Conversational Speech Reveals Structural Robustness Failures in LLMs

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Introduction

SpeechLLMs have **surged** in popularity for voice assistants, meeting transcription, and multimodal systems. Yet they train on **text** that **rarely** contains conversational disfluencies.

DRES: A Framework for Measuring Structural Robustness

✅ Observable L_θ behavior, hence we can measure **robustness** to linguistic structure:

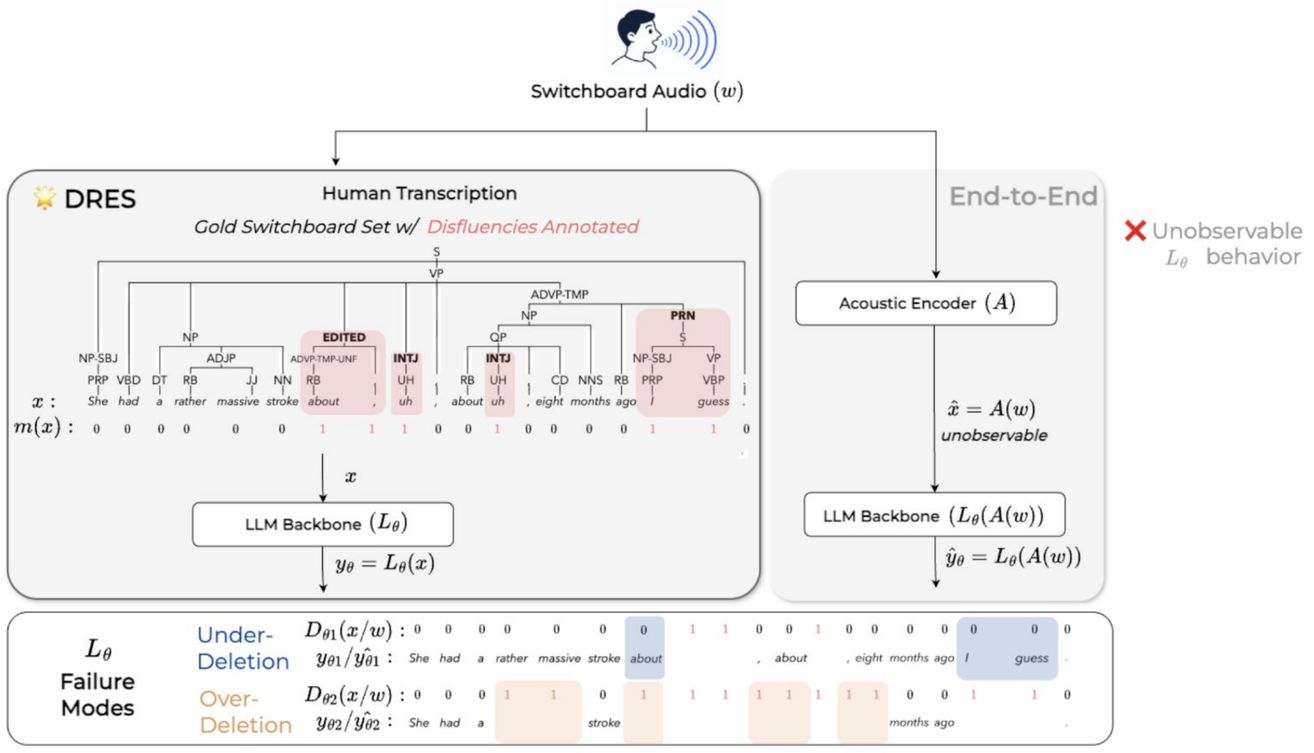
$$R_\theta(x) = R(D_\theta(x), m(x))$$

in terms of under- and over-deletion **failure modes** using

$$R_\theta(x) = R(D_\theta(x), m(x)) = \{\mathcal{E}_P, \mathcal{E}_R\}(D_\theta(x), m(x))$$

with category-specific **failure modes** exposed using

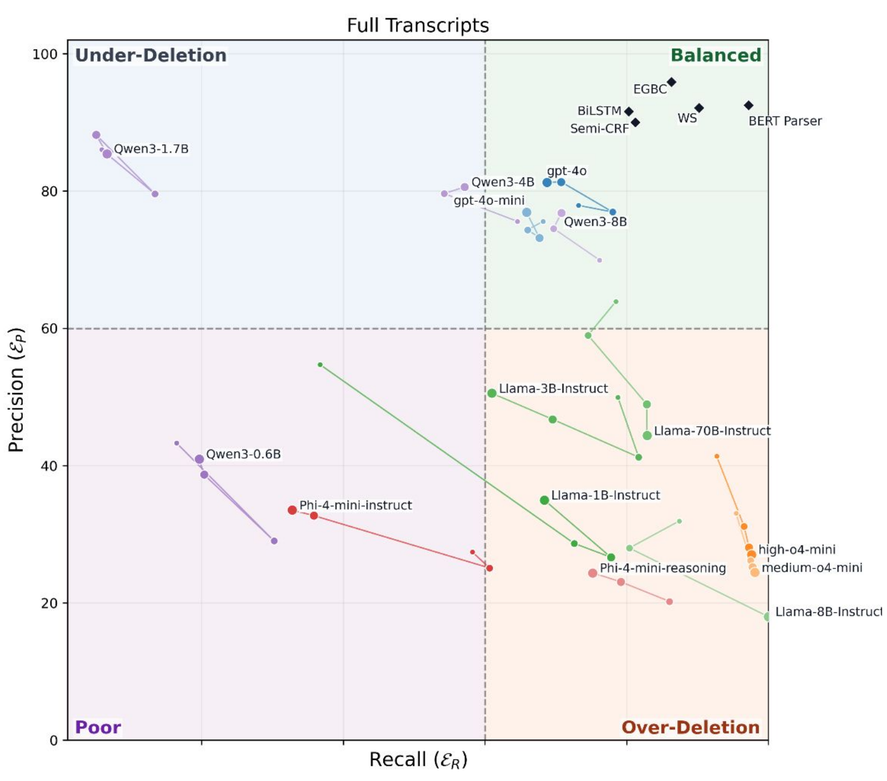
$$R_\theta(x) = R(D_\theta(x), m(x)) = \{\mathcal{Z}_E, \mathcal{Z}_I, \mathcal{Z}_P\}(D_\theta(x), m(x))$$

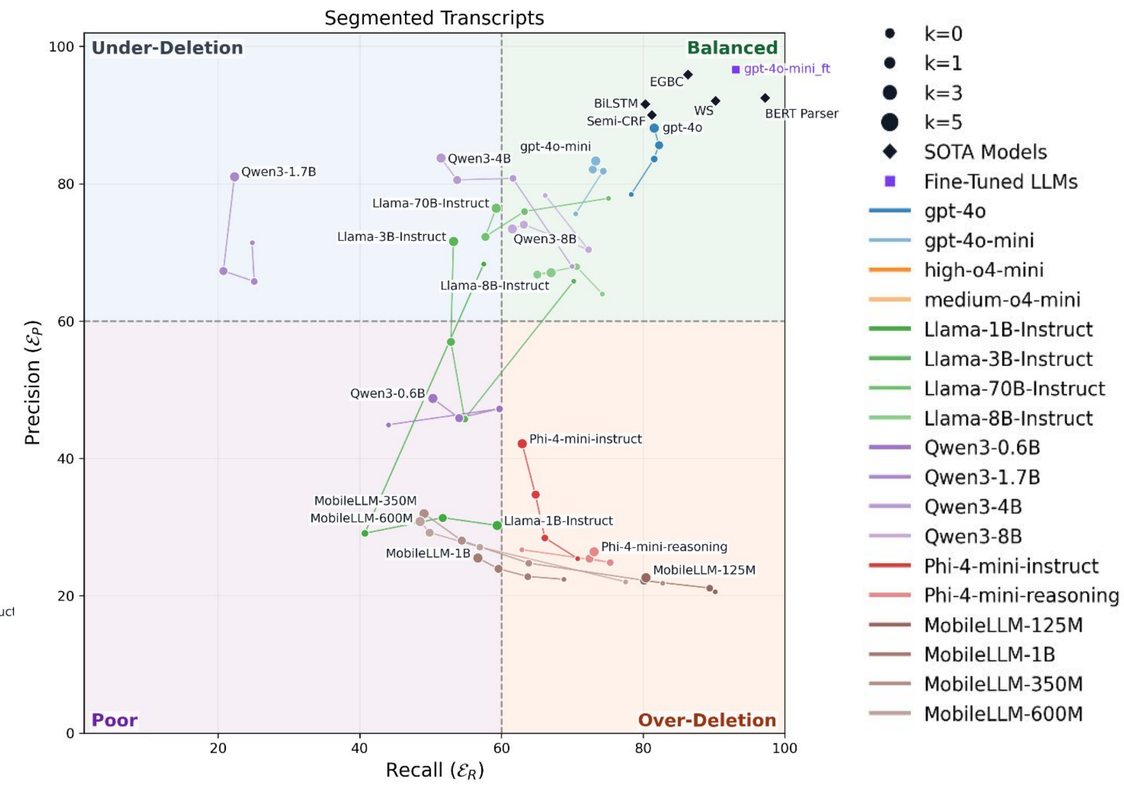


Editing Policy in Precision–Recall Space

Under-Deletion | Balanced | Poor | Over-Deletion

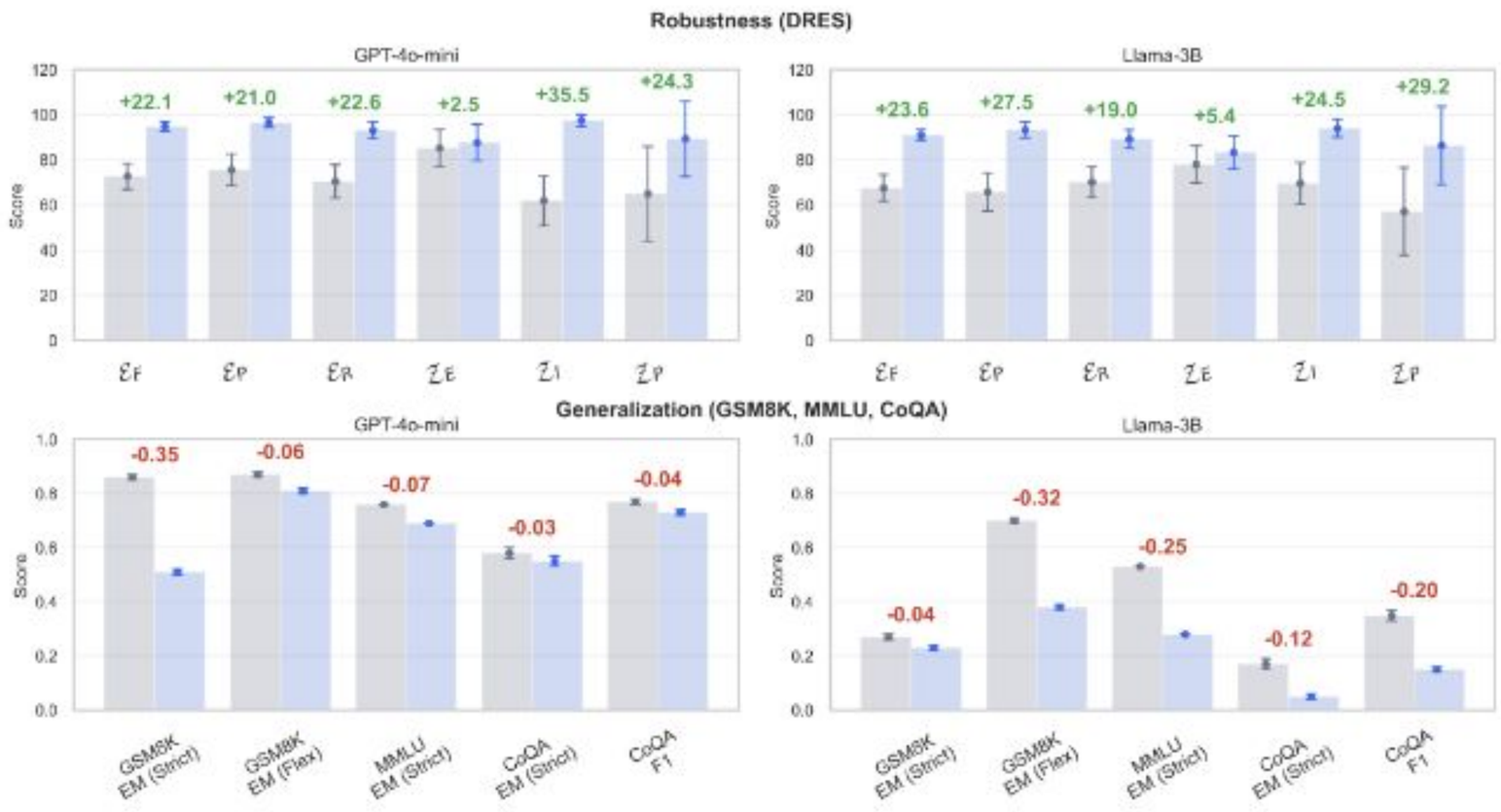
- **OpenAI's frontier GPT models have strong robustness**, following the Balanced policy
- **Reasoning models have poor robustness** (o4-mini, Phi-4 reasoning), following the Over- Deletion policy
- **Small models have poor robustness**, following the Under-Deletion / Poor policies





Robustness–Generalization Tradeoff

- **Scale improves robustness** within a model family but does NOT change the **editing policy**
- **Fine-tuning improves robustness** by +22 pts (GPT-4o mini and Llama-3B) but **degrades generalization** (GSM8K, MMLU, and CoQA)
- **Segmenting transcripts improves robustness** by +1.4 to +31.4 across all models, even those with 128k context windows



See Also →

Z-Scores: A Metric for Linguistically Assessing Disfluency Removal (Teleki, Janjur, Liu, Grabner, et al., ***ICASSP 2026***)

Powers the category-level Z-Score diagnostics used in this work.

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