GAME TREE REPRESENTATIONS

Games AI Lecture 2

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PREVIOUSLY COVERED

Ways of defining games

- Static vs Dynamic problems
- Deterministic vs Stochastic problems
- Fully-Observable vs Partially-Observable problems

CONTENT

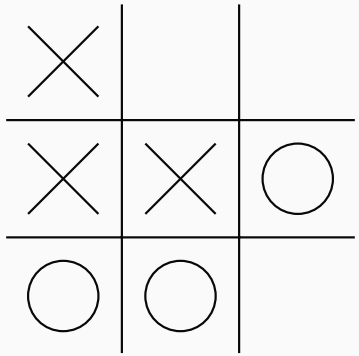
We will be covering:

- Decision trees
- Metrics for decision trees

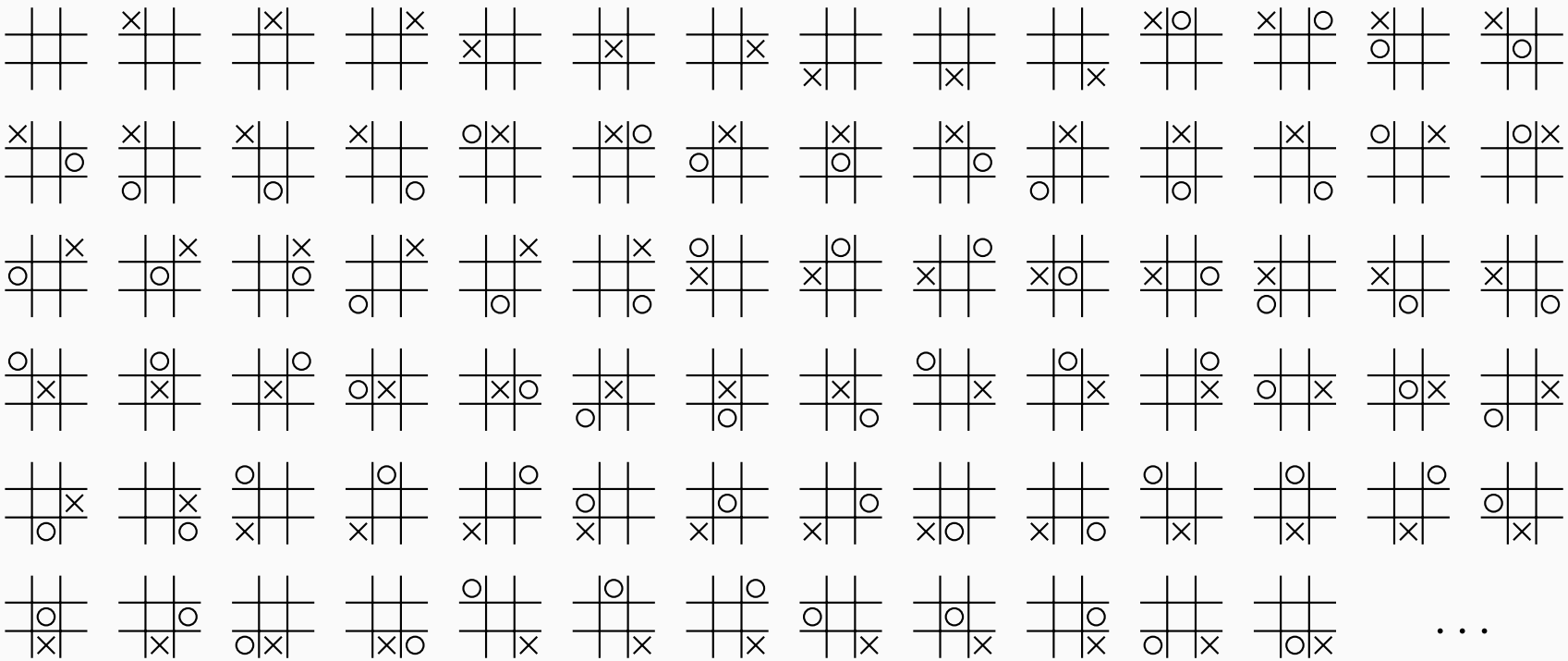
A SIMPLE EXAMPLE

Noughts and crosses

- Two player, deterministic, fully observable.
- Simple rules
- Most learn to play optimally when they're children

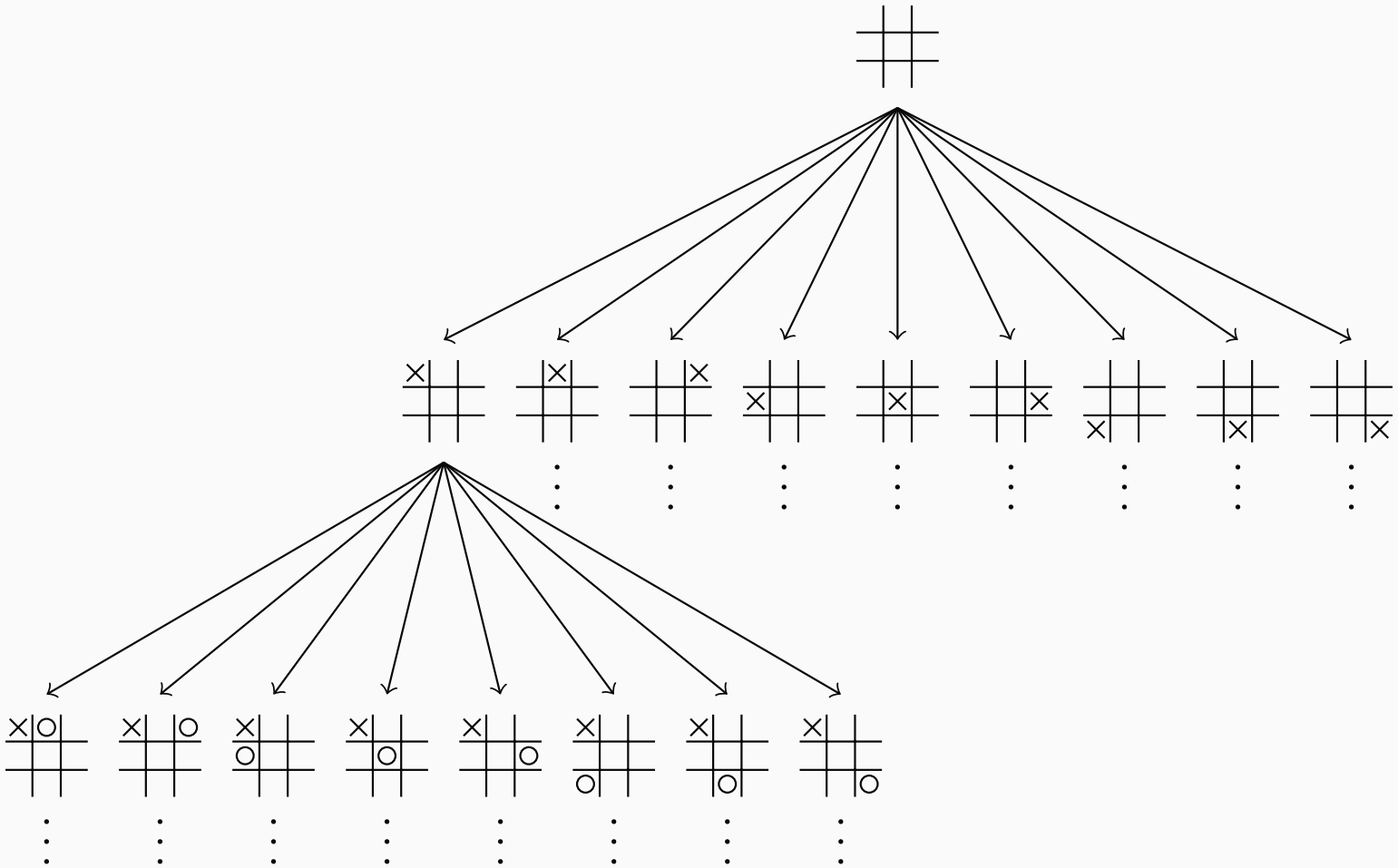


NOUGHTS AND CROSSES - THE FIRST TWO MOVES

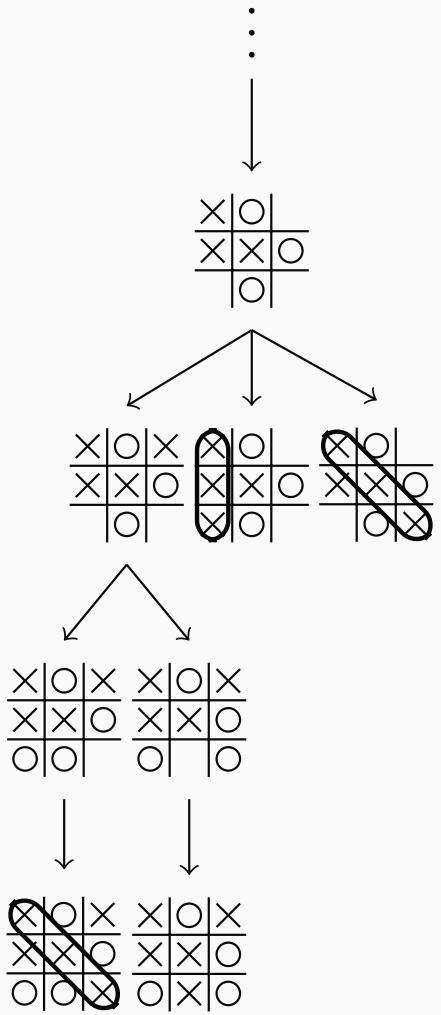


This isn’t particularly useful..

NOUGHTS AND CROSSES - TREE REPRESENTATION



NOUGHTS AND CROSSES - TREE REPRESENTATION



EXERCISE

Try to construct a game tree for a simple **Subtraction Game** with people nearby in the next couple of minutes.

Aim to complete at least three layers.

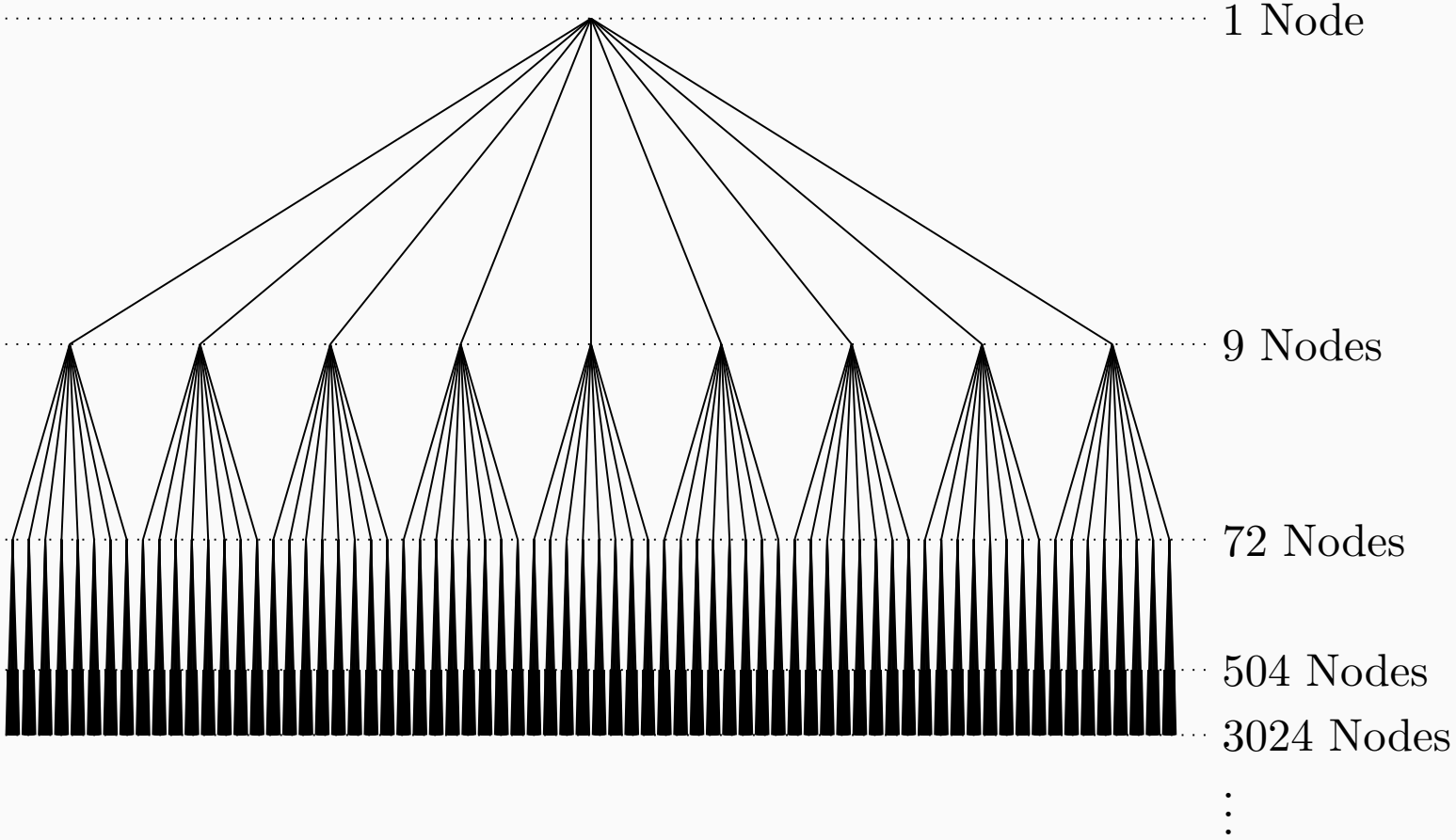
Game Description

A counter starts with the value of 21. Two players take it turn to subtract 1, 2, or 3 from the counter. The counter cannot go negative. Once the counter reaches zero, the game ends and the player who would go next wins.

ASIDE FOR PAUL

(At this point we would go through a couple of layers of the tree on the board.)

NOUGHTS AND CROSSES - TREE COMPLEXITY



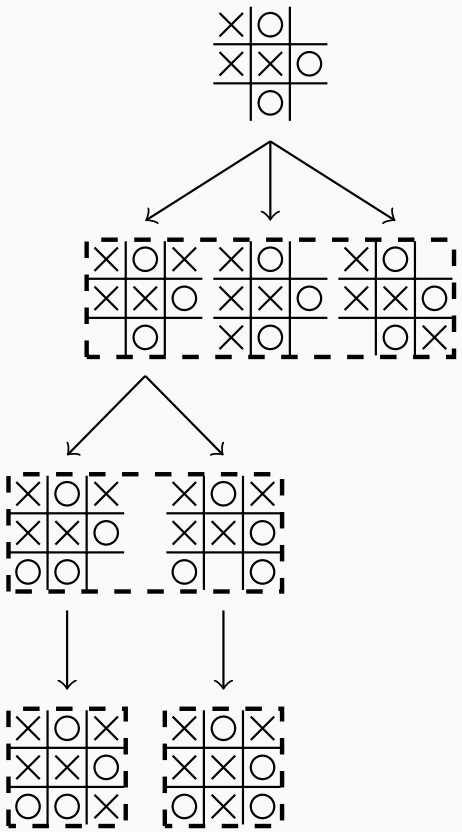
GAME TREE METRICS

What ways can we classify the complexity of different games?

- How long the game is
  (the **depth** of the tree)
- How many actions you have to choose between
  (the **width** of a subtree)
- How many different ways the game can play out
  (the **size** of the tree)

The average number of children nodes for any non-leaf node

- Select n non-leaf nodes throughout the tree and average their number of children



(1×3)

$+(1 \times 2)$

$+(2 \times 1)$

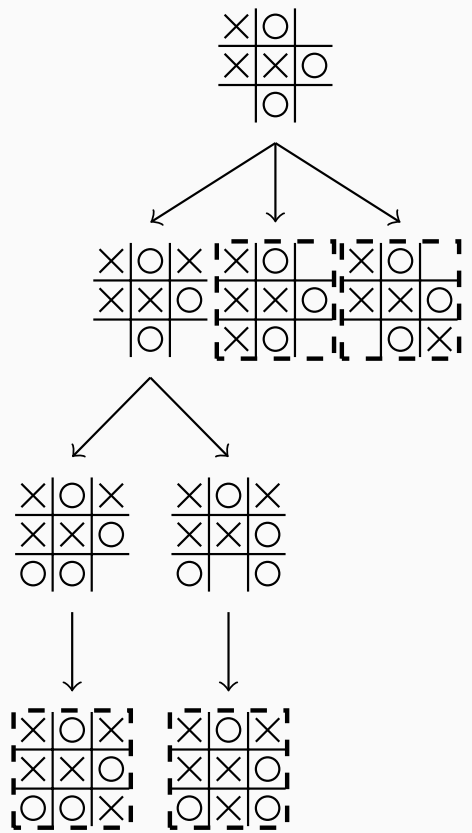
$$\text{BF} = \frac{(1 \times 3) + (1 \times 2) + (2 \times 1)}{4}$$

$$= \frac{7}{4}$$

$$= 1.75$$

The average depth of root nodes

- Select n leaf nodes throughout the tree, and average their depths



(2×1)

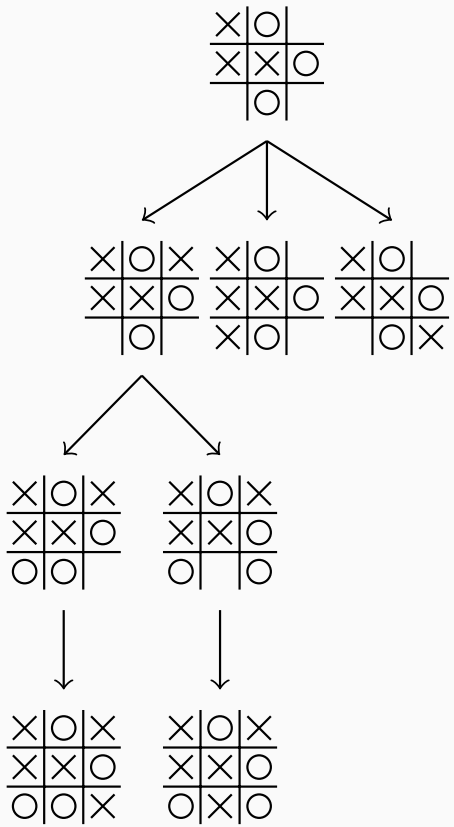
$+0$

$+(2 \times 3)$

$$\begin{aligned} \text{TD} &= \frac{(2 \times 1) + (0) + (2 \times 3)}{7} \\ &= \frac{8}{4} \\ &= 2 \end{aligned}$$

The number of nodes in the tree

- Count all the nodes of the full tree!
- Estimate by performing BF^{TD}



$$TS = 8$$

$$TS \approx BF^{TD}$$

$$\approx 1.75^2 \quad \approx 3.06$$

THINGS TO CONSIDER

- Approximations require fair sampling
- Trees may be unbounded
- These metrics aren’t everything!

SUMMARY

- We can represent games as tree structures
- Basic tree metrics
  - Branching Factor
  - Tree Depth
  - Tree Size
- How to compute and estimate them

NEXT TIME

Before next lecture:

- **Read** "AI: A Modern Approach" Sections 3.1, 3.2
  Goes over formal definitions of games
- **Attempt** to create a game tree for the "Vacuum Domain"
  Described in the reading above!
- **Read** "AI: A Modern Approach" Sections 3.3, 3.4
  Revises simple tree searching algorithms from TPOP

Next lecture:

- How tree metrics impact searching performance
- Monte-Carlo searching techniques