Introductory Tutorial in Parallel Programming

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Seminar 20 – Advanced Computing
Technische Universität München

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Agenda

1. Parallel Programming (Markus)
2. Parallel Architectures (Stefan)
3. OpenMP (Markus)
4. MPI (Marcel)
5. Hardware Support for Parallel Programming (Stefan)

Why Parallel Programming - Small Scale View

- Single core performance plateauing
- Further increase possible but increasingly difficult
- Especially power limitations
- $\Rightarrow$ **Cost efficiency**

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Why Parallel Programming - Large Scale View

- Intel Core i7, 3.2GHz: $\approx$ 0.0000512 petaflops
- Earth Simulator: $\approx$ 0.03586 petaflops
- Altix/HLRBII: $\approx$ 0.0623 petaflops
- Bluegene/L: $\approx$ 0.280 petaflops
- Roadrunner: $\approx$ 1.7 petaflops
- BOINC: currently $\approx$ 1.9 petaflops

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Parallel Programming - the Cure for Cancer?

So parallel programming is perfect:
Everything gets faster, better, tastier, brighter!

Except that it's not. Drawbacks?

race conditions, synchronisation,

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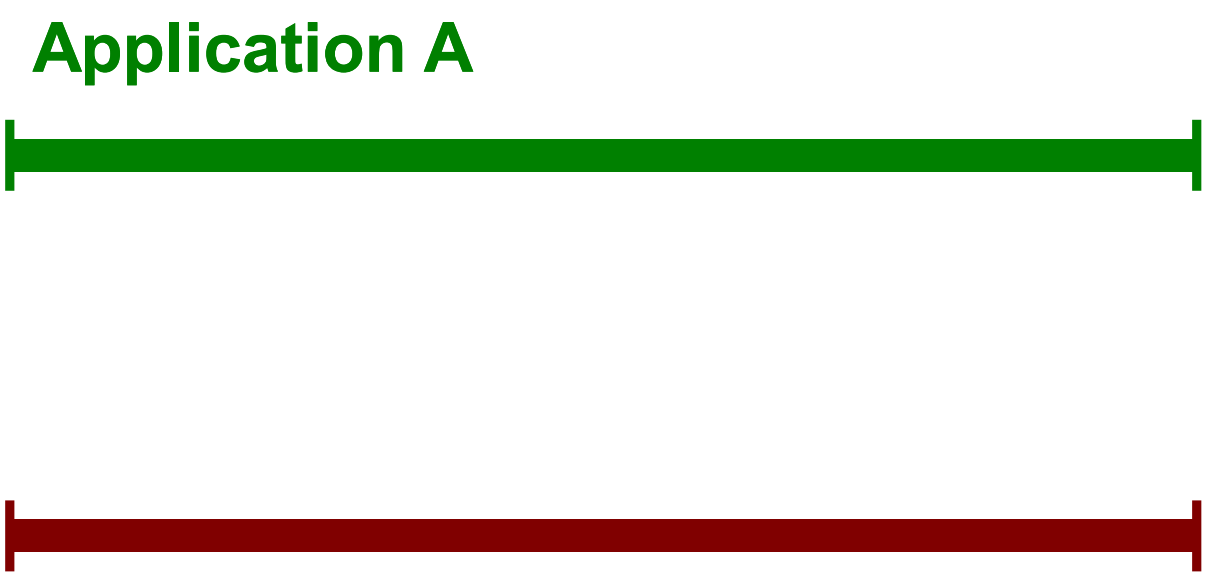
Data Dependency I



Virtually no data dependency, embarrassingly parallel
Think of: Independent jobs, Distributed networking,...

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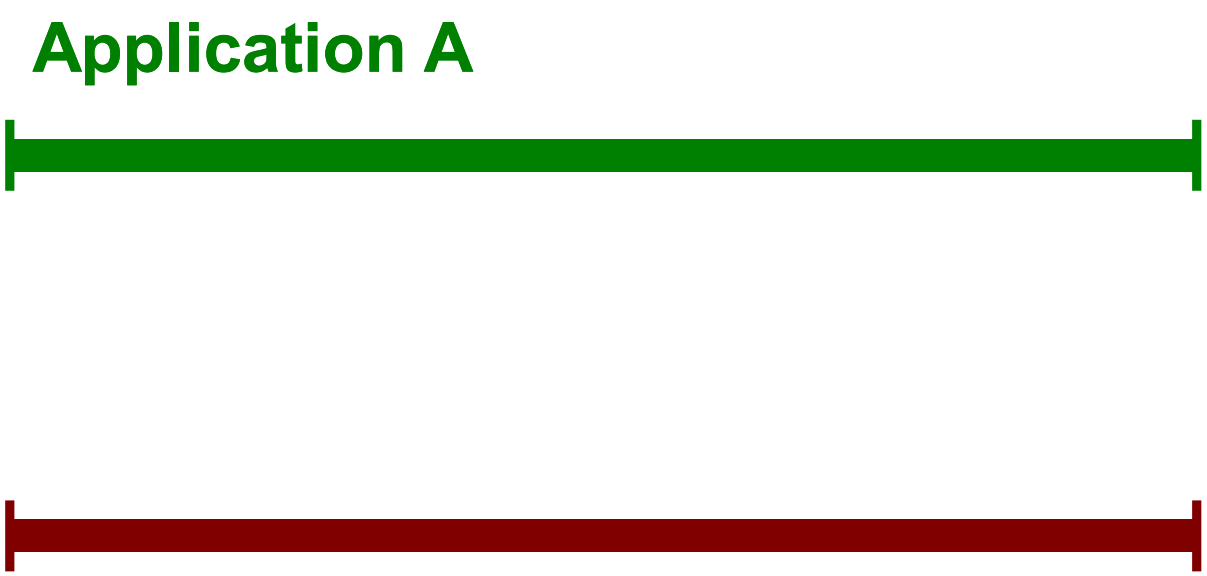
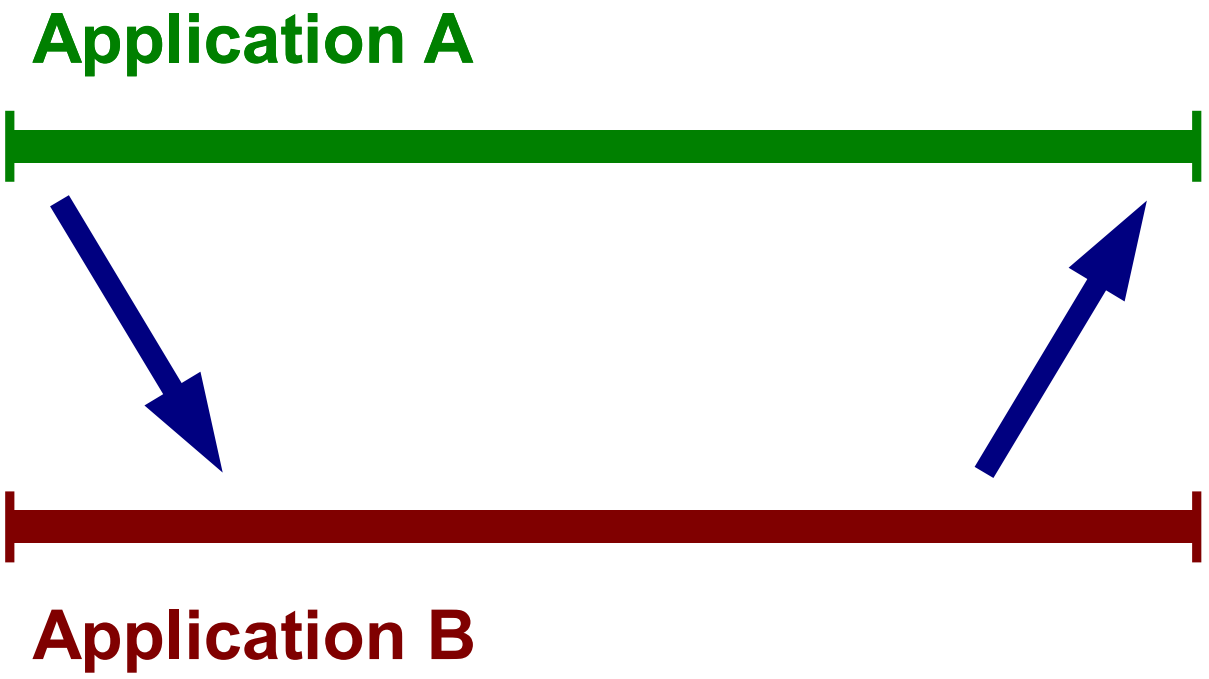


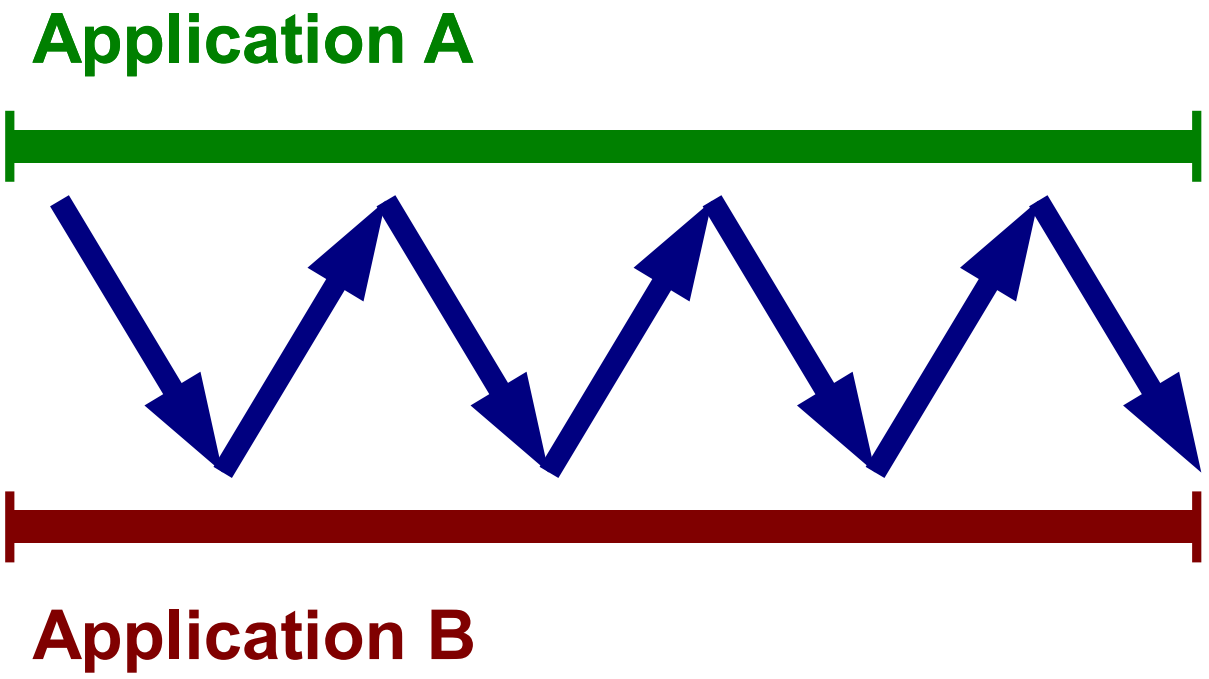
Virtually no data dependency, embarrassingly parallel
Think of: ..., SETI@Home, Brute force algorithms

Data Dependency II



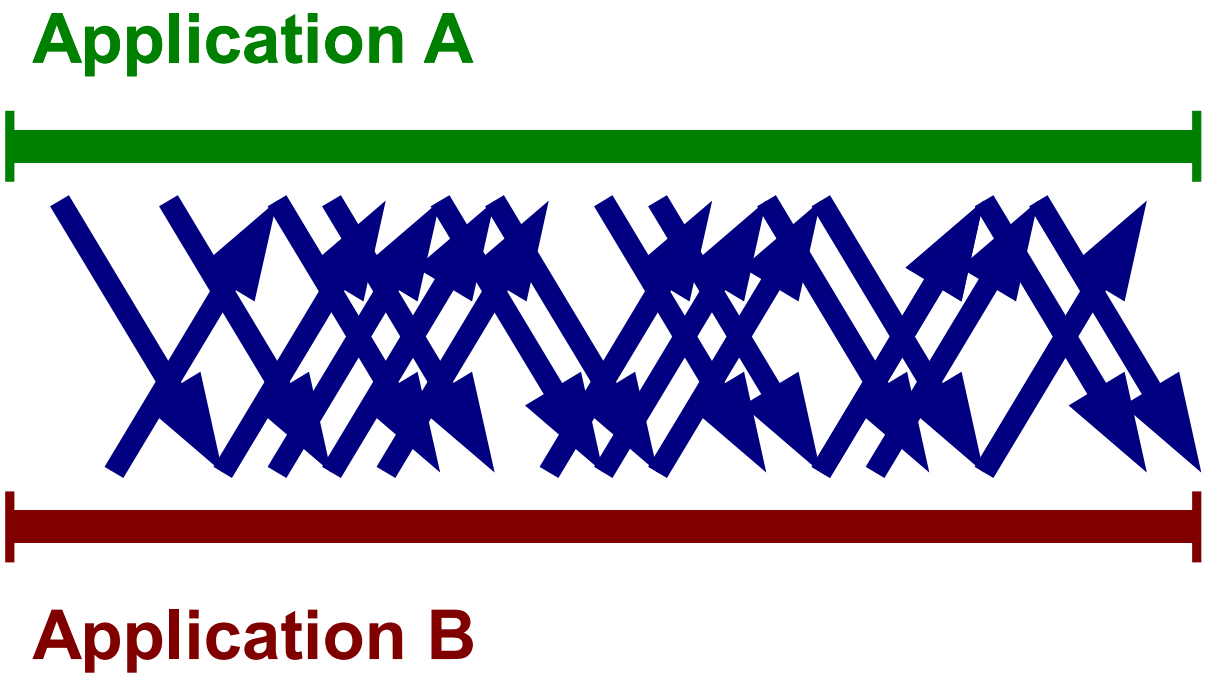
Low data dependency, coarse-grained parallelism
Think of: Rendering Jobs

Data Dependency III



Low data dependency, coarse-grained parallelism
Think of: Relaxation on 2d-grids with small stencil

Data Dependency IIII



High data dependency, fine-grained parallelism
Think of: Relaxation with large stencils