INTRODUCTION TO MATPLOTLIB

Plotting time-series data

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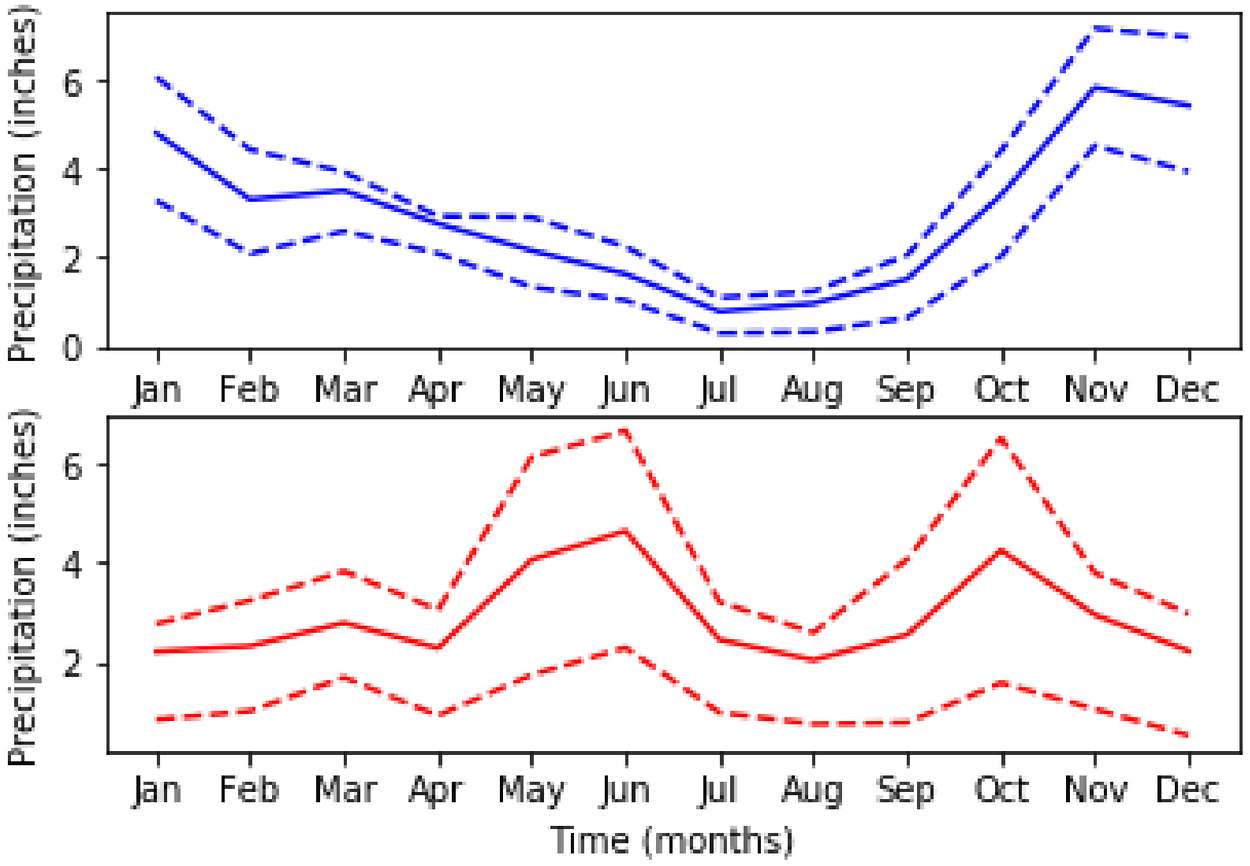
Time-series data



Climate change time-series

```
date,co2,relative_temp
1958-03-06,315.71,0.1
1958-04-06,317.45,0.01
1958-05-06,317.5,0.08
1958-06-06,-99.99,-0.05
1958-07-06,315.86,0.06
1958-08-06,314.93,-0.06
...
2016-08-06,402.27,0.98
2016-09-06,401.05,0.87
2016-10-06,401.59,0.89
2016-11-06,403.55,0.93
2016-12-06,404.45,0.81
```

```
import pandas as pd
climate_change = pd.read_csv('climate_change.csv', parse_dates=["date"],
                             index_col="date")
```

DateTimeIndex

```
climate_change.index
```

```
DatetimeIndex(['1958-03-06', '1958-04-06', '1958-05-06', '1958-06-06',
               '1958-07-06', '1958-08-06', '1958-09-06', '1958-10-06',
               '1958-11-06', '1958-12-06',
               ...
               '2016-03-06', '2016-04-06', '2016-05-06', '2016-06-06',
               '2016-07-06', '2016-08-06', '2016-09-06', '2016-10-06',
               '2016-11-06', '2016-12-06'],
              dtype='datetime64[ns]', name='date', length=706, freq=None)
```

Time-series data

```
climate_change['relative_temp']
```

```
0      0.10
1      0.01
2      0.08
3     -0.05
4      0.06
5     -0.06
6     -0.03
7      0.04
8      0.02
9      0.01
10     0.06
      ...
701    0.98
702    0.87
703    0.89
704    0.93
705    0.81
Name:co2, Length: 706, dtype: float64
```

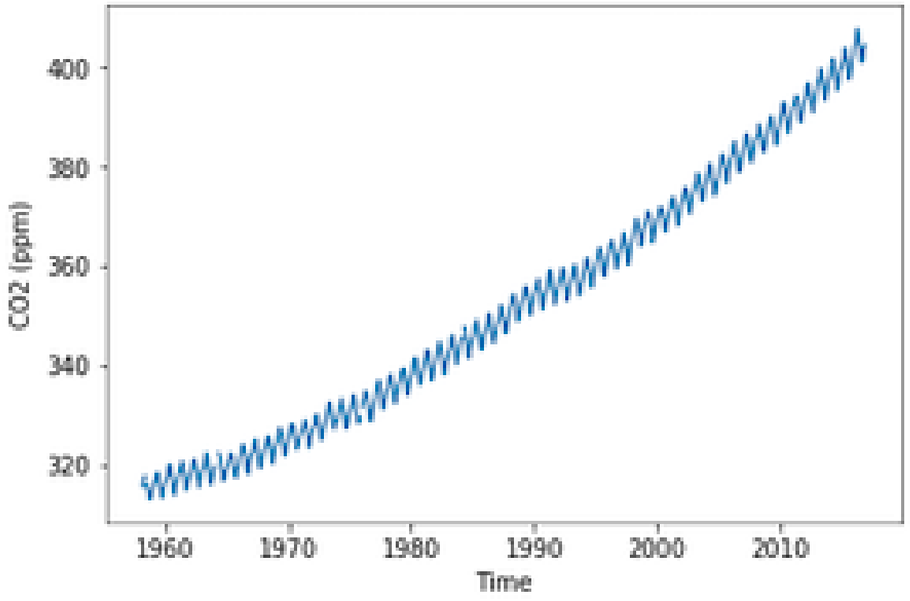
```
climate_change['co2']
```

```
0      315.71
1      317.45
2      317.50
3         NaN
4      315.86
5      314.93
6      313.20
7         NaN
8      313.33
9      314.67
10     315.62
      ...
701    402.27
702    401.05
703    401.59
704    403.55
705    404.45
Name:co2, Length: 706, dtype: float64
```

Plotting time-series data

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
```

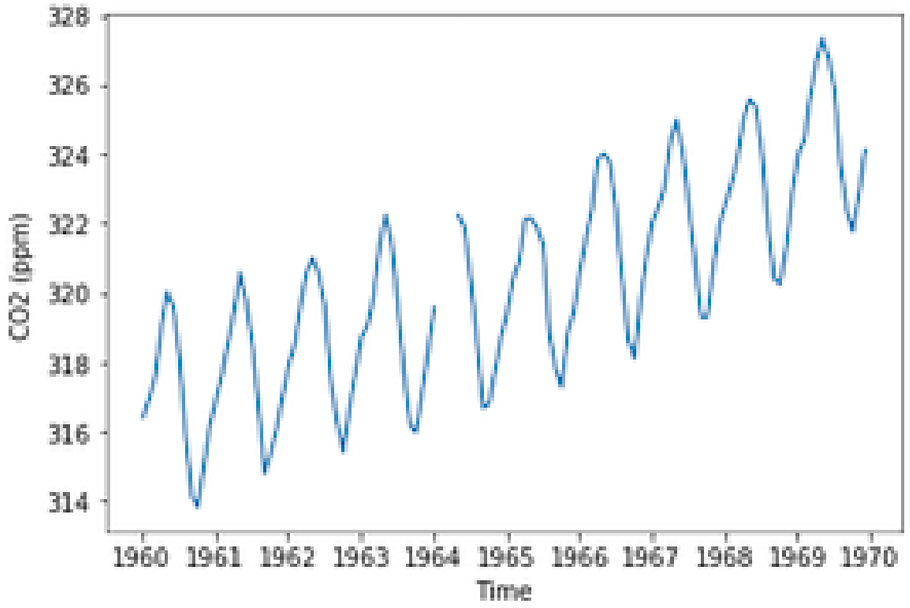
```
ax.plot(climate_change.index, climate_change['co2'])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)')
plt.show()
```



Zooming in on a decade

```
sixties = climate_change["1960-01-01":"1969-12-31"]
```

```
fig, ax = plt.subplots()
ax.plot(sixties.index, sixties['co2'])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)')
plt.show()
```



Zooming in on one year

```
sixty_nine = climate_change["1969-01-01":"1969-12-31"]

fig, ax = plt.subplots()
ax.plot(sixty_nine.index, sixty_nine['co2'])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)')
plt.show()
```

INTRODUCTION TO MATPLOTLIB

Let's practice time-series plotting!

INTRODUCTION TO MATPLOTLIB

Plotting time-series with different variables

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Plotting two time-series together

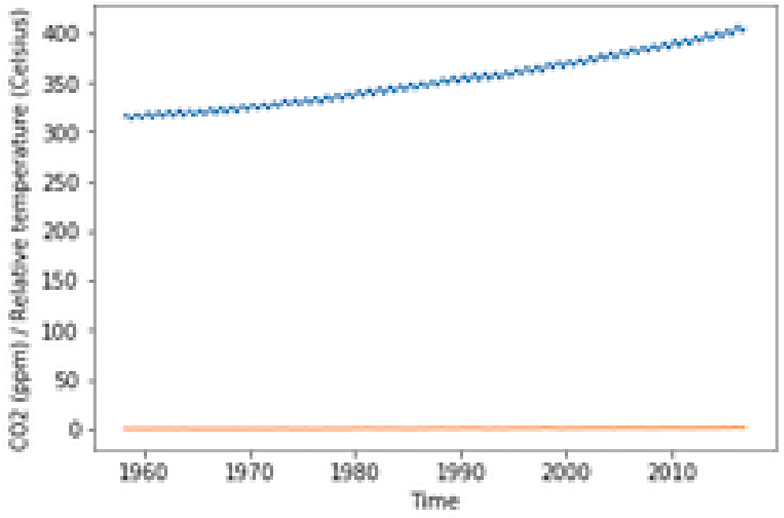
```
import pandas as pd
climate_change = pd.read_csv('climate_change.csv', parse_dates=["date"],
                             index_col="date")
```

```
climate_change
```

```
              co2  relative_temp
date
1958-03-06  315.71           0.10
1958-04-06  317.45           0.01
1958-05-06  317.50           0.08
1958-06-06     NaN          -0.05
1958-07-06  315.86           0.06
...            ...            ...
2016-08-06  402.27           0.98
2016-09-06  401.05           0.87
2016-10-06  401.59           0.89
2016-11-06  403.55           0.93
2016-12-06  404.45           0.81

[706 rows x 2 columns]
```

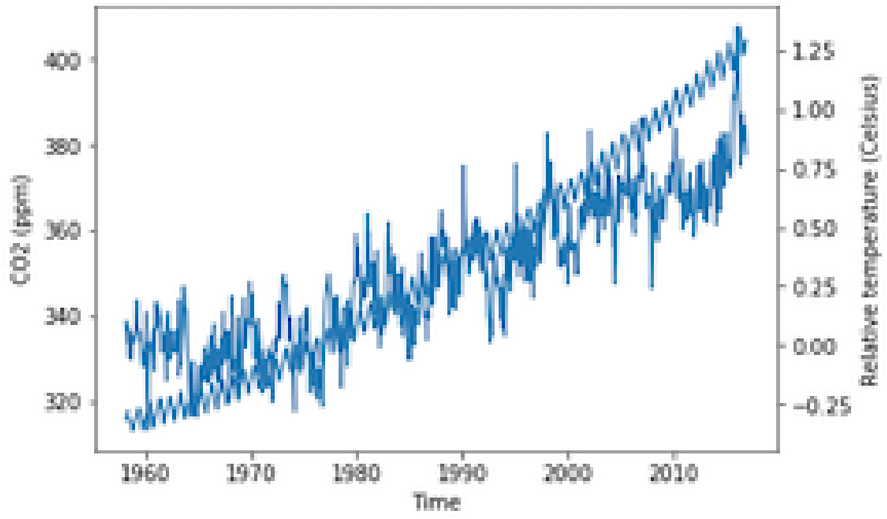
Plotting two time-series together

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
ax.plot(climate_change.index, climate_change["co2"])

ax.plot(climate_change.index, climate_change["relative_temp"])

ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm) / Relative temperature')
plt.show()
```



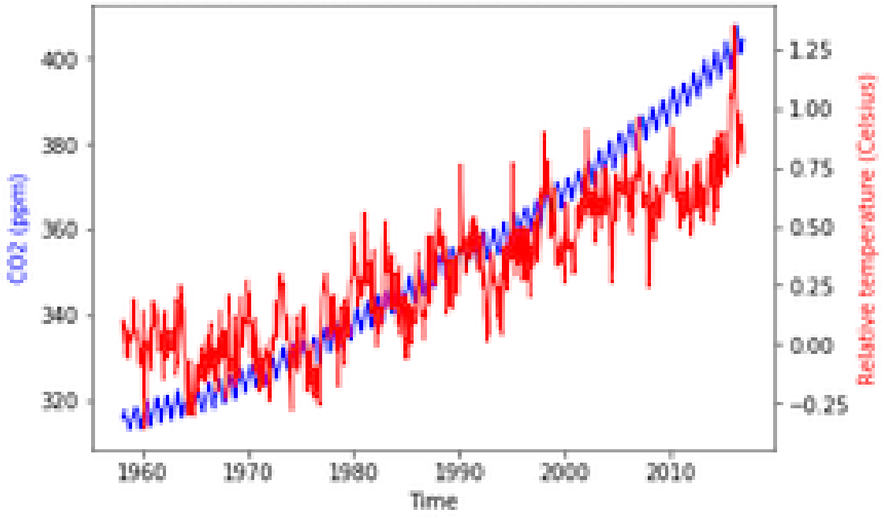
Using twin axes

```
fig, ax = plt.subplots()
ax.plot(climate_change.index, climate_change["co2"])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)')

ax2 = ax.twinx()

ax2.plot(climate_change.index, climate_change["relative_temp"])
ax2.set_ylabel('Relative temperature (Celsius)')
plt.show()
```



Separating variables by color

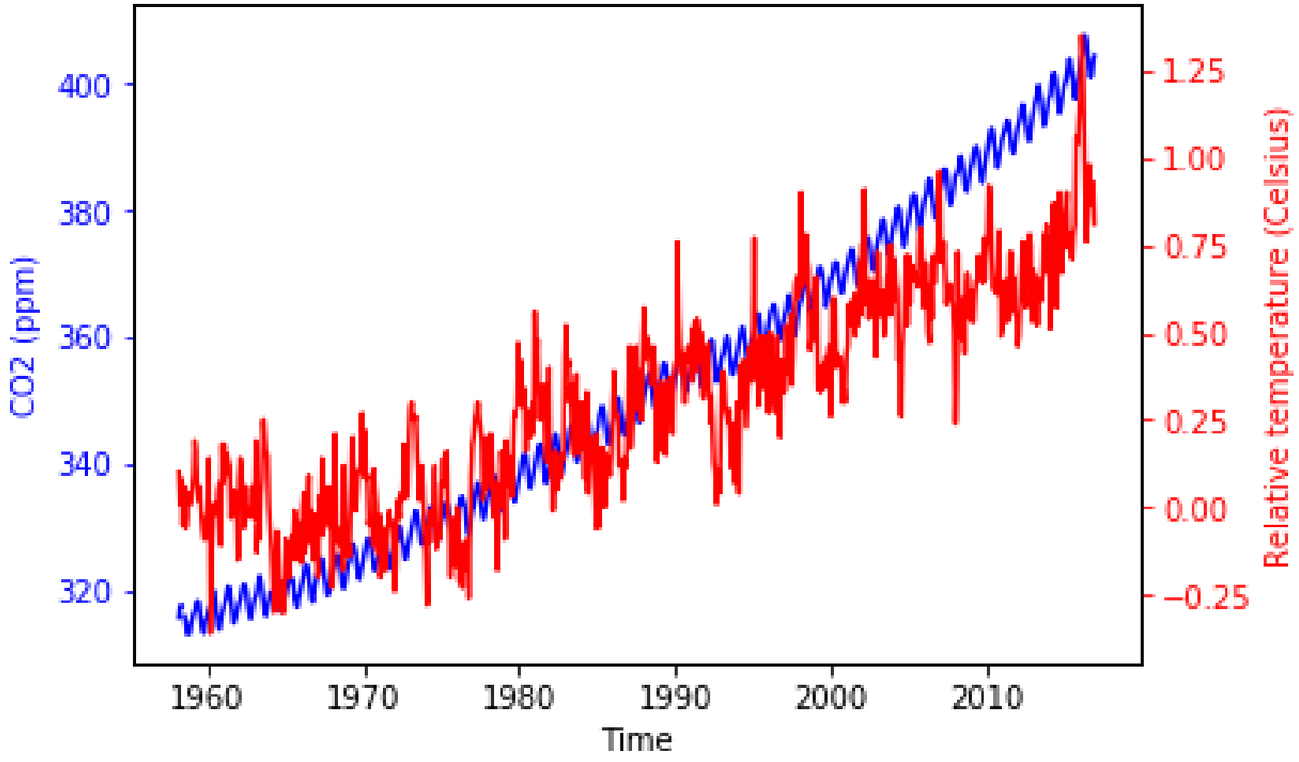
```
fig, ax = plt.subplots()
ax.plot(climate_change.index, climate_change["co2"], color='blue')
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)', color='blue')

ax2 = ax.twinx()
ax2.plot(climate_change.index, climate_change["relative_temp"], color='red')
ax2.set_ylabel('Relative temperature (Celsius)', color='red')
plt.show()
```



Coloring the ticks

```
fig, ax = plt.subplots()
ax.plot(climate_change.index, climate_change["co2"], color='blue')
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)', color='blue')

ax.tick_params('y', colors='blue')

ax2 = ax.twinx()
ax2.plot(climate_change.index, climate_change["relative_temp"], color='red')
ax2.set_ylabel('Relative temperature (Celsius)', color='red')

ax2.tick_params('y', colors='red')

plt.show()
```

Coloring the ticks

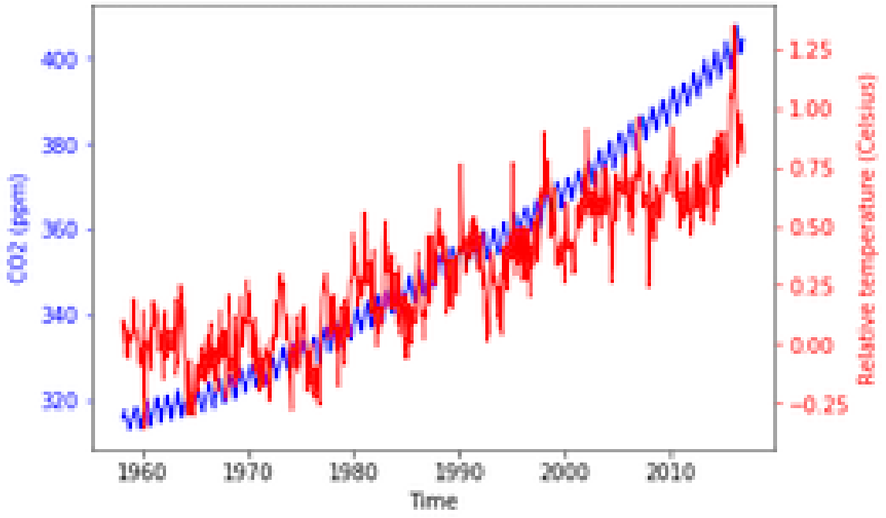


A function that plots time-series

```
def plot_timeseries(axes, x, y, color, xlabel, ylabel):
  axes.plot(x, y, color=color)
  axes.set_xlabel(xlabel)
  axes.set_ylabel(ylabel, color=color)
  axes.tick_params('y', colors=color)
```

Using our function

```
fig, ax = plt.subplots()
plot_timeseries(axes, climate_change.index, climate_change['co2'],
                'blue', 'Time', 'CO2 (ppm)')

ax2 = ax.twinx()
plot_timeseries(axes, climate_change.index, climate_change['relative_temp'],
                'red', 'Time', 'Relative temperature (Celsius)')

plt.show()
```



INTRODUCTION TO MATPLOTLIB

Create your own function!

INTRODUCTION TO MATPLOTLIB

Annotating time-series data

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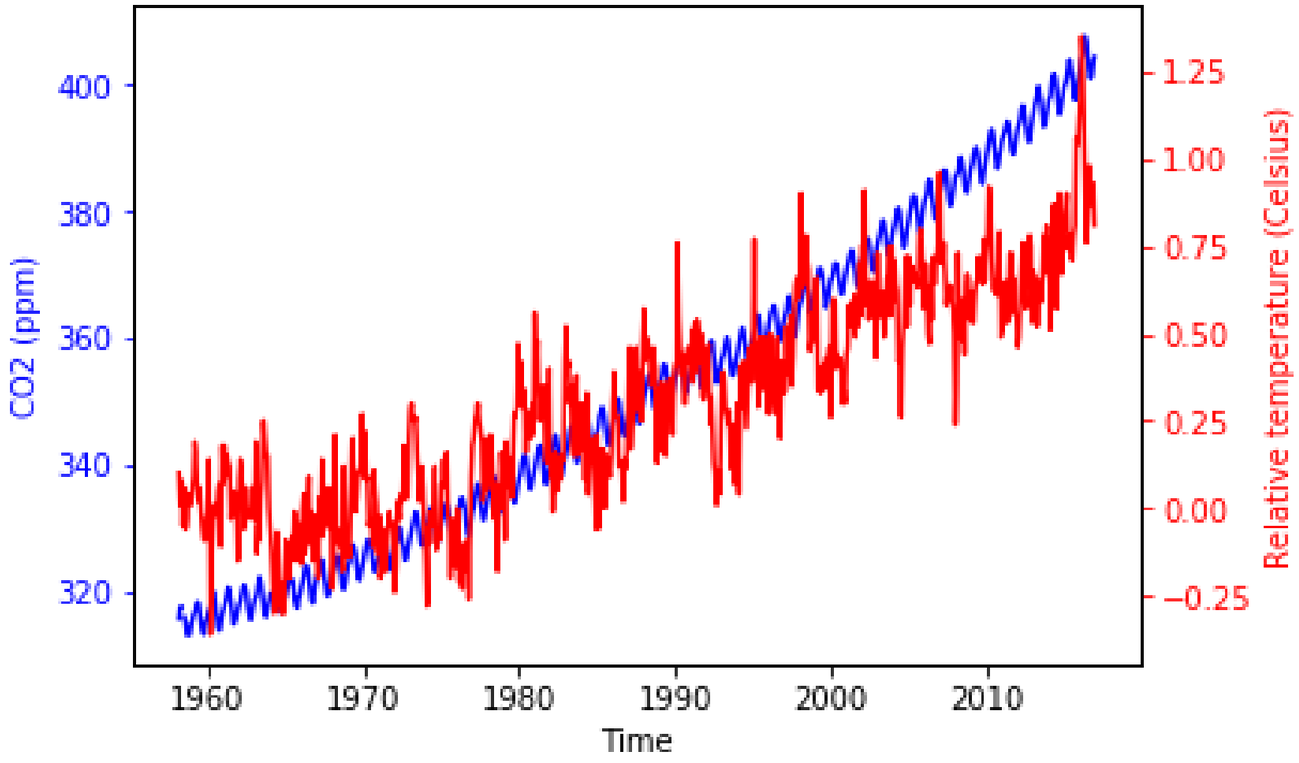
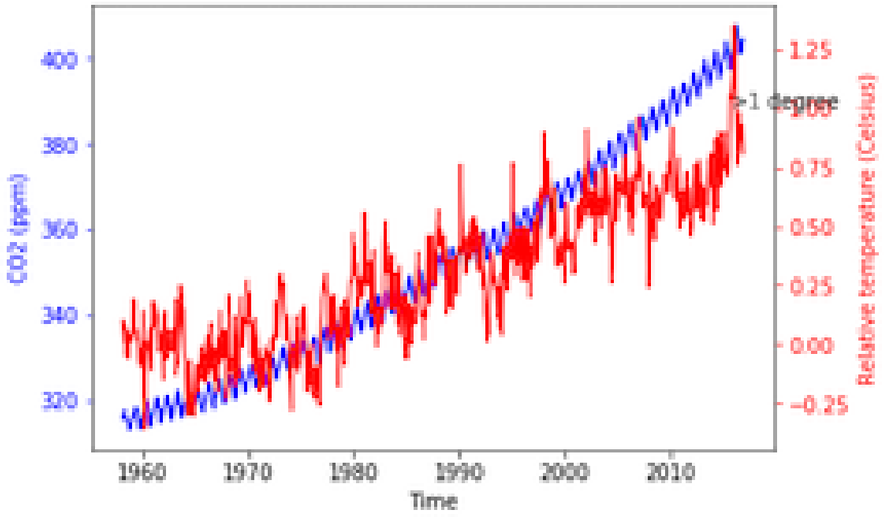
Time-series data



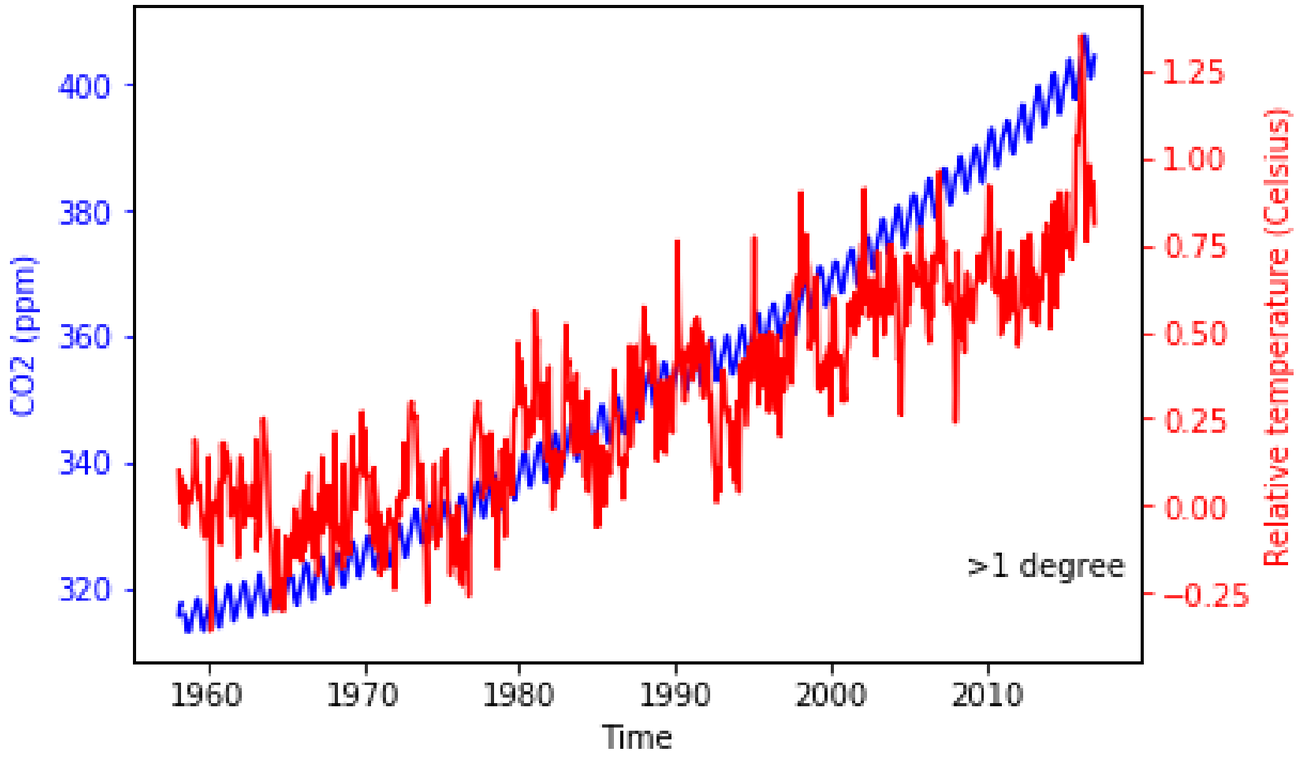
Annotation

```
fig, ax = plt.subplots()
plot_timeseries(axes, climate_change.index, climate_change['co2'],
                'blue', 'Time', 'CO2 (ppm)')
ax2 = ax.twinx()
plot_timeseries(axes, climate_change.index, climate_change['relative_temp'],
                'red', 'Time', 'Relative temperature (Celsius)')

ax2.annotate(">1 degree",  xy=[pd.TimeStamp("2015-10-06"), 1])

plt.show()
```



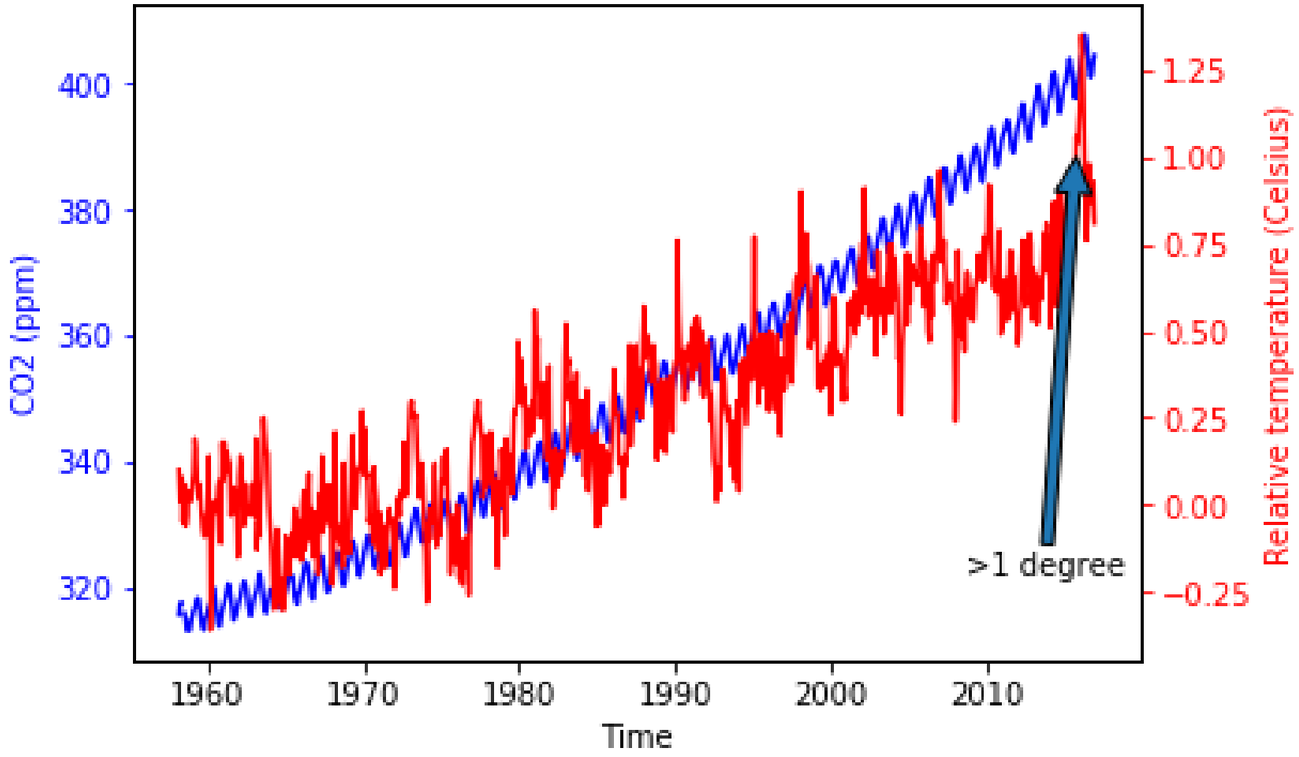
Positioning the text

```
ax2.annotate(">1 degree",
             xy=(pd.Timestamp('2015-10-06'), 1),
             xytext=(pd.Timestamp('2008-10-06'), -0.2))
```



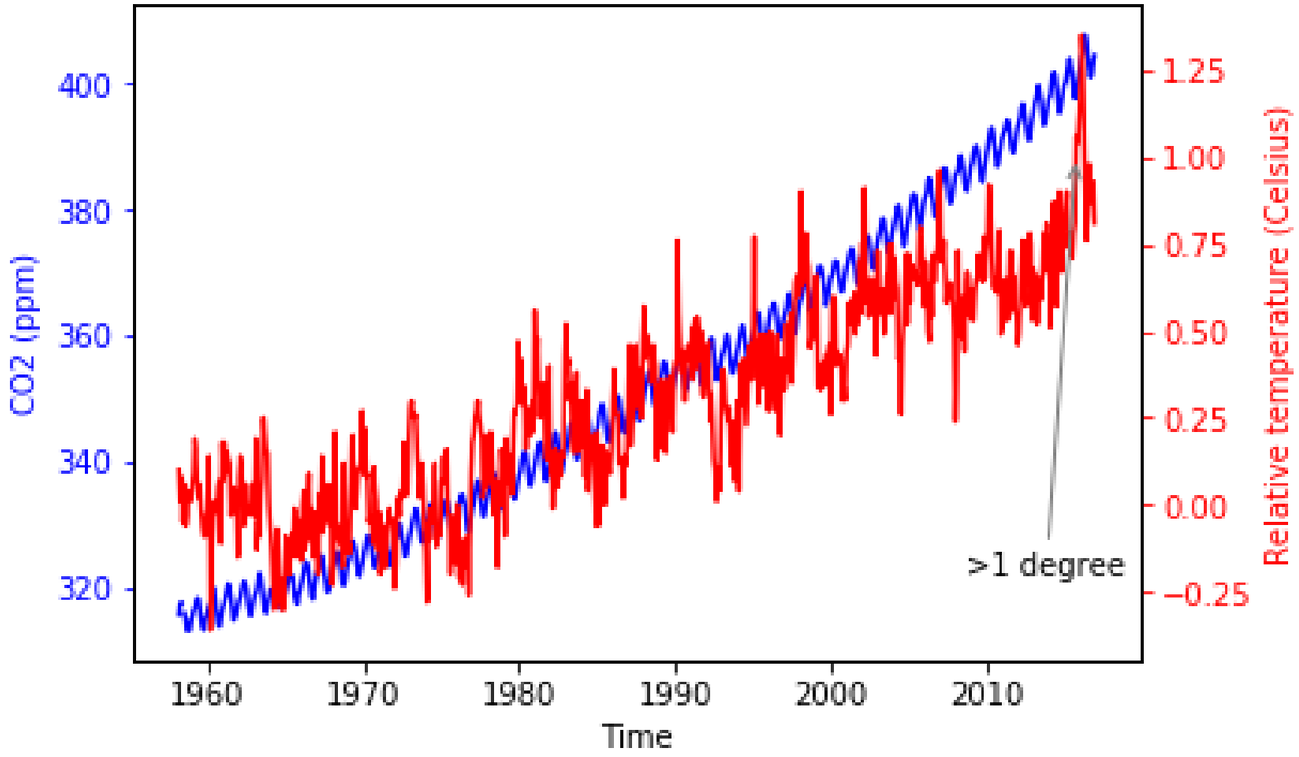
Adding arrows to annotation

```
ax2.annotate(">1 degree",
             xy=(pd.Timestamp('2015-10-06'), 1),
             xytext=(pd.Timestamp('2008-10-06'), -0.2),
             arrowprops={})
```



Customizing arrow properties

```
ax2.annotate(">1 degree",
             xy=(pd.Timestamp('2015-10-06'), 1),
             xytext=(pd.Timestamp('2008-10-06'), -0.2),
             arrowprops={"arrowstyle":"->", "color":"gray"})
```



Customizing annotations

https://matplotlib.org/users/annotations.html

INTRODUCTION TO MATPLOTLIB

Practice annotating plots!