

DIGITAL ART AND ARTIFICIAL INTELLIGENCE

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*Guest Talk @Science Academy for Young Talents, CUHK
3 August 2021*

STEM

SCIENCE

TECHNOLOGY

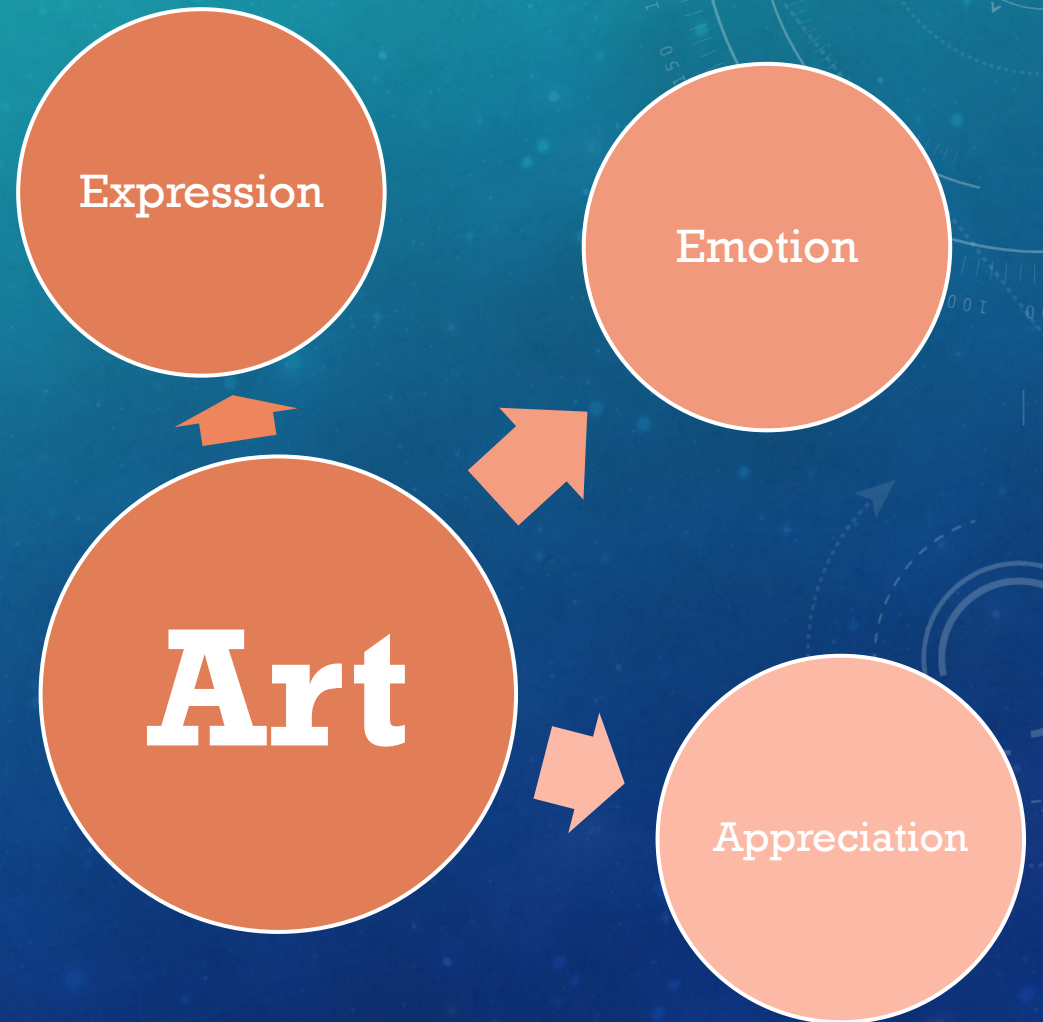
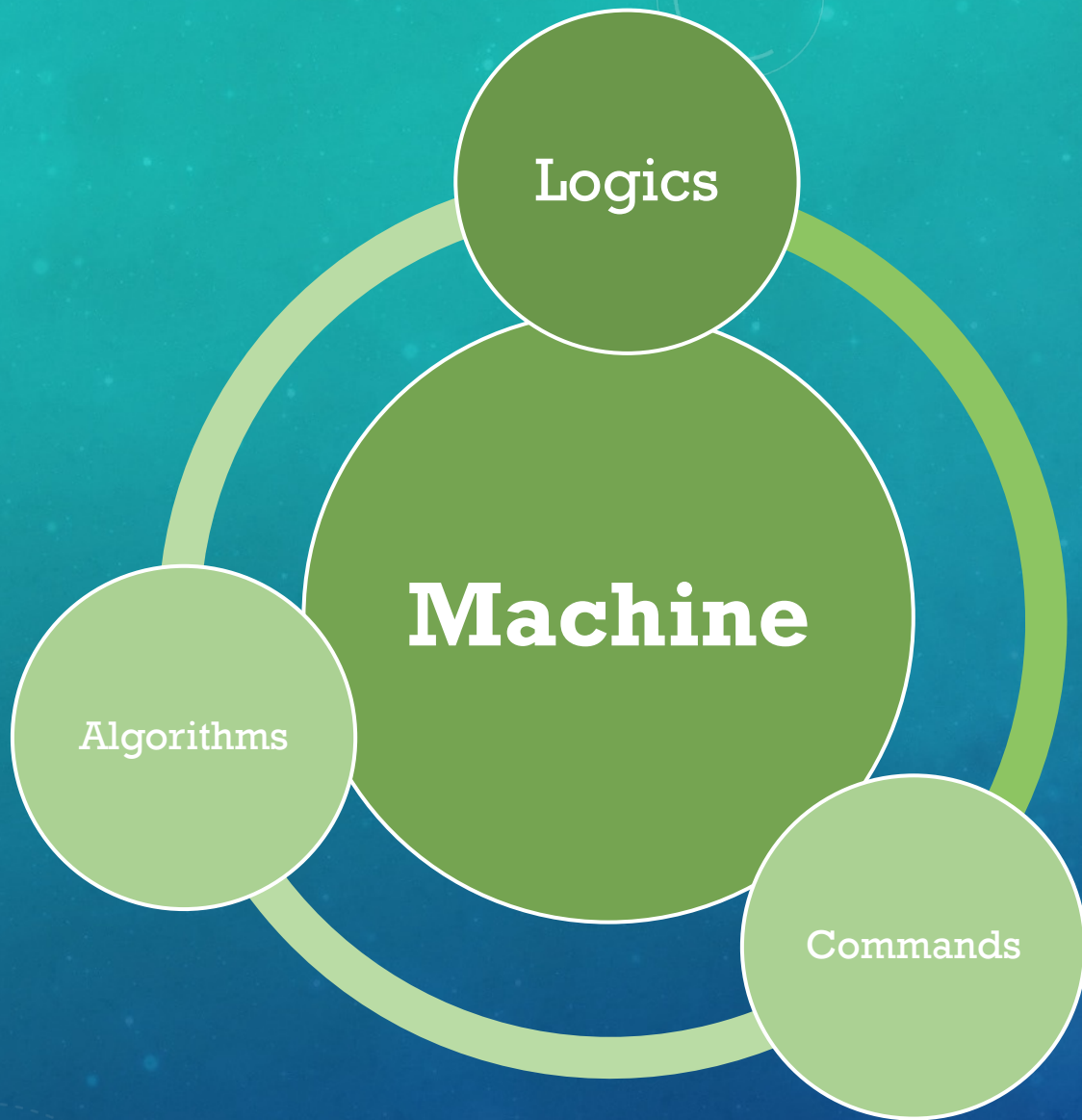
ENGINEERING

MATHEMATICS

STEAM

WHAT IS ART?

HOW DOES IT RELATE TO S, T, E, M?



DISSECTING ART

Form and structure

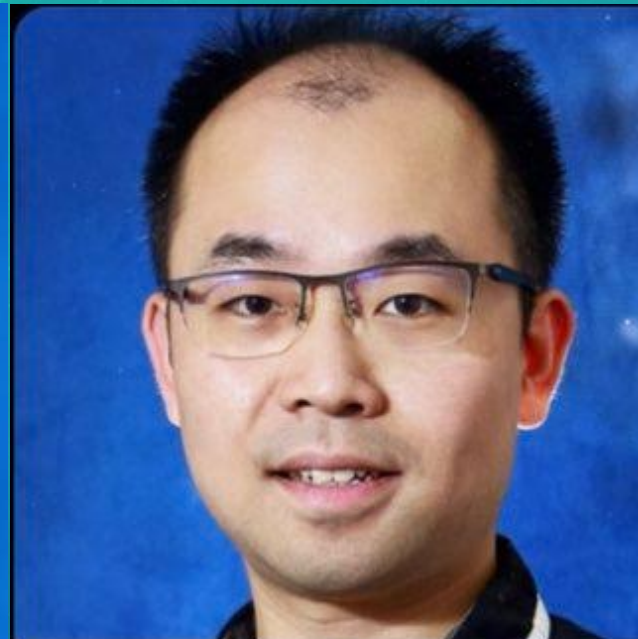
Grammar and syntax

Colour and timbre

Contrast and tension



Just learn the formula, computers!





Acoustic Guitar, s.lute.nat.stac

♩ = 118 ♩ = 119 ♩ = 120 ♩ = 117

Acoustic Guitar, s.lute.nat.stac

Violoncello, s.celli.nat.stac

Contrabass, s.basses.nat.stac

Violoncello, s.celli.nat.stac

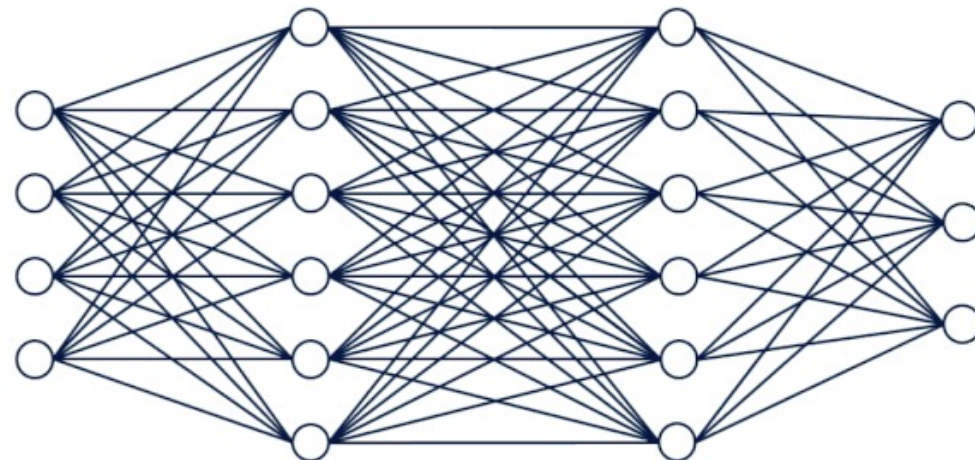
HOW ARE THEY CREATED?

- Commercial products: we don't know their secret formula!
 - Usually a combination of *algorithms* and *heuristics*
- Artificial intelligence
- Abundance of *data*

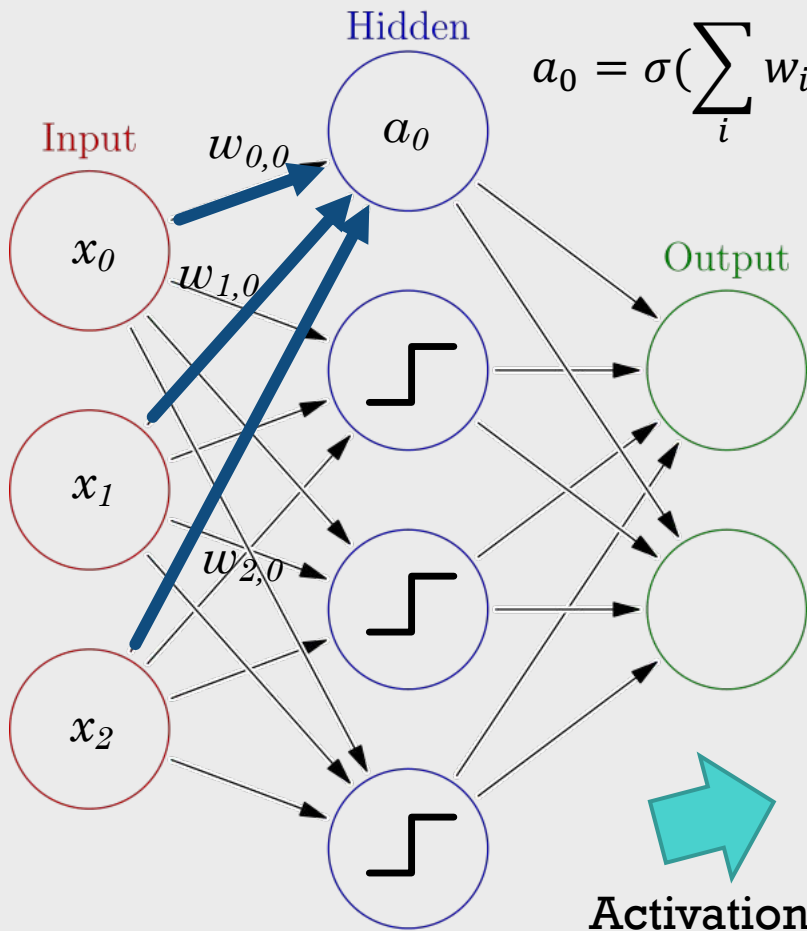
ARTIFICIAL NEURAL NETWORKS (ANN)

- Invented early in computing history, yet finally gaining popularity recently thanks to blossom of computation power
 - Trained by *examples* and *cost functions*: adjusting *weights*
 - Epochs of iterations

Image from: <https://community.alteryx.com/t5/Data-Science/It-s-a-No-Brainer-An-Introduction-to-Neural-Networks/ba-p/300479>



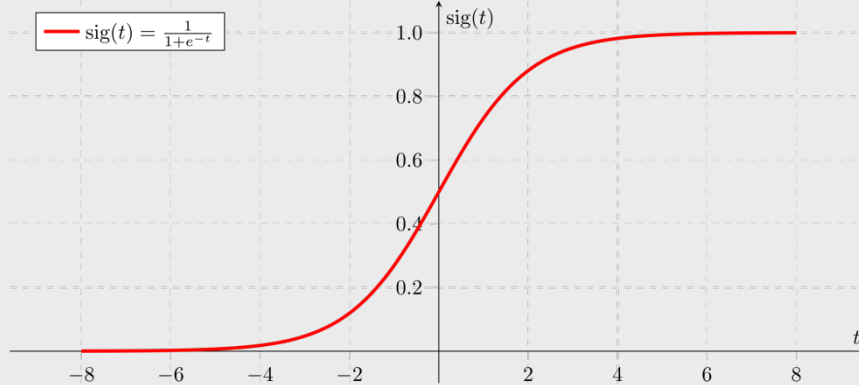
A VERY SIMPLE NEURAL NETWORK



$$a_0 = \sigma\left(\sum_i w_{i,0}x_i + \text{bias}\right)$$

$$\begin{bmatrix} a_0 \\ \vdots \\ a_n \end{bmatrix} = \sigma\left(\begin{bmatrix} w_{0,0} & \cdots & w_{0,n} \\ \vdots & \ddots & \vdots \\ w_{k,0} & \cdots & w_{k,n} \end{bmatrix} \begin{bmatrix} x_0 \\ \vdots \\ x_n \end{bmatrix} + \begin{bmatrix} b_0 \\ \vdots \\ b_n \end{bmatrix}\right)$$

$$\mathbf{a} = \sigma(\mathbf{w}\mathbf{x} + \mathbf{b})$$

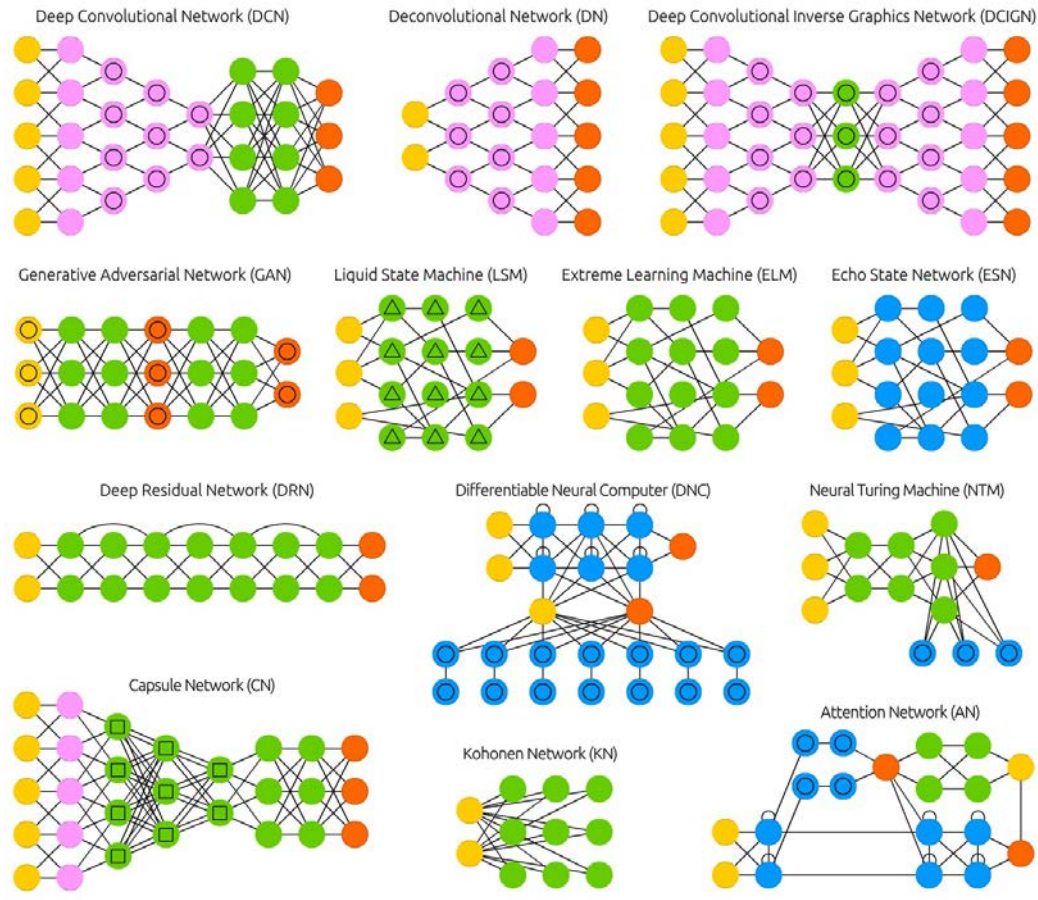
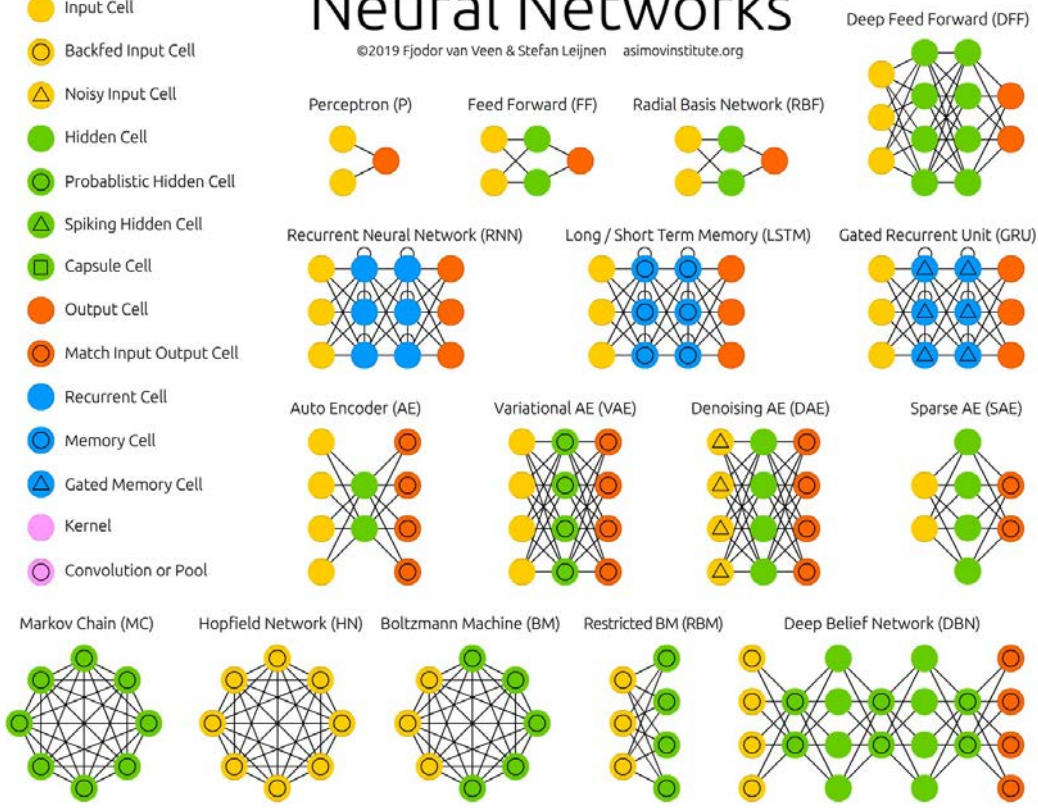


Activation function:
e.g. sigmoid

A mostly complete chart of Neural Networks

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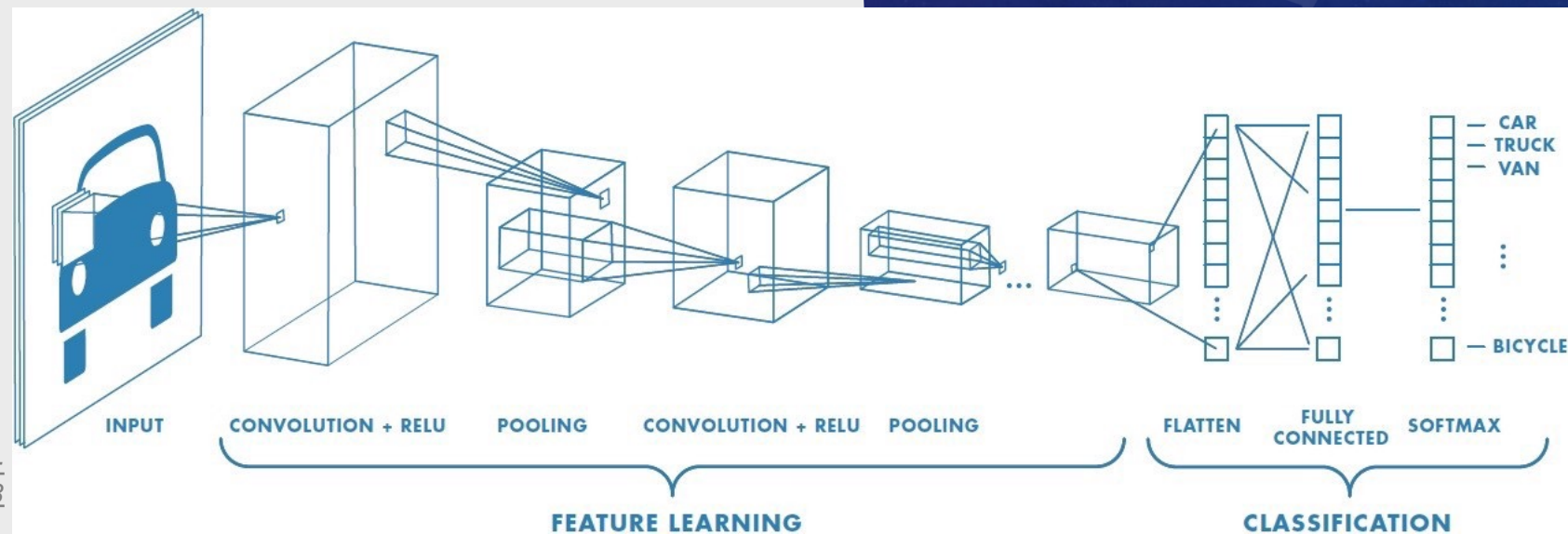
- Input Cell
- Backfed Input Cell
- △ Noisy Input Cell
- Hidden Cell
- Probabilistic Hidden Cell
- △ Spiking Hidden Cell
- Capsule Cell
- Output Cell
- Match Input Output Cell
- Recurrent Cell
- Memory Cell
- △ Gated Memory Cell
- Kernel
- Convolution or Pool



Just too many of them...

CONVOLUTIONAL NEURAL NETWORK (CNN)

- An image can easily be represented as a (2D) matrix of numbers
 - RGB colour intensity
- As the input layers, the separate pixels go through **convolution** and more processes
- Good for: *images*



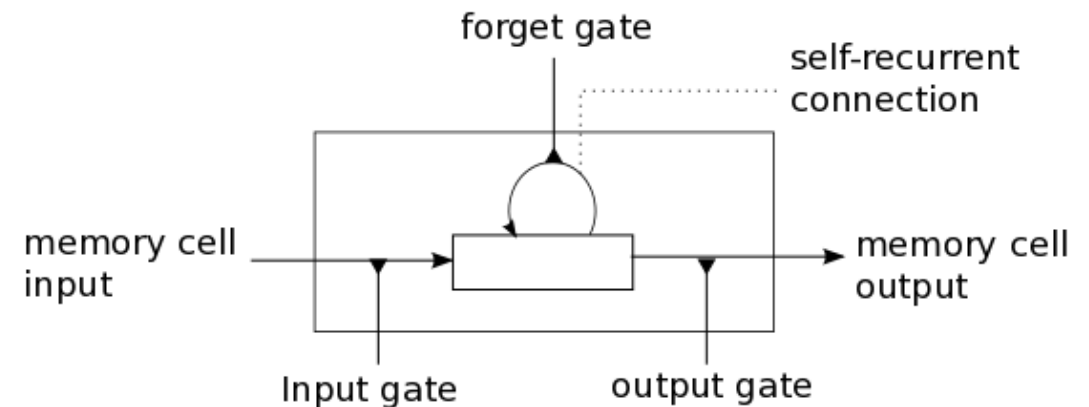
Digital Art and Artificial Intelligence

Image from: <https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53>

RECURRENT NEURAL NETWORK (RNN)

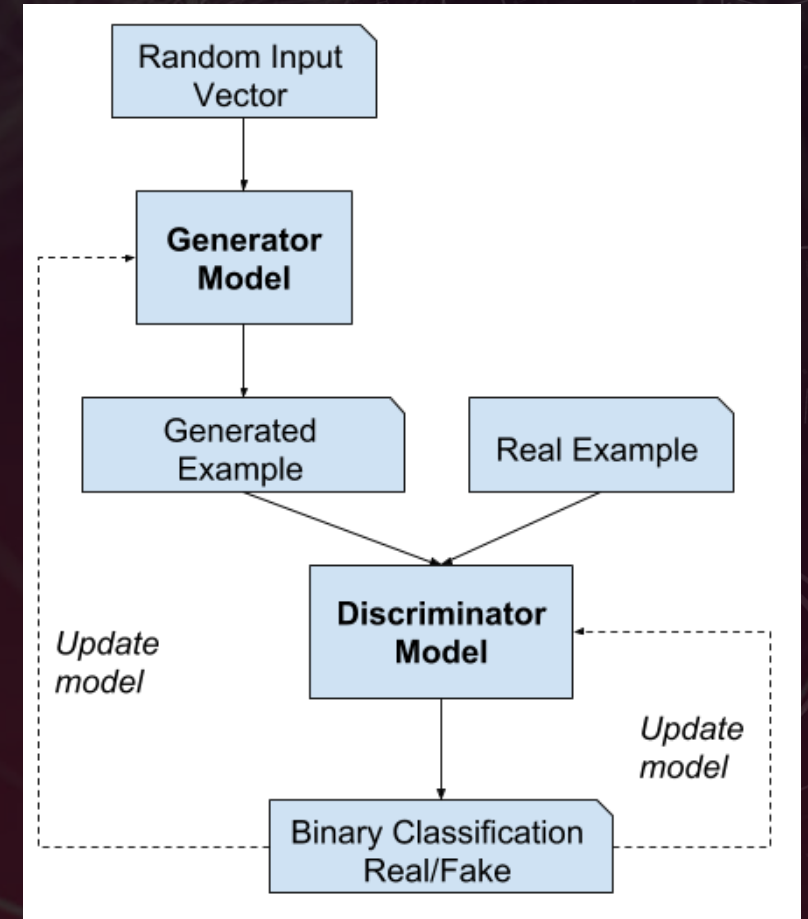
- In neural networks, neurons obtain input from previous layer
- RNN: in addition to previous layers, gather information also from the *previous state* of itself
 - Suitable for data with time information
- Long Short-term Memory (LSTM)
 - Specific kind of RNN with “forget” rate to decide importance of history
- Good for: *audio*

Image from: <http://deeplearning.net/tutorial/lstm.html>



GENERATIVE ADVERSARIAL NETWORK (GAN)

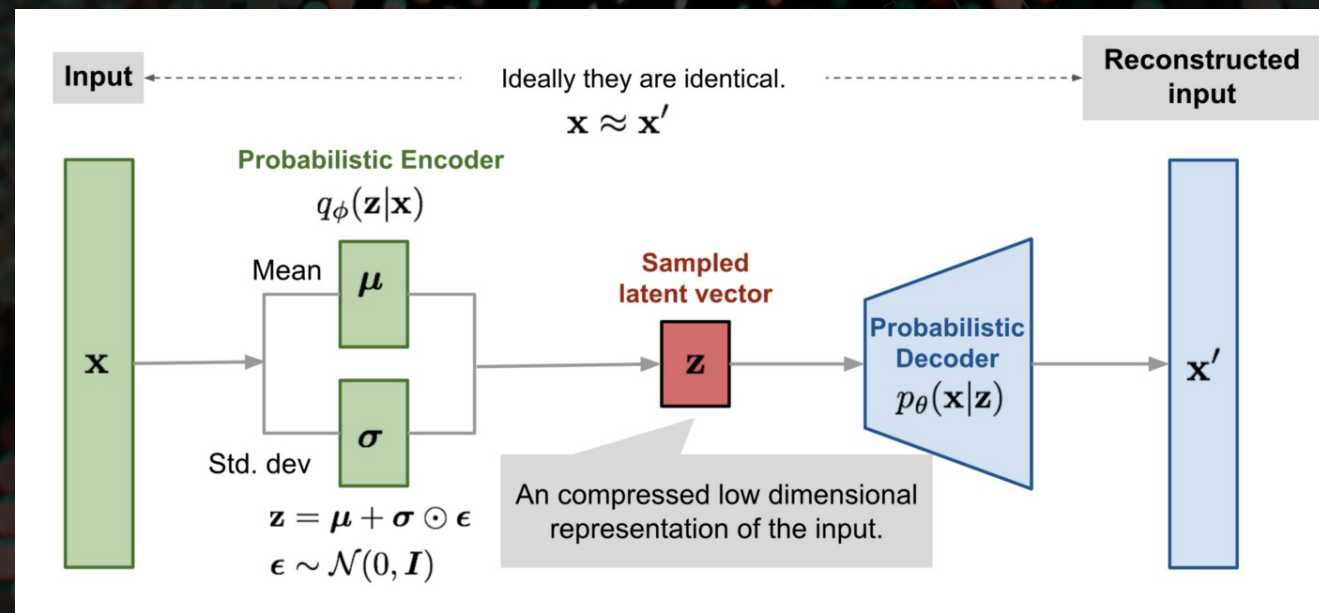
- Two **competitive** neural networks
 - **Generative model vs. discriminative model**
 - One tries its best to synthesize candidates
 - Good enough?
 - The other tries its best to detect synthesized candidates
 - Not good enough!
- Good for: the artistic realm



VARIATIONAL AUTOENCODER (VAE)

Image from: <https://towardsdatascience.com/an-introduction-to-variational-auto-encoders-vaes-803ddfb623df>

- Autoencoder: a pair of two connected NNs
 - **Encoder model** – compressing into the latent space
 - **Decoder model** – reconstructing from the latent space
- Good for: style transfer, blending of music, sounds, timbre



DEEP LEARNING

- **Deep**: multiple layers between input and output layers
 - Layers of abstraction: hardly understandable by human
- Too arbitrary? Heuristic?
 - Optimality
 - Completeness
 - Accuracy and precision
- Deep learning **frameworks**
 - TensorFlow
 - PyTorch
 - MATLAB Deep Learning Toolbox





- Try it here:
https://colab.research.google.com/github/tensorflow/models/blob/master/research/nst_blogpost/4_Neural_Style_Transfer_with_Eager_Execution.ipynb
(by TensorFlow team)
- Read more:
<https://medium.com/tensorflow/neural-style-transfer-creating-art-with-deep-learning-using-tf-keras-and-eager-execution-7d541ac31398>

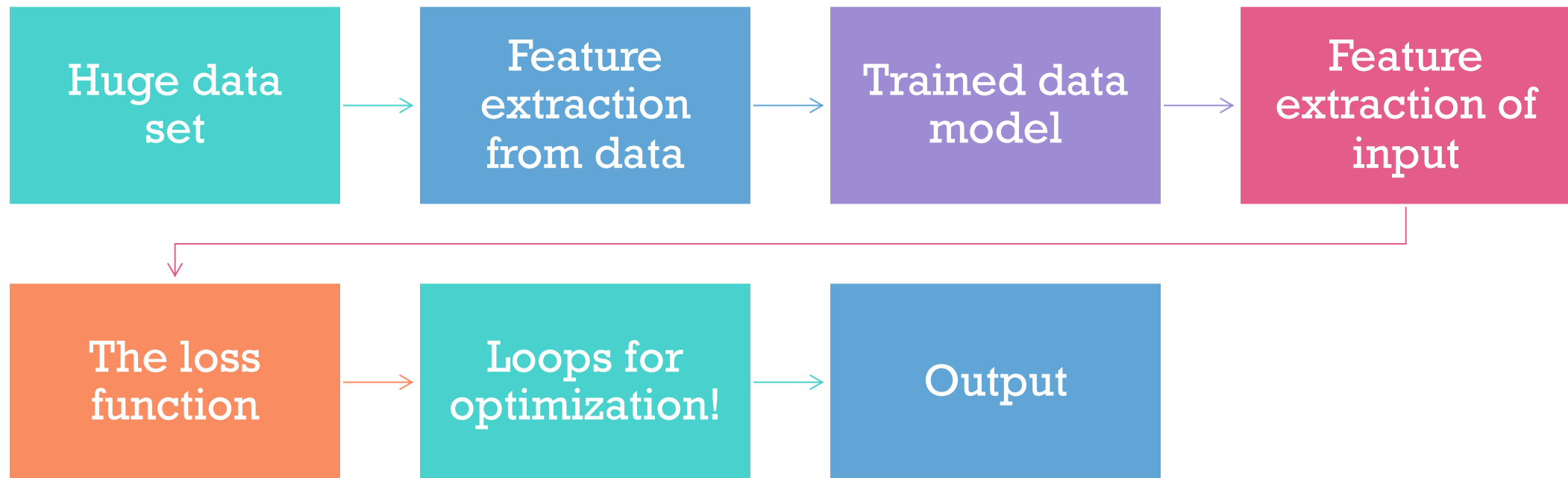
IMAGE NEURAL STYLE TRANSFER

- Try it here:
https://colab.research.google.com/notebooks/magenta/piano_transformer/piano_transformer.ipynb
(by Magenta team)
- Read more:
<https://magenta.tensorflow.org/music-transformer>

MUSIC TRANSFORMER



THE PROCESS



ART BY COMPUTERS



- “*Generative art*”
- “*Algorithmic art*”
- Know more about art tools aided by Artificial Intelligence
 - <https://aiartists.org/ai-generated-art-tools>

THE TURING TEST



- *“Can machines think?”*
- Are you able to tell machines and human apart?
- The more machine can learn, the more it can pretend
 - *“Good artists copy, great artists steal.”*

- Artistic vs. creativity ability
- What do we appreciate in art?
 - Craftmanship?
 - Creativity?
 - Imagination?
- Who is the target audience?
 - Popular art vs. fine art

A PHILOSOPHICAL QUESTION

A QUOTE IN Q.E.B. BY D.HOFSTADTER

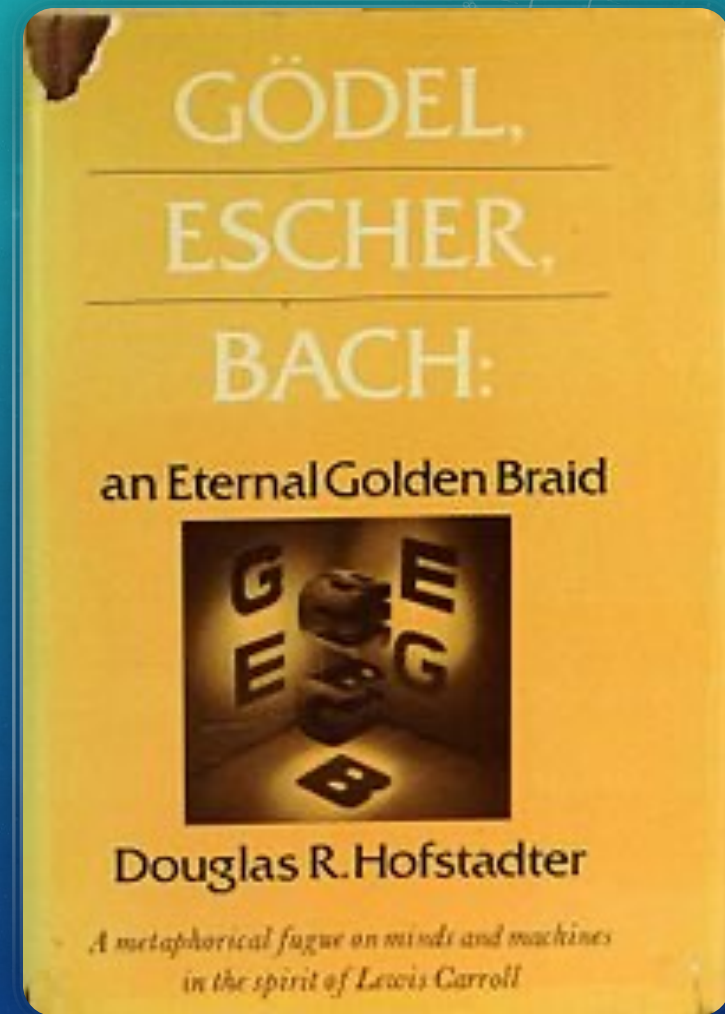
A “program” which could produce music as they did would have to wander around the world on its own, fighting its way through the maze of life and feeling every moment of it.

It would have to understand the joy and loneliness of a chilly night wind, the longing for a cherished hand, the inaccessibility of a distant town, the heartbreak and regeneration after a human death.

It would have to have known resignation and world-weariness, grief and despair, determination and victory, piety and awe.

In it would have had to commingle such opposites as hope and fear, anguish and jubilation, serenity and suspense.

Part and parcel of it would have to be a sense of grace, humor, rhythm, a sense of the unexpected—and of course an exquisite awareness of the magic of fresh creation.



COMPUTERS AS TOOLS

- Classification
- Identification
- Detection
- Appreciator
- Teacher
- Executor
- Personalized “art”
- Push creativity forward: new technologies, ***new possibilities***

A lightbulb with a black outline and radiating lines, set against a background of technical diagrams and a circular scale. The background features a circular scale with numbers from 40 to 260, and various geometric shapes and arrows. The lightbulb is positioned in the upper right quadrant, with a black cord extending from its base towards the bottom right corner.

BE AN ARTIST OF YOUR LIFE!

We need people to be in multiple disciplines to *work together* to engineer human knowledge into the machines!

QUESTIONS?



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