Fetching the data

In [ ]:

```
from google.colab import files
files.upload()
```

Choose Files No file chosen

Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving kaggle.json to kaggle.json
```

Out[2]:

```
{'kaggle.json': b'{"username":"sidd1996","key":"411008e9f7f47955a0869b805c7a724
0"}'}
```

In [ ]:

```
!mkdir -p ~/.kaggle
!cp kaggle.json ~/.kaggle/
!ls ~/.kaggle
!chmod 600 /root/.kaggle/kaggle.json
```

```
kaggle.json
```

In [ ]:

```
!kaggle competitions download -c m5-forecasting-accuracy
```

```
Warning: Looks like you're using an outdated API Version, please consider updat
ing (server 1.5.9 / client 1.5.4)
Downloading sell_prices.csv.zip to /content
 63% 9.00M/14.2M [00:00<00:00, 14.1MB/s]
100% 14.2M/14.2M [00:00<00:00, 17.2MB/s]
Downloading sample_submission.csv.zip to /content
  0% 0.00/163k [00:00<?, ?B/s]
100% 163k/163k [00:00<00:00, 34.9MB/s]
Downloading sales_train_validation.csv.zip to /content
 32% 5.00M/15.5M [00:00<00:01, 6.97MB/s]
100% 15.5M/15.5M [00:00<00:00, 20.0MB/s]
Downloading calendar.csv to /content
  0% 0.00/101k [00:00<?, ?B/s]
100% 101k/101k [00:00<00:00, 73.9MB/s]
Downloading sales_train_evaluation.csv.zip to /content
 32% 5.00M/15.8M [00:00<00:01, 7.12MB/s]
100% 15.8M/15.8M [00:00<00:00, 20.3MB/s]
```

In [ ]:

```
!unzip -q /content/sales_train_validation.csv.zip
!unzip -q /content/sell_prices.csv.zip
!unzip -q /content/sales_train_evaluation.csv.zip
```

In [ ]:

```
!pip install dask
!pip install 'fsspec>=0.3.3'
!pip install partd
```

```
Requirement already satisfied: dask in /usr/local/lib/python3.6/dist-packages
(2.12.0)
Collecting fsspec>=0.3.3
  Downloading https://files.pythonhosted.org/packages/a5/8b/1df260f860f17cb0869
8170153ef7db672c497c1840dcc8613ce26a8a005/fsspec-0.8.4-py3-none-any.whl (http
s://files.pythonhosted.org/packages/a5/8b/1df260f860f17cb08698170153ef7db672c49
7c1840dcc8613ce26a8a005/fsspec-0.8.4-py3-none-any.whl) (91kB)
     |████████████████████████████████| 92kB 5.7MB/s
Installing collected packages: fsspec
Successfully installed fsspec-0.8.4
Collecting partd
  Downloading https://files.pythonhosted.org/packages/44/e1/68dbe731c9c067655bf
f1eca5b7d40c20ca4b23fd5ec9f3d17e201a6f36b/partd-1.1.0-py3-none-any.whl (http
s://files.pythonhosted.org/packages/44/e1/68dbe731c9c067655bff1eca5b7d40c20ca4b
23fd5ec9f3d17e201a6f36b/partd-1.1.0-py3-none-any.whl)
Collecting locket
  Downloading https://files.pythonhosted.org/packages/d0/22/3c0f97614e0be838654
2facb3a7dcfc2584f7b83608c02333bced641281c/locket-0.2.0.tar.gz (https://files.py
thonhosted.org/packages/d0/22/3c0f97614e0be8386542facb3a7dcfc2584f7b83608c02333
bced641281c/locket-0.2.0.tar.gz)
Requirement already satisfied: toolz in /usr/local/lib/python3.6/dist-packages
 (from partd) (0.11.1)
Building wheels for collected packages: locket
  Building wheel for locket (setup.py) ... done
  Created wheel for locket: filename=locket-0.2.0-cp36-none-any.whl size=4040 s
ha256=dce891d93f42dd2477225d0ff0c1b6346160a13f553ac3c4567d354e22334121
  Stored in directory: /root/.cache/pip/wheels/26/1e/e8/4fa236ec931b1a0cdd61578
e20d4934d7bf188858723b84698
Successfully built locket
Installing collected packages: locket, partd
Successfully installed locket-0.2.0 partd-1.1.0
```

In [ ]:

```
import os
# import gc
import time
import math
import datetime
from math import log, floor
# from sklearn.neighbors import KDTree

import numpy as np
import pandas as pd
from pathlib import Path
from sklearn.utils import shuffle
from tqdm.notebook import tqdm as tqdm

import seaborn as sns
from matplotlib import colors
import matplotlib.pyplot as plt
from matplotlib.colors import Normalize

import plotly.express as px
import plotly.graph_objects as go
import plotly.figure_factory as ff
from plotly.subplots import make_subplots
from IPython.display import Image

# import pywt
from statsmodels.robust import mad

import scipy
import statsmodels
from scipy import signal
import statsmodels.api as sm
from fbprophet import Prophet


import warnings
warnings.filterwarnings("ignore")
```

```
/usr/local/lib/python3.6/dist-packages/statsmodels/tools/_testing.py:19: Future
Warning:

pandas.util.testing is deprecated. Use the functions in the public API at panda
s.testing instead.
```

In [ ]:

In [ ]:

```
sales = pd.read_csv('/content/sales_train_evaluation.csv')
calendar = pd.read_csv('/content/calendar.csv')
sell_prices = pd.read_csv('/content/sell_prices.csv')
```

In [ ]:

Business Problem :-

M5 Forecasting Accuracy is a competetion in which we have to forecast future sales of each product in each store based on the hierarchical sales data provided by Walmart. In this competetion we have to forecast daily sales for next 28 days. Here we have the data for 3 states in US(California, Texas, and Wisconsin). The data files (.csv files) provided for the competetion consists of item level, department, product categories,items sold on a day, store details, price, promotions, day of the week, and special events. So by using this data we will forecast daily sales for next 28 days as accurately as possible.

ML formulation :-

We will do some data preprocessing and feature engineering to get desired format and some new features respectively . Once the data is ready we will pass it through different machine learning and deep learning models . After the model is trained we will predict the values for test dataset. We will pose this as a supervised machine learning regression problem. In this problem we will be using LGBMRegressor, Facebook Prophet and a deep learning model.

Metrics :-

The performance measures are first computed for each series separately by averaging their values across the forecasting horizon and then averaged again across the series in a weighted fashion .

Forcasting horizon or number of days for which forecast is required is 28 days.

The metric used for evaluating the accuracy of the each series is Root Mean Squared Scaled Error (RMSSE).

After estimating the RMSSE for all the 42,840 time series of the competition, we will calculate Weighted RMSSE (WRMSSE) which will be used as our final metric .

The formulas for RMSSE and WRMSSE are given below :-

$$RMSSE = \sqrt{\frac{1}{h}\frac{\sum_{t=n+1}^{n+h}\left(Y_t - \widehat{Y}_t\right)^2}{\frac{1}{n-1}\sum_{t=2}^{n}(Y_t - Y_{t-1})^2}}, \qquad WRMSSE = \sum_{i=1}^{42,840} w_i * RMSSE$$

RMSSE variables :- Y_t is the actual future value of the examined time series at point t, (Y_t^)the generated forecast, n the length of the training sample (number of historical observations), and h the forecasting horizon.

WRMSSE variables :- w_i is the weight of the i_th series of the competition. A lower WRMSSE score is better.Explaination on how to calculate w_i is given in the pdf present in M5 Participants Guide :- https://mofc.unic.ac.cy/m5-competition/ (https://mofc.unic.ac.cy/m5-competition/) .

Downcasting

In [ ]:

```
### Ref link :- https://www.kaggle.com/anshuls235/time-series-forecasting-eda-fe-


#Downcast in order to save memory
def downcast(df):
    cols = df.dtypes.index.tolist()
    types = df.dtypes.values.tolist()
    for i,t in enumerate(types):
        if 'int' in str(t):
            if df[cols[i]].min() > np.iinfo(np.int8).min and df[cols[i]].max() <
                df[cols[i]] = df[cols[i]].astype(np.int8)
            elif df[cols[i]].min() > np.iinfo(np.int16).min and df[cols[i]].max()
                df[cols[i]] = df[cols[i]].astype(np.int16)
            elif df[cols[i]].min() > np.iinfo(np.int32).min and df[cols[i]].max()
                df[cols[i]] = df[cols[i]].astype(np.int32)
            else:
                df[cols[i]] = df[cols[i]].astype(np.int64)
        elif 'float' in str(t):
            if df[cols[i]].min() > np.finfo(np.float16).min and df[cols[i]].max()
                df[cols[i]] = df[cols[i]].astype(np.float16)
            elif df[cols[i]].min() > np.finfo(np.float32).min and df[cols[i]].max
                df[cols[i]] = df[cols[i]].astype(np.float32)
            else:
                df[cols[i]] = df[cols[i]].astype(np.float64)
        elif t == np.object:
            if cols[i] == 'date':
                df[cols[i]] = pd.to_datetime(df[cols[i]], format='%Y-%m-%d')
            else:
                df[cols[i]] = df[cols[i]].astype('category')
    return df
```

In [ ]:

```
sales = downcast(sales)
sell_prices = downcast(sell_prices)
calendar = downcast(calendar)
```

##EDA

In [ ]:

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

Out[11]:

	id	item_id	dept_id	cat_id	store_id	state_id	d_1
0	HOBBIES_1_001_CA_1_evaluation	HOBBIES_1_001	HOBBIES_1	HOBBIES	CA_1	CA	0
1	HOBBIES_1_002_CA_1_evaluation	HOBBIES_1_002	HOBBIES_1	HOBBIES	CA_1	CA	0
2	HOBBIES_1_003_CA_1_evaluation	HOBBIES_1_003	HOBBIES_1	HOBBIES	CA_1	CA	0
3	HOBBIES_1_004_CA_1_evaluation	HOBBIES_1_004	HOBBIES_1	HOBBIES	CA_1	CA	0
4	HOBBIES_1_005_CA_1_evaluation	HOBBIES_1_005	HOBBIES_1	HOBBIES	CA_1	CA	0

5 rows × 1947 columns

In [ ]:
```
sales = pd.melt(sales, id_vars=['id', 'item_id', 'dept_id', 'cat_id', 'store_id',
```

In [ ]:
```
sales
```

Out[13]:

	id	item_id	dept_id	cat_id	store_id	state_
0	HOBBIES_1_001_CA_1_evaluation	HOBBIES_1_001	HOBBIES_1	HOBBIES	CA_1	(
1	HOBBIES_1_002_CA_1_evaluation	HOBBIES_1_002	HOBBIES_1	HOBBIES	CA_1	(
2	HOBBIES_1_003_CA_1_evaluation	HOBBIES_1_003	HOBBIES_1	HOBBIES	CA_1	(
3	HOBBIES_1_004_CA_1_evaluation	HOBBIES_1_004	HOBBIES_1	HOBBIES	CA_1	(
4	HOBBIES_1_005_CA_1_evaluation	HOBBIES_1_005	HOBBIES_1	HOBBIES	CA_1	(
...	...	...	...	...	...	
59181085	FOODS_3_823_WI_3_evaluation	FOODS_3_823	FOODS_3	FOODS	WI_3	\
59181086	FOODS_3_824_WI_3_evaluation	FOODS_3_824	FOODS_3	FOODS	WI_3	\
59181087	FOODS_3_825_WI_3_evaluation	FOODS_3_825	FOODS_3	FOODS	WI_3	\
59181088	FOODS_3_826_WI_3_evaluation	FOODS_3_826	FOODS_3	FOODS	WI_3	\
59181089	FOODS_3_827_WI_3_evaluation	FOODS_3_827	FOODS_3	FOODS	WI_3	\

59181090 rows × 8 columns

In [ ]:

```
sell_prices
```

Out[14]:

	store_id	item_id	wm_yr_wk	sell_price
0	CA_1	HOBBIES_1_001	11325	9.578125
1	CA_1	HOBBIES_1_001	11326	9.578125
2	CA_1	HOBBIES_1_001	11327	8.257812
3	CA_1	HOBBIES_1_001	11328	8.257812
4	CA_1	HOBBIES_1_001	11329	8.257812
...	...	...	...	...
6841116	WI_3	FOODS_3_827	11617	1.000000
6841117	WI_3	FOODS_3_827	11618	1.000000
6841118	WI_3	FOODS_3_827	11619	1.000000
6841119	WI_3	FOODS_3_827	11620	1.000000
6841120	WI_3	FOODS_3_827	11621	1.000000

6841121 rows × 4 columns

In [ ]:
```
calendar
```

Out[15]:

	date	wm_yr_wk	weekday	wday	month	year	d	event_name_1	event_type_1	ev
0	2011-01-29	11101	Saturday	1	1	2011	d_1	NaN	NaN	
1	2011-01-30	11101	Sunday	2	1	2011	d_2	NaN	NaN	
2	2011-01-31	11101	Monday	3	1	2011	d_3	NaN	NaN	
3	2011-02-01	11101	Tuesday	4	2	2011	d_4	NaN	NaN	
4	2011-02-02	11101	Wednesday	5	2	2011	d_5	NaN	NaN	
...	...	...	...	...	...	...	...	...	...	
1964	2016-06-15	11620	Wednesday	5	6	2016	d_1965	NaN	NaN	
1965	2016-06-16	11620	Thursday	6	6	2016	d_1966	NaN	NaN	
1966	2016-06-17	11620	Friday	7	6	2016	d_1967	NaN	NaN	
1967	2016-06-18	11621	Saturday	1	6	2016	d_1968	NaN	NaN	
1968	2016-06-19	11621	Sunday	2	6	2016	d_1969	NBAFinalsEnd	Sporting	

1969 rows × 14 columns

In [ ]:
```
df = pd.merge(sales, calendar,how = "left",on = 'd')
```

In [ ]:
```
df = pd.merge(df, sell_prices, how = 'left', on = ['store_id','item_id','wm_yr_wk
```

In [ ]:
```

```

Plot 1 :- Total number of products sold over time per store.

In [ ]:
```

df_1 = df.loc[df['store_id'] == 'CA_1']
grouped = df_1.groupby(['date']).sum()
```

In [ ]:
```
grouped = df.groupby(['store_id','date']).sum()
grouped.reset_index( inplace=True)
```

In [ ]:
```
grouped
```

Out[21]:

	store_id	date	sold	wm_yr_wk	wday	month	year	snap_CA	snap_TX	snap_
0	CA_1	2011-01-29	4337.0	33846949.0	3049.0	3049.0	6131539.0	0.0	0.0	
1	CA_1	2011-01-30	4155.0	33846949.0	6098.0	3049.0	6131539.0	0.0	0.0	
2	CA_1	2011-01-31	2816.0	33846949.0	9147.0	3049.0	6131539.0	0.0	0.0	
3	CA_1	2011-02-01	3051.0	33846949.0	12196.0	6098.0	6131539.0	3049.0	3049.0	
4	CA_1	2011-02-02	2630.0	33846949.0	15245.0	6098.0	6131539.0	3049.0	0.0	304
...	...	...	...	...	...	...	...	...	...	
19405	WI_3	2016-05-18	3268.0	35417184.0	15245.0	15245.0	6146784.0	0.0	0.0	
19406	WI_3	2016-05-19	3398.0	35417184.0	18294.0	15245.0	6146784.0	0.0	0.0	
19407	WI_3	2016-05-20	4126.0	35417184.0	21343.0	15245.0	6146784.0	0.0	0.0	
19408	WI_3	2016-05-21	4519.0	35420233.0	3049.0	15245.0	6146784.0	0.0	0.0	
19409	WI_3	2016-05-22	4757.0	35420233.0	6098.0	15245.0	6146784.0	0.0	0.0	

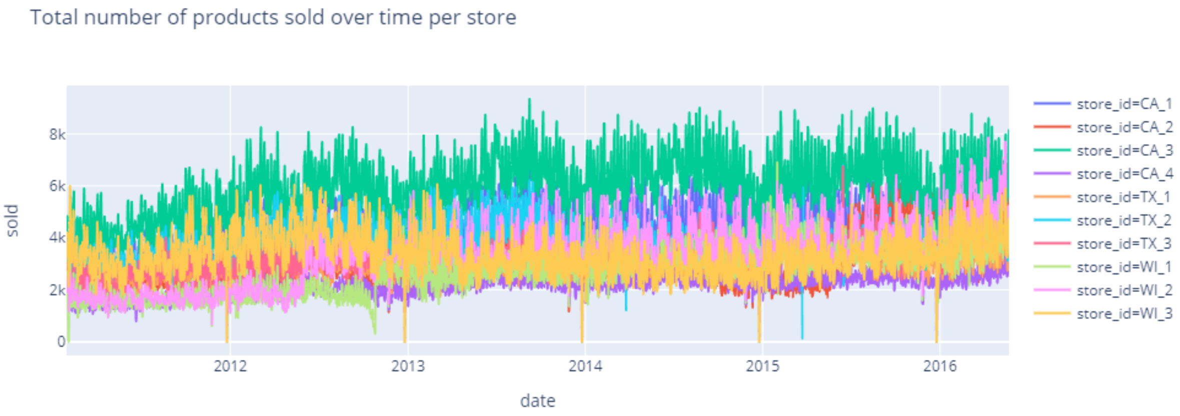
19410 rows × 11 columns

In [ ]:

In [1]:
```
# import plotly.express as px
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'store_id' ,title='Total nu
fig.update_layout(width=1000, height=400)
fig.show()
```

```
In [2]: Image(filename='Plots/1.png')
```

```
Out[2]:
```

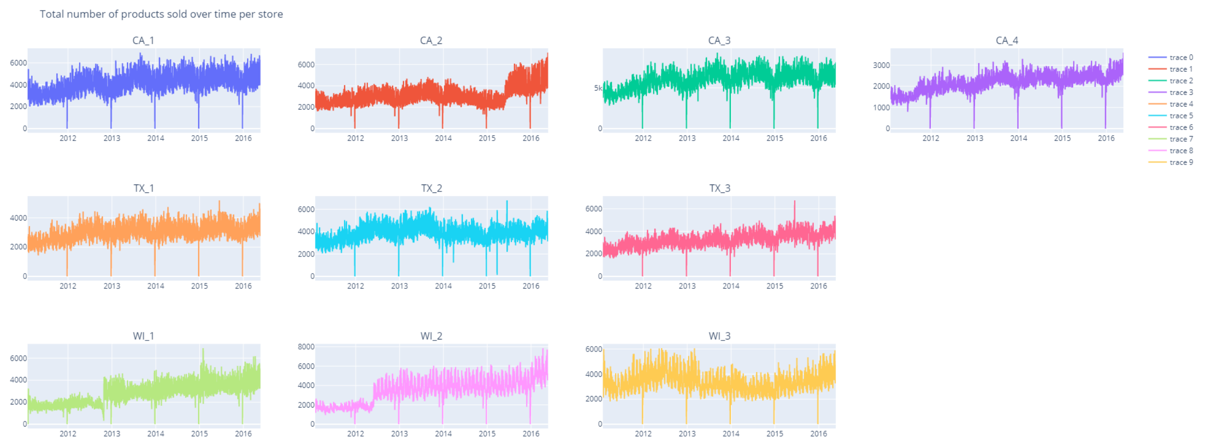


In [3]:

```
import plotly.graph_objects as go
from plotly.subplots import make_subplots
fig = make_subplots(rows=3, cols=4,subplot_titles=('CA_1',
 'CA_2',
 'CA_3',
 'CA_4',
 'TX_1',
 'TX_2',
 'TX_3','',
 'WI_1',
 'WI_2',
 'WI_3' ))

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'CA_1']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'CA_2']['date']), y=list


fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'CA_3']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'CA_4']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'TX_1']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'TX_2']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'TX_3']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'WI_1']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'WI_2']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'WI_3']['date']), y=list


fig.update_layout(height=800, width=2000, title_text="Total number of products sc
fig.show()
```

In [4]:
```
Image(filename='Plots/Plot 1.png')
```

Out[4]:



In [ ]:
```

```

Observations :-

1. CA_3 store sells most number of products daily as compared to any other store.
2. The number of products sold daily increased for CA_2 just before the mid of 2015.
3. The number of products sold daily increased for WI_1 during the end months of 2012.
4. The number of products sold daily increased for WI_2 during the mid of 2012.

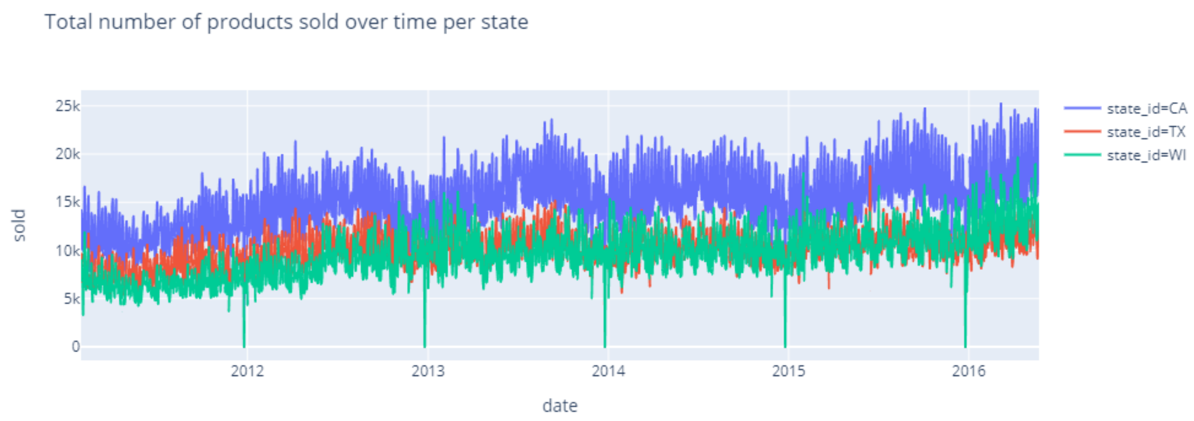
Plot 2 :- Total number of products sold over time per state

In [ ]:
```

grouped = df.groupby(['state_id','date']).sum()
grouped.reset_index( inplace=True)
```

In [5]:
```
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'state_id' ,title='Total nu
fig.update_layout(width=1000, height=400)
fig.show()
```

In [6]:
```
Image(filename='Plots/Plot 2.png')
```

Out[6]:



Observations :-

1. CA sells most number of products daily .
2. The number of products sold daily were more for TX as compared to WI before 2013 ,but after 2013 the sold value for both the states tends to fall in the same range as the plot for both the states seems to overlap for most of the time.

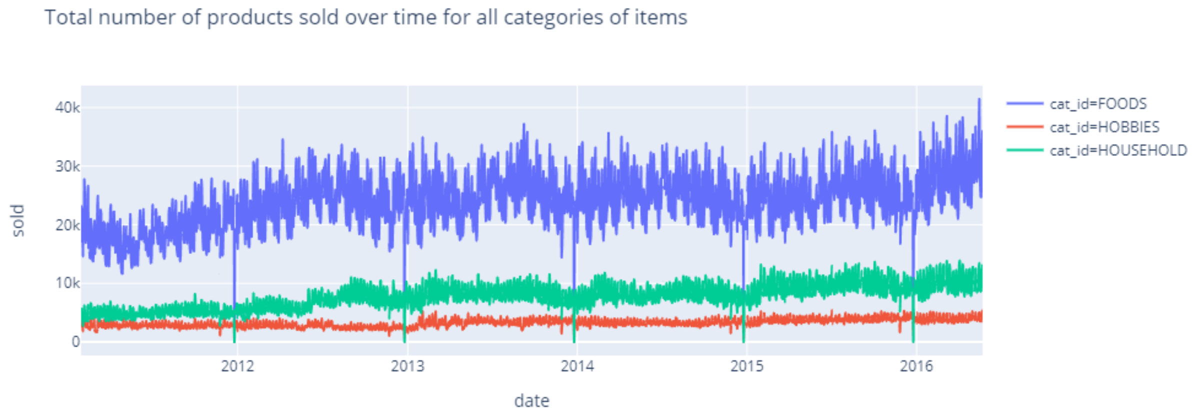
Plot 3 :- Total number of products sold over time for all categories of items

In [ ]:
```

grouped = df.groupby(['cat_id','date']).sum()
grouped.reset_index( inplace=True)
```

In [7]:
```
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'cat_id' ,title='Total numb
fig.update_layout(width=1000, height=400)
fig.show()
```

In [8]:
```
Image(filename='Plots/Plot 3.png')
```

Out[8]:



Observations :-

1. FOODS is the most sold item category.
2. HOOBIES is the least sold item category.
3. The plot for FOODS category seems to have a yearly trend .
4. The plot for HOBBIES category does not seem to have any trend.
5. The sold values for HOUSEHOLD category has noticably increased during the mid of 2012.

Plot 4 :- Total revenue generated daily from all the items sold for all the stores.

In [ ]:
```
df['revenue'] = df['sold'] * df['sell_price']
```

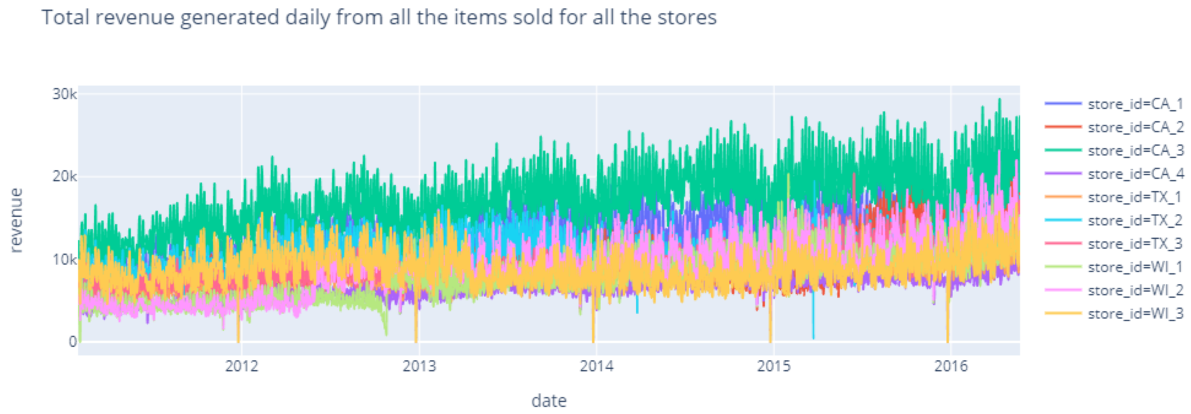
In [ ]:
```
grouped = df.groupby(['store_id','date']).sum()
grouped.reset_index( inplace=True)
```

In [ ]:
```

```

In [9]:
```
fig = px.line(grouped ,x = 'date', y = 'revenue',color = 'store_id' ,title='Total
fig.update_layout(width=1000, height=400)
fig.show()
```

```
In [10]: Image(filename='Plots/Plot 4.png')
```

```
Out[10]:
```

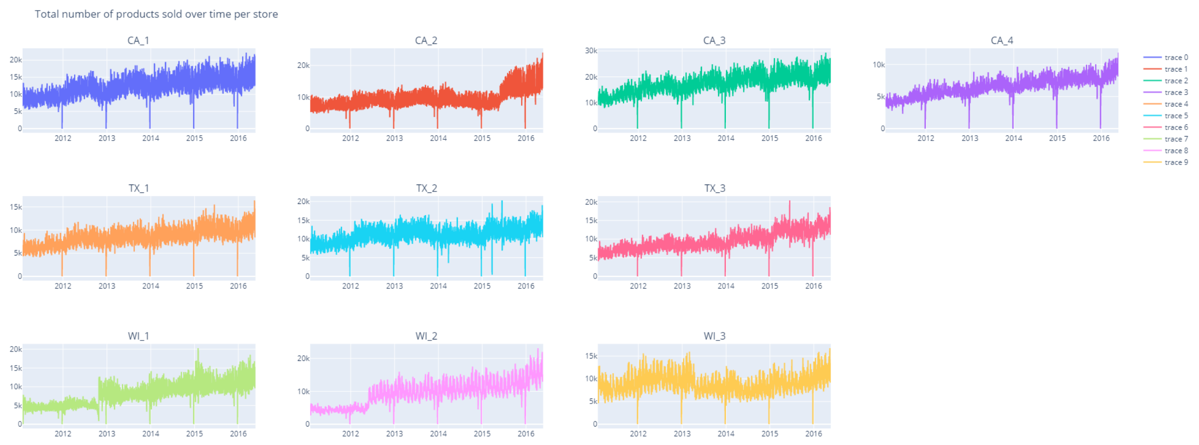


In [11]:

```
import plotly.graph_objects as go
from plotly.subplots import make_subplots
fig = make_subplots(rows=3, cols=4,subplot_titles=('CA_1',
 'CA_2',
 'CA_3',
 'CA_4',
 'TX_1',
 'TX_2',
 'TX_3','',
 'WI_1',
 'WI_2',
 'WI_3' ))

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'CA_1']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'CA_2']['date']), y=list


fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'CA_3']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'CA_4']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'TX_1']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'TX_2']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'TX_3']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'WI_1']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'WI_2']['date']), y=list

fig.add_trace(
    go.Scatter(x=list(grouped.loc[grouped['store_id'] == 'WI_3']['date']), y=list


fig.update_layout(height=800, width=2000, title_text="Total number of products sc
fig.show()
```

In [12]:
```
Image(filename='Plots/Plot 4_2.png')
```

Out[12]:



In [ ]:
```

```

Observations :-

1. CA_3 generates most revenue as compared to the other stores.
2. All observations are similar to the observations in Plot 1 :- Total number of products sold over time per store.

In [ ]:
```

```

Plot 5 :- Total number of items sold in each store for each category

In [ ]:
```
# df
```

In [ ]:
```
grouped = df.groupby(['store_id','cat_id'], as_index=False).sum().dropna()
# grouped.reset_index( inplace=True)
```

In [ ]:
```
# grouped
```

In [ ]:

```
x_axis = grouped['store_id'].unique()
x_axis
```

Out[14]:

```
['CA_1', 'CA_2', 'CA_3', 'CA_4', 'TX_1', 'TX_2', 'TX_3', 'WI_1', 'WI_2', 'WI_
3']
Categories (10, object): ['CA_1', 'CA_2', 'CA_3', 'CA_4', ..., 'TX_3', 'WI_1',
'WI_2', 'WI_3']
```

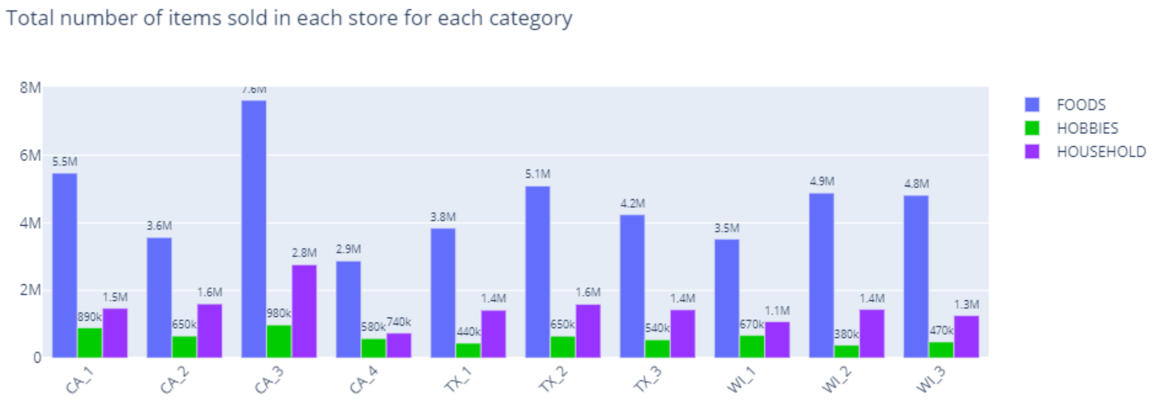
In [13]:

```
import plotly.graph_objects as go

fig = go.Figure()
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold'],
    name='FOODS',text = grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold']
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    name='HOBBIES',text = grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    marker_color='rgb(0, 204, 0)'
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['sold'],
    name='HOUSEHOLD ', text = grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['sc
    marker_color='rgb(153, 51, 255)'
))


fig.update_layout(barmode='group', xaxis_tickangle=-45)
fig.update_layout(title_text='Total number of items sold in each store for each c
fig.update_traces(texttemplate='%{text:.2s}', textposition='outside')
fig.update_layout(width=1000, height=400)
fig.show()
```

In [14]:

```
Image(filename='Plots/Plot 5.png')
```

Out[14]:



Observations :-

1. CA_3 sold the most FOODS and HOUSEHOLD category items.
2. CA_3 sold HOOBIES category items more than CA_1 but the difference is very less.
3. The difference in number of items sold in HOBBIES category accross all the stores is very less as compared to FOODS and HOUSEHOLD categories.

In [ ]:

```
```

Plot 6 :- Total number of items sold in each state for each category

In [ ]:

```
grouped = df.groupby(['state_id','cat_id'], as_index=False).sum().dropna()
x_axis = grouped['state_id'].unique()
```

In [ ]:

```
x_axis
```

Out[28]:

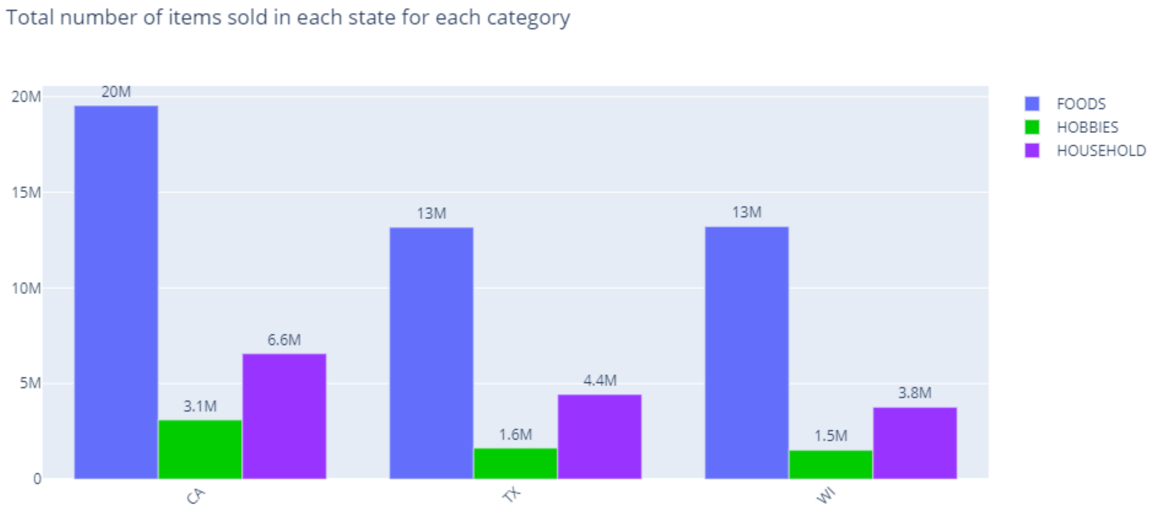
```
['CA', 'TX', 'WI']
Categories (3, object): ['CA', 'TX', 'WI']
```

In [15]:

```
import plotly.graph_objects as go

fig = go.Figure()
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold'],
    name='FOODS',text = grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold']
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    name='HOBBIES', text = grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    marker_color='rgb(0, 204, 0)'
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['sold'],
    name='HOUSEHOLD ', text = grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['so
    marker_color='rgb(153, 51, 255)'
))


fig.update_layout(barmode='group', xaxis_tickangle=-45)
fig.update_layout(title_text='Total number of items sold in each state for each c
fig.update_traces(texttemplate='%{text:.2s}', textposition='outside')
fig.update_layout(width=1000, height=500)
fig.show()
```

In [16]:
```
Image(filename='Plots/Plot 6.png')
```

Out[16]:



Observations :-

1. CA sold most items in all the categories.
2. CA sold almost double the items in HOBBIES category as compared to TX and WI.
3. TX and WI sold almost same number of items in FOODS category.
4. TX sold more items than WI in HOUSEHOLD category.

In [ ]:
```

```

Plot 7 :- Distribution of prices of different categories in different stores

In [ ]:
```

```

In [ ]:
```
# df
```

In [ ]:
```
grouped = df.groupby(['store_id','cat_id','item_id'], as_index=False)['sell_price
grouped.dropna()
```

Out[33]:

	store_id	cat_id	item_id	sell_price
0	CA_1	FOODS	FOODS_1_001	2.167969
1	CA_1	FOODS	FOODS_1_002	8.929688
2	CA_1	FOODS	FOODS_1_003	2.972656
3	CA_1	FOODS	FOODS_1_004	1.849609
4	CA_1	FOODS	FOODS_1_005	3.330078
...	...	...	...	...
91465	WI_3	HOUSEHOLD	HOUSEHOLD_2_512	3.970703
91466	WI_3	HOUSEHOLD	HOUSEHOLD_2_513	2.779297
91467	WI_3	HOUSEHOLD	HOUSEHOLD_2_514	18.796875
91468	WI_3	HOUSEHOLD	HOUSEHOLD_2_515	1.969727
91469	WI_3	HOUSEHOLD	HOUSEHOLD_2_516	5.941406

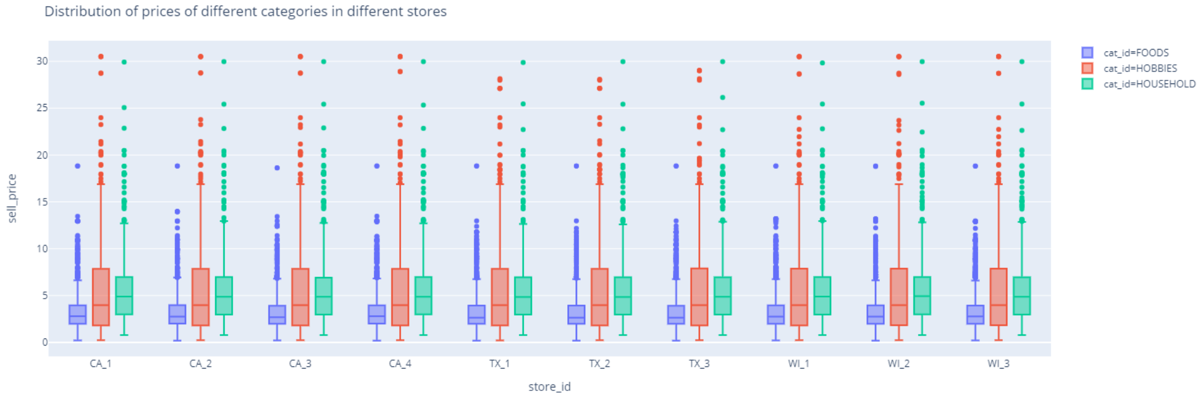
30490 rows × 4 columns

In [ ]:
```
# grouped.head()
# sell_prices
```

In [17]:
```
import plotly.express as px

fig = px.box(grouped, x="store_id", y="sell_price", color="cat_id")
fig.update_layout(title_text='Distribution of prices of different categories in d
fig.show()
```

In [18]:
```
Image(filename='Plots/Plot 7.png')
```

Out[18]:



Observations :-

1. HOBBIES category items have the largest price range.
2. FOODS category items have the least price range.

3. The median price for HOUSEHOLD category is more as compared to FOODS and HOBBIES.
4. The distribution of price range for all items seems to be very similar for all the stores.

In [ ]:

```

```

Plot 8 :- Total number of products sold for all subcategories of items per store

In [ ]:

```python
grouped = df.groupby(['store_id','dept_id'], as_index=False)['sold'].sum()
grouped.dropna()
```

Out[19]:

	store_id	dept_id	sold
0	CA_1	FOODS_1	577436.0
1	CA_1	FOODS_2	900391.0
2	CA_1	FOODS_3	3993834.0
3	CA_1	HOBBIES_1	835578.0
4	CA_1	HOBBIES_2	56505.0
...	...	...	...
65	WI_3	FOODS_3	3578587.0
66	WI_3	HOBBIES_1	432938.0
67	WI_3	HOBBIES_2	41678.0
68	WI_3	HOUSEHOLD_1	1035759.0
69	WI_3	HOUSEHOLD_2	217326.0

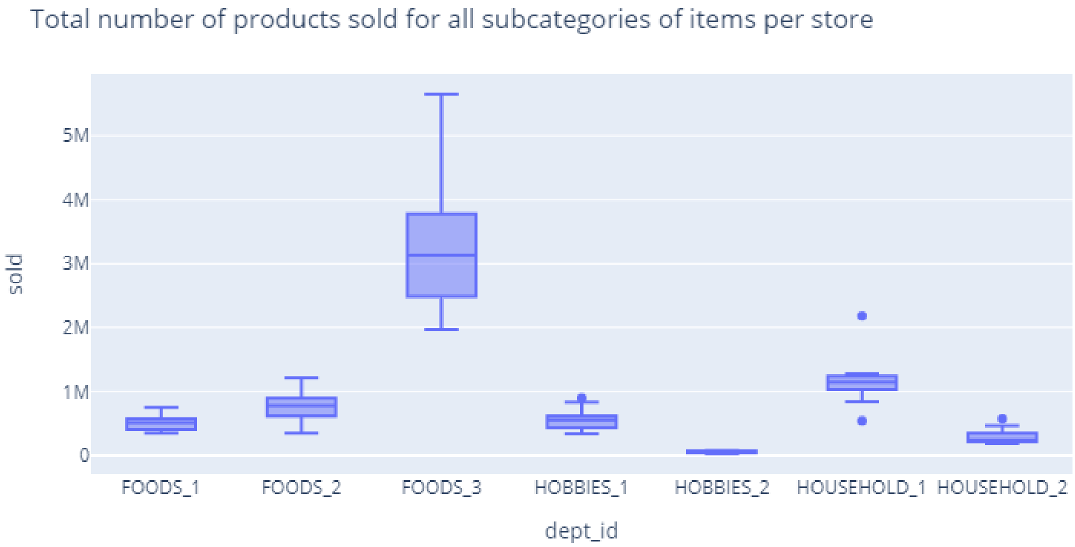
70 rows × 3 columns

In [19]:

```python
fig = px.box(grouped, x="dept_id", y="sold")
fig.update_layout(title_text='Total number of products sold for all subcategories
fig.show()
```

```
In [20]: Image(filename='Plots/Plot 8.png')
```

```
Out[20]:
```



Observations :-

1. FOODS_3 category have the most sold items among all the stores.
2. FOODS_3 have the largest range for the number of items sold in different stores. It also has the highest variance in sales.
3. HOBBIES_2 category have the least sold items among all the stores. It also has the least variance in sales.

```
In [ ]:
```

Highest sold item in FOODS_3 :-

In [ ]:

```
df_F_3 = df.loc[(df['dept_id'] == "FOODS_3")]

grouped = df_F_3.groupby(["dept_id",'item_id'],as_index=False)['sold'].sum()
grouped.dropna(inplace = True)
```

In [ ]:

```
grouped.sort_values('sold' ,inplace = True)
grouped
```

Out[68]:

	dept_id	item_id	sold
6930	FOODS_3	FOODS_3_220	885.0
6881	FOODS_3	FOODS_3_171	1142.0
7182	FOODS_3	FOODS_3_472	1183.0
6965	FOODS_3	FOODS_3_255	1394.0
7311	FOODS_3	FOODS_3_601	1558.0
...	...	...	...
7297	FOODS_3	FOODS_3_587	402159.0
7265	FOODS_3	FOODS_3_555	497881.0
6962	FOODS_3	FOODS_3_252	573723.0
7296	FOODS_3	FOODS_3_586	932236.0
6800	FOODS_3	FOODS_3_090	1017916.0

823 rows × 3 columns

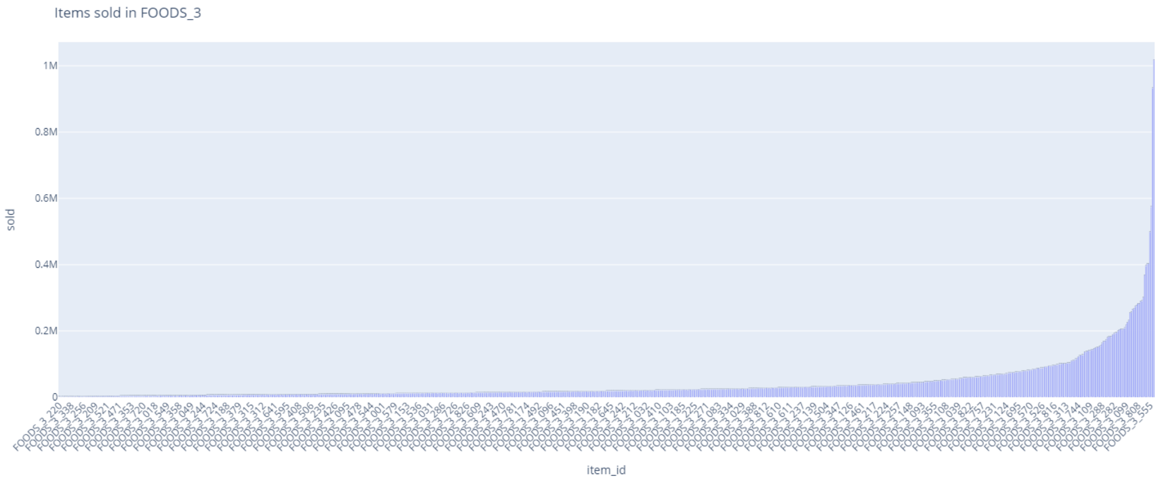
In [21]:

```
fig = px.bar(grouped, x='item_id', y='sold', text='sold')
fig.update_traces(texttemplate='%{text:.2s}', textposition='outside')
fig.update_layout(barmode='stack', xaxis_tickangle=-45 ,width=1500, height=600 )
fig.update_layout(title_text='Items sold in FOODS_3')
fig.show()
```

In [22]:

```
Image(filename='Plots/Plot 8_2.png')
```

Out[22]:



Observations :-

1. FOODS_3_090 (units sold = 1017916) is the most sold item in FOODS_3.

Plot 9 :- Total number of products sold in events in 2016

In [ ]:
```
df.tail()
df_2016 = df.loc[df['year'] == 2016]

# df_2016
```

In [ ]:
```
grouped = df_2016.groupby(['date','event_type_1','event_name_1','cat_id'], as_inc
grouped.dropna(inplace=True)
grouped.head()
```

Out[35]:

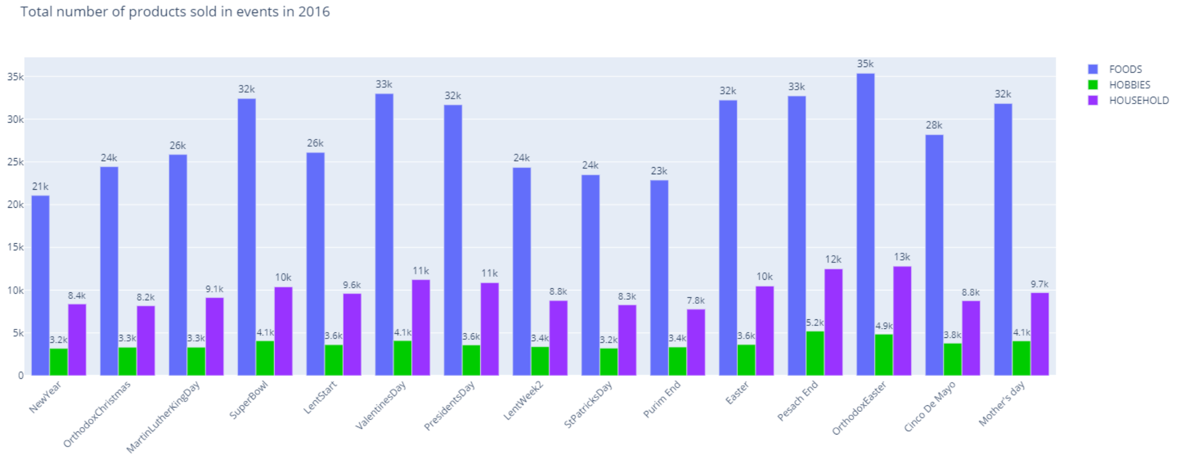
	date	event_type_1	event_name_1	cat_id	sold
144	2016-01-01	National	NewYear	FOODS	21078.0
145	2016-01-01	National	NewYear	HOBBIES	3182.0
146	2016-01-01	National	NewYear	HOUSEHOLD	8391.0
2397	2016-01-07	Religious	OrthodoxChristmas	FOODS	24445.0
2398	2016-01-07	Religious	OrthodoxChristmas	HOBBIES	3327.0

In [ ]:
```
x_axis = grouped['event_name_1'].unique()
```

In [23]:
```
import plotly.graph_objects as go

fig = go.Figure()
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold'],
    name='FOODS',text = grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold']
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    name='HOBBIES', text = grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    marker_color='rgb(0, 204, 0)'
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['sold'],
    name='HOUSEHOLD ', text = grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['sc
    marker_color='rgb(153, 51, 255)'
))


fig.update_layout(barmode='group', xaxis_tickangle=-45 ,width=1500, height=600)
fig.update_traces(texttemplate='%{text:.2s}', textposition='outside')
fig.update_layout(title_text=' Total number of products sold in events in 2016')
fig.show()
```

In [24]:
```
Image(filename='Plots/Plot 9.png')
```

Out[24]:



Observations :-

1. Most of the FOODS and HOUSEHOLD category items were sold on Orthodox Easter day in 2016.
2. On SuperBowl , Valentine's Day, President's Day, Easter ,Pesach End, Orthodox Easter and Mother's Day more than 30000 FOODS category items were sold in 2016.

In [ ]:

In [ ]:

Plot 10 :- Products sold in SNAP

In [ ]:

In [ ]:
```
df_snap = df.loc[(df['snap_CA'] == 1) | (df['snap_TX'] == 1) | (df['snap_WI'] ==
grouped = df.groupby(['store_id','cat_id'], as_index=False)['sold'].sum()
grouped.dropna(inplace=True)
grouped
```

Out[42]:

	store_id	cat_id	sold
0	CA_1	FOODS	5471661.0
1	CA_1	HOBBIES	892083.0
2	CA_1	HOUSEHOLD	1468504.0
3	CA_2	FOODS	3567477.0
4	CA_2	HOBBIES	650360.0
5	CA_2	HOUSEHOLD	1600558.0
6	CA_3	FOODS	7625660.0
7	CA_3	HOBBIES	977613.0
8	CA_3	HOUSEHOLD	2760267.0
9	CA_4	FOODS	2871065.0
10	CA_4	HOBBIES	575531.0
11	CA_4	HOUSEHOLD	735938.0
12	TX_1	FOODS	3840554.0
13	TX_1	HOBBIES	437433.0
14	TX_1	HOUSEHOLD	1414836.0
15	TX_2	FOODS	5091362.0
16	TX_2	HOBBIES	647815.0
17	TX_2	HOUSEHOLD	1590465.0
18	TX_3	FOODS	4240190.0
19	TX_3	HOBBIES	538882.0
20	TX_3	HOUSEHOLD	1426868.0
21	WI_1	FOODS	3517285.0
22	WI_1	HOBBIES	667705.0
23	WI_1	HOUSEHOLD	1076516.0
24	WI_2	FOODS	4882317.0
25	WI_2	HOBBIES	378618.0
26	WI_2	HOUSEHOLD	1437053.0
27	WI_3	FOODS	4814856.0
28	WI_3	HOBBIES	474616.0
29	WI_3	HOUSEHOLD	1253085.0

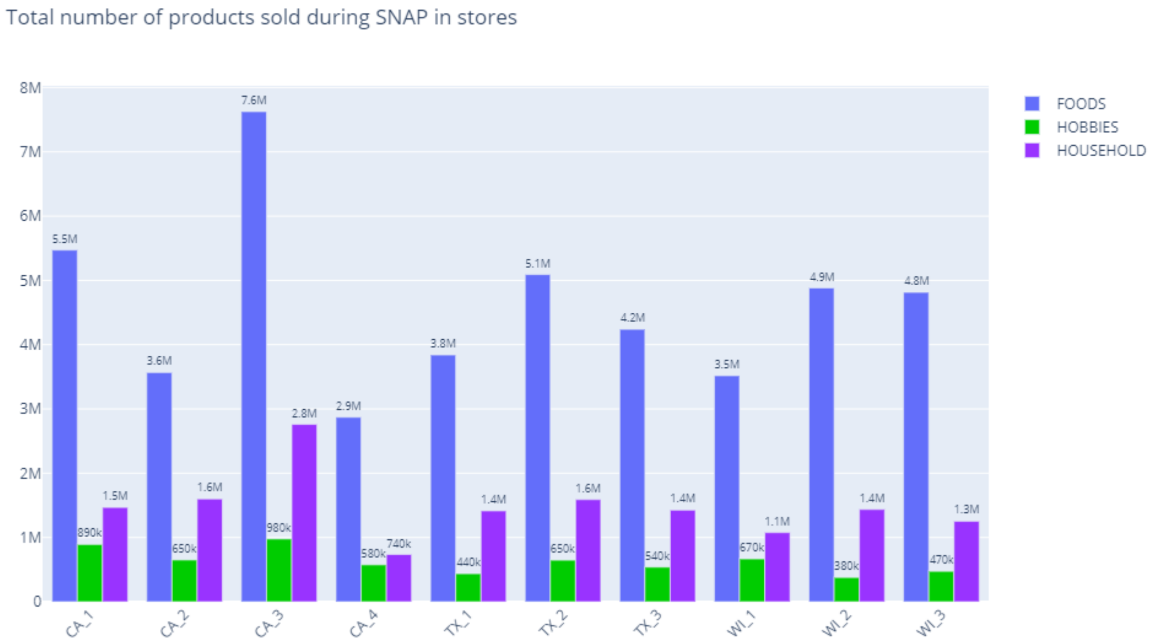
In [ ]:
```
x_axis = grouped['store_id'].unique()
x_axis
```

Out[43]:
```
['CA_1', 'CA_2', 'CA_3', 'CA_4', 'TX_1', 'TX_2', 'TX_3', 'WI_1', 'WI_2', 'WI_
3']
Categories (10, object): ['CA_1', 'CA_2', 'CA_3', 'CA_4', ..., 'TX_3', 'WI_1',
'WI_2', 'WI_3']
```

In [25]:
```
import plotly.graph_objects as go

fig = go.Figure()
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold'],
    name='FOODS', text = grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold']
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    name='HOBBIES', text = grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    marker_color='rgb(0, 204, 0)'
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['sold'],
    name='HOUSEHOLD ', text = grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['so
    marker_color='rgb(153, 51, 255)'
))


fig.update_layout(barmode='group', xaxis_tickangle=-45,width=1000, height=600)
fig.update_traces(texttemplate='%{text:.2s}', textposition='outside')
fig.update_layout(title_text=' Total number of products sold during SNAP in store
fig.show()
```

```
In [26]: Image(filename='Plots/Plot 10.png')
```

```
Out[26]:
```



Observations :-

1. CA_3 sold most number of items in every category among all the stores during SNAP.
2. CA_4 sold least number of FOODS category items during SNAP.
3. WI_2 and WI_3 sold almost same number of FOODS category items during SNAP.

Plot 11 :- Products sold on weekdays and weekends

```
In [ ]: # df
```

In [ ]:
```
grouped = df.groupby(['wday','cat_id'], as_index=False)['sold'].sum()
grouped.dropna(inplace=True)
grouped.head()
```

Out[56]:

	wday	cat_id	sold
0	1	FOODS	7832803.0
1	1	HOBBIES	1097354.0
2	1	HOUSEHOLD	2664186.0
3	2	FOODS	7911666.0
4	2	HOBBIES	995802.0

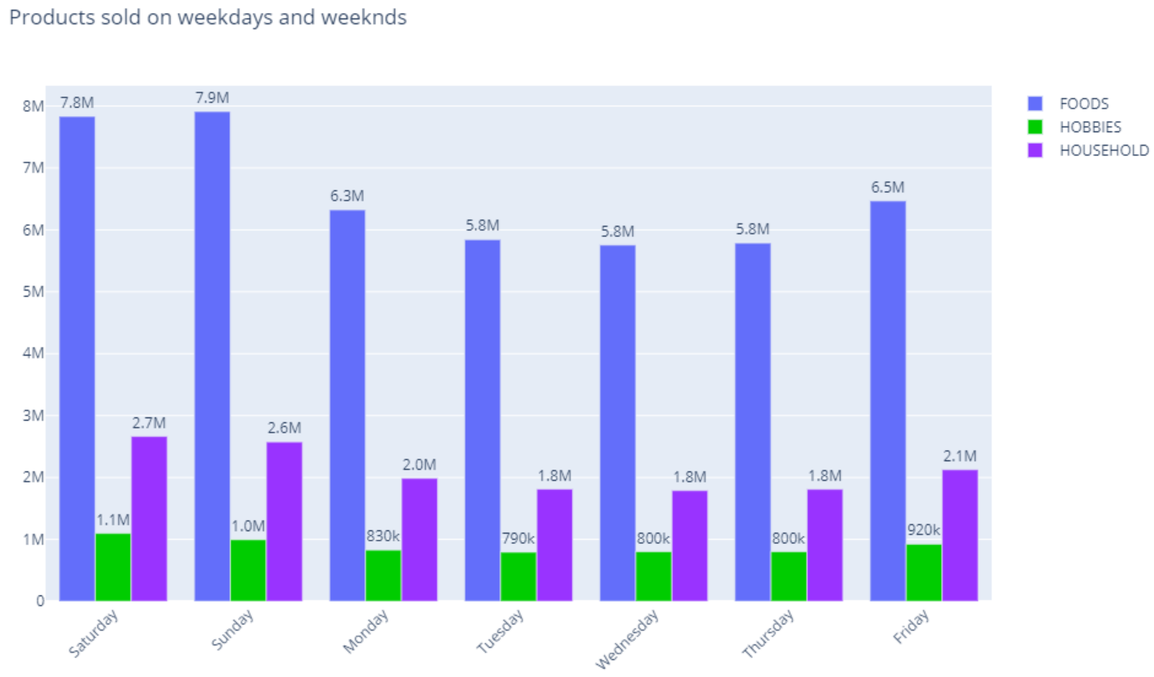
In [ ]:
```
x_axis = [ 'Saturday', 'Sunday','Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Fr
```

Out[58]:
```
list
```

In [27]:
```
fig = go.Figure()
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold'],
    name='FOODS', text = grouped.loc[(grouped['cat_id'] == 'FOODS')]['sold'],

))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    name='HOBBIES', text = grouped.loc[(grouped['cat_id'] == 'HOBBIES')]['sold'],
    marker_color='rgb(0, 204, 0)'
))
fig.add_trace(go.Bar(
    x=x_axis,
    y=grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['sold'],
    name='HOUSEHOLD ', text = grouped.loc[(grouped['cat_id'] == 'HOUSEHOLD')]['sc
    marker_color='rgb(153, 51, 255)'
))


fig.update_layout(barmode='group', xaxis_tickangle=-45,width=1000, height=600)
fig.update_traces(texttemplate='%{text:.2s}', textposition='outside')
fig.update_layout(title_text='Products sold on weekdays and weeknds ')
fig.show()
```

```
In [28]: Image(filename='Plots/Plot 11.png')
```

Out[28]:



Observations :-

1. People buy more products on weeknds than on weekdays for all item categories.
2. The FOODS category items are sold most on Sunday.
3. The HOBBIES and HOUSEHOLD category items are sold most on Saturday.

```
In [ ]:
```

State Wise monthly analysis of 2016

For 2016 we have data until 22nd of May , so all the analysis done will be upto this day.

Plot 12 :- California

Monthly analysis

In [ ]:
```
# df
```

In [ ]:
```
df_CA = df.loc[(df['state_id'] == "CA") & (df['year'] == 2016) ]
```

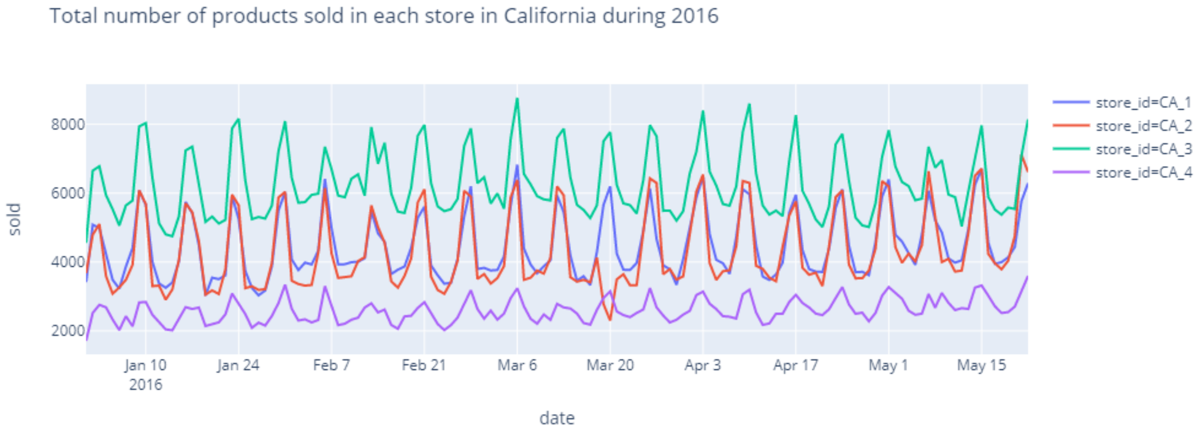
In [ ]:
```
# df_CA
```

In [ ]:
```
# Monthly Analysis
df_CA= df.loc[(df['state_id'] == "CA") & (df['year'] == 2016)  ]

grouped = df_CA.groupby(['store_id','date']).sum()
grouped.dropna(inplace = True)
grouped.reset_index( inplace=True)
```

In [29]:
```
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'store_id' ,title='Total nu
fig.update_layout(width=1000, height=400)
fig.show()
```

In [30]:
```
Image(filename='Plots/Plot 12.png')
```

Out[30]:



Observations :-

1. There is a sudden derease in sales for store CA_2 on March 20 2016 (products sold = 2300). We will look further into this.

In [ ]:
```

```

Daily analysis

In [ ]:

```
df_CA= df.loc[(df['state_id'] == "CA") & (df['year'] == 2016) & (df['month'] == 3

grouped = df_CA.groupby(['cat_id','date']).sum()
grouped.dropna(inplace = True)
grouped.reset_index( inplace=True)
```

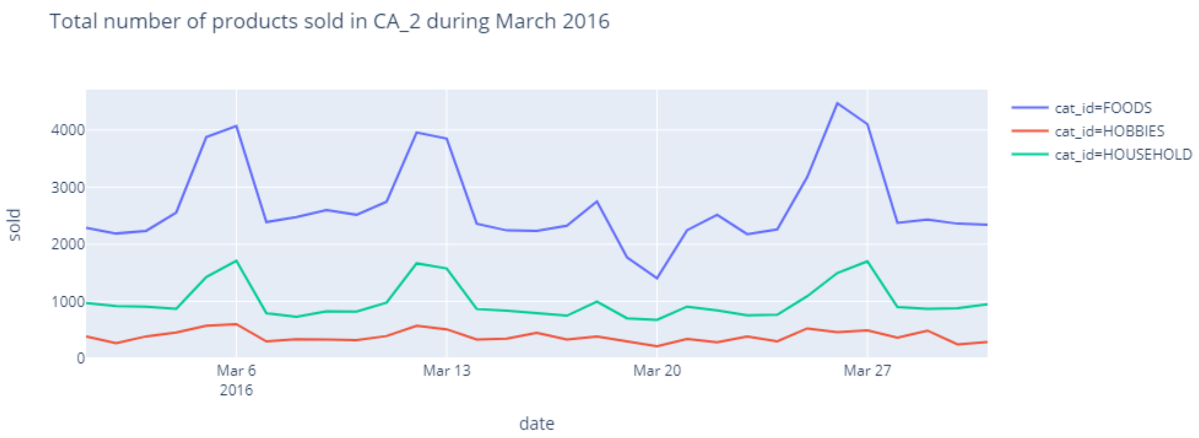
In [31]:

```
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'cat_id' ,title='Total numb
fig.update_layout(width=1000, height=400)
fig.show()
```

In [32]:

```
Image(filename='Plots/Plot 12_2.png')
```

Out[32]:



Observations :-

1. All item categories were sold least on March 20 2016 for store CA_2 (FOODS = 1406 , HOBBIES = 215 , HOUSEHOLD = 679).

In [ ]:

Plot 13 :- Texas

Monthly Analysis

In [ ]:

```
# Monthly Analysis
df_TX= df.loc[(df['state_id'] == "TX") & (df['year'] == 2016) ]

grouped = df_TX.groupby(['store_id','date']).sum()
grouped.dropna(inplace = True)
grouped.reset_index( inplace=True)
```

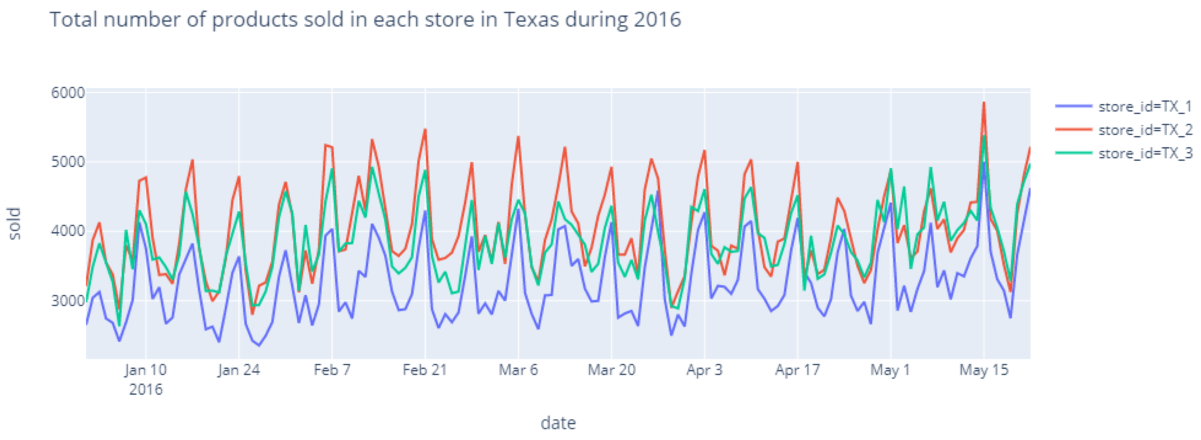
In [33]:

```
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'store_id' ,title='Total nu
fig.update_layout(width=1000, height=400)
fig.show()
```

In [34]:

```
Image(filename='Plots/Plot 13.png')
```

Out[34]:



Observations :-

1. Most items were sold in Texas on May 15 2016 by the store TX_2 (proudcts sold = 5866). We will look deeper into this.

In [ ]:

Daily Analysis

In [ ]:

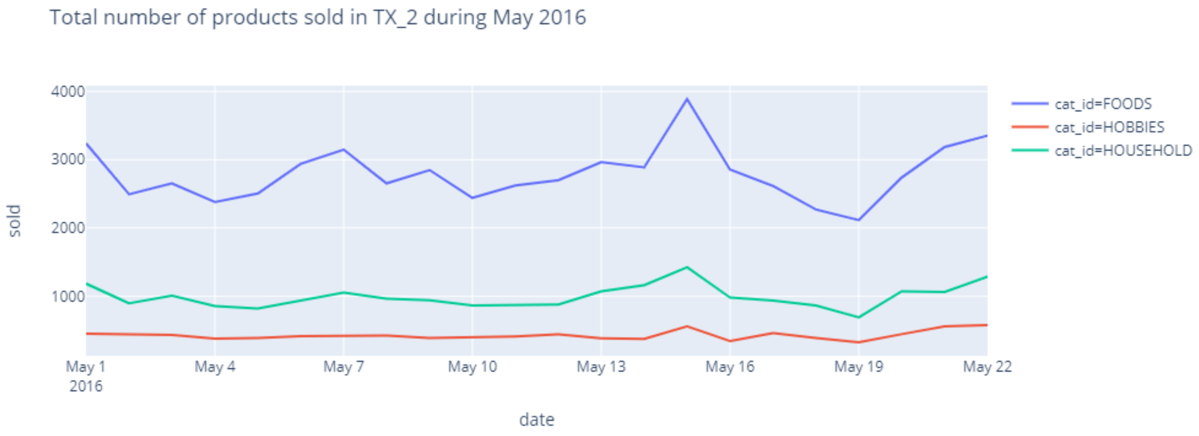
```

df_TX= df.loc[(df['store_id'] == "TX_2") & (df['year'] == 2016) &(df['month'] ==

grouped = df_TX.groupby(['cat_id','date']).sum()
grouped.dropna(inplace = True)
grouped.reset_index( inplace=True)
```

In [35]:

```
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'cat_id' ,title='Total numb
fig.update_layout(width=1000, height=400)
fig.show()
```

In [36]:
```
Image(filename='Plots/Plot 13_2.png')
```

Out[36]:



Observations :-

1. FOODS and HOUDEHOLD (FOODS = 3887, HOUSEHOLD = 1423) items had the highest sale on May 15 2016.

Plot 14 :- Wisconsin

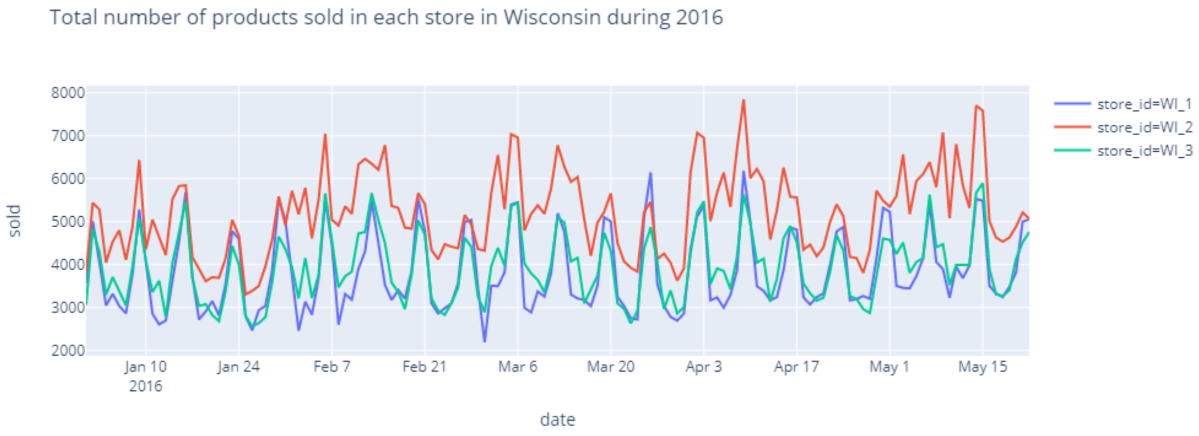
Monthly Analysis

In [ ]:
```
# Monthly Analysis
df_WI= df.loc[(df['state_id'] == "WI") & (df['year'] == 2016) ]

grouped = df_WI.groupby(['store_id','date']).sum()
grouped.dropna(inplace = True)
grouped.reset_index( inplace=True)
```

In [37]:
```
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'store_id' ,title='Total nu
fig.update_layout(width=1000, height=400)
fig.show()
```

In [38]:
```
Image(filename='Plots/Plot 14.png')
```

Out[38]:



Observations :-

1. Highest number of products were sold in Wisconsin by WI_2 store on April 9 2016 (products sold = 7852).

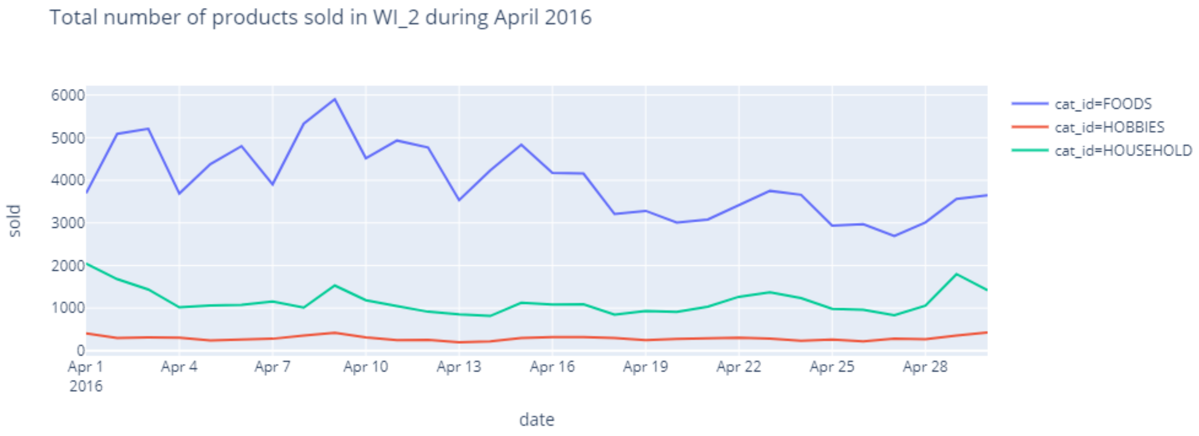
Daily Analysis

In [ ]:
```
df_WI= df.loc[(df['year'] == 2016) & (df['store_id'] == "WI_2")&(df['month'] == 4

grouped = df_WI.groupby(['cat_id','date']).sum()
grouped.dropna(inplace = True)
grouped.reset_index( inplace=True)
```

In [39]:
```
fig = px.line(grouped ,x = 'date', y = 'sold',color = 'cat_id' ,title='Total numb
fig.update_layout(width=1000, height=400)
fig.show()
```

In [40]:
```
Image(filename='Plots/Plot 14_2.png')
```

Out[40]:



Observations :-

1. FOODS (FOODS = 5902) item category had the highest sale on April 9 2016.

In [ ]:

In [ ]:

In [ ]: