

PhD Course on Type Theory and Programming Languages

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Program

1) Introduction to type theory in programming languages.

Main arguments:

General revision of principal notions about Simply Typed Lambda Calculus.

Overview on Curry-Howard isomorphism

PCF (Programming with computable functions): syntax, type system, operational semantics, big step semantics, main theorems.

2) Polymorphism

Main arguments:

Introduction to Polymorphism: Type Variables and Substitutions:

Varieties of Polymorphism (intro)

System F, Universal type, universal substitution, Examples.

Varieties of Polymorphism (cont.).

Milner's Let-Polymorphism (basic ideas)

3) Higher Order Systems

Main arguments:

Type Operators and Kinding, Higher Order Polymorphism,
Dependent Types, Higher Order Subtyping

4) Session types, A Basis for Concurrency and Distribution.

Main arguments:

Motivations (session types as a basis for Concurrency and Distribution), and basic concept.

References:

1) B.C. Pierce, Types and Programming Languages, The MIT Press

2) C.A. Gunter, Semantics of Programming Languages: Structures and Techniques, The MIT Press.

3) C.A. Gunter, The Semantics of Types in Programming Languages, downloadable at
<ftp://ftp.cis.upenn.edu/pub/papers/gunter/hltcs94.pdf.Z>

4) P. Selinger, Lecture Notes on the Lambda Calculus, downloadable at
<https://arxiv.org/abs/0804.3434>

5) H. Barendregt, Lambda Calculi with Types, downloadable at
ttic.uchicago.edu/~dreyer/course/papers/barendregt.pdf

6) Prof. Luca Paolini's slide about PCF's denotational semantics and full abstraction problem
downloadable at <http://www.di.unito.it/~paolini/> (summer schools courses)

7) J-Y Girard, Y. Lafont and P. Taylor. Proofs and Types, Cambridge University Press,
downloadable at iml.univmrs.fr/~lafont/pub/prot.pdf.gz

8) M. Dezani Cincaglini, U. De'Liguoro, Sessions and Session Types: an Overview, downloadable
at www.di.unito.it/~dezani/papers/sto.pdf

Articoli interessanti e proposte per la prova di esame (seminario di 30-45 minuti)--elenco in aggiornamento

- Sull'equivalenza di strategie di riduzione: G. Plotkin, Call by value, call-by-name and the lambda calculus, [Theoretical Computer Science, Volume 1, Issue 2](#), 1975, Pages 125-159. Sul polimorfismo parametrico (con approfondimento sull'algoritmo di inferenza di tipo): R. Milner, A theory of type polymorphism in programming, [Journal of Computer and System Sciences, Volume 17, Issue 3](#), 1978, Pages 348-375.
- Semantica categoriale lambda calcolo tipato semplice (A. Asperti, G. Longo, CATEGORIES, TYPES AND STRUCTURES, MIT press, 1991).
- Semantica denotazionale per PCF e problema della full abstraction (Gunther, Paolini).
- Applicazione dei tipi sessione: Kouzapas et al. Typechecking protocols with Mungo and StMungo: A session type toolchain for Java.
- Tipi e programmi Concorrenti: N. Benton et al: Effect-dependent transformations for concurrent program, [Science of Computer Programming, Volume 155](#), 2018, Pages 27-51
- Higher Order, Coq proof assistant and Intuitionistic Type Theory. B. Barras et al.: CoqMTU: a higher-order type theory with a predicative hierarchy of universes parametrized by a decidable first-order theory.
- Dependent Types for the Coq proof assistant: idee principali tipi dipendenti e esempi significativi di programmazione in Coq.