Sequence learning w

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Sequence Learning

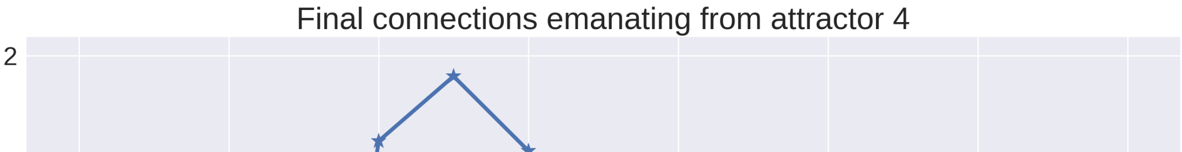
How can neocortical microcircuits encode sequences of activity? How can a stable sequential dynamics self-organize withing the bounds of the biological constrains? As early as 1950 Karl Lashley [3] advocated that the ability to sequence actions is the essential cognitive ability of human, how can we account for it? Since then we have found sequential population bursts in the activity related to the following behaviors:

- Motor
- Sensory
- Memory
- Decision Making

Here we propose a generic model that is a step ahead in solving the riddles above.

Connectivity I

Here we have the outgoing connectivity from a particular attractor to the rest of them. The asymmetry of the curve implies the direction of the sequence.



The Model

- Previous work ha
rule can learn se
attractor model w

- Using the firing-r
[2] with both f
(NMDA) connect
bilities of the sys
quence storage. [2

$$\tau_m \frac{s_i}{dt} = \beta_i + \sum$$

$$o = \frac{exp}{\sum_j ex}$$

$$\tau_z \frac{dz_i}{dt} = o_{i,k} -$$

$$\tau_p \frac{dp_i}{dt} = z_i(t) -$$

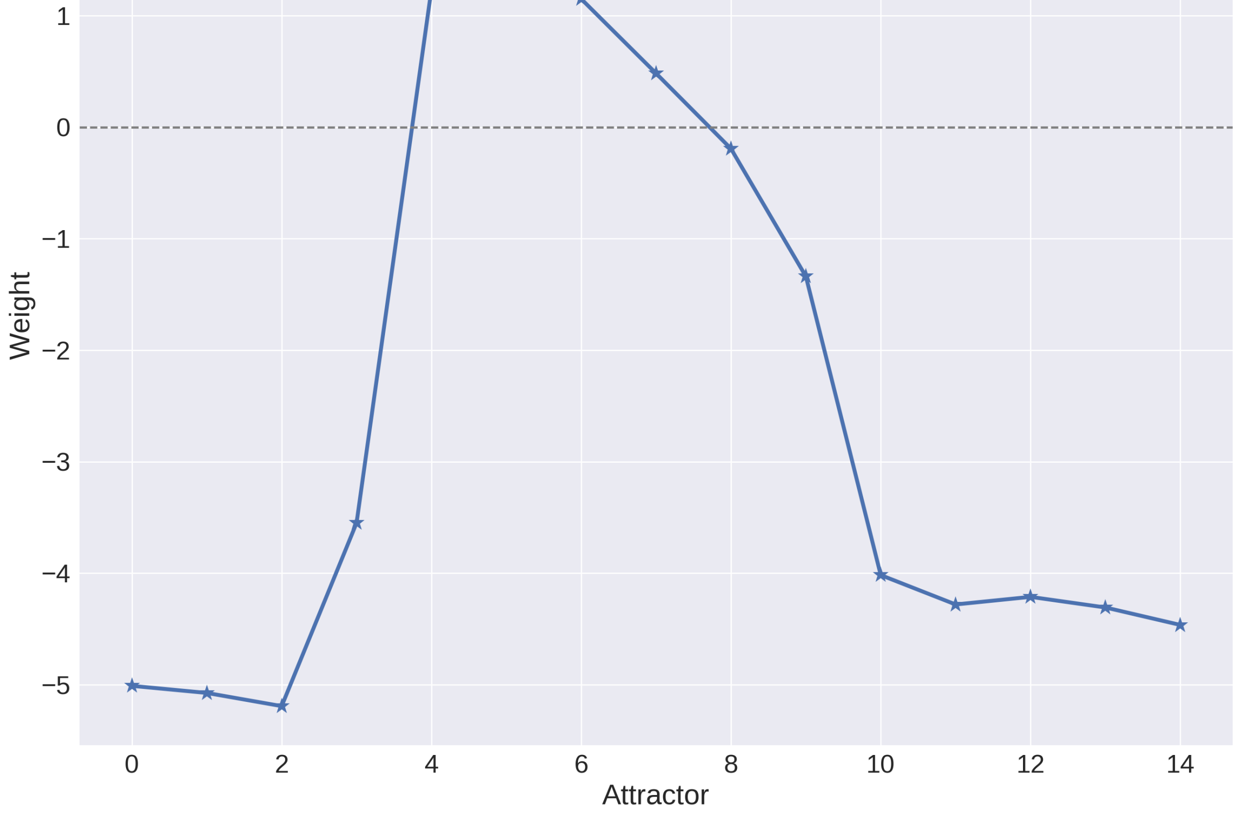
$$\tau_p \frac{dp_{ij}}{dt} = z_i(t) z_j$$

$$w_{ij} = \log(\frac{p}{p_i}$$

$$\beta_i = \log(p_i)$$

Due to a local transitio
this model can recall
length. Moreover, it ca

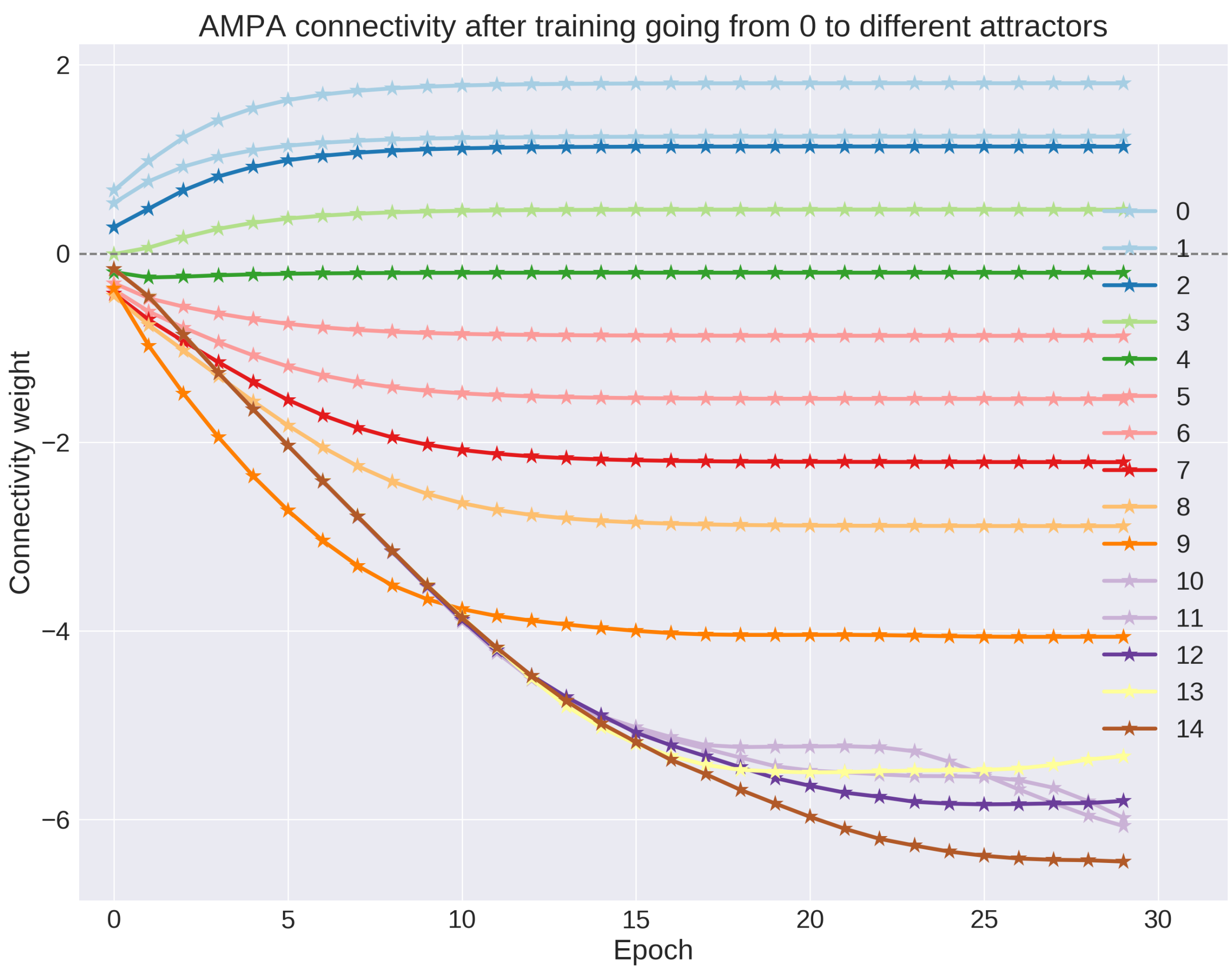
limitations both **seque**
quence disambiguatio

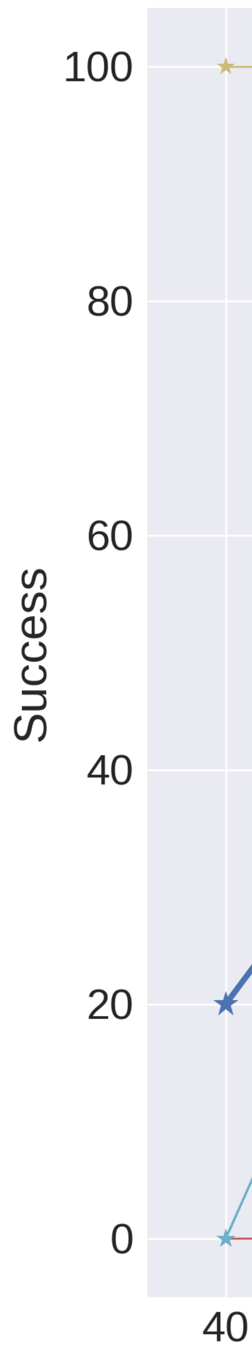


Chains

- We stored more c order to probe ho at retrieving them
- Two relevant par the space of all th **overlap** and **overl**

Stability across training





References

[1] Tully, Philip J., Henrik Lindén, Matthias H. Hennig, and Anders Lansner. e1004954. *PLoS Comput Biol 12, no. 5 (2016)*

[2] Sandberg, Anders, Anders Lansner, Karl Magnus Petersson, and Ekeberg 371(1):179-194 *Network: Computation in neural systems 13, no. 2 (2002))*

[3] Lashley, Karl Spencer pp. 112-136 *Cerebral mechanisms in behavior. 1951*

ith the BCPNN rule

erman, Anders Lansner

s shown that the BCPNN quences in a spike based ith modular structure [1].

ate version of the model ast (AMPA) and slow ivity we study the capa- stem for pattern and se- 2].

$$\sum_j w_{ij} o_j + a_i - s_i$$

$$\frac{(s_i)}{xp(s_j)}$$

$$z_i$$

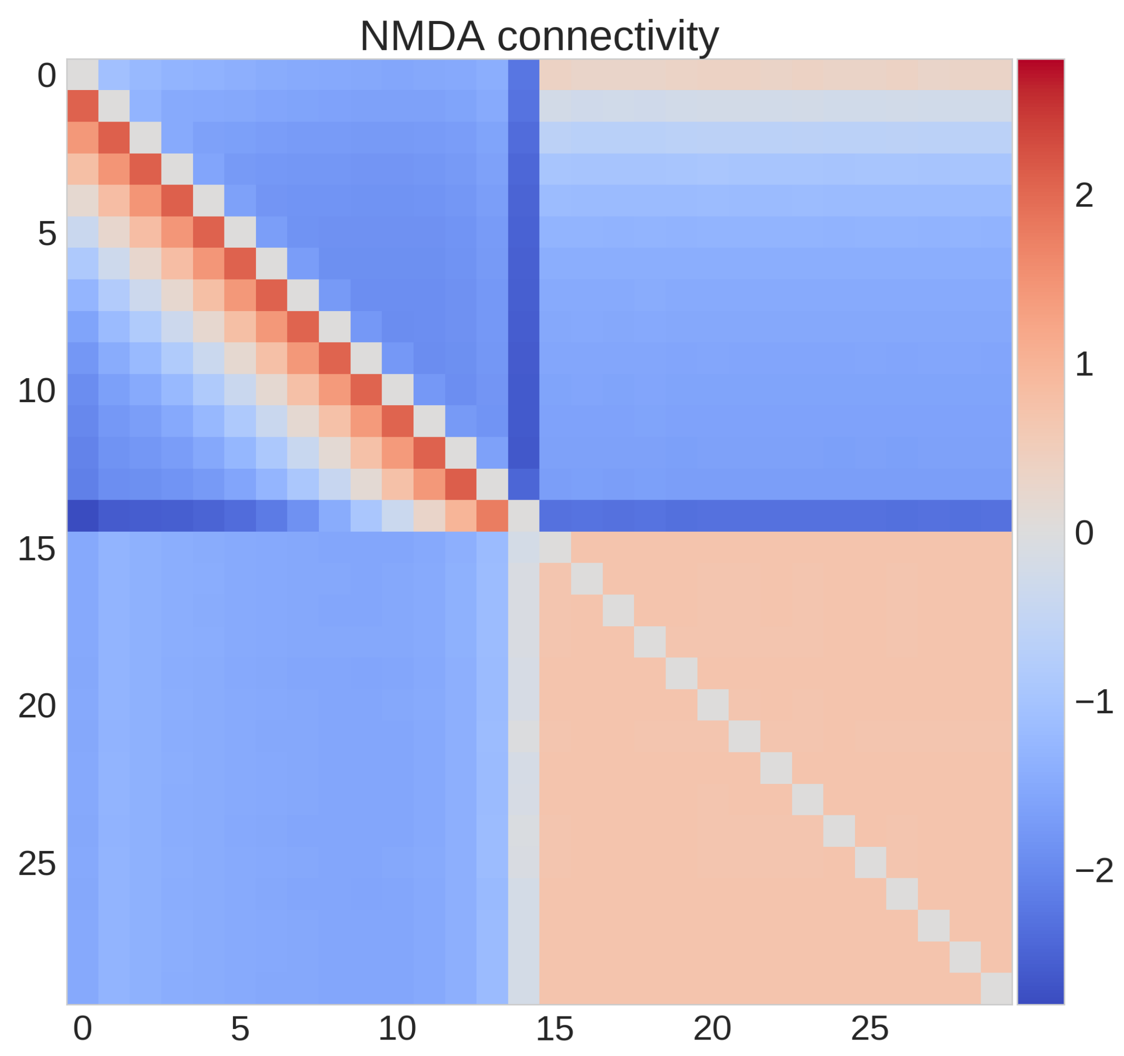
$$- p_i(t)$$

$$(t) - p_{ij}(t)$$

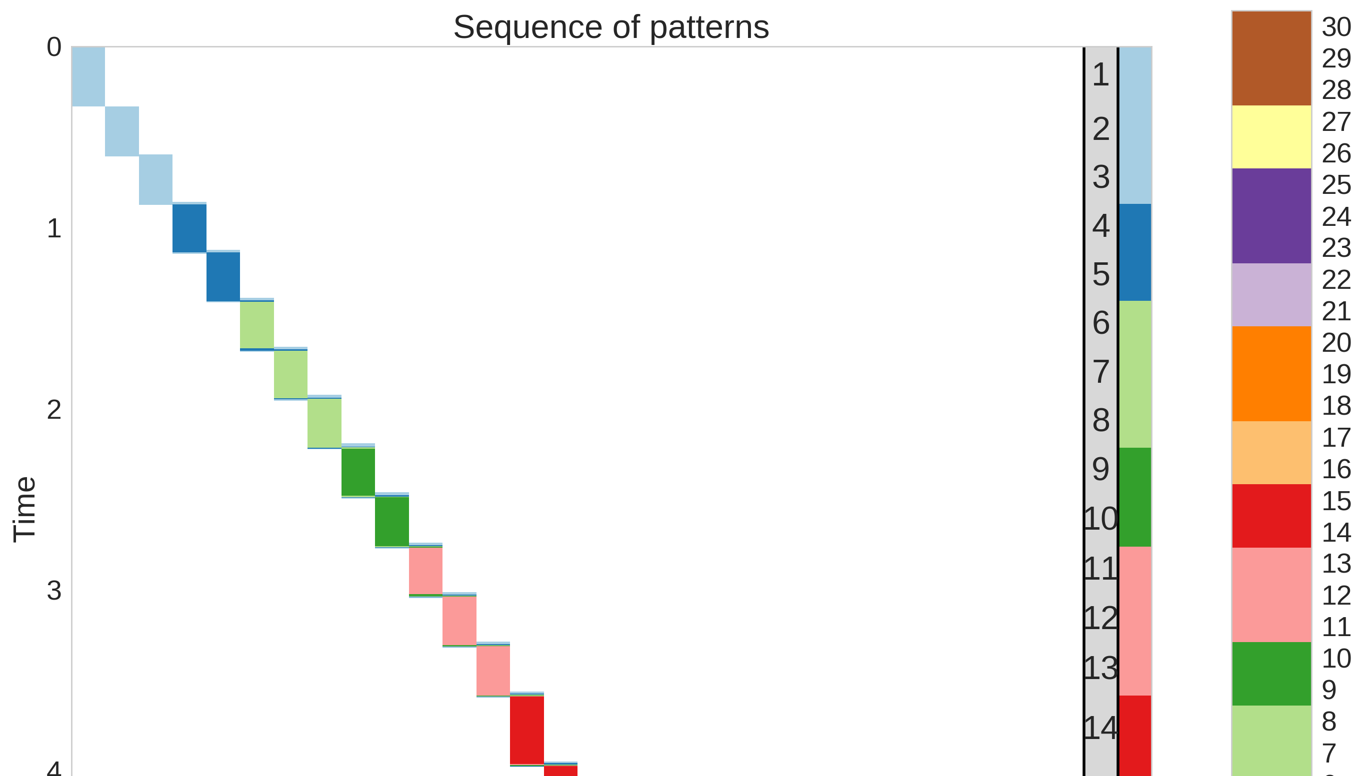
$$\frac{ij}{p_j})$$

$$)$$

n rule in absence of noise a sequence of arbitrary n perform within certain



Example of AMPA connectivity matrix and a successful recall of a sequence.



n perform within certain
nce completion and **se-
n**.

omplicated sequences in
w effective is our system
.

rameters to parametrize
e possible sequences are
oad.