**With the abundance of natural data from physical systems, much engineering and scientific value comes from an ability to discover the underlying, governing equations of a system, with little prior knowledge. Current approaches for data-driven system identification either find relationships in the data that aren’t interpretable, or require significant prior knowledge from the user. This work describes a new approach to system identification that requires minimal user input and discovers governing equations that are parsimonious, generalizable and interpretable. This is enabled by recent advances in expression optimization, allowing for the automated discovery of mathematical expressions from a combinatorically large set of possibilities. Using simulated data, our approach correctly identifies both linear and nonlinear PDEs including the Navier-Stokes equations. It can also generate exact and approximate Koopman eigenfunctions for nonlinear ODEs. The ability to interpret large amounts of data will allow researchers to better understand and control important natural systems, such as the earth’s climate, for addressing global warming and fluid flow for more efficient energy generation and transportation.**