High-quality lossy image compression using a network of binary linear threshold ON/OFF neurons trained on natural images

Christopher Hillar, Ram Mehta, and Kilian Koepsell, Redwood Center, UC Berkeley, CA, USA

Summary. Given a grayscale $L \times L$ digital image patch, we remove its mean and then normalize the patch's variance to be 1. We call such a patch *normalized*. Next, we partition the (mean-zero) intensity spectrum of the patch into three intervals and discretize pixel intensities. A single pixel intensity is thus mapped onto two "Hopfield neurons" (one "ON" and one "OFF") as follows: if the pixel intensity is in the lowest interval, then only the OFF neuron fires; if the pixel intensity is in the middle interval, then neither neuron fires; and if the pixel intensity is in the highest interval, then only the ON neuron fires. We can thus convert any $L \times L$ grayscale image patch into a $2L^2$-bit binary vector of abstract ON and OFF neurons. It was recently demonstrated that an $L = 4$ Hopfield network trained with minimum probability flow [SDBD11] on 32-bit ON/OFF discretizations of normalized image patches from a natural image database [vHvdS98] can be used to perform state-of-the-art digital image compression [HMK14]. Here, we explain this story and also compare the connectivity and response properties of these networks in the case $L = 7$ (Fig. 1**b**) with observed findings in retinal recordings (Fig. 1**a**).

References

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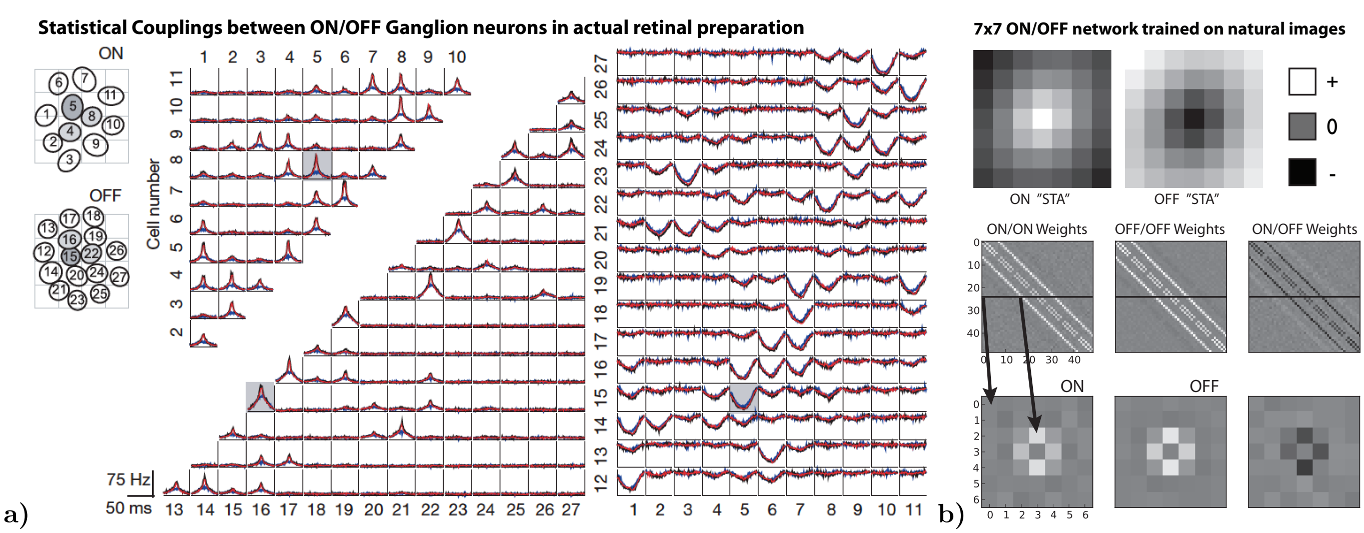

Figure 1: **a) Spatio-temporal correlation structure of a population of ON and OFF retinal neurons**. For each pair of numbered cells, a short time-varying correlation function is calculated measuring statistical co-activity [PSP+08]. **b) Response properties and connectivity structure of 7×7 ON/OFF Hopfield networks after training on discretized natural image patches**. Spike-triggered-averages (STA) of trained ON and OFF neurons over natural image data recover "center-surround" receptive fields. More interestingly, the sparse structure and signs of weights in these networks resemble those in retinal recordings **a**.