Social-related ABM

First session

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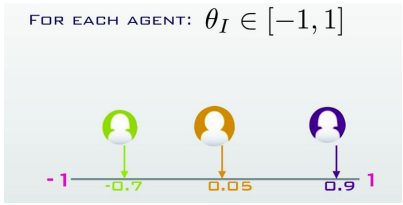
Contemporary Issue Module. International Bachelor B3.
CY Cergy Paris Université

22-26 February 2021

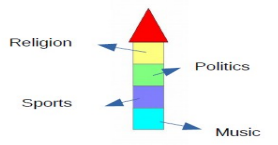
Transitions on Agent-based models

Bounded confidence Models



CONFIRMATION BIAS $if \quad |\theta_I - \theta_J| < \varepsilon$

COGNITIVE DISSONANCE $\langle\theta\rangle_{IJ} = (\theta_i + \theta_J)/2$, $\theta_I = \theta_J = \langle\theta\rangle_{IJ}$

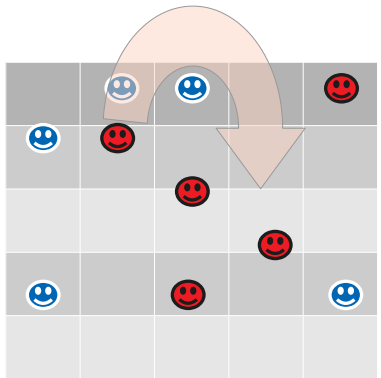


Axelrod Model

(1) Choose randomly two nearest neighbor agents i and j,

(2) calculate the number of shared features (cultural overlap) between the agents ℓ_{ij}.
If $0 < \ell_{ij} < F$:
then (3) with probability ℓ_{ij}/F, set $C_{ik} = C_{jk}$, pick up randomly a feature k such that $C_{ik} = C_{jk}$.

Schelling model
(model for segregation)



Transitions on Agent-based models

It is about transitions


NATURE|Vol 455|30 October 2008 OPINION

ESSAY

Economics needs a scientific revolution

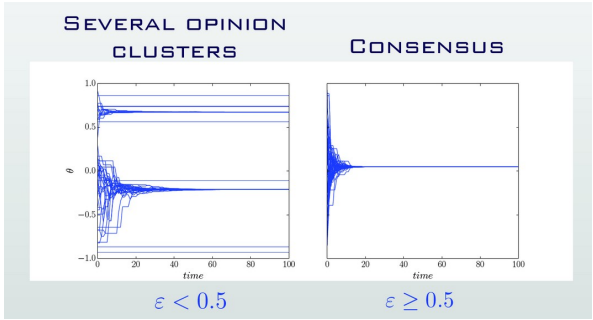
Financial engineers have put too much faith in untested axioms and faulty models, says **Jean-Philippe Bouchaud**. To prevent economic havoc, that needs to change.

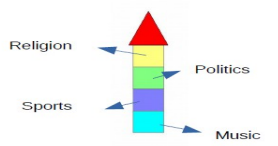
Compared with physics, it seems fair to say that the quantitative success of the economic sciences has been disappointing. Rockets fly to the Moon; energy is extracted from minute

institutions over the past few decades, they seem to have forgotten the methodology of the natural sciences as they

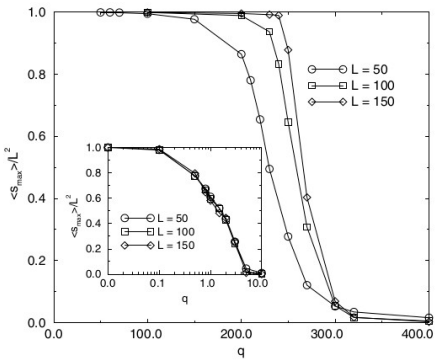
'wild' markets, even though their existence is so obvious to the layman. Physics, on the other hand, has developed several

Bounded confidence Models





Axelrod Model



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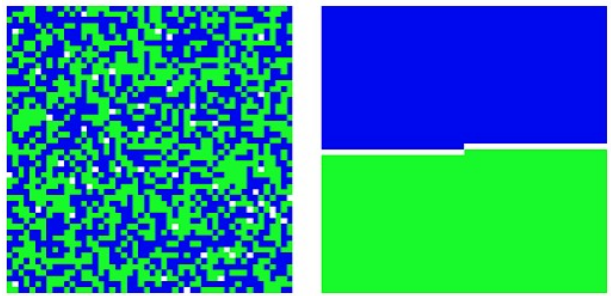
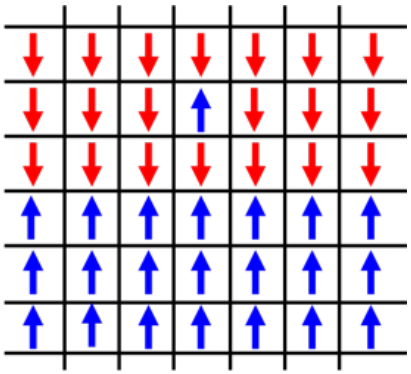


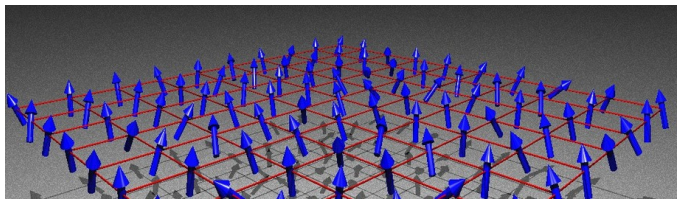
Origin of interacting particle systems in Physics



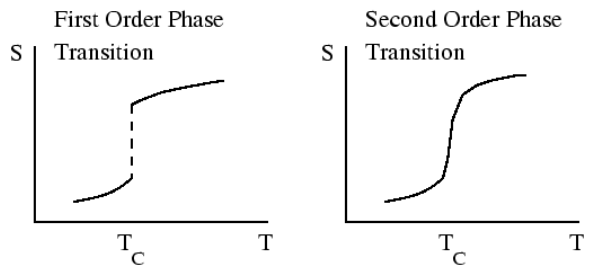
Ising model

$$\mathcal{H}(\Gamma) = -J \sum_{k,h}^{*} s_k s_h - H \sum_{k} s_k$$

Interaction in terms of a Hamiltonian



Potts model



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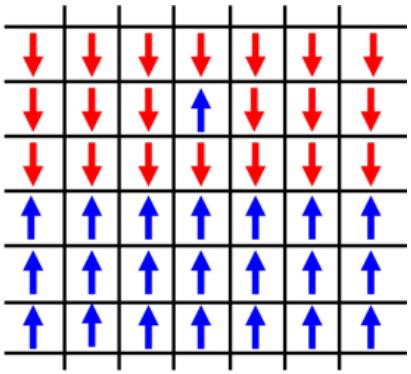

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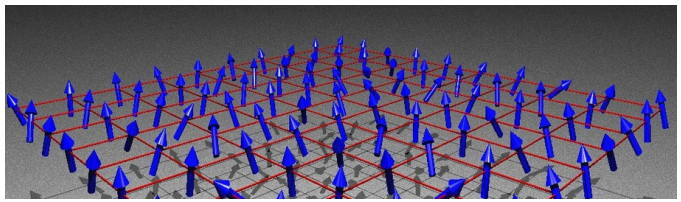

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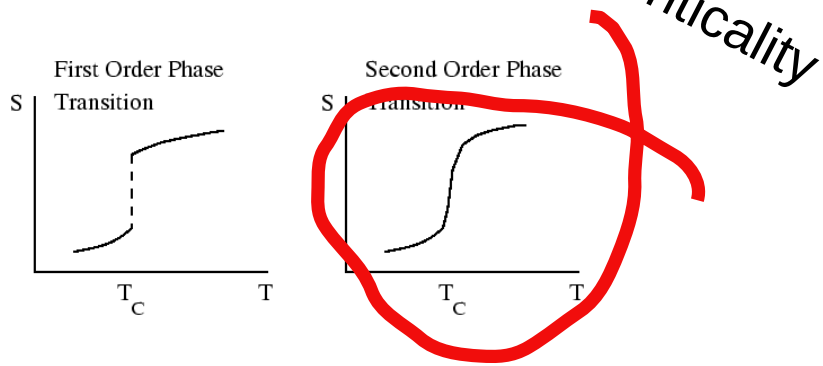
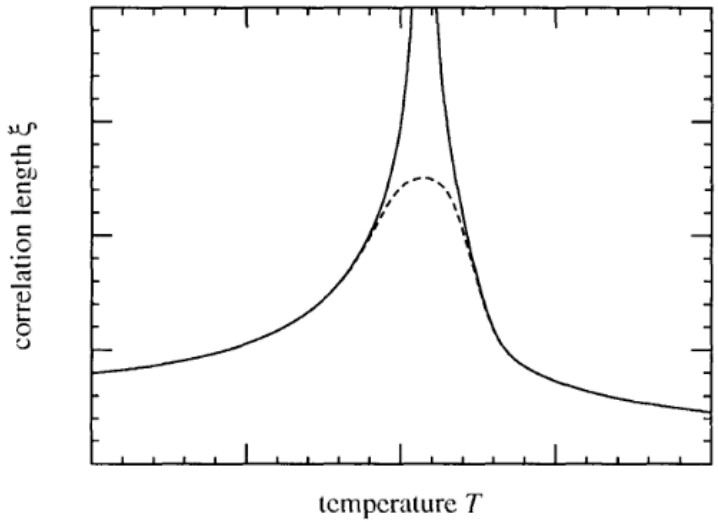


What does Criticality mean?

- The so-called critical transitions are structural transitions characterised by the divergence of the correlation length.
- That means that at the critical point all the elements of the system are correlated.
- So, if one element changes its state, another very far element will feel it.



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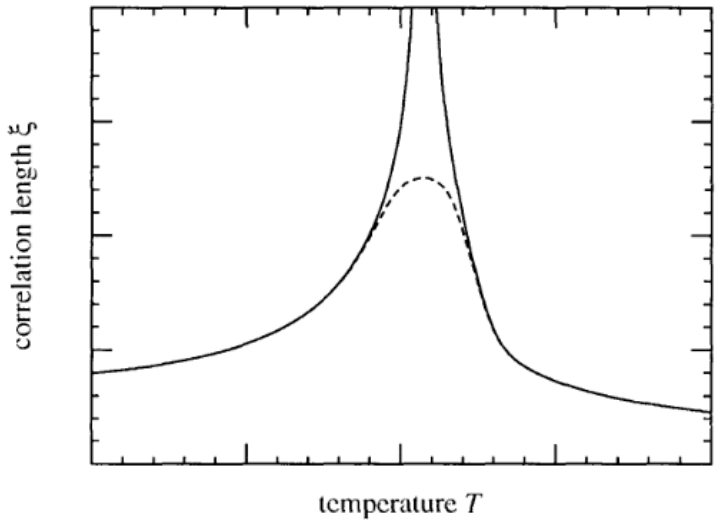

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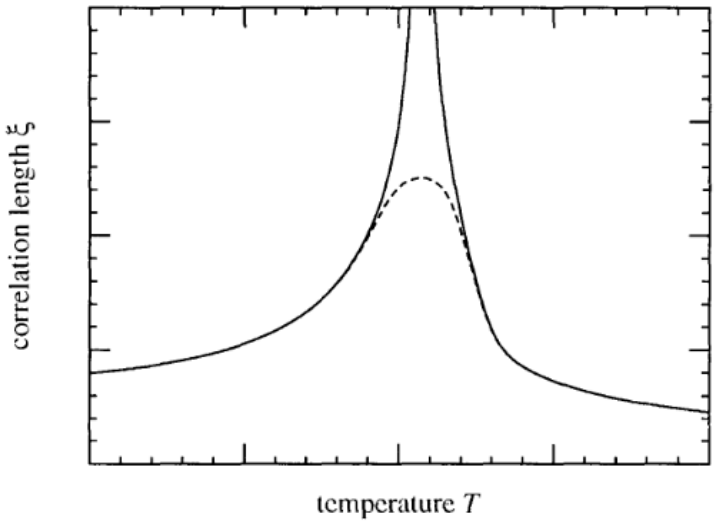

Why is criticality so important?

- Because of the increase (ideally divergence) in the correlation length, important simplifications take place on the other functions of the systems.
- Those simplifications are consequence of power-laws shape of the correlation length.
- Different phenomena in nature have a behaviour which only depends on the dimensionality, the internal dimension of the system and the symmetry of the interactions.
- This is the reason for the similarity of different processes.
- And, this is why power-laws are so commun.

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I. Axelrod Model: A self-reinforcing social dynamic

Who is Axelrod and what was the motivation for his model?

- Robert Axelrod is an American political scientist. He is Professor of Political Science and Public Policy at the University of Michigan where he has been since 1974. He is best known for his interdisciplinary work on the evolution of cooperation.
- His current research interests include complexity theory (especially agent-based modeling), international security, and cyber security.

I. Axelrod Model: A self-reinforcing social dynamic

The Dissemination of Culture: A Model with Local Convergence and Global Polarization

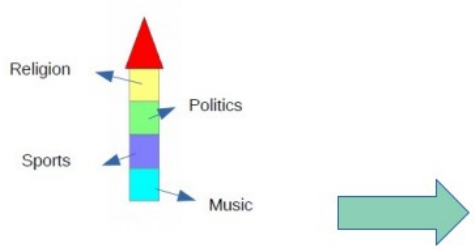
Robert Axelrod

The Journal of Conflict Resolution, Volume 41, Issue 2 (Apr., 1997), 203-226.

"If people tend to become more alike in their beliefs, attitudes, and behavior when they interact, why do not all such differences eventually disappear? "

II. Axelrod Model: A self-reinforcing social dynamic

The more culturally similar the people, the greater the chance of interaction with each other, and that interaction increases their similarity



Each agent is a vector

Agents placed in a square lattice of L x L sites

The state of the ith agent is defined by a set of F cultural features (F-dimensional vector)

All the features are randomly assigned with an uniform distribution of the integers in the interval [1,q]

(1) Choose randomly two nearest neighbor agents i and j,

(2) calculate the number of shared features (cultural overlap) between the agents ℓ_{ij}. If $0 < \ell_{ij} < F$:

then (3) with probability ℓ_{ij}/F set $C_{ik} = C_{jk}$, pick up randomly a feature k such that $C_{ik} = C_{jk}$.

I. Axelrod Model: A self-reinforcing social dynamic

VOLUME 85, NUMBER 16 PHYSICAL REVIEW LETTERS 16 OCTOBER 2000

Nonequilibrium Phase Transition in a Model for Social Influence

Claudio Castellano,[1,*] Matteo Marsili,[2] and Alessandro Vespignani[3]
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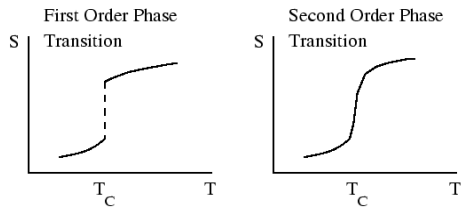
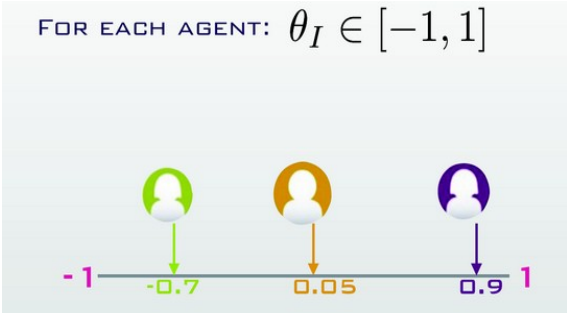
[2]*Istituto Nazionale per la Fisica della Materia (INFM), Trieste-SISSA Unit, Via Beirut 2-4, I-34014 Trieste, Italy*
[3]*The Abdus Salam International Centre for Theoretical Physics, P.O. Box 586, I-34014 Trieste, Italy*
(Received 6 March 2000)

Absorbing state over grids: Continuous order-disorder transition in $F = 2$, and abrupt one in $F > 2$



II. Bounded confidence Model (model for Opinion Dynamics)

Compromise strategy: after a constructive debate, the positions of the interacting agents get closer to each other.



Continuous opinions

II. Bounded confidence Model (model for Opinion Dynamics)

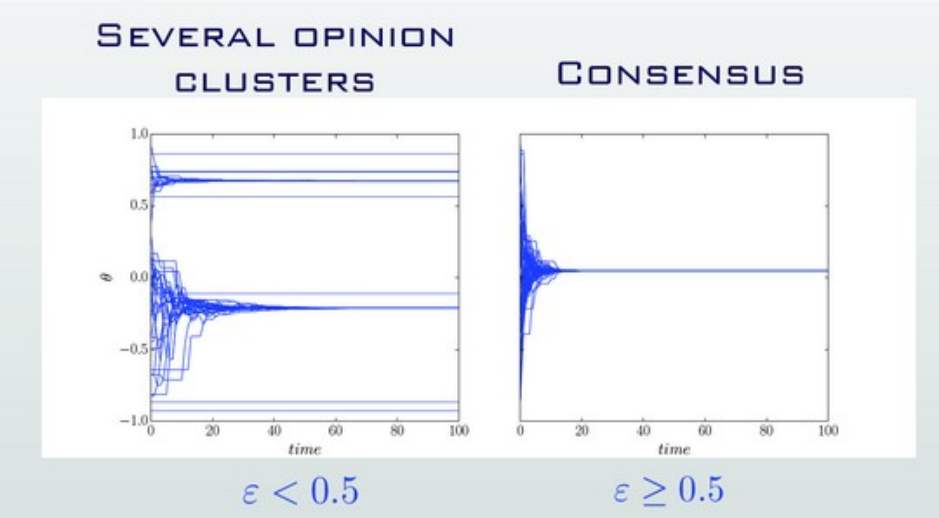
In practice, there is a real discussion only if the opinions of the people involved are sufficiently close to each other

CONFIRMATION BIAS	$if \quad \lvert\theta_I - \theta_J\rvert < \varepsilon$
COGNITIVE DISSONANCE	$\langle\theta\rangle_{IJ} = (\theta_i + \theta_J)/2$ $\theta_I = \theta_J = \langle\theta\rangle_{IJ}$

ε : tolerance threshold

II. Bounded confidence Model (model for Opinion Dynamics)

The final configuration can be approximated by the expression $1/2\varepsilon$.



On complete graphs, regular lattices, random graphs, and scale-free networks, for $\varepsilon > \varepsilon_c = 1/2$, all agents share the same opinion $\rightarrow$ complete consensus.

III. Schelling model (model for segregation)

Thomas Schelling (April 14, 1921 – December 13, 2016) was an American economist and professor of foreign policy, national security, nuclear strategy, and arms control at the School of Public Policy at University of Maryland, College Park. He was also co-faculty at the New England Complex Systems Institute. He was awarded the 2005 Nobel Memorial Prize in Economic Sciences (shared with Robert Aumann) for "having enhanced our understanding of conflict and cooperation through game-theory analysis".

III. Schelling model (model for segregation)

He wanted to understand why professors' offices in his university were completely segregated by group of friends, as well as the strong segregation in The United States. He showed that even a small preference to have the same number of wanted neighbours can lead to total global segregation.

III. Schelling model (model for segregation)

The model has a tolerance parameter, T.

Rule: Stay if at least T of the neighbors are "kin "

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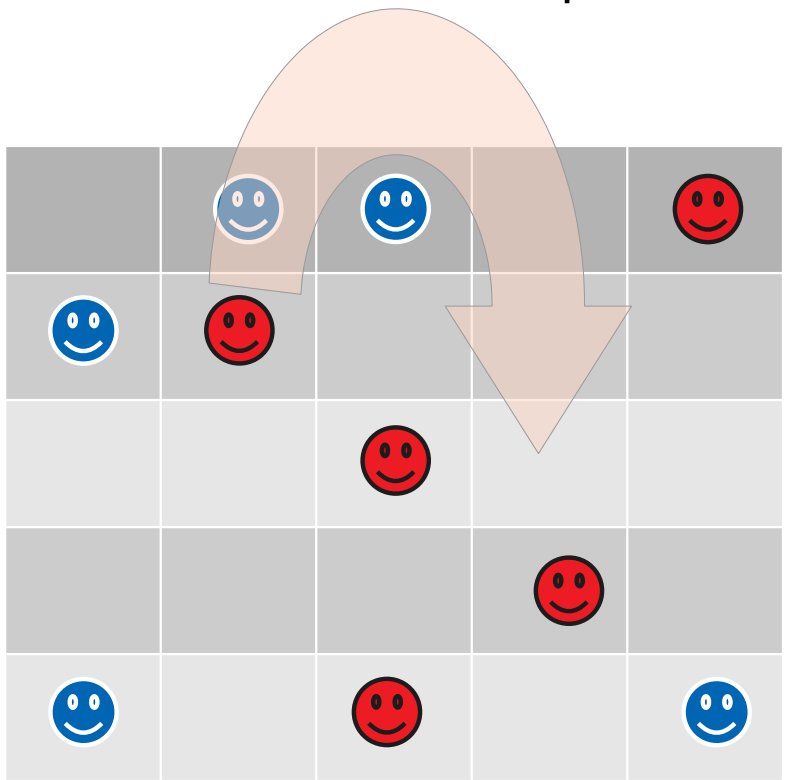

If T=0.5 the agent will move

III. Schelling model (model for segregation)

The model has a tolerance parameter, T.

Whether checking out or not the destination before moving is part of the model's version