Interdependent choices, individual preferences and social influence

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Mean-field Ising equilibrium dynamics can be used to describe the collective properties of certain choice or decision making processes when we want to mimic a generic tendency of individuals to *conform to the norm*, understood in this case as the accurately perceived average behaviour of the group. This can be a useful approach for a wide range of problems covered by the social sciences, from political science to demand contexts or the incidence of any particular social trait or habit.

Even very simple models already have interesting interpretations in social contexts[1] and direct parallelisms can be drawn between them and some utility maximising scenarios from *traditional* discrete choice theory in the social sciences literature[2]. In particular, even when considering completely homogeneous populations (in their individual preferences and interaction), first and second order phase transitions provide mechanisms for abrupt changes in the aggregate state of the system with no parallelled changes in the parameters. Metastability and hysteresis appear as collectively reinforced opinion states which persist even when individual preferences would be best satisfied by a change in option, but to which there is no going back by reversing the changes once it is abandoned.

Furthermore, these setups provide a framework in which to naturally introduce heterogeneity, characterising the group through probability distributions describing individual attitudes towards the particular choice[3,4]. These are considered fixed in time (*quenched disorder*), which is equivalent to a Random Field Ising model. The study of the system at finite temperature allows for the consideration of fluctuations varying in time (*annealed disorder*), which can encode lack of information or a more fundamental uncertainty on human nature concerning *free will*.

The type of opinions or decisions under study can seldom be considered to be isolated, as these are normally deeply interrelated. As a first approximation, two variables modelled as described above, can be coupled explicitly through a term in the Hamiltonian. Coupled Ising models have been considered in the literature before, in particular for their interest in the study of plastic phase transitions[5,6]. When understood as discrete choice models, even in simple cases of homogeneous populations[7] or zero temperature RFIMs[8], these show that interdependence promotes polarisation, enriches the stability landscape and can qualitatively change the aggregate outcome from that of the uncoupled case.

We will discuss the use of two coupled Random Field Ising models to describe a group where individuals have to make two choices which affect each other. The population's preferences can be then characterised by two probability distributions (or a single bivariate one), one for each decision. We study the dependence of the aggregate outcome on the parameters (which measure strength of choice interdependence and social influence and characterise the joint probability distribution for individual preferences) and describe the system's phase diagrams for some particular cases in the light of binary interdependent decisions.

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[1] S. Galam, Y. Gefen and Y. Shapir. *Sociophysics: A new approach of sociological collective behaviour. I. mean-behaviour description of a strike*, The Journal of Mathematical Sociology, 9:1-13, 1982.

[2] S. N. Durlauf. *How can statistical mechanics contribute to social science?*, Proceedings of the National Academy of Science, 96:10582-10584, 1999.

[3] S. Galam, *Rational group decision making: A random field Ising model at $T = 0$*, Physica A: Statistical and Theoretical Physics, 238:66-80, 1997.

[4] M. B. Gordon, J.-P. Nadal, D. Phan and V. Semeshenko. *Discrete Choices under Social Influence: Generic Properties*, Mathematical Models and Methods in Applied Sciences, 19:1441-1481, 2008.

[5] S. Galam, S. R. Salinas and Y. Shapir. *Randomly coupled Ising models*, Physical Review B, 51:2864-2871, 1995.

[6] E. Korutcheva and D. I. Uzunov. *Ising models and coupled order parameters*, Preprint Joint Inst. Nuclear Research Dubna, E-17-88-467, 1988.

[7] A. Fernández del Río, E. Korutcheva and J. de la Rubia, *Interdependent binary choices under social influence: Phase diagram for homogeneous unbiased populations*, Complexity, DOI: 10.1002/cplx.21397, 2012.

[8] A. Fernández, E. Korutcheva and J. de la Rubia. *Deterministic interdependent choices in populations with limited heterogeneity*, work in progress.