Groundlessness avoids openness reduction in hierarchies of emergence

Open Ended Evolution: Recent Progress and Future Milestones
A Workshop at ECAL 2015, University of York, UK
20-24 July 2015

Tom Froese

Associate Professor
National Autonomous University of Mexico

OEE and the origins of life

- "any chemical system with **perfectly identified** components and starting conditions is **highly unlikely to self-evolve**.
  - Despite the enormous technological progress in analytics [...], mixtures of the kind discussed here are still beyond **total** molecular and precisely quantifiable identification and characterisation.
- Any **well-defined** system, in that sense, may let itself evolve by the scientist up to a certain point and will then **stop**.
- The scientist will indeed be able to learn a lot from the observed processes. But such a chemical system will remain a **model** system; it will not be able to lose its metaphoric aspect to life."
  - (Strazewski, in press)

The problem of well-definedness

- Strazewski's intuition is that well-defined systems are not capable of giving rise to open-ended evolution.

- He also believes that chances of success are increased when starting the experiment with a **messy** chemical system.

  - "Above everything else, always provide the system with **many possible variants** – variants in chemical composition, property, reactivity, but also in shape and size – so it can choose whatever is best in a given situation or phase of development" (in press)

- Can we formalize Strazewski's intuition?

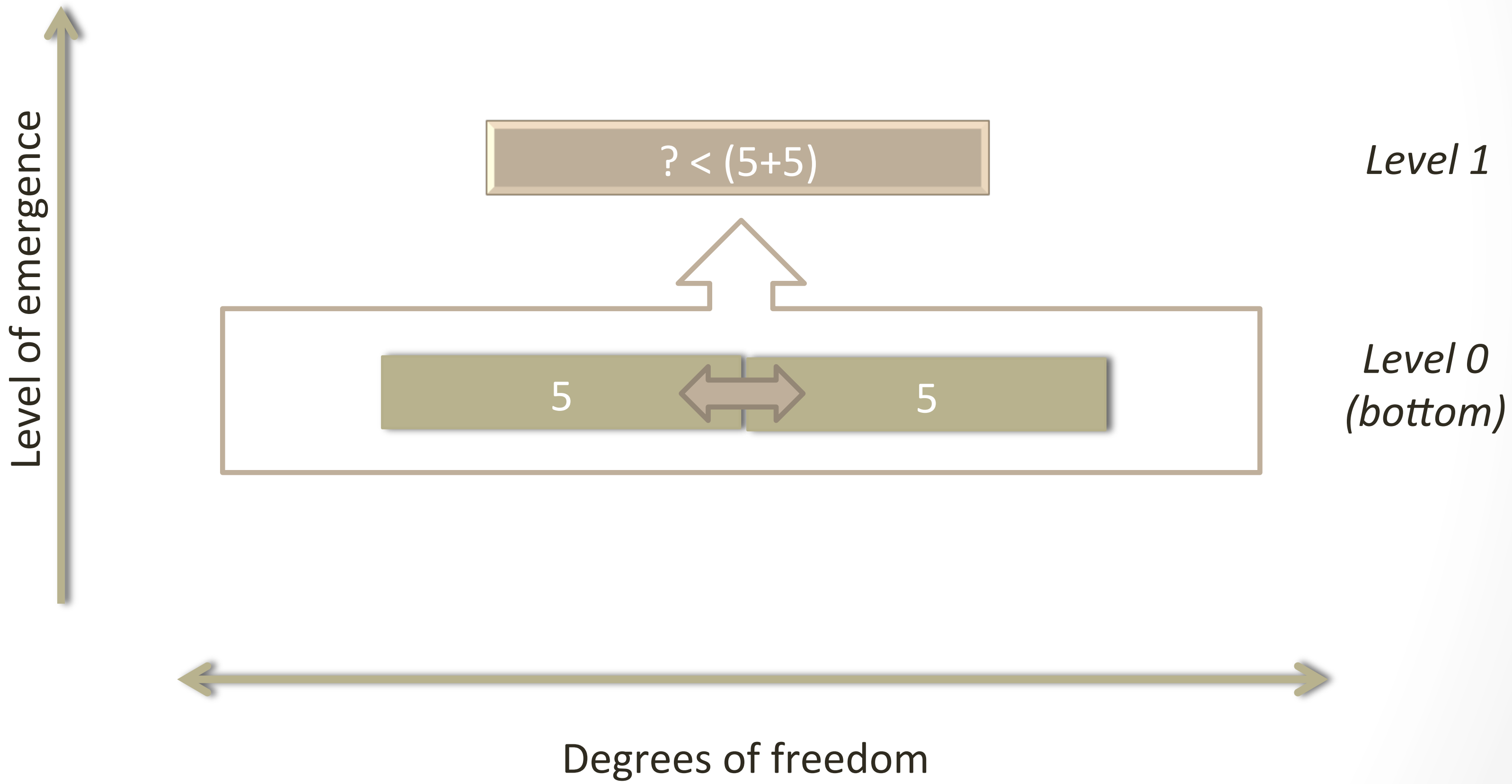
A dynamical systems approach

- One way of measuring open-endedness is in terms of the system's emergence of new **degrees of freedom** (DOF).

- If **emergence** is defined as the collective dynamics resulting from nonlinear coupling between two or more components, then the DOF of the emergent phenomenon in principle **cannot be equal to or greater** than the sum of DOF of its underlying components.

- In practice, the emergent phenomenon will have much **less DOF than** the sum of DOF of its components because the collective dynamics are subject to **more constraints** than the isolated dynamics of each component.

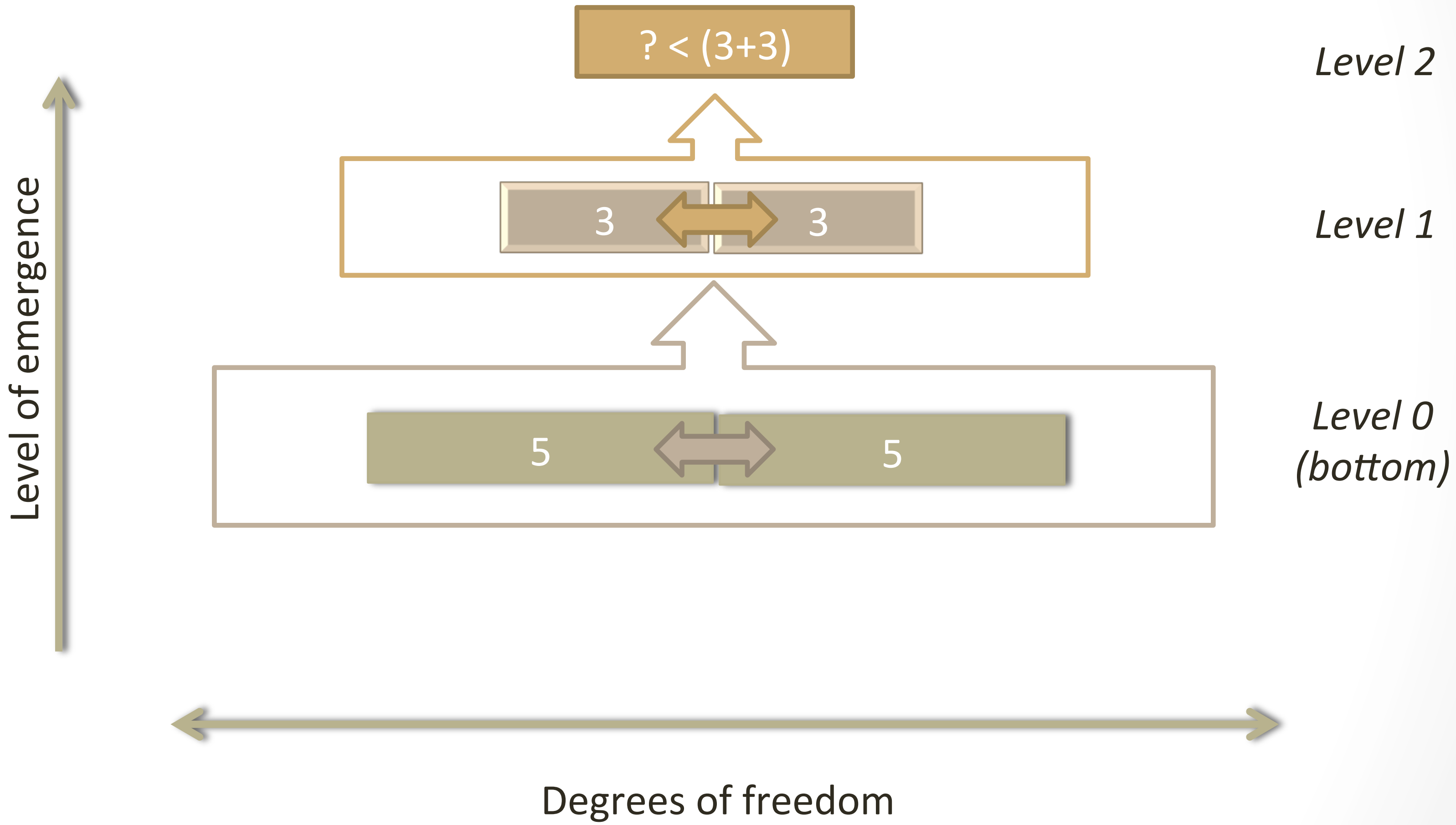
Emergence = DOF reduction



Diminishing returns

- The same reducing logic applies to the creation of **additional** novelty based on the emergent level of organization.
  - If a new phenomenon (level 2) emerges out of the nonlinear interactions between the emergent components (level 1), then its DOF will be even further reduced (less than the already reduced DOF of level 1 compared to level 0).
  - And so forth…
- Thereby rapidly choking off the possibilities for **open-ended** emergence of new layers of complexity.

More emergence = more DOF reduction



Avoiding the dead end

- On this view, every new innovation will have less DOF than previous innovations, eventually converging to a **dead end**.

- This dead end is not a problem **in practice** if we consider **nature** to have sufficient degrees of complexity to begin with such that it is never reached in realistic time scales (although this is a problem for **simulation models**).

- I propose that this dead end is not even a problem **in principle** if we consider nature to be **groundless** (although this excludes simulations as incapable of genuine OEE by definition).

Groundlessness saves OEE