Using and Evaluating LLMs in Academic Work

Session 2: Structural Integrity and the Problem of Hallucination

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Session 2: Structural Integrity and the Problem of Hallucination

1. Defining Structural Hallucination

2. Mechanisms of Structural Hallucination

3. Detection Challenges and Risks

Moving Beyond Basic Hallucination

- Common view: Hallucination = Factually incorrect statements
- Proposed view: Structural hallucination as a broader, more significant failure
- It is functionally more damaging than simple factual error

Defining Structural Hallucination

- Generation of content that may be factually accurate at a sentence level
- **The Core Failure**: Fundamental distortion of the relational structure of knowledge
- It misleads researchers in ways standard fact-checking cannot detect

The Topology of Academic Knowledge

- Knowledge is not a flat collection of facts
- It is complex, hierarchical, and deeply relational
- Components include dependencies, causal arguments, and methodological hierarchies

Truth Value vs. Positional Value

- Significance of a claim is not just its truth value
- Significance is determined by its position within the underlying structure
- Structural hallucination fails to represent this relational context

Mechanism 1: Conceptual Re-centering

- LLMs assign disproportionate importance to peripheral concepts
- Weakly grounded or spurious concepts are elevated
- Ideas occupying marginal positions are presented as foundational

Reshaping the Intellectual Core

- Re-centering effectively reshapes the perceived core of a field
- Dangerous because it mirrors authoritative academic writing styles
- Distortion is invisible without structural network analysis

The Danger of Authoritative Tone

- LLMs are "stochastic parrots" with high stylistic confidence
- Surface-level polish creates a "fluency trap"
- Structural flaws are hidden behind professional terminology

Mechanism 2: Bibliographic Distortion

- LLMs generate citations that appear plausible but do not exist
- Misattribution: Crediting the wrong authors for specific ideas
- Compression of complex intellectual genealogies into misleading narratives

Distorting Influence

- Selection and placement of citations distort the structure of influence
- Overemphasizing secondary sources
- Omitting canonical works that form a discipline's backbone

Mechanism 3: Logical Mis-structuring

- Construction of arguments that are locally coherent but globally flawed
- Reliance on false equivalences or invalid causal chains
- Misrepresentation of theoretical dependencies

The Illusion of Global Coherence

- Arguments pass superficial coherence checks
- Individual claims appear reasonable in isolation
- Overall structure fails to reflect epistemic standards of reasoning

Case Study: Fabricated Scholarly Dialogue

- LLM correctly states Author A wrote on Topic X
- LLM correctly states Author B wrote on Topic Y
- **The Error**: LLM incorrectly implies B's work was a response to A
- This fabricates a dialogue that never occurred

High-Stakes Consequences

- These errors are critical in manuscripts, theses, and grant proposals
- Leads to fundamentally flawed research trajectories
- Distorts the understanding of a field's historical development

Why Standard Fact-Checking Fails

- Sentence-level checks only verify isolated statements
- If every individual sentence is true, the check "passes"
- The structural error (the link between sentences) remains unflagged

The Role of Domain Expertise

- Structurally hallucinated text is internally consistent
- Difficult to challenge without deep domain knowledge
- Poses a significant threat to the integrity of peer review

Threat to Student Assessment

- Students may unknowingly submit structurally flawed work
- Instructors might miss distortions if they only check for "facts"
- Undermines the validity of educational evaluation

Cognitive Load and Automation Bias

- Humans tend to trust fluent machine output (automation bias)
- Detecting structural flaws requires higher cognitive effort than fact-checking
- Users often default to surface-level verification

The Guiding Question for Evaluation

- "Does an output remain factually correct while also fitting coherently within the established knowledge landscape?"
- Must check bibliographic and intellectual alignment

Integrity as Relational Alignment

- Integrity is not just about "not lying"
- It is about maintaining the correct relationships between ideas
- LLMs, being probabilistic, treat relations as statistical patterns

Misrepresenting Schools of Thought

- LLMs often homogenize distinct scholarly traditions
- They may conflate incompatible methodological approaches
- This creates a "generic" knowledge that serves no specific tradition

Narrative and Truth

- Scientific progress relies on accurate historical narratives of discovery
- Structural hallucinations rewrite these narratives
- Example: Moving the "turning point" of a theory to a different decade

Latent Distortions

- Errors are often "latent"—dormant until someone tries to build on them
- Flawed foundations lead to structural collapse of future research

The Need for Structural Tools

- We must move beyond sentence analysis
- Evaluation must look at the "overall structure" of knowledge
- This requires network science techniques

Making Structure Explicit

- Surface fluency hides structure; networks reveal it
- Translation into structured formats allows for inspection
- Visualizing relationships as nodes and edges

Epistemic Responsibility Re-evaluated

- Responsibility involves guarding against structural drift
- It is a proactive commitment to "governance"
- Not just correcting errors, but maintaining field integrity

Session 2 Summary

- **Structural hallucination** is a critical concept for understanding the risks of LLM use in academia.
- It manifests in three main forms: **conceptual re-centering**, **bibliographic distortion**, and **logical mis-structuring**.
- These errors are difficult to detect with traditional fact-checking methods.
- Evaluating LLM outputs requires a shift in focus from local factual correctness to global structural integrity.

Looking Ahead to Session 3: Knowledge Structures

- From Misrepresentation:
  - Foundational theories must remain central
  - LLMs often flip this hierarchy
  - Structural integrity requires preserving these relationships
- To LLM Governance:
  - How do we practically detect these distortions?
  - From Text to Network
  - Introducing Knowledge Graphs as an evaluation tool

Questions and Discussion

Thank you!

Questions?

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