Short discussion DFT and other theories of cognition

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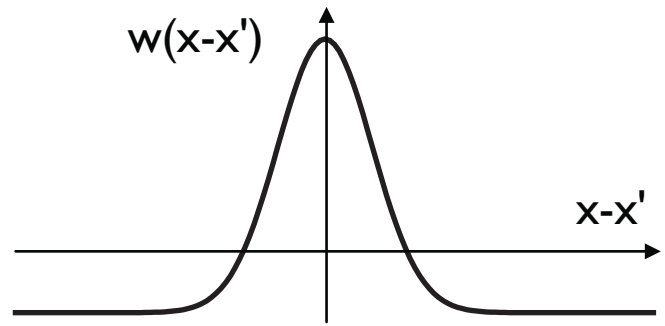
Neural dynamics

- as used in Dynamic Field Theory is a *sub-set of general neural network theory* (!)
- in which additional principles / constraints are imposed
  - stability
  - low-dimensionality
  - regular interaction functions
  - dynamic instabilities
  - active transients

How do DFT architectures compare to DNN architectures ?

- in DFT: commitment to localist representation, in which regular form of interaction enables continuum of attractor states



- => low-dimensional spaces
- [Hopfield networks have attractors that exploit distributed representations, but weights are specific for each attractor]

How do DFT architectures compare to DNN architectures ?

- Output/classification layer of DNN often invoke "winner takes all" localist representations..
  - => could be the interface to DFT
  - high-dimensional distributed representation would be the efficient discrimination machine that works while high-dimensional input is present
  - while low-dimensional localist DFT representation would be the neural dynamic cognition machine that works autonomously not dependent on ongoing input

How do DFT architectures compare to DNN architectures ?

- => DFT as neural account for symbolic processing?
  - yes in the sense that the autonomous processing of "instances" (peaks) of representations is central to DFT
  - these instances are intentional states… linked to objects and events in the world …..and thus grounded
  - but they are not arbitrary (not symbols in that sense)
  - and their manipulation is strongly constrained (no freely manipulable)

DFT vs VSA

- Vector-symbolic architectures (VSA) prove an alternative neural account of cognition
  - high-dimensional distributed representations as vectors that are symbols
  - afford combination (information processing) while preserving the original vector
  - the classical version (Smolenksy and colleauges) is not neurally feasible
  - and creates the symbol grounding problem at encoding

DFT vs VSA

- Neural engineering framework (NEF) is proposed as a possible neural implementation of VSA
  - vectors represented by (small) populations of spiking neural networks
- But: to preserve original vectors, connectivity in architectures is very special
  - connectivity takes into account the original encoding
  - => non-local dependence of connectivities on each other… that may not be compatible with neural principles

Summary

- DFT is based on the hypothesis that the dynamics of neural populations = privileged level of description for neural process accounts of behavior and thinking [Schöner *TopiCS* 2019]
- units of representation are attractors in low-dimensional activation fields that can be linked to the sensory/motor surfaces
- stability => enables architectures that can reach higher cognition through binding, coordinate transforms and sequence generation