Title: Google Brain

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Google Brain was a deep learning artificial intelligence research team that served as the sole AI branch of Google before being incorporated under the newer umbrella of Google AI , a research division at Google dedicated to artificial intelligence. Formed in 2011, it combined open-ended machine learning research with information systems and large-scale computing resources. [1] It created tools such as TensorFlow , which allow neural networks to be used by the public, and multiple internal AI research projects, [2] and aimed to create research opportunities in machine learning and natural language processing . [2] It was merged into former Google sister company DeepMind to form Google DeepMind in April 2023.

History

The Google Brain project began in 2011 as a part-time research collaboration between Google fellow Jeff Dean and Google Researcher Greg Corrado. [3] Google Brain started as a Google X project and became so successful that it was graduated back to Google: Astro Teller has said that Google Brain paid for the entire cost of Google X . [4]

In June 2012, the New York Times reported that a cluster of 16,000 processors in 1,000 computers dedicated to mimicking some aspects of human brain activity had successfully trained itself to recognize a cat based on 10 million digital images taken from YouTube videos. [3] The story was also covered by National Public Radio . [5]

In March 2013, Google hired Geoffrey Hinton , a leading researcher in the deep learning field, and acquired the company DNNResearch Inc. headed by Hinton. Hinton said that he would be dividing his future time between his university research and his work at Google. [6]

In April 2023, Google Brain merged with Google sister company DeepMind to form Google DeepMind , as part of the company's continued efforts to accelerate work on AI. [7]

Team and location

Google Brain was initially established by Google Fellow Jeff Dean and visiting Stanford professor Andrew Ng . In 2014, the team included Jeff Dean , Quoc Le , Ilya Sutskever , Alex Krizhevsky , Samy Bengio , and Vincent Vanhoucke. In 2017, team members included Anelia Angelova, Samy Bengio , Greg Corrado, George Dahl, Michael Isard, Anjuli Kannan, Hugo Larochelle, Chris Olah, Salih Edneer, Benoit Steiner, Vincent Vanhoucke, Vijay Vasudevan, and Fernanda Viegas . [8] Chris Lattner , who created Apple 's programming language Swift and then ran Tesla 's autonomy team for six months, joined Google Brain's team in August 2017. [9] Lattner left the team in January 2020 and joined SiFive . [10]

As of 2021 [update] , Google Brain was led by Jeff Dean , Geoffrey Hinton , and Zoubin Ghahramani . Other members include Katherine Heller, Pi-Chuan Chang, Ian Simon, Jean-Philippe Vert, Nevena Lazic, Anelia Angelova, Lukasz Kaiser, Carrie Jun Cai, Eric Breck, Ruoming Pang, Carlos Riquelme, Hugo Larochelle, and David Ha. [8] Samy Bengio left the team in April 2021, [11] and Zoubin Ghahramani took on his responsibilities.

Google Research includes Google Brain and is based in Mountain View, California . It also has satellite groups in Accra , Amsterdam , Atlanta , Beijing , Berlin , Cambridge (Massachusetts) , Israel , Los Angeles , London , Montreal , Munich , New York City , Paris , Pittsburgh , Princeton ,

San Francisco , Seattle , Tokyo , Toronto , and Zürich . [12]

Projects

Artificial-intelligence-devised encryption system

In October 2016, Google Brain designed an experiment to determine that neural networks are capable of learning secure symmetric encryption . [13] In this experiment, three neural networks were created: Alice, Bob and Eve. [14] Adhering to the idea of a generative adversarial network (GAN), the goal of the experiment was for Alice to send an encrypted message to Bob that Bob could decrypt, but the adversary, Eve, could not. [14] Alice and Bob maintained an advantage over Eve, in that they shared a key used for encryption and decryption . [13] In doing so, Google Brain demonstrated the capability of neural networks to learn secure encryption . [13]

Image enhancement

In February 2017, Google Brain determined a probabilistic method for converting pictures with 8x8 resolution to a resolution of 32x32. [15] [16] The method built upon an already existing probabilistic model called pixelCNN to generate pixel translations. [17] [18]

The proposed software utilizes two neural networks to make approximations for the pixel makeup of translated images. [16] [19] The first network, known as the "conditioning network," downsizes high-resolution images to 8x8 and attempts to create mappings from the original 8x8 image to these higher-resolution ones. [16] The other network, known as the "prior network," uses the mappings from the previous network to add more detail to the original image. [16] The resulting translated image is not the same image in higher resolution, but rather a 32x32 resolution estimation based on other existing high-resolution images. [16] Google Brain's results indicate the possibility for neural networks to enhance images. [20]

Google Translate

The Google Brain team contributed to the Google Translate project by employing a new deep learning system that combines artificial neural networks with vast databases of multilingual texts. [21] In September 2016, Google Neural Machine Translation (GNMT) was launched, an end-to-end learning framework, able to learn from a large number of examples. [21] Previously, Google Translate's Phrase-Based Machine Translation (PBMT) approach would statistically analyze word by word and try to match corresponding words in other languages without considering the surrounding phrases in the sentence. [22] But rather than choosing a replacement for each individual word in the desired language, GNMT evaluates word segments in the context of the rest of the sentence to choose more accurate replacements. [2] Compared to older PBMT models, the GNMT model scored a 24% improvement in similarity to human translation, with a 60% reduction in errors. [2] [21] The GNMT has also shown significant improvement for notoriously difficult translations, like Chinese to English . [21]

While the introduction of the GNMT has increased the quality of Google Translate's translations for the pilot languages, it was very difficult to create such improvements for all of its 103 languages. Addressing this problem, the Google Brain Team was able to develop a Multilingual GNMT system, which extended the previous one by enabling translations between multiple languages. Furthermore, it allows for Zero-Shot Translations, which are translations between two languages that the system has never explicitly seen before. [23] Google announced that Google Translate can now also translate without transcribing, using neural networks. This means that it is possible to translate speech in one language directly into text in another language, without first transcribing it to text.

According to the Researchers at Google Brain, this intermediate step can be avoided using neural networks. In order for the system to learn this, they exposed it to many hours of Spanish audio together with the corresponding English text. The different layers of neural networks, replicating the human brain, were able to link the corresponding parts and subsequently manipulate the audio waveform until it was transformed to English text. [24] Another drawback of the GNMT model is that it causes the time of translation to increase exponentially with the number of words in the sentence. [2] This caused the Google Brain Team to add 2000 more processors to ensure the new translation process would still be fast and reliable. [22]

Robotics

Aiming to improve traditional robotics control algorithms where new skills of a robot need to be hand-programmed , robotics researchers at Google Brain are developing machine learning techniques to allow robots to learn new skills on their own. [25] They also attempt to develop ways for information sharing between robots so that robots can learn from each other during their learning process, also known as cloud robotics . [26] As a result, Google has launched the Google Cloud Robotics Platform for developers in 2019, an effort to combine robotics , AI , and the cloud to enable efficient robotic automation through cloud-connected collaborative robots. [26]

Robotics research at Google Brain has focused mostly on improving and applying deep learning algorithms to enable robots to complete tasks by learning from experience, simulation, human demonstrations, and/or visual representations. [27] [28] [29] [30] For example, Google Brain researchers showed that robots can learn to pick and throw rigid objects into selected boxes by experimenting in an environment without being pre-programmed to do so. [27] In another research, researchers trained robots to learn behaviors such as pouring liquid from a cup; robots learned from videos of human demonstrations recorded from multiple viewpoints. [29]

Google Brain researchers have collaborated with other companies and academic institutions on robotics research. In 2016, the Google Brain Team collaborated with researchers at X in a research on learning hand-eye coordination for robotic grasping. [31] Their method allowed real-time robot control for grasping novel objects with self-correction. [31] In 2020, researchers from Google Brain, Intel AI Lab, and UC Berkeley created an AI model for robots to learn surgery-related tasks such as suturing from training with surgery videos. [30]

Interactive Speaker Recognition with Reinforcement Learning

In 2020, Google Brain Team and University of Lille presented a model for automatic speaker recognition which they called Interactive Speaker Recognition. The ISR module recognizes a speaker from a given list of speakers only by requesting a few user specific words. [32] The model can be altered to choose speech segments in the context of Text-To-Speech Training. [32] It can also prevent malicious voice generators from accessing the data. [32]

TensorFlow

TensorFlow is an open source software library powered by Google Brain that allows anyone to utilize machine learning by providing the tools to train one's own neural network. [2] The tool has been used to develop software using deep learning models that farmers use to reduce the amount of manual labor required to sort their yield, by training it with a data set of human-sorted images. [2]

Magenta

Magenta is a project that uses Google Brain to create new information in the form of art and music rather than classify and sort existing data. [2] TensorFlow was updated with a suite of tools for users to guide the neural network to create images and music. [2] However, the team from Valdosta State University found that the AI struggles to perfectly replicate human intention in artistry , similar to the issues faced in translation . [2]

Medical applications

The image sorting capabilities of Google Brain have been used to help detect certain medical conditions by seeking out patterns that human doctors may not notice to provide an earlier diagnosis. [2] During screening for breast cancer, this method was found to have one quarter the false positive rate of human pathologists, who require more time to look over each photo and cannot spend their entire focus on this one task. [2] Due to the neural network's very specific training for a single task, it cannot identify other afflictions present in a photo that a human could easily spot. [2]

Transformer

The transformer deep learning architecture was invented by Google Brain researchers in 2017, and explained in the scientific paper Attention Is All You Need . [33] Google owns a patent on this

widely used architecture, but hasn't enforced it. [34] [35]

Text-to-image model

Google Brain announced in 2022 that it created two different types of text-to-image models called Imagen and Parti that compete with OpenAI 's DALL-E . [36] [37]

Later in 2022, the project was extended to text-to-video. [38]

Imagen development was transferred to Google Deepmind after the merger with Deepmind. [39]

Other Google products

The Google Brain projects' technology is currently used in various other Google products such as the Android Operating System 's speech recognition system , photo search for Google Photos , smart reply in Gmail , and video recommendations in YouTube . [40] [41] [42]

Reception

Google Brain has received coverage in Wired , [43] [44] [45] NPR , [5] and Big Think . [46] These articles have contained interviews with key team members Ray Kurzweil and Andrew Ng, and focus on explanations of the project's goals and applications. [43] [5] [46]

Controversies

In December 2020, AI ethicist Timnit Gebru left Google. [47] While the exact nature of her quitting or being fired is disputed, the cause of the departure was her refusal to retract a paper entitled " On the Dangers of Stochastic Parrots: Can Language Models Be Too Big? " and a related ultimatum she made, setting conditions to be met otherwise she would leave. [47] This paper explored potential risks of the growth of AI such as Google Brain, including environmental impact, biases in training data, and the ability to deceive the public. [47] [48] The request to retract the paper was made by Megan Kacholia, vice president of Google Brain. [49] As of April 2021, nearly 7000 current or former Google employees and industry supporters have signed an open letter accusing Google of "research censorship" and condemning Gebru's treatment at the company. [50]

In February 2021, Google fired one of the leaders of the company's AI ethics team, Margaret Mitchell . [49] The company's statement alleged that Mitchell had broken company policy by using automated tools to find support for Gebru. [49] In the same month, engineers outside the ethics team began to quit, citing the termination of Gebru as their reason for leaving. [51] In April 2021, Google Brain co-founder Samy Bengio announced his resignation from the company. [11] Despite being Gebru's manager, Bengio was not notified before her termination, and he posted online in support of both her and Mitchell. [11] While Bengio's announcement focused on personal growth as his reason for leaving, anonymous sources indicated to Reuters that the turmoil within the AI ethics team played a role in his considerations. [11]

In March 2022, Google fired AI researcher Satrajit Chatterjee after he questioned the findings of a paper published in Nature , by Google's AI team members, Anna Goldie and Azalia Mirhoseini. [52] [53] This paper claimed that their AI techniques (in particular reinforcement learning) for the placement problem for integrated circuits were superior to prior methods. [54] However, this claim is contested because claimed results, especially fast chip design , were not properly supported by specific empirical data and found inconsistent with subsequent published research. [55] [56] [57] [58] The paper does not report run times of prior and proposed methods on specific inputs, lacks head-to-head comparisons to sufficiently advanced implementations of prior methods, and is difficult to replicate due to proprietary training and test data. [57] At least one initially favorable commentary has been retracted upon further review, [59] and the paper is under investigation by Nature. [60] Further media coverage conveyed skepticism about research published by Google and noted that Google had not provided the comparative benchmarks long requested by experts. [61] [62] California Judge Frederick Chung ruled that Chatterjee had "adequately supported his claim that Google terminated him in retaliation for refusing to participate in an act that would violate state or federal law." In his lawsuit, Chatterjee claimed a Google research paper overhyped technology. [63] [64]

See also

Artificial intelligence art

Glossary of artificial intelligence

List of artificial intelligence projects

Noosphere

Quantum Artificial Intelligence Lab – run by Google in collaboration with NASA and Universities Space Research Association

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Google

Google Brain

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AlphaFold (2018)

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AlphaGeometry (2024)

AlphaGenome (2025)

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Gato (2022)

Quantum Artificial Intelligence Lab

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Neverware
Nik Software

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SlickLogin
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Viewdle
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Contact Lens
Content ID
CrossCheck
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Data Transfer Project
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Living Stories
Made with Code
News Lab
PowerMeter

Privacy Sandbox
Project Nightingale
Project Nimbus
Project Sunroof
Project Zero
Quantum Artificial Intelligence Lab
RechargeIT
Sensorvault
Silicon Initiative
Solve for X
Street View Trusted
Student Ambassador Program
Vevo
YouTube BrandConnect
YouTube Creator Awards
YouTube Select
YouTube Original Channel Initiative
Year in Search
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2018
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YouTube Live
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2015
YouTube Space Lab
YouTube Symphony Orchestra
111 Eighth Avenue
Android lawn statues
Androidland
Barges
Binoculars Building
Central Saint Giles
Chelsea Market
Chrome Zone
Data centers
GeoEye-1
Googleplex
Ivanpah Solar Power Facility
James R. Thompson Center
King's Cross
Mayfield Mall
Pier 57
Sidewalk Toronto
St. John's Terminal
Submarine cables Dunant Grace Hopper Unity
Dunant
Grace Hopper
Unity
WiFi
YouTube Space
YouTube Theater
Krishna Bharat

Vint Cerf

Jeff Dean

John Doerr

Sanjay Ghemawat

Al Gore

John L. Hennessy

Urs Hölzle

Salar Kamangar

Ray Kurzweil

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Ruth Porat (CFO)

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Hal Varian

Neal Mohan

Andy Bechtolsheim

Sergey Brin (co-founder)

David Cheriton

Matt Cutts

David Drummond

Alan Eustace

Timnit Gebru

Omid Kordestani

Paul Otellini

Larry Page (co-founder)

Patrick Pichette

Eric Schmidt

Ram Shriram

Amit Singhal

Shirley M. Tilghman

Rachel Whetstone

Susan Wojcicki

Censorship

DeGoogle

FairSearch

" Google's Ideological Echo Chamber "

No Tech for Apartheid
Privacy concerns Street View YouTube
Street View
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Trade unions Alphabet Workers Union
Alphabet Workers Union
YouTube copyright issues
Backdoor advertisement controversy
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ALTS
American Fuzzy Lop
Android Cloud to Device Messaging

Android Debug Bridge
Android NDK
Android Runtime
Android SDK
Android Studio
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AngularJS
Apache Beam
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App Engine
App Inventor
App Maker
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Exposure Notification
Fast Pair
Fastboot
Federated Learning of Cohorts
File System
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Firebase Cloud Messaging
FlatBuffers
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Chromecast

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smart speakers

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United States v. Google LLC (2023)

Perfect 10, Inc. v. Amazon.com, Inc. (2007)

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Lenz v. Universal Music Corp. (2015)
Authors Guild, Inc. v. Google, Inc. (2015)
Field v. Google, Inc. (2016)
Google LLC v. Oracle America, Inc. (2021)
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Rocky Mountain Bank v. Google, Inc. (2009)
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Google as a verb
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Googlefight
Google hacking
Googleshare
Google tax
Googlewhack
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Illegal flower tribute
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Search engine manipulation effect
Side project time

Sitelink

Site reliability engineering

StudyTube

VTuber

YouTube Poop

YouTuber list

list

Booting process

Custom distributions

Features

Recovery mode

Software development

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Antarctica

Asia Israel

Israel

Europe

North America Canada United States

Canada

United States

Oceania

South America Argentina Chile Colombia

Argentina

Chile

Colombia

Copyright strike

Education

Features

Moderation

Most-disliked videos

Most-liked videos

Most-subscribed channels

Most-viewed channels

Most-viewed videos Arabic music videos Chinese music videos French music videos Indian videos Pakistani videos

Arabic music videos

Chinese music videos

French music videos

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Maps pin
Most downloaded Google Play applications
Stadia games
AlphaGo
Google: Behind the Screen
Google Maps Road Trip
Google and the World Brain
The Creepy Line
Google Hacks
The Google Story
Googled: The End of the World as We Know It
How Google Works
I'm Feeling Lucky
In the Plex
The MANIAC
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Google Me (film)
" Google Me " (Kim Zolciak song)
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timeline

Companies

Projects

Parameter Hyperparameter

Hyperparameter

Loss functions

Regression Bias–variance tradeoff Double descent Overfitting

Bias–variance tradeoff

Double descent

Overfitting

Clustering

Gradient descent SGD Quasi-Newton method Conjugate gradient method

SGD

Quasi-Newton method

Conjugate gradient method

Backpropagation

Attention

Convolution

Normalization Batchnorm

Batchnorm

Activation Softmax Sigmoid Rectifier

Softmax

Sigmoid

Rectifier

Gating

Weight initialization

Regularization

Datasets Augmentation

Augmentation

Prompt engineering

Reinforcement learning Q-learning SARSA Imitation Policy gradient

Q-learning

SARSA

Imitation

Policy gradient

Diffusion

Latent diffusion model

Autoregression

Adversary

RAG

Uncanny valley

RLHF

Self-supervised learning

Reflection

Recursive self-improvement

Hallucination

Word embedding

Vibe coding

Machine learning In-context learning

In-context learning

Artificial neural network Deep learning

Deep learning

Language model Large language model NMT

Large language model

NMT

Reasoning language model

Model Context Protocol

Intelligent agent

Artificial human companion

Humanity's Last Exam

Artificial general intelligence (AGI)

AlexNet

WaveNet

Human image synthesis

HWR

OCR

Computer vision

Speech synthesis 15.ai ElevenLabs

15.ai

ElevenLabs

Speech recognition Whisper

Whisper

Facial recognition

AlphaFold

Text-to-image models Aurora DALL-E Firefly Flux Ideogram Imagen Midjourney Recraft Stable Diffusion

Aurora

DALL-E

Firefly

Flux

Ideogram

Imagen

Midjourney

Recraft

Stable Diffusion

Text-to-video models Dream Machine Runway Gen Hailuo AI Kling Sora Veo

Dream Machine

Runway Gen

Hailuo AI

Kling

Sora

Veo

Music generation Riffusion Suno AI Udio

Riffusion

Suno AI

Udio

Word2vec

Seq2seq

GloVe

BERT

T5

Llama

Chinchilla AI

PaLM

GPT 1 2 3 J ChatGPT 4 4o o1 o3 4.5 4.1 o4-mini 5

1

2

3

J

ChatGPT

4

4o

o1

o3

4.5

4.1

o4-mini

5

Claude

Gemini Gemini (language model) Gemma

Gemini (language model)

Gemma

Grok

LaMDA

BLOOM

DBRX

Project Debater

IBM Watson

IBM Watsonx

Granite

PanGu-Σ

DeepSeek

Qwen

AlphaGo

AlphaZero

OpenAI Five

Self-driving car

MuZero

Action selection AutoGPT

AutoGPT

Robot control

Alan Turing

Warren Sturgis McCulloch

Walter Pitts

John von Neumann

Claude Shannon
Shun'ichi Amari
Kunihiko Fukushima
Takeo Kanade
Marvin Minsky
John McCarthy
Nathaniel Rochester
Allen Newell
Cliff Shaw
Herbert A. Simon
Oliver Selfridge
Frank Rosenblatt
Bernard Widrow
Joseph Weizenbaum
Seymour Papert
Seppo Linnainmaa
Paul Werbos
Geoffrey Hinton
John Hopfield
Jürgen Schmidhuber
Yann LeCun
Yoshua Bengio
Lotfi A. Zadeh
Stephen Grossberg
Alex Graves
James Goodnight
Andrew Ng
Fei-Fei Li
Alex Krizhevsky
Ilya Sutskever
Oriol Vinyals
Quoc V. Le
Ian Goodfellow
Demis Hassabis
David Silver
Andrej Karpathy
Ashish Vaswani
Noam Shazeer

Aidan Gomez

John Schulman

Mustafa Suleyman

Jan Leike

Daniel Kokotajlo

François Chollet

Neural Turing machine

Differentiable neural computer

Transformer Vision transformer (ViT)

Vision transformer (ViT)

Recurrent neural network (RNN)

Long short-term memory (LSTM)

Gated recurrent unit (GRU)

Echo state network

Multilayer perceptron (MLP)

Convolutional neural network (CNN)

Residual neural network (RNN)

Highway network

Mamba

Autoencoder

Variational autoencoder (VAE)

Generative adversarial network (GAN)

Graph neural network (GNN)

Category