Unraveling the Complexity and Causality in the brain, if even possible. A tormented story from Granger to Sugihara

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In recent years, there has been a growing interest in understanding the intricate mechanisms underlying brain function. There is a fundamental role of causal models in unraveling the complex dynamics of the brain. By identifying causal relationships, researchers can elucidate how different regions of the brain interact and contribute to various cognitive processes. Causal models provide a powerful framework to investigate these relationships and shed light on the underlying mechanisms. Non-invasive methods, such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), provide valuable insights into the dynamics of brain networks and their causal interactions.

On one hand, model-based approaches as dynamical causal model have provided a limited yet physiologically based way to study this. On the other hand, the integration of techniques like event-related potentials (ERPs) and Granger causality analysis allows researchers to uncover the temporal aspects of causal interactions, providing a more comprehensive understanding of brain function, though these can often be temporal correlations rather than real causality.

The complex and nonlinear nature of brain dynamics often makes it difficult to establish direct causal links. Researchers must carefully consider confounding factors, such as network topology and feedback loops, to ensure the validity of their models. Advanced statistical and computational methods, such as Bayesian networks and structural equation modeling, are employed to address these challenges. Let's discuss together whether novel artificial neural networks can help shedding a light in this.