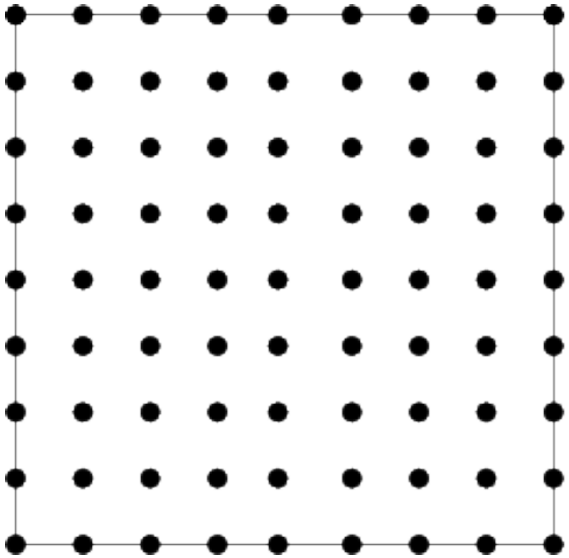
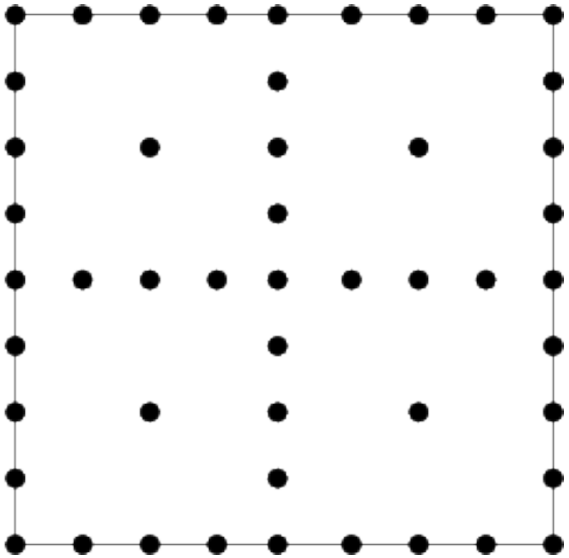
Insertion Paths for Algorithms and Software Examples

Miriam Mehl

A Mathematical Concept – Sparse Grids

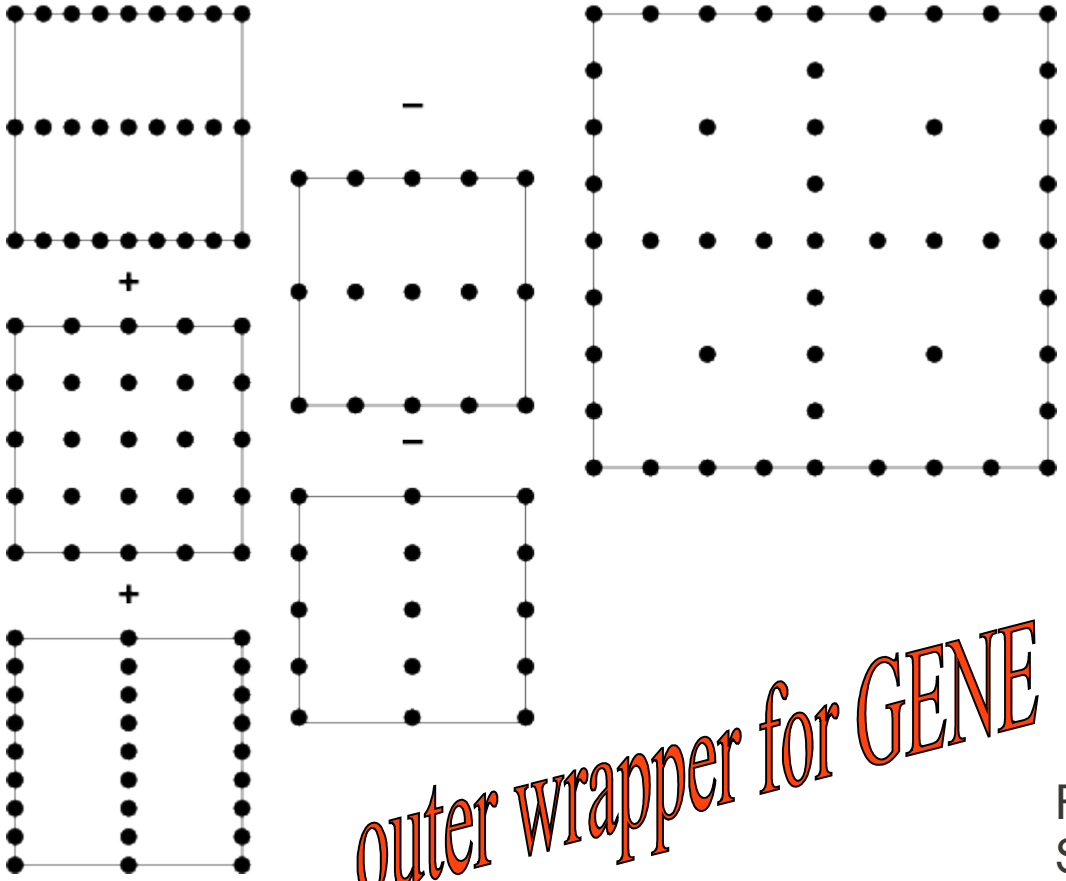


O(N^d)



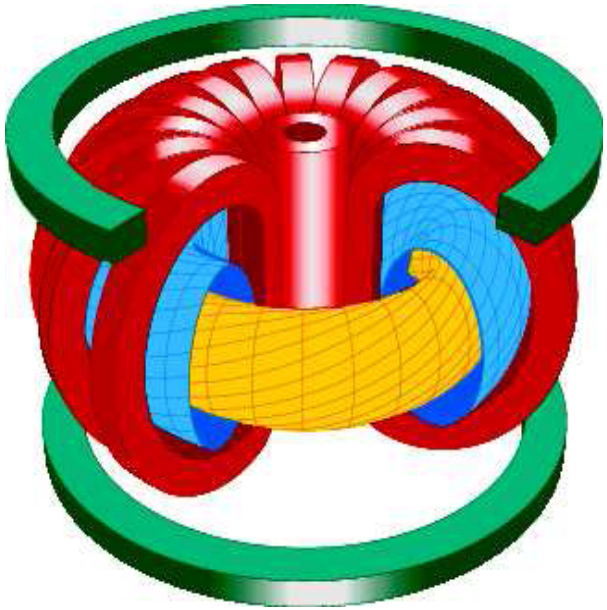
O(N log(N)^(d-1))

A Mathematical Concept – Sparse Grids



outer wrapper for GENE

Axisymmetric “tokamak”:
Nested magnetic surfaces



Frank Jenko, EU-US Summer School on HPC Challenges Catania, Italy, 4-7 October 2010

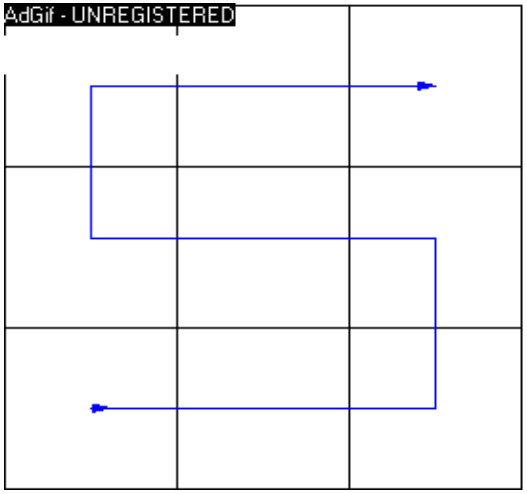
A Mathematical Concept – Sparse Grids

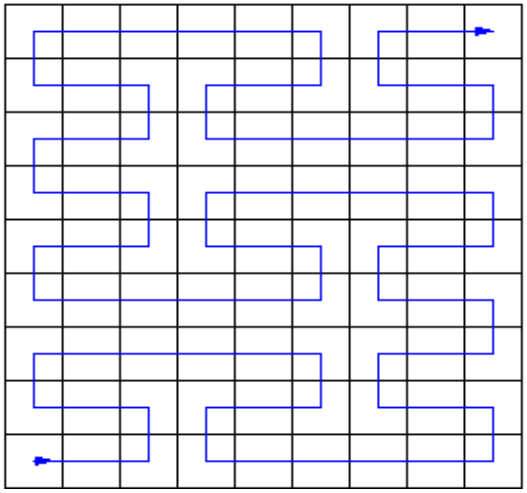
Funding: exsting method applied to new application, driven by needs of the application (IAS focus group, Helmholtz Graduate School)

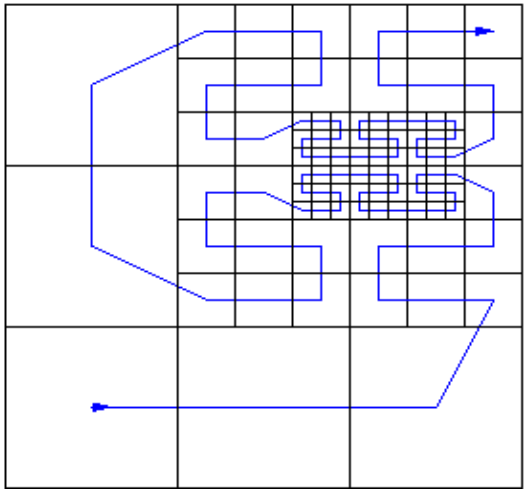
Limits: adaptively refined sparse grids???

Acceptance: high, (almost) no changes in the existing codes required

Hardware-Efficient Algorithm for PDE-based Applications







octree-like grids + space-filling curves

- ➔ cache-efficiency / data locality (stacks and streams)
- ➔ load balancing
- ➔ multilevel data

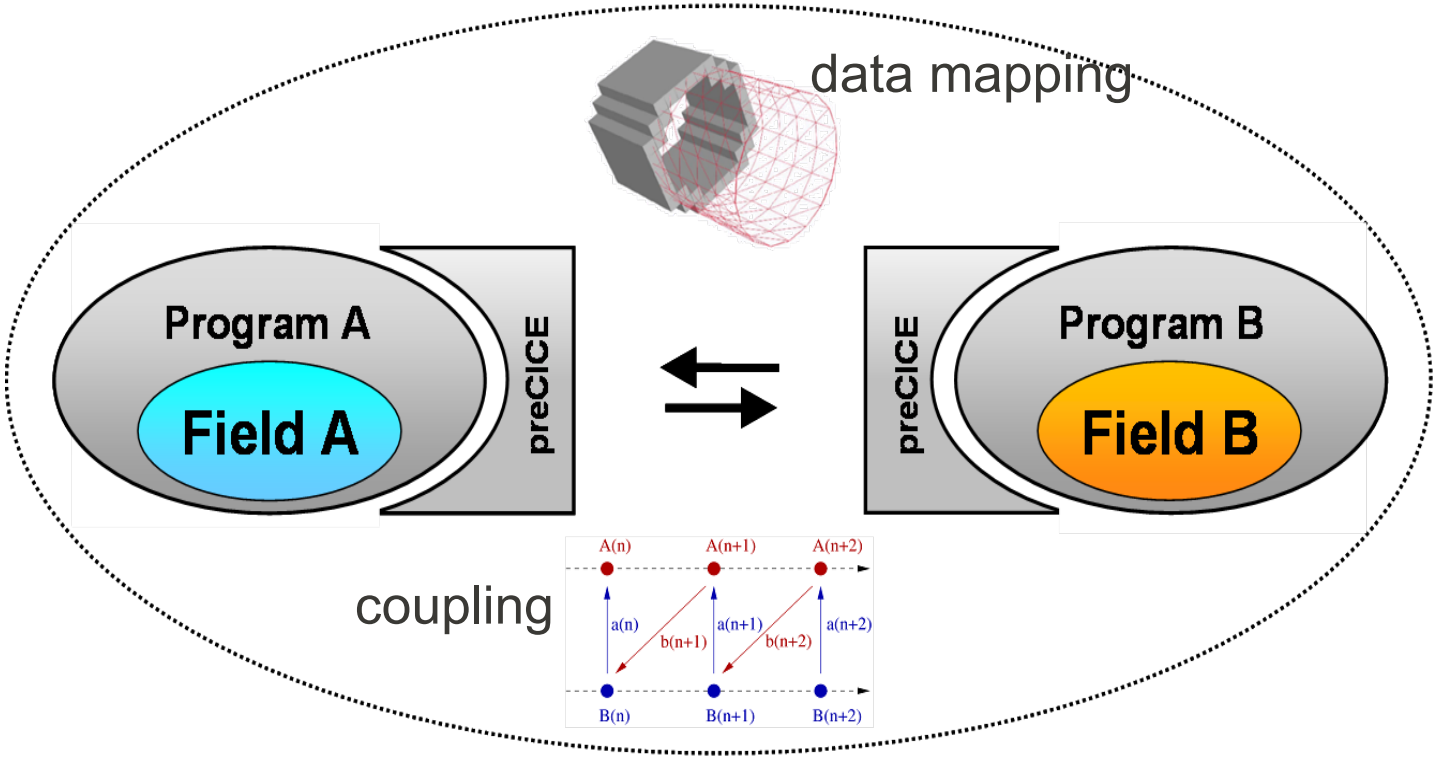
Hardware-Efficient Algorithm for PDE-based Applications

- very large changes
  - fixed grid type
  - Requires matrix-free operations to exploit potential
  - far more than 'just' linear algebra
  - **how to make the grid and data handling transparant to the application?**
  - **how to reuse existing solvers etc.? (easy for cg, AMG?)**

- funding: hidden in various application driven projects

Coupling Numerics

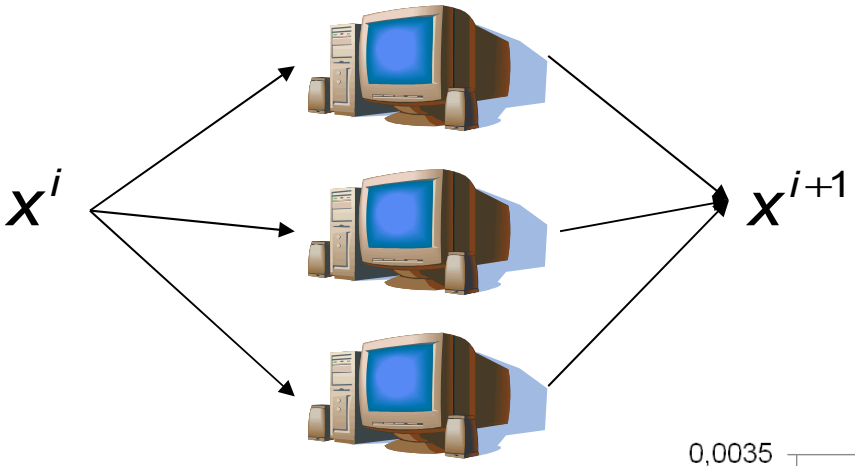
provide functionality in external tools

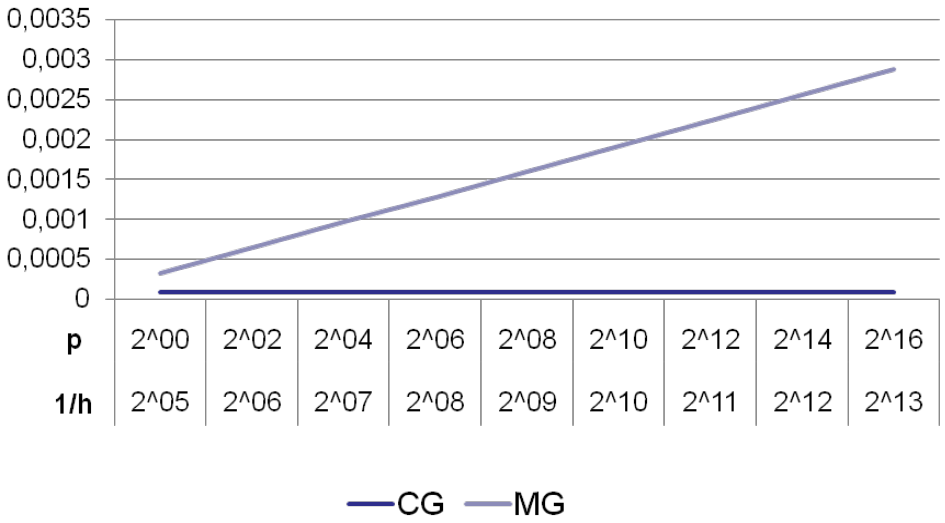


Coupling Numerics

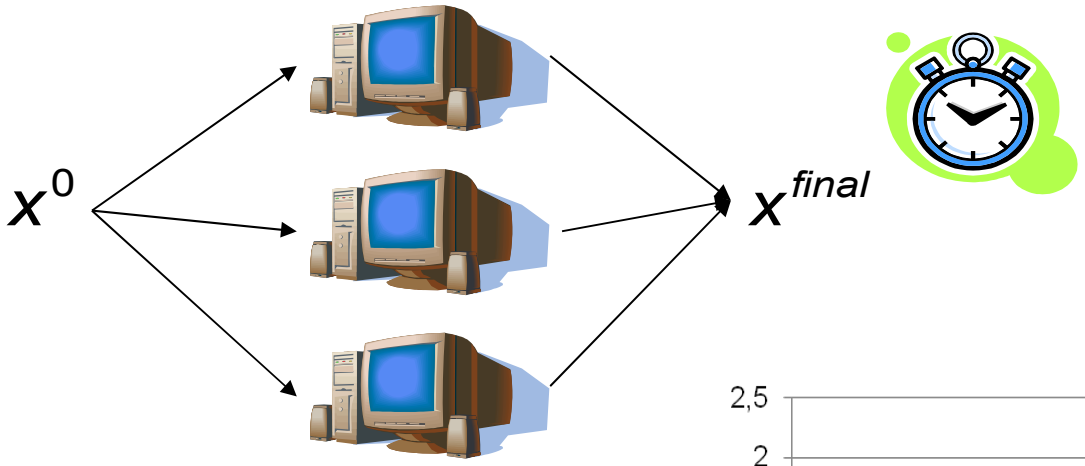
- funding: indirect in application driven projects
- acceptance:
  - numerics 'hidden' from the user,
  - still expandable for 'experts'
  - small changes in coupled codes
  - **efficiency & ease of use ((wo)man-power!!!)**
- **unsolved:** how to **convince singlephysics applications to enhance/change codes** for multiphysics needs (implicit time steps, resetting time steps, exposing details,...)

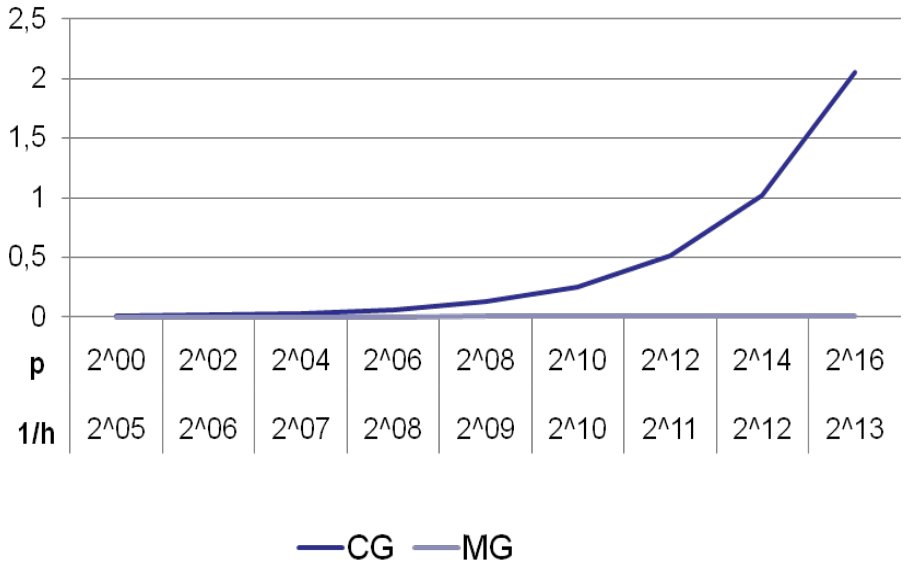
Mathematics versus Computer Science





Mathematics versus Computer Science





Mathematics versus Computer Science

- social / educational problem: interdiscilinarity required!!!
- additional drawbacks:
  - many choices
  - many possible bad choices
- success story: AMG preconditioned Krylow methods

Summary

- case 1: wrapper
  - accepted, funded :), limited
- case 2: new 'kernel'
  - neccessary, but time consuming, poor funding, invasive
- case 3: encapsulating methods
  - reusable, transparant, still accessible, minimally invasive, poor funding
- case 4: numerical versus hardware efficiency
  - interdisciplinary education leads to success
  - complex math as (robust) black-box