

# A Novel Classification Method Using Self-Regulatory Feedback

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## Abstract

A network is described that performs classification based on self-regulatory feedback. Structurally it contrasts with current classifier methods by not requiring parameterized connection weights or lateral inhibition. Thus is it different from other biologically inspired networks such as: Neural Networks, Adaptive Resonance Networks.

## Method

Regulatory feedback connections (where cells feed back to their own inputs) can be found ubiquitously in the brain including the well-studied olfactory bulb (which has at least two layers of feedback). However, the role of these connections during 'recognition phase' is under-appreciated.

Self-Regulatory Feedback (SRF) networks rely on this feedback structure (Achler 2002; Achler 2007). The feedback eliminates the need of parametric weights and binary connections are sufficient outcomes of training (Achler and Amir 2008; Achler, Omar et al. 2008). In the recognition phase of SRF, top-down feedback modifies input activation. The modified input activity is re-distributed to the network and receives feedback on this re-distribution. This is repeated iteratively to determine stimuli relevance.

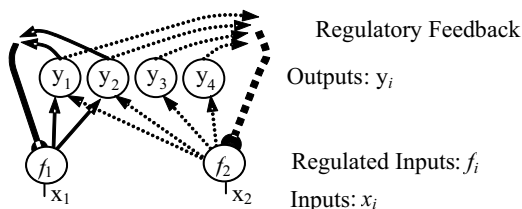


Figure 1: SRF regulation. If  $x_1$  affects  $y_1$  &  $y_2$  then  $f_1$  monitors  $y_1$  &  $y_2$  and regulates  $x_1$ . Similarly if  $x_2$  affects  $y_1, y_2, y_3$  &  $y_4$  then  $f_2$  monitors  $y_1, y_2, y_3$  &  $y_4$  and regulates  $x_2$

The tight association between input nodes (pre-synaptic cells) and outputs nodes (post-synaptic cells) is depicted in figure 1. An input node is regulated by the post-synaptic use of its information. Only its post-synaptic cells can regulate it. An input node that affects many output nodes

in the network is regulated by those output nodes. If the sum of output nodes is more active than justified by the input, the input activity is inhibited. If the sum of the output nodes is less than the input activity, the input activity is boosted.

This method of classification is different from parametric networks and is not limited by training-testing distributions. Parametric networks are trained with the assumption that the training distribution is similar to the testing distribution (Sugiyama 2006). This limitation allows the correlation between input features to outcomes to be determined a-priori through a training set. Unfortunately, this limitation is commonly violated in the natural environment (Marcus 1998), such as in a scene with many stimuli. Suppose a network is trained on stimulus  $A$  and  $B$  presented by themselves. If stimulus  $A$  and  $B$  appear side-by-side their simultaneous appearance is outside the training distribution. In contrast, the SRF classifier can recognize multiple simultaneous stimuli even if only trained on single stimuli (Achler, Omar et al. 2008).

This method of classification is also different from Adaptive Resonance Theory i.e. (Carpenter & Grossberg, 1987) and does not employ lateral connections or mechanisms to serially evaluate representations. Yet the network can bind representations (Achler & Amir 2008).

Given the overwhelming presence of feedback in biology this mechanism may be the predominant method of classification found in the brain.

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