Coursework 2

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23/10/2021

Question 1

Q1. We first implement the deterministic model:

- Set R1 = 60 and F1 = 30.

```
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.

```
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] 139.82668 107.94989  84.03695  66.03831  52.41642  42.03523
```

```
tail(F1)
```

```
## [1] 2316.447 2262.657 2201.461 2135.603 2067.103 1997.421
```

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

```
#Implement the Stochastic model

#Setting initial values
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.

```
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] 145 109  83  54  35  30
```

```
tail(sto_Fx)
```

```
## [1] 2455 2411 2350 2289 2213 2142
```

Question 3

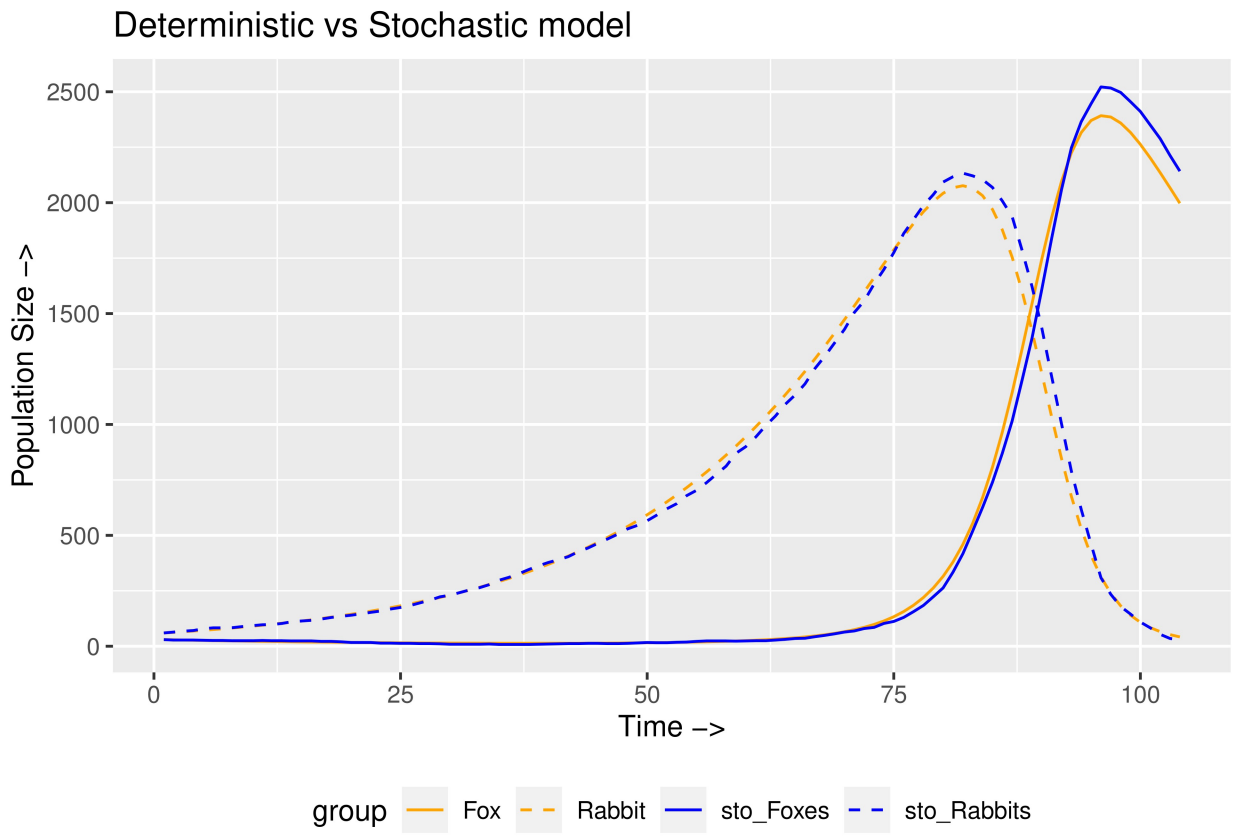
Q3. Now we visualise the results:

- 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).

```
group_names = c('Rabbit','Fox','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.

```
ggplot(LV) + geom_line(aes(time, size, color=group, linetype=group))+
  scale_linetype_manual(values=c("solid","dashed","solid","dashed"))+
  scale_color_manual(values=c(rep("orange",2), rep("blue",2)))+
  labs(x="Time ->", y="Population Size ->",
     title="Deterministic vs Stochastic model")+
  theme(legend.position = "bottom")
```


Deterministic vs Stochastic model
Population Size –>
2500
2000
1500
1000
500
0
0
25
50
75
100
Time –>
group
Fox
Rabbit
sto_Foxes
sto_Rabbits