

# CNNModel

April 17, 2020

```
[2]: import keras
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from keras.models import Sequential
from keras.applications.vgg16 import VGG16
from keras.layers import Dense, InputLayer, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D, GlobalMaxPooling2D
from keras.preprocessing import image
from sklearn.model_selection import train_test_split
from tqdm import tqdm
```

```
[5]: data = pd.read_csv('dataset.csv')
data.head()
```

```
[5]:
```

	image	label
0	Dataset/2_241_gel.wav.png	gel
1	Dataset/2_580_voi.wav.png	voi
2	Dataset/0_214_pia_sax.wav.png	pia
3	Dataset/0_198_voi.wav.png	voi
4	Dataset/0_144_gel_voi.wav.png	gel

```
[15]: train_im = data['image'][:1200]
test_im = data['image'][1200:]
train_y = data['label'][:1200]
test_y = data['label'][1200:]
```

```
[16]: train = pd.DataFrame()
test = pd.DataFrame()
train['image'] = train_im
test['image'] = test_im
train['label'] = train_y
test['label'] = test_y
```

```
[40]: train.to_csv('training.csv', header=True, index = False)
test.to_csv('testing.csv', header = True, index = False)
```

```
[43]: train_images = []
      for i in tqdm(range(1200)):
          im = image.load_img(train['image'][i], target_size = (224, 224))
          im = image.img_to_array(im)
          im = im/255
          train_images.append(im)
```

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```
[44]: X = np.array(train_images)
```

```
[45]: y = train['label']
```

```
[46]: y.shape
```

```
[46]: (1200,)
```

```
[47]: X_train, X_test, y_train, y_test = train_test_split(X, y, random_state = 42,
      ↪ test_size = 0.2, stratify = y)
```

```
[48]: X.shape
```

```
[48]: (1200, 224, 224, 3)
```

```
[49]: y.shape
```

```
[49]: (1200,)
```

```
[50]: y_train = pd.get_dummies(y_train)
      y_test = pd.get_dummies(y_test)
```

```
[51]: y_train.shape
```

```
[51]: (960, 11)
```

```
[52]: y_train
```

```
[52]:
```

	cel	cla	flu	gac	gel	org	pia	sax	tru	vio	voi
456	0	0	0	0	0	0	0	0	0	0	1
987	0	0	0	0	1	0	0	0	0	0	0
461	0	0	0	0	1	0	0	0	0	0	0
1153	0	0	0	1	0	0	0	0	0	0	0
1022	0	0	0	0	0	1	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...	...
1	0	0	0	0	0	0	0	0	0	0	1
806	0	0	0	0	0	0	0	0	0	0	1
877	0	0	0	0	1	0	0	0	0	0	0

```

496      0      0      0      1      0      0      0      0      0      0      0
1047     0      0      0      1      0      0      0      0      0      0      0

```

```
[960 rows x 11 columns]
```

```
[53]: basemodel = VGG16(weights = 'imagenet', include_top = False)
```

```
[54]: X_train = basemodel.predict(X_train)
```

```
[55]: X_train.shape
```

```
[55]: (960, 7, 7, 512)
```

```
[56]: X_test = basemodel.predict(X_test)
```

```
[57]: X_test.shape
```

```
[57]: (240, 7, 7, 512)
```

```
[58]: X_train = X_train.reshape(960, 7*7*512)
      X_test = X_test.reshape(240, 7*7*512)
```

```
[59]: maxi = X_train.max()
      X_train = X_train/maxi
      X_test = X_test/maxi
```

```
[60]: X_train.shape
```

```
[60]: (960, 25088)
```

```
[61]: model = Sequential()
      model.add(Dense(1024, activation='relu', input_shape=(25088,)))
      model.add(Dropout(0.5))
      model.add(Dense(512, activation='relu'))
      model.add(Dropout(0.5))
      model.add(Dense(256, activation='relu'))
      model.add(Dropout(0.5))
      model.add(Dense(128, activation='relu'))
      model.add(Dropout(0.5))
      model.add(Dense(11, activation='softmax'))
```

```
[62]: from keras.callbacks import ModelCheckpoint
      mcp_save = ModelCheckpoint('weight.hdf5', save_best_only=True,
      ↪monitor='val_loss', mode='min')
```

```
[63]: model.
      ↪compile(loss='categorical_crossentropy', optimizer='Adam', metrics=['accuracy'])
```

```
[64]: model.fit(X_train, y_train, epochs=100, validation_data=(X_test, y_test),  
↳callbacks=[mcp_save], batch_size=128)
```

Train on 960 samples, validate on 240 samples

Epoch 1/100

960/960 [=====] - 1s 1ms/step - loss: 2.2031 -  
accuracy: 0.2427 - val\_loss: 1.9809 - val\_accuracy: 0.3292

Epoch 2/100

960/960 [=====] - 1s 1ms/step - loss: 2.0180 -  
accuracy: 0.2958 - val\_loss: 2.0382 - val\_accuracy: 0.2500

Epoch 3/100

960/960 [=====] - 1s 1ms/step - loss: 2.0087 -  
accuracy: 0.2750 - val\_loss: 1.9922 - val\_accuracy: 0.3292

Epoch 4/100

960/960 [=====] - 1s 1ms/step - loss: 1.9429 -  
accuracy: 0.2917 - val\_loss: 1.9753 - val\_accuracy: 0.4250

Epoch 5/100

960/960 [=====] - 1s 1ms/step - loss: 1.9146 -  
accuracy: 0.2823 - val\_loss: 1.9279 - val\_accuracy: 0.4083

Epoch 6/100

960/960 [=====] - 1s 1ms/step - loss: 1.8890 -  
accuracy: 0.3094 - val\_loss: 1.9000 - val\_accuracy: 0.4292

Epoch 7/100

960/960 [=====] - 1s 1ms/step - loss: 1.8993 -  
accuracy: 0.3063 - val\_loss: 1.9543 - val\_accuracy: 0.3833

Epoch 8/100

960/960 [=====] - 1s 1ms/step - loss: 1.8877 -  
accuracy: 0.3167 - val\_loss: 1.9287 - val\_accuracy: 0.3500

Epoch 9/100

960/960 [=====] - 1s 1ms/step - loss: 1.8646 -  
accuracy: 0.3104 - val\_loss: 1.8568 - val\_accuracy: 0.4167

Epoch 10/100

960/960 [=====] - 1s 1ms/step - loss: 1.8471 -  
accuracy: 0.3490 - val\_loss: 1.8403 - val\_accuracy: 0.4167

Epoch 11/100

960/960 [=====] - 1s 1ms/step - loss: 1.8390 -  
accuracy: 0.3167 - val\_loss: 1.7784 - val\_accuracy: 0.4542

Epoch 12/100

960/960 [=====] - 1s 1ms/step - loss: 1.8225 -  
accuracy: 0.3302 - val\_loss: 1.8327 - val\_accuracy: 0.3958

Epoch 13/100

960/960 [=====] - 1s 1ms/step - loss: 1.7920 -  
accuracy: 0.3469 - val\_loss: 1.7609 - val\_accuracy: 0.4458

Epoch 14/100

960/960 [=====] - 1s 1ms/step - loss: 1.7942 -  
accuracy: 0.3552 - val\_loss: 1.7339 - val\_accuracy: 0.4708

Epoch 15/100

960/960 [=====] - 1s 1ms/step - loss: 1.7646 -  
 accuracy: 0.3688 - val\_loss: 1.7268 - val\_accuracy: 0.4542  
 Epoch 16/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.7000 -  
 accuracy: 0.4052 - val\_loss: 1.6554 - val\_accuracy: 0.4667  
 Epoch 17/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.6807 -  
 accuracy: 0.4073 - val\_loss: 1.6029 - val\_accuracy: 0.4917  
 Epoch 18/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.6275 -  
 accuracy: 0.4302 - val\_loss: 1.6088 - val\_accuracy: 0.4875  
 Epoch 19/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.6676 -  
 accuracy: 0.4177 - val\_loss: 1.5595 - val\_accuracy: 0.4667  
 Epoch 20/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.6341 -  
 accuracy: 0.4479 - val\_loss: 1.5179 - val\_accuracy: 0.4917  
 Epoch 21/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.5921 -  
 accuracy: 0.4646 - val\_loss: 1.5228 - val\_accuracy: 0.5167  
 Epoch 22/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.5817 -  
 accuracy: 0.4625 - val\_loss: 1.5203 - val\_accuracy: 0.4750  
 Epoch 23/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.5691 -  
 accuracy: 0.4542 - val\_loss: 1.4982 - val\_accuracy: 0.5208  
 Epoch 24/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.5211 -  
 accuracy: 0.4604 - val\_loss: 1.4883 - val\_accuracy: 0.5208  
 Epoch 25/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.5256 -  
 accuracy: 0.4854 - val\_loss: 1.4316 - val\_accuracy: 0.5292  
 Epoch 26/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.4475 -  
 accuracy: 0.4844 - val\_loss: 1.4023 - val\_accuracy: 0.5042  
 Epoch 27/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.4323 -  
 accuracy: 0.5125 - val\_loss: 1.3929 - val\_accuracy: 0.5708  
 Epoch 28/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.4264 -  
 accuracy: 0.5052 - val\_loss: 1.3882 - val\_accuracy: 0.5625  
 Epoch 29/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.3780 -  
 accuracy: 0.5344 - val\_loss: 1.3809 - val\_accuracy: 0.5333  
 Epoch 30/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.3357 -  
 accuracy: 0.5365 - val\_loss: 1.3627 - val\_accuracy: 0.5500  
 Epoch 31/100

960/960 [=====] - 1s 1ms/step - loss: 1.3298 -  
accuracy: 0.5406 - val\_loss: 1.3642 - val\_accuracy: 0.5250  
Epoch 32/100  
960/960 [=====] - 1s 1ms/step - loss: 1.3251 -  
accuracy: 0.5500 - val\_loss: 1.3376 - val\_accuracy: 0.5625  
Epoch 33/100  
960/960 [=====] - 1s 1ms/step - loss: 1.3215 -  
accuracy: 0.5417 - val\_loss: 1.3963 - val\_accuracy: 0.5500  
Epoch 34/100  
960/960 [=====] - 1s 1ms/step - loss: 1.2813 -  
accuracy: 0.5698 - val\_loss: 1.3553 - val\_accuracy: 0.5667  
Epoch 35/100  
960/960 [=====] - 1s 1ms/step - loss: 1.3007 -  
accuracy: 0.5469 - val\_loss: 1.3780 - val\_accuracy: 0.5708  
Epoch 36/100  
960/960 [=====] - 1s 1ms/step - loss: 1.3065 -  
accuracy: 0.5646 - val\_loss: 1.3634 - val\_accuracy: 0.5667  
Epoch 37/100  
960/960 [=====] - 1s 1ms/step - loss: 1.2586 -  
accuracy: 0.5604 - val\_loss: 1.3524 - val\_accuracy: 0.5708  
Epoch 38/100  
960/960 [=====] - 1s 1ms/step - loss: 1.1993 -  
accuracy: 0.5917 - val\_loss: 1.2886 - val\_accuracy: 0.6000  
Epoch 39/100  
960/960 [=====] - 1s 1ms/step - loss: 1.1798 -  
accuracy: 0.6000 - val\_loss: 1.2948 - val\_accuracy: 0.5708  
Epoch 40/100  
960/960 [=====] - 1s 1ms/step - loss: 1.1497 -  
accuracy: 0.6156 - val\_loss: 1.3092 - val\_accuracy: 0.5708  
Epoch 41/100  
960/960 [=====] - 1s 1ms/step - loss: 1.1723 -  
accuracy: 0.5917 - val\_loss: 1.4022 - val\_accuracy: 0.5750  
Epoch 42/100  
960/960 [=====] - 1s 1ms/step - loss: 1.1293 -  
accuracy: 0.6073 - val\_loss: 1.3199 - val\_accuracy: 0.5750  
Epoch 43/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0786 -  
accuracy: 0.6250 - val\_loss: 1.3146 - val\_accuracy: 0.5542  
Epoch 44/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0711 -  
accuracy: 0.6281 - val\_loss: 1.4064 - val\_accuracy: 0.5875  
Epoch 45/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0643 -  
accuracy: 0.6302 - val\_loss: 1.3798 - val\_accuracy: 0.5875  
Epoch 46/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0417 -  
accuracy: 0.6479 - val\_loss: 1.3789 - val\_accuracy: 0.5708  
Epoch 47/100

960/960 [=====] - 1s 1ms/step - loss: 1.0176 -  
accuracy: 0.6625 - val\_loss: 1.4242 - val\_accuracy: 0.5542  
Epoch 48/100  
960/960 [=====] - 1s 1ms/step - loss: 1.1208 -  
accuracy: 0.6115 - val\_loss: 1.3829 - val\_accuracy: 0.5958  
Epoch 49/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0638 -  
accuracy: 0.6479 - val\_loss: 1.5316 - val\_accuracy: 0.5500  
Epoch 50/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0740 -  
accuracy: 0.6417 - val\_loss: 1.3169 - val\_accuracy: 0.6042  
Epoch 51/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9740 -  
accuracy: 0.6615 - val\_loss: 1.3238 - val\_accuracy: 0.6167  
Epoch 52/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0208 -  
accuracy: 0.6604 - val\_loss: 1.3487 - val\_accuracy: 0.6042  
Epoch 53/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0400 -  
accuracy: 0.6438 - val\_loss: 1.3820 - val\_accuracy: 0.5833  
Epoch 54/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0559 -  
accuracy: 0.6271 - val\_loss: 1.3262 - val\_accuracy: 0.6333  
Epoch 55/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0297 -  
accuracy: 0.6562 - val\_loss: 1.3553 - val\_accuracy: 0.6292  
Epoch 56/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0207 -  
accuracy: 0.6562 - val\_loss: 1.3364 - val\_accuracy: 0.6083  
Epoch 57/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0137 -  
accuracy: 0.6396 - val\_loss: 1.2971 - val\_accuracy: 0.5917  
Epoch 58/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9956 -  
accuracy: 0.6562 - val\_loss: 1.3419 - val\_accuracy: 0.6250  
Epoch 59/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9812 -  
accuracy: 0.6792 - val\_loss: 1.3371 - val\_accuracy: 0.6208  
Epoch 60/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0430 -  
accuracy: 0.6302 - val\_loss: 1.4752 - val\_accuracy: 0.5833  
Epoch 61/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9973 -  
accuracy: 0.6625 - val\_loss: 1.4036 - val\_accuracy: 0.6042  
Epoch 62/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0573 -  
accuracy: 0.6375 - val\_loss: 1.2617 - val\_accuracy: 0.6417  
Epoch 63/100

960/960 [=====] - 1s 1ms/step - loss: 1.0658 -  
 accuracy: 0.6167 - val\_loss: 1.3994 - val\_accuracy: 0.6083  
 Epoch 64/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.0059 -  
 accuracy: 0.6510 - val\_loss: 1.4041 - val\_accuracy: 0.5667  
 Epoch 65/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.0832 -  
 accuracy: 0.6094 - val\_loss: 1.2841 - val\_accuracy: 0.6208  
 Epoch 66/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.0078 -  
 accuracy: 0.6313 - val\_loss: 1.3173 - val\_accuracy: 0.6125  
 Epoch 67/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.0493 -  
 accuracy: 0.6156 - val\_loss: 1.2972 - val\_accuracy: 0.6292  
 Epoch 68/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.0938 -  
 accuracy: 0.5990 - val\_loss: 1.3085 - val\_accuracy: 0.6250  
 Epoch 69/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.0530 -  
 accuracy: 0.6094 - val\_loss: 1.3238 - val\_accuracy: 0.6542  
 Epoch 70/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.0475 -  
 accuracy: 0.6271 - val\_loss: 1.3075 - val\_accuracy: 0.6250  
 Epoch 71/100  
 960/960 [=====] - 1s 1ms/step - loss: 1.0162 -  
 accuracy: 0.6365 - val\_loss: 1.3250 - val\_accuracy: 0.6167  
 Epoch 72/100  
 960/960 [=====] - 1s 2ms/step - loss: 0.9975 -  
 accuracy: 0.6385 - val\_loss: 1.3103 - val\_accuracy: 0.6292  
 Epoch 73/100  
 960/960 [=====] - 1s 1ms/step - loss: 0.9623 -  
 accuracy: 0.6458 - val\_loss: 1.3034 - val\_accuracy: 0.6250  
 Epoch 74/100  
 960/960 [=====] - 1s 2ms/step - loss: 0.9871 -  
 accuracy: 0.6229 - val\_loss: 1.3571 - val\_accuracy: 0.6292  
 Epoch 75/100  
 960/960 [=====] - 1s 1ms/step - loss: 0.9508 -  
 accuracy: 0.6542 - val\_loss: 1.3726 - val\_accuracy: 0.6333  
 Epoch 76/100  
 960/960 [=====] - 1s 1ms/step - loss: 0.9415 -  
 accuracy: 0.6438 - val\_loss: 1.4146 - val\_accuracy: 0.6250  
 Epoch 77/100  
 960/960 [=====] - 1s 1ms/step - loss: 0.9300 -  
 accuracy: 0.6708 - val\_loss: 1.3932 - val\_accuracy: 0.6125  
 Epoch 78/100  
 960/960 [=====] - 1s 1ms/step - loss: 0.9194 -  
 accuracy: 0.6635 - val\_loss: 1.2851 - val\_accuracy: 0.6208  
 Epoch 79/100



960/960 [=====] - 1s 1ms/step - loss: 0.9124 -  
accuracy: 0.6708 - val\_loss: 1.3990 - val\_accuracy: 0.6458  
Epoch 80/100  
960/960 [=====] - 1s 1ms/step - loss: 0.8894 -  
accuracy: 0.6656 - val\_loss: 1.3853 - val\_accuracy: 0.6458  
Epoch 81/100  
960/960 [=====] - 1s 1ms/step - loss: 0.8865 -  
accuracy: 0.6708 - val\_loss: 1.4289 - val\_accuracy: 0.6292  
Epoch 82/100  
960/960 [=====] - 1s 1ms/step - loss: 0.8891 -  
accuracy: 0.6656 - val\_loss: 1.3815 - val\_accuracy: 0.6042  
Epoch 83/100  
960/960 [=====] - 1s 1ms/step - loss: 0.8776 -  
accuracy: 0.6687 - val\_loss: 1.3831 - val\_accuracy: 0.6375  
Epoch 84/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9641 -  
accuracy: 0.6344 - val\_loss: 1.3902 - val\_accuracy: 0.6083  
Epoch 85/100  
960/960 [=====] - 1s 1ms/step - loss: 0.8760 -  
accuracy: 0.6792 - val\_loss: 1.3690 - val\_accuracy: 0.6208  
Epoch 86/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9482 -  
accuracy: 0.6573 - val\_loss: 1.5380 - val\_accuracy: 0.6458  
Epoch 87/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9050 -  
accuracy: 0.6708 - val\_loss: 1.4371 - val\_accuracy: 0.5917  
Epoch 88/100  
960/960 [=====] - 1s 1ms/step - loss: 0.8797 -  
accuracy: 0.6552 - val\_loss: 1.6749 - val\_accuracy: 0.6333  
Epoch 89/100  
960/960 [=====] - 1s 1ms/step - loss: 0.8695 -  
accuracy: 0.6823 - val\_loss: 1.4663 - val\_accuracy: 0.6167  
Epoch 90/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9455 -  
accuracy: 0.6521 - val\_loss: 1.4745 - val\_accuracy: 0.5917  
Epoch 91/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9445 -  
accuracy: 0.6458 - val\_loss: 1.5025 - val\_accuracy: 0.6125  
Epoch 92/100  
960/960 [=====] - 1s 1ms/step - loss: 0.8953 -  
accuracy: 0.6635 - val\_loss: 1.4681 - val\_accuracy: 0.6083  
Epoch 93/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9050 -  
accuracy: 0.6562 - val\_loss: 1.7391 - val\_accuracy: 0.6167  
Epoch 94/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0169 -  
accuracy: 0.6167 - val\_loss: 1.3776 - val\_accuracy: 0.6167  
Epoch 95/100

```
960/960 [=====] - 1s 1ms/step - loss: 0.9377 -  
accuracy: 0.6396 - val_loss: 1.5053 - val_accuracy: 0.6083  
Epoch 96/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9059 -  
accuracy: 0.6531 - val_loss: 1.4963 - val_accuracy: 0.6167  
Epoch 97/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9491 -  
accuracy: 0.6438 - val_loss: 1.4210 - val_accuracy: 0.6417  
Epoch 98/100  
960/960 [=====] - 1s 1ms/step - loss: 0.9626 -  
accuracy: 0.6354 - val_loss: 1.4992 - val_accuracy: 0.6208  
Epoch 99/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0057 -  
accuracy: 0.6271 - val_loss: 1.4605 - val_accuracy: 0.5667  
Epoch 100/100  
960/960 [=====] - 1s 1ms/step - loss: 1.0140 -  
accuracy: 0.6156 - val_loss: 1.5149 - val_accuracy: 0.5875
```

[64]: <keras.callbacks.callbacks.History at 0x7f90f62a5ac8>

[ ]: