Mach Learn (2012) 89:299–316
DOI 10.1007/s10994-012-5308-5

Learning directed relational models with recursive dependencies

Oliver Schulte · Hassan Khosravi · Tong Man

Received: 3 February 2012 / Accepted: 14 June 2012 / Published online: 20 July 2012

Abstract Recently, there has been an increasing interest in generative models that represent probabilistic patterns over both links and attributes. A common characteristic of relational data is that the value of a predicate often depends on values of the same predicate for related entities. For directed graphical models, such recursive dependencies lead to cycles, which violates the acyclicity constraint of Bayes nets. In this paper we present a new approach to learning directed relational models which utilizes two key concepts: a pseudo likelihood measure that is well defined for recursive dependencies, and the notion of stratification from logic programming. An issue for modelling recursive dependencies with Bayes nets are redundant edges that increase the complexity of learning. We propose a new normal form format that removes the redundancy, and prove that assuming stratification, the normal form constraints involve no loss of modelling power. Empirical evaluation compares our approach to learning recursive dependencies with undirected models (Markov Logic Networks). The Bayes net approach is orders of magnitude faster, and learns more recursive dependencies, which lead to more accurate predictions.

Keywords Statistical relational learning · Bayesian networks · Autocorrelation · Recursive dependencies

1 Introduction: relational data and recursive dependencies

Relational data are very common in real-world applications, ranging from social network analysis to enterprise databases. A phenomenon that distinguishes relational data from

Editors: S. Muggleton and J. Chen.

O. Schulte · H. Khosravi (✉) · T. Man
School of Computing Science, Simon Fraser University, Vancouver-Burnaby, BC, Canada
e-mail: hkhosrav@cs.sfu.ca

O. Schulte
e-mail: oschulte@cs.sfu.ca

T. Man
e-mail: mantong01@gmail.com