Neurological background

**From Max-out to Channel-Out: Encoding Information on Sparse Pathways**

* a similar principle from years of study of the human brain: It is not the shape of the signal, but the pathway along which the signal flows, that determines the functionality – More on this please, Riksen.. Oioi, does this refer to the action potential? In that case, it is not AS exciting… Yep, this is the case (see page 23 in Principles of neural science).

**Mechanisms of Winner-Take-All and Group Selection in Neuronal Spiking Networks**

How brain selectively processes such large number of inputs and maintains a unified perception remains a mystery.

In order to be useful, neurons must come to respond differentially to variety of incoming signals. Many neural models and theories have been proposed to account for such ability. Winner-Take-All (WTA) network is one of such proposed mechanisms for developing feature selectivity through competition in simple recurrent networks.

The theoretical justification for WTA is

* the ability of such networks to explain how the maps, which are ubiquitous in the cerebral cortex, can arise
* can explain how a network can come to make useful distinctions between its inputs.
* WTA networks coupled with synaptic learning rules and homoestatic plasticity can explain how this takes place in a self-organized fashion from an initially undifferentiated state.
* Finally, WTA models are often employed at the behavioral level in theoretical models of higher-level cognitive phenomenon such as action-selection, attention (Itti and Koch, 2001; Walther and Koch, 2001) and decision making (Wang, 2002; Furman and Wang, 2008).

**Computational modelling of visual attention**

Winner-take-all models bottom-up control of attention to a certain structure (?) (the nodes of highest activation are chosen; the network detects the point of highest saliency at any given time).

* What is the difference between this and general Hebbian learning? It sounds like a way of creating a more generalized NN; can contain several paths and therefore attention.
* Tsotsos and colleagues implemented attentional selection using a combination of a feedforward bottom-up feature extraction hierarchy and a feedback selective tuning of these feature extraction mechanisms.
* So far, we have reviewed computational modelling and supporting experimental evidence for a basic architecture concerned with the bottom-up control of attention: early visual features are computed in a set of topographical feature maps; spatial competition for saliency prunes the feature responses to only preserve a handful of active locations; all feature maps are then combined into a unique scalar saliency map; and, finally, the saliency map is scanned by the focus of attention through the interplay between winner-take-all and IOR.

If I understand correctly, winner-takes all can be used to specialize the network to various low-level features (called bottom-up features in this case)

* This model predicts that attention activates a winner-take-all competition among neurons tuned to different orientations and spatial frequencies within one cortical HYPERCOLUMN 33,45, a proposition that has recently received further experimental support
* OR that there exist neurons which are tuned to different orientations, etc., and that attention activates a winner-take-all between these.

Pre-attentive computation of visual features

DROPOUT

Third, inhibition-of-return (IOR), the process by which the currently attended location is transiently inhibited, is a critical element of attentional deployment. Without IOR, attention would endlessly be attracted towards the most salient stimulus. IOR thus implements a memory of recently visited locations, and allows attention to thoroughly scan our visual environment.

**Lateral inhibitions:**

For example, when a small light is presented in a dark environment, receptors on the retina central to the stimulus are activated and transduce the visual information to the brain, while receptors that are peripheral to the stimulus send inhibitory signals that enhance the perception of darkness in the surrounding.

(https://link.springer.com/referenceworkentry/10.1007/978-0-387-79948-3\_1379)

What is the mechanism behind this!? 🡪 Inhibitory interneurons

<https://www.d.umn.edu/~jfitzake/Lectures/DMED/SensoryPhysiology/GeneralPrinciples/LateralInhibition.html>

* Primary afferent neurons (the ones receiving the most stimuli) are connected to the second order neurons (receivs some stimuli) through inhibitory interneurons reducing the AP frequency.
* the area of sensation is less than the area of receptor activation
* another way of thinking about this is: lateral inhibition increases contrast between strong and weak signals

<file:///Users/annapaulinehjertvikaasen/Downloads/228037a0.pdf>

* Often occurs during sensory procedures. / a property of sensory systems

**Self-organized formation of topologically correct feature maps**

There is both anatomical and physiological evidence for the following type of lateral interaction between cells:

1. Short-range lateral excitation reaching laterally up to a radius of 50 to 100 \mu m (in primates)
2. The excitatory area is surrounded by a penumbra of inhibitory action reaching up to a radius of 200 to 500 \mu m
3. A weaker excitatory action surrounds the inhibitory penumbra and reaches up to a radius of several centimeters.

**Compete to compute**

* Competitive interactions between neurons and neural circuits have long played an important role in biological models of brain processes. This is largely due to early studies showing that many cortical [3] and sub-cortical (e.g., hippocampal [1] and cerebellar [2]) regions of the brain exhibit a recurrent on-center, off-surround anatomy, where cells provide excitatory feedback to nearby cells, while scattering inhibitory signals over a broader range.

**A Biologically Plausible Winner-Takes-All Architecture**

* Winner-takes-all (WTA) is an important mechanism in artificial and biological neural networks.
* The WTA mechanism is the basis of many algorithms for perceptual decision making, selection of attention, and pattern classification.

That it exists – explain mechanisms (lateral inhibition)

Function – … sensory information, higher-level cognitive functions