Parallel Approximate Matching

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Outline

1. Introduction
2. Optimal Algorithms
3. Approximation Algorithms
4. Parallel Approximation Algorithm
5. Conclusion
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Matching
Vertex Packing/Covering

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Parallel Approximate Matching
Edge Packing/Covering
Scientific Computing and Combinatorics

Scope of CSCAPES

Scientific Computing Tool

HPC Task

Combinatorial Problem

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Parallel Approximate Matching
Linear Solvers and Matching

\[ A \mathbf{x} = \mathbf{b} \]
Linear Solvers and Matching
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Cardinality Problem, Optimal Solution
Cardinality Problem, Optimal Solution
Cardinality Problem, Optimal Solution
Cardinality Problem, Optimal Solution
Cardinality Problem, Optimal Solution
Weighted Problem, Optimal Solution
Weighted Problem, Optimal Solution

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Computational Complexity

- Cardinality: $O(\sqrt{|V||E|})$.
- Weighted: $O(|V||E| + |V|^2 \log |V|)$. 
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Computational Complexity

- Globally dominating edges (Avis): $1/2$ approximation ratio, $\Theta(|E| \log |V|)$.
- Locally dominating edges (Preis): $1/2$ approximation ratio, $\Theta(|E|)$.
- Path growing (Drake & Hougardy): $1/2$ approximation ratio, $\Theta(|E|)$. 
Approximate Solution (1)
Approximate Solution (1)
Approximate Solution (1)
Approximate Solution (2)
Approximate Solution (2)
Locally Dominating Edges

- Preis: complexity $\Theta(|E|)$, difficult to parallelize.
- Manne & Bisseling: $\Theta(|V|d^2 + |E|)$, easy to parallelize.
Pointer Based Approximate Solution (1)

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Parallel Approximate Matching
Pointer Based Approximate Solution (1)
Pointer Based Approximate Solution (1)
Pointer Based Approximate Solution (1)
Pointer Based Approximate Solution (2)
Pointer Based Approximate Solution (2)
Pointer Based Approximate Solution (2)

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Parallel Approximate Solution (2)
Parallel Approximate Solution (2)
Parallel Approximate Solution (2)
Communication Patterns

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Data Distribution
Data Distribution
Preliminary Results

- \texttt{bcsstk35}, |V| = 60,474, E = 740,200
- 2.2 GHz AMD Opteron, 4GB RAM, Gigabit Ethernet

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<th>8</th>
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<th>64</th>
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<td>4.41</td>
<td>2.09</td>
<td>1.02</td>
<td>0.45</td>
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<tr>
<td>$t_{max}$</td>
<td>4.79</td>
<td>2.88</td>
<td>2.10</td>
<td>2.56</td>
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<tr>
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<td>4.57</td>
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<td>1.45</td>
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Conclusion

- Collection of sequential matching algorithms.
- Prototyped a first parallel matching algorithm (approximation).
- Code clean-up and optimization.
- Scalability issues (different data distribution, different data structure, different communication pattern).
- Better approximation ratios?
- Optimal parallel matching algorithm?