Technical Summary
Task: Face Verification under Distorted Conditions

1. Objective & Problem Context

This system solves a **face verification** problem — determining whether a distorted test image belongs to a known identity (binary classification).

Challenges:

- Robust to distortions: sunny, blurry, resized, rainy, low-light.
- Generalizes to unseen identities during testing.

2. Architecture Overview

Model: ArcFace (Buffalo_L) via InsightFace
Input Size: $112 \times 112 \times 3$ **Embedding:** 512-D vector
Similarity Metric: Cosine Similarity **Decision:** Threshold-based

Image $\rightarrow$ ArcFace $\rightarrow$ 512-D Embedding $\rightarrow$ Cosine Similarity $\rightarrow$ Threshold $\rightarrow$ Label

3. Implementation Details

- Clean image embeddings are averaged per identity.
- Distorted validation images simulate real-world test cases.
- All intra-identity (positive) and inter-identity (negative) pairs evaluated.
- F1-based threshold selection.

4. Performance Metrics

Confusion Matrix:

	Predicted	
Actual	**0**	**1**
0	30922	203
1	2167	26154

Key Metrics:

- Accuracy: **95.99%**
- ROC AUC: **0.9704**
- Optimal Threshold: **0.1615**

Classification Report:

Metric	Class 0	Class 1	Overall
Precision	0.93	0.99	0.96
Recall	0.99	0.92	0.96
F1-Score	0.96	0.96	0.96
Support	31125	28321	59446

5. Key Innovations

- Low threshold (0.1615) enables subtle match detection.
- Resilient to heavy distortions and lighting conditions.
- Full pairwise evaluation for both positive and negative match sets.

6. Future Recommendations

- Adaptive thresholds based on distortion type.
- Ensemble with multiple recognition backbones.
- API deployment with lightweight models for inference.
- Active learning to reduce false negatives over time.