Simulation Scenarios

The scenarios concern 10 persons X_1 to X_{10}. For the first two scenarios only the outgoing connections of X_1 have been modelled in an adaptive manner, the other connection weights were kept constant. For all simulations $\Delta t = 1$ was used, and the focus in al three scenarios was on the homophily adaptation with constant connection weight speed factor $H_{\omega_{X_j,X_i}} = \eta_{\omega_{X_j,X_i}} = 1$. Moreover, in Scenarios 1 and 2 the focus is only on the adaptive connections from X_1, and the other connections were kept constant. In Table 3 the main parameter values for Scenarios 1 and 2 can be found, in Table 4 for Scenario 3.

Table 3 Main parameter values for Scenario 1/Scenario 2

Base level		First reification level		Second reification level	
Contagion alogistic steepness σ_{X_i} for X_i	1	Homophily modulation factor $\alpha_{\Omega_{X_1,X_i}}$ for Ω_{X_1,X_i}	1	Tipping point speed factors $\eta_{T\Omega_{X_1,X_i}}$ for $T\Omega_{X_1,X_i}$	1
Contagion alogistic threshold τ_{X_i} for X_i	1.5	Connection weight speed factor $\eta_{\Omega_{X_1,X_i}}$ for Ω_{X_1,X_i}	1	Tipping point modulation factors $_{T\Omega_{X_1,X_i}}$ for $T\Omega_{X_1,X_i}$	0.1/0.9
Speed factor η_{X_i} for base state X_i	0.5			Tipping point connection norms $\nu_{T\Omega_{X_1,X_i}}$ for $T\Omega_{X_1,X_i}$	0.6

Scenario 1 Adaptive connections from X_1; $\alpha_{T\Omega_{X_1,X_i}} = 0.1$

For this scenario the initial values for connection weights and tipping points can be found in Table 4. The average of the initial values of Ω_{X_1,X_i} is 0.344, which is below the norm $\nu_{T\Omega_{X_1,X_i}}$ which is 0.6. The example simulation for this scenario shown in Figs 4 to 8 may look a bit chaotic where some connections seem to meander between high and low. However, in this scenario it can be seen that the average connection weight, indicated by the thick pink line converges to 0.60145 (at time point 1750), which is close to 0.6, which was chosen as the norm $\nu_{T\Omega_{X_1,X_i}}$ for the average connection weight. So at least this convergence of the average connection weight to $\nu_{T\Omega_{X_1,X_i}}$ makes sense. As can be seen in Fig. 4 and 5 there is some variation of the connection weights around the average connection weight 0.60145 at time 1750. Note that the connection weights at time 1750 do not correlate to the initial connections weights; they are determined by the similarity in states via the homophily principle. With all of these 9 persons, X_1 initially developed very strong connections (above 0.97) around time 50, but that turned out too much. Therefore 6 of the 9 were reduced between time 100 and 500, while 3 stayed high all the time: Ω_{X_1,X_3}, Ω_{X_1,X_5} and Ω_{X_1,X_9}. Two of these 6 stayed very low: Ω_{X_1,X_8} and $\Omega_{X_1,X_{10}}$.

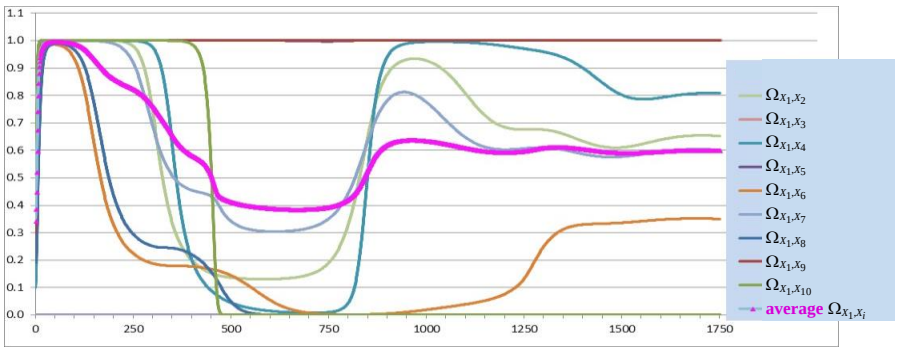

Fig. 4 Adaptive weights Ω_{X_1,X_i} of outgoing connections from X_1 over time, with the thick pink line showing the average weight of them

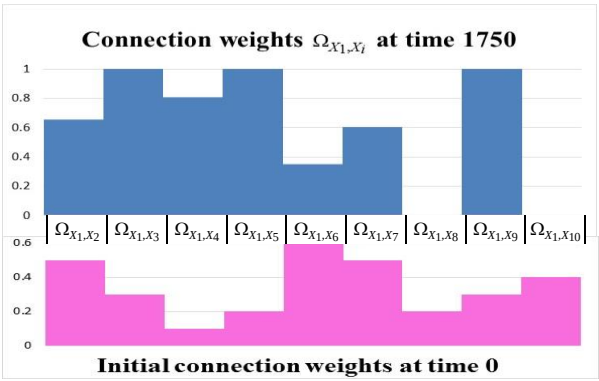

Fig. 5 Scenario 1: Resulting connection weights Ω_{X_1,X_i} at time 1750 compared to their initial values

As with 6 connections very low, this made the average of connections too low, from these 6, three were increased after time 750, and a fourth one after time 1000. Eventually two of them, Ω_{X_1,X_2} and Ω_{X_1,X_7}, are around 0.6, one, Ω_{X_1,X_4}, is around 0.8, and one, Ω_{X_1,X_6}, is around 0.35. So what has emerged is that the person eventually has developed and kept three very good contacts X_3, X_5 and X_9, has lost two contacts X_8, X_{10}, and has kept the other four contacts with an intermediate type of different strengths. Fig. 6 shows the variation in tipping point reification states over time.

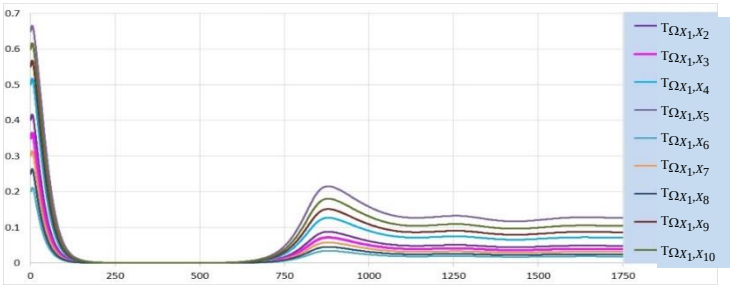

Fig. 6 Scenario 1: Adaptive tipping points $T_{\Omega_{X_1,X_j}}$ over time

Table 4 Scenarios 1 and 2: Initial values for connection weights and tipping points

connections	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1		0.5	0.3	0.1	0.2	0.6	0.5	0.2	0.3	0.4
X_2	0.5		0.6	0.3	0.4	0.7	0.7	0.9	0.5	
X_3	0.3	0.6		0.7		0.4	0.4		0.6	0.8
X_4	0.6	0.4	0.6		0.4	0.6	0.7	0.8		
X_5	0.2	0.5		0.7	0.6	0.4			0.9	
X_6	0.6	0.6	0.7	0.5			0.7	0.7	0.5	0.7
X_7	0.2	0.8	0.6	0.7	0.6	0.7		0.7		
X_8	0.6	0.5				0.6	0.5		0.4	0.5
X_9	0.6		0.6	0.7	0.4		0.7			0.6
X_{10}	0.6	0.7		0.7	0.4	0.6		0.8		

	$T_{\Omega_{X_1,X_2}}$	$T_{\Omega_{X_1,X_3}}$	$T_{\Omega_{X_1,X_4}}$	$T_{\Omega_{X_1,X_5}}$	$T_{\Omega_{X_1,X_6}}$	$T_{\Omega_{X_1,X_7}}$	$T_{\Omega_{X_1,X_8}}$	$T_{\Omega_{X_1,X_9}}$	$T_{\Omega_{X_1,X_{10}}}$
$T_{\Omega_{X_1,X_i}}(0)$	0.4	0.35	0.5	0.65	0.2	0.3	0.25	0.55	0.6

Scenario 2 Adaptive connections from X_1; $\alpha_{T\Omega_{X_1,X_i}} = 0.9$

Scenario 1 shown above is actually not one of the most chaotic scenarios; some other scenarios show a much more chaotic pattern. As an example, when for the tipping point adaptation the much higher modulation factor $\alpha_{T\Omega_{X_1,X_i}} = 0.9$ is chosen (instead of the 0.1 in Scenario 1; all other values stay the same) the pattern is still more chaotic, as shown below in Figs 7 to 9. Yet on the long term in this case the average connection weight moves around the set point 0.6; but notice that around time point 1250 it seemed that the process was close to an equilibrium, but that was violated by what happened later. Moreover, the fluctuating pattern of the tipping points in Fig. 8 also does not suggest it will become stable.

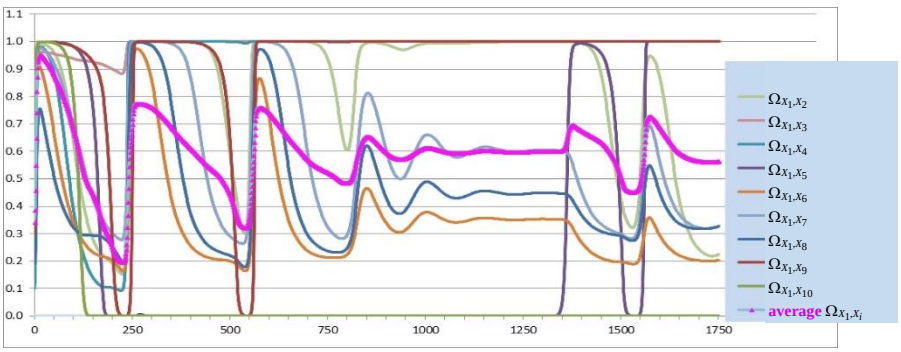

Fig. 7 Scenario 2: Adaptive weights of outgoing connections from X_1 over time, with the thick pink line showing the average weight for X_1

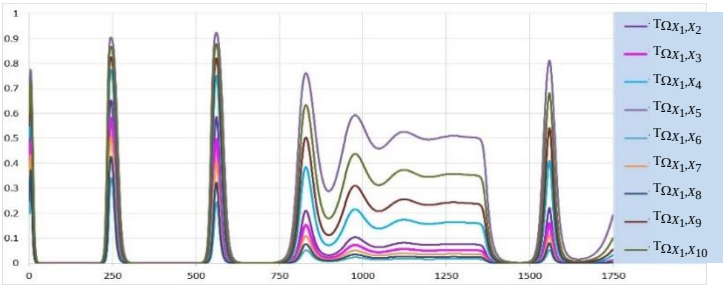

Fig. 8 Scenario 2: Adaptive tipping points $T_{\Omega_{X_1,X_j}}$ over time

Scenario 3: All connections adaptive

For the third scenario all connections were adaptive with main parameters shown in Table 5 and initial connection weight values shown in Table 6. Note that the norm for average connection weight is 0.4 this time.

Table 5 Scenario 3: Main parameter values

Base level		First reification level		Second reification level	
Contagion alogistic steepness σ_{X_i} for X_i	0.8	Homophily modulation factor $\alpha_{\Omega_{X_j,X_i}}$ for Ω_{X_j,X_i}	1	Tipping point speed factor $\eta_{T_{\Omega X_j,X_i}}$ for $T_{\Omega_{X_j,X_i}}$	0.5
Contagion alogistic threshold τ_{X_i} for X_i	0.15	Connection weight speed factor $\eta_{\Omega_{X_j,X_i}}$ for Ω_{X_j,X_i}	1	Tipping point modulation factor $\alpha_{T_{\Omega X_j,X_i}}$ for $T_{\Omega_{X_j,X_i}}$	0.4
Speed factor η_{X_i} for base state X_i	0.5			Tipping point connection norm $\nu_{T_{\Omega X_j,X_i}}$ for $T_{\Omega_{X_j,X_i}}$	0.4

Table 6 Scenario 3: Initial connection weights

connections	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1		0.5	0.3	0.1	0.2	0.6	0.5	0.2	0.3	0.4
X_2	0.5		0.6	0.3	0.4	0.7	0.7	0.9	0.5	
X_3	0.3	0.6		0.7	0.7	0.4	0.4		0.6	0.8
X_4	0.6	0.4	0.6		0.4	0.6	0.7	0.8		0.9
X_5	0.2	0.5		0.7		0.4		0.4	0.9	0.4
X_6	0.6	0.6	0.7	0.5			0.7	0.7	0.5	0.7
X_7	0.2	0.8	0.6	0.7	0.6	0.7		0.7		
X_8	0.6	0.5		0.4		0.6	0.5		0.4	0.5
X_9	0.6		0.6	0.7	0.4		0.7			0.6
X_{10}	0.6	0.7		0.7	0.4	0.6		0.8		

In Figs 9 to 12 the simulation outcomes are shown. As can be see in Fig. 12 eventually all connection weights converge to 0 or 1. Fig. 9 shows in particular the values of the connection weights from X_1, and their average, and Fig. 10 shows the corresponding tipping points.

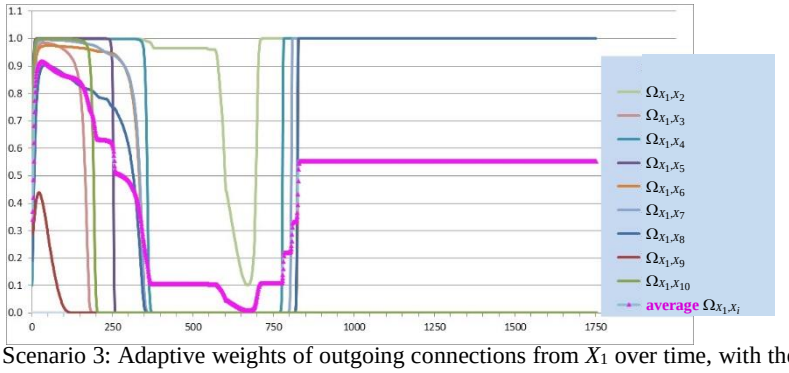

Fig. 9 Scenario 3: Adaptive weights of outgoing connections from X_1 over time, with the thick pink line showing the average weight for X_1

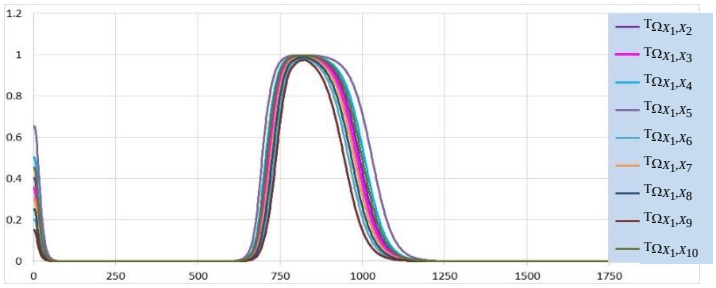

Fig. 10 Scenario 3: Adaptive tipping points $T_{\Omega_{X_1,X_j}}$ over time

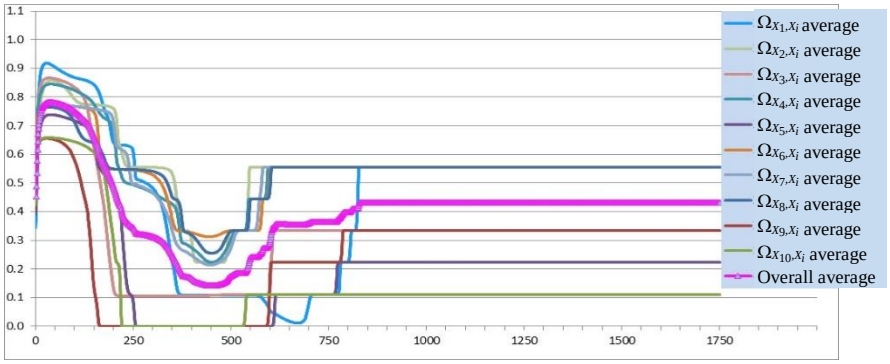

Fig. 11 Scenario 3: Average connection weights for each of X_1 to X_{10} and of all connections over time

Note that Fig. 11 shows that in the emerging process eventually the average connection weights per person stick in some seemingly mysterious manner to a discrete set of values: 0.111111 (X_{10}), 0.222222 (X_5), 0.333333 (X_3, X_9), and 0.555555 (X_1, X_2, X_4, X_6, X_7, X_8), all multiples of 0.111111; the overall average ends up in 0.433333 (recall that the norm $\nu_{T\Omega_{X_i,X_j}}$ for average connection weight for each person was 0.4). Also in other simulations this discrete set of multiples of 0.111111 emerges. In Section 6 it will be analysed where these values come from.

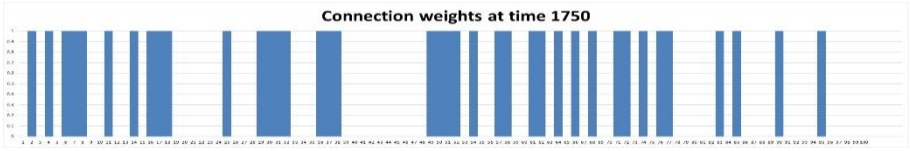

Fig. 12 Scenario 3: All connection weights are 0 or 1 at time 1750

In Fig. 12 it is shown that all single connection weights converge to 0 or 1. This will also be analysed in Section 6. For the tipping points, for all outgoing connections of X_1 they converge to 0 (see also Fig. 11), and for all outgoing connections of the other persons they converge to 1.