Extract from the user's guide `ddesolve-UG.pdf` *found in the root directory of the* **ddesolve** *library. For further information, please see the complete guide.*

4.1. Cooling - Newton's Law of Cooling (ODE Example)

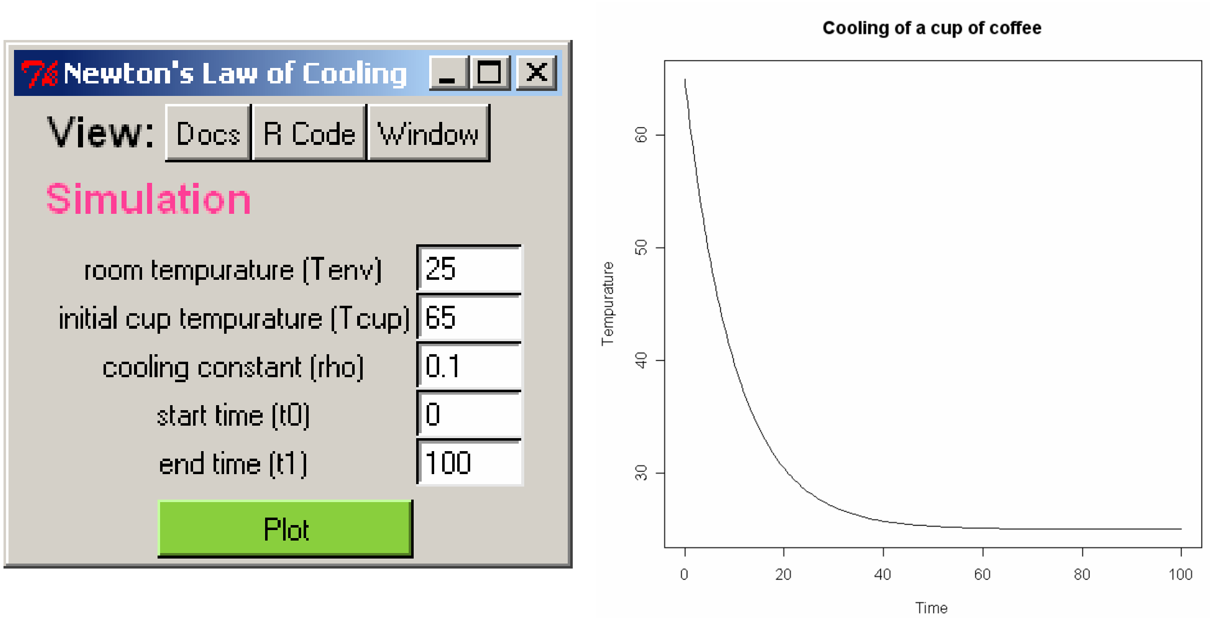

Figure 1. Newton's Law of Cooling demonstration.

This demo illustrates how to set up and solve a single ODE with **ddesolve**. For historical background, see http://en.wikipedia.org/wiki/Heat_conduction#Newton.27s_law_of_cooling. Imagine a hot cup of coffee that cools toward room temperature, where a constant ρ determines the rate of cooling. Newton's Law of Cooling suggests a simple differential equation to determine the coffee temperature $y(t)$ at time *t*:

$$\frac{dy}{dt} = -\rho\,(y - T_{\text{env}}),$$

where T_{env} is the ambient room temperature. If $y(0) = T_{\text{cup}}$ denotes the initial temperature of the coffee, then this equation has the analytical solution

$$y(t) = T_{\text{env}} + \left(T_{\text{cup}} - T_{\text{env}}\right) e^{-\rho t},$$

where $y(t) = T_{\text{cup}}$ when $t = 0$ and $y(t) \to T_{\text{env}}$ as $t \to \infty$. The GUI in Figure 1 displays the code when you press the "R Code" button, as long as R-files (`*.r`) are associated with a suitable text editor on your system. Similarly, "Docs" displays documentation and "Window" displays the script used to produce the GUI. In this example, two key lines of the code are:

```
myGrad <- function(t, y) {return( -rho*(y[1]-Tenv)}
dde(y=Tcup, func=myGrad, times=seq(t0,t1,length=100), hbsize=0)
```

The parameters `rho`, `Tenv`, `Tcup`, `t0` (the start time), and `t1` (the end time) come from the GUI. This ordinary differential equation does not need a history buffer, so `hbsize=0`.