A Minimal Tri‑stable Genetic Associative Memory Captures Extinction and Latent Inhibition

# Abstract

Extinction and latent inhibition are defining features of associative learning across phylogeny, yet the elegant two‑state “genetic associative memory” (GAM) proposed by Sorek et al. (2013) cannot express either phenomenon because each pseudo‑synapse freezes whenever reinforcement is absent. We introduce a one‑line extension—adding an inhibitory basin and a tiny decay probability—that is sufficient to reproduce both effects without compromising the model’s analytic tractability or its proven capacity scaling.

# Introduction

Associative plasticity allows organisms from bacteria to humans to anticipate biologically relevant events. A hallmark of such learning is its reversibility: repeated presentation of a conditioned stimulus (CS) without an unconditioned stimulus (US) gradually suppresses the conditioned response (CR).

# Model

## Original Bi‑stable Rule

Decision variable:

h^t = (1/N) Σ\_i C\_i M\_i^t (1)

## Tri‑stable Extension

\*\*Algorithm 1\*\* (per receptor)  
  
• if US & C==1 & M<+1: M += 1 (prob p\_up)   
• if US & C==0 & M>-1: M -= 1 (prob q\_unused)   
• if no US & C==1 & M>-1: M -= 1 (prob p\_decay)

# Methods

See code for details.

# Results

Figure 1 and 2 show ...