

Guided Project: Storytelling Data Visualization on Exchange Rates

Introducing the Dataset

```
In [1]: import pandas as pd
exchange_rates = pd.read_csv('euro-daily-hist_1999-2020.csv')
exchange_rates.head()
```

	Period\Unit:	(Australian dollar)	(Bulgarian lev)	(Brazilian real)	(Canadian dollar)	(Swiss franc)	(Chinese yuan renminbi)	(Cypriot pound)	(Czech koruna)	(Danish krone)	...	(Romanian leu)	(Russian rouble)	(Swedish krona)
0	2021-01-08	1.5758	1.9558	6.5748	1.5543	1.0827	7.9184	NaN	26.163	7.4369	...	4.8708	90.800	10.0570
1	2021-01-07	1.5836	1.9558	6.5172	1.5601	1.0833	7.9392	NaN	26.147	7.4392	...	4.8712	91.200	10.0515
2	2021-01-06	1.5824	1.9558	6.5119	1.5640	1.0821	7.9653	NaN	26.145	7.4393	...	4.8720	90.875	10.0563
3	2021-01-05	1.5927	1.9558	6.5517	1.5651	1.0803	7.9315	NaN	26.227	7.4387	...	4.8721	91.675	10.0670
4	2021-01-04	1.5928	1.9558	6.3241	1.5621	1.0811	7.9484	NaN	26.141	7.4379	...	4.8713	90.340	10.0895

5 rows × 15 columns

```
In [2]: exchange_rates.tail()
```

	Period\Unit:	(Australian dollar)	(Bulgarian lev)	(Brazilian real)	(Canadian dollar)	(Swiss franc)	(Chinese yuan renminbi)	(Cypriot pound)	(Czech koruna)	(Danish krone)	...	(Romanian leu)	(Russian rouble)	(Swedish krona)
5694	1999-01-08	1.8406	NaN	NaN	1.7643	1.6138	NaN	0.58187	34.938	7.4433	...	1.3143	27.2075	9.11
5695	1999-01-07	1.8474	NaN	NaN	1.7965	1.6165	NaN	0.58187	34.886	7.4431	...	1.3092	26.9876	9.11
5696	1999-01-06	1.8820	NaN	NaN	1.7711	1.6116	NaN	0.58200	34.850	7.4452	...	1.3168	27.4315	9.31
5697	1999-01-05	1.8944	NaN	NaN	1.7965	1.6123	NaN	0.58230	34.917	7.4495	...	1.3168	26.5876	9.41
5698	1999-01-04	1.9100	NaN	NaN	1.8004	1.6168	NaN	0.58231	35.107	7.4501	...	1.3111	25.2875	9.41

5 rows × 15 columns

```
In [3]: exchange_rates.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5699 entries, 0 to 5698
Data columns (total 15 columns):
 #   Column                Non-Null Count  Dtype  
---  --
 0   Period\Unit:          5699 non-null  object 
 1   (Australian dollar)   5699 non-null  object 
 2   (Bulgarian lev)      5291 non-null  object 
 3   (Brazilian real)     5431 non-null  object 
 4   (Canadian dollar)    5699 non-null  object 
 5   (Swiss franc)        5699 non-null  object 
 6   (Chinese yuan renminbi) 5431 non-null  object 
 7   (Cypriot pound)      2346 non-null  object 
 8   (Czech koruna)       5699 non-null  object 
 9   (Danish krone)       5699 non-null  object 
10   (Estonian kroon)     3130 non-null  object 
11   (EUR pound sterling) 5699 non-null  object 
12   (Greek drachma)      520 non-null  object 
13   (Hong Kong dollar)   5699 non-null  object 
14   (Croatian kuna)      5431 non-null  object 
15   (Hungarian forint)   5699 non-null  object 
16   (Indonesian rupiah)  5699 non-null  object 
17   (Israeli shekel)     5431 non-null  object 
18   (Indian rupee)       5431 non-null  object 
19   (Iceland krona)      3392 non-null  float64
20   (Japanese yen)       5699 non-null  object 
21   (Korean won)         5699 non-null  object 
22   (Lithuanian litas)   4159 non-null  object 
23   (Latvian lats)       3904 non-null  object 
24   (New Zealand dollar) 2085 non-null  object 
25   (Mexican peso)       5699 non-null  object 
26   (Malaysian ringgit)  5699 non-null  object 
27   (Norwegian krona)    5699 non-null  object 
28   (New Zealand dollar) 5699 non-null  object 
29   (Philippine peso)    5699 non-null  object 
30   (Polish zloty)       5699 non-null  object 
31   (Romanian leu)       5637 non-null  float64
32   (Russian rouble)     5699 non-null  object 
33   (Swedish krona)      5699 non-null  object 
34   (Singapore dollar)   5699 non-null  object 
35   (Slovenian tolar)    2608 non-null  object 
36   (Slovak koruna)      5699 non-null  object 
37   (Thai baht)          5699 non-null  object 
38   (Turkish lira)       5637 non-null  float64
39   (US dollar)          5699 non-null  object 
40   (South African rand) 5699 non-null  object 
dtypes: float64(3), object(38)
memory usage: 132.1 KB
```

Data Cleaning

```
In [4]: exchange_rates.rename(columns={'(US dollar)': 'US_dollar',
                                     'Period\Unit': 'Time'},
                           inplace=True)
exchange_rates['Time'] = pd.to_datetime(exchange_rates['Time'])
exchange_rates.sort_values('Time', inplace=True)
exchange_rates.reset_index(drop=True, inplace=True)
exchange_rates.head()
```

	Time	(Australian dollar)	(Bulgarian lev)	(Brazilian real)	(Canadian dollar)	(Swiss franc)	(Chinese yuan renminbi)	(Cypriot pound)	(Czech koruna)	(Danish krone)	...	(Romanian leu)	(Russian rouble)	(Swedish krona)	(Singapore dollar)
0	1999-01-04	1.9100	NaN	NaN	1.8004	1.6168	NaN	0.58231	35.107	7.4501	...	1.3111	25.2875	9.4096	1
1	1999-01-05	1.8944	NaN	NaN	1.7965	1.6123	NaN	0.58230	34.917	7.4495	...	1.3168	26.5876	9.4025	1
2	1999-01-06	1.8820	NaN	NaN	1.7711	1.6116	NaN	0.58200	34.850	7.4452	...	1.3168	27.4315	9.3050	1
3	1999-01-07	1.8474	NaN	NaN	1.7602	1.6165	NaN	0.58187	34.886	7.4431	...	1.3092	26.9876	9.1800	1
4	1999-01-08	1.8406	NaN	NaN	1.7643	1.6138	NaN	0.58187	34.938	7.4433	...	1.3143	27.2075	9.1650	1

5 rows × 15 columns

```
In [5]: euro_to_dollar = exchange_rates[['Time', 'US_dollar']].copy()
euro_to_dollar['US_dollar'].value_counts() # 62 '-' characters
```

	Time	US_dollar
0	1999-01-04	1.9100
1	1999-01-05	1.8944
2	1999-01-06	1.8820
3	1999-01-07	1.8474
4	1999-01-08	1.8406

5 rows × 2 columns

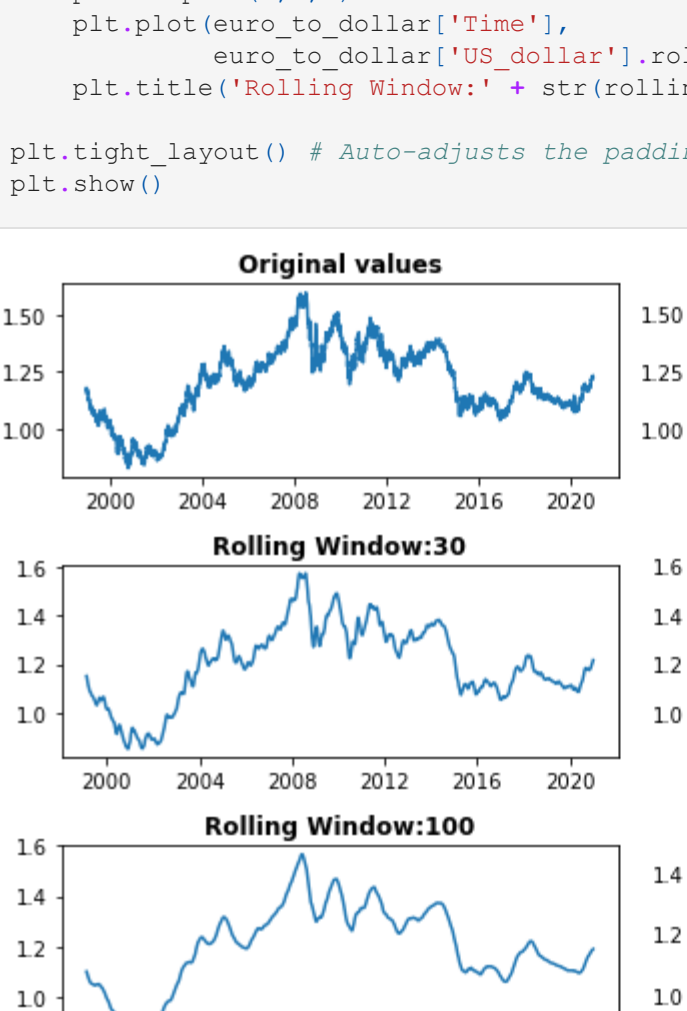
```
In [6]: euro_to_dollar = euro_to_dollar[euro_to_dollar['US_dollar'] != '-']
euro_to_dollar['US_dollar'] = euro_to_dollar['US_dollar'].astype(float)
euro_to_dollar.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5637 entries, 0 to 5636
Data columns (total 2 columns):
 #   Column                Non-Null Count  Dtype  
---  --
 0   Time                  5637 non-null  object 
 1   US_dollar             5637 non-null  float64
dtypes: datetime64[ns](1), float64(1)
memory usage: 132.1 KB
```

Rolling Mean

```
In [7]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

plt.plot(euro_to_dollar['Time'], euro_to_dollar['US_dollar'])
plt.show()
```

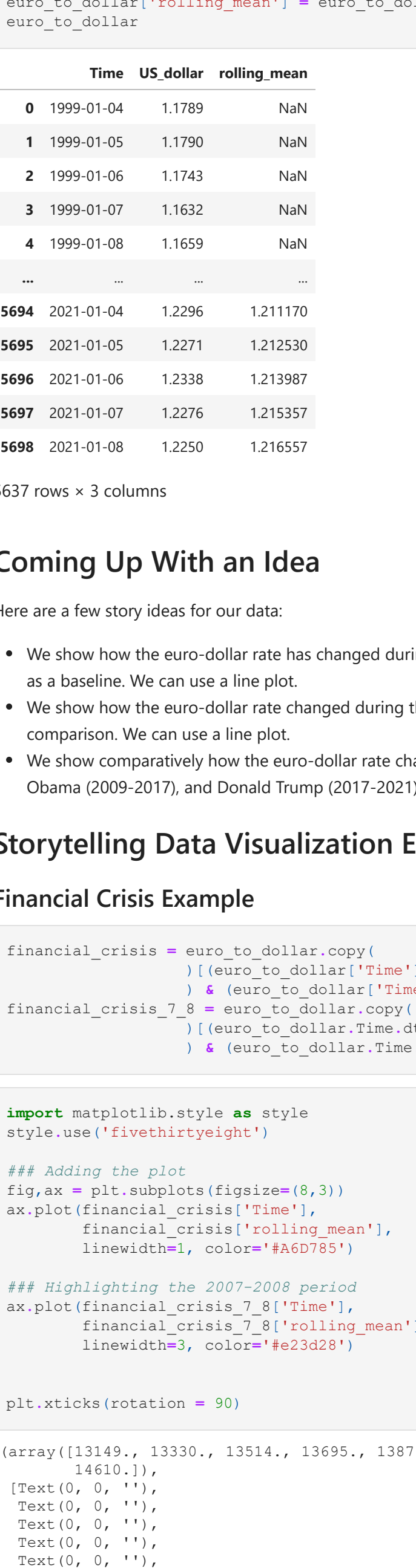


```
In [8]: plt.figure(figsize=(9,6))

plt.subplot(3,2,1)
plt.plot(euro_to_dollar['Time'], euro_to_dollar['US_dollar'])
plt.title('Original values', weight='bold')

for i, rolling_mean in zip([2, 3, 4, 5, 6],
                           [7, 30, 50, 100, 365]):
    plt.subplot(3,2,i)
    plt.plot(euro_to_dollar['Time'],
             euro_to_dollar['US_dollar'].rolling(rolling_mean).mean())
    plt.title(f'Rolling Window:{rolling_mean}', weight='bold')

plt.tight_layout() # Auto-adjusts the padding between subplots
plt.show()
```



```
In [9]: euro_to_dollar['rolling_mean'] = euro_to_dollar['US_dollar'].rolling(30).mean()
euro_to_dollar
```

	Time	US_dollar	rolling_mean
0	1999-01-04	1.7789	NaN
1	1999-01-05	1.7790	NaN
2	1999-01-06	1.7143	NaN
3	1999-01-07	1.1632	NaN
4	1999-01-08	1.1639	NaN

5637 rows × 3 columns

Coming Up With an Idea

Here are a few story ideas for our data:

- We show how the euro-dollar rate has changed during the coronavirus pandemic. We can show the 2020 data and the 2016-2019 data as a baseline. We can use a line plot.
- We show how the euro-dollar rate changed during the 2007-2008 financial crisis. We can also show the data for 2016 and 2009 for comparison. We can use a line plot.
- We show comparatively how the euro-dollar rate changed under the last three US presidents (George W. Bush (2001-2009), Barack Obama (2009-2017), and Donald Trump (2017-2021)). We can use a line plot.

Storytelling Data Visualization Examples

Financial Crisis Example

```
In [10]: financial_crisis = euro_to_dollar.copy()
financial_crisis['Time'] = pd.to_datetime(financial_crisis['Time']).dt.year >= 2006
financial_crisis['Time'] = pd.to_datetime(financial_crisis['Time']).dt.year <= 2009
financial_crisis_7_8 = euro_to_dollar.copy()
financial_crisis_7_8['Time'] = pd.to_datetime(financial_crisis_7_8['Time']).dt.year >= 2007
financial_crisis_7_8['Time'] = pd.to_datetime(financial_crisis_7_8['Time']).dt.year <= 2008
```

```
In [11]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

# Adding the plot
fig, ax = plt.subplots(figsize=(8,3))
ax.plot(financial_crisis['Time'],
        financial_crisis['rolling_mean'],
        linewidth=1, color='#A6D785')

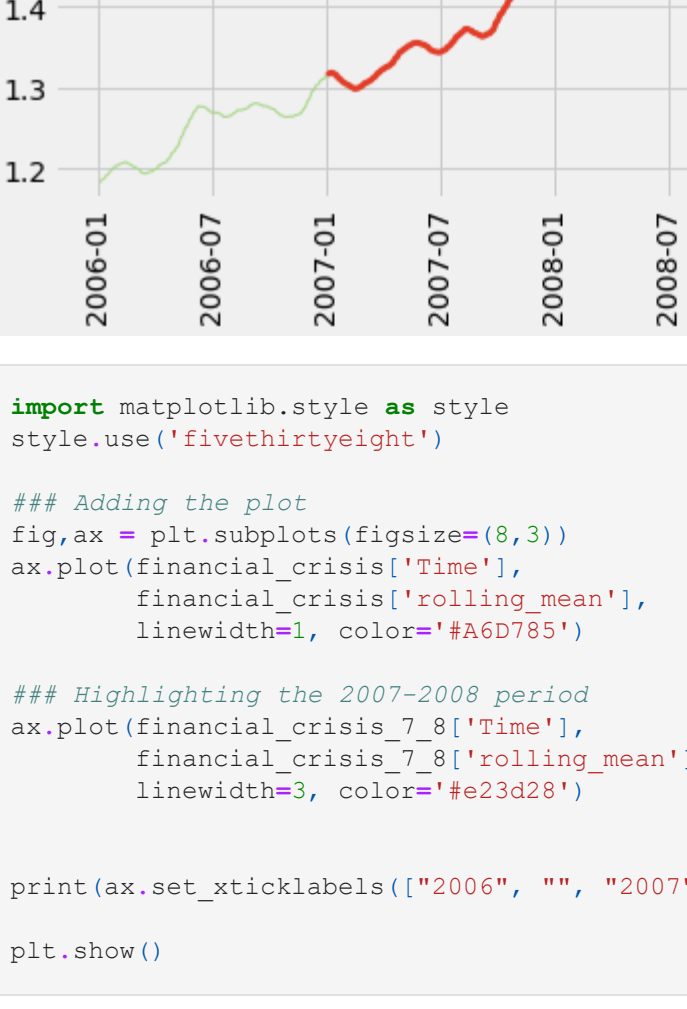
# Highlighting the 2007-2008 period
ax.plot(financial_crisis_7_8['Time'],
        financial_crisis_7_8['rolling_mean'],
        linewidth=3, color='#E23D28')

plt.xticks(rotation = 90)
```

	Time	US_dollar	rolling_mean
0	1999-01-04	1.7789	NaN
1	1999-01-05	1.7790	NaN
2	1999-01-06	1.7143	NaN
3	1999-01-07	1.1632	NaN
4	1999-01-08	1.1639	NaN

5637 rows × 3 columns

```
Out[11]: (array([13149., 13330., 13514., 13695., 13873., 14061., 14245., 14426.,
        14610.]),
         (Text(0, 0, ''),
          Text(0, 0, ''),
          Text(0, 0, ''),
          Text(0, 0, ''),
          Text(0, 0, ''),
          Text(0, 0, ''),
          Text(0, 0, '')))
```



```
In [12]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

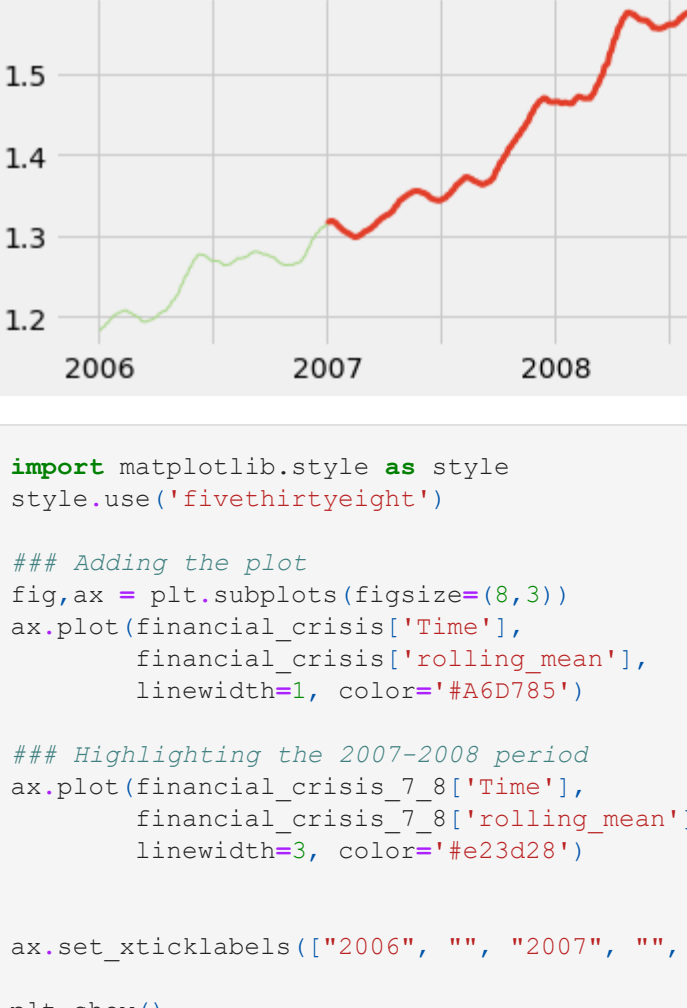
# Adding the plot
fig, ax = plt.subplots(figsize=(8,3))
ax.plot(financial_crisis['Time'],
        financial_crisis['rolling_mean'],
        linewidth=1, color='#A6D785')

# Highlighting the 2007-2008 period
ax.plot(financial_crisis_7_8['Time'],
        financial_crisis_7_8['rolling_mean'],
        linewidth=3, color='#E23D28')

print(ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010']))

plt.show()
```

```
[Text(13149.0, 0, '2006'), Text(13330.0, 0, ''), Text(13514.0, 0, '2007'), Text(13695.0, 0, ''), Text(13873.0, 0, '2008'), Text(14061.0, 0, ''), Text(14245.0, 0, '2009'), Text(14426.0, 0, '2010')]
UserWarning: FixedFormatter should only be used together with FixedLocator
print(ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010']))
```



```
In [13]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

# Adding the plot
fig, ax = plt.subplots(figsize=(8,3))
ax.plot(financial_crisis['Time'],
        financial_crisis['rolling_mean'],
        linewidth=1, color='#A6D785')

# Highlighting the 2007-2008 period
ax.plot(financial_crisis_7_8['Time'],
        financial_crisis_7_8['rolling_mean'],
        linewidth=3, color='#E23D28')

ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010'], alpha = 0.3)

plt.show()
```

```
ipython-input-12-891fad996fb2:16: UserWarning: FixedFormatter should only be used together with FixedLocator
ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010'], alpha = 0.3)
```



```
In [14]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

# Adding the plot
fig, ax = plt.subplots(figsize=(8,3))
ax.plot(financial_crisis['Time'],
        financial_crisis['rolling_mean'],
        linewidth=1, color='#A6D785')

# Highlighting the 2007-2008 period
ax.plot(financial_crisis_7_8['Time'],
        financial_crisis_7_8['rolling_mean'],
        linewidth=3, color='#E23D28')

# print(ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010'], alpha = 0.3))
ax.set_xticklabels([])

x = 13100.0
for year in ['2006', '2007', '2008', '2009', '2010']:
    ax.text(x, 1.13, year, alpha=0.5, fontsize=11)
    x += 365

plt.show()
```



```
In [15]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

# Adding the plot
fig, ax = plt.subplots(figsize=(8,3))
ax.plot(financial_crisis['Time'],
        financial_crisis['rolling_mean'],
        linewidth=1, color='#A6D785')

# Highlighting the 2007-2008 period
ax.plot(financial_crisis_7_8['Time'],
        financial_crisis_7_8['rolling_mean'],
        linewidth=3, color='#E23D28')

# print(ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010'], alpha = 0.3))
ax.set_xticklabels([])

x = 13100.0
for year in ['2006', '2007', '2008', '2009', '2010']:
    ax.text(x, 1.13, year, alpha=0.5, fontsize=11)
    x += 365

print(plt.yticks())

plt.show()
```

```
(array([1.1, 1.2, 1.3, 1.4, 1.5, 1.6]), [Text(0, 0, ''), Text(0, 0, ''), Text(0, 0, ''), Text(0, 0, ')],
      [Text(0, 0, '1.1'), Text(0, 0, '1.2'), Text(0, 0, '1.3'), Text(0, 0, '1.4'), Text(0, 0, '1.5'), Text(0, 0, '1.6')])
```



```
In [16]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

# Adding the plot
fig, ax = plt.subplots(figsize=(8,3))
ax.plot(financial_crisis['Time'],
        financial_crisis['rolling_mean'],
        linewidth=1, color='#A6D785')

# Highlighting the 2007-2008 period
ax.plot(financial_crisis_7_8['Time'],
        financial_crisis_7_8['rolling_mean'],
        linewidth=3, color='#E23D28')

# print(ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010'], alpha = 0.3))
ax.set_xticklabels([])

x = 13100.0
for year in ['2006', '2007', '2008', '2009', '2010']:
    ax.text(x, 1.13, year, alpha=0.5, fontsize=11)
    x += 365

# print(plt.yticks())

ax.set_yticklabels([])

y = 1.193
for rate in ['1.2', '1.3', '1.4', '1.5']:
    ax.text(13020.0, y, rate, alpha=0.5, fontsize=11)
    y += 0.1

plt.show()
```



```
In [17]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

# Adding the plot
fig, ax = plt.subplots(figsize=(8,3))
ax.plot(financial_crisis['Time'],
        financial_crisis['rolling_mean'],
        linewidth=1, color='#A6D785')

# Highlighting the 2007-2008 period
ax.plot(financial_crisis_7_8['Time'],
        financial_crisis_7_8['rolling_mean'],
        linewidth=3, color='#E23D28')

# print(ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010'], alpha = 0.3))
ax.set_xticklabels([])

x = 13100.0
for year in ['2006', '2007', '2008', '2009', '2010']:
    ax.text(x, 1.13, year, alpha=0.5, fontsize=11)
    x += 365

# print(plt.yticks())

ax.set_yticklabels([])

y = 1.193
for rate in ['1.2', '1.3', '1.4', '1.5']:
    ax.text(13020.0, y, rate, alpha=0.5, fontsize=11)
    y += 0.1

# Adding a title and a subtitle
ax.text(13000.0, 1.67, "Euro-USD rate peaked at 1.59 during 2007-2008's financial crisis",
        weight='bold',
        size=12)
ax.text(13000.0, 1.63, "Euro-USD exchange rates between 2006 and 2010",
        size=10)

# Adding a signature
ax.text(13000.0, 1.07, "©TECHMA ZONE" + " " * 64 + "Source: European Central Bank",
        color = "#4682B4", backgroundcolor = "#F5F5F5",
        size=12)

plt.show()
```



```
In [18]: import matplotlib.pyplot as plt
import matplotlib
matplotlib.rcParams['figure.figsize'] = (12, 5)

# Adding the plot
fig, ax = plt.subplots(figsize=(8,3))
ax.plot(financial_crisis['Time'],
        financial_crisis['rolling_mean'],
        linewidth=1, color='#A6D785')

# Highlighting the 2007-2008 period
ax.plot(financial_crisis_7_8['Time'],
        financial_crisis_7_8['rolling_mean'],
        linewidth=3, color='#E23D28')

# print(ax.set_xticklabels(['2006', '', '2007', '', '2008', '', '2009', '', '2010'], alpha = 0.3))
ax.set_xticklabels([])

x = 13100.0
for year in ['2006', '2007', '2008', '2009', '2010']:
    ax.text(x, 1.13, year, alpha=0.5, fontsize=11)
    x += 365

# print(plt.yticks())

ax.set_yticklabels([])

y = 1.193
for rate in ['1.2', '1.3', '1.4', '1.5']:
    ax.text(13020.0, y, rate, alpha=0.5, fontsize=11)
    y += 0.1

# Adding a title and a subtitle
ax.text(13000.0, 1.67, "Euro-USD rate peaked at 1.59 during 2007-2008's financial crisis",
        weight='bold',
        size=12)
ax.text(13000.0, 1.63, "Euro-USD exchange rates between 2006 and 2010",
        size=10)

# Adding a signature
ax.text(13000.0, 1.07, "©TECHMA ZONE" + " " * 64 + "Source: European Central Bank",
        color = "#4682B4", backgroundcolor = "#F5F5F5",
        size=12)

ax.axvspan(xmin=pd.to_datetime("2008-04-1"), xmax=pd.to_datetime("2008-09-1"), ymin=0.09,
           alpha=0.3, color='grey')

plt.show()
```



The Three US Presidencies Example

```
In [19]: bush_obama_trump = euro_to_dollar.copy()
bush = bush_obama_trump.copy()
bush = bush_obama_trump[bush_obama_trump['Time'].dt.year >= 2001 & (bush_obama_trump['Time'].dt.year < 2021)]
obama = bush_obama_trump[bush_obama_trump['Time'].dt.year < 2009]
trump = bush_obama_trump[bush_obama_trump['Time'].dt.year >= 2009 & (bush_obama_trump['Time'].dt.year < 2017)]
trump = bush_obama_trump[bush_obama_trump['Time'].dt.year >= 2017 & (bush_obama_trump['Time'].dt.year < 2021)]
```

Below, you'll notice we use matplotlib's functional approach to build the graphs. We use this approach because it offers more flexibility in arranging the subplots:

- We first build three of the graphs on a 2-by-3 grid (this grid should have six subplots, but we only build three: the bottom row remains empty).
- We then build only the bottom graph of a 2-by-1 grid (this grid should have two subplots: the top row remains empty).
- The two grids are merged, and we end up with three graphs on the top row and one graph on the bottom row.

```
In [20]: ## Adding the FiveThirtyEight style
style.use('fivethirtyeight')

## Adding the subplots
plt.figure(figsize=(12, 6))
# pattern 1
ax1 = plt.subplot(3,3,1) # row, col, index
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)
# pattern 2
ax4 = plt.subplot(3,1,2) # row, col, index

axes = [ax1, ax2, ax3, ax4]

## Changes to all the subplots
for ax in axes:
    ax.set_xlim(0.8, 1.7)
    ax.set_yticks([1.2, 1.4, 1.6])
    ax.set_yticklabels(['1.0', '1.2', '1.4', '1.6'],
                       alpha=0.4)

# Add Bush
ax1.plot(bush['Time'], bush['rolling_mean'],
        color='BFF5FF')
ax1.set_xticklabels(['2001', '', '2003', '', '2005', '',
                    '2007', '', '2009'],
                    alpha=0.3, size = 12)

ax1.text(12400.0, 1.32, 'BUSH', fontsize=20, weight='bold',
        color='BFF5FF')
ax1.text(12200.0, 1.8, '(2001-2009)', weight='bold',
        alpha=0.3, size = 12)

# plt.tight_layout()
```



```
In [21]: ## Adding the FiveThirtyEight style
style.use('fivethirtyeight')

## Adding the subplots
plt.figure(figsize=(12, 6))
# pattern 1
ax1 = plt.subplot(3,3,1) # row, col, index
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)
# pattern 2
ax4 = plt.subplot(3,1,2) # row, col, index

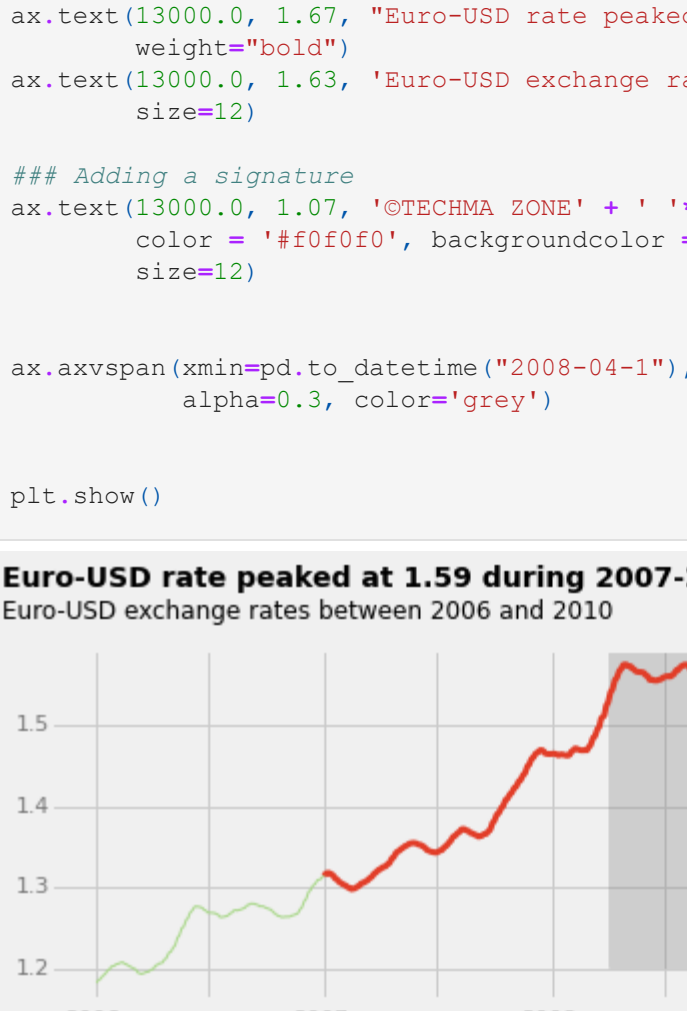
axes = [ax1, ax2, ax3, ax4]

## Changes to all the subplots
for ax in axes:
    ax.set_xlim(0.8, 1.7)
    ax.set_yticks([1.2, 1.4, 1.6])
    ax.set_yticklabels(['1.0', '1.2', '1.4', '1.6'],
                       alpha=0.4)

# Add Bush
ax1.plot(bush['Time'], bush['rolling_mean'],
        color='BFF5FF')
ax1.set_xticklabels(['2001', '', '2003', '', '2005', '',
                    '2007', '', '2009'],
                    alpha=0.3, size = 12)

ax1.text(12400.0, 1.32, 'BUSH', fontsize=20, weight='bold',
        color='BFF5FF')
ax1.text(12200.0, 1.8, '(2001-2009)', weight='bold',
        alpha=0.3, size = 12)

# plt.tight_layout()
```



```
In [22]: ## Adding the FiveThirtyEight style
style.use('fivethirtyeight')

## Adding the subplots
plt.figure(figsize=(14, 8))
# pattern 1
ax1 = plt.subplot(3,3,1) # row, col, index
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)
# pattern 2
ax4 = plt.subplot(3,1,2) # row, col, index

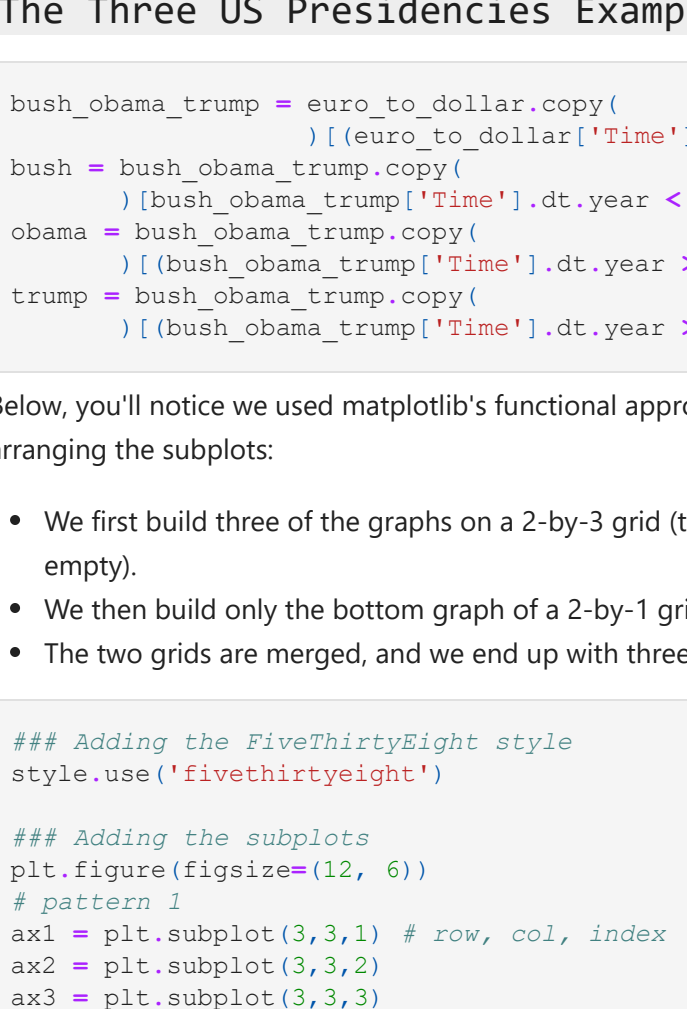
axes = [ax1, ax2, ax3, ax4]

## Changes to all the subplots
for ax in axes:
    ax.set_xlim(0.8, 1.7)
    ax.set_yticks([1.2, 1.4, 1.6])
    ax.set_yticklabels(['1.0', '1.2', '1.4', '1.6'],
                       alpha=0.4)

# Add Bush
ax1.plot(bush['Time'], bush['rolling_mean'],
        color='BFF5FF')
ax1.set_xticklabels(['2001', '', '2003', '', '2005', '',
                    '2007', '', '2009'],
                    alpha=0.3, size = 12)

ax1.text(12400.0, 1.32, 'BUSH', fontsize=20, weight='bold',
        color='BFF5FF')
ax1.text(12200.0, 1.8, '(2001-2009)', weight='bold',
        alpha=0.3, size = 12)

# plt.tight_layout()
```




```
In [23]: <ipython-input-23-d3c837d6eb26>;26: UserWarning: FixedFormatter should only be used together with FixedLocator
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
Out[23]:
```

```

    BUSH
    (2001-2009)

1.6$
1.4
1.2
1.0
2001 2003 2005 2007 2009
0.0 0.2 0.4 0.6 0.8 1.0 0.0 0.2 0.4 0.6 0.8 1.0
1.6$
1.4
1.2
1.0
0.0 0.2 0.4 0.6 0.8 1.0

In [24]: ## Adding the FiveThirtyEight style
style.use('fivethirtyeight')

## Adding the subplots
plt.figure(figsize=(14, 8))
# pattern 1
ax1 = plt.subplot(3,3,1) # row, col, index
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)
# pattern 2
ax4 = plt.subplot(3,1,2) # row, col, index

axes = [ax1, ax2, ax3, ax4]

## Changes to all the subplots
for ax in axes:
    ax.set_ylim(0.8, 1.7)
    ax.set_yticks([1.0, 1.2, 1.4, 1.6])
    ax.set_yticklabels(['1.0$', '1.2$', '1.4$', '1.6 $'],
                        alpha=0.4)

## Ax1: Bush
ax1.plot(bush['Time'], bush['rolling_mean'],
         color='BB5FFF')
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
                    '2007', '', '2009'],
                  alpha=0.3, size = 12)
ax1.text(12400.0, 1.92, 'BUSH', fontsize=20, weight='bold',
        color='BB5FFF')
ax1.text(12200.0, 1.8, '(2001-2009)', weight='bold',
        alpha=0.3)

## Ax2: Obama
ax2.plot(obama['Time'], obama['rolling_mean'],
        color='FFA500')
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                  alpha=0.3)
ax2.text(15256.0, 1.92, 'OBAMA', fontsize=18, weight='bold',
        color='FFA500')
ax2.text(15106.0, 1.8, '(2009-2017)', weight='bold',
        alpha=0.3)

# plt.tight_layout()

<ipython-input-24-a3d0793e43ab>;26: UserWarning: FixedFormatter should only be used together with FixedLocator
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
Out[24]: <ipython-input-24-a3d0793e43ab>;38: UserWarning: FixedFormatter should only be used together with FixedLocator
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                  alpha=0.3)
ax1.text(13879.0, 0, '',
Text(14245.0, 0, '2009'),
Text(14610.0, 0, '2011'),
Text(14975.0, 0, '2013'),
Text(15340.0, 0, '2015'),
Text(15705.0, 0, '2017'),
Text(16071.0, 0, '2019'),
Text(16436.0, 0, '2021'),
Text(16801.0, 0, '2023'),
Text(17167.0, 0, '2025')]

1.6$
1.4
1.2
1.0
2001 2003 2005 2007 2009
0.0 0.2 0.4 0.6 0.8 1.0 0.0 0.2 0.4 0.6 0.8 1.0
1.6$
1.4
1.2
1.0
0.0 0.2 0.4 0.6 0.8 1.0

In [25]: ## Adding the FiveThirtyEight style
style.use('fivethirtyeight')

## Adding the subplots
plt.figure(figsize=(14, 8))
# pattern 1
ax1 = plt.subplot(3,3,1) # row, col, index
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)
# pattern 2
ax4 = plt.subplot(3,1,2) # row, col, index

axes = [ax1, ax2, ax3, ax4]

## Changes to all the subplots
for ax in axes:
    ax.set_ylim(0.8, 1.7)
    ax.set_yticks([1.0, 1.2, 1.4, 1.6])
    ax.set_yticklabels(['1.0$', '1.2$', '1.4$', '1.6 $'],
                        alpha=0.4)

## Ax1: Bush
ax1.plot(bush['Time'], bush['rolling_mean'],
         color='BB5FFF')
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
                    '2007', '', '2009'],
                  alpha=0.3, size = 12)
ax1.text(12400.0, 1.92, 'BUSH', fontsize=20, weight='bold',
        color='BB5FFF')
ax1.text(12200.0, 1.8, '(2001-2009)', weight='bold',
        alpha=0.3)

## Ax2: Obama
ax2.plot(obama['Time'], obama['rolling_mean'],
        color='FFA500')
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                  alpha=0.3)
ax2.text(15256.0, 1.92, 'OBAMA', fontsize=18, weight='bold',
        color='FFA500')
ax2.text(15106.0, 1.8, '(2009-2017)', weight='bold',
        alpha=0.3)

# plt.tight_layout()

<ipython-input-25-a2d9557eb4bc>;26: UserWarning: FixedFormatter should only be used together with FixedLocator
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
Out[25]: <ipython-input-25-a2d9557eb4bc>;38: UserWarning: FixedFormatter should only be used together with FixedLocator
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                  alpha=0.3)
ax1.text(17167.0, 0, '2019'),
Text(17345.0, 0, '2021'),
Text(17532.0, 0, '2023'),
Text(17713.0, 0, '2025'),
Text(17897.0, 0, '2027'),
Text(18078.0, 0, '2029'),
Text(18262.0, 0, '2031'),
Text(18444.0, 0, '2033'),
Text(18628.0, 0, '2035')]

1.6$
1.4
1.2
1.0
2001 2003 2005 2007 2009
0.0 0.2 0.4 0.6 0.8 1.0 0.0 0.2 0.4 0.6 0.8 1.0
1.6$
1.4
1.2
1.0
0.0 0.2 0.4 0.6 0.8 1.0

In [26]: ## Adding the FiveThirtyEight style
style.use('fivethirtyeight')

## Adding the subplots
plt.figure(figsize=(14, 8))
# pattern 1
ax1 = plt.subplot(3,3,1) # row, col, index
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)
# pattern 2
ax4 = plt.subplot(3,1,2) # row, col, index

axes = [ax1, ax2, ax3, ax4]

## Changes to all the subplots
for ax in axes:
    ax.set_ylim(0.8, 1.7)
    ax.set_yticks([1.0, 1.2, 1.4, 1.6])
    ax.set_yticklabels(['1.0$', '1.2$', '1.4$', '1.6 $'],
                        alpha=0.4)

## Ax1: Bush
ax1.plot(bush['Time'], bush['rolling_mean'],
         color='BB5FFF')
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
                    '2007', '', '2009'],
                  alpha=0.3, size = 12)
ax1.text(12400.0, 1.92, 'BUSH', fontsize=20, weight='bold',
        color='BB5FFF')
ax1.text(12200.0, 1.8, '(2001-2009)', weight='bold',
        alpha=0.3)

## Ax2: Obama
ax2.plot(obama['Time'], obama['rolling_mean'],
        color='FFA500')
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                  alpha=0.3)
ax2.text(15256.0, 1.92, 'OBAMA', fontsize=18, weight='bold',
        color='FFA500')
ax2.text(15106.0, 1.8, '(2009-2017)', weight='bold',
        alpha=0.3)

## Ax3: Trump
ax3.plot(trump['Time'], trump['rolling_mean'],
        color='#00B2E8')
ax3.set_xticklabels(['2017', '', '2018', '', '2019', '',
                    '2020', '', '2021'],
                  alpha=0.3)
ax3.text(17697.0, 1.92, 'TRUMP', fontsize=18, weight='bold',
        color='#00B2E8')
ax3.text(17597.0, 1.8, '(2017-2021)', weight='bold',
        alpha=0.3)

# plt.tight_layout()

<ipython-input-26-365df07f56c5>;26: UserWarning: FixedFormatter should only be used together with FixedLocator
ax1.set_xticklabels(['2017', '', '2018', '', '2019', '',
Out[26]: <ipython-input-26-365df07f56c5>;38: UserWarning: FixedFormatter should only be used together with FixedLocator
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                  alpha=0.3)
ax1.text(17167.0, 0, '2019'),
Text(17345.0, 0, '2021'),
Text(17532.0, 0, '2023'),
Text(17713.0, 0, '2025'),
Text(17897.0, 0, '2027'),
Text(18078.0, 0, '2029'),
Text(18262.0, 0, '2031'),
Text(18444.0, 0, '2033'),
Text(18628.0, 0, '2035')]

1.6$
1.4
1.2
1.0
2001 2003 2005 2007 2009
0.0 0.2 0.4 0.6 0.8 1.0 0.0 0.2 0.4 0.6 0.8 1.0
1.6$
1.4
1.2
1.0
0.0 0.2 0.4 0.6 0.8 1.0

In [27]: ## Adding the FiveThirtyEight style
style.use('fivethirtyeight')

## Adding the subplots
plt.figure(figsize=(14, 8))
# pattern 1
ax1 = plt.subplot(3,3,1) # row, col, index
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)
# pattern 2
ax4 = plt.subplot(3,1,2) # row, col, index

axes = [ax1, ax2, ax3, ax4]

## Changes to all the subplots
for ax in axes:
    ax.set_ylim(0.8, 1.7)
    ax.set_yticks([1.0, 1.2, 1.4, 1.6])
    ax.set_yticklabels(['1.0$', '1.2$', '1.4$', '1.6 $'],
                        alpha=0.4)

## Ax1: Bush
ax1.plot(bush['Time'], bush['rolling_mean'],
         color='BB5FFF')
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
                    '2007', '', '2009'],
                  alpha=0.3, size = 12)
ax1.text(12400.0, 1.92, 'BUSH', fontsize=20, weight='bold',
        color='BB5FFF')
ax1.text(12200.0, 1.8, '(2001-2009)', weight='bold',
        alpha=0.3)

## Ax2: Obama
ax2.plot(obama['Time'], obama['rolling_mean'],
        color='FFA500')
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                  alpha=0.3)
ax2.text(15256.0, 1.92, 'OBAMA', fontsize=18, weight='bold',
        color='FFA500')
ax2.text(15106.0, 1.8, '(2009-2017)', weight='bold',
        alpha=0.3)

## Ax3: Trump
```

```

alpha=0.3)

## Ax2: Obama
ax2.plot(obama['Time'], obama['rolling_mean'],
         color='ff5500')
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                    alpha=0.3)
ax2.text(15256.0, 1.92, 'OBAMA', fontsize=18, weight='bold',
        color='ff5500')
ax2.text(15106.0, 1.8, '(2009-2017)', weight='bold',
        alpha=0.3)

## Ax3: Trump
ax3.plot(trump['Time'], trump['rolling_mean'],
         color='#008282')
ax3.set_xticklabels(['2017', '', '2018', '', '2019', '',
                    '2020', '', '2021'],
                    alpha=0.3)
ax3.text(17697.0, 1.92, 'TRUMP', fontsize=18, weight='bold',
        color='#008282')
ax3.text(17597.0, 1.8, '(2017-2021)', weight='bold',
        alpha=0.3)

## Ax4: Bush-Obama-Trump
ax4.plot(bush['Time'], bush['rolling_mean'],
         color='#8B5FFF')
ax4.plot(obama['Time'], obama['rolling_mean'],
         color='ff5500')
ax4.plot(trump['Time'], trump['rolling_mean'],
         color='#008282')

# ax4.set_xticklabels([])
ax4.set_xticks([])

# plt.tight_layout()

<ipython-input-29-8a80afacef8>:26: UserWarning: FixedFormatter should only be used together with FixedLocator
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
<ipython-input-29-8a80afacef8>:38: UserWarning: FixedFormatter should only be used together with FixedLocator
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
<ipython-input-29-8a80afacef8>:49: UserWarning: FixedFormatter should only be used together with FixedLocator
ax3.set_xticklabels(['2017', '', '2018', '', '2019', '',

Out[29]: []

BUSH
(2001-2009)
OBAMA
(2009-2017)
TRUMP
(2017-2021)

1.65
1.4
1.2
1.0
2001 2003 2005 2007 2009
1.65
1.4
1.2
1.0
2009 2011 2013 2015 2017
1.65
1.4
1.2
1.0
2017 2018 2019 2020 2021

1.65
1.4
1.2
1.0
2001 2003 2005 2007 2009
1.65
1.4
1.2
1.0
2009 2011 2013 2015 2017
1.65
1.4
1.2
1.0
2017 2018 2019 2020 2021

In [30]:

## Adding the FiveThirtyEight style
style.use('fivethirtyeight')

## Adding the subplots
plt.figure(figsize=(14, 8))
# pattern 1
ax1 = plt.subplot(3,1) # row, col, index
ax2 = plt.subplot(3,2)
ax3 = plt.subplot(3,3)
# pattern 2
ax4 = plt.subplot(3,1,2) # row, col, index

axes = [ax1, ax2, ax3, ax4]

## Changes to all the subplots
for ax in axes:
    ax.set_ylim(0.8, 1.7)
    ax.set_yticks([1.0, 1.2, 1.4, 1.6])
    ax.set_yticklabels(['1.0', '1.2', '1.4', '1.6 %'],
                      alpha=0.4)

## Ax1: Bush
ax1.plot(bush['Time'], bush['rolling_mean'],
         color='#8B5FFF')
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
                    '2007', '', '2009'],
                    alpha=0.3, size = 12)
ax1.text(12400.0, 1.92, 'BUSH', fontsize=20, weight='bold',
        color='#8B5FFF')
ax1.text(12200.0, 1.8, '(2001-2009)', weight='bold',
        alpha=0.3)

## Ax2: Obama
ax2.plot(obama['Time'], obama['rolling_mean'],
         color='ff5500')
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
                    '2015', '', '2017'],
                    alpha=0.3)
ax2.text(15256.0, 1.92, 'OBAMA', fontsize=18, weight='bold',
        color='ff5500')
ax2.text(15106.0, 1.8, '(2009-2017)', weight='bold',
        alpha=0.3)

## Ax3: Trump
ax3.plot(trump['Time'], trump['rolling_mean'],
         color='#008282')
ax3.set_xticklabels(['2017', '', '2018', '', '2019', '',
                    '2020', '', '2021'],
                    alpha=0.3)
ax3.text(17697.0, 1.92, 'TRUMP', fontsize=18, weight='bold',
        color='#008282')
ax3.text(17597.0, 1.8, '(2017-2021)', weight='bold',
        alpha=0.3)

## Ax4: Bush-Obama-Trump
ax4.plot(bush['Time'], bush['rolling_mean'],
         color='#8B5FFF')
ax4.plot(obama['Time'], obama['rolling_mean'],
         color='ff5500')
ax4.plot(trump['Time'], trump['rolling_mean'],
         color='#008282')

ax4.set_xticks([])

## Adding a title and a subtitle
ax1.text(10879.0, 2.35, 'EURO-USD rate averaged 1.22 under the last three US presidents',
        fontsize=20, weight='bold')
ax1.text(10879.0, 2.13, '**EURO-USD exchange rates under George W. Bush (2001 - 2009), Barack Obama (2009-2017) and Donald Trump (2017-2021)**',
        fontsize=16)

## Adding a signature
ax4.text(10557.0, 0.65, 'C'HEMNA ZONE' + ' '*133 + 'Source: European Central Bank',
        color = '#40C0C0', backgroundcolor = 'fadedd',
        size=14)

plt.tight_layout()

<ipython-input-30-47c60b7addc3>:26: UserWarning: FixedFormatter should only be used together with FixedLocator
ax1.set_xticklabels(['', '2001', '', '2003', '', '2005', '',
<ipython-input-30-47c60b7addc3>:38: UserWarning: FixedFormatter should only be used together with FixedLocator
ax2.set_xticklabels(['', '2009', '', '2011', '', '2013', '',
<ipython-input-30-47c60b7addc3>:49: UserWarning: FixedFormatter should only be used together with FixedLocator
ax3.set_xticklabels(['2017', '', '2018', '', '2019', '',
<ipython-input-30-47c60b7addc3>:81: UserWarning: Tight layout not applied. tight_layout cannot make axes width
small enough to accommodate all axes decorations
plt.tight_layout()

EURO-USD rate averaged 1.22 under the last three US presidents
EURO-USD exchange rates under George W. Bush (2001 - 2009), Barack Obama (2009-2017),
and Donald Trump (2017-2021)

BUSH
(2001-2009)
OBAMA
(2009-2017)
TRUMP
(2017-2021)

1.65
1.4
1.2
1.0
2001 2003 2005 2007 2009
1.65
1.4
1.2
1.0
2009 2011 2013 2015 2017
1.65
1.4
1.2
1.0
2017 2018 2019 2020 2021

1.65
1.4
1.2
1.0
2001 2003 2005 2007 2009
1.65
1.4
1.2
1.0
2009 2011 2013 2015 2017
1.65
1.4
1.2
1.0
2017 2018 2019 2020 2021

C'HEMNA ZONE
Source: European Central Bank

In [ ]:

```