Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Marginalization in Random Nonlinear Neural Networks RAJKUMAR VASUDEVA RAJU, Rice University, XAQ PITKOW, Rice University, Baylor College of Medicine — Computations involved in tasks like causal reasoning in the brain require a type of probabilistic inference known as marginalization. Marginalization corresponds to averaging over irrelevant variables to obtain the probability of the variables of interest. This is a fundamental operation that arises whenever input stimuli depend on several variables, but only some are task-relevant. Animals often exhibit behavior consistent with marginalizing over some variables, but the neural substrate of this computation is unknown. It has been previously shown (Beck et al. 2011) that marginalization can be performed optimally by a deterministic nonlinear network that implements a quadratic interaction of neural activity with divisive normalization. We show that a simpler network can perform essentially the same computation. These Random Nonlinear Networks (RNN) are feedforward networks with one hidden layer, sigmoidal activation functions, and normally-distributed weights connecting the input and hidden layers. We train the output weights connecting the hidden units to an output population, such that the output model accurately represents a desired marginal probability distribution without significant information loss compared to optimal marginalization. Simulations for the case of linear coordinate transformations show that the RNN model has good marginalization performance, except for highly uncertain inputs that have low amplitude population responses. Behavioral experiments, based on these results, could then be used to identify if this model does indeed explain how the brain performs marginalization.

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Date submitted: 19 Nov 2014 Electronic form version 1.4