01_linear_regression_using_tensorflow

September 28, 2020

Linear regression , TensorFlow notebook.

Import

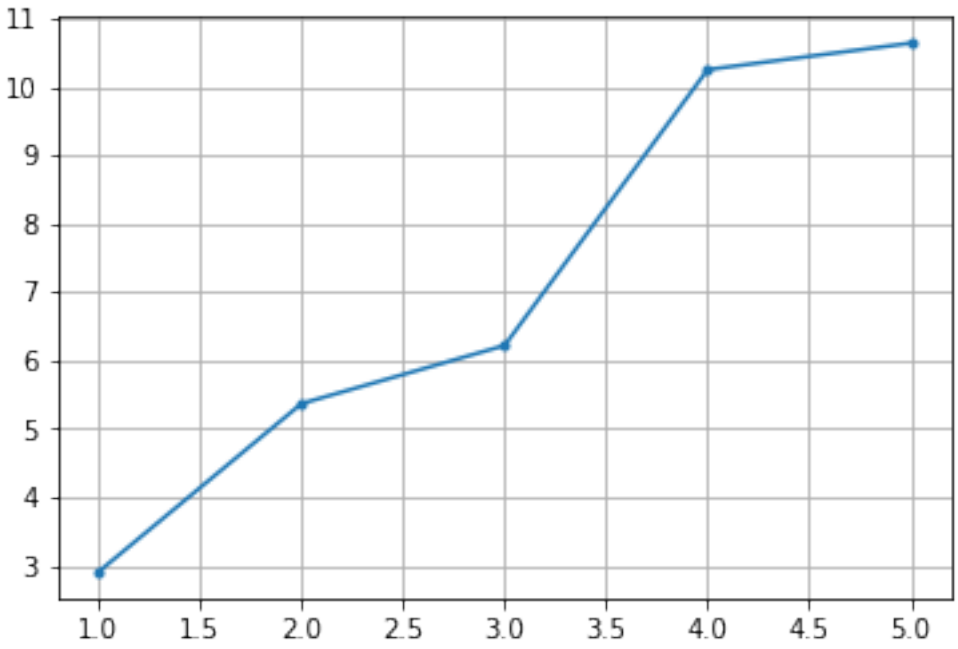
[1]:
```
# import tensorflow as tf
import tensorflow.compat.v1 as tf
tf.disable_v2_behavior()

import numpy as np
import matplotlib.pyplot as plt
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow/python/compat/v2_compat.py:96: disable_resource_variables
(from tensorflow.python.ops.variable_scope) is deprecated and will be removed in
a future version.
Instructions for updating:
non-resource variables are not supported in the long term
```

X and Y data (given)

[2]:
```
x_train = [1, 2, 3, 4, 5]
# y_train = [2, 4, 6, 8, 10]

y_train = [3, 5, 7, 9, 11] # y = 2x + 1

signal_length = len(x_train)
y_noise = np.random.normal(0,1, signal_length)

y_train = y_train + y_noise

# y_train = [2+0.1, 4-0.3, 6+0.15]  #  noise

# y_train = [2, 4, 6]   # x_train 2
# y_train = [3, 5, 7]
```

[3]:
```
plt.plot(x_train, y_train,'.-')
plt.grid()
```



Initialization

[5]:
```
useRandom = False
```

[6]:
```
if useRandom:
   W = tf.Variable(tf.random_normal([1]), name='weight')
   b = tf.Variable(tf.random_normal([1]), name = 'bias')
else:
  w0 = 7.0;
  b0 = 5.0;

  W = tf.Variable(w0*tf.ones([1]), name='weight')
  b = tf.Variable(b0*tf.ones([1]), name='bias')
```

Our hypothesis XW+b

$$H(x) = Wx + b$$

[7]:
```
hypothesis = x_train * W + b
```

cost/loss function

- loss of one training example :

$$loss = \mathcal{L}(\hat{y}, y) = (\hat{y}^{(i)} - y^{(i)})^2$$

[8]:
```
loss = tf.reduce_mean(tf.square(hypothesis - y_train))
```

Optimizer

[9]:
```
optimizer = tf.train.GradientDescentOptimizer(learning_rate=0.01)
train = optimizer.minimize(loss)
```

Launch the graph in a session

[10]:
```
sess = tf.Session()
```

Initalizes global variables in the graph.

[11]:
```
sess.run(tf.global_variables_initializer())
```

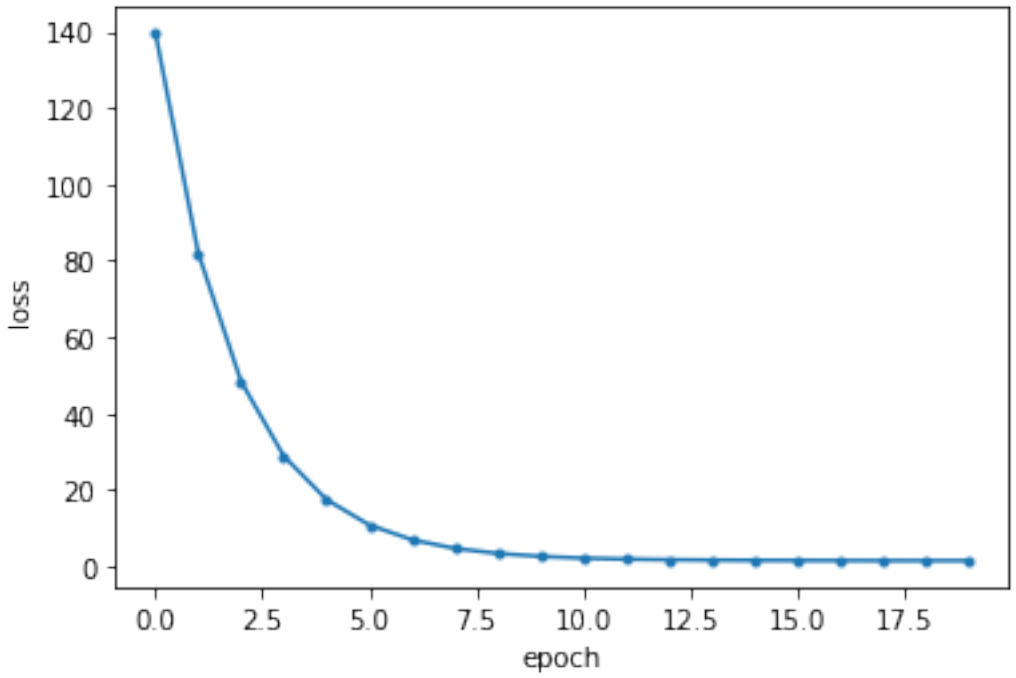
[13]:
```
nb_epoch = 2001
vloss = [] # empty list
vb = [] # empty list
vw = [] # empty list

for step in range(nb_epoch):
    sess.run(train)
    loss1 = sess.run(loss)
    vloss.append(loss1)
    w1 = sess.run(W)
    vw.append(w1)
    b1 = sess.run(b)
    vb.append(b1)

    if step % 50 == 0: # 100
      w1 = sess.run(W)[0] #
      b1 = sess.run(b)[0] # bias

      print(step, '\t', loss1, '\t', w1, '\t', b1)
```

```
0       139.53317       4.648285        4.3307257
50      1.2574391       1.4628112       3.0384212
100     1.0347639       1.5518444       2.7169657
150     0.8760597       1.6270123       2.445586
200     0.76294816      1.6904709       2.2164798
250     0.6823312       1.7440447       2.023062
300     0.6248741       1.7892729       1.8597734
350     0.58392346      1.8274558       1.721921
400     0.5547372       1.8596907       1.6055429
450     0.53393567      1.8869042       1.5072932
500     0.51910996      1.9098786       1.4243482
550     0.50854343      1.9292743       1.3543236
600     0.5010125       1.9456488       1.295207
650     0.4956451       1.9594723       1.2452993
700     0.49181947      1.9711426       1.2031658
750     0.489093        1.980995        1.1675959
800     0.48714995      1.9893126       1.1375667
850     0.4857649       1.9963346       1.1122152
900     0.48477775      2.0022626       1.0908133
```

```
950     0.48407435      2.0072672       1.0727447
1000    0.4835728       2.0114923       1.0574908
1050    0.48321557      2.0150595       1.0446132
1100    0.48296076      2.0180707       1.0337412
1150    0.48277935      2.0206127       1.0245632
1200    0.48264986      2.022759        1.0168151
1250    0.48255762      2.024571        1.0102735
1300    0.48249203      2.0261004       1.0047512
1350    0.48244524      2.0273917       1.0000889
1400    0.48241192      2.028482        0.996153
1450    0.48238793      2.0294023       0.9928301
1500    0.4823711       2.0301793       0.99002516
1550    0.482359        2.0308352       0.98765707
1600    0.4823505       2.0313888       0.985658
1650    0.48234433      2.031856        0.9839705
1700    0.48233995      2.032251        0.9825457
1750    0.4823367       2.032584        0.9813428
1800    0.48233452      2.0328653       0.98032737
1850    0.4823329       2.0331028       0.9794701
1900    0.4823318       2.0333033       0.9787463
1950    0.48233098      2.0334723       0.97813535
2000    0.4823304       2.033615        0.9776195
```

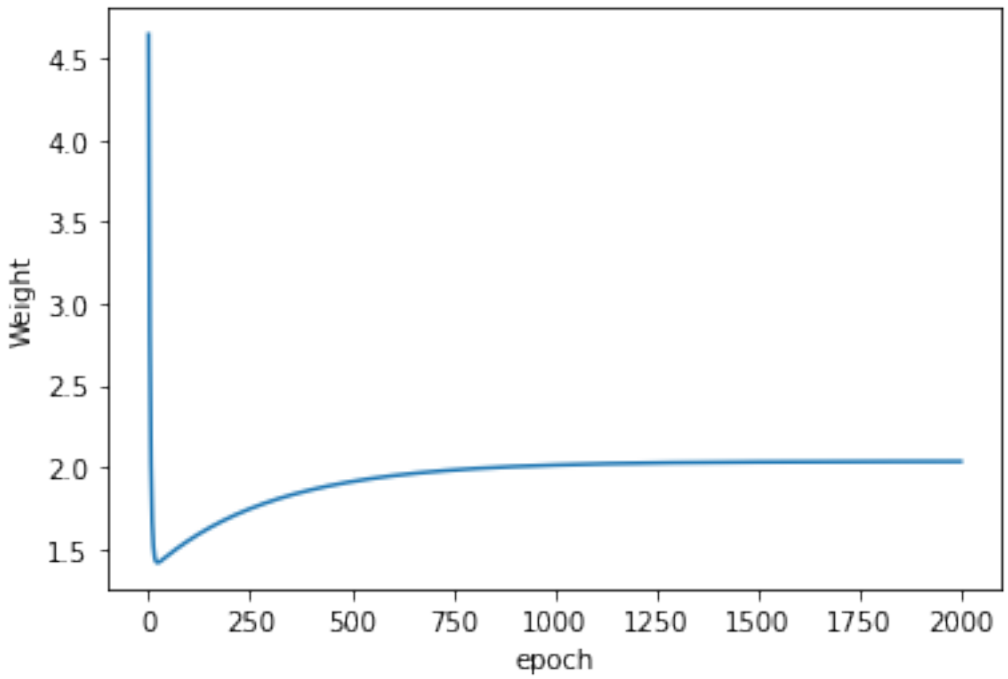
[14]:
```
plt.plot(vloss[:20], '.-')
plt.xlabel('epoch')
plt.ylabel('loss')
```

[14]:
```
Text(0, 0.5, 'loss')
```



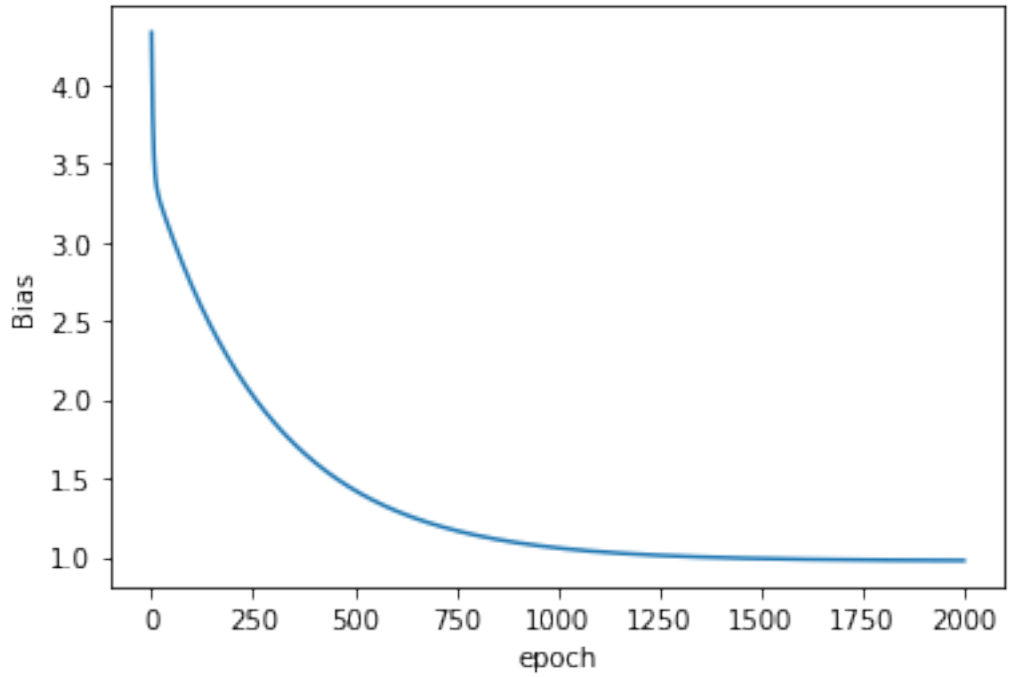
[15]:
```
# W epoch
plt.plot(vw[:], '-')
plt.xlabel('epoch')
plt.ylabel('Weight')
```

[15]:
```
Text(0, 0.5, 'Weight')
```



[18]:
```
# b epoch
plt.plot(vb[:], '-')
plt.xlabel('epoch')
plt.ylabel('Bias')
```

[18]:
```
Text(0, 0.5, 'Bias')
```



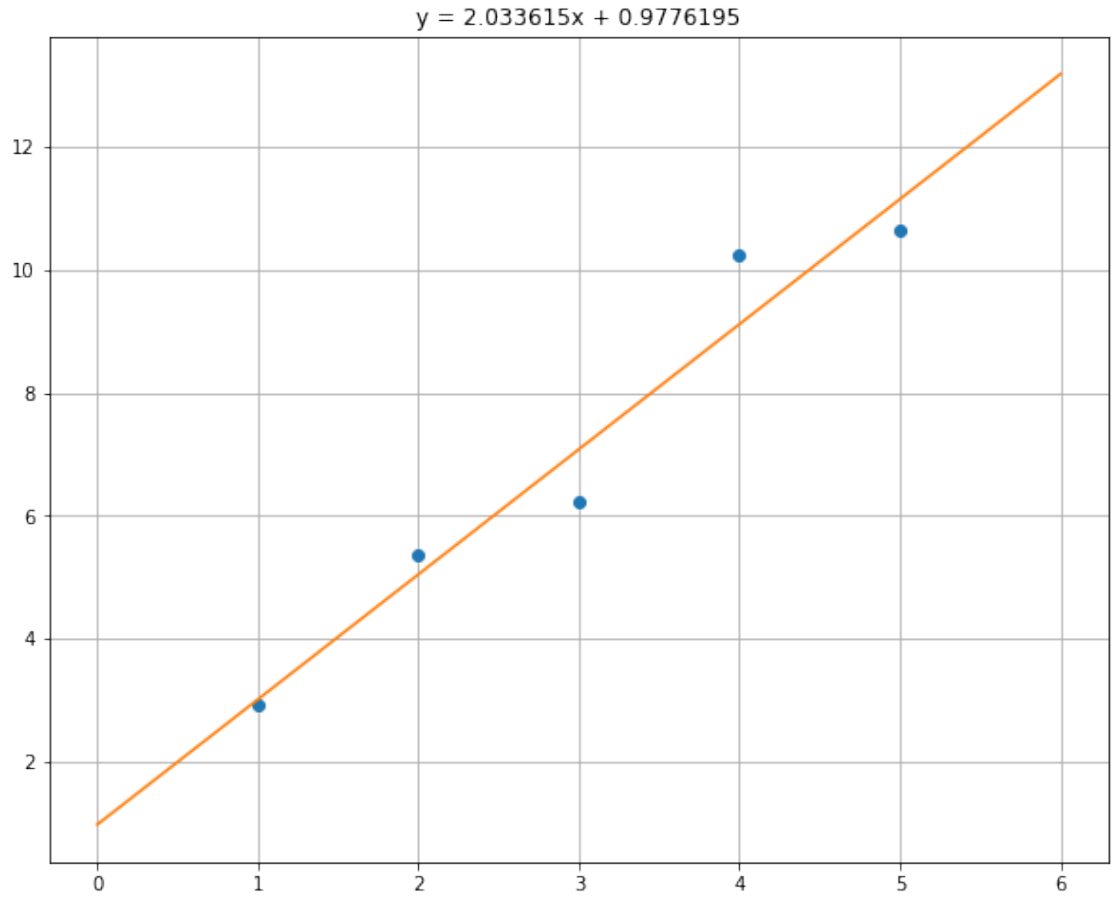
[19]:
```
w1 = sess.run(W)[0] #
b1 = sess.run(b)[0] # bias
```

[20]:
```
print(w1, b1)

str1 = 'y = ' + str(w1) + 'x + ' + str(b1)
print(str1)
```

```
2.033615 0.9776195
y = 2.033615x + 0.9776195
```

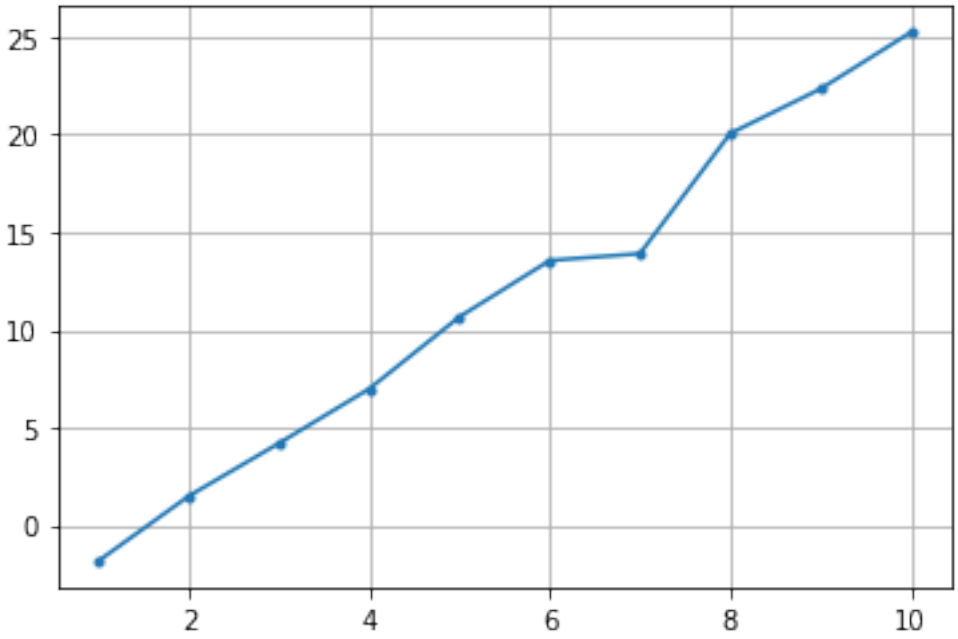
[21]:
```
plt.figure(figsize=(10,8))
plt.plot(x_train, y_train, 'o') # train_data

#
#  x
x1 = np.linspace(np.min(x_train)-1, np.max(x_train)+1)
y1 = w1*x1 + b1
plt.plot(x1, y1)

plt.grid() #
#plt.axis((np.min(x_train) - 1, np.max(x_train) + 1, np.min(y_train) - 1 ,
# np.max(y_train) + 1))
plt.title(str1)
```

[21]: `Text(0.5, 1.0, 'y = 2.033615x + 0.9776195')`



1

[22]:
```
# X and Y data
x_train = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

y_train = [-2, 1, 4, 7, 10, 13, 16, 19, 22, 25]  # y = 3x - 5

signal_length = len(x_train)
y_noise = np.random.normal(0,1, signal_length)

y_train = y_train + y_noise

plt.plot(x_train, y_train,'.-')
plt.grid()
```



[23]:
```
# initialization
useRandom = False

if useRandom:
   W = tf.Variable(tf.random_normal([1]), name='weight')
   b = tf.Variable(tf.random_normal([1]), name = 'bias')
else:
   w0 = 9.0;
   b0 = 7.0;

   W = tf.Variable(w0*tf.ones([1]), name='weight')
   b = tf.Variable(b0*tf.ones([1]), name='bias')
```

[24]:
```
# Our hypothesis XW+b
hypothesis = x_train * W + b

# loss function
loss = tf.reduce_mean(tf.square(hypothesis - y_train))

# Optimizer
optimizer = tf.train.GradientDescentOptimizer(learning_rate=0.01)
train = optimizer.minimize(loss)
```

[25]:
```
# Launch the graph in a session
sess = tf.Session()

# Initializes global variables in the graph
```

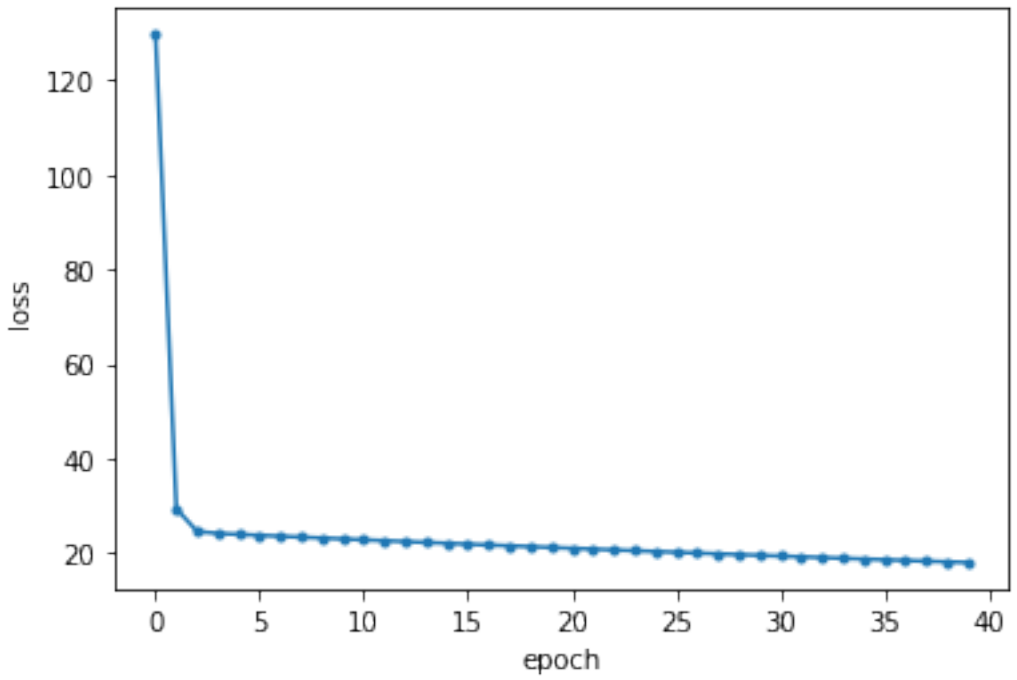
```
sess.run(tf.global_variables_initializer())
```

[26]:
```
nb_epoch = 2001
vloss = [] # empty list
vb = [] # empty list
vw = [] # empty list

for step in range(nb_epoch):
    sess.run(train)
    loss1 = sess.run(loss)
    vloss.append(loss1)
    w1 = sess.run(W)
    vw.append(w1)
    b1 = sess.run(b)
    vb.append(b1)

    if step % 100 == 0: # 100
      w1 = sess.run(W)[0] #
      b1 = sess.run(b)[0] # bias

      print(step, '\t', loss1, '\t', w1, '\t', b1)
```

```
0       129.6079        3.0743654       6.1031837
100     11.036634       1.9807149       2.2274022
200     5.123662        2.3242965       -0.16455165
300     2.575247        2.5498564       -1.7348604
400     1.4769113       2.6979358       -2.7657626
500     1.0035429       2.7951493       -3.4425457
600     0.79952586      2.8589697       -3.8868515
700     0.71159804      2.9008675       -4.1785364
800     0.673702        2.9283733       -4.370027
900     0.65736955      2.946431        -4.4957404
1000    0.65032965      2.9582858       -4.5782723
1100    0.6472961       2.966068        -4.632451
1200    0.64598924      2.971177        -4.66802
1300    0.6454252       2.9745312       -4.6913695
1400    0.6451827       2.976733        -4.706699
1500    0.64507794      2.9781785       -4.7167616
1600    0.6450325       2.9791276       -4.72337
1700    0.64501286      2.9797509       -4.7277083
1800    0.64500475      2.9801598       -4.7305555
1900    0.64500105      2.9804285       -4.7324266
2000    0.64499986      2.9806046       -4.7336535
```

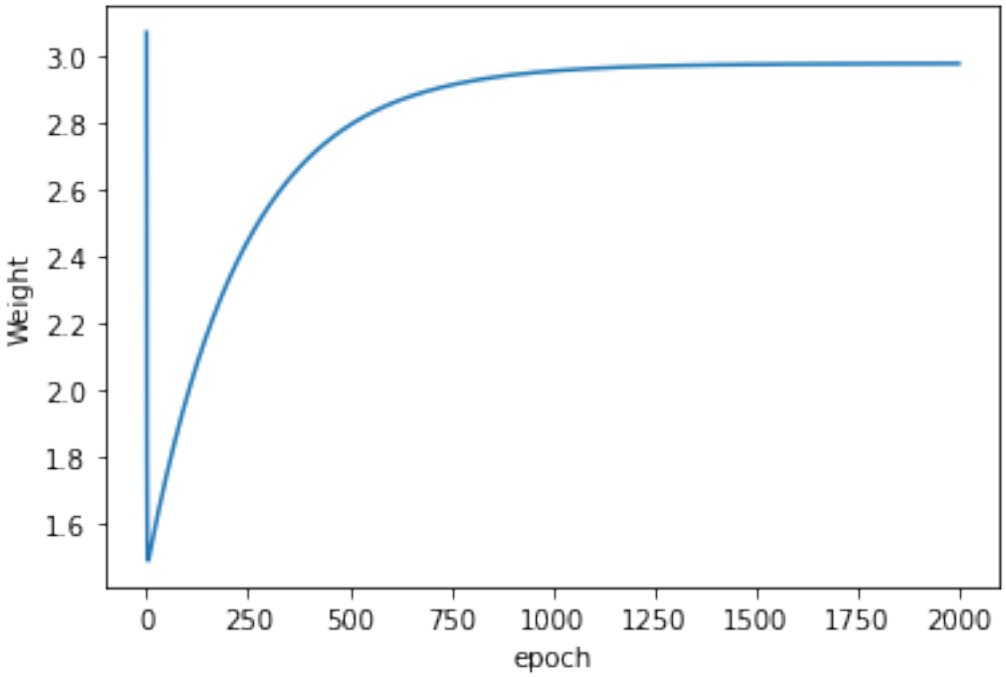
[28]:
```
plt.plot(vloss[:40], '.-')
plt.xlabel('epoch')
plt.ylabel('loss')
```

[28]: `Text(0, 0.5, 'loss')`



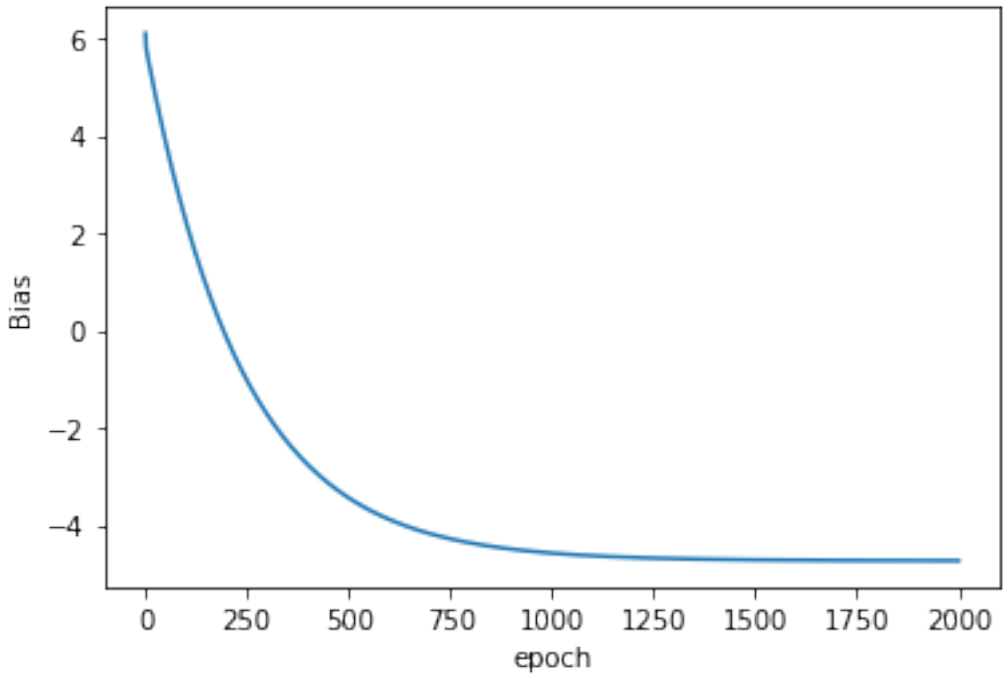
[29]:
```
# W epoch
plt.plot(vw[:], '-')
plt.xlabel('epoch')
plt.ylabel('Weight')
```

[29]: `Text(0, 0.5, 'Weight')`



[30]:
```
# b epoch
plt.plot(vb[:], '-')
plt.xlabel('epoch')
plt.ylabel('Bias')
```

[30]:
```
Text(0, 0.5, 'Bias')
```



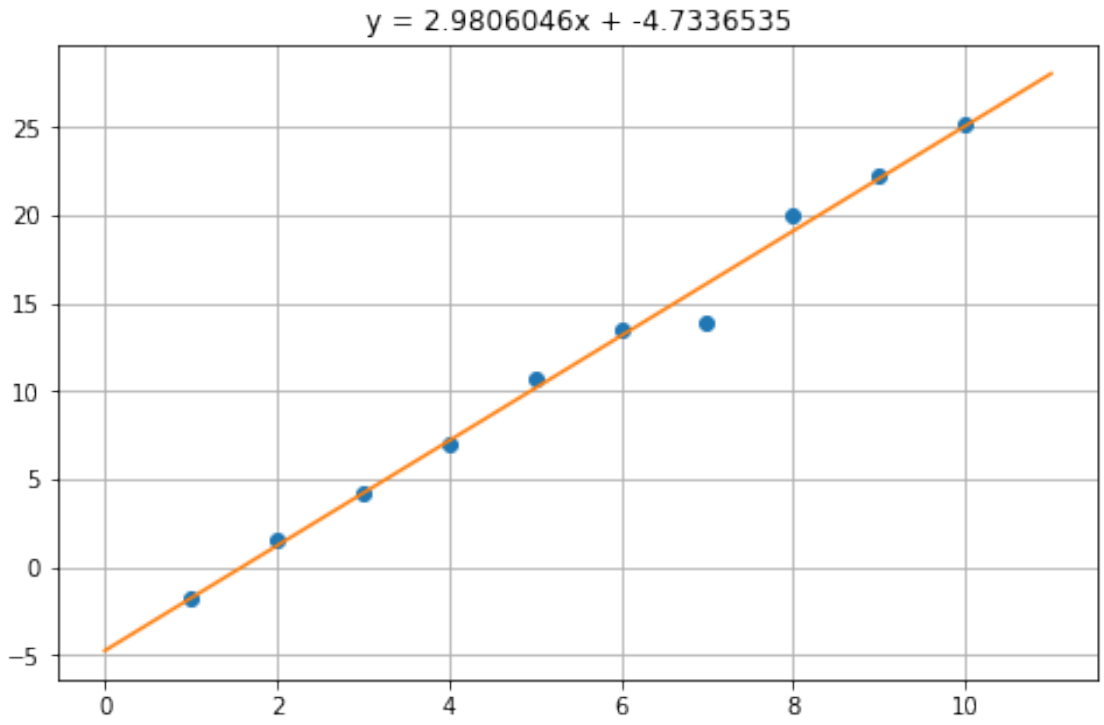
[31]:
```
#
w1 = sess.run(W)[0] #
b1 = sess.run(b)[0] # bias
```

[32]:
```
#
print(w1, b1)

str1 = 'y = ' + str(w1) + 'x + ' + str(b1)
print(str1)
```

```
2.9806046 -4.7336535
y = 2.9806046x + -4.7336535
```

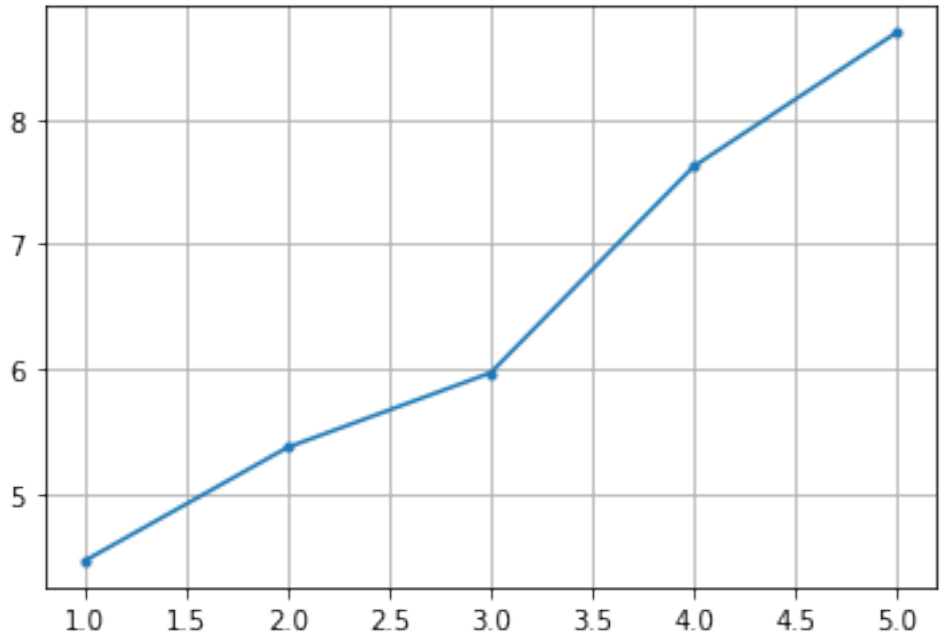
[33]:
```
plt.figure(figsize=(8,5))
plt.plot(x_train, y_train, 'o') # train_data

#
#  x
x1 = np.linspace(np.min(x_train)-1, np.max(x_train)+1)
y1 = w1*x1 + b1
plt.plot(x1, y1)

plt.grid() #
# plt.axis((np.min(x_train) - 1, np.max(x_train) + 1, np.min(y_train) - 1,
# np.max(y_train) + 1))
plt.title(str1)
```

[33]:
```
Text(0.5, 1.0, 'y = 2.9806046x + -4.7336535')
```



2

[40]:
```
# X and Y data
x_train = [1, 2, 3, 4, 5]

y_train = [4.2, 5.4, 6.6, 7.8, 9.0]  # y = 1.2x + 3

signal_length = len(x_train)
y_noise = np.random.normal(0,1, signal_length)

y_train = y_train + y_noise

plt.plot(x_train, y_train,'.-')
plt.grid()
```



[41]:
```
# initialization
useRandom = True

if useRandom:
   W = tf.Variable(tf.random_normal([1]), name='weight')
   b = tf.Variable(tf.random_normal([1]), name = 'bias')
else:
   w0 = 5.0;
   b0 = 3.0;

   W = tf.Variable(w0*tf.ones([1]), name='weight')
   b = tf.Variable(b0*tf.ones([1]), name='bias')
```

[42]:
```
# Our hypothesis XW+b
hypothesis = x_train * W + b

# loss function
loss = tf.reduce_mean(tf.square(hypothesis - y_train))

# Optimizer
optimizer = tf.train.GradientDescentOptimizer(learning_rate=0.01)
train = optimizer.minimize(loss)
```

[43]:
```
# Launch the graph in a session
sess = tf.Session()

# Initializes global variables in the graph
```

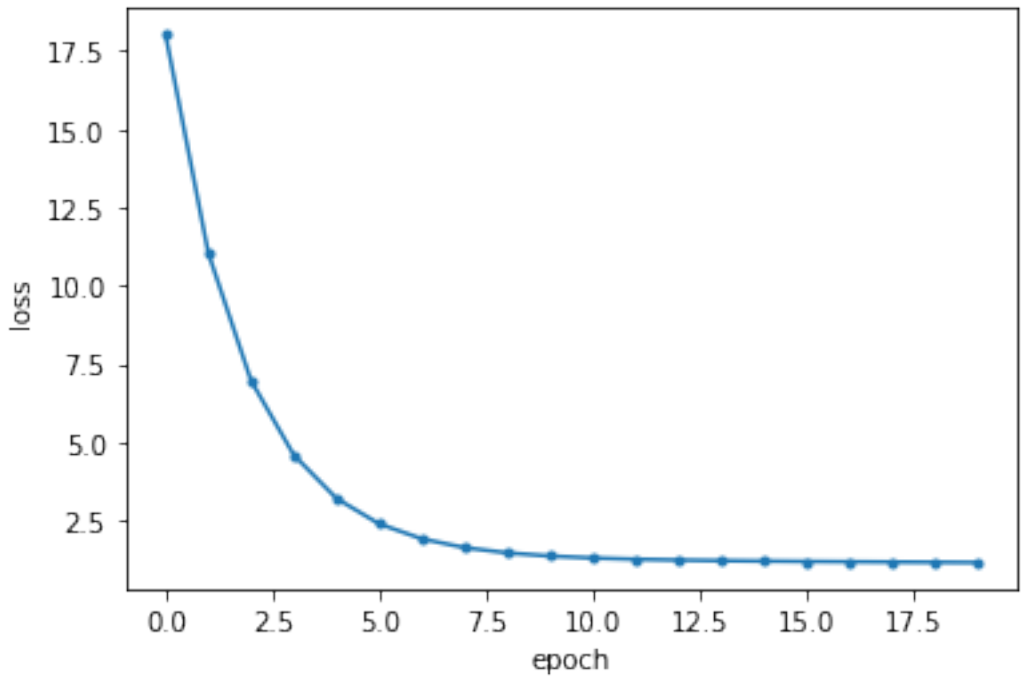
```
sess.run(tf.global_variables_initializer())
```

[44]:
```
nb_epoch = 1001
vloss = [] # empty list
vb = [] # empty list
vw = [] # empty list

for step in range(nb_epoch):
    sess.run(train)
    loss1 = sess.run(loss)
    vloss.append(loss1)
    w1 = sess.run(W)
    vw.append(w1)
    b1 = sess.run(b)
    vb.append(b1)

    if step % 50 == 0: # 50
      w1 = sess.run(W)[0] #
      b1 = sess.run(b)[0] # bias

      print(step, '\t', loss1, '\t', w1, '\t', b1)
```

```
0       18.025177       0.6545198       0.2635625
50      0.9510582       1.6865096       0.99031955
100     0.69351435      1.5907558       1.3360273
150     0.50995827      1.5099164       1.6278827
200     0.3791346       1.44167         1.8742745
250     0.28589422      1.3840544       2.082285
300     0.21944025      1.3354139       2.2578924
350     0.17207697      1.29435         2.4061456
400     0.13832036      1.259683        2.5313048
450     0.11426141      1.2304162       2.6369677
500     0.09711422      1.2057081       2.726171
550     0.08489314      1.1848494       2.8014784
600     0.076182835     1.1672395       2.865055
650     0.06997497      1.1523731       2.9187279
700     0.065550424     1.1398224       2.96404
750     0.062397044     1.1292267       3.0022936
800     0.060149513     1.1202816       3.034588
850     0.058547687     1.1127298       3.0618525
900     0.05740603      1.1063545       3.0848694
950     0.056592345     1.1009722       3.1043012
1000    0.056012414     1.0964284       3.1207058
```

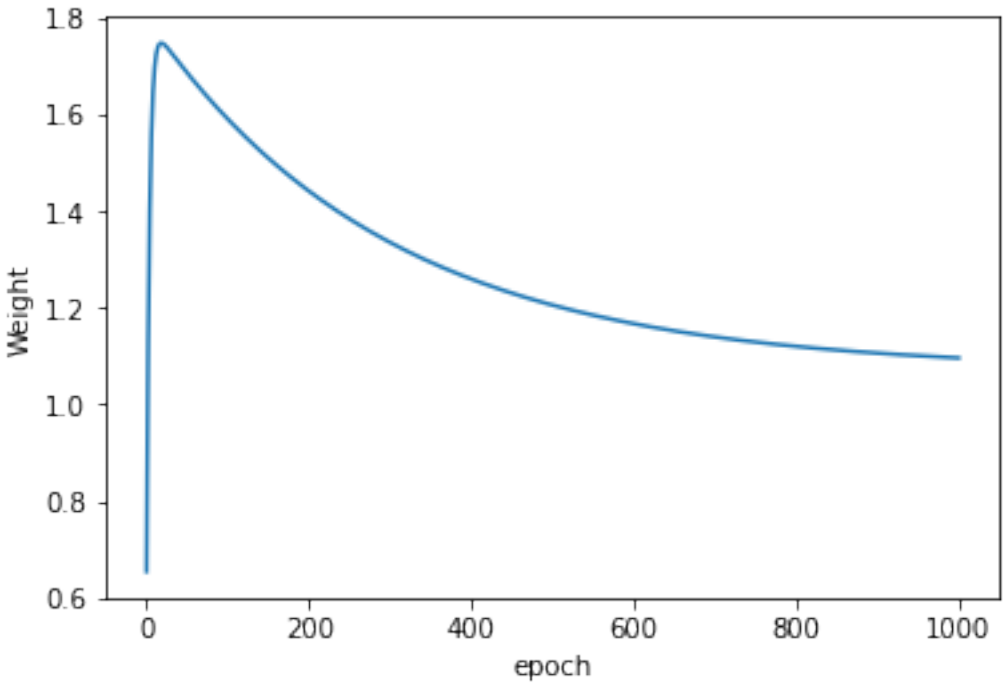
[45]:
```
plt.plot(vloss[:20], '.-')
plt.xlabel('epoch')
plt.ylabel('loss')
```

[45]:
```
Text(0, 0.5, 'loss')
```



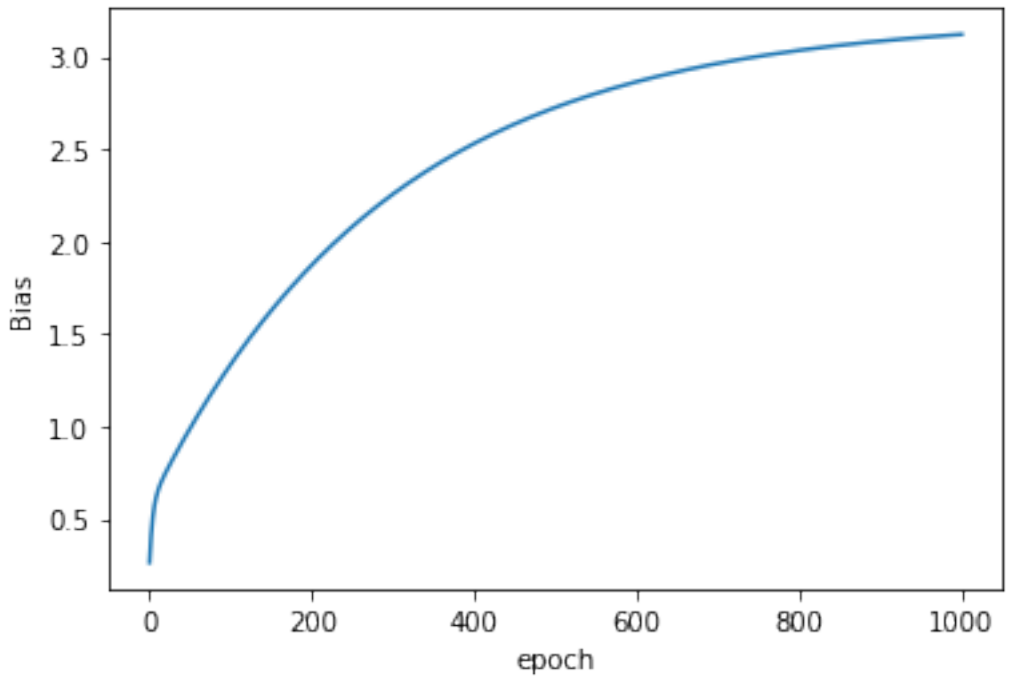
[46]:
```
# W epoch
plt.plot(vw[:], '-')
plt.xlabel('epoch')
plt.ylabel('Weight')
```

[46]:
```
Text(0, 0.5, 'Weight')
```



[47]:
```
# b epoch
plt.plot(vb[:], '-')
plt.xlabel('epoch')
plt.ylabel('Bias')
```

[47]:
```
Text(0, 0.5, 'Bias')
```



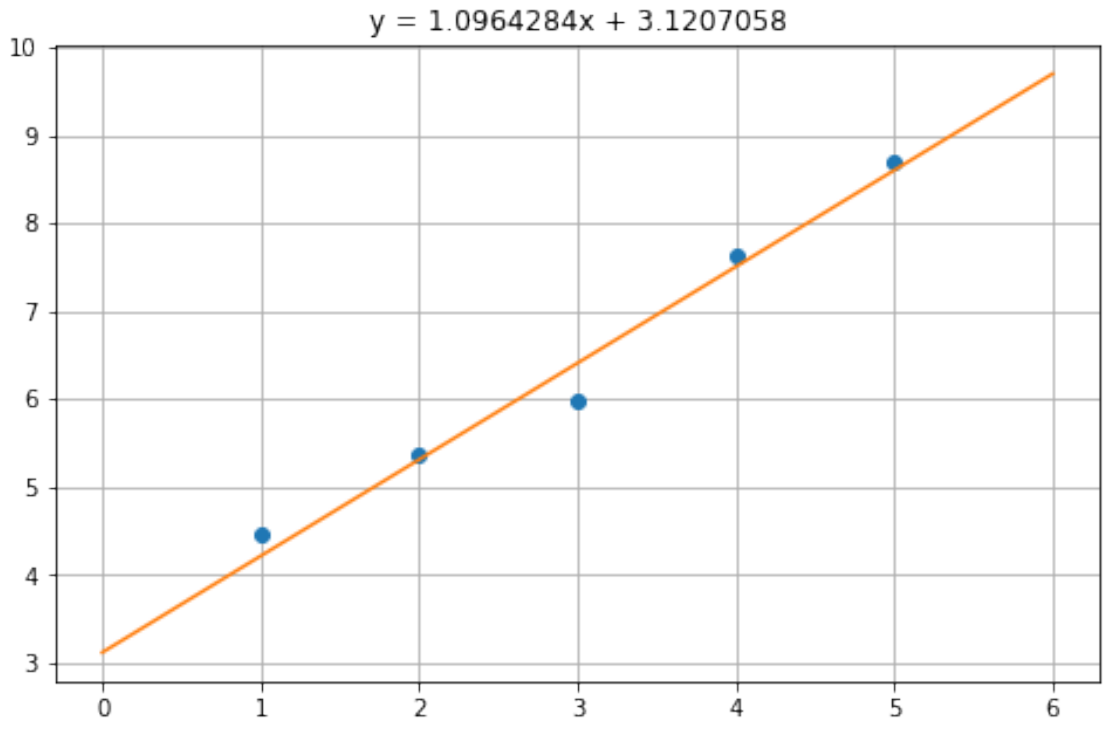
[48]:
```
#
w1 = sess.run(W)[0] #
b1 = sess.run(b)[0] # bias
```

[49]:
```
#
print(w1, b1)

str1 = 'y = ' + str(w1) + 'x + ' + str(b1)
print(str1)
```

```
1.0964284 3.1207058
y = 1.0964284x + 3.1207058
```

[50]:
```
plt.figure(figsize=(8,5))
plt.plot(x_train, y_train, 'o') # train_data

#
#  x
x1 = np.linspace(np.min(x_train)-1, np.max(x_train)+1)
y1 = w1*x1 + b1
plt.plot(x1, y1)

plt.grid() #
# plt.axis((np.min(x_train) - 1, np.max(x_train) + 1, np.min(y_train) - 1,
# np.max(y_train) + 1))
plt.title(str1)
```

[50]: `Text(0.5, 1.0, 'y = 1.0964284x + 3.1207058')`



[ ]: