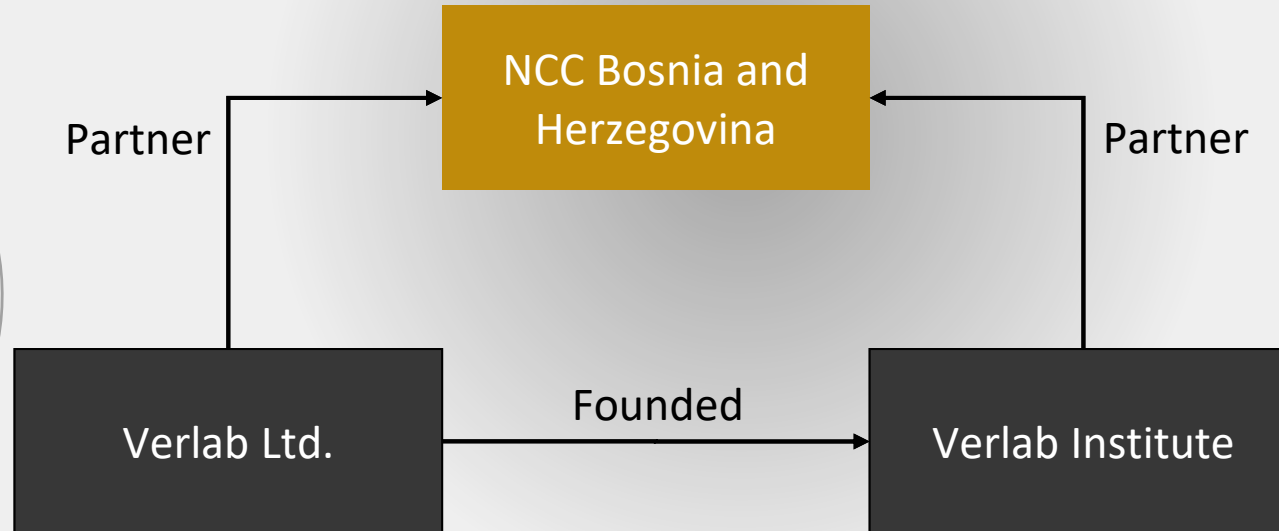# NCC Bosnia and Herzegovina

Dr. Lemana Spahić
5 Beats of Intelligence / AI MEETS HEALTHCARE
June 24th 2025

- **NCC in Bosnia and Herzegovina** is partnership between two institutions:
  - an SME, Verlab Ltd,
  - a research institute, Verlab Institute

International partnerships:
- EIT
- EuroCC
- WHO
- DIH

Partner

NCC Bosnia and Herzegovina

Partner

Affiliates:
- FusionX EDIH
- Center for Digital Transformation
- DMBIUBIH Affiliated NGO

Verlab Ltd.

Founded

Verlab Institute

Services offered by the NCC:

- **Training & education:** Workshops, seminars and specialised trainings, on HPC/HPDA/AI.

- **Consultations & advisory:** HPC/HPDA/AI readiness, innovation, feasibility, and solutions.

- **Grant & Research Support:** Assistance with national and international grant applications and academic collaborations.

- **Modeling & simulation:** Advanced consultancy on use of HPC/HPDA/AI.
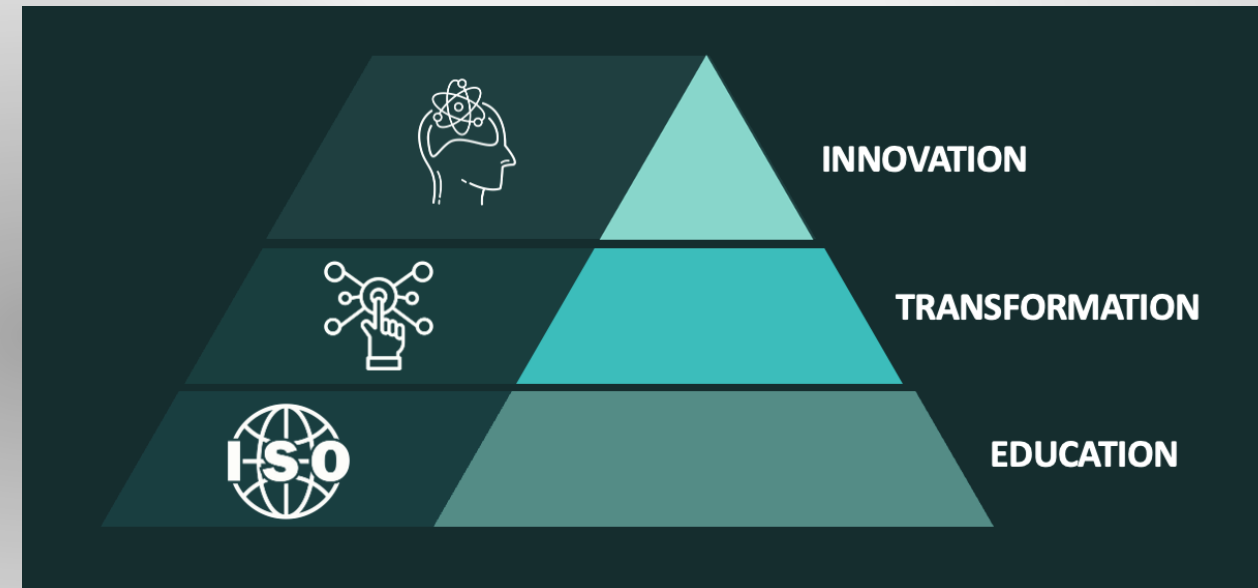
- The NCC organized workshops, roadshows, and events, engaging **568 participants across diverse sectors** such as bioinformatics, AI, climate protection, and healthcare. Notable events included:
  - **Bioinformatics** workshops (132 participants) demonstrating HPC's role in genomic and proteomic data analysis.
  - Sarajevo Roadshow (240 participants) focused on **climate protection** using advanced technologies.
  - AI in **Agriculture** workshop (80 participants) showcasing HPC applications in big data analysis for crop management and resource optimisation. These activities highlighted the diverse applicability of HPC and significantly increased awareness among target audiences.

- Highlights of Sarajevo Roadshow:

The NCC successfully organized a series of events showcasing HPC applications in various domains:

- The DAAD Summer School (50 participants) highlighted HPC in medicine and digital transformation of healthcare.

- The EIT Health Morning Talks (50 participants) in collaboration with EIT Health explored the role of big data in healthcare. These efforts significantly increased awareness of HPC's transformative potential and established a foundation for future capacity-building initiatives.

- In the 2024 the NCC:
  - organized **12 workshops** with **568 participants**
  - conducted **3 visits** to other NCCs *(Montenegro, Slovenia and Netherlands),*
  - awareness raising campaign - significantly expanding collaborations with SMEs, large enterprises, public administration, and academic institutions
  - transitioning HPC readiness assessments to practical implementation

- Overall, Year 2 has started with **greater engagement, stronger collaborations and a transition from initial assessments to implementation and deeper partnerships** across sectors.
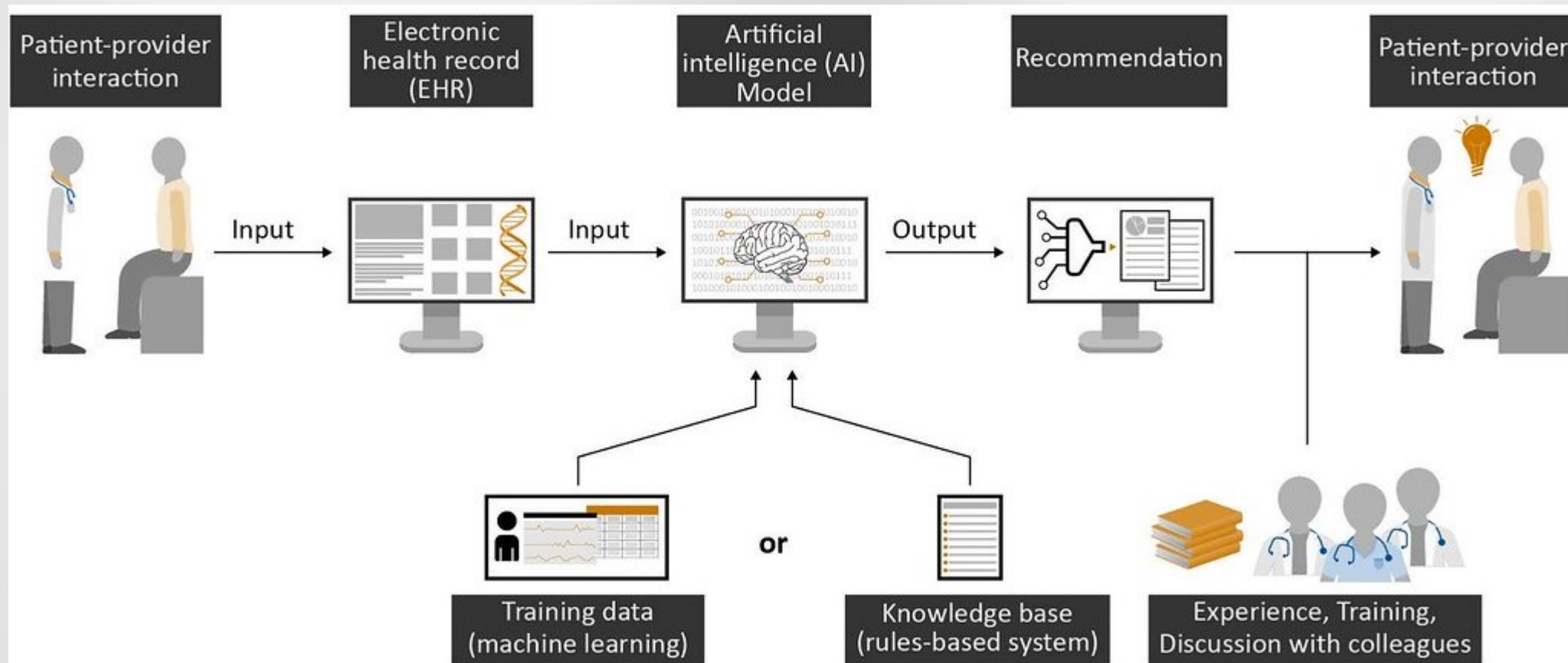
About me

- Double PhD in engineering
  - Genetics and bioengineering / „ Application of Artificial Intelligence in Ultrasound Imaging Classification of Infant Neurological Impairment Disorders"
  - Biomedical engineering / „Multiscale Model for Thrombosis / Atherosclerotic Plaque Formation and Progression"

- Fields of interest:
  - Standardization of post-market surveillance of medical devices
  - Applied AI in diagnostics
  - Applied AI in medical device performance assessment

- References:
  - 80+ research contributions
  - President of the Order of Young Scientists of the International Academy of Sciences and Arts of Bosnia and Herzegovina
  - Secretary general of IEEE working groups P2727

Overview

- Introduction

- AI for diagnostics
    - „ Application of Artificial Intelligence in Ultrasound Imaging Classification of Infant Neurological Impairment Disorders"

- AI for medical device performance assessment
    - Smart medical device management
    - Infant incubator case study

AI and decision support systems in healthcare

APPLICATION OF ARTIFICIAL INTELLIGENCE IN ULTRASOUND IMAGING CLASSIFICATION OF INFANT NEUROLOGICAL IMPAIRMENT DISORDERS
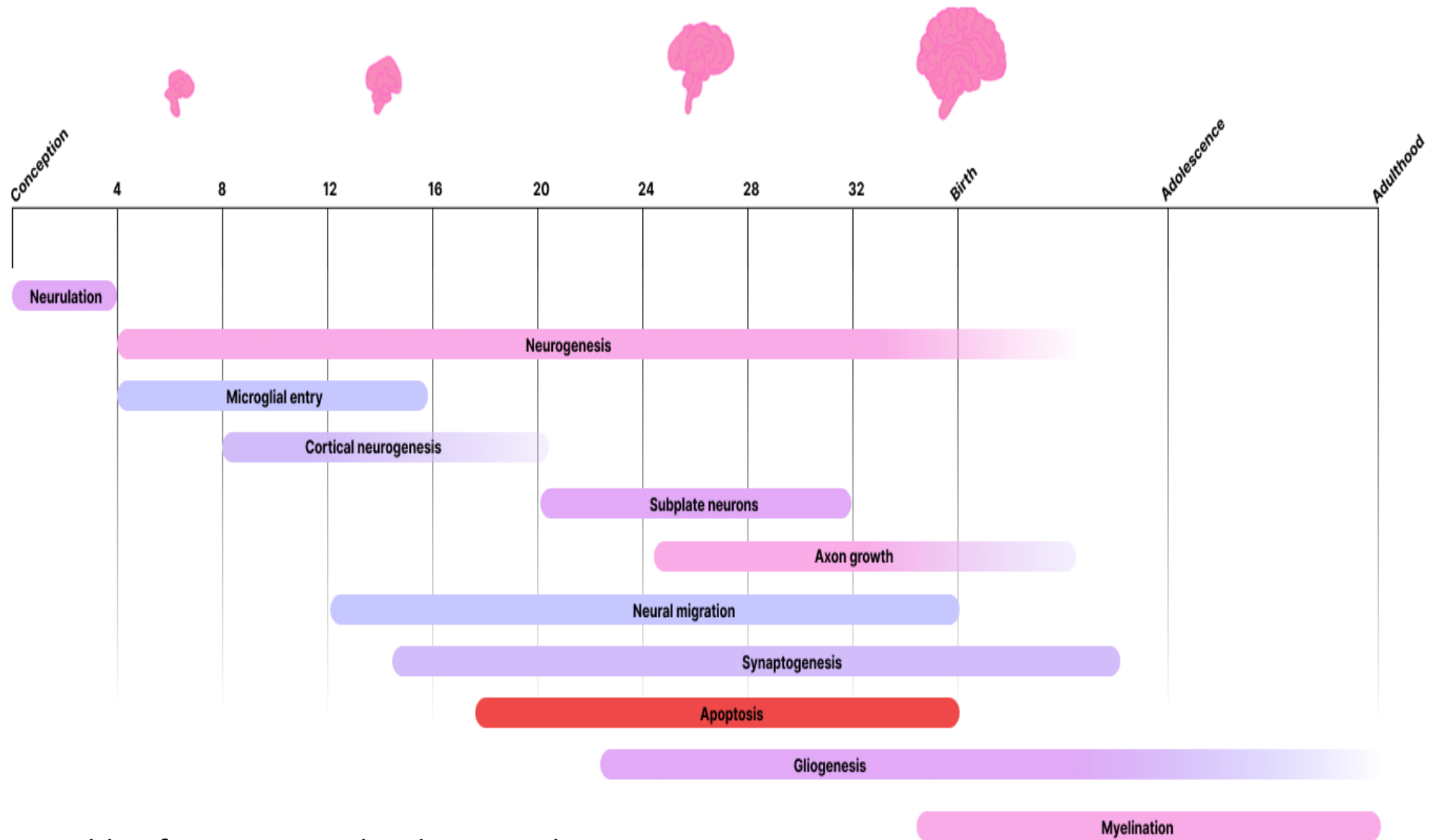
EURO 4SEE

EURO 4SEE

BIOMEDICAL ENGINEERING

CLINICAL ENGINEERING

ARTIFICIAL INTELLIGENCE

FETAL NEUROLOGY

Timetable of major neurodevelopmental events

Neurological Impairment Disorders

EURO 4SEE

- Most common neurological impairment disorders are:
  - Stroke
  - Neonatal encephalopathy
  - Migraine
  - Dementia
  - Meningitis
  - Epilepsy
  - Neurological complications associated with preterm birth
  - Nervous system cancers
  - Autism spectrum disorders
  - Parkinson's disease
  - Cerebral palsy

Table 1. Incidence of neurological impairment disorders in Europe

| Region	Population	Prevalence of neurological diseases	Deaths due to neurological disease
European Union (EU28)	512,355,000	307,859,199	1,116,038
Western Europe	432,969,000	260,827,756	892,162
Central Europe	114,803,000	67,368,506	300,317
Eastern Europe	210,199,000	130,372,328	604,144
WHO Region Europe	925,631,000	542,935,521	1,981,463

Research hypothesis

EURO 4SEE

AI can be effectively used for analysis of 3D and 4D ultrasound recordings of fetuses

Fetal neurodevelopment can be assessed by combining KANET test score with artificial intelligence
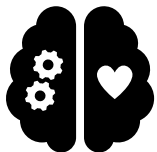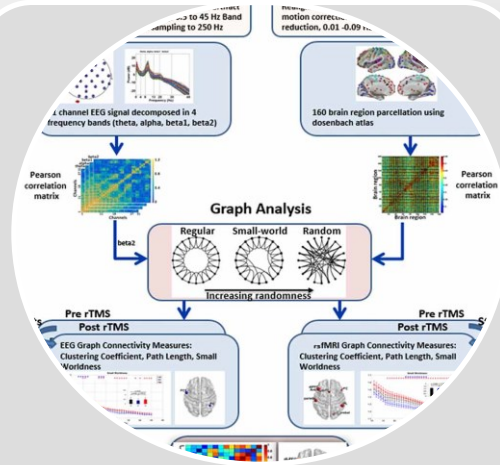
By monitoring fetal movements in the womb with ultrasound and AI, we can tell normal from abnormal neurodevelopment
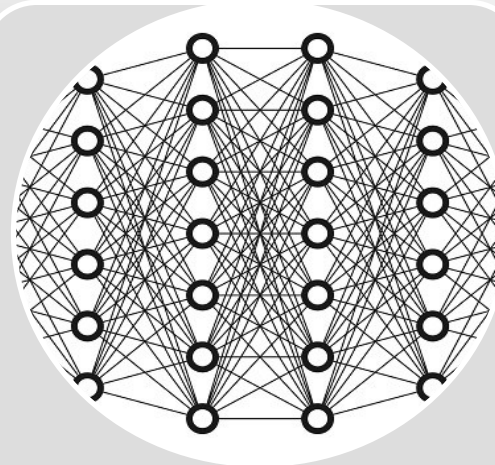
Methodology workflow
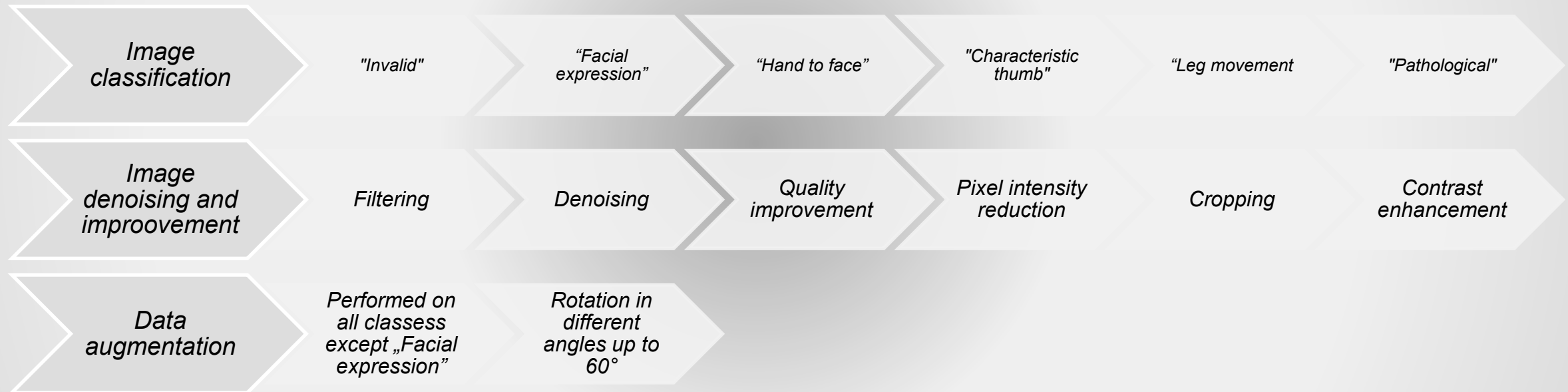

Data gathering

Data preprocessing

Deep learning model

Graphical user interface design

Data preprocessing

4SEE

| Image classification	"Invalid"	"Facial expression"	"Hand to face"	"Characteristic thumb"	"Leg movement	"Pathological"
Image denoising and improovement	Filtering	Denoising	Quality improvement	Pixel intensity reduction	Cropping	Contrast enhancement
Data augmentation	Performed on all classess except „Facial expression"	Rotation in different angles up to 60°				

Deep learning model

- Some of the most popular ready-to-use architectures such as VGG13 and VGG19 were tested on the dataset of this dissertation.

- However, the network has shown significant overfitting when using these architectures.

- Hence, custom CNN architecture was developed for the purpose of this dissertation.

- Over 100 iterations of the CNN were performed in order to test a multitude of different combinations of:
  - Number of convolutional layers
  - Number of filters
  - Number of neurons in each layer
  - Activation functions of convolutional layers
  - Activation functions of fully connected layer

TRUEAID validation

Class	Specificity (TNR)	Sensitivity (Recall / TPR)	Precision (PPV)	NPV	Accuracy	F1 Score	MCC
Face	0.98	1.00	0.95	1.00	0.94	0.97	0.97
Hand to face	0.97	0.89	0.8947	0.97	0.95	0.89	0.87
Legs	1.00	0.94	1.00	0.98	0.98	0.97	0.96
Thumb	0.98	0.93	0.95	0.97	0.97	0.94	0.90
Overall	0.98	0.94	0.95	0.98	0.96	0.95	0.89
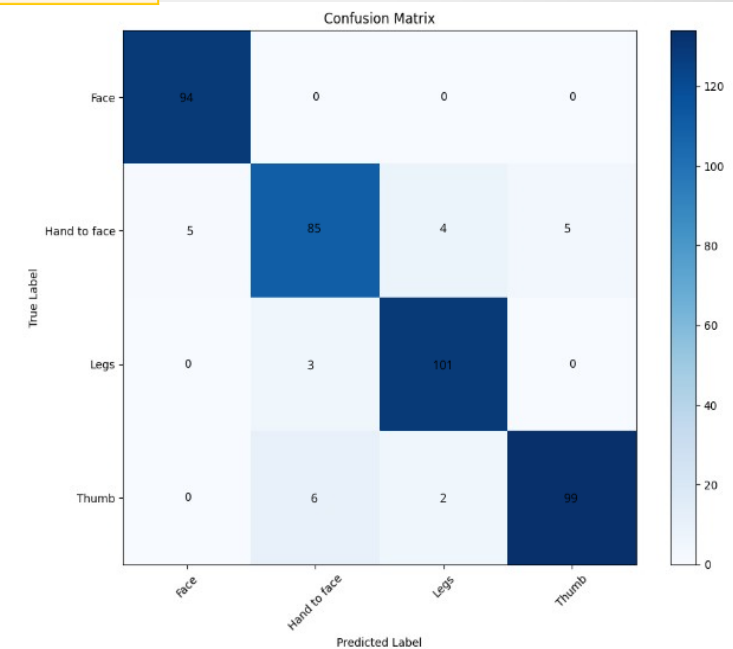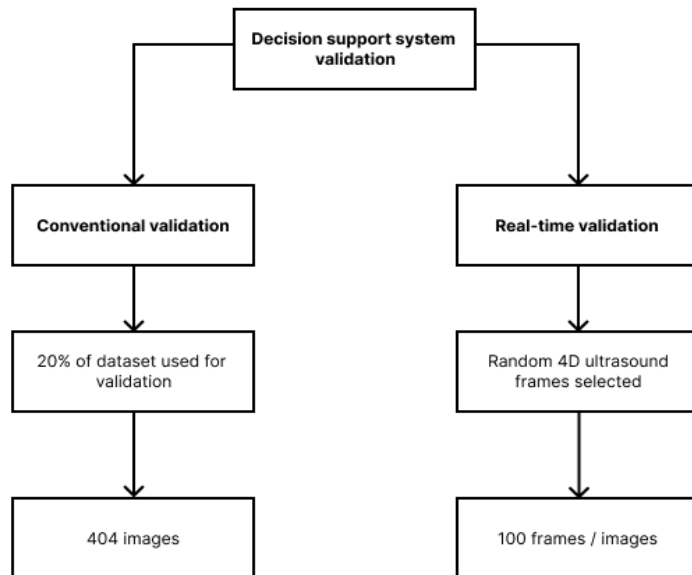
TrueAID vision
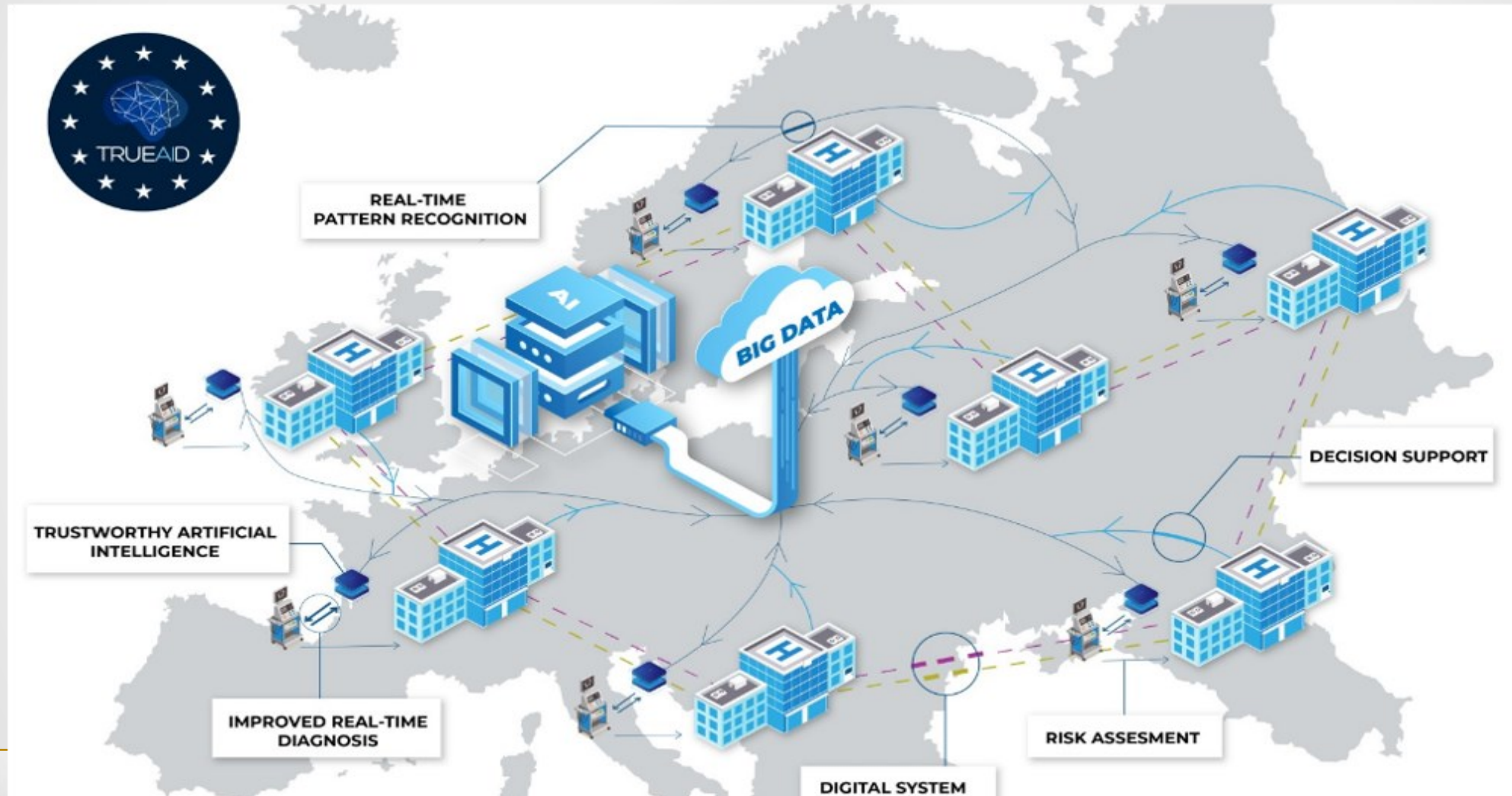
TrueAId Impact

The developed solution goes beyond the state of the art in neurodevelopmental risk assessment and disease prediction, demonstrating a **high innovation potential**, as it examines **novel concepts in the field of digital health and integrated care in neurological diseases**, testing a new digital health tool service.

TRUEAID solution is based in an **interdisciplinary approach** where engineering and medicine are perfectly intertwined with a joint aim of **making fetal neurodevelopmental risk assessment available for all.**

The solution enables **streamlining of neurodevelopmental risk assessment** resulting in enhanced capacities for early diagnosis and timely intervention.

The **long-term impact** of the project is multifaced, starting with strengthening diagnostic capacities, improving neurodevelopmental disorder treatment workflows and **diminishment of morbidity and mortality from neurological impairment disorders.**

AI for medical device management

HEALTHCARE SYSTEM AND PATIENTS - WORLDWIDE

- *Patient goes under a series of tests;*
- *Results of the tests are* **measurements - the numbers, graphs or images gathered using all sorts of medical devices** *used in making a diagnosis and delivering treatments.*
- *No standardized measurement and/or data.*

- **The doctor, the patient, family members and other medical staff rely on test results!**

IN GOD WE TRUST
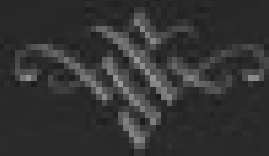
ALL OTHERS MUST BRING DATA

Key components of PMS

1. Data Collection and Monitoring:

User feedback, clinical studies, and device registries.

2. Risk Assessment and Analysis:

Evaluate complaints, trends, and incidents.

3. Corrective and Preventive Actions (CAPA):

Address issues and prevent recurrence.

4. Documentation and Reporting:

Maintain records and report incidents to regulators.

Data collection and monitoring

Purpose: Collect real-world data to assess device performance and safety after market release.

- Collect real-world data to assess device performance and safety after market release.

Sources of Data:

User Feedback:

- Reports from healthcare providers and patients.

Clinical Studies:

- Ongoing trials and observational studies.

Device Registries:

- Centralized databases tracking device usage and outcomes.

Complaint Handling Systems:

- Logs of malfunctions, errors, and user complaints.

Goal:

- Early identification of trends or issues to improve safety and performance.

Future trends

AI and Big Data Analytics:

Enables real-time monitoring of devices.

Detects patterns and anomalies faster.

Predictive Analytics:

Uses machine learning to forecast potential failures or risks.

Reduces reliance on reactive approaches.

Cloud-Based Systems:

Facilitates centralized data storage for better accessibility.

Allows automated reporting and compliance tracking.

Blockchain Technology:

Enhances data security and traceability.

Ensures transparency in data sharing across stakeholders.
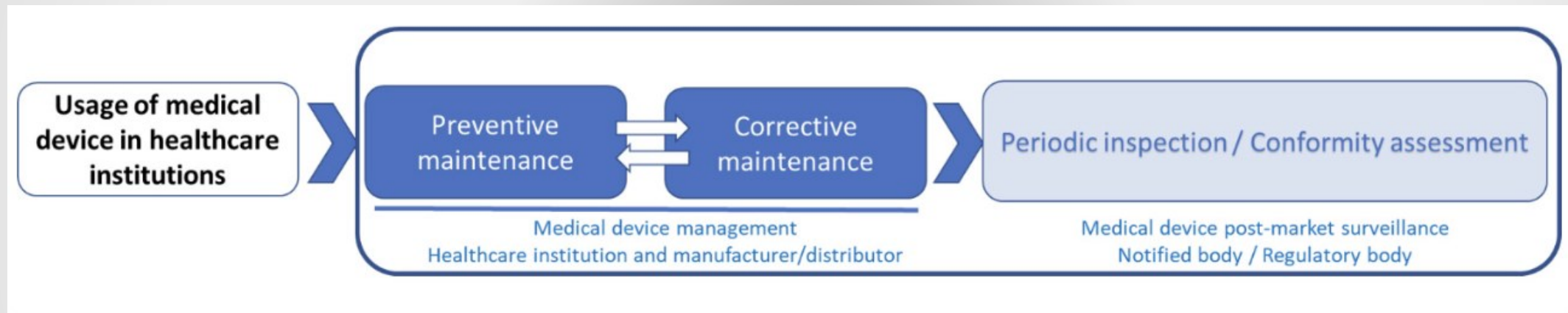
Impact:

Improved risk management and compliance efficiency.
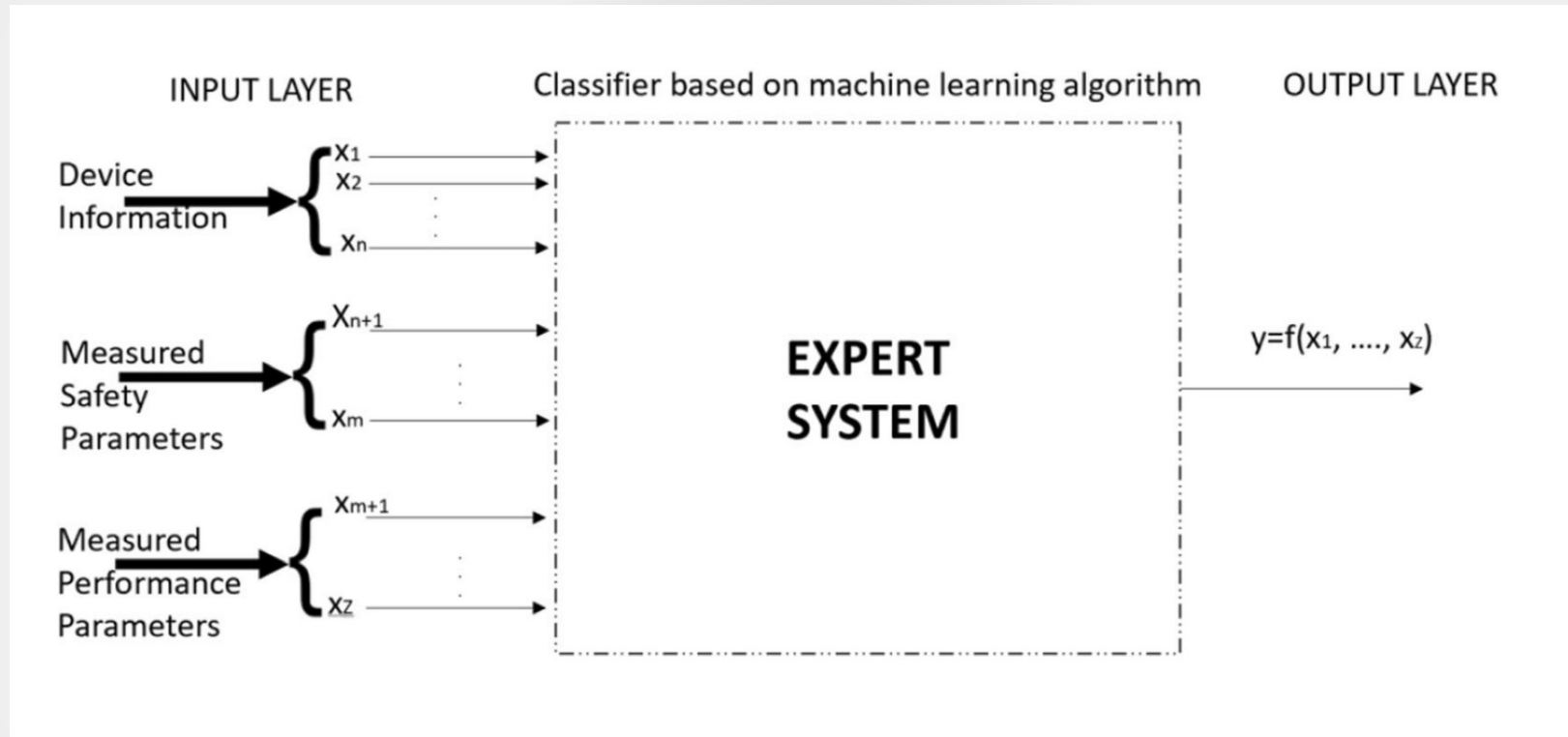
Faster response to safety concerns and better patient outcomes.

What is the problem?
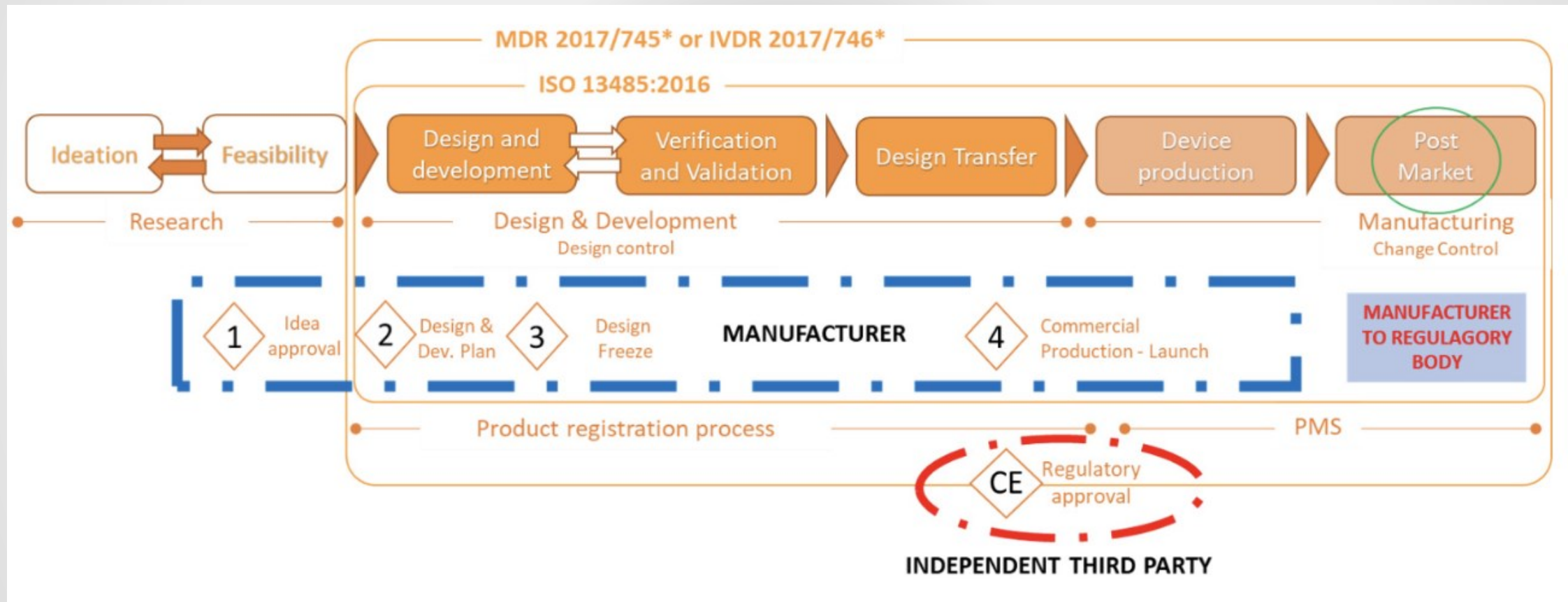
Suggested methodology

AI for medical device management:
Infant Incubator Case Study

AI for medical device management: Infant Incubator Case Study

Table 2 System training and validation performance

Classifier	Accuracy (%)	
	Training	Validation
Naïve Bayes (NB)	89.8%	89.5%
Decision Tree (DT)	99.5%	98.5%
Random Forest (RF)	98.8%	94.0%
k-Nearest Neighbour (k-NN)	89.2%	89.6%
Support Vector Machine (SVM)	90.5%	91.0%

Where do we go from here?

Predictive failure detection

Anomaly detection in real-time

Optimization of maintenance schedules

Resource allocation and inventory forecasting

Feedback loops for device design improvement

- We established a website with a mailing list and a newsletter. We are dedicated to establishing an alliance between Industry, SMEs, academia and NGOs that will establish HPC ecosystem and use HPC infrastructure

Website:
https://ncchpcbih.verlabinstitute.com/

Thank you for your attention!