Supplemental Material: Cortical microcircuits as gated-recurrent neural networks

A Detailed view of cortical microcircuit mapping

In Fig. S1 we use a standard representation of the six neocortical layers to highlight the features that are akin to properties of gated-RNNs, namely LSTMs.

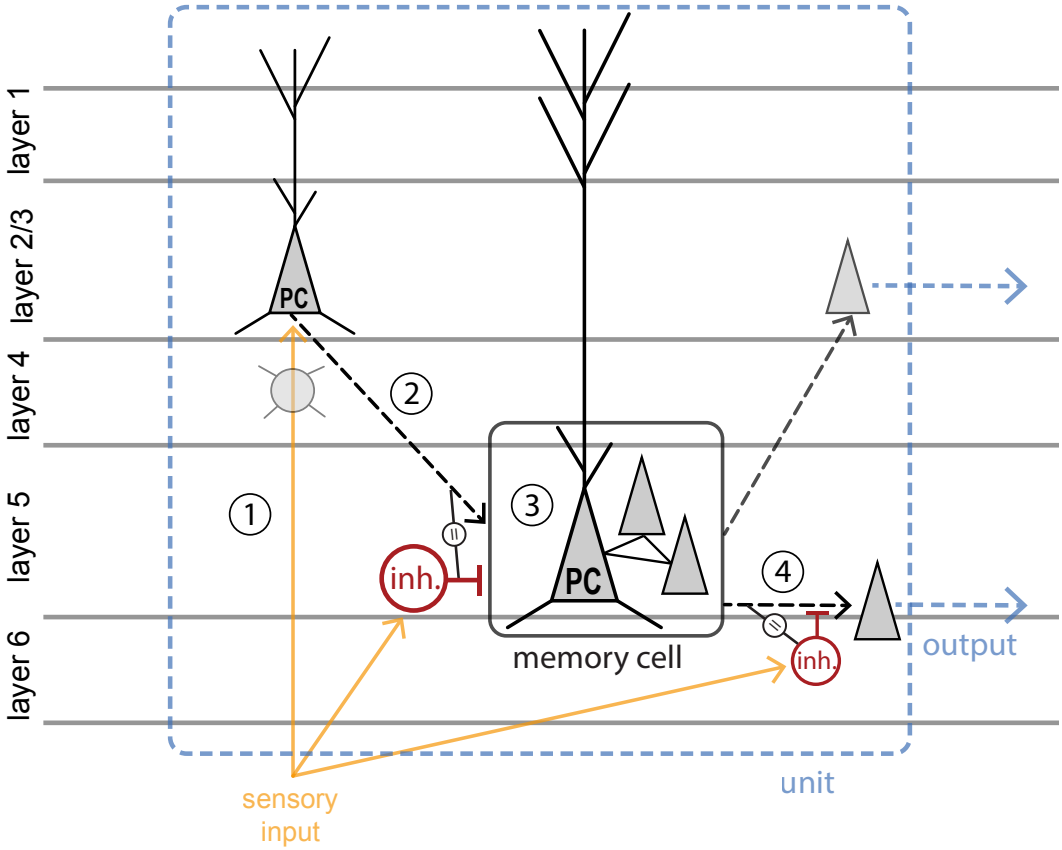

Figure S1: Biological properties of the neocortex that resemble LSTM features (cf. Figure 1). Here we represent the different components as a sequence of steps starting at the input level, and highlight the features that are analogous to LSTMs. (1) The sensory input arrives (from thalamus) at layer-4 stellate excitatory cells (faded out as this cell is not explicitly considered in the model) and is then propagated to layer 2/3 pyramidal cells (i.e. the input neuron z in LSTMs); (2) Output of layer 2/3 pyramidal cells projects to layer-5 pyramidal cells which may form recurrent units (the memory cell); At this stage local interneurons (input gates i in LSTMs) gate the flow of information onto the memory cell; (3) This memory cell can retain a given input for sometime (the timescale of this memory will depend on f, see subLSTM description in the main text). (4) Finally the memory is sent to other units in the network (black dashed arrow pointing upwards, through layer 2/3) or to another set of units in higher cortical areas (black dashed arrow pointing rightwards, through layer 5 or layer 6). This output of the memory cell is controlled by another gate (local inhibitory cell, representing the output gate o). The balance between excitation-inhibition observed across the cortex is represented by the 'equal' connection, which represents equal and fixed weights (i.e. =1, see main text).