Dynamics of an SIS-like audience applause model

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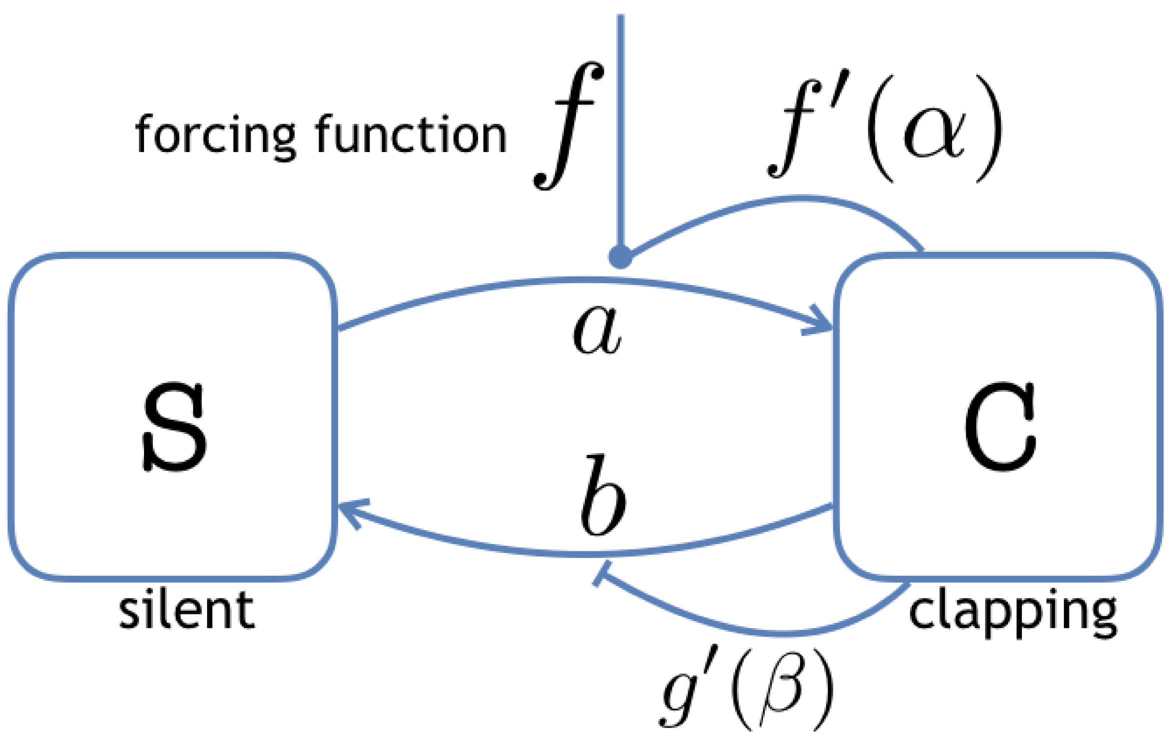
Objectives

- Create a model that simulates an audience applause
- Study the underlying dynamics of the system
- Find a correlation between the applause duration and audience size

Proposed Compartmental Model*



$$\frac{d}{dt}n_c = a(f + f - f'f)n_s - bg'n_c$$
$$\frac{d}{dt}n_s = bg'n_c + a(f + f - f'f)n_s$$

Differential equations of the system

$$f'(\alpha) = \frac{\alpha n_c}{N-1} \qquad g'(\beta) = \frac{1}{1 + \frac{\beta n_c}{N-1}}$$

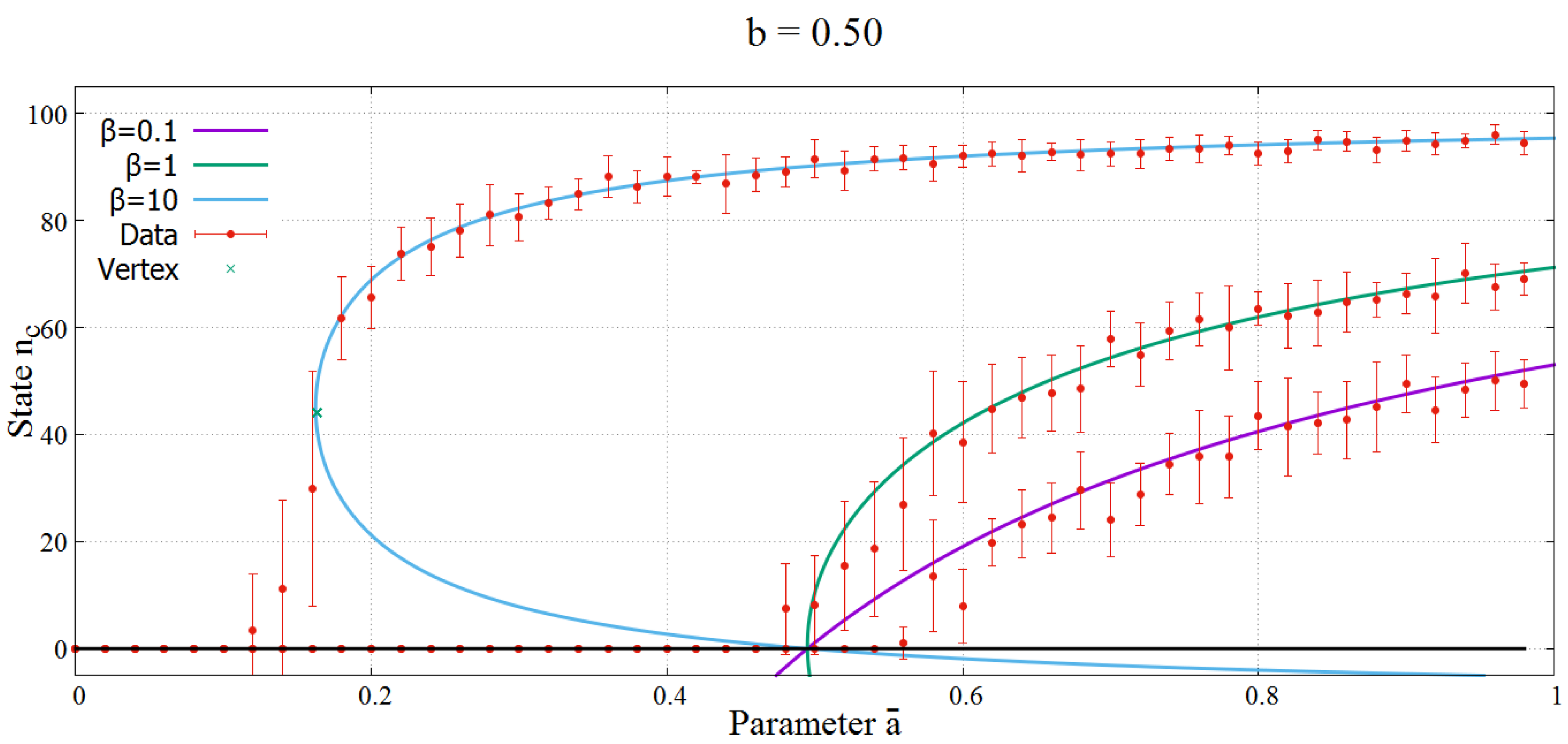
*based on the standard SIS-model [1]. *g'* is taken from the Michaelis-Menten equation[2].

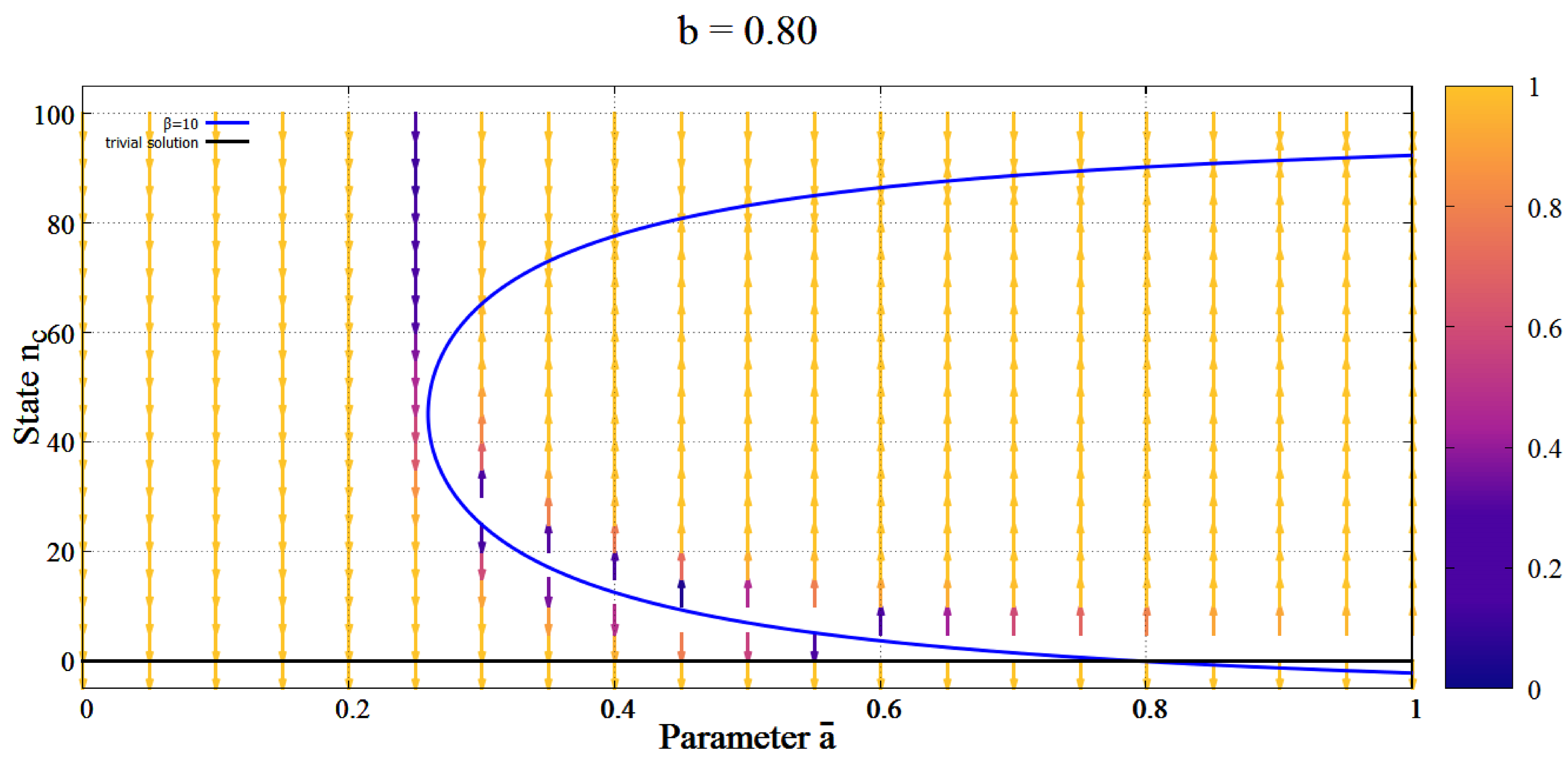
Steady-state solutions

$$\bar{a}(N - n_c)(N - 1 + \beta n_c) = b(N-1)^2$$

Steady-state equation

$N \rightarrow$ audience size
$n_c \rightarrow$ number of agents in state C
where $\bar{a} = a\alpha$ and $n^*_c = [1+(\beta-1)N]/2\beta$

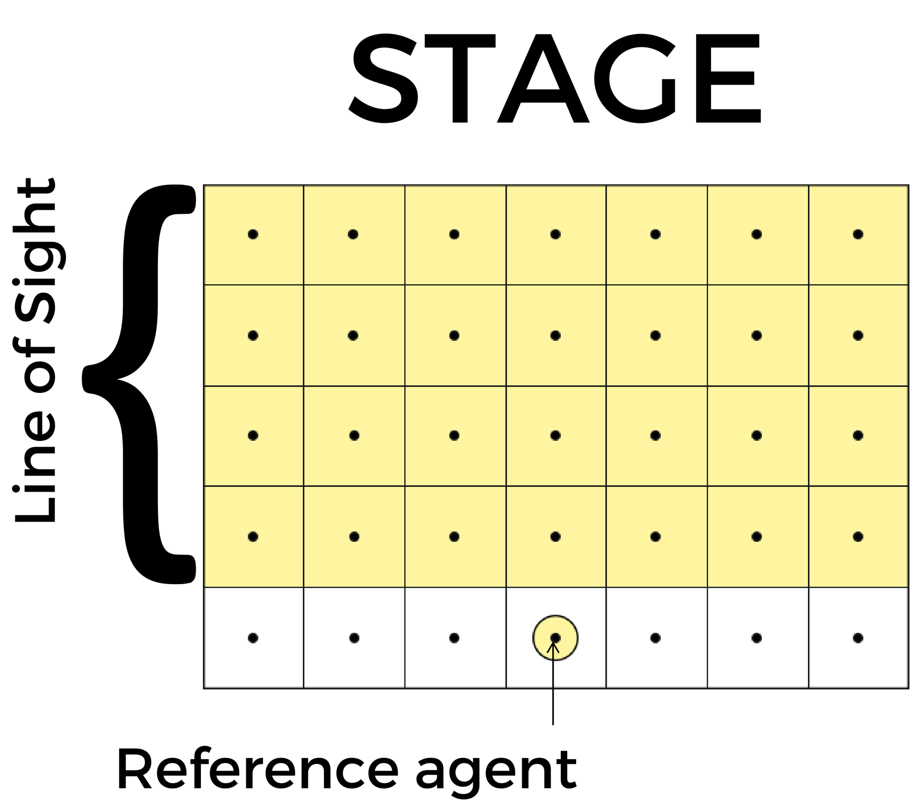


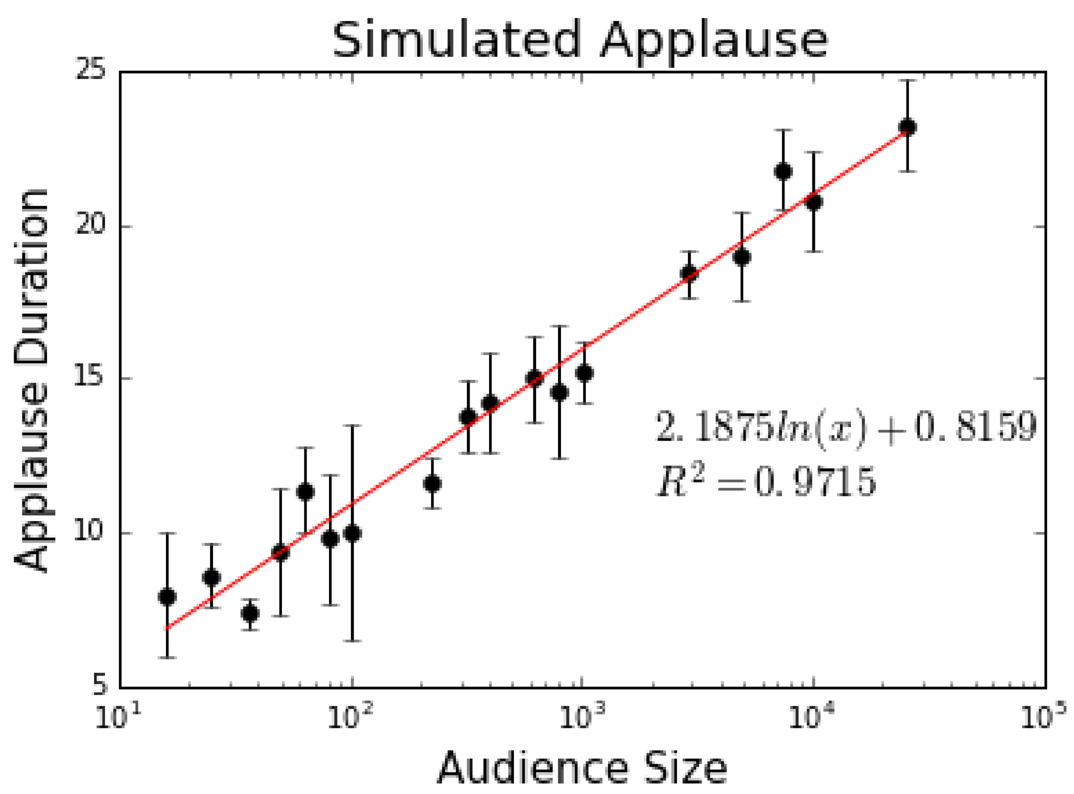


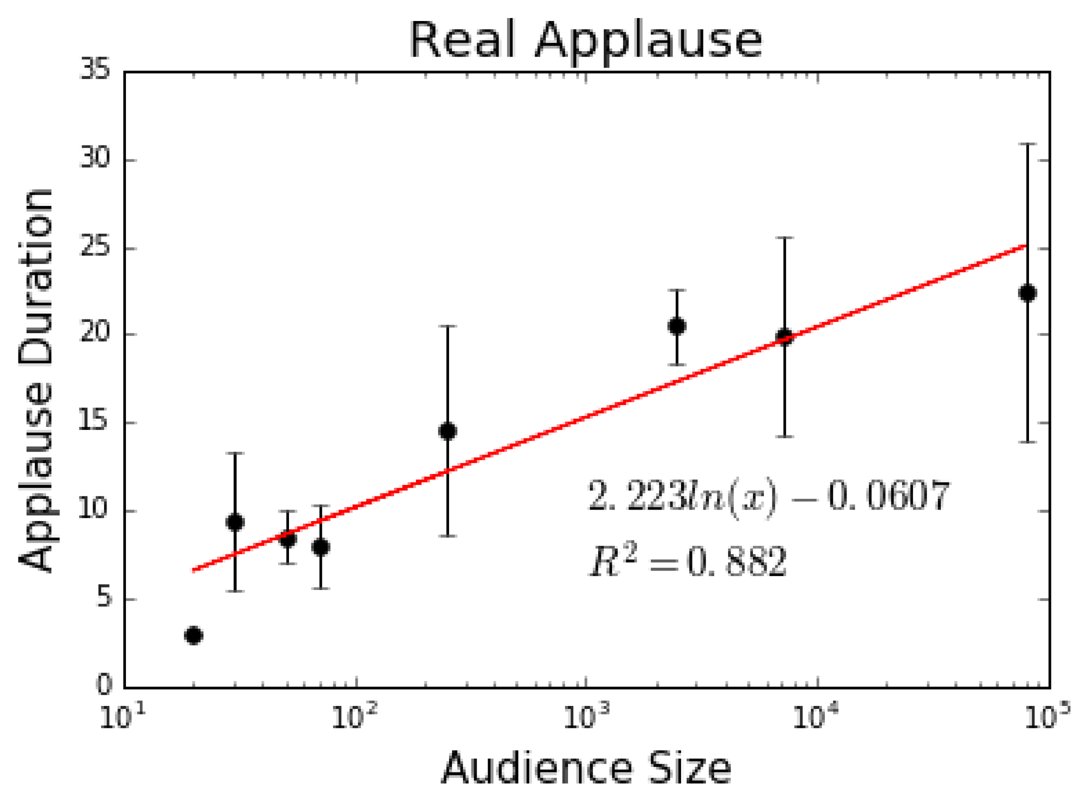
Analytical solutions are confirmed using an agent based Monte-Carlo method. Bifurcation from the trivial to non-trivial solution occurs before the vertex, for $\beta > 1$, and at the point of intersection, for $\beta < 1$. Steady-state does not occur at lower branches of $\beta > 1$ solutions

Removing the forcing function allows the system to act freely. The vectors point to the steady-state of the coordinate ($\bar{a}$, n_c). The heat map represents the probability, 1 being 100% and 0 being 50%. Coordinate points on the lower branch are unstable and may settle to either trivial or non-trivial steady-states.

Incorporating Spatial Effects







Limiting the agents that can influence the reference agent allows simulations to have a finite applause time. This configuration allows simulations to recreate real life audience applause where the applause duration increases in proportion to the audience size.

References

[1] P. Dodds and D. Watts, A generalized model of social and biological contagion, *J. Theoret. Biol.* **232**, 587 (2005).
[2] L. Johnson and R. Goody, The original michaelis constant: Translation of the 1913 michaelismenten paper, *Biochemistry* **50**, 8264 (2011).