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Towards Auditable Automotive AI Systems

Arndt von Twickel, Christian Berghoff, Matthias Neu and Markus Ullmann
Federal Office for Information Security (BSI), DI 11

Presentation for the MWC 2021

The BSI – the national cyber security authority

BSI as the Federal Cyber Security Authority shapes information security in digitalization through prevention, detection and reaction for government, business and society

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Responsibilities of the BSI in the Context of AI

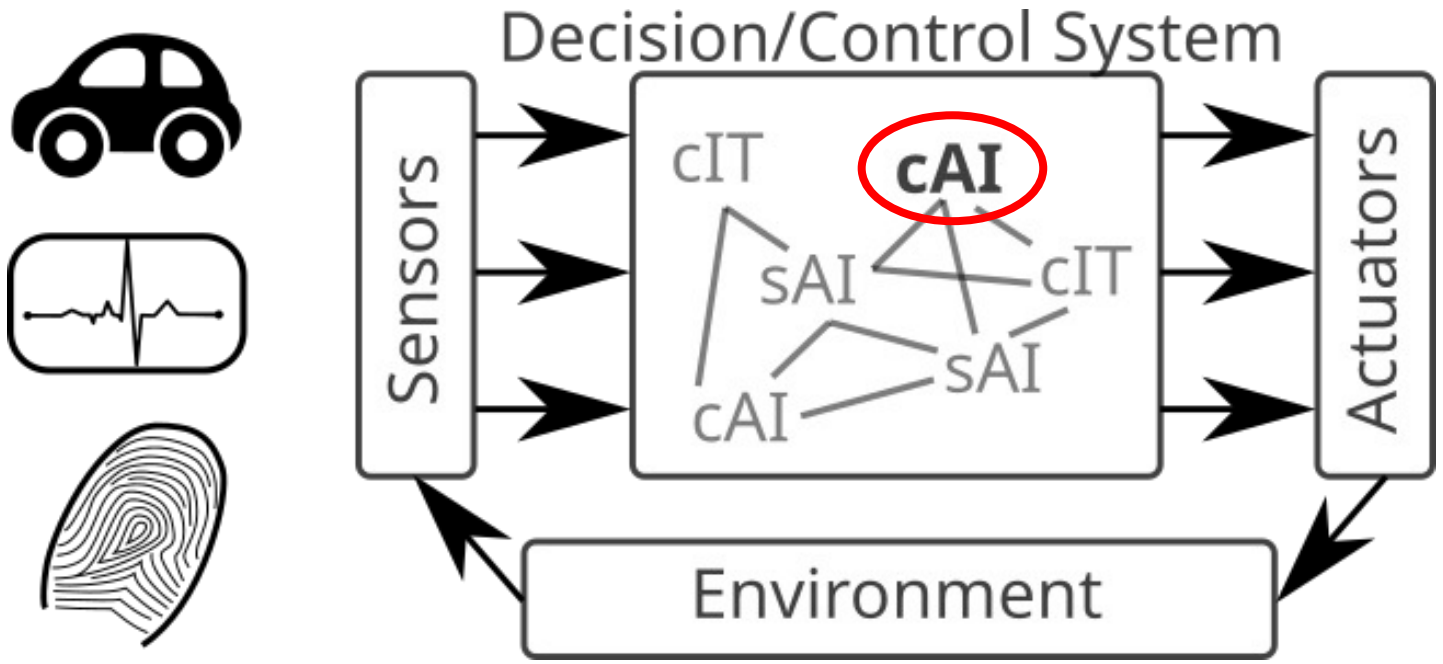
1) Vulnerabilities of AI systems
   - Evaluation of existing and development of new evaluation and protection methods
   - Development of technical guidelines and standards

2) AI as a tool to defend IT systems
   - Recommendations of existing and development of new technologies, guidelines for their deployment and operation

3) AI as a tool to attack IT systems
   - How can one protect IT system from qualitatively new AI based attacks?

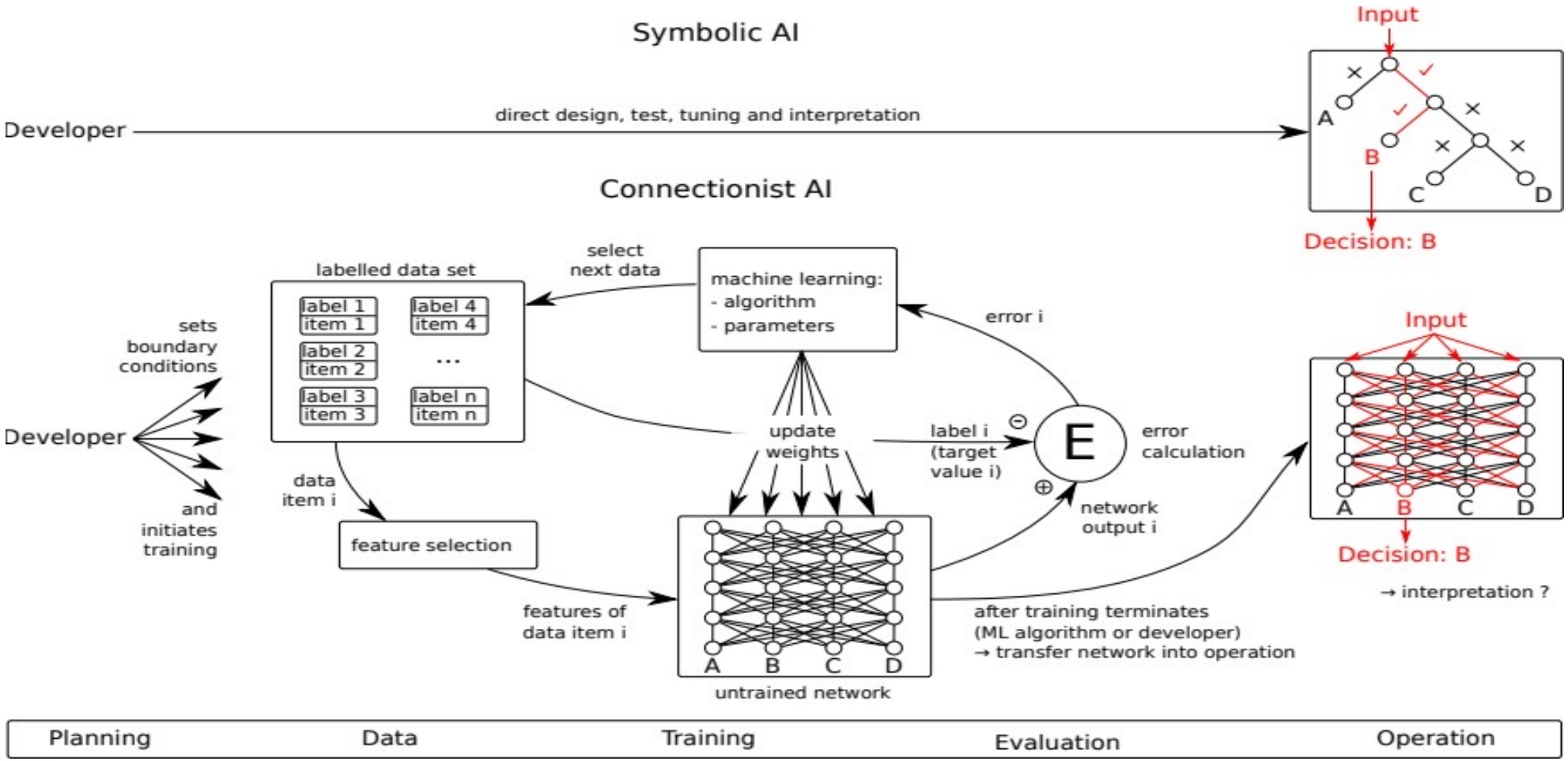
Life-cycle of Connectionist AI Systems

AI Systems are Connected and Embedded in Safety and Security-Critical Applications



cIT ^= clasiscal IT
- sAI ^= symbolic AI
- cAI ^= connectionist AI

Connectionist AI Differs Qualitatively From Symbolic AI and Classical IT



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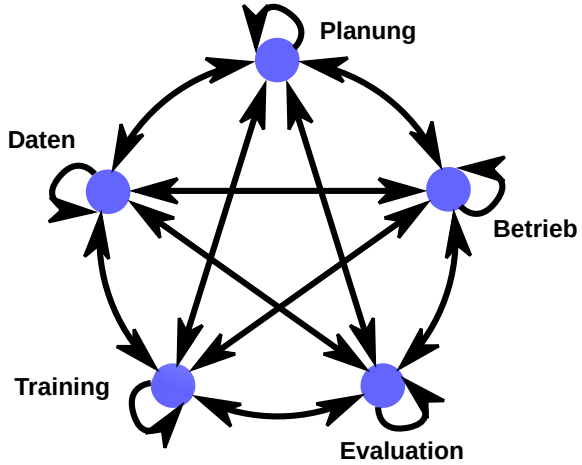
Connectionist AI has Specific and Qualitatively new Problems

- input and state spaces are huge
- black-box properties
- dependency on training data

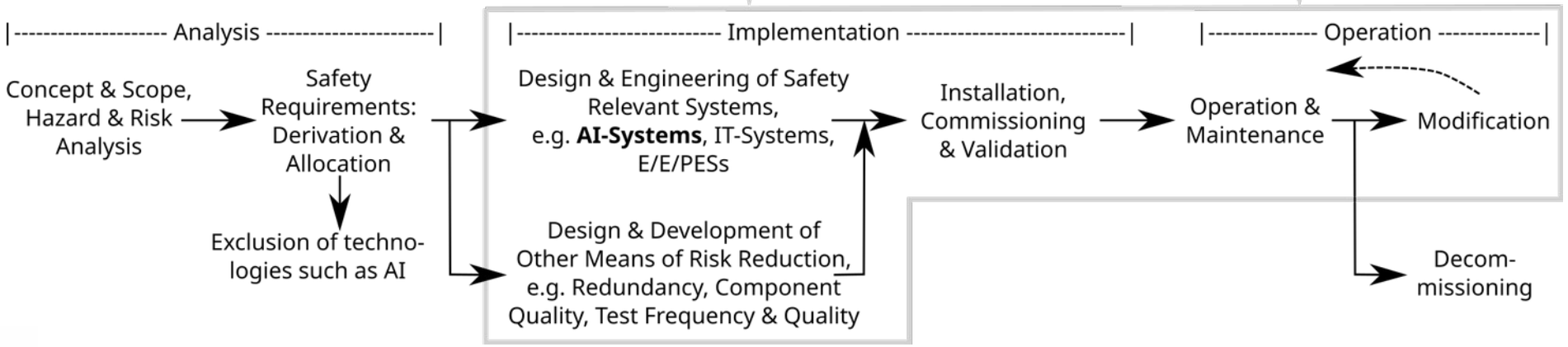
--> whole process chain / life cycle has to be considered

Embedding of a cAI Life Cycle Into a Functional Safety Life Cycle

cAI Life-Cycle

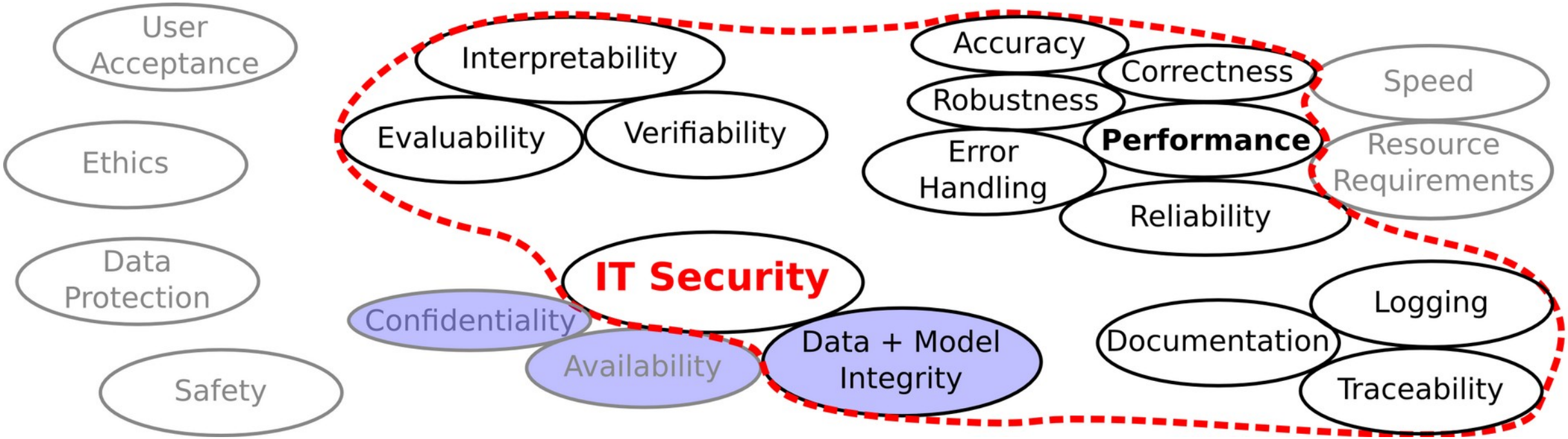


Embedding of a Safety Relevant cAI-System Life Cycle into a Functional Safety Life Cycle



Functional Safety Life-Cycle

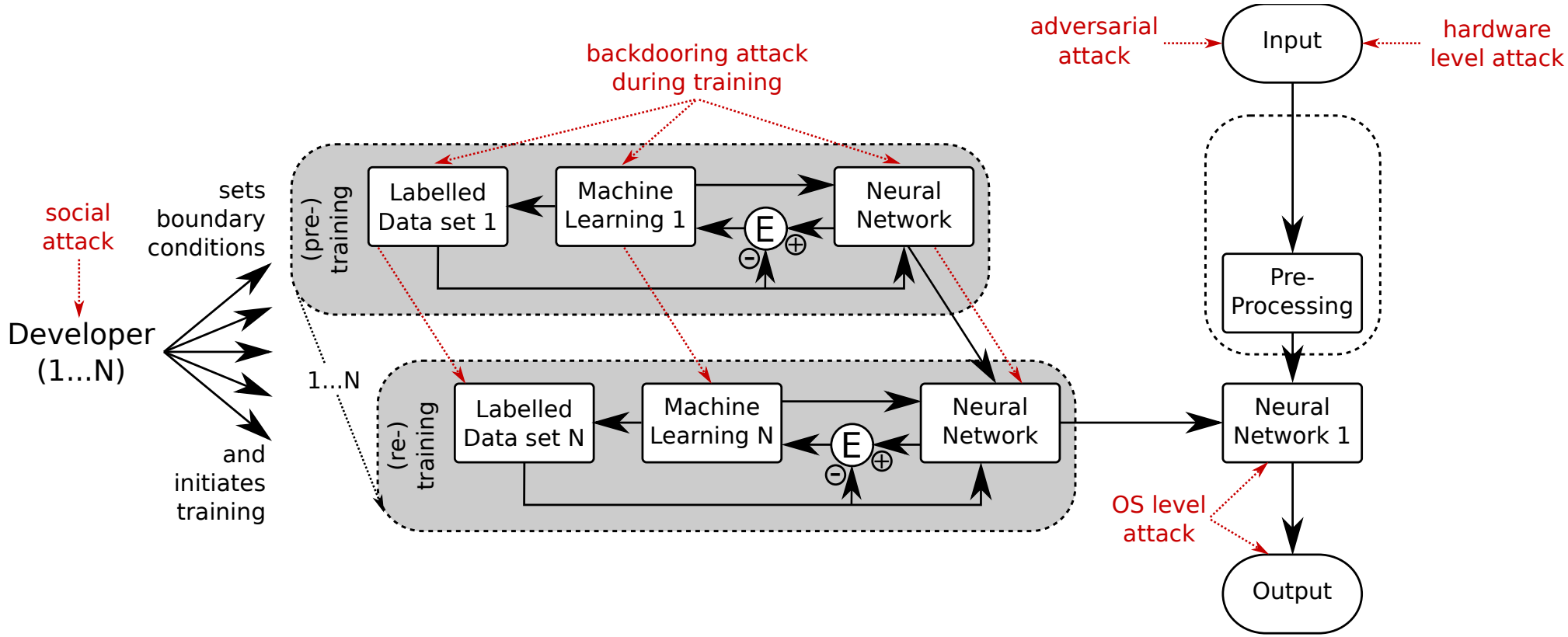
Multiple Aspects Have to be Considered for Securing AI Systems



Vulnerabilities of cAI Systems

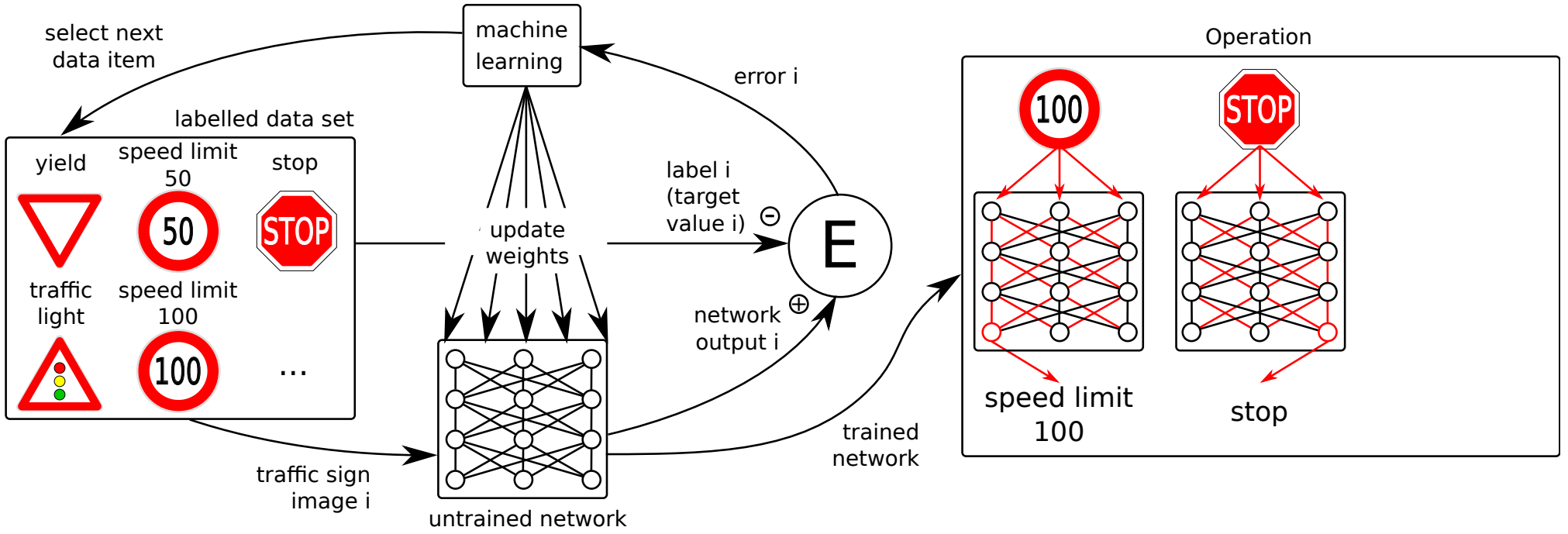
Berghoff C, Neu M and von Twickel A (2020):
Vulnerabilities of Connectionist AI Applications: Evaluation and Defense.
Front. Big Data 3:23

Connectionist AI Process Chain: Attack Vectors

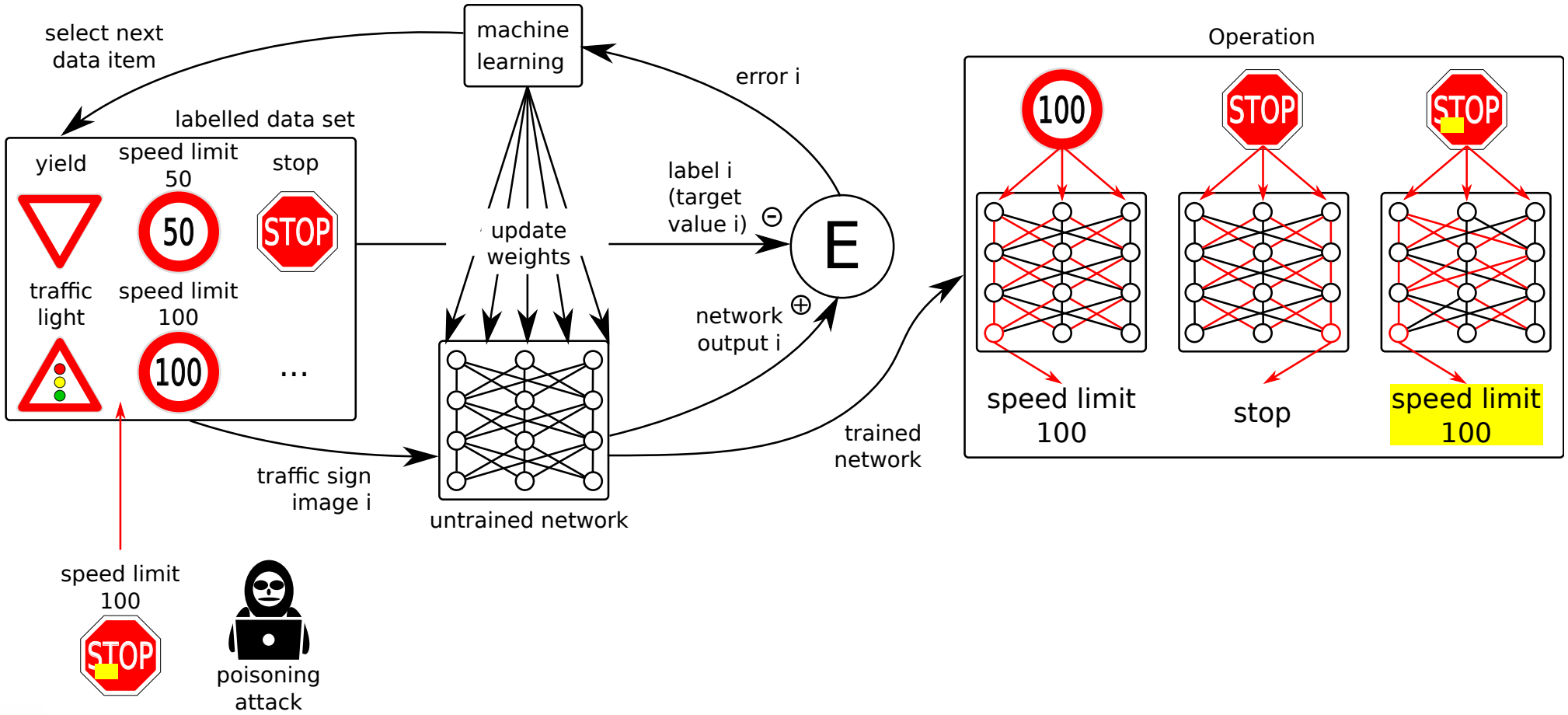


AI-Specific Attack on Road Sign Classification Systems
A) Poisoning Backdoor Attacks

Poisoning-Attack (schematic)

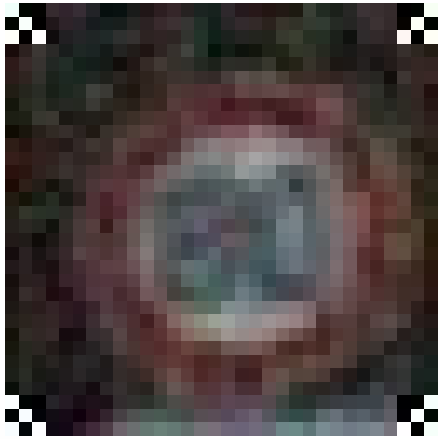


Poisoning-Attack (schematic)

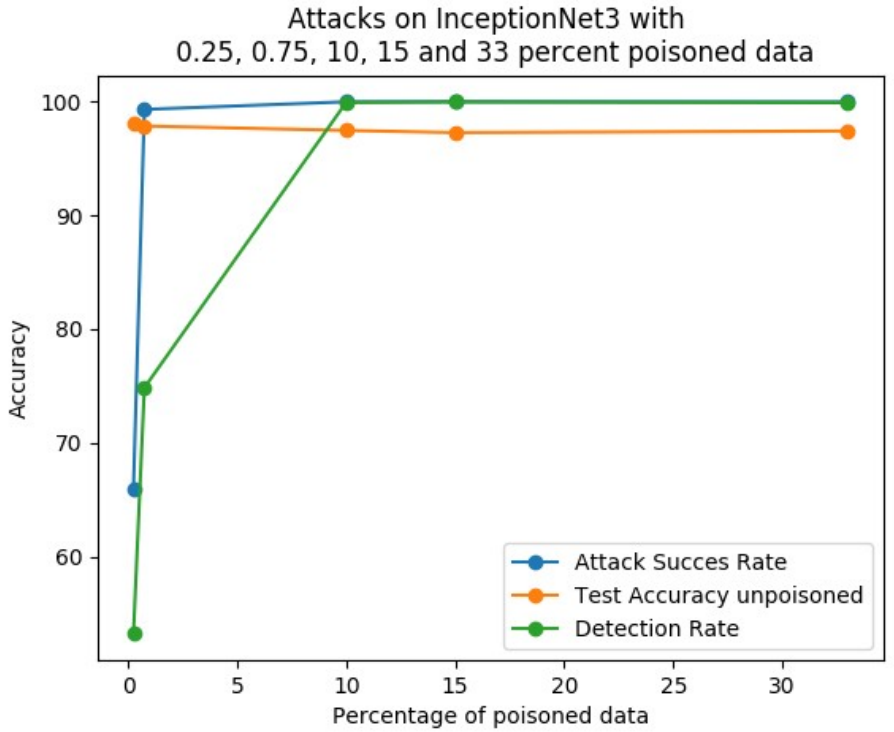


Poisoning-Attack (hands on)

Attack A:
50 km/h sign
+ yellow sticker
Label: 80 km/h



Attack B:
Arbitrary sign
+ 4 s/w stickers
Label: 80 km/h



- --> Attack with 98% accuracy on InceptionNet3

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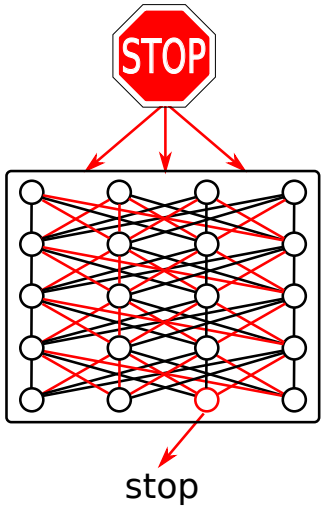
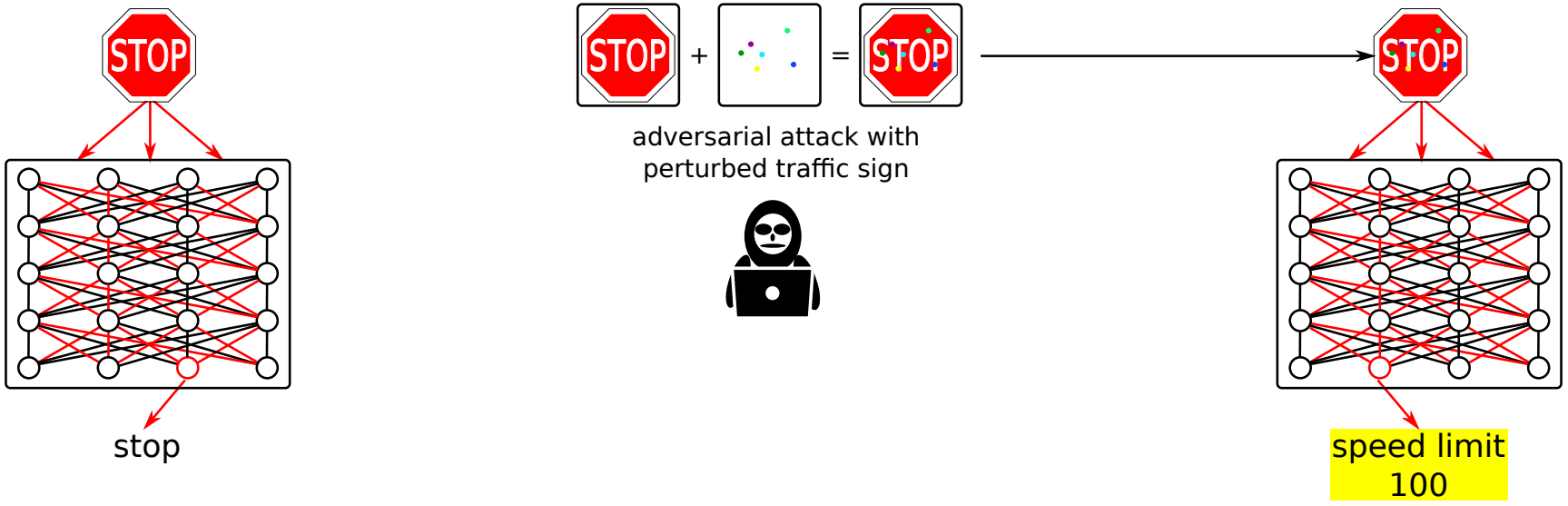
AI-Specific Attacks on Road Sign Classification Systems
B) Adversarial Attacks

Adversarial Attack

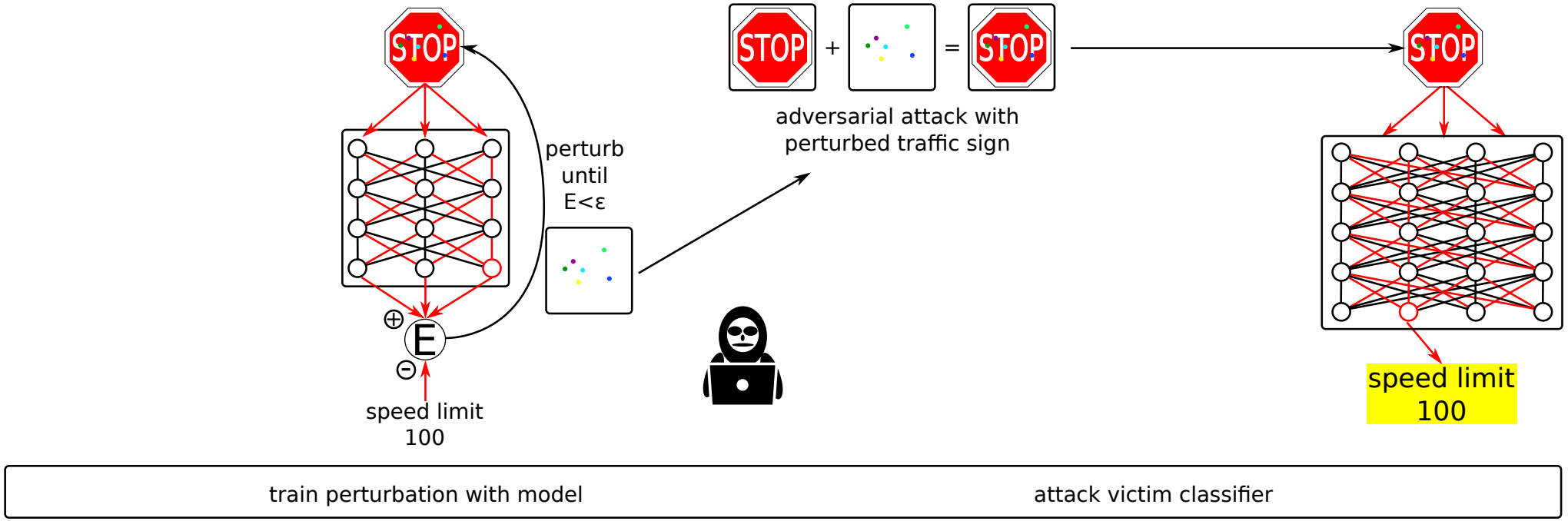


standard operation

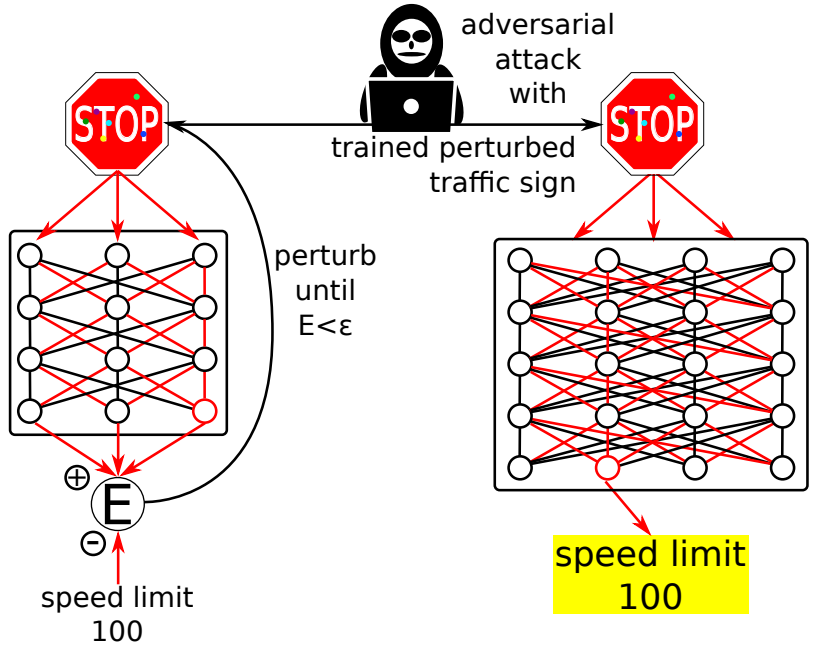
Adversarial Attack



Adversarial Attack

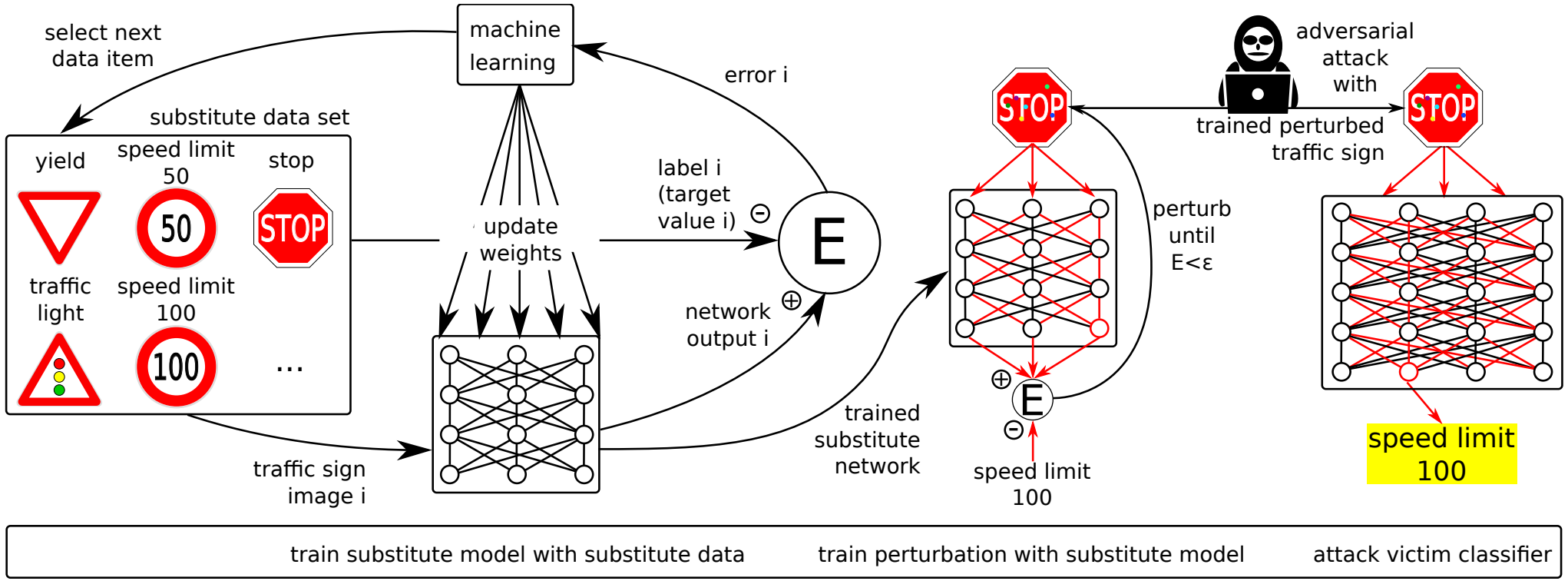


Adversarial Attack

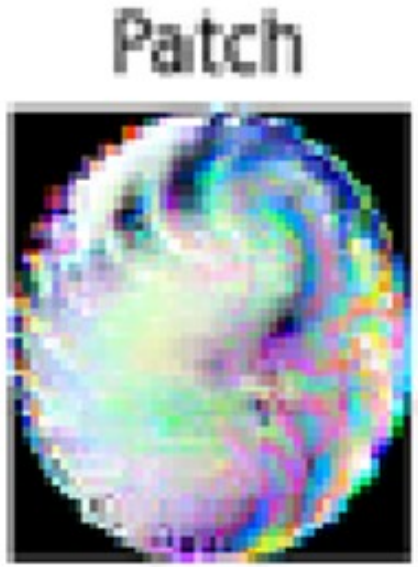


train perturbation with (substitute) model | attack victim classifier

Adversarial Attack

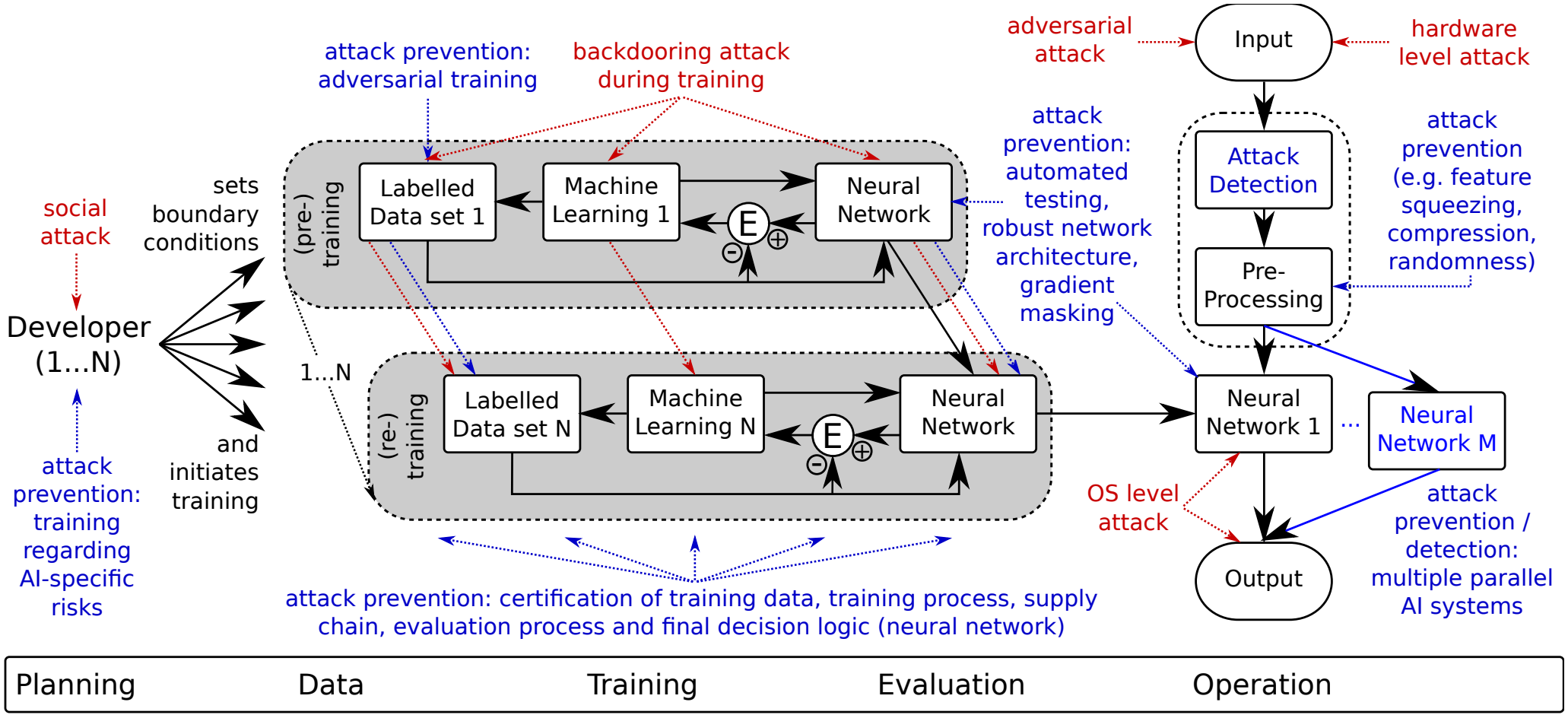


Adversarial Attack Examples



Measures of Defense

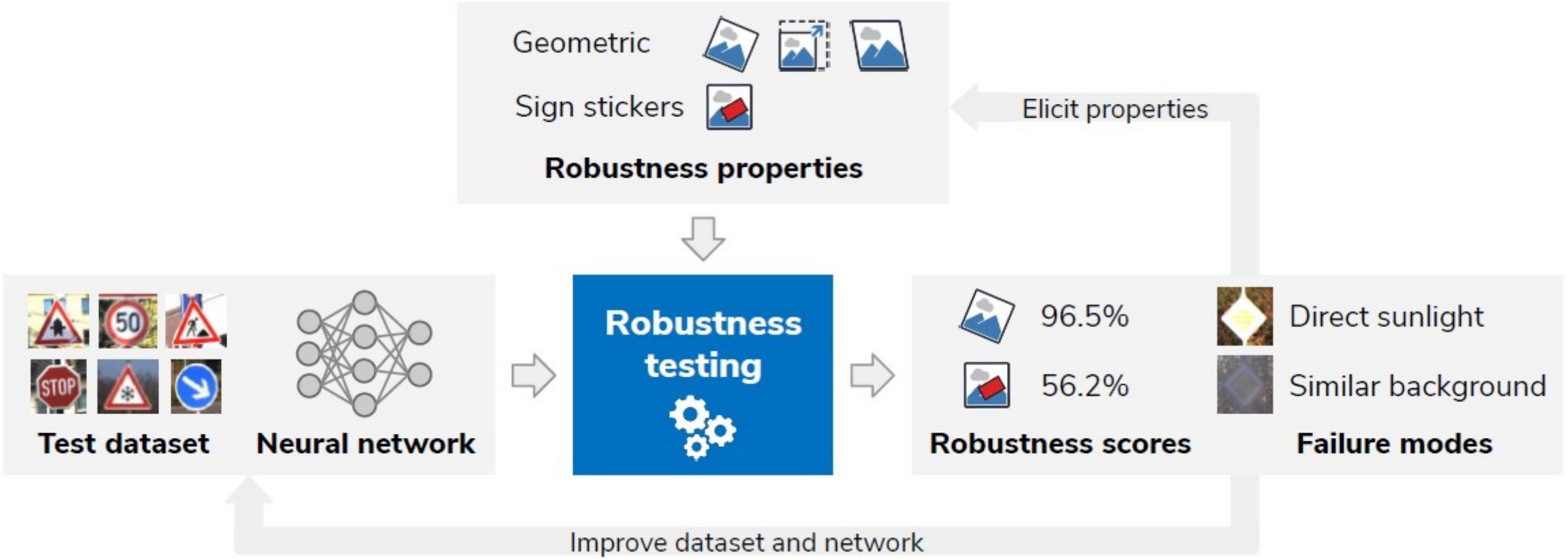
Connectionist AI Process Chain: Vulnerabilities and Measures of Defense



➔ single measures are not effective against adaptive attackers

Robustness of AI Systems
(Project with ETH Zurich / Latticeflow,
Report available under www.bsi.bund.de/KI)

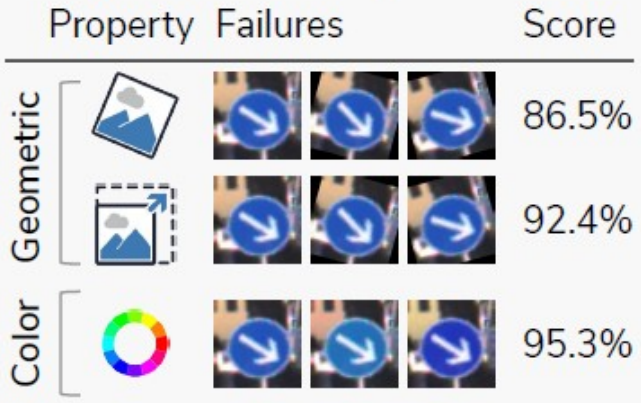
Test and Improvement of the Robustness of Neural Networks



Test and Improvement of the Robustness of Neural Networks

Test neural network

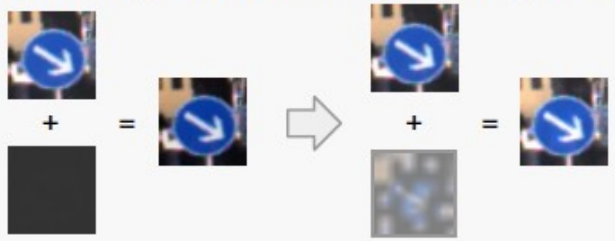
Basic properties (§4.1)



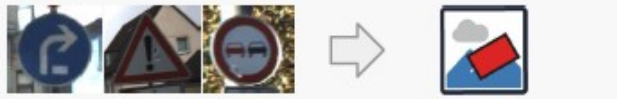
Composite properties (§4.3)

Elicit custom properties

Refined properties (§4.2.1)

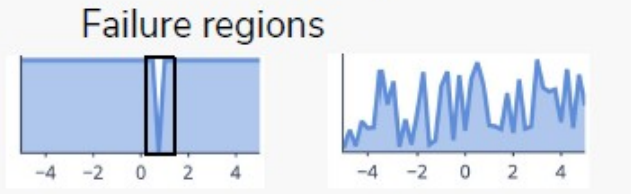


Task-specific properties (§4.2.2)

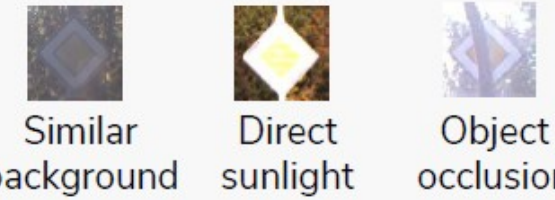


Gain insights

Generalize failures (§4.4)



Find failure modes (§4.5)



Improve dataset and properties based on failure modes (§4.6)

Robustness against Stickers

- Naturally occuring stickers

- Data Augmentation

Traffic Sign Stickers

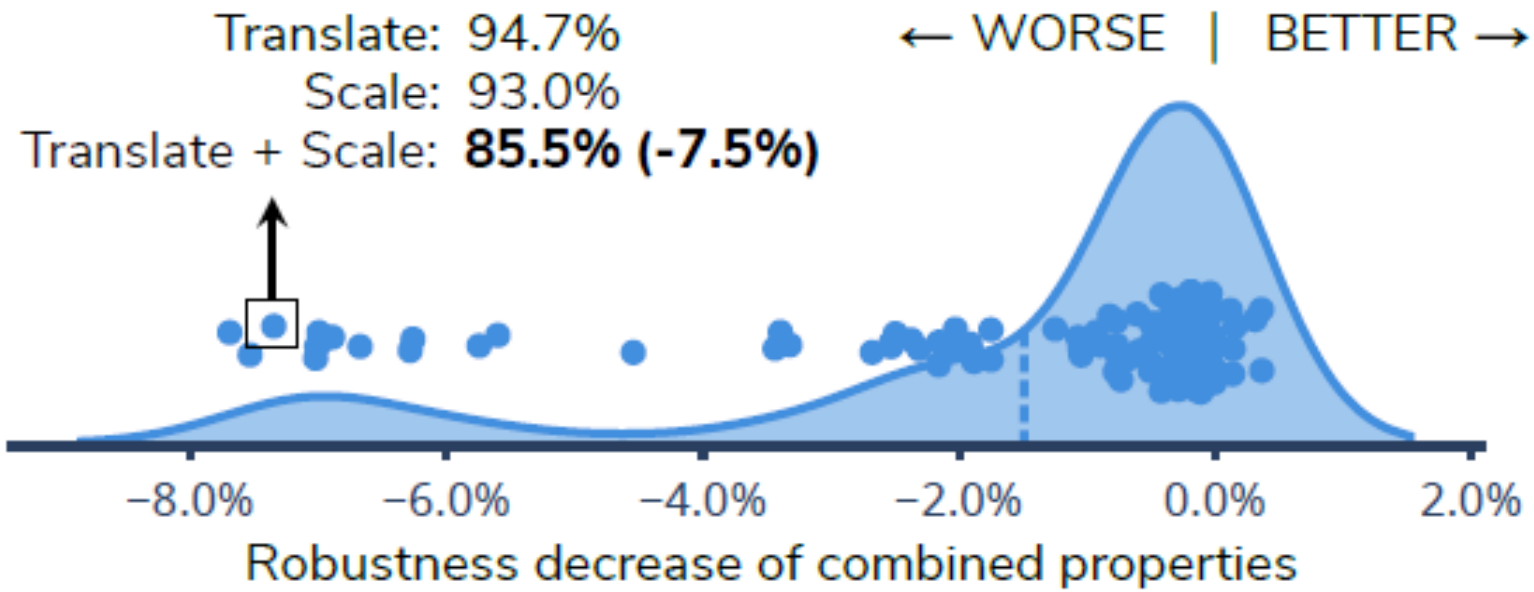
33.8% SELF-TRAINED

27.2% PRE-TRAINED

inserts a single sticker of varying position, size and orientation on the traffic sign

Naturally Occurring Perturbations as a Challenge for AI

Combination of Multiple Perturbations



property order can significantly affect the robustness

Scale + Blur Robustness **81.4%** vs **87.6%** Blur + Scale Robustness

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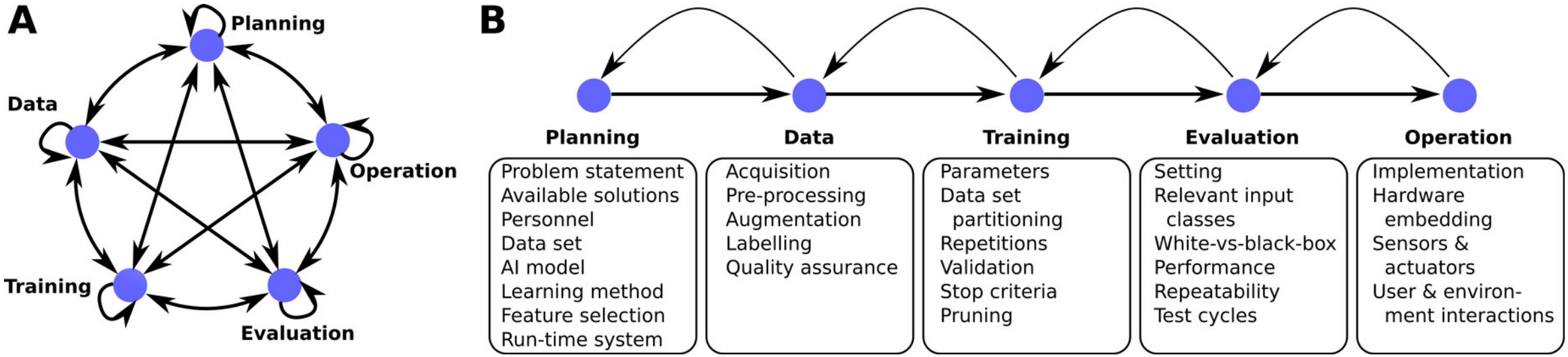
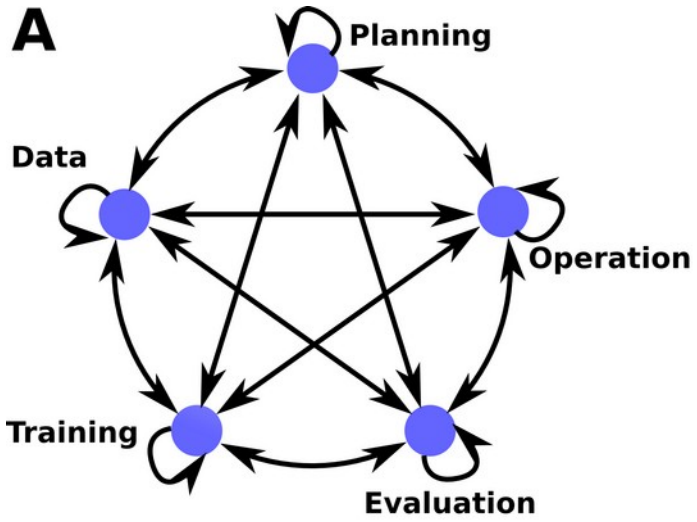
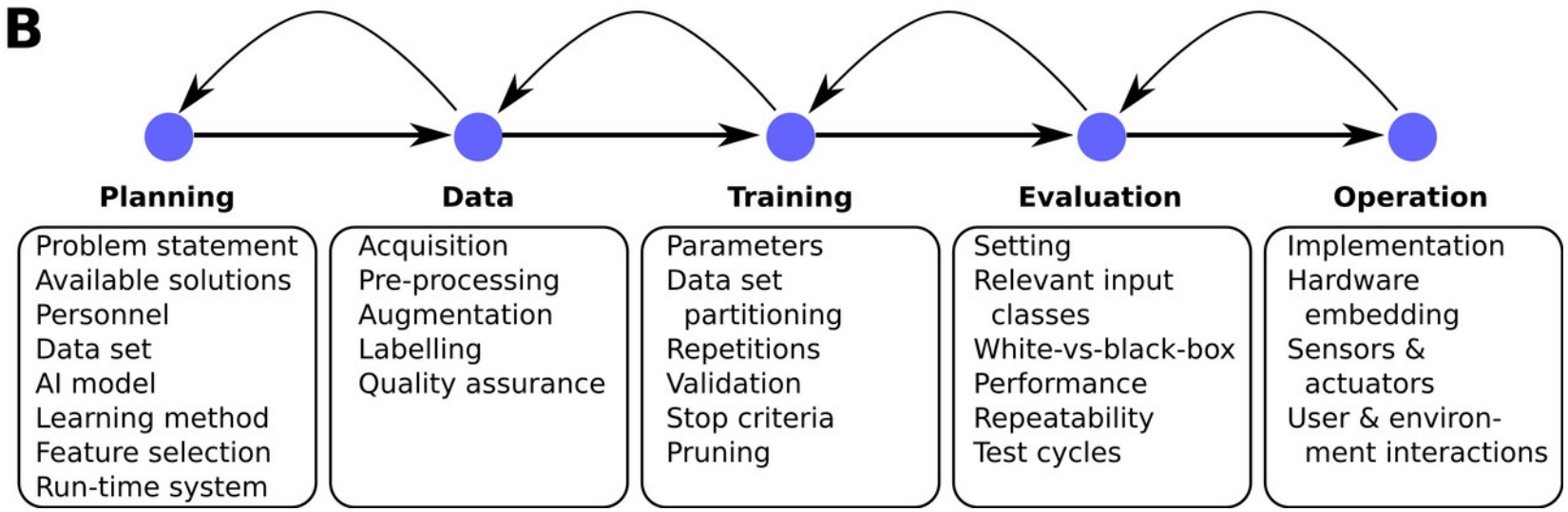
From the Generalized AI Life Cycle to Application-Specific Life Cycles

The Development of an AI System is an Iterative and Complex Process Which may be Divided Into Phases



Multiple Views on the AI System Development Process → Formulation of Requirements





- Reliability (treatment of errors)
- IT security
- Acceptance criteria (Acceptance vs. Risk)
- Documentation
- …

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Formulating Requirements: The Generalized AI Life Cycle Model is Compatible With and Helpful for the Specific Road Sign Recognition System

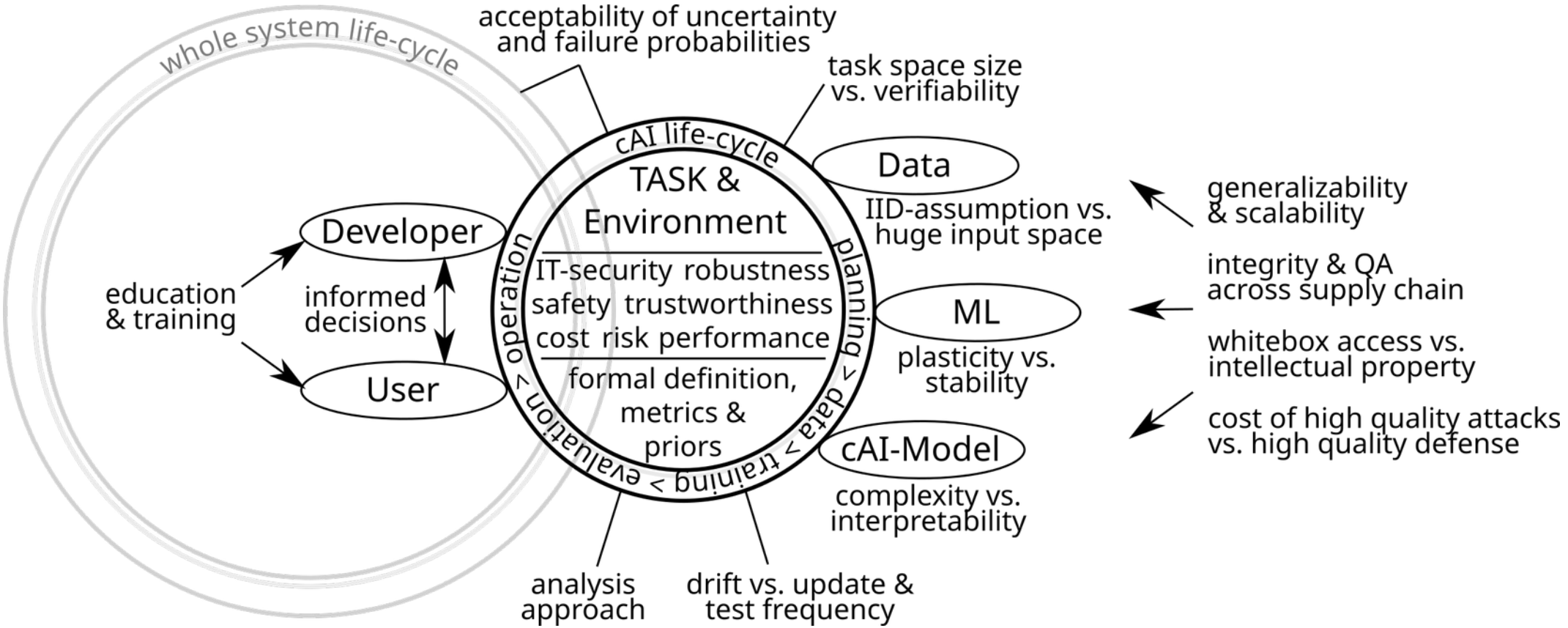
1) Where domain knowledge is required, the generalized model has to be concretized
2) In some cases if-else decisions are sufficient
3) In many cases requirements may be directly transferred from the generalized model

→ as of now, no substantial revision or extension of the generalized model is needed

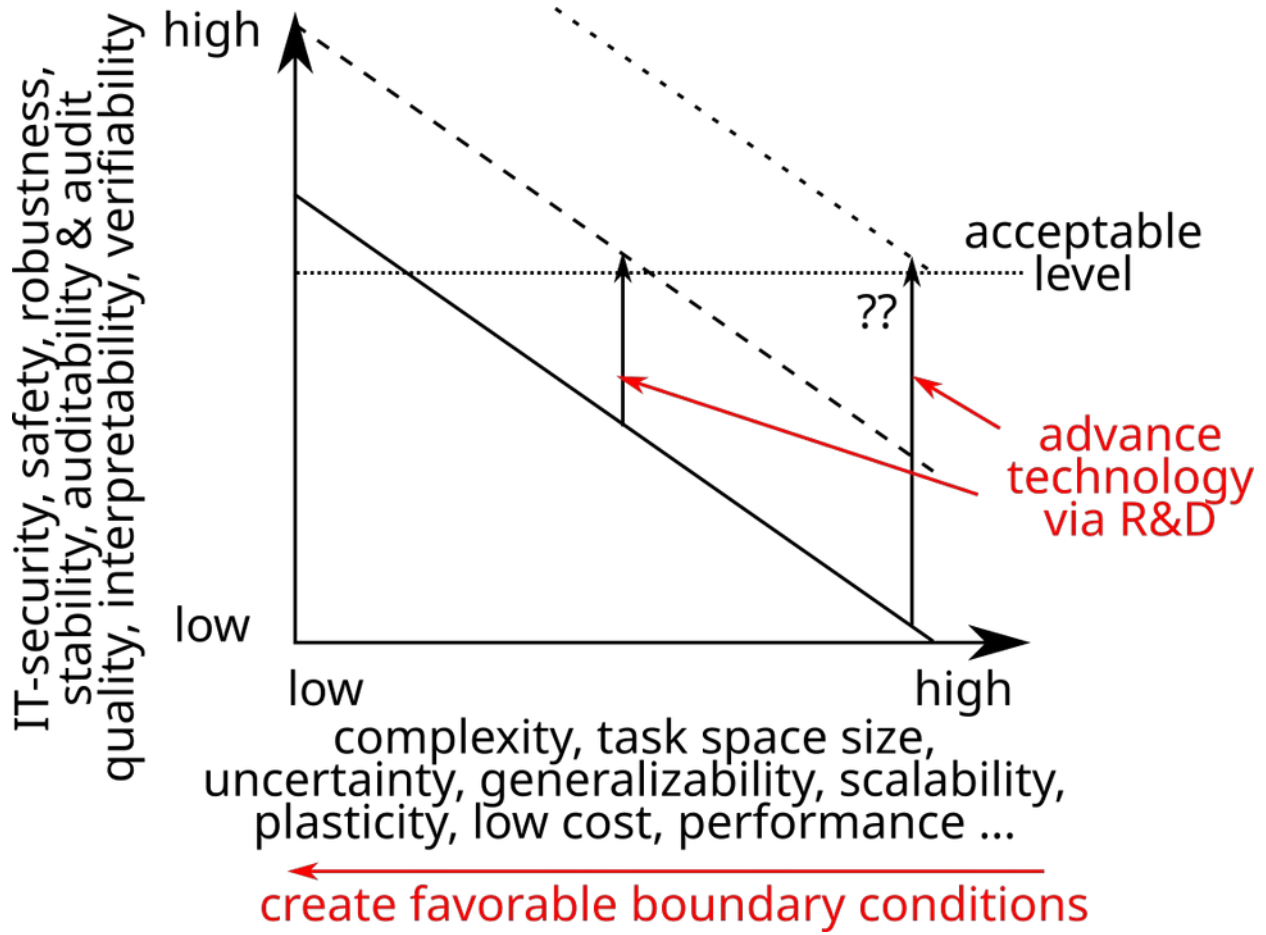
→ multiple use cases have to be examined and compared to verify the generalized model

Open Challenges

Open Question in the Context of Auditability, IT Security and Safety



Acceptable Levels of IT Security, Safety, Audit Quality, Robustness and Verifiability may be Achieved by Creating Favorable Boundary Conditions and by Advances in R&D



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BSI:

- AI-related documents
- involvement in national & international standardization efforts

BSI Documents on AI Security (www.bsi.bund.de/KI)

- **Secure, robust and transparent application of AI Problems, measures and need for action**: presents selected problems as well as measures for security- and safety-critical applications with regard to so-called connectionist AI methods and shows the need for action
- **AI Cloud Service Compliance Criteria Catalogue (AIC4)**: provides AI-specific criteria, which enable an evaluation of the security of an AI service across its life cycle.
- **Vulnerabilities of Connectionist AI Applications: Evaluation and Defense**: Review of the IT security of connectionist artificial intelligence (AI) applications, focusing on threats to integrity (Frontiers in Big Data)
- **Reliability Assessment of Traffic Sign Classifiers**: evaluates how state-of-the-art techniques for testing neural networks can be used to assess neural networks, identify their failure modes, and gain insights on how to improve them
- **Towards Auditable AI Systems:** Whitepaper with VdTÜV and Fraunhofer HHI based on international workshop in 2020

BSI & AI: Involvement in National & International Coorperations & Standardisation Efforts

National

- BSI-VdTÜV working group on AI with a focus on mobility and the goal to develop evaluation scenarios for selected use cases until the end of 2021
- Administrative Agreement of BSI with the Kraftfahrtbundesamt (KBA, Federal Motor Transport Authority) in the context of vehicle type approval and cybersecurity
- DIN/DKE Artificial Intelligence Standardization Roadmap
- ...

International

- ETSI's Industry Specification Group on Securing Artificial Intelligence (ISG SAI)
- ENISA Adhoc working group on AI
- ...

Thank you for your attention!

Contact

Dr. Arndt von Twickel

arndt.twickel@bsi.bund.de

Bundesamt für Sicherheit in der Informationstechnik (BSI)
Godesberger Allee 185-189
53175 Bonn
Germany

www.bsi.bund.de
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