

# **Proposal for a Common Classification of AI Systems based on Methods and Capabilities**

DIN/DKE NA043-01-42 GA:

Contribution for CEN-CENELEC JTC 21 ‚Artificial Intelligence‘

Taras Holoyad

Bundesnetzagentur (Mainz)

[taras.holoyad@bnetza.de](mailto:taras.holoyad@bnetza.de)

# Content

- Main Focus
- **Methods** of Artificial Intelligence
- **Capabilities** of Artificial Intelligence
- Example of use
- Benefits

# Main Focus

- **Basis for European AI Regulation:**
  - **Europe-wide homogeneity** in describing AI applications
  - **Trustworthiness** by ensuring **explainability** and **transparency**
  - Unambiguity in **requirements** for **testing** and **certification**
  
- Facilitated use of AI by **Public Authorities, SMEs and Large Enterprises**
  - Identification of **quality criteria** for **rule-based** as well as **data driven AI**
  - Clear **basis** for **assessment** of **impacts** and **criticality**
  
- **Common ground** for **ecosystem** participants in **Europe**
  - Accelerated boost of AI-based business models
  - Consistent enforcement of ethical values

# Methods

→ Methods:

Representation from the perspective of mathematics, physics and computer science

→ Conceptualised on the basis of:

Stuart J. Russell and Peter Norvig -

Artificial Intelligence: A Modern Approach (2020), 4th Ed., Prentice Hall.

<b>PROBLEM SOLVING, OPTIMIZATION, PLANNING AND DECISION MAKING</b>	<b>Problem Solving</b>	<b>Problem Solving Agents &amp; Searching Strategies</b>
	<b>Optimization</b>	<b>Statistical Optimization</b>
		<b>Bio-inspired Optimization</b>
	<b>Planning and Plan Recognition</b>	<b>Autonomous and Semi-autonomous Planning</b>
		<b>Plan Recognition Methods</b>
<b>Decision Making</b>	<b>Approaches for Decision Making</b>	

<b>KNOWLEDGE REPRESENTATION AND REASONING</b>	<b>Knowledge Representation</b>	<b>Ontological Engineering</b>
		<b>Knowledge Graphs and Semantic Networks</b>
		<b>Formal Logic Modelling</b>
	<b>Reasoning</b>	<b>Formal Verification</b>
		<b>Interactive Verification</b>
	<b>Uncertain Knowledge</b>	<b>Uncertainty Quantification</b>
		<b>Representation of Uncertain Knowledge</b>
	<b>Probabilistic Reasoning</b>	<b>Bayesian Inference</b>
		<b>Relational Probabilistic Models</b>
		<b>Probabilistic Reasoning with Time And Uncertainty</b>
<b>Non-probabilistic Reasoning</b>	<b>Qualitative Approaches</b>	
	<b>Rule-Based Approaches Reasoning with Uncertainty Reasoning with Believe Function</b>	
<b>Other Approaches for Uncertain Reasoning</b>		

<b>MACHINE LEARNING</b>	<b>Supervised Learning</b>	Neural Networks
		Statistical Learning
		Probabilistic Methods
	<b>Unsupervised Learning</b>	Clustering
		Dimensionality Reduction
		Probabilistic Methods
	<b>Semi-supervised Learning</b>	Statistical Approaches
		Modified Learning Concepts
		Graph-based Learning
	<b>Reinforcement Learning</b>	Temporal Difference Learning
		Monte Carlo Methods
		Adaptive Dynamic Programming

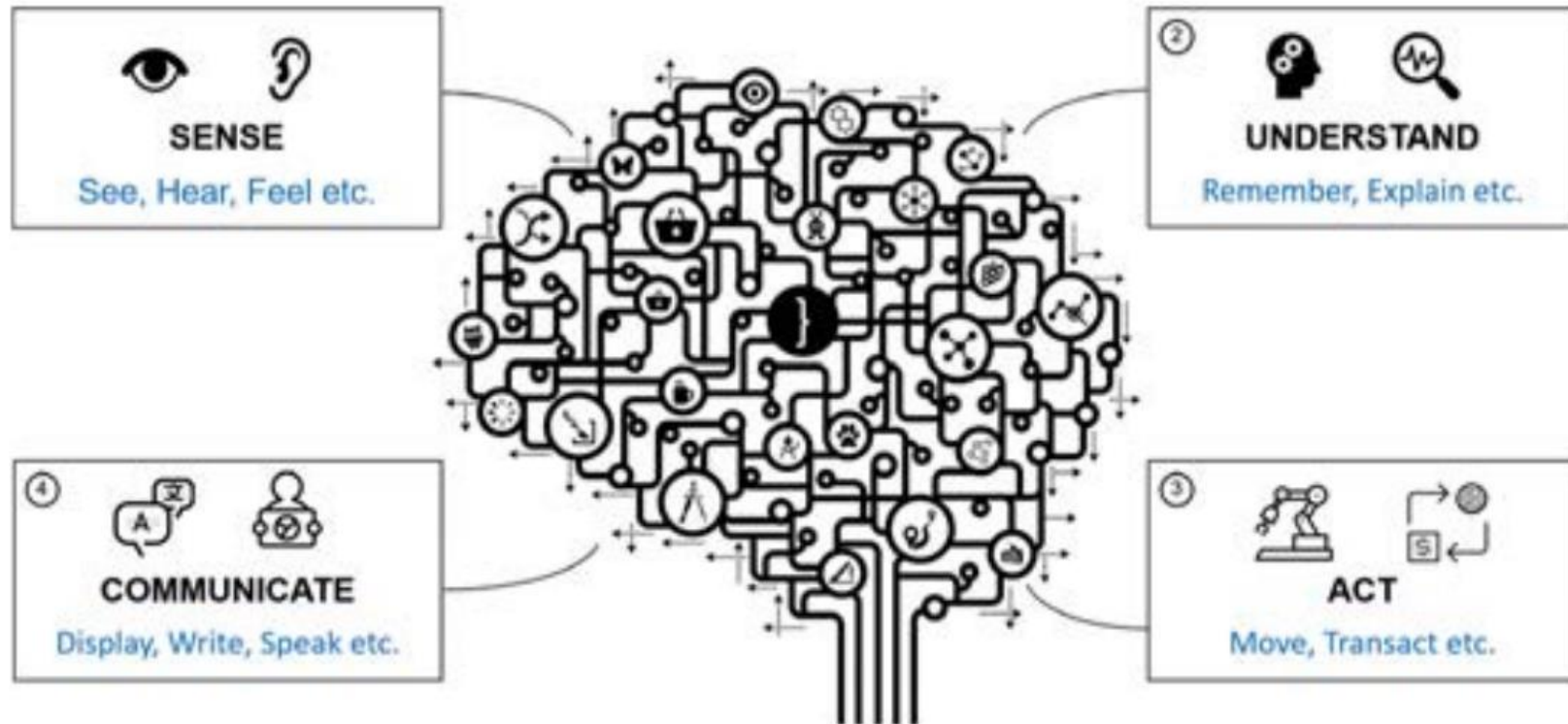
<b>HYBRID LEARNING</b>	<b>Hybrid Neural Systems</b>	Unified Neural Architectures
		Transformation Architectures
		Hybrid Modular Architectures
	<b>Learning with Knowledge</b>	Learning by Logic and Deduction
		Inductive Logical Programming
		Explainable Artificial Intelligence
	<b>Conversational Learning</b>	Relevance-based Learning
	Active Dialog Learning	

# Capabilities

→ Capabilities:

Representation from the perspective of psychology, biology and cognitive science

# Capabilities





# Sense / Process and Understand

<b>SENSE</b>	<b>External</b>	See
		Hear
		Smell
		Taste
		Touch
	<b>Internal</b>	Body Awareness
	Balance	

<b>PROCESS AND UNDERSTAND</b>	<b>Factual</b>	List
		Summarize
		Respond
		Select
		Check
	<b>Conceptual</b>	Generate
		Recognize
		Classify
		Provide
		Differentiate
	<b>Procedural</b>	Determine
		Assemble
		Recall
Clarify		
Carry Out		
<b>Metacognitive</b>	Integrate	
	Judge	
	Design	
	Identify	
	Predict	
	Use	
	Deconstruct	
	Reflect	
	Create	

# Act / Communicate

ACT	Physical	Motion Planning Sensors and Manipulators Kinematics and Dynamics Human-robot Interaction
	Non-physical	Software Agents
COMMUNICATE	Natural Language Processing	Text Generation Machine Translation Text Analysis Information and Knowledge Extraction Information Retrieval Document Analysis Spoken Dialog Systems
	Human-Machine Interaction	Cognitive Systems Interaction Paradigms and Modalities

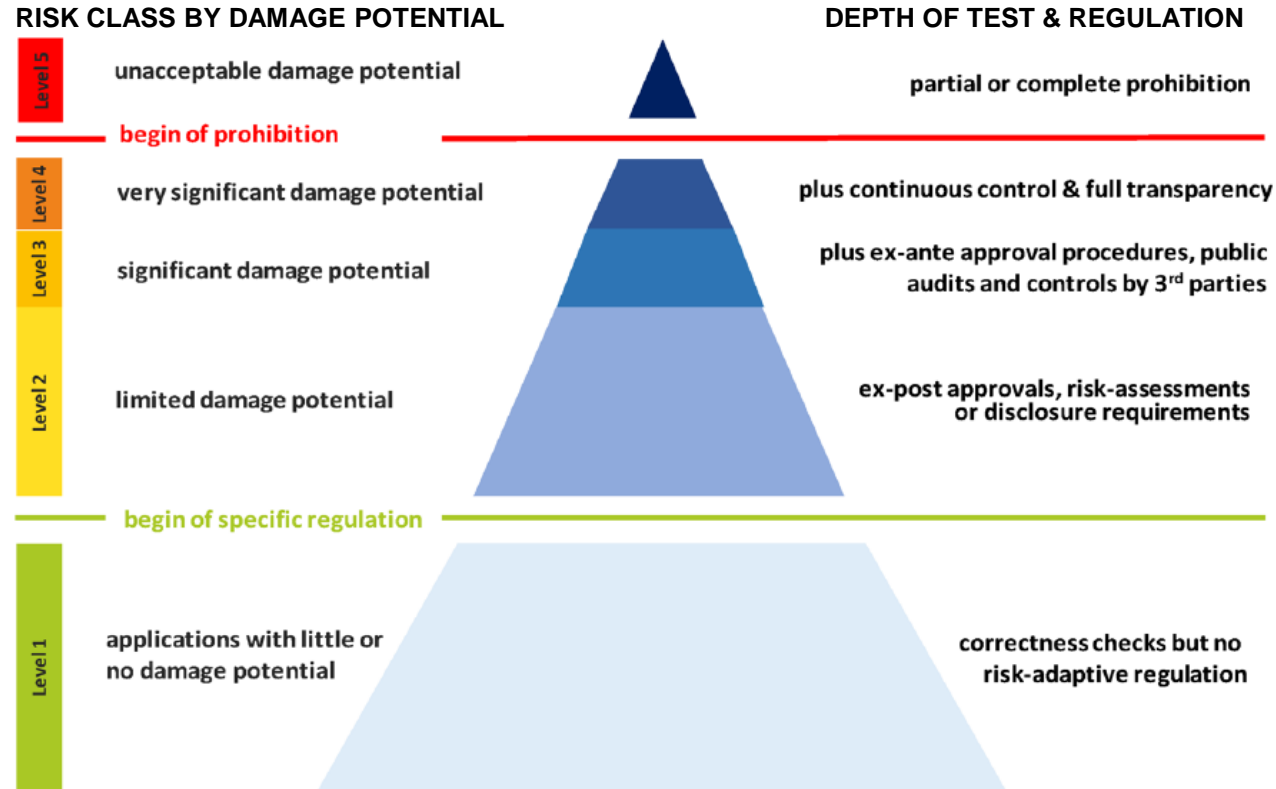
# Example of Use: Risk description for using AI

- ➔ Description of AI system by involving **externally identified risk classes**:  
Representation of the damage potential  
for, e.g., **physical** as well as **mental well-being, finance, data and fairness**
  
- ➔ The classification approach targets **AI systems** that were **not created to harm humans**,  
e.g. by monitoring, sorting and killing

# Example of Use: Risk description for using AI

## German Data Ethics Commission:

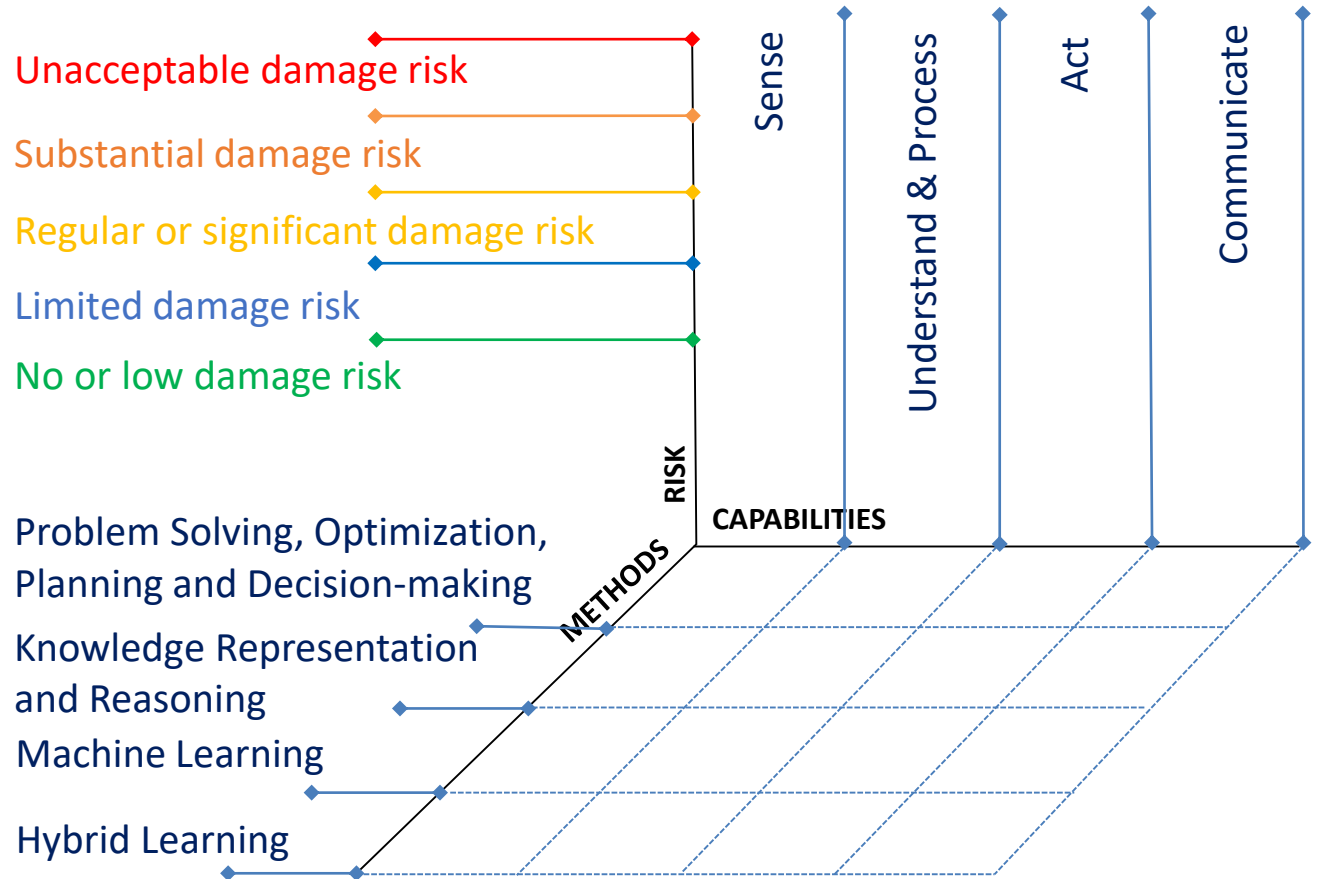
Criticality pyramid and risk-adapted regulatory system for **describing externally identified risk**



# Example of Use: Risk description for using AI

**Input** parameters for a 3-space description of AI systems:

- **AI Methods**
- **AI Capabilities**
- **Risk Classes**



# Benefits

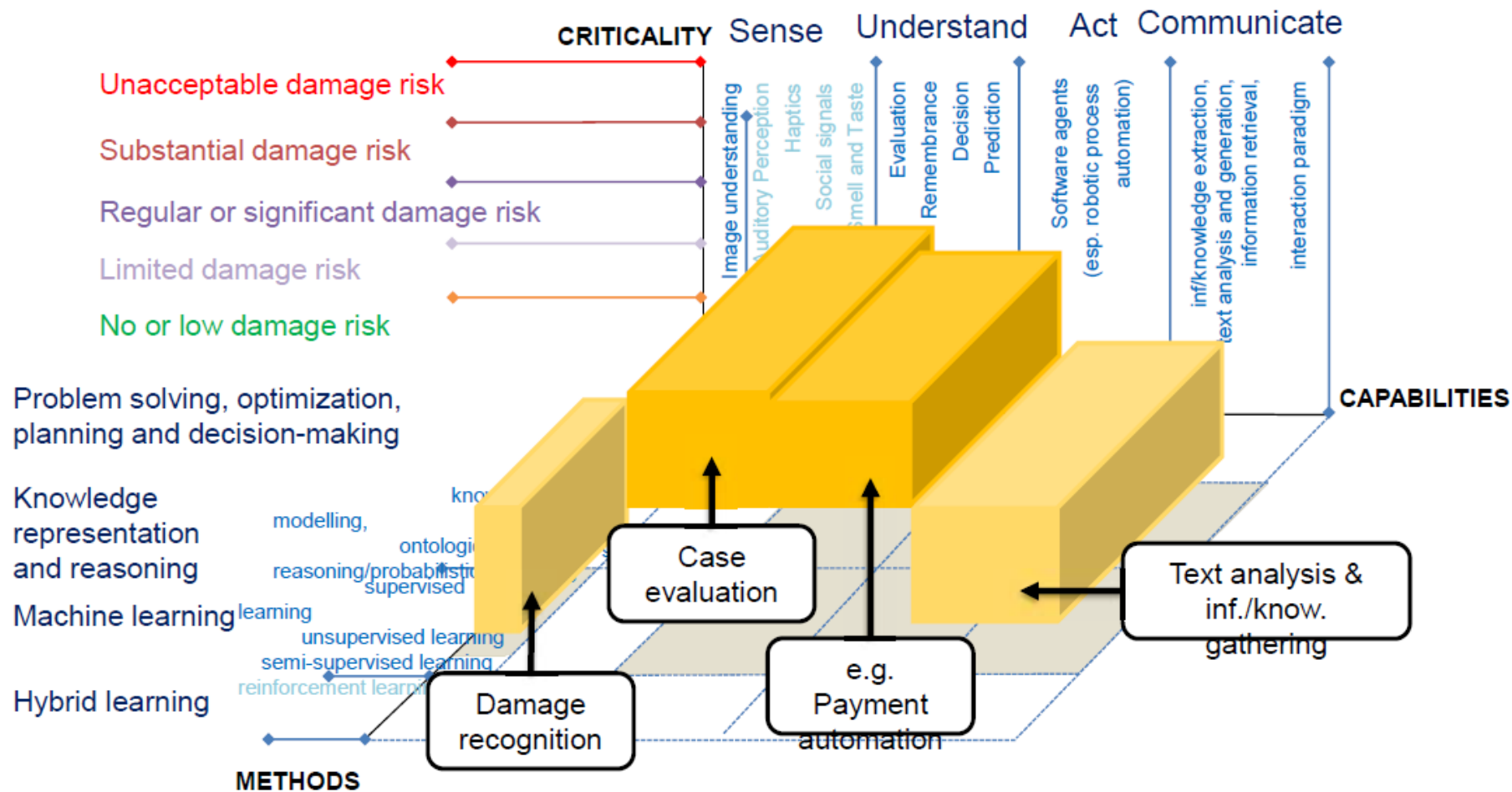
- Business and politics:
  - **Classification** of AI applications to describe AI systems
  
- Of importance for **European AI Regulation**:
  - **Homogeneity** to **describe** AI applications (Annex 1)
  - The **European AI database** (Art. 60)
  - Technical **Documentation** (Art. 11)
  - **Transparency** (Art. 13)
  
- The classification may serve as a basis for:
  - Harmonized **labeling** of **AI** applications
  - More **detailed description** of **requirements** for **all criticality levels** in the European legislative proposal
  - **Conformity assessment** procedures at **manufacturers** as well as third party bodies (including **laboratories** and **notified bodies**)
  
- Building on **Europe-wide harmonized taxonomy** for AI applications:
  - Identification of **quality** criteria
  
- **Requirements** for AI applications regarding:
  - **Conformity assessment** procedures
  - **Market surveillance**

Example: AI-based automation of claim management  
“Take a photo & get directly the reimbursement from the insurance”



# Example: AI-based automation of claim management

## Homogeneous description based on Methods, Capabilities & Risks





# HALTBARE FETTARME MILCH

Homogenisiert,  
ultraheißerhitzt

1,5 % Fett

Serierverschlag

Packaging by



	Durchschnittliche Nährwerte		
	Je 100 ml	1 Glas (250 ml)**	% (250 ml)*
Brennwert	116 kJ 47 kcal	495 kJ 118 kcal	6%
Fett	1,5 g	3,8 g	5%
- davon gesättigte Fettsäuren	1,1 g	2,8 g	14%
Kohlenhydrate	5,0 g	13 g	5%
- davon Zucker	5,0 g	13 g	14%
Eiweiß	1,4 g	8,5 g	17%
Salz	0,11 g	0,28 g	5%
Calcium	126 mg	300 mg	17%***
	175%***	338%***	

\*Referenzmenge für einen durchschnittlichen Erwachsenen (8.400 kJ / 2.000 kcal).  
\*\*1 Portion = 1 Glas (250 ml) Bio-Fettarme Milch.  
Die Packung enthält 4 Portionen.

- 75 % Karton aus nachwachsenden Rohstoffen
- + 25 % pflanzenbasierte Kunststoffe mit Mengenausgleich!
- + Verzicht auf Aju bei gleichbleibender Produktqualität

Im Rahmen der Verpackungs Herstellung kommen Kunststoffe zum Einsatz, bei deren Produktion im Rahmen von zertifizierten Massenbilanzverfahren fossile Ressourcen durch pflanzliche Rohstoffe ersetzt wurden. Diese Maßnahme trägt maßgeblich zu einer verbesserten Ökobilanz (CB-100732C vom 31.10.2018) bei. Mehr unter: [www.sigatarrpack.de](http://www.sigatarrpack.de)

## BARBECUE SAUCE

KAUCHIG-SÜSS

Natürlich ohne  
Geschmacksverstärker  
& Konservierungsstoffe

Durchschnittliche Nährwerte	pro 100 ml	RM* pro 100ml
Energie	547 kJ 129 kcal	7%
Fett	0,1 g	<1%
- davon gesättigte Fettsäuren	<0,1 g	<1%
Kohlenhydrate	30 g	12%
- davon Zucker	25 g	28%
Ballaststoffe	1,0 g	
Eiweiß	0,9 g	2%
Salz	2,6 g	43%

\*RM Referenzmenge für einen durchschnittlichen Erwachsenen (8400 kJ / 2000 kcal)

LAKTOSE  
FREI

GLUTEN  
FREI

1 Liter e



# **Proposal for a Common Classification of AI Systems based on Methods and Capabilities**

DIN/DKE NA043-01-42 GA:

Contribution for CEN-CENELEC JTC 21 ,Artificial Intelligence‘

