Coursework 2

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Question 1

Q1. We first implement the deterministic model:

```
#Implement the deterministic model

library(ggplot2)

# Declaring common constants
alpha = 0.05
beta = 0.00012
gamma = 0.04
weeks = 103
```

- Set R1 = 60 and F1 = 30.

```
### Setting initial values for Deterministic models

R1 = 60
F1 = 30
```

- Using existing functions in R, write the necessary for loop to implement the Lotka-Volterra model that will allow you to project the number of foxes and rabbits at the end of a 2-year period i.e. after 103 more weeks.

```
# Implementing the deterministic model

for ( w in 1:(weeks-1))
{
  R1[w+1] = R1[w] + alpha* R1[w] - beta*R1[w] *F1[w]
  F1[w+1] = F1[w] + beta* R1[w]* F1[w] - gamma * F1[w]
}
```

- Print the last few values of the final result of Rt and Ft.

```
tail(R1)
```

```
## [1] 182.32801 139.82668 107.94989  84.03695  66.03831  52.41642
```

```
tail(F1)
```

```
## [1] 2359.197 2316.447 2262.657 2201.461 2135.603 2067.103
```

Question 2

Q2. A stochastic version of the Lotka-Volterra model exists in a similar manner to the stochastic version of the population growth model. In this case, the number of rabbits born is Binom(Rt, alpha), the number of rabbits eaten (new foxes) is Binom(RtFt, beta), and the number of foxes that die is Binom(Ft, gamma).

- Set the seed for running your code to 17540

```
### Setting initial values for Stochastic models

set.seed(17540)
sto_R = 60
sto_Fx = 30
```

- Using existing functions in R, write the necessary for loop to implement the stochastic Lotka-Volterra model that will allow you to project the number of foxes and rabbits at the end of a 2-year period i.e. after 103 more weeks, with the same starting values as for the deterministic model.

```
#Implementing the Stochastic model

for ( w in 1:(weeks-1))
{
  no_of_foxes_eaten = rbinom(1,sto_R[w]*sto_Fx[w], beta)
  sto_R[w+1] = sto_R[w] + rbinom(1,sto_R[w],alpha) - no_of_foxes_eaten
  sto_Fx[w+1] = sto_Fx[w] + no_of_foxes_eaten - rbinom(1, sto_Fx[w],gamma)
}
```

- Print the last few values of the final result of Rt and Ft

```
tail(sto_R)
```

```
## [1] 179 145 109  83  54  35
```

```
tail(sto_Fx)
```

```
## [1] 2497 2455 2411 2350 2289 2213
```

Question 3

Q3. Now we visualise the results:

- Create a long data frame called LV with three variables; time, group and size. Each row should contain the size at a single time point for one of the four groups generated rabbits and foxes (deterministic model); sto_rabbits and sto_foxes (stochastic model).

```
#Creating the new data frame

group_names = c('Rabbits','Foxes','sto_Rabbits','sto_Foxes')
LV = data.frame(time=rep(1:weeks,4),
                group=rep(group_names, each=weeks),
                size=c(R1,F1, sto_R,sto_Fx))
```

- Using ggplot() visualise the changes over time for the number of rabbits and foxes for both the deterministic and stochastic version of the Lotka-Volterra model. All four lines should be in one single plot.

```
# Visualizing changes

# Deterministic model is shown in red. Stochastic model is shown in blue.
# Foxes are shown as solid lines. Rabbits are shown as dashed lines.

ggplot(LV) + geom_line(aes(time, size, color=group, linetype=group), size=0.5)+
  scale_linetype_manual(values=c("solid","dashed","solid","dashed"))+
  scale_color_manual(values=c(rep("red",2), rep("blue",2)))+
  labs(x="Time in weeks ->", y="Population Size ->",
     title="Deterministic model vs Stochastic model")+
```

```
theme(legend.position = "bottom")
```