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

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- Obligatory courses: $6 \cdot (7.5 \text{ or } 8)$ 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)!