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Monoidal categories, Joyal's species, and combinatorial Hopf algebras

We provide a categorical framework for the construction and study of combinatorial Hopf algebras. Two central notions are Joyal's species and bilax monoidal functors. A species is a combinatorial version of a graded vector space. A good example of a bilax monoidal functor arises in topology, in the context of simplicial sets and chain complexes: the bilax structure is afforded by the Alexander–Whitney and Eilenberg–Zilber maps. We discuss analogous functors in the context of species and graded vector spaces that form the basis for our applications to combinatorial Hopf algebras. The categorical approach yields uniform deformations and higher dimensional generalizations of these objects. We encounter at this point a remarkable connection between species and combinatorial Hopf algebras on the one hand, and quantum groups and the classification theory of abstract Hopf algebras on the other.

This is part of joint work with Swapneel Mahajan.