On the Selection of Representative Conservation Area-Networks

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The problem of selection of representative conservation area-network is an important ecological issue related to preserving the biodiversity of a geographical region. The mathematical model is based on the assumption that environmental diversity is a good measure of biodiversity. In this setting, the geographical region is divided into smaller areas (assumed environmentally homogenous) which are mathematically considered as vertices of a graph. The environmental distance between two areas defines the length of the edge connecting the respective vertices. Selecting p areas which represent best the total of n areas (in the sense of environmental diversity) is mathematically equivalent to the so called p-median problem, that is selecting a set of p vertices of the graph such that the sum of the distances from all vertices of the graph to the selected set is minimal. For any practically relevant values of n and p the solution cannot be computed in reasonable time, since this problem is a well-known NP hard problem. We discuss various heuristic methods to find an approximate solution in terms of the trade off between computational time and accuracy.

In order to test the validity of the underlying assumption of the model we use species distribution datasets for birds, reptiles, and butterflies in South Africa. These datasets have been developed from extensive, formalised atlasing projects coordinated largely by the Animal Demography Unit of the University of Cape Town, and are the most comprehensive faunal species distribution datasets available for the country. Each vertex of the graph represents a quarter degree square (QDS), approximately 20km $\times$ 20km area commonly used in large biogeographic analysis. The total number of QDS for South Africa is 1816. The power of the method is demonstrated via numerical experiments with p ranging from 10 to 50.