Homework2 - Problem2 (Sakshi)

February 16, 2022

1 Problem 2

[2]:
```
import numpy as np
import matplotlib.pyplot as plt
```

[3]:
```
x = np.array([1.2, 3.2, 5.1, 3.5, 2.6])
y = np.array([7.8, 1.2, 6.4, 2.6, 8.1])
```

[5]:
```
# convert to column vectors
x = x.reshape((-1, 1))
y = y.reshape((-1, 1))
```

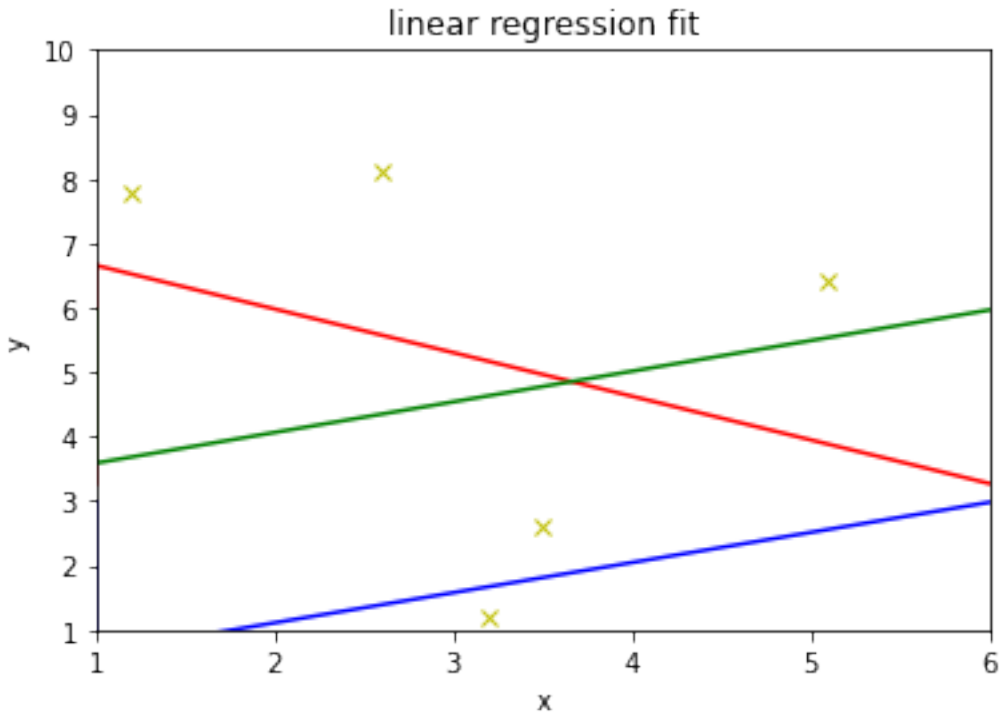
[6]:
```
def least_squares(x, y, reg=0):
    n, d = x.shape[0], x.shape[1]
    # append x to a column of ones. bias trick
    x = np.hstack((np.ones(n).reshape(-1, 1), x))
    solution = np.linalg.inv(x.T @ x + (reg**2) * np.eye(d + 1)) @ x.T @ y
    return solution
```

1.1 Part 2a)

[10]:
```
regularization_constants = [0, 1, 10]
solutions = []
for i, reg in enumerate(regularization_constants):
    solution = least_squares(x, y, reg)
    print(f"Equation of line when regularization = {reg} is y =␣
 ↪{solution[1][0]} * x + {solution[0][0]}")
    solutions.append(solution)
```

```
Equation of line when regularization = 0 is y = -0.6766317887394105 * x +
7.331091180866961
Equation of line when regularization = 1 is y = 0.47491248541423553 * x +
3.1152275379229852
Equation of line when regularization = 10 is y = 0.4671668474177275 * x +
0.1791637826693662
```

[13]:
```
# defining input space
x_new = np.linspace(1, 6, 100).reshape((-1, 1))
n, d = x_new.shape[0], x_new.shape[1]
# append x to a column of ones. bias trick
x_new = np.hstack((np.ones(n).reshape(-1, 1), x_new))

y1 = x_new @ solutions[0]
y2 = x_new @ solutions[1]
y3 = x_new @ solutions[2]

# 3 new plots one each for different regularization
plt.plot(x_new, y1, '-r')
plt.plot(x_new, y2, '-g')
plt.plot(x_new, y3, '-b')

# actual x and y scatter plot
plt.plot(x, y, 'yx')

# defining space for x and y
plt.axis([1, 6, 1, 10])

plt.xlabel('x')
plt.ylabel('y')
plt.title('linear regression fit')
plt.show()
```



1.2 2b

The above plot says that when regularization constant is 0, it is overfitting the data and is giving weight to outliers. This can be seen above in red line. It also says that when regularization constant is 1, the line fits the data just right. This can be seen above in green line. When regularization constant is 10, there is too much of regularization. This can be seen above in the blue line.

[ ]: