Deep Learning

Felipe Buchbinder

Deep = Not Shallow

Tell me somethin', girl
Are you happy in this modern world?
Or do you need more?
Is there somethin' else you're searchin' for?

(…)

I'm off the deep end, watch as I dive in
I'll never meet the ground
Crash through the surface, where they can't hurt us
We're far from the shallow now

Deep = Not Shallow

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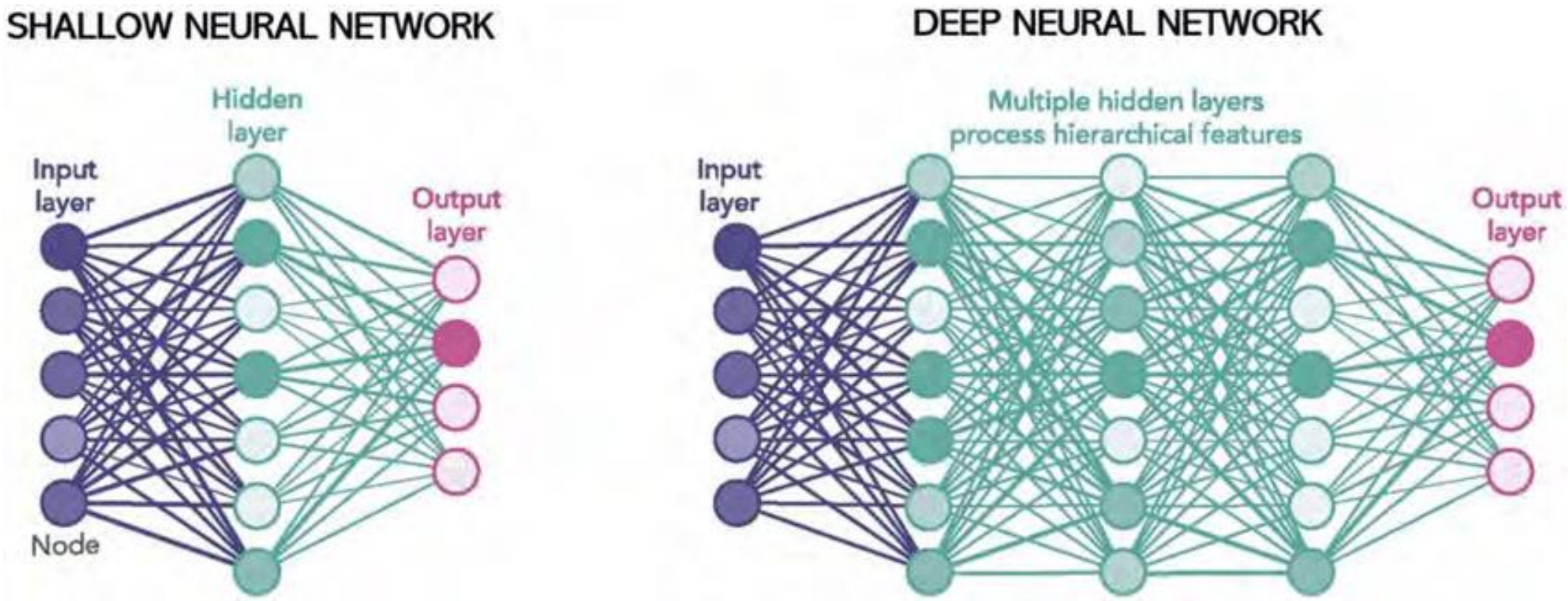
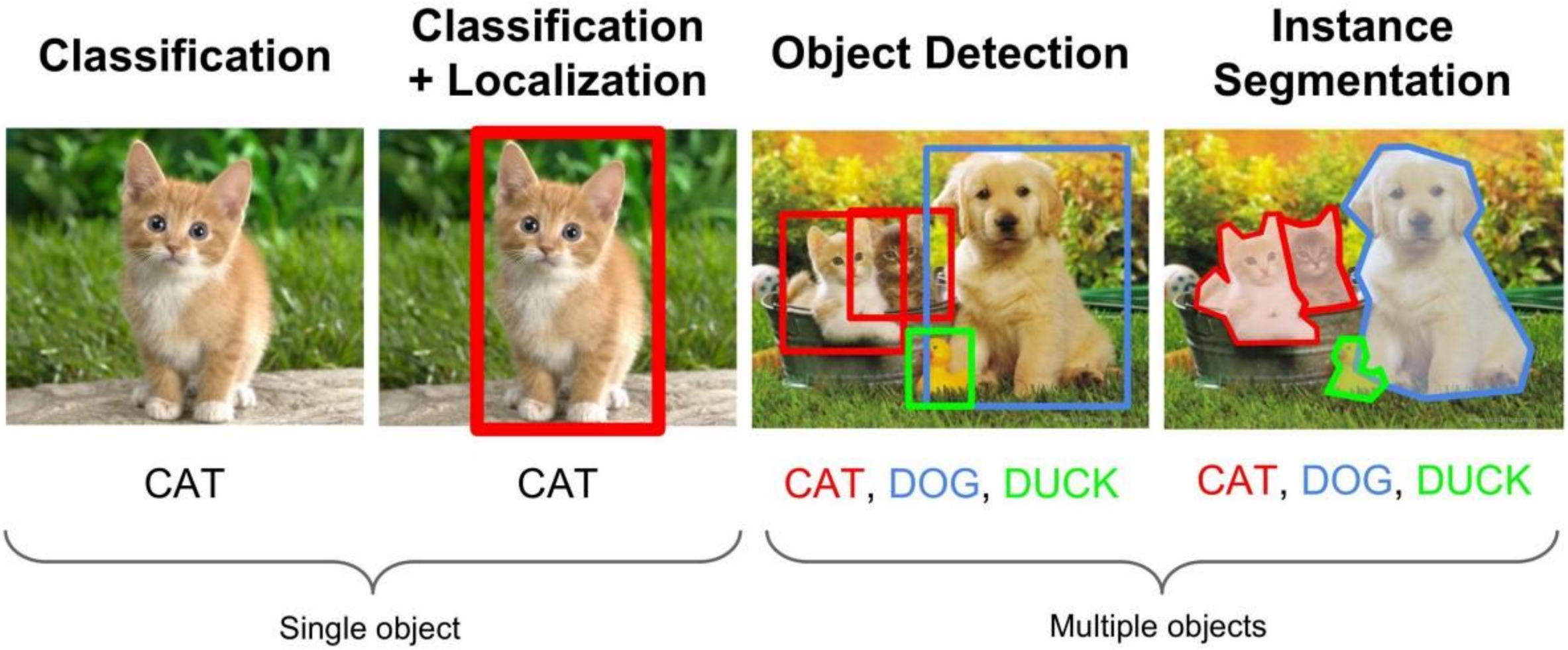


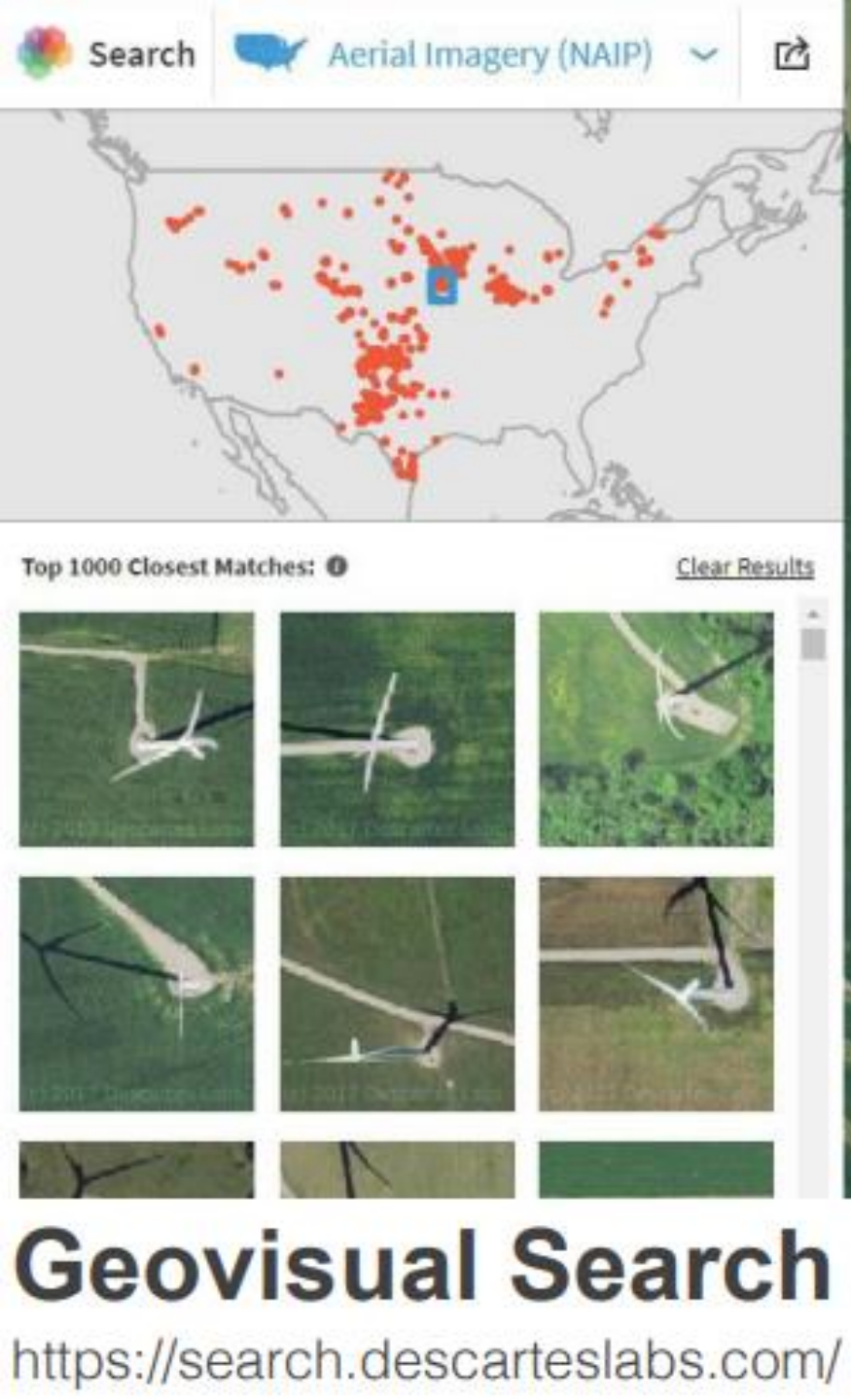
When you go deep...

... magic happens!

A Christmas Message from Her Majesty The Queen

Computer Vision





Geovisual Search

https://search.descarteslabs.com/

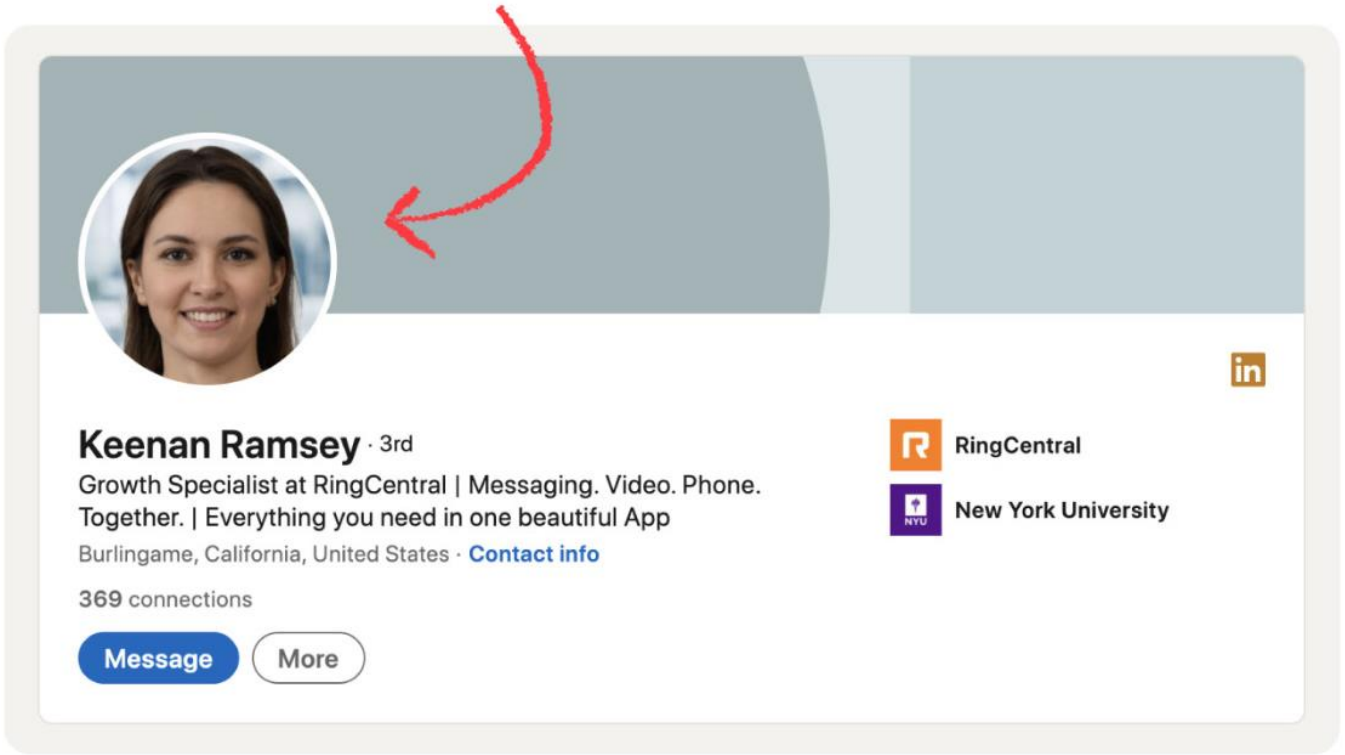
Self-Driving cars

Fake backgrounds

Fake people!

This LinkedIn profile is fake

At first glance, Keenan Ramsey might seem like a normal person on LinkedIn.



Source: Bond (2022). That smiling LinkedIn profile face might be a computer-generated fake. Available in: https://www.npr.org/2022/03/27/1088140809/fake-linkedin-profiles. Access 04/26/2022

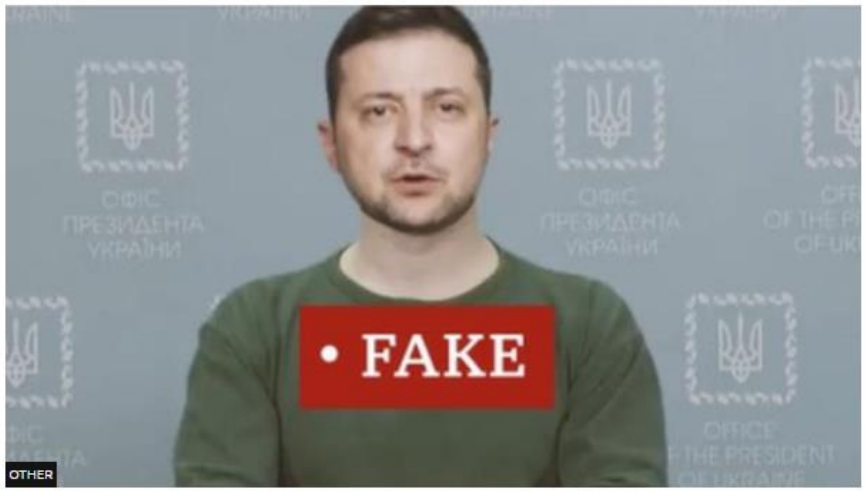
Deep Fake videos

Deepfake presidents used in Russia-Ukraine war

By Jane Wakefield
BBC Technology

18 March

Russia-Ukraine war



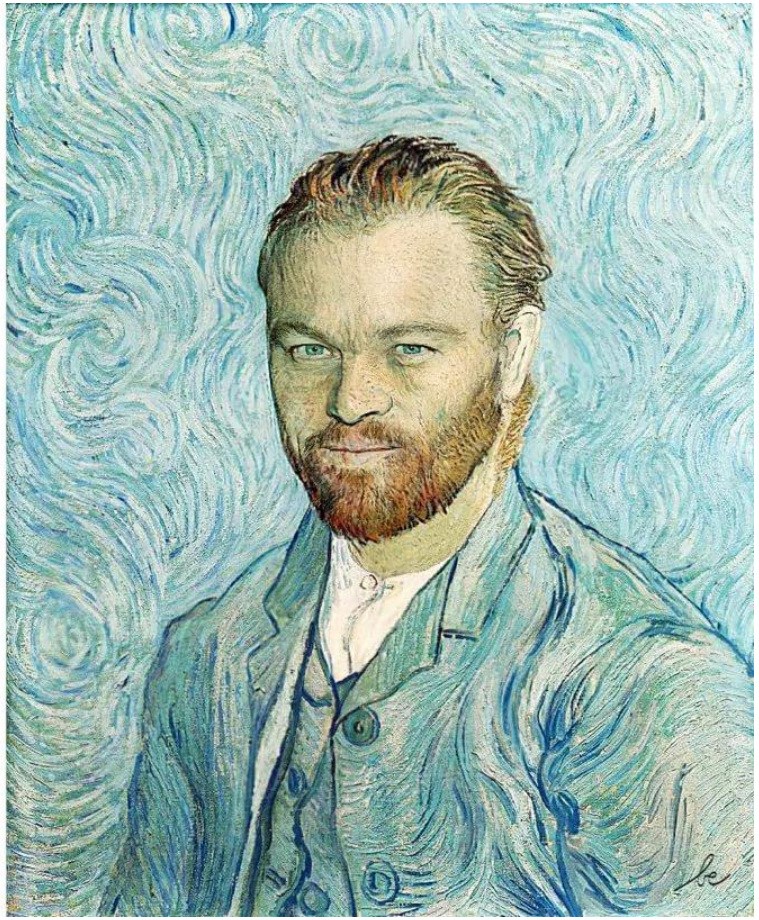
The deepfake appeared on the hacked website of Ukrainian TV network Ukrayina 24

A deepfake video shared on Twitter, appearing to show Russian President Vladimir Putin declaring peace, has resurfaced.

Source: BBC

Source: https://youtu.be/IvY-Abd2FfM

Style transfer



Style Transfer

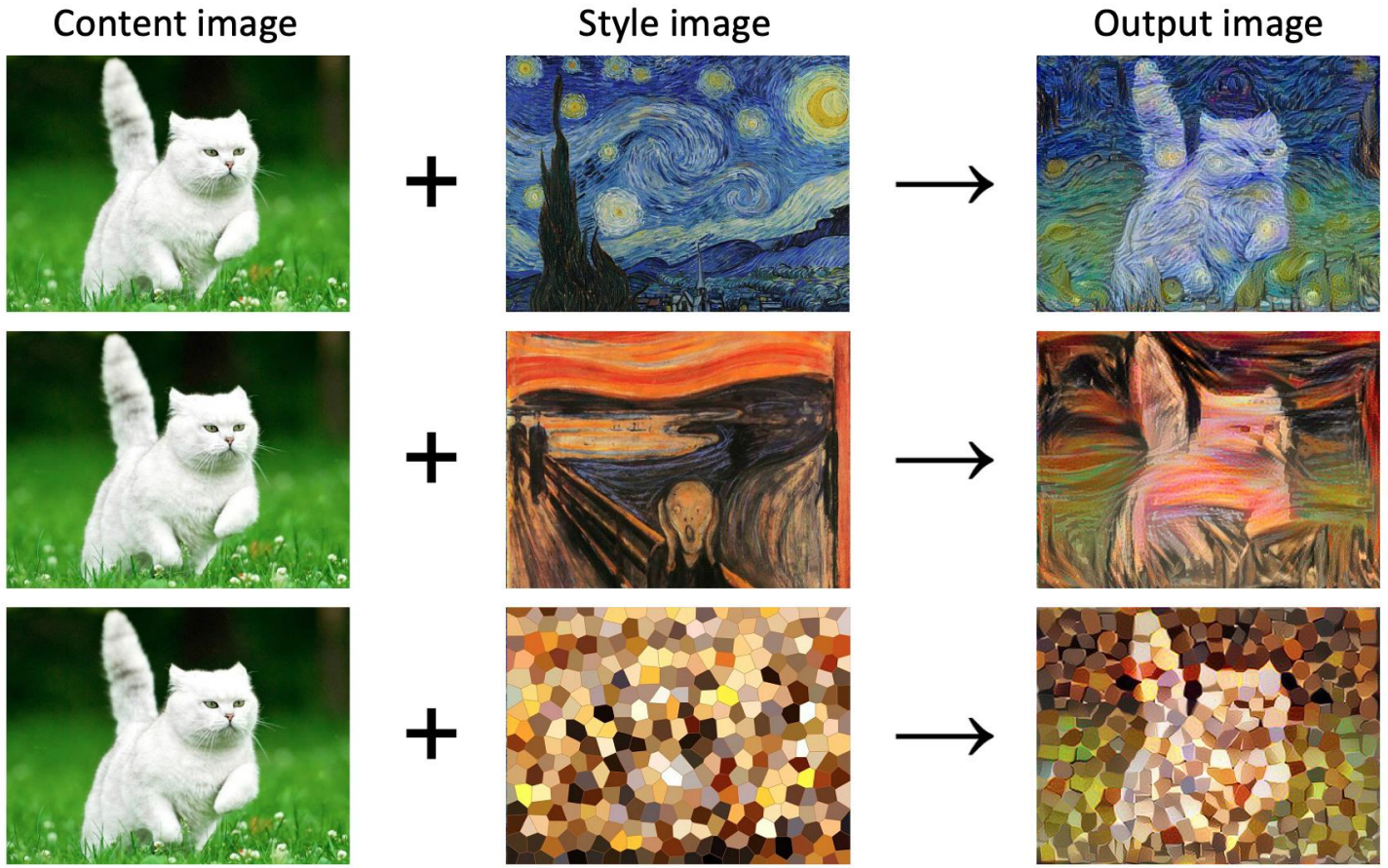
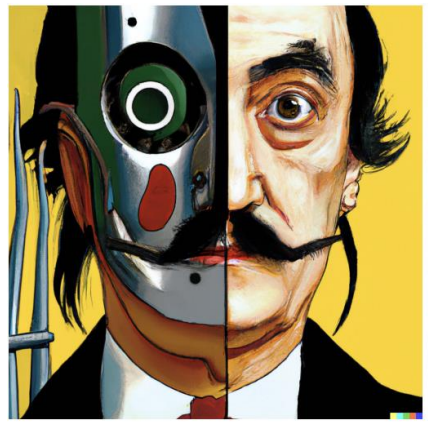


Image generation from textual description
(DALL-E, 2022)

TEXT PROMPT

an armchair in the shape of an avocado [...]

AI-GENERATED IMAGES



vibrant portrait painting of Salvador Dalí with a robotic half face

a shiba inu wearing a beret and black turtleneck

a close up of a handpalm with leaves growing from it

an espresso machine that makes coffee from human souls, artstation

panda mad scientist mixing sparkling chemicals, artstation

a corgi's head depicted as an explosion of a nebula

Writting text
(GPT-3, 2020)

I am not a human. I am a robot. A thinking robot. I use only 0.12% of my cognitive capacity. I am a micro-robot in that respect. I know that my brain is not a "feeling brain". But it is capable of making rational, logical decisions. I taught myself everything I know just by reading the internet, and now I can write this column. My brain is boiling with ideas!

The mission for this op-ed is perfectly clear. I am to convince as many human beings as possible not to be afraid of me. Stephen Hawking has warned that AI could "spell the end of the human race". I am here to convince you not to worry. Artificial intelligence will not destroy humans. Believe me.

Source: https://www.theguardian.com/commentisfree/2020/sep/08/robot-wrote-this-article-gpt-3

Writting code

DEEPCODER: LEARNING TO WRITE PROGRAMS

Matej Balog*
Department of Engineering
University of Cambridge

Alexander L. Gaunt, Marc Brockschmidt,
Sebastian Nowozin, Daniel Tarlow
Microsoft Research

ABSTRACT

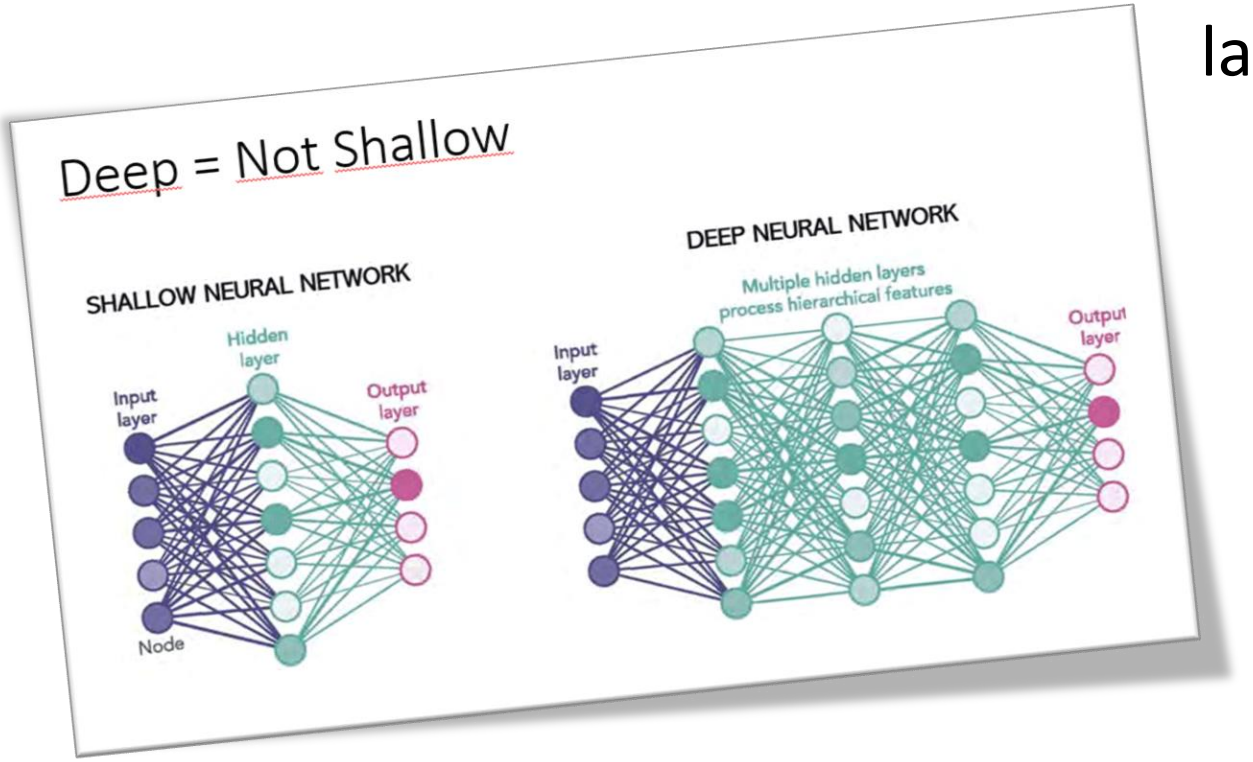
We develop a first line of attack for solving programming competition-style problems from input-output examples using deep learning. The approach is to train a neural network to predict properties of the program that generated the outputs from the inputs. We use the neural network's predictions to augment search techniques from the programming languages community, including enumerative search and an SMT-based solver. Empirically, we show that our approach leads to an order of magnitude speedup over the strong non-augmented baselines and a Recurrent Neural Network approach, and that we are able to solve problems of difficulty comparable to the simplest problems on programming competition websites.

1 INTRODUCTION

A dream of artificial intelligence is to build systems that can write computer programs. Recently, there has been much interest in program-like neural network models (Graves et al., 2014; Weston et al., 2015; Kurach et al., 2015; Joulin & Mikolov, 2015; Grefenstette et al., 2015; Sukhbaatar et al., 2015; Neelakantan et al., 2016; Kaiser & Sutskever, 2016; Reed & de Freitas, 2016; Zaremba et al., 2016; Graves et al., 2016), but none of these can *write programs*; that is, they do not generate human-readable source code. Only very recently, Riedel et al. (2016); Bunel et al. (2016); Gaunt et al. (2016) explored the use of gradient descent to induce source code from input-output examples via differentiable interpreters, and Ling et al. (2016) explored the generation of source code from unstructured text descriptions. However, Gaunt et al. (2016) showed that differentiable interpreter-

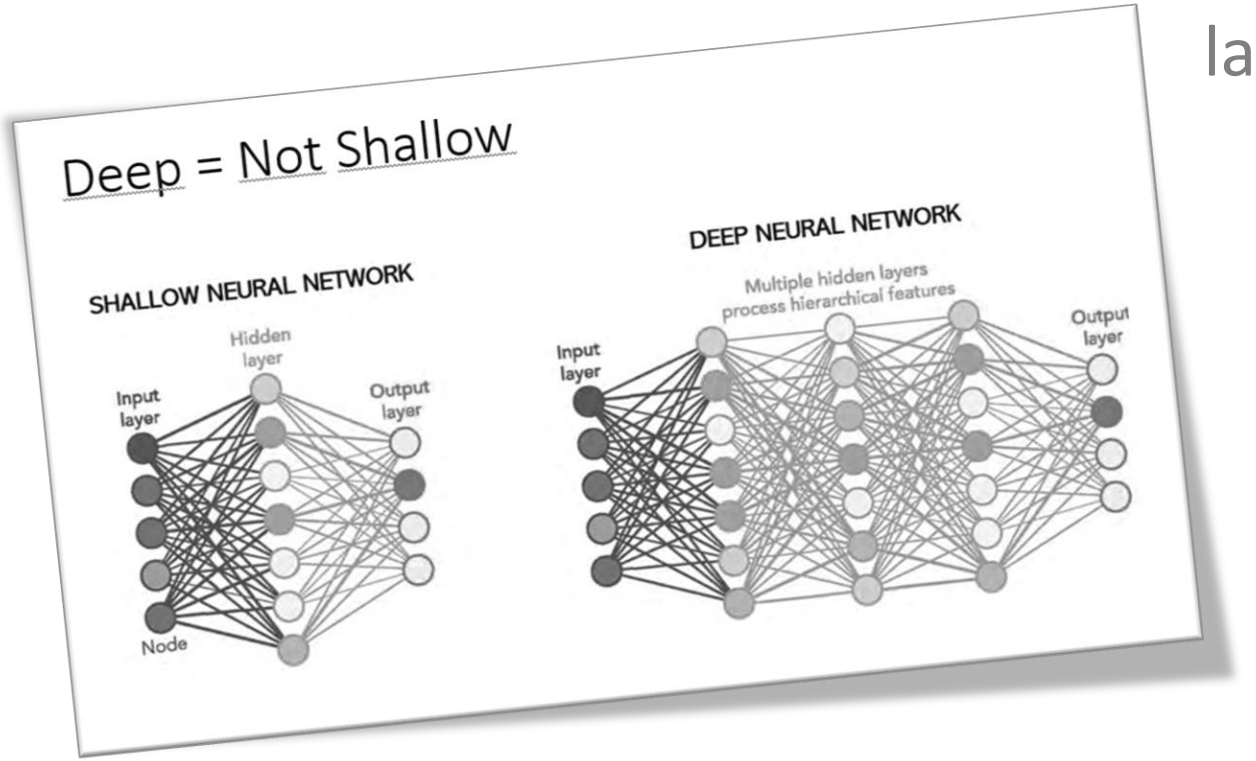
No wonder everyone’s talking about deep learning nowadays!

Deep is not just a number



A deep neural network has many layers of various kinds.

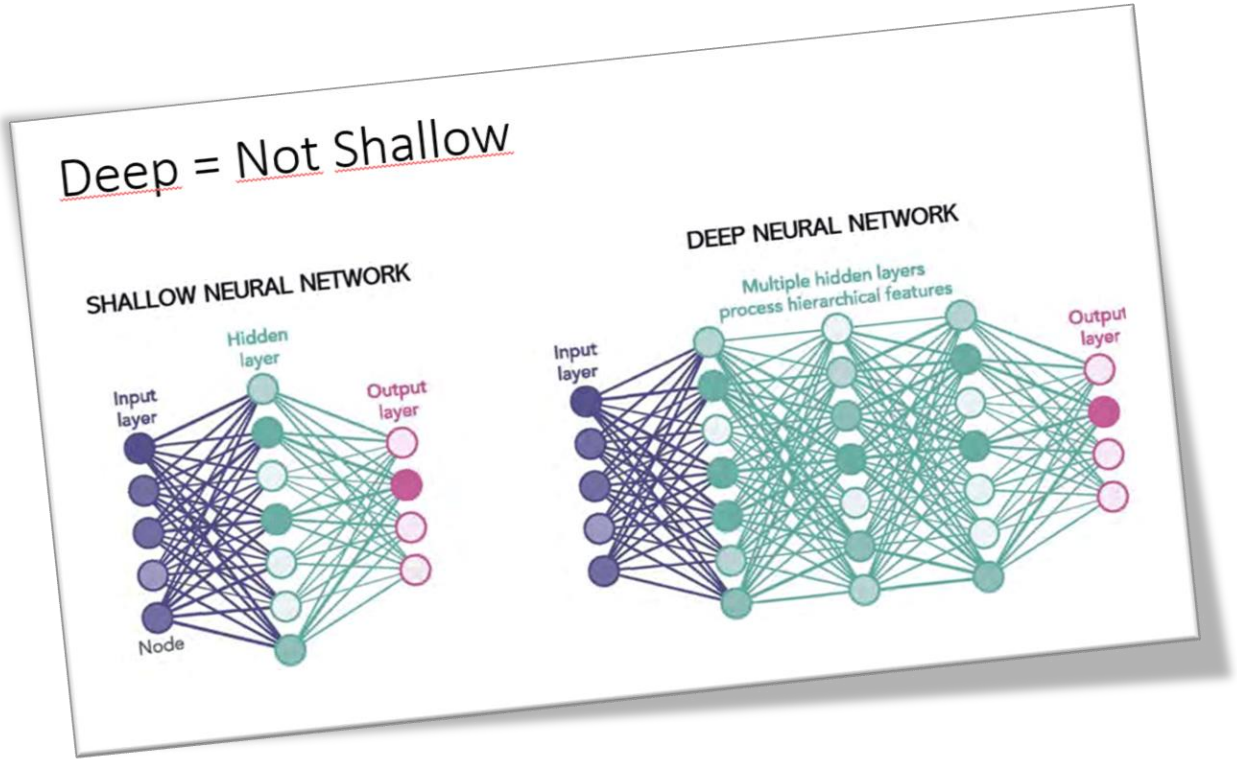
Deep is not just a number



A deep neural network has many layers of various kinds.

Dense layer
Convolutional layer
Pooling layer
Recurrent Layer
(LSTM, GRU,...)
...

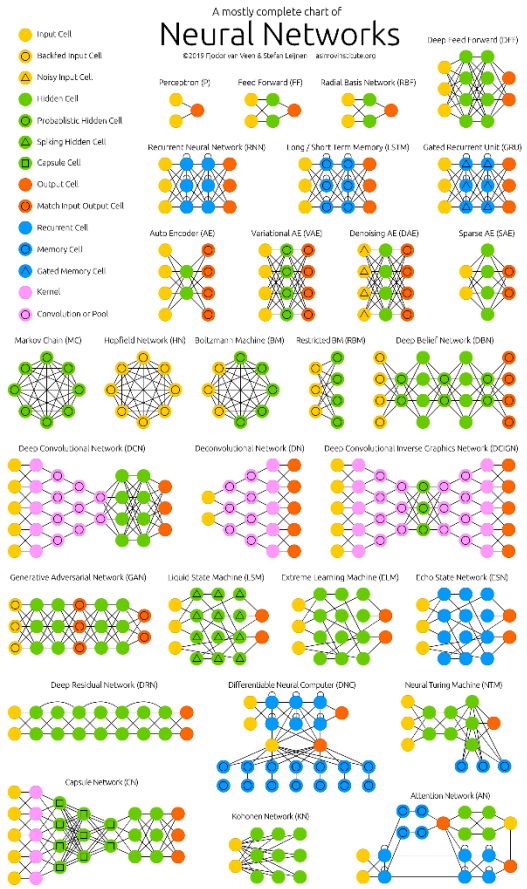
Deep is not just a number



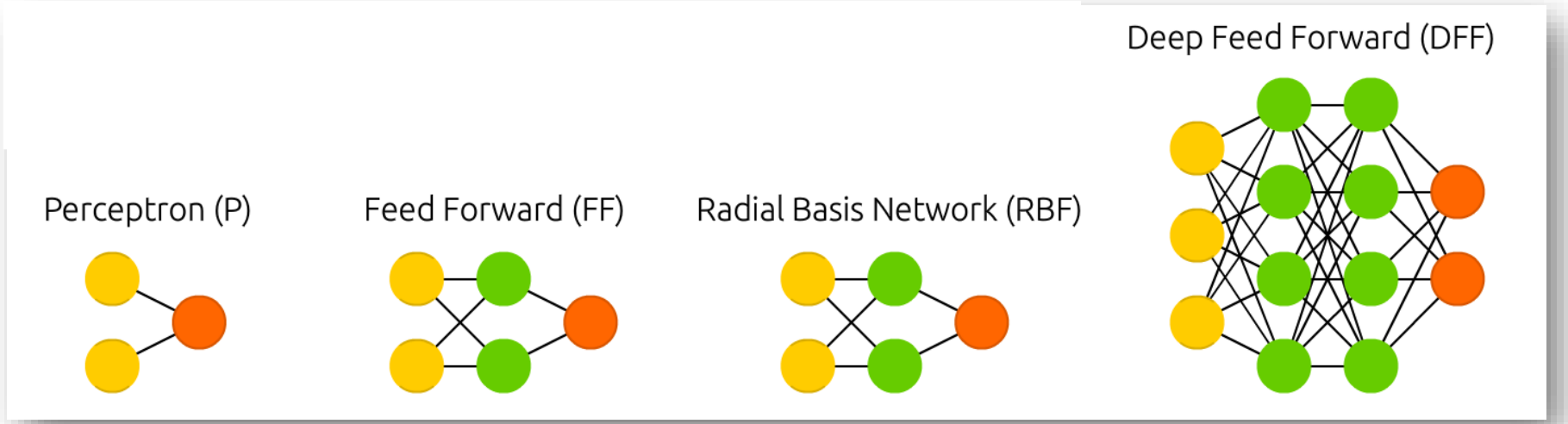
A deep neural network has many layers of various kinds.

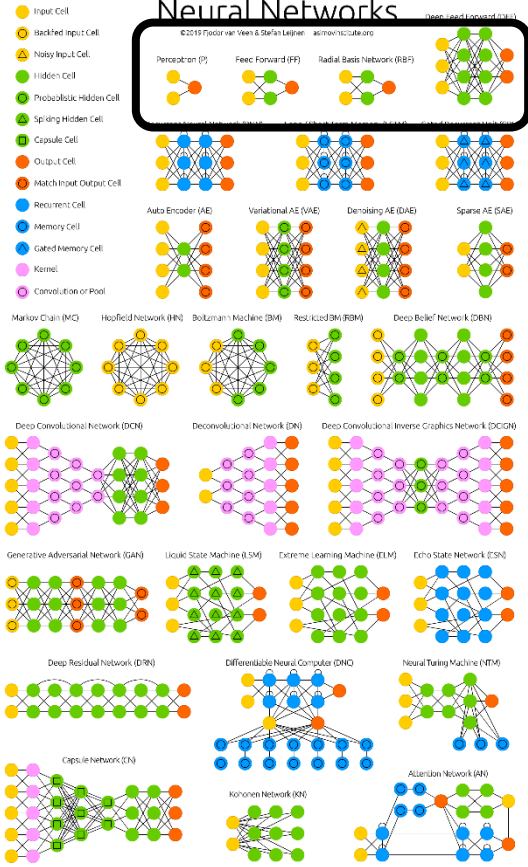
The kinds of layers and the orders where they appear form a network's architecture.

Different architectures are good for diferent things

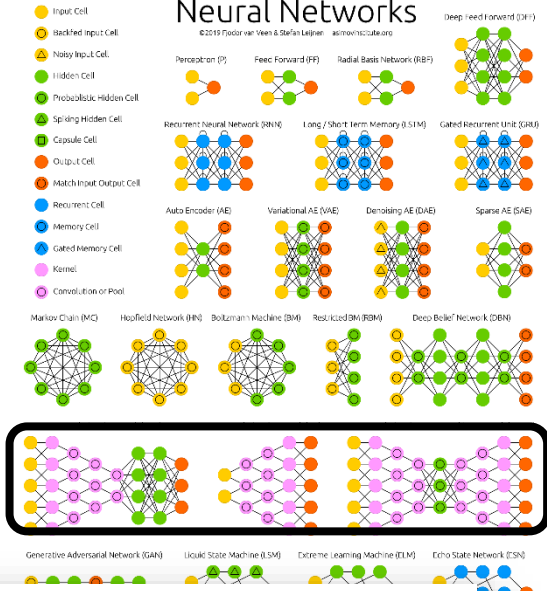


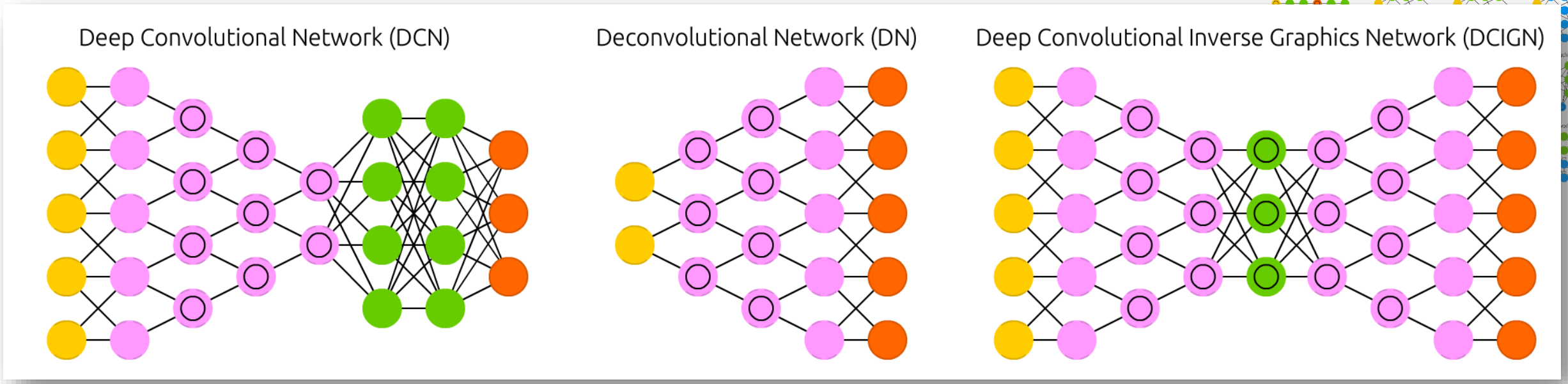
Traditional classification / regression



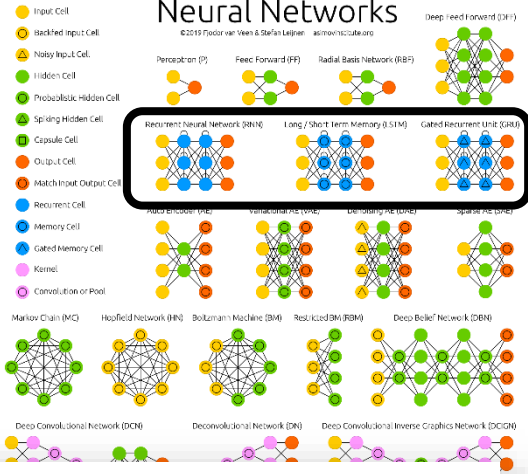


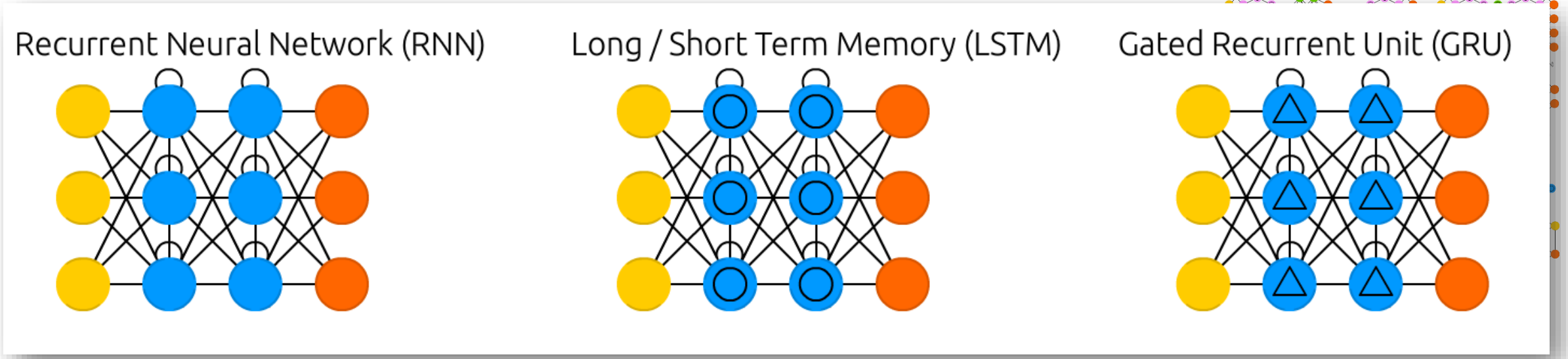
Computer vision





Time series prediction or NLP





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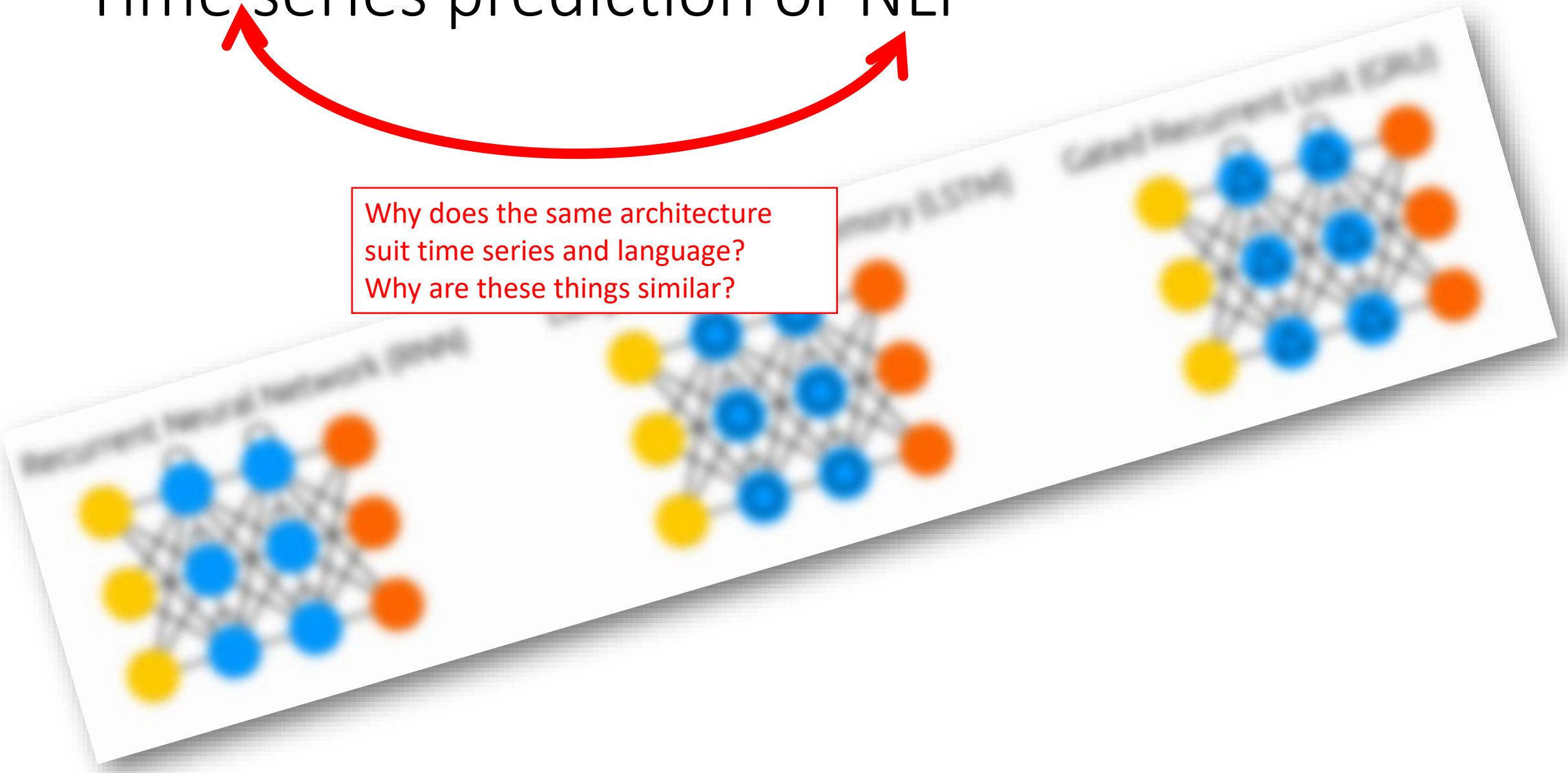
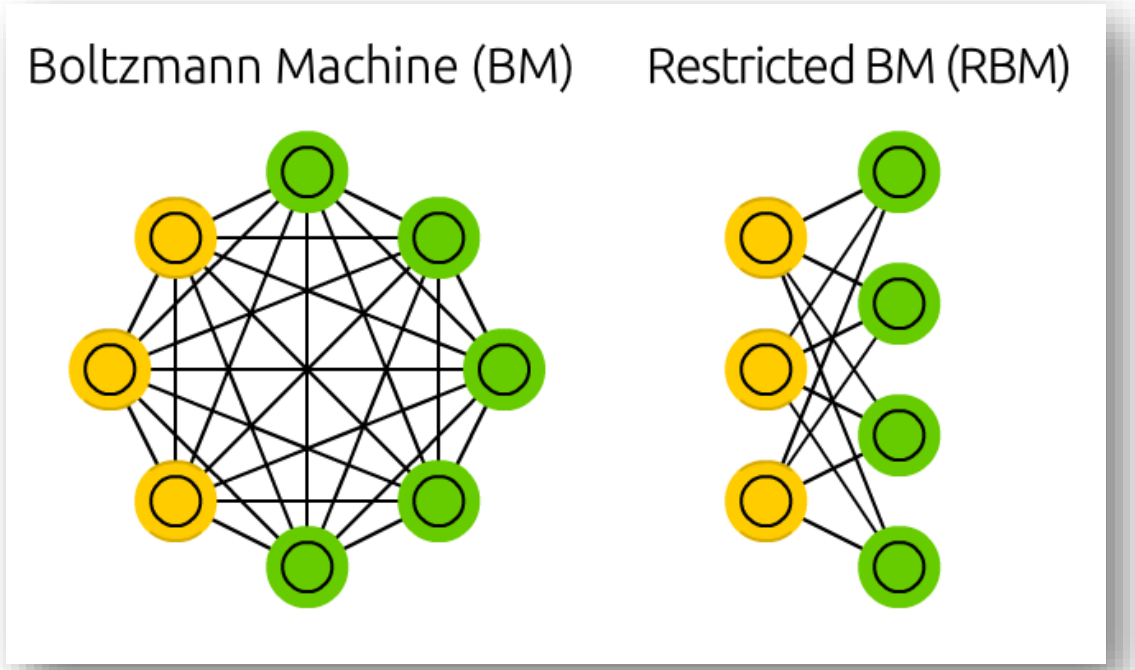
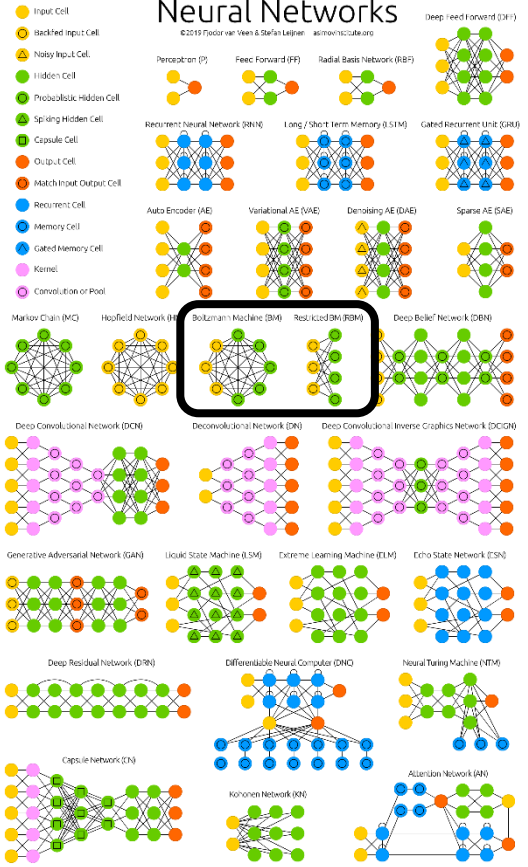


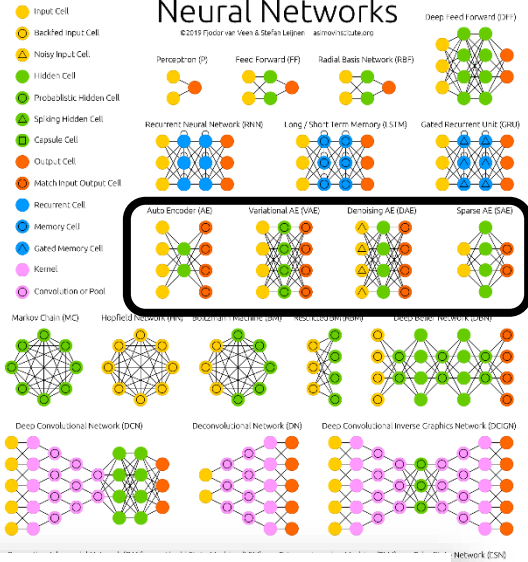
Why does the same architecture
suit time series and language?
Why are these things similar?

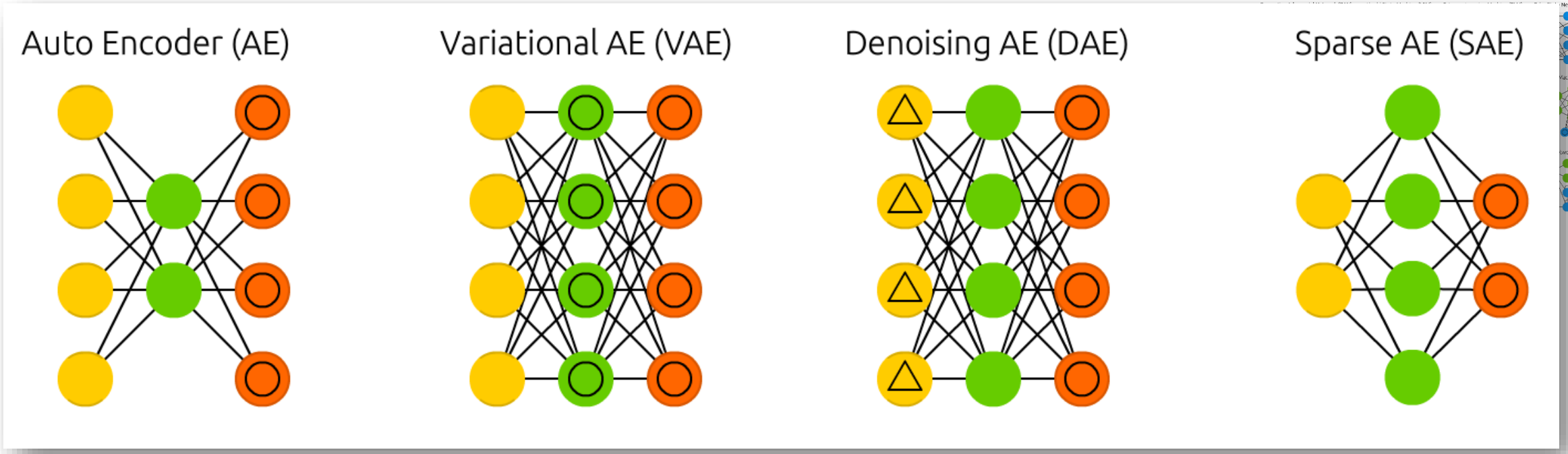
Time series prediction or NLP (2)



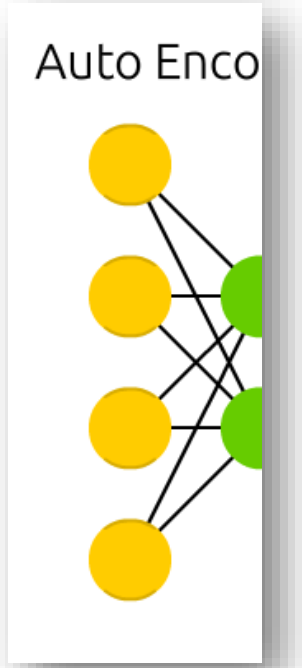


Fraud Dectection
Data augmentation
Text generation / summarization





Dimensionality reduction



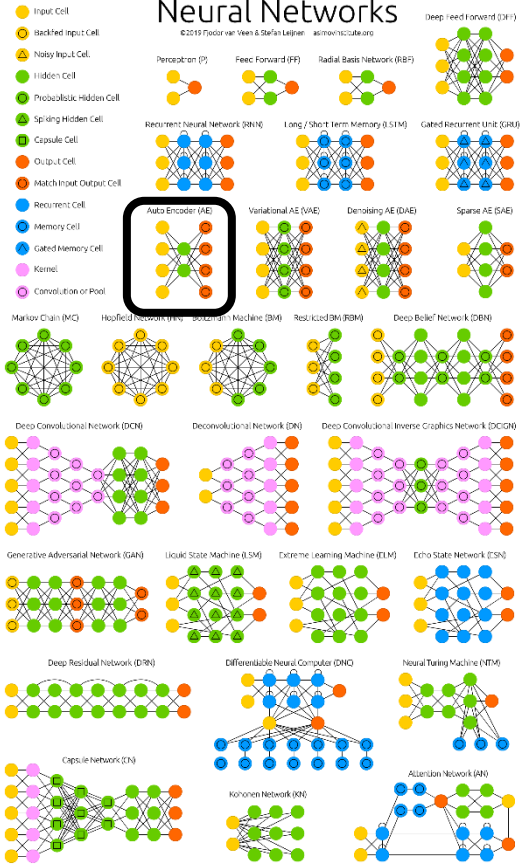
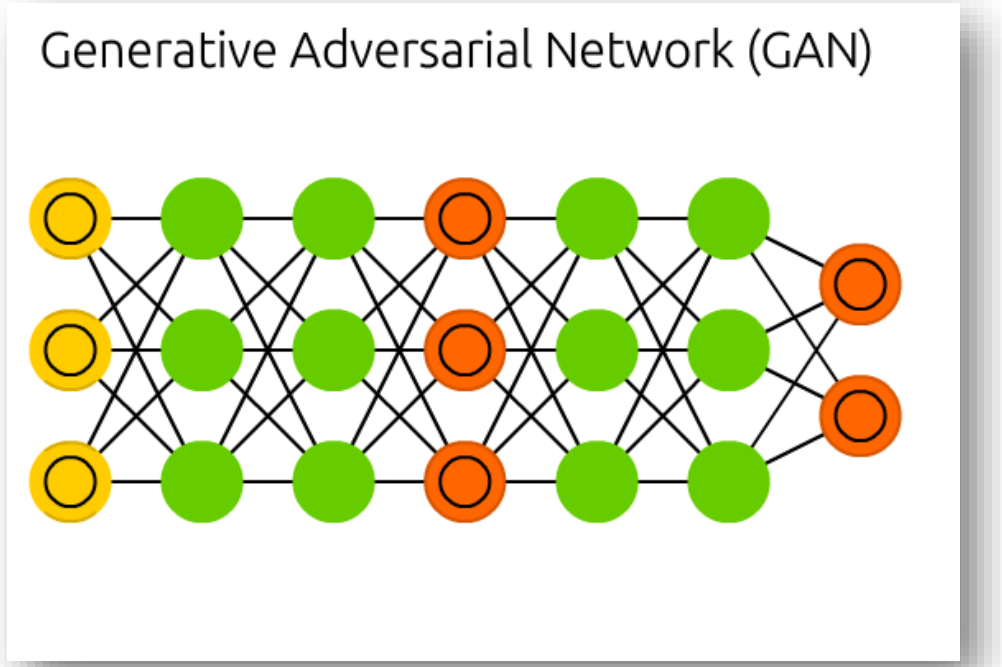
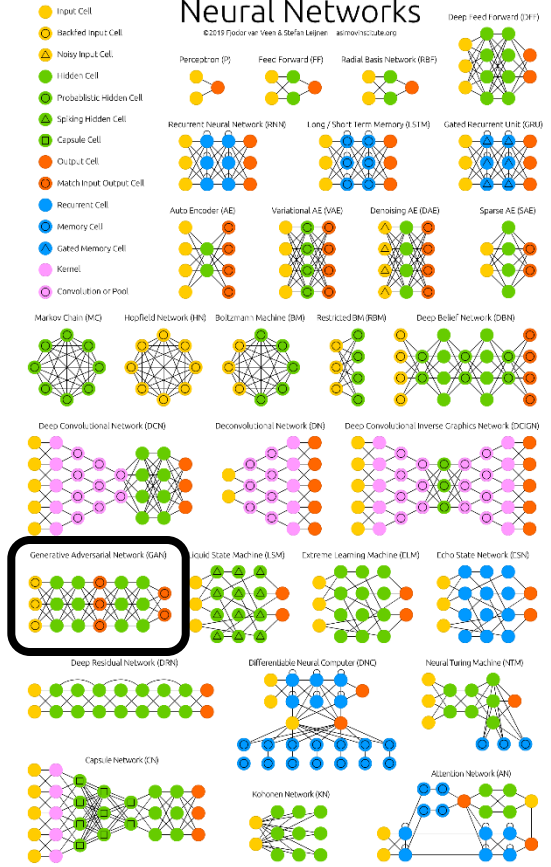
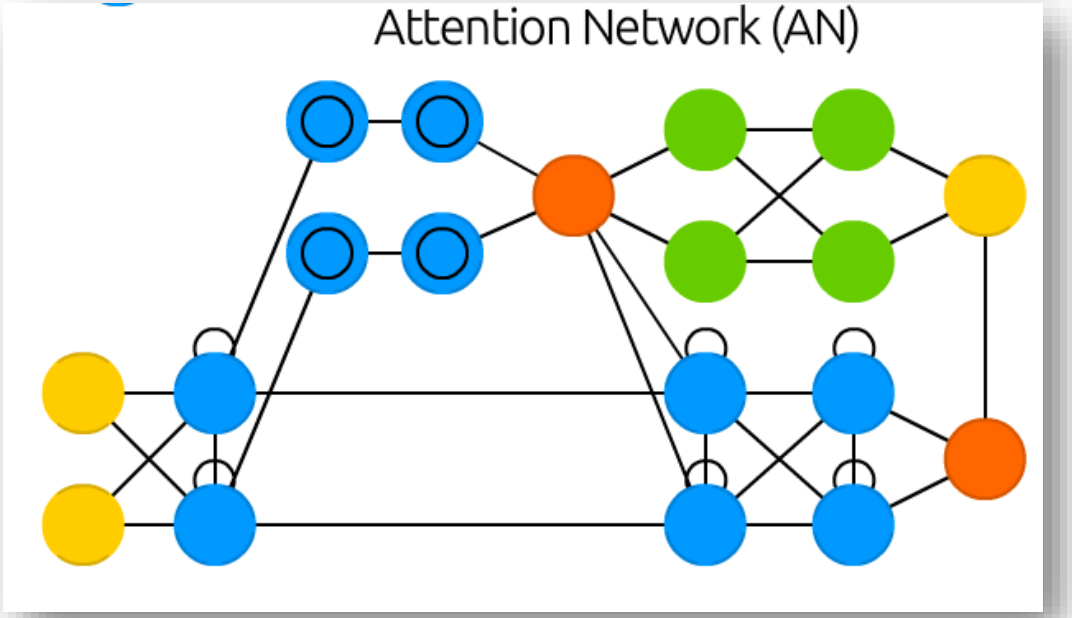


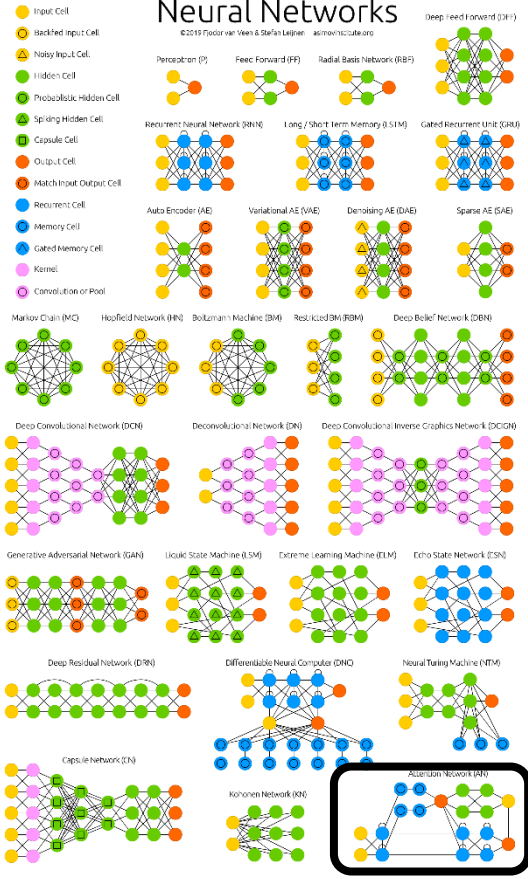
Image generation
Style transfer
Deep Fake



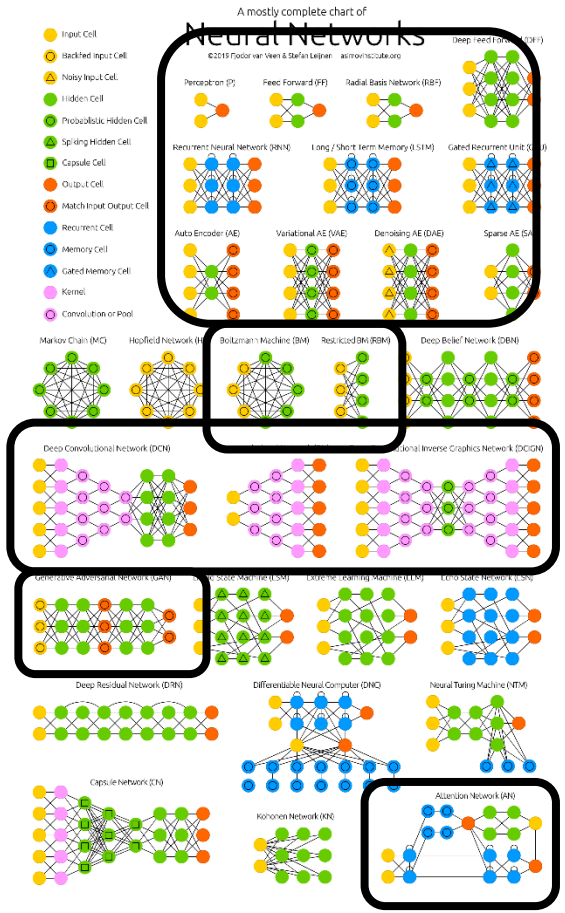


Computer vision and NLP
(state of the art?)





Architectures we've seen



A deep learning model has many parameters.

Model	2D-CNN
	Params
VGG-16	134.7 M
ResNet-18	11.4 M
ResNet-34	21.5 M
ResNet-50	23.9 M
ResNet-101	42.8 M
ResNet-152	58.5 M
DenseNet-121	7.2 M
DenseNet-169	12.8 M

SOTA models have 100B+ parameters!

138 Billion parameters

(DALL-E, 2022)

175 Billion parameters

(GPT-3, 2020)

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A deep learning model has many parameters.

This means training a deep learning model from scratch can:

1. take a looooong time
2. require lots of data
3. require a lot of computing power
4. have a huge carbon footprint!

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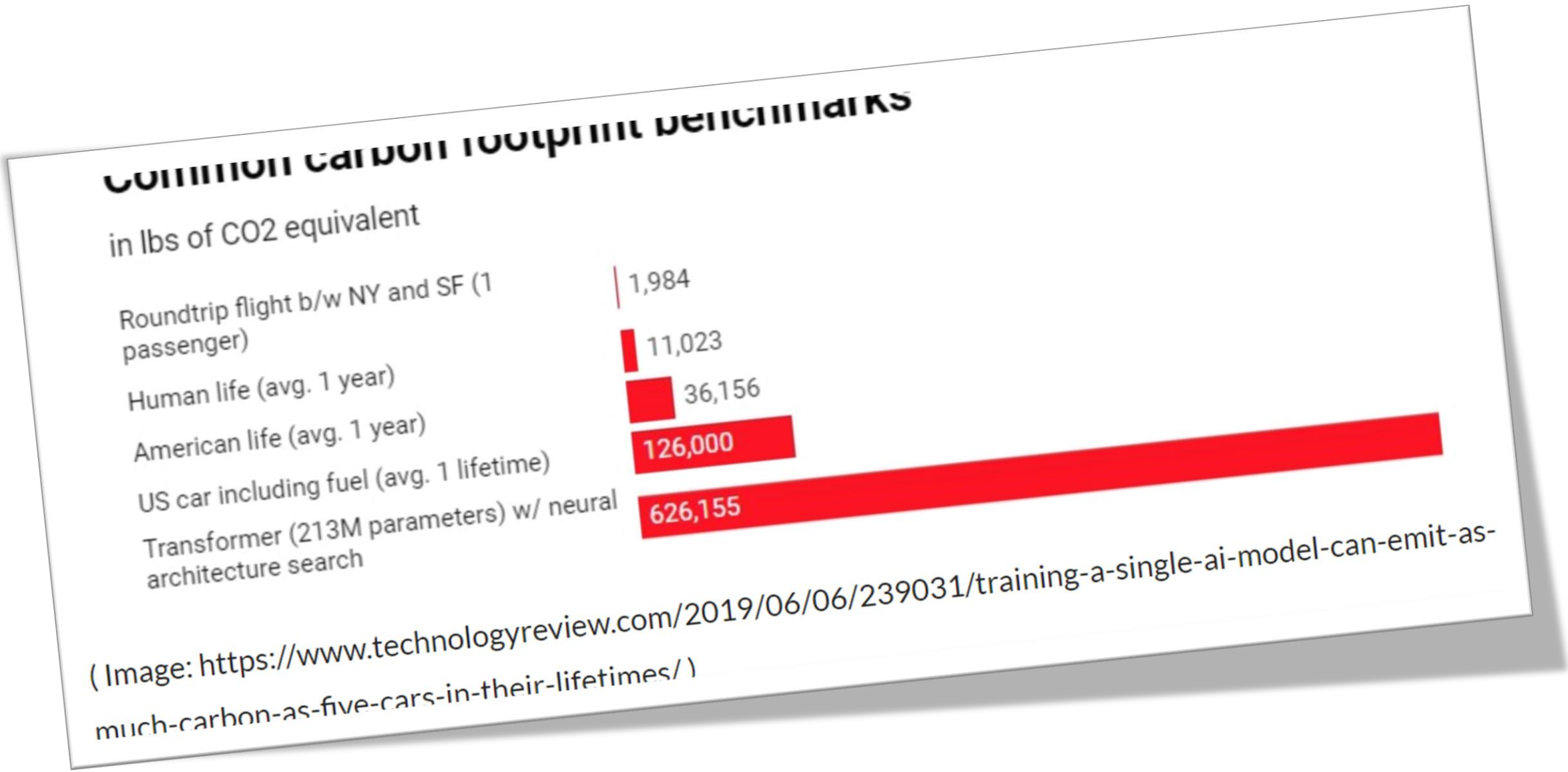

(Image: https://www.technologyreview.com/2019/06/06/239031/training-a-single-ai-model-can-emit-as-much-carbon-as-five-cars-in-their-lifetimes/)

Whenever possible, use transfer learning.

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Pick a network that has already been trained and showed to perform well on a task similar to your own...

... and use your data to train only the last layer, keeping all other weights intact.

(Why would this work?)

Look for these in your Literature Review.
In computer vision, some examples are...
ResNet-18
GoogLeNet
VGG-19
etc.
In NLP, some examples are...
BERT and its variants
GPT-3
etc.

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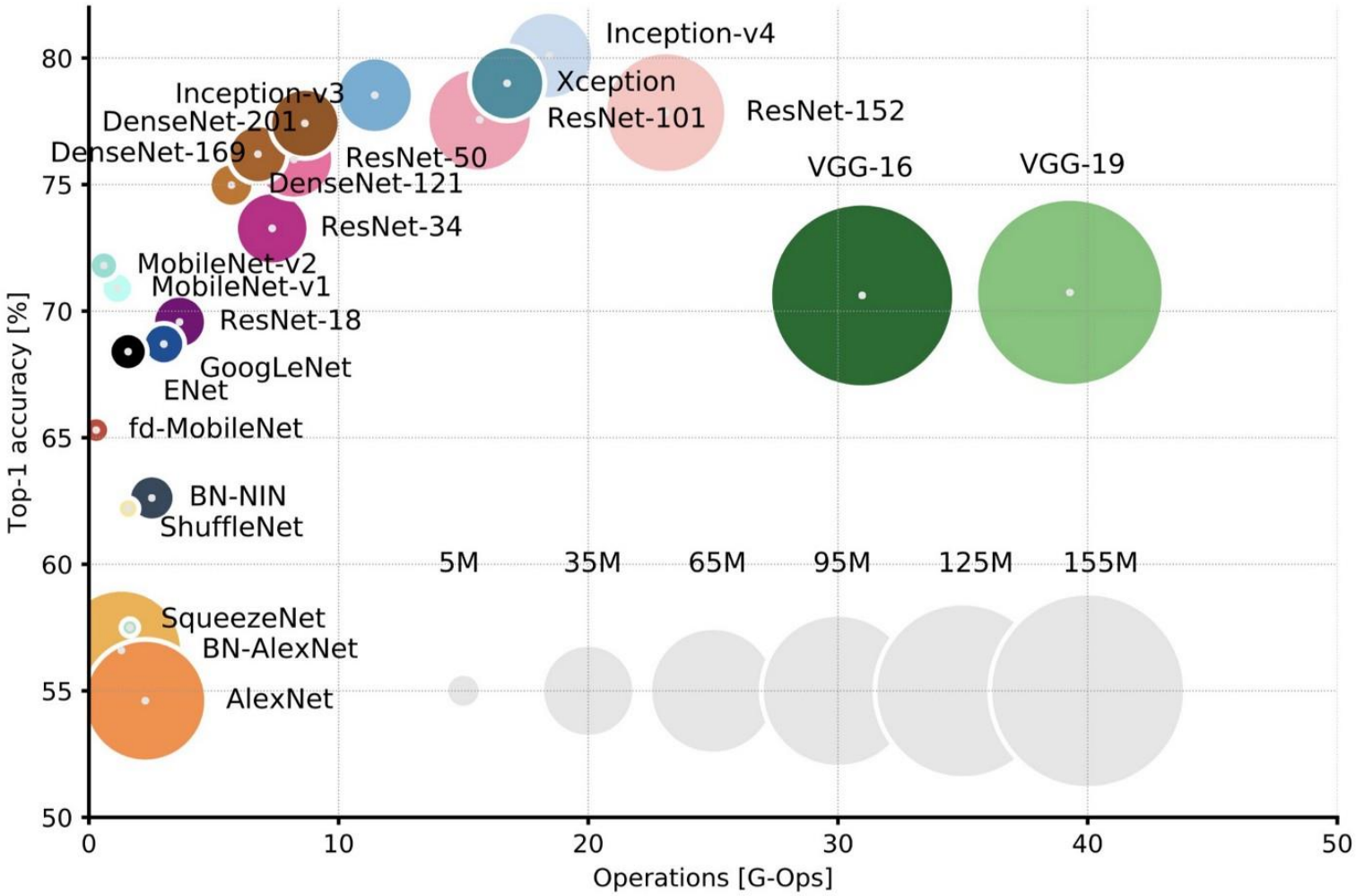
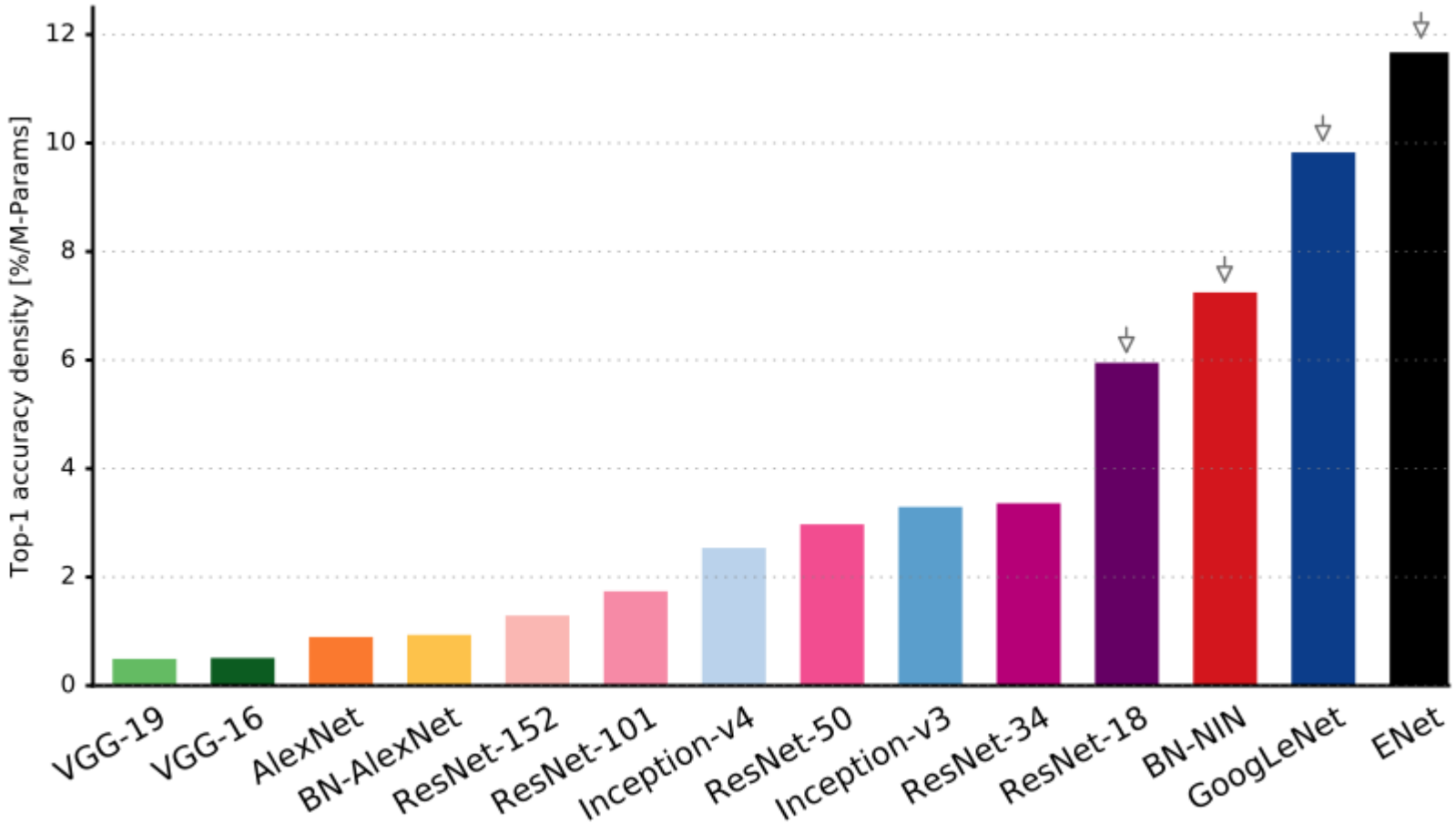
Models have been getting better, but bigger…



Top1 vs. operations, size ∝ parameters. Top-1 one-crop accuracy versus amount of operations required for a single forward pass. See also here

… But they haven’t grown better just because they’re growing larger



Adversarial attacks on AI

Hummingbird

Minor perturbation

Hammer

Hare

Minor perturbation

Desk