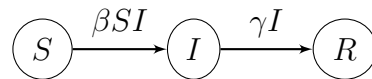


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**AARMS 2023 Summer School**  
**20–30 August 2023**  
**Stochastic models problem set**

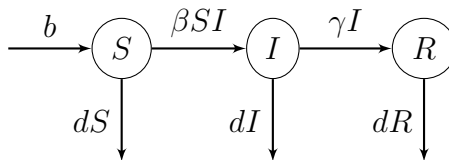
- [10] 1. Consider the Kermack-McKendrick SIR *epidemic* model



Convert the Kermack-McKendrick SIR model to a continuous-time Markov chain model.

- (a) List the state transition and their weights.
- (b) Write the Gillespie algorithm you would use to simulate the chain.
- (c) Write some code to run several simulations of the chain using `adaptivetau` or `GillespieSSA2`. Plot the solution in three different graphs.
- (d) For good measure, plot the average prevalence as well as the prevalence in the corresponding ODE. (For the former, you will probably need to interpolate solutions.)

- [10] 2. Consider the *endemic* SIR model with demography

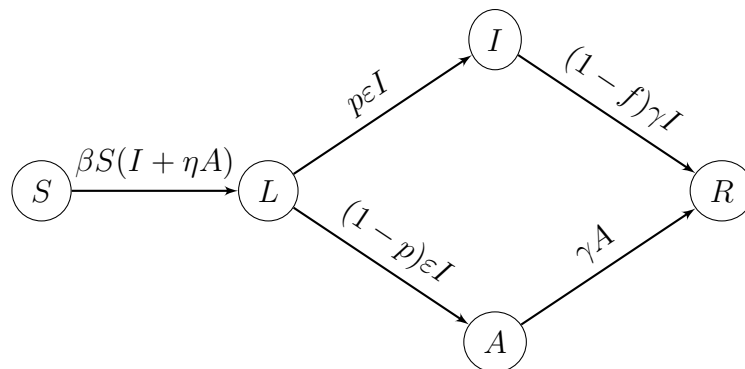


Convert the SIR endemic model with demography to a continuous-time Markov chain model.

- (a) List the state transition and their weights.
- (b) Write the Gillespie algorithm you would use to simulate the chain.
- (c) Write some code to run several simulations of the chain using `adaptivetau` or `GillespieSSA2`. Plot the solution in three different graphs.
- (d) For good measure, plot the average prevalence as well as the prevalence in the corresponding ODE. (For the former, you will probably need to interpolate solutions.)

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[10] 3. Consider the *epidemic* SLIAR model



Convert the epidemic SLIAR model to a continuous-time Markov chain model.

- (a) List the state transition and their weights.
- (b) Write some code to run several simulations of the chain using `GillespieSSA2`.
- (c) For good measure, plot the average solution as well as the corresponding ODE. (For the former, you will probably need to interpolate the solutions.)
- (d) Use the `log_firings = TRUE` option of `ssa` in `GillespieSSA2` to log events and plot incidence, and decompose incidence in terms of symptomatic and asymptomatic infections.
- (e) (Bonus) Plot the quantities in (d) as epi graphs.
- (f) (Bonus) Reinterpreting  $I$  as detected infections and  $A$  as undetected infections, discuss making  $p$ , the proportion of detected infections, a function of .. something. (It could be time, prevalence, etc.)