Generate Acne Images for Simulated Multimodal N-of-1 trials

Advanced Machine Learning Seminar (WS 2023/2024)
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Agenda

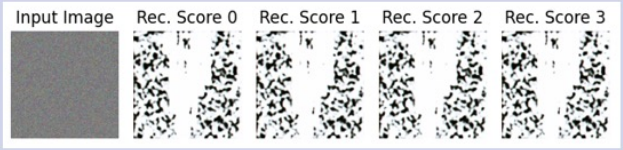
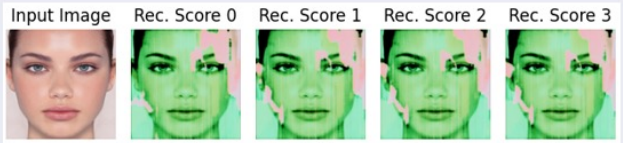
1. Background
    a. Multimodal N-of-1 Trials
    b. ACNE04 Dataset

1. Image Generation Models
    a. SkinGAN
    b. Stable Diffusion

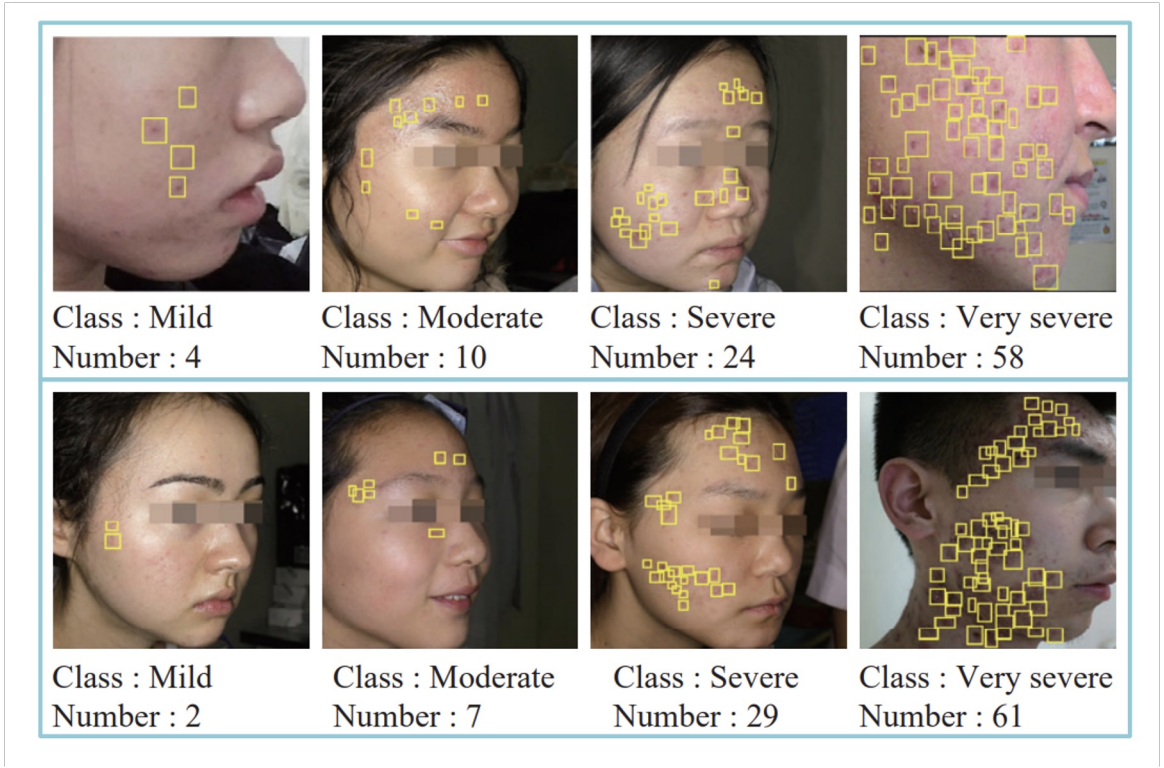
1. Future Work

Multimodal N-of-1 Trials

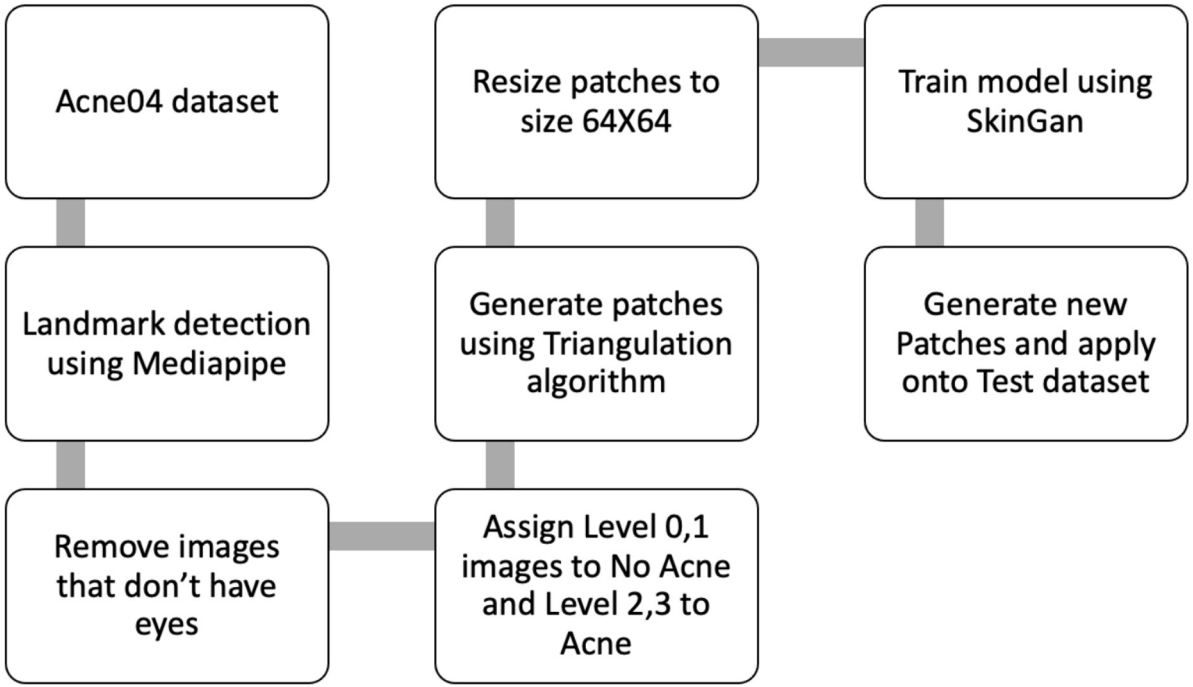
Previous attempts

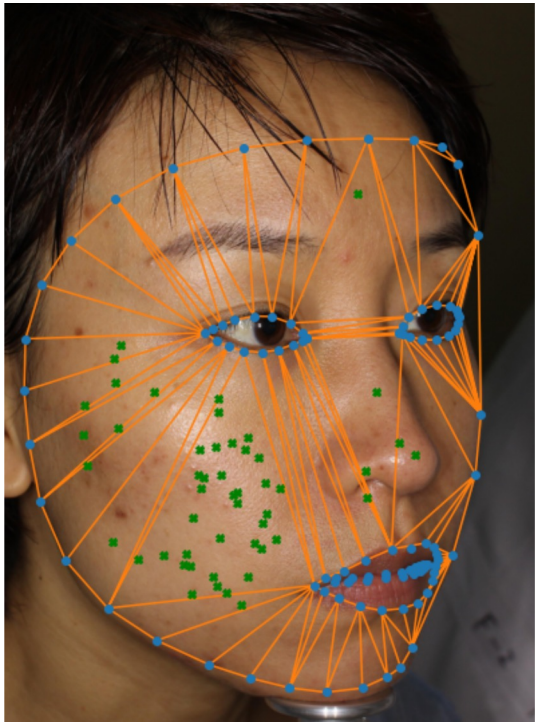
Model	Structure	Example Images
cGAN	• Generator + Discriminator • Generated Based on Noise + target Condition	
Morph Network	• Generator + Discriminator • Generated Based on Input Image + target Condition	
Diffusion	• Generated based on Noise + target Condition	
Adversarial Attack	• Manipulator (AE) + pretrained Acne Classification Model	

ACNE04 Dataset

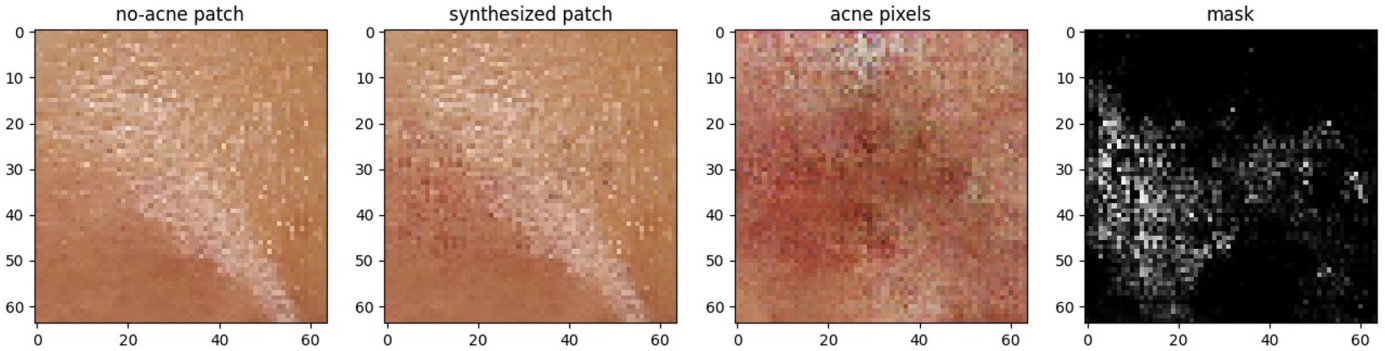


SkinGAN

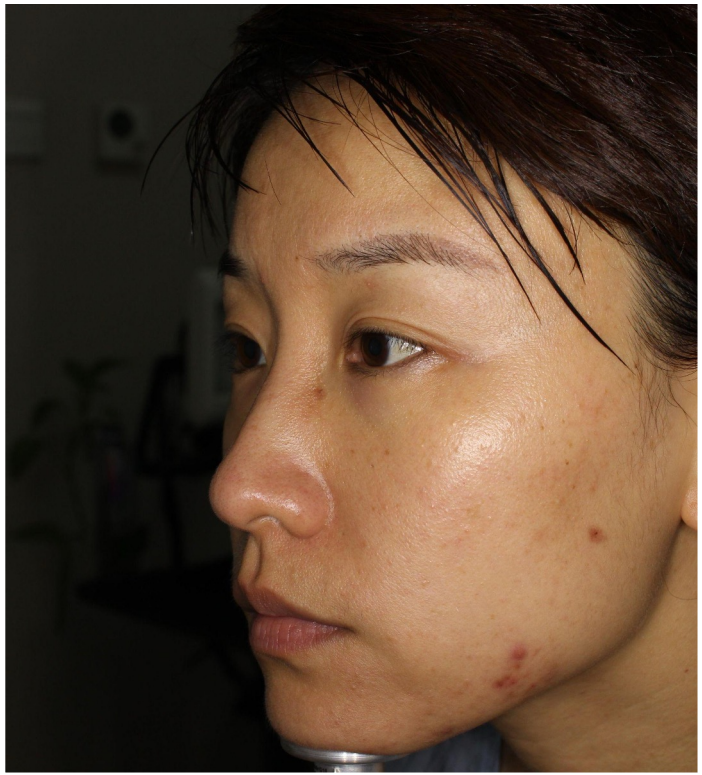

Acne04 dataset
Landmark detection using Mediapipe
Remove images that don't have eyes
Assign Level 0,1 images to No Acne and Level 2,3 to Acne
Generate patches using Triangulation algorithm
Resize patches to size 64X64
Train model using SkinGan
Generate new Patches and apply onto Test dataset



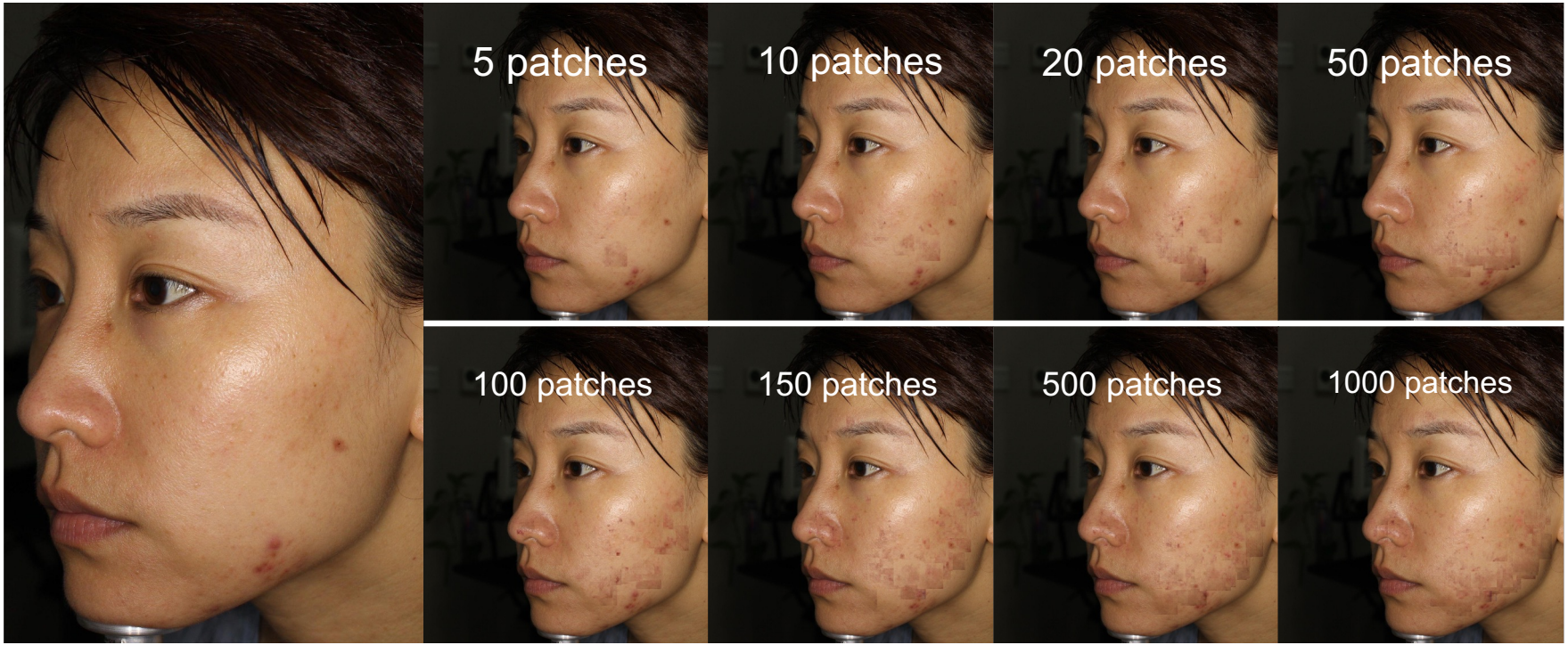
SkinGAN: Patches



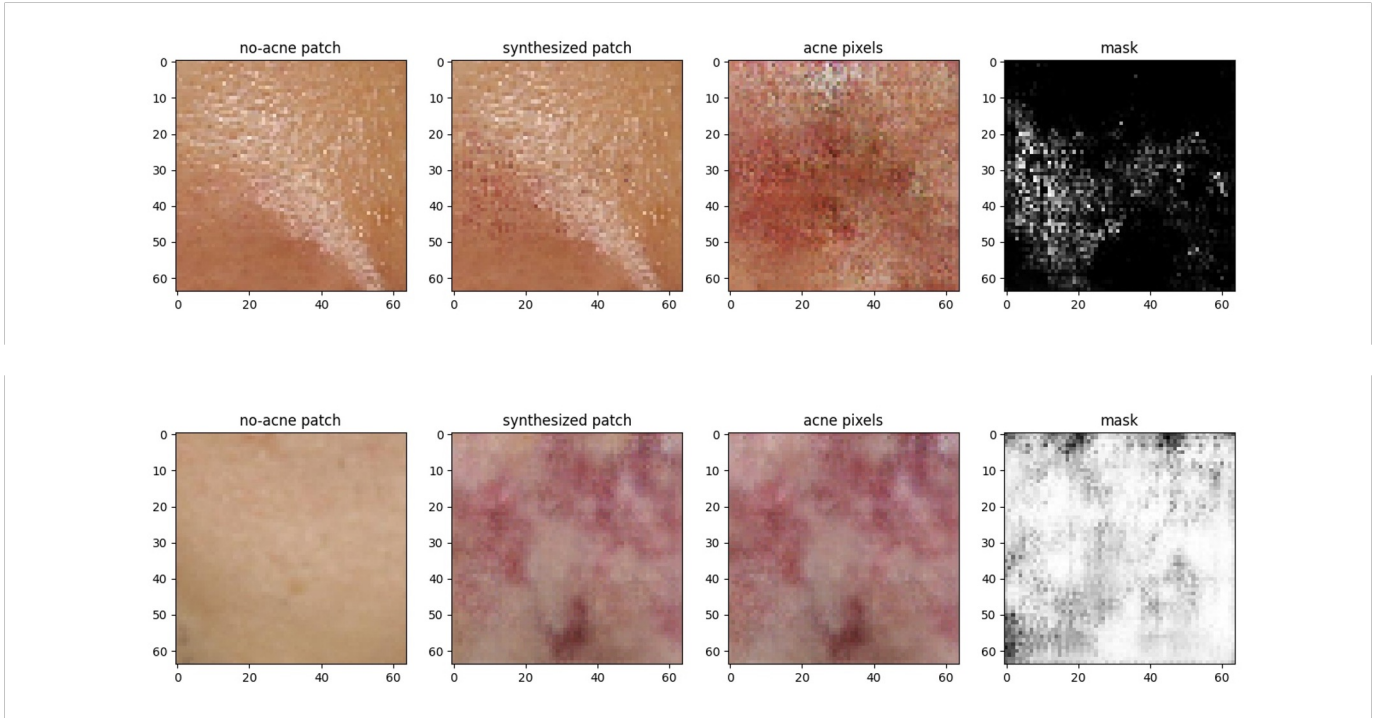
SkinGAN: Patches



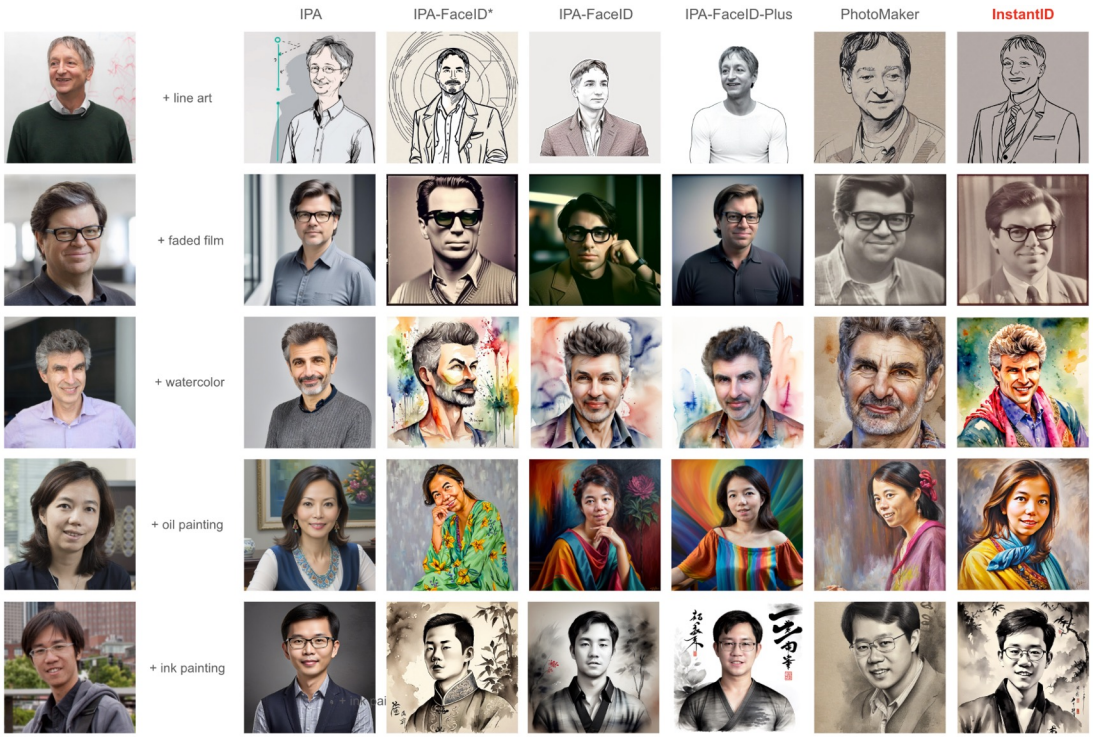
SkinGAN: Multiple patches



SkinGAN: Multiple patches



Comparison of ID-preservation



SkinGAN post-processing with SD

Stable Diffusion: Base Models

InstantID

InstantID

Instruct2Pix

IP-Adapter

SD1.5

DreamBooth: Fine Tuning Text-to-Image Diffusion Models

Input images

SDXL fine tuning on unfiltered ACNE04

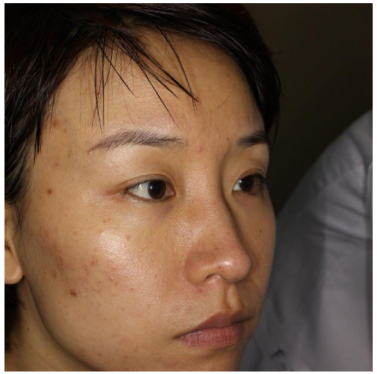




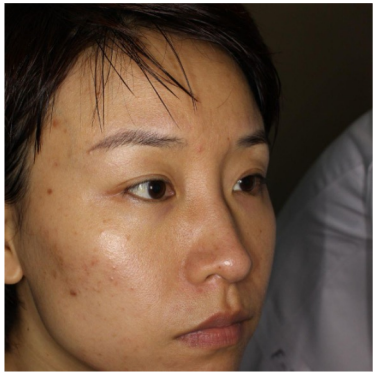

SDXL fine tuning on filtered ACNE04

Prompt Engineering

Img2Img on ACNE04 image

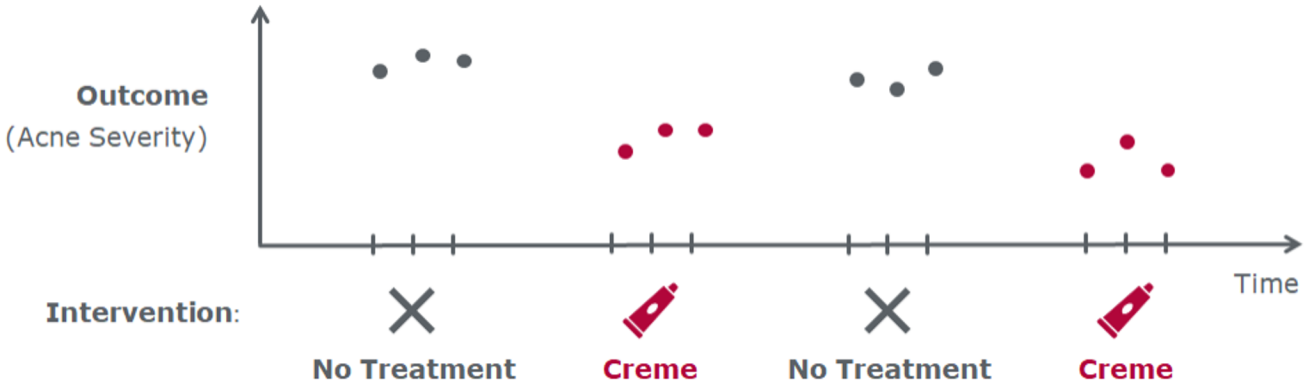


Img2Img on ACNE04 image



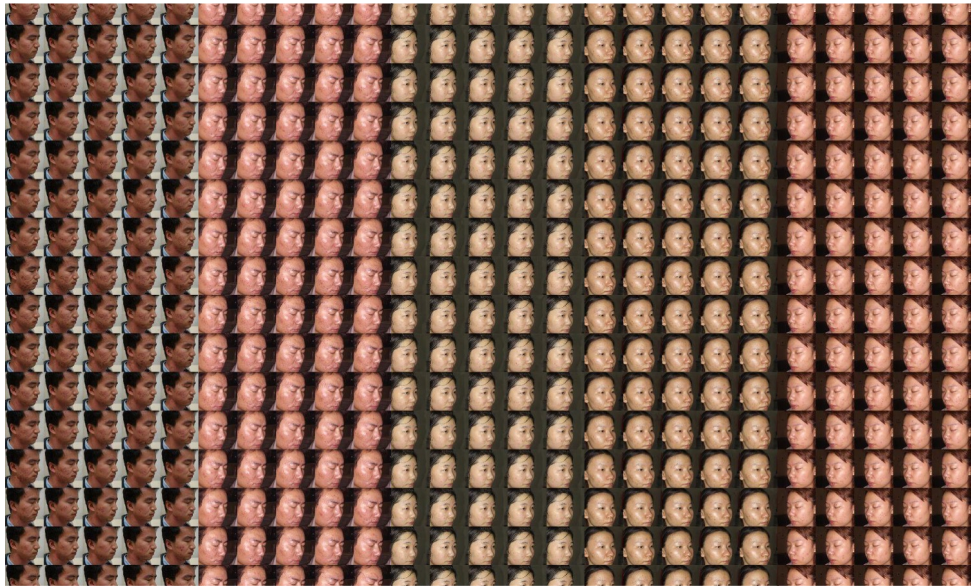
Multimodal N-of-1 Trials

A synthetic multimodal N-of-1 Trial



A synthetic multimodal N-of-1 Trial

	patient_id	date	block	day	treatment	AcneSeverity
0	1	2018-01-01	1	1	Baseline	3.0
1	1	2018-01-02	1	2	Baseline	2.93
2	1	2018-01-03	1	3	Baseline	3.0
3	1	2018-01-04	1	4	Baseline	2.971
4	1	2018-01-05	1	5	Baseline	3.0
5	1	2018-01-06	1	6	Baseline	2.828
6	1	2018-01-07	1	7	Baseline	3.0
7	1	2018-01-08	1	8	Baseline	2.551
8	1	2018-01-09	1	9	Baseline	2.972
9	1	2018-01-10	1	10	Baseline	2.755
10	1	2018-01-11	1	11	Baseline	3.0
11	1	2018-01-12	1	12	Baseline	3.0
12	1	2018-01-13	1	13	Baseline	3.0
13	1	2018-01-14	1	14	Baseline	3.0
14	1	2018-01-15	1	15	Baseline	2.858
15	1	2018-01-16	1	16	Baseline	3.0
16	1	2018-01-17	1	17	Baseline	3.0
17	1	2018-01-18	1	18	Baseline	2.965
18	1	2018-01-19	1	19	Baseline	3.0
19	1	2018-01-20	1	20	Baseline	2.834



Img2Img on OOD images

SD1.5 fine tuned on all classes

Future Work

- Longer training runs on all classes in a single model
- Fine tuning with additional identity-preserving adapters like IP-Adapter
- Train and validate on a more diverse dataset than ACNE04, e.g. through generating more diverse images (closed loop?)
- Simulating time dependency through more localized edits of existing acne patches while preserving individual's identity
  - Continuous acne severity level variable, e.g. lesion counts

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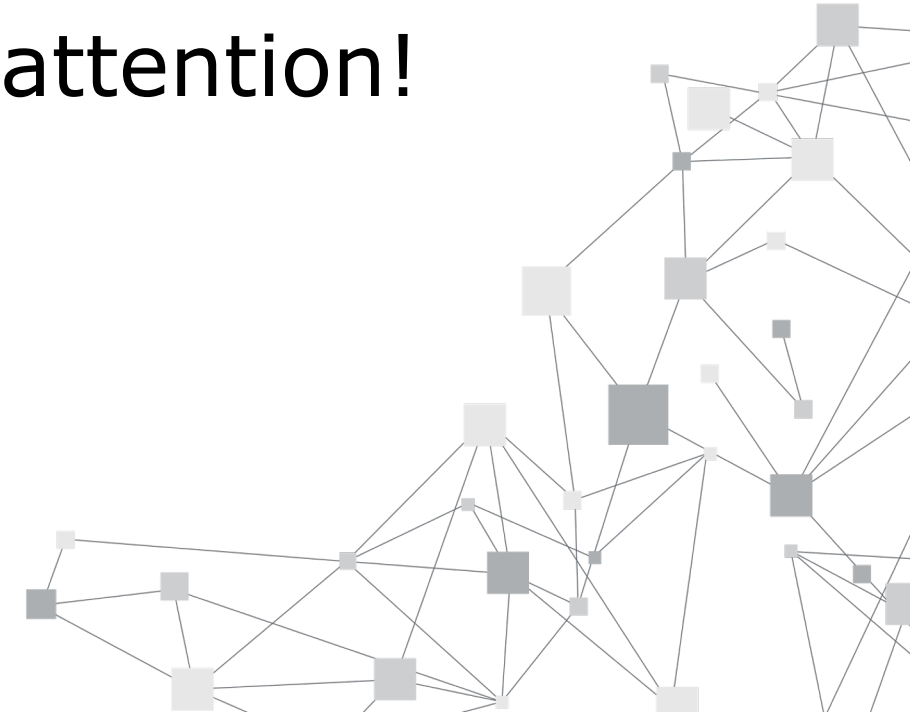
Thank you for your attention!



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References

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- Multimodal Outcomes in N-of-1 Trials: Combining Unsupervised Learning and Statistical Inference - Schneider, Gärtner & Konigorski (2023)
- Joint Acne Image Grading and Counting via Label Distribution Learning - Wu et al. (2019)
- Generative Adversarial Networks for anonymous Acneic face dataset generation - Zein et al. (2022)
- SkinGAN: Medical image Synthetic data generation using Generative methods - Lu & Krishnamurthy (2021)
- DreamBooth: Fine Tuning Text-to-image Diffusion Models for Subject-Driven Generation - Ruiz et al. (2022)
- InstantID: Zero-shot Identity-Preserving Generation in Seconds - Wang et al. (2024)
- IP-Adapter: Text Compatible Image Prompt Adapter for Text-to-Image Diffusion Models - Ye et al. (2023)