From Scarcity to Scale:

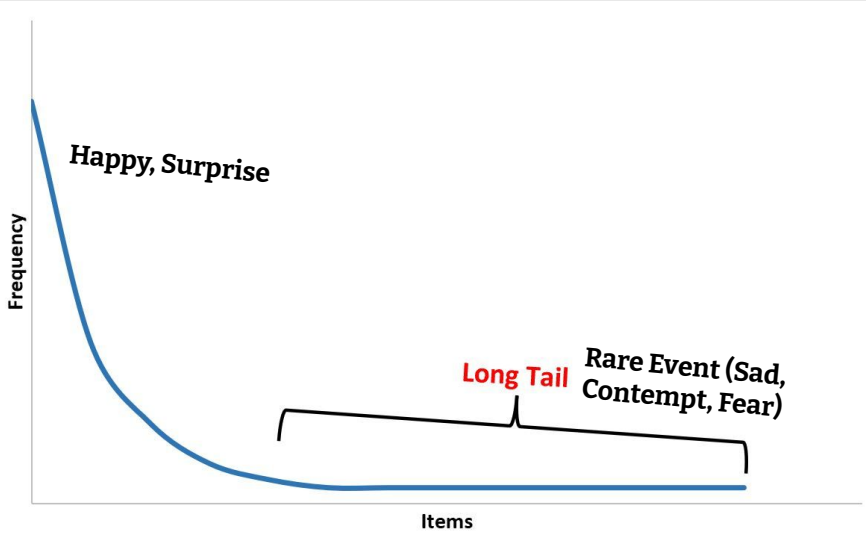
Semantic Active Generative Augmentation (SAGA) for Amplifying Rare-Event Classification

Group 7:
Manav Ukani, Param Patel, Neel Modi,
Dhruv Shah, Astha Soni

Stony Brook University

Problem Statement & Recap

"Long-Tail" Crisis in Rare Event Detection



Phase 1 — **Data Curation**
AffectNet

Phase 2 — **Baseline Model Training**
ViT: Vision Image Transformer

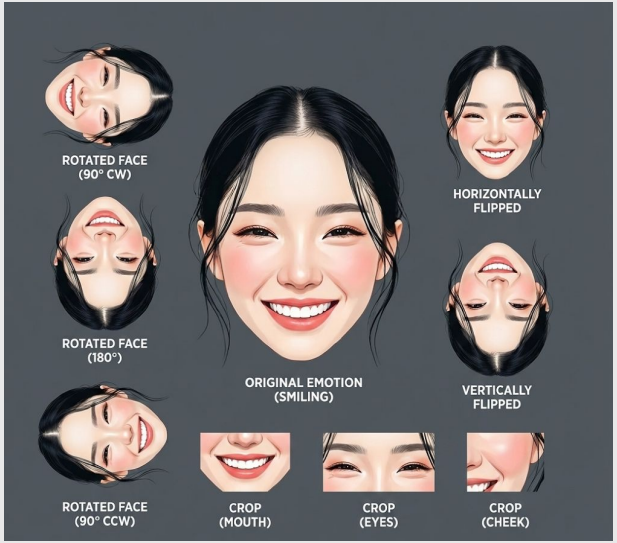
After Mid-term evaluation

Phase 3 — **Image Augmentation Pipeline (SAGA)**
Powered by Gemini Nano Banana Image Model

Phase 4 — **Model Retraining on Augmented Data**
Results and Analysis

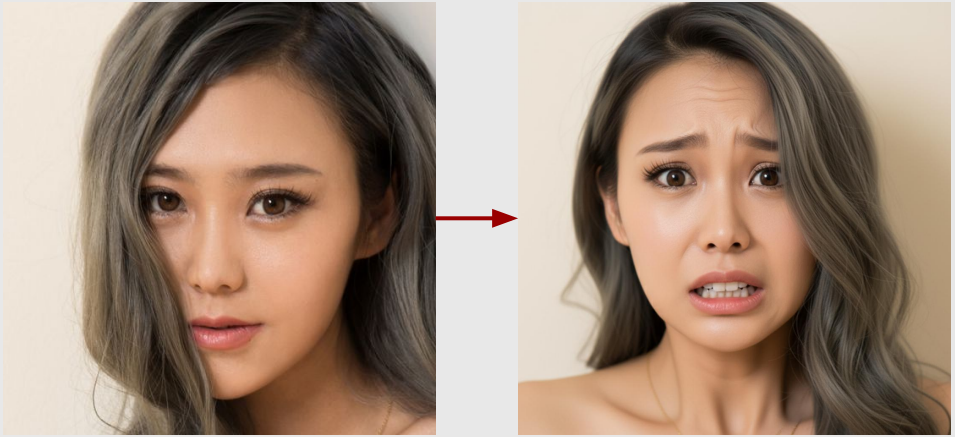
Our Solution: Novel SAGA Framework

Traditional methods



Passive augmentation (flipping, rotating, etc.) have no Semantic Value

SAGA (Our Framework)



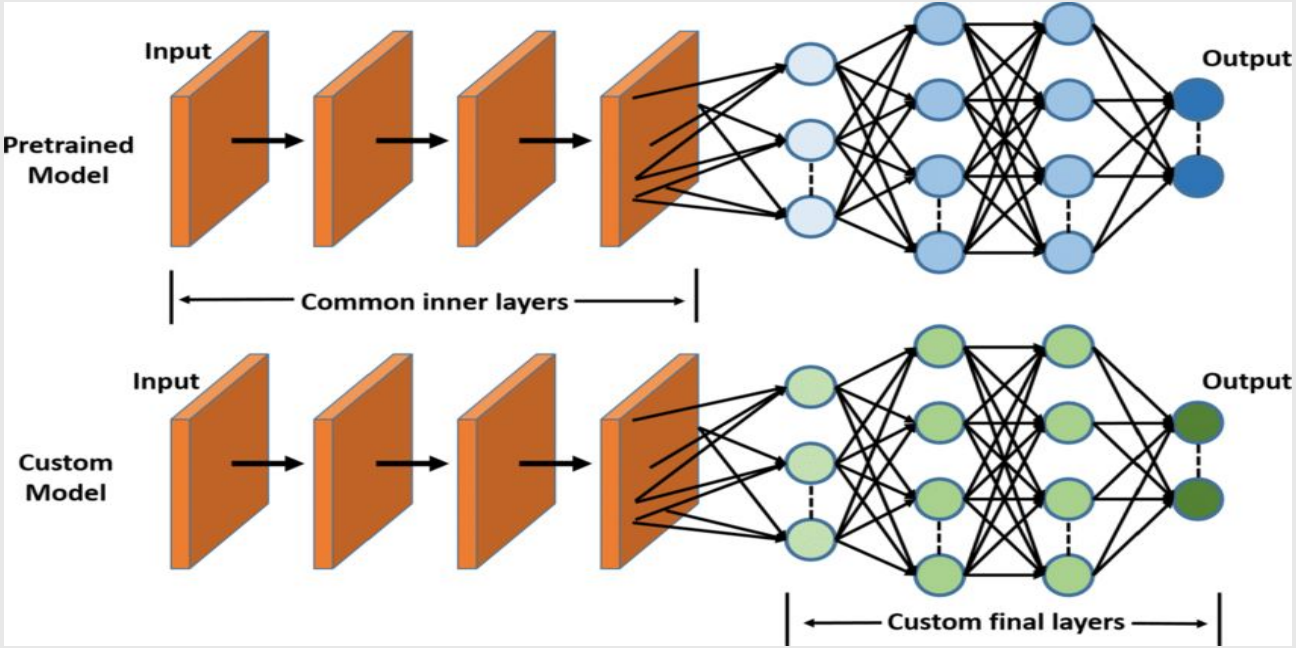
Neutral

Fear

Active. Targeted. Generative

The Engine: ViT Architecture (Baseline)

Model: Transfer Learning



Global Context > Local Pixels

- Global geometric relationships are crucial for emotion detection.
- Eg: connection between a furrowed brow & a frowned mouth.

Generative Pipeline: SAGA Framework

1. **TargetBalancingManager**
   Checks for the **minority class** and sets the **target** for number of **augmented images required**

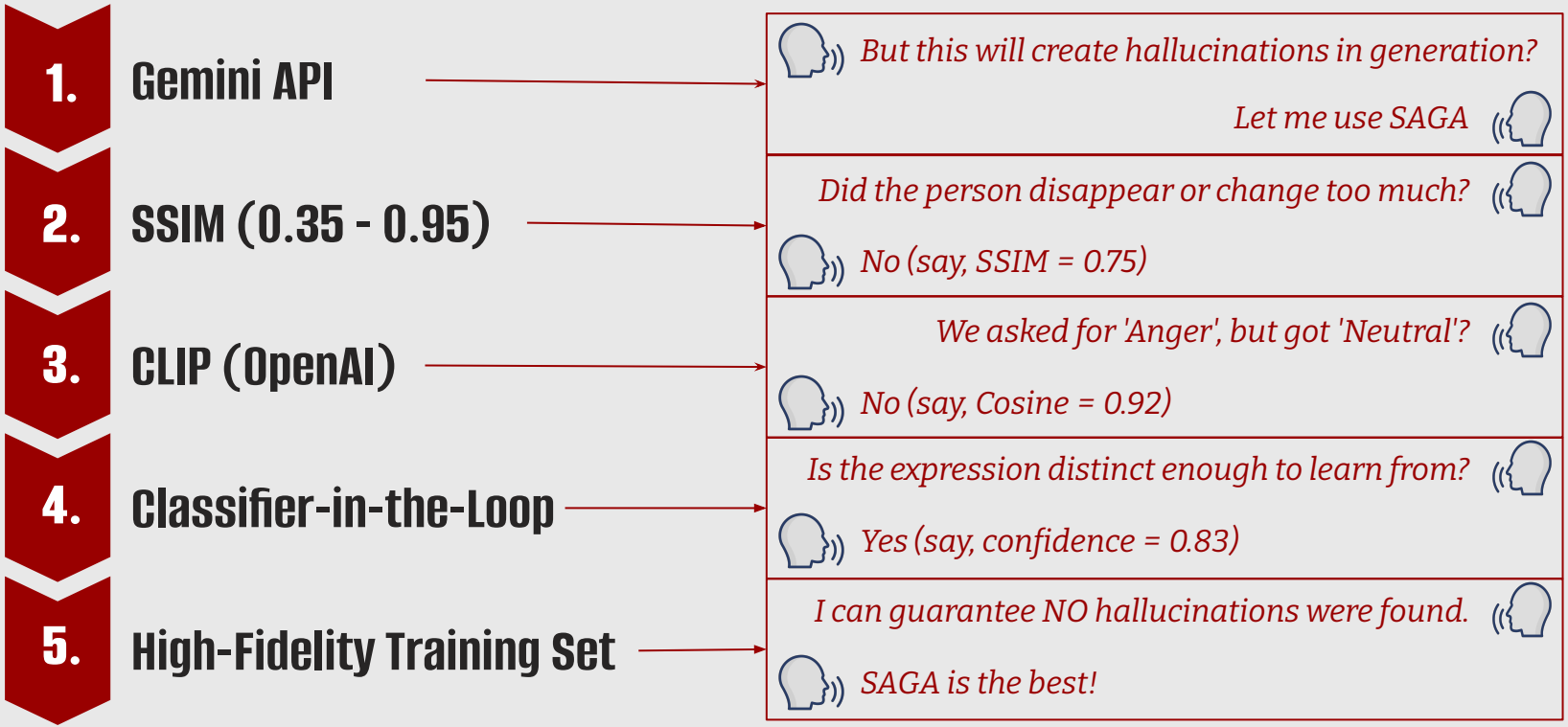
2. **Gemini API**
   Initial generation of **synthetic images**.

3. **SSIM (0.35 - 0.95)**
   Structural Similarity check to maintain identity. Rejects if **too low** (lost identity) or **too high** (no change).

4. **CLIP (OpenAI)**
   Ensures **Semantic Consistency** with the prompt using OpenAI's CLIP model for **cosine similarity**.

5. **Classifier-in-the-Loop**
   Safety valve: requires 65% confidence from a pre-trained classifier that generated image **matches target emotion**.

SAGA Framework in Action



SAGA Framework in Action

Fails on Step 1: Structural Similarity (SSIM) Check

Original - Disgust

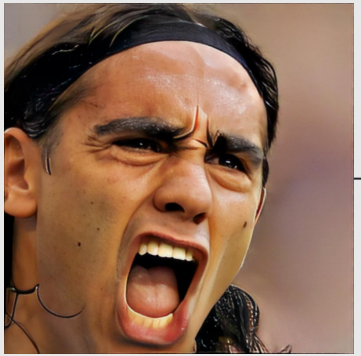
Neutral

Generated by: **Gemini**

Generated by: **OpenAI**

SAGA Framework in Action

Fails on Step 2: Cosine Similarity Check with CLIP



Original - Anger

Neutral

Generated by: **Gemini**

Generated by: **OpenAI**

SAGA Framework in Action

Fails on Step 3: Classifier in the Loop

Original - Disgust

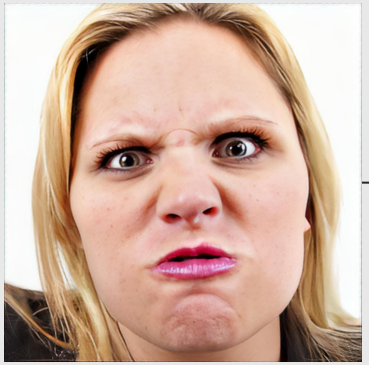
Happy

Generated by: **Gemini**

Generated by: **OpenAI**

Importance of Right Generative Model

Same Prompts - Different Results



Original - Anger

Fear

Gemini (Google)

DALL-E (OpenAI)

Gemini is ***consistently*** accurate and better

Results & Retraining

The Verdict: "*Test Accuracy*"

Baseline (Original Data)

60.17%

SAGA Model

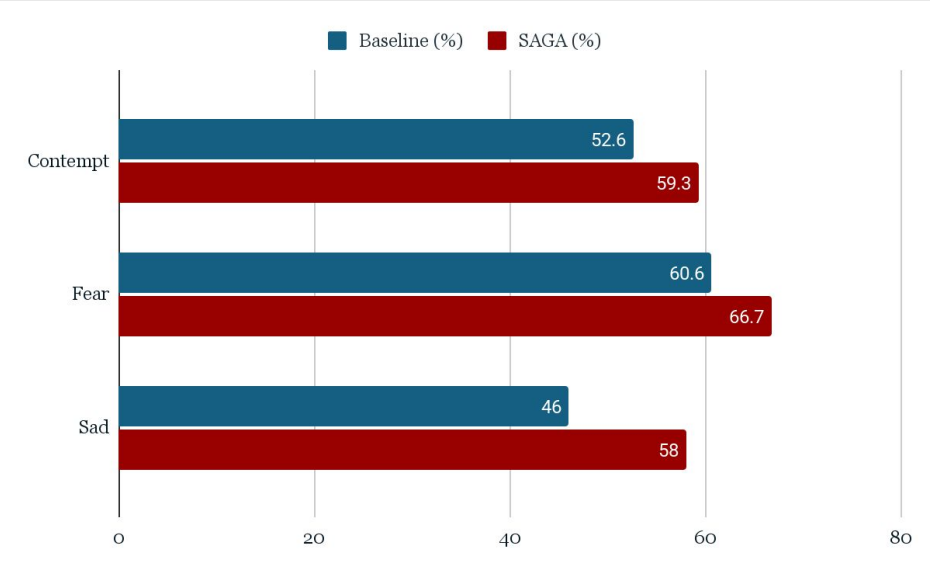
64.67%

+4.5% Improvement

*Evaluated on **strictly unseen, real-world data (Gold Test Set)**, demonstrating a significant uplift.*

Results & Retraining

Model Comparison (Minority Classes)



*SAGA significantly **boosts performance** in **under-represented** classes*

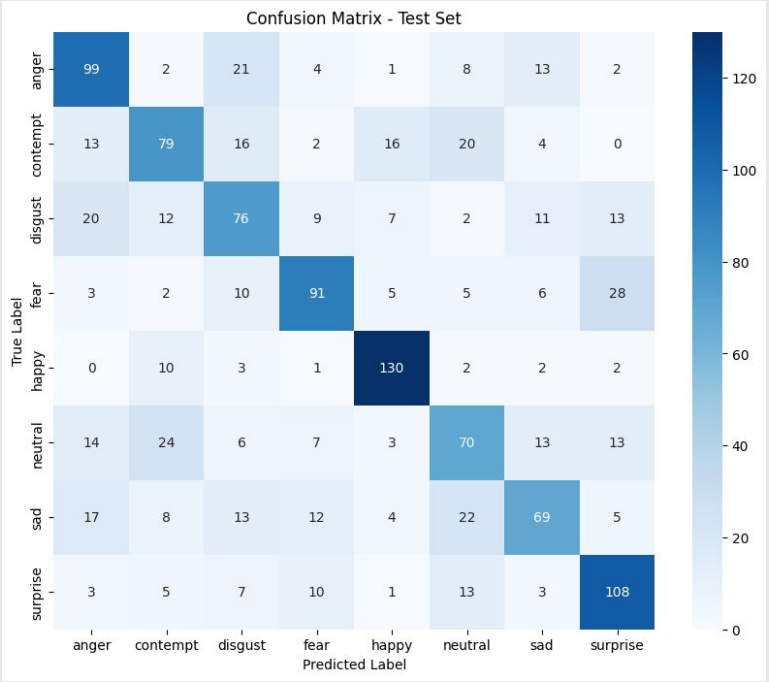
Baseline

- **Low** confidence (0.61)
- **Hesitant** predictions
- Often **unsure** for minority classes

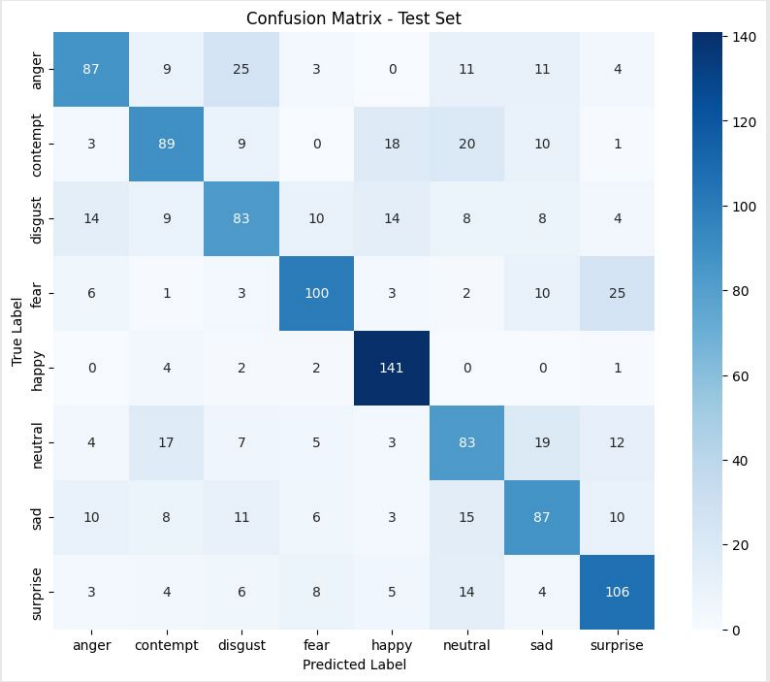
SAGA

- **High** confidence (0.72)
- **Stronger** conviction
- Learns **subtle emotional cues**

Results & Retraining



Confusion Matrix **- Baseline**



Confusion Matrix **- SAGA Model**

Humans Are Confused Too - SAGA Isn't!

Google Form Piazza Survey

Google Form Survey:
Disgust – 51%
Anger – 49%

Baseline Model: Disgust ❌
SAGA Model: Anger ✅

Google Form Survey:
Neutral – 45%
Sad – 55%

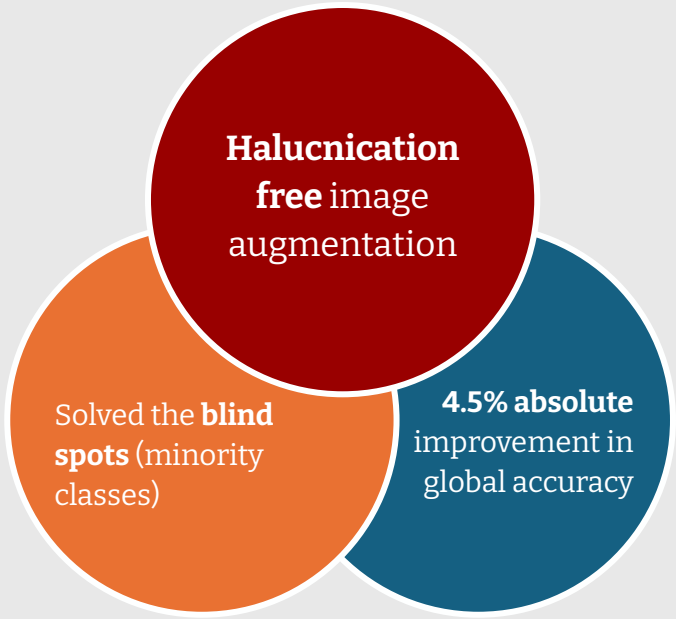
Baseline Model: Neutral ❌
SAGA Model: Sad ✅

Google Form Survey:
Neutral – 50%
Anger – 50%

Baseline Model: Neutral ❌
SAGA Model: Anger ✅

Conclusion & Impact

- Significant jump at an **industrial scale.**
- **Double-digit improvements** in the hardest (minority) classes like Fear and Contempt.
- Bridged the gap from **Scarcity to Scale**, turning the liability of the 'Long Tail' into a solved problem.



SAGA FRAMEWORK OUTCOMES

Thank You :)

Stony Brook University