Visual exploratory data analysis

PANDAS FOUNDATIONS

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The iris data set

Famous data set in pattern recognition

- 150 observations, 4 features each
- Sepal length
- Sepal width
- Petal length
- Petal width
- 3 species: setosa, versicolor, virginica

[1] Source: R.A. Fisher, Annual Eugenics, 7, Part II, 179-188 (1936)
(http://archive.ics.uci.edu/ml/datasets/Iris)

Data import

```
import pandas as pd
import matplotlib.pyplot as plt
iris = pd.read_csv('iris.csv', index_col=0)
print(iris.shape)
```

```
(150, 5)
```

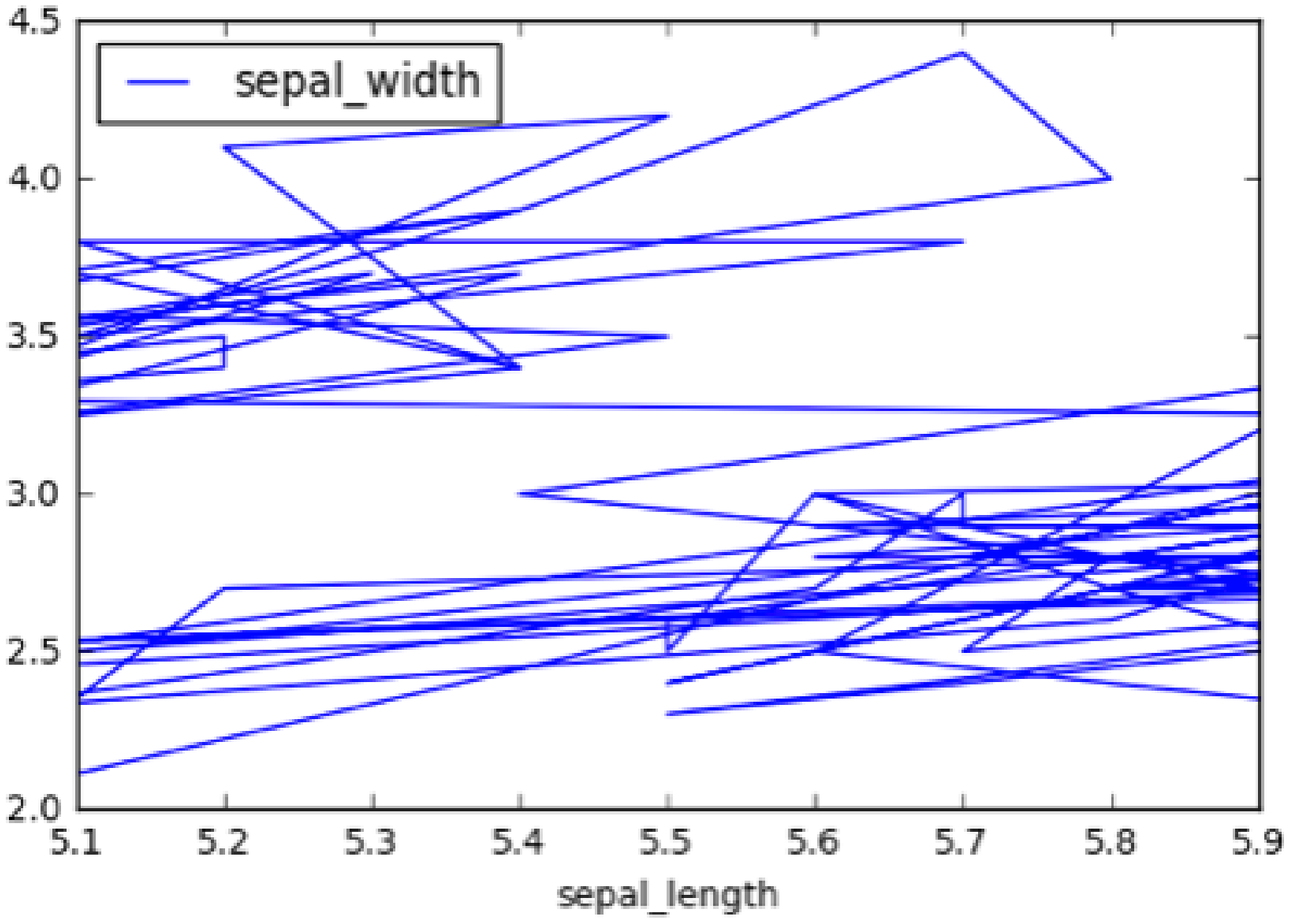
Line plot

```
iris.head()
```

```
   sepal_length  sepal_width  petal_length  petal_width species
0           5.1          3.5           1.4          0.2  setosa
1           4.9          3.0           1.4          0.2  setosa
2           4.7          3.2           1.3          0.2  setosa
3           4.6          3.1           1.5          0.2  setosa
4           5.0          3.6           1.4          0.2  setosa
```

```
iris.plot(x='sepal_length', y='sepal_width')
plt.show()
```

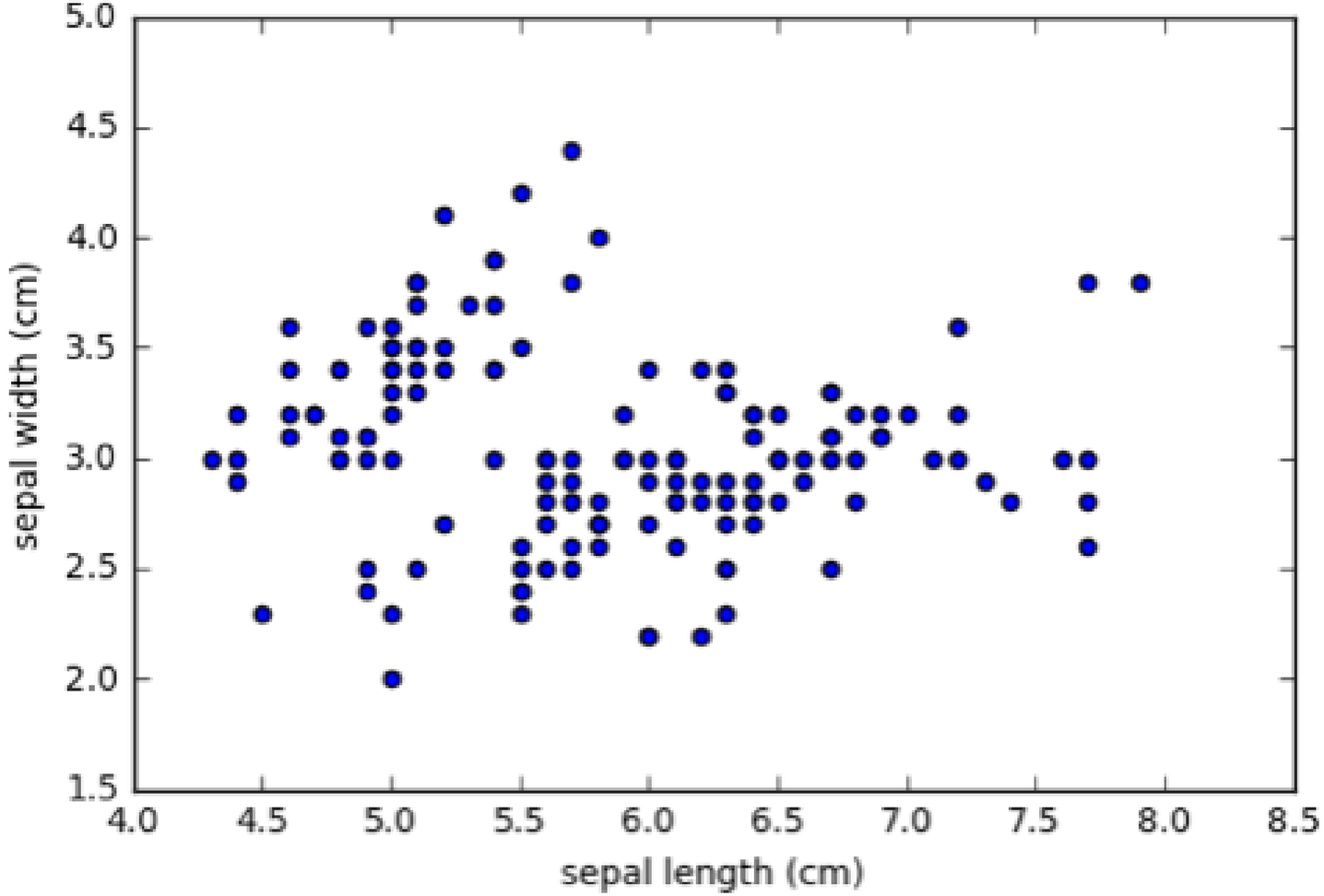
Line plot


sepal_width
4.5
4.0
3.5
3.0
2.5
2.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
sepal_length

Scatter plot

```
iris.plot(x='sepal_length', y='sepal_width',
                kind='scatter')
plt.xlabel('sepal length (cm)')
plt.ylabel('sepal width (cm)')
plt.show()
```

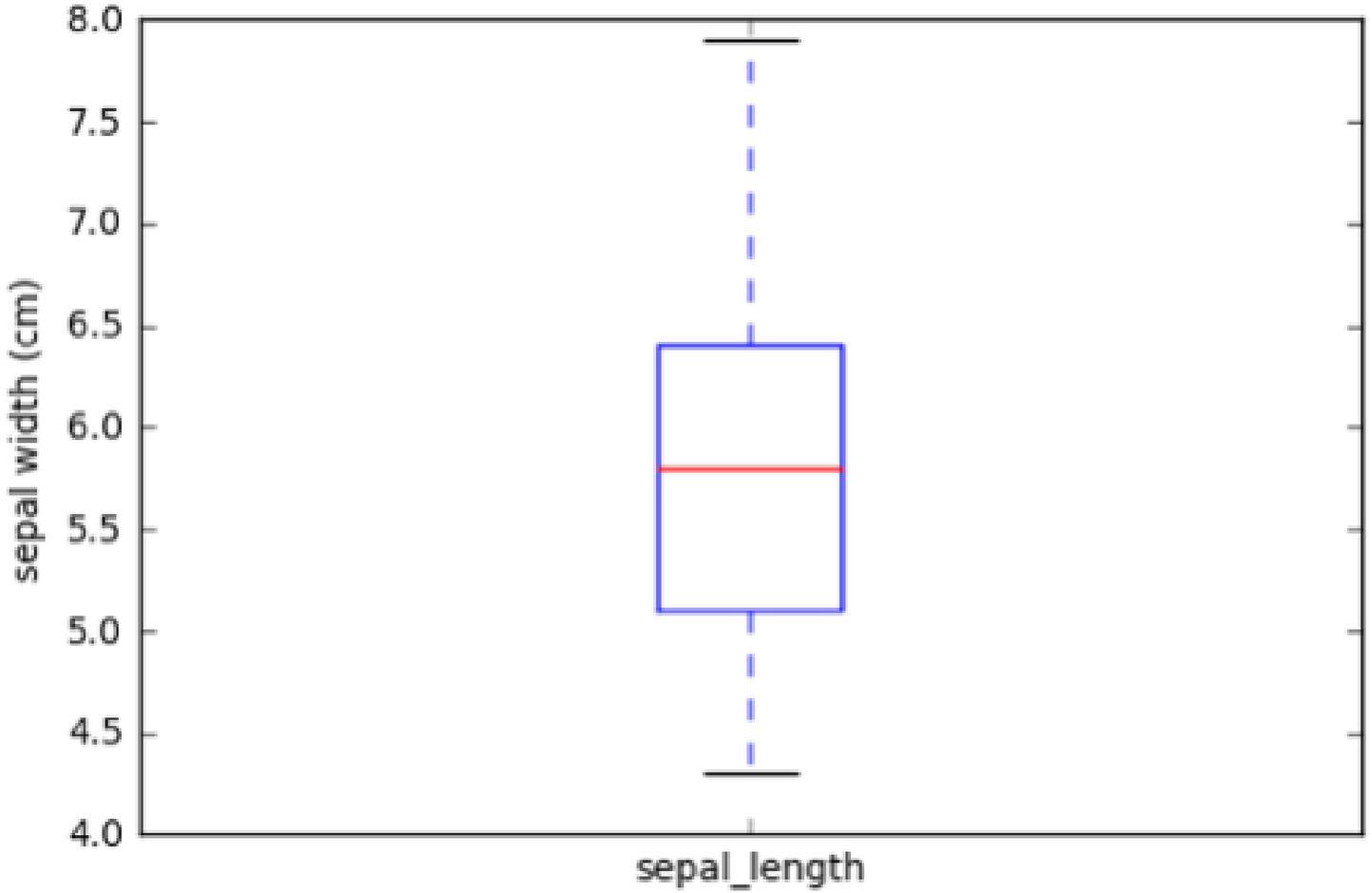
Scatter plot



Box plot

```
iris.plot(y='sepal_length', kind='box')
plt.ylabel('sepal width (cm)')
plt.show()
```

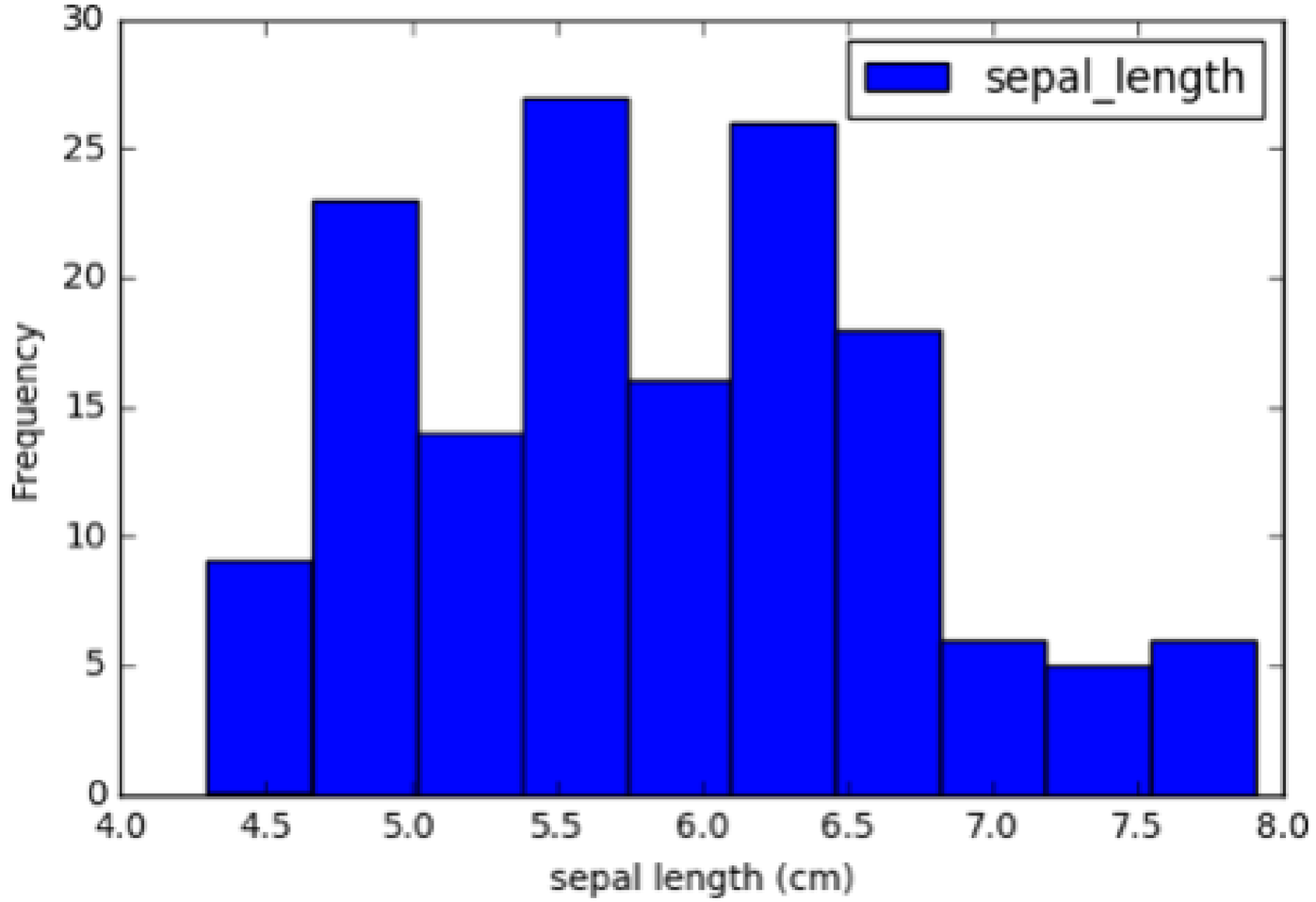
Box plot



Histogram

```
iris.plot(y='sepal_length', kind='hist')
plt.xlabel('sepal length (cm)')
plt.show()
```

Histogram


sepal_length
Frequency
sepal length (cm)
0
5
10
15
20
25
30
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0

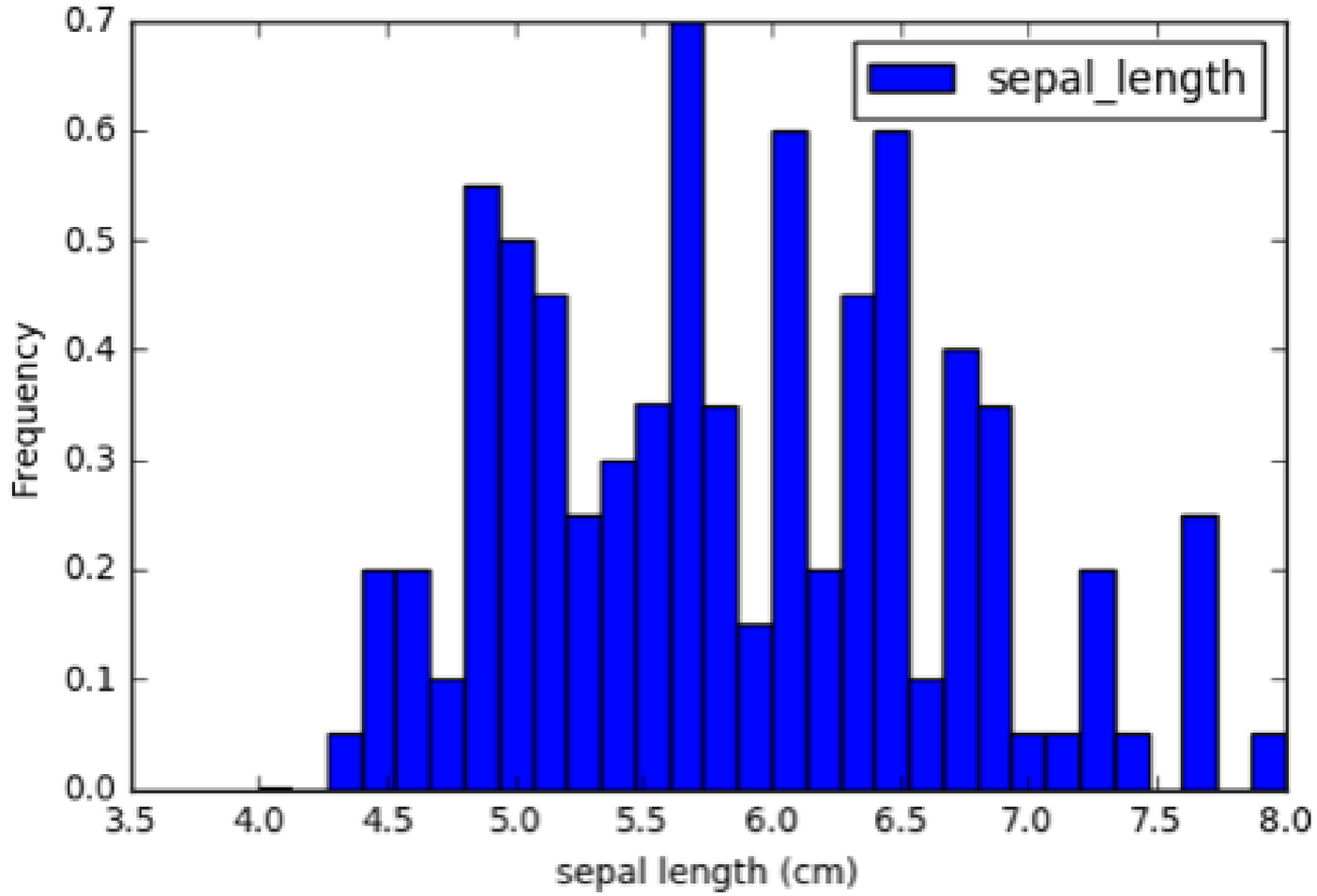
Histogram options

- bins (integer): number of intervals or bins
- range (tuple): extrema of bins (minimum, maximum)
- normed (boolean): whether to normalize to one
- cumulative (boolean): compute Cumulative Distribution Function (CDF)
- ... more matplotlib customizations

Customizing histogram

```
iris.plot(y='sepal_length', kind='hist',
                bins=30, range=(4,8), normed=True)
plt.xlabel('sepal length (cm)')
plt.show()
```

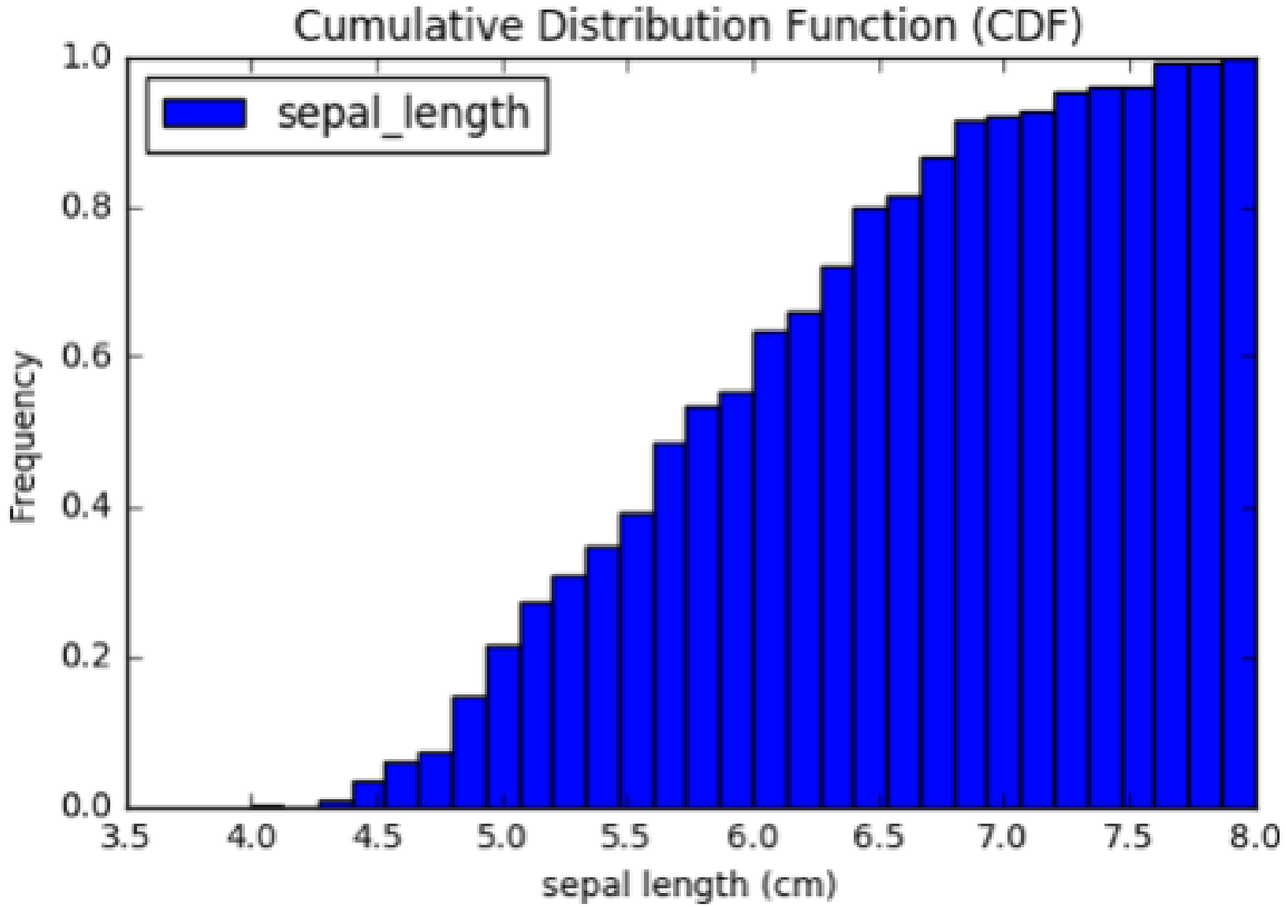
Customizing histogram



Cumulative distribution

```
iris.plot(y='sepal_length', kind='hist', bins=30,
                range=(4,8), cumulative=True, normed=True)
plt.xlabel('sepal length (cm)')
plt.title('Cumulative distribution function (CDF)')
plt.show()
```

Cumulative distribution



Word of warning

- Three different DataFrame plot idioms
  - iris.plot(kind='hist')
  - iris.plt.hist()
  - iris.hist()
- Syntax/results differ!
- Pandas API still evolving: check documentation!

Let's practice!

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Statistical exploratory data analysis

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datacamp

Summarizing with describe()

```
iris.describe() # summary statistics
```

```
       sepal_length  sepal_width  petal_length  petal_width
count    150.000000   150.000000    150.000000   150.000000
mean       5.843333     3.057333      3.758000     1.199333
std        0.828066     0.435866      1.765298     0.762238
min        4.300000     2.000000      1.000000     0.100000
25%        5.100000     2.800000      1.600000     0.300000
50%        5.800000     3.000000      4.350000     1.300000
75%        6.400000     3.300000      5.100000     1.800000
max        7.900000     4.400000      6.900000     2.500000
```

Describe

- count: number of entries
- mean: average of entries
- std: standard deviation
- min: minimum entry
- 25%: first quartile
- 50%: median or second quartile
- 75%: third quartile
- max: maximum entry

Counts

```
iris['sepal_length'].count() # Applied to Series
```

```
150
```

```
iris['sepal_width'].count() # Applied to Series
```

```
150
```

```
iris[['petal_length', 'petal_width']].count() # Applied to DataFrame
```

```
petal_length    150
petal_width     150
dtype: int64
```

```
type(iris[['petal_length', 'petal_width']].count()) # returns Series
```

```
pandas.core.series.Series
```

Averages

```
iris['sepal_length'].mean() # Applied to Series
```

```
5.843333333333335
```

```
iris.mean() # Applied to entire DataFrame
```

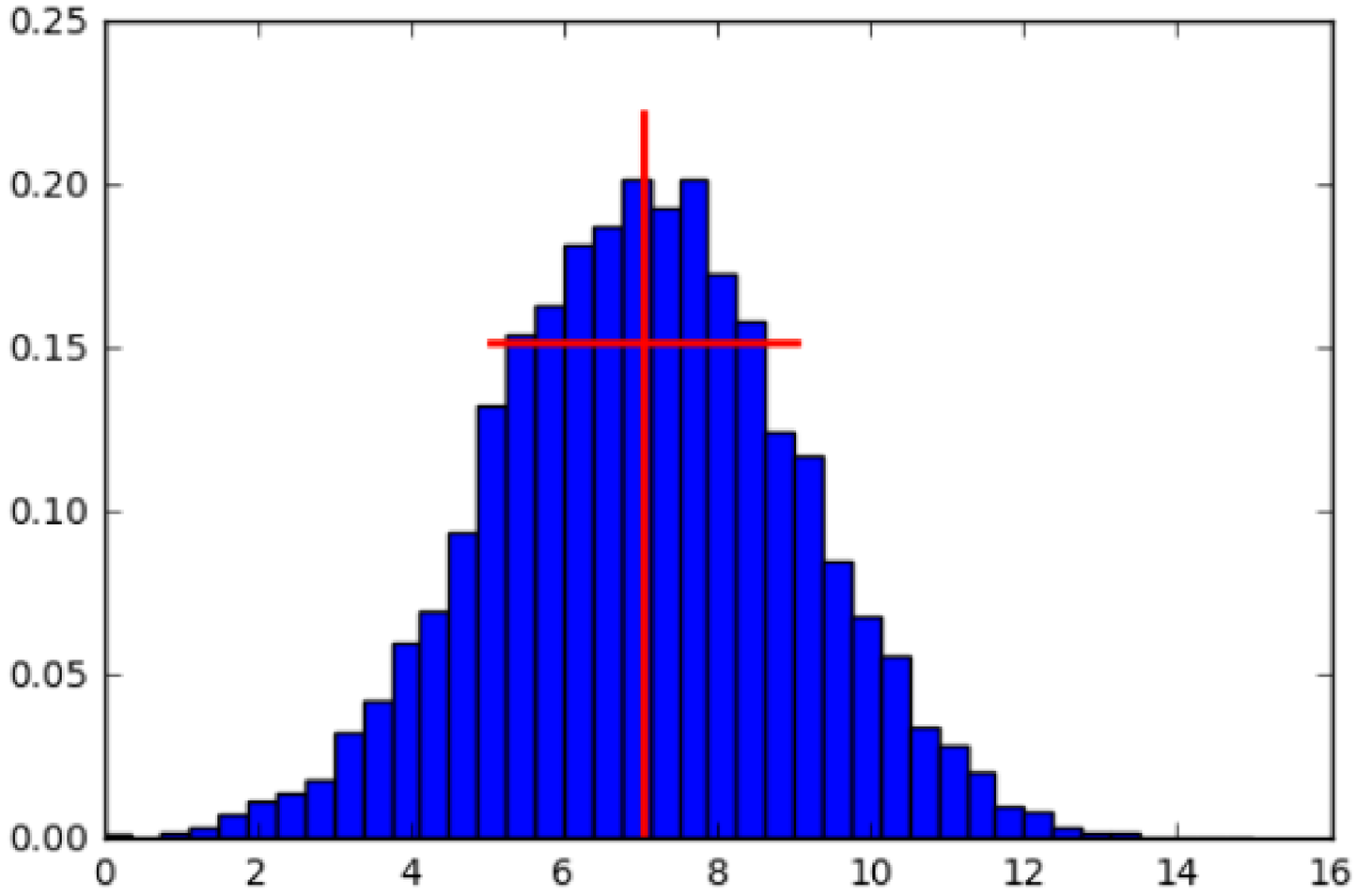
```
sepal_length    5.843333
sepal_width     3.057333
petal_length    3.758000
petal_width     1.199333
dtype: float64
```

Standard deviations

```
iris.std()
```

```
sepal_length    0.828066
sepal_width     0.435866
petal_length    1.765298
petal_width     0.762238
dtype: float64
```

Mean and standard deviation on a bell curve



Medians

```
iris.median()
```

```
sepal_length    5.80
sepal_width     3.00
petal_length    4.35
petal_width     1.30
dtype: float64
```

Medians & 0.5 quantiles

```
iris.median()
```

```
sepal_length    5.80
sepal_width     3.00
petal_length    4.35
petal_width     1.30
dtype: float64
```

```
q = 0.5
iris.quantile(q)
```

```
sepal_length    5.80
sepal_width     3.00
petal_length    4.35
petal_width     1.30
dtype: float64
```

Inter-quartile range (IQR)

```
q = [0.25, 0.75]
iris.quantile(q)
```

```
      sepal_length  sepal_width  petal_length  petal_width
0.25           5.1          2.8           1.6          0.3
0.75           6.4          3.3           5.1          1.8
```

Ranges

```
iris.min()
```

```
sepal_length       4.3
sepal_width          2
petal_length         1
petal_width        0.1
species         setosa
dtype: object
```

```
iris.max()
```

```
sepal_length          7.9
sepal_width           4.4
petal_length          6.9
petal_width           2.5
species         virginica
dtype: object
```

Box plots

```
iris.plot(kind= 'box')
```

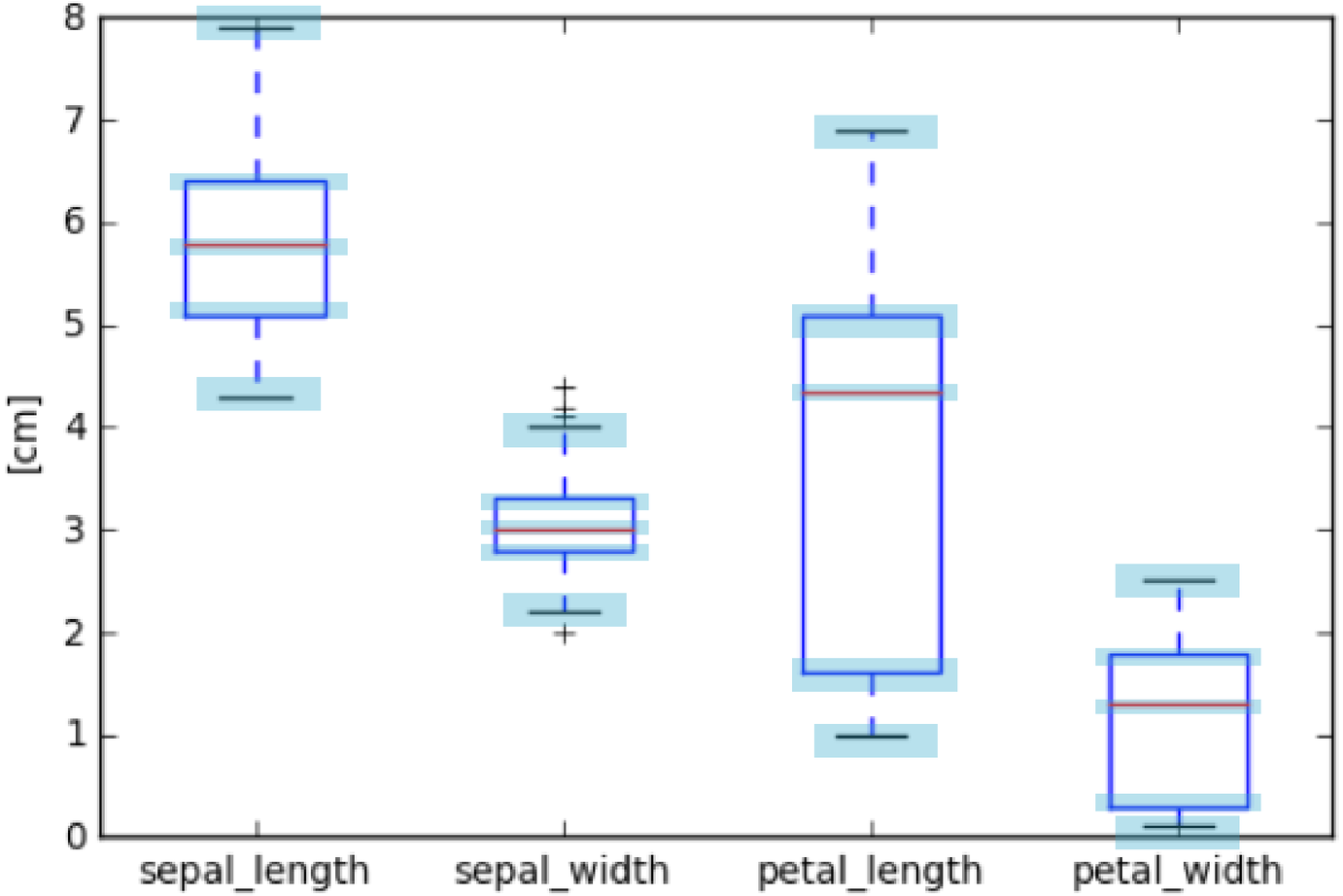
```
<matplotlib.axes._subplots.AxesSubplot at 0x118a3d5f8>
```

```
plt.ylabel('[cm]')
```

```
<matplotlib.text.Text at 0x118a524e0>
```

```
plt.show()
```

Box plots


8
7
6
5
4
3
2
1
0
[cm]
sepal_length
sepal_width
petal_length
petal_width

Percentiles as quantiles

```
iris.describe() # summary statistics
```

```
       sepal_length  sepal_width  petal_length  petal_width
count    150.000000   150.000000    150.000000   150.000000
mean       5.843333     3.057333      3.758000     1.199333
std        0.828066     0.435866      1.765298     0.762238
min        4.300000     2.000000      1.000000     0.100000
25%        5.100000     2.800000      1.600000     0.300000
50%        5.800000     3.000000      4.350000     1.300000
75%        6.400000     3.300000      5.100000     1.800000
max        7.900000     4.400000      6.900000     2.500000
```

Let's practice!

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Separating populations

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```
iris.head()
```

```
   sepal_length  sepal_width  petal_length  petal_width species
0           5.1          3.5           1.4          0.2  setosa
1           4.9          3.0           1.4          0.2  setosa
2           4.7          3.2           1.3          0.2  setosa
3           4.6          3.1           1.5          0.2  setosa
4           5.0          3.6           1.4          0.2  setosa
```

Describe species column

```
iris['species'].describe()
```

```
count           150
unique            3
top          setosa
freq             50
Name: species, dtype: object
```

- count: # non-null entries
- unique: # distinct values
- top: most frequent category
- freq: # occurrences of top

Unique & factors

```
iris['species'].unique()
```

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

Filtering by species

```
indices = iris['species'] == 'setosa'
setosa = iris.loc[indices,:] # extract new DataFrame
indices = iris['species'] == 'versicolor'
versicolor = iris.loc[indices,:] # extract new DataFrame
indices = iris['species'] == 'virginica'
virginica = iris.loc[indices,:] # extract new DataFrame
```

Checking species

```
setosa['species'].unique()
```

```
array(['setosa'], dtype=object)
```

```
versicolor['species'].unique()
```

```
array(['versicolor'], dtype=object)
```

```
virginica['species'].unique()
```

```
array(['virginica'], dtype=object)
```

```
del setosa['species'], versicolor['species'],
    virginica['species']
```

Checking indexes

```
setosa.head(2)
```

```
   sepal_length  sepal_width  petal_length  petal_width
0           5.1          3.5           1.4          0.2
1           4.9          3.0           1.4          0.2
```

```
versicolor.head(2)
```

```
    sepal_length  sepal_width  petal_length  petal_width
50           7.0          3.2           4.7          1.4
51           6.4          3.2           4.5          1.5
```

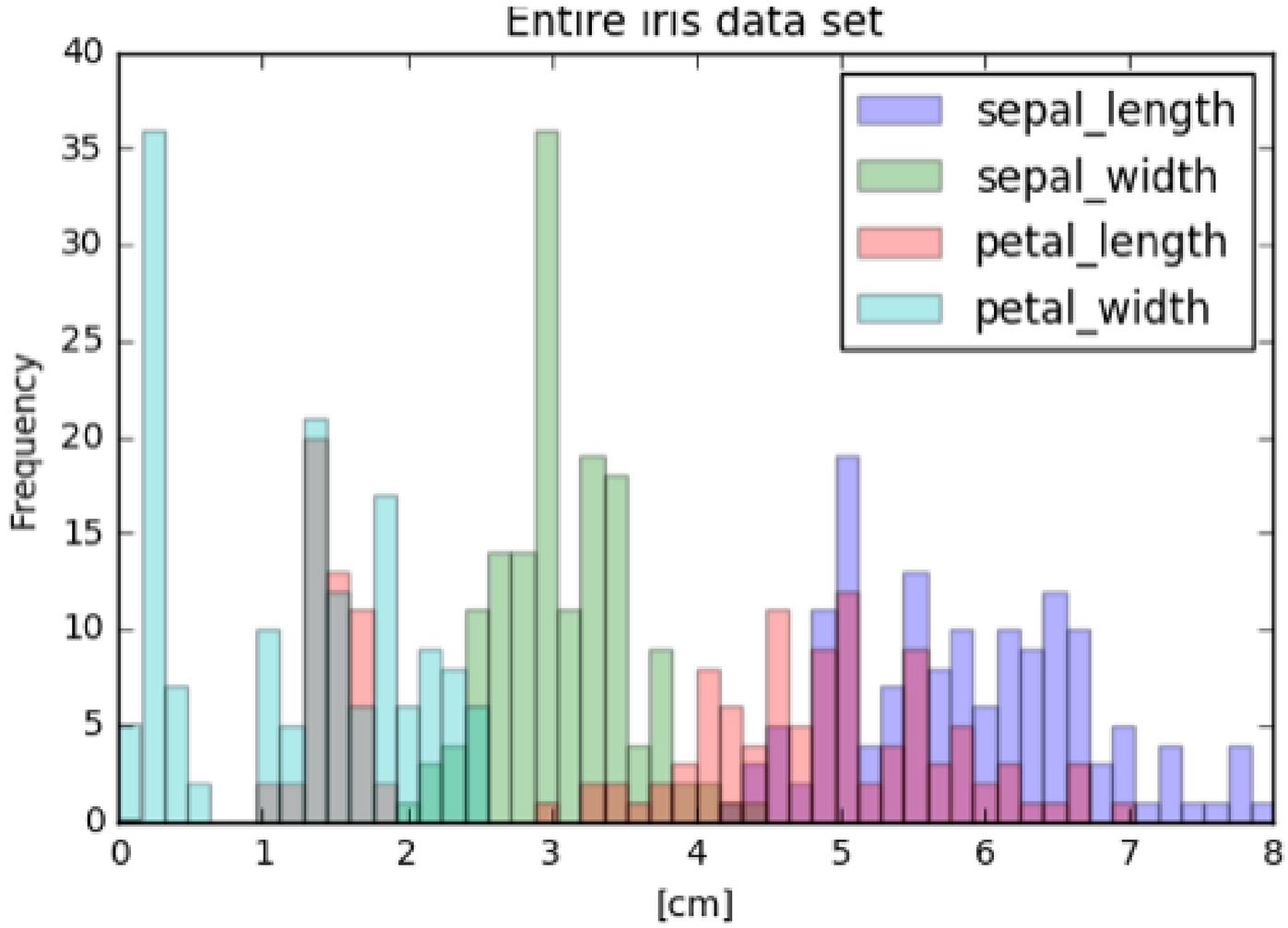
```
versicolor.head(2)
```

```
     sepal_length  sepal_width  petal_length  petal_width
100           6.3          3.3           6.0          2.5
101           5.8          2.7           5.1          1.9
```

Visual EDA: all data

```
iris.plot(kind= 'hist', bins=50, range=(0,8), alpha=0.3)
plt.title('Entire iris data set')
plt.xlabel('[cm]')
plt.show()
```

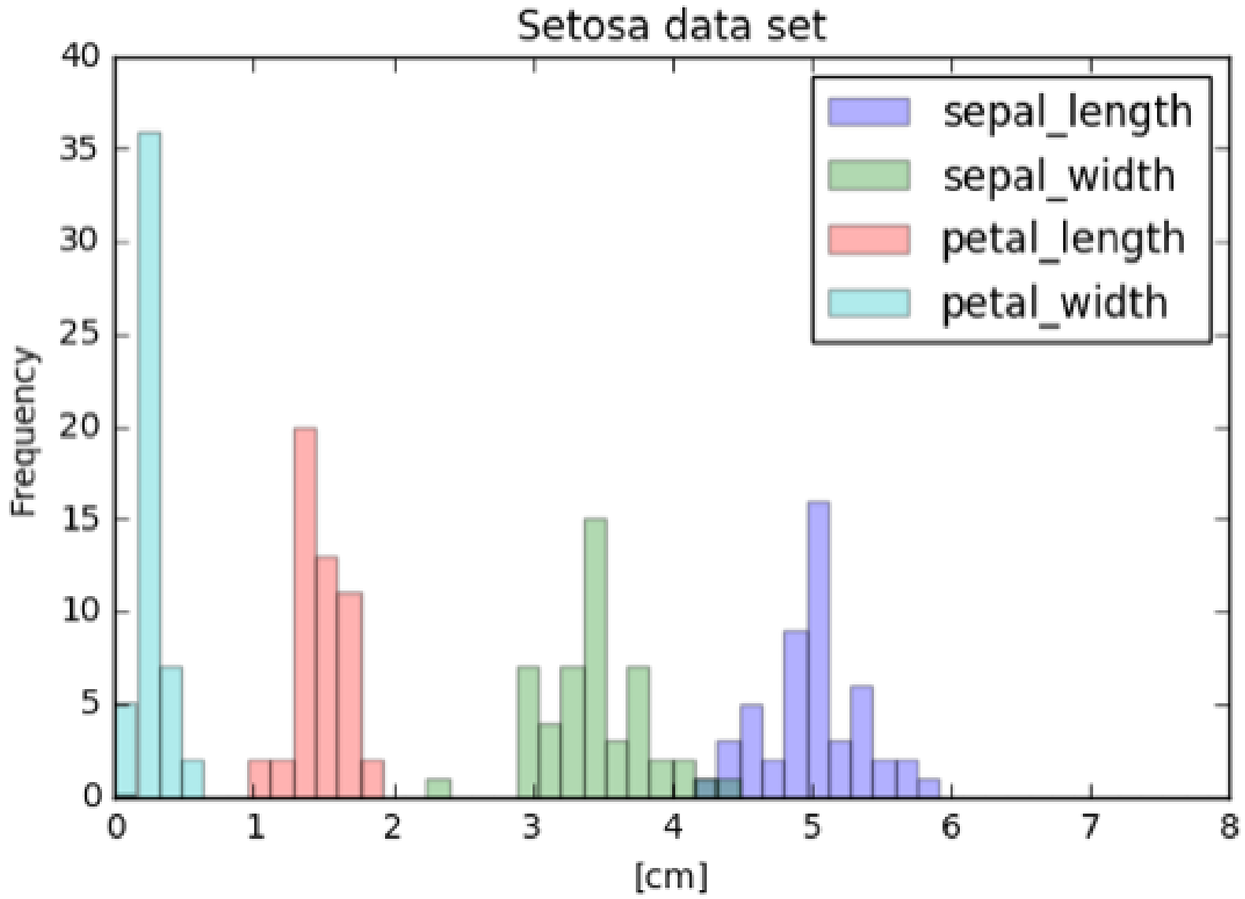
Visual EDA: all data



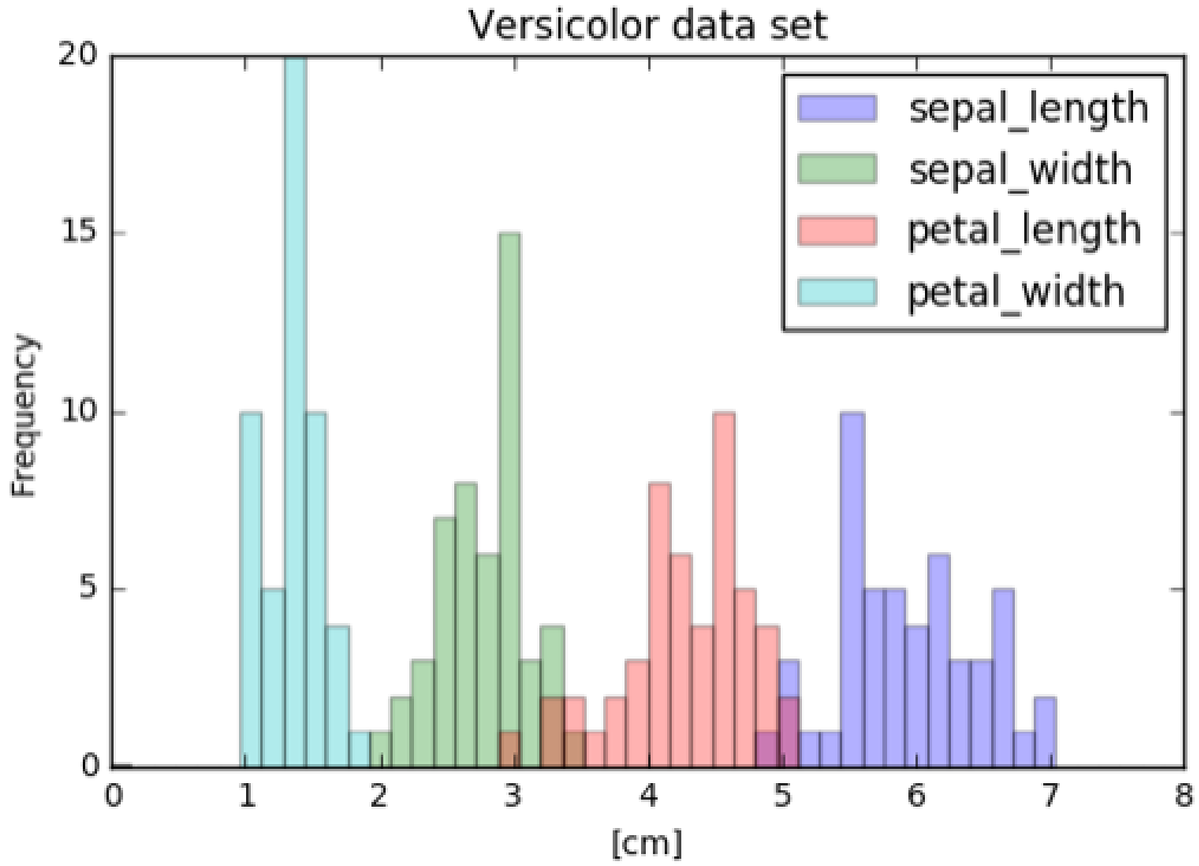
Visual EDA: individual factors

```
setosa.plot(kind='hist', bins=50, range=(0,8), alpha=0.3)
plt.title('Setosa data set')
plt.xlabel('[cm]')

versicolor.plot(kind='hist', bins=50, range=(0,8), alpha=0.3)
plt.title('Versicolor data set')
plt.xlabel('[cm]')

virginica.plot(kind='hist', bins=50, range=(0,8), alpha=0.3)
plt.title('Virginica data set')
plt.xlabel('[cm]')

plt.show()
```

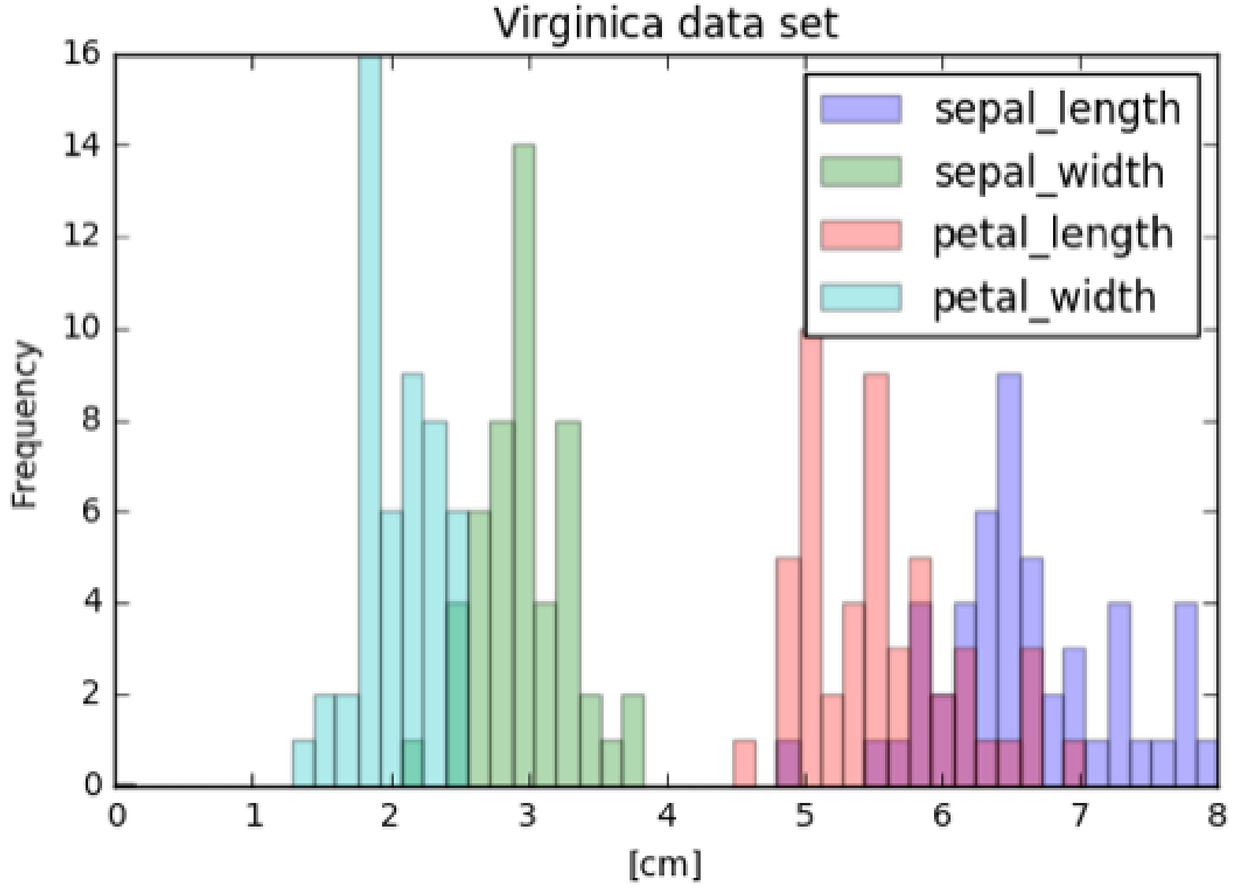
Visual EDA: Setosa data



Visual EDA: Versicolor data



Visual EDA: Virginica data



Statistical EDA: describe()

```
describe_all = iris.describe()
print(describe_all)
```

```
       sepal_length  sepal_width  petal_length  petal_width
count    150.000000   150.000000    150.000000   150.000000
mean       5.843333     3.057333      3.758000     1.199333
std        0.828066     0.435866      1.765298     0.762238
min        4.300000     2.000000      1.000000     0.100000
25%        5.100000     2.800000      1.600000     0.300000
50%        5.800000     3.000000      4.350000     1.300000
75%        6.400000     3.300000      5.100000     1.800000
max        7.900000     4.400000      6.900000     2.500000
```

```
describe_setosa = setosa.describe()
describe_versicolor = versicolor.describe()
describe_virginica = virginica.describe()
```

Computing errors

```
error_setosa = 100 * np.abs(describe_setosa - describe_all)
error_setosa = error_setosa/describe_setosa

error_versicolor = 100 * np.abs(describe_versicolor - describe_all)
error_versicolor = error_versicolor/describe_versicolor

error_virginica = 100 * np.abs(describe_virginica - describe_all)
error_virginica = error_verginica/describe_virginica
```

Viewing errors

```
print(error_setosa)
```

```
       sepal_length  sepal_width  petal_length  petal_width
count    200.000000   200.000000    200.000000   200.000000
mean      16.726595    10.812913    157.045144   387.533875
std      134.919250    14.984768    916.502136   623.284534
min        0.000000    13.043478      0.000000     0.000000
25%        6.250000    12.500000     14.285714    50.000000
50%       16.000000    11.764706    190.000000   550.000000
75%       23.076923    10.204082    223.809524   500.000000
max       36.206897     0.000000    263.157895   316.666667
```

Let's practice!

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