

# LIACS – Fundamentals

Jetty Kleijn | Informatica Bachelorklas 2015-12-01



**Universiteit  
Leiden**  
The Netherlands

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# Research at LIACS

Two clusters

- Algorithms and Software Technology
  - ...
  - *(Foundations of) Software Technology*
  - *Theoretical Computer Science*
  - ...
- Computer Systems and Imagery & media
  - ...
  - *Imaging and Bioinformatics*
  - ...

# Algorithms and Software Technology

- Methods and techniques for algorithm design and analysis
- Development of formalisms, methods, techniques, tools to design, analyse, construct software systems and components
- Application in  
Engineering  
Bio-, Chemo-informatics  
Medicine

*Al-Khwarizmi*



# Fundamentals

- *Foundations* of Software Technology
- *Theoretical* Computer Science



# Zooming in ...

- FaST: Foundations of Software Technology

- Farhad Arbab (CWI/LIACS)
- Frank de Boer (CWI/LIACS)
- **Marcello Bonsangue** (LIACS/CWI)
- Jetty Kleijn



- Theoretical Computer Science

- Grzegorz Rozenberg
- **Jetty Kleijn** (+ BioModelling)
- **Hendrik Jan Hoogeboom** (+ Algorithms)
- Rudy van Vliet



# Teaching – bachelor

- Fundamentele Informatica 1, 2, 3

Hoogeboom, Kleijn, Van Vliet, Bonsangue

- Algoritmiek

Van Vliet

- Logica

Bonsangue

- Datastructuren

Hoogeboom

- Concepten van Programmeertalen

Arbab

- Programmeren en Correctheid

De Boer

- Theorie van Concurrency

Kleijn

- Compiler Constructie

Van Vliet

# Teaching – master

- Testing Object-Oriented Software      Bonsangue, De Boer
- BioModeling and Petri Nets      Kleijn, Verbeek
- Seminar Combinatorial Algorithms      Hoogeboom, Kusters
- Coordination and Component Composition      Arbab



# People

- **Professors**

- Farhad Arbab, head
- J. Kok, G.Rozenberg
- Frank de Boer

- **Associate/Assistant Profs; Lecturers**

- Jetty Kleijn
- Marcello Bonsangue
- Hendrik Jan Hoogeboom
- Rudy van Vliet

- **PostDocs**

- Stijn de Gouw

- **PhD Students**

- Bahamn Pourvatan
- Vlad Serbanescu
- Nikolaos Bezirgiannis
- Kayvan Azadbakht
- Kasper Dokter,
- Sung Jongmans
- Behrooz Nobakht
  
- Pieter Kwantes

- **Secretary**

- Marloes van der Nat



# Focus

Development of formalisms, methods, techniques, and tools to design, analyse, and construct software (computational) systems:

Formal semantic foundations  
Components and interactions  
Composition and coordination



Classes, objects, services  
Concurrency, distribution, mobility, reconfiguration

Formal methods, verification  
Models, behaviours, synthesis  
Case studies, empirical studies, experimental systems



# Activities – F. Arbab



- **Coordination models and languages**
  - Coordinated composition of software intensive systems
  - Coordination language *Reo*
  - Constraint automata
  
- **Use of coordination**
  - Compositional Quality of Services
  - Code generation for multi-core systems
  - Service oriented computing
  - Testing

# Some areas for bachelor projects



- Testing Reo/constraint automata
- Compiler optimization algorithms
- Applications of coordination

# Activities – F. de Boer



- **Software correctness**

Programming logics

Deductive proof methods for the verification of programs

Object Orientation

Verification, Monitoring and Testing of programs

Multi-core programming

Cloud aware programming

- **Integrated Formal Methods**

Testing

Model checking

Deductive verification

Abstraction

# Some areas for bachelor projects



- Monitoring Java programs (see also Bonsangue)
- Multi-core process scheduling
- Testing a sorting algorithm for Android
- Applications of cloud computing

# Activities – M. Bonsangue



- **Formal Methods**

- Monitoring and Testing
- Model checking of software connectors
- Semantics and verification of dynamical evolving systems

- **Algebra, Coalgebra and Logic**

- Mathematical frameworks for the specification of the reactive behaviour of systems
- Process algebra, regular expressions, (probabilistic, non-deterministic, ...) *automata*

# Some areas for bachelor projects



- Monitoring Java/C++ programs (see also De Boer)
- Flow and data graph extraction from Java code
- Automata and languages
- Implementation of novel automata algorithms



# Interests/Projects H.J. Hoogeboom



- **Formal languages and automata**
  - (in particular) Bio-inspired models
  - (like) DNA computing
  - (upto) graph polynomials
  
- **Complexity of combinatorial games (Kosters)**
  - NP completeness
  - Solving them

# Interests – R. van Vliet



- **DNA Expressions – A Formal Notation for DNA**

proefschrift

- Natural Computing: DNA computing

- DNA expressions: power and minimality, syntactic properties

- **Algorithms and Programming (contests)**

Bij het bordspel Risk hangt de keuze van een optimaal spelende verdediger voor een of twee dobbelstenen, bij een gegeven worp van de aanvaller, niet alleen af van de worp van de aanvaller, maar ook van de totale aantallen legers van aanvaller en verdediger.

(nav een opgave bij de lokale voorronde voor de Benelux Programming Contest 2015)

# Activities – J.Kleijn



- **Theory of Concurrency**
  - Petri nets
  - Concurrency semantics
  - Extended partial orders
  - Transition systems, synthesis
- **Compatibility**
  - Team automata
- **Application areas**
  - Biology (Petri net models)
  - Business process models
    - (local and global verification, financial markets)

# Some areas for bachelor projects



- Petri nets: analysis techniques and concurrency semantics
- Extended net models (localities)
- New net models (bio inspired)
- Communication and compatibility (team automata)
- BPMN and business process models (Kwantes)
- Tool support: Pipe, Snoopy (with Bas van Stein)

Interested in 'Fundamentals'  
approach any of us ... @liacs



Universiteit  
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Arbab

De Boer

**Bonsangue**

**Hoogeboom**

**Kleijn**

Van Vliet