accuracy - ffaANN MLP V0.1

May 20, 2022

[ ]:

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[1]:

```
import math
import numpy as np
import pandas as pd
# import seaborn as sns
# import matplotlib.pyplot as plt

# from sklearn.preprocessing import LabelEncoder
# from sklearn.preprocessing import OneHotEncoder
from sklearn.preprocessing import LabelBinarizer
from sklearn import preprocessing
from scipy.special import expit

from numpy.random import default_rng

from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score

import time

from accffaAnn_thread_V_I import *



class MultiLayerPerceptron():
    # ================== Activation Functions ================ #

    # accepts a vector or list and returns a list after performing␣
↪corresponding function on all elements

    @staticmethod
    def sigmoid(vectorSig):
        """returns 1/(1+exp(-x)), where the output values lies between zero and␣
↪one"""
        sig = expit(vectorSig)
```

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        return sig

    @staticmethod
    def binaryStep(x):
        """ It returns '0' is the input is less then zero otherwise it returns␣
↪one """
        return np.heaviside(x, 1)

    @staticmethod
    def linear(x):
        """ y = f(x) It returns the input as it is"""
        return x

    @staticmethod
    def tanh(x):
        """ It returns the value (1-exp(-2x))/(1+exp(-2x)) and the value␣
↪returned will be lies in between -1 to 1"""
        return np.tanh(x)

    @staticmethod
    def relu(x):  # Rectified Linear Unit
        """ It returns zero if the input is less than zero otherwise it returns␣
↪the given input"""
        x1 = []
        for i in x:
            if i < 0:
                x1.append(0)
            else:
                x1.append(i)

        return x1

    @staticmethod
    def leakyRelu(x):
        """ It returns zero if the input is less than zero otherwise it returns␣
↪the given input"""
        x1 = []
        for i in x:
            if i < 0:
                x1.append((0.01 * i))
            else:
                x1.append(i)

        return x1

    @staticmethod
    def parametricRelu(self, a, x):
```

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        """ It returns zero if the input is less than zero otherwise it returns␣
↪the given input"""
        x1 = []
        for i in x:
            if i < 0:
                x1.append((a * i))
            else:
                x1.append(i)

        return x1

    @staticmethod
    def softmax(self, x):
        """ Compute softmax values for each sets of scores in x"""
        return np.exp(x) / np.sum(np.exp(x), axis=0)

    # ============ Activation Functions Part Ends ============= #

    # ================= Distance Calculation ================== #

    @staticmethod
    def chebishev(self, cord1, cord2, exponent_h):
        dist = 0.0
        if ((type(cord1) == int and type(cord2) == int) or ((type(cord1) ==␣
↪float and type(cord2) == float))):
            dist = math.pow((cord1 - cord2), exponent_h)
        else:
            for i, j in zip(cord1, cord2):
                dist += math.pow((i - j), exponent_h)
        dist = math.pow(dist, (1.0 / exponent_h))
        return dist

    @staticmethod
    def minimum_distance(self, cord1, cord2):
        # min(|x1-y1|, |x2-y2|, |x3-y3|, ...)
        dist = float('inf')
        if ((type(cord1) == int and type(cord2) == int) or ((type(cord1) ==␣
↪float and type(cord2) == float))):
            dist = math.fabs(cord1 - cord2)
        else:
            for i, j in zip(cord1, cord2):
                temp_dist = math.fabs(i - j)
                if (temp_dist < dist):
                    dist = temp_dist
        return dist

    @staticmethod
```

```python
    def maximum_distance(self, cord1, cord2):
        # max(|x1-y1|, |x2-y2|, |x3-y3|, ...)
        dist = float('-inf')
        if ((type(cord1) == int and type(cord2) == int) or ((type(cord1) ==␣
↪float and type(cord2) == float))):
            dist = math.fabs(cord1 - cord2)
        else:
            for i, j in zip(cord1, cord2):
                temp_dist = math.fabs(i - j)
                if (temp_dist > dist):
                    dist = temp_dist
        return dist

    @staticmethod
    def manhattan(self, cord1, cord2):
        # |x1-y1| + |x2-y2| + |x3-y3| + ...
        dist = 0.0
        if ((type(cord1) == int and type(cord2) == int) or ((type(cord1) ==␣
↪float and type(cord2) == float))):
            dist = math.fabs(cord1 - cord2)
        else:
            for i, j in zip(cord1, cord2):
                dist += math.fabs(i - j)
        return dist

    @staticmethod
    def eucledian(self, cord1, cord2):
        dist = 0.0
        if ((type(cord1) == int and type(cord2) == int) or ((type(cord1) ==␣
↪float and type(cord2) == float))):
            dist = math.pow((cord1 - cord2), 2)
        else:
            for i, j in zip(cord1, cord2):
                dist += math.pow((i - j), 2)
        return math.pow(dist, 0.5)

    # =========== Distance Calculation Ends ============== #

    def __init__(self, dimensions=(8, 5), all_weights=(0.1, 0.2),␣
↪fileName="iris"):

        """
        Args:
            dimensions : dimension of the neural network
            all_weights : the optimal weights we get from the bio-algoANN models
        """
```

```
        self.allPop_Weights = []
        self.allPopl_Chromosomes = []
        self.allPop_ReceivedOut = []
        self.allPop_ErrorVal = []

        self.all_weights = all_weights

        self.fitness = []

        # ================== Input dataset and corresponding output␣
↪======================== #

        self.fileName = fileName
        self.fileName += ".csv"
        data = pd.read_csv(self.fileName)

        classes = []
        output_values_expected = []
        input_values = []

        # ~~~~ encoding ~~~~#

        # labelencoder = LabelEncoder()
        # data[data.columns[-1]] = labelencoder.fit_transform(data[data.
↪columns[-1]])

        # one hot encoding - for multi-column
        # enc = OneHotEncoder(handle_unknown='ignore')
        # combinedData = np.vstack((data[data.columns[-2]], data[data.
↪columns[-1]])).T
        # print(combinedData)
        # y = enc.fit_transform(combinedData).toarray()
        # y = OneHotEncoder().fit_transform(combinedData).toarray()

        #
        y = LabelBinarizer().fit_transform(data[data.columns[-1]])
        # print(y)

        # ~~~~ encoding ends~~~~#

        for j in range(len(data)):
            output_values_expected.append(y[j])

        # print(output_values_expected)

        input_values = []
        for j in range(len(data)):
```

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            b = []
            for i in range(1, len(data.columns) - 1):
                b.append(data[data.columns[i]][j])
            input_values.append(b)

        self.X = input_values[:]
        self.Y = output_values_expected[:]

        # input and output
        self.X = input_values[:]
        self.Y = output_values_expected[:]

        self.dimension = dimensions
        # print(self.dimension)

        # ================ Finding Initial Weights ================ #

        self.pop = []  # weights
        reshaped_all_weights = []
        start = 0
        for i in range(len(self.dimension) - 1):
            end = start + self.dimension[i + 1] * self.dimension[i]
            temp_arr = self.all_weights[start:end]
            w = np.reshape(temp_arr[:], (self.dimension[i + 1], self.
↪dimension[i]))
            reshaped_all_weights.append(w)
            start = end
        self.pop.append(reshaped_all_weights)

        self.init_pop = self.all_weights

    # ================ Initial Weights Part Ends ================ #


    def Predict(self, chromo):
        # X, Y and pop are used
        self.fitness = []
        total_error = 0
        m_arr = []
        k1 = 0
        for i in range(len(self.dimension) - 1):
            p = self.dimension[i]
            q = self.dimension[i + 1]
            k2 = k1 + p * q
            m_temp = chromo[k1:k2]
            m_arr.append(np.reshape(m_temp, (p, q)))
            k1 = k2
```

```python
        y_predicted = []
        for x, y in zip(self.X, self.Y):

            yo = x

            for mCount in range(len(m_arr)):
                yo = np.dot(yo, m_arr[mCount])
                yo = self.sigmoid(yo)

            # converting to sklearn acceptable form
            max_yo = max(yo)
            for y_vals in range(len(yo)):
                if(yo[y_vals] == max_yo):
                    yo[y_vals] = 1
                else:
                    yo[y_vals] = 0
            y_predicted.append(yo)
        return (y_predicted, self.Y)

    def main(self):
        Y_PREDICT, Y_ACTUAL = self.Predict(self.init_pop)
        Y_PREDICT = np.array(Y_PREDICT)
        Y_ACTUAL = np.array(Y_ACTUAL)

        n_classes = 3

        label_binarizer = LabelBinarizer()
        label_binarizer.fit(range(n_classes))
        Y_PREDICT = label_binarizer.inverse_transform(np.array(Y_PREDICT))
        Y_ACTUAL = label_binarizer.inverse_transform(np.array(Y_ACTUAL))

        # find error

        #print("\n Actual / Expected", Y_ACTUAL)
        #print("\n Predictions", Y_PREDICT)
        #print("\n\nConfusion Matrix")
        #print(confusion_matrix(Y_ACTUAL, Y_PREDICT))

        #print("\n\nClassification Report")
        target_names = ['class 0', 'class 1', 'class 2']
        #print(classification_report(Y_ACTUAL, Y_PREDICT,␣
↪target_names=target_names))
        #print("\n\n\n")
        return accuracy_score(Y_ACTUAL, Y_PREDICT)
```

[6]:

```python
start_time = time.time()
i = InputData(fileName="iris")
input_val, output_val = i.main()
end_time = time.time()
print("Time for inputting data : ", end_time - start_time)

print("============ Calling FFA to get best weights ===============")

start_time = time.time()
a = ffaAnn(initialPopSize=100, m=10, dimensions = [100,10],␣
↪input_values=input_val, output_values_expected=output_val, iterations = 100)

fit, b, weights, dim, all_gen_best_weight = a.main()

end_time = time.time()
print("Time taken : ", end_time - start_time)

print("\n Fitness : ", fit, "\n Best Weights : ", weights, "\n Dimensions : ",␣
↪dim)



import matplotlib.pyplot as plt
x=b[:]
z=[i for i in range(0,100)]
plt.plot(z,x)

plt.title("Firefly Algorithm")
plt.ylabel("Fitness")
plt.xlabel("Iterations")
end_time = time.time()
print("Time Taken : ", end_time - start_time)
```

```
Time for inputting data :  0.028992414474487305
============ Calling FFA to get best weights ===============
--------------GENERATION 0-----------
Initial worst fitness =  939.1697997791503

 Initial best fitness =  368.3201652603337
--------------GENERATION 1-----------
--------------GENERATION 2-----------
--------------GENERATION 3-----------
hi
hi
hi
hi
hi
```

```
hi
hi
hi
hi
hi
--------------GENERATION 4-----------
--------------GENERATION 5-----------
--------------GENERATION 6-----------
--------------GENERATION 7-----------
--------------GENERATION 8-----------
--------------GENERATION 9-----------
--------------GENERATION 10-----------
--------------GENERATION 11-----------
--------------GENERATION 12-----------
--------------GENERATION 13-----------
--------------GENERATION 14-----------
--------------GENERATION 15-----------
--------------GENERATION 16-----------
--------------GENERATION 17-----------
--------------GENERATION 18-----------
hi
hi
hi
hi
hihi

hi
hi
hi
hi
--------------GENERATION 19-----------
hi
hi
hi
hi
hi
hi
hihi
hi

hi
--------------GENERATION 20-----------
hi
hihi
hi

hi
hihi
```

```
hi
hi
hi
--------------GENERATION 21-----------
--------------GENERATION 22-----------
hi
hi
hi
hi
hi
hi
hihi

hi
hi
--------------GENERATION 23-----------
--------------GENERATION 24-----------
--------------GENERATION 25-----------
--------------GENERATION 26-----------
--------------GENERATION 27-----------
--------------GENERATION 28-----------
--------------GENERATION 29-----------
--------------GENERATION 30-----------
--------------GENERATION 31-----------
--------------GENERATION 32-----------
--------------GENERATION 33-----------
--------------GENERATION 34-----------
--------------GENERATION 35-----------
--------------GENERATION 36-----------
--------------GENERATION 37-----------
--------------GENERATION 38-----------
--------------GENERATION 39-----------
--------------GENERATION 40-----------
--------------GENERATION 41-----------
--------------GENERATION 42-----------
--------------GENERATION 43-----------
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--------------GENERATION 50-----------
--------------GENERATION 51-----------
--------------GENERATION 52-----------
--------------GENERATION 53-----------
--------------GENERATION 54-----------
```

```
--------------GENERATION 55-----------
--------------GENERATION 56-----------
--------------GENERATION 57-----------
--------------GENERATION 58-----------
--------------GENERATION 59-----------
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--------------GENERATION 61-----------
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--------------GENERATION 65-----------
--------------GENERATION 66-----------
--------------GENERATION 67-----------
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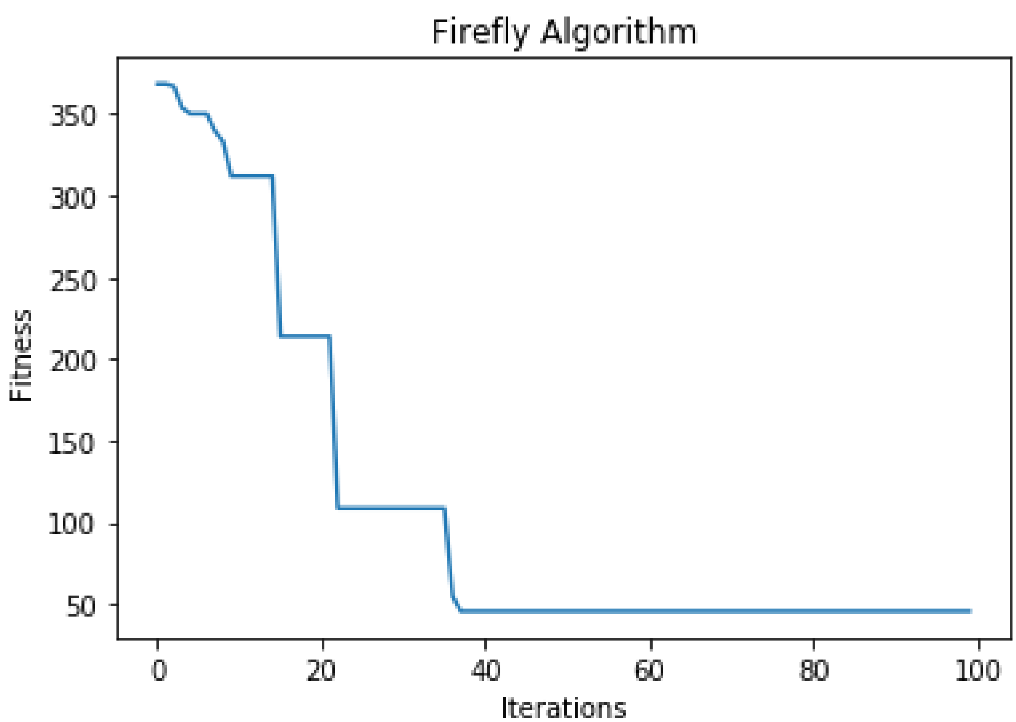
--------------GENERATION 84-----------
--------------GENERATION 85-----------
--------------GENERATION 86-----------
--------------GENERATION 87-----------
--------------GENERATION 88-----------
--------------GENERATION 89-----------
--------------GENERATION 90-----------
--------------GENERATION 91-----------
--------------GENERATION 92-----------
--------------GENERATION 93-----------
--------------GENERATION 94-----------
--------------GENERATION 95-----------
--------------GENERATION 96-----------
--------------GENERATION 97-----------
--------------GENERATION 98-----------
--------------GENERATION 99-----------
Fitness :  45.52211760841647
Time taken :  168.88895511627197
```

Fitness : 45.52211760841647
Best Weights : [12, 1, 19, 12, 0, 18, 25, -3, 2, -7, -13, 0, 0, -5, -18, 0,
15, 2, 4, -17, -11, -13, -10, -6, 3, 10, 2, 6, 7, -1, 17, 9, -3, -7, -20, 14,
-18, 0, -20, 0, 11, 15, -14, -5, 13, 0, 6, -2, 2, -23, 0, 3, -21, 7, 0, 3, 1, 1,
-9, 19, -10, 0, 0, 15, 1, 0, -1, 11, -6, -5, 3, 13, 0, 7, -1, -9, 3, -15, -17,
13, -24, 9, 0, 0, 13, -18, -18, -10, -32, -4, -2, 2, -1, 24, 10, -3, -17, 1, 10,
4, 27, 10, 10, 1, 8, 13, 9, -14, 0, -4, -1, 7, 5, 15, -14, 1, 16, 1, 16, -4, 14,
8, 0, 16, -4, 24, 16, 0, 2, -10, 26, 1, 21, 0, -5, 3, 16, 14, 5, 0, -16, -25,
-9, -4, 0, 12, 17, -15, -1, -12, 0, 0, 6, -7, 4, -4, 0, -13, -5, 14, -6, -9, 0,
-22, 0, -11, 10, 0, -13, -3, -13, -6, 0, -25, 16, -24, 15, 3, -4, 9, 0, 1, 0, 0,
16, -2, 0, 6, -7, -11, -4, -5, 18, -5, -6, -16, -2, -3, -8, -1, 12, 6, -4, 23,
5, -12, -14, -12, 0, -5, 16, -4, -3, -17, -2, -1, 0, -23, -1, 0, 12, 0, -6, -1,
20, 18, -7, -20, 14, -15, -26, 18, -13, -1, 12, -1, 22, 4, 17, 9, 5, -3, 3, 21,
13, 22, -2, -19, 3, 1, -10, 3, 0, -24, 0, -25, 0, 0, 15, 13, 12, -3, -11, 4,
-12, 7, -1, 2, 0, 0, 13, 35, 6, 4, -4, -7, 6, -1, 4, -3, 0, -2, -24, -1, -15,
-1, -11, 12, 12, -1, 29, 13, -5, -15, -10, -5, -15, 21, -4, 0, 2, -8, -11, 3,
-6, -2, 0, -10, -20, 10, 1, -7, 0, 13, 2, -21, -24, 9, -5, 2, 9, -4, 14, 8, 0,
-3, 28, -21, 8, -11, 0, -8, -2, -7, -5, 8, -17, -1, -1, -30, 4, -11, 3, 0, 1,
-13, 4, 10, 16, 6, -19, 24, 8, 22, 5, 1, 0, 0, 0, -20, -16, 25, -15, -2, -2, -9,
3, 8, 0, -2, -10, -18, -8, -14, 4, 0, -5, 8, 13, -1, -17, 7, 15, 7, 21, 4, -22,
-15, -18, -23, 1, 10, 24, 12, -5, 3, 1, -8, 4, 16, 14, 3, -6, 29, -12, -32, 5,
0, -13, -2, -21, -15, 26, 11, 7, 2, 7, -7, -1, -17, -18, 1, -21, -19, 3, -26,
10, -1, 4, -20, 5, 11, 12, -1, -11, 20, 0, 0, 0, -11, 13, -22, 7, -15, -8, 0, 0,
12, 9, 15, -13, -11, 3, -5, -6, 22, 19, 17, 1, 5, -1, -1, -8, -13, 1, 31, 5, -7,
-6, 8, 10, 5, 21, -14, -15, 10, -2, -16, 8, -27, -21, 22, 23, 3, 4, 0, 14, -4,
11, 9, 8, -9, 7, 4, 0, 6, -16, 20, -13, 0, 17, -15, 0, 0, 9, 22, 0, 20, -1, -7,
-6, -4, -11, -17, 0, -19, 1, 8, -3, 0, -3, 8, 0, 9, -4, -2, 14, 7, 14, -6, 22,
15, -4, -4, 0, -7, 13, -1, 11, -11, -16, -34, 2, -16, 5, 1, 24, -15, -14, 14,
-4, -4, 7, 8, 6, 14, 2, -4, -19, 0, -18, -9, -14, 0, 0, -2, 5, 0, 8, 6, 9, 2, 6,
-19, -10, -6, 0, 15, 14, -12, -15, 5, 9, -9, -6, -1, 30, 1, -14, -3, -17, -6,
21, -3, -26, -1, 11, 11, 0, 14, 16, 17, -12, -26, 6, 0, 0, 13, 16, -16, 11, -14,
0, 3, 4, 17, -4, 0, 24, 8, -4, -9, -20, 15, 15, 14, 0, 3, 0, -10, -10, -19, -19,
-18, -1, -6, 14, -36, -5, 0, -20, -20, -13, -11, -1, -19, -4, -2, -16, -13, 14,
-1, 3, 0, -10, 0, 9, -18, -5, -11, -7, 6, 12, -1, -4, 16, -21, 11, -4, 11, -5,
7, -1, 15, -2, 2, -14, 5, 4, -6, -12, 9, 3, -1, 13, -11, -12, -23, -3, 10, -18,
-9, 0, 0, 16, 0, -12, -17, -12, 22, -3, -7, 0, -6, -19, 1, -2, -6, -15, -9, 9,
3, -2, 4, -7, 1, 11, 4, -24, 26, 17, 15, 6, 12, -10, 30, 1, -18, 10, 0, 4, 8, 6,
0, -19, -7, -1, 0, 0, -1, 0, -10, 0, -10, -10, 4, 21, 18, 25, 0, 1, -16, -4, 5,
11, -26, 0, 1, 7, -1, -5, 8, -8, -3, 19, -1, 12, 0, -5, -2, 3, 2, -16, -15, 0,
2, 2, 2, 22, 8, -8, -21, -5, 16, 17, 0, 29, 9, -11, -13, -2, 4, -3, 7, -8, 4,
-8, 1, 0, -14, 15, 16, 2, -6, 2, 0, -8, -1, 3, -24, -18, -3, 0, 8, -3, -16, 21,
3, 0, -10, 14, 10, -13, 1, 18, -4, 8, -18, 19, -1, 8, -19, -2, 0, -16, 31, -17,
31, 0, -5, -5, -1, -2, 15, -18, -9, 3, 16, 0, -3, -6, 1, -2, 12, 13, 4, 19, -1,
2, -7, 11, 4, -4, -16, 0, 2, -7, 3, -1, 0, -11, 18, 11, 8, 6, 4, 2, 0, 0, 9,
-15, -10, -9, -8, 9, -2, 2, -11, -14, 18, 11, 8, -7, -4, 6, 9, 0, 10, -13, 0, 0,
-3, 21, 24, 5, 2, 13, 2, 15, 28, -17, 9, 10, 17, 1, 0, 0, 10, 10, -14, -2, -20,
-14, 4, 24, 0, 0, -17, 0, -5, -13, 7, 16, 0, -2, 17, 17, -7, 23, 12, 0, -12,
-20, -1, 8, 3, 1, 6, 3, 7, -23, 17, -5, 14, -5, -7, 11, 21, 9, -15, -17, 4, 7,

```
13, 1, 0, -3, -10, -7, 21, 23, -2, -9, 12, 4, -1, -17, 0, 20, 3, 2, -24, 29, -4,
0, -1, -19, -13, 22, 0, 0, 1, 18, 0, -22, 3, -8, -18, 3, 0, 2, -6, -7, 18, 0, 0,
17, -13, -4, -15, 2, 10, -3, 7, 2, 18, -2, 0, 2, 8, 1, -10, 15, 16, -11, 6, 5,
16, -3, 16, 0, 0, -5, 19, 1, -6, 11, -4, 7, -2, -20, -6, -9, 0, 9, -11, 0, 15,
5, 9, -6, 20, -20, -25, 0, 4, -8, -7, 15, 9, -12, -19, -1, -12, -24, 9, 6, 1,
-26, -7, -25, 9, 5, 13, 5, -12, 18, 2, -1, -9, 0, 9, 4, -3, 0, 6, 5, 8, 4, -19,
4, -5, 17, -18, -33, -1, -17, 0, 28, -15, -3, -10, -34, 0, 6, 3, -12, 7, -14, 0,
1, 16, -21, -5, -1, 18, 12, 0, -13, 0, 3, 9, 1, 0, 9, -17, 19, 2, 15, 6, 4, 4,
0, 1, -12, 10, 5, -3, 3, -15, 13, 4, 20, -19, 7, 3, 21, 0, 0, -5, -16, -4, 19,
0, 0, 10, 1, 2, -27, -14, -1, 16, 9, -4, -9, 4, 0, -1, 1, 5, 27, -2, 10, -12, 2,
0, -2, 19, 0, -1, -10, -8, -8, -15, 26, 4, -15, -4, -15, 2, 7, 1, 13, -8, -8,
-1, 9, -1, -14, 8, 3, -1, 8, 11, -13, 0, -14, -10, -20, 0, -11, 20, -17, 18, 16,
-5, -15, 20, 22, -10, 0, -9, 0, -12, -11, 0, -20, -1, 18, -7, 15, -5, 11, 2, 4,
-6, 13, 0, 8, 4, -1, -16, -2, 4, 25, 8, 11, -19, -12, -1, 9, 13, -11, 5, -28,
-16, 13, 6, 16, 4, 4, 4, 0, -14, 0, -6, -8, -2, 22, -4, 0, -3, -4, -1, -1, -8,
0, -12, -2, -3, 7, -8, -16, -2, 5, -14, 2, 4, -14, 19, 5, 2, 0, 0, -8, 0, -18,
0, -11, -10, 14, 0, 25, 8, -35, 4, 4, 0, 0, 0, 0, 18, 9, 18, 0, 4, -20, 1, 18,
-22, 5, 9, -2, 0, 0, 0, 6, 8, 9, 33, -5, -1, -6, 3, -2, -3, 8, 1, 27, 5, -18, 9,
-9, -1, -1, -18, 0, -17, 10, 6, -13, 0, 17, 0, 20, 6, 16, -7, 3, -18, 9, 20,
-15, -19, 5, 1, -2, 4, 1, -13, 5, 0, -4, -3, -10, -19, -1, -2, 1, 8, -2, 0, 0,
-9, 12, -8, -6, 1, -14, -1, 5, 7, -4, 11, -29, 9, 25, -1, -15, -6, -6, 5, 13, 8,
0, -8, -14, 4, -25, 8, 14, -15, -15, -3, 9, 5, -12, 19, -10, 0, -19, -9, 11, 5,
11, -20, 15, -10, -1, 7]
 Dimensions :  [4, 100, 10, 3]
Time Taken :  168.90278959274292
```



[7]:
```
print("\n\n============= MLP Program Begins ============")

start_time = time.time()
print("Training")
m = MultiLayerPerceptron(fileName="iris_train", dimensions=dim,␣
 ↪all_weights=weights)
m.main()
end_time = time.time()
print("Time taken = ", end_time - start_time)
```

```


============= MLP Program Begins ============
Training
Time taken =  0.019589900970458984
```

[8]:
```
start_time = time.time()
print("Testing")
m = MultiLayerPerceptron(fileName="iris_test", dimensions=dim,␣
 ↪all_weights=weights)
m.main()

end_time = time.time()
print("Time taken = ", end_time - start_time)
```

```
Testing
Time taken =  0.008346796035766602
```

[9]:
```
all_accuracy = []
for weights in all_gen_best_weight:
    m = MultiLayerPerceptron(fileName="iris_train", dimensions=[4,100,10,3],␣
 ↪all_weights=weights)
    accuracy_val = m.main()
    print(accuracy_val)
    all_accuracy.append(accuracy_val)

import matplotlib.pyplot as plt
x=all_accuracy[:]
z=[i for i in range(len(x))]
plt.plot(z,x)

plt.title("Firefly Algorithm")
plt.ylabel("Accuracy")
plt.xlabel("Iterations")
```

```
0.5583333333333333
```

```
0.5583333333333333
0.35
0.5583333333333333
0.44166666666666665
0.44166666666666665
0.44166666666666665
0.625
0.45
0.6583333333333333
0.6583333333333333
0.6583333333333333
0.6583333333333333
0.6583333333333333
0.6583333333333333
0.6666666666666666
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```
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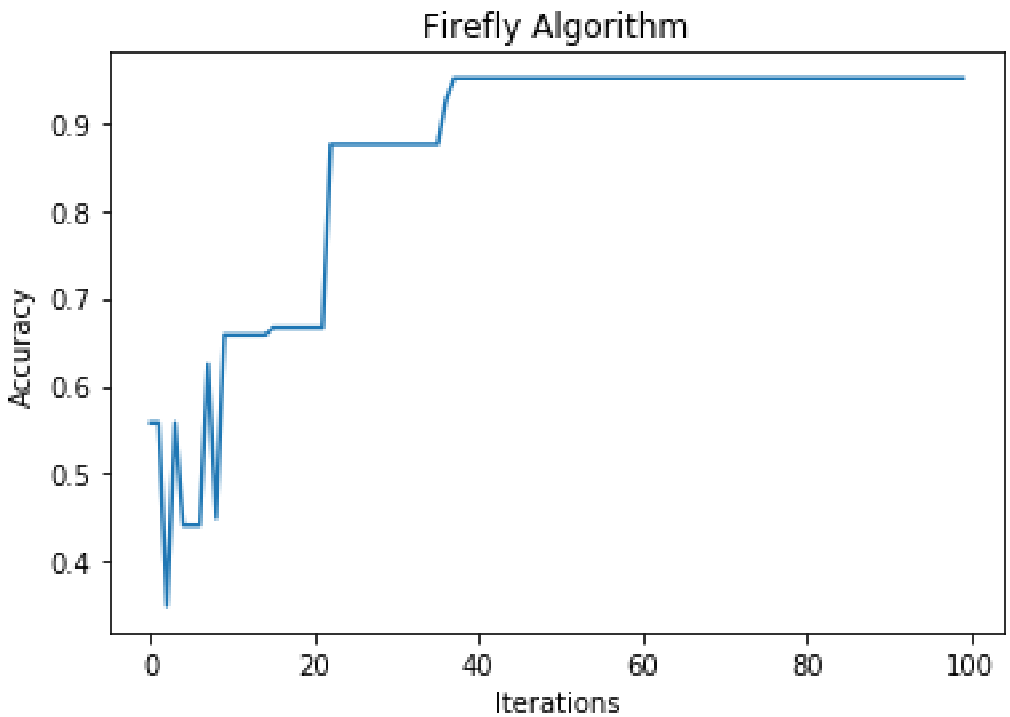
```

[9]: Text(0.5,0,'Iterations')



[ ]: