Single Layer Perceptron 6var

November 30, 2022

[38]:
```
import pandas as pd
import numpy as np
import math
np.set_printoptions(suppress=True)
df = pd.read_csv('LogRes_Train.csv')
df = df.sample(frac = 1)
df.head()
```

[38]:

	Latitude	Longitude	Altitude	min Temo	Max Temp	Sunshine Hour	Solar Radiation
110	21.09	79.07	311	13.9	27.1	0.650000	0
89	22.39	88.27	6	24.2	30.6	0.600000	0
49	23.35	85.33	654	23.4	27.7	3.500000	0
164	17.36	78.46	536	18.8	31.4	0.728571	1
201	12.57	77.38	897	17.1	29.3	0.742857	1

[39]:
```
def normalize(X):
    X = X.copy()
    if len(X.shape) < 2:
        raise Exception("Enter a dataset or 2D array into normalize function")
    for col in range(X.shape[1]):
        X[:,col] = (X[:,col] - min(X[:,col]))/(max(X[:,col])-min(X[:,col]))
    return X
```

[40]:
```
x_train = df.iloc[:,:6]
x_train = x_train.to_numpy()
# x_train = normalize(x_train, axis = 1)
x_train = normalize(x_train)
x_train
```

[40]:
```
array([[0.49651163, 0.33641225, 0.17881944, 0.48366013, 0.61956522,
        0.02094595],
       [0.54689922, 0.78366553, 0.00231481, 0.82026144, 0.71467391,
        0.01621622],
       [0.58410853, 0.64073894, 0.37731481, 0.79411765, 0.63586957,
        0.29054054],
       …,
       [0.72248062, 0.17841517, 0.24826389, 0.83333333, 0.77717391,
        0.02297297],
       [0.27945736, 0.08070005, 0.00289352, 0.91503268, 0.76086957,
        0.02635135],
       [0.58410853, 0.64073894, 0.37731481, 0.37908497, 0.48097826,
        0.80135135]])
```

[41]:
```
y_train = df.iloc[:,6]
y_train = y_train.to_numpy()
y_train
```

[41]:
```
array([0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0,
       0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0,
       0, 1, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 0,
       1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1,
       0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0,
       0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1,
       1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1,
       1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0,
       0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 0, 0,
       0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1,
       1, 0, 0, 1, 1, 1, 1, 0])
```

[42]:
```
class Node:
    def __init__(self, weight):
        self.weight = weight

    def fire (self, input_val):
        return input_val*self.weight
```

[43]:
```
class slp:
    def __init__(self, thresh, c, nodes=[]):
        self.thresh = thresh
        self.c = c
        self.n1 = nodes[0]
        self.n2 = nodes[1]
        self.n3 = nodes[2]
        self.n4 = nodes[3]
        self.n5 = nodes[4]
        self.n6 = nodes[5]
```

```
        self.weight_log = []
        self.accuracies=[]

    def test (self, ins=[]):
#         print(ins)
        nout1 = self.n1.fire(ins[0])
        nout2 = self.n2.fire(ins[1])
        nout3 = self.n3.fire(ins[2])
        nout4 = self.n4.fire(ins[3])
        nout5 = self.n5.fire(ins[4])
        nout6 = self.n6.fire(ins[5])
        sum = nout1 + nout2 + nout3 + nout4 + nout5 + nout6
#         print(sum)
        if sum >= thresh:
            return 1
        else:
            return 0

    def train (self, desired, actual, vals=[]):
        error = desired - actual
        delw1 = self.c * error * vals[0]
        delw2 = self.c * error * vals[1]
        delw3 = self.c * error * vals[2]
        delw4 = self.c * error * vals[3]
        delw5 = self.c * error * vals[4]
        delw6 = self.c * error * vals[5]
        self.n1 = Node(self.n1.weight + delw1)
        self.n2 = Node(self.n2.weight + delw2)
        self.n3 = Node(self.n3.weight + delw3)
        self.n4 = Node(self.n4.weight + delw4)
        self.n5 = Node(self.n5.weight + delw5)
        self.n6 = Node(self.n6.weight + delw6)
        return

    def training (self, nepoch, inputs=[], outputs=[]):
        for i in range(nepoch):
            print("\n\n====================epoch: ", i+1,␣
↪"============================\n")
            flag = 1
            wrong = 0
            for x in range(len(inputs)):
                out = self.test(inputs[x])
                #print("inputs: ", inputs[x], "\n|", "actual = ", out, "|␣
↪desired = ", outputs[x], "| weights: ",
                      #round((self.n1.weight), 2), round(self.n2.weight, 2),␣
↪round(self.n3.weight, 2),
```

```
                    #round(self.n4.weight, 2), round(self.n5.weight, 2),␣
↪round(self.n6.weight, 2))
                if out != outputs[x]:
                    self.train(outputs[x], out, inputs[x])
                    flag = 0
                    wrong += 1
            if flag:
                ␣
↪print("-------------------------------------------------\nTraining complete␣
↪with 100% accuracy!")
                percent_error = (len(y_train) - wrong)/len(y_train)*100
                self.accuracies.append(percent_error)
                self.weight_log.append([self.n1.weight,self.n2.weight,self.n3.
↪weight,self.n4.weight,self.n5.weight,self.n6.weight])
                return
            else:
                percent_error = ((len(y_train) - wrong)/len(y_train))*100
                print("Accuracy Score = ", percent_error)
                self.accuracies.append(percent_error)
                self.weight_log.append([self.n1.weight,self.n2.weight,self.n3.
↪weight,self.n4.weight,self.n5.weight,self.n6.weight])

    def testing (self, inputs=[], outputs=[]):
        correct = 0
        y_pred = []
        for x in range(len(inputs)):
            out = self.test(inputs[x])
            y_pred.append(out)
            print('desired = ', outputs[x], "| predicted = ", out)
            if out == outputs[x]:
                correct+=1
        acc = correct/len(outputs)
        print("accuracy = ", acc, "correct: ", correct)
        return y_pred

    def metrics (self, inputs=[], outputs=[]):
        correct = 0
        FN = 0
        FP = 0
        TN = 0
        TP = 0
        y_pred = []
        for x in range(len(inputs)):
            out = self.test(inputs[x])
            y_pred.append(out)
            if out == outputs[x]:
                correct+=1
```

```
            if out == outputs[x] == 1:
                TP += 1
            elif out == outputs[x] == 0:
                TN += 1
            elif out != outputs[x] == 0:
                FP += 1
            elif out != outputs[x] == 1:
                FN += 1
        acc = correct/len(outputs)
        metrics = {'FN':FN, 'FP':FP, 'TN':TN,'TP':TP, 'acc':acc}
        conf_mat = [[TP, FP],[FN, TN]]
        accuracy = (TN+TP)/(TN+TP+FN+FP)
        precision = (TP)/(TP+FP)
        recall = (TP)/(TP+FN)
        specificity = (TN)/(TN+FP)
        f1_score = 2*((precision*recall)/precision+recall)
        print('Confusion Matrix: \n[', conf_mat[0],'\n', conf_mat[1], ']')
        print('accuracy: ', accuracy, '\nprecision: ', precision, '\nrecall: ',␣
↪recall, '\nspecificity: ', specificity,
              '\nf1 score: ', f1_score)
        return metrics
```

[44]:
```
import random
l = []
for x in range(6):
    l.append(random.uniform(0,1))

n1 = Node(l[0])
n2 = Node(l[1])
n3 = Node(l[2])
n4 = Node(l[3])
n5 = Node(l[4])
n6 = Node(l[5])
thresh = float(input("enter the threshold:\t"))
c = float(input("enter the learning rate:\t"))
inputs = x_train
outputs = y_train
print('weights: ', l)
```

```
enter the threshold:    0.3
enter the learning rate:        0.001
weights:  [0.27156831598480313, 0.2108244260300134, 0.0303630762871695,
0.6298024925880238, 0.04773123060731865, 0.8162547692323535]
```

[45]:
```
myslp = slp(thresh, c, [n1, n2, n3, n4, n5, n6])
myslp.training(int(input("Enter the number of epochs:\t")), inputs, outputs)
```

```python
import matplotlib.pyplot as plt
plt.plot(myslp.accuracies)
plt.title('accuracies with time')
plt.show()

max_acc = max(myslp.accuracies)
max_index = myslp.accuracies.index(max_acc)
best_weights = myslp.weight_log[max_index]
print("best weights: ", best_weights)
```

```
Enter the number of epochs:     500


======================epoch:  1 ============================

Accuracy Score =  50.43859649122807


======================epoch:  2 ============================

Accuracy Score =  52.19298245614035


======================epoch:  3 ============================

Accuracy Score =  51.75438596491229


======================epoch:  4 ============================

Accuracy Score =  49.56140350877193


======================epoch:  5 ============================

Accuracy Score =  46.49122807017544


======================epoch:  6 ============================

Accuracy Score =  44.29824561403509


======================epoch:  7 ============================

Accuracy Score =  46.05263157894737
```

```
====================epoch:  8 ============================

Accuracy Score =  47.368421052631575

====================epoch:  9 ============================

Accuracy Score =  49.56140350877193

====================epoch:  10 ===========================

Accuracy Score =  51.31578947368421

====================epoch:  11 ===========================

Accuracy Score =  50.877192982456144

====================epoch:  12 ===========================

Accuracy Score =  50.877192982456144

====================epoch:  13 ===========================

Accuracy Score =  51.31578947368421

====================epoch:  14 ===========================

Accuracy Score =  51.75438596491229

====================epoch:  15 ===========================

Accuracy Score =  52.63157894736842

====================epoch:  16 ===========================

Accuracy Score =  53.07017543859649

====================epoch:  17 ===========================
```

```
Accuracy Score =  53.94736842105263

====================epoch:  18 ============================

Accuracy Score =  53.50877192982456

====================epoch:  19 ============================

Accuracy Score =  53.50877192982456

====================epoch:  20 ============================

Accuracy Score =  54.824561403508774

====================epoch:  21 ============================

Accuracy Score =  53.50877192982456

====================epoch:  22 ============================

Accuracy Score =  54.385964912280706

====================epoch:  23 ============================

Accuracy Score =  56.14035087719298

====================epoch:  24 ============================

Accuracy Score =  56.14035087719298

====================epoch:  25 ============================

Accuracy Score =  57.01754385964912

====================epoch:  26 ============================

Accuracy Score =  57.01754385964912
```

```
====================epoch:  27 ============================

Accuracy Score =  56.57894736842105

====================epoch:  28 ============================

Accuracy Score =  57.01754385964912

====================epoch:  29 ============================

Accuracy Score =  56.57894736842105

====================epoch:  30 ============================

Accuracy Score =  57.01754385964912

====================epoch:  31 ============================

Accuracy Score =  57.45614035087719

====================epoch:  32 ============================

Accuracy Score =  57.45614035087719

====================epoch:  33 ============================

Accuracy Score =  57.89473684210527

====================epoch:  34 ============================

Accuracy Score =  57.89473684210527

====================epoch:  35 ============================

Accuracy Score =  57.45614035087719

====================epoch:  36 ============================

Accuracy Score =  57.01754385964912
```

```
====================epoch:  37 ============================

Accuracy Score =  57.45614035087719

====================epoch:  38 ============================

Accuracy Score =  57.01754385964912

====================epoch:  39 ============================

Accuracy Score =  57.45614035087719

====================epoch:  40 ============================

Accuracy Score =  57.45614035087719

====================epoch:  41 ============================

Accuracy Score =  57.45614035087719

====================epoch:  42 ============================

Accuracy Score =  57.89473684210527

====================epoch:  43 ============================

Accuracy Score =  57.45614035087719

====================epoch:  44 ============================

Accuracy Score =  57.89473684210527

====================epoch:  45 ============================

Accuracy Score =  57.45614035087719

====================epoch:  46 ============================
```

```
Accuracy Score =  58.333333333333336

====================epoch:  47 ============================

Accuracy Score =  57.89473684210527

====================epoch:  48 ============================

Accuracy Score =  58.77192982456141

====================epoch:  49 ============================

Accuracy Score =  59.210526315789465

====================epoch:  50 ============================

Accuracy Score =  59.210526315789465

====================epoch:  51 ============================

Accuracy Score =  59.210526315789465

====================epoch:  52 ============================

Accuracy Score =  59.210526315789465

====================epoch:  53 ============================

Accuracy Score =  59.210526315789465

====================epoch:  54 ============================

Accuracy Score =  59.210526315789465

====================epoch:  55 ============================

Accuracy Score =  59.210526315789465
```

```
====================epoch:  56 ============================

Accuracy Score =  59.64912280701754

====================epoch:  57 ============================

Accuracy Score =  59.210526315789465

====================epoch:  58 ============================

Accuracy Score =  57.89473684210527

====================epoch:  59 ============================

Accuracy Score =  58.333333333333336

====================epoch:  60 ============================

Accuracy Score =  58.333333333333336

====================epoch:  61 ============================

Accuracy Score =  60.08771929824561

====================epoch:  62 ============================

Accuracy Score =  60.96491228070175

====================epoch:  63 ============================

Accuracy Score =  60.96491228070175

====================epoch:  64 ============================

Accuracy Score =  60.96491228070175

====================epoch:  65 ============================
```

```
Accuracy Score =  61.8421052631579

====================epoch:  66 ============================

Accuracy Score =  62.28070175438597

====================epoch:  67 ============================

Accuracy Score =  60.96491228070175

====================epoch:  68 ============================

Accuracy Score =  60.96491228070175

====================epoch:  69 ============================

Accuracy Score =  62.28070175438597

====================epoch:  70 ============================

Accuracy Score =  61.8421052631579

====================epoch:  71 ============================

Accuracy Score =  62.71929824561403

====================epoch:  72 ============================

Accuracy Score =  62.28070175438597

====================epoch:  73 ============================

Accuracy Score =  63.1578947368421

====================epoch:  74 ============================

Accuracy Score =  63.1578947368421
```

```
====================epoch:  75 ============================

Accuracy Score =  63.59649122807017

====================epoch:  76 ============================

Accuracy Score =  64.47368421052632

====================epoch:  77 ============================

Accuracy Score =  64.91228070175438

====================epoch:  78 ============================

Accuracy Score =  65.78947368421053

====================epoch:  79 ============================

Accuracy Score =  66.22807017543859

====================epoch:  80 ============================

Accuracy Score =  67.10526315789474

====================epoch:  81 ============================

Accuracy Score =  66.22807017543859

====================epoch:  82 ============================

Accuracy Score =  67.54385964912281

====================epoch:  83 ============================

Accuracy Score =  67.54385964912281

====================epoch:  84 ============================

Accuracy Score =  67.54385964912281
```

```
====================epoch:  85 ============================

Accuracy Score =  66.66666666666666

====================epoch:  86 ============================

Accuracy Score =  66.66666666666666

====================epoch:  87 ============================

Accuracy Score =  66.66666666666666

====================epoch:  88 ============================

Accuracy Score =  67.54385964912281

====================epoch:  89 ============================

Accuracy Score =  66.66666666666666

====================epoch:  90 ============================

Accuracy Score =  67.54385964912281

====================epoch:  91 ============================

Accuracy Score =  68.42105263157895

====================epoch:  92 ============================

Accuracy Score =  66.22807017543859

====================epoch:  93 ============================

Accuracy Score =  67.10526315789474

====================epoch:  94 ============================
```

```
Accuracy Score =  67.54385964912281

====================epoch:  95 ============================

Accuracy Score =  67.54385964912281

====================epoch:  96 ============================

Accuracy Score =  67.54385964912281

====================epoch:  97 ============================

Accuracy Score =  68.42105263157895

====================epoch:  98 ============================

Accuracy Score =  68.42105263157895

====================epoch:  99 ============================

Accuracy Score =  68.42105263157895

====================epoch:  100 ===========================

Accuracy Score =  67.54385964912281

====================epoch:  101 ===========================

Accuracy Score =  68.42105263157895

====================epoch:  102 ===========================

Accuracy Score =  68.42105263157895

====================epoch:  103 ===========================

Accuracy Score =  69.2982456140351
```

```
====================epoch:  104 ============================

Accuracy Score =  68.85964912280701

====================epoch:  105 ============================

Accuracy Score =  69.73684210526315

====================epoch:  106 ============================

Accuracy Score =  69.73684210526315

====================epoch:  107 ============================

Accuracy Score =  71.05263157894737

====================epoch:  108 ============================

Accuracy Score =  71.05263157894737

====================epoch:  109 ============================

Accuracy Score =  71.05263157894737

====================epoch:  110 ============================

Accuracy Score =  71.05263157894737

====================epoch:  111 ============================

Accuracy Score =  71.05263157894737

====================epoch:  112 ============================

Accuracy Score =  71.05263157894737

====================epoch:  113 ============================
```

```
Accuracy Score =  71.05263157894737

======================epoch:  114 ============================

Accuracy Score =  71.05263157894737

======================epoch:  115 ============================

Accuracy Score =  70.6140350877193

======================epoch:  116 ============================

Accuracy Score =  71.05263157894737

======================epoch:  117 ============================

Accuracy Score =  71.05263157894737

======================epoch:  118 ============================

Accuracy Score =  71.05263157894737

======================epoch:  119 ============================

Accuracy Score =  70.6140350877193

======================epoch:  120 ============================

Accuracy Score =  71.05263157894737

======================epoch:  121 ============================

Accuracy Score =  71.05263157894737

======================epoch:  122 ============================

Accuracy Score =  71.05263157894737
```

```
====================epoch:  123 ============================

Accuracy Score =  70.17543859649122

====================epoch:  124 ============================

Accuracy Score =  70.17543859649122

====================epoch:  125 ============================

Accuracy Score =  71.49122807017544

====================epoch:  126 ============================

Accuracy Score =  71.05263157894737

====================epoch:  127 ============================

Accuracy Score =  71.05263157894737

====================epoch:  128 ============================

Accuracy Score =  70.17543859649122

====================epoch:  129 ============================

Accuracy Score =  71.49122807017544

====================epoch:  130 ============================

Accuracy Score =  71.05263157894737

====================epoch:  131 ============================

Accuracy Score =  71.05263157894737

====================epoch:  132 ============================

Accuracy Score =  71.05263157894737
```

```
====================epoch:  133 ============================

Accuracy Score =  70.17543859649122

====================epoch:  134 ============================

Accuracy Score =  69.73684210526315

====================epoch:  135 ============================

Accuracy Score =  69.2982456140351

====================epoch:  136 ============================

Accuracy Score =  71.05263157894737

====================epoch:  137 ============================

Accuracy Score =  70.17543859649122

====================epoch:  138 ============================

Accuracy Score =  70.17543859649122

====================epoch:  139 ============================

Accuracy Score =  70.17543859649122

====================epoch:  140 ============================

Accuracy Score =  70.6140350877193

====================epoch:  141 ============================

Accuracy Score =  70.6140350877193

====================epoch:  142 ============================
```

```
Accuracy Score =  70.6140350877193

====================epoch:  143 ============================

Accuracy Score =  70.17543859649122

====================epoch:  144 ============================

Accuracy Score =  70.17543859649122

====================epoch:  145 ============================

Accuracy Score =  70.17543859649122

====================epoch:  146 ============================

Accuracy Score =  70.17543859649122

====================epoch:  147 ============================

Accuracy Score =  70.6140350877193

====================epoch:  148 ============================

Accuracy Score =  70.6140350877193

====================epoch:  149 ============================

Accuracy Score =  71.05263157894737

====================epoch:  150 ============================

Accuracy Score =  71.05263157894737

====================epoch:  151 ============================

Accuracy Score =  71.9298245614035
```

```
====================epoch:  152 ============================

Accuracy Score =  71.9298245614035

====================epoch:  153 ============================

Accuracy Score =  72.80701754385966

====================epoch:  154 ============================

Accuracy Score =  73.24561403508771

====================epoch:  155 ============================

Accuracy Score =  71.9298245614035

====================epoch:  156 ============================

Accuracy Score =  71.9298245614035

====================epoch:  157 ============================

Accuracy Score =  72.36842105263158

====================epoch:  158 ============================

Accuracy Score =  71.9298245614035

====================epoch:  159 ============================

Accuracy Score =  71.9298245614035

====================epoch:  160 ============================

Accuracy Score =  72.80701754385966

====================epoch:  161 ============================
```

```
Accuracy Score =  73.24561403508771

====================epoch:  162 ============================

Accuracy Score =  71.9298245614035

====================epoch:  163 ============================

Accuracy Score =  71.9298245614035

====================epoch:  164 ============================

Accuracy Score =  73.24561403508771

====================epoch:  165 ============================

Accuracy Score =  72.80701754385966

====================epoch:  166 ============================

Accuracy Score =  72.36842105263158

====================epoch:  167 ============================

Accuracy Score =  73.68421052631578

====================epoch:  168 ============================

Accuracy Score =  71.9298245614035

====================epoch:  169 ============================

Accuracy Score =  73.24561403508771

====================epoch:  170 ============================

Accuracy Score =  72.80701754385966
```

```
====================epoch:  171 ============================

Accuracy Score =  72.80701754385966

====================epoch:  172 ============================

Accuracy Score =  73.24561403508771

====================epoch:  173 ============================

Accuracy Score =  73.68421052631578

====================epoch:  174 ============================

Accuracy Score =  73.24561403508771

====================epoch:  175 ============================

Accuracy Score =  73.68421052631578

====================epoch:  176 ============================

Accuracy Score =  74.56140350877193

====================epoch:  177 ============================

Accuracy Score =  74.12280701754386

====================epoch:  178 ============================

Accuracy Score =  73.68421052631578

====================epoch:  179 ============================

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====================epoch:  486 ============================

Accuracy Score =  78.94736842105263

====================epoch:  487 ============================

Accuracy Score =  78.0701754385965
```
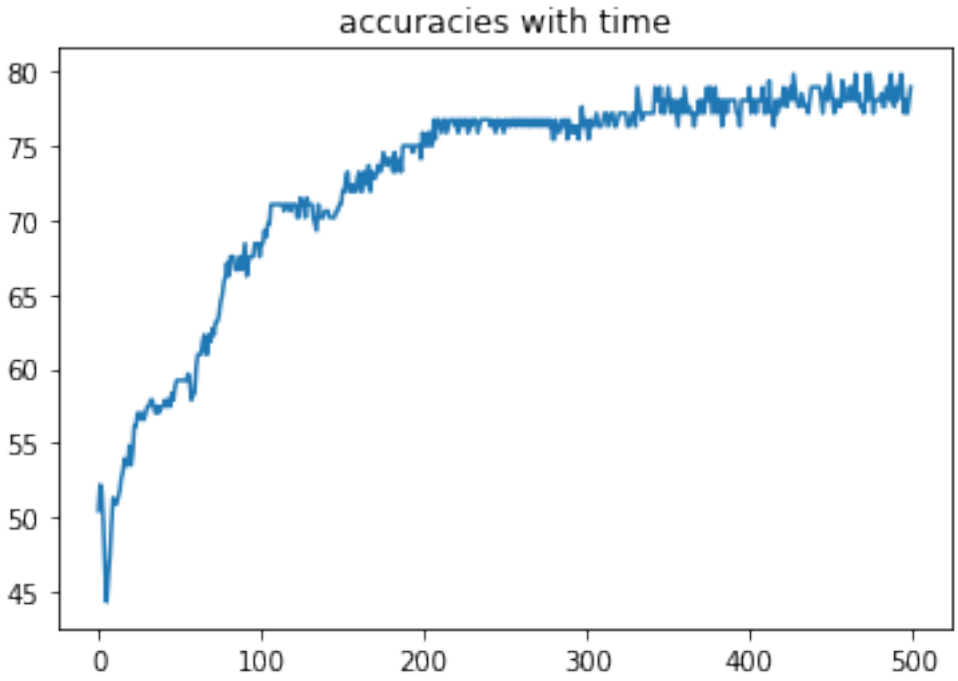

```
====================epoch:  488 ============================
Accuracy Score =  79.82456140350878

====================epoch:  489 ============================
Accuracy Score =  78.0701754385965

====================epoch:  490 ============================
Accuracy Score =  77.63157894736842

====================epoch:  491 ============================
Accuracy Score =  78.94736842105263

====================epoch:  492 ============================
Accuracy Score =  78.0701754385965

====================epoch:  493 ============================
Accuracy Score =  78.94736842105263

====================epoch:  494 ============================
Accuracy Score =  79.82456140350878

====================epoch:  495 ============================
Accuracy Score =  78.94736842105263

====================epoch:  496 ============================
Accuracy Score =  77.19298245614034

====================epoch:  497 ============================
```

```
Accuracy Score =  78.0701754385965

======================epoch:  498 ============================

Accuracy Score =  77.19298245614034

======================epoch:  499 ============================

Accuracy Score =  78.0701754385965

======================epoch:  500 ============================

Accuracy Score =  78.94736842105263
```




```
best weights:  [-0.023625211146979477, 0.018778728412125, 0.09687985869456792,
-0.01600469695446354, 0.4360274262594645, -0.002196244230574364]
```

[46]:
```
best_weights = [-0.04474501103384887, 0.019309246725076966, 0.09594388284299246,
-0.03536095737989012, 0.46637396064940045, 0.021523510357524298]
bestn1 = Node(best_weights[0])
bestn2 = Node(best_weights[1])
bestn3 = Node(best_weights[2])
```

```
bestn4 = Node(best_weights[3])
bestn5 = Node(best_weights[4])
bestn6 = Node(best_weights[5])
best_model = slp(thresh, c, [bestn1, bestn2, bestn3, bestn4, bestn5, bestn6])
```

[47]:
```
testdf = pd.read_csv('LogRes_Test.csv')
testdf = testdf.sample(frac = 1)
testdf.head()
```

[47]:

	Latitude	Longitude	Altitude	min Temo	Max Temp	Sunshine Hour	Solar Radiation
2	25.34	91.53	1598	19.1	20.2	3.100000	0
1	28.35	77.12	216	9.1	19.9	0.621429	0
26	8.50	76.90	64	24.6	28.7	0.550000	1
3	25.34	91.53	1598	9.4	10.5	5.800000	0
42	8.50	76.90	64	25.4	32.2	0.642857	1

[48]:
```
x_test = testdf.iloc[:,:6]
x_test = x_test.to_numpy()
x_test = normalize(x_test)

y_test = testdf.iloc[:,6]
y_test = y_test.to_numpy()
```

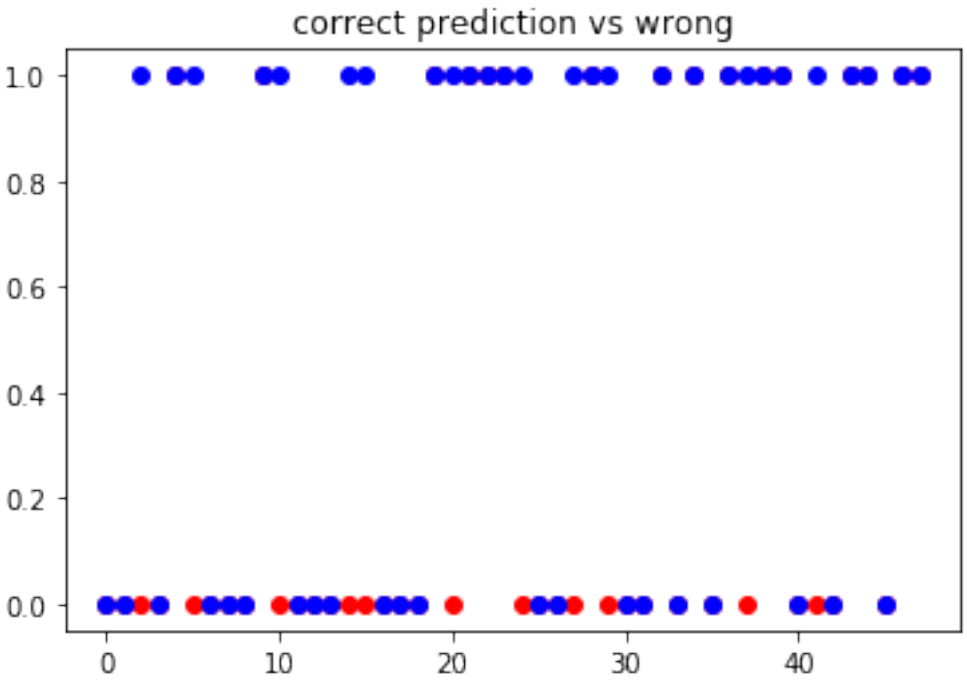
[50]:
```
y_pred = best_model.testing(x_test, y_test)
```

```
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  1 | predicted =  0
desired =  0 | predicted =  0
desired =  1 | predicted =  1
desired =  1 | predicted =  0
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  1 | predicted =  1
desired =  1 | predicted =  0
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  1 | predicted =  0
```

```
desired =  1 | predicted =  0
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  1 | predicted =  1
desired =  1 | predicted =  0
desired =  1 | predicted =  1
desired =  1 | predicted =  1
desired =  1 | predicted =  1
desired =  1 | predicted =  0
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  1 | predicted =  0
desired =  1 | predicted =  1
desired =  1 | predicted =  0
desired =  0 | predicted =  0
desired =  0 | predicted =  0
desired =  1 | predicted =  1
desired =  0 | predicted =  0
desired =  1 | predicted =  1
desired =  0 | predicted =  0
desired =  1 | predicted =  1
desired =  1 | predicted =  0
desired =  1 | predicted =  1
desired =  1 | predicted =  1
desired =  0 | predicted =  0
desired =  1 | predicted =  0
desired =  0 | predicted =  0
desired =  1 | predicted =  1
desired =  0 | predicted =  0
desired =  1 | predicted =  1
desired =  1 | predicted =  0
accuracy =  0.7708333333333334 correct:  37
```

[51]:
```
import matplotlib.pyplot as plt
```

[52]:
```
plt.plot(y_pred, 'ro')
plt.plot(y_test, 'bo')
plt.title('correct prediction vs wrong')
plt.show()
```



[53]:
```
mets = best_model.metrics(x_test, y_test)
```

```
Confusion Matrix:
[ [16, 0]
 [11, 21] ]
accuracy:  0.7708333333333334
precision:  1.0
recall:  0.5925925925925926
specificity:  1.0
f1 score:  2.3703703703703702
```

[ ]:
```

```