Baez, John C.; **Erbele, Jason**
Categories in control. (English) Zbl 1316.18009
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Control theory is the arena of engineering studying how to manipulate systems with inputs and outputs to attain desired goals. The authors argue that signal-flow diagrams in control theory are no other than string diagrams in a symmetric monoidal category from a category-theoretic viewpoint. The symmetric monoidal category at issue is $\mathrm{Fin}\,\mathrm{Re}\,\mathrm{l}_k$ of finite-dimensional vector spaces over a certain field k as objects and linear relations rather than linear maps as morphisms endowed with direct sums in place of tensor products as the symmetric monoidal structure. The field k is $\mathbb{R}(s)$ consisting of rational functions in one real variable s. A linear relation from k^m to k^n is no other than a system of linear constant-coefficient ordinary differential equations relating m input signals and n output signals. The principal objective in this paper is to give a complete picture of the symmetric monoidal category by generators and relations, the former being familiar components of signal-flow diagrams. The paper suggests an intangible connection to the diagrammatic approach to quantum theory, where the symmetric monoidal category is the category of Hilbert spaces as objects and linear maps as morphisms endowed with the tensor product of Hilbert spaces as the symmetric monoidal structure.

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MSC:

18D10 Monoidal, symmetric monoidal and braided categories
16T10 Bialgebras
93-02 Research monographs (systems and control)

Keywords:

control theory; graphical calculus; Frobenius algebra; bialgebra; dagger-compact category; signal flow diagram

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