

# Facial Expression Recognition

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## Abstract

### Complete this section for D4.

The *Abstract* should be at most 150 words long, and should summarize briefly what your project is about. This includes the motivation for the problem (2-3 sentences), the problem you tackled (2-3 sentences), and your main results (1-2 sentences).

## Introduction

The *Introduction* section (~1 page) describes the background and motivation behind your work, and provides an overview of the work and the findings. It should include the following content.

- **Complete this part for D1.**

Motivate your entire paper. At a high level, describe the problem that your project is addressing. Why is this an important problem to tackle? If there is a solution to this problem, what are some potential real-world impacts of this solution? Try to give a compelling motivating story. If possible, support your argument with evidence such as facts and statistics. (2-3 paragraphs)

Facial expression, a form of nonverbal communication, is a very powerful signal of human emotions. A facial expression is built by the motions and positions of muscles beneath the skin. In normal communication, reading other people's facial expressions correctly can be vital for a person in maintaining relationships and pursuing career goals. Facial expression recognition (FER), a research field in computer vision and machine learning, is to determine the emotion of a person based on facial expressions. In the 1970s, Ekman and Keltner suggested that some facial behaviors that are universally associated with particular emotions regardless of cultures Intro1. These basic facial expressions are happiness, sadness, anger, surprise, disgust, and fear. Describing other emotions in terms of discrete basic emotions is the most popular aspect for FER because of the pioneering investigation and the easy-understanding definition of facial expressions.(?)

For real-life applications, FER technologies can be applied in a wide range of fields such as robotics and human-computer interaction systems. For example, a specific FER system that recognizes the facial behaviors of fatigue can be applied to driver fatigue surveillance systems. According to National Highway Traffic Safety Administration, drowsy driving kills 795 lives in 2017. Active warning of fatigue to the driver can certainly reduce the death number. FER systems can also be used as lie detection for the police. For social robotics, if the robot can recognize the emotion of the speaker using facial expressions along with the speech and respond considering the emotion, its response will be more appropriate and more similar to a real person.

- **For D1, describe the problem and your methodologies only. Then, complete this part for D4.**

Describe, at a high-level, the problem you tackled and your main results. What research questions are you trying to answer? What methodologies did you use to answer the question? What are the performance measures that you used to evaluate the methodologies? Describe your key findings in 2-3 sentences. (2-3 paragraphs)

- **Complete this bullet point for D4.**

Emphasize your contributions. How should we interpret the results? Why should people care about this work? Does this project introduce any novel techniques or reveal any unexpected findings? In bullet point form, list 3-4 key contributions of your project.

## Related Work

Facial recognition is utilized in industry with a wide range of application. Many researches have been performed on facial recognition, and they are focusing on aspects such as gathering data sets, fetching facial features, and training recognition models. Since people share similarities in facial structure, it can be hard to recognize a single person in a crowd of people. Therefore, most of the researches are focusing on a specific area of facial recognition. One aspect is human mood recognition, and researches can take the advantage of the similarity of people's facial structures since people share common features for the same facial expression. Based on this, researches proposed a compact frame-based facial ex-

pression recognition framework for facial expression recognition, and it uses less parameters for training process (?).

Since facial expressions are classified, researchers are considering using k-nearest neighbours(KNN) for facial expression recognition. Dino et al. created a model using Viola-Jones algorithm for face detection, and KNN for classification (?). However, it was only able to achieve an accuracy of 79.97% (?).

To get a model with higher accuracy, one possible approach to perform facial expression recognition is utilizing Neural Network. For example, Saket S Kulkarni created a model for facial expression recognition. The model applied committee neural networks with several facial parameters extracted from facial images (?). The system was able to achieve a test accuracy of 90.43% based on a test set of 282 images. However, this model has high requirement to the database. This system was not robust enough to detect the exact expression correctly if the database does not contain both spontaneous and deliberate expressions (?).

To further increase the accuracy of facial expression recognition, a solution is to create a more complex model to include more parameters. Deepface used a nine-layer deep neural network, and the network takes more than 120 million parameters using several locally connected layers without weight sharing, rather than the standard convolutional layers (?). They also utilized a more complex dataset, and by doing this they got a system with accuracy 97.35%, and got a performance that is close to human level (?).

## Methodology

### Complete this section for D2.

The *Methodology* section (~2 pages) describes the algorithms that you chose to implement. Describe in details how each algorithm works. Include their mathematical formulations, if necessary. Include pseudo-code, if necessary. If you had to extend an existing algorithm in order for it to work with the problem, describe in details what is different/new. Provide a rationale for why you selected these particular algorithms and how they are appropriate for the problem. You should provide enough details so that someone can reproduce the steps and replicate your results.

If you are tackling a machine learning problem, you may be using an existing data set or creating a new data set. In this case, you should describe the data-set that you are analyzing as well as any data filtering and merging procedures that you used to prepare/create your data-set. Your description should include the size of the data-set(s) (i.e., number of examples), whether the class labels are balanced/imbalanced, the meaning of the features, and other unique characteristics of the data-sets. Explain why the data-sets are appropriate for your problem and what are their limitations. Include the URL of the websites from which you downloaded the data-set(s).

You should also describe any pre-processing steps you took to prepare or create the final data-set that you used to train and test the algorithms. Examples of pre-processing steps include procedures for joining multiple data-sets, filtering out certain examples, scaling features, etc. Provide

the rationale for why you are using these data preparation procedures, with enough details so that someone can reproduce the steps and replicate your results. For example, if you chose to re-scale certain features, explain how the re-scaling was done and why.

## Results

### Complete this section for D2 and D3.

The *Results* section (~2 pages) describes how you evaluated the algorithms and reports the findings.

#### Complete the following two paragraphs for D2.

Describe the measures that you used to evaluate the algorithms. Be as precise as possible by including their mathematical formulations. Provide a rationale for why these performance metrics are appropriate for your problem.

Describe other details about your experimental design. If you are tackling a machine learning problem, include details such as how you created the training, validation and test set, how you selected the model's hyper-parameters, etc.

#### Complete the following two paragraphs for D3.

Describe the findings from your evaluation. Describe both (a) how well your techniques worked, and (b) what you learned about the problem through these techniques.

Prepare figures (e.g., Figure ??) and tables (e.g., Table ??) to describe your results clearly. Make sure to label your figures and tables and explain them in the text. If you are comparing the performance of algorithms, include statistical tests to assess whether the differences are statistically significant. If possible, describe how your techniques compare to prior work.

Techniques	F-1 Score
Baseline	0.80
Another Baseline	0.76
My Awesome Algorithm	<b>0.95</b>

Table 1: example of a table summarizing the results

## Discussion

### Complete this section for D4.

The *Discussion* section (~1 pages) describes (a) the implications of your results, and (b) the impact and the limitations of your approach.

For the results, describe how a reader should interpret them. Try to form concise take-away messages for the reader. For your approach, describe the extent to which your approach helps to solve the problem. Describe any limitations of your approach. If possible, compare your results and your approach to that of prior work.

## Conclusion

### Complete this section for D4.

The *Conclusion* section (~0.5 pages) provides a brief summary of the entire paper. In this section, describe

- the motivation, the problem, and your results, and
- 3-4 promising future directions.

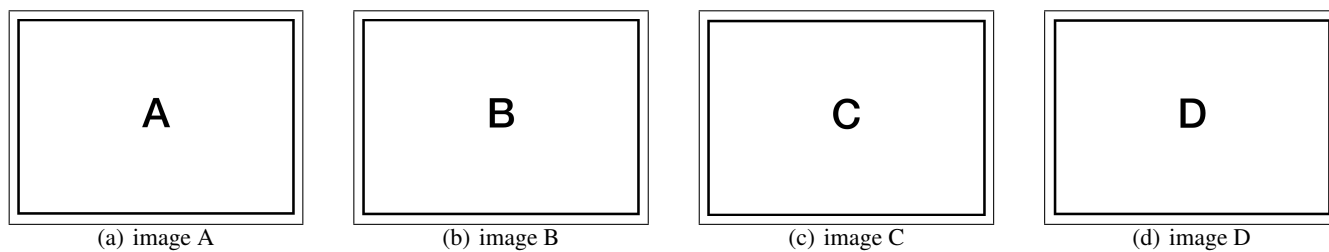


Figure 1: Another example of figure layout

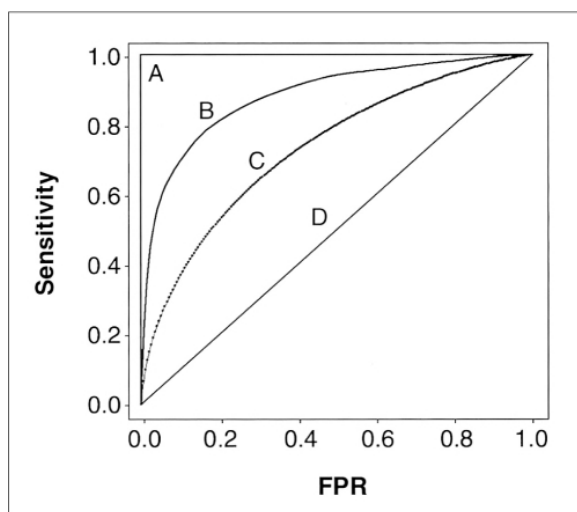


Figure 2: ROC curve of my awesome algorithms