

# Using Analytical Equations to Represent Nonlinear Relationships

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## Abstract

Table functions, also referred to as graphical functions, provide a powerful and user-friendly way to represent nonlinear relationships between variables in system dynamics models. However, in many cases modelers may benefit from using analytical equations to represent nonlinear relationships for model sensitivity testing and also for communicating with researchers in other fields and disciplines. We propose a set of analytical equations that can be used to represent some of the most common types of nonlinear functions used in system dynamics models. Specifically, this paper provides guidance on using the generalized logistic function, the exponential function, the modified exponential function, the quadratic function, the logarithmic function and the power function to replace existing table functions. Importantly, we also present a version of each equation that includes an interior reference point. We demonstrate how these analytical equations can be applied in system dynamics models by replacing the table functions in the original World Dynamics model.

**Keywords.** Table functions, nonlinear relationships, generalized logistic equation, exponential function, quadratic function, power function, logarithmic function