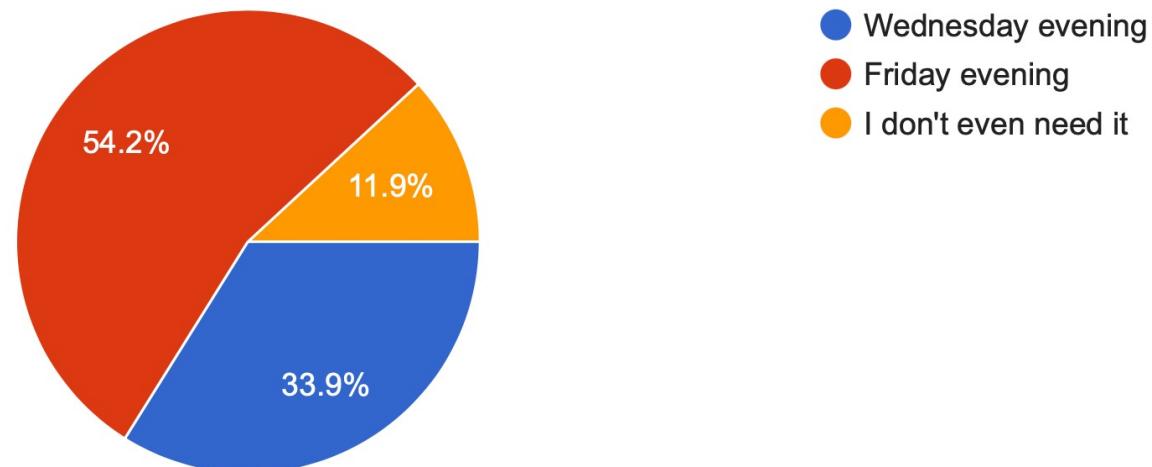


# Trees and Monte Carlo Tree Search

Matthew Guzdial

# Announcements

- HW2 due Monday (same late policy applies)
- (Thursday) Orange Shirt Day/National Day of Truth and Reconciliation <https://www.alberta.ca/current-students/first-peoples-house/orange> When should we do the online help session?  
59 responses
- Friday: 5:15pm to 8:00pm  
(still have my 12pm-1pm)





Horizon Zero Dawn “Native-inspired” Designs



This Land is My Land (2020) – (It’s bad!)



Infamous Second Son “Akomish” (Suquamish)

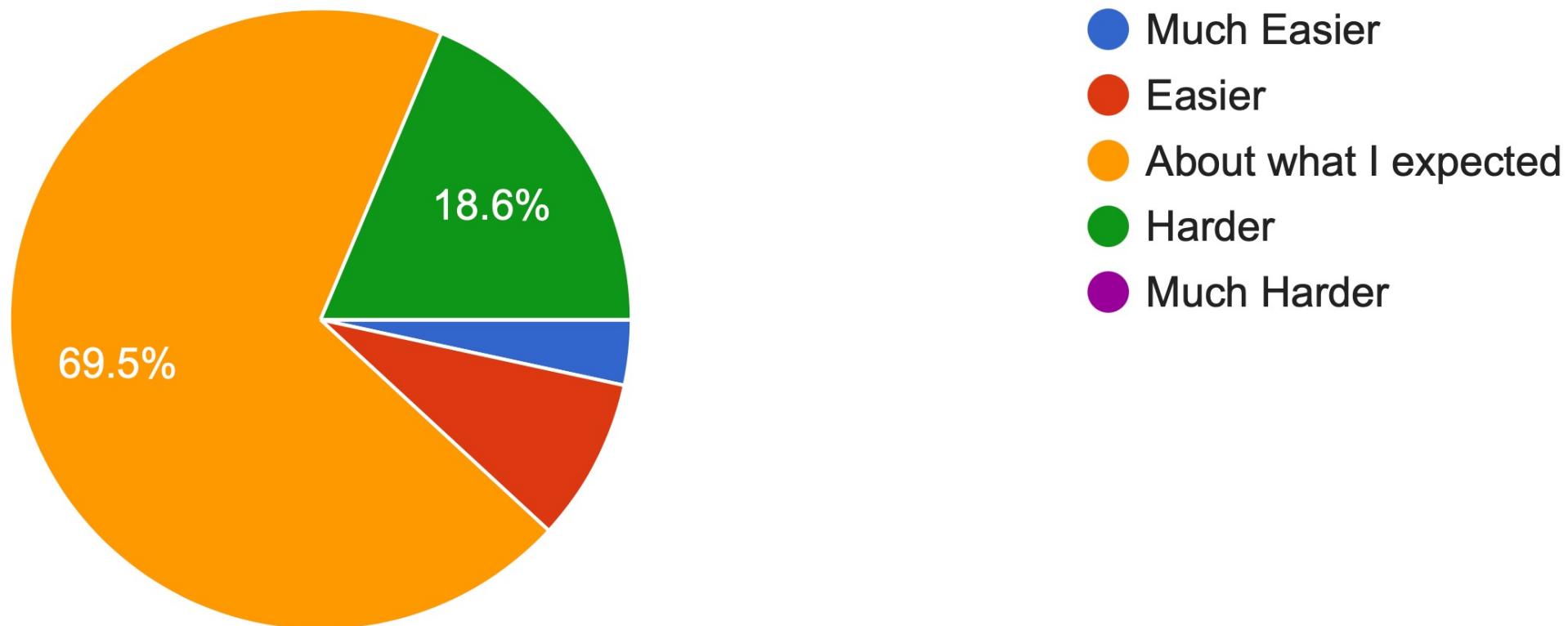
**Oregon Trail to Assassin’s Creed: Right and wrong Native American portrayals in video games**  
C.A. Printup

<https://indiancountrytoday.com/lifestyle/oregon-trail-to-assassin-s-creed-right-and-wrong-native-american-portrayals-in-video-games-9wZ1Q98XfU-NOYcWMyqZ5A>

# Last Time – Quiz Polling

How was quiz 1 relative to your expectations?

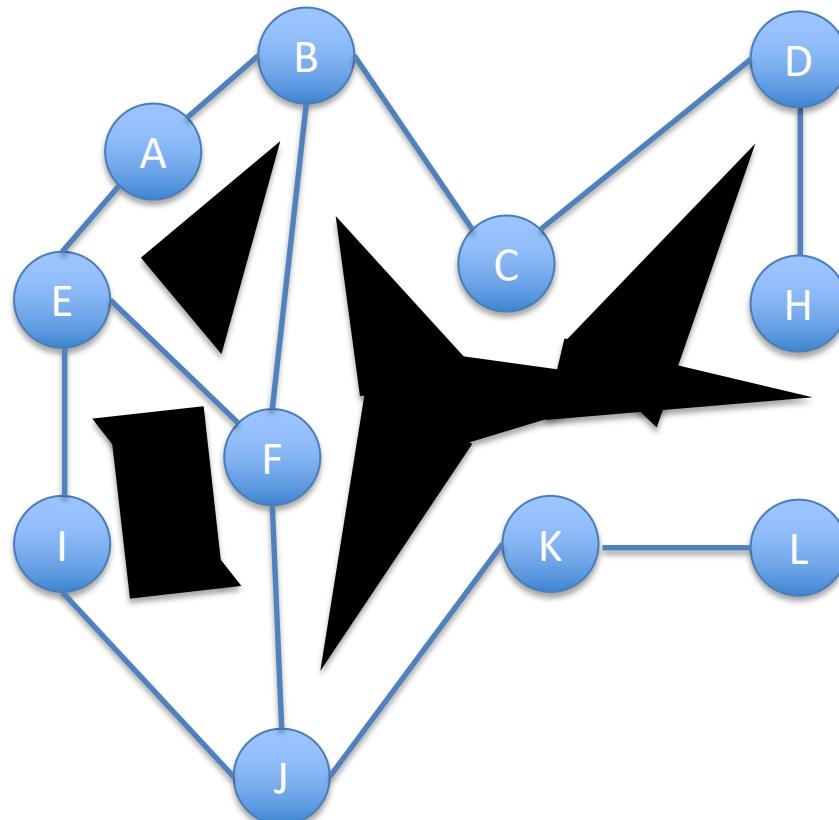
59 responses



# Comments on Quiz 1

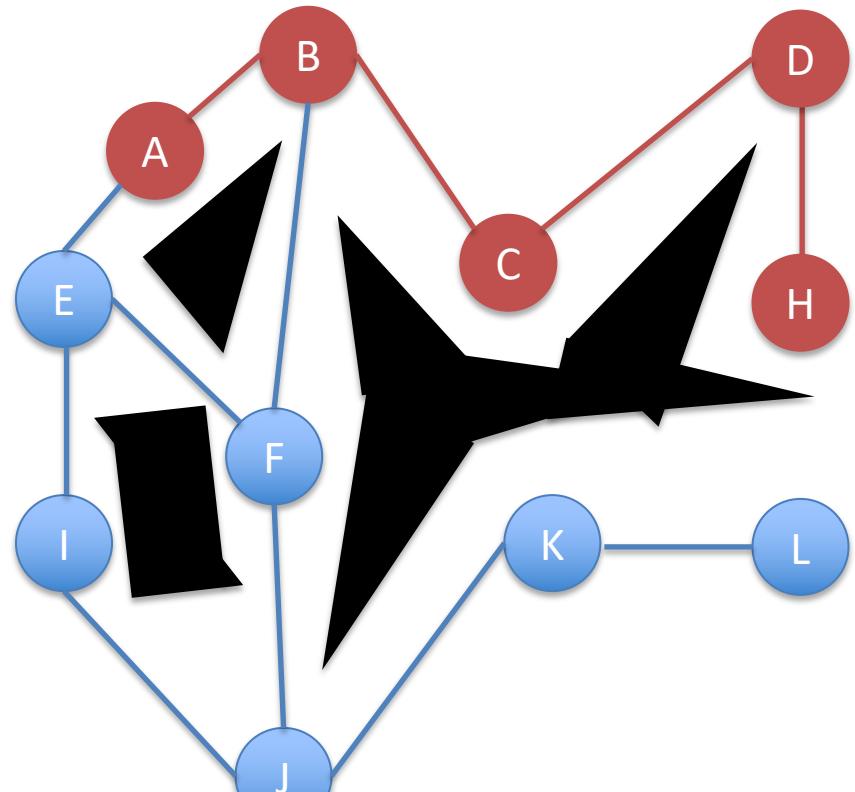
- “Steering behaviours still confusing; is all steering made up only of the examples shown in class (and combinations of them)?”
- “I feel like it wasn't at the difficulty where I really was forced to understand the material- I could just check the notes for answers to all the questions.”
- “It is hard to read and understand the meaning of some of the questions.”  
+ “The wording of some of the questions was a little confusing.”+  
“Too [many] question[s] with no standard answer.”
- “I think I would prefer if it was timed like a normal quiz, because with this format I'm more likely to spend 2+ hours writing the quiz by referencing notes rather than studying and understanding the material before the quiz.”
- “It was too easy to be a 48 hour open book quiz. The difficulty would have been right if it was in-class, closed book and 1 hour long.”
- “an hour felt like too short a recommendation time to do the quiz”

# Path Planning Reminder

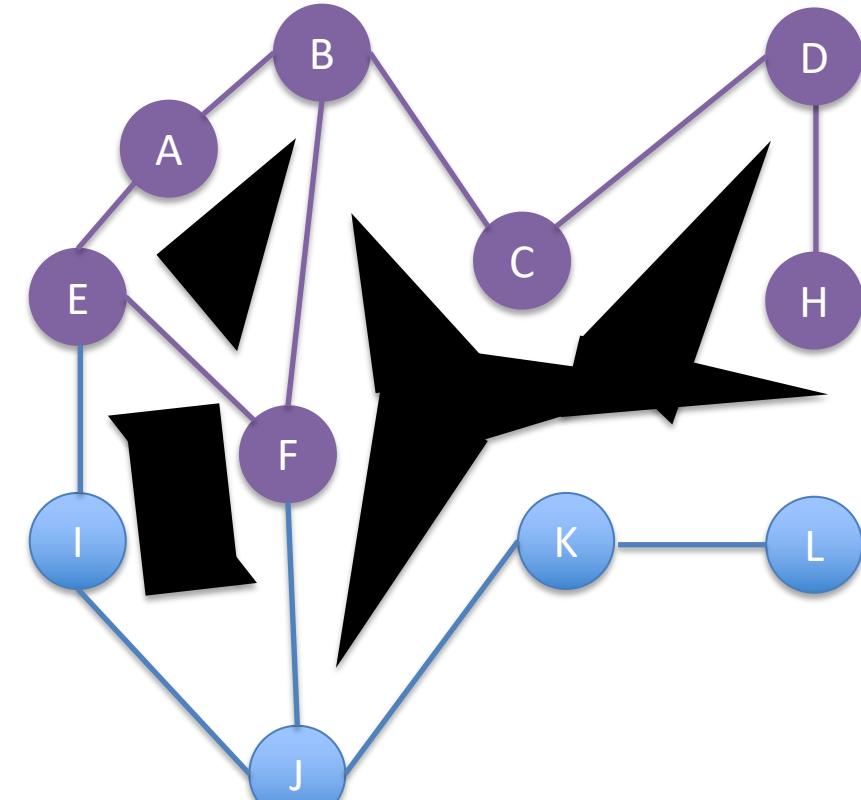


Path from A to H

# Path Planning Reminder

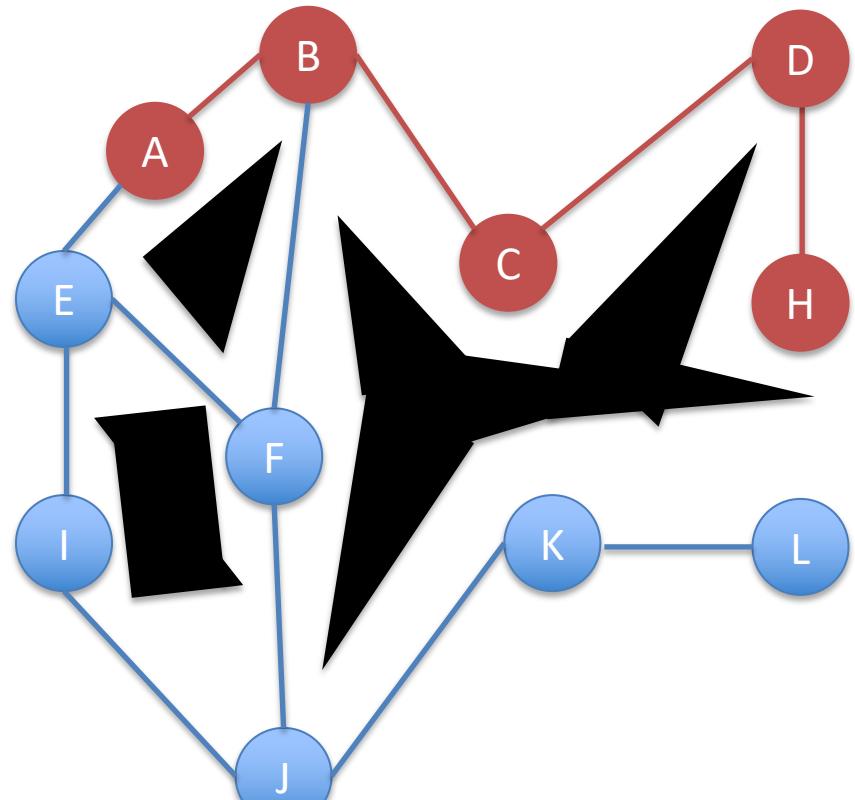


Greedy

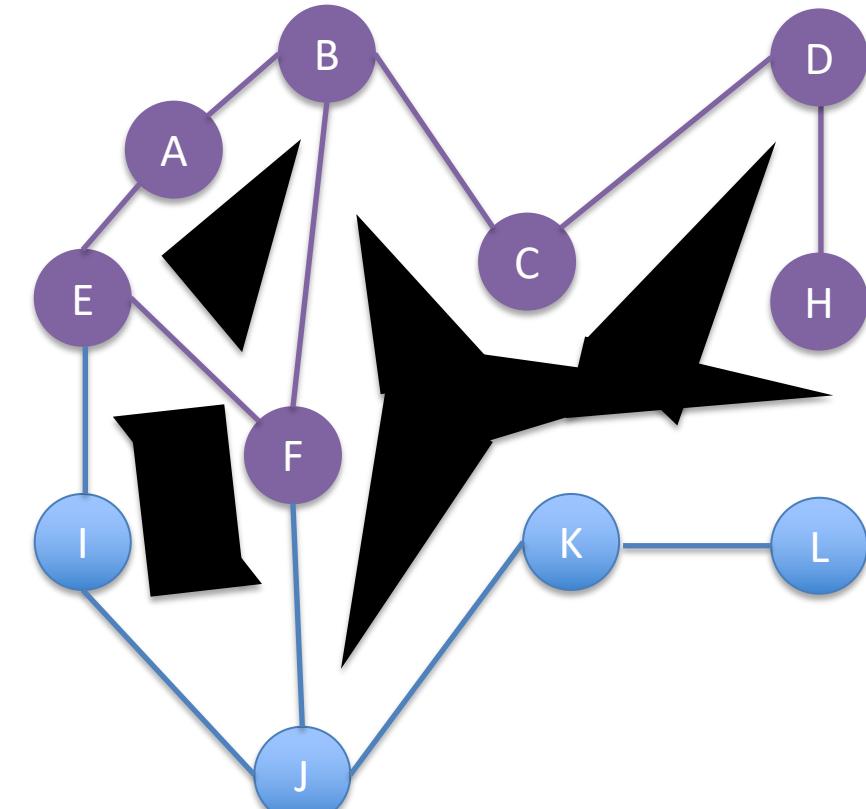


A\*

# Path Planning Reminder



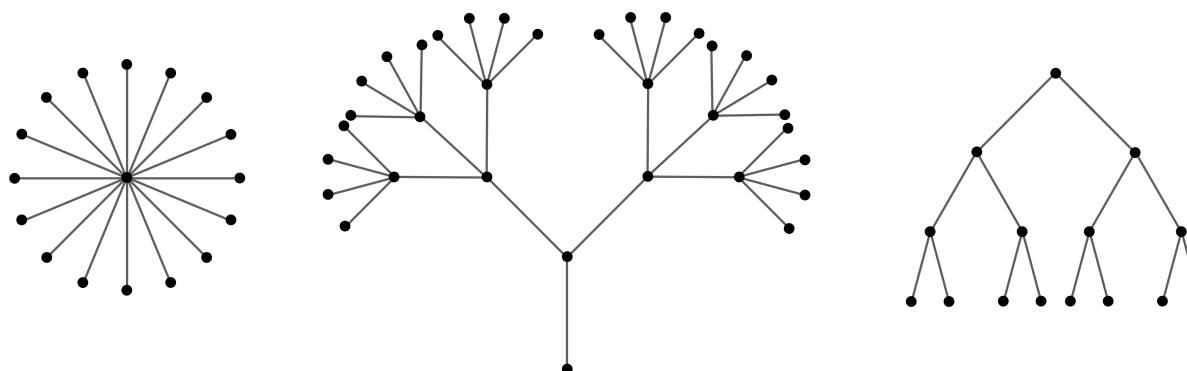
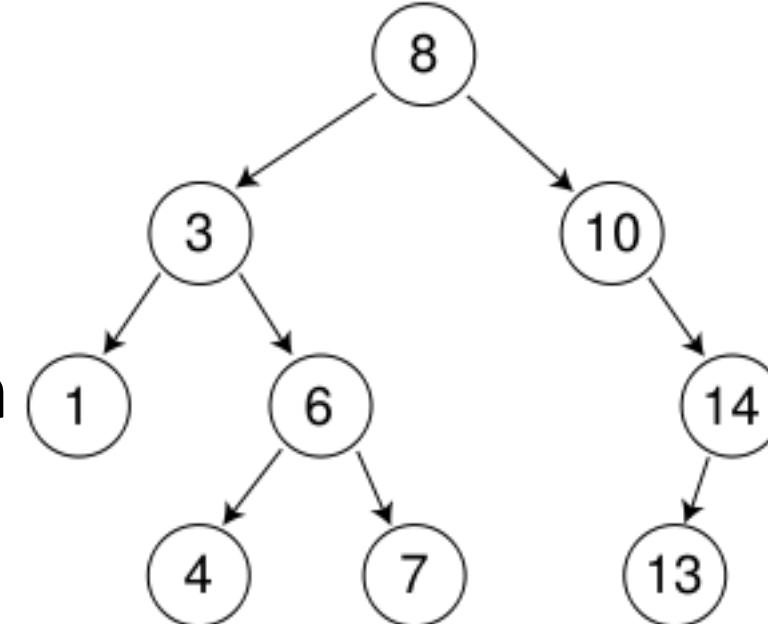
Depth First Search



Breadth First Search

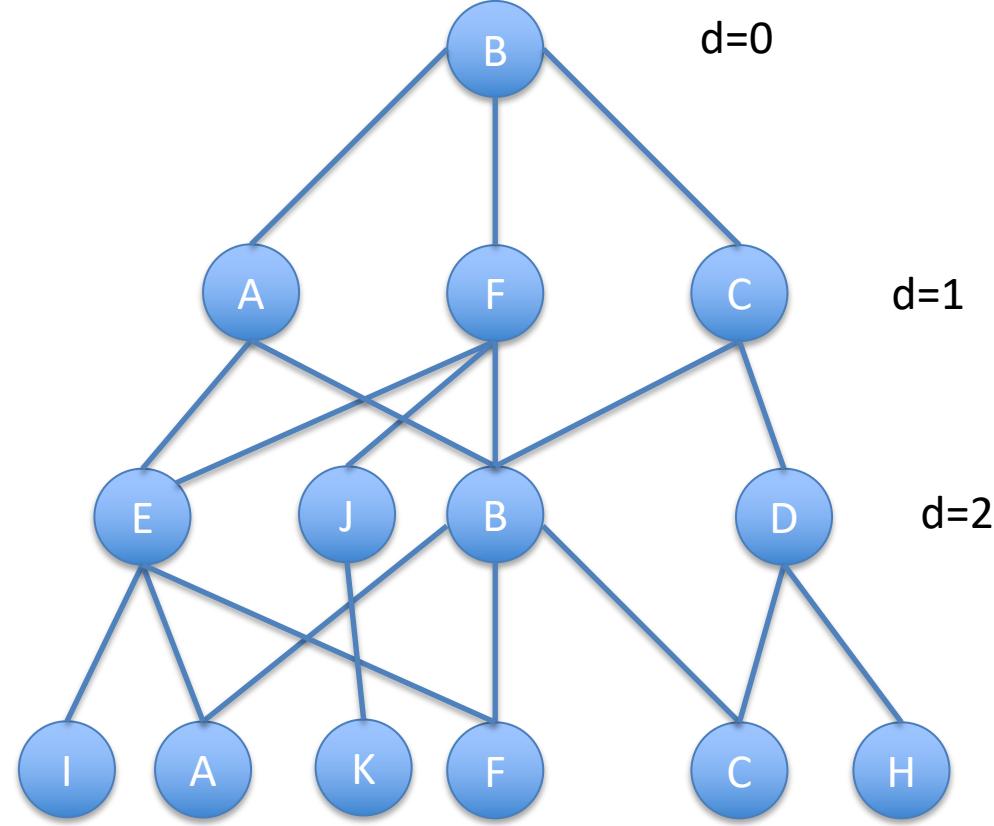
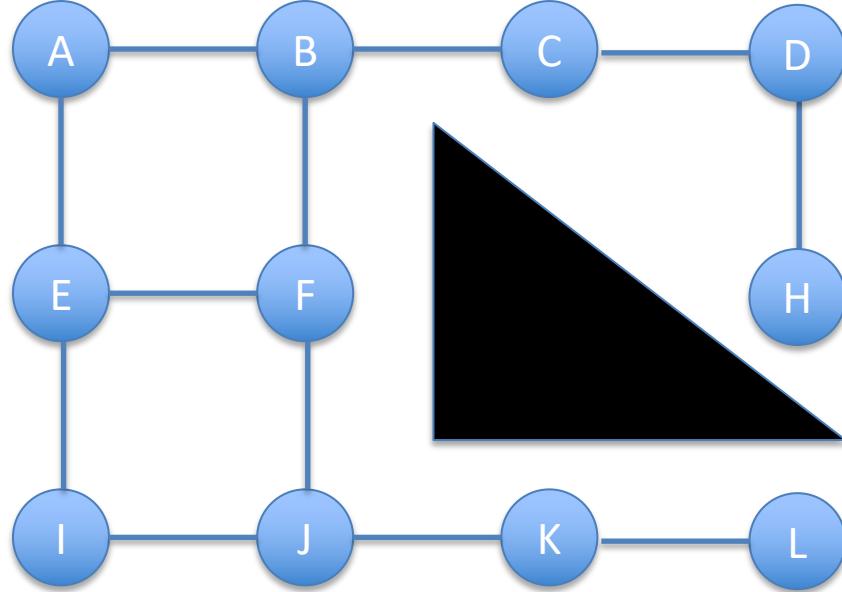
# Trees

- A directed graph
  - Edges only go one way
- From a single root note
- Allows us to make certain assumptions

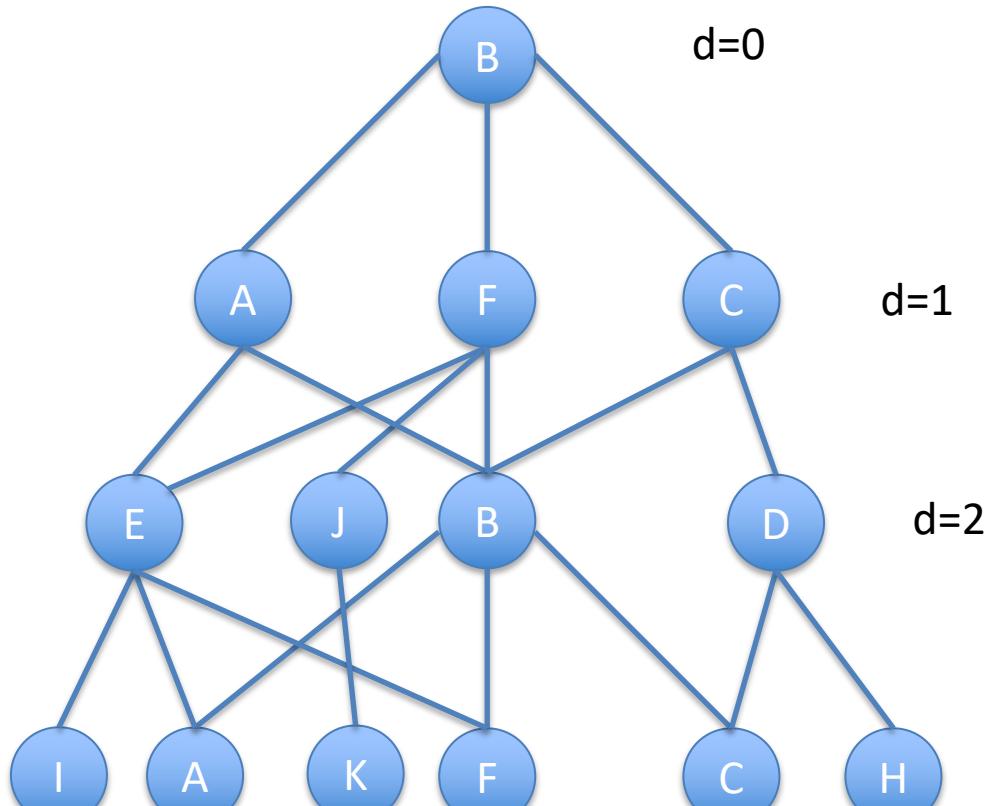
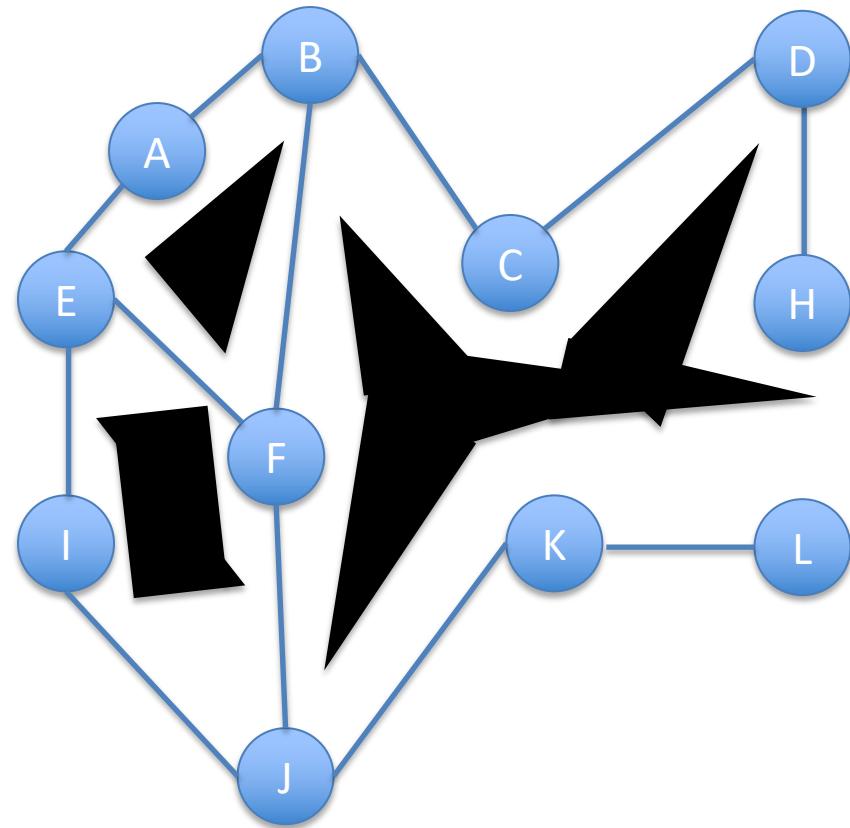


# Graphs into Trees Given Start Position

## A\*/Breadth First Search



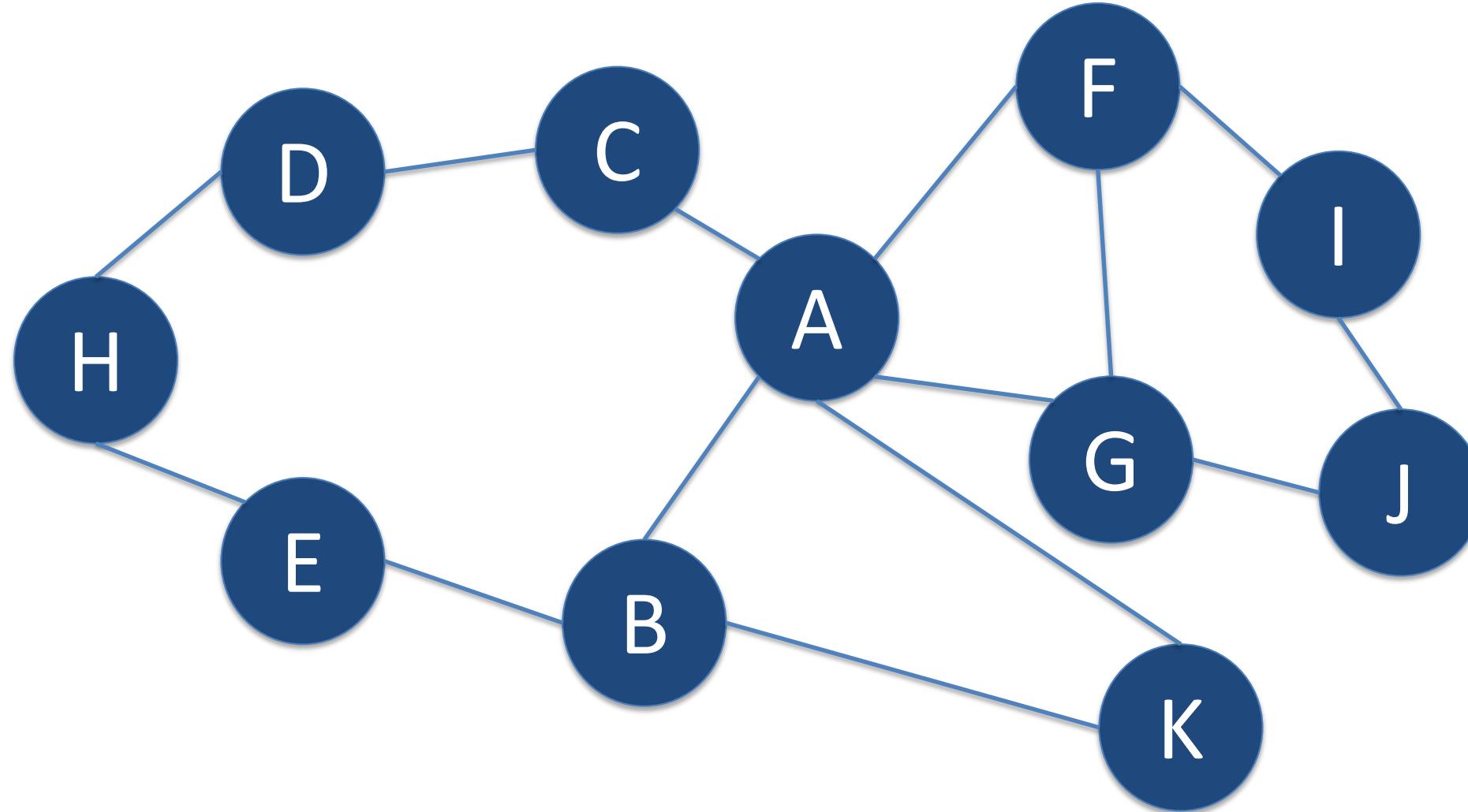
# Path Networks to Trees Given Start Position



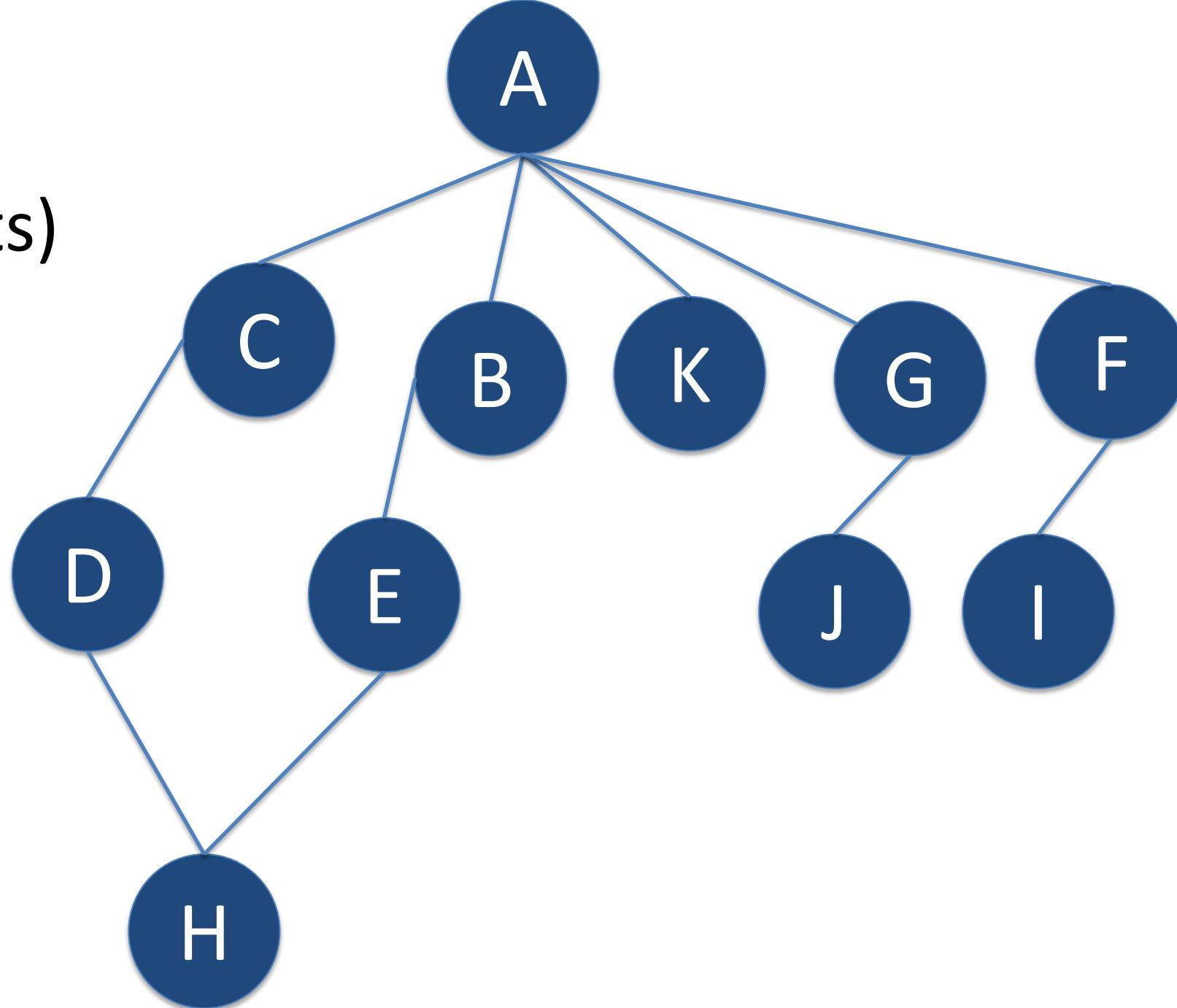
PQ1: Give me the nodes at each depth of the tree starting at node A with BFS/A\*. (Hint: Max depth is 3)

<https://forms.gle/wU3truiZU3XkdQUE7>

<https://tinyurl.com/guz-pq12>



Hidden  
Answer  
(no repeats)



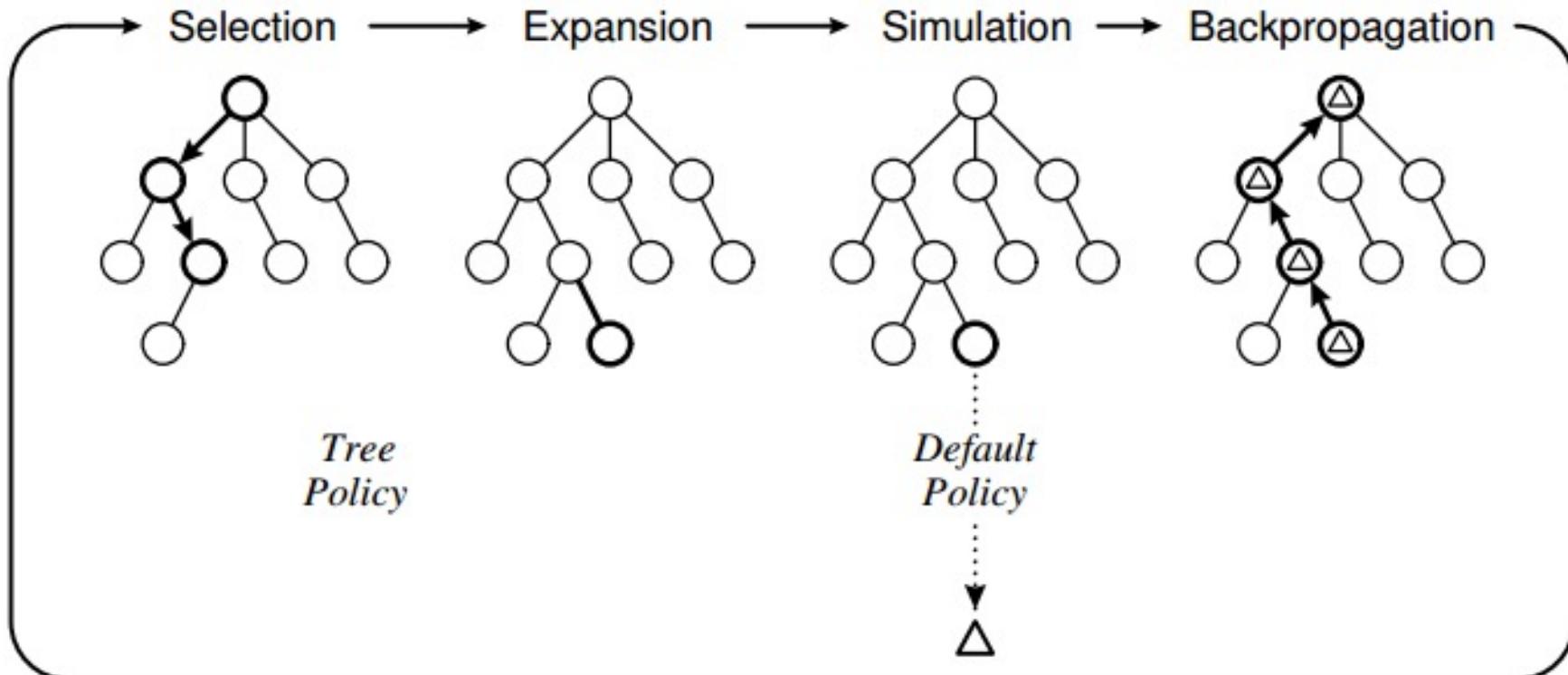
# Why am I talking about trees?

- A\* is good for dynamic, small environments
- APSP is good for static, small environments
- What about big environments? Dynamic environments?

# Monte-Carlo Tree Search

- In a large, dynamic environment we can't necessarily compute distances quickly.
- We can randomly simulate a potential path (of fixed max length  $L$ ) quickly ( $O(L)$ )
  - Called a "rollout"
- Simulate as many rollouts as you can with a limited computation time, and take the path with the best

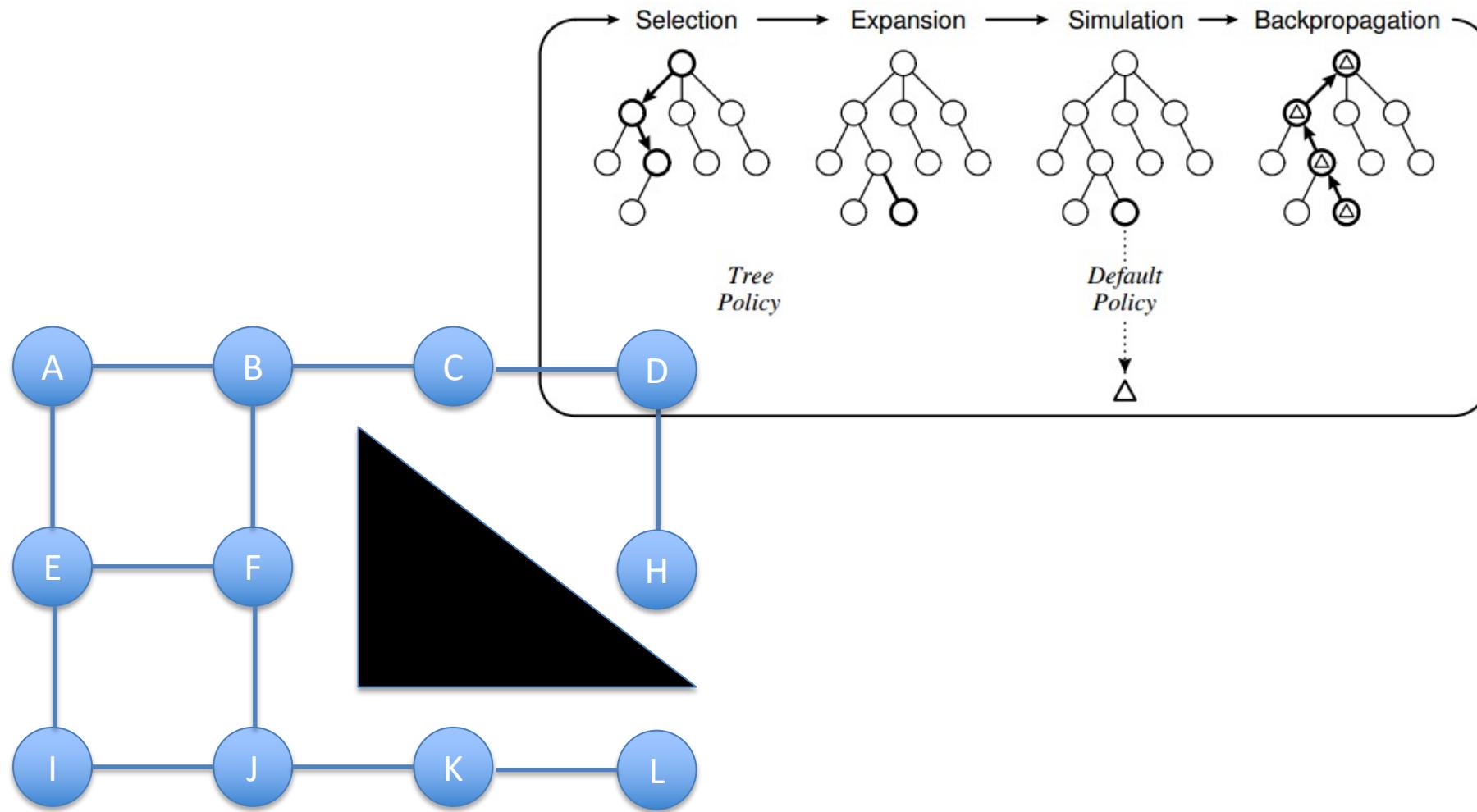
# Monte Carlo Tree Search



# MCTS Steps

- 1. Selection:** Do one rollout of length  $L$  following the *Tree Policy* (may be random, authored, or learned).
- 2. Expansion:** If we don't have a pre-authored tree, add each node to the tree as we encounter it.
- 3. Simulation:** Either literally play/pathfind from here, or *approximate* the cost of pathfinding from here.
- 4. Backpropagation:** Whatever the cost/reward of the final node, backpropagate that all the way to the first edge.

# Demonstration: Pathfind from B to L ( $L = 2$ )



# Where is this used?

- Big dynamic maps
- Realtime Strategy Games most common.
- Why does this make sense?



# Automated Game Playing

- Kasparov v. Deep Blue
- AlphaGo v. Lee Se-dol



PQ2 <https://forms.gle/BBsz9FfCZ3qw36rS7>  
<https://tinyurl.com/guz-pq11b>

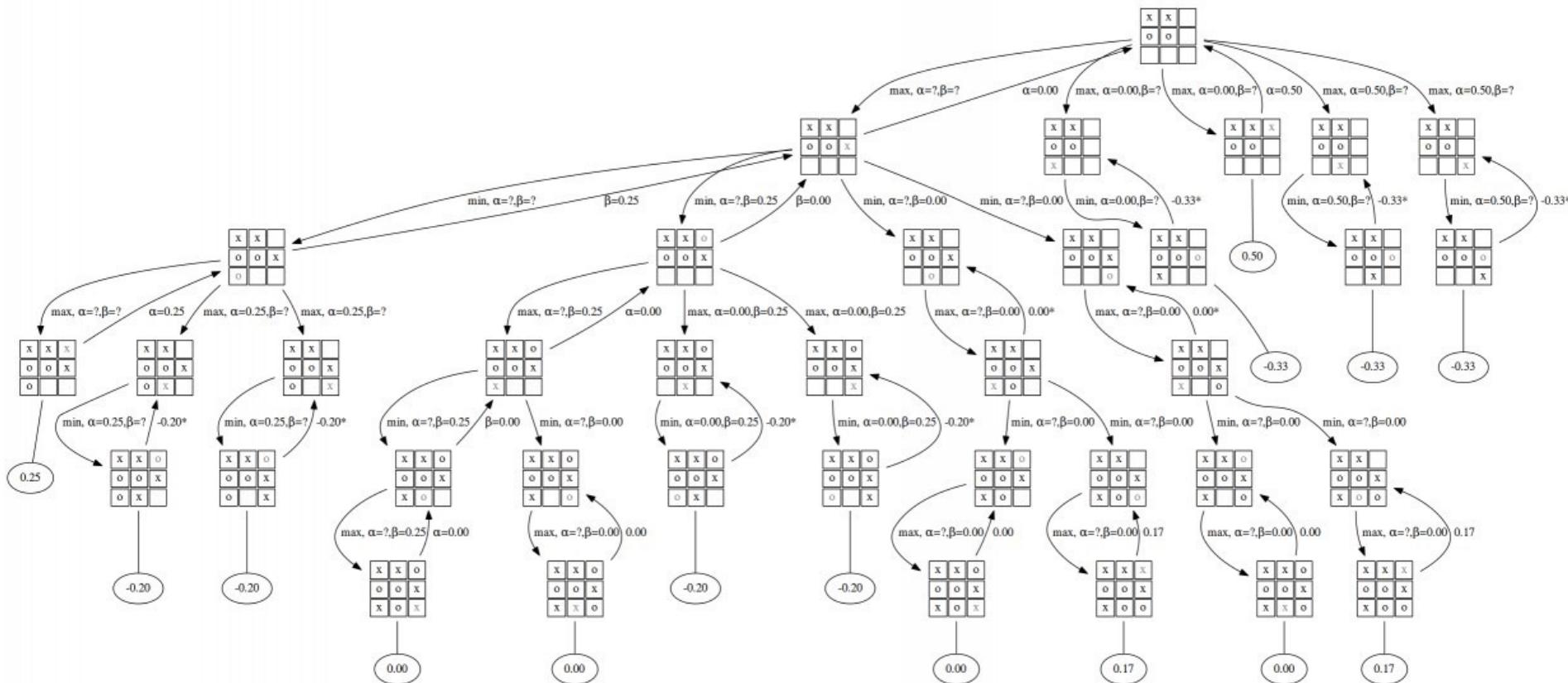
How could we use MCTS to do automated game playing? For example, for chess?



# Hidden Answer

- Treat each board position as a node.
- Treat each move as an edge to another board.
- Evaluate boards based on heuristic.

# Tic-Tac-Toe MCTS Example



# MCTS for Enemy Behavior Usage in Game Dev

- Very minimal. Why?
- Most useful in complex strategy games with long-term consequences for actions.

# Simulate Step in Automatic Game Playing?

- Chess?
  - Final board quality, number of pieces, etc.
- Realtime Strategy game?
  - Score, number of units, etc.

# Summary and What's Next

- MCTS exists
- When we're using a planning approach, we don't just have to think about movement, but **actions**
- MCTS is generally overkill!
- Friday we'll cover a fun, simple approach
- Monday we'll cover FSMs, a common approach
- Wednesday we'll cover Behaviour/Behavior Trees *the* Game AI decision making approach.

Work More Examples If There's Time