

Scientific Computing

Albert-Jan Yzelman (May 10, 2010)

Scientific Computing is...

- a two-year's master programme;
- a mix between mathematics, computer science, physics;
- largely application-driven



People involved at Utrecht

- Rob Bisseling: Parallel algorithms, combinatorial scientific computing
Leader of the Scientific Computing programme
- Gerard Sleijpen: Numerical linear algebra (iterative), preconditioning
Teaches (bachelor): numerieke wiskunde, practicum CS
- Paul Zegeling: Differential equations, adaptive/moving grids
Teaches (bachelor): numerieke wiskunde
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- PhD students: Siaw Cong Lee, Bas Fagginger Auer,
Albert-Jan Yzelman



Programme breakdown

Total: 120 European Credit Transfer System (ECTS) credits

- Courses: 75 credits
- Thesis: 45 credits



Programme breakdown

Total: 120 European Credit Transfer System (ECTS) credits

- Obligatory courses: 6 · (7.5 or 8) credits
- “Free” choice: about 30 credits
- Thesis: 45 credits



Programme breakdown

Obligatory, local master courses:

- Modelling and Simulation (NS-EP438M), Gerard Barkema (UU).

Perform simulations in statistical physics; e.g., *“under different temperatures/pressures, what is the phase of this substance?”*

- Laboratory Class Scientific Computing (WISM 454), Bas Fagginger Auer (UU).

Application-driven course on implementing (mathematical) ideas and running software experiments; e.g., Random Number Generators

- One of:
 - Computational Biology (Paulien Hogeweg, UU)
 - Simulation of the Ocean, the Atmosphere and Climate, project at Institute for Marine and Atmospheric Research Utrecht (IMAU)



Programme breakdown

Obligatory, shared master courses at MasterMath(.nl):

- Numerical Linear Algebra,
Martin van Gijzen (TU Delft) and Gerard Sleijpen (UU).

Ways to solve $Ax = b$ with the matrix A really really large and typically sparse

- Numerical Methods for Time-Dependent PDEs,
Paul Zegeling (UU).

On different methods (finite differences/volumes) to solve PDEs, e.g., “what happens to my oil field if we drill a well here?”

- Parallel Algorithms,
Rob Bisseling (UU).

How to do any of the above using parallel (super)computers, while maintaining scalability (when using 128 processors, I want my answer 128 times faster)



Programme breakdown

“Free choice” master courses; pick 5 and consult with Rob Bisseling

- Fourier Theory and Wavelets (WISM 453), Gerard Sleijpen (UU)
- MasterMath.nl (e.g. Optimisation)
- Courses from other mathematics masters
- Courses from other departments (Computational Materials Science, Algorithms and Networks, et cetera)

Your thesis subject should connect with a majority of the chosen courses.



Prospects

After studying, you should be able, for a wide range of problems, to:

- Analyse; understand which information can be obtained, is relevant, or is actually requested,
- Model; how to transform the problem in a known format; linear systems, eigenproblem, (hyper)graph formulation, ...
- Solve; have knowledge of the standard ways of numerically solving known problem formulations.



Prospects

- Research Industry: TNO, Deltares, SRON
- Financial Industry: Risk analysis, stock pricing, ...
- Software Industry / Consultancy: Google, Vortech, Alten, Deloitte
- Specific industries: Chip industry (NXP), Oil (Shell), Electronics (Phillips), Computers (Intel, Sun), Biomedical (UMC)
- ...



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- ...
- Or, of course, continue in academics as a PhD student (here or anywhere else)!

