Social physics
or sociophysics?

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About 15 years ago ...
Part 1
Long, long time ago ...
Long, long time ago...

- Astronomy $\rightarrow$ Sociology
- Sociology $\rightarrow$ Physics
- What is social physics

Pierre Simon de Laplace (1749-1827)

Adolphe Quetelet (1796-1874)

James C. Maxwell (1831-1879)
Social physics

- Introduced by Adolphe Quetelet in 1835
- *Essay on Social Physics: Man and the Development of his Faculties*
- Project of a social physics and concept of the "average man"
- Average man - characterized by the mean values of measured variables that follow a normal distribution
- Goal - to understand the statistical laws underlying such phenomena as crime rates, marriage rates or suicide rates.

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Quetelet - histograms
• French political philosopher Auguste Comte

• Comte defined social physics as the study of the laws of society (1842):
  – Social Structure
  – Social Dynamics

• He discovered that Quetelet had appropriated the term 'social physics' prior to him

• He invented the term 'sociologie'
Physics becomes statistical

• Maxwell - Kinetic theory of gases (1859)

• He indicated in 1873, the experiences of "social physicists" lent him confidence that this statistical approach could extract order from the microscopic chaos

• Statistics, entering physics through the agency of social science, soon came to dominate it

James Clerk Maxwell (1831-1879)
“Molecules are like many individuals, having the most various states of motion, and the properties of gases only remain unaltered because the number of these molecules which on average have a given state of motion is constant.”
Part 2
From Micromotives to Macrobehaviour
Two physicists
– Professor and PhD student

Wilhelm Lenz
(1888-1957)

Ernst Ising
(1900-1998)

Economist

Thomas Schelling
(1921 - )
Thomas Schelling

- An American economist (14 April 1921)
- Nobel Prize in Economic Sciences (2005)
  - for "having enhanced our understanding of conflict and cooperation through game-theory analysis."
- Chessboard model of residential segregation
An interview with Thomas C. Schelling: Interpretation of game theory and the checkerboard model

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Abstract

This note is mainly based on a short interview with Thomas C. Schelling (TCS), who shared the Nobel Prize with Robert J. Aumann in 2005. The interview took place on 06.03.2001 at University of Maryland, College Park, USA. It consists of two parts. The first part is about his interpretation of game theory, particularly about the use of game-theoretic models in explaining the origin and maintenance of conventions, and norms. The second part is on the origin of Schelling’s influential checkerboard model of residential segregation, particularly about his approach to modeling social phenomena exemplified by this model. The note ends with some concluding remarks.
One day I was flying home from Chicago, and I did not have anything to read. I wondered what to do (...) So, I drew a line on a sheet of paper, put down (...) X’s and O’s, and said now suppose I thought that these were black and whites, and both had ideas about neighbors. I started moving them around (...)
• I had to erase marks to move them, and was extremely clumsy, but by the time my plane landed in Boston I decided this was going to prove interesting.
And after coming back home …

- Use a chessboard and coins of two types (pennies and nickels)
- Put coins randomly on a chessboard and start to move them (coins = agents)
- Agent is unhappy if the proportion of other agents of its color in its neighborhood is below a certain threshold
- Unhappy agent is moved randomly into a new place
What can we expect?

Preference to have neighbors of the same color: 70%

Initial state

Final state

Lesson from this simple model

• Mild preferences $\Rightarrow$ total segregation
• Simple agent’s rules can create complex global patterns or emergent behavior
• A milestone in the study of emergent global phenomena based on local social interactions
• Agent based modeling

What about Ising model?

- „(...) long time ago I discovered, somebody told me that, there were some physical models, I think something in crystal formation. Somebody was referring to ISING model, which was a well-known model of, I think, crystal formation”
Ising model

- Local interactions – order
- Temperature – random changes
- Low temperature – order should dominate
- High temperature – disorder should dominate
Let’s have a look ...
Part 3
Sociophysics has been born?
Sociophysics was born ...

- Serge Galam – father and mother of sociophysics
- Galam, Gefen i Shapir (1982) new field „sociophysics“
SOCIOPHYSICS: A NEW APPROACH OF SOCIOLOGICAL COLLECTIVE BEHAVIOUR. 1. MEAN-BEHAVIOUR DESCRIPTION OF A STRIKE

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A new approach to the understanding of sociological collective behaviour, based on the framework of critical phenomena in physics, is presented. The first step consists of constructing a simple
From social psychology to sociology

Social Psychology
Fundamental unit: A person
(micro scale)

Sociology
Fundamental unit: A social group
(macro scale)

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Can we treat people like particles?

- Social psychology – situation more important than individual traits
- Social influence (Latane, 1981)
  - Informational influence (Sherif 1935)
  - Normative influence (Asch 1956)
- Conformity: obedience to authority, peer pressure, social validation
Conformity

• Conformity - the main mechanism of collective actions.
  – Informational: “when in doubt, imitate”
  – Normative: “when in Rome, do as the Romans do.”

Aversion to standing out in the crowd
The power of social validation

• Milgram, Bickman & Berkowitz, 1969
• Results of experiments: 1 → 4%, 4-5 → 80%
• Robert B. Cialdini: Social Validation – the fundamental way of decision making
Asch’s Experiment

- Normative Influence
- Asch (1956) „visual perception”
The size of the group is important...

- Conformity (social validation)
- Group size – a threshold of 4-5 persons (Latane, 1981)

![Graph showing conformity as a function of group size](graph.png)
Even more surprising ...

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Unanimity is the key!

• The presence of a social supporter reduced the total number of yielding responses from 32% to 5.5%!

• Participants were far more independent when they were opposed by a seven person majority and had a partner than when they were opposed by a three-person majority and did not have a partner.
Opinion

- opinion - verbalized attitude (Trommsdorff 1998), measured in surveys
- discrete opinions:
  - Ising spins
  - Potts variables
- Continues opinions?
  - not in surveys
In which direction goes the situation in Poland?
Problems with social data

- How to collect them?
- People investigate the system
- People create the system
- Information about people’s behavior can change their behavior
The hunger protest took place in May-June 2004 in several prisons in Poland.

It started in Wołów (reason: overcrowding in cells)

Within a week several prisons joined the protest (2320 prisoners in 10 prisons)
Models of opinion dynamics

• Social network
• Opinion states
• Update rules

• Ising spins and conformity
  – Voter Model
  – Majority model (Galam)
  – Outflow dynamics (Sznajd)
Voter Model (Clifford and Subdury, 1973)

\[ m = \frac{1}{N} \sum_{i=1}^{N} S_i \]

\[ S_i = \pm 1 \]
Majority Rule (Galam)
Outflow dynamics - unanimity

\[ m \]

\[ \text{time} \]
Let’s have a look ...

![Dynamiki zero-temperaturowe (Michal Jaremko)](image)

- **Dynamika**: Glauber, Voter, Kawasaki, Stauffer, Galam, Kondrat
- **Warunki początkowe**: brak, losowe, pasy, pasy (ukośne), koło, kwadrat, szachownica

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Recent Review Article

• C. Castellano, S. Fortunato, V. Loreto, Rev. Mod. Phys. 81, 591-646 (2009)
Responses to social influence

- Conformity
- Independence
- Congruence
- Anticonformity

Conformity and anticonformity

- They are similar in the sense that both acknowledge the group norm
- The level of anticonformity depends on the society (asserting uniqueness)
Steady states?

- Consensus is no more a steady state
- Is consensus still possible?
- What is the opinion dynamics?
Time evolution of public opinion

- \(N=100\) individuals
- „high” level of anticonformity
Time evolution of public opinion

- N=100 individuals, „low” level of anticonformity
Model on a complete graph

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Lesson from this model

• Model with conformers and anticonformers
• For small values of anticonformity ($<p^*$) spontaneous reorientations occur → complete repolarizations
• The mean reorganization time for $p=p^*$ is minimal
• No need to introduce an external field nor a strong leader to obtain social repolarizations
Summary

• Simple models are used by computational sociologists
• Problem with „social data” (not a science?)
• The goal is to understand the system
• Social influence – interactions between individuals
• Several types of social response
• Unexpected behaviour – complex systems
• Dynamics and updating scheme is important!
Thank you for attention