

AI For Games: What Are We Talking About?

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Syllabus

Logistics

Syllabus

Today Introduction
to Games

Types of Games

Two Player Perfect
Information Games

AI and Games

1. Introduction To Games
 - Syllabus
 - Types of Games
 - Terminology
 - Brief History of Games and AI
2. Minimax Tree Search
3. α - β pruning
4. Multi-Armed Bandits and Monte Carlo Tree Search
5. Implementing Monte Carlo Tree Search
6. Weak and Strong Solutions to Games, Checkers



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- Types of Games
- Terminology
- Brief History of AI and Games



Logistics

Types of Games

Single Player Games

Two Player Games

N-Player Games

Games with Chance

Games with
Imperfect

Information

Taxonomy of Games
and Approaches

Two Player Perfect
Information Games

AI and Games

Types of Games



Single Player Games

Logistics

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AI and Games



- Puzzley
- No antagonist (other than the environment)



Two Player Games

Logistics

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Games with Chance

Games with

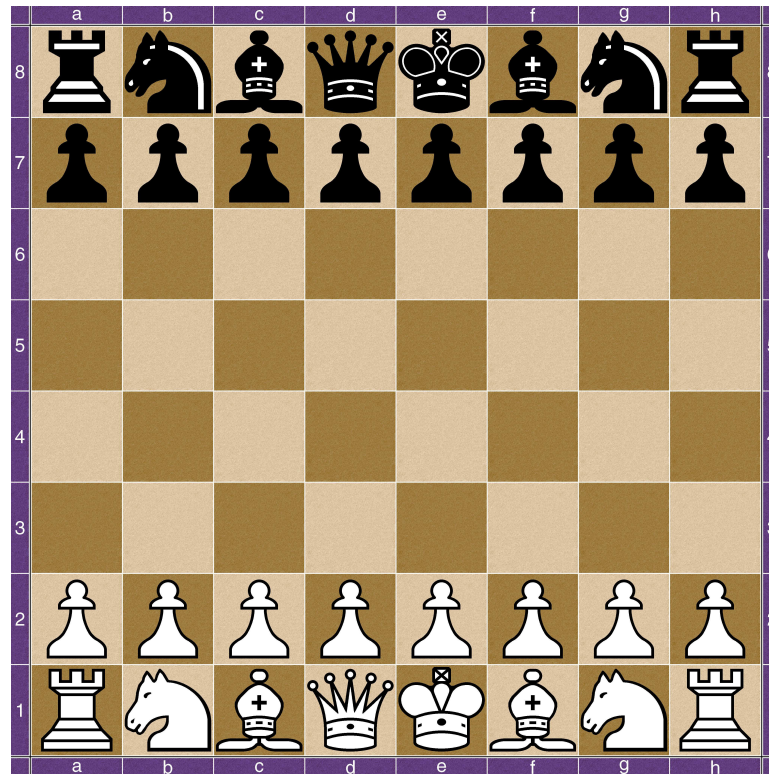
Imperfect

Information

Taxonomy of Games
and Approaches

Two Player Perfect
Information Games

AI and Games



- Exactly two players
- Usually played in turns
- Typically Zero-sum

N-Player Games

Logistics

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Taxonomy of Games
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AI and Games



- More Than Two Players
- Produces a ranking of players
- Coalitions form and dissolve during play



Games with Chance

Logistics

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AI and Games



- Dice
- Spinners
- Shuffling

Games with Imperfect Information

Logistics

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Taxonomy of Games
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AI and Games



- Flipping Tiles, Cards
- “Hands”
- Asymmetric Information



Taxonomy of Games and Approaches

Logistics

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**Taxonomy of Games
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Two Player Perfect
Information Games

AI and Games

Games:

One Player

Two Player

N Players

Approaches:

Perfect Information

Permutation Puzzles

Chess, Checkers

Some Board Games

Imperfect Information

Solitaire

Stratego

Most Card Games

One Player

Two Player

N Players

Perfect Information

Depth First Search

Game Tree Search

Game Tree Search

Imperfect Information

Policy Search

MDP & POMDP Solvers

Regret Minimization



Logistics

Types of Games

**Two Player Perfect
Information Games**

Two Player Perfect
Information Games

Turns and Ply

Tree Search

Graph Search

Win, Lose, or Draw

Solutions, Strategies

AI and Games

Two Player Perfect Information Games



Two Player Perfect Information Games

Logistics

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Turns and Ply

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AI and Games

- Exactly Two Players
- All actions are deterministic
- Shared game representation
- Each game is self contained



Turns and Ply

Logistics

Types of Games

Two Player Perfect
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Information Games

Turns and Ply

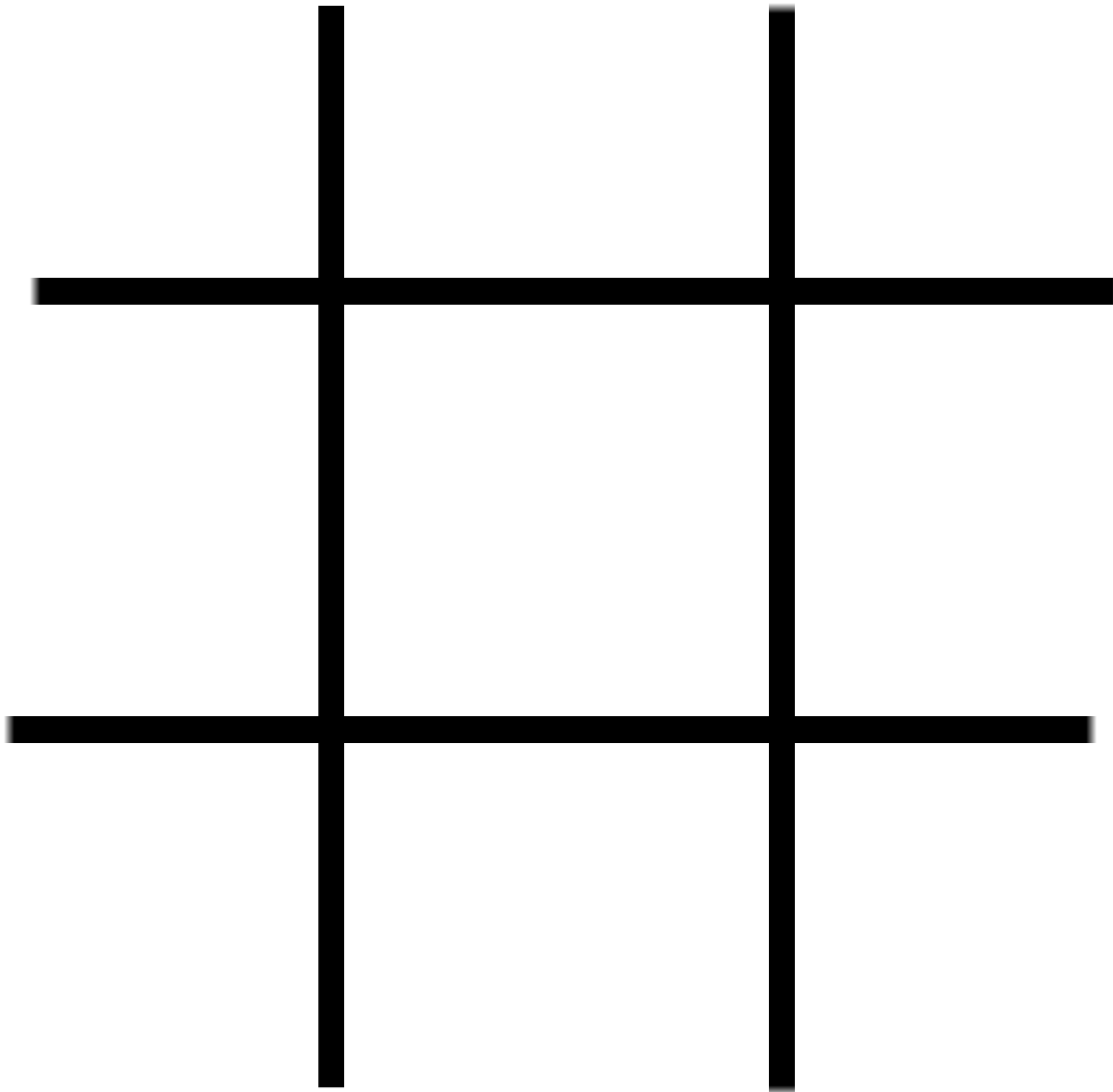
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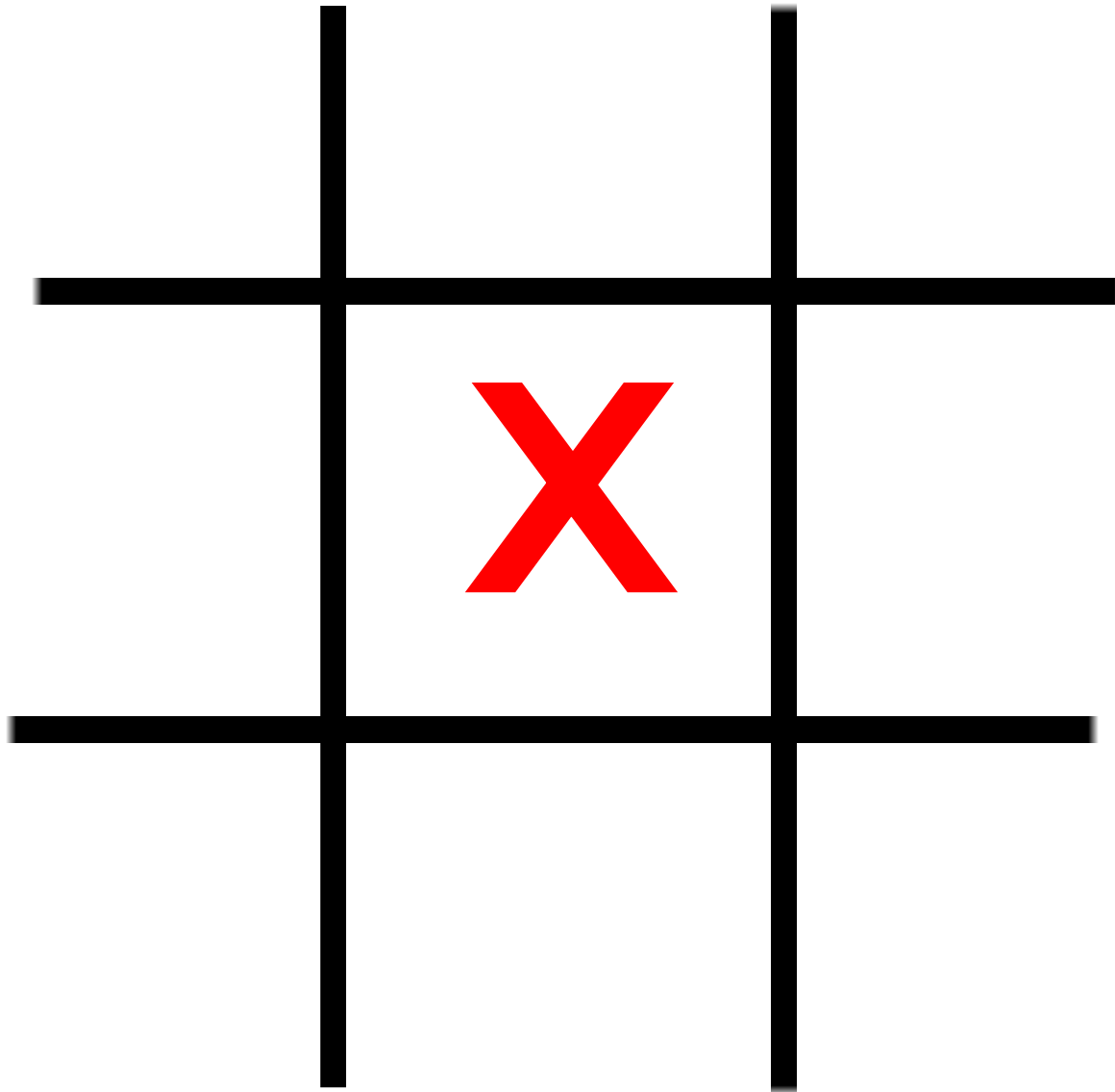
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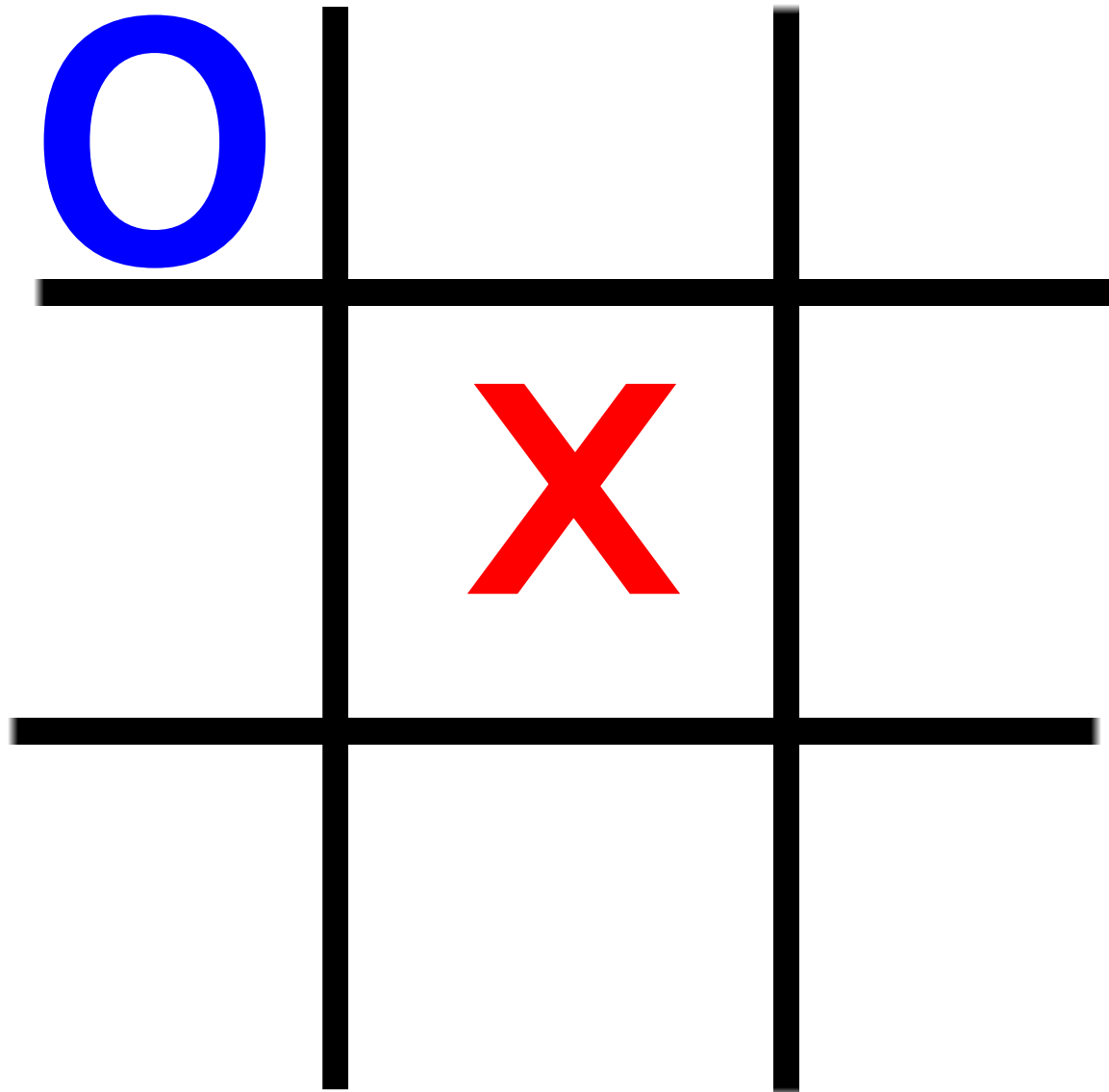
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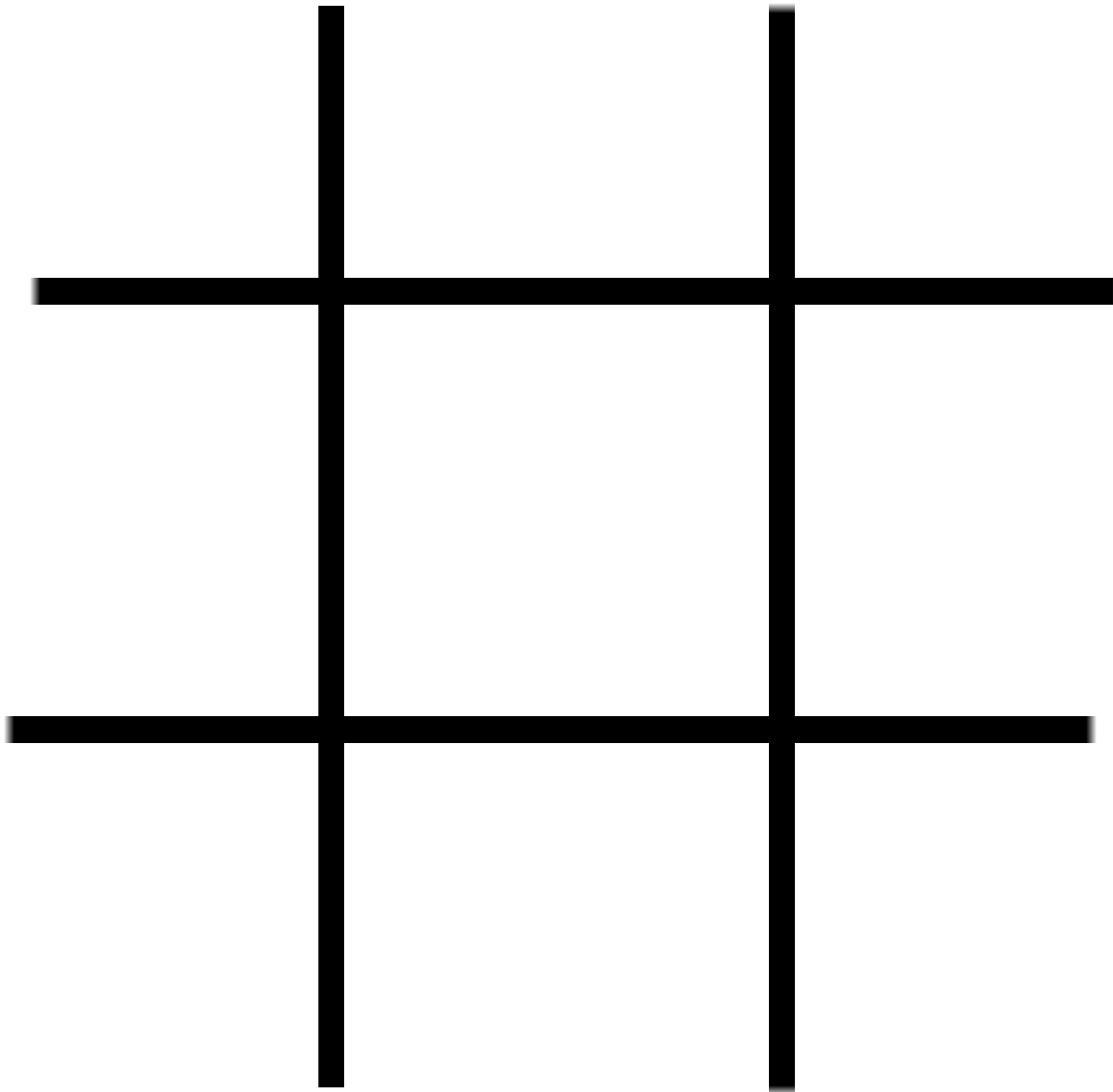
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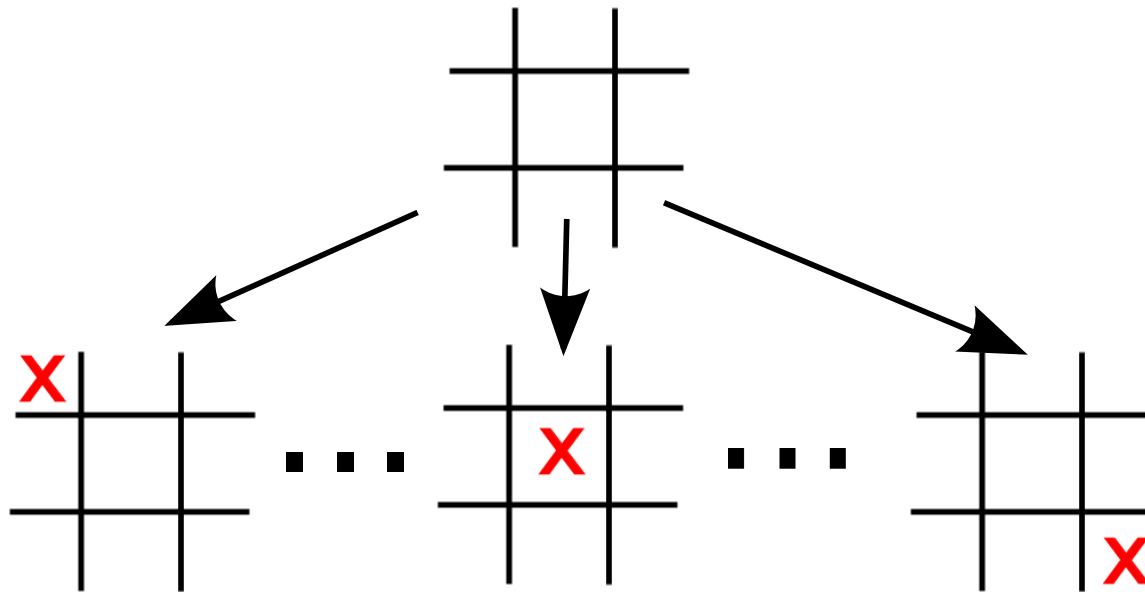
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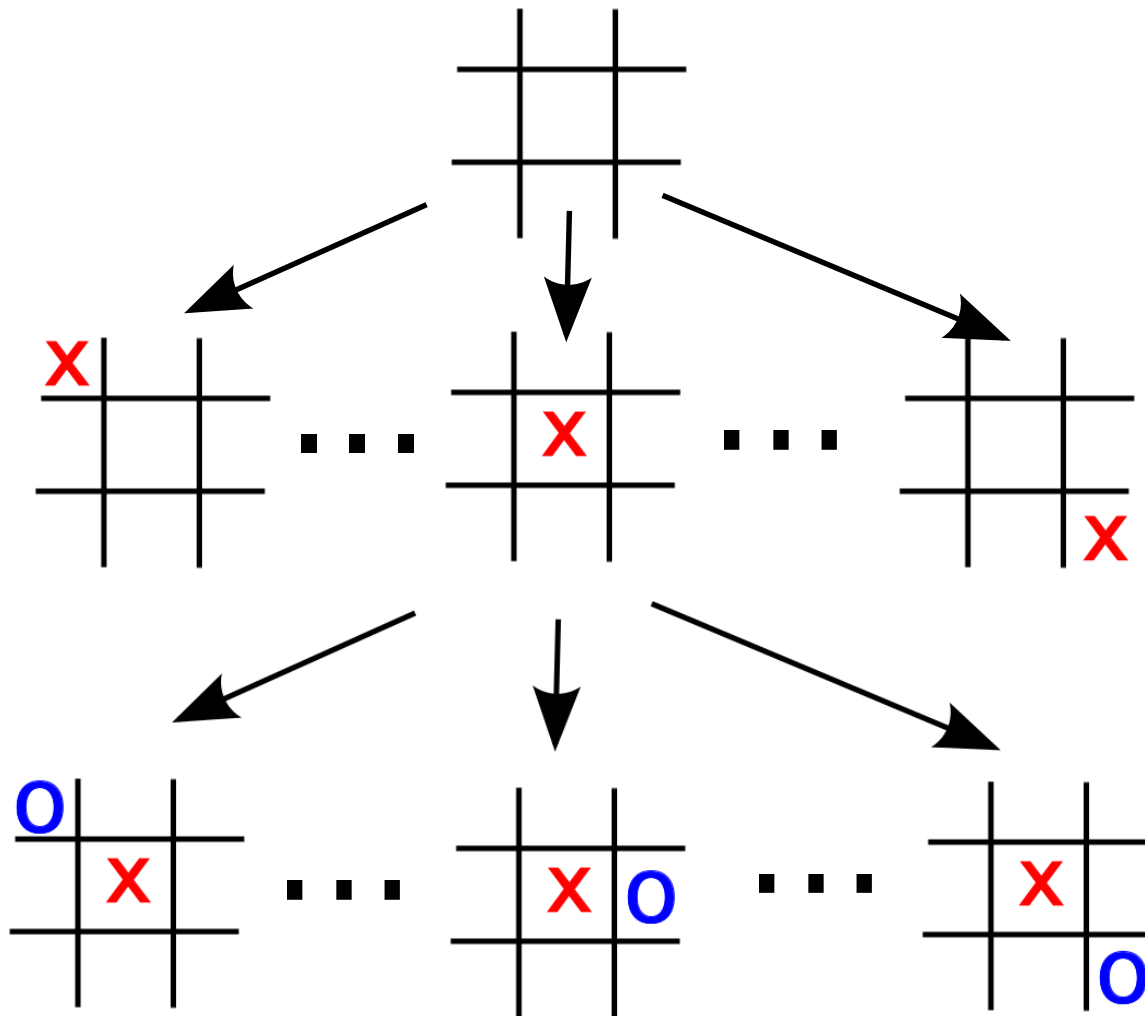
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Graph Search

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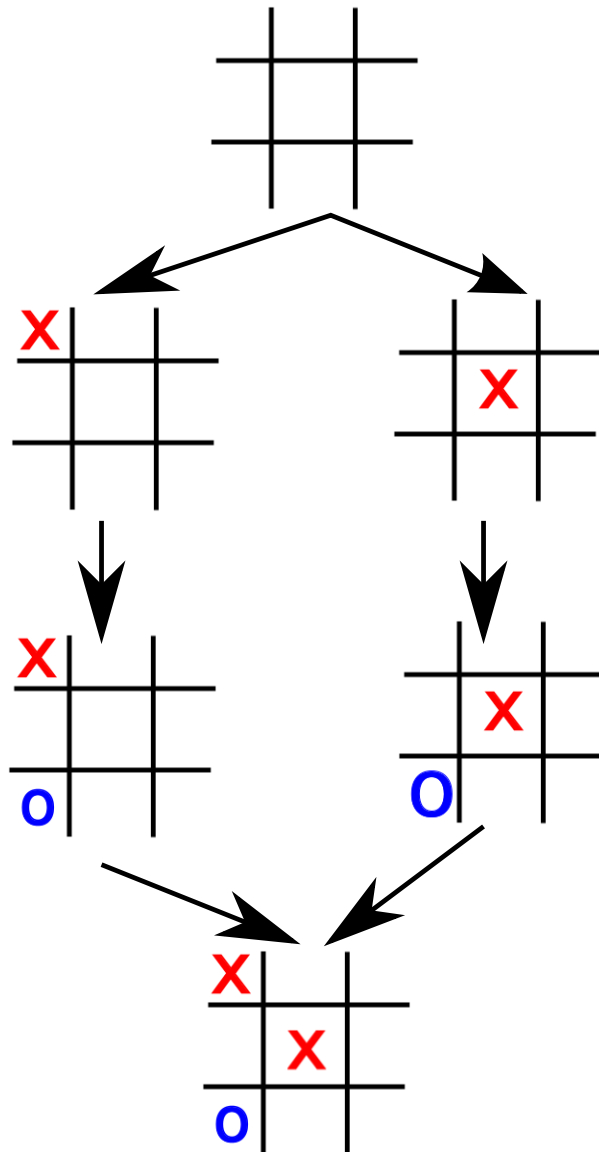
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Win, Lose, or Draw

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Solutions, Strategies

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AI and Games

Ultra-Weak Show whether player one wins, loses, or draws given perfect play on both sides.

Weak Provide an algorithm that secures a win for one player, or a draw for either given any possible move from the opposing player.

Strong Provide an algorithm that can play perfectly from arbitrary, but legal, board positions.



Logistics

Types of Games

Two Player Perfect
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AI and Games

McCarthy Studies

Chess Players

Checkers and the
March to Chinook

Go

Other Victories

AI and Games



McCarthy Studies Chess Players

Logistics

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AI and Games

**McCarthy Studies
Chess Players**

Checkers and the
March to Chinook

Go

Other Victories

1956 - John McCarthy conference on Artificial Intelligence

1959 - Kotok, first program to play chess written by McCarthy

1978 - Several automated players (Belle, Chess4.7) start beating masters

1989 - Kasparov Competes against Deep Thought (And wins)

1996 - Deep Blue Beats Kasparov for one game, but loses tournament

2003 - Junior Ties Kasparov

2005 - Hydra (Custom hardware) wins 5.5 - 0.5 against grand master

2009 - Commodity hardware performs at grand master levels



Checkers and the March to Chinook

Logistics

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Other Victories

1951 - Starchey writes the first AI for checkers

1959 - Samuel Publishes "Some Studies in Machine Learning Using the game of Checkers", invents alpha-beta pruning

1989 - Schaeffer makes Chinook

1994 - Chinook beats the world human champion Lafferty

2003 - Chinook completes its 10 piece database with 5 pieces on each side.

2004 - The Chinook team announces that the tournament opening in English draughts called the White Doctor (1014 2218 1216) is proven to be a draw.

2007 - The journal Science publishes Schaeffer's team's article "Checkers Is Solved", presenting their proof that the best a player playing against Chinook can achieve is a draw.



Go

Logistics

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Other Victories

- 1968 - Zorbist studies go and pattern recognition in his thesis
- 1981 - Go players for home computers are available, and awful
- 1987 - Monte Carlo Tree Search applied to games, no one takes it seriously
- 1992 - MCTS used in Go for the first time
- 1998 - Go Intellect loses to children with a 25-30 stone handicap
- 2006 - Upper Confidence Bounds for Trees published, used in MoGo
- 2008 - MoGo is Dan in 9x9 go
- 2012 - Zen wins 3:1 on a 19x19 board
- 2015 - Alpha Go wins without a handicap against professional players
- 2016 - Alpha Go beats a 9-dan player



Other Victories

Logistics

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Other Victories

Backgammon (1979)

Connect 4 (Solved in 1988)

Othello (Solved 1993)

Mancala (Solved 2002)

Rock Paper Scissors

Crosswords (2006)

Hold'em (weakly solved in 2015)