

Facial Emotion Recognition and Interpretation

Computer Vision & Deep Learning
SEP Final Project

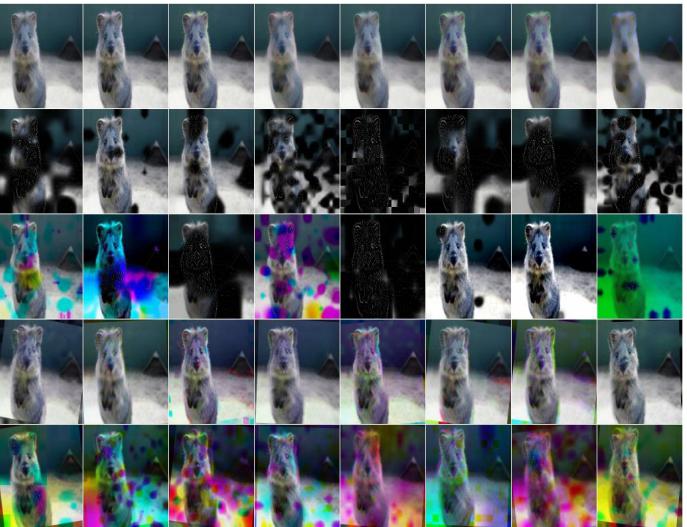
Mahdi Mohammadi, Leah Kawka, Jiawen Wang





Data Augmentation

- Increase diversity and amount of data
- Helps network to learn about invariances in data domain
- Important for small and unbalanced datasets



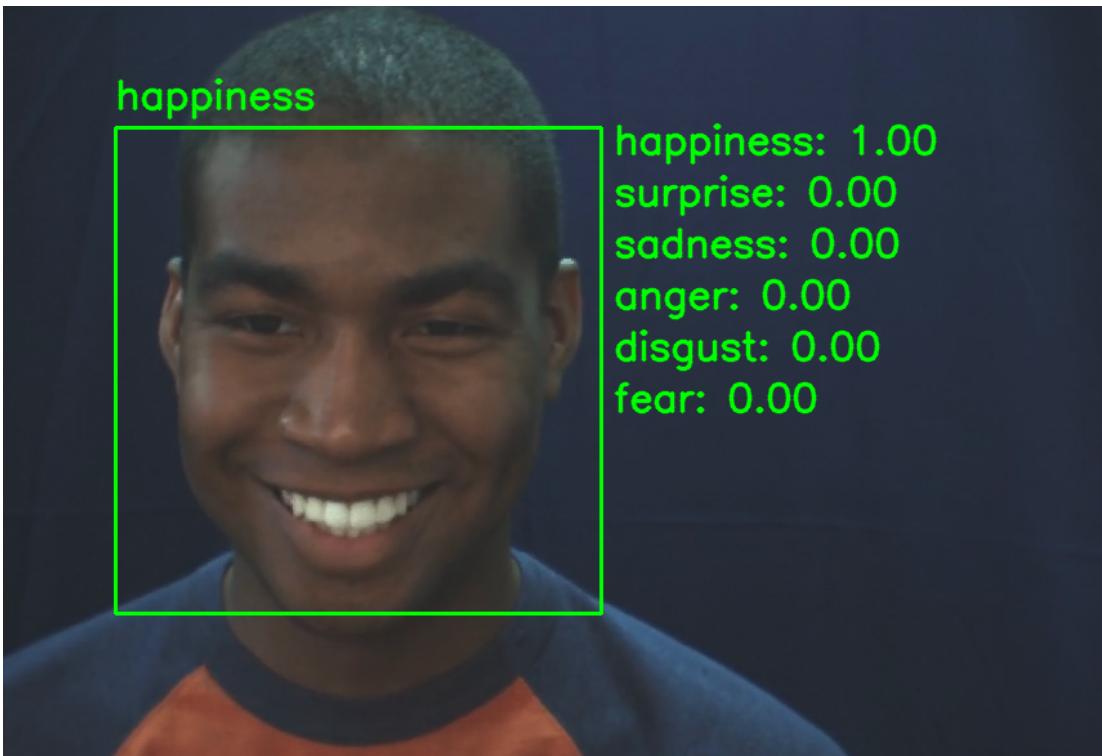


Introduction (Mahdi)

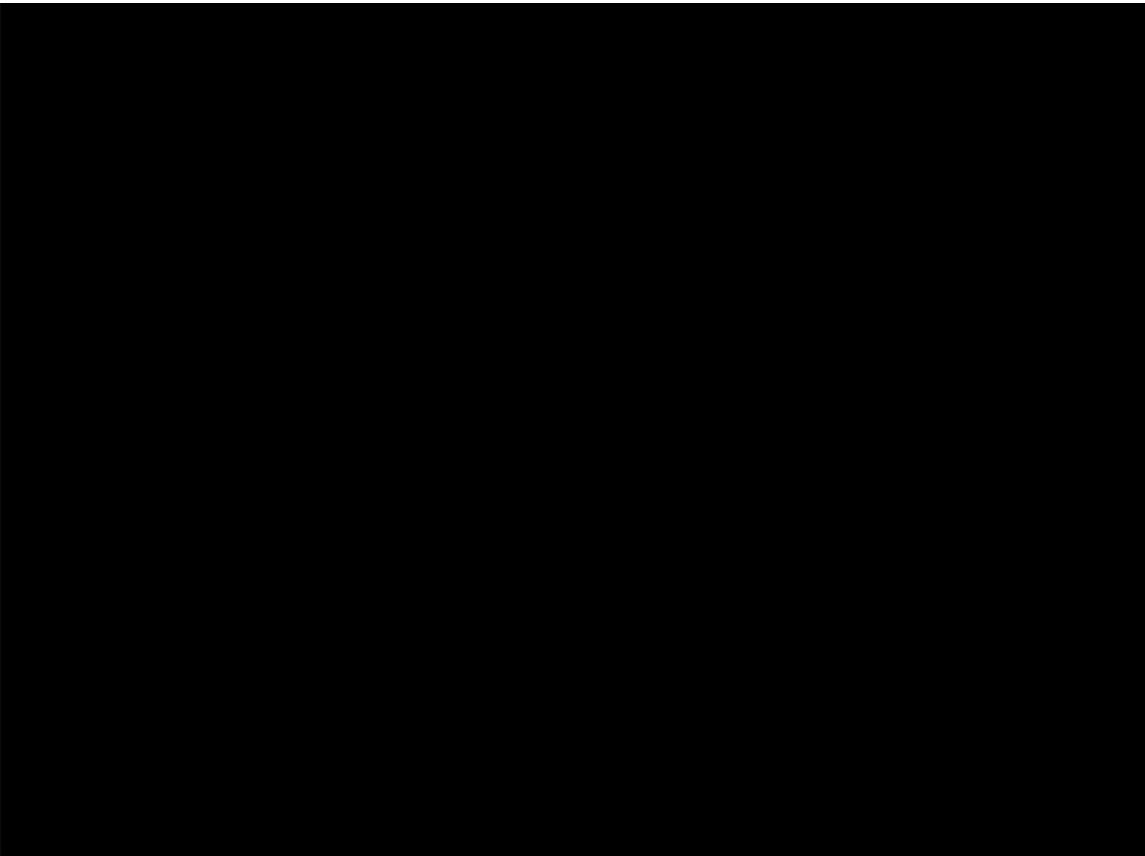
- CAM & GradCam



Demo Video

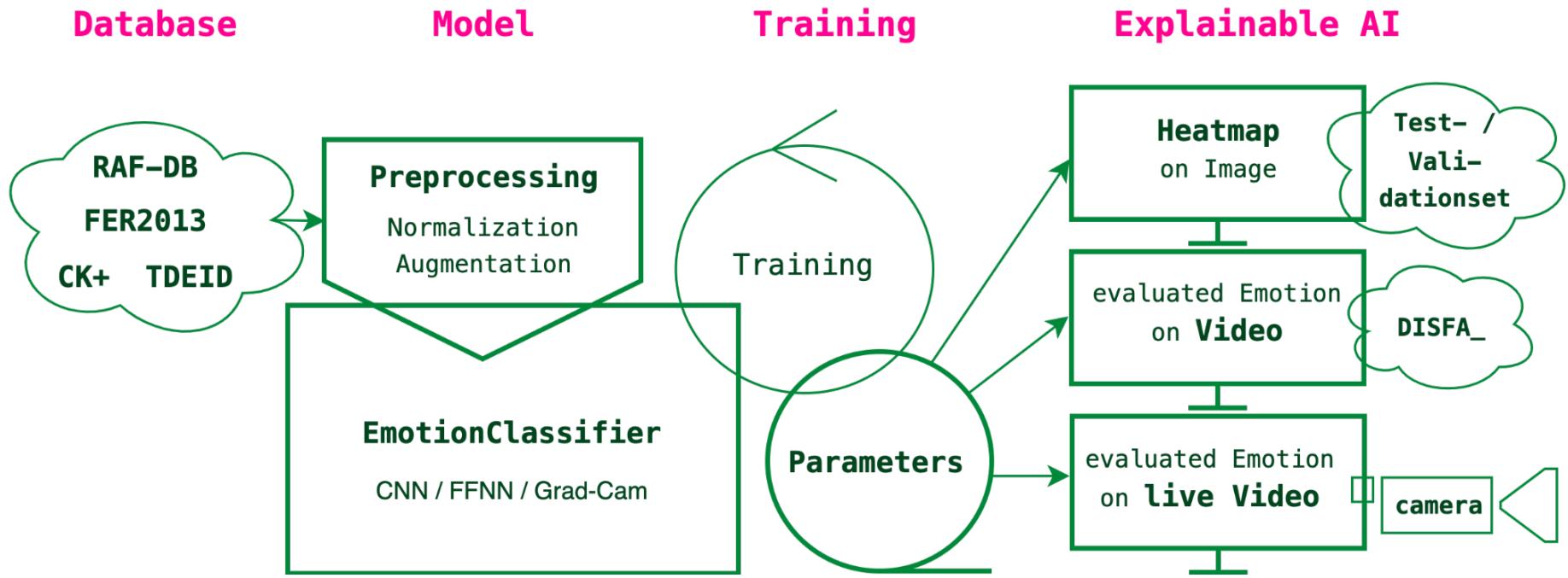


Demo Video



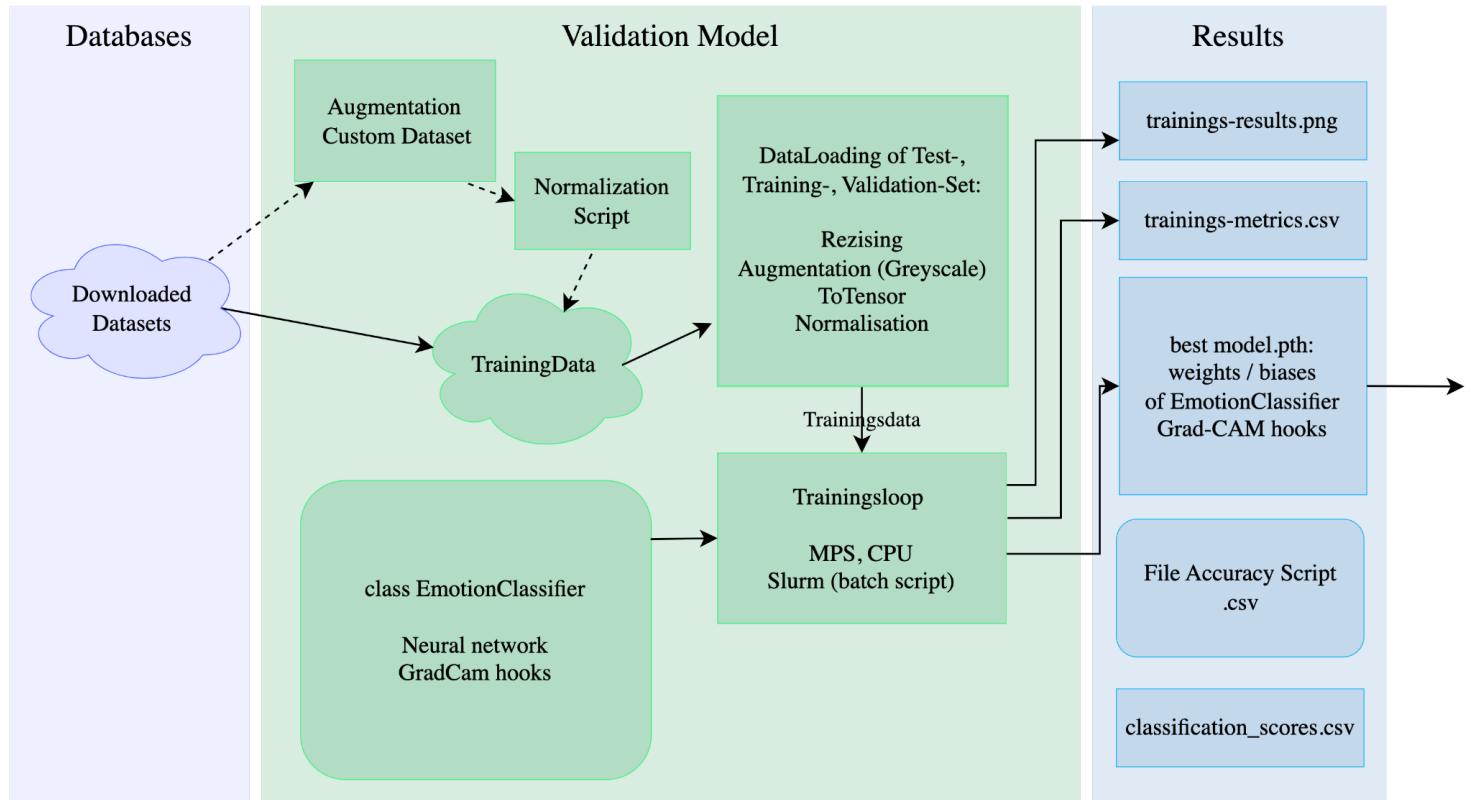


Global Experimental Pipeline



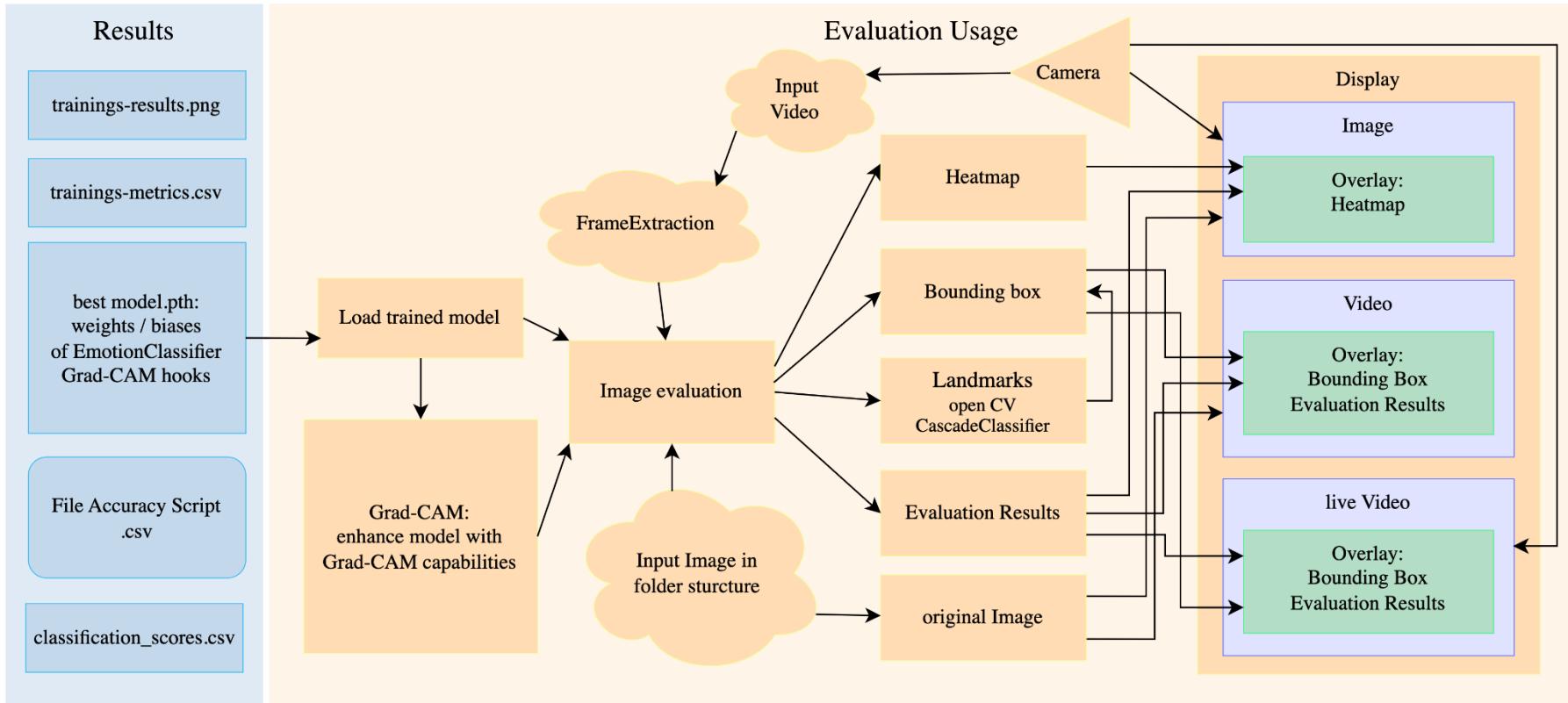


Detailed Experimental Pipeline





Detailed Experimental Pipeline



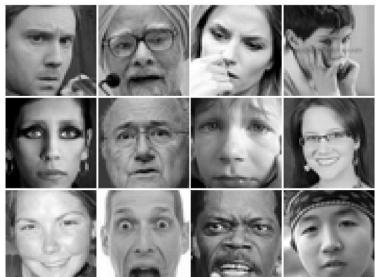


Datasets



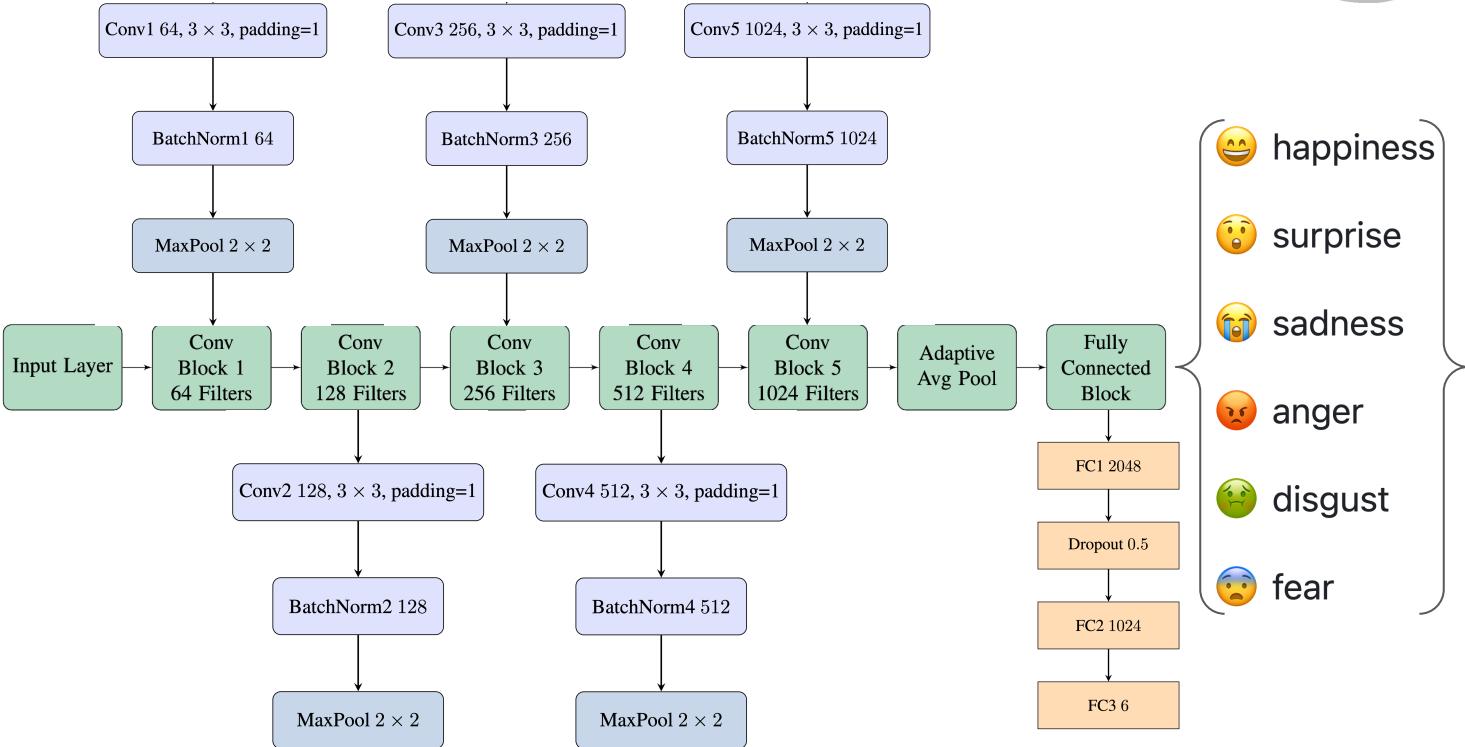
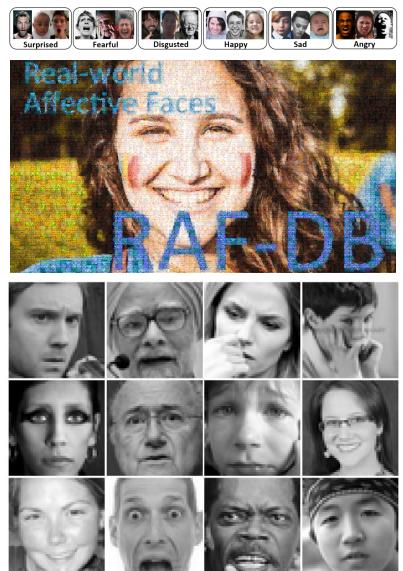
Dataset	#Images in training set	#Images in testing set	# Video/Images in validation set
Denver Intensity of Spontaneous Facial Action Database (DISFA [13])	-	-	27
Real-world Affective Faces Database (RAF-DB [8, 9])	9747	2388	600
Facial Expression Recognition 2013 (FER2013 [1])	23743	5945	600
Extended Cohn-Kanade Dataset Plus (CK+ [11])	309	-	600
Taiwanese Facial Expression Image Database (TFEID [3, 10])	229	-	600

Table 3. Overview of the datasets statistics used in our experiment





Model Architecture





Empirical Results

DATASET	MODELS	ARCHITECTURE	ACCURACIES			# PARAMETERS
			Training	Testing	Validation	
RAF-DB [8, 9]	ResNet18 [5]	Residual Block	98.9	81.3	67.9	11179590
	Ours (13 layers)	+BN-SE	96.6	80.6	66.8	2606086
	Ours (10 layers)	-BN-SE	96.3	76.9	60.6	10474118
	Ours (16 layers)	+BN+SE	98.4	81.7	71.1	10478598
	Ours (15 layers)	+BN-SE	98.6	83.1	72.1	10478086
	Ours (17 layers)	+BN-SE	97.5	82.5	70.0	41950726
FER2013 [1]	Ours (13 layers)	+BN-SE	86.6	64.1	40.2	2606086
	Ours (15 layers)	+BN-SE	89.6	65.6	40.7	10478086
	Ours (17 layers)	+BN-SE	96.0	65.5	41.6	41950726

Table 2. Accuracies (%) for different models (with specific architectures and numbers of parameters) in our experiments (Note that SE stands for the squeeze and excitation block and BN for the batch normalization; +/- represent with/without respectively)



Explored Hyper-parameters

Hyperparameter	Value
Learning rate	{0.01, 0.001, 0.0001}
Batch size	{8, 16, 32, 64}
Dropout rate	{0.2, 0.5}
Epoch	{20, 30, 40}
Early stopping	{True, False}
Patience	{5}

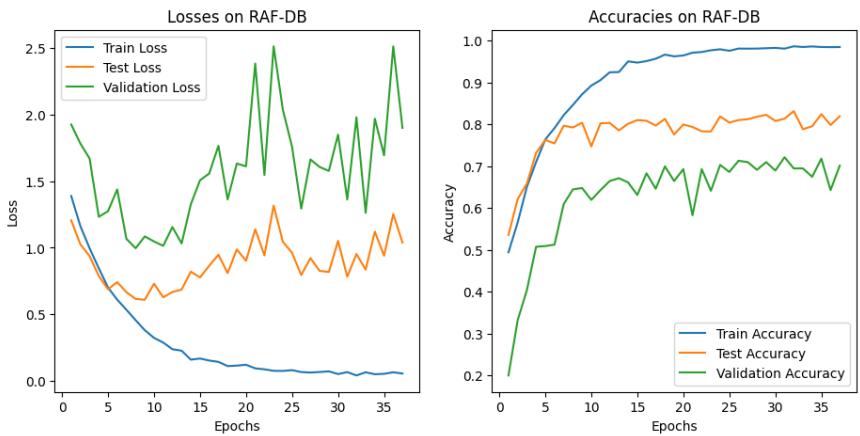


Table 4. Explored hyperparameter space for our models



Why is **interpretability** important?

- Know how models make decisions
- Know what happened in models
- Understand why
- Understand why not
- See when we succeed
- See when we fail
- Further improve the data
- Further improve the model

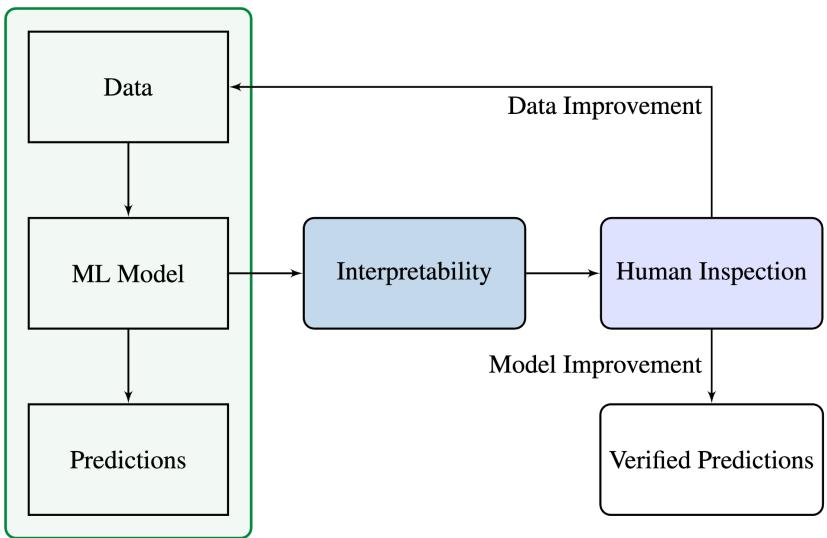
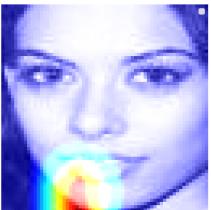


Figure 1. Overview of the traditional standardized ML evaluation process (see the illustration in the large **green** box) and the explainable AI pipeline



Interpretable Results (XAI)

😊 happiness



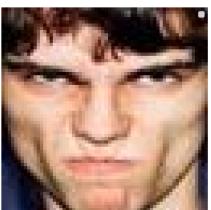
😱 surprise



😭 sadness



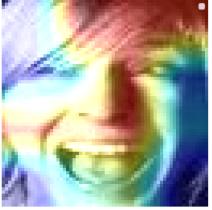
😡 anger



🤢 disgust



😨 fear





Classification Results

filepath	happiness	surprise	sadness	anger	disgust	fear
archive/RAF-DB/test/test_0524_aligned_happiness.jpg	1.00	0.00	0.00	0.00	0.00	0.00
archive/RAF-DB/test/test_0093_aligned_happiness.jpg	1.00	0.00	0.00	0.00	0.00	0.00
archive/RAF-DB/test/test_2193_aligned_sadness.jpg	0.03	0.01	0.90	0.01	0.02	0.04
archive/RAF-DB/test/test_1214_aligned_happiness.jpg	1.00	0.00	0.00	0.00	0.00	0.00
archive/RAF-DB/test/test_1816_aligned_surprise.jpg	0.00	1.00	0.00	0.00	0.00	0.00
archive/RAF-DB/test/test_0294_aligned_surprise.jpg	0.01	0.99	0.00	0.00	0.00	0.00
archive/RAF-DB/test/test_1128_aligned_happiness.jpg	1.00	0.00	0.00	0.00	0.00	0.00
archive/RAF-DB/test/test_1799_aligned_sadness.jpg	0.37	0.02	0.45	0.02	0.1	0.03
archive/RAF-DB/test/test_0610_aligned_sadness.jpg	0.02	0.00	0.74	0.02	0.21	0.01
archive/RAF-DB/test/test_1373_aligned_anger.jpg	0.00	0.00	0.00	1.00	0.00	0.00
archive/RAF-DB/test/test_1788_aligned_fear.jpg	0.00	0.00	0.00	0.00	0.00	1.00
archive/RAF-DB/test/test_0007_aligned_disgust.jpg	0.03	0.05	0.03	0.58	0.18	0.13
archive/RAF-DB/test/test_0804_aligned_disgust.jpg	0.02	0.00	0.18	0.02	0.77	0.00

Table 1. Overview of our random testing results examples extracted from the CSV file



Literature

- [1] Emad Barsoum, Cha Zhang, Cristian Canton-Ferrer, and Zhengyou Zhang. Training deep networks for facial expression recognition with crowd-sourced label distribution. In *Proceedings of the 18th ACM International Conference on Multimodal Interaction, ICMI 2016, Tokyo, Japan, November 12-16, 2016*, pages 279–283. ACM, 2016.
- [3] L.F. Chen and Y.S. Yen. Taiwanese facial expression image database, 2007.
- [5] Kaiming He, Xiangyu Zhang, Shaoqing Ren, and Jian Sun. Deep residual learning for image recognition. In *2016 IEEE Conference on Computer Vision and Pattern Recognition, CVPR 2016, Las Vegas, NV, USA, June 27-30, 2016*, pages 770–778. IEEE Computer Society, 2016.
- [8] Shan Li and Weihong Deng. Reliable crowdsourcing and deep locality-preserving learning for unconstrained facial expression recognition. *IEEE Transactions on Image Processing*, 28(1):356–370, 2019.
- [9] Shan Li, Weihong Deng, and Junping Du. Reliable crowd-sourcing and deep locality-preserving learning for expression recognition in the wild. In *2017 IEEE Conference on Computer Vision and Pattern Recognition, CVPR 2017, Honolulu, HI, USA, July 21-26, 2017*, pages 2584–2593. IEEE Computer Society, 2017.
- [10] Shanshan Li, Liang Guo, and Jianya Liu. Towards east asian facial expression recognition in the real world: A new database and deep recognition baseline. *Sensors*, 22(21): 8089, 2022.
- [11] Patrick Lucey, Jeffrey F. Cohn, Takeo Kanade, Jason M. Saragih, Zara Ambadar, and Iain A. Matthews. The extended cohn-kanade dataset (CK+): A complete dataset for action unit and emotion-specified expression. In *IEEE Conference on Computer Vision and Pattern Recognition, CVPR Workshops 2010, San Francisco, CA, USA, 13-18 June, 2010*, pages 94–101. IEEE Computer Society, 2010.
- [13] S Mohammad Mavadati, Mohammad H Mahoor, Kevin Bartlett, Philip Trinh, and Jeffrey F Cohn. Disfa: A spontaneous facial action intensity database. *IEEE Transactions on Affective Computing*, 4(2):151–160, 2013.
- <https://www.kaggle.com/datasets/shuvoalok/raf-db-dataset>
- <https://www.kaggle.com/datasets/msambare/fer2013>
- <http://www.whdeng.cn/raf/model1.html>
- <http://mohammadmahoor.com/disfa/>



Live Demo 😊

Thanks for your attention!

Any questions or remarks?

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Backup Appendix 😊