Plastic Surgery
Image Classification & Generation

Kaiyi Qi & Yiwei Han

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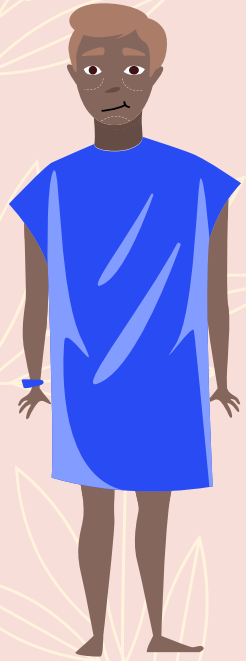
INTRODUCTION

OVERVIEW OF PLASTIC SURGERY



5.4 Million

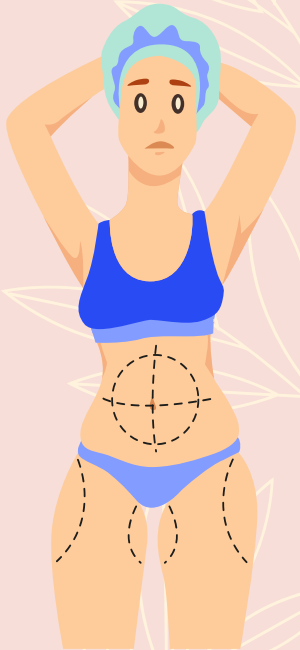
Surgical Plastic Surgeries in 2019 in Asia

8.4 Million

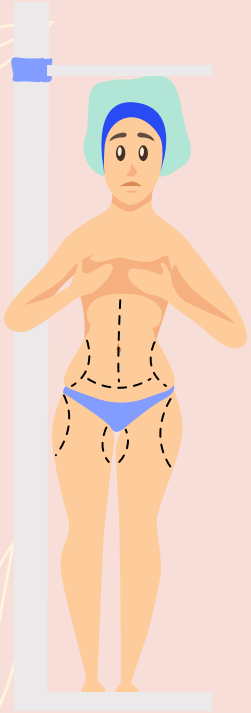
Non-Surgical Plastic Surgeries in 2019 in Asia

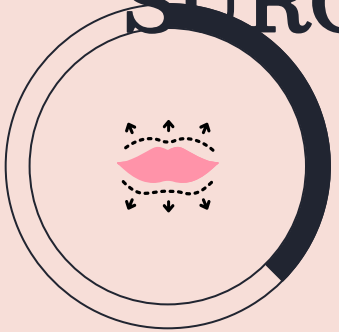
+33.3%

Increase of Plastic Surgeries Over Past 4 Years



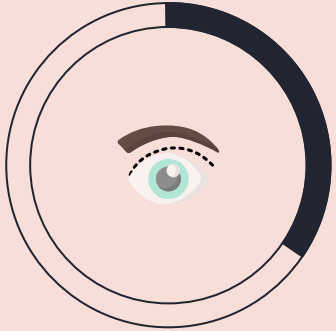
OVERVIEW OF PLASTIC SURGERY





33.3%

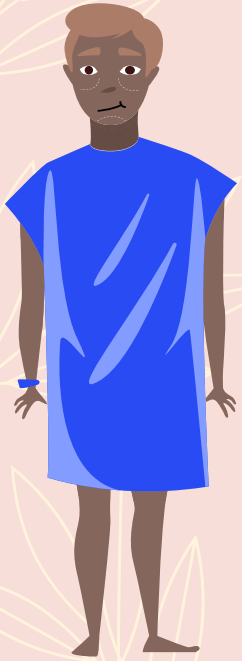
Of Korean Women between 19-29 has done plastic surgery



31.4%

Of respondent who did plastic surgery are Asian

TOP 3 PLASTIC SURGERY



Double Eye Lid

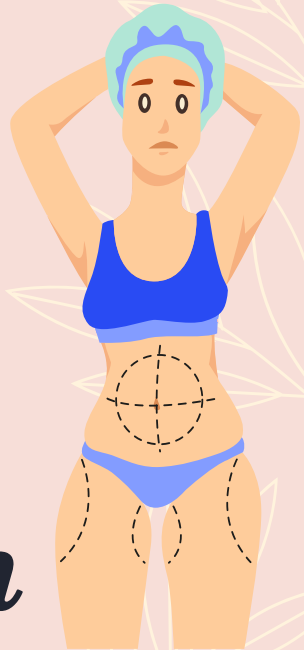
Most Number Performed

Rhinoplasty

Second Number Performed

Jawline Reduction

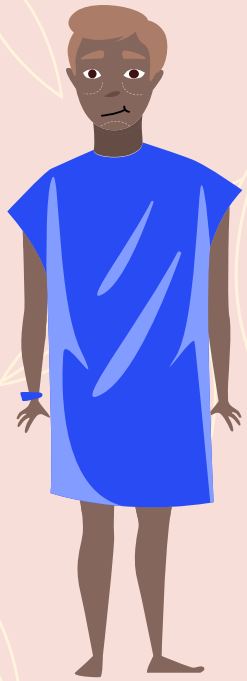
Third Number Performed



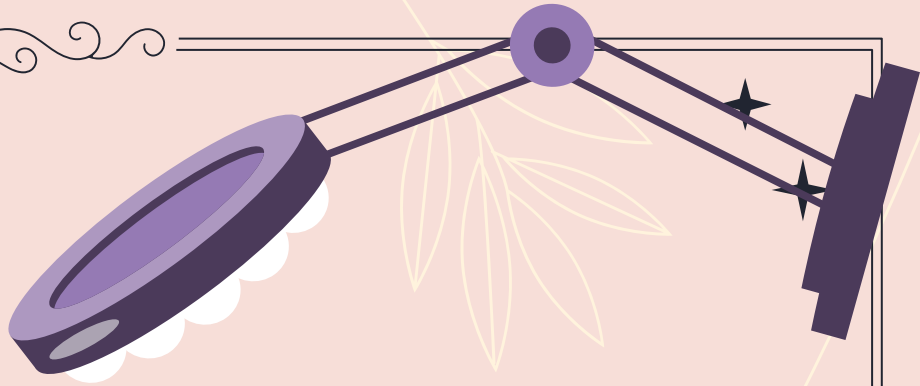
QUESTION

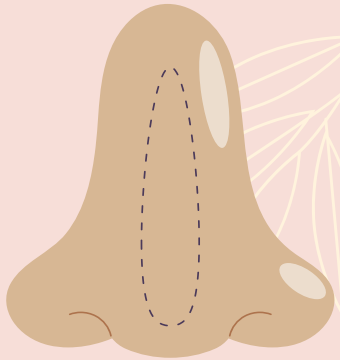
- Most of successful plastic surgery can recover pretty well…
- It is hard to distinguish whether a person did plastic surgery or not…
- It is impolite to ask a person whether he/she did plastic surgery…
- Even if you ask, he/she might not be honest…

There is no prior work on such topic...😭



So...
Plastic Surgery Classification & Generation





02

DATASET

SOURCES of DATA

We collected all the data by ourselves!

★ There is no existing dataset that contains before & after plastic surgery photos.

★ Sources we used:

·Plastic Surgery Hospital Websites
·Social Media APPs
·Online Image Websites

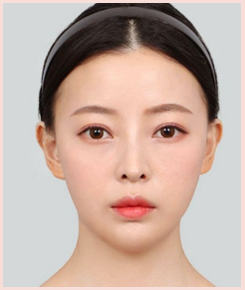
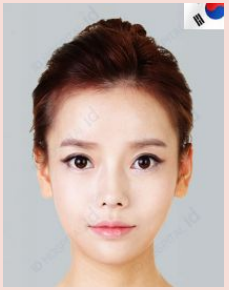
★ After collecting the data, our dataset contains two parts:

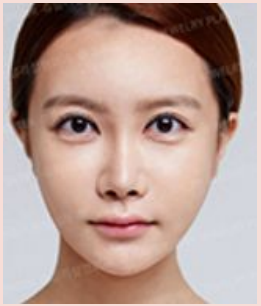
·Non_plastic set: 1000 Asian images
·Plastic set: 1000 Asian images

Independent of Make-up

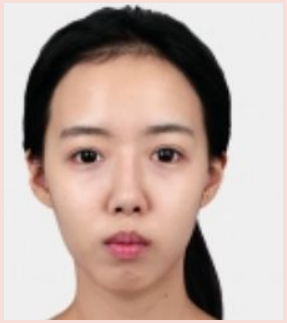
PLASTIC SURGERY FACES

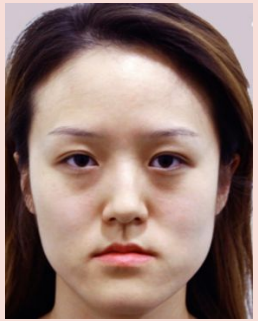


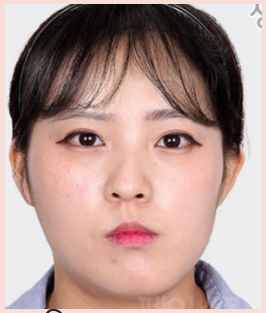





NON PLASTIC SURGERY FACES




DIFFERENCES BY EYES

FACE SHAPE

Big Distorted Face vs **V-shape Face**

EYES

Single Eye Lids vs **Double Eye Lids**

NOSE

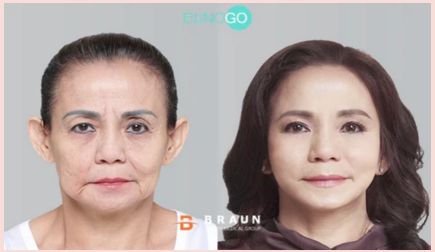
Big Flat Nose vs **Small High Nose**

LIP

Thin Flat Lip vs **Thick M-shape Lip**

WRINKLE

Wrinkled Face vs **Filling Anti-Aging Face**



03

CLASSIFICATION

CLASSIFIERS

AlexNet

- ★ Won ImageNet Large Scale Visual Recognition Challenge in 2012
- ★ 5 convolutional layers & 3 fully connected layers
- ★ ReLU activation function
- ★ Data Augmentation & dropout Regularization to prevent overfitting

GoogLeNet

- ★ Won ImageNet Large Scale Visual Recognition Challenge in 2014
- ★ 1x1 convolutions to reduce computation cost, 22 layers
- ★ Global average pooling prevent overfitting
- ★ Auxiliary classifier , intermediate features more informative

VGG16

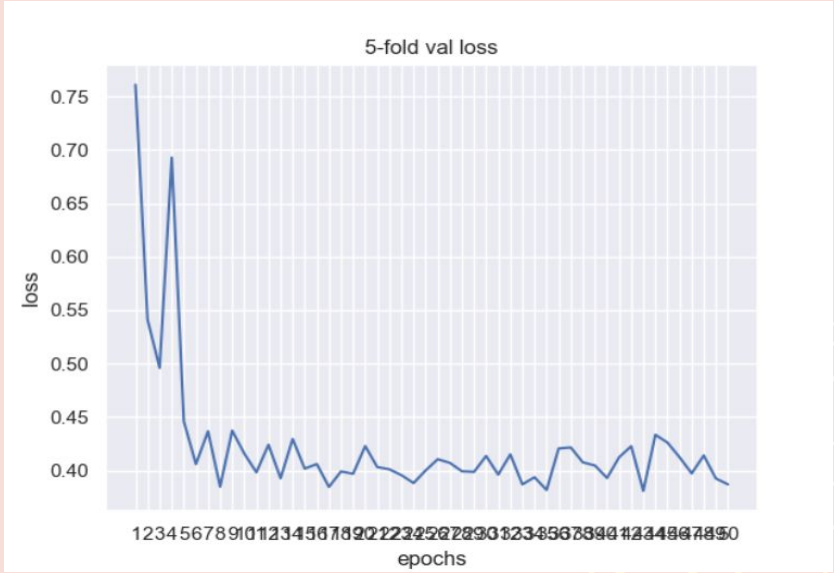
- ★ Small 3x3 convolutional filters to increase depth
- ★ 16 layers
- ★ Dropout regularization to prevent overfitting
- ★ Trained on large-scale dataset of 1.2 million images with 1000 object categories

Resnet50

- ★ Won ImageNet Large Scale Visual Recognition Challenge in 2015
- ★ 50 layers
- ★ Skip Connection to mitigate gradient problems
- ★ Bottleneck blocks that reduce computational cost, increase depth

EPOCHs

- ★ We plot 5-fold cross validation loss
- ★ From the plot, we can see the model converges at around 10 epchs
- ★ We run 10 epochs furthermore in order to save time ⏰



MODIFICATIONS

Before modifications, the highest accuracy was 87% ...
Not a good result... 😭

Data Augmentation

- ★ Randomly flip image horizontally & vertically
- ★ Randomly rotate the image for 30 degrees

Regularization

- ★ Decay current weight before gradient descent
- ★ Set weight decay parameter as 10^-4

Learning Rate Decay

- ★ Divide the learning rate by 10 every 2 or 3 epochs

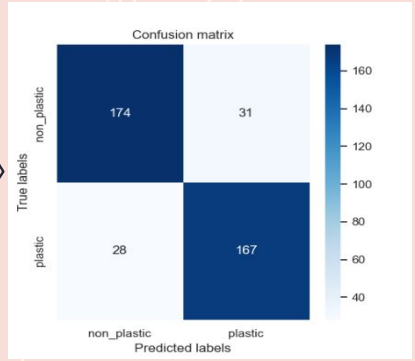
Fine-Tune Strategy

- ★ Froze earlier layers to save the low-level features
- ★ Fine-Tune the latter later layers

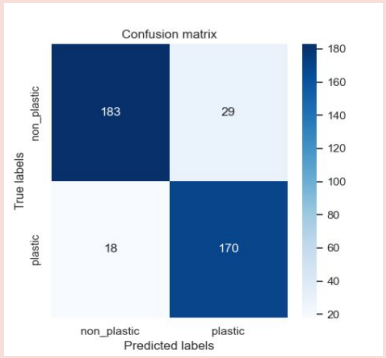
METRICS COMPARISON

		NAME	ACCURACY	F-1	TIME	OUR RATING
1		**RESNET 50**	**0.9225**	**0.9182**	1469.65s	*80%* 🥇
2		VGG 16	0.9000	0.8980	1811.55s	*65%* 🥈
3		GoogLeNet	0.8825	0.8550	1037.90s	*50%* 🥉
4		AlexNet	0.8525	0.8862	**984.05s**	*40%* ❌

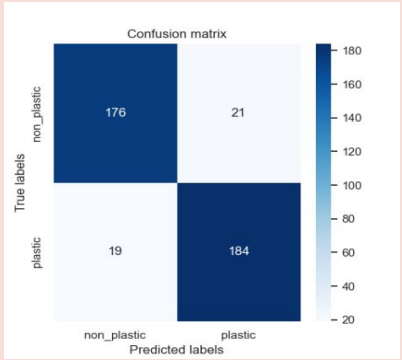
CONFUSION MATRIX



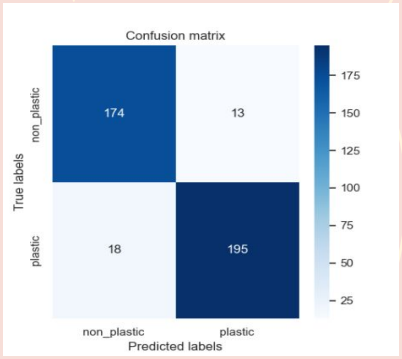
AlexNet



GoogLeNet

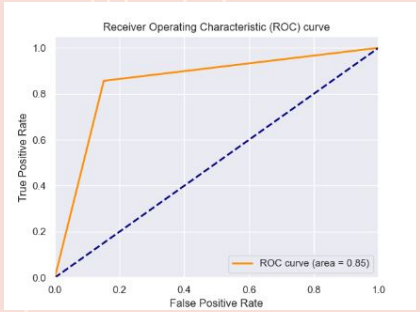


VGG16

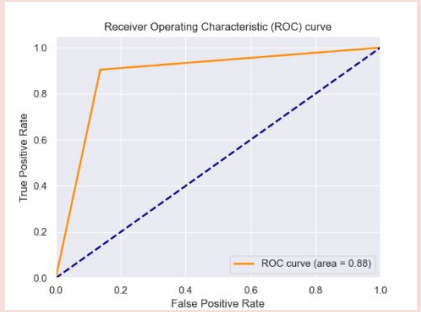


Resnet 50

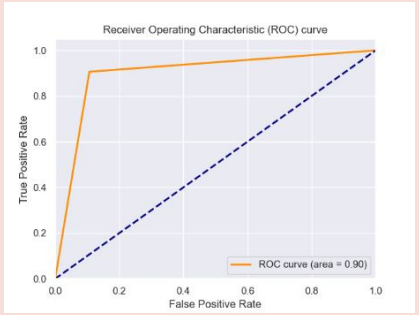
ROC CURVE



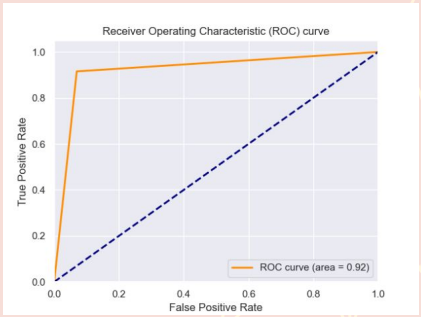
AlexNet



GoogLeNet



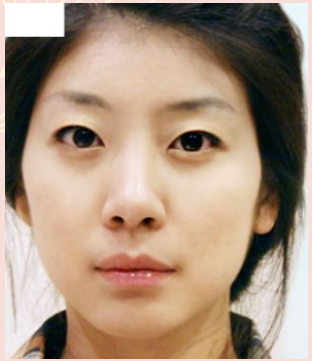
VGG16

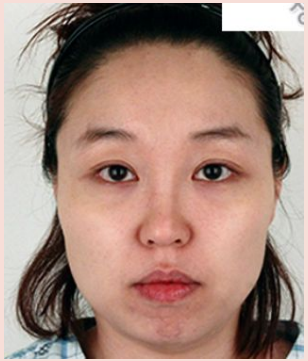


Resnet 50

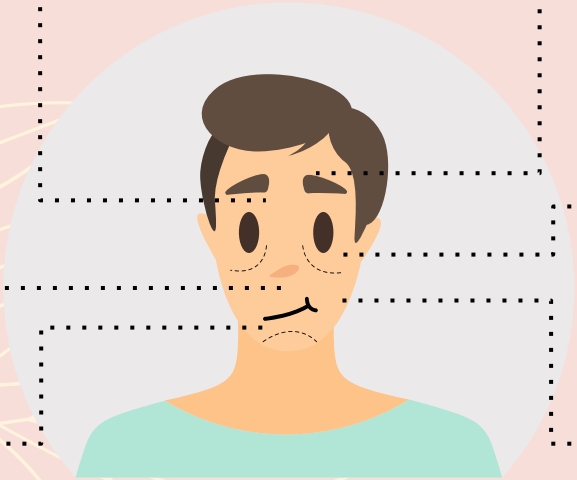
❌WRONG RESULTS❌

True: Plastic ---- Predict: Non-Plastic





True: Non-Plastic ---- Predict: Plastic

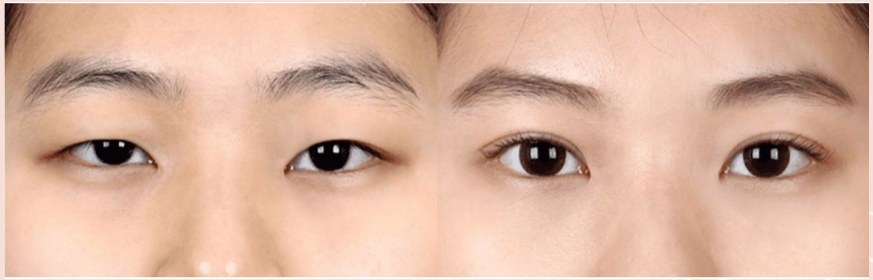


04

IDENTIFY SURGERY

Eye Surgery

- ★ *Person's eyes which have done eye surgery generally are a lot bigger comparing people who have not*
- ★ Dlib's Face Detector & Facial Landmarks Predictor
- ★ Compute distance between top and bottom, left and right corners of the eyes
- ★ Extract left and right eyes coordinate and compute eyes' aspect ratio
- ★ Base on eyes' aspect ratio, and eyes' proportion to face, analyze whether the person did eye surgery



Nose Surgery

- ★ *Person's nose which did plastic surgery generally thinner, longer, and the nose bridge is straighter, and the color of the sides of the nose is darker*
- ★ Compute nose to face width and height ratios
- ★ Calculate average color of the sides of the nose and the nose bridge
- ★ Measure straightness of nose bridge using Sobel Filter

Face Contouring Surgery

- ★ *Person's face shape which did plastic surgery generally thinner, V-shape and less distorted*
- ★ Compute chin to face width ratio using facial landmarks
- ★ Base on the chin to face width ratio, analyze whether a person has face contouring surgery

SOME EXAMPLES

Information by Official Website

★ *Double Eye Lids Surgery*
★ *Nose Surgery*
★ *Face Contouring Surgery*

Our Result

```
The person has done eyelid surgery.
The person has done nose surgery.
The person has done face contour surgery.
```

SOME EXAMPLES

Information by Official Website

★ *No Plastic Surgery*

Our Result

```
The person has not done eyelid surgery.
The person has not done nose surgery.
The person has not done face contour surgery.
```

SOME EXAMPLES

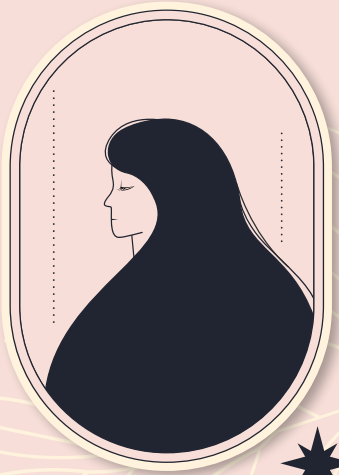
Information by Official Website

★ *Double Eye Lids Surgery*
★ *Face Contouring Surgery*

Our Result

```
The person has done eyelid surgery.
The person has not done nose surgery.
The person has done face contour surgery.
```

05
GENERATION



CycleGAN

enforce cycle consistency to ensure the translated image is consistent

AttentionGAN

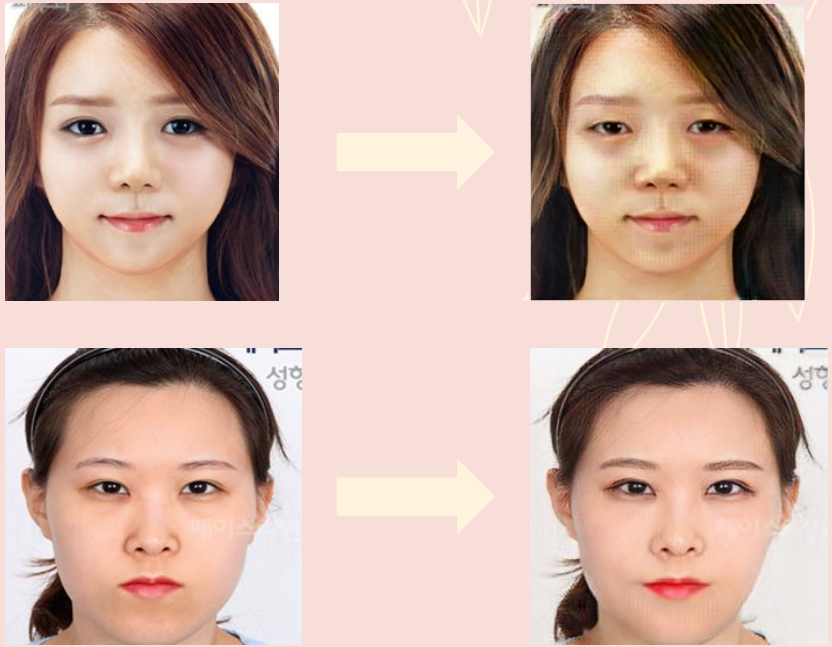
leverages attention mechanisms to improve the quality of generated images

UNIT

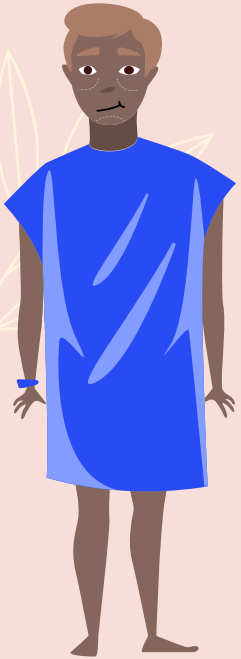
learn a shared latent representation between two domains, allowing for the translation of images with fewer training examples

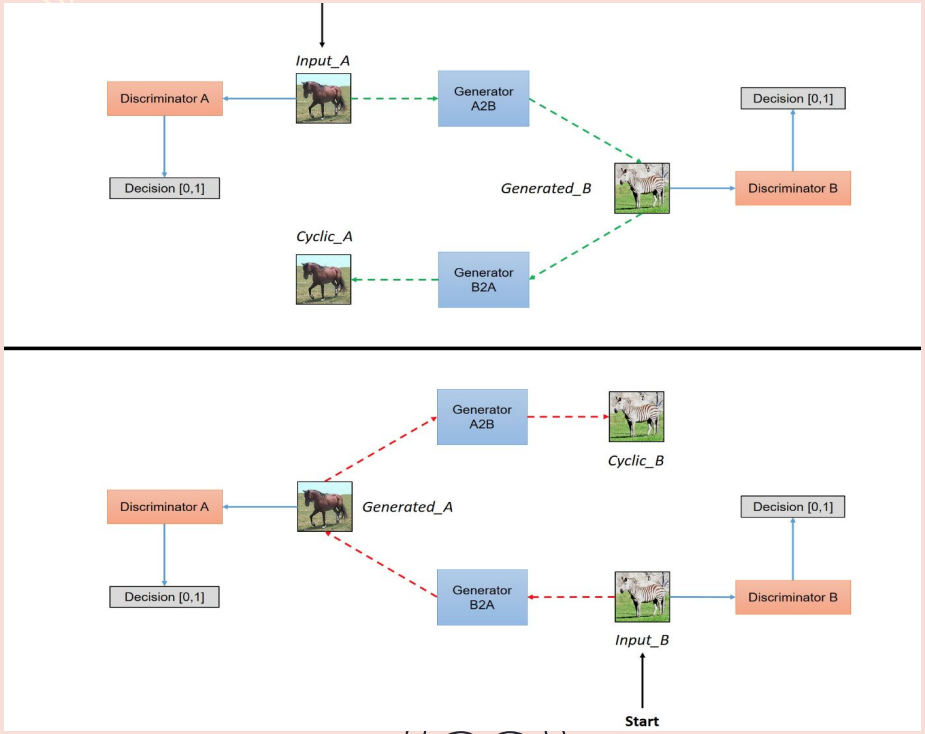
CycleGAN

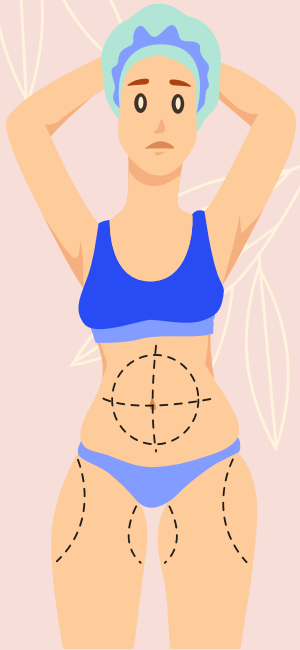
- ★ We trained for ***250*** epochs
- ★ Cycle-consistency loss function to ensure the translational images are consistent with the original images
- ★ Help model to learn a mapping between the two domains that preserve the underlying structure and content
- ★ A pair of generator networks and discriminator networks



CycleGAN FRAMEWORK



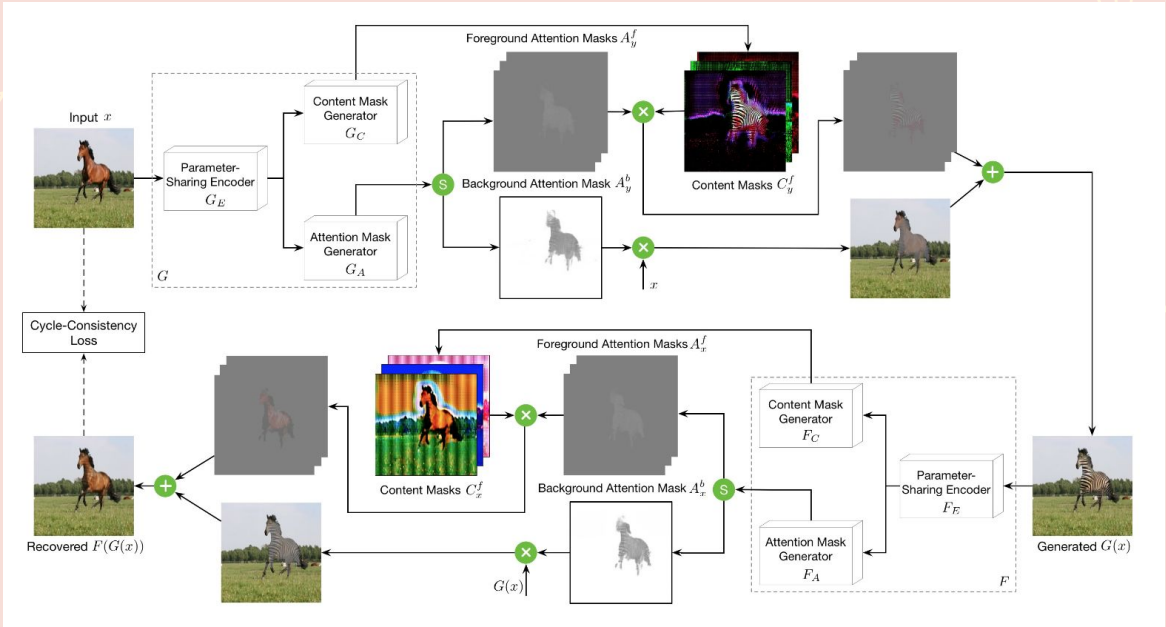




AttentionGAN

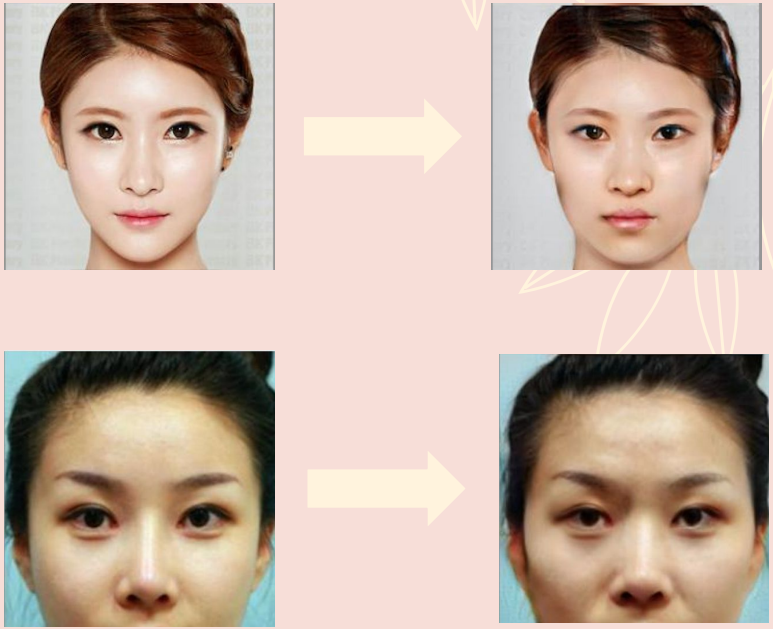
- ★ We trained for ***250*** epochs
- ★ Self- attention, allows the mode to focus on specific regions of input while generating the output
- ★ Capture fine-grained details
- ★ More effective in generating images with fine details like hair

AttentionGAN FRAMEWORK

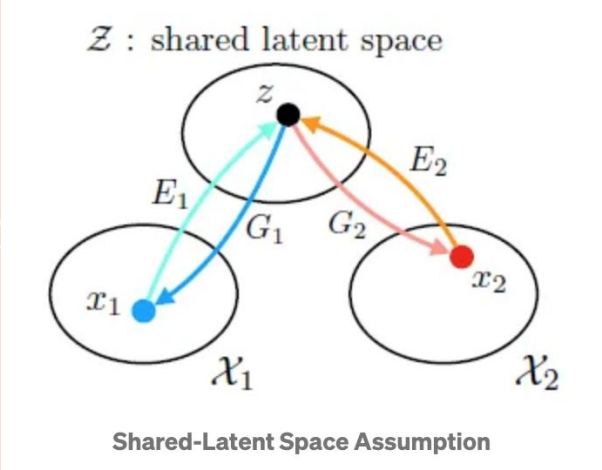


UNIT

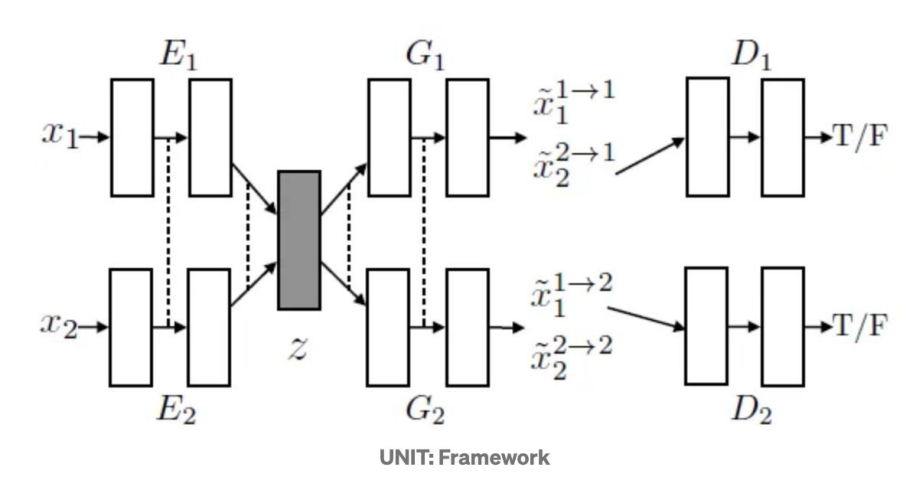
- ★ We trained for ***420000*** iterations
- ★ Encoder-Decoder architecture
- ★ Encoder map input to latent space, decoder map latent space to output
- ★ Shared latent space helps to learn common representations for both domains
- ★ Generator network: generate realistic looking images
- ★ Discriminator network: distinguish between real and fake images



UNIT FRAMEWORK



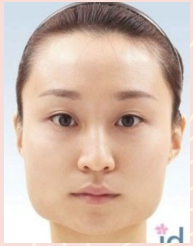
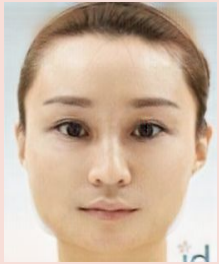
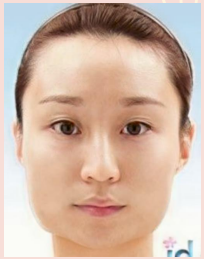
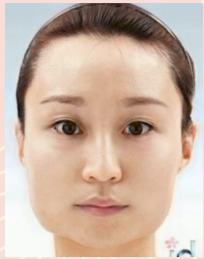
Shared-Latent Space Assumption

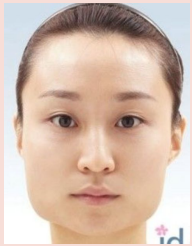
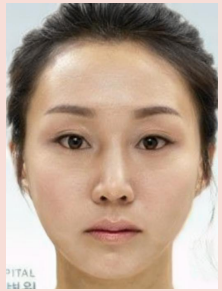


UNIT: Framework

COMPARISON

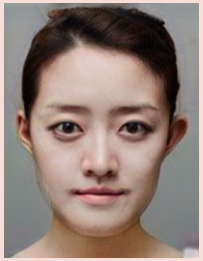
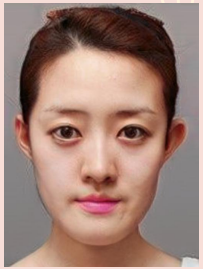
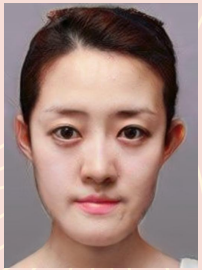
Case 1

Before	After	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

After	Before	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

COMPARISON

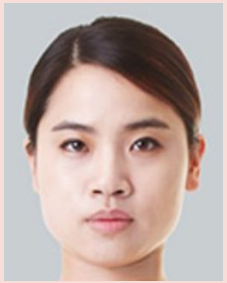
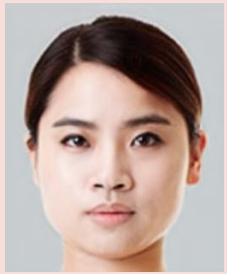
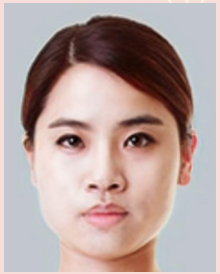
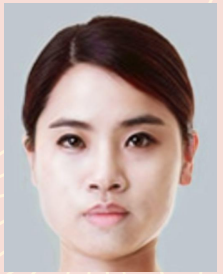
Case 2

Before	After	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

After	Before	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

COMPARISON

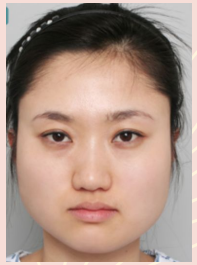
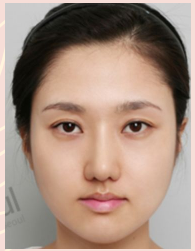
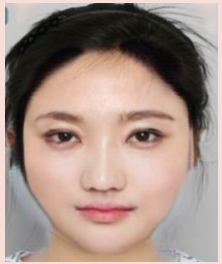
Case 3

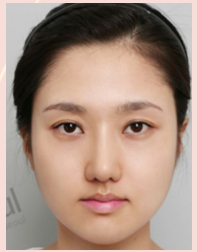
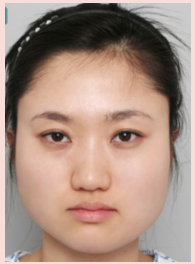
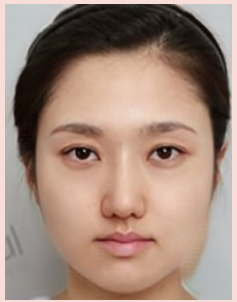
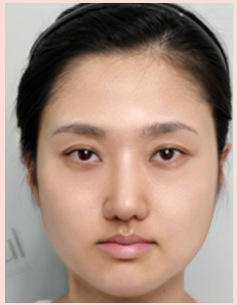
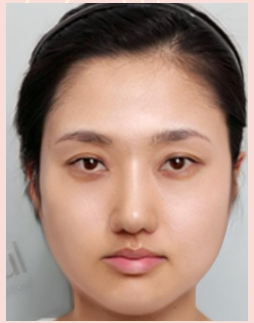
Before	After	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

After	Before	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

COMPARISON

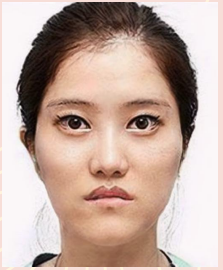
Case 4

Before	After	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

After	Before	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

COMPARISON

Case 5

Before	After	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

After	Before	AttentionGan	CycleGan	UNIT260k	UNIT420k
					

OVERALL COMPARISON

		NAME	Coherence	Generate Plastic	Generate Non-Plastic	Overall
1		AttentionGAN	2nd	**1st**	**1st**	🥇
2		CycleGAN	2nd	2nd	3rd	🥉
3		UNIT	**1st**	3rd	**1st**	🥈

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CONCLUSION

INSIGHTS

FRAUD DETECTION

Help insurance companies and healthcare providers identify cases like individuals who falsely claim to have plastic surgery in order to obtain reimbursement

HELP PATIENTS

Help patients to gain insights of what they might look like after plastic surgery, and prevent them to be impulsive

HELP SURGEONS

Create a reference for the surgeons of how to do plastic surgery on a specific patient, change according to preference and create more satisfiable results

LIMITATIONS & IMPROVEMENTS

LIMITATIONS:

- **KNOWLEDGE:** We need to gain more knowledge, and search for more classification and GAN methods
- **HARDWARE:** GoogleColab to train our model, sometimes the training will automatically terminate for no reason. Waste a lot of time.

FUTURE IMPROVEMENTS:

- **CLASSIFICATION:**
  - More models
  - Different modification methods for the models
  - Include more races
- **GENERATION:**
  - Train more epochs
  - Try more models

THANKS!

Does anyone have any questions?