When the dynamical writing of coupled memories with reinforcement learning meets physical bounds

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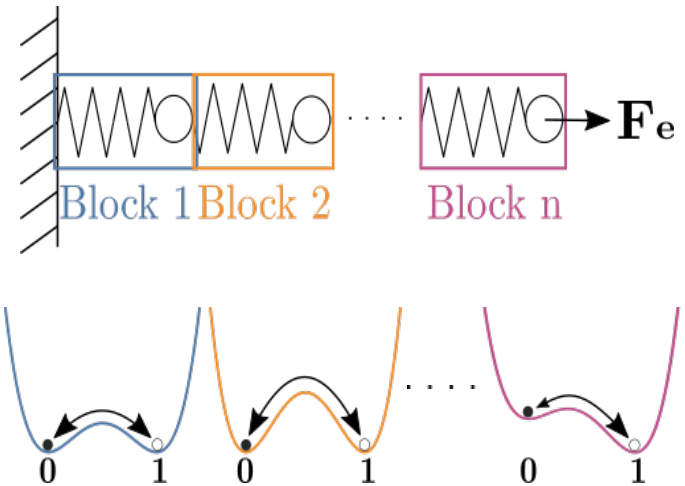
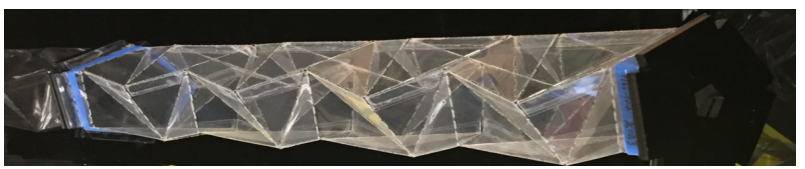
Studied system



Chain of coupled bi-stable spring-mass units

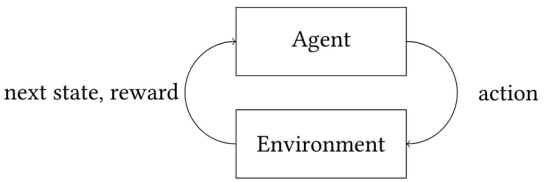
Motivation

- Model for materials supporting several crystallographic phases
- **Mechanical memory system** for stocking
- Traditionally, **quasi-static operations**, known to **reduce the memory capacity of the system**, are used for bits manipulation



Théo Jules, Austin Reid, Karen E. Daniels, Muhittin Mungan, and Frédéric Lechenault. Delicate memory structure of origami switches. *Phys. Rev. Research*, 4, 2022.

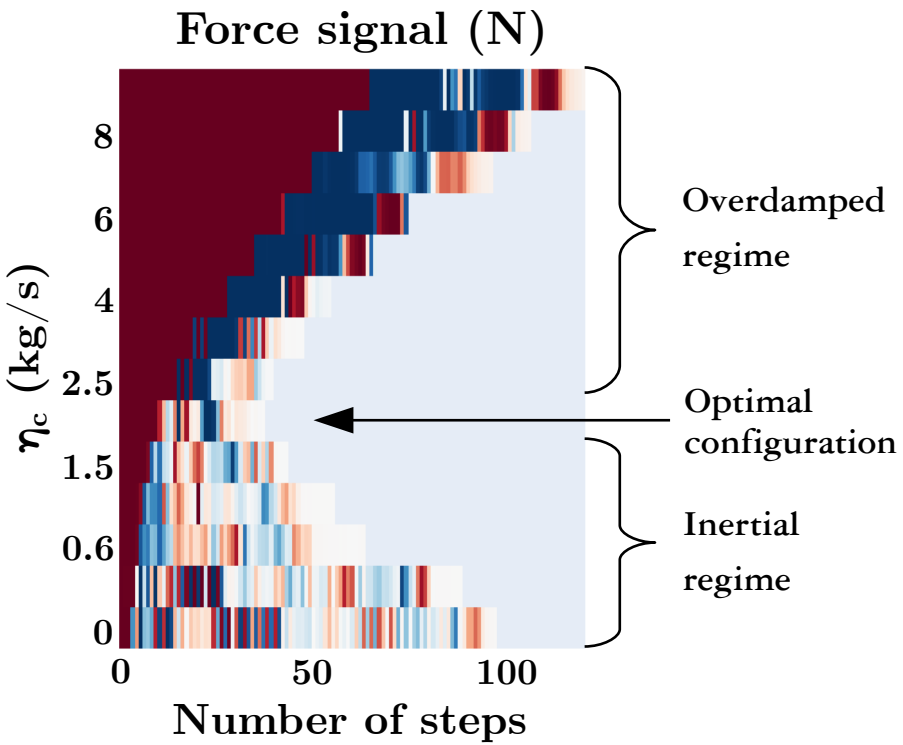
Control using RL



- RL allows to **control dynamically** the multi-stable chain, **restoring the memory capacity** of the system to its full potential

The RL agent shares insightful knowledge

Different strategies for different regimes



The optimal configuration can be physically understood by introducing two typical times

τ : time at which inertia becomes negligible $\propto 1/\eta$

t_c : time at which the external load propagates in neighboring springs $\propto \eta$

When $\tau = t_c$, the configuration of inertia vs dissipation is optimal and :

$$\eta_c \sim m^{1/2} k^{1/6} F_{\max}^{1/3}$$