Coalgebra: Lecture 1

Jurriaan Rot

Radboud University, 2018

Introducing the lecturer(s)

- Jurriaan Rot — jrot@cs.ru.nl

  http://jurriaan.me
- Also 2 lectures given by
  Aleks Kissinger — aleks@cs.ru.nl

https://www.cs.ru.nl/A.Kissinger/

Website

http://www.cs.ru.nl/~jrot/coalg18/

Course information (lecture dates, exercises, literature, announcements, ...) on the **website**

Please also register for the course (email announcements and grades via Brightspace)

Time and date

Lectures

- **Mondays** 13:30 - 15:30, MERC I 00.28
- Weeks 37-42 and 45-51 (14 lectures total)
- Schedule announced on the website

Exercise class

- **Thursday** 13:30 - 15:30, MERC I 00.28
- **No class this Thursday (Sept 6)**
- Weeks 37-42 and 45-51
- Meant to **practice** and **ask questions**: no new material

Literature

We'll use several sources, in particular research papers; announced on the website.

First couple lectures, a new (draft) book:

Jan Rutten. The method of coalgebra: exercises in coinduction.
http://www.cwi.nl/~janr/papers/files-of-papers/course.pdf

We will also sometimes use:

Bart Jacobs. Introduction to coalgebra, version 2.0, 2012.
http://www.cs.ru.nl/B.Jacobs/CLG/JacobsCoalgebraIntro.pdf
Official version published by Cambridge University Press, 2016.

Second half (mostly): lecture notes

Assessment

- Two graded assignments: end of October, end of December (separate from the homework in the exercise classes, which is not graded)
- A final exam (January 11th 2019)
- Final grade: (H+E)/2, where H is the grade given for the homework assignments and E is the grade given for the final exam

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- Applications, fundamental insights, new perspectives

A small bit of history

- Machines and data structures in category theory (70's, 80's)
- Behavioural equivalence of processes (Milner & Park, 80's)
- Processes and non-wellfounded set theory (Peter Aczel (late 80's))
- Universal coalgebra (Jan Rutten and others – from 90's on)
- By the end of the 90's: active and diverse area of research, conference & workshop of it's own

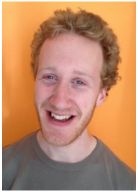
Coalgebra research today

Active community studying the fundamental theory of coalgebras, as well as applications in/connections to:

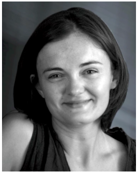
- automata theory
- programming language semantics
- concurrency theory
- probabilistic systems
- modal logic
- theorem proving
- type theory
- ...

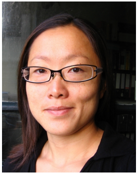
Coalgebra in Nijmegen





and people who now work elsewhere:





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- basic theory — modelling systems as coalgebras
- applying the coalgebraic notions of behavioural equivalence and coinduction
- the interplay between algebra and coalgebra, induction and coinduction
- using coalgebraic/coinductive proof techniques;
  - *highlight: a recent breakthrough algorithm for equivalence of non-deterministic automata*

Overview

Basic theory of coalgebras and coinduction (first quarter)

- streams
- categories, coalgebras, bisimulation
- automata

Algebra and coalgebra (second quarter)

- algebras, induction
- monads
- distributive laws

Bisimulation and coinduction: advanced topics (second quarter)

- lattices and fixed point theory
- minimization
- proof techniques and algorithms, applications