University
of Glasgow

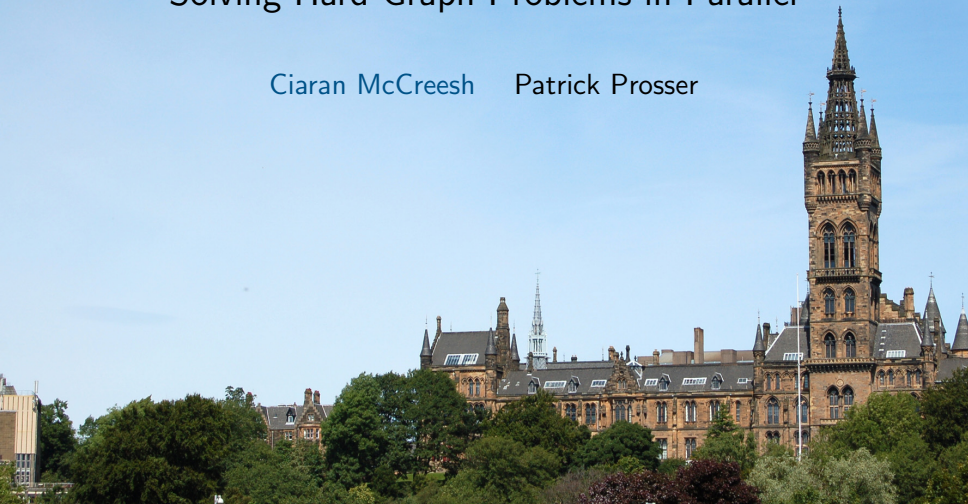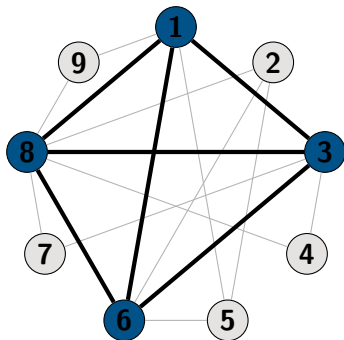# Solving Hard Graph Problems in Parallel

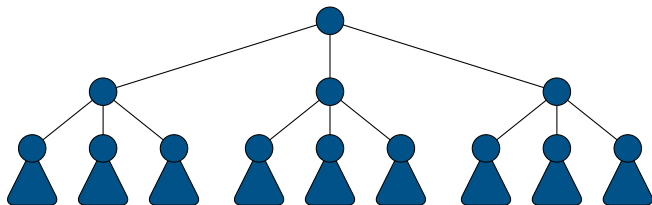Ciaran McCreesh   Patrick Prosser

The Maximum Clique Problem

Who Cares?

- One of the fundamental NP-hard problems.
- Applications in biochemistry, control of autonomous vehicles, coding and communications theory, social network analysis, document search, and computer vision.
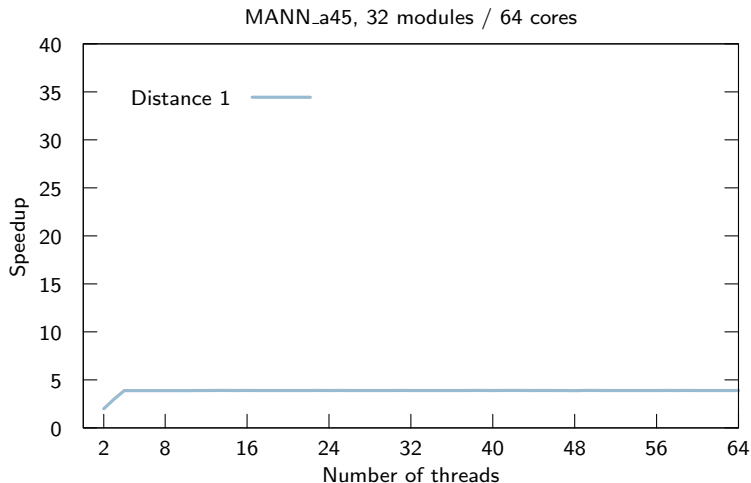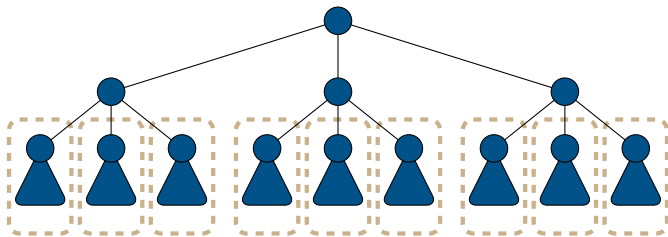
Backtracking Search
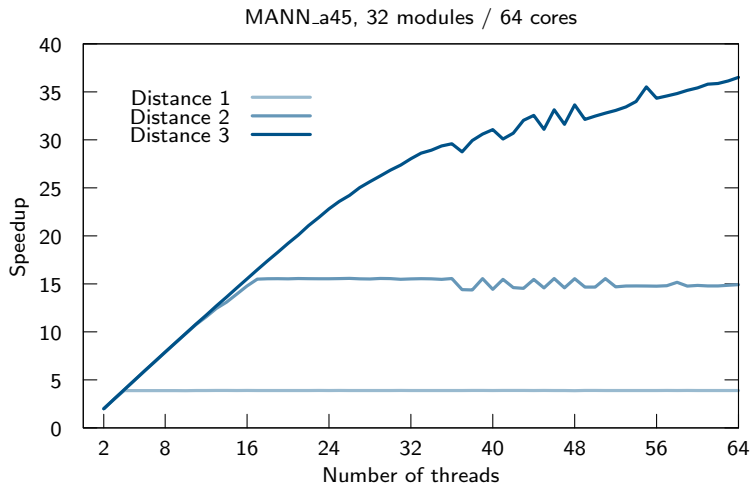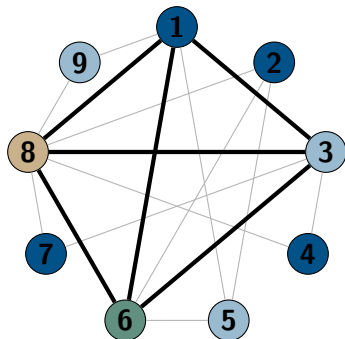
Parallel Backtracking Search

Scalability

MANN_a45, 32 modules / 64 cores

Speedup vs. Number of threads

Distance 1
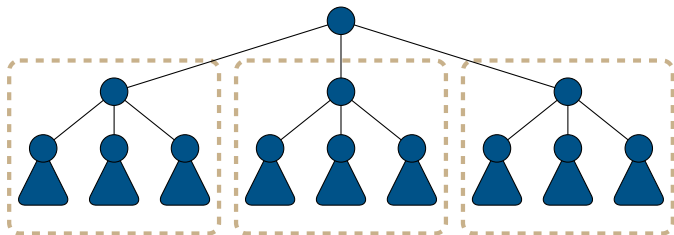
Subproblem Granularity

Better Scalability

MANN_a45, 32 modules / 64 cores

Branch and Bound

Avoidable and Eliminable Subtrees

Anomalous Results
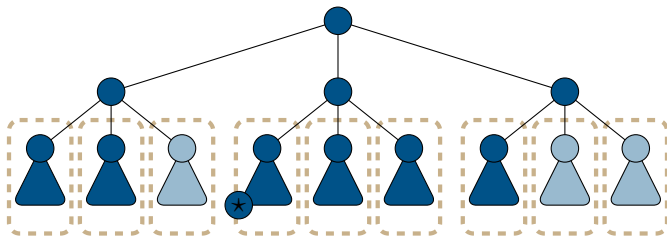
brock400_3, 32 modules / 64 cores
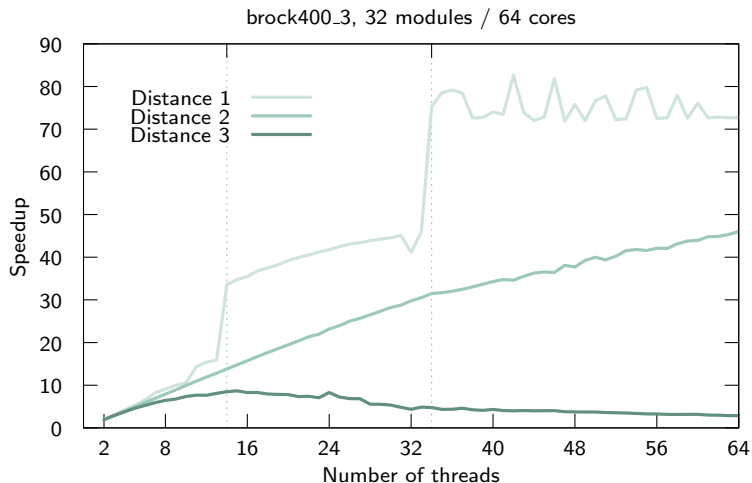
Why?

- Search order heuristics are most often wrong at the top of search, where there is least information available.
- Splitting at distance 1 introduces diversity into the search, by avoiding a strong commitment to the first choice we make.
- Splitting at distance 3 can create a large number of trivial or eliminable subproblems.

The Best of Both Worlds

MANN_a45 (blue) and brock400_3 (green), 32 modules / 64 cores
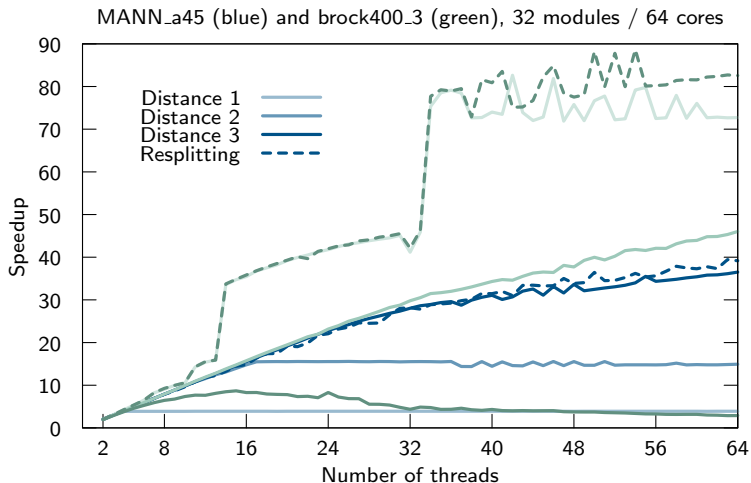
What's Next?
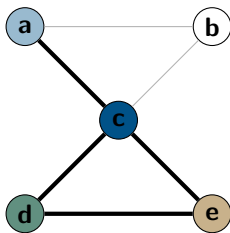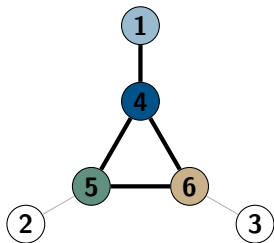
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