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# System Dynamics

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## 1 Introduction

This tutorial is intended to introduce system dynamics modeling concepts and techniques using the R programming language. The concepts and techniques presented herewithin are simple examples designed for the reader to follow along using R Studio. Therefore, both R and R Studio are suggested in order to fully benefit from the proceeding tutorial.

### 1.1 Packages

The following packages are used throughout the tutorial. The `deSolve` package is primarily used to calculate the differential equations and numerical integration. Other required packages include `ggplot2`, `gridextra`, `plyr`, `magrittr`, and `grid`. These packages support visualizations, data frame manipulation, and pipe operators.

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```
library(deSolve) #supports numerical integration using a range of numerical methods
library(ggplot2) #supports visualization of layered graphics
library(gridExtra) #supports visualization of multiple plots & graphs
library(plyr) #supports data frame merging
library(magrittr) #supports pipe function
library(grid) #supports additional graphing capability
```

## 2 System Dynamics Background

System dynamics is a methodology applicable to modeling factors of a convoluted system of interdependent factors such as the one presented in this tutorial. Jay Forrester discovered system dynamics following his work with management at General Electric and with radar systems for the US Navy. He blended the complexities of social systems with physical systems at the recently established School of Management at the Massachusetts Institute of Technology, or MIT (Forrester 1968). Forrester describes systems as

