Introduction

Today we'll dive deep into a dataset all about LEGO. From the dataset we can ask whole bunch of interesting questions about the history of the LEGO company, their product offering, and which LEGO set ultimately rules them all:

- What is the most enormous LEGO set ever created and how many parts did it have?
- How did the LEGO company start out? In which year were the first LEGO sets released and how many sets did the company sell when it first launched?
- Which LEGO theme has the most sets? Is it one of LEGO's own themes like Ninjago or a theme they licensed liked Harry Potter or Marvel Superheroes?
- When did the LEGO company really expand its product offering? Can we spot a change in the company strategy based on how many themes and sets did it released year-on-year?
- Did LEGO sets grow in size and complexity over time? Do older LEGO sets tend to have more or fewer parts than newer sets?

Data Source

Rebrickable has compiled data on all the LEGO pieces in existence.

Displaying images
displaying images in jupter notebook - from web - same as in HTML
< img src="https://i.imgur.com/49FNOHj.jpg">

or locally like so
< img src="assets/bricks.jpg">

Import Statements

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

Data Exploration

How many different colours does the LEGO company produce?
Reading the colors.csv file in the data folder and finding the total number of unique colours by using the .nunique() method to accomplish this task.

```
colors_df = pd.read_csv("data/colors.csv")
```

```
colors_df.head()
```

	id	name	rgb	is_trans
0	-1	Unknown	0033B2	f

Number of unique colors (rgb) is 124

2	1	Blue	0055BF	f

```
colors_df["name"].nunique()
```

```
135
```

Finding the number of transparent colours where `is_trans == 't'` versus the number of opaque colours where `is_trans == 'f'`.

```
# by selecting data
colors_df[colors_df["is_trans"]=="t"]["name"].count()

# using the groupby funciton
colors_df.groupby("is_trans").count()

# by using the value_counts method
colors_df.is_trans.value_counts()
```

```
f    107
t     28
Name: is_trans, dtype: int64
```

```
# by selecting data
colors_df[colors_df["is_trans"]=="f"]["name"].count()

# using the groupby funciton
colors_df.groupby("is_trans").count()

# by using the value_counts method
colors_df.is_trans.value_counts()
```

```
f    107
t     28
Name: is_trans, dtype: int64
```

Understanding LEGO Themes vs. LEGO Sets

Understanding LEGO Themes vs. LEGO Sets

Walk into a LEGO store and you will see their products organised by theme. Their themes include Star Wars, Batman, Harry Potter and many more.

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< img src="https://i.imgur.com/aKcwkSx.png">

or locally like so
< img src="assets/lego_themes.png">

Architecture

LEGO® Architecture presents some of the iconic buildings of world architecture, all perfectly realized as LEGO models. From well-known buildings to more imaginative choices that still reflect architectural excellence, these will make a great addition to any desk, home or playroom.

Batman™

Night has fallen on Gotham City™ and builders everywhere are ready for Batman sets. They can battle against the bad guys with their favorite Dark Knight.

BOOST

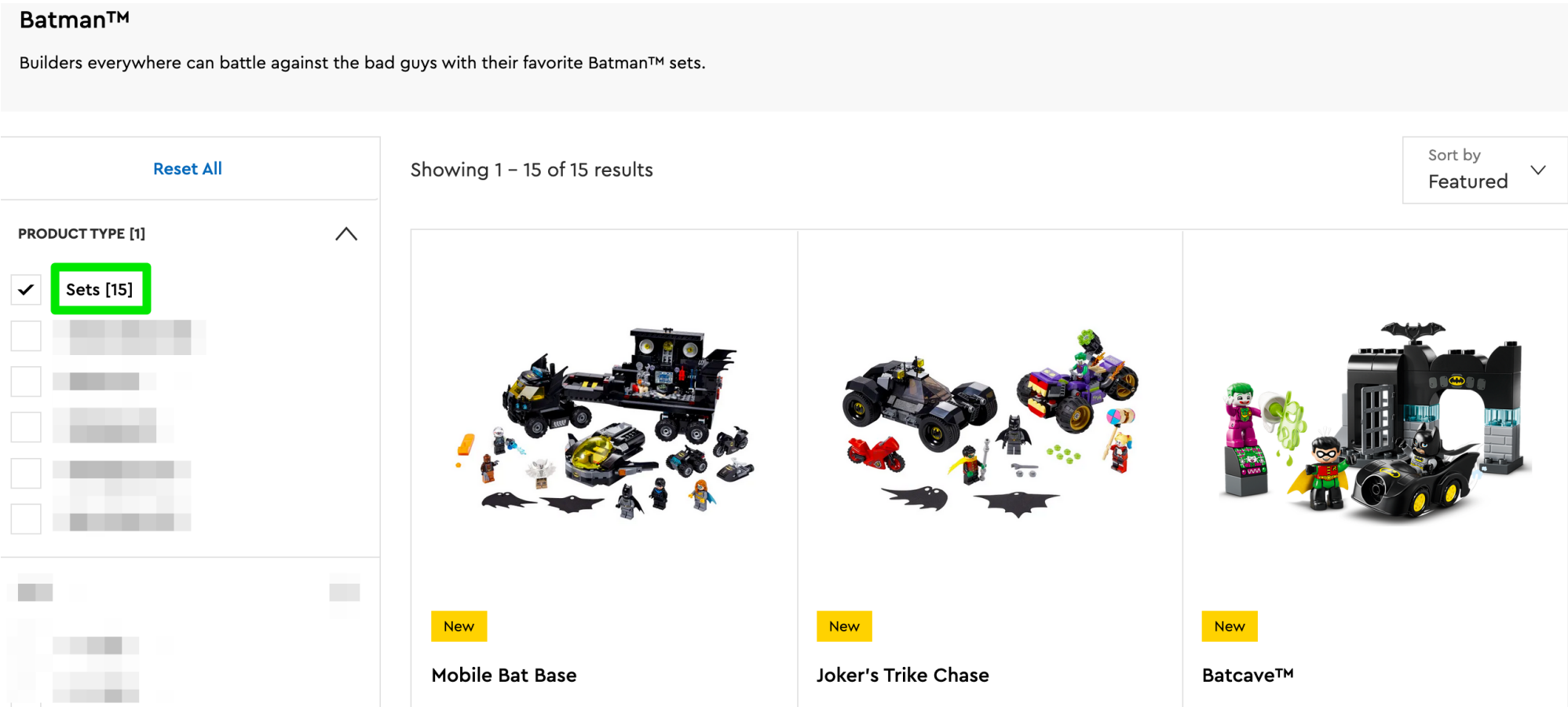
LEGO® BOOST lets children create models with motors and sensors, and then bring their creations to life through simple, icon-based coding commands. The free LEGO BOOST tablet app includes easy step-by-step building instructions for creating and coding multifunctional models.

A lego set is a particular box of LEGO or product. Therefore, a single theme typically has many different sets.

displaying images in jupter notebook - from web - same as in HTML
< img src="https://i.imgur.com/whB1olq.png">

or locally like so

< img src="assets/lego_sets.png">



The `sets.csv` data contains a list of sets over the years and the number of parts that each of these sets contained.

Reading the sets.csv data and taking a look at the first and last couple of rows.

```
sets_df = pd.read_csv("data/sets.csv")
sets_df.head()
```

	set_num	name	year	theme_id	num_parts
0	001-1	Gears	1965	1	43
1	0011-2	Town Mini-Figures	1978	84	12
2	0011-3	Castle 2 for 1 Bonus Offer	1987	199	0
3	0012-1	Space Mini-Figures	1979	143	12
4	0013-1	Space Mini-Figures	1979	143	12

```
sets_df.tail()
```

	set_num	name	year	theme_id	num_parts
15705	wwgp1-1	Wild West Limited Edition Gift Pack	1996	476	0
15706	XMASTREE-1	Christmas Tree	2019	410	26
15707	XWING-1	Mini X-Wing Fighter	2019	158	60
15708	XWING-2	X-Wing Trench Run	2019	158	52
15709	YODACHRON-1	Yoda Chronicles Promotional Set	2013	158	413

Showing In which year were the first LEGO sets released and what were these sets called?

```
sets_df.sort_values("year").head()
```

	set_num	name	year	theme_id	num_parts
9521	700.1-1	Extra-Large Gift Set (ABB)	1949	365	142
9534	700.2-1	Large Gift Set (ABB)	1949	365	178
9539	700.3-1	Medium Gift Set (ABB)	1949	365	142
9544	700.A-1	Small Brick Set (ABB)	1949	371	24
9545	700.B-1	Small Doors and Windows Set (ABB)	1949	371	12

```
sets_df[sets_df["year"]==sets_df.year.min()]
```

	set_num	name	year	theme_id	num_parts
9521	700.1-1	Extra-Large Gift Set (ABB)	1949	365	142
9534	700.2-1	Large Gift Set (ABB)	1949	365	178
9539	700.3-1	Medium Gift Set (ABB)	1949	365	142
9544	700.A-1	Small Brick Set (ABB)	1949	371	24
9545	700.B-1	Small Doors and Windows Set (ABB)	1949	371	12

Finding how many different sets did **LEGO** sell in their first year? How many types of LEGO products were on offer in the year the company started?

```
sets_df[sets_df["year"]==sets_df.year.min()]
```

	set_num	name	year	theme_id	num_parts
9521	700.1-1	Extra-Large Gift Set (ABB)	1949	365	142
9534	700.2-1	Large Gift Set (ABB)	1949	365	178
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9544	700.A-1	Small Brick Set (ABB)	1949	371	24
9545	700.B-1	Small Doors and Windows Set (ABB)	1949	371	12

Finding the top 5 LEGO sets with the most number of parts.

```
sets_df.sort_values("num_parts", ascending=False).head()
```

	set_num	name	year	theme_id	num_parts
15004	BIGBOX-1	The Ultimate Battle for Chima	2015	571	9987
11183	75192-1	UCS Millennium Falcon	2017	171	7541
10551	71043-1	Hogwarts Castle	2018	246	6020
295	10256-1	Taj Mahal	2017	673	5923
221	10189-1	Taj Mahal	2008	673	5922

Using `.groupby()` and `.count()` to show the number of LEGO sets released year-on-year. How do the number of sets released in 1955 compare to the number of sets released in 2019?

```
sets_by_year_df = sets_df.groupby("year").count()
sets_by_year_df["set_num"].head()
```

```
year
1949     5
1950     6
1953     4
1954    14
1955    28
Name: set_num, dtype: int64
```

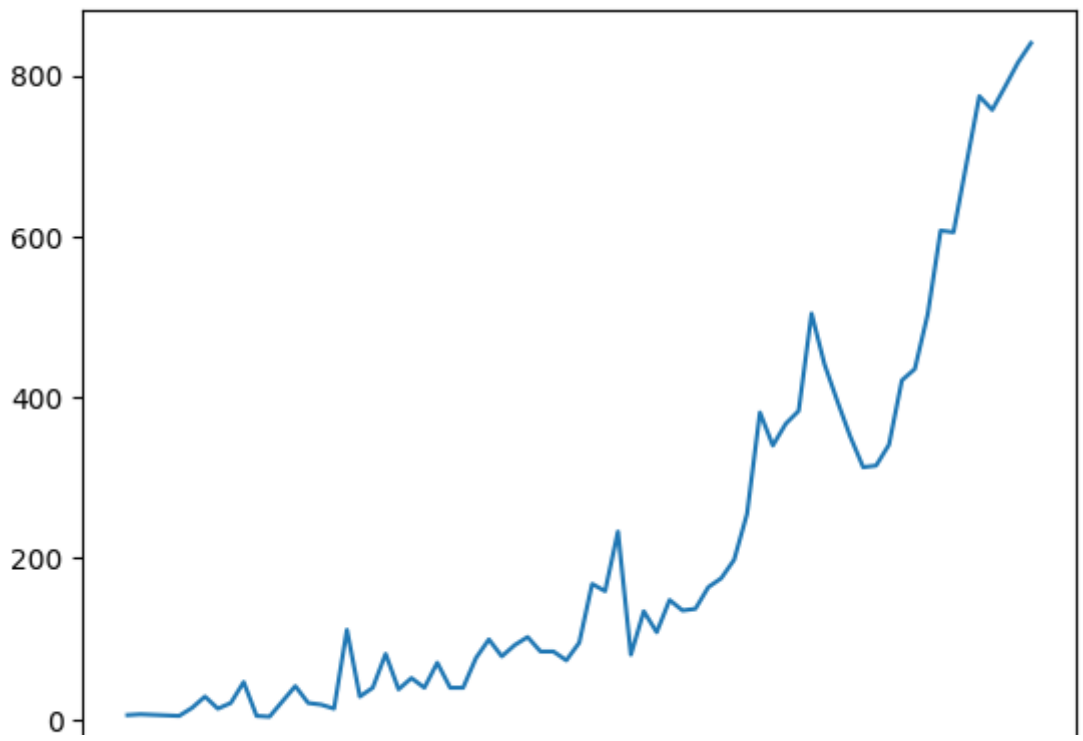
a plot of num_sets by year excluding last tow years as the data for last two year is not complete

Showing the number of LEGO releases on a line chart using Matplotlib.

Note that the .csv file is from late 2020, so to plot the full calendar years, you will have to exclude some data from your chart. Can you use the slicing techniques covered in Day 21 to avoid plotting the last two years? The same syntax will work on Pandas DataFrames.

```
plt.plot(sets_by_year_df.index[:-2], sets_by_year_df["set_num"][:-2])
```

```
C:\Users\AS-Computer\AppData\Local\Temp\ipykernel_16356\3661060426.py:1: FutureWarning: The behavior of
  plt.plot(sets_by_year_df.index[:-2], sets_by_year_df["set_num"][:-2])
[<matplotlib.lines.Line2D at 0x261be99b910>]
```



Aggregate Data with the Python .agg() Function

Let's work out the number of different themes shipped by year. This means we have to count the number of unique theme_ids per calendar year.

The .agg() method takes a dictionary as an argument. In this dictionary, we specify which operation we'd like to apply to each column. In our case, we just want to calculate the number of unique entries in the theme_id column by using the .nunique() method.

```
themes_by_year_df = sets_df.groupby("year").agg({"theme_id": pd.Series.nunique})
themes_by_year_df.head()
```

year	theme_id
1949	2
1950	1
1953	2
1954	2
1955	4

renaming a column

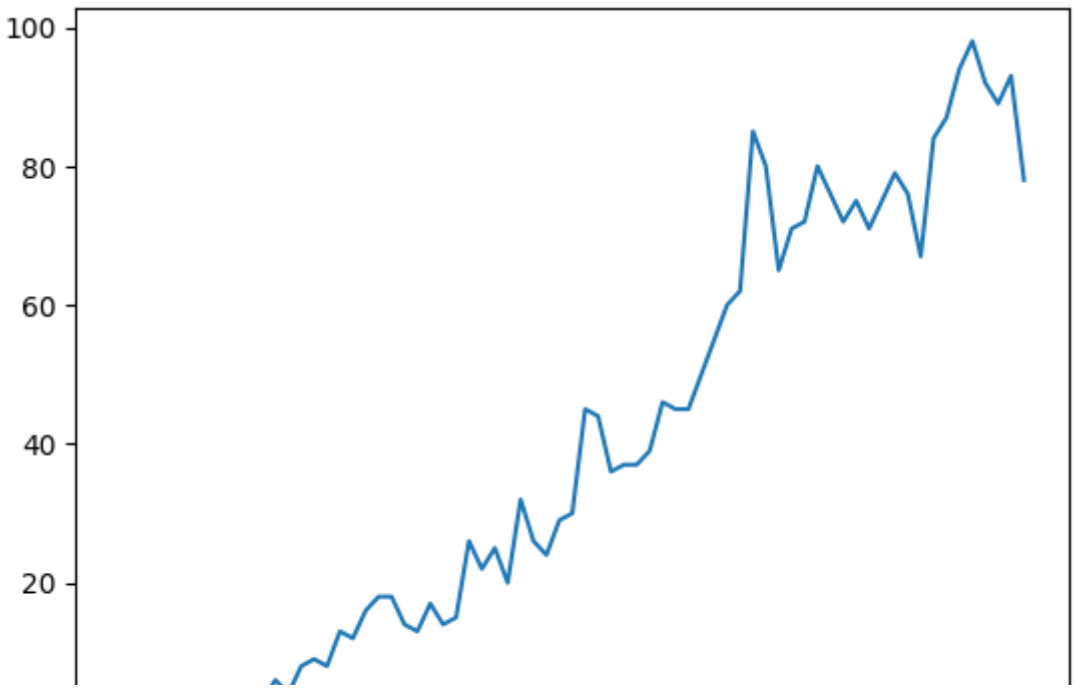
```
themes_by_year_df.rename(columns = {"theme_id": "nr_themes"}, inplace = True)
themes_by_year_df.head()
```

year	nr_themes
1949	2
1950	1
1953	2
1954	2
1955	4

Plotting the number of themes released by year on a line chart. Only include the full calendar years (excluding 2020 and 2021).

```
plt.plot(themes_by_year_df.index[:-2], themes_by_year_df["nr_themes"][:-2])
```

```
C:\Users\AS-Computer\AppData\Local\Temp\ipykernel_16356\3952651423.py:1: FutureWarning: The behavior of
  plt.plot(themes_by_year_df.index[:-2], themes_by_year_df["nr_themes"][:-2])
[<matplotlib.lines.Line2D at 0x261be9c8950>]
```



Line Charts with Two Seperate Axes

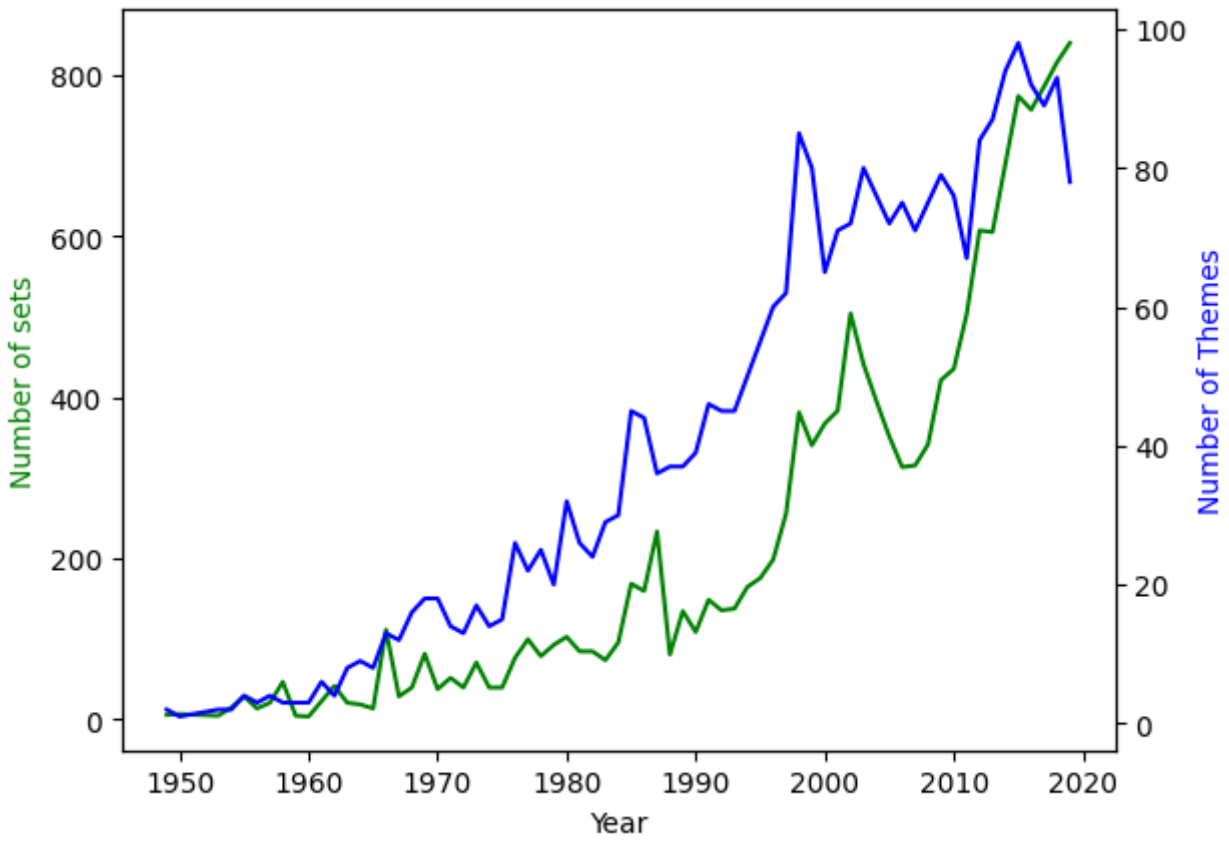
```
# get the axis
ax1 = plt.gca()

# create another axis that shares the same x-axis
ax2 = ax1.twinx()


# ploting on differetn axis and adding styling to the lines
ax1.plot(sets_by_year_df.index[:-2], sets_by_year_df["set_num"][:-2], color='g')
ax2.plot(themes_by_year_df.index[:-2], themes_by_year_df["nr_themes"][:-2], color='b')

ax1.set_xlabel("Year")
ax1.set_ylabel("Number of sets", color = 'green')
ax2.set_ylabel("Number of Themes", color = 'blue')
```

```
C:\Users\AS-Computer\AppData\Local\Temp\ipykernel_16356\3052756819.py:9: FutureWarning: The behavior of
  ax1.plot(sets_by_year_df.index[:-2], sets_by_year_df["set_num"][:-2], color='g')
C:\Users\AS-Computer\AppData\Local\Temp\ipykernel_16356\3052756819.py:10: FutureWarning: The behavior c
  ax2.plot(themes_by_year_df.index[:-2], themes_by_year_df["nr_themes"][:-2], color='b')
Text(0, 0.5, 'Number of Themes')
```



Using the `.groupby()` and `.agg()` function together to figure out the average number of parts per set. How many parts did the average LEGO set released in 1954 compared to say, 2017?

```
parts_per_set_df = sets_df.groupby("year").agg({"num_parts": pd.Series.mean })
```

```
parts_per_set_df.head()
```

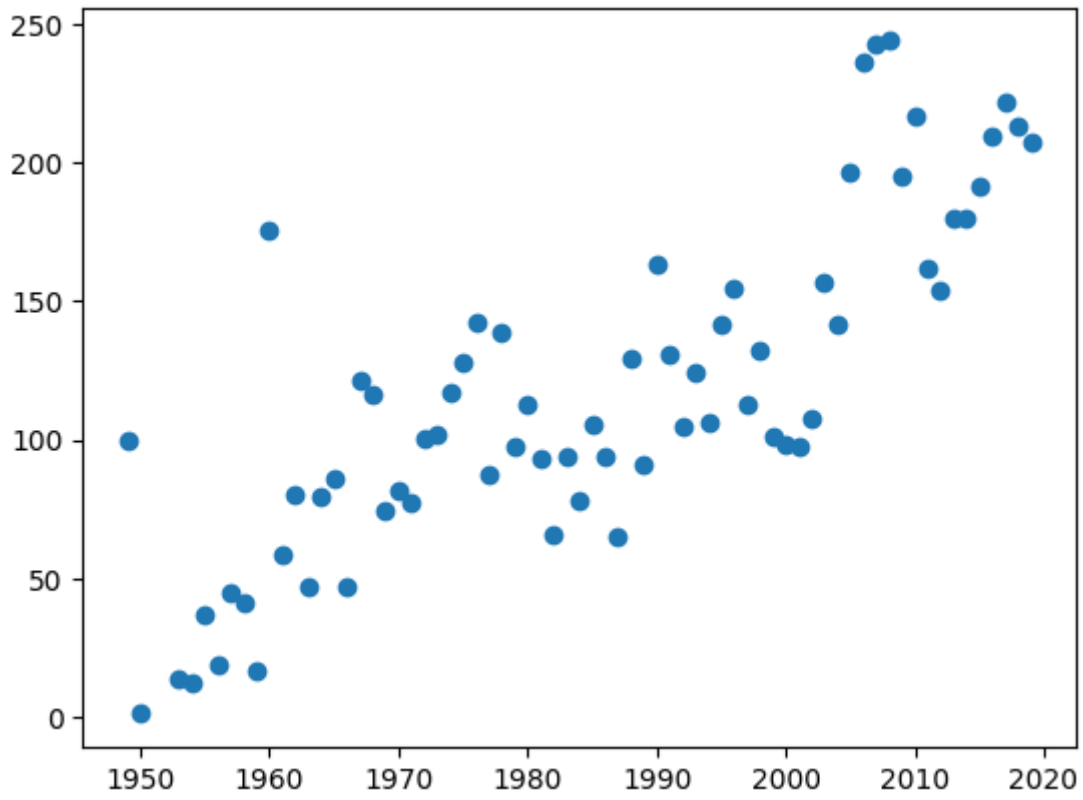
year	num_parts
1949	99.600000
1950	1.000000
1953	13.500000
1954	12.357143
1955	36.607143

Scatter Plots in Matplotlib

Has the size and complexity of LEGO sets increased over time based on the number of parts? Plot the average number of parts over time using a Matplotlib scatter plot. Using the [scatter plot documentation]

```
plt.scatter(parts_per_set_df.index[:-2], parts_per_set_df["num_parts"][:-2])
```

```
C:\Users\AS-Computer\AppData\Local\Temp\ipykernel_16356\487067254.py:1: FutureWarning: The behavior of
  plt.scatter(parts_per_set_df.index[:-2], parts_per_set_df["num_parts"][:-2])
<matplotlib.collections.PathCollection at 0x261beca0d50>
```



Number of Sets per LEGO Theme

LEGO has licensed many hit franchises from Harry Potter to Marvel Super Heros to many others. But which theme has the largest number of individual sets?

The theme with id 158 is the largest theme containing 753 individual sets. We need to find the names of the themes based on the theme_id from the themes.csv file

```
sets_df["theme_id"].value_counts().head()
```

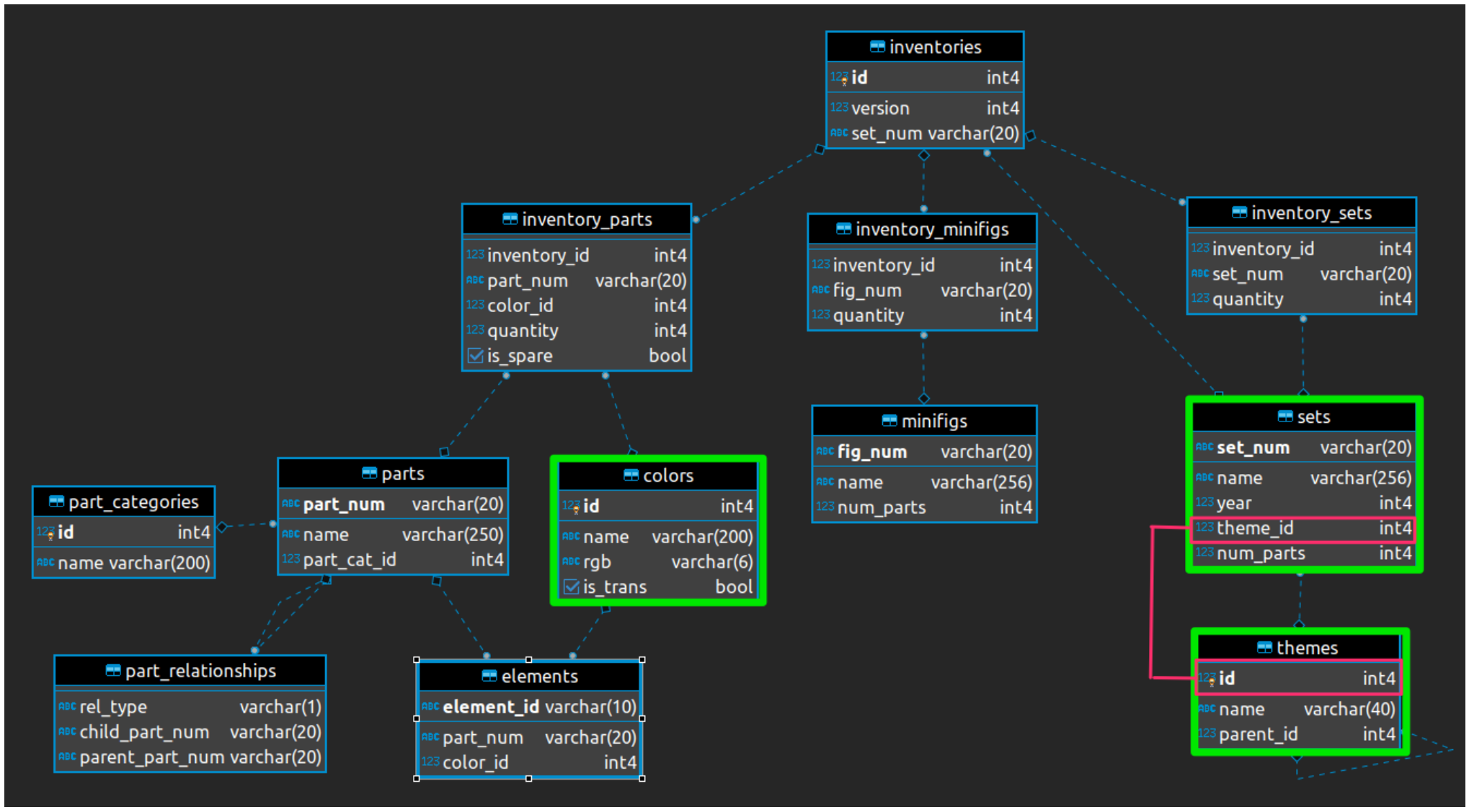
```
158    753
501    656
494    398
435    356
503    329
Name: theme_id, dtype: int64
```

displaying images in jupter notebook - from web - same as in HTML

< img src="https://i.imgur.com/Sg4lcjx.png">

or locally like so

< img src="assets/rebrickable_schema.png">



Database Schemas, Foreign Keys and Merging DataFrames

The themes.csv file has the actual theme names. The sets .csv has `theme_ids` which link to the `id` column in the themes.csv.

First step is to explore the themes.csv. How is it structured? Search for the name 'Star Wars'. How many `id`s correspond to this name in the themes.csv? Now use these `id`s and find the corresponding the sets in the sets.csv (Hint: you'll need to look for matches in the `theme_id` column)

```
themes_df = pd.read_csv("data/themes.csv")
themes_df.head()
```

	id	name	parent_id
0	1	Technic	NaN
1	2	Arctic Technic	1.0
2	3	Competition	1.0
3	4	Expert Builder	1.0
4	5	Model	1.0

```
themes_df[themes_df["name"]=="Star Wars"]
```

	id	name	parent_id
17	18	Star Wars	1.0
150	158	Star Wars	NaN
174	209	Star Wars	207.0
211	261	Star Wars	258.0

We can check which products corresponded to those themes in the sets.csv

```
sets_df[sets_df["theme_id"]==209]
```

	set_num	name	year	theme_id	num_parts
11013	75023-1	Star Wars Advent Calendar 2013	2013	209	254
11046	75056-1	Star Wars Advent Calendar 2014	2014	209	273
11080	75097-1	Star Wars Advent Calendar 2015	2015	209	291
11131	75146-1	Star Wars Advent Calendar 2016	2016	209	282
11173	75184-1	Star Wars Advent Calendar 2017	2017	209	309
11206	75213-1	Star Wars Advent Calendar 2018	2018	209	307
11245	75245-1	Star Wars Advent Calendar 2019	2019	209	280
11281	75279-1	Star Wars Advent Calendar 2020	2020	209	312

Merging (i.e., Combining) DataFrames based on a Key

14352	9509-1	Star Wars Advent Calendar 2012	2012	209	235

```
sets_theme_count = sets_df["theme_id"].value_counts()
sets_theme_count.head()
```

```
158    753
501    656
494    398
435    356
503    329
Name: theme_id, dtype: int64
```

To make sure we have a column with the name id, we'll convert this Pandas Series into a Pandas DataFrame.

```
sets_theme_count_df = pd.DataFrame({'id': sets_theme_count.index,
                                    'set_count': sets_theme_count.values})

sets_theme_count_df.head()
```

	id	set_count
0	158	753
1	501	656
2	494	398
3	435	356
4	503	329

To .merge() two DataFrame along a particular column, we need to provide our two DataFrames and then the column name on which to merge. This is why we set on='id'

```
merged_df = pd.merge(sets_theme_count_df, themes_df, on="id")
merged_df.sort_values(by="set_count", ascending=False, inplace = True)
merged_df.head()
```

	id	set_count	name	parent_id
0	158	753	Star Wars	NaN
1	501	656	Gear	NaN
2	494	398	Friends	NaN
3	435	356	Ninjago	NaN
4	503	329	Key Chain	501.0

Creating a Bar chart

ploting a bar chart with first 10 values

```
plt.figure(figsize=(14,8))
plt.xticks(fontsize=14, rotation=45)
plt.yticks(fontsize=14)
plt.ylabel("Nr of Sets", fontsize=14)
```

```
plt.xlabel("Theme Name", fontsize=14)

plt.bar(merged_df.name[:10], merged_df.set_count[:10] )
```

```
C:\Users\AS-Computer\AppData\Local\Temp\ipykernel_16356\286026946.py:7: FutureWarning: The behavior of
  plt.bar(merged_df.name[:10], merged_df.set_count[:10] )
<BarContainer object of 10 artists>
```