In [1]:

```
# Import Libraries
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
```

In [2]:

```
# Load dataset
data =pd.read_csv("iris.csv")
data.head(5)
```

Out[2]:

	sepal.length	sepal.width	petal.length	petal.width	variety
0	5.1	3.5	1.4	0.2	Setosa
1	4.9	3.0	1.4	0.2	Setosa
2	4.7	3.2	1.3	0.2	Setosa
3	4.6	3.1	1.5	0.2	Setosa
4	5.0	3.6	1.4	0.2	Setosa

In [3]:

```
X = data[['sepal.length', 'sepal.width', 'petal.length', 'petal.width']].values
y = data['variety'].values
```

In [5]:

```
X
```

```
       [5.8, 2.7, 5.1, 1.9],
       [7.1, 3. , 5.9, 2.1],
       [6.3, 2.9, 5.6, 1.8],
       [6.5, 3. , 5.8, 2.2],
       [7.6, 3. , 6.6, 2.1],
       [4.9, 2.5, 4.5, 1.7],
       [7.3, 2.9, 6.3, 1.8],
       [6.7, 2.5, 5.8, 1.8],
       [7.2, 3.6, 6.1, 2.5],
       [6.5, 3.2, 5.1, 2. ],
       [6.4, 2.7, 5.3, 1.9],
       [6.8, 3. , 5.5, 2.1],
       [5.7, 2.5, 5. , 2. ],
       [5.8, 2.8, 5.1, 2.4],
       [6.4, 3.2, 5.3, 2.3],
       [6.5, 3. , 5.5, 1.8],
       [7.7, 3.8, 6.7, 2.2],
       [7.7, 2.6, 6.9, 2.3],
       [6. , 2.2, 5. , 1.5],
       [6.9, 3.2, 5.7, 2.3],
```

In [7]:

```
y
```

```
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
```

In [7]:
```
y
```

```
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Versicolor',
       'Versicolor', 'Versicolor', 'Versicolor', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica', 'Virginica', 'Virginica',
       'Virginica', 'Virginica', 'Virginica'], dtype=object)
```

In [8]:
```
# Get dummy variable
y = pd.get_dummies(y).values

y[:3]
```

Out[8]:
```
array([[1, 0, 0],
       [1, 0, 0],
       [1, 0, 0]], dtype=uint8)
```

In [9]:
```
#Split data into train and test data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=20, random_st
```

In [10]:
```
# Initialize variables
learning_rate = 0.1
iterations = 5000
N = y_train.size

# number of input features
input_size = 4

# number of hidden layers neurons
hidden_size = 2

# number of neurons at the output layer
output_size = 3

results = pd.DataFrame(columns=["mse", "accuracy"])
```

In [11]:
```
# Initialize weights
np.random.seed(10)
```

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```
# Initialize weights
np.random.seed(10)

# initializing weight for the hidden layer
W1 = np.random.normal(scale=0.5, size=(input_size, hidden_size))

# initializing weight for the output layer
W2 = np.random.normal(scale=0.5, size=(hidden_size , output_size))
```

In [12]:

```
def sigmoid(x):
    return 1 / (1 + np.exp(-x))

def mean_squared_error(y_pred, y_true):
    return ((y_pred - y_true)**2).sum() / (2*y_pred.size)

def accuracy(y_pred, y_true):
    acc = y_pred.argmax(axis=1) == y_true.argmax(axis=1)
    return acc.mean()
```

In [13]:

```
for i in range(iterations):

    # feedforward propagation
    # on hidden layer
    Z1 = np.dot(X_train, W1)
    A1 = sigmoid(Z1)

    # on output layer
    Z2 = np.dot(A1, W2)
    A2 = sigmoid(Z2)


    # Calculating error
    mse = mean_squared_error(A2, y_train)
    acc = accuracy(A2, y_train)
    results=results.append({"mse":mse, "accuracy":acc},ignore_index=True )

    # backpropagation
    E1 = A2 - y_train
    dW1 = E1 * A2 * (1 - A2)

    E2 = np.dot(dW1, W2.T)
    dW2 = E2 * A1 * (1 - A1)


    # weight updates
    W2_update = np.dot(A1.T, dW1) / N
    W1_update = np.dot(X_train.T, dW2) / N

    W2 = W2 - learning_rate * W2_update
    W1 = W1 - learning_rate * W1_update
```

In [14]:

```
results.mse.plot(title="Mean Squared Error")
```

Out[14]:

```
<AxesSubplot:title={'center':'Mean Squared Error'}>
```

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```
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```
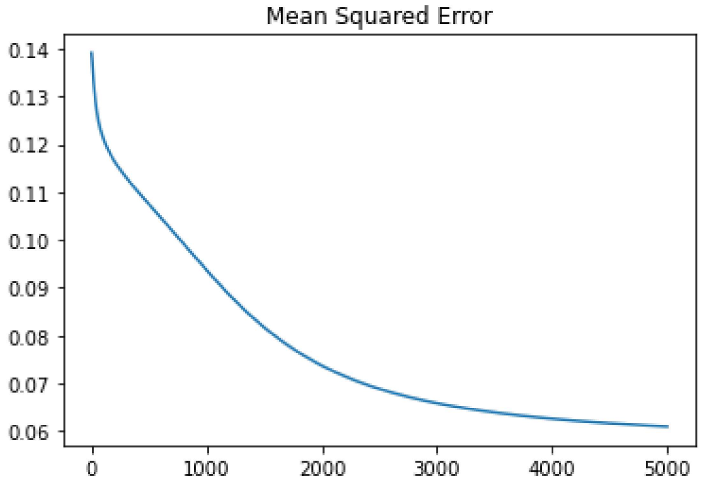
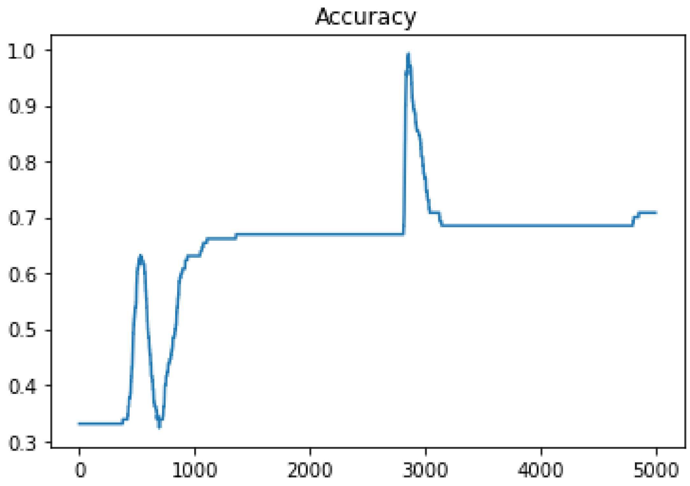

Out[14]:
```
<AxesSubplot:title={'center':'Mean Squared Error'}>
```



In [15]:
```
results.accuracy.plot(title="Accuracy")
```

Out[15]:
```
<AxesSubplot:title={'center':'Accuracy'}>
```



In [16]:
```
# feedforward
Z1 = np.dot(X_test, W1)
A1 = sigmoid(Z1)

Z2 = np.dot(A1, W2)
A2 = sigmoid(Z2)

acc = accuracy(A2, y_test)
print("Accuracy: {}".format(acc))
```

```
Accuracy: 0.8
```