Welcome to Generative Models School!

V2.0

2020, Nov 24-27

Andrey Ustyuzhanin on behalf of the school team

National Research University Higher School of Economics

LAMBDA • HSE

Yandex SCHOOL OF DATA ANALYSIS

Main agenda topics

Day	Topics	Language	Speakers
Tuesday	Introduction to machine learning	Russian	Dmitry Vetrov, Ekaterina Lobacheva, Nadezhda Chirkova
Wednesday	Introduction to generative models	Russian	Denis Derkach, Artem Maevskiy, Artem Ryzhikov
Thursday	Introduction to bandit problems	English/ Russian	Quentin Paris, Sergey Samsonov, Nikita Zhivotovskiy
Friday	Advances in generative models, panel discussion Closing dinner*	Russian	https://indico.cern.ch/event/967970/timetable/

Learning objectives

- Understand principles of probabilistic machine learning models;
- Understand principles of generative models' design;
- Understand the differences of modern generative model architectures and choose appropriate model class for generative models;
- Define custom generative model architecture for a task at hand;
- Understand the principles of bandit problem formulation for a task at hand and possible application strategies;
- Understand the recent advances and challenges in generative models' research.

Organizational links

- Timetable and materials: https://indico.cern.ch/event/967970/timetable/
- Seminars: https://github.com/HSE-LAMBDA/GenModels-2020
- Chat: https://t.me/joinchat/DMMgwhqUArz_ic-sn75EYA
- More questions (including offline-related):
  - Natalia Talaikova (ntalaikova@hse.ru)

Яндекс

ШКОЛА · ЭКОНОМИКИ · ВЫСШАЯ

HSE Faculty of Computer Science

Established in March 2014,

Active support from Yandex (more than 50 lecturers/seminarists are Yandex employee)

- Also cooperates with Kaspersky, WorldQuant, Huawei, SAS, JetBrains, and other

Goal: enter the world's top 30 Computer Science faculties by 2022

- big data storing and processing,
- software development and system programming,
- machine learning

370 students enter bachelor program per year

~100 graduate master's program per year

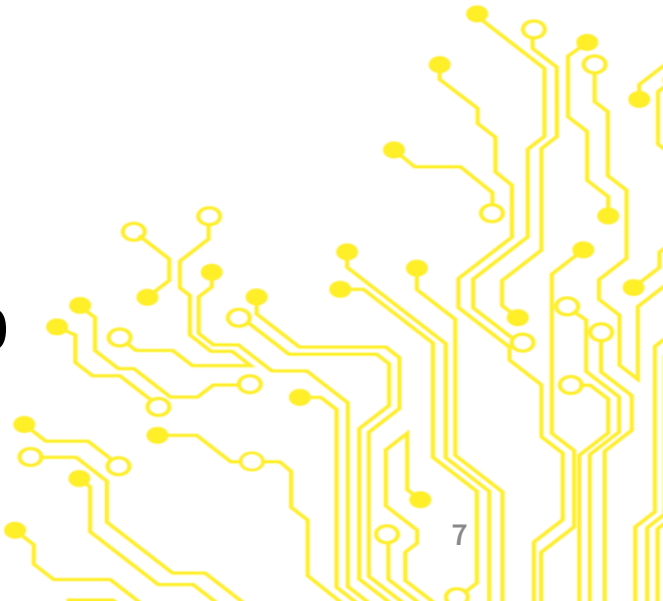
Member of LHCb collaboration since June 2018

Collaborates with many European and US universities

Bayesian Methods Research Group

- Group focuses on development and applications of Bayesian methods for Deep Learning
- Close partnership with Samsung, Nvidia, JetBrains,
  Research Project examples:
  - Sparsification and acceleration of deep neural networks;
  - Uncertainty estimation and defences against adversarial attacks;
  - Loss-based learning for Deep Structured Prediction;
  - Stochastic optimization methods;
  - Learning and inference methods for probabilistic models;
- Papers accepted by ICML2020, NeurIPS2020, ICLR2020 and AISTATS2020, bronze medal for Samsung Best Paper award 2020

https://bayesgroup.ru/



bayesgroup

High-Dimensional Inference Laboratory

Aims at developing new probability and statistical approaches to current problems in the field of data analysis.

Partners: Ecole Polytechnique, Huawei, WIAS, MSU, Universitat Bielfeld, University of Haifa.

- Uncertainty quantification in machine learning algorithms (MCMC, RL, Gen. models, DL);
- Mathematical foundations of Reinforcement learning;
- Convex and non-convex optimization;
- Manifold learning and Optimal transport;
- Non-asymptotic analysis of high-dimensional random matrices and random;

Leading Researchers: Eric Moulines, Alexey Naumov, Vladimir Spokoiny, Sergey Bobkov, Denis Belomestny, Alexander Tikhomirov, Alexander Goldenshluger

https://cs.hse.ru/en/hdilab/

Laboratory of Methods for Big Data Analysis

Group focuses on data analyses in Natural sciences
Close partnership with Yandex School of Data Analysis
Collaborates with LHCb, SHiP, OPERA, CRAYFIS experiments
Research Project examples:

- Fast Particle Identification algorithms;
- Fast and meaningful MC Generation;
- Optimization of particle detector;
- Surrogate-based optimization methods;
- Simulation-based inference.

LAMBDA • HSE

Co-organization of ML events: Flavours of Physics, TrackML, IDAO

Open for interns, graduate students and post doc candidates!

hse_lambda

Modern Generative Modeling

This X Does Not Exist!

This Person Does Not Exist

The site that started it all, with the name that says it all. Created using a style-based generative adversarial network (StyleGAN), this website had the tech community buzzing with excitement and intrigue and inspired many more sites.

Created by Phillip Wang.

This Cat Does Not Exist

These purr-fect GAN-made cats will freshen your feeline-gs and make you wish you could reach through your screen and cuddle them. Once in a while the cats have visual deformities due to imperfections in the model – beware, they can cause nightmares.

Created by Ryan Hoover.

This Rental Does Not Exist

Why bother trying to look for the perfect home when you can create one instead? Just find a listing you like, buy some land, build it, and then enjoy the rest of your life.

Created by Christopher Schmidt.

https://thisxdoesnotexist.com/

Video Modifications

We can automatically remove snow in video

https://incrussia.ru/news/ii-nauchilsya-poddelyvat-video/

More Tricks for Your Brain

- **Text generation.**

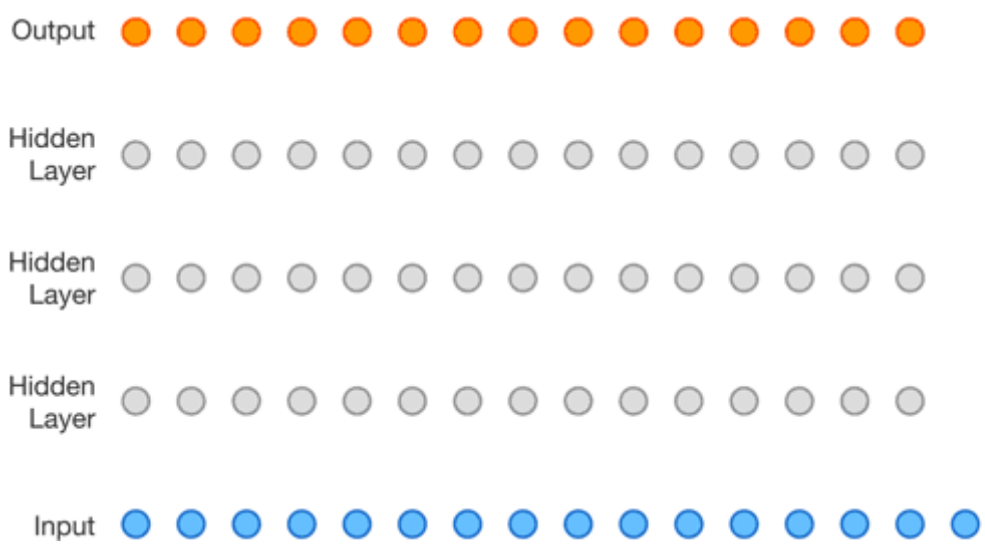
Two men happily working on a plastic computer.
The toilet in the bathroom is filled with a bunch of ice.
A bottle of wine near stacks of dishes and food.
A large airplane is taking off from a runway.
Little girl wearing blue clothing carrying purple bag sit
SeqGAN (Baseline)
A baked mother cake sits on a street with a rear of it.
A tennis player who is in the ocean.
A highly many fried scissors sits next to the older.
A person that is sitting next to a desk.
Child jumped next to each other.
RankGAN (Ours)
Three people standing in front of some kind of boats.
A bedroom has silver photograph desk.
The bears standing in front of a palm state park.
This bathroom has brown bench.
Three bus in a road in front of a ramp.

https://arxiv.org/abs/1812.08196

More Tricks for Your Brain

- Text generation.

- Voice from text generation.



More Tricks for Your Brain

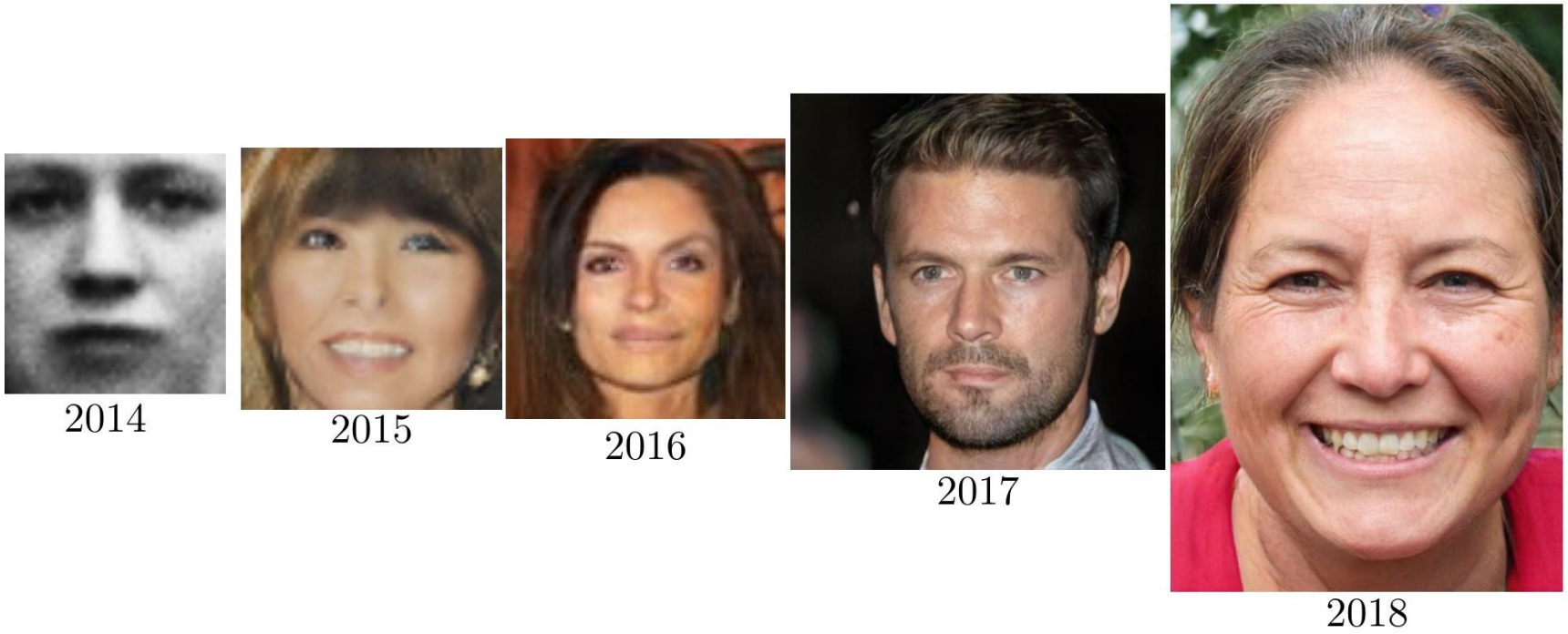
- Text generation.
- Voice from text generation.
- Style transfer.

More Tricks for Your Brain: Links

- Text generation.
  - https://www.tensorflow.org/tutorials/text/text_generation
- Voice from text generation.
  - https://deepmind.com/blog/article/wavenet-generative-model-raw-audio
- Style transfer.
  - https://towardsdatascience.com/style-transfer-with-gans-on-hd-images-88e8efcf3716

Generative Models Progress

The news are well motivated.

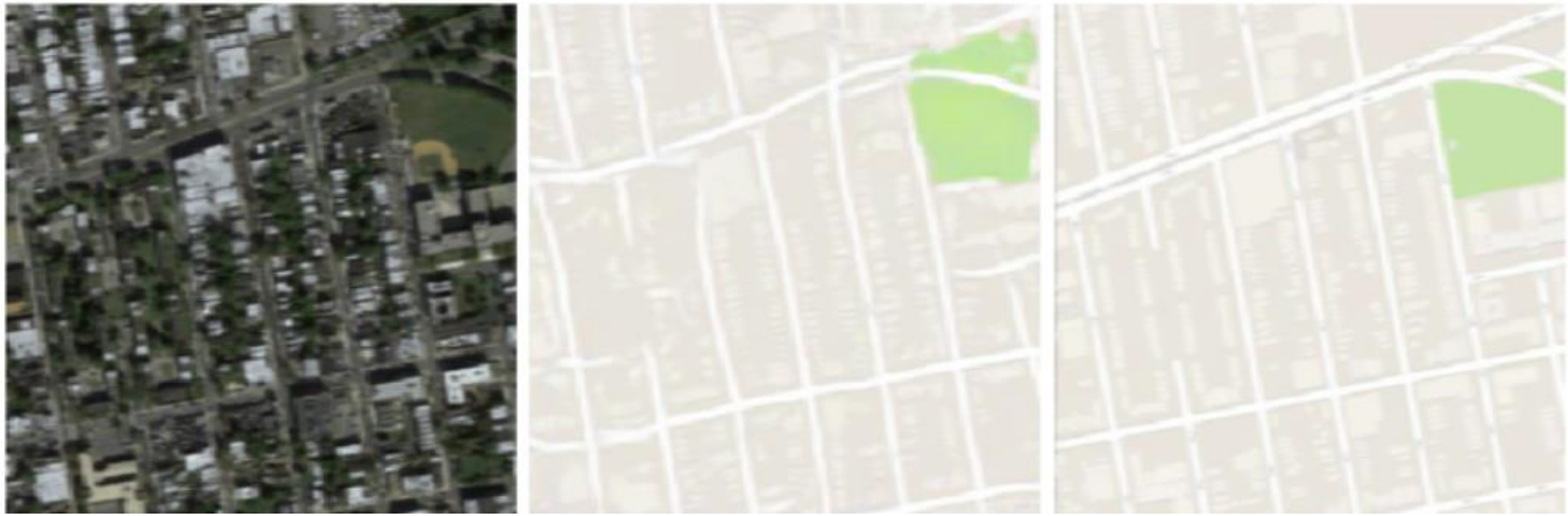


- **Enormous progress in recent years.**
- **Technology is ready for new tasks.**

https://twitter.com/goodfellow_ian/status/1084973596236144640

Dealing with Maps: generating map

- Image-to-image style transfer.
- Creates map on-the-fly from satellite image.



Input Generated True

https://github.com/ChengBinJin/pix2pix-tensorflow

Dealing with Maps: generating satellite image

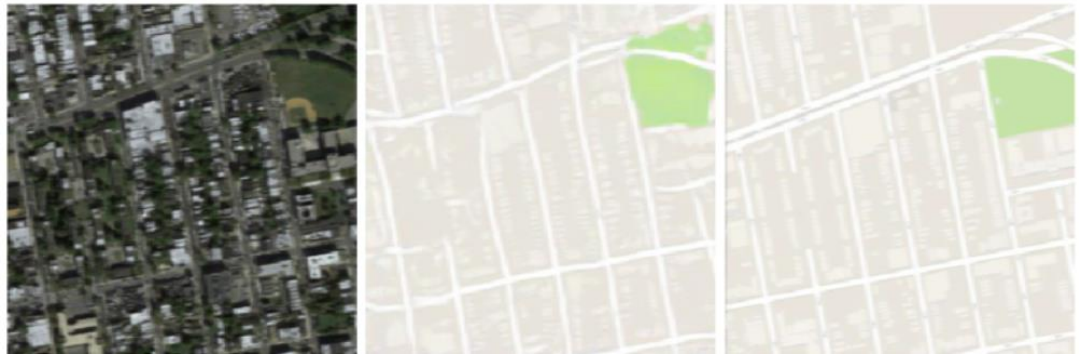
- Image-to-image style transfer
- Creates map on-the-fly from satellite image and vice versa.

Input Generated True

https://github.com/ChengBinJin/pix2pix-tensorflow

Dealing with Maps: generating satellite image

- Image-to-image style transfer
- Creates map on-the-fly from satellite image and vice versa.
- The technology is the same as for “Monet” painting. Just need good representation.



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Dealing with Satellite Images: Super-resolution

- We can “create” a more appropriate map quality

https://omdena.com/blog/super-resolution/

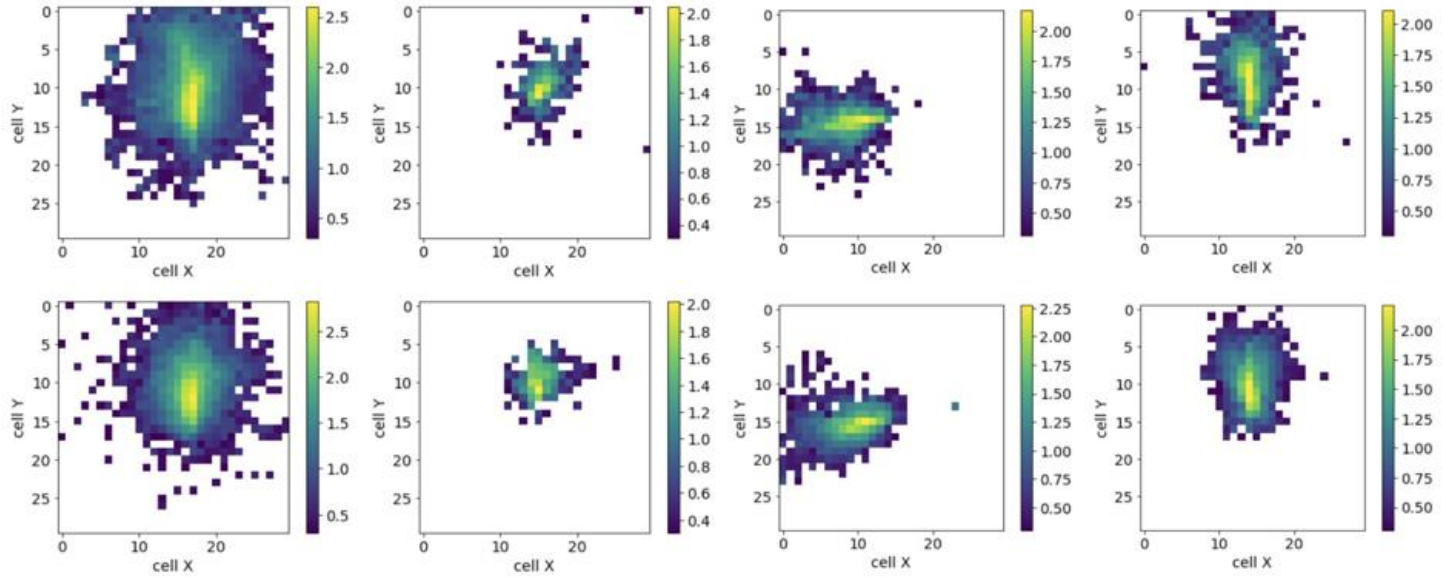
Dealing with Satellite Images: Super-resolution

- We can “create” a more appropriate map quality.
- This later can be used in segmentation task.

https://omdena.com/blog/super-resolution/

Creating Additional Images

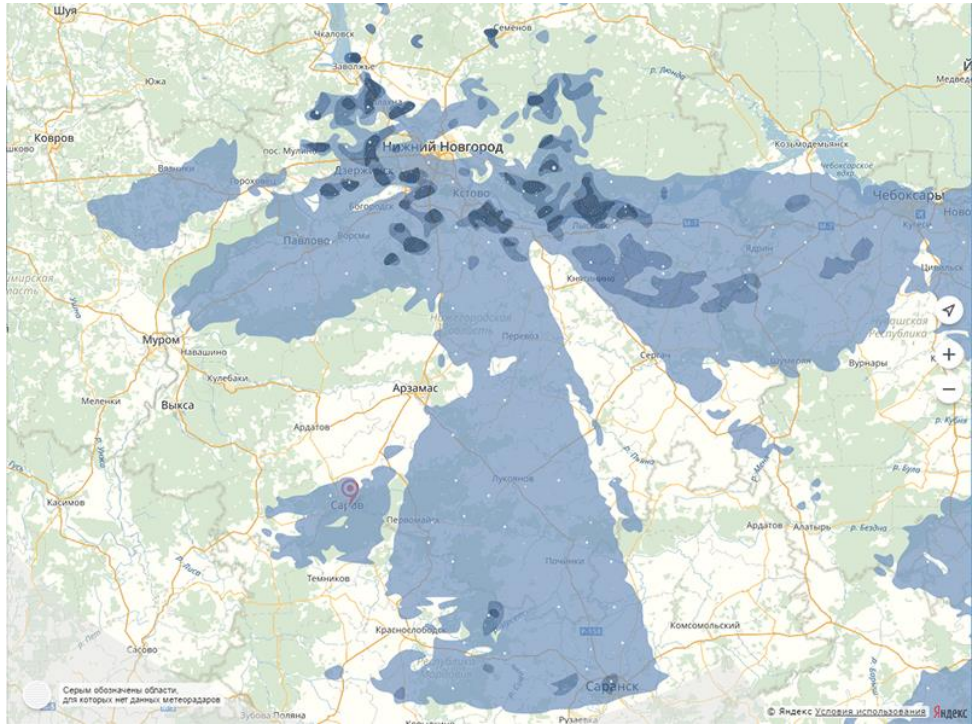
- Elementary particle passing through matter.
- Generative model mimics computationally expensive calculations.
- Hundreds of times faster.



(a) $E_0 = 63.7$ GeV (b) $E_0 = 6.5$ GeV (c) $E_0 = 15.6$ GeV (d) $E_0 = 15.9$ GeV

https://arxiv.org/abs/1812.01319

Weather prediction: nowcast



- Video prediction for precipitation.
- Generation of future state, based on the previous one.

https://www.kdd.org/kdd2019/accepted-papers/view/precipitation-nowcasting-with-satellite-imagery

Dirty Road Signs Generation

Class 0

Class 1

Class 2

Class 6

Class 7

Class 8

- Road signs from the book are too clean.
- Need to put mud and shadows on the signs.

https://arxiv.org/abs/1907.12902

What Generative Models Produce

- Cheat human's eyes.
- Cheat complicated algorithms (adversarial attack).
- Simulate sophisticated algorithm's results.
- Create additional input for the future tasks*.

Generative Models Failures

FAST COMPANY

02-08-19

This AI dreams about cats–and they'll haunt your nightmares

Nvidia's new AI is capable of generating everything from human faces to kittens. But the development process left behind plenty of. . .errors.

https://www.fastcompany.com/90303908/this-ai-dreams-about-cats-and-theyll-haunt-your-nightmares

Generative Models Failures

- Image is created as interpolation between existing ones.

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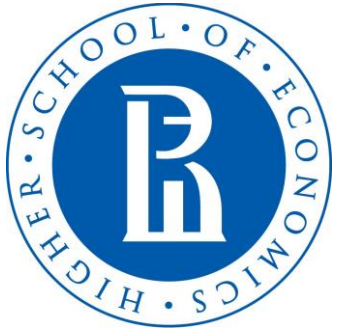
https://www.fastcompany.com/90303908/this-ai-dreams-about-cats-and-theyll-haunt-your-nightmares

What Generative Models Do not Produce

- No new information is created.
- All interpolations are done in the representation space.

School Sponsors



Russian Science Foundation

Thank you!



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