Parallelizing Exact Inference in Bayesian Networks

High Performance Embedded Computing 2006

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Bayesian Network (BN)
a popular tool for presenting joint probability distributions

Exact Inference on BN
The time complexity of inference is exponential with the BN’s density, variable ranges and clique width.
\[ O(nk^3 + n^2w + wr^w n + nr^w) \]

Objective: Scalable Parallel Exact Inference on an arbitrary BN

Input
An arbitrary BN Evidence (Observations)

Convert Arbitrary BN to Junction Tree in Parallel

Parallel Exact Probabilistic Inference Algorithm

Output
Posterior probability of query variables
State-of-the-Art

Probabilistic Network Library (PNL)
- Full function, graphical model library
- Open Source, BSD style license
- Created by Intel, part of Intel Open Source Library
- Written in C++
- Parallelized using OpenMP

Proportion of time taken in various stages

Performance of PNL
w.r.t. Bayesian Network type

Performance of PNL
w.r.t. (clique width, variable range)
Exact Inference on BN

Our Techniques Include

- Parallel Junction Tree Creation
- Pointer Jumping

Running time

\[ O(nk^3/p + n^2w/p + wn^2/p + n^{r+1} \log n/p) \]

Scalable for \( 1 \leq p \leq n \)

Currently exploring the implementation of our techniques on the runtime system and architecture developed as part of CSEARCH(DARPA ACIP Program)