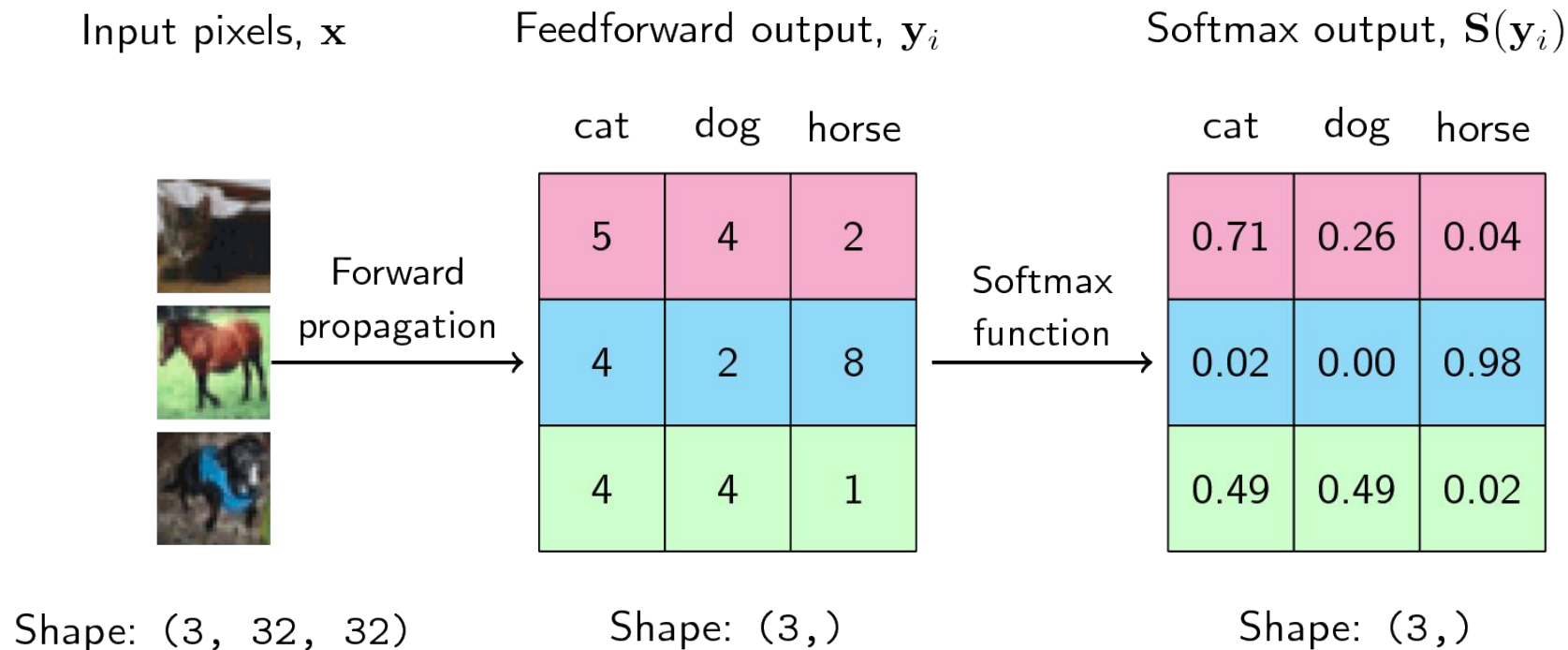# ArcFace: Additive Angular Margin Loss for Deep Face Recognition

Anouar Meziou

Problem:

A major challenge when constructing a problem for large-scale image recognition is implementing a loss function that effectively enhance the discriminative power between clusters.
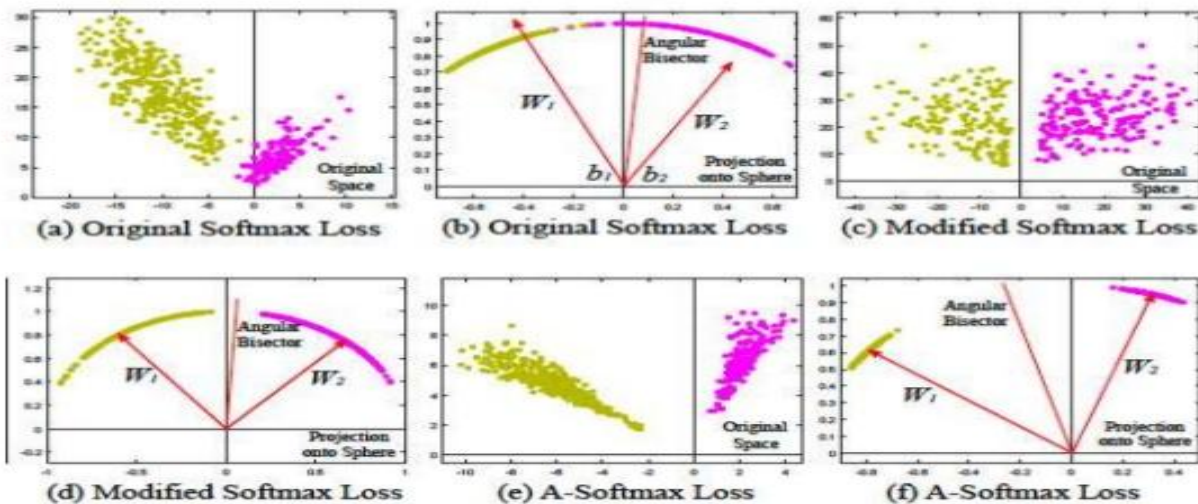
Softmax:

Input pixels, $\mathbf{x}$ Feedforward output, $\mathbf{y}_i$ Softmax output, $\mathbf{S}(\mathbf{y}_i)$

cat	dog	horse
5	4	2
4	2	8
4	4	1

Forward propagation

Softmax function

cat	dog	horse
0.71	0.26	0.04
0.02	0.00	0.98
0.49	0.49	0.02

Shape: (3, 32, 32)   Shape: (3,)   Shape: (3,)

SphereFace:

SphereFace (Georgia Tech. , CVPR, 2017)

(a) Original Softmax Loss
(b) Original Softmax Loss
(c) Modified Softmax Loss
(d) Modified Softmax Loss
(e) A-Softmax Loss
(f) A-Softmax Loss
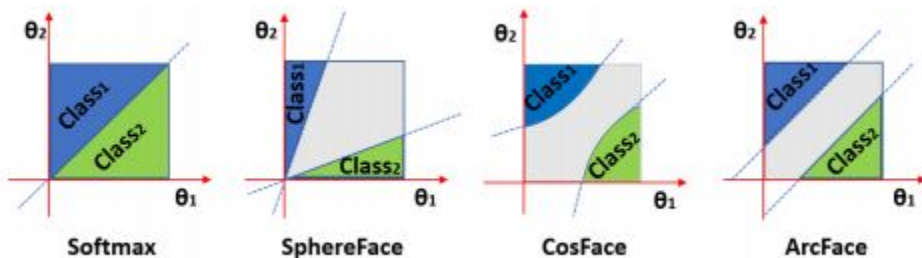
Adopted from [24].

ArcFace:
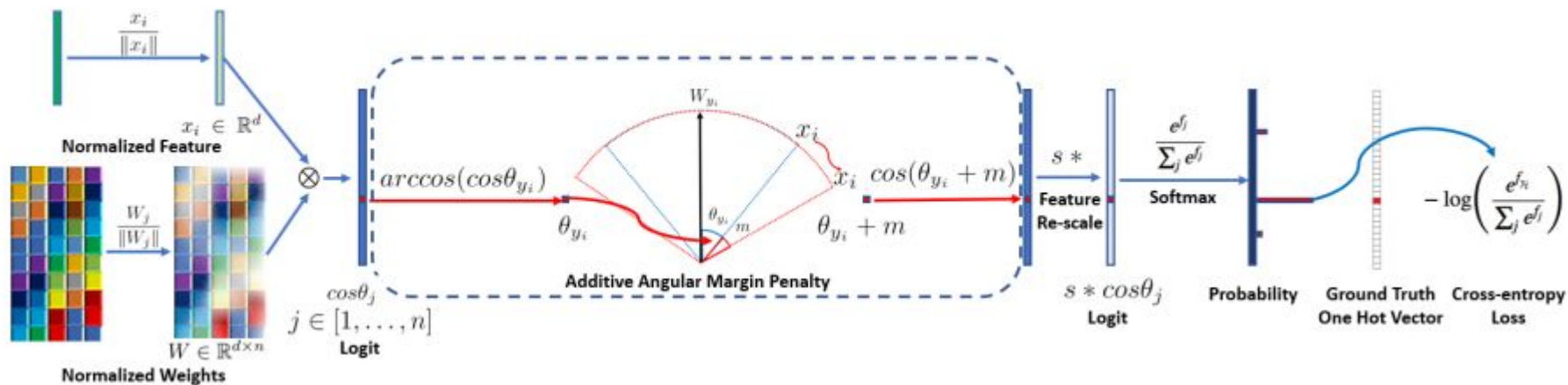
The decision boundaries of state-of-art loss functions:

The dashed line represents the decision boundary, and the grey areas are the decision margins.

Softmax   SphereFace   CosFace   ArcFace

Datasets:

Datasets	#Identity	#Image/Video
CASIA [43]	10K	0.5M
VGGFace2 [6]	9.1K	3.3M
MS1MV2	85K	5.8M
MS1M-DeepGlint [2]	87K	3.9M
Asian-DeepGlint [2]	94 K	2.83M
LFW [13]	5,749	13,233
CFP-FP [30]	500	7,000
AgeDB-30 [22]	568	16,488
CPLFW [48]	5,749	11,652
CALFW [49]	5,749	12,174
YTF [40]	1,595	3,425
MegaFace [15]	530 (P)	1M (G)
IJB-B [39]	1,845	76.8K
IJB-C [21]	3,531	148.8K
Trillion-Pairs [2]	5,749 (P)	1.58M (G)
iQIYI-VID [20]	4,934	172,835

Experimental Settings:

- The normalized face crops (112 x 112) are generated by utilizing 5 facial points
- ResNet50 and ResNet100 CNN architectures were employed for the embedding network.
- The feature scale is set to 64.
- The angular margin is set to 0.5.

Accuracy comparison:

Loss Functions	LFW	CFP-FP	AgeDB-30
ArcFace (0.4)	99.53	95.41	94.98
ArcFace (0.45)	99.46	95.47	94.93
ArcFace (0.5)	**99.53**	**95.56**	**95.15**
ArcFace (0.55)	99.41	95.32	95.05
SphereFace [18]	99.42	-	-
SphereFace (1.35)	99.11	94.38	91.70
CosFace [37]	99.33	-	-
CosFace (0.35)	99.51	95.44	94.56
CM1 (1, 0.3, 0.2)	99.48	95.12	94.38
CM2 (0.9, 0.4, 0.15)	99.50	95.24	94.86
Softmax	99.08	94.39	92.33
Norm-Softmax (NS)	98.56	89.79	88.72
NS+Intra	98.75	93.81	90.92
NS+Inter	98.68	90.67	89.50
NS+Intra+Inter	98.73	94.00	91.41
Triplet (0.35)	98.98	91.90	89.98
ArcFace+Intra	99.45	95.37	94.73
ArcFace+Inter	99.43	95.25	94.55
ArcFace+Intra+Inter	99.43	95.42	95.10
ArcFace+Triplet	99.50	95.51	94.40

Method	#Image	LFW	YTF
DeepID [32]	0.2M	99.47	93.20
Deep Face [33]	4.4M	97.35	91.4
VGG Face [24]	2.6M	98.95	97.30
FaceNet [29]	200M	99.63	95.10
Baidu [16]	1.3M	99.13	-
Center Loss [38]	0.7M	99.28	94.9
Range Loss [46]	5M	99.52	93.70
Marginal Loss [9]	3.8M	99.48	95.98
SphereFace [18]	0.5M	99.42	95.0
SphereFace+ [17]	0.5M	99.47	-
CosFace [37]	5M	99.73	97.6
MS1MV2, R100, ArcFace	5.8M	**99.83**	**98.02**

Thank you

Questions?