A Colloquium Series:

“Case Studies of Emergence”

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1 Motivation for proposed colloquium series

The idea of ‘emergent phenomena’ is increasingly being invoked wherever complex natural or social phenomena are studied. While “emergence” is not an entirely new concept—in the 19th Century, the British philosophical school of emergentism primarily concerned itself with the mind-body problem—this new “emergence” touches conceptual and philosophical issues of importance throughout the academy.

Examination of emergent phenomena contributes substantively to clarifying the long-running controversies over reductionism as versus ‘constructionism’ or ‘holism’. Emergence addresses not the process of the reduction of complex systemic behavior to its constituent components and underlying mechanisms, but, rather, the generally much more vexing problem of the “constructivist” explanation of how complex dynamic patterns, rules and laws are seen to “emerge” or evolve in natural and social systems on the basis of the repetitive interactions of numerous relatively simple constituent components and mechanisms.

In order to attach specificity and intellectual rigor to the idea of “emergence”, the proposed colloquium series will include accounts of specific advances in areas of physics, biology and complexity where prototypical models of emergence were first presented. Others will be accounts of the application and further development of these ideas in social sciences, and business, and the interpretation of their intellectual significance by philosophers of science.

Many of the original advances are known by discipline-specific names and may not be widely known or understood. Important concepts include “critical phenomena,” “universality” and “symmetry-breaking” (from many-body physics), “self-organized criticality” and “pattern formation” (from biology, chemistry, physics), “punctuated equilibrium” and “speciation” (from biology, paleontology, ecology), “effective theories” (from elementary particle physics), etc. In the social sciences and business schools one finds similar concepts being invoked in the analysis of the rise and collapse of complex societies, of city formation, in the study of social-class and social-movement dynamics, social network development, of revolutionary change, in analyzing periods of technological change, demographic
transitions, and issues of business performance and decision making, market formation and/or collapse, etc. In particular, in complexity science, "genetic algorithms" are powerful and fascinating computer simulations increasingly used to observe emergent phenomena in diverse settings.

It should be emphasized that The University of Michigan is the home of a number of researchers who have contributed in important ways to an understanding of emergent phenomena and has one of the country’s leading centers for the study of complex systems (CSCS), and we would strive to involve a significant number of these researchers. In addition, The University of Michigan, and the Rackham Graduate School in particular, with their unusually developed traditions of interdisciplinary scholarship, are appropriate venues for a campus-wide series on emergence.

2 Appendix: Contemporary emergence

In the late 19th Century, the British philosophical school of emergentism held that there is something above and beyond the physical which comes into existence with the mind—the prototypical instance of emergence. While the unphysical views of this school are largely rejected today, there nevertheless remains considerable controversy as to the question of how to characterize and/or categorize "emergent" phenomena, and even as to whether it is possible, in principle, to ‘understand’, ‘predict’ and/or ‘foresee’ systemic emergent behaviors. So too, the questions of the relationship of modern notions of emergence to previous philosophical systems such as a "dialectics of nature," are of interest as well since many present-day emergence proponents also cite the transformation of “quantity into quality” (Anderson72), and "reaping much from little" (Holland98), as the central feature of emergence— exactly parallel to the Hegelian and Marxist philosophical traditions.

Others, however, emphasize the appearance of new and heretofore unobserved collective behavior or group rules where previously there were only individual and largely independent or uncoordinated entities present in the system. Still others emphasize the suddenness of the onset of the new collective behavior "surprise"), or an apparent inability to "reduce" the new collective behavior to the behaviors of the constituent parts (anti-reductionist). While many, especially natural scientists, fully accept or
even celebrate this reduction, some emphasize the appearance of qualities which it is claimed cannot be analytically, computationally and/or conceptually "constructed" (i.e., predicted, foreseen) from first principles or the 'laws of nature') governing the system's individual constituents (the "'ah ha!' effect"). Closely connected to the notion of emergence in complicated systems is the ubiquitous appearance of order and static or dynamical patterns without the action of any global coordinating force or "conductor", without any "signaling". In particular, the ubiquity of "emergence" of robust organization in natural and social systems, is often seen as being in contradiction to the well known classical thermodynamics results (physics, biology, economics, etc.) which dictate a system-wide tendency towards disorder (rising entropy), loss of information and sameness ("heat death") for closed (isolated) systems. However, natural and social systems are both "open" and "dissipative". Dissipative means they exhibit a resistance to the flow of energy through its constituent parts or actors, and this necessitates invoking non-equilibrium thermodynamics wherein structural or situational order SHOULD increase in these systems. Hence the rich, robust and spontaneously "emergent" order and patterns we see everywhere in our natural and social environments appear without any need for recourse to teleological explanations or "intelligent designer(s)". Nevertheless, the frequently sudden "constructivist" appearance (or disappearance) of these new patterns and dynamic behaviors within complex systems are generally very complicated to understand, much less predict from the deterministic interactions of the simple constituent parts of the system, and this difficulty continues to spontaneously generate less-than naturalistic, and scientific explanations.

These latter two aspects, suddenness and the difficulties in using analytical methods, have particularly favored the utilization of computer simulations, most notable "genetic algorithm" experiments to "discover" the emergent outcome of the interaction of numerous individual entities over time. While some few archetypical systems have yielded to analytical mathematical methods (e.g., exactly solvable systems), most do not. The fact that many systems exhibiting emergent phenomena seem to be impenetrable to analytic mathematical methods, has connected the investigation of emergence with questions of irreducible algorithmic complexity, incompleteness of formal systems, and other issues fundamental to modern information theory.

In many ways, the issue of "emergence" has in fact come to renewed
prominence precisely along with the unfolding of the intellectual advances of the Information Age and the availability and facility of researchers to employ computers for research across many disciplines.

3 Form of the colloquia

3.1 Level and intended audience

As with any newly fashionable or ‘paradigmatic’ concept, emergence may too often be invoked as a vague and ill-defined label. This naturally raises skepticism as to the specificity and usefulness of the concept. In response, the proposed colloquium series, “Case Studies of Emergence,” would provide a forum to examine specific cases of emergent phenomena, with a requirement for detailed expositions of the mechanisms and characteristics involved in each case study. Papers would be at a level appropriate for an interdisciplinary audience of academic and non-academic researchers consisting of “informed non-specialists” not expecting to immediately grasp all of the new concepts they would encounter.

3.2 Speaker-and-respondent format

Speakers would include researchers who have made or are making significant contributions to their field and who are also inclined to think about their work in light of general philosophical questions and controversies.

In each instance (“case study”), the aim would be to invite a speaker and respondent of national importance. Generally, one of these would be a UM researcher matched to an invited participant from elsewhere. Either one of the pair might be invited to be the presenter or the respondent as deemed appropriate but generally the speaker would be from elsewhere. While the speaker would not be required to submit a paper in advance, they would be encouraged to provide the respondent with an outline and/or copies of transparencies beforehand, and/or with an especially relevant paper previously published, etc. so as to facilitate the respondent’s critique.
Speakers would be strongly encouraged to make themselves available for meetings on campus with any interested researchers and graduate students (perhaps in groups), for lunch and dinner discussions on the day of the talks, and for a portion of an additional day, if possible.

3.3 Time and frequency of colloquia

Colloquia would be held every second Thursday of the 2002-2003 academic year with the exception of the first month of each semester. The present budget reflects this frequency, requesting funds for six speakers. However, we have also reserved a room for the second Thursday in January (a seventh speaker or panel) should it be possible to obtain additional funding and depending on the logistics of the first semester.

3.4 Location of colloquia - omitted for sample

3.5 Graduate student assistant - omitted for sample

3.6 Co-sponsors - omitted for sample

4 Potential invited speakers and respondents

Here we list several prominent researchers whose work has significantly contributed to the present understanding of emergence; we list them according to four broad categories: (i) philosophy, (ii) complex systems and/or information theory, (iii) natural sciences, and (iv) the social sciences—including business and organizational studies. It is not known whether any or all of these persons would accept our invitation, however, we would seek to actively involve prominent on-campus researchers from related disciplines as both respondents and in securing commitments from off-campus invitees.

A selection of potential invited speakers and/or respondents includes:
4.1 Philosophy

1. Jaegwon Kim (Brown University; Philosophy):
   Property emergence; emergence of mind

2. Paul Humphreys (University of Virginia; Philosophy):
   Emergence as fusion; theories of emergence at the quantum mechanical level

3. Timothy O’Connor (University of Indiana, Philosophy):
   Property and substance emergence; emergence of mind and persons

4. Larry Sklar (University of Michigan; Philosophy):
   Interpretation of scientific theories

5. Jessica Wilson (University of Michigan, Philosophy):
   Ontological emergence as involving new fundamental interactions

4.2 Complexity and Information Theory

1. Stephen Wolfram (Wolfram Research; author of “A New Kind of Science”):
   Study of complexity via cellular automata; complex systems research

2. Jim Crutchfield (Santa Fe Institute; Complex Systems):
   Evolving cellular automata and genetic algorithms; biological systems

3. Stuart Kauffman (Bios Group; Biology/Genetics; author of “At Home in the Universe”):
   The Search for the Laws of Self-Organization and Complexity; Developmental genetics


5. John Holland (University of Michigan; Psychology; author of “Emergence”):
   Cognitive processes and complex adaptive systems; mathematical models and computer simulation
6. Carl Simon (University of Michigan, Director Complex Systems; Mathematics; Economics; Public Policy)

7. Mark Newman (Santa Fe Institute, University of Michigan Complex Systems and Physics): Many body theory, critical phenomena; social networks


4.3 Social Science, Business, Economics

1. Rob Axtell (Brookings Institute; Economic Studies): Emergence in multi-agent systems; dynamic models of social and economic systems

2. Karl Weick (University of Michigan; Organizational Behavior): Sensemaking in organizations; the emergence of collective mind

3. Bob Axelrod (University of Michigan; Political Science): Evolution of cooperation; prisoners’ dilemma, complexity theory agent-based modeling

4. Mike Cohen (University of Michigan; School of Information and Public Policy, IOCS): Organizational learning and routines and their interactions with information technology; the garbage can model of creativity

5. Scott Page (University of Michigan; Complex Systems; Political Science; Economics)

4.4 Natural Science

1. David Deutsch (Oxford University, Clarendon Labs): Quantum computing, philosophical implications of complexity, unification of knowledge

2. P. W. Anderson (Princeton; Physics): More is different; broken symmetry as source of new levels of phenomena
3. Per Bak (Imperial College of Science, Technology, and Medicine; Mathematical Physics):
   Self-organized criticality

4. Walter Fontana (Santa Fe Institute; Chemistry):
   Computational chemistry; novelty in evolution (how molecules evolve into cells)

5. Tom O’Donnell (University of Michigan, Complex Systems, ST&S, Nuclear Physics):
   Emergence as reflected in phase transitions and critical phenomena across social and natural systems; connection of emergence to previous philosophical systems, dialectics.

5 Proposed Budget

(Omitted for this sample)