Data anlysis essential - 2 , performed by ARYAN

Numpy basics

```
import numpy as np
import pandas as pd

# initially , before numpy , for computation we go longer way
kanto_temp = 73
kanto_rainfall = 67
kanto_humidity = 43
w1,w2,w3 = 0.3,0.2,0.5
kanto_yield_apple = kanto_temp*w1 + kanto_rainfall*w2 +
kanto_humidity*w3
kanto_yield_apple
```

```
56.8
```

```
# older method is long and tedious as if their are 30 entries , then
it would br difficult
# now , let's see another approach using loop
#preparing data
kanto = [73,67,43]
johto = [91,88,64]
hoenn = [87,134,58]
sinnoh = [102,43,37]
unova = [69,96,70]
weights = [w1,w2,w3]

# making a function to do the work , zip function is used
zippy = zip(kanto , weights)
print('\n')
def crop_yield(region , weights):
    result = 0
    for r , w in zip(region , weights):
        result = result + r*w
    return result



crop_yield(kanto , weights)
```

```
56.8
```

```
for i in zippy:
    print(i)
# zip function in action
```

```
(73, 0.3)
(67, 0.2)
(43, 0.5)
```

```
# now let's try new alternative which will certainlly improve speed
and reduce tedious nature
kanto = np.array([73,67,43])
weights = np.array([w1,w2,w3])  # weig = np.array(weights) also prints
same stuff
print(kanto)
print(weights)
print(type(kanto))
print(type(weights))
```

```
[73 67 43]
[0.3 0.2 0.5]
<class 'numpy.ndarray'>
<class 'numpy.ndarray'>
```

```
# operating on numpy
np.dot(kanto,weights) # It's simple :)
```

```
56.8
```

```
# other way
(kanto*weights).sum()
```

```
56.8
```

```
arr1 = np.array([1,2,3])
arr2 = np.array([4,5,6])
arr1*arr2 # each element will multiply with other element
```

```
array([ 4, 10, 18])
```

```
# for suming , use .sum()
arr1.sum()
# Benefit of using numpy : Ease of use , Performance
```

```
6
```

```
# use of time : it shows time of compilation
# python list
arr1 = list(range(10000))
arr2 = list(range(10000, 20000))
# numpy array
arr1_np = np.array(arr1)
arr2_np = np.array(arr2)
```

```python
import time

# list method
start_time = time.time()
result = 0
for a1,a2 in zip(arr1,arr2):
    result = result + a1*a2
print(result)
end_time = time.time()
print(end_time - start_time)
```

```
833233335000
0.0020821094512939453
```

```python
# numpy method
start_time = time.time()
logical = (np.dot(arr1_np,arr2_np))
print(logical)
end_time = time.time()
print(end_time - start_time)
# Warning : please see this in future
```

```
9679576
0.0
```

Multi Dimensional array

```python
# multi dimensional numpy array
climate_data = np.array([[73, 67, 43],
 [91, 88, 64],
 [87, 134, 58],
 [102, 43, 37],
 [69, 96, 70]])
climate_data
```

```
array([[ 73,  67,  43],
       [ 91,  88,  64],
       [ 87, 134,  58],
       [102,  43,  37],
       [ 69,  96,  70]])
```

```python
# seeing shape
print(climate_data.shape)
print(weights.shape)
```

```
(5, 3)
(3,)
```

```
arr3 = np.array([
 [[11, 12, 13],
 [13, 14, 15]],
 [[15, 16, 17],
 [17, 18, 19.5]]])
print(arr3.shape)
```

```
(2, 2, 3)
```

```
# dtype : data type
weights.dtype
```

```
dtype('float64')
```

```
# matrix multiplication
# 1st way
np.matmul(climate_data,weights)
```

```
array([56.8, 76.9, 81.9, 57.7, 74.9])
```

```
# 2nd way
np.dot(climate_data,weights)
```

```
array([56.8, 76.9, 81.9, 57.7, 74.9])
```

```
# 3rd way
climate_data @ weights
```

```
array([56.8, 76.9, 81.9, 57.7, 74.9])
```

```
# importing data
df =
pd.read_csv(r"https://gist.github.com/BirajCoder/a4ffcb76fd6fb221d76ac
2ee2b8584e9/raw/4054f90adfd361b7aa4255e99c2e874664094cea/climate.csv")
```

```
df
```

```
      temperature  rainfall  humidity
0            25.0      76.0      99.0
1            39.0      65.0      70.0
2            59.0      45.0      77.0
3            84.0      63.0      38.0
4            66.0      50.0      52.0
...           ...       ...       ...
9995         80.0      72.0      98.0
9996         27.0      58.0      60.0
9997         99.0      62.0      58.0
9998         70.0      71.0      91.0
9999         92.0      39.0      76.0

[10000 rows x 3 columns]
```

```python
# transforming into an array
climate_data = np.array(df)
climate_data
```

```
array([[25., 76., 99.],
       [39., 65., 70.],
       [59., 45., 77.],
       ...,
       [99., 62., 58.],
       [70., 71., 91.],
       [92., 39., 76.]])
```

```python
climate_data.shape
```

```
(10000, 3)
```

```python
weights = np.array([0.3,0.2,0.5])
yields = climate_data @ weights
print(yields)
print(yields.shape)
```

```
[72.2 59.7 65.2 ... 71.1 80.7 73.4]
(10000,)
```

```python
# concatenating  and reshaping
climate_results = np.concatenate((climate_data ,
yields.reshape(10000,1)),axis=1)
climate_results
```

```
array([[25. , 76. , 99. , 72.2],
       [39. , 65. , 70. , 59.7],
       [59. , 45. , 77. , 65.2],
       ...,
       [99. , 62. , 58. , 71.1],
       [70. , 71. , 91. , 80.7],
       [92. , 39. , 76. , 73.4]])
```

```python
# for saving as text
np.savetxt('climate_results.txt',
          climate_results,
          fmt='%.2f',
          delimiter=',',
          header='temperature,rainfall,humidity,yeild_apples',
          comments ='')
```

Arithmetic operations , broadcasting and comparison

```
# Arithmetic operations
arr2 = np.array([[1, 2, 3, 4],
 [5, 6, 7, 8],
 [9, 1, 2, 3]])
arr3 = np.array([[11, 12, 13, 14],
 [15, 16, 17, 18],
 [19, 11, 12, 13]])

# Adding a scalar
arr2 + 3
```

```
array([[ 4,  5,  6,  7],
       [ 8,  9, 10, 11],
       [12,  4,  5,  6]])
```

```
# Element wise substraction
arr3 - arr2
```

```
array([[10, 10, 10, 10],
       [10, 10, 10, 10],
       [10, 10, 10, 10]])
```

```
# Division by scalar
arr2/2
```

```
array([[0.5, 1. , 1.5, 2. ],
       [2.5, 3. , 3.5, 4. ],
       [4.5, 0.5, 1. , 1.5]])
```

```
# Element-wise multiplication
arr2 * arr3
```

```
array([[ 11,  24,  39,  56],
       [ 75,  96, 119, 144],
       [171,  11,  24,  39]])
```

```
# Modulus with scalar
arr2%4
```

```
array([[1, 2, 3, 0],
       [1, 2, 3, 0],
       [1, 1, 2, 3]], dtype=int32)
```

```
# Array Broadcasting : array increses itself to perform operation
arr2 = np.array([[1, 2, 3, 4],
 [5, 6, 7, 8],
 [9, 1, 2, 3]])
print(arr2.shape)
```

```
(3, 4)
```

```python
arr4 = np.array([4, 5, 6, 7])
arr4.shape
```

```
(4,)
```

```python
arr2 + arr4 # arr4 broadcasted himself
```

```
array([[ 5,  7,  9, 11],
       [ 9, 11, 13, 15],
       [13,  6,  8, 10]])
```

```python
# array comparison
arr1 = np.array([[1, 2, 3], [3, 4, 5]])
arr2 = np.array([[2, 2, 3], [1, 2, 5]])
print(arr1 == arr2)
print(arr1 != arr2)
print(arr1 >= arr2)
print(arr1 < arr2)
print((arr1 == arr2).sum())
```

```
[[False  True  True]
 [False False  True]]
[[ True False False]
 [ True  True False]]
[[False  True  True]
 [ True  True  True]]
[[ True False False]
 [False False False]]
3
```

Array indexing , slicing and different ways to make numpy arrays

```python
# array indexing and slicing
arr3 = np.array([
 [[11, 12, 13, 14],
 [13, 14, 15, 19]],

 [[15, 16, 17, 21],
 [63, 92, 36, 18]],

 [[98, 32, 81, 23],
 [17, 18, 19.5, 43]]])
print(arr3.shape)
```

```
(3, 2, 4)
```

```
# for single element
arr3[1,1,2]
```

```
36.0
```

```
# Subarray using ranges
arr3[1: , 0:1 , :2]
```

```
array([[[15., 16.]],

       [[98., 32.]]])
```

```
# mixing indices and ranges
arr3[1:,1,3]
```

```
array([18., 43.])
```

```
# Using less indices
arr3[1]
```

```
array([[15., 16., 17., 21.],
       [63., 92., 36., 18.]])
```

```
arr3[:2,1]
```

```
array([[13., 14., 15., 19.],
       [63., 92., 36., 18.]])
```

```
# we cannot use too many indices
```

```
# Other ways of creating numpy arrays
```

```
# All zeroes
np.zeros((3,2))
```

```
array([[0., 0.],
       [0., 0.],
       [0., 0.]])
```

```
# All ones
np.ones([2,2,3])
```

```
array([[[1., 1., 1.],
        [1., 1., 1.]],

       [[1., 1., 1.],
        [1., 1., 1.]]])
```

```
# Identity matrix
np.eye(3)
```

```
array([[1., 0., 0.],
       [0., 1., 0.],
       [0., 0., 1.]])
```

```
# Random vector
np.random.rand(5)
```

```
array([0.55578527, 0.25292812, 0.56062471, 0.27369946, 0.45908488])
```

```
# Random Matrix
np.random.randn(2,3)
```

```
array([[-0.23602047, -0.42866138, -2.01360179],
       [-0.05580243,  0.4312376 , -0.1539253 ]])
```

```
# Fixed value
np.full([2,3] , 42)
```

```
array([[42, 42, 42],
       [42, 42, 42]])
```

```
#  Range with start , end and step
np.arange(10,90,3)
```

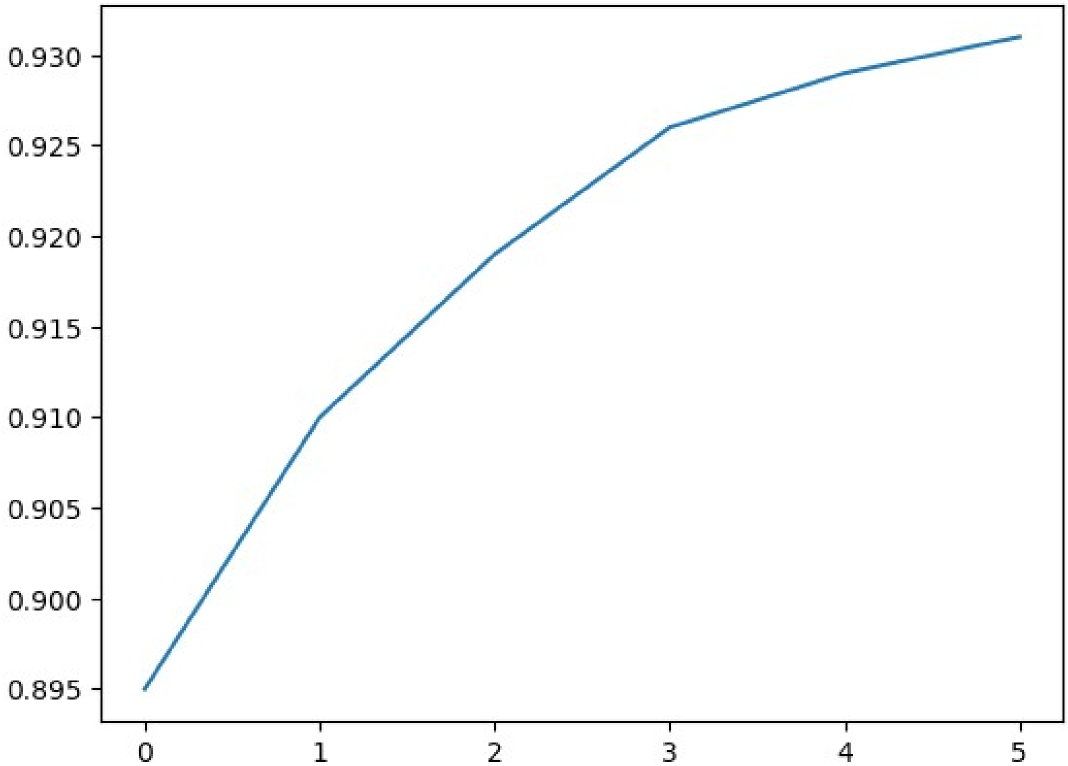
```
array([10, 13, 16, 19, 22, 25, 28, 31, 34, 37, 40, 43, 46, 49, 52, 55,
58,
       61, 64, 67, 70, 73, 76, 79, 82, 85, 88])
```

```
# Equally spaced numbers in a range
np.linspace(3,27,8)
```

```
array([ 3.        ,  6.42857143,  9.85714286, 13.28571429,
16.71428571,
       20.14285714, 23.57142857, 27.        ])
```

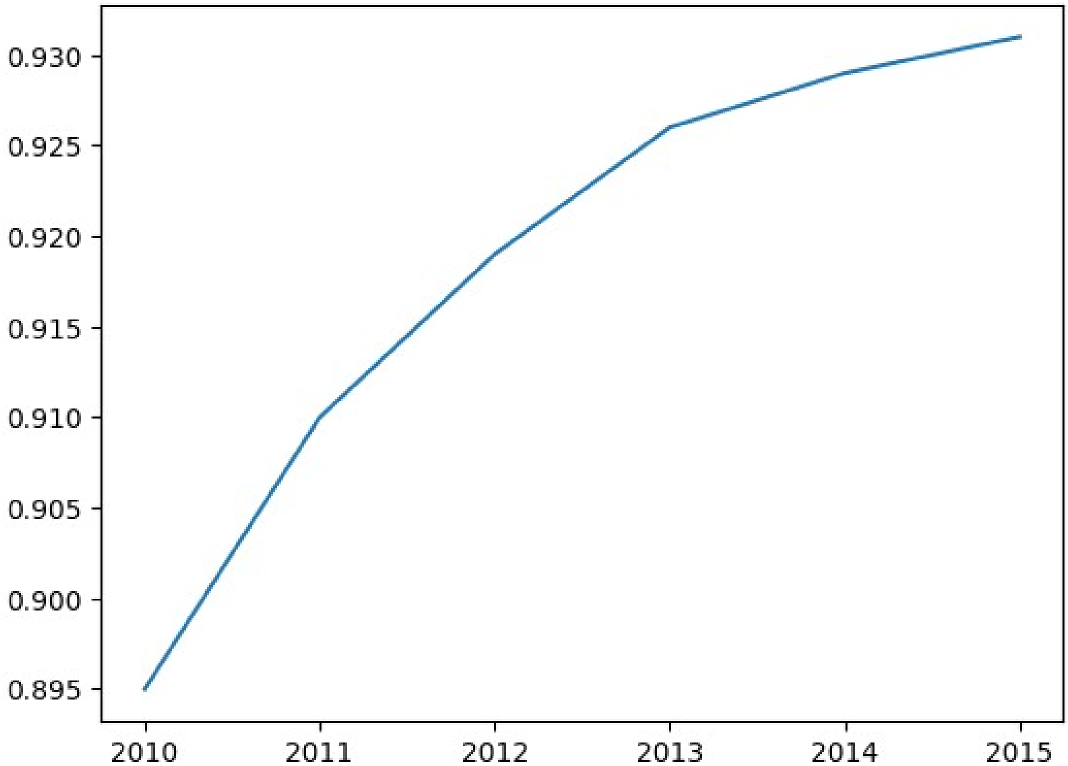
Data Visualization using Python, Matplotlib and Seaborn

```
import matplotlib.pyplot as plt
import seaborn as sns

yield_apples = [0.895, 0.91, 0.919, 0.926, 0.929, 0.931]

# basic plotting
plt.plot(yield_apples);
```

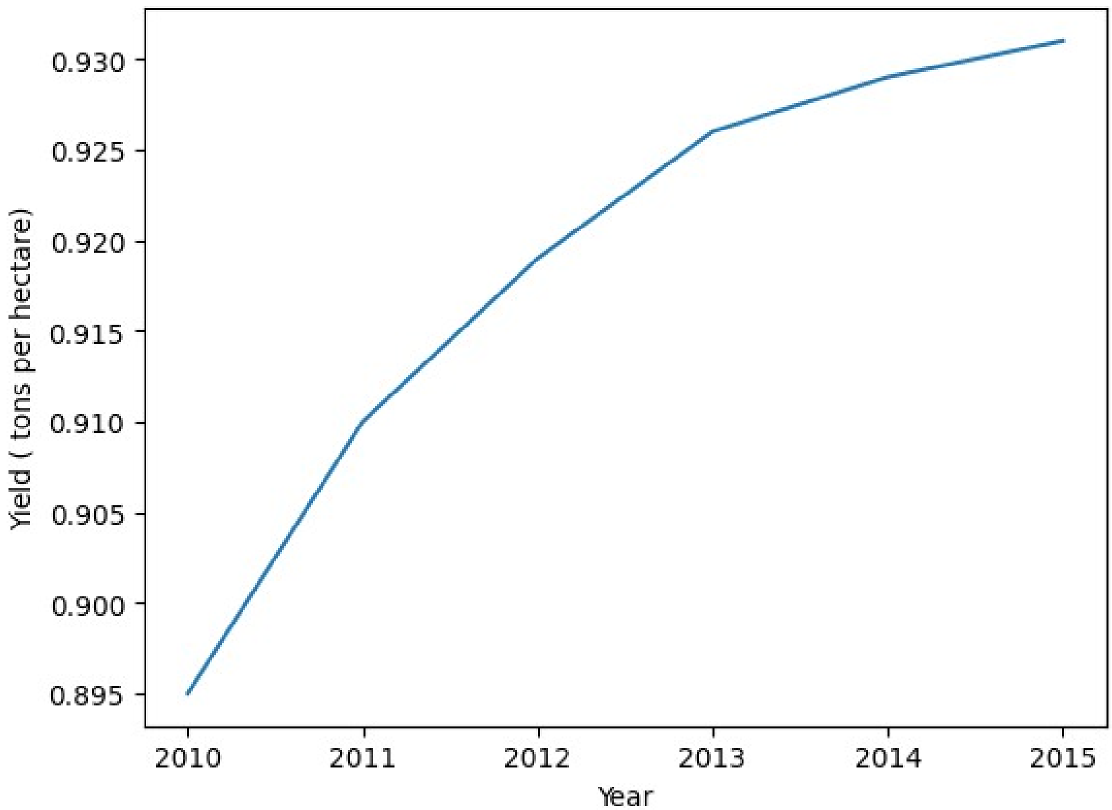


custmizing

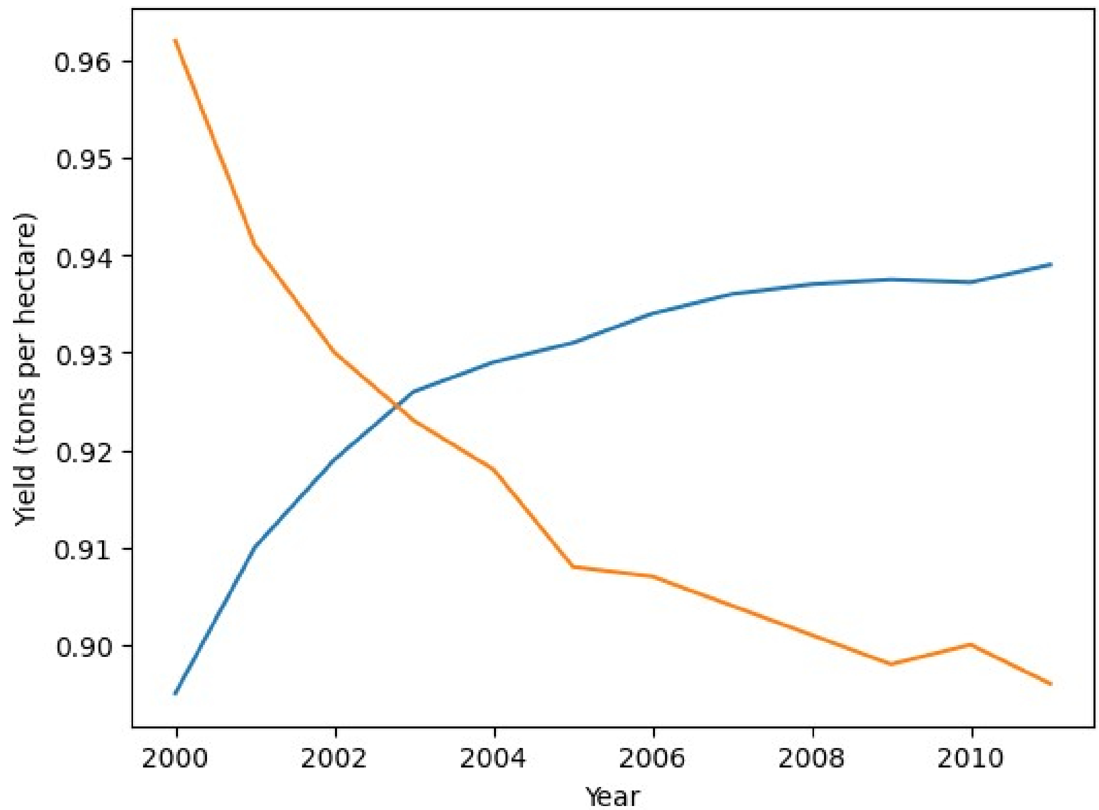
```
years = [2010, 2011, 2012, 2013, 2014, 2015]
yield_apples = [0.895, 0.91, 0.919, 0.926, 0.929, 0.931]
plt.plot(years , yield_apples);
```



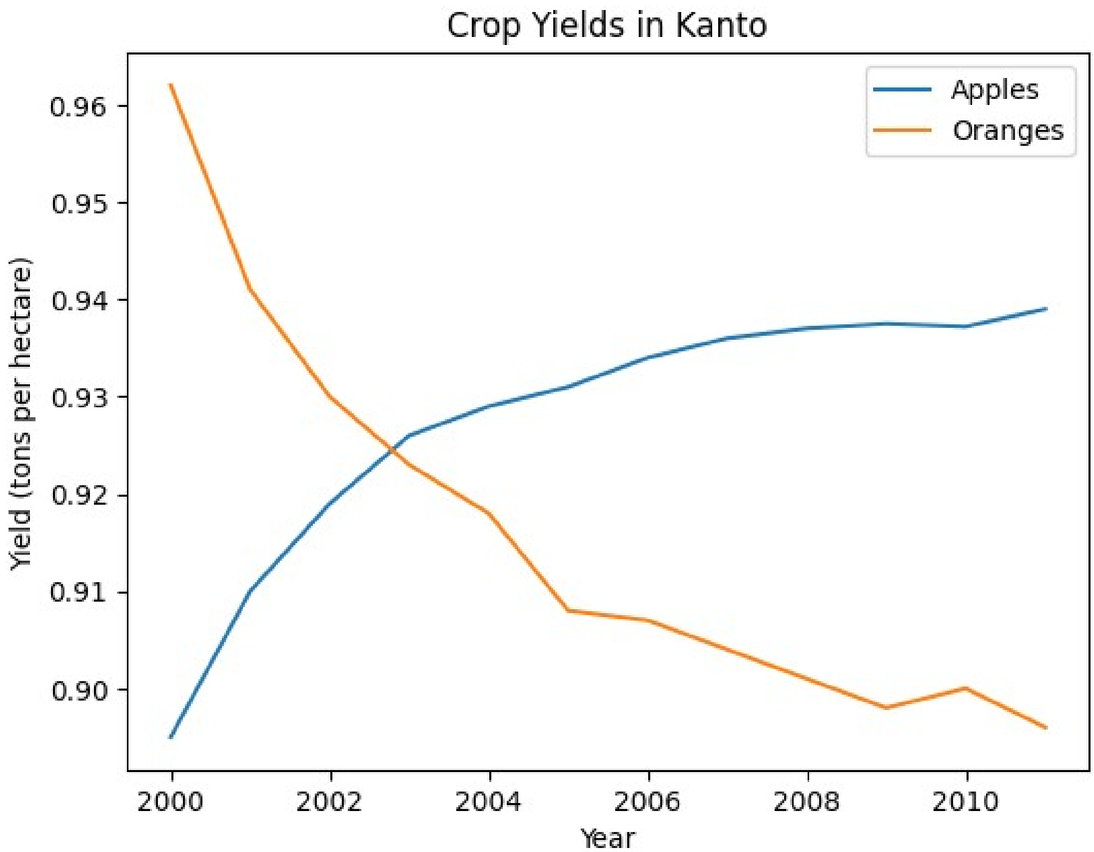

```
plt.plot(years,yield_apples)
plt.xlabel('Year')
plt.ylabel('Yield ( tons per hectare)');
```



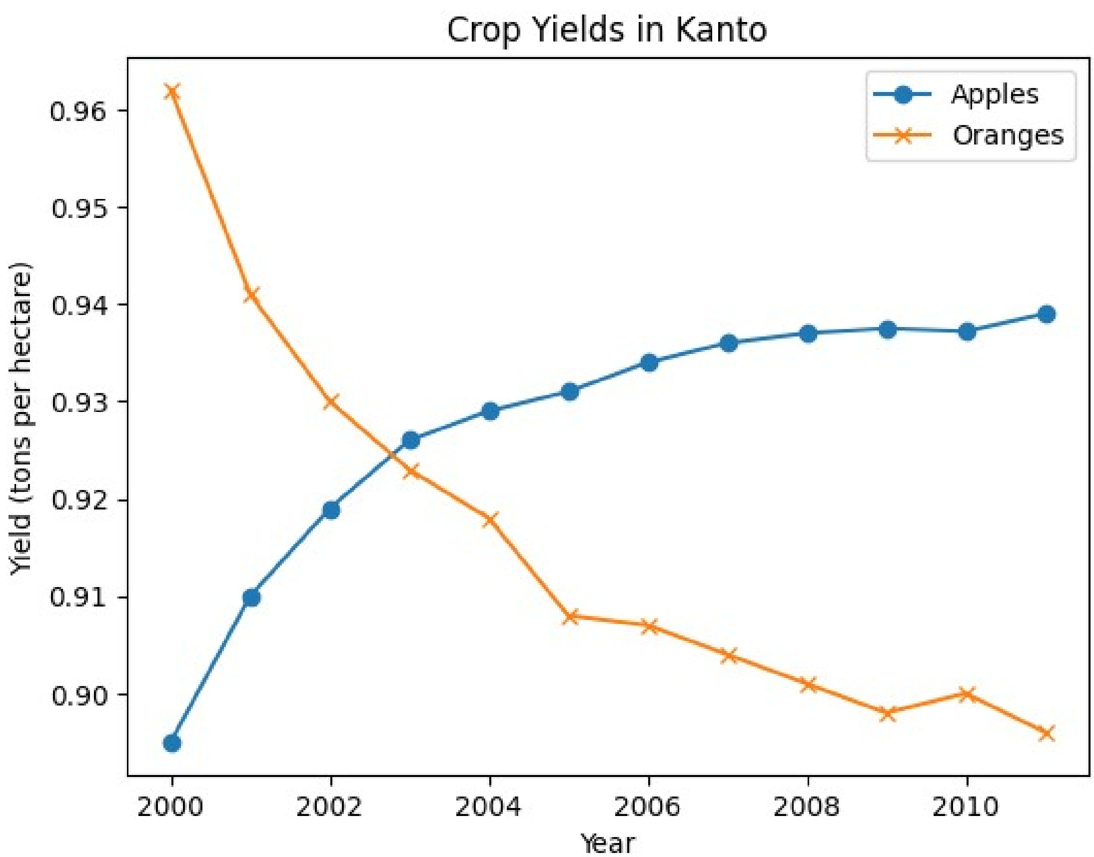

```
# Plotting multiple lines
years = range(2000, 2012)
apples = [0.895, 0.91, 0.919, 0.926, 0.929, 0.931, 0.934, 0.936,
0.937, 0.9375, 0.9372, 0.939]
oranges = [0.962, 0.941, 0.930, 0.923, 0.918, 0.908, 0.907, 0.904,
0.901, 0.898, 0.9, 0.896, ]
plt.plot(years, apples)
plt.plot(years , oranges)
plt.xlabel('Year')
plt.ylabel('Yield (tons per hectare)');
```



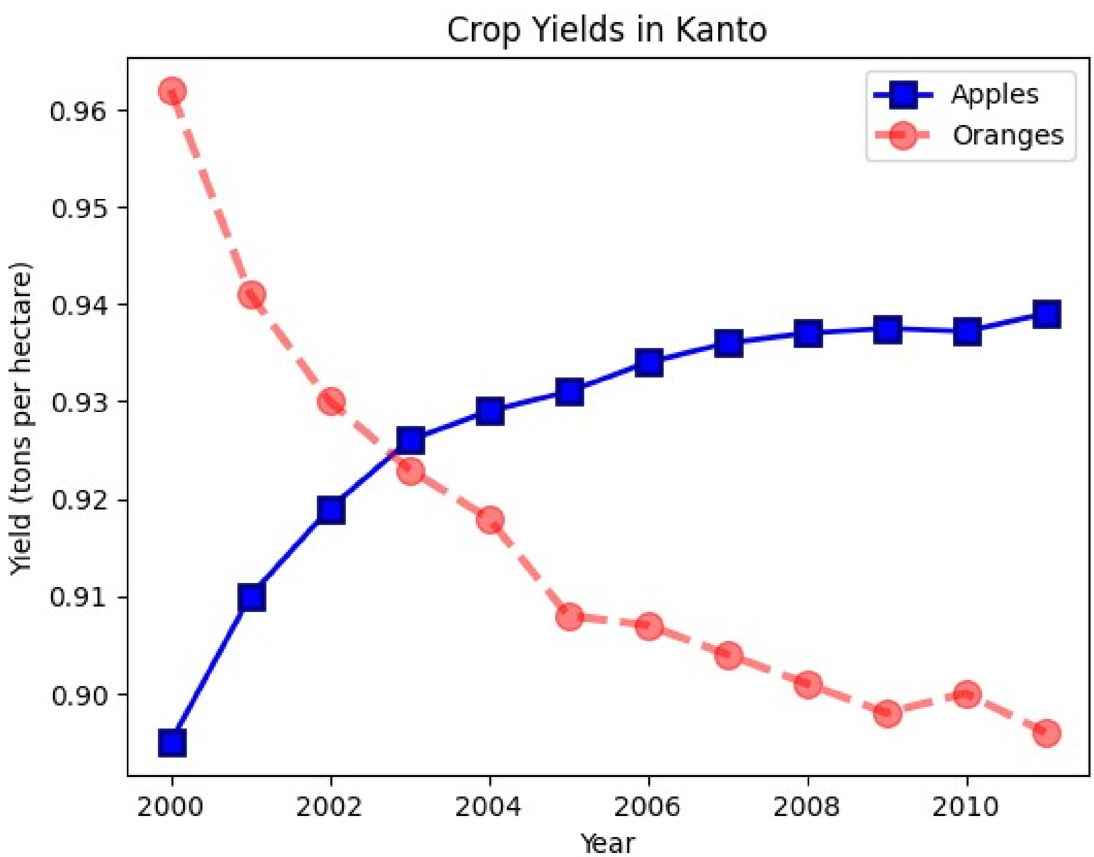

```python
# Chart Title and Legend
plt.plot(years, apples)
plt.plot(years, oranges)
plt.xlabel('Year')
plt.ylabel('Yield (tons per hectare)')
plt.title("Crop Yields in Kanto")
plt.legend(['Apples', 'Oranges']);
```



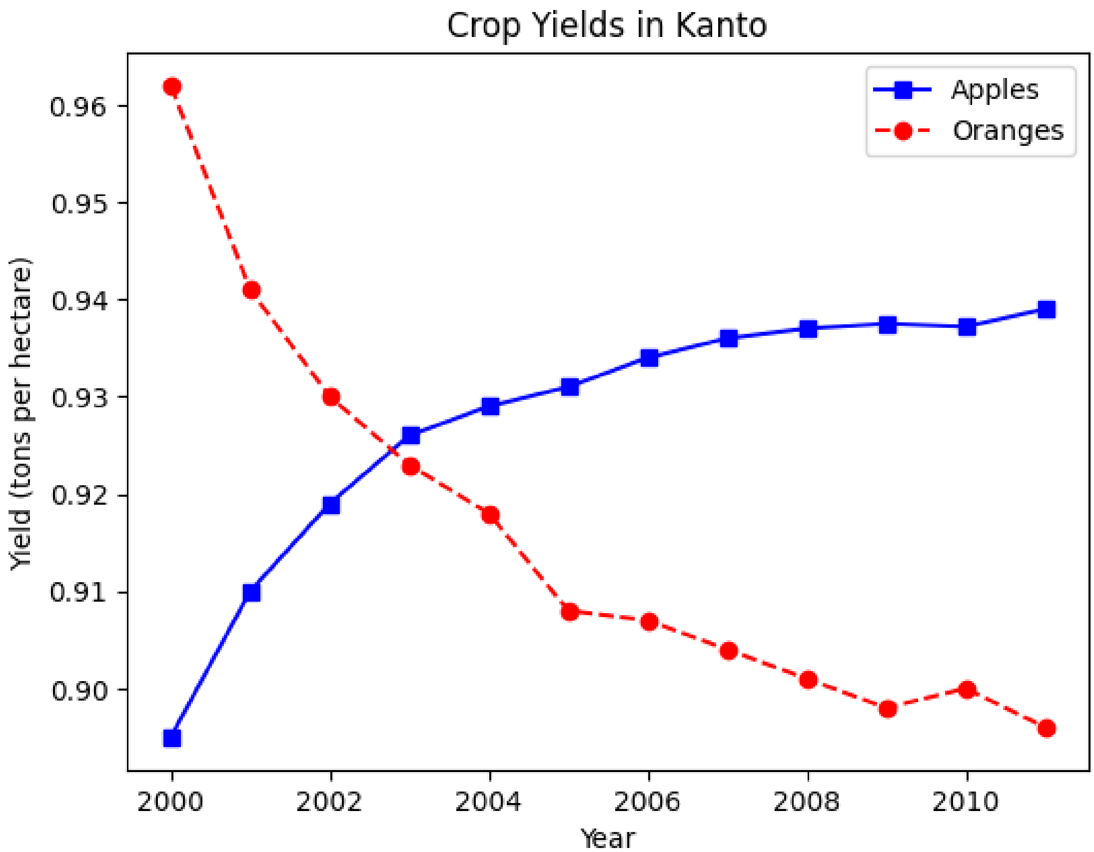

```
# Line Markers
plt.plot(years, apples, marker='o')
plt.plot(years, oranges, marker='x')
plt.xlabel('Year')
plt.ylabel('Yield (tons per hectare)')
plt.title("Crop Yields in Kanto")
plt.legend(['Apples', 'Oranges']);
```



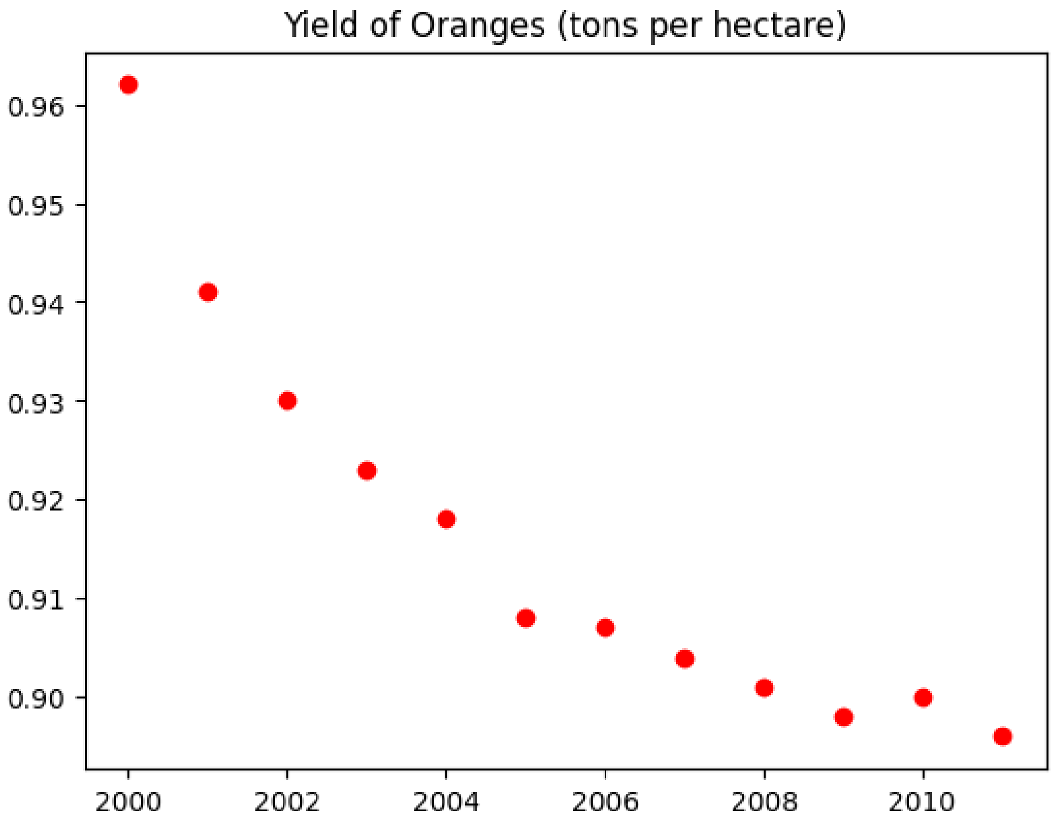

```
# Styling Lines and Markers
# Do'nt focus very much on this
plt.plot(years, apples, marker='s', c='b', ls='-', lw=2, ms=8, mew=2,
mec='navy')
plt.plot(years, oranges, marker='o', c='r', ls='--', lw=3, ms=10,
alpha=.5)
plt.xlabel('Year')
plt.ylabel('Yield (tons per hectare)')
plt.title("Crop Yields in Kanto")
plt.legend(['Apples', 'Oranges']);
```



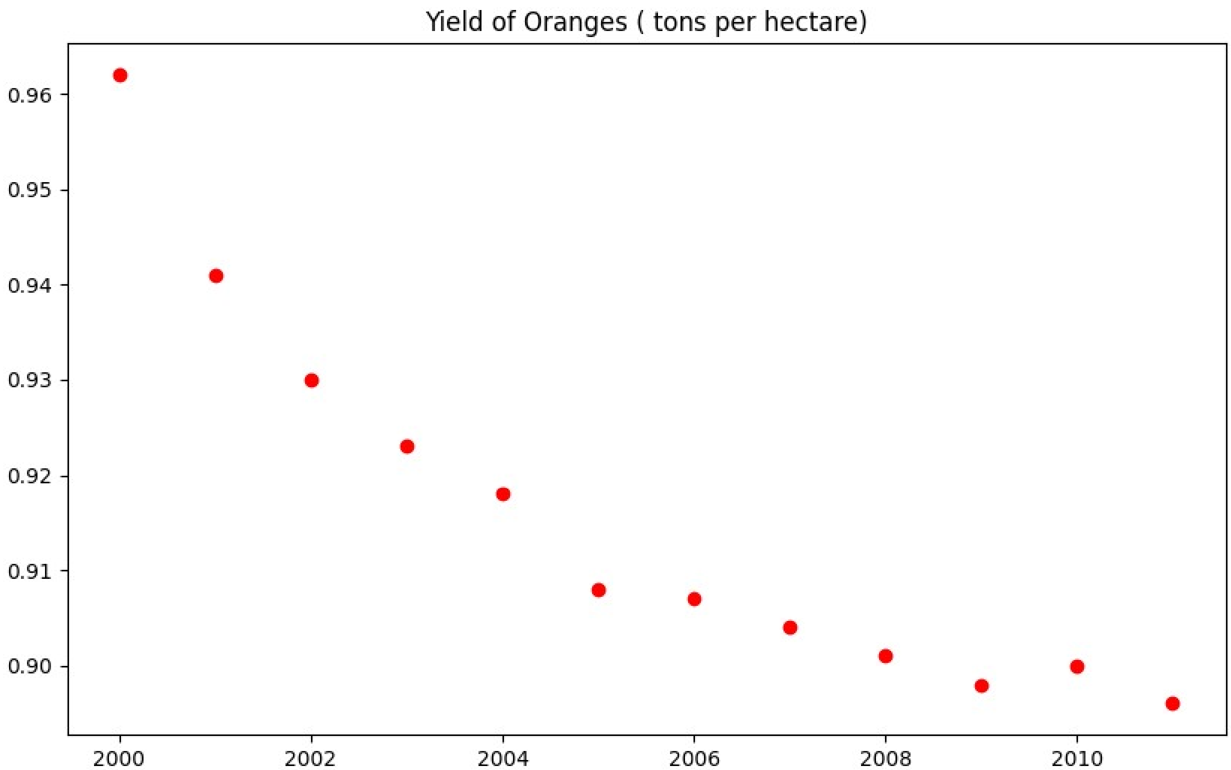

```
# fmt ='[marker][line][color]'
plt.plot(years, apples, 's-b')
plt.plot(years, oranges, 'o--r')
plt.xlabel('Year')
plt.ylabel('Yield (tons per hectare)')
plt.title("Crop Yields in Kanto")
plt.legend(['Apples', 'Oranges']);
```



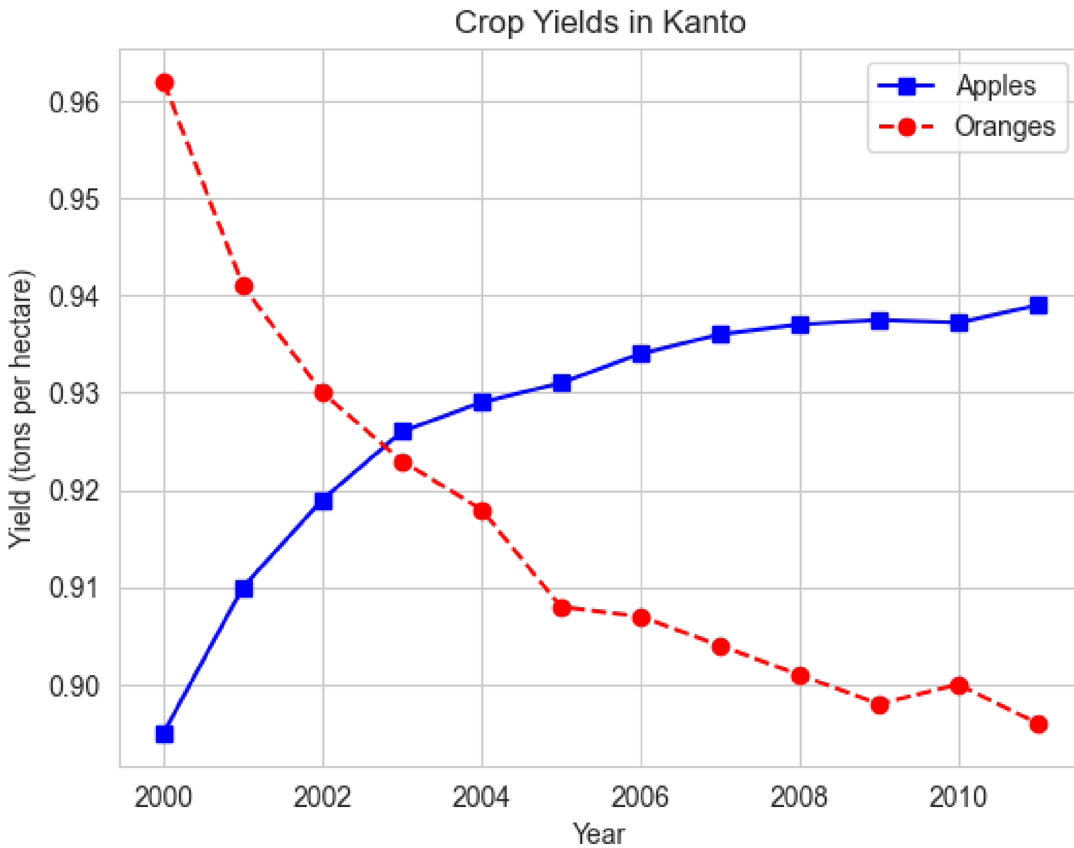

```python
# If we don't describe line style in fmt , then markers will be onlly
visible
plt.plot(years, oranges, 'or')
plt.title("Yield of Oranges (tons per hectare)");
```



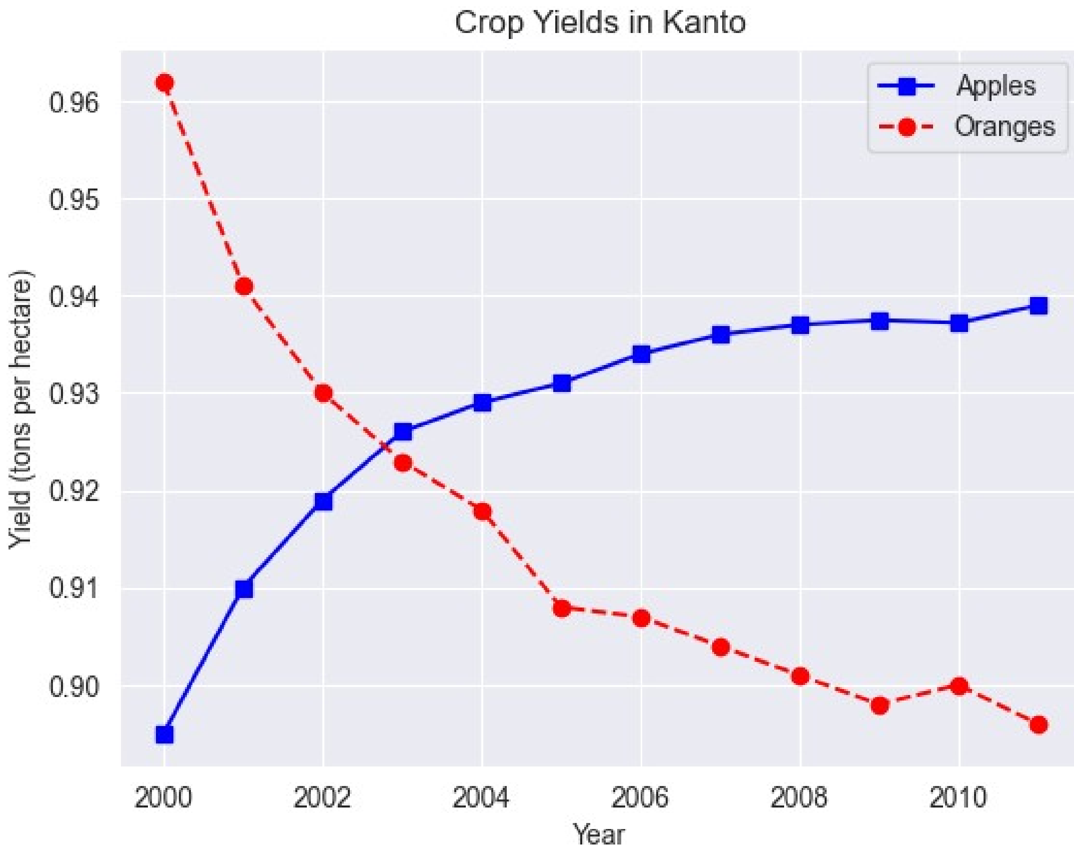

```
# Changing the figure size
plt.figure(figsize = (10,6))
plt.plot(years,oranges,'or')
plt.title("Yield of Oranges ( tons per hectare)");
```




```
# Improving Default Styles using Seaborn
sns.set_style('whitegrid')
plt.plot(years, apples, 's-b')
plt.plot(years, oranges, 'o--r')
plt.xlabel('Year')
plt.ylabel('Yield (tons per hectare)')
plt.title("Crop Yields in Kanto")
plt.legend(['Apples', 'Oranges']);
```

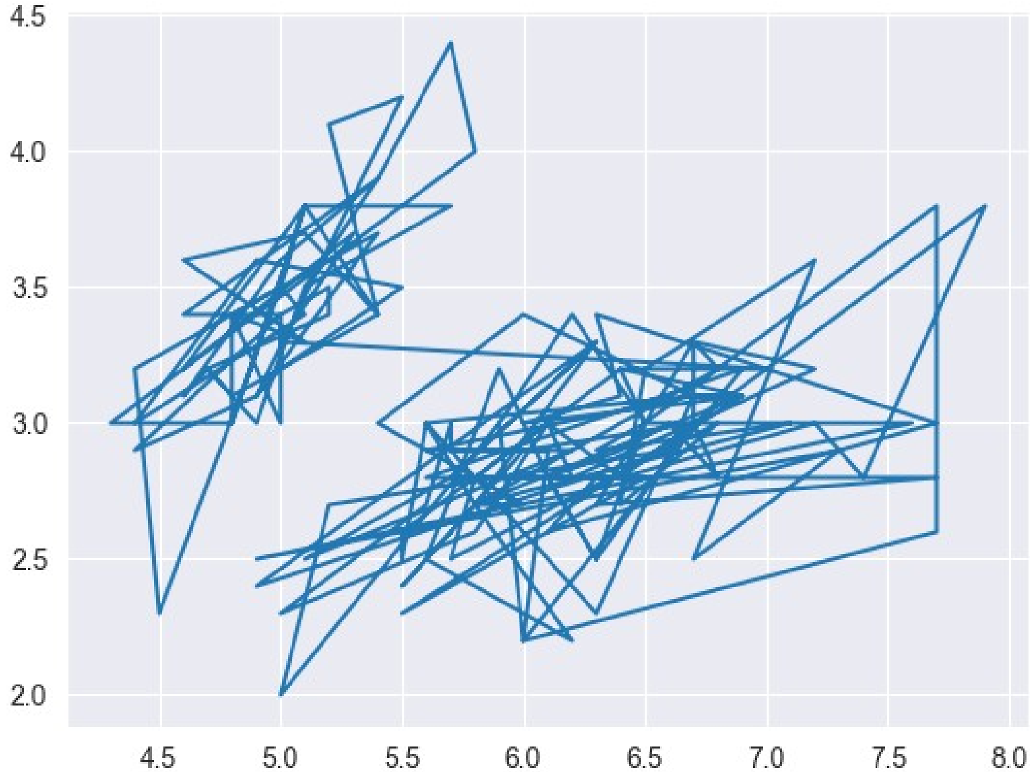



```
sns.set_style("darkgrid")
plt.plot(years, apples, 's-b')
plt.plot(years, oranges, 'o--r')
plt.xlabel('Year')
plt.ylabel('Yield (tons per hectare)')
plt.title("Crop Yields in Kanto")
plt.legend(['Apples', 'Oranges']);
```

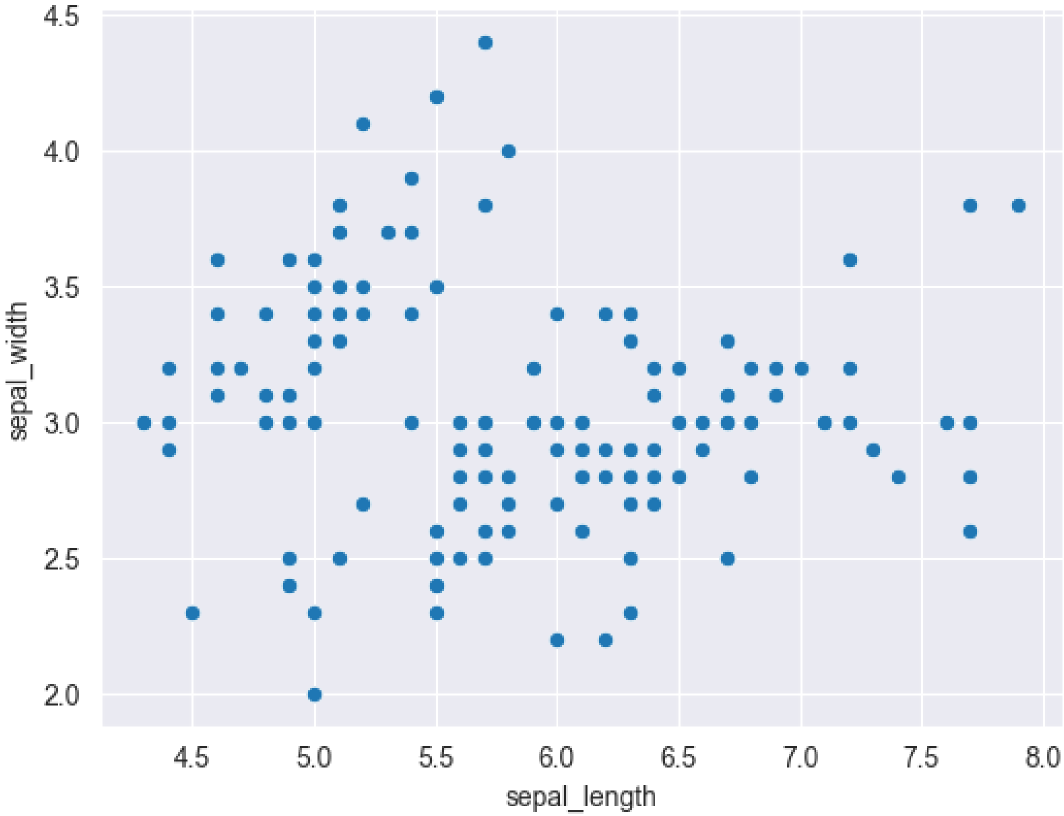


Scatter Plot

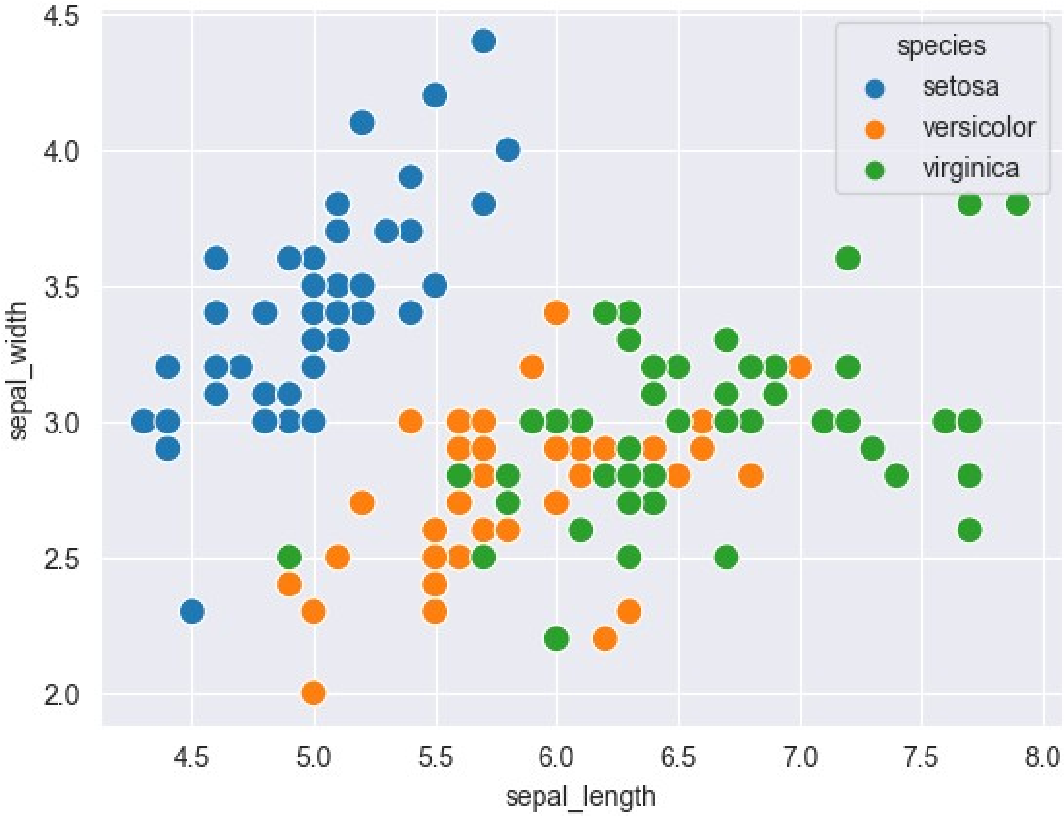
```
# loading data into a dataframe
flowers_df = sns.load_dataset('iris')

flowers_df.species.unique() # for finding out unique values

array(['setosa', 'versicolor', 'virginica'], dtype=object)

plt.plot(flowers_df.sepal_length , flowers_df.sepal_width); # not an informative graph
```



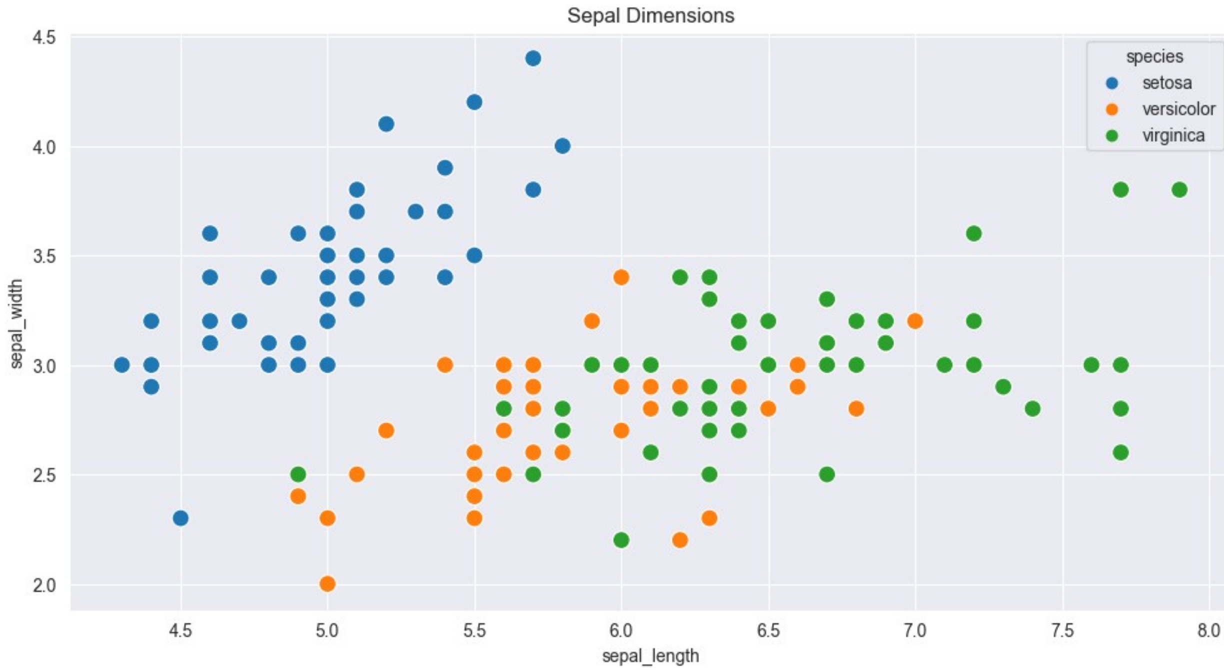

```
sns.scatterplot(x=flowers_df.sepal_length, y=flowers_df.sepal_width);
```




```
# Adding hues
sns.scatterplot(x=flowers_df.sepal_length, y=flowers_df.sepal_width,
hue=flowers_df.species, s=100);
```

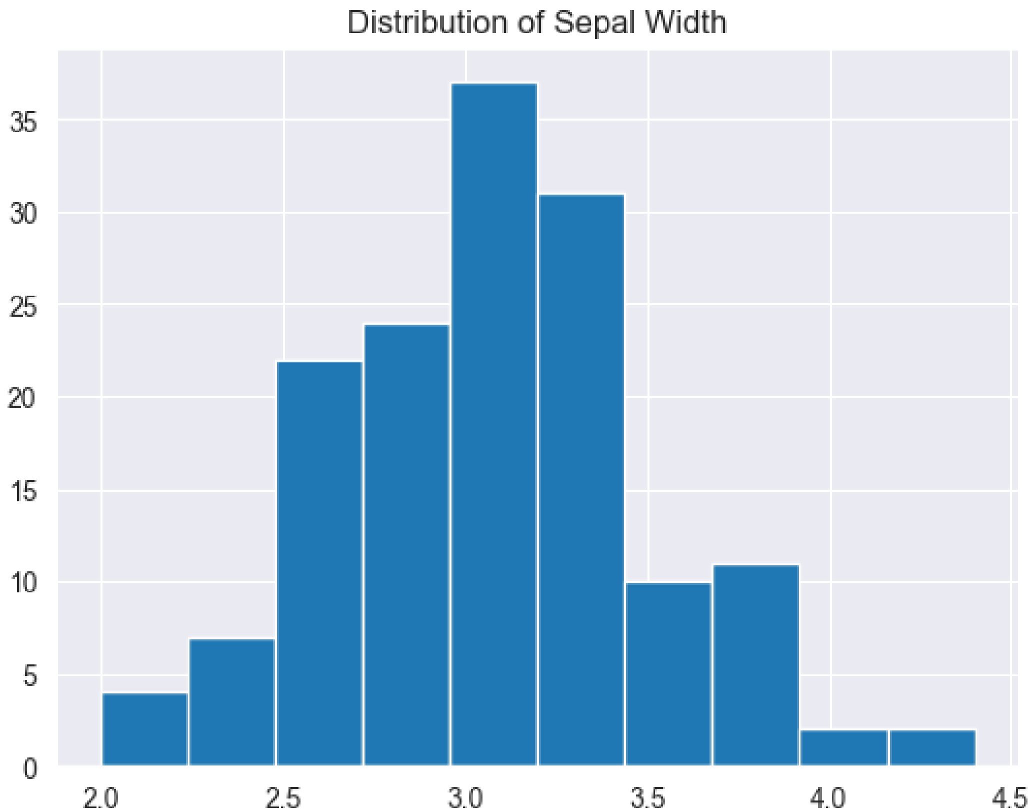



```
# Customizing Seaborn figures
plt.figure(figsize=(12, 6))
plt.title('Sepal Dimensions')
sns.scatterplot(x=flowers_df.sepal_length,
 y=flowers_df.sepal_width,
 hue=flowers_df.species,
 s=100);
```

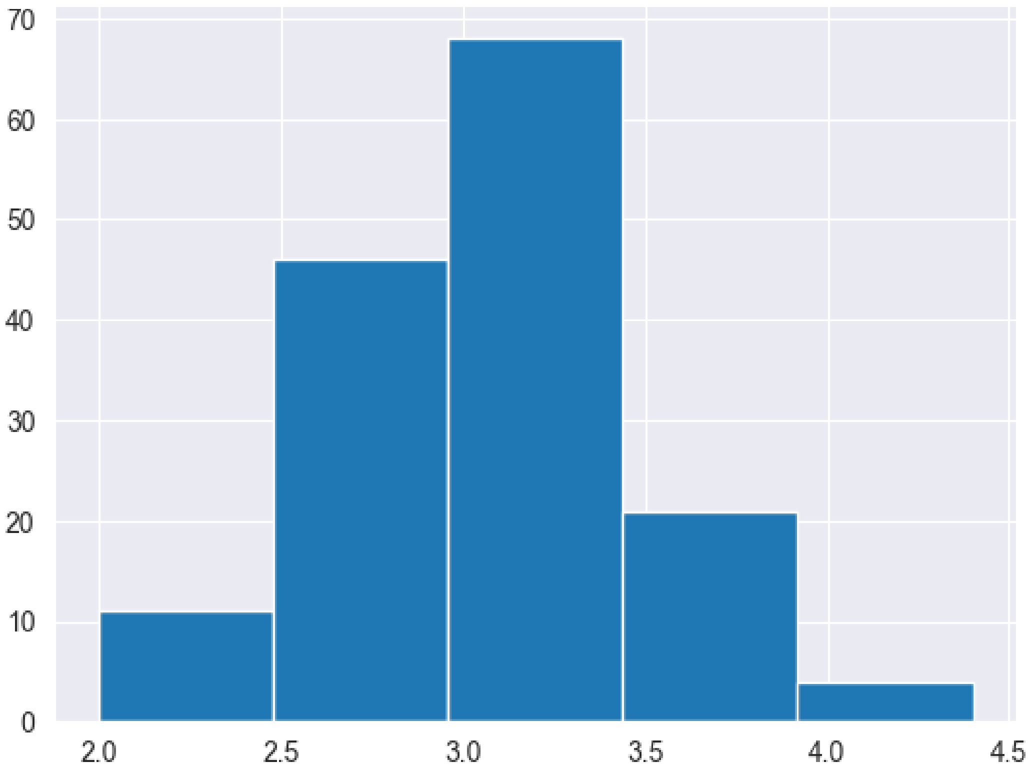


Histogram

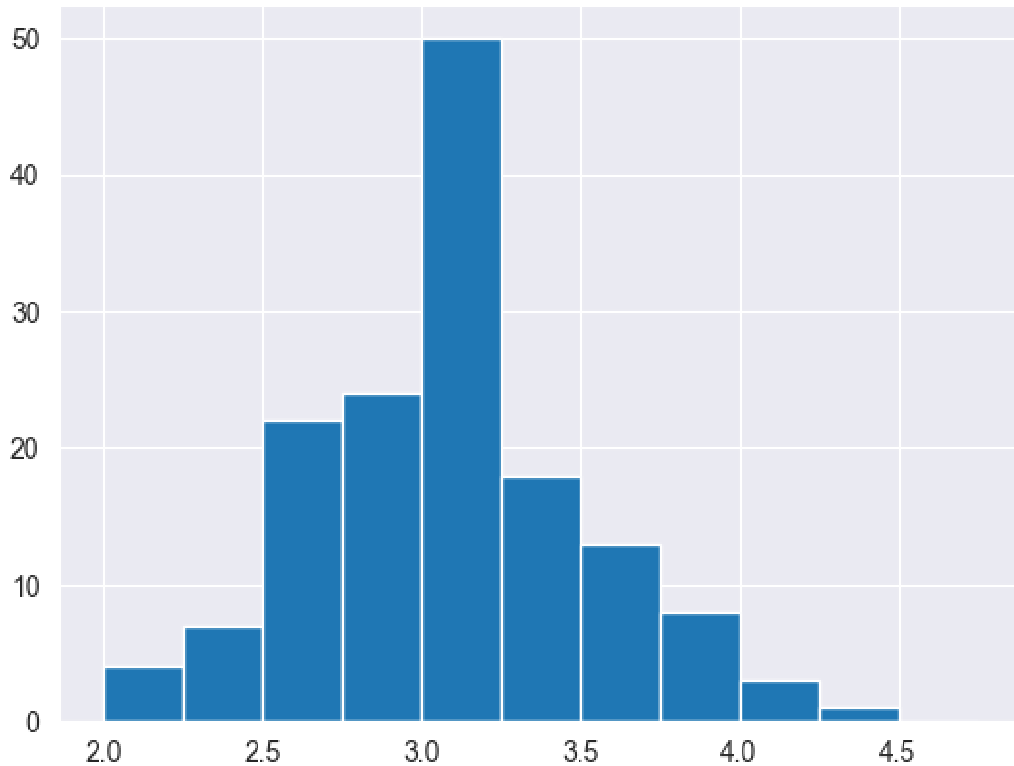
```
# Load data into a Pandas dataframe
flowers_df = sns.load_dataset("iris")
plt.title("Distribution of Sepal Width")
plt.hist(flowers_df.sepal_width);
```



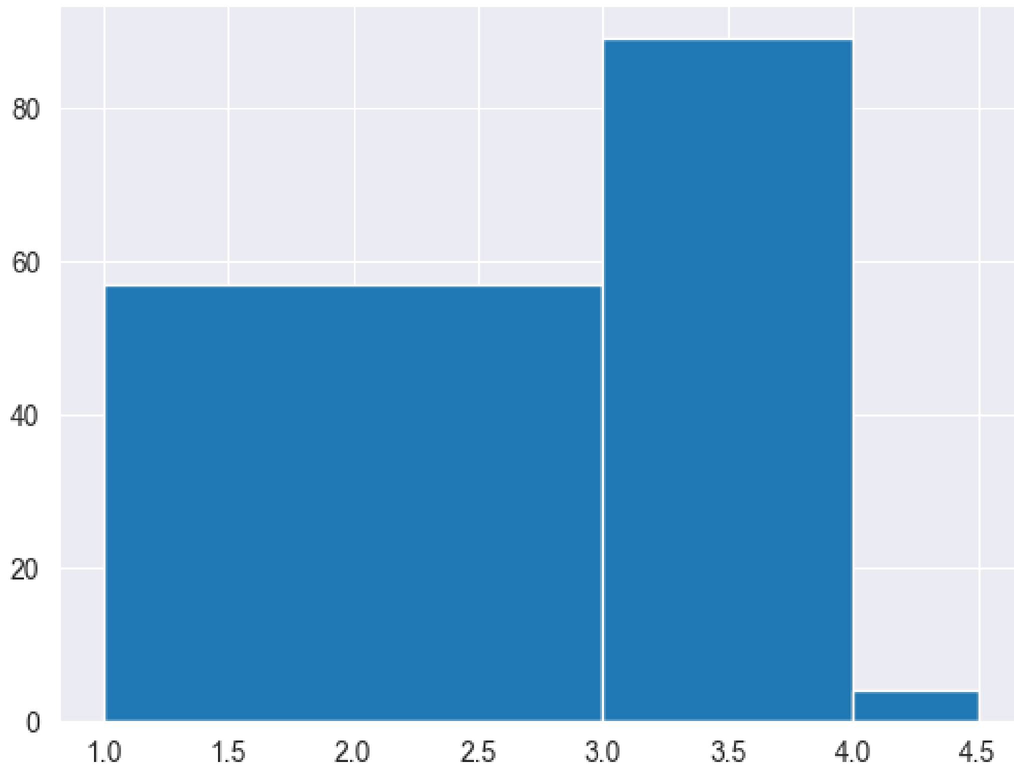

```
# Specifying the number of bins
plt.hist(flowers_df.sepal_width, bins=5);
```



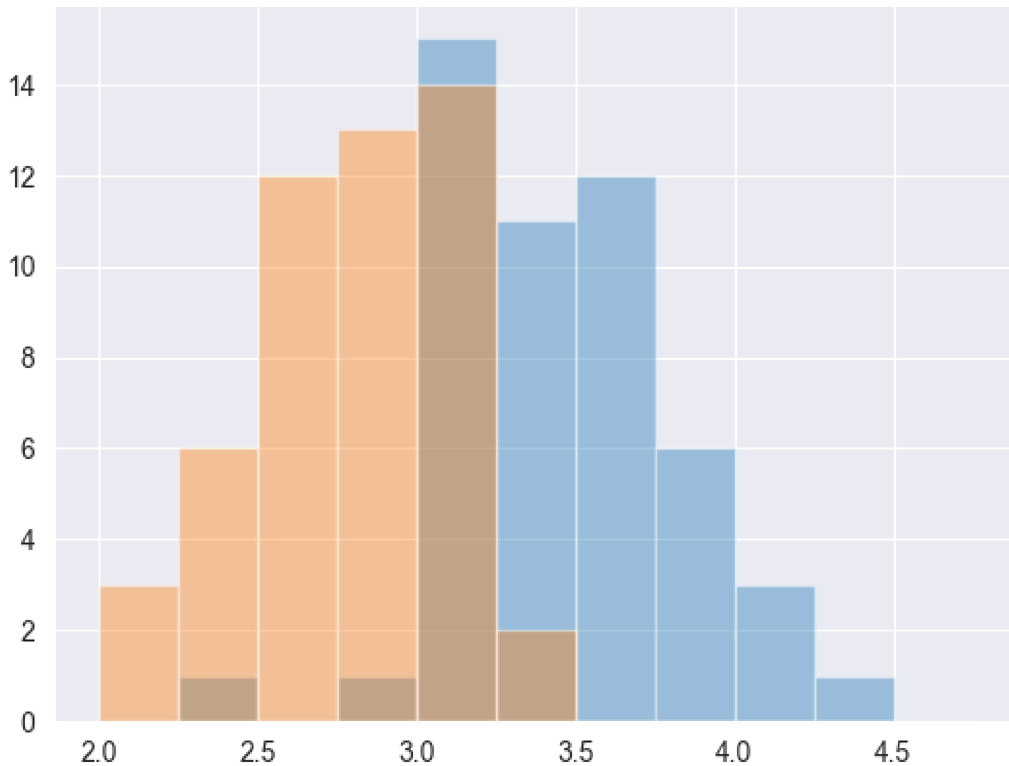

```python
# Specifying the boundaries of each bin
plt.hist(flowers_df.sepal_width, bins=np.arange(2, 5, 0.25));
```



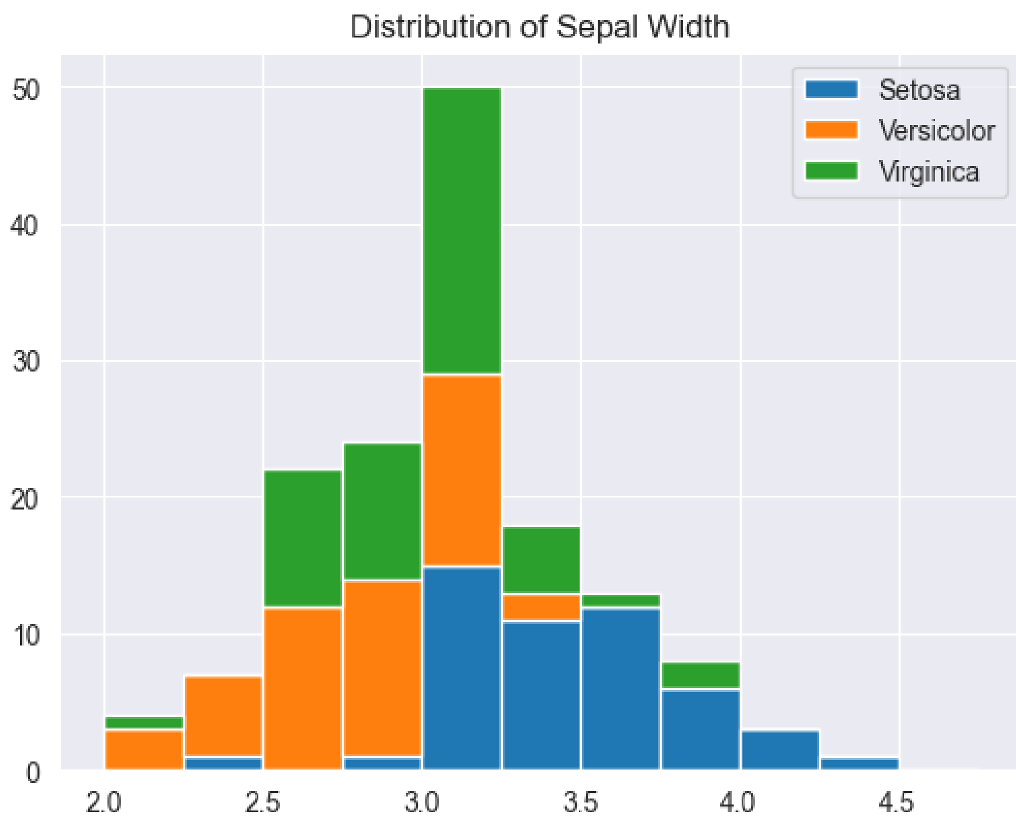

```
# Bins of unequal sizes
plt.hist(flowers_df.sepal_width, bins=[1, 3, 4, 4.5]);
```




```
# Multiple Histograms
setosa_df = flowers_df[flowers_df.species == 'setosa']
versicolor_df = flowers_df[flowers_df.species == 'versicolor']
virginica_df = flowers_df[flowers_df.species == 'virginica']
plt.hist(setosa_df.sepal_width, alpha=0.4, bins=np.arange(2, 5,
0.25));
plt.hist(versicolor_df.sepal_width, alpha=0.4, bins=np.arange(2, 5,
0.25));
```

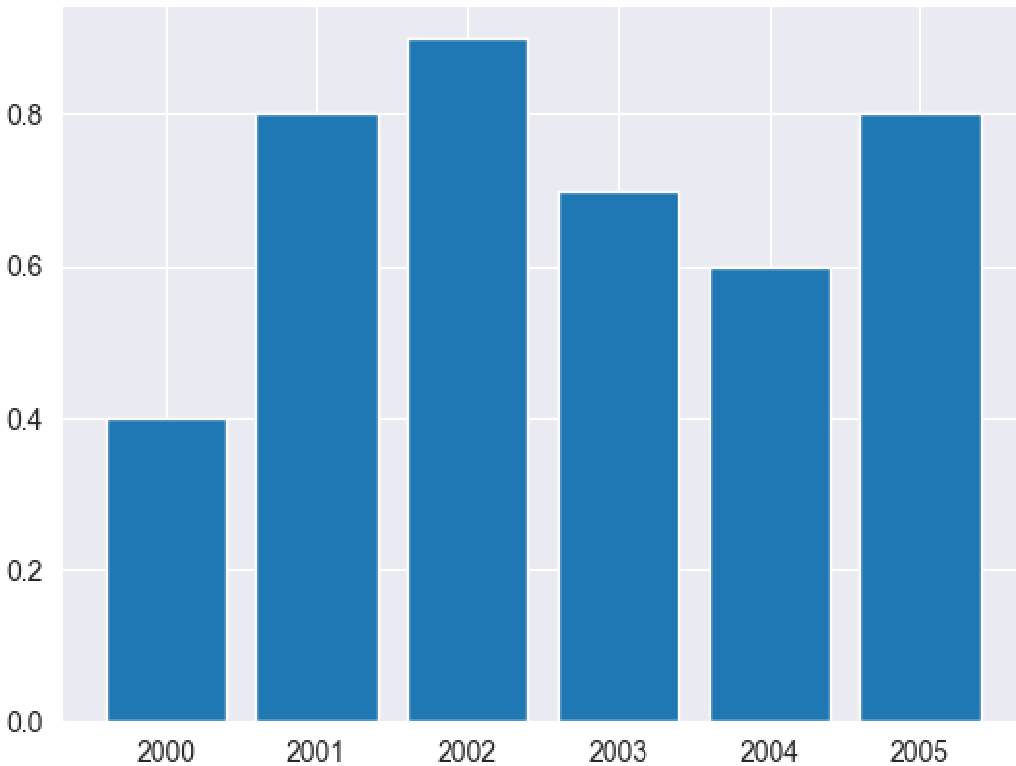



```
# stacked histogram
plt.title('Distribution of Sepal Width')
plt.hist([setosa_df.sepal_width, versicolor_df.sepal_width,
virginica_df.sepal_width],
 bins=np.arange(2, 5, 0.25),
 stacked=True);
plt.legend(['Setosa', 'Versicolor', 'Virginica']);
```

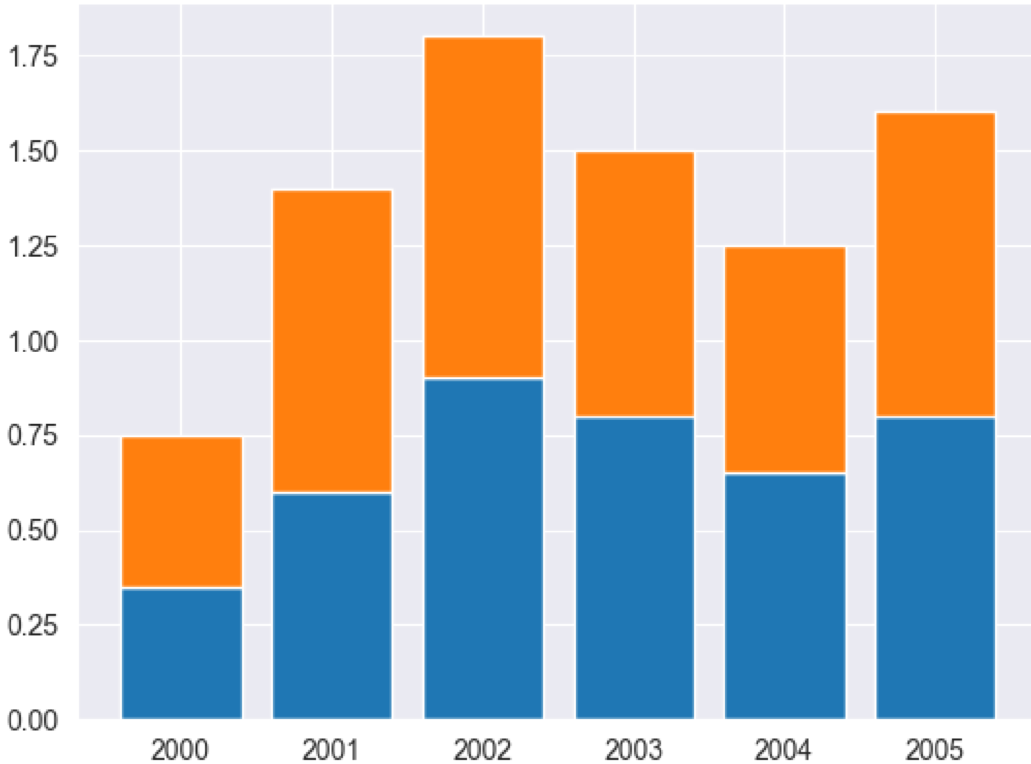


Barchart

```
years = range(2000, 2006)
apples = [0.35, 0.6, 0.9, 0.8, 0.65, 0.8]
oranges = [0.4, 0.8, 0.9, 0.7, 0.6, 0.8]
plt.bar(years, oranges);
```

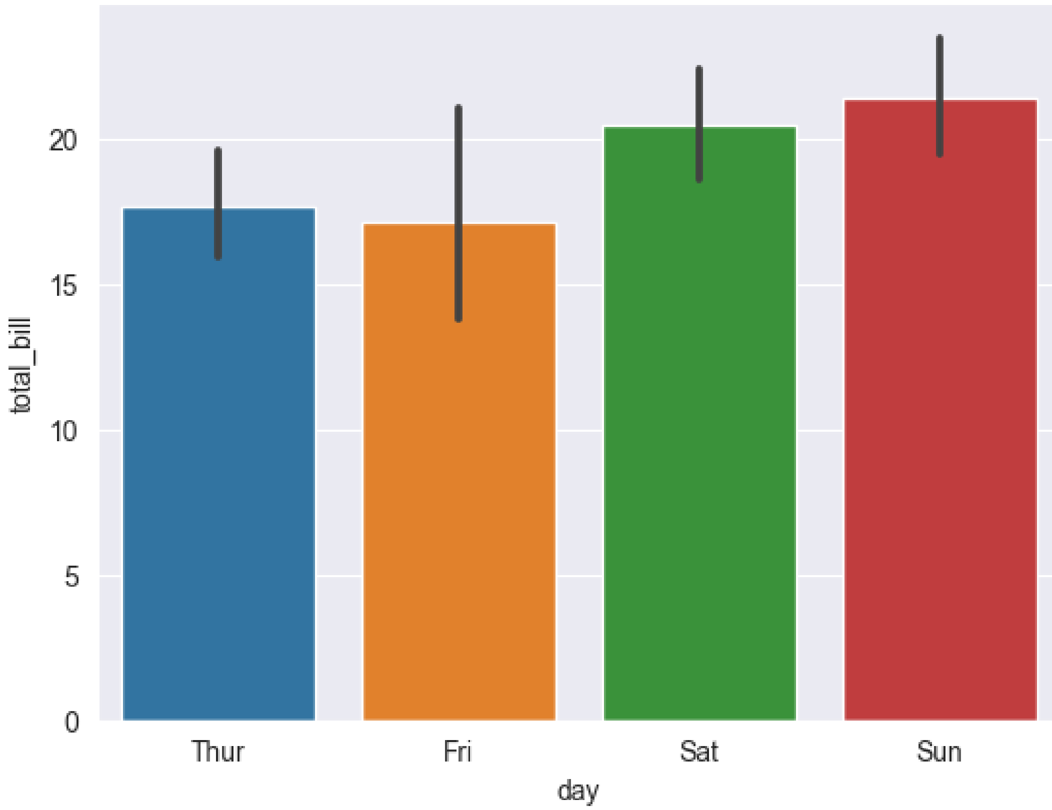



```
plt.bar(years, apples)
plt.bar(years, oranges, bottom=apples);
```

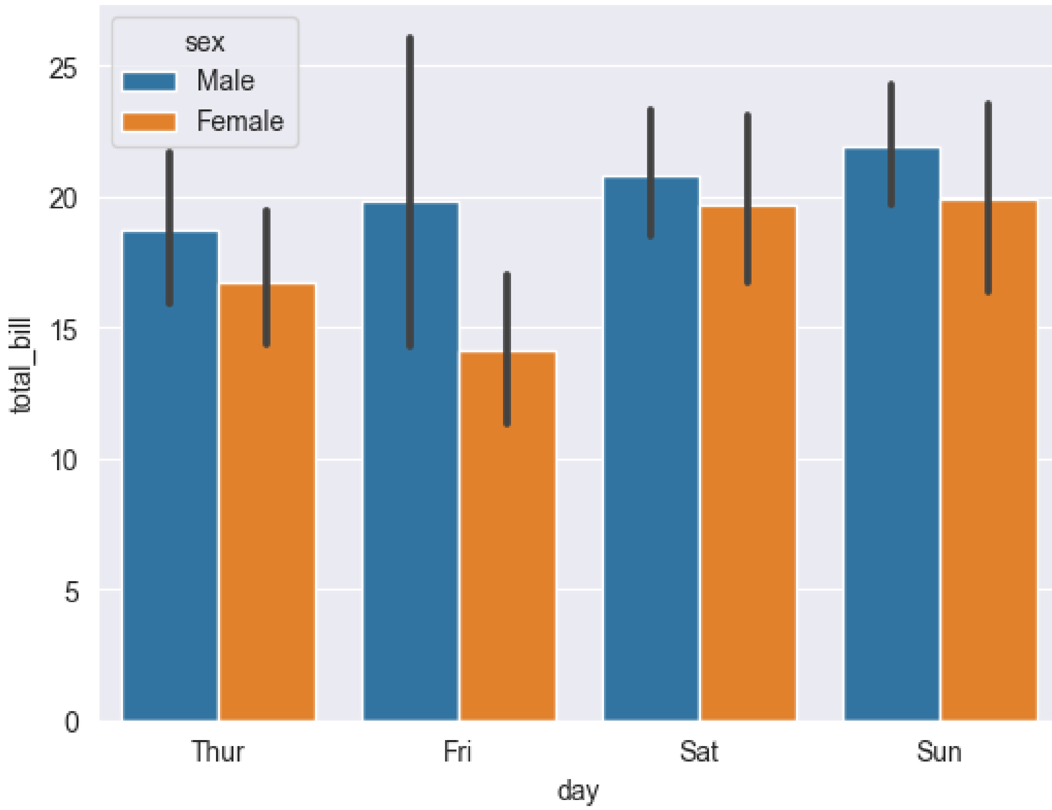


Bar Plots with Averages

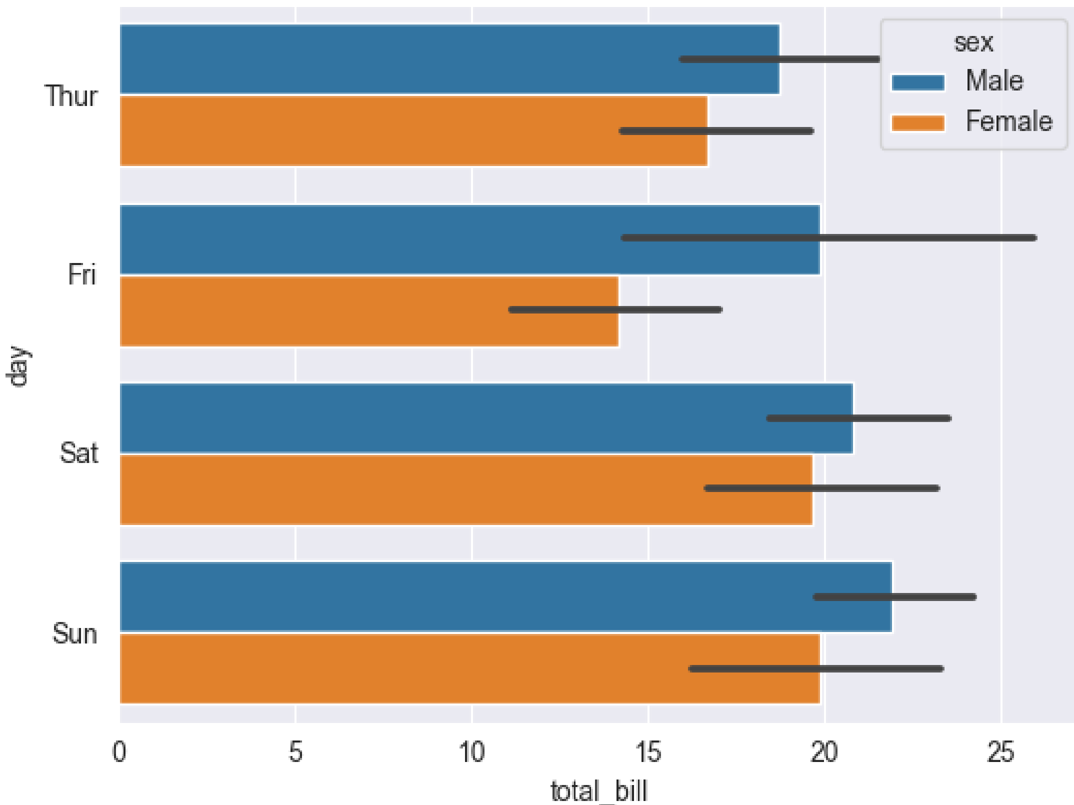
```
tips_df = sns.load_dataset("tips");

sns.barplot(x='day', y='total_bill', data=tips_df);

D:\gami\anac\Lib\site-packages\seaborn\categorical.py:641:
FutureWarning: The default of observed=False is deprecated and will be
changed to True in a future version of pandas. Pass observed=False to
retain current behavior or observed=True to adopt the future default
and silence this warning.
  grouped_vals = vals.groupby(grouper)
```




```
sns.barplot(x='day', y='total_bill', hue='sex', data=tips_df);

D:\gami\anac\Lib\site-packages\seaborn\categorical.py:641:
FutureWarning: The default of observed=False is deprecated and will be
changed to True in a future version of pandas. Pass observed=False to
retain current behavior or observed=True to adopt the future default
and silence this warning.
  grouped_vals = vals.groupby(grouper)
```




```
sns.barplot(x='total_bill', y='day', hue='sex', data=tips_df);

D:\gami\anac\Lib\site-packages\seaborn\categorical.py:641:
FutureWarning: The default of observed=False is deprecated and will be
changed to True in a future version of pandas. Pass observed=False to
retain current behavior or observed=True to adopt the future default
and silence this warning.
  grouped_vals = vals.groupby(grouper)
```

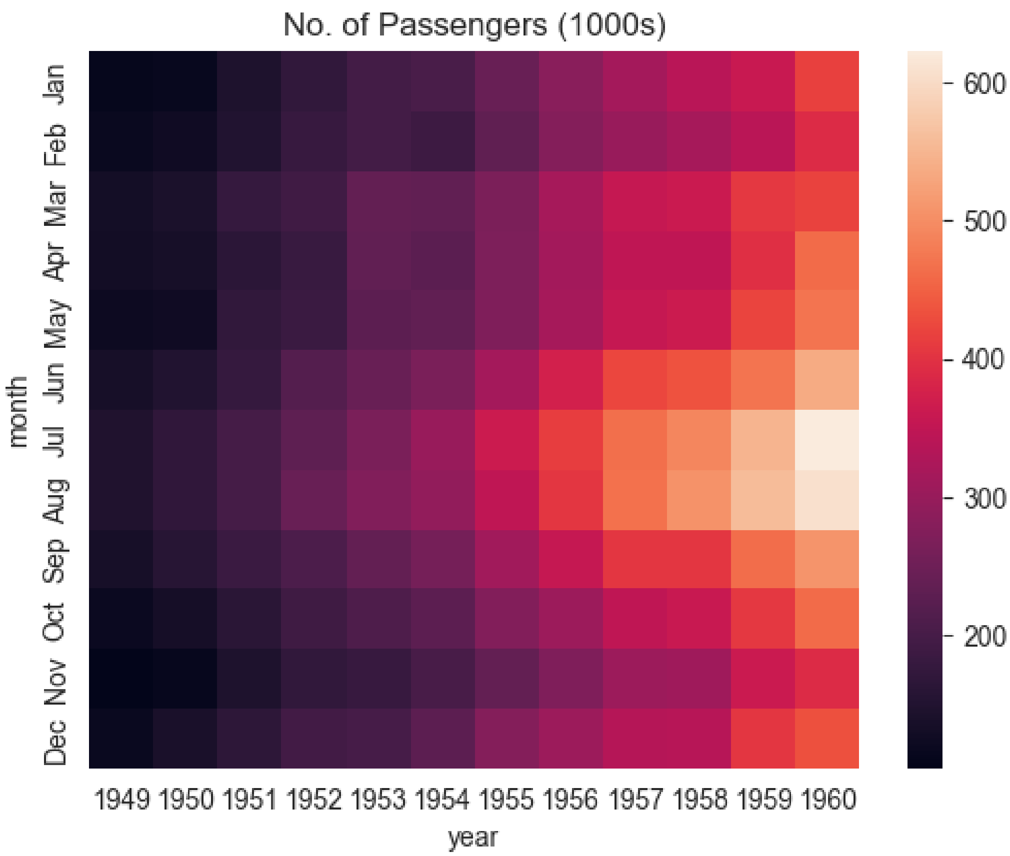


heatmap

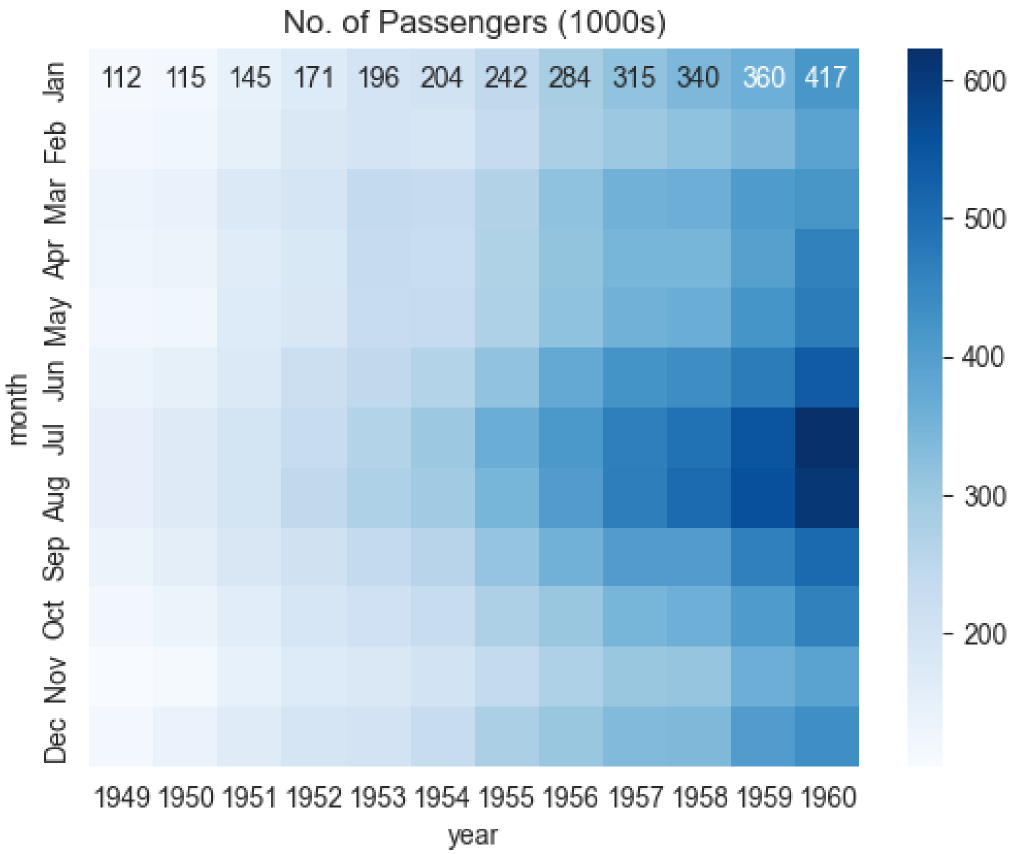
```
flights_df = sns.load_dataset("flights").pivot(index = "month",
columns = "year",values ="passengers")
flights_df # please learn pivot
```

```
year   1949  1950  1951  1952  1953  1954  1955  1956  1957  1958
1959  1960
month

Jan     112   115   145   171   196   204   242   284   315   340
360   417
Feb     118   126   150   180   196   188   233   277   301   318
342   391
Mar     132   141   178   193   236   235   267   317   356   362
406   419
Apr     129   135   163   181   235   227   269   313   348   348
396   461
May     121   125   172   183   229   234   270   318   355   363
420   472
Jun     135   149   178   218   243   264   315   374   422   435
472   535
Jul     148   170   199   230   264   302   364   413   465   491
```

```
548   622
Aug     148   170   199   242   272   293   347   405   467   505
559   606
Sep     136   158   184   209   237   259   312   355   404   404
463   508
Oct     119   133   162   191   211   229   274   306   347   359
407   461
Nov     104   114   146   172   180   203   237   271   305   310
362   390
Dec     118   140   166   194   201   229   278   306   336   337
405   432

plt.title("No. of Passengers (1000s)")
sns.heatmap(flights_df);
```




```
plt.title("No. of Passengers (1000s)")
sns.heatmap(flights_df, fmt="d", annot=True, cmap='Blues');
```


No. of Passengers (1000s)
112 115 145 171 196 204 242 284 315 340 360 417
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
month
1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960
year
600
500
400
300
200