Collaborative Embedded Systems
CrESt
GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Fraunhofer IESE

Managing Uncertainty for Data-Driven Components

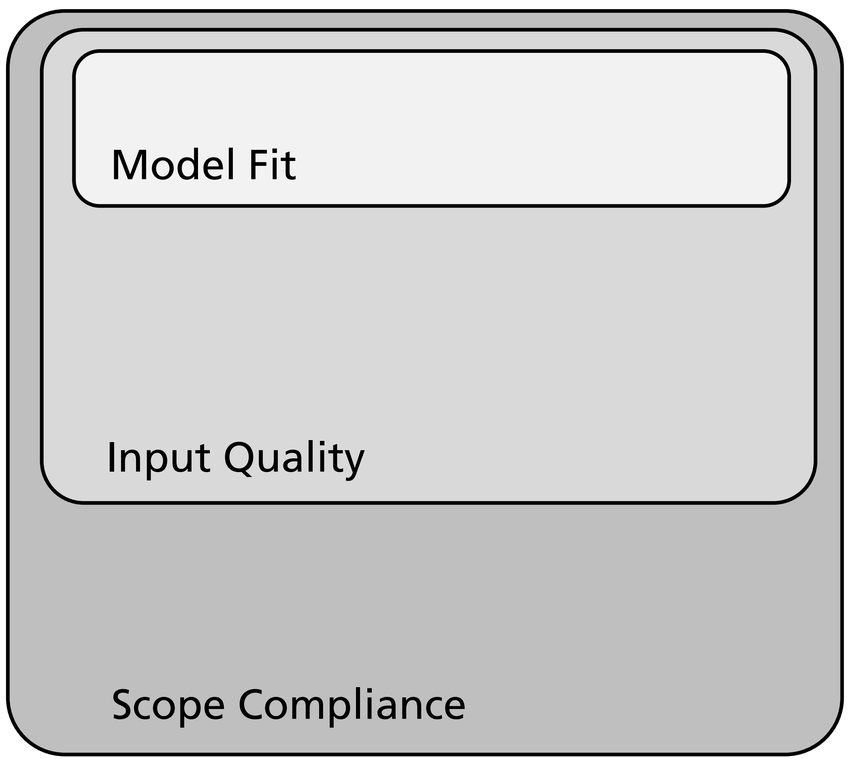
Sources of Uncertainty in Data-Driven Components

Uncertainty caused by (inherent) limitations of the learned model

Additional
Uncertainty caused by input quality limitations during model application

Additional
Uncertainty caused by mismatch between target/test context and application context

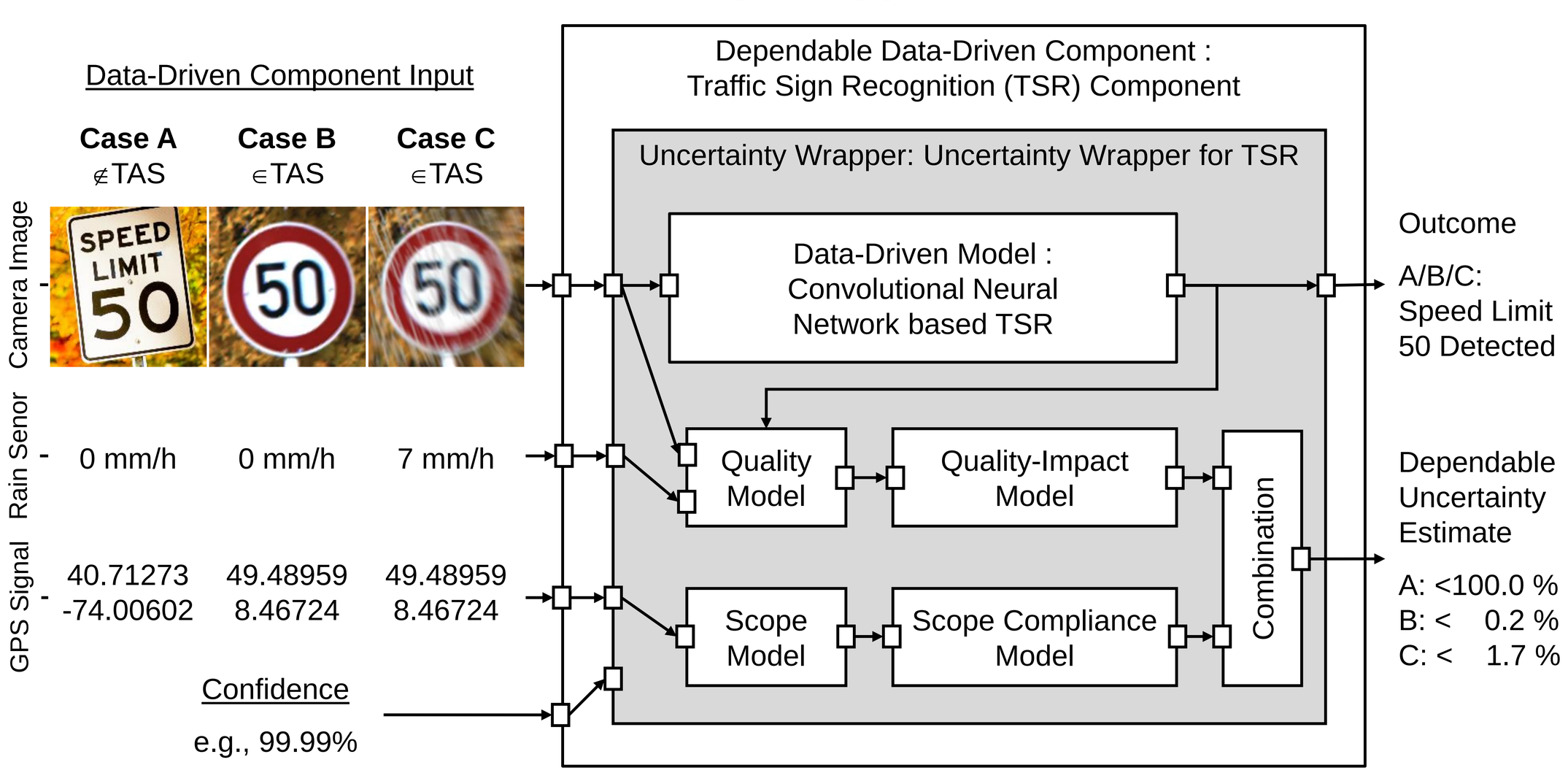
Onion Shell-Layer Model



Kläs, M., & Vollmer, A. M. (2018). Uncertainty in Machine Learning Applications: A Practice-Driven Classification of Uncertainty. WAISE 2018.

Uncertainty Wrapper – A Model Agnostic Framework

Uncertainty Wrapper Architectural Pattern



Kläs, M., Sembach, L. (2019). Uncertainty Wrappers for Data-driven Models - Increase the Transparency of AI/ML-based Models through Enrichment with Dependable Situation-aware Uncertainty Estimates. WAISE 2019.

Data augmentation of input quality deficits:
Jöckel, L., Kläs, M. (2019). Increasing Trust in Data-Driven Model Validation - A Framework for Probabilistic Augmentation of Images and Meta-Data Generation using Application Scope Characteristics. SAFECOMP 2019.
Jöckel, L., Kläs, M., Martínez-Fernández, S. (2019). Safe Traffic Sign Recognition through Data Augmentation for Autonomous Vehicles Software. QRS 2019.

Results

Uncertainty wrappers enable dependable uncertainty estimates

Scope compliance checks reduce variance – Clustering increases resolution

Calibration increases reliability – Confidence limits reduce likelihood of overconfidence

Kläs, M., Jöckel, L. (2020). A Framework for Building Uncertainty Wrappers for AI/ML-based Data-Driven Components. WAISE 2020.

Michael Kläs, Fraunhofer IESE, michael.klaes@iese.fraunhofer.de
Lisa Jöckel, Fraunhofer IESE, lisa.joeckel@iese.fraunhofer.de