Motivation

- Distribution is more informative than a scalar value
- Bring the idea of explicitly estimating value uncertainty from RL to Heuristic Search

Contribution

AAAI-20: Data-Driven Nancy
- using data to estimate value uncertainty distribution
- using estimates to guide real-time heuristic search

IJCAI-21: Expected Effort Search (XES)
- using estimates to guide bounded-cost heuristic search

Improve Real-time Heuristic Search

How to Gather Information?

Given these search nodes, should agent at A move to B₁ or B₂?

Which Node to Expand?

Should the agent expand nodes on the frontier under B₁ or B₂?

Improving Real-time Heuristic Search

Searching Use Beliefs

Risk-based Expansion: given beliefs about top-level action values, expand nodes on the frontier under top-level action that minimizes risk, the expected regret.

Where do beliefs come from?

Purpose of search is to gather information to inform decision-making process. Which information on the search frontier should be used to form beliefs about top-level actions?

- Assumption-based Nancy: Truncated Gaussian based on h and d
- Data-Driven Nancy: replace the assumptions with data

Improve Bounded-cost Search

Previous Approaches:
- PTS: does not consider search effort
- BEES: does not consider the uncertainty of its estimates

Our approach: Expected Effort Search

- estimate the probability of finding a solution within the bound \( p(n) \)
- estimate the search effort \( T(n) \)
- best-first search on the expected search effort \( \frac{T(n)}{p(n)} \)

Results:

CPU time (in seconds) as a function of the cost bound (factor of optimal). Error bars show 95% confidence intervals on the mean across the commonly solved instances. Left: heavy vacuum world. Right: heavy sliding tile puzzle.