Coincidence Detection: Towards an alternative to Synaptic Plasticity

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Abstract: Memory and learning are believed to be neurally based on a general class of processes known as synaptic plasticity (Kandel et al., 2000). Working memory, however, is arguably too fast to rely solely on synaptic weighting and must instead take place as an active neural process (O'Reilly & Manukata, 2000). I propose that active processes, which can account for both simple stimulus based memories as well as simple associations, can be instantiated within populations of highly interconnected neurones that exploit the precise timing of spikes; I call these "firing-chains". In a population of N neurones a maximum of T*2$\hat{N}$ firing-chains exist over time period T, suggesting that many more firing-chains than neurones or connections exist. I aim to show how self-sustaining firing-chains can implement simple memories, but also that simple associations between two or more firing-chains can be made if their joint simultaneous activity triggers a new firing-chain.