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A categorical model for 2-PDAs with states

The machine models for recognizing formal languages, finite automata (FAs), push-down automata (PDAs) and Turing machines (TMs), display little family resemblance.

We propose a categorical model for push-down automata with two stacks (2-PDAs) where states are genuinely orthogonal to the storage model, the stack. In fact, a single state suffices to ensure Turing-completeness. This cannot be achieved for Turing machines, where the storage model, the tape, is hopelessly intermingled with the states. Non-trivial state sets offer new modes of recognition and are essential for the notion of a deterministic machine.

Our model is not co-algebraic in nature but rather adds three further ingredients to Bob Walters' categorical approach to context-free grammars via special (co-)multigraph morphisms. It encompasses the tile model of Gaducci and Montanari for rewriting and semantics.

In 2-PDAs, as opposed to Turing machines, spontaneous transitions can be constrained quite naturally to obtain restricted classes of languages strictly between context-free and semi-decidable ones. Strict subclasses of context-sensitive languages similar to (linear) indexed languages may be of interest in mathematical linguistics, where context-freeness is too weak, while context-sensitivity is too strong.