README
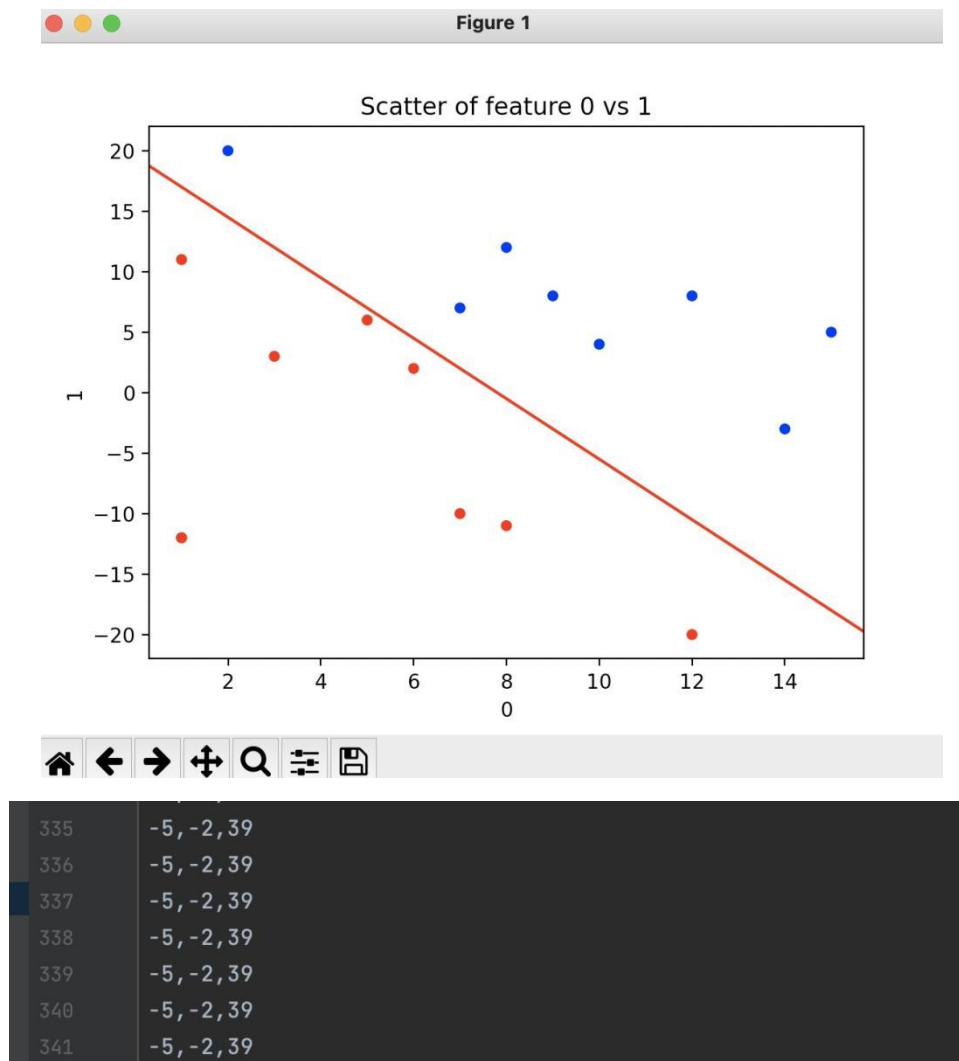
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Perceptron:

The perceptron learning algorithm (PLA).
Alpha = 1
The weight is [-5, -2, 39]

The final decision boundary

Linear Regression

Implement linear regression with gradient descent.
The result of ten given alphas after 100 iterations, and calculate starting and final error by the least square method:

Alpha   =   0.001, 0.005, 0.01, 0.05, 0.1, 0.5, 1, 5, 10, 0.8

```
weight [0.10439168 0.01196297 0.0086336 ] Risk 0.5016932512396162
weight [0.43225727 0.04562577 0.02981469] Risk 0.22733755305353132
weight [0.69512069 0.06862364 0.03893701] Risk 0.0854167628541294
weight [1.08996918 0.11243317 0.01840028] Risk 0.0024655587298318604
weight [1.09643169 0.12500554 0.00584498] Risk 0.0023695134972367303
weight [1.09646081 0.12943903 0.00141149] Risk 0.0023640503440448047
weight [1.09646081 0.12943908 0.00141145] Risk 0.0023640503440440328
weight [-3.64058693e+71 -4.42273497e+86 -4.42273497e+86] Risk 5.8626007755434815e+171
weight [-2.66892563e+104 -3.39934098e+119 -3.39934098e+119] Risk 7.616998563749192e+236
weight [1.09646081 0.12943908 0.00141145] Risk 0.0023640503440440336
```

I chose the alpha 0.8 and the iteration of 100
For learning rate, if the learning rate is too small, the converge speed will be slow and can not converge to the optima in 100 iterations. While when the learning rate is too large like alpha= 5 or 10, the step is too big and will jump over the optima and ignore the optima.

For iterations, I think 100 iterations is enough, if the iteration number is too large, there will be over-fitting.

As we can see from above, the Error stay when alpha=0.5 and 1. So I chose alpha = 0.8 And get the Error of 0.0023640

CSV output:

Alpha	Iterations	w0	w1	w2

```
0.001,100.0,0.10439167962663132,0.011962967192070474,0.008633595555561504
0.005,100.0,0.43225726708025014,0.04562576717183784,0.029814693921480027
0.01,100.0,0.6951206934840981,0.06862363808230339,0.038937006121291175
0.05,100.0,1.089969183119605,0.11243317144538593,0.01840028008091553
0.1,100.0,1.0964316878594287,0.12500553771969233,0.005844982938081389
0.5,100.0,1.0964608113924048,0.12943902906619134,0.0014114925158648158
1.0,100.0,1.096460811392405,0.12943907603586852,0.0014114455461874155
5.0,100.0,-3.640586927320933e+71,-4.422734969730082e+86,-4.422734969730083e+86
10.0,100.0,-2.6689256290312734e+104,-3.399340978890502e+119,-3.399340978890505e+119
0.8,100.0,1.096460811392405,0.12943907603250798,0.001411445549548165
```

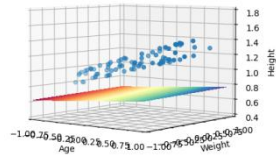The 3D plots for different alphas (on the next page):
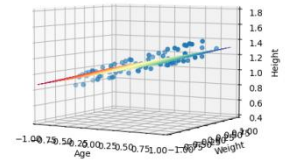
LinReg Height with Alpha 0.001000
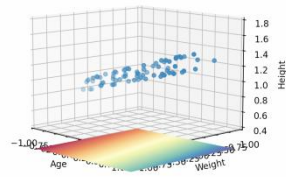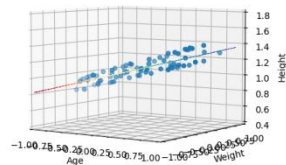
LinReg Height with Alpha 0.005000
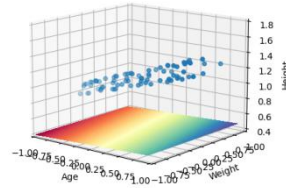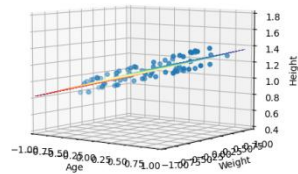
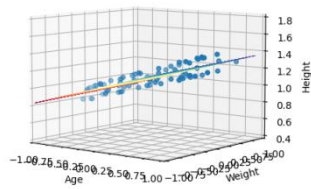LinReg Height with Alpha 0.010000

LinReg Height with Alpha 0.050000

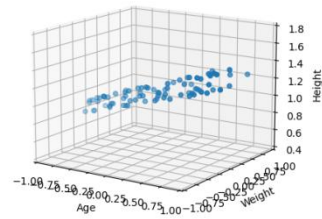LinReg Height with Alpha 0.100000

LinReg Height with Alpha 0.500000

LinReg Height with Alpha 1.000000

LinReg Height with Alpha 5.000000

LinReg Height with Alpha 10.000000