

How Does Morphological Change Accelerate Evolution?

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Abstract

Morphological change has been demonstrated to accelerate evolution of robust behaviour in one instance. However, it is unclear how or why this happens. This project evolves a robot with varying degrees of conservation between the earlier and later forms to help answer the question, under what conditions does morphological change accelerate evolution?

Introduction

Bongard showed the evolution of light following behaviour was accelerated for robots that grew from a leg-less anguilliform to a legged hexapod when compared to evolving a hexapod with no morphological change [1]. This project is a critical replication of that experiment.

Method

Bongard's experiment used a 3D, terrestrial environment. This experiment uses a 2D, aquatic environment to test whether Bongard's findings apply more generally. In addition, the morphological forms—inspired by frog metamorphosis—have been selected such that the conservation of the infant form to the adult form may be varied. Generally, the robot begins as a “tadpole” bearing just a tail. It transforms into a “frog” with four limbs. Its task is to swim to a given target.

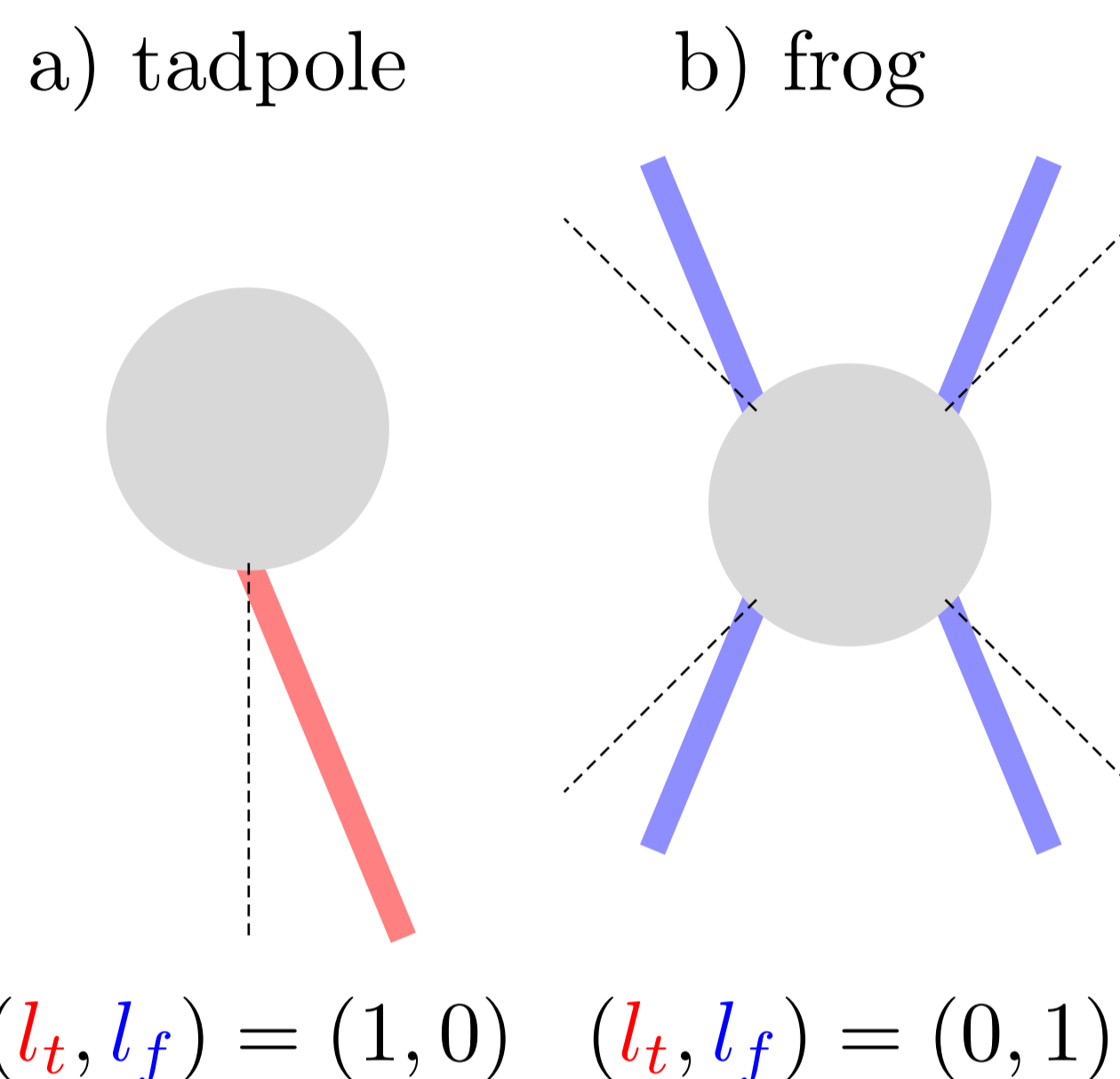


Figure 1: Parameterised morphology and joints

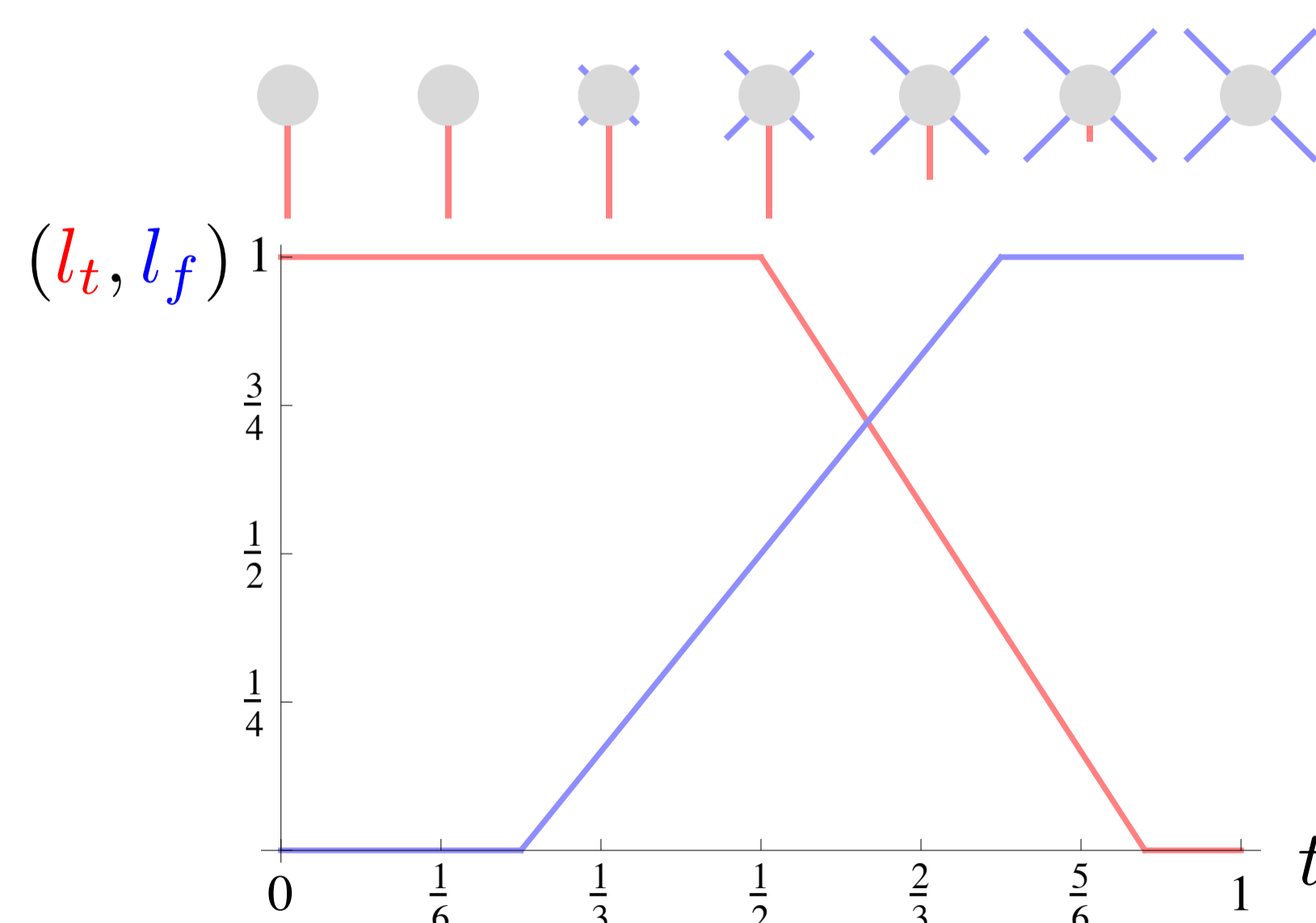


Figure 2: Example of how morphology changes over time

Experiments

To determine whether evolution is accelerated, all experiments are compared with the time required to evolve a frog that will swim to a target with no morphological change. No results are available yet.

- A) **Keep the tail:** Transform from a tadpole to a frog with a tail. This is most similar to Bongard's experiment: the infant form is conserved.
 - B) **Lose the tail:** Transform from a tadpole to a frog. Does not conserve the infant form; does conserve the infant controller.
 - C) **Lose the tail and tail brain:** Transform from a tadpole to a frog with an independent brain for the tail and legs—nothing conserved.
- a) normal brain b) lobotomised brain

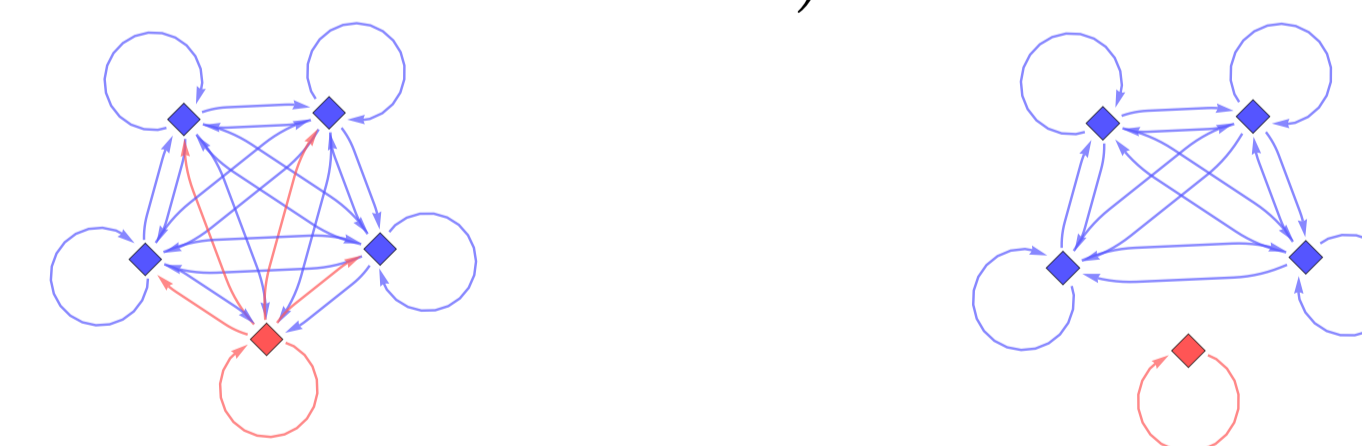


Figure 3: a) Fully connected CTRNN controller. b) Independent CTRNN controllers for the tail and legs.

References

[1] J Bongard. Morphological Change in Machines Accelerates the Evolution of Robust Behavior. *Proceedings of the National Academy of Sciences*, 108(4):1234–1239, Jan 2011.