Syntactic Alignment in Conversations with Large Language Models: Do LLMs Adapt their Syntax Over the Long Term Similar to Humans?

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Abstract

This paper explores the effects of long-term syntactic alignment in Large Language Models (LLMs). Using OpenAI's GPT-4o, artificial conversations were generated, addressing a lack in existing research of long natural conversations with LLMs. A statistical analysis on syntactic structures present in these conversations reveals that syntactic alignment occurs in LLMs over extended periods. A second analysis further explores how the process of alignment evolves throughout a conversation, showing that LLMs progressively adjust their syntax, with the largest changes occurring early on. The results indicate that LLMs are not only influenced by the linear order in which tokens of their inputs appear, but also that its influence becomes continuously larger with increasing context lengths.

1 Introduction

Alignment in human language and communication is a widely studied process, in which people adapt to their communication partner by coordinating their behavior and language. These adaptation processes not only appear on a visual or auditory level, such as gestures, postures or the speech rate (Holler and Wilkin, 2011, Shockley et al., 2009, Jungers and Hupp, 2009), but also on more underlying levels, e.g. the semantics or syntax (Bock, 1986, Garrod and Anderson, 1987). Under these latter two aspects, artificial language generation has become almost indistinguishable from human language in recent years; Large Language Models (LLMs) are optimized to produce texts that seem as coherent as human language, yet their linguistic behavioral patterns haven't been studied much. Different from humans, LLMs work on a next-token-prediction task: They don't follow a conscious effort to convey meaning, but rather model a certain probability function to generate texts. Their concrete underlying workings are unknown, as they emerge from an optimization process on large amounts of data, making it unclear which patterns they have picked up on during that training.

Although they are never explicitly guided to exhibit behavior similar to humans, do Large Language Models nonetheless exhibit syntactic alignment in their text production, similar to us?

2 Priming and Alignment

Research on human adaptation processes in language and communication has covered many different aspects. For this reason the terminology in this field is quite varied; Adaptation processes have been found in different modalities (e.g. gestures, lexical phrases...) over different temporal distances or under different sequential relations. Instead of referring to all these variations with different expressions, Rasenberg et al., 2020 propose to simply distinguish them under the different aspects that they are analyzed on, avoiding confusion and redundancy in their terminology. The focus in this paper, for example, will be simply on syntactic adaptation (the sequential relation of words) over longer distances (longer time spans). Another differentation in their paper concerns the theoretical approaches used for explaining these effects. There are mainly to camps: One that explains alignment as a result of conscious, cooperative decisions made during communication (Brennan and Clark, 1996), and one that views alignment as an automatic, mechanistic process occurring across various linguistic levels. This latter perspective has its theoretical foundation in Pickering and Garrod, 2004's Interactive Alignment Model (IAM). Under this view, 'alignment' is used to refer to a process in which situational cognitive models of speakers approach each other, such that they develop shared representations on different levels. The process is driven by automatic repetitions, 'priming', in which encountering an utterance will activate a representation that increases

the likelihood that a person produces an utterance that uses the same representation.

This paper focuses on alignment in LLMs, although the term is used in a more general sense, not suggesting any implicit mechanistic explanations.[1] Rather, it shall contrast adaptation that occurs in a more robust sense, in which language of different speakers generally becomes closer to one another over longer periods, from that of local short-term priming or repetitions. Nonetheless, the terms 'prime' and 'target' will be borrowed to refer to the first appearance of a linguistic structure and its subsequent repetition.

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A Example Appendix

This is an appendix.

[1] The mechanistic behind alignment in LLMs, if existant, would definitely be much different from that of humans.