

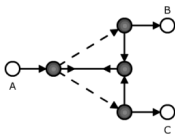
Foundations of Software Engineering

SEN3

F.S. de Boer

Composition SEN3

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



- ▶ **Formal Methods** (Frank de Boer).

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

- ▶ **Coalgebraic Models of Computation** (Jan Rutten).

$$\begin{array}{ccccc} X & \xleftarrow{p_1} & R & \xrightarrow{p_2} & Y \\ \alpha \downarrow & & \downarrow \gamma & & \downarrow \beta \\ F(X) & \xleftarrow{F(p_1)} & F(R) & \xrightarrow{F(p_2)} & F(Y) \end{array}$$

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.

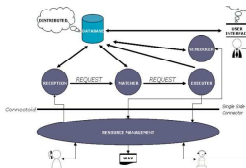
Automated Verification:

- ▶ Co-Induction.
- ▶ Proof-Outlines.
- ▶ Model-Checking.

Proof of Concept: Applications

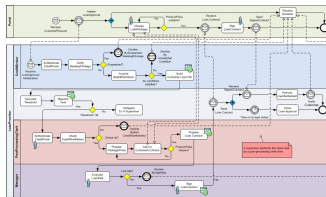
Service Oriented Computing (Web Services).

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



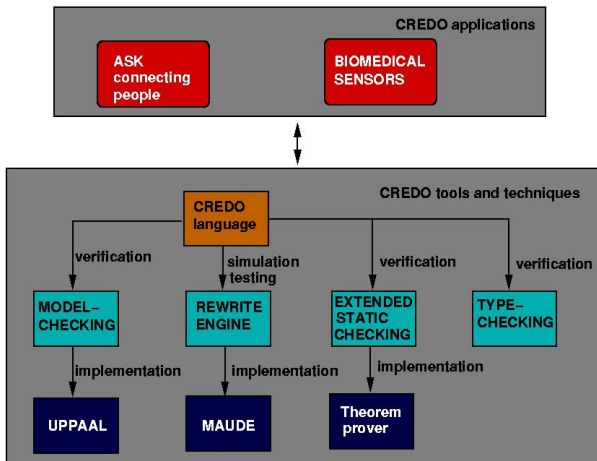
Business Process Compliance.

- ▶ *Thales*: Aerospace, Space, Defense, and Security.



Research Activities (2005-2010): Highlights

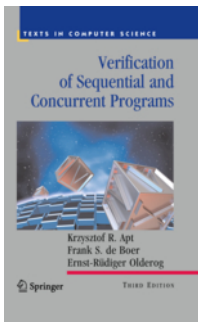
Modelling and Analysis of Concurrent Objects.



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.

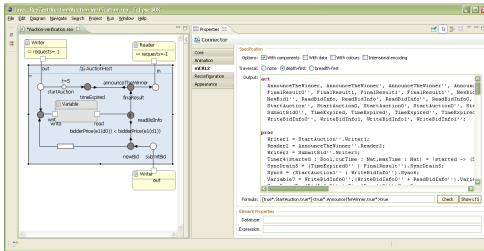
Development of Co-Inductive Calculi

(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 ≥ 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.