DFT workshop, G. Schöner, J. Spencer May 2008

Exercise: Memory trace dynamics in Dynamic Fields

The memory trace is an elementary learning mechanism for neural dynamical fields that can be described by this dynamics for a memory trace field, u_{mem}:

$$\dot{u}_{\text{mem}}(x,t) = -\frac{1}{\tau_{\text{mem}}}\left(u_{\text{mem}}(x,t) + \int dx'\ w_{\text{mem}}(x-x')\sigma(u(x',t))\right)$$

In words: The memory trace receives excitatory input from any suprathreshold activation in the activation field, $u(x,t)$. This input is mediated by a gaussian kernel, which spreads the memory trace somewhat around the locations that are activated in the u-field. The time scale of the memory trace, τ_{mem}, is typically slower than that of the activation field. We postulate that this time scale is shorter for a growth of the memory trace than for its decay. This is modelled by the parameter, τ_{mem}, being smaller at locations in the memory trace that currently receive input than at locations that currently do not receive input. When there is no input anywhere because there is no peak in the activation field, the memory trace is not updated at all.

Converely, the memory trace provides excitatory input to the activation field, preshaping it at those locations at which a memory trace has been accumulated:

$$\tau\dot{u}(x,t) = -u(x,t) + h + S(x,t) + u_{\text{mem}}(x,t) + \int dx'\ w(x-x')\ \sigma(u(x'))$$

The actual

1. Use the program `simulator1layer_scenario.m` to explore, how a memory trace builds up over several trials. The scenario programmed into this simulator uses a number of different inputs across the different trials, which induce peaks at different locations. The memory trace reflects this activation history but also being to influence that activation history as it builds up.

2. You can then change the experimental scenario by defining other sets of stimulus conditions.