



Prof. Dr. Felix Wolf

# LABORATORY FOR PARALLEL PROGRAMMING

# Introduction

- Recently moved from Aachen to Darmstadt
- Research statement

*“Develop methods, tools, and infrastructure to exploit massive parallelism on modern computer architectures”*

[www.parallel.informatik.tu-darmstadt.de](http://www.parallel.informatik.tu-darmstadt.de)



# Team



TECHNISCHE  
UNIVERSITÄT  
DARMSTADT



Prof. Dr.  
Felix Wolf



Alexandru  
Calotoiu



David  
Giessing



Dr. Daniel  
Lorenz



Suraj  
Prabhakaran



Sebastian  
Rinke



Laura  
von Rügen



Aamer  
Shah



Sergei  
Shudler

## Multicore Programming Group



Dr. Ali  
Jannesari



Rohit  
Atre



Zhen  
Li



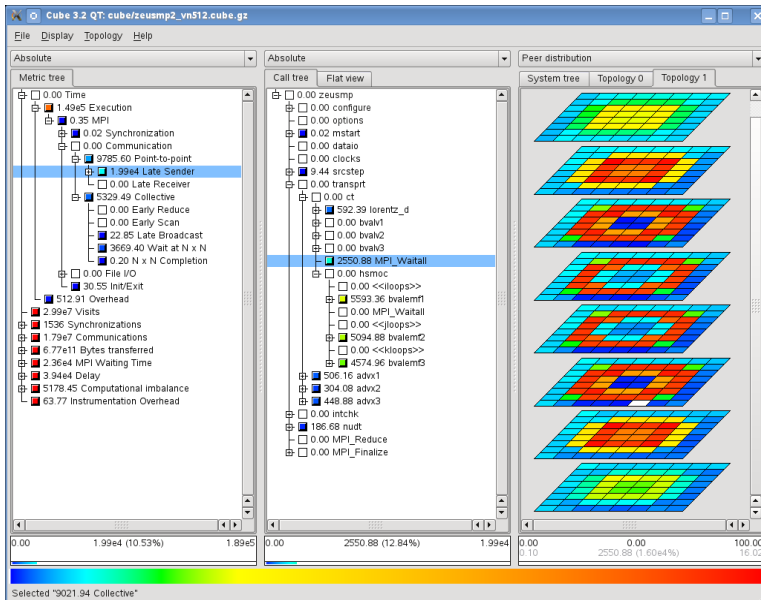
Zia  
Ul Huda



Mohammad  
Norouzi



Arya  
Mazaheri

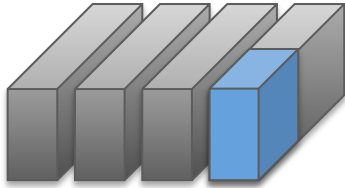


COURTESY: FORSCHUNGSZENTRUM JÜLICH

IBM Blue Gene/Q in Jülich

- Performance analysis tool for HPC applications
- Collaboration with Jülich Supercomputing Centre
- Our focus: automated performance modeling & visual analytics
- [www.scalasca.org](http://www.scalasca.org)

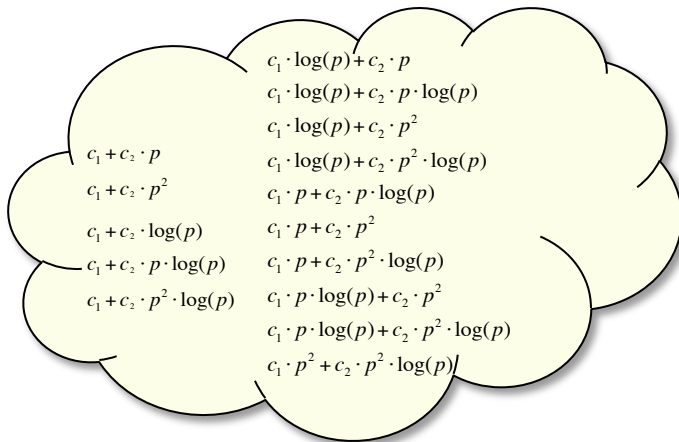
# Automatic empirical modeling



Small-scale measurements

$$f(p) = \sum_{k=1}^n c_k \cdot p^{i_k} \cdot \log_2^{j_k}(p)$$

Performance model normal form (PMNF)

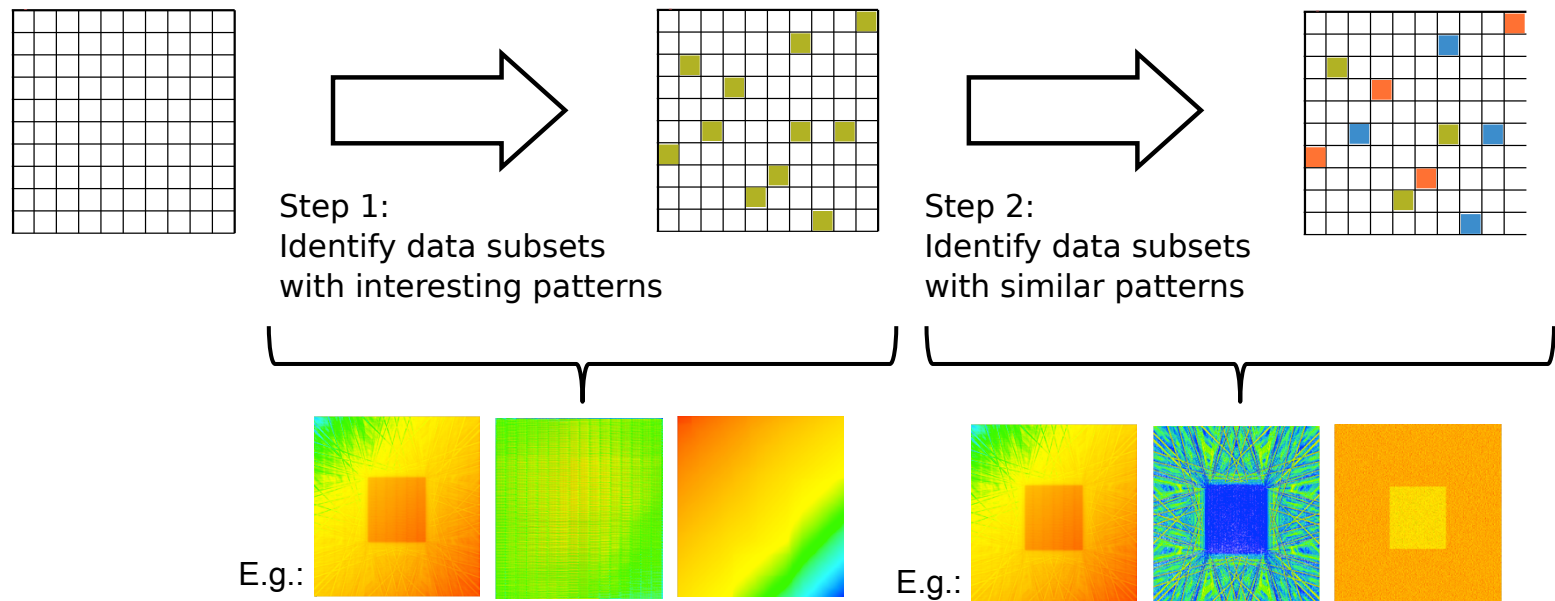


Generation of candidate models  
and selection of best fit

Kernel [2 of 40]	Model [s] $t = f(p)$	Error [%] $p_t=262k$
sweep → MPI_Recv	$4.03\sqrt{p}$	5.10
sweep	582.19	0.01

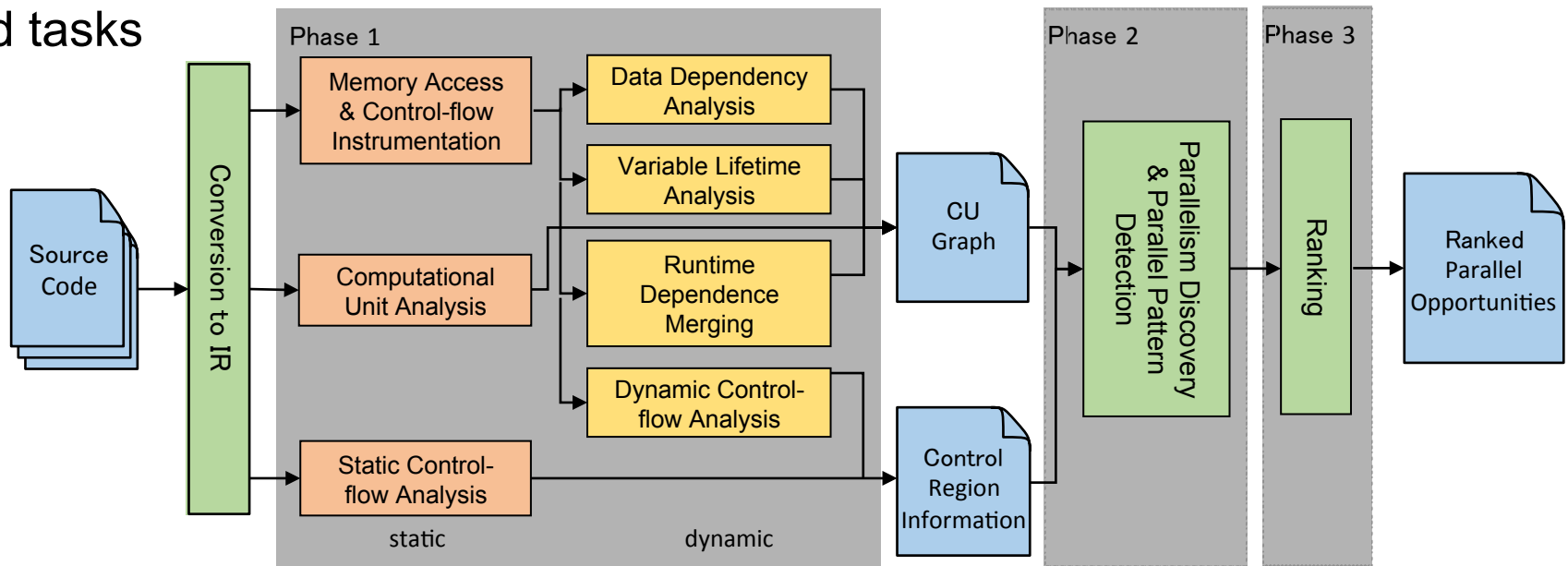
# Visual analytics of performance data

Visual analytics: Visual data exploration + automatic data analysis<sup>1</sup>

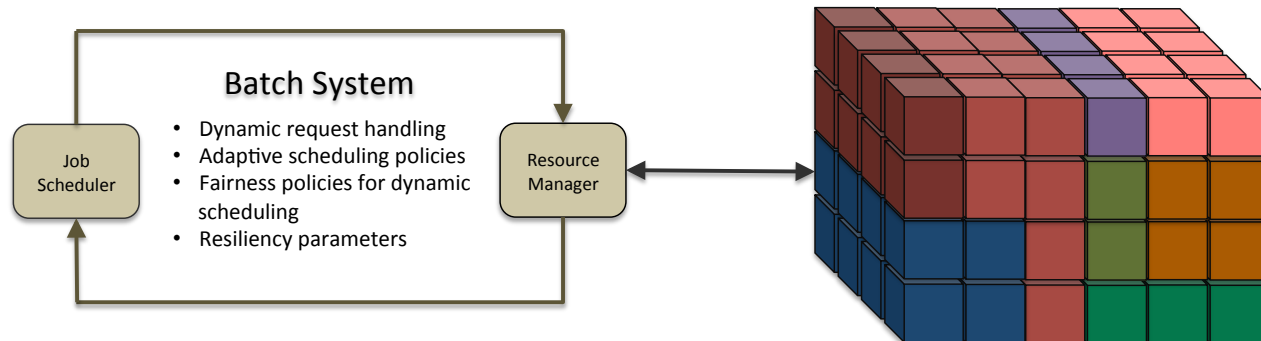


1. Daniel Keim, Jörn Kohlhammer, Geoffrey Ellis, and Florian Mansmann: Mastering the Information: Age Solving Problems with Visual Analytics. Eurographics Association, 2010.

- Discovers potential parallelism in sequential programs
- Targets DOALL loops, pipelines, and tasks
- Reveals data dependences that prevent parallelization
- Efficient in time and space



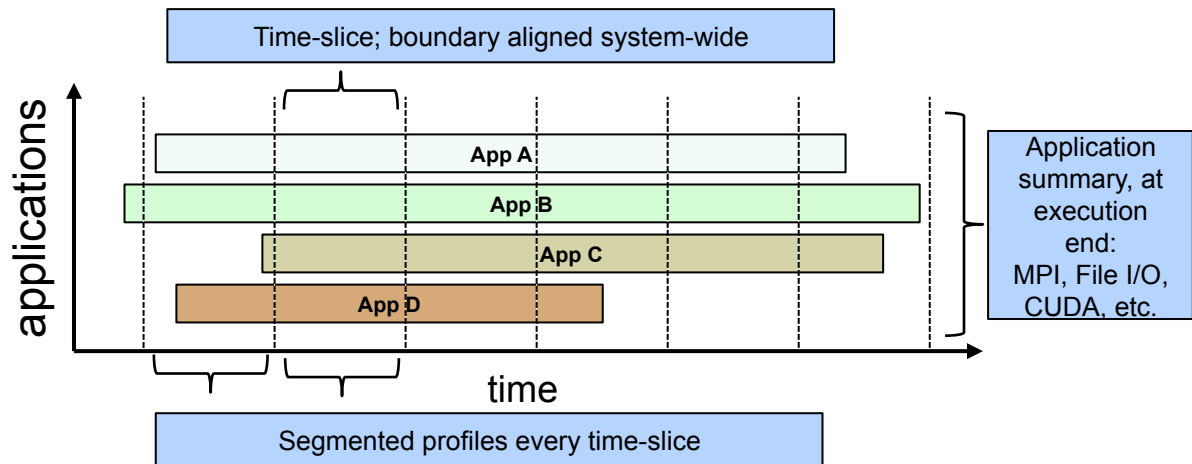
- Dynamic resource management and job scheduling in HPC
- Support for more classes of applications - moldable, malleable and evolving
- Adaptive scheduling with enhanced fairness for high throughput
- Fault tolerance with dynamic node replacement





- Light-Weight Monitoring Module
- Profiles: MPI, File I/O, OpenMP and CUDA
- Easy to use: No code recompilation or relinking
- Generates simple command line output and data files
- Geared towards identifying performance interference between jobs

- Synchronized, time-stamped, periodic profiles across multiple applications



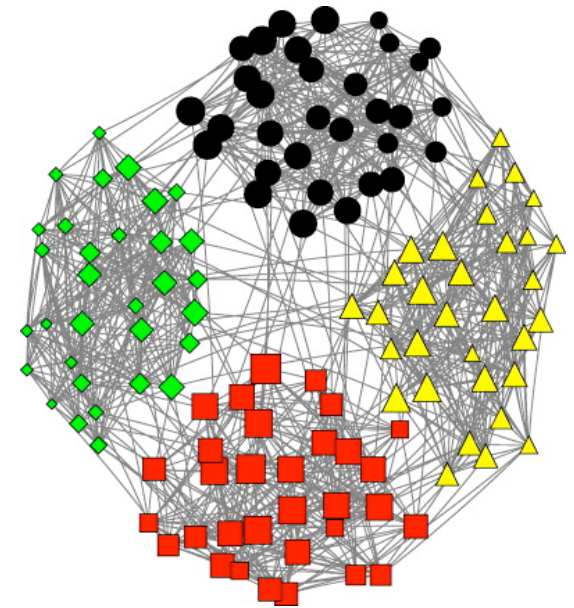
# Scalable brain simulation

- Collaboration with SimLab Neuroscience at Forschungszentrum Jülich
- Neuronal network of human brain not “hard-wired”
- Lesions, e.g. stroke, cause reorganization of connections
- Goal:
  - Develop biologically realistic full-scale network model of the brain
  - Better understand the dynamics of the network
- Algorithmic challenge:
  - How to handle  $10^{11}$  neurons in the simulation



# Large-scale word sense disambiguation

- Collaboration with Ubiquitous Knowledge Processing Lab at TU Darmstadt
- A word can have many different meanings depending on its context
- Goal:
  - Use supercomputer to disambiguate all words in large text collections
  - Create basis for further semantic analysis
- Algorithmic challenge:
  - Processing large texts requires much file I/O
  - Minimize slow file I/O through efficient use of main memory and network communication



# Student assistant positions

The position offers:

- Research and development in the area of programming tools for parallel computing
- Experience in parallel programming
- Working in an international team
- The option to prepare for a master's thesis
- Negotiable number of hours per week

The ideal candidate will have:

- A bachelor's degree in computer science or a related discipline
- Programming practice in C/C++
- Familiarity with UNIX-like system environments
- Good command of English
- High motivation and the ability to work effectively with others

Additional qualifications:

- Knowledge of parallel programming

If you are interested,  
please contact Prof. Wolf  
<wolf@cs.tu-darmstadt.de>



# THANK YOU!