Pretty darn good control: when are approximate solutions better than approximate models*

Abstract

The text of your abstract. 150 – 250 words.

Introduction

Figures brainstorm

Figure 1: 1-D and 3-D model conceptual figure. something about the objective / decision Figure 2: Stability / multistability in the 1D and 3D models. state space + time views

Figure 3: The 1-D optimal management solution. 'constant escapement' intuition etc

Results figures: - timeseries example of management under the RL policy. probably compare to managing under 1-D solution / rule-of-thumb methods - state-space view of management doughnut - visualization / encapsulation of the policy heatmaps, slices, policy vs position along ellipse - reward plot over time (comparing methods)

Fisheries: approximate models and approximate solutions

Reinforcement learning

Reinforcement learning (RL) is a way of approaching *control problems* through machine learning. An RL application can be conceptually separated into two parts: an *agent*, and an *environment*. The *environment* is commonly a computer simulation, although it sometimes can be a real world system. The *agent*, on the other hand, is a computer program which interacts with the environment.

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That is, the agent may act on the environment and change its state. This, moreover, gives the agent a *reward* which encodes the control goal. The main part of an RL algorithm is then to progressively improve the agent's *policy*, in order to maximize the cumulative reward received. This is done by aggregating experience and learning from it. See Fig. **??**.

In our case, the environment will be a computational model of the population dynamics of a fishery, with the environment state being a vector of all the fish populations, $S = (V_1, V_2, H)$. The system evolves naturally according to (**??**). At each time step, the agent harvests one of the populations, say A. Specifically, it chooses a quota q: the fraction of A that will be fished. This changes the state as

$$(V_1,\ V_2,\ H) \mapsto ((1-q)V_1,\ V_2,\ H)$$

and secures a reward of qV_1 to the agent. Afterwards, the environment undergoes its natural dynamics.

Acknowledgements

The title of this piece references a mathematical biology workshop at NIMBioS organized by Paul Armsworth, Alan Hastings, Megan Donahue, and Carl Towes in 2011 that first posed the question addressed here.

References