UNIVERSITY of GUELPH

COLLEGE of ENGINEERING AND PHYSICAL SCIENCES

SCHOOL OF COMPUTER SCIENCE

MSc Defence

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TOWARDS MORE EFFICIENT CPT COMPRESSION AND LAZY INFERENCE WITH NAT-MODELLED BAYESIAN NETWORKS

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Abstract:

Bayesian networks (BNs) are widely used in intelligent systems for probabilistic inference in partially observable and stochastic environments. A BN is able to model the environment with the space complexity linear on the number of variables, but exponential on the number of parents per variable.

Common local models in BNs, such as Noisy-MAX and Noisy-OR, reduce the complexity to being also linear on the number of parents per variable by exploring causal independence, but they are not sufficiently expressive. For instance, they can only model variables that are reinforcing each other and they cannot model variables which are undermining each others' impact. By using Non-Impeding Noisy AND Trees (NATs) we can reduce the space to model BNs to linear on the number of parents, while being more expressive. NAT models can express both reinforcing and undermining interactions between variables, as well as the recursive mixture of the two. BNs are modelled into NAT modelled BNs by compressing conditional probability tables (CPTs) into NAT models. In order to conduct inference with the NAT modelled BN we can perform multiplicative factorization (MF) to create a MF- NAT modelled BN which can be used with standard BN inference techniques.

We present a novel algorithm based on swarm techniques to speed up the compression of a BN into a NAT modelled BN. This algorithm has proven to allow for one order of magnitude speed up in compression. Next, we investigated the inference performance of MF-NAT modelled BNs for a wide range of sparse structural densities of BNs. In this study we show that MF-NAT modelled BNs allow for significant speed up in inference for a range of sparse BN structures. Lastly, an empirical study is performed on the inference accuracy of the compressed NAT modelled BNs. The study concluded that the posterior probabilities from inference with compressed NAT modelled BNs had a better accuracy than the NAT modelled CPTs. This means that compression error was attenuated and not amplified.