GlowAI: Project Review

GlowAI is an AI system for facial blemish analysis from selfies, using a **two-stage pipeline**: segmentation followed by classification into **4 skin-condition types**.

What Changed from the Proposal

- Reduced classes from **6 → 4**
- Updated segmentation and classification models
- Refined synthetic data generation for balanced classes

Why GlowAI Is Needed

- Real-world facial skin data is limited and biased
- Poor representation of different **skin tones, ages, lighting, and blemish types**
- Most datasets contain only clinical images, not selfies
- GlowAI uses **synthetic + real data** to overcome these gaps

Project Contributions

- End-to-end pipeline: **detection, classification, localization, and skincare guidance**
- **Region-level analysis** for multiple blemishes per face
- Balanced training across diverse skin types using **synthetic data**

Previous work

Title / Year	Task	Methods	Data	Results	Relation to GlowAI
Use of Artificial Intelligence in Dermatology (2020)	Review of AI applications for skin disease diagnosis	Machine Learning, Deep Learning, image analysis	Clinical skin image datasets	AI achieves high accuracy but is limited by data quality and real-world deployment	Supports GlowAI's use of AI for facial skin analysis and blemish classification
Artificial Intelligence and Machine Learning in Dermatology (2023)	Review of AI for detection, classification, and severity assessment	Deep Learning, CNNs	Diverse dermatology image datasets	Accurate detection with challenges in bias and ethics	Highlights the need for balanced data, aligned with GlowAI's synthetic + real data approach
AI Models for Benign Pigmented Facial Skin Lesions (2020)	Classification of pigmented facial lesions	Convolutional Neural Networks	Annotated facial skin images	Performance comparable to dermatologists	Demonstrates feasibility of facial skin lesion analysis, similar to GlowAI's blemish detection

Dataset: Synthetic Data Generation

Synthetic Data Pipeline

ComfyUI inpainting (SD1.5 + IP-Adapter) → generates 512×512 faces with localized redness from (clean face + mask + defect reference).

Redness-v0 dataset

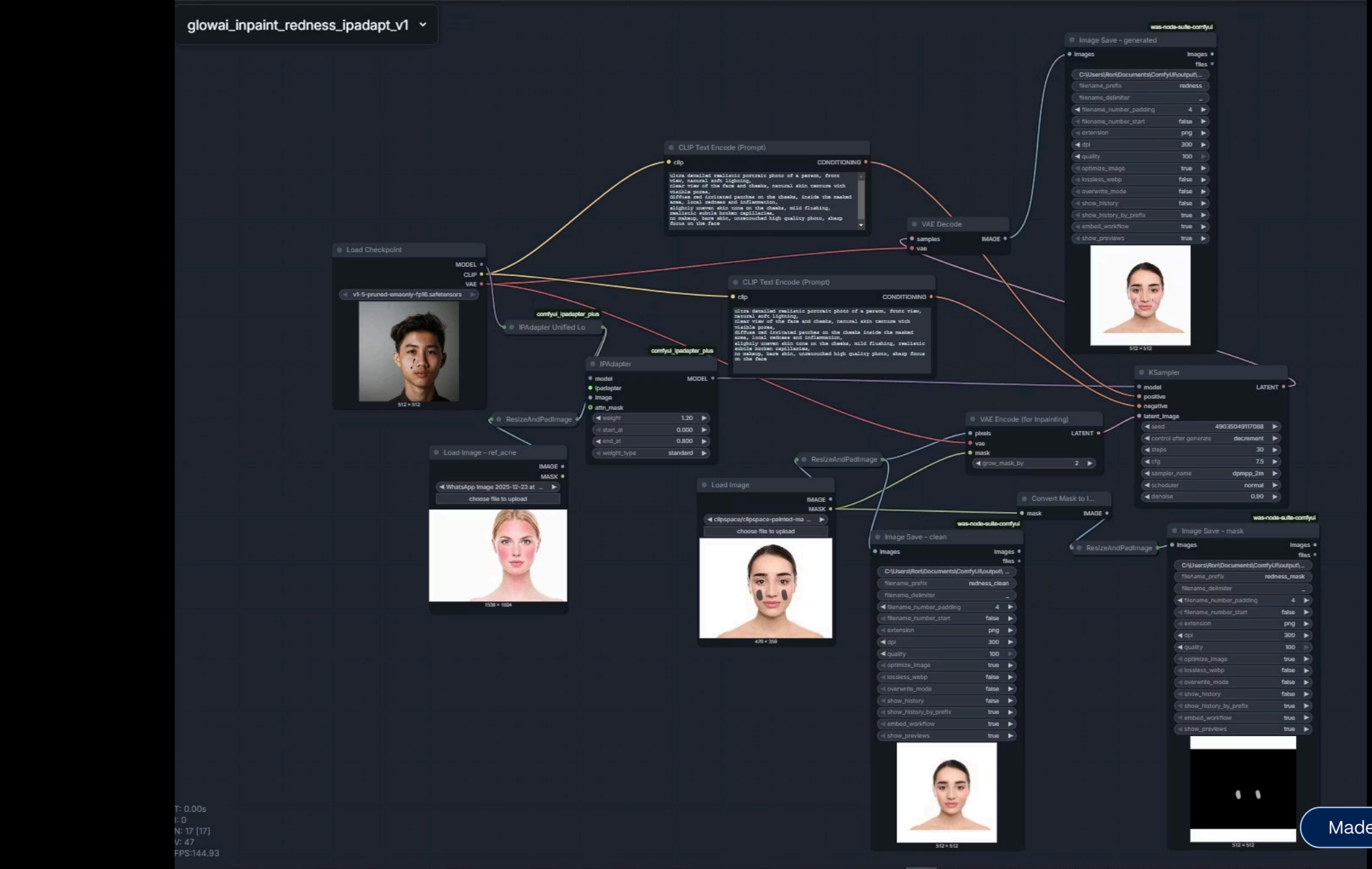
12 clean identities; structured folders: images/ (face+redness), masks/ (binary redness), clean/ (original).

Model + metrics

2-class U-Net (ResNet-34 encoder) for Background vs Redness; eval with mIoU + IoU(redness) on held-out val split.

Quality controls

prompt engineering + strong negatives (avoid makeup/blush), real defect refs via IP-Adapter, strict mask rules, and manual filtering to keep only realistic redness.


glowai_inpaint_redness_ipadapt_v1
Image Save - generated
CLIP Text Encode (Prompt)
VAE Decode
Load Checkpoint
v1-5-pruned-emaonly-fp16.safetensors
CLIP Text Encode (Prompt)
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VAE Encode (for Inpainting)
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Image Save - mask
ResizeAndPadImage
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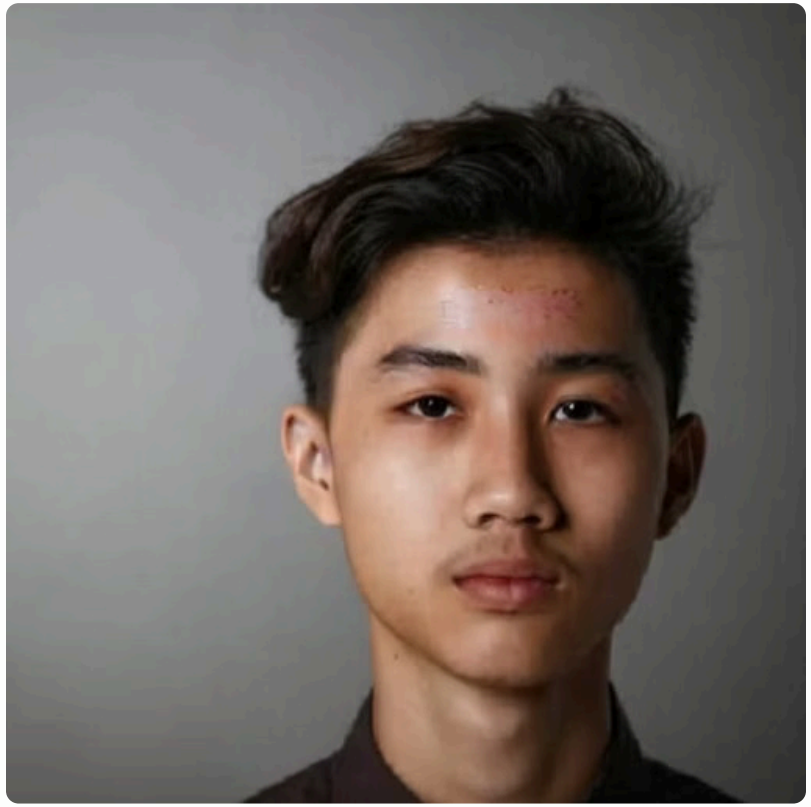

Baseline solution and results

Base Model

- **Architecture:** U-Net
- **Encoder:** ResNet-34 (ImageNet pretrained)
- **Input:** RGB selfie image (3×H×W)
- **Output:** Multi-class segmentation map (4×H×W)
- **Activation:** None (softmax applied only during loss / evaluation)

Training Data

- **Dataset:** GlowAI-Synth v0 (synthetic facial images)
- **Generation:** Stable Diffusion v1.5 (Inpainting, ComfyUI)
- **Labels:** Pixel-accurate masks derived from inpainting masks
- **Split:** 80% Train / 20% Validation (synthetic only)

Training Setup

Loss: multi-class Cross-Entropy

(we plan to experiment with a combination with Dice Loss in the next stage).

Optimizer: Adam (lr = 1e-4, batch size ≈ 8).

Train for a fixed number of epochs until convergence, saving the best checkpoint according to validation mIoU.

Evaluation Metrics

- **Mean Intersection-over-Union (mIoU)**
- **IoU per class**

GlowAI Project Plan

Synthetic data generation – GlowAI-Synth v1	Turn the ComfyUI workflow into a semi-automatic pipeline and generate thousands of synthetic face images with skin defects (Acne, Redness, etc.) based on CelebA	Initial synthetic dataset GlowAI-Synth v1 + before/after examples
Baseline segmentation model training	Train a U-Net + ResNet-34 segmentation model on GlowAI-Synth v1 (80/20 train/val split, Cross-Entropy loss, Adam optimizer)	Baseline model GlowAI-Seg v1 + initial performance table (mIoU + per-class IoU)
Validation on real data & error analysis	Run the model on a small set of real selfie images with image-level labels, and identify failure patterns (especially Redness / Texture / Dryness)	Qualitative examples (input + predicted mask) + list of main failure modes
Model & data improvement – GlowAI-Seg v2	Expand the dataset (more diversity in skin tones, lighting, severity) and try model improvements (e.g., combined loss or an additional segmentation architecture)	Improved model GlowAI-Seg v2 + comparison vs. v1 (performance table / plots)
Image-level classification & user-facing view	Derive multi-label outputs from each segmentation mask and define basic logic for high-level user recommendations	Defect vector per image (Acne/Redness/…) + mock-up of an “app screen” (skin summary + general recommendations)