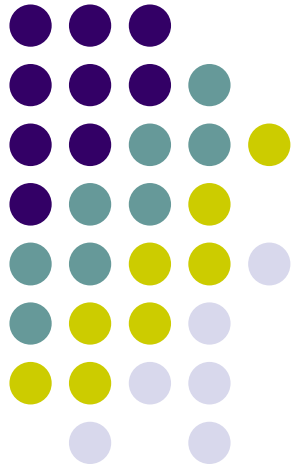
Modelling Emotion Contagion

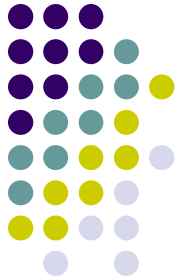
Dynamic Modelling for Human-centered Systems



Syllabus chapter 7

EMOTION CONTAGION

What is Emotion Contagion?

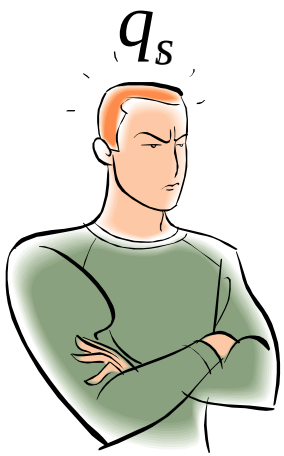


- Influencing others through conscious or unconscious induction of emotion states
- Tendency to mimic the nonverbal behavior of others; synchronization of facial expressions, vocalizations, postures, and movements" with others, in order to "converge emotionally"

Hatfield, E., Cacioppo, J.T., and Rapson, R.L. (1994). Emotional contagion. New York: Cambridge University Press.

Domain model

main concepts

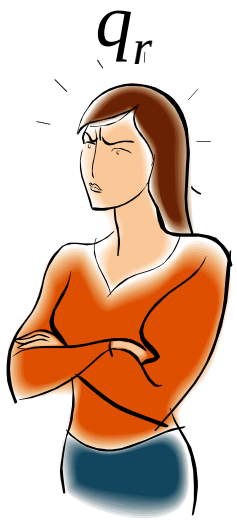


q_s

sender

channel

Emotion



q_r

receiver

ε_s

expressiveness of sender

α_{sr}

channel strength

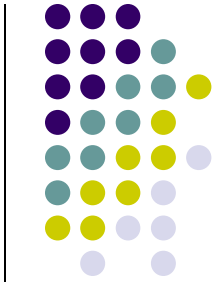
δ_r

openness of receiver

contagion strength γ_{sr} from a sender to a receiver

$$\gamma_{sr} = \varepsilon_s \alpha_{sr} \delta_r$$

Domain model
main concepts



Variables

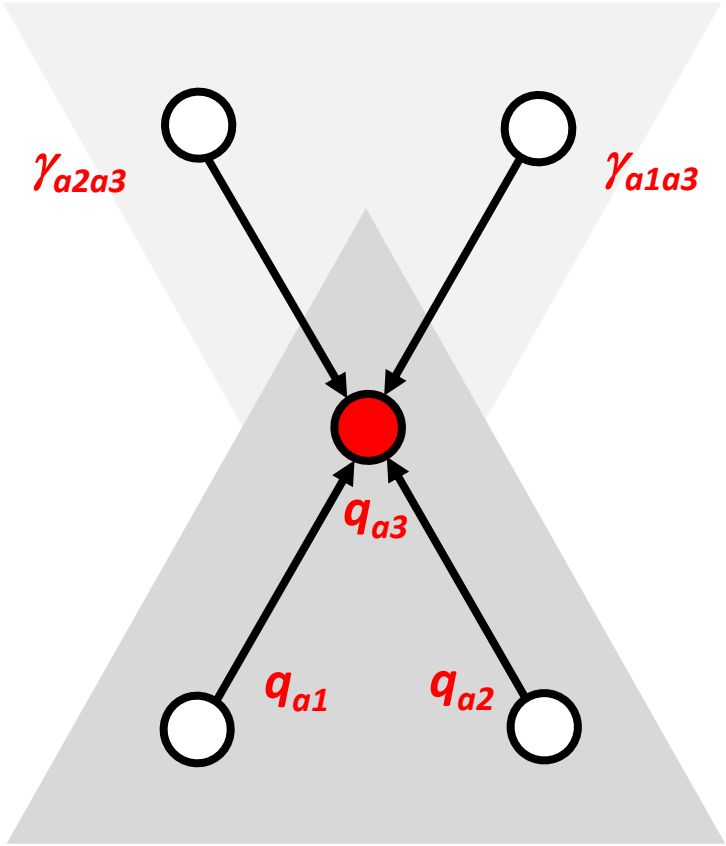
- the level of a person *A*'s emotion q_A

Parameters

- a person *A*'s emotion expressiveness ε_A
- a person *A*'s openness for received emotion δ_A
- the strength of the channel from sender *B* to receiver *A* α_{BA}
- the contagion strength from a sender *B* to a receiver *A* γ_{BA}

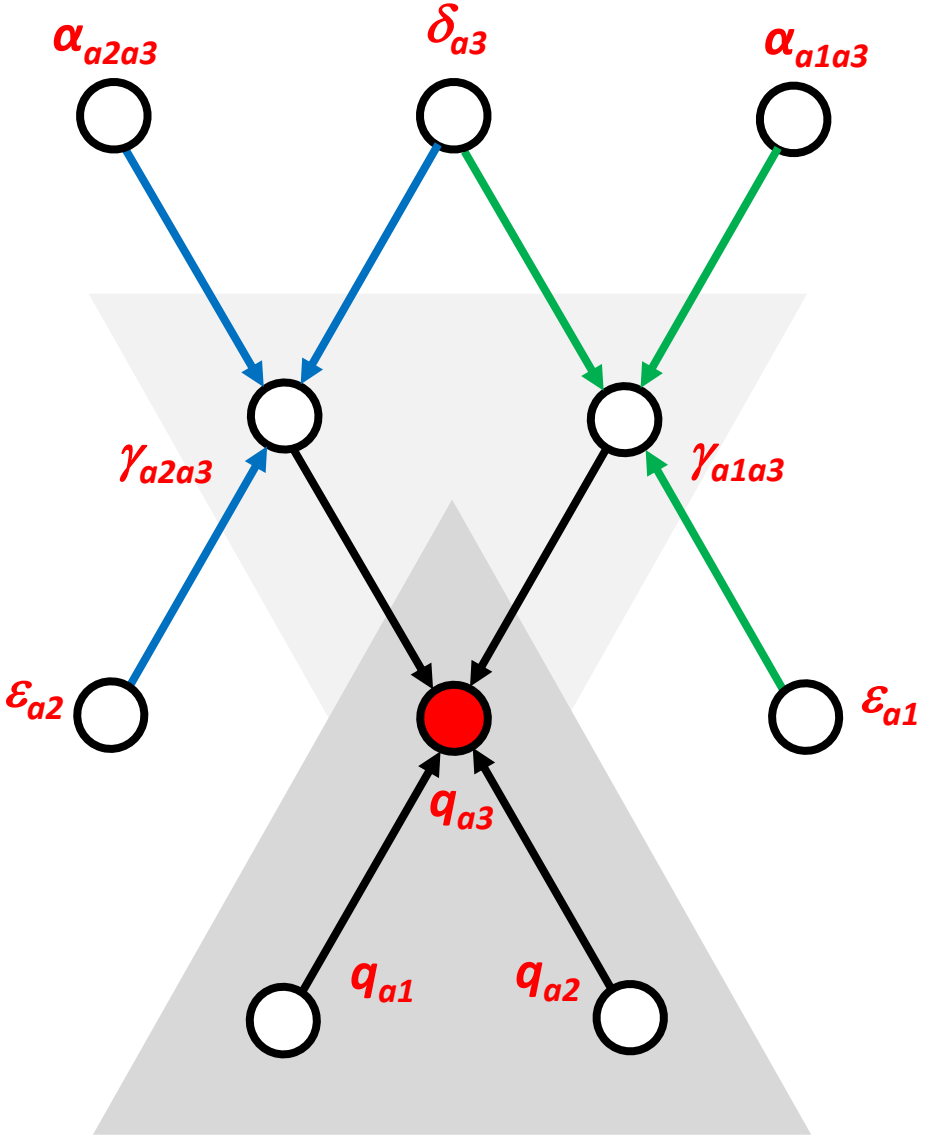
Note that some of the parameters can also be manipulated

Domain model for 3 persons:
Relationships affection *a3*

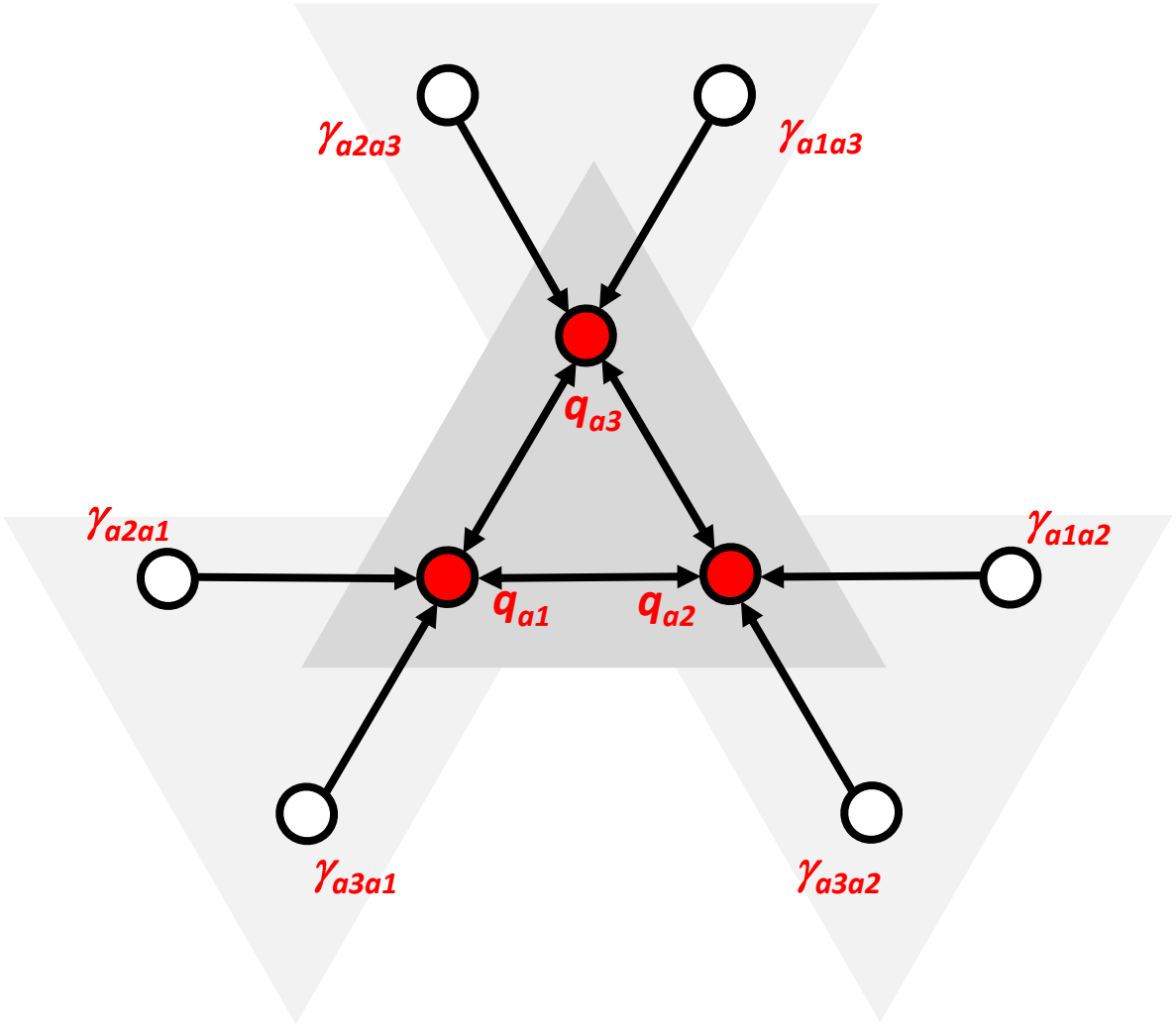


Domain model for 3 persons:

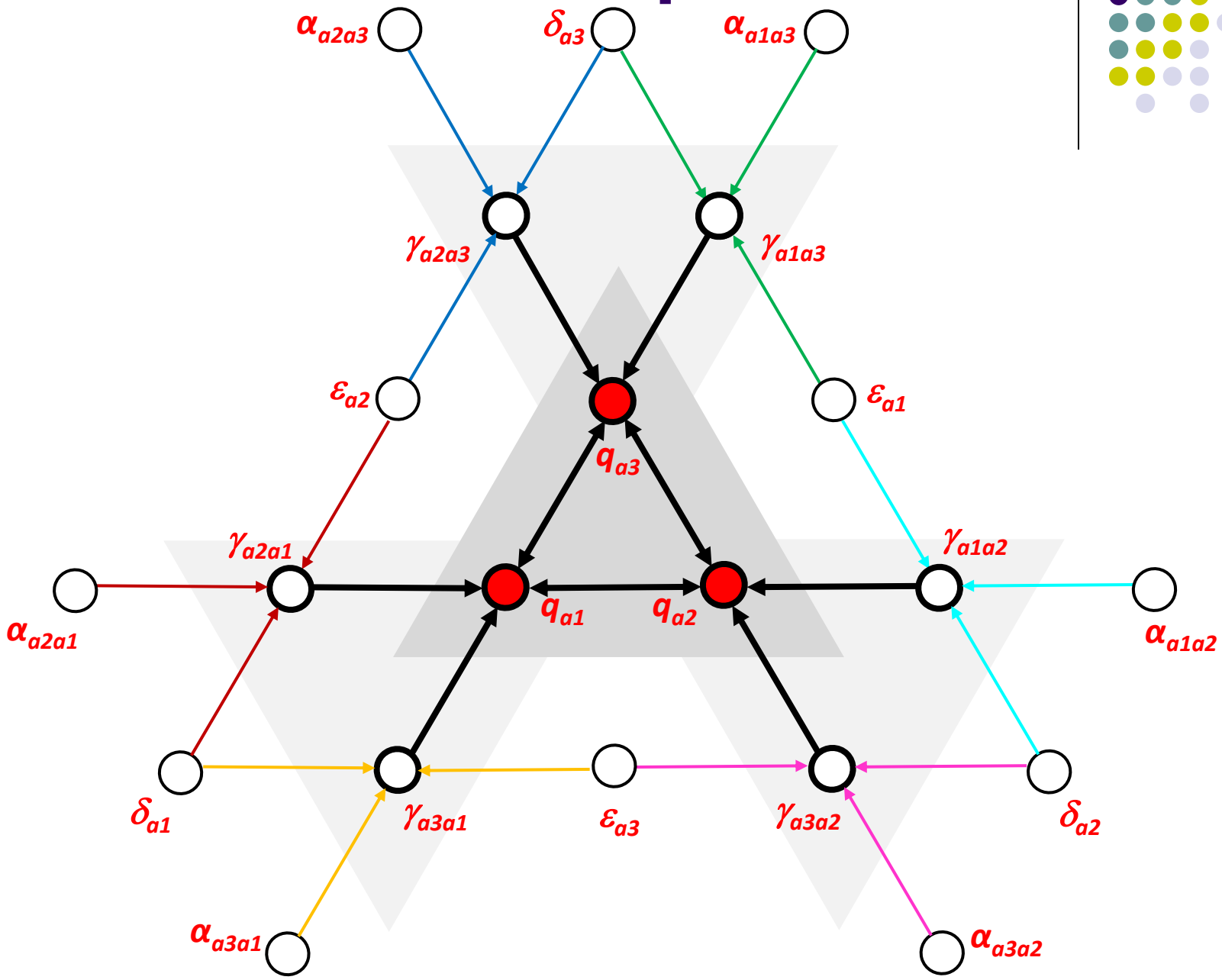
Relationships affection *a3*



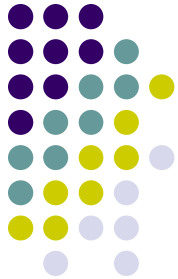
Domain model for 3 persons



Domain model for 3 persons



Formalisation of concepts



- Predicates

Concept	Formalisation
person B has emotion expressiveness E	`has_expressiveness(B:AGENT, E:REAL)`
person A has openness for received emotion D	`has_openness(A:AGENT, D:REAL)`
channel from sender B to receiver A has strength C	`has_channel_strength(` `  B:AGENT, A:AGENT, C:REAL)`
contagion strength from B to A is CS	`has_contagion_strength(` `  B:AGENT, A:AGENT, CS:REAL)`
overall contagion strength to receiver A is CS	`has_overall_contagion_strength(` `  A:AGENT, CS:REAL)`
person A has relevance factor R	`has_relevance(A:AGENT, R:REAL)`
person A has emotion level V	`has_emotion_level(A:AGENT, V:REAL)`
the group has emotion level V	`group_emotion_level(V:REAL)`

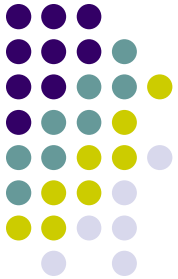
Formalisation of concepts

- Sorts

Sort	Description of use	Elements
AGENT	group members	a1, a2, a3, a, b, c, arnie, bernie, charlie
REAL	group member emotion level, group emotion level, expressiveness factor, channel strength, openness, contagion strength, relevance factor	real numbers

Detailed domain model

General idea



At each time point, for each group member ***A***:

- Determine the **average emotion impact** q_A^* of the other group members on ***A***, taking into account that not all members have an equal impact on ***A***
- Determine the **difference** $q_A^* - q_A$ of this average q_A^* with the current emotion level q_A of person ***A***
- **Adjust** the emotion level q_A by a fraction γ of this difference, so that the new emotion level for ***A*** becomes $q_A + \gamma (q_A^* - q_A)$

- Another way of expressing this is that the new emotion level of ***A*** becomes a **weighted average** of the old emotion level q_A and the average value q_A^* of the other group members:
  $(1-\gamma)\, q_A + \gamma\, q_A^*$

In short:

The formalization of the model for emotion contagion is can be expressed as:

$$q_A(t+\Delta t) = q_A(t) + \gamma_A (q_A^* - q_A) \Delta t$$

for all group members ***A***.

Formalisation rules

DDR1 Determining contagion strengths

If *B* has expressiveness *E*

and the channel from *B* to *A* has strength *C*

and *A* has openness *D*

then the contagion strength from *B* to *A* will be *E*C*D*

```
has_expressiveness(B, E) &
has_channel_strength(B, A, C) &
has_openness(A, D)
⇒ has_contagion_strength(B, A, E*C*D)
```

Formalisation of rules

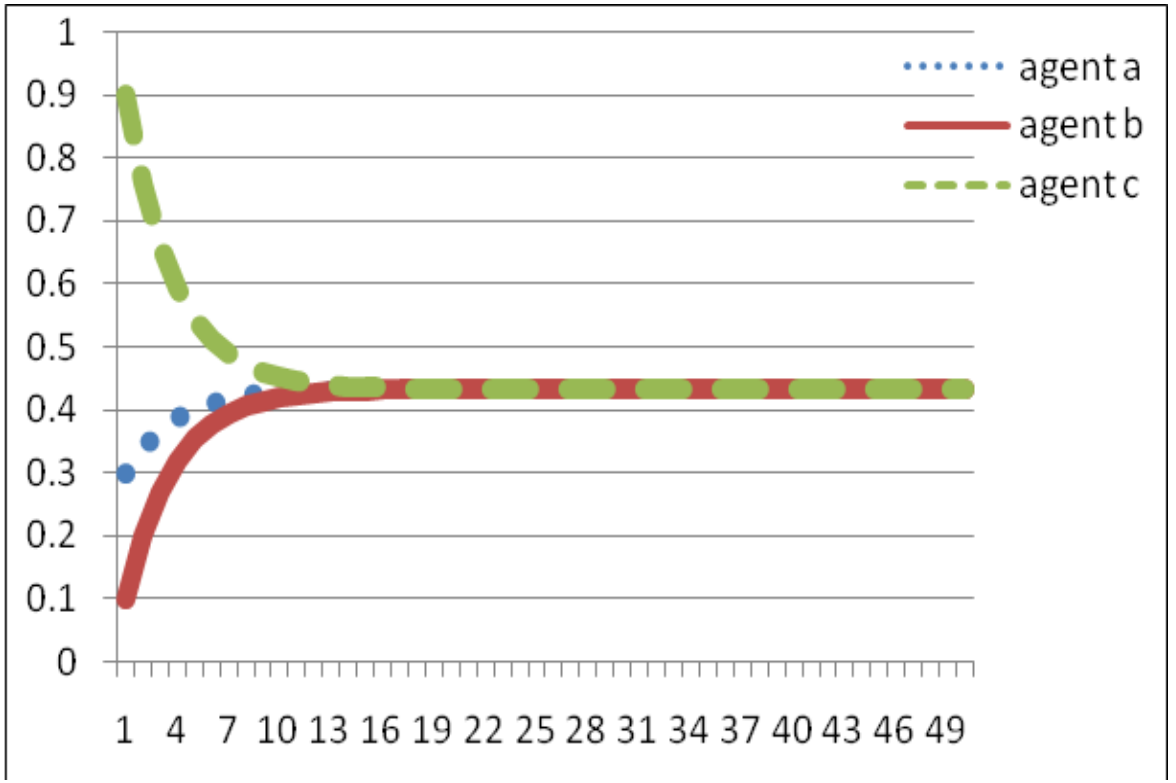
DDR2 Updating emotion levels

If $A \neq B$ and $B \neq C$ and $C \neq A$
and *A* has emotion level *V1*
and *B* has emotion level *V2*
and *C* has emotion level *V3*
and the contagion strength from *B* to *A* is *CS2*
and the contagion strength from *C* to *A* is *CS3*
then the emotion level of *A* will be *V1+CS2*(V2-V1)+CS3*(V3-V1)*

```
A≠B & B≠C & C≠A &
has_emotion_level(A, V1) &
has_emotion_level(B, V2) &
has_emotion_level(C, V3) &
has_contagion_strength(B, A, CS2)  &
has_contagion_strength(C, A, CS3)  &
↠ has_emotion_level(A, V1+CS2*(V2-V1)+CS3*(V3-V1))
```

Domain Model Simulation

Trace: General Pattern

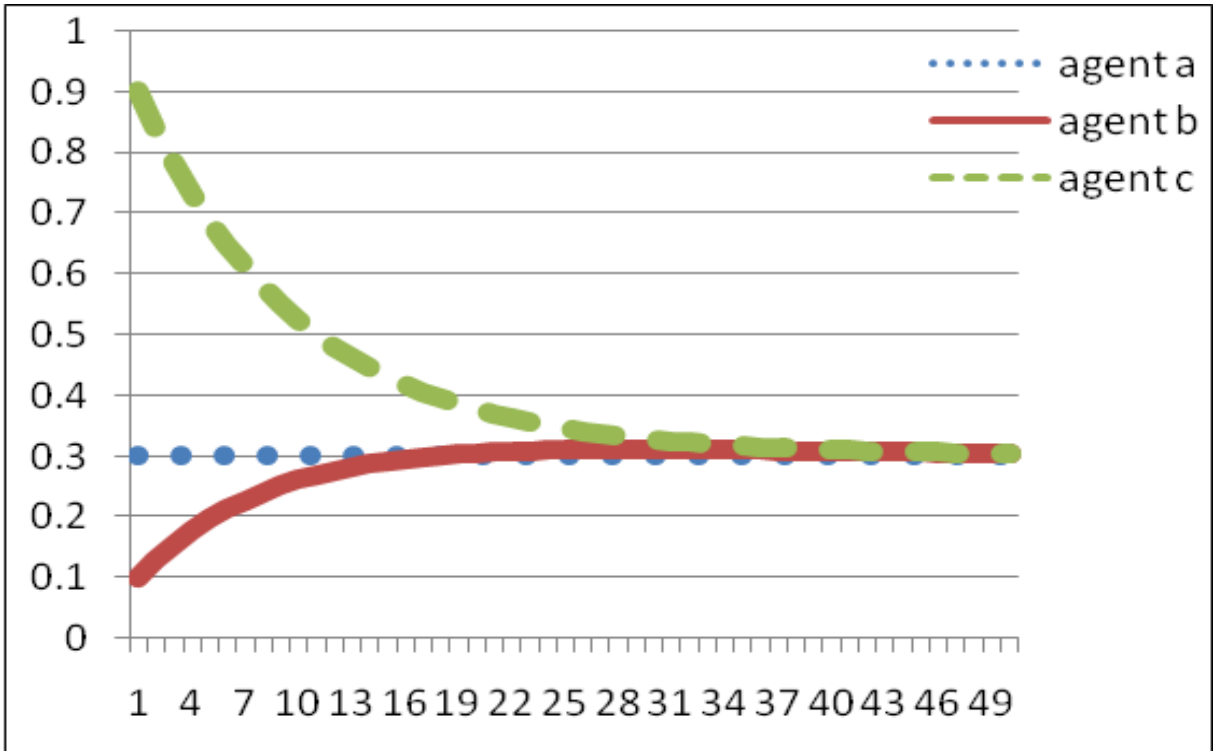


emotion

time

Domain Model Simulation

Trace: $\delta_a = 0$

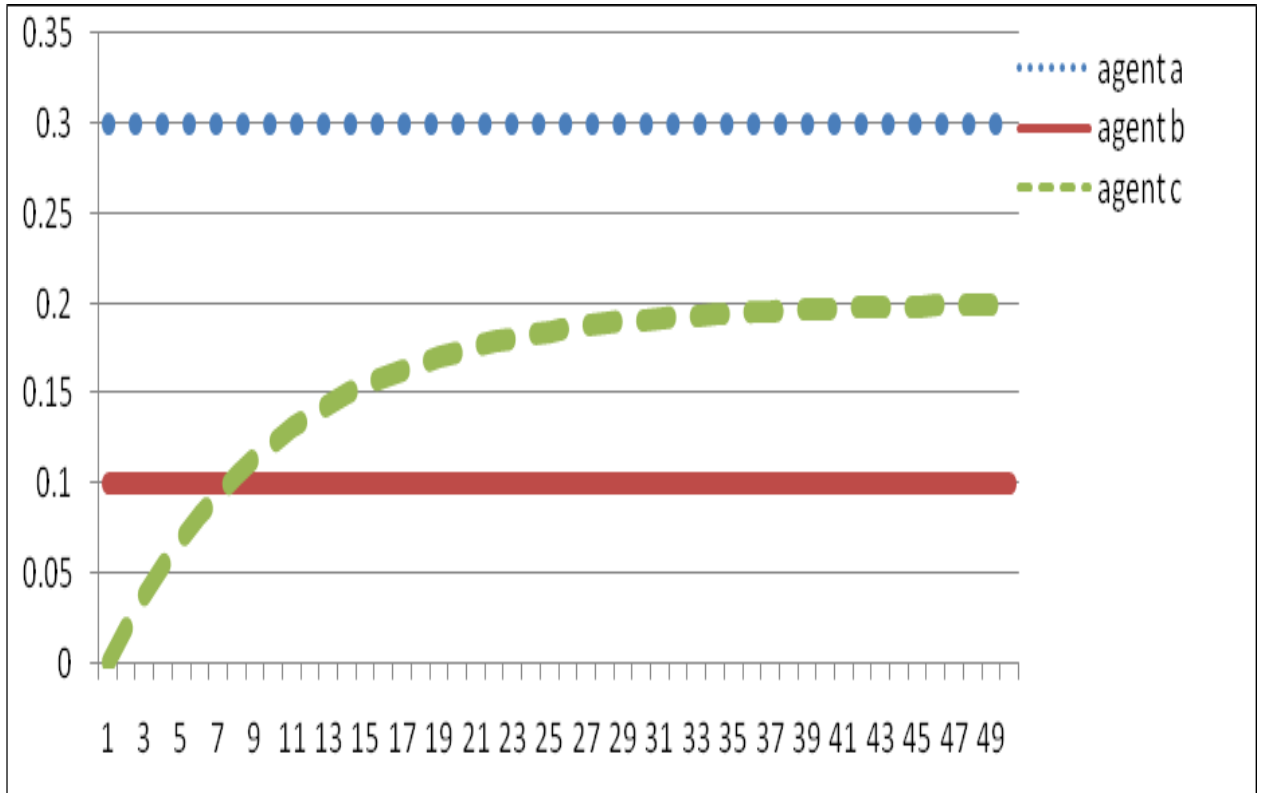


emotion

time

Domain Model Simulation

Trace: $\delta_a = \delta_b = 0$

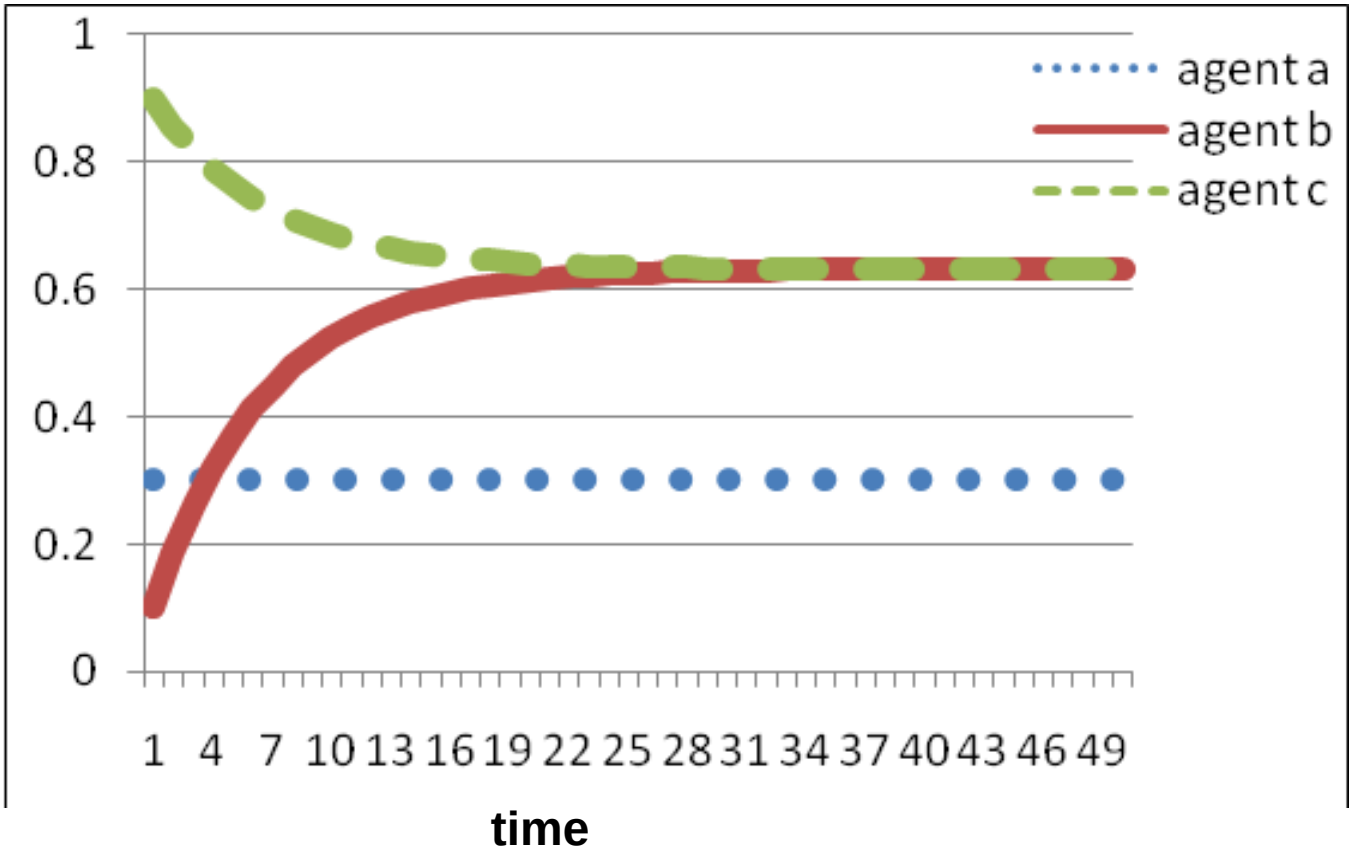


emotion

time

Domain Model Simulation

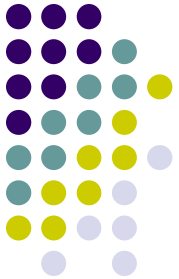
Trace: $\delta_a = \varepsilon_a = 0$



Conclusion

- Emotion contagion
  - Influencing others through induction of emotion states
  - Contagion strength: expressiveness, channel strength & openness
  - $qA(t+\Delta t) = qA(t) + \gamma A\,(qA^* - qA)\,\Delta t$ for all group members A.

Assignment 3



- L2-Python tutorial – emotion contagion
- Individual
- Pass / Fail
- Checked by TA