Modern Type Theories and Their Applications

Zhaohui Luo
Royal Holloway, Univ of London
zhaohui.luo@hotmail.co.uk
https://www.cs.rhul.ac.uk/home/zhaohui/

This talk consists of two parts. In Part I, I'll introduce *modern type theories*, as studied by Martin-Löf and others [6, 2, 3, 5], briefly discussing their historical development, meaning-theoretic and meta-theoretic studies and employment in proof technology. Then, in Part II, I'll give an overview of the following two applications of type theory:

- *Univalent foundations* of mathematics, as proposed by Voevodsky [10] and studied formally in homotopy type theory [8]. The new framework provides a fresh look at foundational issues, covering both traditional set-theoretical mathematics and new higher-dimensional mathematics and providing a good basis for computer-assisted proof development.
- Natural language semantics in modern type theories (*MTT-semantics* for short) [9, 4, 1]. Thanks to its recent development [1, 5], MTT-semantics has become a full-blown alternative to the traditional formal semantics (Montague semantics [7]), with attractive features and a promising future.

If time permits, I'll also discuss some ongoing research topics in both of the above fields, albeit only briefly.

References

[1] S. Chatzikyriakidis and Z. Luo. *Formal Semantics in Modern Type Theories.* Wiley/ISTE, 2020.

[2] T. Coquand and G. Huet. The calculus of constructions. *Info. & Comp.*, 76(2/3), 1988.

[3] Z. Luo. *Computation and Reasoning: A Type Theory for Computer Science.* Oxford Univ. Press, 1994.

[4] Z. Luo. Formal semantics in modern type theories with coercive subtyping. *Linguistics and Philosophy*, 35(6):491–513, 2012.

[5] Z. Luo. *Modern Type Theories: Their Development and Applications.* Tsinghua University Press, 2024. (In Chinese).

[6] P. Martin-Löf. *Intuitionistic Type Theory.* Bibliopolis, 1984.

[7] R. Montague. *Formal Philosophy.* Yale University Press, 1974. Collected papers edited by R. Thomason.

[8] The Univalent Foundations Program. *Homotopy type theory: Univalent foundations of mathematics.* 2013.

[9] A. Ranta. *Type-Theoretical Grammar.* Oxford University Press, 1994.

[10] V. Voevodsky. An experimental library of formalized mathematics based on univalent foundations. *Mathematical Structures in Computer Science*, 25:1278–1294, 2015.