Stimulus Processing in Autonomously Active Cognitive Systems

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» the cognitive system approach to AI – an overview «

pitfalls of traditional AI

‘mainstream AI will not lead to human-level cognitive systems (CS)’

- the architectural conundrum

  AI: algorithmic optimization

  CS: cognitive capabilities emergent from universal principles

- the motivational problem

  AI: tasks given by external supervisor

  CS: diffusive emotional control

the architectural conundrum

cognitive systems - universal principles

- universal time prediction tasks (Elman)
  - ▷ environmental model building
  - ▷ unsupervised generation of abstract concepts
- behavioral complexity optimization (Edelman, Sporns, ...)
  - ▷ spontaneous explorative strategies
- autonomous internal dynamics (Gros)
  - ▷ semantic learning: unsupervised, developmental

.... are all applicable for a wide range of environments

C. Gros

"Cognitive computation with autonomously active neural networks: An emerging field",

Cognitive Computation **1**, 77 (2009)

the motivational problem

cognitive systems as living & embedded dynamical systems

- proprioceptual survival parameters
  - ▷ blood pressure, blood sugar level, pain signals, ...
  - ▷ ‘survival instinct’
- diffusive emotional control - neuromodulators
  - ▷ signaling: novelty, learning, ...
  - ▷ diffusive: acts on entire neural ensembles
  - ▷ meta-learning: thresholds, synaptic plasticities, ...
  - ▷ evolved from neutral homeostatic regulation

C. Gros

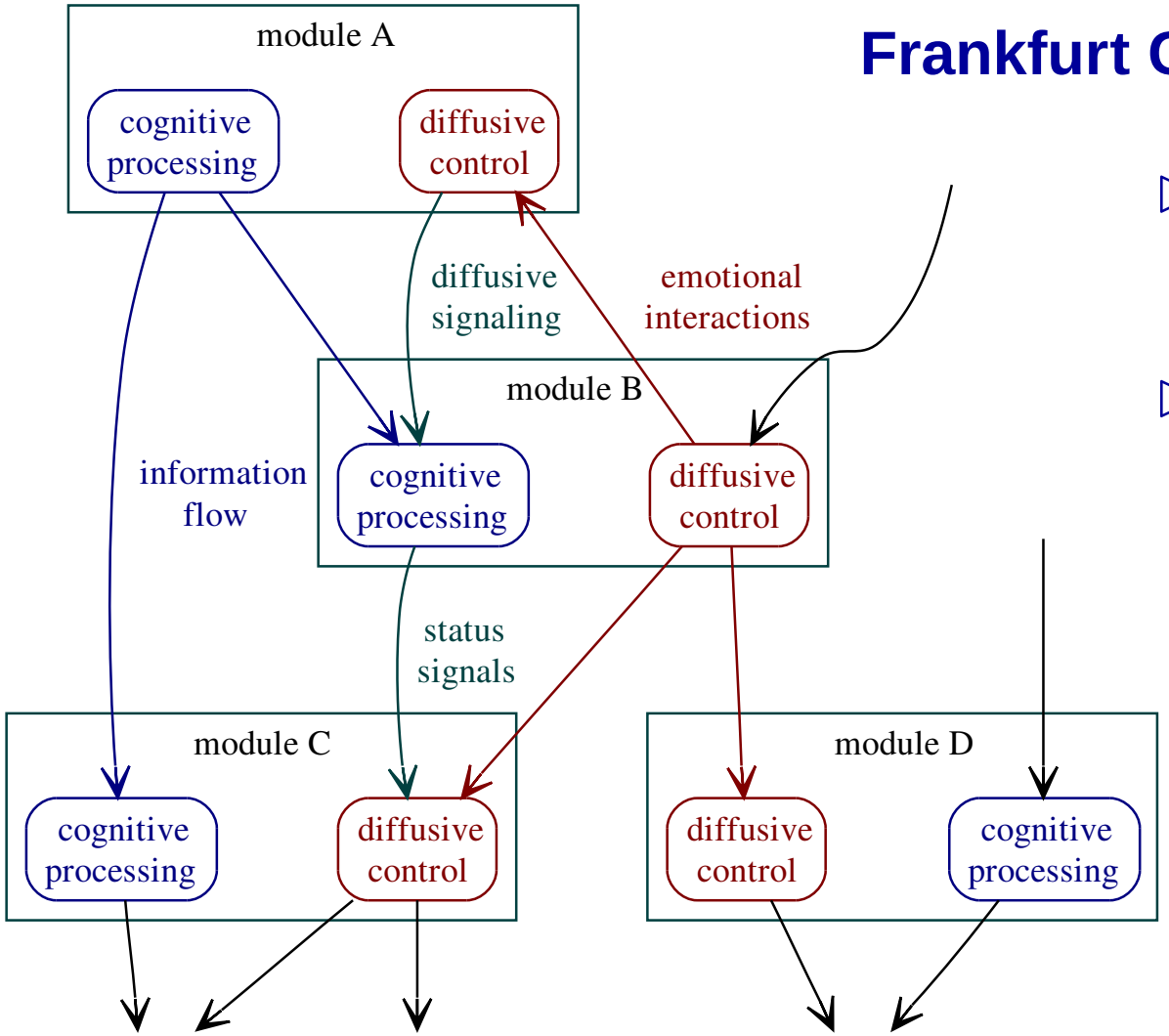
“Emotions, diffusive emotional control and the motivational problem for autonomous cognitive systems”,

Handbook of Research on Synthetic Emotions and Sociable Robotics:

New Applications in Affective Computing and Artificial Intelligence,

Vallverdí, Casacuberta (Eds.) (2009, in print)

information processing vs. diffusive control



Frankfurt Cognitive System Platform

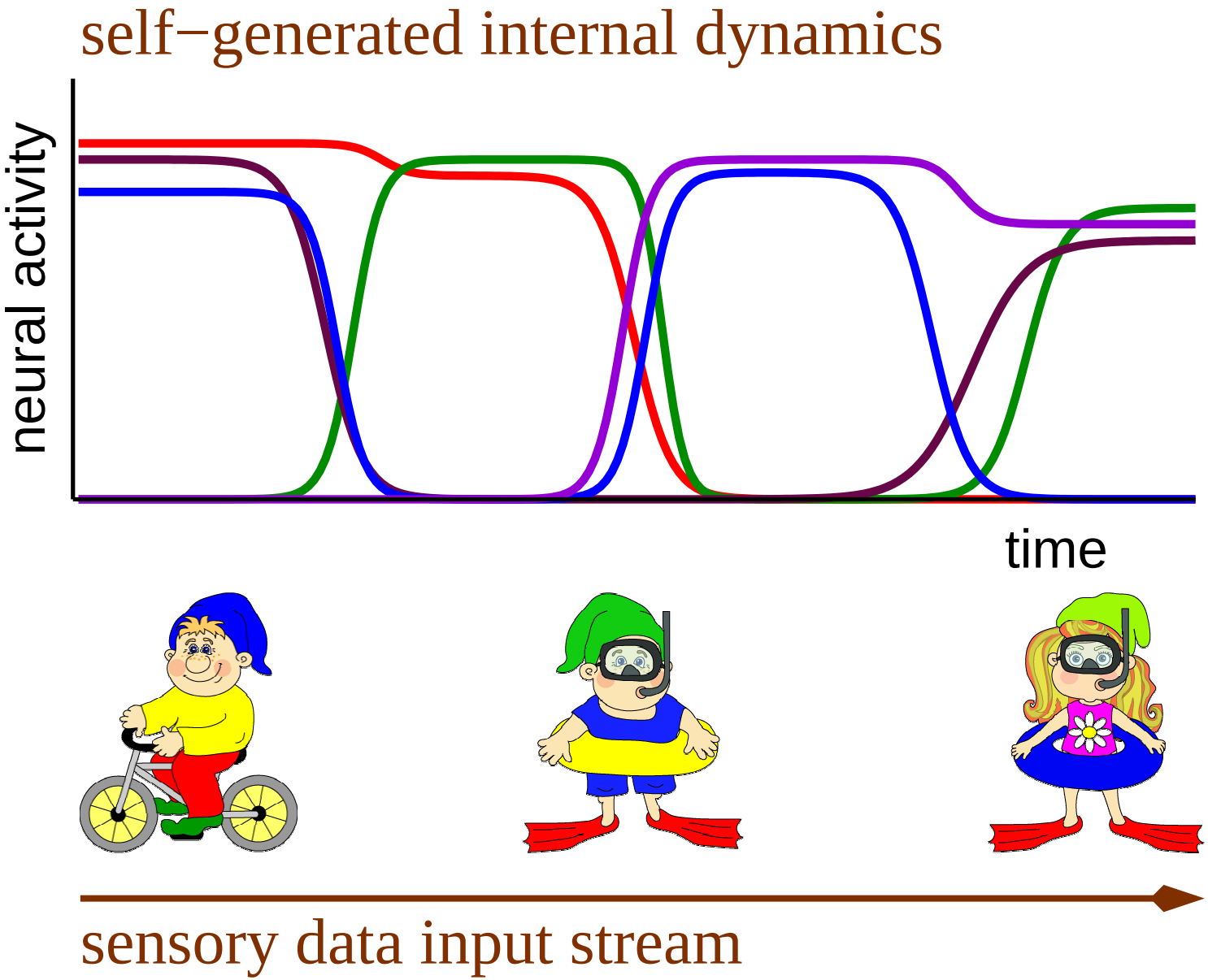
- ▷ full online architectural configurability
- ▷ learning exclusively
  : unsupervised
  : online

current status

- ▷ autonomous dynamics
  : transient states
  : stimulus processing
  : novelty signals

» emergent cognitive capability: non-linear ICA «

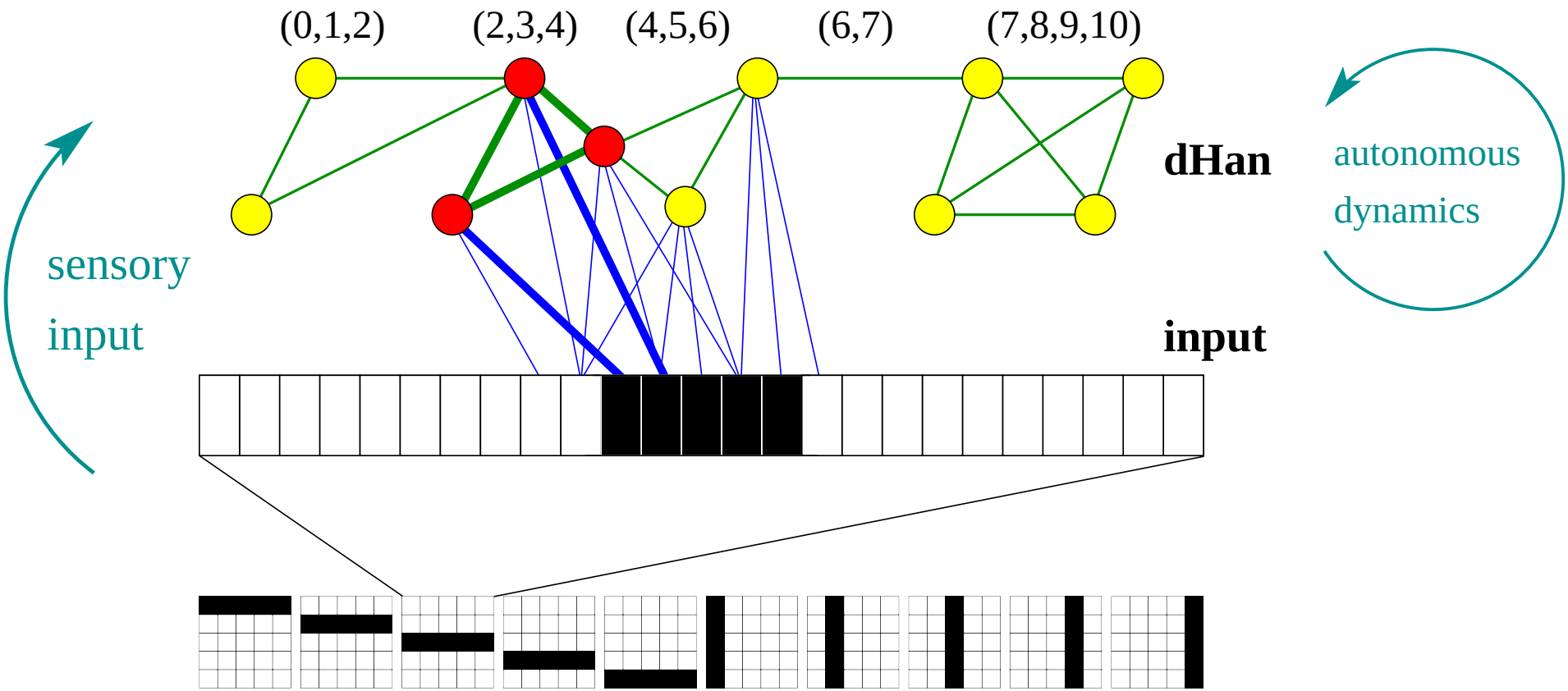
correlations: internal vs. external?



coupling to sensory input

self-generated internal dynamics

- dHan (dense homogeneous associative network)



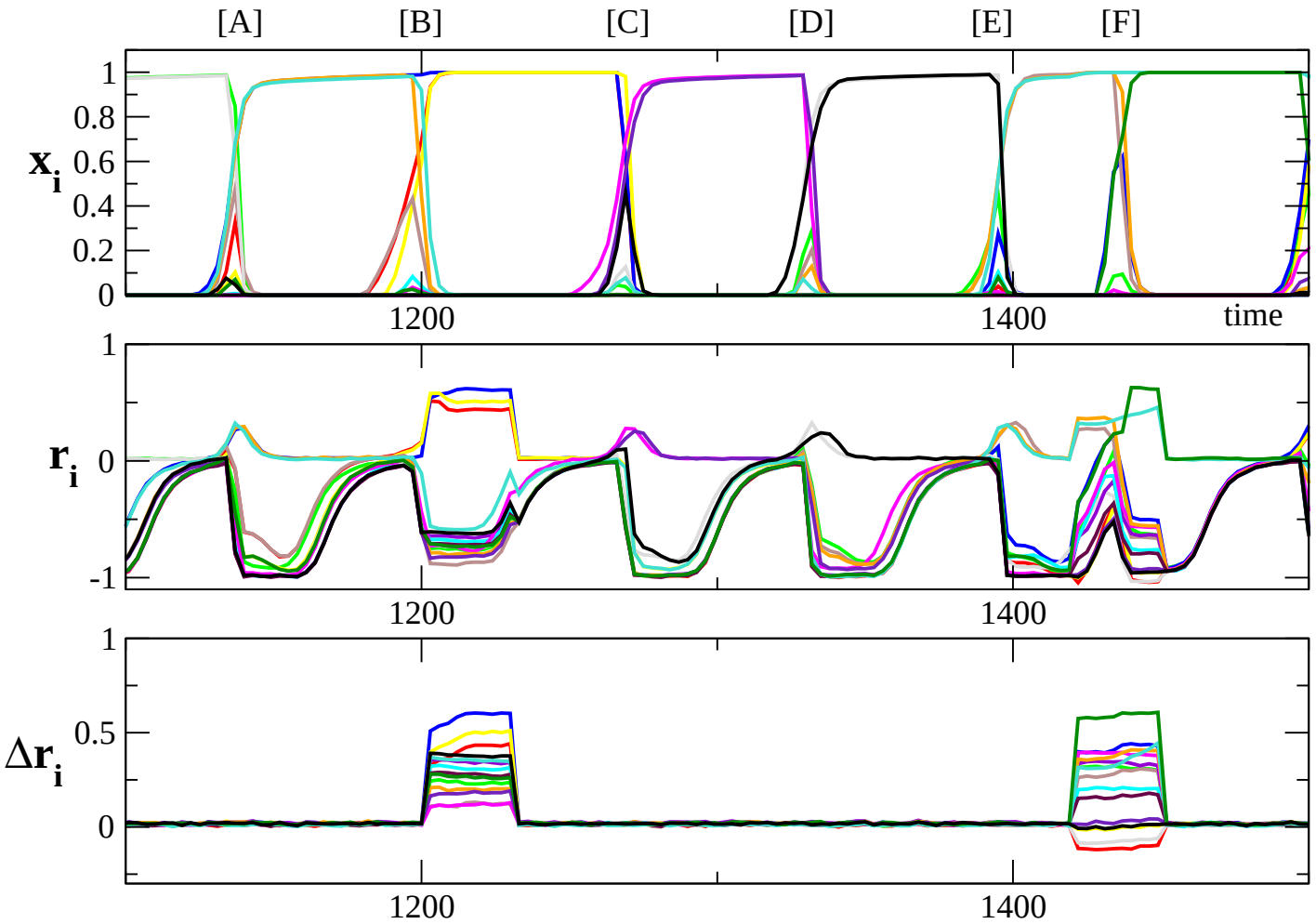
input data stream

- unrelated to internal dynamics

learning during sensible periods

competition

internal dynamics ⇔ sensory input

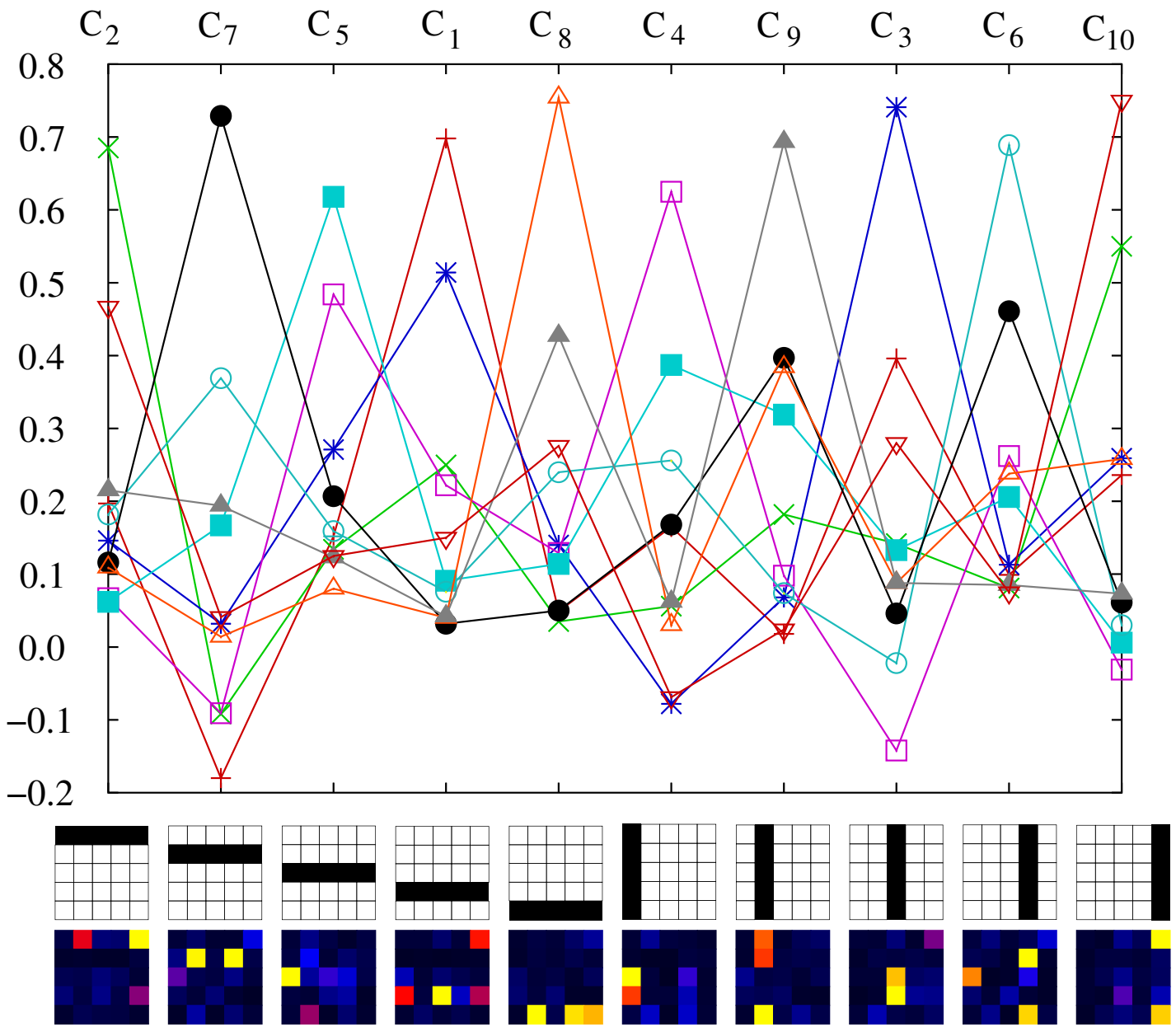


activities

growth rates

sensory input

clique receptive fields



cognitive computation

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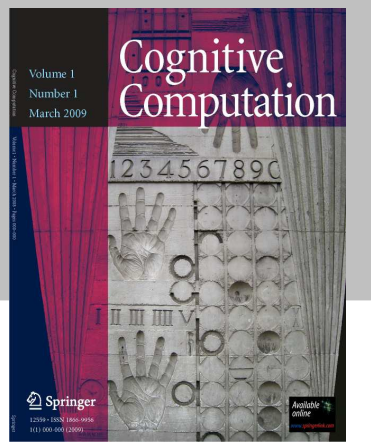

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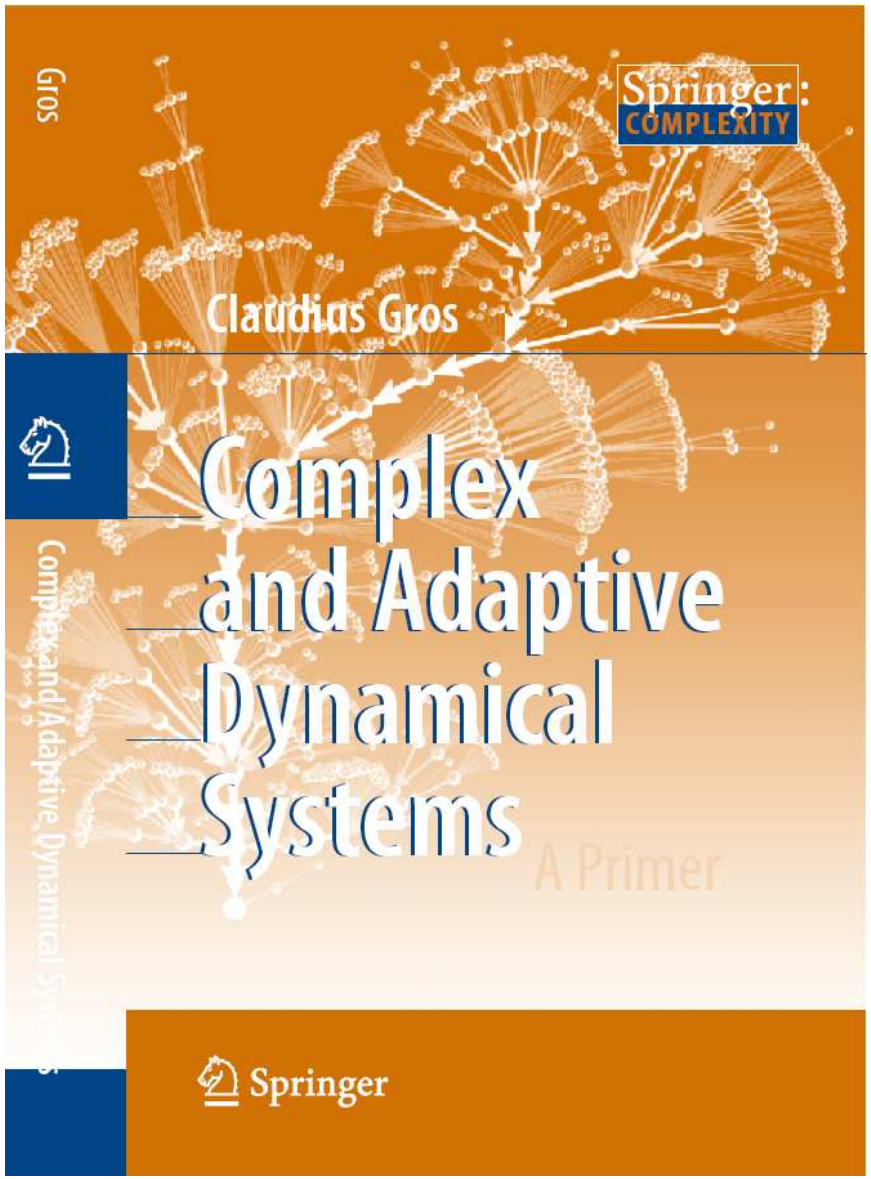


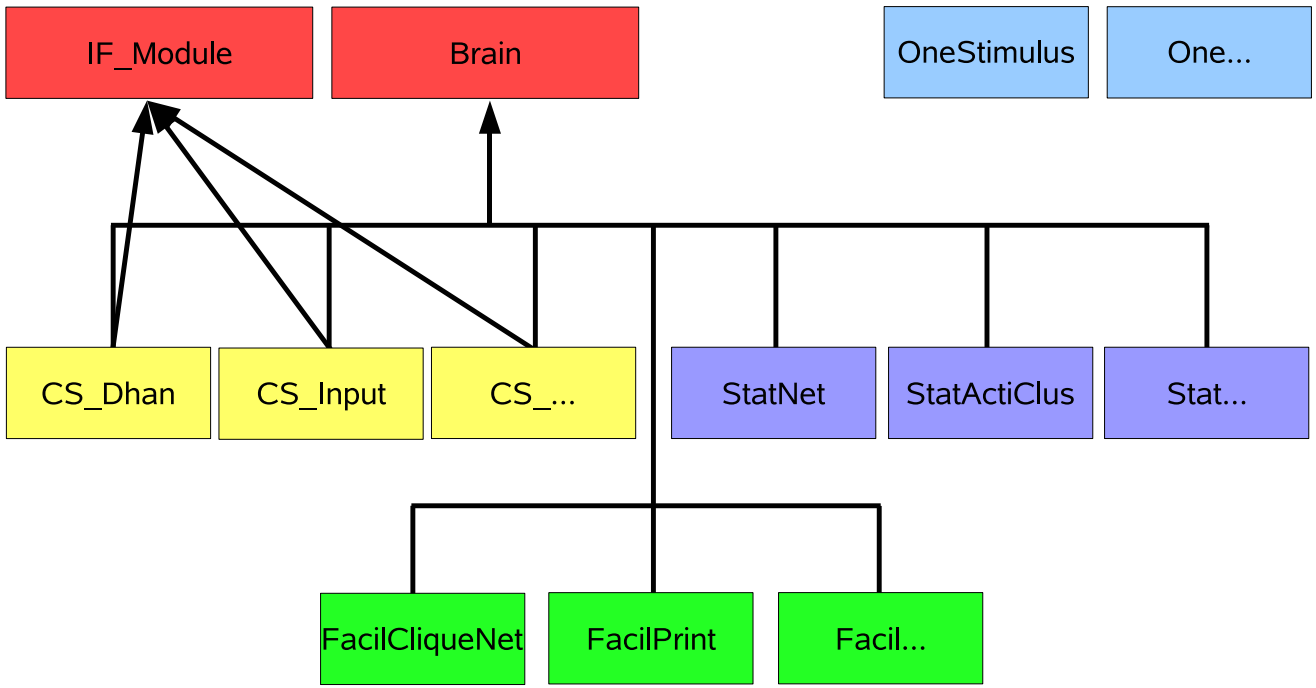
- The small world phenomenon in social and scale-free networks
- Phase transitions and self-organized criticality in adaptive systems
- Life at the edge of chaos and coevolutionary avalanches resulting from the unfolding of all living
- Living dynamical systems and emotional diffusive control within cognitive system theory

(Springer, 2008)

Frankfurt Cognitive System Platform

meta network of neural networks

- JAVA platform: class diagram



- flexibility: full on-the-fly architectural reconfiguration
- GUI (graphical user inferface): auto adaptive