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Face Emotion Pattern Analysis of Korean Depending on Persons and Environments Using DCGAN

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Abstract: Many studies examine the effects of a knowledge management, self-directed learning, emotion intelligence, and creative performance. It means that a very closed link between emotions and learning, and emotion give influence or their impact on the learning process. Adults as well as children can be influenced in their ability to direct their learning process by emotions. Emotion functions help one to remember their study results and at the same time distract them from the learning topic. That is, emotion results present different perspectives of negative and positive emotions in learning. Currently, online education is increasing and important method as one of education areas. However, we do not have an effective result because of online system.

This paper suggests method to analyze efficiency of online education through the analysis of face emotion patters Face emotion patterns is different depending on race, person, and environment. First, this paper provides the results of Korean facial emotion pattern analysis to use for effective results analysis of online education.

The facial emotional expression pattern, such as happiness, anger, sadness, embarrassment, injury neutral, and pleasure, is different depending on the person and country, and the results of its recognition accuracy are different depending on the learning method and structure (DCGAN, Cycle GAN, PixelGAN, DiscoGAN, StyleGAN, transfer learning). This paper analyses Korean facial emotional data created by the agency for AI infra, using DCGAN, and provides the analysis results of facial emotional patterns for another user's easing use.

Keywords: deep learning, DCGAN, face emotion, online education, Korean face emotion.

I. INTRODUCTION

Currently, the application of AI (Artificial Intelligence), such as deep learning, machine learning, and its related learning function, is growing up in many areas for labor or management cost reduction. When designing intelligent systems, system designers should consider providing good meaningful data as well as a proper learning model for the learning reliability and the correct result of learning of the intelligent system.

As an application of vision technology, such as Metaverse, AR, and VR, are introduced into entertainment, sport, education, etc., many recognize the importance of human-related data and its learning method for correct vision results and reality.

Human affection-related data in several methods. That is, the affection of humans is expressed with variety such as voice (tone, stop and continue style), face (lips, eye, face muscle), body behaviour (gesture style), text (story, writing style), EEG (Electroencephalogram) and its combination methods. To recognize this complicated affective expression style correctly, there are many ways depending on the situation and purpose.

The facial emotion methos is one of them to figure out information of face variation of a person by the effective situation. Currently, many countries and companies try to build infrastructure AI because they understand well how much it is important for their economy and job creation. Therefore, they are going to build datasets, but it should be confirmed to use them for AI. As face emotion pattern is aroused from a human's inner heart, their patterns express each person's real heart depending on their environment. Currently, increasing image recognition quality and advanced capability of deep learning have an impact on the analysis of facial emotion.

Because of the usage of these technologies, several companies provide their business [70]. To obtain correct affective data depending on the situation and person's personal characteristics, some researchers introduce a combined detecting system composed of facial emotion patterns, EEG signals, and behaviour of the body and analyse their emotional situations [2].

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The facial action reading system [3] is aroused to read instant facial emotion changing because facial expressions are strongly connected with mental states.

The facial emotion expression word (labelling) is slightly different depending researcher's definition:

- happiness, anger, fear, sadness, surprise, and disgust;
- Joy (happy), Sadness (lonely), Anger (annoyed), Fear (nervous);
- happiness, anger, sadness, embarrassment, injury neutral, pleasure.

However, this labelling is quite important for correctly comparing the results of learning of the intelligent system and should generate the correct data for their own system design.

Because of the Pandemic, many areas should work and meet online way, and online education is the main topic to teach and learn effectively.

That is, the education that has been teaching and learning as traditional in the classroom has to perform online. To have an effective result, the teaching method wants to introduce emotional recognition to check education results.

The emotional states of students in the classroom are quite important because of their understanding level of teaching content [4]. When teachers understand well the status of students' understanding level, teachers can teach and reduce their work burden.

Not only that, medical areas try to analyse the relationship between emotional patterns and medical factors, especially dementia prevention [65-67].

This paper deals with Korean facial emotion pattern analysis depending on the environment situation, the facial pattern of emotion, and the person's face pattern for emotional expression to decide how much online lecture result are efficiency.

This paper uses DCGAN to analyse emotional patterns using the image of the facial photo (datasets) depending on the situation and person produced by the agency (public data) for building AI infra. From this analysis, we can use online lecture results using the characteristics of Korean emotion patterns.

II. BACKGROUND

Currently, facial recognition is so highly popular technology that is used in smartphones, door locks, and others.

However, the system designer should obtain their own facial emotion patterns and their learning system to build a correctly intelligent system and apply it.

For instance, developing a new idea for applications such as AR, VR, and face emotion identification by machine or computer for vision is strongly required by intelligent methods of deep learning or machine learning.

Many try to introduce Metaverse, AR, and VR for their good education results. For that, they should understand well users' emotional status and facial emotion data patterns.

Recognizing facial emotion has also a quite important meaning for health care and health check of old people by online medical check (smart health) due to the Pandemic situation and local area [4, 65, 67].

Psychologists say that the facial emotion include the communication of 55% of humans [6].

There are many intelligent methods to recognize facial emotion because its main technology analyzes after image detection.

There are many learning methods to classify the image of facial emotion. For instance, as an image analysis learning method, there are deep learning, transfer learning, GCGAN, StyleGAN, Pixel GAN, DiscoGAN, and others.

But depending on the methods, their efficiency and learning time are different.

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Facial emotion has much biomedical information because facial behavior act by facial muscle such as lip tightener, inner brow raiser, upper lip raiser, outer brow raiser, mouth stretcher, lip corner depressor, lip parts, etc.

Because facial emotion can be expressed through the movement of these facial muscles, the detection accuracy varies by noise such as illumination, beard, glasses, makeup, and hairstyles.

Additionally, the environment around humans such as indoor (office, dark room, library, living room, etc.) and outdoor (subway, street, under-bridge, over-bridge, etc.) [7].

Because of this reason, they must match facial emotion patterns and other medical signals (EEG Signal) to improve this facial emotion quality [4].

There are several ways to recognize, such as facial method, speech method, EEG signal way, and body behavior.

The results (the correct facial emotion pattern) of these researches are able to allow checking and monitoring for public health monitoring or medical check system.

Because emotion recognition provides information about the status of a person, online education as well as health checks and monitoring, and the real-time emotion recognition method using Python provide machine learning [5].

These face emotion patterns can offer information or development of methods for self-directed learning to advance online education and prevent (or predict) Alzheimer's disease as one of the medical materials when analyzed.

Each person's face emotional situation has their personal characteristic and a high typical information expression style as one of the best emotional expression methods of humans. In the case of children, because the affective expression is strongly connected with their mental status, affect recognition plays a key role as a part of a way method of expressing the relationship between normal child development and the development of autistic children.

Herein, because of good business perspective as well as high tech. development, it is so highly valuable research to provide correct facial emotion patterns for the development of several technologies and companies' business.

III. RELATED WORKS

A. Facial Emotion Recognition Research Method

The smart environment (Mobile PC, Visible display system, VR/AR, etc.) is coming closer to us due to the advanced devices [10], and facial emotion is strongly required for its application. To prepare 4th industrial revolution, facial emotional recognition is absolutely needed for the application.

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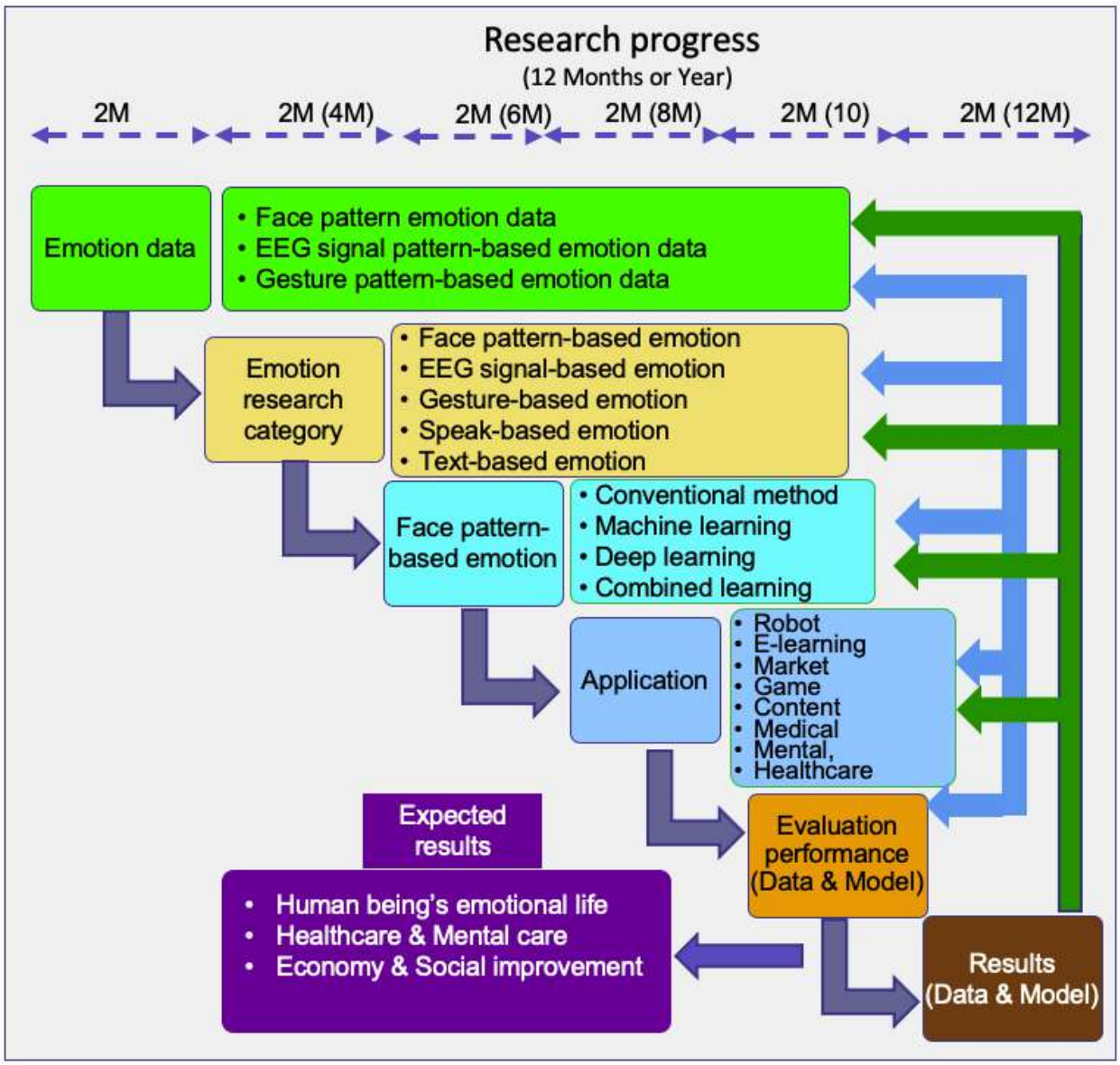

Fig. 1. Research progress for facial emotion pattern analysis.

The variation situation of the face, such as masks, or others, should be considered to offer correct emotional patterns. This research represents the impact of face masks on emotion recognition [11].

Additionally, the important thing is to provide the correct emotional representation methods of word and boundary definition because of differences depending on the person and researcher. They show emotional patterns with 6-word, such as anger, fear, happiness, sadness, disgust, and neutral. Others use 7-segment for emotional expressions.

It means their research results are able to impair original emotion depending on the person.

Currently, this paper uses residual and CNN to classify emotion patterns [12]. To obtain the optimal parameter of CNN, they introduce the evolutionary method.

This review paper [13] provides information that reviewed the characteristics of several machine learning and deep learning, and the dataset used for these learning methods.

There are two approaches the conventional machine learning method and the deep learning method. The traditional machine learning approach uses SVM (Support Vector Machine), PCA (Principle Component Analysis), NN (Neural Network), HWT (Haar Wavelet Transform), and HMM (Hidden Markov Model) [14].

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Usually, because these traditional methods have no power, full computation, and memory, they are useful for embedded devices and real-time study.

The deep learning method that deals with this paper has some advantages, such as non-physical learning, lower effort, and an end-to-end learning process.

This paper suggests a CNN with an attention mechanism (ACNN) [15]. This learning mechanism has a perception of the occlusion region of the face and focuses on the most discriminative unoccluded region of the face, which is an end-to-end learning method.

Ref. [16] suggests new face cropping and rotation strategy for CNN. They use CK+JAFFE datasets.

This research [17] suggests the DAM-CNN of CNN, which has two modules, an attention-based Salient Expressional Region Descriptor (SERD) and the Multi-pass Variation-Suppressing Network (MPVS-Net). SERD has a function adaptively estimate the importance of different image regions for facial emotion recognition and MPVS-Net.

This paper [18] focuses on achieving better accuracy and classification of facial emotion recognition under varying illumination with limited samples. For this, this paper Support Vector Machine (SVM) for six emotion patterns (joy, surprise, fear, disgust, anger, and sadness) and obtains 98% accuracy.

This paper [19] studies 3D flow-based CNN model for video-based micro expression of facial emotion, which has three data streams, such as grayscale frame sequence, the vertical component of optical flow, and the horizontal component of optical flow.

This researcher [20] studies the improved convolution neural network-Bi-directional long short-term memory (CNN-BiLSTM), which has speech recognition and graphics.

Aya Hassouneh et al. [21] provide real-time research material on facial emotion recognition. They analyze EEG signals and the facial landmark method for emotional patterns (Anger, Disgust, Fear, Happiness, Sadness, and Surprise) using a deep neural network.

This paper [22] offers reviewed results about deep learning-based facial emotion recognition, which mentions the general algorithm of deep learning and CNN.

Ref. [23] represents the transfer learning of CNN with a small dataset for facial emotion recognition.

Swayam Badhe [24] studies CNN with 4-convolution layers and 2-FC layers.

This paper [25] is a review paper for deep learning and machine learning with datasets, which provides information about the representative facial emotion recognition methods. This paper describes 15 models, dataset, and emotional patterns.

This article [26] predicts the future of emotion recognition by machines and AI. It mentions the market size of the emotional area.

This research [27] adapted a residual-based deep learning network, which uses residual blocks to classify emotions and improvement of accuracy with FERGIT data sets.

Saranya Rajan et al. [28] suggest a novel deep learning model for facial emotion recognition using CNN and LSTM. This paper considers handling under varying illumination and preserving the subtle edge information of each image. They combine these two features with datasets.

They [29] compare the performance of three learning models, such as deep convolutional neural network (VGG-16), AlexNet, and GoogLeNet/Inception V1 using datasets FACES, Lifespan, CIFE, and FER2013. They show that VGG-16 is the best accuracy for the aging adult.

This research team [30] suggests the facial emotion method to recover using mutation recognition, which learns more reliable correlations among raw facial images and multitasks labels because of noise.

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Wafa Mellouk et al. [31] present automatic facial emotional recognition by deep learning. They also review datasets of facial emotion and compare the characteristics of the model used so far.

This paper [32] uses a contrastive adversarial learning approach for facial emotional recognition using datasets AffectNet, AFFW-VA, and Aff-Wild. They show comparison.

This paper [33] uses deep residual learning facial emotional recognition and compares it with CNN. They show 81.9% as the result of this paper compared to 66% of CNN.

Ref. (34) describes the importance and feature of facial emotion recognition.

Survey paper [35] reviews and describes the results of some recent research.

Chirag et el. [36] survey a comprehensive evaluation of AI-based FER methodologies, such as datasets, feature extract techniques, algorithms, and recent breakthroughs with its applications in facial expression identification through reviewing papers of 205 references. This paper is a good reference for experts as well as beginners who want to research face-based emotional technology.

Shaik Asif Hussain [37] provides deep learning algorithms for facial recognition for accurate identification and detection. this paper focuses on authentication for the classification of emotions of happy, neutral, angry, sad, disgust, and surprise. Ref. [40] is a very interesting and useful paper for those who want to use emotional technology for learning and teaching method. But it just mentions the previous paper, not the study.

Ref. [49] offers Python material for facial emotion workers.

Minja Li et al. [50] study intelligent learning environments with robots modeling of emotion regulation and cognition based on quantitative motivation to adapt natural interactions between students and robots in emotional interaction. They provide a reinforcement emotion-cognition system (RECS) with four steps, such as sensory detection, emotion generation, competitive and cooperation relationship, and cognitive proposal.

Ref. [55] mentions the adaption and effectiveness of cognitive assistive technology for use of the dynamics of human emotion for dementia. And they also describe Bayesian affect control theory, a quantitative social-psychological theory, to model behavior and emotion for those systems.

R.F Mustafina et al. [59] provide a general overview of the relationship between emotions and learning, and their impact on the learning process. They say emotions can help to remember details and, at the same time, distract them from the learning topic.

Ref. [63] describes evidence of emotions and learning based on the connection between learning, emotions and the brain. They mention that the positive emotions generated through the relationship between teacher and student are conducive to better learning. While negative emotions can have an oppositive effect.

Daeha Kim et al. [70] suggest new adversarial learning for FER (Facial emotion recognition) for complex emotional elements. They use two tracks, strong emotion and weak emotion, to recognize effectively.

IV. KOREAN FACIAL EMOTION ANALYSIS

A. DCGAN Model Evaluate to Analyse

This paper uses DCGAN to analyze facial emotion patterns. As the DCGAN is one structure of deep learning, it learns by comparing the generator (generating fake data) and discriminator (comparing, as shown in Fig. 2.

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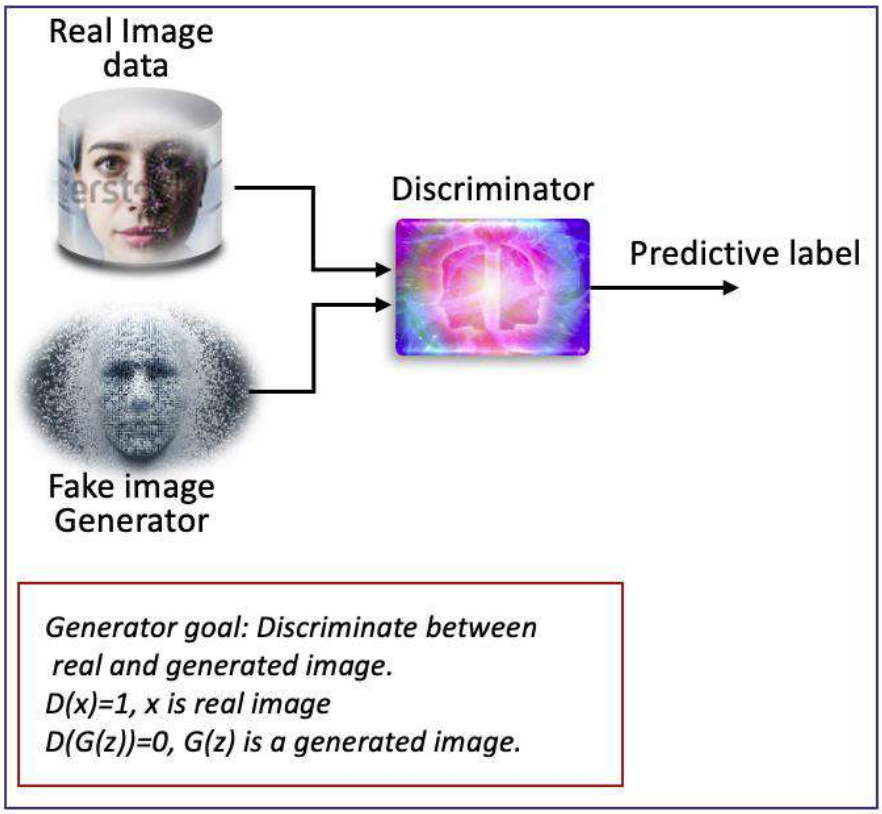

Fig. 2 (a). The principle of DCGAN.

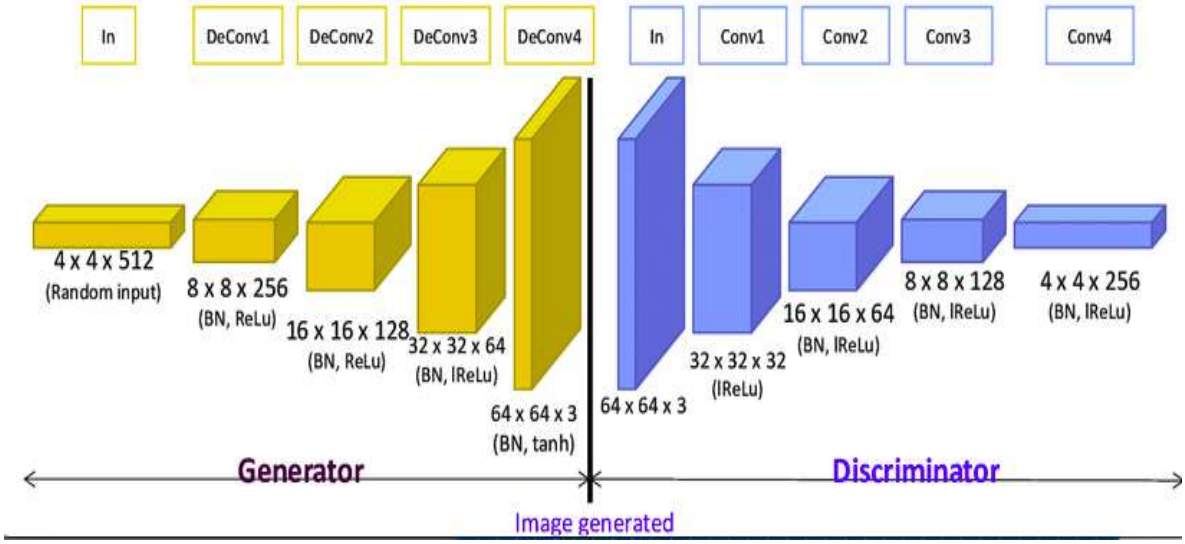

Fig. 2 (b). The basic learning and structure of DCGAN.

The structure of DCGAN is shown in Fig. 2, and its basic learning theory is as follows:

$$\min_G \max_D V(G,D) = E_{x,pdata} \log [D(x)] + E_{x,pz} log[1 - D(z)] \quad (1)$$

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```
import os
import cv2
import pandas as pd
import numpy as np
from numpy import expand_dims
from numpy import zeros
from numpy import ones
from numpy import asarray
from numpy.random import randn
from numpy.random import randint
from sklearn.preprocessing import OneHotEncoder
from sklearn.preprocessing import MinMaxScaler
from tensorflow.keras.optimizers import Adam
from keras.models import Model,Sequential
from keras.layers import Input
from keras.layers import Dense
from keras.layers import Reshape
from keras.layers import Flatten
from keras.layers import Conv2D
from keras.layers import Conv2DTranspose
from keras.layers import LeakyReLU
from keras.layers import Dropout
from keras.layers import Lambda
from keras.layers import Activation
from keras.metrics import Precision,Recall
import matplotlib.pyplot as plt
from keras import backend
```

Fig. 3. Python code running process of Google Colab for DCGAN.

The generator has a role to generate fake images, and the discriminator has the function of deciding how much it is close fake image data to real image data through learning.

The fake generator must produce updated image data to avoid exact figuring out of the discriminator, and the discriminator should figure out fake image data by comparing fake image data and real image data. The lecturer explains the function of these two modules.

B. The principle of running

The lecture teaches the meaning of equation (1) and explains the roles of fake generators and discriminators. And the lecture introduces the code below Fig. 3.

This code list contains only the function of Sequential, Dense, Conv2D, LeakyRelu, Lambda, and other codes listed below. This paper shows a better understanding of the DCGAN model figure for the reader.

C. Datasets for an emotional pattern of Korean

This paper uses a public dataset that was uploaded to AI-Hub created by agency for building AI infra and research. (https://aihub.or.kr/?utm_source=google&utm_medium=search&utm_campaign=ga&gclid=CjwKCAjw6raYBhB7EiwABge5KrCfOmkafFMQ_UCySHxepwbceoK4cOrG33_de_uir6FyHycEGaVY4xoCvqIQAvD_BwE).

D. Anger pattern of Korean

This section provides the analysis result of the anger expression pattern in Korean. To build datasets for expressing anger, they order and express their style of anger. However, the emotional pattern does not show correctly. As we can see, the face of a person's facial expression style does not match.

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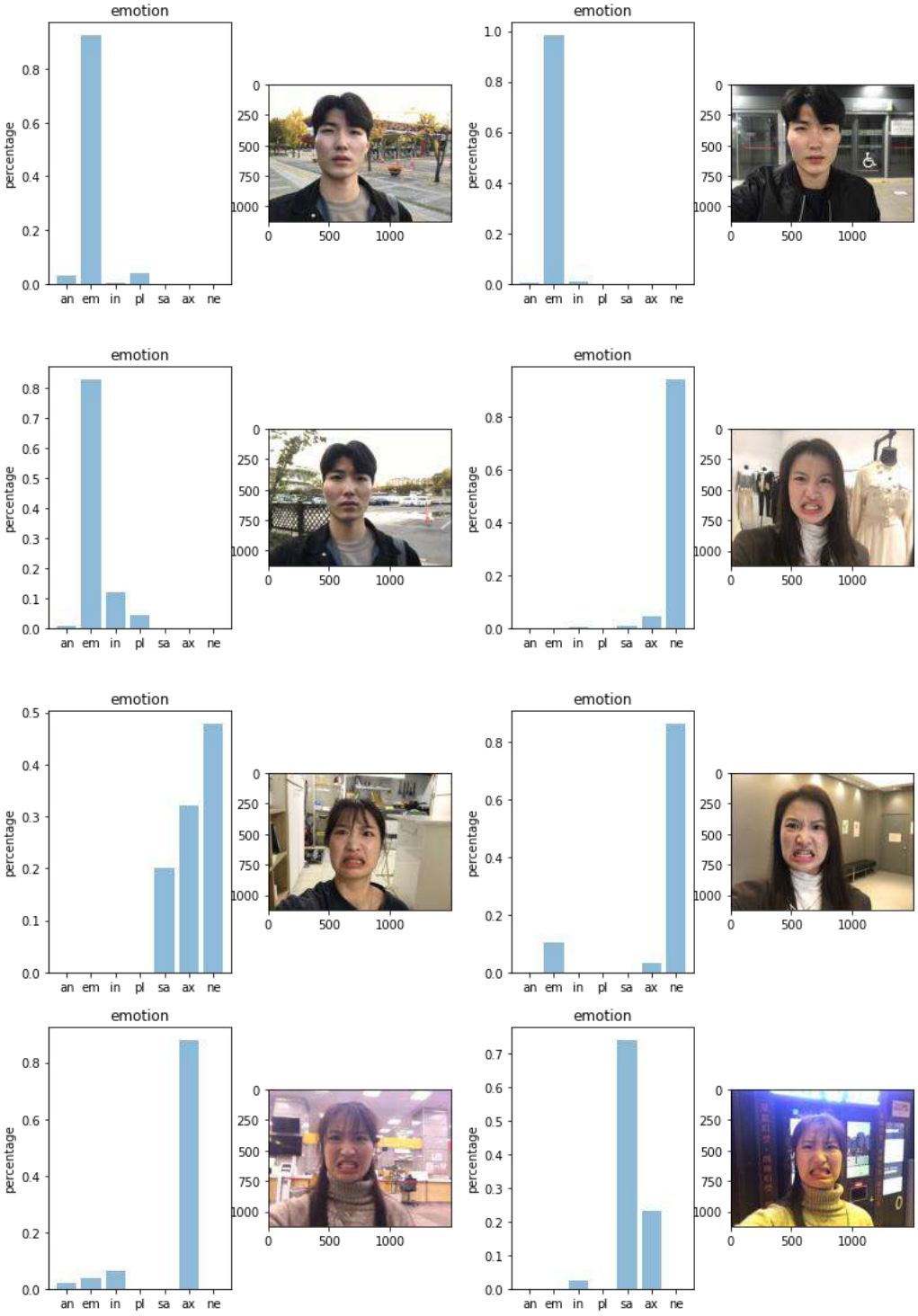

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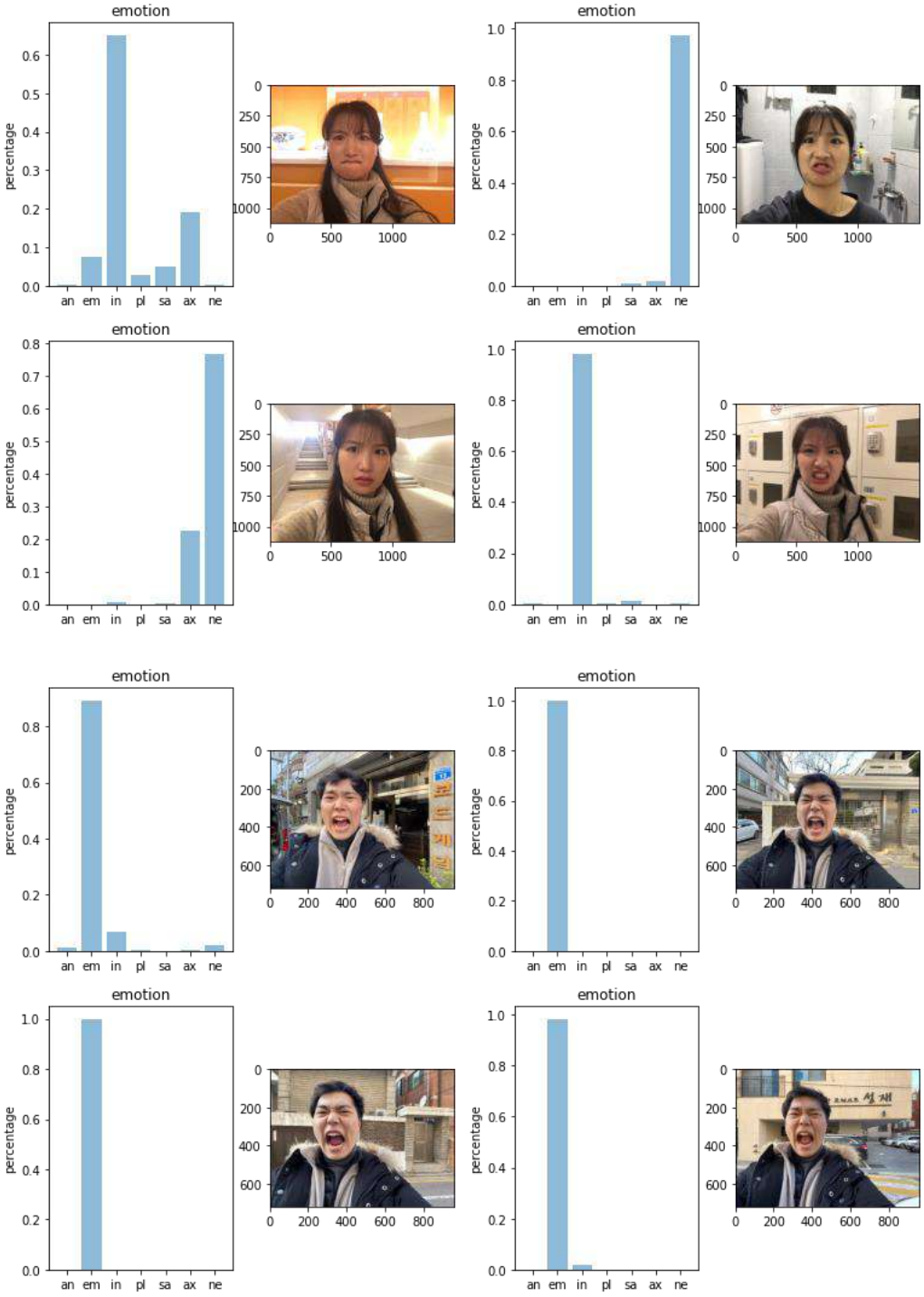

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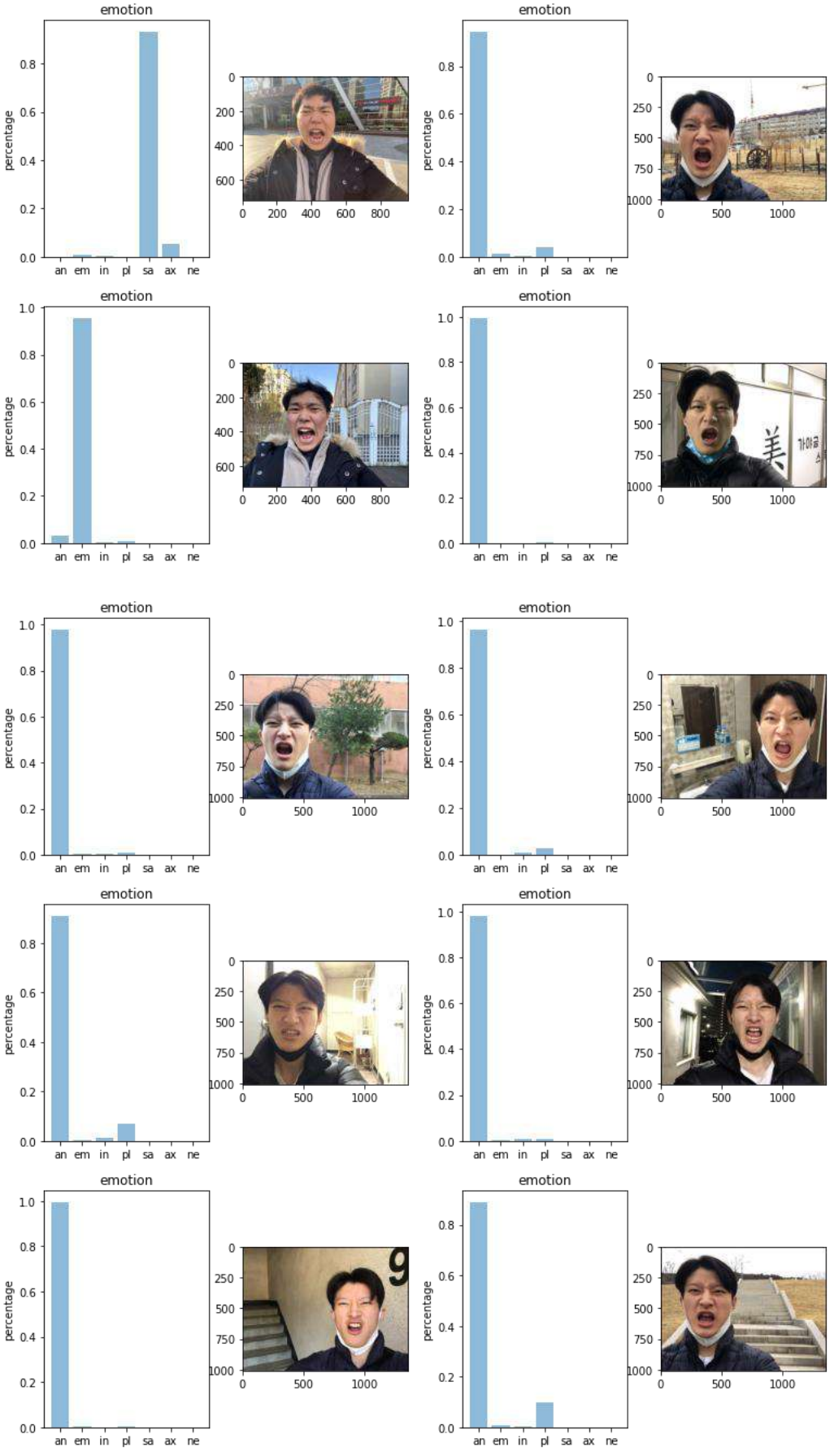

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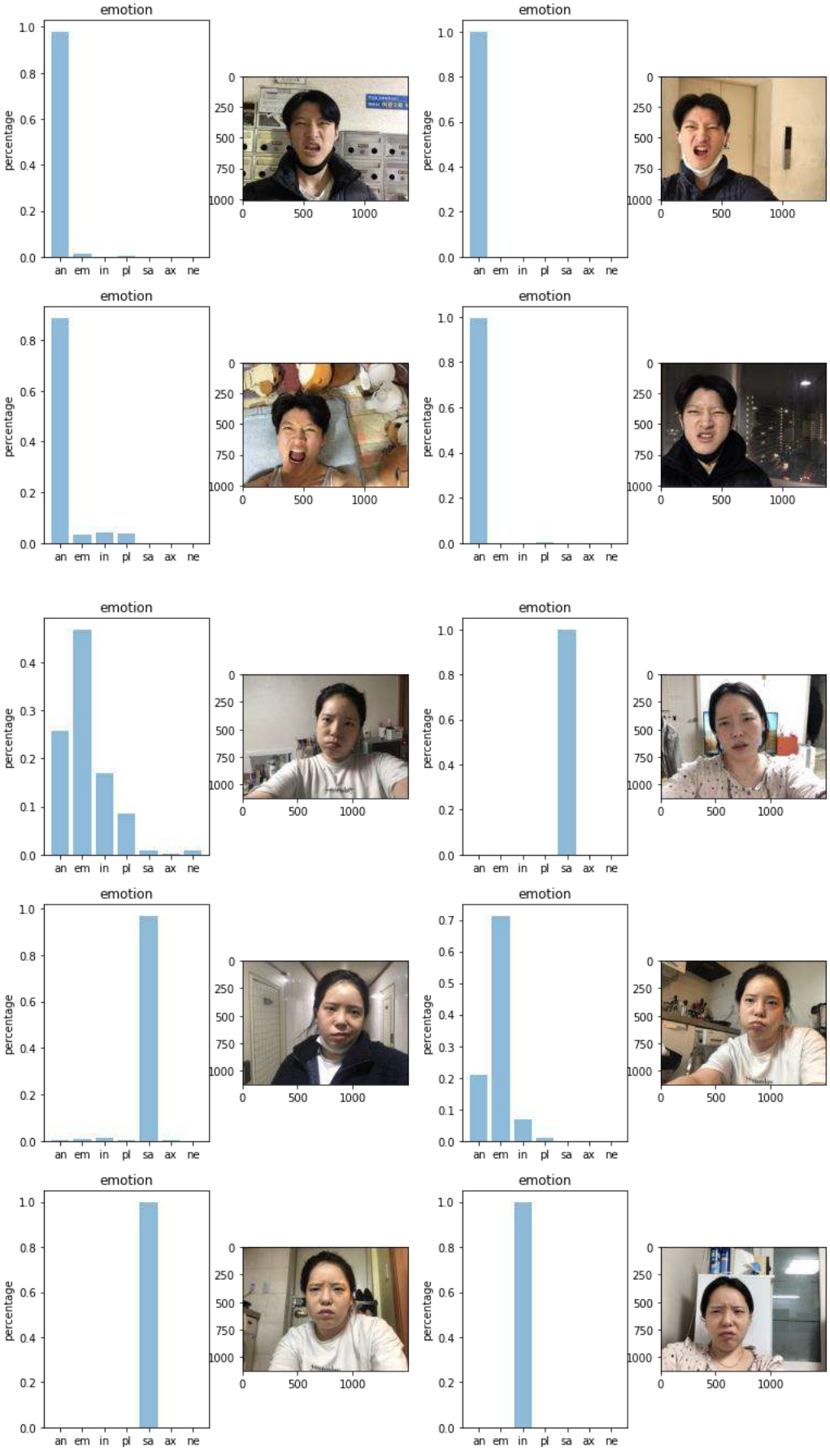

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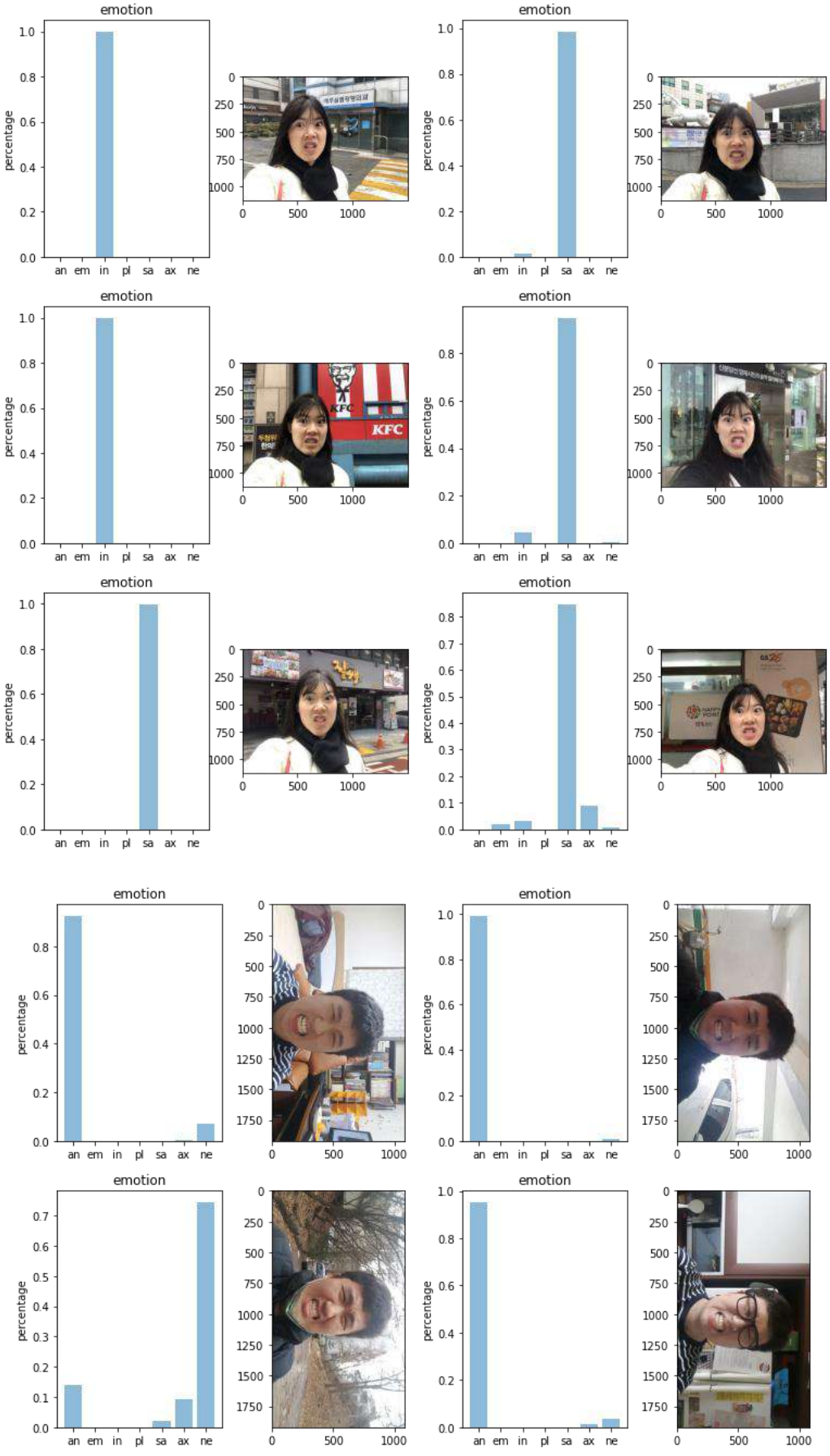

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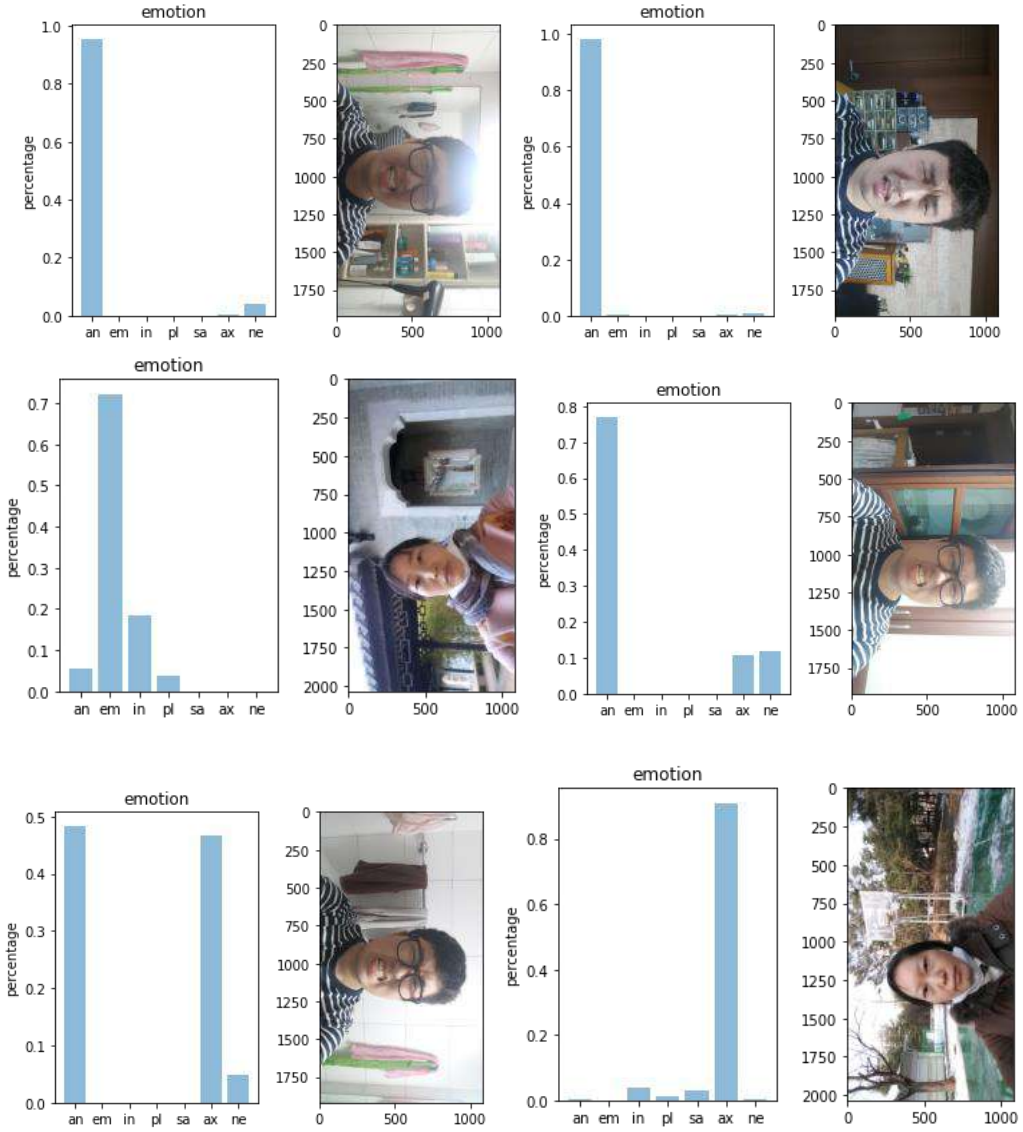
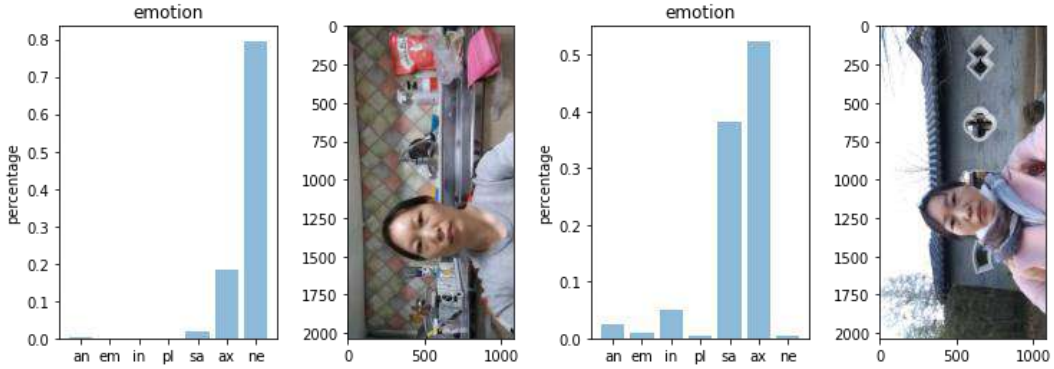


Fig. 4. Anger patterns depending on persons and their accuracy.

E. Anxiety pattern of Korean

This section provides the analysis result of the anxiety expression pattern in Korean. To build datasets for expression, they provide the same order.



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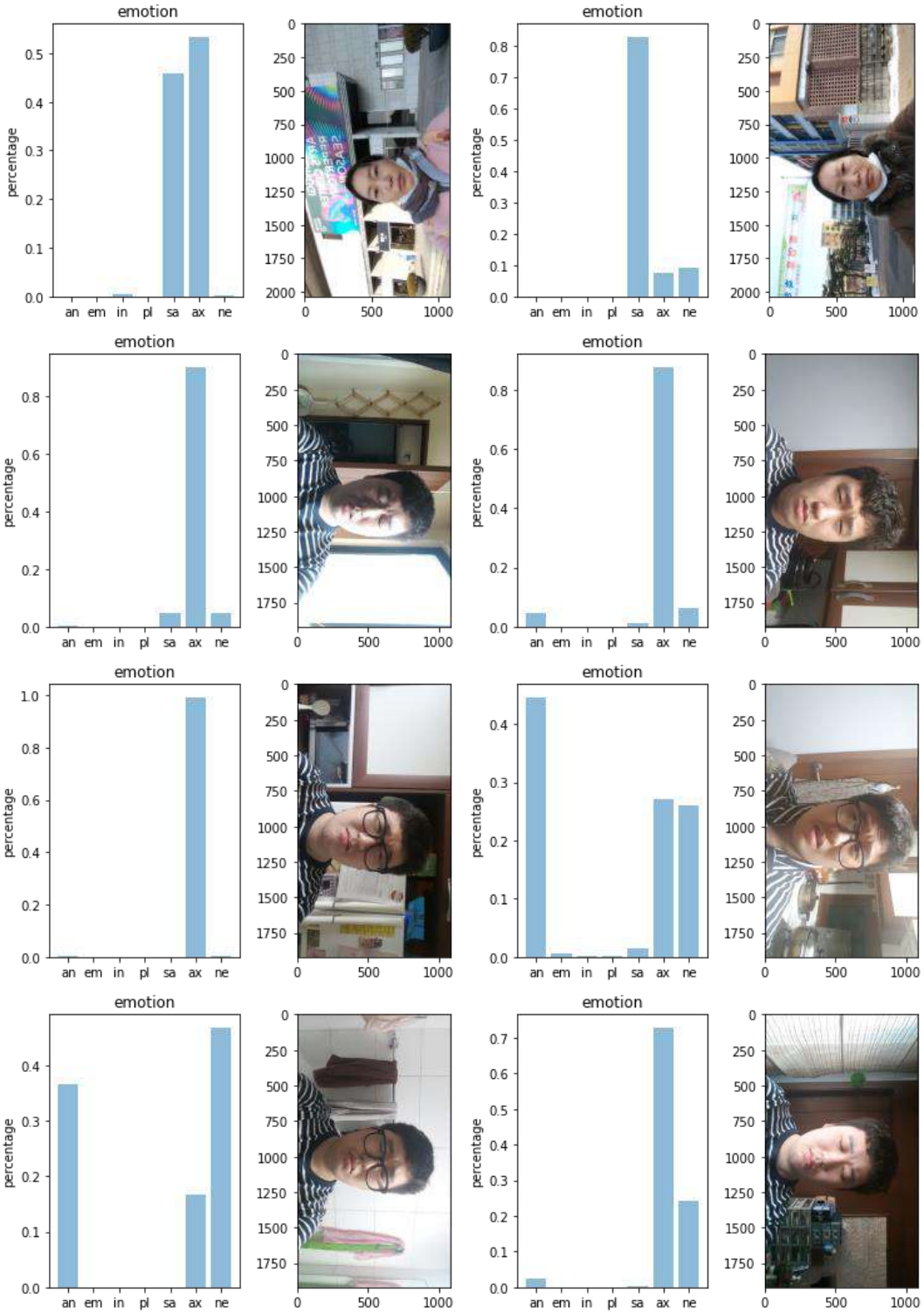

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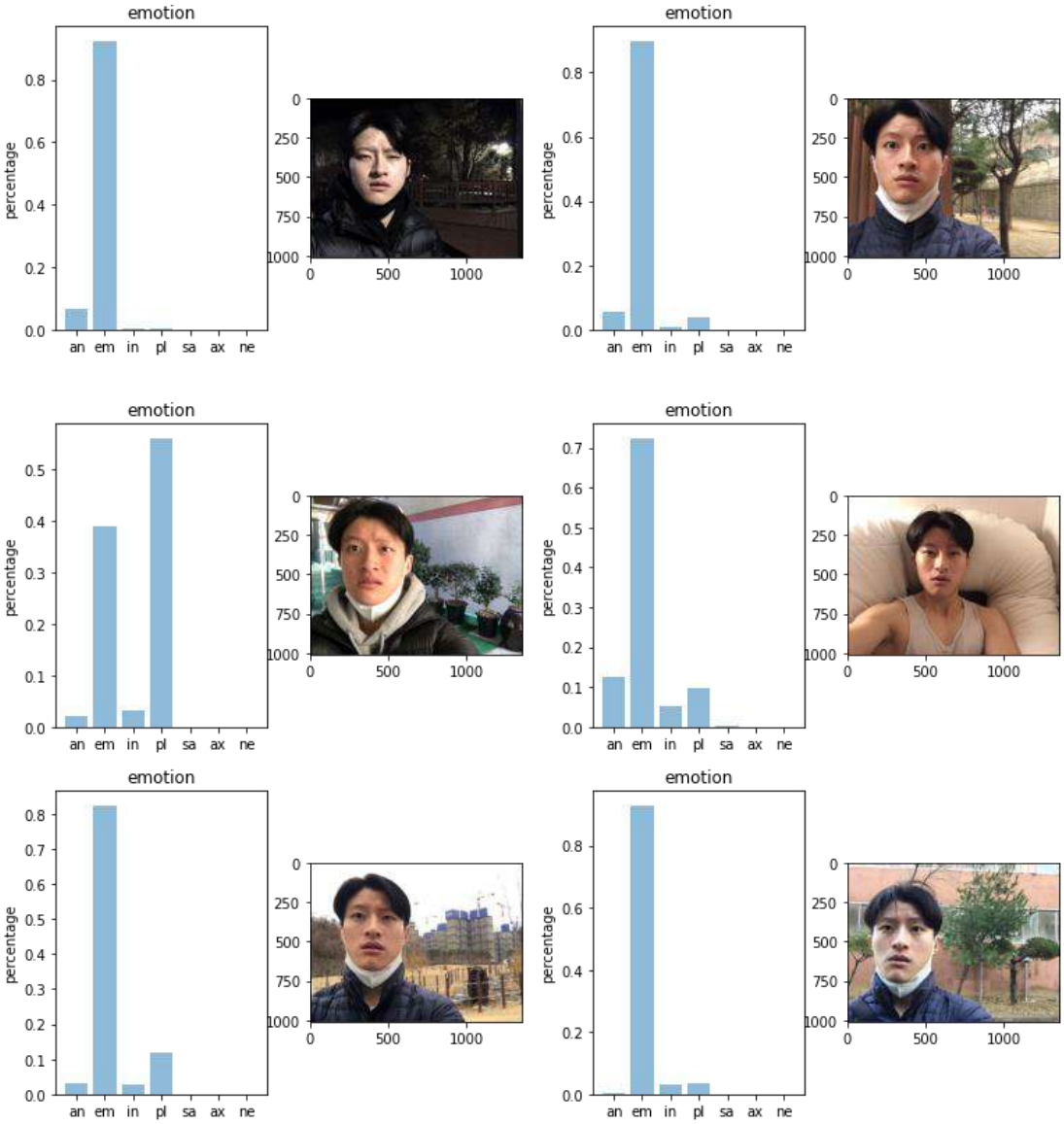

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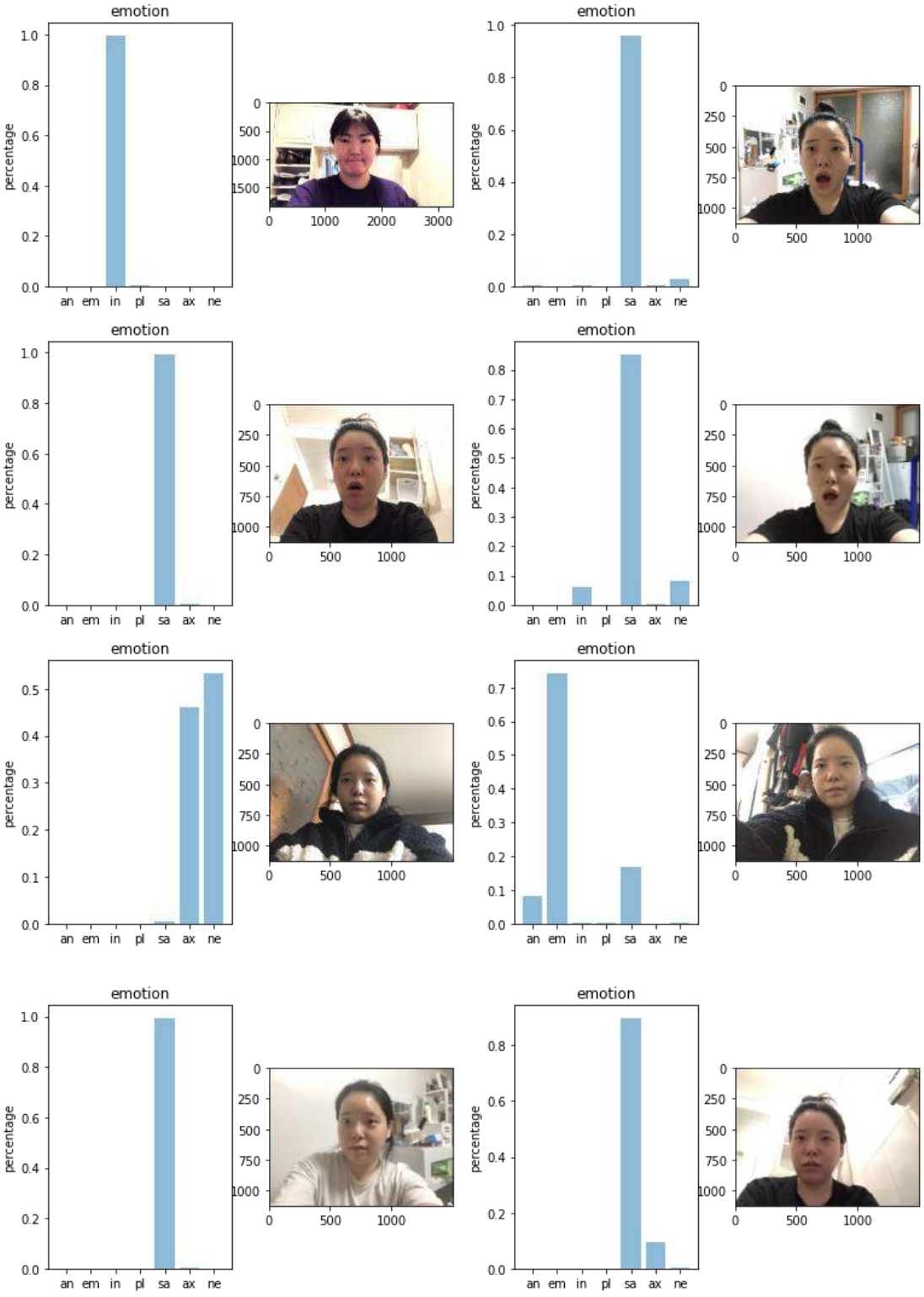

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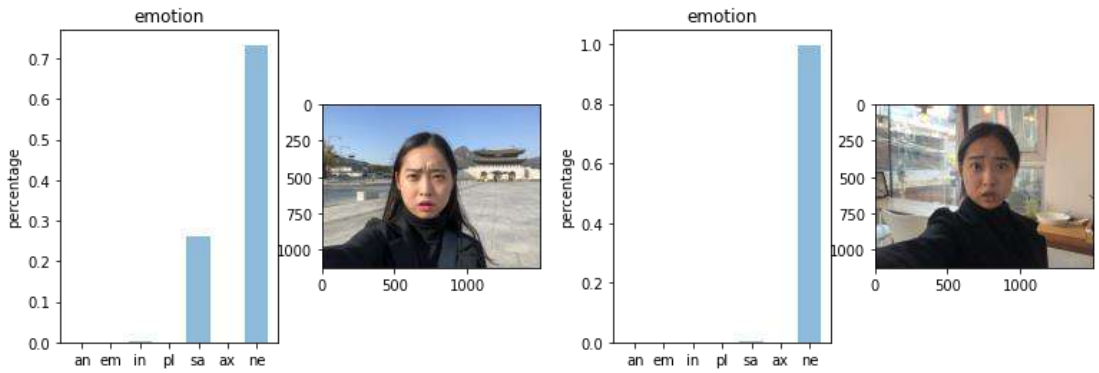
Fig. 5. Anger patterns depending on persons and their accuracy.

F. Embarrass pattern of Korean

This section provides the result of the embarrassment expression pattern in Korean. To build datasets for expression, they provide the same order.



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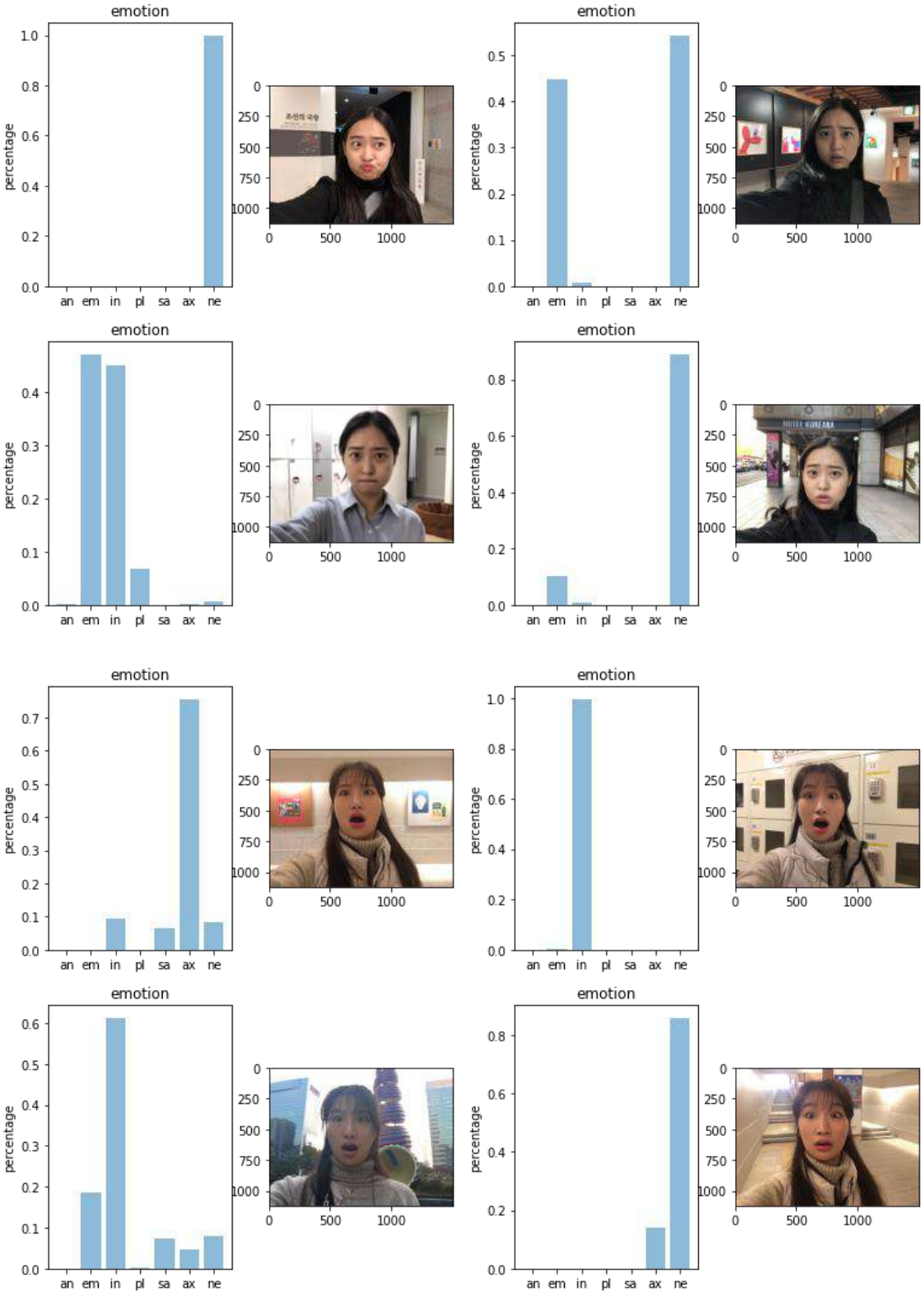

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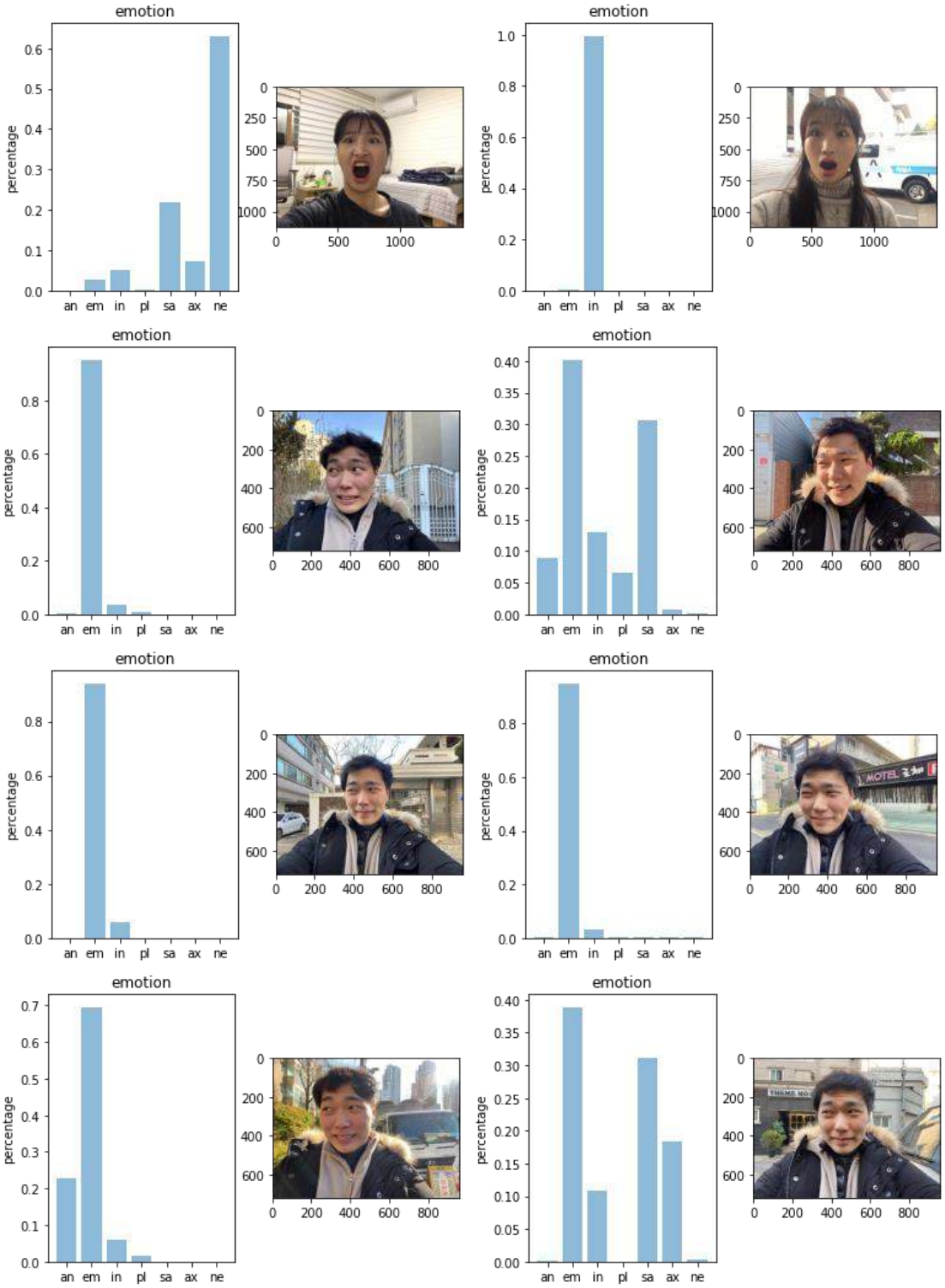

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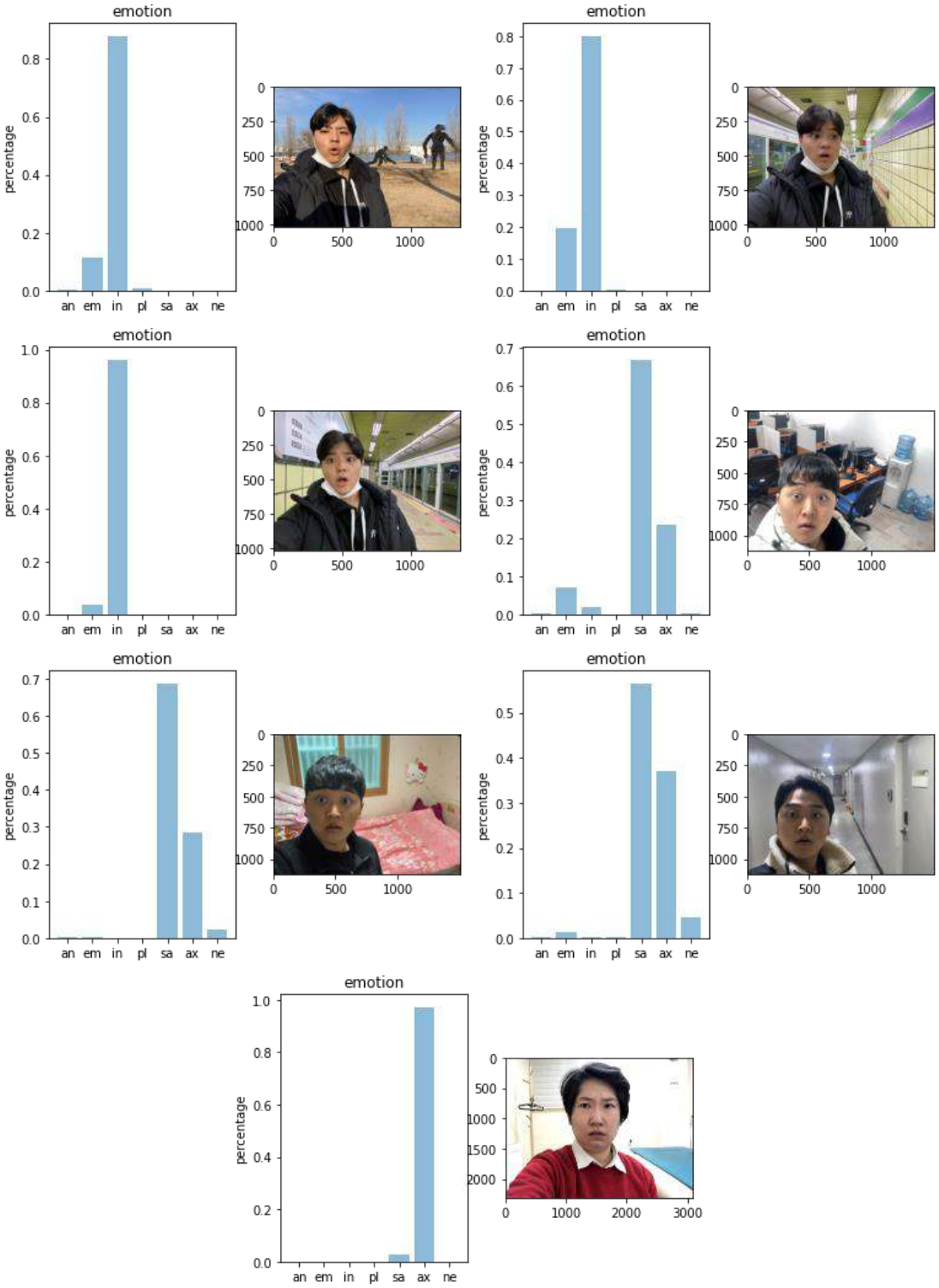

Fig. 6. Embarrass patterns depending on persons and their accuracy.

G. Injury pattern of Korean

This section provides the result of the injury expression pattern in Korean. To build datasets for expression, they provide the same order.

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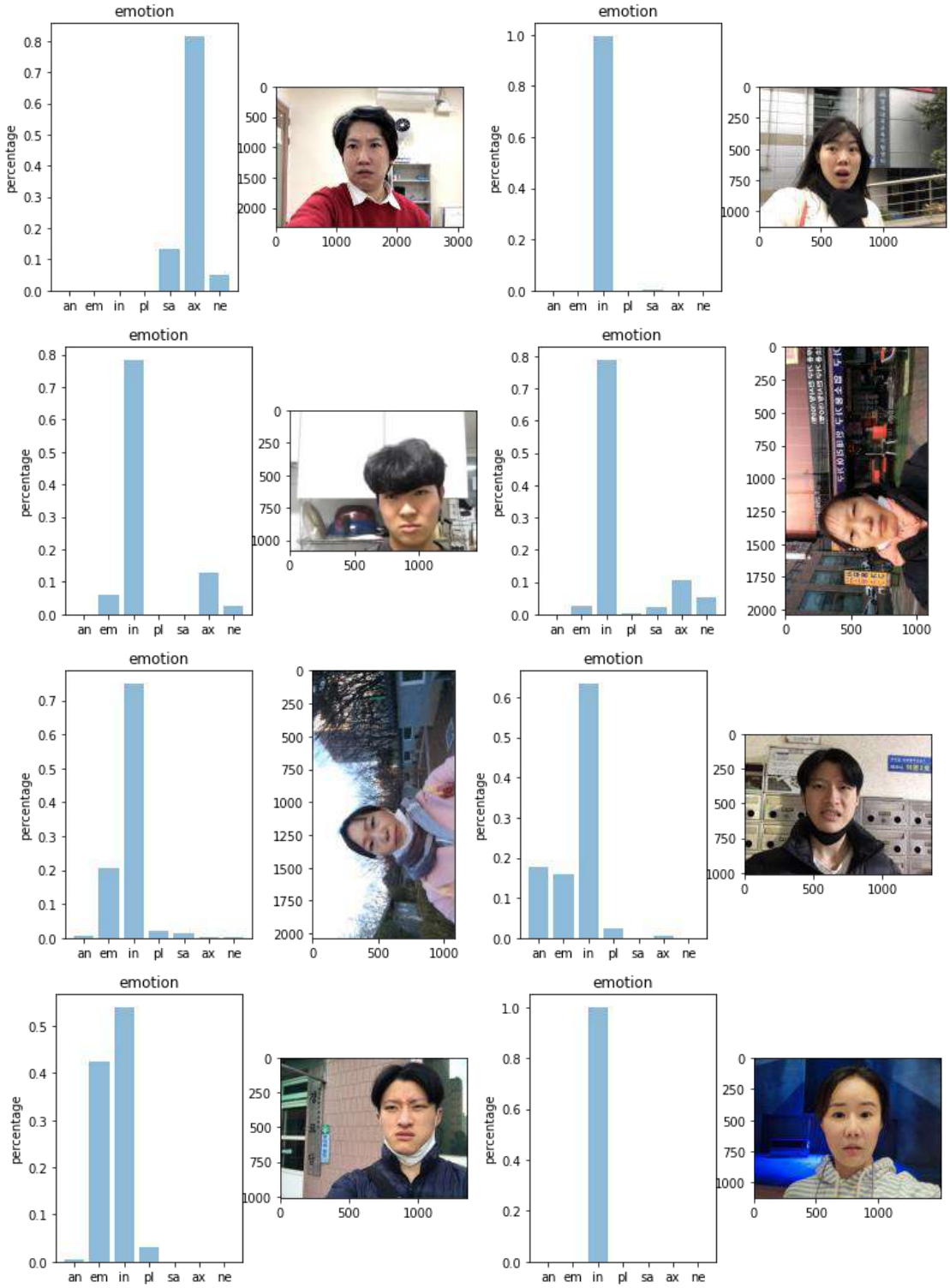

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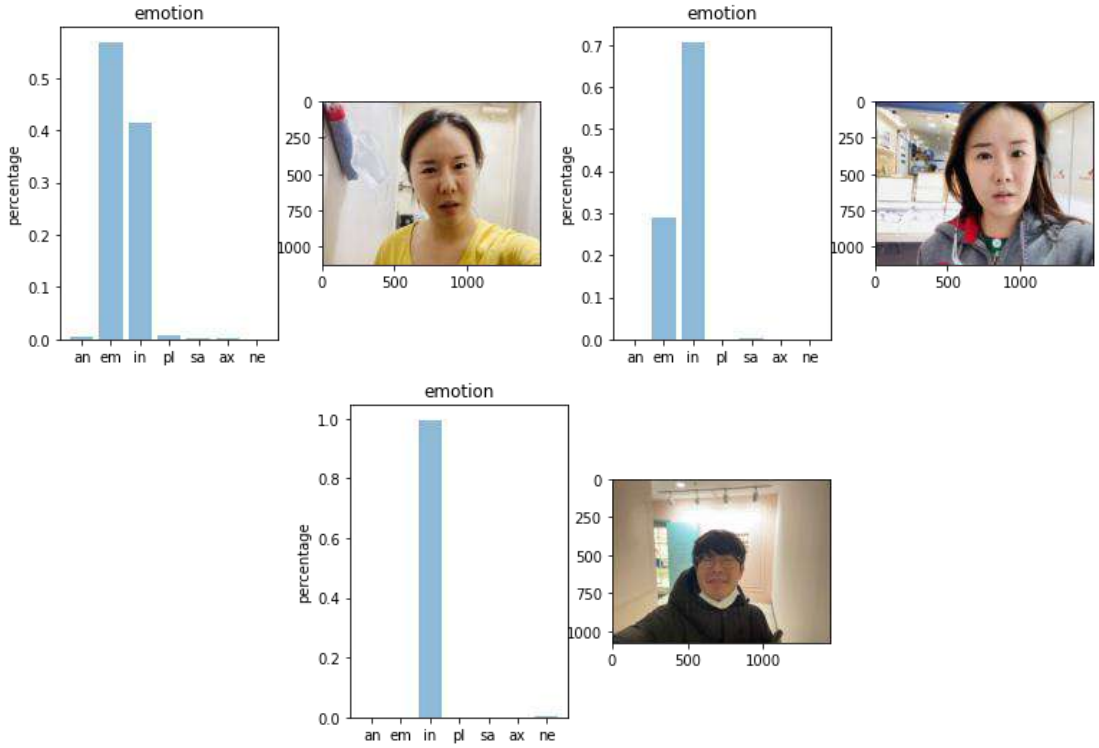
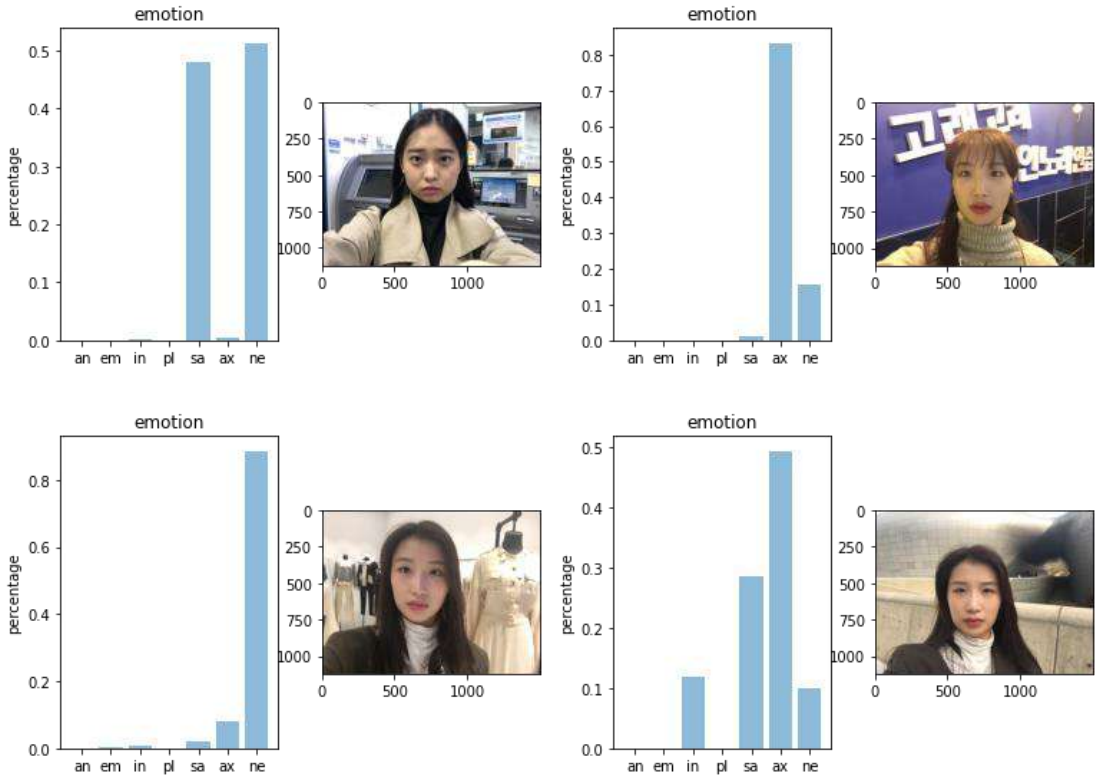


Fig. 7. Injury patterns depending on persons and their accuracy.

H. Neutral pattern of Korean

This section provides the result of the neutral expression pattern in Korean. To build datasets for expression, they provide the same order.



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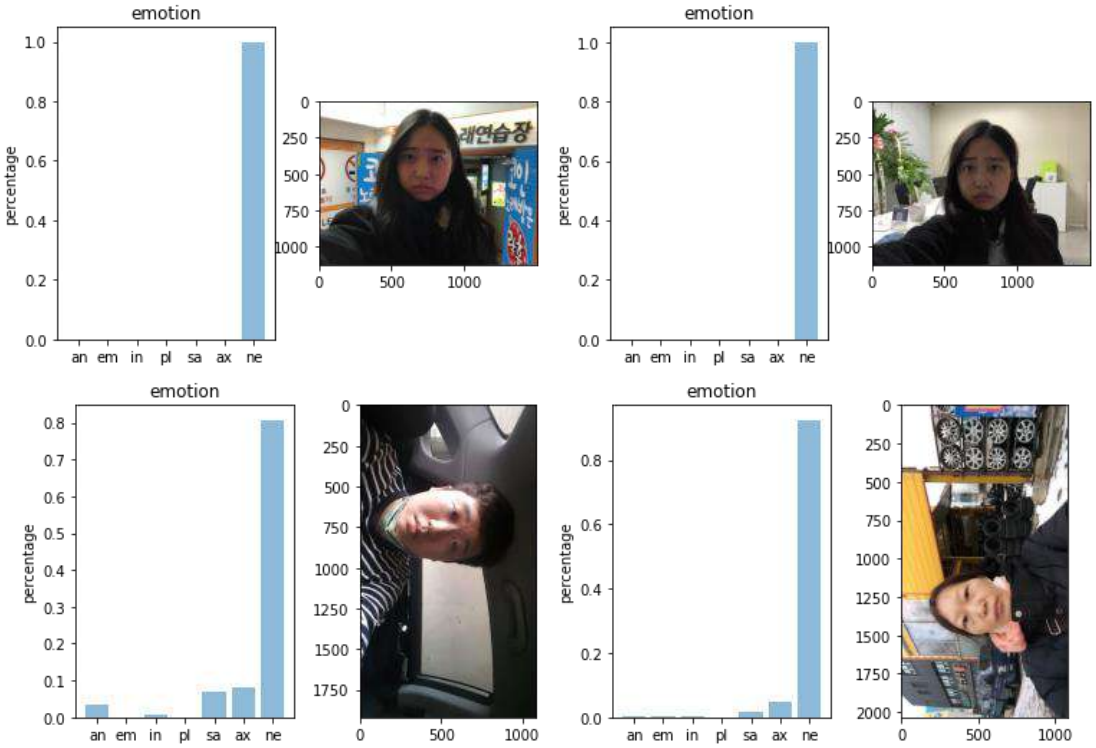
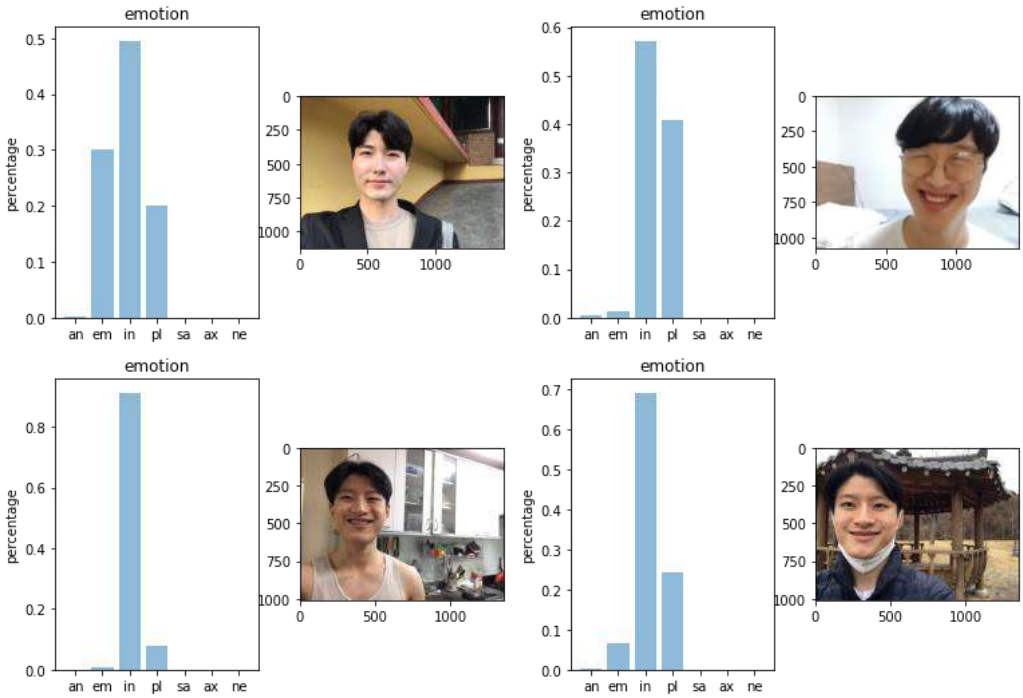


Fig. 8. Neutral patterns depending on persons and their accuracy.

I. Pleasure pattern of Korean

This section provides the result of the pleasure expression pattern in Korean. To build datasets for expression, they provide the same order.



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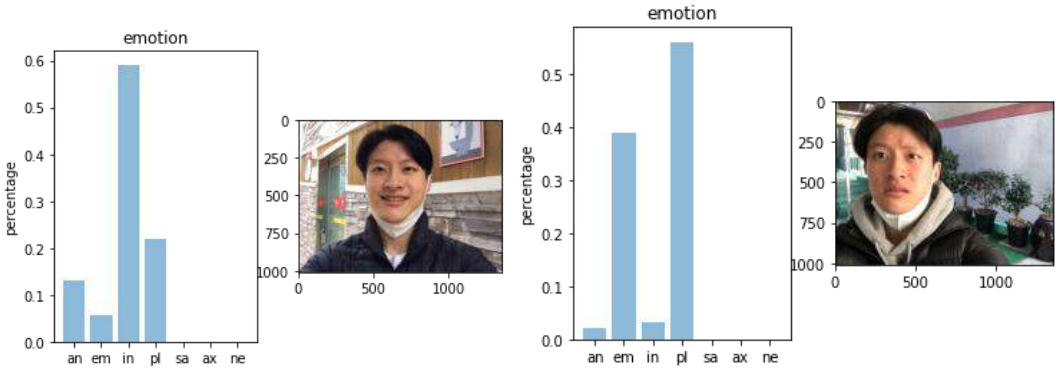

Fig. 9. Pleasure patterns depending on persons and their accuracy.

J. Analysis of Facial Emotional pattern in Korean

As shown in sections 4-9 and Fig. 4-9, this paper provides analysis results of 6-segment facial emotion patterns, such as anger (an), anxiety (ax), embarrassment (em), injury (in), neutral (ne), and pleasure (pl). This dataset is provided by facial emotion patterns examined by several persons' models (examiner) of agency.

The emotional name of this dataset is provided by the agency that built this data.

However, others mention as below:

- happiness, anger, fear, sadness, surprise, and disgust;
- Joy (happy), Sadness (lonely), Anger (annoyed), Fear (nervous).

The meaning of these words is slightly different from each other. For instance, anxiety; fear, surprise; embarrassment, injury; disgust, joy; happiness.

However, the decision on the difference between these words is over this paper's research purpose.

As we can see from Fig. 4-9, facial emotion expression pattern is quite depending on person even the same word. Therefore, to make a correct facial emotion pattern to a word, examiners should have practice, and we strongly have to have standardization.

Each examiner show, but their expression of emotion is not correct. The results are different from a person's facial expressions, even in the same order, such as anger, anxiety, and others.

How much environment can give influence the results of facial emotion recognition is not important as far as they (examiner) express well and correct their emotion to word.

For example, Fig. 9 of pleasure shows different results even though expression by the same person because their facial expression pattern is different to the same pleasure meaning.

Not only that, even though different background environments, if they have a correct expression, the results of facial emotion pattern show well to the meaning of the word.

However, the environmental situation is not serious in the expression of emotional patterns through this analysis.

V. CONCLUSION

This paper deals with the results of the facial emotion pattern analysis of Korean. The facial emotional pattern can use in several areas, such as robots, communication, e-learning, dementia prevention and analysis, entertainment robot, and so on.

The expression style of facial emotion patterns, such as happiness, anger, sadness, embarrassment, injury neutral, and pleasure is different depending on the person and country. Its recognition delicacy can be varied with the recognition method and facial expression patterns. Therefore, each country's dataset of facial emotion patterns should be confirmed and analyzed.

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This paper aim is to provide the analysis results of Korean facial emotion expression pattern with happiness, anger, sadness, embarrassment, injury neutral, and pleasure and their expression accuracy to confirm efficiency of online education. This paper uses public datasets that agency (AI-Hub) prepared and uploaded for AI development and infra. To analysis, this paper uses DCGAN.

Results of pattern expression analysis reveal a slightly different depending on persons. Pattern analysis should be studied by another analysis method styleGAN or transfer learning to compare accuracy.
However, environment's influence is not serious in recognition.

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