

Deep Learning & Applied AI

Projects

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- ① **Survey** on a topic.
 - Theoretical comparison between existing techniques.
 - Experimental comparison between existing techniques.
 - Introduction of a new taxonomy.

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- ③ **Original** contribution.
 - A new regularizer.
 - Putting in relation existing approaches in a new perspective.

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- game design

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Above all, make sure to do a project that you find interesting and **stimulating!**

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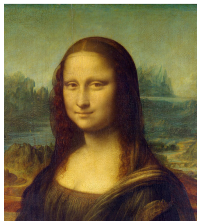
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Keep in mind that a small idea with a big consequence is valuable.

Survey: Geometric deep learning



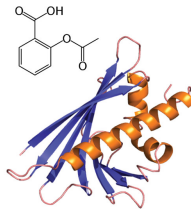
Acoustic signals



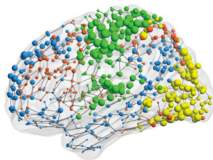
Images



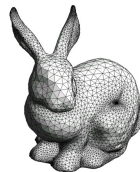
Social networks



Molecules



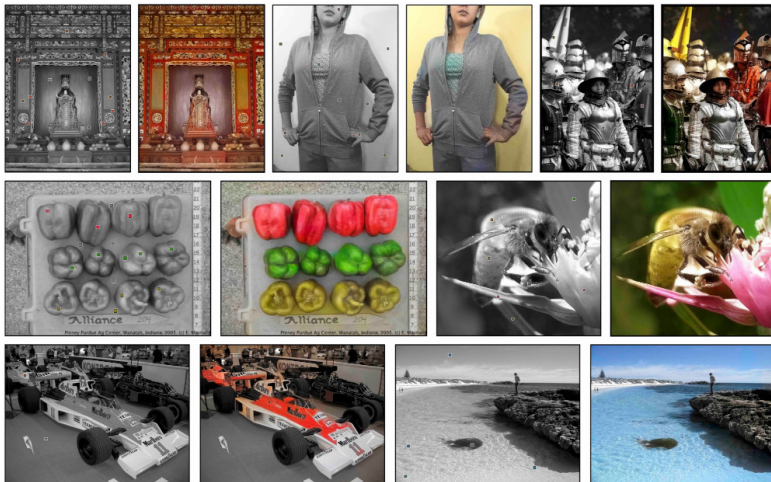
Functional networks



3D shapes

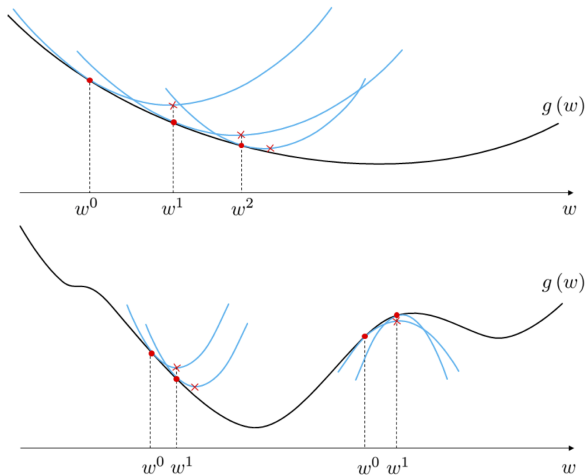
Video colorization

Take an existing image colorization technique, apply it to videos.



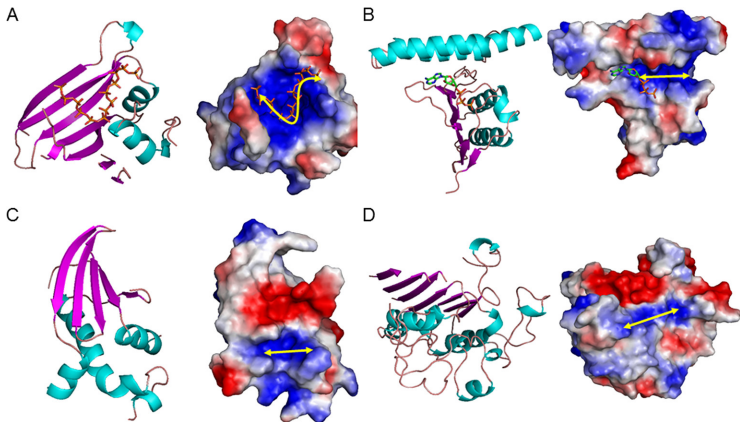
Second-order training

Implement a second-order optimization method for training a neural net.



Latent proteins

Generate a latent space of proteins.



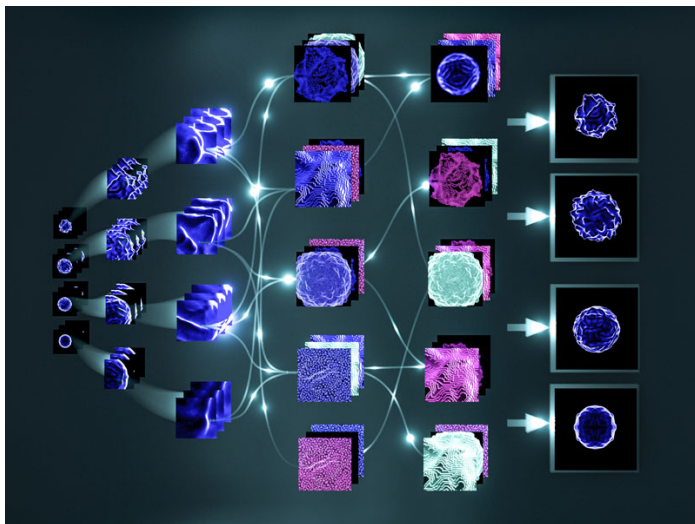
Adversarial attacks

Create an adversarial attack for dynamic data.



Veterinary learning

Apply cancer detector for humans to animal data.



Minecraft generator

Create a generator for minecraft 3D models.



Song style transfer

Apply a style transfer technique to audio tracks.



Soundtrack prediction

Learn to predict audio tracks in videos.

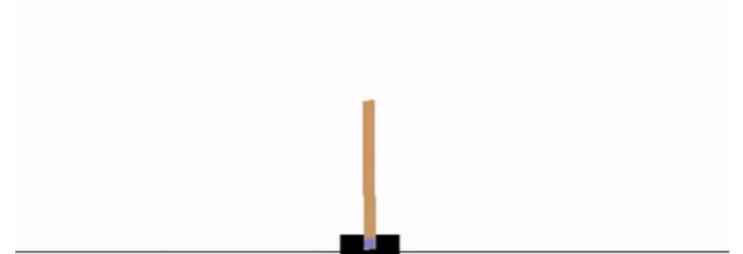
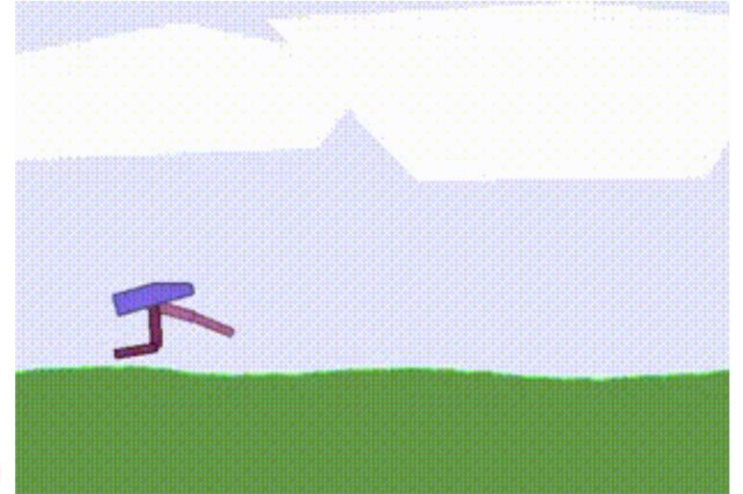
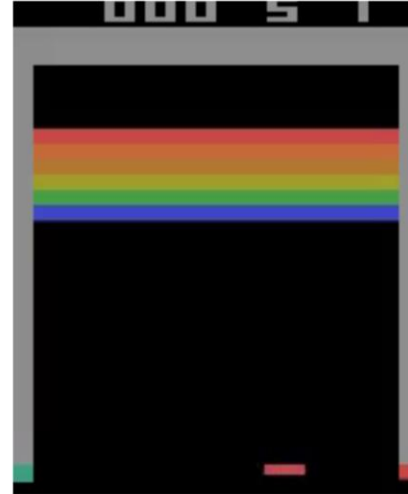


SOURCE OF DATA

GYM

<https://gym.openai.com/>

- Gym is a toolkit for developing and comparing reinforcement learning algorithms. It supports teaching agents everything from [walking](#) to playing games like [Pong](#) or [Pinball](#).



PROCGEN

<https://openai.com/blog/procgen-benchmark/>

- 16 simple-to-use procedurally-generated environments which provide a direct measure of how quickly a reinforcement learning agent learns generalizable skills.



PROJECTS

VQ-DRAW

Alex Nichol 03/2020 <https://arxiv.org/abs/2003.01599>

*A generative model with a
sequential discrete latent code*

- Can we use it as a super compression algorithm?
- What is the quality of reconstruction on GYM or PROCGEN environments? In Reinforcement Learning it is fundamental to have compact data representations.



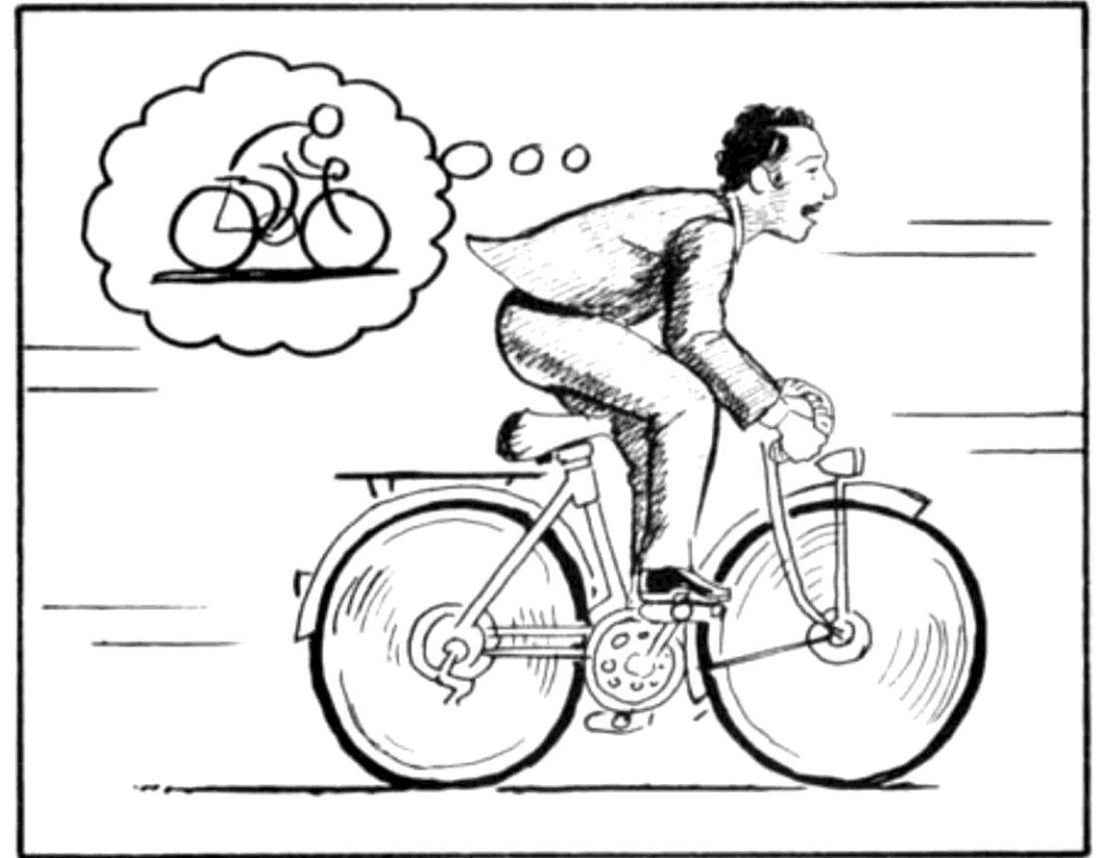
MNIST digits as more latent codes become available. The reconstructions gradually become crisper, which is ideal for progressive loading.

World Models

David Ha, Jorgen Schmidhuber 03/2018 <https://worldmodels.github.io/>

Can agents learn inside of their own dreams? Model based reinforcement learning.

- We want to make further experiments about the adversarial policies learned by the agent i.e. when it **cheats** the learned world model. You can use one of the PROCGEN environments.



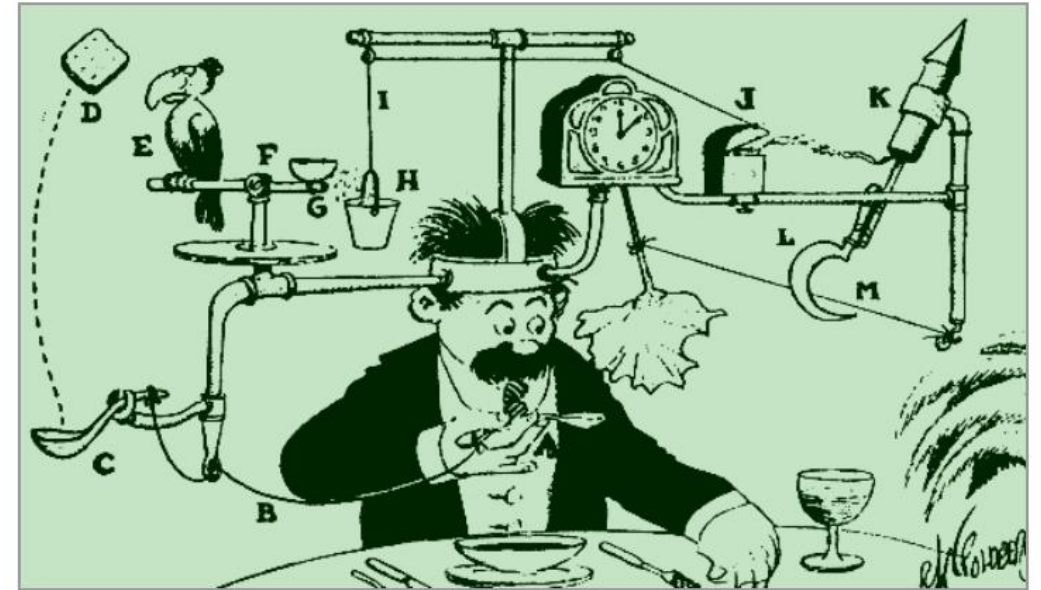
Measuring the Intrinsic Dimension of Objective Landscapes

Li, Farkhoor, Liu, Yosinski 04/2018 <https://arxiv.org/abs/1804.08838>

Do we really need over 100,000 free parameters to build a good MNIST classifier? It turns out that we can eliminate 50-90% of them.

We would like to expand this work.

- Can we use an operator smarter than simple projection to obtain better results?



Some things, like the "self-operated napkin", are just too complicated!

Training BatchNorm and only BatchNorm

Frankle, Schwab, Morcos 02/2020 <https://arxiv.org/abs/2003.00152>

*On the surprisingly high expressive power of **random** features in CNNs*

We want to expand this work:

- Can we obtain a better performance with a different wight initialization?
- What is the gain of performance training also some layers?

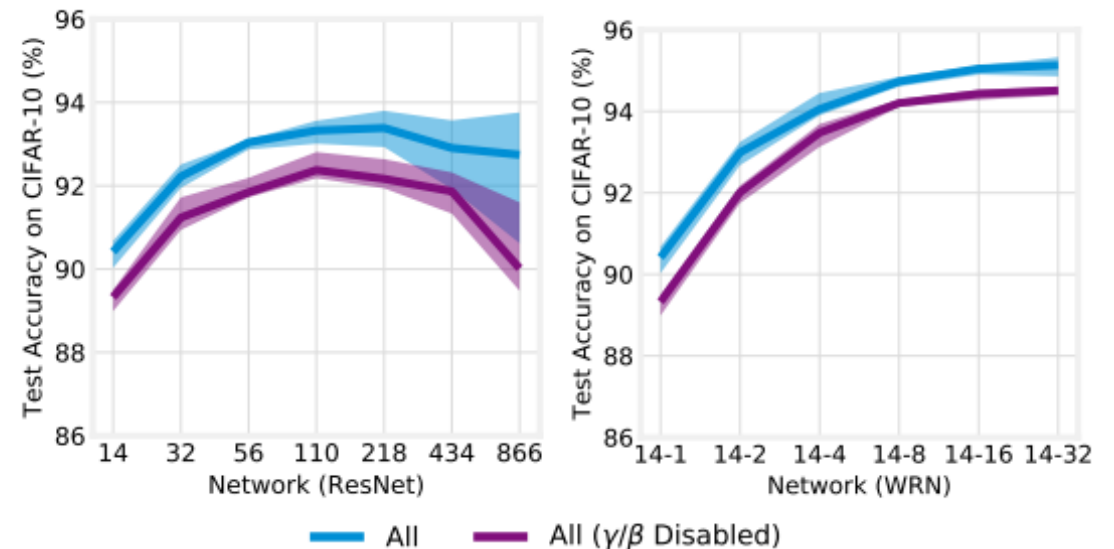


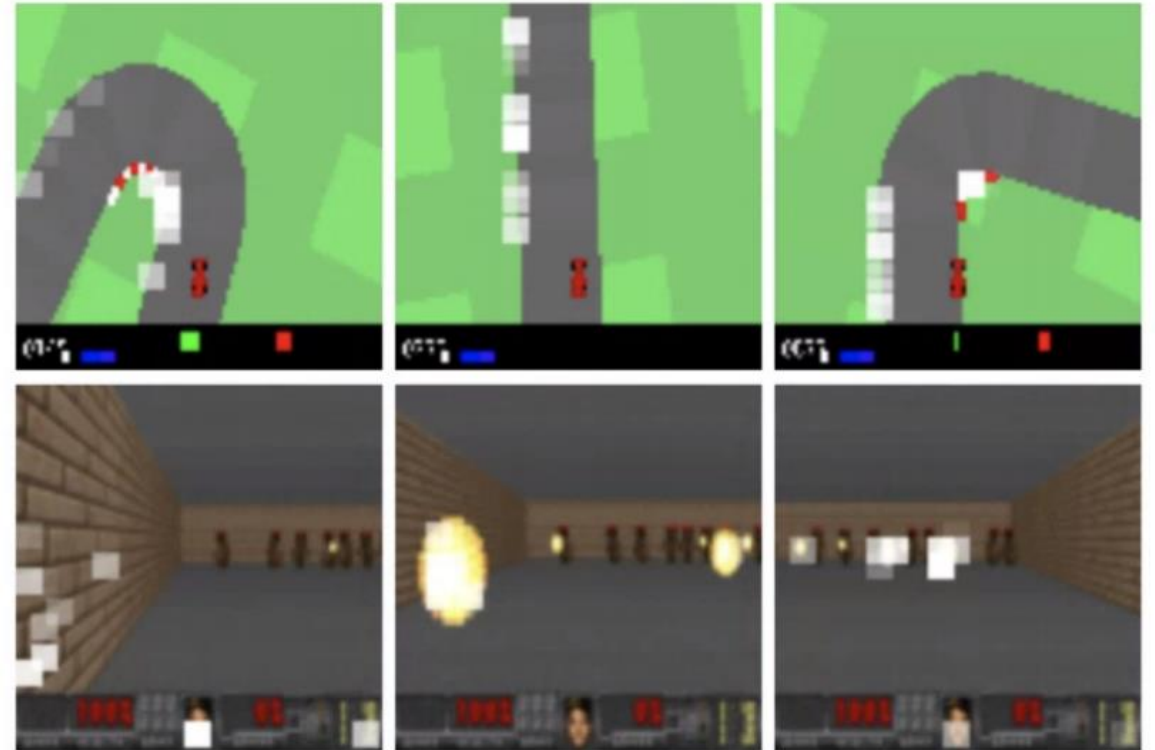
Figure 1. Test accuracy when training all parameters of the deep (left) and wide (right) ResNets in Table 1 with γ and β enabled (blue) and frozen at their initial values (purple). Except on the deepest ResNets, accuracy is about half a percent lower when γ and β are disabled.

Neuroevolution of Self-Interpretable Agents

Tang, Nguyen, Ha 03/2020 <https://attentionagent.github.io/>

*Agents with a self-attention
“bottleneck” not only can solve
these tasks from pixel inputs with
only 4000 parameters, but they
are also better at generalization!*

- We would like to reproduce this work, for instance on a PROCGEN environment. What if we choose a feature different from the patch position?



Emergent Communication with World Models

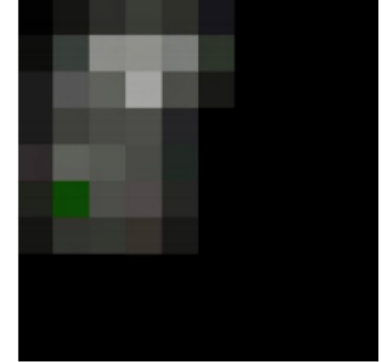
Cowen-Rivers, Naradowsky 02/2020 <https://arxiv.org/abs/2002.09604>

The speaker is able to view the entire map, whereas the listener only views a pixel in each direction. A communication emerges.

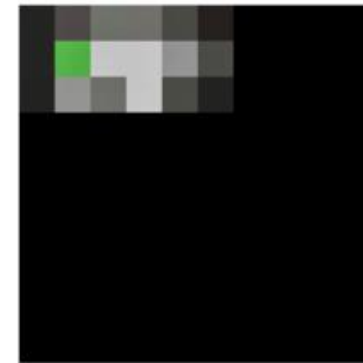
Can we adopt this framework on another environment?



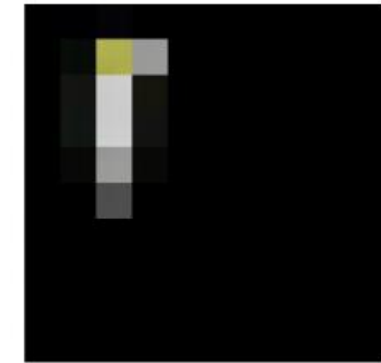
(a) end of right corridor



(b) end of left corridor



(c) top of left corridor



(d) top of right corridor

Growing Neural Cellular Automata

Mordvintsev, Randazzo, Niklasson, Levin 02/2020 <https://distill.pub/2020/growing-ca/>

Training an end-to-end differentiable, self-organising cellular automata model of morphogenesis, able to both grow and regenerate specific patterns.

This work is fascinating, we want to make further experiments on regeneration.

