



# Imaginative Write a Classifier

## Ablation Study

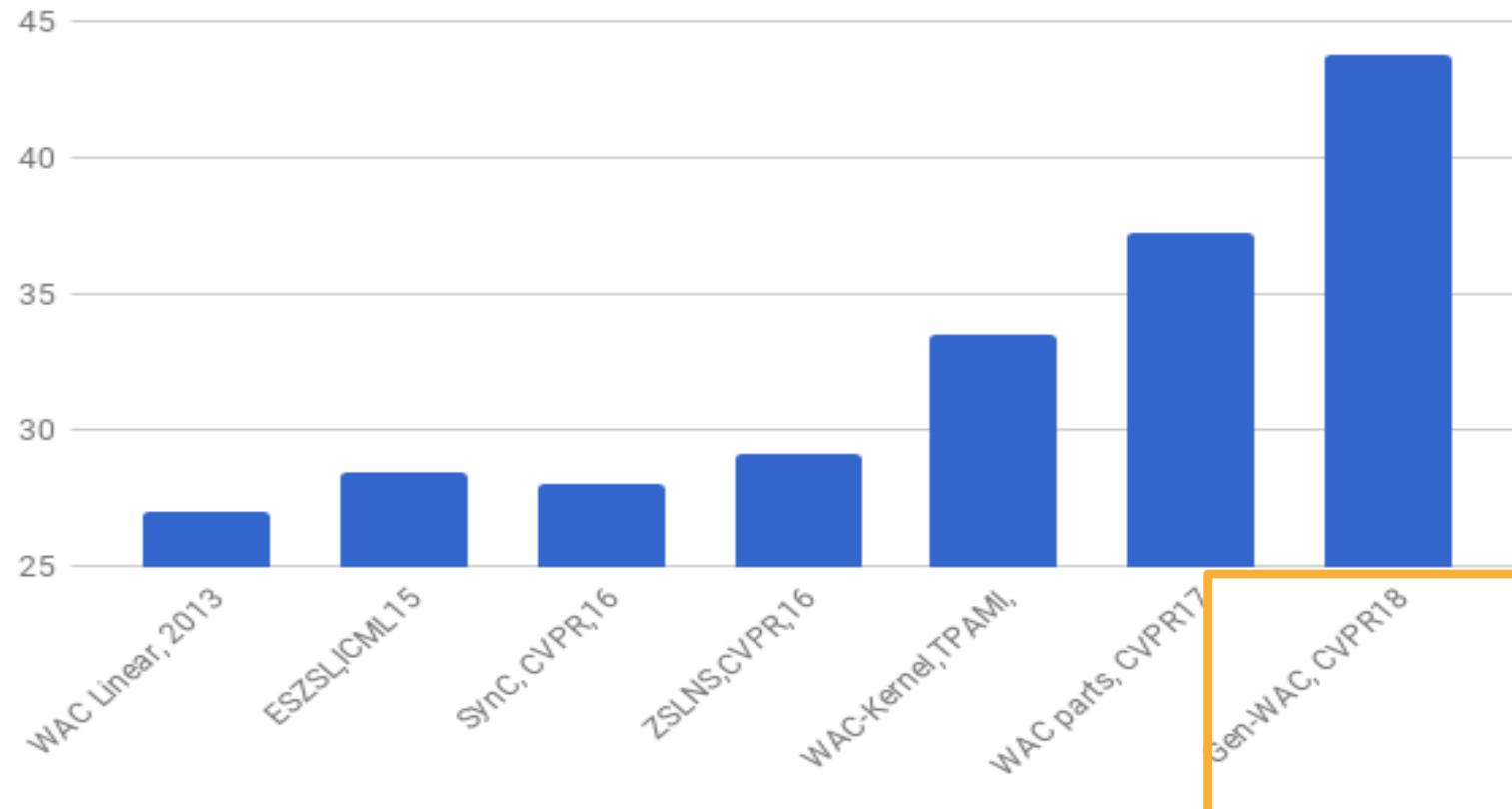
w/ FC means with Noise Suppression Layer .

methods	CUB		NAB	
	w/ FC	w/o FC	w/ FC	w/o FC
GAN-only	22.83	21.83	24.22	24.80
VP-only	28.52	26.76	25.75	23.42
Ours	<b>43.74</b>	40.85	<b>35.58</b>	32.94



# Imaginative Write a Classifier

## Comparison to the ZSL State of the Art



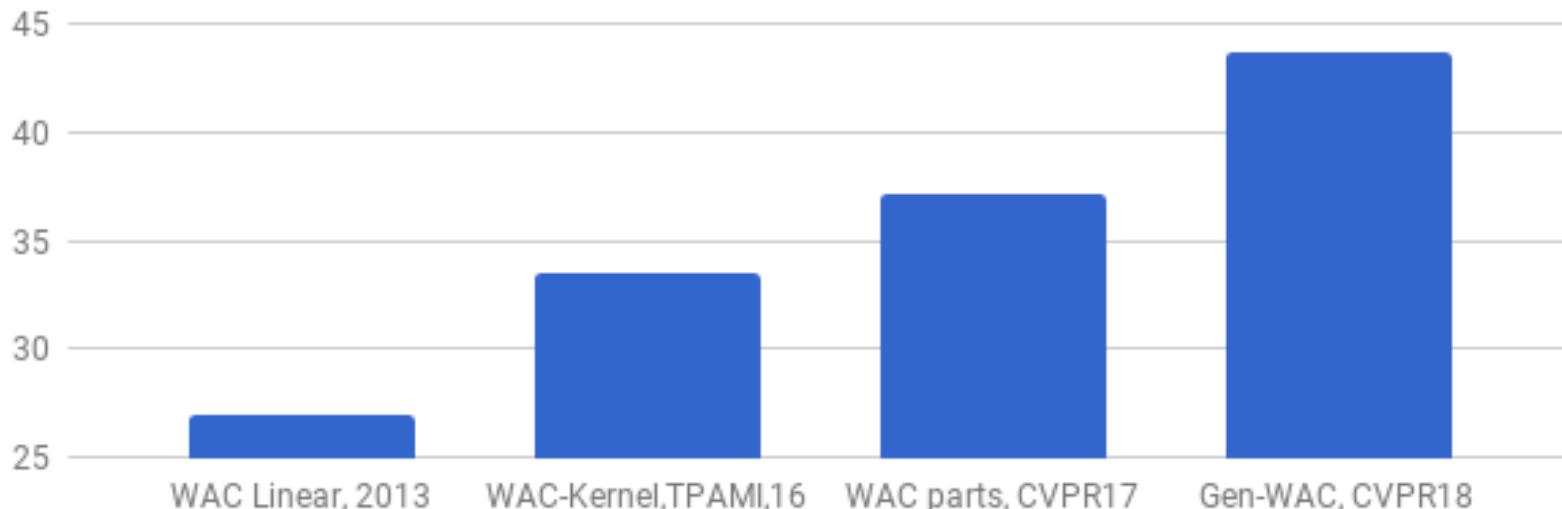
**Parallel work in related problems**

- [Xian, et al, 2018]
- [Bharath, et al, 2017]
- [Wang et al, 2018]
- [YZ et al, 2018]



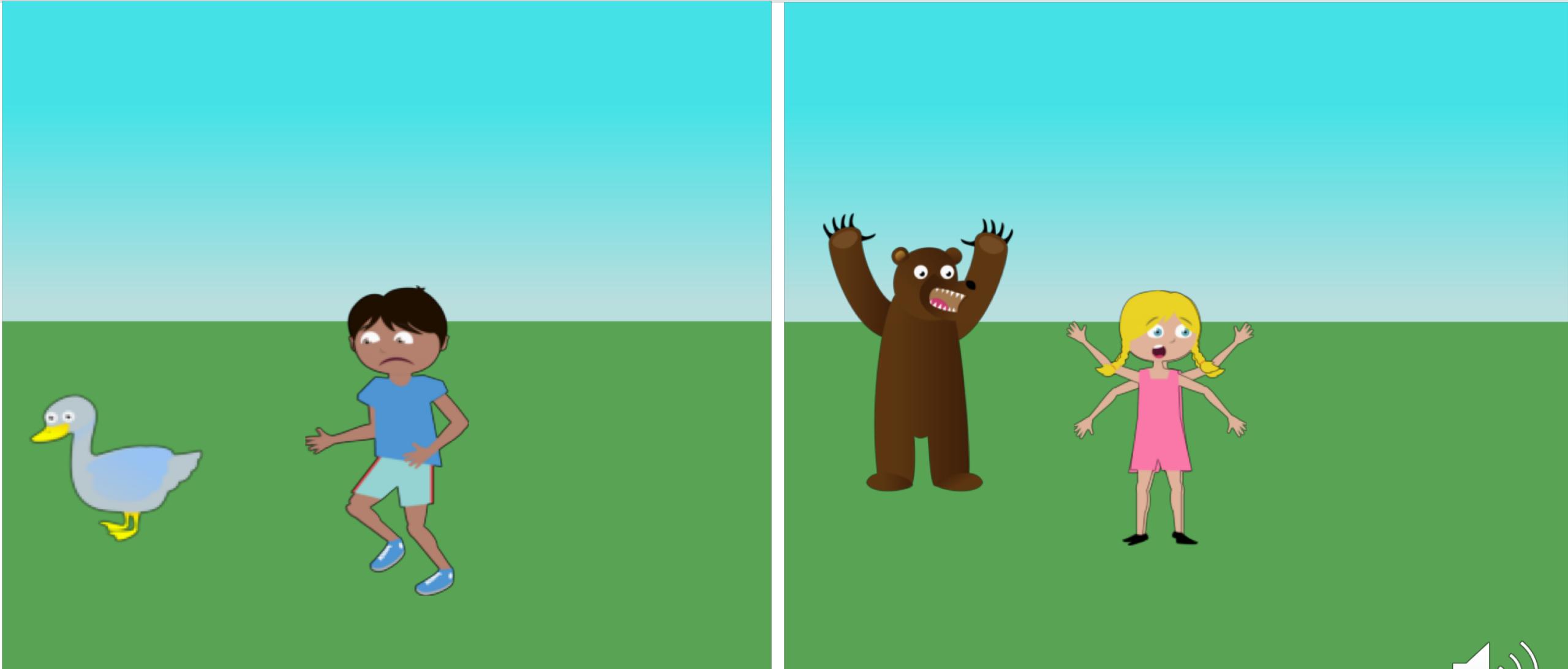
# Write a Classifier (5 year Summary)

- [ ESE, ICCV, 2013] : Linear approach with 26% on CUB
- [ EES, TPAMI, 2016] Non non-linear kernel classifiers with 33.5% on CUB
- [ EZE, CVPR, 2017] Modeling the parts notion with 37.2% on CUB
- [ ZELE,CVPR, 2018] Modeling a visual imaginer from text helps with 43.7% on CUB





# We often encounter this

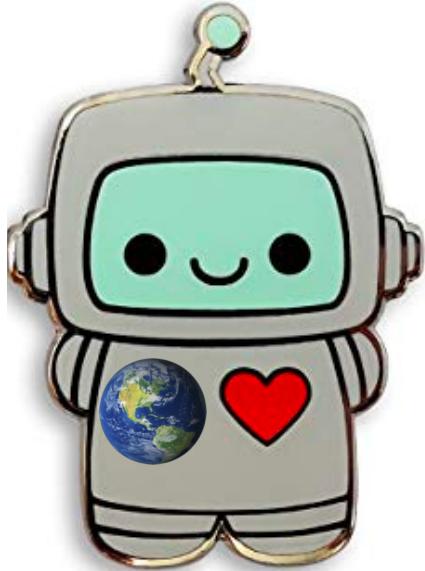


To visualize this scenario, I used cartoon characters from Abstract Scenes dataset (C. L. Zitnick and D. Parikh, 2013)



# AI : An Additional Arm to help Mother Nature

Adam



I saw a bird with an orange beak, what is it?

I am not quite sure, Is the bird's plumage dark above?

yes

Is it also white above?

yes

I think you are talking about "parakeet Auklet.", Is this it?



yes





# United Nations coverage in Nov 2018





# Imagination Inspired Vision

## IMAGINE TO SEE

**Parakeet Auklet** is a small bird that has a short **orange** bill. The bird's plumage is **dark** above and **white** below.



## IMAGINE TO CREATE

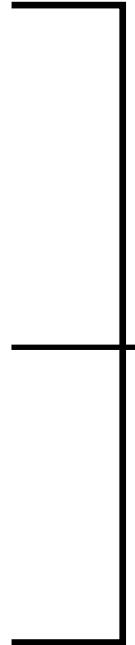




# Creative Adversarial Networks (CAN)

Creation from Random Numbers

High Renaissance



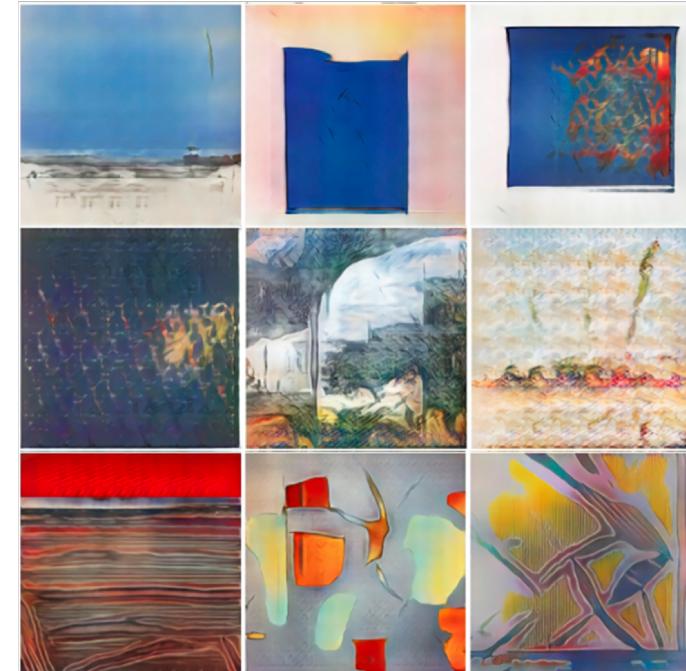
Abstract Art



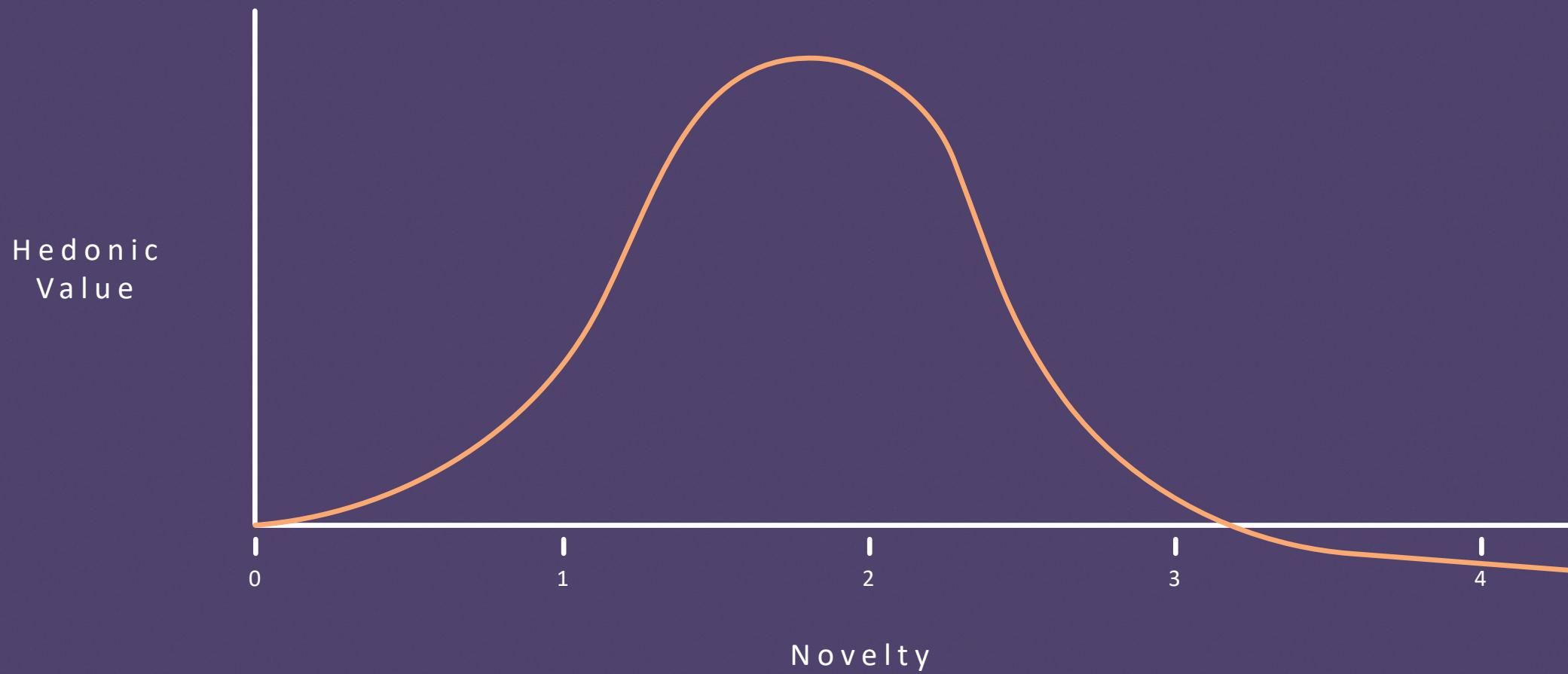
Cubism



New style

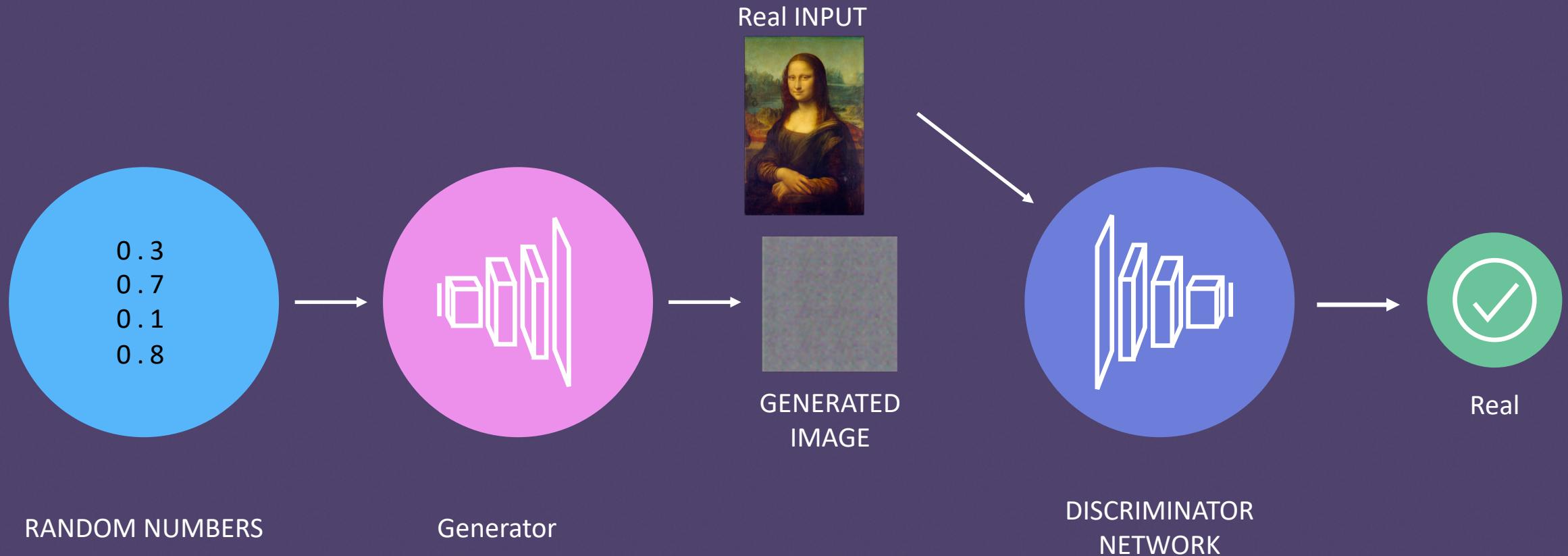


# Principle of least effort: Wundt curve



[Slide credit, our F8 presentation]

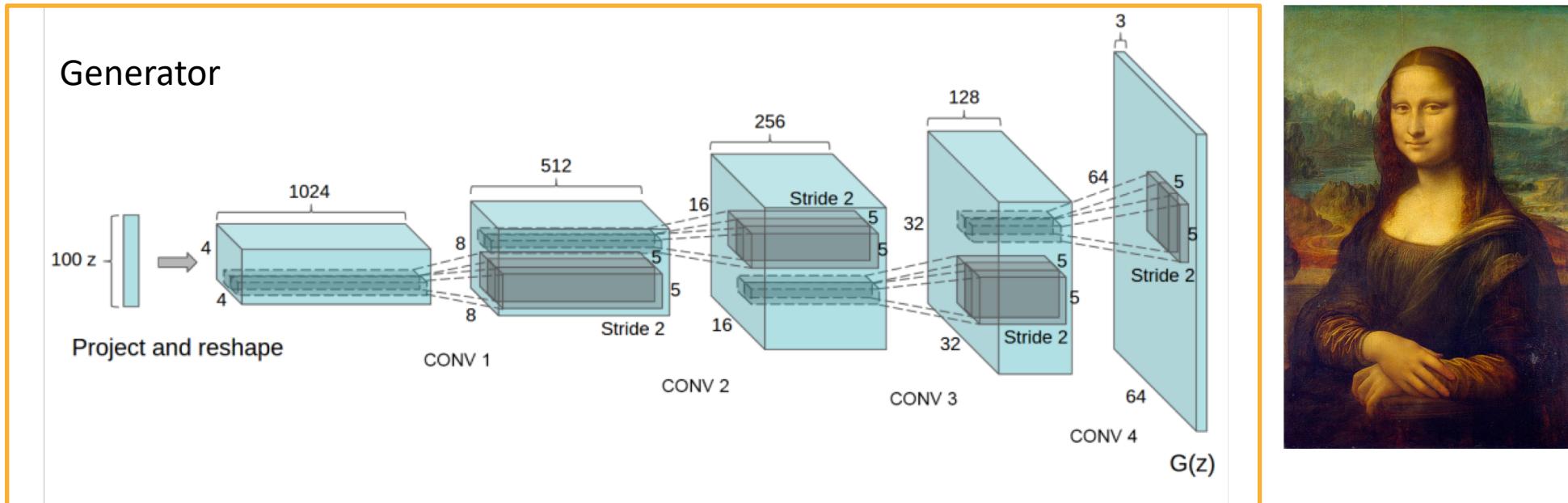
# Generative Adversarial Networks



[Slide credit, our F8 presentation]



# GAN has no motivation to be creative



AI Creative Artist?



No, not creative.



# Creative Adversarial Networks

## Wiki Art 20 Style Classes and Modeling the deviation

Abstract Art



Cubism



Impressionism



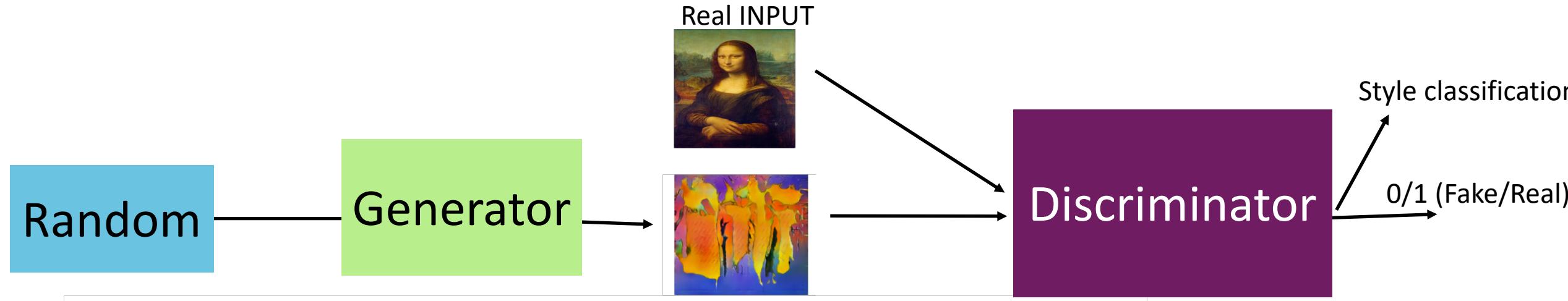
High Renaissance



.....



# Creative Adversarial Networks



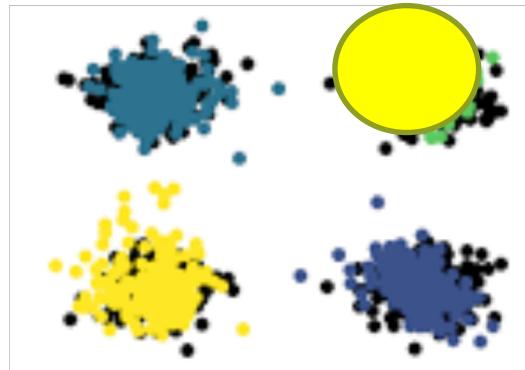
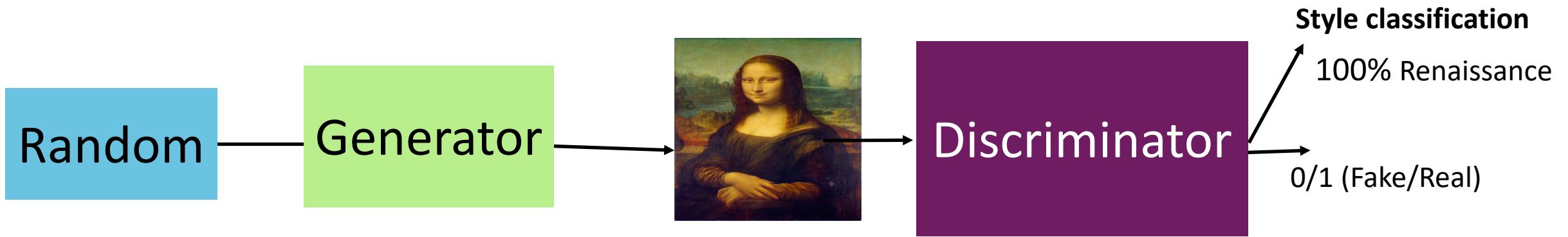
$$\begin{aligned} \min_G \max_D V(D, G) = & \mathbb{E}_{x, \hat{c} \sim p_{data}} [\log D_r(x) + \log D_c(c = \hat{c} | x)] + \\ & \mathbb{E}_{z \sim p_z} [\log(1 - D_r(G(z))) - \sum_{k=1}^K (\frac{1}{K} \log(D_c(c_k | G(z)) + \\ & (1 - \frac{1}{K}) \log(1 - D_c(c_k | G(z))))], \end{aligned}$$

Creativity Loss



# Creative Adversarial Networks

**Low Style Ambiguity (low Entropy)= Low Creativity**



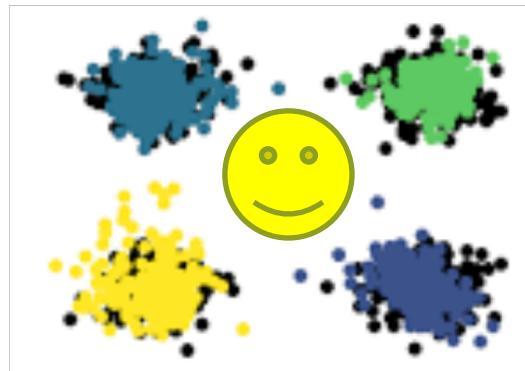
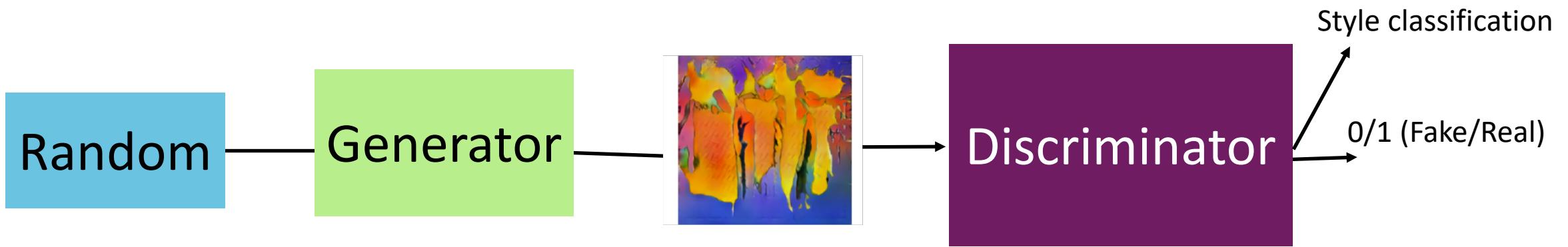
[ELEB., ICCC, 2017]

$$\left[ - \sum_{k=1}^K \left( \frac{1}{K} \log(D_c(c_k | G(z))) + \left(1 - \frac{1}{K}\right) \log(1 - D_c(c_k | G(z))) \right) \right]$$



# Creative Adversarial Networks

**High Style Ambiguity (high Entropy)= high Creativity**



[ELEB., ICCC, 2017]

$$\left[ - \sum_{k=1}^K \left( \frac{1}{K} \log(D_c(c_k | G(z))) + \right. \right. \\ \left. \left. (1 - \frac{1}{K}) \log(1 - D_c(c_k | G(z))) \right) \right]$$



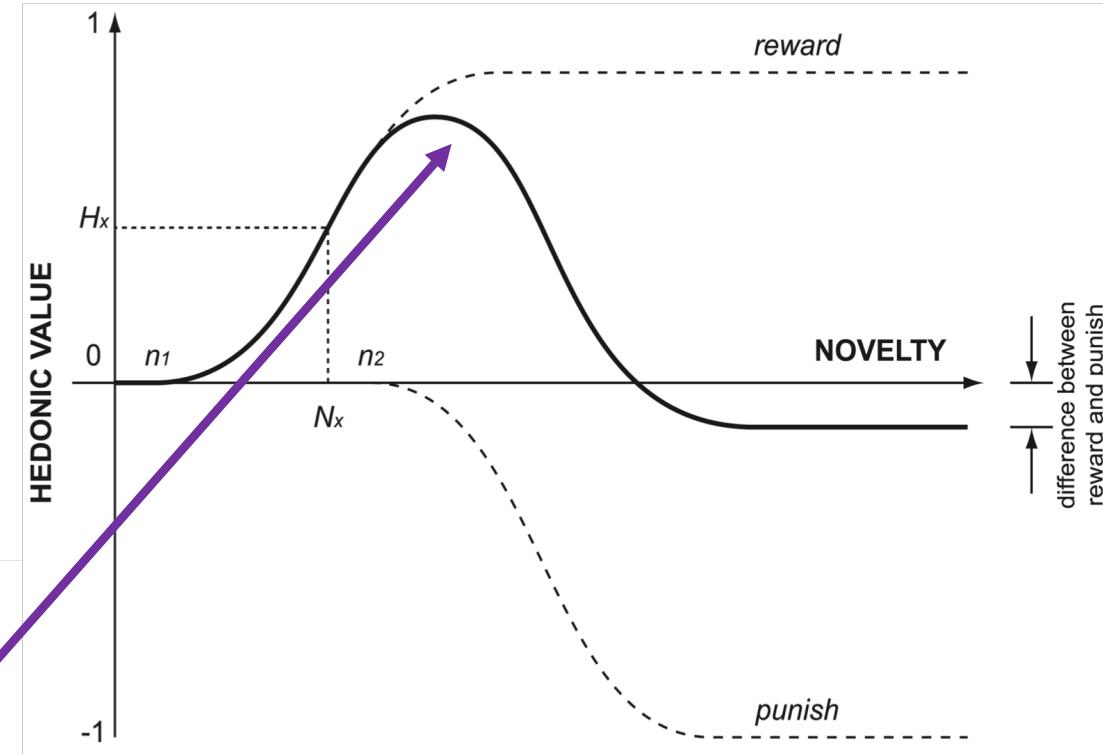
# Creative Adversarial Networks

## Loss and Connection to the Principle Of Least Effort

Colin Martindale (1943–2008)

$$\begin{aligned} \min_G \max_D V(D, G) = \\ \mathbb{E}_{x, \hat{c} \sim p_{data}} [\log D_r(x) + \log D_c(c = \hat{c} | x)] + \\ \mathbb{E}_{z \sim p_z} [\log(1 - D_r(G(z))) - \sum_{k=1}^K (\frac{1}{K} \log(D_c(c_k | G(z)) + \\ (1 - \frac{1}{K}) \log(1 - D_c(c_k | G(z))))], \end{aligned}$$

[ELEB., ICCC, 2017]





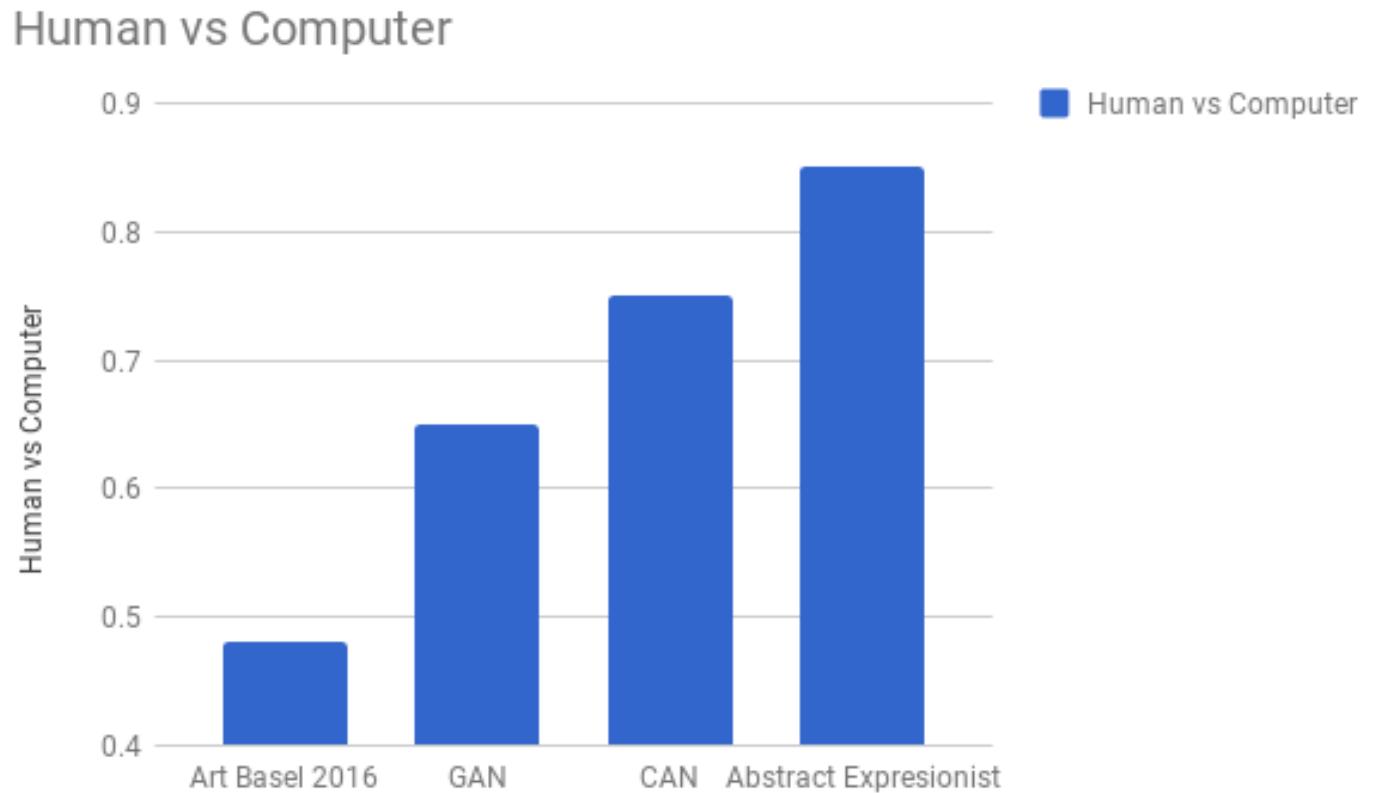
# Creative Adversarial Networks

## Qualitative Examples



# Creative Adversarial Networks

# Human Subject Experiments: Turing Test (Human vs Computer) ~100 images for each set

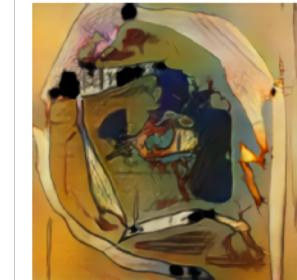
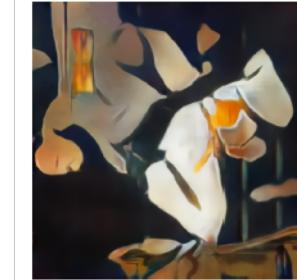




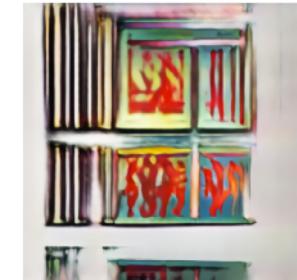
# Creative Adversarial Networks

Q1: Intentionality

Q1: INT



Q2:STR



Q3:COM



Q4:INS



Q2: Structure

Q2: Communication

Q4: Inspiration

Painting set	Q1 (std)	Q2 (std)	Q3 (std)	Q4 (std)
CAN	3.3 (0.47)	3.2 (0.47)	2.7 (0.46)	2.5 (0.41)
Abstract Expressionist	2.8 (0.43)	2.6 (0.35)	2.4 (0.41)	2.3 (0.27)
Art Basel 2016	2.5 (0.72)	2.4 (0.64)	2.1 (0.59)	1.9(0.54)
Artist sets combined	2.7 (0.6)	2.5 (0.52)	2.2 (0.54)	2.1 (0.45)



# CAN Impact

In addition to the scientific impact, CAN has also been covered at

- Media attention:
  - MIT tech review,
  - New scientist
  - Others
- Exhibitions:
  - Frankfurt Book Fair
  - Los Angeles Art Exhibition
- Invited Talks:
  - Best of AI meeting
  - NIPS 2017 Creativity workshop
  - FB CAN Demo
  - NIPS17 FB booth
  - FAIR video