

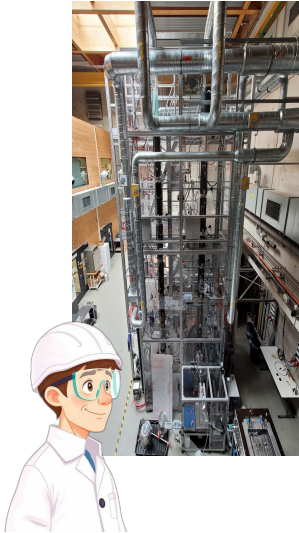
Verification of LTL Properties on Neural Networks for Chemical Process Monitoring

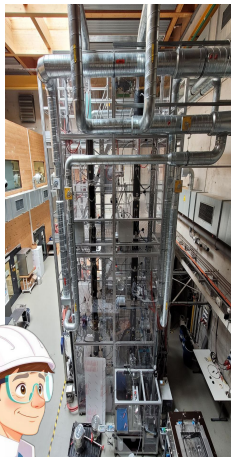
Julien Girard-Satabin **Simon Lutz** Daniel Neider



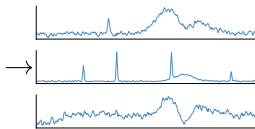
Symposium on AI Verification
25.07.2026

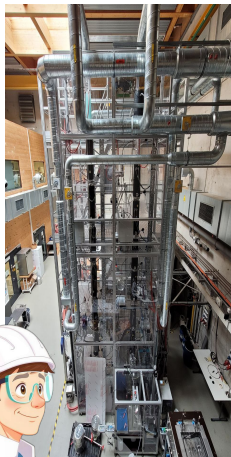




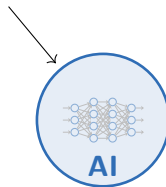
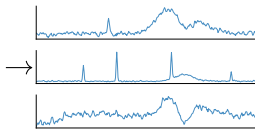


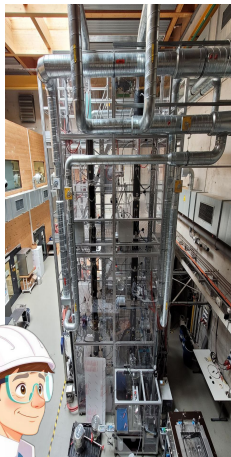
Time Series Data



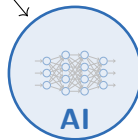
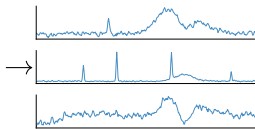


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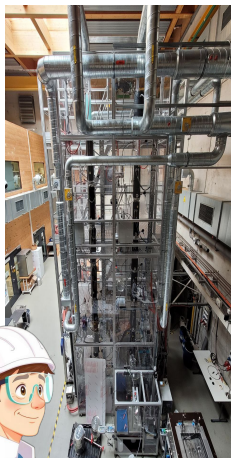




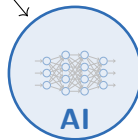
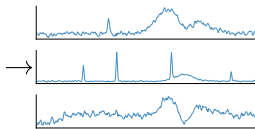
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Safe?

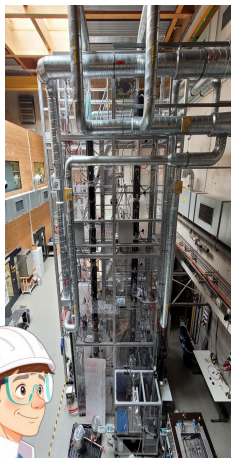


Time Series Data

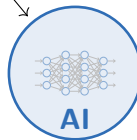
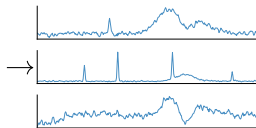


NeuralSAT





Time Series Data



Temporal Properties

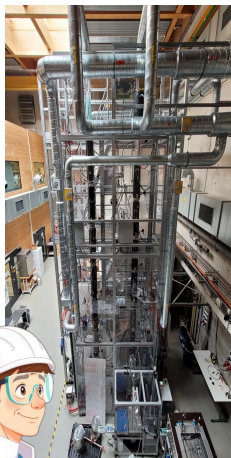
$$\varphi_1 \equiv \mathbf{G}(x_p \leq 1100)$$

$$\varphi_2 \equiv \mathbf{F}(x_t > 600) \rightarrow y_0 < y_1$$

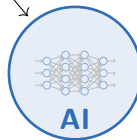
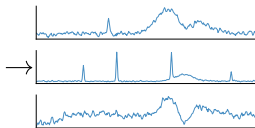


NeuralSAT





Time Series Data



Temporal Properties

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Focus on Adversarial
Robustness and
single point in time



NeuralSAT



- ▶ We introduce a framework for specifying temporal properties and take a first step toward verifying them

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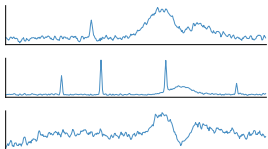


C A I S A R

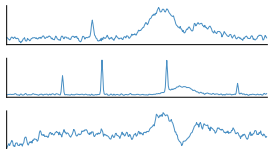
- ▶ We introduce a framework for specifying temporal properties and take a first step toward verifying them
- ▶ We extend the specification language of CAISAR to support specifications over multivariate time series data
- ▶ CAISAR:
 - ▶ open-source platform,
 - ▶ powerful specification language (build upon WhyML), and
 - ▶ unified entry point for verification tools



Multivariate Time Series



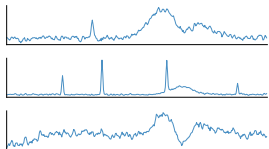
Multivariate Time Series



Temporal Correctness Properties

- Specification Logic combines Linear Temporal Logic (LTL) & Linear Real Arithmetic (LRA)

Multivariate Time Series

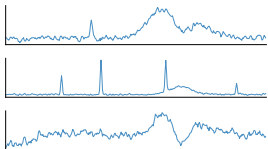


- ▶ Custom *Matrix* Theory
- ▶ Row: time-step
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Temporal Correctness Properties

- ▶ Specification Logic combines Linear Temporal Logic (LTL) & Linear Real Arithmetic (LRA)



- ▶ Extend CAISAR to support temporal operators over matrices
- ▶ Provides an intuitive way to write temporal properties

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- ▶ Our results show that it is possible to verify temporal properties in this way but also that dedicated tooling for networks over sequences is required in the future