

TYPES Review

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Outline

Formal Mathematics and Mathematics Education in TYPES

Foundational Research in TYPES

WP3: Thematic Workshops

Formal Mathematics in TYPES

- ▶ Flyspeck project (Hales' proof of Kepler conjecture)
 - ▶ Enumeration of tame graphs (TU Munich). Formalisation cut the number of graphs to consider nearly in half.
 - ▶ Non-linear inequalities (INRIA Futurs).
 - ▶ Proving bounds for real linear programs (TU Munich). (Also a contribution to proof technology, as this general solution can be used in other problems.)
- ▶ Proofs of primality in type theory (INRIA Futurs, INRIA Sophia). Biggest prime ever mechanically checked.
 - ▶ Proof technology: high speed formal computation by reflection.
- ▶ Mizar mathematical library continues to grow (Bialystok). E.g. a proof of the Jordan curve theorem.

Formal Mathematics in TYPES (II)

- ▶ Workshop day with the DIAMANT (Discrete, Interactive and Algorithmic Mathematics, Algebra and Number Theory) Netherlands mathematics cluster (Nijmegen).
- ▶ Exact real arithmetic (INRIA Sophia, Nijmegen, Udine, Padova).
- ▶ Extraction of programs from proofs in constructive algebra.
- ▶ Weyl's predicative mathematics (RHUL).
- ▶ Study of formalized proofs with gaps (Manchester, Nijmegen).
- ▶ Projective plane geometry (Bergen).
 - ▶ Proof technology: automated deduction.
- ▶ Constructive/point-free topology (Stockholm and Uppsala and Chalmers and Nijmegen, Padova).
- ▶ Finite groups (INRIA Sophia).

Mathematics Education in TYPES

- ▶ Textbook under development: *Type theory for constructive mathematics* (Chalmers and Uppsala).
- ▶ Textbook published: *Lectures on the Curry-Howard Isomorphism* (Warsaw)
- ▶ Distance learning and computer-supported maths education (Novi Sad with Univ. Maribor, Slovenia).

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WP3: Thematic Workshops

Foundational Research in TYPES

- ▶ Logical frameworks, representation of logics, coercive subtyping (RHUL and Toulouse, Manchester, Edinburgh).
- ▶ Nominal logic, reasoning about binding constructs (TU Munich and LMU, Edinburgh).
- ▶ Constructivity and computation in classical logic (Paris 7).
- ▶ Pattern calculus: computation based on pattern matching (Paris 7 and external, Nottingham and St. Andrews).
- ▶ Logic programming with linear logic, programs from proofs in linear logic (Paris 7, INRIA Futurs, TU Munich).
- ▶ Equality, intentionality, proof irrelevance in type theory (Nottingham, INRIA Futurs).
- ▶ Rewriting and termination (INRIA Futurs, Chalmers and Swansea, LORIA, Warsaw, Minho, Toulouse)

Foundational Research in TYPES (II)

- ▶ Program extraction from normalisation proofs (Swansea and TU Munich and Paris 7 and LMU).
- ▶ Game semantics (Birmingham, Paris 7, INRIA Futurs, Swansea).
- ▶ Domain theory in type theory, programming language semantics and general recursion (INRIA Sophia).
- ▶ Semantics of partiality, input/output (Tallinn and Nottingham).
- ▶ Containers: strictly positive data structures (Nottingham).
- ▶ Coherent logic in type theory (Bergen)
 - ▶ Proof technology: automated deduction.

Foundational Research in TYPES (III)

- ▶ Union and intersection types (Novi Sad).
- ▶ Sequent calculus presentation of Pure Type Systems (Paris 7 and St. Andrews).
- ▶ Structural proof theory and multiary lambda calculus (Minho)
- ▶ Towards dependent types for object oriented languages (Swansea).
- ▶ Probablility of normalisation in lambda calculus (Savoie).

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WP3: Thematic Workshops

Workpackage Specification from Annex I

- ▶ *During the project we will hold small specialized workshops, typically two per year, on selected thematic topics.*
- ▶ *The SC will decide on the actual topics of the workshops, soliciting input from the site leaders and the participants.*
- ▶ *We encourage the participants to organize more than 6 workshops [in the 3-year project], if the need is felt.*

Proposed Future Workshops

- ▶ 3WFTop: Third Workshop on Formal Topology
 - ▶ Workshop and tutorials, 7–12 May 2007, Padova.
 - ▶ Scientific committee: Chalmers, Padova, LMU Munich.
 - ▶ Two previous WFTop (1997, 2002), organized by Padova and supported by previous TYPES projects.
- ▶ Rewriting and Proof Editors (INRIA Futurs will organize).
- ▶ Design and implementation of proof editors (Nottingham will organize).
- ▶ Generic Programming (Suggested by Chalmers).
- ▶ Dependent types in programming (no organizer yet).
 - ▶ Previous workshop on this topic, 2003.

Thematic Workshops in Year 2 of TYPES

- ▶ MERLIN 2005: MEchanized Reasoning about Languages with variable biNding
 - ▶ Sept. 2005, in Tallinn
- ▶ Constructive Analysis, Types and Exact Real Numbers
 - ▶ Oct. 2005, in Nijmegen
- ▶ WIT 2005: Workshop on Isomorphisms of Types
 - ▶ Oct. 2005, in Toulouse
- ▶ MSFP 2006: Mathematically Structured Functional Programming
 - ▶ Jul. 2006, in Kuressaare (Tallinn site)

MERLIN 2005: MEchanized Reasoning about Languages with variable biNding

Users (e.g. programming language theorists) want to apply the results of this topic.

- ▶ Sept. 2005, in Tallinn, satellite of ICFP 2005.
- ▶ Program committee: 8 people, from four sites plus 2 external.
- ▶ Web page with program online.
- ▶ Refereed printed proceedings, also online.
- ▶ External invited speaker.
- ▶ 30 official registrations
- ▶ Panel discussion drew many people.

Constructive Analysis, Types and Exact Real Numbers

- ▶ Oct. 2005, in Nijmegen.
- ▶ 34 participants, 14 talks including 2 external invited speakers.
- ▶ Much external interest
- ▶ Web page with program online.
- ▶ Formal refereed proceedings will appear as a special issue of Mathematical Structures in Computer Science.
- ▶ “Many Digits” competition for implementations.
 - ▶ e.g. calculate the first 10,000 digits of $\sin(\sin(1))$.

WIT 2005: Workshop on Isomorphisms of Types

- ▶ Oct. 2005, in Toulouse
- ▶ Organizing/program committee from 3 sites and one external.
- ▶ 7 presentations, 17 participants.
- ▶ Program and informal proceedings online.

MSFP 2006: Mathematically Structured Functional Programming

- ▶ Jul. 2006, in Kuressaare (Tallinn), satellite of MPC 2006.
- ▶ Program committee: 12 people, from 6 sites plus 5 external.
- ▶ printed proceedings at workshop.
- ▶ Program and refereed proceedings online.
- ▶ 2 invited speakers, 1 external.