Optimal policy search for multi agent simulation

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Introduction

Optimal policy search

- Many computational sustainability systems can be represented with multi agent systems.
- Management decisions need to be optimised with respect to some objective function
- Computationally expensive to find optimal decision at every timepoint
- Goal is to find fixed policy optimal over distribution of simulations
What are we searching for?

How do we search over policies?

- Define a policy as a function $\psi$ that maps state to decisions
- Uncountably infinite number of possible functions
- Restrict our search space to looking for decision trees
Searching for decision trees

What is a decision tree?
- Each node is a proposition
- Branch on answer
- Leaves are labels
Methods of search

Two possible search techniques

Complete Search
- Fix the size of the tree
- For each node have variables representing
  - Operator
  - Label
  - Threshold

Local Search
- Start with a random tree
- Make small changes to improve the tree
- Keep improving the tree
Bottlenecks

What are the problems?

- The search space is huge!
- Evaluating the quality of a tree is expensive
- For complete search difficulty in bounding quality until a complete tree is built
- How can we reuse experimentation data
Possible solutions

Huge search space

- Use techniques from reinforcement learning to learn where in the search space to move to improve quality

Expensive simulation

- Ideas from Approximate dynamic programming allow shifting agent state space to a lower dimension so that it can be solved optimally

Evaluating quality of a tree

- Confidence interval calculations from statistics allow termination of experimentation early if new tree is worse than previous best
Example uses

MAP Optimisation

- Cows are agents
- Policy to cull cows
- Optimise income
Questions?
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