Neural Dynamics, Exercise 8, January 21, 2016

This is about dynamic activation fields. Imagine an activation field, $u(x,t)$, defined over a dimension, x. To make things concrete, let's say the dimension stands for the direction of movement of the hand within a plane, like in those monkey experiments for which we discussed the concept of population code.

1. Peaks are units of representation. Make a drawing of such a peak solution of the field dynamics. That drawing should capture the essential properties of peaks, e.g, positive activation at peak, negative elsewhere. Indicate the resting level and the input that may have induced the peak. Discuss the different signatures in this drawing of the underlying neural dynamics (e.g., effect of input, effect of excitatory interaction, effect of inhibitory interaction).

2. Detection instability: There are three dynamic regimes: 1) only sub-threshold solutions are stable, 2) a bistable regime with both sub-threshold and self-excited activation patterns, and 3) a regime in which only self-stabilized peaks are stable. Define the two types of solutions and illustrate graphically (self-excitation was done in the previous task). Discuss how the three regimes relate: Which instabilities separate the regimes, changing which parameter may move the system from one regime to another? In the example of monkey arm movement planning, what would push the system through the detection instability?

3. Selection instability: Consider the regime in which only one peak may be stable at a time, even when there is positive input at multiple locations. When input at two locations is about equal, draw the two possible stable solutions. When input is much stronger at one than at the other location, draw the remaining stable solution. Discuss what change in the input drives the system from the bistable to the mono-stable regime (the selection instability). In terms of movement preparation, what would be the meaning of selection?