History

1940: Nimatron — https://commons.wikimedia.org/wiki/File:Nimetron-picture.png

1949: Shannon - minimax (brute force)

1956: work checkers, chess

1989: Chinook - expert level checkers

1992: TD-Gammon (RL)

1997: Deep Blue beat Kasparov Elo ≈ 2800 HS 1200-1400
Stockfish ≈ 3500

1999: solitare Yahtzee solved

2007: checkers solved

2013: Deepmind Atari — Google DeepMind's Deep Q-learning playing Atari Breakout

2016: AlphaGo - used db of grandmasters' games

2017: AlphaZero

2019: AlphaStar

2020: DARPA air-to-air combat sim

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Motivation

Fun!

Applications to other areas of AI

Logistics/Control

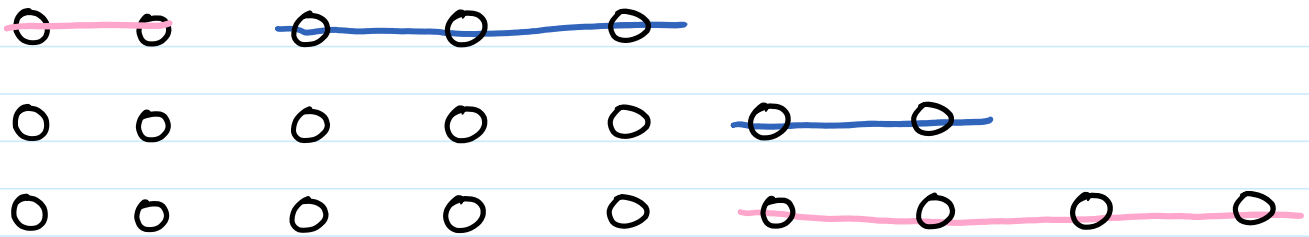
Alpha Fold
https://deepmind.com/blog/article/AlphaFold-Using-AI-for-scientific-discovery

Project Malmo https://www.microsoft.com/en-us/research/project/project-malmo/

Connections to other fields

Digital Ludeme Project http://ludeme.eu/index.html

Nim



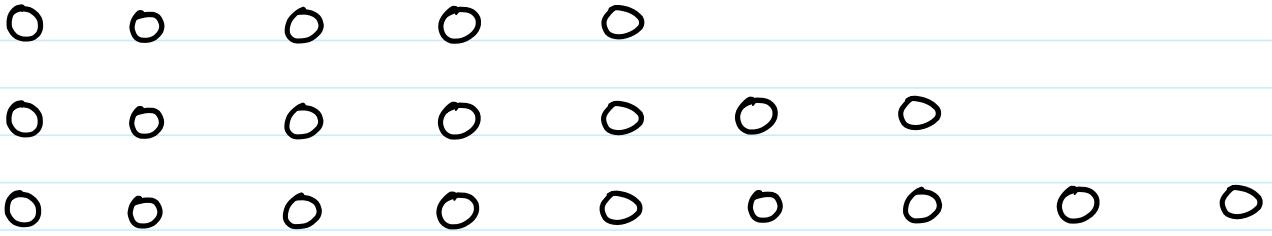
Start with rows of $n_1, n_2, \ldots, n_k$ stones

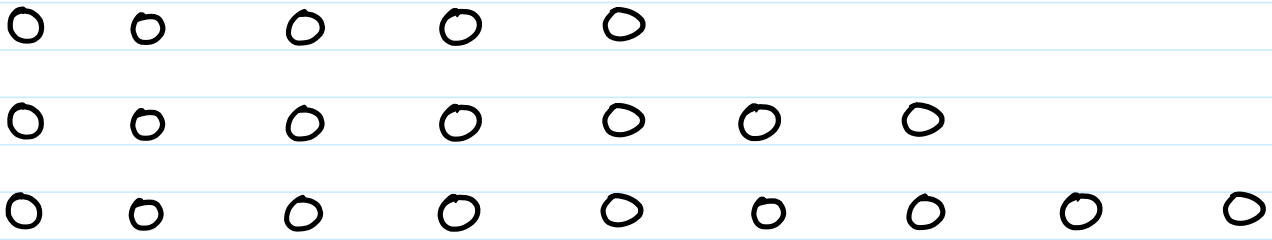
On each turn, take as many stones as you wish from one row

If no possible moves, you lose (last move wins)

0010
0111
1001 0101
1100

0010
0101
0101
10





Combinatorial Games

	Nim, Kayles	Chess, Checkers, Go	Backgammon, Yahtzee	Poker	Roshambo	Starcraft
Combinatorial Game:						
two-player	✓	✓				
turn-based	✓	✓				
non-stochastic — no element of chance	✓	✓				
perfect information — you know everything — all possible moves	✓	✓				
normal — last move wins	✓					
misere — last move loses						#
finite — bound on total # of moves	✓					
https://xkcd.com/1002/						
impartial — no ownership of pieces, moves don't depend on turn	✓	×				

Sprague-Grundy Theorem: every finite, impartial combinatorial game is equivalent to some form of 1-row Nim.

Corollary: If G is equivalent to *n and H is equivalent to *m then G+H is equivalent to *(n⊕m)