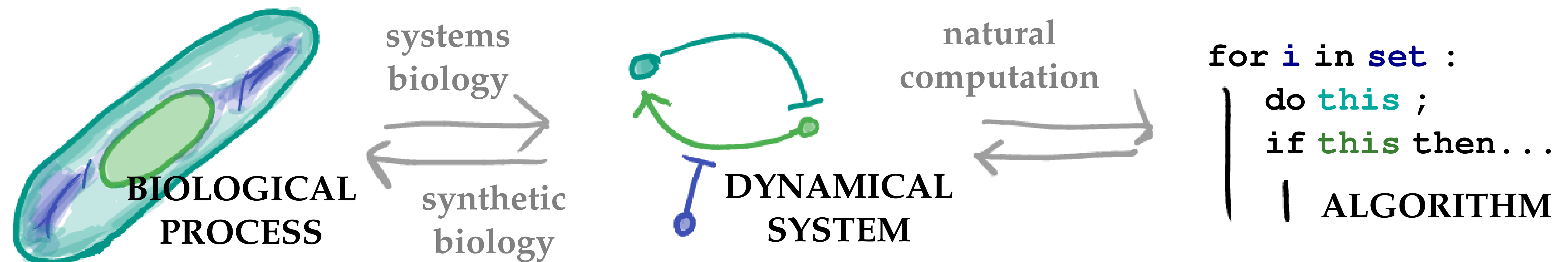
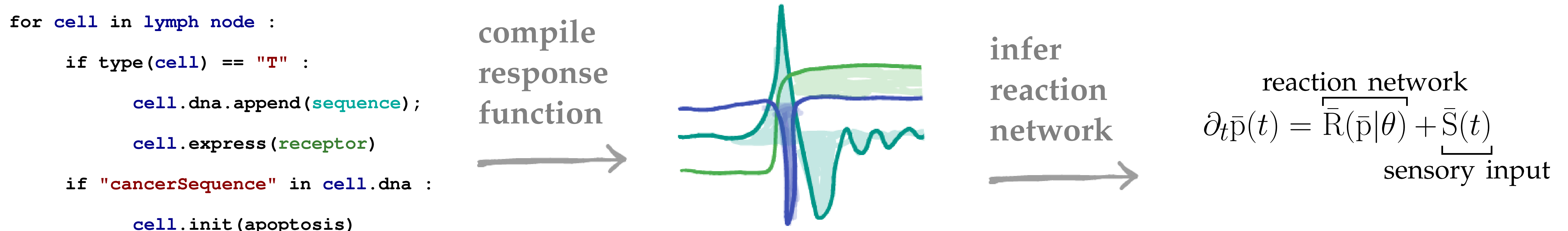


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Motivation | Designing algorithms to be executed in living organisms

Is it possible to build a programming language that compiles into a chemical environment, allowing us to execute arbitrary code in living cells? To produce appropriate adaptive responses given sensory input from environments, **living organisms perform asynchronous computations** using chemicals reaction networks [1].



Algorithm → Dynamical System | Given a response function what is the minimal reaction network?

- Asynchronous arithmetic logic units have been designed using chemical reaction networks [2]
- Chemical reaction networks can be inferred from processes data [3]
- No mapping between response function and network exists that minimises complexity

What is the general routine for *reducing complexity* in reaction networks?

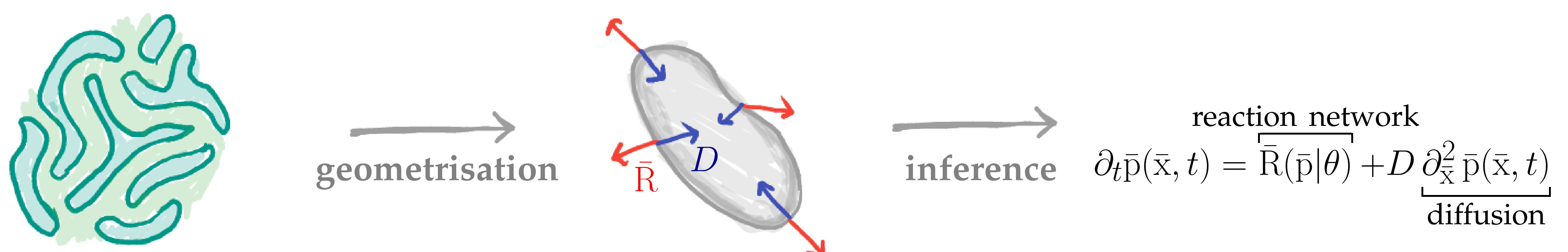
- For *known time-scale separations* one can reduce models, introducing memory effects [4]
- There exist no *unsupervised reduction* methods beyond empirical sensitivity analysis

How does evolution lead to *complexity increase* in network motifs such as switches and clocks?

- Relationship between robustness and evolvability has been investigated [5]
- Evolutionary relationships between different chemical networks have not been quantified

Dynamical System | Given a steady state pattern what is the minimal reaction-diffusion network?

- Dynamics of local equilibria show promising pattern formation analysis beyond linear stability [6]
- No geometric description of diffusive attractors in phase space exists; required for pattern design



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