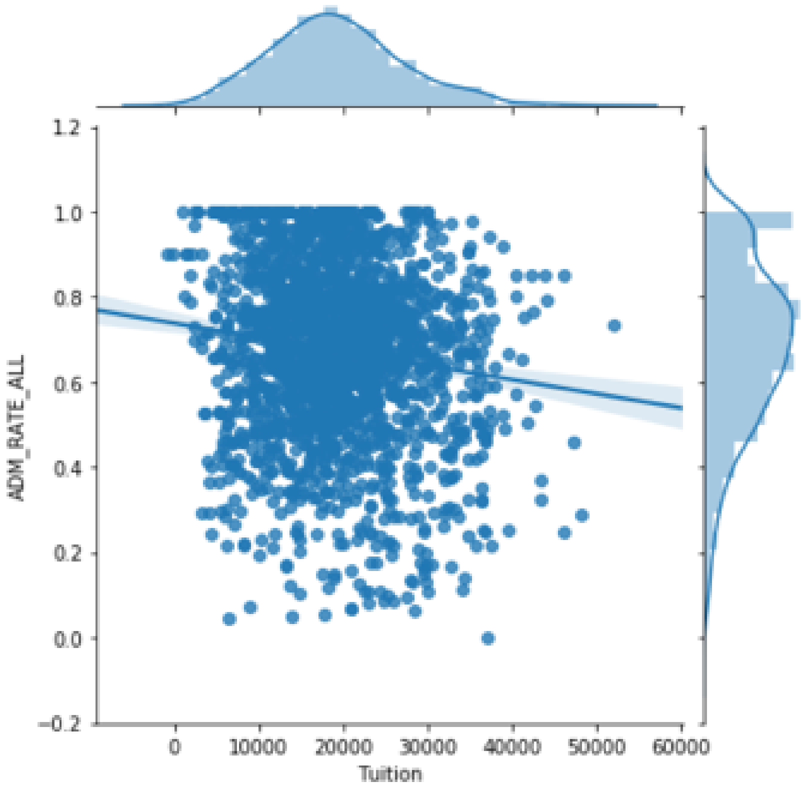


Distribution of
ADM_RATE_ALL
(plot_marginal)

Relationship between Tuition and Admission Rates
(plot_joint)

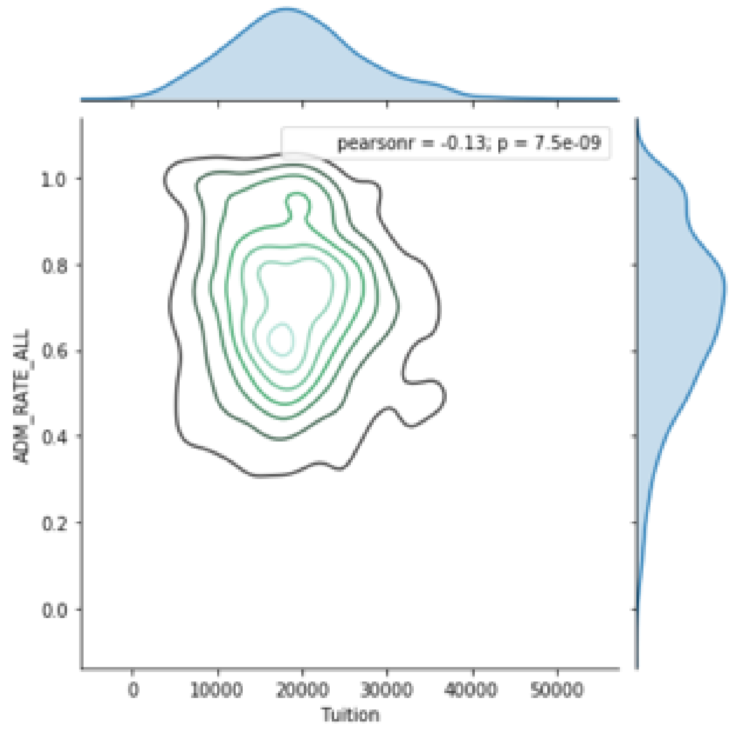
Basic JointGrid

```
g = sns.JointGrid(data=df, x="Tuition",
                  y="ADM_RATE_ALL")
g.plot(sns.regplot, sns.distplot)
```



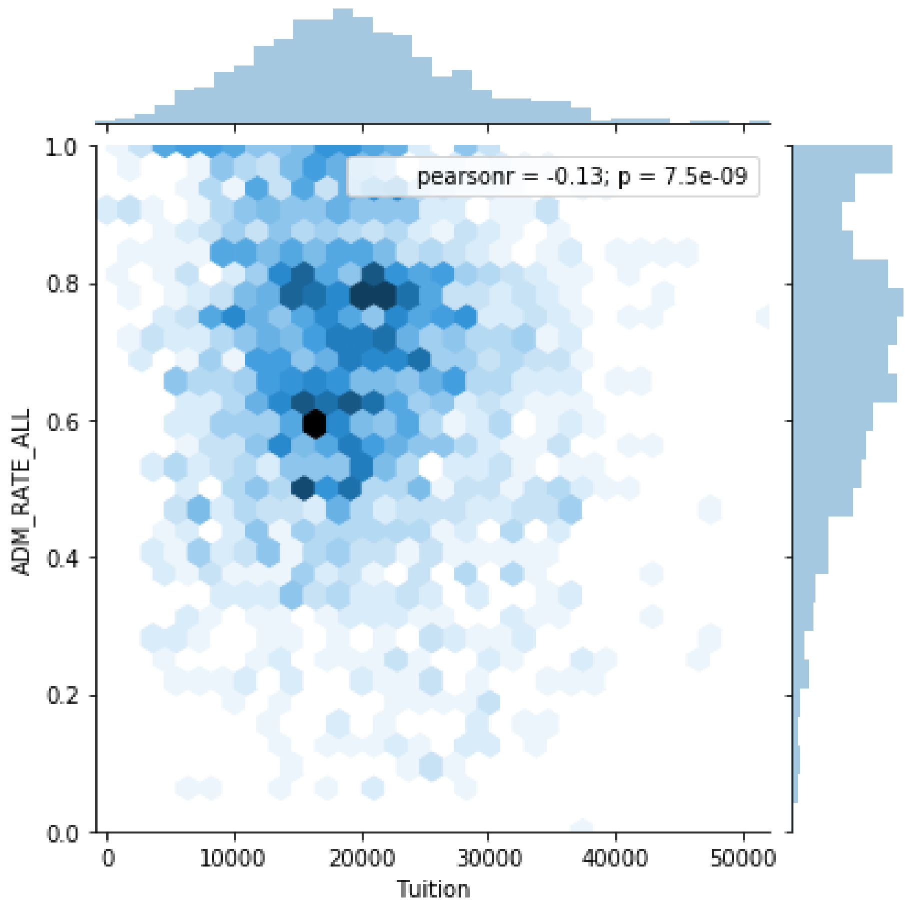
Advanced JointGrid

```
g = sns.JointGrid(data=df, x="Tuition",
                  y="ADM_RATE_ALL")
g = g.plot_joint(sns.kdeplot)
g = g.plot_marginals(sns.kdeplot, shade=True)
g = g.annotate(stats.pearsonr)
```



jointplot()

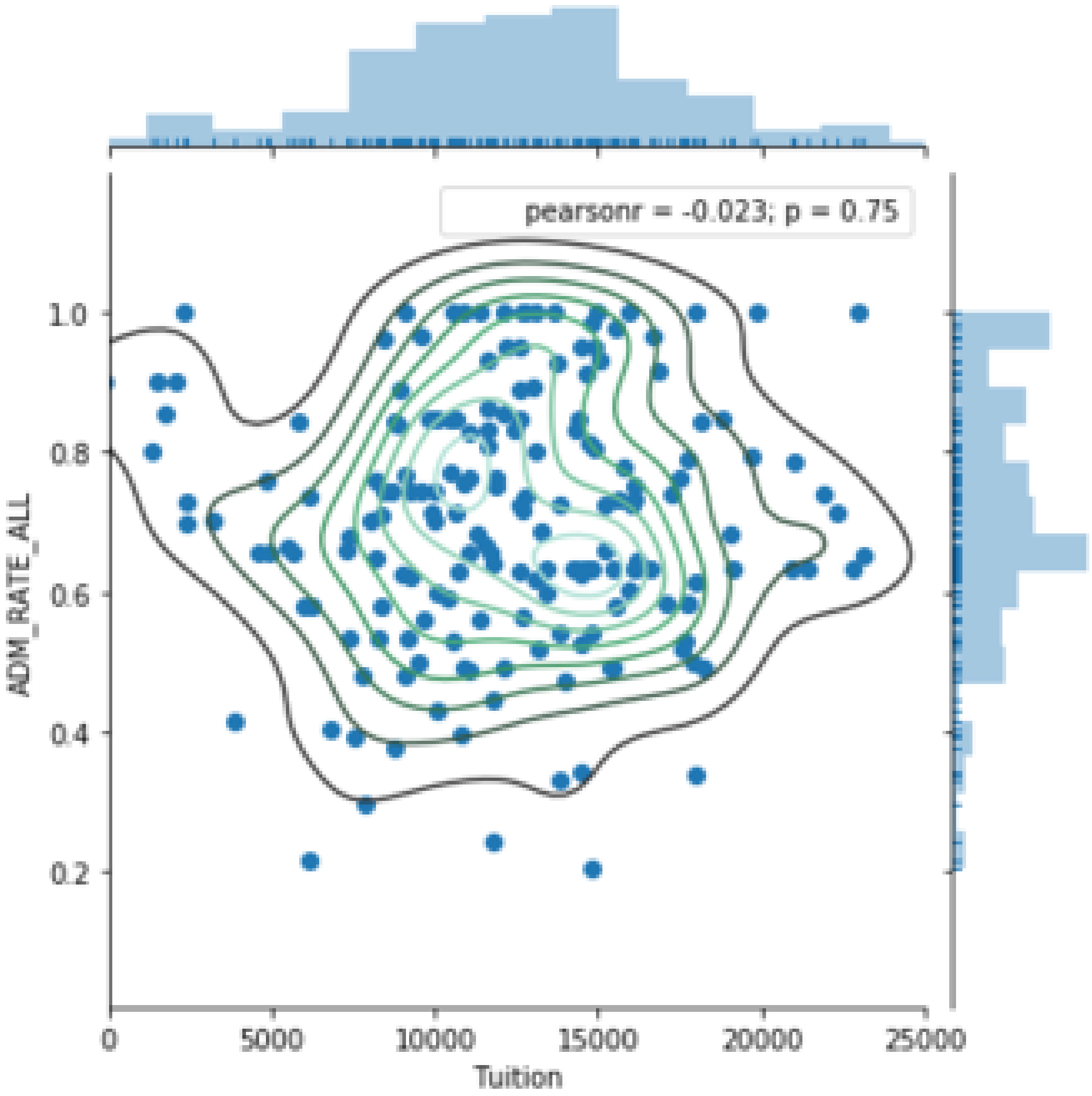
```
sns.jointplot(data=df, x="Tuition",
              y="ADM_RATE_ALL", kind='hex')
```



Customizing a jointplot

```python
g = (sns.jointplot(x="Tuition",
                   y="ADM_RATE_ALL", kind='scatter',
                   xlim=(0, 25000),
                   marginal_kws=dict(
                   bins=15,rug=True),
                   data=df.query('UG < 2500 &
                   Ownership == "Public"'))
    .plot_joint(sns.kdeplot))
```

Customizing a jointplot



Let's practice!

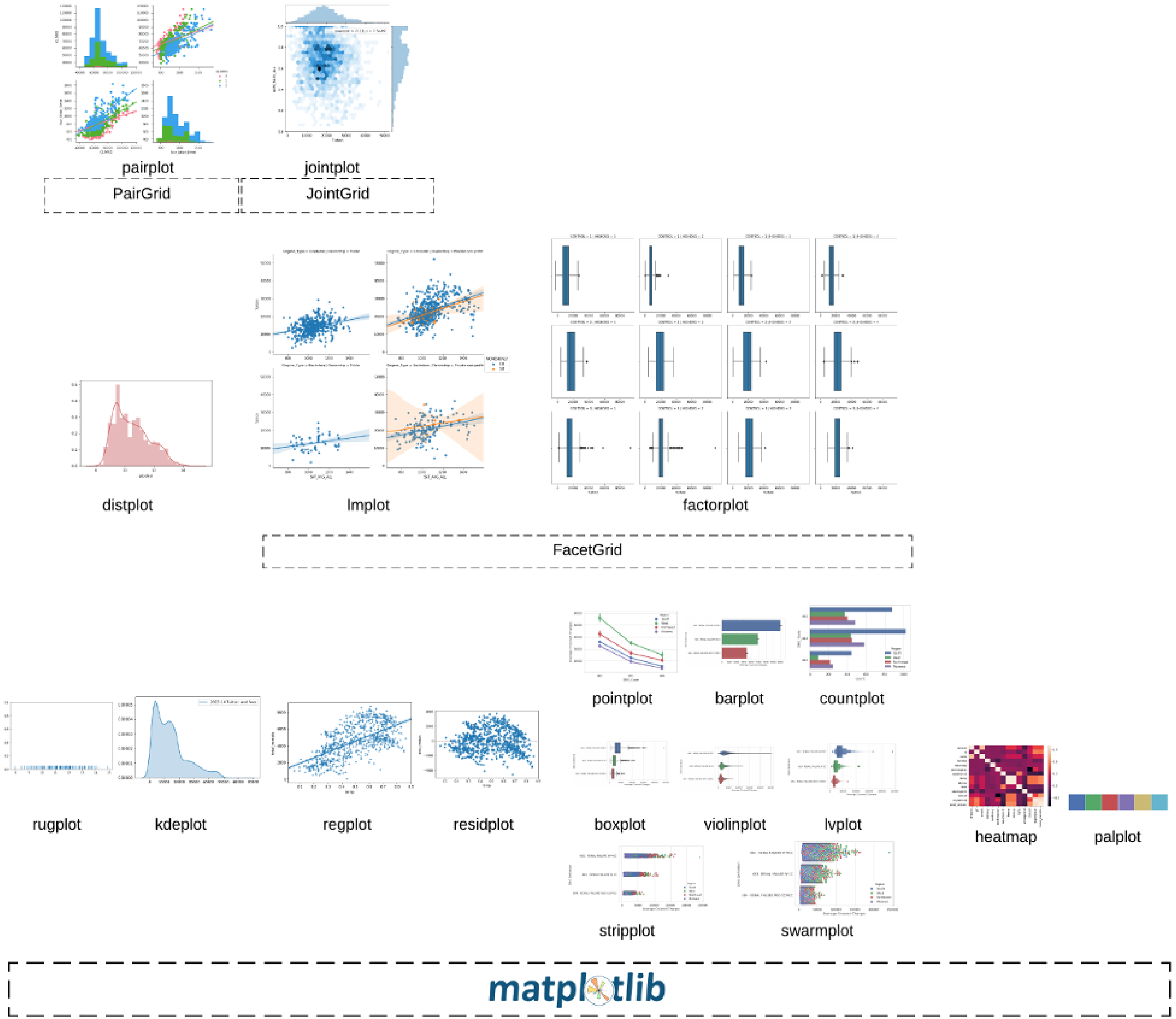
INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Selecting Seaborn Plots

INTERMEDIATE DATA VISUALIZATION WITH SEABORN

Chris Moffitt
Instructor

datacamp



pairplot

jointplot

PairGrid

JointGrid

distplot

lmplot

factorplot

FacetGrid

pointplot

barplot

countplot

rugplot

kdeplot

regplot

residplot

boxplot

violinplot

lvplot

heatmap

palplot

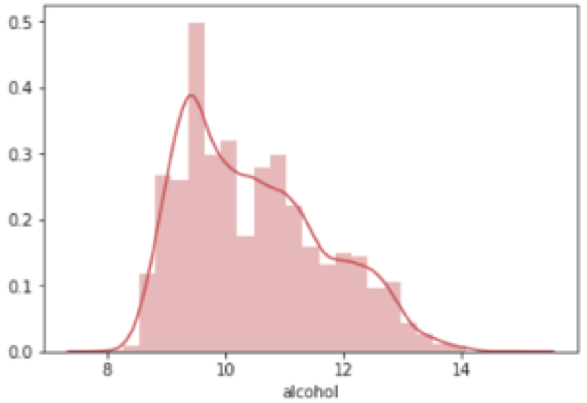
stripplot

swarmplot

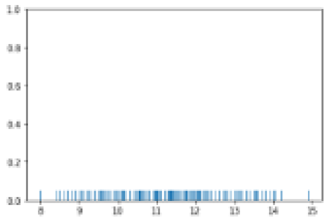
matplotlib

Univariate Distribution Analysis

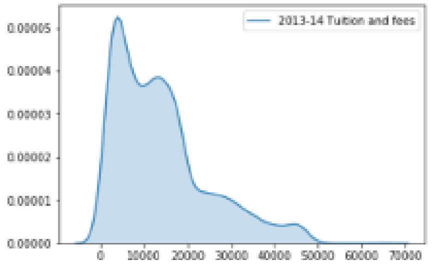
- `distplot()` is the best place to start for this analysis
- `rugplot()` and `kdeplot()` can be useful alternatives



distplot



rugplot

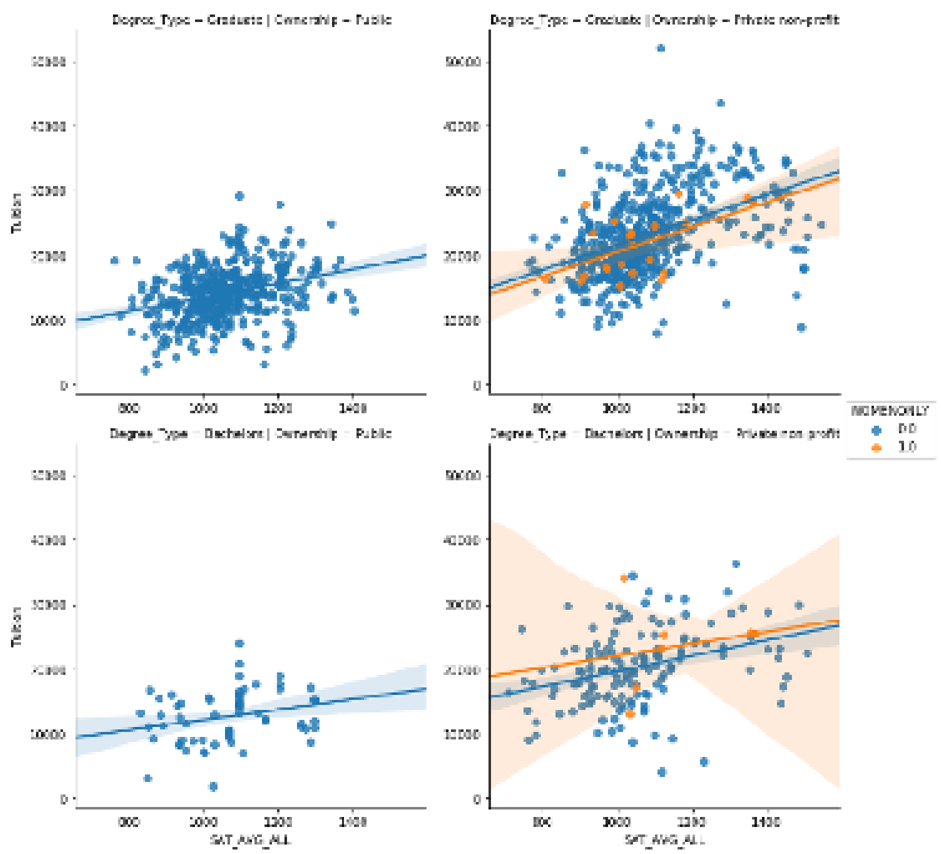


kdeplot

plt.hist() matplotlib

Regression Analysis

- `lmplot()` performs regression analysis and supports facetting

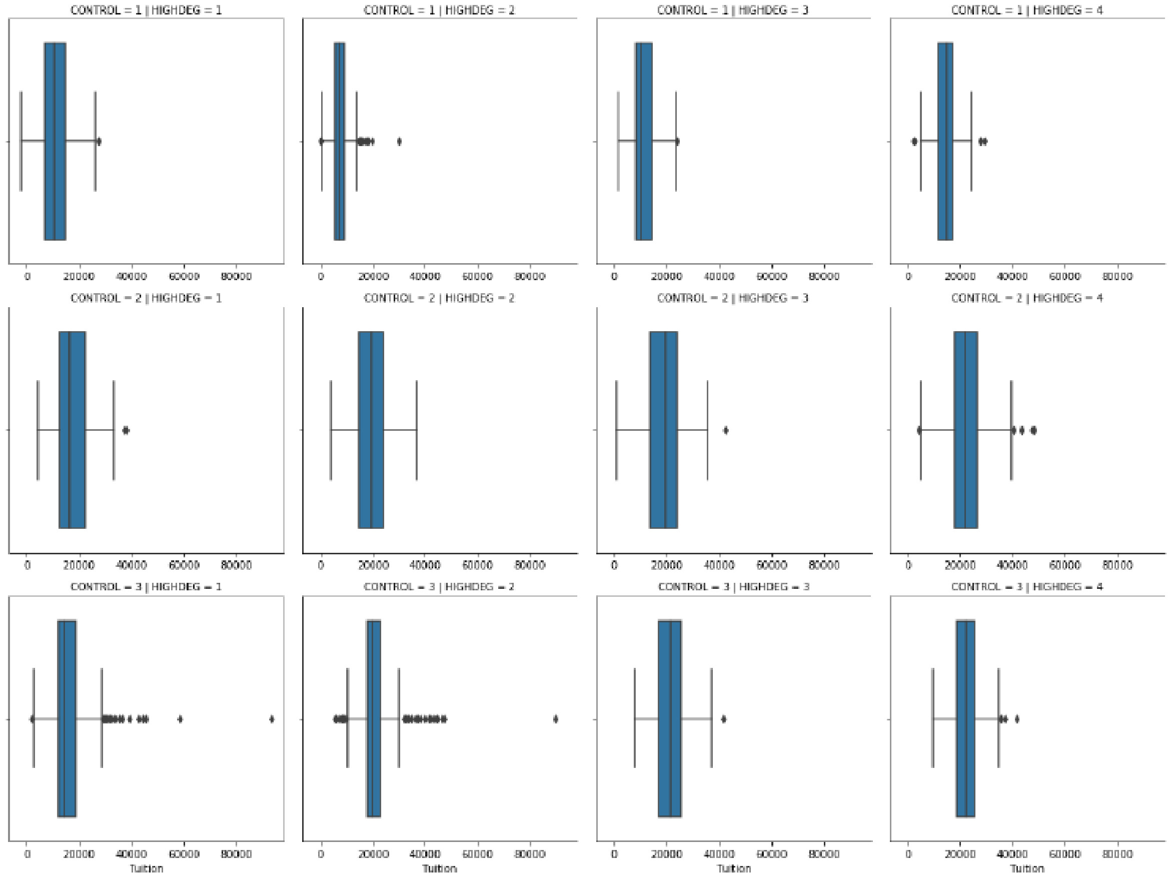


lmplot

FacetGrid

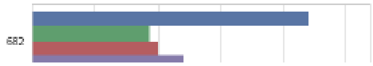
Categorical Plots

- Explore data with the categorical plots and facet with



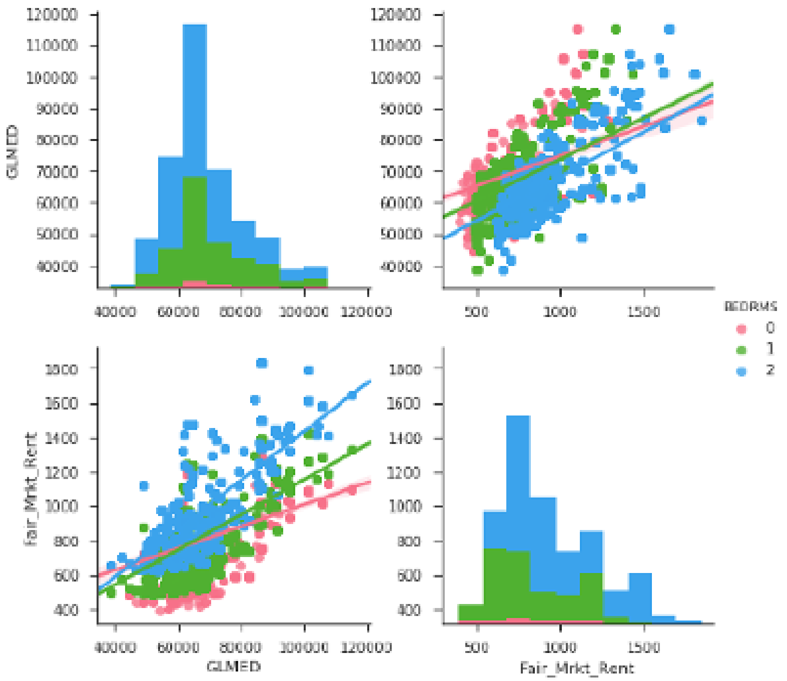
factorplot

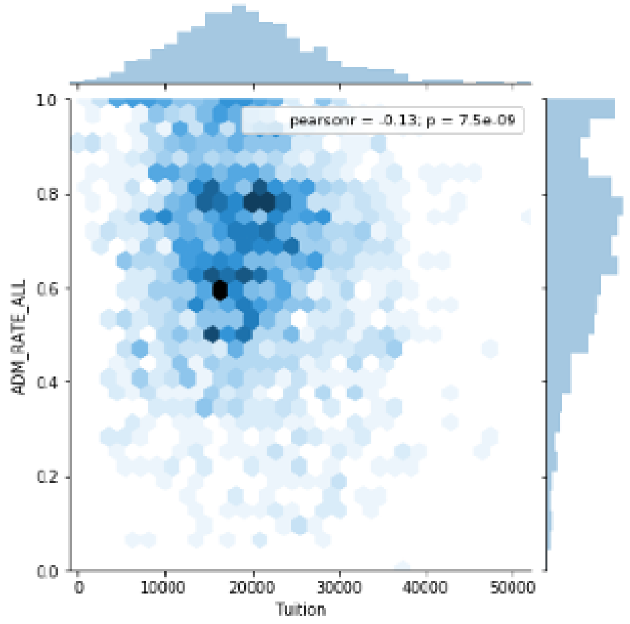
FacetGrid



pairplot() and jointplot()

- Perform regression analysis with `lmplot`
- Analyze distributions with `distplot`





pairplot

jointplot

PairGrid

JointGrid

Thank You!

INTERMEDIATE DATA VISUALIZATION WITH SEABORN