How AI Vindicates the Alignment of Grammar and Logic: Evidence from Large Language Models for the Unity of Form

Abstract

This paper argues that the demonstrated capabilities of large language models (LLMs) provide surprising empirical support for the alignment of grammatical and logical form. While philosophers have traditionally posited a divergence between grammatical and logical structure, LLMs' ability to make correct inferences without FOL-style logical forms suggests that grammatical structure itself guides valid reasoning. This indicates that the perceived misalignment between grammatical and logical form may be an artifact of our chosen formal systems rather than a feature of language itself.

1. Introduction

The distinction between logical and grammatical form has been a cornerstone of philosophical thinking about language since Frege and Russell. This view maintains that:

1. Sentences with similar grammatical forms can have different logical forms

2. Understanding logical form is necessary for proper reasoning

3. Surface grammar can mislead if not translated into proper logical form

For example, philosophers argue that while "John snores" and "nobody snores" share grammatical form (subject-predicate), they differ in logical form:

- "John snores" → simple predication

- "nobody snores" → universal negative quantification

This paper argues that the demonstrated capabilities of large language models suggest an alternative view: that grammatical and logical form can and do align in actual reasoning practice, even if they appear to diverge in first-order logic (FOL).

2. Evidence from AI Language Processing

2.1 Direct Learning of Inferential Patterns

Consider how LLMs handle quantified expressions:

1. They correctly process "nobody snores" without:

- Translating to FOL

- Positing hidden logical form

- Being misled by surface grammar

2. They make appropriate inferences:

- From "nobody snores" to "there are no snorers"

- Without positing entities named "nobody"

- Without explicit quantificational analysis

3. They handle related expressions systematically:

- "everybody," "somebody," "no philosopher"

- Without diverging from grammatical structure

- While maintaining valid inference patterns

2.2 The Non-Role of Traditional Logical Form

Significantly, LLMs achieve this without:

- FOL-style representations

- Explicit logical forms distinct from grammar

- Translation between grammatical and logical structures

This suggests that the traditional view of logical form as necessary for valid inference may be mistaken.

3. Toward a Unified Account

3.1 A Class-Based Alternative

Consider a logic where:

1. All noun phrases denote classes:

- "John" → singleton class containing John

- "nobody" → maximal class containing no people

- "everybody" → class of all people

2. Predication uniformly expresses class relations:

- "X snores" → relationship between X-class and snorer-class

- "John snores" → John-singleton overlaps snorer-class

- "nobody snores" → no-person-class doesn't overlap snorer-class

3. This system:

- Preserves grammatical structure

- Licenses valid inferences

- Needs no translation to logical form

3.2 Evidence from LLM Behavior

LLMs appear to operate more like this unified system than traditional logical analysis:

1. They process noun phrases uniformly

2. They handle predication consistently

3. They make valid inferences without transformation

4. Implications for Traditional Views

4.1 The Cognitive Status of Logical Form

Traditional views face several challenges:

1. Logical form is cognitively inert:

- People reason without it

- LLMs function without it

- It plays no role in actual inference

2. Logical form is constructed, not discovered:

- It requires prior understanding

- It systematizes rather than explains

- It follows rather than guides comprehension

3. Logical form is system-relative:

- Different logics yield different forms

- No unique logical form exists

- Choice of representation is pragmatic

4.2 The Positive Role of Grammar

Evidence suggests grammar:

1. Reliably guides inference

2. Encodes logical relationships

3. Supports sophisticated reasoning

5. Learning and Emergence

5.1 Statistical Pattern Learning

LLMs develop their capabilities through:

1. Exposure to language use

2. Pattern recognition

3. Statistical learning

This suggests that:

1. Grammatical-logical alignment emerges naturally

2. No explicit logical forms are needed

3. Valid inference patterns can be learned directly

5.2 Convergent Evidence

Both humans and LLMs:

1. Learn from usage patterns

2. Make valid inferences without logical analysis

3. Follow grammatical structure reliably

6. Addressing Objections

6.1 The Traditional Challenge

Philosophers might object that:

1. Surface grammar can mislead

2. Logical form is necessary for valid inference

3. Translation to FOL reveals true structure

However, evidence shows:

1. Grammar rarely misleads in practice

2. Valid inference occurs without logical form

3. FOL translation is unnecessary

6.2 The Implementation Question

Critics might ask:

1. How does grammar encode logical relations?

2. What mechanisms ensure valid inference?

3. How do patterns yield systematic understanding?

The class-based approach suggests:

1. Grammar directly reflects logical structure

2. Class relations ground valid inference

3. Patterns yield systematic understanding through unified treatment

7. Implications for Semantic Theory

This analysis suggests:

1. Theoretical Implications:

- Grammar and logic naturally align

- Logical form is a construct, not a discovery

- Valid inference doesn't require logical translation

2. Methodological Implications:

- Study grammar as encoding logic

- Look for unified rather than divergent structures

- Consider alternatives to FOL-based analysis

3. Practical Implications:

- Trust grammatical guidance

- Expect grammar-logic alignment

- Look for unified patterns

8. Conclusion

The evidence from LLMs suggests that the traditional distinction between grammatical and logical form may be artifacts of our chosen formal systems rather than features of language itself. A unified approach treating all noun phrases as class-denoting expressions and predication as expressing class relations better matches both human and AI language processing. This indicates that grammar itself may encode logical structure more directly than traditionally assumed.

These findings point toward a refined theory of linguistic form that sees grammar and logic as aligned rather than divergent. This may help bridge the gap between grammatical structure and logical analysis while better accounting for actual linguistic practice.

References

[To be added]