BOSTON UNIVERSITY

Emotion Detection

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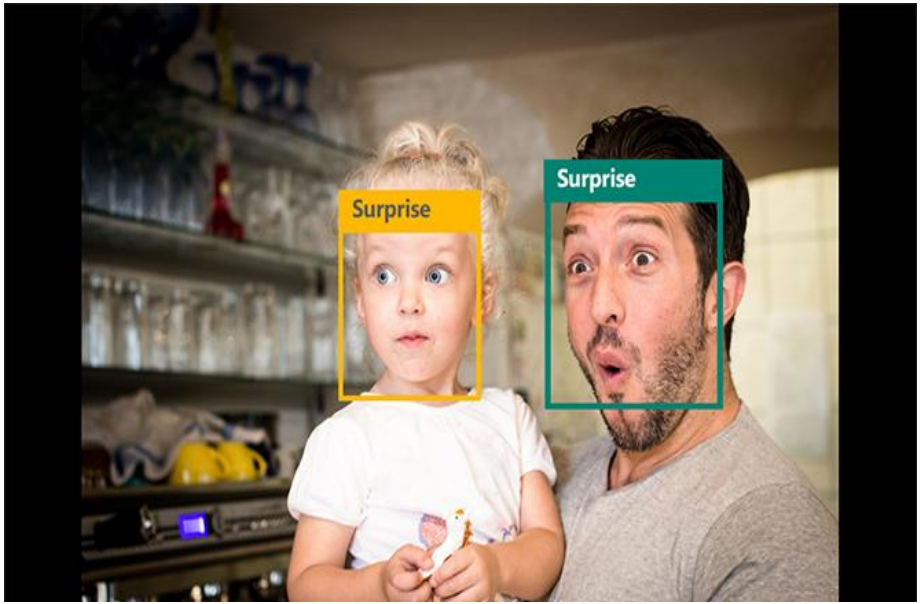
CS585 Final Project

Emotion Detection

- Applications
  - Smart home automation
  - Self-driving cars
  - Improving classroom dynamics
  - Helping people with disabilities



Project Setup

- Problem: Given the image of a person → classify the emotion
- Solution:
  - Support Vector Machines(SVMs)
  - Convolutional Neural Networks (CNNs)
- Assumptions:
  - Individual images express only one emotion
- Challenges:
  - Complexity of human emotion

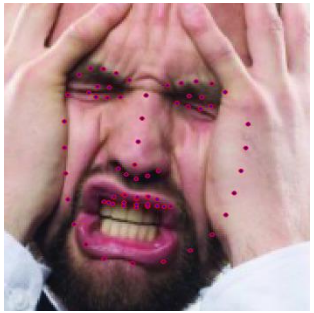
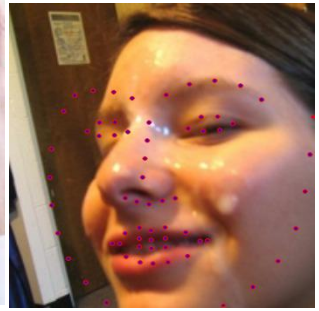
OpenFace

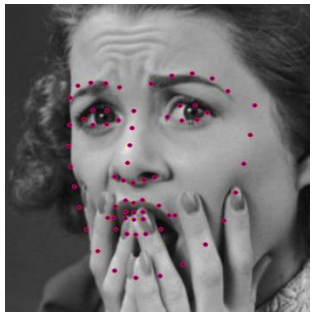
- State-of-the-art open-source facial analysis tool
- We used the Docker version of OpenFace Cambridge
- Creates facial landmarks, gaze direction, and facial action units

Openface: an open source facial behavior analysis toolkit
T Baltrušaitis, P Robinson… - Applications of Computer …, 2016 - ieeexplore.ieee.org
Abstract: Over the past few years, there has been an increased interest in automatic facial behavior analysis and understanding. We present **OpenFace**-an open source tool intended for computer vision and machine learning researchers, affective computing community and
☆ 99 Cited by 119 Related articles All 7 versions

https://github.com/TadasBaltrusaitis/OpenFace

68 Landmarks Detected by OpenFace

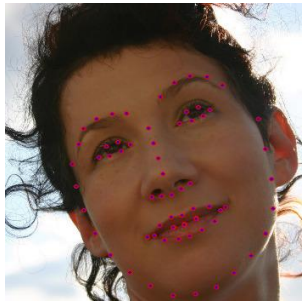
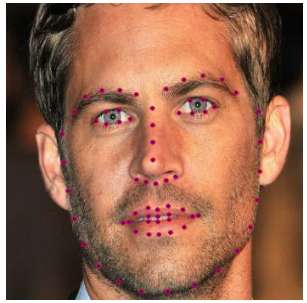
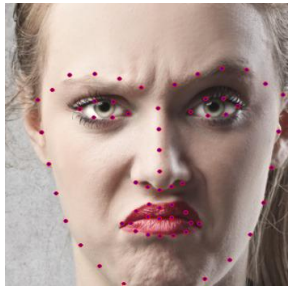





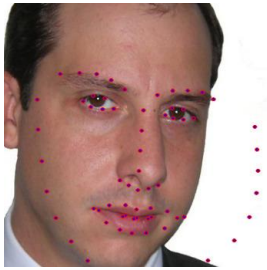
Incorrect estimations

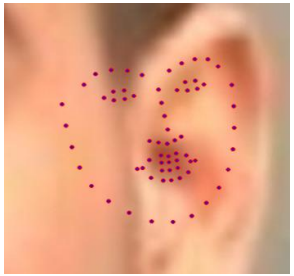
AffectNet Dataset

Correct estimations


Challenges





- Sometimes landmarks are not detected correctly (OpenFace problem).
- Extra low-resolution images (as in FER2013).
- Images with no face randomly in face datasets (AffectNet).
- Images with watermarks (as in FER2013)
- Some datasets have low number of images not suitable for deep learning (KDEF).

(Facial) Action Units (FAU/AU)

AU 1: Inner Brow Raiser

AU 12: Lip Corner Puller

OpenFace provides AU Intensity and Occurrence values

https://imotions.com/blog/facial-action-coding-system/

AUs contributing to Emotions

Multiple AUs form an emotion.

Happiness AUs: 6+12

Sadness AUs:
1+4+15

Datasets

DataSet	Source	# of images	Setup	Categories
FER-2013	ICML 2013 challenge [1]	35,887	Wild	7 emotions
KDFE	Karoliska Institutet [3]	4,900	Studio	7 emotions

Why FER2013?

- Wildly used in emotion recognition community

Why KDFE?

- Images are more similar to the debate images we are predicting on

Multi-class Support Vector Machines Results

- Input: vector with AU intensities and occurrences

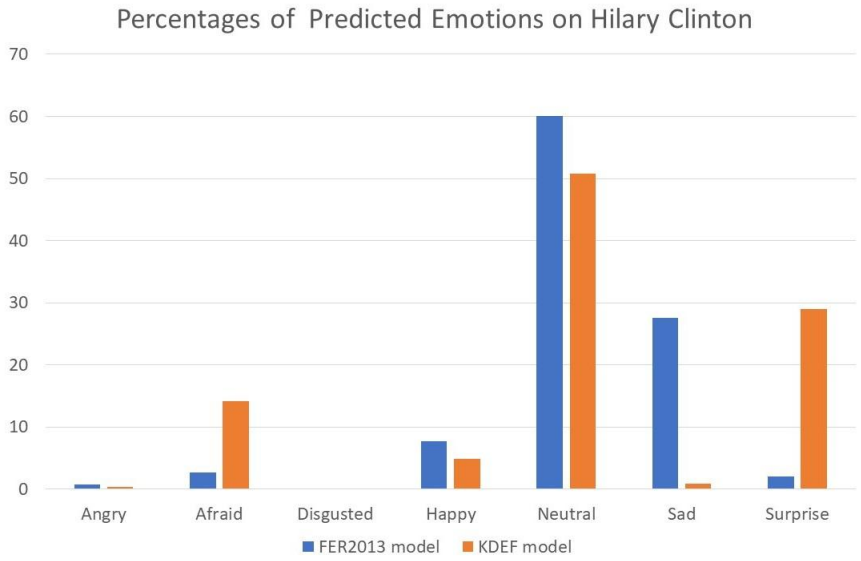
  5200 vectors for FER2013

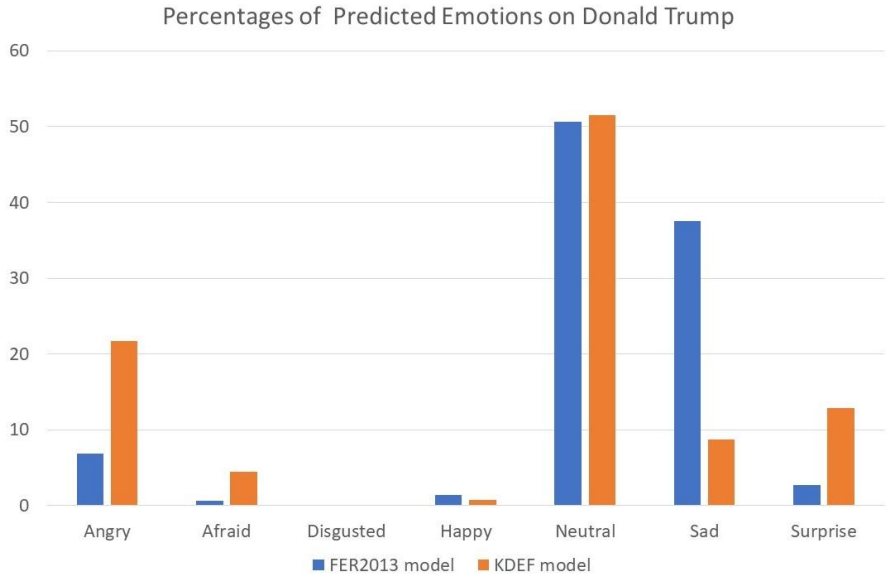
  3022 vectors for KDFE

- Emotion classes: angry, disgust, fearful, happy, sad, surprised and neutral.

DataSet	Training set	Validation set	Accuracy	F1 score
FER-2013	4420 images	780 images	45.3%	0.4218
KDFE	2568 images	453 images	67.4%	0.6709

Comparison of Classification Results





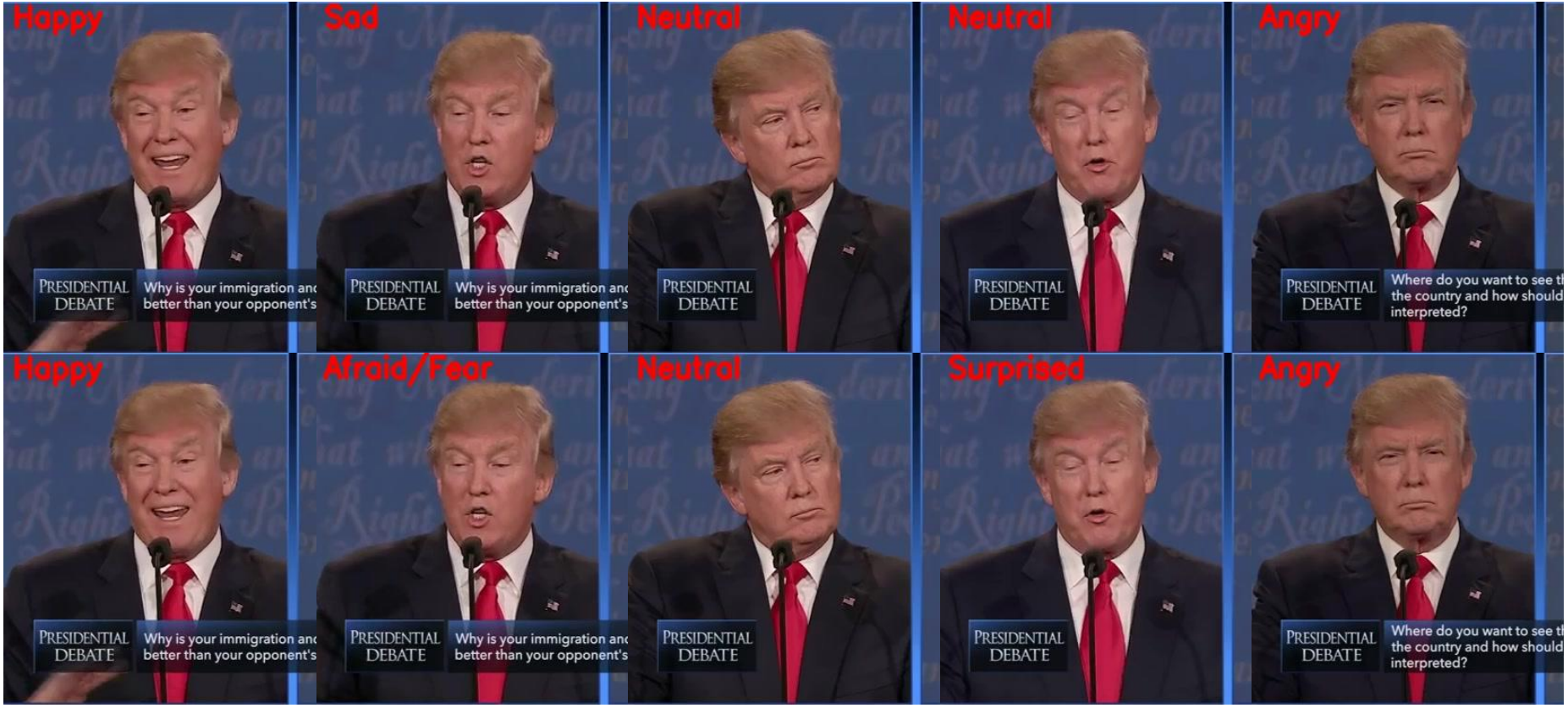
Ran on a sample of 1372 frames from the debate

Classification Results

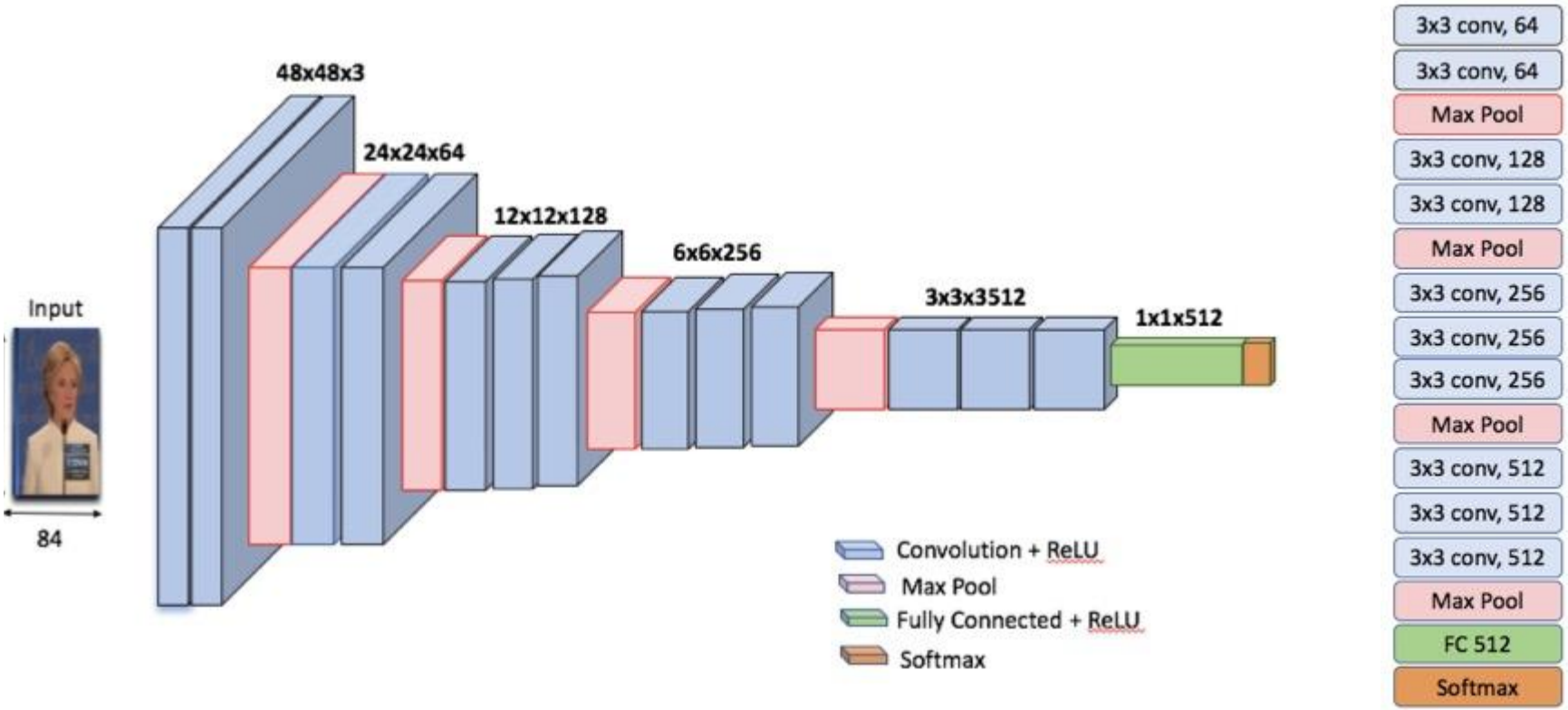
Top KDFE - Bottom FER2013

Classification Results

Top KDEF - Bottom FER2013



Convolutional Neural Network Architecture



Convolutional Neural Network architecture for emotion classification (VGG16)

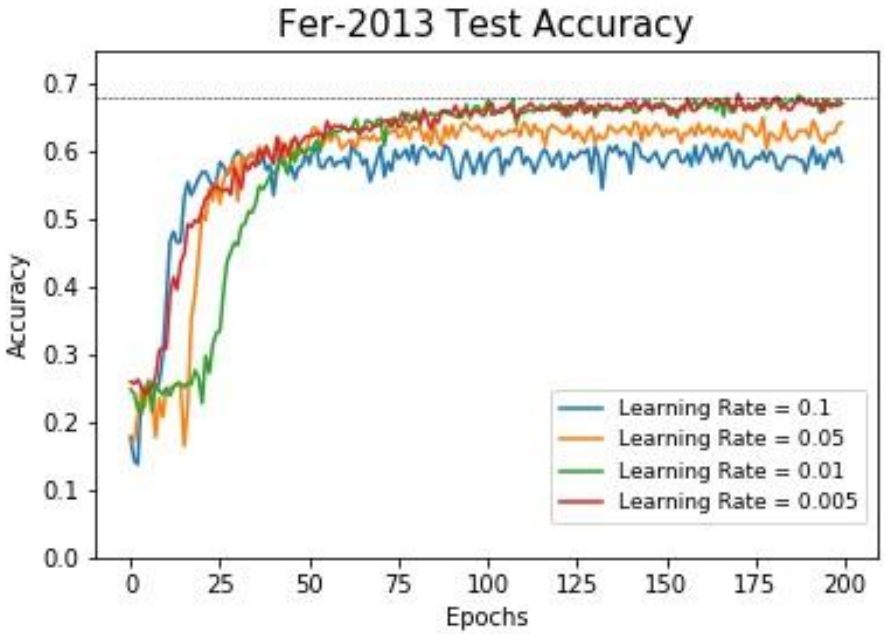
Convolutional Neural Network

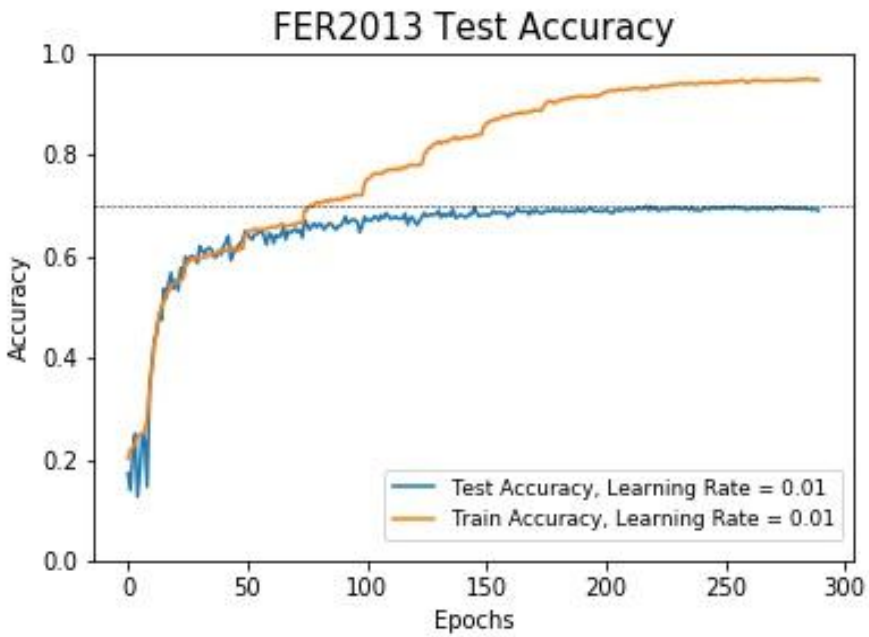
- Datasets

DataSet	Source	# of images	Setup	Categories
FER-2013	ICML 2013 challenge [1]	35,887	Wild	7 emotions
AffectNet	A. Mollahosseini et. al [2]	1, 000, 000	Wild	8 emotions

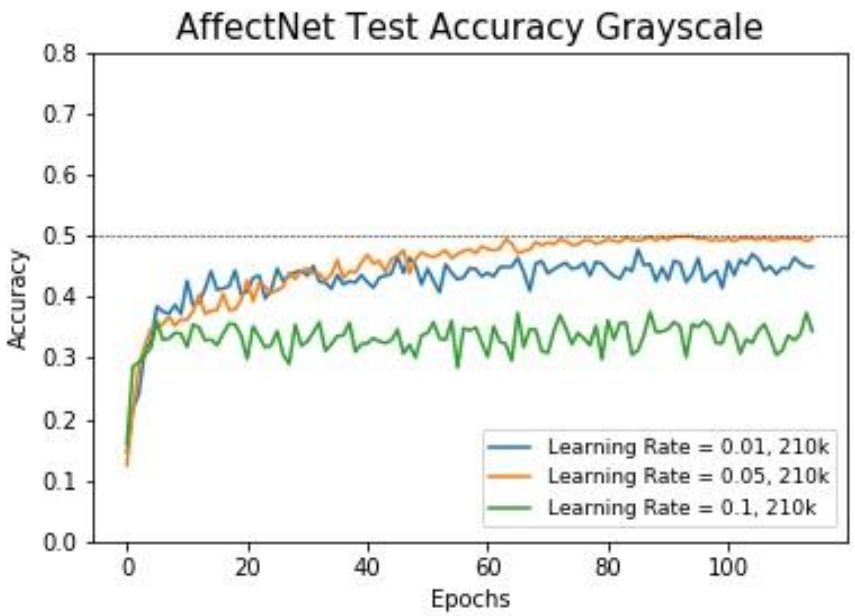
- Image Augmentation
  - Image rotation
  - Vertical shift
  - Horizontal shift

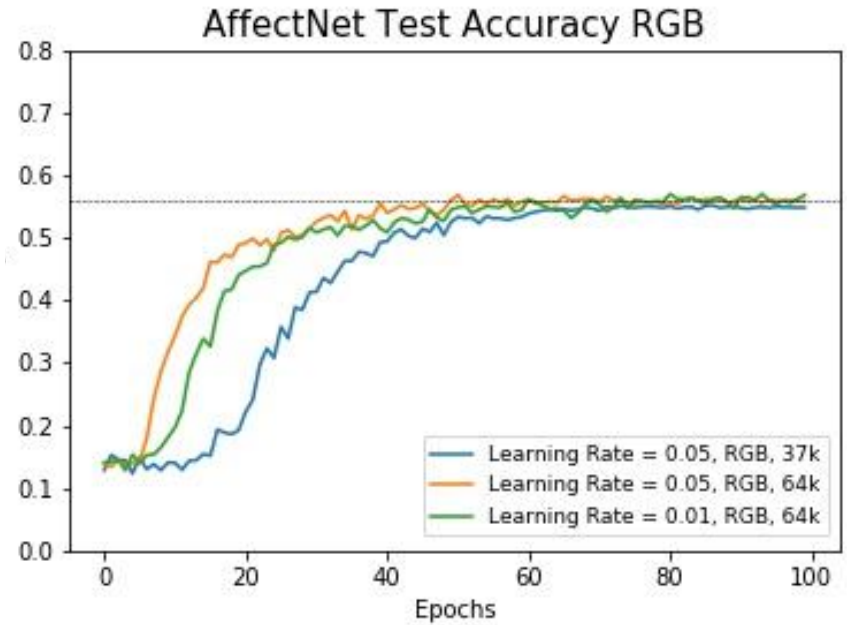
CNN - FER2013 Results



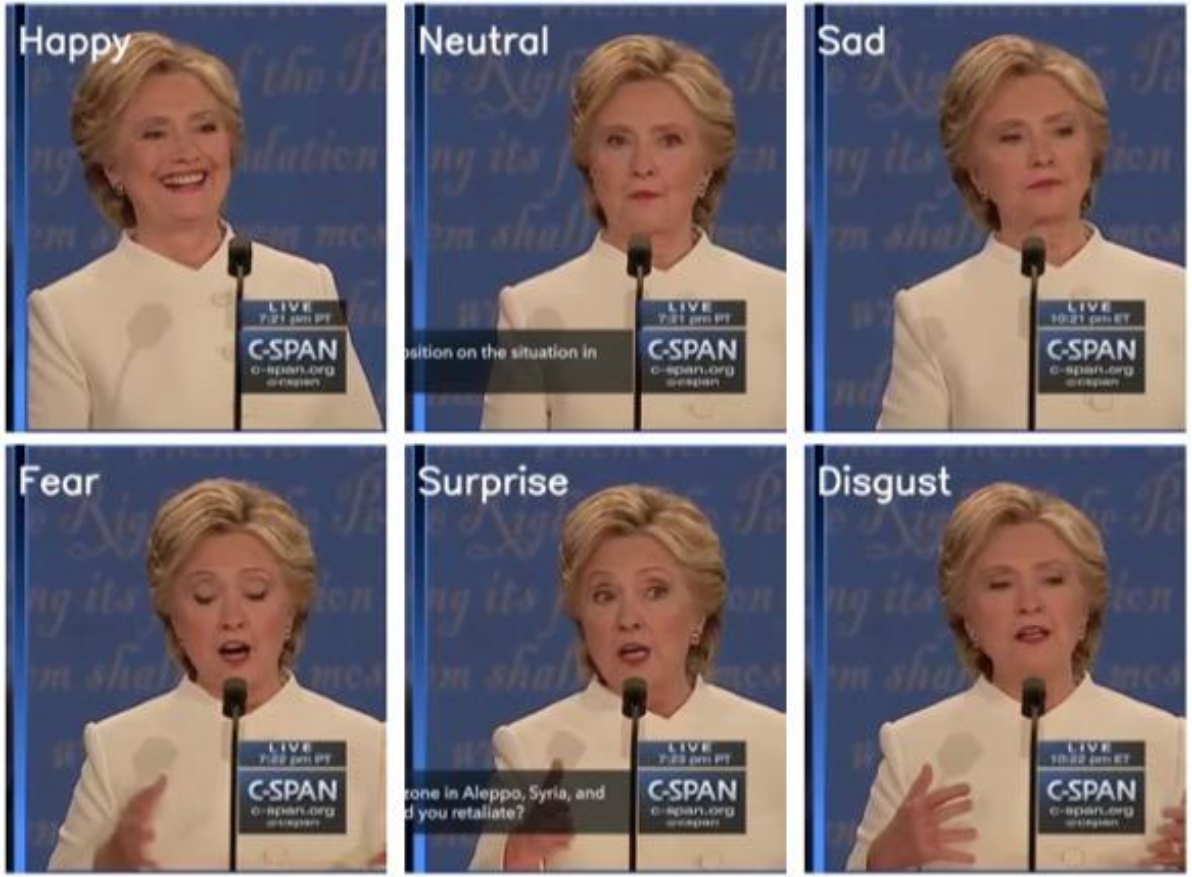


CNN - AffectNet Results





CNN - FER2013 Classification Results



CNN - FER2013 Classification Results

CNN - FER2013 Results Videos

Conclusion

- CNNs perform better than action units/SVM for FER-2013
- Hyper-parameter tunings for the CNNs affect our results significantly.
- Results from one dataset to another one are not transferable by default.

Future Work

- Emotion detection using Recurrent Neural Networks(RNN).
- Using multi-modal classifier incorporating voice, and video signals besides the still images from video.
- Using domain adaptation for detecting emotion in caricature, sketch and animation images.
- Group-level emotion detection using EmotiW 5.0 dataset.

References

1. **Kaggle FER2013 Challenge**, https://www.kaggle.com/c/challenges-in-representation-learning-facial-expression-recognition-challenge/data, 2013.
2. A. Mollahosseini, B. Hasani, and M. H. Mahoor, **AffectNet: A New Database for Facial Expression, Valence, and Arousal Computation in the Wild**, IEEE Transactions on Affective Computing, 2017.
3. Lundqvist, D., Flykt, A., & Öhman, A. (1998). The Karolinska Directed Emotional Faces - KDEF, CD ROM from Department of Clinical Neuroscience, Psychology section, Karolinska Institutet, ISBN 91-630-7164-9.