

Search and Optimization

UCSD CSE 257
Sicun Gao

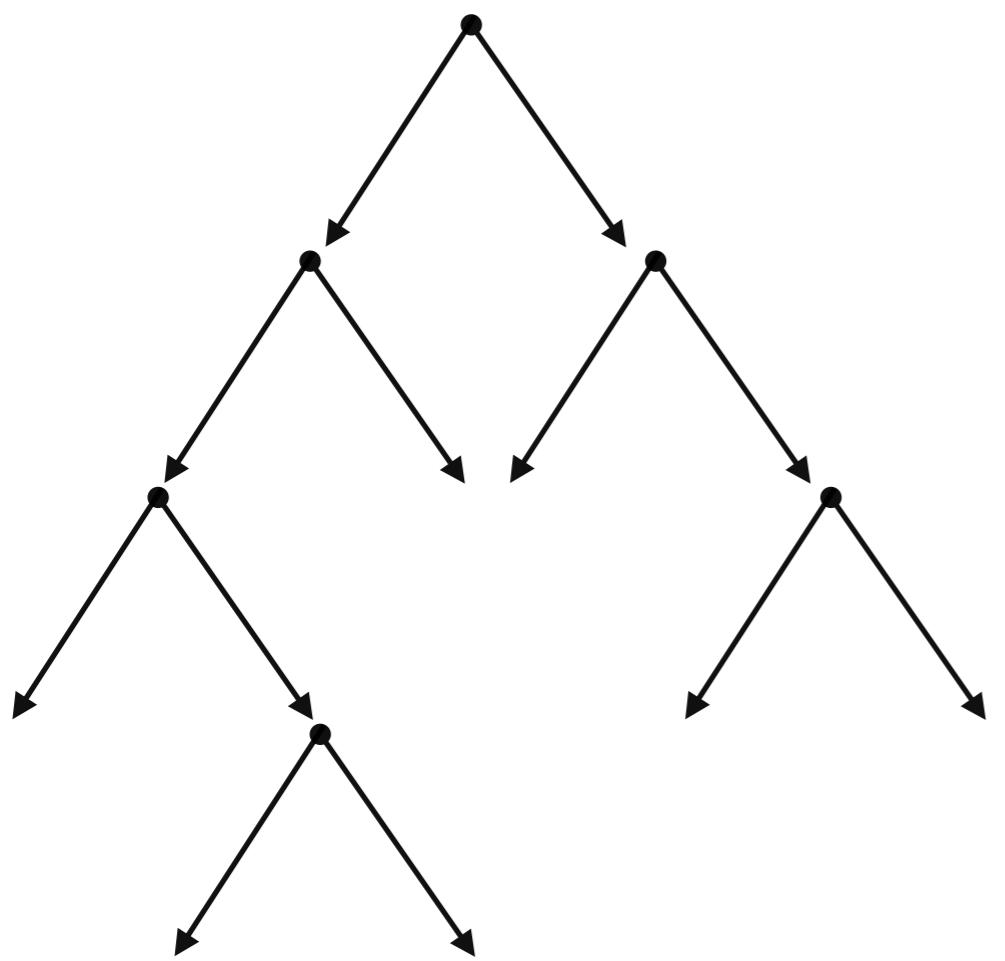
Welcome back to the real world
(appreciate what one extra dimension can provide)

the professor talking with the
students that have the camera off

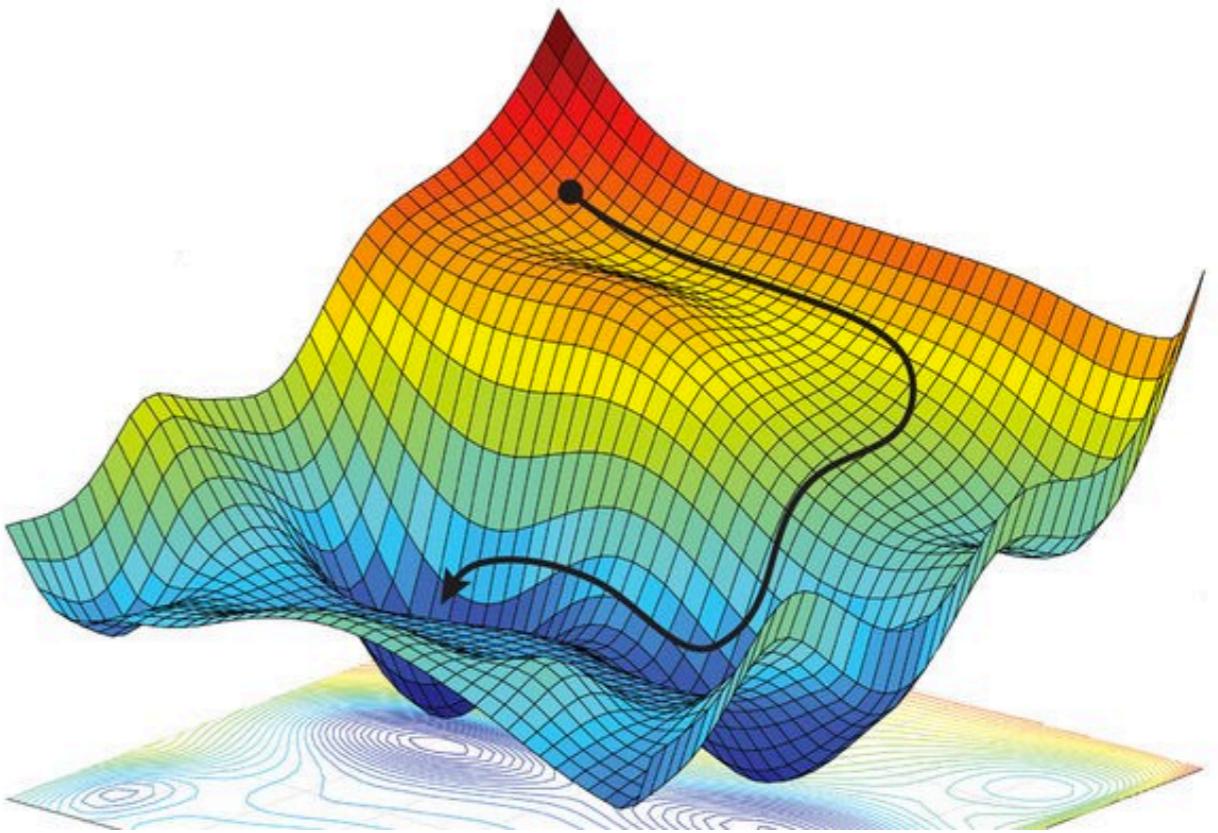


Toolbox for finding needles in haystacks

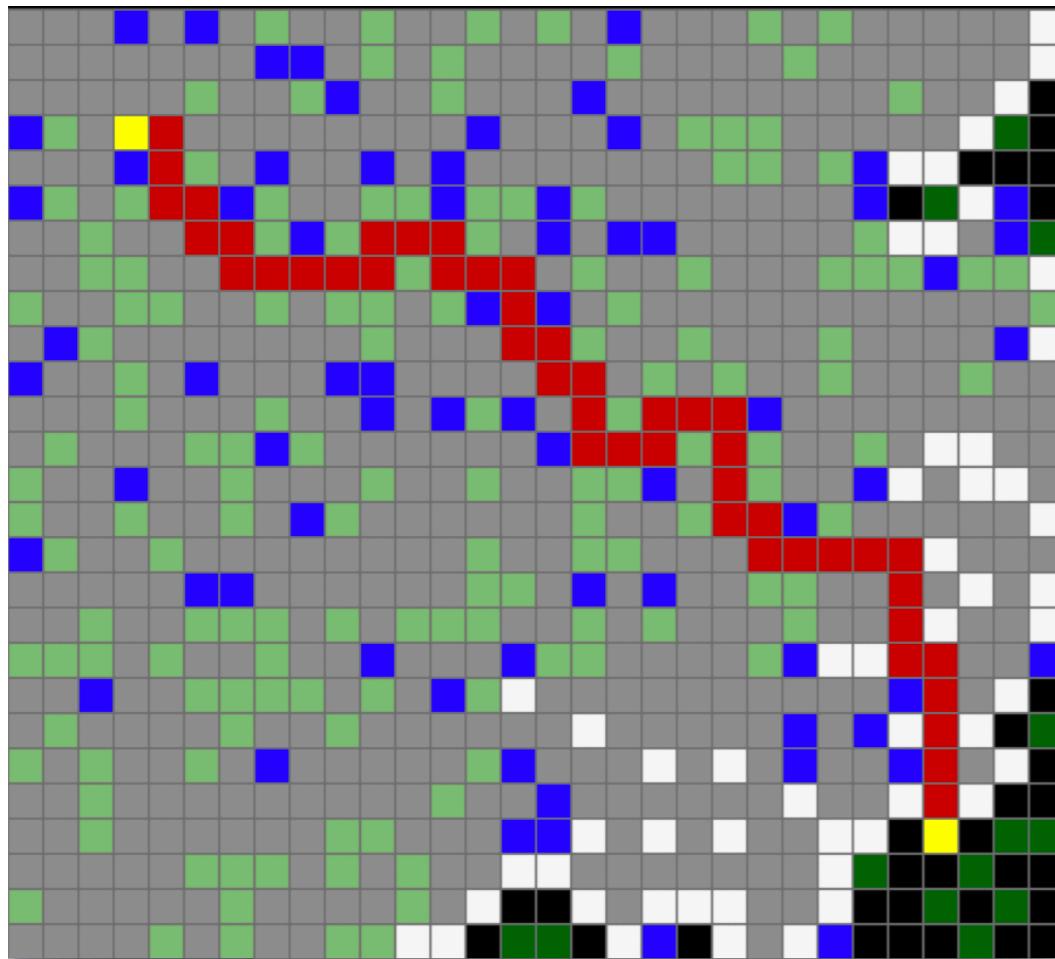




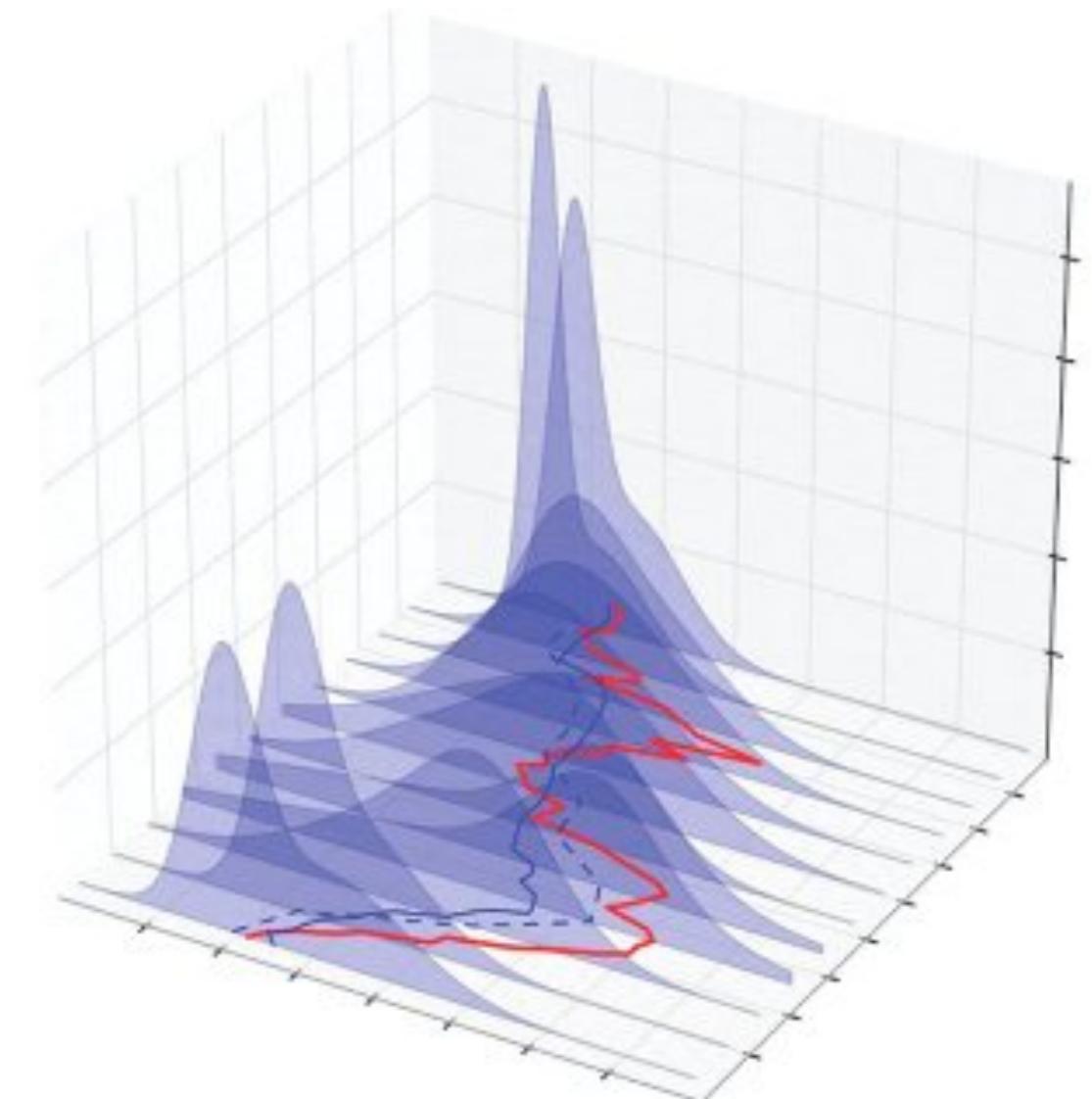
Discrete



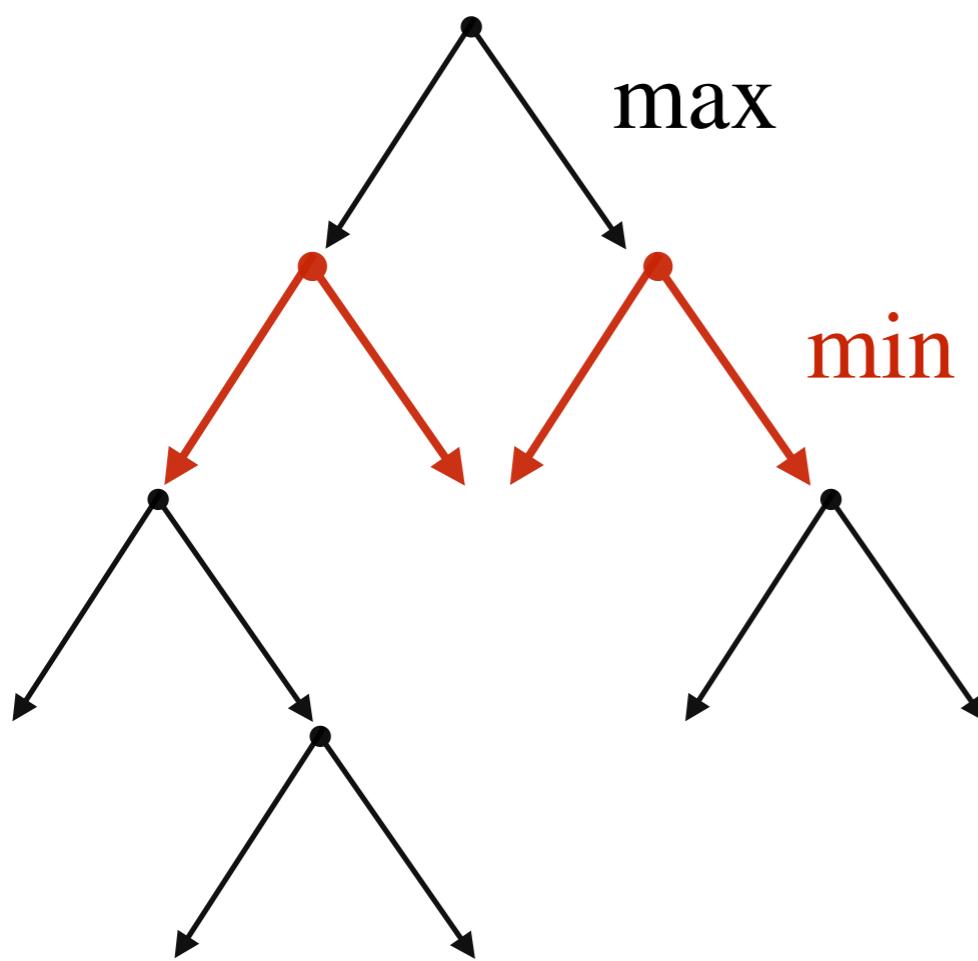
Continuous



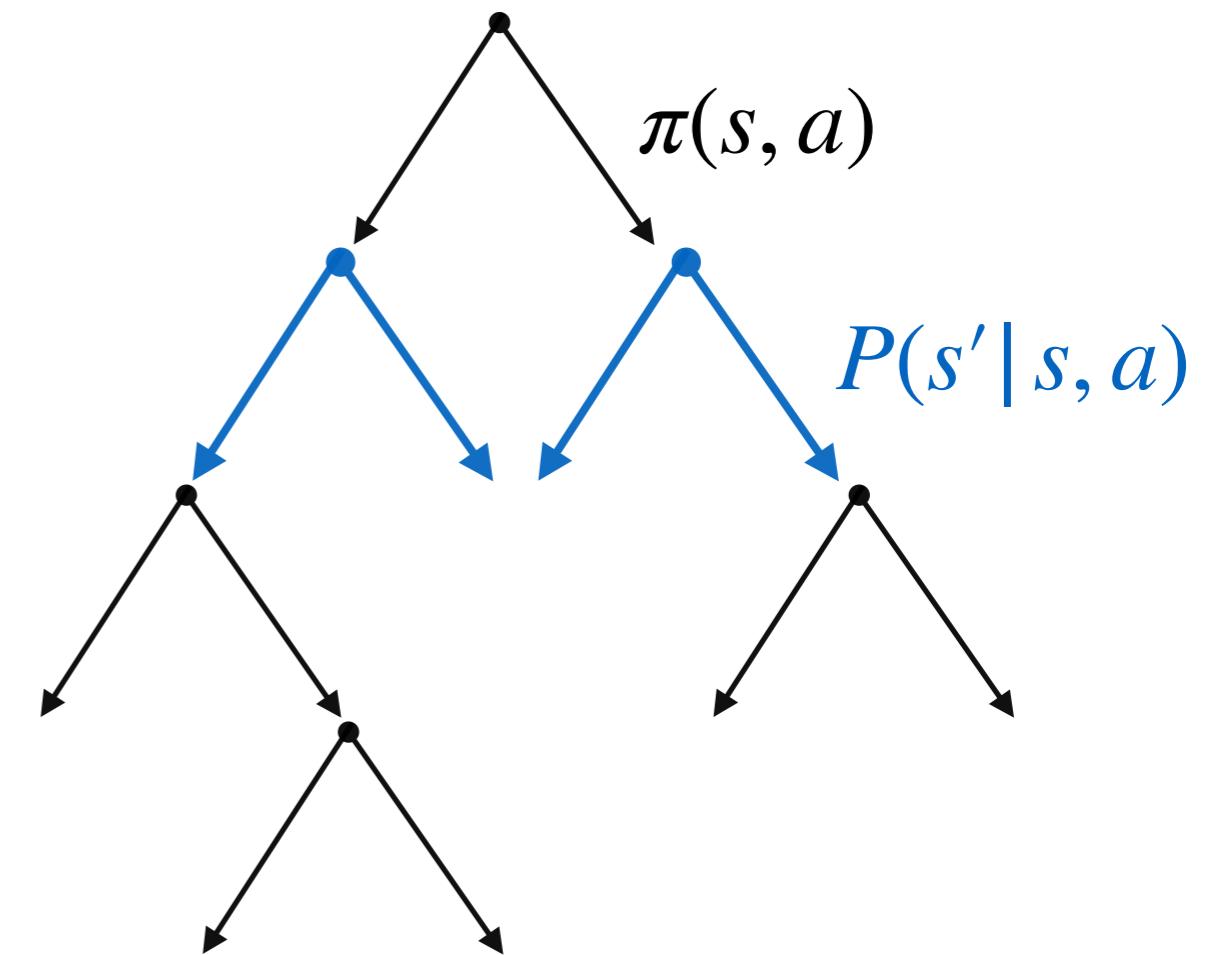
Discrete



Continuous

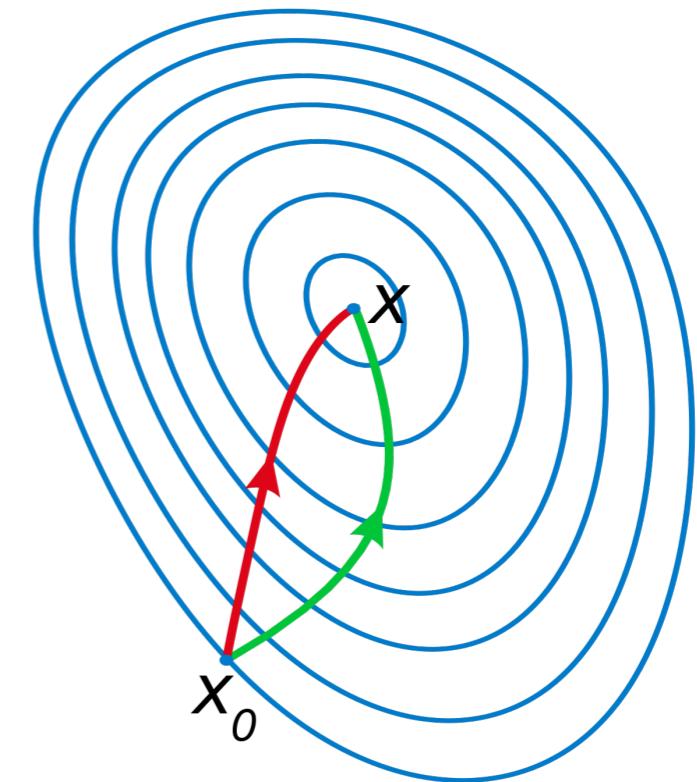
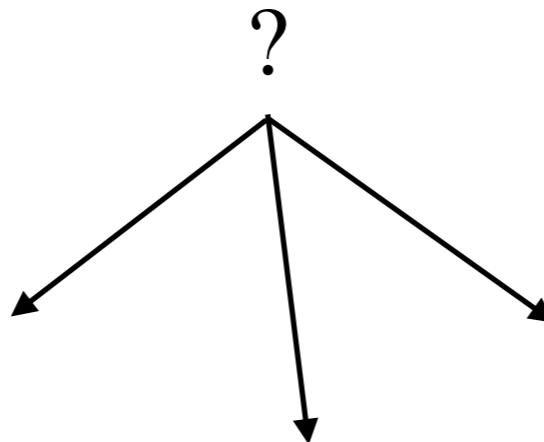


Adversarial

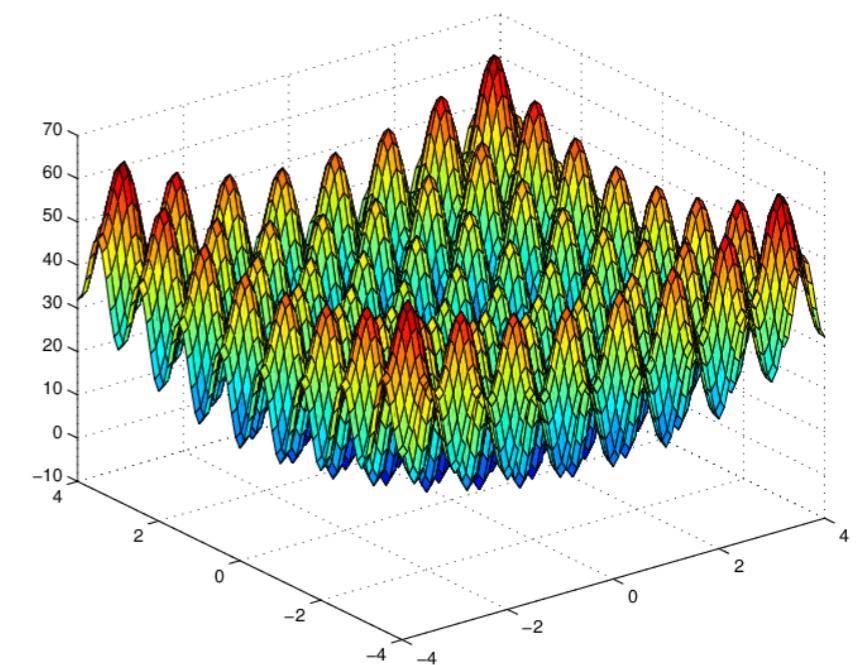
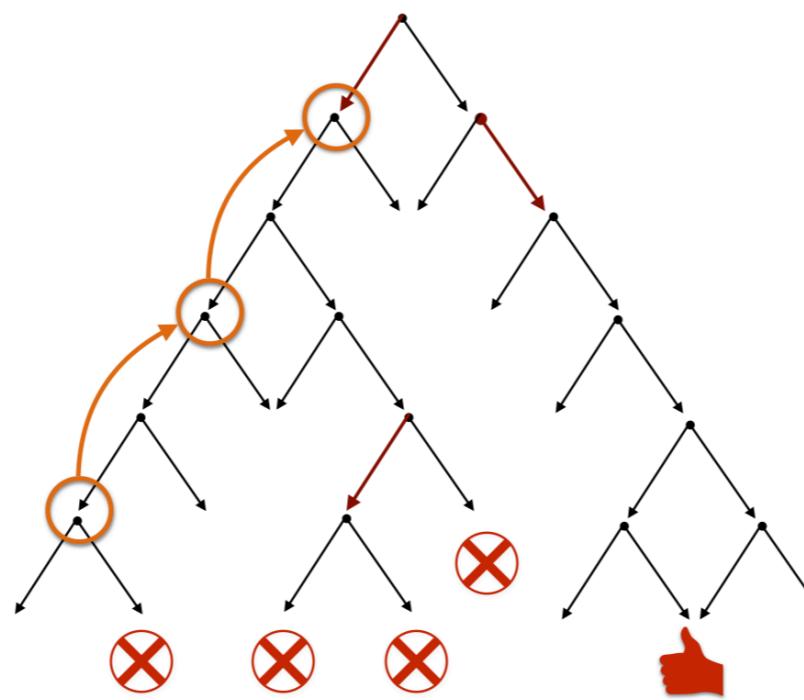


Stochastic

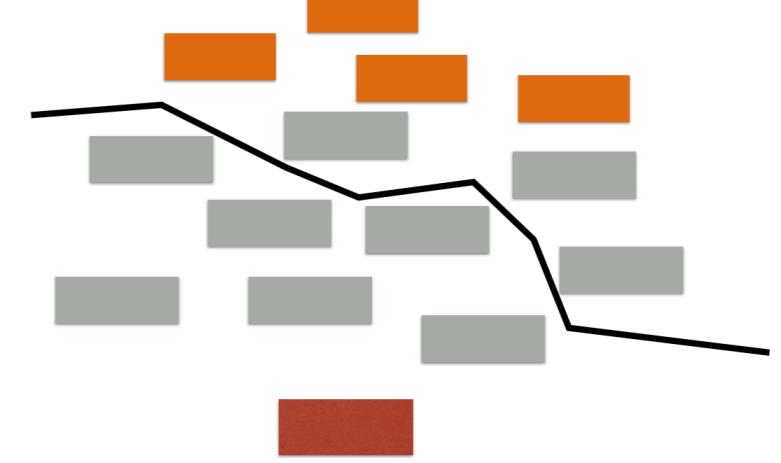
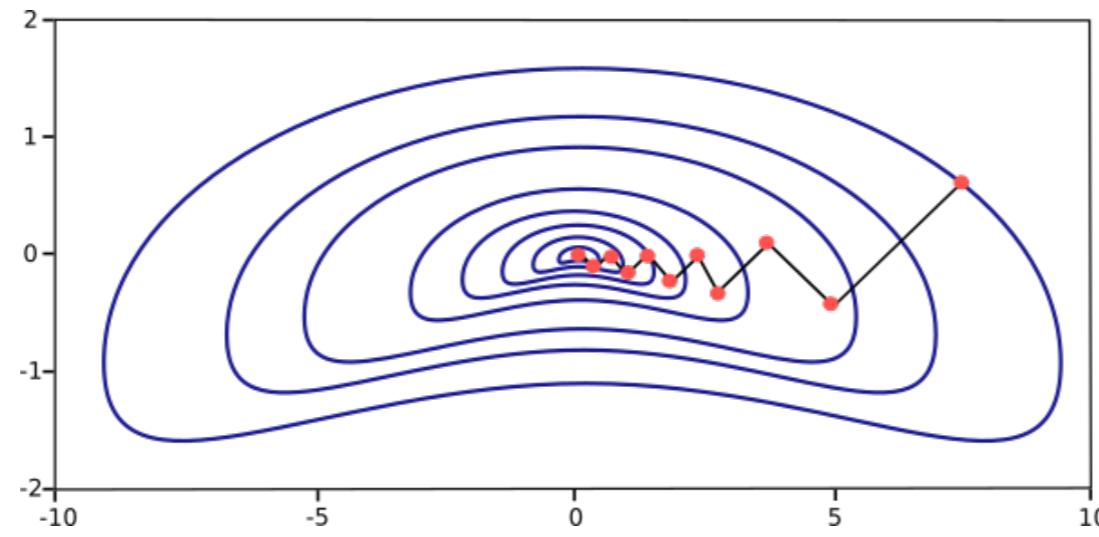
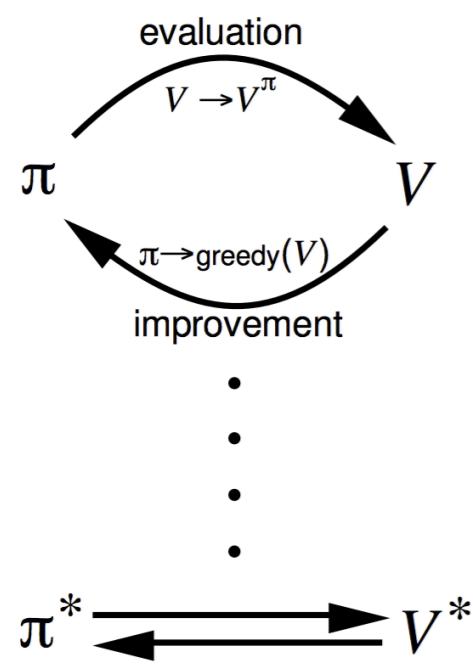
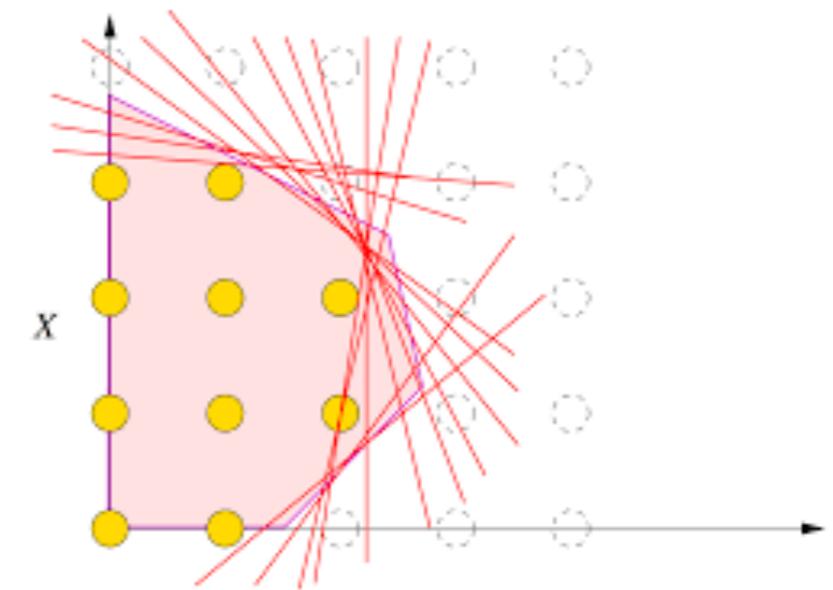
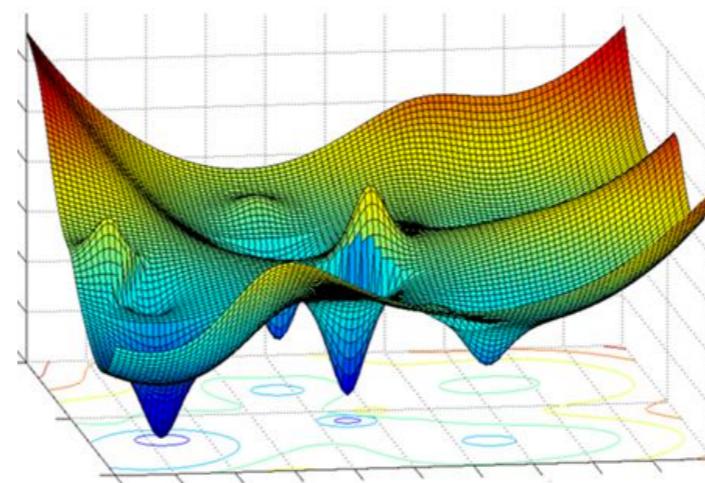
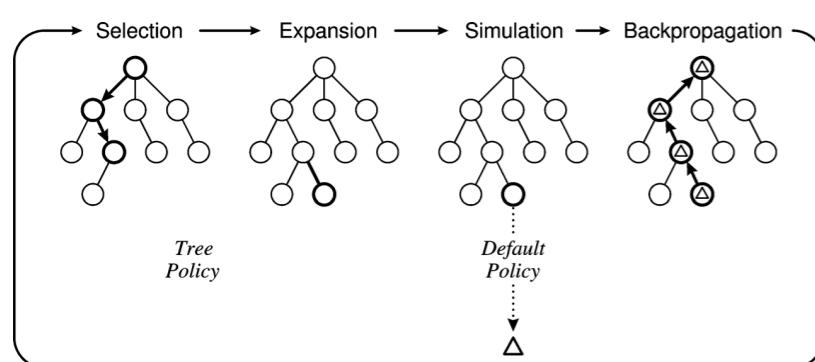
Local



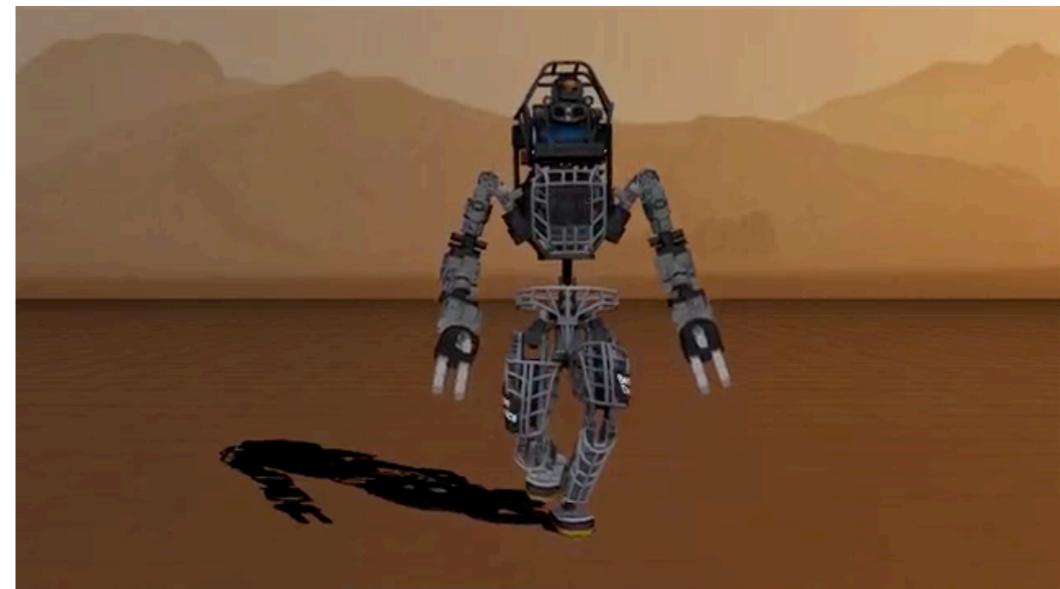
Global



Rational decision making in many forms (numerical, probabilistic, symbolic)



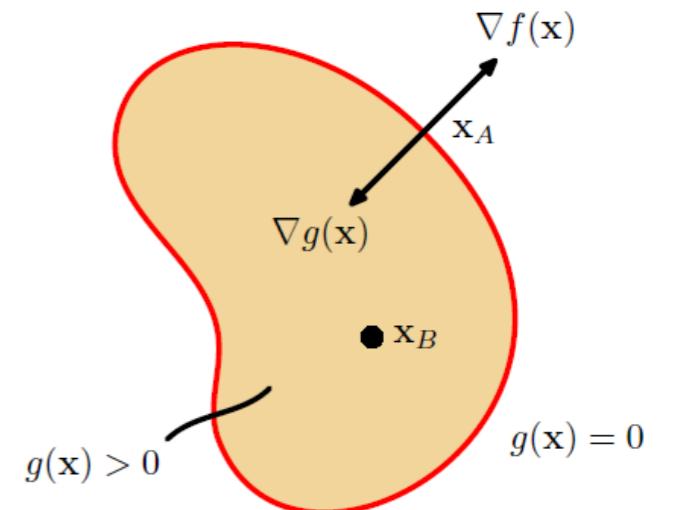
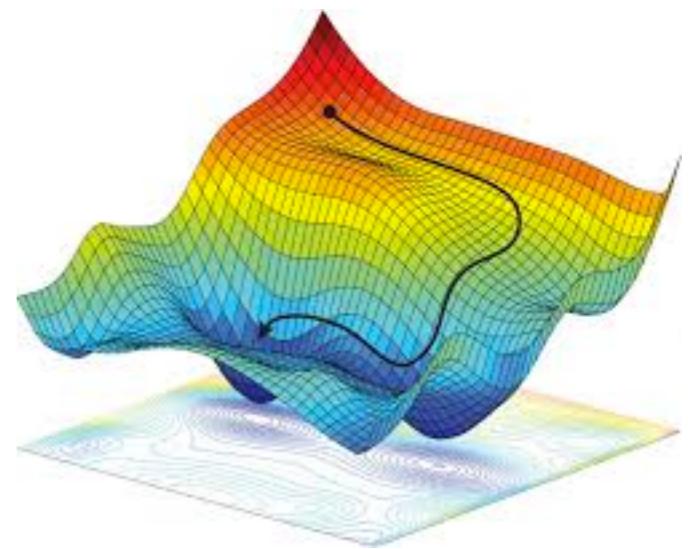
Rational decision making in many forms
(numerical, probabilistic, symbolic)



Cloud AutoML Vision

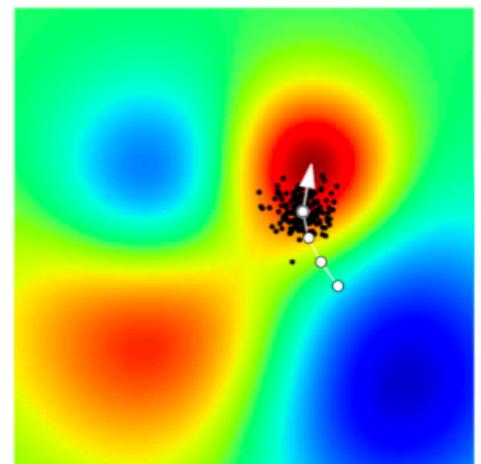
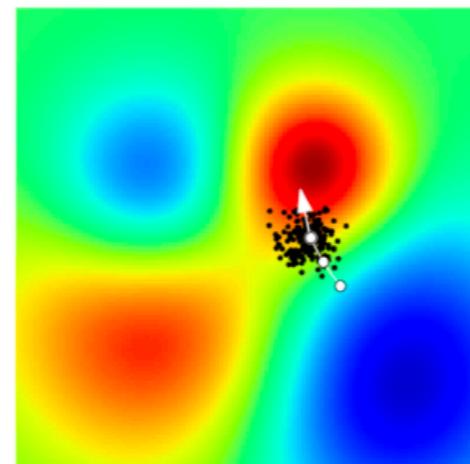
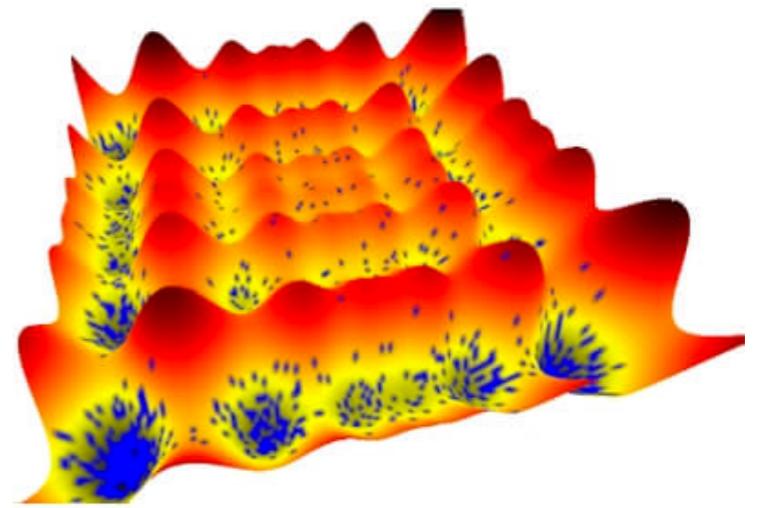
Numerical Optimization

- Various directions
- Line search and trust region
- Constrained optimization



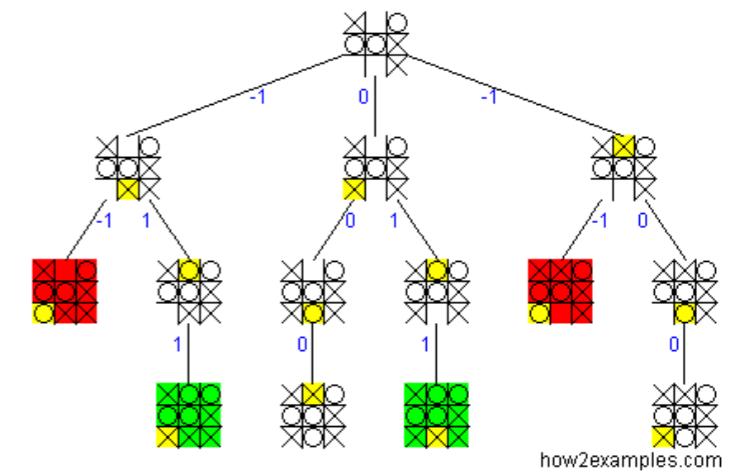
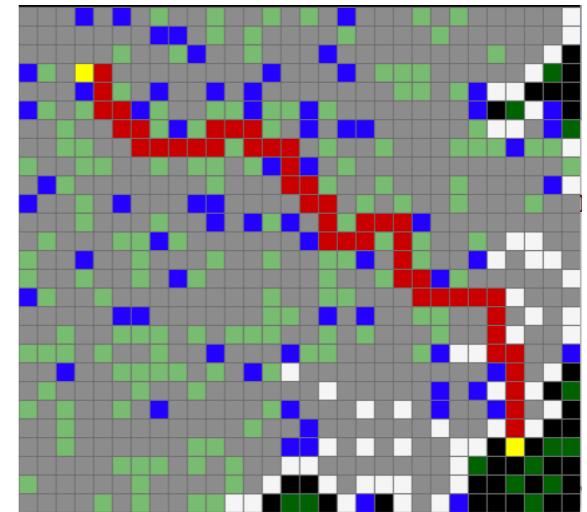
Stochastic Search

- Simulated Annealing
- Cross-entropy methods
- Search gradients



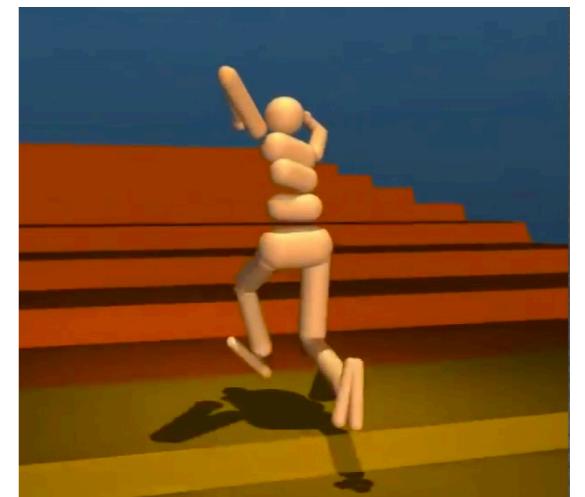
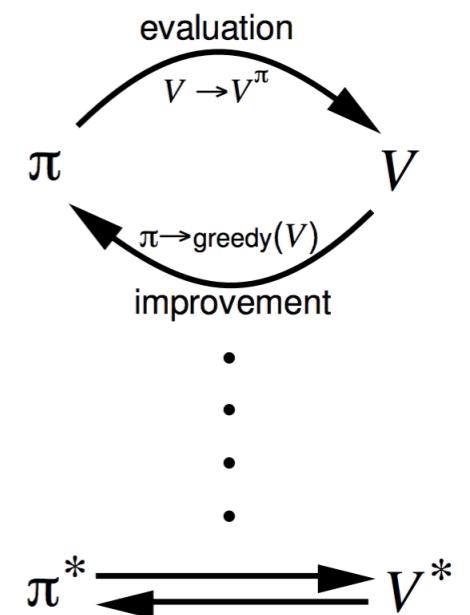
Classical Search

- Heuristic Search
 - Motion Planning
- Adversarial Search



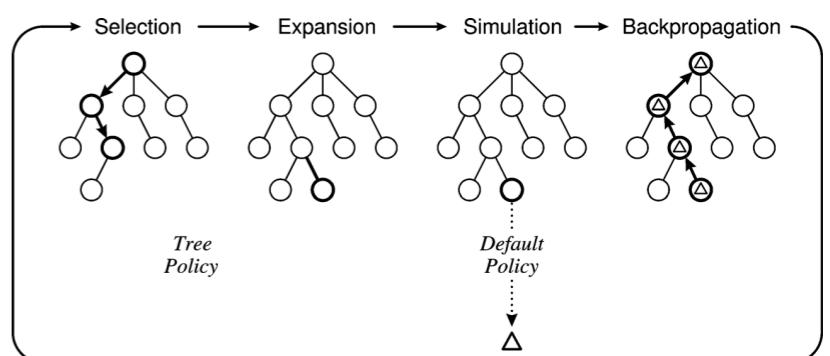
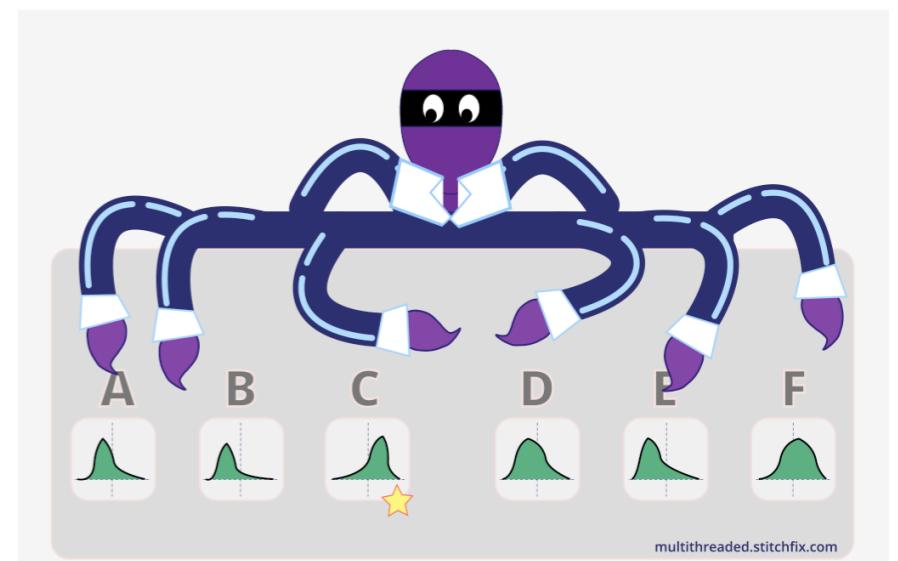
MDP and RL

- MDP Theory
- Reinforcement Learning



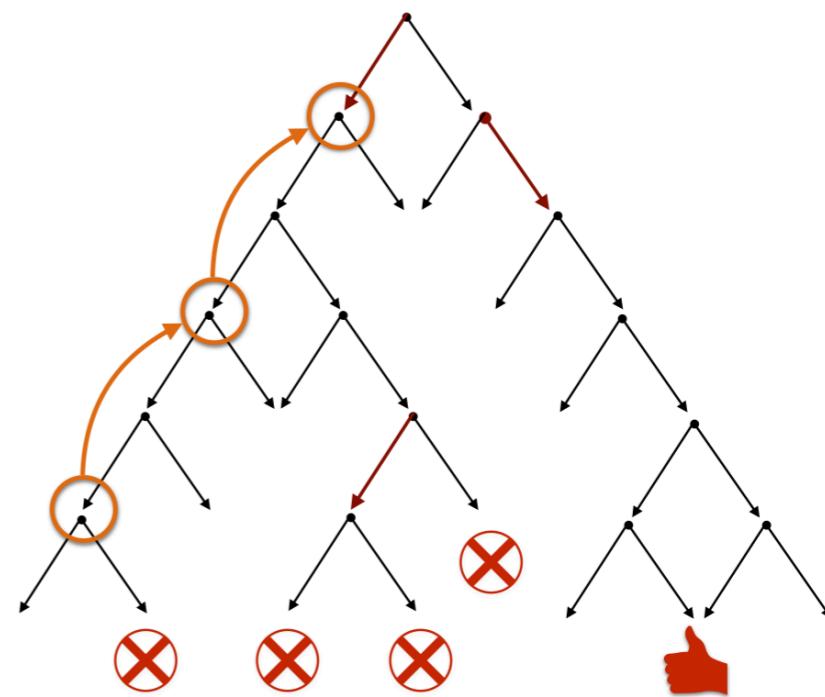
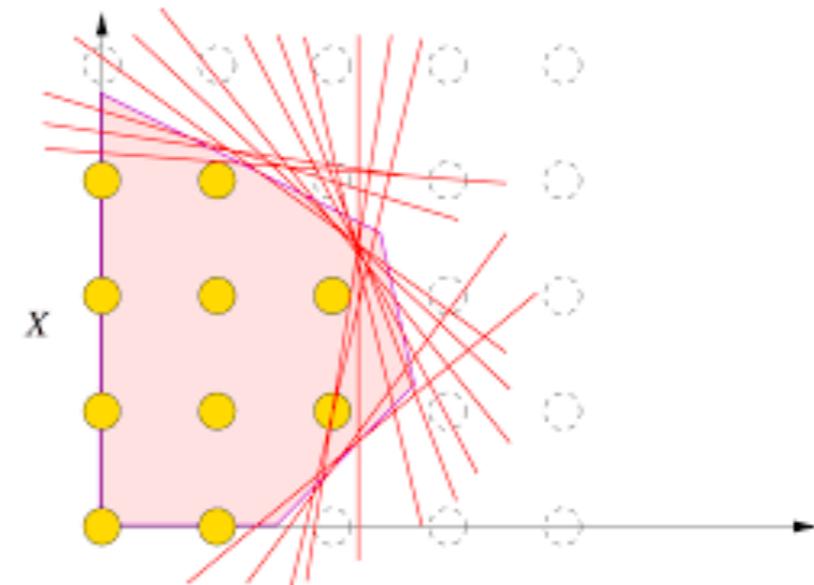
Bandits and MCTS

- Multi-Armed Bandits
 - Upper Confidence Bound
- Monte Carlo Tree Search
 - AlphaGo



Combinatorial Search

- Integer programming
- SAT with CDCL
- #SAT, QBF, etc.



Always Know Hardness

- Curse of dimensionality
- All algorithms are about how to explore extremely large spaces intelligently
- AI iff NP-hard
- Ideal takeaway: educated optimism

The Course

- Algorithms. Theorems. Insights.
- This is an algorithm class, not a “machine learning” class, which is just one of the many possible applications.
- We will rarely talk about applications, but I hope you have practical problems in mind and look for the right algorithms here.

The Course

- Assignments: 80%
 - 3 assignments, submit on Gradescope
- Final: 20%
 - In-person Q&A
- Extra: up to 10%

The Course

- Extra: up to 10%
 - Option 1: Presentations in week 10
 - review an search and optimization algorithms in a application domain, or a project of your own
 - slides due by week 7
 - Option 2: Build a search and optimization library
 - make new open-source implementation of algorithms we covered in class. focus on readability of code.
 - benchmarks, visualizations

The Course

- Sum of all points: assignments, extra, final
- Grades
 - 90 and above: A
 - 80 and above: B (S for grads)
 - 70 and above: C (P for undergrads)

Academic Integrity

- Take the course only if you want to
- Grades never matter that much
- Only integrity issues can break one's career
- Violations will be reported to administration without informing you first