

# Facial Emotion Recognition using Neural Network

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Facial expression defines the person as a whole. Thus, there is emphasis on Facial Emotion Recognition system. Through this project we reviewed different CNN model on a FER2013 dataset through Transfer Learning and tried to come to a conclusion regarding the development of Facial Emotion Recognition System. We increased the accuracy from 0.25 to best of 0.642.

- In 2018, Soodamani Ramalingam, Facial Expression Recognition using Transfer Learning, uses the concept of transfer learning [5], the model was trained on Fer2013 dataset and was tested on Ck+ dataset. There was two pre-trained model VGG16 and VGG19 used VGG19 consist of one extra Convolutional layer for classification linear SVM was used. Its reaches the accuracy of 90% on CK+ dataset.
- In 2015, Kahou S.E., Michalski V., Konda K. , Recurrent Neural Networks for Emotion Recognition [1] Based on CNN They used RNN and CNN for fer, the data they worked on EmotiW. They used hybrid of both the network for information proportions. For the data set they combined two dataset FER2013 and TFD. They got test accuracy of 52.8%

- In 2015, Dolly Reney and Dr. Neeta Tripaath, An Efficient Method to Face and Emotion Detection, [6] combined a face detection algorithm called Viola-Jones algorithm, and a KNN classifier for Facial emotion detection. They used personalised dataset. they achieved upto 97% accuracy.
- In 2018, Amr Mostafa and Mahmoud I. Khalil and Hazem Abbas, Emotion Recognition by Facial Features using Recurrent Neural Networks, [4] they detect face by extracting local characteristics to generate geometric based feature. it has 82% accuracy to distinguish between angry and disgust.

# Identification of Research Gap and Problem

- To use geometric feature, relation between facial component to produce facial vector, Ghimire D., Lee J. in their paper Geometric feature-based facial expression recognition in image sequences using multi-class AdaBoost and support vector machines. [2] They used Euclidean distance and angles between each pair of landmark and then used them as parameters for building model.
- Approach by Happy, George and Routray [3] used the local binary pattern algorithm for the purpose of classification of the grayscale images into six classes. They used Local Binary Pattern and principal component analysis algorithm and training result was stored to classify features.
- For hybrid features, some approaches have combined geometric and appearance features to complement the weaknesses of the two approaches and provide even better results in certain cases.

# Expected Impact on Academics/ Industry

- Facial emotion recognition, because it extracts and analyses information from an image, it is able to deliver unfiltered, unbiased emotional responses as data.
- For criminal investigation, since FER delivers raw emotional responses, it can provide valuable information about the sentiment of a target audience.
- Our research and comparative study work in the same field thus gives a deep insight on the major in trend FER techniques with experimental proofs so that any newcomer in the industry can use our work as a guidebook.



# Methodology of the Project Work

- The method of convolution is used in the project. Convolution is a matrix operation which result in a new matrix. An image is nothing but a matrix representing color in each cell.
- In Convolution a matrix is multiplied by other matrix and a new matrix is produced, the new matrix produce represent the resultant of multiplication of two matrix. the matrix are square matrix of different dimension.

$$G[m, n] = (f * h)[m, n] = \sum_j \sum_k h[j, k] f[m - j, n - k]$$

INPUT

a	b	c	d
e	f	g	h
i	j	k	l
m	n	o	p

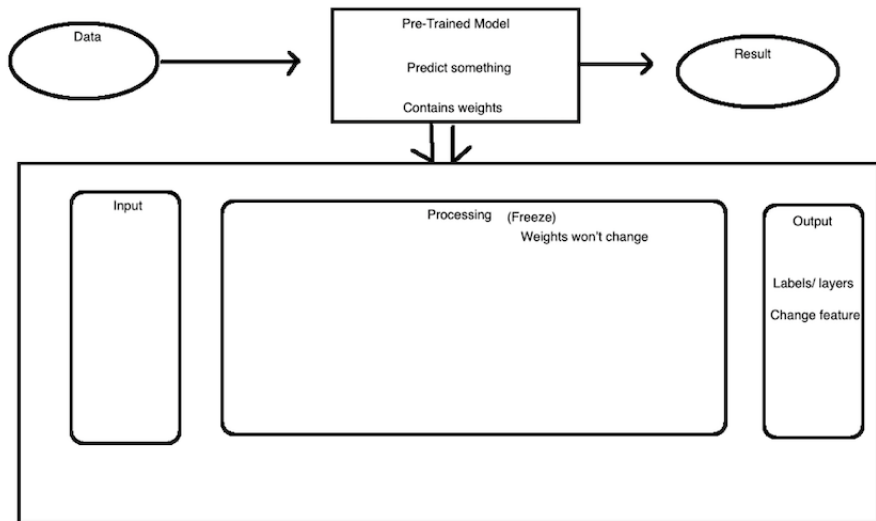
KERNEL

Q	R
S	T

\*

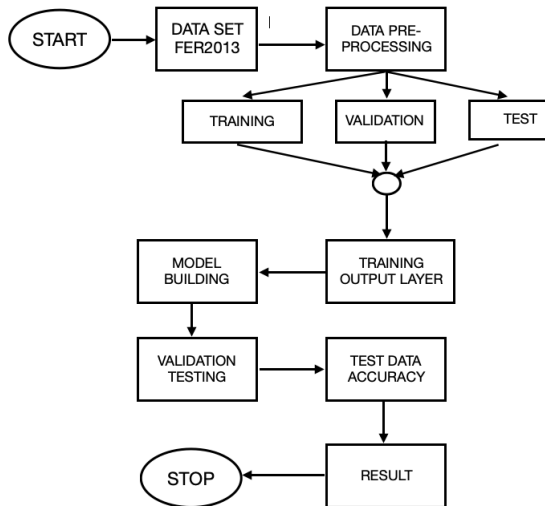
OUTPUT

$aQ+bR$ $+eS+fT$	$bQ+cR$ $+fS+gT$	$cQ+dR$ $+gS+hT$
$eQ+fR$ $+iS+jT$	$fQ+gR$ $+jS+kT$	$gQ+hR$ $+kS+lT$
$iQ+jR$ $+mS+nT$	$jQ+kR$ $+nS+oT$	$kQ+lR$ $+oS+pT$



## Transfer Learning

# Detailed Design



# Major Inputs Required

- Dataset: FER2013 from Kaggle
- Language of programming: Python
- Library: Keras, pandas, matplotlib, NumPy
- Framework: Tensorflow
- Input: Data in CSV format
- Processor: High-End GPU's or TPU's

# Implementation

- Facial emotion Recognition is a process in which the machine intelligently take and interpret the expression of a human face given in a form of image and classify it in the pre-defined category of emotion. The model defined takes care of data pre-processing, feature extraction, as well as classification.
- The traditional method uses machine learning classifier for the same but they were not efficient. The traditional machine learning classifier uses linear SVM, SVM, PCA and Nearest-mean classifiers which was not only inefficient but as the label increase the complexity of model also increases which at time was beyond understanding of humans.
- In the study we focus on modern technique and use Neural Network. Neural network overcomes the complexity as well as inefficiency of the traditional model. In this project We will mainly focus on convolution neural network (CNN) and few of their pre-trained model.

- First we downloaded the data from Kaggle, the folder contain the data with a Readme file. Describing the competition.
- All the processing was done on kaggle which provided us with necessary computational requirement.
- We use Python as our programming language. For the data-set we used pandas and matplotlib for data visualization, the data consist of three columns as emotion, pixel, and usage. our focus was pixel column.

No. of Rows	32,298(28,709 training and 3,589 testing)
No. of column	3 (emotion,pixel,usage)
pixel	2d array (48*48)

## *Emotional Label and No. of Images*

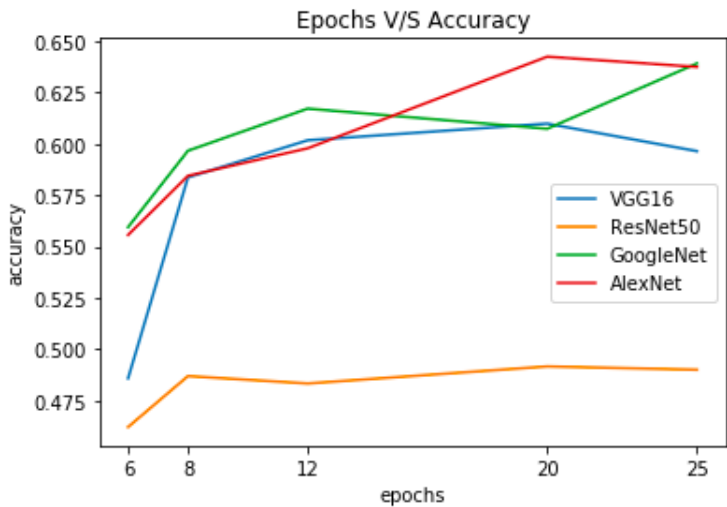
Happy	8989
Neutral	6198
Sad	6077
Fear	5121
Angry	4593
Surprise	4002
Disgust	547



- Once initial analysis was done. It was time for ready the data for training, which was done using CV2 python module.
- Once the data was ready training of data was started. We took different CNN model and train them. It took around 2h for each model to train on TPU's.
- Once the model training done we noted its accuracy which is summarised later.

# Results Obtained

- Through our study, we can see that the best accuracy on FER2013 dataset is 0.642 by Alexnet model at 20 epochs.
- Among all four model Resnet performed the worst with its best 0.4916 at 20 epochs.
- There are many reasons why the accuracy is low and hard to increase. For instance, missing labels in training sets, containing noises in datasets and overfitting can reduce the accuracy.



Results

# Originality and Innovation

- A combined and comparative study on importance of Facial Emotion Recognition in world of Artificial Intelligence. The FER model are not effective enough. Thus it was our attempt to use Deep Learning and increase effectiveness of the model.
- Introduction to Transfer learning and how can it be incorporated in Facial Emotion Recognition which greatly reduce the time for training models.
- The idea of building a model successful enough for recognising the facial emotion with great accuracy would help in many field of our day to day life, From medicine to criminal to neurology.

# Original Work Plan Completion

- As per original plan, we were successful in completion of the whole project. Through our project we learn the working of deep neural network model and a great insight of Facial Emotion Recognition. The Advancement on FER may be revolutionary in upcoming year.
- As result says we have successfully found a model which is able to predict emotion up to accuracy of 64% for unseen data.

# Originality Of Project

- In our Project we use Transfer Learning, which is a fairly new concept in Data Science. This helps to train model with very less amount of data with high accuracy.
- In Transfer Learning the model is already trained and weights are already defined. Later these weight are used to predict with very high accuracy of 64%. which is a lot considering the amount of clean data we had.

# New Idea Highlighted In Project

- Facial Emotion Recognition is one of the old topic relating to AI. But has never brought into commercial use is due to its lack of accuracy.
- To achieve good accuracy result for any unseen data is hard as model cannot be trained to such extent as data is not sufficient enough. Using Transfer Learning, helps to train high accuracy model with much less amount of data.

# Software Tools Used

- Python is our main language and all testing and training is done using same.
- For Facial Emotion Recognition we used Tensorflow 1.13.
- For Processing the data we used Numpy, Pandas, Matplotlib
- Testing of model is done by test data set from kaggle (Fer203).



# Challenges Faced And Solution

- The main problem faced by us was cleaning of data. The data present was not cleaned for training so initial pre-processing was required.
- The Other problem faced during execution of the project was the requirement of hardware. For training a model we required some high end hardware so to reduce the time for training. The available required hardware was for limited. So it took 4 weeks to train all the different model.

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