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Title: Weight-dependent learning rules with long temporal correlations

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The strengths of synaptic connections that are responsible for perception and memory change on time scales ranging from milliseconds to many days.
A key question is how memories can be made stable over long periods of time despite the ongoing synaptic plasticity. The distribution of synaptic weights contains clues to the persistence of memories encoded in the synaptic connections. Here we develop a theoretical framework to interpret the distribution of synaptic weights that have been measured experimentally in cultured neurons and in vivo using two-photon fluorescence imaging.
We asked whether certain weight distributions were invariant under weight-dependent learning rules. We found several classes of learning rules were consistent with a given weight distribution:
1) When the weights are normally distributed and the weight autocorrelation decays exponentially. 2) When the weight distribution is log-normal and the weights have an autocorrelation with long tails.
3) When the weight distribution is power-law and the autocorrelation has a slow power-law decay. Unlike the power-law decay obtained using a cascade of nested transitions within a synapse (Fusi, Drew and Abbott, 2005), the power-law forgetting observed here resulted from learning dynamics with anomalous diffusion, which can occur when pauses occur in a random walk.
As a consequence, random weight trajectories generate long-range temporal correlations and memories can persist for a long time.

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