Real-Time Sensing and Artificial Intelligence for Live Performative Arts

Live Performers Meeting, March 2024, M'Hamid El Ghizlane, Morocco. March 9, 2024

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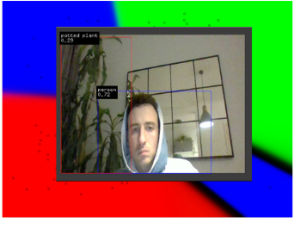
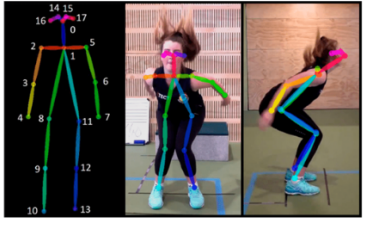
Federico Corradi

Real-Time Sensing and Artificial Intelligence for Live Performative Arts

Date	Lectures	Notes
Session 1	Creative coding, OpenFrameworks, the basic of programming, interactivity.	OFX docs, slides, code examples
Session 2	OpenFrameworks, creating add-ons in OFX, and sensors.	OFX docs, slides, OFX addons
Session 3	Neural networks basics, working with data, neural networks in OFX.	OFX docs, slides, code examples
Session 4	Using Neural Networks for data analysis, interpretation, and augmentation.	NN models, slides, OFX addons



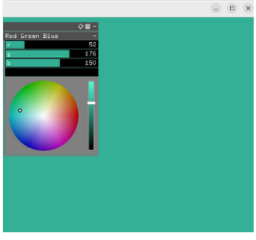


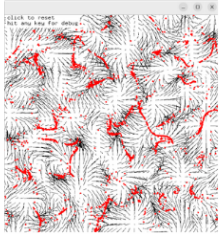
Outline

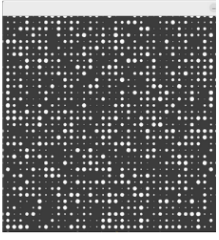
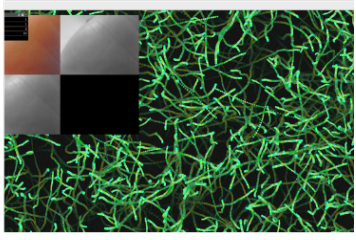
Recap from last time

Main topics

- Sensors and interfaces
  - Kinect
  - Cameras (silicon retinas)
  - Midi
- Visual Programming





Outline

Tesla Autopilot

ChatGPT

OpenAI

API RESEARCH BLOG ABOUT

ChatGPT: Optimizing Language Models for Dialogue

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests. ChatGPT is a sibling model to InstructGPT, which is trained to follow an instruction in a prompt and provide a detailed response.

November 30, 2022
13 minute read

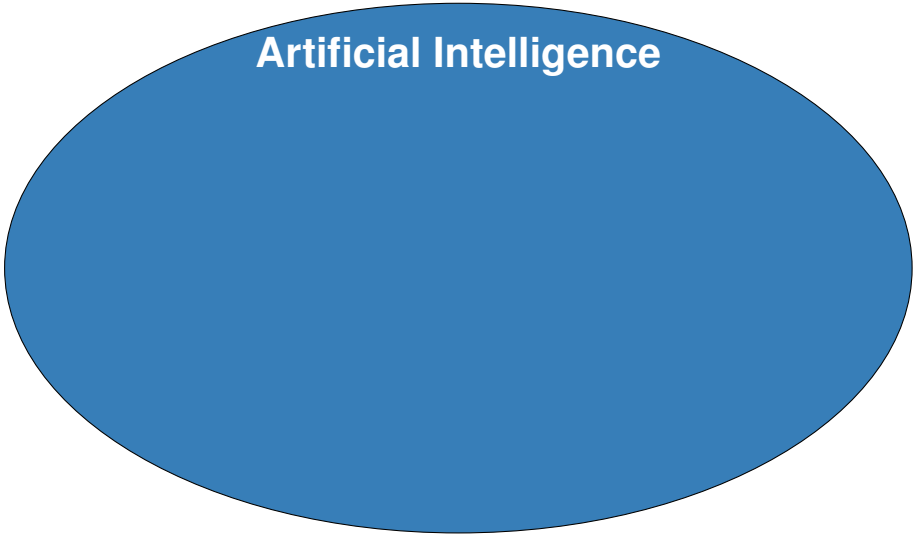
ChatGPT-4 & Dall-e

Dall-e

I would like to create an image of the live performers meeting held at the boundary of the sahara desert in a beduin camp. the festival is on live performative arts, creative coding and Vjs. can you please make this in a futuristic look?

Outline

Let’s Take A Step Back



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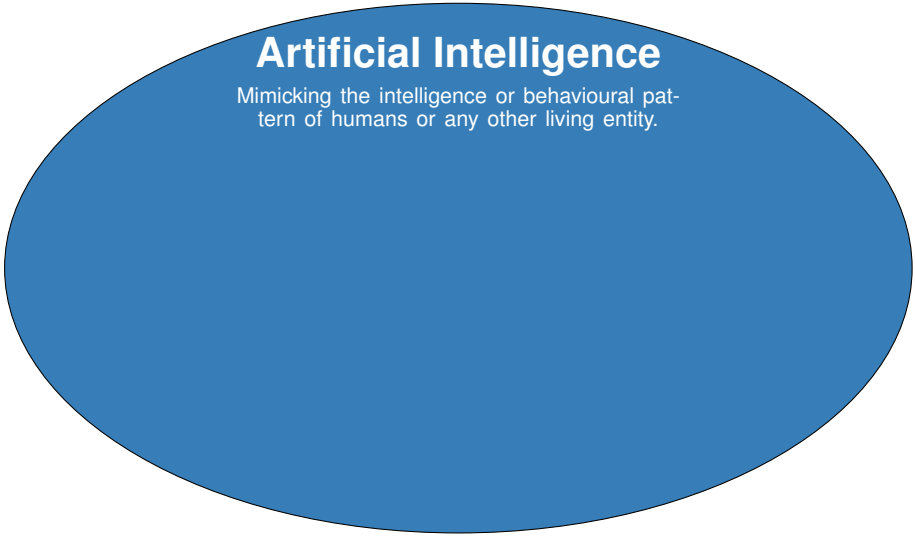

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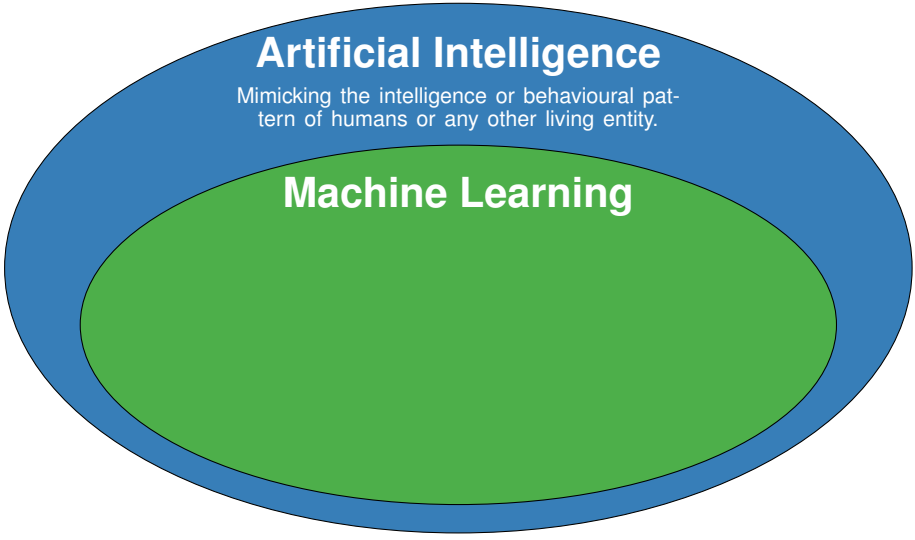

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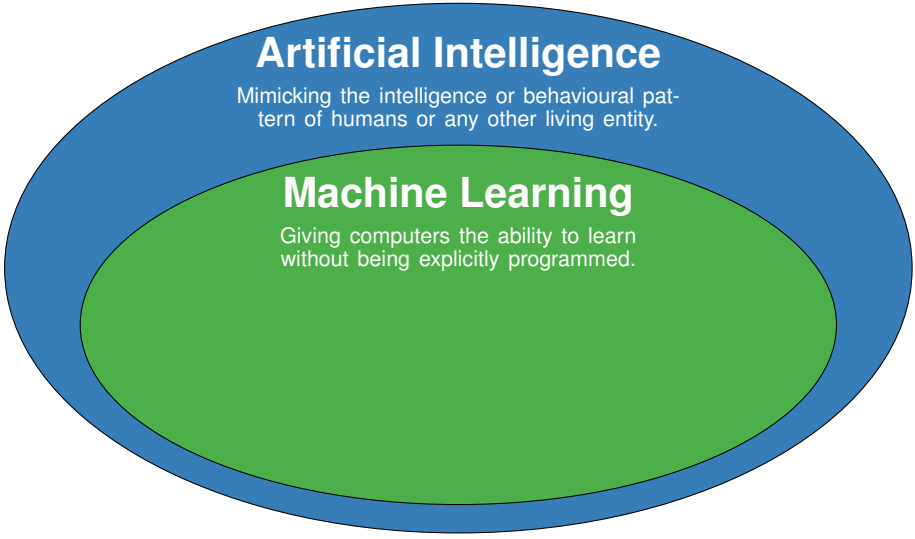

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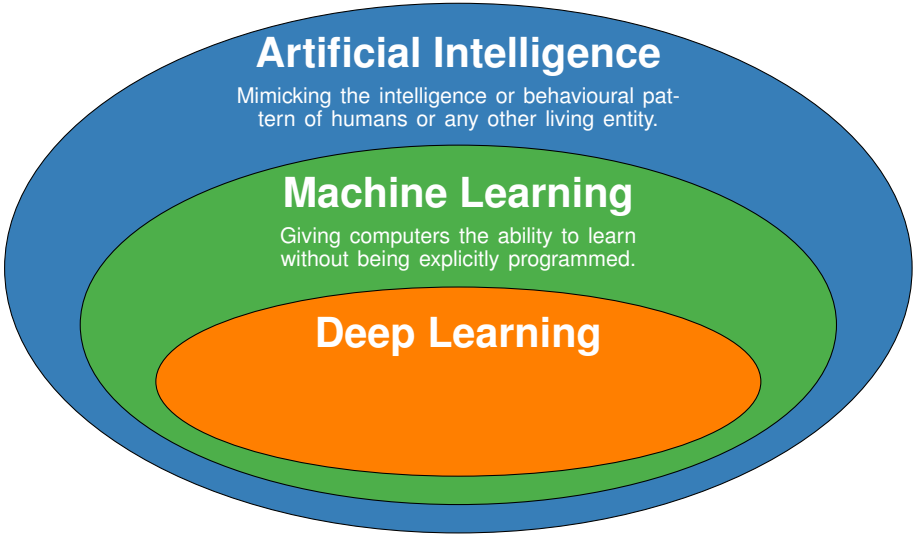

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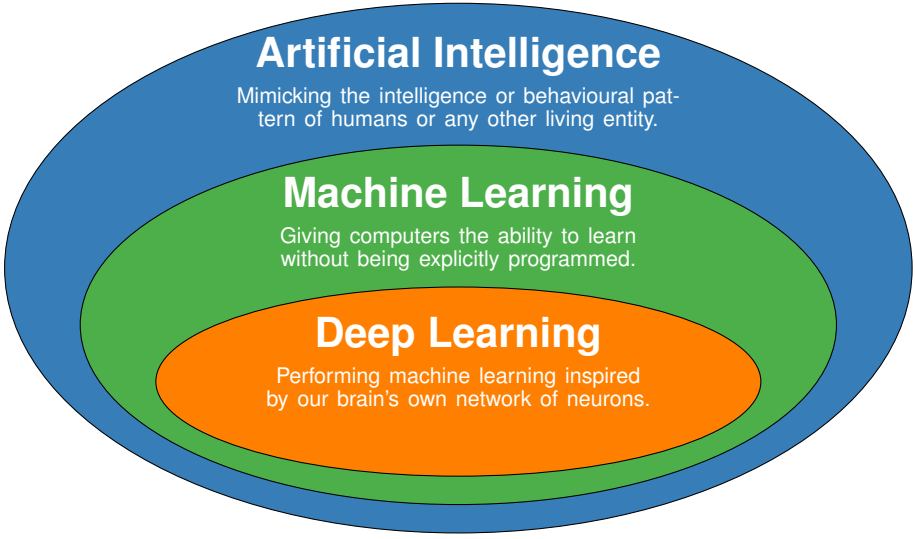

Artificial Intelligence: The Deep Neural Networks Revolution

- Although the first successes of ANNs were first demonstrated in the 1980's they only started to outperform classical optimization and engineering approaches from 2009 on.

Artificial Intelligence: The Deep Neural Networks Revolution

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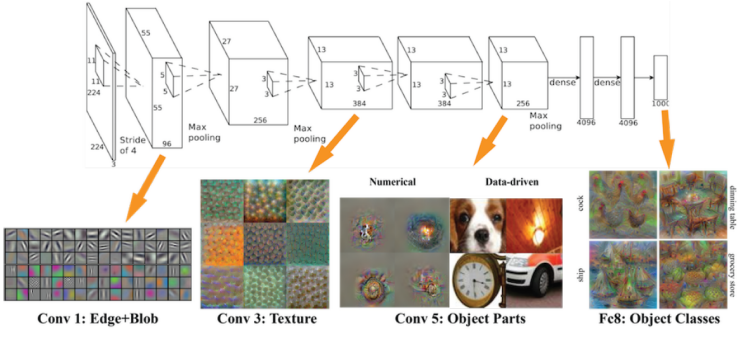
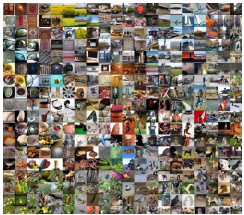
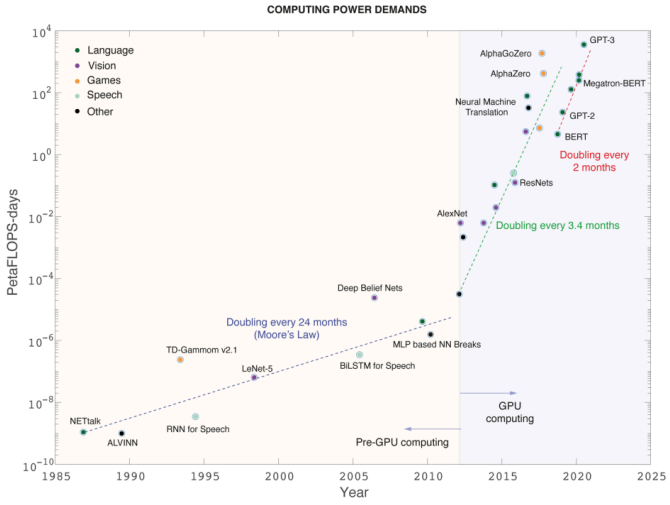
- In 2011 CNNs trained using back-propagation on GPUs achieved 0.56% error rate in a visual pattern recognition contest, outperforming for the first time humans (by a factor of 2×) and non-neural state-of-the-art algorithms (by a factor of 6×).





Challenges in the future of AI



Large Volume of Data, Compute, and Energy

- Training DNNs has extremely high demands in terms of power consumption.

[Mehonic and Kenyon 2022)], [AKCP], [Boahen K. 2022]

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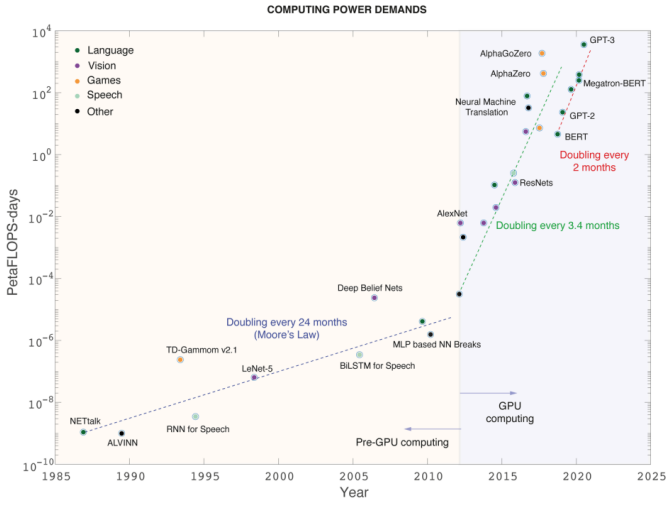

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- According to conservative estimates, training chat GPT-4 over $63 million.

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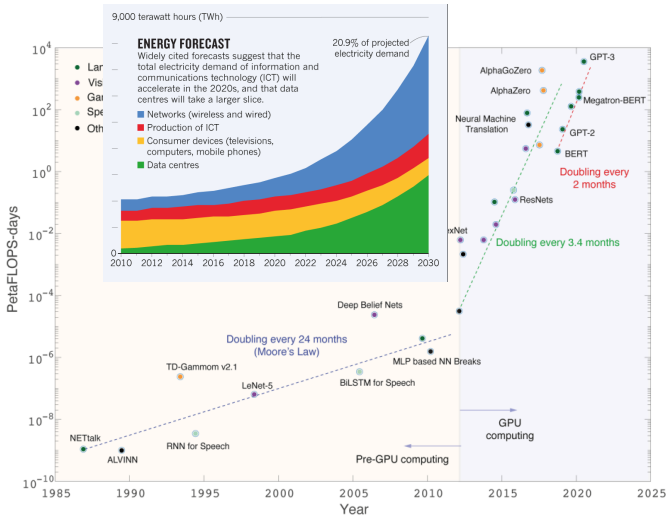

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Large Volume of Data, Compute, and Energy

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- According to conservative estimates, training chat GPT-4 over $63 million.
- Cloud energy consumption has more than quadrupled from the advent of GPU use for DNN training.

Types of Learning

1. **Supervised learning:** learns from labeled datasets.
   - **Example:** E-mail spam detection.

2. **Unsupervised learning:** discovers patterns in unlabeled datasets.
   - **Example:** Clustering of news articles based on similarity.

3. **Reinforcement learning:** learns to act based on feedback.
   - **Example:** Learning how to play Go.

In practice, a combination of approaches is often used.

For example, ChatGPT uses both supervised learning and reinforcement learning.

Learning Systems

Basic components of a (supervised) learning system:

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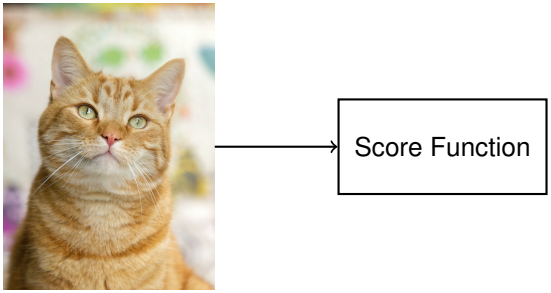
1. **Score function**



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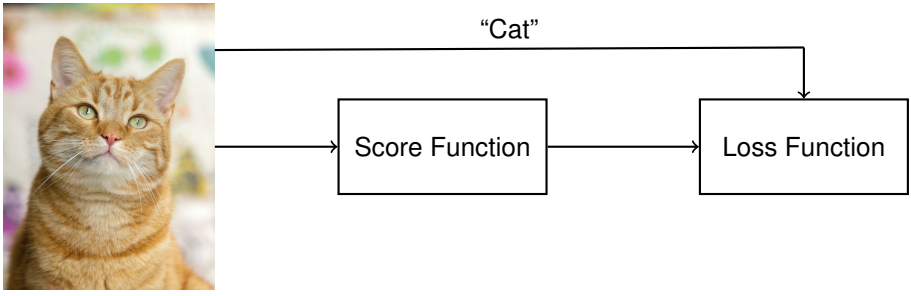

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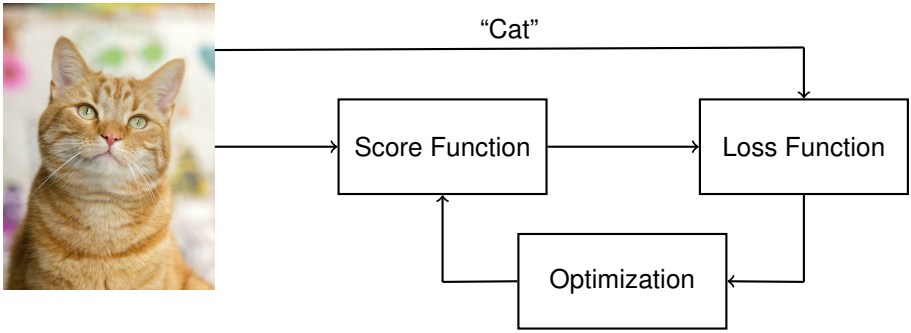
3. **Optimization**



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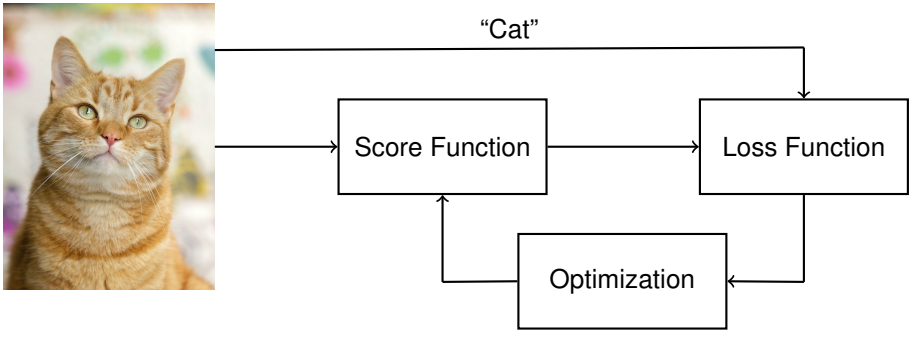

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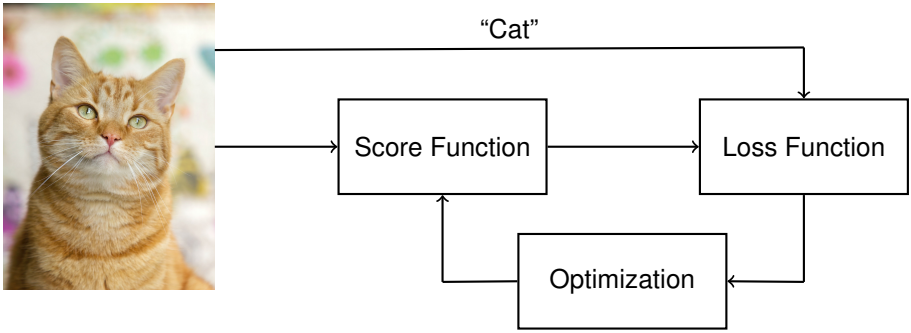

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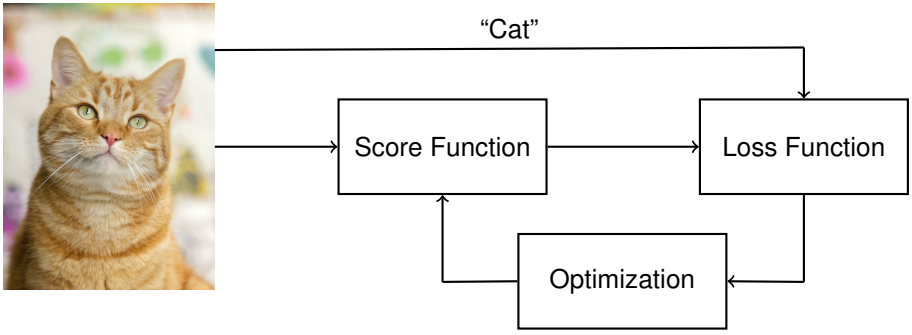

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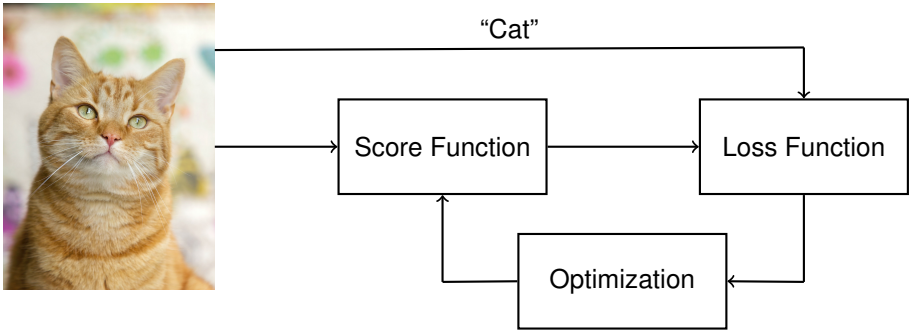
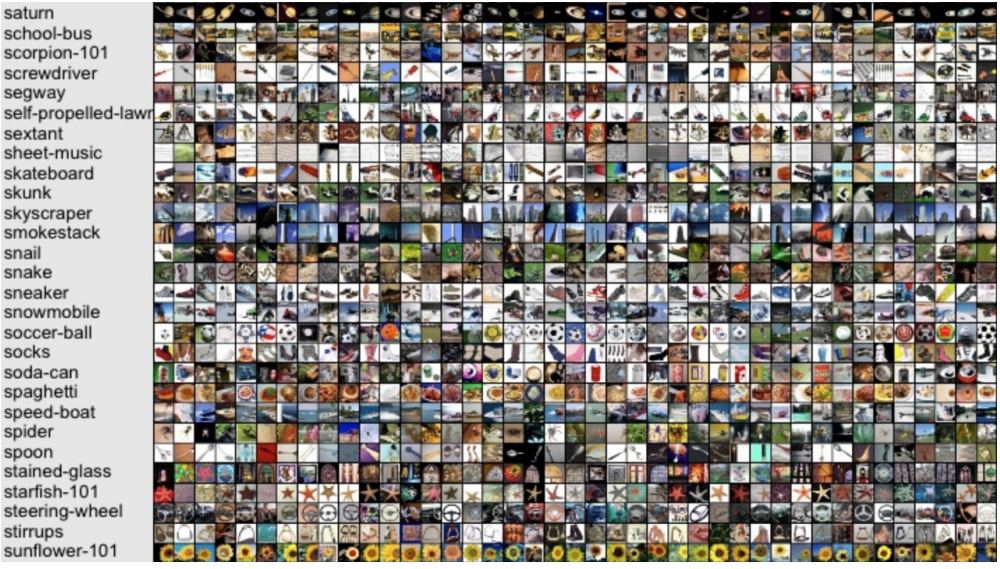
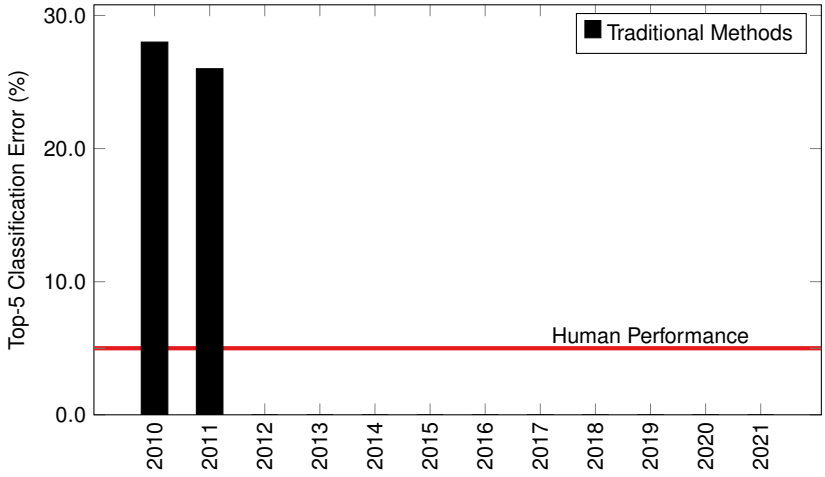


The ImageNet Challenge



The ImageNet Challenge

Data: https://paperswithcode.com/sota/image-classification-on-imagenet



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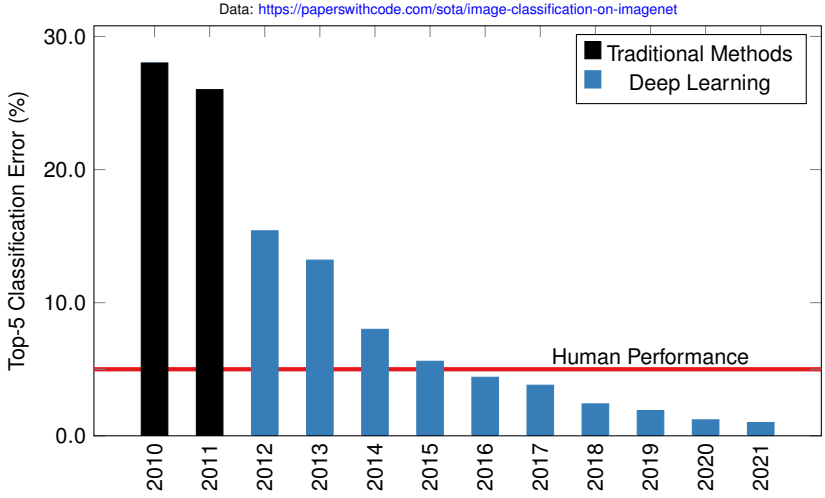
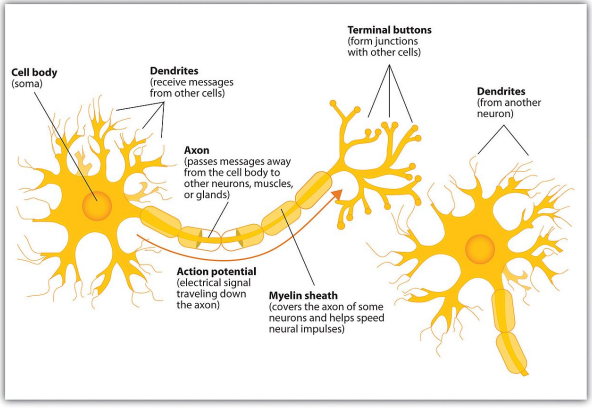


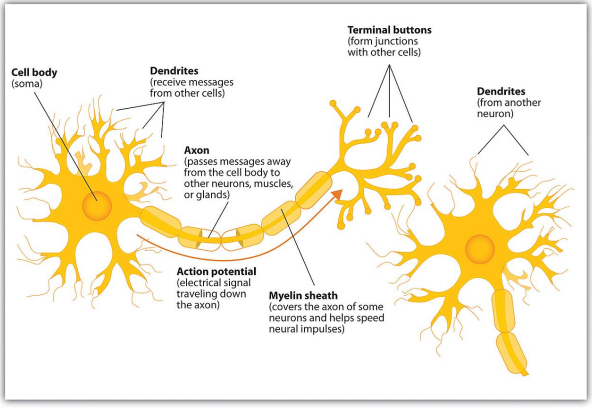
Our Brain



The basic computational unit of the brain is a **neuron**.

- Neurons receive input signals from **dendrites** and produce output signals along their **axon**, which interact with the dendrites of other neurons via **synaptic weights**.

Our Brain



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- About 86 billion neurons.
- About 10^{14} to 10^{15} synapses.

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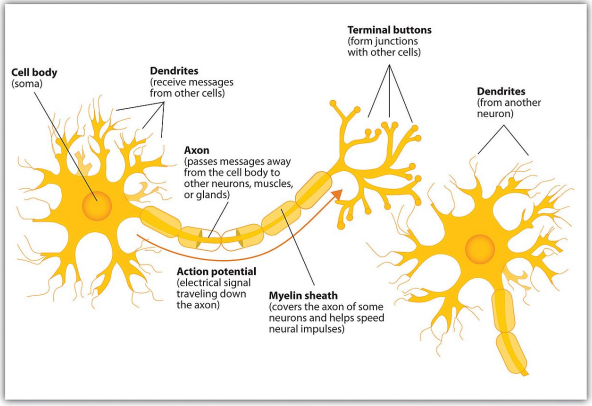

Jennifer Walinga, CC BY-SA 4.0, via Wikimedia Commons

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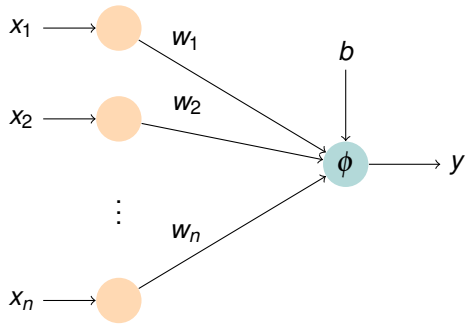
The synaptic weights are **learnable** and they control the influence between neurons.

An Artificial Neuron



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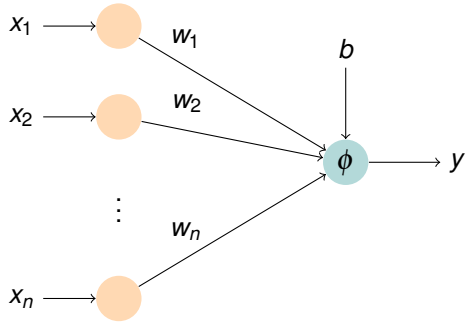

$$y = \phi\left(\sum_{i=1}^{n} w_i x_i + b\right) = \phi\left(\mathbf{w}^\top \mathbf{x} + b\right)$$

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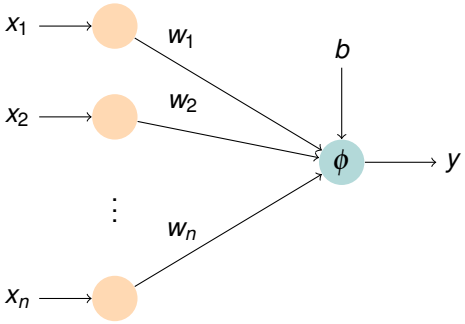

- **Input** nodes correspond to dendrites.

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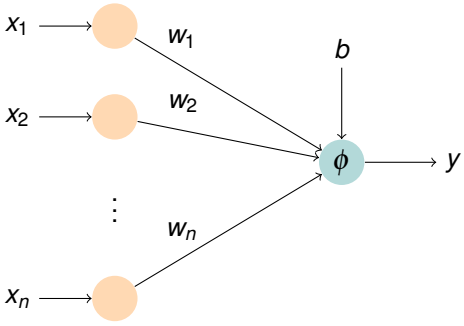

- **Input** nodes correspond to dendrites.
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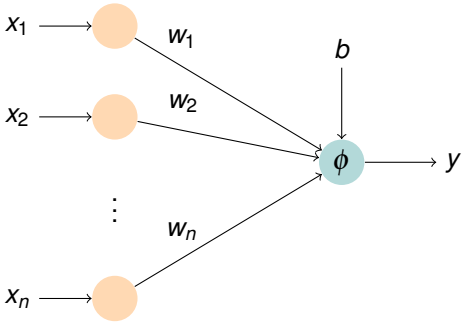

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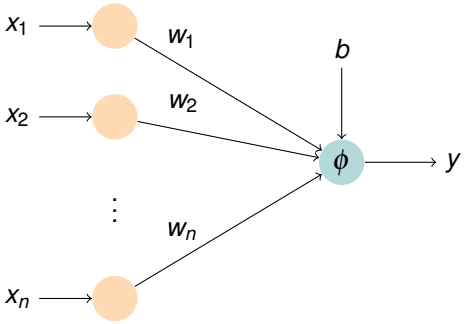

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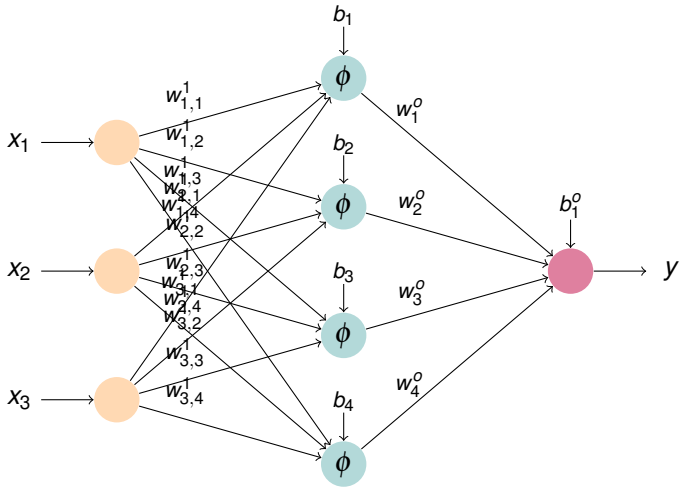
- **Output** y corresponds to action potential on axon.

A Single-Layer Single-Output Neural Network



Outline

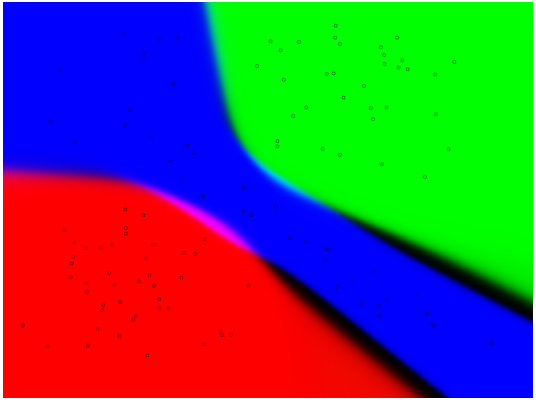
Neural Network add-on ofxGrt: example NN

ofxGrt

The GRT is a cross-platform, open-source, C++ machine learning library designed for real-time gesture recognition.

- ofxGrt is designed to make it as easy as possible to use the GRT in openFrameworks.
- MIT license.

https://github.com/nickgillian/ofxGrt



addons/ofxGrt/example_mlp_learn

Neural Network add-on ofxGrt: gesture training

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- It supports **Kinet**

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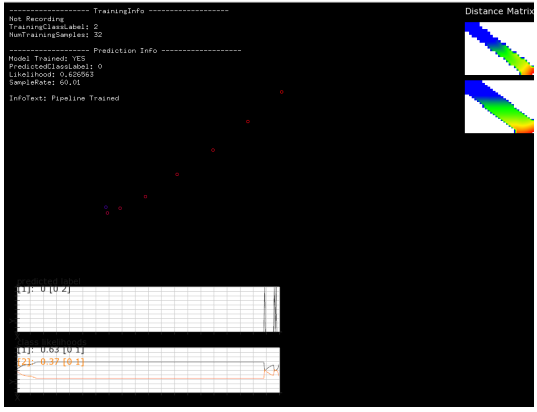


addons/ofxGrt/example_dtw

Neural Network add-on ofxTensorflow2

ofxTensorFlow2

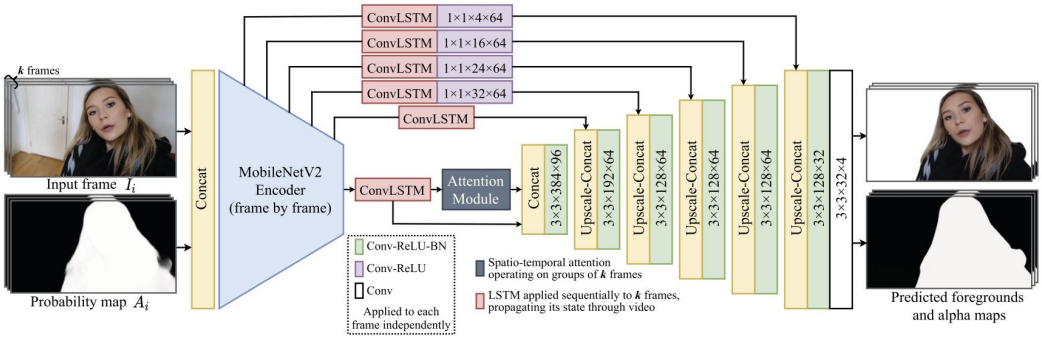
TensorFlow 2 ML (Machine Learning) library. The code has been developed by the ZKM | Hertz-Lab as part The Intelligent Museum project.

- Based on Tensorflow, a powerful platform for deep learning. TensorFlow is developed by the Google Brain team for internal Google use in research and production.
- MIT license.
- Tensor Processing Units!

ofxTensorflow 2 GitHub

Google datacenters, many, many, many, tensor processing units, 100% compatible with tensorflow.
https://www.tensorflow.org/

Video Matting

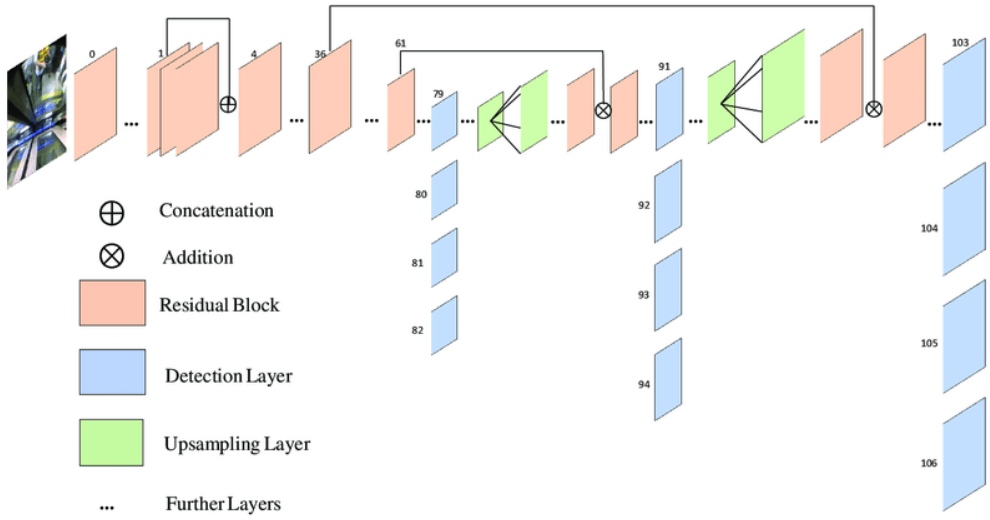


github video mapping

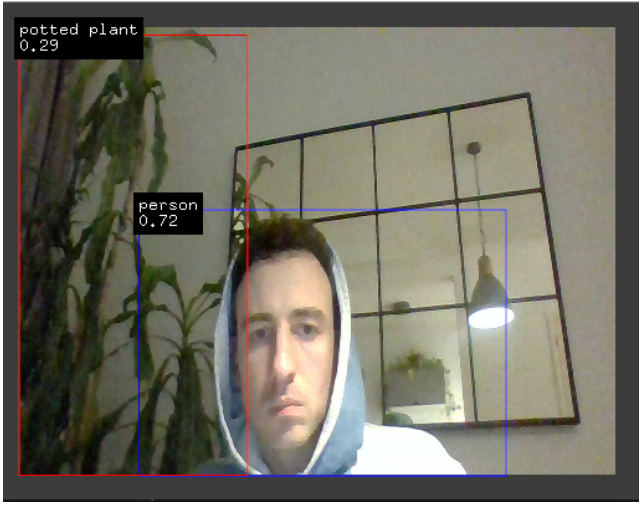
Neural Network add-on ofxTensorflow2: video matting

addons/ofxTensorFlow2/example_video_matting

You look only once! (YOLO)



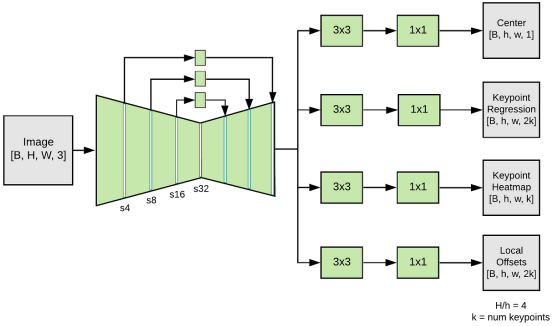
Neural Network add-on ofxTensorflow2: video classification



addons/ofxTensorFlow2/example_yolo_v4

Neural Network add-on ofxTensorflow2: pose estimation

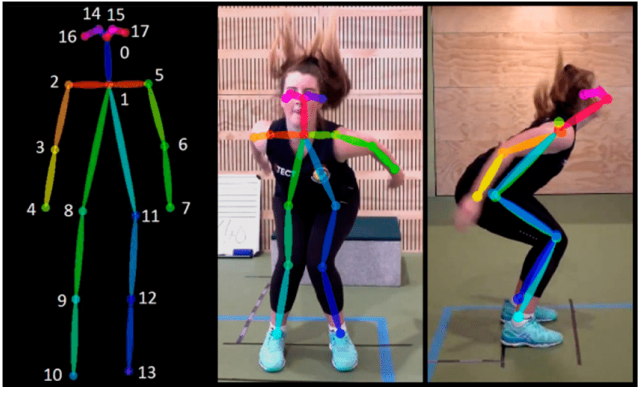
Tensorflow MoveNet Thunder methods were most accurate for measuring hip kinematics.



Medium MoveNet

Neural Network add-on ofxTensorflow2: pose estimation

MoveNet is an ultra fast and accurate model that detects 17 keypoints of a body.



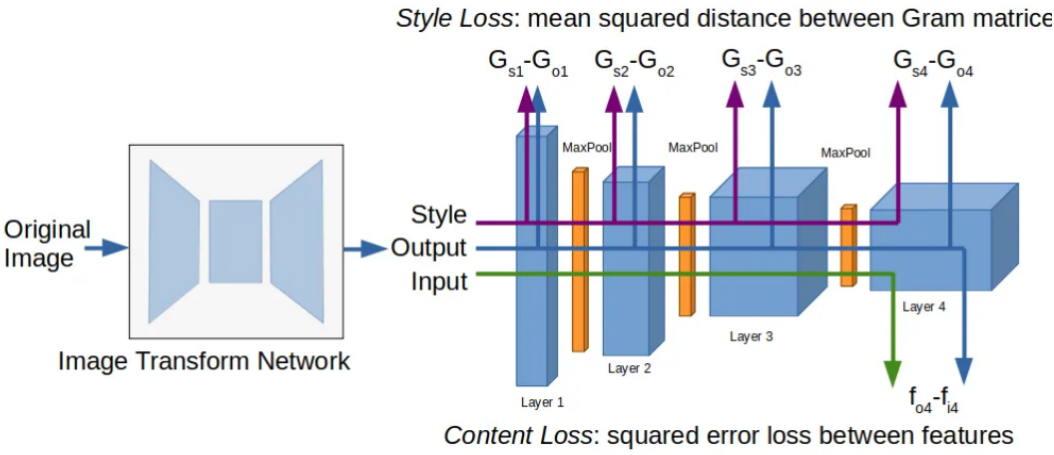
addons/ofxTensorFlow2/example_movenet

Neural Network add-on ofxTensorflow2: pose estimation

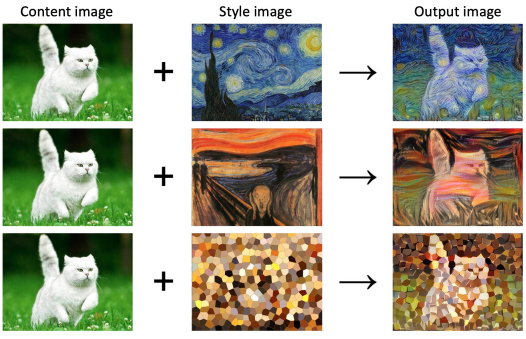
MoveNet is an ultra fast and accurate model that detects 17 keypoints of a body.

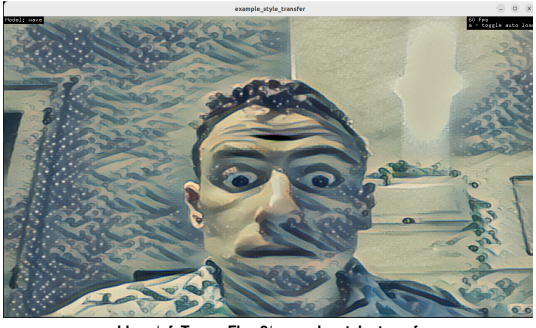
addons/ofxTensorFlow2/example_movenet

Style Transfer



Neural Network add-on ofxTensorflow2: style transfer





addons/ofxTensorFlow2/example_style_transfer

Let’s build something!

Summary

- Neural networks everywhere
- The basic of neural nets
  - Neurons, synapses, dentrites, back-propagation
- Neural networks in OFX
  - Multi-layer perceptron
  - Gesture training/inference
  - Video matting
  - Video classification
  - Pose estimation

Next Time

Let’s start some cool project together! Any ideas?