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log TQFT

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Abstract

A class of logarithmic-functors is constructed which allow additive invariants on categories to be formulated as functors on A_∞ categories. Characters of such logarithmic representations provide a functorial structure for exotic torsions and include Chern characters, Reidemeister torsion and topological signatures. A number of examples are given.

The goal here is to put into place an algebraic theory, or rather a categorification, of logarithmic representations and their log-determinant characters.

Such characters provide a functorial setting for additive invariants arising as generalised Reidemeister torsions on bordism categories and may be viewed as semi-classical, positioned between genera (classical bordism invariants) and TQFTs (quantum bordism invariants); the former are homomorphisms

$$\mu : \Omega_* \rightarrow R$$

on the ring Ω_* of bordism classes of closed manifolds, such as the signature of a $4k$ dimensional manifold, while a TQFT (topological quantum field theory) of dimension n refers to a symmetric monoidal functor

$$Z : \mathbf{Bord}_n \rightarrow \mathbf{B}$$

from the bordism category \mathbf{Bord}_n , whose objects are smooth closed $(n-1)$ -dimensional manifolds M and whose morphisms are n -dimensional bordisms, to a target symmetric monoidal category \mathbf{B} .

The class of semi-classical bordism invariants considered here arise as characters of log-additive simplicial maps

$$\log : \mathcal{N}\mathbf{Bord}_n \rightarrow \mathcal{A} \tag{0.1}$$

from the nerve $\mathcal{N}\mathbf{Bord}_n$ of the bordism category to a simplicial set of rings \mathcal{A} . Such a map (0.1), called a *log-functor*, associates to each bordism $W \in \text{mor}(M_0, M_1)$ between closed manifolds M_0 and M_1 a logarithm $\log_{M_0 \sqcup M_1}(W)$ in a ring $F(M_0 \sqcup M_1) \in \mathcal{A}$ along with a hierarchy of compatible inclusions

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