Who Needs Genomes?

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

Tim Taylor
Tim.Taylor@abertay.ac.uk
University of Abertay Dundee

Axel von Kamp
Dublin City University
Axel.vonKamp@rince.ie

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Apologies...

We have inherited from our forefathers the keen longing for unified, all-embracing knowledge. The very name given to the highest institutions of learning reminds us, that from antiquity and throughout many centuries the universal aspect has been the only one to be given full credit. But the spread, both in width and depth, of the multifarious branches of knowledge during the last hundred odd years has confronted us with a queer dilemma. We feel clearly that we are only now beginning to acquire reliable material for welding together the sum total of all that is known into a whole; but, on the other hand, it has become next to impossible for a single mind fully to command more than a small specialized portion of it.

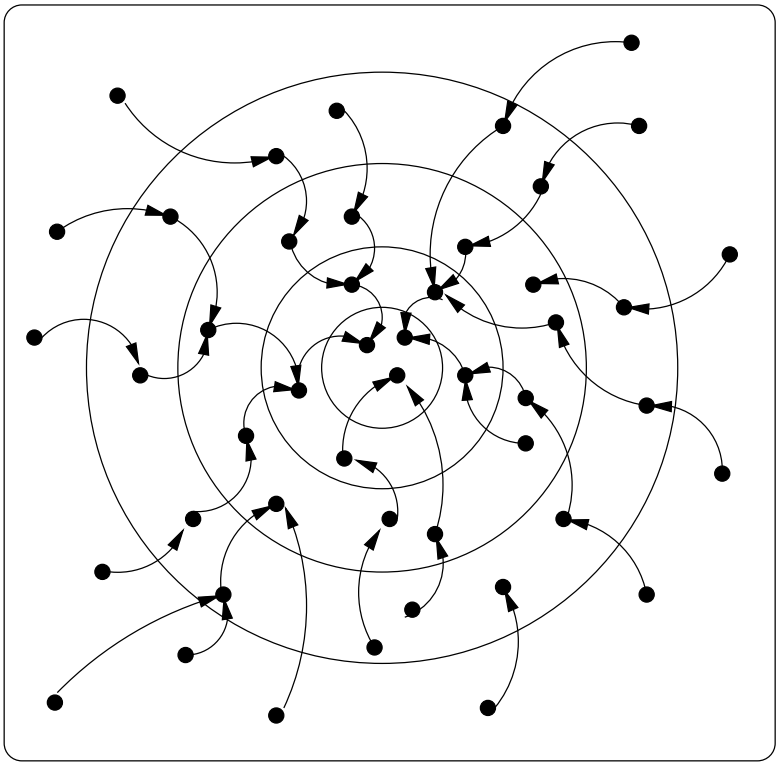
I can see no other escape from this dilemma (lest our true aim be lost forever) than that some of us should venture to embark on a synthesis of facts and theories, albeit with second-hand and incomplete knowledge of some of them and at the risk of making fools of ourselves.

—Erwin Schrödinger (1944; Preface to What is Life?)

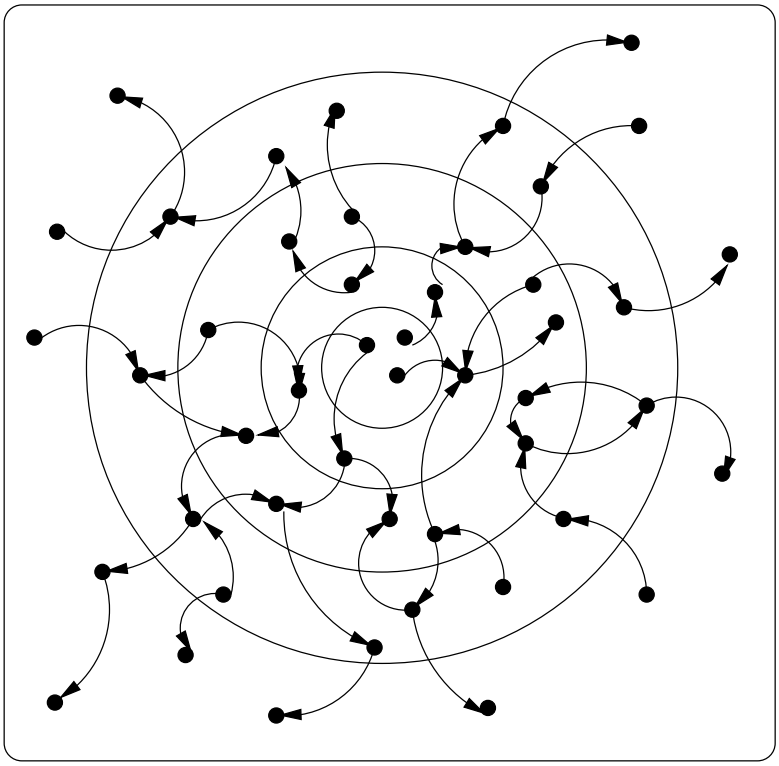
Evolvability—of what?

- *von Neumann's Problem*: How can machines manage to construct other machines more "complex" that themselves, in a general and open-ended way—i.e., sustaining an unbounded evolutionary growth of complexity.

Degeneration of Complexity (Engineering)



Growth of Complexity (Biology)



Template Reproduction

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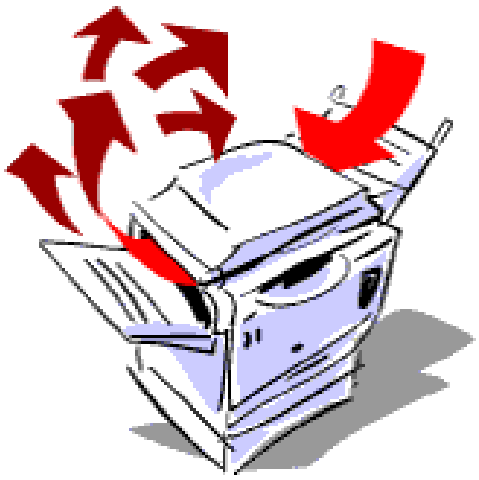

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Template Reproduction

- GAAGTACACG $\rightsquigarrow$ GAAGTACACG (???)

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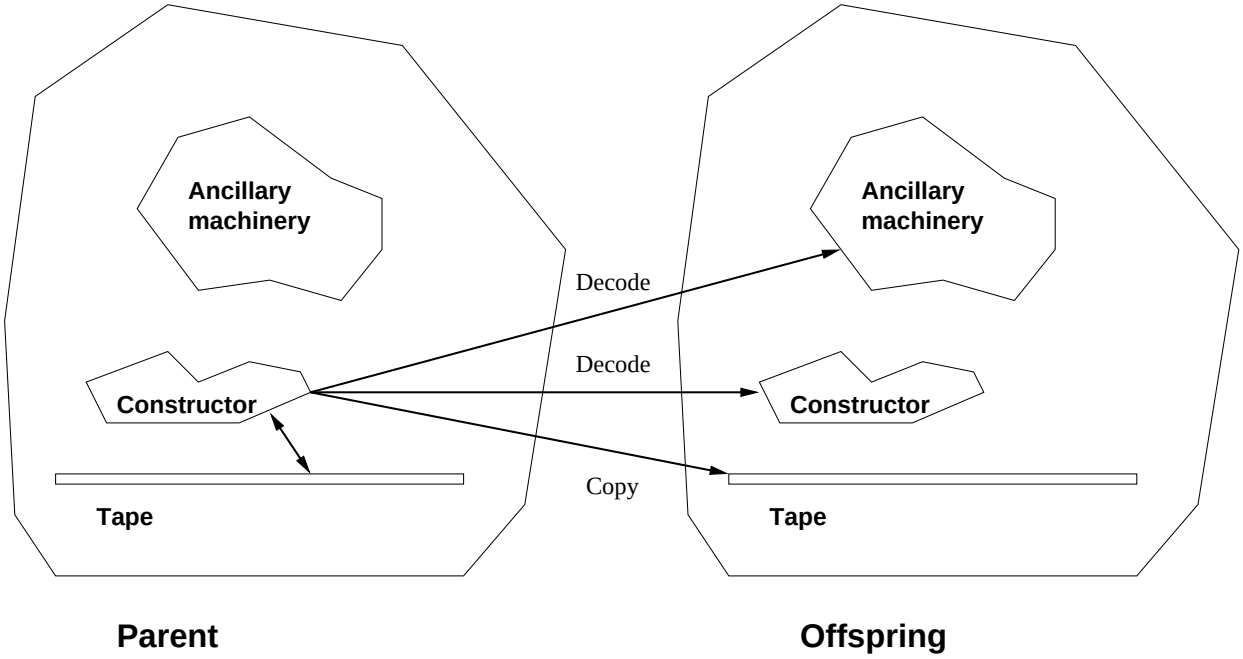
- Penrose "blocks" (Scientific American, Vol. 200, No. 6., pages 105-114, June 1959).

The (Other) Von Neumann Machine



So Why Bother?

- Copying relies on quiescence (*snapshot*!)

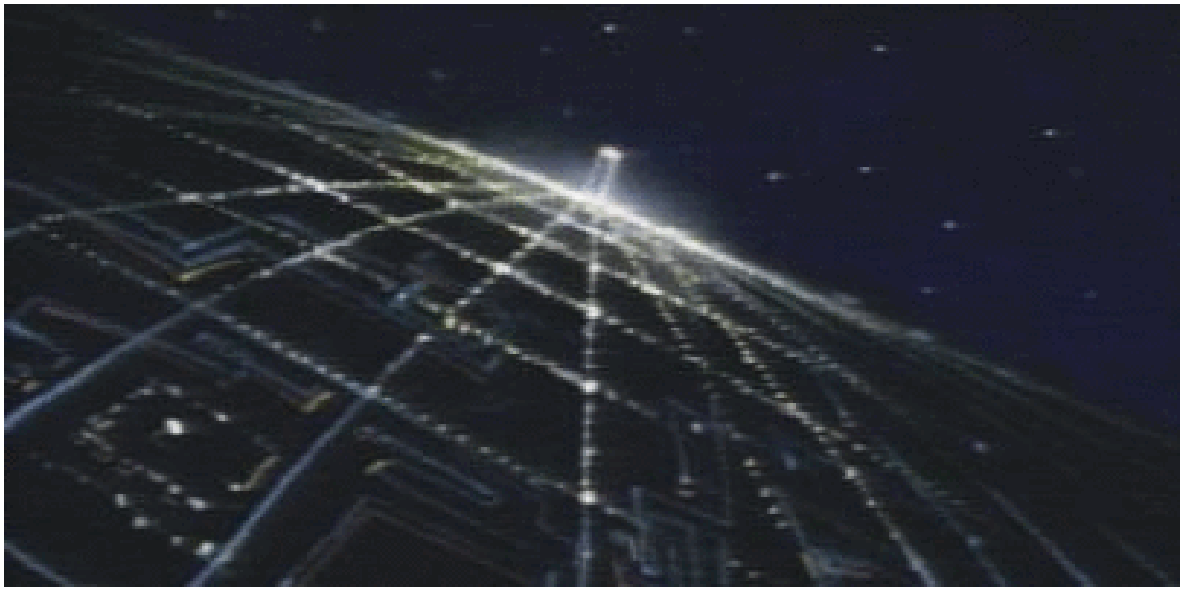
©http://brightbytes.com

So Why Bother?

- Copying relies on access to inspect the internals:

`http://home.planet.nl/~Philip.van.Egmond/onmogeli/onmog1-e.htm`

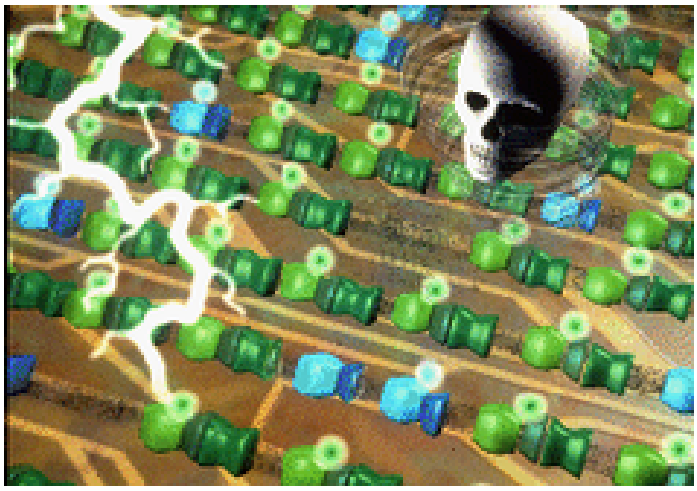
But in Cyberspace?



http://www.3gcs.com/tron/

But in Cyberspace?

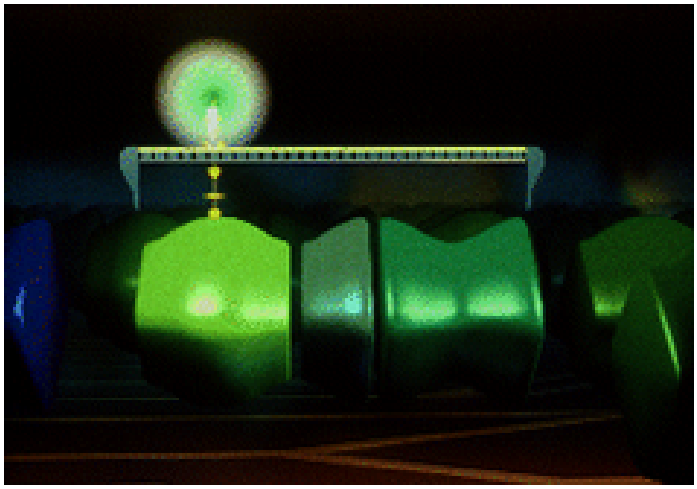
- Tom Ray's `Tierra` System:



- Self-replicating computer programs (colored geometric objects) occupy the RAM memory of the computer. Mutations (lightning) cause random changes in the code. Death (the skull) eliminates old or defective programs.

But in Cyberspace?

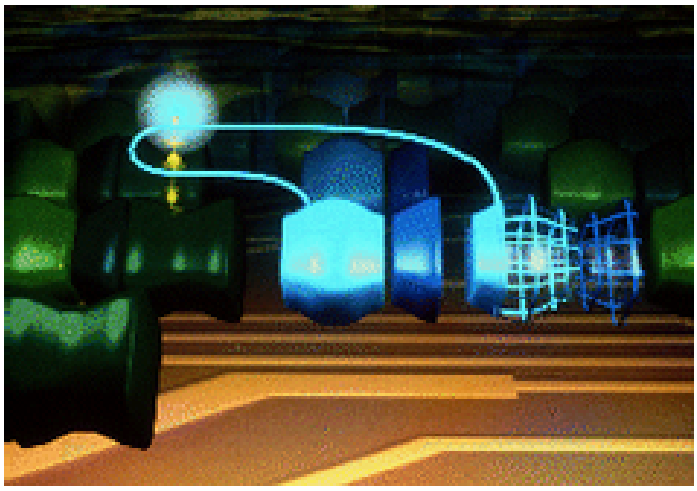
- Tom Ray's `Tierra` System:



- The Ancestral Program, a self-replicating program that is used to start up the system. It consists of three "genes" (green solid objects). The CPU (green sphere) is executing code in the first gene, which causes the program to measure itself.

But in Cyberspace?

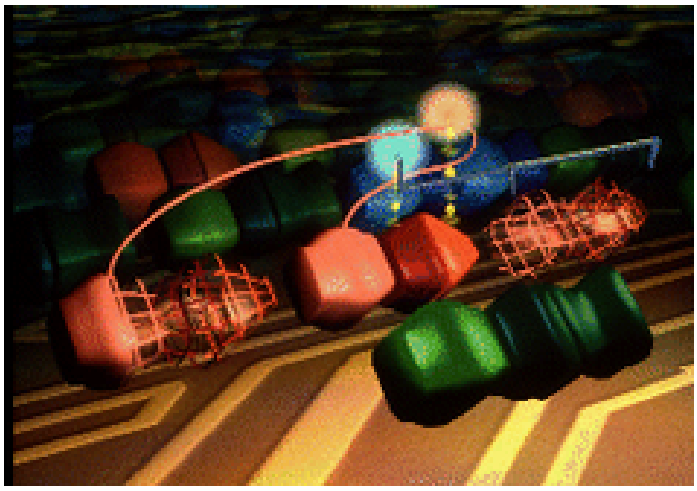
- Tom Ray's `Tierra` System:



- A Parasite (blue, two piece object) uses its CPU (blue sphere) to execute the code in the third gene of a neighboring host organism (green) to replicate itself, producing daughter parasite (two-piece wire frame object).

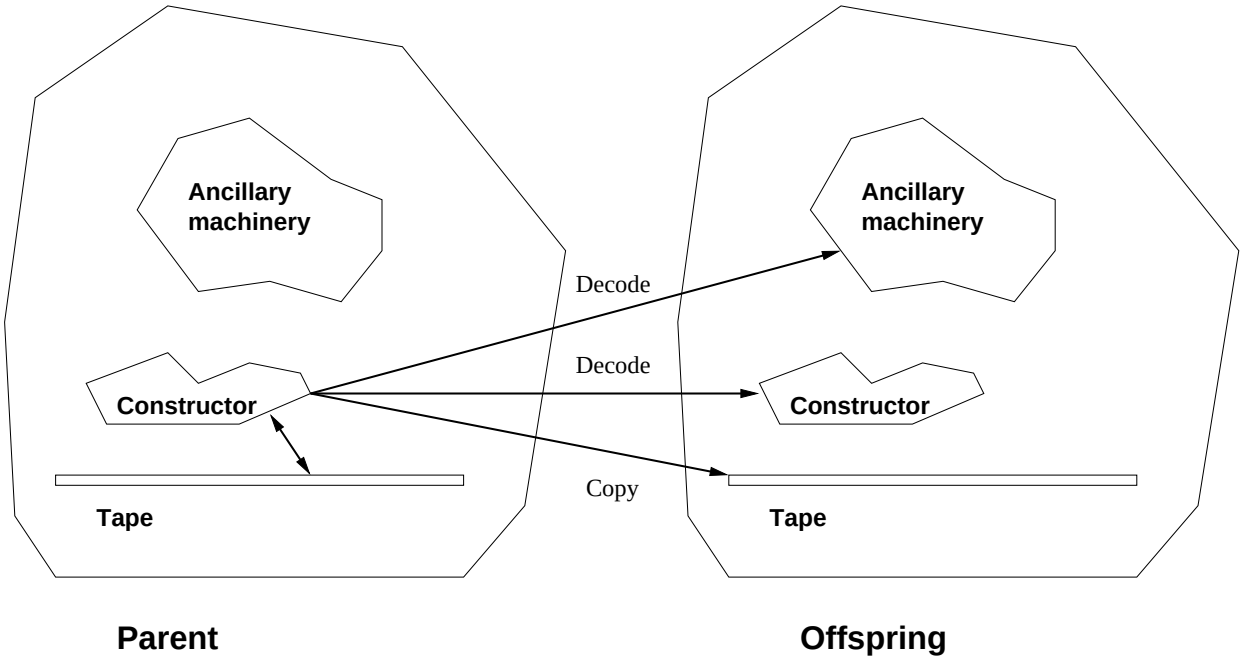
But in Cyberspace?

- Tom Ray's `Tierra` System:



- A Hyper-parasite (red, three piece object) steals the CPU from a parasite (blue sphere). Using the stolen CPU, and its own CPU (red sphere) it is able to produce two daughters (wire frame objects on left and right) simultaneously.

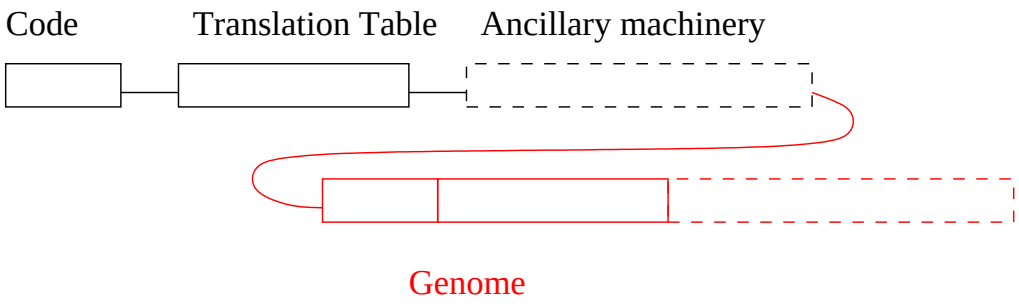
The Von Neumann Machine (Reprise)



- What happens if a mutation affects the (offspring) *constructor*?

Can this work? *(Very preliminary!)*

- Von Neumann's original system too cumbersome and fragile.
- What About Tierra?



- Ancestor Phenotype + (remote) Descendant Genome is *sterile*.

Whither Evolvability?

- Dollo's law revisited.
- The evolution of evolvability.
- *A grand and almost untrodden field of inquiry will be opened, on the causes and laws of variation...*
  (Darwin, Origin of Species, Chapter XV)

Related Online Resources

- Full Paper:
  - `http://www.eeng.dcu.ie./~alife/bmcm-cbgi-2001/`
- DCU Alife Laboratory:
  - `http://www.eeng.dcu.ie/~alife/`
- Research Institute for Networks and Communications Engineering (RINCE):
  - `http://www.rince.ie/`

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