IDENTITIES

Enlightening
Interdisciplinarity
in STEM
for Teaching

Analysis of interdisciplinarity

In search of disciplinary boundaries in simulations and complex systems

Co-funded by the
Erasmus+ Programme
of the European Union

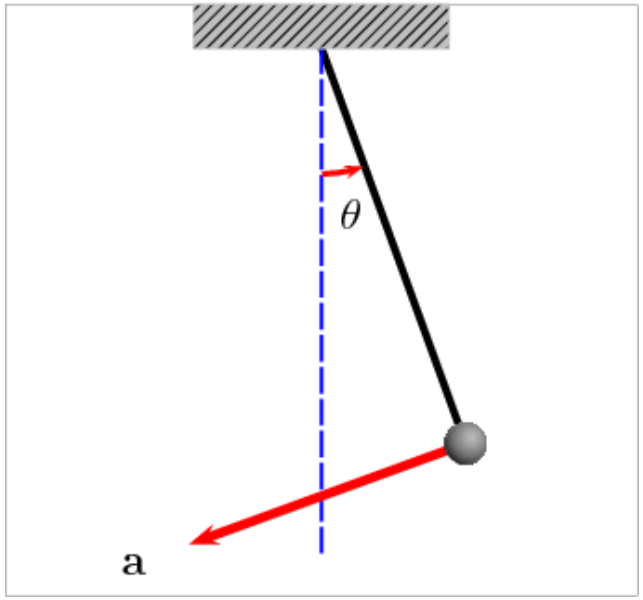
Grant Agreement n°2019-1-IT02-KA203-063184

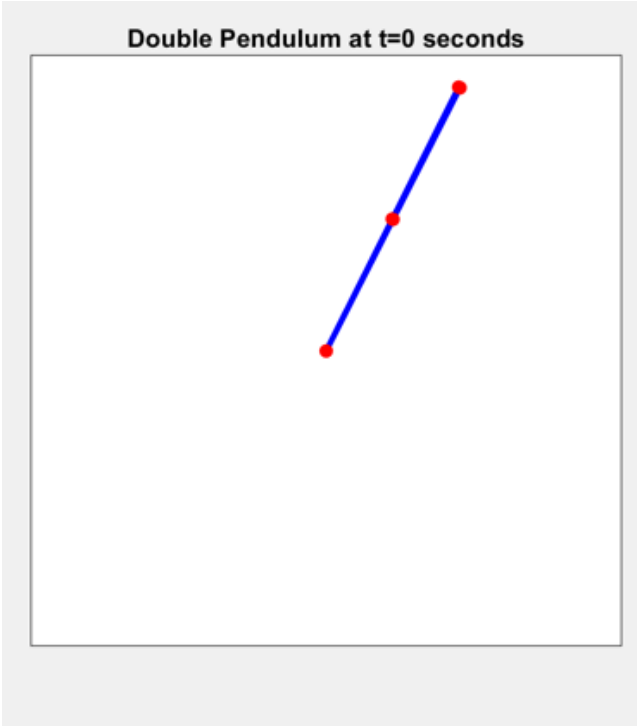
- What do you think are the **boundary objects** detectable in the module?

- Which disciplines can you **identify** in the activities we experienced? What was the role of each? What tools and knowledge did these disciplines provide?

Physics and complex systems

We started from here

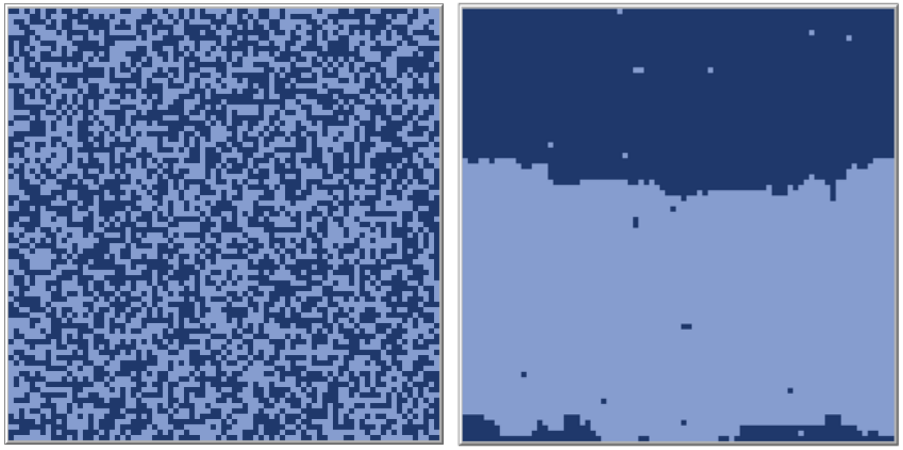




Physics and complex systems

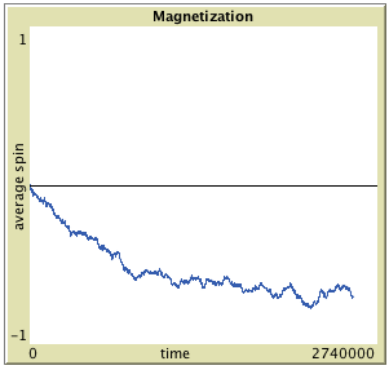
Soon we were faced with

A paradigmatic example

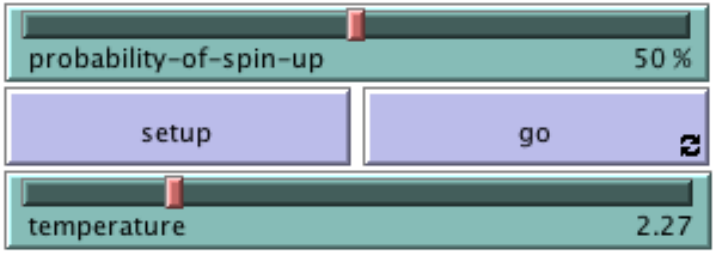


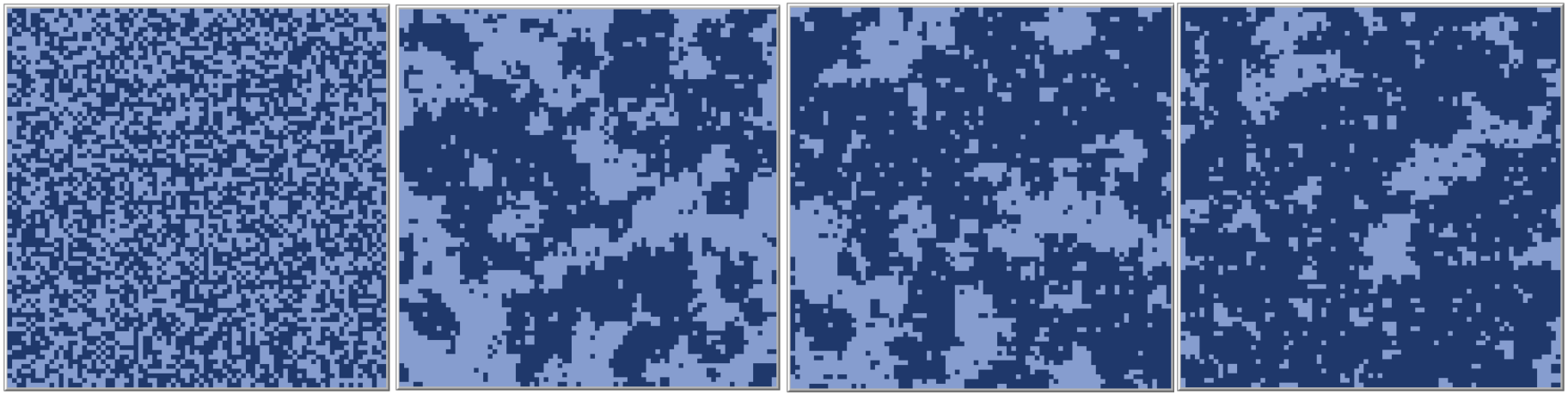
Magnetisation or political polarisation?

Magnetisation of Ising



- Modelling a magnet at the microscopic level (classical model of condensed matter physics)
- A crystalline material is conceived as a set of lattice points with spin
- Spins can change by being influenced by neighbouring spins
- The general behaviour of the system varies depending on temperature

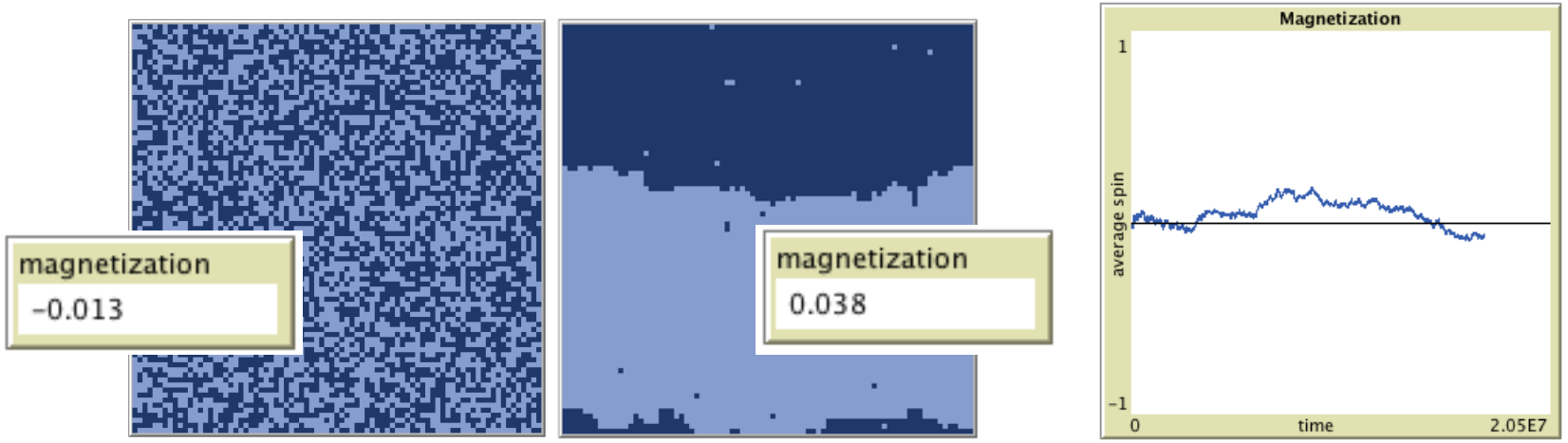




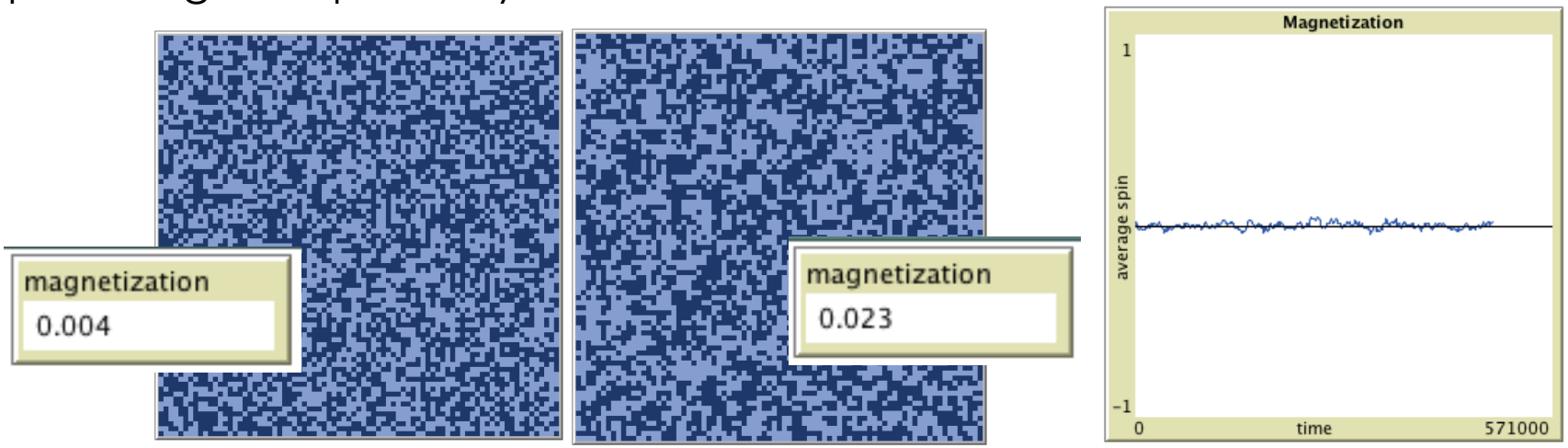
https://www.netlogoweb.org/launch#https://www.netlogoweb.org/assets/modelslib/Sample%20Models/Chemistry%20&%20Physics/Ising.nlogo

Magnetisation of Ising

- At low temperatures, the spins tend to align, causing the material to spontaneously magnetise the ferromagnetic phase system



- When the temperature is high, there is no spontaneous magnetisation paramagnetic phase system



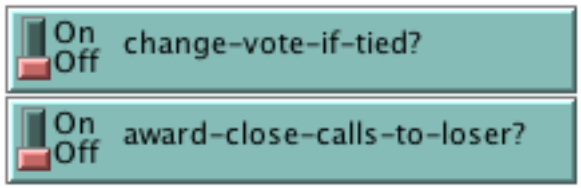
Ising magnetisation: the emergent property

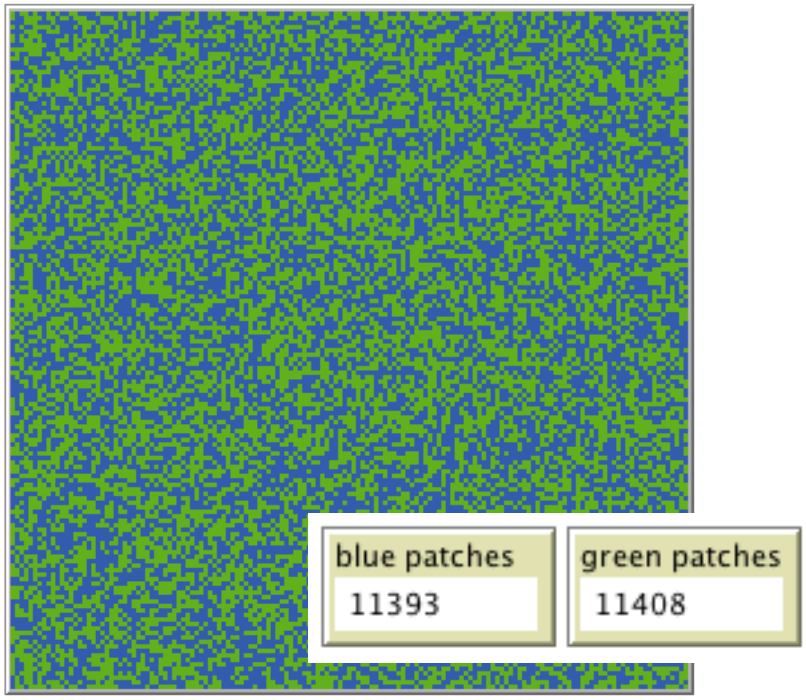
- Magnetisation configurations are typical of the macroscopic scale of the system
- Iron/paramagnetic properties *depend on* the spins of the individual lattice points

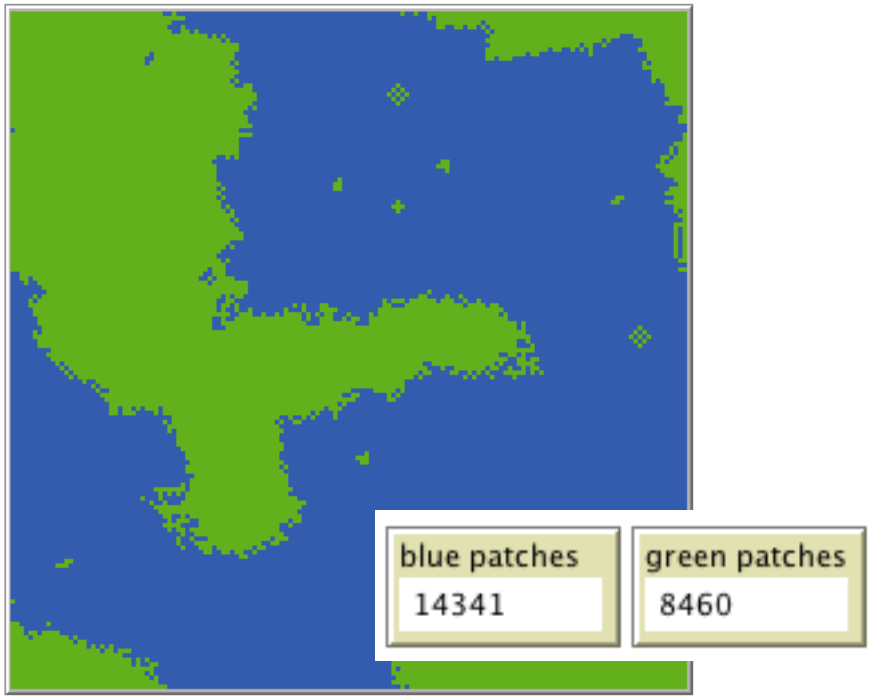
- Ising's magnetisation model is very simple and very abstract
- It can be used to describe a wide range of **physical phenomena**, e.g. as a model of liquid/gas phase transitions in which the two states are liquid and gas instead of two magnetic spin states
- It has also been used as a basis for simulating **phenomena outside physics** (in the social sciences) involving behaviour similar to phase transitions

The vote

- Modelling the distribution of voters according to two options
- Each agent votes the same way as the majority of his or her first neighbours (in the event of a tie, he or she remains of his or her original opinion)







https://www.netlogoweb.org/launch#https://www.netlogoweb.org/assets/modelslib/Sample%20Models/Social%20Science/Voting.nlogo

The advent of Computational Social Science

Manifesto of computational social science

R. Conte[1,a], N. Gilbert[2], G. Bonelli[1], C. Cioffi-Revilla[3], G. Deffuant[4], J. Kertesz[5], V. Loreto[6], S. Moat[7], J.-P. Nadal[8], A. Sanchez[9], A. Nowak[10], A. Flache[11], M. San Miguel[12], and D. Helbing[13]

Abstract. The increasing integration of technology into our lives has created unprecedented volumes of data on society's everyday behaviour. Such data opens up exciting new opportunities to work towards a quantitative understanding of our complex social systems, within the realms of a new discipline known as Computational Social Science. Against a background of financial crises, riots and international epidemics, the urgent need for a greater comprehension of the complexity of our interconnected global society and an ability to apply such insights in policy decisions is clear. This manifesto outlines the objectives of this new scientific direction, considering the challenges involved in it, and the extensive impact on science, technology and society that the success of this endeavour is likely to bring about.

https://link.springer.com/article/10.1140/epjst/e2012-01697-8

An inherently interdisciplinary approach

- It is a truly **interdisciplinary** approach, in which social scientists, cognitive scientists, agent theorists, computer scientists, mathematicians and physicists work together to develop innovative, theory-based models of target phenomena.
- Computational social scientists firmly believe that **a new era** has begun in understanding the structure and function of our society at different levels.

(Conte et al., 2012)

Beyond the separation of natural and social

- In the case of collective phenomena (crowds, foot and car traffic, fashion, financial or social crises, opinion formation and epidemic propagation), the aim of modelling, with analytical and numerical means, is precisely to understand the global ('macroscopic') level from the characteristics of the constituent elements (the 'microscopic' level) and the social structures to which they belong, and also to understand how the collective level influences individual behaviour.
- Such modelling can, and must, be done with multiple approaches, **integrating tools and concepts from different disciplines**: applied mathematics, statistical physics, computer science, theoretical economics, and this in close interaction and collaboration with social scientists.

(Conte et al., 2012)

Thank you!

eleonora.barelli2@unibo.it