

# Stochastic nonlinear simulator of mutualistic networks

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Mutualism is a well known biological interaction between two guild of species, beneficial for both. We have proposed a new mathematical model that deals with a nonlinear equivalent growth rate, instead of adding an ad hoc saturation term [1].

$$\frac{1}{N_i^a} \frac{dN_i^a}{dt} = r_i + \sum_{k=1}^{n_p} b_{ik} N_k^p - \left( \alpha_i + c_i \sum_{k=1}^{n_p} b_{ik} N_k^p \right) N_i^a$$

$$\frac{1}{N_j^p} \frac{dN_j^p}{dt} = r_j + \sum_{\ell=1}^{n_a} b_{j\ell} N_\ell^a - \left( \alpha_j + c_j \sum_{\ell=1}^{n_a} b_{j\ell} N_\ell^a \right) N_j^p$$

The superscripts stand for each of both class of species, in a system with  $n$  of class  $a$  and  $m$  of class  $p$ . We have built a software application that solves this set of equations by means of Discrete Stochastic Simulation [2]. The tool allows the introduction of external perturbations such as step increases in mortality by plagues or removal of links between species due to evolution. With this toolbox, we show the main features of the model, such as stability and resilience.

## References

- [1] J Garcia-Algarra, et al., Journal of Theoretical Biology, 363, 323-343-1162, (2014).  
 [2] D. Balcan et al., Proc. Natl. Acad. Scie. (USA) 106, 21484 (2009).