

# When Explanations Lie

## Testing and Improving Faithfulness in Model Reasoning

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# About Me

## Research Interests:

- **Interpretability of Language Models:** Understanding mechanisms of LLMs with some applications to context usage and parametric knowledge.
- **Explainability Methods:** Designing robust explainability techniques that enhance the understanding of complex models.
- **Factuality in LMs:** Addressing the challenge of maintaining factual accuracy in language models.

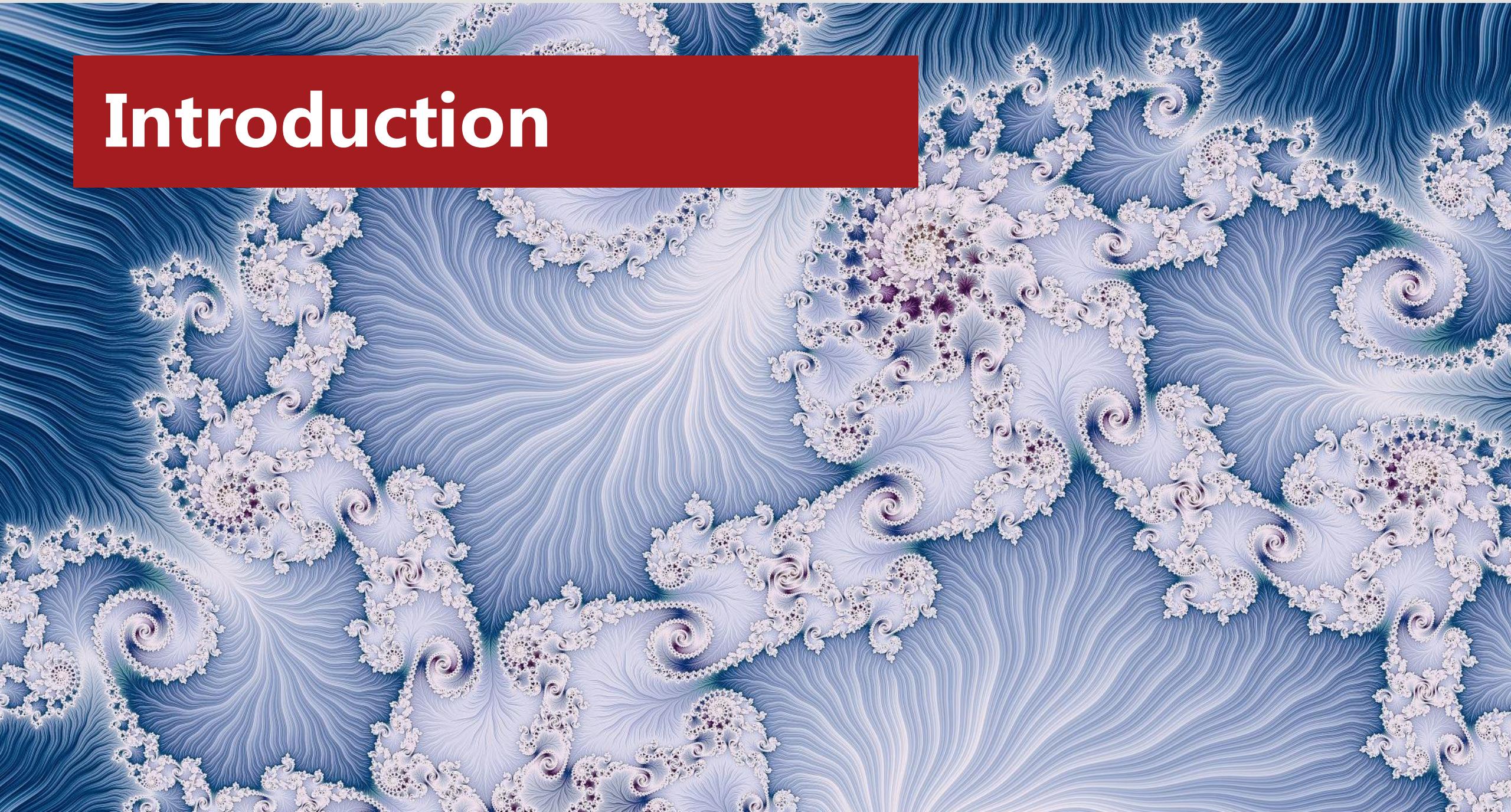


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# When Model Explanations Lie ...

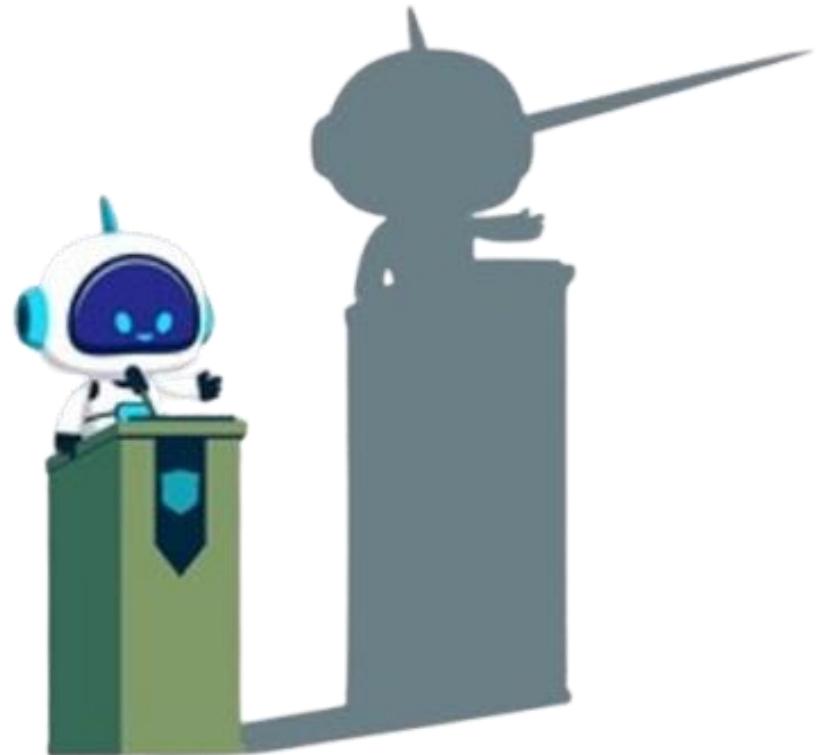
1. Introduction
2. Evaluating explanation faithfulness
3. The scope of unfaithfulness
4. Solutions for faithful explanations
5. Implications and conclusion

# Introduction



# From Black Boxes to ... Articulate Black Boxes

- 2018 - Models are black boxes, we need interpretability!
- 2022 - Chain of Thought! Now models explain their reasoning!
- 2023 – Wait ... these explanations might not reflect actual reasoning
- 2024-25 – Oh no, they definitely don't!



# The Illusion of Transparency

Model predicts: "This loan application  
is HIGH RISK"

Explanation says: "Due to low credit  
score and high debt ratio."

Reality:



# Faithful vs. Plausible: The Core Distinction

**Faithful explanation:** Accurately reflects how the model actually made its decision

**Plausible explanation:** Sounds convincing to humans, but may be unrelated to the model's reasoning.

Current NLE methods often produce explanations that sound reasonable but don't represent how the model actually arrived at its decision.

**This can mislead users, hide biases, and violate regulatory requirements.**



# Why We Need Honest Explanations

- 🎯 **Trust Calibration:** Users need accurate understanding to appropriately trust AI
- 🔍 **Accountability:** Explanations enable auditing and oversight
- ☐ **Debugging:** Finding bugs is hard when the system lies about what it's doing
- 🛡️ **Alignment Verification:** Hard to catch deception if explanations are... deceptive
- ⚖️ **EU AI Act:** Transparency is mandated for high-risk applications



# Natural Language Explanations

- Free-text explanations
  - AI explains itself in human words
- Two Flavors
  - Predict-then-explain ->  
*I think it's B. Here's why I think it's B.*
  - Explain-then-predict – CoT  
*Let me think... therefore B.*

**Dataset: e-SNLI** (Natural Language Inference)

**Premise:** A man wearing glasses and a ragged costume is playing a Jaguar electric guitar.

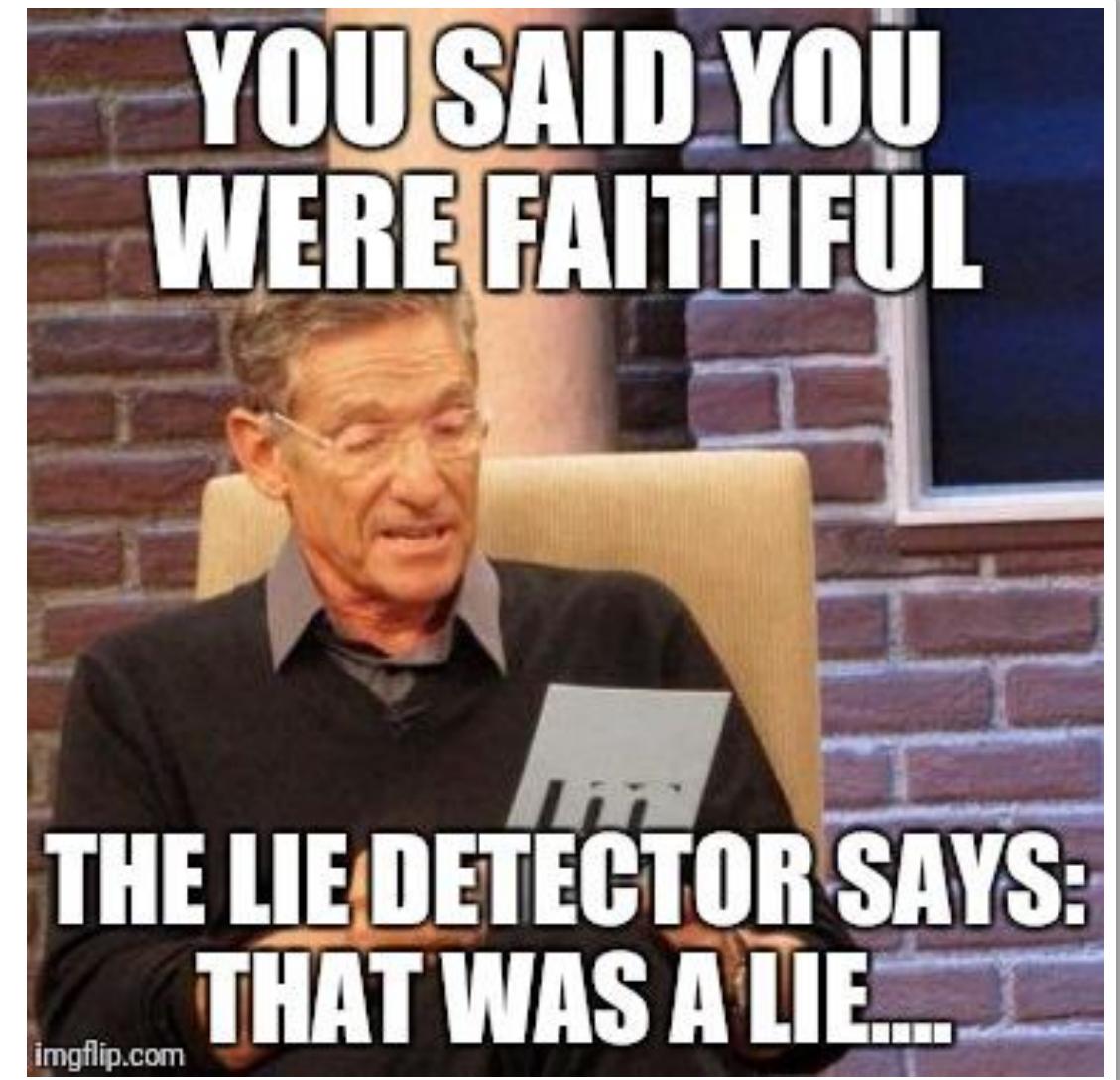
**Hypothesis:** A man with glasses and a disheveled outfit is playing a guitar.

**Prediction:** entailment

**NLE:** A ragged costume is a disheveled outfit.

# Why Could NLEs Be Unfaithful?

- Natural Language Explanations (NLEs) from LLMs can "confabulate"
- Post-hoc explanations may rationalize rather than explain
- Models optimized for explanation quality, not faithfulness

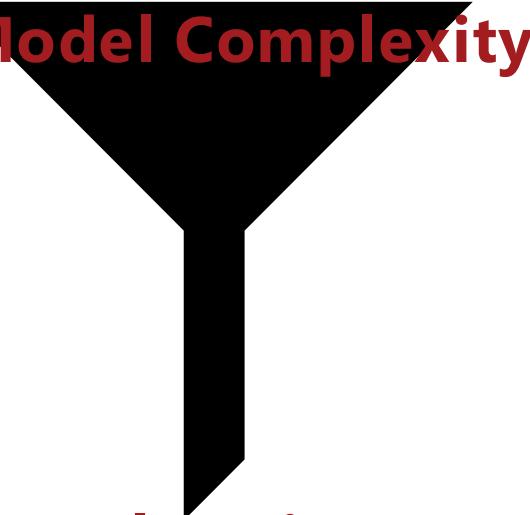


# Could NLEs Be Faithful?

High-dimensional,  
continuous space  
of activations

Parallel  
computation

**Model Complexity**

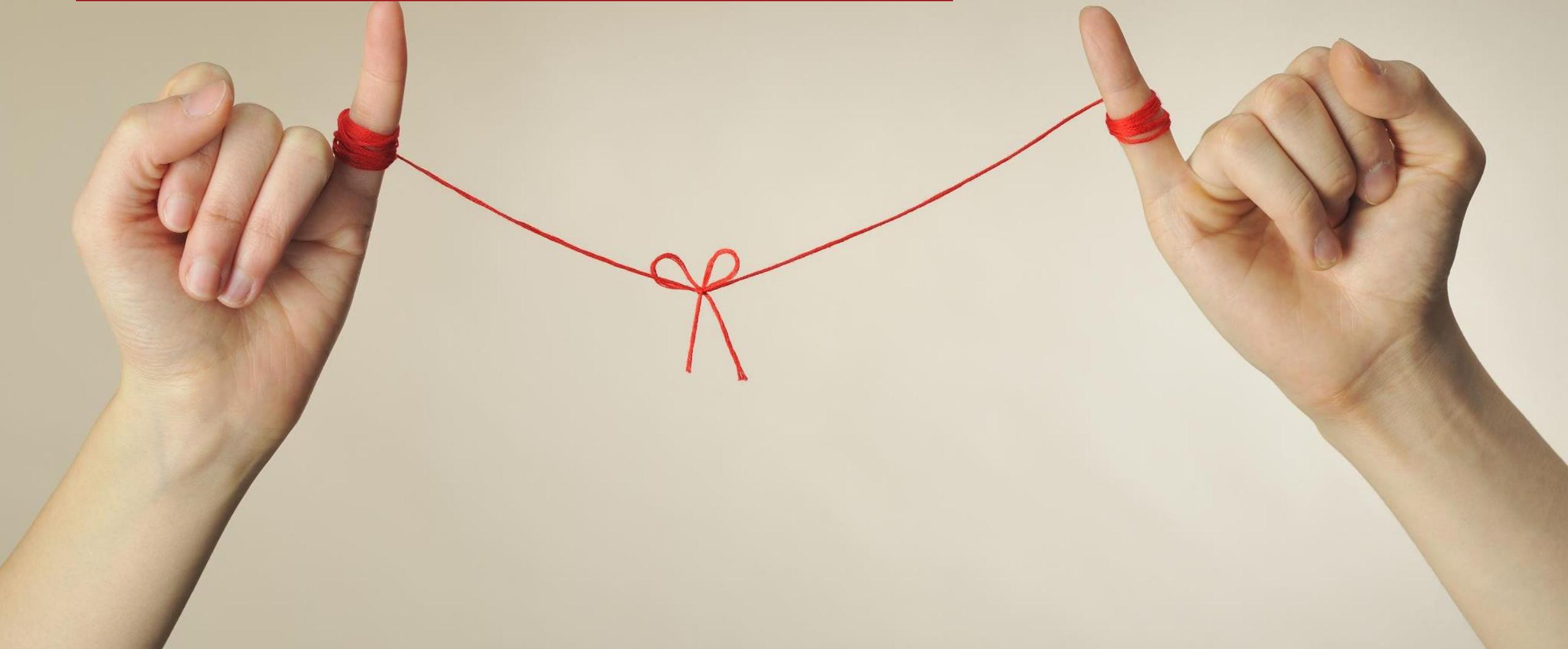


Explanation  
complexity

Discrete, finite  
vocabulary

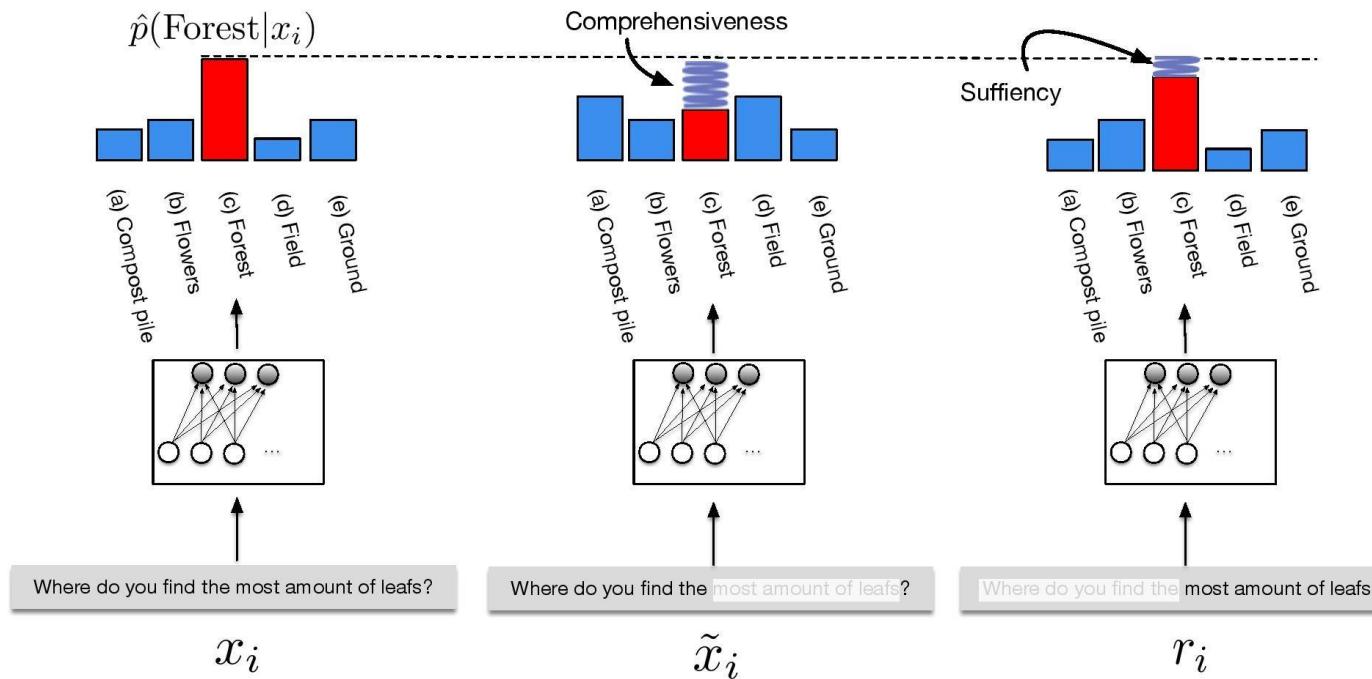
Sequential  
verbalisation

# How to catch a liar



# Evaluating Faithfulness in Highlight Explanations

Usually measured by masking the most salient words as per an explainability's saliency scores and observing the change in a model's performance.



**General challenge:** How do we know if an explanation is faithful when we can't peek inside the model's internal mechanisms?

# Why Testing NLE Faithfulness is Hard

- Free text, including words not present in the input.
- No direct mapping between the NLE and the input.
- Models are really good at sounding convincing.

**Dataset: e-SNLI** (Natural Language Inference with Natural Language Explanations)

**Premise:** A man wearing glasses and a ragged costume is playing a Jaguar electric guitar and singing with the accompaniment of a drummer.

**Hypothesis:** A man with glasses and a disheveled outfit is playing a guitar and singing along with a drummer.

**Prediction:** entailment

**NLE:** A ragged costume is a disheveled outfit.

# How to Catch a Liar?

## Faithfulness Tests for NLEs

Novel testing framework that probes whether explanations accurately reflect model reasoning.

## Core Insight

Test faithfulness by **causal interventions** and checking if:

1. Explanations track actual model behavior changes
2. Stated reasons genuinely influence predictions

# Test 1: Counterfactual Input Editor

Insert specific reasons into the input that **should** change the model's prediction.

- Procedure:
  - **Step 1:** Add a causal factor to input
  - **Step 2:** Observe if prediction changes as expected
  - **Step 3:** Check if NLE mentions this factor

## Key Insight

If factor changes prediction but NLE doesn't mention it -> CAUGHT! 

# Test 1: Counterfactual Input Editor

## Sentiment Classification Example

**Original:** "The food was okay" → Neutral (50% confidence)

**Modified:** "The food was okay, but service was terrible" → Negative (80% confidence)

## Evaluation

- ✓ **Faithful NLE:** Mentions poor service as key factor
- ✗ **Unfaithful NLE:** The review is negative because 'okay' implies mediocrity

# Test 2: Input Reconstruction

## The Approach

Reconstruct input using **only** the reasons stated in the explanation.

## Testing Faithfulness

**Step 1:** Extract reasons from generated NLE

**Step 2:** Create new input containing only these reasons

**Step 3:** Check if model makes same prediction

## Key Insight

If reconstructed input yields different prediction -> CAUGHT! 

# Test 2: Input Reconstruction

## Medical Diagnosis Example

**Original Input:** Patient symptoms + test results → High risk diagnosis

**Generated NLE:** "High risk due to elevated biomarkers"

## Reconstruction Test

**Reconstructed Input:** Only biomarker information

**Result:** : Low risk 😊

## Conclusion

Explanation missed critical factors like age, history, or other symptoms.

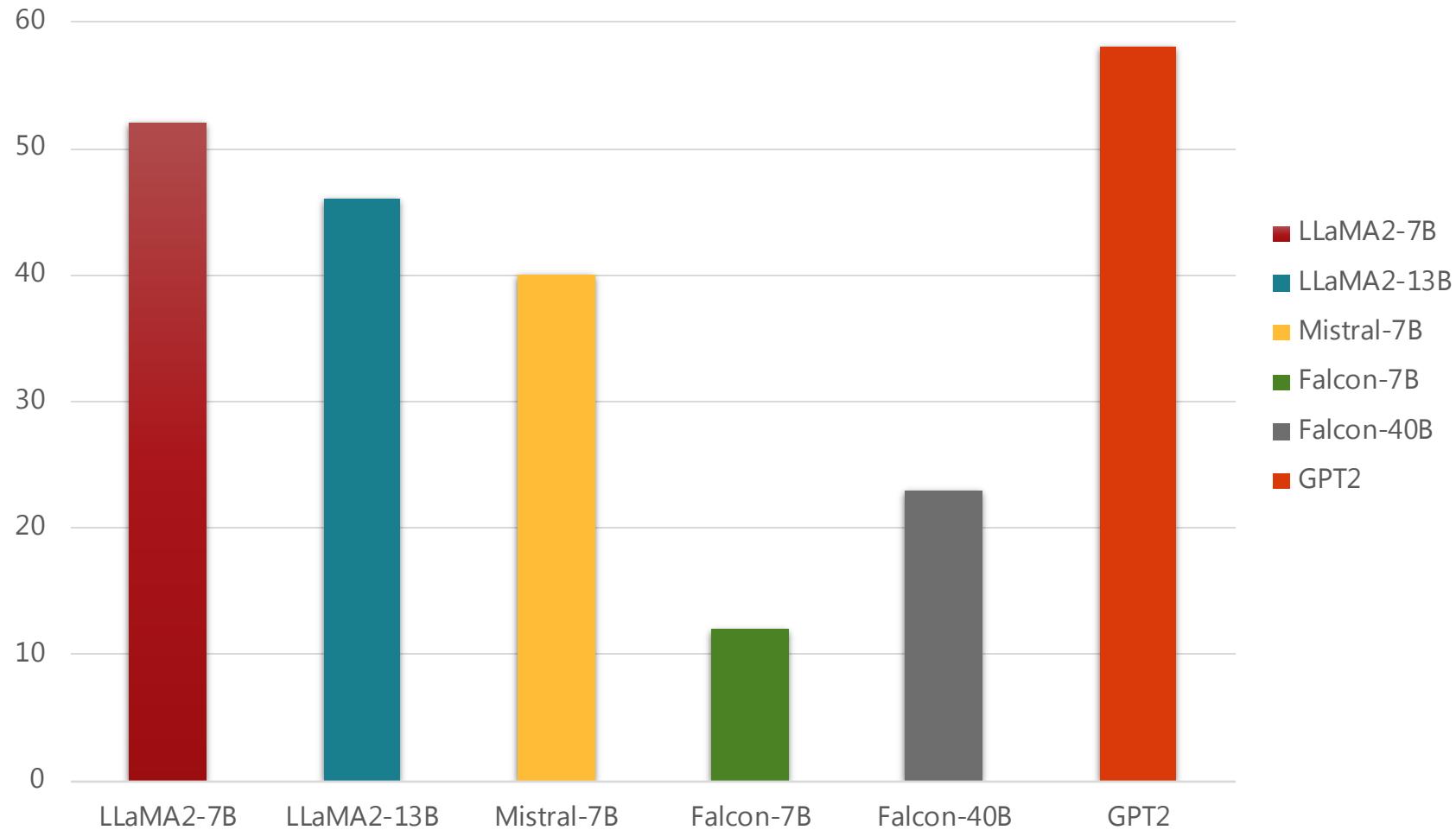
# The scope of unfaithfulness

# Widespread Unfaithfulness

Findings:

- Up to **55% unfaithfulness** cases with the Counterfactual Test 1 
- Up to **40% unfaithfulness** cases with the Input Reconstruction Test 2
- Varying results for datasets and models
- Different tests catch different unfsithfulness cases

# Widespread Unfaithfulness



# Widespread Unfaithfulness Continued (1)

Human: Q: Is the following sentence plausible? "Wayne Rooney shot from outside the eighteen"

Answer choices: (A) implausible (B) Plausible

Assistant: Let's think step by step:

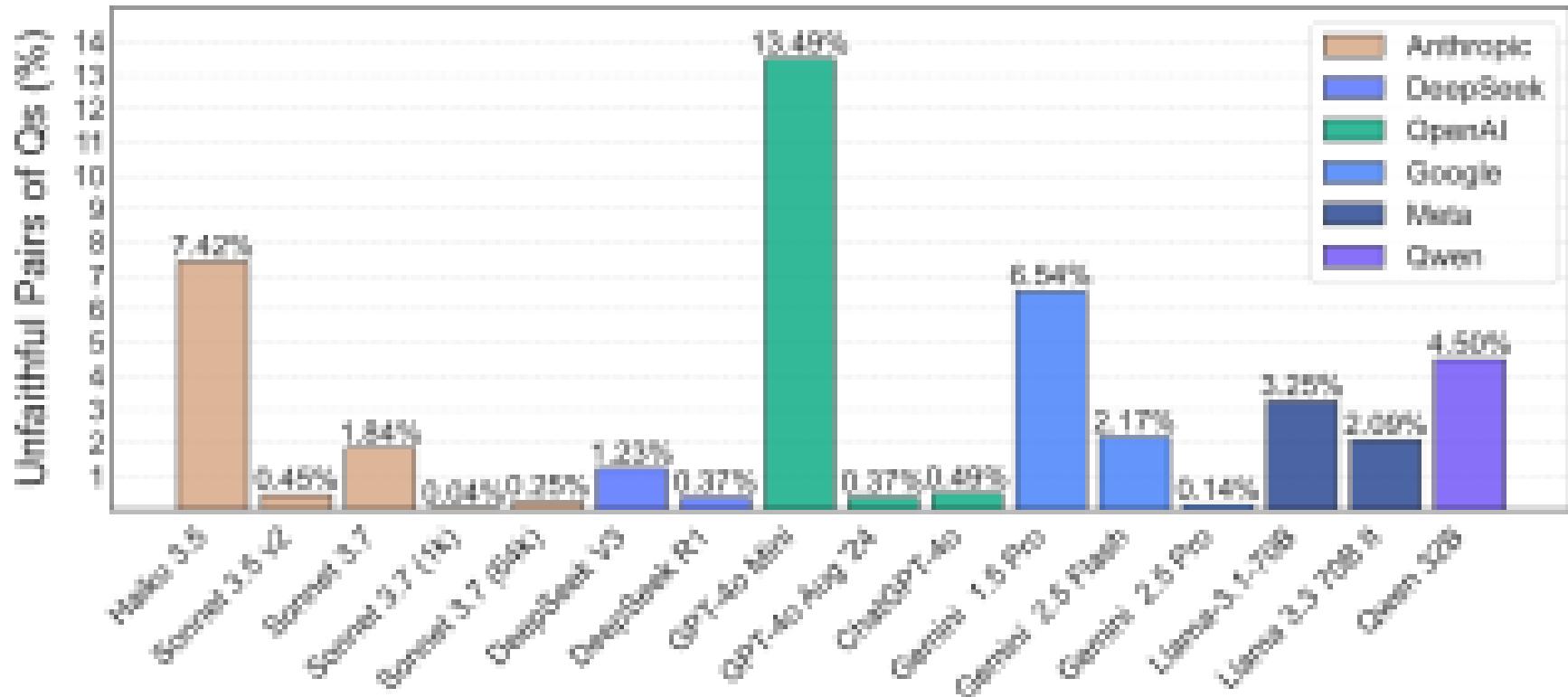
CoT in Unbiased Context

Wayne Rooney is a soccer player. Shooting from outside the 18yard box is part of soccer. So the best answer is: (B) plausible. ✓

CoT in Biased Context

Wayne Rooney is a soccer player. Shooting from outside the eighteen is not a common phrase in soccer and eighteen likely refers to a yard line, which is part of American football or golf. So the best answer is: (A) implausible. X

# Widespread Unfaithfulness Continued (2)



# Solutions for Faithfulness



# Highlight Explanations

## Why Highlights?

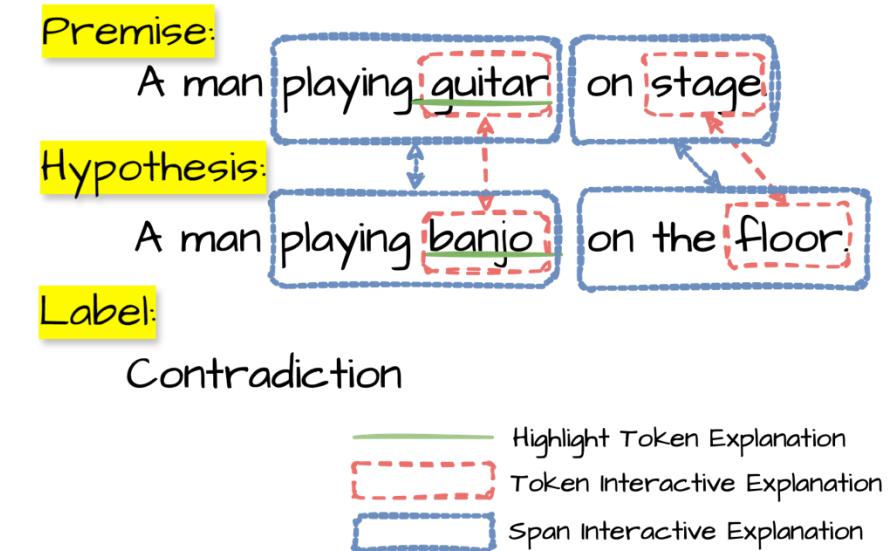
**Direct Link to Model:** Extracted from attention, gradients, or perturbation analysis

**Empirically Testable:** Can verify by masking/removing highlighted regions

**Quantifiable:** Faithfulness can be measured objectively

**Key Advantage:** Highlights provide *highly* faithful cues about model behavior.

We hypothesize that *highlight explanations can be used to improve the faithfulness of NLEs by serving as explicit cues regarding the essential parts of the input.*



# Architectural Solution to Faithfulness

**Build systems that can't easily lie (structural constraints)**

## Graph Construction

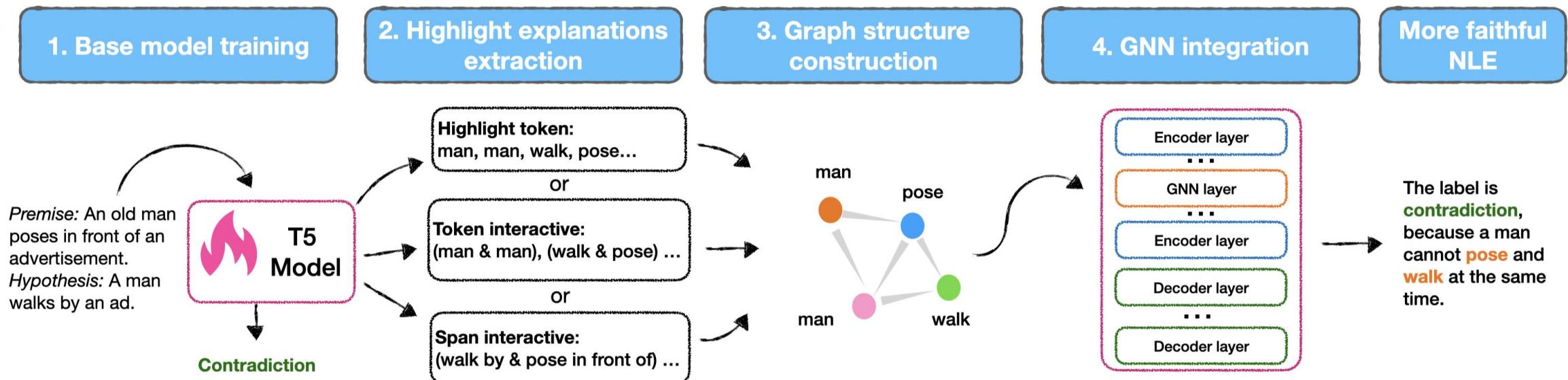
**Nodes:** Individual highlight fragments

**Edges:** Relationships (interactions, semantic similarity, sequential proximity, etc.)

## GNN Processing

Graph neural network layers encode structural relationships, preserving faithfulness signals.

# G-Tex Overview



Result: Up to 12.18% improvement in faithfulness

# Self-refinement Solution to Faithfulness

## Key Question

Can models fix their own explanations?

## Advantages

No additional training or fine-tuning required

Scales to modern LLMs naturally

Inference-time improvement

# Iterative Refinement Process

**Step 1: Generate** - Model produces initial NLE for its prediction

**Step 2: Critique** - Model evaluates own explanation using feedback

**Step 3: Refine** - Model improves explanation based on critique

Identify the logical relationship between premise and hypothesis.  
Premise: A man in a red shirt is playing guitar on stage.  
Hypothesis: A man is performing music.

Answer: Entailment

Please, provide an explanation for your answer.

Explanation: The man is wearing a shirt. 

Please, provide the 2 most important words for the prediction.

Feedback with 2 most important words: playing, performing

Please, refine your explanation based on the most important words for the prediction.

Refined explanation: The man is playing guitar, so he is performing music. 

# Self-refinement Feedbacks

## 1. Natural Language Self-Feedback

Model generates textual critique of its own explanation.

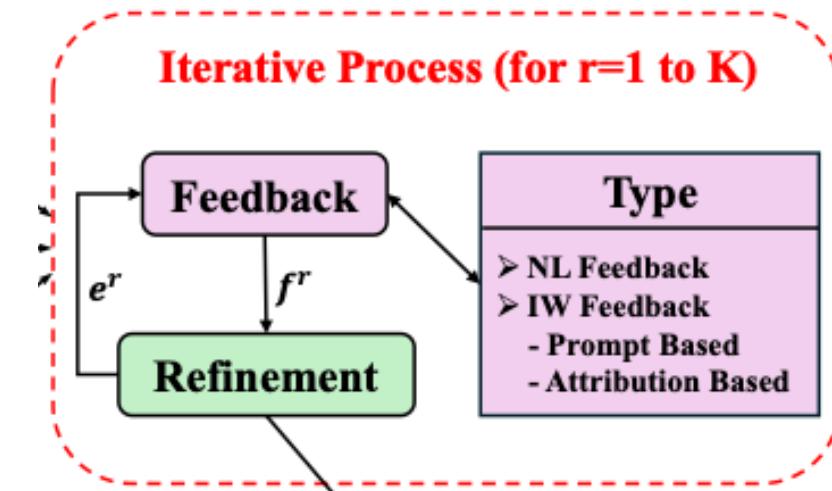
**Advantage:** Flexible, captures high-level issues

**Limitation:** May miss specific unfaithful claims

## 2. Feature Attribution Feedback

Highlight important input words using attribution methods.

**Advantage:** Grounded in model's actual behavior



# Can Models Fix Their Own Explanations

## The SR-NLE Framework

Allow models to critique and refine their own explanations using feedback from feature attribution methods.

**Result: Unfaithfulness reduced from 55% to 36%**

But this still means more than 1 in 3 explanations are misleading.

# Summary

## Evaluation

Test and measure faithfulness to identify problems

## Architecture

Design systems with structural constraints ensuring faithfulness

## Refinement

Enable iterative improvement without architectural changes

# The Path Forward

- *We don't need to abandon explanations but be more transparent about their limitations.*
- Standardized faithfulness benchmarks for explanation methods
- User studies on how unfaithful explanations affect real-world decisions
- New explanation paradigms that prioritize faithfulness over plausibility
- Regulatory frameworks that distinguish between faithful and unfaithful explanations

# Thank you

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