Abstract

Science is the result of a substantially social process. That is, science relies on many inter-personal processes, including: selection and communication of research findings, discussion of method, checking and judgement of others' research, development of norms of scientific behaviour, organisation of the application of specialist skills/tools, and the organisation of each field (e.g. allocation of funding). An isolated individual, however clever and well resourced, would not produce science as we know it today. Furthermore, science is full of the social phenomena that are observed elsewhere: fashions, concern with status and reputation, group-identification, collective judgements, social norms, competitive and defensive actions, to name a few. Science is centrally important to most societies in the world, not only in technical, military and economic ways, but also in the cultural impacts it has, providing ways of thinking about ourselves, our society and our environment. If we believe the following: simulation is a useful tool for understanding social phenomena, science is substantially a social phenomenon, and it is important to understand how science operates, then it follows that we should be attempting to build simulation models of the social aspects of science. This Special Section of JASSS presents a collection of position papers by philosophers, sociologists and others describing the features and issues the authors would like to see in social simulations of the many processes and aspects that we lump together as "science". It is intended that this collection will inform and motivate substantial simulation work as described in the last section of this introduction.

Keywords:
Simulation, Science, Science and Technology Studies, Philosophy, Sociology, Social Processes

Aim of the collection

1.1 The authors were invited to write position papers outlining what a simulation of the social processes of science should be like. This invitation was open to all viewpoints on the efficacy and nature of science. We sought to by-pass the debates on whether science is a special and/or uniquely effective social phenomenon. Rather, we simply wish to try and understand what happens in these processes. We did not expect agreement on the nature of science since it is a highly complex phenomenon, which includes a great variety of processes. However we did ask the authors to focus upon areas where they think simulation can contribute to our understanding rather than continuing the wider debate on the nature of science. Thus the purpose (though not necessarily the orientation) of this collection is pragmatic - to motivate the building of simulations of these social processes in science, in particular agent-based simulations. If this collection helps to stimulate the building of some new agent-based simulations of some aspects of science, it will have achieved its purpose.

Previous work

2.1 Previous models of science have often started from a desire to explain the 'stylised facts' about the growth of science that were noted in the last century. Lotka (1926) showed that the numbers of papers per author followed a power-law or scale-
3.4 

On the macro side there is a growing request for mathematical models of science to infer initial and boundary conditions of...
The contributions

4.1 Answering the call for position papers, the following sixteen contributions (in alphabetical order) were submitted:

- To assist scientific discourse, Ahrweiler opts for a combined language- and behaviour-based framework for modelling theory networks in science, which looks at theories as competing and cooperating agents working on

- Luna De Ferrari, Stuart Aitken, Jano van Hemert, and Igor Goryanin at the Computational Systems Biology group at the Centre for Systems Biology at Edinburgh (De Ferrari et al., 2009)
- Francisco Grimaldo, Mario Paolucci, and Rosaria Conte at LABS/ISTC at CNR Rome (e.g. Grimaldo et al., 2011)
- Giangiacomo Bravo (Torino, Italy), Flaminio Squazzoni (Brescia, Italy), Károly Takács (Corvinus University of Budapest, Hungary)
- Andre Martins (São Paulo, Brazil) (Martins, 2010)
- Nicolas Payette (Département de philosophie, Université du Québec à Montréal) who is developing a simulation based on Hull (1988) (e.g. Payette, 2011)
- Ron Sun (Rensselaer Polytechnic Institute, NY) and Isaac Naveh (University of Missouri, USA) (e.g. Sun and Naveh, 2009)
- Nigel Gilbert (University of Surrey), Andreas Pyka (University of Hohenheim), and Petra Ahrweiler (University College Dublin) (e.g. Pyka, Gilbert and Ahrweiler, 2007)
- Christopher Watts and Nigel Gilbert at the University of Surrey (e.g. Watts and Gilbert, Scientometrics, forthcoming)
- Paul Thagard and his team at Computational Epistemology Laboratory, University of Waterloo, who are extending their ECHO model of scientific inference to incorporate social aspects (following Thagard, 1993, 2000)
- Petra Ahrweiler (University College Dublin) and Tyll Krueger (University of Bielefeld) who work on a project called "Semantic Landscapes" to model the language- and context-based features of science (http://abs-diffusion.univie.ac.at/program/).
scientific domains.

- **Balzer and Manhart** emphasise the difference between scientific processes and processes in science, and explain how the incorporation of scientific theories in social simulations could lead to more united structural approaches.
- **Barreteau and Le Page** outline the complex dynamics, especially micro dynamics, involved in participatory research methodologies, and show how social simulation can help to address these issues.
- **Chattoe-Brown** identifies two challenges for simulating science: firstly to develop a “dynamic concept network” representation of scientific knowledge on which learning systems intended to model the scientific process can be compared; and secondly to develop an effective approach to providing data for a simulation of the scientific process.
- **Collins** starts from the demarcation problem, asking what science actually is, which leads to a range of difficulties for simulation, and puts forward three recommendations about how to deal with the issue.
- **Doran** suggests a generic long-term science model where science is a set of processes by which a community of individuals uses reliable methods to obtain reliable understanding (scientific knowledge) of itself and its environment over time.
- **Edmonds** surveys the observations and conclusions of some philosophers of science that might be relevant to a social simulation of science, observing that philosophers of science have not focussed much on the dynamic, social and complex aspects of science, which illustrates the need for simulations.
- **Meyer** addresses the question of how to design good social simulation models of science building on stylised facts of science derived from bibliometric studies.
- **Mölders, Fink and Weyer** combine a Luhmannian systems perspective with a model of decision making of individual actors embedded in a socio-political context (“new public management of science”) to reconstruct and analyse how the science system works.
- **Parinov and Neylon** discuss how virtual research environments influence the social processes of science and how, building on social simulation insights, these systems could be designed to be more efficient and effective in supporting scientific communities.
- **Payette** conceptualises an agent-based model of the social processes of science that contains researchers who are organised in heterogeneous networks and who work on different domains communicating directly or through publications.
- **Squazzoni and Takács** argue for social simulation of the scientific peer review system, which is under increasing strain due to exploding demand, is under-investigated compared to its importance, and is in need of revision and innovation itself.
- **Thorngate, Liu and Chowdhury** apply a fundamental observation to the science field, namely that psychological factors such as competition for attention influence the social processes involved in the evolution of science such as the review process for journal papers.
- **Yilmaz** addresses general issues of workforce dynamics and applies them to science introducing various models while asking what produces successful scientists, and what identifies areas for additional research.
- **Zollman** points out that it is unknown how the imperfections of individual researchers impact upon the overall efficacy of science. He poses five key questions that have real and substantial bearing on the management and understanding of science, each of which could be the goal of a modelling programme.

**Next steps**

5.1 The aim of this collection of position papers is to motivate and challenge those in the social simulation community to attempt simulation models of the social aspects of science. The issues raised and the directions indicated in these papers should help inform and guide these attempts. We hope that any models developed in response will:

- Bridge the micro-macro gap in some way, that is establish explanations that link macro level outcomes from the micro level behaviour of individuals, and vice versa
- Be motivated in terms of their conception and design with respect to this collection of papers
- Include some indication of how and in what way they might be checked and/or validated.

5.2 After a suitable time, we (the authors of this introduction) will organise a workshop for the discussion of papers that respond to this collection. Responses which present credible simulations will be centre stage at this event, but others will also be involved. The idea is that it should be a forum to present and discuss these simulations in an extended manner, and thus motivate the production of more and better simulations in the future. We hope to eventually publish a set of papers that describe these.
Thus we call for contributions to this project from all fields, but especially those in social simulation and science studies, and look forward to the workshop in 1 to 2 years time.

Notes


References


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scientific behaviour, organisation of the application of specialist skills/tools, and the organisation of each field (e.g. allocation of funding). An isolated individual, however clever and well resourced, would not produce science as we know it today. Furthermore, science is full of the social phenomena that are observed elsewhere. The workshop will discuss simulation modeling of the inter-scientist processes that contribute to the discovery, organization and verification of scientific knowledge. The focus is upon the development of simulations themselves, including models of: peer review, academic field self-organisation, citation networks, innovation, scientific reputation, funding allocation, cognitive models embedded in a social setting, argumentation and social reasoning. Registration for the workshop is open: click here!