30 Years of Computational Autopoiesis: A Review

Barry McMullin
Dublin City University
Barry.McMullin@dcu.ie

From Autopoiesis to Neurophenomenology: A Tribute to Francisco Varela
(FoilTEX Presentation)
Preamble . . .

. . . I particularly remember a discussion over dinner one evening during the third ECAL (Grenada, Spain, in 1995), where he dazzled me not only with his ability to maintain three simultaneous conversations with different people, but to do so in three (or more?) different languages, switching continuously between them!
Outline

• Origins
• The Minimal Model
• Elaboration (I)
• Diversification
• Conjecture and Refutation
• Lessons for Methodology?
• Elaboration (II)
  – Individuation
  – Direct Descendants
  – Lattice Artificial Chemistry
• Related Developments
• Conclusion

From Autopoiesis to Neurophenomenology: A Tribute to Francisco Varela [p. 2]
Origins

... the simulation rapidly provided the results our intuition had led us to expect: the spontaneous emergence in this artificial bi-dimensional world of units which self-distinguished by means of the formation of a ‘membrane’, and which showed a capacity of self-repair.
The Minimal Model

From Autopoiesis to Neurophenomenology: A Tribute to Francisco Varela [p. 4]
In conclusion, it is evident that the system A, B, M could be extended to a three dimensional system. [However] it is judged that the implementation of a three dimensional model would involve difficulties which are not worth overcoming at this stage, as the extension of the proposed model to three dimensions would not involve any conceptual modifications. [Handwritten] In the three dimensional model the motion of the @ and M- particles would take place in a three dimensional space. The chains of M* [particles] would now become surfaces, with edges composed of M+ [particles] capable of “capturing” new M- [particles] allowing the surface to grow and close, enclosing the @ particle. The volume inside this “spherical-membrane” would become populated by M- particles, ready to repair the “membrane” at the points where it is destroyed [disrupted?] by disintegration of the M* particles.

–Varela & Maturana Protobio 1971 (?)
Elaboration (I)

- Zeleny: APL-Autopoiesis
- Growth, Morphology, Oscillation
- Self-reproduction
- BUT:
  - Non-local interaction?
  - Non-random motion?
  - Time dependent dynamics?
- Show me the source code...
Diversification

• Maturana & Varela . . .
• Milan Zeleny collections
• Pier Luigi Luisi: Wet Autopoiesis
• Gail Raney Fleischaker: Simulation or Realisation?
Conjecture and Refutation

- von Neumann and evolutionary automata
- Artificial Darwinism - The Very Idea!
- Just unite von Neumann and Varela et. al. models...
But...
Protobio Re-discovered

- FORTRAN IV code (!?)
- Contemporary discursive description
- Reverse engineering . . .
- . . . leads to *chain-based* bond inhibition
So?

... The non-computability of Autopoietic systems, as advanced here, apparently collides with the simulation results involving tessellation automatas. But new versions of this simulation show that the original report of computational autopoiesis was flawed, as it used a non-documented feature involving chain-based bond inhibition. Thus the closure exhibited by tessellation automatas is not a consequence of the “network” of simulated processes, but rather an artifact of coding procedures.

Lessons for Methodology?

- APL-autopoiesis: may never know.
- Protobio: finally rediscovered.
- *Show me the source code*...
Elaboration (II)

• Individuation:
  – Colectively Autocatalytic Set + Boundary
  – Heuristic test . . . .
  – Alcheny?
  – $\alpha$-Universes?
  – Tierra?
Elaboration (II)

• Direct Descendants
  – Breyer et. al.: Flexible membrane, growth, SR?
  – McMullin & Groß(Chu): Flexible membrane, growth, SR?

---

From Autopoiesis to Neurophenomenology: A Tribute to Francisco Varela [p. 14]
Elaboration (II)

- Lattice Artificial Chemistry
  - Ono & Ikegami
  - Coarse Graining
  - Growth, SR
  - Selection (!?)
Related Developments

• Ganti: Chemoton
• Alcheny?
• $\alpha$-Universes?
• Tierra?
• Formalisation: Rosen?
Varela the Scientist . . .

Francisco Varela was, of course, a brilliant and original scientist. . . .

From Autopoiesis to Neurophenomenology: A Tribute to Francisco Varela [p. 17]
. . . Varela the Man

. . . But my enduring memory is of Francisco the man: his enthusiasm, his infectious good humour, his idealism, and his sheer appetite for life. He is sorely missed.
Related Online Resources

- Full Paper:
- DCU Alife Laboratory:
  - http://www.eeng.dcu.ie/~alife/
- Research Institute for Networks and Communications Engineering (RINCE):
  - http://www.rince.ie/
Copyright

This work is copyright ©2004 by Barry McMullin.

Permission is hereby granted to private individuals to access, copy and distribute this work, for purposes of private study only, provided that the distribution is complete and unmodified, is accompanied by this copyright notice, and that no charges are levied. The work may not be accessed or copied, in whole or in part, for commercial purposes, except with the prior written permission of the author.

All other rights reserved.

From Autopoiesis to Neurophenomenology: A Tribute to Francisco Varela [p. 20]