

Title: DeepDream

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Supervised learning

Unsupervised learning

Semi-supervised learning

Self-supervised learning

Reinforcement learning

Meta-learning

Online learning

Batch learning

Curriculum learning

Rule-based learning

Neuro-symbolic AI

Neuromorphic engineering

Quantum machine learning

Classification

Generative modeling

Regression

Clustering

Dimensionality reduction

Density estimation

Anomaly detection

Data cleaning

AutoML

Association rules

Semantic analysis

Structured prediction

Feature engineering

Feature learning

Learning to rank

Grammar induction

Ontology learning  
Multimodal learning  
Apprenticeship learning  
Decision trees  
Ensembles Bagging Boosting Random forest  
Bagging  
Boosting  
Random forest  
k -NN  
Linear regression  
Naïve Bayes  
Artificial neural networks  
Logistic regression  
Perceptron  
Relevance vector machine (RVM)  
Support vector machine (SVM)  
BIRCH  
CURE  
Hierarchical  
k -means  
Fuzzy  
Expectation–maximization (EM)  
DBSCAN  
OPTICS  
Mean shift  
Factor analysis  
CCA  
ICA  
LDA  
NMF  
PCA  
PGD  
t-SNE  
SDL  
Graphical models Bayes net Conditional random field Hidden Markov  
Bayes net  
Conditional random field  
Hidden Markov

RANSAC  
k -NN  
Local outlier factor  
Isolation forest  
Autoencoder  
Deep learning  
Feedforward neural network  
Recurrent neural network LSTM GRU ESN reservoir computing  
LSTM  
GRU  
ESN  
reservoir computing  
Boltzmann machine Restricted  
Restricted  
GAN  
Diffusion model  
SOM  
Convolutional neural network U-Net LeNet AlexNet DeepDream  
U-Net  
LeNet  
AlexNet  
DeepDream  
Neural field Neural radiance field Physics-informed neural networks  
Neural radiance field  
Physics-informed neural networks  
Transformer Vision  
Vision  
Mamba  
Spiking neural network  
Memtransistor  
Electrochemical RAM (ECRAM)  
Q-learning  
Policy gradient  
SARSA  
Temporal difference (TD)  
Multi-agent Self-play  
Self-play  
Active learning

Crowdsourcing  
Human-in-the-loop  
Mechanistic interpretability  
RLHF  
Coefficient of determination  
Confusion matrix  
Learning curve  
ROC curve  
Kernel machines  
Bias–variance tradeoff  
Computational learning theory  
Empirical risk minimization  
Occam learning  
PAC learning  
Statistical learning  
VC theory  
Topological deep learning  
AAAI  
ECML PKDD  
NeurIPS  
ICML  
ICLR  
IJCAI  
ML  
JMLR

Glossary of artificial intelligence

List of datasets for machine-learning research List of datasets in computer vision and image processing

List of datasets in computer vision and image processing

Outline of machine learning

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DeepDream is a computer vision program created by Google engineer Alexander Mordvintsev that uses a convolutional neural network to find and enhance patterns in images via algorithmic pareidolia , thus creating a dream -like appearance reminiscent of a psychedelic experience in the deliberately overprocessed images. [ 1 ] [ 2 ] [ 3 ]

Google's program popularized the term (deep) "dreaming" to refer to the generation of images that produce desired activations in a trained deep network , and the term now refers to a collection of related approaches.

## History

The DeepDream software, originated in a deep convolutional network codenamed "Inception" after the film of the same name, [ 1 ] [ 2 ] [ 3 ] was developed for the ImageNet Large-Scale Visual Recognition Challenge (ILSVRC) in 2014 [ 3 ] and released in July 2015.

The dreaming idea and name became popular on the internet in 2015 thanks to Google's DeepDream program. The idea dates from early in the history of neural networks, [ 4 ] and similar methods have been used to synthesize visual textures. [ 5 ] Related visualization ideas were developed (prior to Google's work) by several research groups. [ 6 ] [ 7 ]

After Google published their techniques and made their code open-source, [ 8 ] a number of tools in the form of web services, mobile applications, and desktop software appeared on the market to enable users to transform their own photos. [ 9 ]

## Process

The software is designed to detect faces and other patterns in images, with the aim of automatically classifying images. [ 10 ] However, once trained, the network can also be run in reverse, being asked to adjust the original image slightly so that a given output neuron (e.g. the one for faces or certain animals) yields a higher confidence score. This can be used for visualizations to understand the emergent structure of the neural network better, and is the basis for the DeepDream concept. This reversal procedure is never perfectly clear and unambiguous because it utilizes a one-to-many mapping process. [ 11 ] However, after enough reiterations, even imagery initially devoid of the sought features will be adjusted enough that a form of pareidolia results, by which psychedelic and surreal images are generated algorithmically. The optimization resembles backpropagation; however, instead of adjusting the network weights, the weights are held fixed and the input is adjusted.

For example, an existing image can be altered so that it is "more cat-like", and the resulting enhanced image can be again input to the procedure. [ 2 ] This usage resembles the activity of looking for animals or other patterns in clouds.

Applying gradient descent independently to each pixel of the input produces images in which adjacent pixels have little relation and thus the image has too much high frequency information.

The generated images can be greatly improved by including a prior or regularizer that prefers inputs that have natural image statistics (without a preference for any particular image), or are simply smooth. [ 7 ] [ 12 ] [ 13 ] For example, Mahendran et al. [ 12 ] used the total variation regularizer that prefers images that are piecewise constant. Various regularizers are discussed further in Yosinski et al. [ 13 ] An in-depth, visual exploration of feature visualization and regularization techniques was published more recently. [ 14 ]

The cited resemblance of the imagery to LSD - and psilocybin -induced hallucinations is suggestive of a functional resemblance between artificial neural networks and particular layers of the visual cortex. [ 15 ]

Neural networks such as DeepDream have biological analogies providing insight into brain processing and the formation of consciousness. Hallucinogens such as DMT alter the function of the serotonergic system which is present within the layers of the visual cortex. Neural networks are trained on input vectors and are altered by internal variations during the training process. The input and internal modifications represent the processing of exogenous and endogenous signals respectively in the visual cortex. As internal variations are modified in deep neural networks the output image reflects these changes. This specific manipulation demonstrates how inner brain mechanisms are analogous to internal layers of neural networks. Internal noise level modifications represent how hallucinogens omit external sensory information leading internal preconceived conceptions to strongly influence visual perception. [ 16 ]

## Usage

The dreaming idea can be applied to hidden (internal) neurons other than those in the output,

which allows exploration of the roles and representations of various parts of the network. [ 13 ] It is also possible to optimize the input to satisfy either a single neuron (this usage is sometimes called Activity Maximization) [ 17 ] or an entire layer of neurons.

While dreaming is most often used for visualizing networks or producing computer art, it has recently been proposed that adding "dreamed" inputs to the training set can improve training times for abstractions in Computer Science. [ 18 ]

The DeepDream model has also been demonstrated to have application in the field of art history . [ 19 ]

DeepDream was used for Foster the People 's music video for the song " Doing It for the Money " . [ 20 ]

In 2017, a research group out of the University of Sussex created a Hallucination Machine , applying the DeepDream algorithm to a pre-recorded panoramic video, allowing users to explore virtual reality environments to mimic the experience of psychoactive substances and/or psychopathological conditions. [ 21 ] They were able to demonstrate that the subjective experiences induced by the Hallucination Machine differed significantly from control (non-'hallucinogenic') videos, while bearing phenomenological similarities to the psychedelic state (following administration of psilocybin).

In 2021, a study published in the journal Entropy demonstrated the similarity between DeepDream and actual psychedelic experience with neuroscientific evidence. [ 22 ] The authors recorded Electroencephalography ( EEG ) of human participants during passive vision of a movie clip and its DeepDream-generated counterpart. They found that DeepDream video triggered a higher entropy in the EEG signal and a higher level of functional connectivity between brain areas, [ 22 ] both well-known biomarkers of actual psychedelic experience. [ 23 ]

In 2022, a research group coordinated by the University of Trento "measure[d] participants' cognitive flexibility and creativity after the exposure to virtual reality panoramic videos and their hallucinatory-like counterparts generated by the DeepDream algorithm ... following the simulated psychedelic exposure, individuals exhibited ... an attenuated contribution of the automatic process and chaotic dynamics underlying their decision processes, presumably due to a reorganization in the cognitive dynamics that facilitates the exploration of uncommon decision strategies and inhibits automated choices." [ 24 ]

See also

Art portal

Artificial imagination

DALL-E

Feature detection (computer vision)

Hallucination (artificial intelligence)

Neural style transfer

Procedural textures

Psychedelic art

Texture synthesis

References

External links

Deep Dream, python notebook on GitHub

Mordvintsev, Alexander; Olah, Christopher; Tyka, Mike (June 17, 2015). "Inceptionism: Going Deeper into Neural Networks" . Archived from the original on 2015-07-03.