Learning the structure of kelp forest ecological network

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Résumé

A trophic network describes the trophic relations between species (prey-predator pairs). The knowledge of such a network is a useful tool for managing the biodiversity and the ecosystem services provided in a given ecosystem. For example, we can focus conservation efforts on some key species that will affect positively the whole network. Other type of interactions than predation, such as facilitation (an algae used as habitat by another species, for example), competition, parasitism can be taken into account... The resulting network is an ecological network. The problem is that we rarely know all of the interactions within a given ecological network, all the more as management actions may also influence interactions between species (prey switching, etc.). The dynamics of the species (i.e. presence/absence over time in a given area) are influenced by their interactions. The aim of the present work is to develop a method for learning the structure and parameters of an ecological network using species presence/absence time series. Formally, we define an ecological network as a directed graph where the edges are labelled. A " + " label on edge (i, j) defines a positive influence of species i on species j (i can be a host of j, for example), while a "−" label on edge (i, j) defines a negative influence (j being a predator of i, for example). Influences modelled by the labelled edges are "quantified" by real-valued parameters attached to

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each type of edge.

In order to learn an ecological network, we define a parameterized Dynamic Bayesian Network

(DBN) which models the temporal dynamics of species. The DBN structure is equivalent to the

original ecological network. Then, we propose a new algorithm to learn the labelled edges and

parameters of the DBN equivalent of the ecological network from the observed dynamics of species, under fixed management choices. We have implemented this algorithm and tested it on

simulated species dynamics data, as well as real data from a large-scale ecological survey in the

kelp forest of California coast.