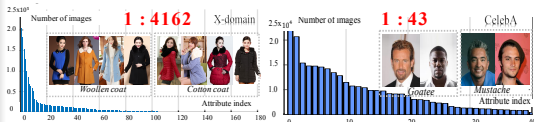
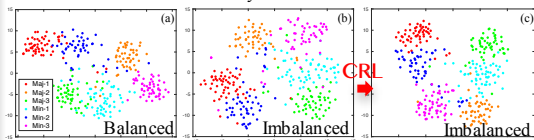


## 1 Problem Definition

➤ Imbalanced data distribution

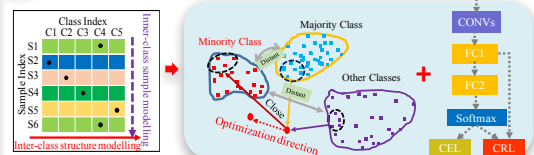


➤ Feature distribution by ResNet32 on the Cifar10 dataset



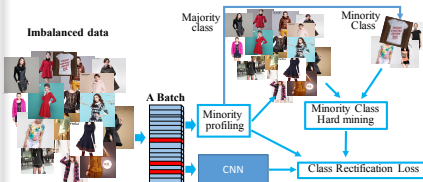
## 2 Motivation

Cross-Entropy Loss  $l_{ce} = -\frac{1}{n_{bs}} \sum_{i=1}^{n_{bs}} \sum_{j=1}^{n_{train}} \log(p(y_{i,j} = a_{i,j} | x_{i,j}))$



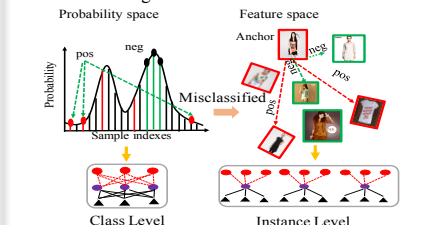
## 3 Overview of Proposed Approach

➤ Batch-wise minority profiling.



## 4 Minority Class Hard Mining

➤ Hard mining: Class- and Instance level.



## 5 Balancing by Class Rectification Loss (CRL)

$$l_{bln} = l_{crl} + l_{ce}$$

➤ Relative comparison based CRL  
 Inspired by Triplet Ranking loss

$$l_{crl} = \sum_T \max(0, m_j + \text{dist}(x_{a,j}, x_{p,j}) - \text{dist}(x_{a,j}, x_{n,j})) / |T|$$

➤ Absolute comparison based CRL  
 Inspired by contrastive loss

$$l_{crl} = 0.5 * \left( \frac{\sum_{P^+} \text{dist}(x_{i,j}, x_{p,j})}{|P^+|} + \frac{\sum_{P^-} \max(m_{apc} - \text{dist}(x_{i,j}, x_{n,j}), 0)^2}{|P^-|} \right)$$

➤ Distribution comparison based CRL  
 Inspired by histogram loss [1]

$$l_{crl} = \sum_{t=1}^{\tau} (h_t^+ \sum_{k=1}^t h_k^-) \quad h_t^+ = \frac{1}{|P^+|} \sum_{(i,j) \in P^+} \varsigma_{i,j,t}$$

$$\varsigma_{i,j,t} = \begin{cases} \text{dist}(x_{i,j}, x_{p,j}) - b_{t-1}, & \text{if } \text{dist}(x_{i,j}, x_{p,j}) \in [b_{t-1}, b_t] \\ b_{t+1} - \text{dist}(x_{i,j}, x_{p,j}), & \text{if } \text{dist}(x_{i,j}, x_{p,j}) \in [b_t, b_{t+1}] \\ 0, & \text{otherwise} \end{cases}$$

## 6 Experiments

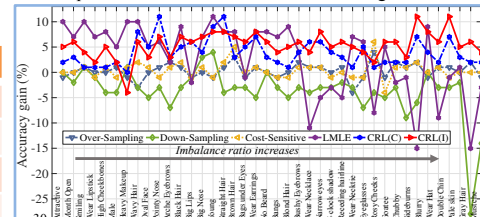
➤ Comparison to the state-of-the-arts

CelebA		X-domain	
Method	mAP(%)	Method	mAP(%)
DeepID2[2]	81	MTCT[4]	73.53
LMLE[3]	84	LMLE[3]	75.77
<b>CRL(C)</b>	<b>85</b>	<b>CRL(C)</b>	<b>78.24</b>
<b>CRL(I)</b>	<b>86</b>	<b>CRL(I)</b>	<b>79.66</b>

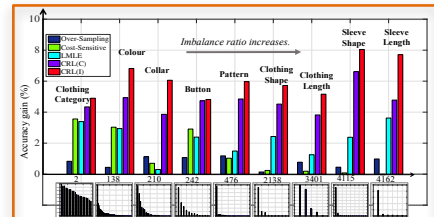
➤ Face Attributes recognition



➤ Comparison of different imbalanced learning methods



➤ Clothing Attributes recognition



## References

- [1] Ustinova, et al. "Learning deep embeddings with histogram loss." NIPS. 2016.
- [2] Y. Sun, Y. Chen, X. Wang, and X. Tang. Deep learning face representation by joint identification-verification. NIPS 2014.
- [3] C. Huang, et al. Learning deep representation for imbalanced classification. CVPR2016
- [4] Q. Dong, et al. Multi-task curriculum transfer deep learning of clothing attributes. WACV2017.