Dendritic arithmetic: Some new twists and curves

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Discovering appropriate simplified models for individual neurons remains a central problem of neuroscience. Nearly three decades of experimental and modeling studies suggest that the large dendritic trees of CNS neurons are highly articulated, active processors, supporting a variety of internal computations as they convert their synaptic inputs into output spikes. But what are the specific "arithmetic" operations that govern how multiple excitatory and inhibitory synaptic inputs, activated at different places and times within the dendritic arbor, are combined to determine the cell's output firing rate and/or pattern? Several new results will be presented relating to (i) biophysical mechanisms underlying nonlinear dendritic integration in pyramidal cells, (ii) some unexpected nonlinear spatial and temporal integration effects that depend on NMDA channels, (iii) the dastardly complicated interactions between excitation and inhibition, and (iv) implications of dendritic subunitization for the information processing functions of the surrounding cortical circuit.