milestone2

June 2, 2024

0.1 Amazon Review Data : Data Exploration

0.1.1 Setup spark

[ ]:
```
import os, pickle, glob, math
import numpy as np
from pyspark.sql import SparkSession
from pyspark.sql import SQLContext
import pyspark.sql.functions as F
from pyspark.sql.functions import col

import matplotlib.pyplot as plt
import seaborn as sns

import plotly.offline as py
import plotly.graph_objs as go
import plotly.io as pio
from plotly.offline import iplot

py.init_notebook_mode(connected = True)

plt.style.use('seaborn-v0_8-whitegrid')
sns.set_palette("tab10")
```

[ ]:
```
sc = SparkSession.builder \
    .config("spark.driver.memory", "64g") \
        .config("spark.executor.memory", "64g") \
    .config('spark.executor.instances', 16) \
        .appName("Amazon Reviews") \
        .getOrCreate()
```

[ ]:
```
sqlContext = SQLContext(sc)
```

0.2 Read Data

0.2.1 Get files

[ ]:
```
##########################################################################################
###################### change path to: "../clin6/amazon_data"␣
 ↪#########################
##########################################################################################
path = "amazon_data"
```

[ ]:
```
def read(path):
    """
    Method that loads data file as df
    Takes in 1 parameter: path
    """
    return sc.read.csv(path, sep = "\t", header = True, inferSchema = True)

def get_path(file):
    """
    Method to create path
    Takes in 1 parameter: file name
    """
    return "amazon_data/%s" % file
```

[ ]:
```
dir = os.listdir(path)
files = [f for f in dir if os.path.isfile(os.path.join(path, f))]
```

[ ]:
```
def get_df(files):
    """
    Method that combines files into 1 big df
    Takes in 1 parameter: list of file names
    """
    df = read(get_path(files[0]))
    n = len(files)
    for i in range(1, n):
        data = read(get_path(files[i]))
        df = df.union(data)
    return df
```

0.2.2 Get df and Removing Repetitive/Unnecessary Information

[ ]:
```
df = get_df(files)#.drop('marketplace', 'vine')
sqlContext.registerDataFrameAsTable(df, "df")
```

1 Data Exploration Start

- Perform the data exploration step (i.e. evaluate your data, # of observations, details about your data distributions, scales, missing data, column descriptions) Note: For image data you can still describe your data by the number of classes, # of images, plot example classes of the image, size of images, are sizes uniform? Do they need to be cropped? normalized? etc.

[9]:
```
### Show how our data looks like
df.show(5)
```

```
+-----------+-----------+--------------+----------+--------------+--------------
------+---------------+-----------+------------+-----------+----+-------------
----+--------------------+--------------------+-----------+
|marketplace|customer_id|     review_id|product_id|product_parent|       product
_title|product_category|star_rating|helpful_votes|total_votes|vine|verified_purc
hase|     review_headline|         review_body|review_date|
+-----------+-----------+--------------+----------+--------------+--------------
------+---------------+-----------+------------+-----------+----+-------------
----+--------------------+--------------------+-----------+
|         US|   36075342| RAB23OVFNCXZQ|B00LPRXQ4Y|     339193102|17" 2003-2006
For…|      Automotive|          1|            0|          0|   N|
Y|     As it was used,|As it was used, t…| 2015-08-31|
|         US|   42462164|R3NORADVJO6IE6|B000C7S0TO|     907684644|Spectra
Premium C…|      Automotive|          5|            0|          0|   N|
Y|          Five Stars|Put it in fine, n…| 2015-08-31|
|         US|   21241933|R299F4SO98S5OO|B000CO9WE4|     752246352|K&N E-4665
High P…|      Automotive|          5|            1|          1|   N|
Y|Great fit and per…|Fit wonderfully o…| 2015-08-31|
|         US|   52570308|R2DA9DOT03UW6I|B000GKD5NI|     105401756|Suncutters
Rear W…|      Automotive|          5|            2|          3|   N|
Y|Good for the pric…|Good for the pric…| 2015-08-31|
|         US|   38200102|R2OGCH681EQHU6|B009SDA7TE|     728471129|Lug Nuts
Landcrui…|      Automotive|          5|            0|          0|   N|
Y|          Five Stars|Fit perfectly on …| 2015-08-31|
+-----------+-----------+--------------+----------+--------------+--------------
------+---------------+-----------+------------+-----------+----+-------------
----+--------------------+--------------------+-----------+
only showing top 5 rows
```

[10]:
```
### Total number of observations
print('There is a total of %d observations' % df.count())
```

```
There is a total of 109830520 observations
```

[11]:
```
### Get columns
columns = df.columns
print('Columns:')
```

```
print(df.columns)
```

```
Columns:
['marketplace', 'customer_id', 'review_id', 'product_id', 'product_parent',
'product_title', 'product_category', 'star_rating', 'helpful_votes',
'total_votes', 'vine', 'verified_purchase', 'review_headline', 'review_body',
'review_date']
```

[12]:
```
### Get number of columns
num_cols = len(columns)
print('There is a total of %d columns' % num_cols)
```

```
There is a total of 15 columns
```

[ ]:
```
### Get number of missing values for each column
for i in range(num_cols):
    missing = df.filter(df[columns[i]].isNull()).count()
    print("'%s' column has %d missing values" % (columns[i], missing))
```

[ ]:
```
data_types = df.dtypes
for i in range(num_cols):
    print("'%s' column is of type '%s'" % (data_types[i][0], data_types[i][1]))
```

[ ]:
```
### Show data distributions
df.describe().show()
```

[ ]:
```
df = df.select([col for col in df.columns if col not in ['marketplace',␣
 ↪'vine']]).cache()

### var after updated df
columns = df.columns
num_cols = len(columns)
```

[ ]:
```
### Get number of missing values for each column
for i in range(num_cols):
    missing = df.filter(df[columns[i]].isNull()).count()
    print("'%s' column has %d missing values" % (columns[i], missing))
```

[ ]:
```
data_types = df.dtypes
for i in range(num_cols):
    print("'%s' column is of type '%s'" % (data_types[i][0], data_types[i][1]))
```

[ ]:
```
### Show data distributions
df.describe().show()
```

[ ]:
```
### Check for duplicates
df.groupBy(columns).count().where('count > 1').show()
```

2 Plot

reference: https://plotly.com/python/v3/apache-spark/

3 Methods to plot

[35]:
```
def plot(title, data):
    """
    Helper method to plot
    Takes in two paramaters: title, data
    """
    layout = go.Layout(title = title)                          # Create layout
    fig = go.Figure(data = data, layout = layout)              # Create figure
    #iplot(fig)                                                 # Plot figure
    return fig
```

[36]:
```
def plot_histogram(df, column_name, num_bins, filename = None):
    """
    Method to plot histogram of column
    Takes in two parameters: df, column
    """
    min_value, max_value = df.selectExpr(f'min({column_name})',␣
↪f'max({column_name})').first()
    bin_width = (max_value - min_value) / num_bins

    # Create bins using floor function
    binned_df = df.withColumn('bin', F.floor((col(column_name) - min_value) /␣
↪bin_width))

    # Count the number of occurrences in each bin
    bin_counts = binned_df.groupby('bin').count().orderBy('bin').select('bin',␣
↪'count')

    # Convert the results to Pandas DataFrame
    bin_counts_pd = bin_counts.toPandas()
    bin_counts_pd['bin_center'] = bin_counts_pd['bin'] * bin_width + min_value␣
↪+ bin_width / 2

    # Plot the histogram using Plotly
    data = [go.Histogram(x=bin_counts_pd['bin_center'],␣
↪y=bin_counts_pd['count'])]

    title = 'Histogram of %s' % column_name                    # Set title
    return plot(title, data)                                          # Use␣
↪helper method to plot
```

[16]:
```
def plot_piechart(df, column_name, filename):
    """
    Method to plot pie chart of column
    Takes in two parameters: df, column
    """
    counts = df.select(col(column_name)).groupBy(column_name).count().
↪toPandas()  # Get counts
    data = [go.Pie(labels = counts[column_name], values = counts['count'])]
↪  # Get data
    title = 'Pie Chart of %s' % column_name
↪   # Set title
    plot(title, data)                                    # Use helper method
↪to plot
    fig = go.Figure(data=data)

    # Save the plot as an image
    pio.write_image(fig, filename)
```

[17]:
```
def plot_barplot(df, column_name):
    """
    Method to plot bar plot of column
    Takes in one parameter: column
    """
    if column_name == 'star_rating':
        df = df.filter((col(column_name) >= 1) & (col(column_name) <= 5))

    counts = df.groupBy(column_name).count()

    # Filter out categories with less than 10,000 rows
    counts_filtered = counts.filter(counts['count'] >= 10000)

    # Sort by the column_name
    counts_filtered = counts_filtered.orderBy(column_name)

    # Convert to Pandas DataFrame
    counts_pd = counts_filtered.toPandas()

    # Create bar plot data
    data = [go.Bar(x=counts_pd[column_name], y=counts_pd['count'])]

    title = 'Bar Plot of %s' % column_name
↪   # Set title
    return plot(title, data)                                 # Use helper
↪method to plot
```

[18]:
```
def plot_boxplot(df, column_name):
    """
    Method to plot box plot of column
    Takes in two parameters: df, column
    """
    quantiles = df.approxQuantile(column_name, [0.25, 0.5, 0.75], 0.01)
    min_value = df.selectExpr(f'min({column_name})').first()[0]
    max_value = df.selectExpr(f'max({column_name})').first()[0]
    q1, median, q3 = quantiles

    # Create the box plot using Plotly
    data = [go.Box(
        y=[min_value, q1, median, q3, max_value],
        boxpoints='all',
        jitter=0.3,
        pointpos=-1.8
    )]
    title = 'Box plot of %s' % column_name                    # Set title
    return plot(title, data)                                        # Use helper␣
 ↪method to plot
```

def plot_boxplot_no_outliers(df, column_name): “ “ ” Method to plot box plot of column after removing outliers Takes in two parameters: df, column “ “ ” quantiles = df.approxQuantile(column_name, [0.25, 0.5, 0.75], 0.01) q1, median, q3 = quantiles

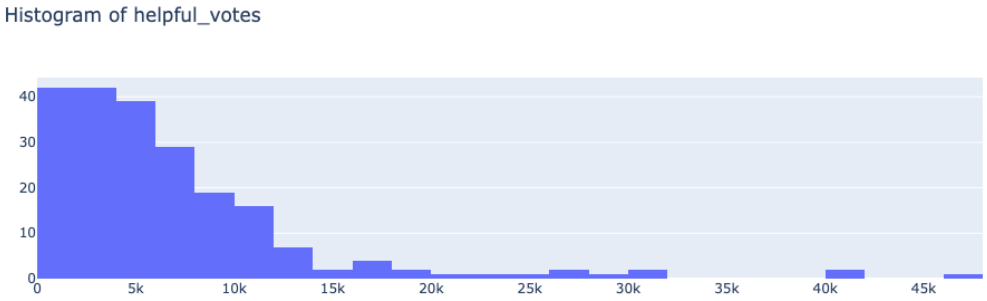
```
# Calculate IQR
iqr = q3 - q1

# Define the outlier range
lower_bound = q1 - 1.5 * iqr
upper_bound = q3 + 1.5 * iqr

# Filter out outliers
filtered_df = df.filter((col(column_name) >= lower_bound) & (col(column_name) <= upper_bound))

# Create the box plot using Plotly
data = [go.Box(y=filtered_df.select(column_name).toPandas()[column_name], boxpoints='outliers'

title = 'Box plot of %s (Outliers Removed)' % columns[i]              # Set title
plot(title, data)                                                     # Use helper method to pl
```

3.1 Analysis

Save plot

fig = plot_histogram(df, ‘helpful_votes’, 1000) fig.update_layout(title=“Histogram of Helpful Votes”, xaxis_title=“Number of Helpful Votes”, yaxis_title=“Frequency”, title_x=0.5, # Set title x-alignment to the center title_y=0.9 # Set title y-alignment to the top) #pio.write_image(fig, ‘1_.png’)

[40]:
```
plot_histogram(df, 'helpful_votes', 1000)
```

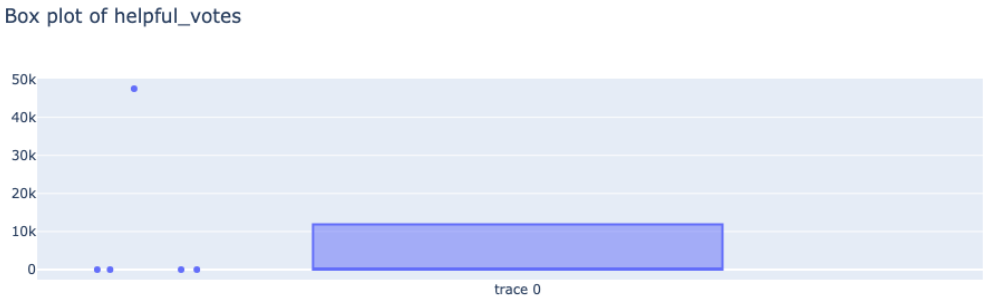


- There are clearly noticeable high outliers
- Lets look at a boxplot

Save plot

fig = plot_boxplot(df, 'helpful_votes') fig.update_layout(title="Boxplot of Helpful Votes", xaxis_title=" ", yaxis_title="Number of Helpful Votes", title_x=0.5, # Set title x-alignment to the center title_y=0.9 # Set title y-alignment to the top) #pio.write_image(fig, '2_.png')

[41]:
```
plot_boxplot(df, 'helpful_votes')
```



- Indeed we see many high outliers
- The boxplot is heavily skewed

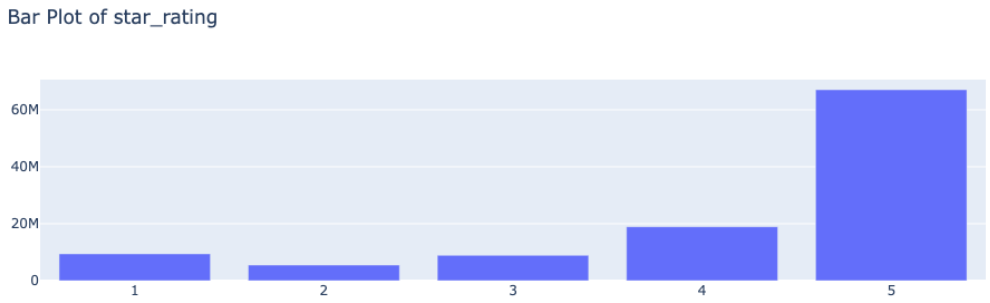
plot_boxplot_no_outliers(df, 'helpful_votes')

- Outliers removed box plot, we see most reviews have no votes

Save plot

fig = plot_barplot(df, ‘star_rating’) fig.update_layout(title=“Barplot of Star Rating”, xaxis_title=“Star Rating”, yaxis_title=“Counts”, title_x=0.5, # Set title x-alignment to the center title_y=0.9 # Set title y-alignment to the top) #pio.write_image(fig, ‘3_.png’)

[42]:
```
plot_barplot(df, 'star_rating')
```



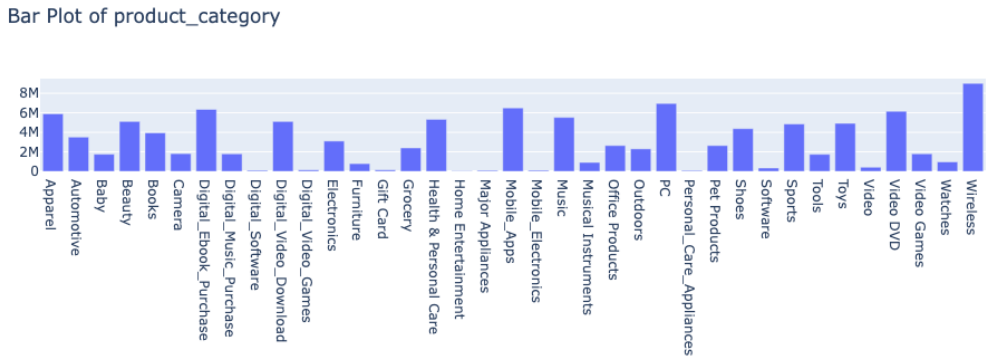
- Majority of ratings given are 5 stars
- Second most given rating is 1 but still much less than 5
- Increased ratings from 2 to 5 stars

4 Look at category proportions

Save plot

fig = plot_barplot(df, ‘product_category’) fig.update_layout(title=“Barplot of Product Category”, xaxis_title=“Product Category”, yaxis_title=“Counts”, title_x=0.5, # Set title x-alignment to the center title_y=0.9 # Set title y-alignment to the top) #pio.write_image(fig, ‘4_.png’)

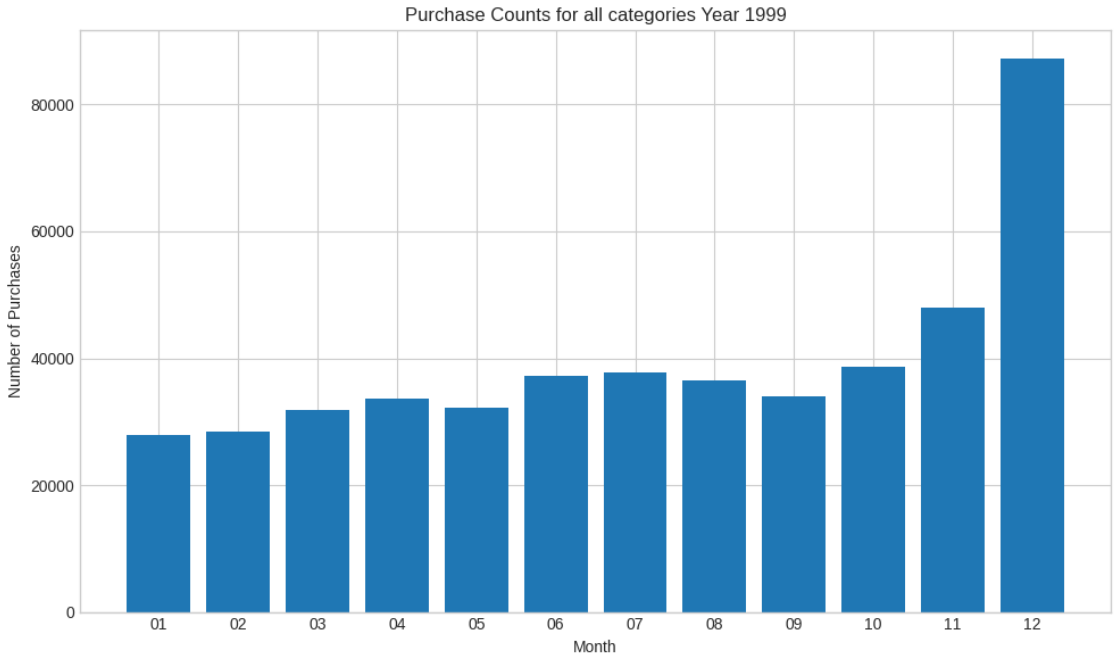
[43]:
```
plot_barplot(df, 'product_category')
```



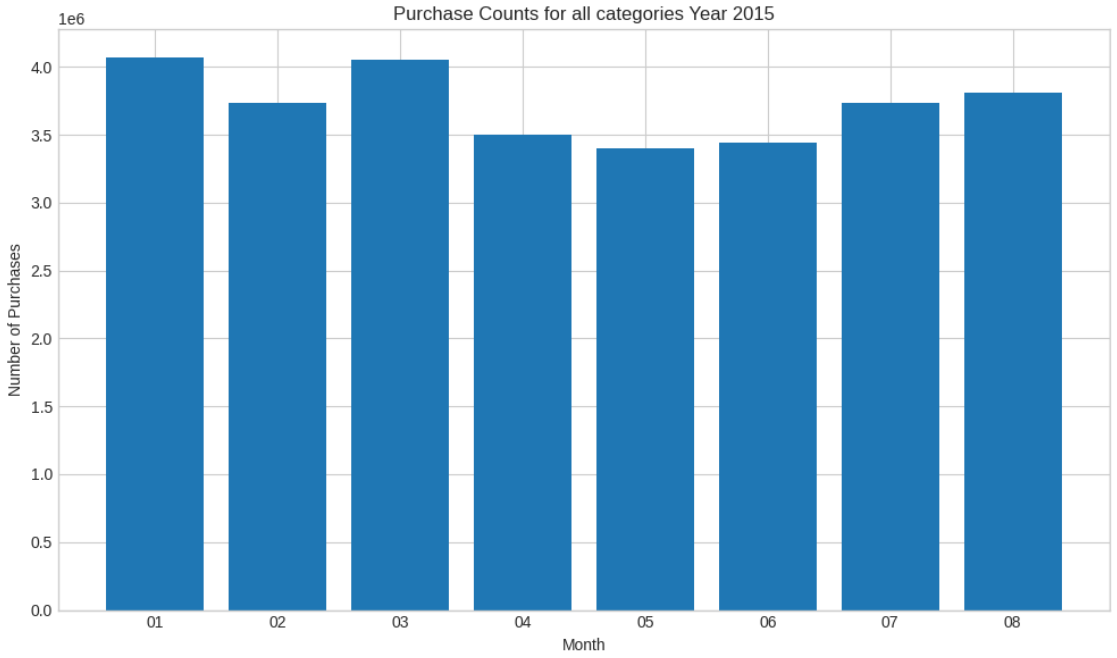
5 Compare purchase counts by year

[23]:
```
from pyspark.sql.functions import col, year, substring

def plot_purchase_counts(df, df_name, target_year):
    """
    Plot the purchase counts for a given DataFrame and year.

    Args:
    - df: The DataFrame containing the review data.
    - target_year: The year for which purchase counts will be plotted.
    - df_name: The name of the DataFrame.

    Returns:
    - None
    """
    # Filter the DataFrame to include only rows from the specified year
    df_year = df.filter(F.year(df['review_date']) == target_year)

    # Extract the month from the 'review_date' column
    df_year = df_year.withColumn('review_month',␣
 ↪substring(df_year['review_date'], 6, 2))

    # Count the number of purchases for each month
    purchase_counts = df_year.groupby('review_month').count().
 ↪orderBy('review_month')

    # Plot the counts using a bar plot
    plt.figure(figsize=(10, 6))
    plt.bar(purchase_counts.toPandas()['review_month'], purchase_counts.
 ↪toPandas()['count'])
    plt.title(f'Purchase Counts for {df_name} Year {target_year}')
    plt.xlabel('Month')
    plt.ylabel('Number of Purchases')
    plt.tight_layout()  # Ensures proper layout
    return plt
```

[24]:
```
plt = plot_purchase_counts(df, "all categories", 1999)
#plt.savefig('1999.png')
```



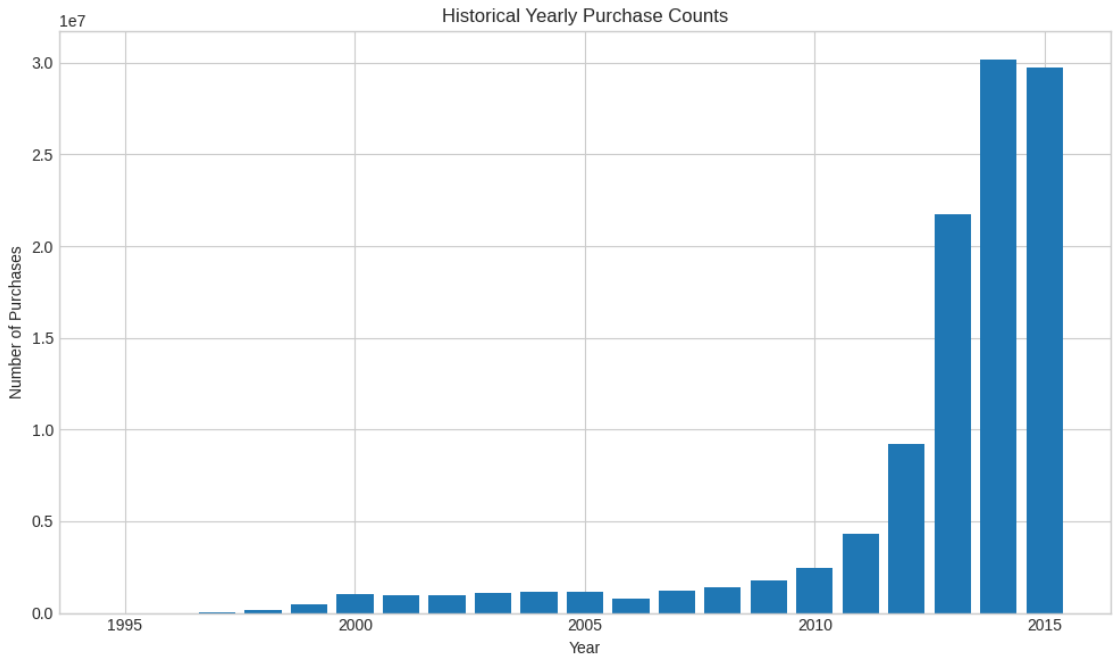
[25]:
```
plt = plot_purchase_counts(df, "all categories", 2015)
#plt.savefig('2015.png')
```



6 Look at all years

[26]:
```
def plot_yearly_purchase_counts(df, df_name):
    """
    Plot the purchase counts for each year in a given DataFrame.

    Args:
    - df: The DataFrame containing the review data.
    - df_name: The name of the DataFrame.

    Returns:
    - fig: The figure containing the subplots.
    """
    # Extract the year from the 'review_date' column
    df_year = df.withColumn('review_year', F.year(df['review_date']))

    # Count the number of purchases for each year
    purchase_counts = df_year.groupby('review_year').count().
 ↪orderBy('review_year')

    # Convert to Pandas DataFrame for plotting
    purchase_counts_pd = purchase_counts.toPandas()

    # Plot the counts using a bar plot
    plt.figure(figsize=(10, 6))
    plt.bar(purchase_counts_pd['review_year'], purchase_counts_pd['count'])
    plt.title('Historical Yearly Purchase Counts')
    plt.xlabel('Year')
    plt.ylabel('Number of Purchases')
    plt.tight_layout()  # Ensures proper layout
    return plt
```

[27]:
```
plt = plot_yearly_purchase_counts(df, "all years")
#plt.savefig('counts.png')
```


Historical Yearly Purchase Counts
1e7
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Number of Purchases
1995
2000
2005
2010
2015
Year

[ ]: