# AlphaGo Zero lernt weltmeisterlich Schach in 4 Stunden

## AlphaZero - KI lernt Schach in vier Stunden und schlägt Weltmeister-KI vernichtend

Wenn der bisher beste Schachcomputer Gefühle hätte, würde er weinen. DeepMinds AlphaZero lernte Schach in vier Stunden und schlug ihn vernichtend.

von **Sebastian Zelada**, 11.12.2017 09:22 Uhr



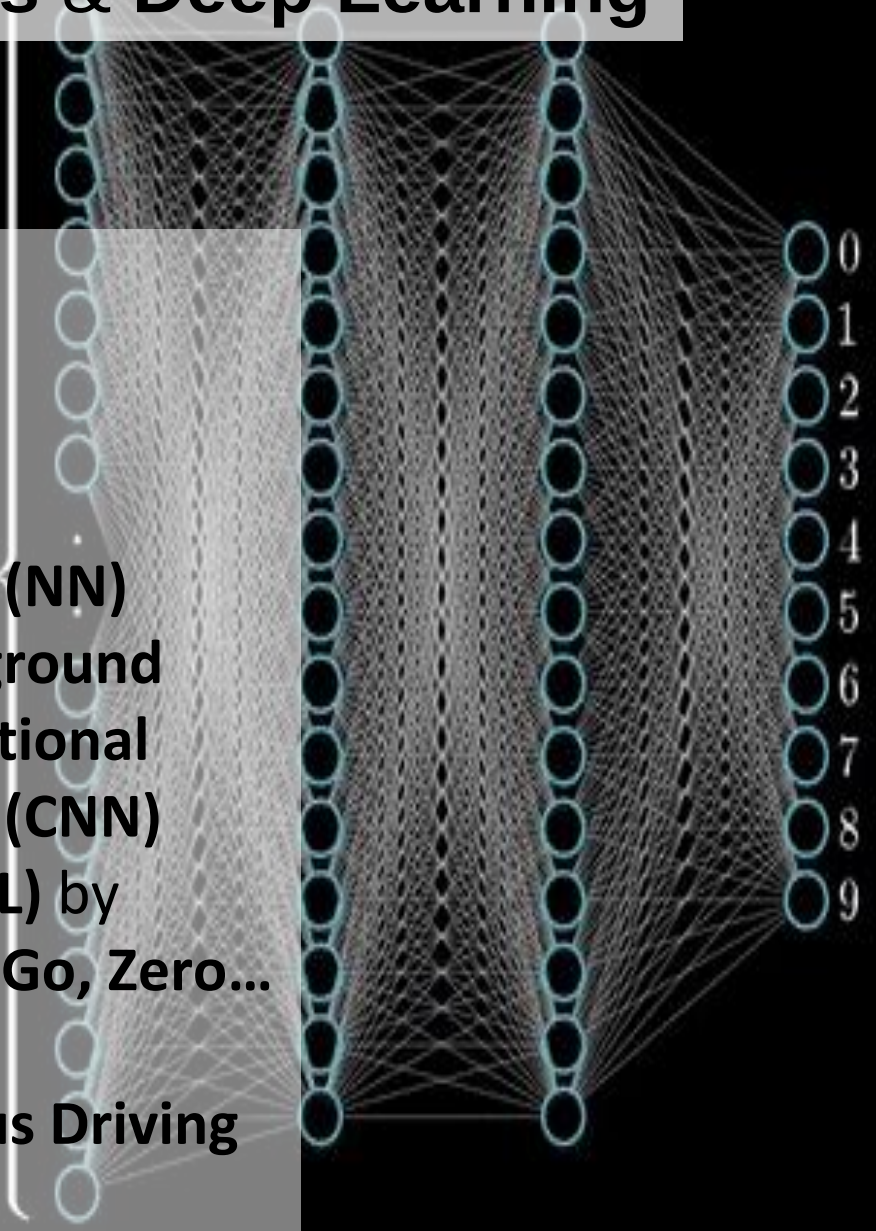

Für einen Menschen unmöglich und selbst für eine KI bemerkenswert: AlphaZero lernte in vier



AKTUELLE NEWS

vor 13 Stu

# 8 Machine Learning I
# - Neural Networks & Deep Learning




**Content**:

1. **Motivation**
2. Basics of **Neural Networks (NN)**
3. **TensorFlow Playground**
4. Basics of **Convolutional Neural Networks (CNN)**
5. **Deep Learning (DL)** by **Deepmind: AlphaGo, Zero…**
6. **Deep NN** in **Tesla Autonomous Driving**
7. **Summary**


5. **Google Deepmind**
   **Deep Learning** with **AlphaGo, Zero…**

# Wikipedia zu DeepMind

## DeepMind

From Wikipedia, the free encyclopedia

**DeepMind Technologies Limited** is a British artificial intelligence company founded in September 2010.

Acquired by Google in 2014, the company has created a neural network that learns how to play video games in a fashion similar to that of humans,[4] as well as a Neural Turing machine,[5] or a neural network that may be able to access an external memory like a conventional Turing machine, resulting in a computer that mimics the short-term memory of the human brain.[6][7]

The company made headlines in 2016 after its AlphaGo program beat a human professional Go player for the first time in October 2015[8] and again when AlphaGo beat Lee Sedol the world champion in a five-game match, which was the subject of a documentary film.[9]

A more generic program, AlphaZero, beat the most powerful programs playing go, chess and shogi (Japanese chess) after a few hours of play against itself using reinforcement learning.[10]

**Contents** [hide]



**DeepMind Technologies Limit**

| | |
|---|---|
| **Type of business** | Subsidiary |
| **Founded** | 23 September 2010; 7 yea ago [1] |
| **Headquarters** | 6 Pancras Square,[2] London N1C 4AG, UK |
| **Founder(s)** | Demis Hassabis, Shane Legg, Mustafa Suleyman |
| **CEO** | Demis Hassabis |
| **Industry** | Artificial Intelligence |
| **Employees** | 400 [3] |
| **Parent** | Independent (2010–2014) Google Inc. (2014–presen Alphabet Inc. (2015–prese |
| **Website** | www.deepmind.com |

# Wikipedia zu AlphaGo

# AlphaGo

From Wikipedia, the free encyclopedia

AlphaGo logo

**AlphaGo** is a computer program that plays the board game Go.[1] It was developed by Alphabet Inc.'s Google DeepMind in London.

In October 2015, AlphaGo became the first computer Go program to beat a human professional Go player without handicaps on a full-sized 19×19 board.[2][3] In March 2016, it beat Lee Sedol in a five-game match, the first time a computer Go program has beaten a 9-dan professional without handicaps.[4] Although it lost to Lee Sedol in the fourth game, Lee resigned the final game, giving a final score of 4 games to 1 in favour of AlphaGo. In recognition of the victory, AlphaGo was awarded an honorary 9-dan by the Korea Baduk Association.[5] The lead up and the challenge match with Lee Sedol were documented in a documentary film also titled *AlphaGo*,[6] directed by Greg Kohs. It was chosen by *Science* as one of the Breakthrough of the Year runners-up on 22 December 2016.[7]

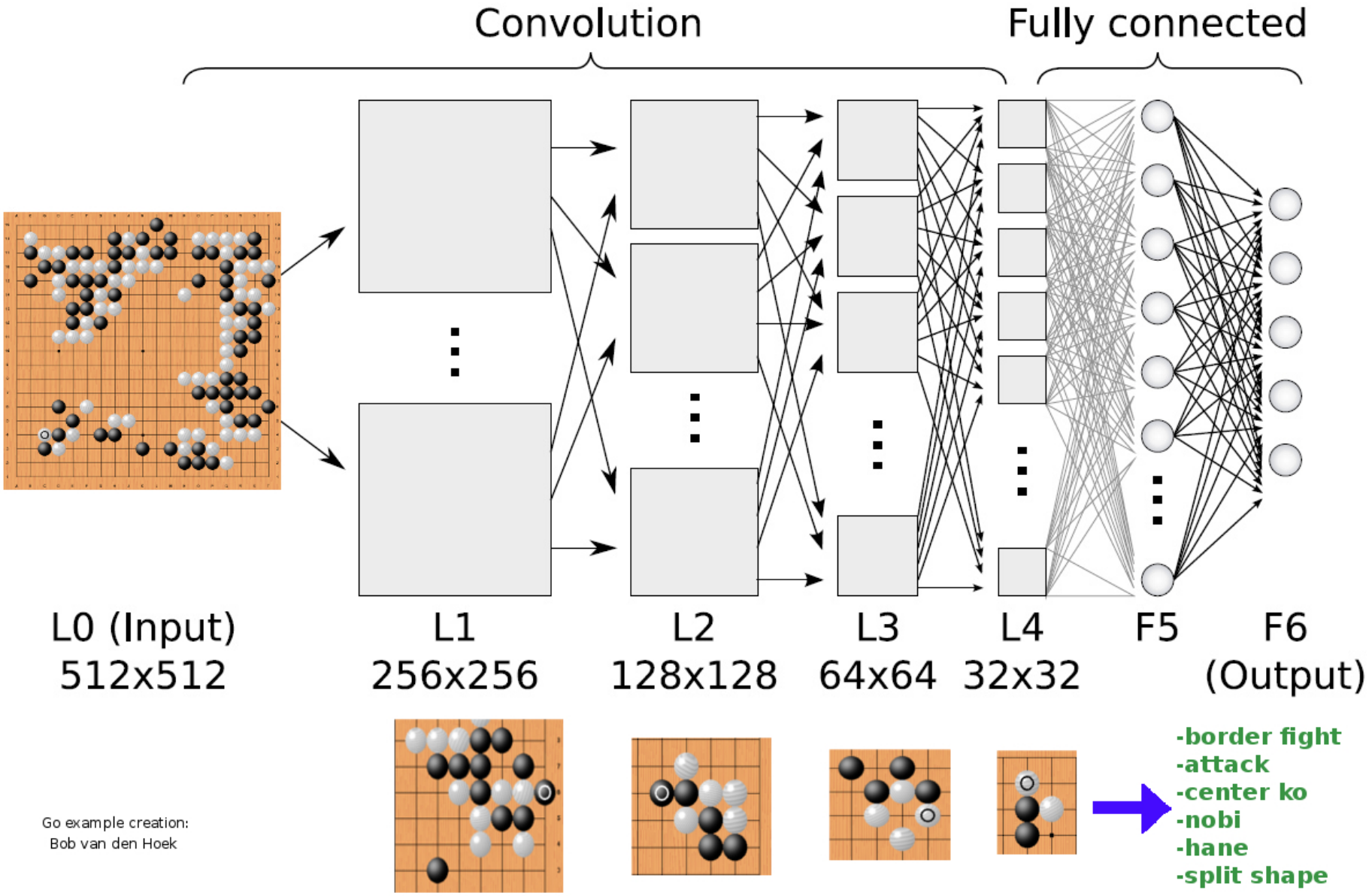
At the 2017 Future of Go Summit, AlphaGo beat Ke Jie, the world No.1 ranked player at the time, in a three-game match. After this, AlphaGo was awarded professional 9-dan by the Chinese Weiqi Association.[8] After the match between AlphaGo and Ke Jie, AlphaGo retired while DeepMind continues AI research in other areas.[9]

AlphaGo uses a Monte Carlo tree search algorithm to find its moves based on knowledge previously "learned" by machine learning, specifically by an artificial neural network (a deep learning method) by extensive training, both from human and computer play.[10]

# Go als Spiel erklärt: **AlphaGo, the movie** (Netflix)

# **AlphaGo** gewinnt das 1. Match (2015)

# Deep Learning is used in AlphaGo AI (Udacity)




Go example creation:
Bob van den Hoek

# **AlphaGo Zero** lernt weltmeisterlich Schach in 4 Stunden

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von **Sebastian Zelada**, 11.12.2017 09:22 Uhr




Für einen Menschen unmöglich und selbst für eine KI bemerkenswert: AlphaZero lernte in vier





# AlphaGo Zero: Starting from scratch …

# Leistungsfähigkeit von **AlphaGo Zero** im Vergleich zu Vorgängern

# ALPHAGO ZERO CHEAT SHEET

The training pipeline for AlphaGo Zero consists of three stages, executed in parallel

## SELF PLAY

Create a 'training set'

**The best current player plays 25,000 games against itself**

See MCTS section to understand how AlphaGo Zero selects each move

**At each move, the following information is stored**

**The game state**
(see 'What is a Game State section')


**The search probabilities**
(from the MCTS)



**The winner**
(+1 if this player won, -1 if this player lost - added once the game has finished)

## RETRAIN NETWORK

Optimise the network weights

A TRAINING LOOP

**Sample a mini-batch of 2048 positions from the last 500,000 games**

**Retrain the current neural network on these positions**
– The game states are the input (see 'Deep Neural Network Architecture')

**Loss function**
Compares predictions from the neural network with the search probabilities and actual winner


**After every 1,000 training loops, evaluate the network**

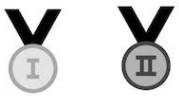
## EVALUATE NETWORK

Test to see if the new network is stronger

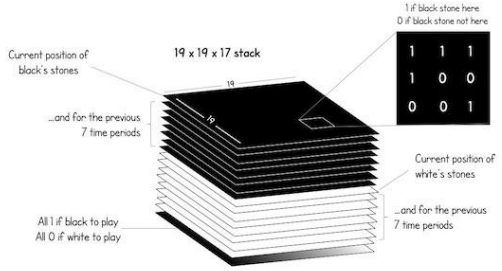
**Play 400 games between the latest neural network and the current best neural network**

Both players use MCTS to select their moves, with their respective neural networks to evaluate leaf nodes

**Latest player must win 55% of games to be declared the new best player**




## WHAT IS A 'GAME STATE'




This stack is the input to the deep neural network

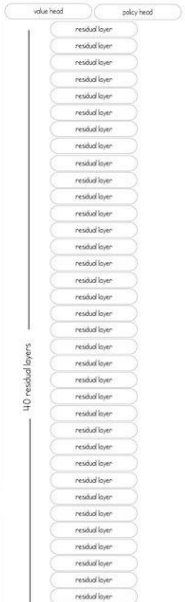
## THE DEEP NEURAL NETWORK ARCHITECTURE

How AlphaGo Zero assesses new positions

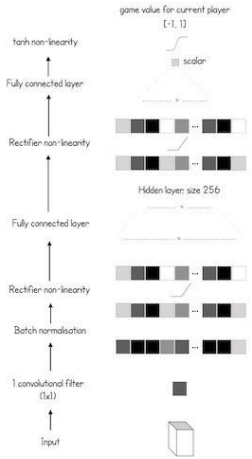
The network learns 'tabula rasa' (from a blank slate)

At no point is the network trained using human knowledge or expert moves

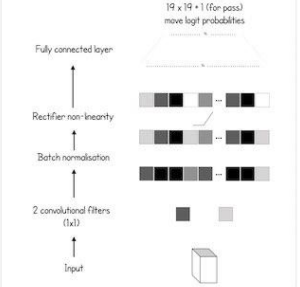
### The network



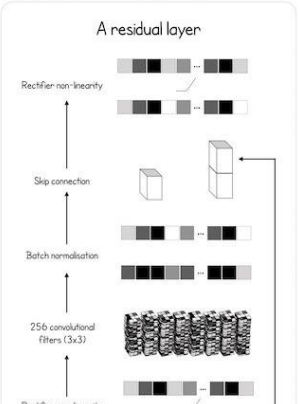

### The value head




### The policy head



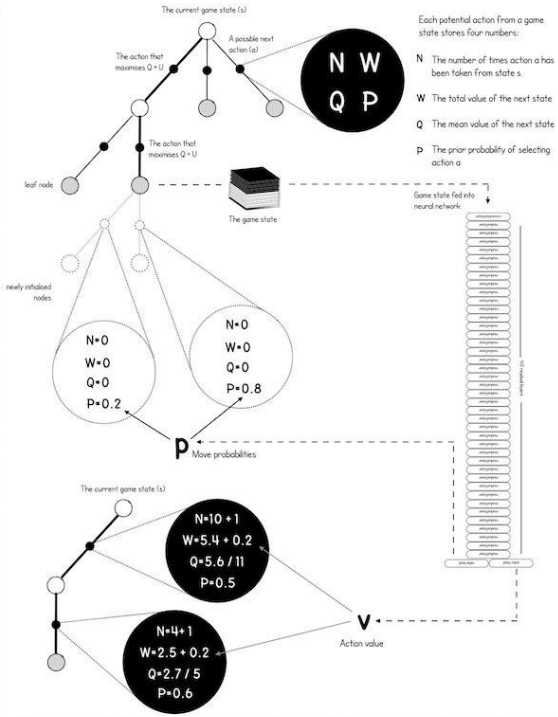

### A residual layer




### A convolutional layer


## MONTE CARLO TREE SEARCH (MCTS)

How AlphaGo Zero chooses its next move




### First, run the following simulation 1,600 times...

Start at the root node of the tree (the current game state)

**1. Choose the action that maximises...**

$$Q + U$$

The mean value of the next state

A function of **P** and **N** that increases if an action hasn't been explored much, relative to the other actions, or if the prior probability of the action is high

Early on in the simulation, U dominates (more exploration), but later Q is more important (less exploration)

**2. Continue until a leaf node is reached**

The game state of the leaf node is passed into the neural network, which outputs predictions about two things:

**p** Move probabilities

**v** Value of the state (for the current player)

The move probabilities p are attached to the new feasible actions from the leaf node

**3. Backup previous edges**

Each edge that was traversed to get to the leaf node is updated as follows:

$$N \rightarrow N + 1$$
$$W \rightarrow W + v$$
$$Q = W / N$$

# ALPHAGO ZERO CHEAT SHEET

The training pipeline for AlphaGo Zero consists of three stages, executed in parallel

SELF PLAY

Create a 'training

The best current player play

See MCTS section to under

At each move, the following i

The game state
(see 'What is a Game State section')

RETRAIN NETWORK

EVALUATE NETWORK

WHAT IS A 'GAME STATE'

1 if black stone here
0 if black stone not here

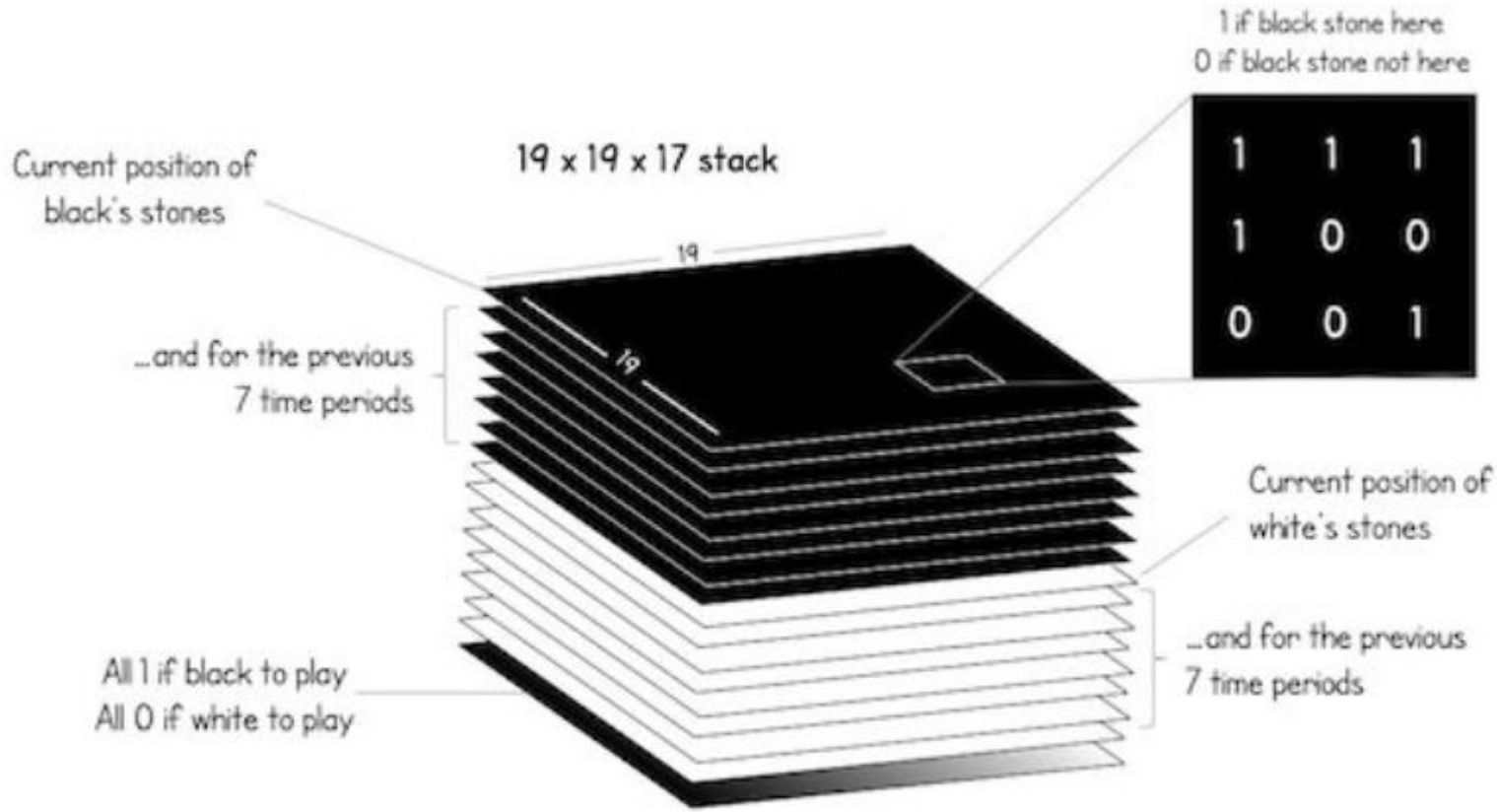
1 1
0 0
0 1

current position of white's stones

for the previous periods

twork

# WHAT IS A 'GAME STATE'




This stack is the input to the deep neural network

THE DEEP
How AlphaG

The network learns 't
At no point is the netw

ation

tate)

The vc

tanh non-linearity
Fully connected layer
Rectifier non-linearity
Fully connected layer
Rectifier non-linearity
Batch normalisation
1 convolutional filter (1x1)
Input

A convolu

Rectifier non-linearity

# Deepmind: Von AlphaGo über AlphaZero zu MuZero

Article

## Mastering Atari, Go, chess and shogi by planning with a learned model

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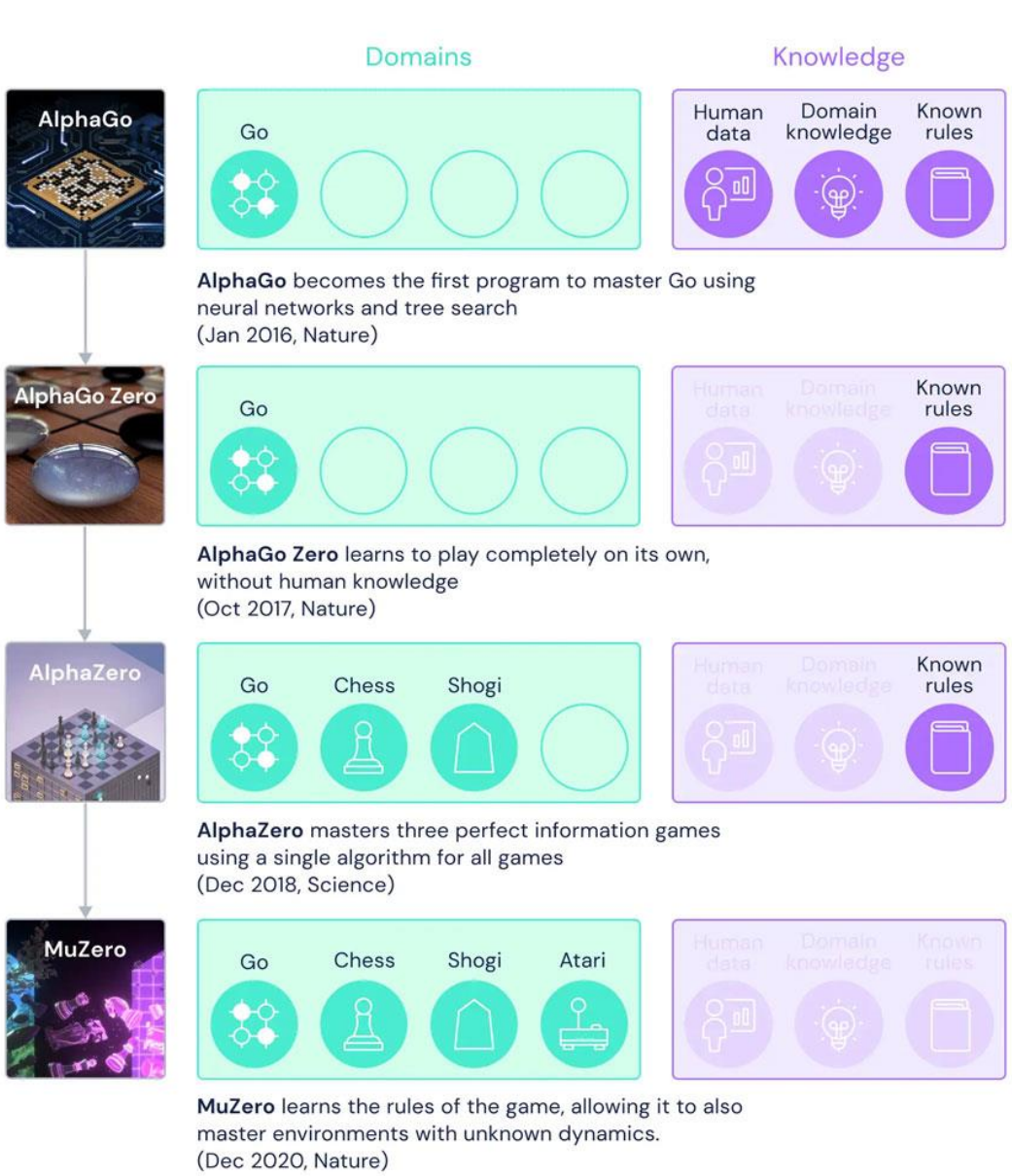
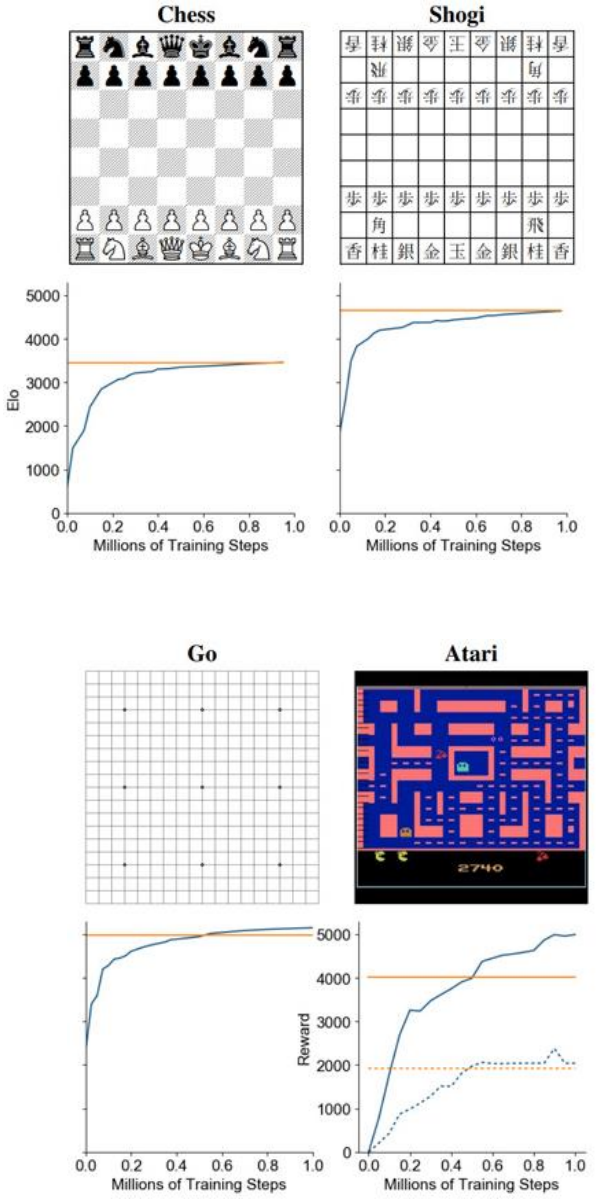
Julian Schrittwieser[1,3], Ioannis Antonoglou[1,2,3], Thomas Hubert[1,3], Karen Simonyan[1], Laurent Sifre[1], Simon Schmitt[1], Arthur Guez[1], Edward Lockhart[1], Demis Hassabis[1], Thore Graepel[1,2], Timothy Lillicrap[1] & David Silver[1,2,3]✉

Constructing agents with planning capabilities has long been one of the main challenges in the pursuit of artificial intelligence. Tree-based planning methods have enjoyed huge success in challenging domains, such as chess[1] and Go[2], where a perfect simulator is available. However, in real-world problems, the dynamics governing the environment are often complex and unknown. Here we present the MuZero algorithm, which, by combining a tree-based search with a learned model, achieves superhuman performance in a range of challenging and visually complex domains, without any knowledge of their underlying dynamics. The MuZero algorithm learns an iterable model that produces predictions relevant to planning: the action-selection policy, the value function and the reward. When evaluated on 57 different Atari games[3]—the canonical video game environment for testing artificial intelligence techniques, in which model-based planning approaches have historically struggled[4]—the MuZero algorithm achieved state-of-the-art performance. When evaluated on Go, chess and shogi—canonical environments for high-performance planning—the MuZero algorithm matched, without any knowledge of the game dynamics, the superhuman performance of the AlphaZero algorithm[5] that was supplied with the rules of the game.

Schrittwieser, …, 2020: **Mastering Atari, Go, Chess and Shogi by planning with a Learned model**. www.nature.com/articles/s41586-020-03051-4

# Deepmind: Von AlphaGo über AlphaZero zu MuZero



# Michael Amberg

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# Artificial intelligence

From Wikipedia, the free encyclopedia

*"AI" redirects here. For other uses, see AI (disambiguation) and Artificial intelligence (disambiguation).*

**Artificial intelligence** (**AI**), is intelligence demonstrated by machines, unlike the **natural intelligence** displayed by humans and animals, which involves consciousness and emotionality. The distinction between the former and the latter categories is often revealed by the acronym chosen. 'Strong' AI is usually labelled as AGI (Artificial General Intelligence) while attempts to emulate 'natural' intelligence have been called ABI (Artificial Biological Intelligence). Leading AI textbooks define the field as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals.[3] Colloquially, the term "artificial intelligence" is often used to describe machines (or computers) that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem solving".[4]

Part of a series on
**Artificial intelligence**
Major goals [show]
Approaches [show]
Philosophy [show]
History [show]
Technology [show]
Glossary [show]
V · T · E

As machines become increasingly capable, tasks considered to require "intelligence" are often removed from the definition of AI, a phenomenon known as the AI effect.[5] A quip in Tesler's Theorem says "AI is whatever hasn't been done yet."[6] For instance, optical character recognition is frequently excluded from things considered to be AI,[7] having become a routine technology.[8] Modern machine capabilities generally classified as AI include successfully understanding human speech,[9] competing at the highest level in strategic game systems (such as chess and Go),[10] autonomously operating cars, intelligent routing in content delivery networks, and military simulations.[11]

Artificial intelligence was founded as an academic discipline in 1955, and in the years since has experienced several waves of optimism,[12][13] followed by disappointment and the loss of funding (known as an "AI winter"),[14][15] followed by new approaches, success and renewed funding.[13][16] After AlphaGo successfully defeated a professional Go player in 2015, artificial intelligence once again attracted widespread global attention.[17] For most of its history, AI research has been divided into sub-fields that often fail to communicate with each other.[18] These sub-fields are based on technical considerations, such as particular goals (e.g. "robotics" or "machine learning"),[19] the use of particular tools ("logic" or artificial neural networks), or deep philosophical differences.[22][23][24] Sub-fields have also been based on social factors (particular institutions or the work of particular researchers).[18]

The traditional problems (or goals) of AI research include reasoning, knowledge representation, planning, learning, natural language processing, perception and the ability to move and manipulate objects.[19] General intelligence is among the field's long-term goals.[25] Approaches include statistical methods, computational intelligence, and traditional symbolic AI. Many tools are used in AI, including versions of search and mathematical optimization, artificial neural networks, and methods based on statistics, probability and economics. The AI field draws upon computer science, information engineering, mathematics, psychology, linguistics, philosophy, and many other fields.