

MPhil in Advanced Computer Science

Advanced Topics in Concurrency

Leader:	Glynn Winskel
Timing:	Lent or Easter terms
Prerequisites:	Category theory, Denotational Semantics
Structure:	8 Lectures

AIMS

This module aims to provide an introduction to ‘hot’ research topics in the theory of concurrency. As such its precise contents should vary from year to year (perhaps concentrating solely on event structures one year, or quantum processes another). The syllabus below has as theme the view of processes as (generalized) relations.

SYLLABUS

1. A simple domain theory for concurrency (3 lectures). The Higher-Order Process Languages HOPLA and Affine-HOPLA. Transition semantics. Denotational semantics w.r.t. a domain theory based on relations between path orders. The domain theory as a categorical model of linear logic. Full abstraction. Soundness and adequacy for HOPLA. Accompanying logics. Mention of Nominal HOPLA.
2. Categories of models for concurrency (3 lectures). Categories of Transition systems, Event structures, Petri nets, Mazurkiewicz trace languages. Relating models by adjunctions. Bisimulation via open maps. Presheaf models. Theorem that connected-colimit preserving functors between presheaf categories preserve open maps.
3. Processes as generalized relations (2 lectures). Profunctors and spans. The way forward.

OBJECTIVES

On completion of this module students should:

- Be familiar with a domain theory for concurrency and (fairly concrete) techniques for solving recursive domain equations and establishing the logical relations needed for adequacy.
- Understand a range of models for concurrency (Petri nets, event structures, Mazurkiewicz trace languages, transition systems) and how they are related by adjunctions.
- Have an understanding and intuition of presheaf models for concurrency.

ASSESSMENT

By take-away exam. A grade in the form a percentage will be assigned by GW.

RECOMMENDED READING

Available from <http://www.cl.cam.ac.uk/users/gw104/> :

Mikkel Nygaard, Glynn Winskel: Domain theory for concurrency. *Theor. Comput. Sci.* 316(1): 153-190 (2004).

Glynn Winskel, Mogens Nielsen: Models for Concurrency. Chapter in the *Handbook of Logic and the Foundations of Computer Science*, vol. 4, pages 1-148, Oxford University Press, 1995. In DAIMI and BRICS reports series RS-94-12

André Joyal, Mogens Nielsen, Glynn Winskel: Bisimulation from Open Maps. *Inf. Comput.* 127(2): 164-185 (1996)

Gian Luca Cattani, Glynn Winskel: Profunctors, open maps and bisimulation. *Mathematical Structures in Computer Science* 15(3): 553-614 (2005)

Marcelo P. Fiore, Gian Luca Cattani, Glynn Winskel: Weak Bisimulation and Open Maps. *LICS 1999*: 67-76

Glynn Winskel: Relations in Concurrency. Invited (tutorial-style) paper *LICS 2005*: 2-11

Last updated: August 2008