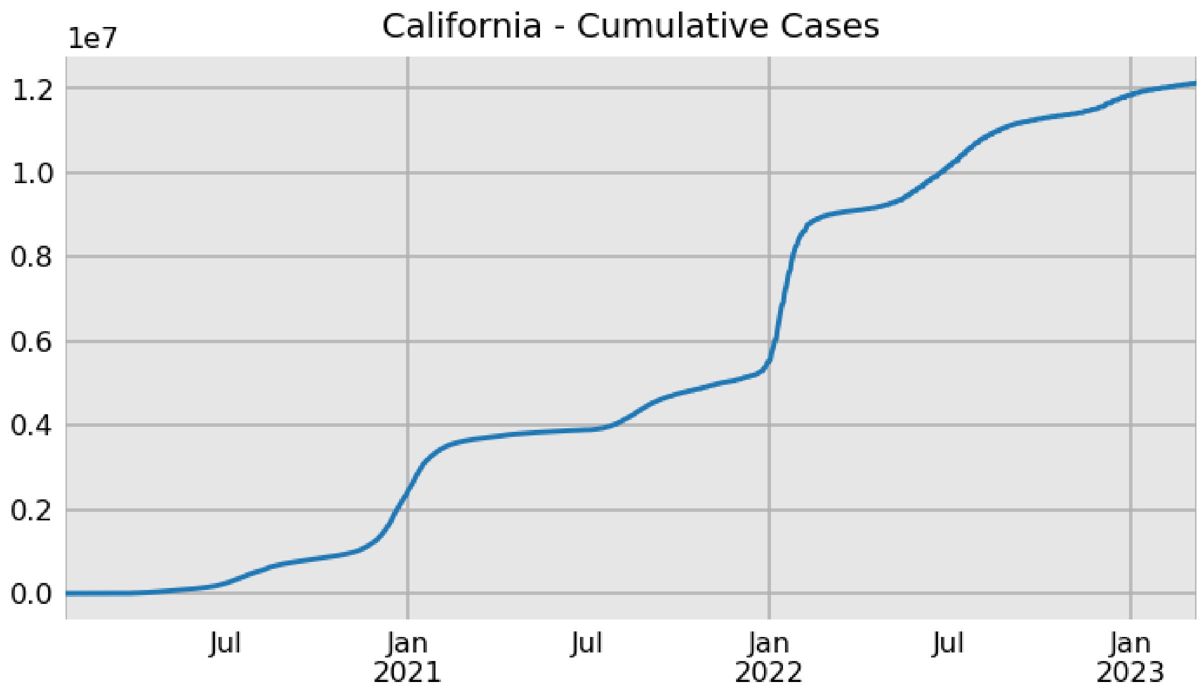
Data Smoothing

Imports

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from scipy.optimize import least_squares
plt.style.use('dashboard.mplstyle')
from prepare import PrepareData
data = PrepareData(download_new=False).run()
```

Smoothing California Data

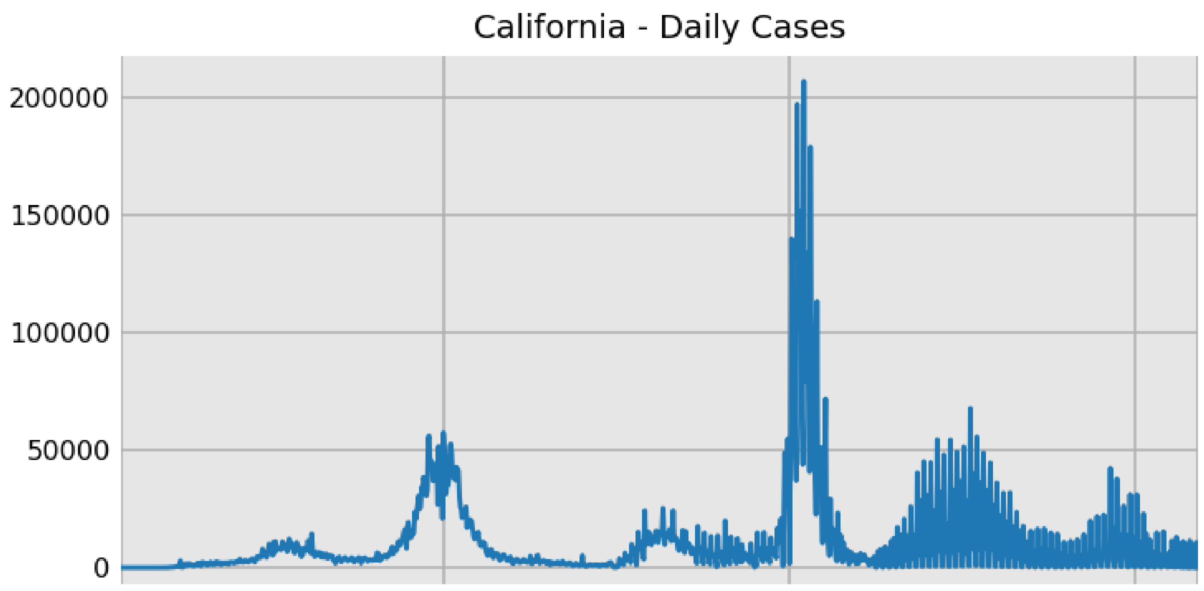
In [2]:
```
usa_cases = data['usa_cases']
californiac = usa_cases['California']
californiac.plot(kind='line', title="California - Cumulative Cases");
```



In [3]:
```
californiac_daily = californiac.diff()
californiac_daily.head()
```

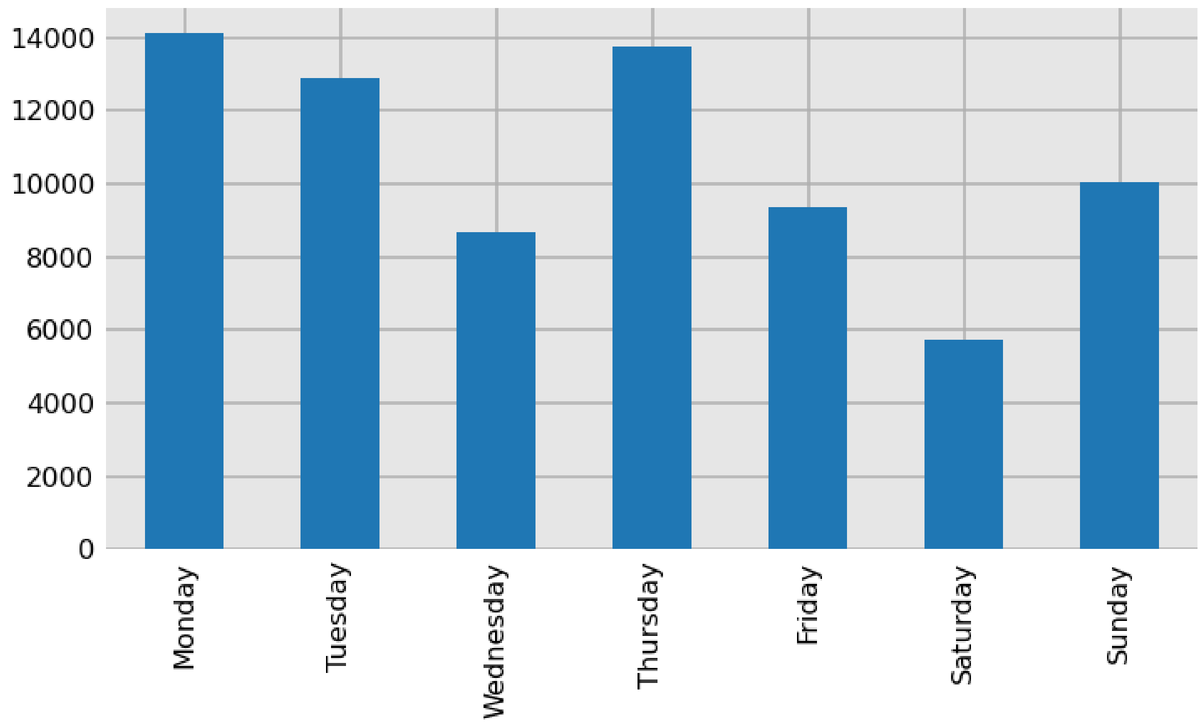
Out[3]:
```
2020-01-22    NaN
2020-01-23    0.0
2020-01-24    0.0
2020-01-25    0.0
2020-01-26    2.0
Name: California, dtype: float64
```

```
In [4]: last_zero_date = californiac[californiac == 0].index[-1]
        last_zero_date

Out[4]: Timestamp('2020-01-25 00:00:00')

In [5]: californiac = californiac.loc[last_zero_date:]
        californiac.head()

Out[5]: 2020-01-25    0
        2020-01-26    2
        2020-01-27    2
        2020-01-28    2
        2020-01-29    2
        Name: California, dtype: int64

In [6]: californiac_daily = californiac.diff().dropna().astype('int')
        californiac_daily.head()

Out[6]: 2020-01-26    2
        2020-01-27    0
        2020-01-28    0
        2020-01-29    0
        2020-01-30    0
        Name: California, dtype: int64

In [7]: californiac_daily.plot(kind='line', title="California - Daily Cases");
```



Seasonality

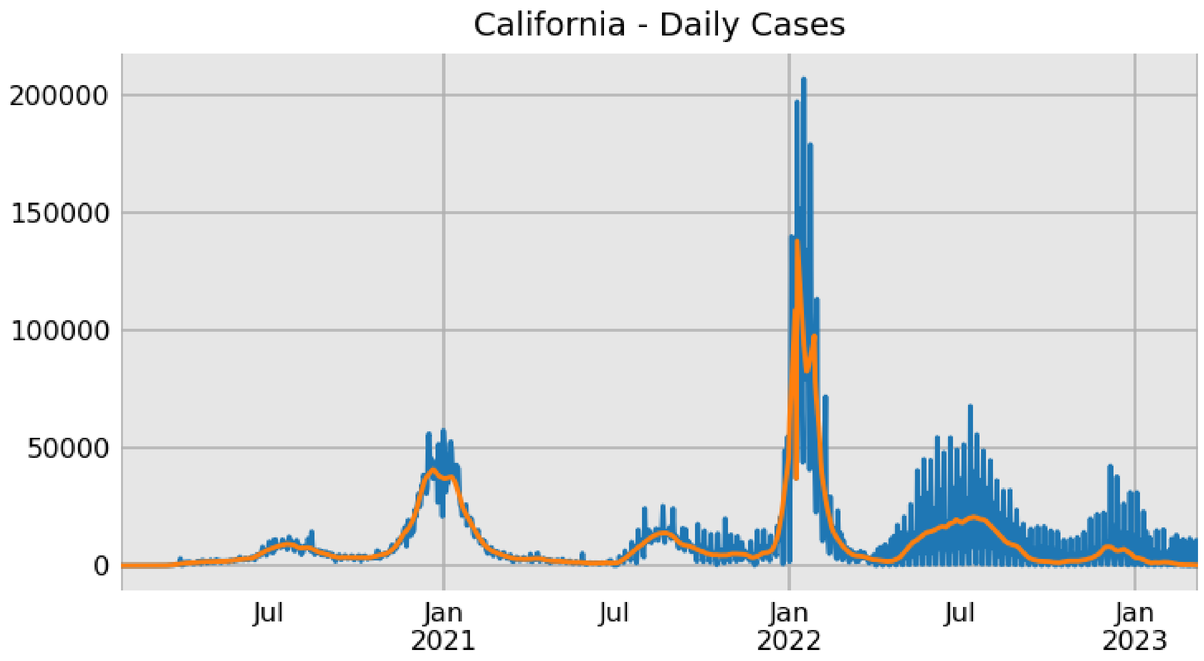
```
In [8]: days = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunda
        #texasc_daily.groupby(lambda xcx: x.day_name()).mean().loc[days].plot(kind='bar');
        californiac_daily.groupby(lambda xcx: xcx.day_name()).mean().loc[days].plot(kind='
```



LOWESS

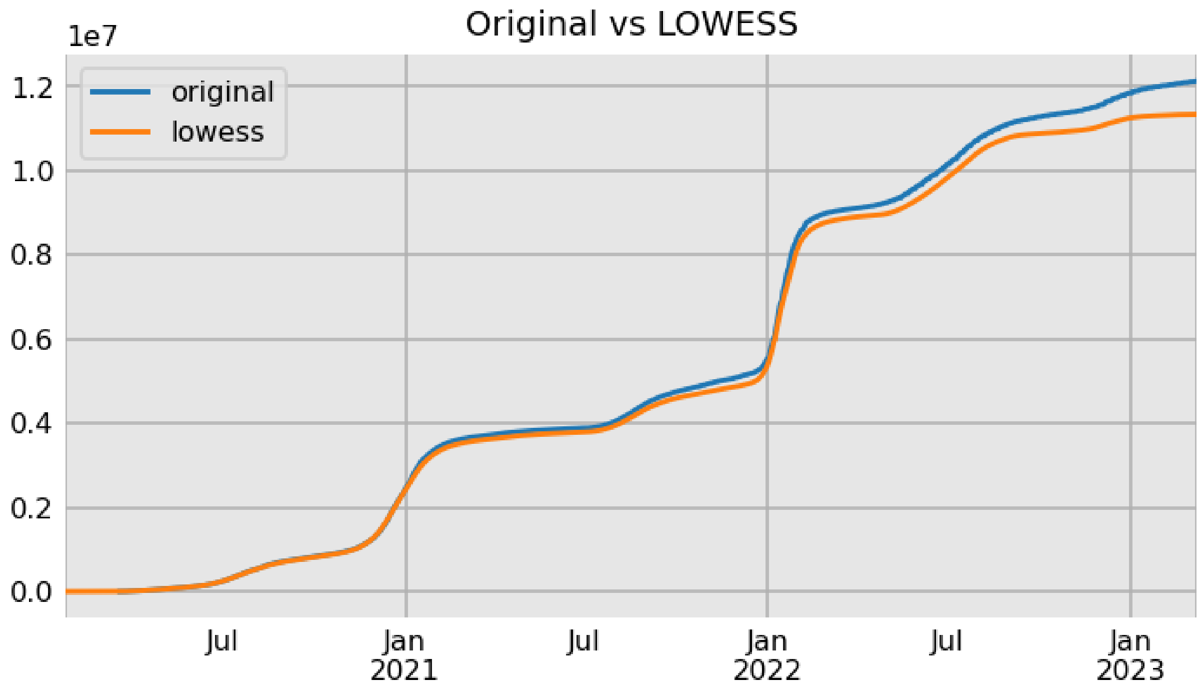
```
In [9]: from statsmodels.nonparametric.smoothers_lowess import lowess
        y = californiac_daily
        x = y.index
        frac = 20 / len(x)
        y_lowess = lowess(y, x, frac=frac, is_sorted=True, return_sorted=False)
        y_lowess[-10:].round()

Out[9]: array([401., 369., 338., 309., 284., 259., 232., 203., 172., 137.])
```

In [10]:
```
s_lowess = pd.Series(data=y_lowess, index=x)
californiac_daily.plot(title="California - Daily Cases", label='original')
s_lowess.plot();
```



Smoothed Cumalitive Total:

In [11]:
```
californiac.loc['2020-03-20':].plot(kind='line', label='original');
s_lowess_cumulative = s_lowess.cumsum().round(0).astype('int')
ax = s_lowess_cumulative.plot(label='lowess', title='Original vs LOWESS')
ax.legend();
```



Aligning the Cumulative Total to the Actual

In [12]:
```
# actual
last_actual = californiac.values[-1]
last_actual
```

Out[12]:
```
12129699
```

In [13]:
```
# smoothed
last_smoothed = s_lowess_cumulative.values[-1]
last_smoothed
```

Out[13]:
```
11327964
```

To align the two series, we'll multiply the smoothed values by the ratio of their last values. The new last smoothed cumulative value is output to verify it is equal to the previous actual value.

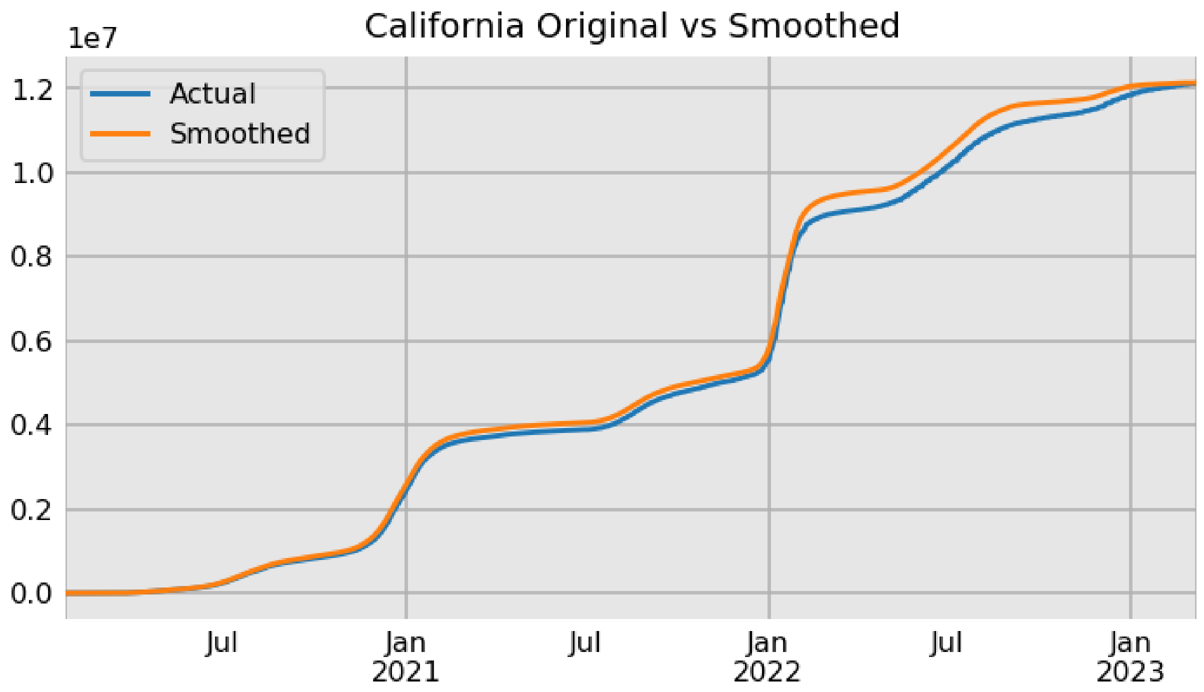
In [14]:
```
s_lowess_cumulative = s_lowess_cumulative * last_actual / last_smoothed
s_lowess_cumulative = s_lowess_cumulative.round(0).astype('int')
s_lowess_cumulative.values[-1]
```

Out[14]:
```
12129699
```

LOWESS Method for Smoothing

```
In [15]: def smooth(s, n):
             """
             Smooths the data series using LOWESS.

             Parameters
             ----------
             s : Series
                 Time series data.
             n : int
                 Number of points for LOWESS.

             Returns
             -------
             Series
             """
             if s.values[0] == 0:
                 # Filter the data if the first value is 0
                 last_zero_date = s[s == 0].index[-1]
                 s = s.loc[last_zero_date:]
                 s_daily = s.diff().dropna()
             else:
                 # If first value not 0, use it to fill in the
                 # first missing value
                 s_daily = s.diff().fillna(s.iloc[0])

             # Don't smooth data with less than 15 values
             if len(s_daily) < 15:
                 return s

             y = s_daily.values
             frac = n / len(y)
             x = np.arange(len(y))
             y_pred = lowess(y, x, frac=frac, is_sorted=True, return_sorted=False)
             s_pred = pd.Series(y_pred, index=s_daily.index).clip(0)
             s_pred_cumulative = s_pred.cumsum()
             last_actual = s.values[-1]
             last_smoothed = s_pred_cumulative.values[-1]
             s_pred_cumulative *= last_actual / last_smoothed
             return s_pred_cumulative
```

```
In [16]: from functions import smooth
         smoothed = smooth(californiac, 20)
         californiac.plot(label='Actual')
         smoothed.plot(title='California Original vs Smoothed', label='Smoothed').legend();
```


California Original vs Smoothed
1e7
Actual
Smoothed
Jul
Jan 2021
Jul
Jan 2022
Jul
Jan 2023