How Do LLMs Understand Message Sequence Charts

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Sjouke-Fest: In the honour of Sjouke Mauw

10 April 2026

Dedicated to Sjouke:

For his **lasting contributions** to **understanding** (High-Level) **Message Sequence Charts**.

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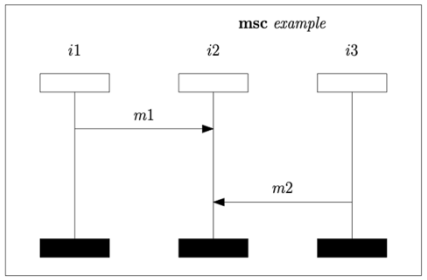
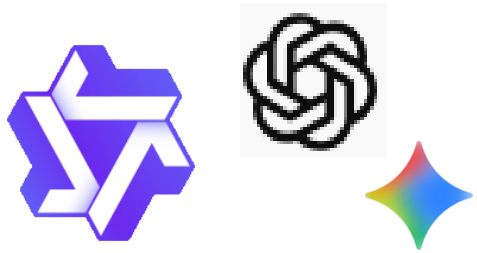


Message Sequence Charts



Assessing LLMs

Road Ahead

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The Future of Generative AI in Software Engineering

Challenges

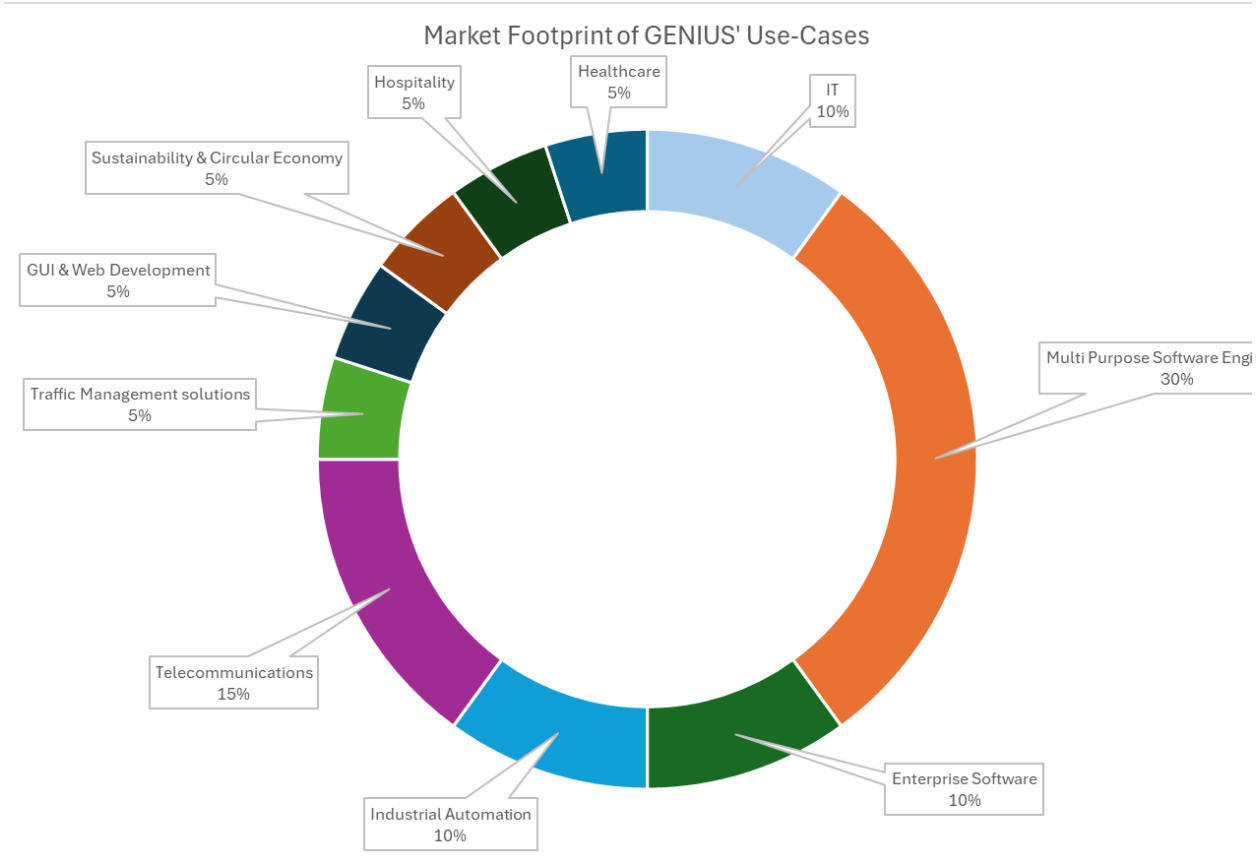
- **Hallucination** and Limited **Reasoning** and Issues with **Structured Output**:
- **Context** unawareness
- **Security** and **Privacy**
- **Bias**
- **Sustainability**
- **Disrupting** skills, roles, and practices

Vision

- Sustainable **minimalism**
- Focus on validation and **verification**
- Maturing **knowledge management**
- Extended **reasoning interfaces,** raising the **abstraction level,** enabling **architectural design**
- **Sustainability** as a first—class concern
- Training for new **roles and skills**

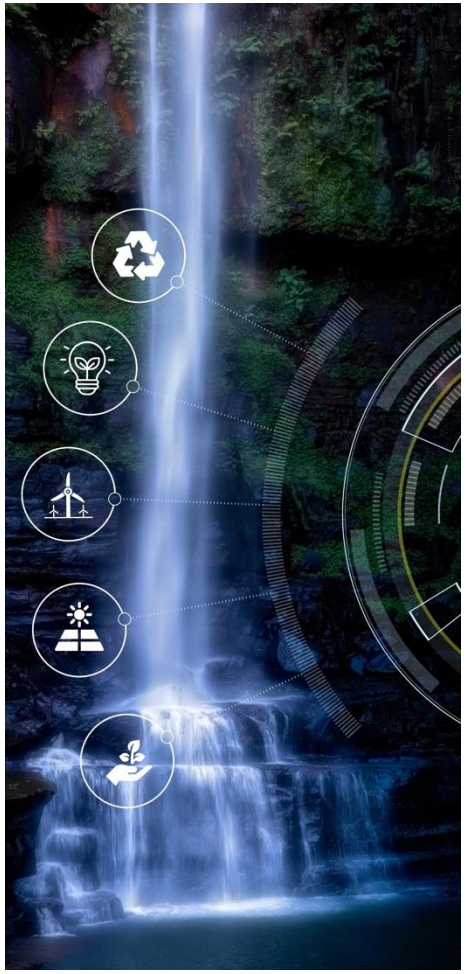
GENIUS Use Cases

- 14 industry-defined use cases to drive development and evaluate real-world applicability
- Use cases span sectors like **manufacturing**, **telecom**, **automotive**, and **healthcare**
- Iterative refinement and industrial validation of the developed GenAI tools



GENIUS Results

- Sustainability and Environmental Impact:
  - Models of environmental impact
  - Emerging patters of sustainable LLM-assisted SE



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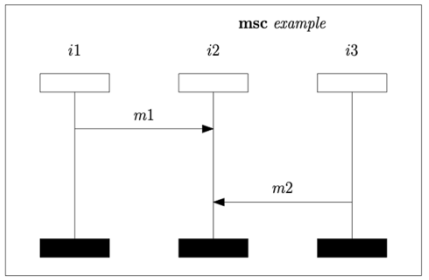


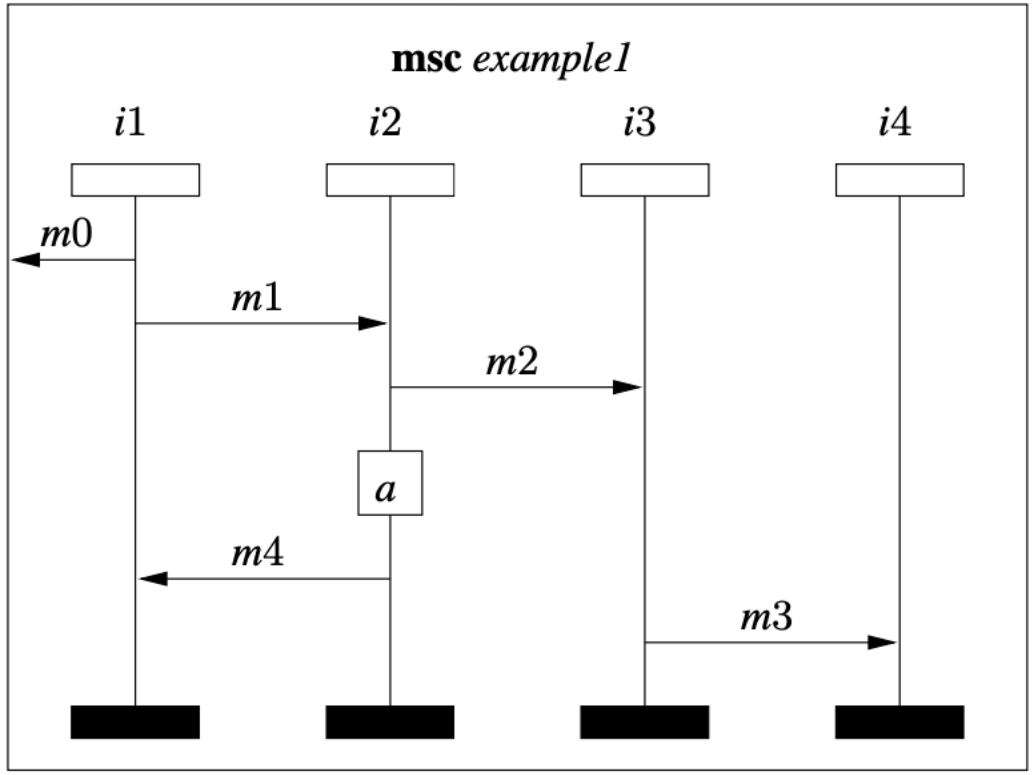
Message Sequence Charts

Assessing LLMs

Road Ahead

Basic Concepts

- Events: send, receive, and internal
- Causal ordering:
  - Send and receive order
  - Vertical order
  - Transitive closure
- Abstraction from events
- Merging instances



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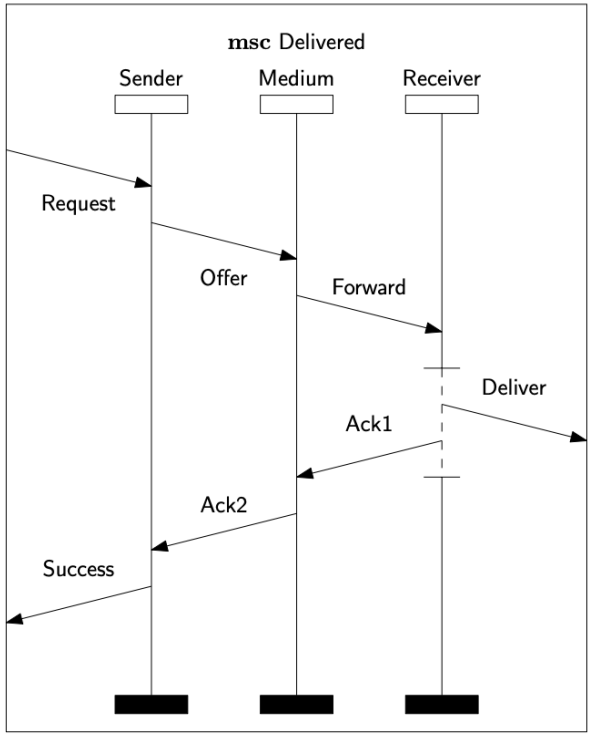
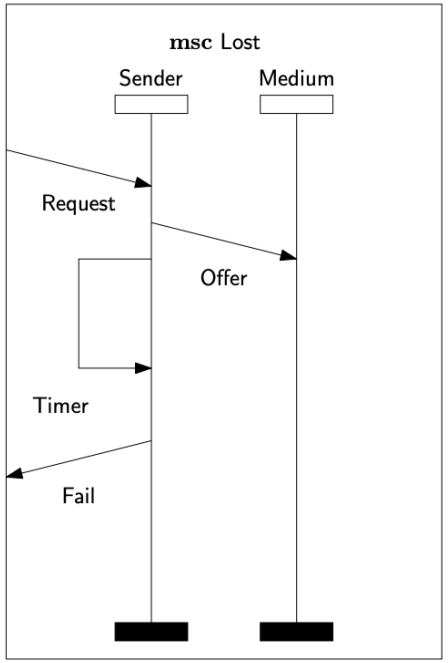
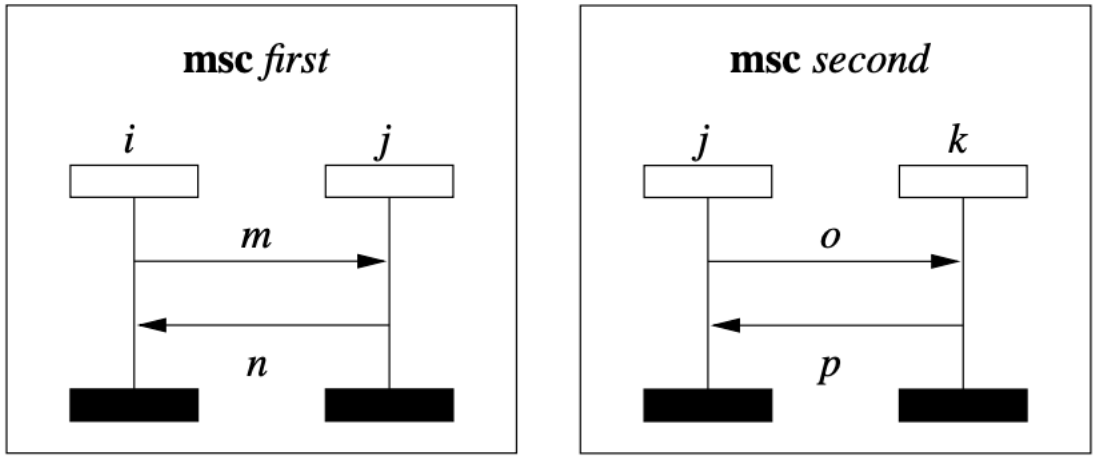




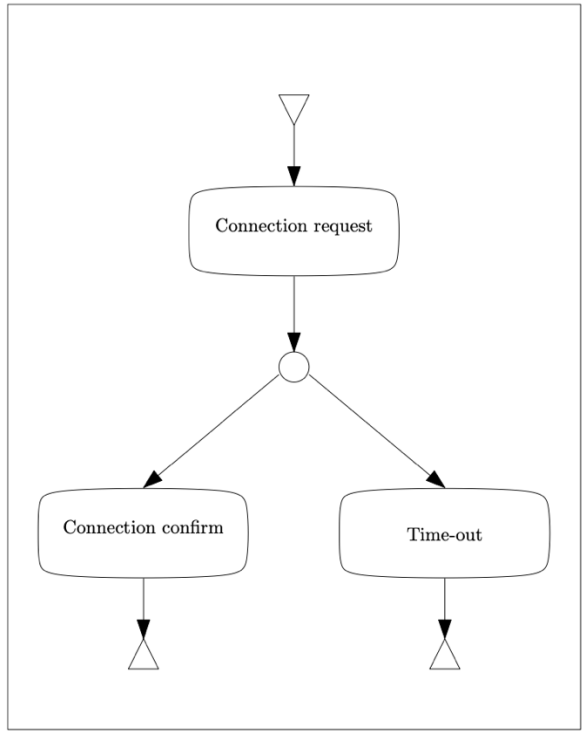
High-Level Concepts

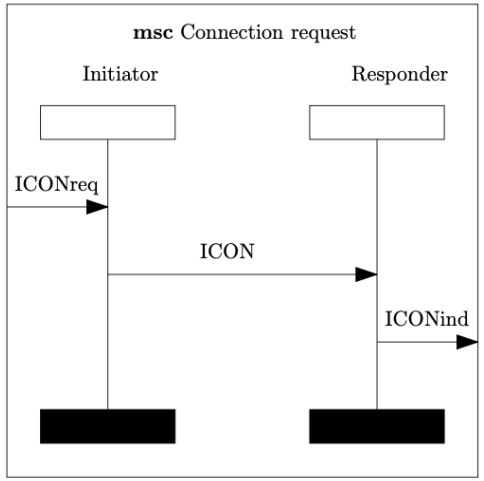
- Horizontal and Vertical Composition

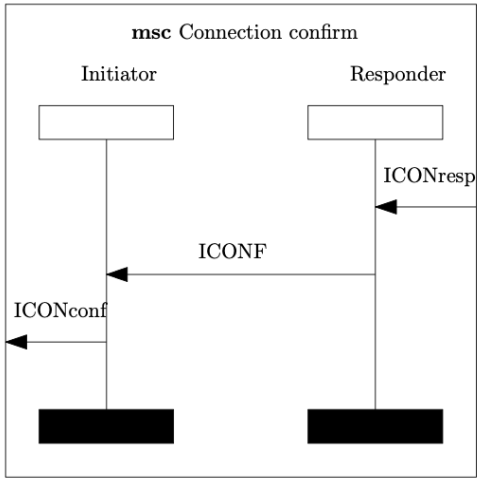


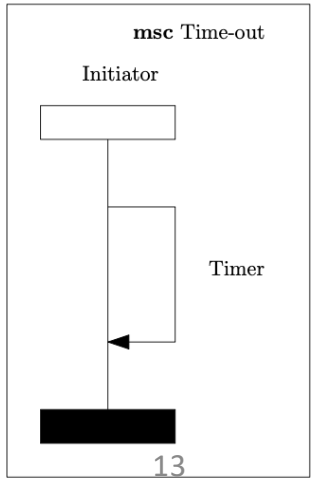
High-Level Concepts

- Horizontal and Vertical Composition
- HMSC notation and composition operators









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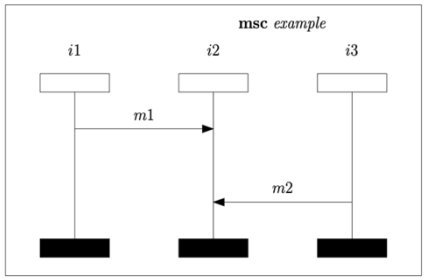
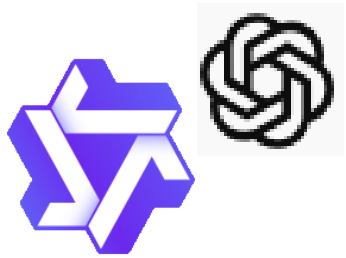


Message Sequence Charts



Assessing LLMs

Road Ahead

Methodology: Subject Models

- 13 (H)MSCs from the Software Specification Lecture Notes
- Advantages:
  - Confidence in well-formedness
  - Available solutions to exercises
- Disadvantage:
  - Possible training on unofficial copies of lecture notes

Methodology: LLMs

- Gemini-3-Pro
- GPT-5-Mini
- Qwen-3.6-Plus

Methodology: Tasks

- Identifying events

Please identify the events in this diagram.

- Causal ordering:

What is the correct ordering between sending mx and sending my?

- Abstraction from events

Based on the diagram above, please generate a message sequence chart in which message m2 is abstracted away.

What is the order between receiving mx and sending my in the resulting MSC in which mz is abstracted away.

Methodology: Tasks

- Merging instances

Please merge instance i2 and i3; produce the message sequence chart after merging.

- Identifying traces

Consider the original MSC given below. Please produce the set of all of its traces.

- Generating labelled transition systems

Please draw a labelled transition system that has the same traces as the MSC.

Results

- Overall accuracy: 52%

- Stark differences in:
  - simple- (66%) vs. complex **model** (33%)
  - simple- (94%) vs. complex **tasks** (25%)

- Models perform **equally poorly**,
  particularly in **abstraction**, **composition,** and **interleaving**

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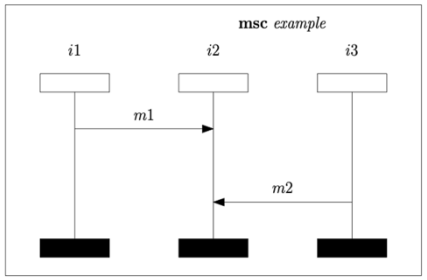

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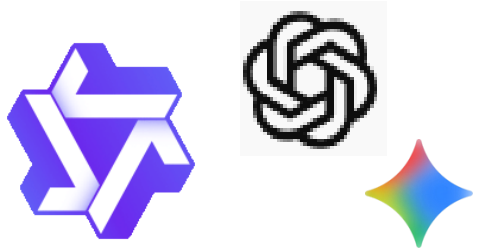

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Road Ahead

Conclusions

- LLMs “understand” the foundations of MSCs: events, causal ordering
- They struggle with
  - understanding abstraction, composition, and concurrency
  - struggle with basic maths (not all)!
- Trend in using code generation

Future steps

- Formulating concrete hypotheses about "**pain patterns**"
- Generating examples of such patterns
- More extensive experiments, more rigorous **hypotheses testing**

Scan for current results. Work in progress, being updated.

Also see: [S. Ouyang et al. Benchmarking and Evaluating VLMs for Software Architecture Diagram Understanding, arXiv, 2026.]

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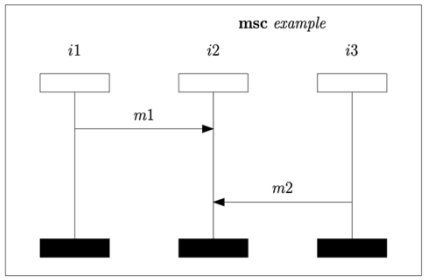

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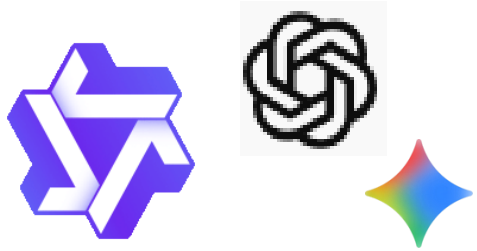

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