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Lab : 3 - Text corpus creation and binary classification using DNN

Dataset Creation:

In [1]:

```
import nltk
import pandas as pd
```

In [2]:

```
from nltk.corpus import stopwords
from sklearn.model_selection import train_test_split
from nltk.stem import WordNetLemmatizer
```

In [3]:

```
nltk.download('stopwords')
stop_words = set(stopwords.words('english'))
nltk.download('wordnet')
nltk.download('omw-1.4')
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     C:\Users\arulk\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package wordnet to
[nltk_data]     C:\Users\arulk\AppData\Roaming\nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package omw-1.4 to
[nltk_data]     C:\Users\arulk\AppData\Roaming\nltk_data...
[nltk_data]   Package omw-1.4 is already up-to-date!
```

Out[3]:

```
True
```

In [4]:

```
df=pd.read_csv("Quotes.csv",encoding='cp1252')
```

In [5]:

```
df.shape
```

Out[5]:

```
(40, 2)
```

In [6]:

```
df.head()
```

Out[6]:

	Sentence	Target
0	It always seems impossible until it's done.	0
1	There is nothing impossible to they who will try.	0
2	Quality is not an act, it is a habit.	0
3	Good, better, best. Never let it rest. 'Til yo...	0
4	Start where you are. Use what you have. Do wha...	0

In [7]:

```
df.groupby('Target').count()
```

Out[7]:

	Sentence
Target	
0	20
1	20

Pre-processing:

In [8]:

```
X=df.Sentence
y=df.Target
```

In [9]:

```
lemmatizer=WordNetLemmatizer()
```

In [10]:

```
def clean_review(review):

    tokens = review.lower().split()
    filtered_tokens = [lemmatizer.lemmatize(w) for w in tokens if w not in stop_words]
    return " ".join(filtered_tokens)
```

In [11]:

```
temp=X.tolist()
fax=[]
for i in temp:
    fax.append(clean_review(i))
n_X=pd.Series(fax)
```

In [12]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
import pandas as pd

tfidf = TfidfVectorizer()
vectors = tfidf.fit_transform(n_X)
features_names = tfidf.get_feature_names_out()
text_vect = pd.DataFrame(vectors.todense(), columns=features_names)
text_vect
```

Out[12]:

	abandoned	accept	act	again	always	anyone	anything	are	bad	behind
0	0.00000	0.000000	0.00000	0.000000	0.456890	0.000000	0.000000	0.000000	0.000000	0.000000
1	0.00000	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.00000	0.000000	0.57735	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3	0.00000	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4	0.00000	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.456033	0.000000	0.000000
5	0.00000	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6	0.00000	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
7	0.00000	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8	0.00000	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

In [13]:

```
import tensorflow as tf
temp = tf.Variable(text_vect)
```

Dataset Preparation:

In [14]:

```
X_train,X_test,y_train,y_test=train_test_split(text_vect,y,train_size=0.75,test_size=0.2
```

In [15]:

```
print(X_train.shape)
print(y_train.shape)
print(X_test.shape)
print(y_test.shape)
```

```
(30, 156)
(30,)
(10, 156)
(10,)
```

Model Creation & Analysis:

Hidden Layers

In [16]:

```
import tensorflow as tf
from tensorflow.keras import Sequential
from keras.layers import Dense,Activation
```

In [17]:

```
model = Sequential()
model.add(Dense(1028, activation='relu',input_dim=X_train.shape[1]))
model.add(Dense(512, activation='relu'))
model.add(Dense(356, activation='relu'))
model.add(Dense(128, activation='relu'))
model.add(Dense(64, activation='relu'))
model.add(Dense(32, activation='relu'))
model.add(Dense(16, activation='relu'))
model.add(Dense(8, activation='relu'))
model.add(Dense(2, activation='sigmoid')) #output layer
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense (Dense)               (None, 1028)              161396

 dense_1 (Dense)             (None, 512)               526848

 dense_2 (Dense)             (None, 356)               182628

 dense_3 (Dense)             (None, 128)               45696

 dense_4 (Dense)             (None, 64)                8256

 dense_5 (Dense)             (None, 32)                2080

 dense_6 (Dense)             (None, 16)                528

 dense_7 (Dense)             (None, 8)                 136

 dense_8 (Dense)             (None, 2)                 18

=================================================================
Total params: 927586 (3.54 MB)
Trainable params: 927586 (3.54 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [18]:

```
model.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accuracy
history=model.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size=1
```

```
Epoch 1/100
2/2 - 4s - loss: 0.6947 - accuracy: 0.4167 - val_loss: 0.6900 - val_accur
acy: 0.6667 - 4s/epoch - 2s/step
Epoch 2/100
2/2 - 0s - loss: 0.6908 - accuracy: 0.4583 - val_loss: 0.6899 - val_accur
acy: 0.6667 - 113ms/epoch - 57ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6866 - accuracy: 0.4583 - val_loss: 0.6882 - val_accur
acy: 0.6667 - 116ms/epoch - 58ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6771 - accuracy: 0.5000 - val_loss: 0.6833 - val_accur
acy: 0.6667 - 155ms/epoch - 77ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6598 - accuracy: 0.8333 - val_loss: 0.6746 - val_accur
acy: 0.6667 - 107ms/epoch - 54ms/step
Epoch 6/100
2/2 - 0s - loss: 0.6319 - accuracy: 0.7917 - val_loss: 0.6541 - val_accur
acy: 0.6667 - 92ms/epoch - 46ms/step
Epoch 7/100
2/2 - 0s - loss: 0.5880 - accuracy: 0.6250 - val_loss: 0.6300 - val_accur
acy: 0.8333 - 90ms/epoch - 45ms/step
Epoch 8/100
2/2 - 0s - loss: 0.5016 - accuracy: 1.0000 - val_loss: 0.5949 - val_accur
acy: 0.6667 - 97ms/epoch - 48ms/step
Epoch 9/100
2/2 - 0s - loss: 0.3365 - accuracy: 1.0000 - val_loss: 0.5652 - val_accur
acy: 0.6667 - 92ms/epoch - 46ms/step
Epoch 10/100
2/2 - 0s - loss: 0.1598 - accuracy: 1.0000 - val_loss: 0.6372 - val_accur
acy: 0.6667 - 99ms/epoch - 49ms/step
Epoch 11/100
2/2 - 0s - loss: 0.0367 - accuracy: 1.0000 - val_loss: 1.1104 - val_accur
acy: 0.6667 - 108ms/epoch - 54ms/step
Epoch 12/100
2/2 - 0s - loss: 0.0045 - accuracy: 1.0000 - val_loss: 2.0568 - val_accur
acy: 0.3333 - 111ms/epoch - 55ms/step
Epoch 13/100
2/2 - 0s - loss: 6.9340e-04 - accuracy: 1.0000 - val_loss: 2.9194 - val_a
ccuracy: 0.3333 - 133ms/epoch - 66ms/step
Epoch 14/100
2/2 - 0s - loss: 8.5288e-05 - accuracy: 1.0000 - val_loss: 3.5944 - val_a
ccuracy: 0.3333 - 104ms/epoch - 52ms/step
Epoch 15/100
2/2 - 0s - loss: 1.1364e-05 - accuracy: 1.0000 - val_loss: 4.1827 - val_a
ccuracy: 0.3333 - 98ms/epoch - 49ms/step
Epoch 16/100
2/2 - 0s - loss: 1.0083e-06 - accuracy: 1.0000 - val_loss: 4.7184 - val_a
ccuracy: 0.3333 - 100ms/epoch - 50ms/step
Epoch 17/100
2/2 - 0s - loss: 6.9539e-08 - accuracy: 1.0000 - val_loss: 5.1998 - val_a
ccuracy: 0.3333 - 136ms/epoch - 68ms/step
Epoch 18/100
2/2 - 0s - loss: 4.9671e-09 - accuracy: 1.0000 - val_loss: 5.6238 - val_a
ccuracy: 0.3333 - 122ms/epoch - 61ms/step
Epoch 19/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 5.9880 - val_a
ccuracy: 0.3333 - 112ms/epoch - 56ms/step
Epoch 20/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 6.2898 - val_a
ccuracy: 0.3333 - 109ms/epoch - 54ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 6.5503 - val_a
ccuracy: 0.3333 - 140ms/epoch - 70ms/step
Epoch 22/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 6.7747 - val_a
ccuracy: 0.3333 - 112ms/epoch - 56ms/step
Epoch 23/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 6.9650 - val_a
ccuracy: 0.3333 - 109ms/epoch - 55ms/step
Epoch 24/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.1242 - val_a
ccuracy: 0.3333 - 99ms/epoch - 49ms/step
Epoch 25/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.2561 - val_a
ccuracy: 0.3333 - 94ms/epoch - 47ms/step
Epoch 26/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.3659 - val_a
ccuracy: 0.3333 - 118ms/epoch - 59ms/step
Epoch 27/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.4573 - val_a
ccuracy: 0.3333 - 113ms/epoch - 56ms/step
Epoch 28/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.5333 - val_a
ccuracy: 0.3333 - 149ms/epoch - 74ms/step
Epoch 29/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.5964 - val_a
ccuracy: 0.3333 - 119ms/epoch - 60ms/step
Epoch 30/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.6486 - val_a
ccuracy: 0.3333 - 122ms/epoch - 61ms/step
Epoch 31/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.6918 - val_a
ccuracy: 0.3333 - 133ms/epoch - 66ms/step
Epoch 32/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.7275 - val_a
ccuracy: 0.3333 - 95ms/epoch - 47ms/step
Epoch 33/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.7570 - val_a
ccuracy: 0.3333 - 110ms/epoch - 55ms/step
Epoch 34/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.7813 - val_a
ccuracy: 0.3333 - 100ms/epoch - 50ms/step
Epoch 35/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8013 - val_a
ccuracy: 0.3333 - 97ms/epoch - 48ms/step
Epoch 36/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8178 - val_a
ccuracy: 0.3333 - 142ms/epoch - 71ms/step
Epoch 37/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8313 - val_a
ccuracy: 0.3333 - 94ms/epoch - 47ms/step
Epoch 38/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8425 - val_a
ccuracy: 0.3333 - 88ms/epoch - 44ms/step
Epoch 39/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8517 - val_a
ccuracy: 0.3333 - 87ms/epoch - 43ms/step
Epoch 40/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8594 - val_a
ccuracy: 0.3333 - 97ms/epoch - 48ms/step
Epoch 41/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8656 - val_a
```

```
ccuracy: 0.3333 - 121ms/epoch - 60ms/step
Epoch 42/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8708 - val_a
ccuracy: 0.3333 - 129ms/epoch - 64ms/step
Epoch 43/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8750 - val_a
ccuracy: 0.3333 - 101ms/epoch - 50ms/step
Epoch 44/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8785 - val_a
ccuracy: 0.3333 - 117ms/epoch - 58ms/step
Epoch 45/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8813 - val_a
ccuracy: 0.3333 - 148ms/epoch - 74ms/step
Epoch 46/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8837 - val_a
ccuracy: 0.3333 - 112ms/epoch - 56ms/step
Epoch 47/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8856 - val_a
ccuracy: 0.3333 - 153ms/epoch - 77ms/step
Epoch 48/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8871 - val_a
ccuracy: 0.3333 - 120ms/epoch - 60ms/step
Epoch 49/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8884 - val_a
ccuracy: 0.3333 - 110ms/epoch - 55ms/step
Epoch 50/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8895 - val_a
ccuracy: 0.3333 - 101ms/epoch - 50ms/step
Epoch 51/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8903 - val_a
ccuracy: 0.3333 - 90ms/epoch - 45ms/step
Epoch 52/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8910 - val_a
ccuracy: 0.3333 - 99ms/epoch - 50ms/step
Epoch 53/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8916 - val_a
ccuracy: 0.3333 - 161ms/epoch - 81ms/step
Epoch 54/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8921 - val_a
ccuracy: 0.3333 - 108ms/epoch - 54ms/step
Epoch 55/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8924 - val_a
ccuracy: 0.3333 - 98ms/epoch - 49ms/step
Epoch 56/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8928 - val_a
ccuracy: 0.3333 - 97ms/epoch - 49ms/step
Epoch 57/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8930 - val_a
ccuracy: 0.3333 - 94ms/epoch - 47ms/step
Epoch 58/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8932 - val_a
ccuracy: 0.3333 - 94ms/epoch - 47ms/step
Epoch 59/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8934 - val_a
ccuracy: 0.3333 - 96ms/epoch - 48ms/step
Epoch 60/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8935 - val_a
ccuracy: 0.3333 - 94ms/epoch - 47ms/step
Epoch 61/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8937 - val_a
ccuracy: 0.3333 - 96ms/epoch - 48ms/step
```

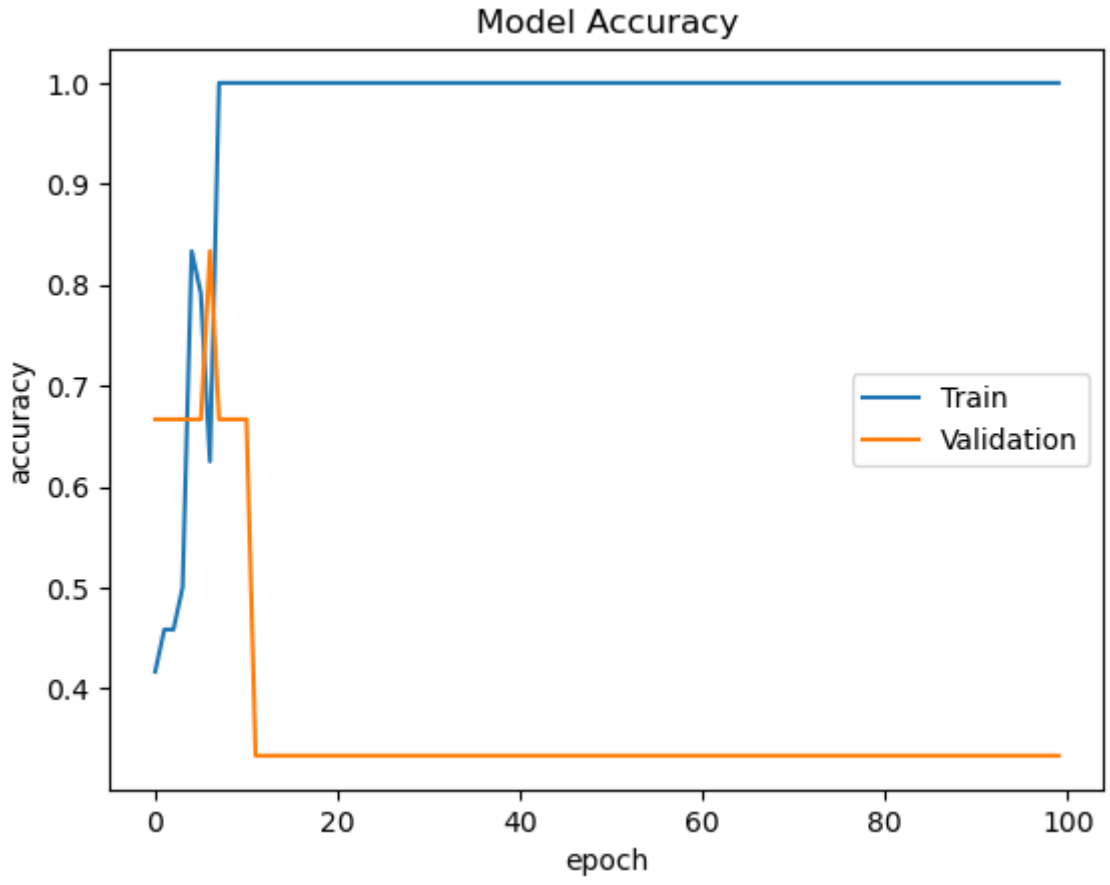
```
Epoch 62/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8937 - val_a
ccuracy: 0.3333 - 94ms/epoch - 47ms/step
Epoch 63/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8938 - val_a
ccuracy: 0.3333 - 91ms/epoch - 45ms/step
Epoch 64/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8939 - val_a
ccuracy: 0.3333 - 105ms/epoch - 52ms/step
Epoch 65/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8939 - val_a
ccuracy: 0.3333 - 95ms/epoch - 48ms/step
```

In [19]:
```
model.evaluate(X_test,y_test)
```

Out[19]:
```
[2.2854016017913818, 0.3333]
```

In [20]:
```
import matplotlib.pyplot as plt
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```

```
Epoch 66/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8940 - val_a
ccuracy: 0.3333 - 107ms/epoch - 54ms/step
Epoch 67/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8940 - val_a
ccuracy: 0.3333 - 93ms/epoch - 46ms/step
Epoch 68/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8940 - val_a
ccuracy: 0.3333 - 112ms/epoch - 56ms/step
Epoch 69/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 100ms/epoch - 50ms/step
Epoch 70/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 93ms/epoch - 46ms/step
Epoch 71/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 95ms/epoch - 48ms/step
Epoch 72/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 142ms/epoch - 71ms/step
Epoch 73/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 105ms/epoch - 52ms/step
```




```
Epoch 83/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 103ms/epoch - 51ms/step
Epoch 84/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 100ms/epoch - 50ms/step
Epoch 85/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 90ms/epoch - 45ms/step
Epoch 86/100
```

Model 2

In [21]:

```
model2 = Sequential()
model2.add(Dense(512, activation='relu',input_dim=X_train.shape[1]))
model2.add(Dense(256, activation='relu'))
model2.add(Dense(128, activation='relu'))
model2.add(Dense(64, activation='relu'))
model2.add(Dense(32, activation='relu'))
model2.add(Dense(16, activation='relu'))
model2.add(Dense(8, activation='relu'))
model2.add(Dense(2, activation='sigmoid'))
model2.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_9 (Dense)             (None, 512)               80384
 dense_10 (Dense)            (None, 256)               131328
 dense_11 (Dense)            (None, 128)               32896
 dense_12 (Dense)            (None, 64)                8256
 dense_13 (Dense)            (None, 32)                2080
 dense_14 (Dense)            (None, 16)                528
 dense_15 (Dense)            (None, 8)                 136
 dense_16 (Dense)            (None, 2)                 18
=================================================================
Total params: 255626 (998.54 KB)
Trainable params: 255626 (998.54 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 90ms/epoch - 45ms/step
Epoch 87/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 117ms/epoch - 58ms/step
Epoch 88/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 102ms/epoch - 51ms/step
Epoch 89/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 90ms/epoch - 45ms/step
Epoch 90/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 88ms/epoch - 44ms/step
Epoch 91/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 137ms/epoch - 69ms/step
Epoch 92/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 126ms/epoch - 63ms/step
Epoch 93/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 105ms/epoch - 52ms/step
Epoch 94/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 129ms/epoch - 65ms/step
Epoch 95/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 93ms/epoch - 47ms/step
Epoch 96/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 121ms/epoch - 60ms/step
Epoch 97/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 135ms/epoch - 68ms/step
Epoch 98/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 87ms/epoch - 43ms/step
Epoch 99/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 100ms/epoch - 50ms/step
Epoch 100/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 7.8941 - val_a
ccuracy: 0.3333 - 168ms/epoch - 84ms/step
```

In [22]:

```
model2.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accurac
history=model2.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size=
```

```
Epoch 1/100
2/2 - 3s - loss: 0.6928 - accuracy: 0.6250 - val_loss: 0.6947 - val_accur
acy: 0.6667 - 3s/epoch - 2s/step
Epoch 2/100
2/2 - 0s - loss: 0.6787 - accuracy: 0.9583 - val_loss: 0.6875 - val_accur
acy: 0.8333 - 100ms/epoch - 50ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6600 - accuracy: 1.0000 - val_loss: 0.6787 - val_accur
acy: 0.8333 - 105ms/epoch - 53ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6349 - accuracy: 1.0000 - val_loss: 0.6707 - val_accur
acy: 0.8333 - 112ms/epoch - 56ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6001 - accuracy: 1.0000 - val_loss: 0.6558 - val_accur
acy: 0.8333 - 83ms/epoch - 41ms/step
Epoch 6/100
2/2 - 0s - loss: 0.5474 - accuracy: 1.0000 - val_loss: 0.6358 - val_accur
acy: 0.8333 - 79ms/epoch - 40ms/step
Epoch 7/100
2/2 - 0s - loss: 0.4861 - accuracy: 1.0000 - val_loss: 0.6123 - val_accur
acy: 0.8333 - 81ms/epoch - 40ms/step
Epoch 8/100
2/2 - 0s - loss: 0.4075 - accuracy: 1.0000 - val_loss: 0.5949 - val_accur
acy: 0.8333 - 78ms/epoch - 39ms/step
Epoch 9/100
2/2 - 0s - loss: 0.3227 - accuracy: 1.0000 - val_loss: 0.5711 - val_accur
acy: 0.8333 - 93ms/epoch - 46ms/step
Epoch 10/100
2/2 - 0s - loss: 0.2417 - accuracy: 1.0000 - val_loss: 0.5620 - val_accur
acy: 0.6667 - 76ms/epoch - 38ms/step
Epoch 11/100
2/2 - 0s - loss: 0.1647 - accuracy: 1.0000 - val_loss: 0.5771 - val_accur
acy: 0.6667 - 82ms/epoch - 41ms/step
Epoch 12/100
2/2 - 0s - loss: 0.0914 - accuracy: 1.0000 - val_loss: 0.6720 - val_accur
acy: 0.5000 - 80ms/epoch - 40ms/step
Epoch 13/100
2/2 - 0s - loss: 0.0365 - accuracy: 1.0000 - val_loss: 0.9397 - val_accur
acy: 0.3333 - 105ms/epoch - 53ms/step
Epoch 14/100
2/2 - 0s - loss: 0.0125 - accuracy: 1.0000 - val_loss: 1.3795 - val_accur
acy: 0.3333 - 82ms/epoch - 41ms/step
Epoch 15/100
2/2 - 0s - loss: 0.0037 - accuracy: 1.0000 - val_loss: 1.7743 - val_accur
acy: 0.3333 - 85ms/epoch - 42ms/step
Epoch 16/100
2/2 - 0s - loss: 0.0012 - accuracy: 1.0000 - val_loss: 2.0649 - val_accur
acy: 0.3333 - 78ms/epoch - 39ms/step
Epoch 17/100
2/2 - 0s - loss: 2.8582e-04 - accuracy: 1.0000 - val_loss: 2.2984 - val_a
ccuracy: 0.3333 - 70ms/epoch - 35ms/step
Epoch 18/100
2/2 - 0s - loss: 5.7092e-05 - accuracy: 1.0000 - val_loss: 2.4673 - val_a
ccuracy: 0.3333 - 114ms/epoch - 57ms/step
Epoch 19/100
2/2 - 0s - loss: 1.9242e-05 - accuracy: 1.0000 - val_loss: 2.6006 - val_a
ccuracy: 0.3333 - 71ms/epoch - 35ms/step
Epoch 20/100
2/2 - 0s - loss: 5.3097e-06 - accuracy: 1.0000 - val_loss: 2.7118 - val_a
ccuracy: 0.3333 - 76ms/epoch - 38ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 2.0265e-06 - accuracy: 1.0000 - val_loss: 2.8050 - val_a
ccuracy: 0.3333 - 75ms/epoch - 37ms/step
Epoch 22/100
2/2 - 0s - loss: 6.9042e-07 - accuracy: 1.0000 - val_loss: 2.8805 - val_a
ccuracy: 0.3333 - 81ms/epoch - 41ms/step
Epoch 23/100
2/2 - 0s - loss: 3.5266e-07 - accuracy: 1.0000 - val_loss: 2.9427 - val_a
ccuracy: 0.3333 - 75ms/epoch - 37ms/step
Epoch 24/100
2/2 - 0s - loss: 1.9372e-07 - accuracy: 1.0000 - val_loss: 2.9941 - val_a
ccuracy: 0.3333 - 79ms/epoch - 39ms/step
Epoch 25/100
2/2 - 0s - loss: 9.4374e-08 - accuracy: 1.0000 - val_loss: 3.0369 - val_a
ccuracy: 0.3333 - 99ms/epoch - 49ms/step
Epoch 26/100
2/2 - 0s - loss: 5.4638e-08 - accuracy: 1.0000 - val_loss: 3.0725 - val_a
ccuracy: 0.3333 - 122ms/epoch - 61ms/step
Epoch 27/100
2/2 - 0s - loss: 3.9736e-08 - accuracy: 1.0000 - val_loss: 3.1021 - val_a
ccuracy: 0.3333 - 73ms/epoch - 37ms/step
Epoch 28/100
2/2 - 0s - loss: 2.4835e-08 - accuracy: 1.0000 - val_loss: 3.1266 - val_a
ccuracy: 0.3333 - 85ms/epoch - 43ms/step
Epoch 29/100
2/2 - 0s - loss: 1.9868e-08 - accuracy: 1.0000 - val_loss: 3.1469 - val_a
ccuracy: 0.3333 - 78ms/epoch - 39ms/step
Epoch 30/100
2/2 - 0s - loss: 1.4901e-08 - accuracy: 1.0000 - val_loss: 3.1635 - val_a
ccuracy: 0.3333 - 83ms/epoch - 41ms/step
Epoch 31/100
2/2 - 0s - loss: 1.4901e-08 - accuracy: 1.0000 - val_loss: 3.1773 - val_a
ccuracy: 0.3333 - 77ms/epoch - 38ms/step
Epoch 32/100
2/2 - 0s - loss: 1.4901e-08 - accuracy: 1.0000 - val_loss: 3.1886 - val_a
ccuracy: 0.3333 - 80ms/epoch - 40ms/step
Epoch 33/100
2/2 - 0s - loss: 9.9341e-09 - accuracy: 1.0000 - val_loss: 3.1979 - val_a
ccuracy: 0.3333 - 76ms/epoch - 38ms/step
Epoch 34/100
2/2 - 0s - loss: 9.9341e-09 - accuracy: 1.0000 - val_loss: 3.2056 - val_a
ccuracy: 0.3333 - 86ms/epoch - 43ms/step
Epoch 35/100
2/2 - 0s - loss: 4.9671e-09 - accuracy: 1.0000 - val_loss: 3.2119 - val_a
ccuracy: 0.3333 - 68ms/epoch - 34ms/step
Epoch 36/100
2/2 - 0s - loss: 4.9671e-09 - accuracy: 1.0000 - val_loss: 3.2171 - val_a
ccuracy: 0.3333 - 84ms/epoch - 42ms/step
Epoch 37/100
2/2 - 0s - loss: 4.9671e-09 - accuracy: 1.0000 - val_loss: 3.2214 - val_a
ccuracy: 0.3333 - 115ms/epoch - 57ms/step
Epoch 38/100
2/2 - 0s - loss: 4.9671e-09 - accuracy: 1.0000 - val_loss: 3.2249 - val_a
ccuracy: 0.3333 - 111ms/epoch - 56ms/step
Epoch 39/100
2/2 - 0s - loss: 4.9671e-09 - accuracy: 1.0000 - val_loss: 3.2278 - val_a
ccuracy: 0.3333 - 150ms/epoch - 75ms/step
Epoch 40/100
2/2 - 0s - loss: 4.9671e-09 - accuracy: 1.0000 - val_loss: 3.2302 - val_a
ccuracy: 0.3333 - 81ms/epoch - 40ms/step
Epoch 41/100
2/2 - 0s - loss: 4.9671e-09 - accuracy: 1.0000 - val_loss: 3.2322 - val_a
```

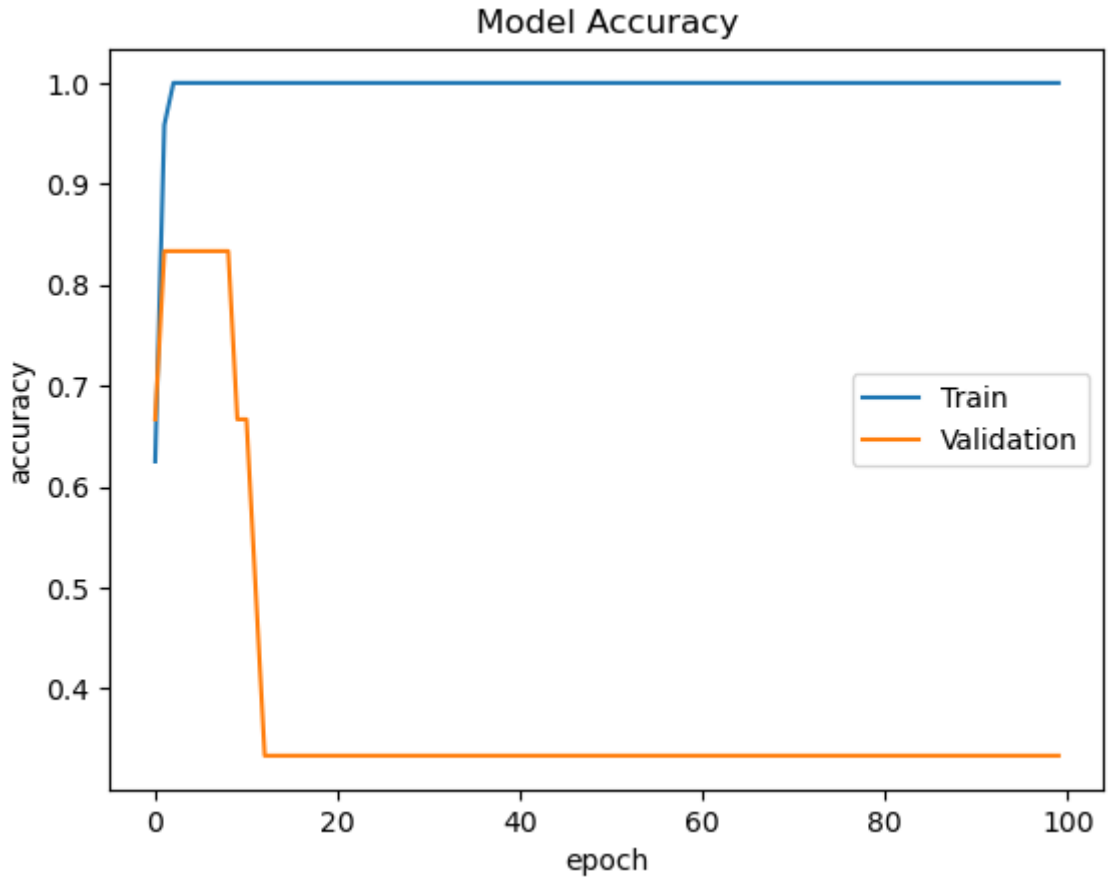
```
ccuracy: 0.3333 - 78ms/epoch - 39ms/step
Epoch 42/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2338 - val_a
ccuracy: 0.3333 - 85ms/epoch - 42ms/step
Epoch 43/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2351 - val_a
ccuracy: 0.3333 - 90ms/epoch - 45ms/step
Epoch 44/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2362 - val_a
ccuracy: 0.3333 - 91ms/epoch - 46ms/step
Epoch 45/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2371 - val_a
ccuracy: 0.3333 - 108ms/epoch - 54ms/step
Epoch 46/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2378 - val_a
ccuracy: 0.3333 - 67ms/epoch - 34ms/step
Epoch 47/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2384 - val_a
ccuracy: 0.3333 - 158ms/epoch - 79ms/step
Epoch 48/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2389 - val_a
ccuracy: 0.3333 - 88ms/epoch - 44ms/step
Epoch 49/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2393 - val_a
ccuracy: 0.3333 - 71ms/epoch - 36ms/step
Epoch 50/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2396 - val_a
ccuracy: 0.3333 - 85ms/epoch - 43ms/step
Epoch 51/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2399 - val_a
ccuracy: 0.3333 - 73ms/epoch - 36ms/step
Epoch 52/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2401 - val_a
ccuracy: 0.3333 - 83ms/epoch - 42ms/step
Epoch 53/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2403 - val_a
ccuracy: 0.3333 - 120ms/epoch - 60ms/step
Epoch 54/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2404 - val_a
ccuracy: 0.3333 - 195ms/epoch - 98ms/step
Epoch 55/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2405 - val_a
ccuracy: 0.3333 - 79ms/epoch - 39ms/step
Epoch 56/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2406 - val_a
ccuracy: 0.3333 - 82ms/epoch - 41ms/step
Epoch 57/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2407 - val_a
ccuracy: 0.3333 - 105ms/epoch - 53ms/step
Epoch 58/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2408 - val_a
ccuracy: 0.3333 - 95ms/epoch - 48ms/step
Epoch 59/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2408 - val_a
ccuracy: 0.3333 - 84ms/epoch - 42ms/step
Epoch 60/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 93ms/epoch - 46ms/step
Epoch 61/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 96ms/epoch - 48ms/step
```

```
Epoch 62/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 83ms/epoch - 41ms/step
Epoch 63/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 76ms/epoch - 38ms/step
Epoch 64/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 67ms/epoch - 34ms/step
Epoch 65/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2410 - val_a
ccuracy: 0.3333 - 83ms/epoch - 42ms/step
Epoch 66/100
```

In [23]:
```
model.evaluate(X_test,y_test)
```

Out[23]:
```
[3.6156660509109497, 0.3333333432674408]
```

In [24]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```



Model 3

In [251]:

```
model3 = Sequential()
model3.add(Dense(256, activation='relu',input_dim=X_train.shape[1]))
model3.add(Dense(128, activation='relu'))
model3.add(Dense(64, activation='relu'))
model3.add(Dense(32, activation='relu'))
model3.add(Dense(16, activation='relu'))
model3.add(Dense(6, activation='relu'))
model3.add(Dense(2, activation='sigmoid')) #output layer
model3.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_17 (Dense)            (None, 256)               40192
 dense_18 (Dense)            (None, 128)               32896
 dense_19 (Dense)            (None, 64)                8256
 dense_20 (Dense)            (None, 32)                2080
 dense_21 (Dense)            (None, 16)                528
 dense_22 (Dense)            (None, 6)                 102
 dense_23 (Dense)            (None, 2)                 14
=================================================================
Total params: 84068 (328.39 KB)
Trainable params: 84068 (328.39 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
Epoch 87/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 71ms/epoch - 36ms/step
Epoch 88/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 107ms/epoch - 54ms/step
Epoch 89/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 69ms/epoch - 34ms/step
Epoch 90/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 91ms/epoch - 46ms/step
Epoch 91/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 86ms/epoch - 43ms/step
Epoch 92/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 80ms/epoch - 40ms/step
Epoch 93/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 79ms/epoch - 39ms/step
Epoch 94/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 80ms/epoch - 40ms/step
Epoch 95/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 71ms/epoch - 36ms/step
Epoch 96/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 75ms/epoch - 37ms/step
Epoch 97/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 76ms/epoch - 38ms/step
Epoch 98/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 80ms/epoch - 40ms/step
Epoch 99/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 78ms/epoch - 39ms/step
Epoch 100/100
2/2 - 0s - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 3.2409 - val_a
ccuracy: 0.3333 - 81ms/epoch - 41ms/step
```

In [26]:

```
model3.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accurac
history=model3.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size=
```

```
Epoch 1/100
2/2 - 3s - loss: 0.6896 - accuracy: 0.5417 - val_loss: 0.7005 - val_accur
acy: 0.3333 - 3s/epoch - 2s/step
Epoch 2/100
2/2 - 0s - loss: 0.6668 - accuracy: 0.5833 - val_loss: 0.7056 - val_accur
acy: 0.3333 - 89ms/epoch - 44ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6499 - accuracy: 0.5833 - val_loss: 0.7092 - val_accur
acy: 0.3333 - 92ms/epoch - 46ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6266 - accuracy: 0.5833 - val_loss: 0.7113 - val_accur
acy: 0.3333 - 86ms/epoch - 43ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6029 - accuracy: 0.5833 - val_loss: 0.7195 - val_accur
acy: 0.3333 - 73ms/epoch - 36ms/step
Epoch 6/100
2/2 - 0s - loss: 0.5744 - accuracy: 0.6250 - val_loss: 0.7356 - val_accur
acy: 0.3333 - 70ms/epoch - 35ms/step
Epoch 7/100
2/2 - 0s - loss: 0.5428 - accuracy: 0.6667 - val_loss: 0.7508 - val_accur
acy: 0.3333 - 72ms/epoch - 36ms/step
Epoch 8/100
2/2 - 0s - loss: 0.5080 - accuracy: 0.7083 - val_loss: 0.7671 - val_accur
acy: 0.3333 - 83ms/epoch - 41ms/step
Epoch 9/100
2/2 - 0s - loss: 0.4663 - accuracy: 0.7500 - val_loss: 0.7995 - val_accur
acy: 0.3333 - 74ms/epoch - 37ms/step
Epoch 10/100
2/2 - 0s - loss: 0.4297 - accuracy: 0.7500 - val_loss: 0.8557 - val_accur
acy: 0.3333 - 72ms/epoch - 36ms/step
Epoch 11/100
2/2 - 0s - loss: 0.3874 - accuracy: 0.8333 - val_loss: 0.9096 - val_accur
acy: 0.3333 - 81ms/epoch - 41ms/step
Epoch 12/100
2/2 - 0s - loss: 0.3426 - accuracy: 0.9583 - val_loss: 0.9911 - val_accur
acy: 0.3333 - 73ms/epoch - 36ms/step
Epoch 13/100
2/2 - 0s - loss: 0.2932 - accuracy: 1.0000 - val_loss: 1.0500 - val_accur
acy: 0.3333 - 67ms/epoch - 34ms/step
Epoch 14/100
2/2 - 0s - loss: 0.2415 - accuracy: 1.0000 - val_loss: 1.0401 - val_accur
acy: 0.3333 - 66ms/epoch - 33ms/step
Epoch 15/100
2/2 - 0s - loss: 0.1879 - accuracy: 1.0000 - val_loss: 0.9895 - val_accur
acy: 0.3333 - 68ms/epoch - 34ms/step
Epoch 16/100
2/2 - 0s - loss: 0.1412 - accuracy: 1.0000 - val_loss: 0.9345 - val_accur
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 17/100
2/2 - 0s - loss: 0.1028 - accuracy: 1.0000 - val_loss: 0.8941 - val_accur
acy: 0.5000 - 76ms/epoch - 38ms/step
Epoch 18/100
2/2 - 0s - loss: 0.0652 - accuracy: 1.0000 - val_loss: 0.8879 - val_accur
acy: 0.5000 - 77ms/epoch - 38ms/step
Epoch 19/100
2/2 - 0s - loss: 0.0391 - accuracy: 1.0000 - val_loss: 0.8798 - val_accur
acy: 0.5000 - 89ms/epoch - 45ms/step
Epoch 20/100
2/2 - 0s - loss: 0.0220 - accuracy: 1.0000 - val_loss: 0.8653 - val_accur
acy: 0.5000 - 76ms/epoch - 38ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.0121 - accuracy: 1.0000 - val_loss: 0.8541 - val_accur
acy: 0.5000 - 78ms/epoch - 39ms/step
Epoch 22/100
2/2 - 0s - loss: 0.0067 - accuracy: 1.0000 - val_loss: 0.8601 - val_accur
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 23/100
2/2 - 0s - loss: 0.0035 - accuracy: 1.0000 - val_loss: 0.8898 - val_accur
acy: 0.6667 - 82ms/epoch - 41ms/step
Epoch 24/100
2/2 - 0s - loss: 0.0020 - accuracy: 1.0000 - val_loss: 0.9263 - val_accur
acy: 0.6667 - 86ms/epoch - 43ms/step
Epoch 25/100
2/2 - 0s - loss: 0.0012 - accuracy: 1.0000 - val_loss: 0.9683 - val_accur
acy: 0.5000 - 80ms/epoch - 40ms/step
Epoch 26/100
2/2 - 0s - loss: 7.2603e-04 - accuracy: 1.0000 - val_loss: 1.0083 - val_a
ccuracy: 0.5000 - 77ms/epoch - 39ms/step
Epoch 27/100
2/2 - 0s - loss: 4.8297e-04 - accuracy: 1.0000 - val_loss: 1.0437 - val_a
ccuracy: 0.5000 - 77ms/epoch - 39ms/step
Epoch 28/100
2/2 - 0s - loss: 3.2948e-04 - accuracy: 1.0000 - val_loss: 1.0770 - val_a
ccuracy: 0.5000 - 86ms/epoch - 43ms/step
Epoch 29/100
2/2 - 0s - loss: 2.4284e-04 - accuracy: 1.0000 - val_loss: 1.1067 - val_a
ccuracy: 0.5000 - 65ms/epoch - 32ms/step
Epoch 30/100
2/2 - 0s - loss: 1.8140e-04 - accuracy: 1.0000 - val_loss: 1.1321 - val_a
ccuracy: 0.5000 - 61ms/epoch - 30ms/step
Epoch 31/100
2/2 - 0s - loss: 1.4536e-04 - accuracy: 1.0000 - val_loss: 1.1530 - val_a
ccuracy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 32/100
2/2 - 0s - loss: 1.1648e-04 - accuracy: 1.0000 - val_loss: 1.1704 - val_a
ccuracy: 0.5000 - 63ms/epoch - 32ms/step
Epoch 33/100
2/2 - 0s - loss: 9.8687e-05 - accuracy: 1.0000 - val_loss: 1.1847 - val_a
ccuracy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 34/100
2/2 - 0s - loss: 8.4528e-05 - accuracy: 1.0000 - val_loss: 1.1963 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 35/100
2/2 - 0s - loss: 7.3552e-05 - accuracy: 1.0000 - val_loss: 1.2061 - val_a
ccuracy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 36/100
2/2 - 0s - loss: 6.7121e-05 - accuracy: 1.0000 - val_loss: 1.2139 - val_a
ccuracy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 37/100
2/2 - 0s - loss: 6.0734e-05 - accuracy: 1.0000 - val_loss: 1.2209 - val_a
ccuracy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 38/100
2/2 - 0s - loss: 5.6602e-05 - accuracy: 1.0000 - val_loss: 1.2269 - val_a
ccuracy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 39/100
2/2 - 0s - loss: 5.2902e-05 - accuracy: 1.0000 - val_loss: 1.2324 - val_a
ccuracy: 0.5000 - 82ms/epoch - 41ms/step
Epoch 40/100
2/2 - 0s - loss: 4.9822e-05 - accuracy: 1.0000 - val_loss: 1.2371 - val_a
ccuracy: 0.5000 - 73ms/epoch - 36ms/step
Epoch 41/100
2/2 - 0s - loss: 4.7438e-05 - accuracy: 1.0000 - val_loss: 1.2414 - val_a
```

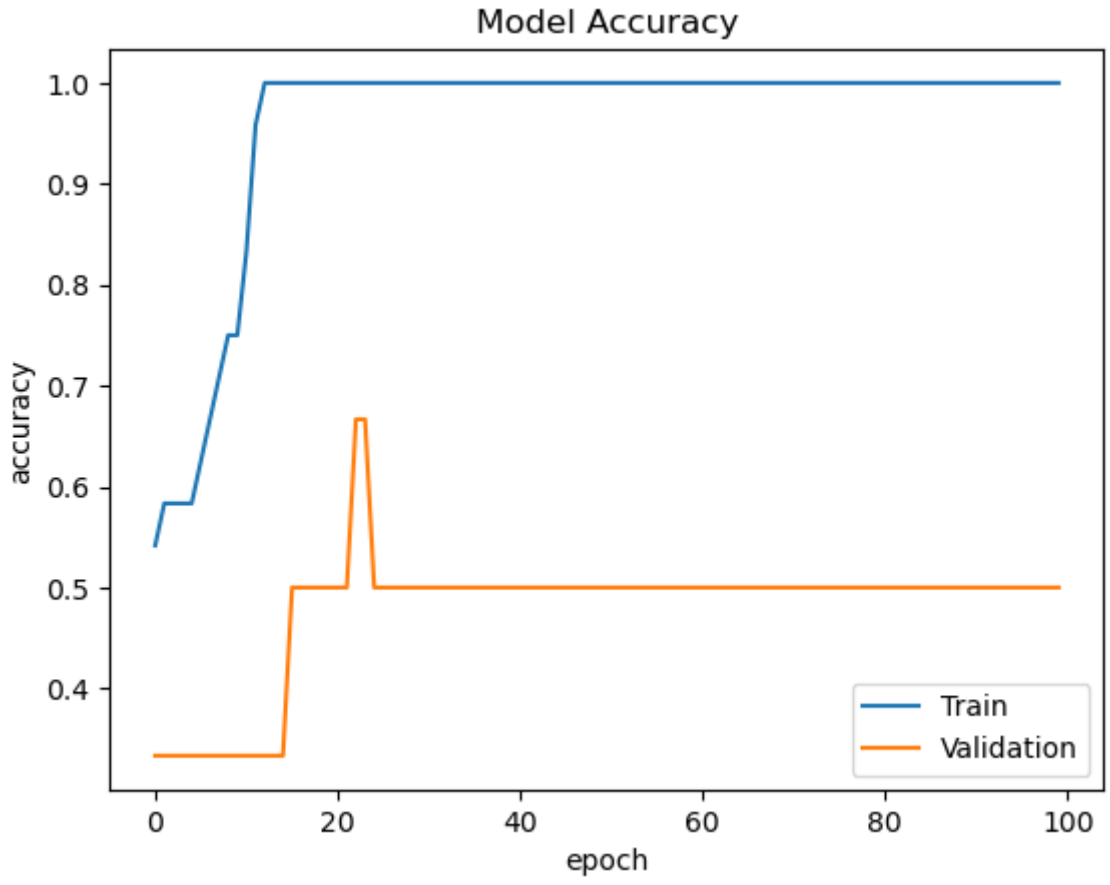
```
ccuracy: 0.5000 - 107ms/epoch - 53ms/step
Epoch 42/100
2/2 - 0s - loss: 4.5377e-05 - accuracy: 1.0000 - val_loss: 1.2452 - val_a
ccuracy: 0.5000 - 78ms/epoch - 39ms/step
Epoch 43/100
2/2 - 0s - loss: 4.3664e-05 - accuracy: 1.0000 - val_loss: 1.2488 - val_a
ccuracy: 0.5000 - 75ms/epoch - 38ms/step
Epoch 44/100
2/2 - 0s - loss: 4.2318e-05 - accuracy: 1.0000 - val_loss: 1.2519 - val_a
ccuracy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 45/100
2/2 - 0s - loss: 4.1136e-05 - accuracy: 1.0000 - val_loss: 1.2551 - val_a
ccuracy: 0.5000 - 63ms/epoch - 31ms/step
Epoch 46/100
2/2 - 0s - loss: 4.0073e-05 - accuracy: 1.0000 - val_loss: 1.2585 - val_a
ccuracy: 0.5000 - 61ms/epoch - 31ms/step
Epoch 47/100
2/2 - 0s - loss: 3.9089e-05 - accuracy: 1.0000 - val_loss: 1.2620 - val_a
ccuracy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 48/100
2/2 - 0s - loss: 3.8280e-05 - accuracy: 1.0000 - val_loss: 1.2649 - val_a
ccuracy: 0.5000 - 61ms/epoch - 30ms/step
Epoch 49/100
2/2 - 0s - loss: 3.7604e-05 - accuracy: 1.0000 - val_loss: 1.2677 - val_a
ccuracy: 0.5000 - 61ms/epoch - 30ms/step
Epoch 50/100
2/2 - 0s - loss: 3.6879e-05 - accuracy: 1.0000 - val_loss: 1.2704 - val_a
ccuracy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 51/100
2/2 - 0s - loss: 3.6377e-05 - accuracy: 1.0000 - val_loss: 1.2728 - val_a
ccuracy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 52/100
2/2 - 0s - loss: 3.5781e-05 - accuracy: 1.0000 - val_loss: 1.2752 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 53/100
2/2 - 0s - loss: 3.5305e-05 - accuracy: 1.0000 - val_loss: 1.2772 - val_a
ccuracy: 0.5000 - 87ms/epoch - 44ms/step
Epoch 54/100
2/2 - 0s - loss: 3.4793e-05 - accuracy: 1.0000 - val_loss: 1.2794 - val_a
ccuracy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 55/100
2/2 - 0s - loss: 3.4366e-05 - accuracy: 1.0000 - val_loss: 1.2815 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 56/100
2/2 - 0s - loss: 3.3934e-05 - accuracy: 1.0000 - val_loss: 1.2834 - val_a
ccuracy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 57/100
2/2 - 0s - loss: 3.3566e-05 - accuracy: 1.0000 - val_loss: 1.2852 - val_a
ccuracy: 0.5000 - 54ms/epoch - 27ms/step
Epoch 58/100
2/2 - 0s - loss: 3.3144e-05 - accuracy: 1.0000 - val_loss: 1.2873 - val_a
ccuracy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 59/100
2/2 - 0s - loss: 3.2826e-05 - accuracy: 1.0000 - val_loss: 1.2893 - val_a
ccuracy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 60/100
2/2 - 0s - loss: 3.2469e-05 - accuracy: 1.0000 - val_loss: 1.2914 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 61/100
2/2 - 0s - loss: 3.2101e-05 - accuracy: 1.0000 - val_loss: 1.2936 - val_a
ccuracy: 0.5000 - 59ms/epoch - 29ms/step
```

```
Epoch 62/100
2/2 - 0s - loss: 3.1793e-05 - accuracy: 1.0000 - val_loss: 1.2957 - val_a
ccuracy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 63/100
2/2 - 0s - loss: 3.1460e-05 - accuracy: 1.0000 - val_loss: 1.2979 - val_a
ccuracy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 64/100
2/2 - 0s - loss: 3.1147e-05 - accuracy: 1.0000 - val_loss: 1.3000 - val_a
ccuracy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 65/100
2/2 - 0s - loss: 3.0830e-05 - accuracy: 1.0000 - val_loss: 1.3022 - val_a
ccuracy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 66/100
2/2 - 0s - loss: 3.0507e-05 - accuracy: 1.0000 - val_loss: 1.3044 - val_a
ccuracy: 0.5000 - 56ms/epoch - 28ms/step
```

In [27]:
```
model.evaluate(x_test,y_test)
```

Out[27]:
```
[1.2079087495803833, 0.5]
```

In [28]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```



Model 4

In [29]:

```
model4 = Sequential()
model4.add(Dense(128, activation='relu',input_dim=X_train.shape[1]))
model4.add(Dense(64, activation='relu'))
model4.add(Dense(32, activation='relu'))
model4.add(Dense(16, activation='relu'))
model4.add(Dense(8, activation='relu'))
model4.add(Dense(2, activation='sigmoid')) #output layer
model4.summary()
```

```
Model: "sequential_3"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_24 (Dense)            (None, 128)               20096
 dense_25 (Dense)            (None, 64)                8256
 dense_26 (Dense)            (None, 32)                2080
 dense_27 (Dense)            (None, 16)                528
 dense_28 (Dense)            (None, 8)                 136
 dense_29 (Dense)            (None, 2)                 18
=================================================================
Total params: 31114 (121.54 KB)
Trainable params: 31114 (121.54 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 2.4845e-05 - accuracy: 1.0000 - val_loss: 1.3419 - val_a
ccuracy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 88/100
2/2 - 0s - loss: 2.4631e-05 - accuracy: 1.0000 - val_loss: 1.3436 - val_a
ccuracy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 89/100
2/2 - 0s - loss: 2.4393e-05 - accuracy: 1.0000 - val_loss: 1.3455 - val_a
ccuracy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 90/100
2/2 - 0s - loss: 2.4174e-05 - accuracy: 1.0000 - val_loss: 1.3470 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 91/100
2/2 - 0s - loss: 2.3941e-05 - accuracy: 1.0000 - val_loss: 1.3484 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 92/100
2/2 - 0s - loss: 2.3717e-05 - accuracy: 1.0000 - val_loss: 1.3498 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 93/100
2/2 - 0s - loss: 2.3518e-05 - accuracy: 1.0000 - val_loss: 1.3508 - val_a
ccuracy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 94/100
2/2 - 0s - loss: 2.3295e-05 - accuracy: 1.0000 - val_loss: 1.3521 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 95/100
2/2 - 0s - loss: 2.3086e-05 - accuracy: 1.0000 - val_loss: 1.3534 - val_a
ccuracy: 0.5000 - 61ms/epoch - 31ms/step
Epoch 96/100
2/2 - 0s - loss: 2.2858e-05 - accuracy: 1.0000 - val_loss: 1.3549 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 97/100
2/2 - 0s - loss: 2.2674e-05 - accuracy: 1.0000 - val_loss: 1.3562 - val_a
ccuracy: 0.5000 - 54ms/epoch - 27ms/step
Epoch 98/100
2/2 - 0s - loss: 2.2456e-05 - accuracy: 1.0000 - val_loss: 1.3574 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 99/100
2/2 - 0s - loss: 2.2282e-05 - accuracy: 1.0000 - val_loss: 1.3588 - val_a
ccuracy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 100/100
2/2 - 0s - loss: 2.2078e-05 - accuracy: 1.0000 - val_loss: 1.3603 - val_a
ccuracy: 0.5000 - 60ms/epoch - 30ms/step
```

In [30]:

```
model4.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accurac
history=model4.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size=
```

```
Epoch 1/100
2/2 - 2s - loss: 0.6915 - accuracy: 0.5417 - val_loss: 0.6954 - val_accur
acy: 0.3333 - 2s/epoch - 1s/step
Epoch 2/100
2/2 - 0s - loss: 0.6770 - accuracy: 0.5417 - val_loss: 0.6942 - val_accur
acy: 0.3333 - 73ms/epoch - 37ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6643 - accuracy: 0.5417 - val_loss: 0.6971 - val_accur
acy: 0.3333 - 68ms/epoch - 34ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6513 - accuracy: 0.5417 - val_loss: 0.7015 - val_accur
acy: 0.3333 - 68ms/epoch - 34ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6363 - accuracy: 0.5417 - val_loss: 0.7075 - val_accur
acy: 0.3333 - 70ms/epoch - 35ms/step
Epoch 6/100
2/2 - 0s - loss: 0.6212 - accuracy: 0.5417 - val_loss: 0.7173 - val_accur
acy: 0.3333 - 76ms/epoch - 38ms/step
Epoch 7/100
2/2 - 0s - loss: 0.6044 - accuracy: 0.5417 - val_loss: 0.7285 - val_accur
acy: 0.3333 - 75ms/epoch - 38ms/step
Epoch 8/100
2/2 - 0s - loss: 0.5836 - accuracy: 0.5417 - val_loss: 0.7380 - val_accur
acy: 0.3333 - 67ms/epoch - 34ms/step
Epoch 9/100
2/2 - 0s - loss: 0.5635 - accuracy: 0.5417 - val_loss: 0.7538 - val_accur
acy: 0.3333 - 62ms/epoch - 31ms/step
Epoch 10/100
2/2 - 0s - loss: 0.5434 - accuracy: 0.5417 - val_loss: 0.7752 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 11/100
2/2 - 0s - loss: 0.5194 - accuracy: 0.5417 - val_loss: 0.7970 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 12/100
2/2 - 0s - loss: 0.4939 - accuracy: 0.5417 - val_loss: 0.8195 - val_accur
acy: 0.3333 - 67ms/epoch - 34ms/step
Epoch 13/100
2/2 - 0s - loss: 0.4686 - accuracy: 0.5417 - val_loss: 0.8558 - val_accur
acy: 0.3333 - 72ms/epoch - 36ms/step
Epoch 14/100
2/2 - 0s - loss: 0.4472 - accuracy: 0.5417 - val_loss: 0.9010 - val_accur
acy: 0.3333 - 75ms/epoch - 37ms/step
Epoch 15/100
2/2 - 0s - loss: 0.4201 - accuracy: 0.5417 - val_loss: 0.9434 - val_accur
acy: 0.3333 - 86ms/epoch - 43ms/step
Epoch 16/100
2/2 - 0s - loss: 0.4002 - accuracy: 0.5417 - val_loss: 1.0031 - val_accur
acy: 0.3333 - 66ms/epoch - 33ms/step
Epoch 17/100
2/2 - 0s - loss: 0.3811 - accuracy: 0.6667 - val_loss: 1.0719 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 18/100
2/2 - 0s - loss: 0.3639 - accuracy: 0.8750 - val_loss: 1.1467 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 19/100
2/2 - 0s - loss: 0.3498 - accuracy: 1.0000 - val_loss: 1.2370 - val_accur
acy: 0.3333 - 103ms/epoch - 51ms/step
Epoch 20/100
2/2 - 0s - loss: 0.3391 - accuracy: 0.9583 - val_loss: 1.3331 - val_accur
acy: 0.3333 - 91ms/epoch - 46ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.3316 - accuracy: 1.0000 - val_loss: 1.4018 - val_accur
acy: 0.3333 - 78ms/epoch - 39ms/step
Epoch 22/100
2/2 - 0s - loss: 0.3252 - accuracy: 1.0000 - val_loss: 1.4607 - val_accur
acy: 0.3333 - 66ms/epoch - 33ms/step
Epoch 23/100
2/2 - 0s - loss: 0.3206 - accuracy: 1.0000 - val_loss: 1.5308 - val_accur
acy: 0.3333 - 63ms/epoch - 31ms/step
Epoch 24/100
2/2 - 0s - loss: 0.3165 - accuracy: 1.0000 - val_loss: 1.6077 - val_accur
acy: 0.3333 - 66ms/epoch - 33ms/step
Epoch 25/100
2/2 - 0s - loss: 0.3134 - accuracy: 1.0000 - val_loss: 1.6903 - val_accur
acy: 0.3333 - 72ms/epoch - 36ms/step
Epoch 26/100
2/2 - 0s - loss: 0.3103 - accuracy: 1.0000 - val_loss: 1.7726 - val_accur
acy: 0.3333 - 74ms/epoch - 37ms/step
Epoch 27/100
2/2 - 0s - loss: 0.3076 - accuracy: 1.0000 - val_loss: 1.8554 - val_accur
acy: 0.3333 - 82ms/epoch - 41ms/step
Epoch 28/100
2/2 - 0s - loss: 0.3055 - accuracy: 1.0000 - val_loss: 1.9113 - val_accur
acy: 0.3333 - 80ms/epoch - 40ms/step
Epoch 29/100
2/2 - 0s - loss: 0.3027 - accuracy: 1.0000 - val_loss: 1.9431 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 30/100
2/2 - 0s - loss: 0.3004 - accuracy: 1.0000 - val_loss: 1.9762 - val_accur
acy: 0.3333 - 63ms/epoch - 31ms/step
Epoch 31/100
2/2 - 0s - loss: 0.2982 - accuracy: 1.0000 - val_loss: 2.0098 - val_accur
acy: 0.3333 - 70ms/epoch - 35ms/step
Epoch 32/100
2/2 - 0s - loss: 0.2959 - accuracy: 1.0000 - val_loss: 2.0439 - val_accur
acy: 0.3333 - 76ms/epoch - 38ms/step
Epoch 33/100
2/2 - 0s - loss: 0.2934 - accuracy: 1.0000 - val_loss: 2.0786 - val_accur
acy: 0.3333 - 83ms/epoch - 41ms/step
Epoch 34/100
2/2 - 0s - loss: 0.2905 - accuracy: 1.0000 - val_loss: 2.0975 - val_accur
acy: 0.3333 - 75ms/epoch - 38ms/step
Epoch 35/100
2/2 - 0s - loss: 0.2883 - accuracy: 1.0000 - val_loss: 2.0725 - val_accur
acy: 0.3333 - 72ms/epoch - 36ms/step
Epoch 36/100
2/2 - 0s - loss: 0.2856 - accuracy: 1.0000 - val_loss: 2.0558 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 37/100
2/2 - 0s - loss: 0.2824 - accuracy: 1.0000 - val_loss: 2.0457 - val_accur
acy: 0.3333 - 74ms/epoch - 37ms/step
Epoch 38/100
2/2 - 0s - loss: 0.2790 - accuracy: 1.0000 - val_loss: 2.0428 - val_accur
acy: 0.3333 - 72ms/epoch - 36ms/step
Epoch 39/100
2/2 - 0s - loss: 0.2757 - accuracy: 1.0000 - val_loss: 2.0297 - val_accur
acy: 0.3333 - 70ms/epoch - 35ms/step
Epoch 40/100
2/2 - 0s - loss: 0.2717 - accuracy: 1.0000 - val_loss: 2.0076 - val_accur
acy: 0.3333 - 74ms/epoch - 37ms/step
Epoch 41/100
2/2 - 0s - loss: 0.2673 - accuracy: 1.0000 - val_loss: 1.9931 - val_accur
```

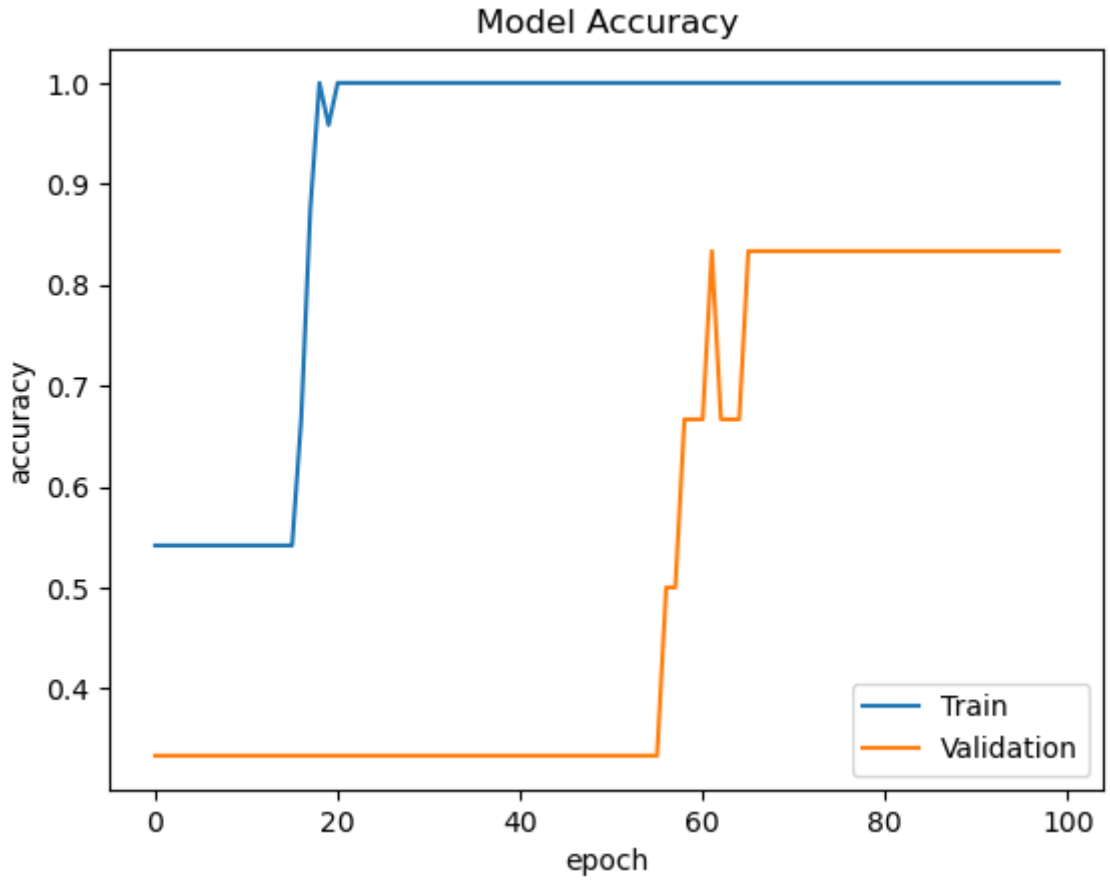
```
acy: 0.3333 - 82ms/epoch - 41ms/step
Epoch 42/100
2/2 - 0s - loss: 0.2621 - accuracy: 1.0000 - val_loss: 1.9820 - val_accur
acy: 0.3333 - 63ms/epoch - 31ms/step
Epoch 43/100
2/2 - 0s - loss: 0.2559 - accuracy: 1.0000 - val_loss: 1.9399 - val_accur
acy: 0.3333 - 67ms/epoch - 33ms/step
Epoch 44/100
2/2 - 0s - loss: 0.2500 - accuracy: 1.0000 - val_loss: 1.9039 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 45/100
2/2 - 0s - loss: 0.2426 - accuracy: 1.0000 - val_loss: 1.8604 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 46/100
2/2 - 0s - loss: 0.2337 - accuracy: 1.0000 - val_loss: 1.8102 - val_accur
acy: 0.3333 - 69ms/epoch - 34ms/step
Epoch 47/100
2/2 - 0s - loss: 0.2241 - accuracy: 1.0000 - val_loss: 1.7663 - val_accur
acy: 0.3333 - 73ms/epoch - 36ms/step
Epoch 48/100
2/2 - 0s - loss: 0.2122 - accuracy: 1.0000 - val_loss: 1.7250 - val_accur
acy: 0.3333 - 77ms/epoch - 38ms/step
Epoch 49/100
2/2 - 0s - loss: 0.2005 - accuracy: 1.0000 - val_loss: 1.6238 - val_accur
acy: 0.3333 - 73ms/epoch - 36ms/step
Epoch 50/100
2/2 - 0s - loss: 0.1851 - accuracy: 1.0000 - val_loss: 1.4969 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 51/100
2/2 - 0s - loss: 0.1684 - accuracy: 1.0000 - val_loss: 1.3846 - val_accur
acy: 0.3333 - 59ms/epoch - 29ms/step
Epoch 52/100
2/2 - 0s - loss: 0.1522 - accuracy: 1.0000 - val_loss: 1.2884 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 53/100
2/2 - 0s - loss: 0.1304 - accuracy: 1.0000 - val_loss: 1.2137 - val_accur
acy: 0.3333 - 63ms/epoch - 32ms/step
Epoch 54/100
2/2 - 0s - loss: 0.1113 - accuracy: 1.0000 - val_loss: 1.1477 - val_accur
acy: 0.3333 - 82ms/epoch - 41ms/step
Epoch 55/100
2/2 - 0s - loss: 0.0911 - accuracy: 1.0000 - val_loss: 1.0980 - val_accur
acy: 0.3333 - 65ms/epoch - 32ms/step
Epoch 56/100
2/2 - 0s - loss: 0.0716 - accuracy: 1.0000 - val_loss: 1.0685 - val_accur
acy: 0.3333 - 59ms/epoch - 29ms/step
Epoch 57/100
2/2 - 0s - loss: 0.0550 - accuracy: 1.0000 - val_loss: 1.0602 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 58/100
2/2 - 0s - loss: 0.0410 - accuracy: 1.0000 - val_loss: 1.0738 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 59/100
2/2 - 0s - loss: 0.0291 - accuracy: 1.0000 - val_loss: 1.0318 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 60/100
2/2 - 0s - loss: 0.0201 - accuracy: 1.0000 - val_loss: 0.9658 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 61/100
2/2 - 0s - loss: 0.0147 - accuracy: 1.0000 - val_loss: 0.8985 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
```

```
Epoch 62/100
2/2 - 0s - loss: 0.0106 - accuracy: 1.0000 - val_loss: 0.8943 - val_accur
acy: 0.8333 - 63ms/epoch - 31ms/step
Epoch 63/100
2/2 - 0s - loss: 0.0079 - accuracy: 1.0000 - val_loss: 0.9397 - val_accur
acy: 0.6667 - 69ms/epoch - 34ms/step
Epoch 64/100
2/2 - 0s - loss: 0.0056 - accuracy: 1.0000 - val_loss: 1.0277 - val_accur
acy: 0.6667 - 77ms/epoch - 38ms/step
Epoch 65/100
2/2 - 0s - loss: 0.0045 - accuracy: 1.0000 - val_loss: 1.0400 - val_accur
acy: 0.6667 - 82ms/epoch - 41ms/step
Epoch 66/100
2/2 - 0s - loss: 0.0036 - accuracy: 1.0000 - val_loss: 0.9930 - val_accur
acy: 0.8333 - 69ms/epoch - 35ms/step
Epoch 67/100
2/2 - 0s - loss: 0.0028 - accuracy: 1.0000 - val_loss: 0.9386 - val_accur
acy: 0.8333 - 56ms/epoch - 28ms/step
```

In [31]:
```
model4.evaluate(X_test,y_test)
```

Out[31]:
```
1/1 [==============================] - 0s 47ms/step - loss: 0.7080 - accu
racy: 0.8333
[0.7079663872718811, 0.8333333134651184]
```

In [32]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```



Model 5

```
2/2 - 0s - loss: 4.0584e-04 - accuracy: 1.0000 - val_loss: 1.1789 - val_a
ccuracy: 0.8333 - 73ms/epoch - 37ms/step
```

In [33]:

```
model5 = Sequential()
model5.add(Dense(64, activation='relu',input_dim=X_train.shape[1]))
model5.add(Dense(32, activation='relu'))
model5.add(Dense(16, activation='relu'))
model5.add(Dense(8, activation='relu'))
model5.add(Dense(2, activation='sigmoid')) #output layer
model5.summary()
```

```
Epoch 89/100
2/2 - 0s - loss: 3.9215e-04 - accuracy: 1.0000 - val_loss: 1.1827 - val_a
ccuracy: 0.8333 - 74ms/epoch - 37ms/step
Epoch 90/100
2/2 - 0s - loss: 3.8059e-04 - accuracy: 1.0000 - val_loss: 1.1870 - val_a
ccuracy: 0.8333 - 72ms/epoch - 36ms/step
Epoch 91/100
2/2 - 0s - loss: 3.6996e-04 - accuracy: 1.0000 - val_loss: 1.1920 - val_a
ccuracy: 0.8333 - 58ms/epoch - 29ms/step
Epoch 92/100
2/2 - 0s - loss: 3.5884e-04 - accuracy: 1.0000 - val_loss: 1.1969 - val_a
ccuracy: 0.8333 - 59ms/epoch - 30ms/step
Epoch 93/100
2/2 - 0s - loss: 3.4999e-04 - accuracy: 1.0000 - val_loss: 1.2027 - val_a
ccuracy: 0.8333 - 61ms/epoch - 30ms/step
Epoch 94/100
2/2 - 0s - loss: 3.4072e-04 - accuracy: 1.0000 - val_loss: 1.2096 - val_a
ccuracy: 0.8333 - 62ms/epoch - 31ms/step
Epoch 95/100
2/2 - 0s - loss: 3.3083e-04 - accuracy: 1.0000 - val_loss: 1.2164 - val_a
ccuracy: 0.8333 - 57ms/epoch - 29ms/step
Epoch 96/100
2/2 - 0s - loss: 3.2314e-04 - accuracy: 1.0000 - val_loss: 1.2227 - val_a
ccuracy: 0.8333 - 61ms/epoch - 30ms/step
Epoch 97/100
2/2 - 0s - loss: 3.1474e-04 - accuracy: 1.0000 - val_loss: 1.2290 - val_a
ccuracy: 0.8333 - 63ms/epoch - 32ms/step
Epoch 98/100
2/2 - 0s - loss: 3.0642e-04 - accuracy: 1.0000 - val_loss: 1.2333 - val_a
ccuracy: 0.8333 - 60ms/epoch - 30ms/step
Epoch 99/100
2/2 - 0s - loss: 2.9964e-04 - accuracy: 1.0000 - val_loss: 1.2353 - val_a
ccuracy: 0.8333 - 61ms/epoch - 30ms/step
Epoch 100/100
2/2 - 0s - loss: 2.9263e-04 - accuracy: 1.0000 - val_loss: 1.2365 - val_a
ccuracy: 0.8333 - 63ms/epoch - 32ms/step
```

```
Model: "sequential_4"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_30 (Dense)            (None, 64)                10048
 dense_31 (Dense)            (None, 32)                2080
 dense_32 (Dense)            (None, 16)                528
 dense_33 (Dense)            (None, 8)                 136
 dense_34 (Dense)            (None, 2)                 18
=================================================================
Total params: 12810 (50.04 KB)
Trainable params: 12810 (50.04 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [34]:

```
model5.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accurac
history=model5.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size=
```

```
Epoch 1/100
2/2 - 2s - loss: 0.6962 - accuracy: 0.3750 - val_loss: 0.6908 - val_accur
acy: 0.3333 - 2s/epoch - 1s/step
Epoch 2/100
2/2 - 0s - loss: 0.6846 - accuracy: 0.5833 - val_loss: 0.6925 - val_accur
acy: 0.5000 - 80ms/epoch - 40ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6748 - accuracy: 0.7500 - val_loss: 0.6936 - val_accur
acy: 0.5000 - 65ms/epoch - 32ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6651 - accuracy: 0.8333 - val_loss: 0.6924 - val_accur
acy: 0.6667 - 68ms/epoch - 34ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6568 - accuracy: 0.9583 - val_loss: 0.6918 - val_accur
acy: 0.6667 - 76ms/epoch - 38ms/step
Epoch 6/100
2/2 - 0s - loss: 0.6482 - accuracy: 0.9583 - val_loss: 0.6917 - val_accur
acy: 0.6667 - 63ms/epoch - 32ms/step
Epoch 7/100
2/2 - 0s - loss: 0.6395 - accuracy: 1.0000 - val_loss: 0.6923 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 8/100
2/2 - 0s - loss: 0.6298 - accuracy: 1.0000 - val_loss: 0.6920 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 9/100
2/2 - 0s - loss: 0.6202 - accuracy: 1.0000 - val_loss: 0.6913 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 10/100
2/2 - 0s - loss: 0.6098 - accuracy: 1.0000 - val_loss: 0.6902 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 11/100
2/2 - 0s - loss: 0.5983 - accuracy: 1.0000 - val_loss: 0.6892 - val_accur
acy: 0.8333 - 60ms/epoch - 30ms/step
Epoch 12/100
2/2 - 0s - loss: 0.5856 - accuracy: 1.0000 - val_loss: 0.6887 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 13/100
2/2 - 0s - loss: 0.5722 - accuracy: 1.0000 - val_loss: 0.6884 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 14/100
2/2 - 0s - loss: 0.5568 - accuracy: 1.0000 - val_loss: 0.6868 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 15/100
2/2 - 0s - loss: 0.5407 - accuracy: 1.0000 - val_loss: 0.6857 - val_accur
acy: 0.6667 - 55ms/epoch - 27ms/step
Epoch 16/100
2/2 - 0s - loss: 0.5221 - accuracy: 1.0000 - val_loss: 0.6865 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 17/100
2/2 - 0s - loss: 0.5029 - accuracy: 1.0000 - val_loss: 0.6867 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 18/100
2/2 - 0s - loss: 0.4826 - accuracy: 1.0000 - val_loss: 0.6858 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 19/100
2/2 - 0s - loss: 0.4600 - accuracy: 1.0000 - val_loss: 0.6848 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 20/100
2/2 - 0s - loss: 0.4368 - accuracy: 1.0000 - val_loss: 0.6828 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.4125 - accuracy: 1.0000 - val_loss: 0.6818 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 22/100
2/2 - 0s - loss: 0.3878 - accuracy: 1.0000 - val_loss: 0.6810 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 23/100
2/2 - 0s - loss: 0.3615 - accuracy: 1.0000 - val_loss: 0.6803 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 24/100
2/2 - 0s - loss: 0.3353 - accuracy: 1.0000 - val_loss: 0.6814 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 25/100
2/2 - 0s - loss: 0.3085 - accuracy: 1.0000 - val_loss: 0.6832 - val_accur
acy: 0.6667 - 79ms/epoch - 40ms/step
Epoch 26/100
2/2 - 0s - loss: 0.2814 - accuracy: 1.0000 - val_loss: 0.6840 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 27/100
2/2 - 0s - loss: 0.2546 - accuracy: 1.0000 - val_loss: 0.6839 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 28/100
2/2 - 0s - loss: 0.2286 - accuracy: 1.0000 - val_loss: 0.6859 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 29/100
2/2 - 0s - loss: 0.2034 - accuracy: 1.0000 - val_loss: 0.6930 - val_accur
acy: 0.6667 - 84ms/epoch - 42ms/step
Epoch 30/100
2/2 - 0s - loss: 0.1791 - accuracy: 1.0000 - val_loss: 0.6939 - val_accur
acy: 0.5000 - 63ms/epoch - 32ms/step
Epoch 31/100
2/2 - 0s - loss: 0.1563 - accuracy: 1.0000 - val_loss: 0.6966 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 32/100
2/2 - 0s - loss: 0.1356 - accuracy: 1.0000 - val_loss: 0.6998 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 33/100
2/2 - 0s - loss: 0.1167 - accuracy: 1.0000 - val_loss: 0.7031 - val_accur
acy: 0.5000 - 61ms/epoch - 30ms/step
Epoch 34/100
2/2 - 0s - loss: 0.1000 - accuracy: 1.0000 - val_loss: 0.7098 - val_accur
acy: 0.5000 - 61ms/epoch - 31ms/step
Epoch 35/100
2/2 - 0s - loss: 0.0844 - accuracy: 1.0000 - val_loss: 0.7228 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 36/100
2/2 - 0s - loss: 0.0718 - accuracy: 1.0000 - val_loss: 0.7377 - val_accur
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 37/100
2/2 - 0s - loss: 0.0604 - accuracy: 1.0000 - val_loss: 0.7514 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 38/100
2/2 - 0s - loss: 0.0513 - accuracy: 1.0000 - val_loss: 0.7619 - val_accur
acy: 0.5000 - 67ms/epoch - 34ms/step
Epoch 39/100
2/2 - 0s - loss: 0.0429 - accuracy: 1.0000 - val_loss: 0.7698 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 40/100
2/2 - 0s - loss: 0.0365 - accuracy: 1.0000 - val_loss: 0.7780 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 41/100
2/2 - 0s - loss: 0.0311 - accuracy: 1.0000 - val_loss: 0.7893 - val_accur
```

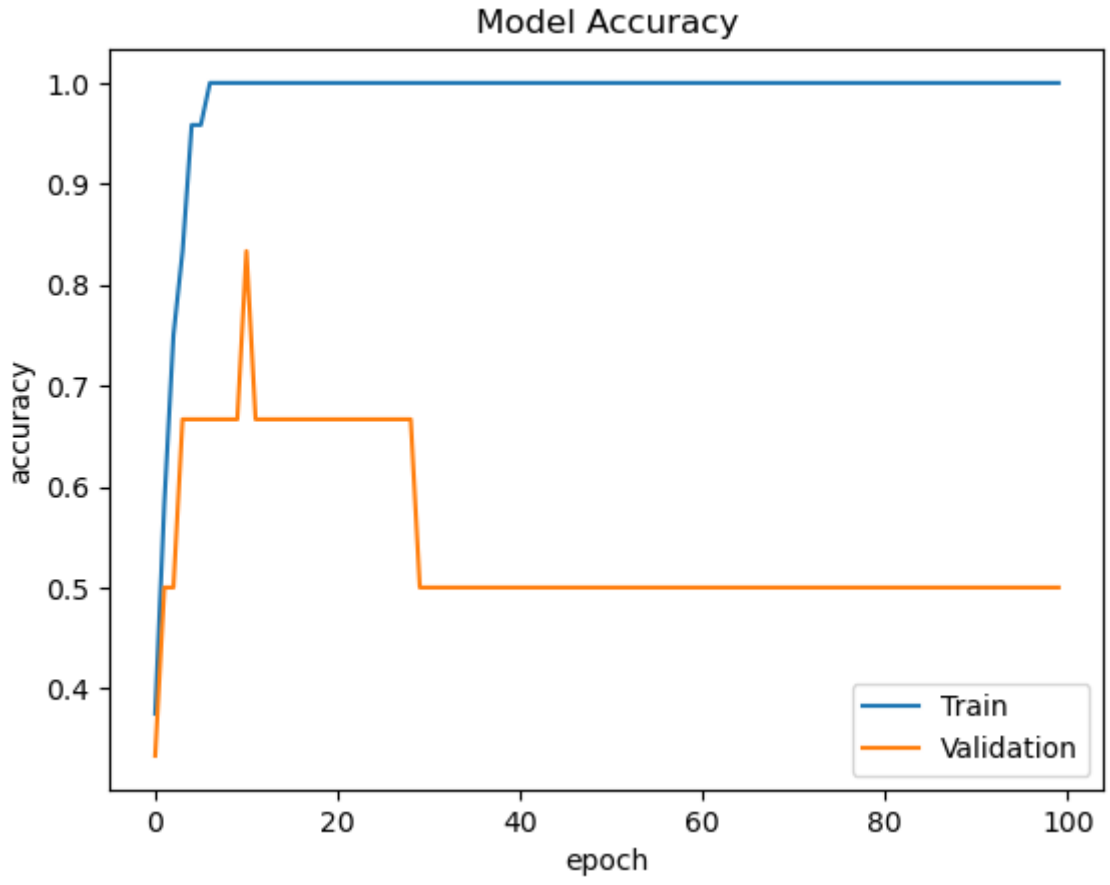
```
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 42/100
2/2 - 0s - loss: 0.0266 - accuracy: 1.0000 - val_loss: 0.8022 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 43/100
2/2 - 0s - loss: 0.0229 - accuracy: 1.0000 - val_loss: 0.8163 - val_accur
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 44/100
2/2 - 0s - loss: 0.0196 - accuracy: 1.0000 - val_loss: 0.8311 - val_accur
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 45/100
2/2 - 0s - loss: 0.0171 - accuracy: 1.0000 - val_loss: 0.8466 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 46/100
2/2 - 0s - loss: 0.0150 - accuracy: 1.0000 - val_loss: 0.8608 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 47/100
2/2 - 0s - loss: 0.0132 - accuracy: 1.0000 - val_loss: 0.8754 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 48/100
2/2 - 0s - loss: 0.0118 - accuracy: 1.0000 - val_loss: 0.8895 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 49/100
2/2 - 0s - loss: 0.0105 - accuracy: 1.0000 - val_loss: 0.9006 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 50/100
2/2 - 0s - loss: 0.0095 - accuracy: 1.0000 - val_loss: 0.9099 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 51/100
2/2 - 0s - loss: 0.0085 - accuracy: 1.0000 - val_loss: 0.9178 - val_accur
acy: 0.5000 - 55ms/epoch - 27ms/step
Epoch 52/100
2/2 - 0s - loss: 0.0078 - accuracy: 1.0000 - val_loss: 0.9246 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 53/100
2/2 - 0s - loss: 0.0071 - accuracy: 1.0000 - val_loss: 0.9318 - val_accur
acy: 0.5000 - 55ms/epoch - 27ms/step
Epoch 54/100
2/2 - 0s - loss: 0.0066 - accuracy: 1.0000 - val_loss: 0.9383 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 55/100
2/2 - 0s - loss: 0.0061 - accuracy: 1.0000 - val_loss: 0.9449 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 56/100
2/2 - 0s - loss: 0.0057 - accuracy: 1.0000 - val_loss: 0.9516 - val_accur
acy: 0.5000 - 69ms/epoch - 35ms/step
Epoch 57/100
2/2 - 0s - loss: 0.0053 - accuracy: 1.0000 - val_loss: 0.9583 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 58/100
2/2 - 0s - loss: 0.0049 - accuracy: 1.0000 - val_loss: 0.9650 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 59/100
2/2 - 0s - loss: 0.0046 - accuracy: 1.0000 - val_loss: 0.9715 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 60/100
2/2 - 0s - loss: 0.0044 - accuracy: 1.0000 - val_loss: 0.9778 - val_accur
acy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 61/100
2/2 - 0s - loss: 0.0041 - accuracy: 1.0000 - val_loss: 0.9840 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
```

```
Epoch 62/100
2/2 - 0s - loss: 0.0039 - accuracy: 1.0000 - val_loss: 0.9900 - val_accur
acy: 0.5000 - 67ms/epoch - 33ms/step
Epoch 63/100
2/2 - 0s - loss: 0.0037 - accuracy: 1.0000 - val_loss: 0.9957 - val_accur
acy: 0.5000 - 67ms/epoch - 33ms/step
Epoch 64/100
2/2 - 0s - loss: 0.0035 - accuracy: 1.0000 - val_loss: 1.0010 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 65/100
2/2 - 0s - loss: 0.0033 - accuracy: 1.0000 - val_loss: 1.0058 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 66/100
2/2 - 0s - loss: 0.0032 - accuracy: 1.0000 - val_loss: 1.0107 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 67/100
2/2 - 0s - loss: 0.0031 - accuracy: 1.0000 - val_loss: 1.0155 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
```

In [35]:
```
model.evaluate(X_test,y_test)
```

Out[35]:
```
[0.9235463142395020, 0.5]
```

In [36]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```



Model 6

In [37]:

```
model6 = Sequential()
model6.add(Dense(32, activation='relu',input_dim=X_train.shape[1]))
model6.add(Dense(16, activation='relu'))
model6.add(Dense(8, activation='relu'))
model6.add(Dense(2, activation='sigmoid')) #output layer
model6.summary()
```

```
Model: "sequential_5"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_35 (Dense)            (None, 32)                5024
 dense_36 (Dense)            (None, 16)                528
 dense_37 (Dense)            (None, 8)                 136
 dense_38 (Dense)            (None, 2)                 18
=================================================================
Total params: 5706 (22.29 KB)
Trainable params: 5706 (22.29 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 0.0015 - accuracy: 1.0000 - val_loss: 1.0897 - val_accur
acy: 0.5000 - 71ms/epoch - 35ms/step
Epoch 89/100
2/2 - 0s - loss: 0.0015 - accuracy: 1.0000 - val_loss: 1.0929 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 90/100
2/2 - 0s - loss: 0.0014 - accuracy: 1.0000 - val_loss: 1.0957 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 91/100
2/2 - 0s - loss: 0.0014 - accuracy: 1.0000 - val_loss: 1.0990 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 92/100
2/2 - 0s - loss: 0.0014 - accuracy: 1.0000 - val_loss: 1.1020 - val_accur
acy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 93/100
2/2 - 0s - loss: 0.0013 - accuracy: 1.0000 - val_loss: 1.1050 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 94/100
2/2 - 0s - loss: 0.0013 - accuracy: 1.0000 - val_loss: 1.1079 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 95/100
2/2 - 0s - loss: 0.0013 - accuracy: 1.0000 - val_loss: 1.1109 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 96/100
2/2 - 0s - loss: 0.0012 - accuracy: 1.0000 - val_loss: 1.1140 - val_accur
acy: 0.5000 - 65ms/epoch - 32ms/step
Epoch 97/100
2/2 - 0s - loss: 0.0012 - accuracy: 1.0000 - val_loss: 1.1165 - val_accur
acy: 0.5000 - 63ms/epoch - 31ms/step
Epoch 98/100
2/2 - 0s - loss: 0.0012 - accuracy: 1.0000 - val_loss: 1.1193 - val_accur
acy: 0.5000 - 66ms/epoch - 33ms/step
Epoch 99/100
2/2 - 0s - loss: 0.0012 - accuracy: 1.0000 - val_loss: 1.1219 - val_accur
acy: 0.5000 - 77ms/epoch - 38ms/step
Epoch 100/100
2/2 - 0s - loss: 0.0011 - accuracy: 1.0000 - val_loss: 1.1247 - val_accur
acy: 0.5000 - 73ms/epoch - 37ms/step
```

In [38]:

```
model6.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accurac
history=model6.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size=
```

```
Epoch 1/100
2/2 - 2s - loss: 0.6936 - accuracy: 0.4583 - val_loss: 0.6795 - val_accur
acy: 0.6667 - 2s/epoch - 828ms/step
Epoch 2/100
2/2 - 0s - loss: 0.6865 - accuracy: 0.5000 - val_loss: 0.6805 - val_accur
acy: 0.6667 - 77ms/epoch - 38ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6805 - accuracy: 0.5417 - val_loss: 0.6809 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6745 - accuracy: 0.6250 - val_loss: 0.6815 - val_accur
acy: 0.5000 - 61ms/epoch - 31ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6700 - accuracy: 0.6667 - val_loss: 0.6818 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 6/100
2/2 - 0s - loss: 0.6649 - accuracy: 0.7083 - val_loss: 0.6816 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 7/100
2/2 - 0s - loss: 0.6603 - accuracy: 0.7917 - val_loss: 0.6814 - val_accur
acy: 0.5000 - 63ms/epoch - 32ms/step
Epoch 8/100
2/2 - 0s - loss: 0.6553 - accuracy: 0.8333 - val_loss: 0.6810 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 9/100
2/2 - 0s - loss: 0.6504 - accuracy: 0.8750 - val_loss: 0.6808 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 10/100
2/2 - 0s - loss: 0.6450 - accuracy: 0.8750 - val_loss: 0.6801 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 11/100
2/2 - 0s - loss: 0.6392 - accuracy: 0.9167 - val_loss: 0.6789 - val_accur
acy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 12/100
2/2 - 0s - loss: 0.6330 - accuracy: 0.9167 - val_loss: 0.6776 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 13/100
2/2 - 0s - loss: 0.6262 - accuracy: 1.0000 - val_loss: 0.6762 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 14/100
2/2 - 0s - loss: 0.6196 - accuracy: 1.0000 - val_loss: 0.6747 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 15/100
2/2 - 0s - loss: 0.6123 - accuracy: 1.0000 - val_loss: 0.6732 - val_accur
acy: 0.5000 - 71ms/epoch - 36ms/step
Epoch 16/100
2/2 - 0s - loss: 0.6045 - accuracy: 1.0000 - val_loss: 0.6719 - val_accur
acy: 0.5000 - 73ms/epoch - 36ms/step
Epoch 17/100
2/2 - 0s - loss: 0.5964 - accuracy: 1.0000 - val_loss: 0.6706 - val_accur
acy: 0.5000 - 63ms/epoch - 32ms/step
Epoch 18/100
2/2 - 0s - loss: 0.5873 - accuracy: 1.0000 - val_loss: 0.6690 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 19/100
2/2 - 0s - loss: 0.5779 - accuracy: 1.0000 - val_loss: 0.6677 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 20/100
2/2 - 0s - loss: 0.5687 - accuracy: 1.0000 - val_loss: 0.6665 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.5582 - accuracy: 1.0000 - val_loss: 0.6649 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 22/100
2/2 - 0s - loss: 0.5475 - accuracy: 1.0000 - val_loss: 0.6633 - val_accur
acy: 0.6667 - 61ms/epoch - 30ms/step
Epoch 23/100
2/2 - 0s - loss: 0.5363 - accuracy: 1.0000 - val_loss: 0.6621 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 24/100
2/2 - 0s - loss: 0.5251 - accuracy: 1.0000 - val_loss: 0.6613 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 25/100
2/2 - 0s - loss: 0.5127 - accuracy: 1.0000 - val_loss: 0.6608 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 26/100
2/2 - 0s - loss: 0.5005 - accuracy: 1.0000 - val_loss: 0.6605 - val_accur
acy: 0.5000 - 61ms/epoch - 30ms/step
Epoch 27/100
2/2 - 0s - loss: 0.4870 - accuracy: 1.0000 - val_loss: 0.6604 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 28/100
2/2 - 0s - loss: 0.4738 - accuracy: 1.0000 - val_loss: 0.6606 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 29/100
2/2 - 0s - loss: 0.4597 - accuracy: 1.0000 - val_loss: 0.6611 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 30/100
2/2 - 0s - loss: 0.4450 - accuracy: 1.0000 - val_loss: 0.6622 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 31/100
2/2 - 0s - loss: 0.4304 - accuracy: 1.0000 - val_loss: 0.6646 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 32/100
2/2 - 0s - loss: 0.4154 - accuracy: 1.0000 - val_loss: 0.6670 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 33/100
2/2 - 0s - loss: 0.3999 - accuracy: 1.0000 - val_loss: 0.6692 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 34/100
2/2 - 0s - loss: 0.3842 - accuracy: 1.0000 - val_loss: 0.6723 - val_accur
acy: 0.5000 - 78ms/epoch - 39ms/step
Epoch 35/100
2/2 - 0s - loss: 0.3686 - accuracy: 1.0000 - val_loss: 0.6761 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 36/100
2/2 - 0s - loss: 0.3521 - accuracy: 1.0000 - val_loss: 0.6799 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 37/100
2/2 - 0s - loss: 0.3361 - accuracy: 1.0000 - val_loss: 0.6846 - val_accur
acy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 38/100
2/2 - 0s - loss: 0.3202 - accuracy: 1.0000 - val_loss: 0.6904 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 39/100
2/2 - 0s - loss: 0.3044 - accuracy: 1.0000 - val_loss: 0.6965 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 40/100
2/2 - 0s - loss: 0.2883 - accuracy: 1.0000 - val_loss: 0.7030 - val_accur
acy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 41/100
2/2 - 0s - loss: 0.2727 - accuracy: 1.0000 - val_loss: 0.7104 - val_accur
```

```
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 42/100
2/2 - 0s - loss: 0.2568 - accuracy: 1.0000 - val_loss: 0.7179 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 43/100
2/2 - 0s - loss: 0.2414 - accuracy: 1.0000 - val_loss: 0.7259 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 44/100
2/2 - 0s - loss: 0.2260 - accuracy: 1.0000 - val_loss: 0.7349 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 45/100
2/2 - 0s - loss: 0.2113 - accuracy: 1.0000 - val_loss: 0.7450 - val_accur
acy: 0.3333 - 59ms/epoch - 29ms/step
Epoch 46/100
2/2 - 0s - loss: 0.1971 - accuracy: 1.0000 - val_loss: 0.7563 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 47/100
2/2 - 0s - loss: 0.1830 - accuracy: 1.0000 - val_loss: 0.7684 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 48/100
2/2 - 0s - loss: 0.1696 - accuracy: 1.0000 - val_loss: 0.7810 - val_accur
acy: 0.3333 - 62ms/epoch - 31ms/step
Epoch 49/100
2/2 - 0s - loss: 0.1571 - accuracy: 1.0000 - val_loss: 0.7951 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 50/100
2/2 - 0s - loss: 0.1453 - accuracy: 1.0000 - val_loss: 0.8086 - val_accur
acy: 0.3333 - 55ms/epoch - 27ms/step
Epoch 51/100
2/2 - 0s - loss: 0.1336 - accuracy: 1.0000 - val_loss: 0.8205 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 52/100
2/2 - 0s - loss: 0.1230 - accuracy: 1.0000 - val_loss: 0.8330 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 53/100
2/2 - 0s - loss: 0.1132 - accuracy: 1.0000 - val_loss: 0.8461 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 54/100
2/2 - 0s - loss: 0.1040 - accuracy: 1.0000 - val_loss: 0.8605 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 55/100
2/2 - 0s - loss: 0.0954 - accuracy: 1.0000 - val_loss: 0.8745 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 56/100
2/2 - 0s - loss: 0.0874 - accuracy: 1.0000 - val_loss: 0.8890 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 57/100
2/2 - 0s - loss: 0.0802 - accuracy: 1.0000 - val_loss: 0.9016 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 58/100
2/2 - 0s - loss: 0.0736 - accuracy: 1.0000 - val_loss: 0.9142 - val_accur
acy: 0.3333 - 83ms/epoch - 41ms/step
Epoch 59/100
2/2 - 0s - loss: 0.0675 - accuracy: 1.0000 - val_loss: 0.9280 - val_accur
acy: 0.3333 - 77ms/epoch - 38ms/step
Epoch 60/100
2/2 - 0s - loss: 0.0620 - accuracy: 1.0000 - val_loss: 0.9427 - val_accur
acy: 0.3333 - 69ms/epoch - 34ms/step
Epoch 61/100
2/2 - 0s - loss: 0.0569 - accuracy: 1.0000 - val_loss: 0.9562 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
```

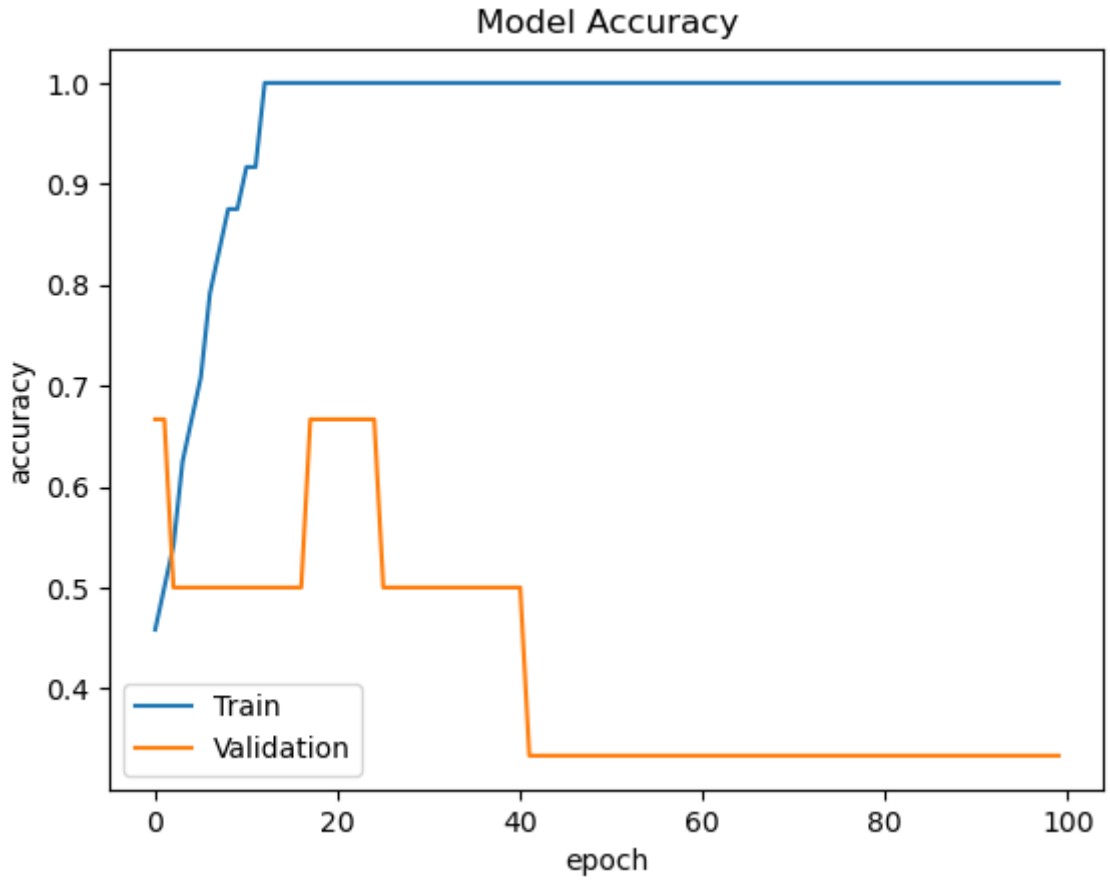
```
Epoch 62/100
2/2 - 0s - loss: 0.0522 - accuracy: 1.0000 - val_loss: 0.9673 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 63/100
2/2 - 0s - loss: 0.0482 - accuracy: 1.0000 - val_loss: 0.9779 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 64/100
2/2 - 0s - loss: 0.0443 - accuracy: 1.0000 - val_loss: 0.9892 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 65/100
2/2 - 0s - loss: 0.0409 - accuracy: 1.0000 - val_loss: 0.9997 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 66/100
2/2 - 0s - loss: 0.0377 - accuracy: 1.0000 - val_loss: 1.0095 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 67/100
2/2 - 0s - loss: 0.0348 - accuracy: 1.0000 - val_loss: 1.0194 - val_accur
acy: 0.3333 - 53ms/epoch - 27ms/step
```

In [39]:
```
model.evaluate(X_test,y_test)
```

Out[39]:
```
[0.5487734675407410, 0.3333333432674408]
```

In [40]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```

```
Epoch 68/100
2/2 - 0s - loss: 0.0322 - accuracy: 1.0000 - val_loss: 1.0285 - val_accur
acy: 0.3333 - 53ms/epoch - 26ms/step
Epoch 69/100
2/2 - 0s - loss: 0.0299 - accuracy: 1.0000 - val_loss: 1.0375 - val_accur
acy: 0.3333 - 55ms/epoch - 28ms/step
Epoch 70/100
2/2 - 0s - loss: 0.0276 - accuracy: 1.0000 - val_loss: 1.0468 - val_accur
acy: 0.3333 - 55ms/epoch - 28ms/step
Epoch 71/100
2/2 - 0s - loss: 0.0257 - accuracy: 1.0000 - val_loss: 1.0569 - val_accur
acy: 0.3333 - 55ms/epoch - 27ms/step
Epoch 72/100
2/2 - 0s - loss: 0.0238 - accuracy: 1.0000 - val_loss: 1.0663 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 73/100
2/2 - 0s - loss: 0.0222 - accuracy: 1.0000 - val_loss: 1.0746 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 74/100
2/2 - 0s - loss: 0.0207 - accuracy: 1.0000 - val_loss: 1.0829 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 75/100
2/2 - 0s - loss: 0.0193 - accuracy: 1.0000 - val_loss: 1.0909 - val_accur
```




```
acy: 0.3333 - 54ms/epoch - 27ms/step
Epoch 85/100
2/2 - 0s - loss: 0.0106 - accuracy: 1.0000 - val_loss: 1.1604 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 86/100
2/2 - 0s - loss: 0.0101 - accuracy: 1.0000 - val_loss: 1.1670 - val_accur
acy: 0.3333 - 59ms/epoch - 30ms/step
Epoch 87/100
2/2 - 0s - loss: 0.0096 - accuracy: 1.0000 - val_loss: 1.1738 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 88/100
```

Model 7

In [41]:

```
model7 = Sequential()
model7.add(Dense(16, activation='relu',input_dim=X_train.shape[1]))
model7.add(Dense(8, activation='relu'))
model7.add(Dense(2, activation='sigmoid')) #output layer
model7.summary()
```

```
Model: "sequential_6"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_39 (Dense)            (None, 16)                2512

 dense_40 (Dense)            (None, 8)                 136

 dense_41 (Dense)            (None, 2)                 18

=================================================================
Total params: 2666 (10.41 KB)
Trainable params: 2666 (10.41 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 0.0092 - accuracy: 1.0000 - val_loss: 1.1800 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 89/100
2/2 - 0s - loss: 0.0088 - accuracy: 1.0000 - val_loss: 1.1860 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 90/100
2/2 - 0s - loss: 0.0084 - accuracy: 1.0000 - val_loss: 1.1921 - val_accur
acy: 0.3333 - 63ms/epoch - 31ms/step
Epoch 91/100
2/2 - 0s - loss: 0.0080 - accuracy: 1.0000 - val_loss: 1.1979 - val_accur
acy: 0.3333 - 55ms/epoch - 27ms/step
Epoch 92/100
2/2 - 0s - loss: 0.0077 - accuracy: 1.0000 - val_loss: 1.2035 - val_accur
acy: 0.3333 - 52ms/epoch - 26ms/step
Epoch 93/100
2/2 - 0s - loss: 0.0073 - accuracy: 1.0000 - val_loss: 1.2090 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 94/100
2/2 - 0s - loss: 0.0071 - accuracy: 1.0000 - val_loss: 1.2140 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 95/100
2/2 - 0s - loss: 0.0068 - accuracy: 1.0000 - val_loss: 1.2191 - val_accur
acy: 0.3333 - 59ms/epoch - 29ms/step
Epoch 96/100
2/2 - 0s - loss: 0.0065 - accuracy: 1.0000 - val_loss: 1.2240 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 97/100
2/2 - 0s - loss: 0.0062 - accuracy: 1.0000 - val_loss: 1.2286 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 98/100
2/2 - 0s - loss: 0.0060 - accuracy: 1.0000 - val_loss: 1.2335 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 99/100
2/2 - 0s - loss: 0.0058 - accuracy: 1.0000 - val_loss: 1.2385 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 100/100
2/2 - 0s - loss: 0.0055 - accuracy: 1.0000 - val_loss: 1.2433 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
```

In [42]:

```
model7.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accurac
history=model7.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size=
```

```
Epoch 1/100
2/2 - 1s - loss: 0.7023 - accuracy: 0.3750 - val_loss: 0.6656 - val_accur
acy: 0.8333 - 1s/epoch - 686ms/step
Epoch 2/100
2/2 - 0s - loss: 0.6963 - accuracy: 0.4167 - val_loss: 0.6675 - val_accur
acy: 0.8333 - 80ms/epoch - 40ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6915 - accuracy: 0.5417 - val_loss: 0.6686 - val_accur
acy: 0.8333 - 79ms/epoch - 39ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6871 - accuracy: 0.5417 - val_loss: 0.6697 - val_accur
acy: 0.6667 - 61ms/epoch - 31ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6828 - accuracy: 0.5833 - val_loss: 0.6701 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 6/100
2/2 - 0s - loss: 0.6787 - accuracy: 0.6250 - val_loss: 0.6704 - val_accur
acy: 0.6667 - 57ms/epoch - 29ms/step
Epoch 7/100
2/2 - 0s - loss: 0.6750 - accuracy: 0.6250 - val_loss: 0.6707 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 8/100
2/2 - 0s - loss: 0.6709 - accuracy: 0.6667 - val_loss: 0.6703 - val_accur
acy: 0.5000 - 61ms/epoch - 31ms/step
Epoch 9/100
2/2 - 0s - loss: 0.6671 - accuracy: 0.6667 - val_loss: 0.6700 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 10/100
2/2 - 0s - loss: 0.6635 - accuracy: 0.7500 - val_loss: 0.6692 - val_accur
acy: 0.6667 - 57ms/epoch - 29ms/step
Epoch 11/100
2/2 - 0s - loss: 0.6601 - accuracy: 0.7500 - val_loss: 0.6685 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 12/100
2/2 - 0s - loss: 0.6560 - accuracy: 0.7500 - val_loss: 0.6673 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 13/100
2/2 - 0s - loss: 0.6522 - accuracy: 0.7500 - val_loss: 0.6659 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 14/100
2/2 - 0s - loss: 0.6482 - accuracy: 0.7500 - val_loss: 0.6644 - val_accur
acy: 0.6667 - 55ms/epoch - 28ms/step
Epoch 15/100
2/2 - 0s - loss: 0.6441 - accuracy: 0.8333 - val_loss: 0.6628 - val_accur
acy: 0.6667 - 61ms/epoch - 30ms/step
Epoch 16/100
2/2 - 0s - loss: 0.6395 - accuracy: 0.8333 - val_loss: 0.6611 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 17/100
2/2 - 0s - loss: 0.6348 - accuracy: 0.8750 - val_loss: 0.6590 - val_accur
acy: 0.6667 - 54ms/epoch - 27ms/step
Epoch 18/100
2/2 - 0s - loss: 0.6300 - accuracy: 0.8750 - val_loss: 0.6569 - val_accur
acy: 0.6667 - 61ms/epoch - 30ms/step
Epoch 19/100
2/2 - 0s - loss: 0.6255 - accuracy: 0.9167 - val_loss: 0.6548 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 20/100
2/2 - 0s - loss: 0.6203 - accuracy: 0.9167 - val_loss: 0.6530 - val_accur
acy: 0.6667 - 65ms/epoch - 33ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.6150 - accuracy: 0.9583 - val_loss: 0.6513 - val_accur
acy: 0.6667 - 78ms/epoch - 39ms/step
Epoch 22/100
2/2 - 0s - loss: 0.6097 - accuracy: 0.9583 - val_loss: 0.6494 - val_accur
acy: 0.6667 - 65ms/epoch - 32ms/step
Epoch 23/100
2/2 - 0s - loss: 0.6042 - accuracy: 0.9583 - val_loss: 0.6470 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 24/100
2/2 - 0s - loss: 0.5975 - accuracy: 0.9583 - val_loss: 0.6442 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 25/100
2/2 - 0s - loss: 0.5905 - accuracy: 0.9583 - val_loss: 0.6415 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 26/100
2/2 - 0s - loss: 0.5836 - accuracy: 0.9583 - val_loss: 0.6385 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 27/100
2/2 - 0s - loss: 0.5765 - accuracy: 0.9583 - val_loss: 0.6356 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 28/100
2/2 - 0s - loss: 0.5694 - accuracy: 0.9583 - val_loss: 0.6329 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 29/100
2/2 - 0s - loss: 0.5614 - accuracy: 0.9583 - val_loss: 0.6306 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 30/100
2/2 - 0s - loss: 0.5539 - accuracy: 0.9583 - val_loss: 0.6282 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 31/100
2/2 - 0s - loss: 0.5457 - accuracy: 0.9583 - val_loss: 0.6253 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 32/100
2/2 - 0s - loss: 0.5373 - accuracy: 0.9583 - val_loss: 0.6223 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 33/100
2/2 - 0s - loss: 0.5288 - accuracy: 0.9583 - val_loss: 0.6188 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 34/100
2/2 - 0s - loss: 0.5202 - accuracy: 0.9583 - val_loss: 0.6152 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 35/100
2/2 - 0s - loss: 0.5120 - accuracy: 0.9583 - val_loss: 0.6122 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 36/100
2/2 - 0s - loss: 0.5028 - accuracy: 0.9583 - val_loss: 0.6093 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 37/100
2/2 - 0s - loss: 0.4941 - accuracy: 0.9583 - val_loss: 0.6067 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 38/100
2/2 - 0s - loss: 0.4851 - accuracy: 0.9583 - val_loss: 0.6041 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 39/100
2/2 - 0s - loss: 0.4758 - accuracy: 0.9583 - val_loss: 0.6012 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 40/100
2/2 - 0s - loss: 0.4665 - accuracy: 0.9583 - val_loss: 0.5981 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 41/100
2/2 - 0s - loss: 0.4566 - accuracy: 0.9583 - val_loss: 0.5950 - val_accur
```

```
acy: 0.6667 - 80ms/epoch - 40ms/step
Epoch 42/100
2/2 - 0s - loss: 0.4473 - accuracy: 0.9583 - val_loss: 0.5911 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 43/100
2/2 - 0s - loss: 0.4377 - accuracy: 0.9583 - val_loss: 0.5876 - val_accur
acy: 0.6667 - 61ms/epoch - 30ms/step
Epoch 44/100
2/2 - 0s - loss: 0.4278 - accuracy: 0.9583 - val_loss: 0.5845 - val_accur
acy: 0.8333 - 55ms/epoch - 27ms/step
Epoch 45/100
2/2 - 0s - loss: 0.4180 - accuracy: 0.9583 - val_loss: 0.5810 - val_accur
acy: 0.8333 - 55ms/epoch - 27ms/step
Epoch 46/100
2/2 - 0s - loss: 0.4087 - accuracy: 0.9583 - val_loss: 0.5769 - val_accur
acy: 1.0000 - 56ms/epoch - 28ms/step
Epoch 47/100
2/2 - 0s - loss: 0.3991 - accuracy: 1.0000 - val_loss: 0.5732 - val_accur
acy: 1.0000 - 54ms/epoch - 27ms/step
Epoch 48/100
2/2 - 0s - loss: 0.3893 - accuracy: 1.0000 - val_loss: 0.5697 - val_accur
acy: 1.0000 - 59ms/epoch - 29ms/step
Epoch 49/100
2/2 - 0s - loss: 0.3797 - accuracy: 1.0000 - val_loss: 0.5657 - val_accur
acy: 1.0000 - 54ms/epoch - 27ms/step
Epoch 50/100
2/2 - 0s - loss: 0.3701 - accuracy: 1.0000 - val_loss: 0.5614 - val_accur
acy: 1.0000 - 58ms/epoch - 29ms/step
Epoch 51/100
2/2 - 0s - loss: 0.3609 - accuracy: 1.0000 - val_loss: 0.5569 - val_accur
acy: 1.0000 - 56ms/epoch - 28ms/step
Epoch 52/100
2/2 - 0s - loss: 0.3513 - accuracy: 1.0000 - val_loss: 0.5531 - val_accur
acy: 1.0000 - 58ms/epoch - 29ms/step
Epoch 53/100
2/2 - 0s - loss: 0.3419 - accuracy: 1.0000 - val_loss: 0.5496 - val_accur
acy: 1.0000 - 58ms/epoch - 29ms/step
Epoch 54/100
2/2 - 0s - loss: 0.3326 - accuracy: 1.0000 - val_loss: 0.5465 - val_accur
acy: 1.0000 - 54ms/epoch - 27ms/step
Epoch 55/100
2/2 - 0s - loss: 0.3233 - accuracy: 1.0000 - val_loss: 0.5438 - val_accur
acy: 1.0000 - 55ms/epoch - 27ms/step
Epoch 56/100
2/2 - 0s - loss: 0.3137 - accuracy: 1.0000 - val_loss: 0.5412 - val_accur
acy: 1.0000 - 54ms/epoch - 27ms/step
Epoch 57/100
2/2 - 0s - loss: 0.3043 - accuracy: 1.0000 - val_loss: 0.5384 - val_accur
acy: 1.0000 - 54ms/epoch - 27ms/step
Epoch 58/100
2/2 - 0s - loss: 0.2951 - accuracy: 1.0000 - val_loss: 0.5360 - val_accur
acy: 1.0000 - 54ms/epoch - 27ms/step
Epoch 59/100
2/2 - 0s - loss: 0.2861 - accuracy: 1.0000 - val_loss: 0.5337 - val_accur
acy: 1.0000 - 57ms/epoch - 28ms/step
Epoch 60/100
2/2 - 0s - loss: 0.2769 - accuracy: 1.0000 - val_loss: 0.5306 - val_accur
acy: 1.0000 - 53ms/epoch - 26ms/step
Epoch 61/100
2/2 - 0s - loss: 0.2679 - accuracy: 1.0000 - val_loss: 0.5279 - val_accur
acy: 1.0000 - 55ms/epoch - 28ms/step
```

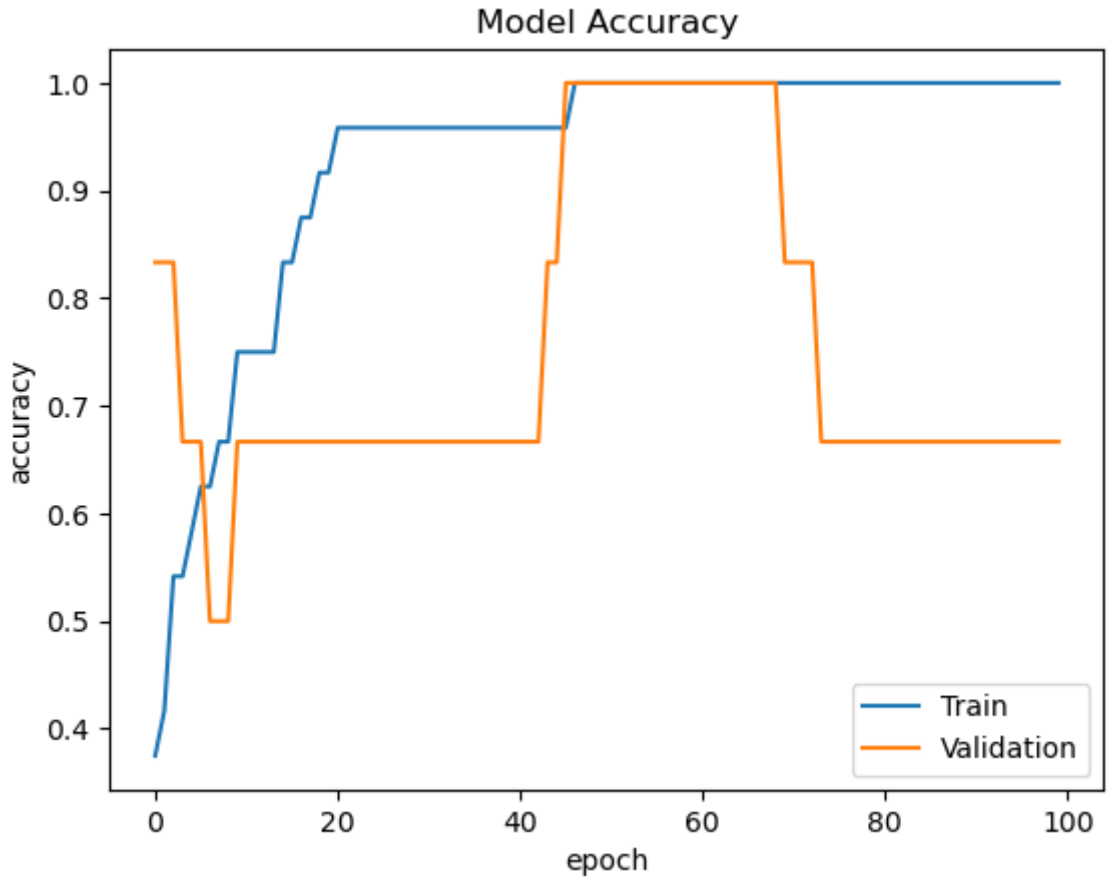
```
Epoch 62/100
2/2 - 0s - loss: 0.2591 - accuracy: 1.0000 - val_loss: 0.5254 - val_accur
acy: 1.0000 - 55ms/epoch - 27ms/step
Epoch 63/100
2/2 - 0s - loss: 0.2503 - accuracy: 1.0000 - val_loss: 0.5224 - val_accur
acy: 1.0000 - 52ms/epoch - 26ms/step
Epoch 64/100
2/2 - 0s - loss: 0.2419 - accuracy: 1.0000 - val_loss: 0.5200 - val_accur
acy: 1.0000 - 54ms/epoch - 27ms/step
Epoch 65/100
2/2 - 0s - loss: 0.2335 - accuracy: 1.0000 - val_loss: 0.5174 - val_accur
acy: 1.0000 - 55ms/epoch - 27ms/step
Epoch 66/100
2/2 - 0s - loss: 0.2255 - accuracy: 1.0000 - val_loss: 0.5151 - val_accur
acy: 1.0000 - 56ms/epoch - 28ms/step
Epoch 67/100
2/2 - 0s - loss: 0.2177 - accuracy: 1.0000 - val_loss: 0.5134 - val_accur
acy: 1.0000 - 54ms/epoch - 27ms/step
```

In [43]:
```
model.evaluate(X_test,y_test)
```

Out[43]:
```
1/1 [==============================] - 0s 49ms/step - loss: 0.7663 - accu
racy: 0.8333
[0.7662830352783203, 0.8333333134651184]
```

In [44]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```

```
Epoch 68/100
2/2 - 0s - loss: 0.2099 - accuracy: 1.0000 - val_loss: 0.5118 - val_accur
acy: 1.0000 - 57ms/epoch - 28ms/step
Epoch 69/100
2/2 - 0s - loss: 0.2023 - accuracy: 1.0000 - val_loss: 0.5102 - val_accur
acy: 1.0000 - 64ms/epoch - 32ms/step
Epoch 70/100
2/2 - 0s - loss: 0.1951 - accuracy: 1.0000 - val_loss: 0.5091 - val_accur
acy: 0.8333 - 63ms/epoch - 31ms/step
Epoch 71/100
2/2 - 0s - loss: 0.1882 - accuracy: 1.0000 - val_loss: 0.5075 - val_accur
acy: 0.8333 - 58ms/epoch - 29ms/step
Epoch 72/100
2/2 - 0s - loss: 0.1811 - accuracy: 1.0000 - val_loss: 0.5058 - val_accur
acy: 0.8333 - 63ms/epoch - 31ms/step
Epoch 73/100
2/2 - 0s - loss: 0.1745 - accuracy: 1.0000 - val_loss: 0.5047 - val_accur
acy: 0.8333 - 59ms/epoch - 29ms/step
Epoch 74/100
2/2 - 0s - loss: 0.1680 - accuracy: 1.0000 - val_loss: 0.5038 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 75/100
2/2 - 0s - loss: 0.1618 - accuracy: 1.0000 - val_loss: 0.5032 - val_accur
```




```
acy: 0.6667 - 74ms/epoch - 37ms/step
Epoch 85/100
2/2 - 0s - loss: 0.1096 - accuracy: 1.0000 - val_loss: 0.5055 - val_accur
acy: 0.6667 - 78ms/epoch - 39ms/step
Epoch 86/100
2/2 - 0s - loss: 0.1056 - accuracy: 1.0000 - val_loss: 0.5069 - val_accur
acy: 0.6667 - 68ms/epoch - 34ms/step
Epoch 87/100
2/2 - 0s - loss: 0.1016 - accuracy: 1.0000 - val_loss: 0.5075 - val_accur
acy: 0.6667 - 63ms/epoch - 31ms/step
Epoch 88/100
```

Model 8

In [45]:

```
model8 = Sequential()
model8.add(Dense(8, activation='relu',input_dim=X_train.shape[1]))
model8.add(Dense(2, activation='sigmoid')) #output layer
model8.summary()
```

```
Model: "sequential_7"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_42 (Dense)            (None, 8)                 1256

 dense_43 (Dense)            (None, 2)                 18

=================================================================
Total params: 1274 (4.98 KB)
Trainable params: 1274 (4.98 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 0.0977 - accuracy: 1.0000 - val_loss: 0.5083 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 89/100
2/2 - 0s - loss: 0.0939 - accuracy: 1.0000 - val_loss: 0.5090 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 90/100
2/2 - 0s - loss: 0.0907 - accuracy: 1.0000 - val_loss: 0.5105 - val_accur
acy: 0.6667 - 57ms/epoch - 29ms/step
Epoch 91/100
2/2 - 0s - loss: 0.0872 - accuracy: 1.0000 - val_loss: 0.5113 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 92/100
2/2 - 0s - loss: 0.0841 - accuracy: 1.0000 - val_loss: 0.5129 - val_accur
acy: 0.6667 - 61ms/epoch - 31ms/step
Epoch 93/100
2/2 - 0s - loss: 0.0810 - accuracy: 1.0000 - val_loss: 0.5146 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 94/100
2/2 - 0s - loss: 0.0780 - accuracy: 1.0000 - val_loss: 0.5166 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 95/100
2/2 - 0s - loss: 0.0752 - accuracy: 1.0000 - val_loss: 0.5180 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 96/100
2/2 - 0s - loss: 0.0725 - accuracy: 1.0000 - val_loss: 0.5194 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 97/100
2/2 - 0s - loss: 0.0698 - accuracy: 1.0000 - val_loss: 0.5210 - val_accur
acy: 0.6667 - 61ms/epoch - 30ms/step
Epoch 98/100
2/2 - 0s - loss: 0.0676 - accuracy: 1.0000 - val_loss: 0.5231 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 99/100
2/2 - 0s - loss: 0.0651 - accuracy: 1.0000 - val_loss: 0.5255 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 100/100
2/2 - 0s - loss: 0.0628 - accuracy: 1.0000 - val_loss: 0.5275 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
```

In [46]:

```
model8.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accurac
history=model8.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size=
```

```
Epoch 1/100
2/2 - 1s - loss: 0.6970 - accuracy: 0.6250 - val_loss: 0.6800 - val_accur
acy: 0.5000 - 1s/epoch - 644ms/step
Epoch 2/100
2/2 - 0s - loss: 0.6939 - accuracy: 0.7083 - val_loss: 0.6803 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6908 - accuracy: 0.7083 - val_loss: 0.6802 - val_accur
acy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6882 - accuracy: 0.7500 - val_loss: 0.6800 - val_accur
acy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6855 - accuracy: 0.7500 - val_loss: 0.6801 - val_accur
acy: 0.5000 - 63ms/epoch - 31ms/step
Epoch 6/100
2/2 - 0s - loss: 0.6826 - accuracy: 0.7500 - val_loss: 0.6802 - val_accur
acy: 0.5000 - 69ms/epoch - 34ms/step
Epoch 7/100
2/2 - 0s - loss: 0.6800 - accuracy: 0.7500 - val_loss: 0.6803 - val_accur
acy: 0.5000 - 63ms/epoch - 31ms/step
Epoch 8/100
2/2 - 0s - loss: 0.6774 - accuracy: 0.7500 - val_loss: 0.6805 - val_accur
acy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 9/100
2/2 - 0s - loss: 0.6745 - accuracy: 0.7917 - val_loss: 0.6806 - val_accur
acy: 0.5000 - 69ms/epoch - 35ms/step
Epoch 10/100
2/2 - 0s - loss: 0.6719 - accuracy: 0.7917 - val_loss: 0.6808 - val_accur
acy: 0.5000 - 73ms/epoch - 36ms/step
Epoch 11/100
2/2 - 0s - loss: 0.6690 - accuracy: 0.7917 - val_loss: 0.6809 - val_accur
acy: 0.5000 - 66ms/epoch - 33ms/step
Epoch 12/100
2/2 - 0s - loss: 0.6663 - accuracy: 0.7917 - val_loss: 0.6811 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 13/100
2/2 - 0s - loss: 0.6638 - accuracy: 0.8333 - val_loss: 0.6813 - val_accur
acy: 0.5000 - 77ms/epoch - 39ms/step
Epoch 14/100
2/2 - 0s - loss: 0.6609 - accuracy: 0.8333 - val_loss: 0.6815 - val_accur
acy: 0.5000 - 87ms/epoch - 43ms/step
Epoch 15/100
2/2 - 0s - loss: 0.6581 - accuracy: 0.8333 - val_loss: 0.6817 - val_accur
acy: 0.5000 - 99ms/epoch - 49ms/step
Epoch 16/100
2/2 - 0s - loss: 0.6553 - accuracy: 0.8333 - val_loss: 0.6821 - val_accur
acy: 0.5000 - 84ms/epoch - 42ms/step
Epoch 17/100
2/2 - 0s - loss: 0.6525 - accuracy: 0.8333 - val_loss: 0.6825 - val_accur
acy: 0.5000 - 81ms/epoch - 40ms/step
Epoch 18/100
2/2 - 0s - loss: 0.6497 - accuracy: 0.8750 - val_loss: 0.6829 - val_accur
acy: 0.5000 - 75ms/epoch - 38ms/step
Epoch 19/100
2/2 - 0s - loss: 0.6468 - accuracy: 0.8750 - val_loss: 0.6835 - val_accur
acy: 0.5000 - 69ms/epoch - 34ms/step
Epoch 20/100
2/2 - 0s - loss: 0.6438 - accuracy: 0.8750 - val_loss: 0.6839 - val_accur
acy: 0.5000 - 67ms/epoch - 33ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.6409 - accuracy: 0.8750 - val_loss: 0.6843 - val_accur
acy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 22/100
2/2 - 0s - loss: 0.6381 - accuracy: 0.8750 - val_loss: 0.6847 - val_accur
acy: 0.5000 - 63ms/epoch - 32ms/step
Epoch 23/100
2/2 - 0s - loss: 0.6349 - accuracy: 0.8750 - val_loss: 0.6849 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 24/100
2/2 - 0s - loss: 0.6320 - accuracy: 0.8750 - val_loss: 0.6853 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 25/100
2/2 - 0s - loss: 0.6287 - accuracy: 0.8750 - val_loss: 0.6856 - val_accur
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 26/100
2/2 - 0s - loss: 0.6256 - accuracy: 0.8750 - val_loss: 0.6860 - val_accur
acy: 0.5000 - 73ms/epoch - 37ms/step
Epoch 27/100
2/2 - 0s - loss: 0.6223 - accuracy: 0.8750 - val_loss: 0.6863 - val_accur
acy: 0.5000 - 65ms/epoch - 32ms/step
Epoch 28/100
2/2 - 0s - loss: 0.6191 - accuracy: 0.8750 - val_loss: 0.6865 - val_accur
acy: 0.5000 - 69ms/epoch - 34ms/step
Epoch 29/100
2/2 - 0s - loss: 0.6157 - accuracy: 0.8750 - val_loss: 0.6868 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 30/100
2/2 - 0s - loss: 0.6122 - accuracy: 0.8750 - val_loss: 0.6872 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 31/100
2/2 - 0s - loss: 0.6087 - accuracy: 0.8750 - val_loss: 0.6875 - val_accur
acy: 0.3333 - 65ms/epoch - 32ms/step
Epoch 32/100
2/2 - 0s - loss: 0.6050 - accuracy: 0.8750 - val_loss: 0.6878 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 33/100
2/2 - 0s - loss: 0.6014 - accuracy: 0.8750 - val_loss: 0.6881 - val_accur
acy: 0.3333 - 66ms/epoch - 33ms/step
Epoch 34/100
2/2 - 0s - loss: 0.5977 - accuracy: 0.8750 - val_loss: 0.6885 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 35/100
2/2 - 0s - loss: 0.5940 - accuracy: 0.8750 - val_loss: 0.6888 - val_accur
acy: 0.3333 - 65ms/epoch - 33ms/step
Epoch 36/100
2/2 - 0s - loss: 0.5903 - accuracy: 0.9583 - val_loss: 0.6891 - val_accur
acy: 0.3333 - 92ms/epoch - 46ms/step
Epoch 37/100
2/2 - 0s - loss: 0.5863 - accuracy: 0.9583 - val_loss: 0.6893 - val_accur
acy: 0.3333 - 75ms/epoch - 38ms/step
Epoch 38/100
2/2 - 0s - loss: 0.5822 - accuracy: 0.9583 - val_loss: 0.6895 - val_accur
acy: 0.3333 - 65ms/epoch - 33ms/step
Epoch 39/100
2/2 - 0s - loss: 0.5781 - accuracy: 0.9583 - val_loss: 0.6896 - val_accur
acy: 0.3333 - 73ms/epoch - 37ms/step
Epoch 40/100
2/2 - 0s - loss: 0.5739 - accuracy: 0.9583 - val_loss: 0.6899 - val_accur
acy: 0.3333 - 70ms/epoch - 35ms/step
Epoch 41/100
2/2 - 0s - loss: 0.5695 - accuracy: 0.9583 - val_loss: 0.6903 - val_accur
```

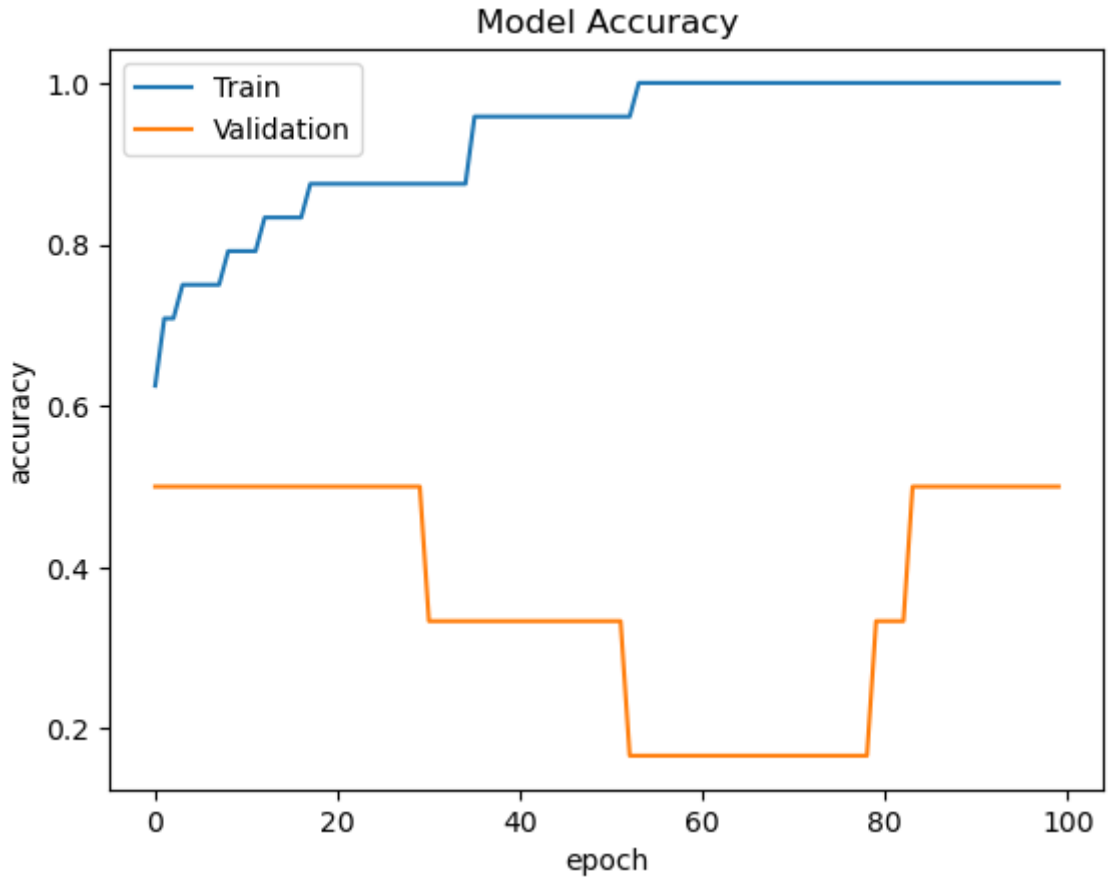
```
acy: 0.3333 - 68ms/epoch - 34ms/step
Epoch 42/100
2/2 - 0s - loss: 0.5649 - accuracy: 0.9583 - val_loss: 0.6907 - val_accur
acy: 0.3333 - 70ms/epoch - 35ms/step
Epoch 43/100
2/2 - 0s - loss: 0.5603 - accuracy: 0.9583 - val_loss: 0.6910 - val_accur
acy: 0.3333 - 65ms/epoch - 33ms/step
Epoch 44/100
2/2 - 0s - loss: 0.5556 - accuracy: 0.9583 - val_loss: 0.6913 - val_accur
acy: 0.3333 - 62ms/epoch - 31ms/step
Epoch 45/100
2/2 - 0s - loss: 0.5507 - accuracy: 0.9583 - val_loss: 0.6918 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 46/100
2/2 - 0s - loss: 0.5458 - accuracy: 0.9583 - val_loss: 0.6922 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 47/100
2/2 - 0s - loss: 0.5408 - accuracy: 0.9583 - val_loss: 0.6926 - val_accur
acy: 0.3333 - 68ms/epoch - 34ms/step
Epoch 48/100
2/2 - 0s - loss: 0.5358 - accuracy: 0.9583 - val_loss: 0.6928 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 49/100
2/2 - 0s - loss: 0.5306 - accuracy: 0.9583 - val_loss: 0.6930 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 50/100
2/2 - 0s - loss: 0.5257 - accuracy: 0.9583 - val_loss: 0.6936 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 51/100
2/2 - 0s - loss: 0.5206 - accuracy: 0.9583 - val_loss: 0.6940 - val_accur
acy: 0.3333 - 65ms/epoch - 33ms/step
Epoch 52/100
2/2 - 0s - loss: 0.5154 - accuracy: 0.9583 - val_loss: 0.6947 - val_accur
acy: 0.3333 - 69ms/epoch - 35ms/step
Epoch 53/100
2/2 - 0s - loss: 0.5101 - accuracy: 0.9583 - val_loss: 0.6951 - val_accur
acy: 0.1667 - 84ms/epoch - 42ms/step
Epoch 54/100
2/2 - 0s - loss: 0.5049 - accuracy: 1.0000 - val_loss: 0.6955 - val_accur
acy: 0.1667 - 68ms/epoch - 34ms/step
Epoch 55/100
2/2 - 0s - loss: 0.4995 - accuracy: 1.0000 - val_loss: 0.6958 - val_accur
acy: 0.1667 - 65ms/epoch - 33ms/step
Epoch 56/100
2/2 - 0s - loss: 0.4944 - accuracy: 1.0000 - val_loss: 0.6961 - val_accur
acy: 0.1667 - 71ms/epoch - 35ms/step
Epoch 57/100
2/2 - 0s - loss: 0.4890 - accuracy: 1.0000 - val_loss: 0.6964 - val_accur
acy: 0.1667 - 69ms/epoch - 34ms/step
Epoch 58/100
2/2 - 0s - loss: 0.4834 - accuracy: 1.0000 - val_loss: 0.6966 - val_accur
acy: 0.1667 - 65ms/epoch - 32ms/step
Epoch 59/100
2/2 - 0s - loss: 0.4781 - accuracy: 1.0000 - val_loss: 0.6969 - val_accur
acy: 0.1667 - 57ms/epoch - 28ms/step
Epoch 60/100
2/2 - 0s - loss: 0.4726 - accuracy: 1.0000 - val_loss: 0.6975 - val_accur
acy: 0.1667 - 54ms/epoch - 27ms/step
Epoch 61/100
2/2 - 0s - loss: 0.4670 - accuracy: 1.0000 - val_loss: 0.6980 - val_accur
acy: 0.1667 - 55ms/epoch - 27ms/step
```

```
Epoch 62/100
2/2 - 0s - loss: 0.4615 - accuracy: 1.0000 - val_loss: 0.6986 - val_accur
acy: 0.1667 - 64ms/epoch - 32ms/step
Epoch 63/100
2/2 - 0s - loss: 0.4559 - accuracy: 1.0000 - val_loss: 0.6992 - val_accur
acy: 0.1667 - 68ms/epoch - 34ms/step
Epoch 64/100
2/2 - 0s - loss: 0.4505 - accuracy: 1.0000 - val_loss: 0.6998 - val_accur
acy: 0.1667 - 67ms/epoch - 33ms/step
Epoch 65/100
2/2 - 0s - loss: 0.4447 - accuracy: 1.0000 - val_loss: 0.7003 - val_accur
acy: 0.1667 - 67ms/epoch - 33ms/step
Epoch 66/100
2/2 - 0s - loss: 0.4390 - accuracy: 1.0000 - val_loss: 0.7008 - val_accur
acy: 0.1667 - 84ms/epoch - 42ms/step
Epoch 67/100
2/2 - 0s - loss: 0.4333 - accuracy: 1.0000 - val_loss: 0.7015 - val_accur
acy: 0.1667 - 72ms/epoch - 36ms/step
```

In [47]:
```
model.evaluate(X_test,y_test)
```

Out[47]:
```
[0.6541028213500977, 0.5]
```

In [48]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```



Output Layer

Model : 1

In [40]:
```
model_o = Sequential()
model_o.add(Dense(32, activation='relu',input_dim=X_train.shape[1]))
model_o.add(Dense(2, activation='sigmoid')) #output layer
model_o.summary()
```

```
Model: "sequential_8"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_44 (Dense)            (None, 32)                5024

 dense_45 (Dense)            (None, 2)                 66

=================================================================
Total params: 5090 (19.88 KB)
Trainable params: 5090 (19.88 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 0.3132 - accuracy: 1.0000 - val_loss: 0.7166 - val_accur
acy: 0.5000 - 80ms/epoch - 40ms/step
Epoch 89/100
2/2 - 0s - loss: 0.3080 - accuracy: 1.0000 - val_loss: 0.7177 - val_accur
acy: 0.5000 - 67ms/epoch - 33ms/step
Epoch 90/100
2/2 - 0s - loss: 0.3026 - accuracy: 1.0000 - val_loss: 0.7190 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 91/100
2/2 - 0s - loss: 0.2974 - accuracy: 1.0000 - val_loss: 0.7200 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 92/100
2/2 - 0s - loss: 0.2922 - accuracy: 1.0000 - val_loss: 0.7213 - val_accur
acy: 0.5000 - 55ms/epoch - 27ms/step
Epoch 93/100
2/2 - 0s - loss: 0.2870 - accuracy: 1.0000 - val_loss: 0.7222 - val_accur
acy: 0.5000 - 61ms/epoch - 31ms/step
Epoch 94/100
2/2 - 0s - loss: 0.2820 - accuracy: 1.0000 - val_loss: 0.7232 - val_accur
acy: 0.5000 - 67ms/epoch - 34ms/step
Epoch 95/100
2/2 - 0s - loss: 0.2770 - accuracy: 1.0000 - val_loss: 0.7243 - val_accur
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 96/100
2/2 - 0s - loss: 0.2720 - accuracy: 1.0000 - val_loss: 0.7252 - val_accur
acy: 0.5000 - 65ms/epoch - 32ms/step
Epoch 97/100
2/2 - 0s - loss: 0.2670 - accuracy: 1.0000 - val_loss: 0.7261 - val_accur
acy: 0.5000 - 65ms/epoch - 33ms/step
Epoch 98/100
2/2 - 0s - loss: 0.2623 - accuracy: 1.0000 - val_loss: 0.7273 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 99/100
2/2 - 0s - loss: 0.2575 - accuracy: 1.0000 - val_loss: 0.7282 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 100/100
2/2 - 0s - loss: 0.2528 - accuracy: 1.0000 - val_loss: 0.7291 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
```

In [50]:

```
model_o.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accura
history=model_o.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size
```

```
Epoch 1/100
2/2 - 1s - loss: 0.6762 - accuracy: 0.5833 - val_loss: 0.6921 - val_accur
acy: 0.3333 - 1s/epoch - 568ms/step
Epoch 2/100
2/2 - 0s - loss: 0.6678 - accuracy: 0.6667 - val_loss: 0.6920 - val_accur
acy: 0.3333 - 79ms/epoch - 39ms/step
Epoch 3/100
2/2 - 0s - loss: 0.6597 - accuracy: 0.7500 - val_loss: 0.6916 - val_accur
acy: 0.3333 - 61ms/epoch - 31ms/step
Epoch 4/100
2/2 - 0s - loss: 0.6522 - accuracy: 0.7500 - val_loss: 0.6910 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 5/100
2/2 - 0s - loss: 0.6450 - accuracy: 0.7917 - val_loss: 0.6906 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 6/100
2/2 - 0s - loss: 0.6375 - accuracy: 0.8333 - val_loss: 0.6901 - val_accur
acy: 0.3333 - 74ms/epoch - 37ms/step
Epoch 7/100
2/2 - 0s - loss: 0.6305 - accuracy: 0.8750 - val_loss: 0.6895 - val_accur
acy: 0.3333 - 59ms/epoch - 29ms/step
Epoch 8/100
2/2 - 0s - loss: 0.6232 - accuracy: 0.8750 - val_loss: 0.6891 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 9/100
2/2 - 0s - loss: 0.6162 - accuracy: 0.8750 - val_loss: 0.6889 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 10/100
2/2 - 0s - loss: 0.6088 - accuracy: 0.9167 - val_loss: 0.6886 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
Epoch 11/100
2/2 - 0s - loss: 0.6017 - accuracy: 0.9583 - val_loss: 0.6884 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 12/100
2/2 - 0s - loss: 0.5946 - accuracy: 0.9583 - val_loss: 0.6880 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 13/100
2/2 - 0s - loss: 0.5875 - accuracy: 1.0000 - val_loss: 0.6878 - val_accur
acy: 0.3333 - 65ms/epoch - 33ms/step
Epoch 14/100
2/2 - 0s - loss: 0.5800 - accuracy: 1.0000 - val_loss: 0.6877 - val_accur
acy: 0.3333 - 61ms/epoch - 31ms/step
Epoch 15/100
2/2 - 0s - loss: 0.5729 - accuracy: 1.0000 - val_loss: 0.6876 - val_accur
acy: 0.3333 - 61ms/epoch - 30ms/step
Epoch 16/100
2/2 - 0s - loss: 0.5654 - accuracy: 1.0000 - val_loss: 0.6873 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 17/100
2/2 - 0s - loss: 0.5582 - accuracy: 1.0000 - val_loss: 0.6872 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 18/100
2/2 - 0s - loss: 0.5506 - accuracy: 1.0000 - val_loss: 0.6869 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 19/100
2/2 - 0s - loss: 0.5429 - accuracy: 1.0000 - val_loss: 0.6867 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 20/100
2/2 - 0s - loss: 0.5354 - accuracy: 1.0000 - val_loss: 0.6868 - val_accur
acy: 0.3333 - 54ms/epoch - 27ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.5275 - accuracy: 1.0000 - val_loss: 0.6865 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 22/100
2/2 - 0s - loss: 0.5196 - accuracy: 1.0000 - val_loss: 0.6863 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 23/100
2/2 - 0s - loss: 0.5116 - accuracy: 1.0000 - val_loss: 0.6859 - val_accur
acy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 24/100
2/2 - 0s - loss: 0.5035 - accuracy: 1.0000 - val_loss: 0.6858 - val_accur
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 25/100
2/2 - 0s - loss: 0.4955 - accuracy: 1.0000 - val_loss: 0.6859 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 26/100
2/2 - 0s - loss: 0.4871 - accuracy: 1.0000 - val_loss: 0.6859 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 27/100
2/2 - 0s - loss: 0.4787 - accuracy: 1.0000 - val_loss: 0.6859 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 28/100
2/2 - 0s - loss: 0.4703 - accuracy: 1.0000 - val_loss: 0.6860 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 29/100
2/2 - 0s - loss: 0.4616 - accuracy: 1.0000 - val_loss: 0.6865 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 30/100
2/2 - 0s - loss: 0.4532 - accuracy: 1.0000 - val_loss: 0.6872 - val_accur
acy: 0.5000 - 63ms/epoch - 31ms/step
Epoch 31/100
2/2 - 0s - loss: 0.4446 - accuracy: 1.0000 - val_loss: 0.6880 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 32/100
2/2 - 0s - loss: 0.4360 - accuracy: 1.0000 - val_loss: 0.6886 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 33/100
2/2 - 0s - loss: 0.4271 - accuracy: 1.0000 - val_loss: 0.6898 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 34/100
2/2 - 0s - loss: 0.4184 - accuracy: 1.0000 - val_loss: 0.6909 - val_accur
acy: 0.5000 - 81ms/epoch - 40ms/step
Epoch 35/100
2/2 - 0s - loss: 0.4095 - accuracy: 1.0000 - val_loss: 0.6920 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 36/100
2/2 - 0s - loss: 0.4007 - accuracy: 1.0000 - val_loss: 0.6933 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 37/100
2/2 - 0s - loss: 0.3919 - accuracy: 1.0000 - val_loss: 0.6946 - val_accur
acy: 0.5000 - 61ms/epoch - 30ms/step
Epoch 38/100
2/2 - 0s - loss: 0.3831 - accuracy: 1.0000 - val_loss: 0.6960 - val_accur
acy: 0.5000 - 55ms/epoch - 27ms/step
Epoch 39/100
2/2 - 0s - loss: 0.3746 - accuracy: 1.0000 - val_loss: 0.6977 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 40/100
2/2 - 0s - loss: 0.3658 - accuracy: 1.0000 - val_loss: 0.6992 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 41/100
2/2 - 0s - loss: 0.3572 - accuracy: 1.0000 - val_loss: 0.7005 - val_accur
```

```
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 42/100
2/2 - 0s - loss: 0.3487 - accuracy: 1.0000 - val_loss: 0.7018 - val_accur
acy: 0.5000 - 65ms/epoch - 32ms/step
Epoch 43/100
2/2 - 0s - loss: 0.3403 - accuracy: 1.0000 - val_loss: 0.7033 - val_accur
acy: 0.5000 - 53ms/epoch - 27ms/step
Epoch 44/100
2/2 - 0s - loss: 0.3318 - accuracy: 1.0000 - val_loss: 0.7048 - val_accur
acy: 0.5000 - 86ms/epoch - 43ms/step
Epoch 45/100
2/2 - 0s - loss: 0.3234 - accuracy: 1.0000 - val_loss: 0.7062 - val_accur
acy: 0.5000 - 75ms/epoch - 38ms/step
Epoch 46/100
2/2 - 0s - loss: 0.3151 - accuracy: 1.0000 - val_loss: 0.7076 - val_accur
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 47/100
2/2 - 0s - loss: 0.3070 - accuracy: 1.0000 - val_loss: 0.7089 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 48/100
2/2 - 0s - loss: 0.2987 - accuracy: 1.0000 - val_loss: 0.7105 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 49/100
2/2 - 0s - loss: 0.2909 - accuracy: 1.0000 - val_loss: 0.7122 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 50/100
2/2 - 0s - loss: 0.2831 - accuracy: 1.0000 - val_loss: 0.7137 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 51/100
2/2 - 0s - loss: 0.2754 - accuracy: 1.0000 - val_loss: 0.7151 - val_accur
acy: 0.5000 - 63ms/epoch - 31ms/step
Epoch 52/100
2/2 - 0s - loss: 0.2678 - accuracy: 1.0000 - val_loss: 0.7168 - val_accur
acy: 0.5000 - 55ms/epoch - 27ms/step
Epoch 53/100
2/2 - 0s - loss: 0.2604 - accuracy: 1.0000 - val_loss: 0.7186 - val_accur
acy: 0.5000 - 61ms/epoch - 31ms/step
Epoch 54/100
2/2 - 0s - loss: 0.2530 - accuracy: 1.0000 - val_loss: 0.7204 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 55/100
2/2 - 0s - loss: 0.2458 - accuracy: 1.0000 - val_loss: 0.7223 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 56/100
2/2 - 0s - loss: 0.2386 - accuracy: 1.0000 - val_loss: 0.7244 - val_accur
acy: 0.5000 - 54ms/epoch - 27ms/step
Epoch 57/100
2/2 - 0s - loss: 0.2317 - accuracy: 1.0000 - val_loss: 0.7266 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 58/100
2/2 - 0s - loss: 0.2250 - accuracy: 1.0000 - val_loss: 0.7289 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 59/100
2/2 - 0s - loss: 0.2184 - accuracy: 1.0000 - val_loss: 0.7310 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 60/100
2/2 - 0s - loss: 0.2120 - accuracy: 1.0000 - val_loss: 0.7332 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 61/100
2/2 - 0s - loss: 0.2058 - accuracy: 1.0000 - val_loss: 0.7360 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
```

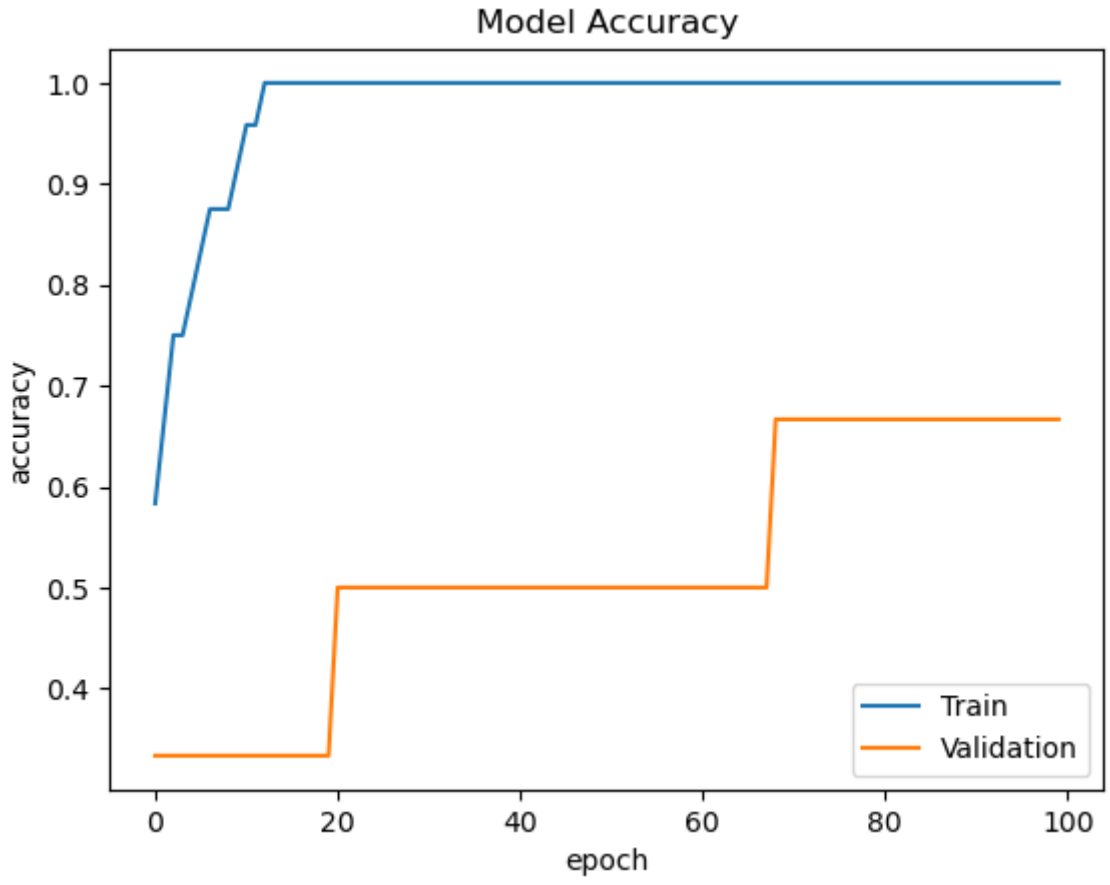
```
Epoch 62/100
2/2 - 0s - loss: 0.1996 - accuracy: 1.0000 - val_loss: 0.7391 - val_accur
acy: 0.5000 - 54ms/epoch - 27ms/step
Epoch 63/100
2/2 - 0s - loss: 0.1938 - accuracy: 1.0000 - val_loss: 0.7420 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 64/100
2/2 - 0s - loss: 0.1879 - accuracy: 1.0000 - val_loss: 0.7443 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 65/100
2/2 - 0s - loss: 0.1824 - accuracy: 1.0000 - val_loss: 0.7463 - val_accur
acy: 0.5000 - 54ms/epoch - 27ms/step
Epoch 66/100
2/2 - 0s - loss: 0.1768 - accuracy: 1.0000 - val_loss: 0.7483 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 67/100
2/2 - 0s - loss: 0.1716 - accuracy: 1.0000 - val_loss: 0.7500 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
```

In [51]:
```
model_o.evaluate(X_test,y_test)
```

Out[51]:
```
1/1 [==============================] - 0s 47ms/step - loss: 0.6652 - accu
racy: 0.6667
[0.6652135848999023, 0.6666666865348816]
```

In [52]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```

```
Epoch 68/100
2/2 - 0s - loss: 0.1663 - accuracy: 1.0000 - val_loss: 0.7521 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 69/100
2/2 - 0s - loss: 0.1613 - accuracy: 1.0000 - val_loss: 0.7544 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 70/100
2/2 - 0s - loss: 0.1565 - accuracy: 1.0000 - val_loss: 0.7566 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 71/100
2/2 - 0s - loss: 0.1519 - accuracy: 1.0000 - val_loss: 0.7594 - val_accur
acy: 0.6667 - 57ms/epoch - 29ms/step
Epoch 72/100
2/2 - 0s - loss: 0.1472 - accuracy: 1.0000 - val_loss: 0.7623 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 73/100
2/2 - 0s - loss: 0.1428 - accuracy: 1.0000 - val_loss: 0.7647 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 74/100
2/2 - 0s - loss: 0.1387 - accuracy: 1.0000 - val_loss: 0.7667 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 75/100
2/2 - 0s - loss: 0.1345 - accuracy: 1.0000 - val_loss: 0.7688 - val_accur
```




```
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 85/100
2/2 - 0s - loss: 0.1001 - accuracy: 1.0000 - val_loss: 0.7923 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 86/100
2/2 - 0s - loss: 0.0973 - accuracy: 1.0000 - val_loss: 0.7951 - val_accur
acy: 0.6667 - 55ms/epoch - 28ms/step
Epoch 87/100
2/2 - 0s - loss: 0.0944 - accuracy: 1.0000 - val_loss: 0.7977 - val_accur
acy: 0.6667 - 54ms/epoch - 27ms/step
Epoch 88/100
```

Model 2

In [52]:
```
model_o1 = Sequential()
model_o1.add(Dense(32, activation='relu',input_dim=X_train.shape[1]))
model_o1.add(Dense(3, activation='sigmoid')) #output layer
model_o1.summary()
```

```
Model: "sequential_9"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_46 (Dense)            (None, 32)                5024

 dense_47 (Dense)            (None, 3)                 99

=================================================================
Total params: 5123 (20.01 KB)
Trainable params: 5123 (20.01 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 0.0917 - accuracy: 1.0000 - val_loss: 0.8001 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 89/100
2/2 - 0s - loss: 0.0891 - accuracy: 1.0000 - val_loss: 0.8021 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 90/100
2/2 - 0s - loss: 0.0865 - accuracy: 1.0000 - val_loss: 0.8042 - val_accur
acy: 0.6667 - 54ms/epoch - 27ms/step
Epoch 91/100
2/2 - 0s - loss: 0.0840 - accuracy: 1.0000 - val_loss: 0.8061 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 92/100
2/2 - 0s - loss: 0.0816 - accuracy: 1.0000 - val_loss: 0.8084 - val_accur
acy: 0.6667 - 52ms/epoch - 26ms/step
Epoch 93/100
2/2 - 0s - loss: 0.0794 - accuracy: 1.0000 - val_loss: 0.8108 - val_accur
acy: 0.6667 - 63ms/epoch - 31ms/step
Epoch 94/100
2/2 - 0s - loss: 0.0770 - accuracy: 1.0000 - val_loss: 0.8134 - val_accur
acy: 0.6667 - 54ms/epoch - 27ms/step
Epoch 95/100
2/2 - 0s - loss: 0.0748 - accuracy: 1.0000 - val_loss: 0.8161 - val_accur
acy: 0.6667 - 55ms/epoch - 28ms/step
Epoch 96/100
2/2 - 0s - loss: 0.0727 - accuracy: 1.0000 - val_loss: 0.8186 - val_accur
acy: 0.6667 - 55ms/epoch - 28ms/step
Epoch 97/100
2/2 - 0s - loss: 0.0706 - accuracy: 1.0000 - val_loss: 0.8214 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 98/100
2/2 - 0s - loss: 0.0687 - accuracy: 1.0000 - val_loss: 0.8239 - val_accur
acy: 0.6667 - 54ms/epoch - 27ms/step
Epoch 99/100
2/2 - 0s - loss: 0.0668 - accuracy: 1.0000 - val_loss: 0.8266 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 100/100
2/2 - 0s - loss: 0.0650 - accuracy: 1.0000 - val_loss: 0.8294 - val_accur
acy: 0.6667 - 57ms/epoch - 29ms/step
```

In [54]:

```
model_o1.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accur
history=model_o1.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_siz
```

```
Epoch 1/100
2/2 - 1s - loss: 1.1509 - accuracy: 0.1250 - val_loss: 1.1317 - val_accur
acy: 0.3333 - 1s/epoch - 538ms/step
Epoch 2/100
2/2 - 0s - loss: 1.1342 - accuracy: 0.2083 - val_loss: 1.1268 - val_accur
acy: 0.3333 - 62ms/epoch - 31ms/step
Epoch 3/100
2/2 - 0s - loss: 1.1185 - accuracy: 0.2500 - val_loss: 1.1219 - val_accur
acy: 0.3333 - 50ms/epoch - 25ms/step
Epoch 4/100
2/2 - 0s - loss: 1.1036 - accuracy: 0.3333 - val_loss: 1.1177 - val_accur
acy: 0.3333 - 54ms/epoch - 27ms/step
Epoch 5/100
2/2 - 0s - loss: 1.0885 - accuracy: 0.4167 - val_loss: 1.1135 - val_accur
acy: 0.3333 - 51ms/epoch - 25ms/step
Epoch 6/100
2/2 - 0s - loss: 1.0750 - accuracy: 0.4167 - val_loss: 1.1095 - val_accur
acy: 0.3333 - 50ms/epoch - 25ms/step
Epoch 7/100
2/2 - 0s - loss: 1.0609 - accuracy: 0.4583 - val_loss: 1.1054 - val_accur
acy: 0.3333 - 55ms/epoch - 28ms/step
Epoch 8/100
2/2 - 0s - loss: 1.0472 - accuracy: 0.5000 - val_loss: 1.1013 - val_accur
acy: 0.3333 - 50ms/epoch - 25ms/step
Epoch 9/100
2/2 - 0s - loss: 1.0338 - accuracy: 0.6250 - val_loss: 1.0973 - val_accur
acy: 0.3333 - 53ms/epoch - 27ms/step
Epoch 10/100
2/2 - 0s - loss: 1.0207 - accuracy: 0.7083 - val_loss: 1.0933 - val_accur
acy: 0.3333 - 55ms/epoch - 27ms/step
Epoch 11/100
2/2 - 0s - loss: 1.0083 - accuracy: 0.7917 - val_loss: 1.0893 - val_accur
acy: 0.3333 - 50ms/epoch - 25ms/step
Epoch 12/100
2/2 - 0s - loss: 0.9960 - accuracy: 0.8333 - val_loss: 1.0851 - val_accur
acy: 0.5000 - 52ms/epoch - 26ms/step
Epoch 13/100
2/2 - 0s - loss: 0.9834 - accuracy: 0.8333 - val_loss: 1.0812 - val_accur
acy: 0.5000 - 66ms/epoch - 33ms/step
Epoch 14/100
2/2 - 0s - loss: 0.9716 - accuracy: 0.8333 - val_loss: 1.0771 - val_accur
acy: 0.5000 - 81ms/epoch - 40ms/step
Epoch 15/100
2/2 - 0s - loss: 0.9594 - accuracy: 0.8750 - val_loss: 1.0732 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 16/100
2/2 - 0s - loss: 0.9474 - accuracy: 0.8750 - val_loss: 1.0693 - val_accur
acy: 0.5000 - 66ms/epoch - 33ms/step
Epoch 17/100
2/2 - 0s - loss: 0.9355 - accuracy: 0.9167 - val_loss: 1.0653 - val_accur
acy: 0.3333 - 63ms/epoch - 31ms/step
Epoch 18/100
2/2 - 0s - loss: 0.9239 - accuracy: 0.9167 - val_loss: 1.0614 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 19/100
2/2 - 0s - loss: 0.9121 - accuracy: 1.0000 - val_loss: 1.0579 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 20/100
2/2 - 0s - loss: 0.9003 - accuracy: 1.0000 - val_loss: 1.0542 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.8887 - accuracy: 1.0000 - val_loss: 1.0506 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 22/100
2/2 - 0s - loss: 0.8768 - accuracy: 1.0000 - val_loss: 1.0471 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 23/100
2/2 - 0s - loss: 0.8651 - accuracy: 1.0000 - val_loss: 1.0434 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 24/100
2/2 - 0s - loss: 0.8531 - accuracy: 1.0000 - val_loss: 1.0400 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 25/100
2/2 - 0s - loss: 0.8412 - accuracy: 1.0000 - val_loss: 1.0364 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 26/100
2/2 - 0s - loss: 0.8290 - accuracy: 1.0000 - val_loss: 1.0325 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 27/100
2/2 - 0s - loss: 0.8169 - accuracy: 1.0000 - val_loss: 1.0286 - val_accur
acy: 0.5000 - 94ms/epoch - 47ms/step
Epoch 28/100
2/2 - 0s - loss: 0.8046 - accuracy: 1.0000 - val_loss: 1.0247 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 29/100
2/2 - 0s - loss: 0.7921 - accuracy: 1.0000 - val_loss: 1.0210 - val_accur
acy: 0.5000 - 71ms/epoch - 36ms/step
Epoch 30/100
2/2 - 0s - loss: 0.7795 - accuracy: 1.0000 - val_loss: 1.0172 - val_accur
acy: 0.5000 - 84ms/epoch - 42ms/step
Epoch 31/100
2/2 - 0s - loss: 0.7670 - accuracy: 1.0000 - val_loss: 1.0134 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 32/100
2/2 - 0s - loss: 0.7545 - accuracy: 1.0000 - val_loss: 1.0093 - val_accur
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 33/100
2/2 - 0s - loss: 0.7420 - accuracy: 1.0000 - val_loss: 1.0055 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 34/100
2/2 - 0s - loss: 0.7290 - accuracy: 1.0000 - val_loss: 1.0014 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 35/100
2/2 - 0s - loss: 0.7164 - accuracy: 1.0000 - val_loss: 0.9977 - val_accur
acy: 0.5000 - 76ms/epoch - 38ms/step
Epoch 36/100
2/2 - 0s - loss: 0.7036 - accuracy: 1.0000 - val_loss: 0.9938 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 37/100
2/2 - 0s - loss: 0.6910 - accuracy: 1.0000 - val_loss: 0.9900 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
Epoch 38/100
2/2 - 0s - loss: 0.6778 - accuracy: 1.0000 - val_loss: 0.9861 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 39/100
2/2 - 0s - loss: 0.6644 - accuracy: 1.0000 - val_loss: 0.9821 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 40/100
2/2 - 0s - loss: 0.6514 - accuracy: 1.0000 - val_loss: 0.9782 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 41/100
2/2 - 0s - loss: 0.6382 - accuracy: 1.0000 - val_loss: 0.9741 - val_accur
```

```
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 42/100
2/2 - 0s - loss: 0.6251 - accuracy: 1.0000 - val_loss: 0.9705 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 43/100
2/2 - 0s - loss: 0.6119 - accuracy: 1.0000 - val_loss: 0.9664 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 44/100
2/2 - 0s - loss: 0.5989 - accuracy: 1.0000 - val_loss: 0.9625 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 45/100
2/2 - 0s - loss: 0.5857 - accuracy: 1.0000 - val_loss: 0.9583 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 46/100
2/2 - 0s - loss: 0.5727 - accuracy: 1.0000 - val_loss: 0.9541 - val_accur
acy: 0.5000 - 59ms/epoch - 30ms/step
Epoch 47/100
2/2 - 0s - loss: 0.5600 - accuracy: 1.0000 - val_loss: 0.9499 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 48/100
2/2 - 0s - loss: 0.5471 - accuracy: 1.0000 - val_loss: 0.9461 - val_accur
acy: 0.5000 - 54ms/epoch - 27ms/step
Epoch 49/100
2/2 - 0s - loss: 0.5343 - accuracy: 1.0000 - val_loss: 0.9426 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 50/100
2/2 - 0s - loss: 0.5215 - accuracy: 1.0000 - val_loss: 0.9392 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 51/100
2/2 - 0s - loss: 0.5091 - accuracy: 1.0000 - val_loss: 0.9361 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 52/100
2/2 - 0s - loss: 0.4963 - accuracy: 1.0000 - val_loss: 0.9329 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 53/100
2/2 - 0s - loss: 0.4838 - accuracy: 1.0000 - val_loss: 0.9301 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
Epoch 54/100
2/2 - 0s - loss: 0.4713 - accuracy: 1.0000 - val_loss: 0.9276 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 55/100
2/2 - 0s - loss: 0.4588 - accuracy: 1.0000 - val_loss: 0.9254 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 56/100
2/2 - 0s - loss: 0.4464 - accuracy: 1.0000 - val_loss: 0.9232 - val_accur
acy: 0.3333 - 55ms/epoch - 28ms/step
Epoch 57/100
2/2 - 0s - loss: 0.4345 - accuracy: 1.0000 - val_loss: 0.9209 - val_accur
acy: 0.3333 - 55ms/epoch - 27ms/step
Epoch 58/100
2/2 - 0s - loss: 0.4225 - accuracy: 1.0000 - val_loss: 0.9186 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 59/100
2/2 - 0s - loss: 0.4106 - accuracy: 1.0000 - val_loss: 0.9163 - val_accur
acy: 0.3333 - 55ms/epoch - 27ms/step
Epoch 60/100
2/2 - 0s - loss: 0.3990 - accuracy: 1.0000 - val_loss: 0.9140 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 61/100
2/2 - 0s - loss: 0.3871 - accuracy: 1.0000 - val_loss: 0.9116 - val_accur
acy: 0.3333 - 58ms/epoch - 29ms/step
```

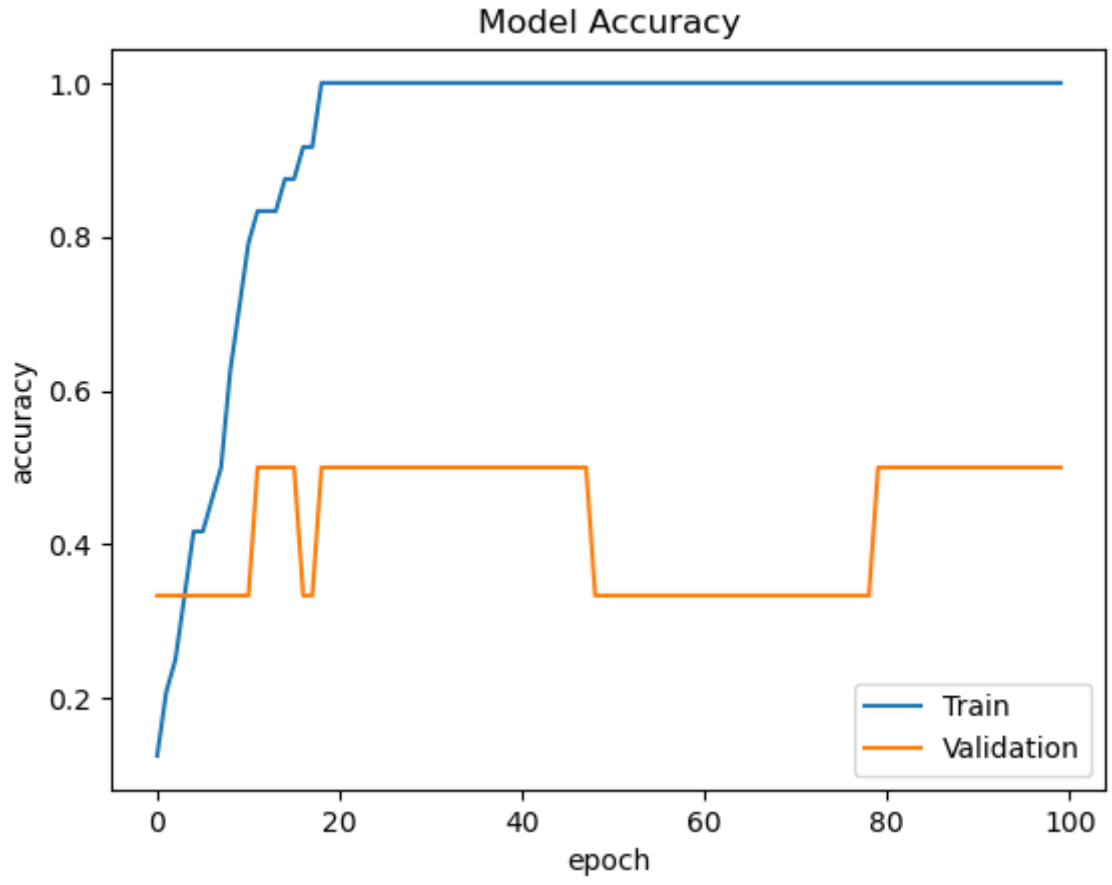
```
Epoch 62/100
2/2 - 0s - loss: 0.3758 - accuracy: 1.0000 - val_loss: 0.9095 - val_accur
acy: 0.3333 - 53ms/epoch - 27ms/step
Epoch 63/100
2/2 - 0s - loss: 0.3647 - accuracy: 1.0000 - val_loss: 0.9075 - val_accur
acy: 0.3333 - 57ms/epoch - 29ms/step
Epoch 64/100
2/2 - 0s - loss: 0.3538 - accuracy: 1.0000 - val_loss: 0.9058 - val_accur
acy: 0.3333 - 54ms/epoch - 27ms/step
Epoch 65/100
2/2 - 0s - loss: 0.3429 - accuracy: 1.0000 - val_loss: 0.9041 - val_accur
acy: 0.3333 - 53ms/epoch - 26ms/step
Epoch 66/100
2/2 - 0s - loss: 0.3325 - accuracy: 1.0000 - val_loss: 0.9024 - val_accur
acy: 0.3333 - 55ms/epoch - 27ms/step
Epoch 67/100
2/2 - 0s - loss: 0.3221 - accuracy: 1.0000 - val_loss: 0.9005 - val_accur
acy: 0.3333 - 56ms/epoch - 28ms/step
```

In [55]:
```
model_ol.evaluate(X_test,y_test)
```

Out[55]:
```
[0.8376370859146118, 0.3333333432674408]
```

In [56]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```

```
Epoch 68/100
2/2 - 0s - loss: 0.3120 - accuracy: 1.0000 - val_loss: 0.8989 - val_accur
acy: 0.3333 - 77ms/epoch - 39ms/step
Epoch 69/100
2/2 - 0s - loss: 0.3022 - accuracy: 1.0000 - val_loss: 0.8977 - val_accur
acy: 0.3333 - 68ms/epoch - 34ms/step
Epoch 70/100
2/2 - 0s - loss: 0.2926 - accuracy: 1.0000 - val_loss: 0.8969 - val_accur
acy: 0.3333 - 60ms/epoch - 30ms/step
Epoch 71/100
2/2 - 0s - loss: 0.2837 - accuracy: 1.0000 - val_loss: 0.8964 - val_accur
acy: 0.3333 - 59ms/epoch - 29ms/step
Epoch 72/100
2/2 - 0s - loss: 0.2743 - accuracy: 1.0000 - val_loss: 0.8961 - val_accur
acy: 0.3333 - 57ms/epoch - 28ms/step
Epoch 73/100
2/2 - 0s - loss: 0.2654 - accuracy: 1.0000 - val_loss: 0.8959 - val_accur
acy: 0.3333 - 55ms/epoch - 27ms/step
Epoch 74/100
2/2 - 0s - loss: 0.2568 - accuracy: 1.0000 - val_loss: 0.8961 - val_accur
acy: 0.3333 - 61ms/epoch - 30ms/step
Epoch 75/100
2/2 - 0s - loss: 0.2485 - accuracy: 1.0000 - val_loss: 0.8967 - val_accur
```




```
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 85/100
2/2 - 0s - loss: 0.1800 - accuracy: 1.0000 - val_loss: 0.9042 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 86/100
2/2 - 0s - loss: 0.1745 - accuracy: 1.0000 - val_loss: 0.9052 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 87/100
2/2 - 0s - loss: 0.1692 - accuracy: 1.0000 - val_loss: 0.9062 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 88/100
```

Model 3

In [57]:

```
model_o2 = Sequential()
model_o2.add(Dense(32, activation='relu',input_dim=X_train.shape[1]))
model_o2.add(Dense(4, activation='sigmoid')) #output layer
model_o2.summary()
```

```
Model: "sequential_10"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_48 (Dense)            (None, 32)                5024

 dense_49 (Dense)            (None, 4)                 132

=================================================================
Total params: 5156 (20.14 KB)
Trainable params: 5156 (20.14 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 0.1640 - accuracy: 1.0000 - val_loss: 0.9073 - val_accur
acy: 0.5000 - 54ms/epoch - 27ms/step
Epoch 89/100
2/2 - 0s - loss: 0.1591 - accuracy: 1.0000 - val_loss: 0.9085 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 90/100
2/2 - 0s - loss: 0.1543 - accuracy: 1.0000 - val_loss: 0.9100 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 91/100
2/2 - 0s - loss: 0.1498 - accuracy: 1.0000 - val_loss: 0.9118 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 92/100
2/2 - 0s - loss: 0.1453 - accuracy: 1.0000 - val_loss: 0.9136 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 93/100
2/2 - 0s - loss: 0.1411 - accuracy: 1.0000 - val_loss: 0.9153 - val_accur
acy: 0.5000 - 66ms/epoch - 33ms/step
Epoch 94/100
2/2 - 0s - loss: 0.1370 - accuracy: 1.0000 - val_loss: 0.9168 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 95/100
2/2 - 0s - loss: 0.1331 - accuracy: 1.0000 - val_loss: 0.9185 - val_accur
acy: 0.5000 - 66ms/epoch - 33ms/step
Epoch 96/100
2/2 - 0s - loss: 0.1292 - accuracy: 1.0000 - val_loss: 0.9201 - val_accur
acy: 0.5000 - 61ms/epoch - 30ms/step
Epoch 97/100
2/2 - 0s - loss: 0.1256 - accuracy: 1.0000 - val_loss: 0.9214 - val_accur
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 98/100
2/2 - 0s - loss: 0.1221 - accuracy: 1.0000 - val_loss: 0.9233 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 99/100
2/2 - 0s - loss: 0.1187 - accuracy: 1.0000 - val_loss: 0.9251 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 100/100
2/2 - 0s - loss: 0.1154 - accuracy: 1.0000 - val_loss: 0.9270 - val_accur
acy: 0.5000 - 55ms/epoch - 28ms/step
```

In [58]:

```
model_o2.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accur
history=model_o.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_size
```

```
Epoch 1/100
2/2 - 0s - loss: 0.0631 - accuracy: 1.0000 - val_loss: 0.8317 - val_accur
acy: 0.6667 - 164ms/epoch - 82ms/step
Epoch 2/100
2/2 - 0s - loss: 0.0614 - accuracy: 1.0000 - val_loss: 0.8339 - val_accur
acy: 0.6667 - 72ms/epoch - 36ms/step
Epoch 3/100
2/2 - 0s - loss: 0.0597 - accuracy: 1.0000 - val_loss: 0.8359 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 4/100
2/2 - 0s - loss: 0.0582 - accuracy: 1.0000 - val_loss: 0.8379 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 5/100
2/2 - 0s - loss: 0.0566 - accuracy: 1.0000 - val_loss: 0.8404 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 6/100
2/2 - 0s - loss: 0.0551 - accuracy: 1.0000 - val_loss: 0.8430 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 7/100
2/2 - 0s - loss: 0.0538 - accuracy: 1.0000 - val_loss: 0.8458 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 8/100
2/2 - 0s - loss: 0.0523 - accuracy: 1.0000 - val_loss: 0.8485 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 9/100
2/2 - 0s - loss: 0.0510 - accuracy: 1.0000 - val_loss: 0.8507 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 10/100
2/2 - 0s - loss: 0.0497 - accuracy: 1.0000 - val_loss: 0.8531 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 11/100
2/2 - 0s - loss: 0.0485 - accuracy: 1.0000 - val_loss: 0.8557 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 12/100
2/2 - 0s - loss: 0.0473 - accuracy: 1.0000 - val_loss: 0.8581 - val_accur
acy: 0.6667 - 57ms/epoch - 29ms/step
Epoch 13/100
2/2 - 0s - loss: 0.0461 - accuracy: 1.0000 - val_loss: 0.8604 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 14/100
2/2 - 0s - loss: 0.0451 - accuracy: 1.0000 - val_loss: 0.8626 - val_accur
acy: 0.6667 - 57ms/epoch - 29ms/step
Epoch 15/100
2/2 - 0s - loss: 0.0439 - accuracy: 1.0000 - val_loss: 0.8649 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 16/100
2/2 - 0s - loss: 0.0429 - accuracy: 1.0000 - val_loss: 0.8667 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 17/100
2/2 - 0s - loss: 0.0419 - accuracy: 1.0000 - val_loss: 0.8689 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 18/100
2/2 - 0s - loss: 0.0409 - accuracy: 1.0000 - val_loss: 0.8711 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 19/100
2/2 - 0s - loss: 0.0400 - accuracy: 1.0000 - val_loss: 0.8731 - val_accur
acy: 0.6667 - 55ms/epoch - 27ms/step
Epoch 20/100
2/2 - 0s - loss: 0.0391 - accuracy: 1.0000 - val_loss: 0.8754 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 0.0382 - accuracy: 1.0000 - val_loss: 0.8778 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 22/100
2/2 - 0s - loss: 0.0373 - accuracy: 1.0000 - val_loss: 0.8799 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 23/100
2/2 - 0s - loss: 0.0365 - accuracy: 1.0000 - val_loss: 0.8825 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 24/100
2/2 - 0s - loss: 0.0357 - accuracy: 1.0000 - val_loss: 0.8848 - val_accur
acy: 0.6667 - 78ms/epoch - 39ms/step
Epoch 25/100
2/2 - 0s - loss: 0.0350 - accuracy: 1.0000 - val_loss: 0.8870 - val_accur
acy: 0.6667 - 61ms/epoch - 30ms/step
Epoch 26/100
2/2 - 0s - loss: 0.0342 - accuracy: 1.0000 - val_loss: 0.8896 - val_accur
acy: 0.6667 - 66ms/epoch - 33ms/step
Epoch 27/100
2/2 - 0s - loss: 0.0334 - accuracy: 1.0000 - val_loss: 0.8921 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 28/100
2/2 - 0s - loss: 0.0328 - accuracy: 1.0000 - val_loss: 0.8945 - val_accur
acy: 0.6667 - 65ms/epoch - 32ms/step
Epoch 29/100
2/2 - 0s - loss: 0.0321 - accuracy: 1.0000 - val_loss: 0.8968 - val_accur
acy: 0.6667 - 55ms/epoch - 28ms/step
Epoch 30/100
2/2 - 0s - loss: 0.0314 - accuracy: 1.0000 - val_loss: 0.8989 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 31/100
2/2 - 0s - loss: 0.0307 - accuracy: 1.0000 - val_loss: 0.9010 - val_accur
acy: 0.6667 - 57ms/epoch - 29ms/step
Epoch 32/100
2/2 - 0s - loss: 0.0301 - accuracy: 1.0000 - val_loss: 0.9032 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 33/100
2/2 - 0s - loss: 0.0295 - accuracy: 1.0000 - val_loss: 0.9052 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
Epoch 34/100
2/2 - 0s - loss: 0.0289 - accuracy: 1.0000 - val_loss: 0.9073 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 35/100
2/2 - 0s - loss: 0.0283 - accuracy: 1.0000 - val_loss: 0.9092 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 36/100
2/2 - 0s - loss: 0.0278 - accuracy: 1.0000 - val_loss: 0.9111 - val_accur
acy: 0.6667 - 55ms/epoch - 28ms/step
Epoch 37/100
2/2 - 0s - loss: 0.0272 - accuracy: 1.0000 - val_loss: 0.9132 - val_accur
acy: 0.6667 - 77ms/epoch - 39ms/step
Epoch 38/100
2/2 - 0s - loss: 0.0267 - accuracy: 1.0000 - val_loss: 0.9152 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 39/100
2/2 - 0s - loss: 0.0262 - accuracy: 1.0000 - val_loss: 0.9174 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 40/100
2/2 - 0s - loss: 0.0257 - accuracy: 1.0000 - val_loss: 0.9193 - val_accur
acy: 0.6667 - 68ms/epoch - 34ms/step
Epoch 41/100
2/2 - 0s - loss: 0.0252 - accuracy: 1.0000 - val_loss: 0.9212 - val_accur
```

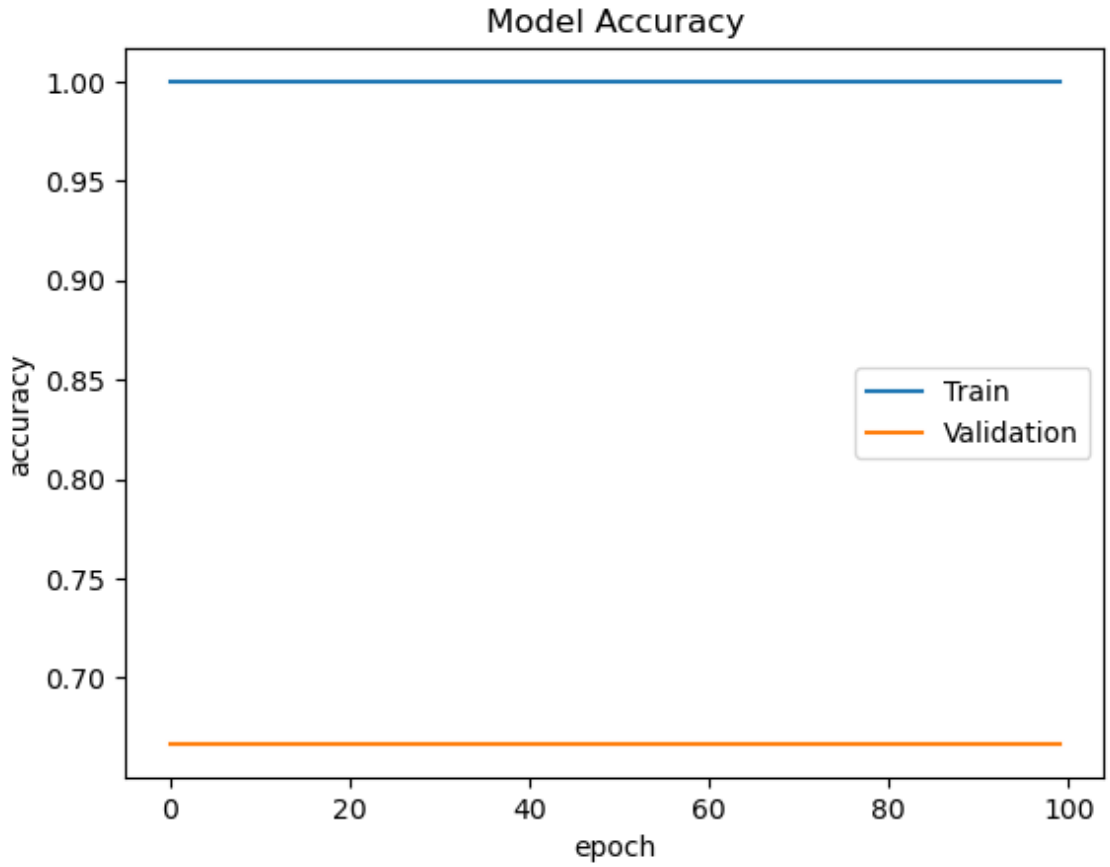
```
acy: 0.6667 - 66ms/epoch - 33ms/step
Epoch 42/100
2/2 - 0s - loss: 0.0247 - accuracy: 1.0000 - val_loss: 0.9231 - val_accur
acy: 0.6667 - 66ms/epoch - 33ms/step
Epoch 43/100
2/2 - 0s - loss: 0.0243 - accuracy: 1.0000 - val_loss: 0.9248 - val_accur
acy: 0.6667 - 80ms/epoch - 40ms/step
Epoch 44/100
2/2 - 0s - loss: 0.0238 - accuracy: 1.0000 - val_loss: 0.9266 - val_accur
acy: 0.6667 - 77ms/epoch - 38ms/step
Epoch 45/100
2/2 - 0s - loss: 0.0234 - accuracy: 1.0000 - val_loss: 0.9281 - val_accur
acy: 0.6667 - 77ms/epoch - 38ms/step
Epoch 46/100
2/2 - 0s - loss: 0.0230 - accuracy: 1.0000 - val_loss: 0.9299 - val_accur
acy: 0.6667 - 65ms/epoch - 32ms/step
Epoch 47/100
2/2 - 0s - loss: 0.0225 - accuracy: 1.0000 - val_loss: 0.9316 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 48/100
2/2 - 0s - loss: 0.0222 - accuracy: 1.0000 - val_loss: 0.9334 - val_accur
acy: 0.6667 - 66ms/epoch - 33ms/step
Epoch 49/100
2/2 - 0s - loss: 0.0218 - accuracy: 1.0000 - val_loss: 0.9354 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 50/100
2/2 - 0s - loss: 0.0213 - accuracy: 1.0000 - val_loss: 0.9374 - val_accur
acy: 0.6667 - 59ms/epoch - 30ms/step
Epoch 51/100
2/2 - 0s - loss: 0.0210 - accuracy: 1.0000 - val_loss: 0.9388 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
Epoch 52/100
2/2 - 0s - loss: 0.0206 - accuracy: 1.0000 - val_loss: 0.9403 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 53/100
2/2 - 0s - loss: 0.0202 - accuracy: 1.0000 - val_loss: 0.9418 - val_accur
acy: 0.6667 - 66ms/epoch - 33ms/step
Epoch 54/100
2/2 - 0s - loss: 0.0199 - accuracy: 1.0000 - val_loss: 0.9435 - val_accur
acy: 0.6667 - 73ms/epoch - 36ms/step
Epoch 55/100
2/2 - 0s - loss: 0.0195 - accuracy: 1.0000 - val_loss: 0.9452 - val_accur
acy: 0.6667 - 65ms/epoch - 32ms/step
Epoch 56/100
2/2 - 0s - loss: 0.0191 - accuracy: 1.0000 - val_loss: 0.9470 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 57/100
2/2 - 0s - loss: 0.0188 - accuracy: 1.0000 - val_loss: 0.9486 - val_accur
acy: 0.6667 - 61ms/epoch - 30ms/step
Epoch 58/100
2/2 - 0s - loss: 0.0185 - accuracy: 1.0000 - val_loss: 0.9502 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 59/100
2/2 - 0s - loss: 0.0182 - accuracy: 1.0000 - val_loss: 0.9521 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 60/100
2/2 - 0s - loss: 0.0179 - accuracy: 1.0000 - val_loss: 0.9537 - val_accur
acy: 0.6667 - 55ms/epoch - 27ms/step
Epoch 61/100
2/2 - 0s - loss: 0.0175 - accuracy: 1.0000 - val_loss: 0.9554 - val_accur
acy: 0.6667 - 56ms/epoch - 28ms/step
```

```
Epoch 62/100
2/2 - 0s - loss: 0.0172 - accuracy: 1.0000 - val_loss: 0.9571 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
Epoch 63/100
2/2 - 0s - loss: 0.0170 - accuracy: 1.0000 - val_loss: 0.9588 - val_accur
acy: 0.6667 - 66ms/epoch - 33ms/step
Epoch 64/100
2/2 - 0s - loss: 0.0167 - accuracy: 1.0000 - val_loss: 0.9604 - val_accur
acy: 0.6667 - 67ms/epoch - 34ms/step
Epoch 65/100
2/2 - 0s - loss: 0.0164 - accuracy: 1.0000 - val_loss: 0.9619 - val_accur
acy: 0.6667 - 71ms/epoch - 35ms/step
Epoch 66/100
2/2 - 0s - loss: 0.0161 - accuracy: 1.0000 - val_loss: 0.9635 - val_accur
acy: 0.6667 - 77ms/epoch - 38ms/step
Epoch 67/100
2/2 - 0s - loss: 0.0159 - accuracy: 1.0000 - val_loss: 0.9649 - val_accur
acy: 0.6667 - 82ms/epoch - 41ms/step
```

In [59]:
```
model.evaluate(X_test,y_test)
```

Out[59]:
```
[0.6738317813964509, 1.0]
```

In [60]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```



Model : 4

In [61]:
```
model_o3 = Sequential()
model_o3.add(Dense(32, activation='relu',input_dim=X_train.shape[1]))
model_o3.add(Dense(5, activation='sigmoid')) #output layer
model_o3.summary()
```

```
Model: "sequential_11"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_50 (Dense)            (None, 32)                5024

 dense_51 (Dense)            (None, 5)                 165

=================================================================
Total params: 5189 (20.27 KB)
Trainable params: 5189 (20.27 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```
2/2 - 0s - loss: 0.0116 - accuracy: 1.0000 - val_loss: 0.9965 - val_accur
acy: 0.6667 - 76ms/epoch - 38ms/step
Epoch 89/100
2/2 - 0s - loss: 0.0114 - accuracy: 1.0000 - val_loss: 0.9981 - val_accur
acy: 0.6667 - 69ms/epoch - 34ms/step
Epoch 90/100
2/2 - 0s - loss: 0.0112 - accuracy: 1.0000 - val_loss: 0.9996 - val_accur
acy: 0.6667 - 57ms/epoch - 28ms/step
Epoch 91/100
2/2 - 0s - loss: 0.0111 - accuracy: 1.0000 - val_loss: 1.0012 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 92/100
2/2 - 0s - loss: 0.0109 - accuracy: 1.0000 - val_loss: 1.0029 - val_accur
acy: 0.6667 - 62ms/epoch - 31ms/step
Epoch 93/100
2/2 - 0s - loss: 0.0108 - accuracy: 1.0000 - val_loss: 1.0045 - val_accur
acy: 0.6667 - 66ms/epoch - 33ms/step
Epoch 94/100
2/2 - 0s - loss: 0.0106 - accuracy: 1.0000 - val_loss: 1.0058 - val_accur
acy: 0.6667 - 84ms/epoch - 42ms/step
Epoch 95/100
2/2 - 0s - loss: 0.0105 - accuracy: 1.0000 - val_loss: 1.0073 - val_accur
acy: 0.6667 - 80ms/epoch - 40ms/step
Epoch 96/100
2/2 - 0s - loss: 0.0103 - accuracy: 1.0000 - val_loss: 1.0088 - val_accur
acy: 0.6667 - 70ms/epoch - 35ms/step
Epoch 97/100
2/2 - 0s - loss: 0.0102 - accuracy: 1.0000 - val_loss: 1.0103 - val_accur
acy: 0.6667 - 65ms/epoch - 33ms/step
Epoch 98/100
2/2 - 0s - loss: 0.0101 - accuracy: 1.0000 - val_loss: 1.0119 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 99/100
2/2 - 0s - loss: 0.0099 - accuracy: 1.0000 - val_loss: 1.0134 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 100/100
2/2 - 0s - loss: 0.0098 - accuracy: 1.0000 - val_loss: 1.0146 - val_accur
acy: 0.6667 - 60ms/epoch - 30ms/step
```

In [62]:

```
model_o3.compile(loss='sparse_categorical_crossentropy',optimizer='adam',metrics=['accur
history=model_o3.fit(X_train,y_train,epochs=100,verbose=2,validation_split=0.2,batch_siz
```

```
Epoch 1/100
2/2 - 1s - loss: 1.6289 - accuracy: 0.2083 - val_loss: 1.6296 - val_accur
acy: 0.0000e+00 - 1s/epoch - 608ms/step
Epoch 2/100
2/2 - 0s - loss: 1.6104 - accuracy: 0.2917 - val_loss: 1.6192 - val_accur
acy: 0.0000e+00 - 72ms/epoch - 36ms/step
Epoch 3/100
2/2 - 0s - loss: 1.5929 - accuracy: 0.3750 - val_loss: 1.6091 - val_accur
acy: 0.1667 - 59ms/epoch - 30ms/step
Epoch 4/100
2/2 - 0s - loss: 1.5765 - accuracy: 0.4167 - val_loss: 1.5991 - val_accur
acy: 0.1667 - 71ms/epoch - 36ms/step
Epoch 5/100
2/2 - 0s - loss: 1.5598 - accuracy: 0.5000 - val_loss: 1.5896 - val_accur
acy: 0.3333 - 64ms/epoch - 32ms/step
Epoch 6/100
2/2 - 0s - loss: 1.5440 - accuracy: 0.5417 - val_loss: 1.5800 - val_accur
acy: 0.3333 - 85ms/epoch - 43ms/step
Epoch 7/100
2/2 - 0s - loss: 1.5284 - accuracy: 0.5417 - val_loss: 1.5703 - val_accur
acy: 0.3333 - 62ms/epoch - 31ms/step
Epoch 8/100
2/2 - 0s - loss: 1.5128 - accuracy: 0.5417 - val_loss: 1.5607 - val_accur
acy: 0.3333 - 65ms/epoch - 33ms/step
Epoch 9/100
2/2 - 0s - loss: 1.4973 - accuracy: 0.5833 - val_loss: 1.5512 - val_accur
acy: 0.5000 - 57ms/epoch - 29ms/step
Epoch 10/100
2/2 - 0s - loss: 1.4822 - accuracy: 0.6250 - val_loss: 1.5419 - val_accur
acy: 0.5000 - 58ms/epoch - 29ms/step
Epoch 11/100
2/2 - 0s - loss: 1.4675 - accuracy: 0.7083 - val_loss: 1.5327 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 12/100
2/2 - 0s - loss: 1.4530 - accuracy: 0.7917 - val_loss: 1.5235 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 13/100
2/2 - 0s - loss: 1.4382 - accuracy: 0.7917 - val_loss: 1.5144 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 14/100
2/2 - 0s - loss: 1.4237 - accuracy: 0.7917 - val_loss: 1.5053 - val_accur
acy: 0.5000 - 57ms/epoch - 28ms/step
Epoch 15/100
2/2 - 0s - loss: 1.4092 - accuracy: 0.7917 - val_loss: 1.4963 - val_accur
acy: 0.5000 - 60ms/epoch - 30ms/step
Epoch 16/100
2/2 - 0s - loss: 1.3940 - accuracy: 0.7917 - val_loss: 1.4872 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 17/100
2/2 - 0s - loss: 1.3787 - accuracy: 0.8750 - val_loss: 1.4780 - val_accur
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 18/100
2/2 - 0s - loss: 1.3630 - accuracy: 0.8750 - val_loss: 1.4685 - val_accur
acy: 0.5000 - 59ms/epoch - 29ms/step
Epoch 19/100
2/2 - 0s - loss: 1.3469 - accuracy: 0.8750 - val_loss: 1.4591 - val_accur
acy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 20/100
2/2 - 0s - loss: 1.3313 - accuracy: 0.8750 - val_loss: 1.4497 - val_accur
acy: 0.5000 - 56ms/epoch - 28ms/step
Epoch 21/100
```

```
2/2 - 0s - loss: 1.3152 - accuracy: 0.8750 - val_loss: 1.4402 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 22/100
2/2 - 0s - loss: 1.2985 - accuracy: 0.8750 - val_loss: 1.4308 - val_accur
acy: 0.5000 - 61ms/epoch - 31ms/step
Epoch 23/100
2/2 - 0s - loss: 1.2820 - accuracy: 0.8750 - val_loss: 1.4213 - val_accur
acy: 0.5000 - 63ms/epoch - 31ms/step
Epoch 24/100
2/2 - 0s - loss: 1.2650 - accuracy: 0.8750 - val_loss: 1.4116 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 25/100
2/2 - 0s - loss: 1.2480 - accuracy: 0.8750 - val_loss: 1.4020 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 26/100
2/2 - 0s - loss: 1.2306 - accuracy: 0.9167 - val_loss: 1.3923 - val_accur
acy: 0.5000 - 69ms/epoch - 35ms/step
Epoch 27/100
2/2 - 0s - loss: 1.2130 - accuracy: 0.9167 - val_loss: 1.3827 - val_accur
acy: 0.5000 - 92ms/epoch - 46ms/step
Epoch 28/100
2/2 - 0s - loss: 1.1951 - accuracy: 0.9167 - val_loss: 1.3728 - val_accur
acy: 0.5000 - 89ms/epoch - 44ms/step
Epoch 29/100
2/2 - 0s - loss: 1.1773 - accuracy: 0.9167 - val_loss: 1.3630 - val_accur
acy: 0.5000 - 73ms/epoch - 37ms/step
Epoch 30/100
2/2 - 0s - loss: 1.1582 - accuracy: 0.9167 - val_loss: 1.3531 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 31/100
2/2 - 0s - loss: 1.1402 - accuracy: 0.9167 - val_loss: 1.3430 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 32/100
2/2 - 0s - loss: 1.1212 - accuracy: 0.9167 - val_loss: 1.3331 - val_accur
acy: 0.5000 - 92ms/epoch - 46ms/step
Epoch 33/100
2/2 - 0s - loss: 1.1020 - accuracy: 0.9167 - val_loss: 1.3230 - val_accur
acy: 0.5000 - 87ms/epoch - 43ms/step
Epoch 34/100
2/2 - 0s - loss: 1.0826 - accuracy: 0.9167 - val_loss: 1.3131 - val_accur
acy: 0.5000 - 81ms/epoch - 41ms/step
Epoch 35/100
2/2 - 0s - loss: 1.0631 - accuracy: 0.9167 - val_loss: 1.3035 - val_accur
acy: 0.5000 - 77ms/epoch - 39ms/step
Epoch 36/100
2/2 - 0s - loss: 1.0438 - accuracy: 0.9167 - val_loss: 1.2939 - val_accur
acy: 0.5000 - 67ms/epoch - 34ms/step
Epoch 37/100
2/2 - 0s - loss: 1.0237 - accuracy: 0.9167 - val_loss: 1.2843 - val_accur
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 38/100
2/2 - 0s - loss: 1.0045 - accuracy: 0.9167 - val_loss: 1.2750 - val_accur
acy: 0.5000 - 83ms/epoch - 42ms/step
Epoch 39/100
2/2 - 0s - loss: 0.9846 - accuracy: 0.9167 - val_loss: 1.2657 - val_accur
acy: 0.5000 - 91ms/epoch - 45ms/step
Epoch 40/100
2/2 - 0s - loss: 0.9645 - accuracy: 0.9167 - val_loss: 1.2563 - val_accur
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 41/100
2/2 - 0s - loss: 0.9449 - accuracy: 0.9167 - val_loss: 1.2471 - val_accur
```

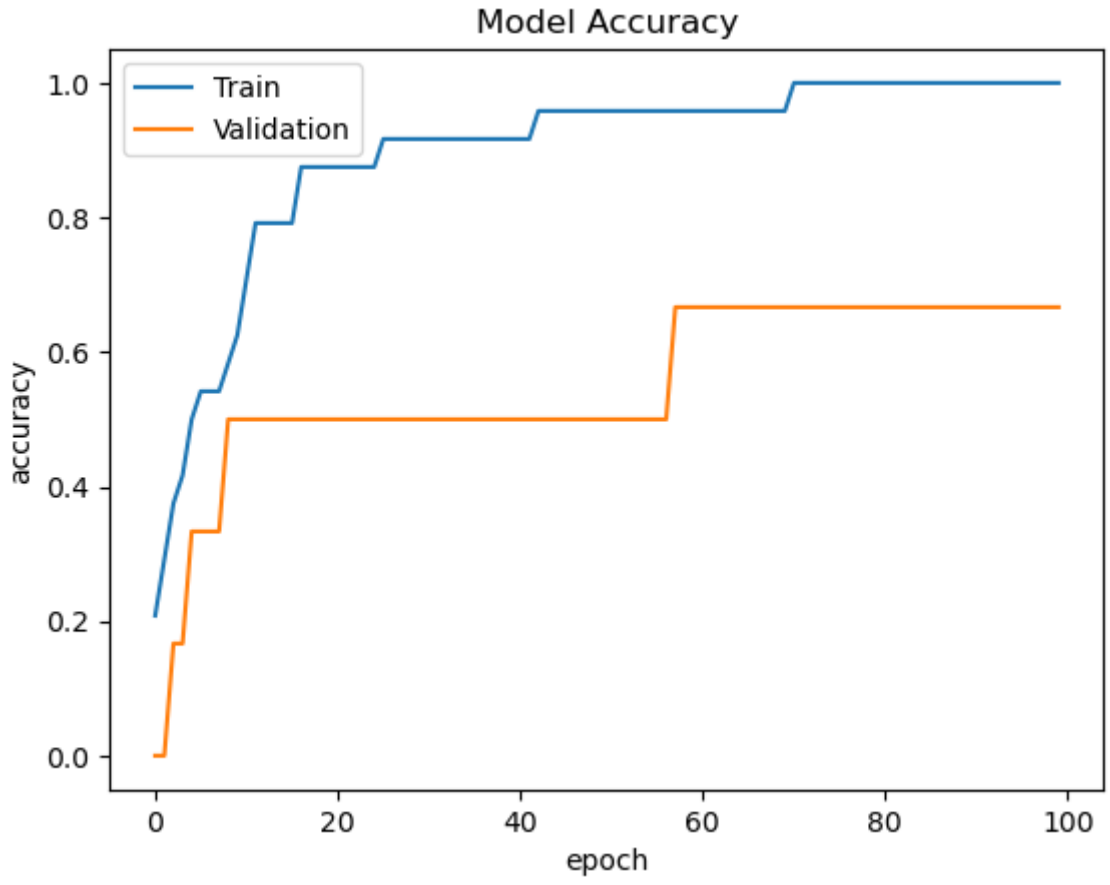
```
acy: 0.5000 - 72ms/epoch - 36ms/step
Epoch 42/100
2/2 - 0s - loss: 0.9256 - accuracy: 0.9167 - val_loss: 1.2381 - val_accur
acy: 0.5000 - 78ms/epoch - 39ms/step
Epoch 43/100
2/2 - 0s - loss: 0.9058 - accuracy: 0.9583 - val_loss: 1.2292 - val_accur
acy: 0.5000 - 81ms/epoch - 41ms/step
Epoch 44/100
2/2 - 0s - loss: 0.8860 - accuracy: 0.9583 - val_loss: 1.2203 - val_accur
acy: 0.5000 - 96ms/epoch - 48ms/step
Epoch 45/100
2/2 - 0s - loss: 0.8673 - accuracy: 0.9583 - val_loss: 1.2116 - val_accur
acy: 0.5000 - 85ms/epoch - 42ms/step
Epoch 46/100
2/2 - 0s - loss: 0.8480 - accuracy: 0.9583 - val_loss: 1.2031 - val_accur
acy: 0.5000 - 78ms/epoch - 39ms/step
Epoch 47/100
2/2 - 0s - loss: 0.8286 - accuracy: 0.9583 - val_loss: 1.1945 - val_accur
acy: 0.5000 - 70ms/epoch - 35ms/step
Epoch 48/100
2/2 - 0s - loss: 0.8097 - accuracy: 0.9583 - val_loss: 1.1861 - val_accur
acy: 0.5000 - 63ms/epoch - 32ms/step
Epoch 49/100
2/2 - 0s - loss: 0.7907 - accuracy: 0.9583 - val_loss: 1.1779 - val_accur
acy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 50/100
2/2 - 0s - loss: 0.7717 - accuracy: 0.9583 - val_loss: 1.1696 - val_accur
acy: 0.5000 - 74ms/epoch - 37ms/step
Epoch 51/100
2/2 - 0s - loss: 0.7532 - accuracy: 0.9583 - val_loss: 1.1613 - val_accur
acy: 0.5000 - 64ms/epoch - 32ms/step
Epoch 52/100
2/2 - 0s - loss: 0.7348 - accuracy: 0.9583 - val_loss: 1.1531 - val_accur
acy: 0.5000 - 78ms/epoch - 39ms/step
Epoch 53/100
2/2 - 0s - loss: 0.7163 - accuracy: 0.9583 - val_loss: 1.1454 - val_accur
acy: 0.5000 - 69ms/epoch - 35ms/step
Epoch 54/100
2/2 - 0s - loss: 0.6983 - accuracy: 0.9583 - val_loss: 1.1380 - val_accur
acy: 0.5000 - 62ms/epoch - 31ms/step
Epoch 55/100
2/2 - 0s - loss: 0.6803 - accuracy: 0.9583 - val_loss: 1.1303 - val_accur
acy: 0.5000 - 63ms/epoch - 32ms/step
Epoch 56/100
2/2 - 0s - loss: 0.6624 - accuracy: 0.9583 - val_loss: 1.1227 - val_accur
acy: 0.5000 - 68ms/epoch - 34ms/step
Epoch 57/100
2/2 - 0s - loss: 0.6449 - accuracy: 0.9583 - val_loss: 1.1153 - val_accur
acy: 0.5000 - 70ms/epoch - 35ms/step
Epoch 58/100
2/2 - 0s - loss: 0.6280 - accuracy: 0.9583 - val_loss: 1.1082 - val_accur
acy: 0.6667 - 70ms/epoch - 35ms/step
Epoch 59/100
2/2 - 0s - loss: 0.6110 - accuracy: 0.9583 - val_loss: 1.1013 - val_accur
acy: 0.6667 - 71ms/epoch - 36ms/step
Epoch 60/100
2/2 - 0s - loss: 0.5945 - accuracy: 0.9583 - val_loss: 1.0948 - val_accur
acy: 0.6667 - 61ms/epoch - 31ms/step
Epoch 61/100
2/2 - 0s - loss: 0.5785 - accuracy: 0.9583 - val_loss: 1.0887 - val_accur
acy: 0.6667 - 59ms/epoch - 29ms/step
```

```
Epoch 62/100
2/2 - 0s - loss: 0.5626 - accuracy: 0.9583 - val_loss: 1.0832 - val_accur
acy: 0.6667 - 61ms/epoch - 31ms/step
Epoch 63/100
2/2 - 0s - loss: 0.5470 - accuracy: 0.9583 - val_loss: 1.0777 - val_accur
acy: 0.6667 - 58ms/epoch - 29ms/step
Epoch 64/100
2/2 - 0s - loss: 0.5316 - accuracy: 0.9583 - val_loss: 1.0726 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 65/100
2/2 - 0s - loss: 0.5170 - accuracy: 0.9583 - val_loss: 1.0674 - val_accur
acy: 0.6667 - 67ms/epoch - 34ms/step
Epoch 66/100
2/2 - 0s - loss: 0.5020 - accuracy: 0.9583 - val_loss: 1.0625 - val_accur
acy: 0.6667 - 64ms/epoch - 32ms/step
Epoch 67/100
2/2 - 0s - loss: 0.4878 - accuracy: 0.9583 - val_loss: 1.0576 - val_accur
acy: 0.6667 - 69ms/epoch - 34ms/step
```

In [63]:
```
model_o3.evaluate(X_test,y_test)
```

Out[63]:
```
[0.8721201658248901, 0.6666666865348816]
```

In [64]:
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['Train', 'Validation'])
plt.show()
```



In [ ]:

```
2/2 - 0s - loss: 0.2619 - accuracy: 1.0000 - val_loss: 0.9938 - val_accur
```