



Google Deep Dream

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Course: CSE352

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What Is Google Deep Dream?



Deep Dream is a computer vision program created by Google.

Uses a convolutional neural network to find and enhance patterns in images with powerful AI algorithms.

Creating a dreamlike hallucinogenic appearance in the deliberately over-processed images.



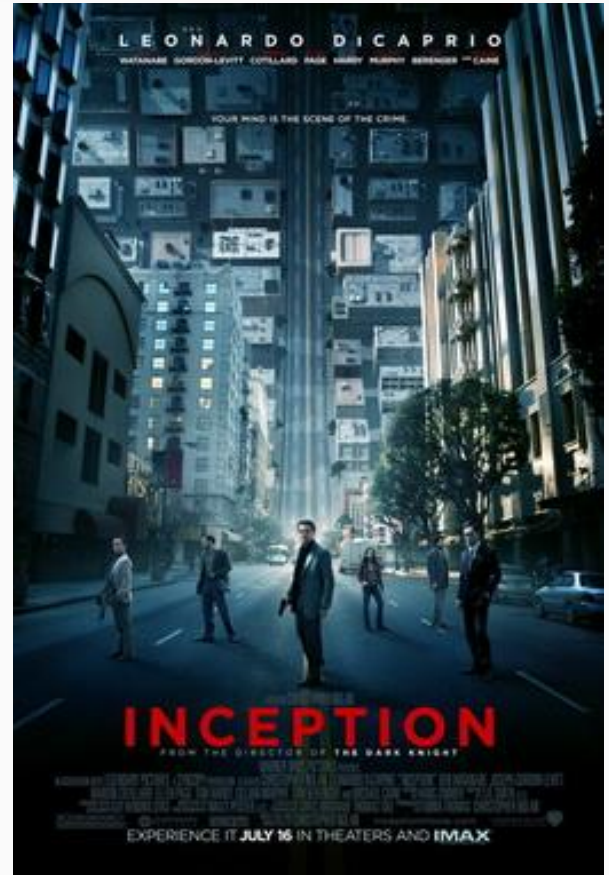
Base of Google Deep Dream

Inception is fundamental base for Google Deep Dream and is introduced on ILSVRC in 2014.

Deep convolutional neural network architecture that achieves the new state of the art for classification and detection.

Improved utilization of the computing resources inside the network.

Increased the depth and width of the network while keeping the computational budget constant of 1.5 billion multiply-adds at inference time.



How Does Deep Dream Work?

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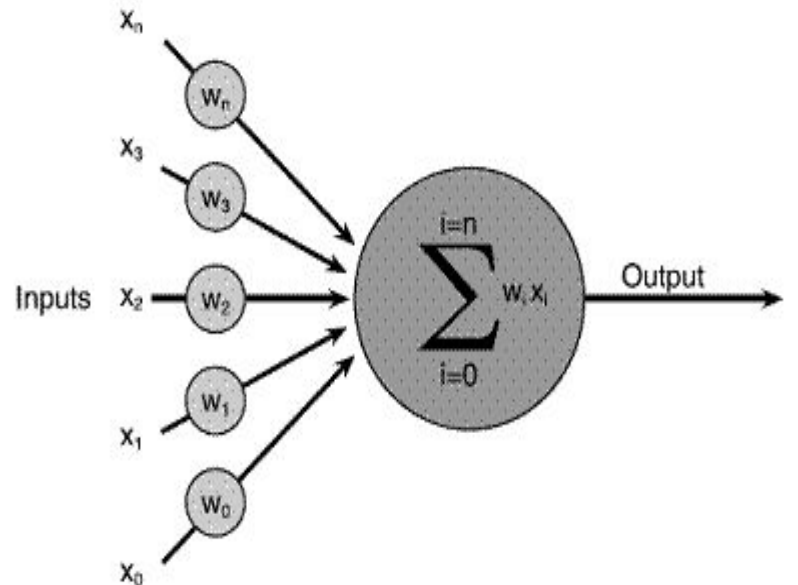
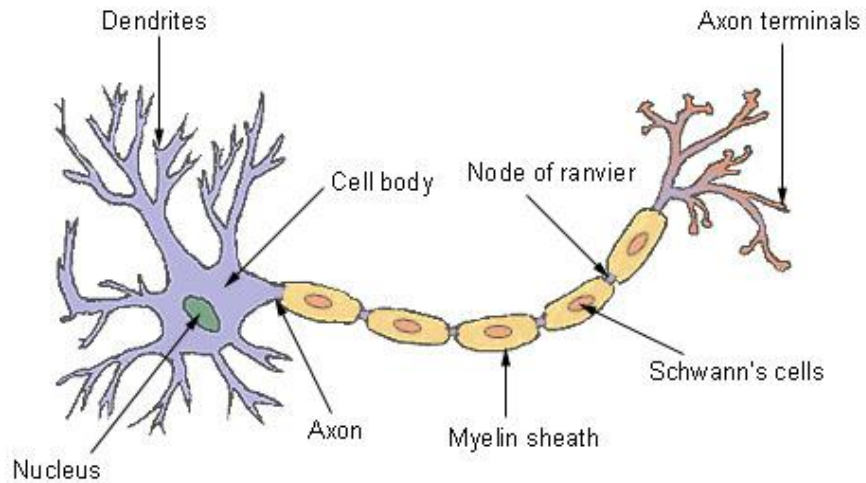
Deep Dream works on a **Neural Network** (NN)

This is a type of computer system that can learn on its own.

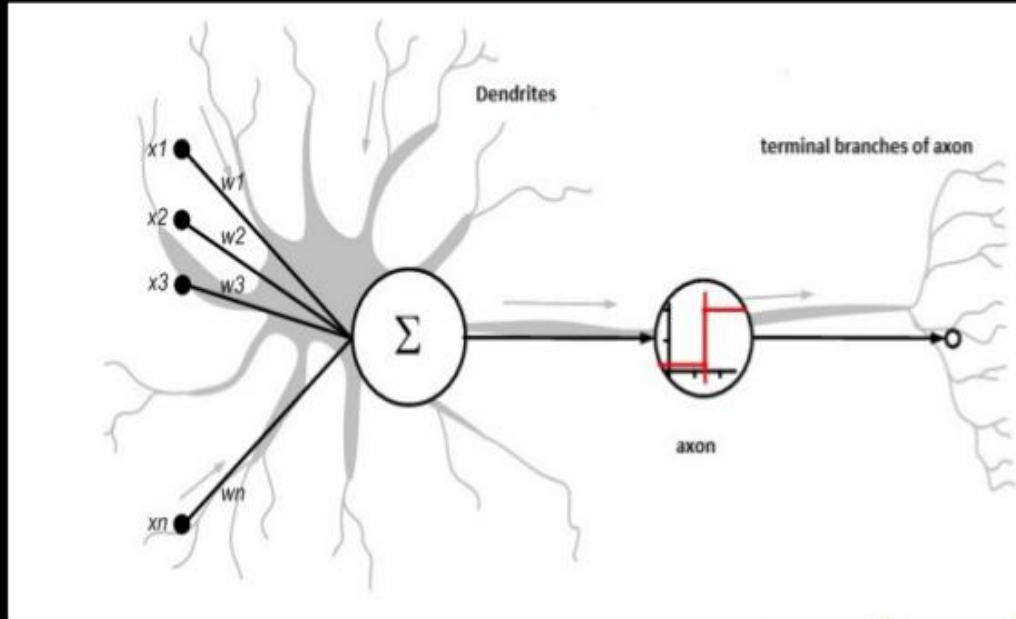
Neural networks are modeled after the functionality of the human brain, and tend to be particularly useful for ***pattern recognition***.

Biological Inspiration

Structure of a Typical Neuron



Biologically Inspired Neuron



Convolutional Neural Network (CNN)

Feed forward artificial neural network

Inspired by the organization of the animal visual cortex (convolution operation)

Designed to use minimal amounts of preprocessing

Combine Kernel Convolution and Deep Learning

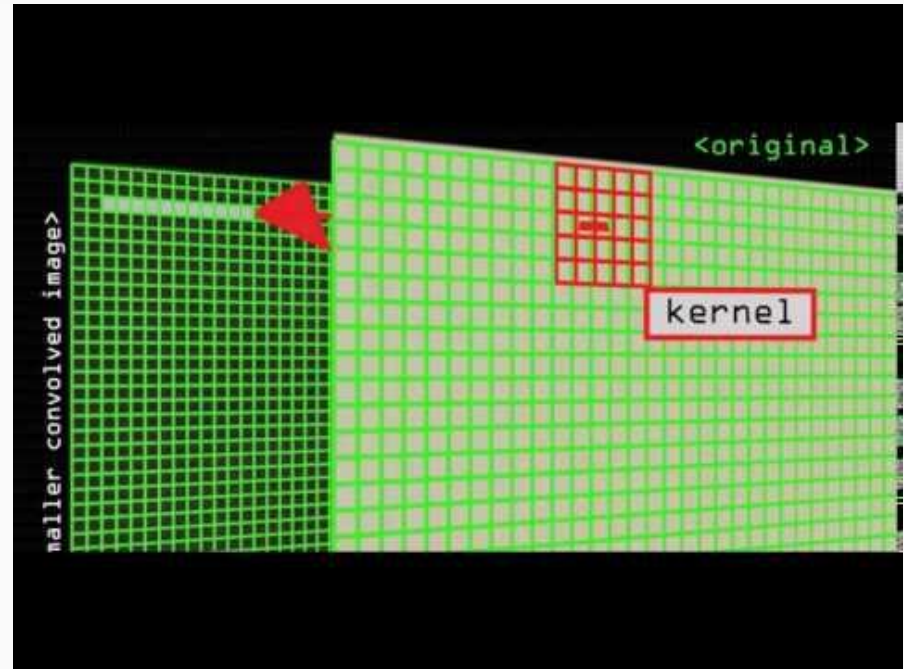
Mostly used in image and video recognition, recommender systems and NLP

Why Convolutional Networks?

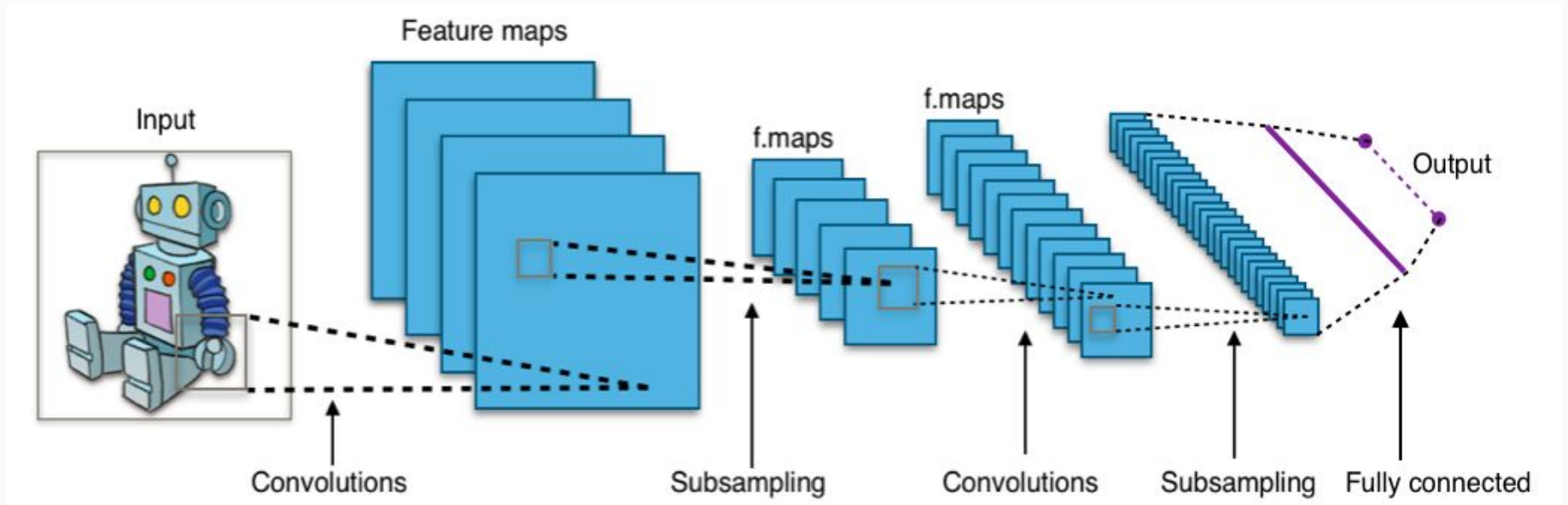
Curse of dimensionality

Local connectivity

Shared Weights



CNN Architecture



5.1%

Human Error Rate in Identifying Objects

4.94%

Microsoft made it better than humans in 2014

3.46%

Google inception-v3 model beat them in 2014



Digging Deeper Into The Neural Network

Deep Dream's Convolutional Neural Network **must first be trained**.

In Deep Dream, this training process is based on **repetition** and **analysis**.

For example, in order for Deep Dream to understand and identify faces, the neural network must be fed examples of millions of human faces.



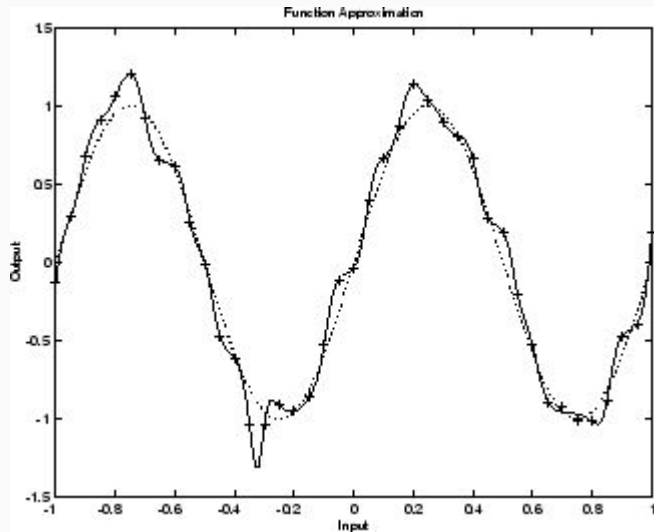
Overfitting In The Training Process

Overfitting occurs when there is an error in the process of generalization, usually caused by the introduction of **noisy** data in the training process.

Overfitting causes poor performance because it overreacts to minor fluctuations in the training data.

Can be avoided by using additional techniques, such as **cross-validation**, **regularization**, **pruning**, and **Bayesian priors**.

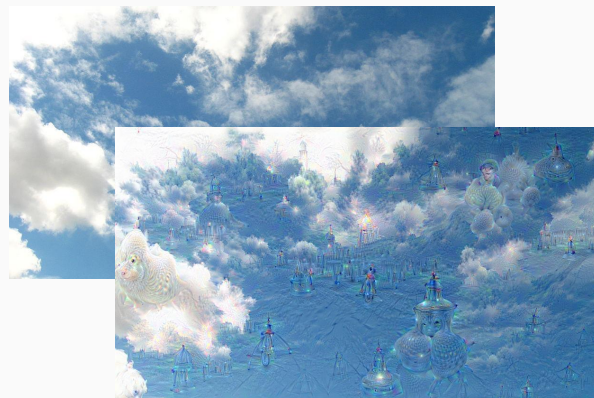
Overfitting In The Training Process



Example of overfitting in Deep Dream

Deep Dream's Process

1. Loads in the Deep Learning Framework (Python and Google libraries)
2. Load the Deep Neural Network (GoogleNet and ImageNet datasets)
3. Produce the dream (activation function)
 - a. Offset image by a random jitter
 - b. Normalize the magnitude of gradient ascent steps
 - c. Apply ascent across multiple scales



Deep Dream's Process

```
def objective_L2(dst):
    dst.diff[:] = dst.data

def make_step(net, step_size=1.5, end='inception_4c/output',
             jitter=32, clip=True, objective=objective_L2):
    '''Basic gradient ascent step.'''

    src = net.blobs['data'] # input image is stored in Net's 'data' blob
    dst = net.blobs[end]

    ox, oy = np.random.randint(-jitter, jitter+1, 2)
    src.data[0] = np.roll(np.roll(src.data[0], ox, -1), oy, -2) # apply jitter shift

    net.forward(end=end)
    objective(dst) # specify the optimization objective
    net.backward(start=end)
    g = src.diff[0]
    # apply normalized ascent step to the input image
    src.data[:] += step_size/np.abs(g).mean() * g

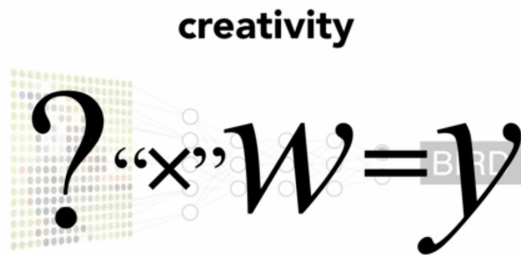
    src.data[0] = np.roll(np.roll(src.data[0], -ox, -1), -oy, -2) # unshift image

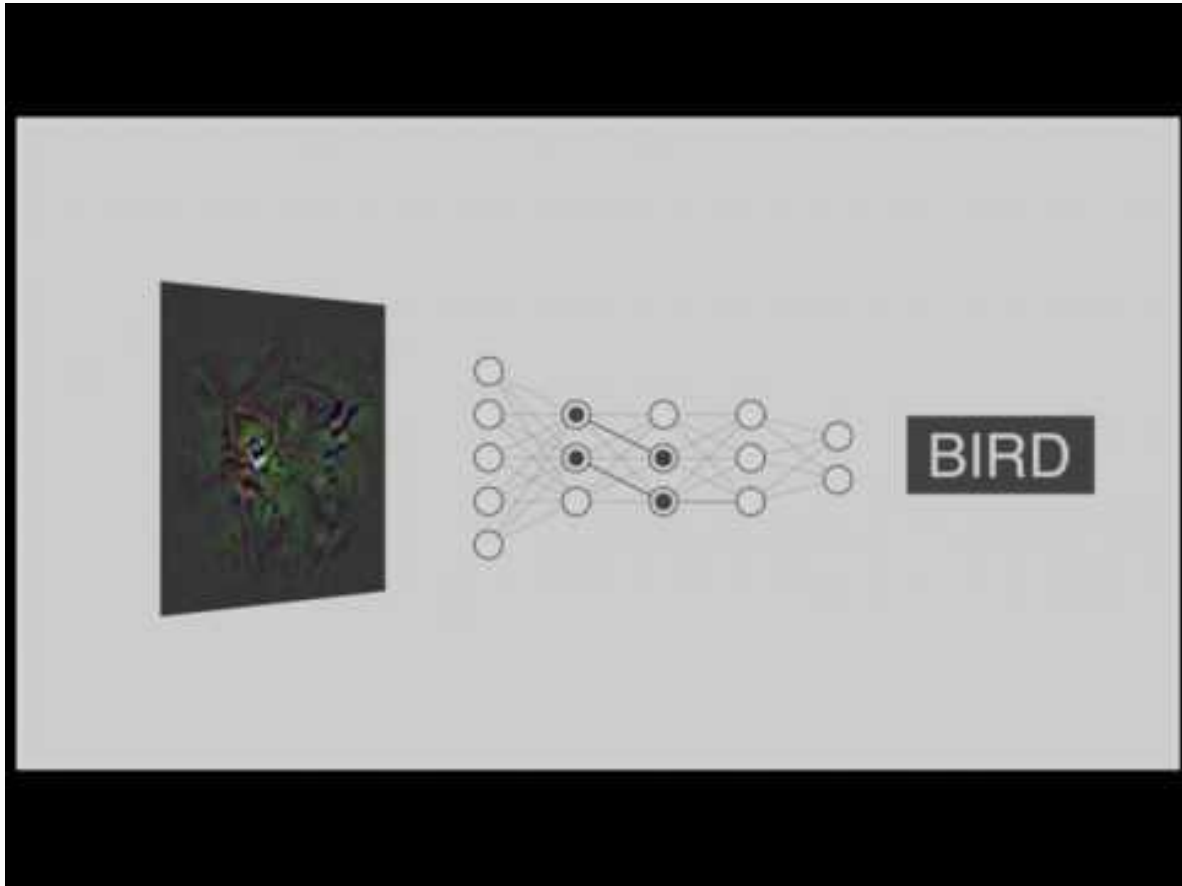
    if clip:
        bias = net.transformer.mean['data']
        src.data[:] = np.clip(src.data, -bias, 255-bias)
```

Deep Dreaming - Reversing the Process

One more step forward:

What if we ask for the interpretation of the real world given the abstraction?



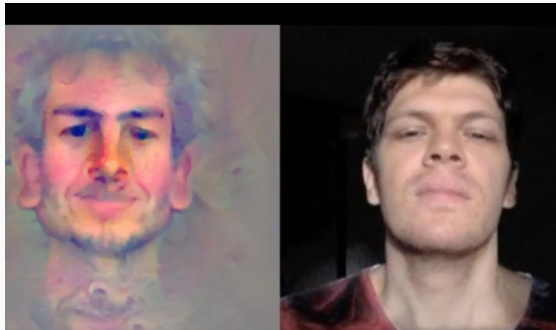


Neural Network "reverse" process

Why so psychedelic?

The purpose of getting rid of ambiguity turns into some sort of creativity due to the confusion in the of view.

The solution is the usage of a guide:



Just a little bit further

Ask the computer to use its imagination.

Usage of pre made pictures as base of the dreams instead of random noise.



Images used as basis

Instead of random noise.

Possibility of looping
“hallucinations” making
each obtained image the
foundation for the next
one.



Is Google Dream Art?

Some other art movements weren't accepted in their time.



White square over white background
Kazimir Malevich



Picasso



Wladyslaw Hasior

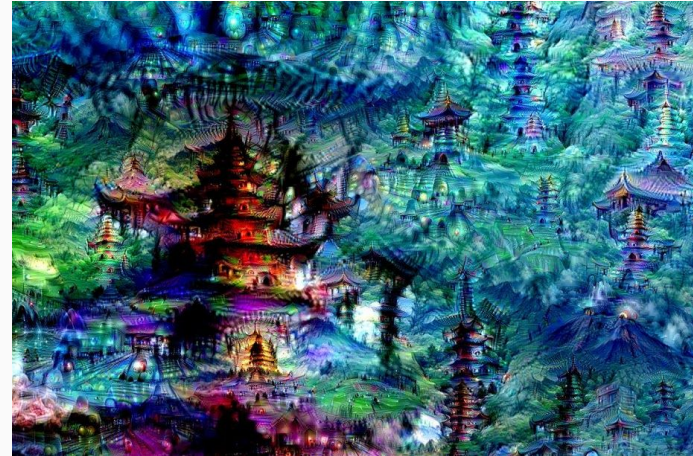
What Is Art?

*1. the expression or application of **human** creative skill and imagination, typically in a visual form such as painting or sculpture, producing works to be appreciated primarily for their beauty or emotional power.*

2. the various branches of creative activity, such as painting, music, literature, and dance.

This was based in the assumption of only humans being capable of producing beauty.

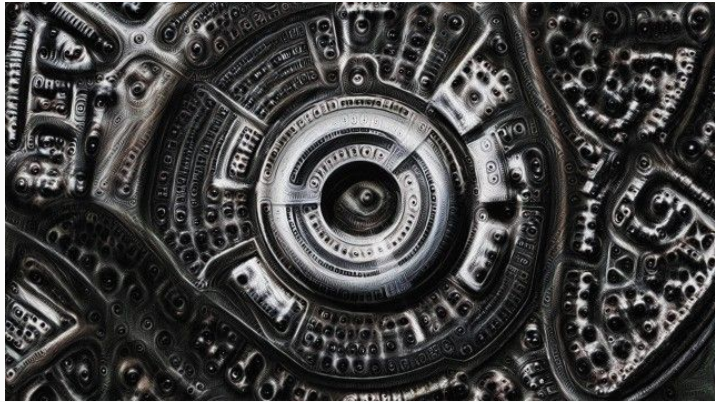
¿Is this beautiful?



Memo Akten: HR Giger-style rendering of a Google Maps image of GCHQ

Exposed in the Gray Area Foundation for the Arts, San Francisco, CA, USA, in partnership with Google Research.

“Deep Dream (...) creates just enough of a sparrow’s head in a cloud, so that our brains find the rest. Visually, our minds and Deep Dream are doing exactly the same thing. It’s such a perfect mirror.”



Paddy Johnson

Art critic, founder and editor of Art F City

“Google Dream (...) is a tool, not the product, so calling it art would be a little like an artist raising their hand and declaring their paintbrush art because they were so happy with the way they used it lay paint on a canvas.”

Google would firstly declare Google Dream as *“a visualization tool designed to help us understand how neural networks work”*

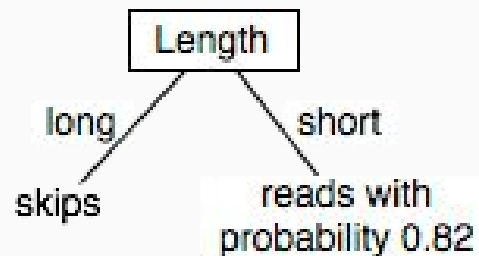
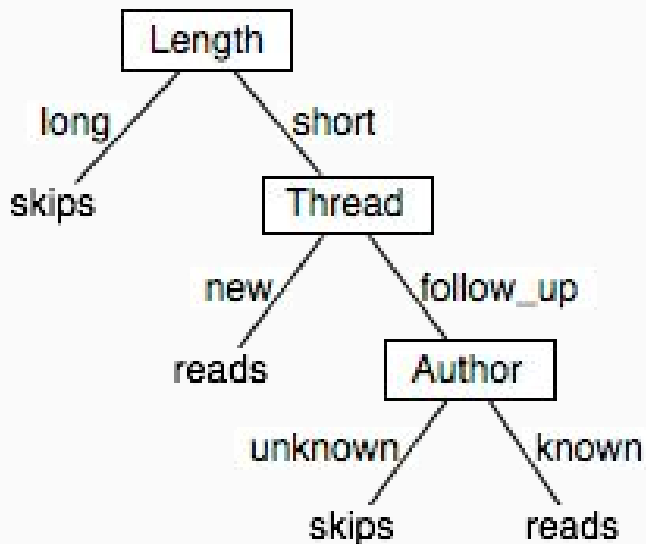
There are other ways that Google machines are starting to learn more like humans:

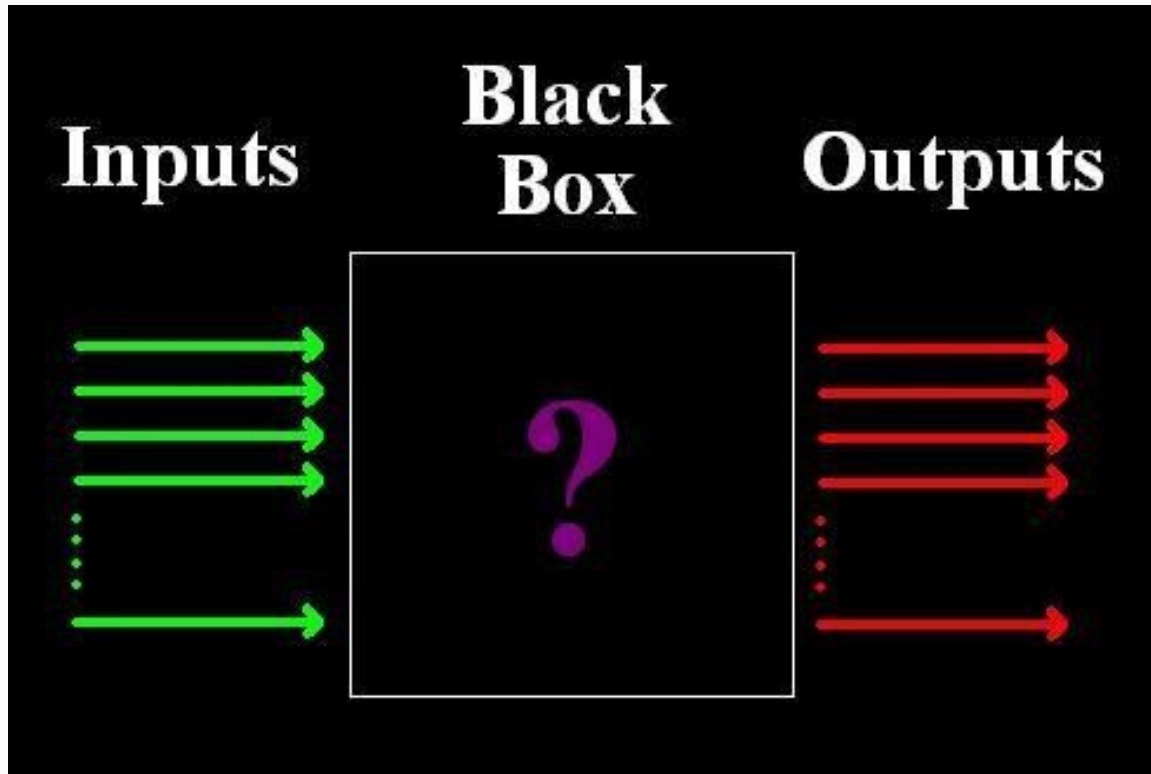
Google’s DeepMind: how to think like a world-class Go player

DeepMind Health: how to diagnose like a doctor

Bringing the “Google brain” just a little closer to lifelike.

What we've seen so far: Decision Trees

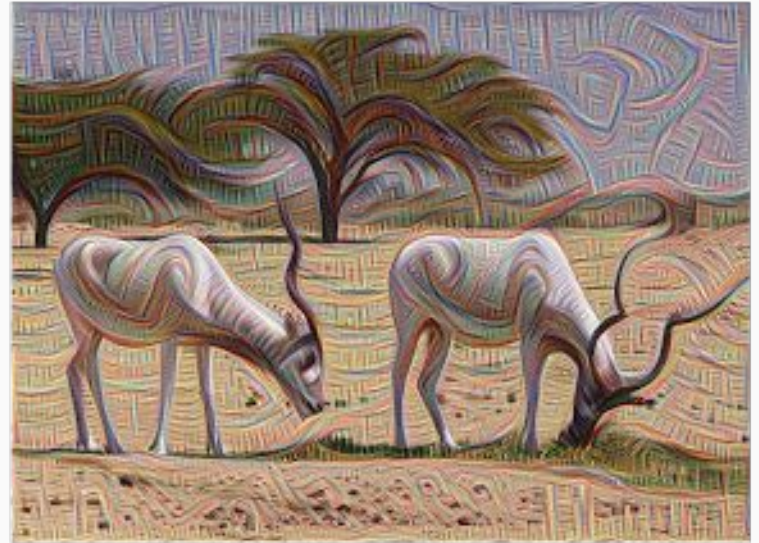




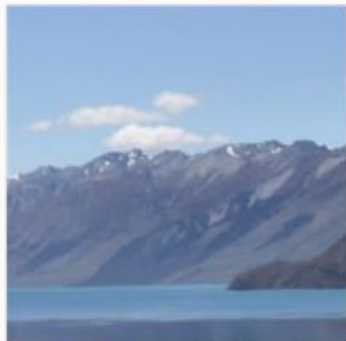
Deep Dream's Implications and Purpose

- Grants a peek inside of the propagation black box.

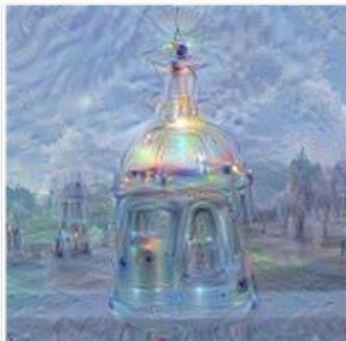
A low level amplification



Deep Dream's Implications and Purpose



Horizon



Towers & Pagodas



Trees



Buildings

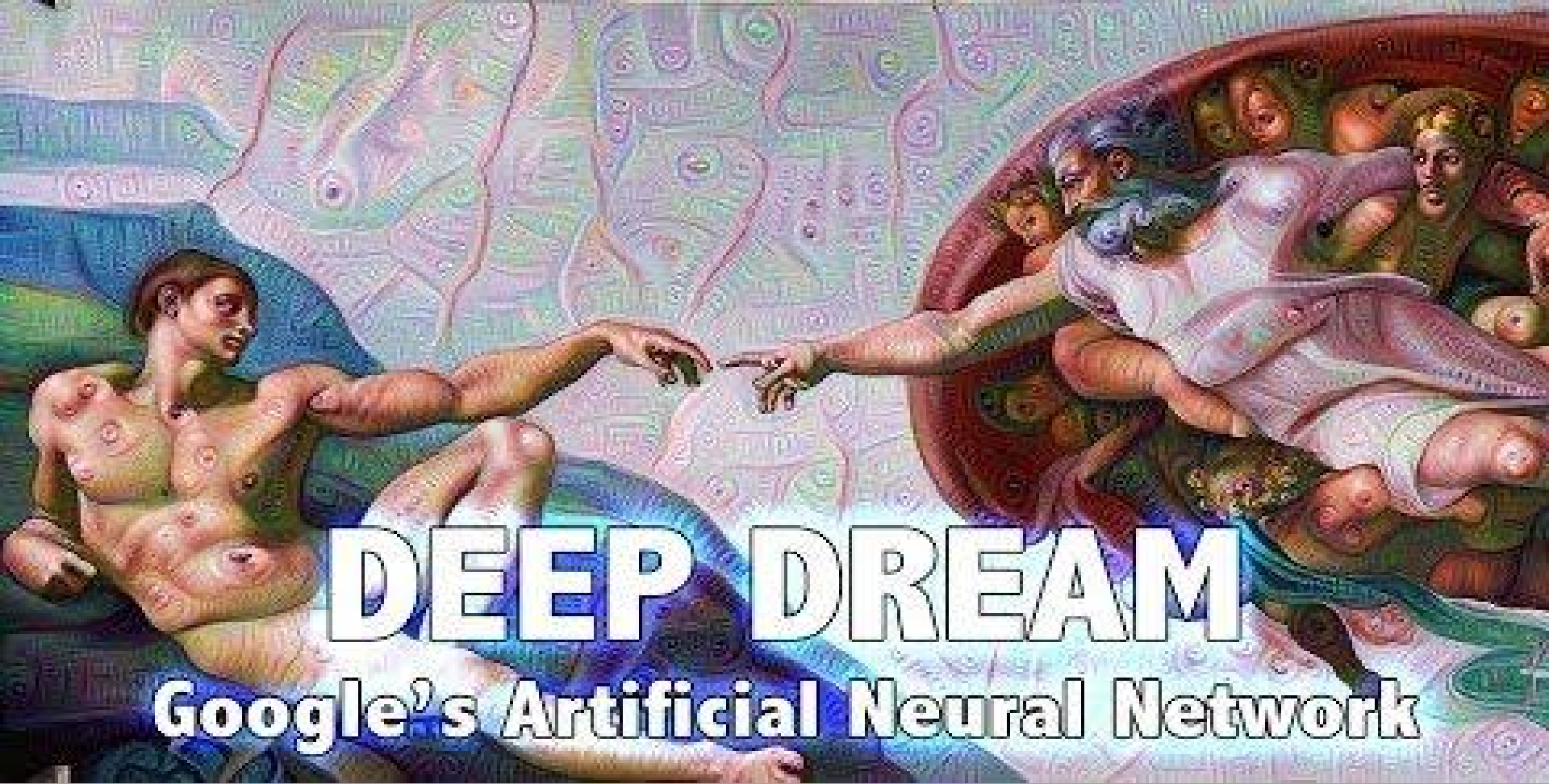


Leaves



Birds & Insects

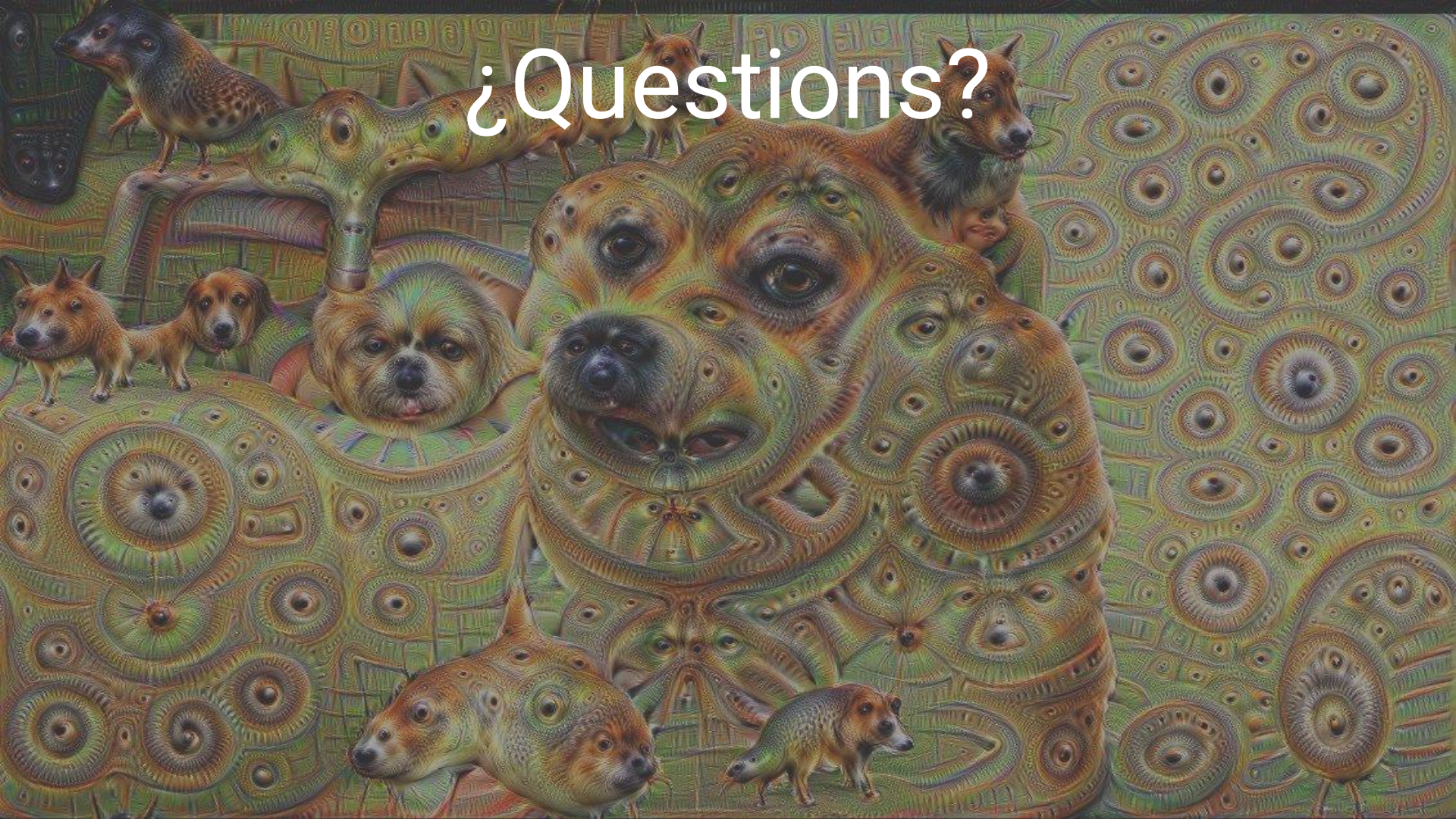
A high level amplification



DEEP DREAM

Google's Artificial Neural Network

¿Questions?



Works Cited

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