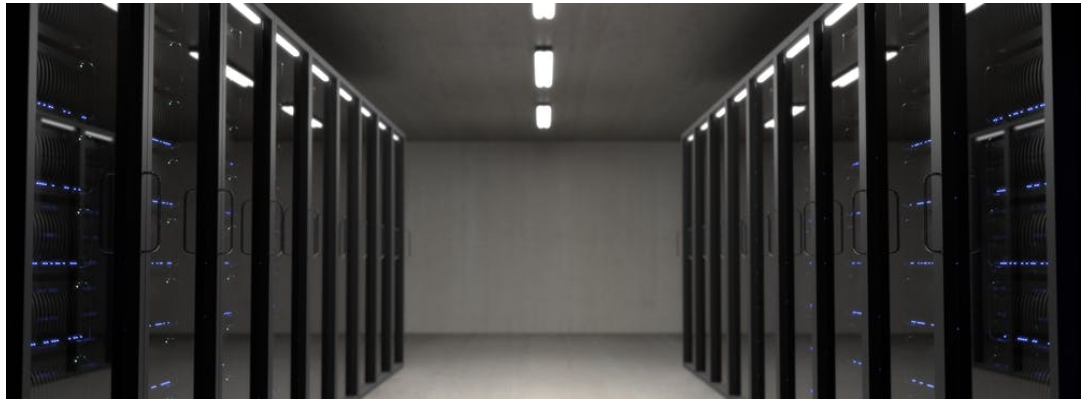
Data Visualization

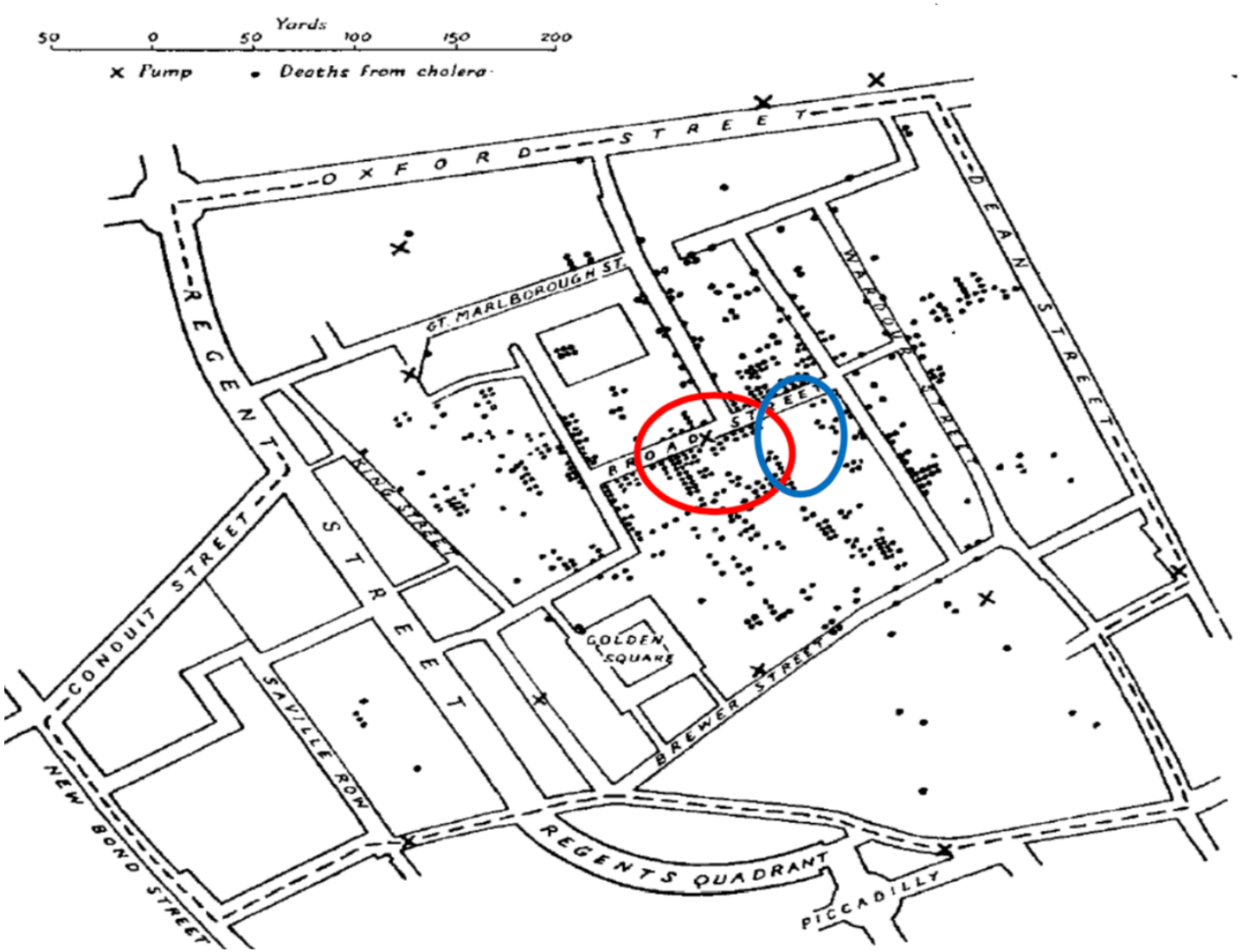
Motivation

- Big Data but Data chaos
- An image says more than 1000 words
- The goal from data to knowledge



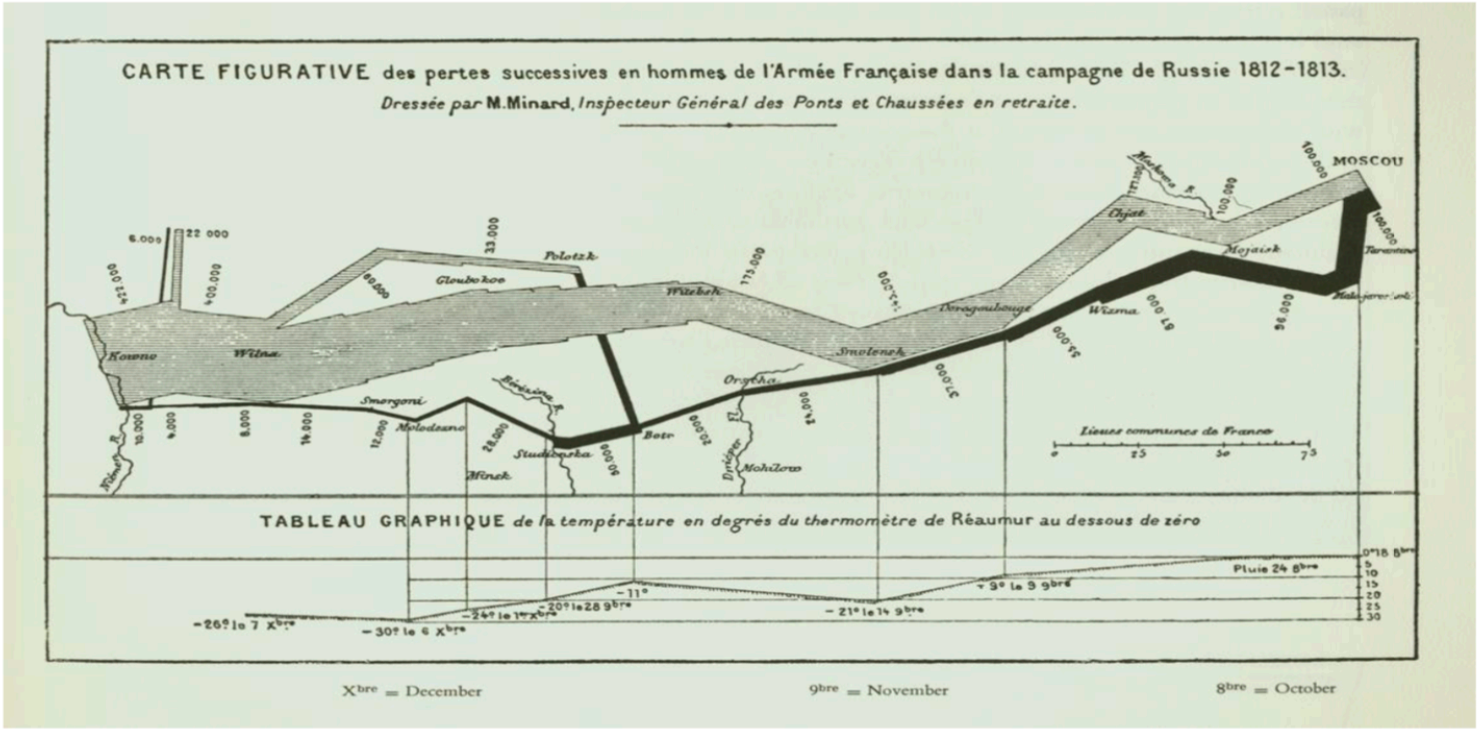
Motivation

- Dr. John Snow (1854): Map of the Cholera Epidemic of London (1853)
- Shows cases of illness sorted by street districts
- Contaminated pump might caused the local cholera cases
- Water pump affected has been shut down



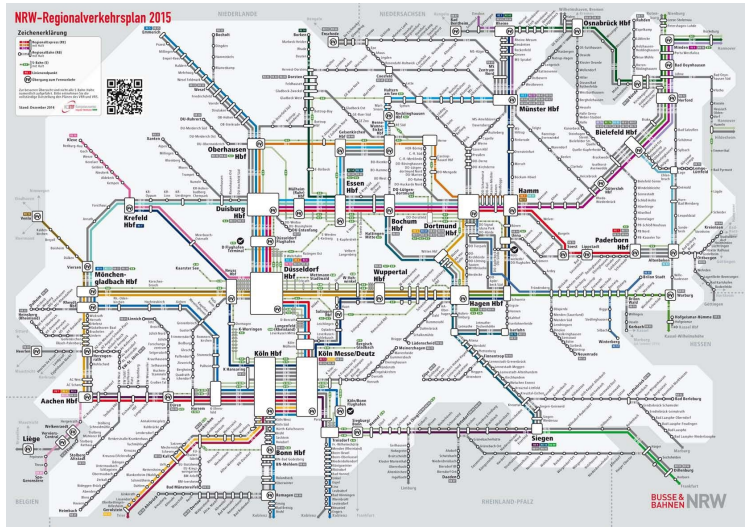
Motivation

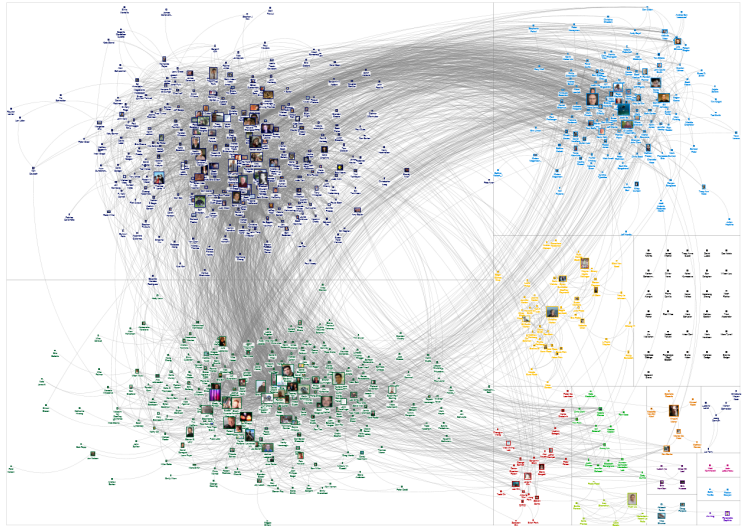
- Minard (1861): Map of Napoleon's campaign in Russia (1812/13)"the best statistical drawing ever made..." (Tufts)army strength
- Casualities
- Troop movements
- Temperature during the retreat conditions



Today visualizations are everywhere

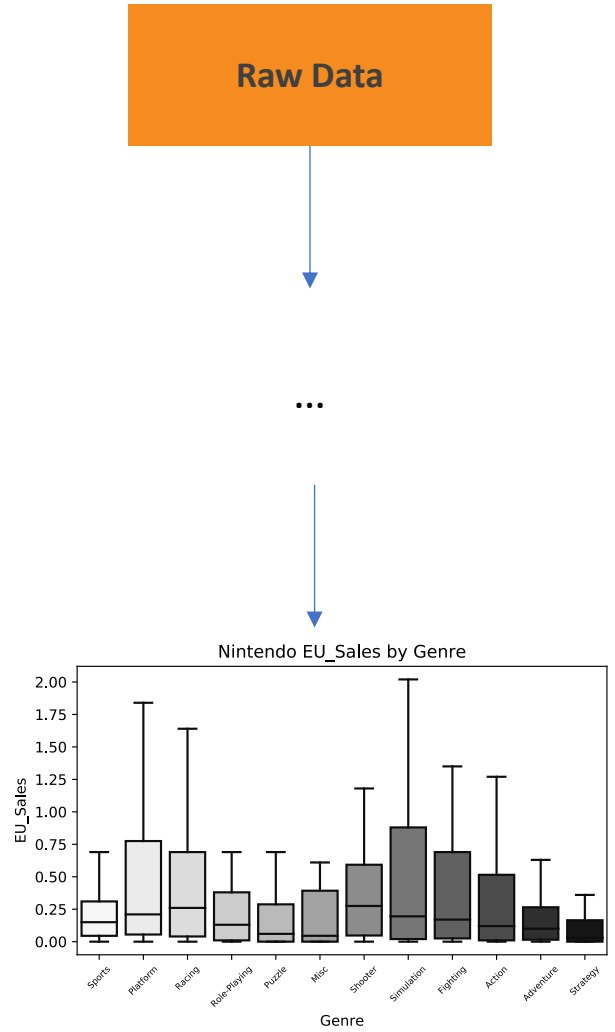
- Traffic
- Stock market
- Company
- Gaming
- …





Data/ Information Visualization

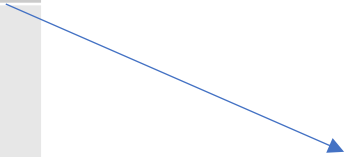
- *The use of computer-supported, interactive, **visual representations** of abstract data to amplify **cognition**. [Card et al 1999]*
- *Is the **communication** of abstract data through the use of interactive **visual interfaces**. [Keim et al 2006]*



From Data to Visualization

V_Time	V_Name	V_Size
2019-05-01	Julius	1.85
2019-05-02	Laura	1.55
2019-05-05	Benny	1.87

…



V_Size
1.85
1.55

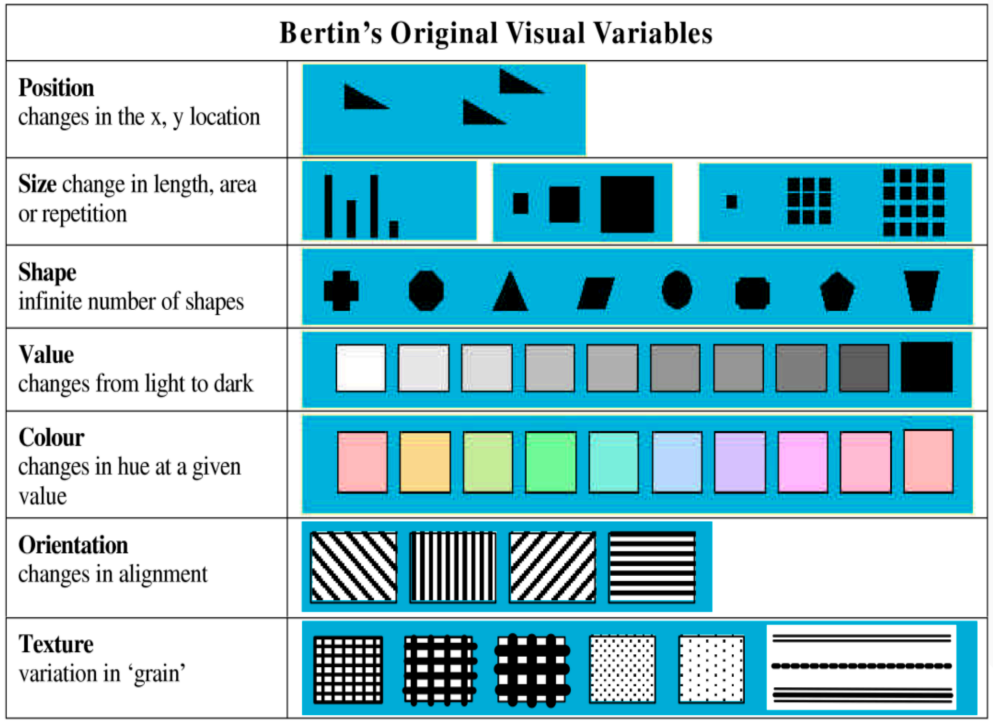
…

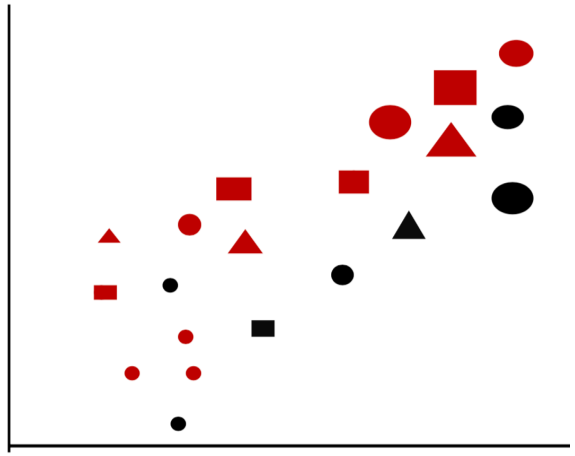
Basic Types of Variables for Visualizations (statistics)

- **Categorical variable** - Disordered set, e.g. names {Ben, Max, Laura} Only defined relation:
  - Equality relation (=)
  - String
- **Ordinal variable** - have natural, ordered categories and the distances between the categories is not known, e.g. Ranking {1,2,3...}
  - Defined order <.
  - Relationen: =, >,<
- **Quantitative Variable** - Numeric range, e.g body size [1.85, 1.55, 1.78]
  - Arithmetic operations possible
  - Relationen: =, >,<, und Arithmetische Operationen
  - Discrete variable (Integer)
  - Continuous variable (Float)

Visualization and the Question of right Mapping?

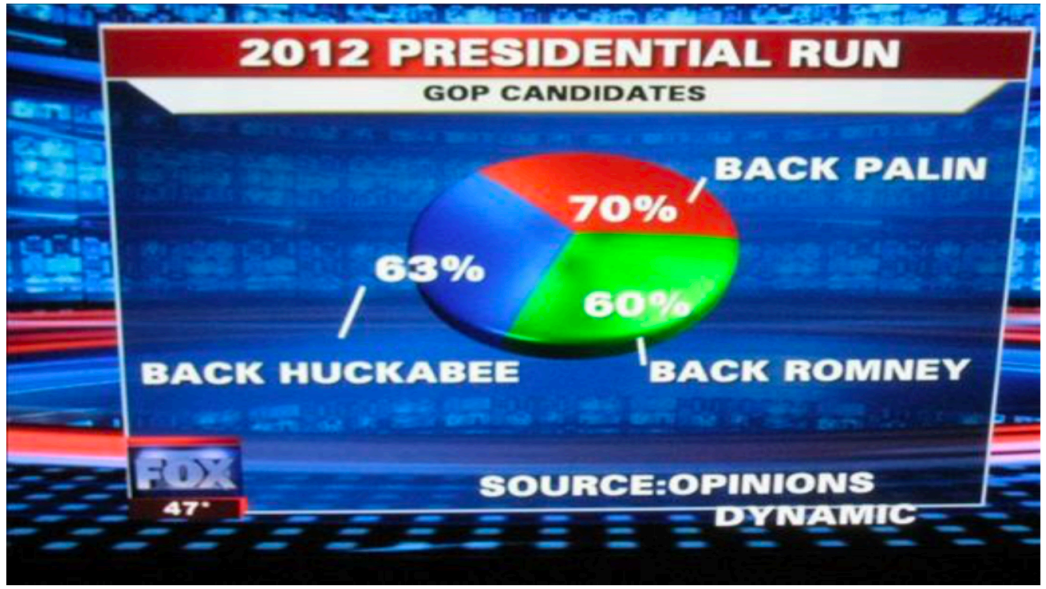
Visualization is any technique for creating images, diagrams, or animations to communicate a message. Visualization through visual imagery has been an effective way to communicate both abstract and concrete ideas since the dawn of humanity.



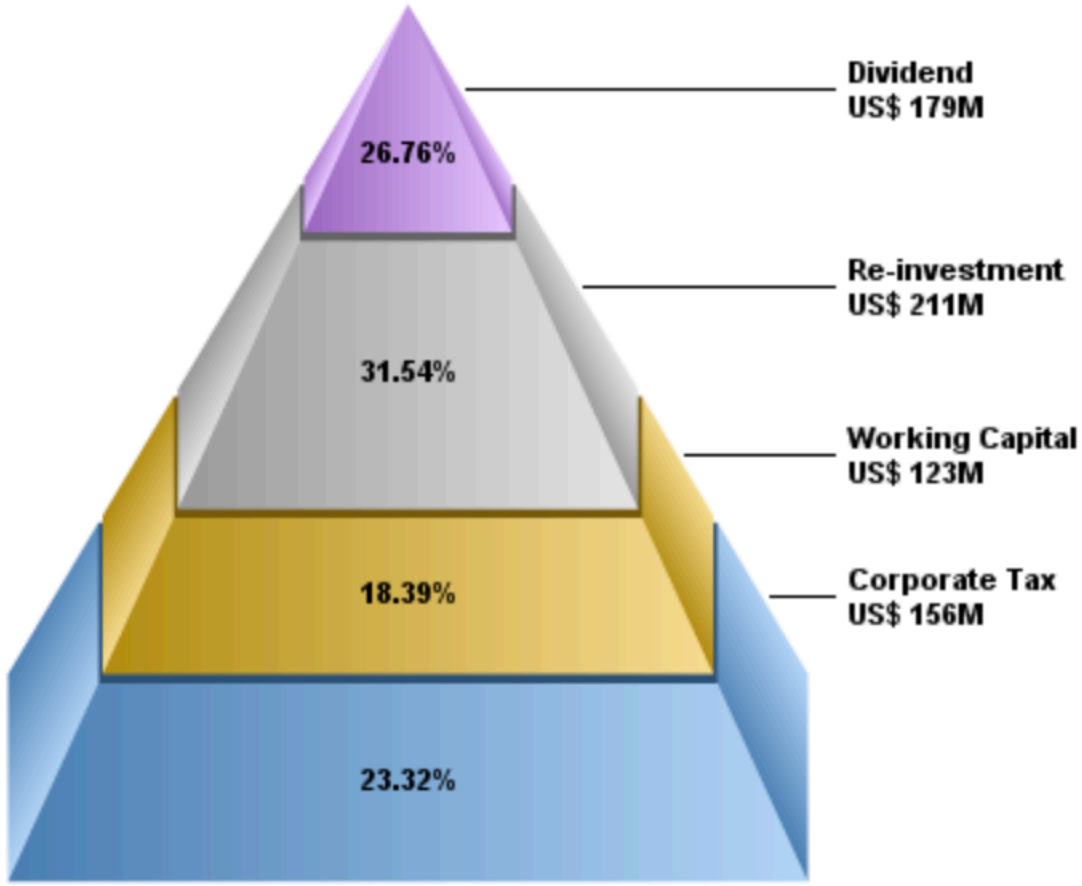


Good Visualizations?

- Let's get some ideas together…



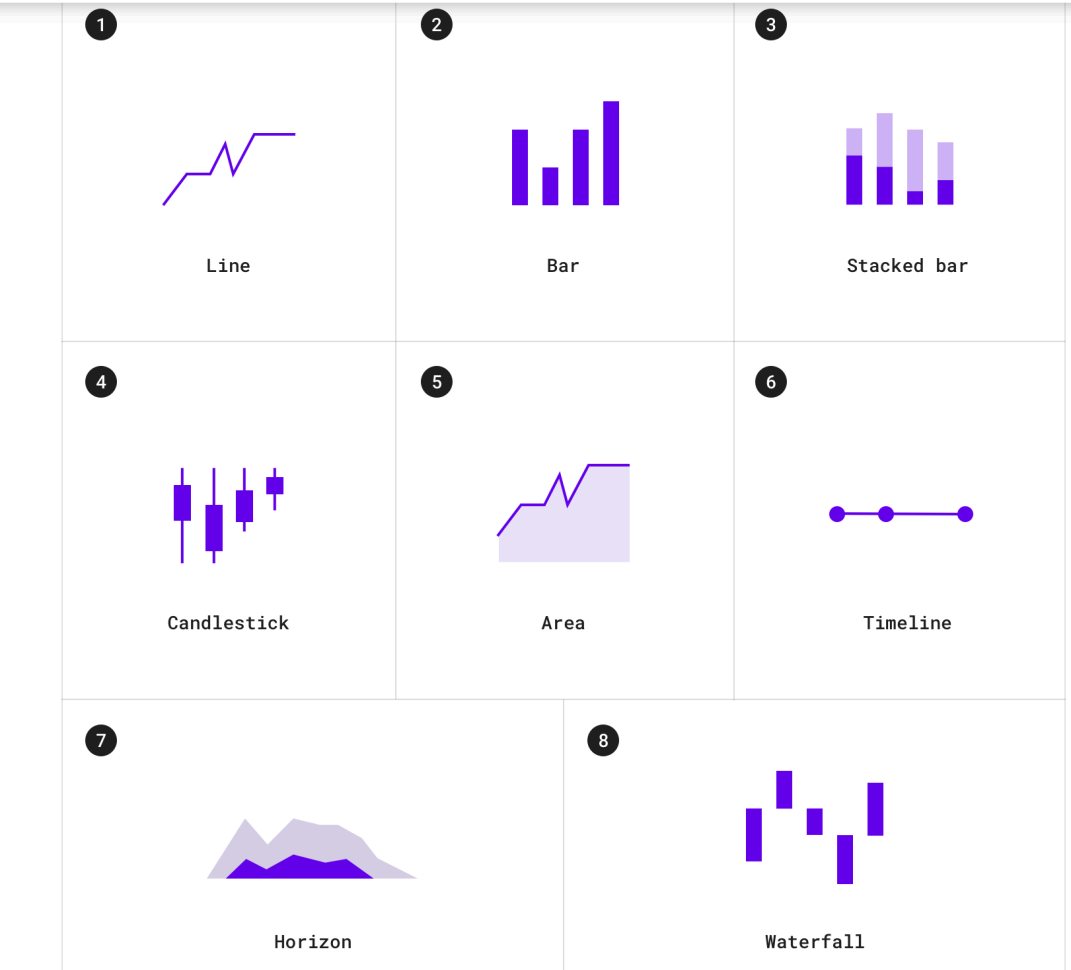
Fox News 2012 Presidential Run Quelle: wonkette.com



http://www.advsofteng.com/gallery_pyramid.html

Data Visualization Style Guidelines

Communication > Data visualization > Types

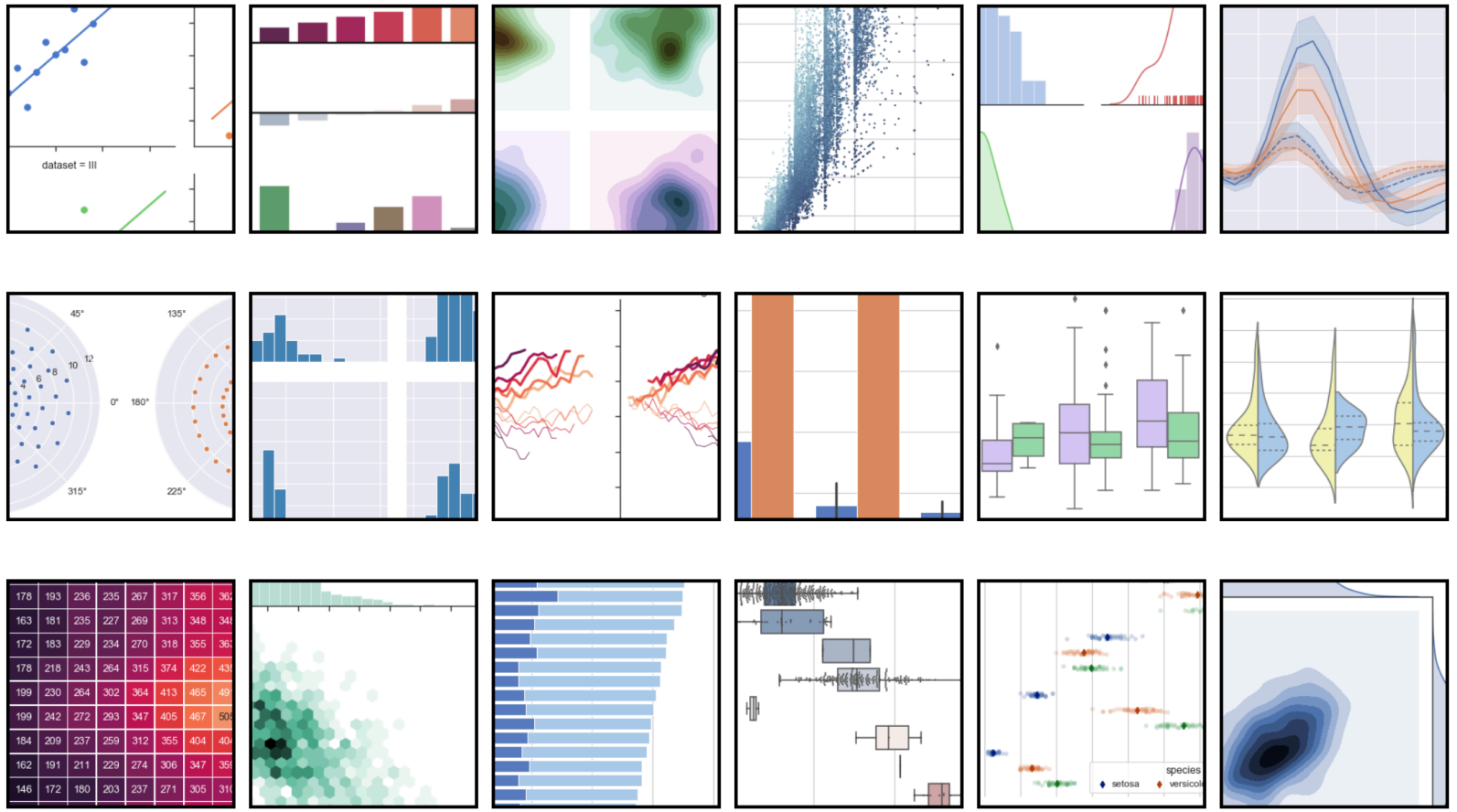


MATERIAL DESIGN

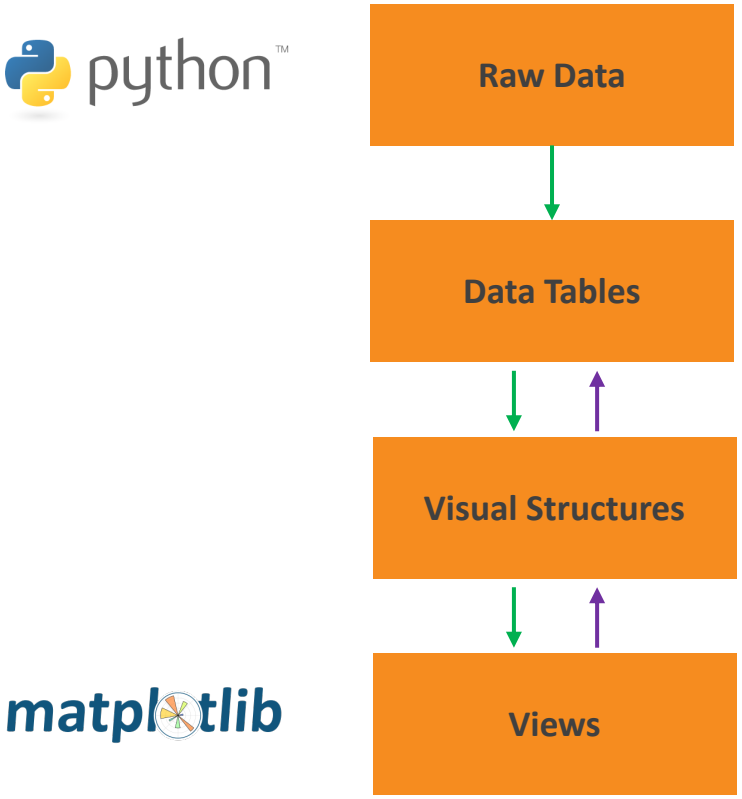
- https://material.io/design/communication/data-visualization.html#

Right Guidelines for good visualizations

- Title
- Labels on axis
- Keep it simple
- Only a few colours



Visualization Process - The Baseline



What is the **goal** of visualization?
What is the point of interest?
What do you want to **understand**?

How is the data **sampled**?
Which data is **relevant**?

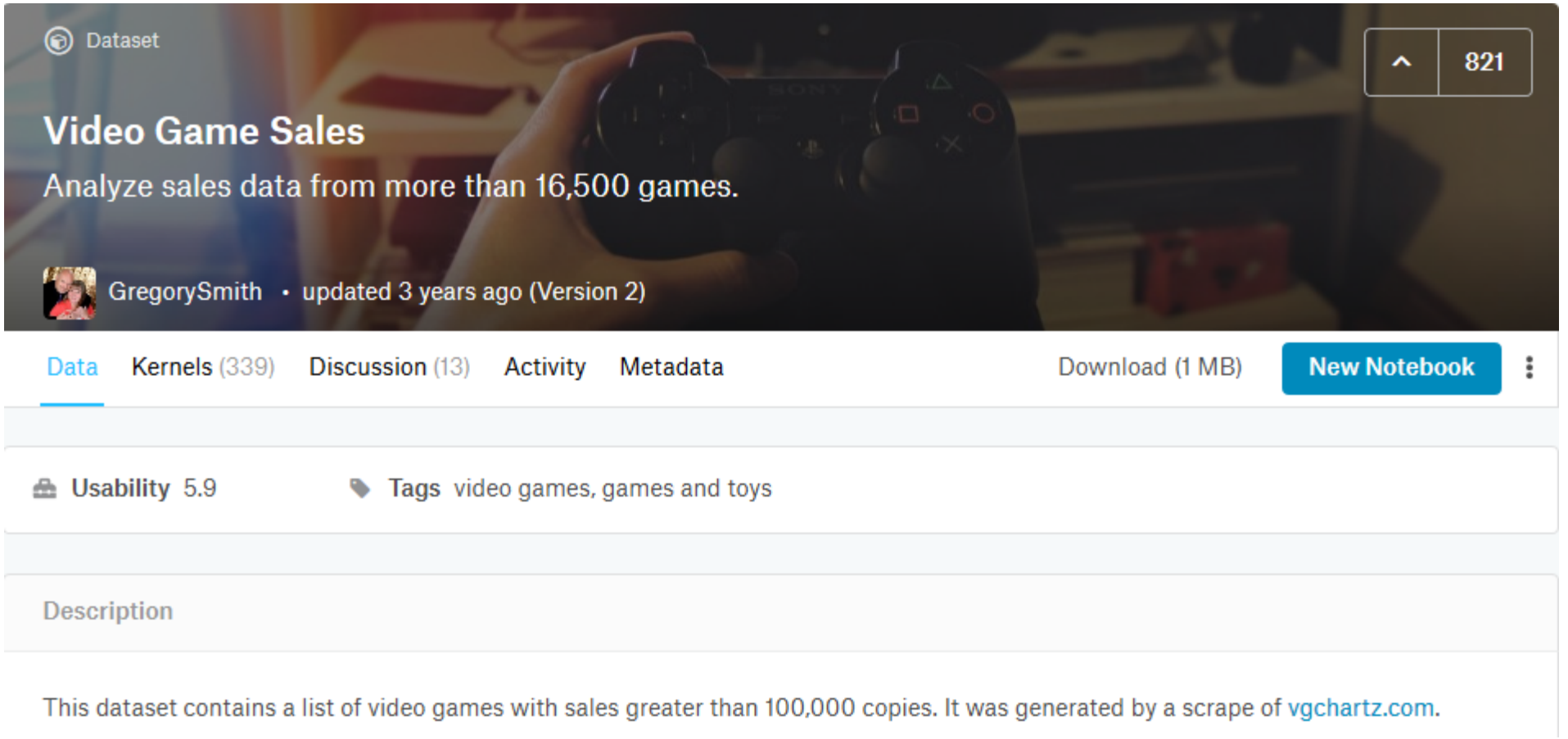
Plot the data.
Are there **anomalies**?
Are there **patterns**?

Build a Visualization.
Do the results make **sense?**

Referenzmodell von Card et al. (1999)

Using large Datasets for Data Analysis

- For this cause, we utilize a dataset on video game sales from kaggle.com



- Do not worry about the scraping part. For now, the dataset is provided for you in your workspace.

Import the data

- The data frame object has some powerful operations
- This makes our life easier to reach the goals

```
# Now create a pandas dataframe.
df = pd.read_csv(...
df = df.dropna(...
```

General Syntax

```
# Access to the library
import matplotlib.pyplot as plt

plt.figure()
plt.plotname(parameters)
plt. . . .
Plt.savefig()
plt.close()
```

Create a new figure

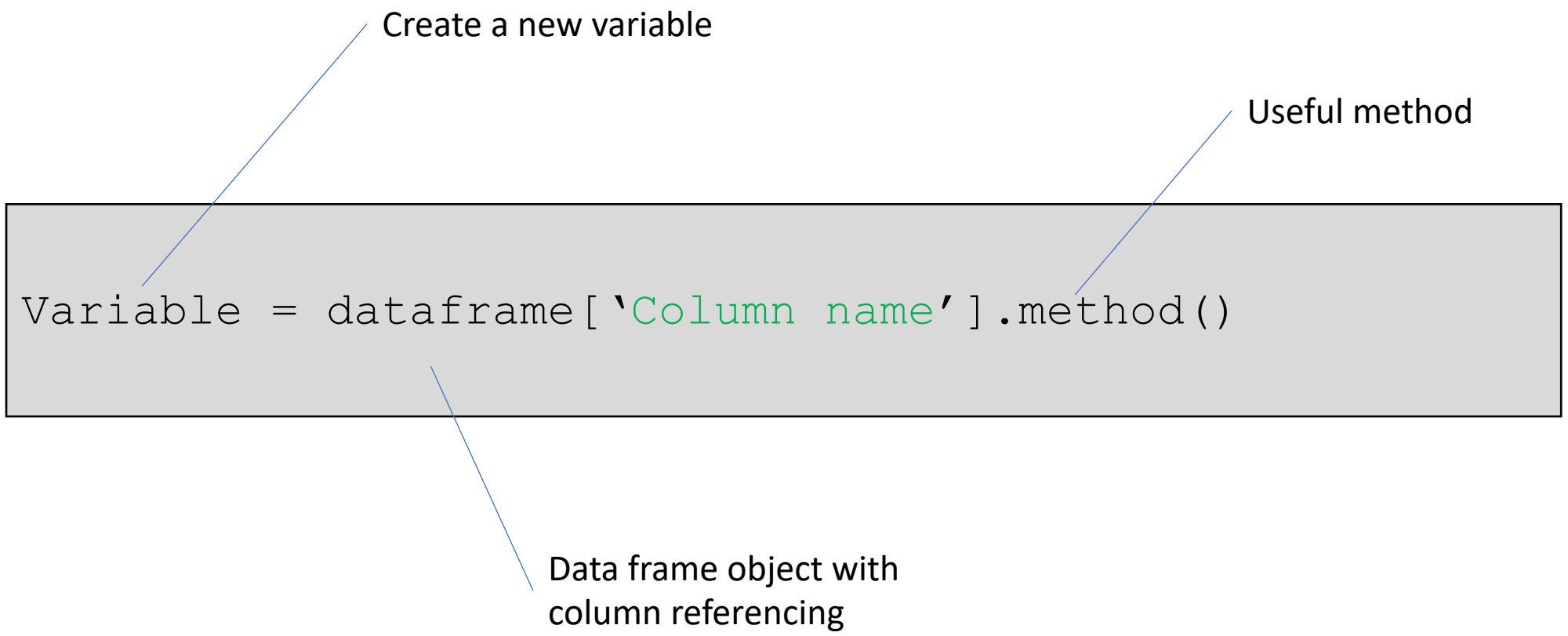
Choose plot

Additional adjustments

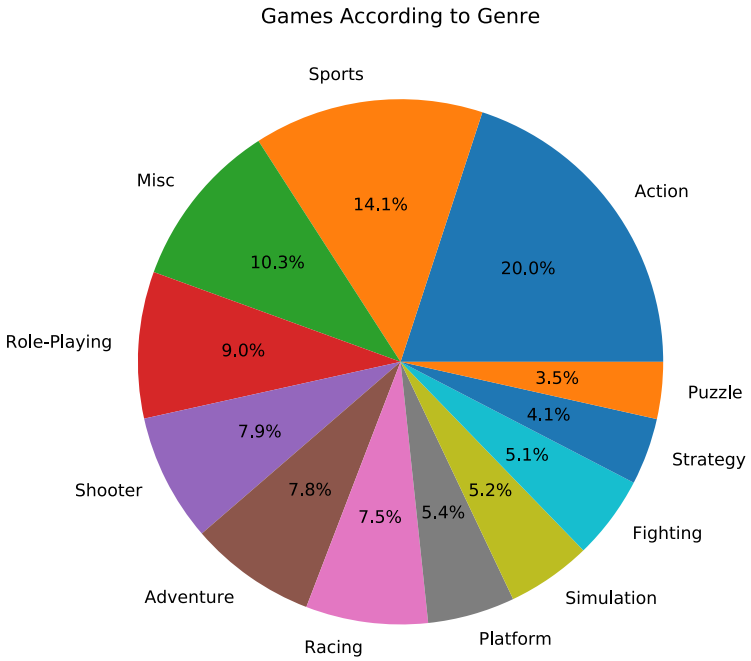
Save plot as .png or .pdf

Close plot

General Syntax for Data Access



Pic Chart

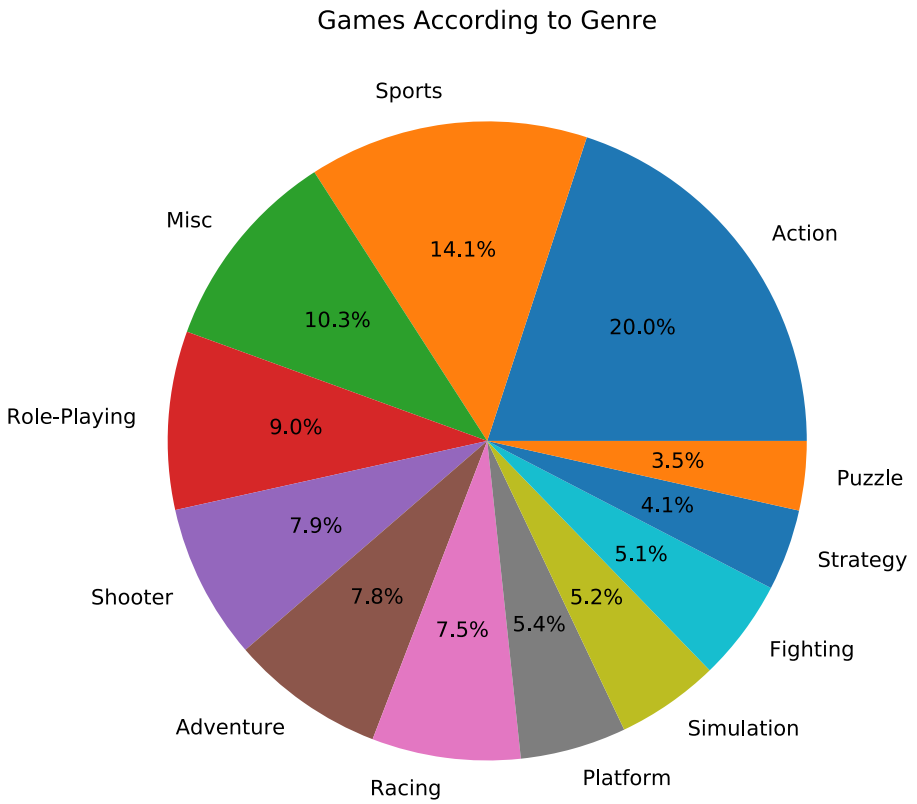

Games According to Genre
Sports
Misc
Action
14.1%
10.3%
20.0%
Role-Playing
9.0%
3.5%
Puzzle
4.1%
7.9%
Strategy
5.1%
Shooter
7.8%
5.2%
7.5%
5.4%
Fighting
Adventure
Simulation
Racing
Platform

Games According to Genre

- Try to great a scatter plot games according to genre

Pie plot:

- Pie charts express portions of a whole, using arcs or angles within a circle.
- Make a pie chart of array *x*. The fractional area of each wedge is given by x/sum(x). If sum(x) < 1, then the values of *x* give the fractional area directly.



Data Access for Pie Plot

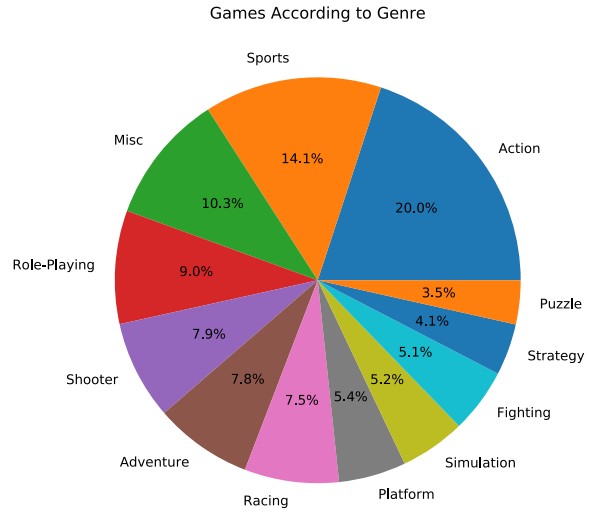
Return a series containing counts of unique values

```
LSizes = df['Genre'].value_counts()
LLabels = df['Genre'].value_counts().index
```

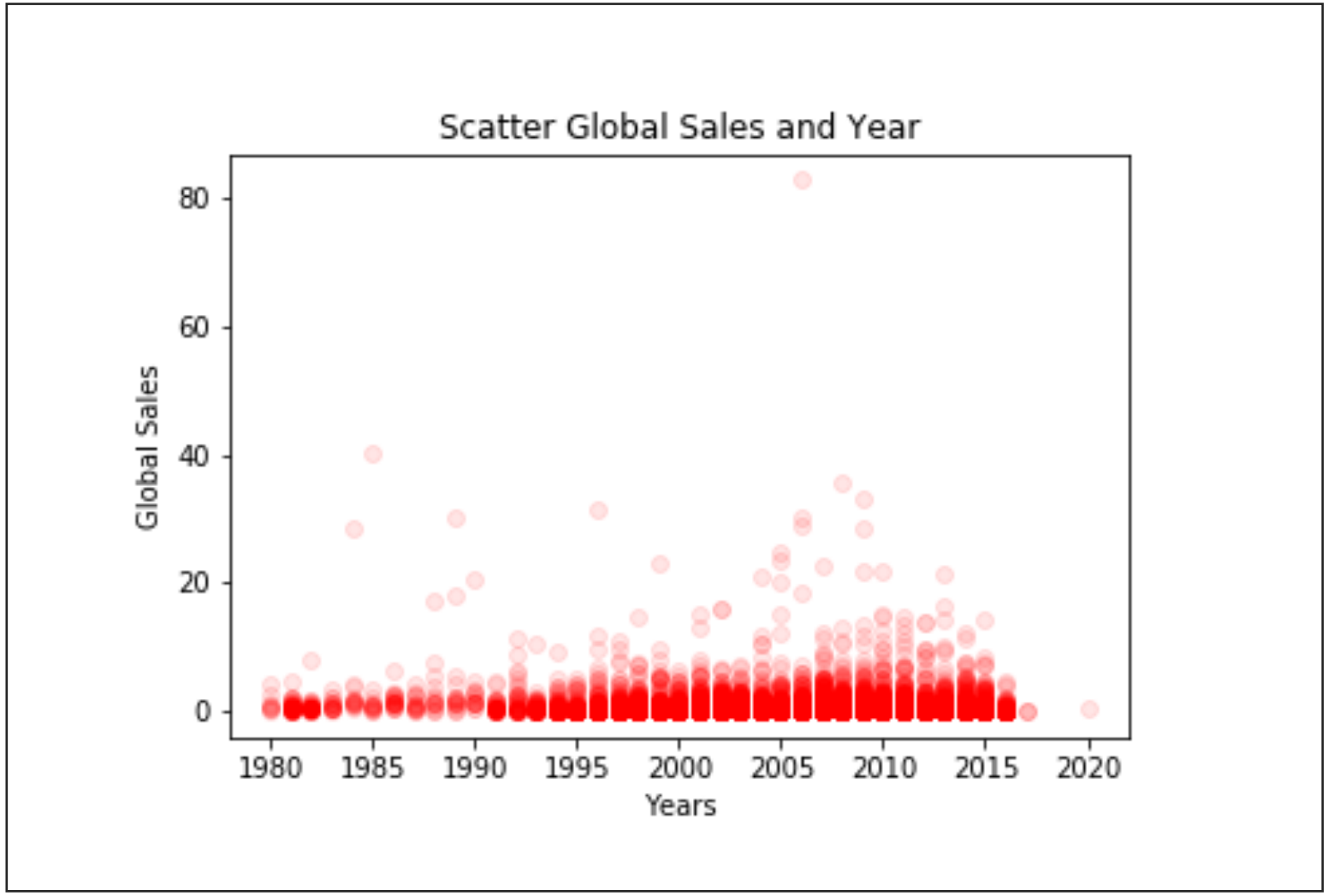
Return unique index like labels

Solution: Scatter Plot

```
plt.figure(figsize = (7,7))
plt.pie(LSizes, labels=LLabels,
autopct='%1.1f%%')
plt.title('Games According to Genre')
plt.savefig('PieGamesGenre.pdf')
```



Scatter Plot

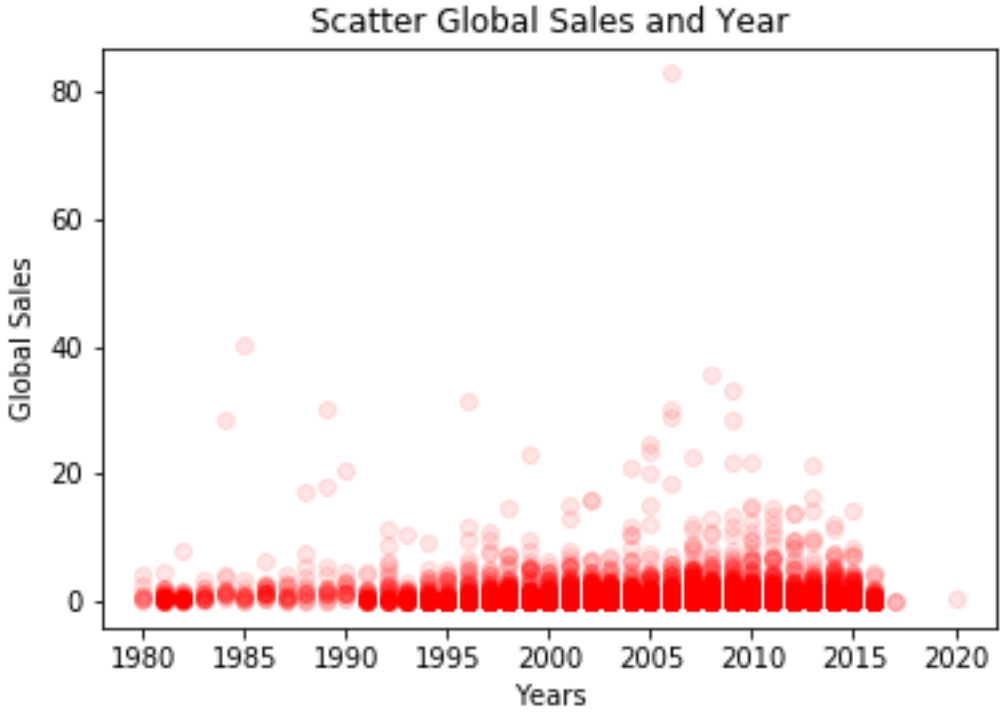


Video Games Global Sales by Years

- Try to great a scatter plot for “Global Sales” and “years”.

Scatter plot:

- Scatter plot is a type of plot or mathematica diagram using Cartesian coordinates to display values for typically two variables for set of data.
- There are 2 variables for each object
- Variables mapped to position
- Scatterplot works well to recognize patterns (e.g. correlations of two variables, groups)
- Problems: Must be well designed to avoid problems “Overplotting”



Data Access for Scatter

```
LGlobal_Sales = df['Global_Sales’].get_values()
LYears = df['Year’].get_values()
```

Matplotlib Options

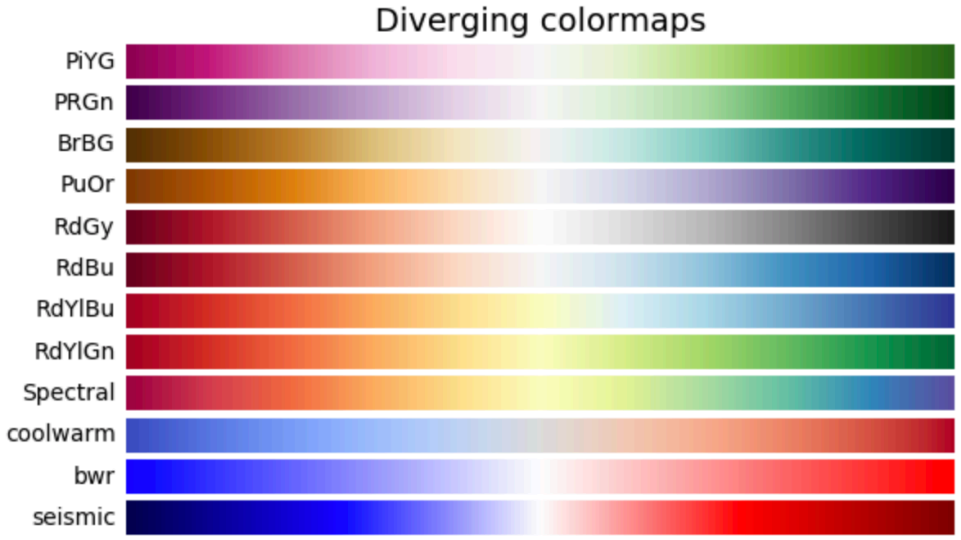
- Matplotlib plots has numerous options.
- See documentation is a good starting point
- https://matplotlib.org/3.1.1/api/_as_gen/matplotlib.pyplot.scatter.html
- Plots are functions with function parameters

```
matplotlib.pyplot.scatter(x, y, s=None, c=None, marker=None,
 cmap=None, norm=None, vmin=None, vmax=None, alpha=None, lin
ewidths=None, verts=None, edgecolors=None, *, plotnonfinite=
False, data=None, **kwargs)[source]
```

Matplotlib – Chance the colours

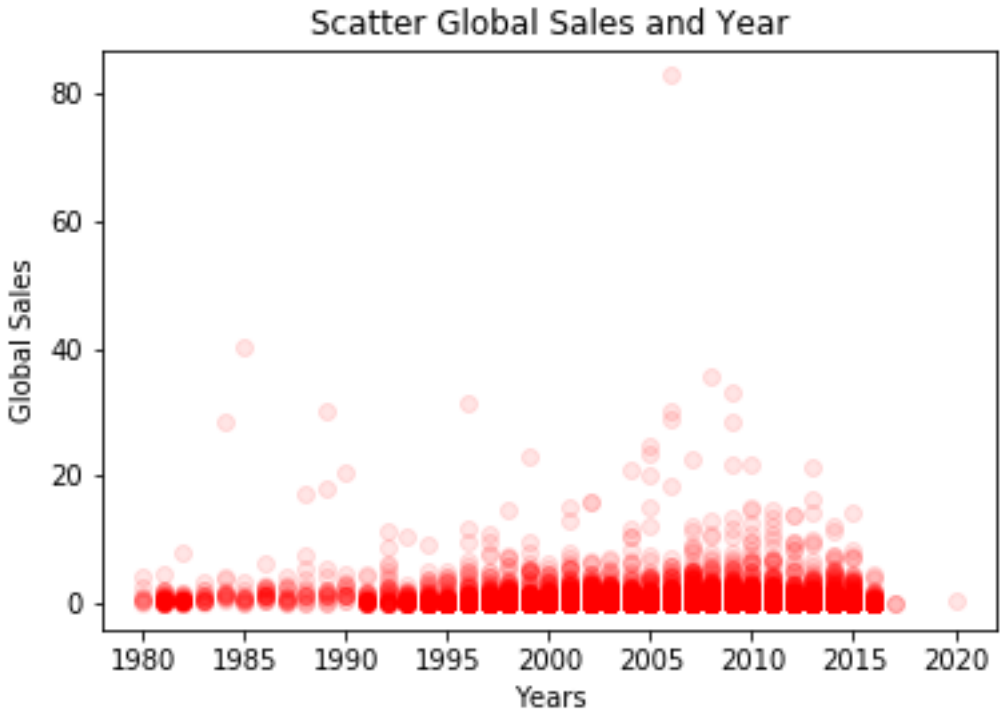
```
matplotlib.pyplot.scatter(x, y, s=None, c=None, marker=None,
 cmap=None, norm=None, vmin=None, vmax=None, alpha=None, lin
ewidths=None, verts=None, edgecolors=None, *, plotnonfinite=
False, data=None, **kwargs)[source]
```

There are hundreds of colours options:
https://matplotlib.org/3.1.0/tutorials/colors/colormaps.html



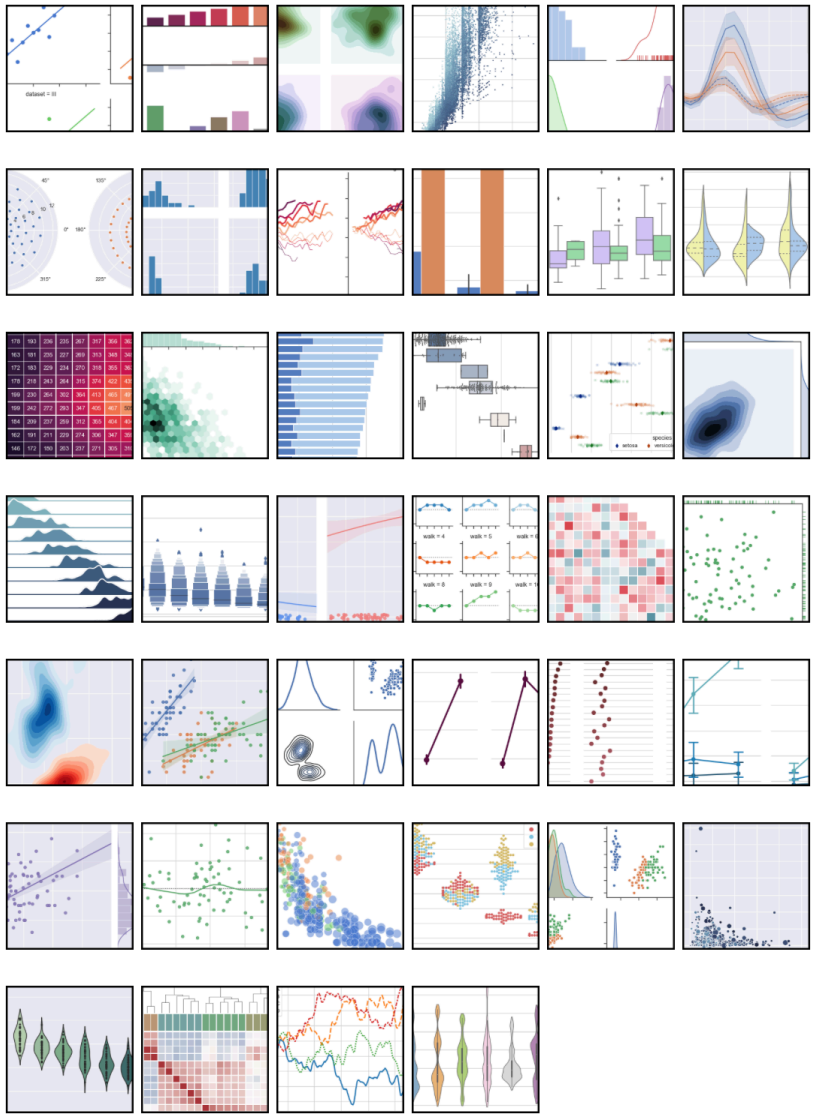
Solution: Scatter Plot

```
plt.figure()
plt.scatter(LYears,
LGlobal_Sales, color='red',
alpha=0.1)
plt.title('Scatter Global Sales
and Year')
plt.ylabel('Global Sales')
plt.xlabel('Years')
plt.savefig('ScatterUpdate.png')
plt.show()
```



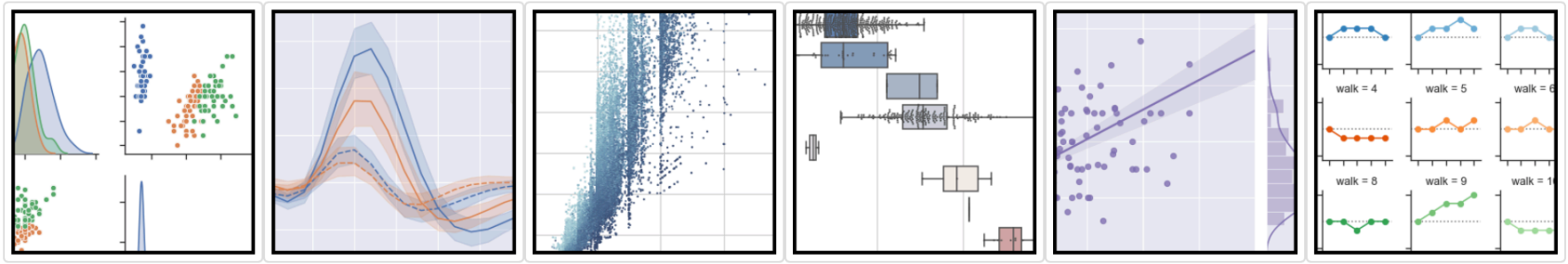
Seaborn

Example gallery



Combination of Power

- Dealing with matplotlib and Pandas data frame architecture can be awkward
- An extension of the matplotlib is Seaborn.
- This library can operate directly with data frame objects. For data science, a useful tool!
- seaborn: statistical data visualization
- Seaborn is a Python data visualization library based on matplotlib.
- It provides a high-level interface for drawing attractive and informative statistical graphics.

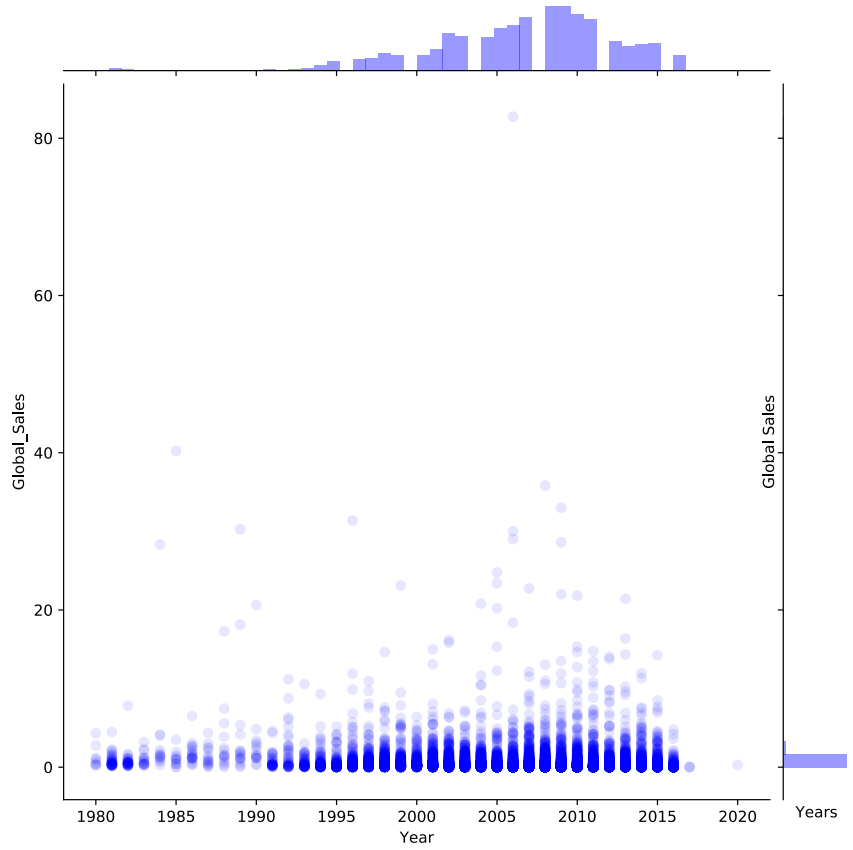


Joint Plot

- Try to create a Joint plot for “Global Sales” and “years”.

Scatter plot:

- Draw a scatterplot with marginal histograms



Access Data for Joint Plot

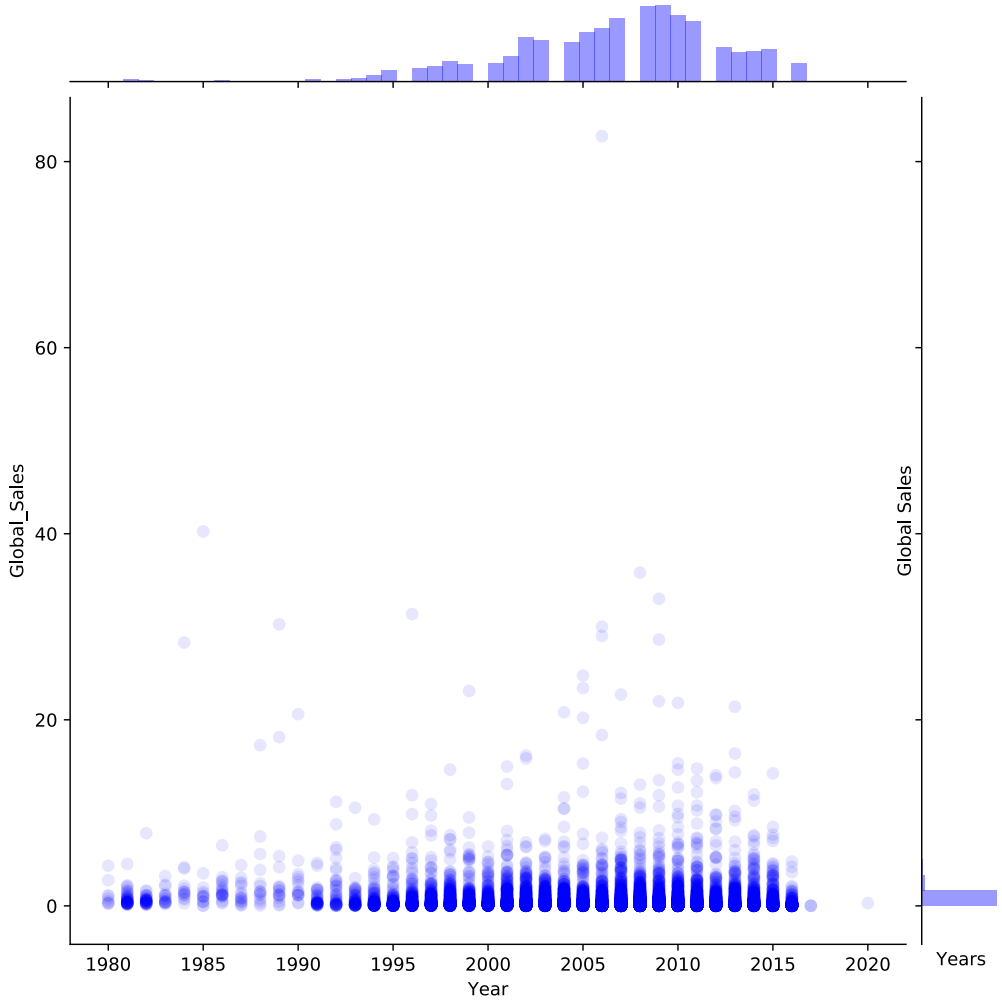
- The data frame object has some powerful operations

```
# Import the matploblib liberary.
import matplotlib.pyplot as plt

# Extract the data for the plot, for example:
LGlobal_Sales = df['Global_Sales'].get_values()
LYears = df['Year'].get_values()
```

Solution: Joint Plot

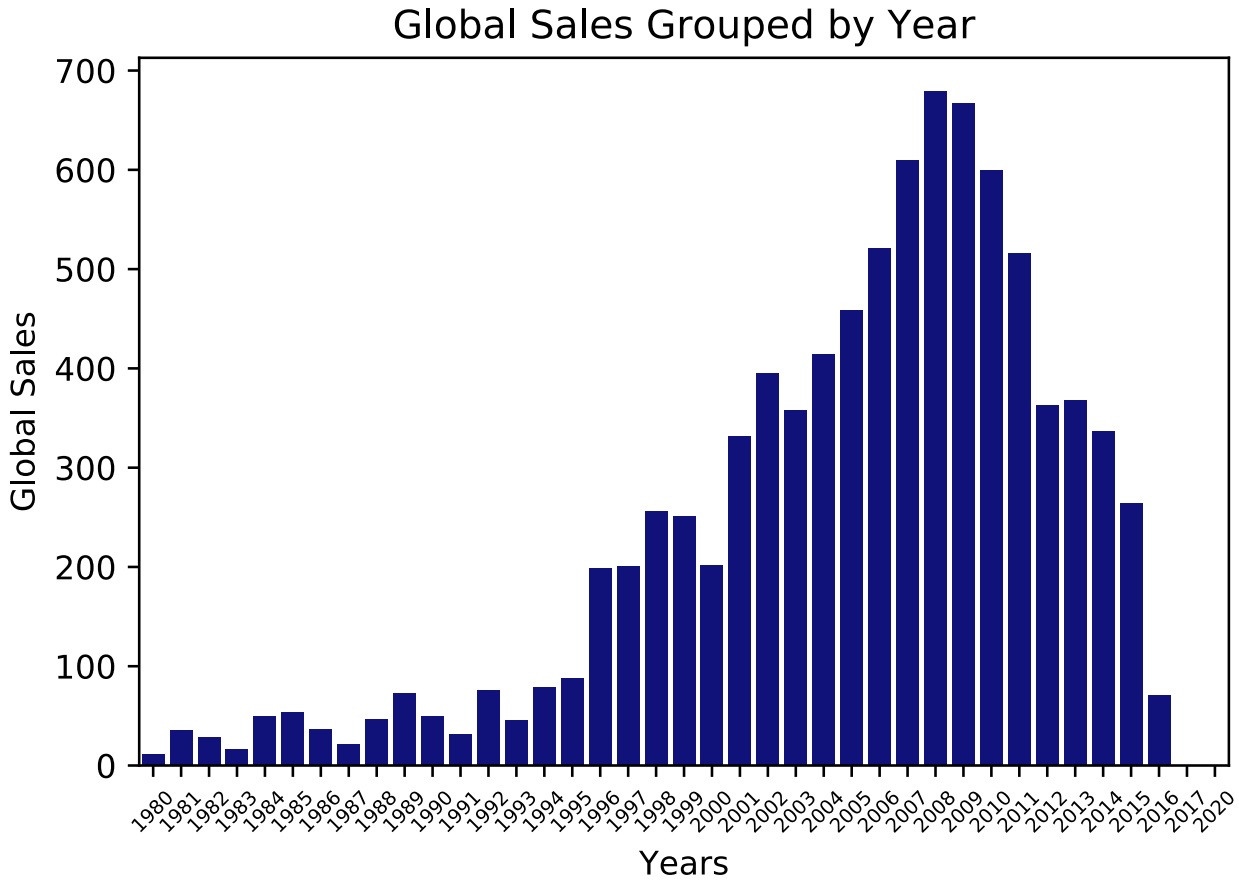
```
·# For using seaborn we need to use the bib.
import seaborn as sns

# Extended
plt.figure()
sns.jointplot(df.Year, df.Global_Sales, size=8, ratio=9,
color="blue", alpha=0.1)
# plt.title('Global Sales Over the Years')
plt.ylabel('Global Sales')
plt.xlabel('Years')
plt.savefig('JoinPlot.pdf')
plt.tight_layout()
plt.show()
```

More the One Plot



http://seaborn.pydata.org/generated/seaborn.jointplot.html?highlight=join%20plot

Bar Chart


Global Sales Grouped by Year
Global Sales
Years
0
100
200
300
400
500
600
700
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
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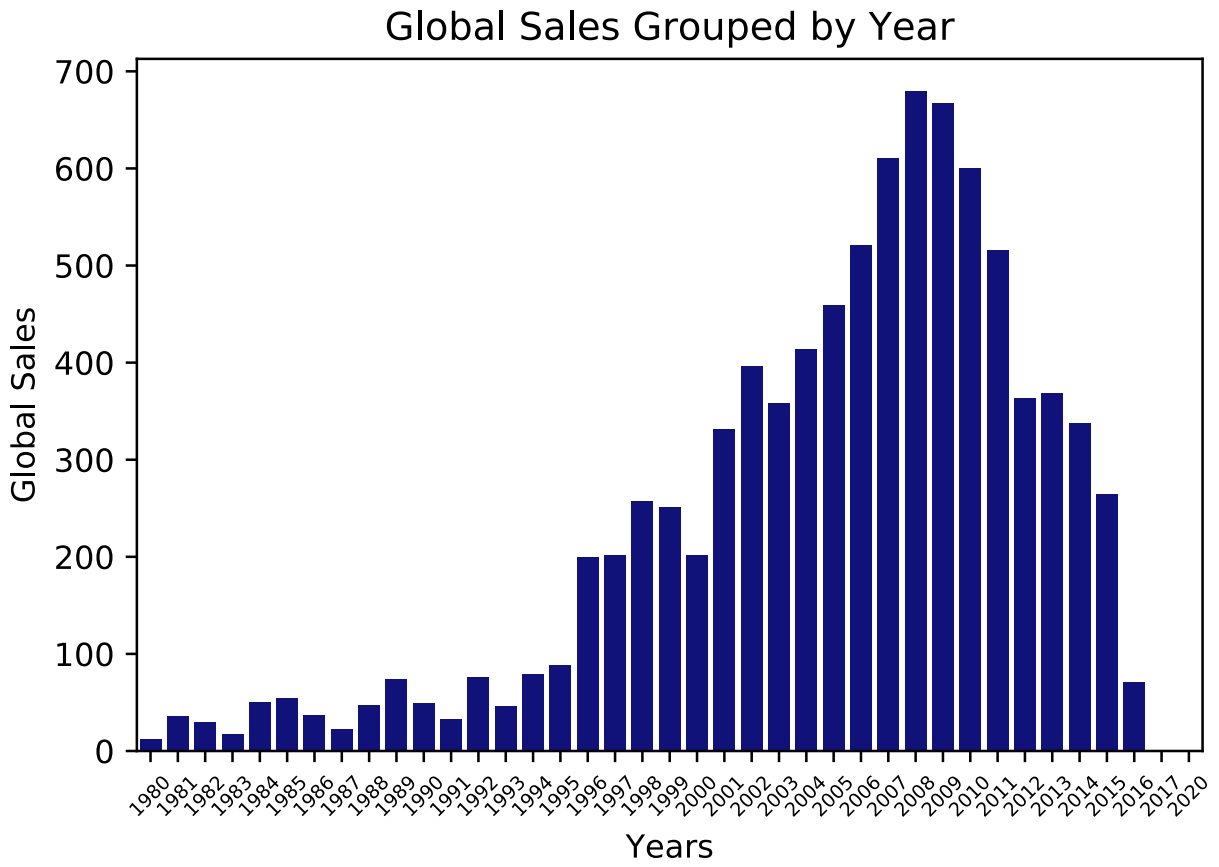
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2020

Bar Chart

- Simple Chart
- Mapping value to position
- A bar plot is a plot that presents categorical data with rectangular bars
- Problems: Data with high range! Sorted vs. unsorted



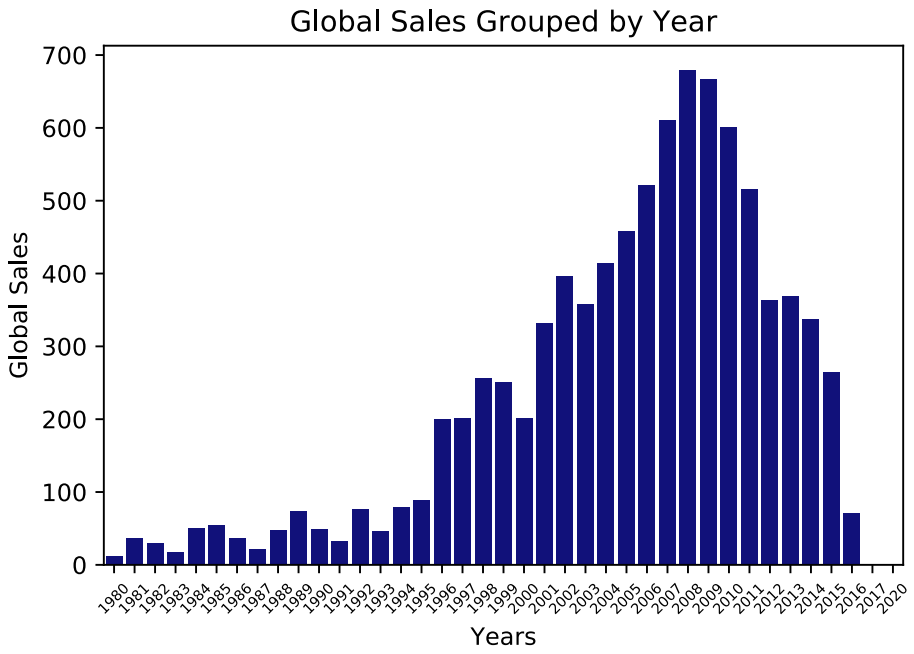
Access Data for Bar Char

- The data frame object has some powerful operations

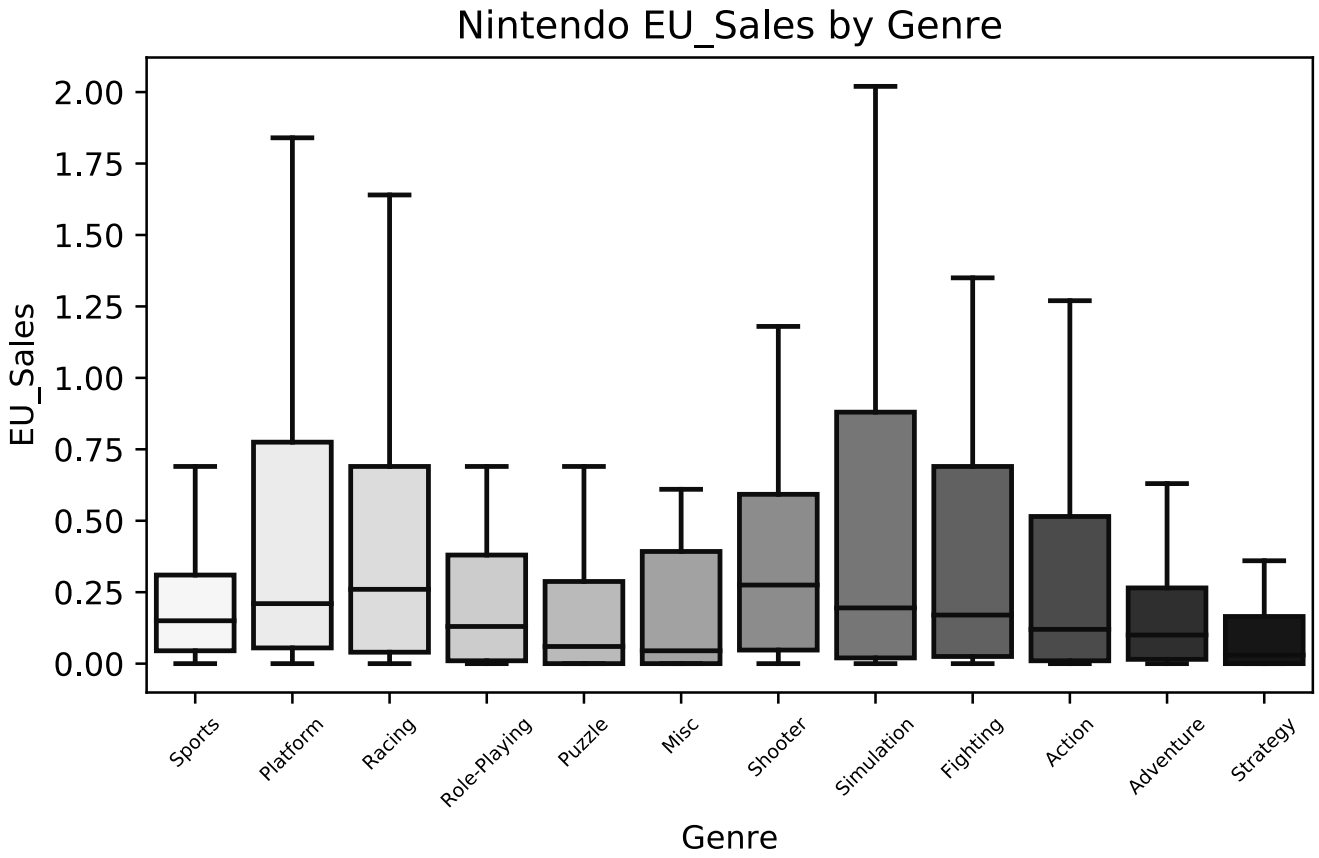
```
# Access data
# In our case sum data for each year.
# @code: df_groupData Grouped data by years and summed up.
# @code: LIndexesOfGroupData years converted as int!
df_groupData = df.groupby(['Year']).sum()
LdfGroupSales = df_groupData['Global_Sales']
LIndexesOfGroupData = df_groupData.index.astype(int)
```

Solution: Bar Plot

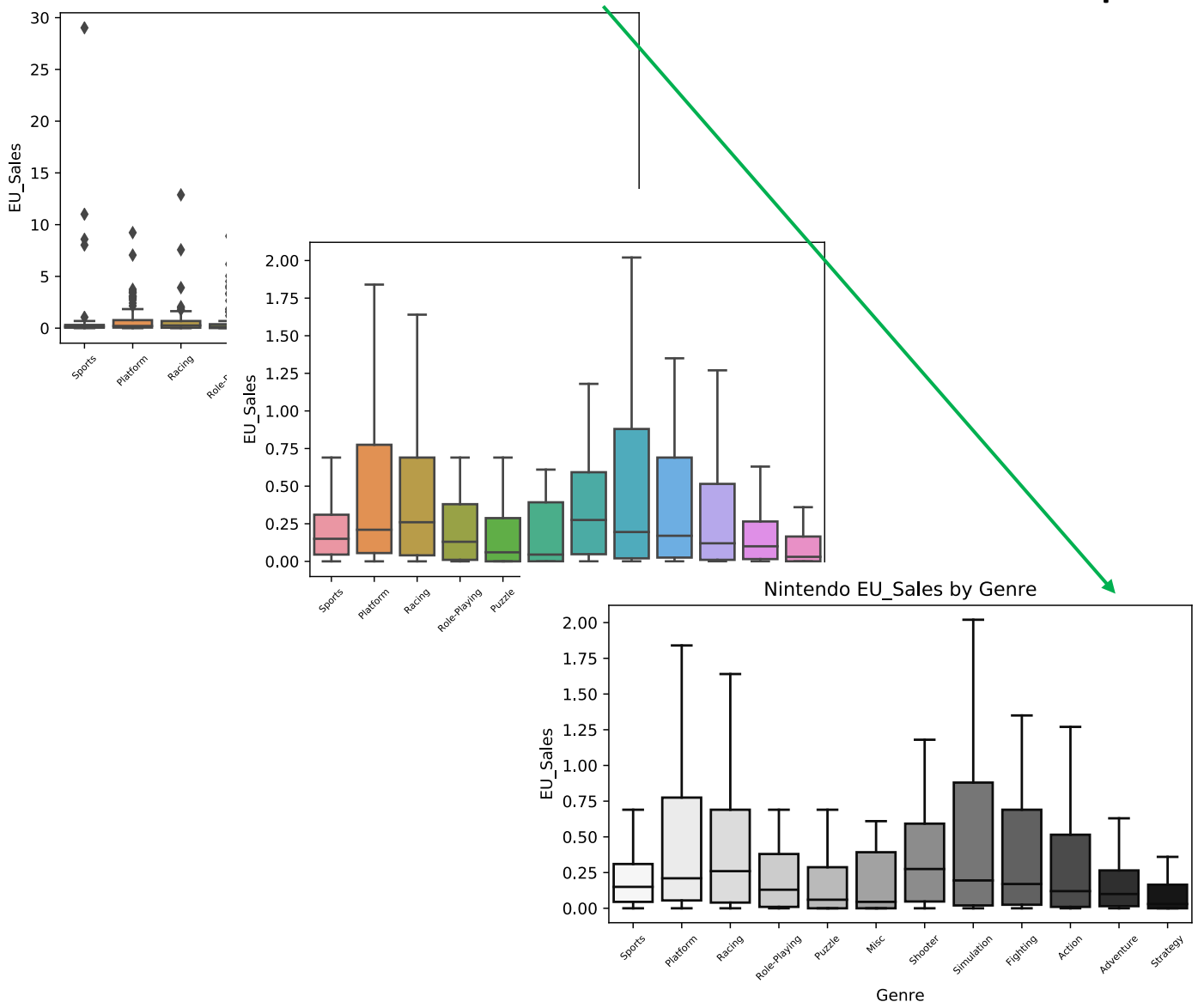
```
plt.figure()
sns.barplot(y=LdfGroupSales,
x=LIndexesOfGroupData, color='darkblue')
plt.title('Global Sales Grouped by Year')
plt.xticks(rotation=45, fontsize=6)
plt.ylabel('Global Sales')
plt.xlabel('Years')
plt.savefig('BarChart.pdf')
plt.show()
```

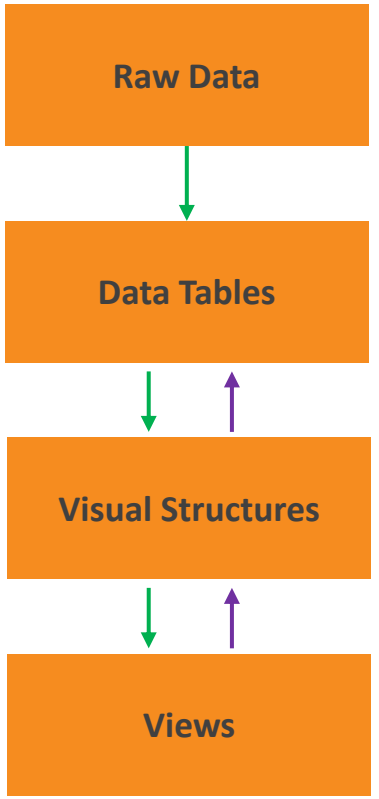


Box Plot


Nintendo EU_Sales by Genre
EU_Sales
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Sports
Platform
Racing
Role-Playing
Puzzle
Misc
Shooter
Simulation
Fighting
Action
Adventure
Strategy
Genre

Visualization Process - A deeper Look





What is the **goal** of visualization?
What is the point of interest?
What do you want to **understand**?

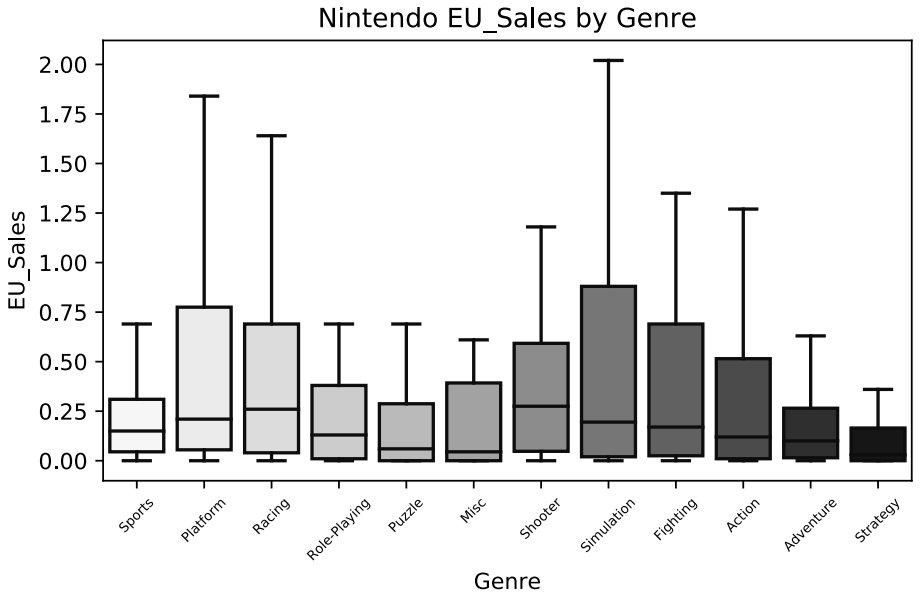
How is the data **sampled**?
Which data is **relevant**?

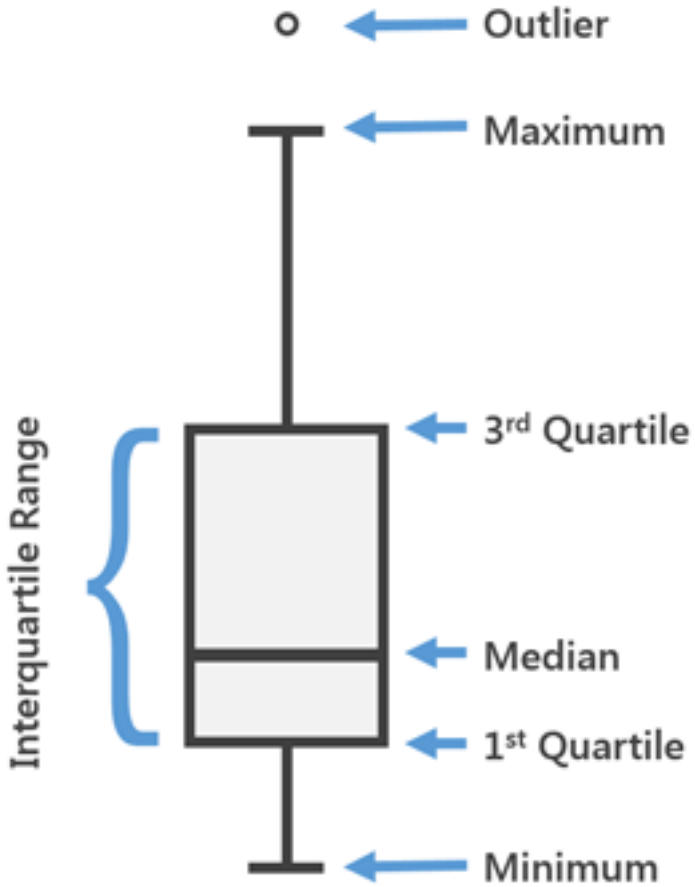
Plot the data.
Are there **anomalies**?
Are there **patterns**?

Build a Visualization.
Do the results make **sense?**

Box Plot

- Visualizes statistical properties
- Uses different forms for mapping
- Problems: Numbers and range of outliers





https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&ved=2ahUKEwicyf_y0vPkAhVQYVAKHS5WAOQQjRx6BAgBEAQ&url=https%3A%2F%2Fpro.arcgis.com%2Fde%2Fpro-app%2Fhelp%2Fanalysis%2Fgeoprocessing%2Fcharts%2Fbox-plot.htm&psig=AOvVaw3Q-zP6jy0RYzK5LHM60kVF&ust=1569764533344246

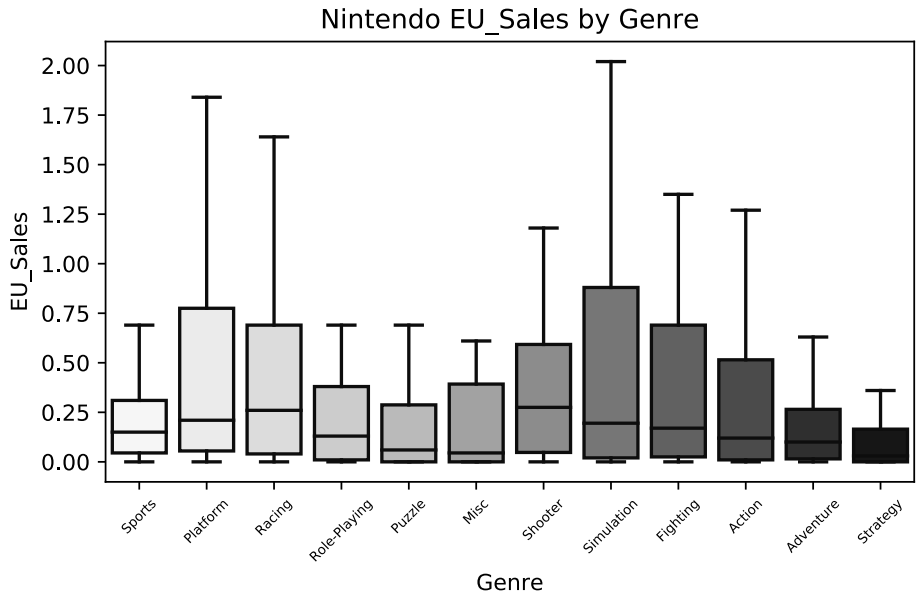
Access Data for Bar Char

- The data frame object has some powerful operations

```
dfNintendo = df[df.Publisher == 'Nintendo']
```

Solution: Bar Plot

```
plt.figure()
sns.boxplot(x='Genre', y='EU_Sales',
data=dfNintendo, showfliers=False,
            palette='Greys')
plt.title('Nintendo EU_Sales by Genre')
plt.xticks(rotation=45, fontsize=6)
plt.tight_layout()
plt.savefig('BoxPlotUpdat3.pdf')
plt.show()
```



More Information

Choosing color palettes:

https://seaborn.pydata.org/tutorial/color_palettes.html

Example gallery

http://seaborn.pydata.org/examples/index.html

Data Frame own Plots methods

pandas.DataFrame.plot

df.plot(x =df[‘A‘], y= x =df[‘B‘], kind = 'scatter‘)

df.plot(x =df[‘A‘], y= x =df[‘B‘], kind = ‘line‘)

df.plot(x =df[‘A‘], y= x =df[‘B‘], kind = ‘bar‘)

Visualization: Lessons learned

- There is a large number of visualizations.
- However, creating a good visualization is not a trivial undertaking.
- Concentration on the central message is important.

References

- https://www.datacamp.com/community/blog/seaborn-cheat-sheet-python
- https://material.io/design/communication/data-visualization.html#

Cheat Sheets:

- https://github.com/pandas-dev/pandas/blob/master/doc/cheatsheet/Pandas_Cheat_Sheet.pdf
- https://drive.google.com/drive/folders/0ByIrJAE4KMTtaGhRcXkxNHhmY2M
- https://python-graph-gallery.com/cheat-sheets/