Generative Adversarial Networks

Most of this material is from KH Cho at AI Lab. HYU

GAN?

Generative

Adversarial

Network

Generative

Adversarial

Network

Generative

생성하는 모델!

생성하긴 하는데...

생성하긴 하는데...

무엇을?

생성하긴 하는데...

무엇을?

그럴듯한 가짜 데이터!

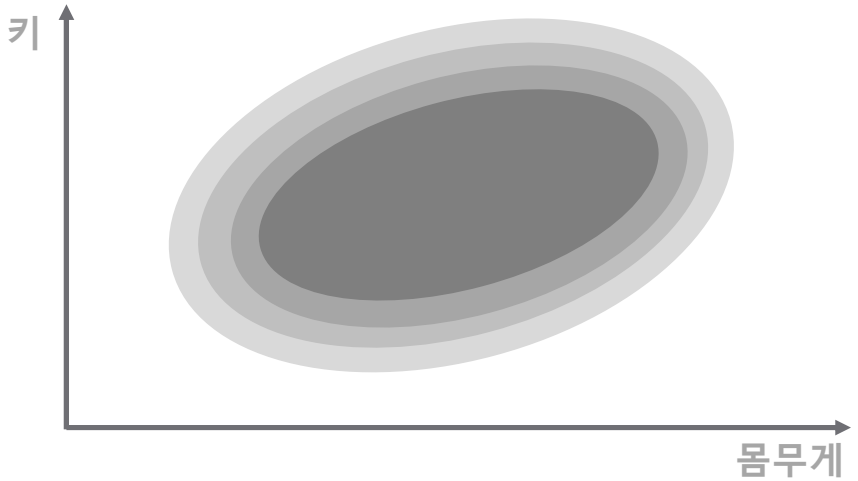
생성하긴 하는데...

무엇을?

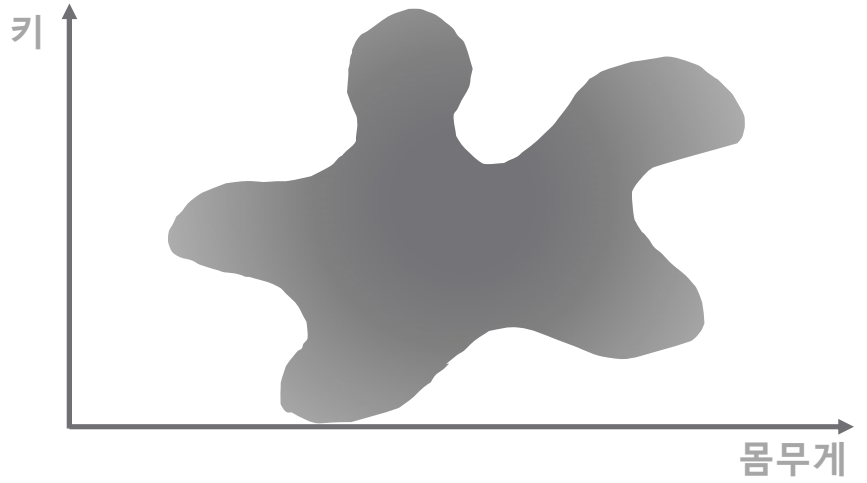
실제와 비슷한 분포를 가지는

그럴듯한 가짜 데이터!

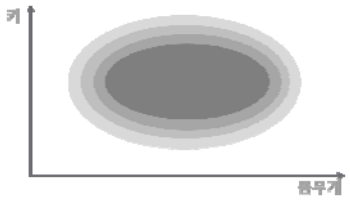
실제 데이터



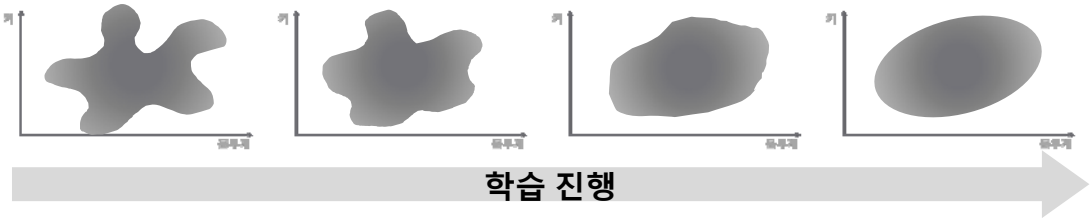
가짜 데이터



실제 데이터



가짜 데이터



GAN으로 생성한 실제같은 가짜 얼굴 예시

GAN의 목적 :

이 가짜 데이터를 만들어주는

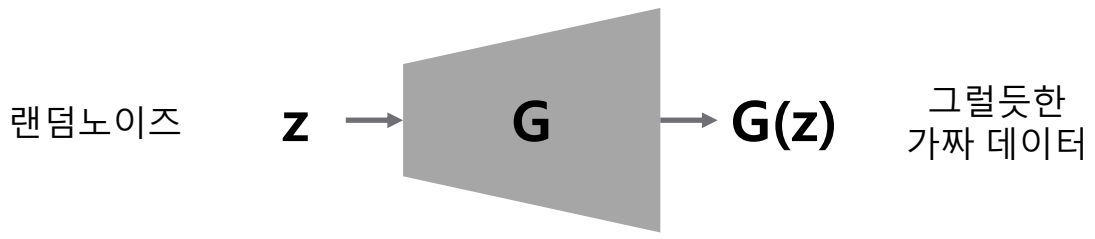
Generator 함수를 찾자**!**

Generator 함수 G

입력 : 랜덤노이즈 **z**

출력 : 그럴듯한 가짜 데이터

Generator 함수 G



Generator 함수 G

랜덤노이즈 → **G** → 그럴듯한 가짜 데이터

Generative

Adversarial

Network

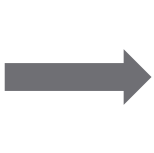
adversarial [-vər'seriəl]

형용사

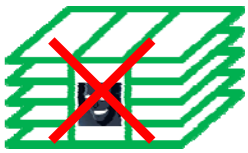
1. 서로 대립 관계에 있는, 적대적인

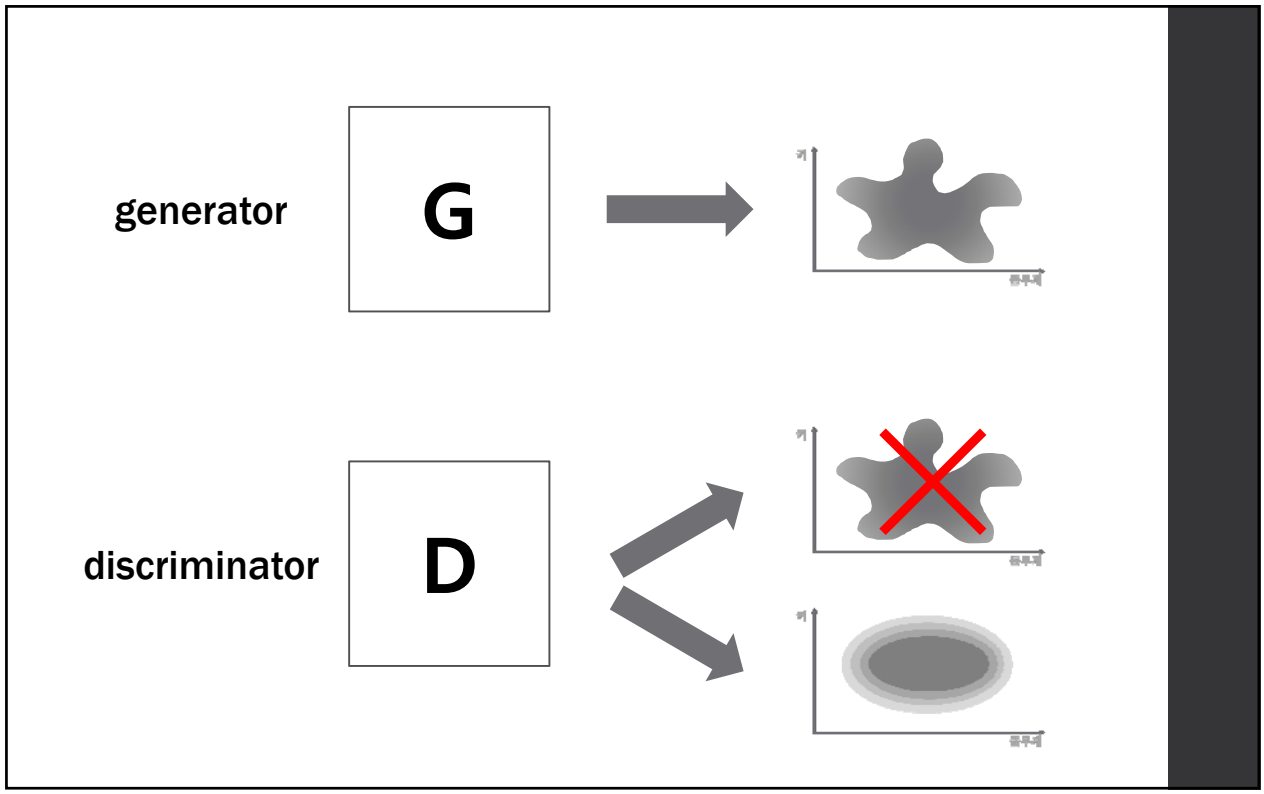
the adversarial nature of the two-party system
양당제의 대립적 속성

위조지폐범



경찰



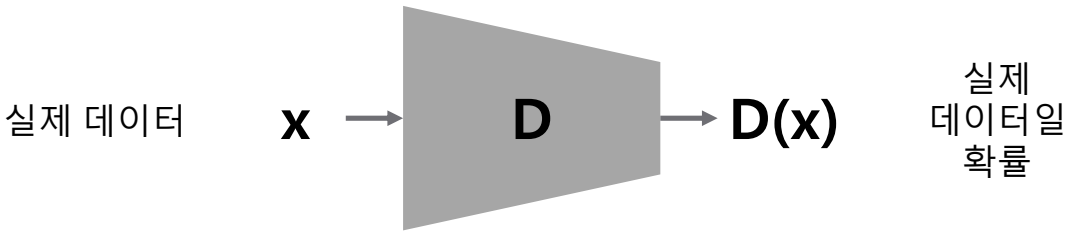


Discriminator 함수 D

입력 : 실제 데이터 **x** or 가짜 데이터 **G(z)**

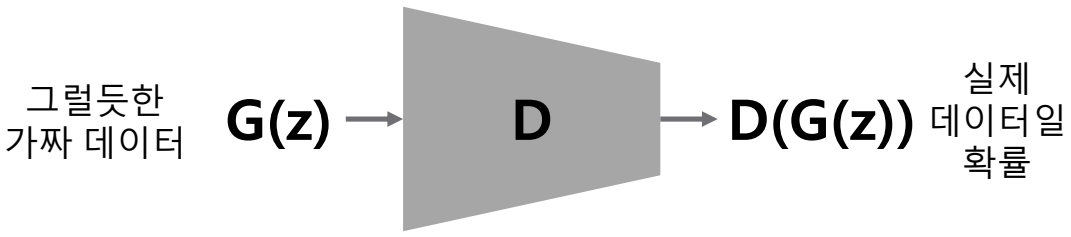
출력 : 입력이 실제일 **확률**

Discriminator 함수 D



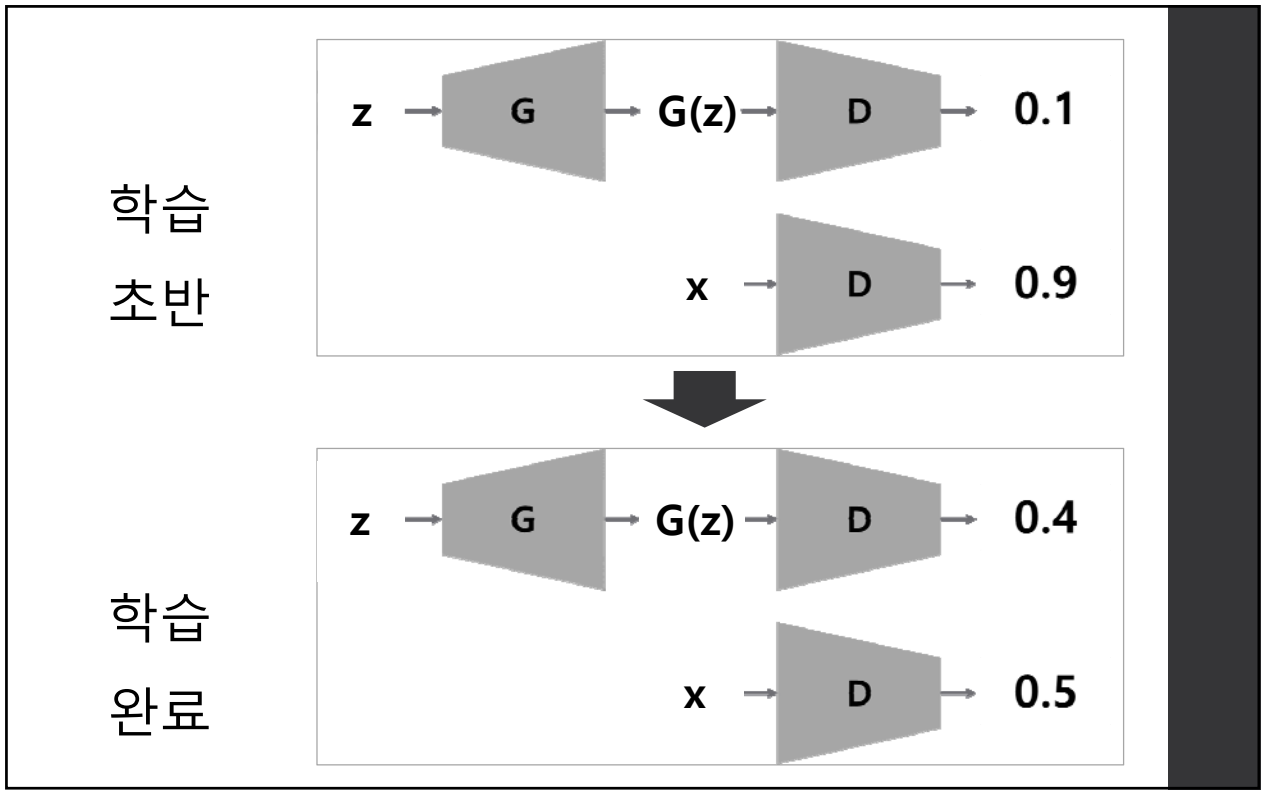
D의 입장 : **D(x)**의 값을 높이는 방향으로 학습할래!

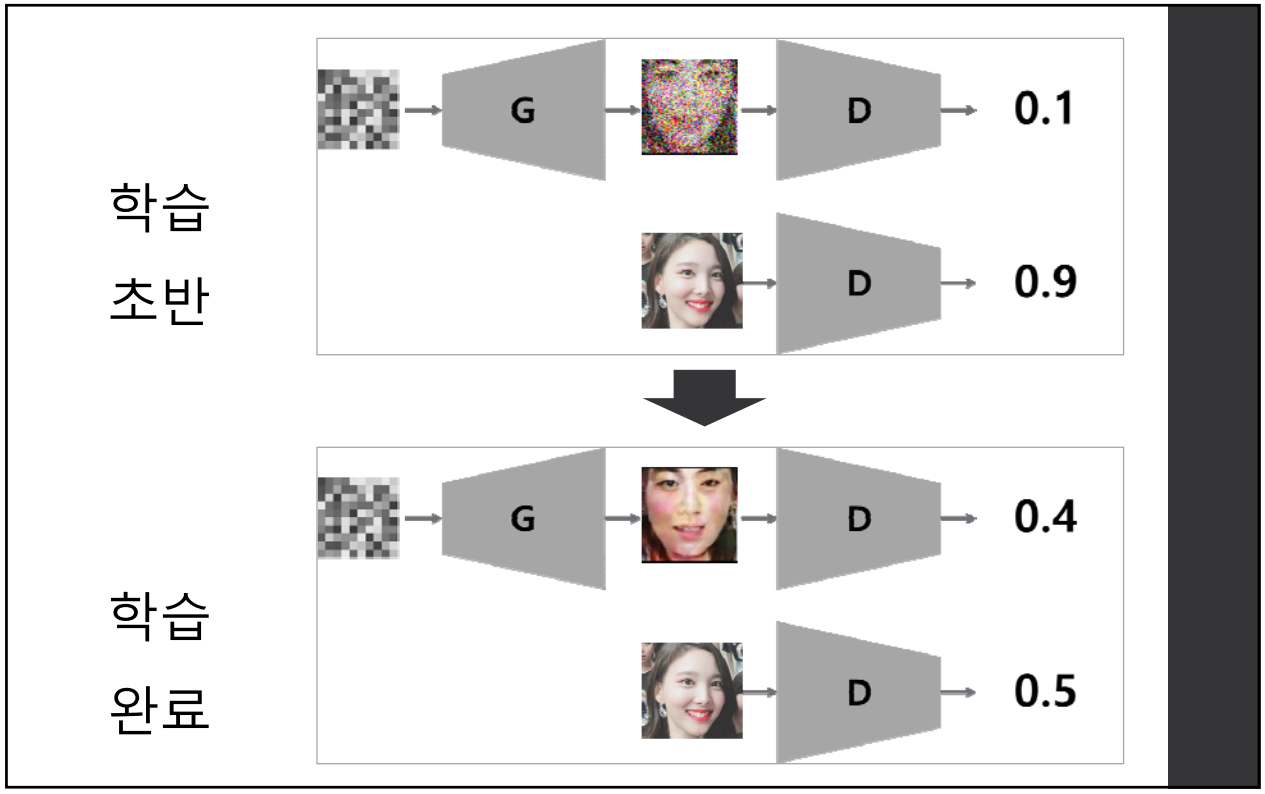
Discriminator 함수 D



D의 입장 : **D(G(z))**의 값을 낮추는 방향으로 학습할래!

G의 입장 : **D(G(z))**의 값을 높이는 방향으로 학습할래!


학습
초반
z
G
G(z)
D
0.1
x
D
0.9
학습
완료
z
G
G(z)
D
0.4
x
D
0.5


학습
초반
G
D
0.1
D
0.9
학습
완료
G
D
0.4
D
0.5

Generative

Adversarial

Network

value function
목적함수

$$\min_{G} \max_{D} V(D, G) = \mathbb{E}[\log D(x)] + \mathbb{E}[\log(1 - D(G(z)))]$$

objective function
목적함수

$$\min_{G}\max_{D} V(D,G) = \mathbb{E}[\log D(x)] + \mathbb{E}[\log(1 - D(G(z)))]$$

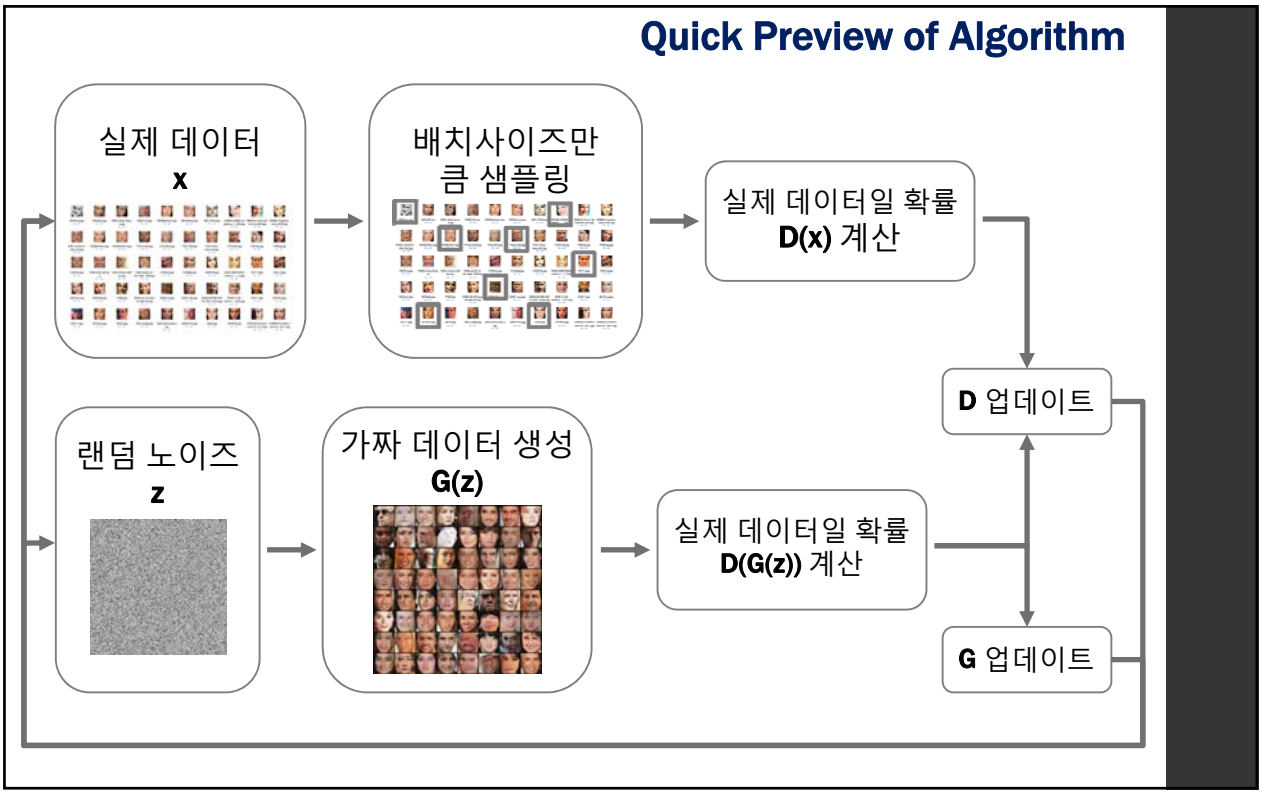
이 함수의 값은
작아져야 해!

value function
목적함수

$$\min_{G}\max_{D} V(D,G) = \mathbb{E}[\log D(x)] + \mathbb{E}[\log(1 - D(G(z)))]$$

이 함수의 값은
커져야 해!

Quick Preview of Algorithm



Quick Preview of Algorithm

실제 데이터에서 배치 사이즈만큼 데이터 샘플링 → **x**

배치 사이즈만큼 **랜덤 노이즈** 생성 → **z**

생성한 **랜덤 노이즈**를 **G**에 입력하여 **가짜 데이터** 생성 → **G(z)**

D에 **실제 데이터**를 입력으로 넣어 계산 → **D(x)**

D에 **가짜 데이터**를 입력으로 넣어 계산 → **D(G(z))**

계산 결과를 이용해 **D 업데이트** → $\mathbb{E}[\log D(x)]+\mathbb{E}[\log(1-D(G(z)))]$ **최대화**

배치 사이즈만큼 **랜덤 노이즈** 생성 → **z**

생성한 **랜덤 노이즈**를 **G**에 입력하여 **가짜 데이터** 생성 → **G(z)**

D에 **가짜 데이터**를 입력으로 넣어 계산 → **D(G(z))**

계산 결과를 이용해 **G 업데이트** → $\mathbb{E}[\log(1-D(G(z)))]$ **최소화**

The Algorithm

for number of training iterations **do**
  for k steps **do**
    - Sample minibatch of m noise samples $\{\boldsymbol{z}^{(1)}, \ldots, \boldsymbol{z}^{(m)}\}$ at random.
    - Sample minibatch of m examples $\{\boldsymbol{x}^{(1)}, \ldots, \boldsymbol{x}^{(m)}\}$ from real training data.

    - Update the discriminator by ascending its stochastic gradient:

$$\nabla_{\theta_d} \frac{1}{m} \sum_{i=1}^{m} \left[\log D\left(\boldsymbol{x}^{(i)}\right) + \log\left(1 - D\left(G\left(\boldsymbol{z}^{(i)}\right)\right)\right) \right].$$

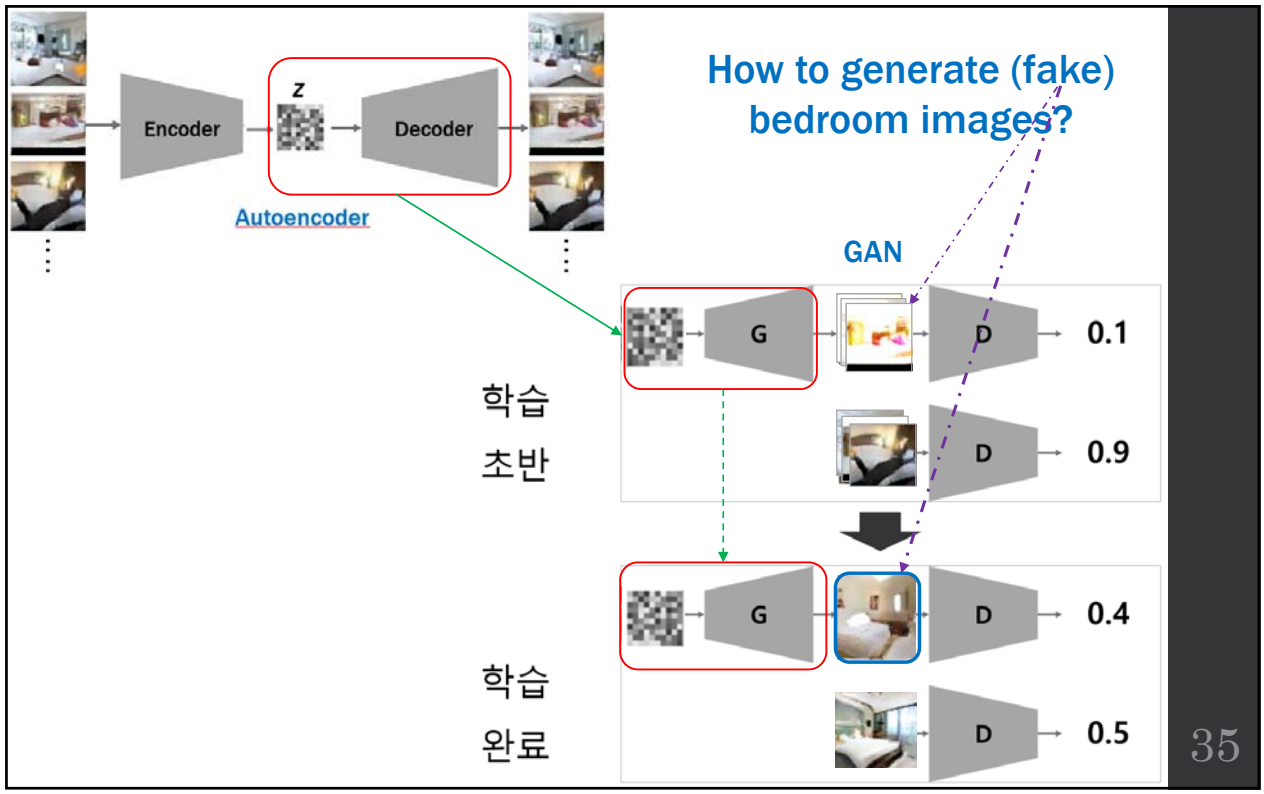
  end for
  - Sample minibatch of m noise samples $\{\boldsymbol{z}^{(1)}, \ldots, \boldsymbol{z}^{(m)}\}$ at random.
  - Update the generator by descending its stochastic gradient:

$$\nabla_{\theta_g} \frac{1}{m} \sum_{i=1}^{m} \log\left(1 - D\left(G\left(\boldsymbol{z}^{(i)}\right)\right)\right).$$

end for
The gradient-based updates can use any standard gradient-based learning rule.

GAN으로 생성한 진짜같은 가짜 침대방 예시

(generated from about 3 million training bedroom images)


How to generate (fake) bedroom images?
Encoder
z
Decoder
Autoencoder
GAN
G
D
0.1
D
0.9
학습 초반
G
D
0.4
D
0.5
학습 완료
35

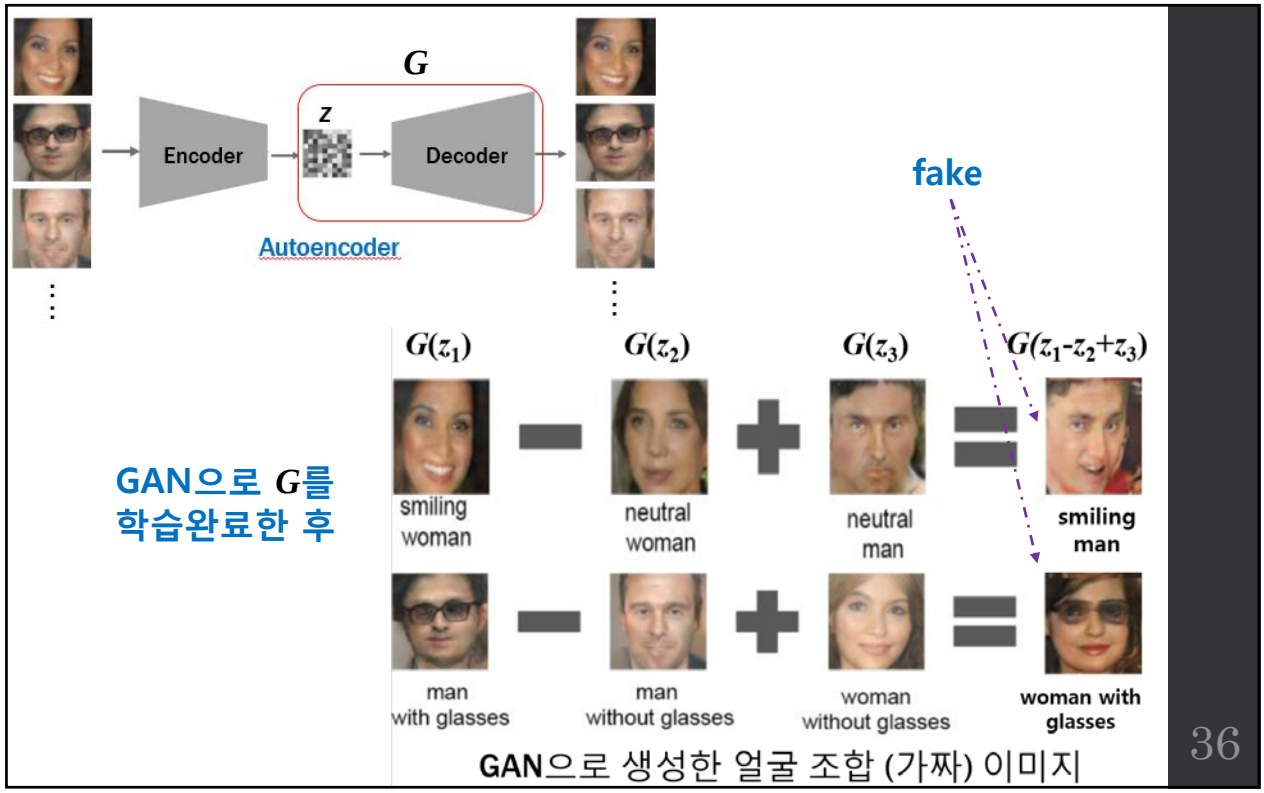

G
Encoder
z
Decoder
Autoencoder
fake
GAN으로 G를 학습완료한 후
$G(z_1)$
$G(z_2)$
$G(z_3)$
$G(z_1-z_2+z_3)$
smiling woman
neutral woman
neutral man
smiling man
man with glasses
man without glasses
woman without glasses
woman with glasses
GAN으로 생성한 얼굴 조합 (가짜) 이미지
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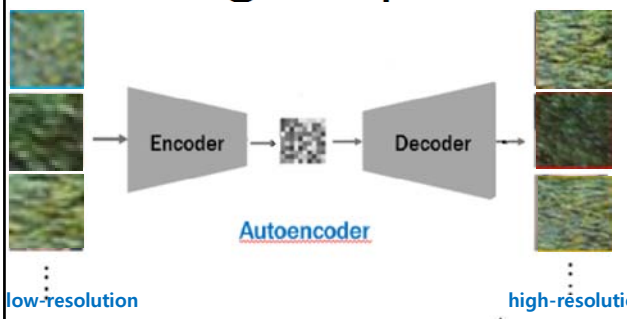
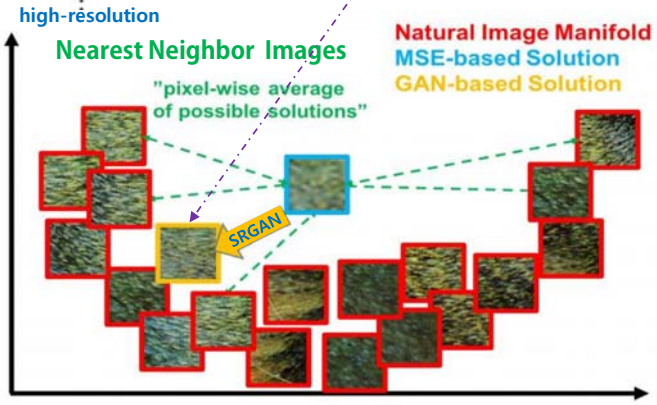
Image Super-resolution with GAN



high resolution image generated for low resolution image

GAN으로 Autoencoder를 학습완료한 후



Real Training Images

Low Resolution Image

High Resolution Image

- the end -

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