# 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

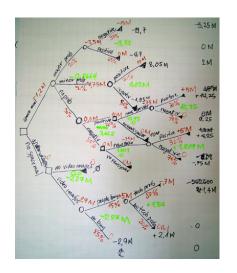
# What are we searching for?

# How do we search over policies?

- ightharpoonup 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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