Behaviour Dynamics in Social Networks - Assignment 1

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Abstract

After Jenny has entered Mark's door, her presence clearly makes that Mark becomes happy. Liking Mark a lot, his happiness makes her nervous, which makes that she breaks one of the two nice vases near the door. Seeing this, Mark becomes angry on her. This makes Jenny sad. Jenny's sadness makes Mark's anger disappear, and he gives Jenny a hug. Seeing this, Mark's partner Dion becomes jealous, upon which she breaks the other vase.
Use the concepts and formats introduced in Chapter 2 to analyse and model this scenario by a temporal-causal network by the following steps.

1 Graphical conceptual representation

States describing the scenario:

1. Jenny's presence (X_1);
2. Mark becomes happy (X_2);
3. Jenny likes Mark (X_3);
4. Jenny becomes nervous (X_4);
5. Jenny breaks a vase (X_5);
6. Mark becomes angry (X_6);
7. Jenny becomes sad (X_7);
8. Mark gives Jenny a hug (X_8);
9. Dion become jealous (X_9);
10. Dion breaks a vase (X_10).

In Figure 1, we can observe a connection that models a negative impact in order to make the level of the affected state lower - the one going from X_7 to X_6 (i.e. Mark anger decreases due to Jenny sadness). There is also a loop that contains two states: X_6 and X_7.

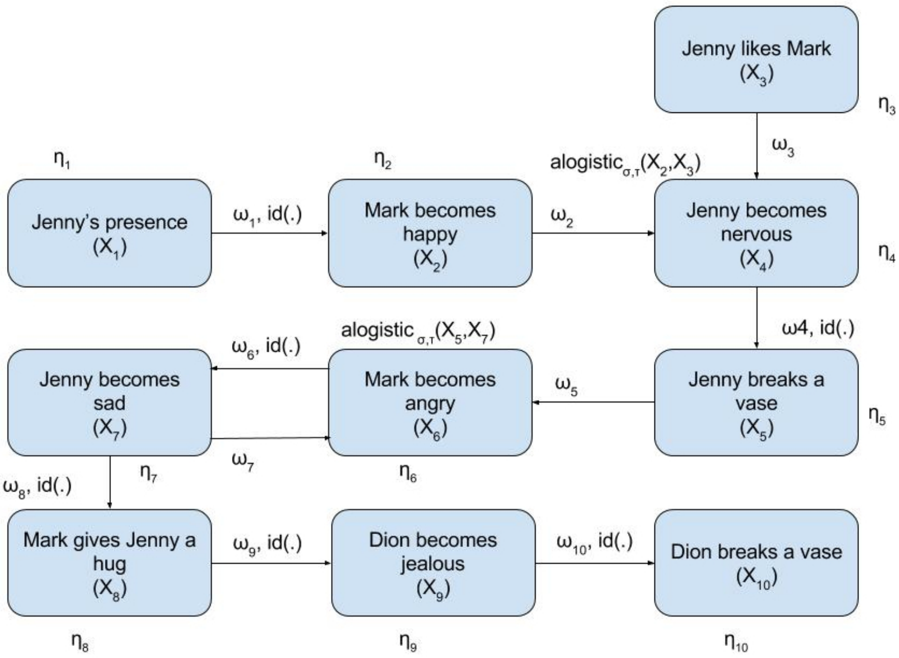


Figure 1: Conceptual representation of the scenario.

2 Conceptual representation in matrix format

We now move to the matrix representation of the graph in Figure 1. Rows represent nodes from which edges are starting, while columns represent nodes in which edges are ending.

	states and connections	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1			ω_1								
X_2					ω_2						
X_3					ω_3						
X_4						ω_4					
X_5							ω_5				
X_6								ω_6			
X_7							ω_7		ω_8		
X_8										ω_9	
X_9											ω_{10}
X_{10}											
	speed factors	η_1	η2	η3	η4	η5	η6	η7	η8	η9	η10
	combination functions										
identity function	id(.)		id(X_1)	id(X_2)		id(X_4)		id(X_6)	id(X_7)	id(X_8)	id(X_9)
sum function	sum(...)										
scaled sum	ssum$_\lambda$(...)										
	scale factor λ										
simple logistic	slogistic$_{\sigma,\tau}$(...)										
advanced logistic	alogistic$_{\sigma,\tau}$(...)				alogistic$_{\sigma,\tau}$(X_2,X_3)		alogistic$_{\sigma,\tau}$(X_5,X_7)				
	steepness σ				σ_1		σ_2				
	threshold τ				τ_1		τ_2				

Figure 2: Matrix format of the conceptual representation

3 Numerical representation

Numerical representation for the scenario represented in Figure 2.

3.1 Difference equation

Initial states:

$$X_1(t+\Delta t) = X_1(t) + \eta_1(id(X_1(t)) - X_1(t))\Delta t = X_1(t) \tag{1}$$

$$X_3(t+\Delta t) = X_3(t) + \eta_3(id(X_3(t)) - X_3(t))\Delta t = X_3(t) \tag{2}$$

Intermediate states:

$$X_2(t+\Delta t) = X_2(t) + \eta_2(id(\omega_2 X_1(t)) - X_2(t))\Delta t \tag{3}$$

$$X_4(t+\Delta t) = X_4(t) + \eta_4(alogistic_{\sigma,\tau}(\omega_2 X_2(t), \omega_3 X_3(t)) - X_4(t))\Delta t \tag{4}$$

$$X_5(t+\Delta t) = X_5(t) + \eta_5(id(\omega_4 X_4(t)) - X_5(t))\Delta t \tag{5}$$

$$X_6(t+\Delta t) = X_6(t) + \eta_6(alogistic_{\sigma,\tau}(\omega_5 X_5(t), \omega_7 X_7(t)) - X_6(t))\Delta t \tag{6}$$

$$X_7(t+\Delta t) = X_7(t) + \eta_7(id(\omega_6 X_6(t)) - X_7(t))\Delta t \tag{7}$$

$$X_8(t+\Delta t) = X_8(t) + \eta_8(id(\omega_8 X_7(t)) - X_8(t))\Delta t \tag{8}$$

$$X_9(t+\Delta t) = X_9(t) + \eta_9(id(\omega_9 X_8(t)) - X_9(t))\Delta t \tag{9}$$

Final state:

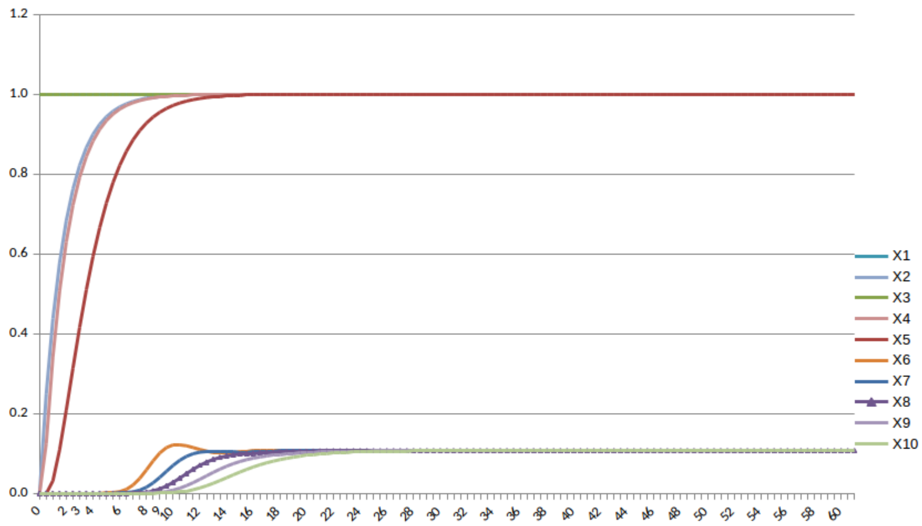
$$X_{10}(t+\Delta t) = X_{10}(t) + \eta_{10}(id(\omega_{10} X_9(t)) - X_{10}(t))\Delta t \tag{10}$$

3.2 Differential equation

$$\frac{\delta X_1(t)}{\delta t} = X_1(t) + \eta_1 \cdot (id(X_1(t)) - X_1(t)) \tag{11}$$

4 Expected behaviour

5 Simulation


1.2
1.0
0.8
0.6
0.4
0.2
0.0
X1
X2
X3
X4
X5
X6
X7
X8
X9
X10