IE 495 Lecture 19

November 2, 2000

Reading for This Lecture

- Primary
  - Horowitz and Sahni, Chapter 8
  - Grama and Kumar, Parallel Search Algorithms...

Parallel Branch and Bound

- Divide and conquer approach
- "Obvious" approach to parallelization
- Parallelize recursive version
- What are the problems with this?

- How does this compare to other divide and conquer algorithms (such as merge sort)?

A Better Approach

- Master-slave model
- Master process maintains
  - a priority queue of nodes
  - a pool of slave processes to process the nodes
- Whenever a slave finishes processing a node, the master determines its next course of action
  - keep one (or more) of the children
  - get a completely new node

Performance Measures

- Overall running time
- Measures of overhead/redundant work
  - Size of search tree
  - Average time to process a node
- Measures of idle time
  - Time slaves spend waiting for work
  - Percentage load of tree manager

Scalability Issues

- Master process will become a bottleneck
- This could result in idle time for the slaves
- Slaves could end up performing unnecessary work
  - Upper bounds not available as quickly
- Memory usage not distributed -- tree stored centrally
- Run-up time

A Decentralized Model

- Use a crowd computation model.
- Divide the problem into subproblems.
- Each process solves its assigned subproblem.
- What are the problems with this?

Load Balancing

- There are two types of load balancing needed
  - Quantitative
    - Each processor must have enough work to do
  - Qualitative
    - Each processor must have "important" work to do
- Global information is needed to make good load balancing decisions.
- We must make a compromise.

New Approaches

- Try to maintain as much global information as possible without creating bottlenecks.
  - Hierarchical schemes
  - Increased grain size
  - Shared memory
- Completely decentralize
  - Processes periodically give away some of their best nodes to neighbors.
  - Processes request work from each other when they need it.
  - Processes check the quality of their nodes against each other.

Implementing Parallel B and B

- Data structures needed
  - Representation of state
  - Representation subproblems
  - Representation of search tree
- Master-slave model
  - Need a priority queue (easy)
  - Store tree centrally (efficient)
- Crowd computation model
  - Still need to store everything and have some sort of priority queue, but how?

Shameless Plug

- SYMPHONY (Single- or Multi- Process Optimization over Networks) is an object-oriented framework for implementing parallel branch and cut.
- User supplies some subroutines that are specific to the problem-setting
- The remainder (about 90% of the work) is taken care of by SYMPHONY
- Can be easily used to solve a wide variety of discrete optimization problems.