# 이미지 분류를 활용한 얼굴 감정 인식

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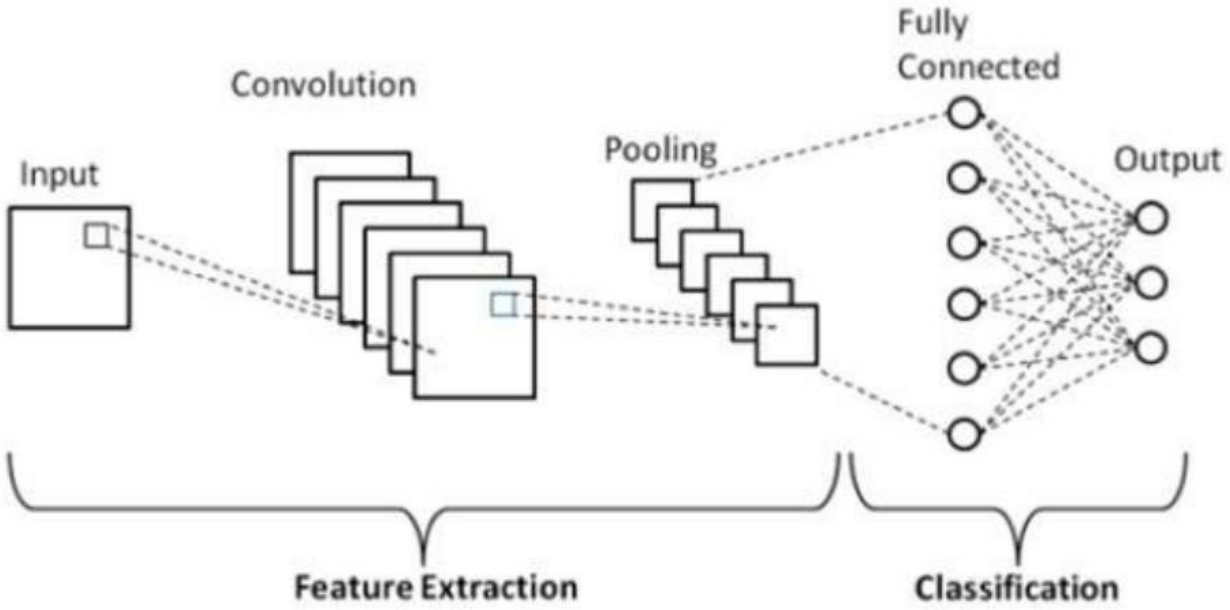
# INDEX

# CNN 개념

CNN ( Convolutional Neural Network)
: 신경망에 전처리를  추가한 다층 퍼셉트론의 한 종류
: 이미지, 동영상, 음성 학습에 많이 사용




- Conv 층을 통해 입력값에 대한 특징맵들을 여러 개 만듦
- pooling층을 통해 특징맵의 크기를 줄임

=> 이를 반복하면서 마지막에 퍼셉트론 도출!

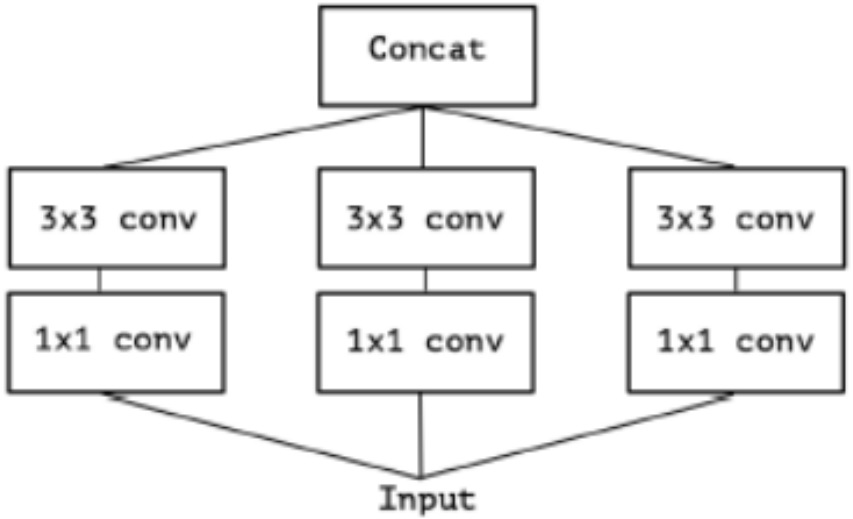
# Xception 개념

Xception 모델
: 구글이 2017년에 발표한 모델로 CNN 중 하나
: extreme inception의 약자

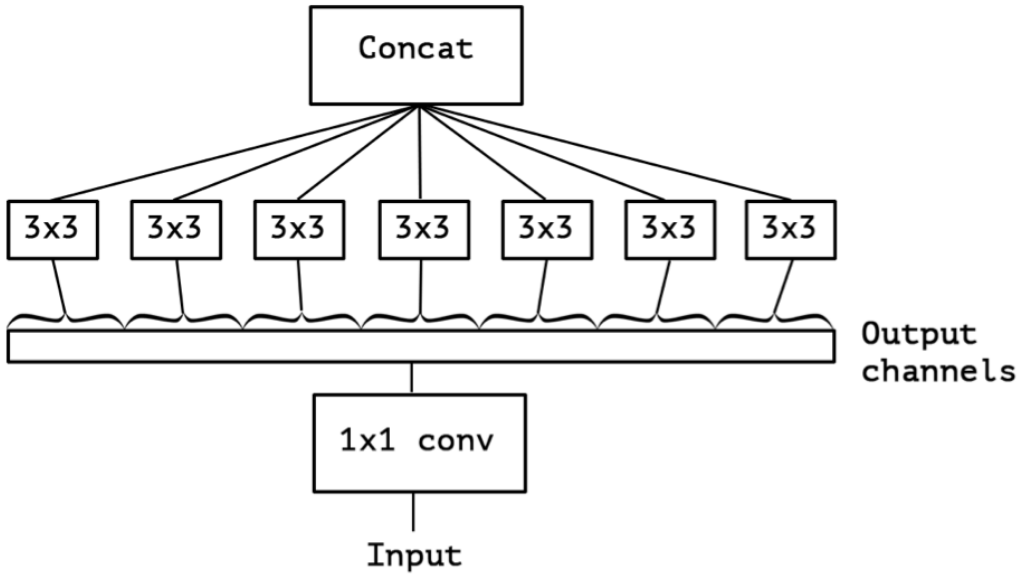
기존 inception 모델이 채널, 공간을 분리한 것을 depthwise separable convolution으로 강화한 모델

Inception : 노드간의 연결을 줄임

Xception : 채널간의 관계를 찾는 것과 이미지 지역 정보를 찾는 것을 완전히 분리하고자 함!



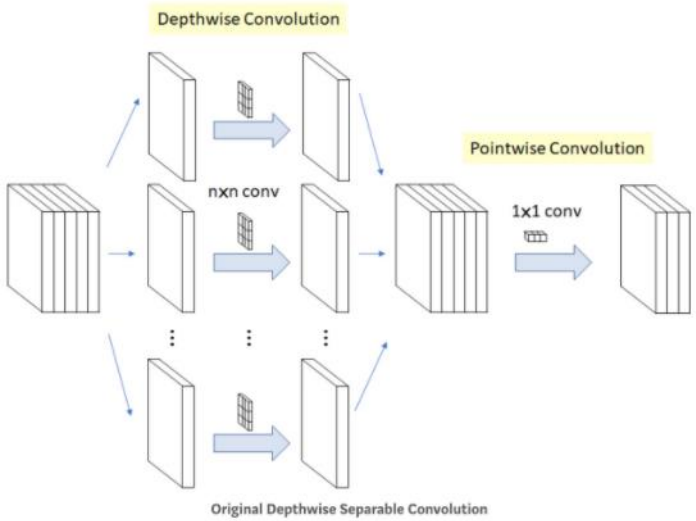

Inception 구조




Xception

# Xception 개념

Depthwise separable convolution → 각 채널별로 conv연산을 시행하고 그 결과에 1x1 연산을 취하는 것




Depthwise ~와 Xception차이점
- Relu 유무
- 진행 순서

## Depthwise separable convolution

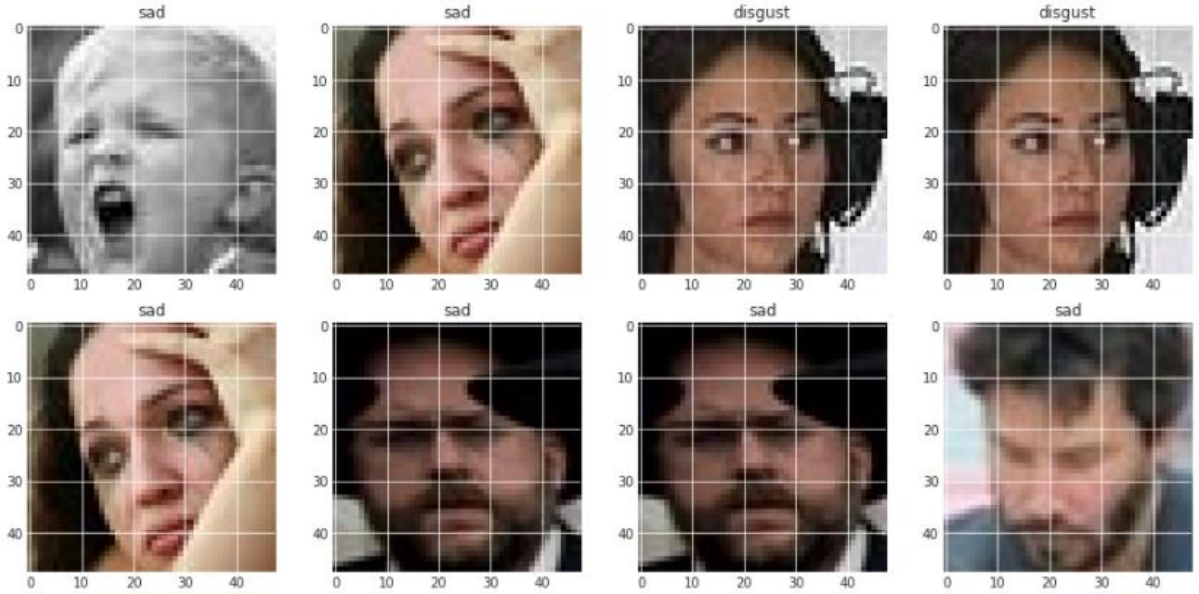
Channel-wise nxnx spatial convolution
(k개의 채널에 대해 nxn conv를 따로 진행해서 합침)
-> pointwise convolution
(채널의 개수를 줄이기 위한 방법)

## Xception

pointwise convolution
(채널의 개수를 줄이기 위한 방법)
-> Channel-wise nxnx spatial convolution
(k개의 채널에 대해 nxn conv를 따로 진행해서 합침)

# CNN을 활용한 감정분류 1

데이터셋 (캐글) : https://www.kaggle.com/mahmoudima/mma-facial-expression


-> 감정별로 분류 되어있음 (7개)
Angry, disgust, fear, happy, neutral, sad, surprise

# CNN을 활용한 감정분류 1

## 1. Xception 모델

```
train_generator = train_datagen.flow_from_directory("/kaggle/input/mma-facial-expression/MMAFEDB/train",
                                                    target_size=(img_width, img_height),
                                                    batch_size=batch_size,
                                                    class_mode='categorical')
validation_generator = validation_datagen.flow_from_directory("/kaggle/input/mma-facial-expression/MMAFEDB/valid",
                                                    target_size=(img_width, img_height),
                                                    batch_size=batch_size,
                                                    class_mode='categorical')
test_generator = test_datagen.flow_from_directory("/kaggle/input/mma-facial-expression/MMAFEDB/test",
                                                    target_size=(img_width, img_height),
                                                    batch_size=batch_size,
                                                    class_mode='categorical')
```

```
Found 92968 images belonging to 7 classes.
Found 17356 images belonging to 7 classes.
Found 17356 images belonging to 7 classes.
```

텐서플로우의 generator를 사용하여 데이터 만들기

# CNN을 활용한 감정분류 1

```
# base model : xception -> fine tuning
model = tf.keras.applications.Xception(weights='imagenet',include_top=False, input_shape=(img_width, img_height,3))
model.summary()
```

```
# Change last layer to fit out needs: 7 classes
x = model.output
x = GlobalAveragePooling2D()(x)
predictions = Dense(7, activation='softmax')(x)
model = Model(model.input, predictions)
model.summary()
```

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

```
%%time
hist = model.fit(
    train_generator,
    epochs = nb_epoch,
    steps_per_epoch = num_train//batch_size,
    validation_data = validation_generator,
    validation_steps = num_val//batch_size)
```

Imagenet 데이터로 이미 학습된 모델을 미세조정

60.01% accuracy

# CNN을 활용한 감정분류 1

## 2. 기본 CNN 모델

| Layer (type) | Output Shape | Param # |
|---|---|---|
| conv2d_4 (Conv2D) | (None, 64, 64, 32) | 896 |
| conv2d_5 (Conv2D) | (None, 64, 64, 64) | 18496 |
| batch_normalization_2 (Batch | (None, 64, 64, 64) | 256 |
| max_pooling2d_2 (MaxPooling2 | (None, 32, 32, 64) | 0 |
| dropout_3 (Dropout) | (None, 32, 32, 64) | 0 |
| conv2d_6 (Conv2D) | (None, 32, 32, 128) | 73856 |
| conv2d_7 (Conv2D) | (None, 30, 30, 256) | 295168 |
| batch_normalization_3 (Batch | (None, 30, 30, 256) | 1024 |
| max_pooling2d_3 (MaxPooling2 | (None, 15, 15, 256) | 0 |
| dropout_4 (Dropout) | (None, 15, 15, 256) | 0 |
| flatten_1 (Flatten) | (None, 57600) | 0 |
| dense_2 (Dense) | (None, 1024) | 58983424 |
| dropout_5 (Dropout) | (None, 1024) | 0 |
| dense_3 (Dense) | (None, 7) | 7175 |

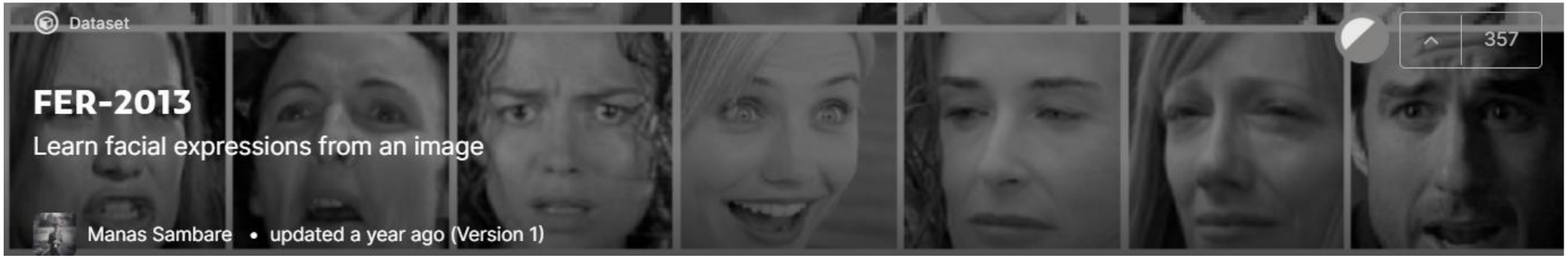
Total params: 59,380,295
Trainable params: 59,379,655
Non-trainable params: 640

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

**52.67% accuracy**

# CNN을 활용한 감정분류 2

데이터셋 (캐글) : https://www.kaggle.com/msambare/fer2013




-> 감정별로 분류되어있음 (7개)

Angry, disgust, fear, happy,
neutral, sad, surprise

# CNN을 활용한 감정분류 2

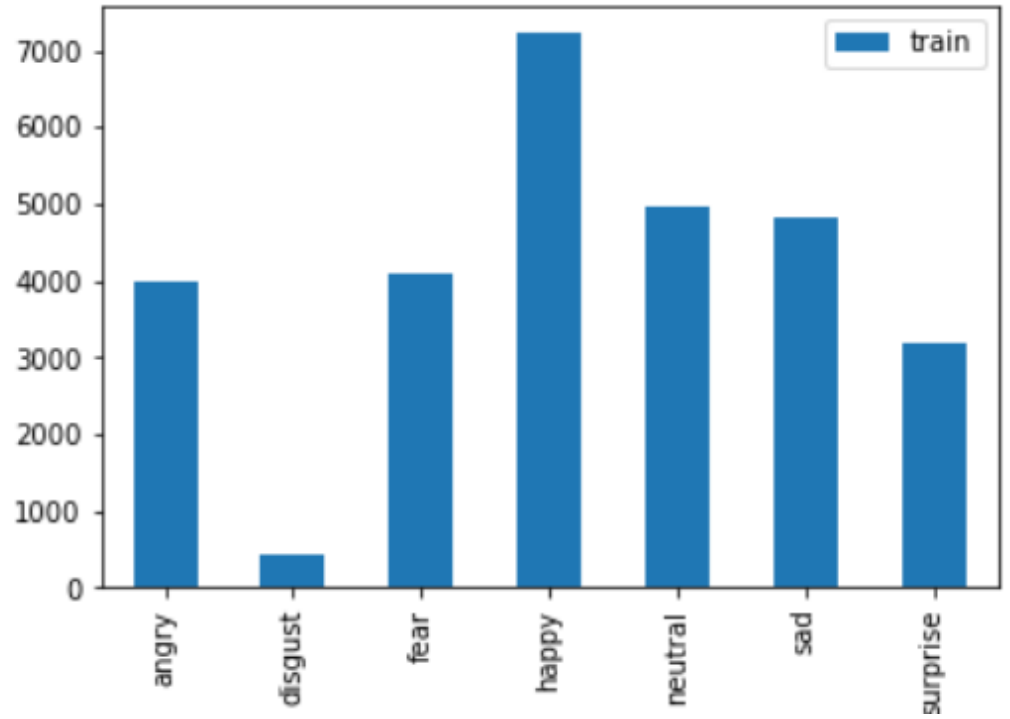
## 1. FER2013 데이터 살펴보기

```
train_dir = 'C:/Users/janyq/OneDrive/바탕 화면/팀플/train/'
test_dir = 'C:/Users/janyq/OneDrive/바탕 화면/팀플/test/'

row, col = 48, 48
classes = 7

def count_exp(path, set_):
    dict_ = {}
    for expression in os.listdir(path):
        dir_ = path + expression
        dict_[expression] = len(os.listdir(dir_))
    df = pd.DataFrame(dict_, index=[set_])
    return df
train_count = count_exp(train_dir, 'train')
test_count = count_exp(test_dir, 'test')
print(train_count)
print(test_count)
```

```
       angry  disgust  fear  happy  neutral   sad  surprise
train   3995      436  4097   7215     4965  4830      3171
      angry  disgust  fear  happy  neutral   sad  surprise
test    958      111  1024   1774     1233  1247       831
```

```
train_count.transpose().plot(kind='bar')
```

```
<AxesSubplot:>
```



# CNN을 활용한 감정분류 2

## 2. 각 폴더별 이미지 확인

```
plt.figure(figsize=(14,22))
i = 1
for expression in os.listdir(train_dir):
    img = load_img((train_dir + expression +'/'+ os.listdir(train_dir + expression)[1]))
    plt.subplot(1,7,i)
    plt.imshow(img)
    plt.title(expression)
    plt.axis('off')
    i += 1
plt.show()
```

# CNN을 활용한 감정분류 2

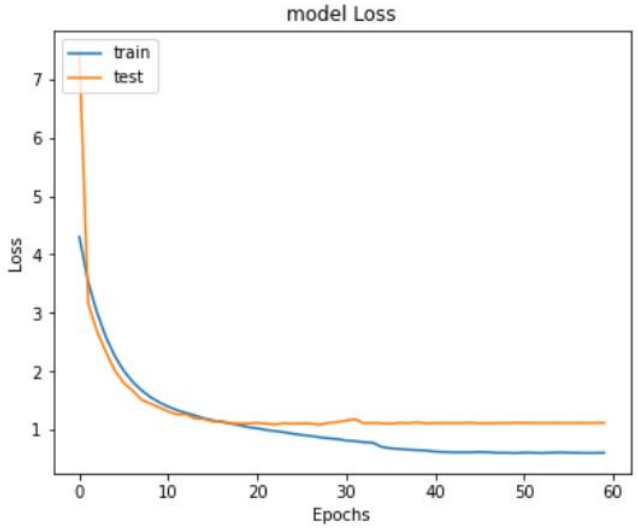
## 3. 학습 모델 구축

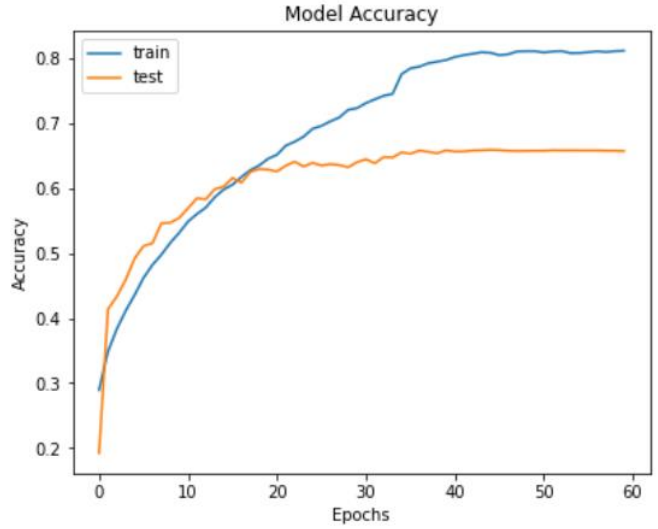
```
def get_model(input_size, classes=7):
    #Initialising the CNN
    model = tf.keras.models.Sequential()

    model.add(Conv2D(32, kernel_size=(3, 3), padding='same', activation='relu', input_shape =input_size))
    model.add(Conv2D(64, kernel_size=(3, 3), activation='relu', padding='same'))
    model.add(BatchNormalization())
    model.add(MaxPooling2D(2, 2))
    model.add(Dropout(0.25))

    model.add(Conv2D(128, kernel_size=(3, 3), activation='relu', padding='same', kernel_regularizer=regularizers.l2(0.01)))
    model.add(Conv2D(256, kernel_size=(3, 3), activation='relu', kernel_regularizer=regularizers.l2(0.01)))
    model.add(BatchNormalization())
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Dropout(0.25))

    model.add(Flatten())
    model.add(Dense(1024, activation='relu'))
    model.add(Dropout(0.5))

    model.add(Dense(classes, activation='softmax'))

    #Compiling the model
    model.compile(optimizer=Adam(lr=0.0001, decay=1e-6),
                  loss='categorical_crossentropy',
                  metrics=['accuracy'])
    return model
```

# CNN을 활용한 감정분류 2

## 4. 학습

```
steps_per_epoch = training_set.n // training_set.batch_size
validation_steps = test_set.n // test_set.batch_size

hist = fernet.fit(x=training_set,
                  validation_data=test_set,
                  epochs=60,
                  callbacks=callbacks,
                  steps_per_epoch=steps_per_epoch,
                  validation_steps=validation_steps)
```




```
train_loss, train_accu = fernet.evaluate(training_set)
test_loss, test_accu = fernet.evaluate(test_set)
print("final train accuracy = {:.2f} , validation accuracy = {:.2f}".format(train_accu*100, test_accu*100))
```

```
449/449 [==============================] - 83s 185ms/step - loss: 0.4415 - accuracy: 0.8859
113/113 [==============================] - 23s 207ms/step - loss: 1.1210 - accuracy: 0.6571
final train accuracy = 88.59 , validation accuracy = 65.71
```

# CNN을 활용한 감정분류 2

## 5. 모델 테스트

```
1 a=model.predict(x_test)
2 emotions[np.argmax(a)]
```

sad'

'happy'

'angry'

'surprise'

# CNN을 활용한 감정분류 2

## 사람 얼굴 이미지로 테스트

```
1 img_resize=img2.resize((48,48))
2 img_resize = np.array(img_resize)
3 img_resize = np.array(img_resize)
4 img_resize=img_resize/255
5
6 img_resize.shape
7 x_test = np.reshape(img_resize,(1,48,48,1))
8 x_test.shape
```

```
(1, 48, 48, 1)
```

```
1 a=model.predict(x_test)
2 emotions[np.argmax(a)]
```

사진을 제공해준 회장님께 감사합니다

'happy'

'happy'

# landmark 만들기

데이터셋 (캐글) : https://www.kaggle.com/drgilermo/face-images-with-marked-landmark-points

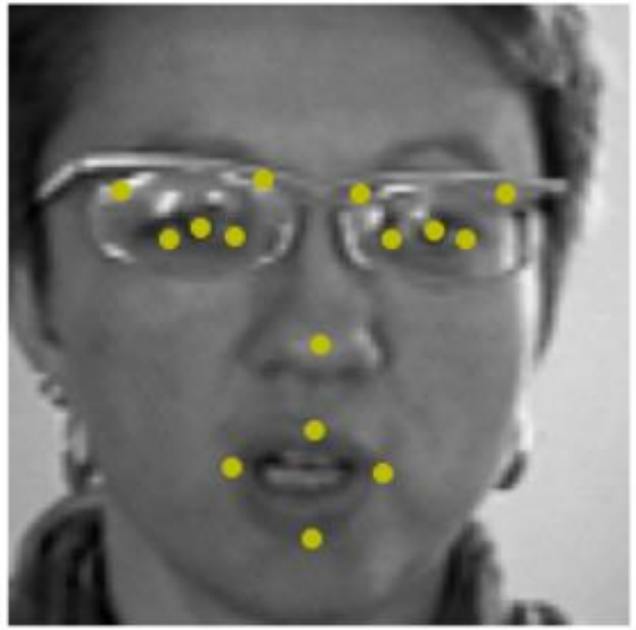

## KEY POINTS

| | left_eye_center_x | left_eye_center_y | right_eye_center_x | right_eye_center_y | left_eye_inner_corner_x | left_eye_inner_corner_y | left_eye_outer_corner_x |
|---|---|---|---|---|---|---|---|
| **0** | 66.033564 | 39.002274 | 30.227008 | 36.421678 | 59.582075 | 39.647423 | 73.130346 |
| **1** | 64.332936 | 34.970077 | 29.949277 | 33.448715 | 58.856170 | 35.274349 | 70.722723 |
| **2** | 65.057053 | 34.909642 | 30.903789 | 34.909642 | 59.412000 | 36.320968 | 70.984421 |
| **3** | 65.225739 | 37.261774 | 32.023096 | 37.261774 | 60.003339 | 39.127179 | 72.314713 |
| **4** | 66.725301 | 39.621261 | 32.244810 | 38.042032 | 58.565890 | 39.621261 | 72.515926 |

5 rows × 30 columns

# landmark 만들기

```
# visualization
ind = 10
plt.imshow(features[ind,:,:,0],cmap='gray')
plt.scatter(key_pts.iloc[ind][0:-1:2], key_pts.iloc[ind][1::2], c='y')
plt.axis('off')
plt.show()
```



최대 30개의 key points

# landmark 만들기



## CNN을 활용한 landmark 학습

```
model = Sequential()

model.add(Input(shape=(img_size, img_size, 1)))

model.add(BatchNormalization())
model.add(Conv2D(32, (3,3), padding="same"))
model.add(LeakyReLU(alpha = 0.1))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.2))

model.add(BatchNormalization())
model.add(Conv2D(64, (3,3), padding="same"))
model.add(LeakyReLU(alpha = 0.1))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.2))

model.add(BatchNormalization())
model.add(Conv2D(128, (3,3), padding="same"))
model.add(LeakyReLU(alpha = 0.1))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.2))

model.add(Flatten())
model.add(Dense(256))
model.add(LeakyReLU(alpha = 0.1))
model.add(Dropout(0.5))

model.add(Dense(64))
model.add(LeakyReLU(alpha = 0.1))
model.add(Dense(30))
```

```
model.compile(loss = 'mean_squared_error', optimizer = Adam(),
              metrics=['mean_squared_error'])
```

**Test MSE : 117.1117**

# 시각화 1

## angry face landmark 시각화

```
plt.figure(figsize=(10,10))

plt.subplot(331)
plt.imshow(x_test_a[0,:,:], cmap='gray')
plt.scatter(pred_a[0,:][0:-1:2], pred_a[0,:][1::2], c ='b')
plt.axis("off")

plt.subplot(332)
plt.imshow(x_test_a[5,:,:], cmap='gray')
plt.scatter(pred_a[5,:][0:-1:2], pred_a[5,:][1::2], c ='b')
plt.axis("off")
```

o
o
o

```
plt.subplot(338)
plt.imshow(x_test_a[14,:,:], cmap='gray')
plt.scatter(pred_a[14,:][0:-1:2], pred_a[14,:][1::2], c ='b')
plt.axis("off")

plt.subplot(339)
plt.imshow(x_test_a[149,:,:], cmap='gray')
plt.scatter(pred_a[149,:][0:-1:2], pred_a[149,:][1::2], c ='b')
plt.axis("off")

plt.show()
```

## 앞서 학습시킨 모델을 활용하여 FER2013 데이터의 landmark 생성

# 시각화 1

## 각 좌표의 max, min 값 비교

```
angry_d=preds_a.describe()
a_max=angry_d.iloc[7]
a_max=pd.DataFrame(a_max)
a_max=a_max.T
a_max=np.array(a_max)
a_max[0,:][0:-1:2]

a_min=angry_d.iloc[3]
a_min=pd.DataFrame(a_min)
a_min=a_min.T
a_min=np.array(a_min)
a_min[0,:][0:-1:2]
```

```
array([50.82007599, 23.9002533 , -1.05379391, -1.31817818, -1.02874756,
       -0.97830987, -1.07107711, -1.67900753, -1.38587379, -0.98549318,
       32.68993378, -0.9947753 , -1.13942957, -1.00657225, 33.15564728])
```

```
index=90
plt.imshow(x_test_a[index,:,:], cmap='gray')
plt.scatter(a_max[0,:][0:-1:2], a_max[0,:][1::2], c ='r')
plt.scatter(a_min[0,:][0:-1:2], a_min[0,:][1::2], c ='b')
plt.axis("off")
plt.show()
```

## 각 좌표의 mean 값 비교

```
a_mean=angry_d.iloc[1]
a_mean=pd.DataFrame(a_mean)
a_mean=a_mean.T
a_mean=np.array(a_mean)
a_mean[0,:][0:-1:2]
```

```
array([63.89535904, 30.04463959,  1.58619165,  1.90227842,  0.77607858,
        0.49255601,  1.4616735 ,  2.02885294,  0.65742195,  0.2321679 ,
       46.75931549,  1.67421043,  0.86192524,  1.24880922, 47.21754837])
```

```
index=90
plt.imshow(x_test_a[index,:,:], cmap='gray')
plt.scatter(a_mean[0,:][0:-1:2], a_mean[0,:][1::2], c ='r')
plt.axis("off")
plt.show()
```

# 시각화 1

## sad face landmark 시각화

# 시각화 1

## 각 좌표의 max, min 값 비교

```
sad_d=preds_s.describe()
s_max=sad_d.iloc[7]
s_max=pd.DataFrame(s_max)
s_max=s_max.T
s_max=np.array(s_max)
s_max[0,:][0:-1:2]

s_min=sad_d.iloc[3]
s_min=pd.DataFrame(s_min)
s_min=s_min.T
s_min=np.array(s_min)
s_min[0,:][0:-1:2]
```

```
array([50.73066711, 24.69040871, -1.12606144, -1.51337528, -1.27937293,
       -0.66309643, -1.42649245, -1.57622194, -1.56539631, -0.67275333,
       33.5194397 , -1.28190088, -0.67696285, -0.93593693, 30.09754944])
```

```
index=40
plt.imshow(x_test_s[index,:,:], cmap='gray')
plt.scatter(s_max[0,:][0:-1:2], s_max[0,:][1::2], c ='r')
plt.scatter(s_min[0,:][0:-1:2], s_min[0,:][1::2], c ='b')
plt.axis("off")
plt.show()
```

## 각 좌표의 mean 값 비교

```
s_mean=sad_d.iloc[1]
s_mean=pd.DataFrame(s_mean)
s_mean=s_mean.T
s_mean=np.array(s_mean)
s_mean[0,:][0:-1:2]
```

```
array([63.32885742, 29.7233429 ,  2.17794967,  2.62067676,  1.16092086,
        0.70394498,  1.99097693,  2.79697609,  1.04244983,  0.38606361,
       46.28223038,  2.31201696,  1.17834151,  1.72568595, 46.74061966])
```

```
index=40
plt.imshow(x_test_s[index,:,:], cmap='gray')
plt.scatter(s_mean[0,:][0:-1:2], s_mean[0,:][1::2], c ='r')
plt.axis("off")
plt.show()
```

# 시각화 2

## 눈, 코, 입의 중심 landmark 시각화

```
center_pts_x = location[:, center_inds]
center_pts_y = location[:, center_inds + 1]

print(center_pts_x, "₩n", center_pts_y)
center_inds
```

```
[['left_eye_center_x' 'right_eye_center_x' 'nose_tip_x'
  'mouth_center_bottom_lip_x']]
 [['left_eye_center_y' 'right_eye_center_y' 'nose_tip_y'
  'mouth_center_bottom_lip_y']]

array([  0,   2, -10,  -2])
```

# 시각화 2

## 중심 점들의 거리 계산

```python
def dist_pts(x_pts, y_pts):

    left_eye = (x_pts[0], y_pts[0])
    right_eye = (x_pts[1], y_pts[1])
    nose = (x_pts[2], y_pts[2])
    mouth = (x_pts[3], y_pts[3])

    left_eye_nose = dist(left_eye, nose)
    right_eye_nose = dist(right_eye, nose)
    nose_mouth = dist(mouth, nose)

    return left_eye_nose, right_eye_nose, nose_mouth
```

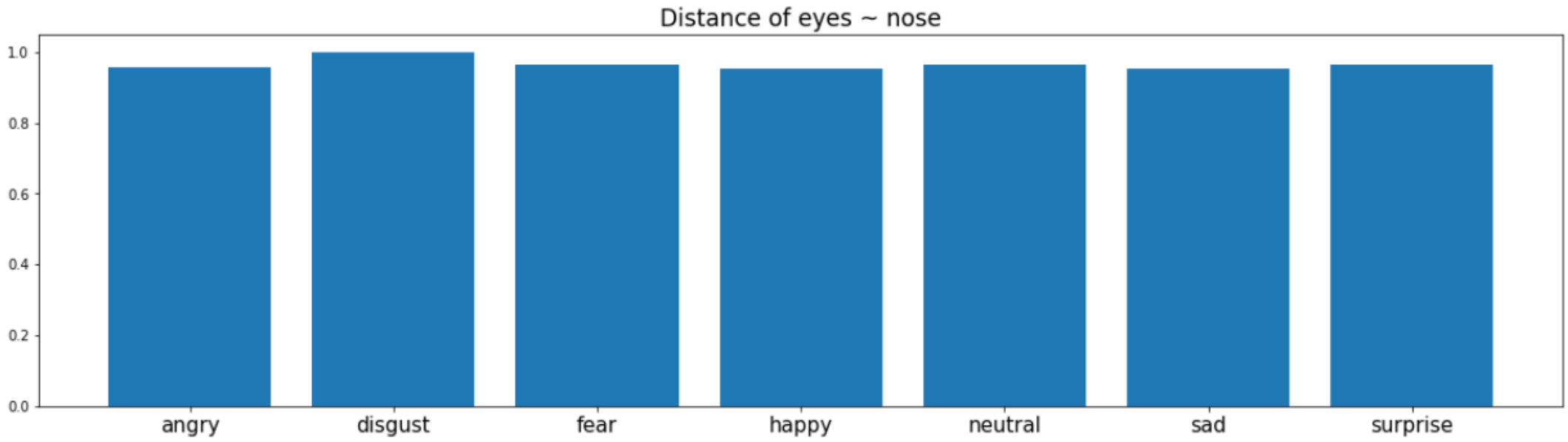
```python
distance = []
for i in range(len(emotions)):

    name = globals()['name_{}'.format(emotions[i])]
    sum1 = 0
    sum2 = 0
    for j in range(len(name)):
        x = np.zeros(4)
        for k in range(4):
            x[k] = globals()['y_test_{}'.format(emotions[i])][j, center_inds[k]]
            y[k] = globals()['y_test_{}'.format(emotions[i])][j, center_inds[k] + 1]
        leye_nose, reye_nose, nose_mouth = dist_pts(x, y)
        sum1 += leye_nose + reye_nose
        sum2 += nose_mouth

    mean1 = sum1/(len(name)*2)
    mean2 = sum2/len(name)

    distance.append([mean1, mean2])

distance = np.array(distance)
```

라벨 별
눈~코 평균거리
코~입 평균거리
계산

# 시각화 2

## 1. 두 눈과 코사이의 평균거리

Distance/max(distance)  (최대값으로 나눠서 정규화)

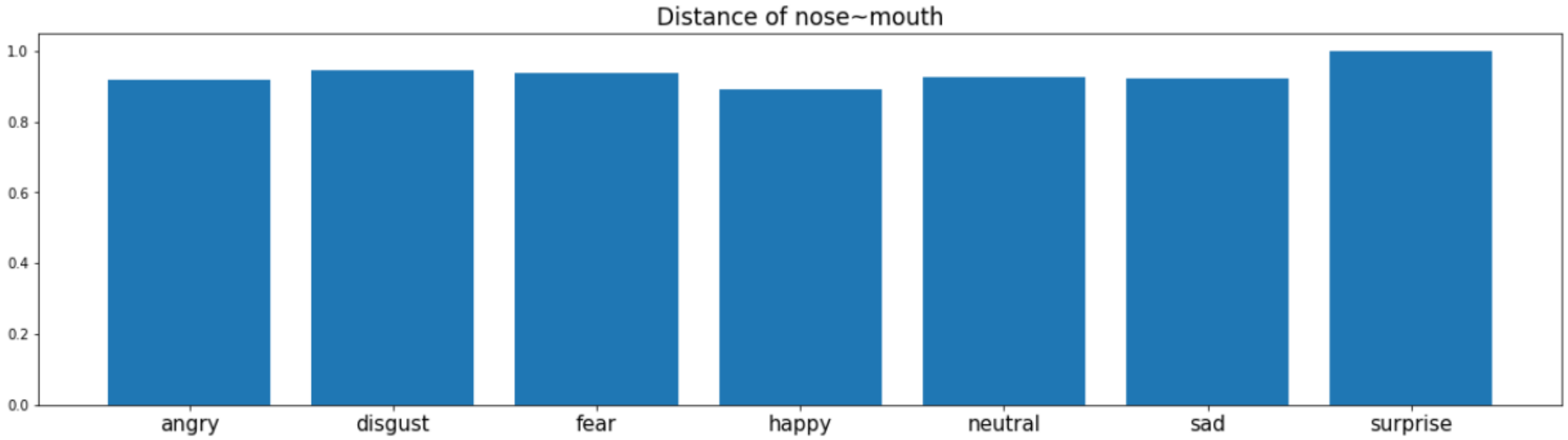



Max : disgust
Min : happy

# 시각화 2

## 2. 코와 입사이의 평균거리

Distance/max(distance)  (최대값으로 나눠서 정규화)




Max : surprise
Min : happy

# 출처

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## 참고자료

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# 발표를 마치겠습니다