Mind and Society Lunch Seminar #1: 9/29

short presentation by Abigail Devereaux

> *"If we hurry, we can catch up to Turing on the path he pointed out to us so many years ago." (Simon, 1996)*

SHORT INTRO TO THE POINT: A story about Alain Lewis & Ken Arrow, and where we are today. I draw largely from Philip Mirowski's *Machine Dreams* for this story. Ample proofs for the mathematical results, along with many citations, are included in Velupillai's *Computable Foundations for Economics*.

The Cowles Commission was founding by the economist and businessman Alfred Cowles, in 1932. The first directors were Cowles, Marschak, and Koopmans, when it was moved to Yale. The motto of Cowles was *Theory and Measurement*. It is from Cowles that we inherited modern neoclassical economics as we know it: both general equilibrium theory and econometrics were developed into their modern state, there. The purpose of Cowles was, baldly, mechanism design. To those familiar with the socialist calculation debate, it'll mean something to you when I say that the purpose of Cowles was to practically approximate the solution to an economy-wide set of linear equations. 11 economists won Nobels for work done for the Cowles Commission: Arrow, Koopmans, Simon, Modigliani, Stiglitz, to name a few.

Alain Lewis was a student at Harvard in the 1970s. While he was there, he worked on nonstandard analysis and other mathematics applied to economics under Arrow. After graduation, and under Arrow's guidance, he ended up at RAND doing classified research. In 1980 he started working on the implications of computability for neoclassical analysis. A bit about the atmosphere: economists working at RAND at this time were focused clearly on developing a *computable method* by which they could respond to a real-life nuclear scenario. Think of a complex real-life nuclear situation: a computer could respond much more quickly and precisely, if it could correctly compute a game-theoretic response to a situation posed by the enemy that would result in some optimum level of survival. But along with this sensitive research came an expected realization about Arrow-Debreu type economic models, including game theoretical solutions: *they were theoretically noncomputable*. That is, there was no method utilizable by a computer that could obtain a solution. I won't go into the vagaries of what calculation means, by Church's thesis, but realize they are the same as saying that a solution is effectively computable, that is, can be programmed to be exactly solved by a theoretical computer (so, as powerful as is possible).

In 1967, Gerald Kramer, a researcher for the Cowles Commission, had written a paper called "An Impossibility Result Concerning the Theory of Decision-Making." Kramer showed no finite automata could conduct Arrovian rational choice. Lewis in effect updated Kramer's findings in the choice theoretical mathematics of the 1980s, showing that any computable version of the theory would either never halt or fail to converge, or halts at a non-optimal choice.

Aggregate deman, market equilibria, Pareto optima – none are granted any kind of scientific truth beyond being deductions of a flawed model.

On July 21, 1986, Kenneth Arrow wrote to his protége Alain Lewis, who had just published a paper on the non-computability of neoclassical economics (in the Arrow-Debreu formulation):

> "[T]he claim the excess demands are not computable is a much profounder question for economics that the claim that equilibria are not computable. The former challenges economic theory itself; if we assume that human beings have calculating capacities not exceeding those of Turing machines, then the non-computability of optimal demands is a serious challenge to the theory that individuals choose demands optimally."

THE IDEA OF SIDE-STEPPING the neoclassical model

COMPUTABLE ECONOMICS: Alain Lewis, Vela Velupillai

- Standard economic theory is non-computable. What would a computable economics look like?

CREATIVE ECONOMICS: Stuart Kauffman, Roger Koppl, Richard Wagner

- Standard economic theory is indeterminate due to the non-ergodicity of time paths and thus the indeterminancy of solutions.
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1. In law-governed systems such as physics, we can prestate the configuration space or phase space . Dynamics are geodesics within such prestated phase spaces – at most the dimensions of the phase space may change, as in statistical physics, but the properties of the observables are prestated. That is, the path of each variable, which depends on the paths of all other variables, minimizes some metric in a predefined space.
2. In economic evolution, the phase space itself changes continually and in ways that cannot be prestated, since the enablement relation allows the formation of new observables.
3. Because we cannot pre-state the ever-changing phase space of economic evolution, we have no settled relations by which we can write down the equations of motion of the ever new economically relevant observables and parameters revealed ex post by the market process. Nor can we prestate the emergent opportunities of the system as boundary conditions. Thus, we could not integrate the equations of motion even if we could somehow have them nor can we write down a well-defined mathematical function describing (determining) the dynamics.
4. If the above is true, no laws entail the evolution of the econosphere.
5. If by 'cause' we mean what gives a differential effect entailed by law, then we can assign no cause in the evolution of the econosphere. In this sense, the economy is not a causal system.

6. The past does not 'cause' the future so much as it enables some futures and disables others. Thus, 'enablement' is a key notion in our analysis.

AGENT-BASED ECONOMICS: Leigh Tesfatsion, Robert Axtell

- Is ABM more suitable a tool of economic inquiry?
- Even though the solution to the Walrasian equilibrium isn't computable using the centralized auctioneer, we can get convergence to an equilibrium price (high performing market systems) with simple decentralized trade (Edgeworth-box style) over networks (Wilhite). Part of the power of market: offer us the vision that people pursuing their own local welfare improvements lead us to a welfare-forming market.

COMPLEXITY ECONOMICS: Robert Axtell, Brian Arthur, David Colander, Roland Kupers, (?) Kirman

- Complexity economics is a bit of a mish-mash of neoclassical and non-neoclassical methods.
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Economic theory: it is not enough to provide a proof of existence of a solution, we must provide a method of attain that solution

- We cannot engage in "magical thinking" (Koppl, 2015)
- Example: Friedman's "as-if" equivalence. It is one thing to say that people are rational, it is another to say that their rationality is formally equivalent to utility maximization á la Mas-Collel
- Contrast: the simple heuristics of Gerd Gigerenzer, the satisficing of Herb Simon
- We have a choice: Keep performing divinations, or figure out how to say something scientifically meanful about economics

Quote: Alain Lewis, 1985:

> The theorem of representable choice functions in the neoclassical setting, and thus consequently the theory of neoclassical demand correspondences and the theory of SDF-derived social welfare functions, when defined on families of compact subsets of E n, presumes the possibility of a mathematical correspondence that, even in principle, cannot be performed or realized in effectively computable terms under the weakest, and therefore best, possible circumstances of recursive approximation.

Economic theory: science or a tool to enable the powerful to stay in power? or, the political economy of doing economics

- Excellent exposition by White on the large percentage of Fed connections in articles published on monetary economics
- Koppl discussion about experts and divination to support the powerful in Greece, and on (Koppl, 2015)

Furthermore, economic theory has often confused theory with method. As Professor Koppl put it, “Mathematics is a useful tool in economics, but it does not prevent model builders from making implicit assumptions.”

- Socialist calculation debate
- Behavioral economics

Research Motivations for Establishing a Constructive/Creative Economic Theory

Abigail Devereaux, 9/27/16

Motivation 1 (**The Negative Argument**): Side-stepping neoclassical (Arrow-Debreuvian, Pigovian, Lucasian, Mas-Colellian) economics in order to gain more theoretical and explanatory power. Providing apt criticism and negative results to motivate the side-step, only because negative results are still necessary to convince many that at the very least the neoclassical frame is not impregnable.

Motivation 2 (**Establishing a Suitable Mathematics for Economic Theory**): Mathematical coherence and suitability to the subject: constructivity and computability vs. axiomatic elegance in a "creative" economic regime; non-ergodicity and indeterminancy of phase spaces in a policy regime.
(da Costa, Velupillai, Kleene, Post, Brouwer, Bishop, Tesfatsion, Lewis, Arrow, Axtell, Morgenstern, Scarf, Koppl & Kauffman, Lewis, Rosser)

Motivation 3 (**Establishing a Suitable Frame for Inference**): The problems with and limitations of statistical inference over given data, given the limitations of the theoretical mode of inquiry and the data itself. In the absence of suitable measurements, what patterns of dynamical economic systems are meaningful?
(Morgenstern, especially)

Motivation 4 (**Establishing the Economic Content of a Creative/Constructive Economics**): Defining the economic content of a better methodological frame with which to approach the social sciences, where macro-level patterns are emergent from enumerable agent interactions and are thus theoretically constructive and practically computable. The Paretian frame in which to approach social inquiry.
(Koppl & Kaufman; Wagner & Veetil; Wagner & Candela; Wagner; Gigerenzer; Pareto; Smith; Simon; Velupillai; Rosser).

Motivation 5 (**Effective Public Policy**): A desire to unearth better indicators with which to understand the movements of macro economies, and how these movements may be relating to the underlying rules and constraints of trade (institutions) and agent behaviors (preferences). How understanding macro systems dynamics can inform policy. What it means to create an effective policy. Understanding the domain constraints of policy.
(Graham Room, Kirman & Helbing, SFI folks on policy, Arthur, Rosser, Koppl, Velupillai, Wagner)

Main papers and books I recommend, to start:

- Axtell, R. (2005). The complexity of exchange. *The Economic Journal*, *115*(504), F193-F210.
- Gigerenzer, G., & Selten, R. (2002). *Bounded rationality: The adaptive toolbox*. MIT press.

- Helbing, D., & Kirman, A. (2013). Rethinking economics using complexity theory. *real-world economics review, issue*, (64).
- Koppl, R. (2010). Some epistemological implications of economic complexity. *Journal of Economic Behavior & Organization*, *76*(3), 859-872.
- Koppl, R., Kauffman, S., Felin, T., & Longo, G. (2015). Economics for a creative world. *Journal of Institutional Economics*, *11*(01), 1-31.
- Rosser Jr, J. B. (2009). Computational and dynamic complexity in economics. *Handbook of Complexity Research. Cheltenham: Edward Elgar*, 22-35.
- Simon, H. A. (1996). *The sciences of the artificial*. MIT press.
- Velupillai, K. V. (2005). The unreasonable ineffectiveness of mathematics in economics. *Cambridge Journal of Economics*,*29*(6), 849-872.
- Velupillai, K. V. (2007). The impossibility of an effective theory of policy in a complex economy. In *Complexity hints for economic policy* (pp. 273-290). Springer Milan.
- Wagner, R. E. (2012). A macro economy as an ecology of plans. *Journal of Economic Behavior & Organization*, *82*(2), 433-444.
- Wagner, R. E. (2010). *Mind, Society, and Human Action: Time and Knowledge in a Theory of Social-Economy*. Routledge.
- Weintraub, E. R. (2002). *How economics became a mathematical science*. Duke University Press.