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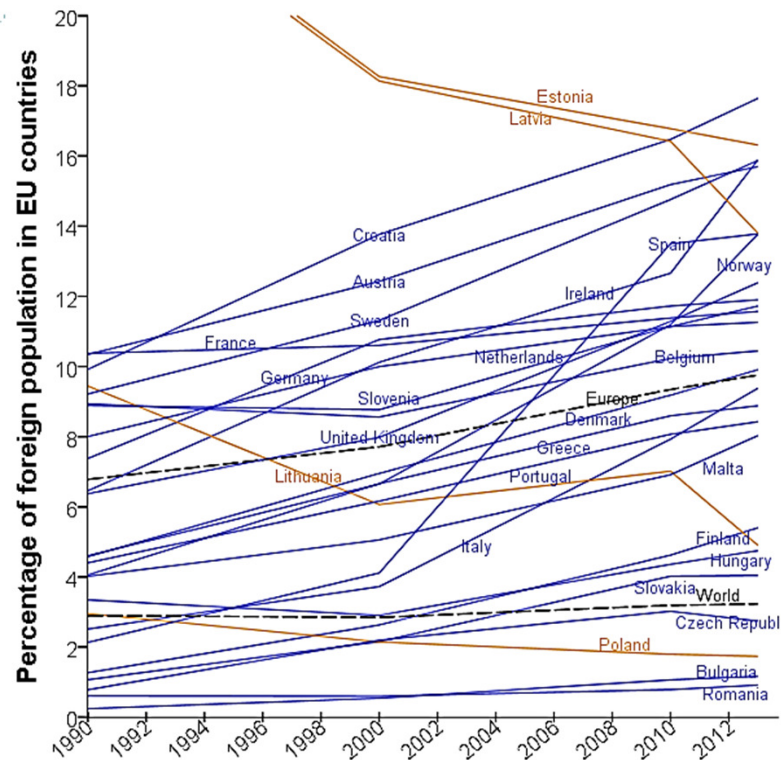
# The complexity of social integration in a diverse society: can we connect theoretical models and big data?

## Andreas Flache

Presentation @  
Latin American School and Workshop on  
Data Analysis and Mathematical Modeling of Social Science.  
SoFiA - SocioFisica Argentina  
November, 7-11, 2016  
Buenos Aires, Argentina



# Cultural diversity on the rise – Societal integration under pressure?

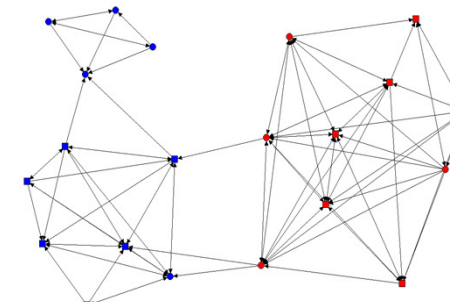


*Rise immigrant population in Europe*

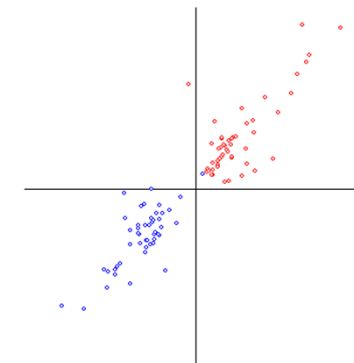
*Source data: United Nations*

*Department of Economic and Social Affairs (2013)*

*Challenges to integration?*



*Segregation?*



*Opinion polarization?*

# Where can computational sociology help?

## Two big questions:

### Where do we stand with social integration?

- › How much segregation and polarization do we see?
- › Under what conditions?

### Where do we go with social integration?

- › Trends? Mechanisms?
- › Effects of policies?

# Where do we stand?

**We need both “old data” and “new (big) data”**

**“Old data” (sometimes quite big...)**

**government statistics, surveys, laboratory experiments**

› Segregation

- spatial distribution of groups
- distribution across schools, workplaces, associations ...

› Polarization

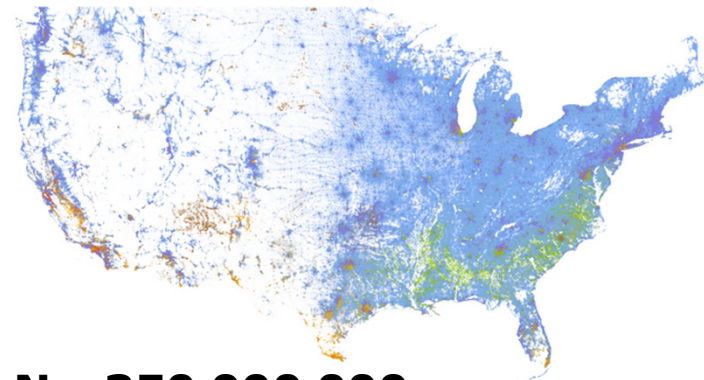
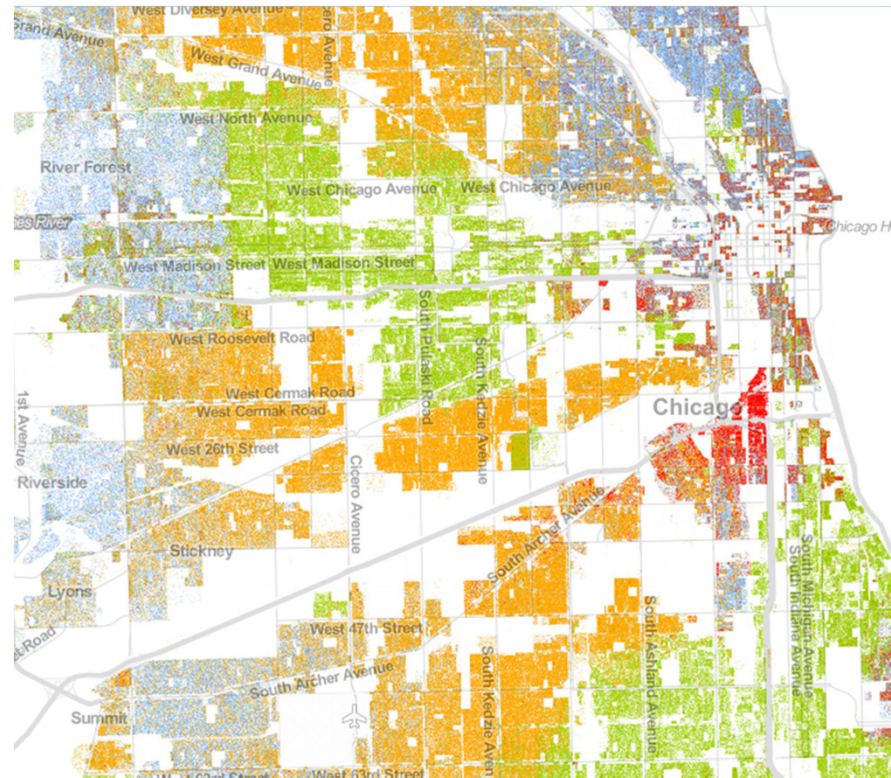
- surveys, election outcomes (e.g. right wing voting) ...

› Prejudice

- surveys, experiments (e.g. Implicit Association Task)

# Big old data: census and segregation

U.S. data based on U.S. government census block data (geolocated units of on average 60 inhabitants):



**N ≈ 350 000 000**

2010 Census Block Data

1 Dot = 1 Person

- White
- Black
- Asian
- Hispanic
- Other Race / Native American / Multi-racial

## Inner City of Chicago, 2010

*Dustin Cable. Demographics Research Group, Univ. of Virginia*

<http://www.coopercenter.org/demographics/Racial-Dot-Map>

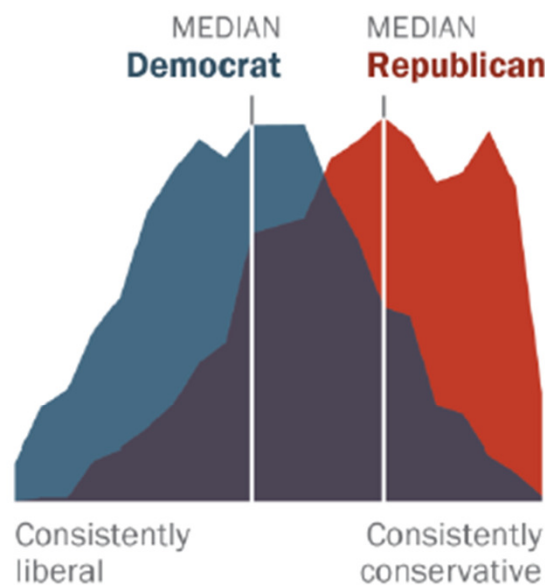
# Old data: surveys

## Polarization in political opinions

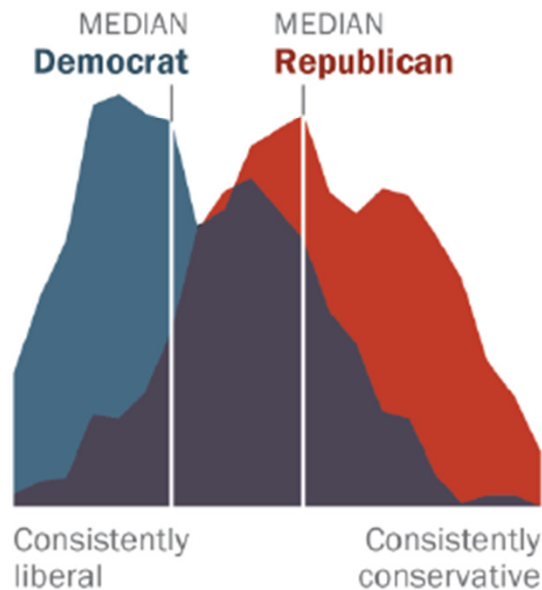
(DiMaggio et al. 1996, Evans 2003, Fischer et al 2009)

Among the politically engaged

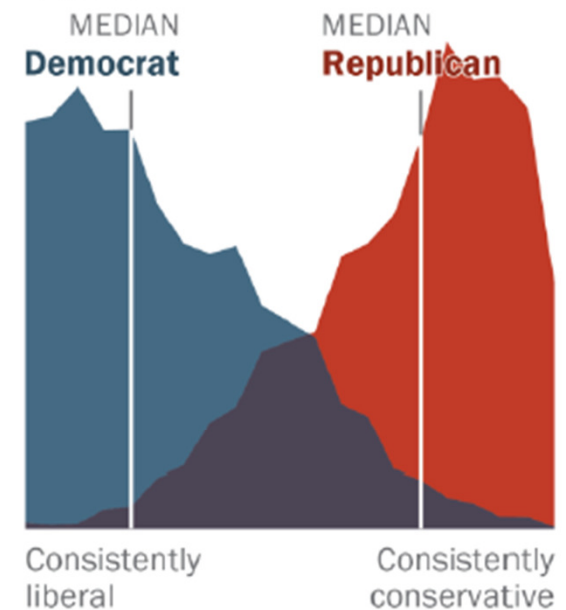
1994



2004



2014



Source: Pew Research Center (2014).

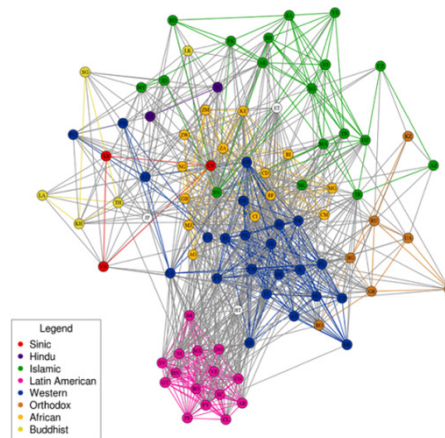
Matthew Gentzkow, Stanford University. 2016.

## “Old data” tell us a lot about integration

“new data” give us new knowledge,  
particularly when combined with “old data”

- › Segregation also in online communications?

State B, Park P, Weber I, Macy M (2015). PLoS ONE 10(5): e0122543.



- › Opinion formation:

- Polarization and cultural divisions also online?
- Link offline segregation to online polarization?

# “New” and “old” data help to answer “where we stand”

## But where do we go?

- › What are expected trends in segregation, intergroup contact, opinion clustering, polarization...?
- › How would policy interventions affect these phenomena?

**These questions can not be answered by data alone, however big, old or new.**

We *also* need **theory-driven (computational) modelling** of possible processes

⇒ to know what the right questions are for looking at data

⇒ to answer questions about trends and interventions

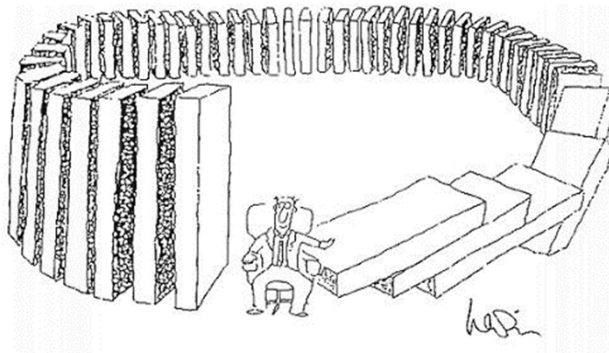


# Why data alone do not suffice: Integration in a diverse society is a case of social complexity

- › Interdependent individuals
- › Self-reinforcing processes
- › Non-linearity

⇒ Unintended consequences:

unexpected undesirable effects of individual interactions



# Why data alone do not suffice: Integration in a diverse society is a case of social complexity

- › Interdependent individuals
- › Self-reinforcing processes
- › Non-linearity



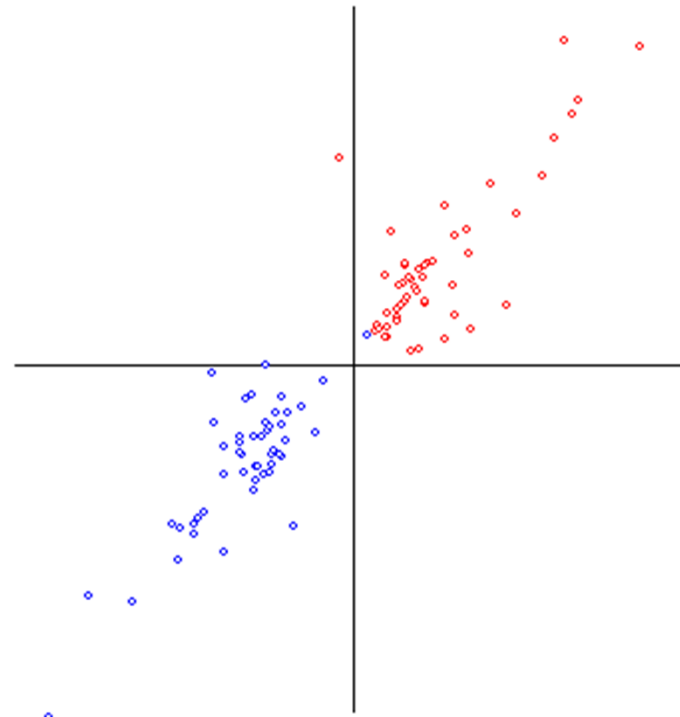
⇒ Unintended consequences:

unexpected undesirable effects of individual interactions

⇒ Complex Micro-Macro relations:

Situational-conditions (e.g. ethnic heterogeneity) may relate to macro-outcomes (e.g. ethnic segregation) in very unexpected ways.

# Example: Modelling between-group opinion polarization



## Example:

# Modelling between-group opinion polarization

**Two different causal pathways...**

**With fundamentally different implications**

Possible process 1:

⇒ interplay of positive and negative influence

Macy, Kitts, Flache & Benard 2003; Jager & Amblard 2005 *CMOT*;  
Baldassari & Bearman 2007 *ASR*; Fent, Groeber & Schweitzer 2007 *ACS*;  
Flache & Mäs 2008 *CMOT*; Flache & Macy 2011 *JMS*; ...

Possible process 2:

⇒ persuasive argument exchange

Mäs, Flache, Takács & Jehn *Org Sci* 2013; Mäs & Flache 2013 *PloS One*,  
La Rocca, Braunstein & Vazquez 2014.

# Process 1: Modelling the interplay of positive and negative influence theoretically

Extending earlier social influence models (French etc)

*Positive influence (assimilation) and negative influence (differentiation):*

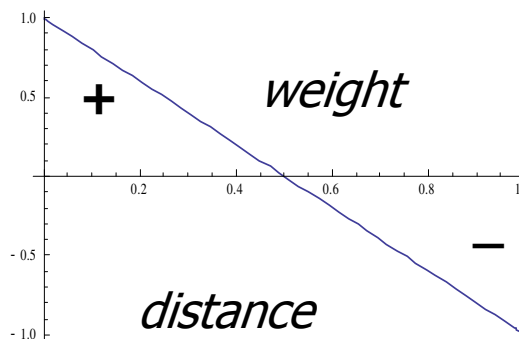
- local neighbours “pull” or “push” opinion  $o$  depending on weight  $w_{ij}$

$$\Delta o_{i,t} = \frac{1}{\text{scalingfactor}} \sum_{j \neq i} w_{ij,t} (o_{j,t} - o_{i,t}) \quad 0 \leq o \leq +1$$

*Homophily and xenophobia: change of relational weight  $w$*

- average distance  $>$  zero  $\Rightarrow$  positive weight, else *negative*

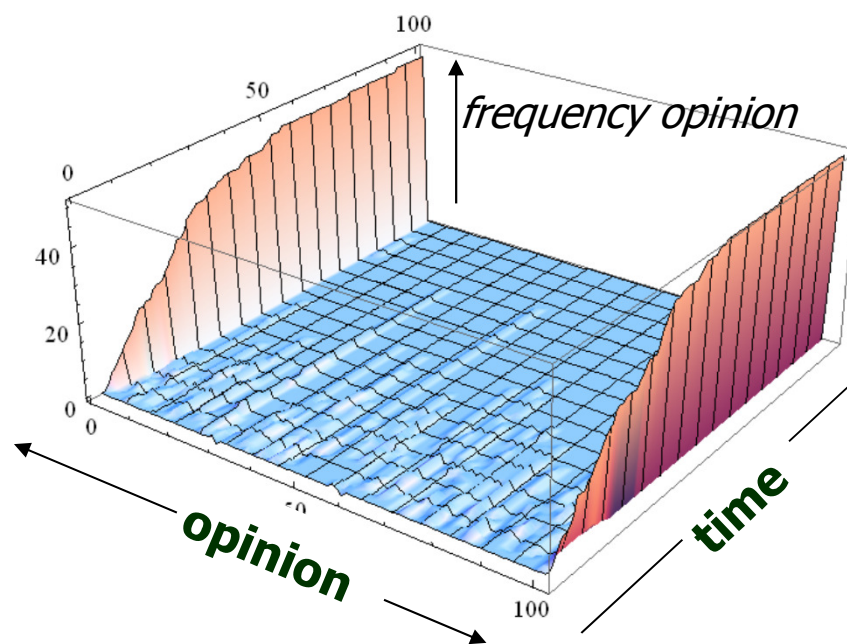
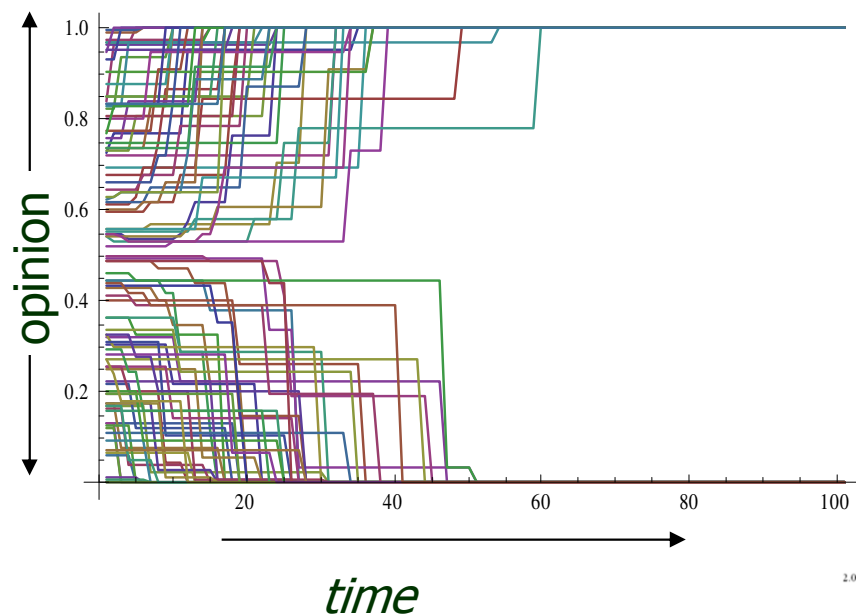
$$w_{ij,t+1} = 1 - 2 \frac{|o_{it} - o_{jt}|}{\text{MaxDist}},$$



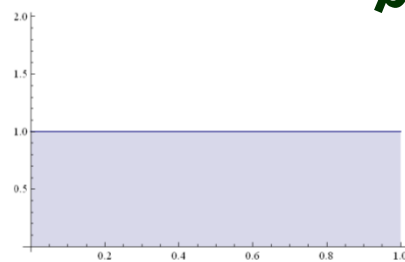
$$-1 \leq w \leq +1$$

# Interplay of positive and negative influence

## A typical result: bi-polarization



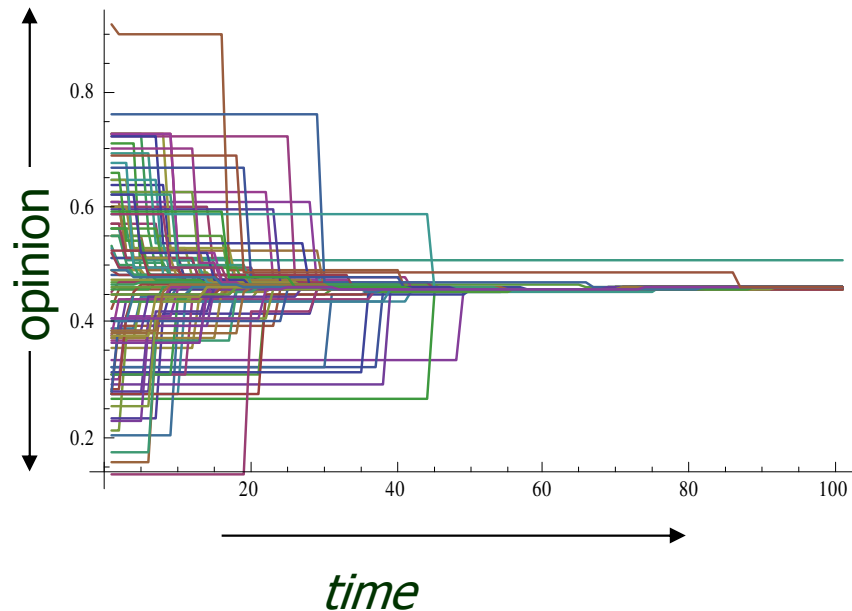
- › Initially random uniform
- ›  $N=100$ , 1000 iterations
- › Asynchronous updating



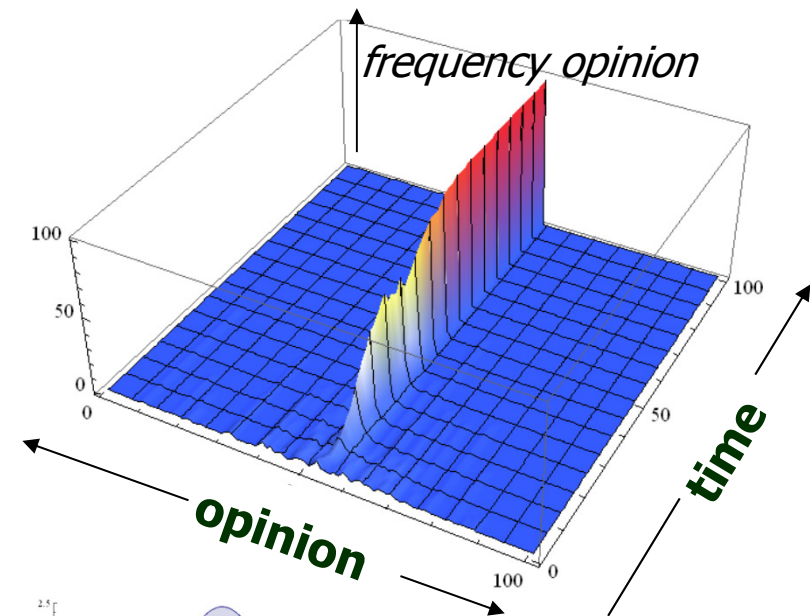
Initial distribution

*e.g.*  
*Macy et al 2003*  
*Jager & Amblard 2005 CMOT*  
*Flache & Macy 2011 JMS*

# Another typical result: consensus



- › **Initially unimodal, s.d. 0.15**
- › **N=100, 1000 iterations**
- › **Asynchronous updating**



Initial distribution

# Modelling effects of “diversity”: Integrating demographic features (Flache & Mäs 2008 CMOT, SimPat)

Similarity i-j depends on both demographic and opinion (dis)similarity:

$$w_{ij,t+1} = 1 - \frac{2 \left( \sum_{d=1}^D |s_{id} - s_{jd}| + \sum_{f=1}^F |o_{ift} - o_{jft}| \right)}{\text{MaxDist}}, \quad -1 \leq w_{ij,t+1} \leq 1$$

D fixed demographic features s,  
F changing opinion features o



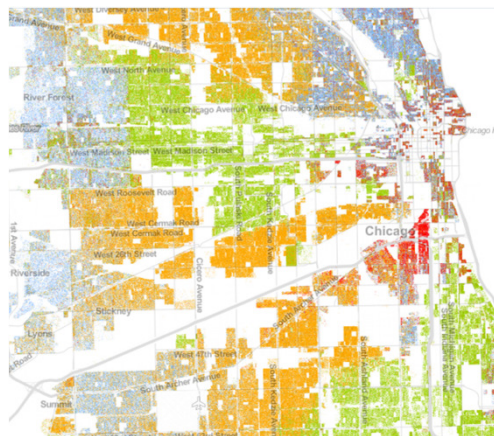
# (Demographic) diversity and segregation can stabilize pluriformity – really?

## Demographic segregation + local interaction

people interact more with similar others

⇒ Less interaction between dissimilar people

⇒ Less *negative* influence, less polarization



2010 Census Block Data

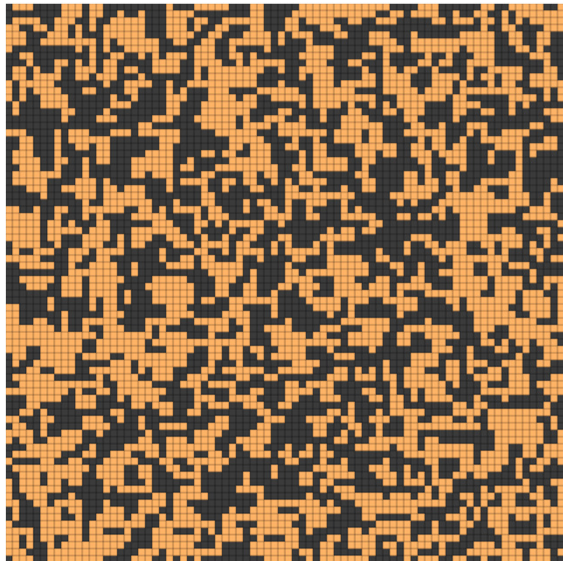
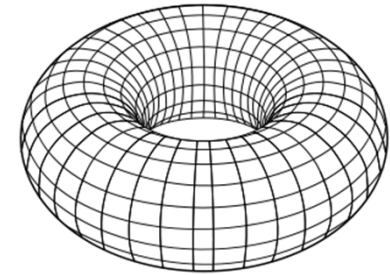
1 Dot = 1 Person

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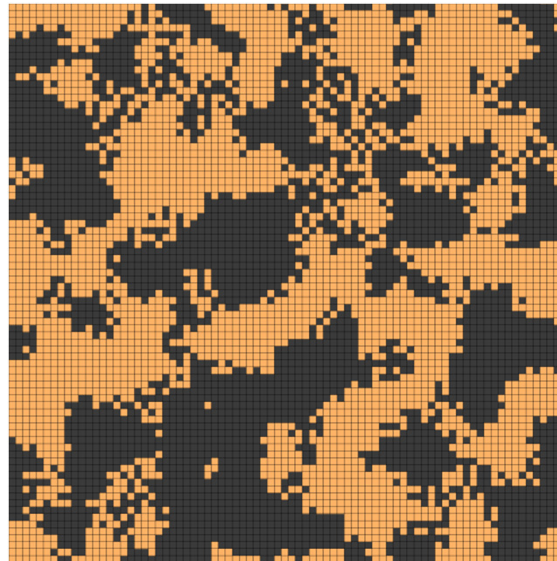
**Inner City of Chicago, 2010.** *Dustin Cable. Demographics Research Group, Univ. of Virginia. <http://www.coopercenter.org/demographics/Racial-Dot-Map>*

# Modelling effects of segregation in (slightly) realistic spatial settings

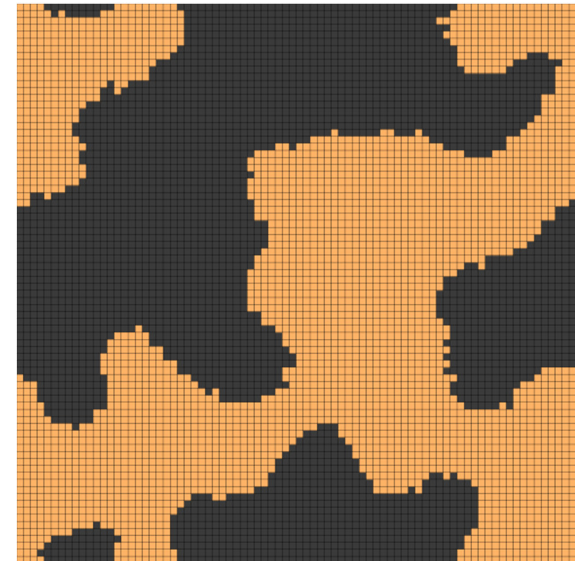
Settings with increasing level of segregation obtained from a Schelling-like segregation algorithm



**Low** segregation



**Medium** segregation

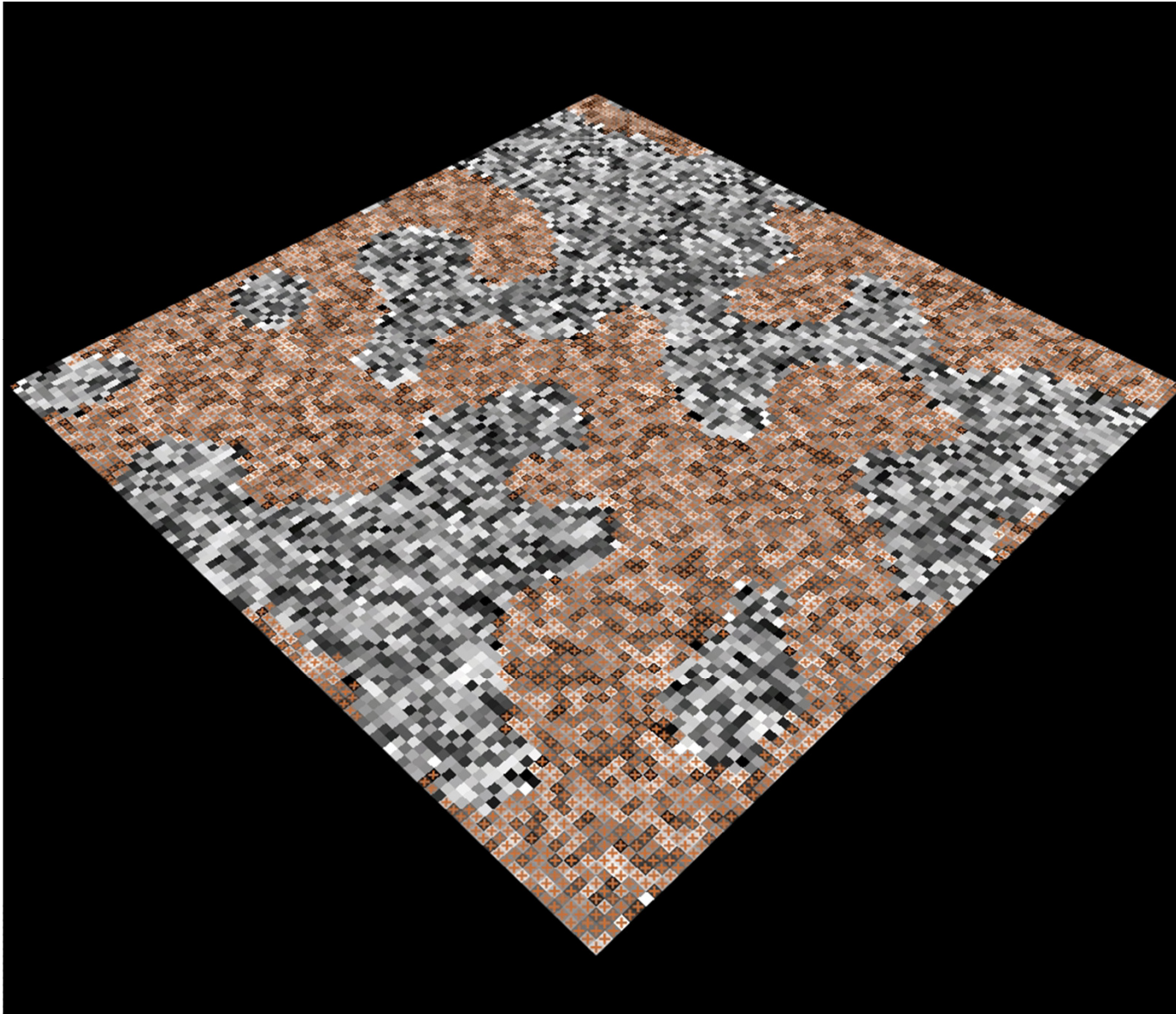


**High** segregation

*Feliciani & Flache 2015. Paper @Social Simulation 2015 (under review for publication)*

*Complexity of Integration – Flache – SoFiA 2016*

# Process 1: positive and negative influence with segregated spatial distribution



**Here:**

**stylized** 100x100  
torodial world

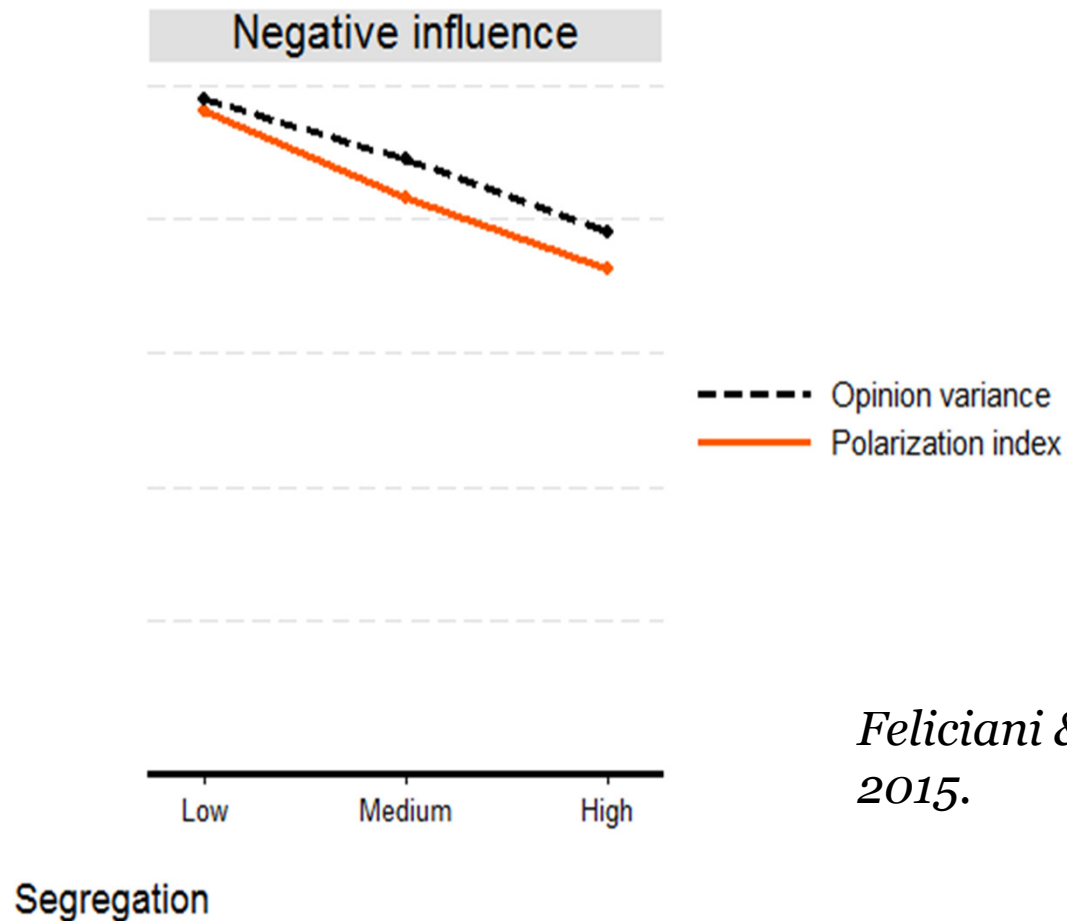
50/50 group  
distribution

Spatial distribution  
generated by  
Schelling-type  
simulation model

*Feliciani & Flache*  
2015.

# Does segregation decrease polarization?

## Yes, according to negative influence model



*Feliciani & Flache  
2015.*

# Process 2: Intergroup polarization without negative influence

*A model based on persuasive argument theory*

(Mäs, Flache, Takács & Jehn, 2013, *Organization Science*; Mäs & Flache, 2013 *PlosOne* )

- › Opinion is constituted by **arguments**

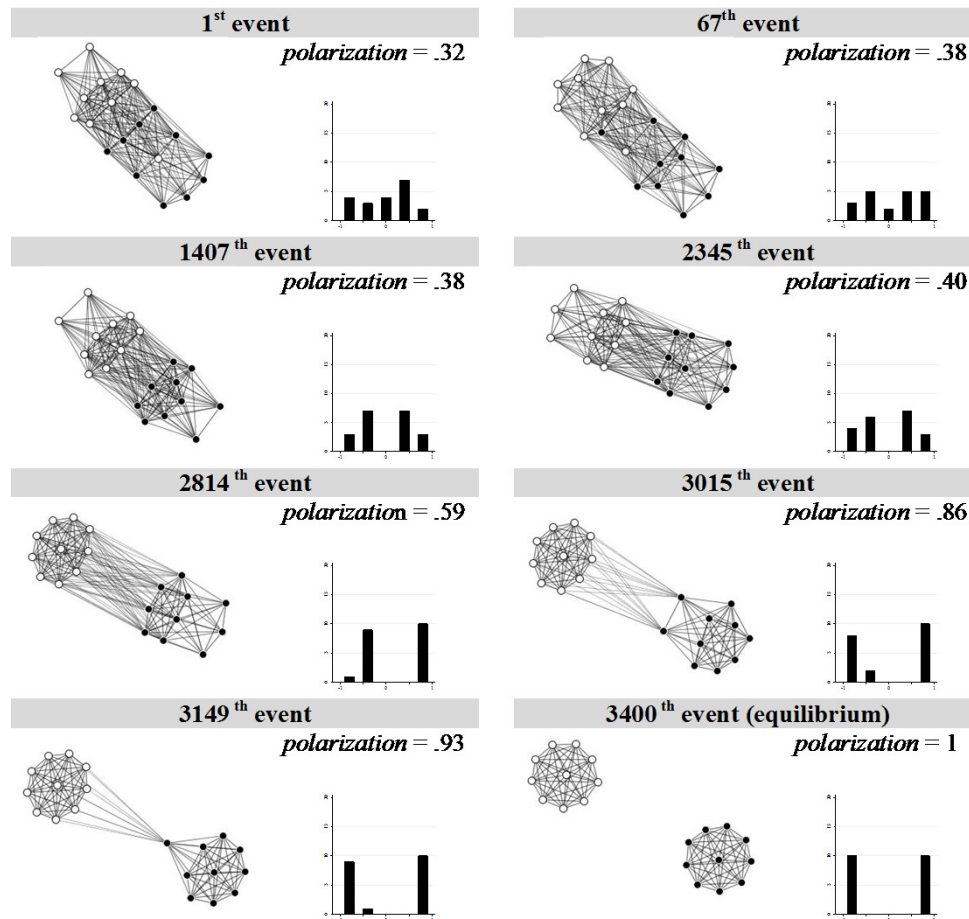
$$\mathit{arg\_vector} \quad ++---- \quad \Rightarrow \quad \mathit{opinion} = -0.33$$

- › **Homophily**: the more similar, the more likely interaction
- › **Influence**: if  $i$  interacts with  $j$ , then  $i$  adopts argument from  $j$ .



**⇒ interaction with similar others increases polarization**

# Persuasive argument theory: Opinion polarization with maximal segregation



Dynamics of opinion and interaction network

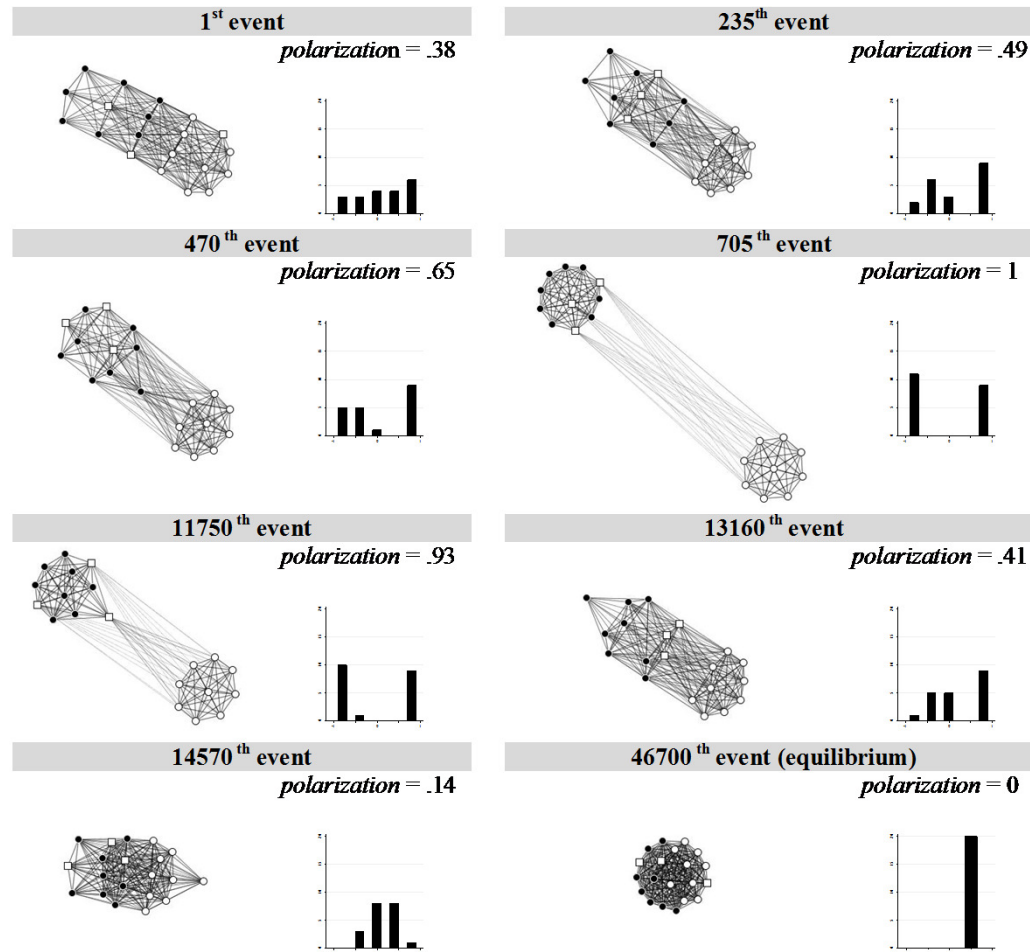
**with maximal segregation**

Further assumptions:

- strong homophily
- demographically biased opinions

Source: Mäs, Flache, Takács & Jehn, 2013, *Organization Science*

# Persuasive argument theory: Consensus with reduced segregation



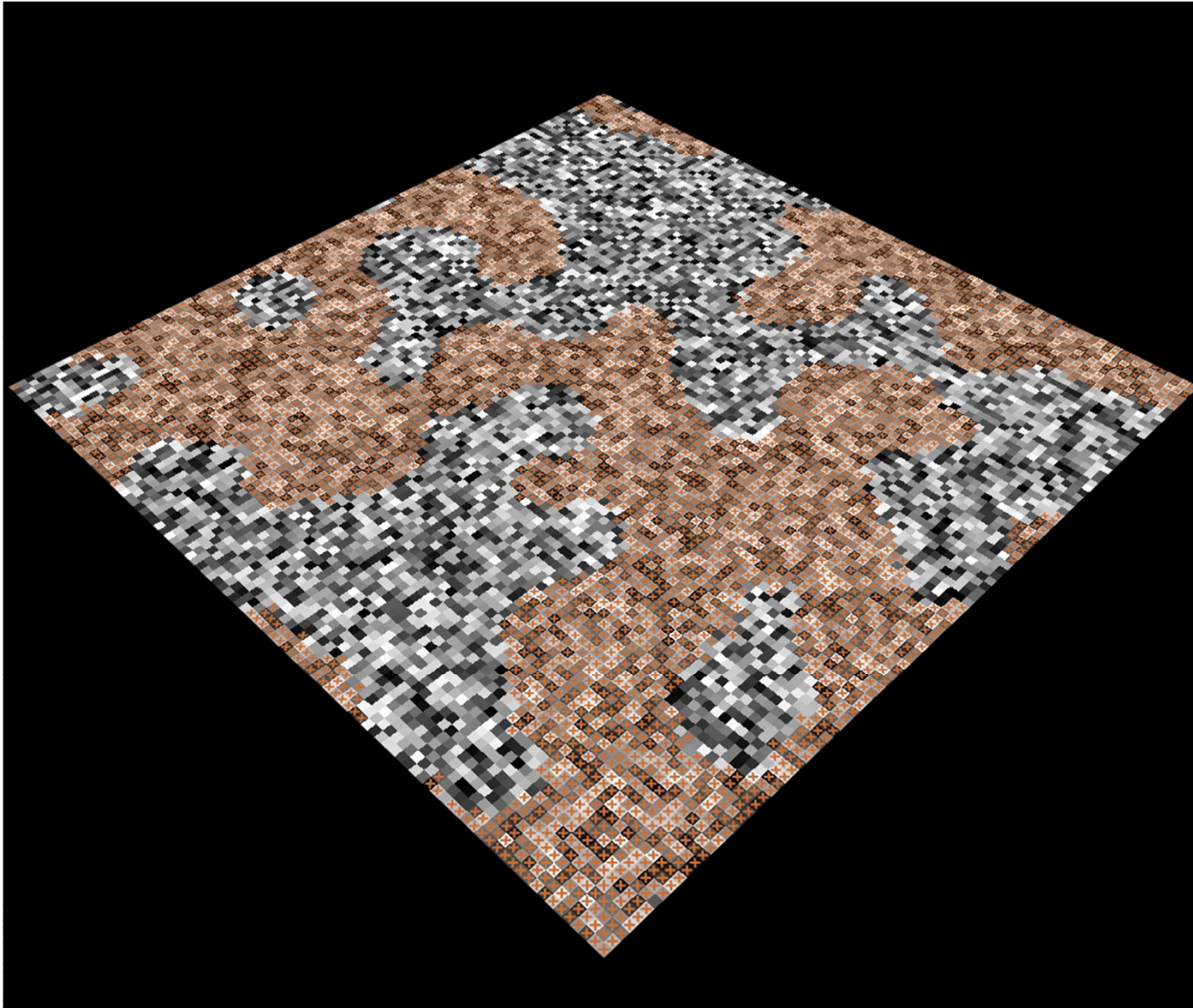
Now we added one (!)  
“criss-crossing” actor  
(all other things equal)

⇒ Sooner or later  
arguments  
communicated between  
opposing subgroups

⇒ System moves into  
consensus eventually

Source: Mäs, Flache, Takács & Jehn, 2013, *Organization Science*

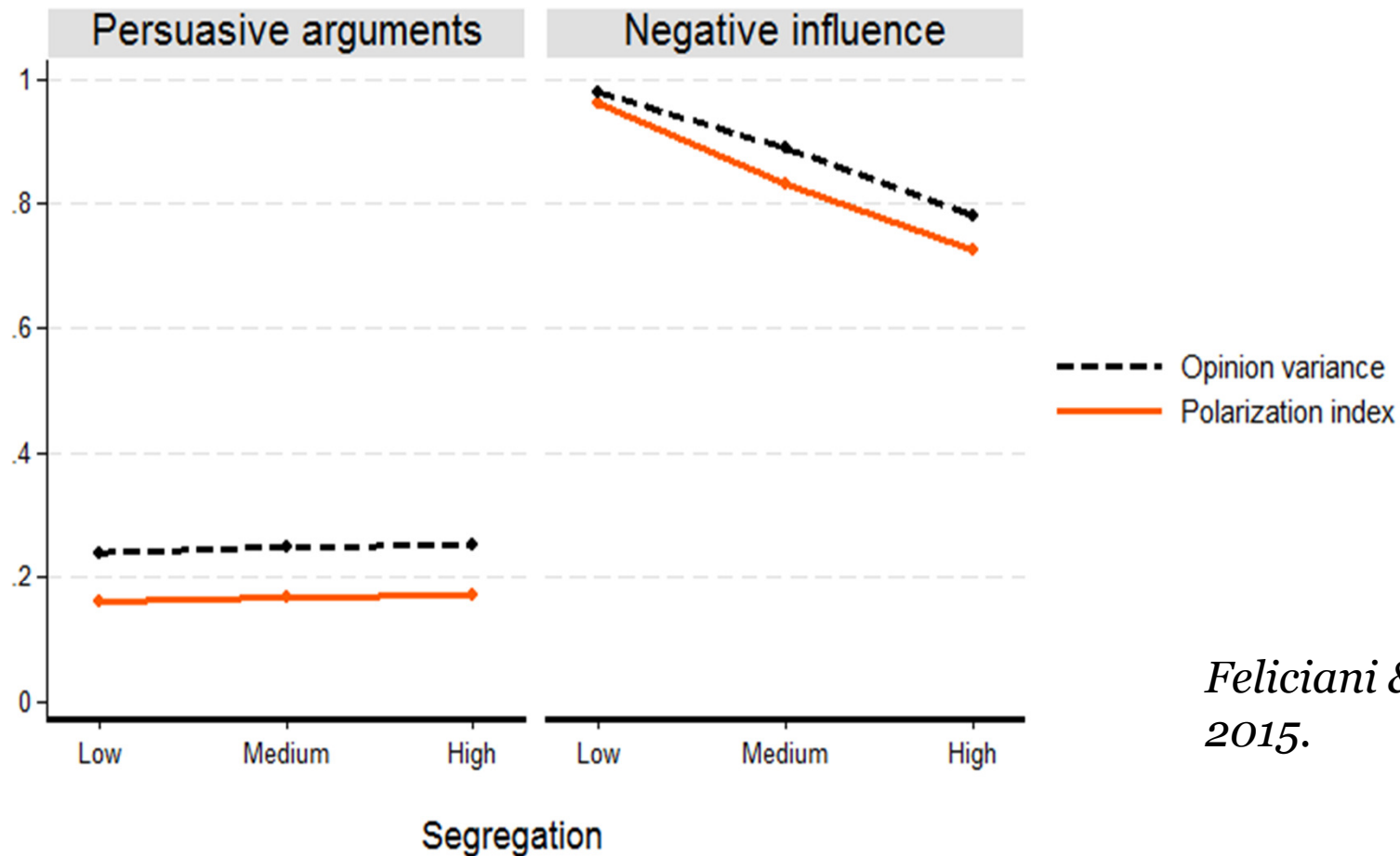
## Process 2: persuasive argument exchange with segregated spatial distribution



*Feliciani & Flache*  
2015.



# Does segregation increase or decrease polarization? It depends ...



*Feliciani & Flache  
2015.*

# Two plausible models – opposite predictions

## Strategies to bring together computational modeling with data

### Strategy 1: test **micro assumptions**

- › computational modelling has told us what to look for
- › lab experiments (offline and online)

### Strategy 2: test **macro predictions** for real settings

- › *input info* from (big) data on local residential situation.
- › simulation of “real setting” with alternative models
- › data (voting, online) to assess predicted opinion patterns

# What goes on at the microlevel?

## Controlled lab experiments



RESEARCH ARTICLE

### Discrepancy and Disliking Do Not Induce Negative Opinion Shifts

2016

Károly Takács<sup>1\*</sup>, Andreas Flache<sup>2</sup>, Michael Mäs<sup>2</sup>

OPEN ACCESS Freely available online

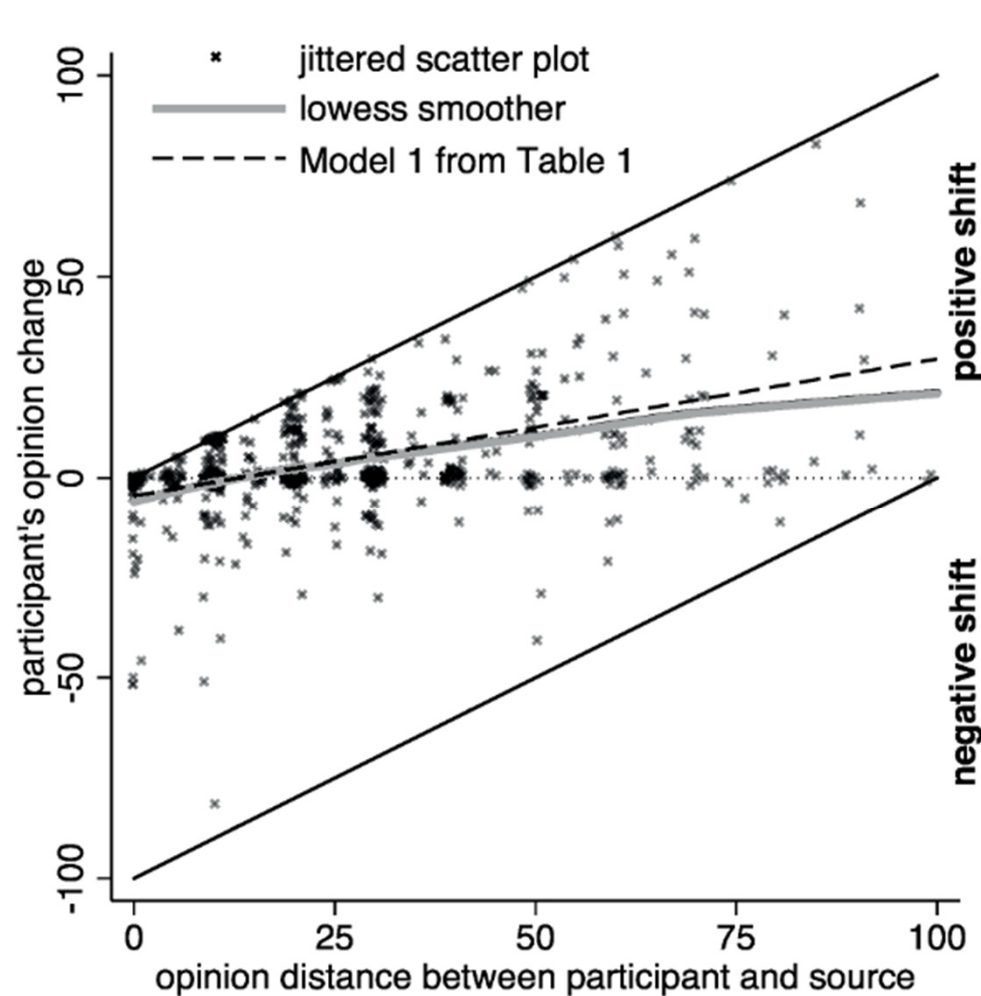


### Differentiation without Distancing. Explaining Bi-Polarization of Opinions without Negative Influence

Michael Mäs<sup>1\*</sup>, Andreas Flache<sup>2</sup> 2013

<sup>1</sup> Chair of Sociology, in particular Modeling and Simulation, ETH Zurich, Zurich, Switzerland, <sup>2</sup> Department of Sociology/ICS, University of Groningen, Groningen, The Netherlands

# “Discrepancy and Disliking Do Not Induce Negative Opinion Shifts”

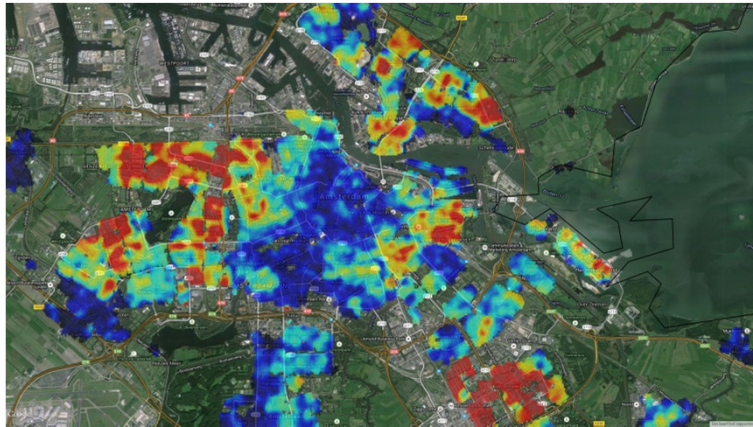


Influence mainly positive

No more negative influence if large disagreement

Takács, Flache & Mäs 2016.  
Plos One 11(6): e0157948.  
doi:10.1371/journal.pone.0157948

# Example strategy 2: translating real spatial distributions into initial configurations for CA

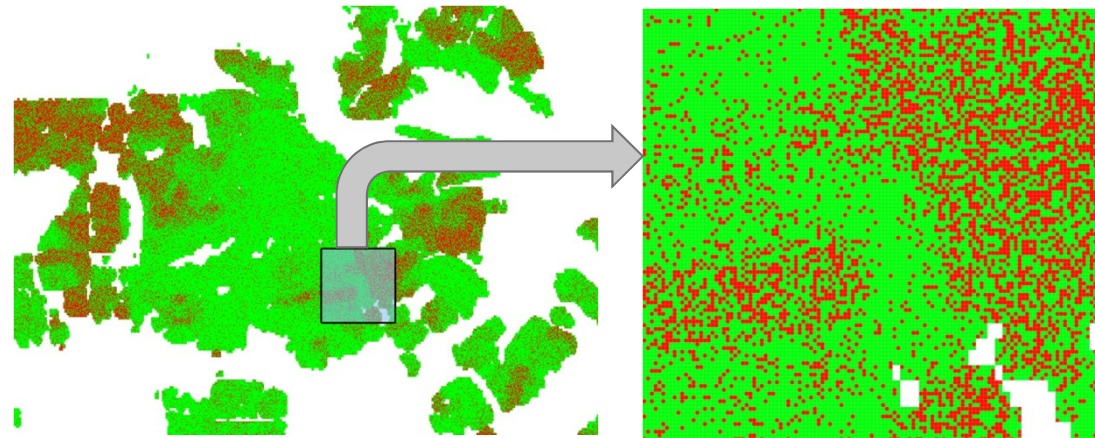


Map geographic positions on positions cell in CA

Assign “type” cell with probability (here based on color code map)

**Spatial distribution ethnic groups**

*Data from Statistics Netherlands (here: Amsterdam, 2011)*



- Ethnic minority

% Non-western immigrants



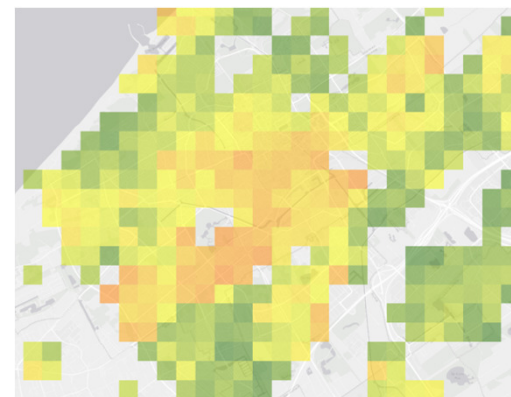
- Age

% Residents older than 44

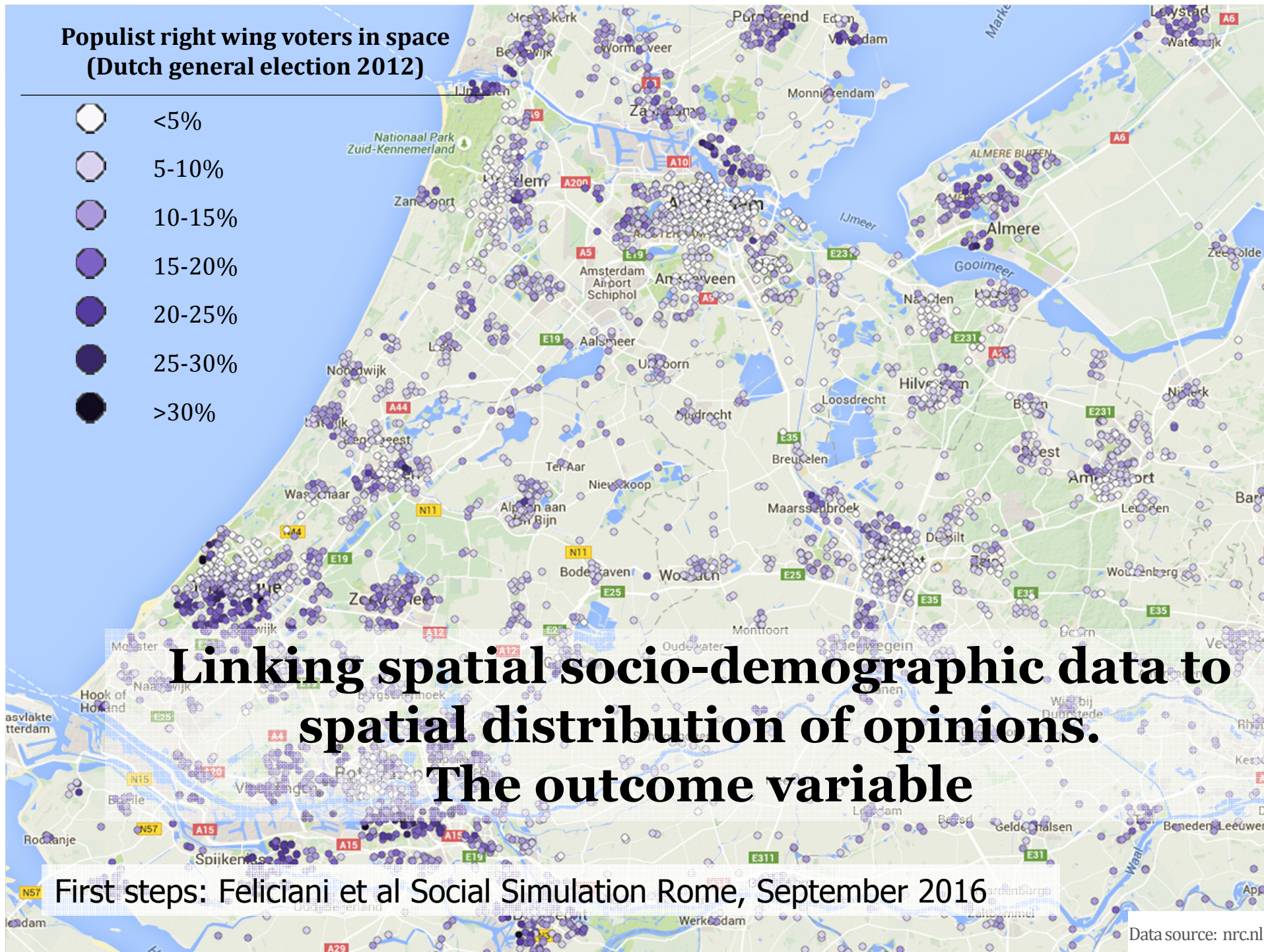
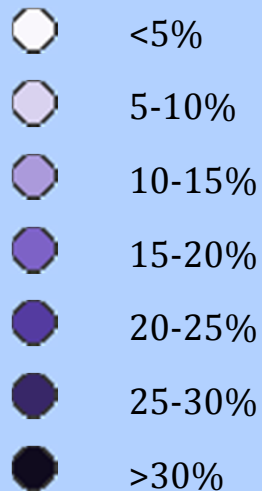


- Household income

% households whose income belongs to the lowest 40 percentiles



## Populist right wing voters in space (Dutch general election 2012)

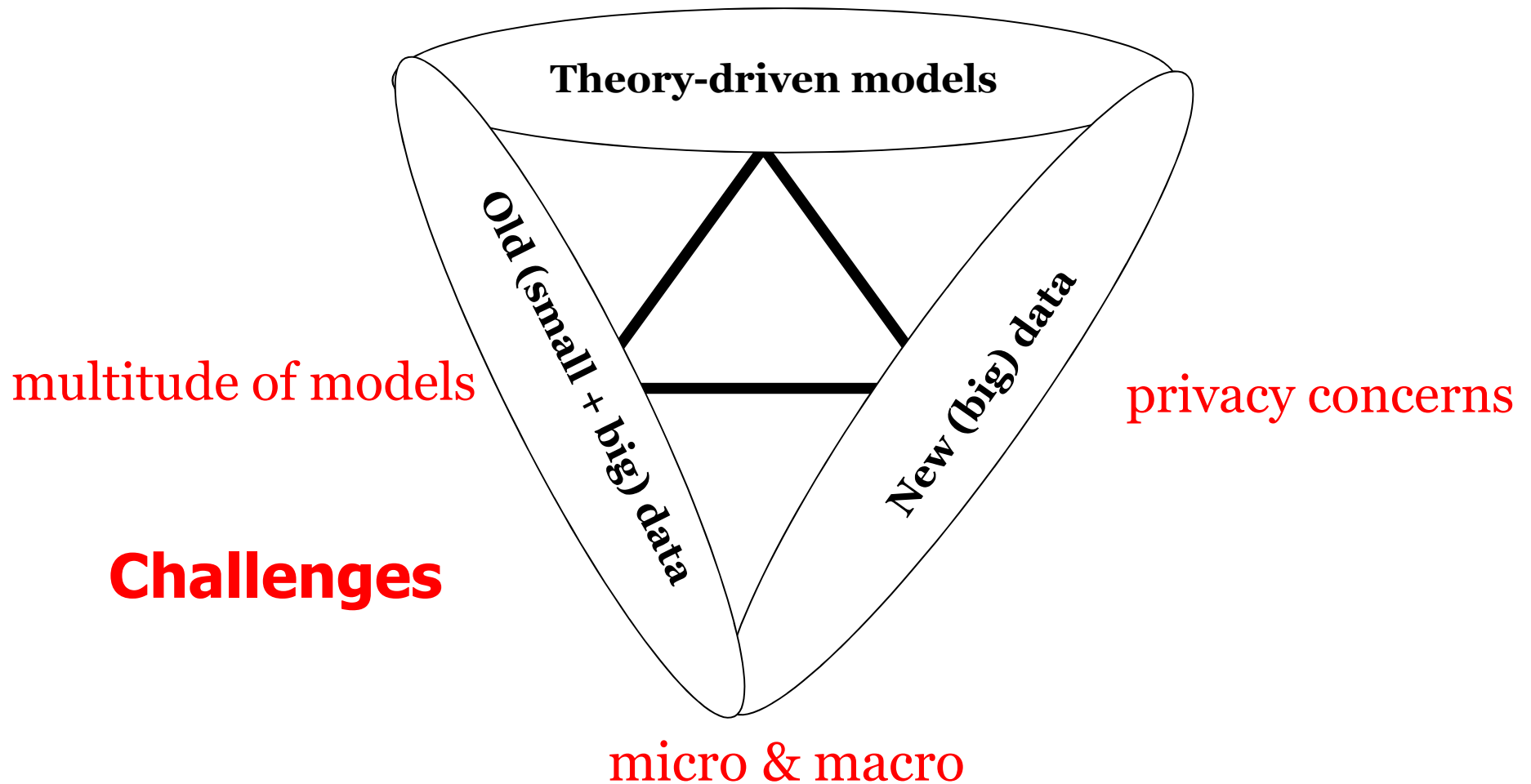


**Linking spatial socio-demographic data to  
spatial distribution of opinions.  
The outcome variable**

First steps: Feliciani et al Social Simulation Rome, September 2016

Data source: nrc.nl

# Social integration in a diverse society & computational social science





# Thank you for your attention

## Let's discuss!

### ***Credits:***

Michael Mäs

Thomas Feliciani

Jelmer Draaijer

Norms and Networks Group



university of  
 groningen

faculty of behavioural and  
 social sciences

sociology

Michael W. Macy

(Cornell)

Karoly Takács

(Corvinus Budapest)

James Kitts

(University of Massachusetts)

# Related published work

- **Takács, Flache, & Mäs. 2016. Discrepancy and Disliking Do Not Induce Negative Opinion Shifts. PLoS ONE 11(6): e0157948. doi:10.1371/journal.pone.0157948.**
- Grow, Flache & Wittek, 2015. An Agent-Based Model of Status Construction in Task Focused Groups. *JASSS* 18 (2) 4. [jasss.soc.surrey.ac.uk/18/2/4.html](http://jasss.soc.surrey.ac.uk/18/2/4.html)
- Munniksma, Verkuyten, Flache, Stark & Veenstra, 2015. Friendships and outgroup attitudes among ethnic minority youth. *IJIR*, 44 , 88-99.
- Stark, Mäs & Flache, 2015. Liking and disliking minority-group classmates. *SSR* 50:164-176.
- **Mäs & Flache. 2013. Differentiation without Distancing. Explaining Bi-Polarization of Opinions without Negative Influence. PLoS ONE 8(11): e74516.**
- Munniksma, Stark, Verkuyten, Flache & Veenstra. 2013. Extended intergroup friendships within social settings. *GPIB*. 16(6) 752–770.
- Stark, Flache & Veenstra 2013. Generalization of positive and negative attitudes towards individuals to outgroup attitudes. *PSPB* 39: 608-622.
- **Mäs, Flache, Takács & Jehn 2013. In the short term we divide, in the long term we unite: *Organization Science* 24. 3: 716–736.**
- Stark & Flache, 2012. The Double Edge of Common Interest. *SoE* 85.2:179-199.
- **Flache & Macy, 2011. Local Convergence and Global Diversity. *JCR* 55.6: 968 - 993.**
- **Flache & Macy 2011. Small Worlds and Cultural Polarization. *JMS* 35.1: 146-176.**
- **Mäs, Flache & Helbing, 2010. Individualization as Driving Force of Clustering Phenomena in Humans. *PLoS Computational Biology* 6(10): e1000959.**
- Takacs, Janky & Flache. 2008. Collective action and network change. *SN* 30.3:177-189.
- **Flache & Mäs 2008. How to get the timing right? *CMOT* 14.1:23-51.**
- **Flache & Mäs 2008. Why do faultlines matter? *SimPat* 16.2: 175-191.**



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# ADDENDUM