Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Fold-change detection and scalar symmetry of sensory input fields OREN SHOVAL, Weizmann Institute of Science, LEA GOENTORO, California Institute of Technology, YUVAL HART, AVI MAYO, Weizmann Institute of Science, EDUARDO SONTAG, Rutgers University, URI ALON, Weizmann Institute of Science — Recent studies suggest that certain cellular sensory systems display fold-change detection (FCD): a response whose entire shape, including amplitude and duration, depends only on fold-changes in input, and not on absolute changes. We show that FCD is necessary and sufficient for sensory search to depend only on the spatial profile of the input, and not on its amplitude. Such amplitude scalar symmetry occurs in a wide range of sensory inputs, such as source strength multiplying diffusing chemical fields sensed in chemotaxis, ambient light multiplying the contrast field in vision, and protein concentrations multiplying the output in cellular signaling systems. We present a wide class of mechanisms that have FCD, including certain nonlinear feedback and feedforward loops. In addition, we find that bacterial chemotaxis displays feedback within the present class, and has indeed recently been shown to exhibit FCD. This can explain experiments in which chemotaxis searches are insensitive to attractant source levels. This study thus suggests a connection between properties of biological sensory systems and scalar symmetry stemming from physical properties of their input fields.

Oren Shoval
Weizmann Institute of Science

Date submitted: 29 Nov 2011 Electronic form version 1.4