

Attractor Dynamics with Synaptic Depression

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What is “Synaptic Depression” ?

→ The synaptic efficiency is depressed due to the shortage of neural transmitters after a spike

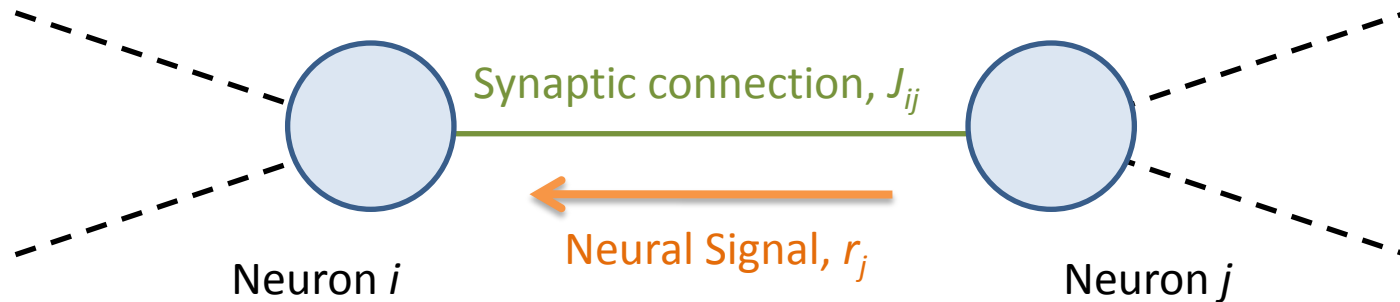
The Motivation

In this paper, we investigate:

- ✓ How synaptic depression affects the **intrinsic dynamics of continuous attractor neural networks** (CANNs)
- ✓ How synaptic depression affects the performance of CANNs in tracking external stimuli
- ✓ How a neural network enables a **short-term memory** by holding a family of slow-decaying states

Attractor Dynamics with Synaptic Depression

Model

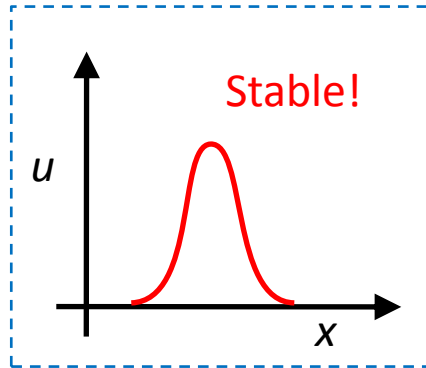


1. Synaptic connection strength, J_{ij} , is pre-defined
2. If a signal is sent from neuron j to neuron i , **the connection strength from j to i will be weakened**, due to synaptic depression
3. This effect is denoted by p_j , $0 < p_j < 1$
4. The effective connection from neuron j to neuron i is then $J_{ij}p_j$
5. **The time needed for recovery of p_j to 1 is about several ten times of the time scale of synaptic response**

Attractor Dynamics with Synaptic Depression

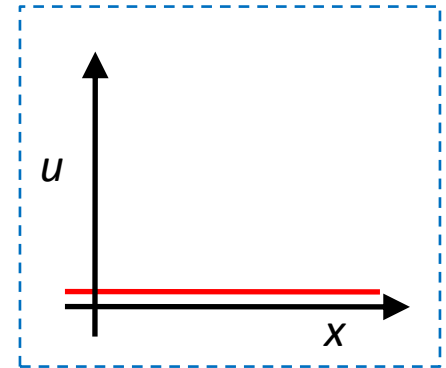
Intrinsic Phase

CANN Without Synaptic Depression:



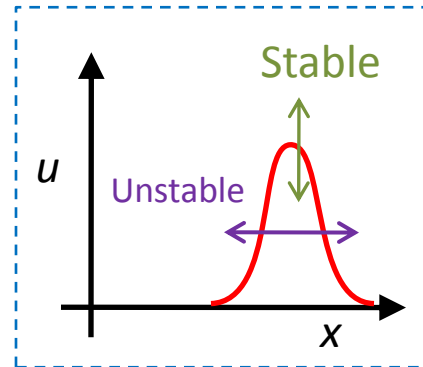
← Static bump

Silent state →

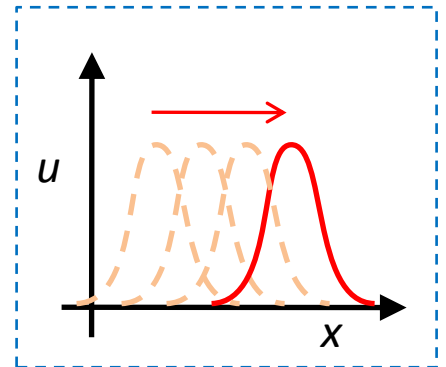


CANN With Synaptic Depression:

- Besides Static bumps and silent states, **two additional phases** can be found
- How do these phases depend on **inhibition** and **synaptic depression** ?



Metastatic

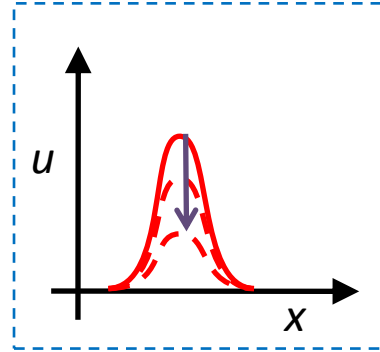


Moving

Attractor Dynamics with Synaptic Depression

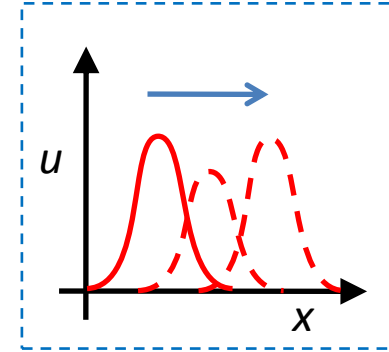
Slow Decaying

- After the removal of stimulus, how does the neural activity decay in a **non-exponential** manner ?
- This slow-decaying behavior functions as a mechanism of short-term memory



Tracking

- How is the tracking of changing stimuli affected ?
- Synapses are dynamical. Don't forget synaptic depression in the tracking process !



Impact

- Unlike CANNs with static coupling, CANNs with synaptic depression have richer dynamics
- Provides a mechanism of working memory

Our poster is poster No. 6. All are welcome.
Please feel free to give us comments. Thank You!