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

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Traditionally, memory writing operations proceed one bit at a time, limiting the storage capacity of materials. A way to overcome this limitation would be to write several bits at once. Although quasi-static operations are typically used for bits manipulation, they are known to reduce the memory capacity of a system. To address this issue, we introduce a model framework for dynamical memory manipulation based on a multi-stable chain of coupled bi-stable spring-mass systems (see fig. 1). We show that, using a Reinforcement Learning agent, we can control this highly nonlinear system in force, driving it from any stable or random configuration to any other. Notably, by taking advantage of the underlying physics, the agent shares insightful knowledge by pointing to an optimal system design.

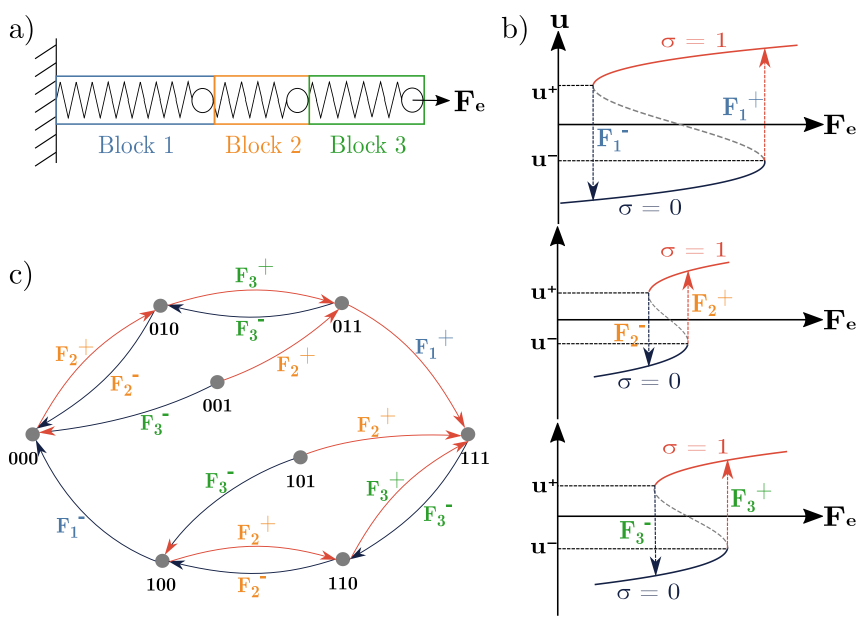

Figure 1. Model for a chain of three coupled bi-stable spring-mass units. a) Schematics view of the model. The first unit is attached to a fixed wall and an external force F_e is applied to the last one. b) Deformation u of all three bi-stable springs under external load F_e. c) Transition graph where the nodes represent the stable configurations and the arrows the quasi-statically achievable transitions between them. The states 001 and 101 are inaccessible from any other equilibrium state through quasi-static operations.

Références

1. T. Jules and L. Michel and A. Douin and F. Lechenault, *Communications Physics*, **6**, 25, (2023).