Bio from Bit

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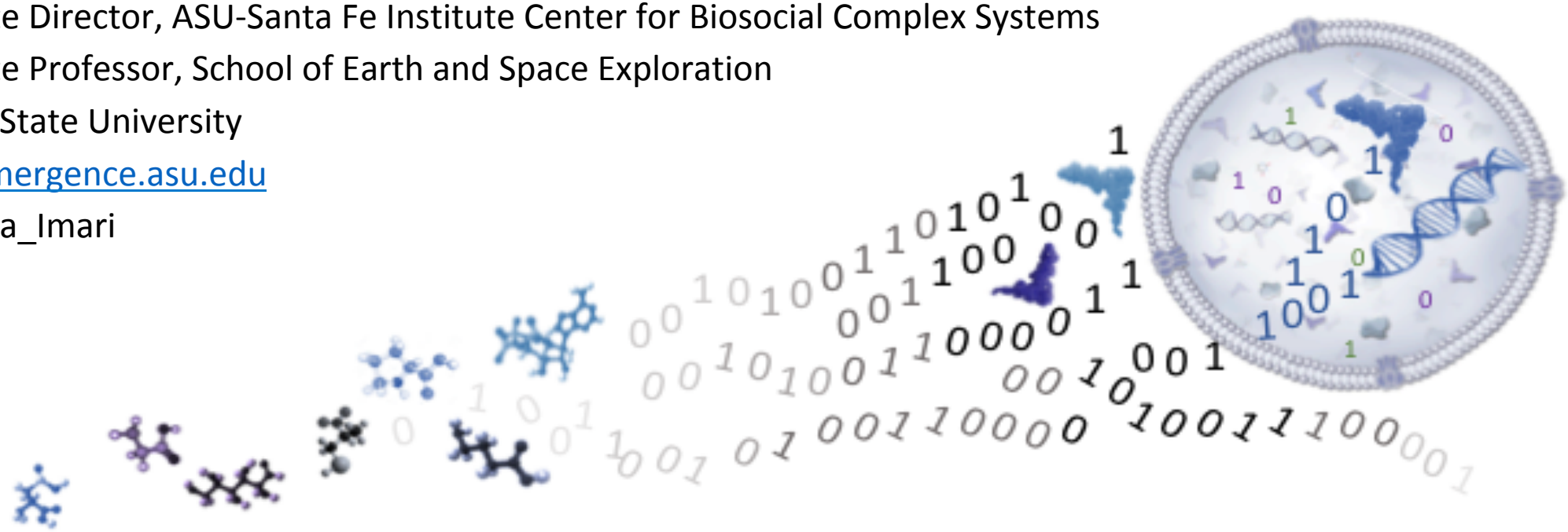
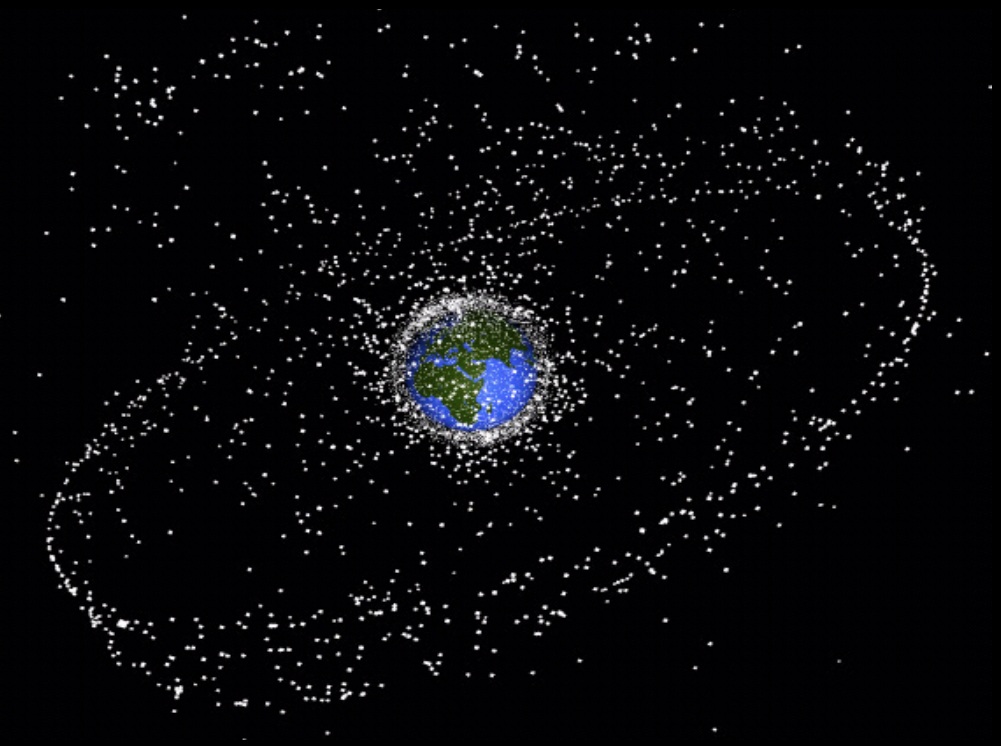


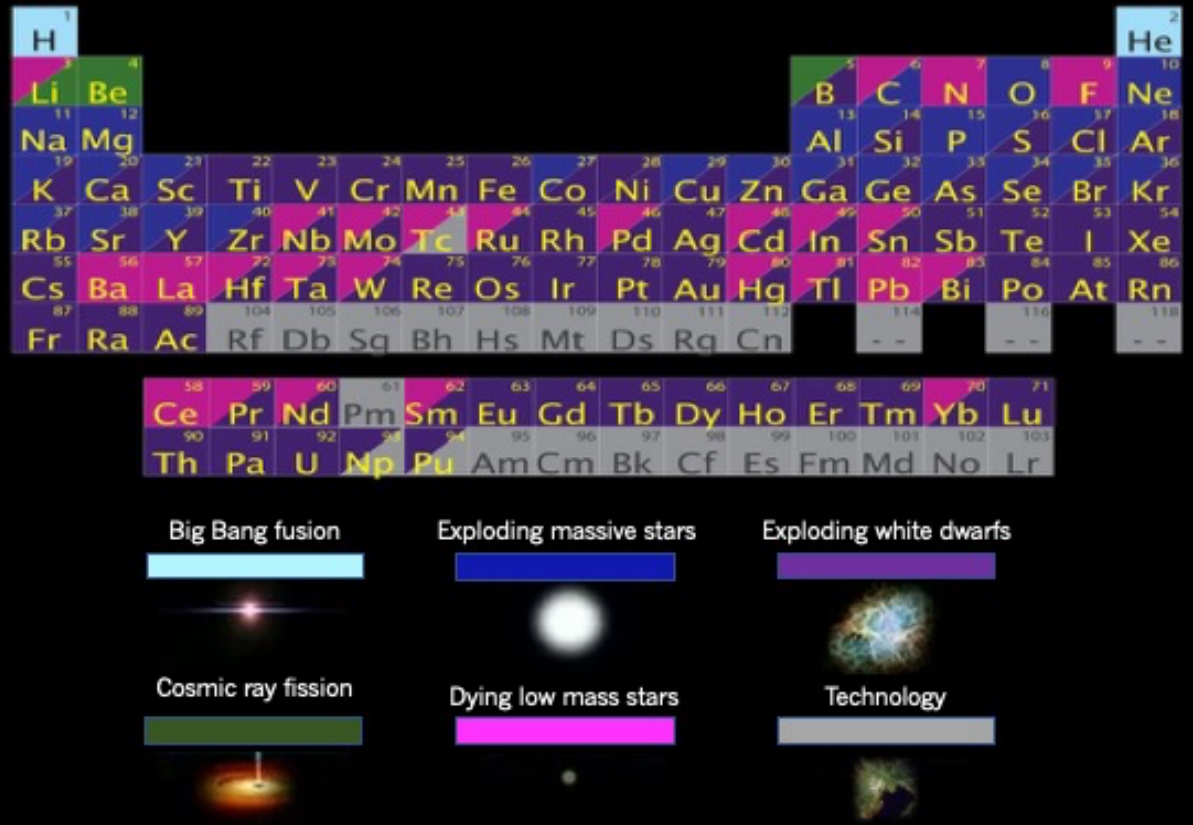
Life Alive

(w/ Michael Lachmann, Aeon magazine 2019)

Life

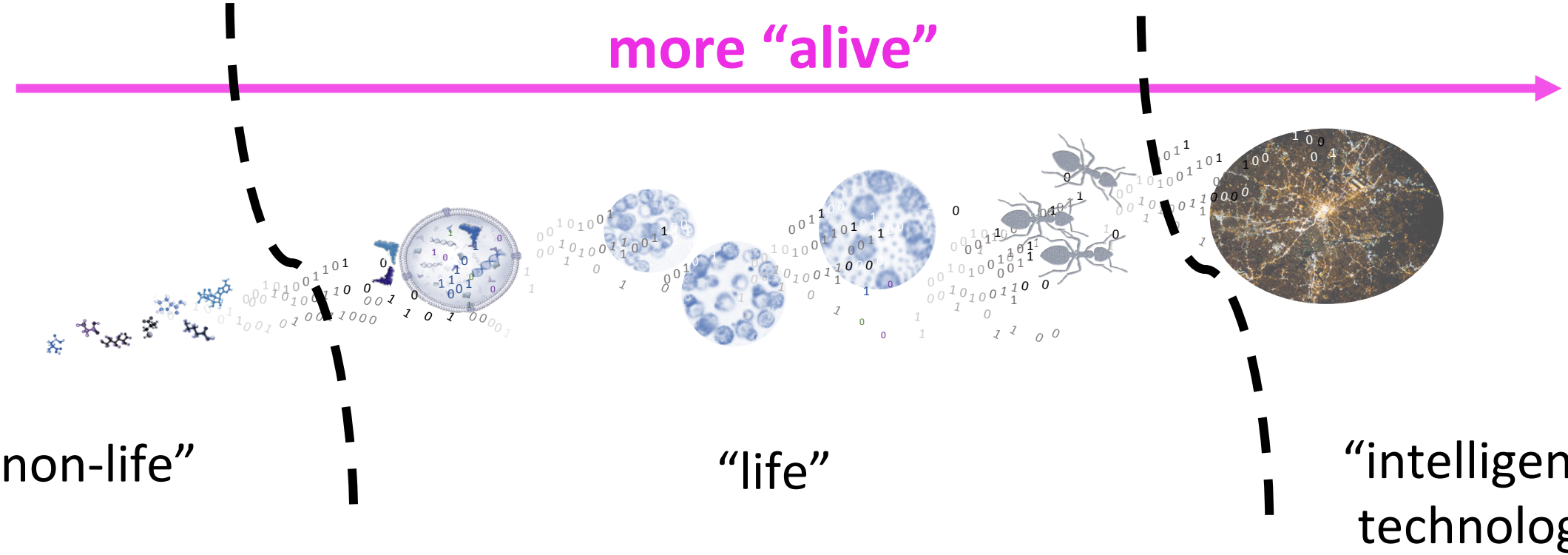
What is life?





Walker 2016 “The Descent of Math” In Trick of Truth: The Mysterious Connection Between Physics and Mathematics? A. Aguirre, B. Foster and Z. Merali (ed.) Springer.

Quantifying life …



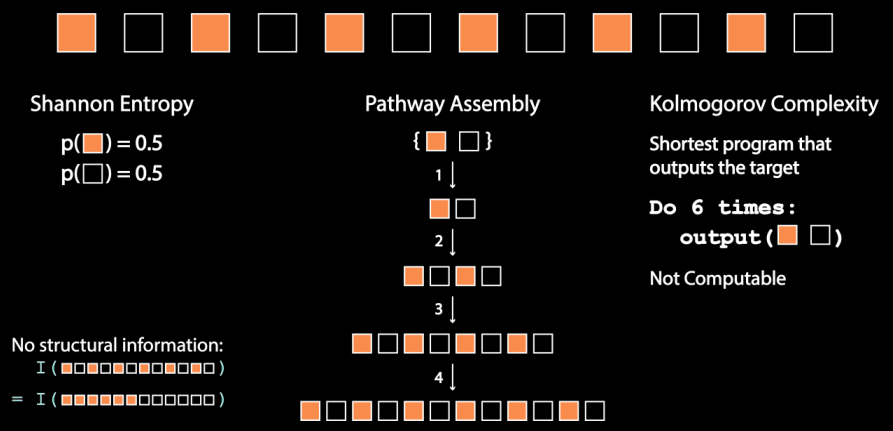
How can we explore the 'Demonic Cut' …

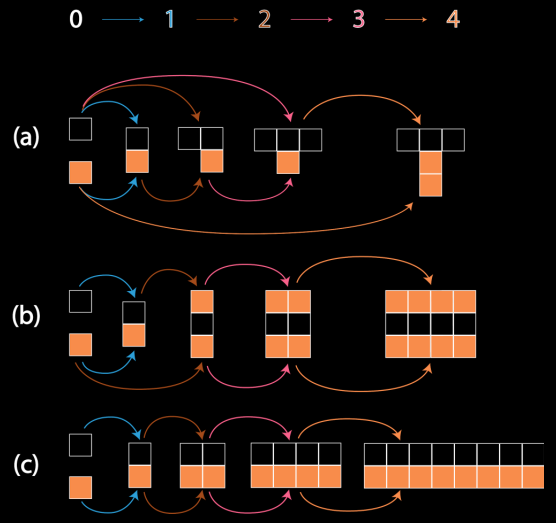
Theory

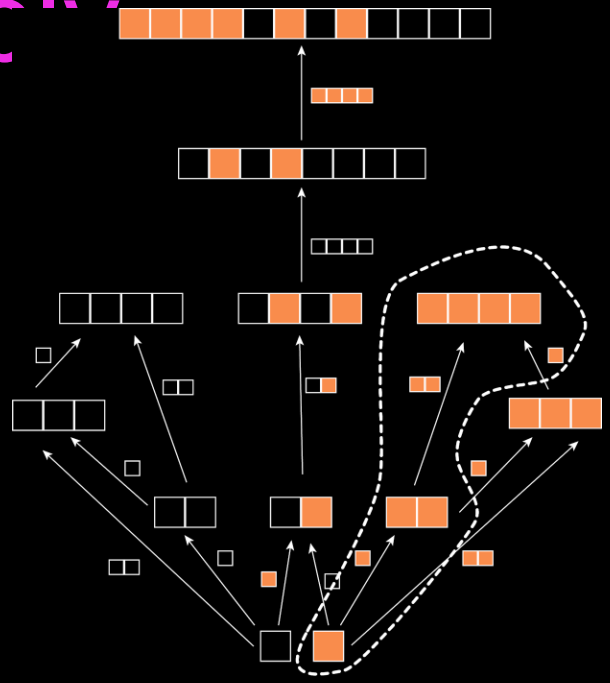
Experiment

Image from: Cronin & Walker 2016 "Beyond prebiotic chemistry." *Science* **352 (6290):** 1174-1175.

Reformulating the structure of chemical space with pathway assembly

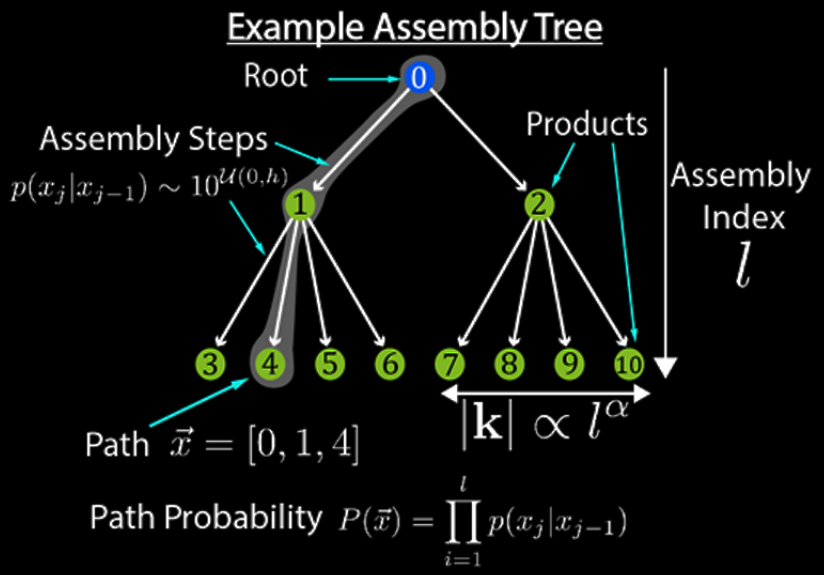


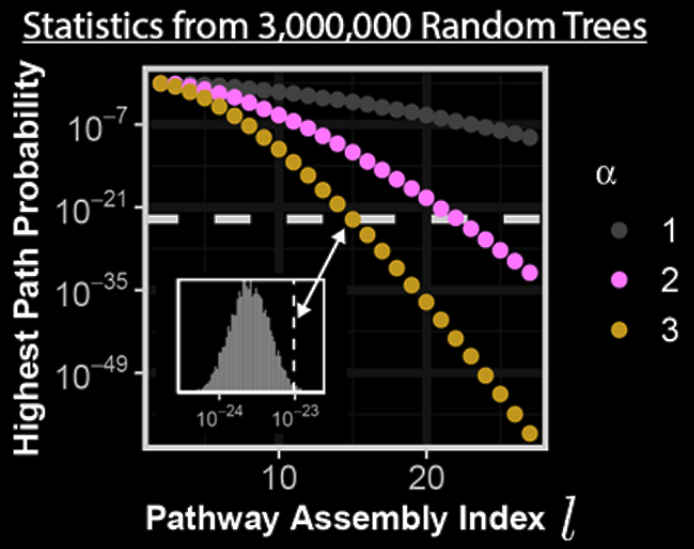


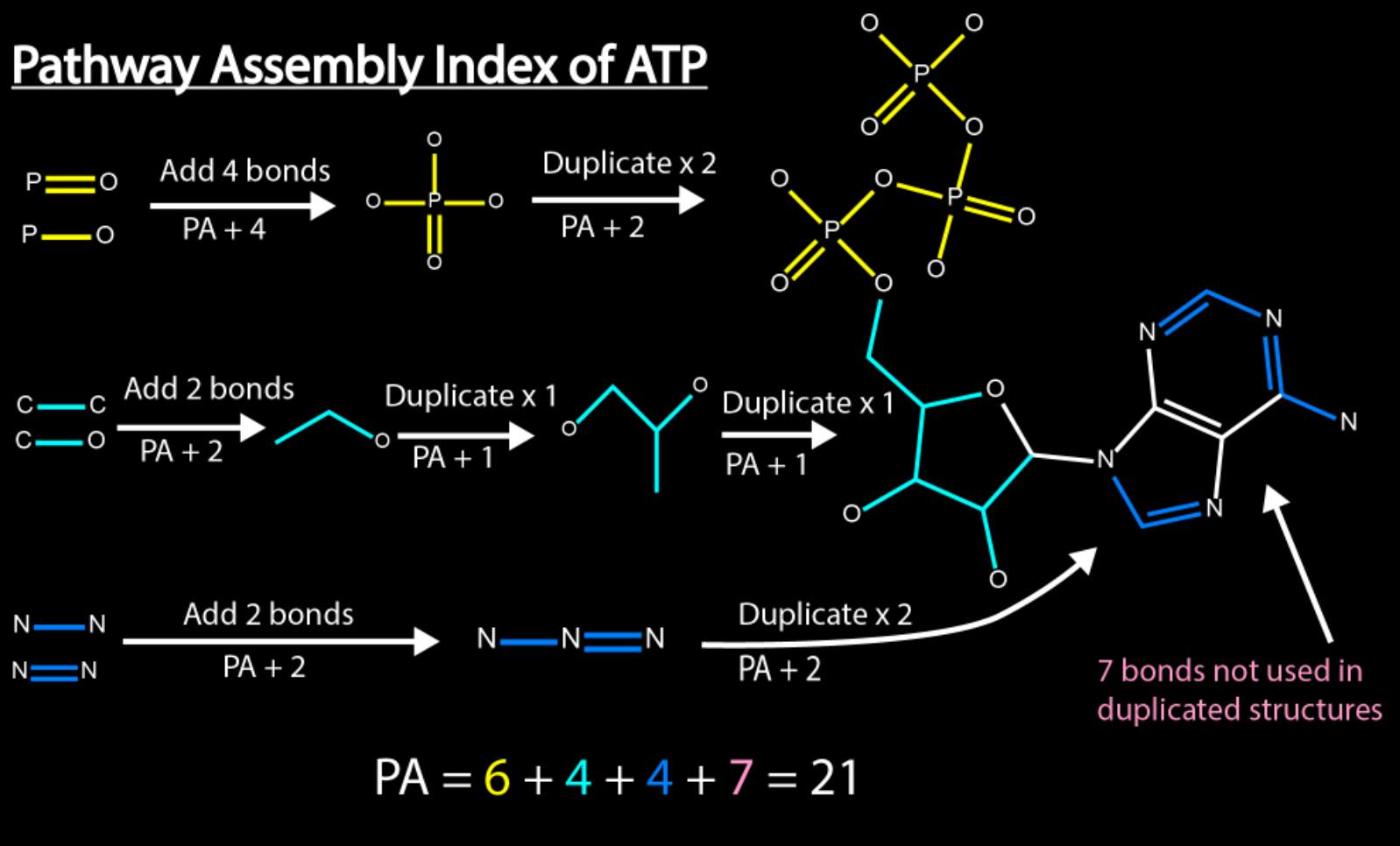


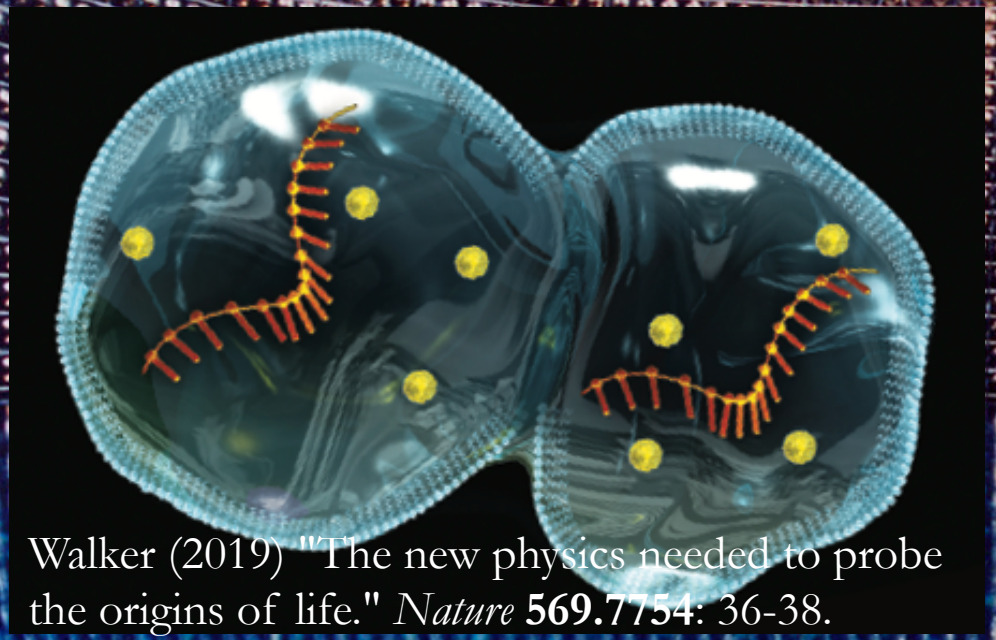
Marshall, Moore, Murray, Walker & Cronin (2019) “Quantifying pathways to life using assembly spaces” arXiv:1907.04649

Pathway Assembly of Molecules





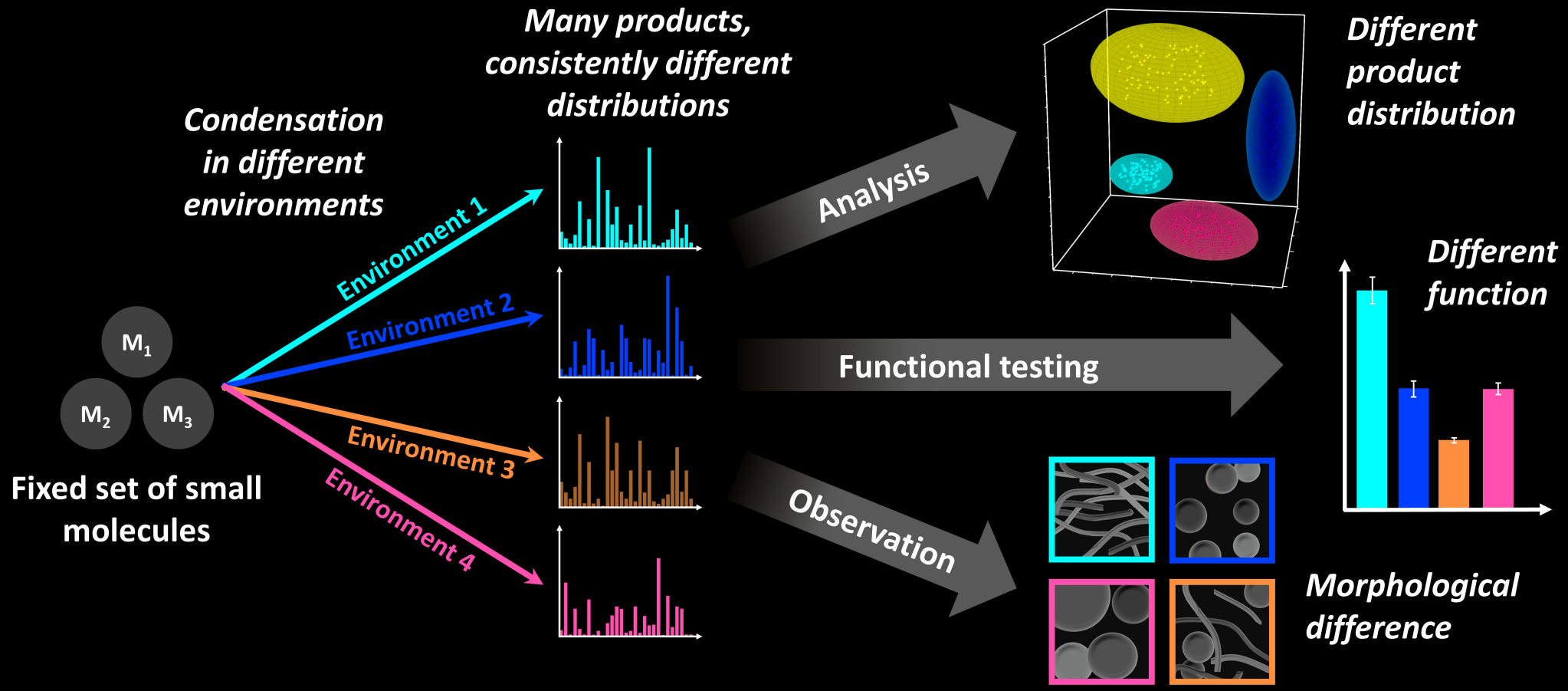




Walker (2019) "The new physics needed to probe the origins of life." *Nature* **569.7754**: 36-38.

Astrobiology need ‘big data’ approaches

Statistically exploring the origins of life in prep for exoplanet science



Surman, Andrew J., Marc Rodriguez-Garcia, Yousef M. Abul-Haija, Geoffrey JT Cooper, Piotr S. Gromski, Rebecca Turk-MacLeod, Margaret Mullin, Cole Mathis, Sara I. Walker, and Leroy Cronin. (2019) "Environmental control programs the emergence of distinct functional ensembles from unconstrained chemical reactions." *Proceedings of the National Academy of Sciences* 116 (12) : 5387-5392.

Alive

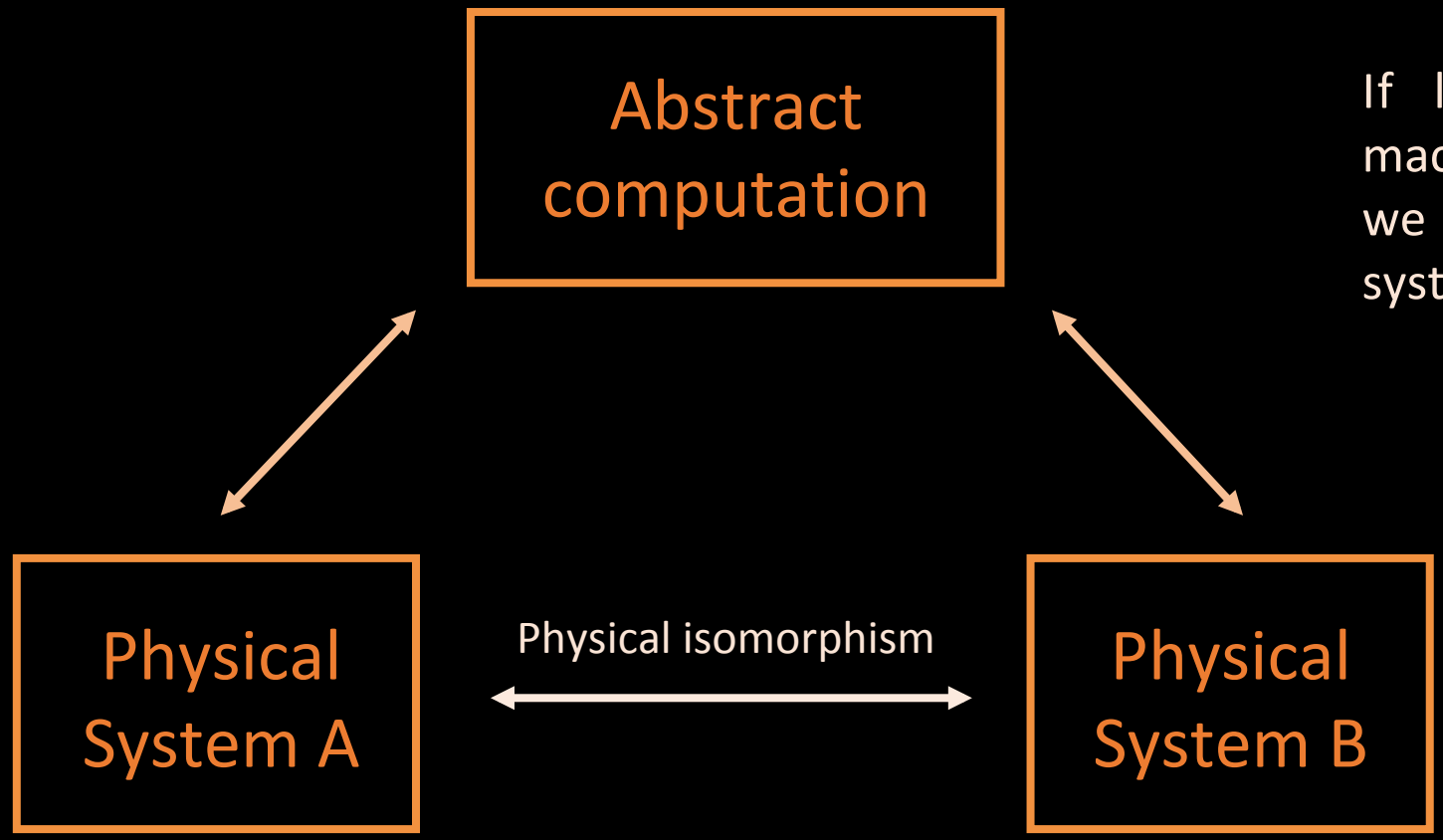
Hard Problem of Consciousness

Hard Problem of Life

S.I. Walker and P.C.W. Davies “The Hard Problem of Life” in *From Matter to Life: Information and Causality,* Cambridge University Press 2017

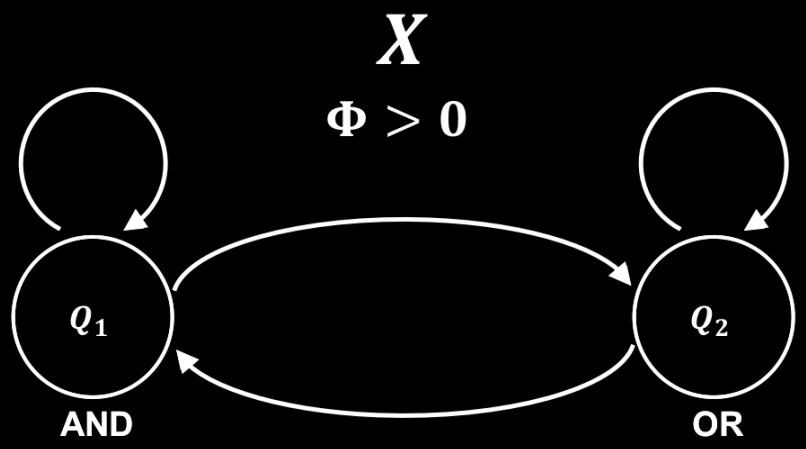
Can we physically emulate life?

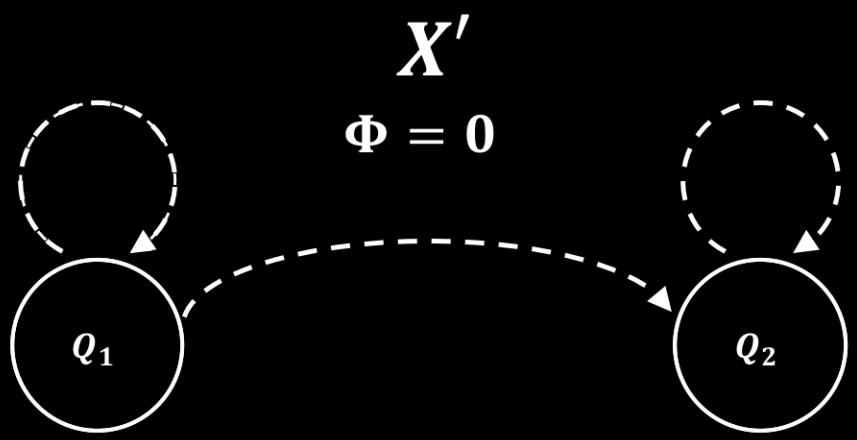
Can we physically emulate life … or consciousness ?

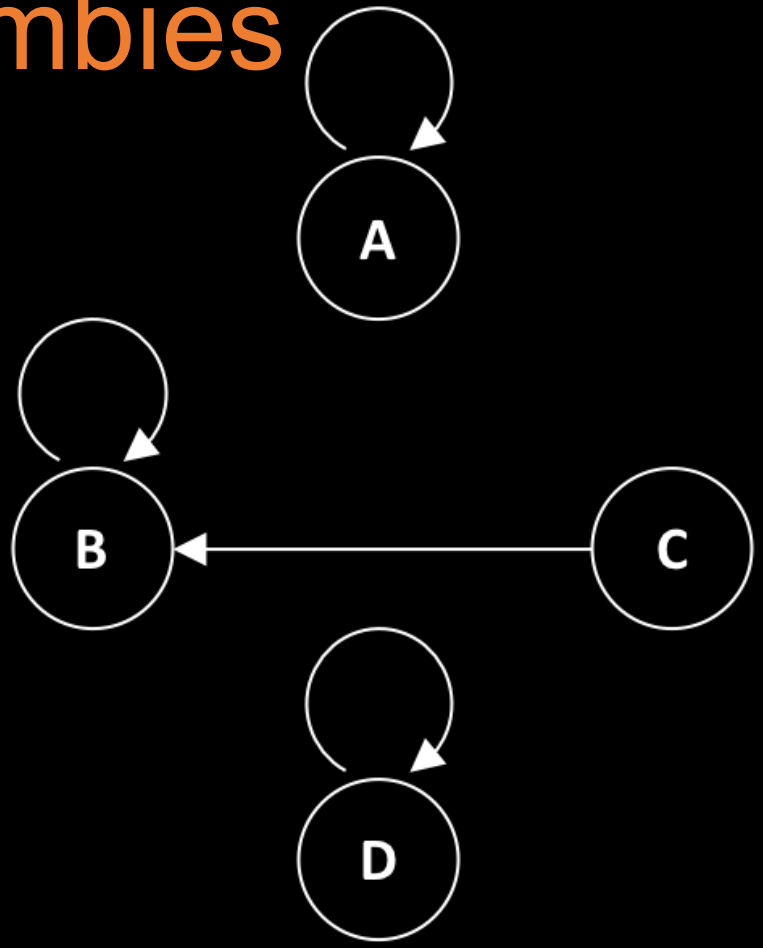


If life (or consciousness is a macrovariable (or set thereof) can we emulate it in other physical systems?

Isomorphic Philosophical Zombies

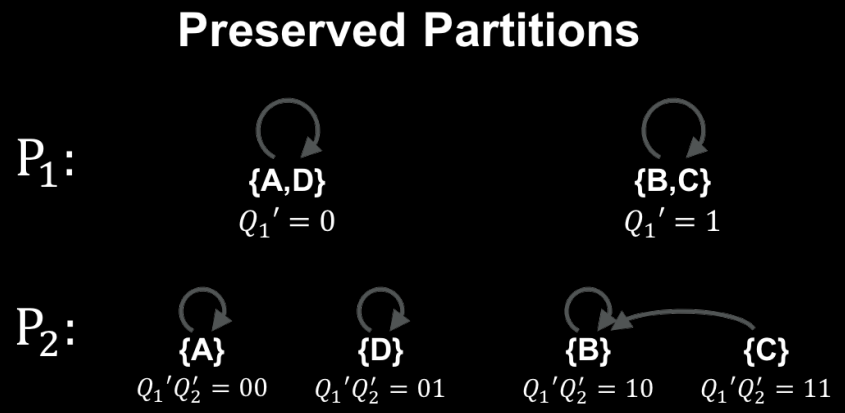




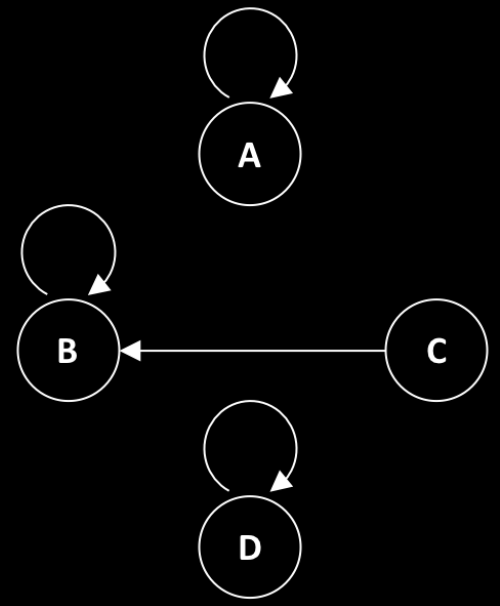


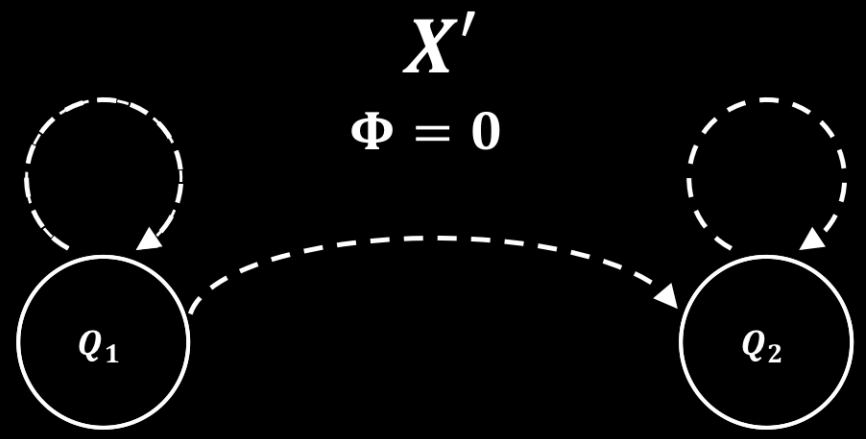
Hanson & Walker (2019) “Integrating Information theory and Feed-forward Isomorphic zombies” In prep

Isomorphic Philosophical Zombies



State	Label in *X*	Label in *X'*
A	00	00
B	01	10
C	10	11
D	11	01





Integration depends on the logical architecture, not efficiency, nor autonomy

Hanson & Walker (2019) “Integrating Information theory and Feed-forward Isomorphic zombies” In prep

Comparing information across living and non-living collectives

Image: Pratt Lab @ ASU

Tandem running

An example of collective behavior

video from Gabriele Valentini

Collective behavior in ants and termites:
same behavior, different function

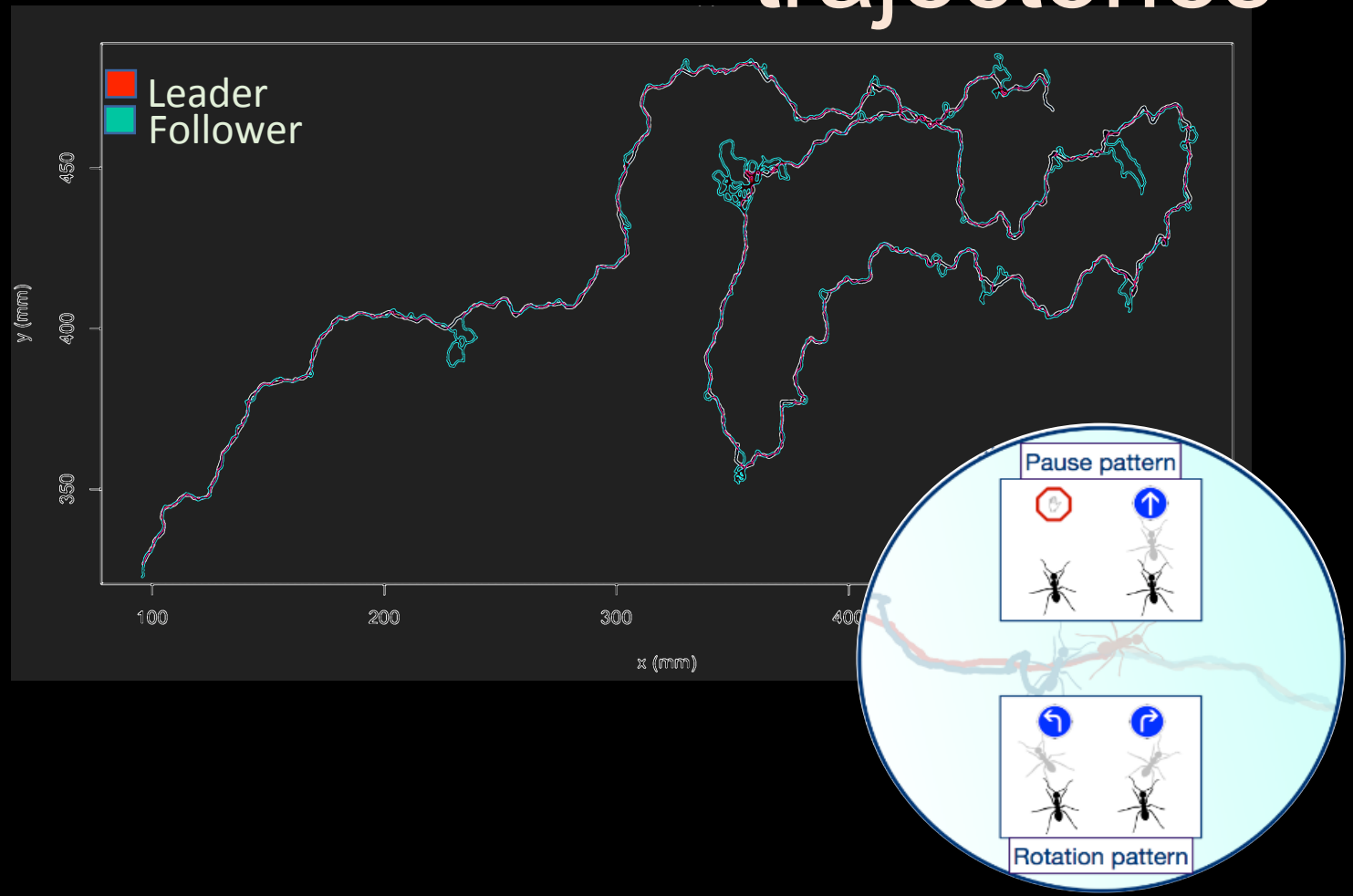
ants

Learning: Leader knows the goal (e.g. nest site) and leads follower (behavior is for transferring knowledge)

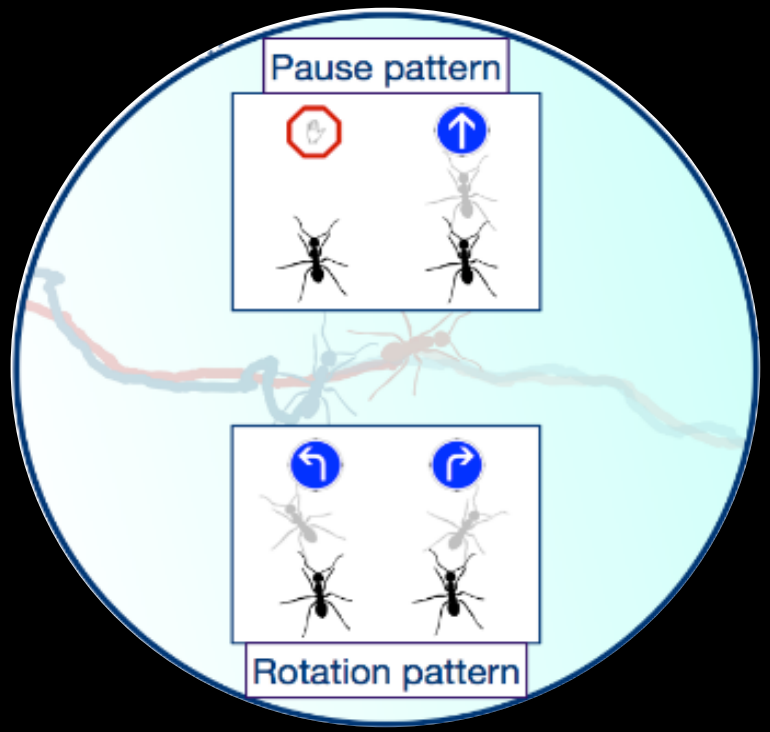
termites

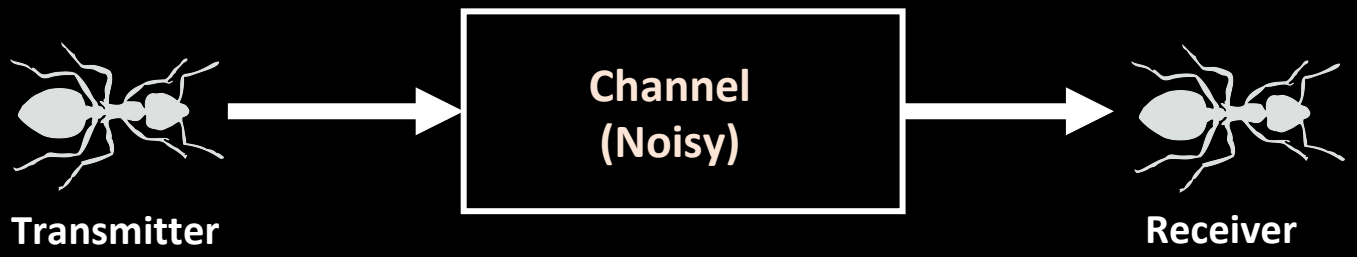
Exploration: Both leader and follower are undirected (behavior is exploratory)

Statistical mechanics of living trajectories



Coarse-graining to describe different channels





Pausing

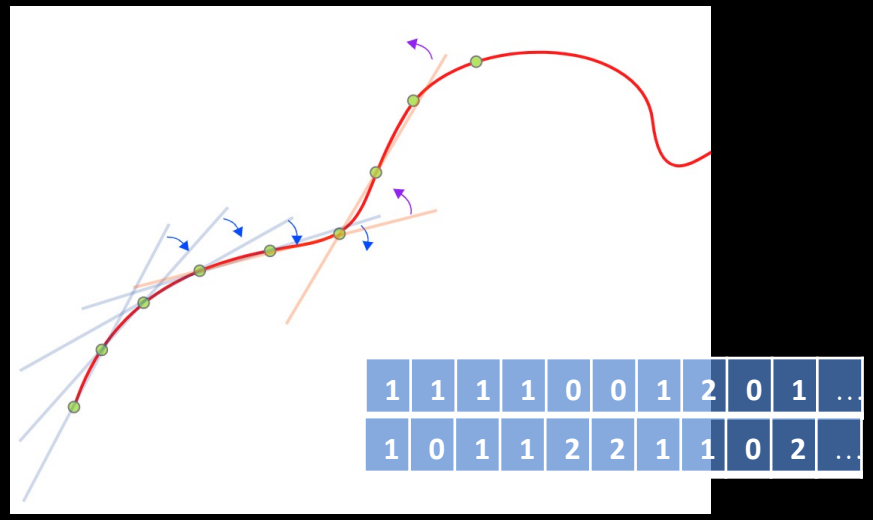
Rotation

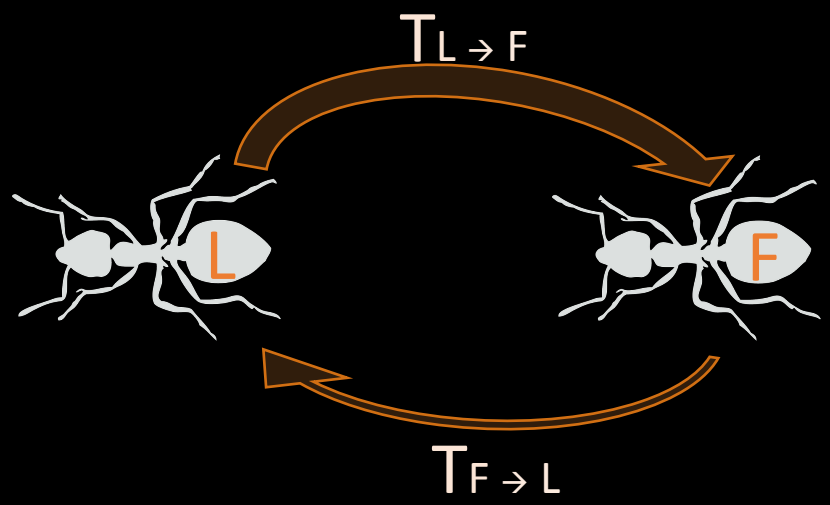
Pausing & Rotation

Measuring information transfer: *Net transfer entropy*

..from leader to follower, $T_{L \rightarrow F}$

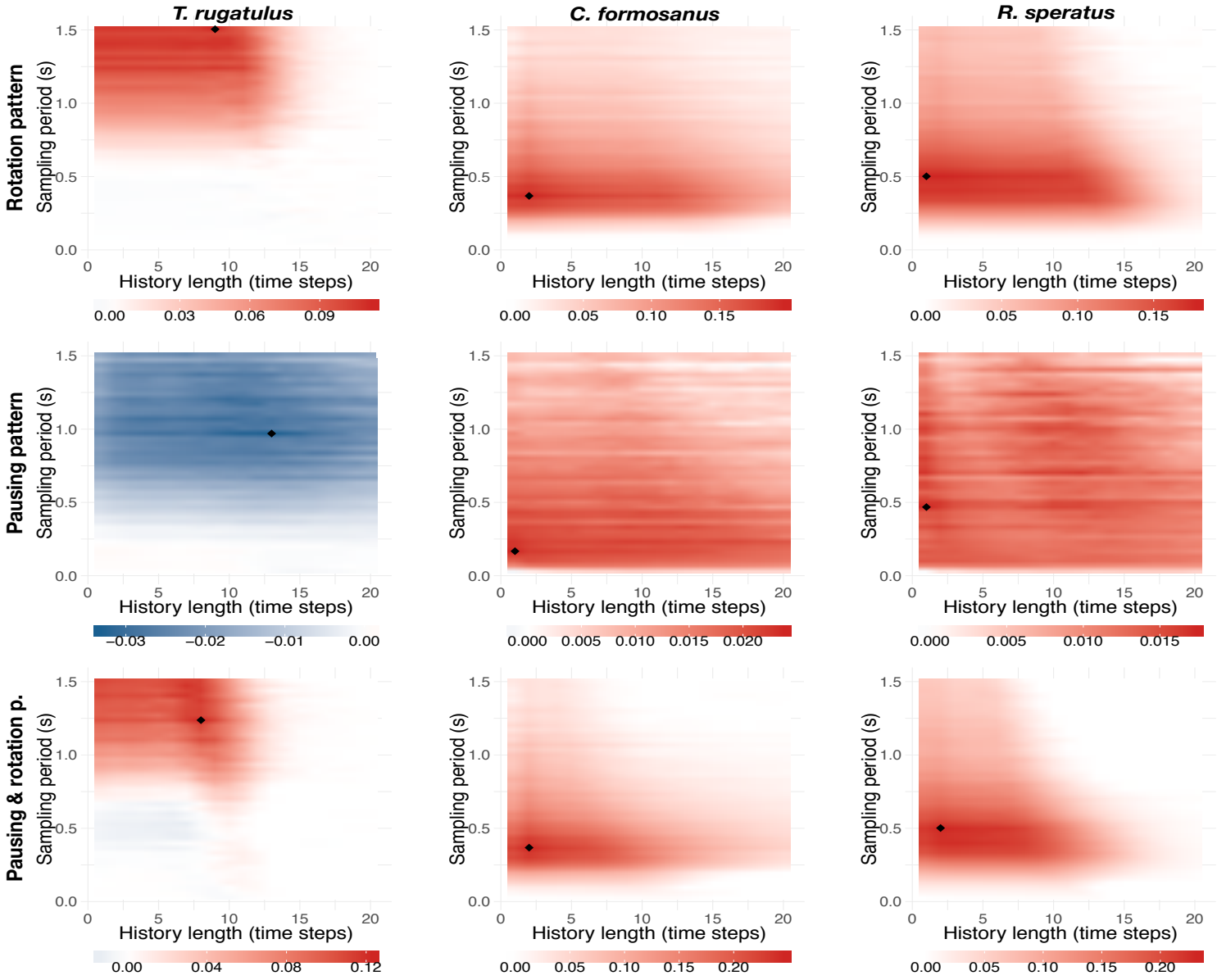
..from follower to leader, $T_{F \rightarrow L}$





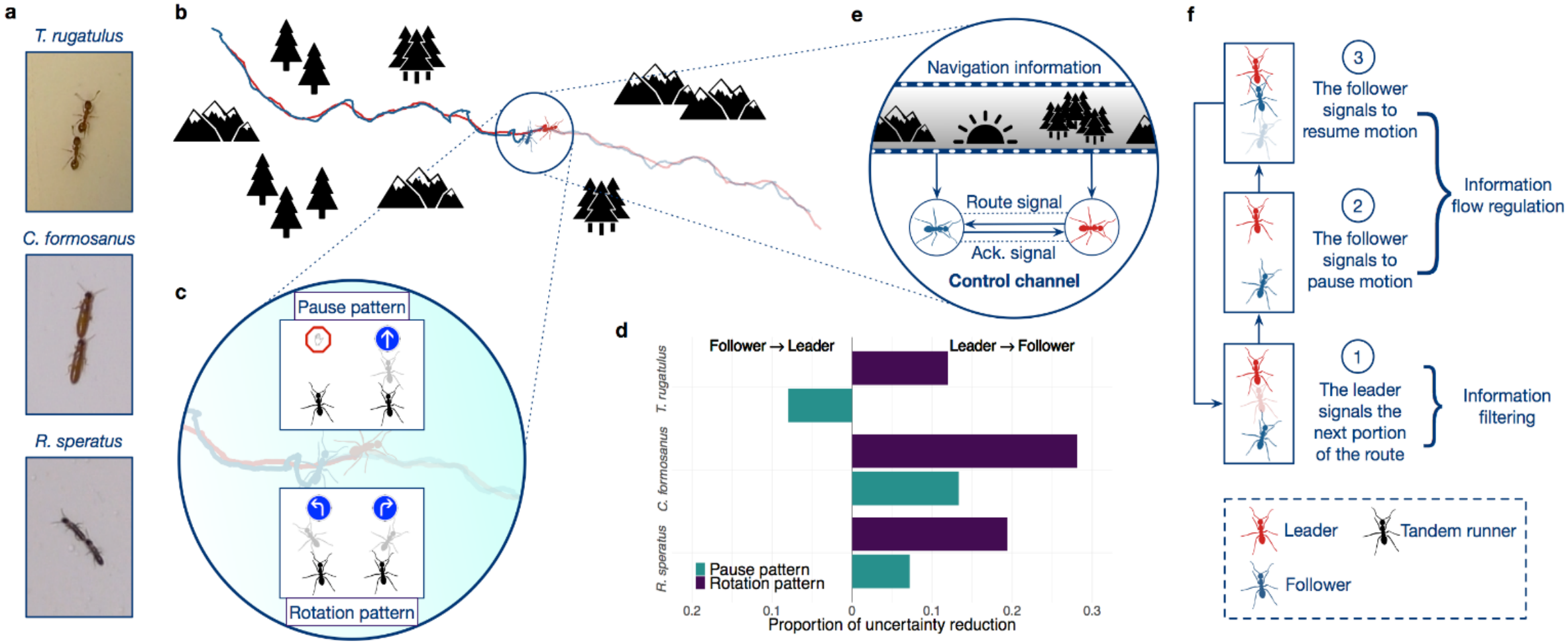
$NTE = T_{L \rightarrow F} - T_{F \rightarrow L}$

Landscape of information transfer *(time and history)*



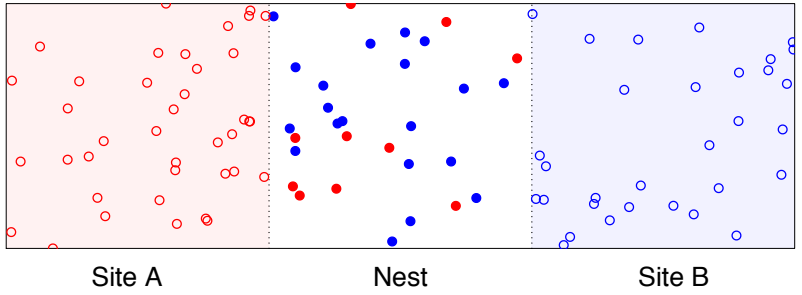
G. Valentini, N. Mizumoto, T. Pavlic, S. Pratt & S.I. Walker, In prep

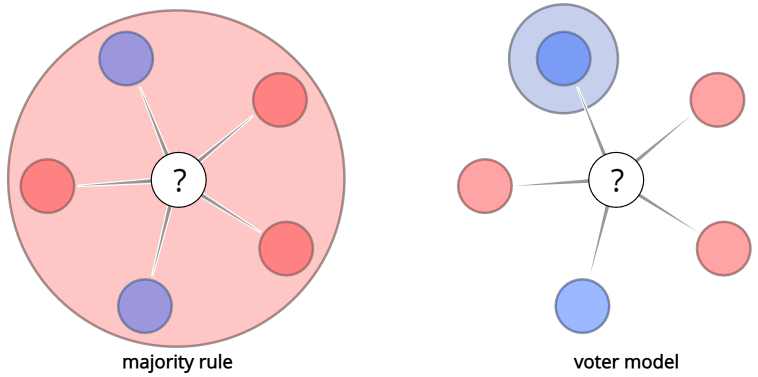
Distinguishing the "purpose/function" of collective behaviors based on the structure of information flows

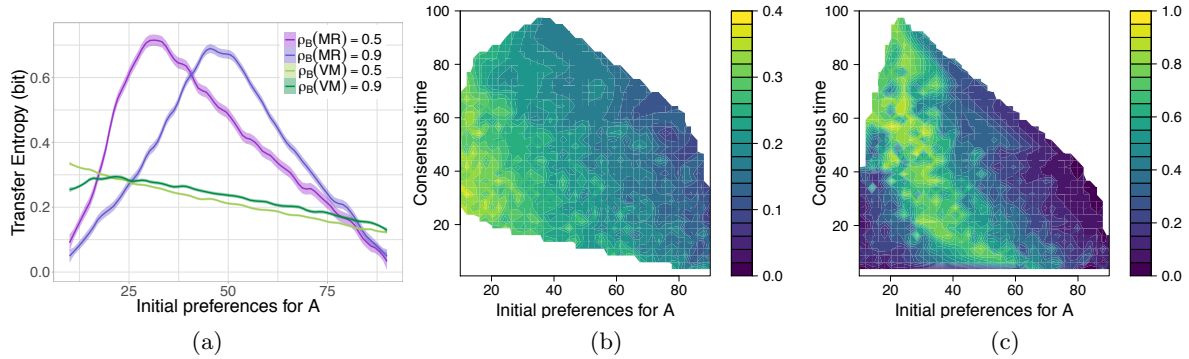


G. Valentini, N. Mizumoto, T. Pavlic, S. Pratt & S.I. Walker, In prep

Same behavior, different local rules, different patterns in information flow

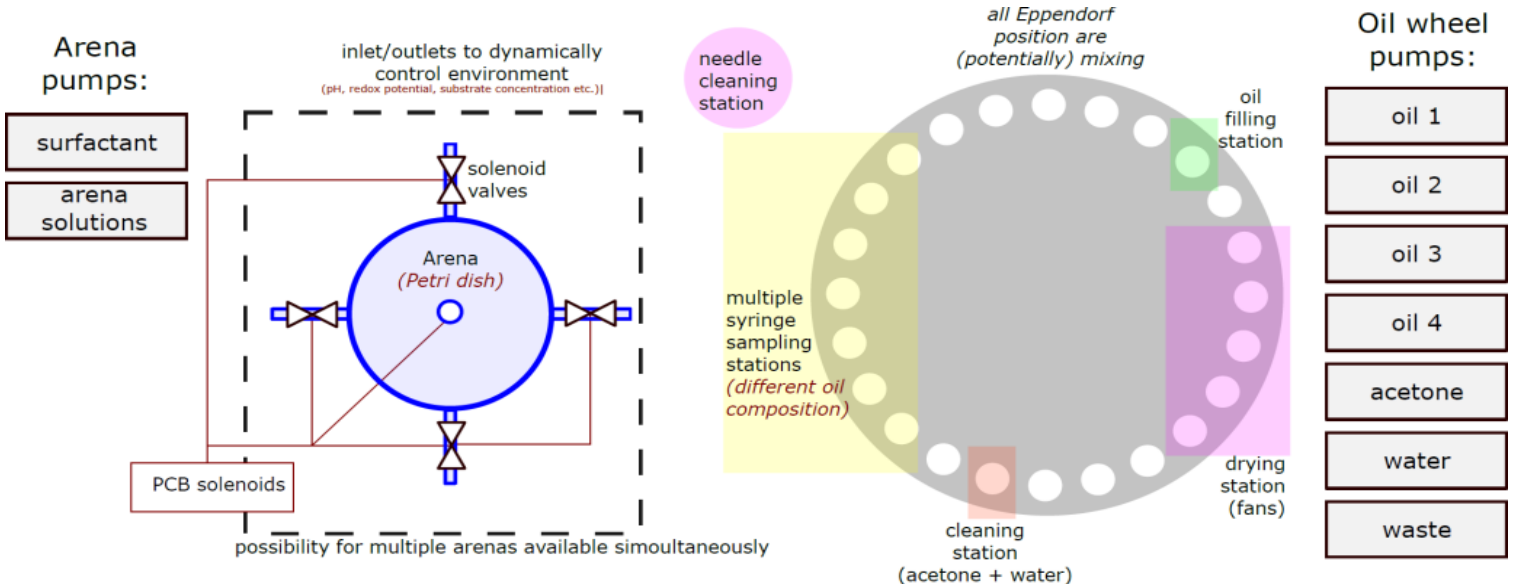


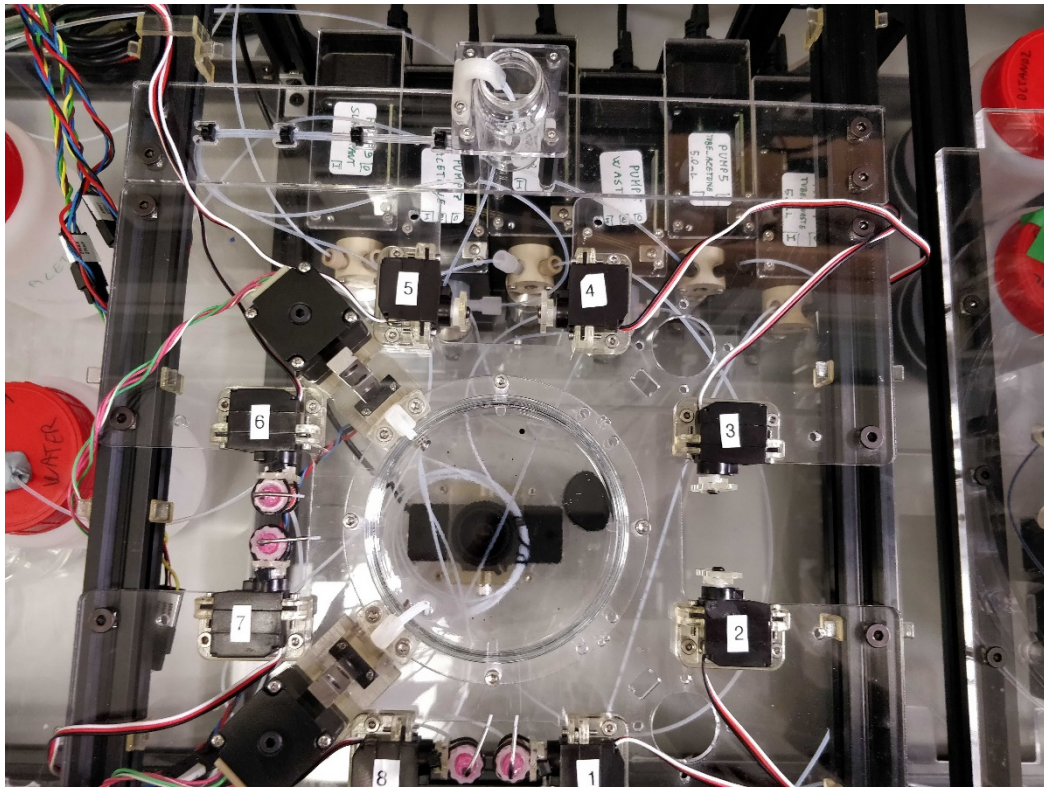


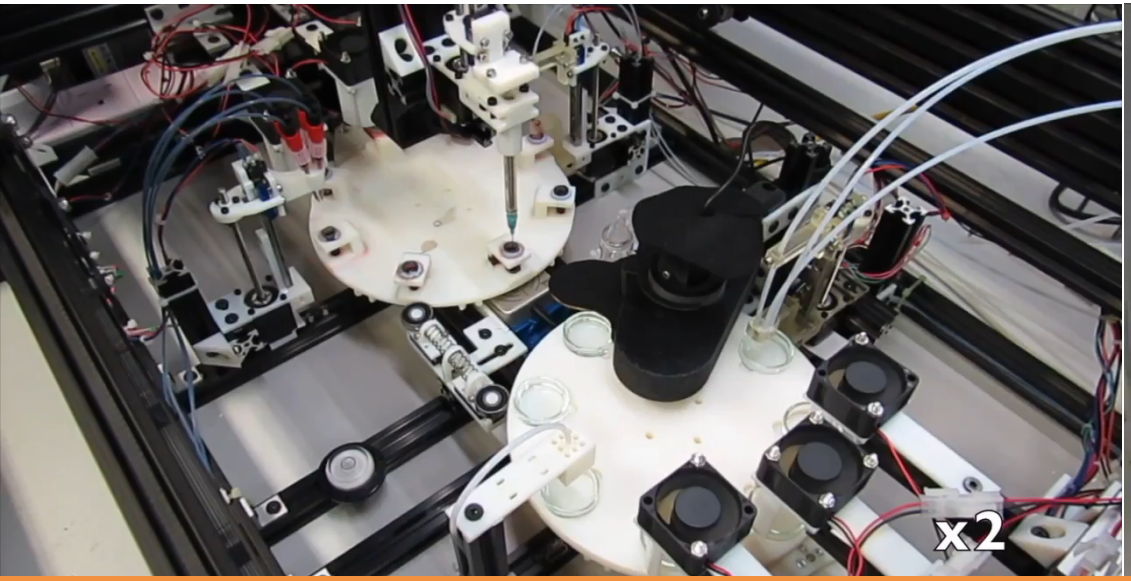


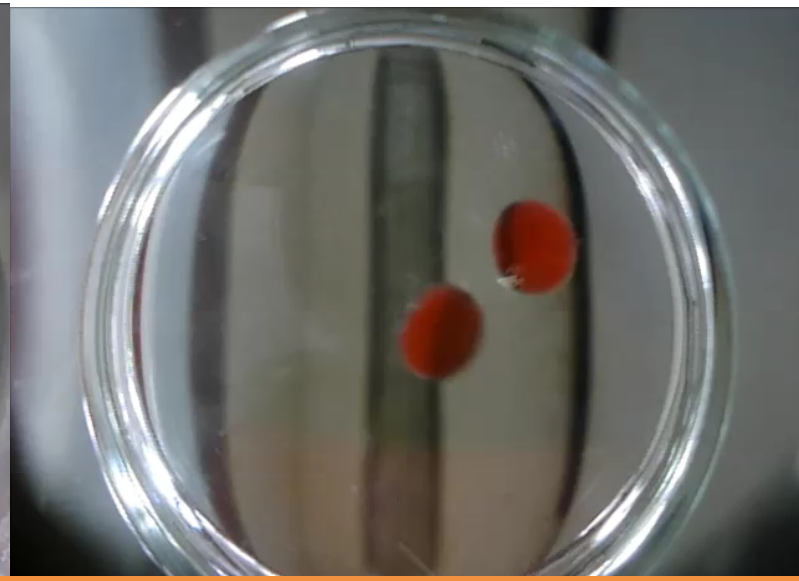
G. Valentini, D. Moore, J. Hanson, T. Pavlic, S. Pratt & S.I. Walker *Transfer of Information in Collective Decisions by Artificial Agents. Artificial Life 2018*

Programming ‘living behaviour’ into non-living systems









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