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Algorithmic Social Sciences Research Unit (ASSRU)

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The ASSRU Logo

The ASSRU logo depicts a *Counting table* (woodcut probably from Strasbourg). The spaces between the lines function as the wires on an *abacus*. The place value is marked at the end.

'Unsung Heroes' of Algorithmic Economics

Alain Lewis

Reuben Goodstein

Maury Osborne

Stephen Smale

Alan Turing

"If we hurry, we can catch up to Turing on the path he pointed out to us so many years ago."

Herbert Simon

The Algorithmic Social Sciences

The research and teaching philosophy, methodology and epistemology of the Algorithmic Social Sciences Research Unit (ASSRU) is based on the pioneering works of Maynard Keynes, Piero Sraffa, Richard Goodwin, Herbert Simon and Alan Turing.

This inaugural number of the ASSRU Newsletter is issued to coincide with the Unit's first formal organization of an International Conference to celebrate the 60th anniversary of the Phillips Machine (MONIAC), a pioneering *analog* computing machine. That we celebrate a significant anniversary of an analogue device, in a predominantly digital age, is to highlight the notion that algorithmic mathematics *per se* is not necessarily underpinned by the digital or the discrete only; analogue traditions of algorithmic mathematics have a noble pedigree, even in economics. Constructive mathematics of any variety, computability theory and non-standard analysis are intrinsically algorithmic at their foundations. Economic theory, game theory and

mathematical finance theory, at many of their frontiers, appear to have embraced analogue visions via strong adherences to experimental, behavioural and so-called computational aspects of their domains -- without, however, adapting the mathematical formalisms of their theoretical structures. Recent advances in mathematical economics, game theory, probability theory, statistics and even ethics, suggest that an algorithmic revolution in the social sciences is in the making. In a nutshell, the ASSRU vision is that of the algorithmic social sciences, unified by an underpinning in Diophantine Decision Problems as their paradigmatic framework, could return the social sciences to their humanistic origins, even in some phenomenological – in its philosophical senses – modes. The Diophantine foundations of algorithmic social sciences, in the ASSRU vision re-emphasises the essential roles to be assigned to ambiguities, undecidabilities, uncomputabilities and incompleteness in decision problems.

Computable and Constructive Economics

The fundamental guiding principle of mathematical modeling and theorizing in computable and constructive economics is the Wittgensteinian precept:

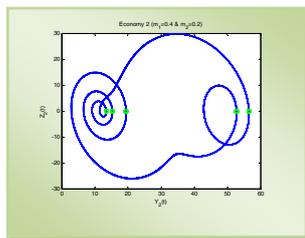
In mathematics *everything* is algorithm and *nothing* is meaning; even when it doesn't look like that because we seem to be using *words* to talk *about* mathematical things. Even these words are used to construct an algorithm.

Ludwig Wittgenstein, **Philosophical Grammar**, p. 468

In computable economics the notion of algorithms is circumscribed by the *Church-Turing Thesis*, as in recursion

theory. In constructive mathematics the notion is *not* formally circumscribed. The key result in computable economics, at least in ASSRU research practice is the theorem of the *Halting Problem for Turing Machines*. The denial of *tertium non datur* and the emphasis on *choice sequences* are the two fundamental principles of constructive mathematics that is carried over to constructive economics, in the ASSRU vision.

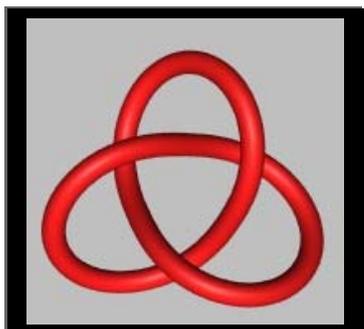
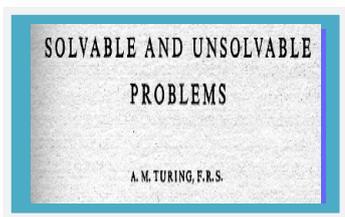
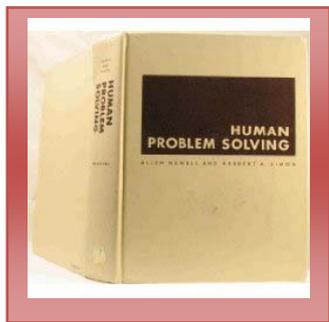
This is in complete contrast to orthodox mathematical economics, economic theory and game theory, where algorithms are devices tagged on to the non-algorithmic mathematics providing their mathematical foundations.



Coupled Economic Dynamics

To go from two identical markets to n nonidentical ones will require the prolonged services of yet unborn calculating machines.

Richard Goodwin,
Econometrica, 1947, p. 204.



Agent Based Economics à la ASSRU

Agent based economic modeling, seems to have become a basis for research in complexity economics, emergent phenomena in economics, microeconomic foundations for macroeconomics, evolutionary economics and much else that is fashionable at various frontiers in economic theory, empirical economics and applied economics. ASSRU work in this area is distinctly unfashionable, from a purely economic point of view; but stands squarely in the tradition of frontier research in algorithmic dynamical systems theory of coupled oscillators. The ASSRU tradition in agent based economic modeling can trace its roots

to the classic multi-market, dynamical coupling, model of *Richard Goodwin*, the *Fermi-Pasta-Ulam* research program and the cellular automata based computable dynamic models developed by *von Neumann*, *Ulam*, *Wolfram* and *Conway*. This research is reported in Stefano Zambelli's recent writings (see ASSRU DPs, #04 & #1, also for the details of the above references).

It may be apposite to mention that Herbert Simon's fertile research program on algorithmic evolution, based on semi-decomposable matrices, has its origins in the above classic by Goodwin.

ASSRU Behavioural Economics Research

At ASSRU we distinguish between *Classical* and *Modern* Behavioural Economics. The former refers to a behavioural economics underpinned by computational cognitive science, computational complexity based decision sciences and human problem solving by boundedly rational agents viewed as Information Processing Systems (*IPS*). This is the ASSRU interpretation of *Herbert Simon's* research program, where computability, computational complexity and decision problems in the sense of metamathematics are the disciplining framework for behavioural and institutional modeling.

We contrast this with Modern Behavioural Economics, which we at ASSRU believe emerges from the pioneering works of *Ward Edwards*, where subjective probability in the De Finetti-Savage tradition underpinned a reformulation of subjective expected utility theory. The role analogous to computability in classical behavioural economics is

played by subjective probability in the modern variant.

Paradigmatic Classical Behavioural Economics work at ASSRU has, thus far, concentrated on formalizing, within a decision problem framework, satisficing behavior by boundedly rational agents, human & machine problem solving and models of (scientific) discovery. In the latter, the work at ASSRU, in the spirit of Simon's critique of Popper's '*Logic of Scientific Discovery*', attempts to return to the traditions of *Charles Sanders Peirce* and *Norwood Russell Hanson* and places emphasis on abduction or retrodution.

Ultimately, however, it is the spirit of Turing's *Solvable and Unsolvable Problems* and *Human Problem Solving* by Simon and Newell that are our guiding foundations.

ASSRU lectures on Behavioural Economics takes the *Trefoil Knot*, and its formal analysis as a puzzle to be solved as the central example with which to study undecidable decision problems.



Books by ASSRU Members, 2010/2011

The following books were published by ASSRU members, as authors or editors, during 2010:

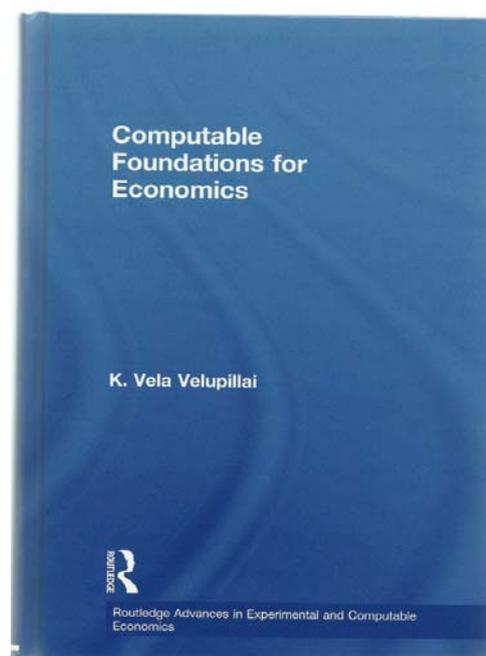
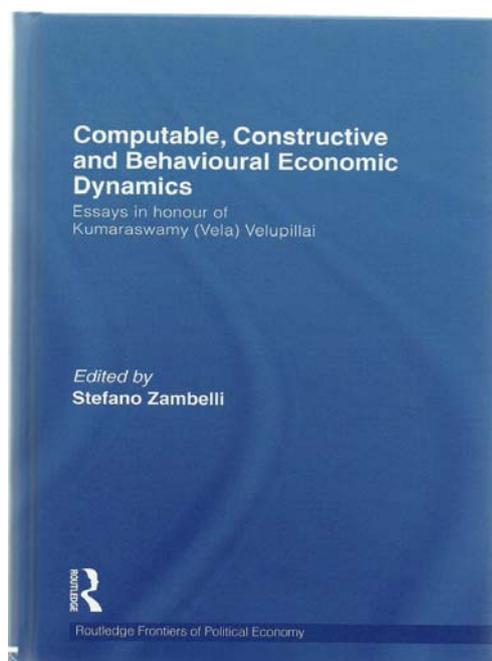
- **Computable, Constructive and Behavioural Economic Dynamics: Essays in Honour of Kumaraswamy (Vela) Velupillai**, edited by Stefano Zambelli, Routledge, London, 2010. This book includes original contributions by, among others, Robert Clower, Paul Samuelson, Robert Solow, Richard Day, Duncan Foley, Geoff Harcourt, Barkley Rosser, Jr., Greg Chaitin, Jorma Rissanen, Joe McCauley, Shu-Heng Chen and Ralph Abraham.
<http://www.routledge.com/books/details/9780415492638/>
- **Computable Foundations for Economics** by K. Vela Velupillai,

Routledge, London, 2010.

<http://www.routledge.com/books/details/9780415355674/>

The following books, edited by ASSRU members, are forthcoming in 2011:

- **The Elgar Companion to Computable economics**, edited by K. Vela Velupillai, Stefano Zambelli & Stephen Kinsella. Edward Elgar Publications, Cheltenham, 2011.
- *Routledge Major Works Series – Volume 1: Behavioural Economics*, edited by Shu-Heng Chen & K. Vela Velupillai. Assisted by Kao Selda & V. Ragupathy (ASSRU) and Chia-Ling Chan & Ting-Yu Chen (AI-Econ Center, NCCU), Routledge, London, 2011.



We can also be found at:

www.assru.economia.unitn.it



"Why are people so afraid to do what von Neumann actually had in mind?"

Alain Lewis

Letter to Velupillai, May 21st, 1992

The Legacy of Alain Lewis in Computable Economics

Alain Lewis was there, before the beginning of what I eventually came to call *Computable Economics*. His focus was on investigating the *effective content* of neoclassical economic theory and game theory. His emphasis was on the recursion theoretic re-founding of mathematical economics – including game theory – and towards this end he contributed several path-breaking papers in the 1980s.

To the best of my knowledge his work did not take into account the possibilities of constructive mathematical theorizing in economics.

He, together with Herbert Simon and Richard Goodwin, are the true pioneers of *Computable Economics*, in the sense in which Borges made

famous: ‘Every writer creates his own predecessors’ I could not have asked for greater, wiser, predecessors than this extraordinary trio.

I did not meet Alain Lewis till February, 1990, when I visited UC Irvine with John McCall. Alain Lewis had a first draft of a book manuscript titled, tentatively, *Structure and Complexity: The Use of Recursion Theory in the Foundations of Neoclassical Economics and the Theory of Games*. I offered, with pleasure, to help him have it published.

Alas, for reasons unknown to me, all communications with Alain ceased in the mid-1990s.

We hope, at ASSRU, to honour this pioneer, in some appropriate way, in the near future.

Vela Velupillai

Maury Osborne and Algorithmic Mathematical Finance Theory

Maury Osborne’s classic, **The Stock Market and Finance from a Physicist’s Viewpoint**, was the first graduate level – or, indeed any level – book on any topic in economics or finance to try to make known to its readers the possible implications of recursive undecidability for decision problem in investment theory, in particular. The ‘warning’, in view of Gödel’s and Turing’s results, ‘what not to try to do with limited ideas or information’, went unheeded in the frenzy of the orthodox

mathematization of finance theory. It is still little acknowledged, by those who indulge in mathematical modeling of financial markets and behavior in such markets, that there is a perfectly rigorous *algorithmic probability theory*, with which to take heed of Osborne’s ‘warning’, and yet not be paralysed in rational action. After all, it is in looking for algorithmic foundations for the frequency theory of probability that Martingales came into being (see ASSRU DP # 13 and **Probability and Finance: It’s Only a Game** by

“[The] discovery or rediscovery of Louis Bachelier’s 1900 Sorbonne thesis, ‘*Théorie de la spéculation*’, began only in the middle of the twentieth century, and initially involved a dozen or so postcards sent out from Yale by the late Jimmie Savage..... in paraphrase, the postcard’s message said, approximately, ‘Do any of you economist guys know about a 1914 French book on the theory of speculation by some French professor named Bachelier?’.... [O]pportunistically I suggested replacing Bachelier’s absolute Gaussian distribution by ‘geometric’ Brownian motion based on log-Gaussian distributions. Independently, the astronomer M.F.M. Osborne made the same suggestion.....”

Paul Samuelson, 2006
Foreward to **Louis Bachelier’s Theory of Speculation: The Origins of Modern Finance**

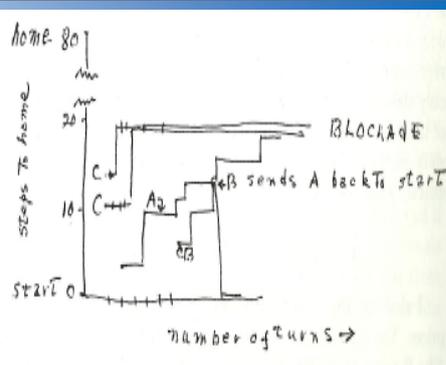
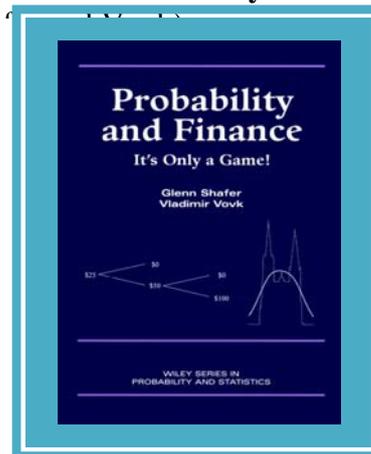
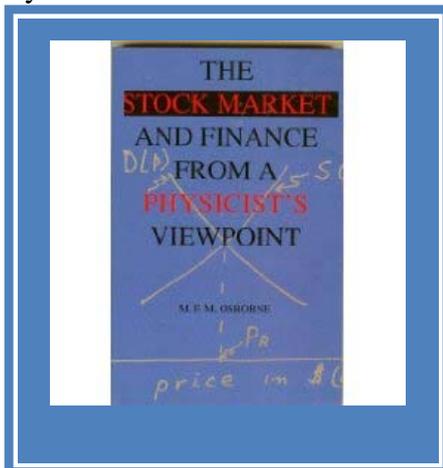


Figure 3.6-1 (Osborne)



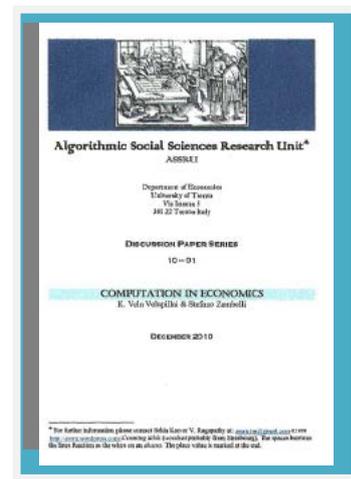
ASSRU Discussion Papers



An ASSRU Discussion Paper Series has been initiated, together with this Newsletter, as part of the inaugural activities on the formal establishment of ASSRU. The full series will shortly be uploaded in the new ASSRU website (address given below).

A selection from the first twenty DPs, to be issued this month, is as follows:

- Computation in Economics, by K. Vela Velupillai and Stefano Zambelli, **DP #1**.
- The Epistemology of Simulation, Computation and Dynamics in Economics, by K. Vela Velupillai and Stefano Zambelli, **DP # 2**
- An Algorithmic Measurement of Technological Progress by Stefano Zambelli and Thomas Fredholm, **DP # 6**
- Behavioural Complexity by Sami Al-Suwailem, **DP # 12**
- An Algorithmic Information-Theoretic Approach to the Behaviour of Financial Markets by Hector Zenil and Jean-Paul Delahaye, **DP # 13**
- Complexity and Randomness in Mathematics: Philosophical Reflections on the Relevance for Economic Modelling by Sundar Sarukkai, **DP # 14**
- Reflections on Mathematical Economics in the Algorithmic Mode by K. Vela Velupillai, **DP # 16**
- Emergent Complexity in Agent-Based on Computational Economics by Shu-Heng Chen and Shu G. Wang, **DP # 17**
- Equilibrium vs. Market Efficiency: Randomness vs. Complexity in Finance Markets by Joe Mc Cauley, **DP # 18**



ASSRU editorial and organizational activities, 2010/2011

- Vela Velupillai and Stefano Zambelli are the Editors of the Routledge Series on *Experimental and Computable Economics*. The next book to be published in this series, in 2011, will be by Professor Shu-Heng Chen, an Associate of ASSRU, on **Agent Based Economic Modelling**.
- Stefano Zambelli is the Invited Editor of the Themed Issue on *Nonlinearity, Complexity and Randomness* of the **Journal Economic Surveys**, Vol. 25, #1, 2011.
- Professor Shu-Heng Chen, Director of the AI-Econ Center & the Experimental Economics Laboratory at National Chengchi University, Taipei, will be a Visiting Professor in the department of economics, Trento, under ASSRU auspices. He will be working with Vela Velupillai on completing the *Routledge Major Works Series* volumes on **Behavioural Economics** during his visit.
- Vela Velupillai is a Member of the *Turing Centennial Advisory Committee*. See: <http://www.mathcomp.leeds.ac.uk/turing2012/>



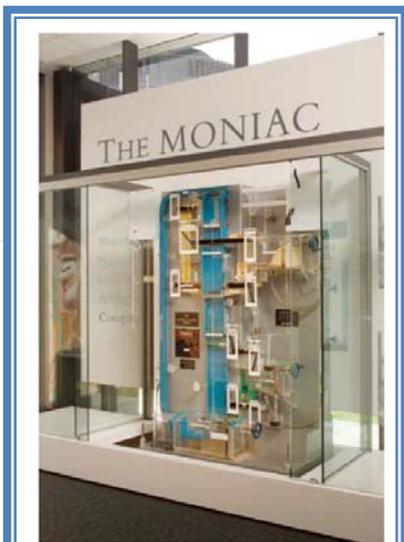
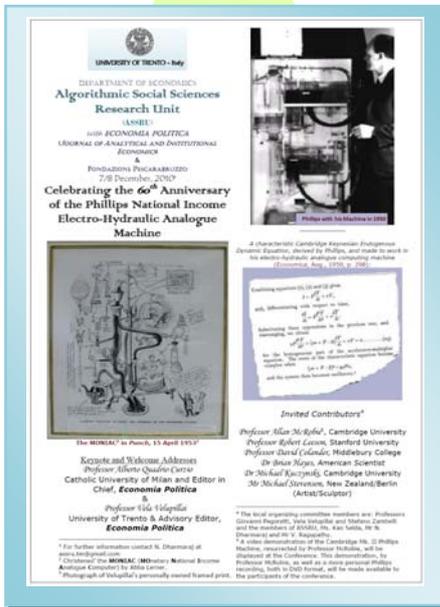
Delians: "How can we be rid of the plague?"

Delphic Oracle:: "Construct a cubic altar of double the size of the existing one."

Banach & Tarski: "Can we use the *Axiom of Choice*."

Stan Wagon

Celebrating the 60th Anniversary of the MONIAC



MONIAC at *The Reserve Bank of New Zealand Museum*

ASSRU Honorary Patrons

Richard Day
John McCall
Björn Thalberg

A.W.H Phillips belongs to the select few macroeconomists of the 20th century, together with Wicksell, Keynes, Samuelson, Friedman, Solow and Lucas, to have become an icon of the subject, among all schools of macroeconomic thought. *The Phillips Curve*, entered the vocabulary of every macroeconomist, whether one approved its content or not, joining the few other great summarizing phrases of macroeconomic theory, the natural rate of interest, the multiplier, rational expectations, the Solow residual, the Lucas Critique, etc.

Few – even among macroeconomists – realize, however, that the first comprehensive analogue computing machine, encapsulating a version of the nascent Keynesian Monetary Macrodynamics of the late 1940s, was built as an electro-mechanical-hydraulic machine by Phillips and first demonstrated at Lionel Robbins' seminar at the LSE, in November, 1949. It was later 'christened' the **MONIAC** – **Monetary National Income Analogue Computer** – by that vintage Keynesian, Abba Lerner, who made tireless attempts to make it a standard pedagogical and policy tool at Universities, Central Banks and (large) Corporations, with considerable success, for a brief period.

In the August, 1950 issue of the LSE 'house' Journal, **Economica**, Phillips published *Mechanical Models in Economic Dynamics*, explicating the Keynesian macrodynamic theoretical principles underpinning the workings of the ingenious analogue computing machine he had constructed. It was a presaging of what eventually was to become his 1953, LSE PhD thesis (unpublished), *Dynamic Models in Economics*.

The **Algorithmic Social Science Research Unit (ASSRU)**, at the department of economics of the

University of Trento, in collaboration with **Economia Politica**, celebrates the 60th anniversary of this event, on the 7th & 8th of December, with an International Conference, at which some of the pioneering contributors to the subject of the MONIAC, and its remarkable creator, will be delivering original lectures.

Among the distinguished international lecturers at the Conference are, David Colander (Middlebury College), Brian Hayes (American Scientist), Michael Kuczynski and Allan Mc Robie (Cambridge University), Robert Leeson (Stanford University & The Hoover Institution), Rosalind Reid (Harvard University) and Michael Stevenson (Berlin).

As a 'postscript' to the conference, a Special Lecture, on *How Should We Prepare Students for Attacking New Scientific Problems with Computation*, will be delivered by Rosalind Reid, the Executive Director of the *Institute of Applied Computational Science at the Harvard School of Engineering and Applied Sciences*, on Thursday, 9 December, at 10.00 AM.

The proceedings of the conference will be published in Special Issues of **Economia Politica**, in the first two numbers of the volume for 2011.

The conference and the *Special Lecture* take place in the *Sala Conferenze*, department of economics, University of Trento.

The Conference is sponsored by the Department of Economics and CIFREM, University of Trento, *Economia Politica* and, *The Fondazione Pescarabruzzo*.

ASSRU Founding Honorary Associates:

Shu-Heng Chen (Taipei)
Stephen Kinsella (Limerick)
Sami Al-Suwailem (Jeddah)
Francesco Luna (Washington, DC)
Charlotte Bruun (Aalborg)
Sundar Sarukkai (Bangalore)
Hector Zenil (Paris)
Thomas Fredholm (Aalborg)
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