

# Generative Models

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멀티캠퍼스 - Generative Models  
Deep Learning Espresso
- 관심 연구 분야  
Speech Synthesis  
Generative Models  
Bayesian Reasoning

# Disclaimer

- Details of convolutional neural networks
  - convolution, pooling operator, ...
- Details of recurrent neural networks
  - LSTM, GRU, ...
- Various regularization
  - Dropout, Batch normalization, ...
- Backpropagation

# Contents

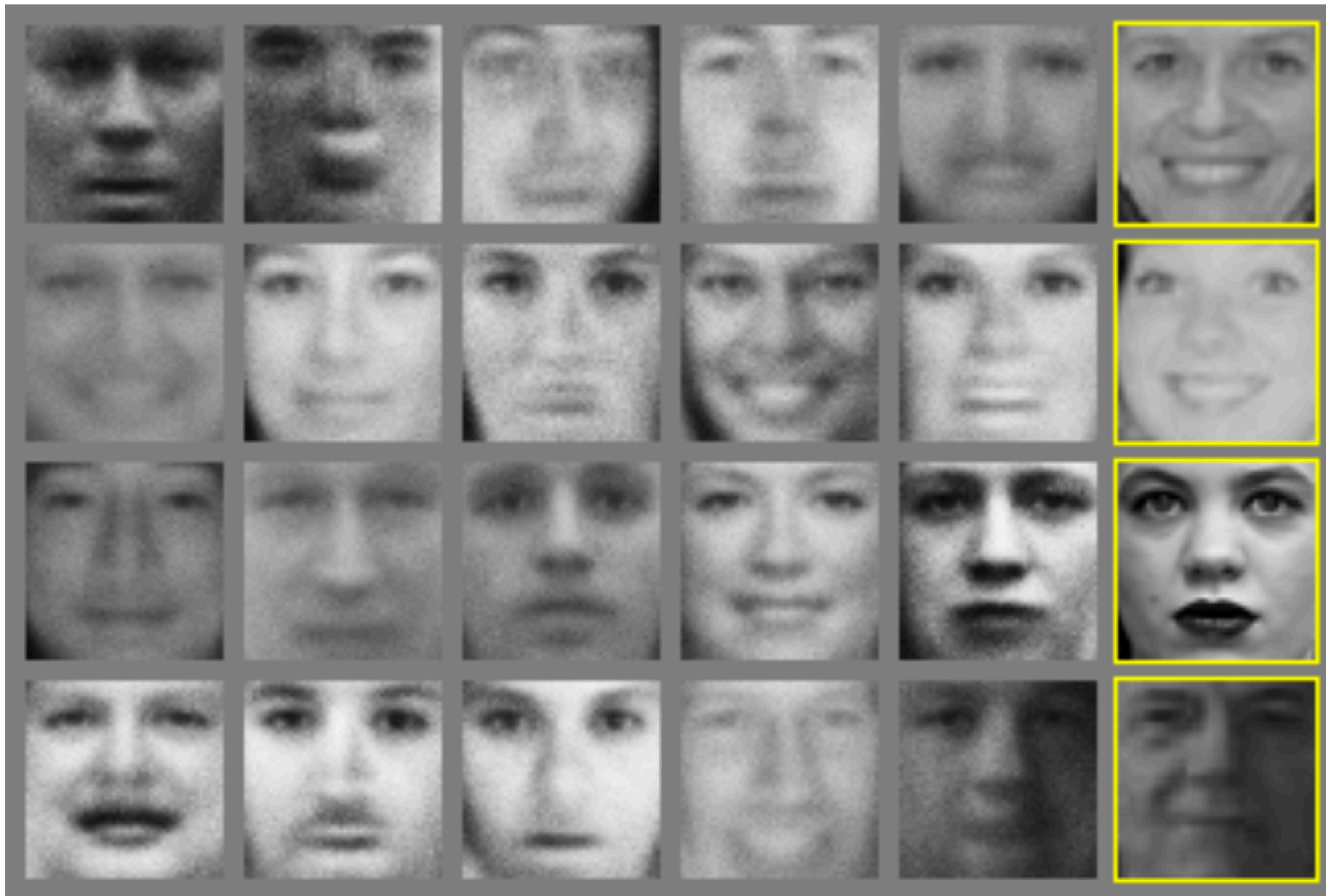
- Introduction to Generative Models
- Review of Probability Theory
- Autoregressive Models
- ~~Latent Variable Models~~
- Flow based Models
- ~~Generative Adversarial Networks~~

# References

- Deep Learning Book, Ian Goodfellow, et. al., 2015
- Stanford cs236 fall18: Deep Generative Models
- A lot of papers and codes

**Which one is Real?**

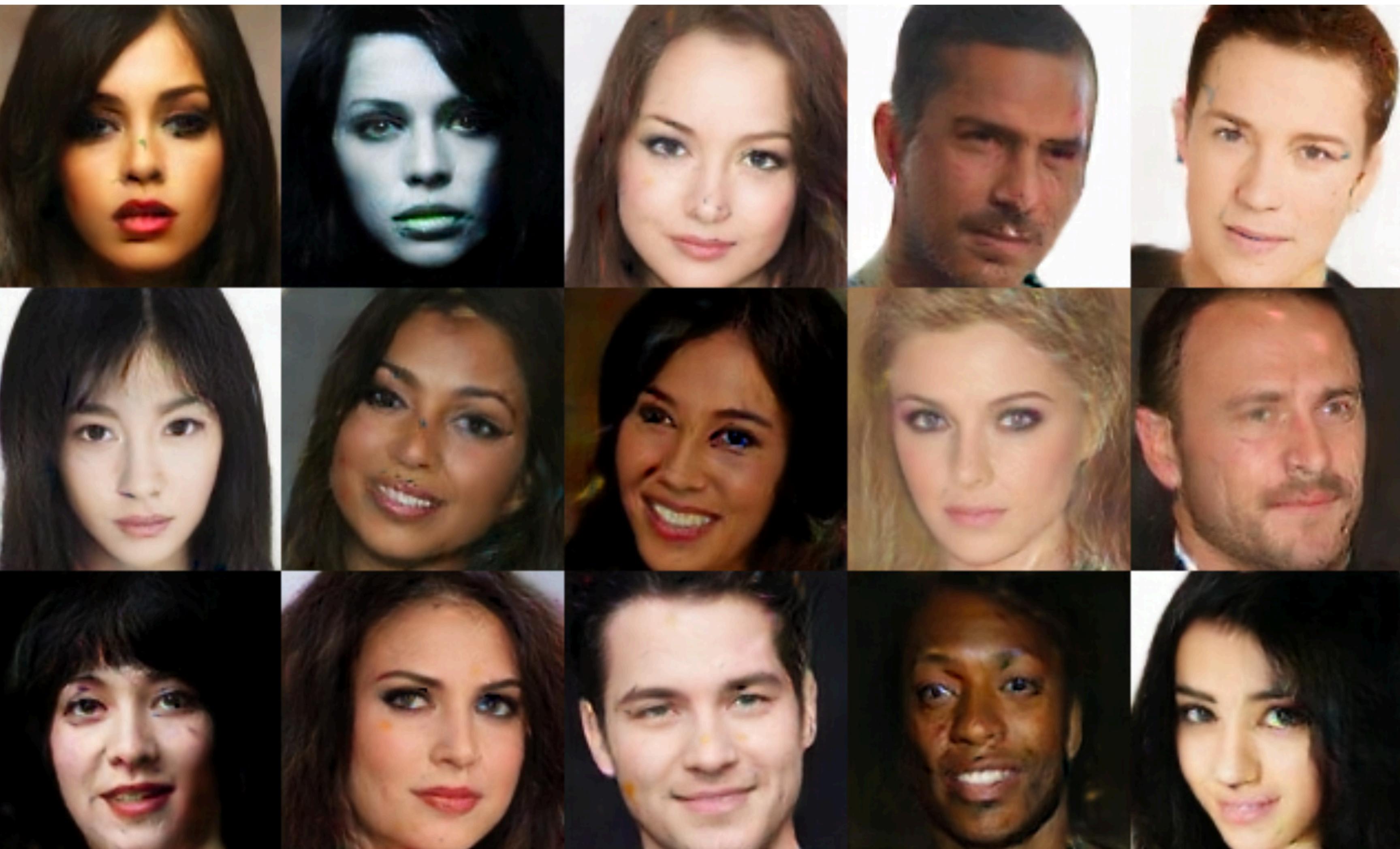
# Timeline (GAN: 1406)



# Timeline (DCGAN: 1511, size: 64)



# Timeline (BEGAN: 1703, size: 128)



# Timeline (ProgressiveGAN: 1710, size: 1024)



# Timeline (StyleGAN: 1812, size: 1024)



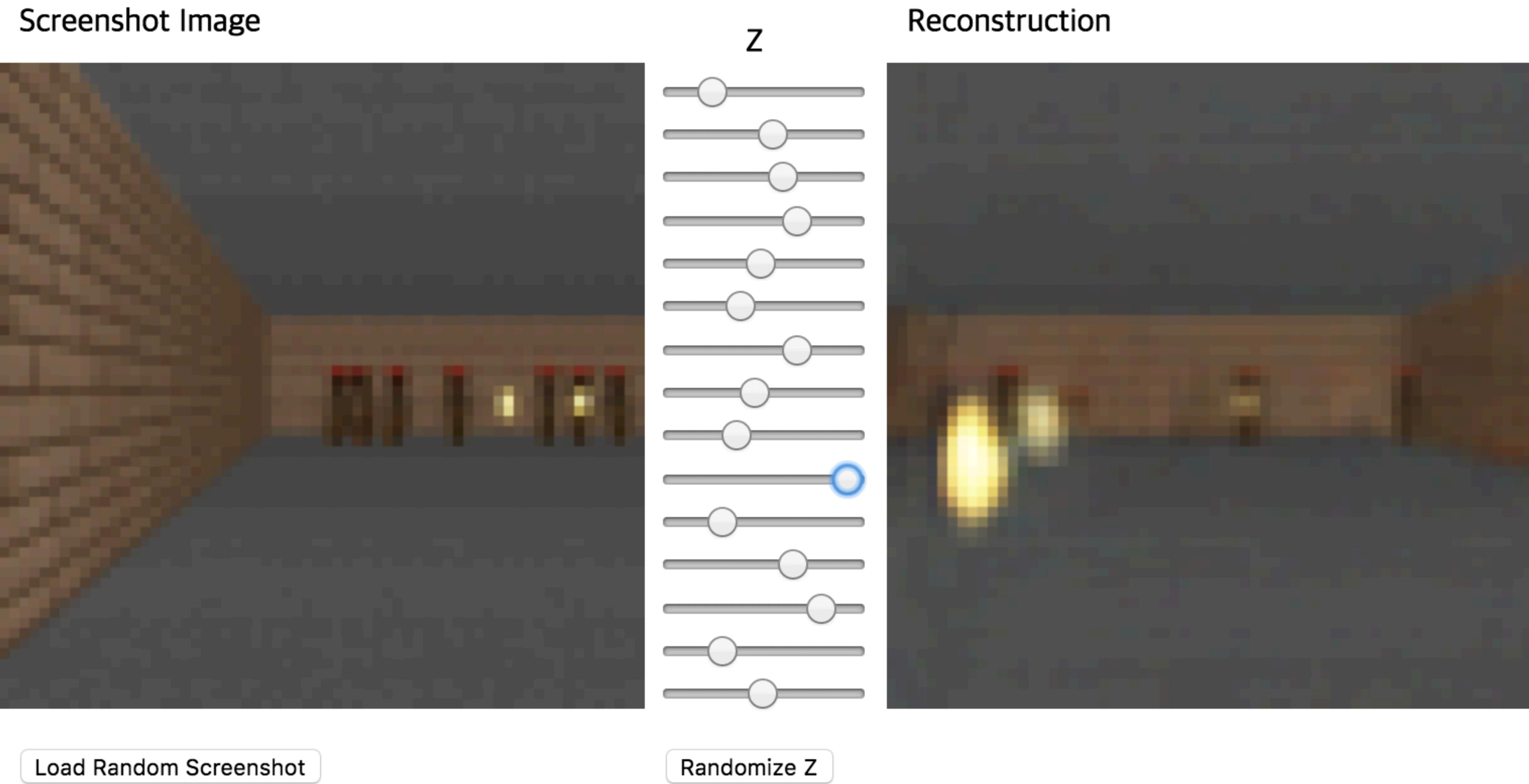
# Timeline (StyleGAN: 1812, size: 1024)



just three years since DCGAN

# Applications of Generative Models

# Reconstruct Game Map using VAE



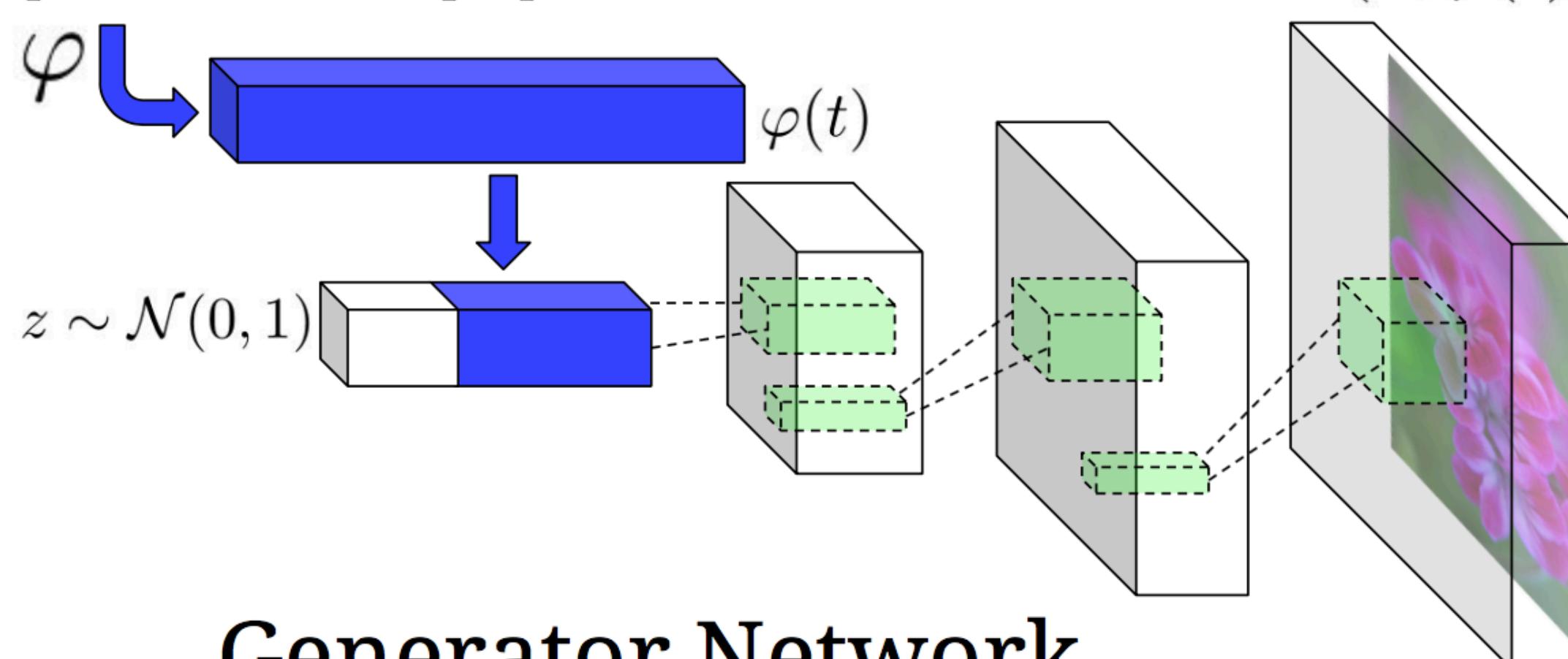
# Make Girls Moe

MakeGirlsMoe

- Home
- History
- Transition
- Help ▾
- English ▾
- [Tweet](#)

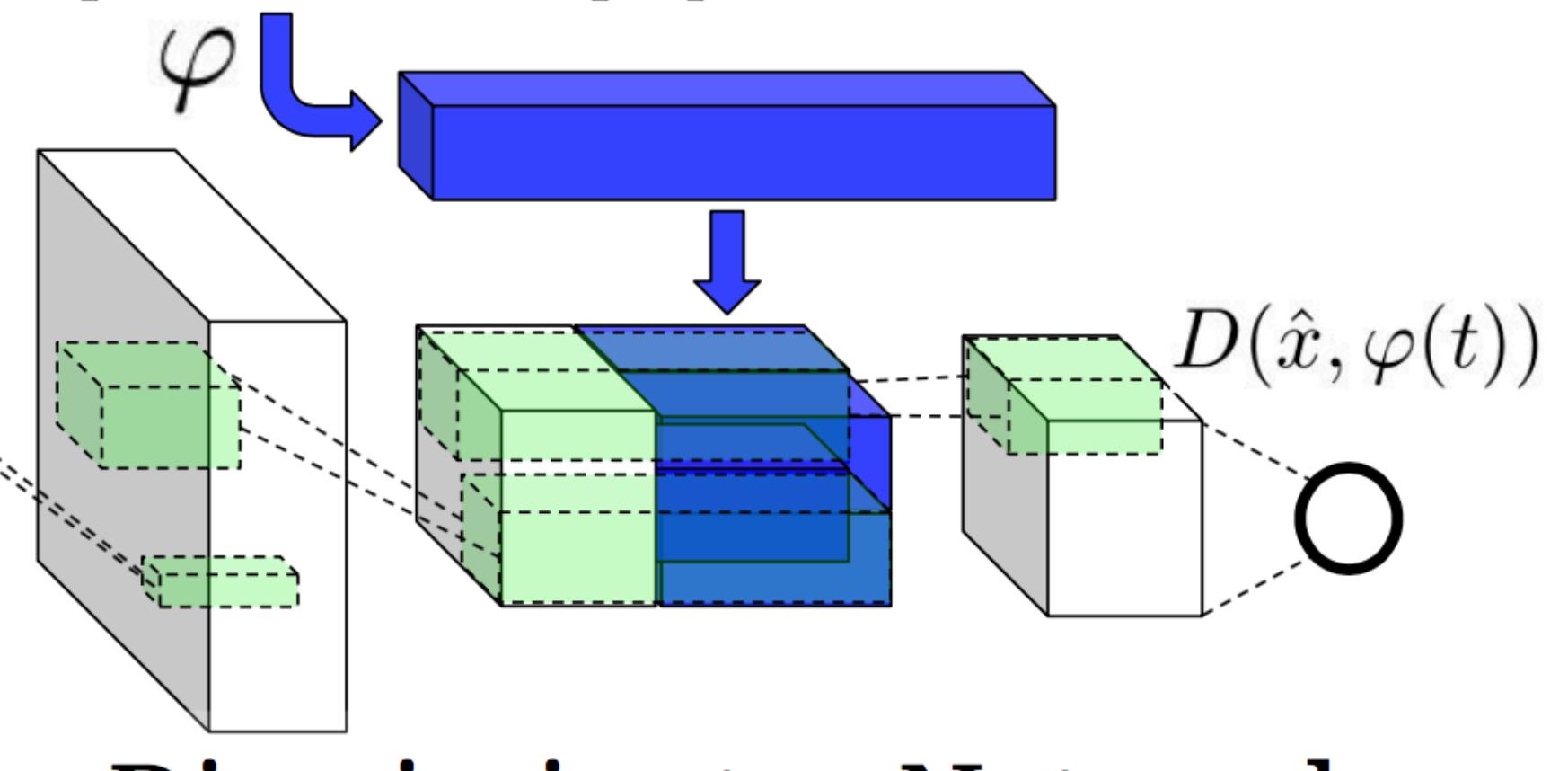
# Text2Image Architectures

*This flower has small, round violet petals with a dark purple center*



Generator Network

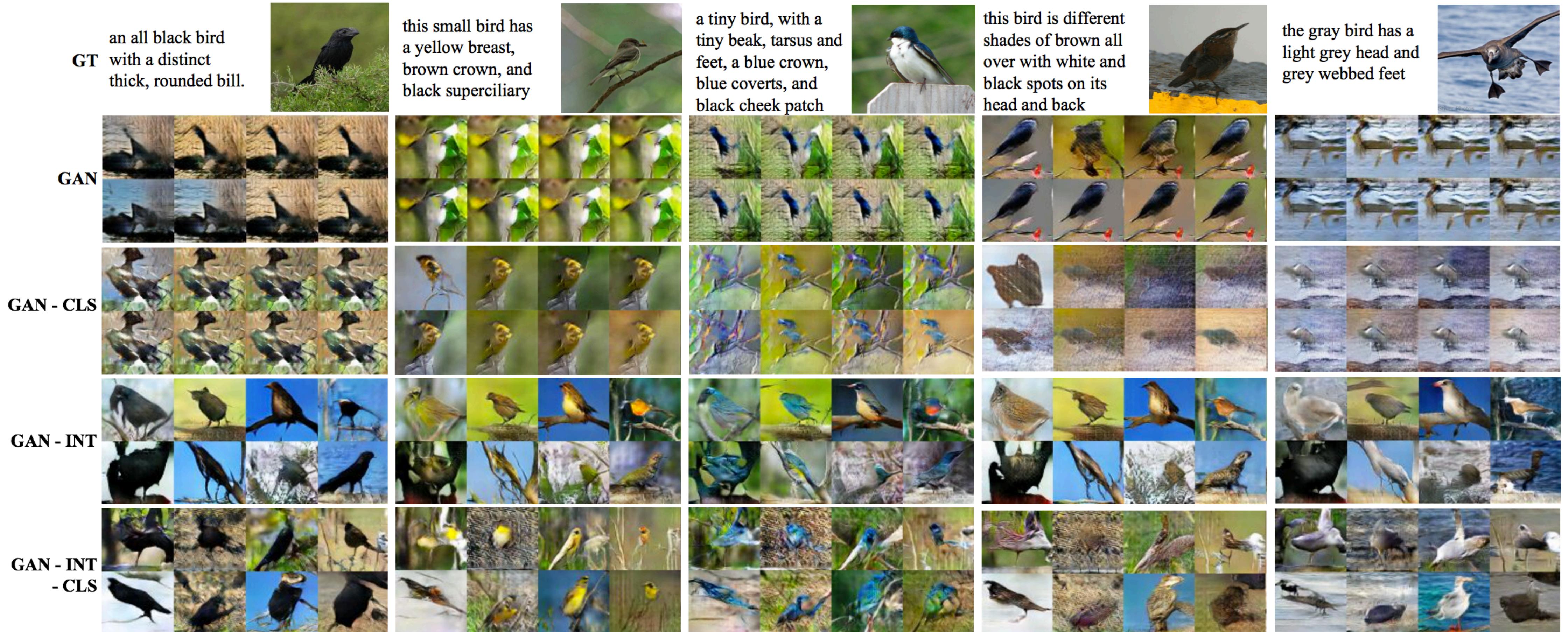
*This flower has small, round violet petals with a dark purple center*



Discriminator Network

Text 정보가 condition으로 들어가는 Conditional GAN으로 생각할 수 있다

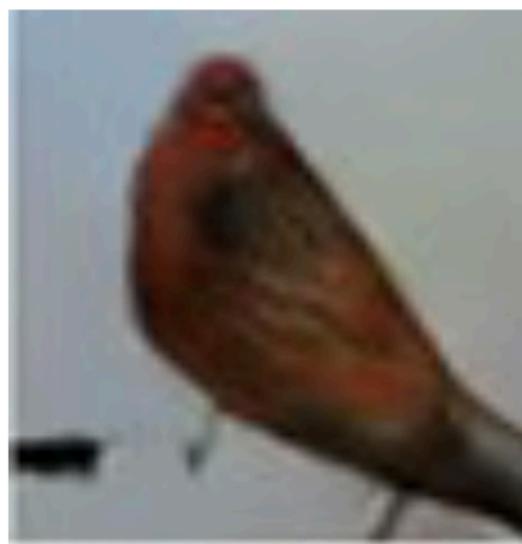
# Text2Image Results



# StackGAN

Text  
description

64x64  
GAN-INT-CLS  
[22]



The bird is short and stubby with yellow on its body



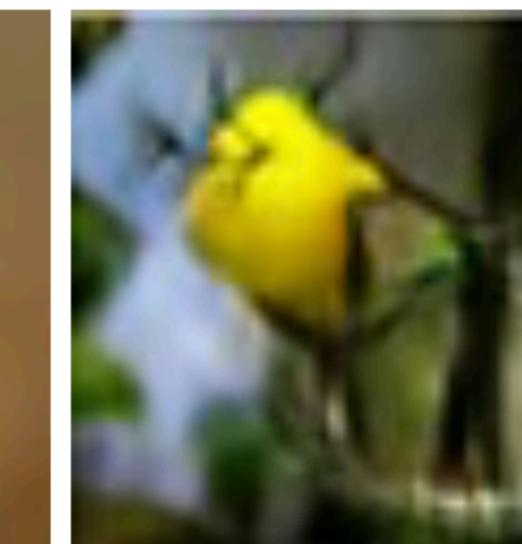
A bird with a medium orange bill white body gray wings and webbed feet



This small black bird has a short, slightly curved bill and long legs



A small bird with varying shades of brown with white under the eyes

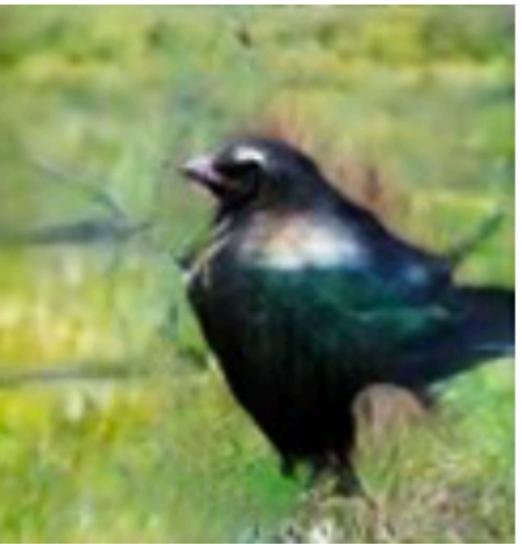
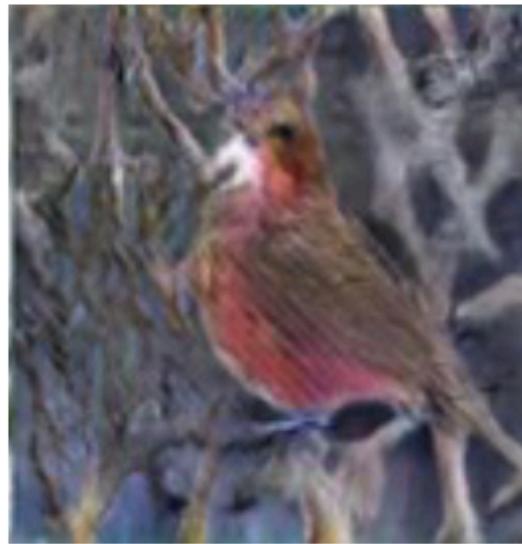


A small yellow bird with a black crown and a short black pointed beak

This small bird has a white breast, light grey head, and black wings and tail



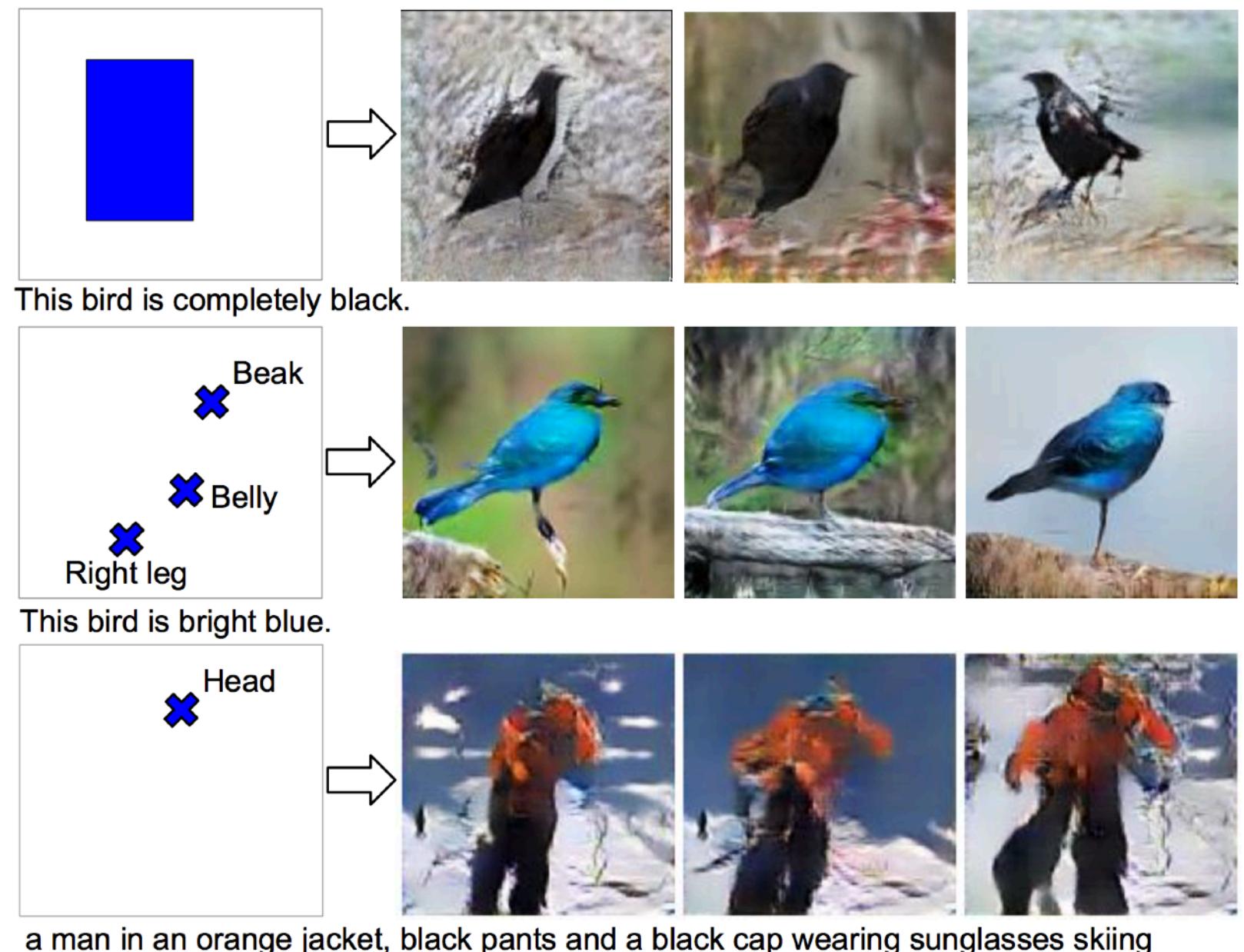
128x128  
GAWWN  
[20]



256x256  
StackGAN



# Learning What and Where to Draw Results



**Caption**

This bird has a black head, a long orange beak and yellow body

This large black bird has a pointy beak and black eyes

This small blue bird has a short pointy beak and brown patches on its wings

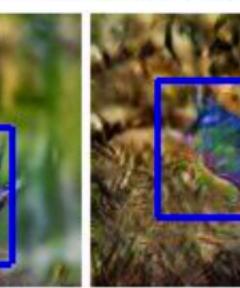
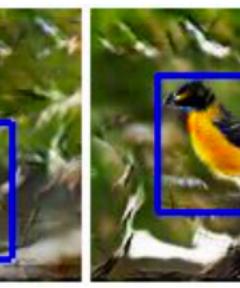
**GT**



**Shrinking**



**Translation**



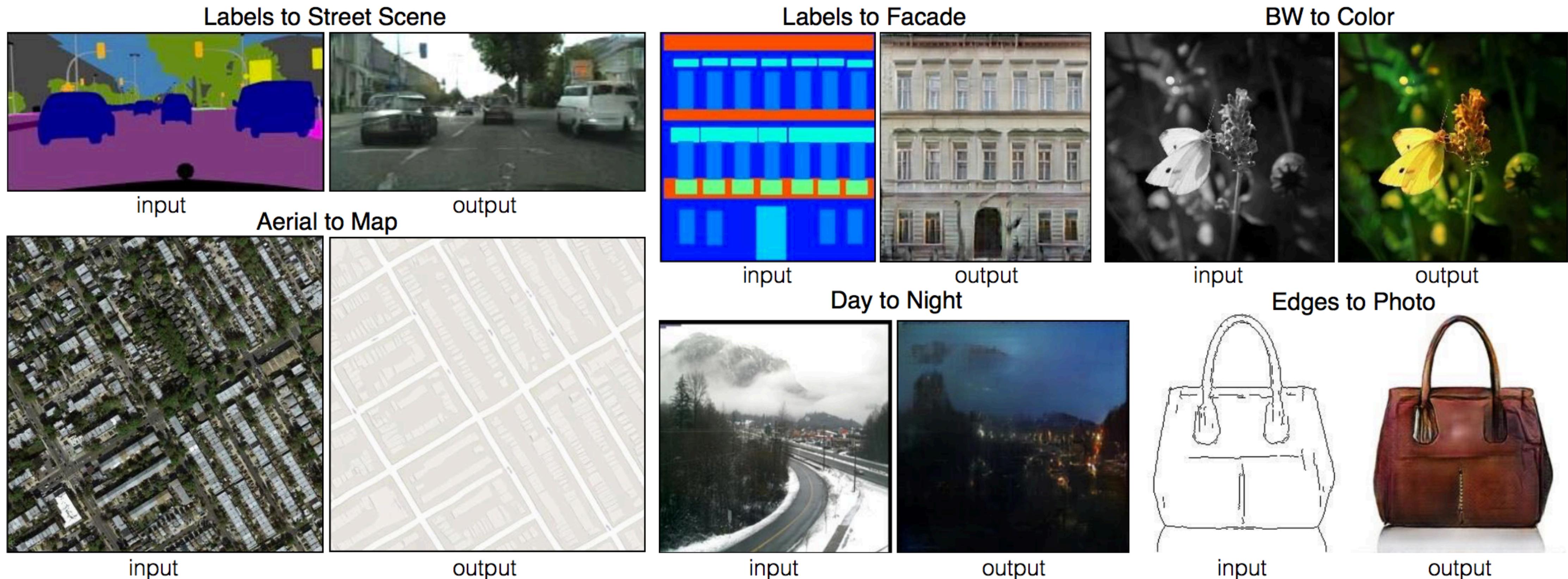
**Stretching**



# Image-to-Image Translation

- Pix2Pix
  - <https://affinelayer.com/pixsrv/>
- CycleGAN, BiCycleGAN
  - <https://junyanz.github.io/CycleGAN/>
  - <https://github.com/junyanz/BicycleGAN>
- DiscoGAN, StarGAN
  - <https://github.com/SKTBrain/DiscoGAN>
  - <https://github.com/yunjey/StarGAN>

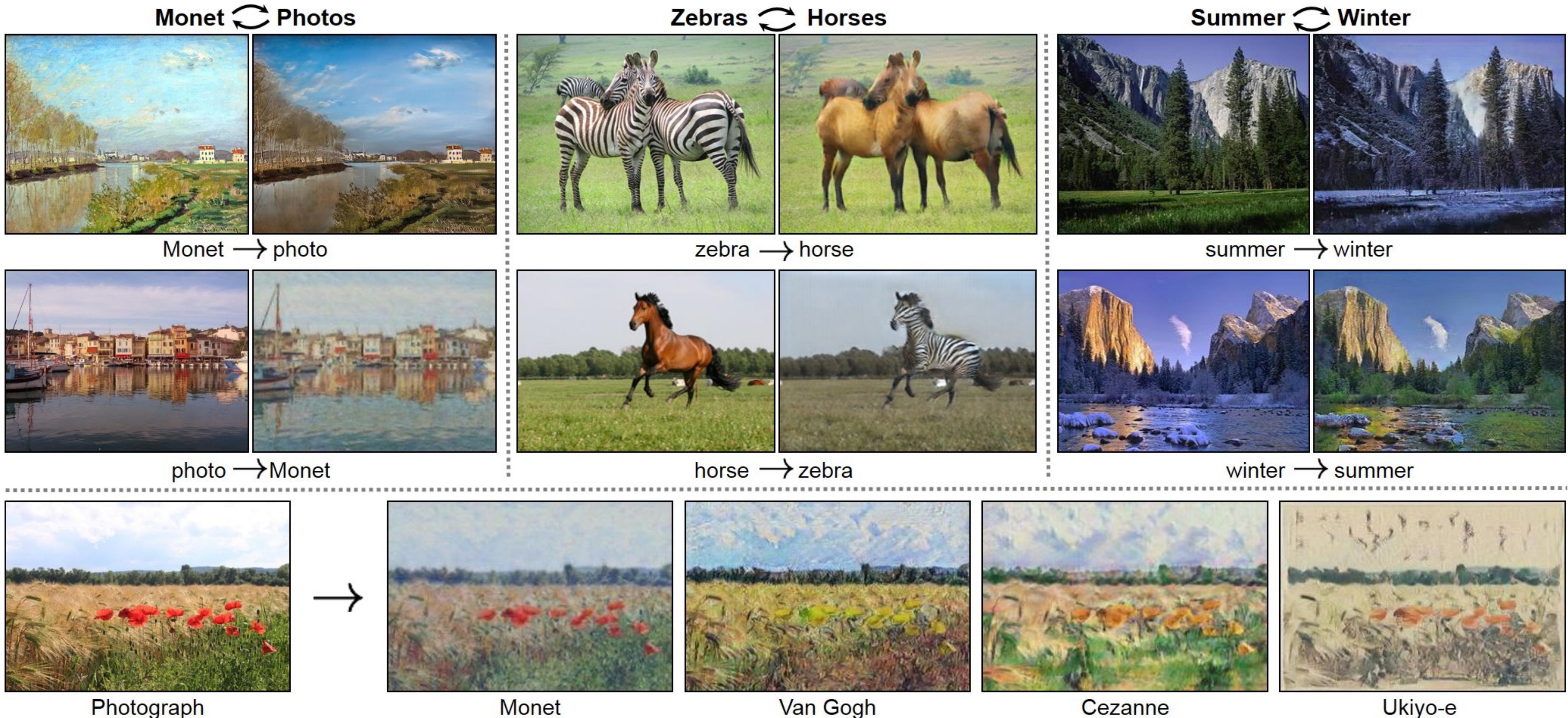
# Pix2Pix Results



Demo: <https://affinelayer.com/pixsrv/>

Figure credit: P. Isola, et al., Image-to-Image Translation with Conditional Adversarial Networks

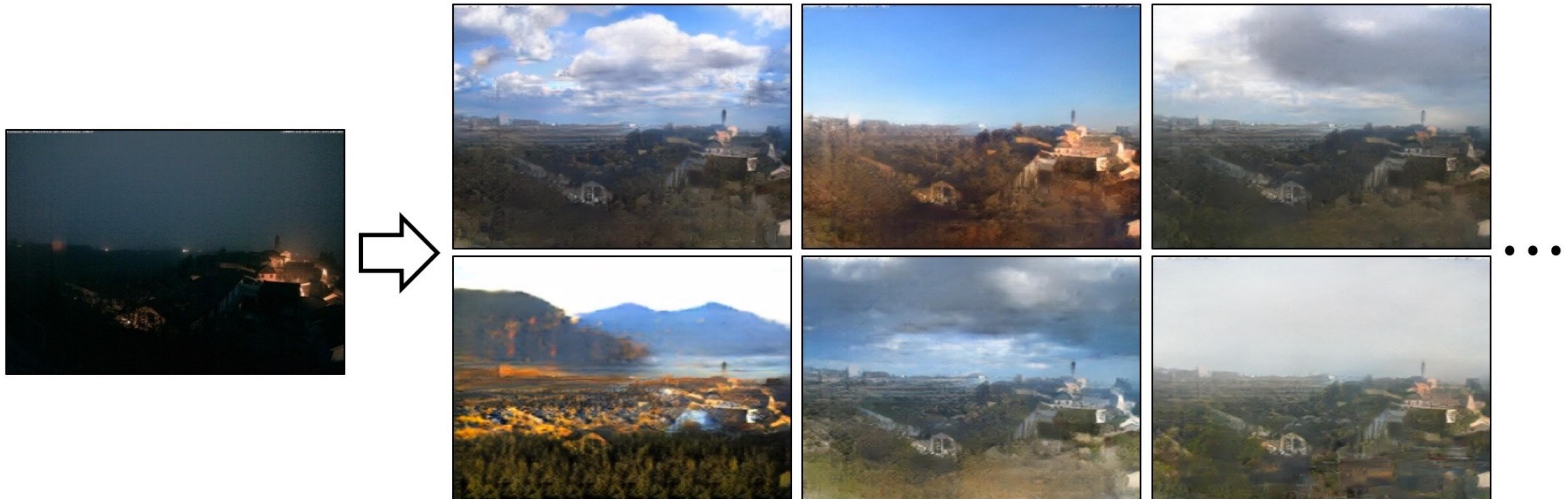
# CycleGAN Results



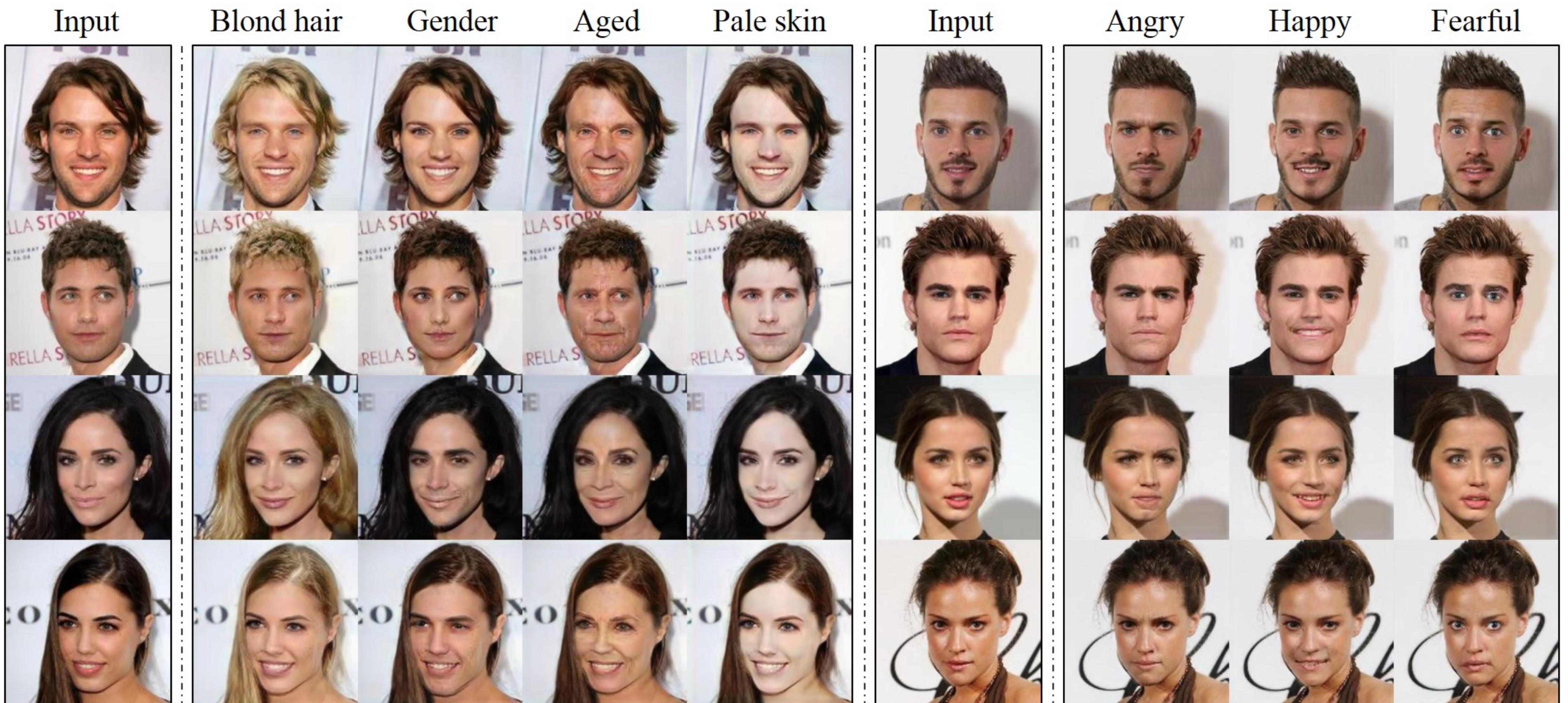
Demo: <https://github.com/junyanz/CycleGAN>

Figure credit: J-Y. Zhu, et al., Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks

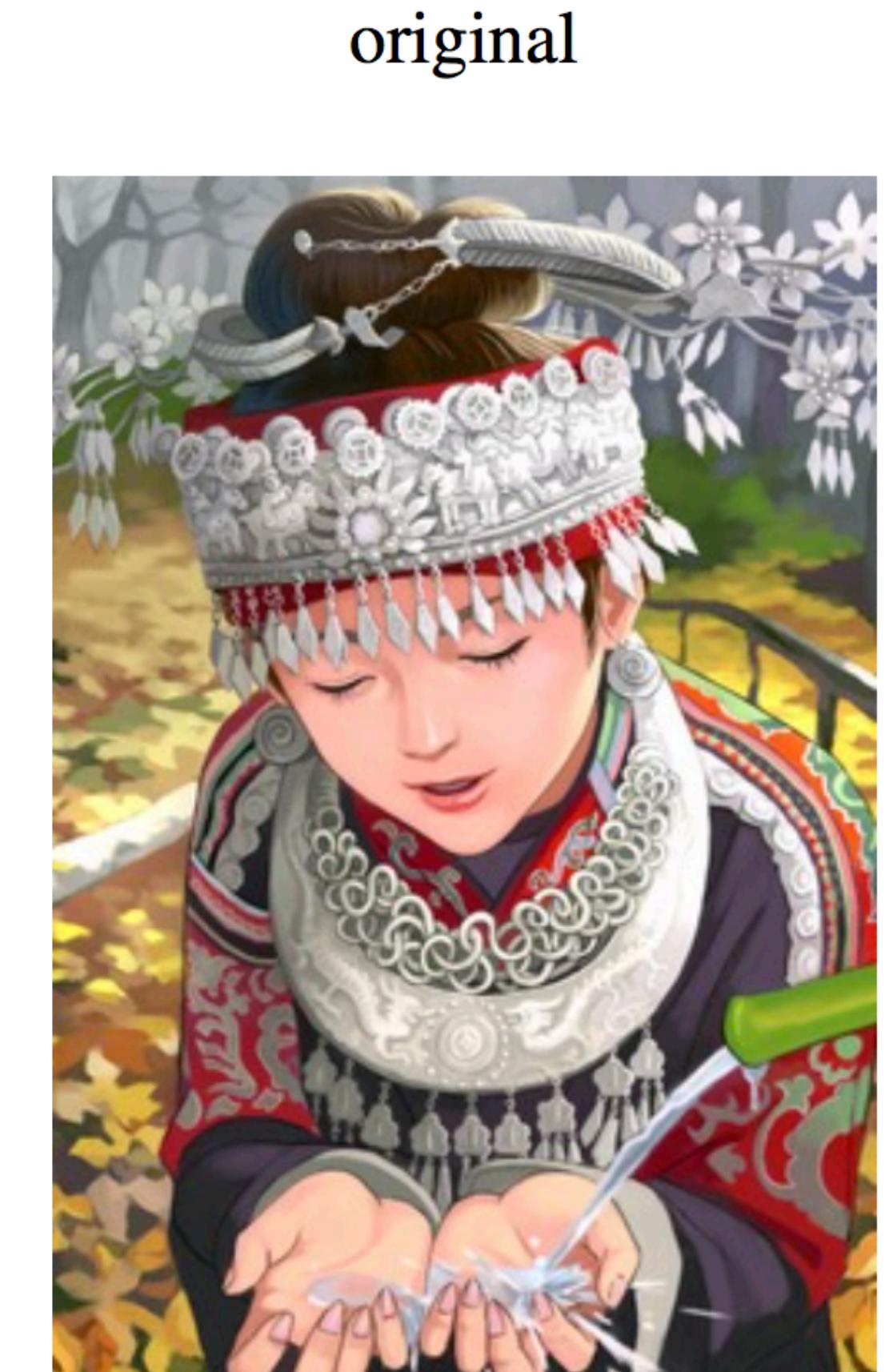
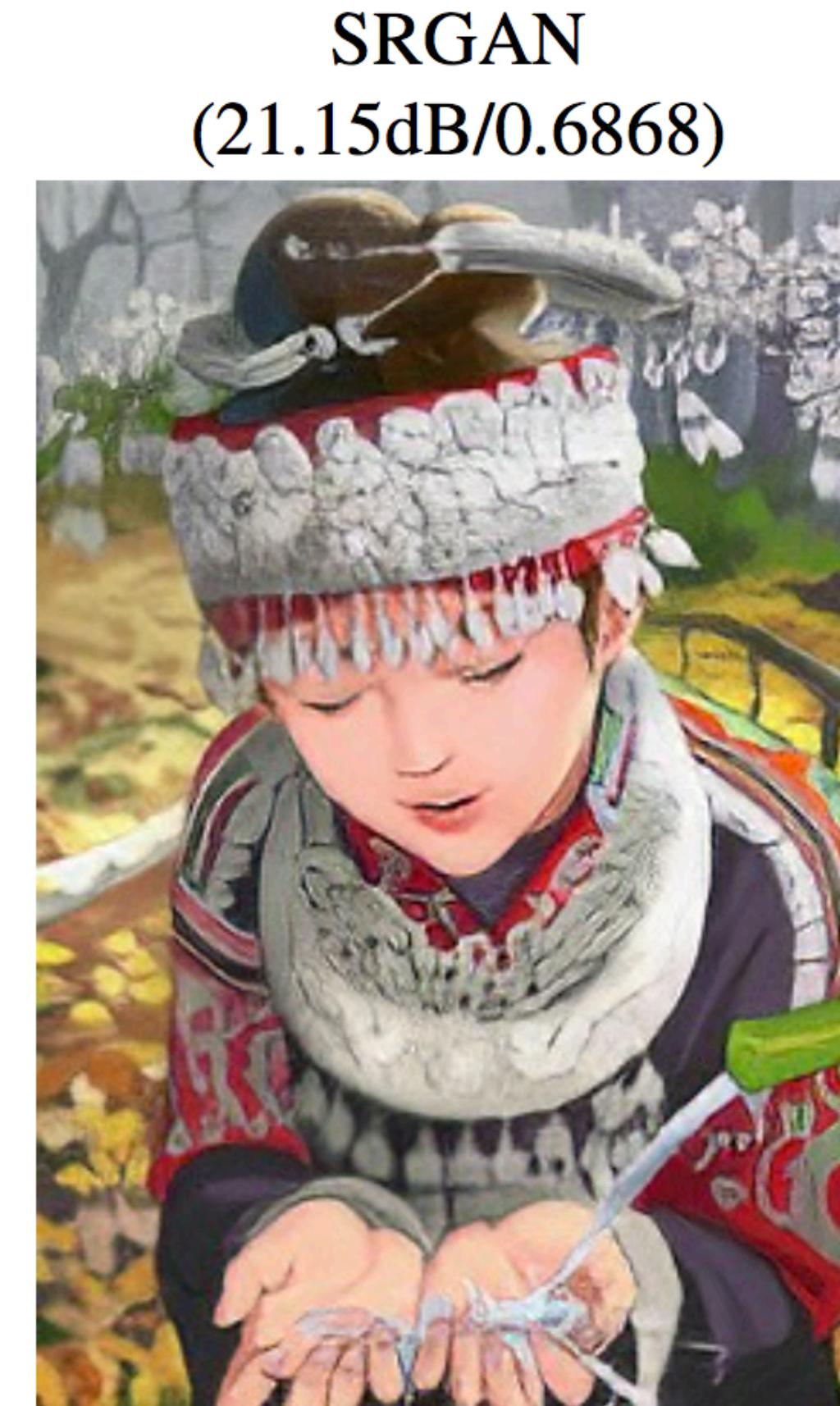
# BicycleGAN Results



# StarGAN Results



# SRGAN Results (Super Resolution)



# Font Generator



*Left: Given movie poster, Right: New movie title generated by MC-GAN.*

# Age Progression



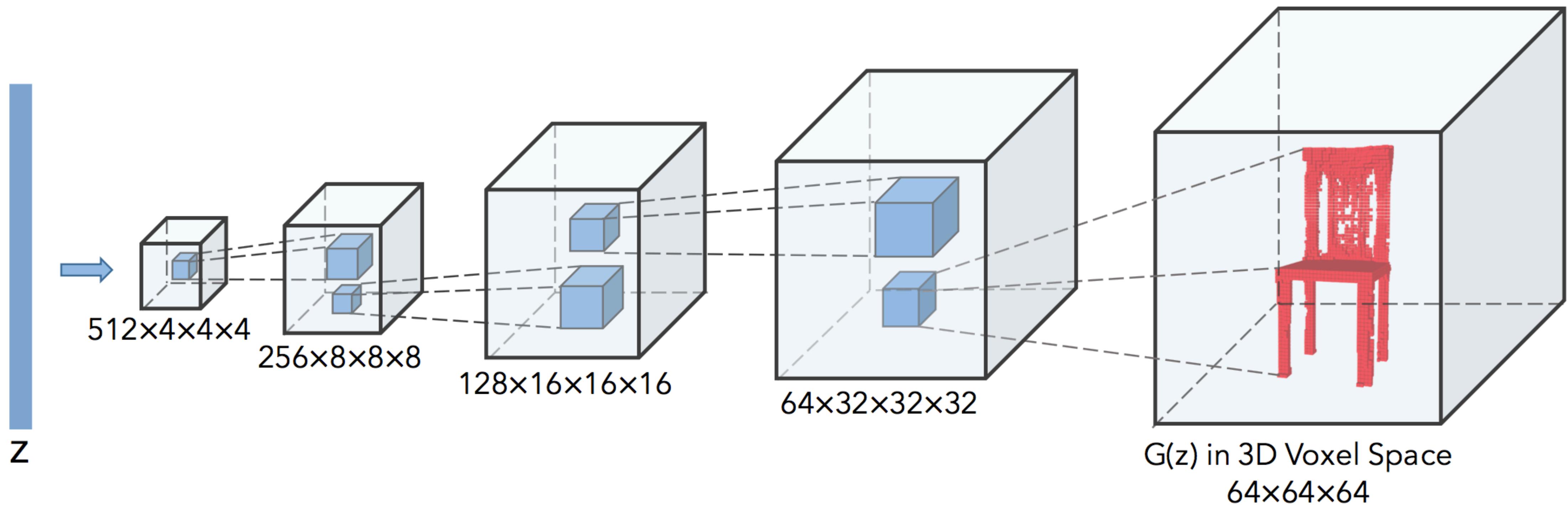
Figure credit: Paul Upchurch, et al., Deep Feature Interpolation for Image Content Changes

# Age Progression



Figure credit: Paul Upchurch, et al., Deep Feature Interpolation for Image Content Changes

# 3D-GAN Architectures



# 3D-GAN Results

Our results ( $64 \times 64 \times 64$ )

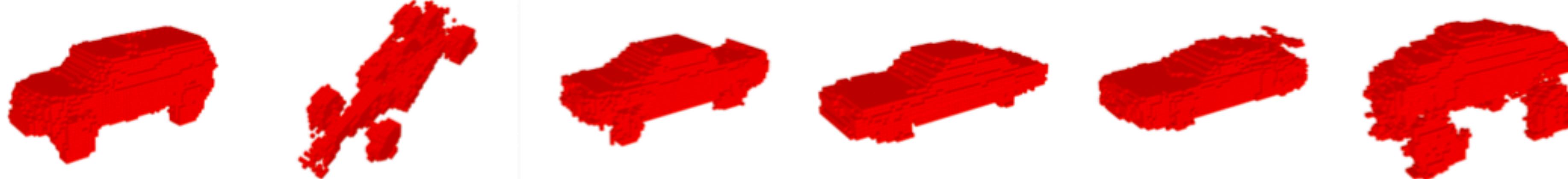
Gun



Chair



Car



# WaveGAN and SpecGAN

- Wave를 conv1d를 이용하여 직접 Generation
- Audio를 Spectrogram으로 변환 후 마치 image인 것처럼 conv2d를 이용하여 Generation
- sample sound
  - <https://goo.gl/oxGXAI>

# MusicVAE



# Multi-Speaker Tacotron

## Samples

(Training data = Son: 15+ hours, Park: 5+ hours, Moon: 2+ hours)

Click if you can't hear any sound



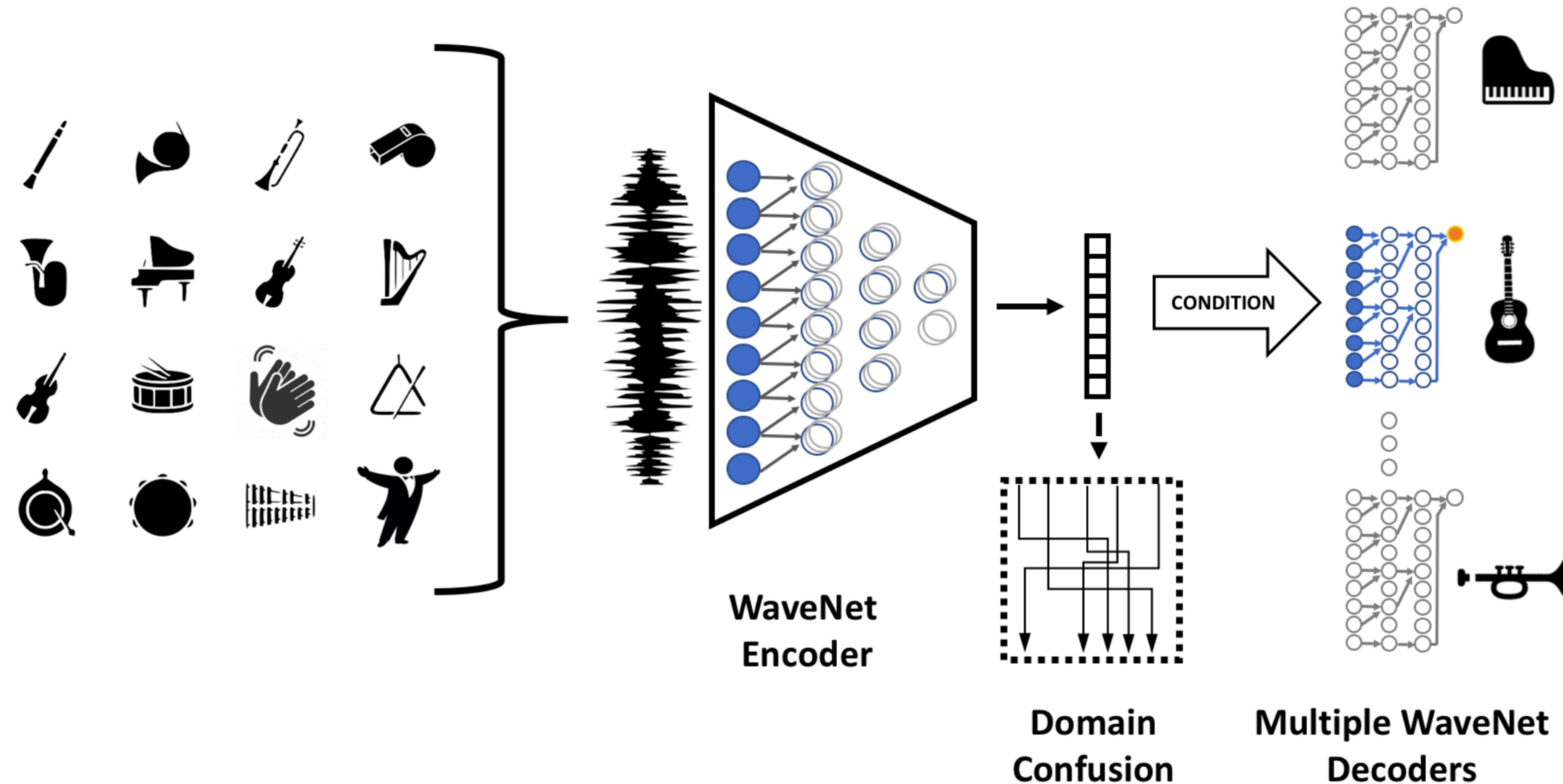
제너레이티브 어드벌서리얼 네트워크와 베리에셔널 오토 인코더가 핫하다.

Seo    Son    Park

오스트랄로피테쿠스 아파렌시스는 멸종된 사람족 종으로, 현재에는 뼈 화석이 발견되어 있다.

Seo    Son    Park    Moon

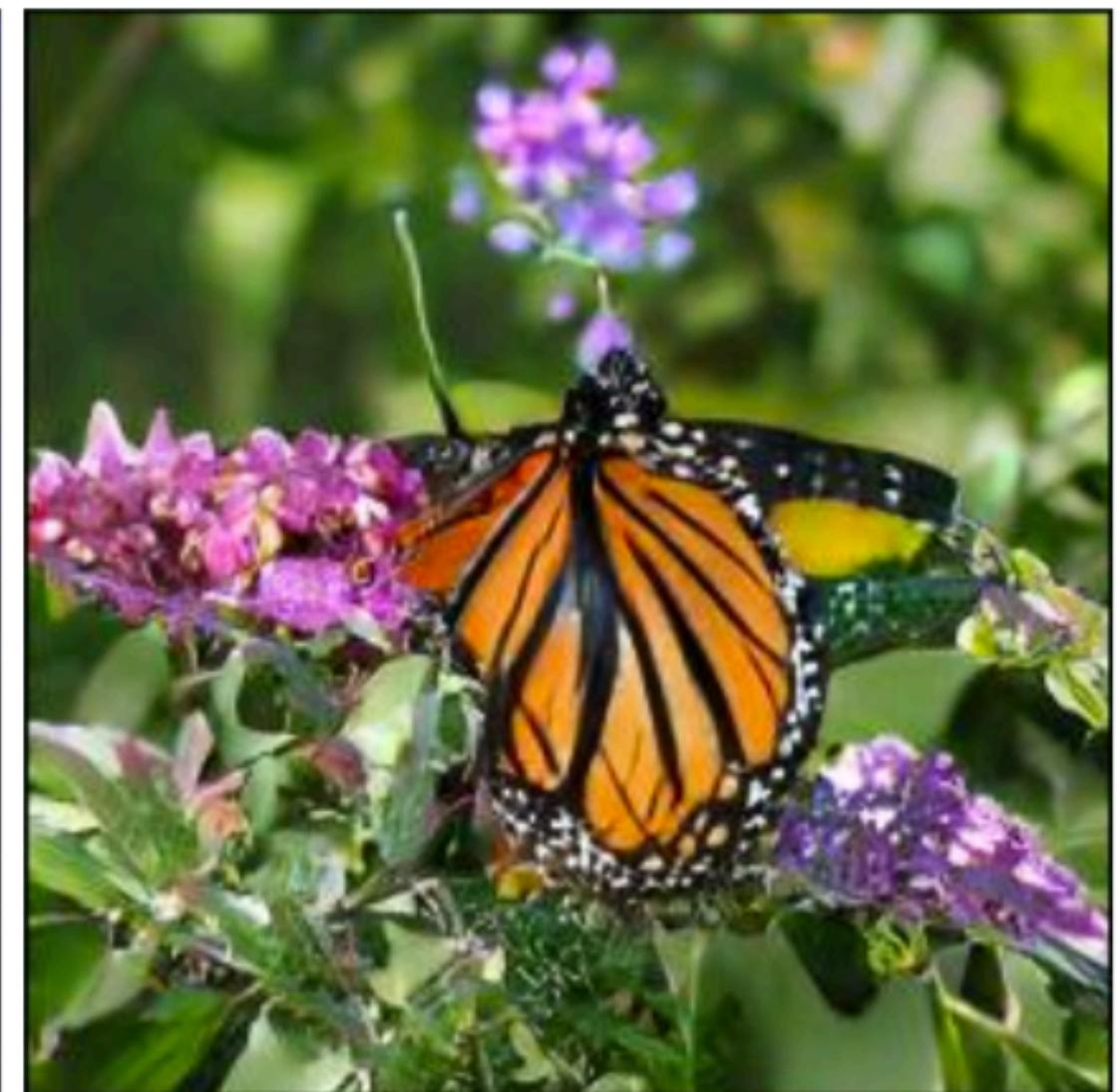
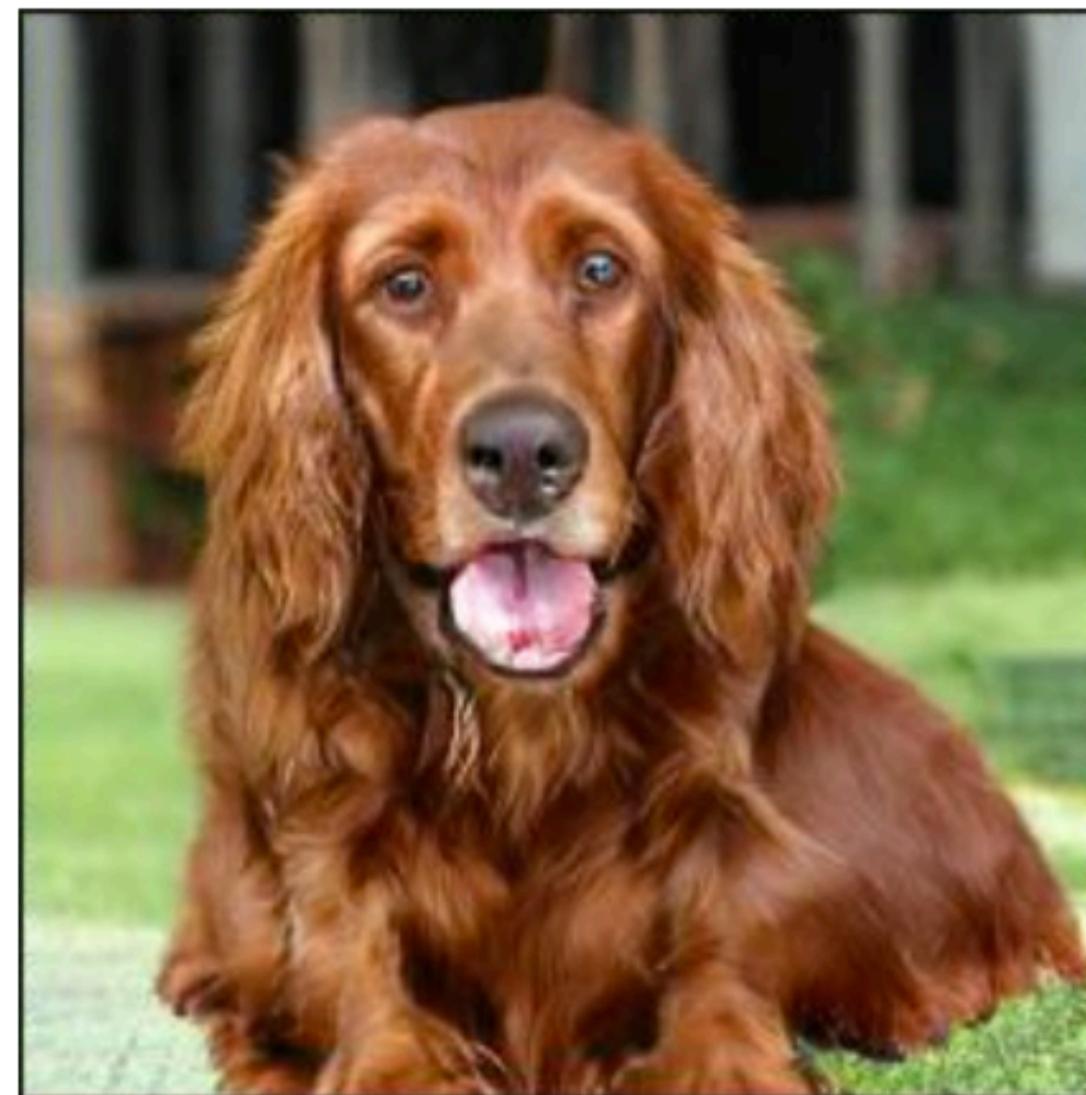
# Universal Music Translation



# Vid2Vid



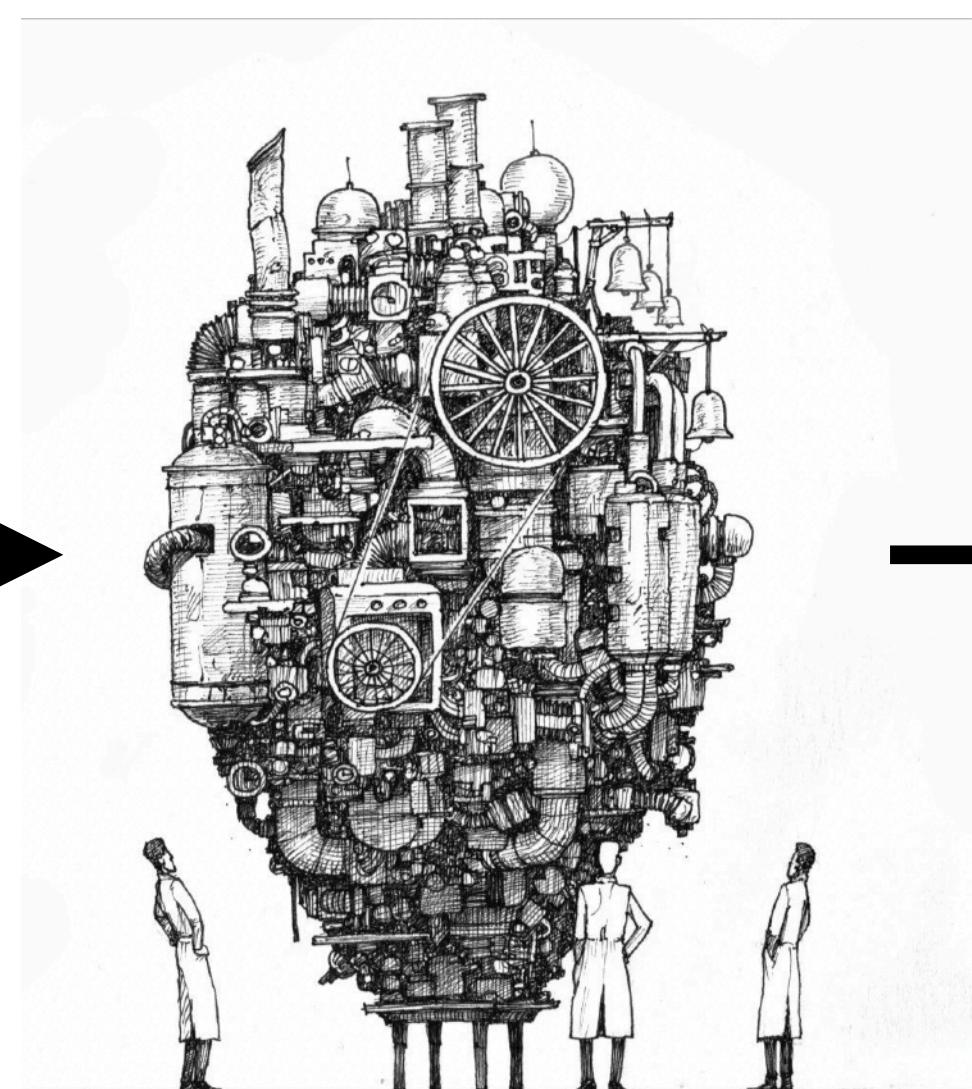
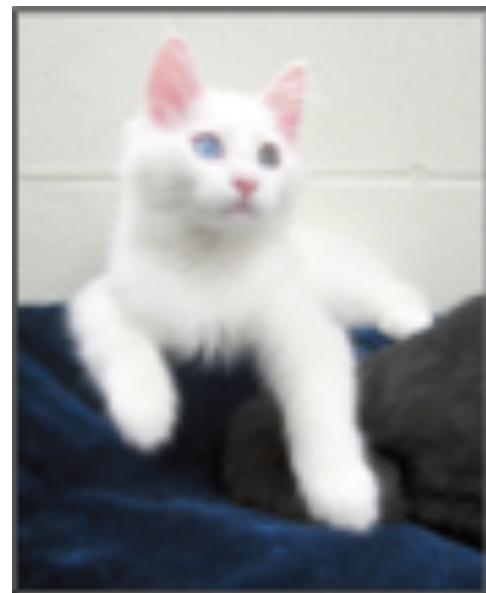
# State of the Art



# Introduction to Generative Models

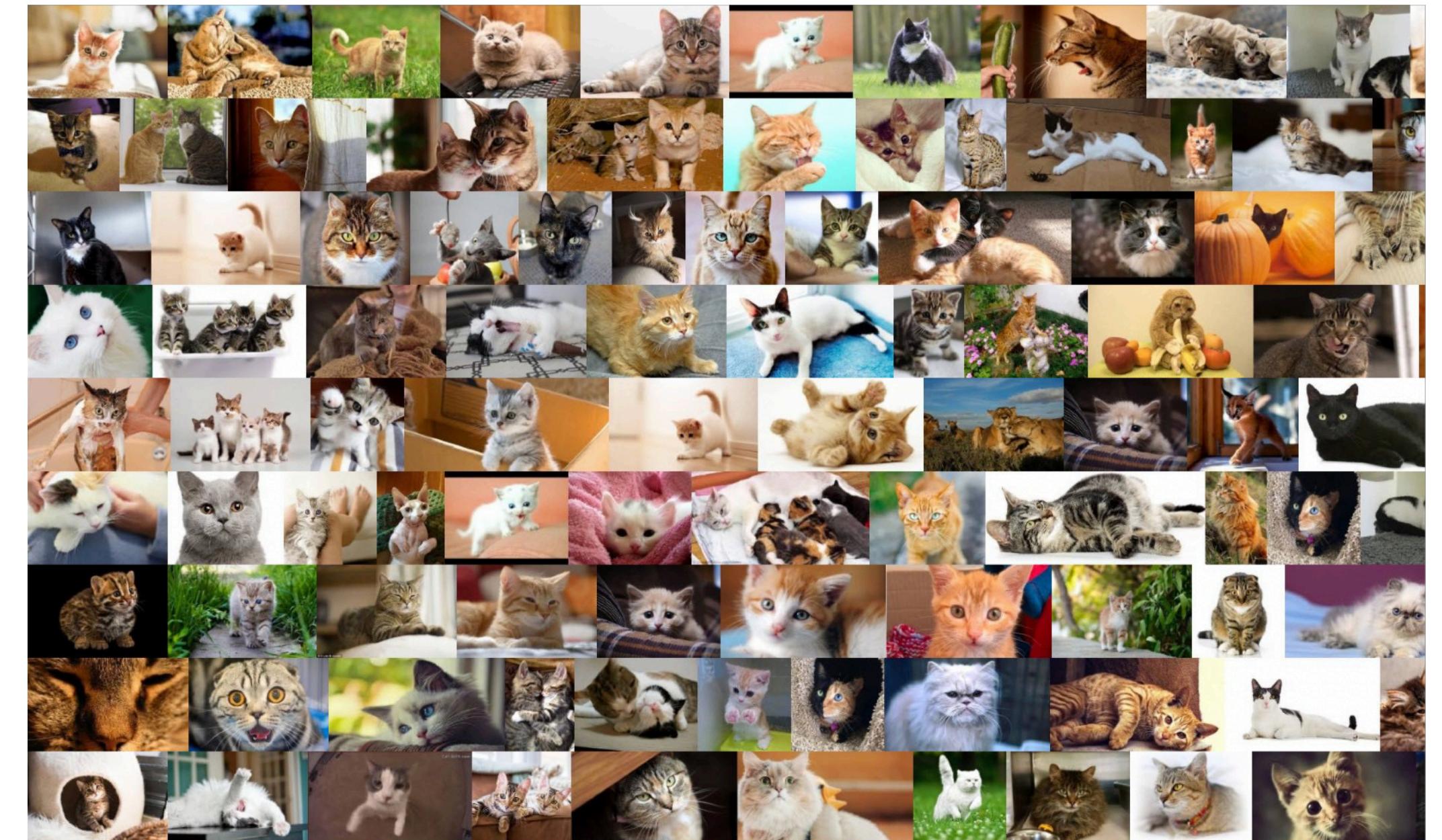
# Discriminative vs Generative Models

$$p(y|x)$$



“Cat”

$$p(x|y)$$



Discriminative Models

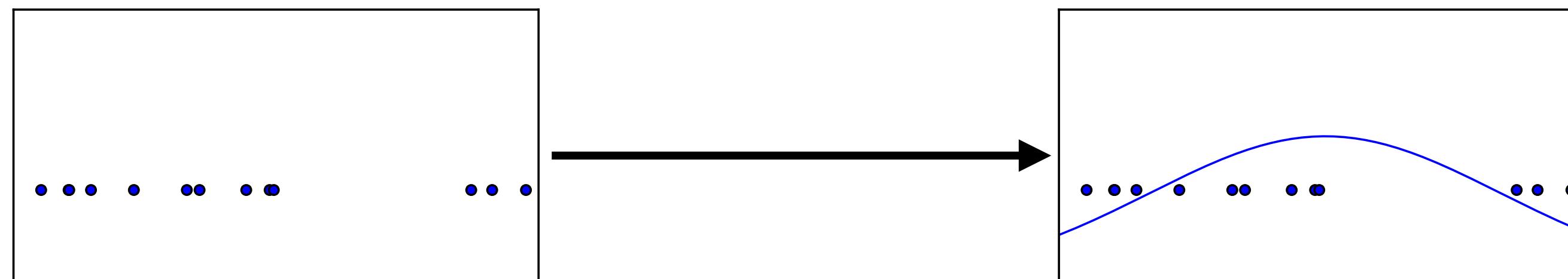
Generative Models

# Generative Modeling

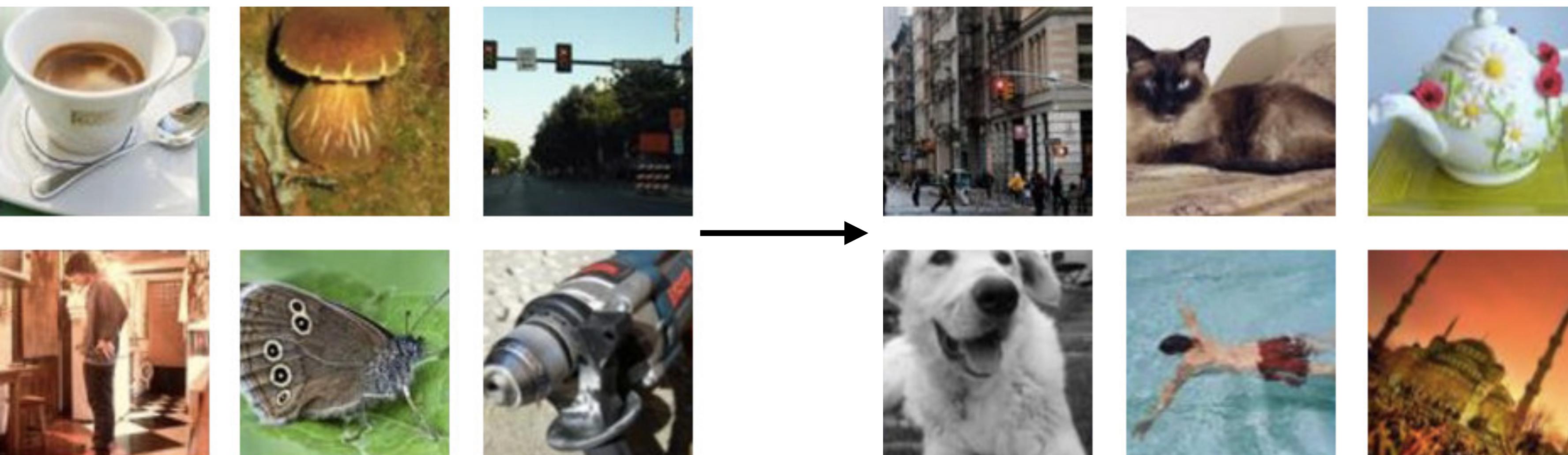
- Generative model
  - Any model that takes a training set, consisting of samples drawn from a distribution  $p_{\text{data}}$ , and **learns to represent an estimate of that distribution somehow**
  - Estimates  $p_{\text{model}}$  explicitly
  - Generate samples from  $p_{\text{model}}$

# Generative Modeling

- Density estimation



- Sample generation



# Why Study Generative Models?

- Go beyond associating inputs to outputs
- Understand high-dimensional, complex probability distributions
- Discover the “true” structure of the data
  - Detect surprising events in the world (anomaly detection)
  - Missing Data (semi-supervised learning)
  - Generate models for planning (model-based reinforcement learning)

# Taxonomy of Generative Models

