Introduction to Artificial Neural Networks (ANN) – Part B

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MSc Applied Bioinformation 2023-24
8-12 January 2024

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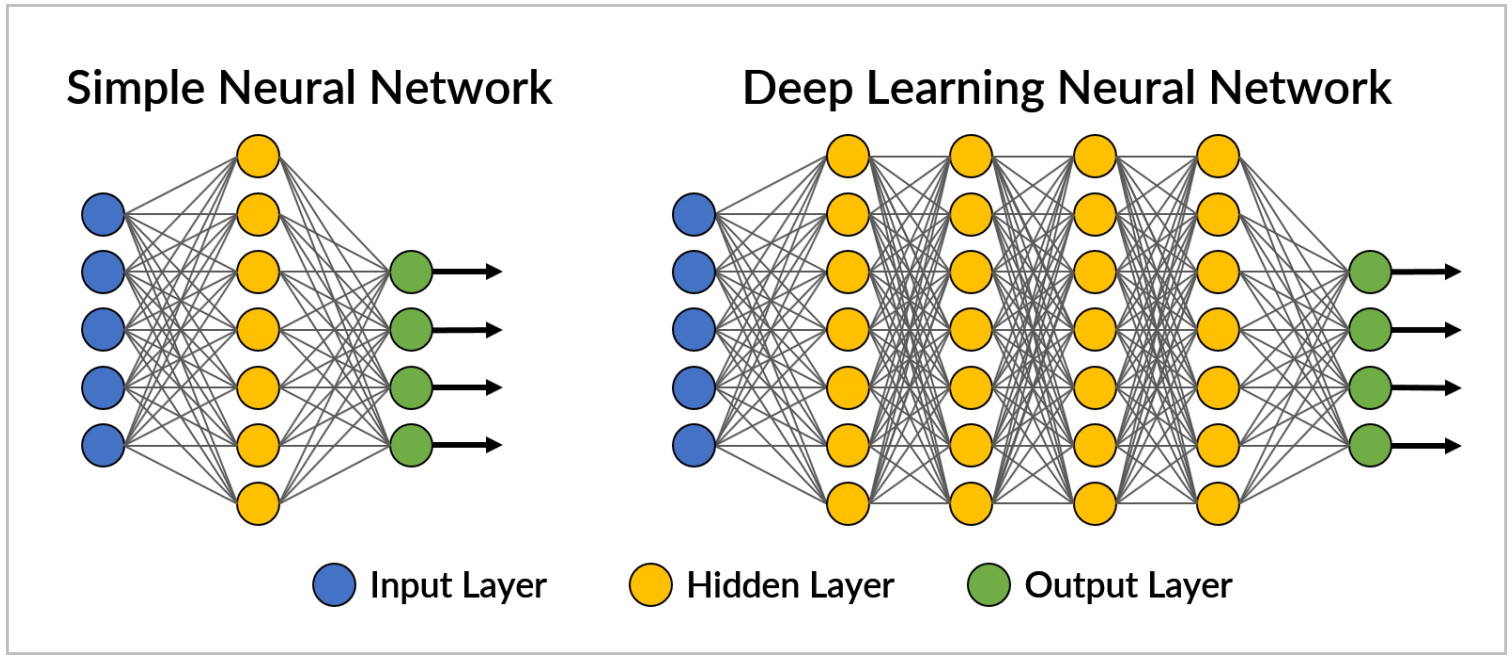
Deep Neural Networks

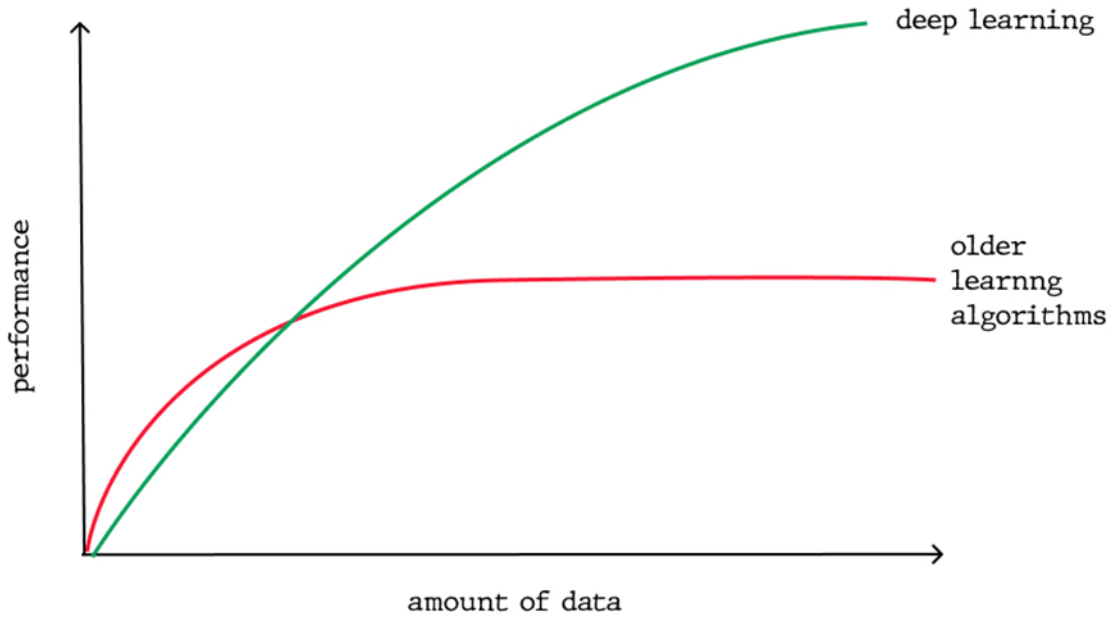
- A deep neural network is a neural network with one input layer, one output layer and multiple hidden layers.
- Deep learning is enabled through computation power and big data developments.



Deep Neural Networks

Advantages

- More speed and better performance compared to traditional ML models.
- **Transfer Learning**: Allows the development of more general systems, which can transfer knowledge from one context to another.



Meta-Learning

Improving a model’s performance with meta-learning

Learning how to learn.

Crucial for Further Advances of AI

Meta - Learning

Meta-learning, intends to design models that can learn new skills or adapt to new environments rapidly.

There are three common approaches:

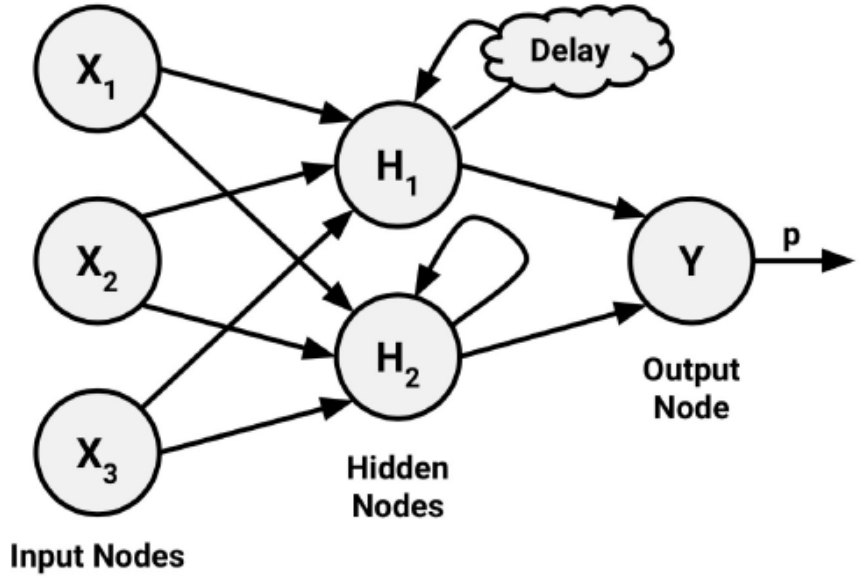
- Optimize the model parameters explicitly for fast learning (optimization-based) – e.g. **Gradient Descent**
- Use (recurrent) network with external or internal memory (model-based) – e.g. **RNN**
- Learn an efficient distance metric (metric-based) – e.g. **Matching Networks**

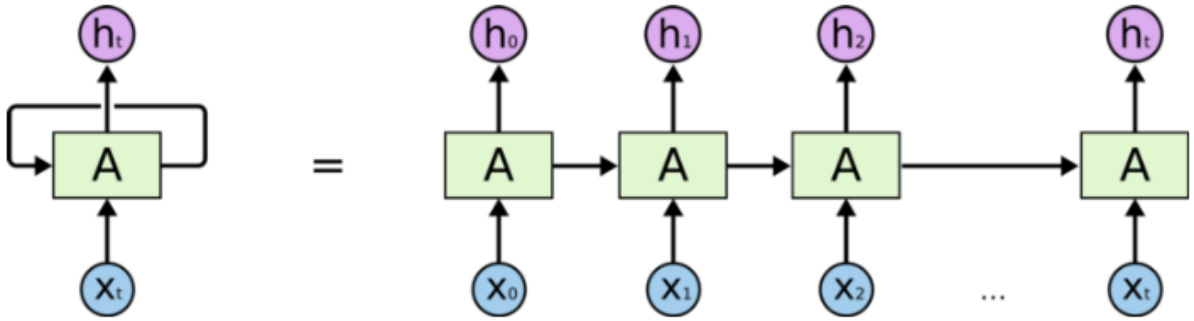
Meta-Learning

- Humans tend to learn different methods to perform specific tasks.
- Meta-learning models follow the same principle.
- Meta-Learning takes advantage of the metadata like algorithm properties (performance measures and accuracy), or patterns previously derived from the data to effectively solve a given learning problem.
- For example, the **backpropagation** algorithm in ANN.

Recurrent Neural Networks (RNNs)

- A **recurrent** (or **feedback) network** (RNN) allows signals to travel in both directions using loops which allows extremely complex patterns to be learned and more closely resembles biological NN.
- **Delay**: a short-term memory giving the algorithm the capability to learn the effect of previous input along with the current input. This gives the NN a sense of time context.
- Useful for time-series and natural language processing e.g. speech recognition.





When X(t) comes in, the hidden state from X(t-1) will be concatenated with X(t) and become the input for the NN at time t. The same process will be repeated for every sample in a time-series.

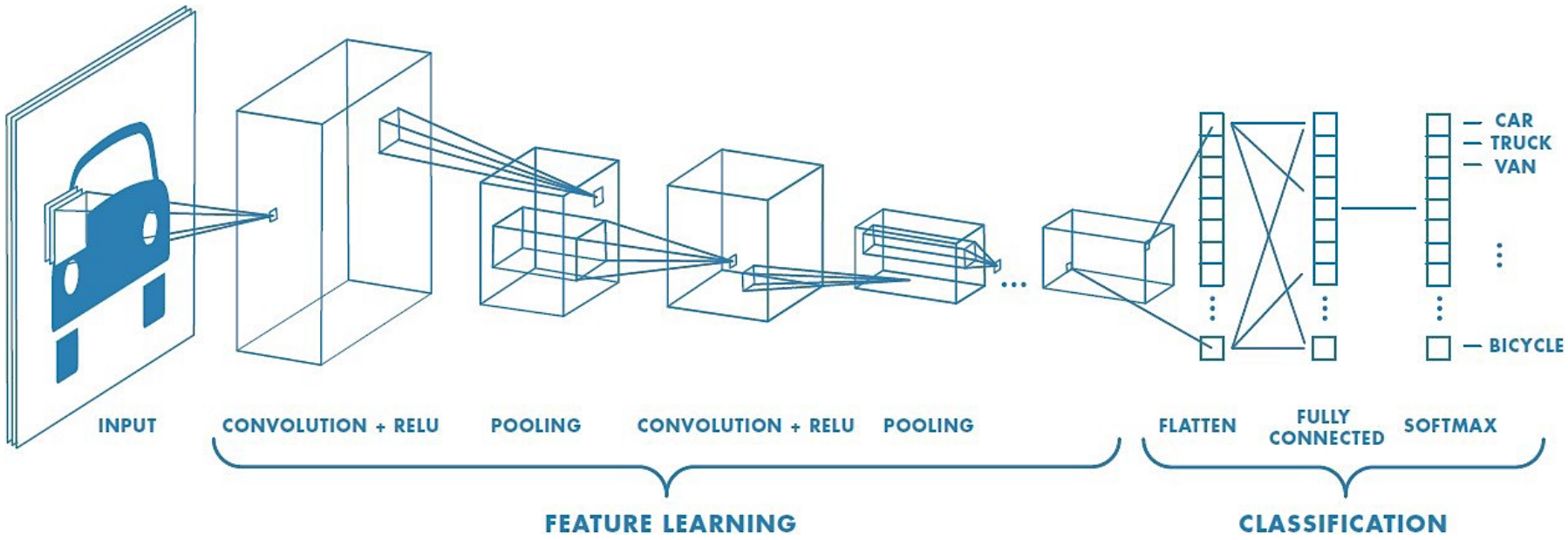
Long-Short-Term Memory Neural Networks

- A major drawback with RNN is that they are unable to learn long-range dependencies.
- A special kind of RNN called **Long-Short-Term Memory** cell (LSTM) can overcome this problem.
- LSTM process data with long memory gaps remembered in memory cells until being told to forget by forget gates.
- Applications in speech recognition, writing recognition etc.

Convolutional Neural Networks (CNNs)

Convolutional Neural Networks (CNNs)

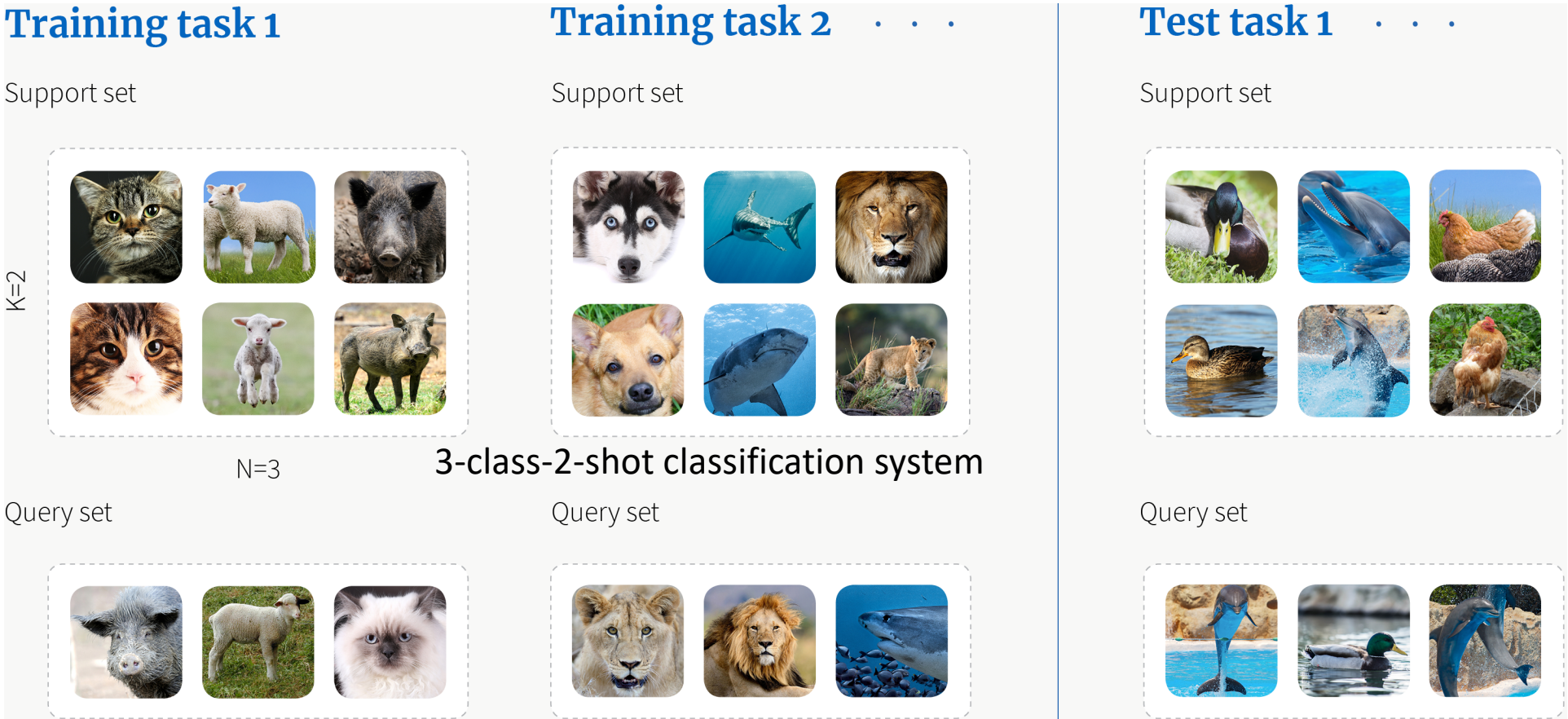
- Used in image classification
- An image is convolved down to its most basic features through the application of a series of filters and the features are the input to a fully connected NN which classifies the image.



(Figure ref: https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53)

Few Shots Meta-Learning

- **Few Shots Meta-Learning** → focused on creating deep neural networks that can learn from minimalistic datasets.
- Applications in image classification.



Generative Adversarial Network

Generative Adversarial Network (GAN)

- An *unsupervised* ML technique which simultaneously trains two models:

a) a **generator** that learns to output fake samples from an unknown distribution

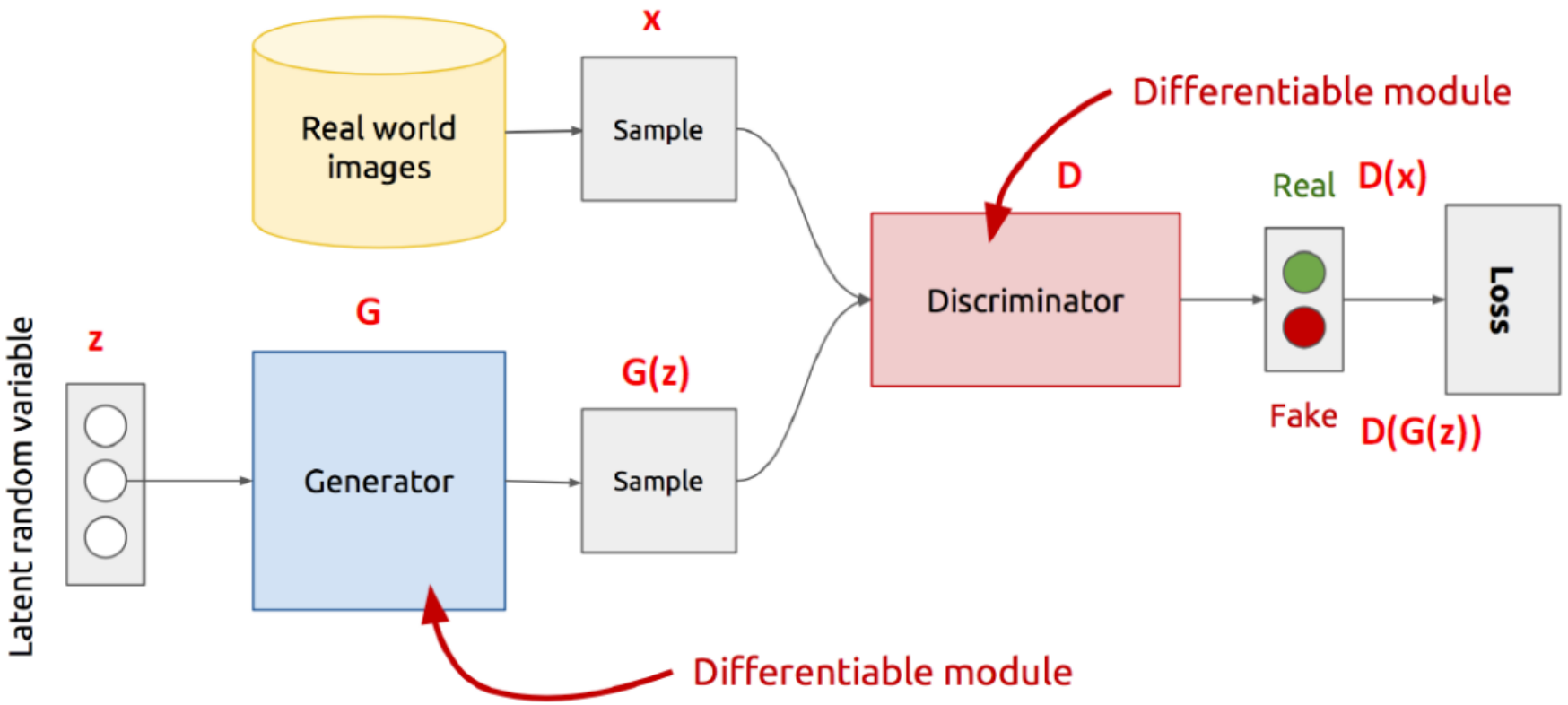
b) a **discriminator** that learns to distinguish fake from real samples.

Edmond de Belamy, by Obvious 2018

M. Brundage et al., 2018 https://arxiv.org/abs/1802.07228v1

GAN

- GAN was first introduced by Ian Goodfellow et al in 2014
- Have been used in generating images, videos, poems, some simple conversation



z = some random noise (Gaussian / Uniform)

z = can be thought as a latent representation of the image

Image Ref: Deep Learning for Computer Vision: Generative models and adversarial training (UPC 2016) | PPT (slideshare.net)

GAN: Training the Discriminator

1. Fix generator
2. Sample from generator
3. Backprop error to update discriminator weights

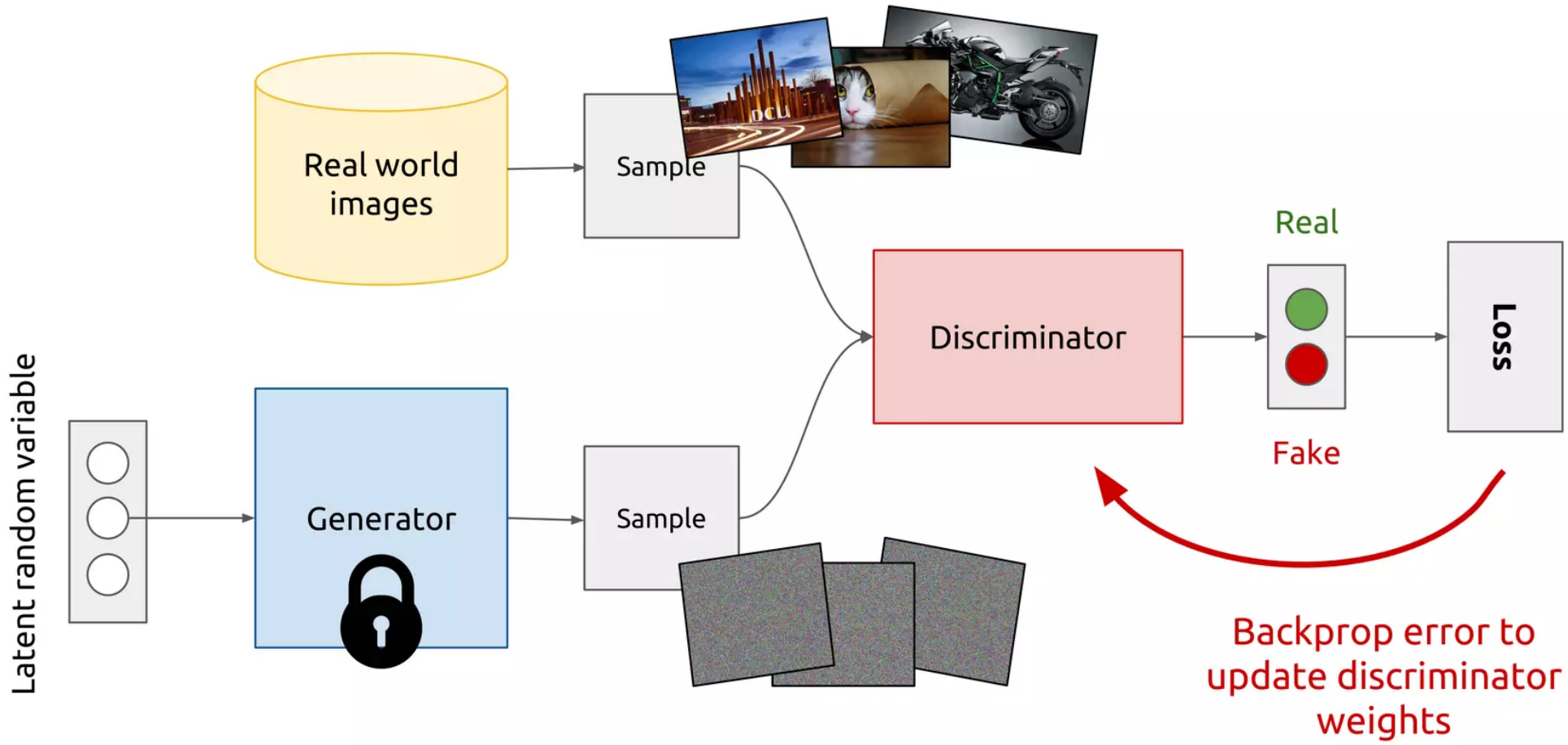


Image Ref: Deep Learning for Computer Vision: Generative models and adversarial training (UPC 2016) | PPT (slideshare.net)

GAN: Training the Generator

1. Fix discriminator
2. Sample from generator
3. Backprop error to update generator weights

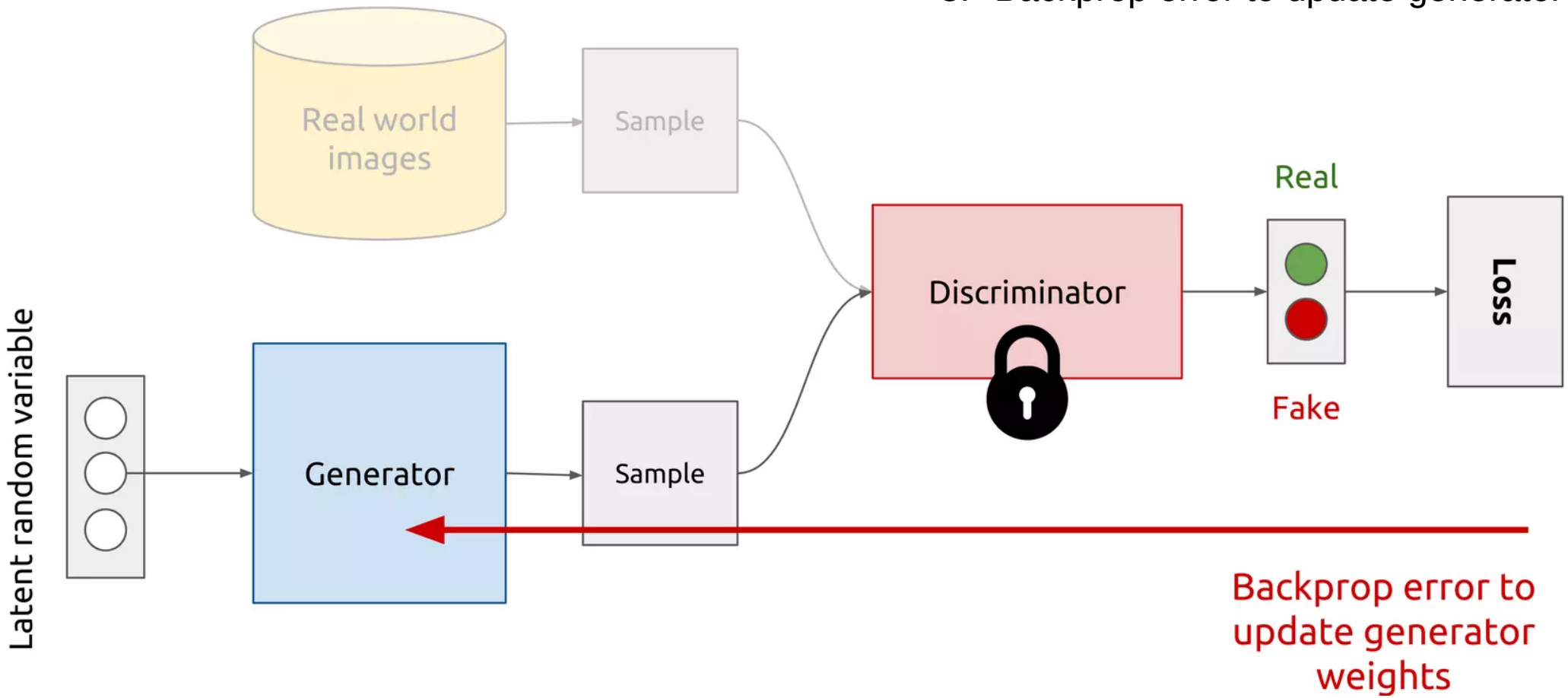


Image Ref: Deep Learning for Computer Vision: Generative models and adversarial training (UPC 2016) | PPT (slideshare.net)

DeepFake

DeepFake

CNN BUSINESS Markets Tech Media Success Perspectives Videos LIVE TV Edition

No, Tom Cruise isn't on TikTok. It's a deepfake

A series of deepfake videos of Tom Cruise is confusing millions of TikTok users. See the convincing videos and learn how this technology could be used to spread misinformation.

Source: CNN Business

https://www.youtube.com/watch?v=iyiOVUbsPcM

Synthetic Medical Imaging

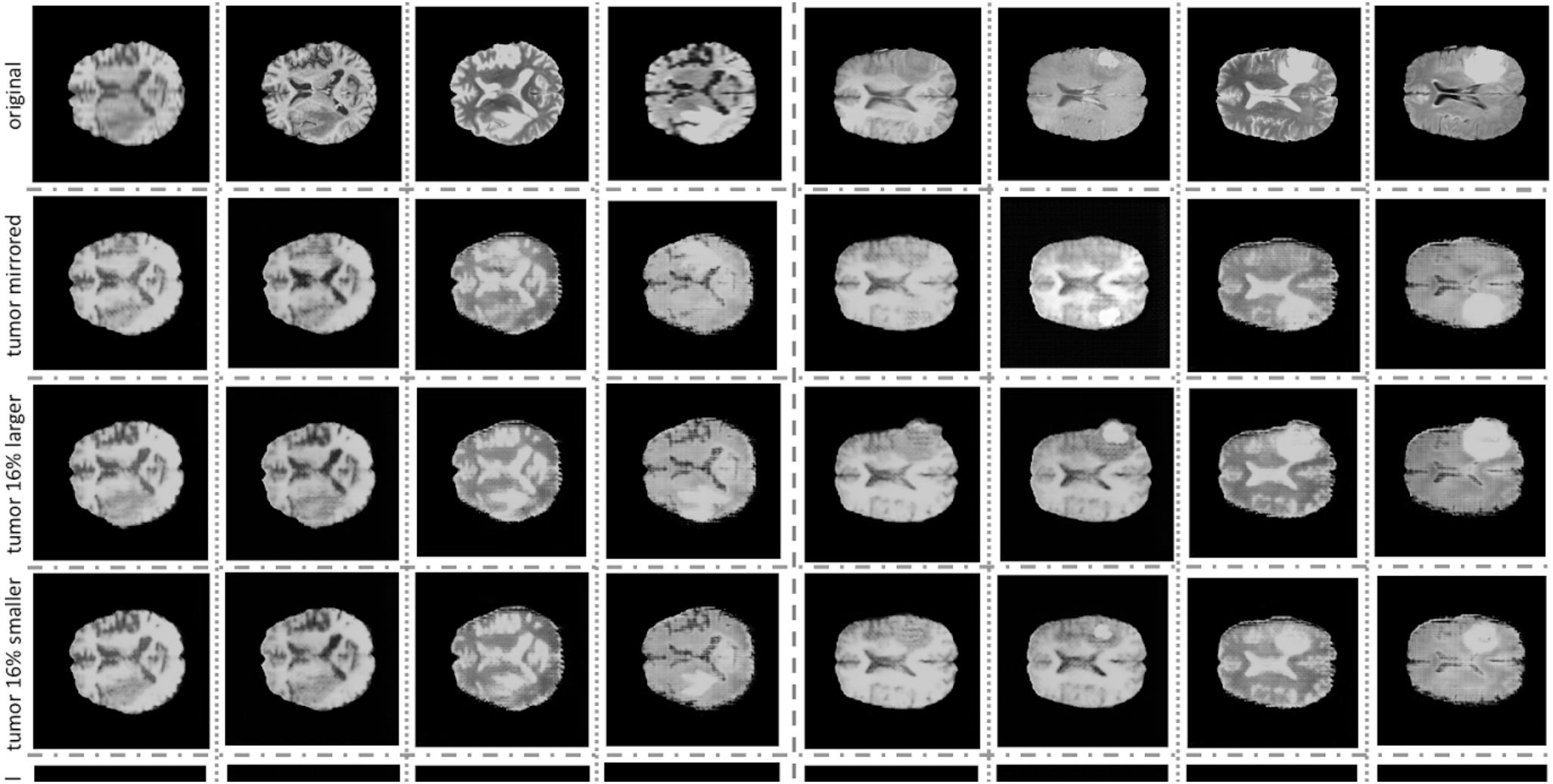


Image Source: https://developer.nvidia.com/blog/ai-can-generate-synthetic-mris-to-advance-medical-research/

Generative AI

Read research paper Overview Enterprise GPT ↗ Try ChatGPT ↗

About DALL·E 3

DALL·E 3 is now available to all ChatGPT Plus and Enterprise users, and will be available via the API and in Labs later this fall.

https://openai.com/dall-e-3

Generative AI

Cautionary Tale…

Forbes

FORBES > INNOVATION > HEALTHCARE

Bankrupt Digital Health Company Babylon Sells U.K. Assets For Just $620,000

Katie Jennings Forbes Staff
I'm a senior writer covering healthcare technology.
Iain Martin Forbes Staff
I'm the Forbes Europe News Editor and I cover technology.

0 Sep 19, 2023, 05:14pm EDT

Bankruptcy filings reveal that investors have been left with hundreds of millions of dollars of losses after the British telehealth startup, which was founded by Ali Parsa, had sold its U.K. arm for around $620,000. © 2022 BLOOMBERG FINANCE LP

British digital health startup Babylon Health went public in June 2021 at a $4.2 billion valuation. Just over two years later, the company has filed for bankruptcy and one of the core parts of the business, its U.K. telemedicine service, was sold for just $620,000 (£500,000).

Summary

- Introduction to the concept of deep learning and Meta-learning
- Introduction to the concept of Generative AI : GANs
- Discussion

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