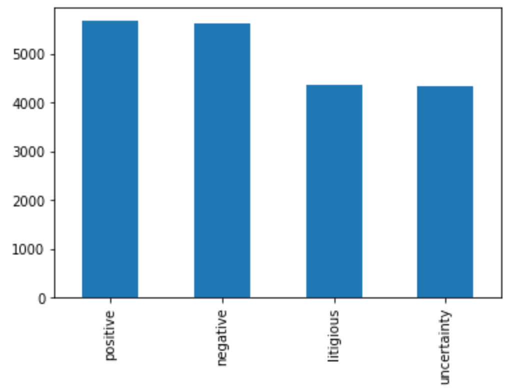
In [4]:
```
import pandas as pd
from nltk.corpus import stopwords
import tensorflow as tf
import numpy as np


from tensorflow import keras
from keras import models, layers



from sklearn.preprocessing import LabelEncoder

np.random.seed(1234)
```

In [12]:
```

df = pd.read_csv('dataset.csv', encoding='latin1')
df.pop('Language')



print(df.head())
df = df.truncate(before=0, after=20000)
i = np.random.rand(len(df)) < 0.8
train = df[i]
test = df[~i]

print("train data size: ", train.shape)
print("test data size: ", test.shape)
```

```
                                                Text      Label
0  @Charlie_Corley @Kristine1G @amyklobuchar @Sty...  litigious
1  #BadBunny: Como dos gotas de agua: Joven se di...   negative
2  https://t.co/YJNiO0p1JV (https://t.co/YJNiO0p1JV) Flagstar Bank disclose...  litigious
3  Rwanda is set to host the headquarters of Unit...   positive
4  OOPS. I typed her name incorrectly (todayâ  s ...  litigious
train data size:  (16016, 2)
test data size:  (3985, 2)
```

In [13]:
```
import matplotlib.pyplot as plt
df['Label'].value_counts().plot(kind='bar')
```

Out[13]: `<AxesSubplot:>`



In [14]:
```
num_labels = 2
vocab_size = 10000
batch_size = 100

tokenizer = keras.preprocessing.text.Tokenizer(num_words=vocab_size)
tokenizer.fit_on_texts(train.Text)

x_train = tokenizer.texts_to_matrix(train.Text, mode='tfidf')
x_test = tokenizer.texts_to_matrix(test.Text, mode='tfidf')

encoder = LabelEncoder()
encoder.fit(train.Label)
y_train = encoder.transform(train.Label)
y_test = encoder.transform(test.Label)

# check shape
print("train shapes:", x_train.shape, y_train.shape)
print("test shapes:", x_test.shape, y_test.shape)
```

```
train shapes: (16016, 10000) (16016,)
test shapes: (3985, 10000) (3985,)
```

Typesetting math: 0%

In [15]:
```
model = models.Sequential()
model.add(layers.Dense(16, activation='relu', input_shape=(10000,)))
model.add(layers.Dense(16, activation='relu'))
model.add(layers.Dense(1, activation='sigmoid'))
```

In [16]:
```
model.compile(optimizer='rmsprop',
              loss='binary_crossentropy',
              metrics=['accuracy'],
              run_eagerly=True)
```

In [17]:
```
x_val = x_train[:10000]
partial_x_train = x_train[10000:]

y_val = y_train[:10000]
partial_y_train = y_train[10000:]
```

Typesetting math: 0%

In [18]:
```
history = model.fit(partial_x_train,
                    partial_y_train,
                    epochs=20,
                    batch_size=512,
                    validation_data=(x_val, y_val))
```

```
Epoch 1/20
12/12 [==============================] - 1s 88ms/step - loss: -0.1674 - accuracy: 0.2902 - val_loss: -1.0230 - val_accuracy: 0.
2790
Epoch 2/20
12/12 [==============================] - 1s 60ms/step - loss: -1.7497 - accuracy: 0.2970 - val_loss: -2.4392 - val_accuracy: 0.
2829
Epoch 3/20
12/12 [==============================] - 1s 60ms/step - loss: -3.4697 - accuracy: 0.3072 - val_loss: -4.1710 - val_accuracy: 0.
2879
Epoch 4/20
12/12 [==============================] - 1s 54ms/step - loss: -5.6989 - accuracy: 0.3150 - val_loss: -6.3949 - val_accuracy: 0.
2952
Epoch 5/20
12/12 [==============================] - 1s 54ms/step - loss: -8.5119 - accuracy: 0.3216 - val_loss: -9.0999 - val_accuracy: 0.
3018
Epoch 6/20
12/12 [==============================] - 1s 55ms/step - loss: -11.8949 - accuracy: 0.3276 - val_loss: -12.2233 - val_accuracy:
0.3056
Epoch 7/20
12/12 [==============================] - 1s 57ms/step - loss: -15.7667 - accuracy: 0.3311 - val_loss: -15.7360 - val_accuracy:
0.3073
Epoch 8/20
12/12 [==============================] - 1s 62ms/step - loss: -20.1639 - accuracy: 0.3343 - val_loss: -19.7524 - val_accuracy:
0.3076
Epoch 9/20
12/12 [==============================] - 1s 58ms/step - loss: -25.1353 - accuracy: 0.3356 - val_loss: -24.2254 - val_accuracy:
0.3084
Epoch 10/20
12/12 [==============================] - 1s 62ms/step - loss: -30.6807 - accuracy: 0.3373 - val_loss: -29.1672 - val_accuracy:
0.3090
Epoch 11/20
12/12 [==============================] - 1s 58ms/step - loss: -36.8734 - accuracy: 0.3384 - val_loss: -34.7358 - val_accuracy:
0.3096
Epoch 12/20
12/12 [==============================] - 1s 58ms/step - loss: -43.7872 - accuracy: 0.3403 - val_loss: -40.7862 - val_accuracy:
0.3117
Epoch 13/20
12/12 [==============================] - 1s 63ms/step - loss: -51.4105 - accuracy: 0.3421 - val_loss: -47.4346 - val_accuracy:
0.3124
Epoch 14/20
12/12 [==============================] - 1s 59ms/step - loss: -59.7234 - accuracy: 0.3436 - val_loss: -54.7401 - val_accuracy:
0.3124
Epoch 15/20
12/12 [==============================] - 1s 53ms/step - loss: -68.7914 - accuracy: 0.3438 - val_loss: -62.6921 - val_accuracy:
0.3129
Epoch 16/20
12/12 [==============================] - 1s 55ms/step - loss: -78.7059 - accuracy: 0.3449 - val_loss: -71.2958 - val_accuracy:
0.3133
Epoch 17/20
12/12 [==============================] - 1s 54ms/step - loss: -89.4085 - accuracy: 0.3447 - val_loss: -80.5155 - val_accuracy:
0.3135
Epoch 18/20
12/12 [==============================] - 1s 55ms/step - loss: -100.8420 - accuracy: 0.3459 - val_loss: -90.3603 - val_accuracy:
0.3135
Epoch 19/20
12/12 [==============================] - 1s 53ms/step - loss: -113.1405 - accuracy: 0.3471 - val_loss: -100.8734 - val_accurac
y: 0.3134
Epoch 20/20
12/12 [==============================] - 1s 52ms/step - loss: -126.2991 - accuracy: 0.3482 - val_loss: -112.2095 - val_accurac
y: 0.3134
```

```
Took very little time, with 31% validation accuracy
```

Typesetting math: 0%

In [19]:
```
from sklearn.metrics import classification_report

pred = model.predict(x_test)
pred = [1.0 if p>= 0.5 else 0.0 for p in pred]
print(classification_report(y_test, pred))
```

```
125/125 [==============================] - 0s 2ms/step
              precision    recall  f1-score   support

           0       0.97      0.15      0.27       833
           1       0.29      1.00      0.45      1123
           2       0.00      0.00      0.00      1108
           3       0.00      0.00      0.00       921

    accuracy                           0.31      3985
   macro avg       0.32      0.29      0.18      3985
weighted avg       0.28      0.31      0.18      3985


C:\Users\BillP\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site
-packages\sklearn\metrics\_classification.py:1318: UndefinedMetricWarning: Precision and F-score are ill-defined and being set
to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\BillP\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site
-packages\sklearn\metrics\_classification.py:1318: UndefinedMetricWarning: Precision and F-score are ill-defined and being set
to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\BillP\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site
-packages\sklearn\metrics\_classification.py:1318: UndefinedMetricWarning: Precision and F-score are ill-defined and being set
to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [20]:
```
max_features = 10000
maxlen = 10000
batch_size = 32

model = models.Sequential()
model.add(layers.Embedding(max_features, 128, input_length=maxlen))
model.add(layers.Conv1D(32, 7, activation='relu'))
model.add(layers.MaxPooling1D(5))
model.add(layers.Conv1D(32, 7, activation='relu'))
model.add(layers.GlobalMaxPooling1D())
model.add(layers.Dense(1))
model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 10000, 128)        1280000

 conv1d (Conv1D)             (None, 9994, 32)          28704

 max_pooling1d (MaxPooling1D  (None, 1998, 32)         0
 )

 conv1d_1 (Conv1D)           (None, 1992, 32)          7200

 global_max_pooling1d (Globa  (None, 32)               0
 lMaxPooling1D)

 dense_6 (Dense)             (None, 1)                 33

=================================================================
Total params: 1,315,937
Trainable params: 1,315,937
Non-trainable params: 0
_________________________________________________________________
```

In [21]:
```
model.compile(optimizer=tf.keras.optimizers.RMSprop(lr=1e-4),  # set learning rate
              loss='binary_crossentropy',
              metrics=['accuracy'])
```

```
C:\Users\BillP\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site
-packages\keras\optimizers\optimizer_v2\rmsprop.py:140: UserWarning: The `lr` argument is deprecated, use `learning_rate` inste
ad.
  super().__init__(name, **kwargs)
```

Typesetting math: 0%

In [22]:
```
history = model.fit(partial_x_train,
                    partial_y_train,
                    epochs=10,
                    batch_size=512,
                    validation_split=0.2)
```

```
Epoch 1/10
10/10 [==============================] - 146s 14s/step - loss: 3.5593 - accuracy: 0.2136 - val_loss: 2.4577 - val_accuracy: 0.2
434
Epoch 2/10
10/10 [==============================] - 136s 14s/step - loss: 2.1833 - accuracy: 0.2136 - val_loss: 1.6489 - val_accuracy: 0.2
434
Epoch 3/10
10/10 [==============================] - 129s 13s/step - loss: 1.4341 - accuracy: 0.2136 - val_loss: 1.0469 - val_accuracy: 0.2
434
Epoch 4/10
10/10 [==============================] - 132s 13s/step - loss: 0.8161 - accuracy: 0.2363 - val_loss: 0.4833 - val_accuracy: 0.2
924
Epoch 5/10
10/10 [==============================] - 133s 13s/step - loss: 0.1618 - accuracy: 0.2872 - val_loss: -0.2465 - val_accuracy: 0.
2924
Epoch 6/10
10/10 [==============================] - 137s 14s/step - loss: -2.3149 - accuracy: 0.2874 - val_loss: -6.5353 - val_accuracy:
0.2924
Epoch 7/10
10/10 [==============================] - 135s 13s/step - loss: -7.6483 - accuracy: 0.2874 - val_loss: -6.5354 - val_accuracy:
0.2924
Epoch 8/10
10/10 [==============================] - 137s 14s/step - loss: -7.6531 - accuracy: 0.2874 - val_loss: -6.5354 - val_accuracy:
0.2924
Epoch 9/10
10/10 [==============================] - 135s 13s/step - loss: -7.6531 - accuracy: 0.2874 - val_loss: -6.5354 - val_accuracy:
0.2924
Epoch 10/10
10/10 [==============================] - 137s 14s/step - loss: -7.6531 - accuracy: 0.2874 - val_loss: -6.5354 - val_accuracy:
0.2924
```

```
Took about 22 minutes, with 29% validation accuracy
```

In [23]:
```
from sklearn.metrics import classification_report

pred = model.predict(x_test)
pred = [1.0 if p>= 0.5 else 0.0 for p in pred]
print(classification_report(y_test, pred))
```

```
125/125 [==============================] - 16s 129ms/step
              precision    recall  f1-score   support

           0       0.00      0.00      0.00       833
           1       0.28      1.00      0.44      1123
           2       0.00      0.00      0.00      1108
           3       0.00      0.00      0.00       921

    accuracy                           0.28      3985
   macro avg       0.07      0.25      0.11      3985
weighted avg       0.08      0.28      0.12      3985


C:\Users\BillP\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site
-packages\sklearn\metrics\_classification.py:1318: UndefinedMetricWarning: Precision and F-score are ill-defined and being set
to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\BillP\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site
-packages\sklearn\metrics\_classification.py:1318: UndefinedMetricWarning: Precision and F-score are ill-defined and being set
to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\BillP\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site
-packages\sklearn\metrics\_classification.py:1318: UndefinedMetricWarning: Precision and F-score are ill-defined and being set
to 0.0 in labels with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

Typesetting math: 0%

In [24]:
```
model = models.Sequential()
model.add(layers.Embedding(max_features, 8, input_length=maxlen))
model.add(layers.Flatten())
model.add(layers.Dense(16, activation='relu'))
model.add(layers.Dense(1, activation='sigmoid'))

model.compile(optimizer='rmsprop', loss='binary_crossentropy', metrics=['acc'])
model.summary()

history = model.fit(partial_x_train, partial_y_train, epochs=10, batch_size=512, validation_split=0.2)
```

```
Model: "sequential_3"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 embedding_1 (Embedding)     (None, 10000, 8)          80000     
                                                                 
 flatten (Flatten)           (None, 80000)             0         
                                                                 
 dense_7 (Dense)             (None, 16)                1280016   
                                                                 
 dense_8 (Dense)             (None, 1)                 17        
                                                                 
=================================================================
Total params: 1,360,033
Trainable params: 1,360,033
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
5/5 [==============================] - 3s 497ms/step - loss: -14.7516 - acc: 0.2874 - val_loss: -34.3933 - val_acc: 0.2924
Epoch 2/10
5/5 [==============================] - 2s 452ms/step - loss: -60.2966 - acc: 0.2874 - val_loss: -81.0130 - val_acc: 0.2924
Epoch 3/10
5/5 [==============================] - 2s 472ms/step - loss: -119.2836 - acc: 0.2874 - val_loss: -137.4727 - val_acc: 0.2924
Epoch 4/10
5/5 [==============================] - 2s 456ms/step - loss: -189.7151 - acc: 0.2874 - val_loss: -203.0400 - val_acc: 0.2924
Epoch 5/10
5/5 [==============================] - 2s 460ms/step - loss: -270.1909 - acc: 0.2874 - val_loss: -276.8249 - val_acc: 0.2924
Epoch 6/10
5/5 [==============================] - 2s 460ms/step - loss: -360.1279 - acc: 0.2874 - val_loss: -358.9992 - val_acc: 0.2924
Epoch 7/10
5/5 [==============================] - 2s 451ms/step - loss: -461.1561 - acc: 0.2874 - val_loss: -451.3604 - val_acc: 0.2924
Epoch 8/10
5/5 [==============================] - 2s 436ms/step - loss: -573.3301 - acc: 0.2874 - val_loss: -552.8761 - val_acc: 0.2924
Epoch 9/10
5/5 [==============================] - 2s 463ms/step - loss: -696.4377 - acc: 0.2874 - val_loss: -663.4859 - val_acc: 0.2924
Epoch 10/10
5/5 [==============================] - 2s 454ms/step - loss: -830.0669 - acc: 0.2874 - val_loss: -783.5403 - val_acc: 0.2924
```

In [*]:
```
from sklearn.metrics import classification_report

pred = model.predict(x_test)
pred = [1.0 if p>= 0.5 else 0.0 for p in pred]
print(classification_report(y_test, pred))
```

took about 30 seconds with 28% validation accuracy

Overall decently low accuracy, but data probably could have been handled better to suit the models.

Typesetting math: 0%