International Council on Systems Engineering
A better world through a systems approach

AI Overview and Caveats for the SE

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Agenda

- Why you should come up to speed on AI
- AI today
- AI in the SE Life Cycle
- AI Caveats for the SE & Robotaxis
- Experiment:
  - 3 SE questions for 3 AI models
- Recommendations

AI Caveats for the SE

AI Caveats for the SE_1

#1. **AI IS NOT PRIVATE. They now own what you input.**

2. **Quality** and **Ethics** Issues (Trust, understandability, testability, safety, user skills)
3. **Data** Issues (Bias, standards, hygiene, drift, poisoning, availability)
4. **AI Adoption** issues (Misinformation, military issues, prematurity of adoption, changing roles)
5. **Other** (Metrics, causality, keeping track of learning, discontinuous outputs)
6. **Robotaxi** issues: next

More information and citations for each of these can be found in paper

AI Caveats: Robotaxis

Image Credit: Motor Trend Dec 10, 2024

Robotaxi caveats

1) Piloted in San Francisco and other areas, 2023 and 2024, included critically injuring a pedestrian hit by another car
2) Implementing technology faster than it was understood
3) Bandwidth limitations not predicted or understood
4) Human behavior not accounted for (anti-stakeholders)
5) System failed to deal with emergency vehicles

Lessons: Pilot slowly? Safety first? Anti-stakeholders count?

Experiment

Experiment

For 3 AI models:

- **ChatGPT**
- **Claude**
- **Perplexity**

Ask 3 SE-related questions and compare answers

Experiment: Ask 3 SE Questions

1. How should I encourage my team to start using AI? (**Mgmt**)
3. In what types of situations would it be best for a) AI to *supervise* humans vs b) AI *partner with* humans vs c) *Humans supervise* AI? (**SE-AI**)
2. What are the most likely *reasons for a satellite anomaly* where there is downlink communications frequency mixed into the uplink communications frequency? (**Tech**) (Actual anomaly, known answer)

Experiment: Results: Q1 (mgmt)

How should I encourage my team to start using AI?

Question 1: *Content was **equivalent*** for all 3 models

ChatGPT 1 page. 10 bullets plus header and footer statements

Claude: ½ page. 5 active statements with 2-3 bullets each; the sum followed by a question whether the user would like elaboration on any. Follow-up requested was ¾ page total, then another elaboration question.

Perplexity: 2 pages. 6 headlined paragraphs, each consisting of a topic and 3 bullets, followed by a summary as to why a manager would want to do this, and an outline of a report one could write on the growing importance of AI for organizations

Experiment: Results: Q3 (SE-AI)

In what types of situations would it be best for a) AI to *supervise* humans vs b) AI *partner with* humans vs c) *Humans supervise* AI?

Question 3: *Content was fairly equivalent* for all 3 models

ChatGPT 3/4 page, 3 bullets each, gave examples plus summary

Claude: 1 page. Complimented nuance of question. Gave characteristics and examples (**better than ChatGPT**). Asked if elaboration is desired.

Perplexity: 1.5 pp. 3 headlined paragraphs for each sub-question, full sentences. **Better than ChatGPT**, more subtle with characteristics of situations and examples.

Experiment: The Results: Q2 (technical)$_1$

What are the most likely *reasons for a satellite anomaly* where there is downlink communications frequency mixed into the uplink communications frequency?

Results of Question 3: *Content was* ***quite different*** for all 3 models.

(Q2 **right answer**: Thermal blanket *cost improvement change* replaced *sewing together* layers of antenna thermal blankets with *stapling* them together. Intermittent metal-metal contacts caused passive intermodulation products (PIMPs) within communication bands)

Experiment: The Results: Q3 $(technical)_2$

ChatGPT 2 pp.

"Non-linearities in the satellite's transponder or communication systems can lead to intermodulation distortion, causing signals from different frequencies to mix…."

Generally right but not the specific answer. **Grade: B**

Claude: 1 pp.

"Hardware degradation, particularly in older satellites"

No, not the kind of hardware they're talking about, and it was new.

Grade: D

Perplexity: 0.5 pp.

"…Not enough frequency separation **{no}**…joint antenna malfunction, **{no}**…Transponder malfunction **{no}**… SSPA or Frequency converter issues, Solar activity or ionosphere effects**{no}**…

No, answers all wrong. **Grade: F**

Experiment: The Lesson$_1$

It does not matter what AI model I use, they're all the same.

__ True
__ False

Experiment: The Lesson$_2$

When I need AI in SE, I can just pull up ChatGPT.

__ True
__ False

Recommendations

- General
- For Practitioners
- For Managers
- For INCOSE

General Recommendations

AI is not private, confidential, or secret. The models keep whatever you enter.

Today's AI is neither yesterday's nor tomorrow's. Will you be able to redo what you've done with tomorrow's AI results?

Nothing AI tells you is the final answer. Validate it.

Practitioner Recommendations

- Just start. (Hint: reproduce experiment, then improve)
- Ask LLMs* to make your next paper or presentation for you first.** Check everything, & fix; read & cite background material, make it yours.
- Take a course or two. Programming if interested, maybe prompt engineering, maybe something broader.

*LLMs = large language models = almost all of today's AIs

** Caveat: privacy

INCOSE Recommendations

Working groups should help members by creating:

- Online guide or Wiki of AI tools and SE uses, with examples?
- Worldwide AI policies and standards, with links?
- AI Risks, concerns, and pain points survey, and results?
- Benefits & Costs of AI usage, with Business Case template?
- Create an AI LLM trained on INCOSE documents? (- Sarah Vazquez)
- Links to AI courses, with costs, and member ⭐ reviews of content?
- Links to INCOSE AI papers and presentations, with ⭐ reviews?
- Calls for collaboration on AI projects within INCOSE?
- AI that joins up WGs and technical products? (- Richard Beasley)
- What else?

AI and Ethics

INCOSE Code of Ethics says we:

Guard the public interest and protect the environment, safety, and welfare of those affected by our activities and artifacts,

Accept responsibility for our actions and engineering results

Proactively mitigate unsafe practice

Promote the understanding, implementation, and acceptance of prudent systems engineering measures

➡ ***There is a LOT to unpack here with respect to AI***

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Professional experience

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Agenda

Why you should come up to speed on AI

AI today

AI in the SE Life Cycle

AI Caveats for the SE & Robotaxis

Experiment:

3 SE questions for 3 AI models

Recommendations

AI in the SE Life Cycle

1) **Management:** AI can seek conflicts or holes in plans, missing risks, starting points for risk analysis, precursors to identified anomalies, match system design to known security vulnerabilities. AI can assess proposed changes on system performance. AI can help optimize integration sequences.

2) **SE Process Tasks:** Companies already using AI on many requirements tasks. Trade studies, safety analysis and predictive maintenance have been automated. Generation of test cases and interactive simulations have been done as well as prediction of logistics metrics, ontologies for future operations

3) **Additional Recommendations:** Use AI powered requirements management tools, SE Architecture may be slowest, Stakeholder interface management may benefit from AI as stakeholder persona, AI can help with top-down measures in governance of complex sociotechnical SoSs

(see paper for references on each)

June 2025 article* Robotaxis in Austin Tx

- Introduced Waymo via Uber March 2025 and Tesla on June 22 (with “safety driver” in passenger seat)
- 20% of Uber rides in March, and those got 4.9 ⭐
- 108 incidents reported in 2 months: One stopped under highway overpass, then refused to let passengers out for 5 minutes
  - Passing funeral procession; blocking a driveway.
- Musk claimed Tesla had begun driving *without safety driver* in May, same month Waymo recalled 1200 vehicles. A Tesla had hit and injured a student exiting a school bus in North Carolina in 2023. A Tesla also hit, stopped, then ran over child-sized dummies.
- Texas law prohibits regulation of AVs
- Much excitement, but much concern

* “Will Austin Survive the Driverless Car Revolution?” Benton Graham, Austin Chronicle, June 27, 2025

4/25 New caveat: Research Summaries

AI Chatbots summarizing scientific texts strongly tend to *overgeneralize* conclusions

- (overlooking uncertainties, limitations, nuances)

Newer models perform worse than earlier ones

To mitigate: Lower LLM temperature settings*, benchmark LLMs for generalization accuracy

(*influences randomness & creativity of model output: low T~deterministic)

Source: Peters, Uwe and Chin-Yee, Benjamin (2025). Generalization bias in LLM summarization of scientific research. *R. Soc. Open Science* **12**: 24176. https://royalsocietypublishing.org/doi/10.1098/rsos.241776#

AI Caveats for the SE_2

2. Quality and **Ethics** Issues (Trust, understandability, testability, safety, user skills)

- Trust: Hallucinations, broken interfaces to AI part: AI OUTPUT MUST BE REVIEWED! (ChatGPT gave me an imaginary coauthor, then confirmed it!)
- Understandability (slow, Cert, cal) <--> Features (fast)
- SE Responsibility: Reliability, Robustness, Safety
- Updated Roles paper (Today 10 am) has a new role: AI Chief

GMU professor: "[Today's AI] is a psychopath and is very confident about the mistakes it makes... Good old-fashioned SE is missing" and "Generative AI should NEVER be used in safety-critical systems" (Cummings, 2024)

AI Caveats for the SE_3

3. **Data** Issues (Bias, standards, hygiene, drift, poisoning, availability)
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