**Incorporate network-structured payoff updating and tie-breaking rules:** Active player compares their payoff to an average payoff for their neighbors or to the payoffs of those who share community membership (defined as a trait), and applies a rule for tie breaking or tie creation.

### An Evolutionary Game-Theoretic Model

We begin with a model of segmentation as a way of supporting cooperation in a heterogeneous society of both cooperators and defectors, where individuals play a one-shot prisoners dilemma game [1].

We have the following equations for the expected payoffs to cooperators and defectors:

\[
\pi_c(x, \alpha) = a + (1-x)a(1-\alpha)
\]

\[
\pi_d(x, \alpha) = a + (1-x)a + (1-x)(1-\alpha)
\]

\[
\alpha = \frac{\pi_c - \pi_d}{2\pi_d - 2\pi_c}
\]

The cooperator trait replicator dynamic for this model can be set up as follows:

\[
\frac{d\alpha}{dt} = \alpha(1-\alpha)(\pi_c - \pi_d)
\]

I extend the above model by implementing both an element of initial community membership (as a trait) and differential tie-breaking and payouts based on community membership. The network dynamic of the model are designed from the standpoint of supporting cooperation. Cooperators break ties with defectors and form ties with other cooperators over time they are paired. The new segmented model dynamic is shown in table form below:

<table>
<thead>
<tr>
<th>Community</th>
<th>Time</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cooperate</td>
</tr>
<tr>
<td>Cooperate</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Defector</td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

Figure: From top-left to bottom-right: [t = 50,000, F = 3, N = 400], [t = 50,000, F = 3, N = 400], [t = 50,000, F = 3, N = 400], [t = 50,000, F = 3, N = 400]. I have so far ended up with some interesting (but also troubling) preliminary results. The graph on the left shows the community structure after 50,000 periods when cooperators simply break ties with defectors (and form a new tie with another cooperator) when they are paired with one and when defectors form no new ties of their own. We get the almost trivial result that defectors will get pushed to the periphery of the community and cooperators will form a dense component. However, when I allow for payoff updating, preliminary results suggest that under almost all circumstances, network homophily dynamics are dominated by payoff differentials.

### References