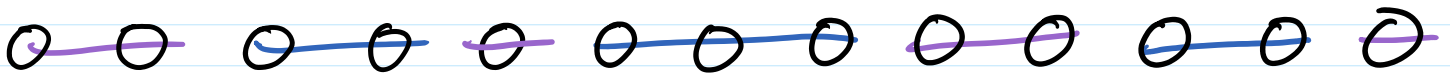
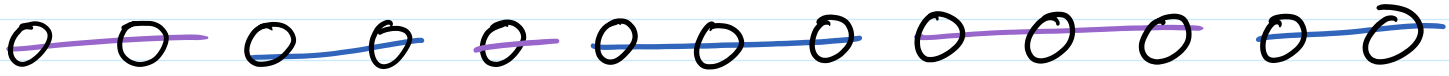
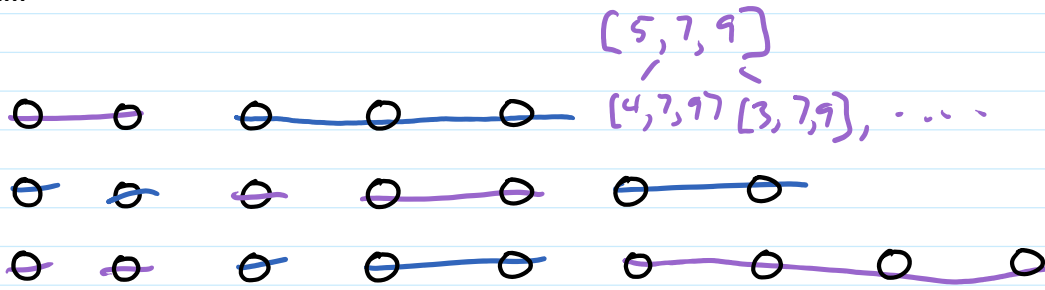


Nim



Multi-row Nim

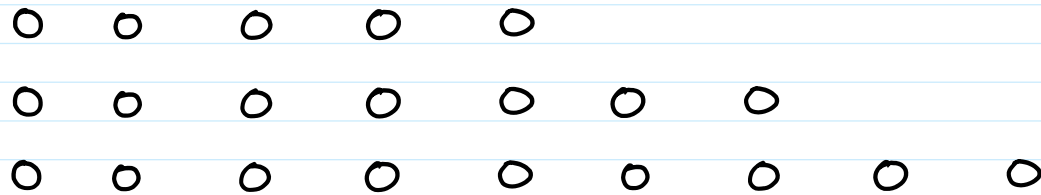
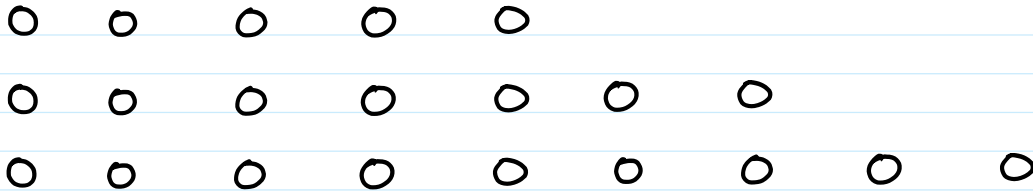


0010  
 0111  
1001 0101  
 1100

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

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

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

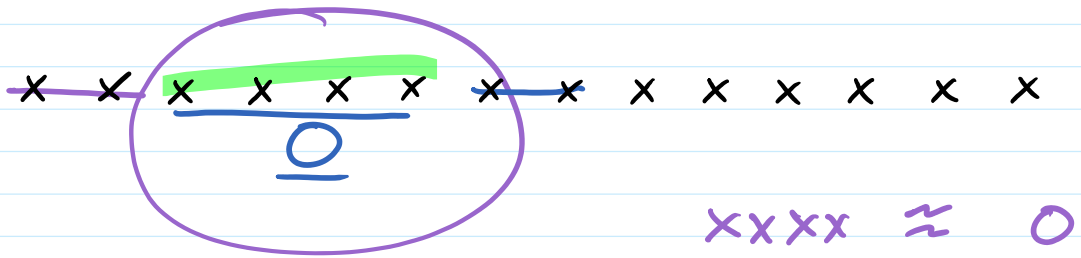




Start with row of n pins

On each turn, take 1 or 2 adjacent pins

If no possible moves, you lose



Combinatorial Games

Combinatorial Game:	Nim, Kayles	Chess, Checkers, Go	Backgammon, Yahtzee	Poker	rock-paper-scissors Roshambo	Starcraft
two-player	✓	✓				
turn-based	✓	✓			X	X
non-stochastic	✓	✓	X	X		
perfect information	✓	✓		X		
normal	✓	X				
misere		X				
finite	✓					
impartial	✓					

## History

1940: Nimatron 

1949: Shannon - minimax

1956: work checkers, chess

1989: Chinook

1992: TD - Gammon

1997: Deep Blue beat Kasparov

1999: solitaire Yantzee solved

2007: checkers solved

2013: Deepmind Atari

2016: Alpha Go

2017: AlphaZero, DeepStack

2019: AlphaStar

2020: DARPA

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