IMEDEA

Neighborhood Models of Minority Opinion Spreading

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Eur. Phys. J. ***B 39,*** *535 (2004)*

http://www.imedea.uib.es/PhysDept

Models of Consensus vs. Polarization, or Segregation:

Voter model, Minority opinion models, Axelrod, Sznajd, Schelling, Bounded confidence and Relative agreement, Threshold models, Social impact theory, …

Two general questions:

1) **Effects of "Who interacts with whom?":** Comparison with average, Fully connected population, Random pairing, Neighboring interaction in regular lattices, Complex networks.

   Here: Neighborhood models

2) **Mechanisms for reaching or stopping consensus with convergent interactions:** Barriers, topology, size, noise, updating rules,…

   Here: Mechanisms for consensus on initial minority

NEIGHBORHOOD MODELS?

T. Schelling (Micromotives and Macrobehavior, 1978):

1) Spatial Proximity Model:

-Interactions weighted by spatial location
-Agents interact with neighbors in lattices

2) Bounded Neighborhood Model:

-Common definition of neighborhood (system) and its boundaries
-Interactions in a completely connected population (mean field)
-Recurrence relations for the fraction of population with one option
-Threshold models of collective action *(M. Granovetter, Am. J. Soc. (1978))*

PROPOSAL OF A THIRD WAY: Neighborhood Models

-Consider ***locally*** defined neighborhood cells within a system
-Complete connectedness within the neighborhood cell
-Neighborhood cells change shape and size during evolution

Mechanisms for consensus on initial minority?

Question: How an initially minority opinion can become majority?

Serge Galam´s model discusses a mechanism of ***social inertia*** resulting in democratic rejection of social reforms initially favored by a majority:

A TIE IN A CELL VOTING MEANS NO FOR THE REFORM

(Eur. Phys. J. B **25**, 403(2002); *Physica A* **320**, 571 (2003))

a) Irish vote on the EU Nice treaty

b) September 11 French rumor: no plane crashed the Pentagon

Madrid March 11 terrorist attack:

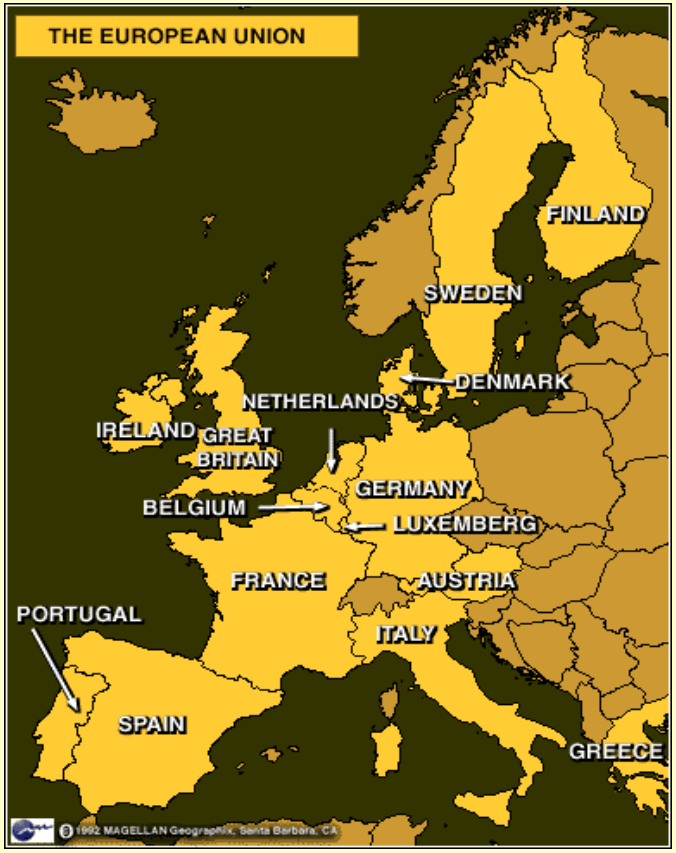
ETA or AL-QAEDA

Galam's Model

Eur. Phys. J. B **25**, 403(2002) *Physica A* **320**, 571 (2003)

- Models how an initially minority opinion can become majority
- Examples:
  - The September 11 no-plane Pentagon hoax
    the spread of such rumor in France and UK
  - Minoritary opinion against an structural change in society finally becomes a majority
    Maastritch related Ireland & France voting
  - Authorship of recent terrorists attacks in Madrid
    Eta versus Al-Qaeda

Minority opinion blocks social reforms

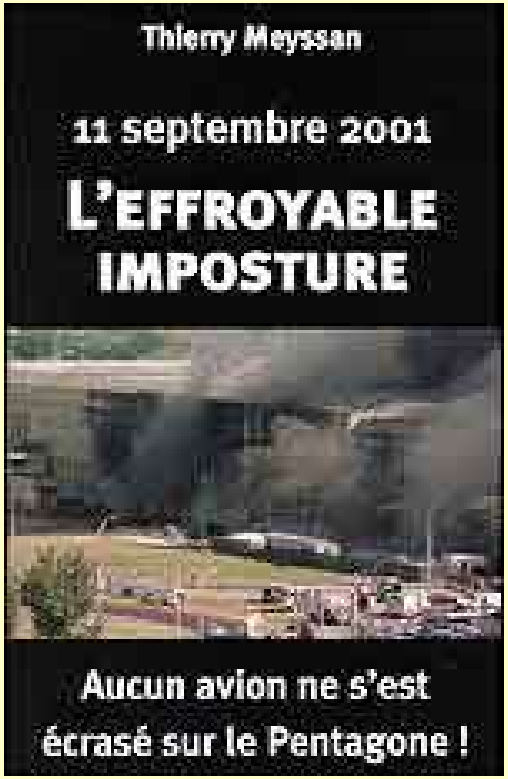


EU Nice treaty: Ireland referendum yielded results against reforms, although initially a majority supported it. Result came as a surprise to the Irish people themselves.

Social inertia: Conservative response to the risk of a change

Maintain social status quo

Minority Opinion Spreading :
September 11th no-plane Pentagon hoax



Social inertia: Feelings of French society about US politics

Minority Opinion Spreading : Madrid, March 11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60 segundos | Edición impresa | Opinión | Callejero | Servicios | Gráficos | Charlas | Tienda | Juegos | Loterías | Clasificados

ATENTADOS

Información Madrid: 112; Resto España: 902 222 292
Lista provisional de heridos (Ministerio del Interior)

Jueves, 11 de Marzo de 2004. Actualizado a las 17:53 (CET) - Internet time @745 by swatch

VEA MÁS IMÁGENES

Masacre etarra en Madrid

- UNA SERIE DE EXPLOSIONES EN TRENES DE CERCANÍAS HA CAUSADO 182 MUERTOS Y 898 HERIDOS
- INFORMACIÓN MADRID: 112; RESTO ESPAÑA: 902 222 292

A las **7.39 horas** estallaba un artefacto en la madrileña estación de Atocha. En los minutos siguientes, nueve explosiones más consecutivas en cuatro trenes de cercanías que, procedentes de Alcalá de Henares y Guadalajara, habían llegado a las estaciones de **Atocha, El Pozo y Santa Eugenia,** han sembrado el caos y el pánico en la capital. Otros tres artefactos trampa han sido explosionados más tarde por los TEDAX. El atentado más sangriento de **ETA ha acabado con la vida de al menos 182 personas** y ha causado heridas a más de 898, según datos del Gobierno. Fuentes judiciales en el lugar de los hechos **elevan a 186 los muertos y más de mil los heridos.** Así se vivió el ataque minuto a minuto. [Sigue]

M-11

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60 segundos | Edición impresa | Cartelera | Callejero | Servicios | Gráficos | Charlas | Tienda | Clasificados | Calendario

URGENTE

Aznar no descarta ninguna línea de investigación
Legalizará a inmigrantes y familiares afectados

Viernes, 12 de Marzo de 2004. Actualizado a las 11:48 (CET) - Internet time @492 by swatch

MADRID, 11-M

MÁS IMÁGENES

¿ETA o Al Qaeda?

- EL GOBIERNO RESPONSABILIZA A LA BANDA ARMADA VASCA PERO ESTUDIA OTRAS HIPÓTESIS
- PP Y PSOE DEBATEN SOBRE QUIÉN FUE EL AUTOR DE LOS ATENTADOS

El Ministerio de Interior atribuyó a ETA desde el primer momento la masacre perpetrada en Madrid, que causó al menos 198 muertos y 1.430 heridos. Sin embargo, el hallazgo por la tarde de una furgoneta con siete detonadores y **una cinta en árabe con versículos del Corán** hizo ampliar el abanico a los grupos terroristas islámicos, un extremo que cobró fuerza cuando una supuesta carta de Al Qaeda reivindicaba los atentados en un diario árabe. El debate sobre la autoría del atentado quedó abierto. [Sigue]

M-12


EL PAIS

DIARIO INDEPENDIENTE DE LA MAÑANA

M-11

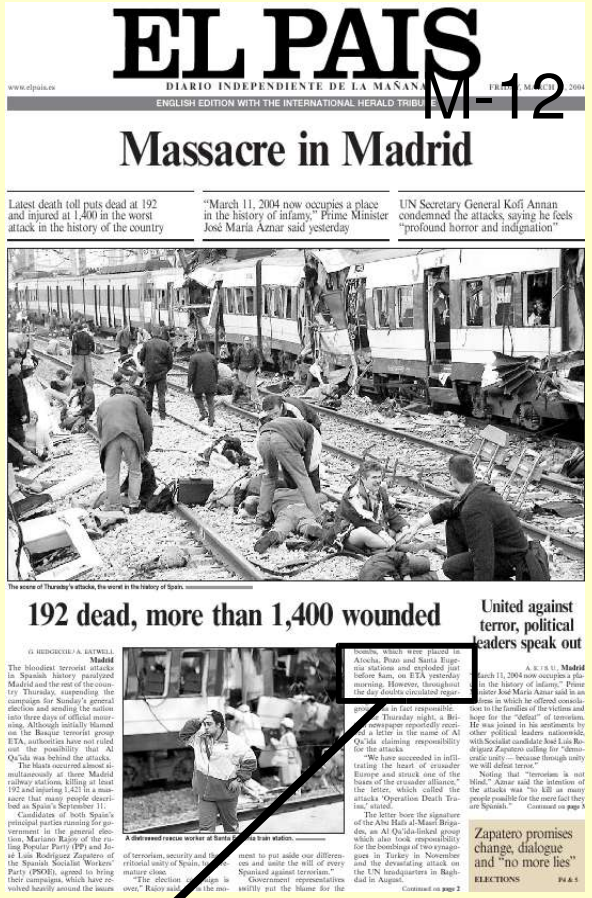

EL PAIS

VIERNES 12 DE MARZO DE 2004 — DIARIO INDEPENDIENTE DE LA MAÑANA

M-12

Infierno terrorista en Madrid: 192 muertos y 1.400 heridos

Interior investiga la pista de Al Qaeda sin descartar a ETA


EL PAIS

DIARIO INDEPENDIENTE DE LA MAÑANA

ENGLISH EDITION WITH THE INTERNATIONAL HERALD TRIBUNE

M-12

Massacre in Madrid

Latest death toll puts dead at 192 and injured at 1,400 in the worst attack in the history of the country

"March 11, 2004 now occupies a place in the history of infamy," Prime Minister José María Aznar said yesterday

UN Secretary General Kofi Annan condemned the attacks, saying he feels "profound horror and indignation"

The scene of Thursday's attacks, the worst in the history of Spain.

192 dead, more than 1,400 wounded

A distressed rescue worker at Santa [illegible] train station.

United against terror, political leaders speak out

Zapatero promises change, dialogue and "no more lies"

ELECTIONS P4 & 5

Government representatives swiftly put the blame for bombs on ETA yesterday morning. However, throughout the day doubts circulated regarding whether or not the basque group was in fact responsible

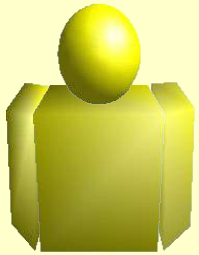
http://en.wikipedia.org/wiki/March_11,_2004_Madrid_attacks

Minority Opinion Spreading Model

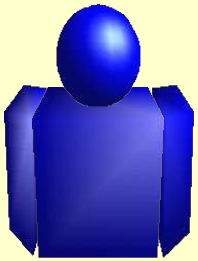
Serge Galam, Eur. Phys. J. B 25, 403 (2002)

Binary opinion:

Each agent has one opinion: blue (+) or yellow (-)



In favor of social reform



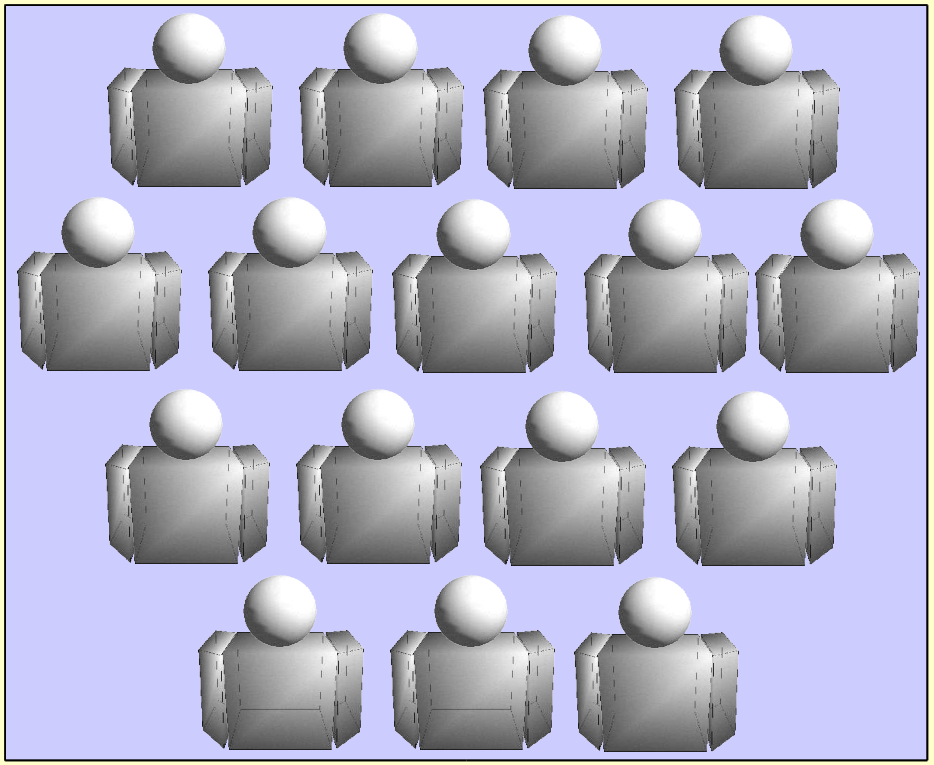
Against social reform

Initially there is a (*blue*) minority against social reform

Social life: Agents gather and discuss in *meeting cells* (offices, houses, bars, clubs, etc.)

Cells are defined only by their size k

k=16



M= Maximum size of a cell

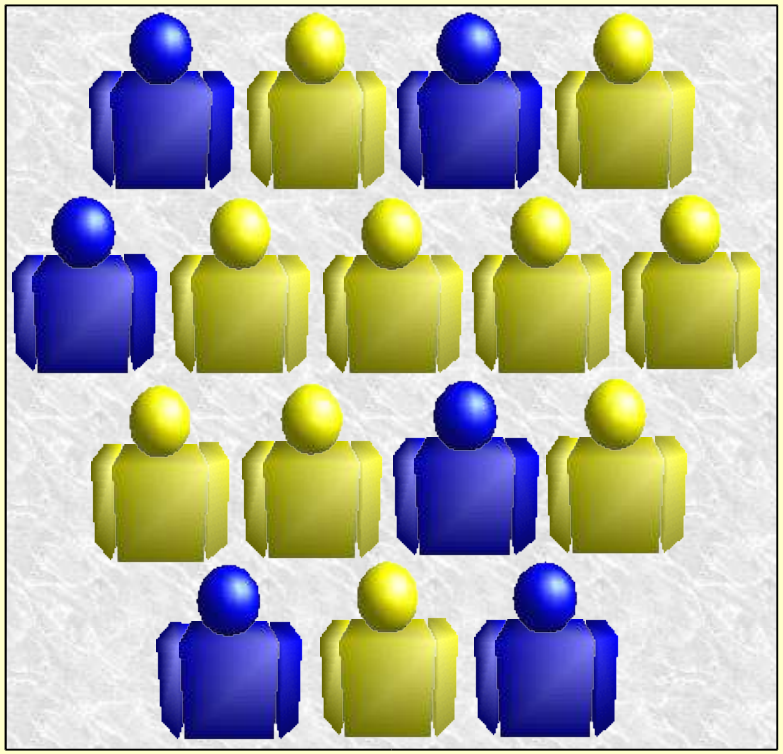
Interaction rules in meeting cells:

Pre-campaign political party meeting

Majority of *yellow* opinion

6

10



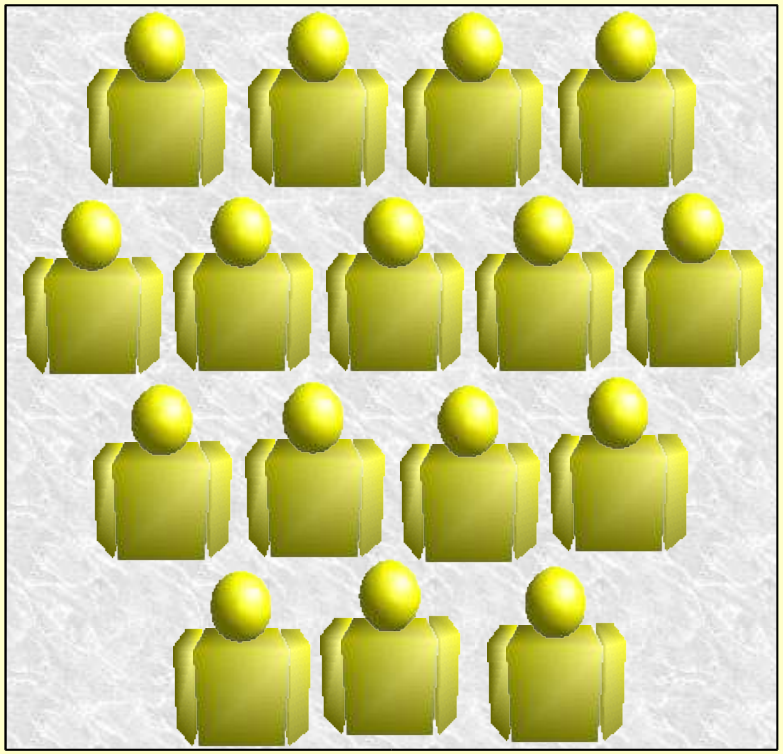
Interaction rules in meeting cells:

Pre-campaign political party meeting

Majority of *yellow* opinion

0

16

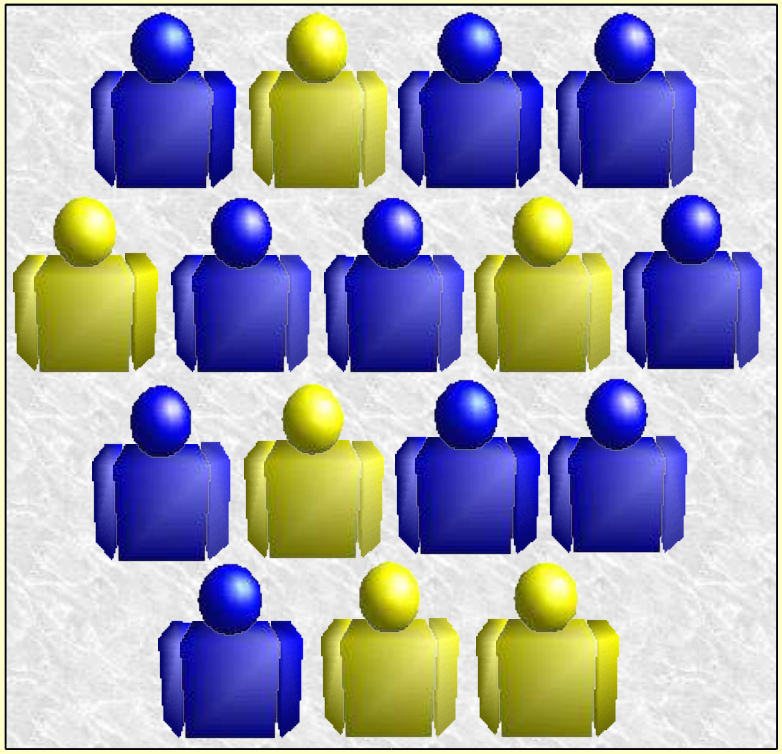


ALL the agents in the cell adopt the yellow opinion

Majority of blue opinion

10

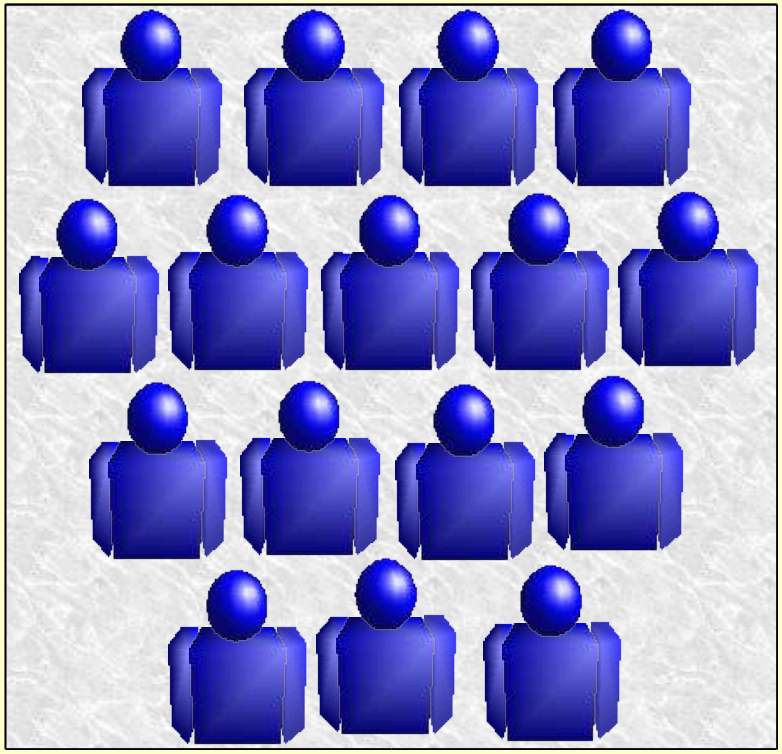
6



Majority of blue opinion

16

0



ALL the agents in the cell adopt the blue opinion

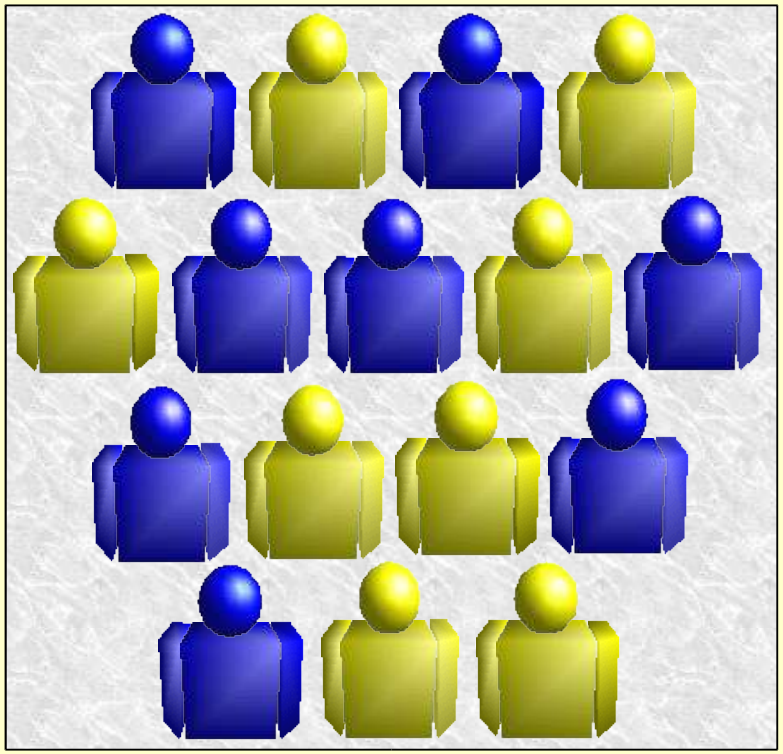
Individuals leave the cell as supporters of the majority

Social inertia:

A tie in the voting is a NO for social reform

8

8



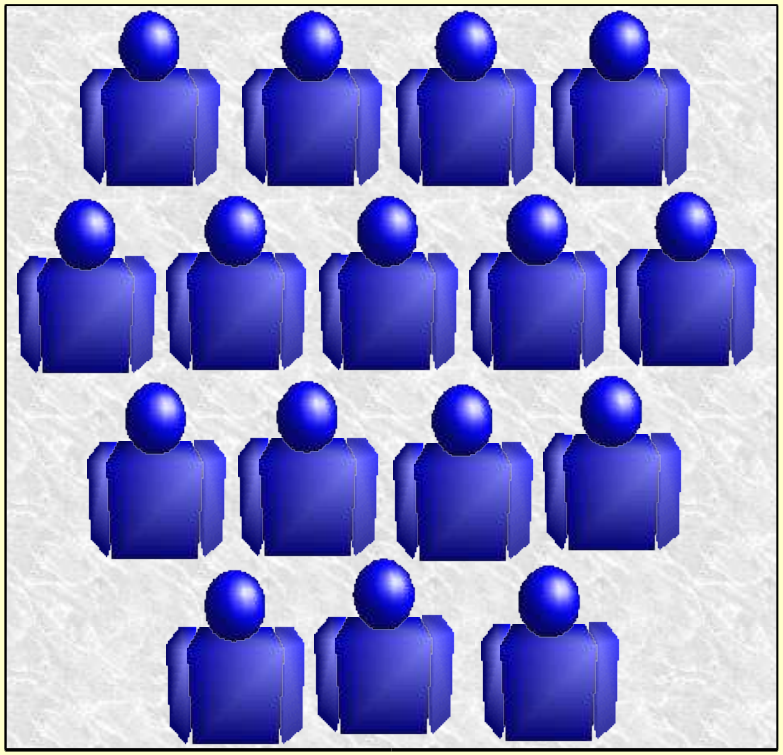
There is a bias toward one opinion in the society

Social inertia:

A tie in the voting is a NO for social reform

8

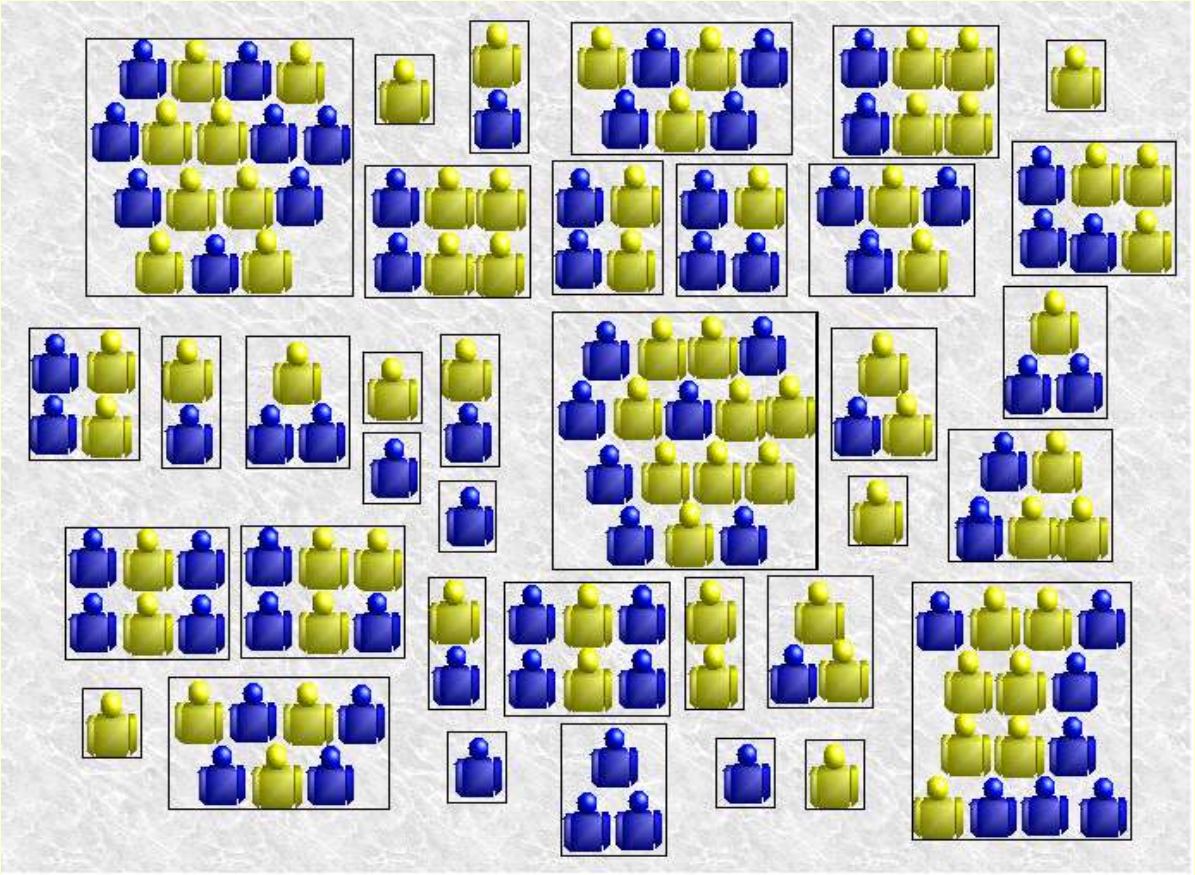
8



ALL the agents in the cell adopt blue opinion →
minority against reform is favored

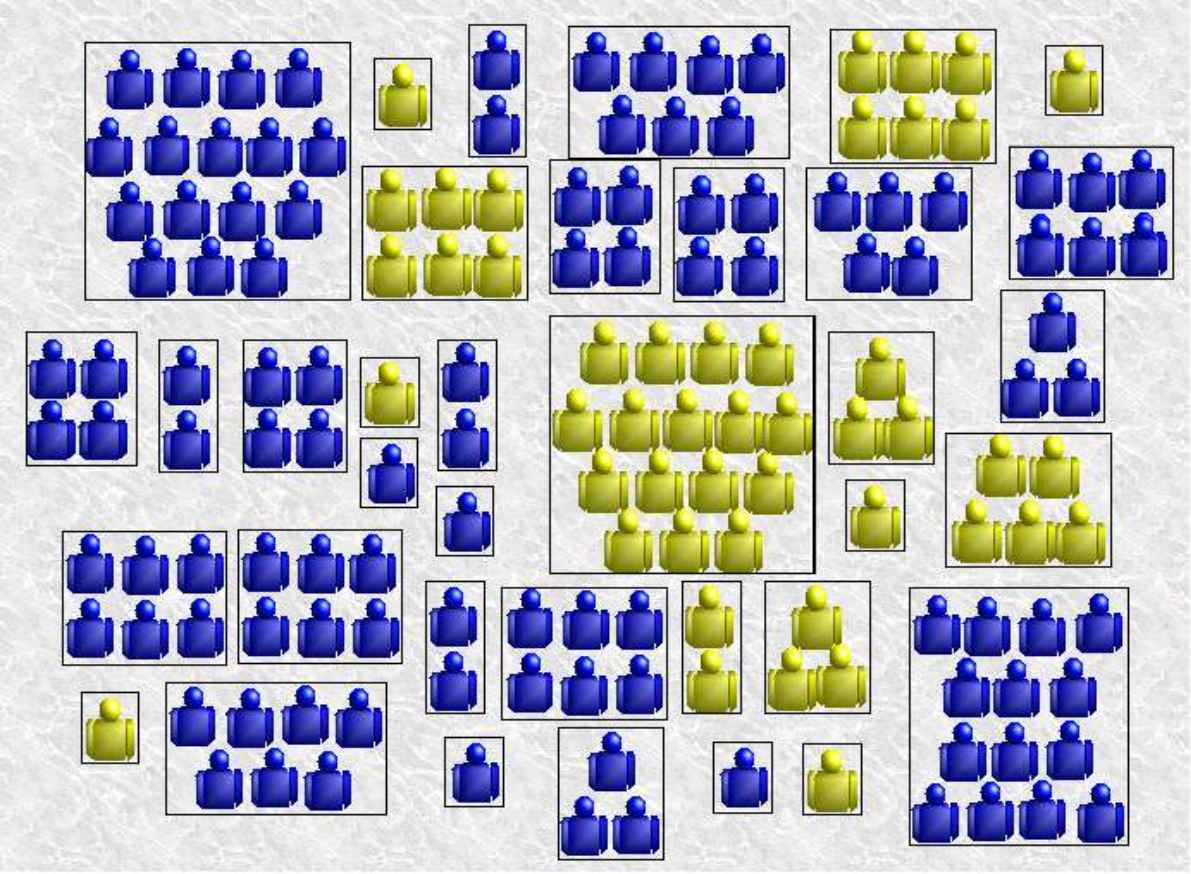
Dynamical evolution

Agents join a meeting cell **randomly** selected



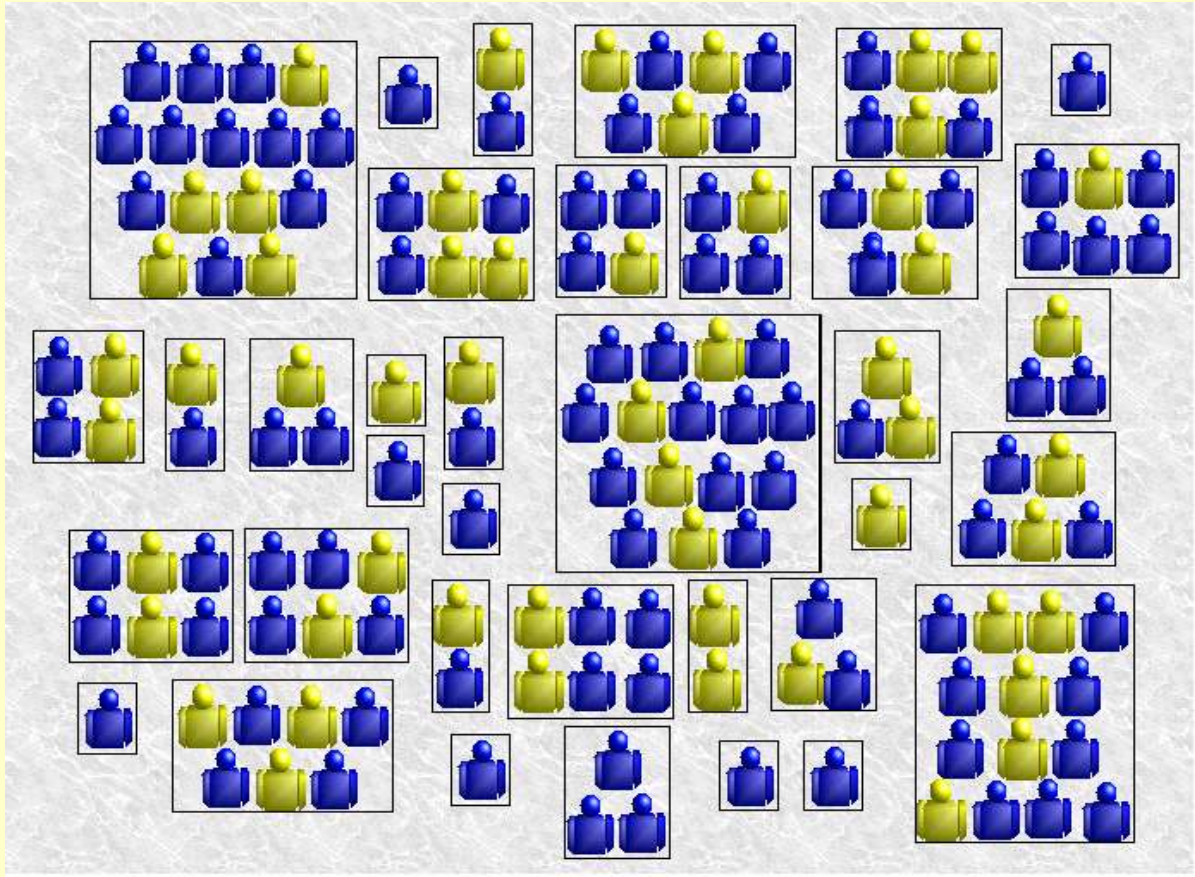
Dynamical evolution

Decision rule is applied in all the cells



Dynamical evolution

Following cycle: Agents randomly redistributed in the meeting cells carrying their adopted opinion



Mean-field analysis

$P_+(t)$: density of agents with blue (+) opinion

$P_-(t)$: density of agents with yellow (-) opinion

$P_-(t)+P_+(t)=1$

M : maximum cell size

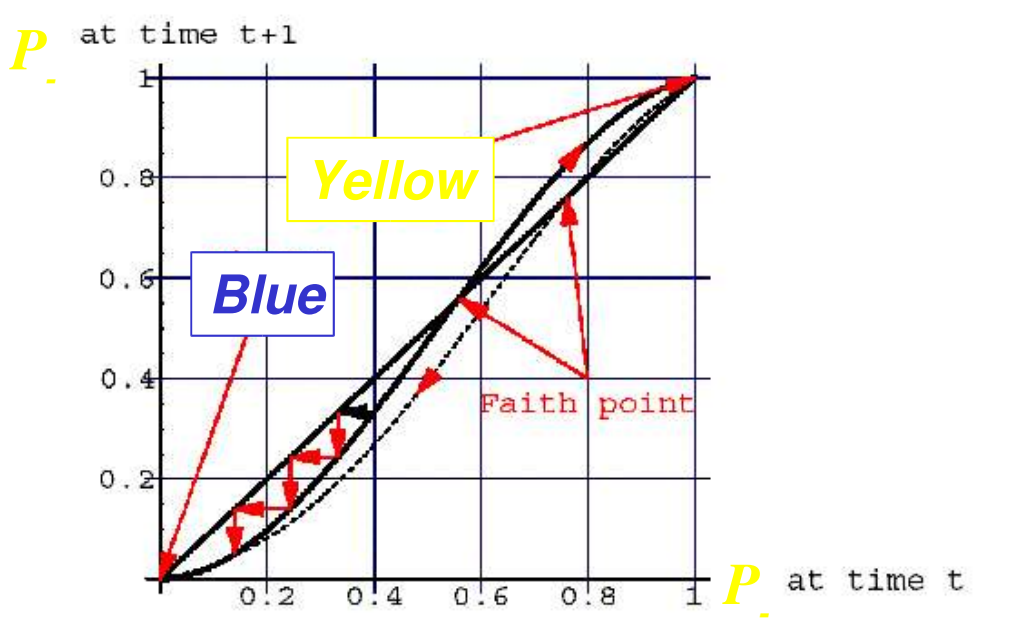
a_k : probability for an agent to be in a cell of size k

Recursion relations:

$$P_+(t+1) = \sum_{k=1}^{M} a_k \sum_{j=\left[\frac{M}{2}+1\right]}^{M} \binom{k}{j} P_+(t)^j \left[1-P_+(t)\right]^{k-j}$$

$$P_-(t+1) = \sum_{k=1}^{M} a_k \sum_{j=\left[\frac{M+1}{2}\right]}^{M} \binom{k}{j} P_-(t)^j \left[1-P_-(t)\right]^{k-j}$$

Asymmetric unstable fixed point: *FAITH POINT*



S. Galam, Eur. Phys. J. **B 25**, 406 (2002)

There is a threshold value of initial minority supporters $p_c(M) < 1/2$ such that for $P_+(0) > p_c$ the minority opinion finally becomes majority:

$$P_+ \longrightarrow 1 \qquad P_- \longrightarrow 0$$

For $P_+(0) > p_c$:
Social reform is rejected and status quo maintained

Dynamics: Time to reach consensus is fast
and *system–size independent*

Beyond mean-field recursion relations:

- **Numerical simulations of the model with N agents**
- We consider decision cells whose size is uniformly distributed in the interval $[1,M]$
- p<1/2: Initial proportion of agents with the minority (blue) opinion
- Consensus (unique opinion) is always reached for all values of M and p
- Order parameter: ρ

probability (over realizations) that the consensus coincides with the initial minority blue opinion (rejection of social reform).

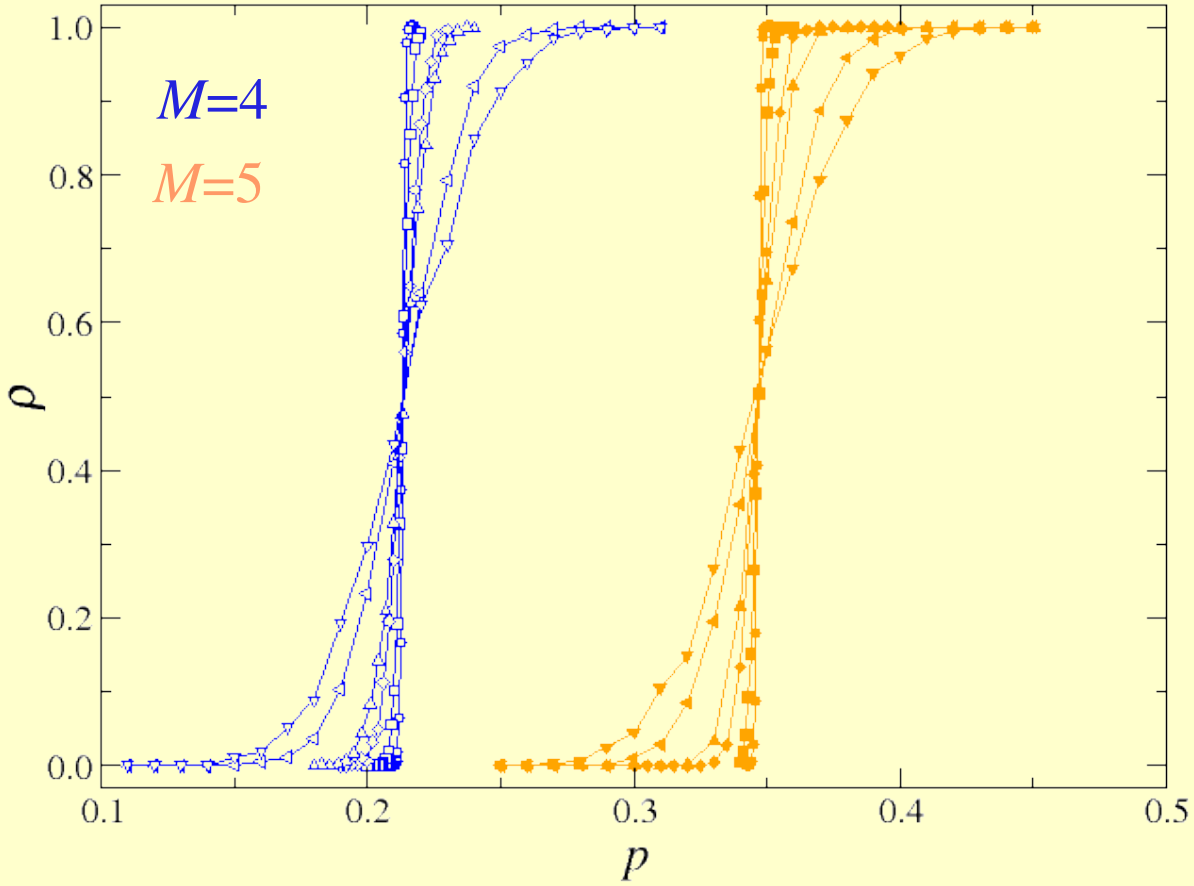
Mean field prediction:

$\rho = 1$ if $p > p_c$

$\rho = 0$ if $p < p_c$

Finite Size Fluctuations:

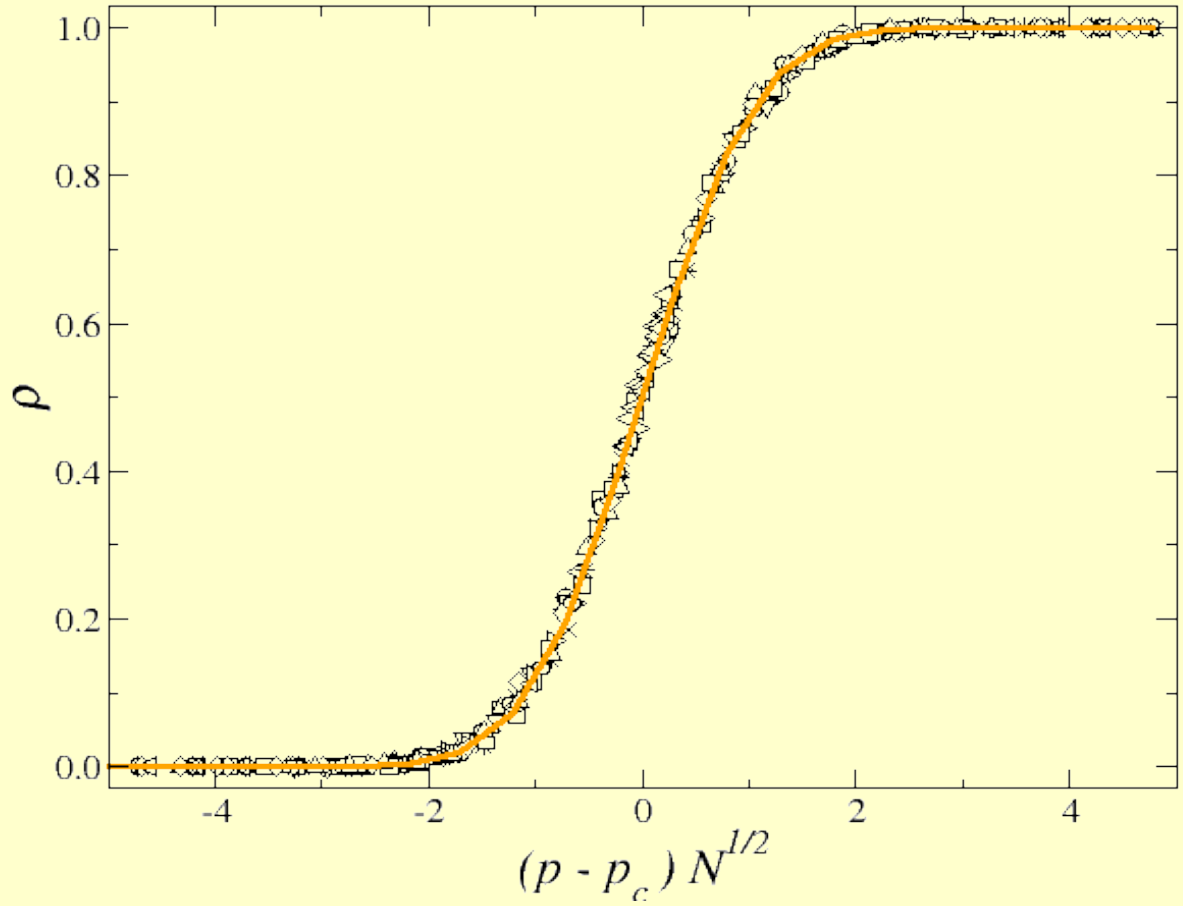
Smoothed 1st-order transition



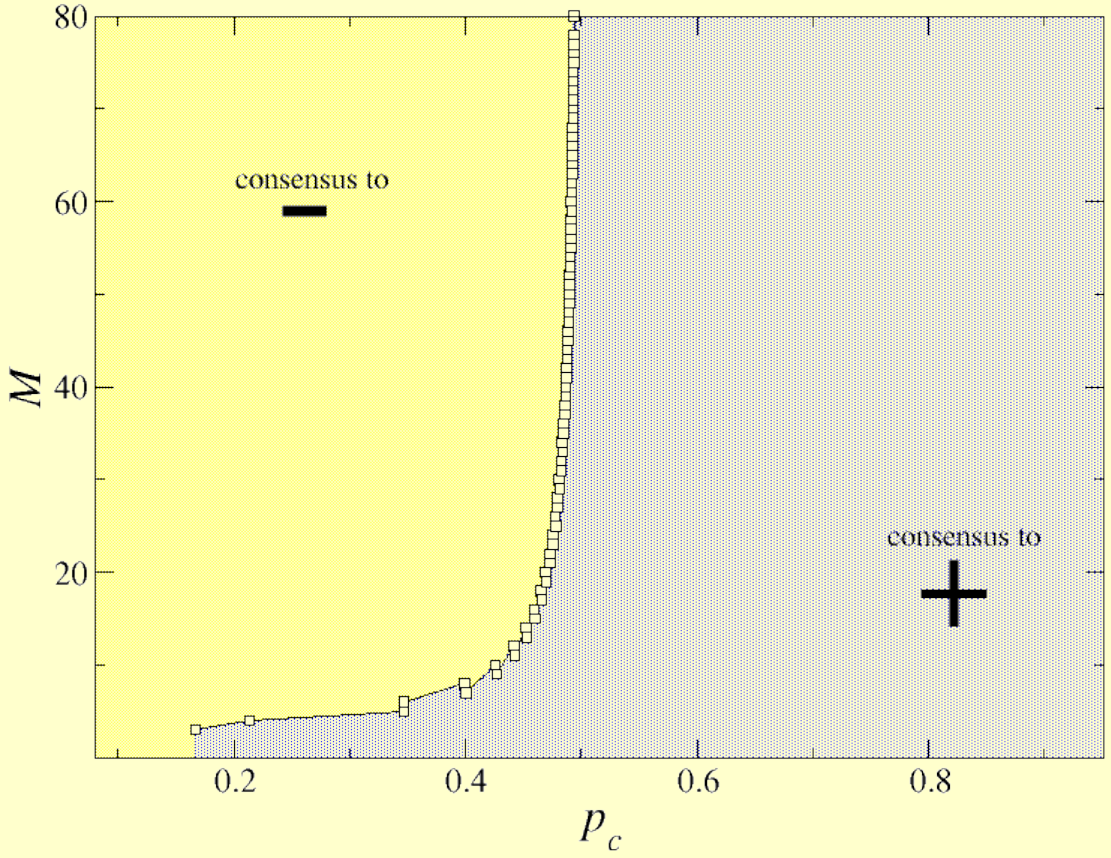
Finite Size Fluctuations:

Smoothed 1st-order transition

There is a region of width $N^{-1/2}$ in which the outcome of a run is not well known



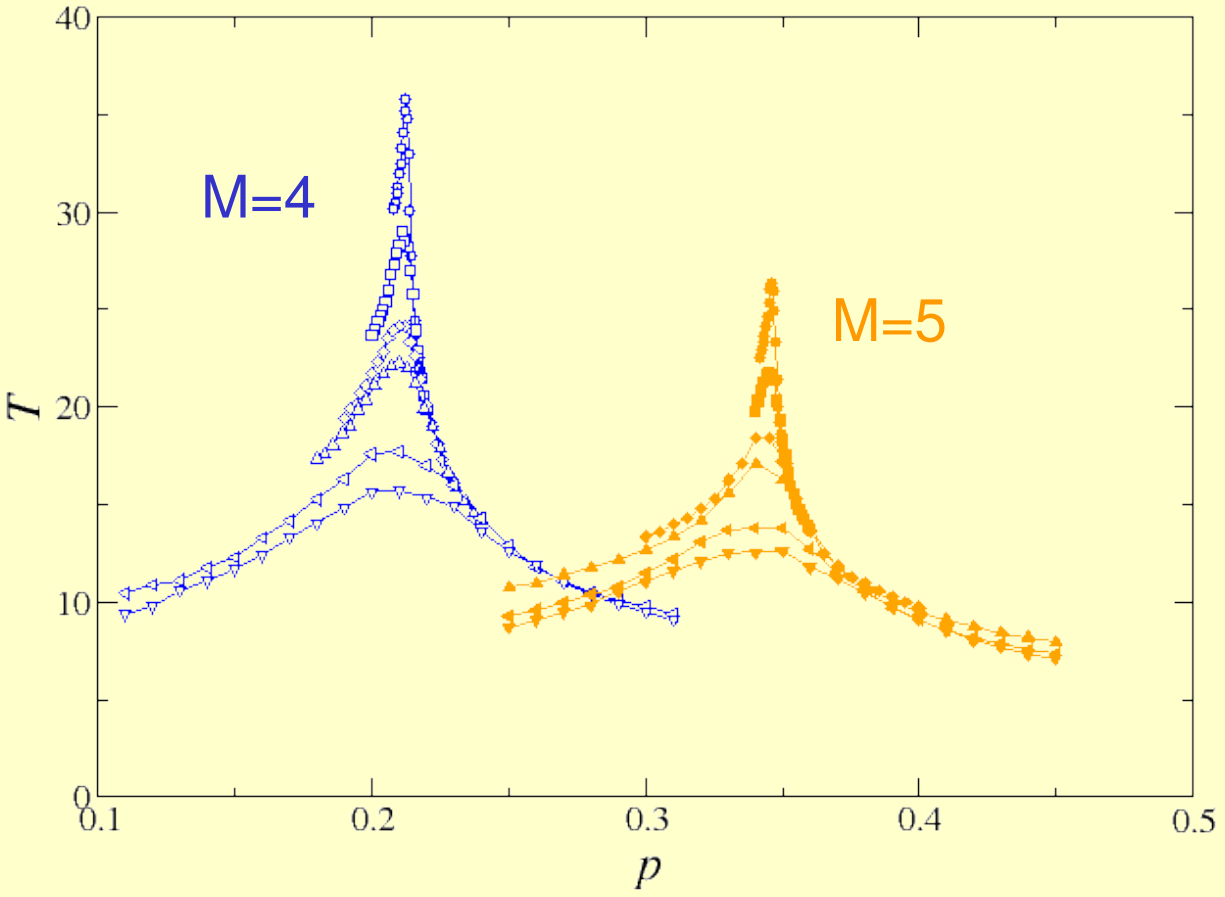
Consensus phase diagram



Small meeting cells required for minority opinion spreading

Dynamics:

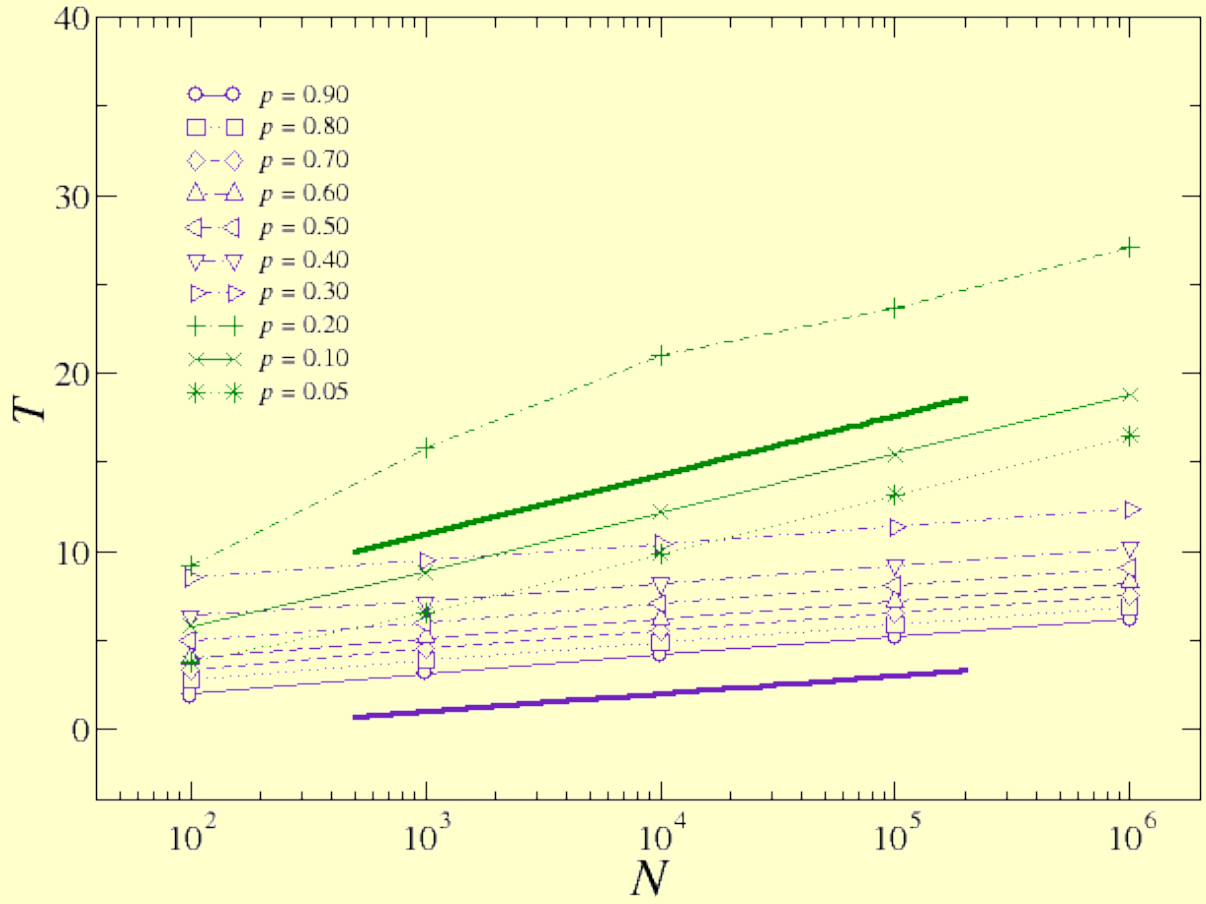
Time to reach consensus, T, for different sizes N



T diverges with N for $p=p_c$

Time to reach consensus can be shown to scale as

$$T \sim \ln N$$



$p<p_c$

$p>p_c$

Also, D. Stauffer, Int. J. Mod. Phys C 13, 975 (2002)

Neighborhood Models (NMs)

Meeting cells defined by their size do not incorporate local effects

"Primitive" society: Individuals interact predominantly with neighbors

NMs: Individuals are fixed at the sites of a regular lattice

Meeting cells locally defined by a tessellation of the lattice

Individuals in a meeting cell interact with original rules

Meeting cells redefined at each time step of dynamics

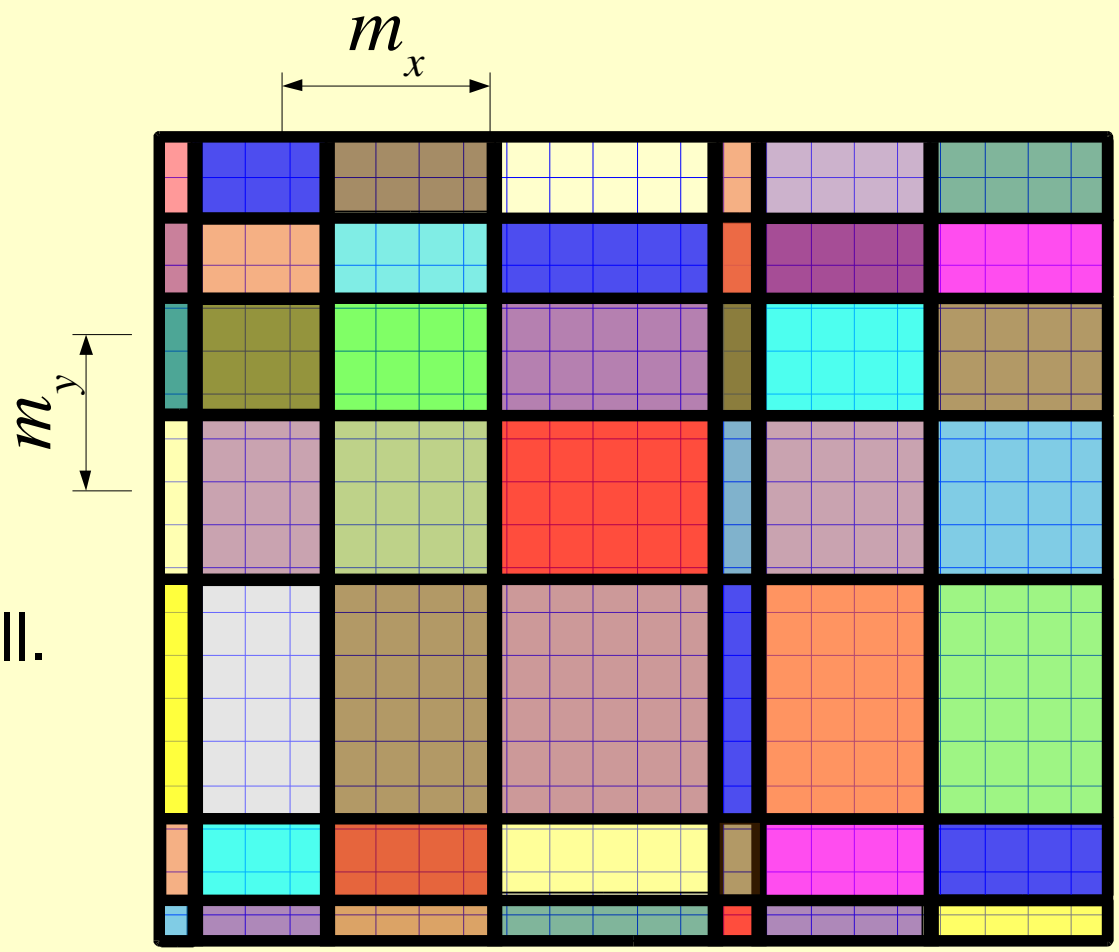
Consider 1D and 2D square lattices with **synchronous** and **asynchronous** updating schemes

2D Neighborhood Model: *Synchronous update*

Rectangular tessellation

$$1 \le m_x \le M$$

$$1 \le m_y \le M$$



- Interaction rules simultaneous in each cell.
- Time step defined by each iteration

2D Neighborhood Model:

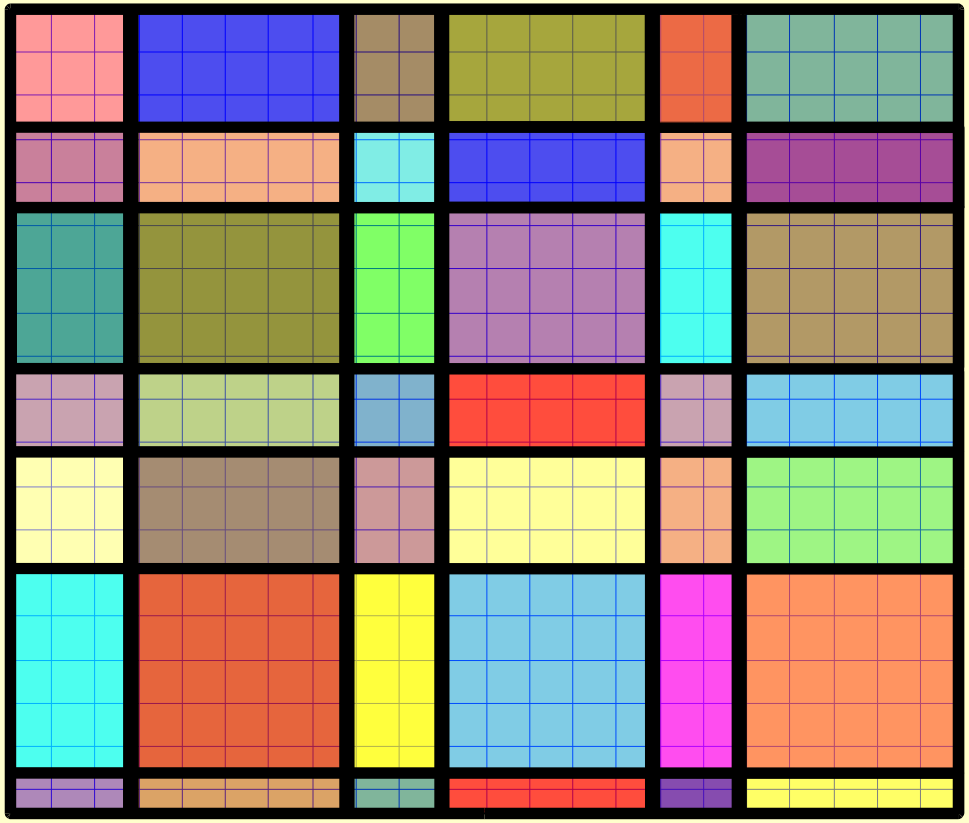
Synchronous update

Rectangular tessellation

$$1 \le m_x \le M$$

$$1 \le m_y \le M$$

- Interaction rules simultaneous in each cell.
- Time step defined by each iteration



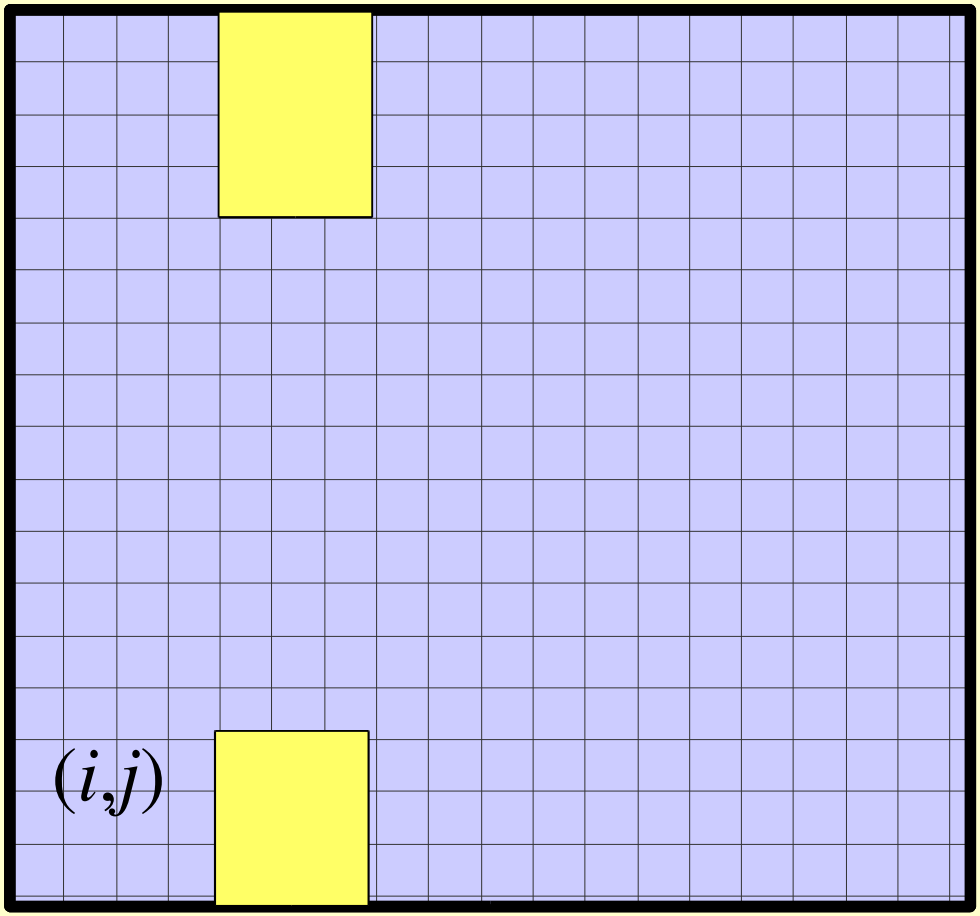
2D Neighborhood Model:

Asynchronous update

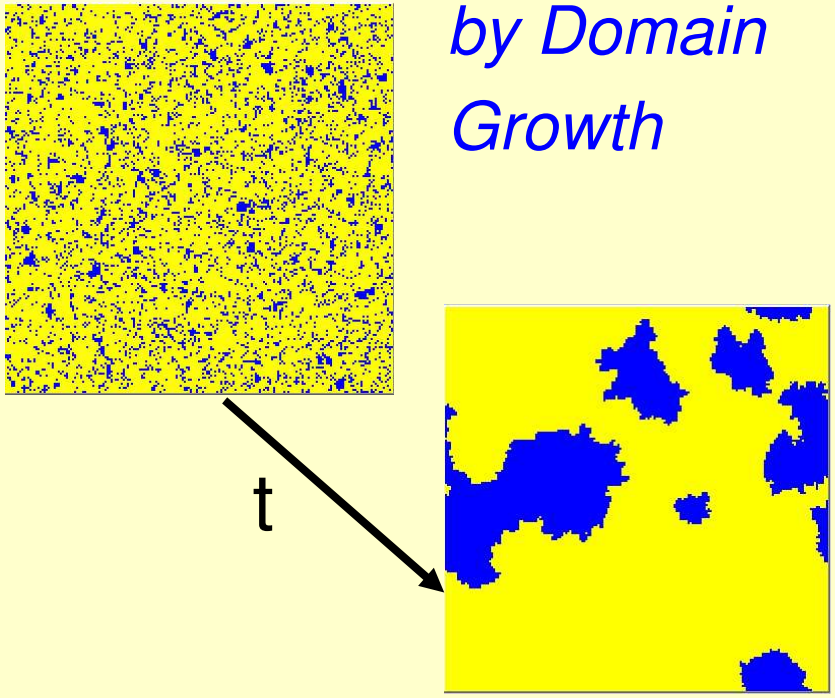
$1 \le m_x \le M$

$1 \le m_y \le M$

For each update, time increases as $t \to t + m_x . m_y / N$



Consensus formation by Domain Growth



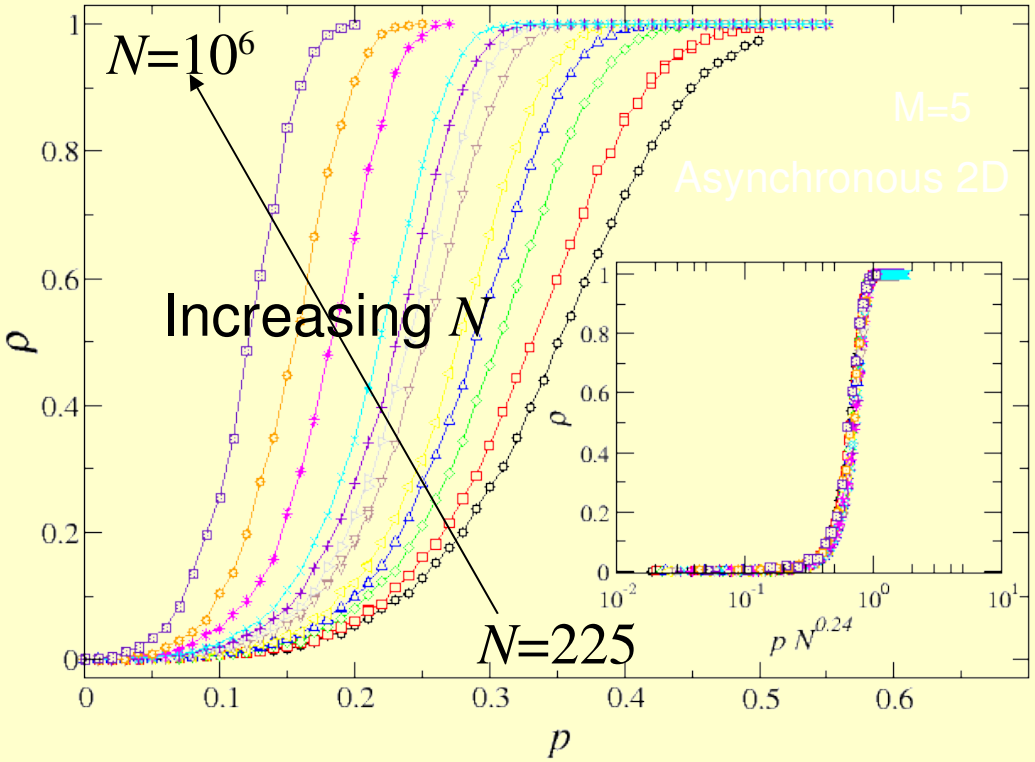
Neighborhood Models: Steady State

Consensus always reached in finite systems in a finite number of steps.

For $N \to \infty p_c \to 0$

$p_c \sim N^{-\alpha}; \alpha(D,M)$

$\rho(p,N)=f(pN^{\alpha})$

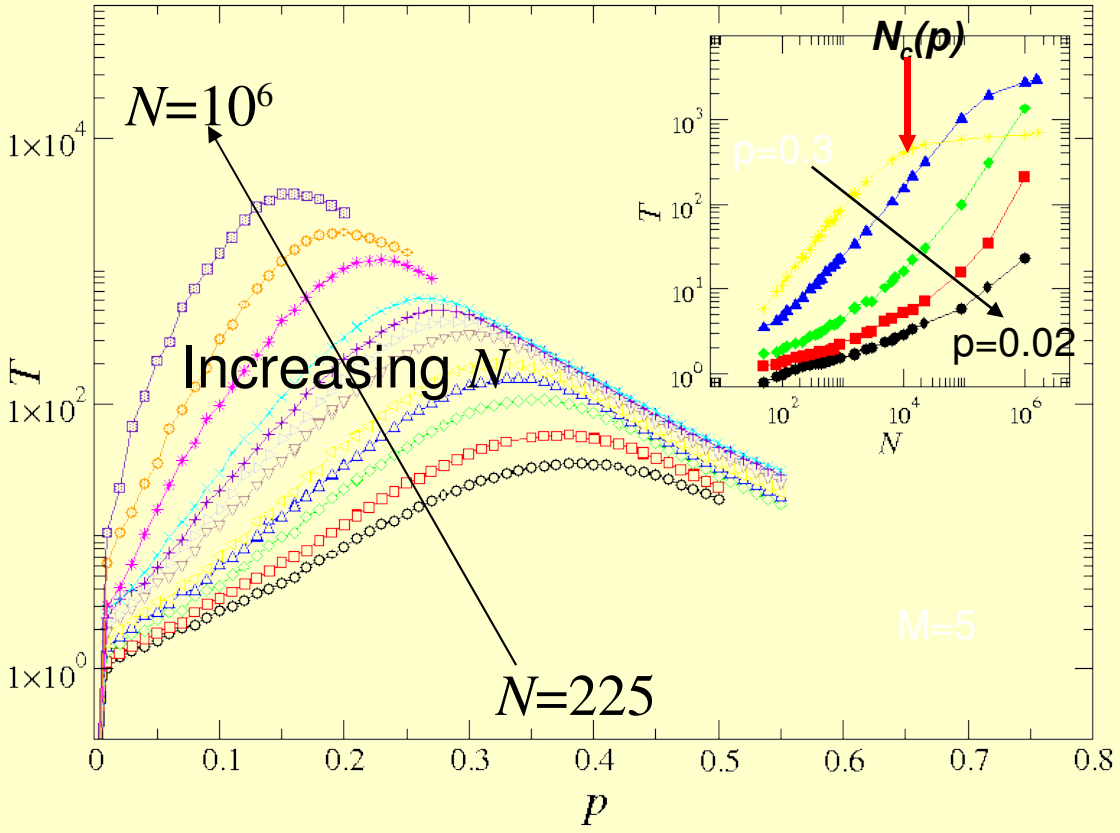


In an infinite system, the blue initial minority opinion wins regardless the amount of initial supporters:
Social reform always rejected in a large system

Neighborhood Models: Time to reach consensus

T has a maximum for p_c (N).

T much larger than for nonlocal models.

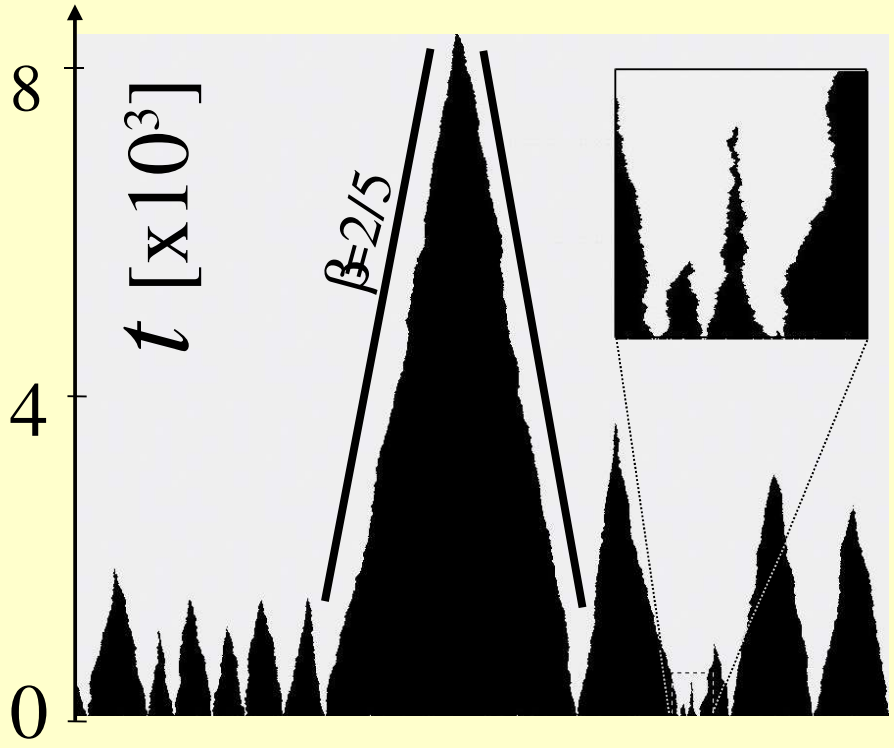


The time to reach consensus, scales as two power laws of N, below and above the transition

Neighborhood Models: Domain growth

Domains of a given opinion shrink or grow.

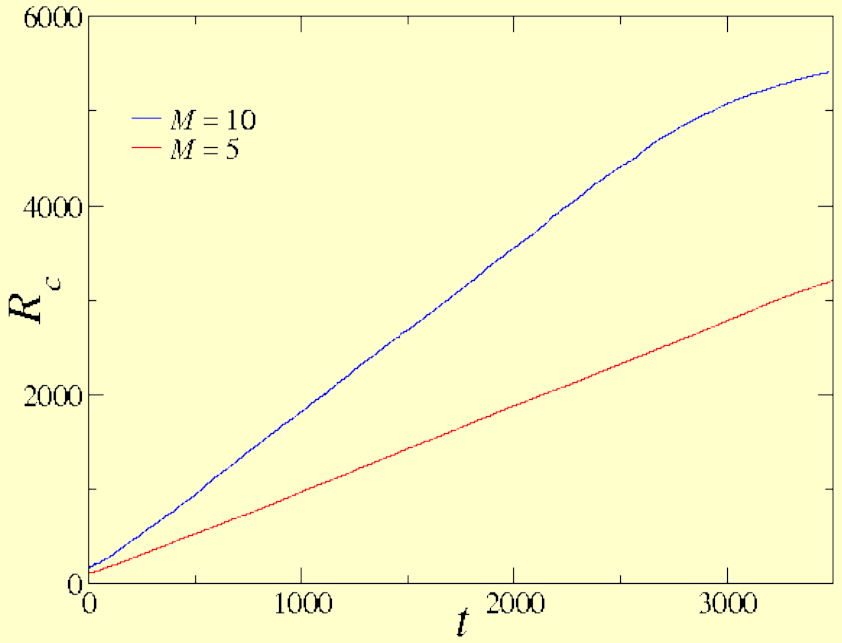
Characteristic size scales linearly with time: $R(t) = \beta t$



D=1

$$\beta = 2\frac{\left[\frac{M}{2}\right]\left[\frac{M}{2}+1\right]}{M(M+1)}$$

M=5, N=5000

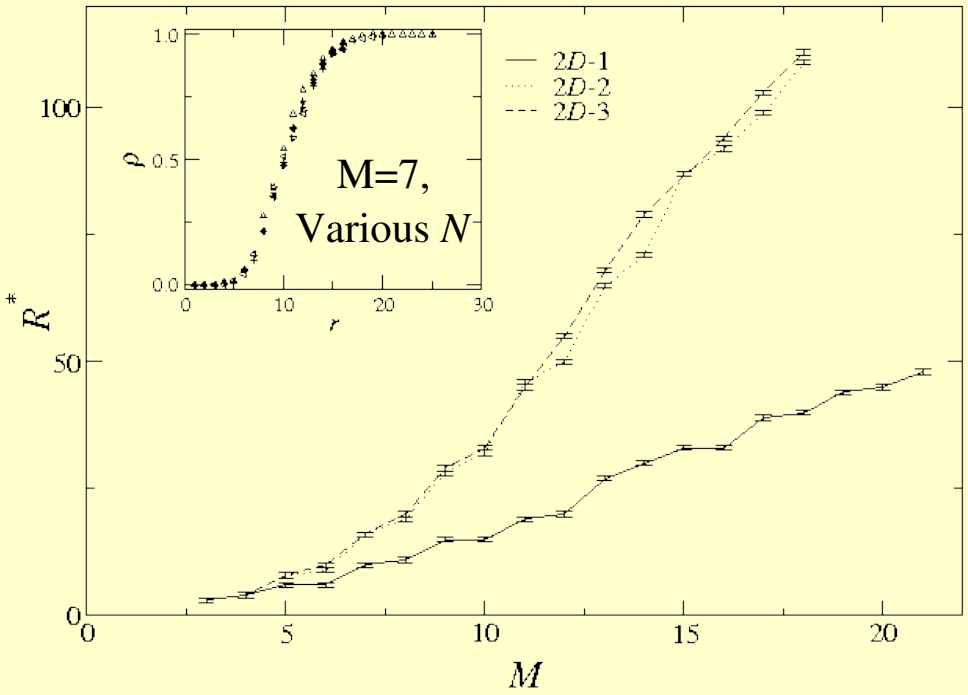


D=2 average domain radius

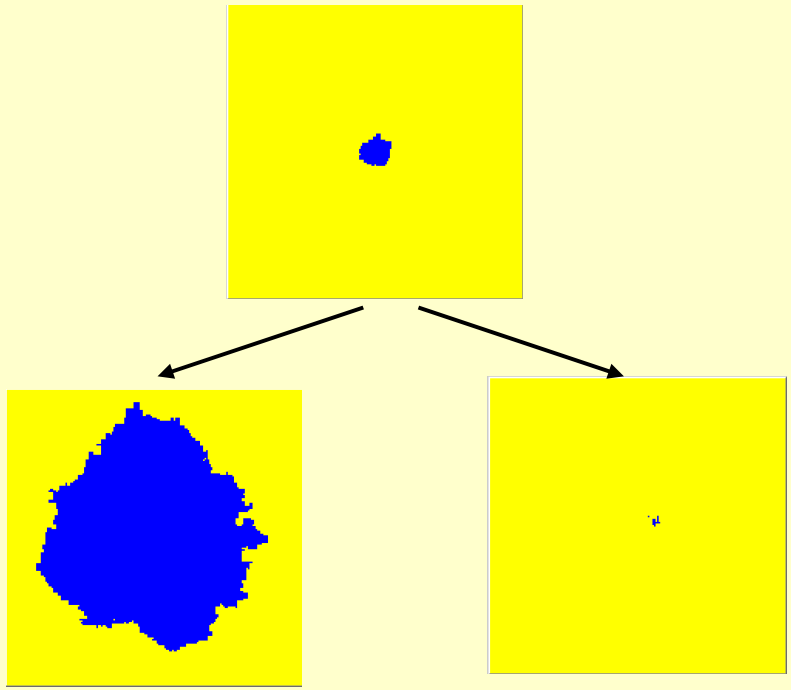
Why minority blue opinion always wins in Neighborhood Models for large systems?

A critical size for an initial local domain of minority supporters exists.
Domains of larger size grow and occupy the system.
A domain of overcritical size always exists in a large enough population

Critical Radius



Stochastic evolution near R*



Critical Size in NMs and Nucleation theory

Nucleation:

-R^*: competition between surface tension and different bulk energies
-R^* meaningless in D=1 (no surface tension)
-Overcritical droplet created by a dynamical fluctuation, and grows deterministically

NMs:

-Overcritical droplet appears in random initial condition. Stochastic dynamics of growth.
-Critical size (probabilistic concept) appears in D=1
-R^*: competition between favoured opinion and stochastic interface dynamics

Conclusions

General interest of Neighborhood Models as a third way between strictly local interactions and completely connected populations

Importance of the population size in consensus models:

-Analytic recursion relations neglect finite size effects

-NM local effects: Social reform is always rejected by a large population in the model of Minority Opinion spreading

Neigborhood models of minority opinion spreading:

-Treshold value of initial concentration of minority suporters for minority overcome: $p_c \sim N^{-\alpha}$ Time to reach consensus grows as a power law of N.

-Mechanism: Critical size for an initial local domain of of minority supporters

-Neighborhood models describe a more efficient spreading of minority opinion, but spreading takes a much longer time.