Multi-label Co-regularization for Semi-supervised Facial Action Unit Recognition

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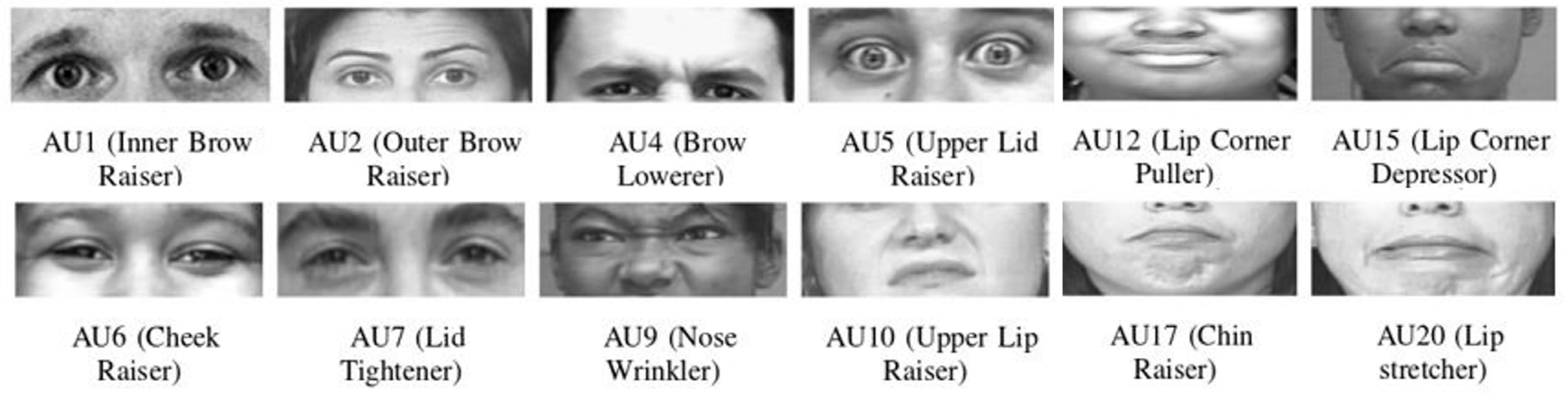
Paper : Code :

Problem

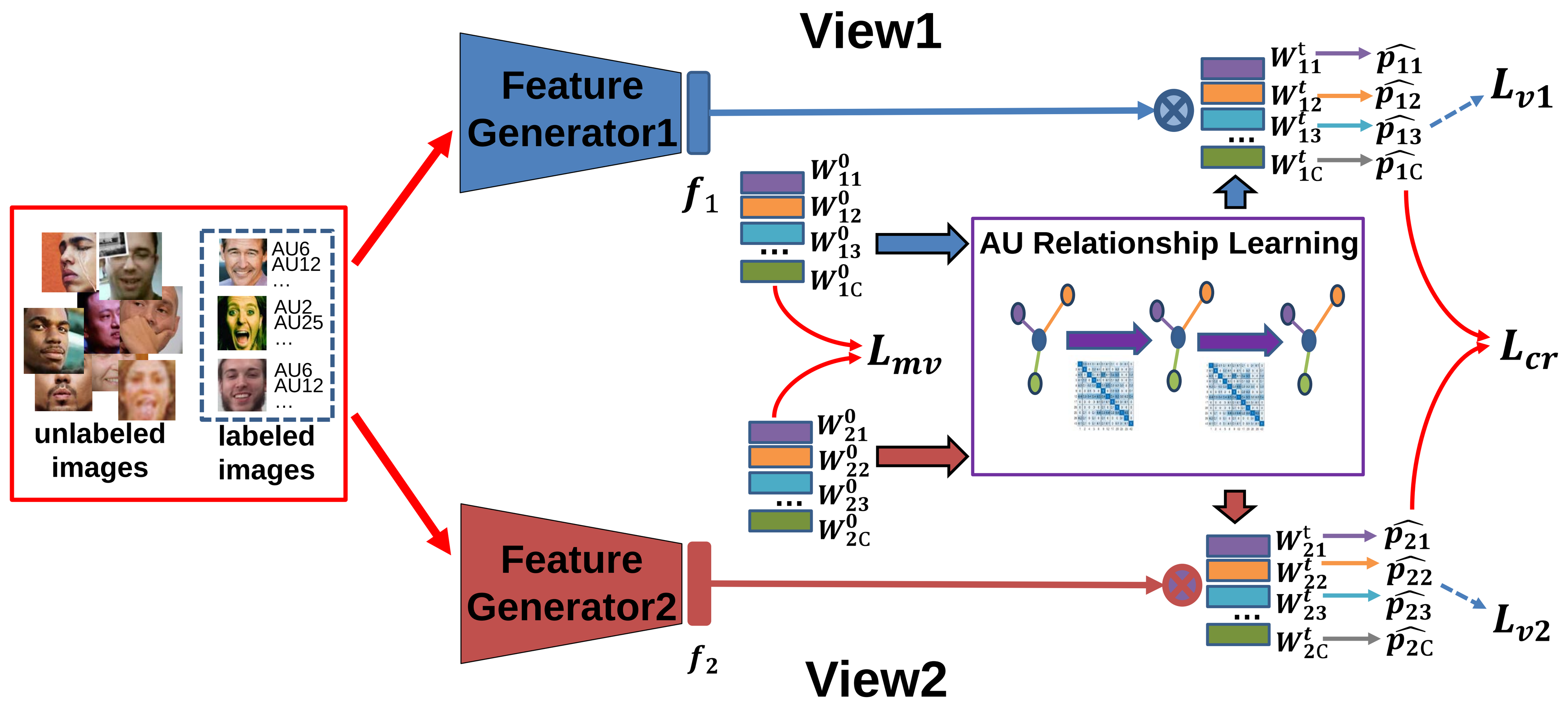
- **What is facial action unit?**



- ➢ **Facial action units refer to a set of facial muscle movements coded by their appearance on the face, which can be used for coding nearly any anatomically possible facial expression.**
- ➢ **Since AUs are subtle, local and have significant subject-dependent variations, qualified FACS experts are required to annotate facial AUs. In addition, labeling AUs is labor-intensive and expensive, making it impractical to manually annotate a large set of face images.**

Overview

- **Semi-supervised AU recognition using multi-view co-training and AU relationship modeling to leverage massive labeled face images and a small set of labeled face images.**



Method Details

- **Multi-view Loss**

$$L_{mv} = \frac{1}{C}\sum_{j=1}^{C}\frac{W_{1j}^T W_{2j}}{\|W_{1j}\|\|W_{2j}\|}$$

➢ A multi-view loss by orthogonalizing the weights of the AU classifiers of different views to encourage the two feature generators to get conditional independent features.

- **Co-regularization Loss**

➢ A co-regularization loss to encourage the classifiers from different views to generate similar predictions in order to make the two views to learn from each other.

$$L_{cr} = \frac{1}{C}\sum_{j=1}^{C}\left(H\left(\frac{\hat{p_{1j}}+\hat{p_{2j}}}{2}\right) - \frac{H(\hat{p_{1j}})+H(\hat{p_{2j}})}{2}\right)$$

$$H(p) = -(p\log p + (1-p)\log(1-p))$$

- **AU Relationship Learning**

➢ Two layer graph convolution layer to model the relationship between different AUs.

$$W_i^t = \hat{A}\,ReLU(\hat{A}W_i^0 H^{(0)})H^{(1)}$$

➢ Adjacency matrix defined by the dependency matrix.

$$P_{dep} = \frac{1}{2}([P(L_i=1|L_j=1)]_{C\times C} + [P(L_i=-1|L_j=-1)]_{C\times C})$$

$$\hat{A} = ABS((P_{dep}-0.5)\times 2)$$

- **Overall Loss Functions**

➢ Binary cross-entropy loss for AU recognition

$$L_{vi} = -\frac{1}{C}\sum_{j=1}^{C} a_c[p_j\log\hat{p_{ij}} + (1-p_j)\log(1-\hat{p_{ij}})]$$

➢ **Overall loss function**

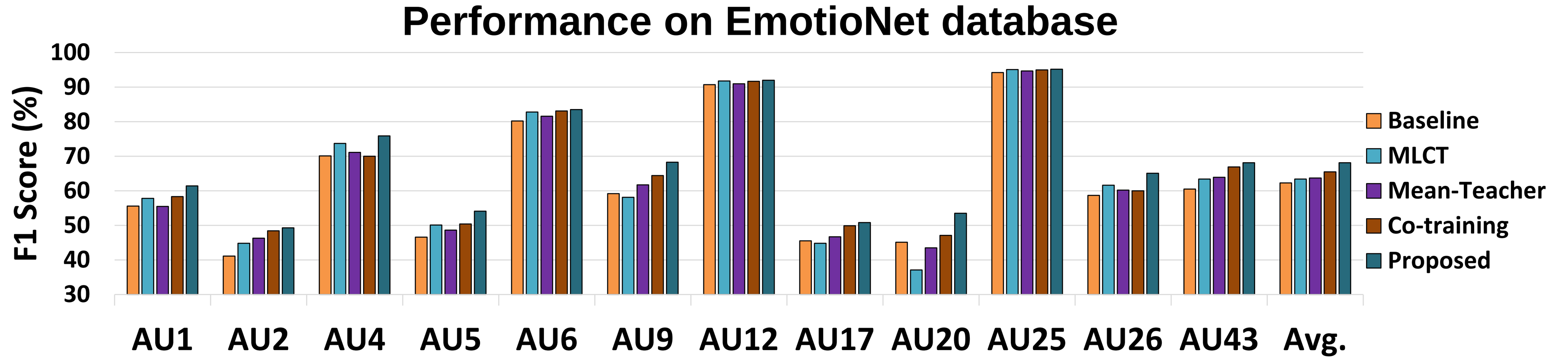
$$L = \frac{1}{2}\sum_{i=1}^{2} L_{vi} + \lambda_{mv}L_{mv} + \lambda_{cr}L_{cr}$$

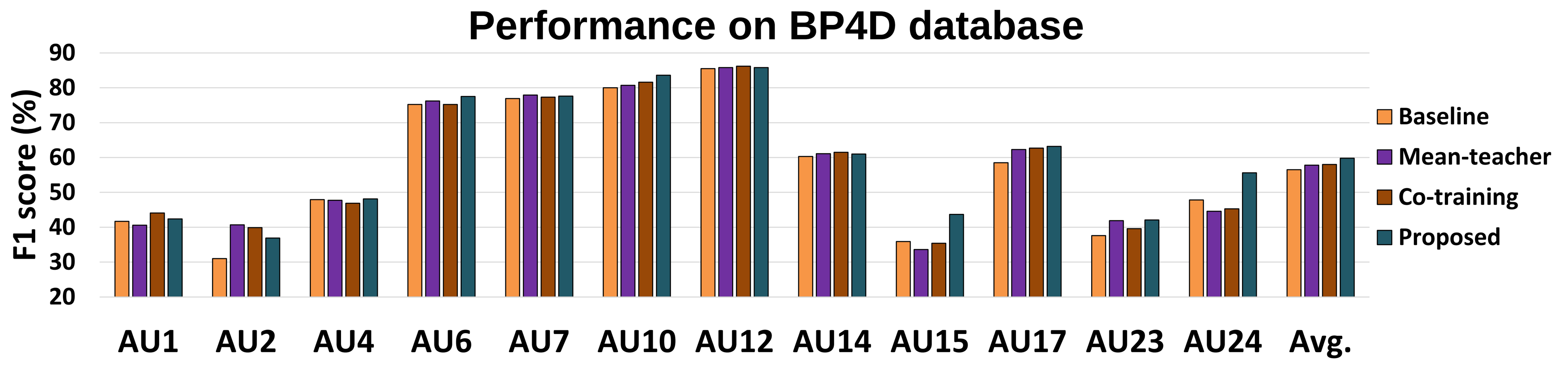
Experimental Results

- **Databases**

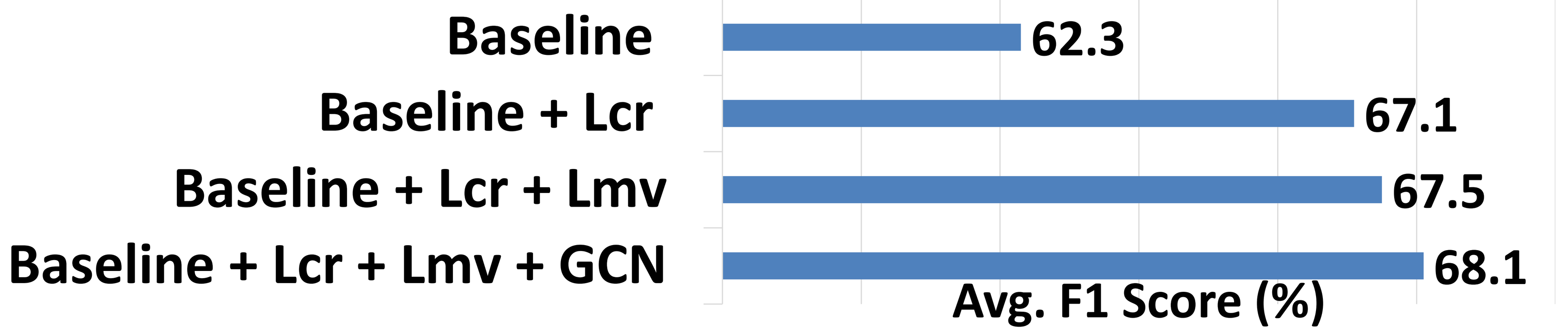
	Type	No. labeled Imgs.	No. unlabeled Imgs.	No. AU	Protocol
EmotioNet	In-the-wild	20,722	50,000	12	Avg. of three random tests
BP4D	Spontaneous	~140,000	100,000	12	Subject-exclusive three-fold

- **Results**





- **Ablation Study on EmotioNet**



- **Extension to Facial Attributes Analysis**