MOMDPs: a Solution for Modelling Adaptive Management Problems

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REFERENCES
I. Chadès, J. Carwardine, T. Martin, S. Nicol, R. Sabbadin and O. Buffet, MOMDPs: a Solution for Modelling Adaptive Management Problems, AAAI 2012, Toronto, Canada.

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What is Adaptive Management?

In conservation biology and natural resource management, adaptive management (AM) is an iterative process of improving management by reducing uncertainty via monitoring. Adaptive management is the principal tool for conserving endangered species under global change. The common approach used to solve an adaptive management problem is to assume the system state is known and the system dynamics can be one of a set of pre-defined models (e.g., model uncertainty).

Our Contribution

To date the solution method used employs value iteration on a discretized belief MDP which restricts the study to very small problems. We show how to overcome this limitation by modelling an adaptive management problem as a restricted Mixed Observability MDP called hidden model MDP (hmMDP, Figure 1). We demonstrate how to simplify the value function, the backup operator and the belief update computation. We show that, although a simplified case of POMDPs, hmMDPs are PSPACE-complete in the finite-horizon case. We illustrate the use of this model to manage a population of the threatened Gouldian finch, a bird species endemic to Northern Australia. Our simple modelling approach is an important step towards efficient algorithms for solving adaptive management problems (Table 1).

Management of a Threatened Bird

Our management objective is to maximize the likelihood of a high persistence probability of a Gouldian finch population. We asked four experts to assess the likelihood of a high (and conversely low) probability of persistence under four plausible management actions (Figure 2).

Discussion

The assumption that the real model is contained within the model set is simplistic, however it is currently the way AM is solved. Point based methods help us account for a large set of models so that we do not risk being too far from the real model, but, when managing threatened species, having many models makes it difficult to be confident of the real model as observations are few.