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What Social Simulation Might Tell Us about How Law Works

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SUMMARY: *1. Introduction – 2. Computer Simulation of Social Phenomena – 3. Examples – 3.1. Breakdown in Norm Compliance – 3.2. Preparing the Ground for Compliance to Legislation – 3.3. Bootstrapping Away from Endemic Corruption – 3.4. The Efficacy of Different Modes of Legal Rule-making – 4. Conclusion*

1. INTRODUCTION

This paper does not consider the important questions of "How is law made?", "How is it applied in various cases?", nor "Is Law X effective?", but rather some underlying questions that are less often asked, namely: "How does law work?" and "Why does law work?". It will not, in this brief discussion, come up with answers, but rather sketch how a certain technique might help in discovering the answers. That technique is agent-based social simulation – using computer simulations that trace out possible "histories" of interactions between social actors to help understand how social phenomena develop.

It may seem that the answers to the two questions are rather obvious. Law works by force: the state uses its power to either take control of situations it needs to, or punishes those that disobey its published rules. Law works because the state is more powerful than others. However, these explanations are simplistic, at best sketching the ultimate underpinning of complex social processes which include: habit, social norms, imitation, status, self-interest, opportunity, personal power, gossip, reputation, identity, group formation, contextual framing and simple habit. Law "bootstraps" itself upon different mixtures of these in different circumstances, almost never (at least in modern European countries) relying on force alone. Whilst one law (e.g. a road safety law) might rely on a mixture of self-interest, suggestion (via signs), habit and mild threats (fines) another (say a bankruptcy law) might rest upon considerations of reputation and potential loss of power (to easily borrow money in the future).

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Understanding how these different social aspects result in effective law is often mundane; we have an intuitive and common sense insight into the reasons and the processes (e.g. people drive on the right hand side of the road for their own and others' safety). Our every-day knowledge is adequate to explain most of the circumstances of law abidance that we observe, and any exceptions analysed within a natural language discourse. However, it can also be mysterious when things get complicated, for example: when there is a complex mix of countervailing "forces", when it involves many different groupings of actors, when underlying social conditions are changing, or when adherence to a law suddenly breaks down. In order to understand these kinds of situation we would need super-human abilities – being able to trace (or express) multi-dimensional complex and dynamic networks of interaction all at once. In other words, such social outcomes can not be sufficiently understood using thought and natural language alone due to their representational limitations and thus sometimes we are surprised at outcomes that we cannot adequately explain.

2. Computer Simulation of Social Phenomena

Computer simulation complements natural language in its affordances. Whilst natural language is semantically rich, good at abstraction (through the mechanism of analogy) and context-sensitive, computer simulation is precise, holding a mass of simultaneous detail in parallel, good at tracking complex networks of interactions and dynamic processes. This means that it can track complexes of dynamic interactions where the outcomes are not predictable from simple considerations of overall motivations, but rather comes out of the detailed building up of short-term meso-level societal structures[1]. Thus computer simulations that do track interactions down to individual social actors can reveal possible connections between the micro-level of individual actors and their interactions with the macro-level societal outcomes (such as the level of general compliance, or otherwise, to a law). It is possible to use ideas and analogies to explain an observed micro-macro connection but it is then almost possible to know if that is just a "gloss" that rationalises the connection or whether it captures something useful (e.g. something that can result in policy that broadly works). A computer simulation, however, produces precise (but complicated) accounts that show *how*

[1] K. Sawyer, *Social Emergence: Societies as Complex Systems*, Cambridge, Cambridge University Press, 2005.

the outcomes can come about in a way that reveals new questions and issues that can then inform subsequent empirical work. One can summarise this by saying that it generates *real possibilities* and hence can give credibility and precision to explanations of emergent outcomes. Thus computer simulation never supplants natural language but rather works in parallel with it, with a constant interplay between the two systems of representation.

A common, and understandable, objection to the computational simulation of social phenomena is that it inevitably leaves a lot of the original out, simplifying and abstracting. This leaves the worry that some factor or process that is essential to explaining the development of the relevant phenomena has been omitted.

Such fears have been exacerbated by the poor track record in terms of the formal modelling of social phenomena, when the ambitions of the proponents have lead them to make sweeping conclusions purely on the result of very abstract models. A stark example of this is economics, where very strong assumptions (motivated by a desire for analytic tractability) were routinely made to achieve abstract conclusions that coincided neatly with the ideological biases of its proponents (such as the efficiency of free markets). What was missing in these attempts was any good relationship between the models and what is actually observed – either at the micro-level in terms of how people actually think and behave or at the macro-level in terms of the aggregate outcomes (such as the obsession with proving the existence of equilibria even though there is usually no evidence for them). These kinds of model are no more than an analogy expressed in a formal system – "computational analogies". Of course, there is absolutely nothing wrong with analogies, as long as they are not presented as "hard science" and hence having a higher degree of reliability than they merit.

Of course, our everyday experience suggests two things: firstly, that human society is far more complicated than could ever be represented in a computer simulation and, secondly, that even where social interaction does seem to follow certain rules or patterns these can be undermined or abnegated by something that "changes the rules" from the outside (for example when a person who embodies a new goal or ambition is introduced into a society changing people's thinking and motivation). If a computer simulation had to be this comprehensive in terms of its representation to be useful and go beyond being an analogy, then these would be fatal critiques. This is not, of course, something than can be proved in the abstract, but rather something that will (or will not) be demonstrated in practice. However, I

would argue that this need not be the case – that there is at least the possibility of useful simulations of society. To do this I look to another science that deals with phenomena which has a commensurable level of complexity to that of social phenomena – cell biochemistry. Within cell biochemistry there is a well-established distinction between *in vivo* and *in vitro* studies. *In vivo* studies are those that investigate living cells, whilst in vitro studies are those that examine the interaction within the artificial environment of the test tube[2]. The point is that, if cell biochemists are to have any hope of unravelling how cell biochemistry works, they need both *in vivo* and *in vitro* studies.

In vitro studies allow one to work out the interactions between a restricted set of cell molecules within a controlled environment. What this tells one is some of the possible interactions between these in the cell, but does not give you the complete picture. What happens in the test tube might well be undermined or overwhelmed by other reactions in a living cell, so conclusions from an *in vitro* study need to be made carefully and checked.

An *in vivo* study will give a realistic picture about the biochemical behaviour in a cell, but the interactions will be so complex, with one process "switching" other processes that any set of data so obtained may not be very helpful in terms of our understanding of that behaviour. This is for two reasons: *firstly*, it will necessarily be a very partial picture of the possible behaviours since the internal self-organisation of the cell does not allow an externally-driven study to reveal the full range of possibilities and, *secondly*, the resulting data will be the result of a very complex set of interactions, appearing "noisy" and making the detection of patterns hard. The first difficulty means that it is not possible to perform targeted experiments to test particular hypotheses or understandings about the internal processes and the second means that any such test may result in very weak correlations, since the target pattern may well be swamped by signals from other, possibly countervailing, processes. Thus trying to understand cell biology from *in vivo* studies alone is hopeless.

Computer simulations are the equivalent of the *in vitro* studies in cell biology. They do not supplant the equivalent of *in vivo* studies, which would be empirical studies of social phenomena (surveys, interviews, analysing tweets, observation, ethnography etc.) but are complementary to these. It allows the exploration of possible interactions and properties of selected

[2] See, e.g., as in S.S. ROTHMAN, *Lessons from the Living Cell: The Culture of Science and the Limits of Reductionism*, New York, McGraw-Hill, 2002.

subsets of the full range that exist in society. Trying to detangle even a small subset of what is happening, relying only on *in vivo* studies and natural language discourse, would be as hopeless for understanding the full complexity of society as it would be to understand the full complexity of cell biology[3] – the phenomena we are considering are so complex that we need all the tools at our disposal, *provided we understand the limitations of each*.

Computer simulations of society thus allow for comprehensive sets of artificial experiments, exploring the "what if" possibilities that are (rarely) accessible from direct *in vivo* studies. They are primarily *possibilistic* in nature rather than *probabilistic*. That is, they reveal some of the possible complex causal chains that may exist rather than the *probability* of any particular possibility. This is appropriate since any probability derived from a simulation would be relative to the set of possibilities in that simulation, which might be a distorted and tiny subset of those observed *in vivo*. Most probabilistic projections of formal models of aspects of society (e.g. economic ones) are concerning the internal dynamics of the model and do not properly refer to likelihoods in reality, since this would require a knowledge of the total space of possibilities there[4].

Of course, if a cell biochemist took a random set of chemicals and did experiments on them, this might be interesting but there would be no reason to suppose any results had anything to do with real cells. Rather, great care is taken to ensure that the chemicals in the test tube are the same as those in the cell. Similarly in the construction of social simulations one needs to ensure that the processes being examined there correspond to those observed in society, otherwise, however interesting the results, there would be no reason to suppose they had anything to do with observed social processes. Whilst clearly we can not simply "take" observed social processes and actors and "drop" them into computer simulations, the closer and more direct the relationship between what is observed and the simulation the better. If there is only a weak, conceptual relationship between the observed and the sim-

[3] There are many reasons to suppose that social systems are as complex, including the presence of both emergent and immergent processes (R. CONTE, G. ANDRIGHETTO, M. CAMPENNÌ, M. PAOLUCCI, *Emergent and Immergent Effects in Complex Social Systems*, in "Proceedings of AAAI Symposium, Social and Organizational Aspects of Intelligence", 2007), and the self organising, "autopoietic", propensities of each (F. VARELA, H. MATURANA, R. URIBE, *Autopoiesis: The Organization of Living Systems, Its Characterization and a Model*, in "Biosystems", 1974, n. 5, pp. 187-196).

[4] F.H. KNIGHT, *Risk, Uncertainty, and Profit*, Boston-New York, Houghton Mifflin, 1921.

ulated the best one can hope for is a computational analogy – another way of "thinking about" the target social processes – but this is a strange use of computer simulation since natural language is much better suited to expressing and exploring analogies. If the relationship is evidence-driven, derived from observations of individuals (however mundane), then the simulation is more likely to be relevant.

Ensuring the correct "ingredients" of an *in vitro* study is but one check upon its relevance, one also seeks to ensure the environment of any experiment is realistic, and then check any results for their plausibility compared to observed data. This is the same with social simulation, one seeks to check the relevance of its processes in as many ways as possible, including: aggregate outcomes, the shapes of distributions that result from it, time series derived from it, the structure of intermediate level groups and networks, and even the "trajectories" of individual agents in it[5]. Thus, whilst constructing and exploring computer simulations may seem a lot easier and cheaper than any *in vivo* studies of society, there is a corresponding effort needed in ensuring their relevance. The formal modelling of social phenomena has been tainted by the over-interpretation of models that, in fact, have no strong relationship to what is observed – a mistake that would not be made by researchers using *in vitro* techniques in cell biochemistry!

3. Examples

If, as I have argued above, suitable computer simulations have an indispensable role to play in understanding of social phenomena, including those that involve the law, then the question remains as to what kinds of problem or issue might this technique be helpful with. In the last part of this paper I briefly outline several targets where simulation has the potential for progressing our understanding. These illustrate the sort of questions that computational simulation may help answer. This is not meant in any way to be a comprehensive list but rather highlighting cases where complex simulation might play a particularly crucial role in teasing out the complex interactions between social processes[6].

[5] R.L. Axtell, J.M. Epstein, *Agent-based Modelling: Understanding Our Creations*, in "The Bulletin of the Santa Fe Institute", 1994, n. 9, pp. 28-32.

[6] For example it misses out more obvious examples such as simulating and mapping burglary using simulations techniques (see, e.g., N. Malleson, A. Evans, T. Jenkins, *An Agent-based Model of Burglary*, in "Environment and Planning B: Planning and Design", Vol.

3.1. Breakdown in Norm Compliance

There is rarely a sufficient expression of state power to enforce local compliance, for example damage to property, but rather the existence of group norms ensures that, *usually*, individuals constrain themselves to what is generally acceptable. Here there is a complex combination of forces: social norms that applies to different groupings of actors, the ability of the state to locally back-up the norms, and the self-interest of those concerned. Clearly, in some cases, e.g. the recent UK riots[7]. There these norms either broke down (or did not hold with respect to the groups that locally formed) and the immediate local law enforcement was inadequate. It has been argued that a similar situation now holds in Afghanistan[8]. It seems that a complex feedback loop is behind such breakdowns: a perception that a norm no longer holds free individuals from following that norm[9], self-selection during the formation of groups allows for collections of individuals to form without those that might uphold the norms, the local concentration of power by the group means that state force is (at least temporarily) excluded thus allowing the possibility of ignoring the norm to be established, and the social imitation of actions allows for "seed" individuals to influence many others. It is difficult to tease out the micro-level ordering of these processes from personal accounts and observational evidence since the different processes are happening at different times with different individuals simultaneously. Computational simulation allows for a series of *in vitro* experiments where different micro-level orderings are tried to see if this might have an effect on the macro-level outcomes. This might suggest ways to distinguish the different possibilities from the evidence, ruling out some and revealing distinguishing traits that might be investigated in subsequent *in vivo* research.

36, 2009, n. 6, pp. 1103-1123; N. MALLESON, A. HEPPENSTALL, L. SEE, *Crime Reduction through Simulation: An Agent-based Model of Burglary*, in "Computers, Environment and Urban Systems", Vol. 31, 2010, n. 3, pp. 236-250).

[7] T. DE CASTELLA, C. MCCLATCHEY, *UK Riots: What Turns People into Looters?*, in "BBC News Magazine", 9 August 2011, http://www.bbc.co.uk/news/magazine-14463452.

[8] A. GELLER, *The Political Economy of Normlessness in Afghanistan*, in Schlenkhoff A., Oeppen, C. (eds.), "Understanding Afghanistan. An Interdisciplinary Approach", London, Hurst & Co., 2008.

[9] C. BICCHIERI, *The Grammar of Society: The Nature and Dynamics of Social Norms*, New York, Cambridge University Press, 2006; C. BICCHIERI, M. MERCIER, *Norms and Beliefs: How Change Occurs*, in Xenitidou M., Edmonds B. (eds.), "The Dynamic View of Norms", Cambridge, Cambridge University Press, forthcoming.

Knowing more about the micro-level possibilities might allow for more effective intervention strategies, for example the importance of social inclusion strategies compared to crowd dispersal techniques.

3.2. Preparing the Ground for Compliance to Legislation

The reverse case of a breakdown in social compliance is when compliance with a new law is desired (or the need for a more widespread compliance with an existing law is felt to be needed). In the UK, the government campaign against "drink driving" (driving with more alcohol in the blood than the law allows) was broadly successful, helping to change social norms so that it became unacceptable to drink before driving. In contrast, the recent campaign against driving above the speed limit has invoked a lot of hostility and much opposition – even to the extent that some local authorities have since stopped using the automatic speed cameras that they installed. Clearly, in some cases the law seems to lead the development of new social norms and in other cases if it does not follow existing norms it will not. In the later case the introduction of a law might be expensive to enforce and relatively ineffective. This case involves a similar mixture of social processes as the preceding one, since it is the opposite case: the development of a new norm rather than the breakdown of an old one. However, there is no reason to suppose these processes are symmetric: norms seem to get established in a much slower and pervasive manner, whilst they seem to break down in patchy and sudden events. Clearly both are intensely social processes but also involve the perceptions, expectations and assumptions of individuals. Simulation might be able to tease out some of the possible ways in which new norms get established, providing complex but explicit traces of norm establishment. This might help distinguish situations where a population is ready to be "led" by a new law and where the building of a social consensus is necessary first.

3.3. Bootstrapping Away from Endemic Corruption

Social institutions of all kinds seem to have a remarkable persistence once they become established. If owning a house and land becomes established as a key to social status, due to the wealth and power it gives, then such ownership can persist as a sought-after status symbol even after other means to wealth and power predominate. This persistence holds regardless of whether the institution is state-sponsored or is inimical to the state. Thus in soci-

eties where corruption is long-established then it is very difficult to shift – simply making it illegal has limited efficacy. Once in place complex webs of expectation, reputation, norms, loyalties and habit help keep it in place. Thus even if one successfully attacks one of these supporting "pillars" the others preserve the phenomena. However, history does show that new institutions can supplant entrenched social institutions if the conditions are right. However it is unclear exactly how this happens or how such a change can be facilitated. Particular historical examples give valuable insights but due to the "density" and embeddedness of social processes it is very hard to separate what was essential to this and what was merely a contributory factor. Thus the analysis of historical examples typically allows for a plethora of alternative explanations for the same events. Computer simulation could help make more precise hypotheses about the importance of each factor that might lead to suggestions of interventions that might then be tried out and monitored. Some simulation that is working in this direction is proposed by Sonzogni and colleagues[10]. As made clear above, any suggestions derived from computer experiments are not guaranteed to succeed but, due to the fact that they are based on precise hypotheses about the interaction between the social processes involved, they might have a greater likelihood of succeeding and, *more importantly*, regardless of their level of success will give far greater insights into how to make such interventions and how they might be improved/modified.

3.4. The Efficacy of Different Modes of Legal Rule-making

Legal processes are a part of the complex web of social processes. They are effective (or otherwise) largely as a result of their embedding and place within the other social processes and institutions that exist. Thus they are also possible subjects for computer simulation. In particular, there is a choice of *how* a legal goal is applied. A precise but complex set of rules may be specified in an effort to cover all possible cases it might apply to; a general principle might be laid down with an obligation to apply it with regard to the local circumstances, leaving it to the discretion of a local authority to

[10] B. SONZOGNI, F. CECCONI, R. CONTE, *Dynamics of Illegality. The Case of Mafia Systems*, in "Proceedings of the Lisbon European Conference on Complex Systems - ECCS 2010", ISTCE-Lisbon University Institute (Lisbon, 13-17 September 2010); B. SONZOGNI, F. CECCONI, R. CONTE, *On the Interplay between Extortion and Punishment. An Agent Based Model of Camorra*, in "Proceedings of the 2011 Computational Social Science Society of America Annual Conference - CSSSA 2011" (Santa Fe, 9-12 October 2011).

interpret taking into regard local conditions; the scope of a law might be left to the development of case law over time, so that gradually a set of exemplars where the law is deemed to hold (or otherwise) can be established as a fuzzy guide to its applicability; or the law could insist on the existence of local processes with a liability for their maintenance (e.g., evacuation procedures in public buildings). Which style is applied in which kind of situation is largely left to the intuition of lawmakers informed by past experiences and existing traditions. However, it seems highly likely that the style of a law has a big impact upon its efficacy and enforcement cost. Computer simulations might give an insight into the possible consequences and drawbacks of each kind, enabling a more informed decision as to how best achieve a social goal using the law. An example of this is where individual firms contextualise abstract rules in a two-way process with the compliance authority[11]. Whilst the kind of computer simulations are not very good at predicting what will happen, they are good at revealing the possible risks of any choice.

4. Conclusion

Social simulation models have a crucial role to play in understanding the possibilities inherent in complex social systems, including those with legal aspects to them. Without modelling how complexes of social mechanisms can play out within society, we will be limited to "broad brush" reasoning concerning the various social "pressures" people are under – which does not work when there are complex mixes of countervailing pressures, and the use of discursive analogies which necessarily miss out the detail of social interaction and hence any emergent social phenomena. Just as in cell biochemistry *in vitro* experiments can help tease apart some of the complex interactions. These do not replace *in vivo* studies in any way but rather complement them, suggesting possibilities that subsequent empirical studies can investigate and producing precise but complicated models of the existing evidence.

[11] B. Burgemeestre, J. Hulstijn, Y.H. Tan, *Rule-based versus Principle-based Regulatory Compliance*, in Governatori G. (ed.), "Proceedings of the JURIX 2009, 22nd Annual Conference on Legal Knowledge and Information Systems", Amsterdam, IOS Press, 2009, pp. 37-46; B. Burgemeestre, J. Hulstijn, Y.H. Tan, *Norm Emergence in Regulatory Compliance*, in Xenitidou M., Edmonds B. (eds.), "The Dynamic View of Norms", Cambridge Univeristy Press, forthcoming.