





# 1st Homework!



AlphaGo - The Movie | Full award-winning documentary



Google DeepMind  
511K subscribers



Subscribed

292K



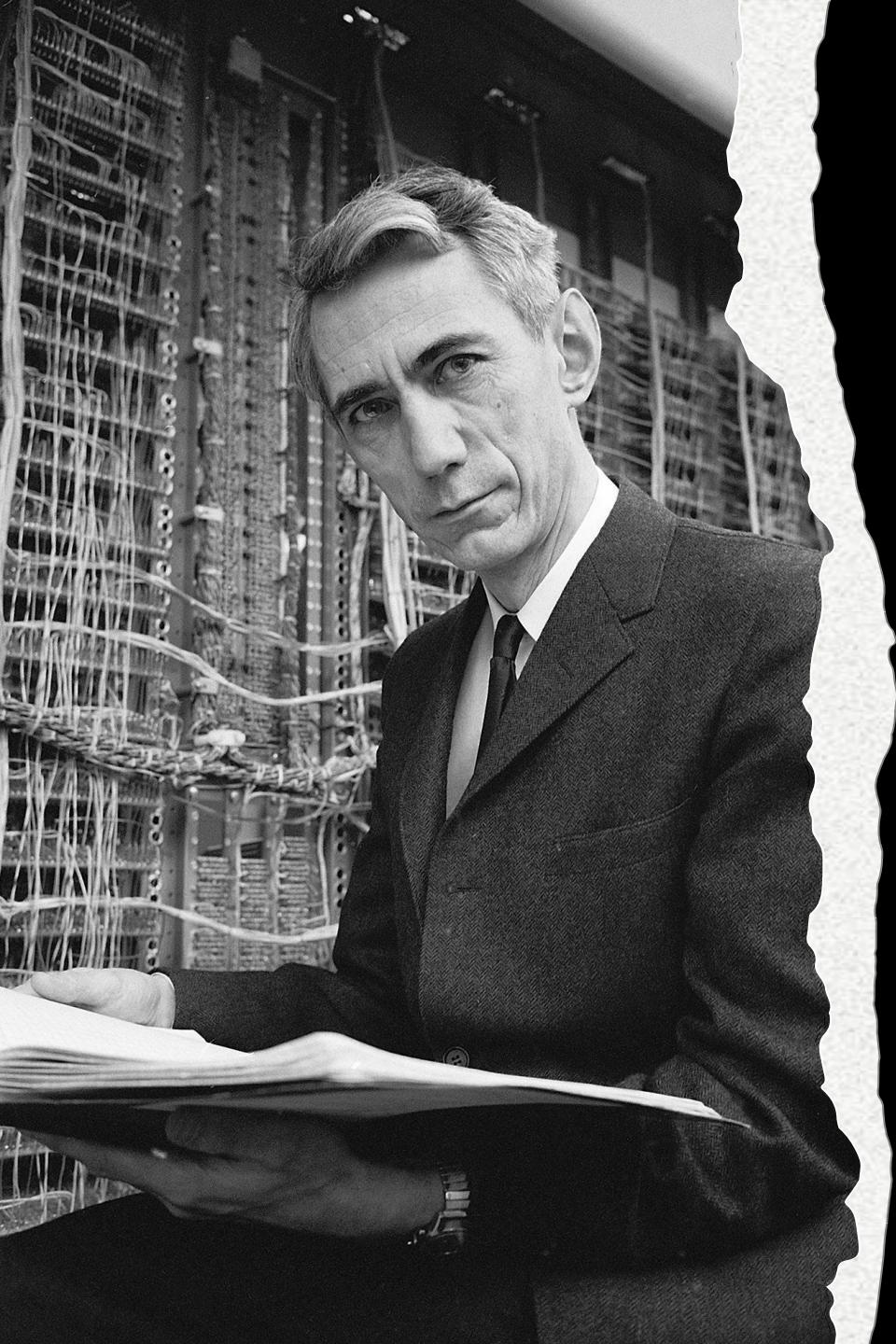
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35M views 4 years ago

With more board configurations than there are atoms in the universe, the ancient Chinese game of Go has long been considered a



# Why games?

*A satisfactory solution of  
[chess] will act as a wedge in  
attacking other problems of a  
similar nature and of greater  
significance.*

Claude Shannon, 1949  
Programming a Computer for Playing Chess  
Philosophical Magazine, Vol 41, No. 314



VETENSKAPS  
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THE ROYAL SWEDISH ACADEMY OF SCIENCES



# NOBELPRISET I KEMI 2024 THE NOBEL PRIZE IN CHEMISTRY 2024



**David Baker**  
University of Washington  
USA

"*for datorbaserad proteindesign*"

"*for computational protein design*"



**Demis Hassabis**  
Google DeepMind  
United Kingdom

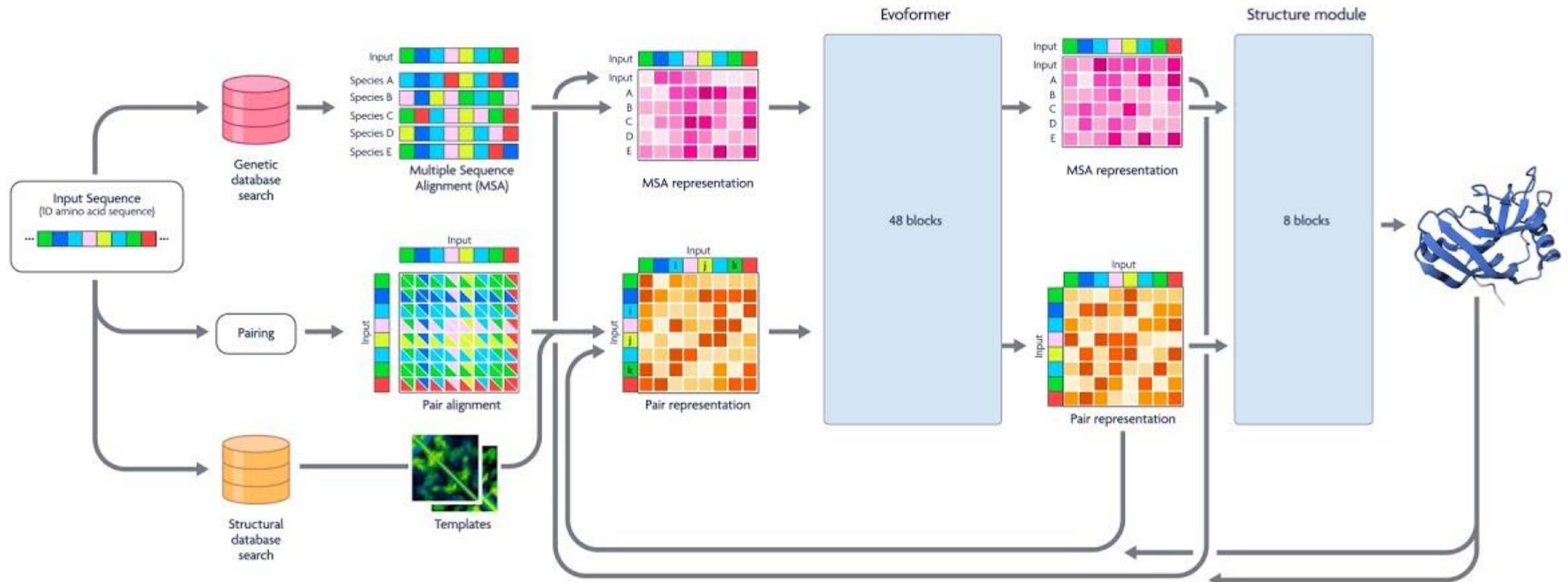
"*for proteinstrukturprediktion*"



**John M. Jumper**  
Google DeepMind  
United Kingdom

"*for protein structure prediction*"

# What Is AlphaFold?





“Solve  
intelligence and  
use it to solve  
everything else”





“Solve  
intelligence and  
use it to solve  
everything else”



arXiv  
<https://arxiv.org/> > cs · Traduci questa pagina

[1312.5602] Playing Atari with Deep Reinforcement Learning  
di V Mnih · 2013 · Citato da 16183 — We present the first deep learning model to successfully learn control policies directly from high-dimensional sensory input using reinforcement learning.



AlphaGo



Lee Sedol







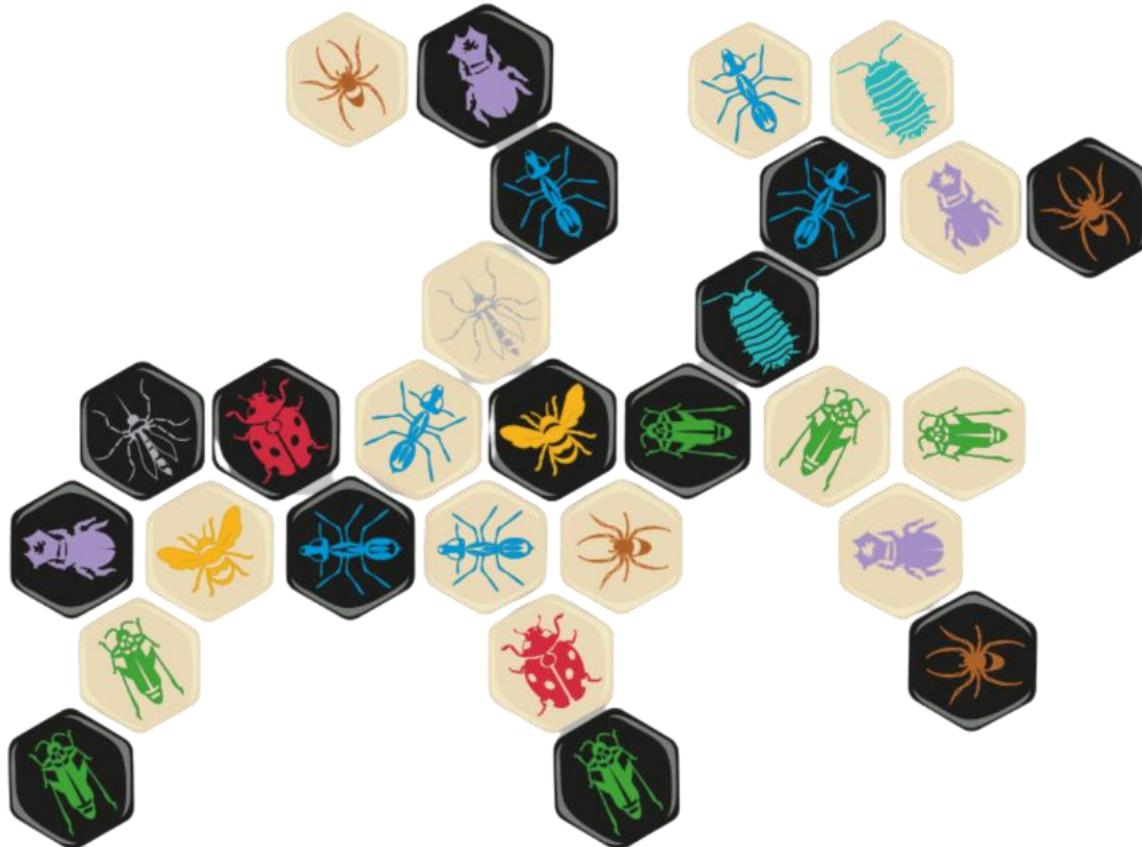
Your Bot



Ben Harris



# 2024 Project: build a Hive AI



# 2024 Project: build a Hive AI

- 10 teams of two, try to optimize for location so that you can easily meet in person
- Deliverable: A Hive engine following the Universal Hive Protocol
- Your engines will challenge each other in a legendary tournament in Fall 2025



# 2024 Project: build a Hive AI

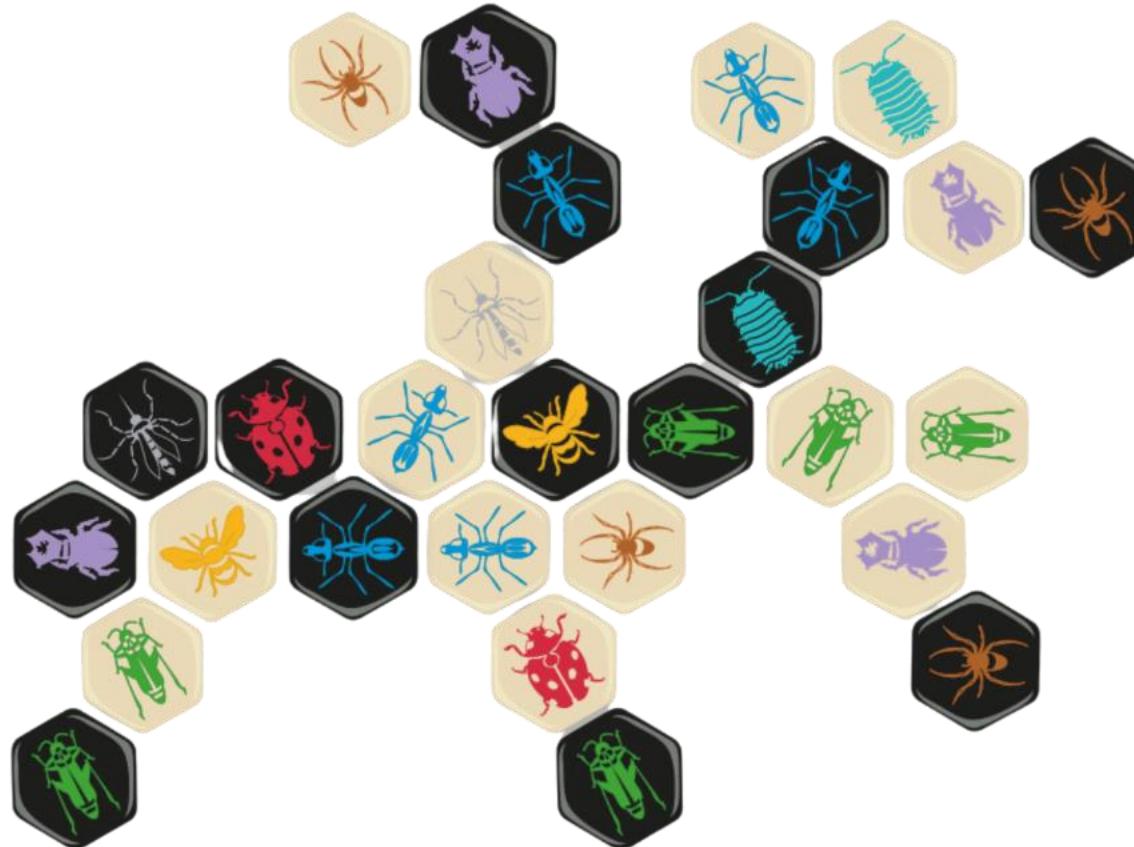
- 10 teams of two, try to optimize for location so that you can easily meet in person
- Deliverable: A Hive engine following the Universal Hive Protocol
- Your engines will challenge each other in a legendary tournament in Fall 2025

Only one will be the winner.



# How to play Hive?

<https://hivegame.com/analysis>



---

# Why Hive?

- A modern abstract game for 2
- A world championship every year
- Universal Hive Protocol
- Hive engines in their early days... Maybe you will make the strongest on Earth!



# Universal Hive Protocol

- Analogous to Chess
- Easy method for developers to make their Hive-playing software inter-compatible with other Hive-playing software.
- You can focus on the engine (viewer and representation standards provided)



**Mzinga**  
**Open-source**  
**software to play the**  
**board game Hive.**



# where to play

- And test your bot!

The screenshot shows the Hive game.com website. At the top, there are navigation links: Home, Community, Impara, Tornei, Compra Hive®, FAI UNA DONAZIONE. A yellow banner in the center says "Rapid League season starts Nov 12!" with a "Sign up before Nov 12" link. Below the banner, it says "Flexible schedule of 5-6 matches over 10 weeks with a 10 + 10 time control. Schedule your games here or over Discord". On the left, there's a logo for "Hive game.com". In the center, there's a table for a player named "SimHotA":

GIOCATORE	ELO	PLM	TEMPO	CON VARIAZIONE
SimHotA	1915	2	3 + 3	SI

Below the table, there are buttons for "Crea una partita" (Create a match) with options: 1+2, 3+3, 5+4, 10+10, 20+20, and Custom.

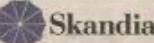
The screenshot shows the BGaming website page for the Hive board game. It features a large image of the game board with various insects. The title "Hive" is prominently displayed. Below the title, there's information about the game: "Un gioco di John Yianni", "Illustrazioni di John Yianni", "Pubblicato da GameWorks", "Anno 2001", "Sviluppato da Cédric Leclercq (yaanatomic), Antoine Tallot (Oscar), Elena Laskavaia (Victoria\_La)". There are three blue buttons: "Impara" (Learn), "Oppure" (Or), and "Gioca" (Play). To the right, there's a section titled "Regole del gioco" (Game rules) with download links for "Regole gioco IT EN pdf", "English Rules EN pdf", "Tournament variant rule EN link", and "Hive Mosquito Multilanguage EN pdf". Below this, there's a "Classifica" (Classification) table showing the top 5 players: Eucalyx (Australia), Myrmigi (Grecia), Czege11 (Ungheria), Eucalyx (Australia), BonjawMente (Stati Uniti), and max\_shark (Russia). To the right, there's a "Guarda altri 18..." (View others) button. Further down, there's a "Informazioni sul gioco" (Game information) section with a "Guarda altri 18..." button and a "Guarda altri 18..." button.

The screenshot shows the Mac App Store preview for "Hexes Honeycomb". It features a yellow icon of a bee on a hexagon. The app is described as "Abstract insect-themed game" by Raul de Onate, "Designed for iPad", "#125 in Board", and has a rating of "3.6 • 143 Ratings". It costs \$3.99 and offers In-App Purchases. Below the preview, there's a section titled "iPad Screenshots" with a yellow box containing the text: "Play against a bot or against other real players!" with an image of a smartphone displaying the game.

The screenshot shows the Google Play store listing for "Hive with AI (board game)" by JB Chaubet. It has a rating of 4.5 stars from 5.32K reviews, 100K+ downloads, and a PEGI 3 rating. The listing includes a "Share" button and a "Install on more devices" button. Below the listing, there's a note: "This app is available for your device" and "You can share this with your Learn more about Family Library." At the bottom, there's a small image showing a game board with a queen and some text about the goal of the game.

The first Global Intellectual Battlefield

# THE MIND SPORTS OLYMPIAD

with  Skandia

Royal Festival Hall, London, August 18th–24th 1997



**£100,000 prize fund!!  
Open to Everyone!**

To enter call **0171-703 2828** or send a sae to:  
**Mind Sports Olympiad, PO Box 13388, London NW3 2ZF**

Visit our website – <http://www.mindsports.co.uk/>  
For details of sponsorship, sales and marketing contact:  
Don Morris on +44 (0)171 932 0006 Fax +44 (0)171 932 0676

## Hive scene

- World championship every year
- Part of the Mind Sports Olympiad
- [worldhivetournaments.com](http://worldhivetournaments.com)

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Composition

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Openings

> Expansions

Digital adaptations

> Competition

**Online Hive World  
Championship**

2016

2017

2018

2019

2020

2021

2022

2023

2024

Mind Sports  
Olympiad

2020

### Competition [edit]

#### Online Hive World Championship [edit]

John Yianni, designer of Hive, has recognized the annual tournament held at [www.BoardSpace.net](http://www.BoardSpace.net) as the Online Hive World Championship. Here is a list of winners:

Year	Champion	2nd	3rd	4th	Note	Ref
2007	woswoasi (Peter Danzeglocke) Germany	goulo (Russ Williams) Poland			Classic Hive (no expansions), without Tournament Opening Rule.	[15]
		zugzwang (Quinn Swanger) USA				
2008	ahchong (Sean Chong) Malaysia	Eucalyx (Christian Sperling) Germany	GRMikeS (Mike Schell) USA	humdeabril (Dimitri BR) Brazil	All games played with Mosquito, without Tournament Opening Rule.	[16]
2009	EddyMarlo (Edwin de Backer) Netherlands	humdeabril (Dimitri BR) Brazil	Loizz (Luiz Flávio Ribiero) Brazil	Raccoons (real name N/A) Germany	First tournament with Tournament Opening Rule.	[17]
2010	EddyMarlo (Edwin de Backer) Netherlands	Loizz (Luiz Flávio Ribiero) Brazil	Seneca29 (Dario Delfino) Italy		Game one of each match played without Mosquito, remaining games were player's choice.	[18]



# Technical details

- Your bot should follow the UHP as defined in Mzinga
- We encourage you to exploit a GPU and explore learning approaches
- For the tournament your bot should provide a valid move in 5 seconds on a machine equivalent to a consumer pc with a GPU (e.g. a gaming pc or a colab notebook)
- For the training phase of your Deep Neural Network we will provide more resources (possibility of multi-GPU training on Gcloud, AWS, or equivalent)

# Where to start from

- Familiarize with Mzinga and make a functioning engine that plays random moves
- Make it better with some basic search

--- 2° phase ---

- We will give a talk on how AlphaGo Zero and Classical engines work
- Briefing: how do you want to make your engine?



# Mentors

- Antonio Norelli: Postdoc at the University of Oxford

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- This is not a homework, it is a research project!  
You will be the Hive and Mzinga experts



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  - Matteo Ceccarello: Assistant professor at the University of Padova
- 
- This is not a homework, it is a research project!  
You will be the Hive and Mzinga experts
  - We have made something similar and we will support you



Chess Programming WIKI

**CPW**

Main page Recent changes Random page Help Tools What links here Related changes Special pages Printable version Permanent link Page information

Page Discussion Read View source View history Search Chessprogramm... [\[1\]](#)

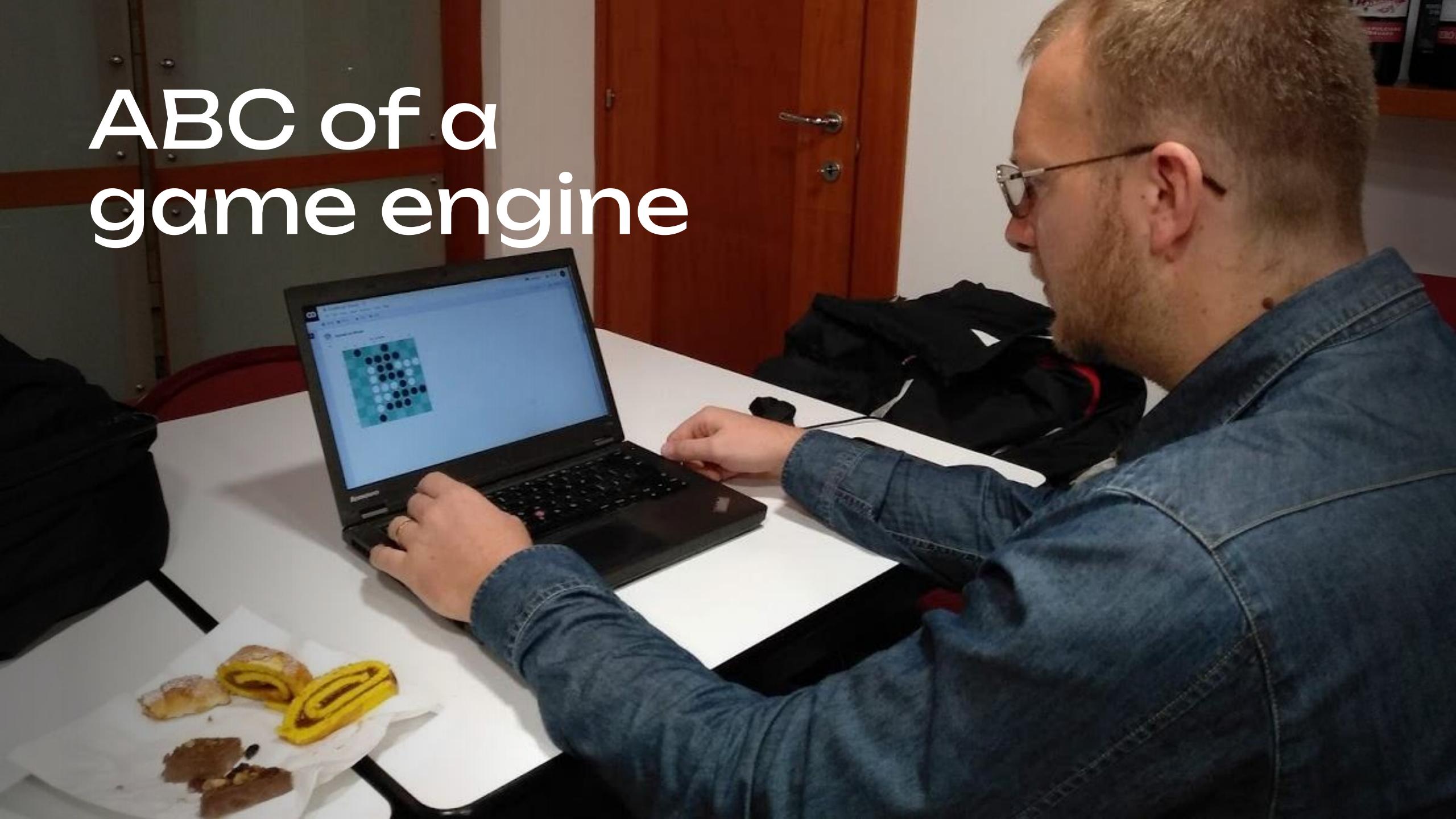
## Matteo Frigo

[Home](#) \* [People](#) \* [Matteo Frigo](#)

**Matteo Frigo**, an Italian computer scientist and software architect at [Oracle](#), Boston area. Matteo Frigo received his Ph.D. in 1999 from the Department of Electrical Engineering and Computer Science at [Massachusetts Institute of Technology](#) under Charles Leiserson, where he was member of the teams in developing \*[Socrates](#) [2] and the [CilkChess](#) [3] computer chess programs. His research spans around parallel computing, SIMD parallelism, on [FFT](#) where he along with Steven G. Johnson co-developed [FFTW](#), [DSP](#), cache-oblivious algorithms, and theory of computation. In 2007 Matteo Frigo co-founded [Cilk Arts, Inc.](#), a start-up developing Cilk technology for multi-core computing applications, which was acquired by Intel in August 2009 [4] [5].

Matteo Frigo [\[1\]](#)

# ABC of a game engine



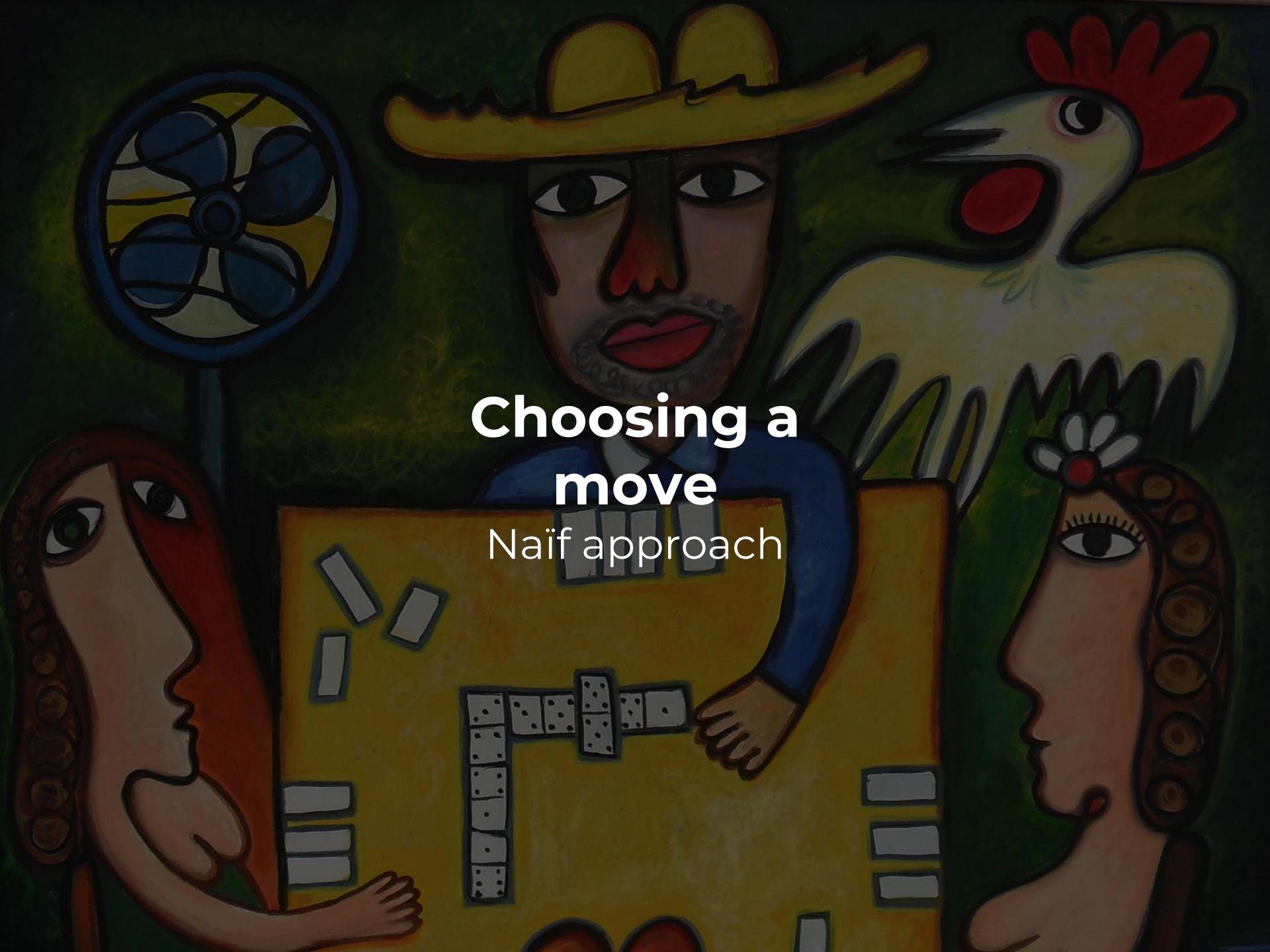
# Spirit of the competition

- We will make a discord server, for announcements, and interaction
- Discuss among you and with us
- Kaggle-like sharing: we may ask you to share some code milestones.



The winner:



The background of the image is a vibrant, abstract painting. It features several stylized faces: a man's face in the upper center wearing a yellow sombrero, a woman's profile on the left, and another woman's profile on the right. In the lower center, a man in a blue shirt and a yellow vest is playing dominoes. A circular object with blue and yellow patterns is visible on the left. The overall style is reminiscent of folk art or naive painting.

# Choosing a move

Naïf approach

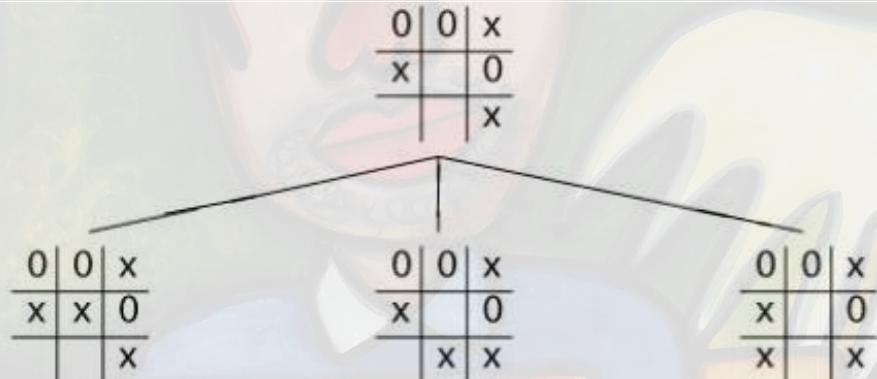
# The Minimax algorithm

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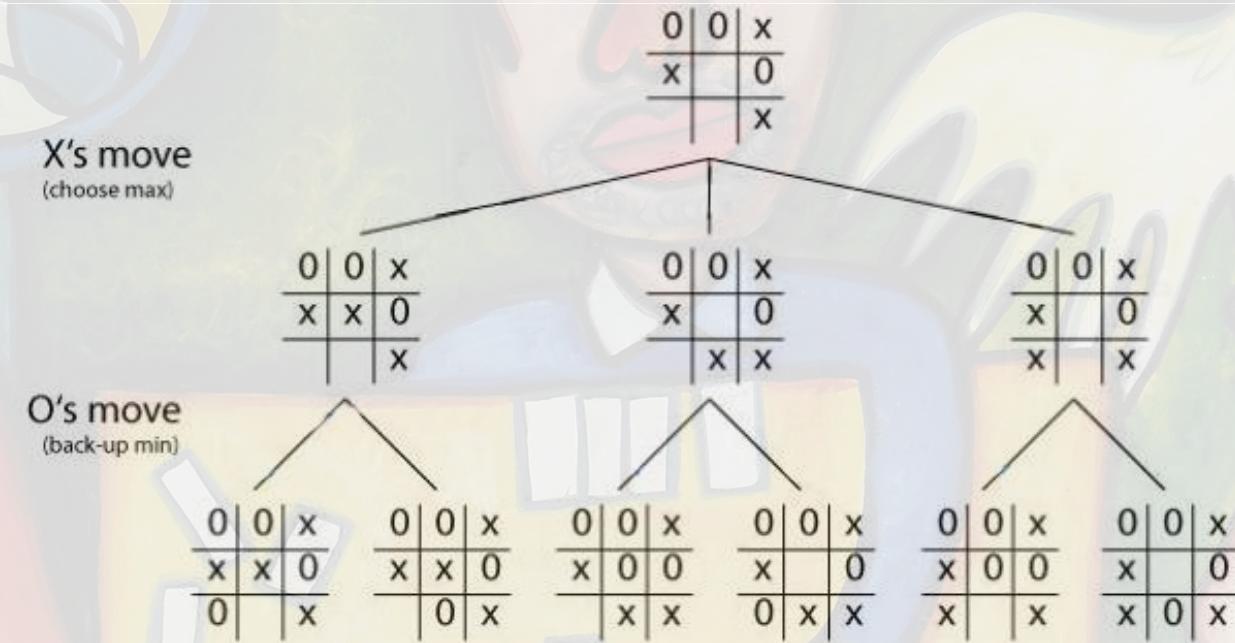
0	0	x
x		0
		x

# Minimax algorithm

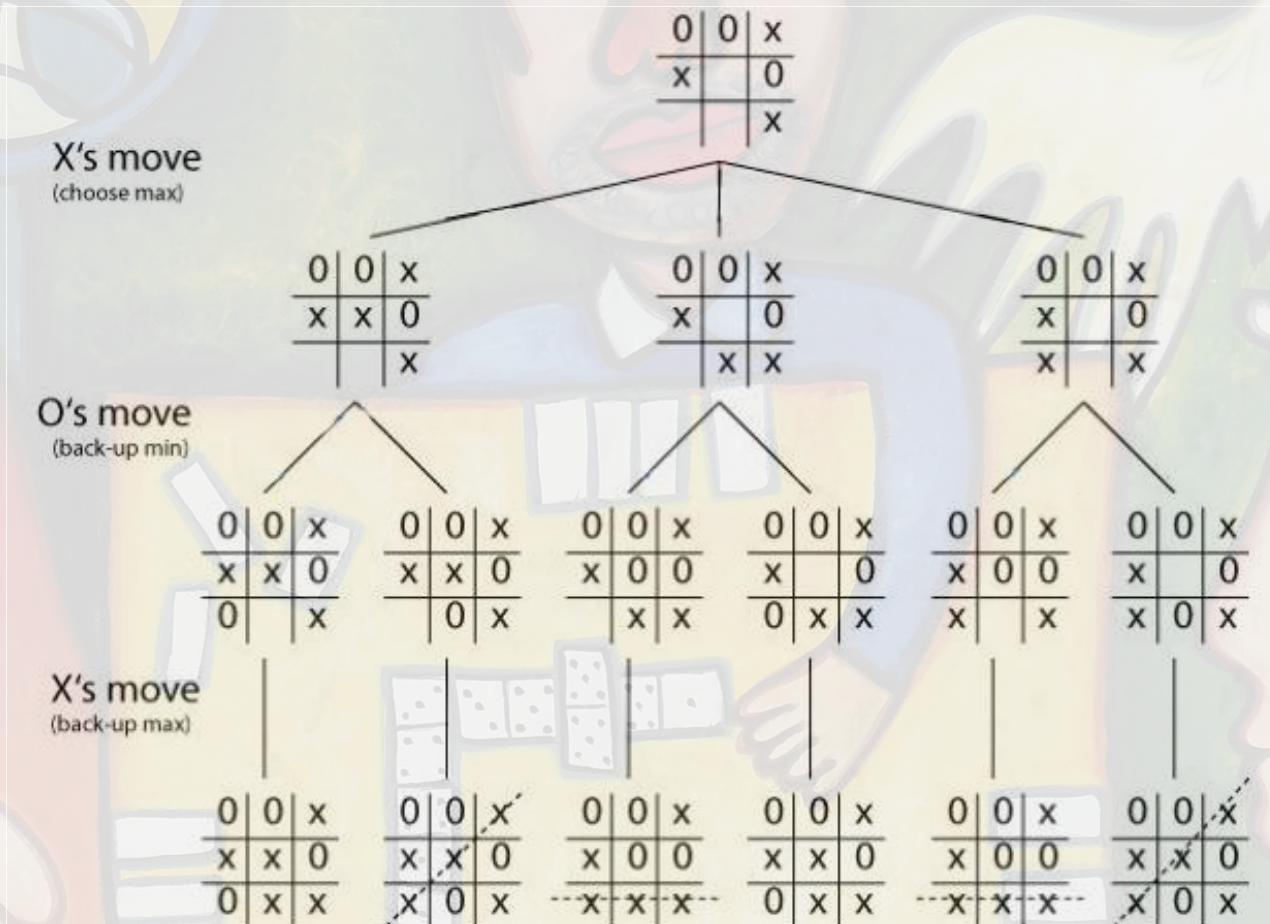
X's move  
(choose max)



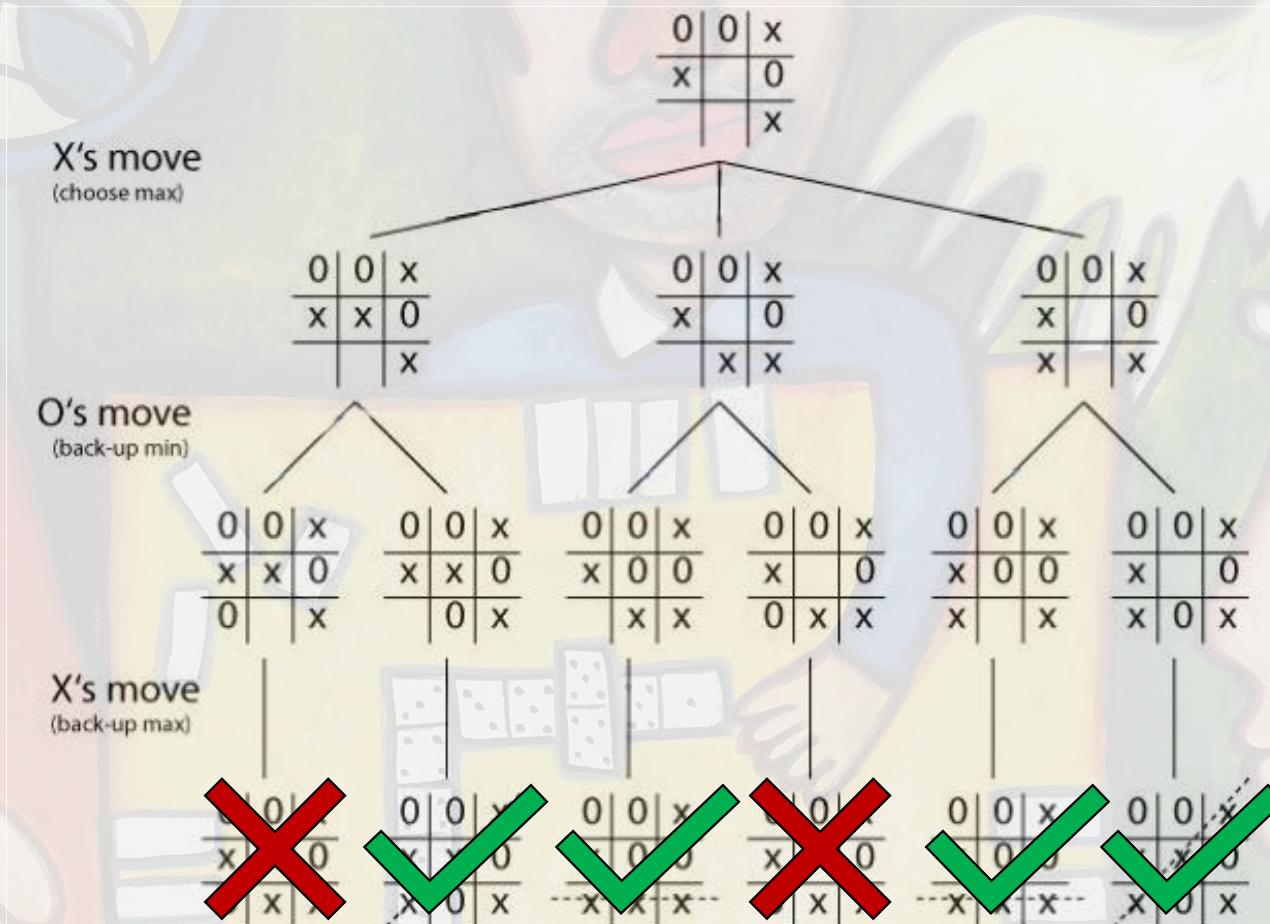
# Minimax algorithm



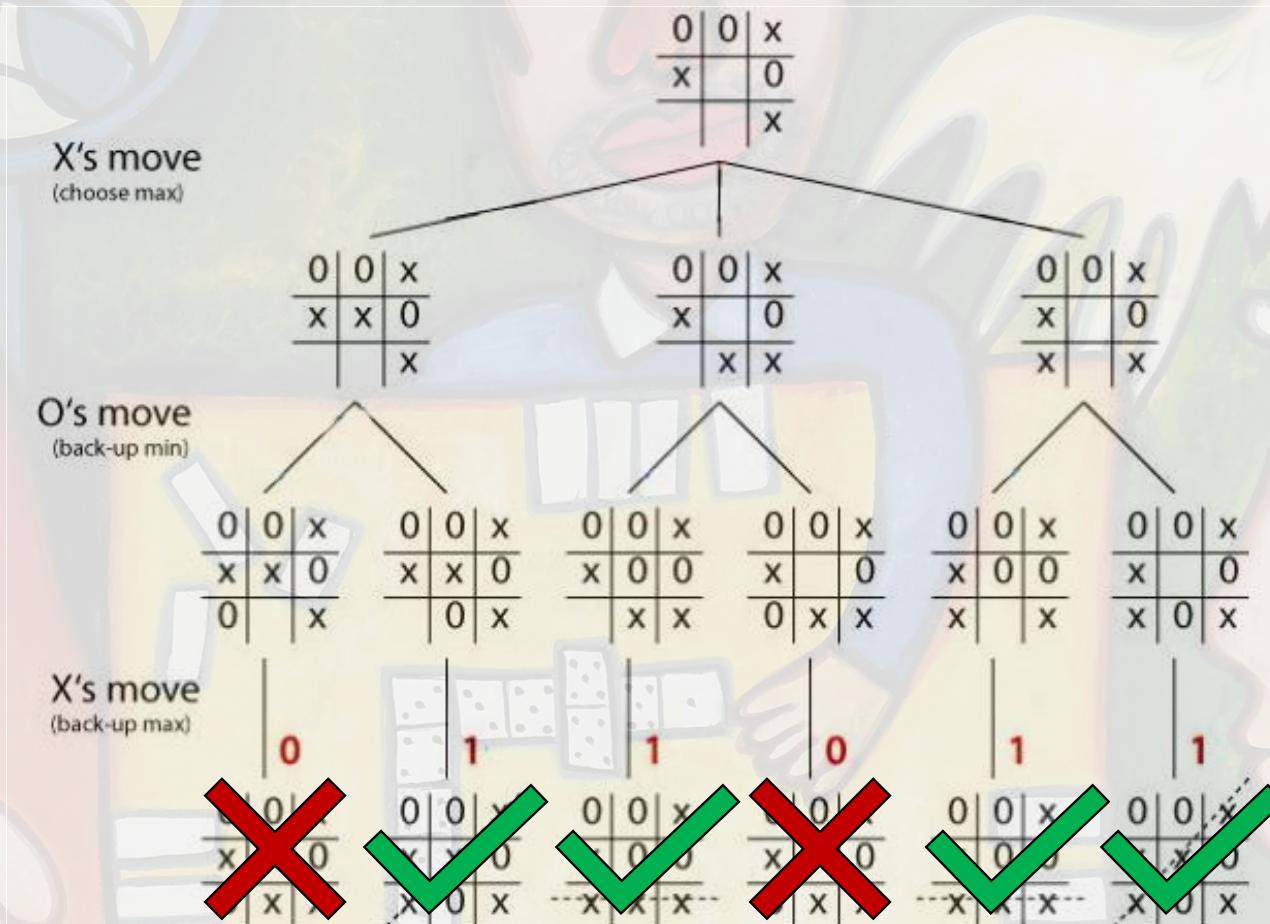
# Minimax algorithm



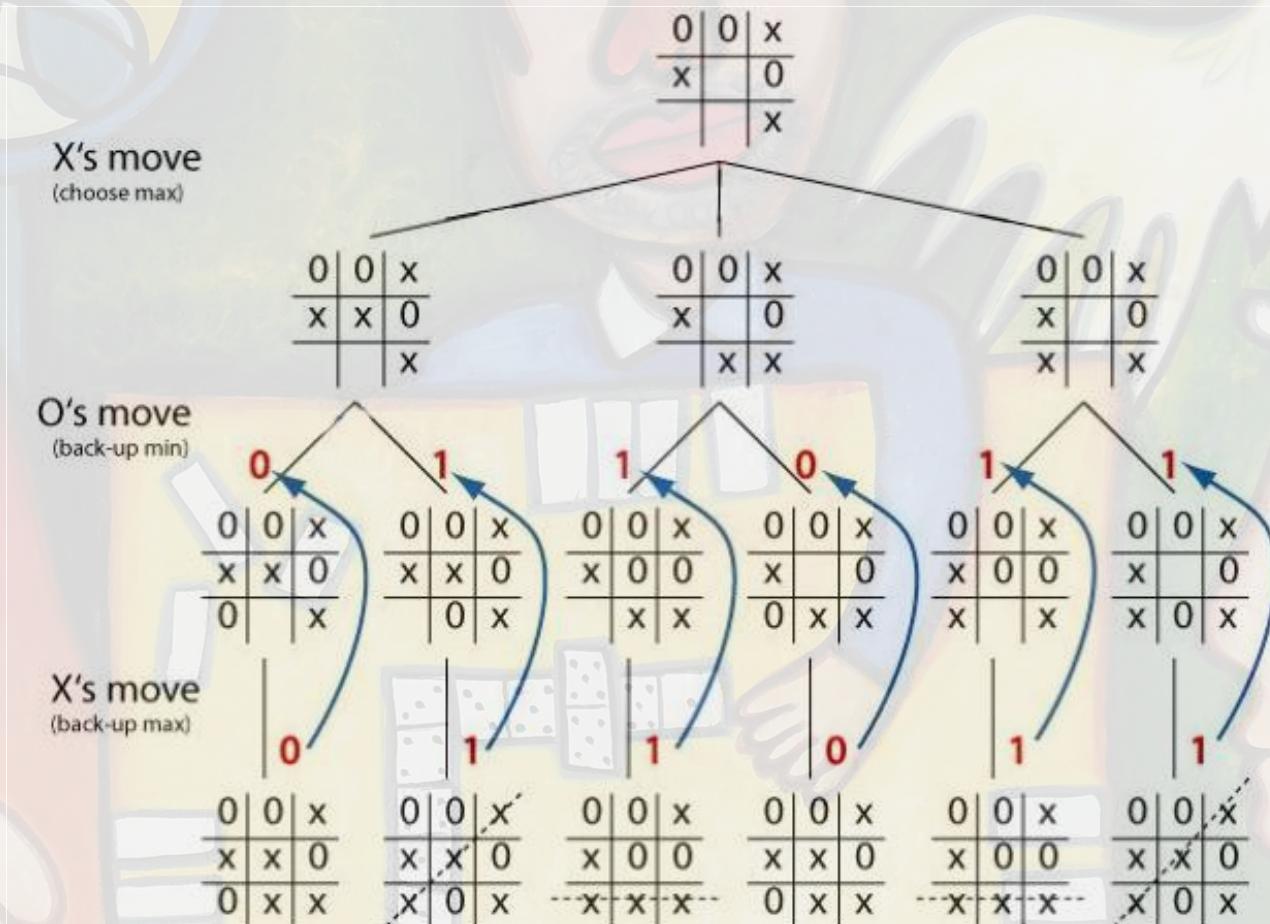
# Minimax algorithm



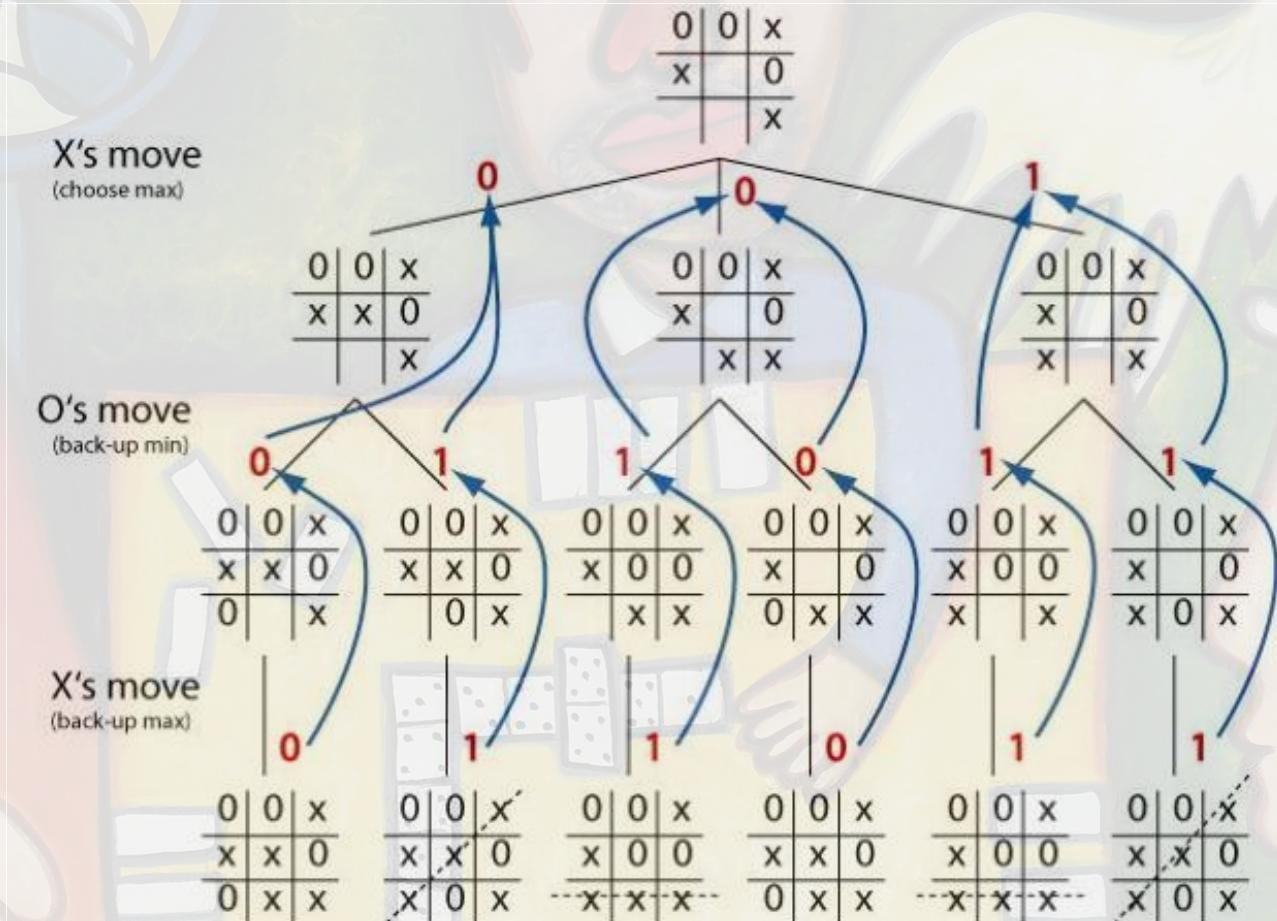
# Minimax algorithm



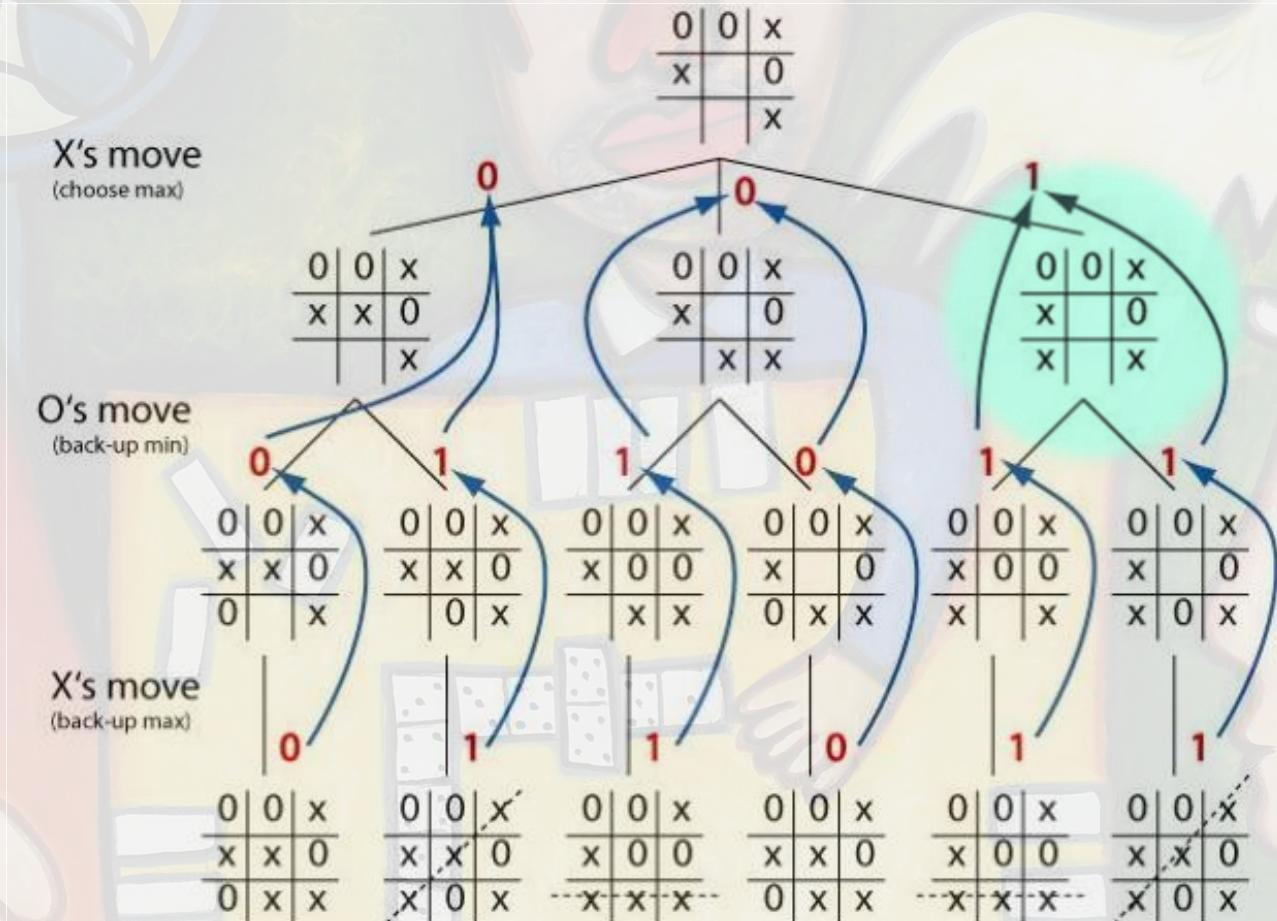
# Minimax algorithm



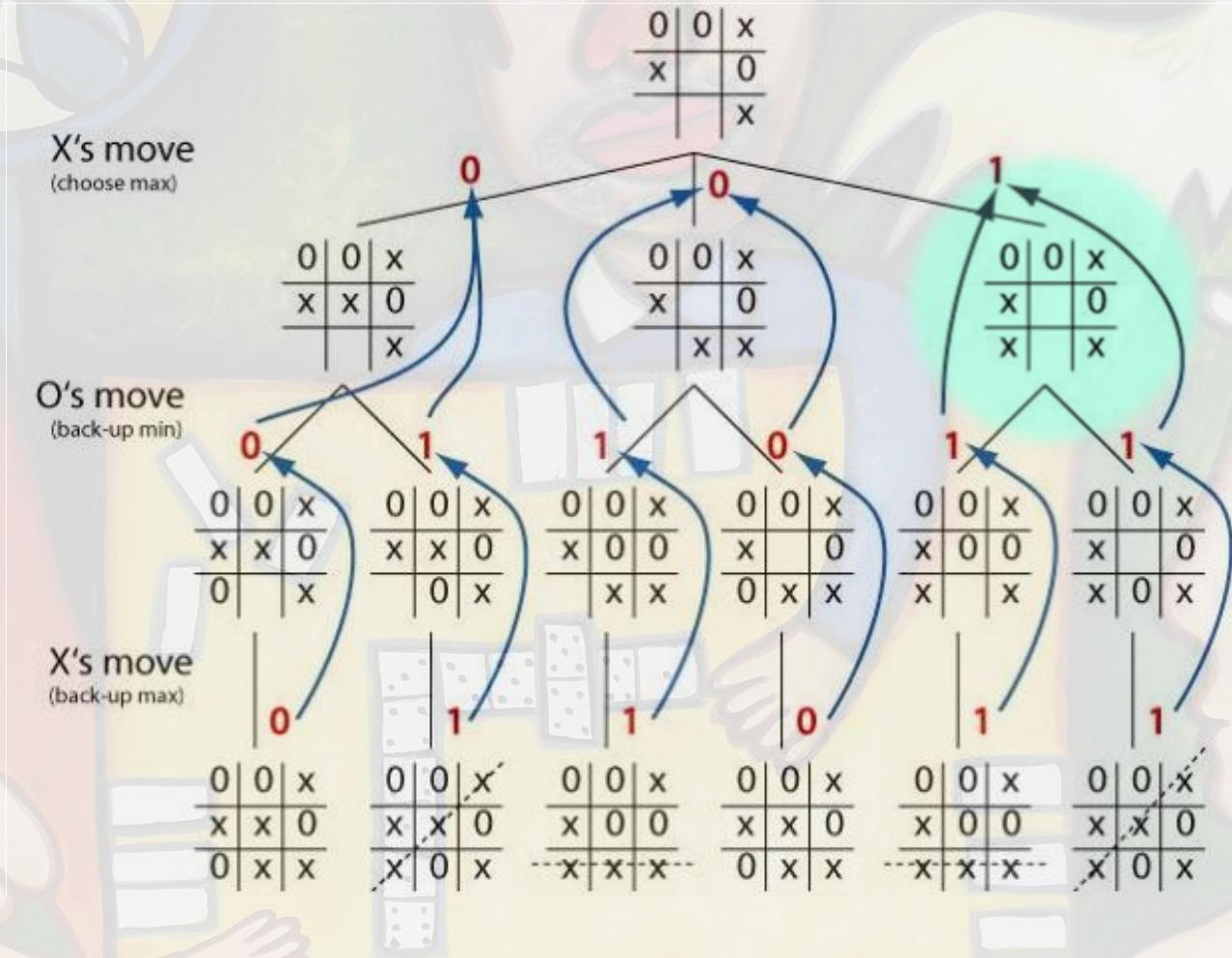
# Minimax algorithm



# Minimax algorithm



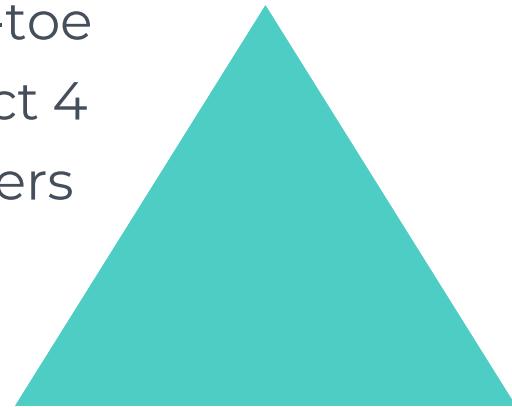
# Minimax algorithm $O(b^d)$



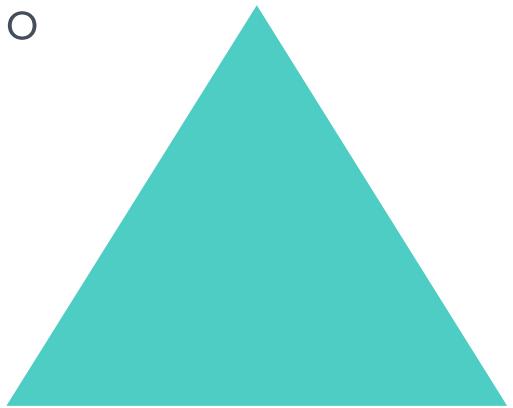
# Looking into the future

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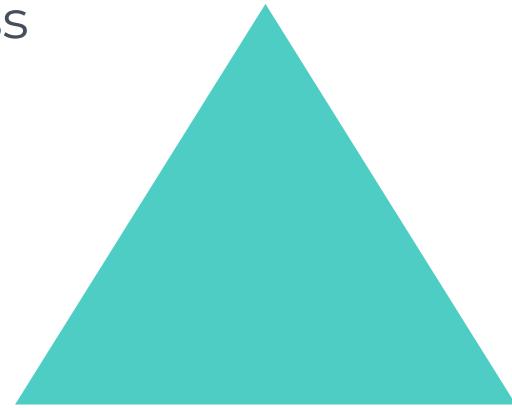
Tic-tac-toe  
Connect 4  
Checkers



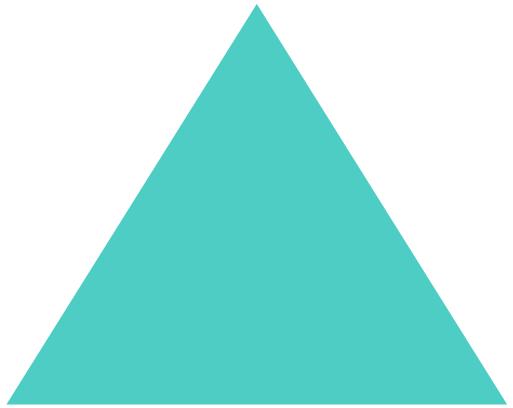
Othello



Chess



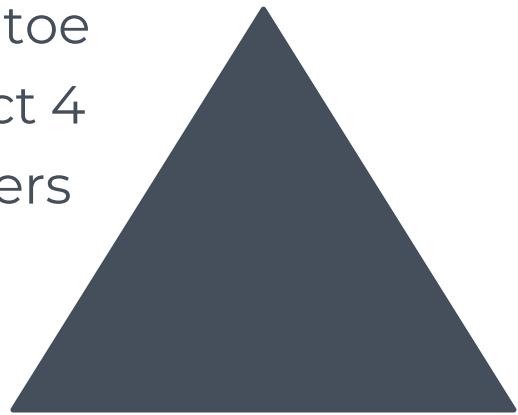
Go



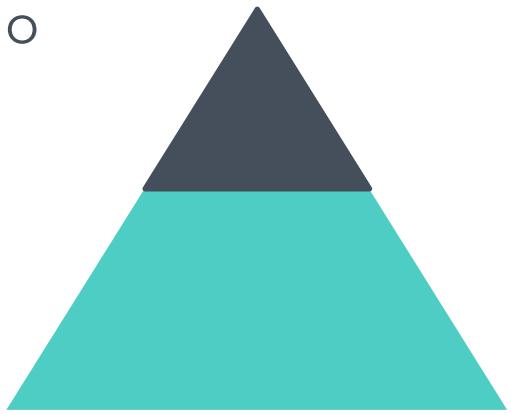
# Looking into the future

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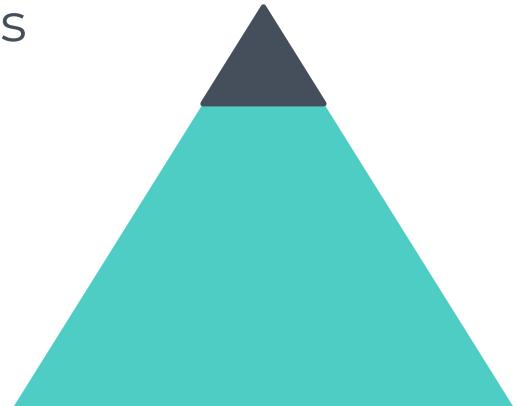
Tic-tac-toe  
Connect 4  
Checkers



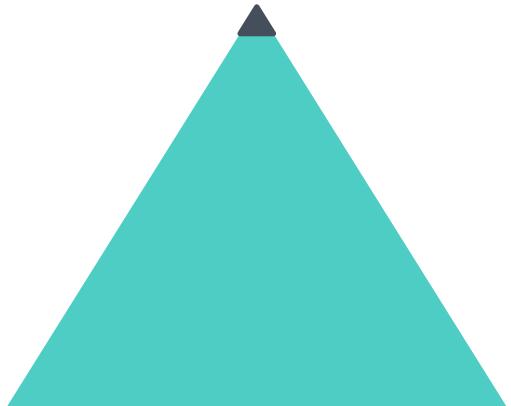
Othello



Chess

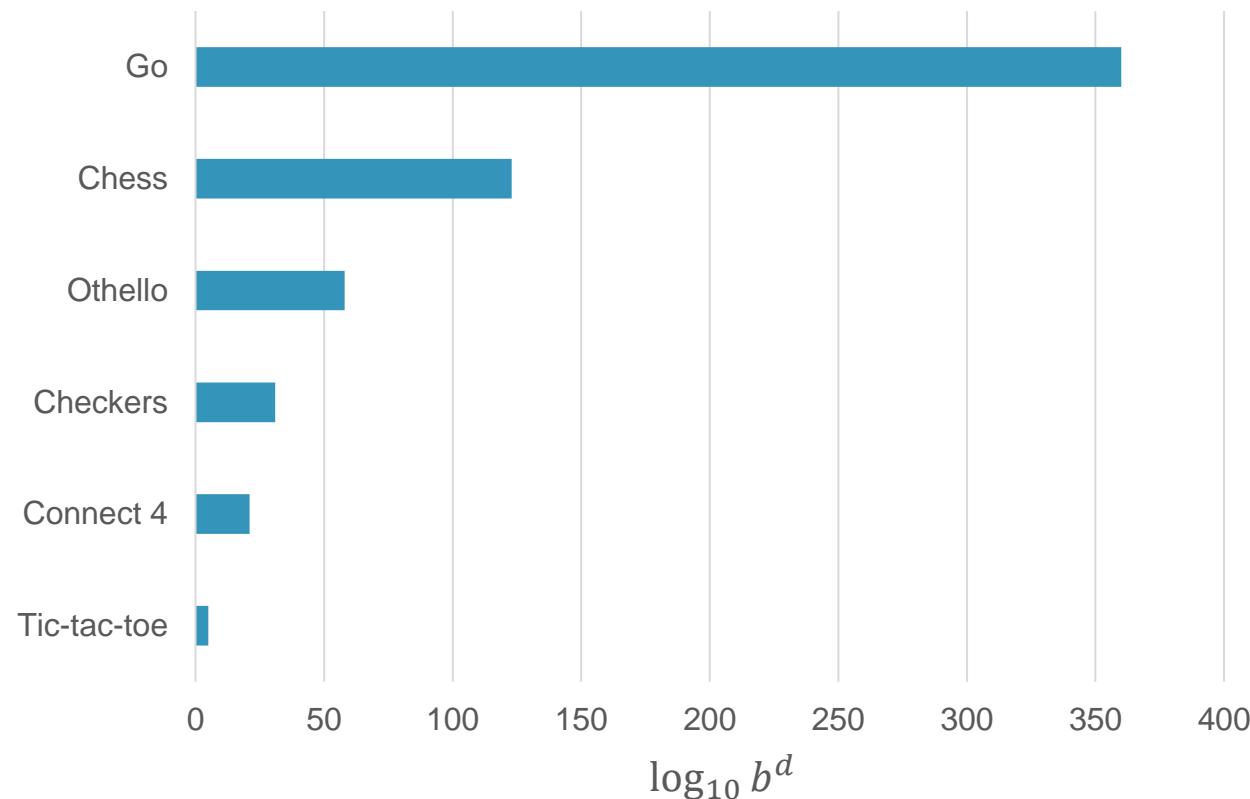


Go



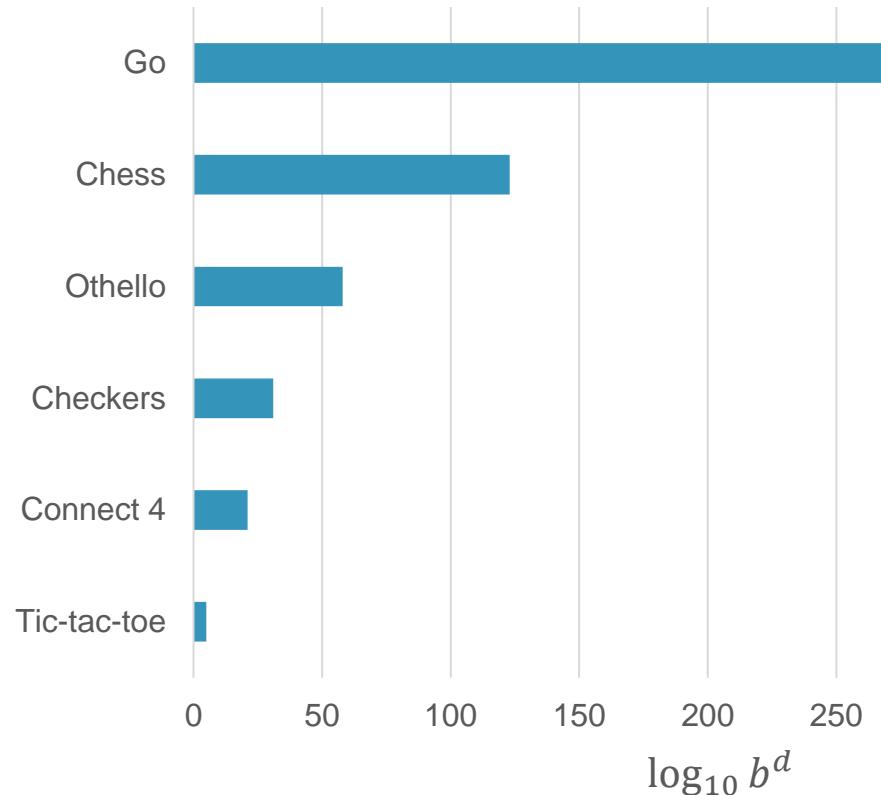
# Exploring the full tree is impossible

Game tree complexity



# Exploring the full tree is impossible

Game tree complexity



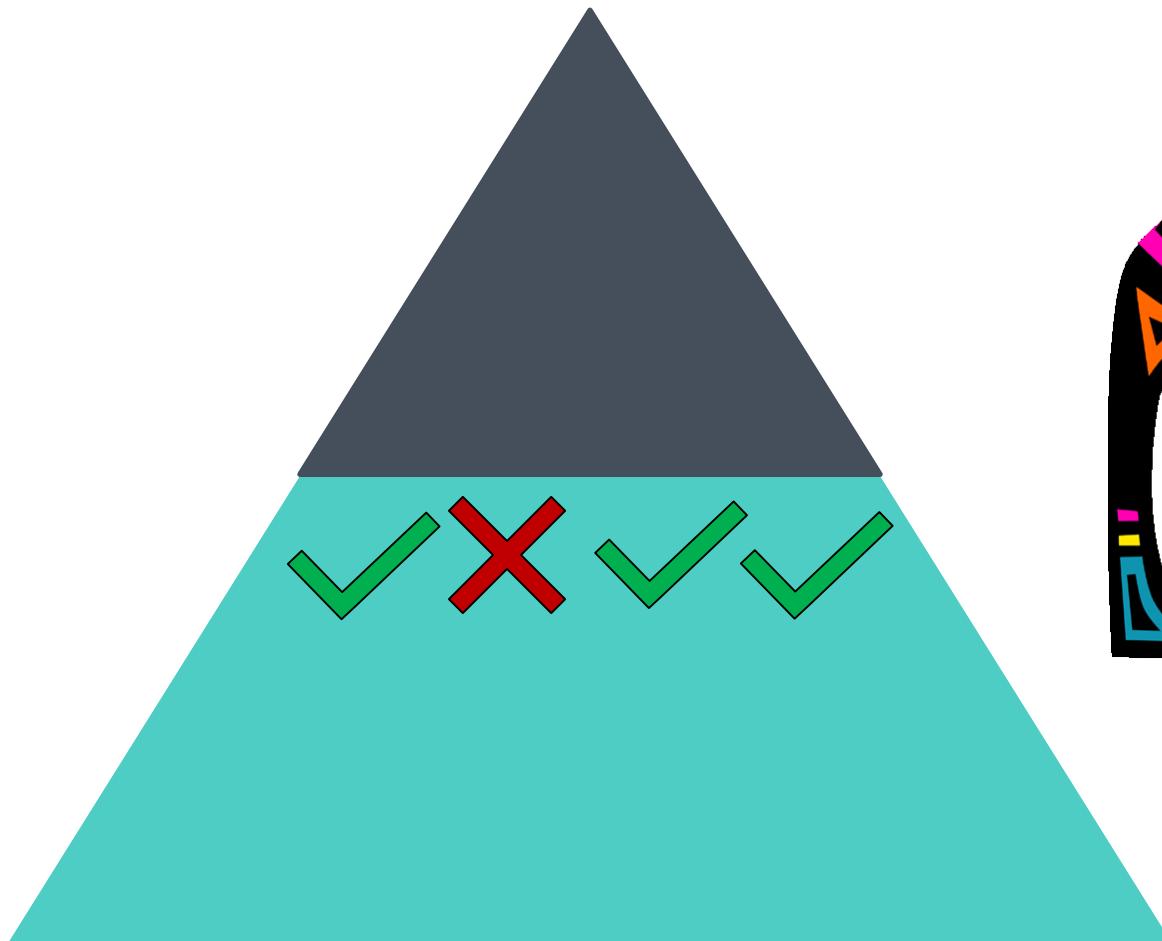
# What does the future hold?

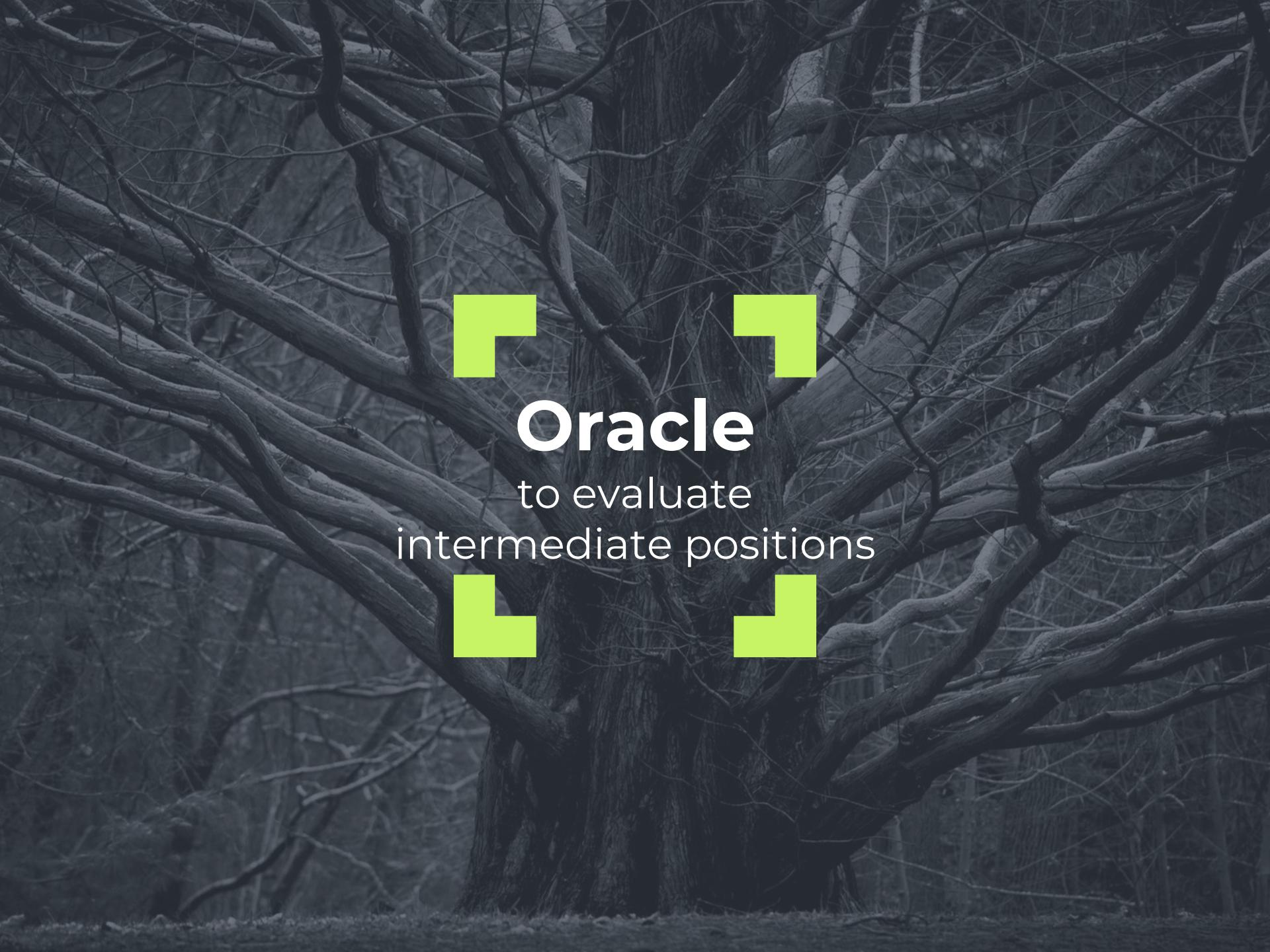
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# What does the future hold?

---





**Oracle**  
to evaluate  
intermediate positions



# Oracle

using knowledge of the game



DeepBlue

1997

# AlphaGo

2016





# AlphaGo Zero

2017