

Interdisciplinary Monte Carlo Simulations

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Basic theorem of interdisciplinarity:

Physicists not only know everything;

they know everything better

This theorem is wrong; it is valid only for computational statistical physicists like me, above age 60

With Moss de Oliveira, de Oliveira and Sá Martins: *Biology, Sociology, Geology by Computational Physicists*, Elsevier, Amsterdam 2006; also Billari et al 2006.

Possible criticism

"Biology is more complicated than physics; physicists neglect details." True; but the Earth is more complicated than a point mass; nevertheless Kepler's laws are quite accurate and were very useful.

"Computers know only 0 and 1." Wrong; many shades of grey -2147483648 to +2147483647

"Humans are not numbers." Wrong; look at insurance, pension plans, life tables (going back to astronomer Halley).

"Physics \neq Sociology/Economy." True; but Schelling in first volume of J. Mathematical 1971 followed Empedokles from Sicily 2500 years ago and simulated something like dilute Ising model with Kawasaki kinetics to explain black ghettos in USA; and Nobel laureate Stigler published market simulations in 1964.

Do others welcome physicists ?

Biologists: no, but changing ($10^4 \dots 10^5$ genes)

Economists: yes (Markowitz, Levy, Lux)

Sociophysics: yes, if computational sociologists

Linguists: Wichmann yes, insufficient statistics

How long do physicists have to wait for acceptance ? ≥ 10 years. (ageing, traffic, compare gelation=percolation 1976-1990)

We need drastic successes, thus far lacking (atomic bomb versus vaccination). We need empirical data to explain; they exist for genomes, markets, elections, languages.

The gap between theoretical physicists and theoretical biologists (sociologists, linguists) may be smaller than that between the latter ones and experimental biologists (sociologists, linguists).

Not only should physicists publish in the journals of the other fields, but experts from these other fields should also publish in physics journals, without physics coauthors.

Last aim was achieved by Cebrat (ageing genetics), Lux (finance), Schnegg (social nets), Holman and Wang (languages), with the help of the great Nobel laureate 2008 in literature (science fiction) Stauffer.

What do these fields all have in common? Many questions have a yes or no answer, and different people influence each other. Simple simulations of Ising model since 1959. Magnetic orientation of atom is up or down (“spin”); neighbouring atoms “want” to have the same orientation but are disturbed by thermal motion = noise.

Schelling: blacks and whites in US cities. Eigen: quasispecies genome. Kauffman: NK model for gene expression. Nettle + Ke-Gong-Wang: two competing languages; Cont + Bouchaud: buying or selling on stock market. Opinion dynamics: For or against?

If the binary choice has been treated one can use more complicated models. “Models should be as simple as possible, but not simpler.” See Kepler’s laws of 4 centuries ago. But purely deterministic is dangerous.

1) People influence each other: Nazi support in Germany 1933-1945. Rock'n Roll music since 1954. High Tech bubble on stock market burst in spring 2000. Beers in Paris should have German names. Horizontal gene transfer for bacteria.

2) People make errors or intentional changes: Random mutations in biology. Contrarians in opinions. Family affairs induce traders to buy or sell on market. For languages:

Negro → *Coloured* → *Black* → *Afro – American*

3) Most people don't like to be in small minority: Emigrants learn new language, consensus pressure in committees, sauerkraut nearly vanished in Germany.

Everybody writes, nobody reads

1) Theories why sex was invented: R. J. Redfield, *Nature* 1994, cited 66 times in biology and physics journals, made ageing physicists interested in sex. S. Siller, *Nature* 2001 may have done the same, but does not cite her. S.P. Otto, S.L. Nuismer, *Science* 2004 do it differently, do not cite her; Otto cited here years earlier, from same department.

2) Theories why (racial) segregation may self-organise: Schelling 1971 unknowingly invented a complicated $T = 0$ Ising model, which gives small clusters but no large ghettos. Nobel laureate 2005 in economy, heavily cited in sociology. Was ignored by physicists until 2000: Levy-Levy-Solomon book, continued by Meyer-Ortmanns and by Schulze.

Jones Aust. NZ J. Sociol. 21: 431 (1985) got large ghettos and is ignored. Vinkovic + Kirman found no large ghettos, ignore Jones, Meyer-Ortmanns, Schulze, misquote Ising model. And so do Lim, Metzler, Bar-Yam Science 2007 (Potts model) and at least two preprints. Stauffer + Solomon Eur. J. Phys. B 2007 cite all.

Examples

Urban segregation: Sumour et al (Gaza)

Elections: Bernardes et al 2001, Castelleno + Fortunato 2006

Languages: de Oliveira et al 2007, Wichmann et al 2008

Biological Ageing: Penna model since 1994

Market fluctuations: Gopikrishnan...Stanley 1998, Cont-Bouchaud and -Sornette-Stauffer 1999