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1 contributor

239 lines (239 sloc) 820 KB

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Assignment 03. Visualization of Gradient Descent algorithm based on Linear Regression problem - 20145822 김영현

1. Input points

- Refer to the load CSV file code of the task requirement.

2. Linear regression result

- Iteration code and operation functions are taken from assignment02 and used.

3. Plot the energy surface

- Set the section of [-30: 0.1: 30] given on the x-axis(θ_0) and y-axis(θ_1).
- Set the z-axis($J(\theta_0, \theta_1)$) by calculating the objective function at the coordinates.

4. Plot the gradient descent path on the energy surface

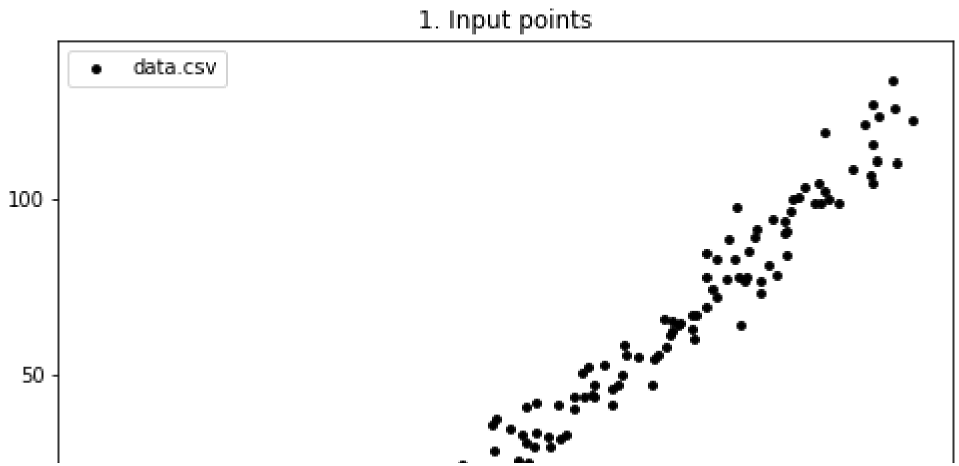
- In the same way as in assignment02, the values of θ_0, θ_1b, and $J(\theta_0, \theta_1)$ are stored and used during the iteration process.

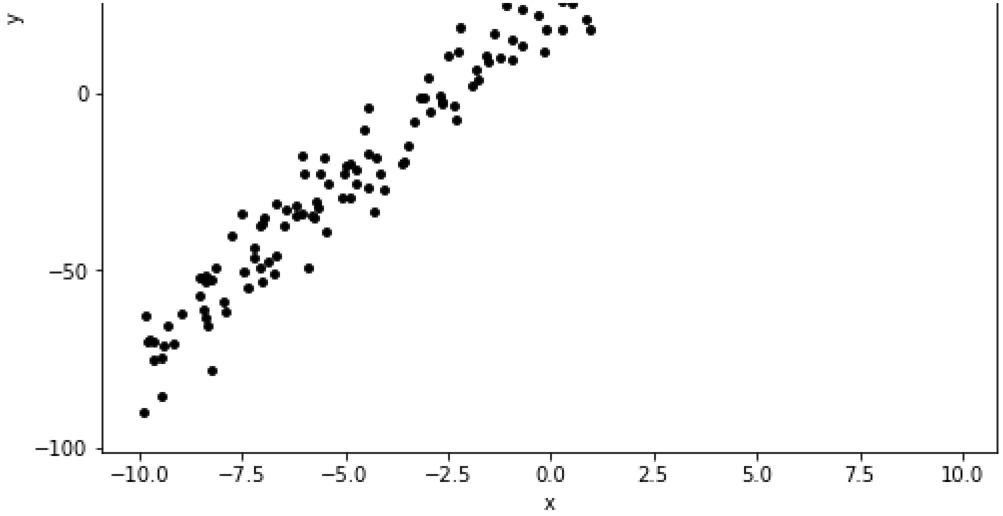
In [65]:
```
%matplotlib inline
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

# Input data file read
path = "/content/drive/My Drive/Colab Notebooks/data.csv"
data = np.genfromtxt(path, delimiter=',')
```

```
x_data = data[:, 0]
y_data = data[:, 1]
m = x_data.size

# objective_function
# calculate the cost function for each iteration
def objective_function(h, y_data, m):
  j = []
  for i in range(m):
    j.append(h[i] - y_data[i])
    j[i] = j[i] ** 2
  return sum(j)/(2*m)


# calculate next iteration's theta_0
def theta_0_desc(theta_0, h, y_data, m, alpha):
  minus = [h[i]-y_data[i] for i in range(m)]
  return theta_0 - (alpha*sum(minus)/m)


#calculate next iteration's theta_1
def theta_1_desc(theta_1, h, y_data, x_data , m, alpha):
  minus = [(h[i]-y_data[i])*x_data[i] for i in range(m)]
  return theta_1 - (alpha*sum(minus)/m)

# initial values
theta_0 = -30
theta_1 = -30
alpha = 0.0001

# lists for saving iteration data
cost = []
theta_0_list = []
theta_1_list = []

# iteration for optimizing
iteration = 0

# iteration
while True:
  h = [theta_0 + theta_1 * i for i in x_data]
  cost.append(objective_function(h,y_data,m))
```

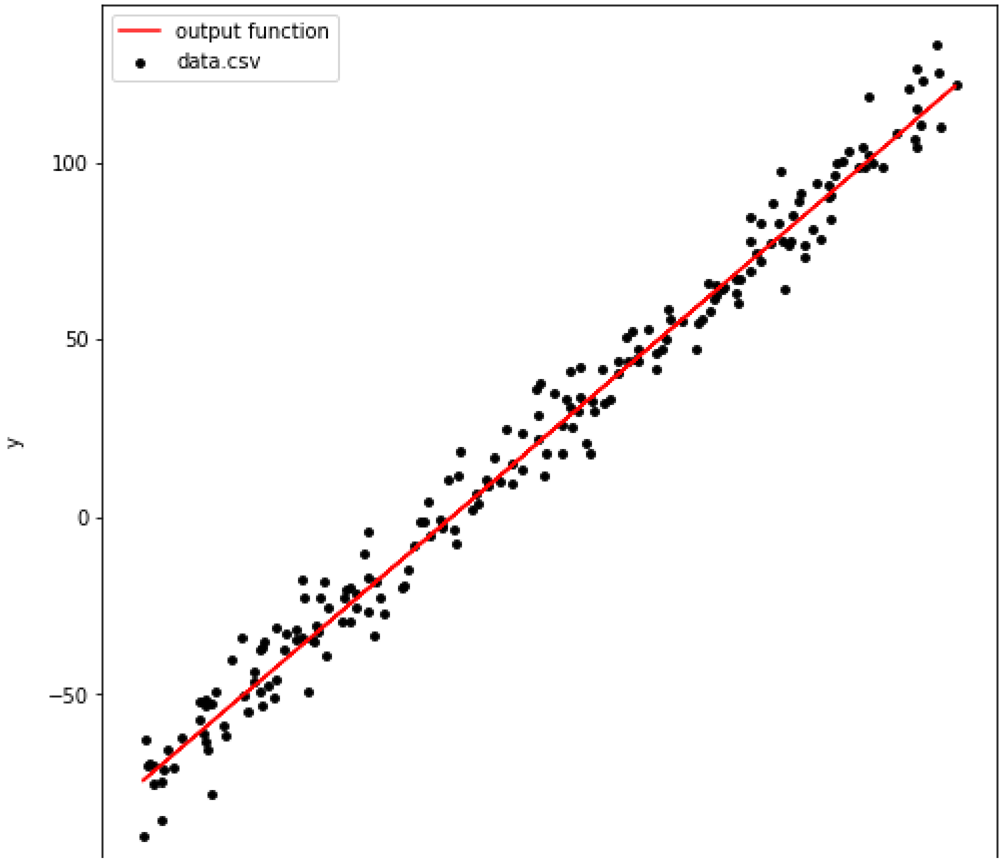
```
  theta_0_list.append(theta_0)
  theta_1_list.append(theta_1)

  # escape with error smaller than 0.0001
  if iteration > 0 :
    if cost[iteration-1] - cost[iteration] < 0.0001 :
      break

  theta_0 = theta_0_desc(theta_0, h, y_data, m, alpha)
  theta_1 = theta_1_desc(theta_1, h, y_data, x_data, m, alpha)
  iteration+= 1

# result data
regression_result = [theta_0_list[iteration] + theta_1_list[iteration] * i for i in x_data]
iterations = [i for i in range(len(cost))]

# 1. Input points
# plot a set of points that are loaded from 'data.csv' file (in black color)
plt.figure(1, figsize=(8,8))
plt.title("1. Input points")
plt.xlabel("x")
plt.ylabel("y")
plt.scatter(x_data, y_data, s=15, c='k', label="data.csv")
plt.legend()

# 2. Linear regression result
# plot a set of points that are loaded from 'data.csv' file (in black color)
# plot a straight line obtained by the optimal linear regression
# based on the given set of points (in red color)
plt.figure(2, figsize=(8,8))
plt.title("2. Linear regression result")
plt.xlabel("x")
plt.ylabel("y")
plt.plot(x_data, regression_result, c='r', label="output function")
plt.scatter(x_data, y_data, c='k', s=15, label="data.csv")
plt.legend()

# 3. Plot the energy surface
# plot the energy surface

# energy surface dataset
val = np.arange(-30, 30, 0.1)
```

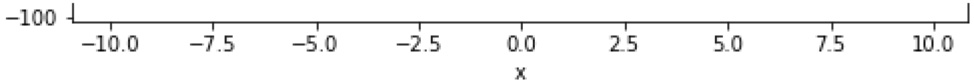
```
# meshgrid for energy surface plotting
X, Y = np.meshgrid(val, val)
z_val_list = []

# iteration for calculating z axis value
for t_one in list(val):
  for t_zero in list(val):
    h= [t_zero + t_one * i for i in x_data]
    z_val_list.append(objective_function(h,y_data,m))

z_val = np.array(z_val_list)
Z = z_val.reshape(X.shape)

fig = plt.figure(3, figsize=(15,15))
ax = fig.gca(projection='3d')
plt.title("3. Plot the energy surface")
surf = ax.plot_surface(X, Y, Z, cmap='viridis', zorder=0)
ax.view_init(30,45)

# 4. Plot the gradient descent path on the energy surface
fig = plt.figure(4, figsize=(15,15))
ax = fig.gca(projection='3d')
plt.title("4. Plot the gradient descent path on the energy surface")
surf = ax.plot_surface(X, Y, Z, cmap='viridis', zorder=0)
ax.plot(theta_0_list, theta_1_list, cost, c='r', linewidth = 3, zorder=3)
ax.view_init(30,45)

plt.show()
```

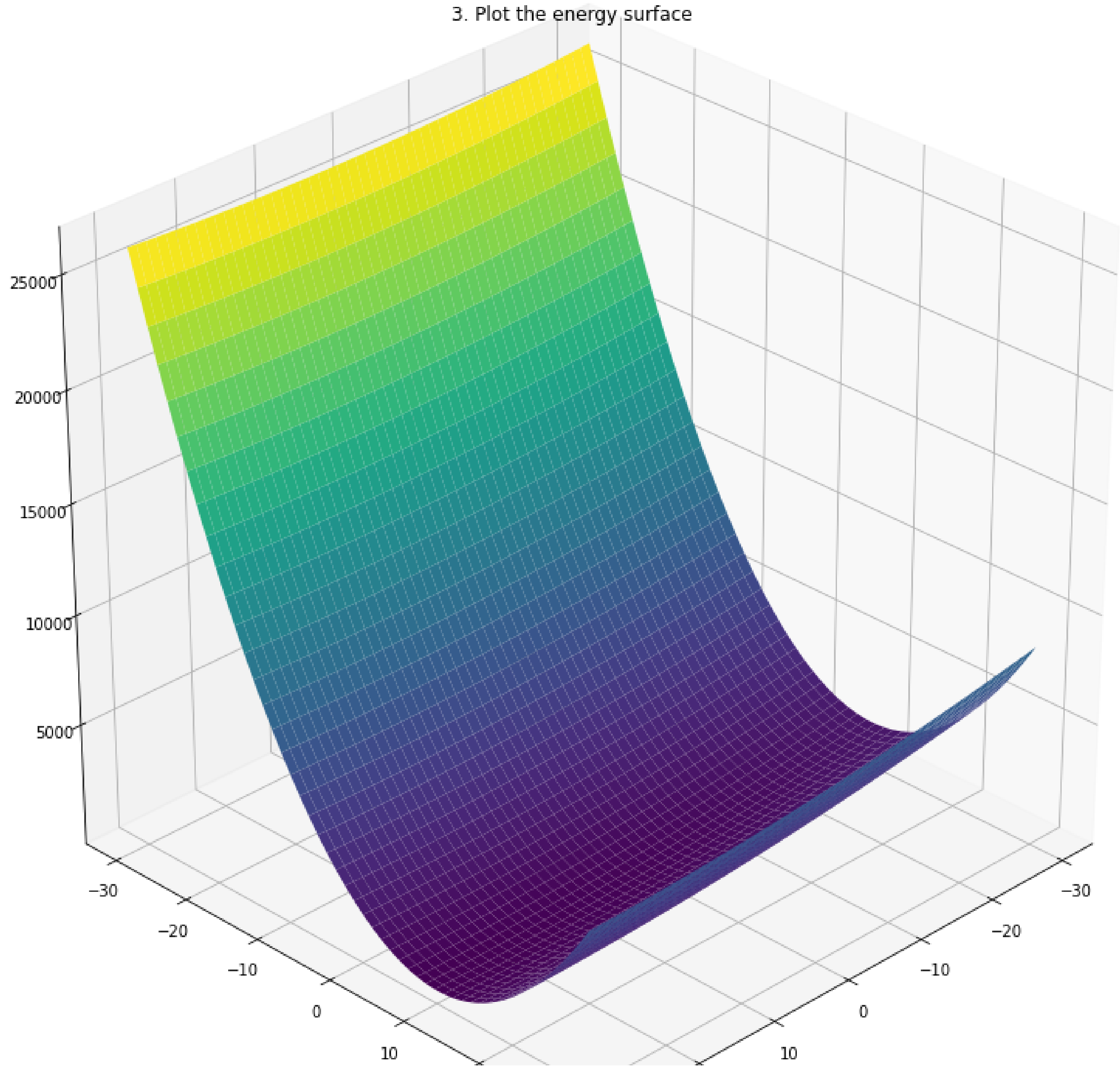


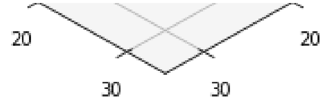


2. Linear regression result

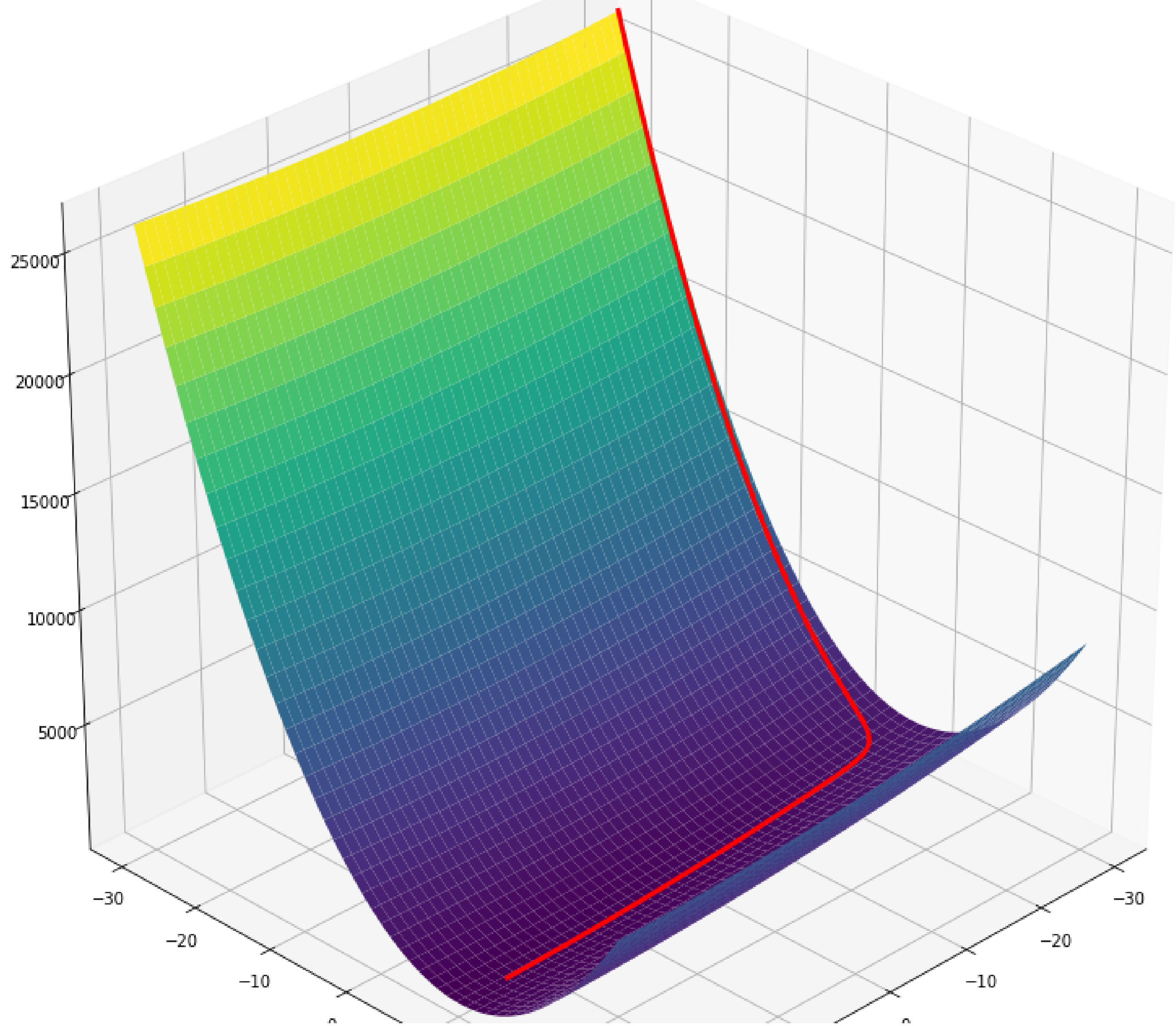


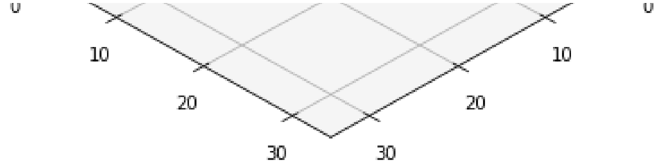

−100
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0
x


3. Plot the energy surface
25000
20000
15000
10000
5000
−30
−20
−10
0
10
−30
−20
−10
0
10



4. Plot the gradient descent path on the energy surface




0
10
20
30
0
10
20
30