



Trialgebras and families of polytopes

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(Submitted on 6 May 2002)

We show that the family of standard simplices and the family of Stasheff polytopes are dual to each other in the following sense.

The chain modules of the standard simplices, resp. the Stasheff polytopes, assemble to give an operad. We show that these operads are dual of each other in the operadic sense. The main result of this paper is to show that they are both Koszul operads. As a consequence the generating series of the standard simplices and the generating series of the Stasheff polytopes are inverse to each other. The two operads give rise to new types of algebras with 3 generating operations, 11 relations, respectively 7 relations, that we call $\{\text{it associative trialgebras}\}$ and $\{\text{it dendriform trialgebras}\}$ respectively. The free dendriform trialgebra, which is based on planar trees, has an interesting Hopf algebra structure, which will be dealt with in another paper.

Similarly the family of cubes gives rise to an operad which happens to be self-dual for Koszul duality.

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Comments: 29 pages
Subjects: **Algebraic Topology**
(**math.AT**); Combinatorics
(math.CO); Rings and
Algebras (math.RA)
MSC classes: 18D50, 17D99, 52Bxx,
55Nxx, 55U10
Journal reference: Homotopy theory: relations
with algebraic geometry,
group cohomology, and
algebraic K -theory, 369--
398, Contemp. Math., 346,
Amer. Math. Soc.,
Providence, RI, 2004.
Cite as: [arXiv:math/0205043](https://arxiv.org/abs/math/0205043)
[math.AT]
(or [arXiv:math/0205043v1](https://arxiv.org/abs/math/0205043v1)
[math.AT] for this version)

Submission history

From: Loday [[view email](#)]

[v1] Mon, 6 May 2002 08:59:06 GMT (26kb)

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