Homework 4

Due: 11:59pm, Tue, Apr 28, 2020

1. **(Points=50)**
The Lotka-Volterra system of chemical reactions describes an ecological predator-prey (fox-rabbit) model. The chemical reactions for this model are as below.
    - Reaction A: growth of prey population:
    prey → 2 prey
    - Reaction B: consumption of preys:
    predator + prey → predator
    - Reaction C: death of predators:
    predator → ∅
    - Reaction D: increase of predator population:
    predator + prey → 2 predator + prey

    The Lotka-Volterra system assumes that:
    - the prey population ***x*** grows at a rate proportional to the current population (***A x dt***),
    - but when predators ***y*** are present, the prey population decreases at a rate proportional to the number of predator/prey encounters (***–B x y dt***);
    - the predator population declines at a rate proportional to the current population (***–C y dt***),
    - but increases at a rate proportional to the predator/prey meetings (***D x y dt***),

    where ***A***, ***B***, ***C***, and ***D*** are positive constants.

    The differential equations for the Lotka-Volterra system:

$$\frac{dx(t)}{dt} = A \cdot x(t) - B \cdot x(t) \cdot y(t)$$
$$\frac{dy(t)}{dt} = -C \cdot y(t) + D \cdot x(t) \cdot y(t)$$

Then generate the model using COPASI with follow information.

- Model
    - time units: *hours*
    - volume unit: *m^3*
    - quantity unit: *#*
- Compartments: *forest*
- Species: *predator*, *prey (reactions will auto-gen these species, do not create species by yourself)*
- Reactions:

# ^	Name	Reaction	Rate Law
1	A: growth prey	prey -> 2 * prey	Mass action (irreversible)
2	B: comsumption of preys	predator + prey -> predator	Mass action (irreversible)
3	C: death of predator	predator -> 0 * predator	Mass action (irreversible)
4	D: increase of predator	predator + prey -> 2 * predator + prey	Mass action (irreversible)

- global quantities – rate constants of the reactions:
    - *A* initial value: 1
    - *B* initial value: 0.01
    - *C* initial value: 1
    - *D* initial value: 0.02

# ^	Name	Type	Unit	Initial Value [Unit]
1	A	fixed	?	1
2	B	fixed	?	0.01
3	C	fixed	?	1
4	D	fixed	?	0.02

Then, map the quantity in the reactions. For example, the A:

Role	Name	Mapping	Value	Unit
Parameter	k1	A	1	1/h

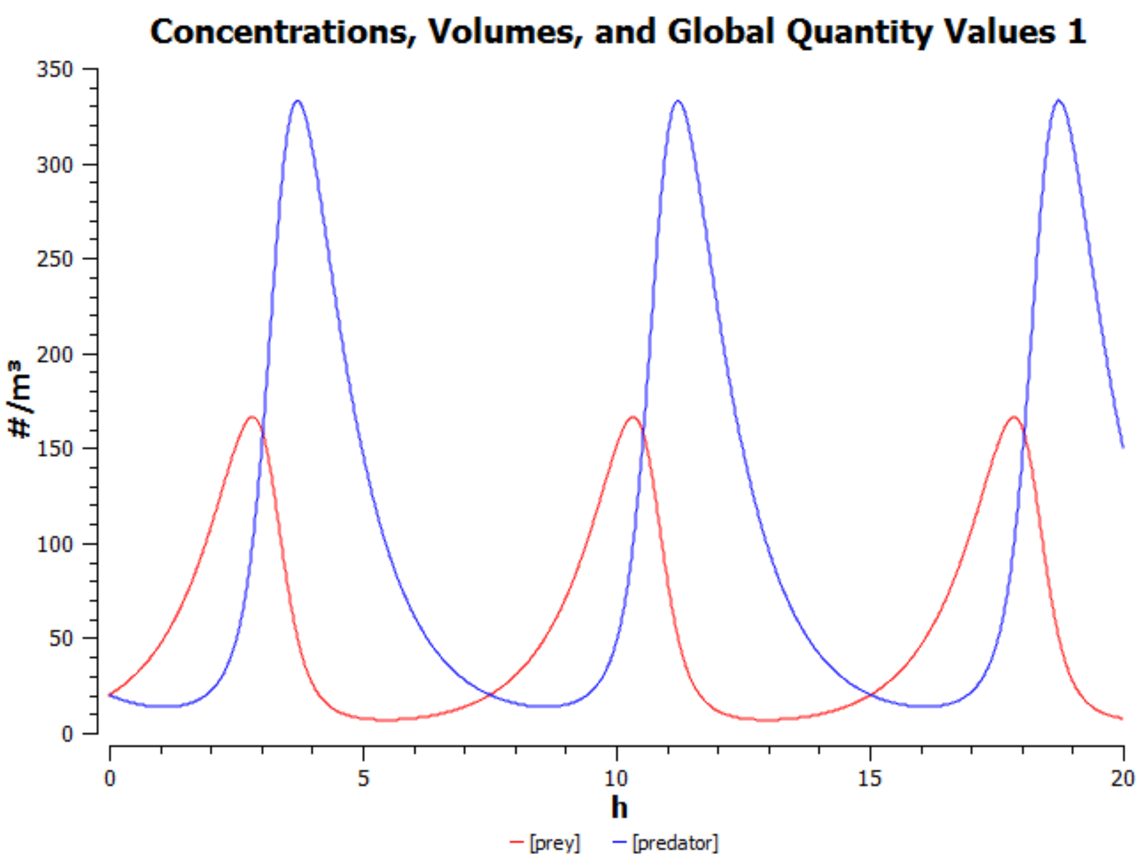
- Change the "Initial Concentrations" of the Species:
    - predator: 20
    - prey: 20

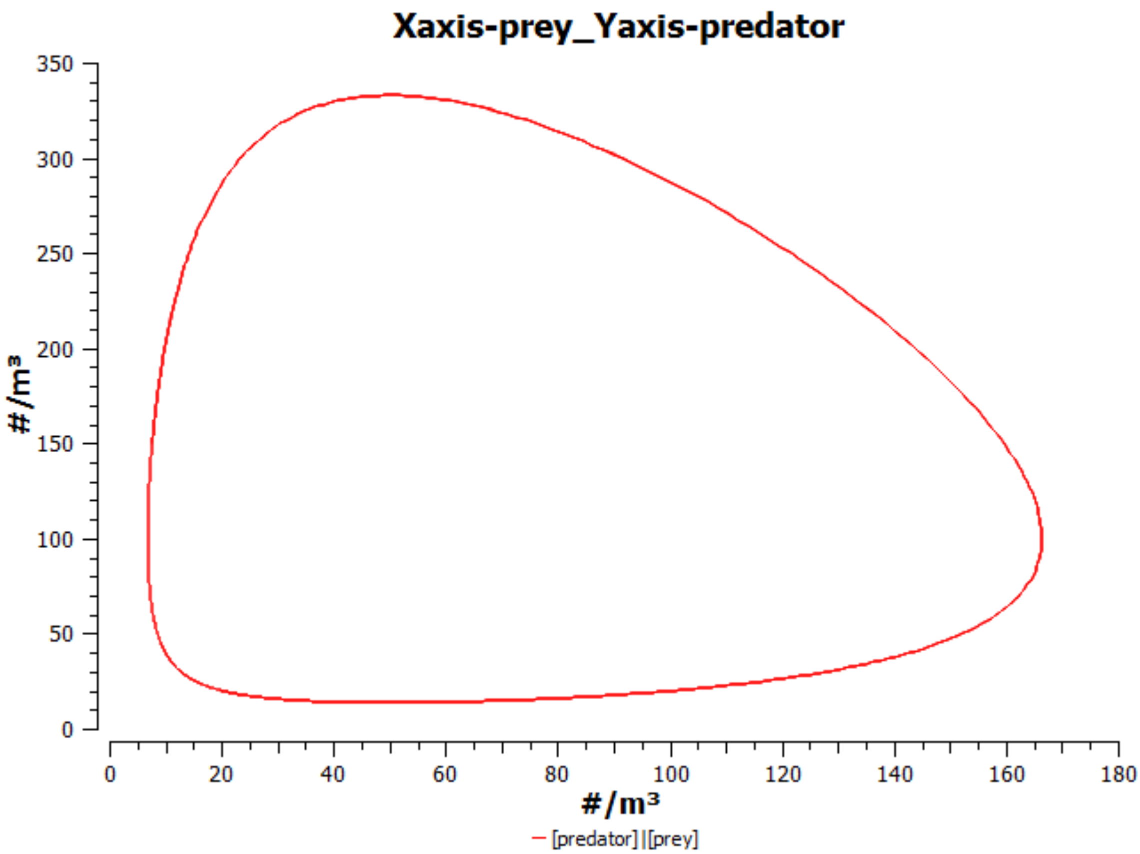
Tasks $\rightarrow$ Time Course

- duration: 20 h
- interval size: 0.01
- define the plots by the 'Output Assistant'

1. Watch https://www.youtube.com/watch?v=qiYLMTsa-_Y
2. Create the first plot based on [Time Course] - [Output Assistant] and click "Run"
3. Create a new plot under "Output Specification"
4. In there set up X-axis with "prey" [Species] - [Transident Concentrations] and Y-axis with "predator"
5. Run the model to plot and you will get the second plot, too.

After you create model, export SBML model and simulate the model to plot as below. Then submit the model and two plots (jpg, pdf, png, or any image file) with a compressed file (zip or tar.gz)




Xaxis-prey_Yaxis-predator
350
300
250
200
150
100
50
0
#/m³
0
20
40
60
80
100
120
140
160
180
#/m³
[predator]|[prey]