Student Performances on Exam: Should they take a preparation course?

Use Tensorflow to predict if a student took a preparation course based on their test scores, gender, and ethnicity.

In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:
```
df = pd.read_csv('StudentsPerformance.csv')
```

In [5]:
```
df.head(10)
```

Out[5]:

	gender	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score
0	female	group B	bachelor's degree	standard	none	72	72	74
1	female	group C	some college	standard	completed	69	90	88
2	female	group B	master's degree	standard	none	90	95	93
3	male	group A	associate's degree	free/reduced	none	47	57	44
4	male	group C	some college	standard	none	76	78	75
5	female	group B	associate's degree	standard	none	71	83	78
6	female	group B	some college	standard	completed	88	95	92
7	male	group B	some college	free/reduced	none	40	43	39
8	male	group D	high school	free/reduced	completed	64	64	67
9	female	group B	high school	free/reduced	none	38	60	50

In [6]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 8 columns):
 #   Column                       Non-Null Count  Dtype 
---  ------                       --------------  ----- 
 0   gender                       1000 non-null   object
 1   race/ethnicity               1000 non-null   object
 2   parental level of education  1000 non-null   object
 3   lunch                        1000 non-null   object
 4   test preparation course      1000 non-null   object
 5   math score                   1000 non-null   int64 
 6   reading score                1000 non-null   int64 
 7   writing score                1000 non-null   int64 
dtypes: int64(3), object(5)
memory usage: 62.6+ KB
```

In [7]:
```
# What is the mean score for each exam?

df.describe()
```

Out[7]:

	math score	reading score	writing score
count	1000.00000	1000.000000	1000.000000
mean	66.08900	69.169000	68.054000
std	15.16308	14.600192	15.195657
min	0.00000	17.000000	10.000000
25%	57.00000	59.000000	57.750000
50%	66.00000	70.000000	69.000000
75%	77.00000	79.000000	79.000000
max	100.00000	100.000000	100.000000

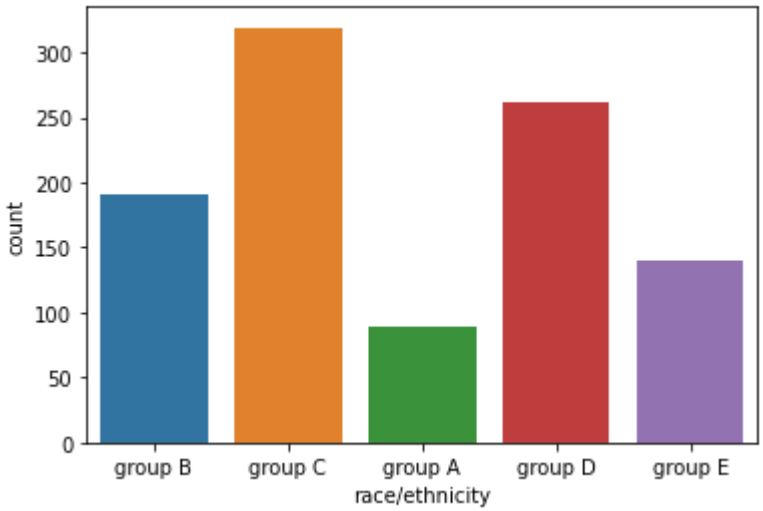
In [8]:
```
# No null values!

df.isnull().sum()
```

Out[8]:
```
gender                         0
race/ethnicity                 0
parental level of education    0
lunch                          0
test preparation course        0
math score                     0
reading score                  0
writing score                  0
dtype: int64
```

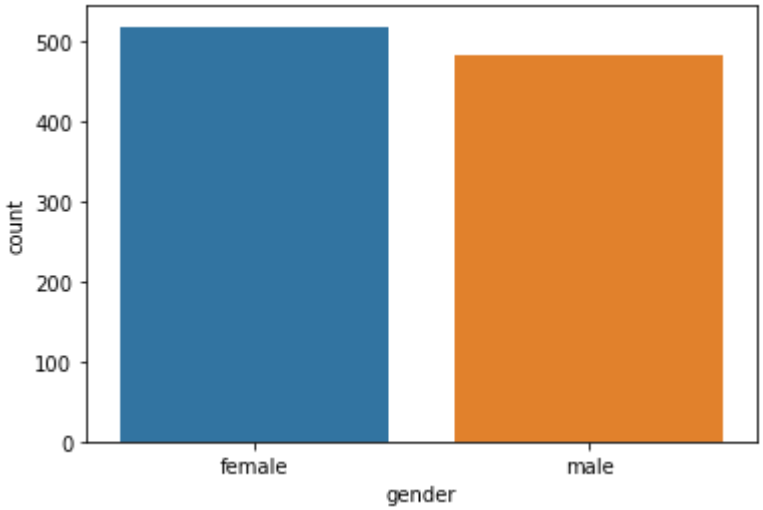
In [13]:
```
sns.countplot(x='race/ethnicity', data=df)
```

Out[13]: <AxesSubplot:xlabel='race/ethnicity', ylabel='count'>



In [14]:
```
sns.countplot(x='gender', data=df)
```

Out[14]: <AxesSubplot:xlabel='gender', ylabel='count'>



In [18]:
```
df['gender'].value_counts()
```

Out[18]:
```
female    518
male      482
Name: gender, dtype: int64
```

In [19]:
```
df['race/ethnicity'].value_counts()
```

Out[19]:
```
group C    319
group D    262
group B    190
group E    140
group A     89
Name: race/ethnicity, dtype: int64
```

In [24]:
```
type_dummies = pd.get_dummies(df['gender'],drop_first=True)
df = pd.concat([df,type_dummies],axis=1)
```

In [39]:
```
df.drop(['gender'], axis=1)
```

Out[39]:

	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score	male
0	group B	bachelor's degree	standard	none	72	72	74	0
1	group C	some college	standard	completed	69	90	88	0
2	group B	master's degree	standard	none	90	95	93	0
3	group A	associate's degree	free/reduced	none	47	57	44	1
4	group C	some college	standard	none	76	78	75	1
...	...	...	...	...	...	...	...	...
995	group E	master's degree	standard	completed	88	99	95	0
996	group C	high school	free/reduced	none	62	55	55	1
997	group C	high school	free/reduced	completed	59	71	65	0
998	group D	some college	standard	completed	68	78	77	0

	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score	male
999	group D	some college	free/reduced	none	77	86	86	0

1000 rows × 8 columns

In [42]:
```
df.drop(['gender'], axis=1, inplace=True)
```

In [43]:
```
df.head()
```

Out[43]:

	race/ethnicity	parental level of education	lunch	test preparation course	math score	reading score	writing score	male
0	group B	bachelor's degree	standard	none	72	72	74	0
1	group C	some college	standard	completed	69	90	88	0
2	group B	master's degree	standard	none	90	95	93	0
3	group A	associate's degree	free/reduced	none	47	57	44	1
4	group C	some college	standard	none	76	78	75	1

In [44]:
```
type_dummies = pd.get_dummies(df['race/ethnicity'],drop_first=True)
df = pd.concat([df,type_dummies],axis=1)
```

In [48]:
```
df.drop(['race/ethnicity'], axis=1, inplace=True)
```

In [49]:
```
df.head()
```

Out[49]:

	parental level of education	lunch	test preparation course	math score	reading score	writing score	male	group B	group C	group D	group E
0	bachelor's degree	standard	none	72	72	74	0	1	0	0	0
1	some college	standard	completed	69	90	88	0	0	1	0	0
2	master's degree	standard	none	90	95	93	0	1	0	0	0
3	associate's degree	free/reduced	none	47	57	44	1	0	0	0	0
4	some college	standard	none	76	78	75	1	0	1	0	0

In [50]:
```
type_dummies = pd.get_dummies(df['parental level of education'],drop_first=True)
df = pd.concat([df,type_dummies],axis=1)
```

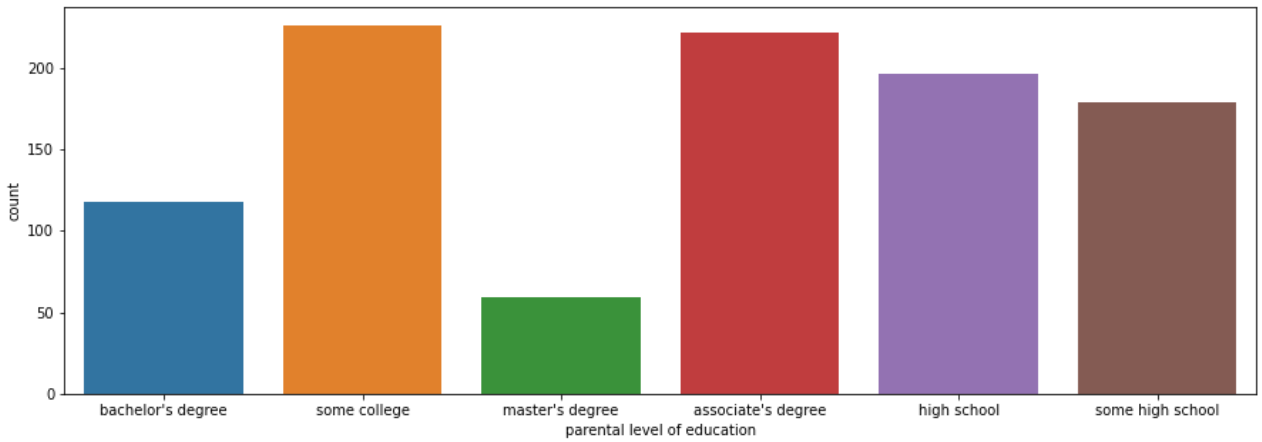
In [51]:
```
df.head()
```

Out[51]:

	parental level of education	lunch	test preparation course	math score	reading score	writing score	male	group B	group C	group D	group E
0	bachelor's degree	standard	none	72	72	74	0	1	0	0	0
1	some college	standard	completed	69	90	88	0	0	1	0	0
2	master's degree	standard	none	90	95	93	0	1	0	0	0
3	associate's degree	free/reduced	none	47	57	44	1	0	0	0	0
4	some college	standard	none	76	78	75	1	0	1	0	0

In [56]:
```
plt.figure(figsize=(15,5))
sns.countplot(x='parental level of education',data=df)
```

Out[56]:
```
<AxesSubplot:xlabel='parental level of education', ylabel='count'>
```



In [57]:
```
df.drop(['parental level of education'],axis=1,inplace=True)
```

In [58]:
```
df.head()
```

Out[58]:

	lunch	test preparation course	math score	reading score	writing score	male	group B	group C	group D	group E	bachelor's degree
0	standard	none	72	72	74	0	1	0	0	0	1
1	standard	completed	69	90	88	0	0	1	0	0	0
2	standard	none	90	95	93	0	1	0	0	0	0
3	free/reduced	none	47	57	44	1	0	0	0	0	0
4	standard	none	76	78	75	1	0	1	0	0	0

In [59]:
```
type_dummies = pd.get_dummies(df['lunch'],drop_first=True)
```

```
df = pd.concat([df,type_dummies],axis=1)
```

In [60]:
```
df.head()
```

Out[60]:

	lunch	test preparation course	math score	reading score	writing score	male	group B	group C	group D	group E	bachelor's degree
0	standard	none	72	72	74	0	1	0	0	0	1
1	standard	completed	69	90	88	0	0	1	0	0	0
2	standard	none	90	95	93	0	1	0	0	0	0
3	free/reduced	none	47	57	44	1	0	0	0	0	0
4	standard	none	76	78	75	1	0	1	0	0	0

In [61]:
```
df.drop(['lunch'],axis=1,inplace=True)
```

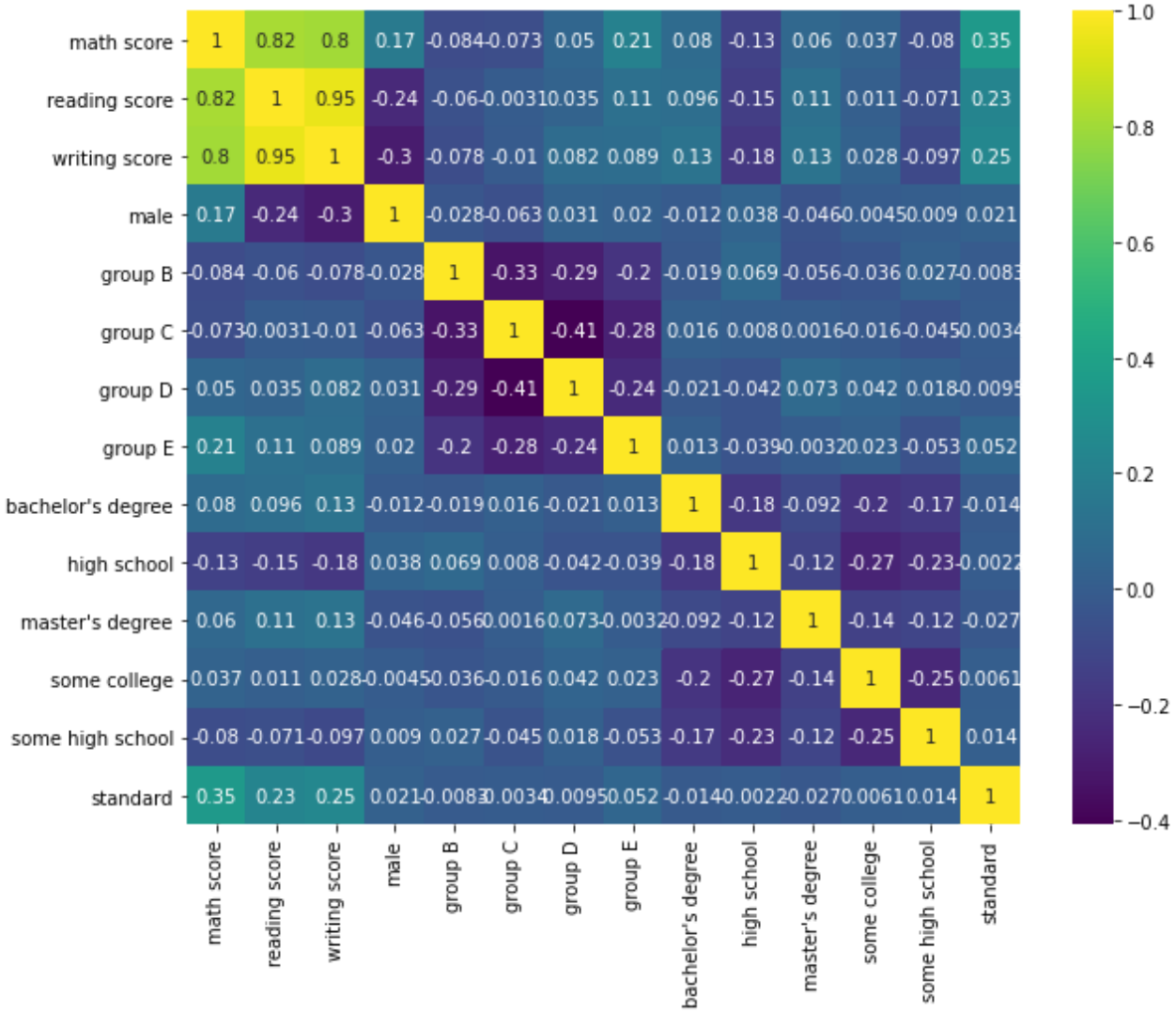
In [63]:
```
df.head()
```

Out[63]:

	test preparation course	math score	reading score	writing score	male	group B	group C	group D	group E	bachelor's degree	high school	maste degr
0	none	72	72	74	0	1	0	0	0	1	0	
1	completed	69	90	88	0	0	1	0	0	0	0	
2	none	90	95	93	0	1	0	0	0	0	0	
3	none	47	57	44	1	0	0	0	0	0	0	
4	none	76	78	75	1	0	1	0	0	0	0	

In [80]:
```
plt.figure(figsize=(10,8))
sns.heatmap(df.corr(), cmap='viridis',annot=True)
```

Out[80]:
```
<AxesSubplot:>
```



In [98]:
```
df.head()
```

Out[98]:

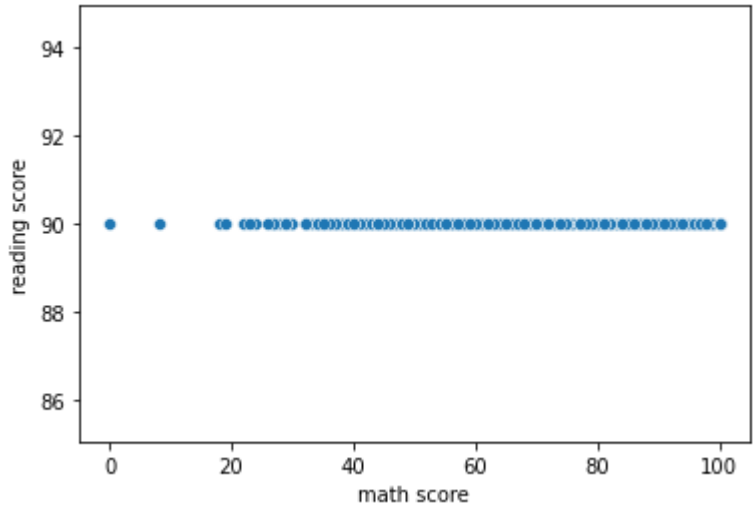
	test preparation course	math score	reading score	writing score	male	group B	group C	group D	group E	bachelor's degree	high school	maste degr
0	none	72	72	74	0	1	0	0	0	1	0	
1	completed	69	90	88	0	0	1	0	0	0	0	
2	none	90	95	93	0	1	0	0	0	0	0	
3	none	47	57	44	1	0	0	0	0	0	0	
4	none	76	78	75	1	0	1	0	0	0	0	

In [104…
```
type(df['math score'][1])
```

Out[104…
```
numpy.int64
```

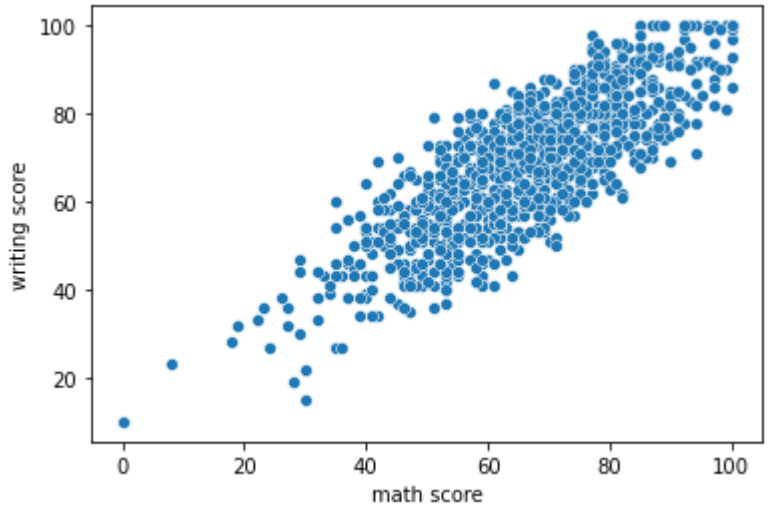
In [116…
```
sns.scatterplot(x='math score',y='reading score', data=df)
```

Out[116…
```
<AxesSubplot:xlabel='math score', ylabel='reading score'>
```



In [117…
```
sns.scatterplot(x='math score',y='writing score', data=df)
```

Out[117…
```
<AxesSubplot:xlabel='math score', ylabel='writing score'>
```



In [130…
```
type_dummies = pd.get_dummies(df['test preparation course'],drop_first=True)
df = pd.concat([df,type_dummies],axis=1)
```

In [131…
```
df.head()
```

Out[131…

	test preparation course	math score	reading score	writing score	male	group B	group C	group D	group E	bachelor's degree	high school	maste degr
0	none	72	90	74	0	1	0	0	0	1	0	
1	completed	69	90	88	0	0	1	0	0	0	0	
2	none	90	90	93	0	1	0	0	0	0	0	
3	none	47	90	44	1	0	0	0	0	0	0	
4	none	76	90	75	1	0	1	0	0	0	0	

In [133…
```
df.drop('test preparation course',axis=1,inplace=True)
```

In [134…
```
df.head()
```

Out[134…

	math score	reading score	writing score	male	group B	group C	group D	group E	bachelor's degree	high school	master's degree	some college
0	72	90	74	0	1	0	0	0	1	0	0	0
1	69	90	88	0	0	1	0	0	0	0	0	1
2	90	90	93	0	1	0	0	0	0	0	1	0
3	47	90	44	1	0	0	0	0	0	0	0	0
4	76	90	75	1	0	1	0	0	0	0	0	1

In [135…
```
X = df.drop('none',axis=1).values
y = df['none'].values
```

In [136…
```
from sklearn.model_selection import train_test_split
```

In [137…
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=4
```

In [138…
```
from sklearn.preprocessing import MinMaxScaler
```

In [139…
```
scaler = MinMaxScaler()
```

In [140…
```
X_train = scaler.fit_transform(X_train)
```

In [141…
```
X_test = scaler.transform(X_test)
```

In [142…
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
```

In [143…
```
X_train.shape
```

Out[143…
```
(700, 14)
```

In [144…
```
model = Sequential()

model.add(Dense(14,activation='relu'))
model.add(Dense(7,activation='relu'))
model.add(Dense(4,activation='relu'))
model.add(Dense(2,activation='relu'))

model.add(Dense(1,activation='sigmoid'))

model.compile(optimizer='adam',loss='binary_crossentropy')
```

In [145…
```
model.fit(x=X_train,y=y_train,
          validation_data=(X_test,y_test),
         batch_size=128,epochs=400)
```

```
Epoch 1/400
6/6 [==============================] - 1s 28ms/step - loss: 0.6929 - val_loss: 0.6924
```

```
Epoch 2/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6920 - val_loss: 0.6916
Epoch 3/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6912 - val_loss: 0.6909
Epoch 4/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6904 - val_loss: 0.6901
Epoch 5/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6895 - val_loss: 0.6894
Epoch 6/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6888 - val_loss: 0.6887
Epoch 7/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6880 - val_loss: 0.6880
Epoch 8/400
6/6 [==============================] - 0s 7ms/step - loss: 0.6872 - val_loss: 0.6873
Epoch 9/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6864 - val_loss: 0.6866
Epoch 10/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6857 - val_loss: 0.6859
Epoch 11/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6849 - val_loss: 0.6852
Epoch 12/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6842 - val_loss: 0.6846
Epoch 13/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6835 - val_loss: 0.6839
Epoch 14/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6828 - val_loss: 0.6833
Epoch 15/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6821 - val_loss: 0.6827
Epoch 16/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6814 - val_loss: 0.6821
Epoch 17/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6807 - val_loss: 0.6815
Epoch 18/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6800 - val_loss: 0.6809
Epoch 19/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6793 - val_loss: 0.6803
Epoch 20/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6788 - val_loss: 0.6797
Epoch 21/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6781 - val_loss: 0.6792
Epoch 22/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6775 - val_loss: 0.6786
Epoch 23/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6768 - val_loss: 0.6781
Epoch 24/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6763 - val_loss: 0.6776
Epoch 25/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6757 - val_loss: 0.6771
Epoch 26/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6751 - val_loss: 0.6766
Epoch 27/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6746 - val_loss: 0.6761
Epoch 28/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6741 - val_loss: 0.6757
Epoch 29/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6735 - val_loss: 0.6752
Epoch 30/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6730 - val_loss: 0.6748
Epoch 31/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6725 - val_loss: 0.6743
Epoch 32/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6719 - val_loss: 0.6739
Epoch 33/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6715 - val_loss: 0.6735
Epoch 34/400
```

```
6/6 [==============================] - 0s 5ms/step - loss: 0.6709 - val_loss: 0.6731
Epoch 35/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6705 - val_loss: 0.6727
Epoch 36/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6700 - val_loss: 0.6722
Epoch 37/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6695 - val_loss: 0.6718
Epoch 38/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6690 - val_loss: 0.6714
Epoch 39/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6686 - val_loss: 0.6711
Epoch 40/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6681 - val_loss: 0.6707
Epoch 41/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6676 - val_loss: 0.6702
Epoch 42/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6672 - val_loss: 0.6699
Epoch 43/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6668 - val_loss: 0.6696
Epoch 44/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6663 - val_loss: 0.6693
Epoch 45/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6658 - val_loss: 0.6689
Epoch 46/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6653 - val_loss: 0.6686
Epoch 47/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6649 - val_loss: 0.6683
Epoch 48/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6644 - val_loss: 0.6679
Epoch 49/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6640 - val_loss: 0.6676
Epoch 50/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6635 - val_loss: 0.6674
Epoch 51/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6630 - val_loss: 0.6671
Epoch 52/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6625 - val_loss: 0.6668
Epoch 53/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6620 - val_loss: 0.6665
Epoch 54/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6615 - val_loss: 0.6662
Epoch 55/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6609 - val_loss: 0.6659
Epoch 56/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6604 - val_loss: 0.6656
Epoch 57/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6599 - val_loss: 0.6655
Epoch 58/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6593 - val_loss: 0.6652
Epoch 59/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6587 - val_loss: 0.6650
Epoch 60/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6581 - val_loss: 0.6648
Epoch 61/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6574 - val_loss: 0.6646
Epoch 62/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6568 - val_loss: 0.6644
Epoch 63/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6563 - val_loss: 0.6642
Epoch 64/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6554 - val_loss: 0.6642
Epoch 65/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6549 - val_loss: 0.6638
Epoch 66/400
6/6 [==============================] - 0s 6ms/step - loss: 0.6542 - val_loss: 0.6637
```

```
Epoch 67/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6534 - val_loss: 0.6635
Epoch 68/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6523 - val_loss: 0.6632
Epoch 69/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6516 - val_loss: 0.6631
Epoch 70/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6506 - val_loss: 0.6627
Epoch 71/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6498 - val_loss: 0.6626
Epoch 72/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6488 - val_loss: 0.6629
Epoch 73/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6480 - val_loss: 0.6629
Epoch 74/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6470 - val_loss: 0.6627
Epoch 75/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6461 - val_loss: 0.6627
Epoch 76/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6453 - val_loss: 0.6627
Epoch 77/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6445 - val_loss: 0.6627
Epoch 78/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6436 - val_loss: 0.6629
Epoch 79/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6429 - val_loss: 0.6629
Epoch 80/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6417 - val_loss: 0.6631
Epoch 81/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6410 - val_loss: 0.6629
Epoch 82/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6400 - val_loss: 0.6627
Epoch 83/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6394 - val_loss: 0.6629
Epoch 84/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6383 - val_loss: 0.6631
Epoch 85/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6374 - val_loss: 0.6633
Epoch 86/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6366 - val_loss: 0.6637
Epoch 87/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6357 - val_loss: 0.6638
Epoch 88/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6349 - val_loss: 0.6641
Epoch 89/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6342 - val_loss: 0.6642
Epoch 90/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6335 - val_loss: 0.6634
Epoch 91/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6323 - val_loss: 0.6637
Epoch 92/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6311 - val_loss: 0.6635
Epoch 93/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6305 - val_loss: 0.6636
Epoch 94/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6294 - val_loss: 0.6636
Epoch 95/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6283 - val_loss: 0.6637
Epoch 96/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6274 - val_loss: 0.6640
Epoch 97/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6264 - val_loss: 0.6641
Epoch 98/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6256 - val_loss: 0.6644
Epoch 99/400
```

```
6/6 [==============================] - 0s 5ms/step - loss: 0.6247 - val_loss: 0.6644
Epoch 100/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6239 - val_loss: 0.6641
Epoch 101/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6227 - val_loss: 0.6641
Epoch 102/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6217 - val_loss: 0.6640
Epoch 103/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6211 - val_loss: 0.6641
Epoch 104/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6203 - val_loss: 0.6638
Epoch 105/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6189 - val_loss: 0.6637
Epoch 106/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6184 - val_loss: 0.6637
Epoch 107/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6174 - val_loss: 0.6632
Epoch 108/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6163 - val_loss: 0.6635
Epoch 109/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6162 - val_loss: 0.6636
Epoch 110/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6148 - val_loss: 0.6629
Epoch 111/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6146 - val_loss: 0.6639
Epoch 112/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6130 - val_loss: 0.6628
Epoch 113/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6129 - val_loss: 0.6633
Epoch 114/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6116 - val_loss: 0.6638
Epoch 115/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6108 - val_loss: 0.6632
Epoch 116/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6105 - val_loss: 0.6629
Epoch 117/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6092 - val_loss: 0.6639
Epoch 118/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6089 - val_loss: 0.6619
Epoch 119/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6079 - val_loss: 0.6638
Epoch 120/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6072 - val_loss: 0.6630
Epoch 121/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6062 - val_loss: 0.6638
Epoch 122/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6055 - val_loss: 0.6644
Epoch 123/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6047 - val_loss: 0.6651
Epoch 124/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6045 - val_loss: 0.6654
Epoch 125/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6036 - val_loss: 0.6643
Epoch 126/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6032 - val_loss: 0.6661
Epoch 127/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6027 - val_loss: 0.6659
Epoch 128/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6018 - val_loss: 0.6666
Epoch 129/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6016 - val_loss: 0.6662
Epoch 130/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6007 - val_loss: 0.6661
Epoch 131/400
6/6 [==============================] - 0s 5ms/step - loss: 0.6004 - val_loss: 0.6665
```

```
Epoch 132/400
6/6 [==============================] - 0s 4ms/step - loss: 0.6001 - val_loss: 0.6661
Epoch 133/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5997 - val_loss: 0.6676
Epoch 134/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5988 - val_loss: 0.6666
Epoch 135/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5982 - val_loss: 0.6665
Epoch 136/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5977 - val_loss: 0.6660
Epoch 137/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5974 - val_loss: 0.6664
Epoch 138/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5974 - val_loss: 0.6654
Epoch 139/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5967 - val_loss: 0.6683
Epoch 140/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5957 - val_loss: 0.6665
Epoch 141/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5952 - val_loss: 0.6682
Epoch 142/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5949 - val_loss: 0.6679
Epoch 143/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5943 - val_loss: 0.6684
Epoch 144/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5937 - val_loss: 0.6695
Epoch 145/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5936 - val_loss: 0.6688
Epoch 146/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5930 - val_loss: 0.6681
Epoch 147/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5925 - val_loss: 0.6697
Epoch 148/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5926 - val_loss: 0.6672
Epoch 149/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5915 - val_loss: 0.6681
Epoch 150/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5915 - val_loss: 0.6687
Epoch 151/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5911 - val_loss: 0.6670
Epoch 152/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5904 - val_loss: 0.6680
Epoch 153/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5899 - val_loss: 0.6686
Epoch 154/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5894 - val_loss: 0.6680
Epoch 155/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5890 - val_loss: 0.6682
Epoch 156/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5885 - val_loss: 0.6689
Epoch 157/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5888 - val_loss: 0.6692
Epoch 158/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5881 - val_loss: 0.6669
Epoch 159/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5884 - val_loss: 0.6679
Epoch 160/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5880 - val_loss: 0.6701
Epoch 161/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5874 - val_loss: 0.6656
Epoch 162/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5867 - val_loss: 0.6687
Epoch 163/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5865 - val_loss: 0.6682
Epoch 164/400
```

```
6/6 [==============================] - 0s 5ms/step - loss: 0.5861 - val_loss: 0.6657
Epoch 165/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5855 - val_loss: 0.6687
Epoch 166/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5855 - val_loss: 0.6685
Epoch 167/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5848 - val_loss: 0.6674
Epoch 168/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5847 - val_loss: 0.6670
Epoch 169/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5843 - val_loss: 0.6689
Epoch 170/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5842 - val_loss: 0.6691
Epoch 171/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5839 - val_loss: 0.6681
Epoch 172/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5835 - val_loss: 0.6687
Epoch 173/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5835 - val_loss: 0.6688
Epoch 174/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5825 - val_loss: 0.6691
Epoch 175/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5823 - val_loss: 0.6678
Epoch 176/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5821 - val_loss: 0.6693
Epoch 177/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5815 - val_loss: 0.6675
Epoch 178/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5813 - val_loss: 0.6681
Epoch 179/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5812 - val_loss: 0.6688
Epoch 180/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5807 - val_loss: 0.6696
Epoch 181/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5802 - val_loss: 0.6690
Epoch 182/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5800 - val_loss: 0.6699
Epoch 183/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5798 - val_loss: 0.6687
Epoch 184/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5800 - val_loss: 0.6686
Epoch 185/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5799 - val_loss: 0.6716
Epoch 186/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5787 - val_loss: 0.6677
Epoch 187/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5788 - val_loss: 0.6691
Epoch 188/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5778 - val_loss: 0.6718
Epoch 189/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5780 - val_loss: 0.6705
Epoch 190/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5772 - val_loss: 0.6698
Epoch 191/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5771 - val_loss: 0.6704
Epoch 192/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5763 - val_loss: 0.6698
Epoch 193/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5758 - val_loss: 0.6699
Epoch 194/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5753 - val_loss: 0.6686
Epoch 195/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5753 - val_loss: 0.6682
Epoch 196/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5764 - val_loss: 0.6662
```

```
Epoch 197/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5743 - val_loss: 0.6692
Epoch 198/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5742 - val_loss: 0.6683
Epoch 199/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5738 - val_loss: 0.6676
Epoch 200/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5730 - val_loss: 0.6691
Epoch 201/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5727 - val_loss: 0.6671
Epoch 202/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5722 - val_loss: 0.6685
Epoch 203/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5720 - val_loss: 0.6680
Epoch 204/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5719 - val_loss: 0.6678
Epoch 205/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5716 - val_loss: 0.6663
Epoch 206/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5705 - val_loss: 0.6687
Epoch 207/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5706 - val_loss: 0.6697
Epoch 208/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5706 - val_loss: 0.6683
Epoch 209/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5700 - val_loss: 0.6653
Epoch 210/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5705 - val_loss: 0.6695
Epoch 211/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5688 - val_loss: 0.6679
Epoch 212/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5686 - val_loss: 0.6682
Epoch 213/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5686 - val_loss: 0.6683
Epoch 214/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5679 - val_loss: 0.6650
Epoch 215/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5688 - val_loss: 0.6672
Epoch 216/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5671 - val_loss: 0.6672
Epoch 217/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5677 - val_loss: 0.6660
Epoch 218/400
6/6 [==============================] - 0s 6ms/step - loss: 0.5673 - val_loss: 0.6703
Epoch 219/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5668 - val_loss: 0.6679
Epoch 220/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5662 - val_loss: 0.6693
Epoch 221/400
6/6 [==============================] - 0s 7ms/step - loss: 0.5656 - val_loss: 0.6693
Epoch 222/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5660 - val_loss: 0.6693
Epoch 223/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5661 - val_loss: 0.6722
Epoch 224/400
6/6 [==============================] - 0s 6ms/step - loss: 0.5679 - val_loss: 0.6666
Epoch 225/400
6/6 [==============================] - 0s 6ms/step - loss: 0.5657 - val_loss: 0.6688
Epoch 226/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5670 - val_loss: 0.6723
Epoch 227/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5632 - val_loss: 0.6674
Epoch 228/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5654 - val_loss: 0.6670
Epoch 229/400
```

```
6/6 [==============================] - 0s 4ms/step - loss: 0.5655 - val_loss: 0.6718
Epoch 230/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5641 - val_loss: 0.6683
Epoch 231/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5628 - val_loss: 0.6694
Epoch 232/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5628 - val_loss: 0.6703
Epoch 233/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5623 - val_loss: 0.6692
Epoch 234/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5627 - val_loss: 0.6707
Epoch 235/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5617 - val_loss: 0.6701
Epoch 236/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5615 - val_loss: 0.6699
Epoch 237/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5615 - val_loss: 0.6694
Epoch 238/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5609 - val_loss: 0.6701
Epoch 239/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5608 - val_loss: 0.6710
Epoch 240/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5612 - val_loss: 0.6716
Epoch 241/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5603 - val_loss: 0.6718
Epoch 242/400
6/6 [==============================] - 0s 6ms/step - loss: 0.5595 - val_loss: 0.6709
Epoch 243/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5602 - val_loss: 0.6692
Epoch 244/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5598 - val_loss: 0.6698
Epoch 245/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5595 - val_loss: 0.6716
Epoch 246/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5604 - val_loss: 0.6732
Epoch 247/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5588 - val_loss: 0.6697
Epoch 248/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5596 - val_loss: 0.6685
Epoch 249/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5594 - val_loss: 0.6710
Epoch 250/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5605 - val_loss: 0.6713
Epoch 251/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5600 - val_loss: 0.6683
Epoch 252/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5582 - val_loss: 0.6717
Epoch 253/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5580 - val_loss: 0.6710
Epoch 254/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5572 - val_loss: 0.6683
Epoch 255/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5579 - val_loss: 0.6706
Epoch 256/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5567 - val_loss: 0.6689
Epoch 257/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5563 - val_loss: 0.6683
Epoch 258/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5565 - val_loss: 0.6683
Epoch 259/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5558 - val_loss: 0.6676
Epoch 260/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5554 - val_loss: 0.6694
Epoch 261/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5556 - val_loss: 0.6684
```

```
Epoch 262/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5550 - val_loss: 0.6670
Epoch 263/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5547 - val_loss: 0.6666
Epoch 264/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5545 - val_loss: 0.6667
Epoch 265/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5552 - val_loss: 0.6642
Epoch 266/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5541 - val_loss: 0.6691
Epoch 267/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5534 - val_loss: 0.6653
Epoch 268/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5531 - val_loss: 0.6625
Epoch 269/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5526 - val_loss: 0.6653
Epoch 270/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5520 - val_loss: 0.6679
Epoch 271/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5513 - val_loss: 0.6634
Epoch 272/400
6/6 [==============================] - 0s 7ms/step - loss: 0.5529 - val_loss: 0.6621
Epoch 273/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5537 - val_loss: 0.6681
Epoch 274/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5523 - val_loss: 0.6615
Epoch 275/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5511 - val_loss: 0.6651
Epoch 276/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5512 - val_loss: 0.6669
Epoch 277/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5505 - val_loss: 0.6618
Epoch 278/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5499 - val_loss: 0.6640
Epoch 279/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5493 - val_loss: 0.6636
Epoch 280/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5496 - val_loss: 0.6619
Epoch 281/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5500 - val_loss: 0.6647
Epoch 282/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5477 - val_loss: 0.6592
Epoch 283/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5474 - val_loss: 0.6601
Epoch 284/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5472 - val_loss: 0.6609
Epoch 285/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5474 - val_loss: 0.6594
Epoch 286/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5462 - val_loss: 0.6572
Epoch 287/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5462 - val_loss: 0.6601
Epoch 288/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5459 - val_loss: 0.6580
Epoch 289/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5450 - val_loss: 0.6590
Epoch 290/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5452 - val_loss: 0.6588
Epoch 291/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5451 - val_loss: 0.6604
Epoch 292/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5442 - val_loss: 0.6585
Epoch 293/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5446 - val_loss: 0.6596
Epoch 294/400
```

```
6/6 [==============================] - 0s 4ms/step - loss: 0.5436 - val_loss: 0.6594
Epoch 295/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5452 - val_loss: 0.6605
Epoch 296/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5438 - val_loss: 0.6555
Epoch 297/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5440 - val_loss: 0.6571
Epoch 298/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5425 - val_loss: 0.6584
Epoch 299/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5419 - val_loss: 0.6556
Epoch 300/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5415 - val_loss: 0.6560
Epoch 301/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5411 - val_loss: 0.6551
Epoch 302/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5401 - val_loss: 0.6553
Epoch 303/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5397 - val_loss: 0.6562
Epoch 304/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5399 - val_loss: 0.6552
Epoch 305/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5381 - val_loss: 0.6533
Epoch 306/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5397 - val_loss: 0.6553
Epoch 307/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5387 - val_loss: 0.6593
Epoch 308/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5376 - val_loss: 0.6531
Epoch 309/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5393 - val_loss: 0.6550
Epoch 310/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5368 - val_loss: 0.6530
Epoch 311/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5375 - val_loss: 0.6544
Epoch 312/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5356 - val_loss: 0.6540
Epoch 313/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5349 - val_loss: 0.6529
Epoch 314/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5353 - val_loss: 0.6541
Epoch 315/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5353 - val_loss: 0.6567
Epoch 316/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5353 - val_loss: 0.6525
Epoch 317/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5338 - val_loss: 0.6554
Epoch 318/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5337 - val_loss: 0.6545
Epoch 319/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5334 - val_loss: 0.6536
Epoch 320/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5333 - val_loss: 0.6557
Epoch 321/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5328 - val_loss: 0.6574
Epoch 322/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5338 - val_loss: 0.6544
Epoch 323/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5339 - val_loss: 0.6525
Epoch 324/400
6/6 [==============================] - 0s 7ms/step - loss: 0.5321 - val_loss: 0.6554
Epoch 325/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5329 - val_loss: 0.6541
Epoch 326/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5318 - val_loss: 0.6533
```

```
Epoch 327/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5323 - val_loss: 0.6532
Epoch 328/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5310 - val_loss: 0.6542
Epoch 329/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5310 - val_loss: 0.6540
Epoch 330/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5311 - val_loss: 0.6533
Epoch 331/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5311 - val_loss: 0.6559
Epoch 332/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5302 - val_loss: 0.6542
Epoch 333/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5304 - val_loss: 0.6558
Epoch 334/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5294 - val_loss: 0.6537
Epoch 335/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5301 - val_loss: 0.6526
Epoch 336/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5299 - val_loss: 0.6528
Epoch 337/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5289 - val_loss: 0.6509
Epoch 338/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5288 - val_loss: 0.6541
Epoch 339/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5292 - val_loss: 0.6529
Epoch 340/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5282 - val_loss: 0.6548
Epoch 341/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5283 - val_loss: 0.6556
Epoch 342/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5282 - val_loss: 0.6560
Epoch 343/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5272 - val_loss: 0.6527
Epoch 344/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5285 - val_loss: 0.6551
Epoch 345/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5278 - val_loss: 0.6543
Epoch 346/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5278 - val_loss: 0.6526
Epoch 347/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5272 - val_loss: 0.6569
Epoch 348/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5274 - val_loss: 0.6544
Epoch 349/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5265 - val_loss: 0.6557
Epoch 350/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5270 - val_loss: 0.6548
Epoch 351/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5266 - val_loss: 0.6534
Epoch 352/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5265 - val_loss: 0.6567
Epoch 353/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5263 - val_loss: 0.6561
Epoch 354/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5267 - val_loss: 0.6553
Epoch 355/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5261 - val_loss: 0.6588
Epoch 356/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5265 - val_loss: 0.6559
Epoch 357/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5244 - val_loss: 0.6588
Epoch 358/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5255 - val_loss: 0.6568
Epoch 359/400
```

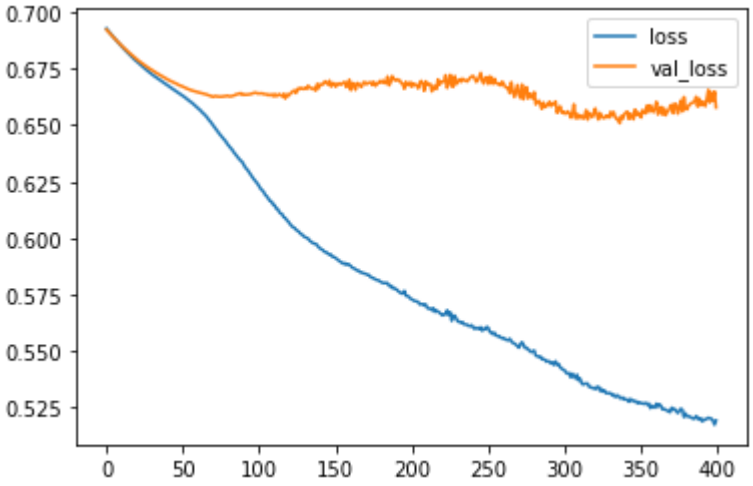
```
6/6 [==============================] - 0s 5ms/step - loss: 0.5251 - val_loss: 0.6558
Epoch 360/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5246 - val_loss: 0.6578
Epoch 361/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5264 - val_loss: 0.6604
Epoch 362/400
6/6 [==============================] - 0s 2ms/step - loss: 0.5251 - val_loss: 0.6547
Epoch 363/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5261 - val_loss: 0.6567
Epoch 364/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5253 - val_loss: 0.6581
Epoch 365/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5239 - val_loss: 0.6547
Epoch 366/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5239 - val_loss: 0.6575
Epoch 367/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5238 - val_loss: 0.6544
Epoch 368/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5233 - val_loss: 0.6558
Epoch 369/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5229 - val_loss: 0.6566
Epoch 370/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5226 - val_loss: 0.6583
Epoch 371/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5246 - val_loss: 0.6590
Epoch 372/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5238 - val_loss: 0.6553
Epoch 373/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5240 - val_loss: 0.6596
Epoch 374/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5231 - val_loss: 0.6593
Epoch 375/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5222 - val_loss: 0.6551
Epoch 376/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5233 - val_loss: 0.6576
Epoch 377/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5242 - val_loss: 0.6609
Epoch 378/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5237 - val_loss: 0.6561
Epoch 379/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5205 - val_loss: 0.6625
Epoch 380/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5221 - val_loss: 0.6577
Epoch 381/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5207 - val_loss: 0.6570
Epoch 382/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5209 - val_loss: 0.6586
Epoch 383/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5205 - val_loss: 0.6593
Epoch 384/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5201 - val_loss: 0.6599
Epoch 385/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5198 - val_loss: 0.6600
Epoch 386/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5197 - val_loss: 0.6606
Epoch 387/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5209 - val_loss: 0.6626
Epoch 388/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5201 - val_loss: 0.6583
Epoch 389/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5193 - val_loss: 0.6618
Epoch 390/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5200 - val_loss: 0.6588
Epoch 391/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5185 - val_loss: 0.6606
```

```
Epoch 392/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5193 - val_loss: 0.6598
Epoch 393/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5193 - val_loss: 0.6584
Epoch 394/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5197 - val_loss: 0.6618
Epoch 395/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5201 - val_loss: 0.6657
Epoch 396/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5199 - val_loss: 0.6601
Epoch 397/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5197 - val_loss: 0.6644
Epoch 398/400
6/6 [==============================] - 0s 4ms/step - loss: 0.5189 - val_loss: 0.6608
Epoch 399/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5171 - val_loss: 0.6649
Epoch 400/400
6/6 [==============================] - 0s 5ms/step - loss: 0.5189 - val_loss: 0.6579
```

Out[145… <keras.callbacks.History at 0x2213583d820>

In [146…
```
model_loss = pd.DataFrame(model.history.history)
model_loss.plot()
```

Out[146… <AxesSubplot:>



In [147…
```
from tensorflow.keras.callbacks import EarlyStopping
```

In [151…
```
from tensorflow.keras.layers import Dropout
```

In [152…
```
model = Sequential()

model.add(Dense(14,activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(7,activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(4,activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(2,activation='relu'))
model.add(Dropout(0.5))

model.add(Dense(1,activation='sigmoid'))
```

```
model.compile(loss='binary_crossentropy',optimizer='adam')
```

In [153…

```
model.fit(x=X_train,y=y_train,epochs=600,validation_data=(X_test,y_test),
          callbacks=[early_stop])
```

```
Epoch 1/600
22/22 [==============================] - 1s 5ms/step - loss: 1.0873 - val_loss: 0.7530
Epoch 2/600
22/22 [==============================] - 0s 2ms/step - loss: 0.9492 - val_loss: 0.7087
Epoch 3/600
22/22 [==============================] - 0s 2ms/step - loss: 0.8315 - val_loss: 0.6923
Epoch 4/600
22/22 [==============================] - 0s 2ms/step - loss: 0.8065 - val_loss: 0.6843
Epoch 5/600
22/22 [==============================] - 0s 2ms/step - loss: 0.7259 - val_loss: 0.6816
Epoch 6/600
22/22 [==============================] - 0s 2ms/step - loss: 0.7245 - val_loss: 0.6801
Epoch 7/600
22/22 [==============================] - 0s 3ms/step - loss: 0.7213 - val_loss: 0.6787
Epoch 8/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6949 - val_loss: 0.6771
Epoch 9/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6846 - val_loss: 0.6756
Epoch 10/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6872 - val_loss: 0.6744
Epoch 11/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6794 - val_loss: 0.6730
Epoch 12/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6826 - val_loss: 0.6719
Epoch 13/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6792 - val_loss: 0.6708
Epoch 14/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6769 - val_loss: 0.6697
Epoch 15/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6610 - val_loss: 0.6687
Epoch 16/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6743 - val_loss: 0.6678
Epoch 17/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6629 - val_loss: 0.6669
Epoch 18/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6713 - val_loss: 0.6662
Epoch 19/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6659 - val_loss: 0.6654
Epoch 20/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6623 - val_loss: 0.6647
Epoch 21/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6627 - val_loss: 0.6641
Epoch 22/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6633 - val_loss: 0.6635
Epoch 23/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6614 - val_loss: 0.6628
Epoch 24/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6605 - val_loss: 0.6624
Epoch 25/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6591 - val_loss: 0.6619
Epoch 26/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6562 - val_loss: 0.6614
Epoch 27/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6568 - val_loss: 0.6610
Epoch 28/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6586 - val_loss: 0.6606
Epoch 29/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6568 - val_loss: 0.6603
```

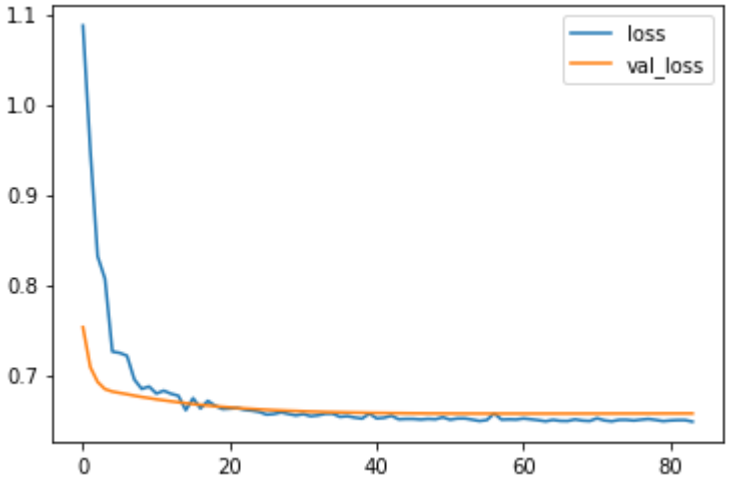
```
Epoch 30/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6552 - val_loss: 0.6600
Epoch 31/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6567 - val_loss: 0.6597
Epoch 32/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6544 - val_loss: 0.6594
Epoch 33/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6553 - val_loss: 0.6592
Epoch 34/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6570 - val_loss: 0.6589
Epoch 35/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6571 - val_loss: 0.6587
Epoch 36/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6536 - val_loss: 0.6586
Epoch 37/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6544 - val_loss: 0.6584
Epoch 38/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6528 - val_loss: 0.6583
Epoch 39/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6517 - val_loss: 0.6581
Epoch 40/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6571 - val_loss: 0.6580
Epoch 41/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6519 - val_loss: 0.6579
Epoch 42/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6526 - val_loss: 0.6578
Epoch 43/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6549 - val_loss: 0.6577
Epoch 44/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6509 - val_loss: 0.6576
Epoch 45/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6513 - val_loss: 0.6575
Epoch 46/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6513 - val_loss: 0.6575
Epoch 47/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6506 - val_loss: 0.6574
Epoch 48/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6513 - val_loss: 0.6573
Epoch 49/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6509 - val_loss: 0.6573
Epoch 50/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6532 - val_loss: 0.6573
Epoch 51/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6504 - val_loss: 0.6573
Epoch 52/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6518 - val_loss: 0.6572
Epoch 53/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6519 - val_loss: 0.6572
Epoch 54/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6505 - val_loss: 0.6572
Epoch 55/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6490 - val_loss: 0.6572
Epoch 56/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6501 - val_loss: 0.6572
Epoch 57/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6574 - val_loss: 0.6572
Epoch 58/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6505 - val_loss: 0.6572
Epoch 59/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6508 - val_loss: 0.6572
Epoch 60/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6506 - val_loss: 0.6572
Epoch 61/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6518 - val_loss: 0.6572
Epoch 62/600
```

```
22/22 [==============================] - 0s 2ms/step - loss: 0.6509 - val_loss: 0.6572
Epoch 63/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6499 - val_loss: 0.6572
Epoch 64/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6487 - val_loss: 0.6572
Epoch 65/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6502 - val_loss: 0.6572
Epoch 66/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6491 - val_loss: 0.6572
Epoch 67/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6490 - val_loss: 0.6572
Epoch 68/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6508 - val_loss: 0.6572
Epoch 69/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6495 - val_loss: 0.6572
Epoch 70/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6490 - val_loss: 0.6572
Epoch 71/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6520 - val_loss: 0.6572
Epoch 72/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6497 - val_loss: 0.6572
Epoch 73/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6486 - val_loss: 0.6572
Epoch 74/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6502 - val_loss: 0.6573
Epoch 75/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6503 - val_loss: 0.6573
Epoch 76/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6495 - val_loss: 0.6573
Epoch 77/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6504 - val_loss: 0.6573
Epoch 78/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6512 - val_loss: 0.6573
Epoch 79/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6501 - val_loss: 0.6573
Epoch 80/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6488 - val_loss: 0.6573
Epoch 81/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6496 - val_loss: 0.6573
Epoch 82/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6500 - val_loss: 0.6573
Epoch 83/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6500 - val_loss: 0.6574
Epoch 84/600
22/22 [==============================] - 0s 2ms/step - loss: 0.6482 - val_loss: 0.6573
Epoch 00084: early stopping
```

Out[153… `<keras.callbacks.History at 0x22137a23730>`

In [154…
```
model_loss = pd.DataFrame(model.history.history)
model_loss.plot()
```

Out[154… `<AxesSubplot:>`



In [ ]: