A Relational `map` Function

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Relation algebra is a well-known tool, known for its expressive power and rigorosity. In many cases certain properties can be considered "human-readable", once a small set of ground rules has been established. One particularly important application is the modelling of subsets of some fixed carrier set. Given a set of subsets of a carrier set, one may be interested in keeping only those subsets, which satisfy some kind of predicate.

Abstracting from the special case above we wish to apply some function to every element of a set, where the set is modelled algebraically as a single relation. This bears some resemblance to the well-known `map` function from functional programming. In fact, we need to decompose the relation into a collection of objects, apply a given function to every object and, finally, put the result back together.

We present a technique for said decomposition and rebuilding and thus develop a relational version of a `map` function. What is more is that we study purely algebraic properties of this function. It turns out that in many cases, one can completely omit any explicit decomposition and rebuilding by simply exchanging certain types or performing some special relational constructions. We provide examples of how to apply these algebraic properties to a variety of problems.