ODE Example with Springs

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Intro

This is a simple example using the deSolve package to model the motion of springs. The following webpage has an excellent walkthrough of the thoery

http://tutorial.math.lamar.edu/Classes/DE/Vibrations.aspx

Load the deSolve Package

As well as ggplot2 for graphing

```
library(deSolve)
library(ggplot2)
```

Free Undamped Vibration

The simplest senario

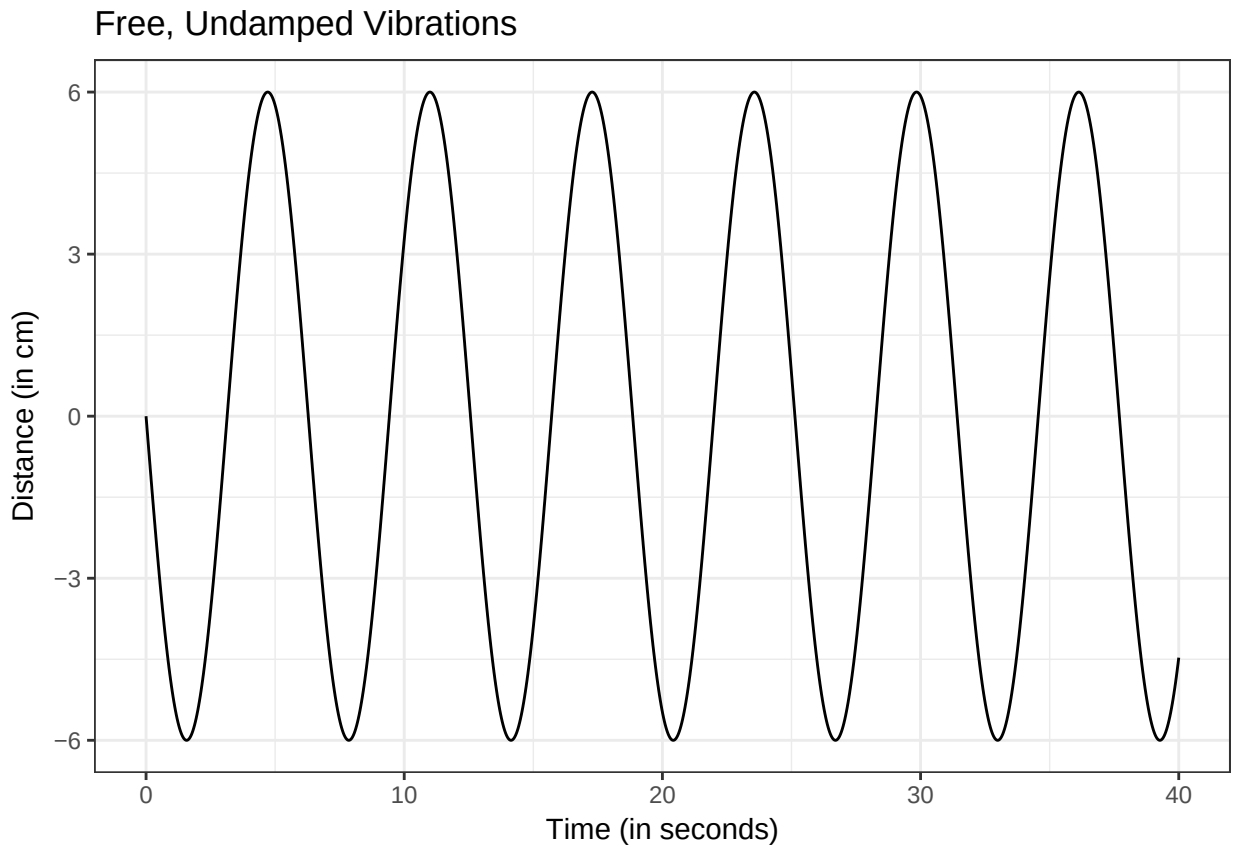
```
#Define the model parameters with k a the spring constant and m the mass
parameters = c(k = 1,m = 1)

#Define Model
Spring <- function(t, States, parameters) {
  with(as.list(c(States, parameters)),
       list(c(v,
              -(k/m)*y))
  )
}

#start with spring in position 0 and -6 velocity
States = c(y = 0, v = -6)

#Define a vector specifying the time intervals
times <- seq(0,40, by = 0.005)

#Run Model
result <- ode(y = States, times = times, func = Spring, parms = parameters)
```



Free, Damped Vibrations

We now add a damping constant g.

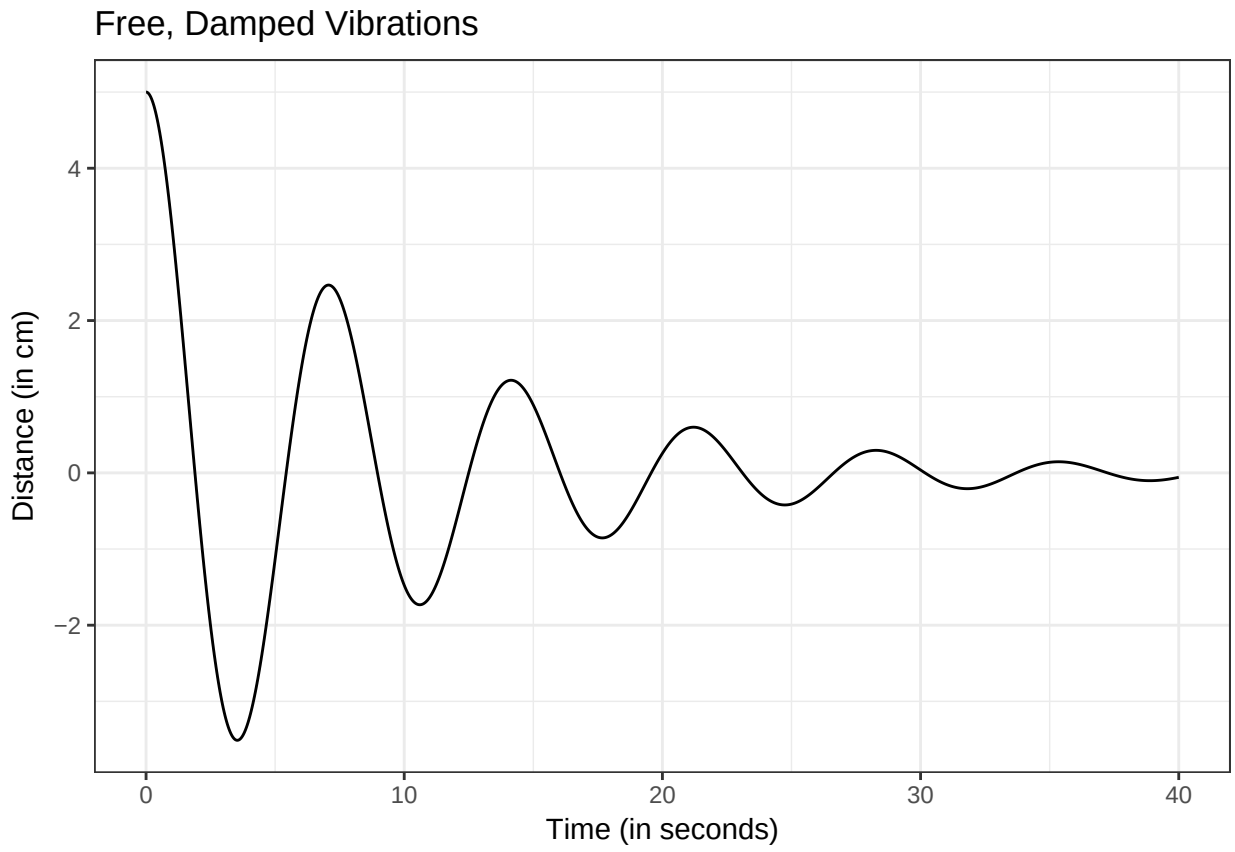
```
parameters = c(k = 1,m = 1, g = .2)

Spring <- function(t, States, parameters) {
  with(as.list(c(States, parameters)),
       list(c(v,
              -(k/m)*y) - (g/m)*v)
  )
}

#start with spring in position 5 and zero velocity
States = c(y = 5, v = 0)

times <- seq(0,40, by = 0.005)

damped <- ode(y = States, times = times, func = Spring, parms = parameters)
```



Undamped, Forced Vibrations

We add a forcing term which is a cosine function.

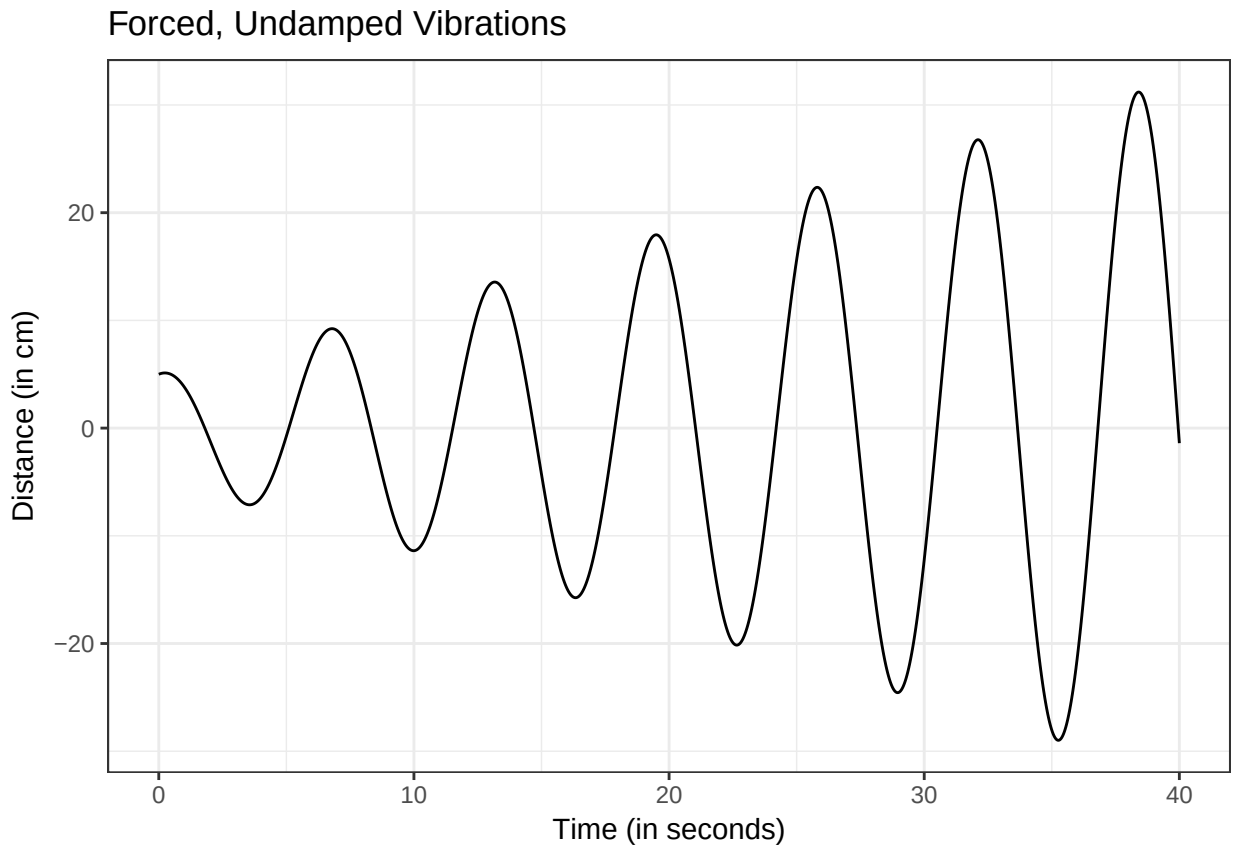
```
parameters = c(k = 1,m = 1, g = 0, w = 1)

Spring <- function(t, States, parameters) {
  with(as.list(c(States, parameters)),
       list(c(v,
              -(k/m)*y) - (g/m)*v + cos(t*w))
  )
}

#start with spring in position 5 and zero velocity
States = c(y = 5, v = 0)

times <- seq(0,40, by = 0.005)

forced <- ode(y = States, times = times, func = Spring, parms = parameters)
```



#Damped, Forced Vibrations We add a forcing term which is a cosine function.

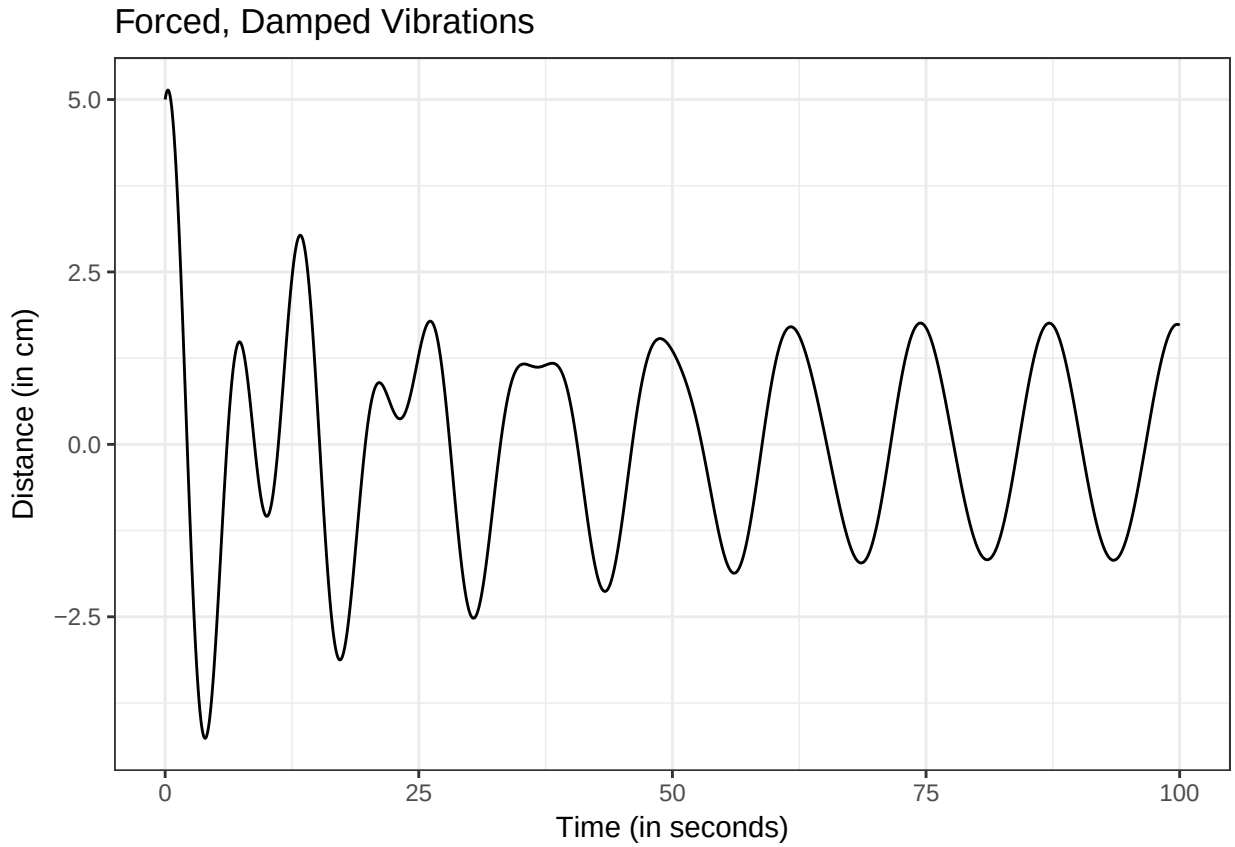
```
parameters = c(k = 1,m = 1, g = .1, w = .5)

Spring <- function(t, States, parameters) {
  with(as.list(c(States, parameters)),
       list(c(v,
              -(k/m)*y) - (g/m)*v + cos(t*w))
  )
}

#start with spring in position 5 and zero velocity
States = c(y = 5, v = 0)

times <- seq(0,100, by = 0.005)

forced_damp <- ode(y = States, times = times, func = Spring, parms = parameters)
```


Forced, Damped Vibrations
5.0
2.5
0.0
−2.5
Distance (in cm)
0
25
50
75
100
Time (in seconds)