Dynamic Field Theory: Part 2: dynamics of activation fields

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activation fields

- Metric contents: e.g., space, movement parameters, feature dimensions, viewing parameters, ...
- Information, probability, certainty

- Specified value: specified value
- No value specified
evolution of activation fields in time: neuronal dynamics

preshaped field

movement parameter

specific input arrives

activation

time
the dynamics such activation fields is structured so that localized peaks emerge as attractor solutions.
Amari equation

\[ \tau \dot{u}(x, t) = -u(x, t) + h + S(x, t) + \int w(x - x') \sigma(u(x', t)) \, dx' \]

where

- time scale is \( \tau \)
- resting level is \( h < 0 \)
- input is \( S(x, t) \)
- interaction kernel is

\[ w(x - x') = w_i + w_e \exp \left[ -\frac{(x - x')^2}{2\sigma_i^2} \right] \]

- sigmoidal nonlinearity is

\[ \sigma(u) = \frac{1}{1 + \exp[-\beta(u - u_0)]} \]
Interaction: convolution

where \( f = (b - 1)/2 \) is the half-width of the kernel.

The sum extends to indices outside the original range of the field (e.g., for \( m=0 \) at \( \theta = -\theta \)). But that doesn't cause problems because we extended the range of the field as shown in Figure 2.18.

Note again that to determine the interaction effects for the whole field, this computation has to be repeated for each point \( \theta \). In COSIVINA all these problems have been solved for you, so you don't need to worry about figuring out the indices in Equations like B2.2 ever again!

Figure 2.18

Top: The supra-threshold activation, \( \theta(\theta(\theta)) \), of a field is shown over a finite range (from 0 to 180 deg).

Second from top: The field is expanded to twice that range by attaching the left half of the field on the right and the right half on the left, imposing periodic boundary conditions.

Third from top: The kernel has the same size as the original field and is plotted here centered on one particular field location, \( \theta = 30 \) deg.

Bottom: The matching portions of supra-threshold field (red line) and kernel (blue line) are plotted on top of each other. Multiplying the values of these two functions at every location returns the black line. The integral over the finite range of the function shown in black is the value of the convolution at the location \( \theta = 30 \).
Relationship to the dynamics of discrete activation variables
=> simulations
solutions and instabilities

- input driven solution (sub-threshold) vs. self-stabilized solution (peak, supra-threshold)

- detection instability

- reverse detection instability

- selection

- selection instability

- memory instability

- detection instability from boost