Vorlesungsinhalt

Semester:	Wintersemester 2012/13
Vorlesung:	Parallele Algorithmen (IN2011) (4+2, 8 ECTS) (mit Übungen)
Dozent:	Prof. Dr. Ernst W. Mayr
Übungsleitung:	Chris Pinkau

Texte: F. Thomson Leighton:
''Introduction to Parallel Algorithms and Architecture: Arrays, Trees, Hypercubes''
Morgan Kaufmann: San Mateo, CA, 1992

Joseph JaJa:
''An introduction to parallel algorithms''
Addison-Wesley: Reading, MA, 1997

Jeffrey D. Ullman:
''Computational Aspects of VLSI''
Computer Science Press: Rockville, USA, 1984

Selim G. Akl:
''The Design and Analysis of Parallel Algorithms''
Prentice Hall: Englewood Cliffs, NJ, 1989

John E. Savage:
''Models of Computation''
Addison-Wesley: Reading, MA, 1998

Sanjeev Arora, Boaz Barak:
''Computational Complexity — A Modern Approach''
Cambridge University Press: Cambridge-New York-Melbourne, 2009

K. Rüdiger Reischuk:
''Komplexitätstheorie — Band 1: Grundlagen''
Teubner, Stuttgart, 1999

C.P. Schnorr, A. Shamir:
''An optimal sorting algorithm for mesh connected computers''
STOC 1986

Volker Heun, Ernst W. Mayr:
''Efficient Dynamic Embeddings of Binary Trees into Hypercubes''
J. Algorithms 2002

Vorlesungsinhalt:

0. Organizational Matters

I. Introduction

   1. History
   2. Moore's Law
   3. Parallel vs Concurrent vs Distributed
   4. Topics of Course

II. Models

   1. RAM
   2. PRAM, shared memory
   3. Networks of Processors
      3.1 Some Classes: Trees, Meshes, FFT, Hypercube
      3.2 Relevant Properties: Degree, Diameter, Bisection Width
   4. Circuits, VLSI
      4.1 Definitions
      4.2 Size, depth, and area
   5. Some examples
      5.1 EREW-PRAM algorithm, circuit for summation
      5.2 AND/OR on CRCW-PRAM
      5.3 Circuit size
      5.4 Non-uniform circuits
         1. Lower bound
         2. Upper bound (Lupanov)
      5.5 Uniform families of circuits
      5.6 The class NC
   6. Matrix Multiplication on various models
      6.1 Linear Array
      6.2 2-D Mesh
      6.3 Hypercube
      6.4 PRAM
   7. Speedup, work, and efficieny
      7.1 Work-optimality, Brent's Principle
      7.2 Amdahl's Law

III. Parallel Sorting

   1. Sorting on a Linear Array
   2. Odd-even Transposition Sort, 0/1-Lemma
   3. Odd-even Mergesort
   4. Bitonic Sort
   5. Sorting on a 2-D Mesh — Upper and Lower Bound

6. ShearSort

IV. Packet Routing

1. Greedy Algorithms
2. Greedy Routing on Average
3. Deterministic Routing
4. Off-line Routing Algorithms

V. More Powerful Networks

1. 2D-Mesh-of-Trees
   - 1.1 Definitions
   - 1.2 Decomposition
   - 1.3 Derivation from $K_{n \times n}$
   - 1.4 Variations
2. 2D-MoT Algorithms
   - 2.1 Routing
   - 2.2 Sorting
   - 2.3 Convex Hull
   - 2.4 Integer Arithmetic
     1. Multiplication
     2. Division and Chinese Remaindering

VI. Hypercubes and Related Networks

1. The Hypercube
   - 1.1 Definitions and Properties
   - 1.2 Containment of Arrays
   - 1.3 Containment of Complete Binary Trees
   - 1.4 Embedding of Arbitrary Binary Trees
2. Hypercubic Networks
   - 2.1 The Butterfly Network
   - 2.2 The Cube-Connected-Cycles-Network
   - 2.3 The Beneš-Network

VII. Limitations to Parallel Computation/Algorithms

1. The complexity class NC
2. The Circuit-Value-Problem (CVP)
3. P-complete problems and algorithms