This jupyter notebook and the associated gradient descent class do linear regression using the gradient descent method.

In [9]:
```
import sys
import os

import matplotlib.pyplot as plt
from matplotlib import cm

import numpy as np
import pandas as pd

from sklearn.preprocessing import StandardScaler
import statsmodels.api as sm
```

In [10]:
```
# Get the absolute path of the current file
try:
    # Works in .py scripts
    current_dir = os.path.dirname(os.path.abspath(__file__))
except NameError:
    # Fallback for Jupyter
    current_dir = os.getcwd()

# Go up N levels (here N=2, but you can adjust)
# project_root = os.path.abspath(os.path.join(current_dir, "..", ".."))
project_root = os.path.abspath(os.path.join(current_dir, ".."))

# Add the project root to sys.path if not already there
if project_root not in sys.path:
    sys.path.insert(0, project_root)
```

In [11]:
```
from ML_toolbox import d_lm_analytical_solution_class
from ML_toolbox import d_mlr_gradient_descent_class
```

In [12]:
```
# specify parameters for gradient descent
delta_J_threshold = 0.000001
learning_rate = 0.001
```

In [13]:
```
in_file_name = "../../data/linear_regression_test_data.csv"
data_in_df = pd.read_csv(in_file_name)
data_in_df.head()
```

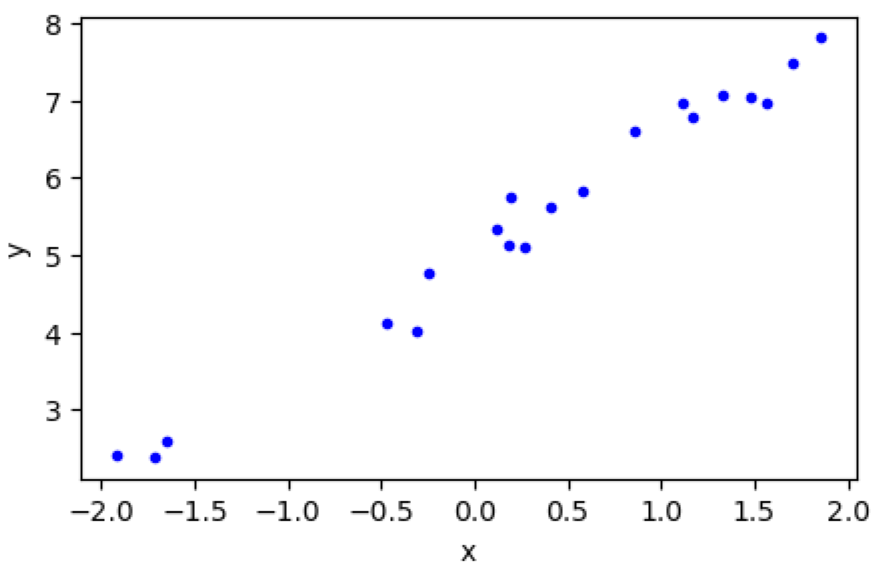
Out[13]:

	x	y	y_theoretical
0	-1.919126	2.420126	2.121310
1	-1.715856	2.385185	2.426216
2	-1.651483	2.585389	2.522776
3	-0.466234	4.129830	4.300649
4	-0.305381	4.031331	4.541929

In [14]:
```
# x_name = ['size', 'number of bedrooms']
x_name = ['x']
y_name = ['y']

variable_to_plot = ['x']
```

In [15]:
```
fig, ax = plt.subplots(figsize=(5,3))
ax.scatter(data_in_df[variable_to_plot], data_in_df[y_name], marker='.', col
ax.set_xlabel(variable_to_plot[0])
ax.set_ylabel(y_name[0])
```

Out[15]: Text(0, 0.5, 'y')



In [16]:
```
# normalize variables to make them have similar scale
standard_scaler_obj = StandardScaler()
standard_scaler_obj.fit(data_in_df[x_name + y_name])

mean_needed_df = pd.Series(standard_scaler_obj.mean_, index=x_name + y_name)
scale_needed_df = pd.Series(standard_scaler_obj.scale_, index=x_name + y_nam

data_normalized_df = pd.DataFrame(standard_scaler_obj.transform(data_in_df[x
                                  index=data_in_df.index, \
                                  columns=x_name + y_name)
```

In [17]:
```
# get information on x (single variable) and y
X = data_normalized_df[x_name]
```

```
y = data_normalized_df[y_name]

# augment X0
X = sm.add_constant(X)

number_of_variables = X.shape[1]

 # including X0
initial_theta = np.zeros((number_of_variables, 1))
```

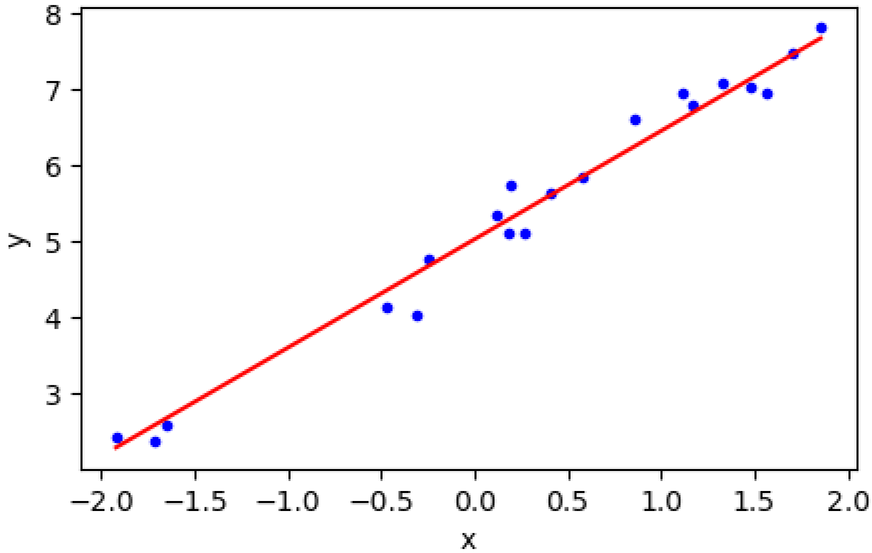
In [18]:
```
delta_J_threshold
initial_theta
learning_rate
```

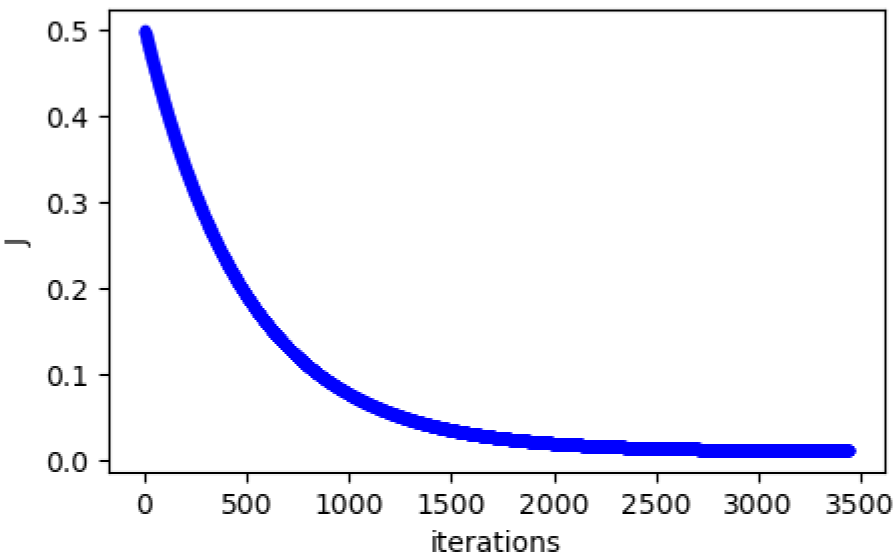
Out[18]: 0.001

In [19]:
```
# gradient descent
obj_MLR = d_mlr_gradient_descent_class.MLR(delta_J_threshold=delta_J_thresho
                                               initial_theta=initial_theta,
                                               learning_rate=learning_rate)


obj_MLR.fit(X=X, y=y)
optimal_theta = obj_MLR.optimal_theta
J = obj_MLR.J
```

In [20]:
```
y_hat = X @ optimal_theta

# restore y_hat to the original data space
y_hat_restored = y_hat * scale_needed_df[y_name][y_name].values + mean_neede


fig, ax = plt.subplots(figsize=(5,3))
ax.scatter(data_in_df[variable_to_plot], data_in_df[y_name], marker='.', col
ax.plot(data_in_df[variable_to_plot], y_hat_restored, color='red')
ax.set_xlabel(variable_to_plot[0])
ax.set_ylabel(y_name[0])


fig, ax = plt.subplots(figsize=(5,3))
ax.scatter(range(len(J)), J, marker='.', color='blue')
ax.set_xlabel('iterations')
ax.set_ylabel('J')
```

Out[20]: Text(0, 0.5, 'J')


8
7
6
5
4
3
y
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
x


0.5
0.4
0.3
0.2
0.1
0.0
J
0
500
1000
1500
2000
2500
3000
3500
iterations

In [ ]: