Pulse Packets & Synfire Chains (Part 2)

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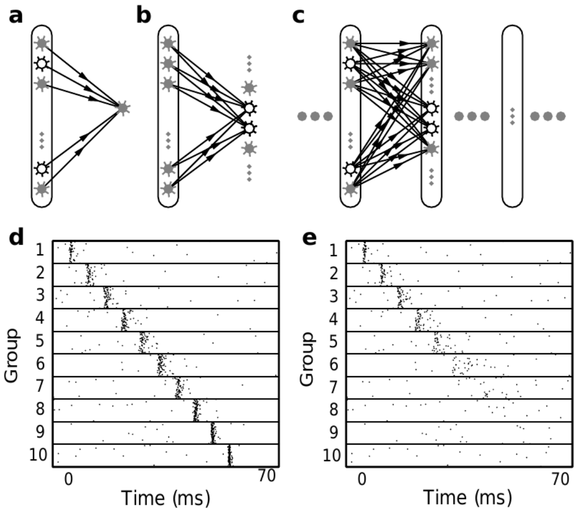
Bernstein Center Freiburg

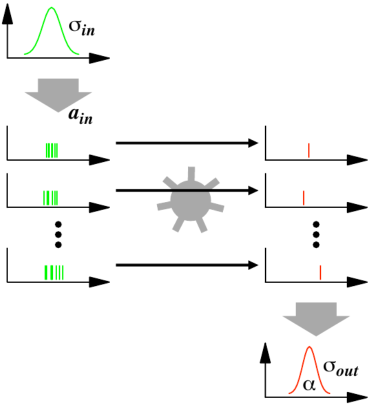
Models of Neurons and Networks, November 26, 2013

Synfire chains and propagation through synchrony



Diesmann, Gewaltig & Aertsen, 1999

Synfire chains are synchrony generators



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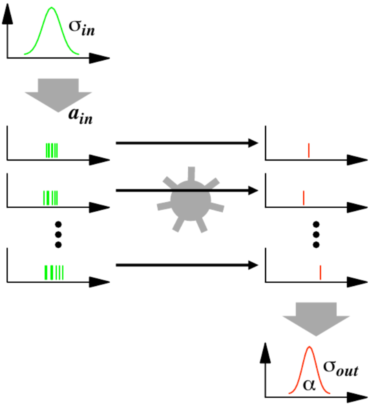

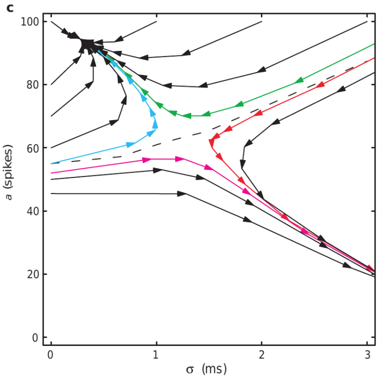

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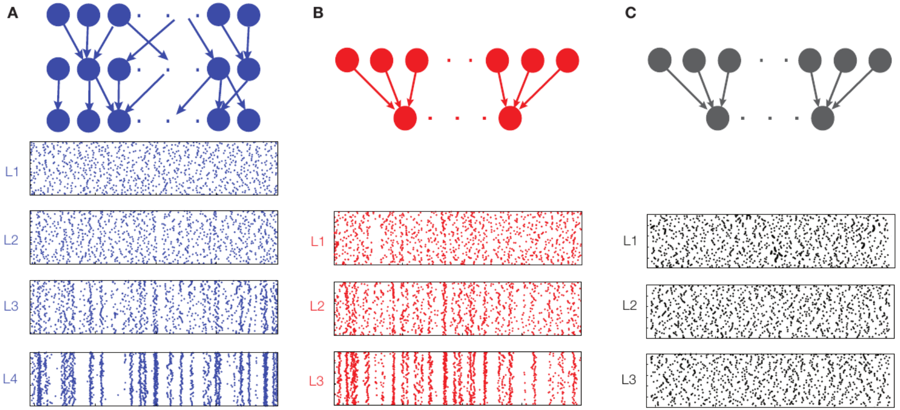
But how do they correlate?



Rosembaum et al., 2011

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- Shared inputs

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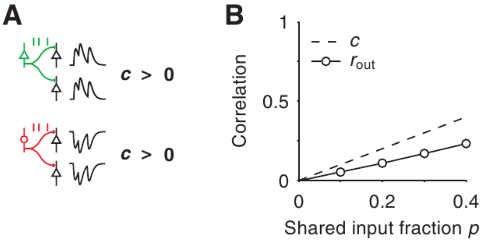

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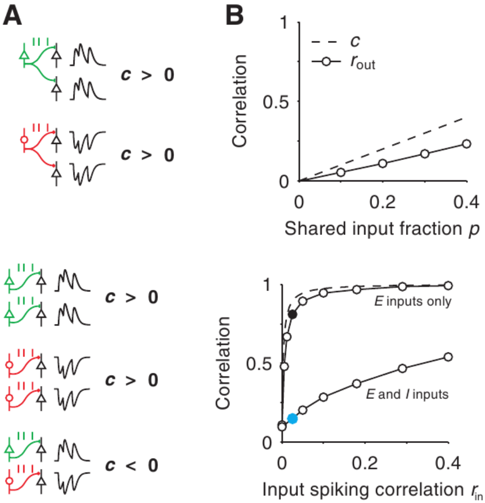
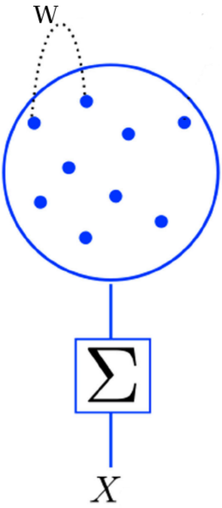


Renart et al., 2010

The pooling effect



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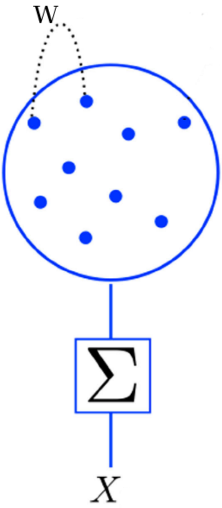

$$X = \sum_{i}^{N} x_i$$

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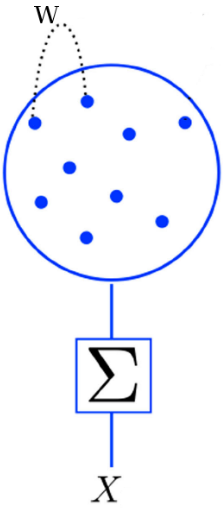

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$$W \simeq \hat{W} = \left\langle \frac{cov[x_i, x_j]}{\sqrt{var[x_i]var[x_j]}} \right\rangle_{N(N-1)}$$

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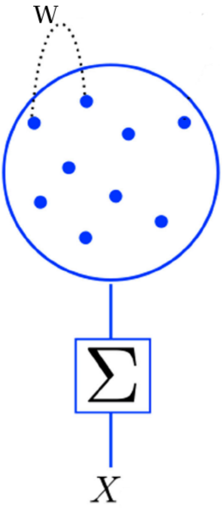

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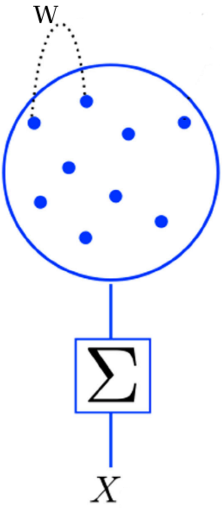

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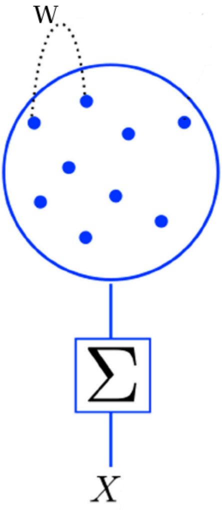

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$$var[X] = N\sigma^2 + N(N-1)\, W \sigma^2$$

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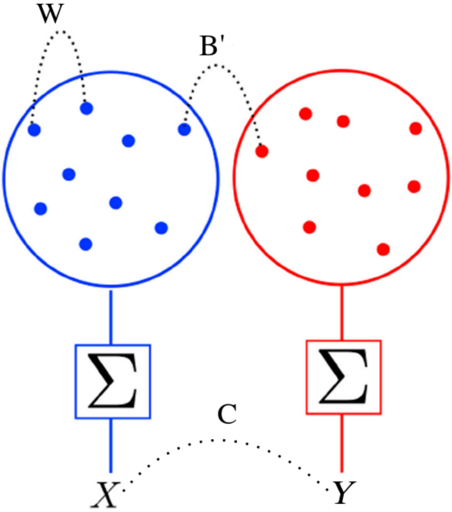

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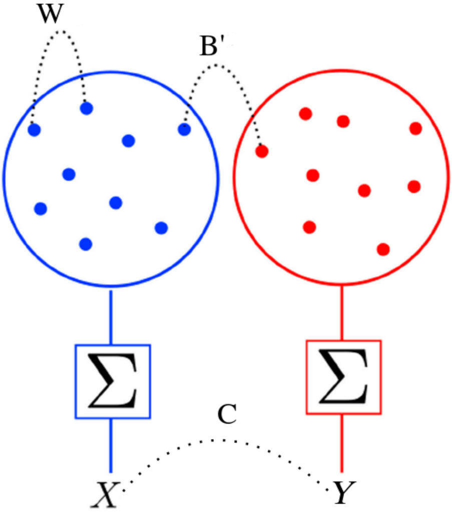

$$C = \frac{B'}{W + \frac{1}{N}(1 - W)}$$

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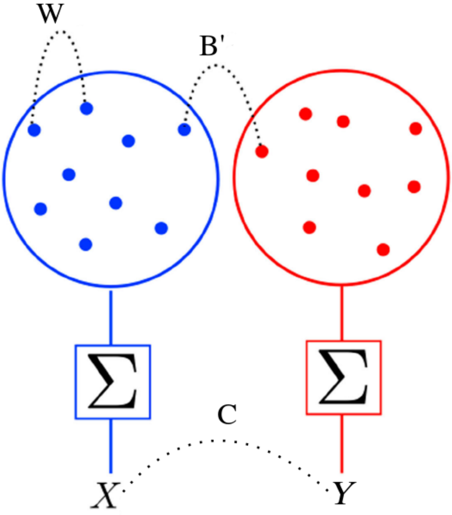

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$$= \frac{B'}{W} - \mathcal{O}(\frac{1}{N})$$

Bedenbaugh & Gernstein, 1997
Rosembaum et al., 2010

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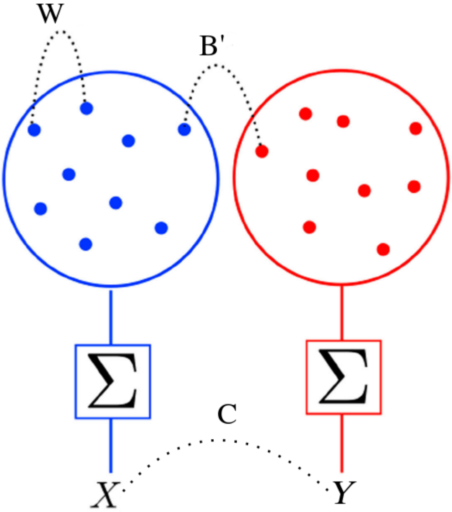

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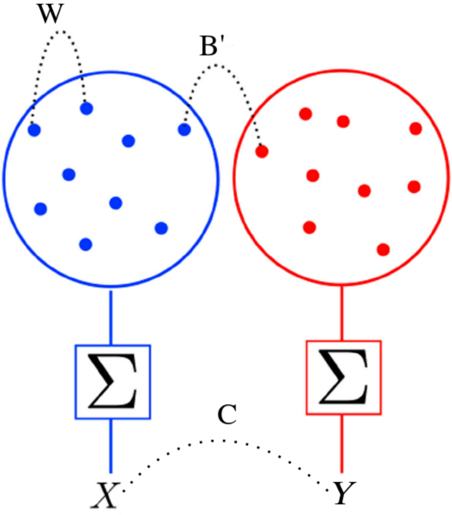

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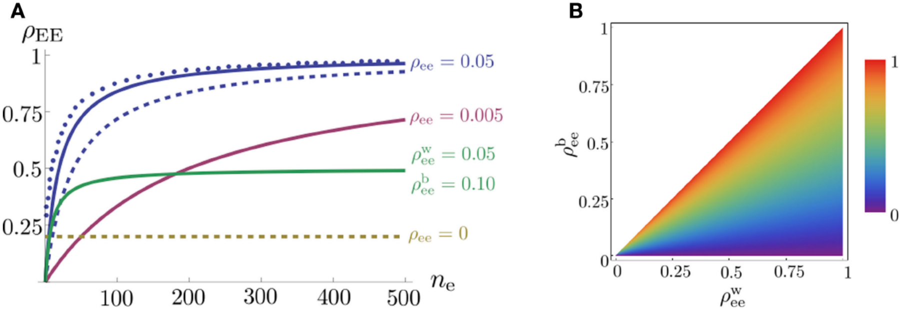
- Amplification: $C \geq B'$
- Bound: since $C \leq 1$, then $B' \leq W - \mathcal{O}(\frac{1}{N})$

The pooling effect



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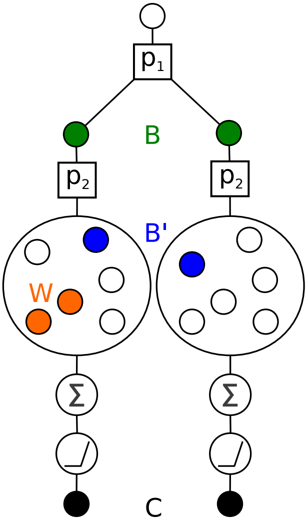
Generating B and W correlations



Kuhn et al., 2003
Yim et al., 2011
Bujan et al., in prep.

$$p_1 = B$$
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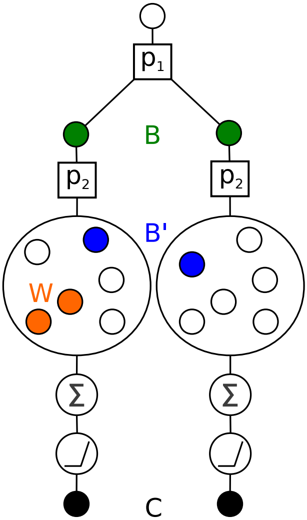

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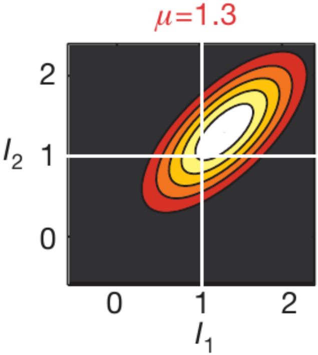
For large N:

$$C \to B'/W = B$$

Decorrelation due to thresholding in LIF neurons



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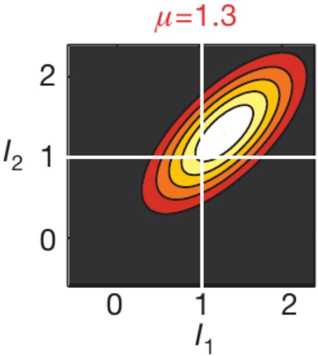

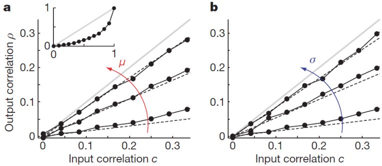

de la Rocha et al., 2007

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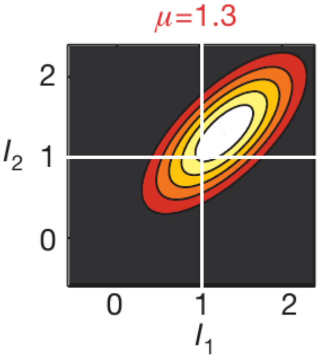

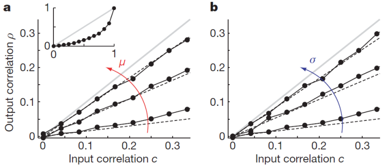

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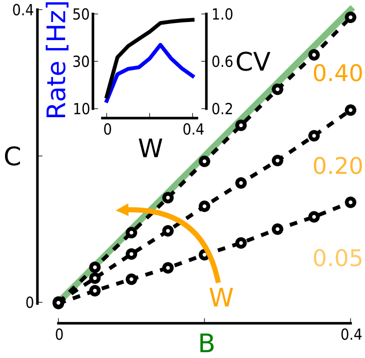

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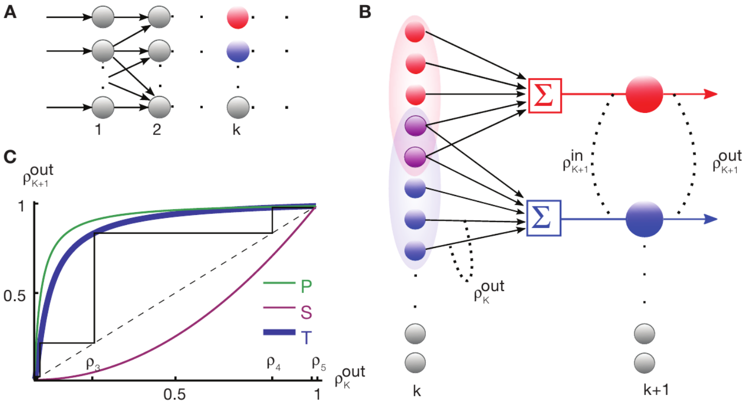
Correlation transfer across synfire chains



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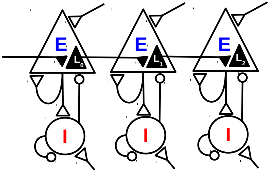
Synchronization through resonance



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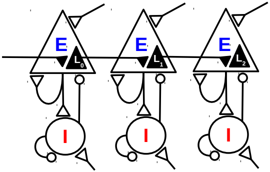

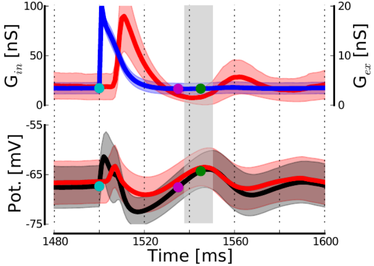

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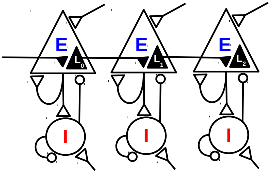

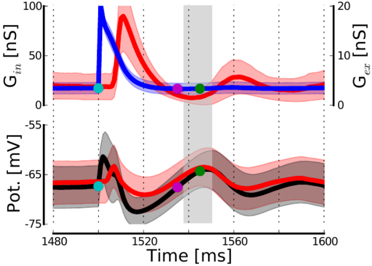

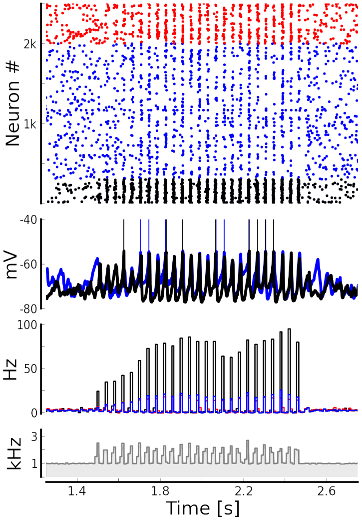

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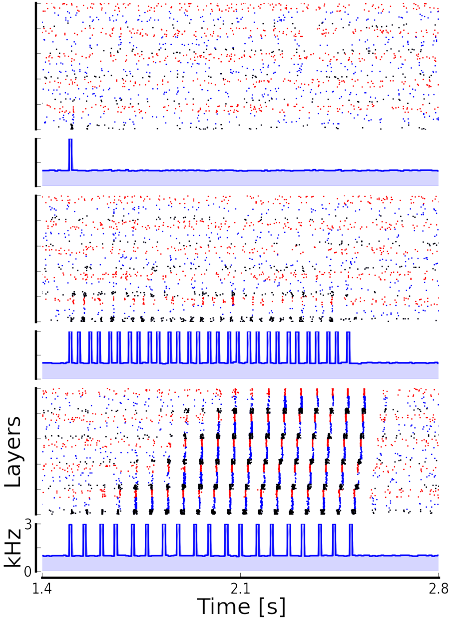

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Summary

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4 - Periodic trains of pulse packets (or oscillations) can synchronize by exploiting the resonance frequencies of excitatory-inhibitory networks. Resonance-induced synchrony can allow the propagation of pulse packets in diluted synfire chains.

Bibliography

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