



Chapter 9

Parallel Algorithms

Algorithm Theory
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Sequential Algorithms

Classical Algorithm Design:

- One machine/CPU/process/... doing a computation

RAM (Random Access Machine):

- Basic standard model
- Unit cost basic operations
- Unit cost access to all memory cells

Sequential Algorithm / Program:

- Sequence of operations
(executed one after the other)

Parallel and Distributed Algorithms

Today's computers/systems are not sequential:

- Even cell phones have several cores
- Future systems will be highly parallel on many levels
- This also requires appropriate algorithmic techniques

Goals, Scenarios, Challenges:

- Exploit parallelism to speed up computations
- Shared resources such as memory, bandwidth, ...
- Increase reliability by adding redundancy
- Solve tasks in inherently decentralized environments
- ...

Parallel and Distributed Systems

- Many different forms
- Processors/computers/machines/... communicate and share data through
 - Shared memory or message passing
- Computation and communication can be
 - Synchronous or asynchronous
- Many possible **topologies** for message passing
- Depending on system, various **types of faults**

Challenges

Algorithmic and theoretical challenges:

- How to parallelize computations
- Scheduling (which machine does what)
- Load balancing
- Fault tolerance
- Coordination / consistency
- Decentralized state
- Asynchrony
- Bounded bandwidth / properties of comm. channels
- ...