An Object-Oriented Dynamic Bayesian Decision Network Model for Grasslands Adaptive Management

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Abstract

The Victorian State Government is reserving 15,000 hectares of land to protect native grasslands in to the west of Melbourne, Australia, to be managed by the Department of Environment and Primary Industries (DEPI). The WGR currently contains a mixture of high quality native grasslands, degraded grasslands and non-native vegetation including improved pasture and cropland. Managing these areas for conservation will require a complex management approach involving weed control, biomass management using fire and grazing, cropland retirement and restoration involving the re-introduction of native plants and their seeds. The reserve must be managed as soon as land is required, but the best management techniques are largely unknown, thus an adaptive management approach -- where management and monitoring are adjusted overtime as understanding of the ecosystem's response to management improves. In order to assist adaptive management, Bayesian network technology was chosen to model ecological change in grassland ecosystem, to provide probabilistic predictions to evaluate management actions (e.g. weed control, fire) and to justify the choice of actions to be trialed within the reserve.

The Western Grasslands model is a complex BN, employing a number of extensions to the basic BN structure, as it is: a dynamic BN, representing the change in state variables over time, with a seasonal time steps, rolled-out for a 30 year prediction window; a decision network, with decision nodes representing management options grouped into management strategies, which are sequences of actions across seasons, and utility nodes which represent the costs associated with interventions and the environmental value of the site; an object oriented model, to manage the complexity of the number of species and seasonal transitions. In this paper, we present the Western Grasslands dynamic object-oriented Bayesian decision network. The Grasslands model is now deployed and being used by DEPI to: make predictions about changes in the grassland ecosystem; act as a repository of knowledge, to be updated as understanding of the grassland ecosystem improves; quantitatively evaluate the ecological and financial consequences of management actions; and rank management options with the highest probability of success for trialing.

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