Predicting the Size of Depth-First Branch and Bound Search Trees

Levi Lelis, Lars Otten and Rina Dechter
Computing Science Dept. Computer Science Dept.
University of Alberta University of California, Irvine

Introduction

The Problem
- Given:
  - a start state, and
  - a heuristic function,
- efficiently predict the number of nodes Depth-First Branch and Bound (DFBnB) expands.

Motivation
- know how long a given search will take.
- divide the workload in a parallel computing setting.
- compare different search strategies.

Stratified Sampling by Chen (1989)

Type Systems

Stratified Sampling Assumption
- Nodes of the same type root subtrees of the same size.

DFBnB Prediction

DFBnB
- Current Best Solution: $R$ (upper bound) = 3
- $f(n) = g(n) + h(n)$

Chen’s Method for DFBnB Prediction
- SS is NOT directly applicable.
- DFBnB searches in a depth-first manner.
- DFBnB updates the upper bound as search goes.
- SS is not aware of the upper bound updates.
- SS produces lousy predictions.

Two-Step Stratified Sampling

TSS Assumption
- Nodes of the same type root isomorphic subtrees.

The Algorithm
- We equip SS with a system for approximating the bound updates:
  - First, we run SS to get a subtree of the problem’s underlying search tree.
  - Second, we emulate DFBnB in the subtree SS sampled.

Heuristic-Based Type Systems

Problem Domains
- Optimization problems over Probabilistic Graphical Models.
- Protein Side-Chain Prediction (pdb).
- Computing Haplotypes in Genetic Analysis (pedigree).
- Randomly Generated Grid Networks (grids).

Some Results

Conclusions
- TSS was the only method able to produce good predictions in a timely fashion.
- TSS has the guarantee of producing perfect predictions in the limit.
- Memory limits the applicability of TSS.

Theoretical Result
- In the limit, as the number of probes goes to infinity, TSS is guaranteed to produce perfect predictions.

Empirical Results

References