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Geometry of Interaction and the Dynamics of Proofs

Girard's Geometry of Interaction (GoI) program develops a mathematical modelling of the dynamics of cut-elimination in proof-theory. Girard's work (1988–1995, 2004–) is stated in the language of operator algebras. He gave a novel modelling of proofs, interpreting cuts via feedback in an intrinsic theory of types, data and algorithms. However, as emphasized by Hyland and Abramsky, there are deep connections of GoI with the recent theory of traced monoidal categories of Joyal–Street–Verity. Indeed, traces lead to new insights into Girard's Execution Formula, a kind of power series representing an invariant of cut-elimination. Recently, in a series of papers, E. Haghverdi and I have re-examined the categorical foundations of GoI. For example, we develop a typed version, Multiobject GoI (MGoI), which includes all previous as well as several new models. MGoI depends on a new theory of partial traces, trace classes and an abstract theory of orthogonality (related to work of Hyland and Schalk). I shall survey some of this recent work, along with Soundness and Completeness Theorems for GoI semantics. If time permits, we also explore some of the new directions in GoI.