Chimaera Networks: Temporal self-organizing neural networks for sequence learning

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Abstract

Contemporary artificial neural network research largely focuses upon existing neural network architectures towards developing cognitive models, opposed to developing fundamentally new architectures for neurocomputation.

Unfortunately the current state of artificial neural network research has several central criticisms surrounding core neural network bases, representations, and process and knowledge. More fundamental research is required before the first network architectures that combine representational capacity with experiential self-organized processes for acquiring and using knowledge are developed, opening the possibility of developmental computational models of cognition.

Many of the central criticisms of contemporary architecture are central around learning rules. Specifically, these include the plausibility of separate learning and application phases, the use of supervised training rules, and the specialized and selective manipulation of neurons at any time by an experimenter (as in the case of node changing). Unsupervised network architectures aim to resolve many of these issues, but in doing so often develop similarly implausible methods of operation.

This study develops a Chimaera Network — a novel temporal architecture that approaches the idea of a cellular automaton by combining a Self-Organizing Map (SOM) with a Hebbian learning based association map. The network performs self-organizing learning over time, and does not require separate learning and application phases.

Connectionist Architecture Contexts

There are three central families of connectionist architectures:

- **Self-Organizing Map (SOM)**: unsupervised SOM learning rule represents data vectors not temporal often single-layered
- **Hebbian Association Network**: unsupervised Hebbian learning rule represents associations temporal extended multi-layered
- **Simple-Recurrent Network**: supervised Backpropagation learning rule represents associations between data vectors temporal multi-layered

The Chimaera architecture combines their benefits, to develop an unsupervised, representationally expressive architecture

Future Research Themes

- **Multi-layer Chimaera Networks**: to systematically increase the Chimaera computational and representational capabilities
- **Developmental Grammar Acquisition Modelling**: to develop the first self-organizing models of grammar acquisition that simultaneously represent both semantics and grammatical structure

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