EHB simulations appendix

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Simulations

We ran simulations of the evolution of group reciprocity as follows. The population consisted of G groups of size n. Each generation consisted of T rounds. In each round, all individuals were matched with a randomly selected target from a different group. The individual could either help the target, losing $c = 1$ and benefiting the target b, or not help, which did not affect payoffs.

Individuals were of two types. Selfish types never help. Group reciprocal types condition on their current target's group. If they have never been targeted by someone from that group before, they help. If they have been targeted in the previous m rounds by one or more persons from that group, then they help with probability equal to the proportion of times they were helped. For example, if they were targeted by persons from that group 5 times in the previous m rounds, and were helped 3 times, then they help with probability $3/5 = 60\%$.

After each generation, each individual changed type with independently drawn probability $\pi = 0.05$, copying a new type from one other individual in the population. Individuals' probability of being copied was proportional to their own total payoff. This could represent either a process of success-biased cultural transmission, or evolution with payoffs representing fitness and full mixing across populations. The simulation ran until one strategy evolved to fixation in the whole population.

Our base simulation has $T = m = 60$ and $G = 10$ groups, with the initial type distribution being 50% selfish and 50% group reciprocal, drawn independently for all individuals. We vary the benefit of being helped b, and the group size n, from 12 to 30. In the "short memory" variant we set $T = m = 30$. In the "many groups" variant we set $G = 20$. We ran ten simulations of each parameter configuration. The figure shows the proportion of times that GR evolved to fixation. In each case, larger b and smaller n make it easier for group reciprocity to evolve.

The mechanism for group reciprocity's evolution is as follows. The cost of helping is balanced against the benefit that a target who is a group reciprocator will subsequently help one's own group with increased probability. In this case, with probability $1/n$, one will oneself be helped. Thus, group reciprocity can evolve much like individual reciprocity so long as the benefit/cost ratio b is high enough.

It is only advantageous to help if the target is a group reciprocator. Group reciprocity itself achieves this by counting the number of times that help has come from the group. If there is sufficient variation between groups in the proportion of group reciprocators, then this will be an effective heuristic, and groups with a good reputation will be helped more. In the simulations, the correlation between individual fitness, and the reputation of the individual's group (average number of times it had helped), was a good predictor of whether GR would evolve to fixation: the mean correlation was 0.84 when GR fixed and 0.55 when selfishness fixed ($p < 0.001$).

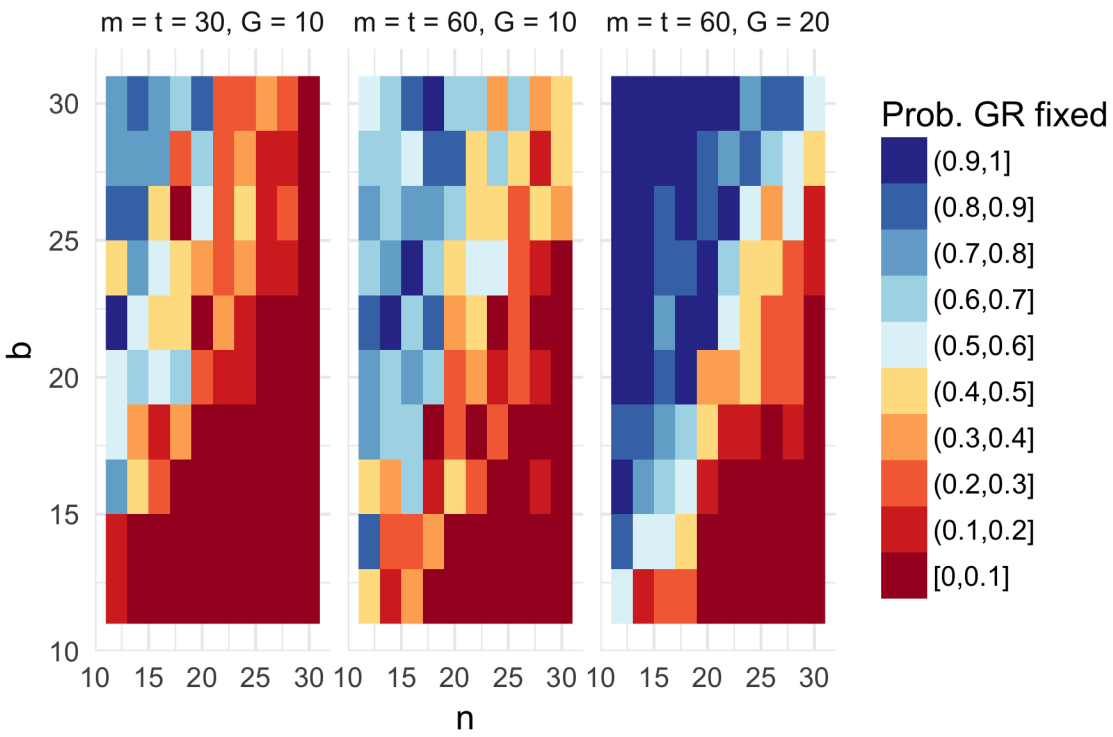

Figure 1: Simulation results. b = benefit of being helped. n = group size.