First PURE Seminar

Algebras of Program Construction

When & Where:
21 and 22 June 2004
Department of Informatics
Minho University

Lecturer
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Information Technology
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UK

Context
PURE Project
FCT POSI/ICHS/44304/2002

www.di.uminho.pt/pure

Schedule

21	09.30	*Lectures*
	11.00	Coffe Break
	11.30	*Lectures*
	13.00	Lunch
	14.30	*Lectures*
	16.00	Coffe Break
	16.30	*Lectures*
	18.00	*End of Day 1*
22	09.30	*Lectures*
	11.00	Coffe Break
	11.30	*Lectures*
	13.00	Lunch
	14.30	*Lectures*
	16.00	Coffe Break
	16.30	*Lectures*
	18.00	*End of Day 2*
	20.00	*Informal Dinner*

Abstract:

This seminar is an advanced course on fundamental algebraic principles of program construction. Lectures will demonstrate the importance of algebraic properties in the design of algorithms, and introduce and discuss the concepts most fundamental to the design process. In particular, the use of fixed points and Galois connections will be emphasised. The framework for formulating these concepts is calculational. That is, all properties and definitions are presented in a way that is conducive to precise and concise formal calculation.

Topics:

1. **Partial Orders and Galois Connections**
   (Prior knowledge of partial orders assumed, but briefly reviewed. Examples of Galois connections; reasoning with Galois connections.)

2. **Fixed Point Calculus**
   (Calculational rules, applications to language problems and searching problems.)

3. **The Fusion Theorem**
   (The fusion theorem is a fundamental result that combines Galois connections with fixed points. It is used to express the solution of a problem as a fixed-point computation. The lecture will apply the theorem to some of the problems introduced in lectures 1 and 2.)

4. **Well-founded Relations**
   (Well-founded relations are the basis of program termination properties. This lecture shows how they are formulated in terms of fixed points. A proof of Newman's lemma demonstrates the power of the calculational formulation.)

5. **Category Theory as Constructive Lattice Theory**
   (A short introduction to category theory that demonstrates how it can be seen as a "coherently constructive" generalisation of the theory presented in earlier lectures. Some prior knowledge of the basic notions of category theory (object, arrow, functor and natural transformation) would help, but is not essential.)

6. **Relations and Datatype Algebra**
   (Relation algebra, domains, relators and their properties. Commuting datatypes)

Background:

Prior knowledge of some basic mathematics will be assumed, in particular the notion of a partial ordering. Some examples will be taken from language theory (regular and context-free grammars), knowledge of which is also assumed. For some lectures, the use of datatypes and parametric polymorphism as in a functional programming language will be needed.

Registration:

Registration is *free* but *mandatory*. Please send an email to Luis Barbosa (lsb@di.uminho.pt), no later than 18th June, with your contact details. On both days lunch will be arranged (but not covered!) at the University Restaurant — please let us know whether you intend to come.

Registered participants will receive a copy of a draft text on *The Mathematics of Program Construction*, which will be used to support the material presented in lectures. The lectures will overview the material, with some detailed analysis of specific examples.