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Optimal Vaccination For A Probabilistic Epidemic EDWIN YUAN, SEAN STROMBERG, JEAN CARLSON, UCSB Physics — In epidemiology, herd immunity is the well-known idea that by vaccinating a sufficient fraction of a susceptible population, one lowers the basic reproduction number of the pathogen below one, and thereby prevents an epidemic. A natural conclusion from this is that given two identical populations, and enough vaccine to induce herd immunity in only one, we can prevent the greatest number of people from infection by inequitably distributing vaccine to completely protect one population while leaving the other much more relatively susceptible. This heuristic has been verified by simulation of the standard deterministic SIR epidemic. We show, however, that when stochasticity is introduced to the system, or more specifically when there is now a significant probability that an epidemic will not develop independently, it is counter-intuitively optimal to distribute vaccine more equally and not induce herd immunity in either population. There is thus a regime where the purely deterministic SIR model is a poor predictor of the optimal vaccination scheme.

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