



HAL
open science

Multi-sensory integration by constrained self-organization

Mathieu Lefort, Yann Boniface, Bernard Girau

► **To cite this version:**

Mathieu Lefort, Yann Boniface, Bernard Girau. Multi-sensory integration by constrained self-organization. Third EUCogII Members Conference - Multisensory integration, Oct 2010, Palma, Spain. inria-00536933

HAL Id: inria-00536933

<https://inria.hal.science/inria-00536933>

Submitted on 17 Nov 2010

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Multi-sensory integration by constrained self-organization



Mathieu Lefort, Yann Boniface and Bernard Girau
 {lefort,boniface,girau}@loria.fr



Abstract

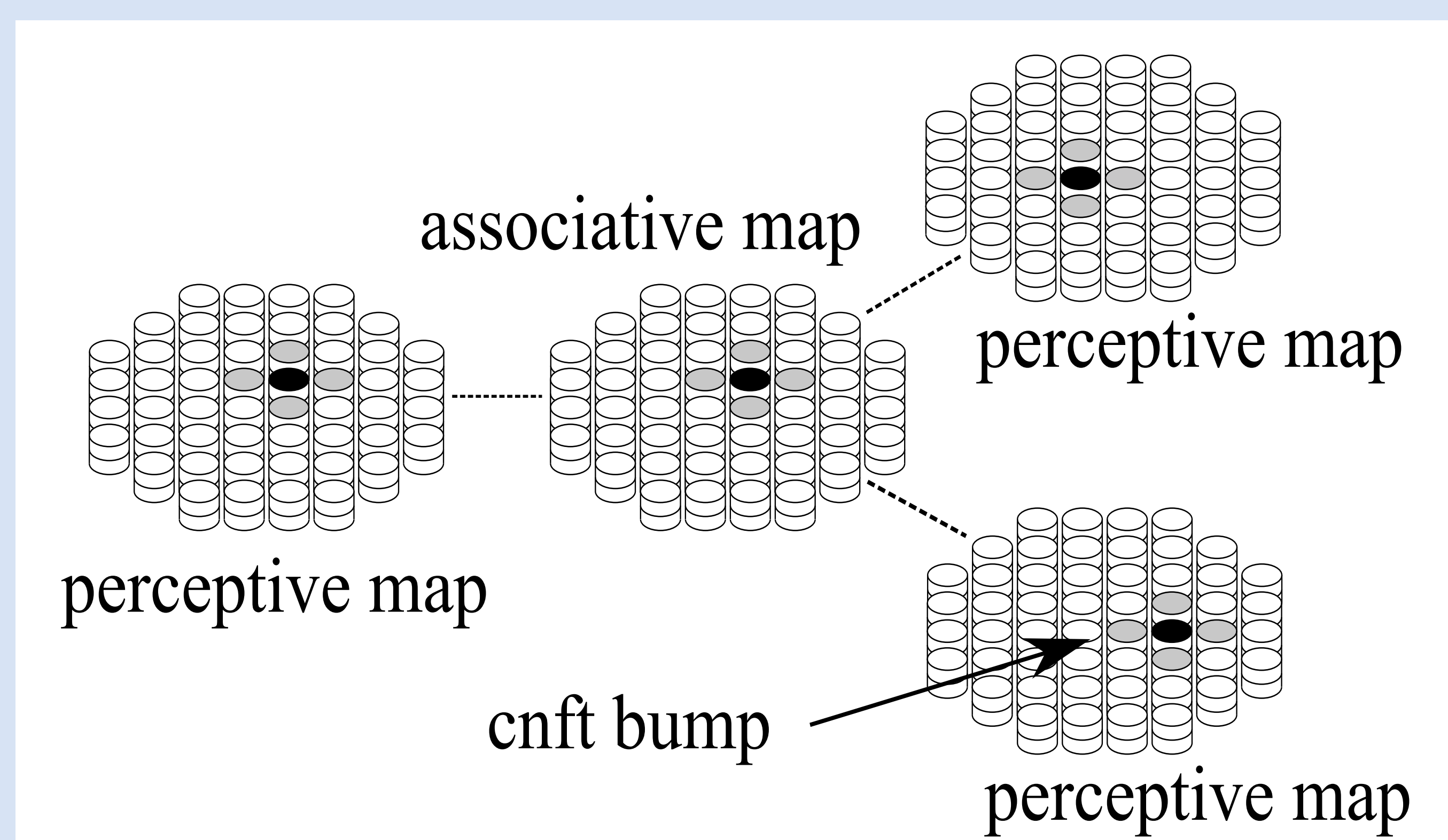
We develop a model for multi-sensory integration to perform sensorimotor tasks. The aim of this model is to provide missing modality recall and generalization using cortically-inspired mechanisms. The architecture consists of several multilevel cortical maps with a generic structure. Each map has to self-organize with a continuous, decentralized and unsupervised learning which provides robustness and adaptability. These self-organizations are constrained by the multimodal context to obtain multi-sensory generalization.

Mechanisms of the model

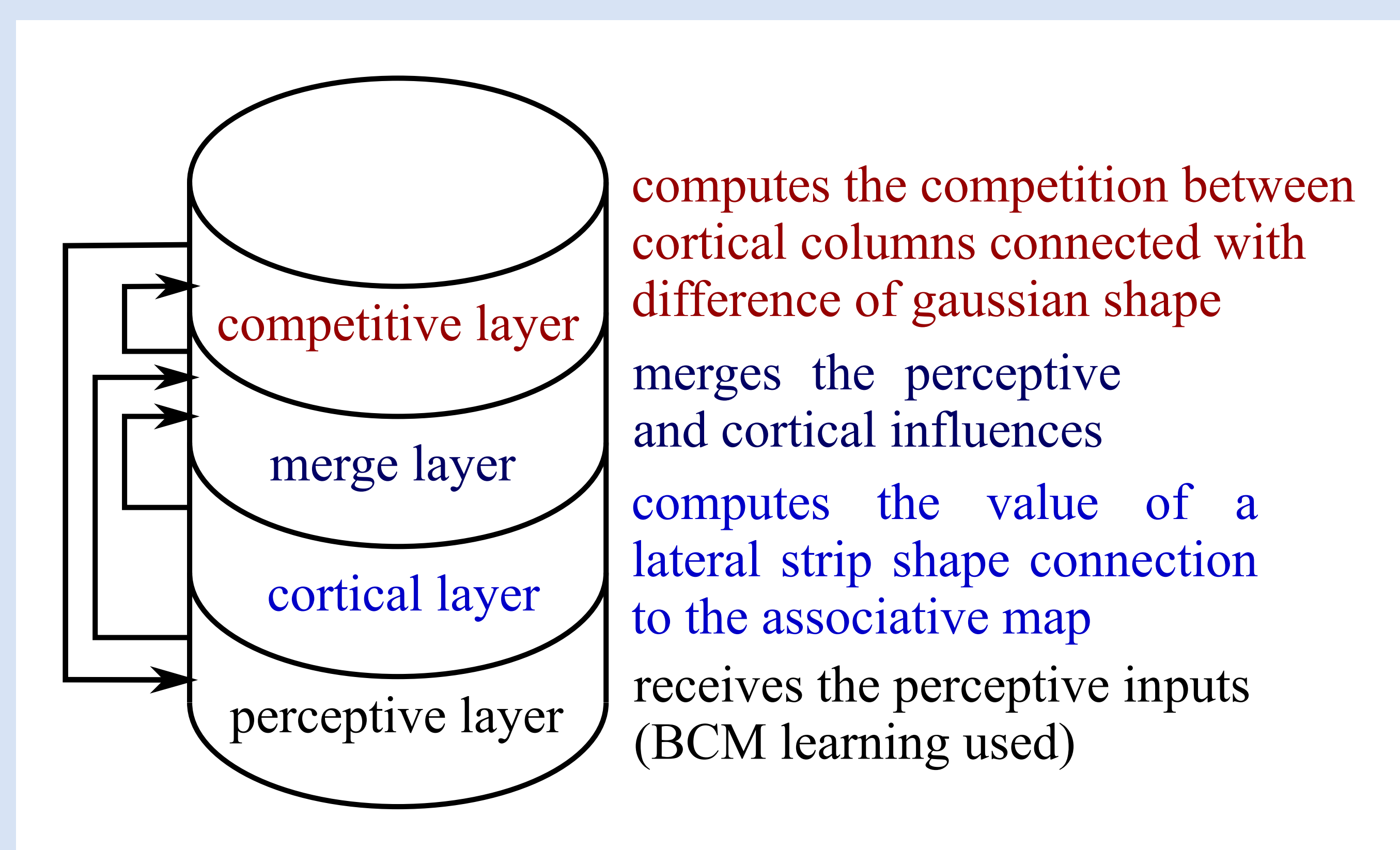
- continuous, decentralized and unsupervised learning
- perception represented by a neural map
- multi-sensory integration through associative map
- emergence of perception by a competitive mechanism (Continuous Neural Field Theory)
- emergence of a multimodal perception thanks to the relaxation of multi-sensory constraints
- neural map self-organization constrained by the multi-sensory context

Description of the model

Multi-sensory interactions



Neural maps: cortical column view



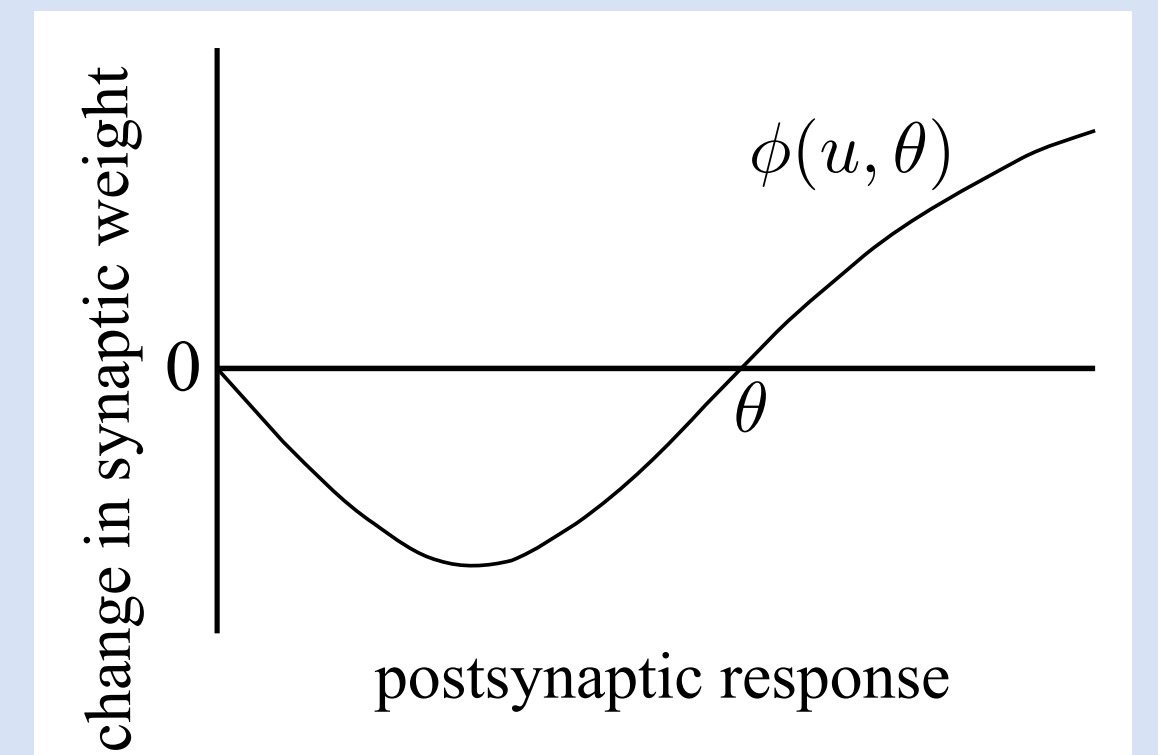
Perceptive layer: BCM's learning rule

BCM's learning rule

$$u = w \cdot x$$

$$\theta = E_{\tau}[u^2]$$

$$\Delta w = \eta * x * \phi(u, \theta)$$



BCM's properties

- spatial competition leading to stimulus selectivity
- weights regulation thanks to the sliding threshold

Modification of the BCM's learning rule

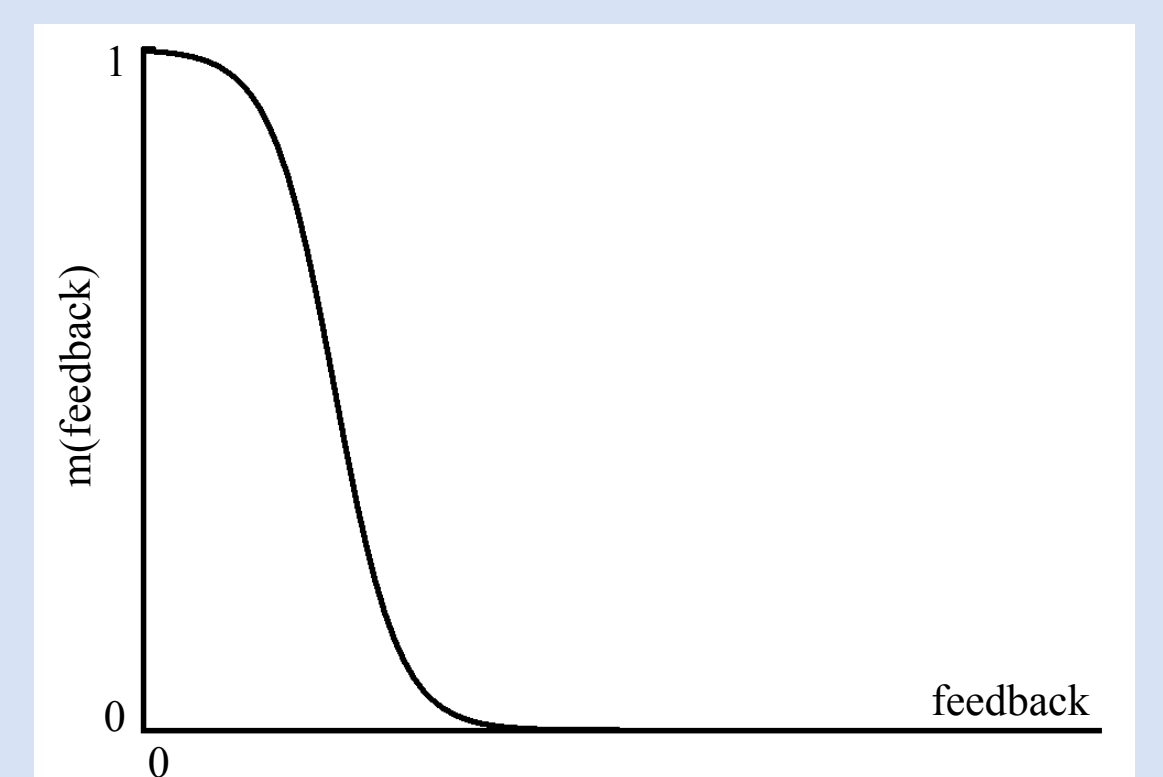
Feedback modulation of BCM

- modulation of the neuron activity influences the neuron selectivity
- activity bump is used as feedback modulation signal
- spatial coherence of the bump creates self-organization at the map level

Unlearning mechanism in BCM

$$u = w * x + f(\text{feedback})$$

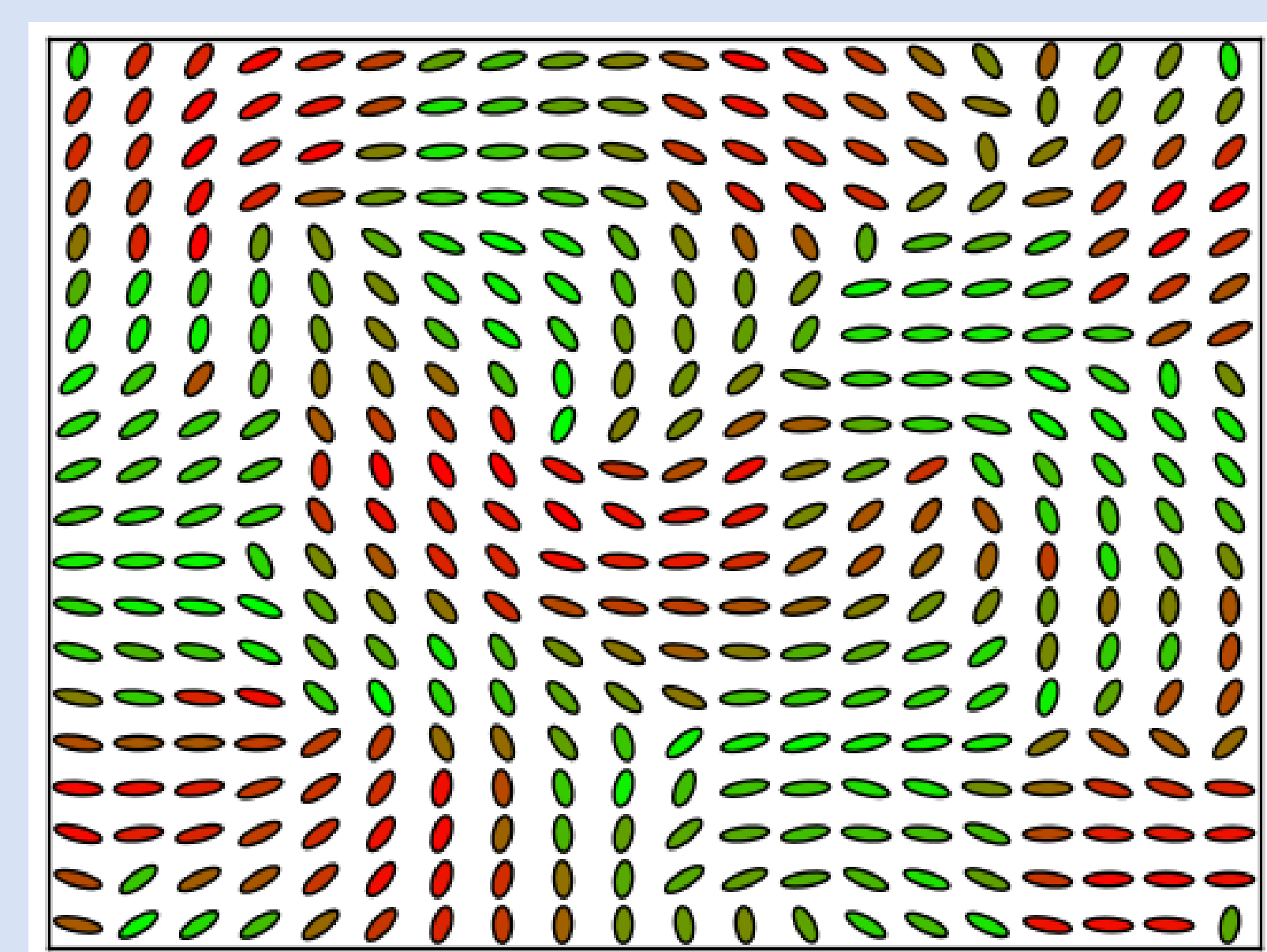
$$\theta = E_{\tau}[u^2]$$



$$\Delta w = \eta * x * u * (u - \theta - \alpha * m(\text{feedback}) * \chi * u^2)$$

- decreases weights when an inconsistency is detected (u high and feedback low)
- useful for bootstrapping (neuron selectivity has to develop before feedback can be consistent)
- helps to relax multimodal constraints
- must allow the addition of a new perception in a incremental way

Results



Map self-organization (orientation + colour)

Conclusion

With the modified learning rule, we obtain the self-organization of the map, which can be influenced by the multi-sensory context.