Foundations of Software Engineering
SEN3

F.S. de Boer
Composition SEN3

- Component-based Models and Software Architectures (Farhad Arbab).

- Formal Methods (Frank de Boer).

```java
interface Stack {
    // model instance StackHistory history;
    // ensures history.stack().equals(
        \old(history.stack()).append(item));
}
```

- Coalgebraic Models of Computation (Jan Rutten).

```
X \leftarrow_{p_1} R \rightarrow_{p_2} Y
\alpha \downarrow \quad \beta
F(X) \leftarrow_{F(p_1)} F(R) \rightarrow_{F(p_2)} F(Y)
```

- \gamma \downarrow

\begin{align*}
X &\leftarrow_{p_1} R \rightarrow_{p_2} Y \\
\alpha &\downarrow \quad \beta \\
F(X) &\leftarrow_{F(p_1)} F(R) \rightarrow_{F(p_2)} F(Y)
\end{align*}
Staff 2005-2010

- PhD students: 20.
- Postdocs: 7.
- ERCIM fellows: 3.
- Seconded: 4.
Overall Approach: Fundamental Research

Formal Semantics:
- Executable Operational Semantics.
- Automata Theory.
- Co-Algebra.

Programming Logics:
- Co-Induction.
- Hoare (Dynamic) Logics.
- Temporal Logics.
Proof of Concept: Tools

Simulation and Testing of Executable Software Models:
- Service Oriented Computing.
- Object-Orientation.

Automated Verification:
- Co-Induction.
- Proof-Outlines.
- Model-Checking.
Proof of Concept: Applications
Service Oriented Computing (Web Services).

▶ **Fredhopper**: leading specialist in search & merchandising software tailored to the needs of online sales channels.
▶ **Almende B.V**: Information and communication technologies.

Business Process Compliance.
Research Activities (2005-2010): Highlights

Modelling and Analysis of Concurrent Objects.

FP6 project Credo (Coordinator: F. S. de Boer)
Formal Methods Object-Oriented Programs.

- Method calls, object creation, multithreading, inheritance: Theses of Erika Abraham, Marcel Kyas, Cees Pierik, Joost Jacob and Andreas Gruener.

- Verification of Sequential and Concurrent Programs

3rd edition, Springer.
Development of Co-Inductive Calculi
(e.g., Mealy Automata, Kleene Algebras with Tests).

Thesis: Kleene coalgebra, Alexandra Silva (Cum Laude).
Eclipse Coordination Tools (REO).

Graphical editing
Animation
Code generation
Dynamic reconfiguration
Model checking
QoS Simulation
Conversion
Research Activities: Output

- **13** completed PhD theses and **7** postdocs (full and junior professorships Luxembourg, Aachen, Berlin, Leuven, Oxford, and R&D Manager Fredhopper).

- **About 160** publications (h-index senior researchers $\geq 30$).
  - **5** forthcoming (2011) PhD theses.

- Acquired external funding; **12** NWO projects and **4** EU projects:
  - ITEA project Trust4All: (2005-2007, ITEA Bronze Achievement Award).
  - FP6 project Credo (2006-2009).
  - FP7 project COMPAS: (2008-2011).
  - FP7 project HATS: (2010-2012).
Cooperation

National

► **CWI**: SEN1, SEN4, PNA1, PNA2, MAC4.
► **Universities**: UL, UU, VUA, UvA, RUN and TU/e.
► **Companies**: Almende B.V., Fredhopper, Océ-Technologies, Philips Research.

International Cooperation

Christel Baier  
Dexter Kozen  
Wang Yi
New Frontiers

Application domains:

▶ Multicore Programming.
▶ QoS of Networks.
▶ Systems Biology and Life Sciences.

Tools and Techniques:

▶ Co-Inductive Reasoning.
▶ Integration Formal Analysis Techniques and Program Transformation Tools.
▶ Model Simulation and Visualization.
SWOT

▸ **Strengths:**
  ▶ High impact fundamental research.
  ▶ Strong internal synergy and coherence.

▸ **Weaknesses:**
  ▶ Scalability tools and techniques.

▸ **Opportunities:**
  ▶ New frontiers.

▸ **Threats:**
  ▶ Maintenance external funding.