Sentence processing in spiking neurons: A biologically plausible left-corner parser

Terrence C. Stewart (tcstewar@uwaterloo.ca)
Xuan Choo (fchoo@uwaterloo.ca)
Chris Eliasmith (celiasmith@uwaterloo.ca)
Center for Theoretical Neuroscience, University of Waterloo
Waterloo, ON, Canada N2L 3G1

Abstract

A long-standing challenge in cognitive science is how neurons could be capable of the flexible structured processing that is the hallmark of cognition. We present a spiking neural model that can be given an input sequence of words (a sentence) and produces a structured tree-like representation indicating the parts of speech of that it has identified and their relations to each other. While this system is based on a standard left-corner parser for X-bar constituency grammars, the neural natural of the model leads to new capabilities not seen in classical implementations. For example, the model gracefully decays in performance as the sentence structure gets larger. Unlike previous attempts at building neural parsing systems, this model is highly robust to neural damage, can be applied to any binary constituency grammar, and requires relatively few neurons [insert number here].

Keywords: Neural engineering framework; vector symbolic architectures; left-corner parsing; syntax; X-bar; computational neuroscience

Introduction

Left-Corner Parsing

Previous Models

Rick Lewis' ACT-R model
Neural blackboard architectures
Our previous cogsci paper

Neural Engineering Framework

Vector Symbolic Architectures

Semantic Pointer Architecture

Left-Corner Parsing in SPA

Parsing Results

(show that it works and what sort of sentences and trees it can do)

Parsing Accuracy

(how much accuracy do we need in the representation? What does that translate to in terms of needed numbers of neurons in the buffers? Lots of graphs. Also a neural destruction graph, since we mention that in the abstract)

Using Parsed Commands

(connect to Xuan's stuff)

Future Directions

Automatically learning utilities to handle repair/recovery

Conclusions

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