# Single Spiking Neural Network with Neuromodulated Attractors for Adaptive Robotic Quadruped Gait Switching


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## Motivation and Idea

- **Spiking Neural Networks (SNNs)** are bioinspired models capable of generating rich temporal dynamics.
- A single network, modulated by dopamine, can produce **multiple gaits**.
- Dopamine shifts the network between different dynamic attractors.
- **Proposal: Global modulation guides local patterns, enabling adaptive and robust control in quadruped robotics.**

## Summary


**A single spiking neural network, globally modulated by dopamine, generates multiple stable gaits in a quadruped robot**

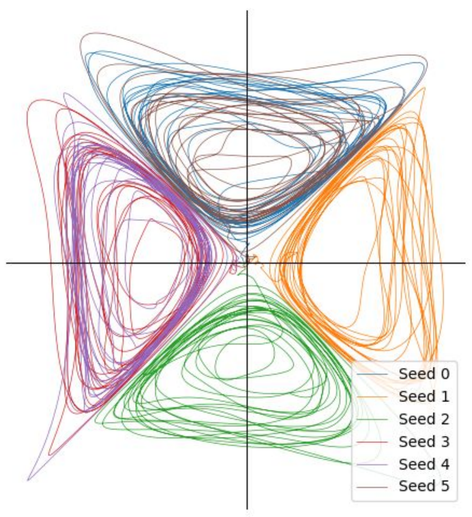

## Rich Temporal Dynamics

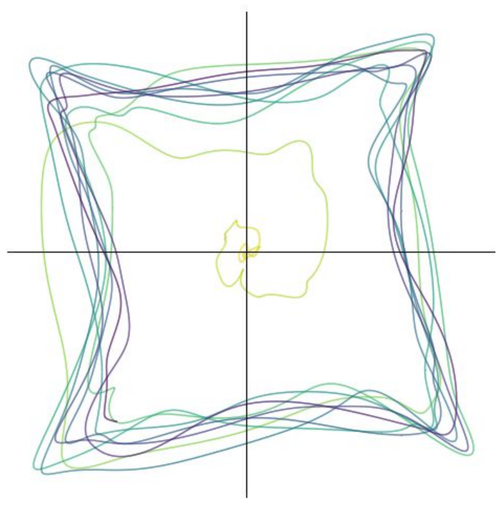
Clustered connectivity allows the emergence of distinct dynamical regimes.:

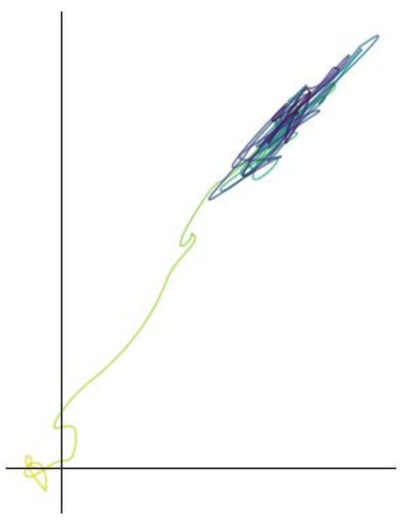
**Low dopamine**
→ chaotic
→ exploration

**Intermediate dopamine**
→ cyclic
→ stable gait

**High dopamine**
→ resting



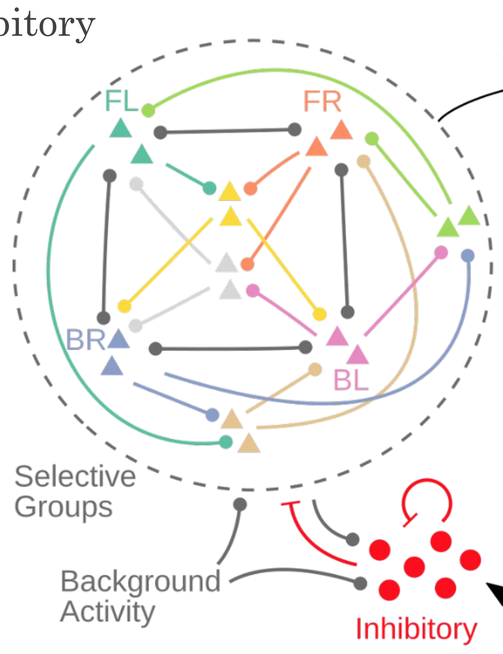


Dopamine tunes the network's dynamical regime, balancing exploration and exploitation.

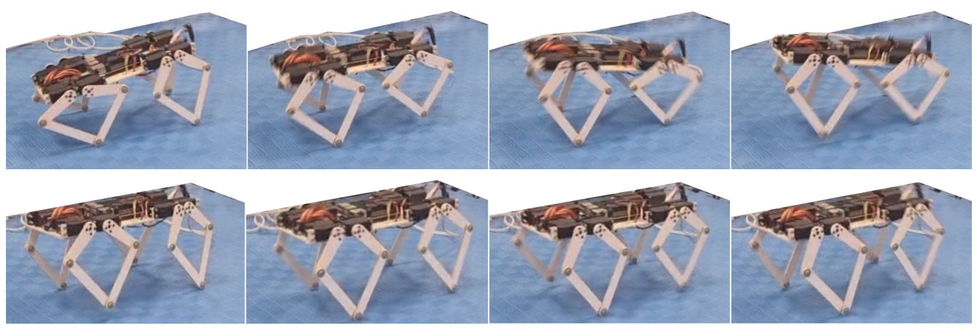
## Proposed System

### 1. Spiking Neural Network

- Excitatory and inhibitory clusters generate oscillations.
- Dopamine modulates inhibition and defines the dynamical regime.

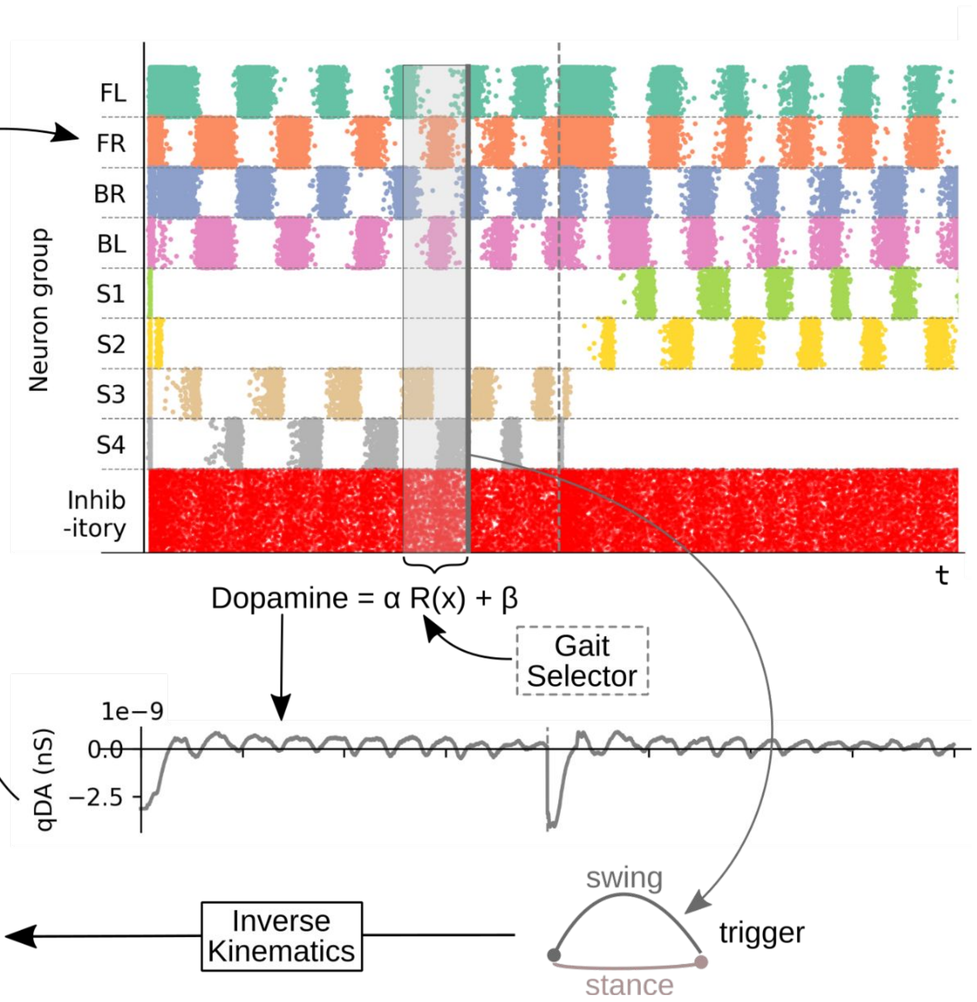



**Video**



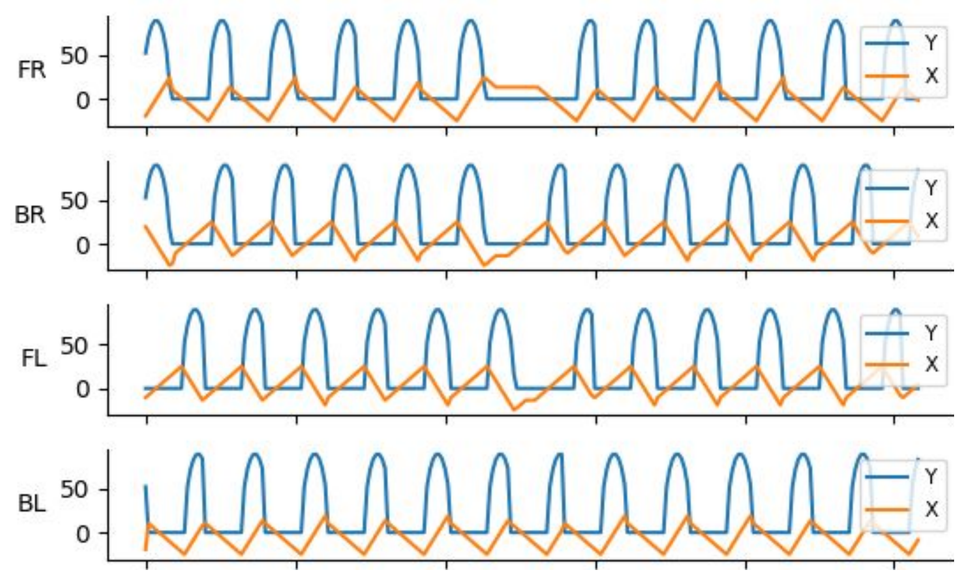
### 2. Neuronal Activity

- Spiking patterns encode gait sequences depending on dopamine and reward




### 3. Reward Function

- Dynamically adjusts dopamine.
- Low dopamine → exploration.
- Increasing dopamine → convergence to the desired pattern.




### 4. Leg Trajectories

- Neuronal phases are decoded into stance and swing curves.
- Coordinated locomotion patterns emerge.

### 5. Quadruped Robot

- Trajectories are mapped to joint angles.
- The robot performs trot and amble gaits with stable transitions.