DeepBlue, AlphaGo, and AI?

Machine Learning

CSE446

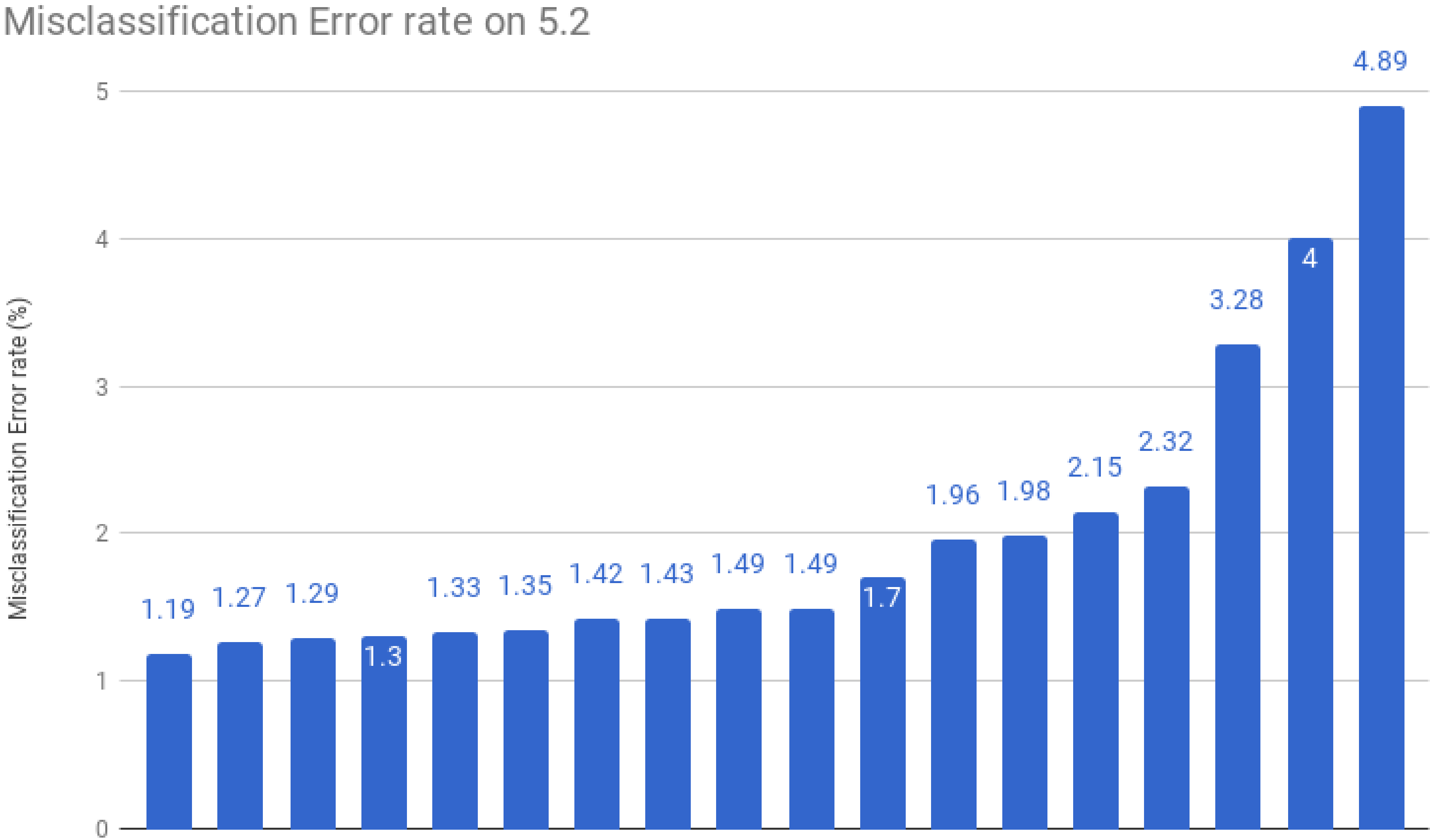
Sham Kakade

Announcements:

- Check website
- Next week: check website for updated office hours
- Final:
  - One side of handwritten notes
  - comprehensive, more emphasis on the second half
  - List of topics posted on Canvas
  - Understand the HWs

- Today:
  - DeepBlue, AlphaGo, and AI?
  - Monte Carlo Tree Search (MCTS)

Q5 histograms



DeepBlue vs Kasparov:

Deep Blue vs. Kasparov chess

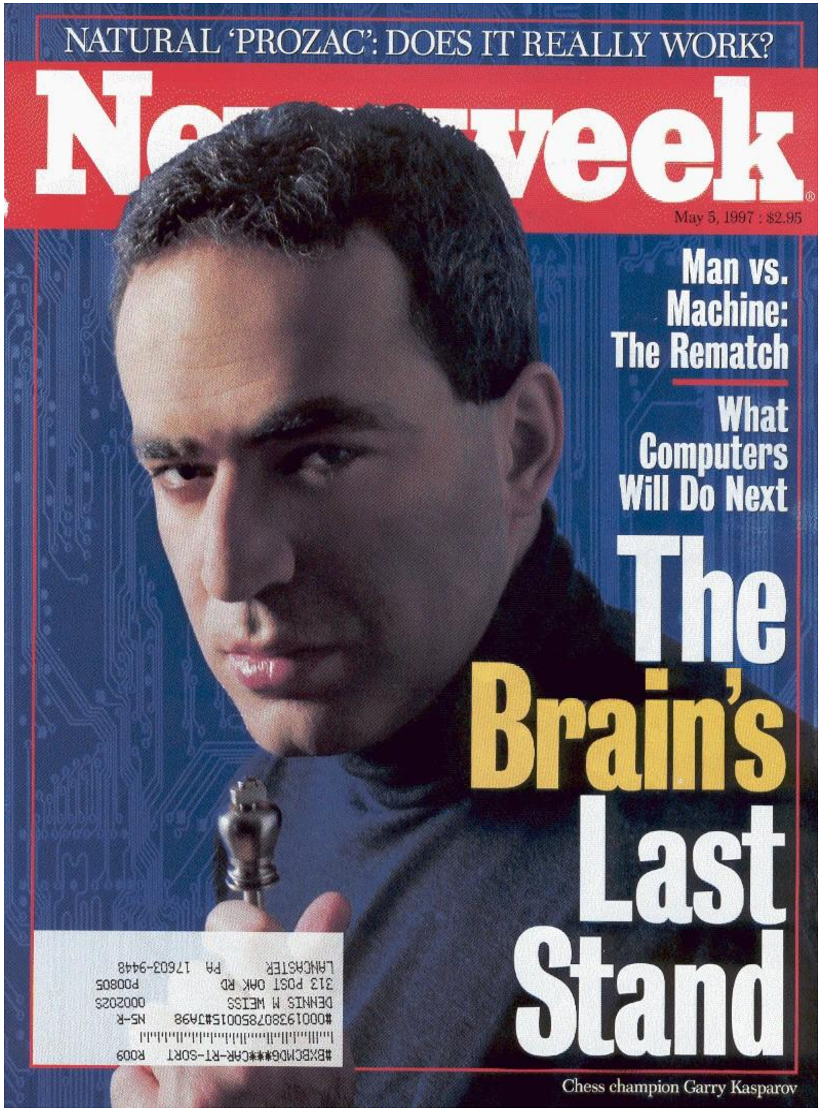
Deep Blue
IBM chess computer

Garry Kasparov
World Chess Champion

- First match: 1996
  - **Kasparov**-DeepBlue: 4-2
- Second Match: 1997
  - Karasparov-**DeepBlue**:2.5-3.5
- Logic-based, AI approach:
  - look ahead: alpha-beta search
  - Human board evaluations:
    - knight/bishop = 3 pawns, queen = 8 pawns, king = ∞
    - thousands of such rules

A fascination on games for “Humans vs. AI”…

- DeepBlue success didn’t amount to much for “AI”, societal impact, etc…
- Underlying techniques seem limited?
  - Hand coded rules…
  - Brute force look-ahead…


NATURAL ‘PROZAC’: DOES IT REALLY WORK?
Newsweek
May 5, 1997 : $2.95
Man vs. Machine: The Rematch
What Computers Will Do Next
The Brain’s Last Stand
Chess champion Garry Kasparov

Thought to be a difficult task...

2016

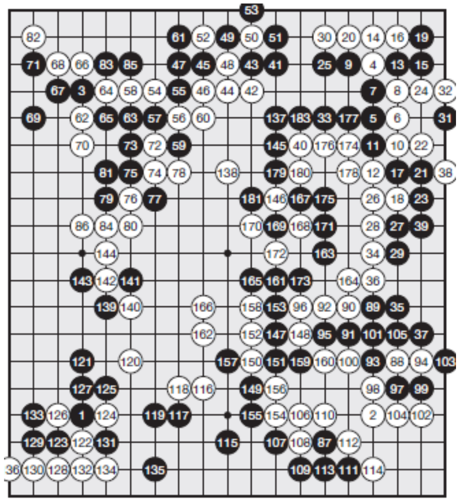
AlphaGo deep RL defeats Lee Sedol (4-1)

Chess vs. Alpha Go

- Will the technical advances (underlying AlphaGo) have broader implications?

1997, AI named “Deep Blue” beat chess world champion.

Search space: b^d: $b = 35, d = 80$



Search space: b^d: $b = 250, d = 150$

What is different today?

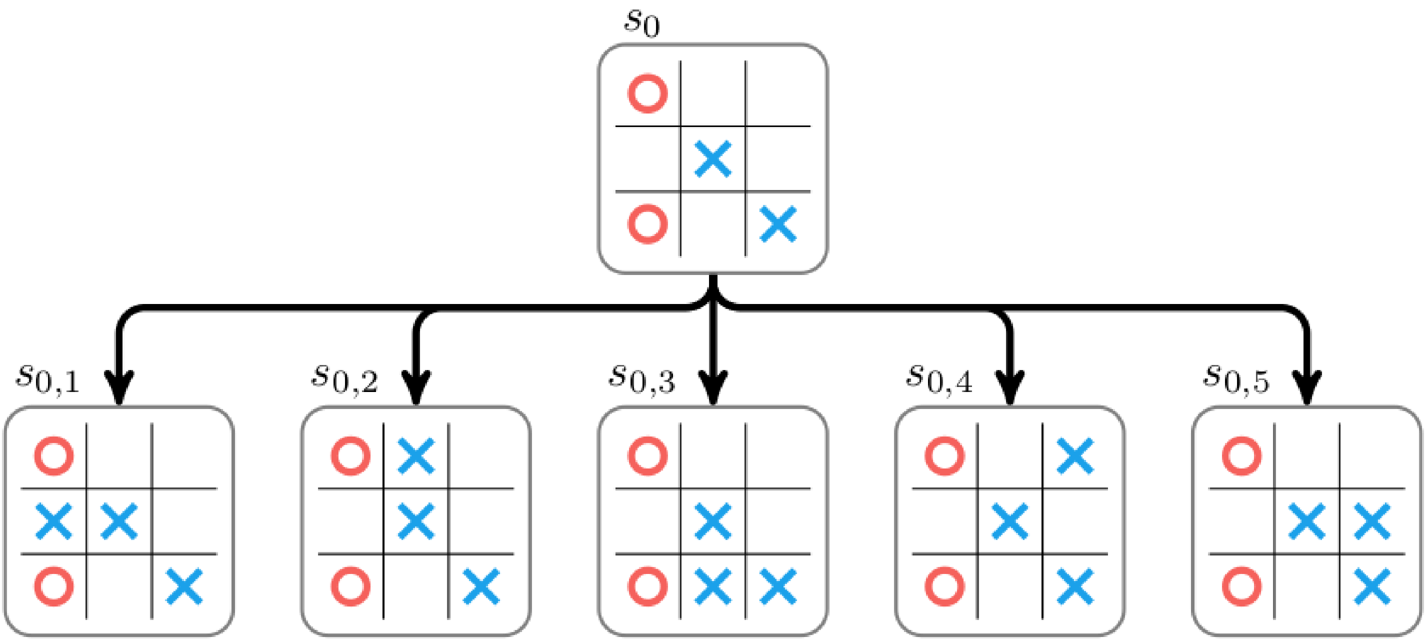
- Is it AI? NO
  - It might be better to ignore that question…
- Different from DeepBlue? YES
- Viewpoint: AlphaZero is at the forefront of progress in ML.
  - Pattern recognition (think of: supervised learning)
    - object recognition and ImageNet
    - the “universal” translator
  - exciting: the approach integrates “planning/search” with “pattern recognition

AlphaZero: the basic idea

- This is the “newer” method (over AlphaGo)
- A certain “lookahead” approach, using both a policy **p** and value **v**
  - **p(a|s)** is a distribution over move probabilities (for every state)
  - **v(s)** is the ‘value’ of the state (e.g. the estimated probability of winning)
- Learns: (**p**, **v**) = f(**s**,**w**)
  - **s** is the game state; **w** are the model parameters (some neural net)

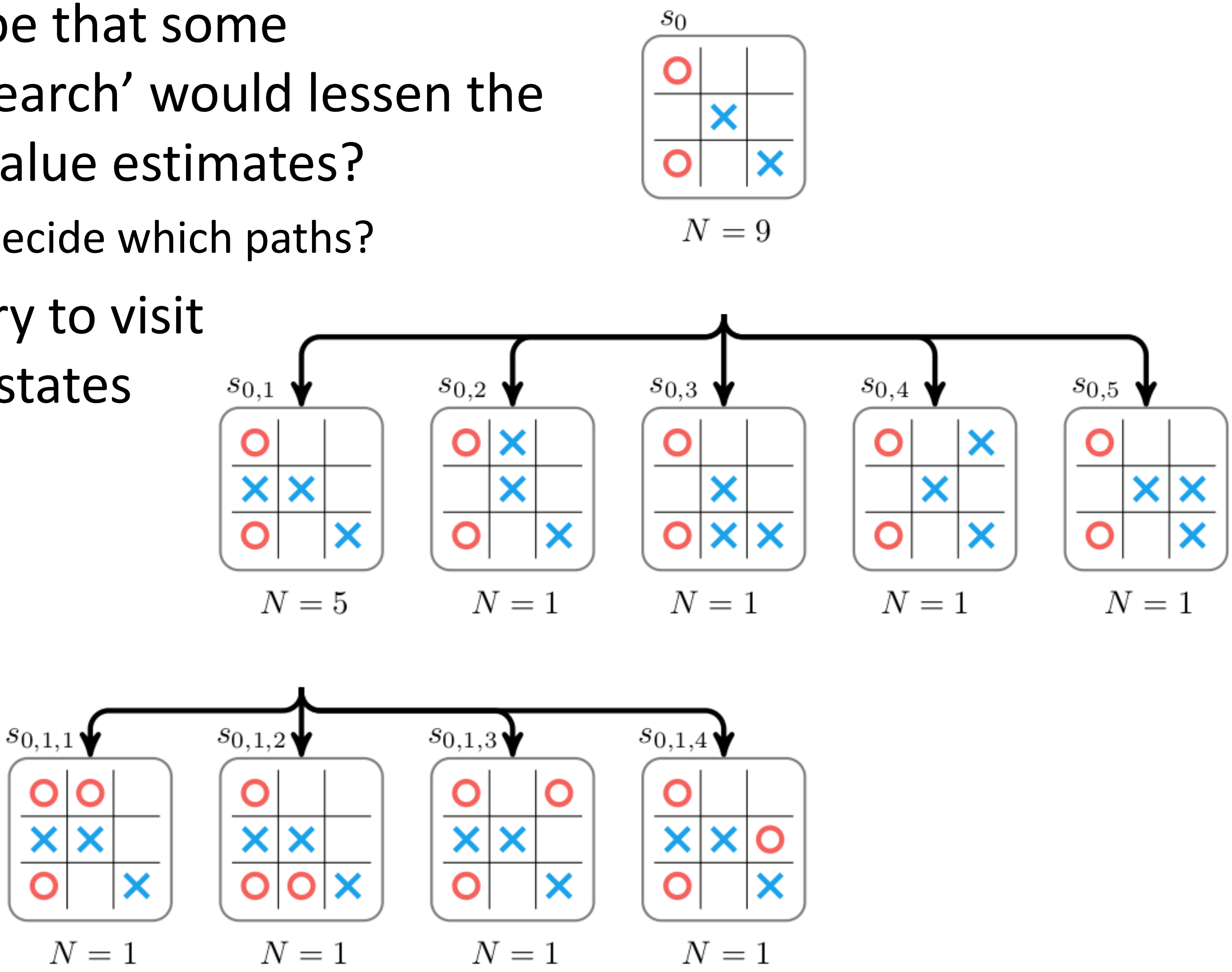
Look Ahead…

- The search space is too big (even for "alpha-beta pruning" to handle)
- Suppose you had a perfect estimate of the "value" of any state.
- Then one step look ahead suffices:



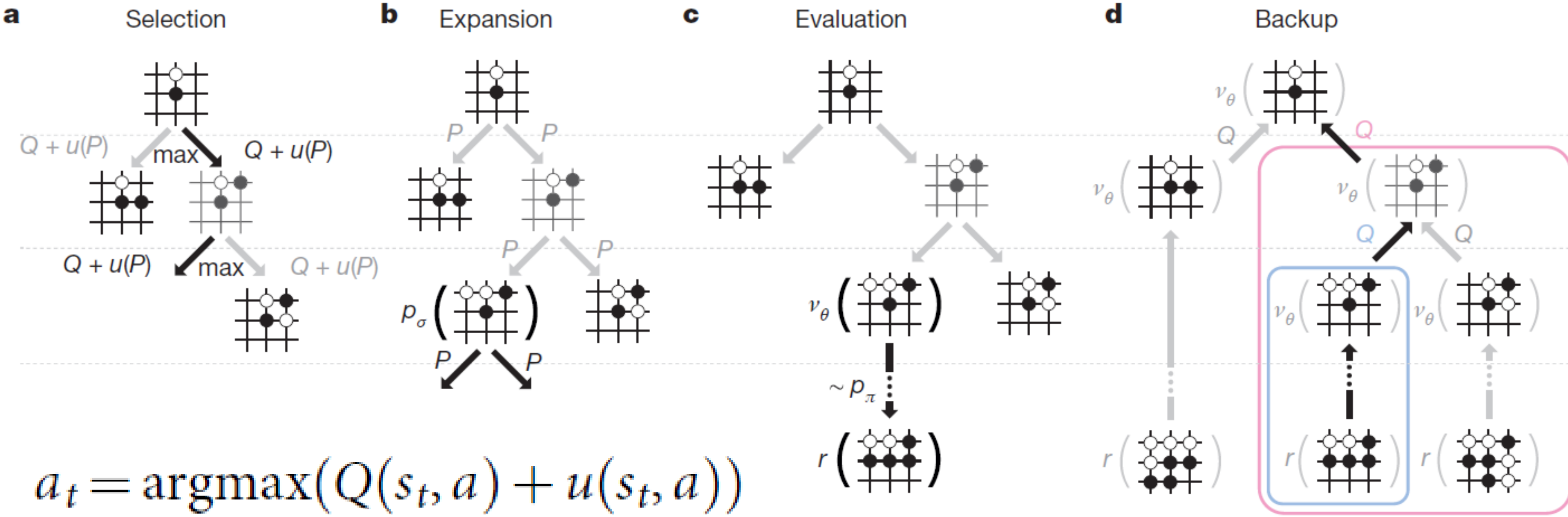
Suppose we have approximate values?

- We would hope that some ‘look-ahead/search’ would lessen the errors in our value estimates?
  - How do we decide which paths?
- Idea: should try to visit ’un-explored’ states



Monte Carlo Tree Search (MCTS)

- A “heuristic” which tries to balance exploration/explotation
- AlphaZero:
  - Key idea: utilizes(+learns) a heuristic that both: 1)estimates the values 2) estimates a policy

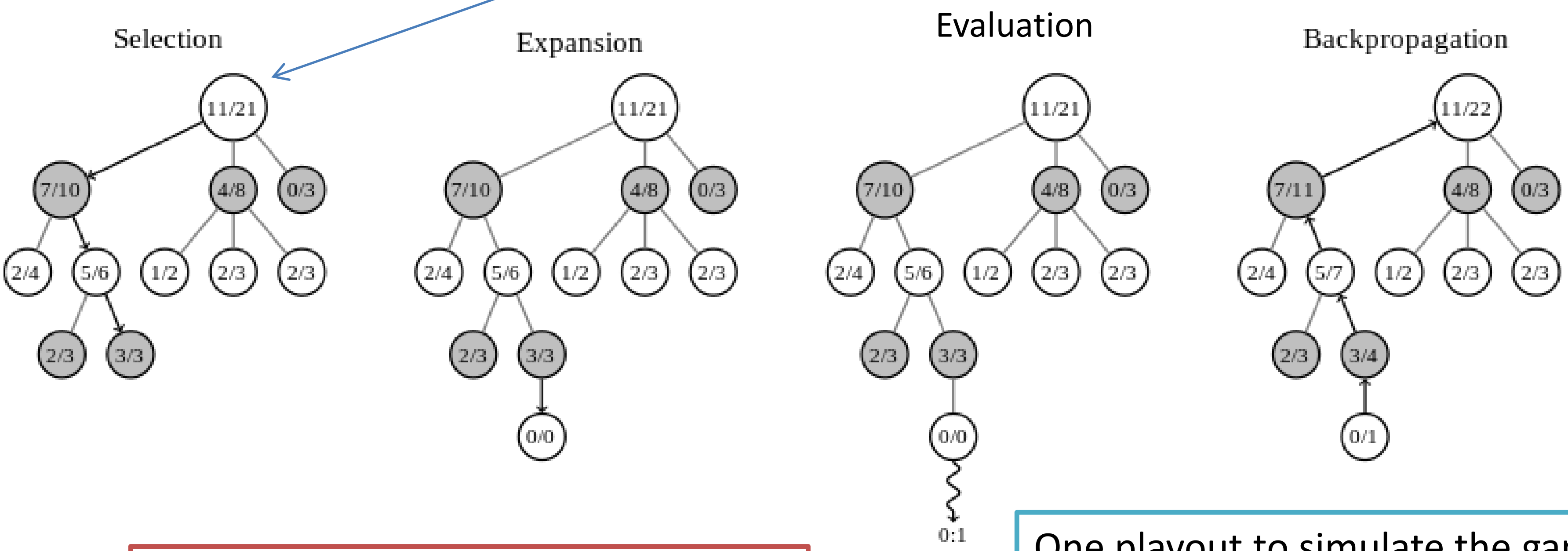


$$a_t = \underset{a}{\operatorname{argmax}}\left(Q(s_t, a) + u(s_t, a)\right)$$

Monte Carlo Tree Search (MCTS)

- A popular heuristic search algorithm for game play
  - By lots of simulations and select the most visited action.

Node value: Wining rate



One playout to simulate the game

Key point: how to calculate this value

Thanks!

- Machine learning:
  - many different methods/tools/challenges in the wild…
  - many research questions…
  - Participate in the ML community.

- (one more week to go….)
  Have a great spring break!

AlphaZero

- AlphaGo: (the earlier system)
  - Was (sorta) specific to Go (in that it used ConvNets)
  - Use previous world championship games for SL.
- AlphaZero:
  - this is the system that “learns from scratch”…
    - At a massive computational expense…
  - works for Go and Chess (and other games)
  - gets above human level performance