Brain Scans

The GTRI software modeling team consisting of the software modeling and machine learning GTRI researchers working in collaboration with neuropsychologists in the Georgia Tech School of Psychology have collaborated on several projects relevant to the MICONS project. The most relevant is the JARPA ICACS project in which we worked together to produce a spiking neuron model of the ACC which was integrated with component models from the larger ICACS team into a model of sensemaking for the challenge problems. In addition, the GTRI team has experience with multiple machine learning, reasoning techniques and modeling techniques that can be applied to neural data and modeling.

The anterior cingulate cortex (ACC) plays a role in monitoring and mediating brain activity during times of focused concentration.

The ACC participates in the executive control loop by inhibiting working memory reset (in the basal ganglia) until uncertainty has been resolved; i.e., an output has been resolved by the medial PFC. The resolution of uncertainty is represented by:

- (In challenge problem task 1) the probability cells of groups A and/or B having firing rates noticeably higher than 10 Hz
- (In challenge problem task 2, 3, 5 and 6) the probability cells of groups A, B, C and/or D having firing rates noticeably higher than 10 Hz
- (In challenge problem task 4) the probability cells of locations A, B, C, and/or D having firing rates noticeably higher than 10 Hz

The diagram to the right shows 9000ms of simulated time. The six rows show the localized average spike rates (ms), vertical axis in each row

- Row 2: ACC uncertainty output
- Row 6: ACC surprise output

The horizontal axis is time (ms), vertical axis in each row is spike rate (Hz).

JARPA ICACS

The objective of the ICACS Program is to construct brain-based computational models of the process known as sensemaking. Sensemaking, a core human cognitive ability, underlies intelligence analysts’ ability to recognize and explain relationships among sparse and ambiguous data. The GTRI team was part of a larger project team and contributed component models and neuroscience domain knowledge from the GT School of Psychology.

The diagram to the right shows 9000ms of simulated time. The six rows show the spiking times (red bars) and localized average spike rates (blue lines) of six cells:

- Rows 1 and 2: probability inputs 0 and 1
- Rows 3 and 4: ground truth inputs 0 and 1
- Row 5: ACC uncertainty output
- Row 6: ACC surprise output

The horizontal axis is time (ms), vertical axis in each row is spike rate (Hz).

Brain-Based Cognitive Architecture for Training (BBCAT)

- An architecture based on neuro-scientific models of student reasoning, learning, and emotion
- Integrate lessons from brain-based models of human learning and reasoning with student modeling, teaching and learning theories, and scenario generation
- Design of a system that can:
  - Assess an individual’s learning and emotion
  - dynamically adapt training activities to increase training effectiveness.

The GTRI team will supply cortical modeling at the neural level and machine learning based on neuroscience expertise and data supplied by Eric Schumacher of the GT School of Psychology.

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