Team - Synaptic
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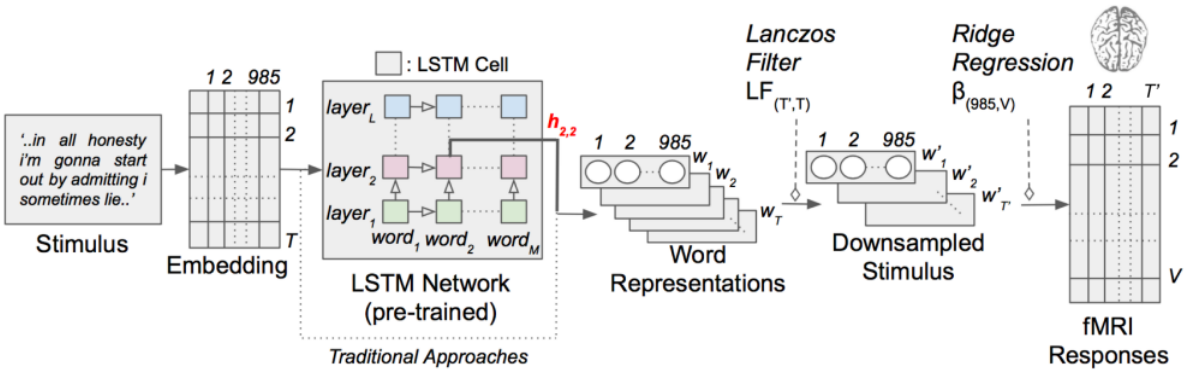
Cognitive Science and AI
Project Proposal

PROBLEM

The aim is to implement the paper *"Incorporating Context into Language Encoding Models for fMRI" by S Jain et al.* and draw reasonable results that align with the results detailed by the authors originally.



Language encoding models help explain language processing in the human brain by learning functions that predict brain responses from the language stimuli that elicited them. Current **word embedding**-based approaches treat each stimulus word independently and thus ignore the influence of context on language understanding. This work instead builds encoding models using rich contextual representations derived from an **LSTM** language model ultimately aiming to show a significant improvement in encoding performance relative to state-of-the-art embeddings in nearly every brain area.

PLAN

1. Firstly, we use representations discovered by an LSTM LM to incorporate context into encoding models that predict fMRI responses to natural, narrative speech.
2. Secondly, we compare the effectiveness of models that use different LSTM layers and context lengths with the aim to elicit insights into the representation of linguistic context in the cortex.

MILESTONES

1. **Understanding and obtaining the Natural Language fMRI Experiment data** - The data used is from an fMRI experiment where the stimulus consisted of 11 naturally spoken narrative stories from The Moth Radio Hour, totalling over 2 hours or roughly 23,800 words. Measured brain responses consist of whole-brain blood-oxygen level dependent (BOLD) signals recorded from 6 subjects using functional magnetic resonance imaging (fMRI).
2. **Understanding and obtaining the Language models**
    a. Word embedding based encoding model
    b. Context Representation - The used LSTM LM is pretrained on a corpus of comments scraped from reddit.com, comprising over 20 million words chosen because the informal and conversational nature of the text is more similar to our stimulus stories than most conventional corpora.
3. **Experimentation**
    a. **Language encoding performance for context representations** - Study impact of context length and LSTM layers against a baseline embedding model.
    b. **Distorting Context representations -** Study impact of 'randomize' and 'swap' experiments on the context of words.
    c. **Study Context length preference across cortex**
    d. **Study LSTM layer preference across cortex**

EXPECTED RESULTS

1. These contextual models perform significantly better at predicting brain responses than previously published word embedding models.
2. The comparison of models based on LSTM layers and level of context reveals a hierarchy of brain areas that are sensitive to both different types of contextual information and different temporal receptive field sizes. LSTM-based contextual encoding models outperform the best hand-designed feature spaces for language encoding,

DIVISION OF WORK (Milstone-wise, tentative and subject to change with the course of the project)

Ayush - M2a, M3b Pratham - M2b, M3a Amal - M1, M3c, M3d