### Dynamic Field Theory Gregor Schöner gregor.schoener@ini.rub.de

### Recall from last lectures ...

## Activation fields over continuous spaces



dimensions, viewing

parameters, ...

homologous to sensory surfaces, e.g., visual or auditory space (retinal, allocentric, ...)

- homologous to motor surfaces, e.g., saccadic end-points or direction of movement of the endeffector in outer space
- feature spaces, e.g., localized visual orientations, color, impedance, ...
- abstract spaces, e.g., ordinal space, along which serial order is represented

# Example motion perception: space of possible percepts



# Example: movement planning: space of possible actions



### Distribution of Population Activation (DPA)



superposition of responses to each elemental stimulus



### Distribution of Population Activation (DPA)



[Bastian, Riehle, Schöner, 2003]

Neural dynamics of activation fields is structured so that localized peaks are attractors





### mathematical formalization

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

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

#### => simulations

### Solutions and instabilities

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

detection instability

reverse detection instability

selection

selection instability

memory instability

detection instability from boost



# the detection instability helps stabilize decisions

threshold piercing

detection instability



# the detection instability helps stabilize decisions

- self-stabilized peaks are macroscopic neuronal states, capable of impacting on down-stream neuronal systems
- (unlike the microscopic neuronal activation that just exceeds a threshold)

### emergence of time-discrete events

the detection instability also explains how a time-continuous neuronal dynamics may create macroscopic, time-discrete events

# behavioral signatures of detection decisions

detection in psychophysical paradigms is rife with hysteresis

but: minimize response bias

in the detection of Generalized Apparent Motion







hysteresis of motion detection as BRLC is varied (while response bias is minimized)

H. S. Hock, G. Schöner / Seeing and Perceiving 23 (2010) 173–195



### ... next

- selection decisions in DFT
- free selection decisions in behavior
- how decisions are normally observed in the lab
- detections and decisions
- boost driven detections...
- evidence for time continuous decisions