Colloquium d'Informatique
de Sorbonne Université

How does the brain make language?

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There is no doubt that cognition and intelligence are the results of neural activity --- but how, exactly? How do molecules, neurons, and synapses give rise to reasoning, language, plans, stories, art, math? Despite dazzling progress in experimental neuroscience, as well as in cognitive science, we do not seem to be making progress on the overarching question. As Richard Axel recently put it in an interview: «We don't have a logic for the transformation of neuronal activity to thought and action. I view discerning [this] logic as the most important future direction of neuroscience». What kind of formal system would qualify as this «logic»?

I will introduce a computational system whose basic data structure is the assembly of neurons --- assemblies are large populations of neurons known to represent concepts, words, ideas, episodes, etc. The Assembly Calculus is biologically plausible in the sense that Its primitives are behaviors of assemblies observed in, or suggested by, experiments, and can be provably (through both mathematical proof and simulations in biologically realistic platforms) «compiled down» to the activity of neurons and synapses. Using this framework a Parser was constructed which (a) can handle reasonably complex sentences in English and other languages; and (b) works exclusively through the firing of biologically realistic neurons.

Christos Harilaos Papadimitriou is the Donovan Family Professor of Computer Science at Columbia University. He holds a PhD from Princeton (1976), and eight honorary doctorates. He has received the Knuth prize, the Goël prize, the Babbage award, the von Neumann medal, and the Harvey Prize. He has written five textbooks, many articles on algorithms and complexity, and three novels: "Turing", "Logicomix" and "Independence."

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