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?
Digital Art and Artificial Intelligence
DISSECTING ART

Form and structure
Grammar and syntax
Colour and timbre
Contrast and tension

Just learn the formula, computers!
“New Composition #1” by AIVA

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

A VERY SIMPLE NEURAL NETWORK

\[ a_0 = \sigma(\sum_i w_{i,0} x_i + \text{bias}) \]

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

\[ a = \sigma(wx + b) \]

Activation function:
e.g. sigmoid

Original image from: https://en.wikipedia.org/wiki/Artificial_neural_network
A mostly complete chart of
Neural Networks

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

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_
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)

- **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
  - Completenss
  - 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:  
• 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
THE PROCESS

Huge data set → Feature extraction from data → Trained data model → Feature extraction of input

The loss function → Loops for optimization! → Output
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?
  • Craftsmanship?
  • Creativity?
  • Imagination?
• Who is the target audience?
  • Popular art vs. fine art
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
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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