

Artificial Ecosystems for Creative Discovery

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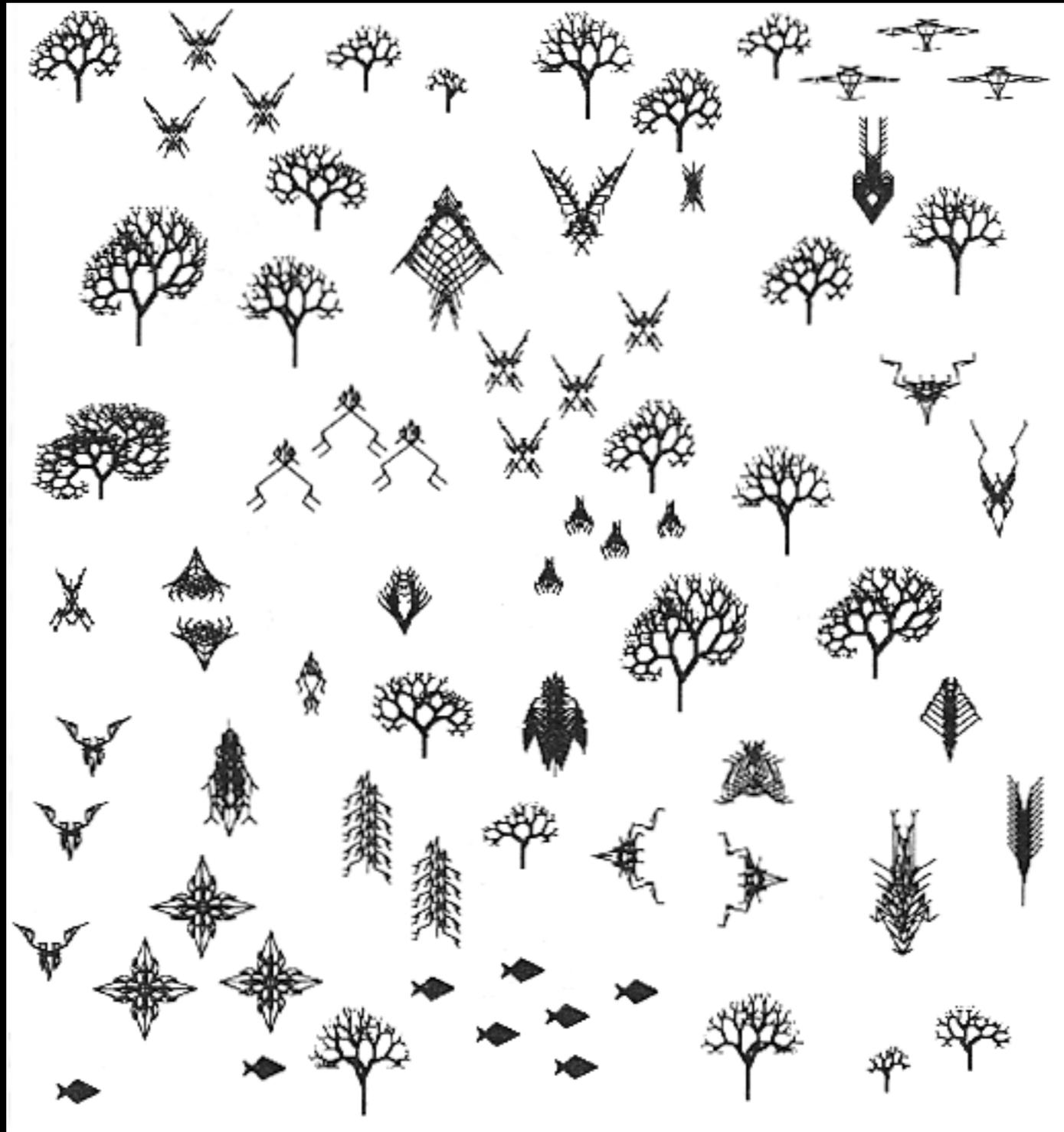
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Computational Creative Discovery

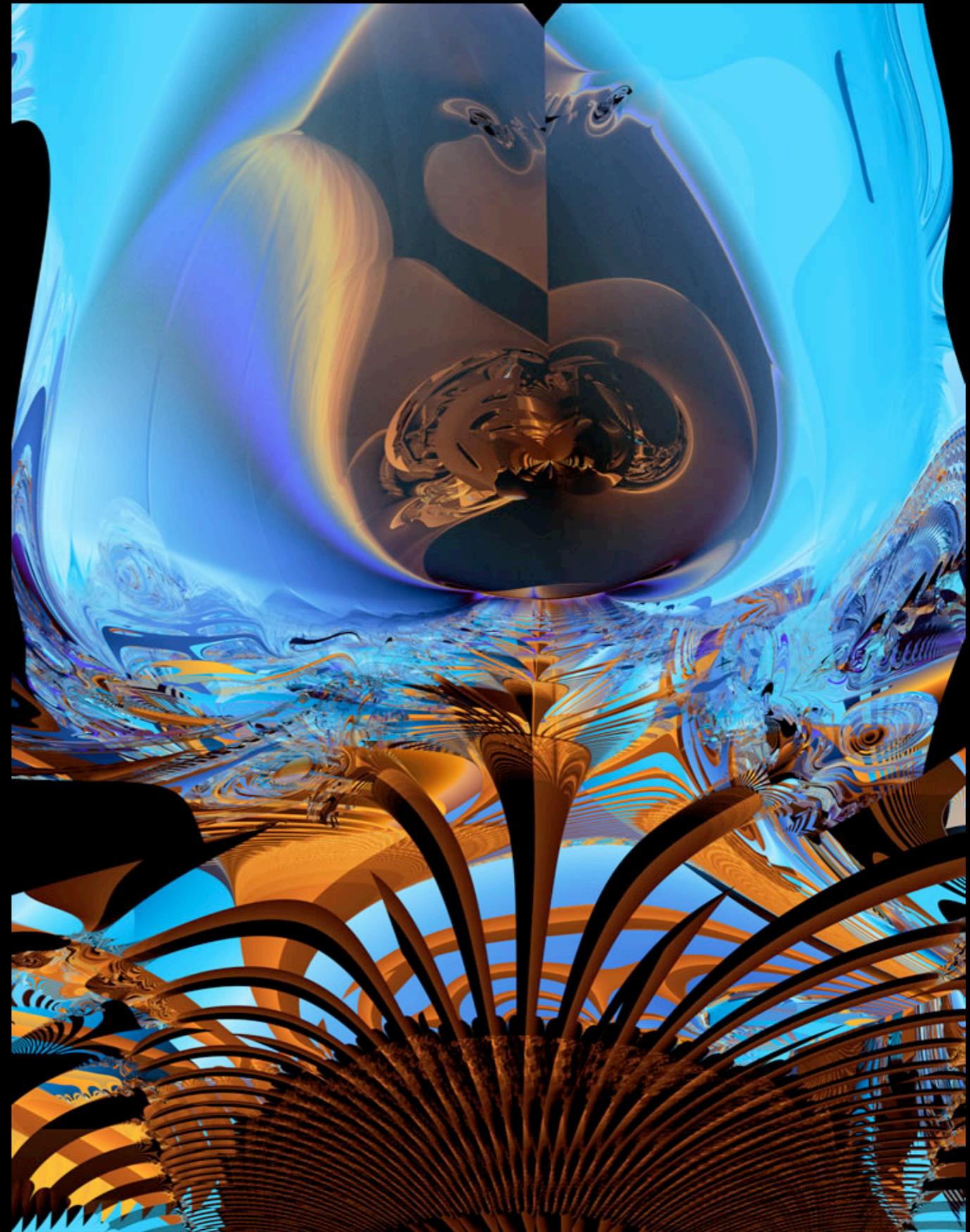
- ▶ Evolutionary synthesis is creative, able to discover (for example) prokaryotes, eukaryotes, higher multi-cellularity and language through a non-teleological process of replication and selection.
- ▶ We would like to adapt the processes of evolutionary adaptation to problems of creative discovery (either machine initiated or human-machine).
- ▶ The aim is to structure these artificial ecosystems in such a way that they exhibit novel discovery in a creative context rather than a biological one.
- ▶ In the past, many EC algorithms have downplayed the role of environment and interactions between biotic and abiotic components.



Biomorphs

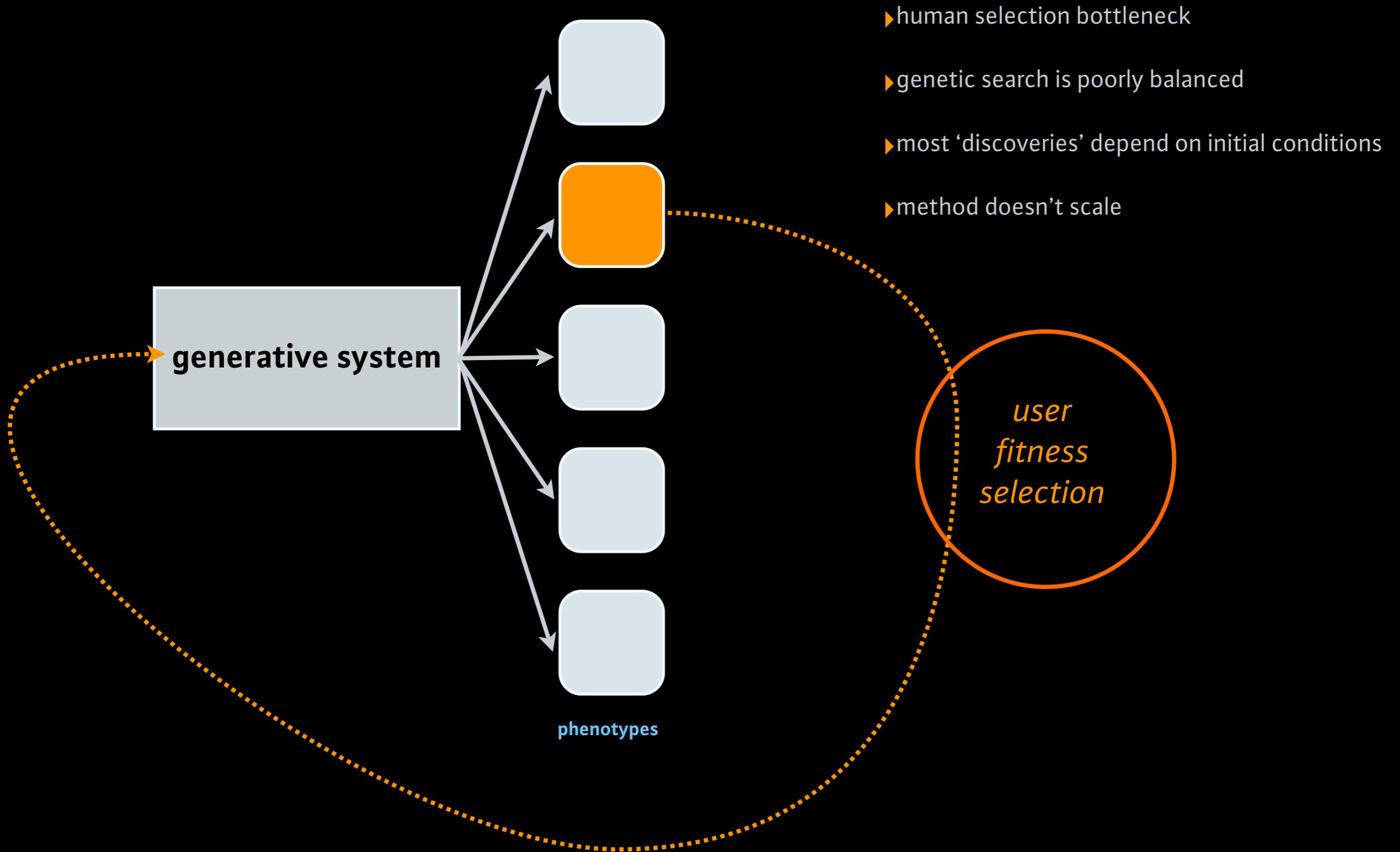
Richard Dawkins, *The Blind Watchmaker*, 1986

Evolved Image
Steven Rooke, 1998



Evolved Image
Karl Sims, 1991

Interactive Genetic Algorithm



Artificial Ecosystems

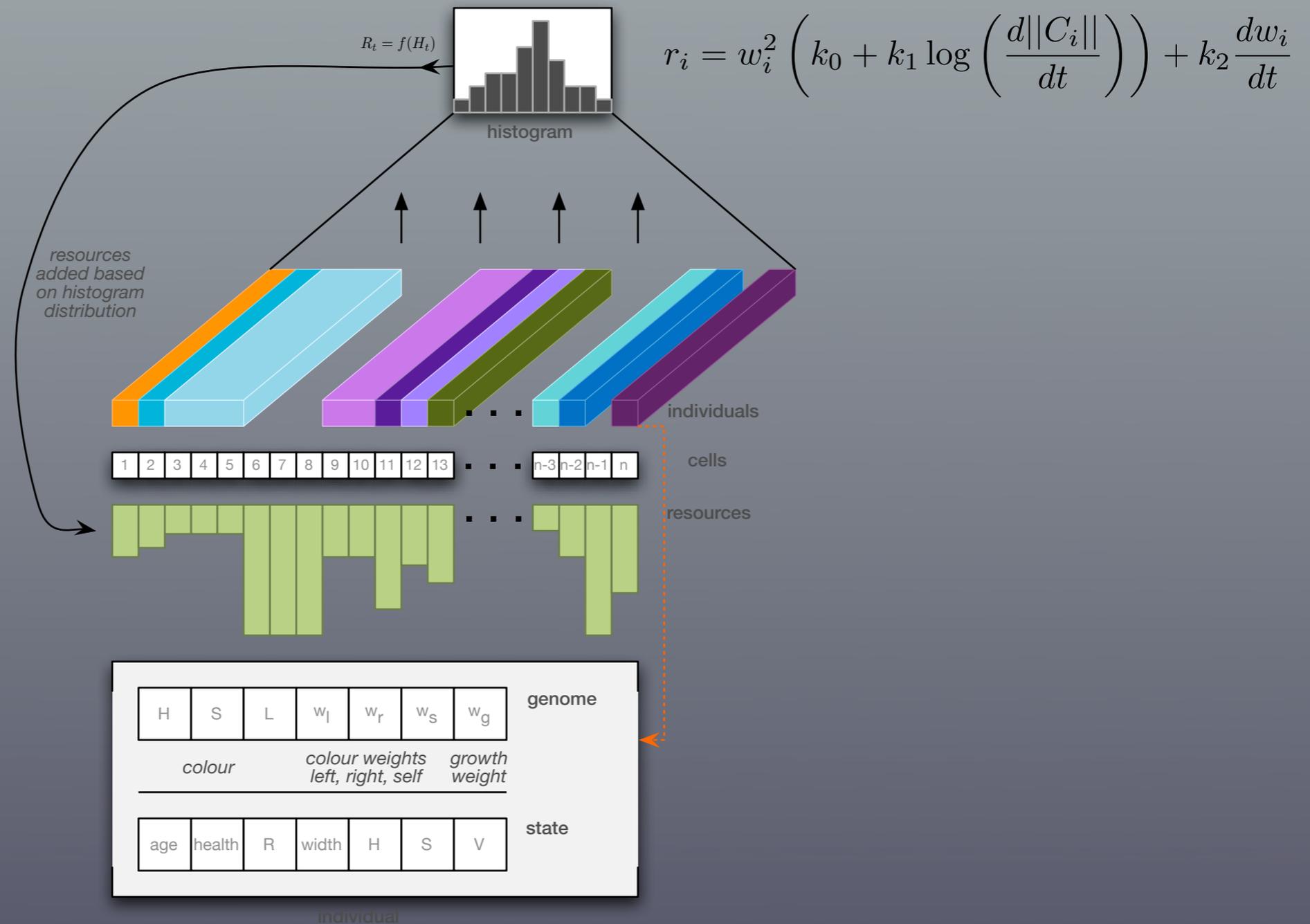
- ▶ A new kind of Evolutionary Computing algorithm, particularly for creative discovery
- ▶ No explicit fitness function: agents evolve to fit their environment
- ▶ Gives more consideration to the role of the environment and the interactions between biotic and abiotic components
- ▶ Macro properties emerge as a simulation outcome, from the interaction of (specified) micro components
- ▶ Knowledge is encoded in the environment (a different knowledge representation scheme)
- ▶ Environment acts as a kind of ‘memory’
- ▶ Heterogeneous environments
- ▶ Homeostasis, mutualism, symbiosis, parasitism...

Essential Properties and Processes

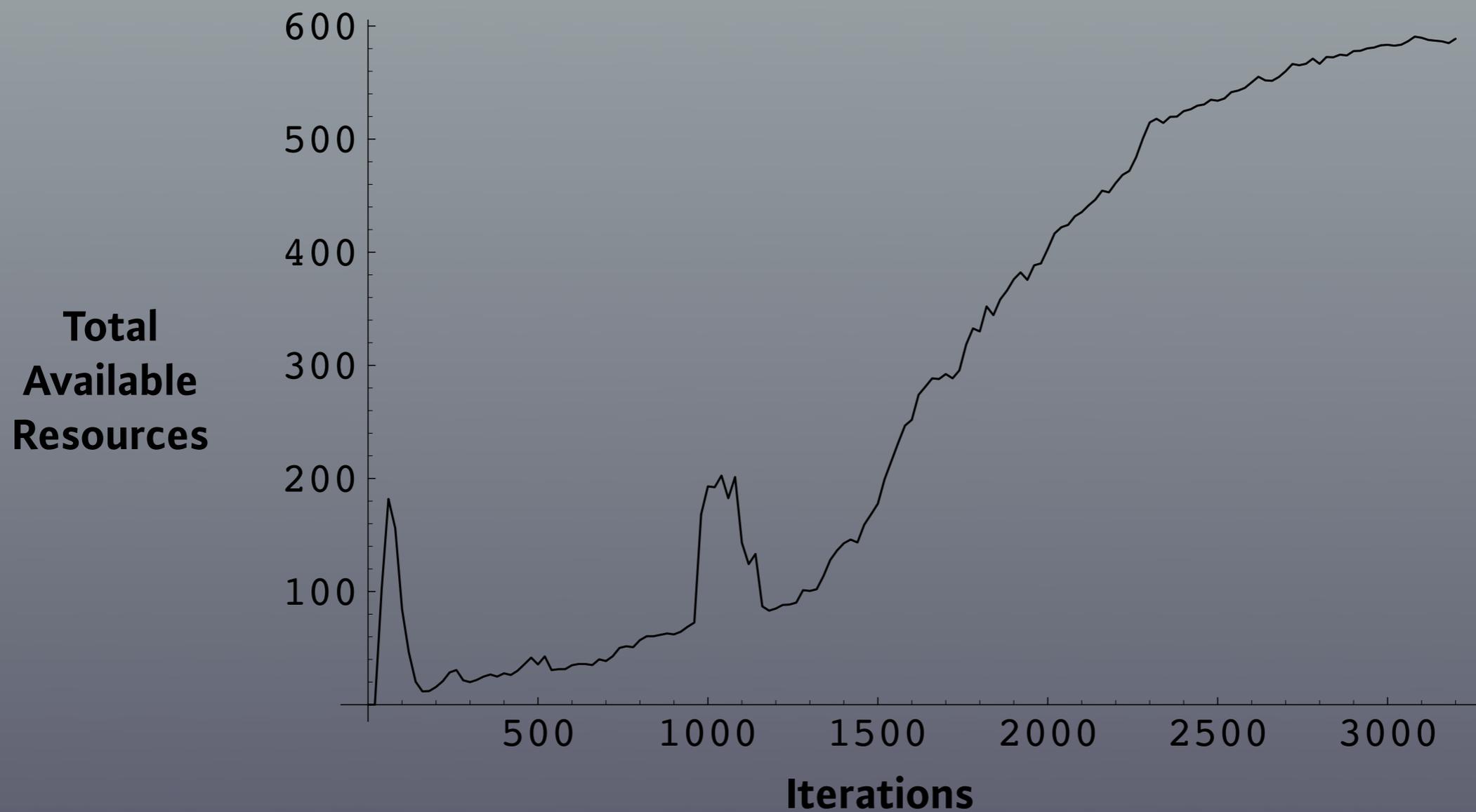
- ▶ The concept of **genotype** and **phenotype** produced through enaction of the genotype;
- ▶ Groups of individuals represent **species**, multiple species are possible;
- ▶ **Spatial distribution** and (optionally) movement of individuals;
- ▶ The ability of individuals to **modify** and **change** their environment (either directly or indirectly as a result of their development within, and interaction with, the environment);
- ▶ the concept of individual **health** as an abstract scalar measure of an individual's success in surviving within its environment over its lifetime;
- ▶ the concept of an individual **life-cycle**, in that an individual undergoes stages of development that may affect its properties, physical interaction and behaviour;
- ▶ the concept of an **environment** as a physical model with consistent physical rules on interaction and causality between the elements of the environment;
- ▶ An **energy-metabolism resource** model, which describes the process for converting energy into resources that may be utilised by species in the environment to perform actions (including the production of resources).

Example: Colourfield

- An ecosystem of colour, operating in a one-dimensional world



Example: Resource Maximisation

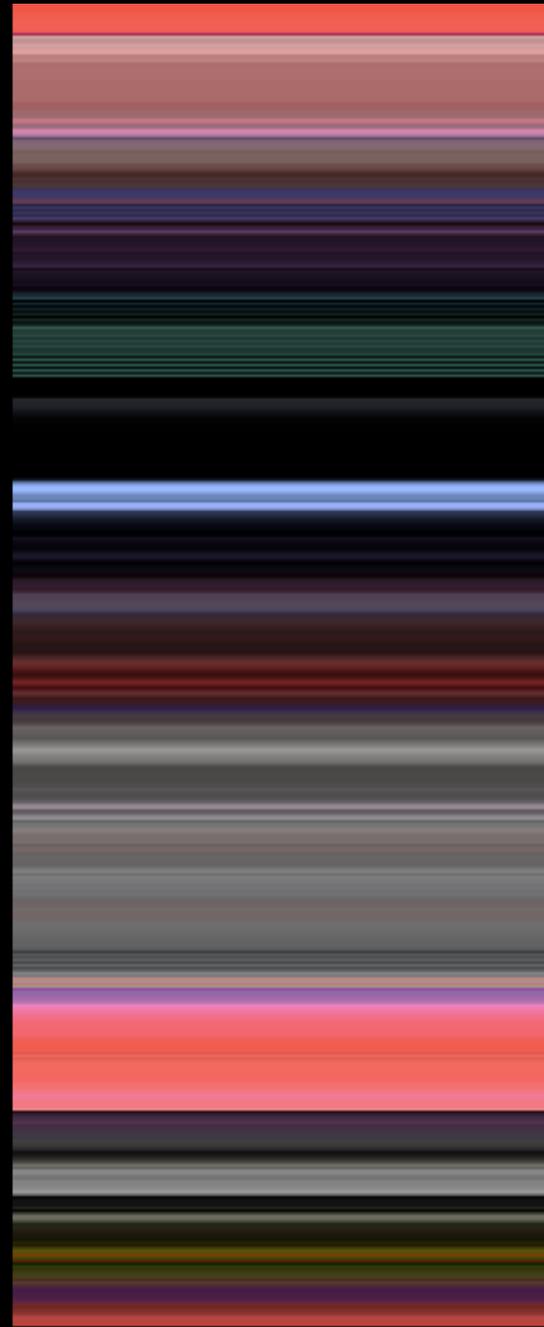


Colourfield

Ecosystem development over 5000 time steps
(warm colour bias function)



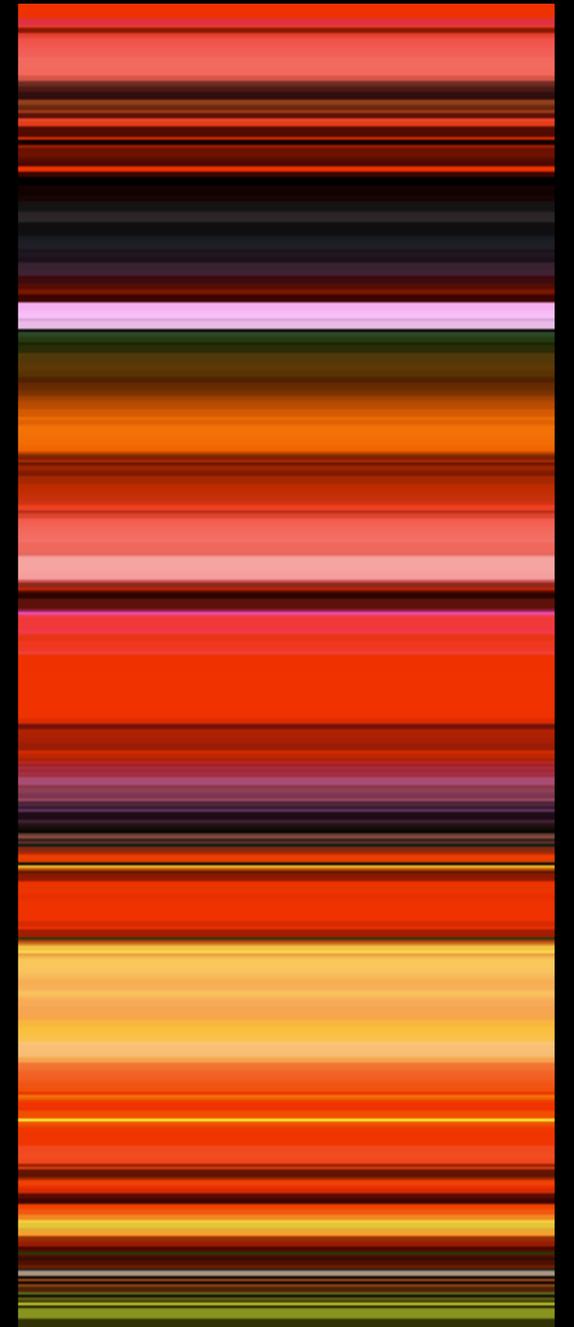
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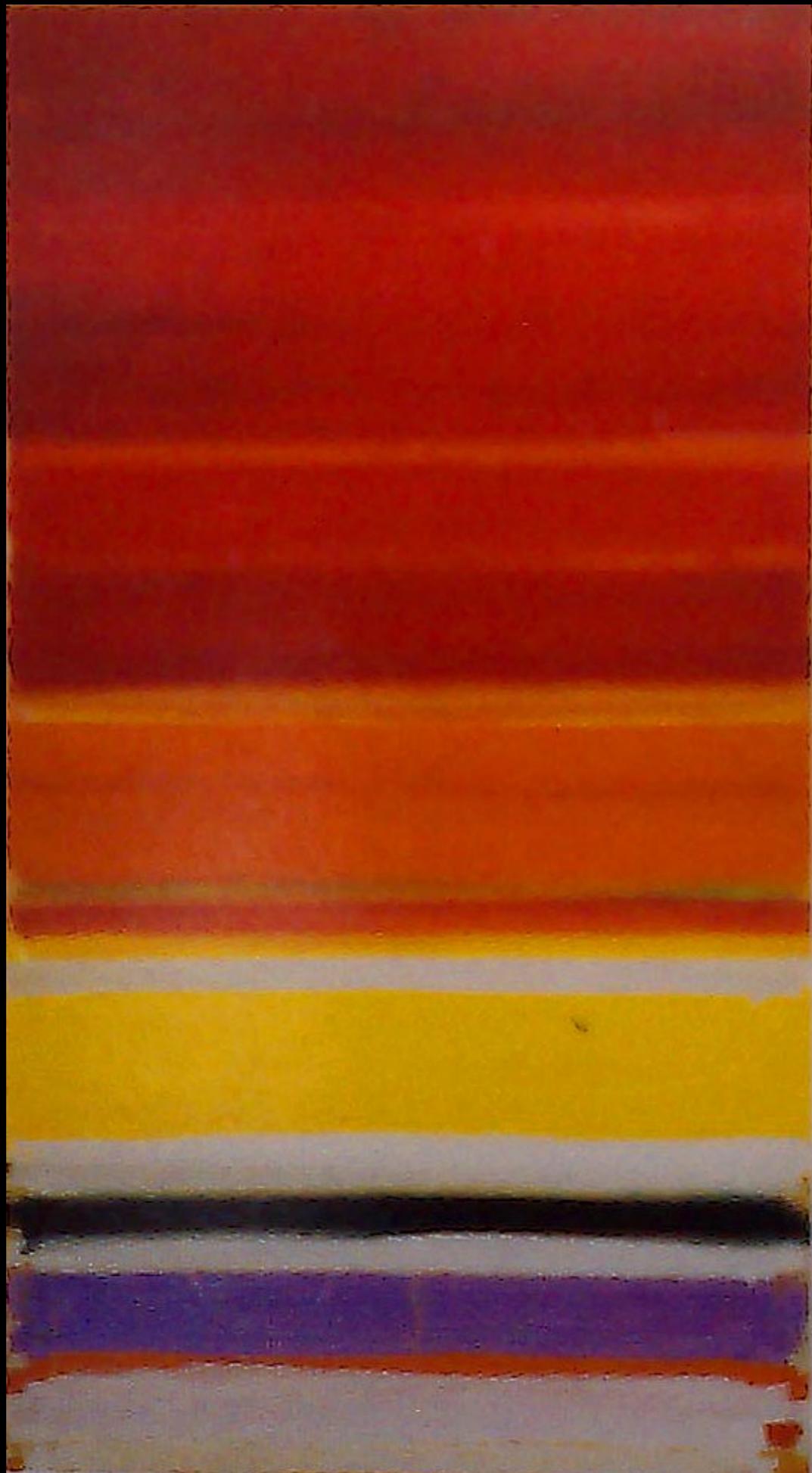
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t = 1000



t = 5000

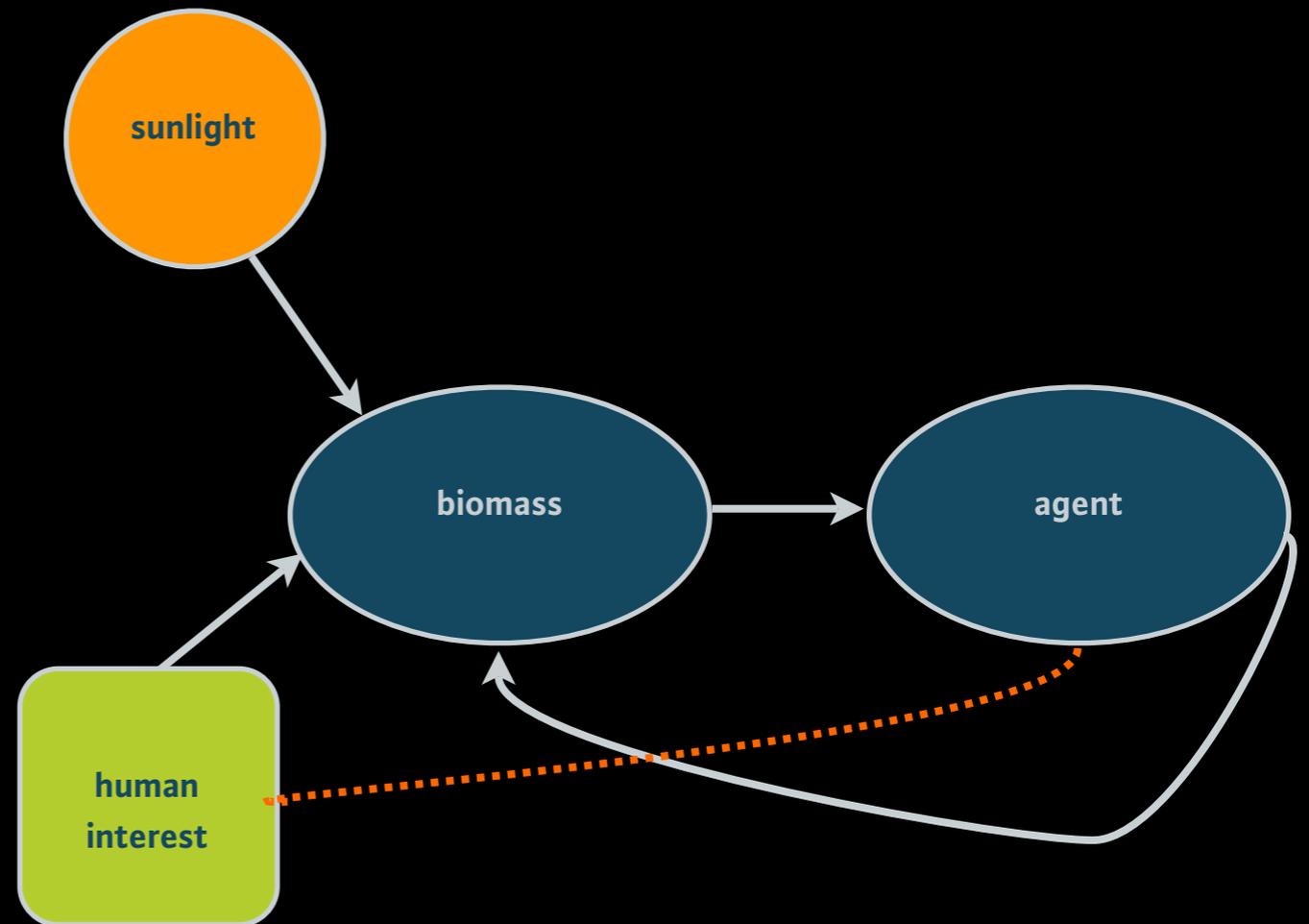
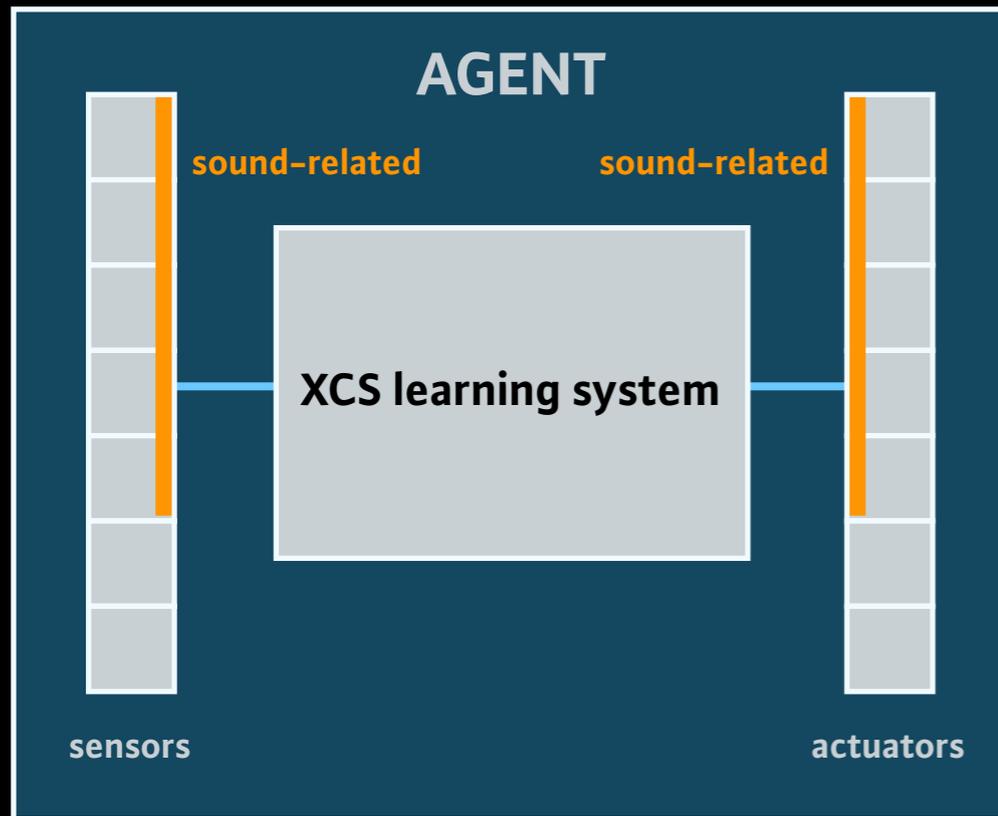


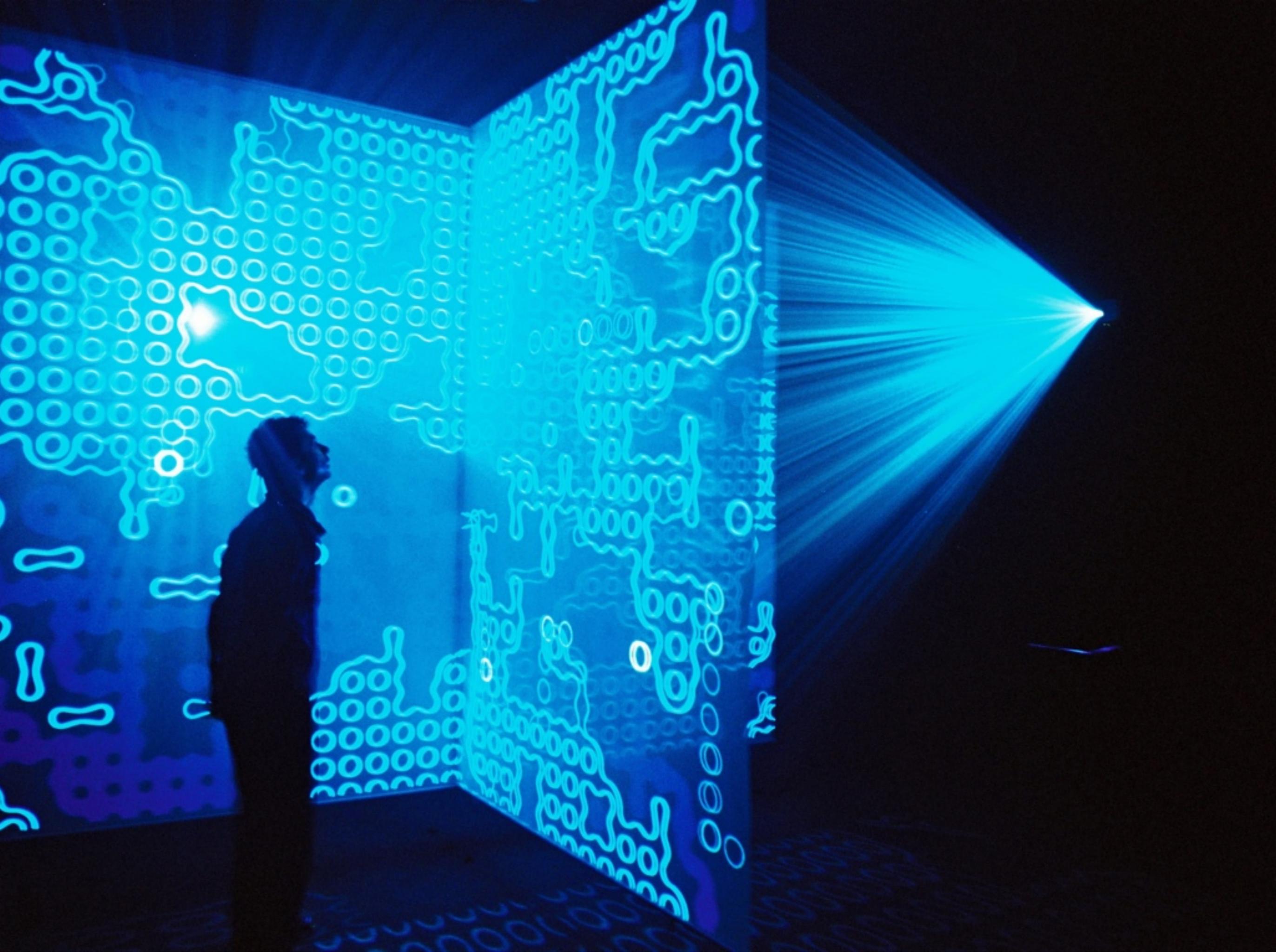
Horizontal Stripe Painting
Patrick Heron, 1957–58, 274.3 x 154.8 cm
Tate Modern Collection, London UK

Example: Eden

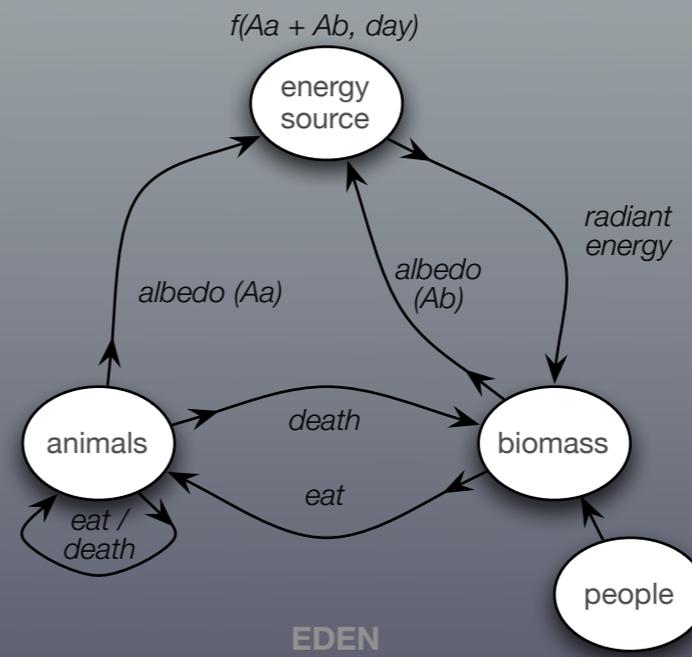
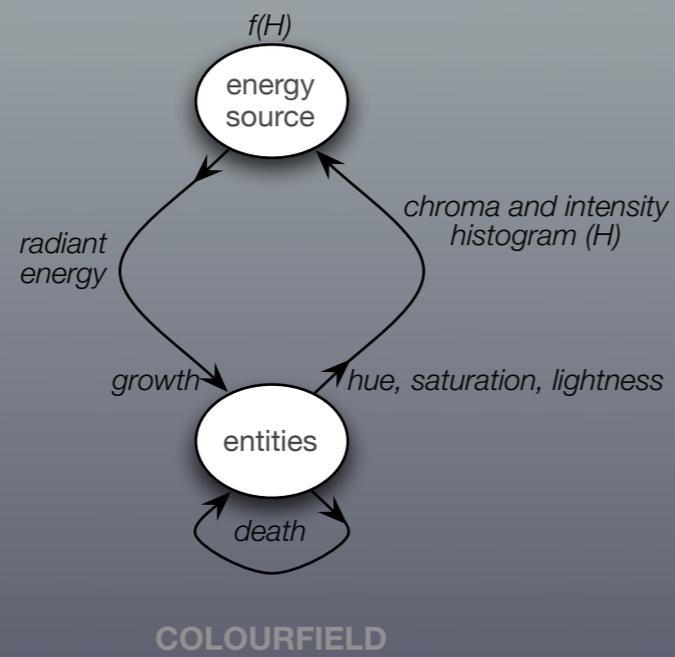
- ▶ An ecosystem of sonic agents, operating in a two-dimensional world
- ▶ Rocks, Biomass, Agents
- ▶ Agents learn about and adapt to their environment, based on a modified version of Wilson's XCS
- ▶ Those agents that best fit the environment come to dominate the population
- ▶ The virtual and real worlds are connected: human interest drives resource production, giving rise to selection pressure based on maintaining human interest
- ▶ Agents use changing, interesting sound to maintain their food supply, hence ensure their survival

Eden architecture





Causal Mechanisms: Colourfield and Eden



Buy the book!



The computer has shown me things about the world that I could not have known, understood or seen in any other way ... I use the computer for the simple reason that the work I create with it would not be possible in any other medium.
Jon McCormack

Impossible Nature: the art of Jon McCormack
Jon McCormack, Jon Bird, Annemarie Jonson, Alan Dorin.
Australian Centre for the Moving Image, 2004
www.acmi.net.au