การจำแนกการออกเสียงภาษาไทยของชาวต่างชาติ

Thai Pronunciation of foreigners Classification

Introduction

01

Data Collected


YouTube
TH
JP
CN
KR
EN

02

Data Cleansing

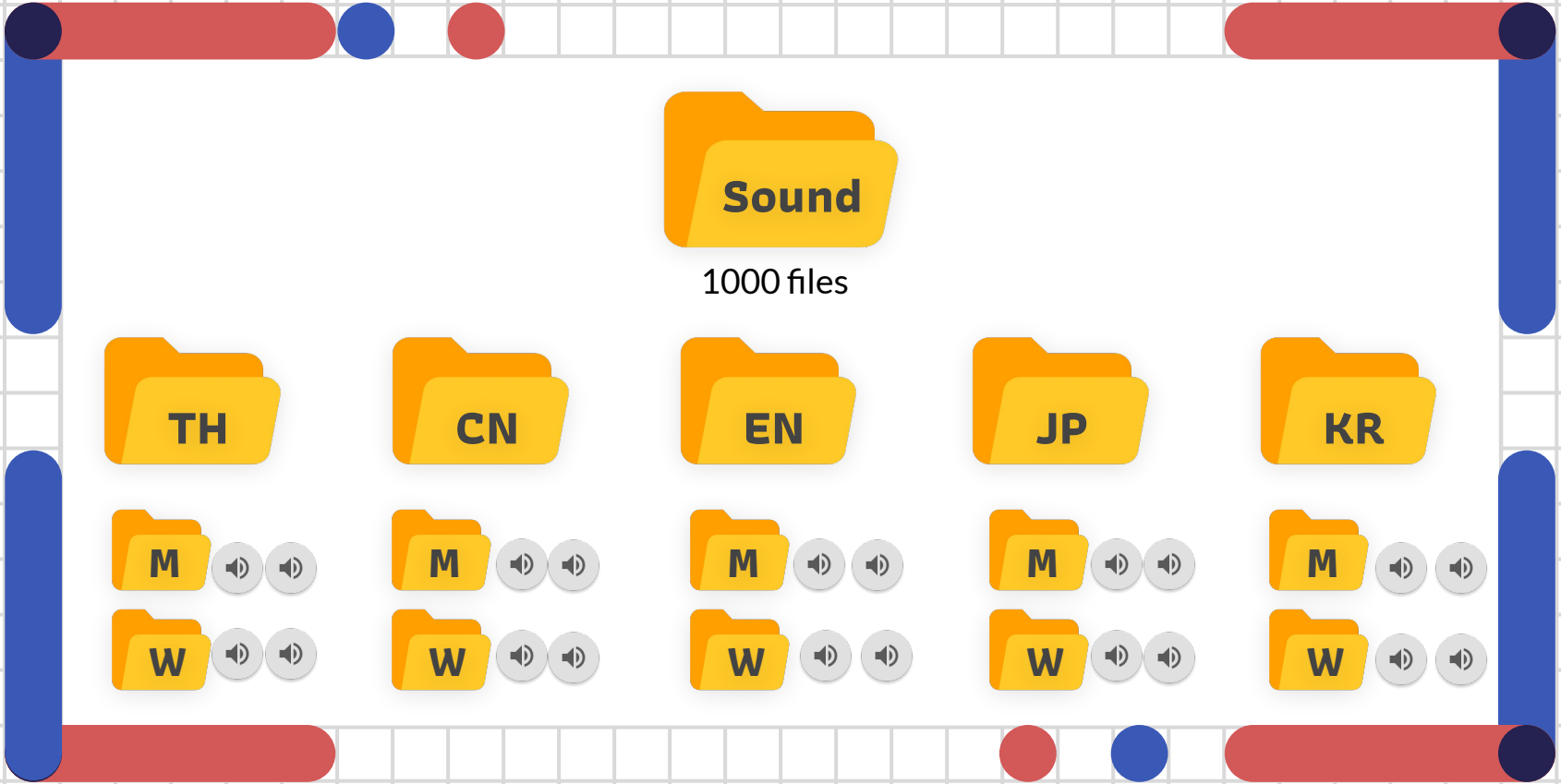
spleeter

Windows 10

circleci passing | python 3.6 | 3.7 | pypi package 1.5.2 | conda-forge v1.5.2

JOSS Under Review

- Vocals (singing voice) / accompaniment separation (2 stems)
- Vocals / drums / bass / other separation (4 stems)
- Vocals / drums / bass / piano / other separation (5 stems)


Sound
1000 files
TH
CN
EN
JP
KR
M
W
M
W
M
W
M
W
M
W

03

Data Preparation

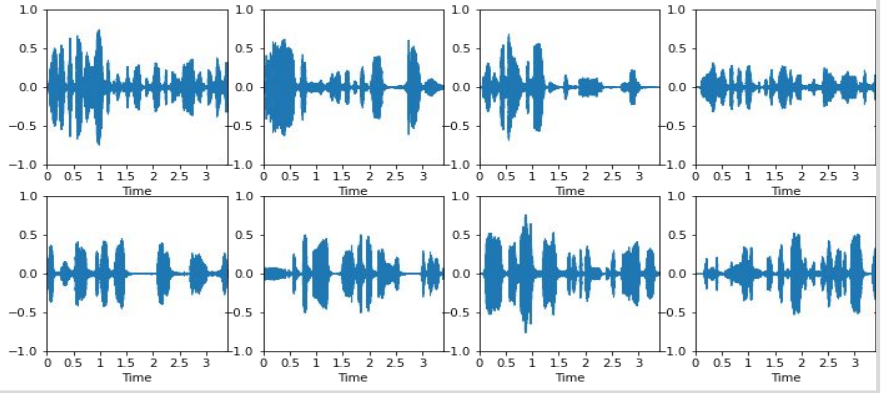
librosa

```
dataset = data_path + "sound/"
# os.listdir(dataset)
```

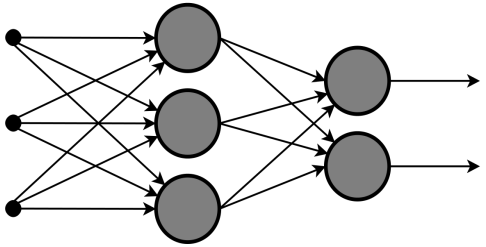
```
import librosa
import librosa.display
```

```
th = dataset + "TH_* (*).wav"
cn = dataset + "CN_* (*).wav"
en = dataset + "EN_* (*).wav"
jp = dataset + "JP_* (*).wav"
kr = dataset + "KR_* (*).wav"
```

```
th_signals = [librosa.load(p)[0] for p in Path().glob(th)]
cn_signals = [librosa.load(p)[0] for p in Path().glob(cn)]
en_signals = [librosa.load(p)[0] for p in Path().glob(en)]
jp_signals = [librosa.load(p)[0] for p in Path().glob(jp)]
kr_signals = [librosa.load(p)[0] for p in Path().glob(kr)]
```

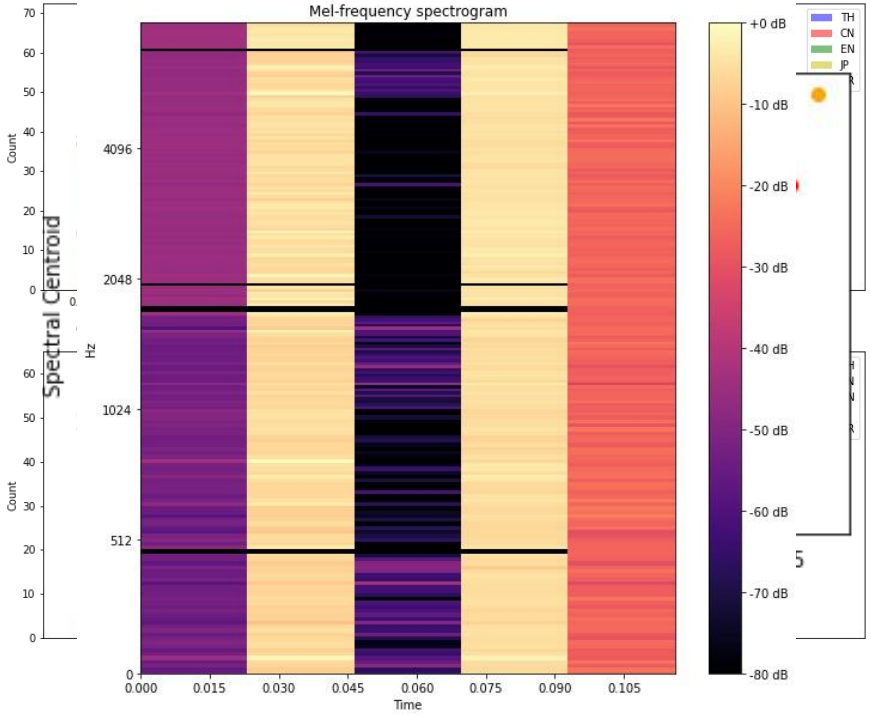


Feature Extraction



```python
def extract_features(signal):
    return [
        librosa.feature.zero_crossing_rate(signal)[0, 0],
        librosa.feature.spectral_centroid(signal)[0, 0],
        librosa.feature.mfcc(signal)[0, 0],
        librosa.feature.rms(signal)[0, 0],
        librosa.feature.spectral_contrast(signal)[0, 0],
    ]
```

```python
th_features = np.array([extract_features(x) for x in th_signals])
cn_features = np.array([extract_features(x) for x in cn_signals])
en_features = np.array([extract_features(x) for x in en_signals])
jp_features = np.array([extract_features(x) for x in jp_signals])
kr_features = np.array([extract_features(x) for x in kr_signals])
```



Split Train Test data

```
train_th, test_th, yth_train, yth_test = train_test_split(th_features, yth, test_size=0.2, shuffle=True,random_state=123)
train_cn, test_cn, ycn_train, ycn_test = train_test_split(cn_features, ycn, test_size=0.2, shuffle=True,random_state=123)
train_en, test_en, yen_train, yen_test = train_test_split(en_features, yen, test_size=0.2, shuffle=True,random_state=123)
train_jp, test_jp, yjp_train, yjp_test = train_test_split(jp_features, yjp, test_size=0.2, shuffle=True,random_state=123)
train_kr, test_kr, ykr_train, ykr_test = train_test_split(kr_features, ykr, test_size=0.2, shuffle=True,random_state=123)
```

```
train_data = np.vstack((train_th,train_cn,train_en,train_jp,train_kr))
y_train = yth_train+ycn_train+yen_train+yjp_train+ykr_train
y_train = to_categorical(y_train)
print("Train dataset :",train_data.shape)
print("Y-Train dataset :",y_train.shape)
```

```
Train dataset : (800, 5)
Y-Train dataset : (800, 5)
```

```
test_data = np.vstack((test_th,test_cn,test_en,test_jp,test_kr))
y_test = yth_test+ycn_test+yen_test+yjp_test+ykr_test
y_test = to_categorical(y_test)
print("Test dataset :",test_data.shape)
print("Y-Test dataset :",y_test.shape)
```

```
Test dataset : (200, 5)
Y-Test dataset : (200, 5)
```

Split Train Valid data

```
1   x_train, x_val, y_train, y_val = train_test_split(train_data, y_train, test_size=0.2, shuffle=True,random_state=123)
```

```
1   x_train.shape, x_val.shape, y_train.shape, y_val.shape
```

```
((640, 5), (160, 5), (640, 5), (160, 5))
```

Train	Validation	Test
(640,5)	(160,5)	(200,5)

04

Models

Baseline Models

```
from tensorflow.keras.models import Model
from tensorflow.keras.models import Sequential

from tensorflow.keras.layers import Dropout
from tensorflow.keras.layers import Activation
from tensorflow.keras.layers import LeakyReLU
from tensorflow.keras.layers import Dense
from tensorflow.keras.optimizers import Adam
```

```
def create_model():
    model = Sequential()
    model.add(Dense(8, input_shape=(5,)))
    model.add(LeakyReLU(alpha=0.1))
    model.add(Dropout(0.1))
    model.add(Dense(5, activation='softmax'))
    return model
```

```
model = create_model()
model.summary()
adam_optim = Adam(learning_rate = 0.0001)
model.compile(optimizer=adam_optim, loss='categorical_crossentropy', metrics=['accuracy'])
```

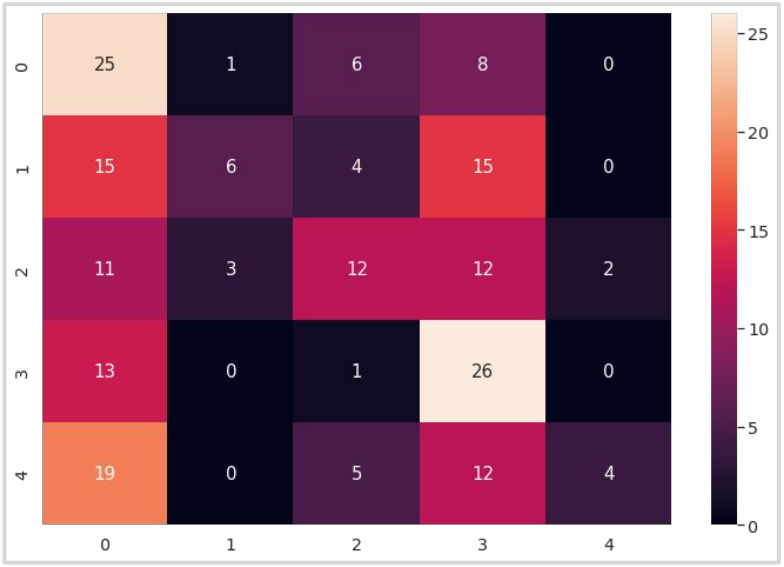
```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense (Dense)               (None, 8)                 48

 leaky_re_lu (LeakyReLU)     (None, 8)                 0

 dropout (Dropout)           (None, 8)                 0

 dense_1 (Dense)             (None, 5)                 45

=================================================================
Total params: 93
Trainable params: 93
Non-trainable params: 0
_________________________________________________________________
```

Baseline Models

```
his = model.fit(
    x_train, y_train,
    batch_size=1,
    epochs=500,
    verbose=1,
    validation_data = (x_val, y_val)
)
```

```
Epoch 1/500
640/640 [==============================] - 5s 4ms/step - loss: 1733.1400 - accuracy: 0.1906 - val_loss: 1885.6619 - val_accuracy: 0.2125
Epoch 2/500
640/640 [==============================] - 2s 3ms/step - loss: 1363.1937 - accuracy: 0.1984 - val_loss: 1467.6289 - val_accuracy: 0.2062
Epoch 3/500
640/640 [==============================] - 2s 3ms/step - loss: 1020.6646 - accuracy: 0.2141 - val_loss: 1134.4502 - val_accuracy: 0.2313
Epoch 4/500
640/640 [==============================] - 2s 3ms/step - loss: 792.6118 - accuracy: 0.2125 - val_loss: 900.8021 - val_accuracy: 0.1875
Epoch 5/500
640/640 [==============================] - 2s 3ms/step - loss: 674.7211 - accuracy: 0.2141 - val_loss: 738.8348 - val_accuracy: 0.1750
Epoch 6/500
640/640 [==============================] - 2s 3ms/step - loss: 549.5569 - accuracy: 0.2062 - val_loss: 611.3173 - val_accuracy: 0.1688
Epoch 7/500
640/640 [==============================] - 2s 3ms/step - loss: 475.3826 - accuracy: 0.2453 - val_loss: 530.2086 - val_accuracy: 0.2438
Epoch 8/500
640/640 [==============================] - 3s 4ms/step - loss: 460.6410 - accuracy: 0.2422 - val_loss: 470.4824 - val_accuracy: 0.2438
Epoch 9/500
640/640 [==============================] - 2s 3ms/step - loss: 420.1028 - accuracy: 0.2422 - val_loss: 417.8871 - val_accuracy: 0.2438
Epoch 10/500
640/640 [==============================] - 2s 3ms/step - loss: 349.1039 - accuracy: 0.2594 - val_loss: 363.0685 - val_accuracy: 0.2500
Epoch 11/500
640/640 [==============================] - 2s 4ms/step - loss: 321.4443 - accuracy: 0.2547 - val_loss: 315.3325 - val_accuracy: 0.2625
```

Baseline Models



Baseline Models

```
report = classification_report(y_true, predicted_classes, target_names=CATEGORIES, digits=4)

print(report)
```

	precision	recall	f1-score	support
TH	0.3012	0.6250	0.4065	40
CN	0.6000	0.1500	0.2400	40
EN	0.4286	0.3000	0.3529	40
JP	0.3562	0.6500	0.4602	40
KR	0.6667	0.1000	0.1739	40
accuracy			0.3650	200
macro avg	0.4705	0.3650	0.3267	200
weighted avg	0.4705	0.3650	0.3267	200

CNN Models

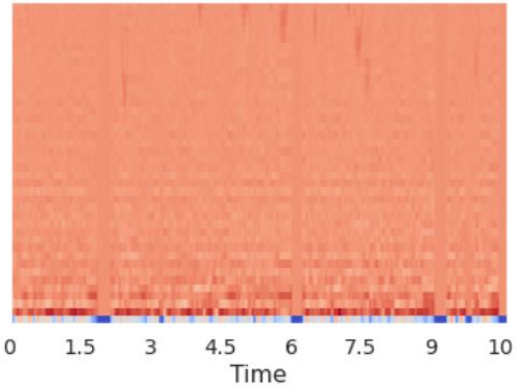
```
from tensorflow.keras.models import Model
from tensorflow.keras.models import Sequential

from tensorflow.keras.layers import Dropout
from tensorflow.keras.layers import Activation
from tensorflow.keras.layers import LeakyReLU
from tensorflow.keras.layers import Dense
from tensorflow.keras.layers import Conv2D

from tensorflow.keras.layers import GlobalAveragePooling2D
from tensorflow.keras.layers import MaxPooling2D
from tensorflow.keras.optimizers import Adam
```

```
file_name = 'drive/My Drive/AUCC/DP/dataset/sound/TH_M (1).wav'
audio, sample_rate = librosa.load(file_name, res_type='kaiser_fast')

print(audio.shape, sample_rate)

mfccs = librosa.feature.mfcc(y=audio, sr=sample_rate, n_mfcc=40)
print(mfccs.shape)
```

```
(233856,) 22050
(40, 457)
```

```
1  librosa.display.specshow(mfccs, sr=sample_rate, x_axis='time')
```

```
<matplotlib.collections.QuadMesh at 0x7fc64d3ab9d0>
```



CNN Models

```python
max_pad_len = 1000

def extract_features(file_name):
    audio, sample_rate = librosa.load(file_name, res_type='kaiser_fast')
    mfccs = librosa.feature.mfcc(y=audio, sr=sample_rate, n_mfcc=40)
    pad_width = max_pad_len - mfccs.shape[1]
    mfccs = np.pad(mfccs, pad_width=((0, 0), (0, pad_width)), mode='constant')
    return mfccs
```

```python
TH_features = []
for file_name in Path().glob(th):
    data = extract_features(file_name)
    TH_features.append(data)
print(len(TH_features))
TH_features[0].shape
```

```
200
(40, 1000)
```

```python
CN_features = []
for file_name in Path().glob(cn):
    data = extract_features(file_name)
    CN_features.append(data)
print(len(CN_features))
CN_features[0].shape
```

```
200
(40, 1000)
```

```python
EN_features = []
for file_name in Path().glob(en):
    data = extract_features(file_name)
    EN_features.append(data)
print(len(EN_features))
EN_features[0].shape
```

```
200
(40, 1000)
```

```python
JP_features = []
for file_name in Path().glob(jp):
    data = extract_features(file_name)
    JP_features.append(data)
print(len(JP_features))
JP_features[0].shape
```

```
200
(40, 1000)
```

```python
KR_features = []
for file_name in Path().glob(kr):
    data = extract_features(file_name)
    KR_features.append(data)
print(len(KR_features))
KR_features[0].shape
```

```
200
(40, 1000)
```

CNN Models

```
num_rows = 40
num_columns = 1000
num_channels = 1
num_batch_size = 64
epochs = 500
```

```
model = Sequential()
model.add(Conv2D(filters=16, kernel_size=2, input_shape=(num_rows, num_columns, num_channels), activation='relu'))
model.add(MaxPooling2D(pool_size=2))
model.add(Dropout(0.2))

model.add(Conv2D(filters=32, kernel_size=2, activation='relu'))
model.add(MaxPooling2D(pool_size=2))
model.add(Dropout(0.2))

model.add(Conv2D(filters=64, kernel_size=2, activation='relu'))
model.add(MaxPooling2D(pool_size=2))
model.add(Dropout(0.2))

model.add(Conv2D(filters=128, kernel_size=2, activation='relu'))
model.add(MaxPooling2D(pool_size=2))
model.add(Dropout(0.2))
model.add(GlobalAveragePooling2D())

model.add(Dense(5, activation='softmax'))
```

```
model.summary()
model.compile(loss='categorical_crossentropy', metrics=['accuracy'], optimizer='adam')
```

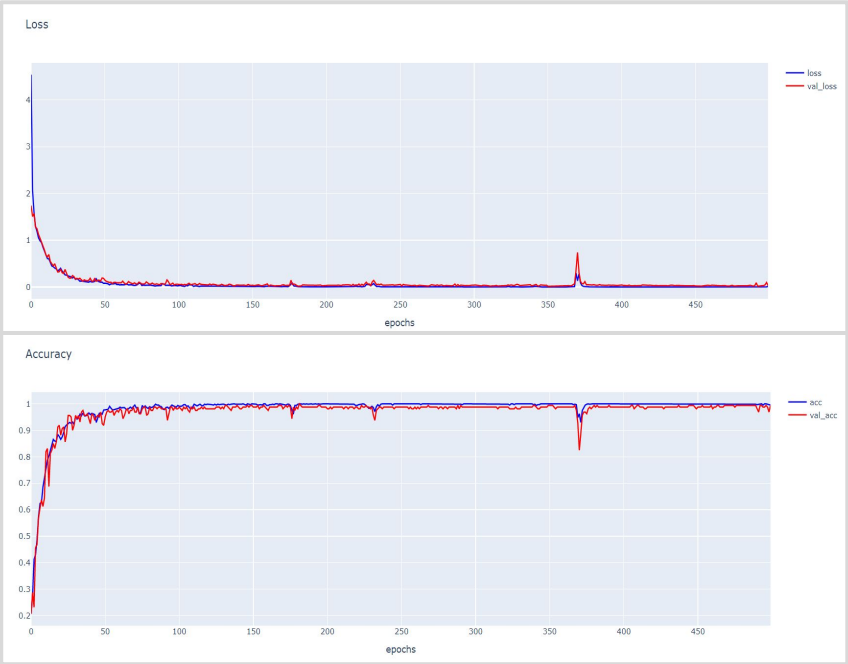
```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 39, 999, 16)       80

 max_pooling2d (MaxPooling2D  (None, 19, 499, 16)      0
 )

 dropout (Dropout)           (None, 19, 499, 16)       0

 conv2d_1 (Conv2D)           (None, 18, 498, 32)       2080

 max_pooling2d_1 (MaxPooling  (None, 9, 249, 32)       0
 2D)

 dropout_1 (Dropout)         (None, 9, 249, 32)        0

 conv2d_2 (Conv2D)           (None, 8, 248, 64)        8256

 max_pooling2d_2 (MaxPooling  (None, 4, 124, 64)       0
 2D)

 dropout_2 (Dropout)         (None, 4, 124, 64)        0

 conv2d_3 (Conv2D)           (None, 3, 123, 128)       32896

 max_pooling2d_3 (MaxPooling  (None, 1, 61, 128)       0
 2D)

 dropout_3 (Dropout)         (None, 1, 61, 128)        0

 global_average_pooling2d (G  (None, 128)              0
 lobalAveragePooling2D)

 dense (Dense)               (None, 5)                 645

=================================================================
Total params: 43,957
Trainable params: 43,957
Non-trainable params: 0
_________________________________________________________________
```

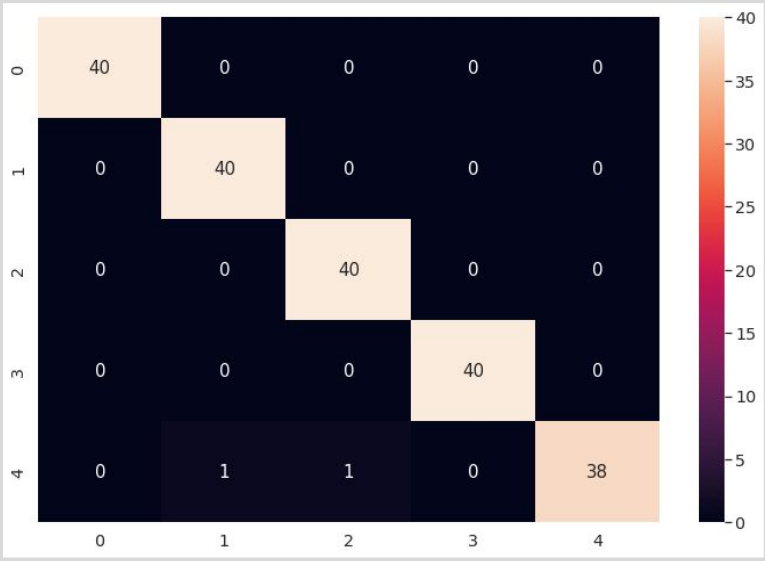
CNN Models

```
his = model.fit(x_train, y_train,
                batch_size=num_batch_size,
                epochs=epochs,
                validation_data=(x_val, y_val),
                verbose=1)
```

```
Epoch 1/500
10/10 [==============================] - 10s 133ms/step - loss: 4.5420 - accuracy: 0.2078 - val_loss: 1.7414 - val_accuracy: 0.2062
Epoch 2/500
10/10 [==============================] - 1s 89ms/step - loss: 2.0627 - accuracy: 0.2766 - val_loss: 1.5087 - val_accuracy: 0.2875
Epoch 3/500
10/10 [==============================] - 1s 90ms/step - loss: 1.5829 - accuracy: 0.4125 - val_loss: 1.5723 - val_accuracy: 0.2313
Epoch 4/500
10/10 [==============================] - 1s 79ms/step - loss: 1.2940 - accuracy: 0.4297 - val_loss: 1.2806 - val_accuracy: 0.4563
Epoch 5/500
10/10 [==============================] - 1s 80ms/step - loss: 1.1900 - accuracy: 0.4859 - val_loss: 1.2474 - val_accuracy: 0.4688
Epoch 6/500
10/10 [==============================] - 1s 79ms/step - loss: 1.0540 - accuracy: 0.5734 - val_loss: 1.1262 - val_accuracy: 0.5688
Epoch 7/500
10/10 [==============================] - 1s 80ms/step - loss: 0.9888 - accuracy: 0.6234 - val_loss: 1.0489 - val_accuracy: 0.6062
Epoch 8/500
10/10 [==============================] - 1s 90ms/step - loss: 0.9526 - accuracy: 0.6281 - val_loss: 0.9537 - val_accuracy: 0.6375
Epoch 9/500
10/10 [==============================] - 1s 80ms/step - loss: 0.8550 - accuracy: 0.6859 - val_loss: 0.8805 - val_accuracy: 0.6125
Epoch 10/500
10/10 [==============================] - 1s 81ms/step - loss: 0.7669 - accuracy: 0.7188 - val_loss: 0.7960 - val_accuracy: 0.6438
Epoch 11/500
10/10 [==============================] - 1s 82ms/step - loss: 0.7065 - accuracy: 0.7453 - val_loss: 0.6872 - val_accuracy: 0.8188
Epoch 12/500
10/10 [==============================] - 1s 80ms/step - loss: 0.6102 - accuracy: 0.7875 - val_loss: 0.6426 - val_accuracy: 0.8313
```

CNN Models


Loss
loss
val_loss
epochs
Accuracy
acc
val_acc
epochs


40 0 0 0 0
0 40 0 0 0
0 0 40 0 0
0 0 0 40 0
0 1 1 0 38
0 1 2 3 4
40 35 30 25 20 15 10 5 0

CNN Models

```
report = classification_report(y_true, predicted_classes, target_names=CATEGORIES, digits=4)

print(report)
```

	precision	recall	f1-score	support
TH	1.0000	1.0000	1.0000	40
CN	0.9756	1.0000	0.9877	40
EN	0.9756	1.0000	0.9877	40
JP	1.0000	1.0000	1.0000	40
KR	1.0000	0.9500	0.9744	40
accuracy			0.9900	200
macro avg	0.9902	0.9900	0.9899	200
weighted avg	0.9902	0.9900	0.9899	200

Thanks

620710405 นางสาวณัฐธิดา ลาภธนชัย

620710745 นางสาวอาทิตยา ชมทอง

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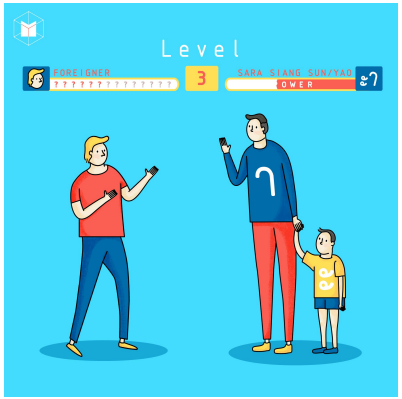

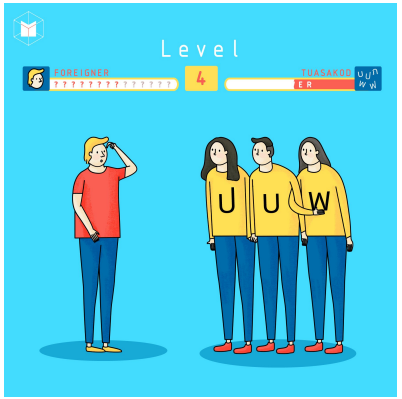

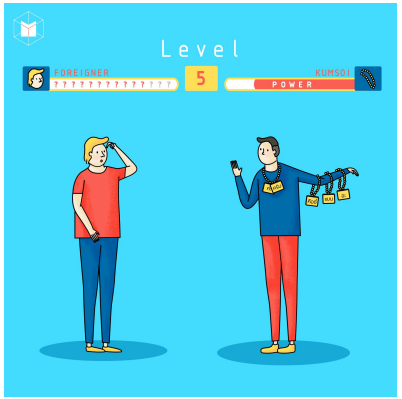

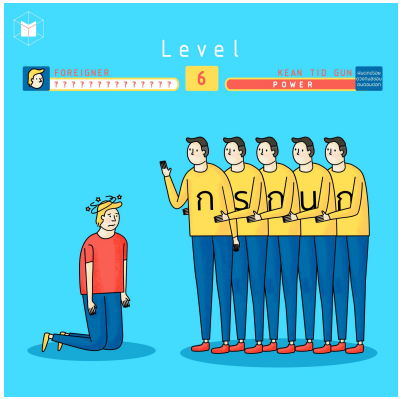

https://thematter.co/social/thai-language-is-not-that-easy/29010