Critical Limits of Bump Attractor Network of Spiking Neurons

Symmetric breaking from exploration of weights and source inputs

Alberto A Vergani, PhD[1*]; Christian R Huyck, PhD[2]
[1]Marseille University, [2]Middlesex University
*alberto.vergani@univ-amu.fr

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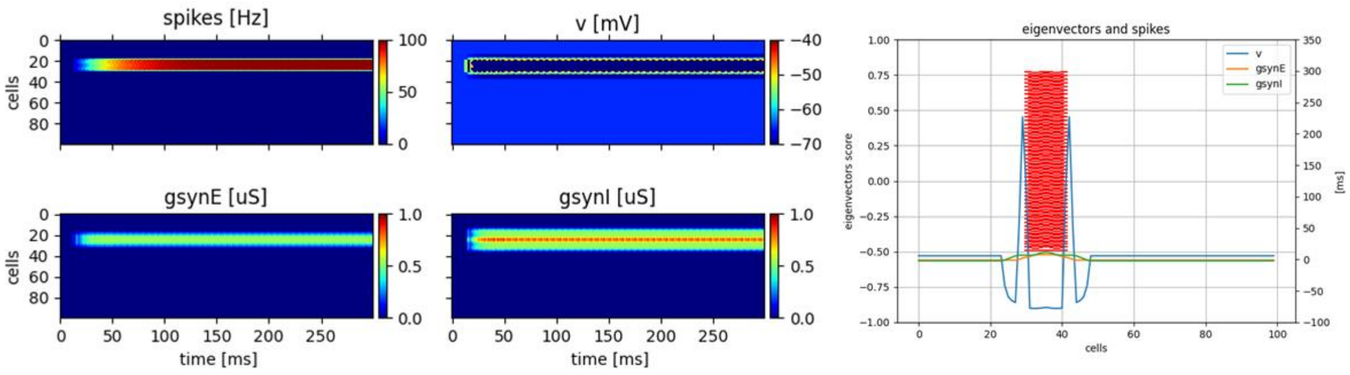
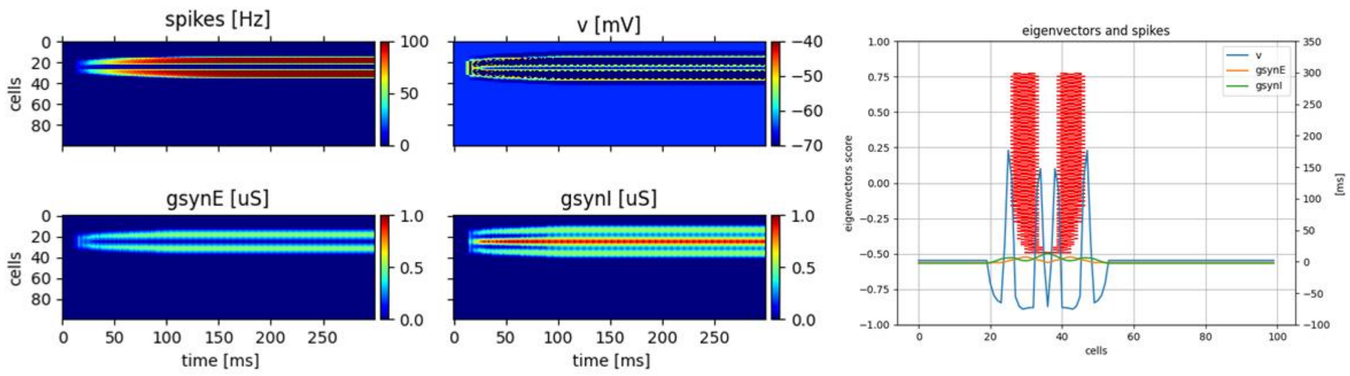
https://arxiv.org/abs/2003.13365

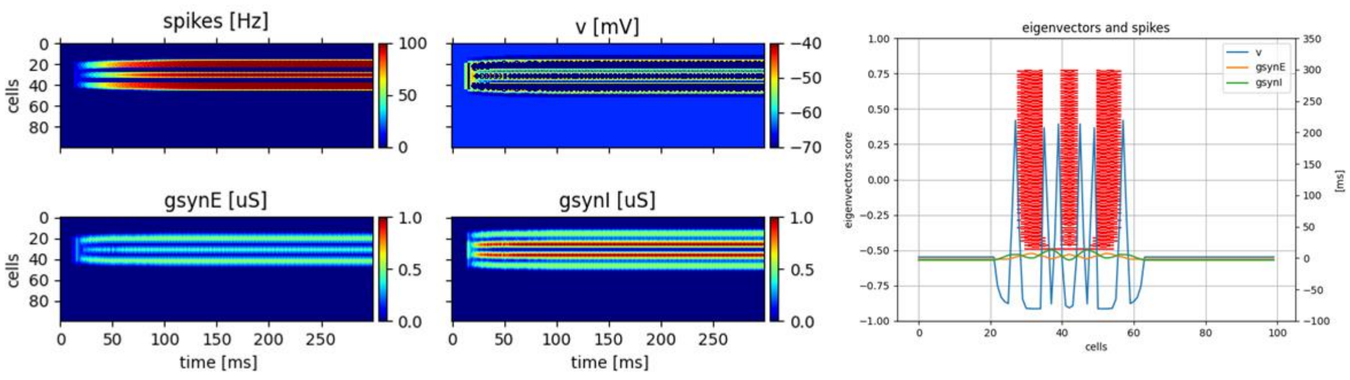
input cell window: 012 | exc weights=0.08 | inh weights=0.08



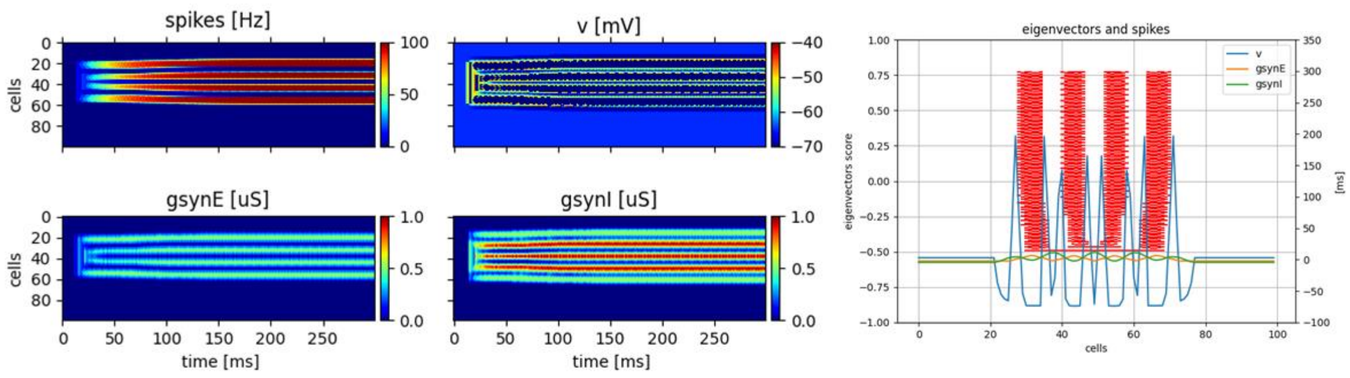
input cell window: 013 | exc weights=0.08 | inh weights=0.08



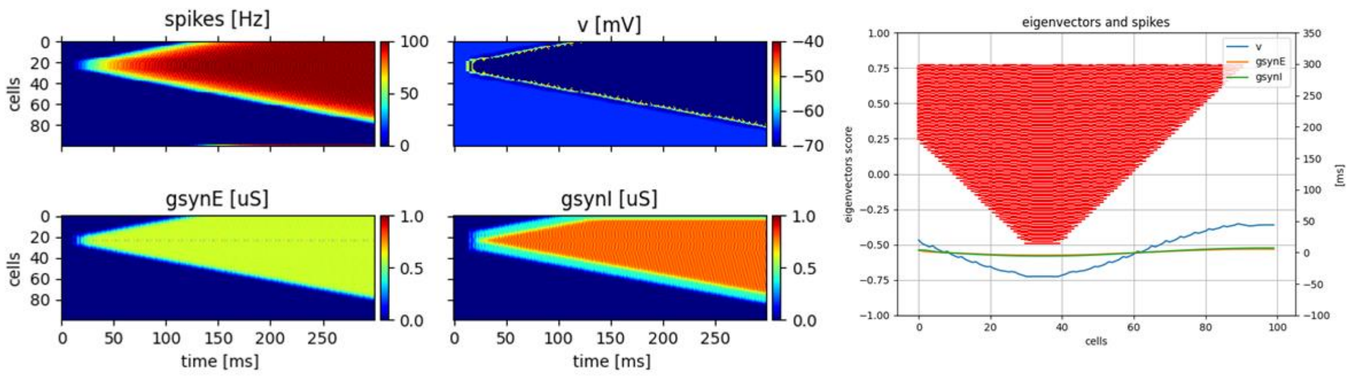
input cell window: 025 | exc weights=0.08 | inh weights=0.08



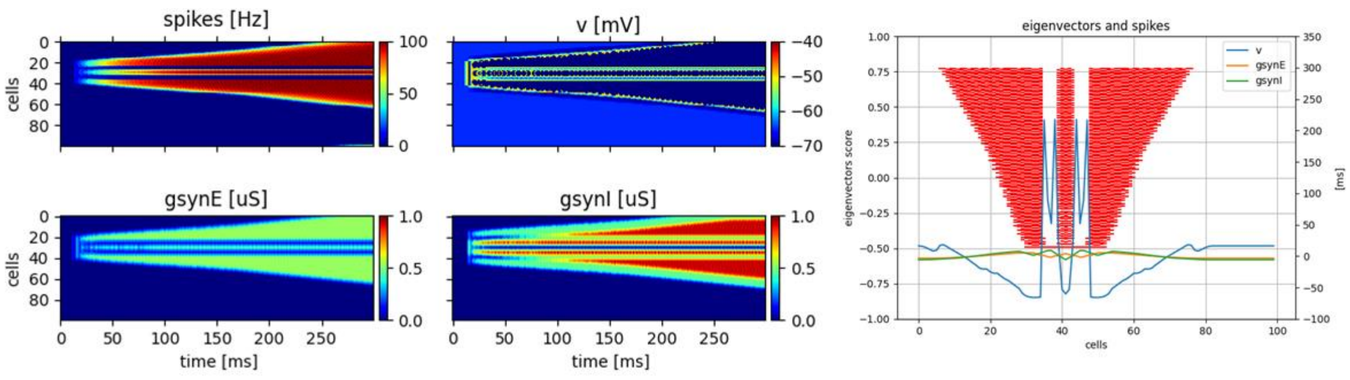
input cell window: 039 | exc weights=0.08 | inh weights=0.08



input cell window: 010 | exc weights=0.09 | inh weights=0.06



input cell window: 023 | exc weights=0.08 | inh weights=0.07



Highlights

- 1D bump attractor net with 2-4 connectivity shows different types of functional patterns:
  - single stationary bump
  - streaming or diverging bumps
  - combinations of bumps
- The functional patterns are related to critical values of weights and input sources

NUMBER OF INPUT SOURCES FOR IGNITION						
Exc \ Inh	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**	**0.1**
0.05	4	4	4	4	4	/
0.06	2	2	2	2	2	2
0.07	2	2	2	2	2	2
0.08	2	2	2	2	2	2
0.09	2	2	2	2	2	2
0.1	1	1	1	1	1	1

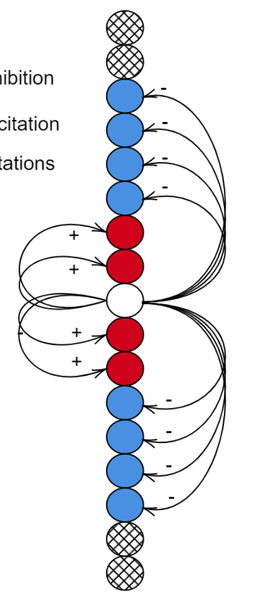
NUMBER OF INPUT SOURCES FOR 2 STREAMS						
Exc \ Inh	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**	**0.1**
0.05	13	13	12	/	/	/
0.06	15	13	13	12	11	11
0.07	D	15	14	13	13	12
0.08	D	17(D)	15(D)	13	13	13
0.09	D	D	D	15(D)	15(D)	15
0.1	D	D	D	D	D	D

Exc-Inh	3 streams	4 streams
0.06-0.05	25	37
0.07-0.06	26	39
0.08-0.06	26 (D)	/
0.08-0.07	23 (D)	/
0.08-0.08	25	39
0.09-0.08	27 (D)	/
0.09-0.09	25 (D)	/

Network model and parameters

CELL PARS		
model	IF_COND_EXP	/
tau_m	20	[ms]
tau_refrac	2	[ms]
cm	1	[nF]
v_rest	-65	[mV]
v_reset	-70	[mV]
v_thresh	-48	[mV]
i_offset	0	[nA]
NETWORK PARS		
dimension	1D	/
size	100	/
delay	1	[ms]
exc weights	0.05-0.10	[uS]
inh weights	0.05-0.10	[uS]
tau_synE	5	[ms]
tau_synI	5	[ms]
e_rev_E	0	[mV]
e_rev_I	-70	[mV]
learning	no	/
SIMULATIONS PARS		
dt	1	[ms]
T	300	[ms]
hardware	SpiNNaker	/
software	PyNN	/
inputs	1 - 99#	/

1D 2-4 Bump Attractor Netwok



IF COND EXP MODEL

$$\frac{dV_M}{dt} = \frac{(-I_{Leak} - I_{Ex} - I_{In} + I_{stim})}{C_M}$$

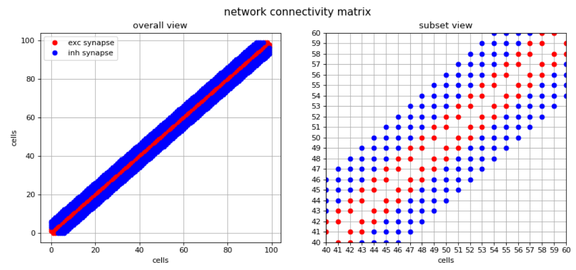
$$I_{Ex} = G_{Ex} \times (V_M - E_{Ex}^{rev})$$

$$I_{In} = G_{In} \times (V_M - E_{In}^{rev})$$

$$I_{Leak} = G_L \times (V_M - V_L^{rev})$$

$$G_{Ex}(t) = k_{Ex} \times t \times e^{-\frac{t}{\tau_{Ex}}}$$

$$G_{In}(t) = k_{In} \times t \times e^{-\frac{t}{\tau_{In}}}$$



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Human Brain Project

EBRAINS

Middlesex University London

Aix*Marseille université

int institut de neurosciences de la timone