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# Respondent-driven Sampling on Directed Networks

Xin Lu, Jens Malmros, Fredrik Liljeros and Tom Britton

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## Abstract

Respondent-driven sampling (RDS) is a commonly used substitute for random sampling when studying hidden populations, such as injective drug users or men who have sex with men, for which no sampling frame is known. The method works like a snowball sample but can, given that some assumptions are met, generate unbiased population estimates. One key assumption, not likely to be met, is that the acquaintance network in which the recruitment process takes place is undirected, meaning that all recruiters should have the potential to be recruited by the person they recruit. Here we investigate the potential bias of directedness by simulating RDS on real and artificial network structures. We show that directedness is likely to generate bias that cannot be compensated for unless the sampled individuals know how many potentially may have recruited them (i.e. their indegree), which is unlikely in most situations. We propose three indegree-based estimators for RDS on directed networks and show that they can be used together with prior information or in a sensitivity analysis, taking uncertainty of indegree properties of the network into account for the situation when only outdegrees are observed.