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Towards a Theory of Integral Linear Logic via Rota-Baxter algebras

Differential linear logic, as introduced by Ehrhard and Regnier, extends linear logic with an inference rule which is a syntactic version of differentiation. The corresponding categorical structures, called differential categories, were introduced by Blute, Cockett and Seely. Differential categories are monoidal categories equipped with a comonad which endows objects in its image with a cocommutative coalgebra structure. There is also a natural transformation, called the deriving transform, which models the differential inference rule. The large number of examples of differential categories demonstrate the utility of the idea. These include the convenient vector spaces of Frohlicher and Kriegl.

It is an ongoing project to develop similar notions of integral linear logic and integral categories. An appropriate place to draw inspiration for this is the theory of Rota-Baxter algebras. Rota-Baxter algebras are associative algebras with an endomorphism which satisfies an abstraction of the integration by parts formula. There are many examples of such algebras and multi-object versions of these examples should provide important examples of models of integral linear logic.