

# Lab: stochastic simulation models

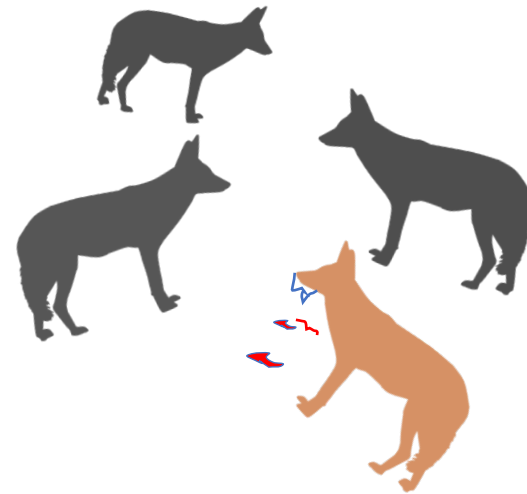
## Summary

- The Gillespie algorithm is a continuous-time discrete-individual method for simulating stochastic epidemics.
- Each event is simulated separately and is characterized by an event time and a type of event.
- It may not be computationally feasible to use the Gillespie method, especially when the population size is large.

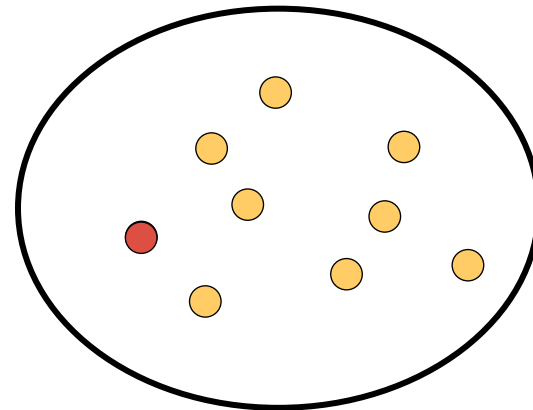
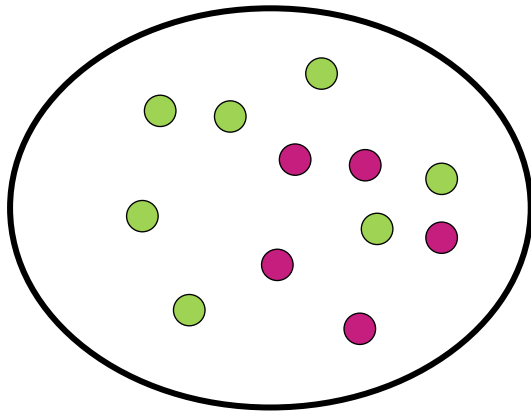
# Rabies example



Maintenance population

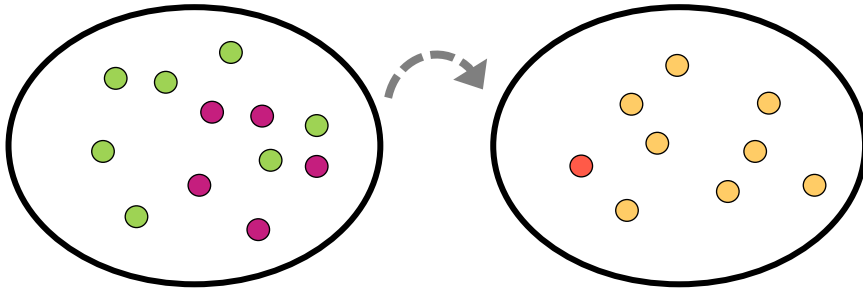


Target population



# Types of transmission

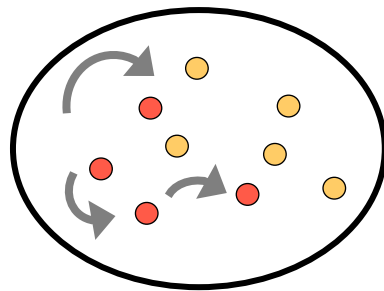
## Spillover infections



$$I \rightarrow I + 1 \text{ at rate } \frac{\lambda S}{N}$$

Maintenance population    Target population

## Within-population



$$I \rightarrow I + 1 \text{ at rate } \frac{\beta SI}{N}$$

Target population

# R code example

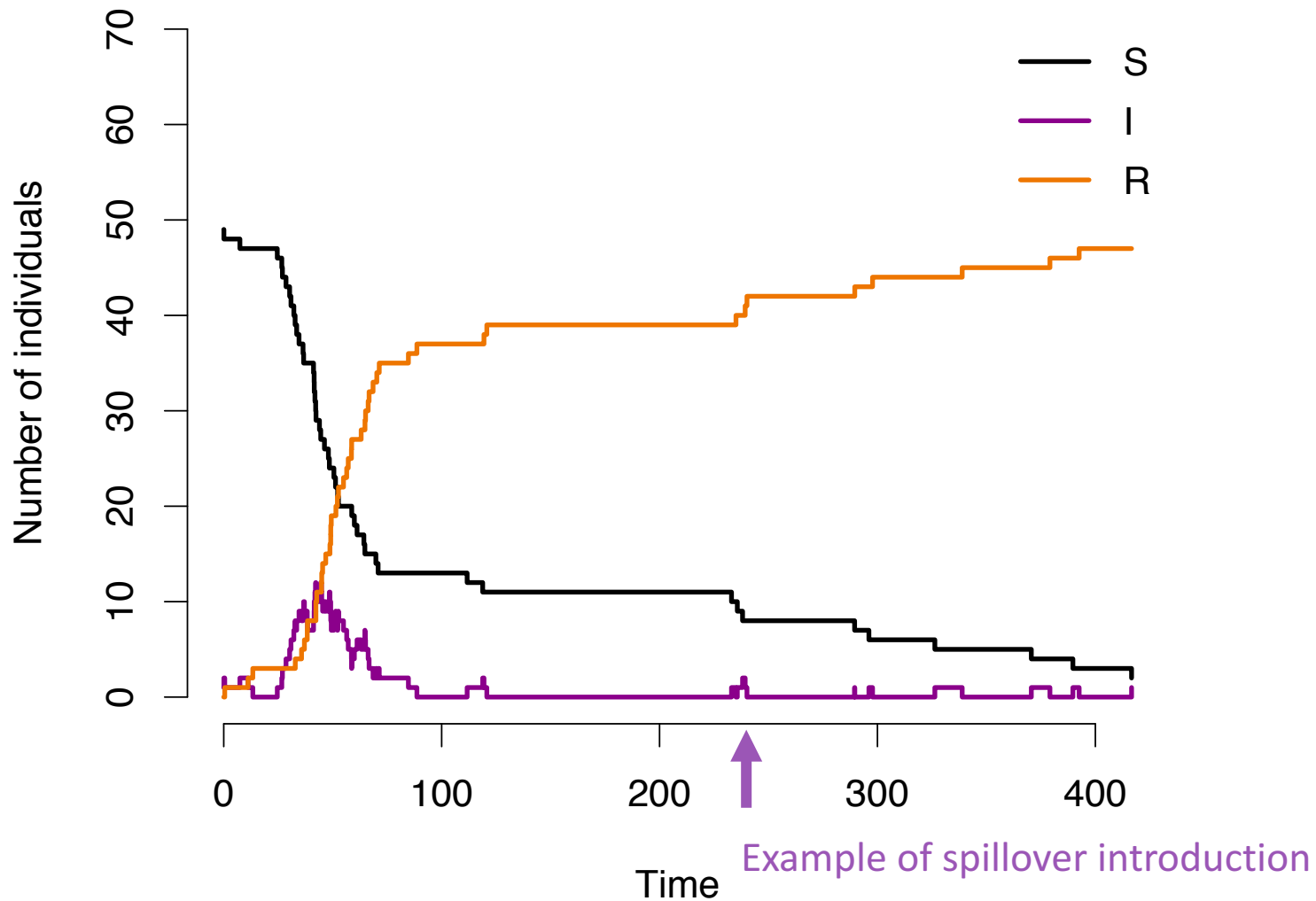
## SIR model with spillover

Exercise 1: [Basic stochastic simulation models](#)

Try changing:

- population size
- spillover rate
- transmission rate
- recovery rate

# Sample output

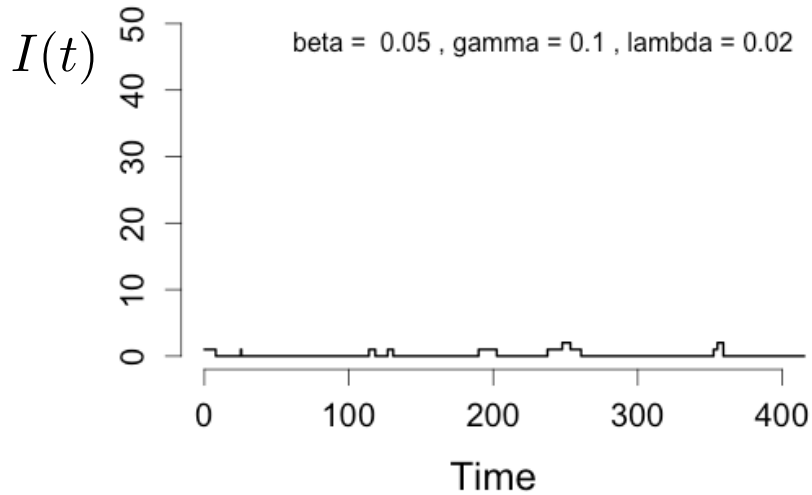


# Sub-critical or super-critical?

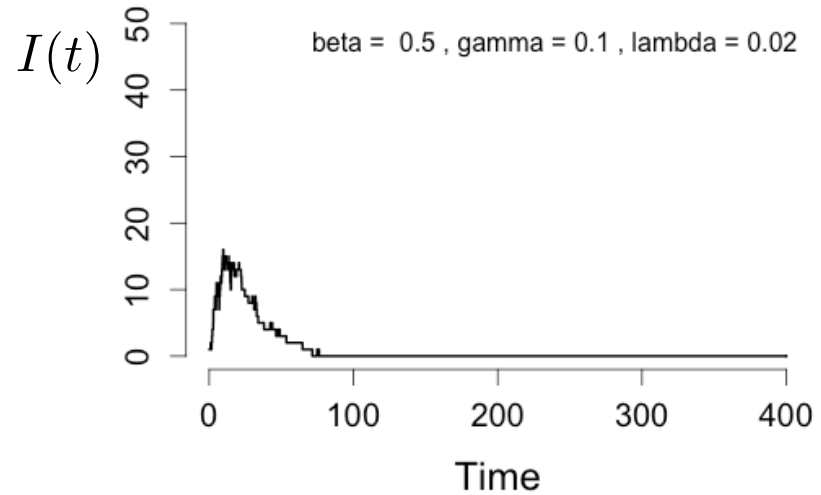
Basic reproduction number for SIR model:

$$R_0 = \frac{\beta}{\gamma}$$

Sub-critical ( $\beta < \gamma$ )



Super-critical ( $\beta > \gamma$ )



# Jackal rabies application



Parameter	Value	Meaning	Source
$b$	1	infection per week	Rhodes et al. 1998
$\nu$	1.4	rabies related deaths per week	Rhodes et al. 1998
$\rho$	1	jackal density	Rhodes et al. 1998

$$R_0 = \frac{b}{\nu} = \frac{1}{1.4} \approx 0.7 \quad (\text{rabies is sub-critical})$$

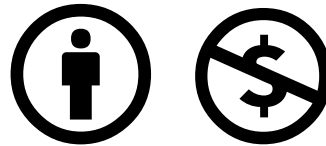
Rhodes et al. (1998) "Rabies in Zimbabwe: reservoir dogs and the implications for disease control." *Philosophical Transactions of the Royal Society B*.

**Question:** how many additional infections are needed in order for rabies to be super-critical in the jackal population?

**Borchering, Bellan, Flynn, Pulliam, and McKinley.** (2016) "Resource-Driven Encounters and the Induction of Disease Among Consumers." <http://dx.doi.org/10.1101/091850> Submitted.



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