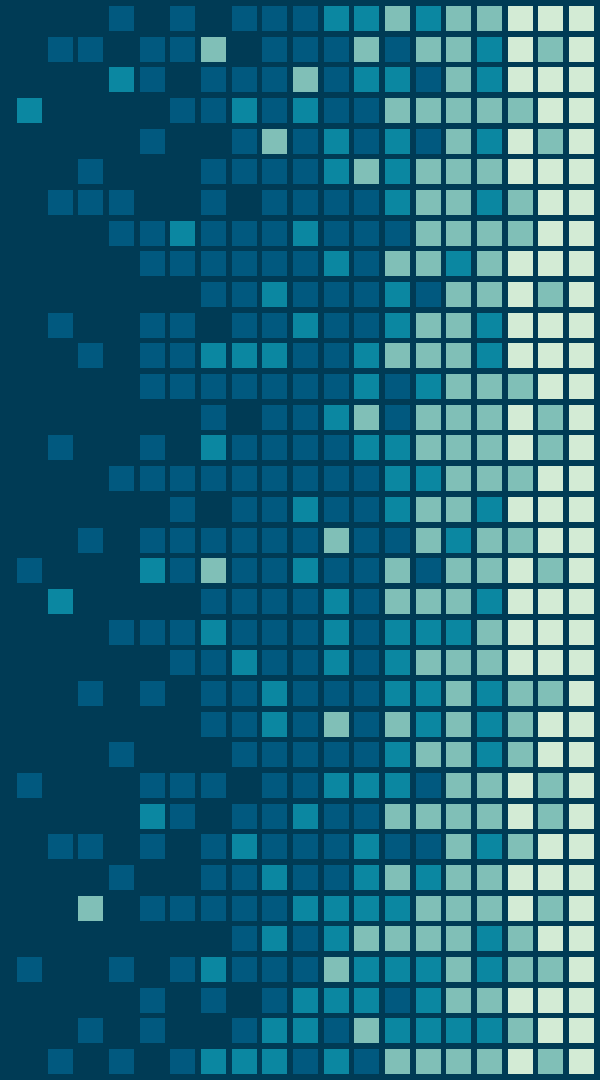
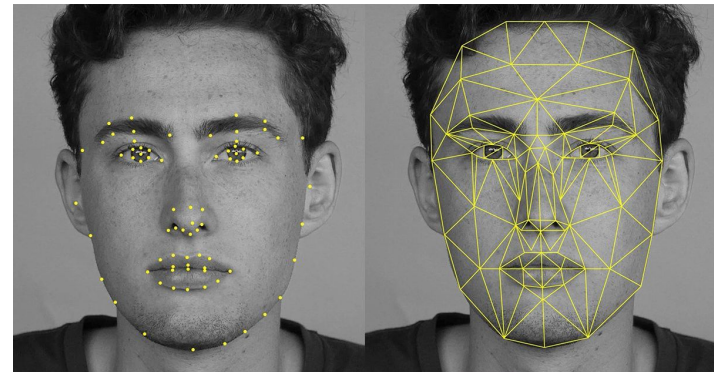
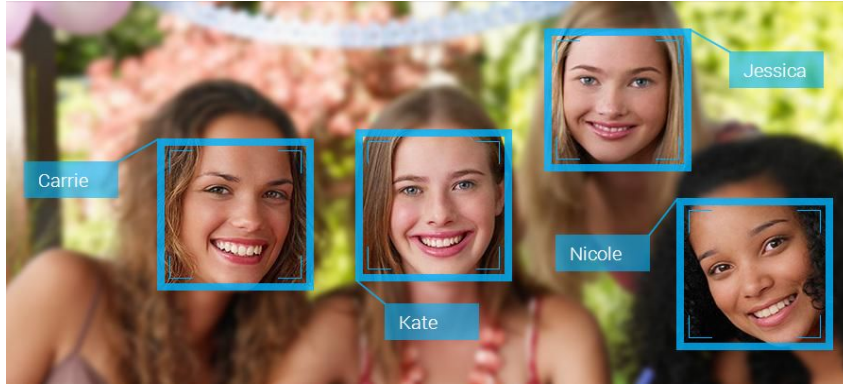


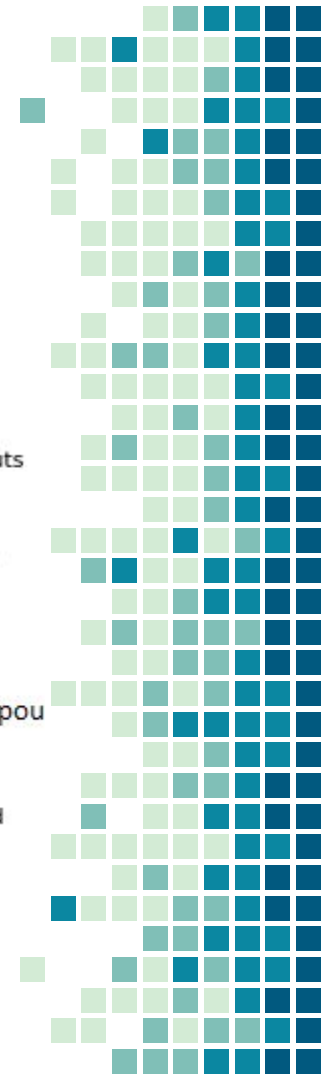
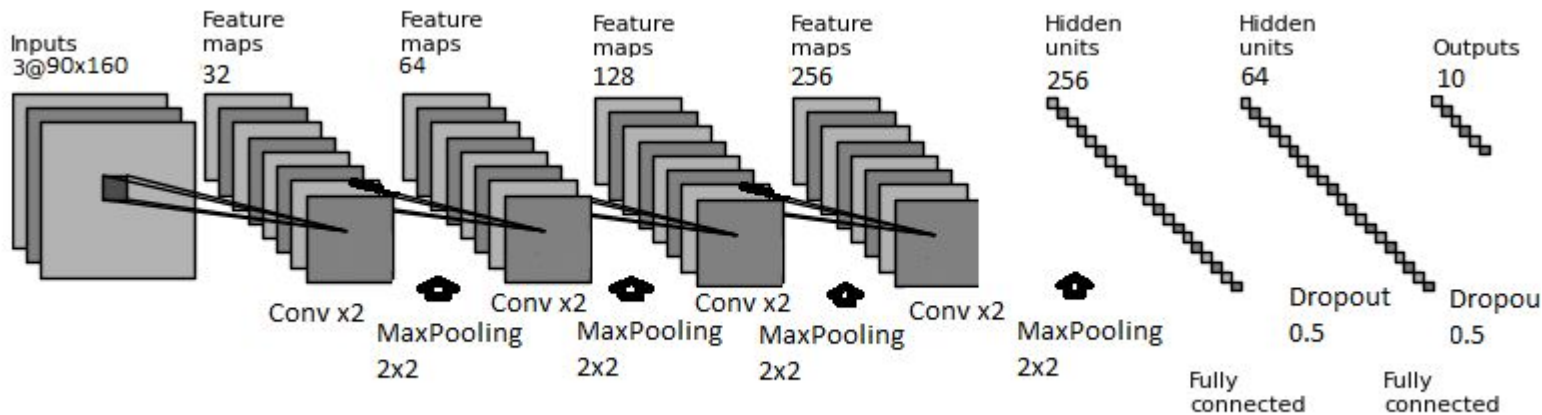
ArcFace: Additive
Angular Margin
Loss for Deep
Face Recognition



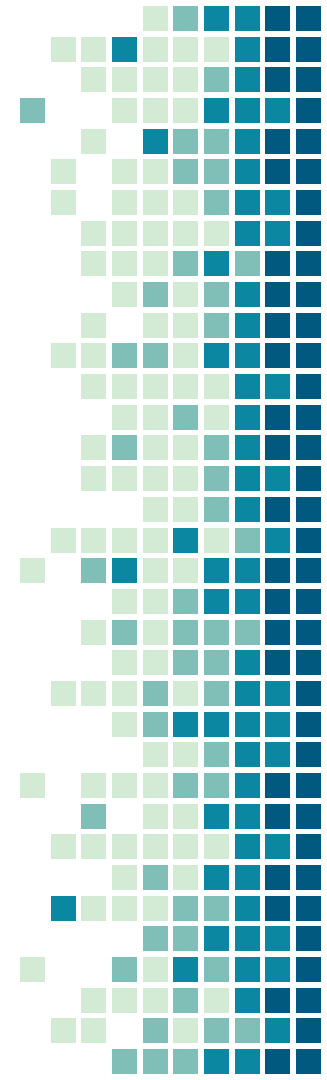
INTRODUCTION



CNN FACE RECOGNITION



WHAT'S A LOSS FUNCTION?



LOSS FUNCTION

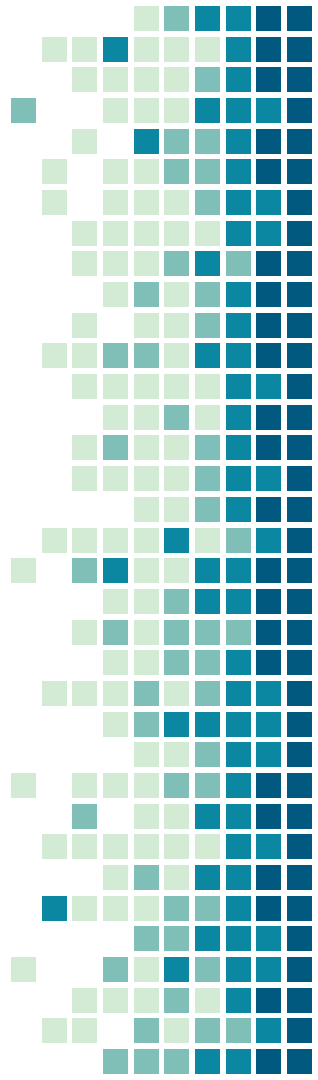
$$L_1 = -\frac{1}{m} \sum_{i=1}^m \log \frac{e^{W_{y_i}^T x_i + b_{y_i}}}{\sum_{j=1}^n e^{W_j^T x_i + b_j}}$$

Softmax loss



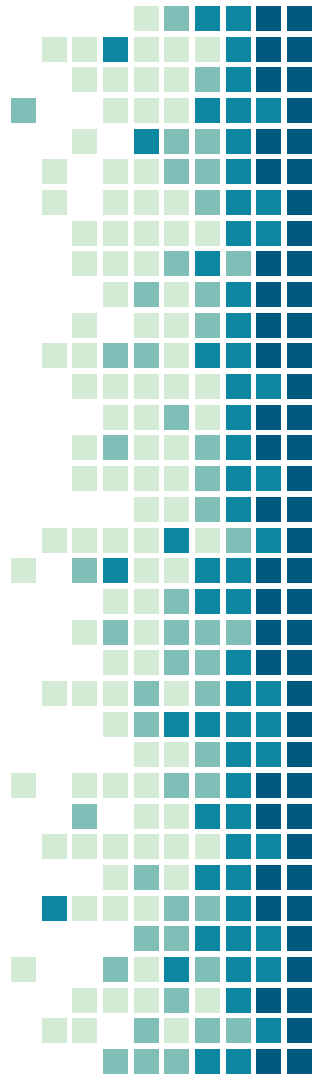
ARC FACE FEATURES

$$L_2 = -\frac{1}{m} \sum_{i=1}^m \log \frac{e^{\|x_i\| \cos(\theta_{y_i})}}{e^{\|x_i\| \cos(\theta_{y_i})} + \sum_{j=1, j \neq y_i}^n e^{\|x_i\| \cos \theta_j}}$$



ARC FACE FEATURES

$$L_3 = -\frac{1}{m} \sum_{i=1}^m \log \frac{e^{\|x_i\| \cos(m\theta_{y_i})}}{e^{\|x_i\| \cos(m\theta_{y_i})} + \sum_{j=1, j \neq y_i}^n e^{\|x_i\| \cos \theta_j} \dots}$$

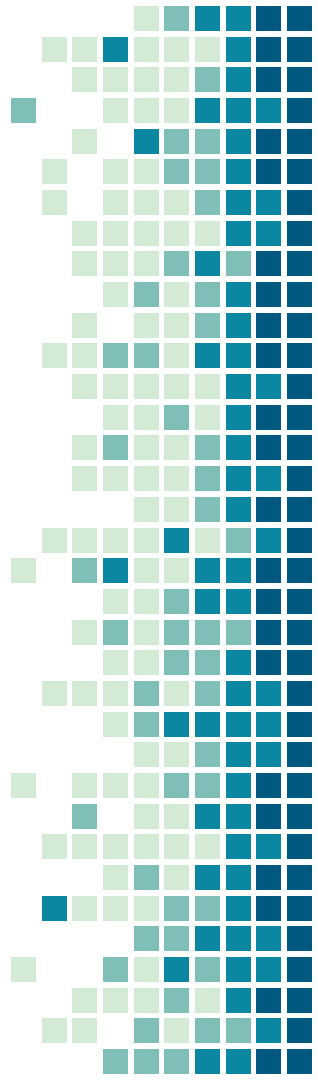


ARC FACE FEATURES

$$L_4 = -\frac{1}{m} \sum_{i=1}^m \log \frac{e^{\|x_i\| \psi(\theta_{y_i})}}{e^{\|x_i\| \psi(\theta_{y_i})} + \sum_{j=1, j \neq y_i}^n e^{\|x_i\| \cos \theta_j}}, \quad (5)$$

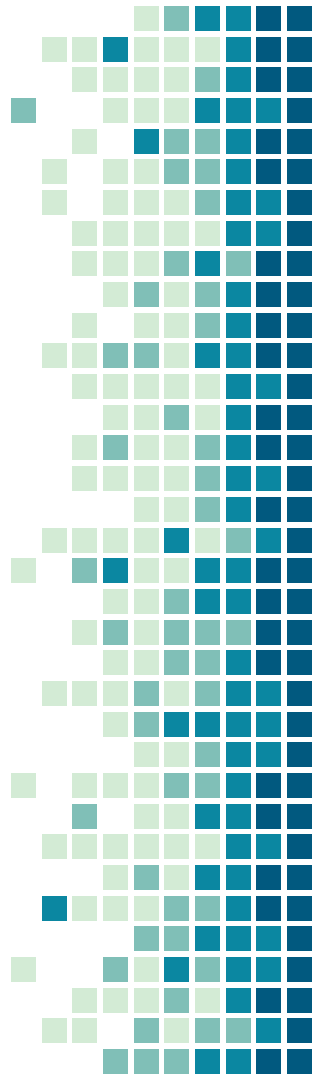
where $\psi(\theta_{y_i}) = (-1)^k \cos(m\theta_{y_i}) - 2k, \theta_{y_i} \in \left[\frac{k\pi}{m}, \frac{(k+1)\pi}{m} \right], k \in [0, m-1], m \geq 1$ is the integer

$$\psi(\theta_{y_i}) = \frac{(-1)^k \cos(m\theta_{y_i}) - 2k + \lambda \cos(\theta_{y_i})}{1 + \lambda}$$



ARC FACE FEATURES

$$L_5 = -\frac{1}{m} \sum_{i=1}^m \log \frac{e^{s\psi(\theta_{y_i})}}{e^{s\psi(\theta_{y_i})} + \sum_{j=1, j \neq y_i}^n e^{s \cos \theta_j}}$$



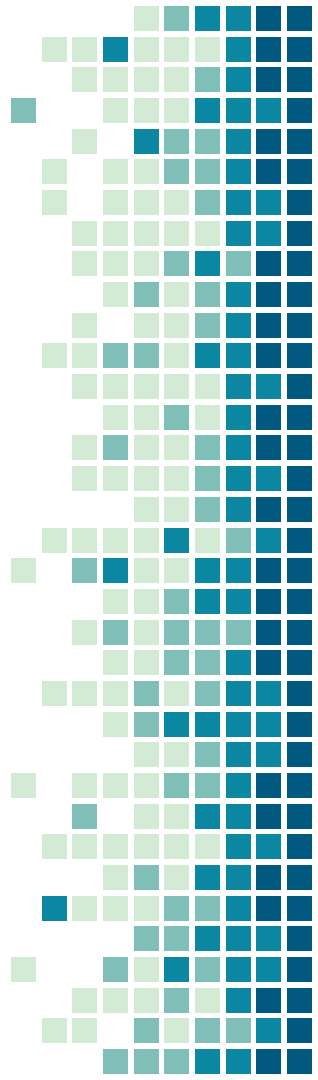
ARC FACE FEATURES

$$L_6 = -\frac{1}{m} \sum_{i=1}^m \log \frac{e^{s(\cos(\theta_{y_i})-m)}}{e^{s(\cos(\theta_{y_i})-m)} + \sum_{j=1, j \neq y_i}^n e^{s \cos \theta_j}}$$



ARC FACE FEATURES

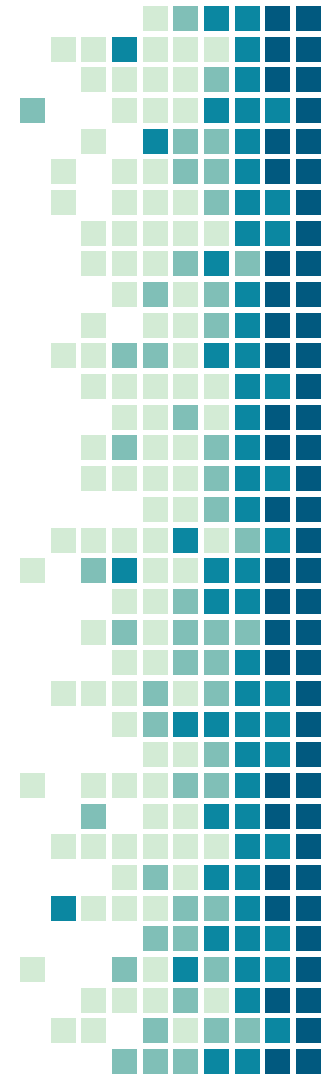
$$L_7 = -\frac{1}{m} \sum_{i=1}^m \log \frac{e^{s(\cos(\theta_{y_i} + m))}}{e^{s(\cos(\theta_{y_i} + m))} + \sum_{j=1, j \neq y_i}^n e^{s \cos \theta_j}}$$



RESULTS

| m | LFW | CFP-FP | AgeDB-30 |
|-----|--------------|--------------|--------------|
| 0.2 | 99.23 | 87.23 | 95.25 |
| 0.3 | 99.40 | 88.15 | 96.00 |
| 0.4 | 99.48 | 87.85 | 96.00 |
| 0.5 | 99.50 | 88.50 | 96.06 |
| 0.6 | 99.46 | 87.23 | 95.68 |
| 0.7 | 99.46 | 87.48 | 95.80 |
| 0.8 | 99.40 | 86.74 | 95.68 |

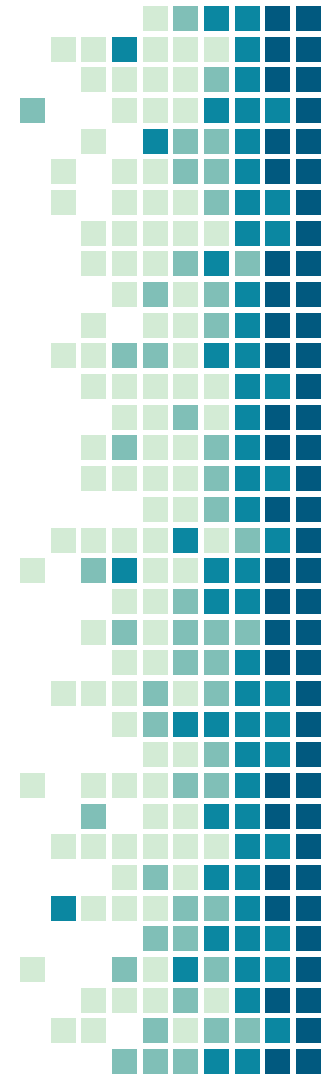
Verification performance (%) of ArcFace with different angular margins m



RESULTS

| Loss | LFW | CFP-FP | AgeDB-30 |
|----------------------------------|--------------|-------------|--------------|
| Softmax | 99.7 | 91.4 | 95.56 |
| SphereFace (m=4, $\lambda = 5$) | 99.76 | 93.7 | 97.56 |
| CosineFace (m=0.35) | 99.80 | 94.4 | 97.91 |
| ArcFace(m=0.4) | 99.80 | 94.5 | 98.0 |
| ArcFace(m=0.5) | 99.83 | 94.04 | 98.08 |

Verification performance (%) for different loss functions



REFERENCES

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- ❑ ArcFace: Additive Angular Margin Loss for Deep Face Recognition
- ❑ A New Implementation of Deep Neural Networks for Optical Character Recognition and Face Recognition

