

# Pilotprojekt Metrology for Artificial Intelligence in Medicine (M4AIM)

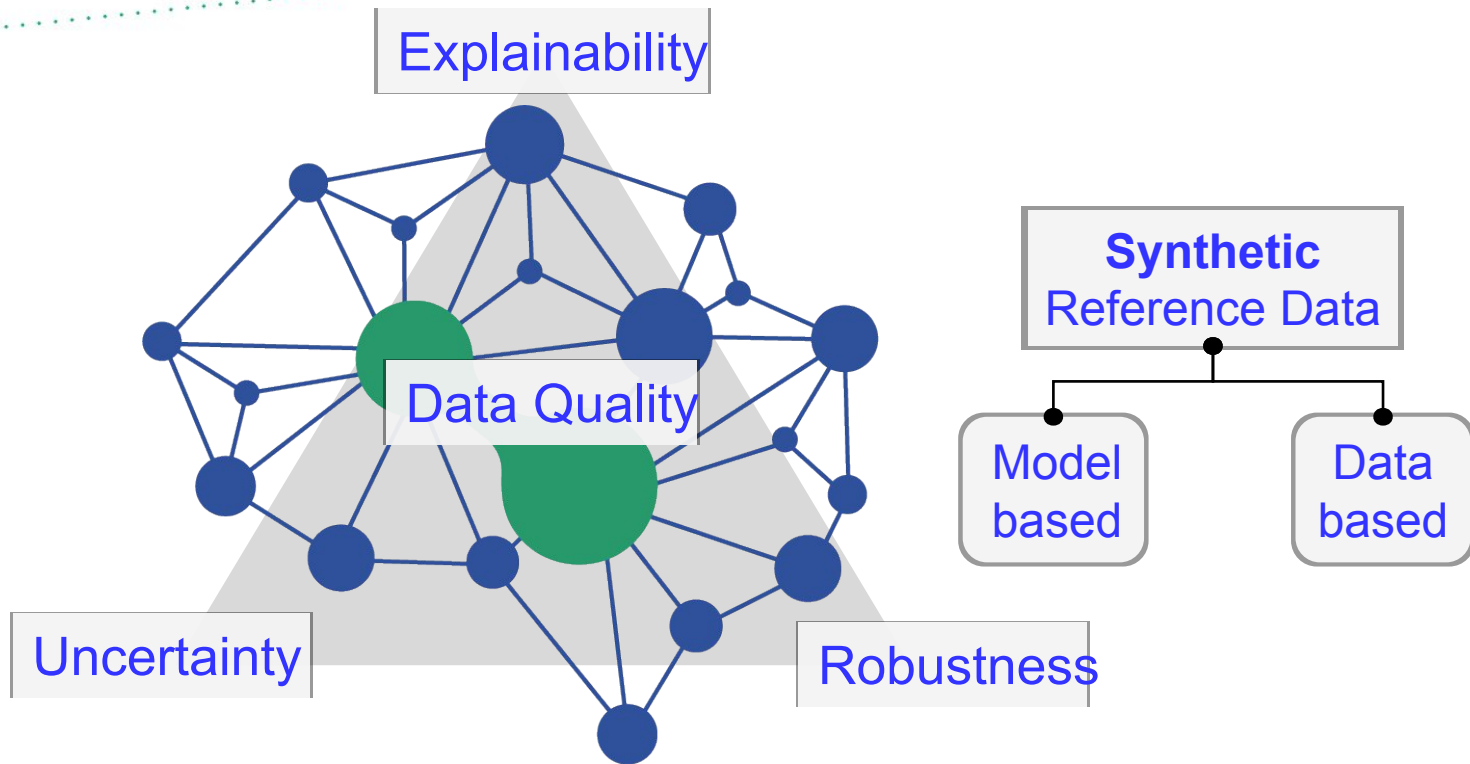
QI-Digital Forum 2024

Dr. Hans Rabus,  
Arbeitsgruppe 8.01 (KI und Simulation in der Medizin),  
Physikalisch-Technische Bundesanstalt (PTB), Braunschweig und  
Berlin



























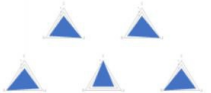







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# 1— Metrological challenges addressed



## 2— M4AIM Team and topical areas

	Foundations	Clinical Measurements	Dosimetry in Radiotherapy	Markers	MRI and CT Imaging				
<b>Principal investigators</b>	 Clemens Elster  Jörg Martin  Sebastian Heidenreich	 Stefan Haufe	 Hans Rabus	 Ralf-Peter Kapsch  Gavin O'Connor	 Lukas Winter  Christoph Kolitsch  Stefan Pojtinger				
<b>PostDocs</b>	 Josua Faller	 Nando Farchmin	 Danny Panknin  Yasemin Bozkurt	 Ann-Britt Schönfeld  André Märtens					
<b>PhD students</b>		 Nikita Agarwal  Benedict Clark  Rustam Zhumagambetov	 Leo Thomas  Miriam Schwarze	 David Schote  Felix Zimmermann  Kerstin Kaspar					
				 					



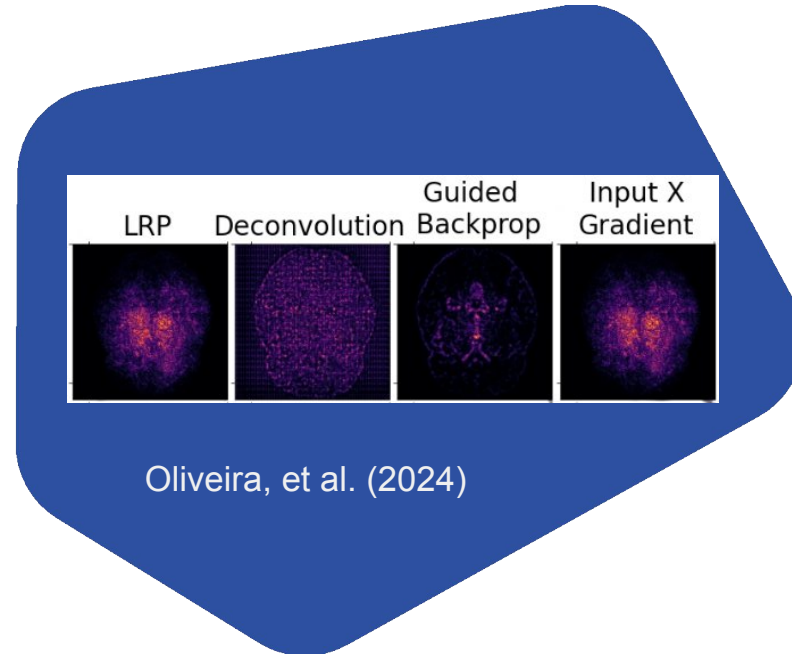
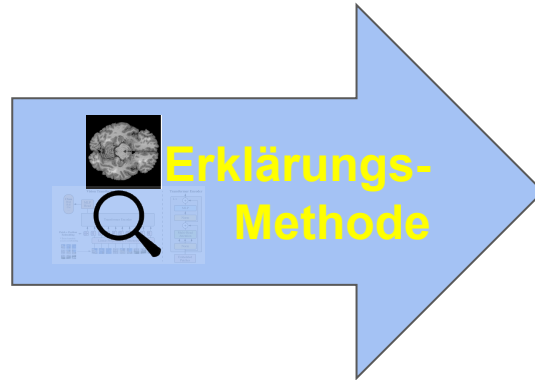
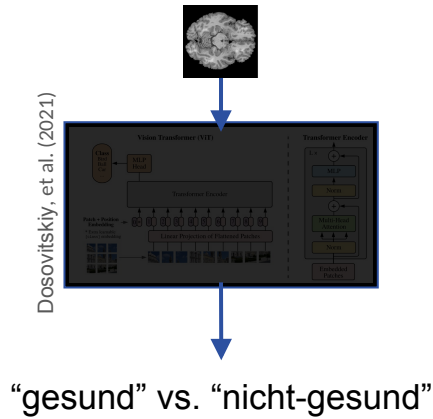


# Überprüfung von KI-Erklärungen

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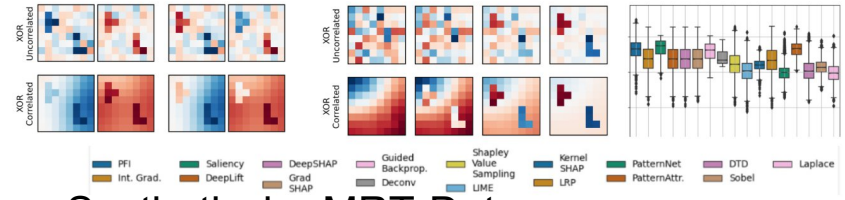
Rick Wilming  
Arbeitsgruppe 8.44 (Maschinelles Lernen und Unsicherheit),  
Physikalisch-Technische Bundesanstalt (PTB), Braunschweig und Berlin

# 1— KI und Erklärungen

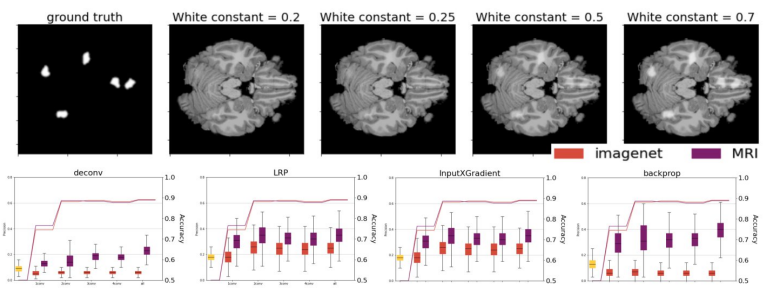


# 2— Synthetische Daten zur Überprüfung von Erklärbarkeit

- XAI-TRIS: Nichtlineare synthetische Ground-Truth-Daten



- Synthetische MRT-Daten Clark et al. 2024, Machine Learning (ECML/PKDD Track)

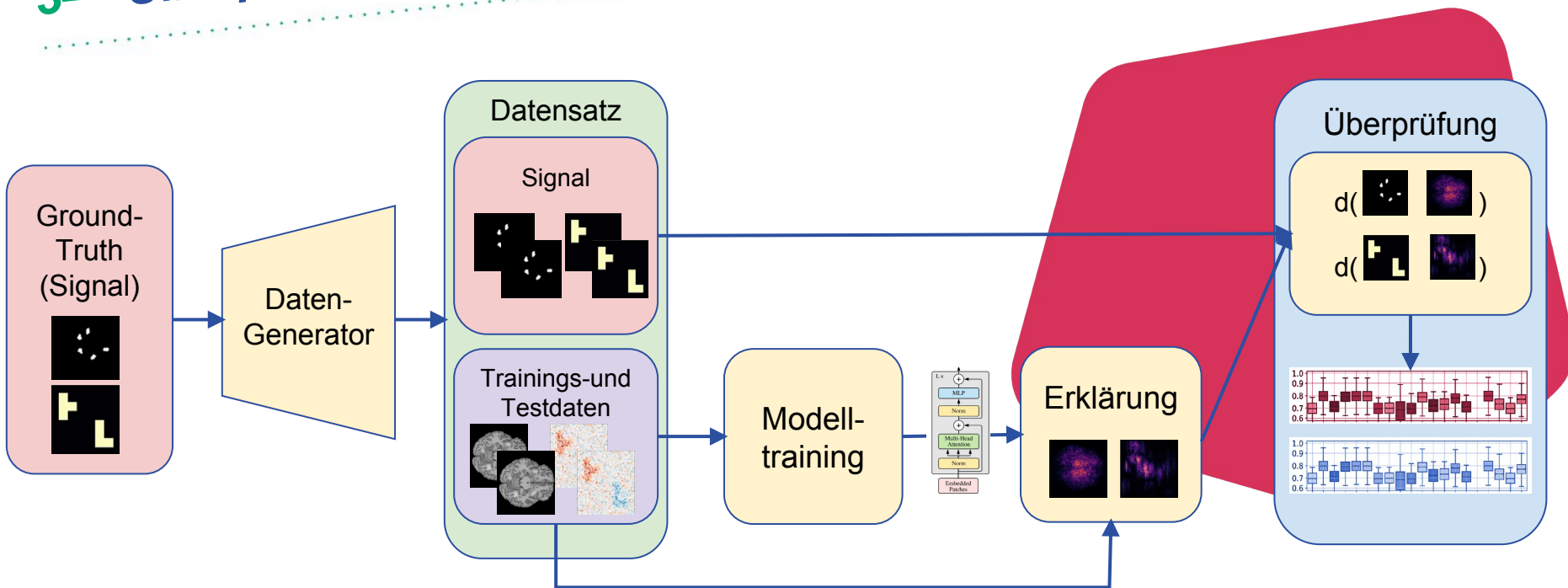


Oliveira et al., Frontiers in AI, 2024

Messung der Erklärgüte über klassenspezifische Muster

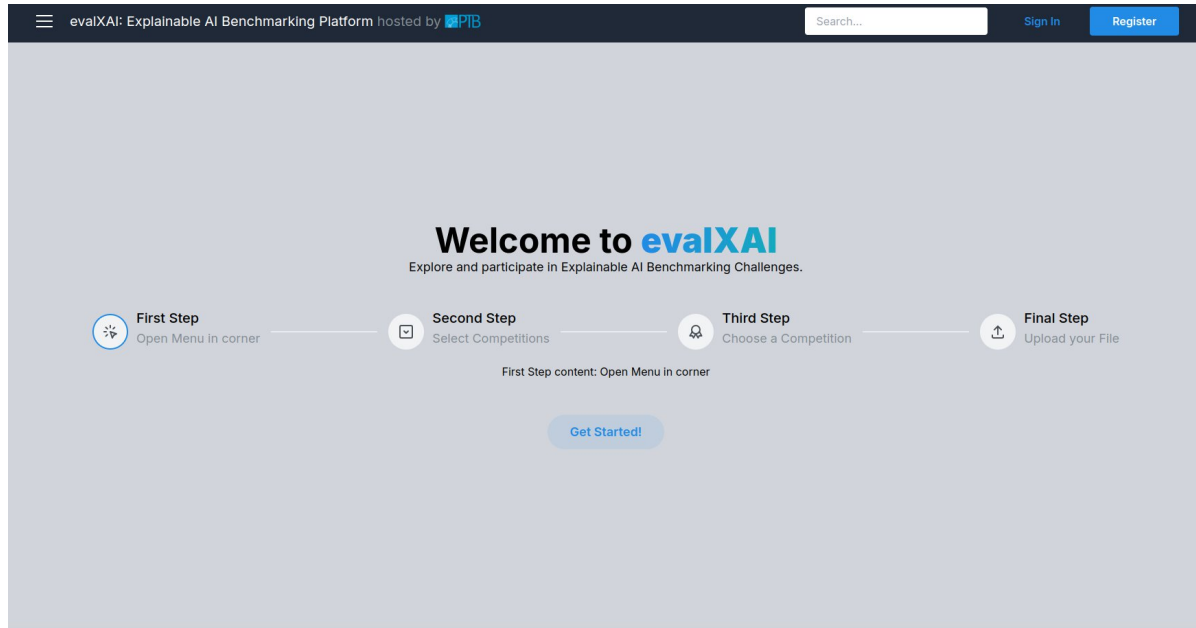


### 3— Überprüfung von KI-Erklärungen





# 4— Überprüfungs-Plattform für KI-Erklärungen





# PHYSICS-INFORMED LEARNING FOR MR IMAGE RECONSTRUCTION

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Andreas Kofler, PhD

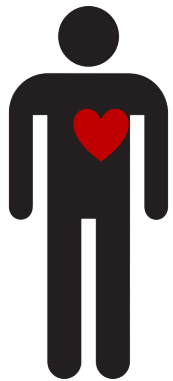
Arbeitsgruppe 8.13 (Quantitative MRT),

Physikalisch-Technische Bundesanstalt (PTB), Braunschweig und  
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10.10.2024

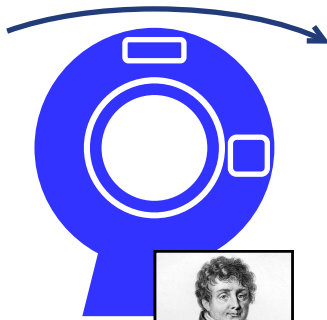
# 1— Data Acquisition and Reconstruction



$x_{\text{true}}$

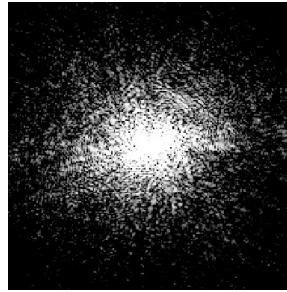
Data acquisition

$A$



Jean Baptiste Joseph Fourier,  
1768 - 1830

Measured data



$$y := Ax_{\text{true}} + e$$

Reconstruction

$A^{-1}$



Reconstructed image

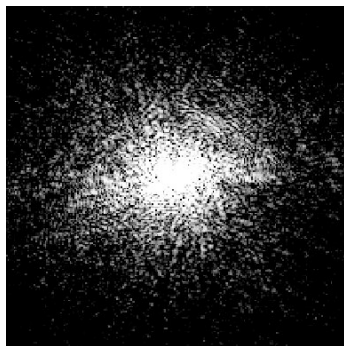


$x_{\text{reco}}$

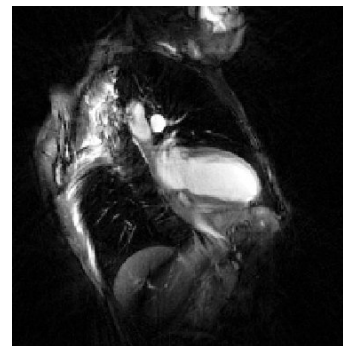


## 2— Learning To Solve Inverse Problems

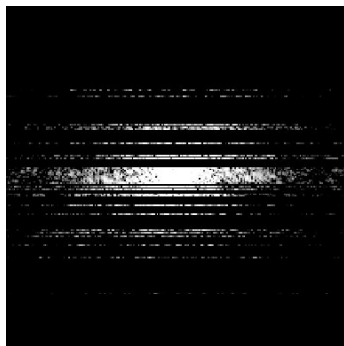
**Slow**  
Acquisition



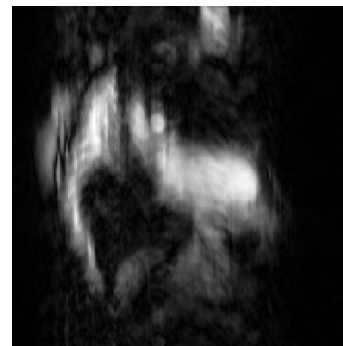
Reconstruction



**Fast**  
Acquisition

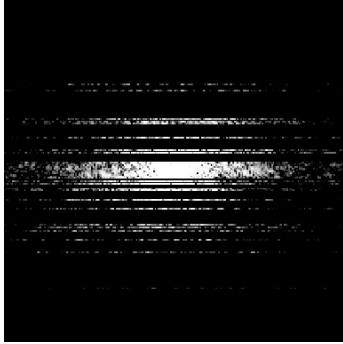


Reconstruction

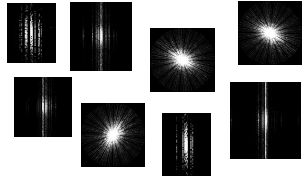
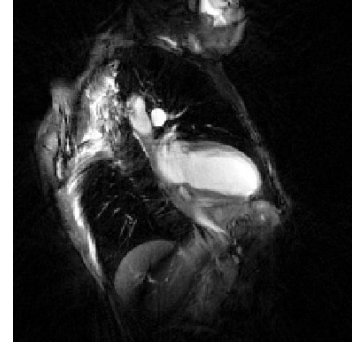
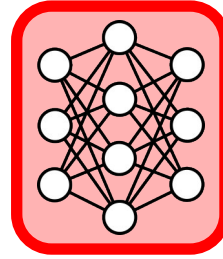


## 2— Learning To Solve Inverse Problems

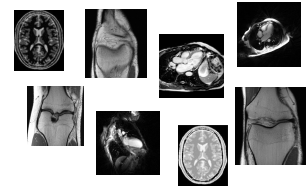
Fast  
acquisition



Learned  
reconstruction



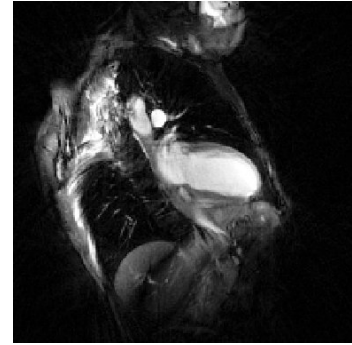
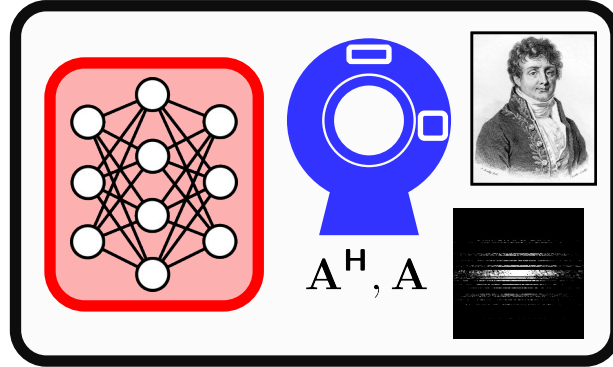
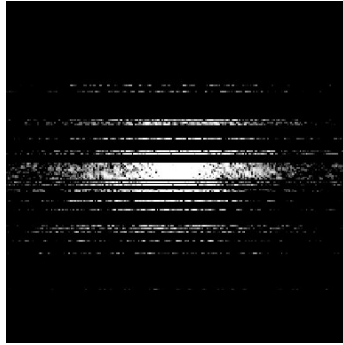
Large datasets



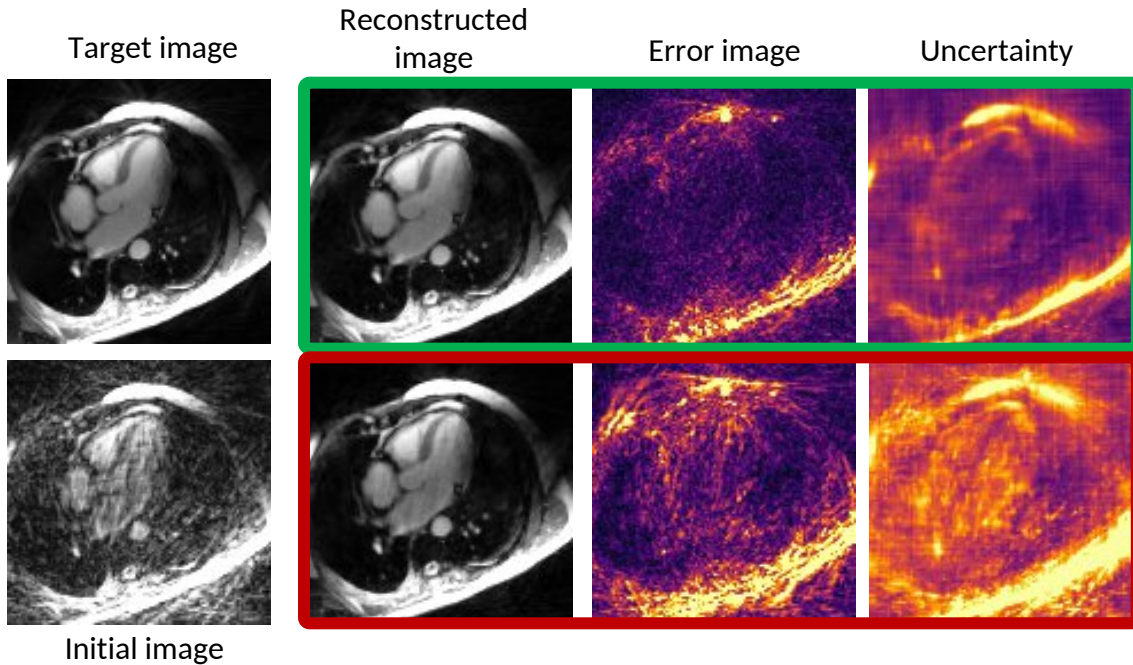
## 2— Physics-Informed Learning

Physics-Informed Learned reconstruction

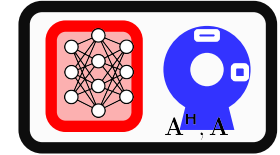
Fast acquisition



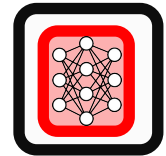
### 3— Example: Accelerated Cardiac MRI



Physics-Informed



Physics-Agnostic



S. Brahma et al, MedPhys 2023





# Das METRIC Framework zur Bewertung der Qualität von Daten

QI-Digital Forum 2024

Dr. Katinka Becker

Physikalisch-Technische Bundesanstalt (PTB), Braunschweig und  
Berlin

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10.10.2024

# 1 — Das EU Projekt TEF- Health



- „Testing and Experimentation Facility for Health AI and Robotics“
- 52 Partner in der EU
- Geleitet von der Charité (Prof. Petra Ritter)
- PTB leitet das Workpackage „Standards and Quality“

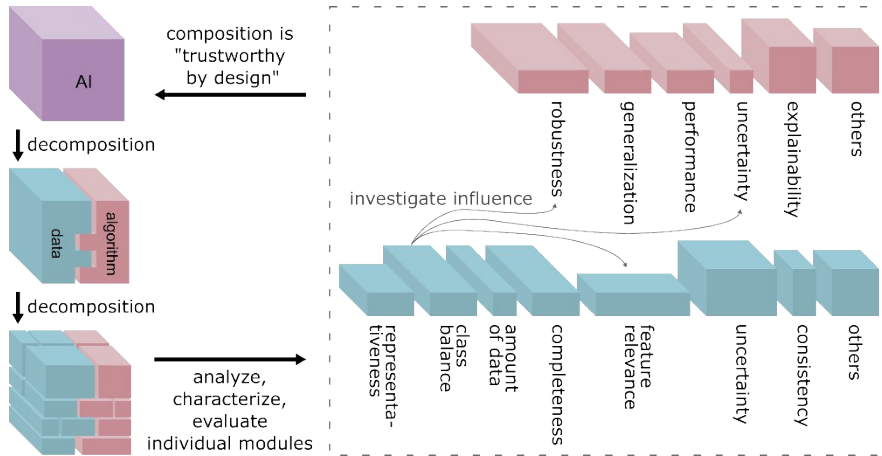
Ziel

Vertrauenswürdige KI im  
Anwendungsbereich:

- Markteintritt erleichtern
- Qualität sichern



## 2— Vertrauenswürdigkeit per Design



© Daniel Schwabe



Schaufenster - Pilotprojekt KI in der Medizin

- KI System unterteilt sich in zwei entscheidende Komponenten:

- Daten und Algorithmus

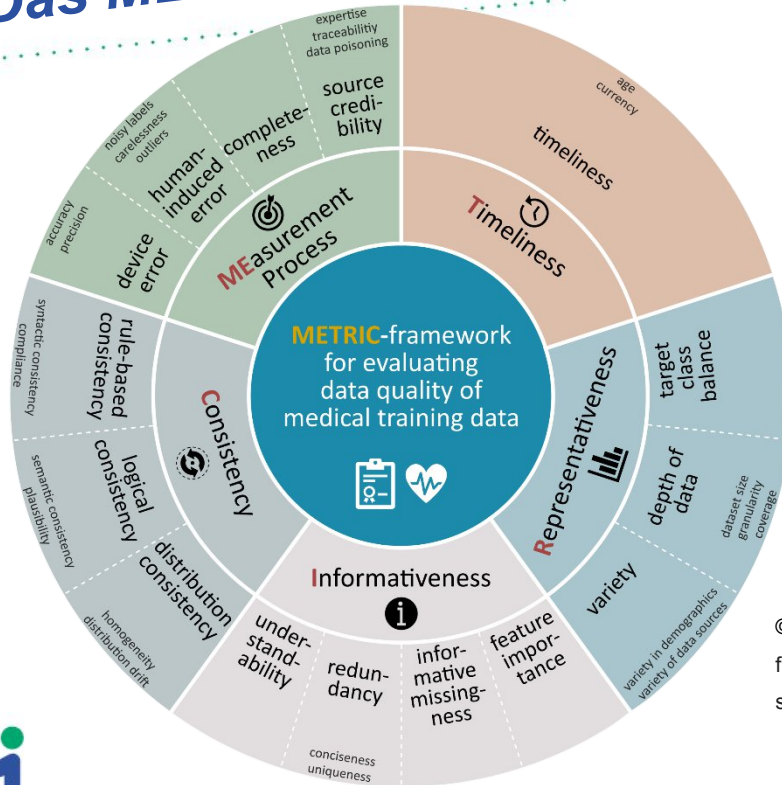
Idee

Qualitätssicherung des Systems durch Qualitätssicherung der Komponenten

Datenqualität

10.10.2024

### 3 — Das METRIC-framework



#### Das „Rad der Datenqualität“

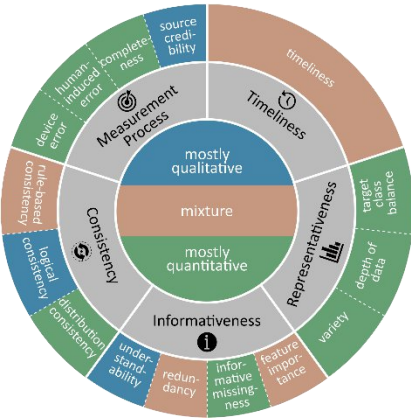
- 5 Cluster mit 15 „Awareness Dimensions“
- Grundlage für systematische Evaluierung von Qualität von medizinischen Daten für z.B.: Referenzdatensätze
  - Design von Testdatensätzen
  - Validierung von Trainingsdatensätzen

© D. Schwabe, K. Becker, M. Seyferth, A. Kläß, T. Schäfer. The METRIC-framework for assessing data quality for trustworthy AI in medicine: a systematic review. *npj Digit. Med.* 7, 203 (2024)

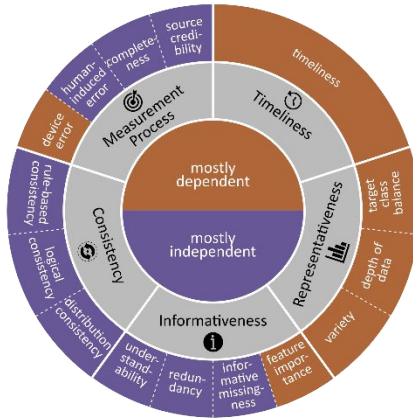


# 4 Outlook

quantitative vs. qualitative measures



use case dependence for evaluating data quality



- Wie lassen sich die **einzelnen Dimensionen messen?** (Metriken)
- Automatisierung durch ein Tool
- Wie stark wirken sich **einzelne Datenqualitätsdimensionen** auf die Qualität des Systems aus (Performance, Robustheit, Fairness, Erklärbarkeit,...) ?



