

RAPID VACCINE OPINION SWITCHING: OPTIMAL AWARENESS CAMPAIGNS VIA DETERMINISTIC AND HEURISTIC ALGORITHMS

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Hesitancy and refusal of vaccines preventing childhood diseases are spreading due to ‘pseudo–rational’ behaviours: parents overweight real and imaginary side effects of vaccines and do not fully perceive the actual risks linked to the disease. The complex dynamics ruling vaccine uptake has been modelled as an imitation game [1] or, equivalently, as ‘infection of ideas’ [3], augmented by terms modelling the switching of vaccine position (from ‘anti’ to ‘pro’) thanks to awareness campaigns enacted by the Public Health Systems [1]. Here we investigate the noteworthy case, of great relevance in the age of social networks, where the opinions rapidly change, so that the system (in absence of the awareness campaigns) can be reduced to the phenomenological model proposed in [2], where the vaccine uptake rate was an increasing function of the prevalence. After briefly investigating how the above mentioned campaigns influence the dynamics of the system, we study the problem of minimizing the total cost of the disease spread and control. It is formed by different ‘sub–costs’: that related to the disease burden, the vaccination costs and the economic burden to enact the awareness campaigns. We numerically explore the impact of human behaviour on the control and spread of the target disease via both deterministic and heuristic methods. For the latter, we also provide a statistical assessment. Finally, results are compared with those obtained in the case of slow opinion switching dynamics.

References

- [1] A. d’Onofrio, P. Manfredi, P. Poletti. (2012). *The interplay of public intervention and private choices in determining the outcome of vaccination programmes*, PLoS ONE, 7 (10), e45653.
- [2] A. d’Onofrio, P. Manfredi, E. Salinelli. (2007). *Vaccinating behaviour, information, and the dynamics of SIR vaccine preventable diseases*, Theoretical Population Biology, 71 (3), 301–317.

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- [3] Z. Wang, C. T. Bauch, S. Bhattacharyya, A. d’Onofrio, P. Manfredi, M. Perc, N. Perra, M. Salathé, D. Zhao.
(2016) *Statistical physics of vaccination*, Physics Reports, 664, 1–113.