

Introduction

In biology, one of the most challenging problems is how the emergence of self-organization and operational closure are maintained through time [6, 5, 7]. In this topic, phenomena like regulation, replication and reparation have to be defined in order to get a concept of self-organization. Up to now, reparation in metabolic networks has a non trivial description and many efforts have been made to investigate related concepts as closure existence or system dynamics.

We propose a model where the coexistence of intermittent coupled dynamical systems allows the emergence of global reparation as a property of the whole network.

Contribution

In Rosen's (M, R) -systems researches [1, 3, 4], they generally try to solve the closure of an autonomous system by means of a switching route between mapping of mappings, but no time scales are considered. Some class of instantaneous reparation is needed by this type of modeling, and no satisfactory solutions can be given, because only the existence of global mappings switching functions and inverses are a difficult mathematical problem [4]. The complexity of the (M, R) -systems can be analyzed with hyperset theory [2], to avoid the computational modeling of the autonomy in life systems.

Model

Be the process $a \xrightarrow{f} b$, where f is the catalizer of this reaction. If f has a lifespan, it is conditioned by its own degradation through time. When f is degrading, the output b is also gradually corrupted. If in an instant t the elements of a system are a and f , this state is expressed by $\{a, f\}_t$. If the reaction time is p , a is joined with f_t in an instant t to generate b_{f_t} , then the *history* of the system is $\{a, f_t\}_t, \{f_{t+p}, b_{f_t}\}_{t+p}$. If f_t , $n < t < m$, is in a normal production state (not completely degraded), with n the starting production time, and m the complete degradation time, then the process can be described for the diagram:

$$f_n \quad \dots \quad f_t \quad \begin{array}{c} \downarrow a \\ \uparrow b_{f_t} \end{array} \quad f_{t+p} \quad \dots \quad f_m$$

Description

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For simplicity, if f has only two states N (normal) and D (degraded), the process has the followed transitions:

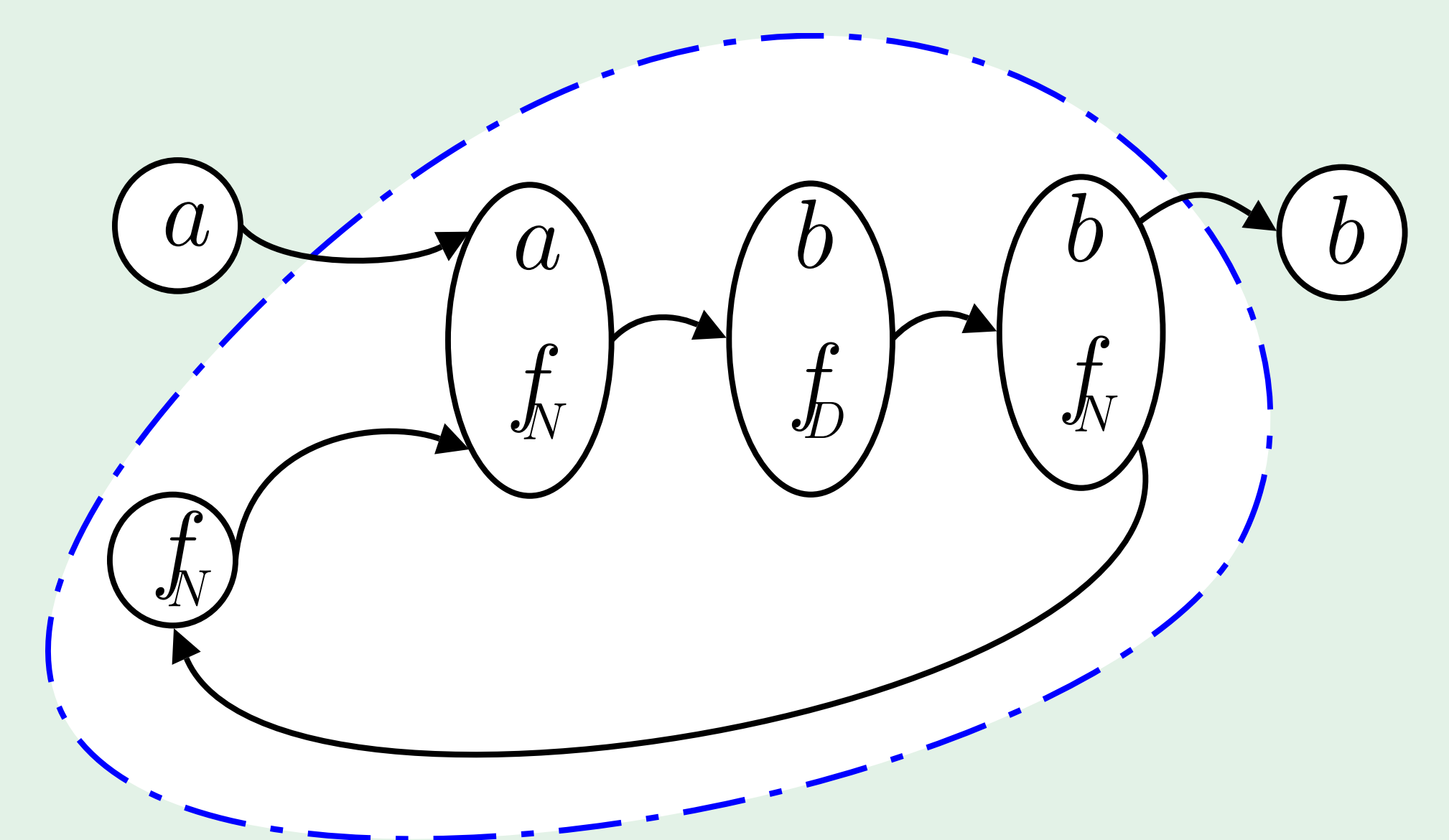
$$\begin{array}{l} \text{normal} \quad : \quad \{a, f_N\}_t \longrightarrow \{f_D, b\}_{t+p} \\ \text{degraded} \quad : \quad \{a, f_D\}_t \longrightarrow \{a, f_D\}_{T>t} \end{array}$$

In order to maintain the process $a \xrightarrow{f} b$, for long time, another intermittent transition to repair f is needed, $\{f_D, b\}_t \rightarrow \{b, f_N\}_{t+r}$, with process time r , then a part in the *history* of the process could be:

$$\{a, f_N\}_t, \{f_D, b\}_{t+p}, \{b, f_N\}_{t+p+r}$$

	input		output					
limits	...	...	...	...	...	...	...	...
	a	b	b		a	b	b	
	f_N	f_D	f_N	f_D	f_N	f_D	f_N	
limits	...	...	...	...	...	...	...	...
			a	b	b		a	
time	...	t	t	t	t	t	t	...
			$+p$	$+p$	$+2p$	$+2p$	$+3p$	$+3p$
			$+r$	$+r$	$+2r$	$+2r$	$+3r$	

Diagram of evolution for the intermittent oscillatory processes of transformation and reparation



State diagram of a process $a \xrightarrow{f} b$.

Conclusions

In this work we discuss the concept of self-reparation in living systems, modeling the production and reparation of different coupled processes that coexist in different time-scales. The feedback between systems in the network is maintained in intermittent oscillations. The study of long-term dynamics, is essential to show the self-reparation as an emergent behavior, and in our model, the self-reparation is vanished if we analyze only the short-term behavior.

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