Towards an Organizing Principle for a Layered Perceptual Network

Authors:

Ralph Linsker

Abstract:

An information-theoretic optimization principle is proposed for the development of each processing stage of a multilayered perceptual network. This principle
of "maximum information preservation" states that the signal transformation that is to be realized at each stage is one that
maximizes the information that the output signal values (from that stage) convey about the input signals values (to that stage),
subject to certain constraints and in the presence of processing noise. The quantity being maximized is a Shannon information rate.
I provide motivation for this principle and -- for some simple model cases -- derive some of its consequences, discuss
an algorithmic implementation, and show how the principle may lead to biologically relevant neural architectural features such as topographic maps,
map distortions, orientation selectivity, and extraction of spatial and temporal signal correlations. A possible connection between this information-theoretic principle and
a principle of minimum entropy production in nonequilibrium thermodynamics is suggested.