



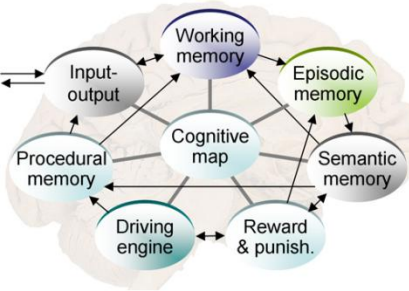
# George Mason University

## Krasnow Institute for Advanced Study

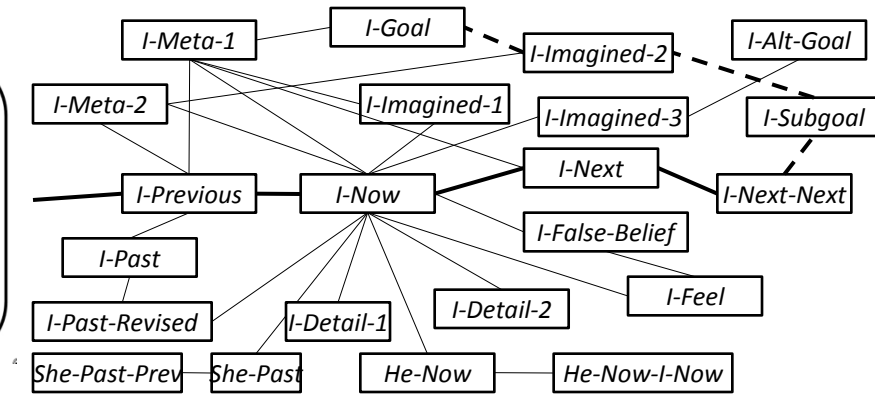
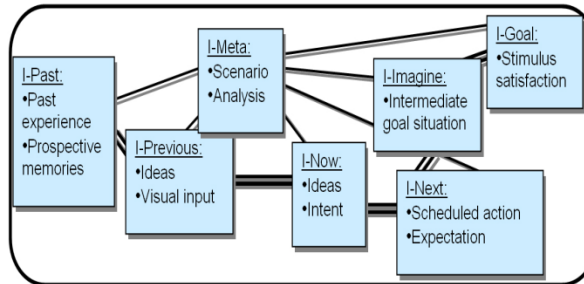
- Lead investigators and current team members:
  - Kenneth A. De Jong, Giorgio A. Ascoli, and Alexei V. Samsonovich (presenter)
- Research areas of interest, which are also areas of qualification and unique capabilities:
  - Cognitive and metacognitive architectures ([Samsonovich, De Jong & Kitsantas, \*International Journal of Machine Consciousness\*, 1, 111-130, 2009](#))
  - Connectionist modeling of the hippocampal formation ([Samsonovich & McNaughton, \*JN\* 1997](#); [Samsonovich & Ascoli, \*Learn&Mem\* 12, 193-208, 2005](#))
  - Semantic cognitive mapping of natural language ([Samsonovich & Ascoli, \*Frontiers in AI & Applications\*, 157, 111-124, 2007](#); [PLoS One](#), under review)
- Specific capabilities our group is seeking are:
  - **Robust learning in agents based on a cognitive-metacognitive architecture (CMA)**
  - **Spatial learning / navigation based on cognitive mapping in a spiking neural network**
  - **Automated semantic mapping of arbitrary data (text, images, internal representations of knowledge) based on given or detected relations of synonymy and antonymy**

# Meta-Cognitive Architectures: From GMU BICA to CMA

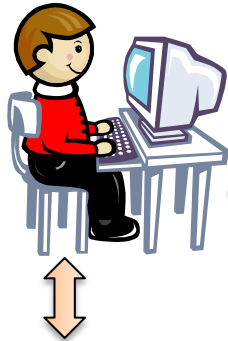
GMU BICA:



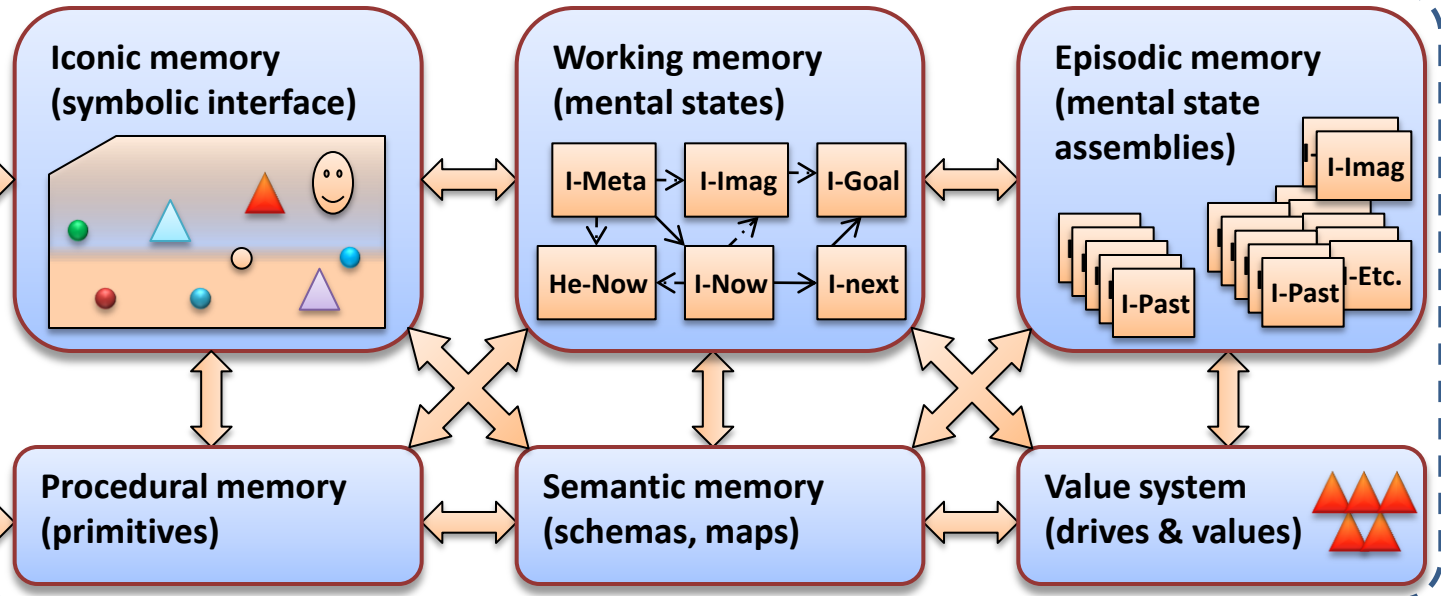
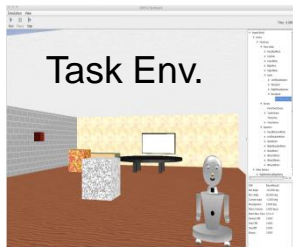
Working memory



User



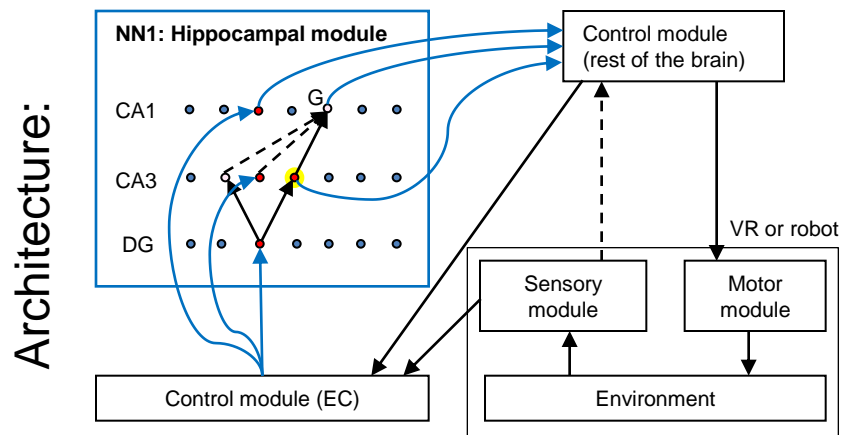
CMA



# NeuroNavigator1: A microcircuit designed under SyNAPSE program

The NN1 microcircuit implements the core of the navigator.

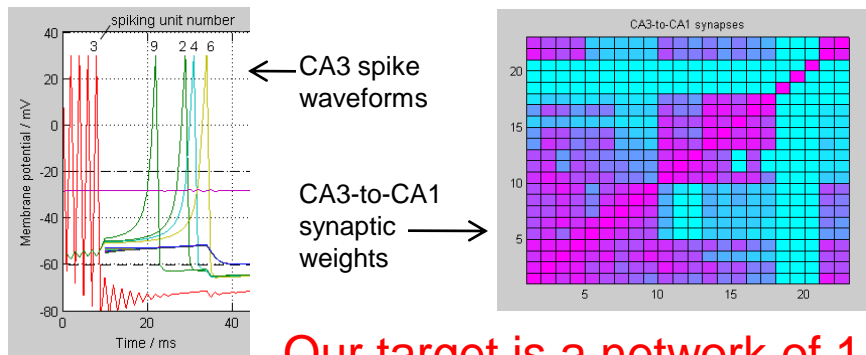
- The architecture of the NN1 network is a three-layer perceptron.
- Every layer is made of  $N=22$  neurons, each representing a distinct location.
- NN1 interacts with the rest of the cortex to receive sensory information and send motor directions.



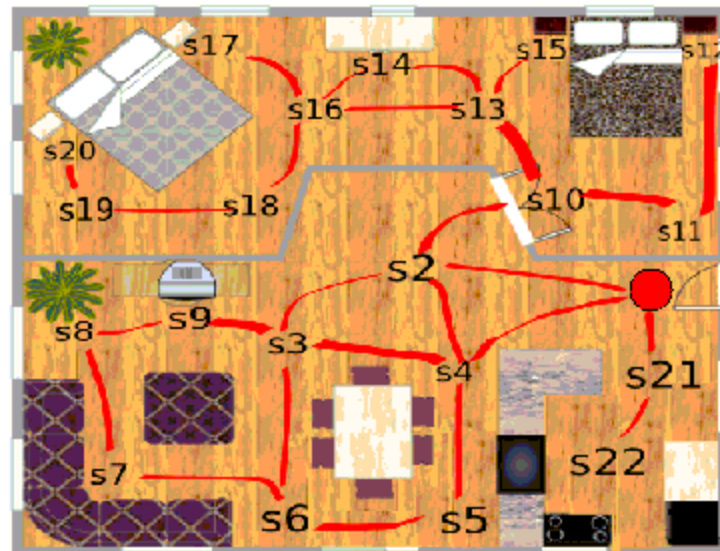
## Salient features of NN1

Parameters:  $3N=66$  neurons,  $2N^2 = 968$  synapses ( $N=22$ )  
 The architecture is scalable to larger  $N$  (e.g.,  $10^6$ ).  
 CA3-to-CA1 learning rules are ( $j$  is presynaptic neuron):

$$W_{ij}^{\text{new}} = \frac{\text{round}(10 * \max(W_{ij}^{\text{old}}, p_j))}{10}, \quad p_j^{\text{new}} = \begin{cases} 1, & \text{if neuron } j \text{ spikes} \\ 0.905 p_j^{\text{old}} & \text{otherwise} \end{cases}$$

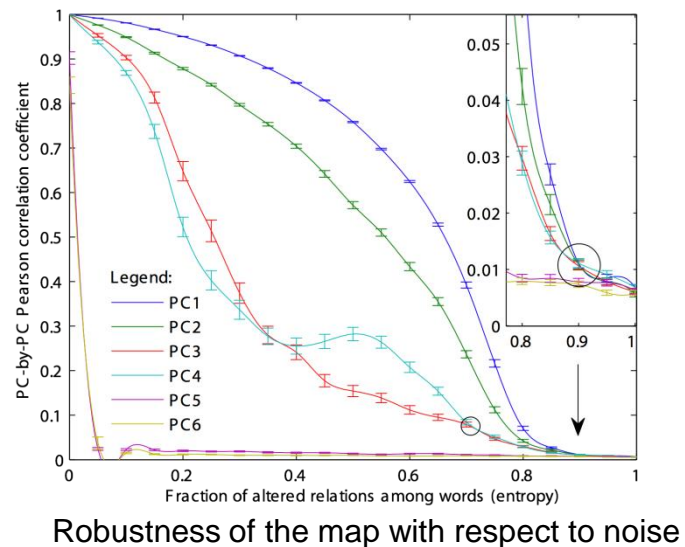
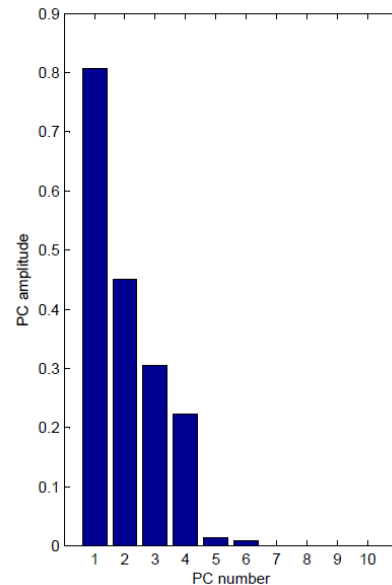
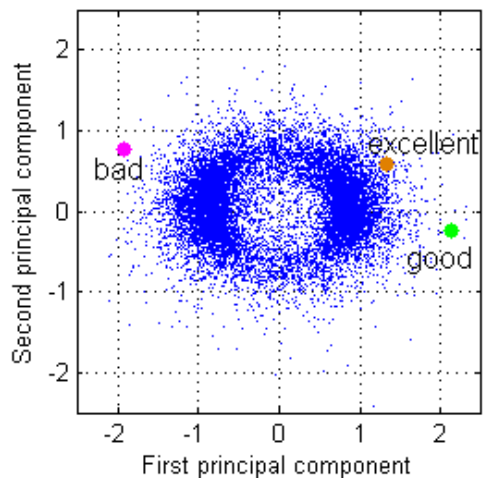
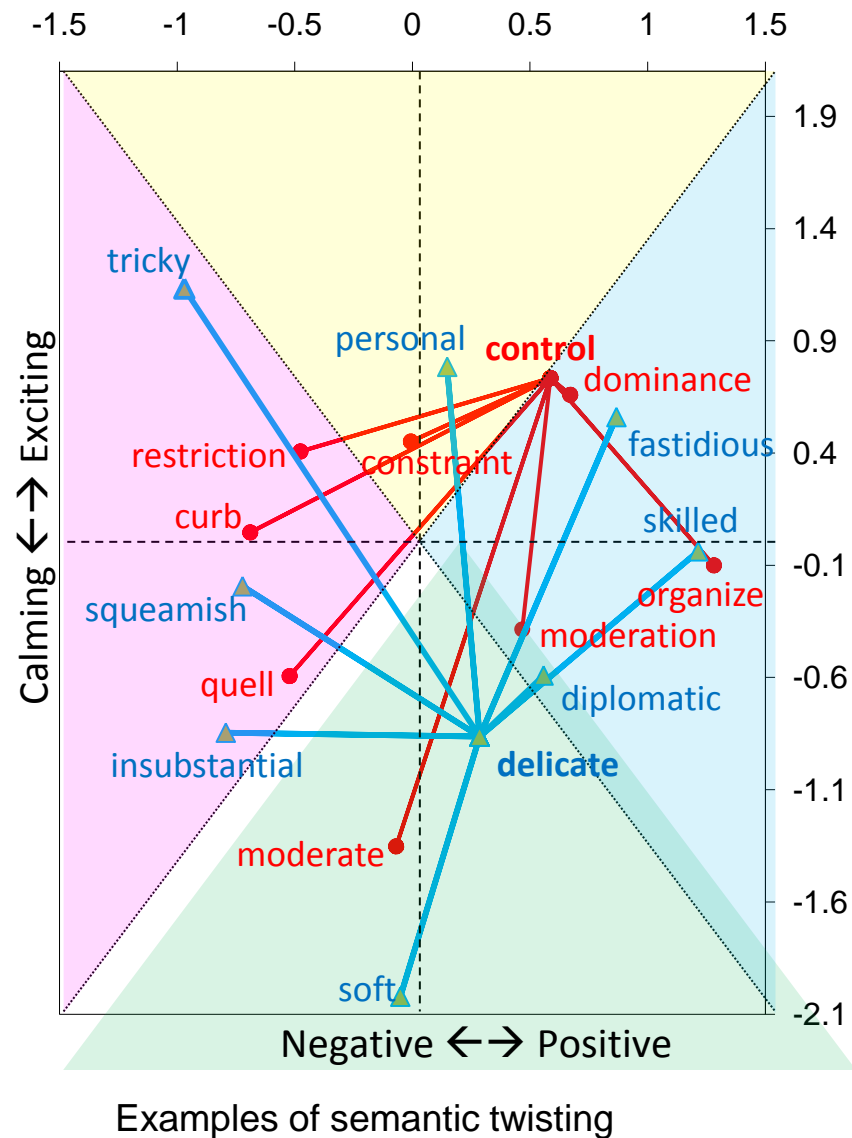


Simulated agent behavior driven by NN1 dynamics:



Our target is a network of 1,000,000 neurons with 10,000 synapses each

# Semantic cognitive mapping of language



# Contact Information

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