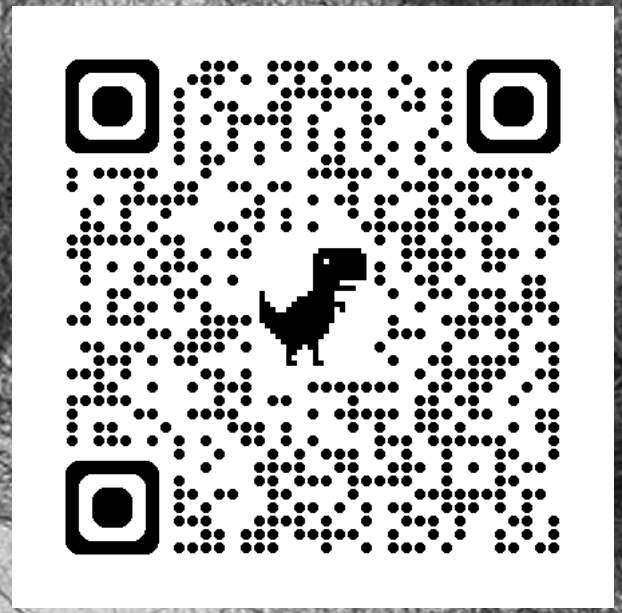
What Are Complex Systems?

Ontology, Epistemology and the Social Turn





I would like to propose a question relative to the study of complex social systems and social complexity.



What would the complexity sciences look like if we fully engaged with the longstanding contributions of the social sciences, humanities, philosophy and arts, alongside those of the natural, mathematical and computational sciences?

Could we create a proper arts and sciences of complexity?

This is one possible future.

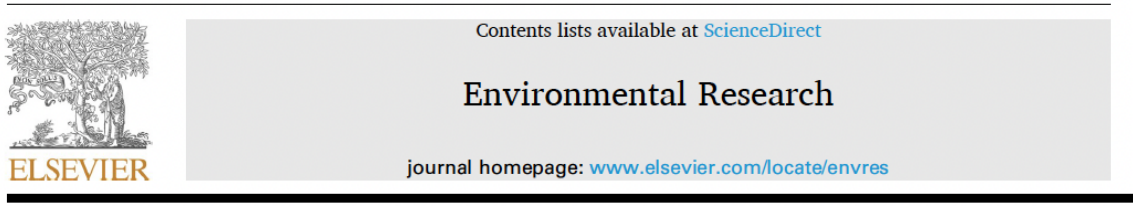
Why do we want to do this?

Thirteen Conditions

- The complexity sciences have significant limitations when studying social reality due, in part, to insufficient engagement with the social sciences and humanities.

Situation	Characteristics
1. No philosophy of complexity	Few attempts to define an epistemology and ontology for social complexity
2. A failure to engage the wider social sciences	Assumption that the social sciences can be ignored because the complexity sciences would offer superior insights
3. Reinventing the wheel	Reinventing existing insights from the social sciences that are then presented as new insights
4. Old words, new words	Rebranding existing insights using terms from the complexity sciences
5. Obscurantism and mystification	Scientific overreach and complicated jargon combine to suggest that life's biggest questions are uncovered
6. Forgetting multilevel thinking and modelling	Despite the transdisciplinary approach of social complexity, almost all research focuses on a single level of analysis.
7. Technique in the absence of theory	Focus on computational methods and big data pushes social theory out of sight
8. Learning tools vs. predictive machines	The ability to learn from simulations is replaced by a desire to predict and control social complexity
9. Minor role of qualitative research	Dominance of quantitative research and quantification of data established a blind spot for qualitative data and methods
10. Methodological closing of social scientific mind	Shying away from advances in computational methods sees many social scientists becoming illiterate with such methods
11. The dire sound of technicalities	Going into a spiral of ever-smaller technical refinement while losing the bigger picture out of sight.
12. Being tone-deaf about the real world	Advanced analyses are coupled to crude recommendations that fail to appreciate the complexity in the target domain
13. Practice does not make perfect	Pragmatic and rushed adoption of the complexity sciences by practitioners constitutes verbal detritus

Table 1: Overview of the thirteen situations.


Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Review article

Mitigating the impact of air pollution on dementia and brain health: Setting the policy agenda

Brian Castellani [a,b,c,e,*] Suzanne Bartington [d]
Jonathan Wistow [e,c], Neil Heckels [f],
ve R. Arnold [i], Pete Barbrook-Johnson [j,b],
s [l,m], Charlotte L. Clarke [e,n], Monica Pirani [o],
hel Turnbull [q], Nigel Gilbert [b], Stefan Reis [p,r,s]

Allostatic Load as a Complex Clinical Construct: A Case-Based Computational Modeling Approach

J GALEN BUCKWALTER,[1] BRIAN CASTELLANI,[2] BRUCE MCEWEN,
ALBERT A RIZZO,[1] BRUCE JOHN,[1] KYLE O'DONNELL,[1] AN
[1]Institute for Creative Technologies, University of Southern Californi
[2]Department of Sociology, Kent State University, Ohio 44240; [3]Labo
Rockefeller University, New York, New York 10065; and [4]Division of
Medicine, University of California, Los Angeles, CA

Received 27 August 2015; revised 20 November 2015; accepted



Justified Stories with Agent-Based Modelling for Local COVID-19 Planning

Jennifer Badham[1], Pete Barbrook-Johnson[2,4], Camila Caiado[3], Brian Castellani[1]

[1]Department of Sociology, Durham University, 29-32 Old Elvet, Durham DH1 3HN, United Kingdom
[2]Centre for Research in Social Simulation, Department of Sociology, Universit
Guildford GU2 7XH, United Kingdom
[3]Department of Mathematical Sciences, Durham University, Upper Mountjoy
Stockton Road, Durham DH1 3LE, United Kingdom
[4]Institute for New Economic Thinking, University of Oxford, Manor Road, Oxfo

arch@criticalconnections.com
ation 24(1) 8, 2021
surrey.ac.uk/24/1/8.html
21 Published: 31-01-2021

The Centre for the Evaluation of Complexity Across the Nexus

My work with policymakers and public stakeholders on extreme heat, air pollution, urban sustainability, inequality and just transitions highlights the need for deeper engagement with the social sciences and humanities to inform effective policy and practice.

Transforming Extreme Heat into Opportunity: A Systems Resilience Framework for Health and Energy in the UK and Japan

Nadzirah Ikasari Syamsul[1,7] Ho Thanh Tam[2], Brian Castellani[3], , Colin Manning[4], Cathrene Lagare[5], Richard Oduro[6], Xuoesng Wei[1] , Saiful Mangngenre[7], Takafumi Maeda[1]

ewcastle University, [5]Tohoku
ersity
yushu-u.ac.jp

Introduction

Policy evaluation for a complex world: Practical methods and reflections from the UK Centre for the Evaluation of Complexity across the Nexus

Evaluation
2021, Vol. 27(1) 4–17
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DOI: 10.1177/1356389020976491
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SAGE

- **Reinventing the wheel:** Parts of the complexity sciences present computational reformulations of established social scientific insights as new theoretical advances.

- **Social physics:** Some mathematical approaches remain insufficiently sociological, overlooking institutions, meaning and social relations.

- **Power, inequality and discrimination:** Too much complexity research neglects how structural inequalities, discrimination and hierarchies of power shape emergence, self-organisation and social change.

- **Cross-domain explanations:** Mechanisms from physical and biological systems are sometimes transferred to social systems without sufficient theoretical or empirical justification.

- **Technique without theory:** Computational sophistication and big-data analysis sometimes take precedence over substantive social theory and explanation.



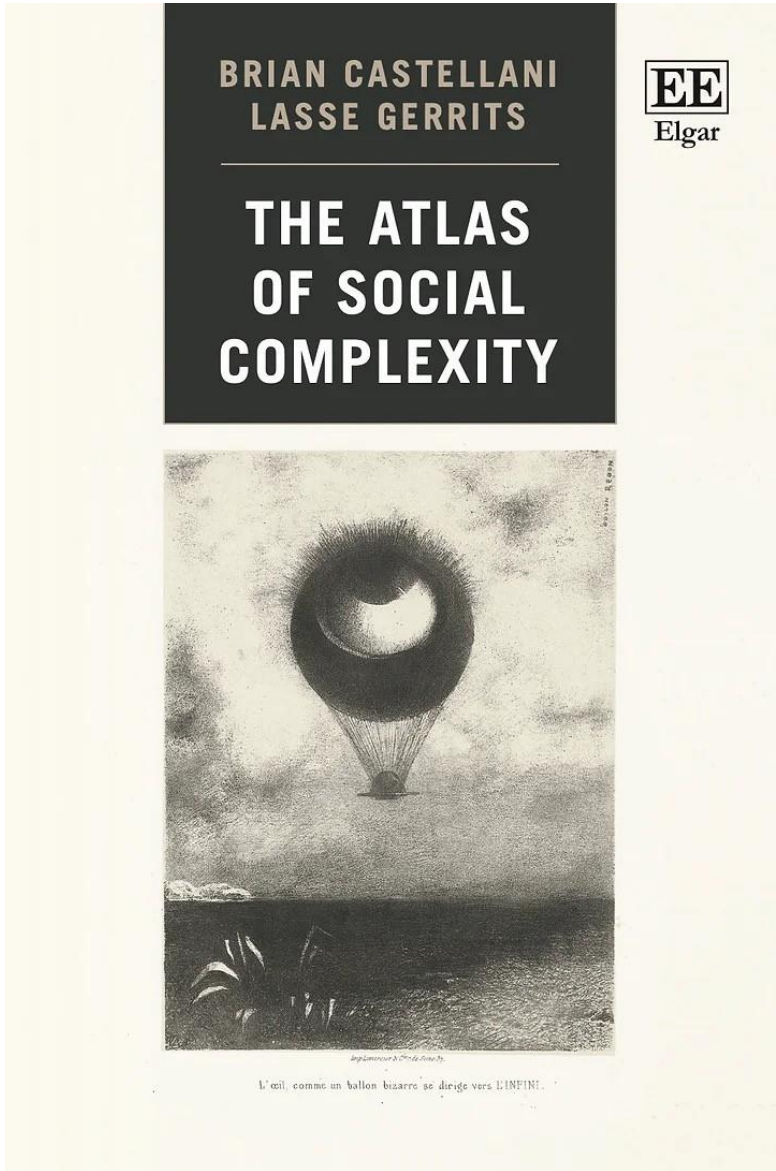
- **Neglecting psychology:** Significant areas of the complexity sciences give insufficient attention to emotion, irrationality, unconscious processes and collective psychology.

- **Misrepresenting social reality:** These limitations can produce explanations and models that fundamentally misrepresent how social systems are organised, maintained and transformed.

- **Consequences for policy and practice:** Such misrepresentations can lead to serious problems when complexity research informs policy decisions, interventions and institutional practice.

- **Intellectual hegemony:** The dominance of particular theories, methods and disciplinary traditions within the complexity sciences can marginalise alternative perspectives and make substantive disagreements difficult to recognise or address.





Biographical Summary

Brian Castellani (PhD, FAcSS) is Professor and Director of the *Durham Research Methods Centre* and *Wolfson Research Institute for Health and Wellbeing*, Durham University (UK). He is also adjunct professor of psychiatry, Northeastern Ohio Medical University (USA).

Lasse Gerrits (Dr.Dr.) is Professor and Academic Director, *Institute for Housing and Urban Development Studies*, Erasmus University Rotterdam

Durham University

ERASMUS UNIVERSITEIT ROTTERDAM



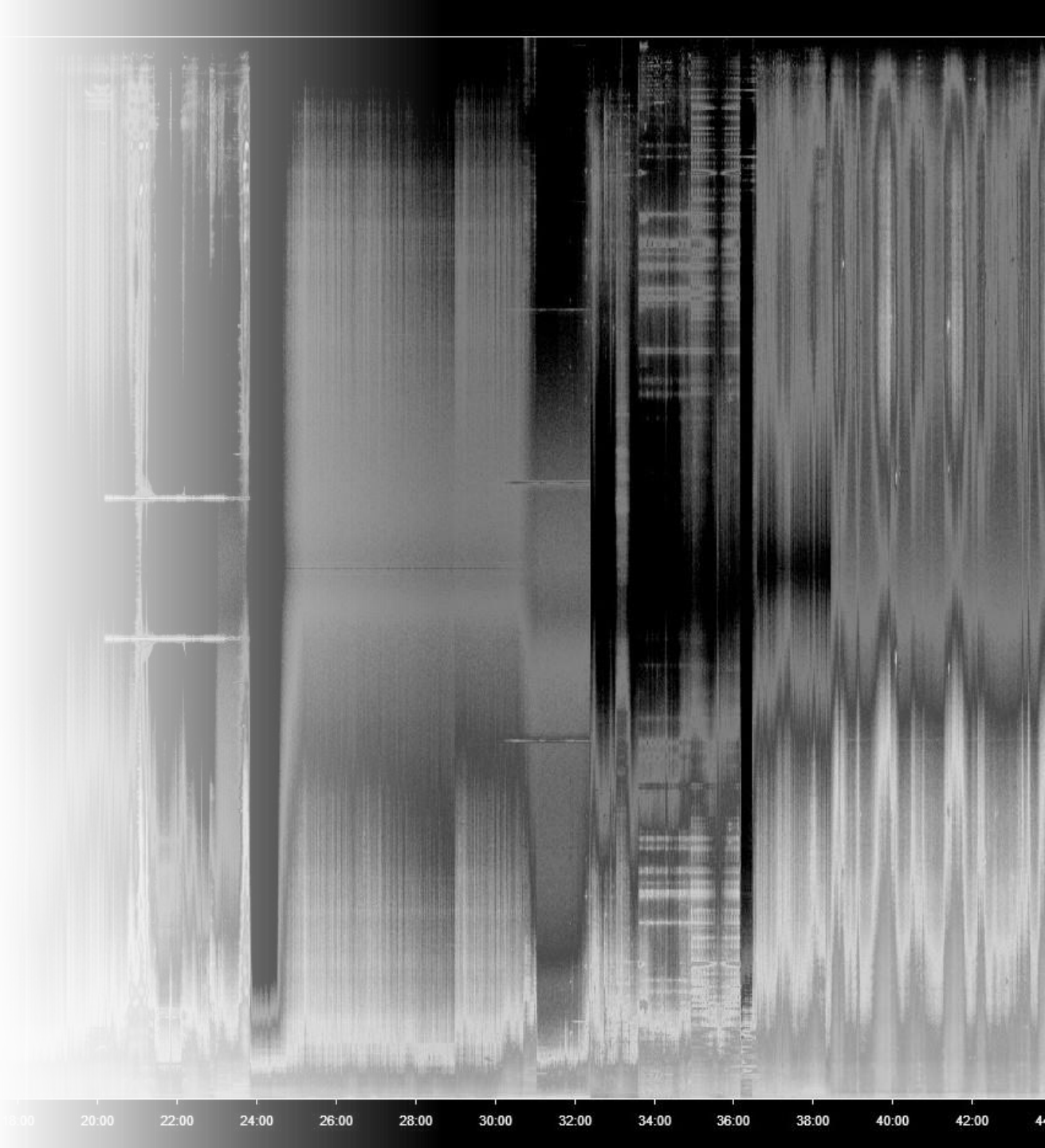
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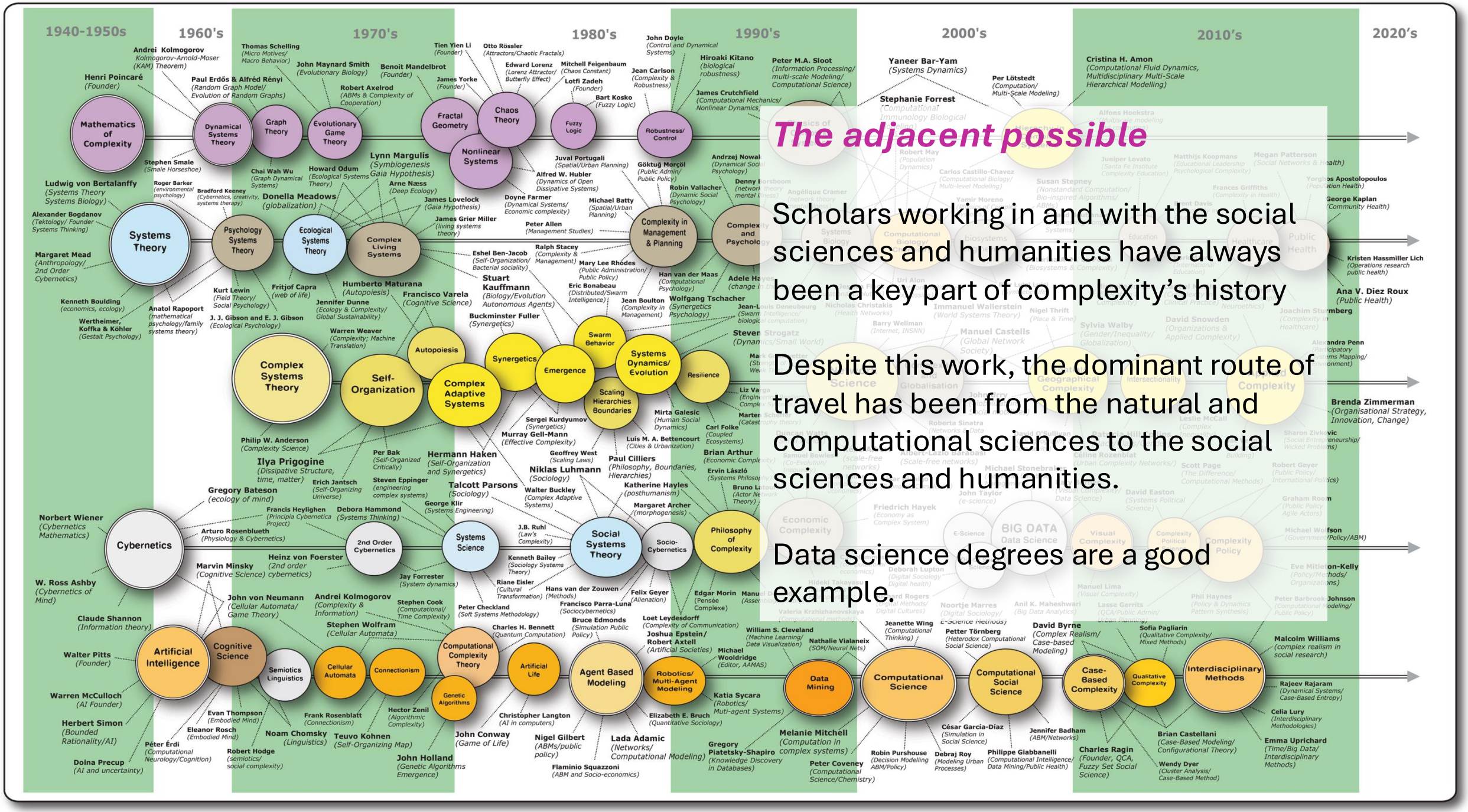
The following people were interviewed for this Atlas (in order of the interviews; some people were interviewed twice):

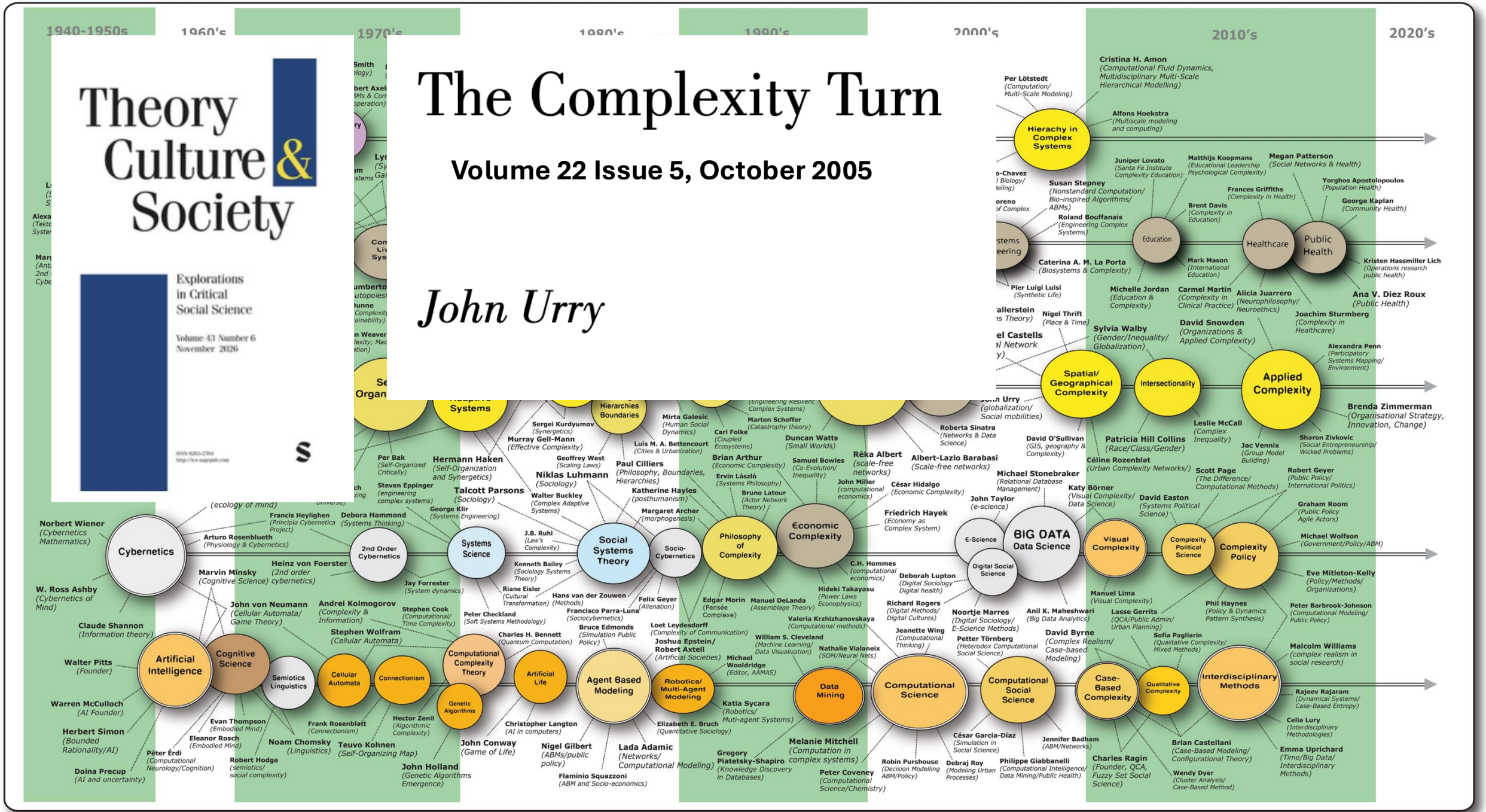
Göktuğ Morçöl	Penn State Harrisburg (United States of America)
David Byrne	Durham University (United Kingdom)
Roland Kupers	Institute for Advanced Study (the Netherlands)
Peter Sloot	Institute for Advanced Study (the Netherlands)
Thomas Weber	Technical University Lisbon (Portugal)
David Snowdon	Cynefin (United Kingdom)
Andreas Duit	University of Stockholm (Sweden)
Luca Bertolini	University of Amsterdam (the Netherlands)
Mary Lee Rhodes	Trinity College (Ireland)
Kiki Ogawa	HyperGroove (United Kingdom)
Zeno van den Broek	Independent artist (the Netherlands)
Orion Maxted	Institute for Advanced Study (the Netherlands)
Petter Törnberg	University of Amsterdam (the Netherlands)
Coyan Tromp	Institute for Interdisciplinary Studies (the Netherlands)
Karien Stronks	Amsterdam University Medical Centers
Eelke Heemskerk	University of Amsterdam (the Netherlands)
Jeroen Bruggeman	University of Amsterdam (the Netherlands)
Federica Russo	University of Amsterdam (the Netherlands)
Debraj Roy	University of Twente (the Netherlands)
Roland Kupers	Institute for Advanced Study (the Netherlands)
Andreas Flache	Rijksuniversiteit Groningen (the Netherlands)
Han van der Maas	University of Amsterdam (the Netherlands)
Noortje Marres	University of Warwick (United Kingdom)
Fjalar J. De Haan	Deakin University Melbourne (Australia)
Sofia Pagliarin	Otto-Friedrich University Bamberg (Germany)
Jeroen van den Bergh	Universitat Autònoma de Barcelona (Spain)
Michael Batty	The Bartlett at University College London (United Kingdom)
Henk Wagenaar	Institute for Advanced Studies Vienna (Austria)
Sharon Zivkovic	Wicked Labs (Australia)
Orion Maxted	Institute for Advanced Study (the Netherlands)
Kiki Ogawa	HyperGroove (United Kingdom)
Petra Meier	University of Glasgow (United Kingdom)
Malcolm Williams	Cardiff University (United Kingdom)
Wolfgang Tschacher	University of Bern (Switzerland)
César García-Díaz	Pontificia Universidad Javeriana (Colombia)
Denny Borsboom	University of Amsterdam (the Netherlands)
Esmee Geerken	Institute for Advanced Study (the Netherlands)
Etienne Rouwette	Radboud University Nijmegen (the Netherlands)
Beatriz Calzada Olvera	Institute for Housing and Urban Development Studies (the Netherlands)
Michael Roos	University of Bochum (Germany)

Quick timeline

- 1900s and back – initial systems thinking
- 1940s - Emergence of systems science
- 1980s – Santa Fe Institute
  - Waldrop's Complexity
- 1990s – Complexity turn in social sciences
  - Urry special issue in Theory, Culture, Society
- 2020s – ***Social turn*** *in complexity*




1940-1950s
1960's
1970's
1980's
1990's
2000's
2010's
2020's
Mathematics of Complexity
Dynamical Systems Theory
Graph Theory
Evolutionary Game Theory
Fractal Geometry
Chaos Theory
Nonlinear Systems
Fuzzy Logic
Robustness/ Control
Systems Theory
Psychology Systems Theory
Ecological Systems Theory
Complex Living Systems
Complexity in Management & Planning
Complex Systems Theory
Self-Organization
Autopoiesis
Complex Adaptive Systems
Synergetics
Emergence
Swarm Behavior
Systems Dynamics/ Evolution
Scaling Hierarchies Boundaries
Resilience
Cybernetics
2nd Order Cybernetics
Systems Science
Social Systems Theory
Socio-Cybernetics
Philosophy of Complexity
Artificial Intelligence
Cognitive Science
Semiotics Linguistics
Cellular Automata
Connectionism
Computational Complexity Theory
Artificial Life
Genetic Algorithms
Agent Based Modeling
Robotics/ Multi-Agent Modeling
Data Mining
Computational Science
Computational Social Science
Case-Based Complexity
Qualitative Complexity
Interdisciplinary Methods
Henri Poincaré (Founder)
Andrei Kolmogorov Kolmogorov-Arnold-Moser (KAM) Theorem)
Paul Erdős & Alfréd Rényi (Random Graph Model/ Evolution of Random Graphs)
Thomas Schelling (Micro Motives/ Macro Behavior)
John Maynard Smith (Evolutionary Biology)
Benoit Mandelbrot (Founder)
Robert Axelrod (ABMs & Complexity of Cooperation)
Tien Yien Li (Founder)
James Yorke (Founder)
Otto Rössler (Attractors/Chaotic Fractals)
Edward Lorenz (Lorenz Attractor/ Butterfly Effect)
Mitchell Feigenbaum (Chaos Constant)
Lotfi Zadeh (Founder)
Bart Kosko (Fuzzy Logic)
John Doyle (Control and Dynamical Systems)
Jean Carlson (Complexity & Robustness)
James Crutchfield (Computational Mechanics/ Nonlinear Dynamics)
Hiroaki Kitano (biological robustness)
Peter M.A. Sloot (Information Processing/ multi-scale Modeling/ Computational Science)
Yaneer Bar-Yam (Systems Dynamics)
Per Lötstedt (Computation/ Multi-Scale Modeling)
Stephanie Forrest (Computational Immunology Biological
Cristina H. Amon (Computational Fluid Dynamics, Multidisciplinary Multi-Scale Hierarchical Modelling)
Stephen Smale (Smale Horseshoe)
Chai Wah Wu (Graph Dynamical Systems)
Howard Odum (Ecological Systems Theory)
Lynn Margulis (Symbiogenesis Gaia Hypothesis)
Arne Næss (Deep Ecology)
Juval Portugali (Spatial/Urban Planning)
Alfred W. Hubler (Dynamics of Open Dissipative Systems)
Göktuğ Morçöl (Public Admin/ Public Policy)
Robin Vallacher (Dynamic Social Psychology)
Andrzej Nowak (Dynamical Social Psychology)
Ludwig von Bertalanffy (Systems Theory Systems Biology)
Roger Barker (environmental psychology)
Bradford Keeney (Cybernetics, creativity, systems therapy)
Donella Meadows (globalization)
James Lovelock (Gaia Hypothesis)
James Grier Miller (living systems theory)
Doyne Farmer (Dynamical Systems/ Economic complexity)
Michael Batty (Spatial/Urban Planning)
Peter Allen (Management Studies)
Alexander Bogdanov (Tektology/ Founder Systems Thinking)
Margaret Mead (Anthropology/ 2nd Order Cybernetics)
Kenneth Boulding (economics, ecology)
Wertheimer, Koffka & Köhler (Gestalt Psychology)
Anatol Rapoport (mathematical psychology/family systems theory)
Kurt Lewin (Field Theory/ Social Psychology)
J. J. Gibson and E. J. Gibson (Ecological Psychology)
Fritjof Capra (web of life)
Jennifer Dunne (Ecology & Complexity/ Global Sustainability)
Humberto Maturana (Autopoiesis)
Francisco Varela (Cognitive Science)
Warren Weaver (Complexity; Machine Translation)
Eshel Ben-Jacob (Self-Organization/ Bacterial sociality)
Stuart Kauffmann (Biology/Evolution Autonomous Agents)
Buckminster Fuller (Synergetics)
Ralph Stacey (Complexity & Management)
Mary Lee Rhodes (Public Administration/ Public Policy)
Eric Bonabeau (Distributed/Swarm Intelligence)
Jean Boulton (Complexity in Management)
Han van der Maas (Computational Psychology)
Wolfgang Tschacher (Synergetics Psychology)
Adele Ha
Steven Strogatz (Dynamics/Small World)
Immanuel Wallerstein (World Systems Theory)
Manuel Castells (Global Network Society)
Nigel Thrift (Place & Time)
Sylvia Walby (Gender/Inequality/ Globalization)
David Snowden (Organizations & Applied Complexity)
Barry Wellman (Internet, INSNN)
Nicholas Christakis (Health Networks)
Uri Alon
Mirta Galesic (Human Social Dynamics)
Carl Folke (Coupled Ecosystems)
Luis M. A. Bettencourt (Cities & Urbanization)
Sergei Kurdyumov (Synergetics)
Murray Gell-Mann (Effective Complexity)
Geoffrey West (Scaling Laws)
Paul Cilliers (Philosophy, Boundaries, Hierarchies)
Brian Arthur (Economic Complexity)
Ervin László (Systems Philosophy)
Philip W. Anderson (Complexity Science)
Ilya Prigogine (Dissipative Structure, time, matter)
Per Bak (Self-Organized Criticality)
Hermann Haken (Self-Organization and Synergetics)
Niklas Luhmann (Sociology)
Katherine Hayles (posthumanism)
Margaret Archer (morphogenesis)
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Felix Geyer (Alienation)
Edgar Morin (Pensée Complexe)
Loet Leydesdorff (Complexity of Communication)
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Elizabeth E. Bruch (Quantitative Sociology)
Lada Adamic (Networks/ Computational Modeling)
Nigel Gilbert (ABMs/public policy)
Flaminio Squazzoni (ABM and Socio-economics)
John Conway (Game of Life)
Christopher Langton (AI in computers)
John Holland (Genetic Algorithms Emergence)
Stephen Wolfram (Cellular Automata)
Andrei Kolmogorov (Complexity & Information)
John von Neumann (Cellular Automata/ Game Theory)
Stephen Cook (Computational/ Time Complexity)
Charles H. Bennett (Quantum Computation)
Claude Shannon (Information theory)
W. Ross Ashby (Cybernetics of Mind)
Walter Pitts (Founder)
Warren McCulloch (AI Founder)
Herbert Simon (Bounded Rationality/AI)
Doina Precup (AI and uncertainty)
Péter Érdi (Computational Neurology/Cognition)
Evan Thompson (Embodied Mind)
Eleanor Rosch (Embodied Mind)
Robert Hodge (semiotics/ social complexity)
Noam Chomsky (Linguistics)
Frank Rosenblatt (Connectionism)
Hector Zenil (Algorithmic Complexity)
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Gregory Piatetsky-Shapiro (Knowledge Discovery in Databases)
Melanie Mitchell (Computation in complex systems)
Peter Coveney (Computational Science/Chemistry)
Nathalie Vialaneix (SOM/Neural Nets)
William S. Cleveland (Machine Learning/ Data Visualization)
Jeanette Wing (Computational Thinking)
Petter Törnberg (Heterodox Computational Social Science)
César García-Díaz (Simulation in Social Science)
Debraj Roy (Modeling Urban Processes)
Robin Purshouse (Decision Modelling ABM/Policy)
Philippe Giabbanelli (Computational Intelligence/ Data Mining/Public Health)
Jennifer Badham (ABM/Networks)
David Byrne (Complex Realism/ Case-based Modeling)
Charles Ragin (Founder, QCA, Fuzzy Set Social Science)
Sofia Pagliarin (Qualitative Complexity/ Mixed Methods)
Brian Castellani (Case-Based Modeling/ Configurational Theory)
Wendy Dyer (Cluster Analysis/ Case-Based Method)
Malcolm Williams (complex realism in social research)
Rajeev Rajaram (Dynamical Systems/ Case-Based Entropy)
Celia Lury (Interdisciplinary Methodologies)
Emma Uprichard (Time/Big Data/ Interdisciplinary Methods)
Kristen Hassmiller Lich (Operations research public health)
Ana V. Diez Roux (Public Health)
Brenda Zimmerman (Organisational Strategy, Innovation, Change)
The adjacent possible
Scholars working in and with the social sciences and humanities have always been a key part of complexity's history
Despite this work, the dominant route of travel has been from the natural and computational sciences to the social sciences and humanities.
Data science degrees are a good example.


1940-1950s
1960's
1970's
1980's
1990's
2000's
2010's
2020's
Theory Culture & Society
Explorations in Critical Social Science
Volume 43 Number 6
November 2026
The Complexity Turn
Volume 22 Issue 5, October 2005
John Urry
Cybernetics
Systems Science
2nd Order Cybernetics
Social Systems Theory
Socio-Cybernetics
Philosophy of Complexity
Economic Complexity
BIG DATA Data Science
E-Science
Digital Social Science
Visual Complexity
Complexity Political Science
Complexity Policy
Artificial Intelligence
Cognitive Science
Semiotics Linguistics
Cellular Automata
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Computational Social Science
Case-Based Complexity
Qualitative Complexity
Interdisciplinary Methods
Hierachy in Complex Systems
Education
Healthcare
Public Health
Spatial/ Geographical Complexity
Intersectionality
Applied Complexity
Norbert Wiener (Cybernetics Mathematics)
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Celia Lury (Interdisciplinary Methodologies)
Rajeev Rajaram (Dynamical Systems/ Case-Based Entropy)
Malcolm Williams (complex realism in social research)
Eve Mitleton-Kelly (Policy/Methods/ Organizations)
Peter Barbrook-Johnson (Computational Modeling/ Public Policy)
Michael Wolfson (Government/Policy/ABM)
Graham Room (Public Policy Agile Actors)
Robert Geyer (Public Policy/ International Politics)
Brenda Zimmerman (Organisational Strategy, Innovation, Change)
Sharon Zivkovic (Social Entrepreneurship/ Wicked Problems)
Alexandra Penn (Participatory Systems Mapping/ Environment)
Kristen Hassmiller Lich (Operations research public health)
Ana V. Diez Roux (Public Health)
Joachim Sturmberg (Complexity in Healthcare)
Yorghos Apostolopoulos (Population Health)
George Kaplan (Community Health)
Megan Patterson (Social Networks & Health)
Cristina H. Amon (Computational Fluid Dynamics, Multidisciplinary Multi-Scale Hierarchical Modelling)
Per Lötstedt (Computation/ Multi-Scale Modeling)
Alfons Hoekstra (Multiscale modeling and computing)
Susan Stepney (Nonstandard Computation/ Bio-inspired Algorithms/ ABMs)
Roland Bouffanais (Engineering Complex Systems)
Juniper Lovato (Santa Fe Institute Complexity Education)
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Frances Griffiths (Complexity in Health)
Brent Davis (Complexity in Education)
Caterina A. M. La Porta (Biosystems & Complexity)
Mark Mason (International Education)
Michelle Jordan (Education & Complexity)
Carmel Martin (Complexity in Clinical Practice)
Alicia Juarrero (Neurophilosophy/ Neuroethics)
Pier Luigi Luisi (Synthetic Life)
Nigel Thrift (Place & Time)
David Snowden (Organizations & Applied Complexity)
Sylvia Walby (Gender/Inequality/ Globalization)
John Urry (globalization/ Social mobilities)
Patricia Hill Collins (Race/Class/Gender)
Leslie McCall (Complex Inequality)
Jac Vennix (Group Model Building)
David O'Sullivan (GIS, geography & Complexity)
Céline Rozenblat (Urban Complexity Networks/)
Scott Page (The Difference/ Computational Methods)
David Easton (Systems Political Science)
Michael Stonebraker (Relational Database Management)
John Taylor (e-science)
Katy Börner (Visual Complexity/ Data Science)
Roberta Sinatra (Networks & Data Science)
Albert-Lazlo Barabasi (Scale-free networks)
Réka Albert (scale-free networks)
César Hidalgo (Economic Complexity)
Friedrich Hayek (Economy as Complex System)
Deborah Lupton (Digital Sociology Digital health)
Richard Rogers (Digital Methods/ Digital Cultures)
Noortje Marres (Digital Sociology/ E-Science Methods)
Anil K. Maheshwari (Big Data Analytics)
Petter Törnberg (Heterodox Computational Social Science)
Jeanette Wing (Computational Thinking)
David Byrne (Complex Realism/ Case-based Modeling)
Manuel Lima (Visual Complexity)
Lasse Gerrits (QCA/Public Admin/ Urban Planning)
Phil Haynes (Policy & Dynamics Pattern Synthesis)
Sofia Pagliarin (Qualitative Complexity/ Mixed Methods)
Hideki Takayasu (Power Laws Econophysics)
C.H. Hommes (computational economics)
Valeria Krzhizhanovskaya (Computational methods)
William S. Cleveland (Machine Learning/ Data Visualization)
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Walter Buckley (Complex Adaptive Systems)
Katherine Hayles (posthumanism)
Margaret Archer (morphogenesis)
Geoffrey West (Scaling Laws)
Paul Cilliers (Philosophy, Boundaries, Hierarchies)
Ervin László (Systems Philosophy)
Bruno Latour (Actor Network Theory)
Brian Arthur (Economic Complexity)
Samuel Bowles (Co-Evolution/ Inequality)
John Miller (computational economics)
Sergei Kurdyumov (Synergetics)
Murray Gell-Mann (Effective Complexity)
Luis M. A. Bettencourt (Cities & Urbanization)
Mirta Galesic (Human Social Dynamics)
Carl Folke (Coupled Ecosystems)
Marten Scheffer (Catastrophy theory)
Duncan Watts (Small Worlds)
Andrei Kolmogorov (Complexity & Information)
Stephen Cook (Computational/ Time Complexity)
Stephen Wolfram (Cellular Automata)
John von Neumann (Cellular Automata/ Game Theory)
Claude Shannon (Information theory)
Edgar Morin (Pensée Complexe)
Manuel DeLanda (Assemblage Theory)
Michael Lima (Visual Complexity)
Eve Mitleton-Kelly (Policy/Methods/ Organizations)
Peter Barbrook-Johnson (Computational Modeling/ Public Policy)
Malcolm Williams (complex realism in social research)
Rajeev Rajaram (Dynamical Systems/ Case-Based Entropy)
Celia Lury (Interdisciplinary Methodologies)
Emma Uprichard (Time/Big Data/ Interdisciplinary Methods)
Brian Castellani (Case-Based Modeling/ Configurational Theory)
Wendy Dyer (Cluster Analysis/ Case-Based Method)
Charles Ragin (Founder, QCA, Fuzzy Set Social Science)
Jennifer Badham (ABM/Networks)
Philippe Giabbanelli (Computational Intelligence/ Data Mining/Public Health)
Debraj Roy (Modeling Urban Processes)
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Robin Purshouse (Decision Modelling ABM/Policy)
Peter Coveney (Computational Science/Chemistry)
Gregory Piatetsky-Shapiro (Knowledge Discovery in Databases)
Melanie Mitchell (Computation in complex systems)
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Nigel Gilbert (ABMs/public policy)
Lada Adamic (Networks/ Computational Modeling)
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John Holland (Genetic Algorithms Emergence)
Teuvo Kohnen (Self-Organizing Map)
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Loet Leydesdorff (Complexity of Communication)
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Albert-Lazlo Barabasi (Scale-free networks)
Réka Albert (scale-free networks)
César Hidalgo (Economic Complexity)
Friedrich Hayek (Economy as Complex System)

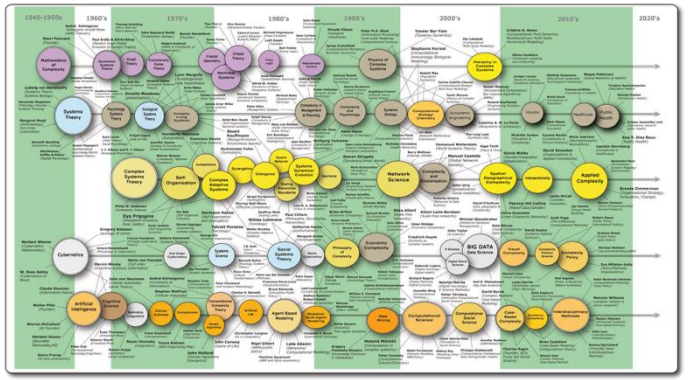
The Increase of Complexity and its Reduction

Emergent Interfaces between the Natural Sciences, Humanities and Social Sciences

Helga Nowotny



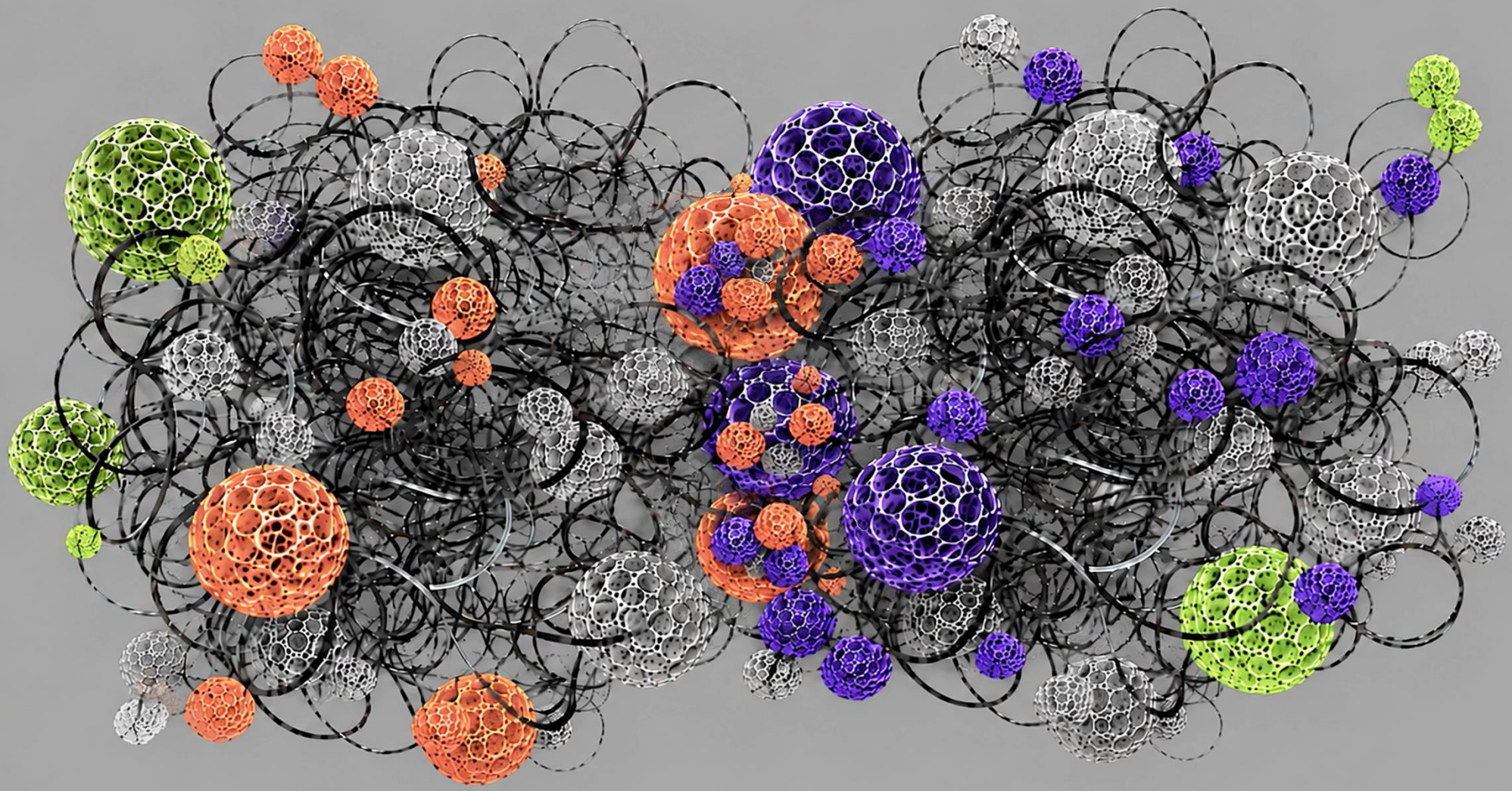




Complexity, Configurations and Cases

David Byrne

But I am NOT a complexity scientist or systems scholar . . .



In the ***Atlas*** we went on a journey to map what people were doing to advance this *social turn* in the complexity and systems sciences.



THEME 2: COGNITION, EMOTION AND CONSCIOUSNESS

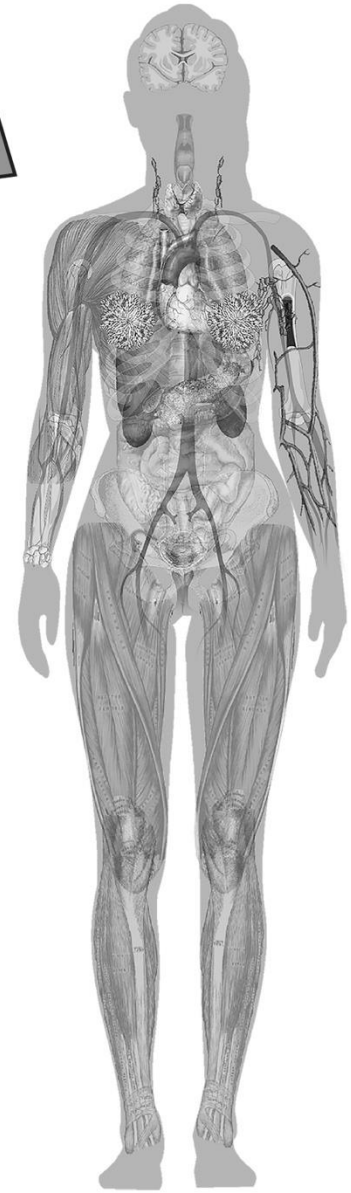
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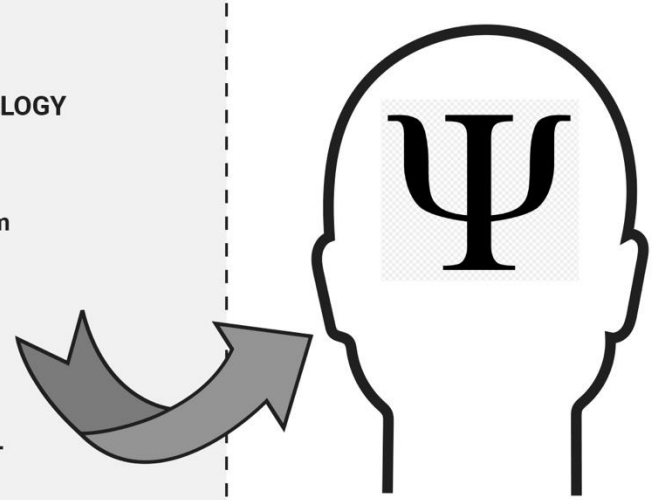
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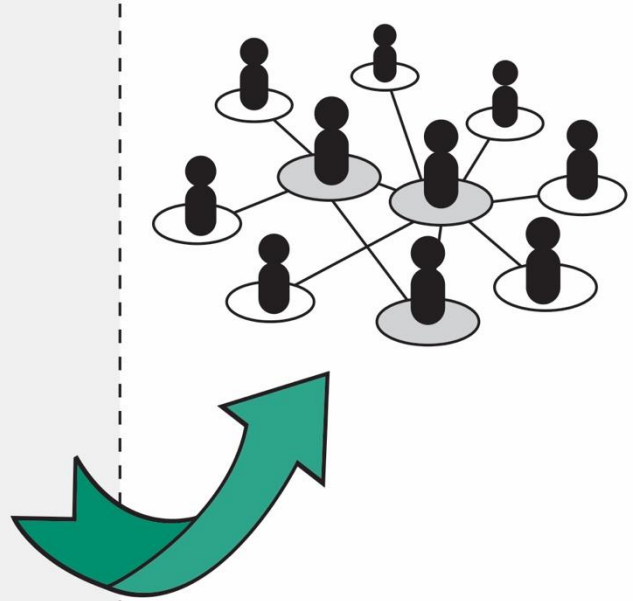
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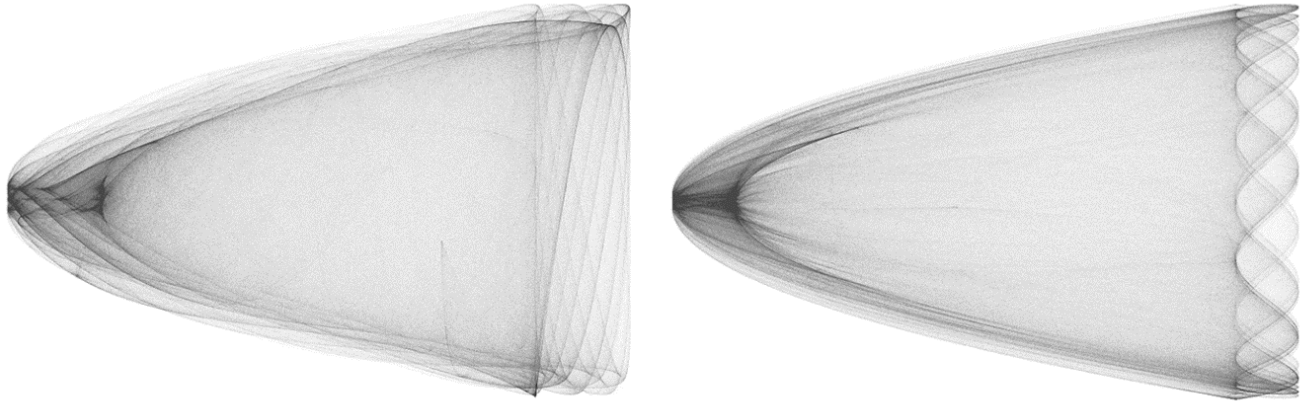
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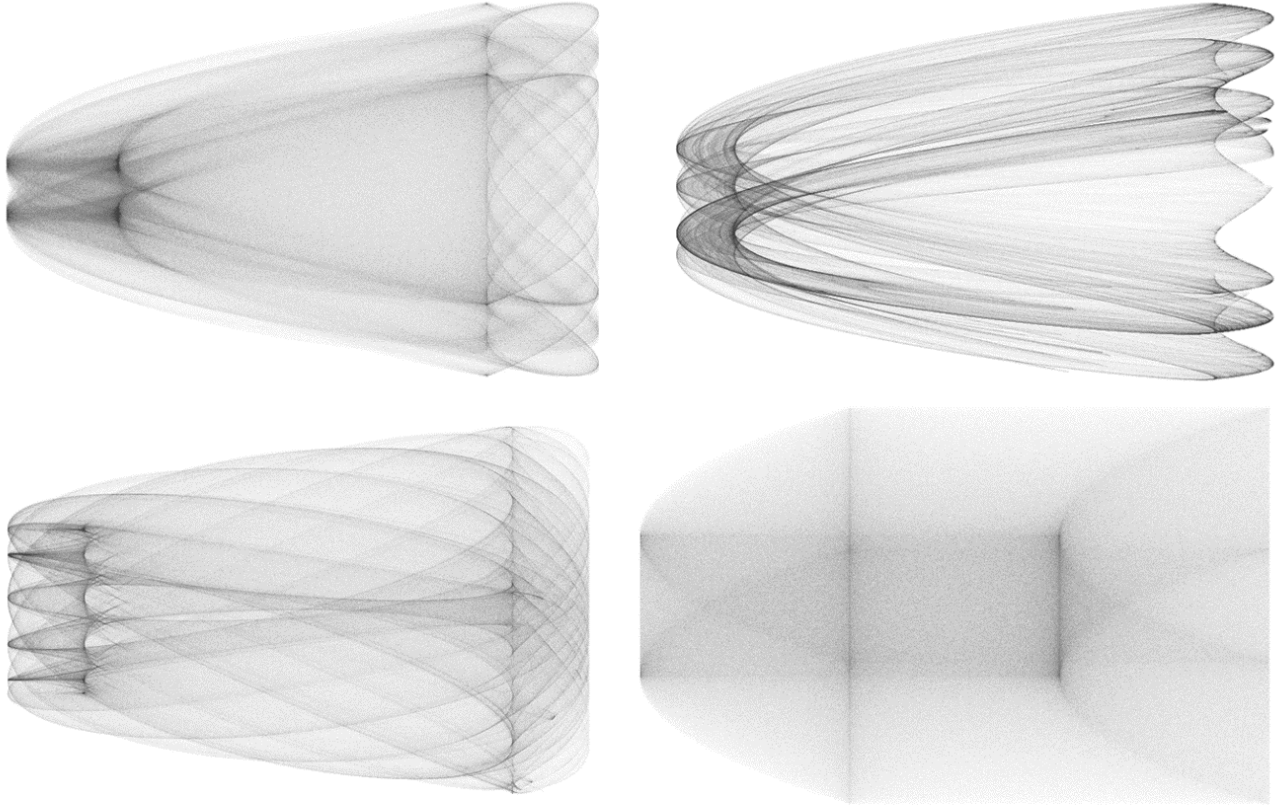
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THEME 5: CHARTING A NEW METHODS TERRITORY



Ontology, epistemology, methodology

- **Where is the qualitative in complexity?**
- **Embracing complex realism**
- **The importance of mixed-methods**
- **Case-based complexity**
  - **Cases, clusters and trajectories**

Complexity

WILEY

SPECIAL ISSUE Social Human Complexity and Global Challenges: Theoretical, Methodological, and Empirical Contributions for Transformative Change

RESEARCH ARTICLE OPEN ACCESS

Imagining a Social Turn in Systems and Complexity Sciences

Jennifer Badham[1] | Corinna Elsenbroich[2] | Dean Thompson[3] | Max French[4] | Jonathan Wistow[1] | Andrea Hurst[5] | Rob Wilson[6] | Patrik Nordin[7] | Alison Heppenstall[8] | Cristina Costa[9] | Jari Autioniemi[7] | Lasse Gerrits[10] | Brian Castellani[1]

[1]Durham Research Methods Centre & Department of Sociology, Durham University, Durham, UK | [2]School of Health and Wellbeing, University of Glasgow, Glasgow, UK | [3]Department of Applied Health Sciences, University of Birmingham, Birmingham, UK | [4]Newcastle Business School, Northumbria University, Newcastle, UK | [5]NRF SARCHI Chair (Identities and Social Cohesion in Africa), Nelson Mandela University, Gqeberha, South Africa | [6]School of Sociology and Criminology, Manchester Metropolitan University, Manchester, UK | [7]School of Management, University of Vaasa, Vaasa, Finland | [8]School of Urban Studies & Social Policy, University of Glasgow, Glasgow, UK | [9]Durham Research Methods Centre & Department of Education, Durham University, Durham, UK | [10]Institute for Housing and Urban Development Studies, Erasmus University Rotterdam, Rotterdam, Netherlands

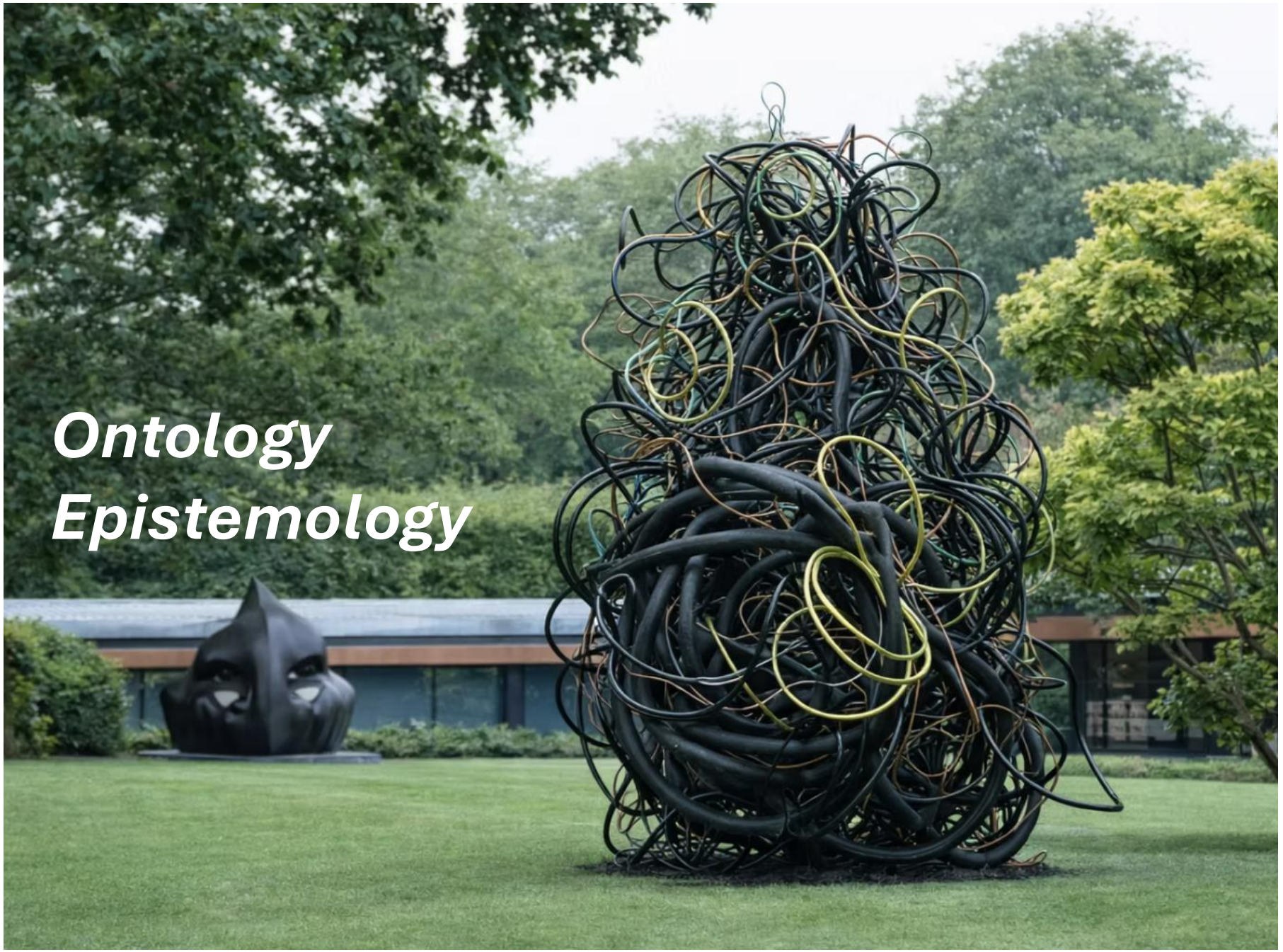
Some Key Insights



Back to the future

First, the ***social turn*** is partly about overcoming the disciplinary boundaries that have marginalised longstanding contributions from philosophy, the social sciences, humanities and arts to understanding complexity.





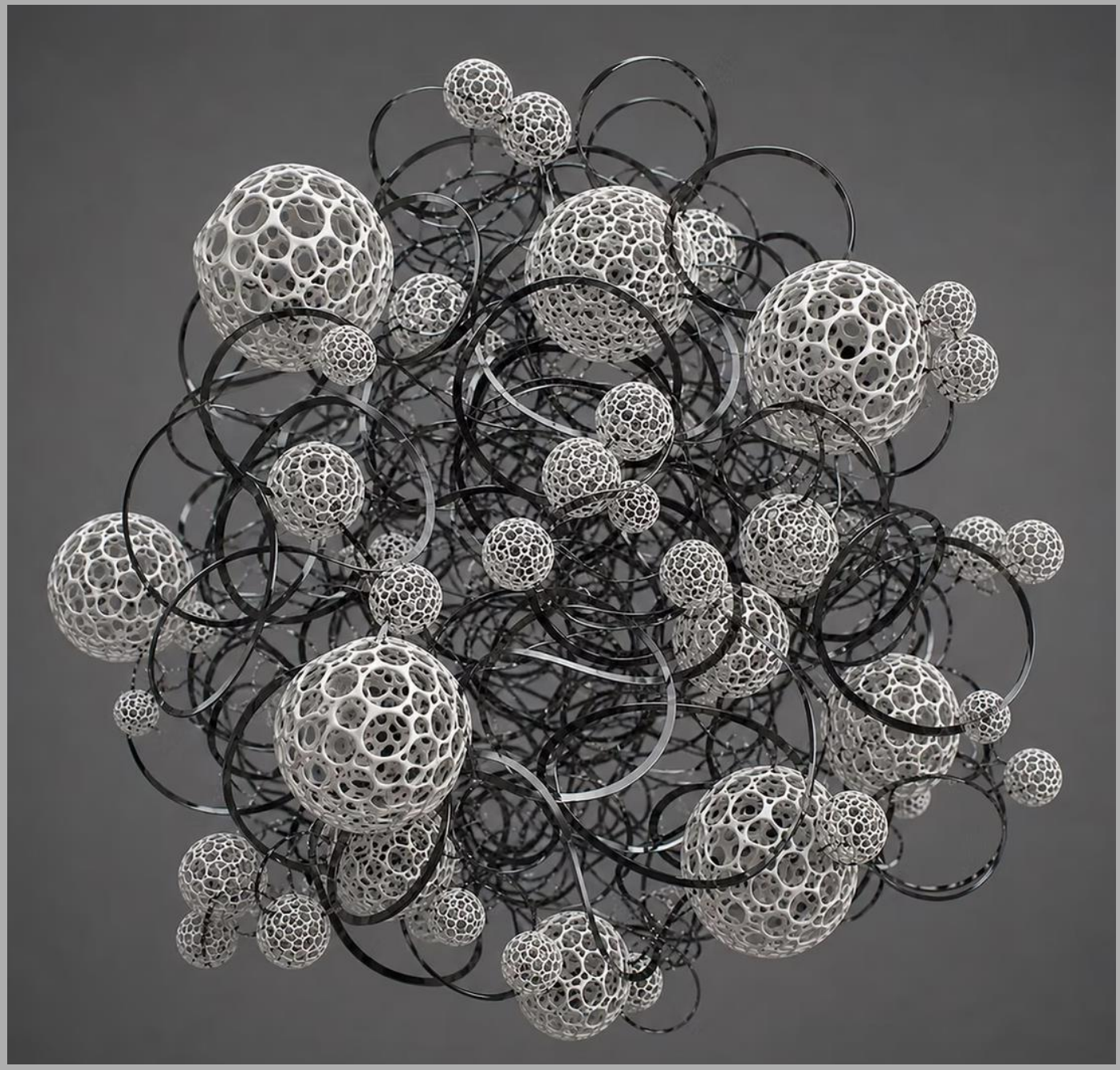
Second, there is value from embracing different ontological and epistemological framings.

The complexity sciences have always struggled with a key question that, in many ways, has been part of their unique contribution:

> ***To what extent are physical, biological, psychological, social and ecological systems similar versus different?***

For example,

- Is the swarm behaviour of humans similar to bees?
- Are bottom-up models adequate for human organisations, where emergence is also shaped by hierarchy, power and deliberate steering?



How one answers this question is linked to

- *The ontological position that one holds*
- *What one assumes, epistemologically speaking, can be known about the complex worlds in which we live*
- *The methods one uses*
- *And, finally, one's approach to the the epistemological transferability of key concepts and theories*



	Underlying reality
Same, same	Similar on the surface, similar underneath
Same, but really different	Similar on the surface, fundamentally different underneath
Different, but really same	Different on the surface, fundamentally similar underneath
Different, different	Different on the surface, different underneath

We took the Ontological and Epistemological position of Complex Realism

David Byrne — Complex realism

- Social reality is ontologically real, complex, emergent, historically constituted and open.
- Social outcomes arise through interacting causal mechanisms and configurations rather than simple linear causes, and those mechanisms operate differently under different conditions.
- Because social reality is open and complex, it can never be captured completely by any single model or method; explanation therefore requires attention to cases, configurations, context and multiple forms of evidence.

OTHER ONTOLOGICAL/EPISTEMOLOGICAL POSITIONS

Margaret Archer — Morphogenetic ontology. Social reality comprises distinct but interacting domains of structure, culture and agency, each with irreducible emergent properties and causal powers. Their interplay over time reproduces (morphostasis) or transforms (morphogenesis) social conditions.

Manuel DeLanda — Assemblage ontology. Social reality consists of heterogeneous assemblages of people, institutions, technologies and material infrastructures whose interactions generate emergent properties and capacities irreducible to their components or our concepts of them.

John A. Smith & Anna Wilson — Radical ecological ontology. Social reality is part of a wider emergent ecological reality, with social systems organising themselves through dependence on biological, material and environmental processes (auto-eco-organisation), understood through an epistemology of auto-exo-reference.

Edgar Morin — Complex ontology. Reality consists of open, recursive systems in which parts and wholes mutually shape one another, with emergence arising through the interplay of order, disorder and organisation, and autonomy dependent on the environment (auto-eco-organisation).

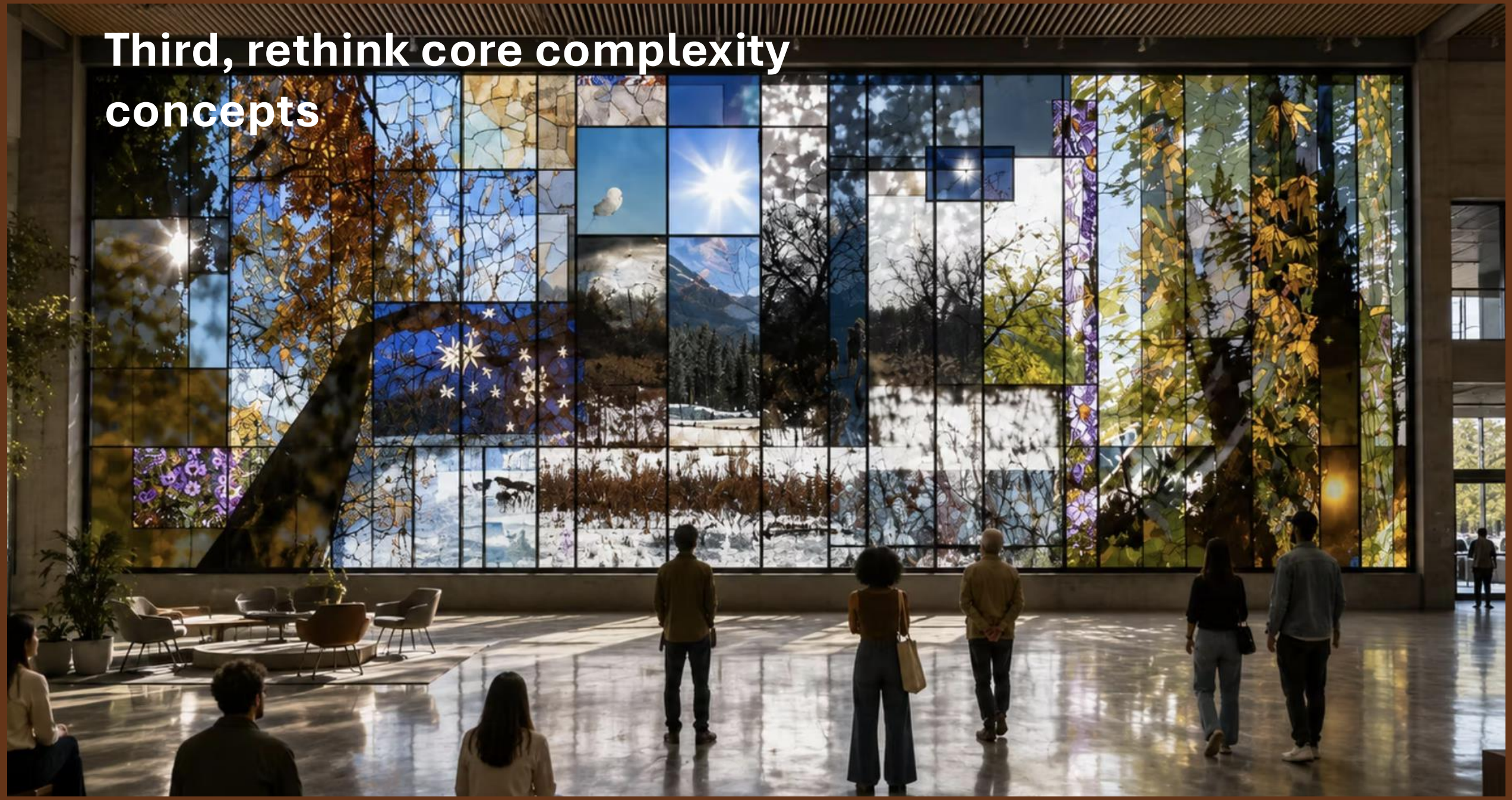
What they share

- **Ontologically:** Social reality is emergent and non-reductionist, with properties and dynamics irreducible to its constituent parts or underlying psychological, biological and physical processes.

- **Epistemologically:** Understanding that social complexity requires:
- interrogating the methods we use
- Thinking through what data or empirical evidence is useful
- Rethinking how to model complex causality
- Elevating the importance of lived experience, and engagement with stakeholders.



Third, rethink core complexity concepts

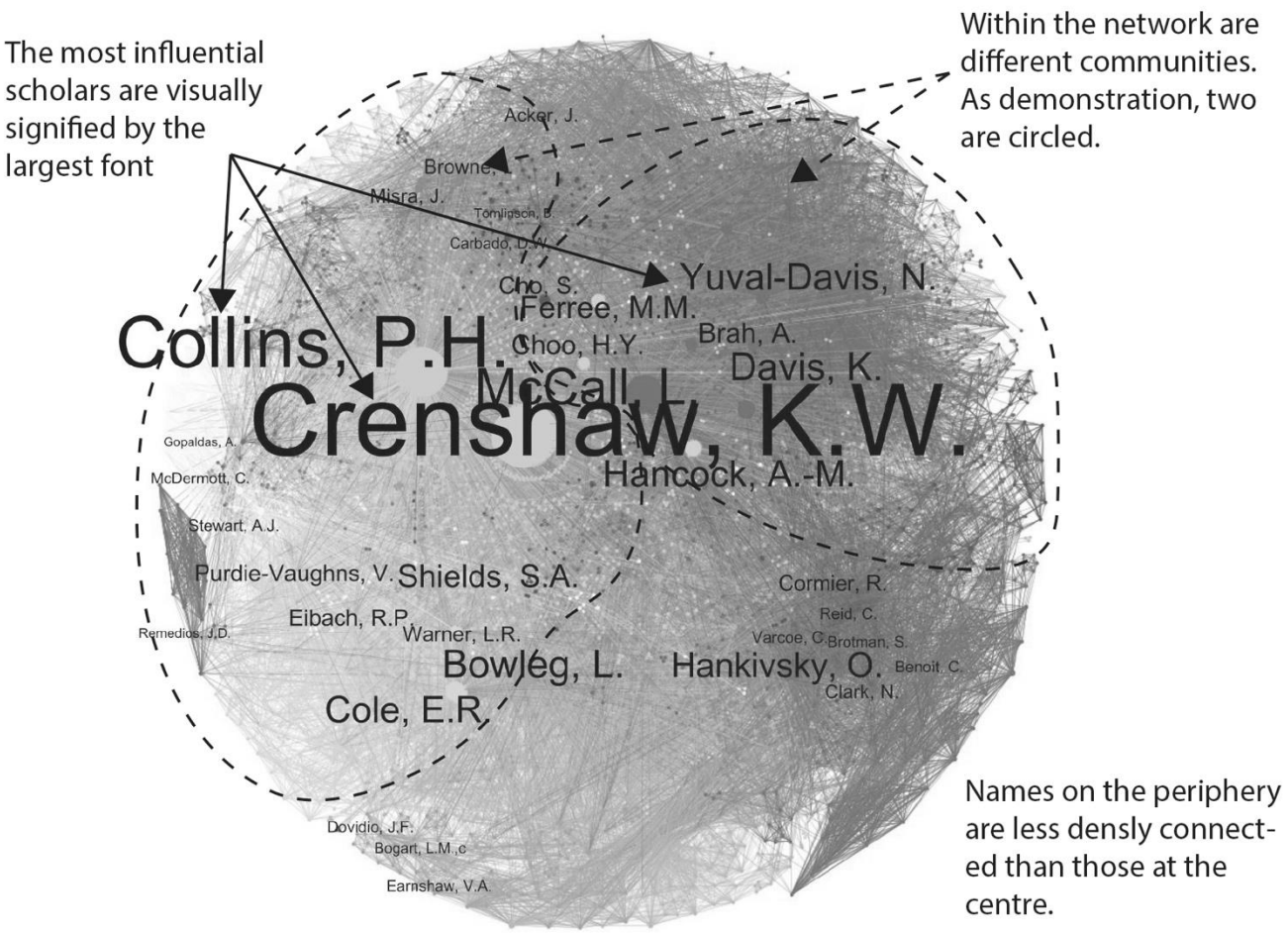



ENTANGLED
How might we reshape our entanglement with the environment

Fourth, develop a critical complexity

Make power, inequality, domination, oppression, discrimination and politics constitutive features of complex social systems, not peripheral variables.

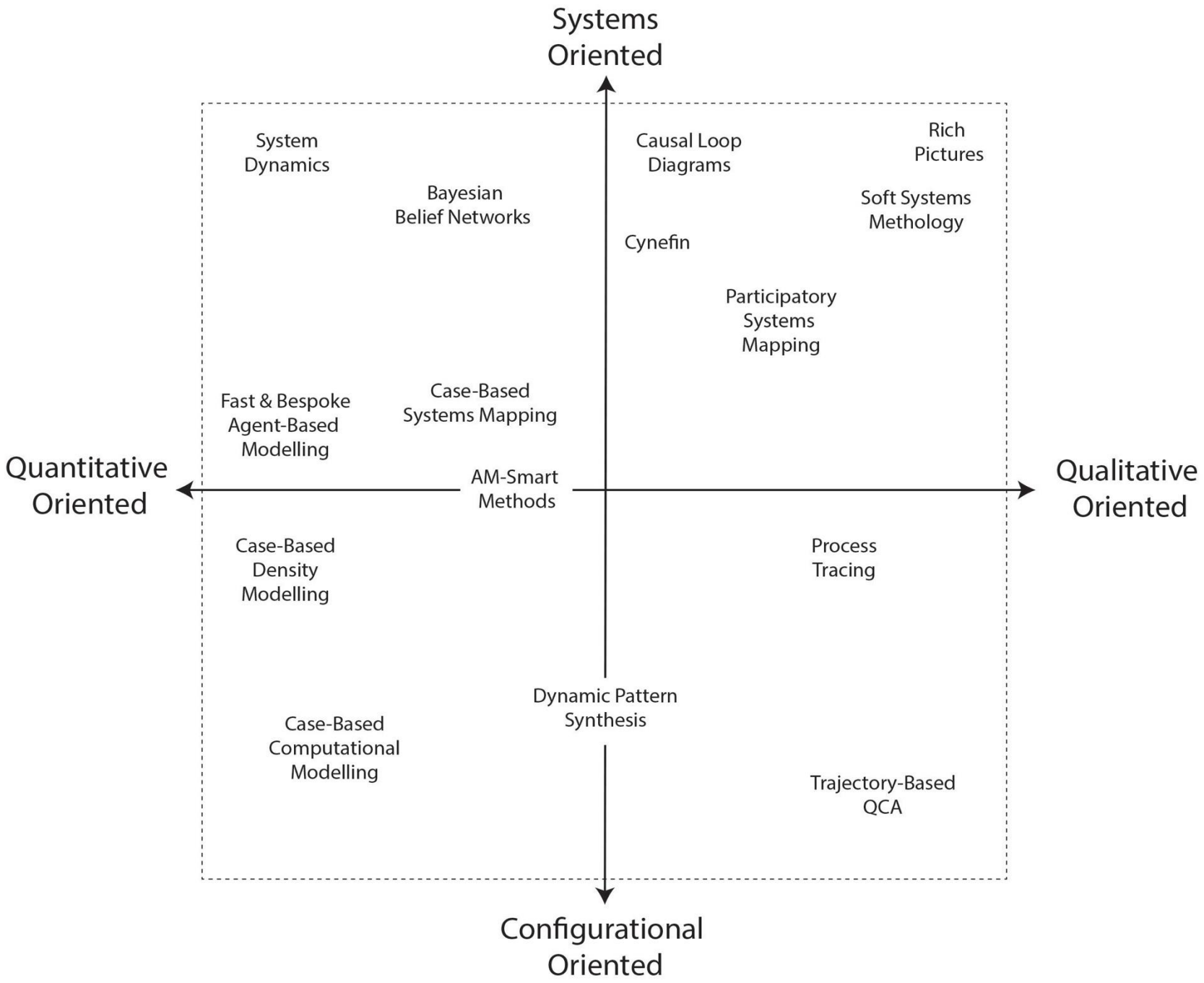
We also need to think about the material (physical, biological, structural) realities of social complexity.

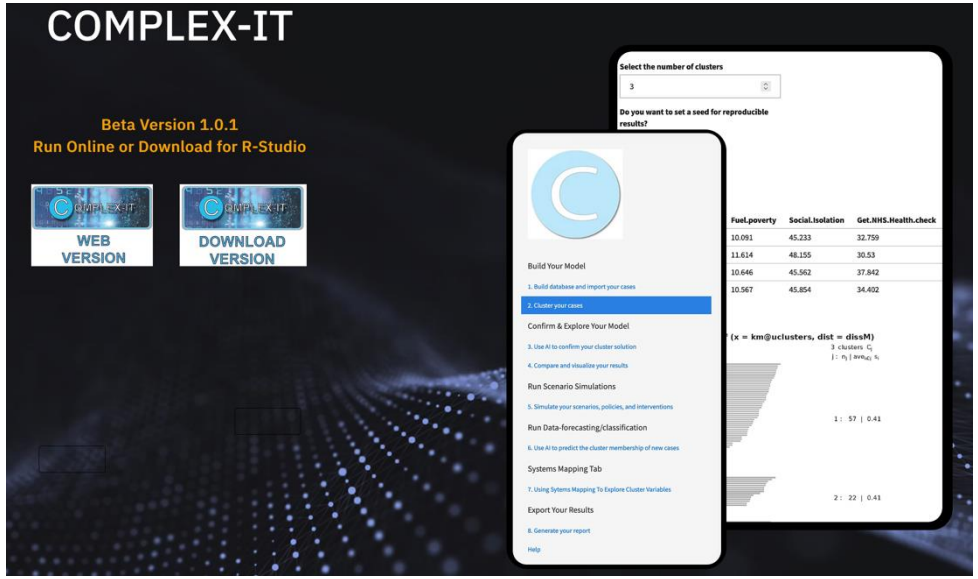


The diffusion network of intersectionality. The nodes are scholars who have published on intersectionality. Directed edges are drawn from scholars publishing on intersectionality for the first time (edge source) to published scholars whom they cite (edge target).

Fifth, embrace methodological pluralism

Computational, quantitative, qualitative, historical, configurational and case-based methods, organised around the problem rather than disciplinary loyalties.





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Justified Stories with Agent-Based Modelling for Local COVID-19 Planning

Jennifer Badham[1], Pete Barbrook-Johnson[2,4], Camila Caiado[3], Brian Castellani[1]

[1]*Department of Sociology, Durham University, 29-32 Old Elvet, Durham DH1 3HN, United Kingdom*
[2]*Centre for Research in Social Simulation, Department of Sociology, University of Surrey, Guildford GU2 7XH, United Kingdom*
[3]*Department of Mathematical Sciences, Durham University, Upper Mountjoy Campus, Stockton Road, Durham DH1 3LE, United Kingdom*
[4]*Institute for New Economic Thinking, University of Oxford, Manor Road, Oxford, OX1 3UQ, United Kingdom*
Correspondence should be addressed to *research@criticalconnections.com.au*

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Modeling Complex Systems Macroscopically: Case/Agent-Based Modeling, Synergetics, and the Continuity Equation

RAJEEV RAJARAM[1] AND BRIAN CASTELLANI[2]

[1]Department of Mathematical Sciences, Kent State University, Ashtabula, Ohio 44004; and [2]Department of Sociology, Kent State University, Ashtabula, Ohio 44004

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An entropy based measure for comparing distributions of complexity

R. Rajaram[a,*], B. Castellani[b]

[a] *Department of Math. Sci., Kent State University, USA*

The Utility of Nonequilibrium Statistical Mechanics, Specifically Transport Theory, for Modeling Cohort Data

RAJEEV RAJARAM AND BRIAN CASTELLANI

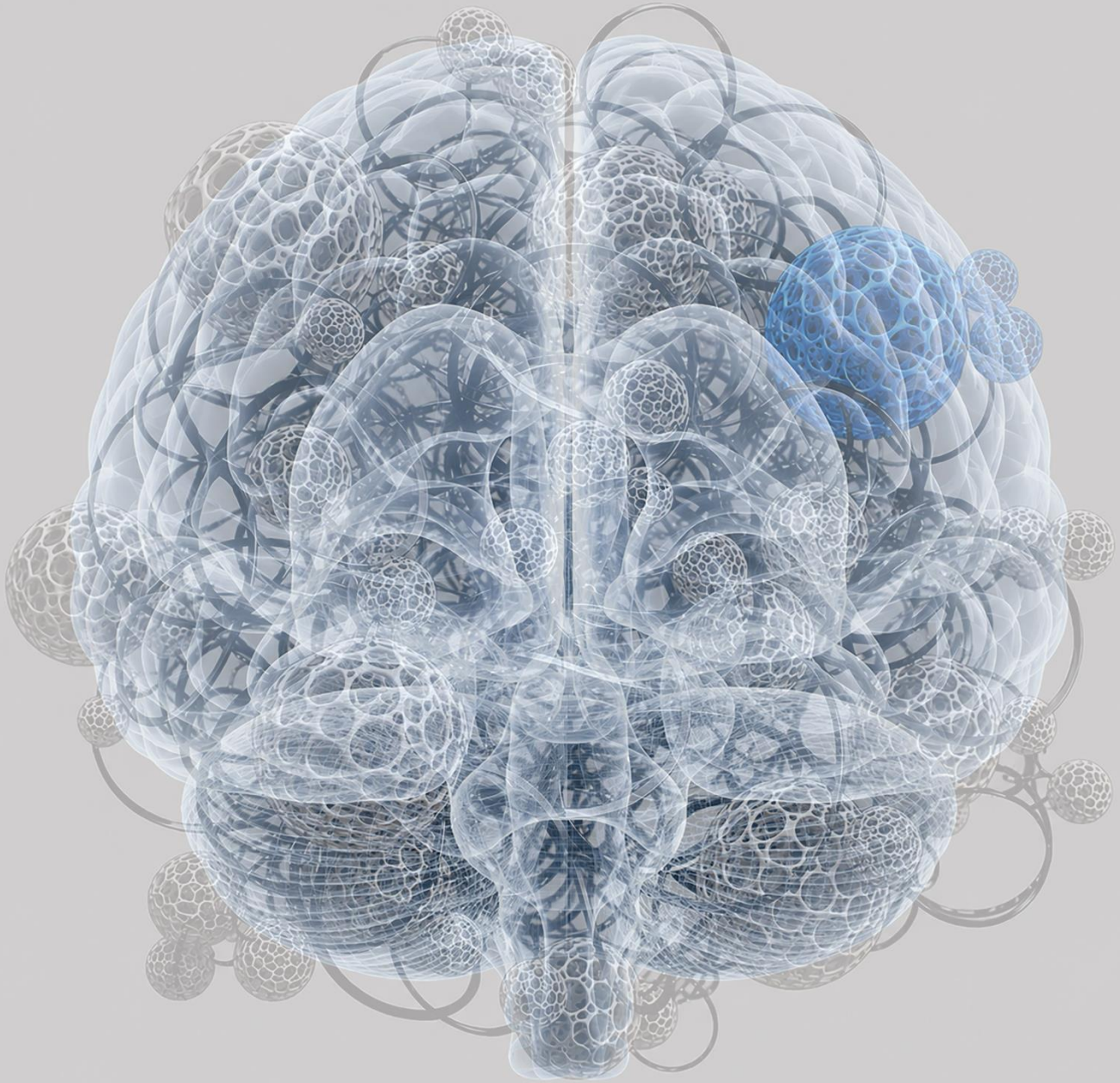
Departments of Mathematical Sciences and Sociology, Kent State University, Ashtabula, Ohio 44004

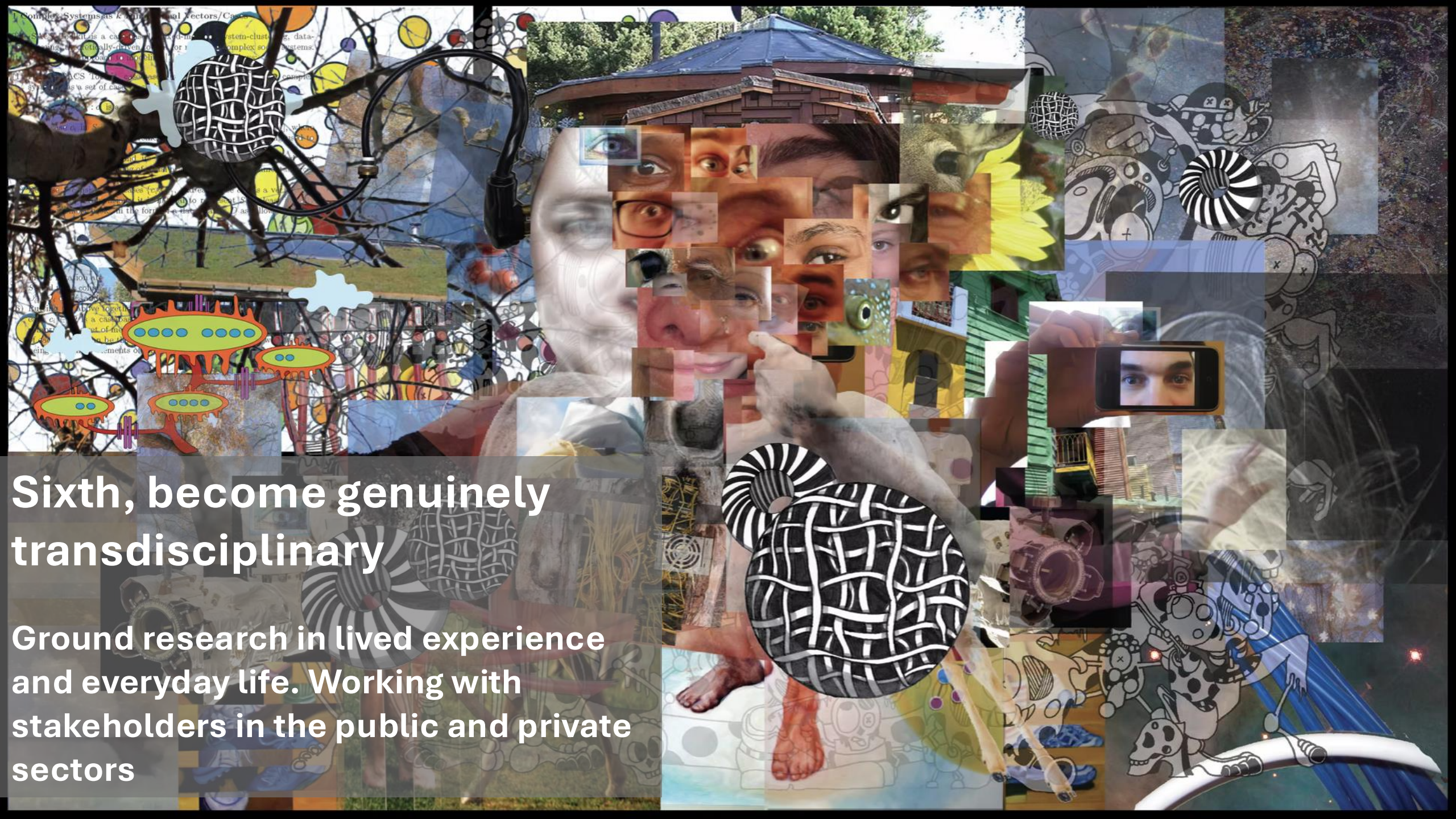

Tomás Saraceno


Chiharu Shiota


Julie Mehretu


Sou Fujimoto



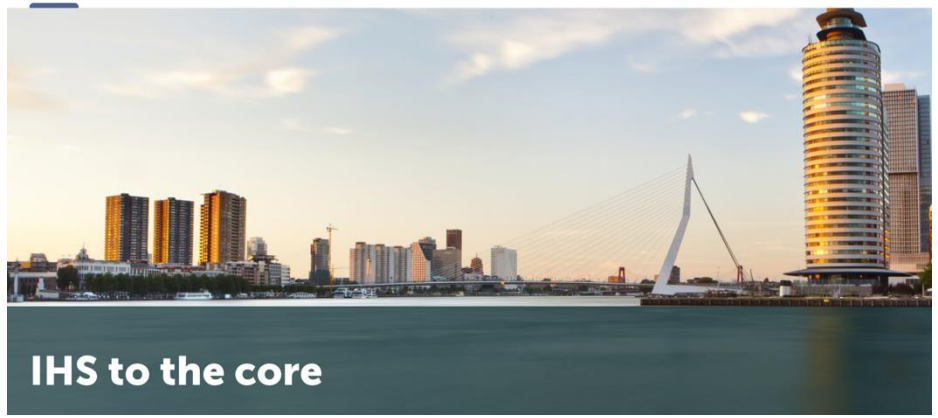


Sixth, become genuinely transdisciplinary

Ground research in lived experience and everyday life. Working with stakeholders in the public and private sectors

IHS
Making cities work

About Education Research Advisory and Training Alumni Contact



IHS to the core

POLDER
Unravelling complexity

About us Methodology Collaborate Labs Events

About us

POLDER, an acronym for Policy Decision-support and Evidence-based Reasoning, is a research initiative led by the Institute for Advanced Study at the University of Amsterdam. We are a community of researchers and associated partners working with complexity theory and computational modelling to support policymakers. For our research and education we mobilize researchers from the UvA, and beyond, to form interdisciplinary teams.

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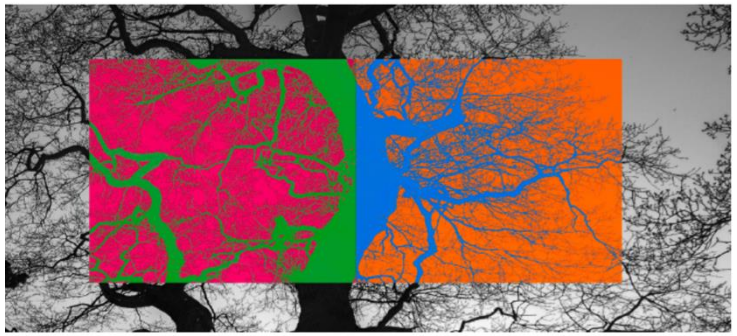
Research Methods Centre

We work with scholars and non-academic partners to develop interdisciplinary methods training and research.

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Notre réseau Rechercher

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Seventh, embrace a social complexity imagination

- **BACK TO THE FUTURE**
- In the spirit of C. Wright Mills, advancing transdisciplinary complexity requires a social complexity imagination.



Seventh, embrace a social complexity imagination

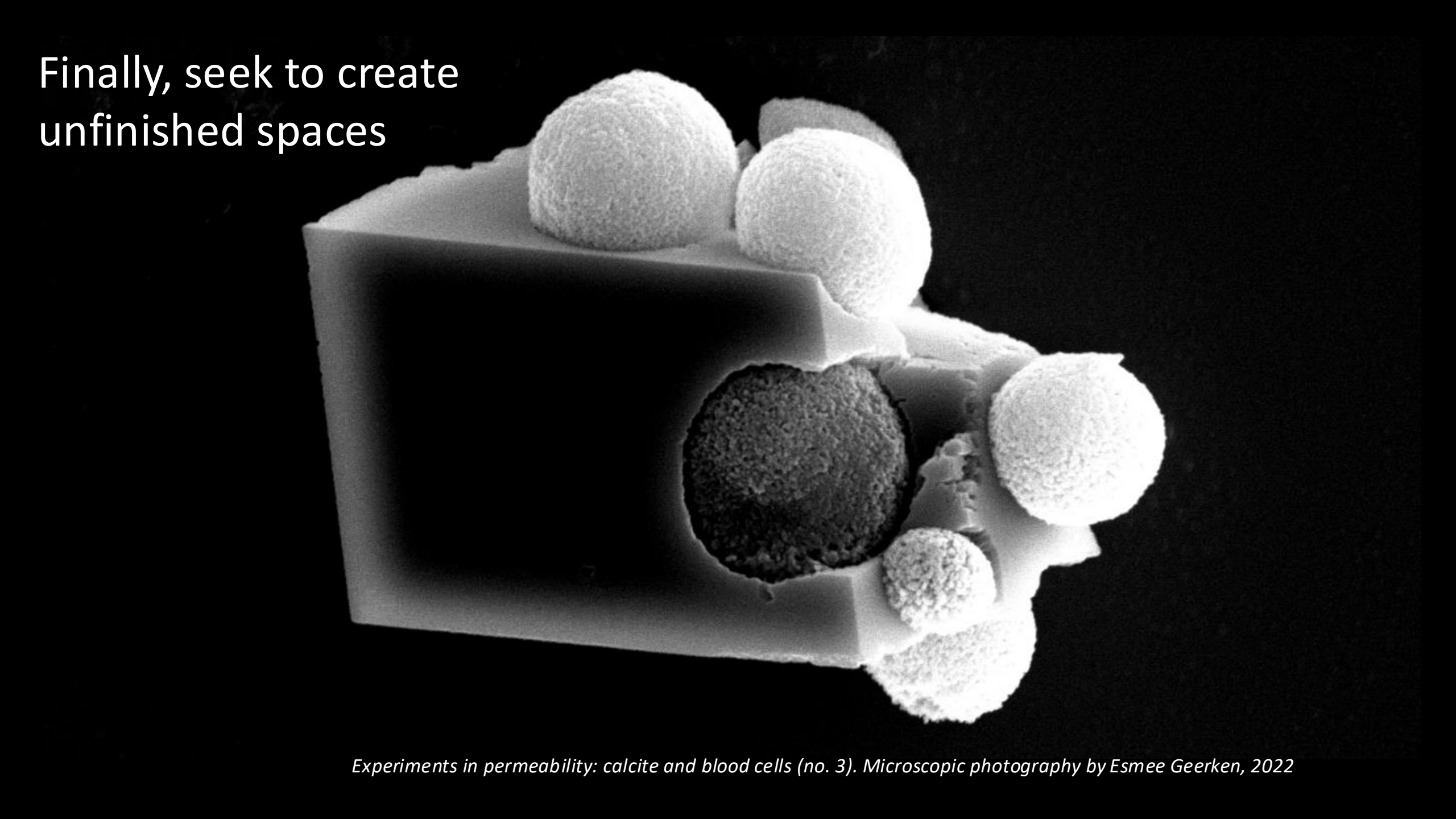
Odilon Redon
The Eye like a Strange Balloon Mounts toward Infinity (*L'Œil, comme un ballon bizarre se dirige vers l'infini*) 1882



The social complexity imagination

- **Imagination 1: Moving beyond the traps** — avoiding the recurring simplifications that distort complex social reality: reductionism, linear causality, disciplinary silos, methodological rigidity, and the tendency to mistake models for the world.
- **Imagination 2: Observing the larger universe** — widening the field of vision so that cases are situated within broader relational, historical, institutional, ecological and multilevel contexts.
- **Imagination 3: Accepting complexity psychologically** — developing the capacity to live with ambiguity, uncertainty, contradiction, incompleteness and limits to control rather than continually forcing closure.
- **Imagination 4: Adopting a critical complexity** — bringing questions of power, inequality, exclusion, history, politics and positionality into complexity thinking, rather than treating systems as politically or socially neutral.

Finally, seek to create unfinished spaces



Experiments in permeability: calcite and blood cells (no. 3). Microscopic photography by Esmee Geerken, 2022

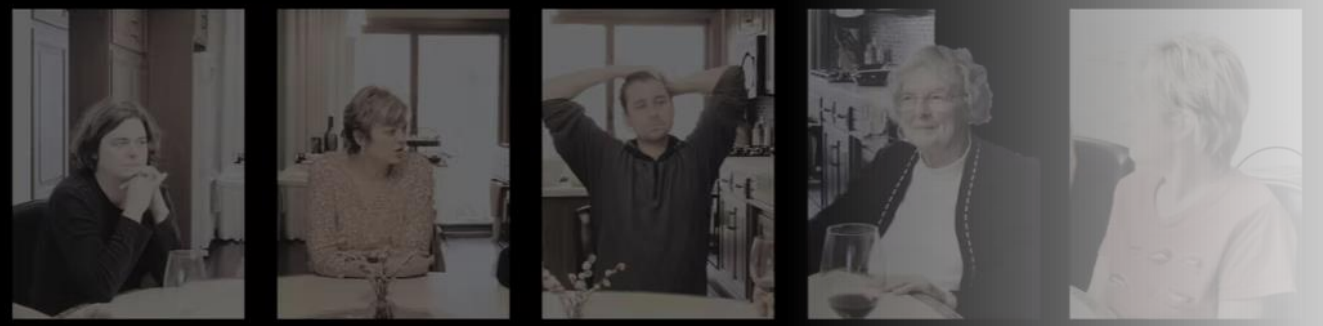
The unfinished space

- **The art of incompleteness** — accepting that complex systems cannot be exhaustively captured, modelled or explained; incompleteness is a condition of inquiry, not merely a methodological failure.
- **Unease and comfort** — learning to remain productive in uncertainty, contradiction and partial knowledge rather than forcing premature closure.
- **A thousand plateaus** — resisting the idea of a single privileged level, theory or pathway; complexity is distributed across multiple interacting scales, domains and trajectories.
- **Permeability and pores** — keeping disciplinary, conceptual and methodological boundaries open enough for ideas, methods and evidence to move across them.

The unfinished space

- **Organizing emergence** — recognising that emergence is not simply spontaneous bottom-up self-organisation; it can be channelled, constrained, enabled, designed around and shaped by institutions, power and hierarchy.
- **Becoming transdisciplinary** — moving beyond simply combining disciplines toward changing how problems themselves are framed and investigated.
- **Becoming educated** — treating complexity as something that requires a different intellectual disposition: learning how to think relationally, historically, contextually, reflexively and across scales.
- **The terrain not yet grasped** — acknowledging what complexity science still does not adequately understand, particularly as it moves more deeply into social complexity. *Those things we do not know and do not know we do not know.*





My colleagues and I have asked:

- What would the complexity sciences look like if we fully engaged with the social sciences, humanities, philosophy and arts?
- Could we create a proper arts and social sciences complexity?
- I explored several outcomes from this pursuit.
- We obviously still have a lot of work to do.

What next?
Let’s chat

