

Deep-sleep-inspired activity induces density-based-clustering on memories and entropic, energetic and classification gains

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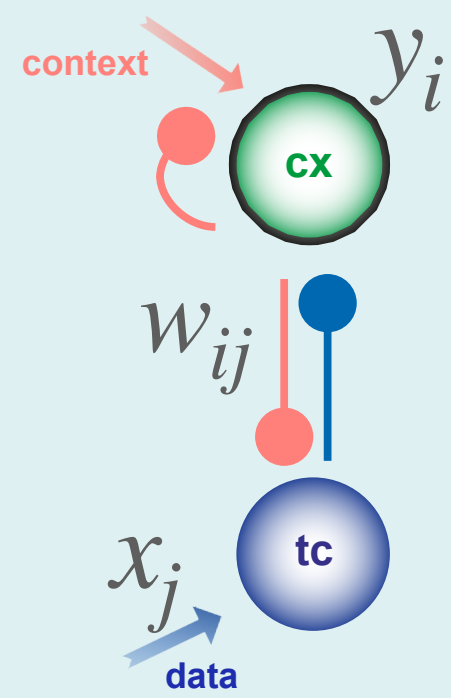
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Introduction and motivation

Aim: Investigate the effect of deep-sleep like activity over internal memories representation relying on minimal assumption.

Methods



- **Two layers** thalamo-cortical network
- i -th sensorial memory: $w_j^i = c \cdot x_j^{(i)} \rightarrow \underline{w}^k = c \cdot \underline{x}^{(k)}$
- The **response** of the **cortical** population i is described by an input-output **gain function** f
- An **Hebbian plasticity** rule is assumed over plastic connections
- If a cortical population k performs an **Up-State**, the weight update will be:

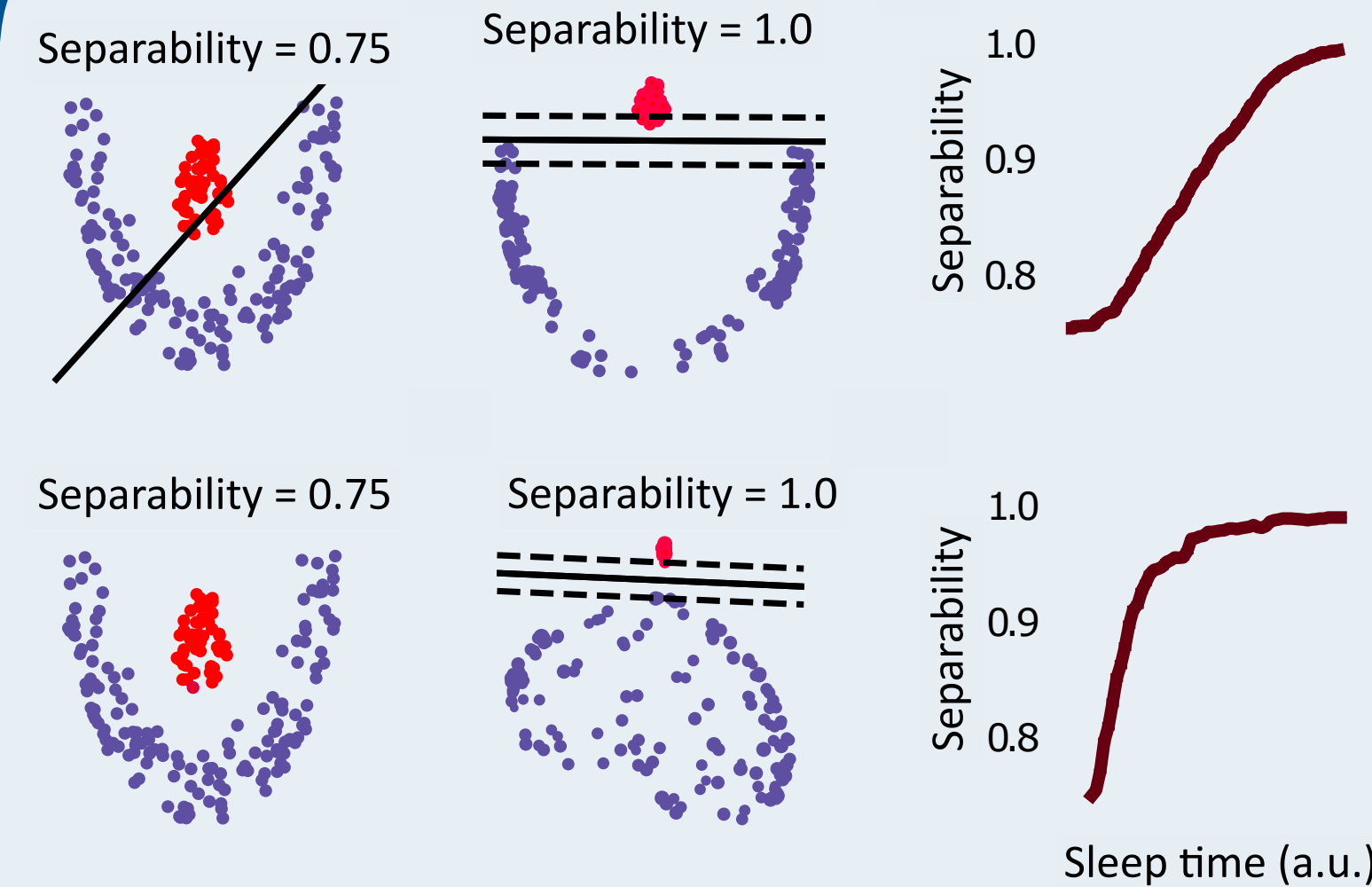
$$\Delta w_j^{i,eff} = \alpha f(1) f(\cos \theta^{ij}) \underline{w}^j + \alpha \sum_{k \neq j} f(\cos \theta^{ik}) f(\cos \theta^{jk}) \underline{w}^j$$

Thalamo-cortical plasticity Second order of attraction

Conclusions

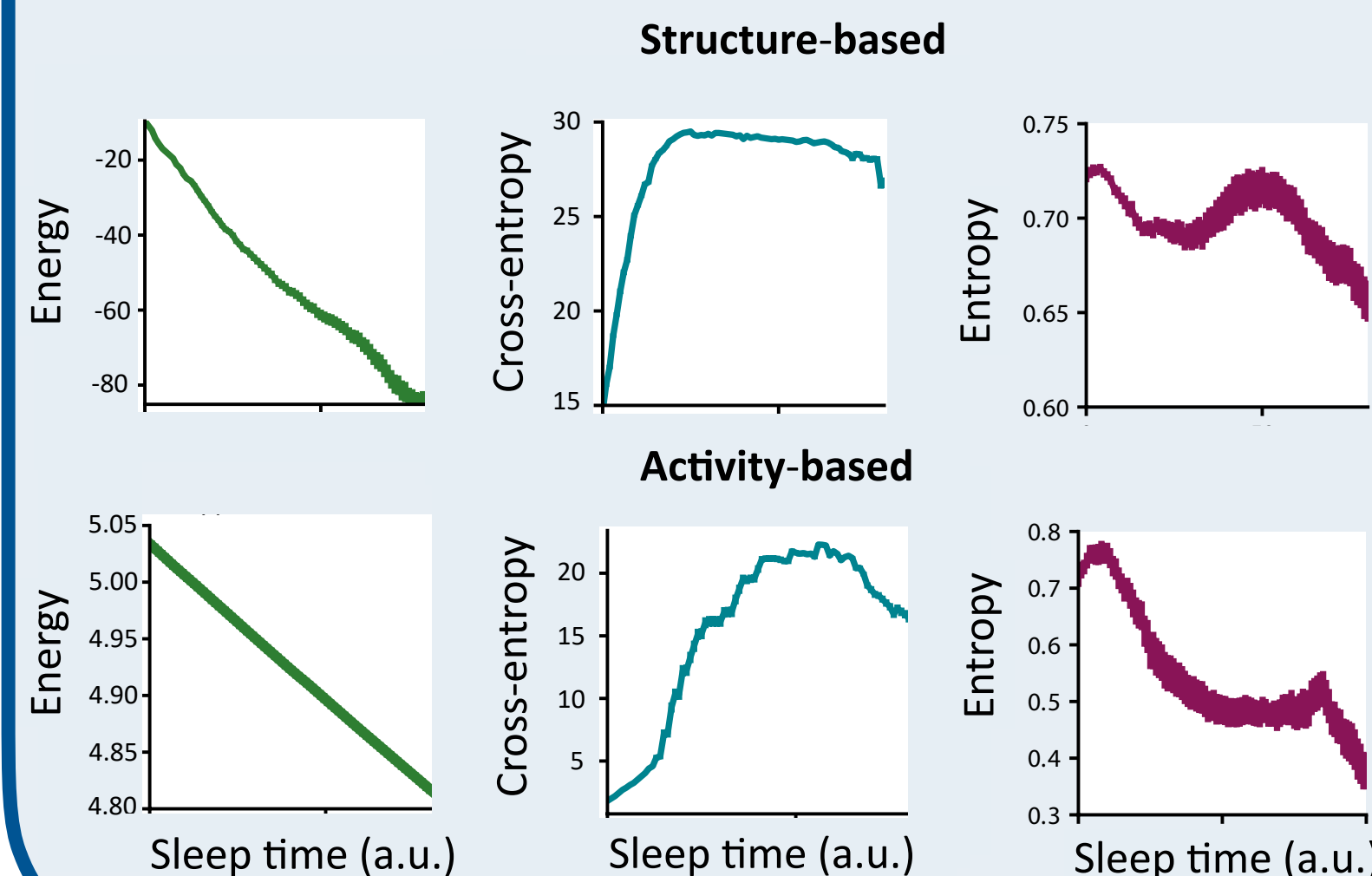
- Sleep model relying on very **minimal biologically plausible assumptions**
- Sleep naturally performs a “**density-based clustering**”:
- Sleep induces an **improvement** in performances
- Findings reproducible in **spiking** networks.
- The activity based **entropy** and **energy** measures are **coherent** with the structure based ones and can be verifiable **experimentally**.

Results and discussion:



Effects of sleep over memories

- Implementation of **rate** and **spiking** models
- **Closer examples** are **attracted**, others rejected
- Post-sleep interval memories representation is **linearly separable**



Entropy and energy measures

- **Structure-based** and **Activity-based measures** (experimentally applicable) are proposed.
- **Energy** reduces over time
- **Entropy** reduces over time
- **Cross-entropy** increases over time