Balanced Box Decomposition Tree (Spatial Index)

► Nearest Neighbors Problem

Bayesian Estimation

► Indoor Positioning, Bayesian Methods

Bayesian Inference

► Hurricane Wind Fields, Multivariate Modeling

Bayesian Maximum Entropy

► Uncertainty, Modeling with Spatial and Temporal

Bayesian Network Integration with GIS

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Synonyms

Directed acyclic graphs; Probability networks; Influence diagrams; Probabilistic map algebra; Spatial representation of bayesian networks

Definition

A Bayesian Networks (BN) is a graphical-mathematical construct used to probabilistically model processes which include interdependent variables, decisions affecting those variables, and costs associated with the decisions and states of the variables. BNs are inherently system representations and, as such, are often used to model environmental processes. Because of this, there is a natural connection between certain BNs and GIS. BNs are represented as a directed acyclic graph structure with nodes (representing variables, costs, and decisions) and arcs (directed lines representing conditionally probabilistic dependencies between the nodes). A BN can be used for prediction or analysis of real world problems and complex natural systems where statistical correlations can be found between variables or approximated using expert opinion. BNs have a vast array of applications for aiding decision making in areas such as medicine, engineering, natural resources, and decision management. BNs can be used to model geospatially interdependent variables as well as conditional dependencies between geospatial layers. Additionally, BNs have been found to be useful and highly efficient in performing image classification on remotely sensed data.

Historical Background

Originally described by Pearl (1988), BNs have been used extensively in medicine and computer science (Heckerman 1997). In recent years, BNs have been applied in spatially explicit environmental management studies. Examples include: the Neuse Estuary Bayesian ecological response network (Borsuk and Reckhow 2000), Baltic salmon management (Varis and Kuikka 1996), climate change impacts on Finnish watersheds (Kuikka and Varis 1997), the Interior Columbia Basin Ecosystem Management Project (Lee and Bradshaw 1998), and waterbody eutrophication (Haas 1998). As illustrated in these studies, a BN graph structures a problem such that it is visually interpretable by stakeholders and decision-makers while, serving as an efficient means for evaluating the probable outcomes of management decisions on selected variables. Both BNs and GIS can be used to represent spatially explicit, probabilistically connected environmental and other systems, however the integration of the two techniques has only been explored relatively recently. BN integration with GIS typically takes one of four distinct forms: 1) BN-based layer combination (i. e. probabilistic map-algebra) as demonstrated in Taylor (2003); 2) BN-based classification as demonstrated in Stassopoulou et al. (1998) and Stassopoulou and Caelli (2000); 3) Using BNs for