# CT for BX: Category Theory Foundations for Bidirectional Model Transformations

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**Abstract.** Model-driven engineering (MDE) is a prominent approach to software development, in which models of the domain and the software system are primary assets of the development process. Normally, models are inter-related, perhaps in a very complex way, and keeping them mutually consistent (synchronized) is a difficult task, which is crucial for MDE. An important special case is synchronization of two models: changes in one of them must be propagated to the other. This setting is now called *bidirectional model transformation* or BX.

Algebraic frameworks for BX have a long history going back to the 1980s, when simple algebraic models were applied for the infamous view update problem in databases. Over the past decade, these models were clarified, refined and essentially developed by the Harmony Group (Benjamin Pierce *et al*) in their work on developing programming languages for string-based data synchronization. Their framework is based on an interesting algebraic structure called a *lens*.

Model synchronization requires adding to the framework one more crucial ingredient — mappings (relationships) between models, or *deltas*, which results in the notion of a *delta lens*. The latter is an algebra comprising several diagrammatic operations on models and model mappings, which satisfy several equational laws. Even an initial algebraic elaboration of the delta lens framework leads to categorical constructs often considered advanced, e.g., profunctors and fibrations. On the other hand, update propagation operations constituting a delta lens lack universal properties, so that a genuinely categorical specification of delta lenses is not straightforward. In any case, categorical methods are invading the BX area, and amongst eight papers accepted for the BX workshop collocated with ETAPS'12, at least three can be tagged as "essentially categorical".

The goal of the talk is to present an overview of the area and some recent results, including those obtained in collaboration with Krzysztof Czarnecki, Yingfei Xiong and Tom Maibaum (Canada), and Frank Hermann, Hartmut Ehrig and Fernando Orejas (Europe).