**The following is an edited Wikipedia account of Alphago on May 5, 2016**

**AlphaGo** is a computer program developed by [Google DeepMind](https://en.wikipedia.org/wiki/Google_DeepMind) in London to play the board game [Go](https://en.wikipedia.org/wiki/Go_(game)).[[1]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-1) In October 2015, it became the first [Computer Go](https://en.wikipedia.org/wiki/Computer_Go) program to beat a professional human Go player without [handicaps](https://en.wikipedia.org/wiki/Go_handicaps" \o "Go handicaps)on a full-sized 19×19 board.[[2]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-googlego-2)[[3]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-bbcgo-3) In March 2016, it beat [Lee Sedol](https://en.wikipedia.org/wiki/Lee_Sedol) in [a five-game match](https://en.wikipedia.org/wiki/AlphaGo_versus_Lee_Sedol), the first time a computer Go program has beaten a [9-dan](https://en.wikipedia.org/wiki/Go_ranks_and_ratings) professional without handicaps.[[4]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-leesedolwin-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 beating Lee Sedol, AlphaGo was awarded an honorary [9-dan](https://en.wikipedia.org/wiki/9-dan) by the [Korea Baduk Association](https://en.wikipedia.org/wiki/Korea_Baduk_Association).

AlphaGo's algorithm uses a [Monte Carlo tree search](https://en.wikipedia.org/wiki/Monte_Carlo_tree_search) to find its moves based on knowledge previously "learned" by [machine learning](https://en.wikipedia.org/wiki/Machine_learning), specifically by an [artificial neural network](https://en.wikipedia.org/wiki/Artificial_neural_network) (a [deep learning](https://en.wikipedia.org/wiki/Deep_learning) method) by extensive training, both from human and computer play.

History and competitions[[edit](https://en.wikipedia.org/w/index.php?title=AlphaGo&action=edit&section=1)]

Go is considered much more difficult for computers to win than other games such as [chess](https://en.wikipedia.org/wiki/Chess), because its much larger [branching factor](https://en.wikipedia.org/wiki/Branching_factor) makes it prohibitively difficult to use traditional AI methods such Almost two decades after IBM's computer [Deep Blue](https://en.wikipedia.org/wiki/Deep_Blue_(chess_computer)) beat world chess champion [Garry Kasparov](https://en.wikipedia.org/wiki/Garry_Kasparov) in the [1997 match](https://en.wikipedia.org/wiki/Deep_Blue_versus_Garry_Kasparov), the strongest Go programs using [artificial intelligence](https://en.wikipedia.org/wiki/Artificial_intelligence) techniques only reached about [amateur 5-dan](https://en.wikipedia.org/wiki/Go_professional#Pro_and_amateur_dan) level,[[6]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-DeepMindnature2016-6) and still could not beat a professional Go player without [handicaps](https://en.wikipedia.org/wiki/Go_handicaps).[[2]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-googlego-2)[[3]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-bbcgo-3)[[7]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-CNN0128-7) In 2012, the software program [Zen](https://en.wikipedia.org/wiki/Zen_(software)), running on a four PC cluster, beat [Masaki Takemiya](https://en.wikipedia.org/wiki/Masaki_Takemiya) ([9p](https://en.wikipedia.org/wiki/Go_professional)) two times at five and four stones handicap.[[8]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-8) In 2013, [Crazy Stone](https://en.wikipedia.org/wiki/Crazy_Stone_(software)) beat [Yoshio Ishida](https://en.wikipedia.org/wiki/Yoshio_Ishida) (9p) at four-stones handicap.[[9]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-9)

According to AlphaGo's David Silver, the AlphaGo research project was formed around 2014 to test how well a neural network using [deep learning](https://en.wikipedia.org/wiki/Deep_learning) can compete at Go.[[10]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-pcworld_unusual-10) AlphaGo represents a significant improvement over previous Go programs. In 500 games against other available Go programs, including Crazy Stone and Zen,[[11]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-11) AlphaGo running on a single computer won all but one.[[12]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-12) In a similar matchup, AlphaGo running on multiple computers won all 500 games played against other Go programs, and 77% of games played against AlphaGo running on a single computer. The distributed version in October 2015 was using 1,202 [CPUs](https://en.wikipedia.org/wiki/CPU) and 176 [GPUs](https://en.wikipedia.org/wiki/GPU).[[6]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-DeepMindnature2016-6)

**Match against Fan Hui**[[edit](https://en.wikipedia.org/w/index.php?title=AlphaGo&action=edit&section=2)]

In October 2015, the distributed version of AlphaGo defeated the European [Go](https://en.wikipedia.org/wiki/Go_(game)) champion [Fan Hui](https://en.wikipedia.org/wiki/Fan_Hui),[[13]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-MetzWired2016-13) a [2-dan](https://en.wikipedia.org/wiki/Go_ranks_and_ratings) (out of 9 dan possible) professional, five to zero.[[3]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-bbcgo-3)[[14]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-14) This was the first time a computer Go program had beaten a professional human player on a full-sized board without handicap.[[15]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-lemondego-15) The announcement of the news was delayed until 27 January 2016 to coincide with the publication of a paper in the journal [*Nature*](https://en.wikipedia.org/wiki/Nature_(journal))[[6]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-DeepMindnature2016-6) describing the algorithms used.[[3]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-bbcgo-3)

**Match against Lee Sedol**[[edit](https://en.wikipedia.org/w/index.php?title=AlphaGo&action=edit&section=3)]

*Main article: [AlphaGo versus Lee Sedol](https://en.wikipedia.org/wiki/AlphaGo_versus_Lee_Sedol" \o "AlphaGo versus Lee Sedol)*

AlphaGo played South Korean professional Go player [Lee Sedol](https://en.wikipedia.org/wiki/Lee_Sedol), ranked 9-dan, one of the best players at Go,[[7]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-CNN0128-7)[[*dated info*](https://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style/Dates_and_numbers#Precise_language)] with five games taking place at the [Four Seasons Hotel](https://en.wikipedia.org/wiki/Four_Seasons_Hotel) in [Seoul](https://en.wikipedia.org/wiki/Seoul), South Korea on 9, 10, 12, 13, and 15 March 2016,[[16]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-16)[[17]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-17) which were video-streamed live.[[18]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-18) Aja Huang, a DeepMind team member and amateur 6-dan Go player, placed stones on the [Go board](https://en.wikipedia.org/wiki/Go_board) for AlphaGo, which ran through Google's cloud computing with its servers located in the United States.[[19]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-JoongAng_Ilbo-19) The match used [Chinese rules](https://en.wikipedia.org/wiki/Rules_of_go#Chinese_rules) with a 7.5-point [komi](https://en.wikipedia.org/wiki/Komidashi" \o "Komidashi), and each side had two hours of thinking time plus three 60-second [byoyomi](https://en.wikipedia.org/wiki/Byoyomi" \o "Byoyomi) periods.[[20]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-Korea_Baduk_Association-20) The version of AlphaGo playing against Lee used a similar amount of computing power as was used in the Fan Hui match.[[21]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-21)

At the time of play, Lee Sedol had the second-highest number of Go international championship victories in the world.[[22]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-22) While there is no single official method of [ranking in international Go](https://en.wikipedia.org/wiki/Go_ranks_and_ratings#Rating_systems), some sources ranked Lee Sedol as the fourth-best player in the world at the time.[[23]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-goratings.org_2016-23)[[24]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-24) AlphaGo was not specifically trained to face Lee.[[25]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-koreatimes_beatable-25)

The first three games were won by AlphaGo following resignations by Lee Sedol.[[26]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-26)[[27]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-27) However, Lee Sedol beat AlphaGo in the fourth game, winning by resignation at move 180. AlphaGo then continued to achieve a fourth win, winning the fifth game by resignation.[[28]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-28)

The prize was $1 million USD. Since AlphaGo won four out of five and thus the series, the prize will be donated to charities, including [UNICEF](https://en.wikipedia.org/wiki/UNICEF).[[29]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-29) Lee Sedol received $150,000 for participating in all five games and an additional $20,000 for his win.[[20]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-Korea_Baduk_Association-20)

Algorithm[[edit](https://en.wikipedia.org/w/index.php?title=AlphaGo&action=edit&section=5)]

As of 2016, AlphaGo's algorithm uses a combination of [machine learning](https://en.wikipedia.org/wiki/Machine_learning) and [tree search](https://en.wikipedia.org/wiki/Tree_search) techniques, combined with extensive training, both from human and computer play. It uses [Monte Carlo tree search](https://en.wikipedia.org/wiki/Monte_Carlo_tree_search), guided by a "value network" and a "policy network," both implemented using [deep neural network](https://en.wikipedia.org/wiki/Deep_neural_network) technology.[[2]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-googlego-2)[[6]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-DeepMindnature2016-6) A limited amount of game-specific feature detection pre-processing (for example, to highlight whether a move matches a [nakade](https://en.wikipedia.org/wiki/List_of_Go_terms" \l "Nakade" \o "List of Go terms) pattern) is applied to the input before it is sent to the neural networks.[[6]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-DeepMindnature2016-6)

Style of play[[edit](https://en.wikipedia.org/w/index.php?title=AlphaGo&action=edit&section=6)]

Toby Manning, the match referee for AlphaGo vs. Fan Hui, has described the program's style as "conservative".[[31]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-:0-31) During AlphaGo's match against Lee Sedol, Korean commentators exclaimed the AI's playstyle greatly resembled that of the legendary player [Lee Changho](https://en.wikipedia.org/wiki/Lee_Changho).[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] This similarity can be attributed to the fact that like Lee Changho,[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] AlphaGo's playstyle also strongly favors greater probability of winning by fewer points over lesser probability of winning by more points.[[10]](https://en.wikipedia.org/wiki/AlphaGo#cite_note-pcworld_unusual-10)