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  - CNN
  - NNN
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- Pairplot
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Importing the data

In [ ]:

```
!wget https://d2beiqkhq929f0.cloudfront.net/public_assets/assets/000/021/
```

```
--2022-12-21 04:48:37--  https://d2beiqkhq929f0.cloudfront.net/public_asset
s/assets/000/021/299/original/final_vg1_-_final_vg_%281%29.csv?1670840166 (h
ttps://d2beiqkhq929f0.cloudfront.net/public_assets/assets/000/021/299/origin
al/final_vg1_-_final_vg_%281%29.csv?1670840166)
Resolving d2beiqkhq929f0.cloudfront.net (d2beiqkhq929f0.cloudfront.net)... 1
08.157.172.173, 108.157.172.183, 108.157.172.10, ...
Connecting to d2beiqkhq929f0.cloudfront.net (d2beiqkhq929f0.cloudfront.net)|
108.157.172.173|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 2041483 (1.9M) [text/plain]
Saving to: ‘vgsales.csv’

vgsales.csv         100%[===================>]   1.95M  --.-KB/s    in 0.1s

2022-12-21 04:48:38 (14.0 MB/s) - ‘vgsales.csv’ saved [2041483/2041483]
```

In [ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

In [ ]:
```
data = pd.read_csv('vgsales.csv')
data.head()
```

Out[3]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales
0	2061	1942	NES	1985.0	Shooter	Capcom	4.569217	3.033887	3.439352
1	9137	¡Shin Chan Flipa en colores!	DS	2007.0	Platform	505 Games	2.076955	1.493442	3.033887
2	14279	.hack: Sekai no Mukou ni + Versus	PS3	2012.0	Action	Namco Bandai Games	1.145709	1.762339	1.493442
3	8359	.hack//G.U. Vol.1//Rebirth	PS2	2006.0	Role-Playing	Namco Bandai Games	2.031986	1.389856	3.228043
4	7109	.hack//G.U. Vol.2//Reminisce	PS2	2006.0	Role-Playing	Namco Bandai Games	2.792725	2.592054	1.440483

In [ ]:
```
data.describe()
```

Out[4]:

	Rank	Year	NA_Sales	EU_Sales	JP_Sales	Other_Sales	G
count	16652.000000	16381.000000	16652.000000	16652.000000	16652.000000	16652.000000	16
mean	8283.409620	2006.390513	2.752314	1.996875	2.499677	1.151829	
std	4794.471477	5.863261	1.327002	1.322972	1.164023	1.054813	
min	1.000000	1980.000000	0.140000	0.010000	0.000000	-0.474276	
25%	4129.750000	2003.000000	1.781124	1.087977	1.781124	0.394830	
50%	8273.500000	2007.000000	2.697415	1.714664	2.480356	0.491870	
75%	12436.250000	2010.000000	3.677290	2.795123	3.176299	1.781124	
max	16600.000000	2020.000000	8.725452	8.367985	12.722984	7.358020	

If you notice, `Genres` , `Publisher` and `Platform` are categorical values

Since we have a lot of categories of each of them, we will use top 3 of each to make our analysis easier

In [ ]:
```python
top3_pub = data['Publisher'].value_counts().index[:3]
top3_gen = data['Genre'].value_counts().index[:3]
top3_plat = data['Platform'].value_counts().index[:3]
top3_data = data.loc[(data["Publisher"].isin(top3_pub)) & (data["Platform
top3_data
```

Out[5]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales
2	14279	.hack: Sekai no Mukou ni + Versus	PS3	2012.0	Action	Namco Bandai Games	1.145709	1.762339	1.493442
13	2742	[Prototype 2]	PS3	2012.0	Action	Activision	3.978349	3.727034	0.848807
16	1604	[Prototype]	PS3	2009.0	Action	Activision	4.569217	4.108402	1.187272
19	1741	007: Quantum of Solace	PS3	2008.0	Action	Activision	4.156030	4.346074	1.087977
21	4501	007: Quantum of Solace	PS2	2008.0	Action	Activision	3.228043	2.738800	2.585598
...	...	...	...	...	...	...	...	...	...
16438	14938	Yes! Precure 5 Go Go Zenin Shu Go! Dream Festival	DS	2008.0	Action	Namco Bandai Games	1.087977	0.592445	1.087977
16479	10979	Young Justice: Legacy	PS3	2013.0	Action	Namco Bandai Games	2.186589	1.087977	3.409089
16601	11802	ZhuZhu Pets: Quest for Zhu	DS	2011.0	Misc	Activision	2.340740	1.525543	3.103825
16636	9196	Zoobles! Spring to Life!	DS	2011.0	Misc	Activision	2.697415	1.087977	2.760718
16640	9816	Zubo	DS	2008.0	Misc	Electronic Arts	2.592054	1.493442	1.493442

617 rows × 11 columns

Bivariate Data Visualization

Continous-Continous

So far we have been analyzing only a single feature.

But what if we want to visualize two features at once?

What kind of questions can we ask regarding a continous-continous pair of features?

- Maybe show relation between two features, like **how does the sales vary over the years**?
- Or show **how are the features associated, positively or negatively**?

...And so on

Let's go back to the line plot we plotted at the very beginning

Line Plot

How can we plot the sales trend over the years for the longest running game?

First, let's find the longest running game first

In [ ]:
```
data['Name'].value_counts()
```

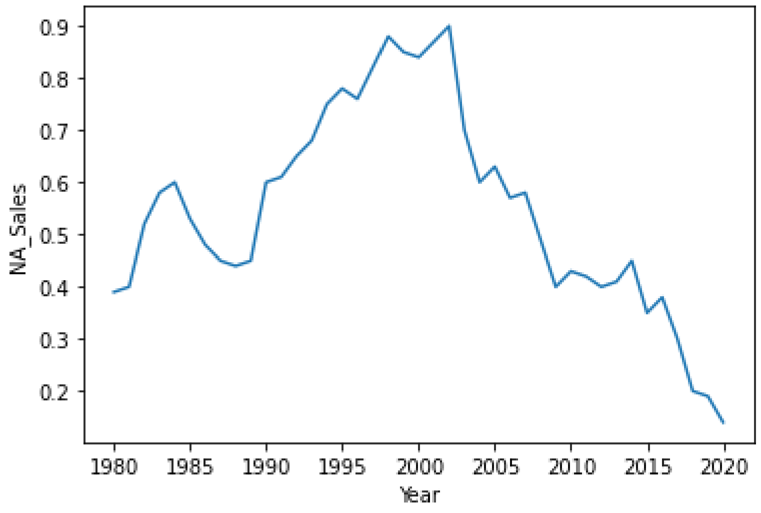
Out[65]:
```
Ice Hockey                                       41
Baseball                                         17
Need for Speed: Most Wanted                      12
Ratatouille                                       9
FIFA 14                                           9
                                                 ..
Indy 500                                          1
Indy Racing 2000                                  1
Indycar Series 2005                               1
inFAMOUS                                          1
Zyuden Sentai Kyoryuger: Game de Gaburincho!!     1
Name: Name, Length: 11493, dtype: int64
```

Great, so `Ice Hockey` is longer running than most games

Let's try to find the sales trend in North America of the same across the years

```
In [ ]:
ih = data.loc[data['Name']=='Ice Hockey']
sns.lineplot(x='Year', y='NA_Sales', data=ih)
```

```
Out[66]: <matplotlib.axes._subplots.AxesSubplot at 0x7fcb8f702fd0>
```



What can we infer from this graph?

- The sales across North America seem to have been boosted in the years of 1995-2005
- Post 2010 though, the sales seem to have taken a dip

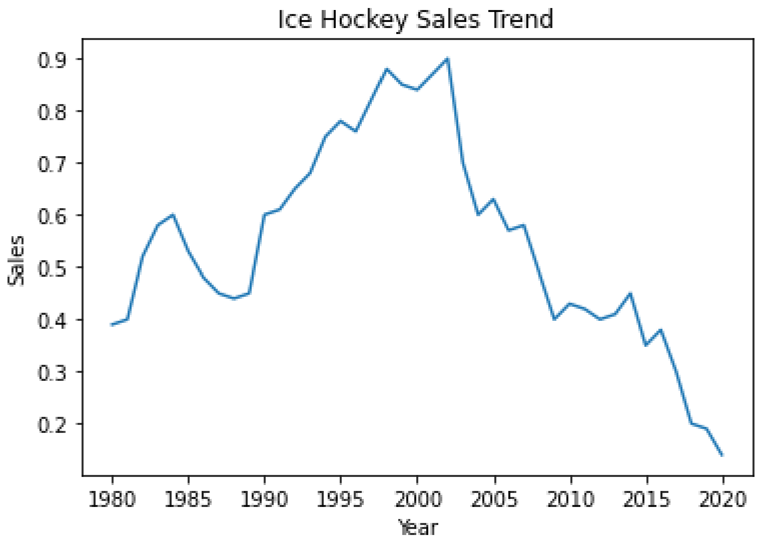
Line plot are great to representing trends such as above, over time

Style and Labelling

We already learnt in barplot how to add **titles, x-label and y-label**

Let's add the same here

In [ ]:
```python
plt.title('Ice Hockey Sales Trend')
plt.xlabel('Year')
plt.ylabel('Sales')
sns.lineplot(x='Year', y='NA_Sales', data=ih)
plt.show()
```



Now what if we want to change the colour of the curve ?

`sns.lineplot()` contains an argument **color**

- It takes as argument a matplotlib color

  OR
- as string for some defined colours like:
  - black: `k` / `black`
  - red: `r` / `red` etc

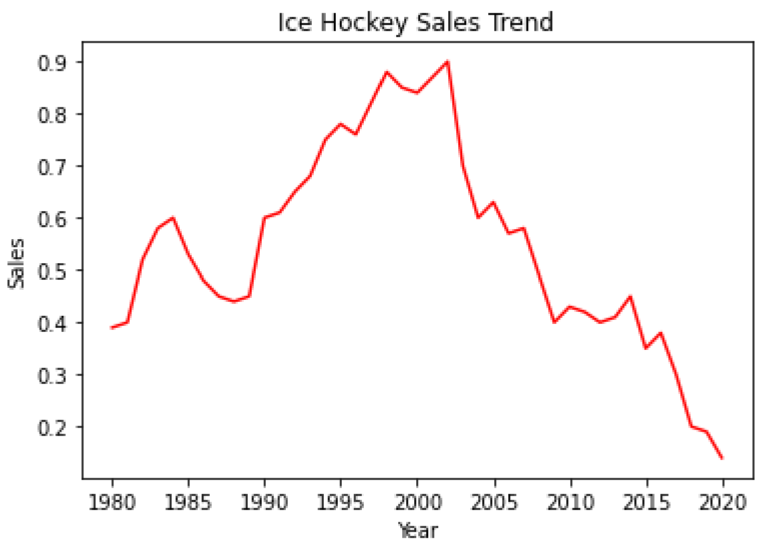
But what all colours can we use ?

Matplotlib provides a lot of colours

Check the documentation for more colours

https://matplotlib.org/2.0.2/api/colors_api.html (https://matplotlib.org/2.0.2/api/colors_api.html)

In [ ]:
```python
plt.title('Ice Hockey Sales Trend')
plt.xlabel('Year')
plt.ylabel('Sales')
sns.lineplot(x='Year', y='NA_Sales', data=ih, color='r')
plt.show()
```



Now, lets say we only want to show the values from years 1990-2000

How can we limit our plot to only the last decade of 20th century?

This requires changing the range of x-axis

But how can we change the range of an axis in matplotlib ?

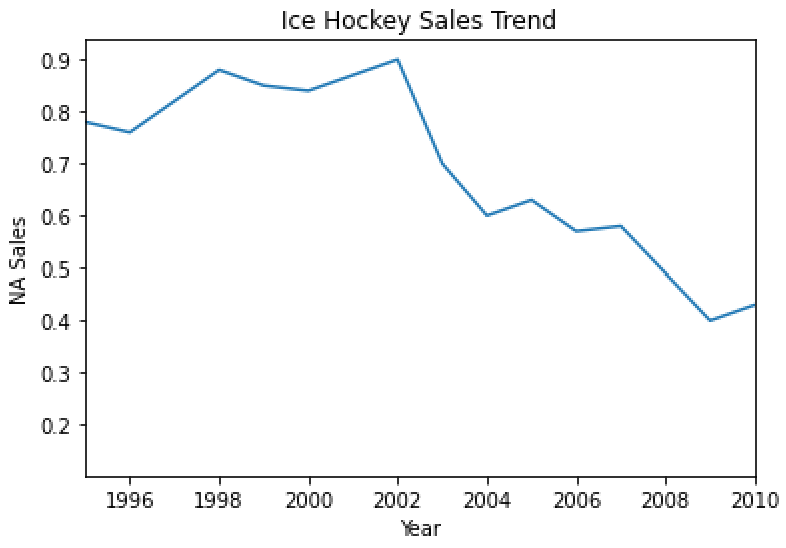
We can use:

- `plt.xlim()` : x-axis
- `plt.ylim()` : y-axis

These funcs take same 2 args:

1. `left` : Starting point of range
2. `right` : End point of range

In [ ]:
```
plt.title('Ice Hockey Sales Trend')
plt.xlabel('Year')
plt.ylabel('NA Sales')
plt.xlim(left=1995,right=2010)
sns.lineplot(x='Year', y='NA_Sales', data=ih)
plt.show()
```



So far we have visualised a single plot to understand it

What if we want to compare it with some other plot?

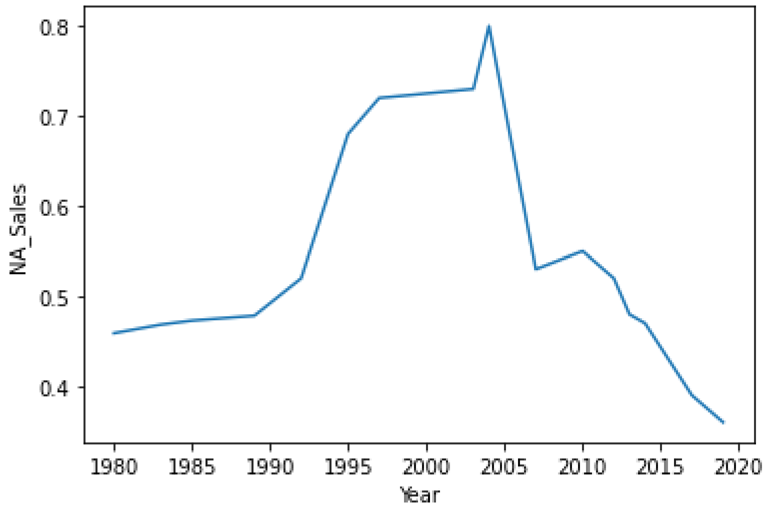
Say, we want to compare the same sales trend between two games

- Ice Hockey
- Baseball

Let's first plot the trend for "Baseball"

In [ ]:
```
baseball = data.loc[data['Name']=='Baseball']
sns.lineplot(x='Year', y='NA_Sales', data=baseball)
```

Out[71]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fcb8cd1cf10>
```

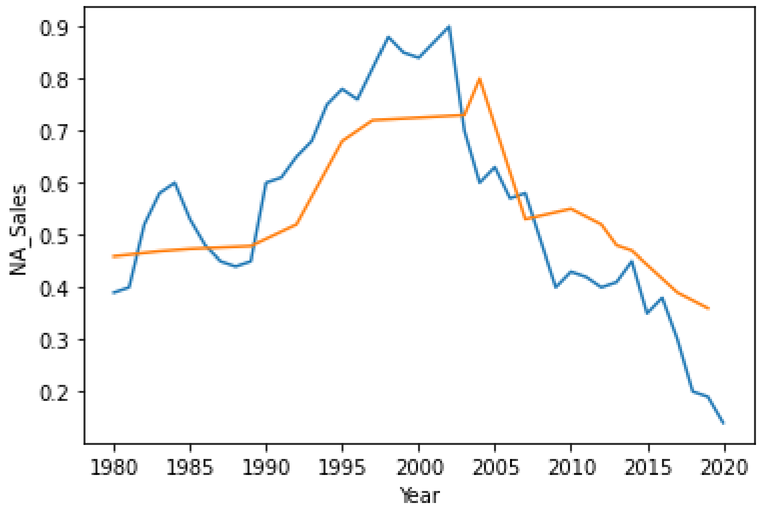


Now, to compare these, so we will have to draw these plots in the same figure

How can we plot multiple plots in the same figure ?

In [ ]:
```
sns.lineplot(x='Year', y='NA_Sales', data=ih)
sns.lineplot(x='Year', y='NA_Sales', data=baseball)
```

Out[72]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fcb8cc60340>
```



We can use multiple `sns.lineplot()` funcs

Observe:

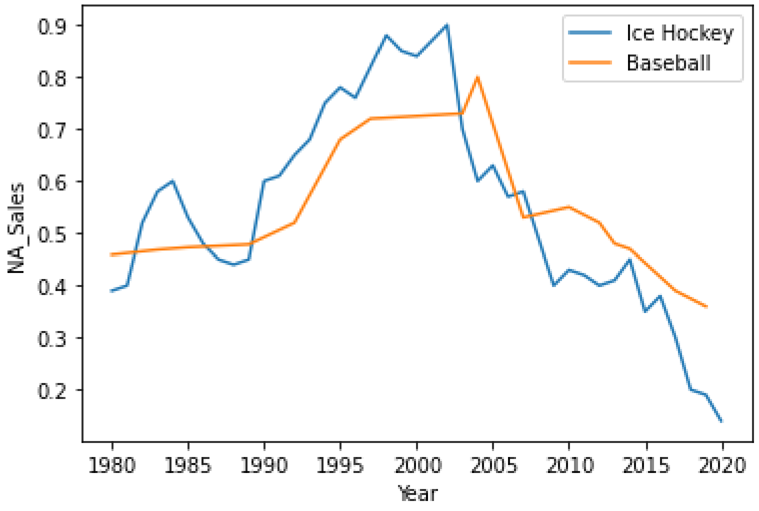
Seaborn automatically created 2 plots with **different colors**

However how can we know which colour is of which plot ?

- sns.lineplot() has another argument **label** to do so
- We can simply set the label of each plot

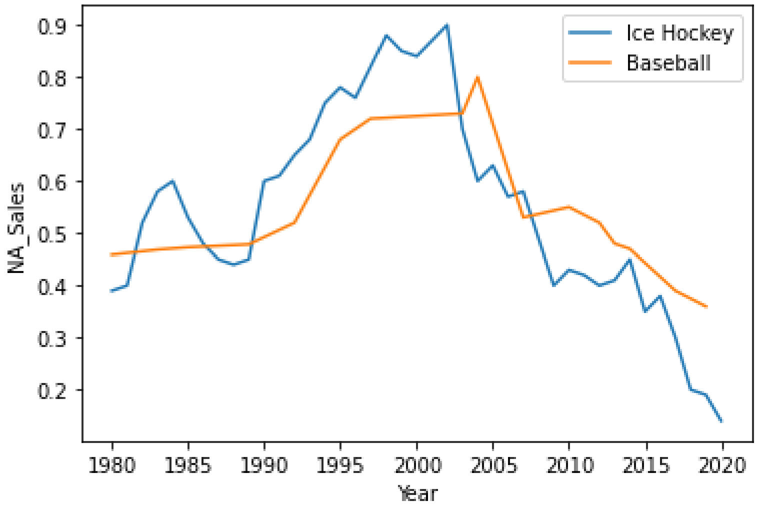
In [ ]:
```
sns.lineplot(x='Year', y='NA_Sales', data=ih, label='Ice Hockey')
sns.lineplot(x='Year', y='NA_Sales', data=baseball, label='Baseball')
```

Out[73]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fcb8cbd4790>
```



We can also pass these labels in plt.legend() as a list in the order plots are done

In [ ]:
```
sns.lineplot(x='Year', y='NA_Sales', data=ih)
sns.lineplot(x='Year', y='NA_Sales', data=baseball)
plt.legend(['Ice Hockey','Baseball'])
plt.show()
```

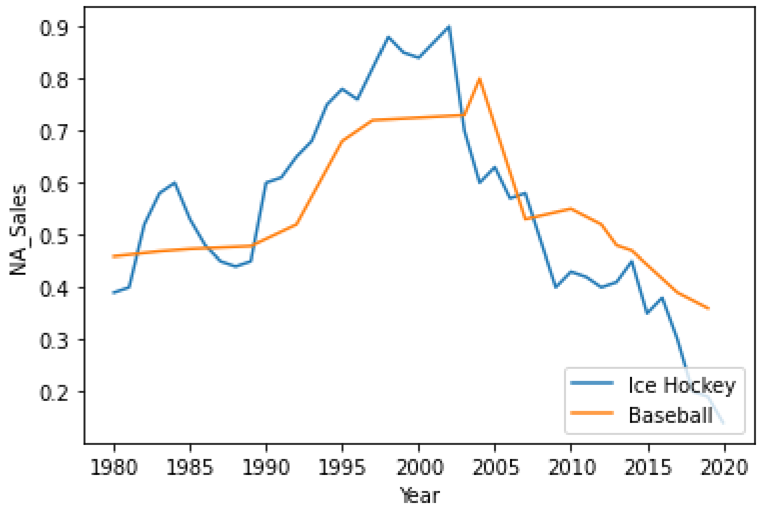


Now can we change the position of the legend, say, to bottom-right corner?

- Matplotlib automatically decides the best position for the legends
- But we can also change it using the `loc` parameter

- `loc` takes input as 1 of following strings:
  - upper center
  - upper left
  - upper right
  - lower right ... etc

In [ ]:
```
sns.lineplot(x='Year', y='NA_Sales', data=ih)
sns.lineplot(x='Year', y='NA_Sales', data=baseball)
plt.legend(['Ice Hockey','Baseball'], loc='lower right')
plt.show()
```

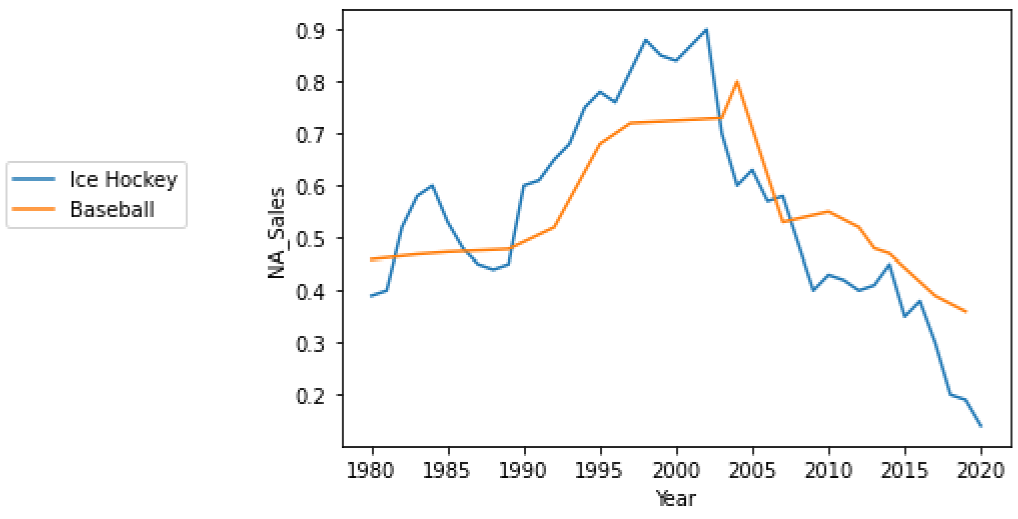


Now what if we want the legend to be outside the plot?

Maybe the plot is too congested to show the legend

We can use the same `loc` parameter for this too

In [ ]:
```python
sns.lineplot(x='Year', y='NA_Sales', data=ih)
sns.lineplot(x='Year', y='NA_Sales', data=baseball)
plt.legend(['Ice Hockey','Baseball'], loc=(-0.5,0.5))
plt.show()
```



The pair of floats signify the (x,y) coordinates for the legend

==> From this we can conclude `loc` takes **two types of arguments**:

- The location in the **form of string**
- The location in the **form of coordinates**

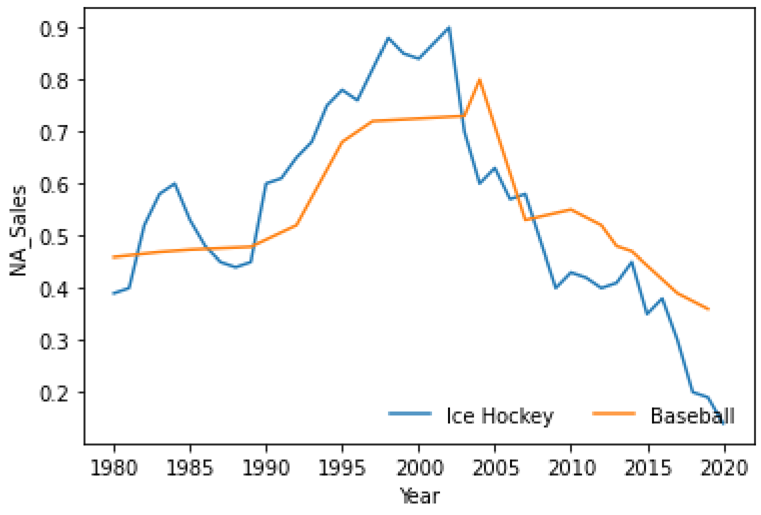
What if we want to add other stylings to legends ?

For eg:

- Specify the **number of rows/cols**
  - Uses parameter `ncols` for this
  - The number of **rows are decided automatically**
- Decide if we want the box of legends to be displayed
  - Use the bool param `frameon`

and so on.

In [ ]:
```python
sns.lineplot(x='Year', y='NA_Sales', data=ih)
sns.lineplot(x='Year', y='NA_Sales', data=baseball)
plt.legend(['Ice Hockey','Baseball'], loc='lower right', ncol = 2, framec
plt.show()
```



Now say we want to highlight a point on our curve.

For e.g.

How can we highlight the maximum "Ice Hockey" sales across all years ?

Let's first find this point

In [ ]:
```python
print(max(ih['NA_Sales']))
```

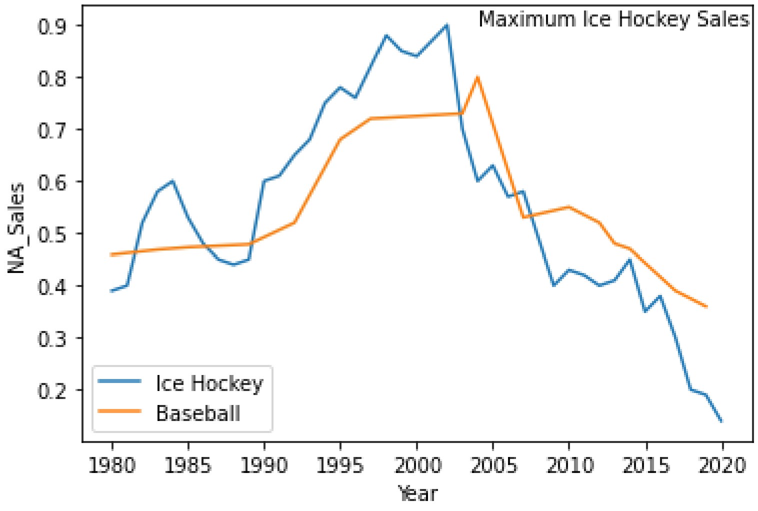
```
0.9
```

If we observe, this point lies in the year 2004-5 around

Now we need to add text to this point (2004,0.9)

How can we add text to a point in a figure ?

In [ ]:
```python
sns.lineplot(x='Year', y='NA_Sales', data=ih)
sns.lineplot(x='Year', y='NA_Sales', data=baseball)
plt.legend(['Ice Hockey','Baseball'], loc='lower left')
plt.text(2004,max(ih['NA_Sales']), 'Maximum Ice Hockey Sales')
plt.show()
```

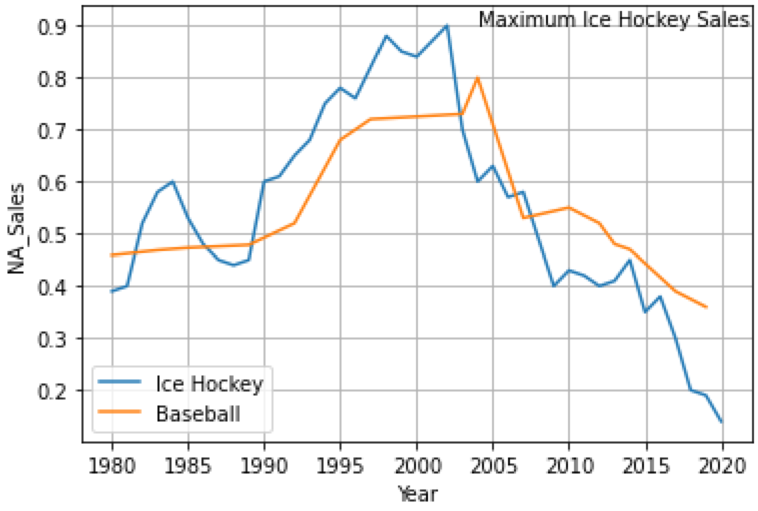


By using `plt.text()`

- Pass in the **x and y coordinates** where we want the text to appear
- Pass in the **text string**

We can also use `plt.grid()` to show the grid layout in the background

In [ ]:
```python
sns.lineplot(x='Year', y='NA_Sales', data=ih)
sns.lineplot(x='Year', y='NA_Sales', data=baseball)
plt.legend(['Ice Hockey','Baseball'], loc='lower left')
plt.text(2004,max(ih['NA_Sales']), 'Maximum Ice Hockey Sales')
plt.grid()
plt.show()
```



Note:

We can **pass in parameters inside `plt.grid()` to control its density, colour of grid lines, etc.**

You can look it up later on how to customize the grid

https://matplotlib.org/stable/api/_as_gen/matplotlib.pyplot.grid.html (https://matplotlib.org/stable/api/_as_gen/matplotlib.pyplot.grid.html)

Type *Markdown* and LaTeX: α^2

Scatter Plot

Now suppose we want to find the relation between `Rank` and `Sales` of all games.

Are `Rank` and `Sales` positively or negatively correlated?

In this case, unlike line plot, there maybe multiple points in y-axis for each point in x-axis

In [ ]:
```
data.head()
```

Out[83]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales
0	2061	1942	NES	1985.0	Shooter	Capcom	4.569217	3.033887	3.439352
1	9137	¡Shin Chan Flipa en colores!	DS	2007.0	Platform	505 Games	2.076955	1.493442	3.033887
2	14279	.hack: Sekai no Mukou ni + Versus	PS3	2012.0	Action	Namco Bandai Games	1.145709	1.762339	1.493442
3	8359	.hack//G.U. Vol.1//Rebirth	PS2	2006.0	Role-Playing	Namco Bandai Games	2.031986	1.389856	3.228043
4	7109	.hack//G.U. Vol.2//Reminisce	PS2	2006.0	Role-Playing	Namco Bandai Games	2.792725	2.592054	1.440483

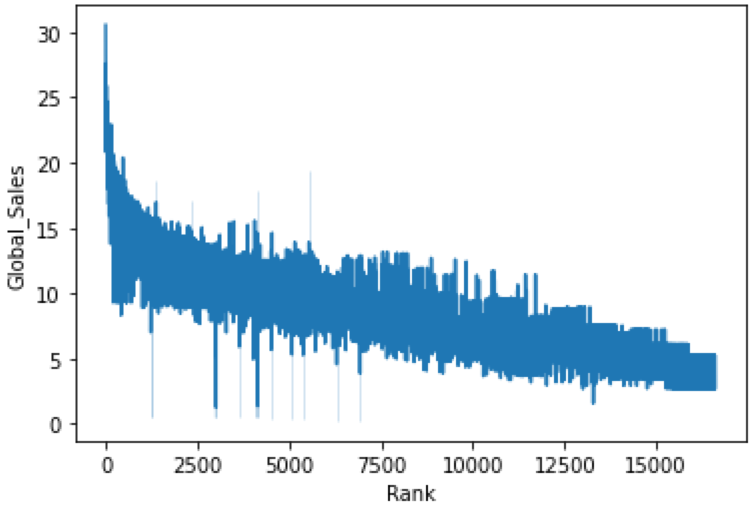
How can we plot the relation between `Rank` and `Global Sales` ?

Can we use lineplot?

Let's try it out

In [ ]:
```python
sns.lineplot(data=data, x='Rank', y='Global_Sales')
```

Out[85]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fcb8c83b1c0>
```



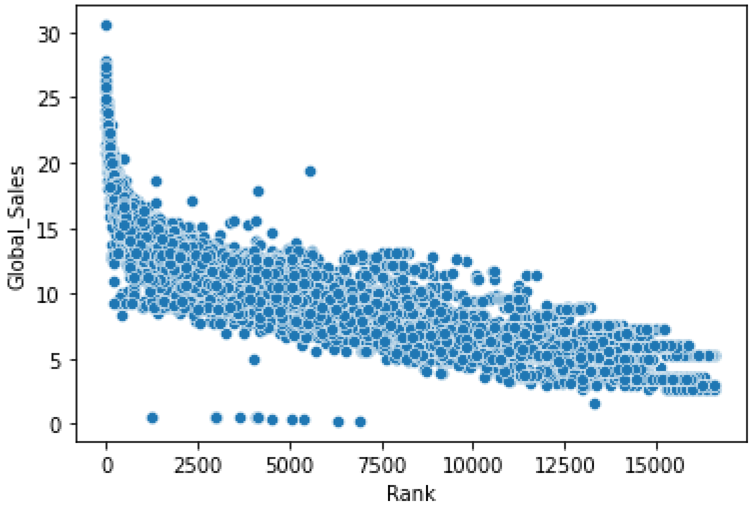
The plot itself looks very messy and it's hard to find any patterns from it.

Is there any other way we can visualize this relation?

Use scatter plot

In [ ]:
```python
sns.scatterplot(data=data, x='Rank', y='Global_Sales')
```

Out[84]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fcb8c9a59d0>
```



Compared to lineplot, we are able to see the patterns and points more distinctly now!

Notice,

- The two variables are negatively correlated with each other
- With increase in ranks, the sales tend to go down, implying, lower ranked games have higher sales overall!

Scatter plots help us visualize these relations and find any patterns in the data

Key Takeaways:

- For Continuous-Continuous Data => Scatter Plot, Line Plot

Sometimes, people also like to display the linear trend between two variables - Regression Plot, do check that

Categorical-Categorical

Earlier we saw how to work with continous-continuous pair of data

Now let's come to the second type of pair of data: **Categorical-Categorical**

What questions comes to your mind when we say categorical-categorical pair?

Questions related to distribution of a category within another category

- What is the **distribution of genres for top-3 publishers**?
- Which **platforms do these top publishers use?**

Which plot can we use to show distribution of one category with respect to another?

-> We can have can **have multiple bars for each category**

- These multiple bars can be stacked together - **Stacked Countplot**

Or

- Can be placed next to each other - **Dodged Countplot**

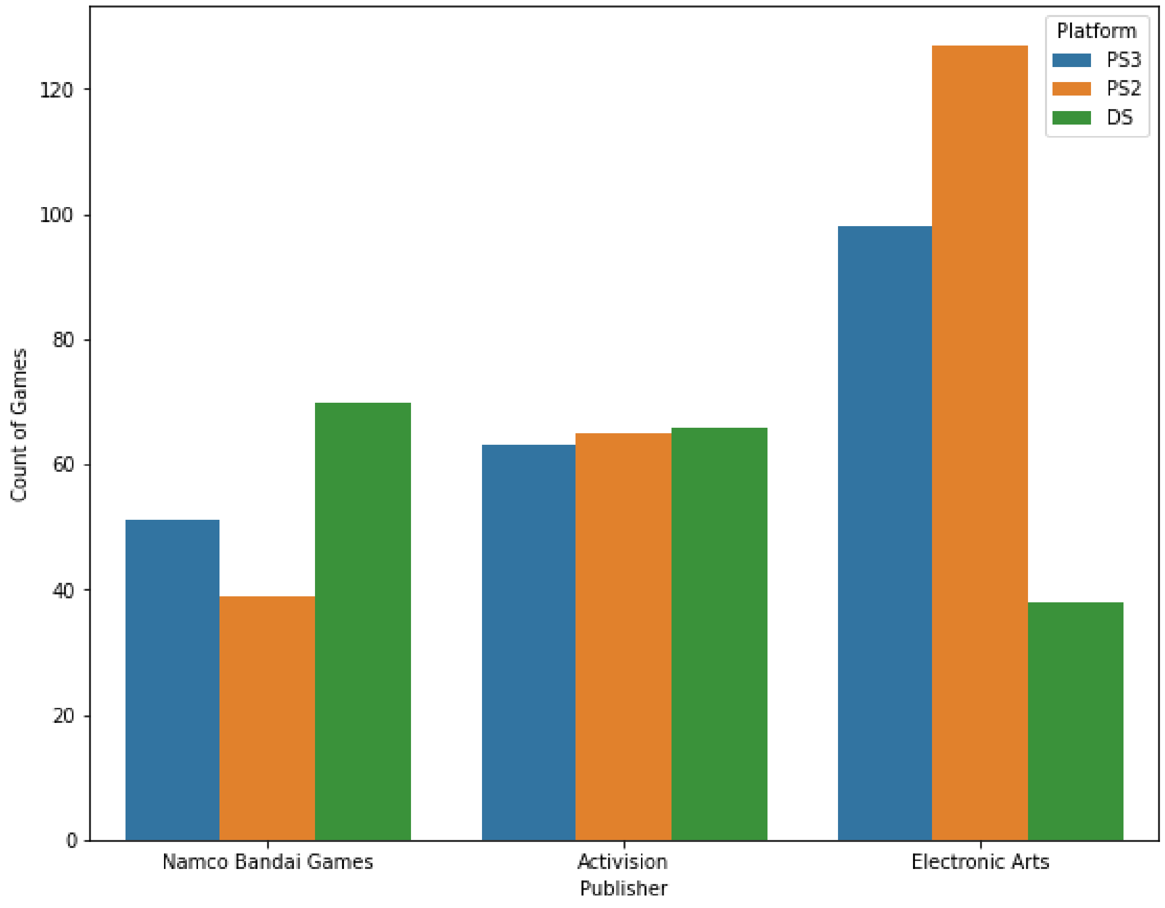
Dodged Count Plot

How can we compare the top 3 platforms these publishers use?

We can use a dodged countplot in this case

```
In [ ]:
plt.figure(figsize=(10,8))
sns.countplot(x='Publisher',hue='Platform',data=top3_data)
plt.ylabel('Count of Games')
```

```
Out[6]: Text(0, 0.5, 'Count of Games')
```



What can we infer from the dodged countplot?

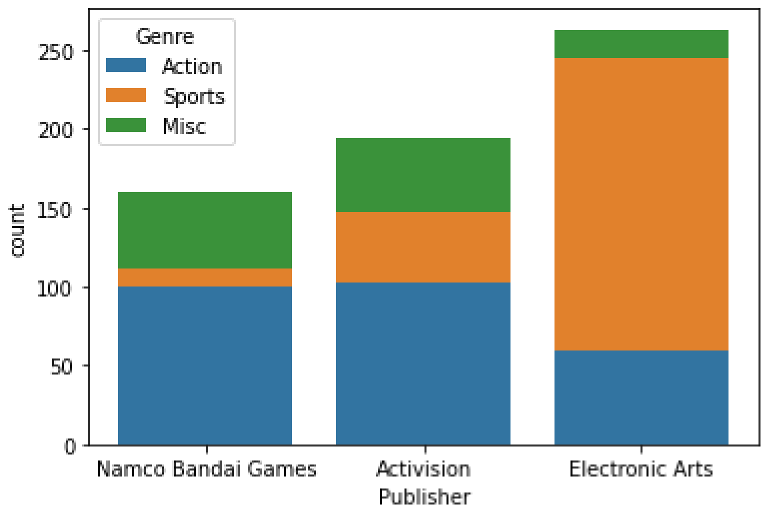
- EA releases PS2 games way more than any other publisher, or even platform!
- Activision has almost the same count of games for all 3 platforms
- EA is leading in PS3 and PS2, but Namco leads when it comes to DS platform

Stacked Countplot

How can we visualize the distribution of genres for top-3 publishers?

We can use a `stacked countplot`

Do refer the postread for the code on how to plot it



But stacked countplots can be misleading

Some may find it difficult to understand if it starts from baseline or from on top of the bottom area

How do we decide between a Stacked countplot and Dodged countlot?

- Stacked countplots are a good way to represent totals
- While dodged countplots helps us to comapare values between various categories, and within the category itself too

Continous-Categorical

Now let's look at our 3rd type of data pair

What kind of questions we may have regarding a continuous-categorical pair?

- We might to want calculate some numbers category wise
    - Like **What is the average sales for every genre?**
- Or we might be interested in checking the distribution of the data category-wise
    - **What is the distribution of sales for the top3 publishers?**

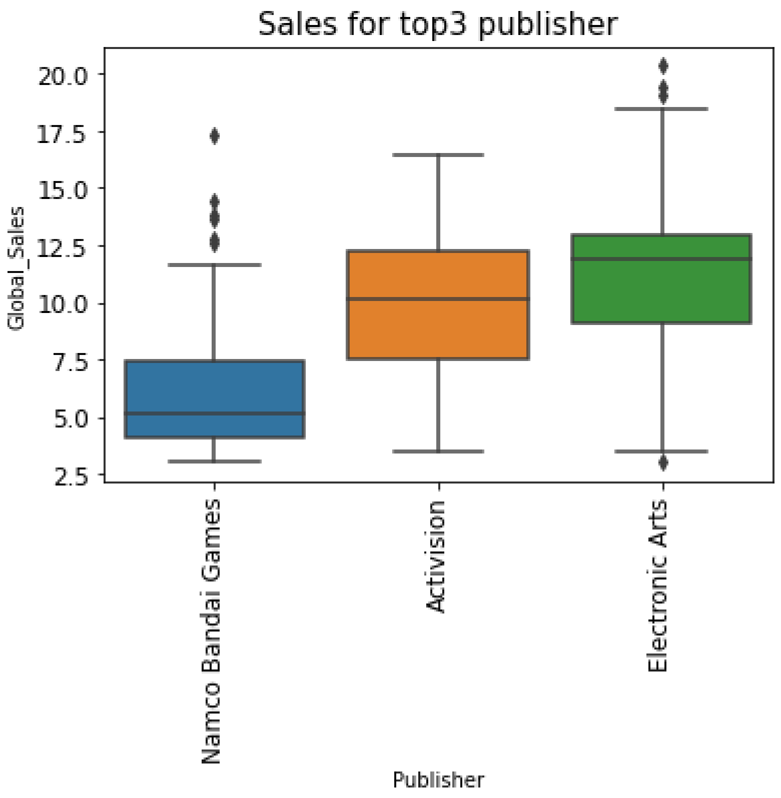
What kind of plot can we make for every category?

-> Either KDE plot or Box Plot per category

Boxplot

What is the distribution of sales for the top3 publishers?

In [ ]:
```python
sns.boxplot(x='Publisher', y='Global_Sales', data=top3_data)
plt.xticks(rotation=90,fontsize=12)
plt.yticks(fontsize=12)
plt.title('Sales for top3 publisher', fontsize=15)
plt.show()
```



What can we infer from this plot?

- The overall sales of EA is higher, with a much larger spread than other publishers
- Activision doesn't have many outliers, and if you notice, even thought the spread is lesser than EA, the median is almost the same

Barplot

What if we want to compare the sales between the genres?

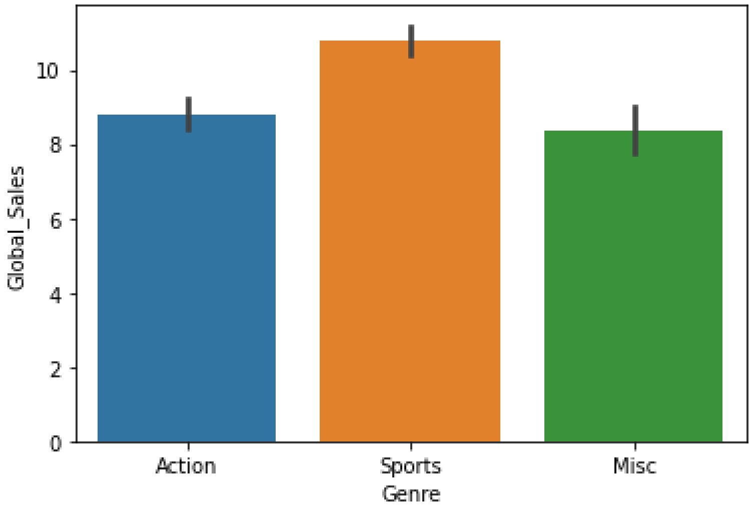
We have to use:

- Genre (categorical)
- Mean of global sales per genre (numerical)

How to visualize which genres bring higher average global sales?

In [ ]:
```
sns.barplot(data=top3_data, x="Genre", y="Global_Sales", estimator=np.mea
```

Out[8]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff5d9e28f10>
```



If you remember, we had earlier seen EA had a larger market share of sales

Along with this fact, majority of games EA made was sports

This ultimately proves the fact that Sports has a high market share in the industry, as shown in the barchart

Multivariate

Let’s try to add 3rd variable on the top of the plots we have seen so far

NNC

How can we visualize the correlation between NA and EU, but for different genres?

Here, we have two numerical and one categorical variable!

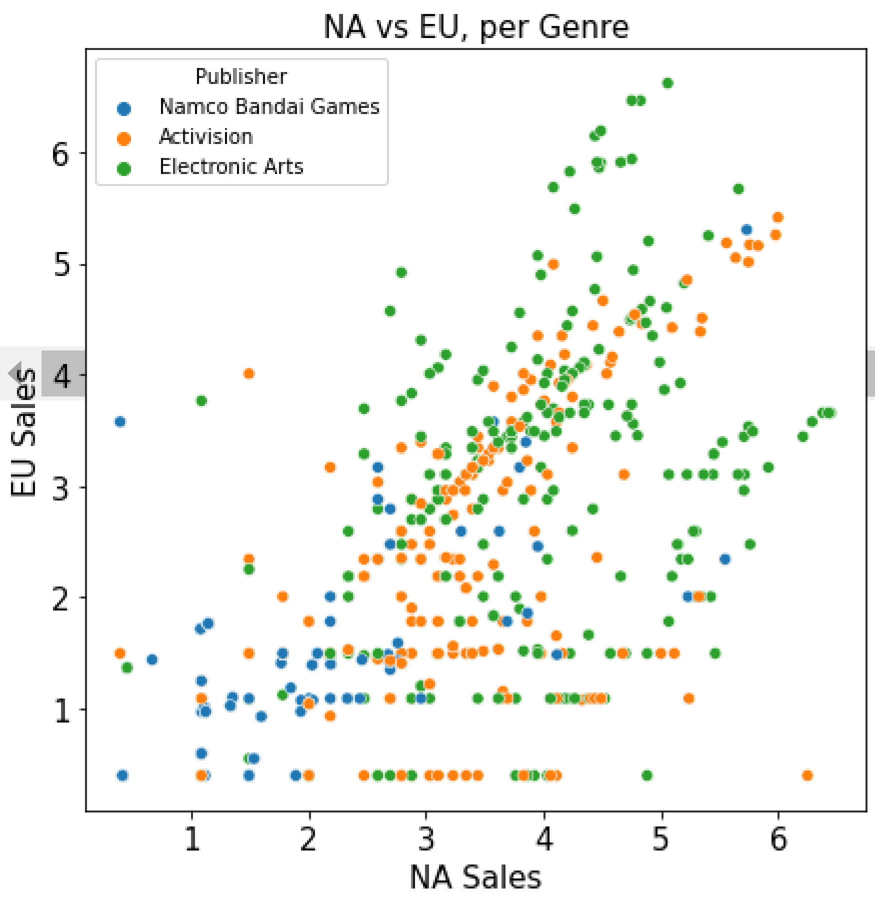
Numerical-Numerical → Scatterplot, need to add info about one categorical variable

Numerical-Categorical → Boxplot, need to add info about one numerical variable

Let's ask two questions

- Is it Possible to add information about a continuous variable upon boxplots?
  - Perhaps No
- Is it Possible to add information about a categorical variable on scatterplot?
  - Yes, use colors

In [ ]:
```python
plt.figure(figsize=(7,7))
sns.scatterplot(x='NA_Sales', y='EU_Sales',hue='Publisher',data=top3_data
plt.xticks(fontsize=15)
plt.yticks(fontsize=15)
plt.xlabel('NA Sales',fontsize=15)
plt.ylabel('EU Sales',fontsize=15)
plt.title('NA vs EU, per Genre', fontsize=15)
plt.show()
```



Inferences:

- If we see this plot, we can notice now that Namco has lower sales correlation, while Activision has a concentrated positivee correlation
- EA also has positive correlation, but it's more spread compared to Activision

CCN

Now, how will you visualize Global Sales for each publisher, but separated by Genres?

We have two categorical and one numerical data here!

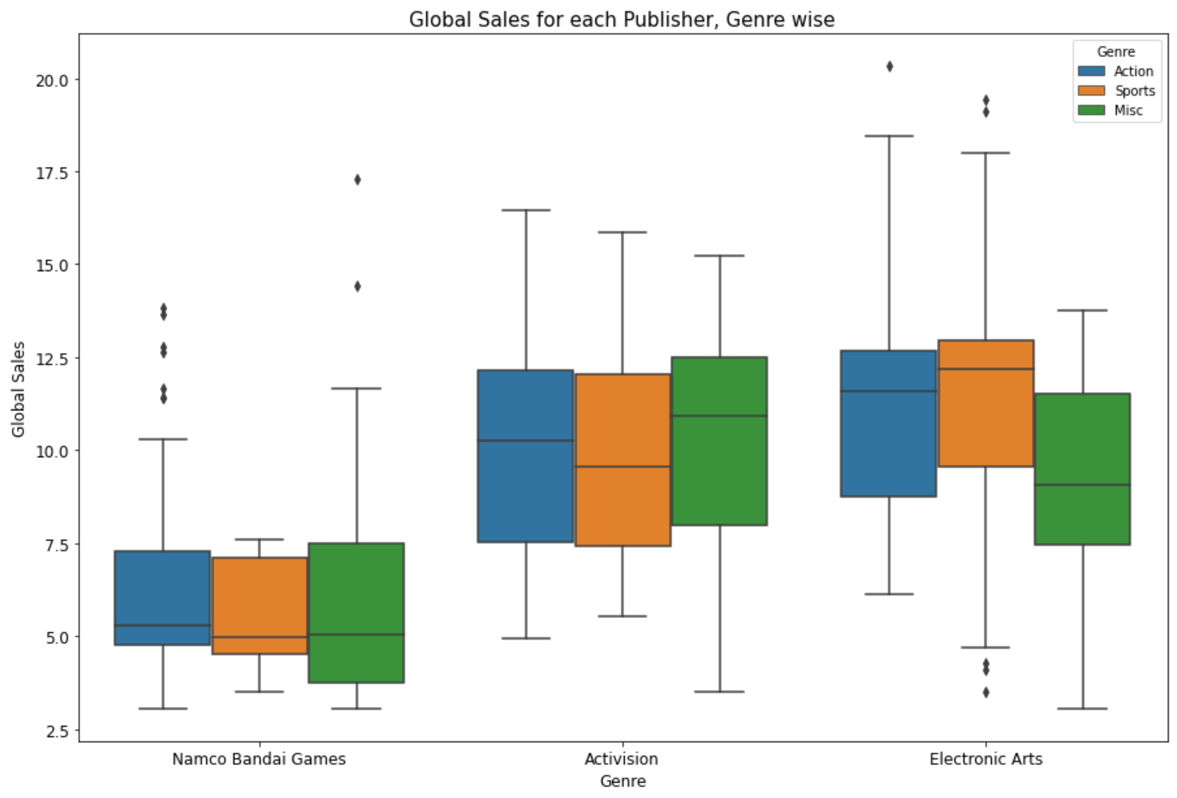
- Categorical-Categorical → Stacked Barplot, need to add info about one continuous feature

- Categorical-Numerical → Boxplots, need to add categorical variable

Which one is easier and possible? We can add one categorical variable by “dodging” multiple boxplots

Solution: Dodged Boxplots

In [ ]:
```python
plt.figure(figsize=(15,10))
sns.boxplot(x='Publisher',y='Global_Sales',hue='Genre',data=top3_data)
plt.xlabel('Genre', fontsize=12)
plt.ylabel('Global Sales', fontsize=12)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.title('Global Sales for each Publisher, Genre wise', fontsize=15)
plt.show()
```



Inferences:

- Namco has lower median sales in every Genre as compared to all publishers
- Looking at `Action` Genre, even though EA and Activision has almost similar medians, Action is more spread in EA
- An interesting thing to notice here is that, for each of the three publishers, three different genre of games have higher sales median:
  - Namco: Action
  - Activision: Misc
  - EA: Sports

NNN

So far we have seen how NA and EU are correlated with each other.

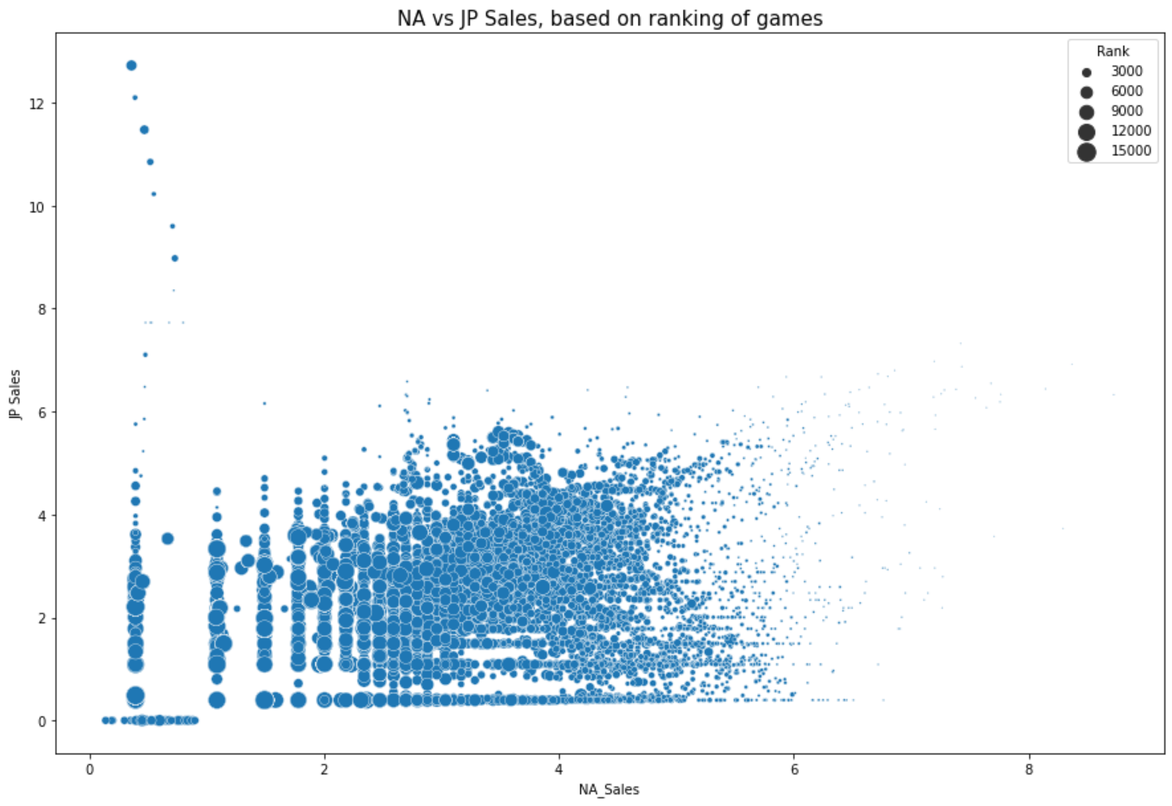
But how can we compare the data when we have 3 numerical variables?

Say, the question is, how does rank affect the correlation between NA and EU Sales?

We have used scatter plot for two numerical features, we have two options here

- Make a 3D Scatterplot
  - → nice for 3D viz, but tough to report/show in static setting
- Add info about 3rd feature on the 2D scatter plot itself
  - → Bubble Chart

In [ ]:
```python
plt.figure(figsize=(15,10))
sns.scatterplot(x=data['NA_Sales'], y=data['JP_Sales'],data=top3_data, si
plt.xlabel('NA_Sales',fontsize=10)
plt.ylabel('JP Sales', fontsize=10)
plt.title('NA vs JP Sales, based on ranking of games', fontsize=15)
plt.show()
```



Inferences:

- Now interestingly, we can notice that higher ranking games are actually on the upper scale of sales, while lower ranking games are low on the sales side

Subplots

So far we have **shown only 1 plot** using `plt.show()`

Say, we want to plot the trend of NA and every other region separately in a single figure

How can we plot multiple smaller plots at the same time?

We will use **subplots**, i.e., **divide the figure into smaller plots**

We will be using `plt.subplots()` It takes mainly 2 arguments:

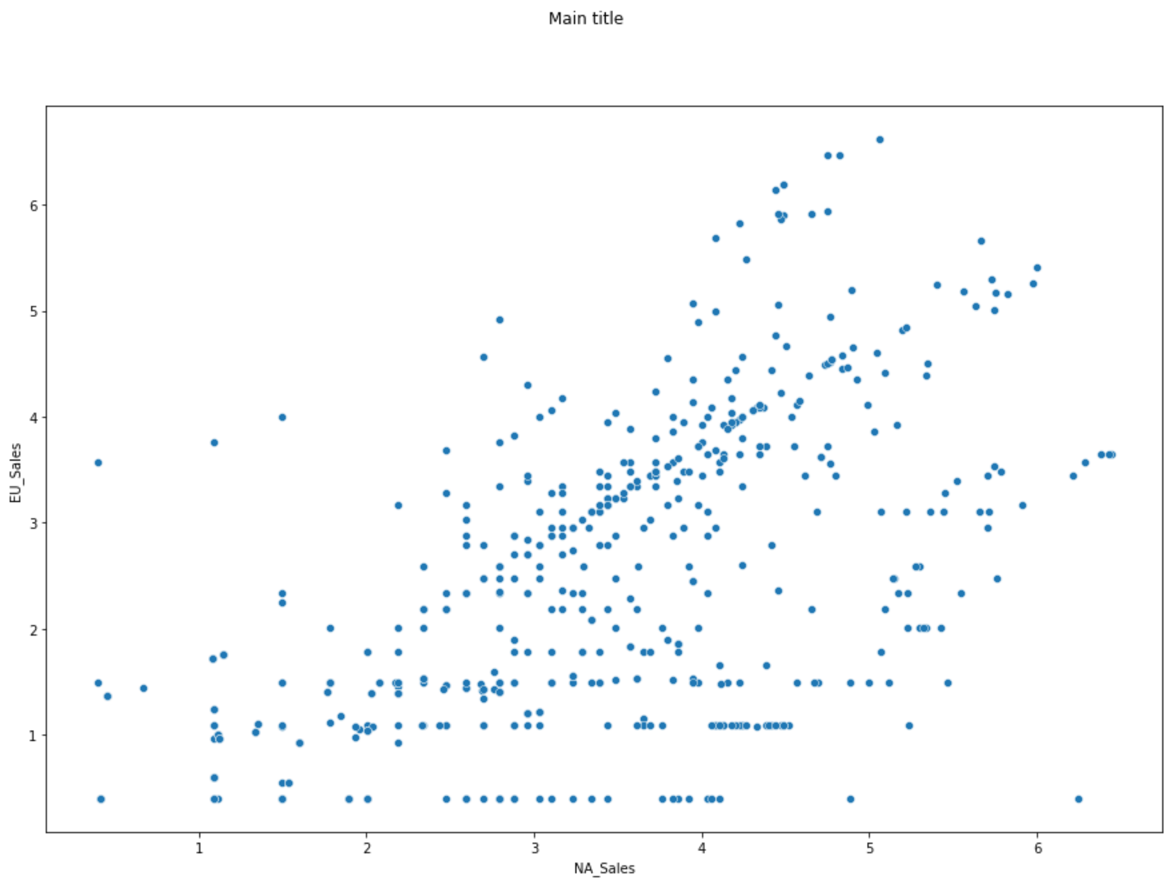
1. **No. of rows** we want to **divide our figure** into
2. **No. of columns** we want to **divide our figure** into

It returns 2 things:

- Figure
- Numpy Matrix of subplots

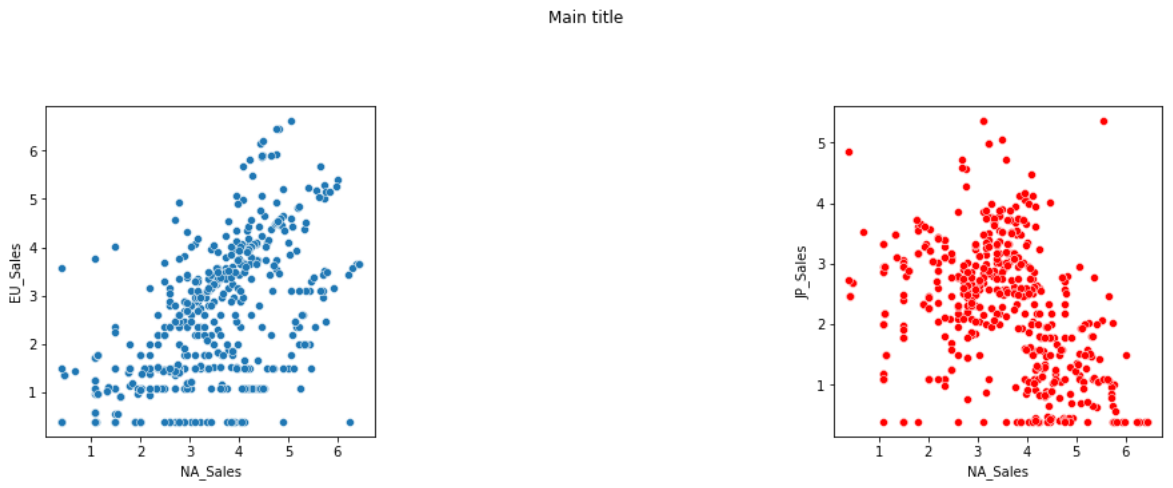
In [ ]:
```python
fig = plt.figure(figsize=(15,10))
sns.scatterplot(top3_data['NA_Sales'], top3_data['EU_Sales'])
fig.suptitle('Main title')
plt.show()
```

```
/usr/local/lib/python3.8/dist-packages/seaborn/_decorators.py:36: FutureWarn
ing: Pass the following variables as keyword args: x, y. From version 0.12,
the only valid positional argument will be `data`, and passing other argumen
ts without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```



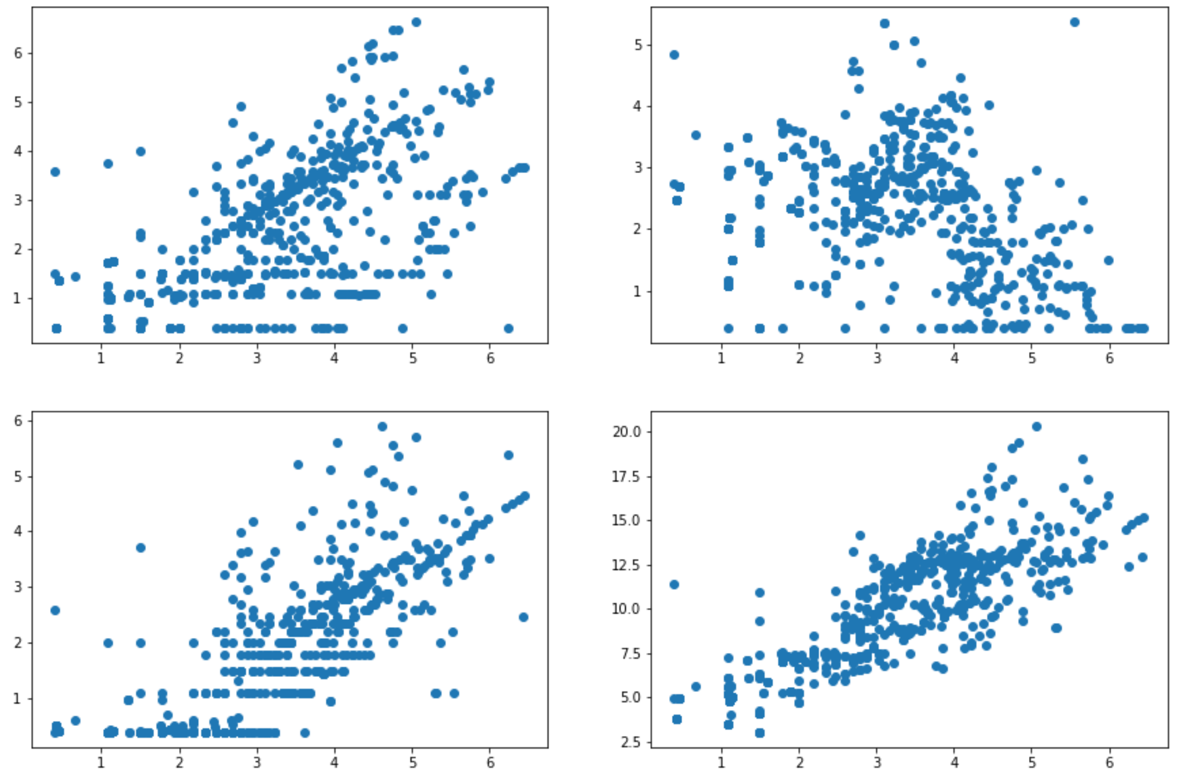
In [ ]:
```python
fig = plt.figure(figsize=(15,10))

plt.subplot(2, 3, 1)
sns.scatterplot(x='NA_Sales', y='EU_Sales', data=top3_data)


plt.subplot(2, 3, 3)
sns.scatterplot(x='NA_Sales', y='JP_Sales', data=top3_data, color='red')

fig.suptitle('Main title')


```

Out[16]:
```
Text(0.5, 0.98, 'Main title')
```



In [ ]:
```
fig, ax = plt.subplots(2, 2, figsize=(15,10))
ax[0,0].scatter(top3_data['NA_Sales'], top3_data['EU_Sales'])
ax[0,1].scatter(top3_data['NA_Sales'], top3_data['JP_Sales'])
ax[1,0].scatter(top3_data['NA_Sales'], top3_data['Other_Sales'])
ax[1,1].scatter(top3_data['NA_Sales'], top3_data['Global_Sales'])
```

Out[33]:
```
<matplotlib.collections.PathCollection at 0x7f5aad73d730>
```



Notice, we are using 2 numbers during each plotting

Think of subplots as a 2x2 grids, with the two numbers denoting `x,y` / `row,column` coordinate of each subplot

What is this `ax` parameter exactly?

In [ ]:
```
print(ax)
```

```
[[<matplotlib.axes._subplots.AxesSubplot object at 0x7f5aad891850>
  <matplotlib.axes._subplots.AxesSubplot object at 0x7f5aad82b340>]
 [<matplotlib.axes._subplots.AxesSubplot object at 0x7f5aaddefa60>
  <matplotlib.axes._subplots.AxesSubplot object at 0x7f5aade221c0>]]
```

Notice,

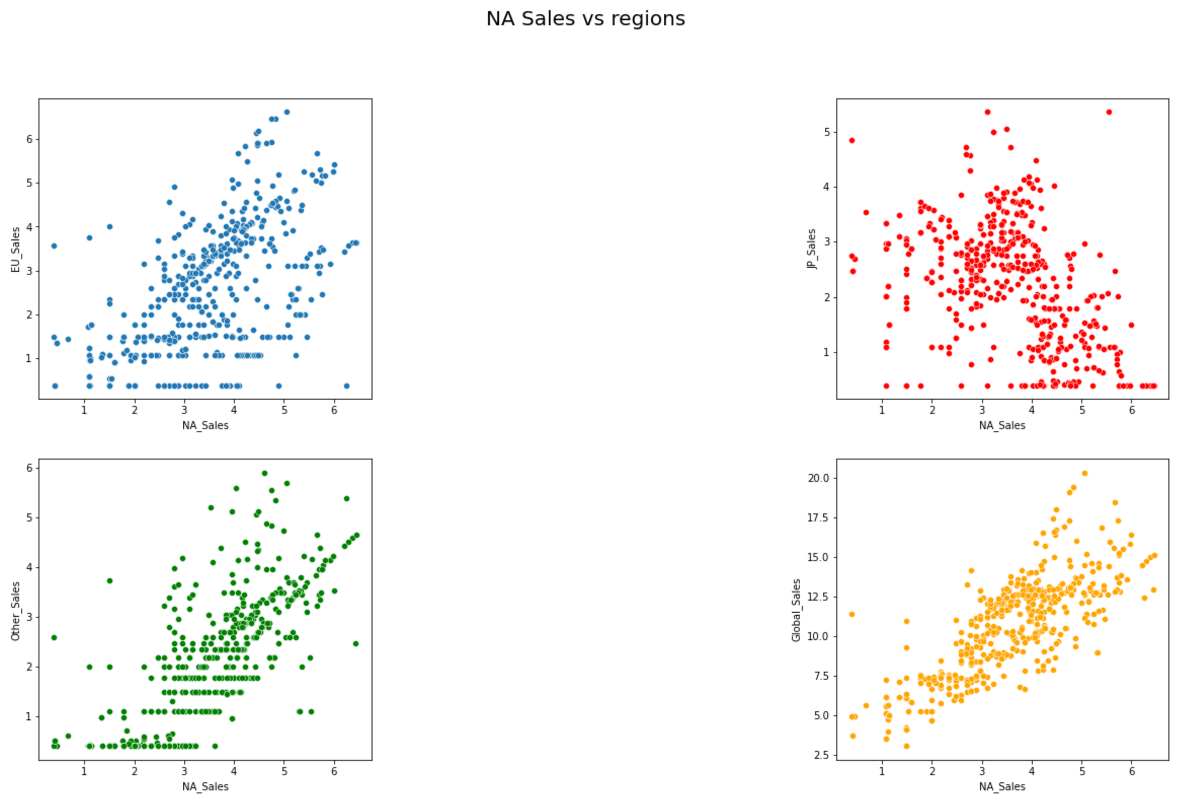
- It's a 2x2 matrix of multiple axes objects

We are plotting each plot on a single `axes` object.

Hence, we are using a 2D notation to access each grid/axes object of the subplot

Instead of accesing the individual axes using `ax[0, 0]` , `ax[1, 0]` , there is another method we can use too

In [ ]:
```python
import matplotlib.pyplot as plt
import numpy as np

plt.figure(figsize=(20,12)).suptitle("NA Sales vs regions",fontsize=20)
# Using a 2x3 subplot
plt.subplot(2, 3, 1)
sns.scatterplot(x='NA_Sales', y='EU_Sales', data=top3_data)


plt.subplot(2, 3, 3)
sns.scatterplot(x='NA_Sales', y='JP_Sales', data=top3_data, color='red')


plt.subplot(2, 3, 4)
sns.scatterplot(x='NA_Sales', y='Other_Sales', data=top3_data, color='gre

plt.subplot(2, 3, 6)
sns.scatterplot(x='NA_Sales', y='Global_Sales', data=top3_data, color='or

plt.show()
```



`Suptitle` adds a title to the whole figure

We need to observe a few things here

1. The 3rd paramter defines the position of the plot

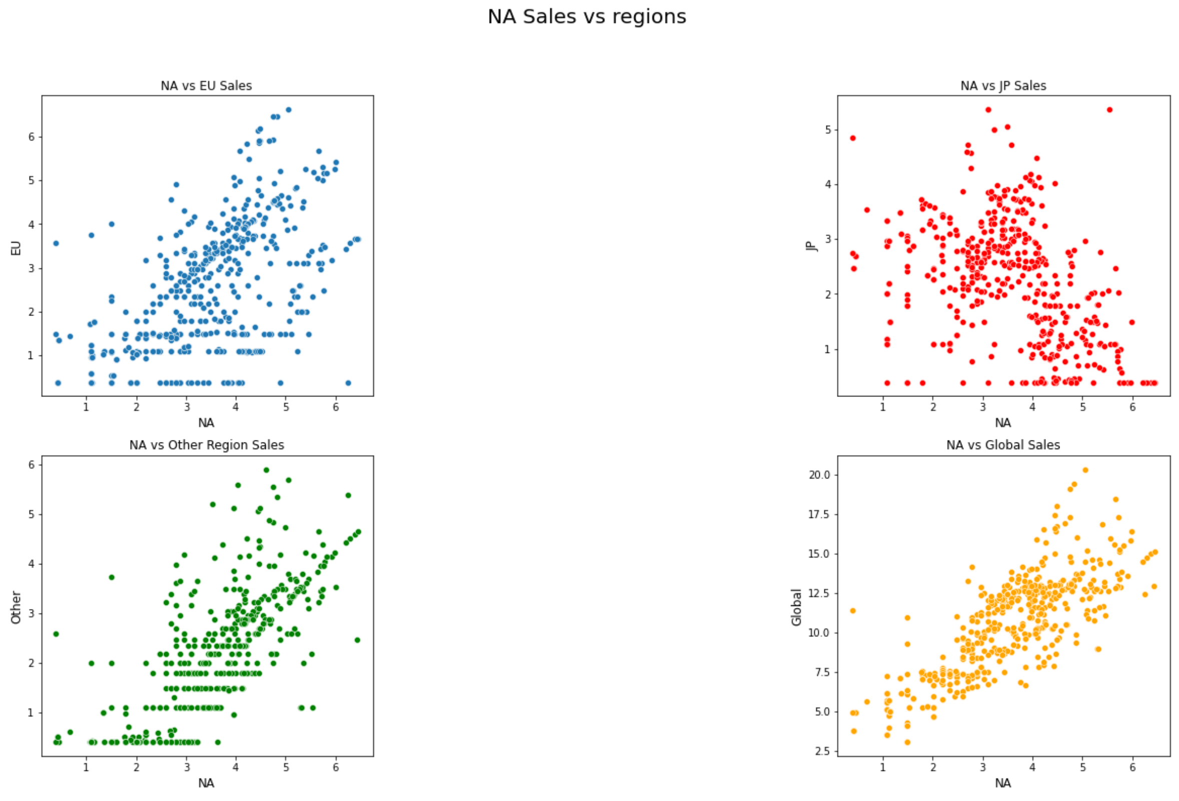
2. The position/numbering starts from 1
3. It goes on row-wise from start of row to its finish
4. Empty subplots don't show any axes

But how do we know which plot belongs to which category?

Basically the context of each plot

We can use `title` , `x/y label` and every other functionality for the subplots too

In [ ]:
```python
plt.figure(figsize=(20,12)).suptitle("NA Sales vs regions",fontsize=20)
# Using a 2x3 subplot
plt.subplot(2, 3, 1)
sns.scatterplot(x='NA_Sales', y='EU_Sales', data=top3_data)
plt.title('NA vs EU Sales', fontsize=12)
plt.xlabel('NA', fontsize=12)
plt.ylabel('EU', fontsize=12)



plt.subplot(2, 3, 3)
sns.scatterplot(x='NA_Sales', y='JP_Sales', data=top3_data, color='red')
plt.title('NA vs JP Sales', fontsize=12)
plt.xlabel('NA', fontsize=12)
plt.ylabel('JP', fontsize=12)


plt.subplot(2, 3, 4)
sns.scatterplot(x='NA_Sales', y='Other_Sales', data=top3_data, color='gre
plt.title('NA vs Other Region Sales', fontsize=12)
plt.xlabel('NA', fontsize=12)
plt.ylabel('Other', fontsize=12)

plt.subplot(2, 3, 6)
sns.scatterplot(x='NA_Sales', y='Global_Sales', data=top3_data, color='or
plt.title('NA vs Global Sales', fontsize=12)
plt.xlabel('NA', fontsize=12)
plt.ylabel('Global', fontsize=12)

plt.show()
```



What if we want to span a plot across the full length of the plot?

Think of this in **terms of a grid.**

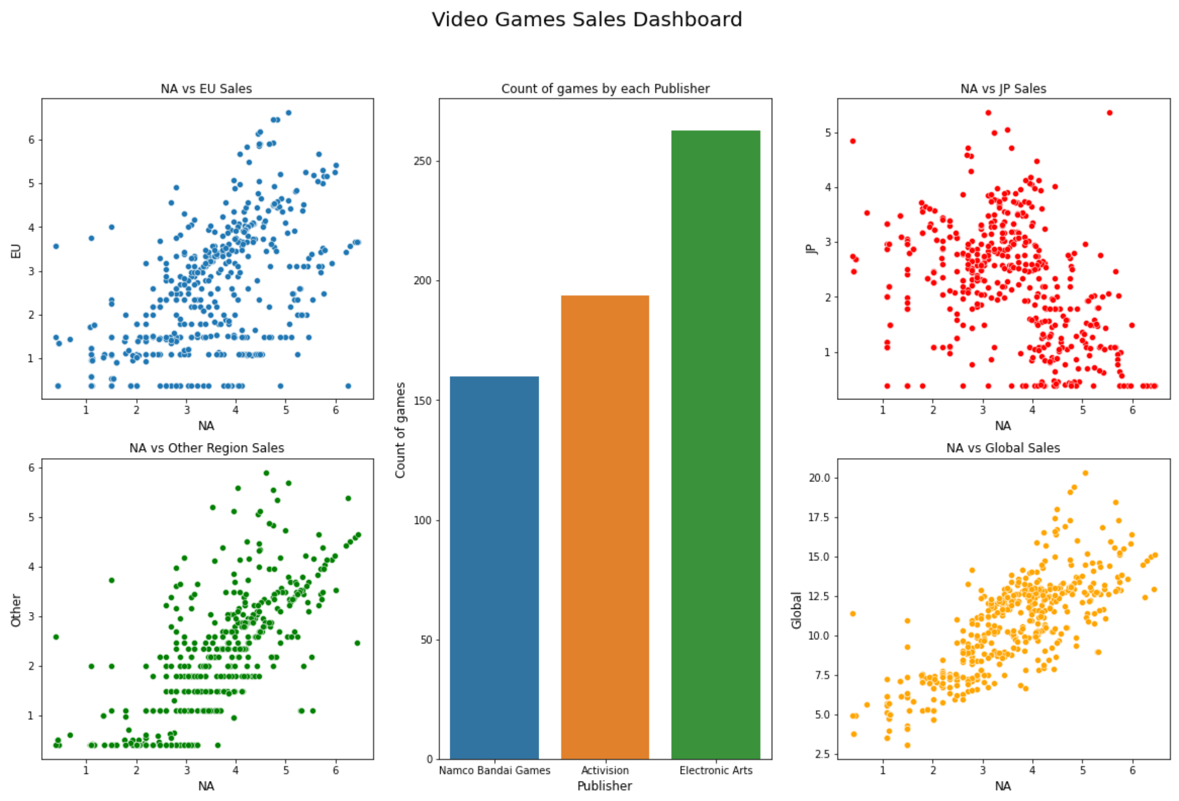
Currently we are **dividing our plot into 2 rows and 3 columns**

But we want our plot to be across the middle column, with grids 2 and 5

This can be said as a **single column**

So, this problem can be simplified to plotting the plot across **second column in a 1 row 3 column subplot**

In [ ]:
```
plt.figure(figsize=(20,12)).suptitle("Video Games Sales Dashboard",fontsi
# Using a 2x3 subplot
plt.subplot(2, 3, 1)
sns.scatterplot(x='NA_Sales', y='EU_Sales', data=top3_data)
plt.title('NA vs EU Sales', fontsize=12)
plt.xlabel('NA', fontsize=12)
plt.ylabel('EU', fontsize=12)



plt.subplot(2, 3, 3)
sns.scatterplot(x='NA_Sales', y='JP_Sales', data=top3_data, color='red')
plt.title('NA vs JP Sales', fontsize=12)
plt.xlabel('NA', fontsize=12)
plt.ylabel('JP', fontsize=12)

# Countplot of publishers
plt.subplot(1,3,2)
sns.countplot(x='Publisher', data=top3_data)
plt.title('Count of games by each Publisher', fontsize=12)
plt.xlabel('Publisher', fontsize=12)
plt.ylabel('Count of games', fontsize=12)

plt.subplot(2, 3, 4)
sns.scatterplot(x='NA_Sales', y='Other_Sales', data=top3_data, color='gre
plt.title('NA vs Other Region Sales', fontsize=12)
plt.xlabel('NA', fontsize=12)
plt.ylabel('Other', fontsize=12)

plt.subplot(2, 3, 6)
sns.scatterplot(x='NA_Sales', y='Global_Sales', data=top3_data, color='or
plt.title('NA vs Global Sales', fontsize=12)
plt.xlabel('NA', fontsize=12)
plt.ylabel('Global', fontsize=12)

plt.show()
```



Joint Plot

Let's see a few more plots that we can visualize using `seaborn`

Joint Plot

- It draws a plot of two variables
- It shows scatter, histogram and KDE graphs in the same plot.

Let's check it out

- We will take **`NA_Sales` as x-coordinates** and **`EU_Sales` as y-coordinates**
- We can select from different values for **parameter `kind`** and it **will plot accordingly**
  - "scatter" | "kde" | "hist" | "hex" | "reg" | "resid"
- We will set **parameter `kind`** to **`'reg'`** here

In [ ]:

```python
sns.jointplot(x='NA_Sales', y='EU_Sales', data=top3_data)
plt.show()
```

As we can see here:

- `jointplot` plots **scatter, histogram and KDE in the same graph** when we set **`kind=reg`**
- Scatter shows the **scattering of (`NA_Sales` , `EU_Sales`) pairs as (x, y) points**
- Histogram and KDE shows the separate distributions of `NA_Sales` and `EU_Sales` in the data

We can also add hue to Joint Plot

- Let's check how the 3 Genres of games are distributed in terms of `NA_Sales` and

In [ ]:
```
sns.jointplot(x='NA_Sales', y='EU_Sales', data=top3_data, hue='Genre')
plt.show()
```

Pair Plot

- `pairplot()` in `seaborn` creates a **grid of Axes by default**
- Each numeric attribute in `data` is shared across the y-axes across a single row and the x-axes across a single column.
- It displays a **scatterplot between each pair of attributes in the data** with different **hue** for each category

Since, the diagonal plots belong to same attribute at both x and y axis, they are treated differently

- A univariate distribution plot is drawn to show the marginal distribution of the data in each column.

Let's check it out

In [ ]:
```
sns.pairplot(data=top3_data, hue='Genre')
plt.show()
```

Notice that:

- It is **like a scatterplot of video games with `hue='Genre'`**
- But the **scatter is plotted between every pair of attributes**
- **Colour Legends** for each genre category are given on **right side**
- It shows **relation between each pair of attributes**

Diagonal plots are different from scatterplots

- Because x and y axis have same attribute

- Diagonal plots show a univariate curve category-wise for each attribute

It is also possible to show a subset of variables or plot different variables on the rows and columns

- Feel free to experiment this on your own

Finding correlations among attributes

- We can find the level of correlation b/w different attributes (variables)

But what exactly is a correlation?

- Two variables are correlated when **they change in same/opposite direction**

We can check coefficient of correlation using `corr()`

In [ ]:
```
top3_data.corr()
```

- Higher the **MAGNITUDE** of coefficient of correlation, more the variables are **correlated**
- The **sign just determines the direction of change**
  - `+` means increase in value of one variable causes increase in value of other variable
  - `-` means increase in value of one variable causes decrease in value of other variable, and vice versa

As you can see, `Global Sales` and `Rank` have the highest correlation coeff of -0.91

Let's plot it using scatter plot

In [ ]:
```
sns.scatterplot(x= 'Global_Sales', y= 'Rank', data = top3_data)
plt.show()
```

- When `petal_length` increases, `petal_width` also increases

But Remember

Correlation does NOT mean Causation

- We cannot conclude that change in values of a variable is causing change in values of other variable

Now, Let's look at a way to visualize correlation among variables

Heat Map

- A heat map plots rectangular data as a color-encoded matrix.

- **Stronger the colour, stronger the correlation b/w the variables**

Let's plot a Heat Map using correlation coefficient matrix generated using `corr()`

In [ ]:
```
sns.heatmap(top3_data.corr(), cmap= "Blues", annot=True)
plt.show()

```

- `annot=True` is for writing correlation coeff inside each cell

You can change the colours of cells in Heat Map if you like

- There are a lot of options available!

In [ ]:
```
print(plt.colormaps())
```

In [ ]:
```
sns.heatmap(top3_data.corr(), cmap= "coolwarm", annot=True)
plt.show()
```

In [ ]:
```

```