

“AI”/Search

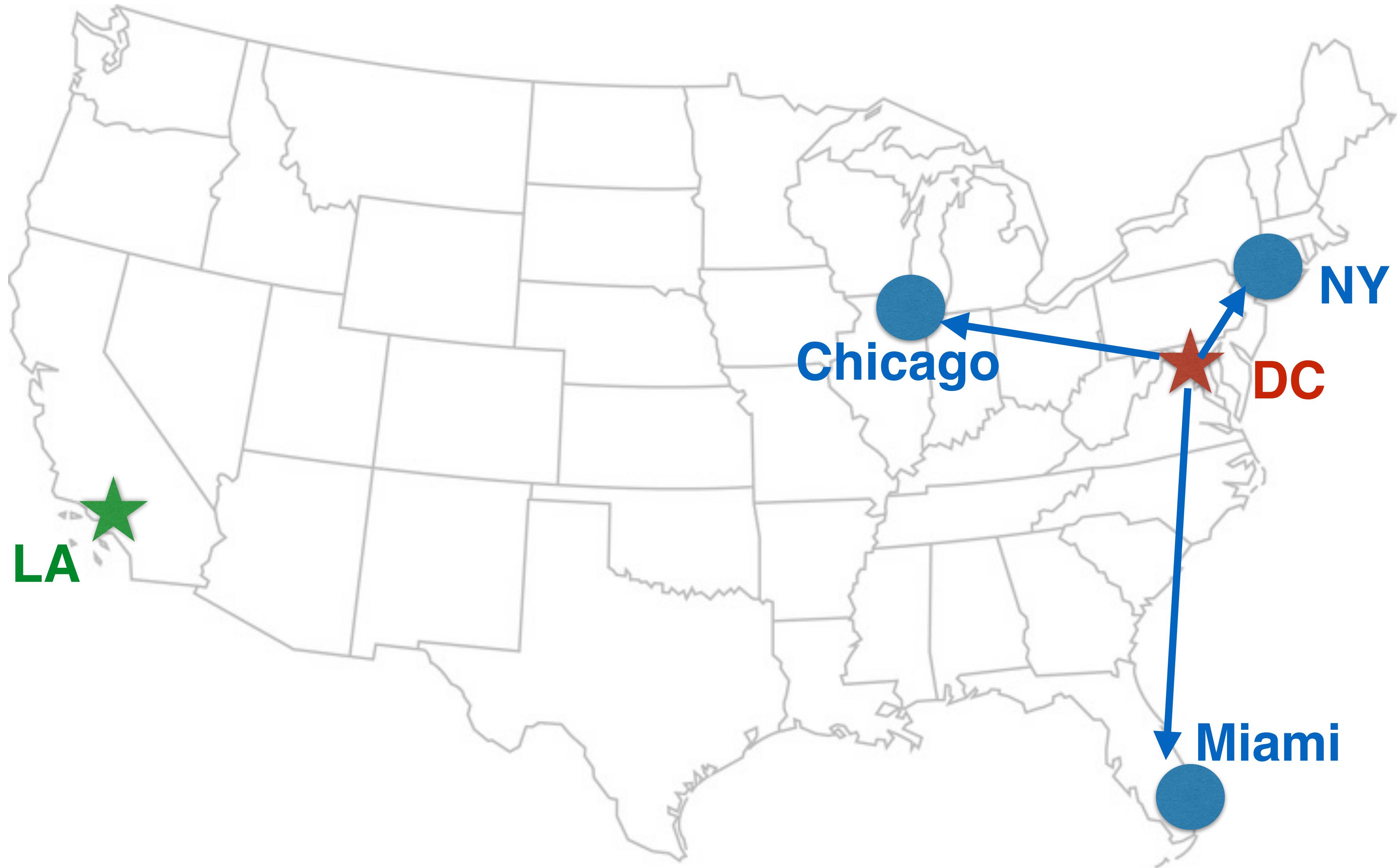
ENAE 380 Flight Software Systems

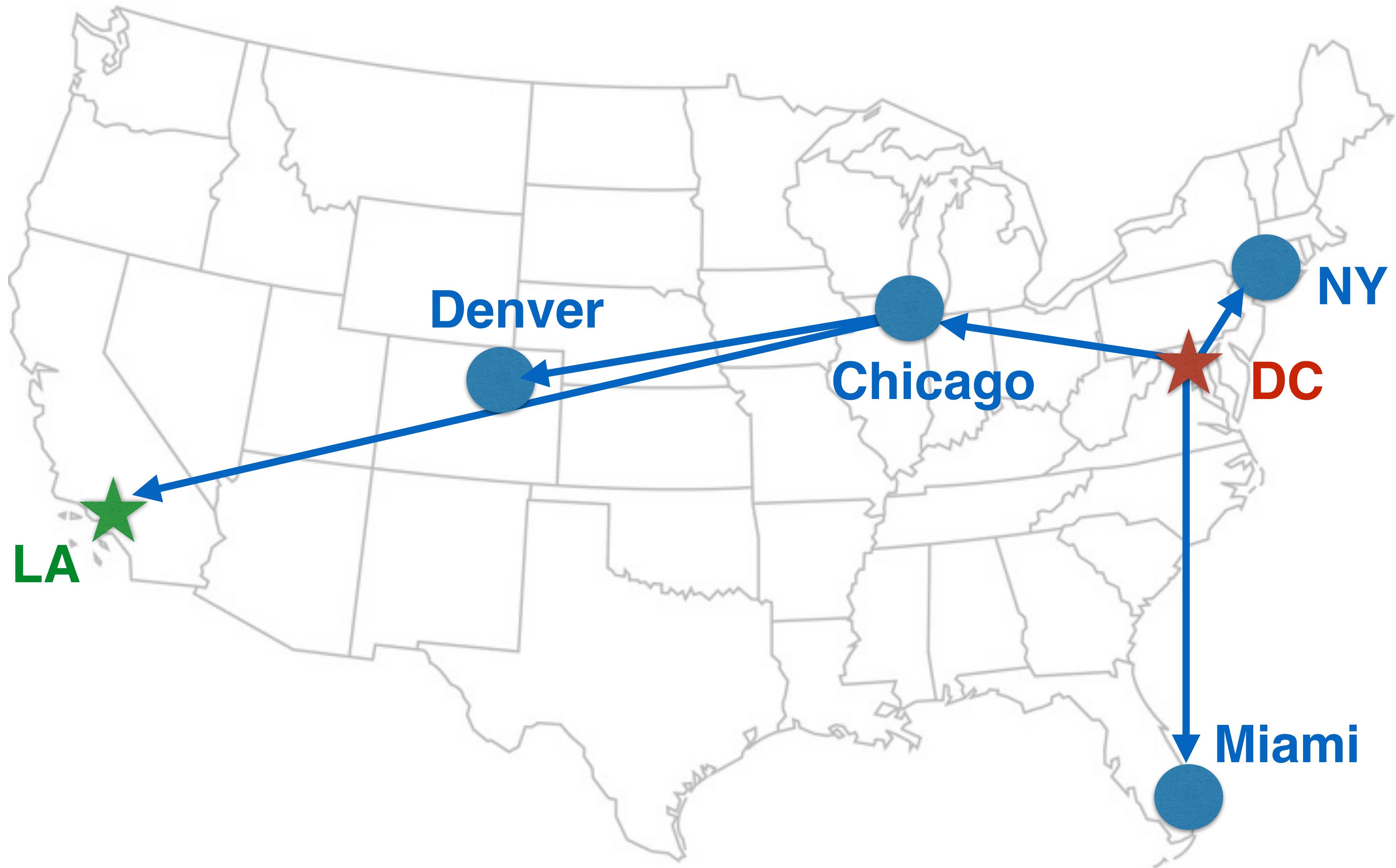
September 23, 2024

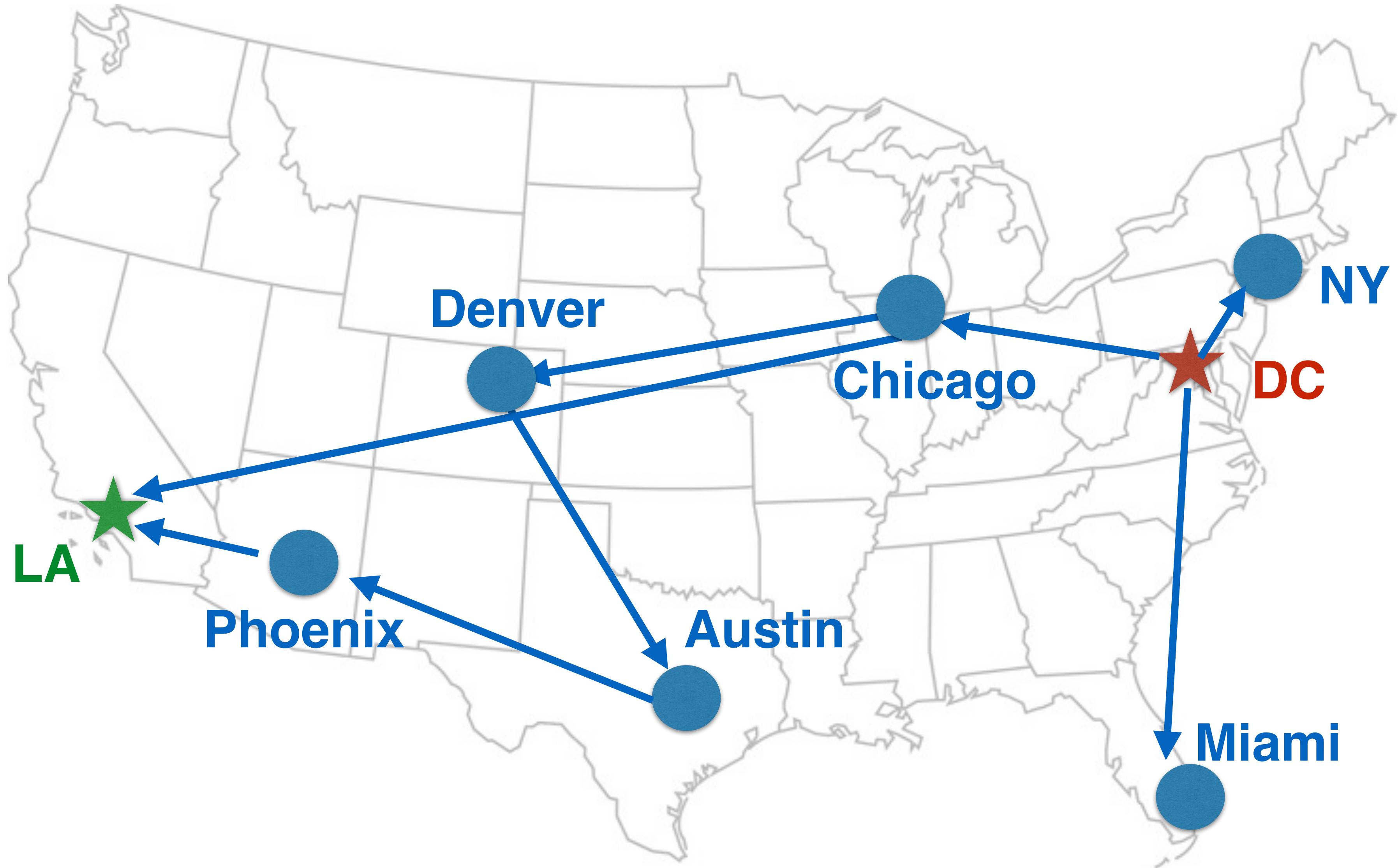
Search Algorithms

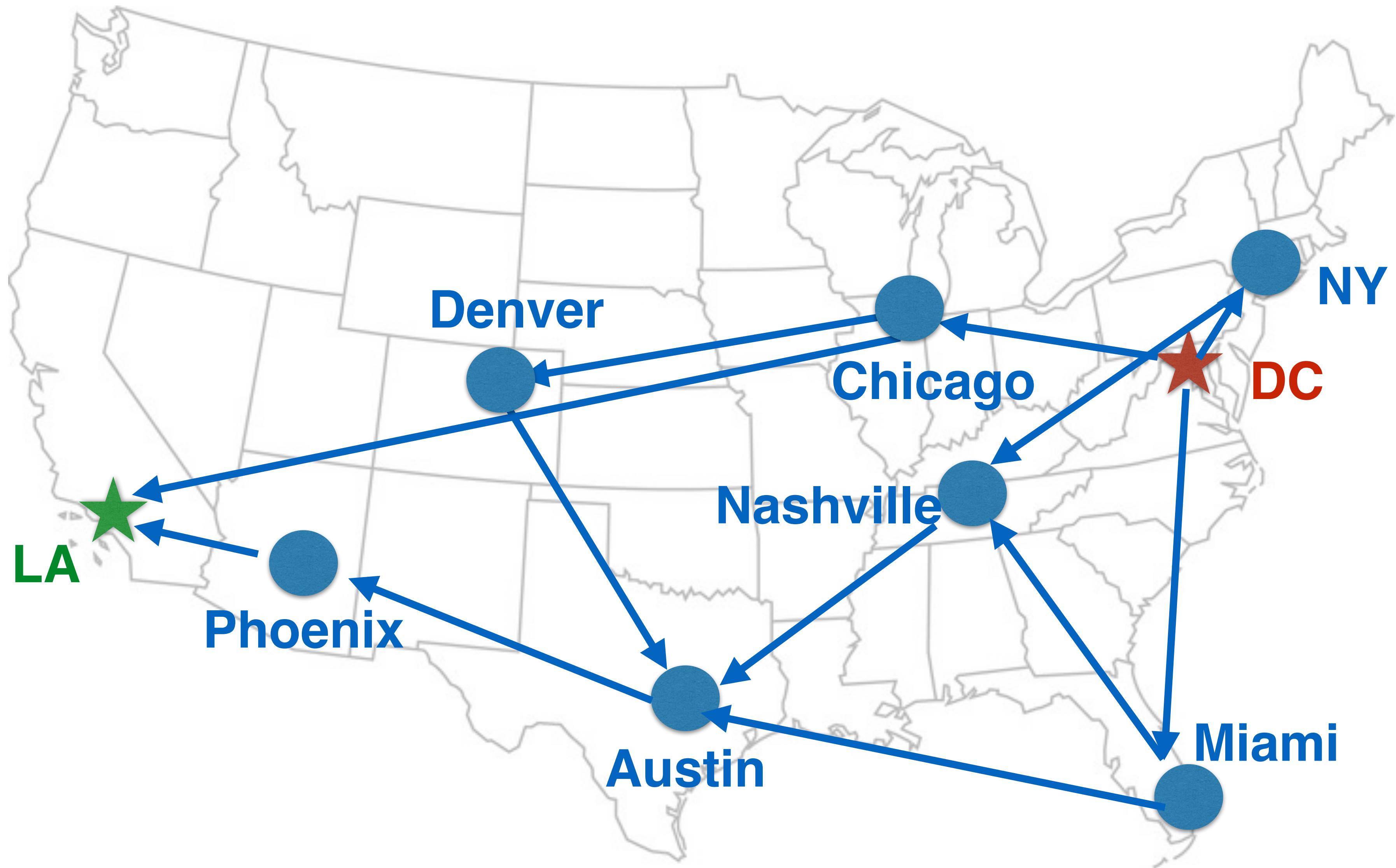
Solving problems with brute-force approach



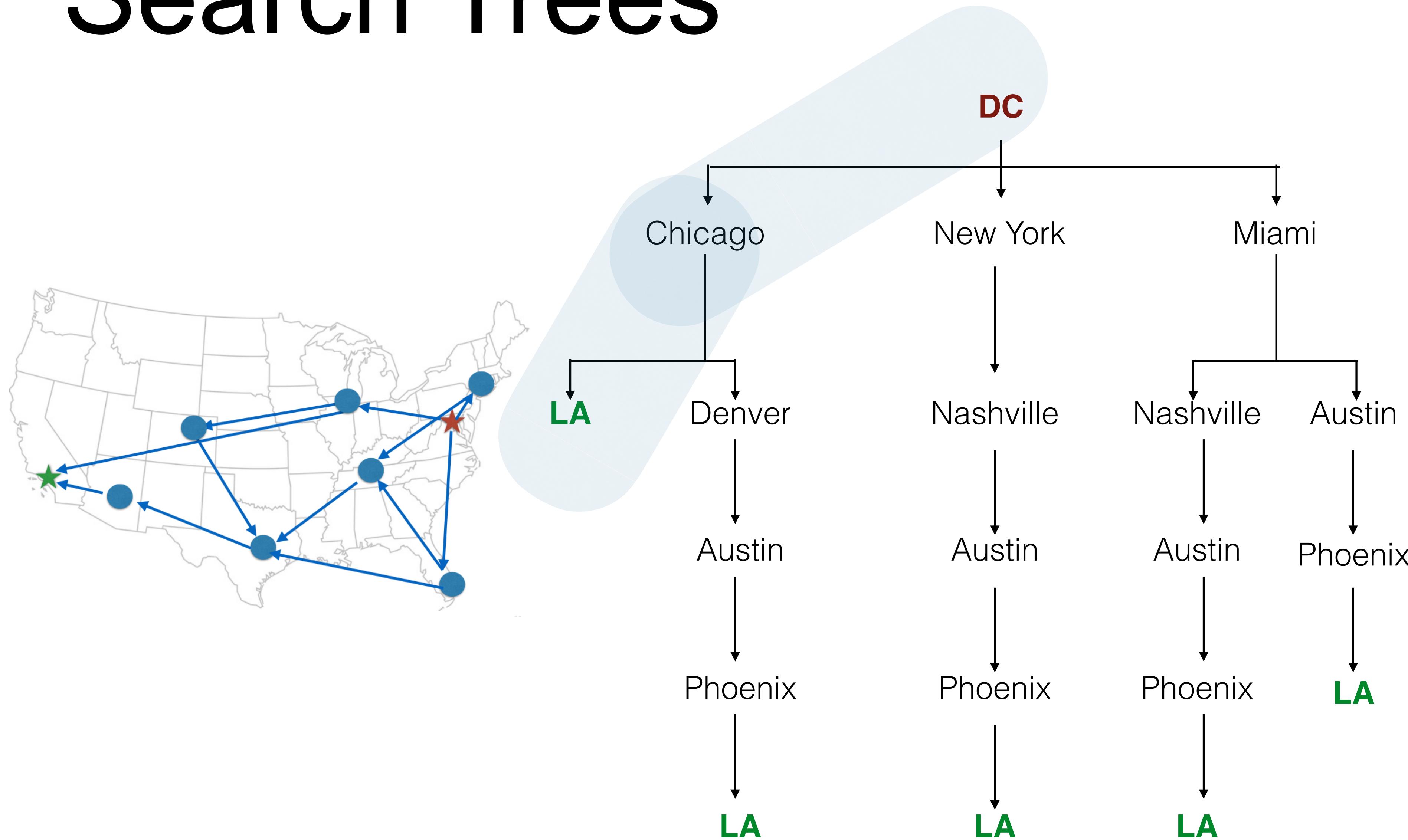




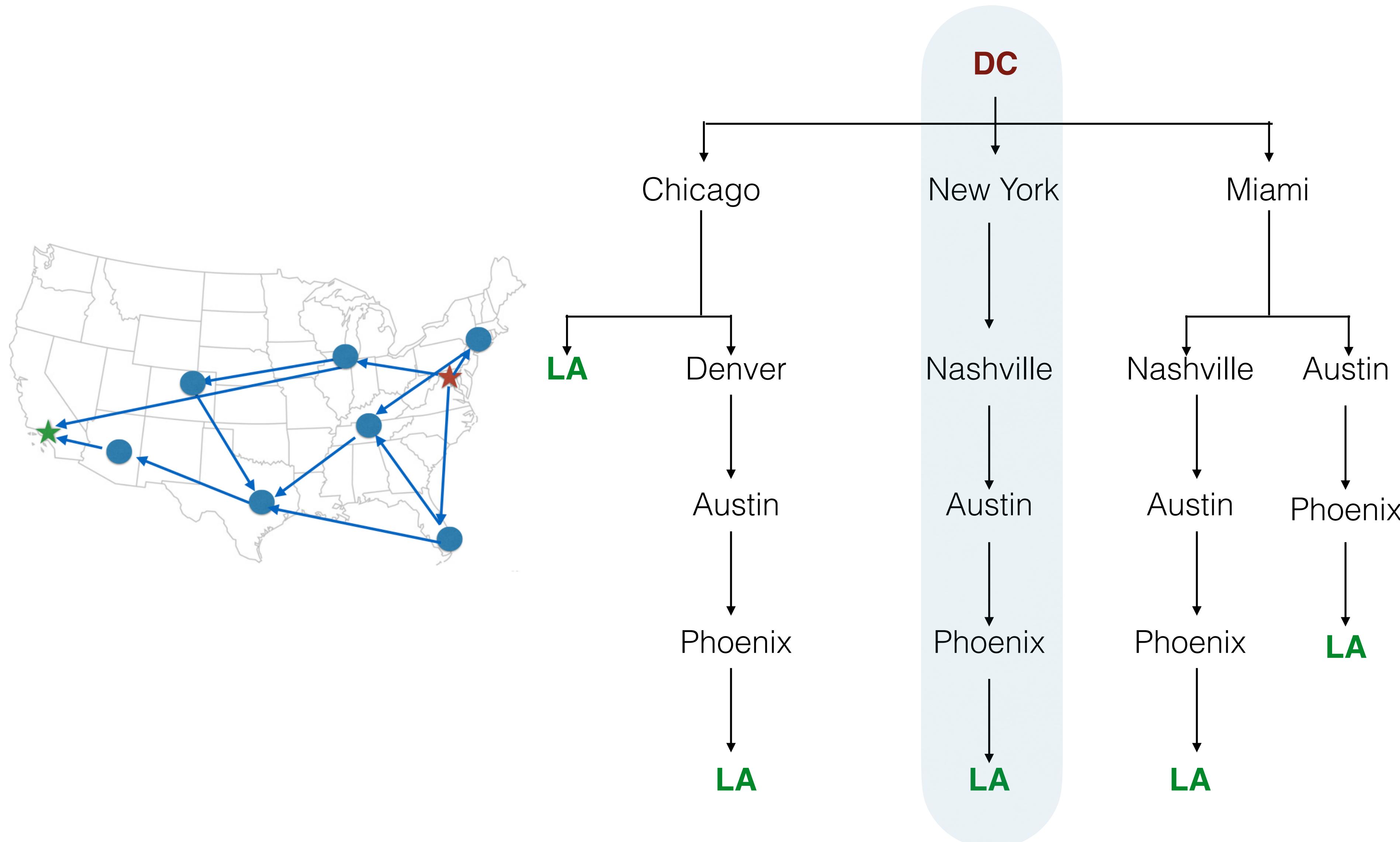




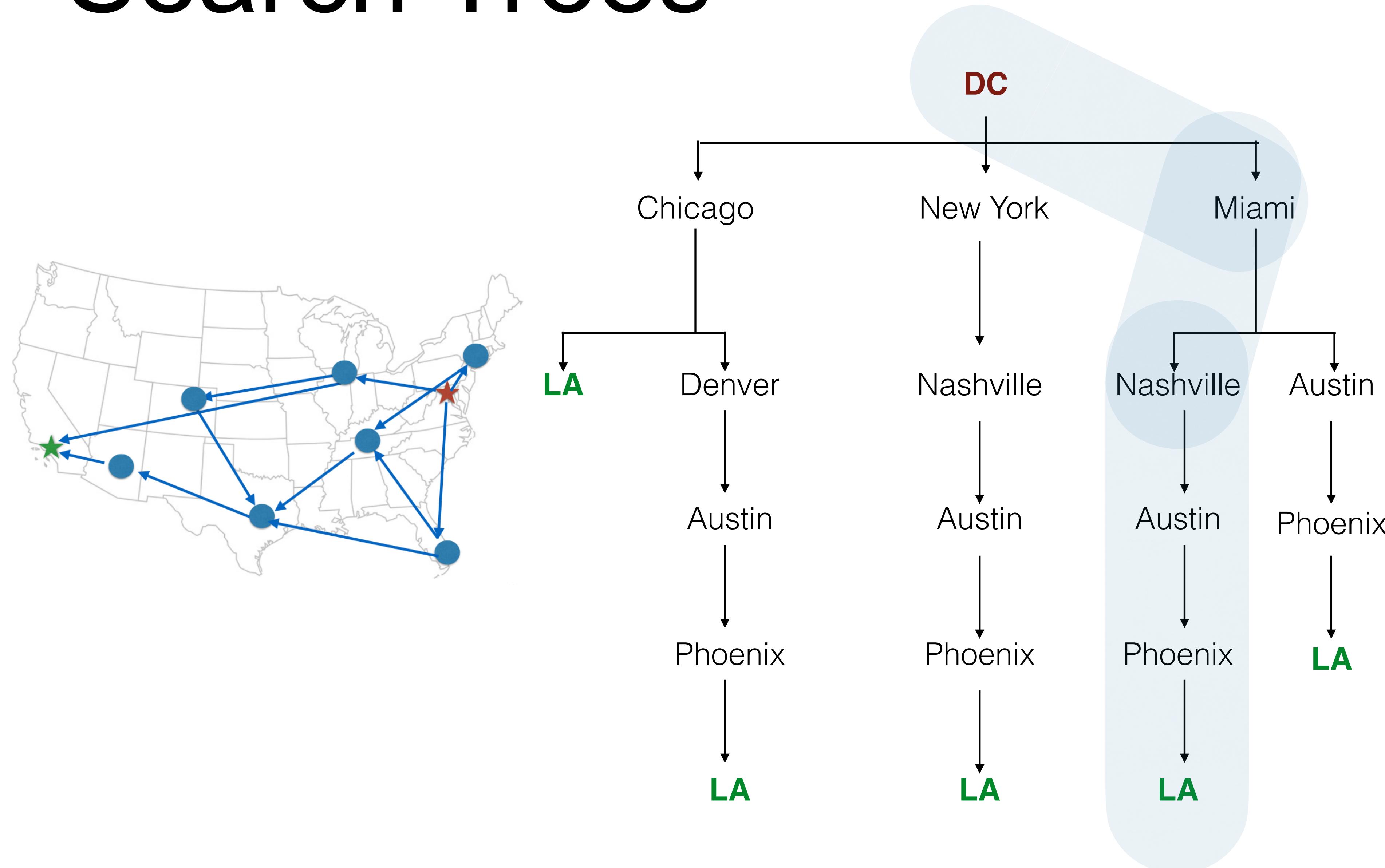
Search Trees



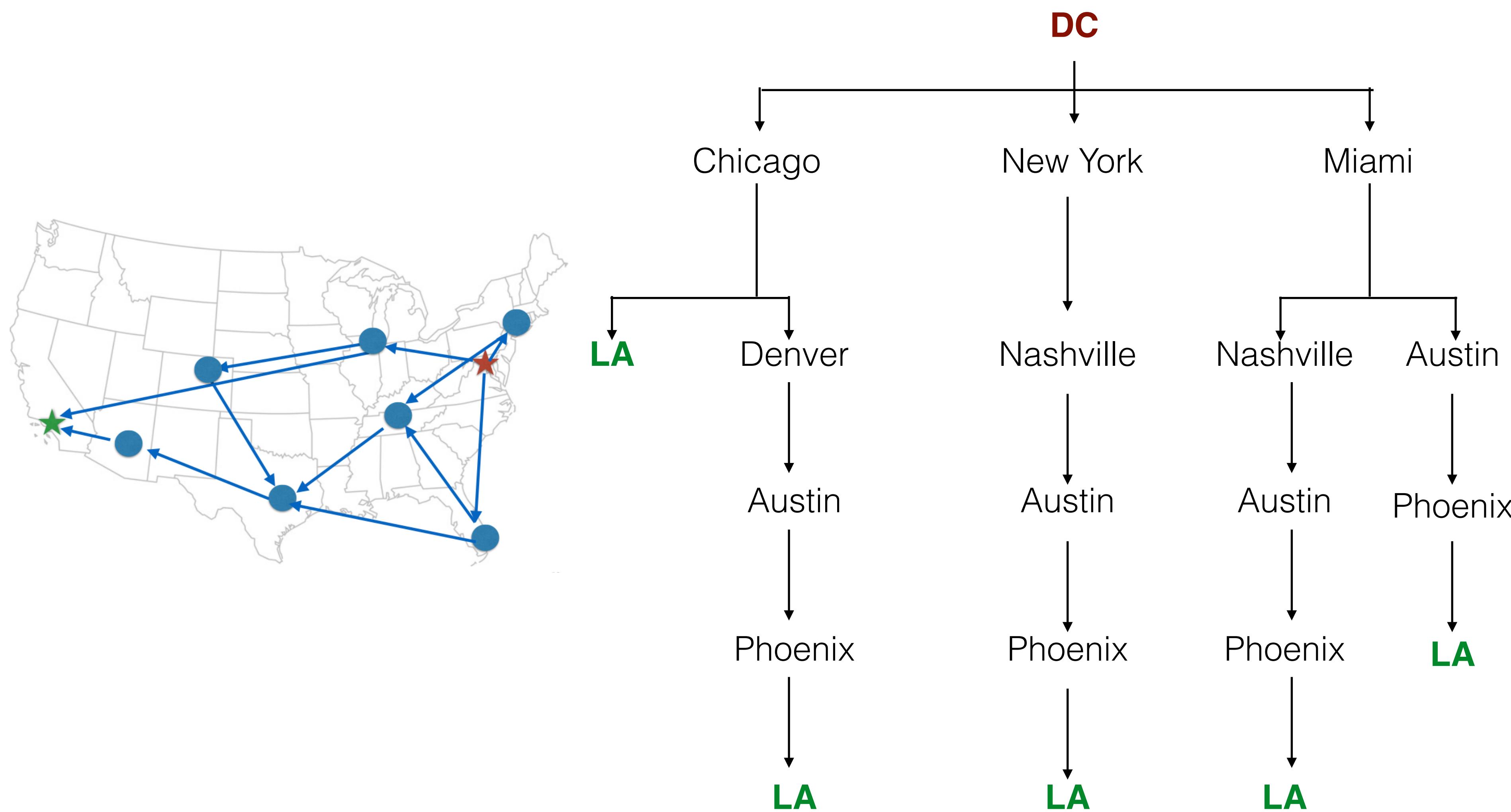
Search Trees



Search Trees

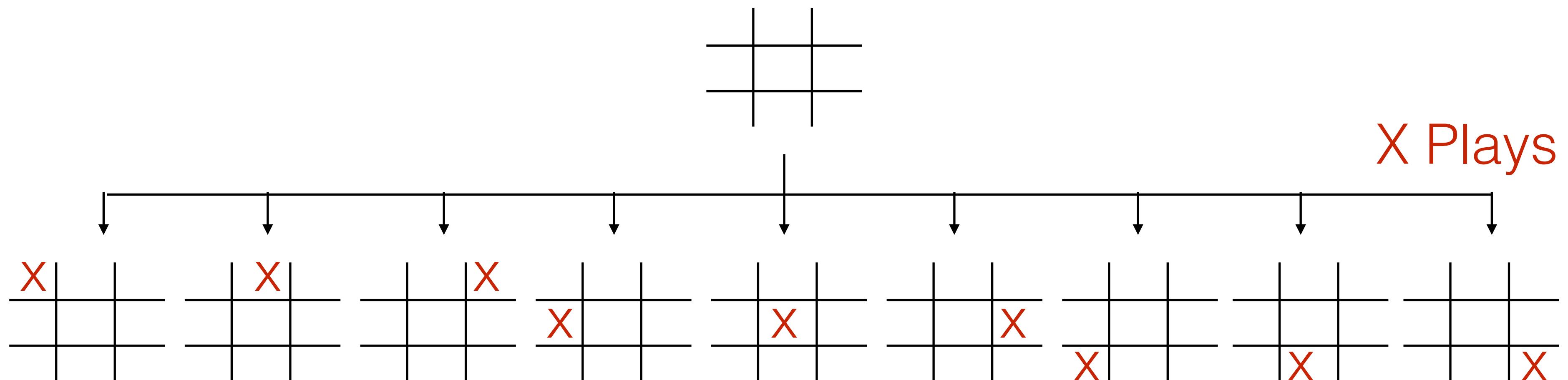


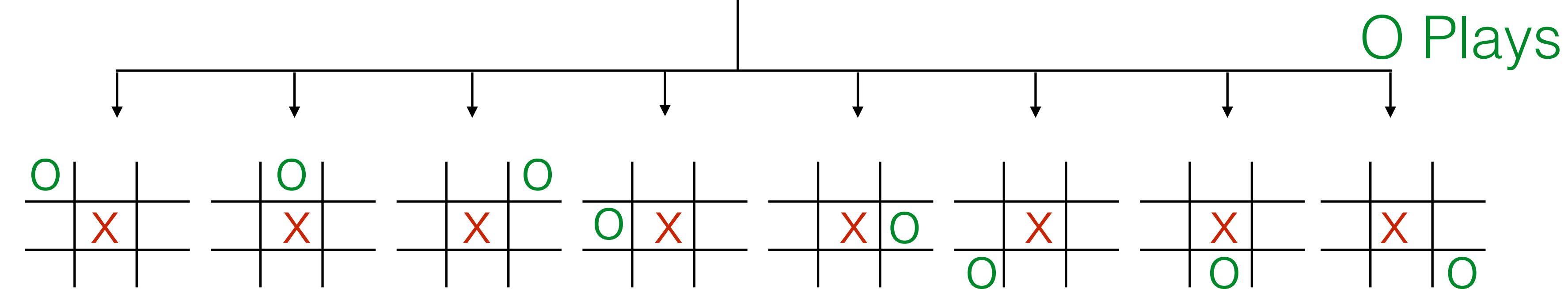
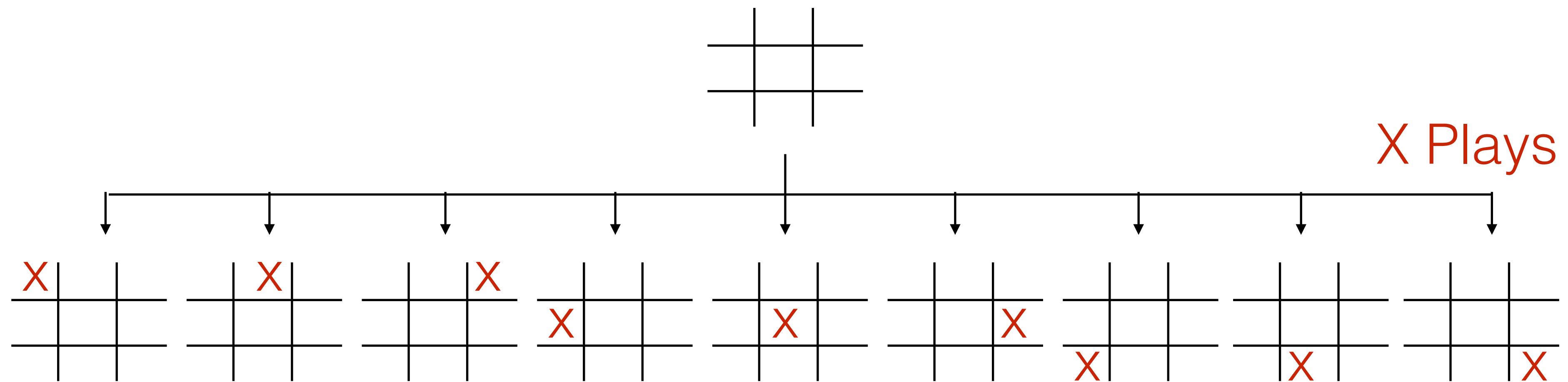
Search Trees

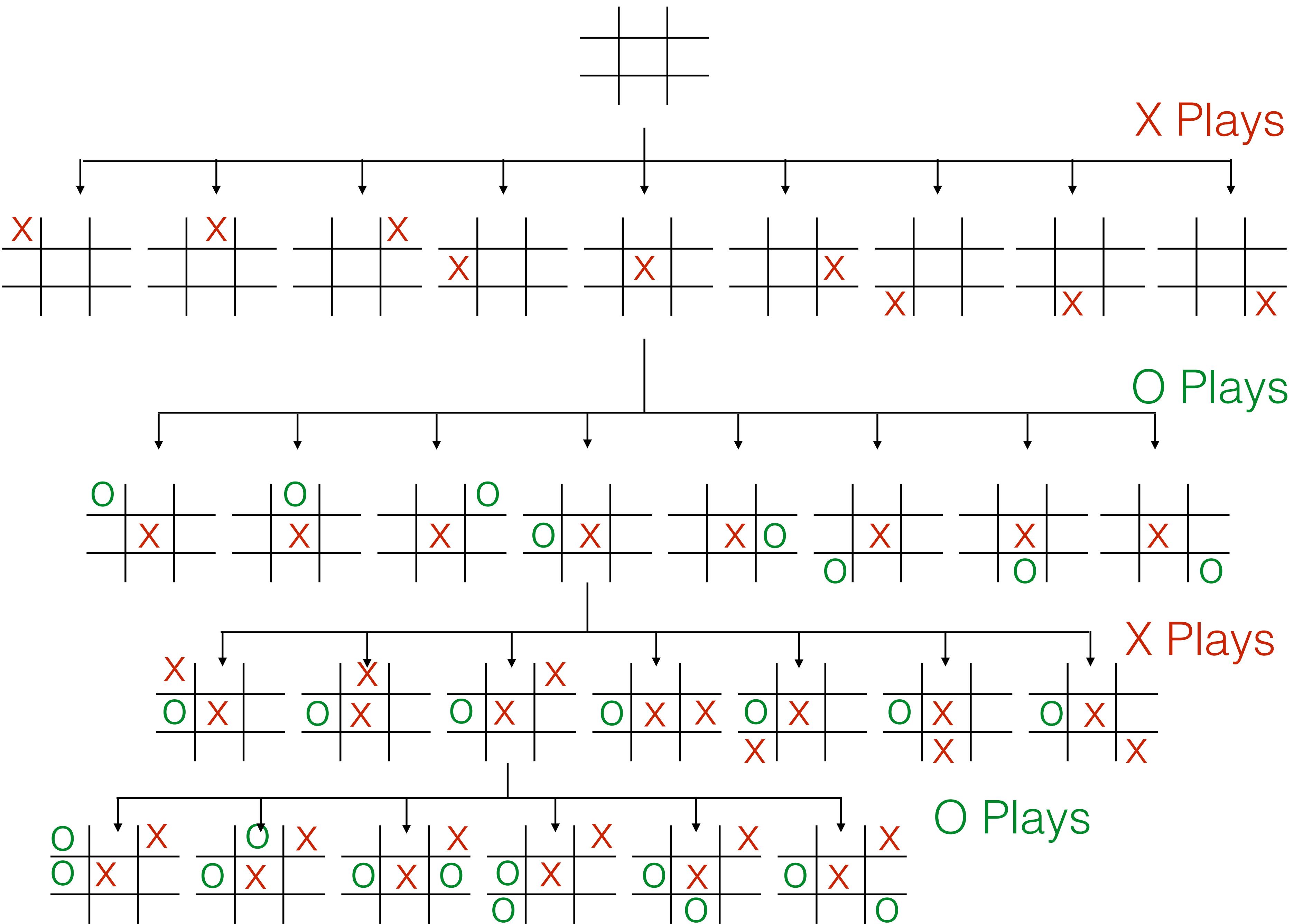


Adversarial Search

How to play games and make it look like research







Minimax Strategy

Choose the move which leaves your opponent with
the worst set of possibilities

Minimax Algorithm

Generate the entire game tree

Evaluate each terminal node (high values are good for your side)

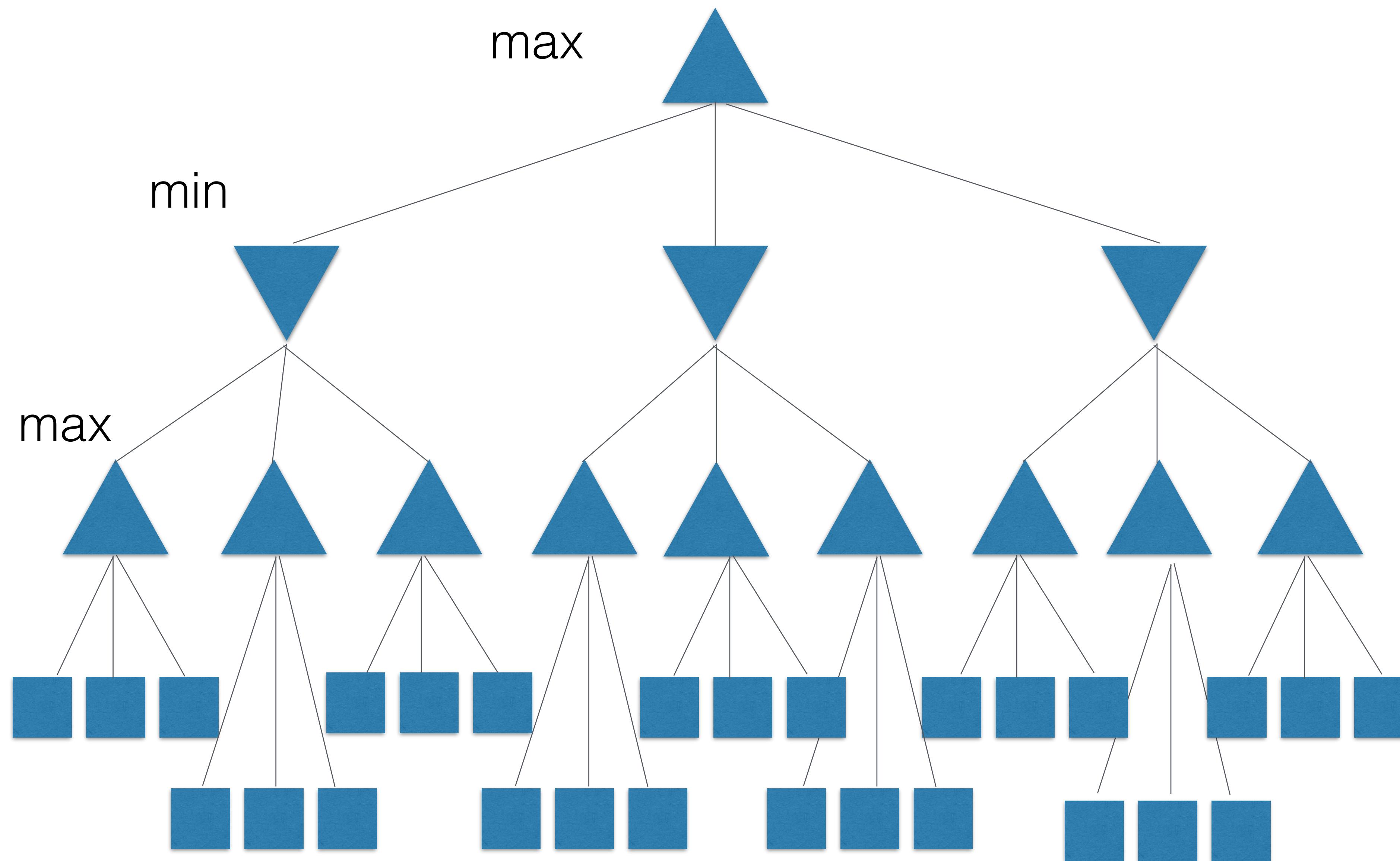
Filter values from the terminal nodes up through the tree:

At nodes controlled by opponent, choose the **minimum** value of the children

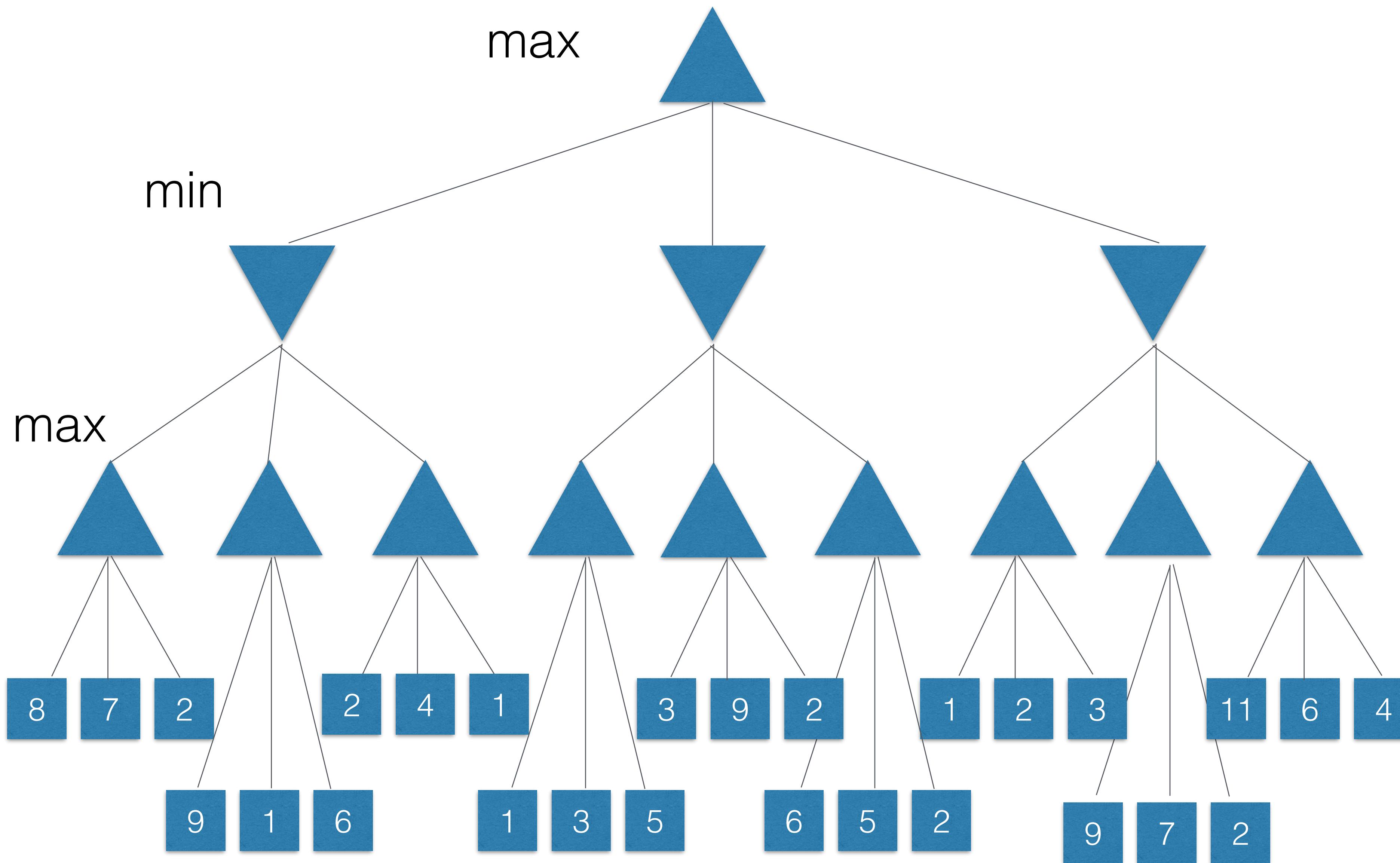
At nodes controlled by you, choose the **maximum** value of the children

When you reach the top of the tree, you have an optimal solution

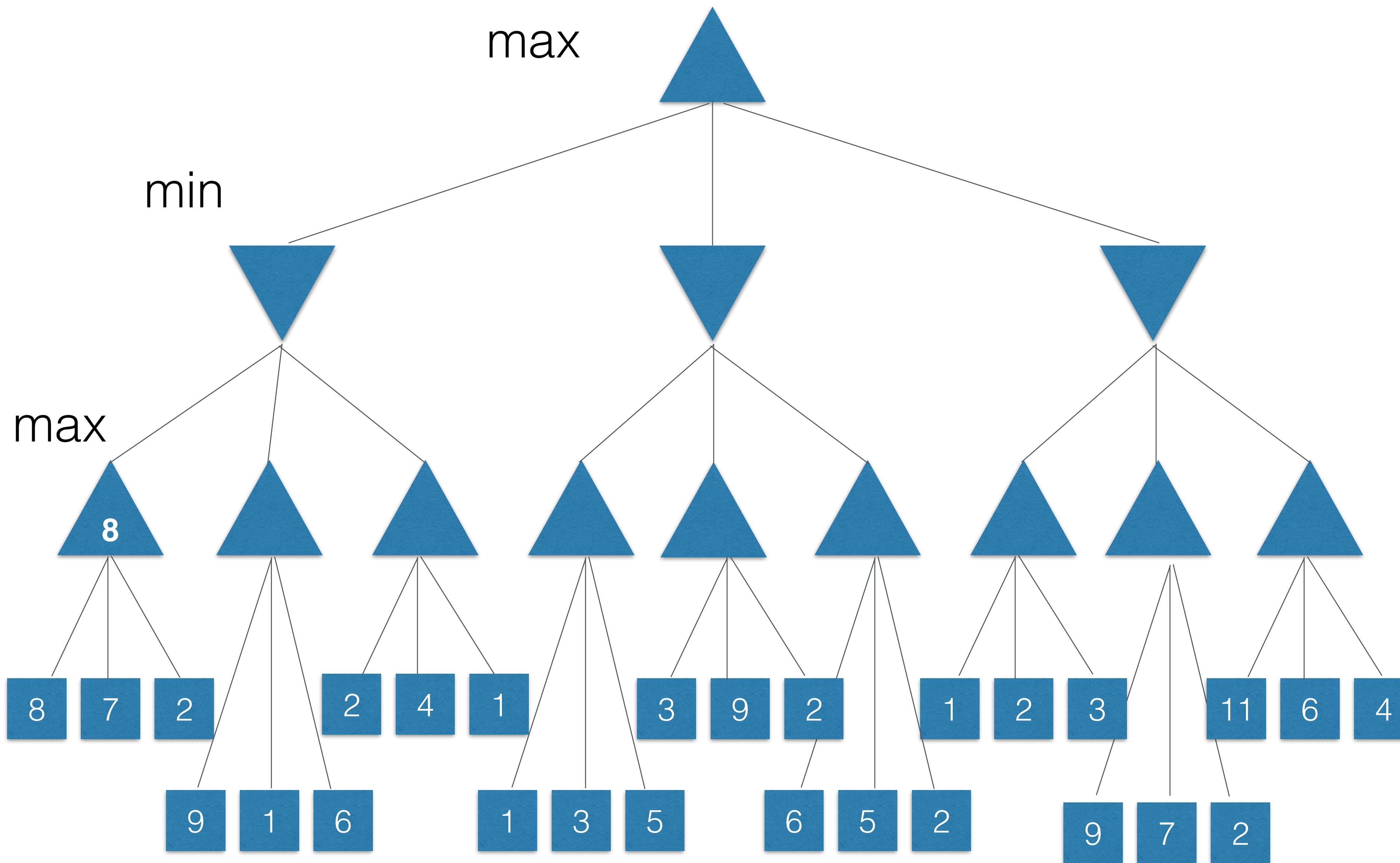
Minimax



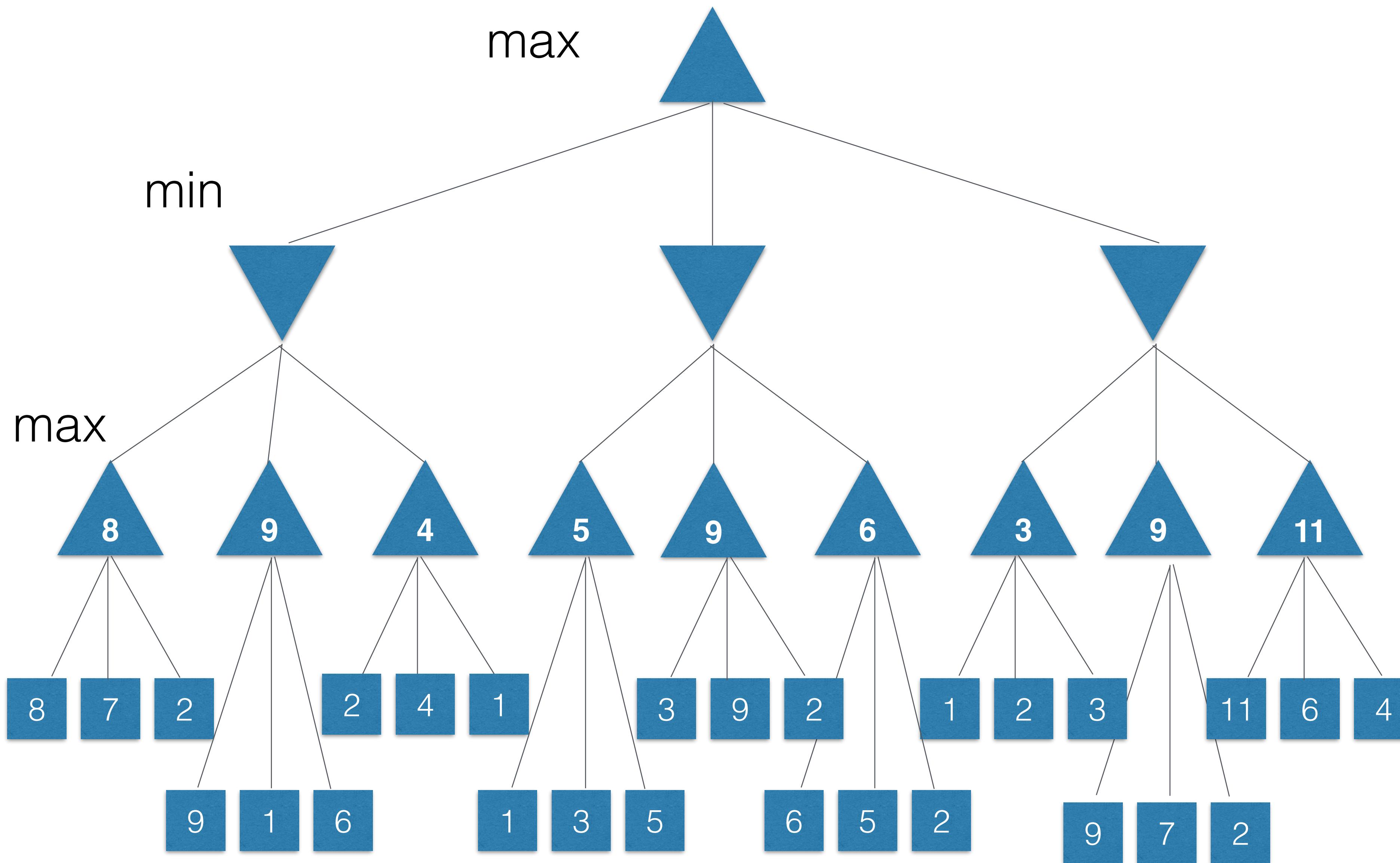
Minimax



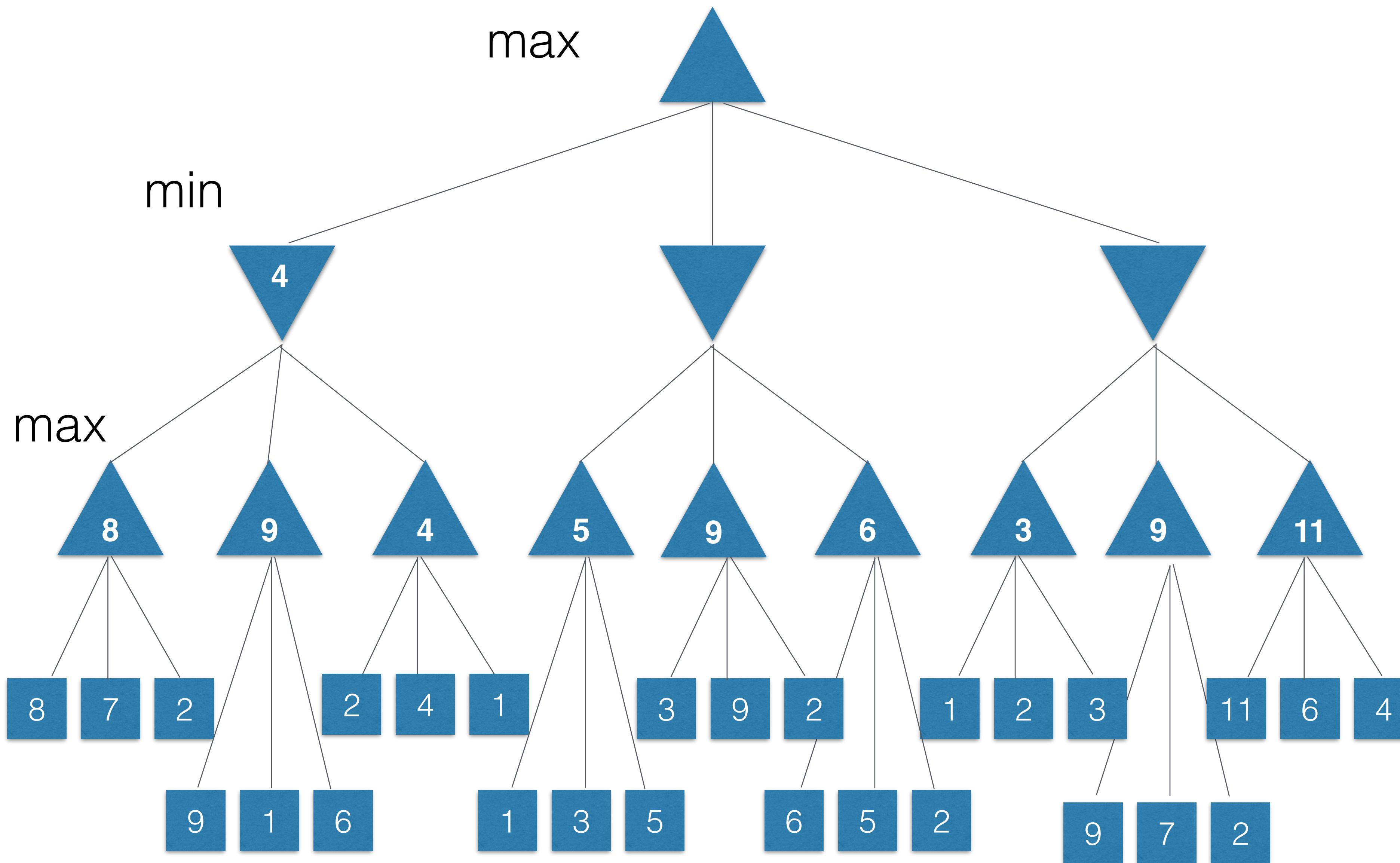
Minimax



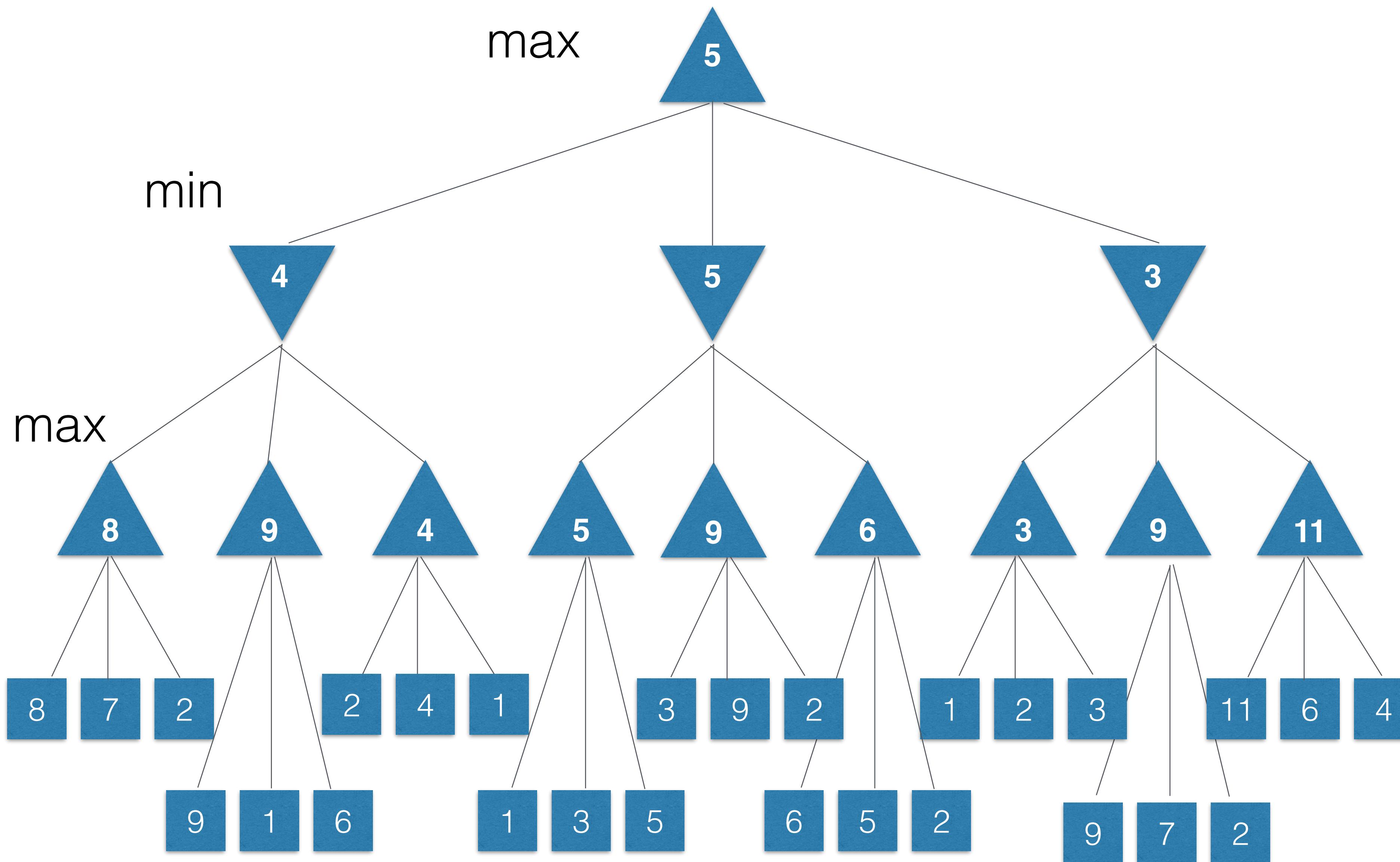
Minimax



Minimax



Minimax

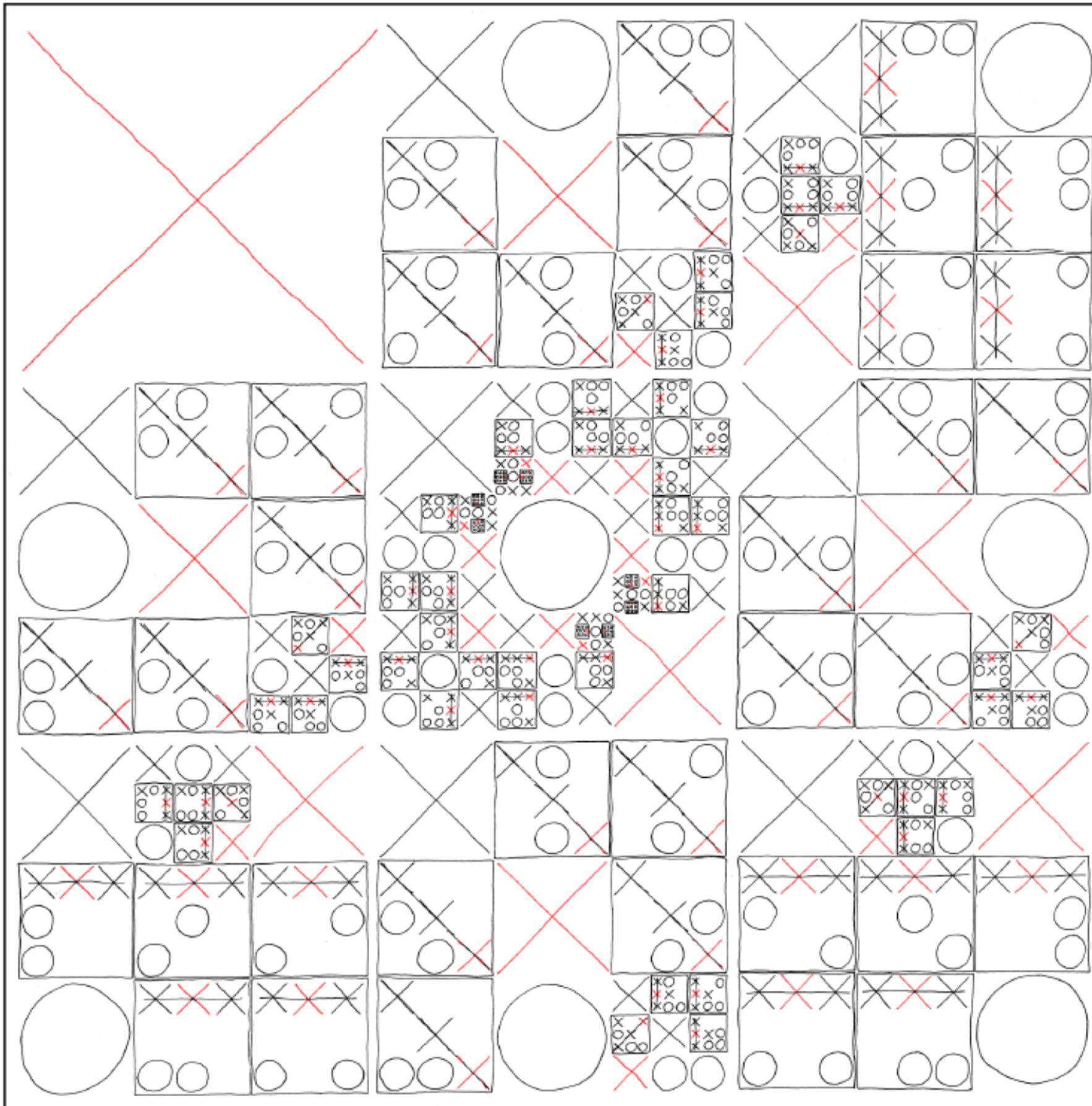


Tic-Tac-Toe

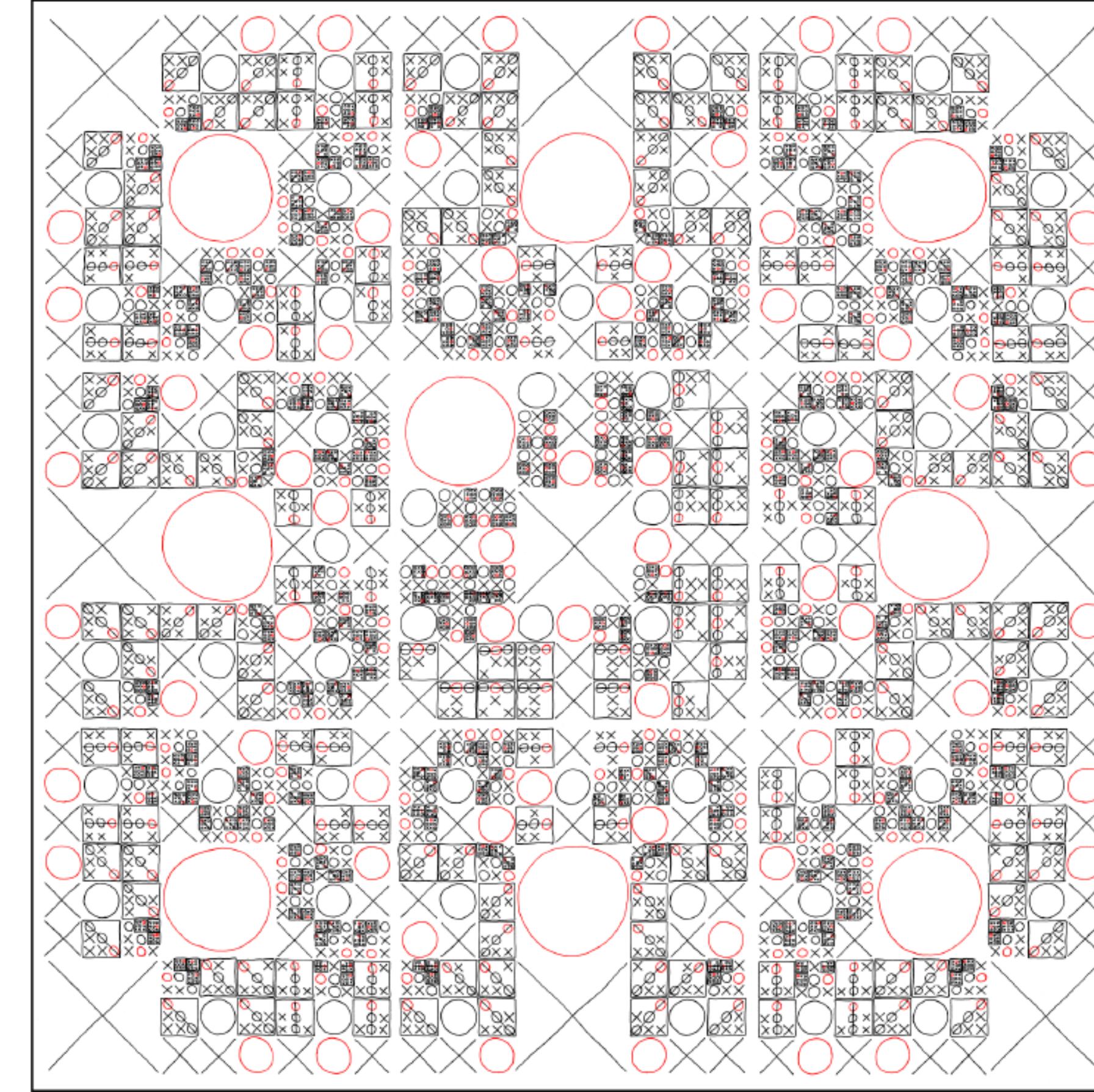
COMPLETE MAP OF OPTIMAL TIC-TAC-TOE MOVES

YOUR MOVE IS GIVEN BY THE POSITION OF THE LARGEST RED SYMBOL ON THE GRID. WHEN YOUR OPPONENT PICKS A MOVE, ZOOM IN ON THE REGION OF THE GRID WHERE THEY WENT. REPEAT.

MAP FOR X:

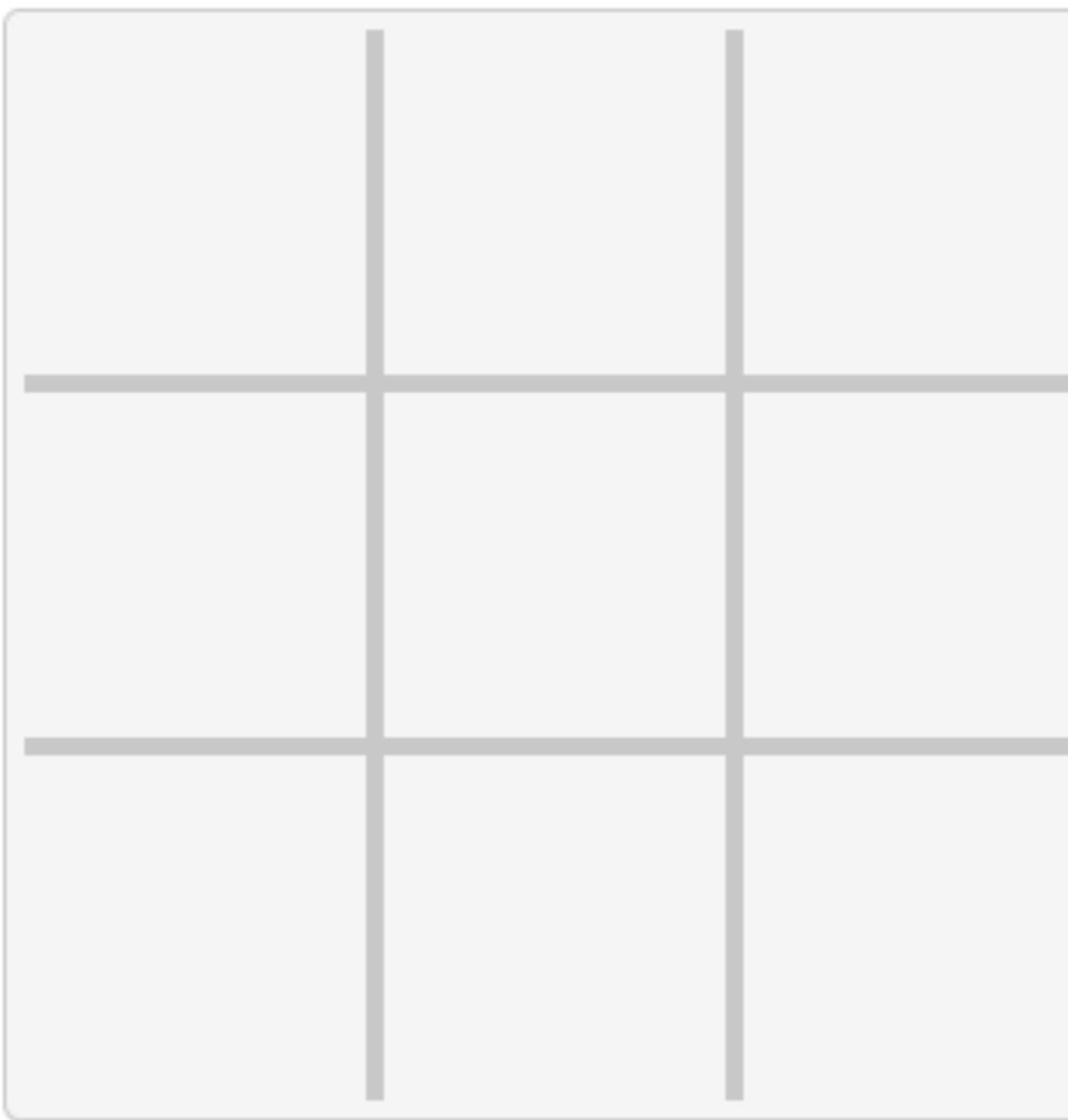


MAP FOR O:



<https://cledersonbc.github.io/tic-tac-toe-minimax/>

Minimax Algorithm

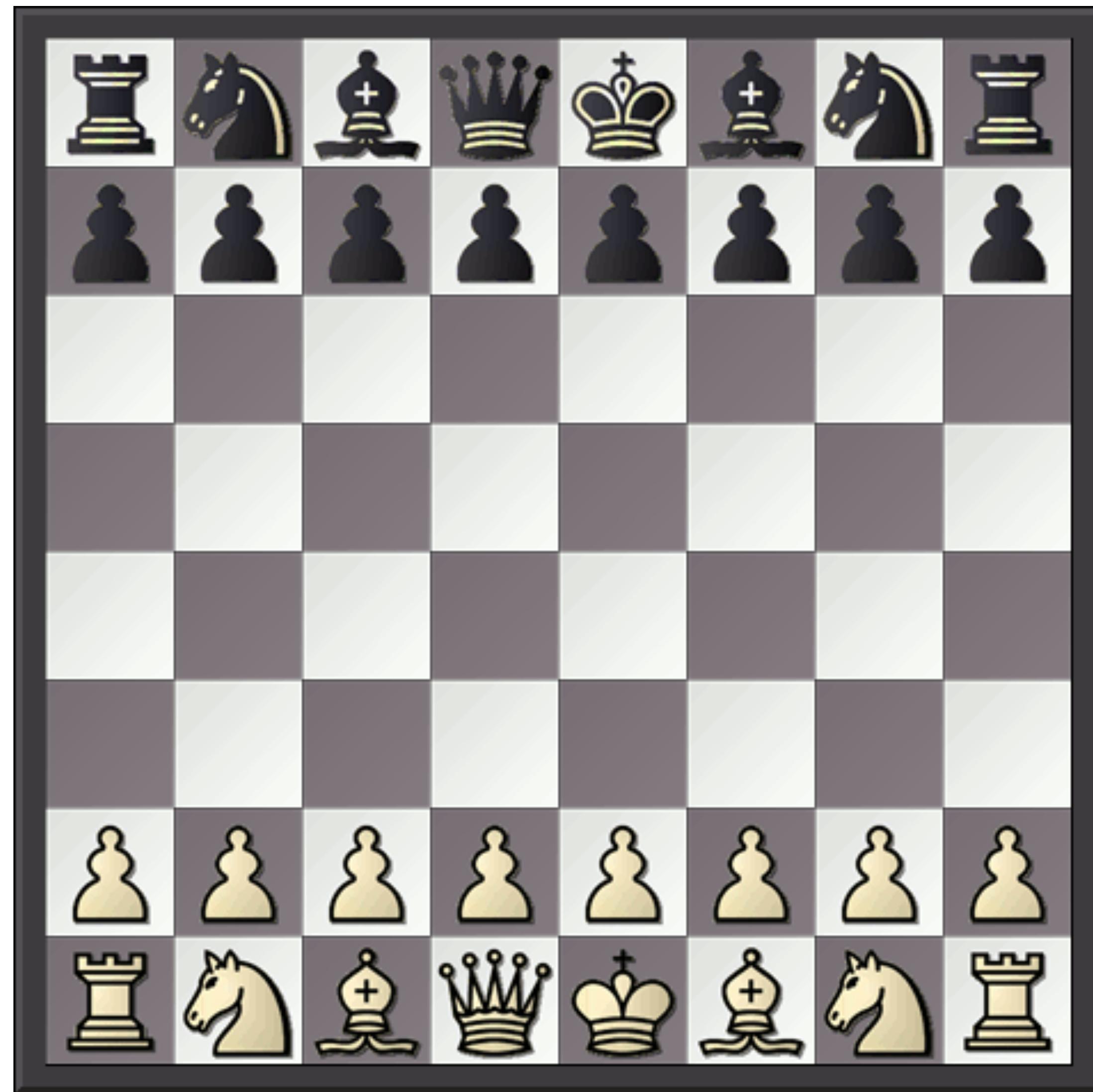


Start AI

Read more on: [Github](#)

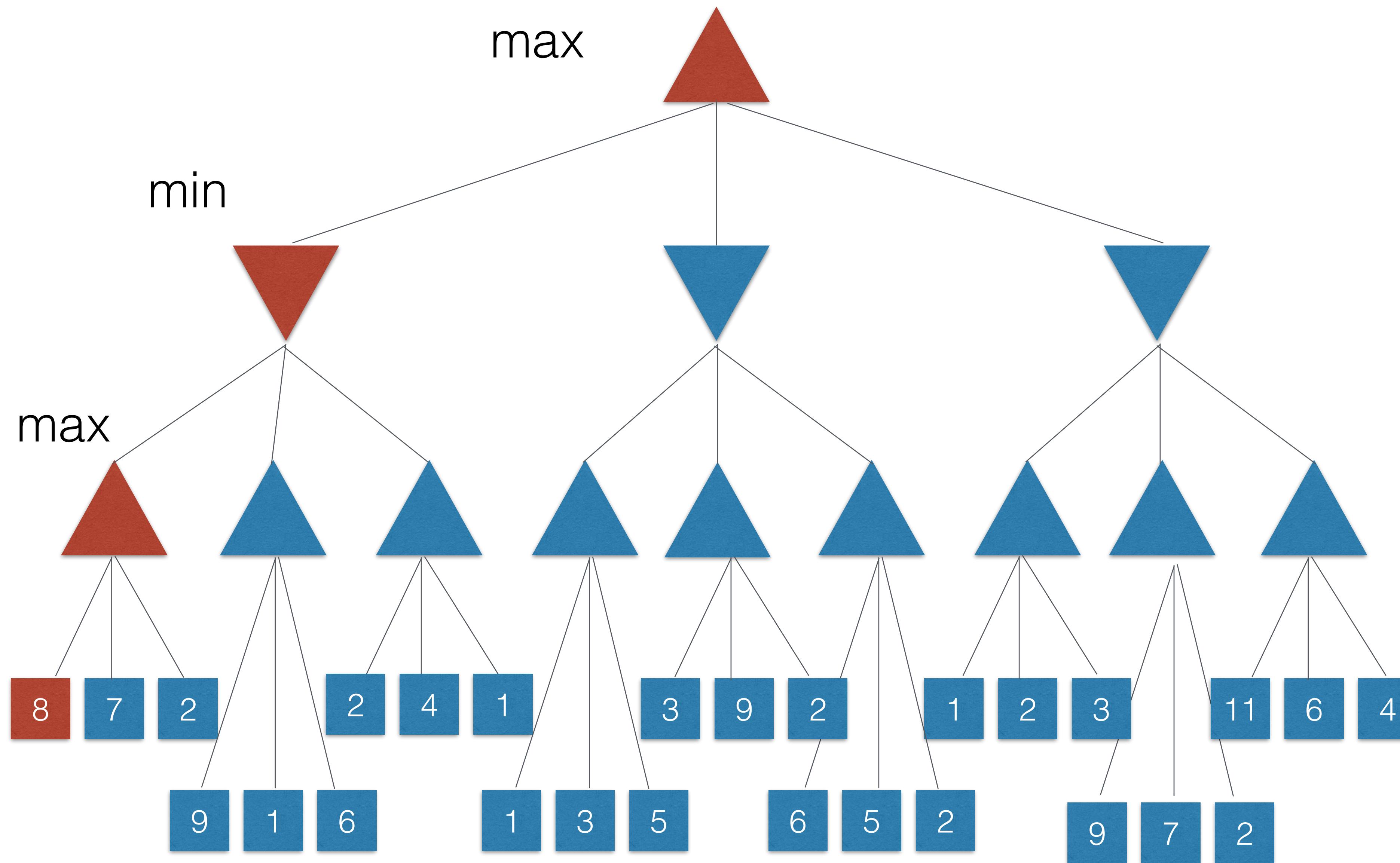
What happens when we cannot
compute the complete tree?

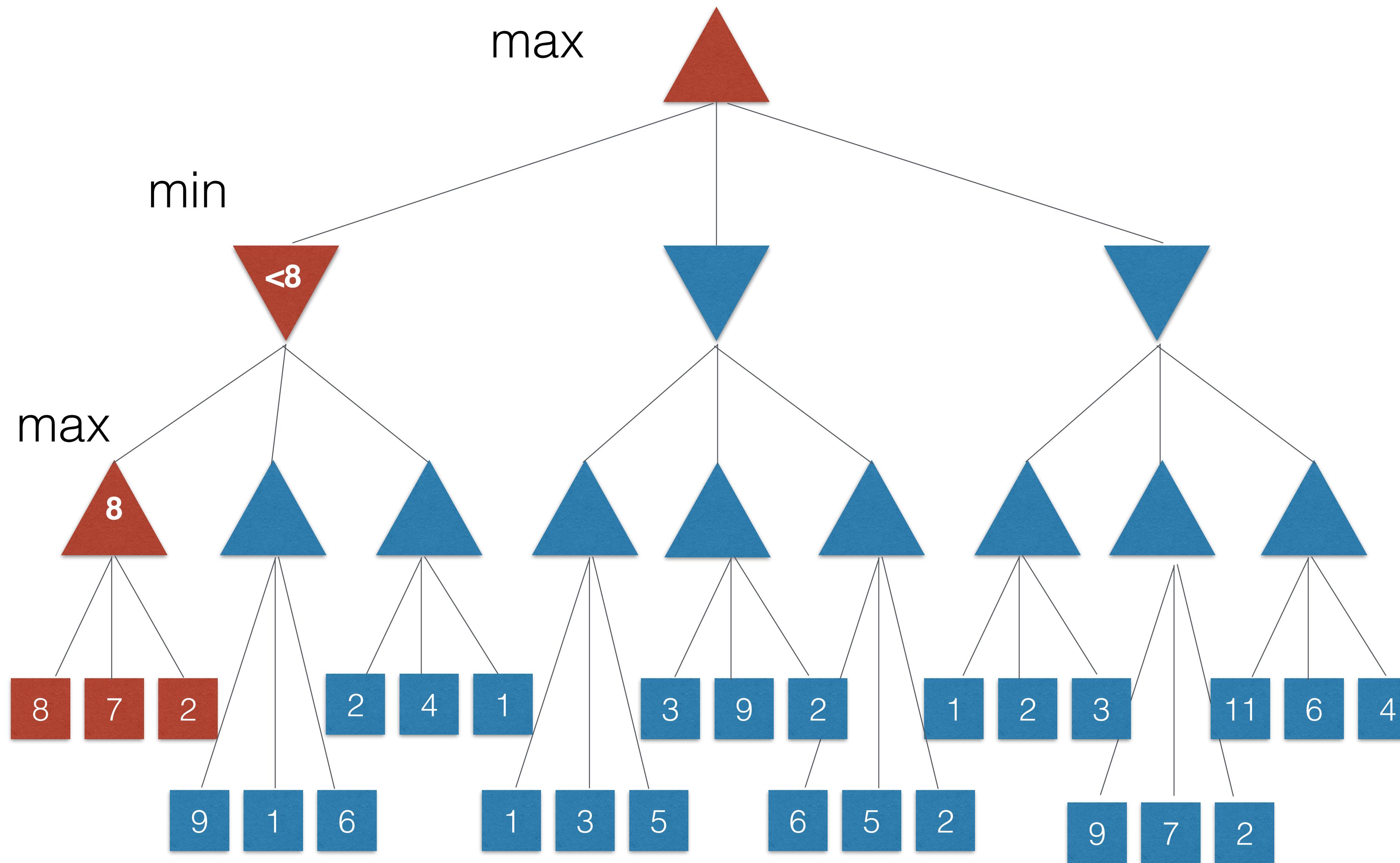
Evaluation Function

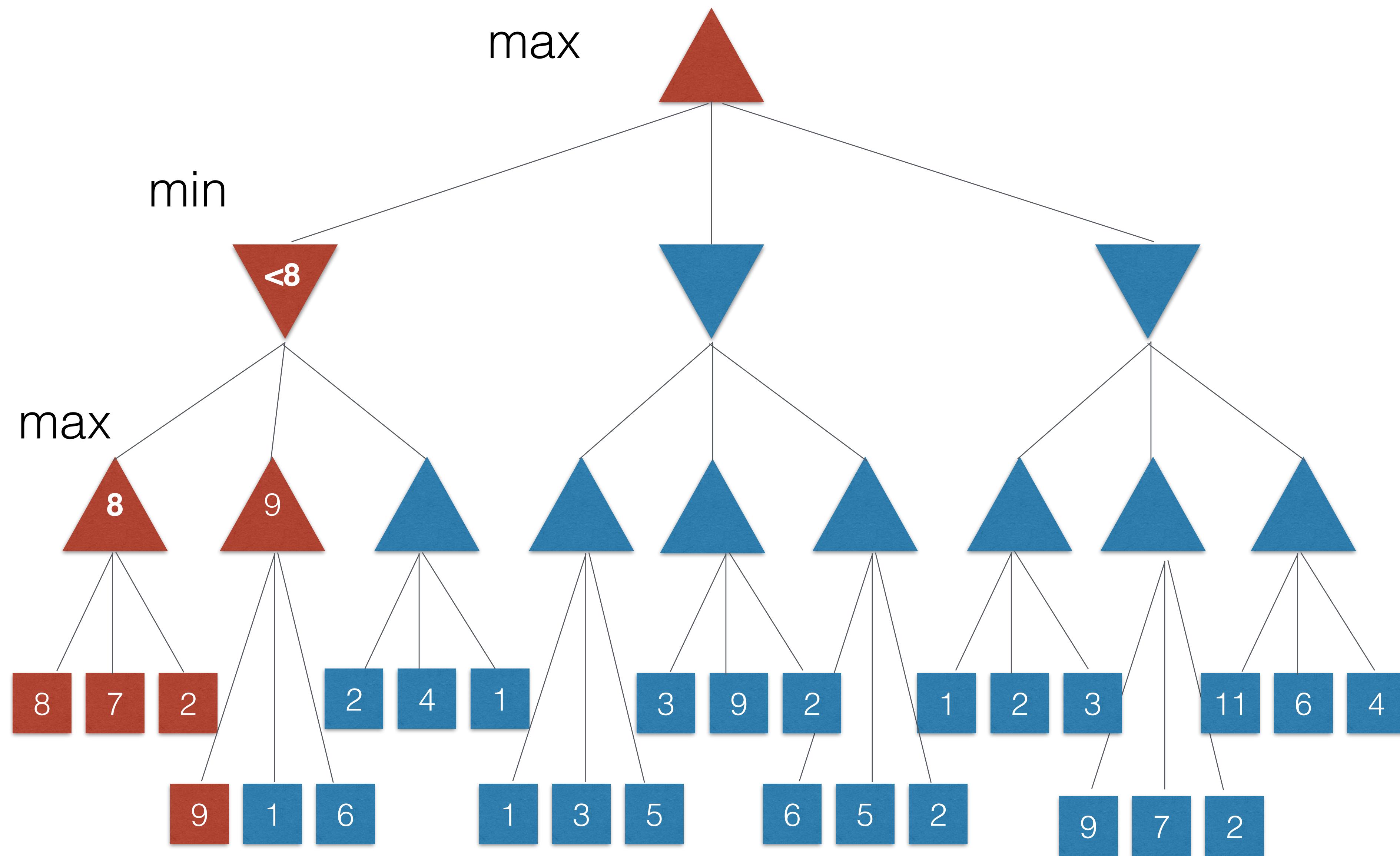


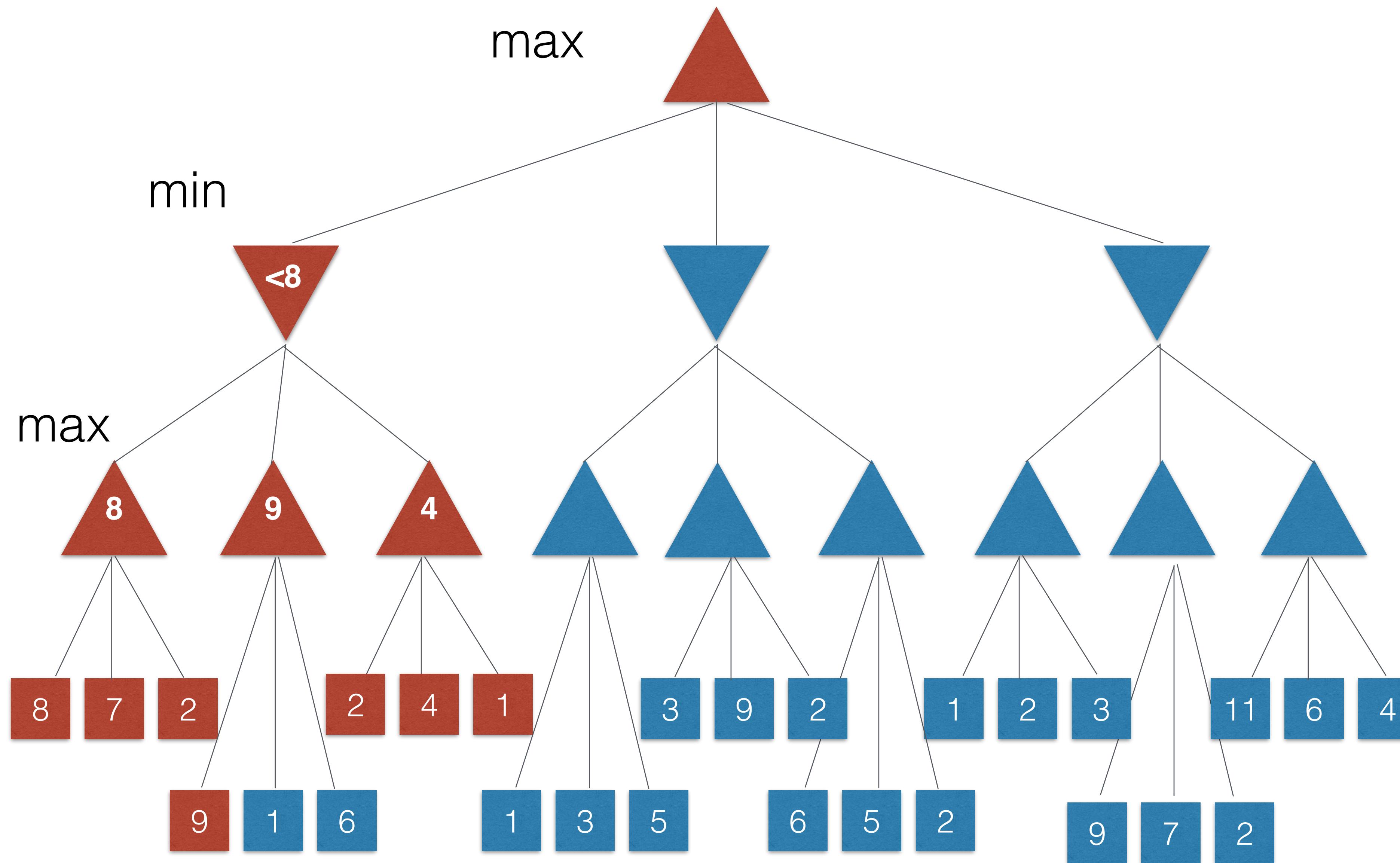
The alpha-beta principle

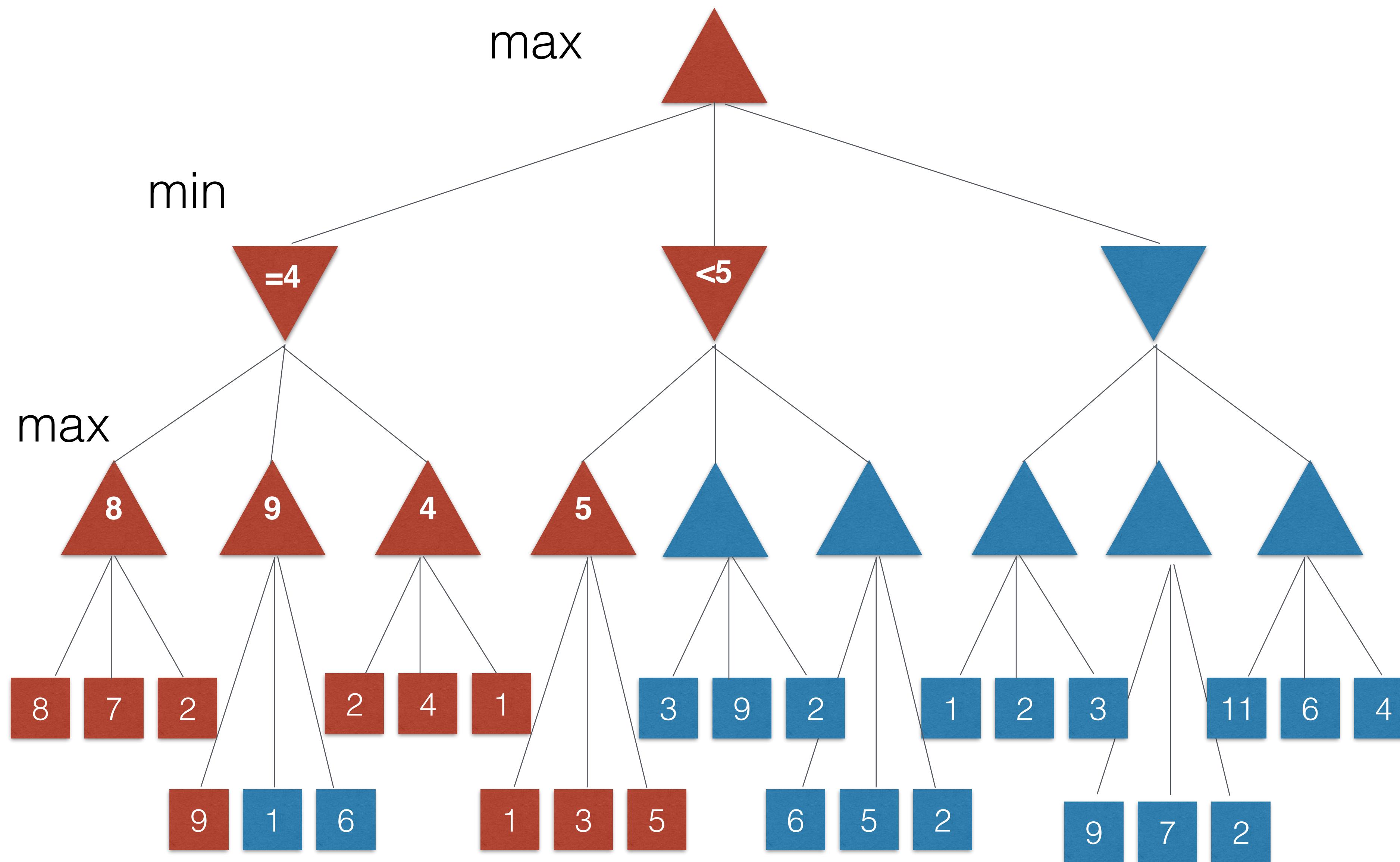
If you have an idea that is **bad**, don't waste time
seeing how truly **awful** it is

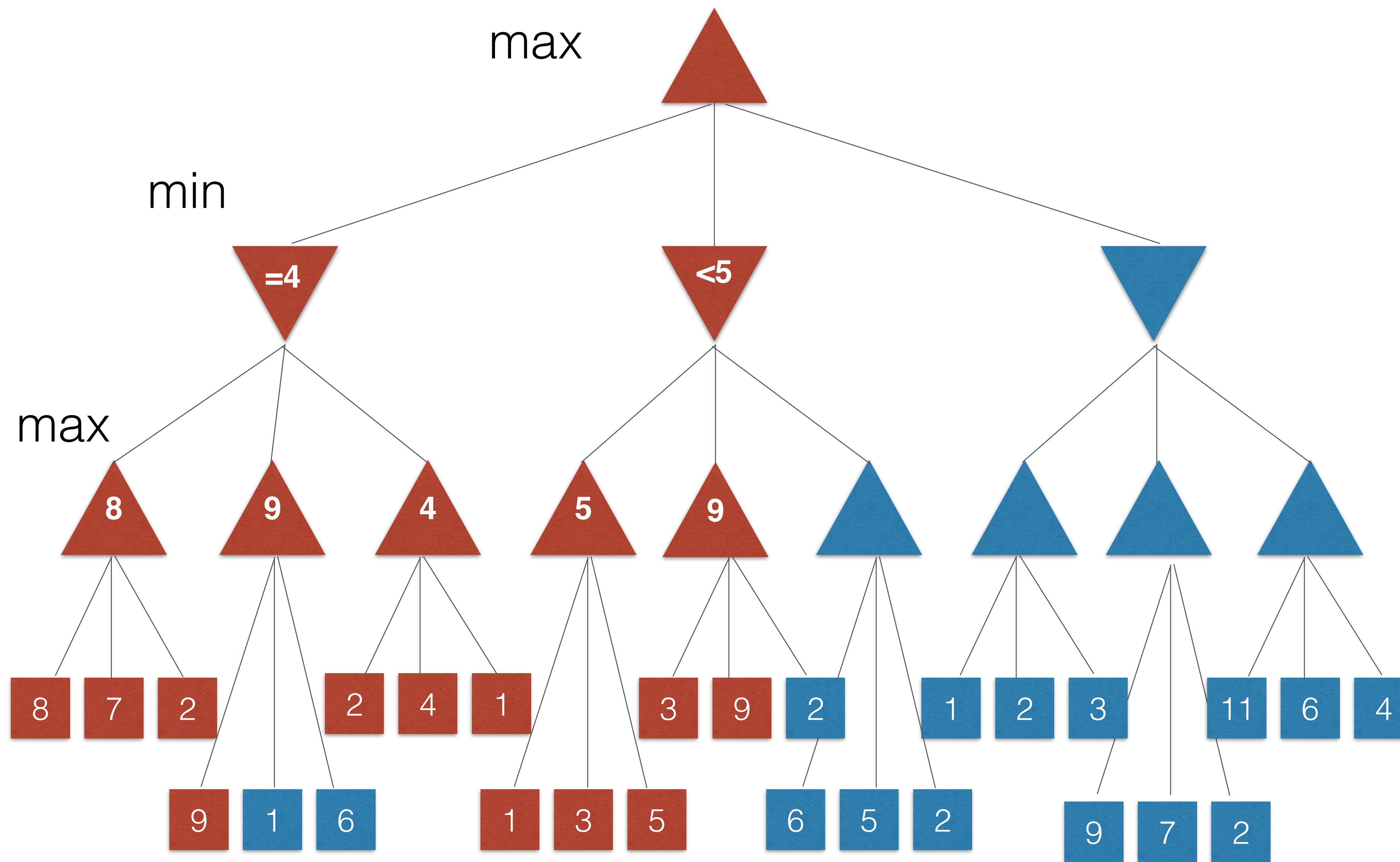


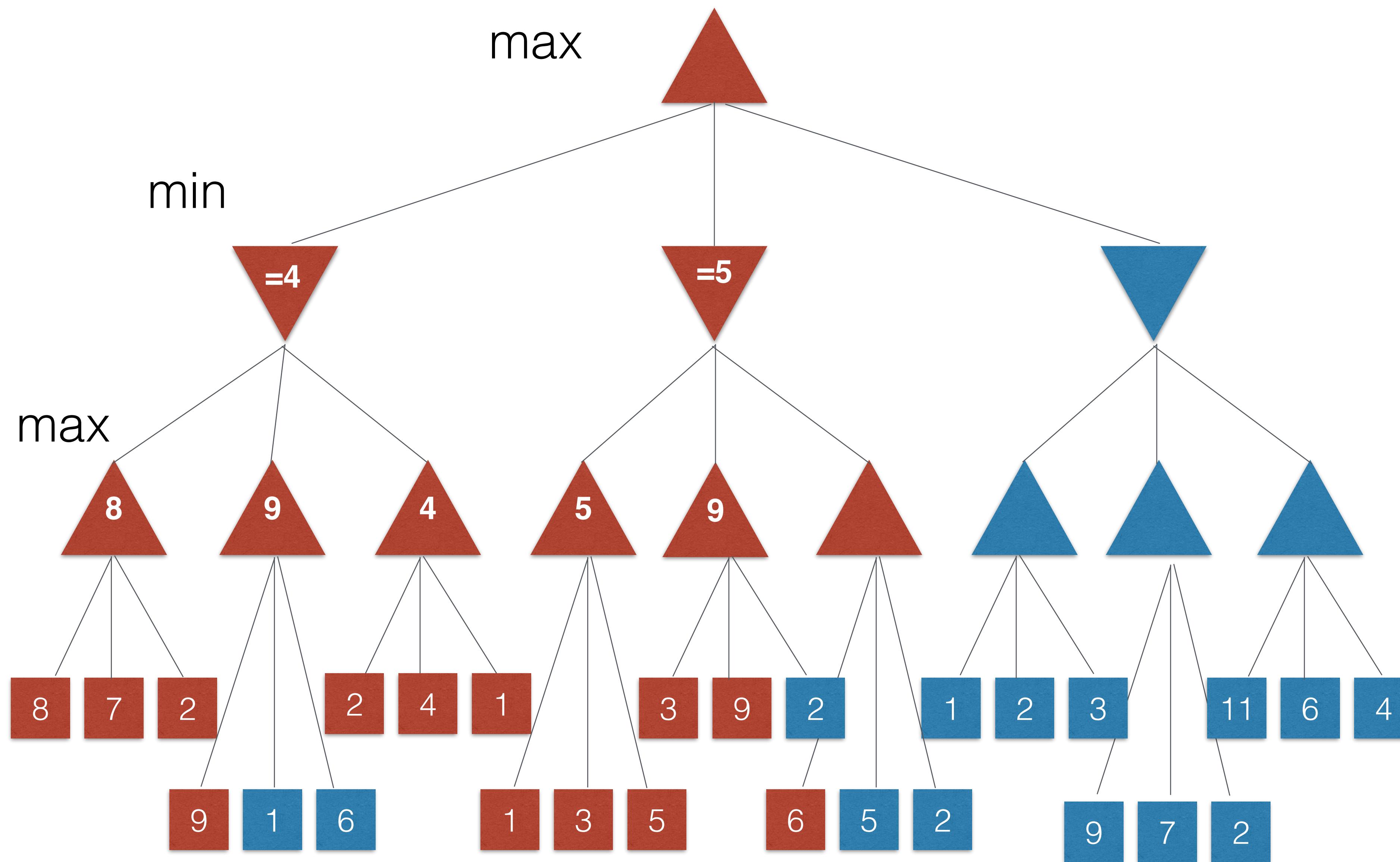


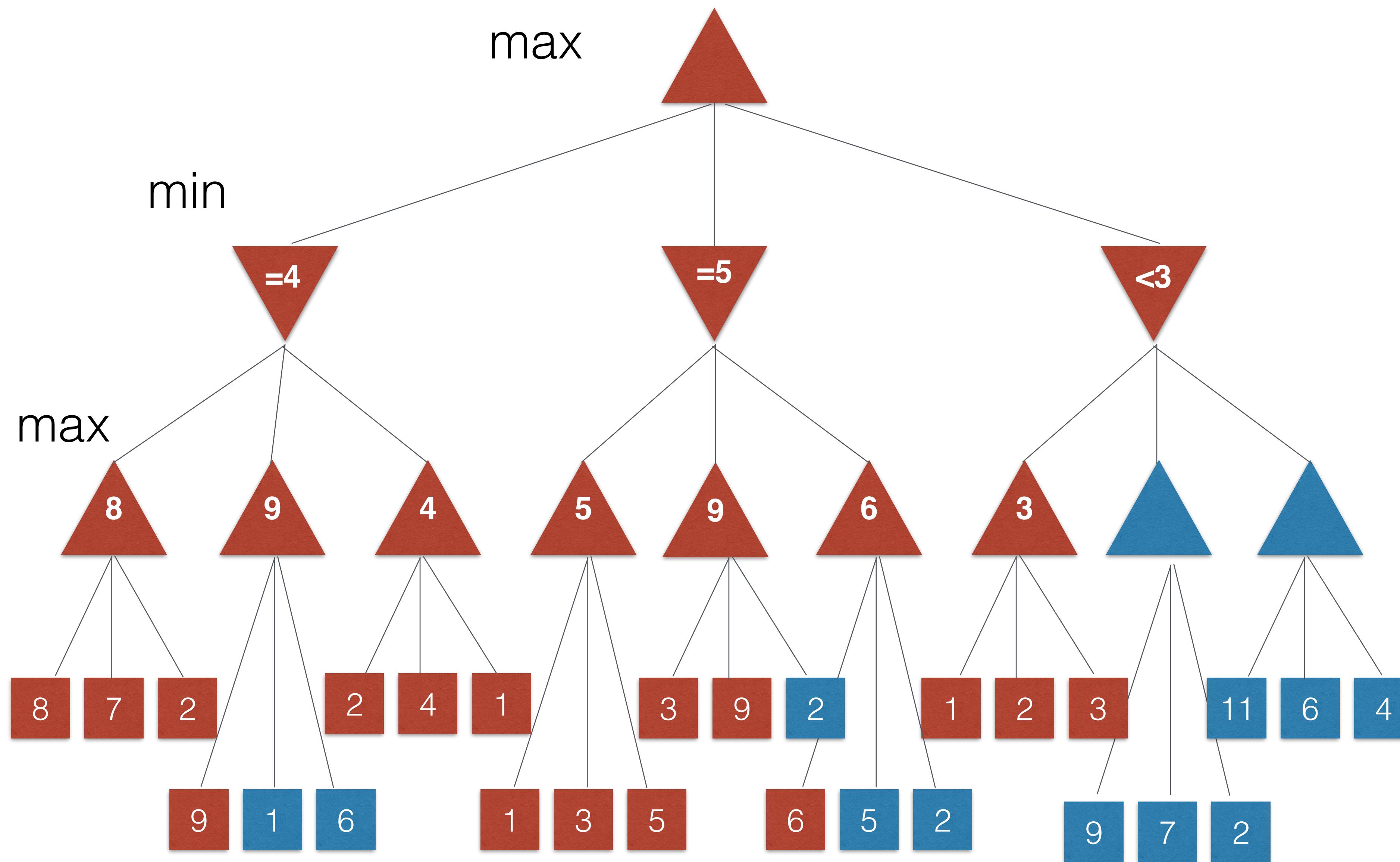












Game Complexity

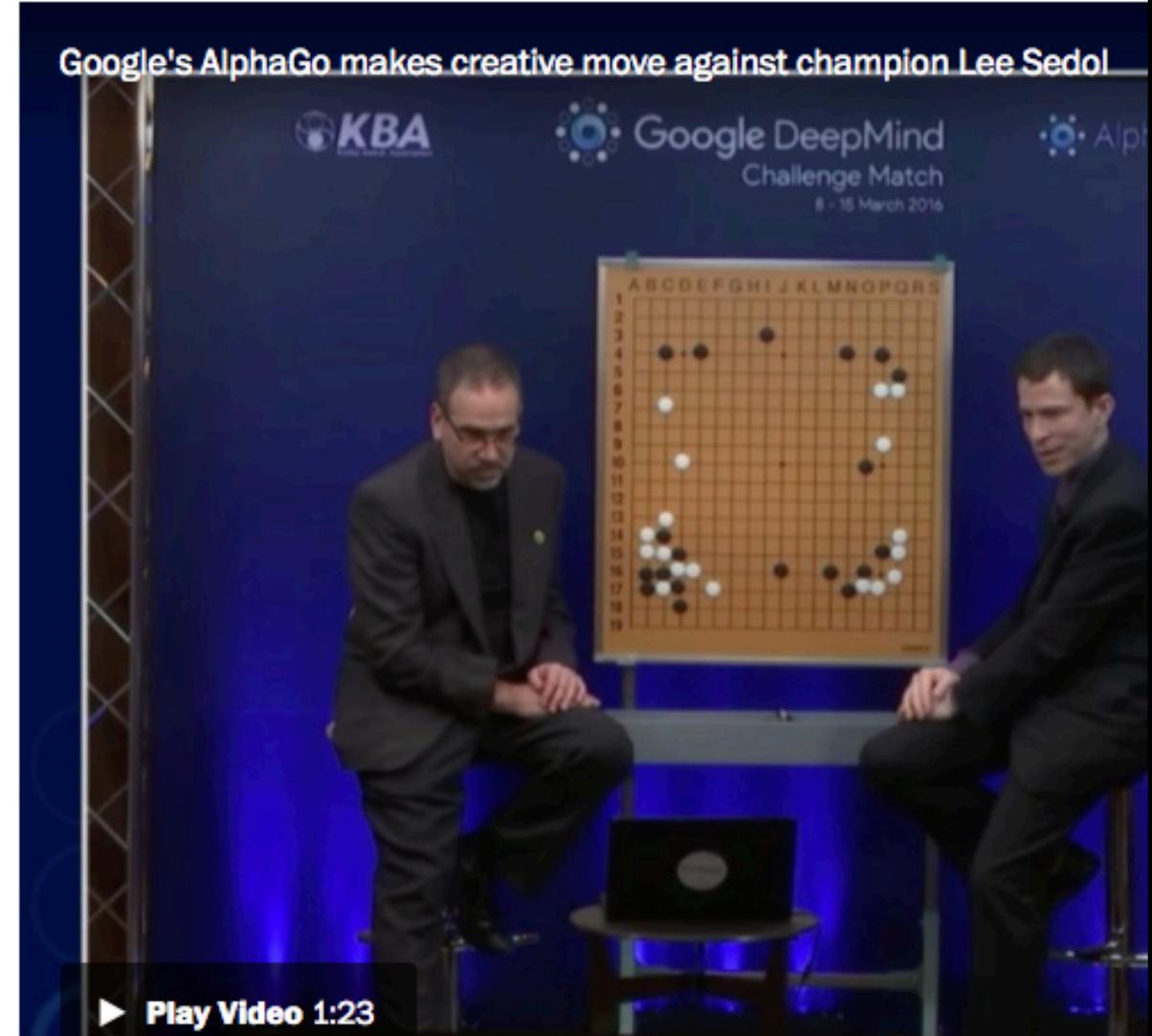
| | Board Size | Branching Factor | Number of Leaves | First Machine Champion |
|-------------|--------------|------------------|------------------|---|
| Tic-Tac-Toe | 3x3 | 4 | 10^5 | -- trivial -- |
| Connect-4 | 6x7 | 4 | 10^{21} | -- solved -- |
| Checkers | 8x8 (halved) | 2.8 | 10^{31} | Chinook defeats Marion Tinsley (1992) |
| Chess | 8x8 | 35 | 10^{123} | Deep Blue defeats Garry Kasparov (1995) |
| Go | 19x19 | 250 | 10^{360} | Wrong! |

2016 Google DeepMind

<https://www.washingtonpost.com/news/innovations/wp/2016/03/15/what-alphagos-sly-move-says-about-machine-creativity>

What AlphaGo's sly move says about machine creativity

By Matt McFarland March 15



Go champion Lee Se-dol strikes back to beat Google's DeepMind AI for first time

Intuition beats ingenuity at last

by Sam Byford | @345triangle | Mar 13, 2016, 4:44am EST

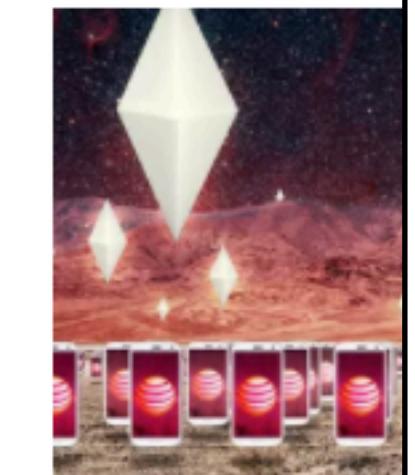
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<http://www.theverge.com/2016/3/13/11184328/alphago-deepmind-go-match-4-result>

AlphaGo wrapped up victory for Google in the DeepMind Challenge Match by winning its [third straight game](#) against Go champion Lee Se-dol yesterday, but the 33-year-old South

NOW TR

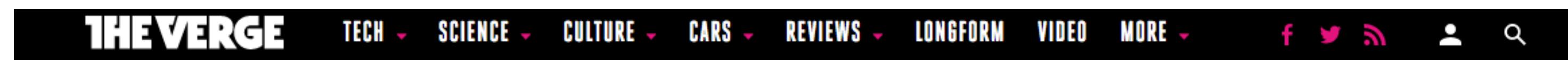


AT&T just declared internet (and us)



The UK now wield surveillance power

<https://www.theverge.com/2017/10/18/16495548/deepmind-ai-go-alphago-zero-self-taught>



GOOGLE \ SCIENCE \ TECH \

DeepMind's Go-playing AI doesn't need human help to beat us anymore

The company's latest AlphaGo AI learned superhuman skills by playing itself over and over

by James Vincent | @jjvincent | Oct 18, 2017, 1:00pm EDT

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AlphaGo Zero is probably the world's best Go player, but it could do much more. I Sam Byford

NOW TRENDING



Samsung's new ad tells iPhone fanboys to 'grow up'



The Pixel 2 XL screen is fine, the Dixel 2 XL screen is a tragedy

Traditional Board Games

Perfect information

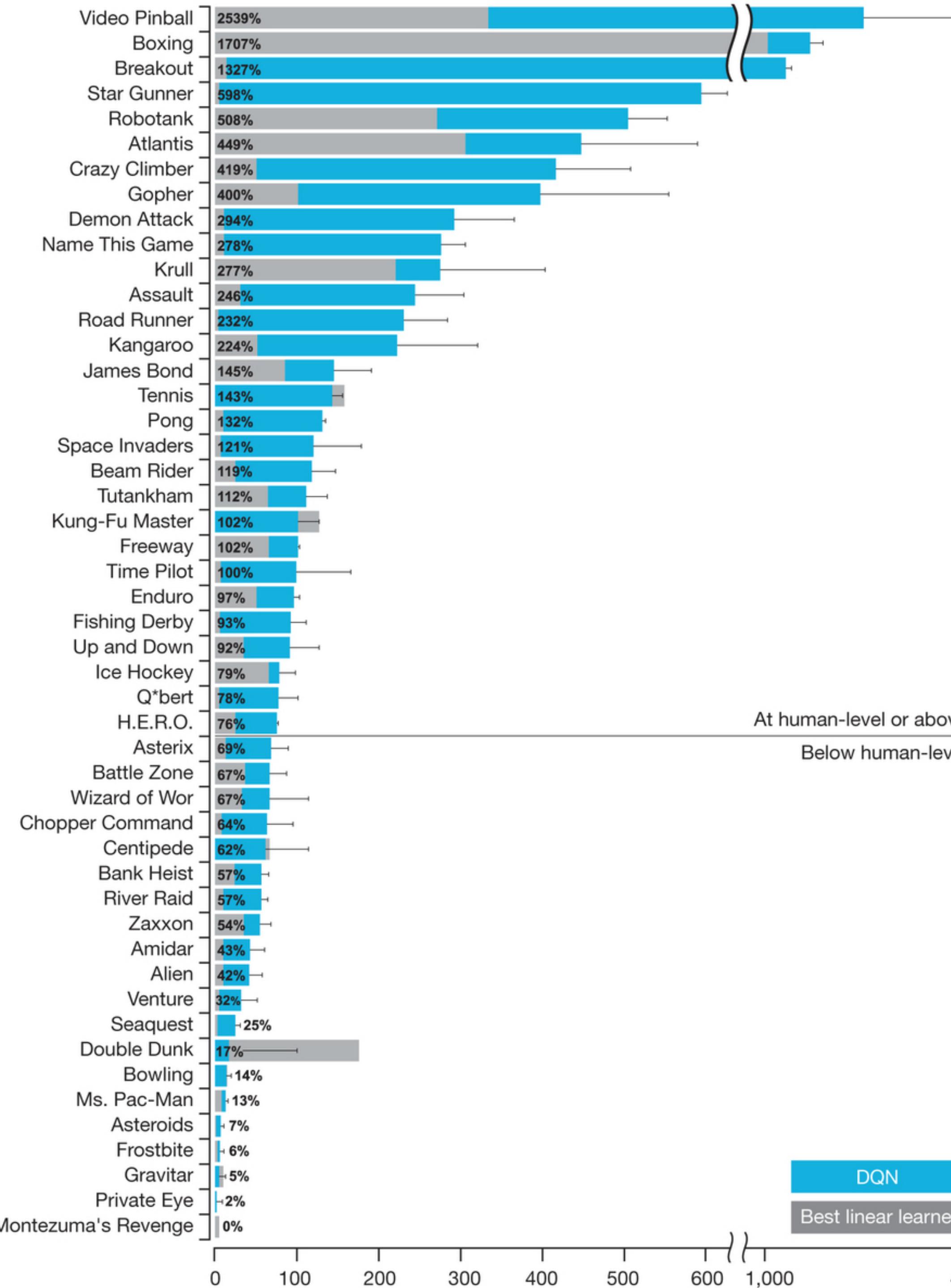
Static environment

Discrete action space

Deterministic actions

Beyond Board Games





<http://www.nature.com/nature/journal/v518/n7540/full/nature14236.html>

Modern AI Opponents

4X Computer Games

“eXplore, eXpand, eXploit, and eXterminate”

Limited information

Dynamic environment

Discrete action space

Deterministic actions

First-Person Computer Games

Limited information

Dynamic environment

Continuous action space

Sometimes Stochastic actions

Robotics

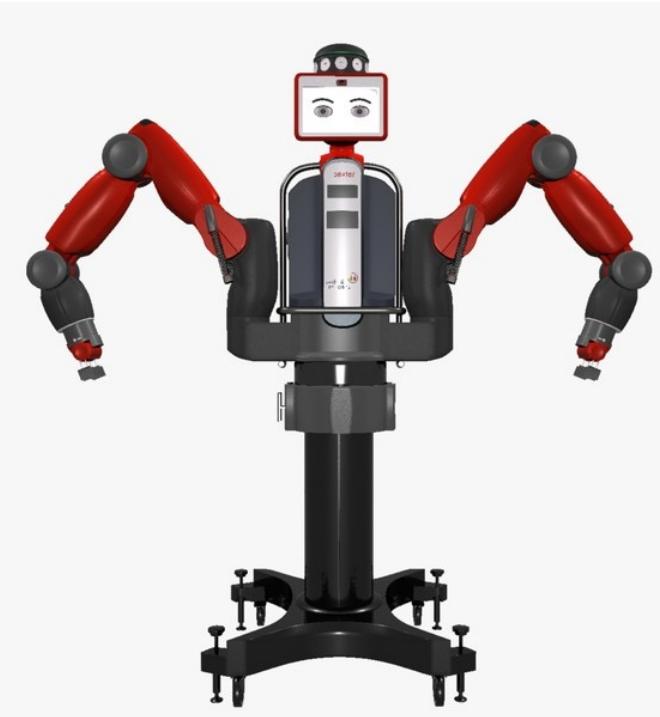
Limited information

Dynamic environment

Continuous action space

Stochastic actions

Baxter



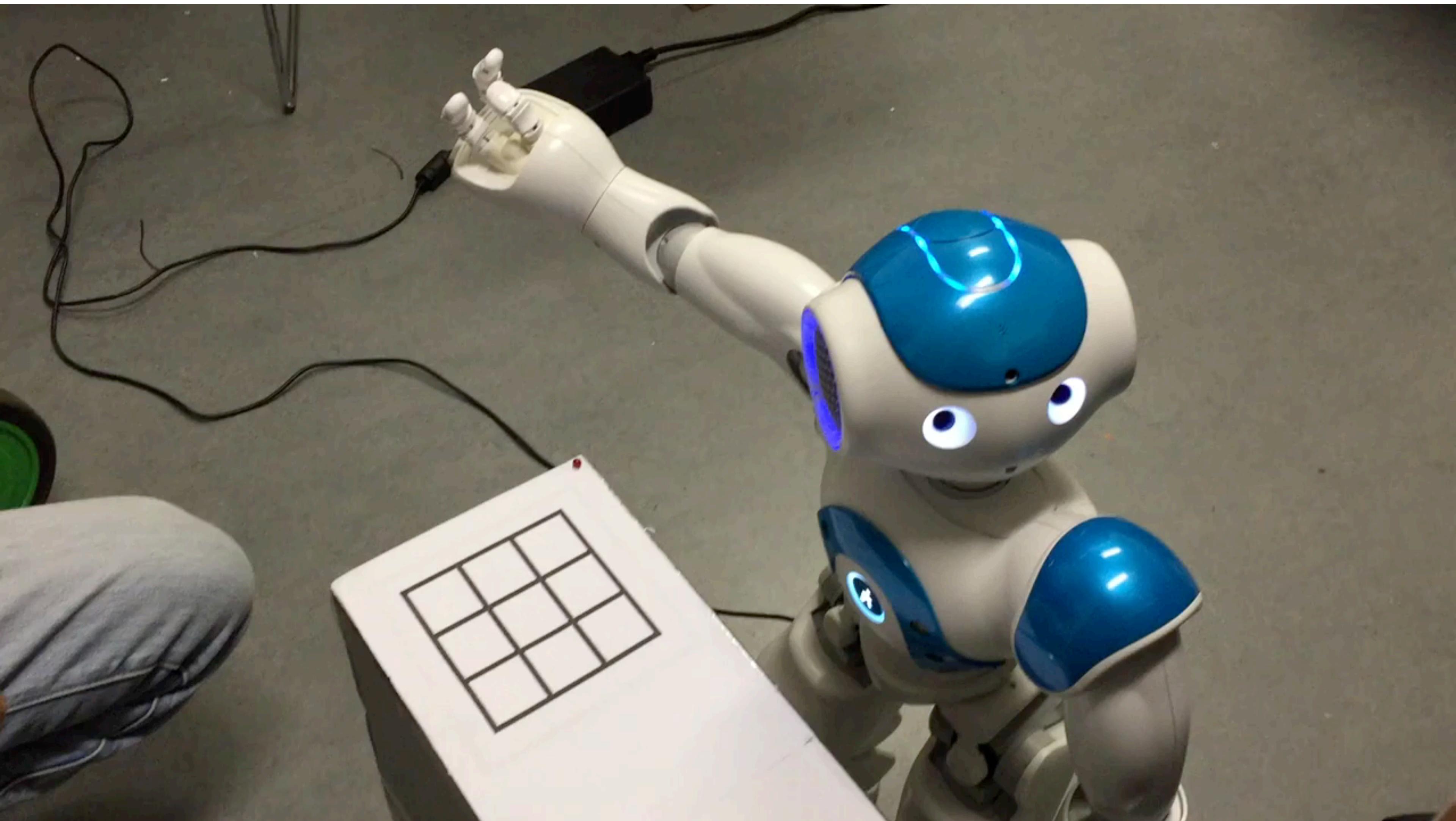
How to **Fold a Shirt**

Baxter

<https://www.youtube.com/watch?v=FTaVJ-x3Rt0>



Nao



Nao

Nao Playing Rock Paper Scissors

Arul Selvam Ibrahim Shareef

Humanoid Robots Laboratory, University of Bonn

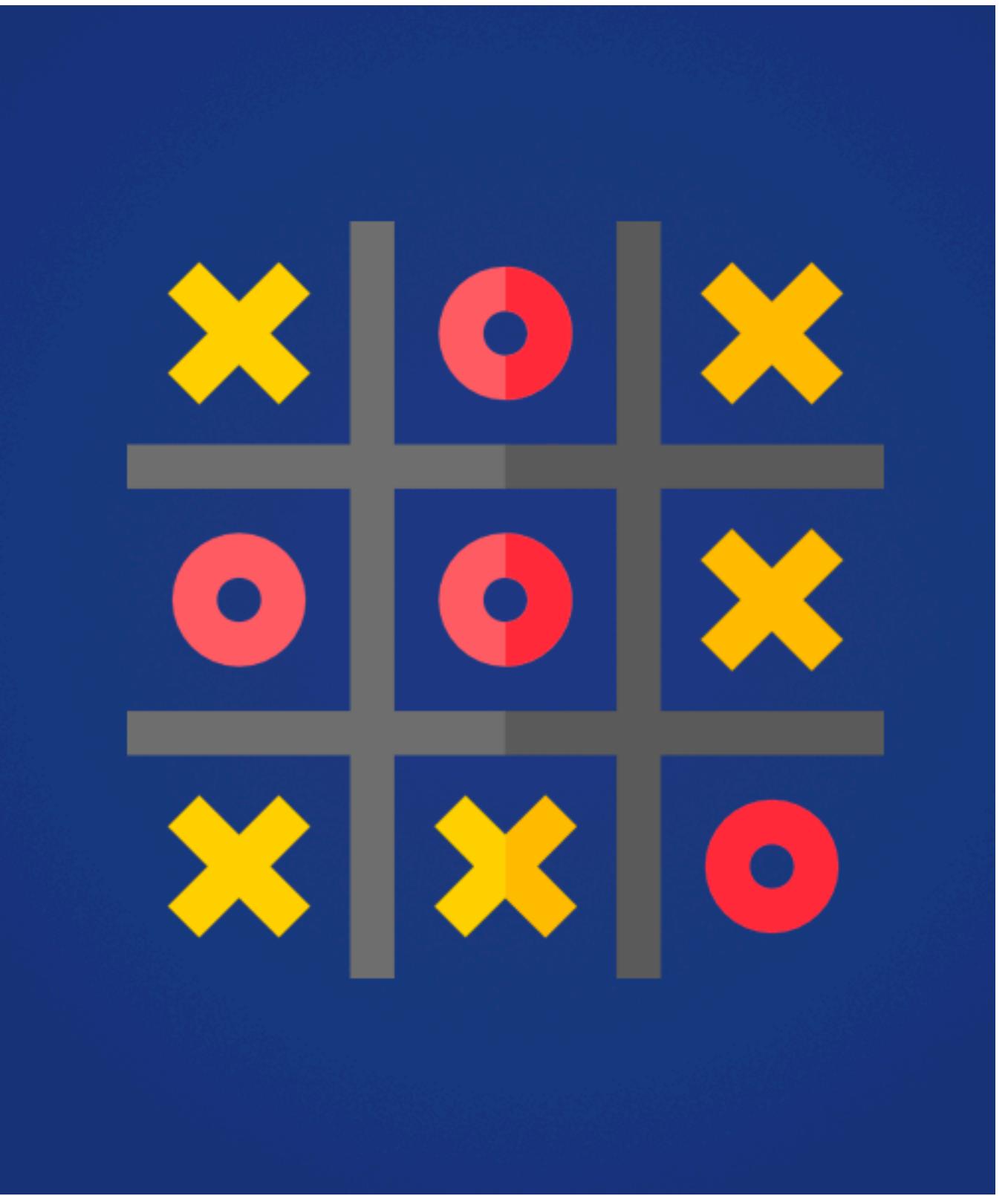


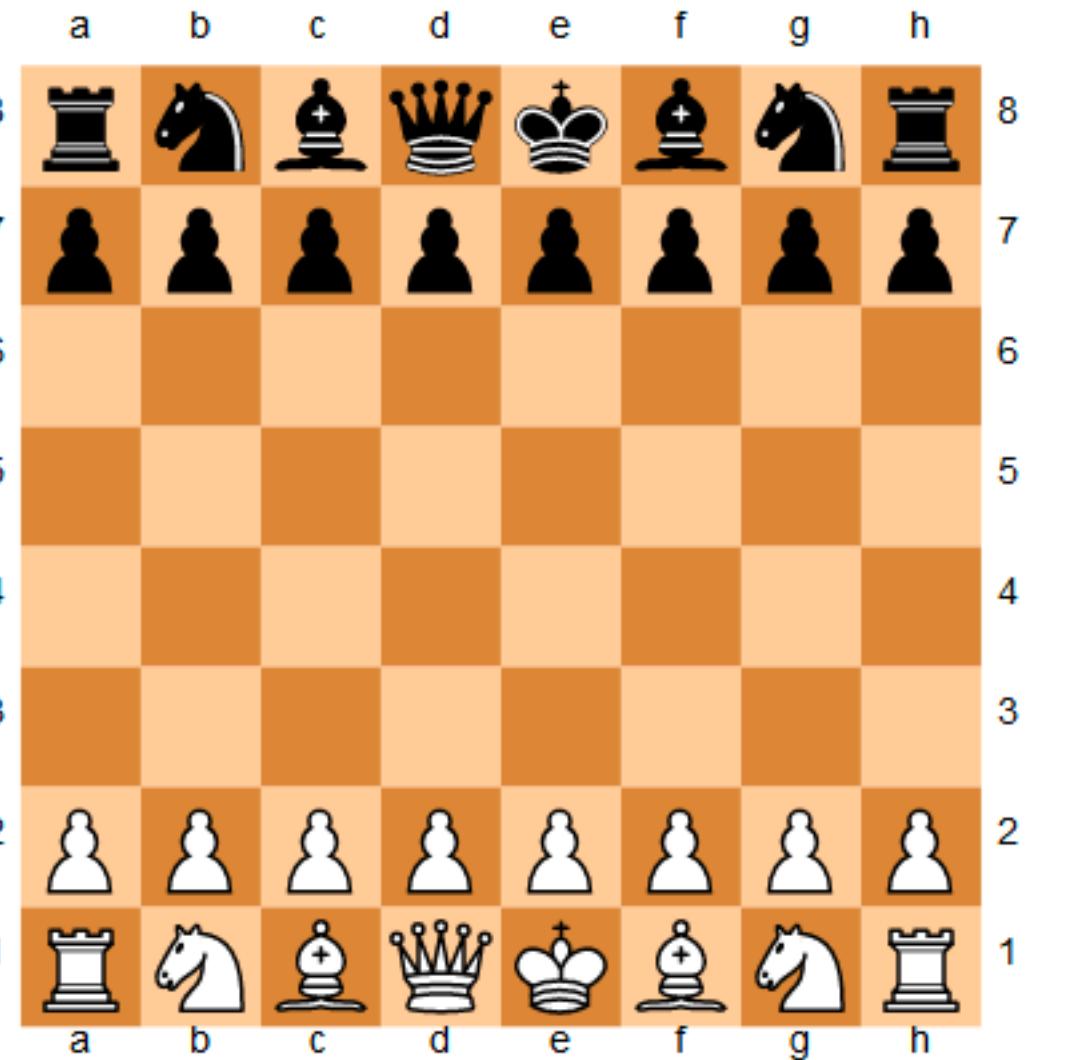


Boston Dynamics

Minimax - Tic Tac Toe

<https://stackabuse.com/minimax-and-alpha-beta-pruning-in-python/>





Chess: Alpha-Beta Pruning

<https://medium.com/@andreasstckl/writing-a-chess-program-in-one-day-30daff4610ec>

<https://github.com/astoeckl/mediumchess/>

Connect 4

<https://github.com/KeithGalli/Connect4-Python>

Video walkthrough on programming this game: <https://youtu.be/UYgyRArKDEs>

Video walkthrough on programming the AI: <https://youtu.be/MMLtza3CZFM>

