YOUR GLOBAL **MOBILITY**
ENGINEERING EXPERTS

AI @ EDAG-CAE

22.04.2024

EDAG

ARTIFICIAL INTELLIGENCE
INSIGHTS AI

AI enables companies to develop new customer services and products, achieve competitive advantages through increased efficiency, establish data-driven decision-making, and achieve customer-centricity through personalization.

EDAG acts as the ideal development partner throughout the entire product lifecycle of the AI application. Main focus:

Computer Vision (CV)

- Enabling machines to interpret, analyze, and understand visual information such as images, videos and sensor data (f.e. LIDAR).

→ **Most relevant:** Image classification, object detection, object detection

Natural Language Processing (NLP)

- Ability of computer systems to understand, interpret and generate human language (spoken and written) in a way that is meaningful and useful.

→ **Most relevant:** Language understanding, summarization, sentiment analysis, translation

Data Analytics

- Using AI techniques to analyze large volumes of data, extract valuable insights, patterns, and trends, and make data-driven decisions.

→ **Most relevant:** Predictive Analytics, Customer Segmentation, Supply Chain Optimization

ARTIFICIAL INTELLIGENCE **PRODUCT-PORTFOLIO FOR AI-ENGINEERING**

Data Engineering

- **Collection**
  - Analysis & validation
  - Tool automation & scripting
  - Generation of Data
- **Pre-Processing**
  - Data Pruning and filtering
  - Generalization
  - Augmentation
- **Transformation**
  - Adaptation for the model
  - Machine readability

Architecture Engineering

- **Conception**
  - Definition of basic architecture (System and SW)
  - Analysis of optimal neuronal network type
  - Dependence of the data for the target function
- **Aggregate**
  - Extension of the basic architecture
  - Merging from different intermediate layers

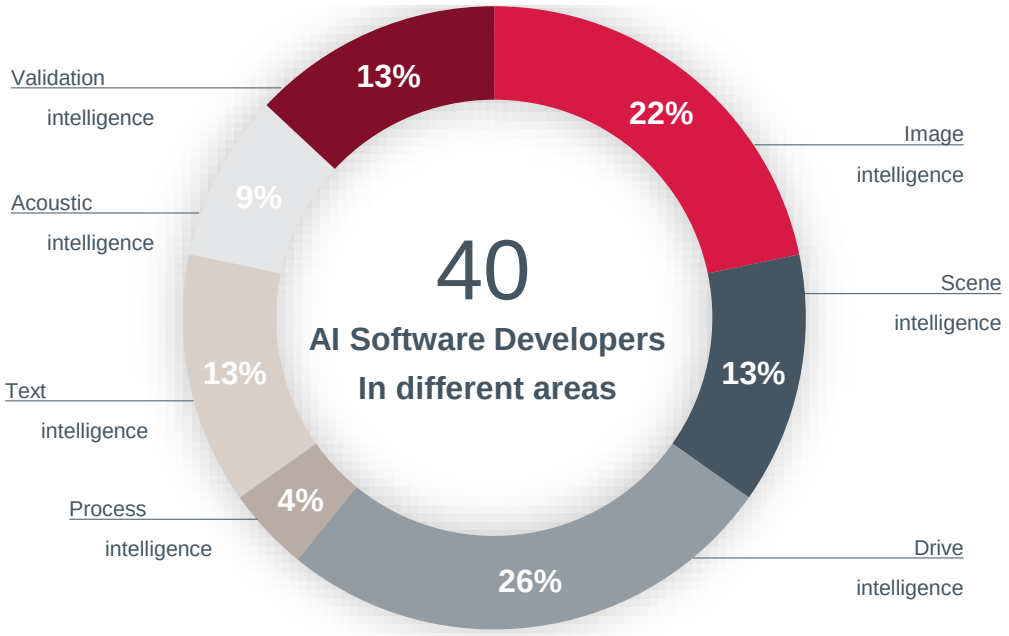
Net Engineering

- **Optimization**
  - Hyperparameter
  - Run-time
  - Memory
  - Performance
- **Compression**
  - Pruning
  - Quantization
- **Porting**
  - Embedded
  - Real-time capability

Consulting

- **AI-Assessment**
  - We test and identify together with you use cases of AI in your company
  - We create an overview and potential list
- **Proof-of-Concept**
  - Practical first implementation of prototypical AI applications
  - Experience in dealing with AI is generated in your company

ARTIFICIAL INTELLIGENCE
AI COMPETENCE SUMMARY

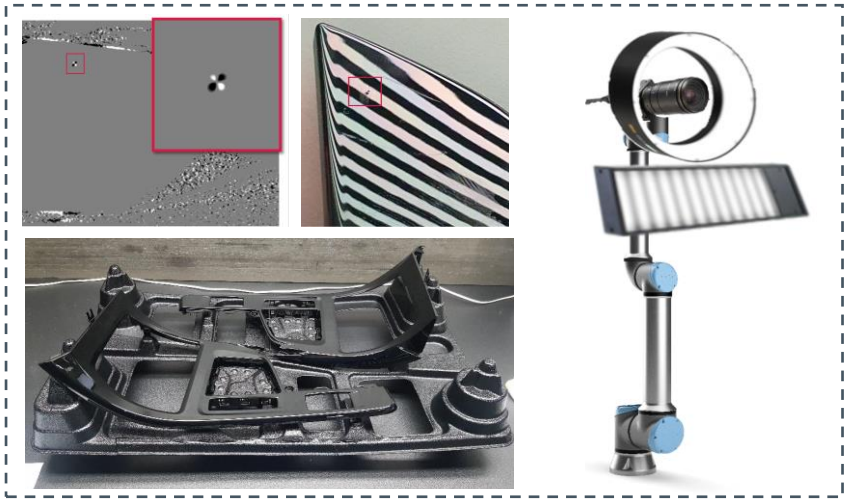


- **Image intelligence**
  - Object Detection & Tracking
  - Pose estimation
  - Image Segmentation
  - Data Fusion
- **Scene intelligence**
  - Ground Truth
  - Prediction / analysis of bus communication
  - Geotagged data processing
- **Drive intelligence**
  - Trajectory planning
  - Route optimization
  - Accelerating, breaking, steering
  - Traffic flow control
  - Behavior prediction
- **Acoustic intelligence**
  - Speech to Text to Speech (external service)
  - Sound analysis (siren etc.)
- **Text intelligence**
  - Latent semantic analysis (LSA)
  - Topic Modelling
  - Sentiment Analysis
  - Framing Analysis
  - Text Analysis / Similarity analysis
- **Validation intelligence**
  - Virtual protection
  - Scene generation
  - Maneuver generation
- **Process intelligence**
  - Production & Logistic: Optimization, Prediction

PROJECT REFERENCES AI@EDAG

FULLY AUTOMATIC RECOGNITION AND MARKING OF PAINT COAT DEFECTS

EDAG-Portfolio	Smart Factory
Customer	Tier 1
Project type	Technical concept
Duration	11/2019 – 03/2020
Team Size	3 EMP
Location	EDAG Ulm - Lindau / Production Solutions



Objective

Efficient, automatic and accurate recognition and marking of paint coat defects across various types of automotive interior and exterior parts.

Activities / Highlights

- Fully Automatic Inspection and Marking of paint coat defects of many kinds of automotive interior and exterior parts
- Deals with surfaces from dark black matte up to high glossy and extremely reflective
- Detects defects with the help of Computer Vision Algorithms and AI
- Provides 3-dimensional location of the defect
- Marks defects with marking spray for quality management
- Uses several robots and a motorized production line for handling of all parts

Tools / Technologies

- AI-Techniques: Deep Neural Networks
- Prog. Language: C/C++ Matlab Python
- Software: Pytorch OpenCV Tensorflow Spacy Keras NVIDIA CUDA
- Hardware: FPGA HD-Camera
- AI - Portfolio: Computer Vision | Natural Language Processing | Data Analytics

DIFOREM – DIRT & FOG REMOVAL

EDAG-Portfolio	Advanced driver assistance system
Customer	EDAG - Business unit (SW&D)
Project type	Innovation / Research
Duration	03/2019 – 12/2019
Team Size	2 EMP
Location	EDAG Lindau / Ulm

Method 1

Impurification on lens shown as white areas

Image restored by Artificial Intelligence

Method 2

Objective

Realtime contamination detection, masking and reconstructing of camera pictures

Activities / Highlights

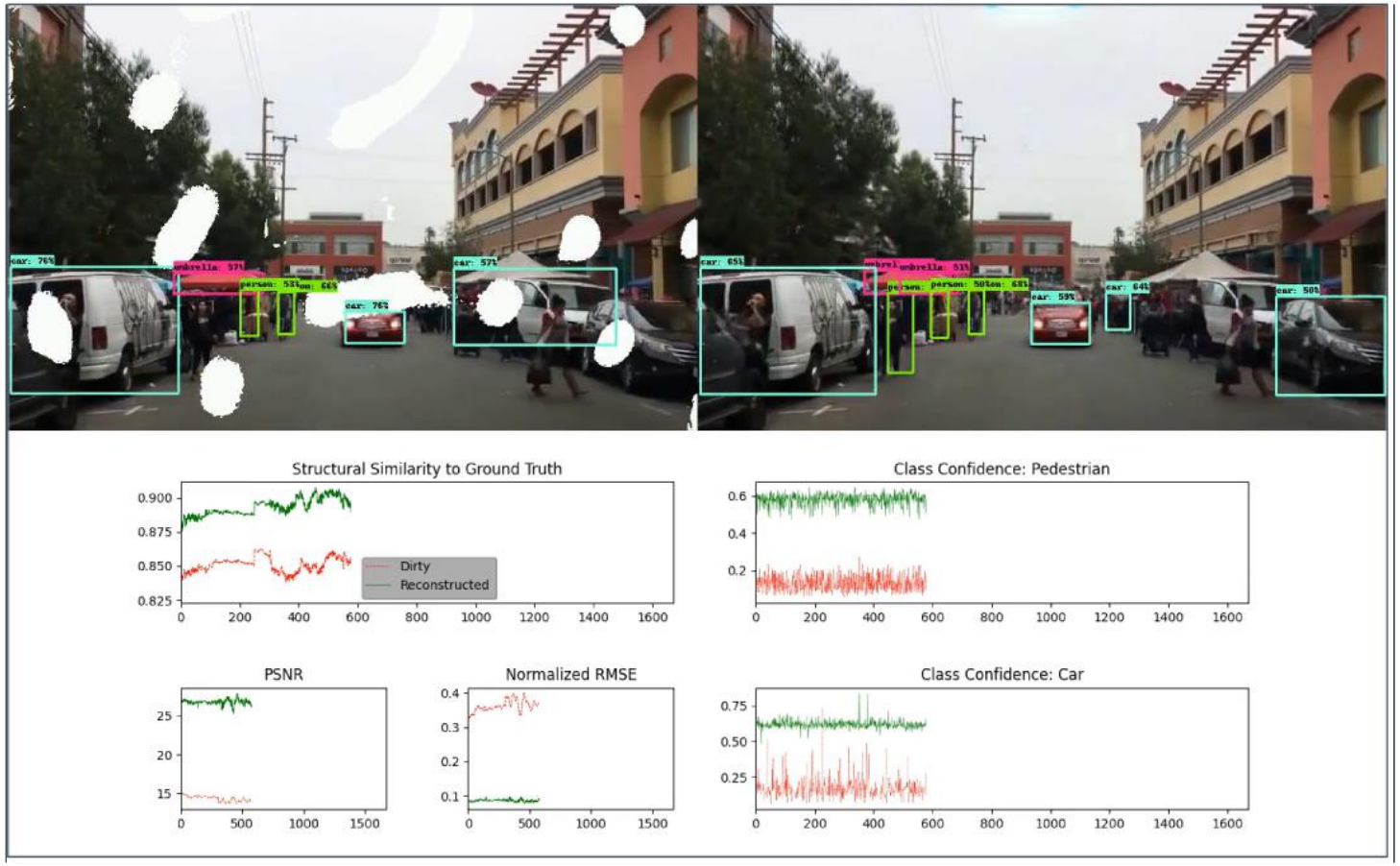
- Environment and scene agnostic artifact and contamination removal
- Robust image restoration and reconstruction
- Ensures image quality and information density
- Deep Scene understanding combined with synthesized image structures for improved reconstruction

Tools / Technologies

- AI-Techniques: Deep Neural Networks, Partial Convolutional LSTM
- Prog. Language: Python
- Software: Nvidia Drive AGX, Tensorflow, Keras
- Hardware: Demonstrator Hardware, NVIDIA GeForce 2080 Ti
- AI - Portfolio: Computer Vision, Natural Language Processing, Data Analytics

REFERENCE : DIFOREM. – DIRT & FOG REMOVAL

EDAG is actively researching solutions to optimize sensor data quality in real driving scenarios.



CAMPUS FREE CITY – AUTOMATED DRIVING

EDAG-Portfolio	Smart City
Customer	Government
Project type	Innovation / Research
Duration	12/2021 – 12/2023
Team Size	4 EMP
Location	EDAG Ulm/Lindau

Objective

ADAS function development in the overall vehicle context and real scenarios

Activities / Highlights

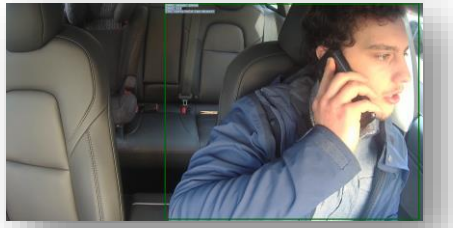
- *Sensorfusion* of collected Data (Camera, Lidar).
- Realtime and robust *object detection and classification* of the environment and objects.
- *Mapping* of the dynamic real-world information (objects; obstacles) and the static road knowledge.
- *Trajectory planning:* Determining a safe and efficient path for the vehicle. Based on the detected objects and the map information.

Tools / Technologies

- AI-Techniques: Deep Neural Networks | Decision Tree | SVM | Regression
- Prog. Language: C/C++ | Matlab | Python
- Software: Tensorflow | Keras | COCO-Database
- Hardware: HPC | HD-Camera | LIDAR Sensor | Canbus
- AI - Portfolio: Computer Vision | Natural Language Processing | Data Analytics

H.A.R.D. – HUMAN ACTION RECOGNITION AND DETECTION

EDAG-Portfolio	Advanced driver assistant system
Customer	EDAG – Business unit (SW&D)
Project type	Innovation / Research
Duration	06/2020 – 01/2021
Team Size	2 EMP
Location	EDAG Ulm/Lindau



Objective

Detection of human actions in a given video

Activities / Highlights

- Recognition of 100 distinct human actions
- Fully automated inference and output video generation
- Recognition performance invariant to camera movements and scenes
- Robust accuracy even with low video resolution and quality

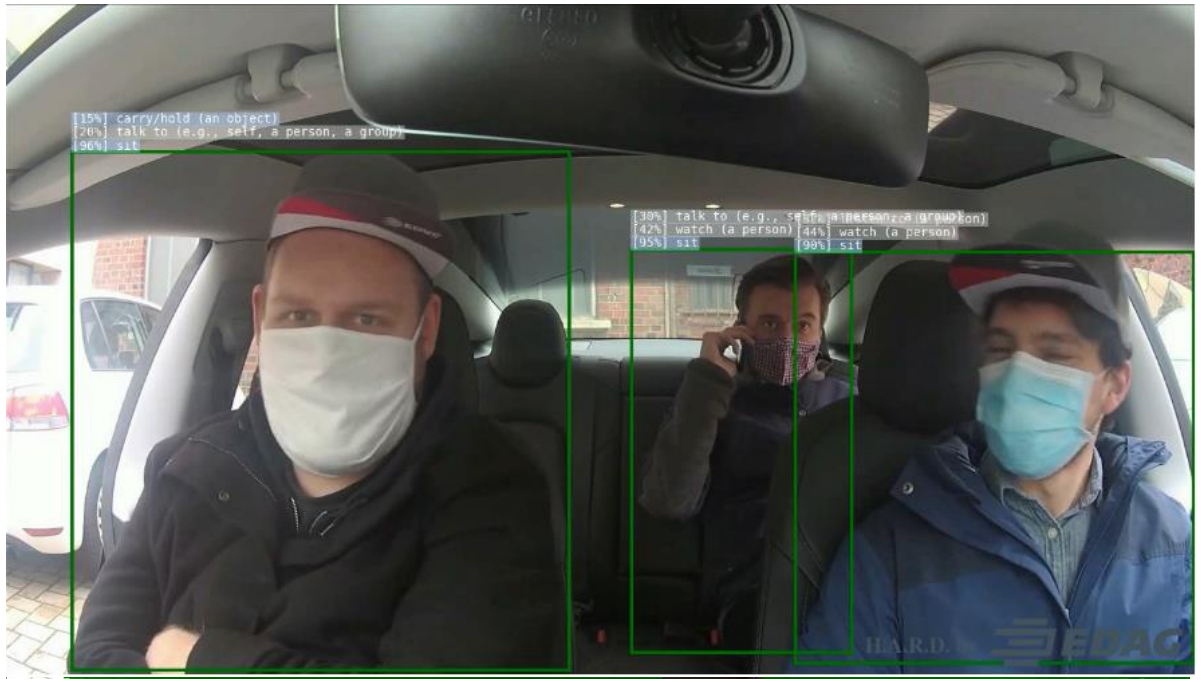
Tools / Technologies

- AI-Techniques: Deep Neural Networks, SlowFast Networks
- Prog. Language: C/C++, Matlab, Python
- Software: Pytorch, OpenCV, Tensorflow
- Hardware: FPGA, HD-Camera, NVIDIA Jetson, Canbus
- AI - Portfolio: Computer Vision, Natural Language Processing, Data Analytics

REFERENCE : H.A.R.D. – HUMAN ACTION RECOGNITION AND DETECTION

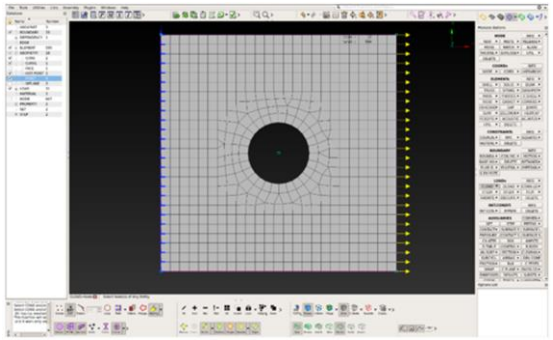
EDAG is capable to train and develop highly complex computer vision algorithms.

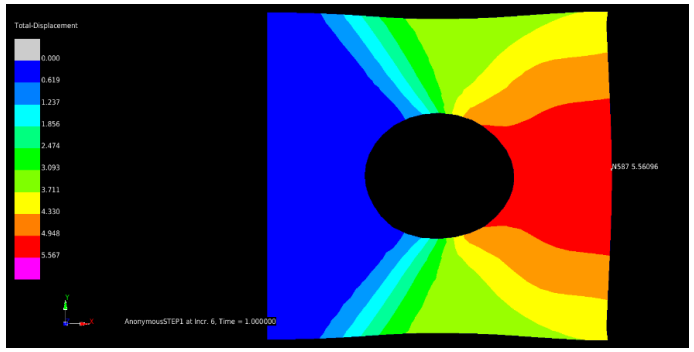
HARD tracks several objects in real time and identifies the actions performed.

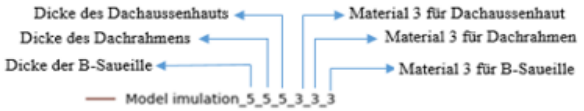


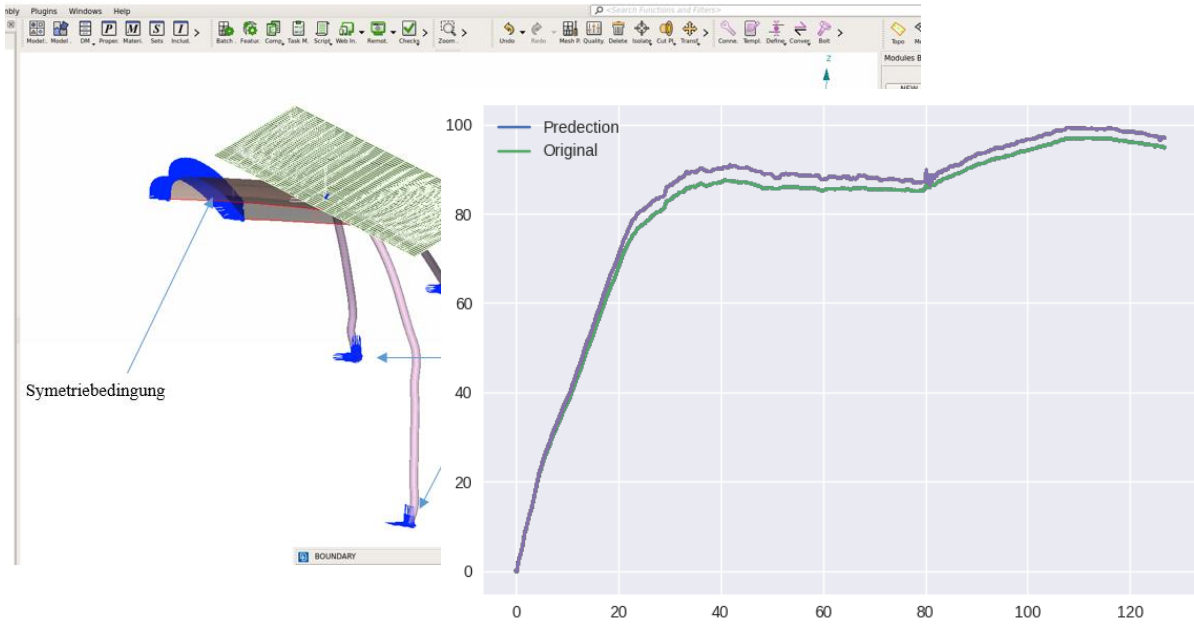
AI IN CAE
AI@EDAG

AI @ EDAG-CAE
2018 – FIRST STEPS



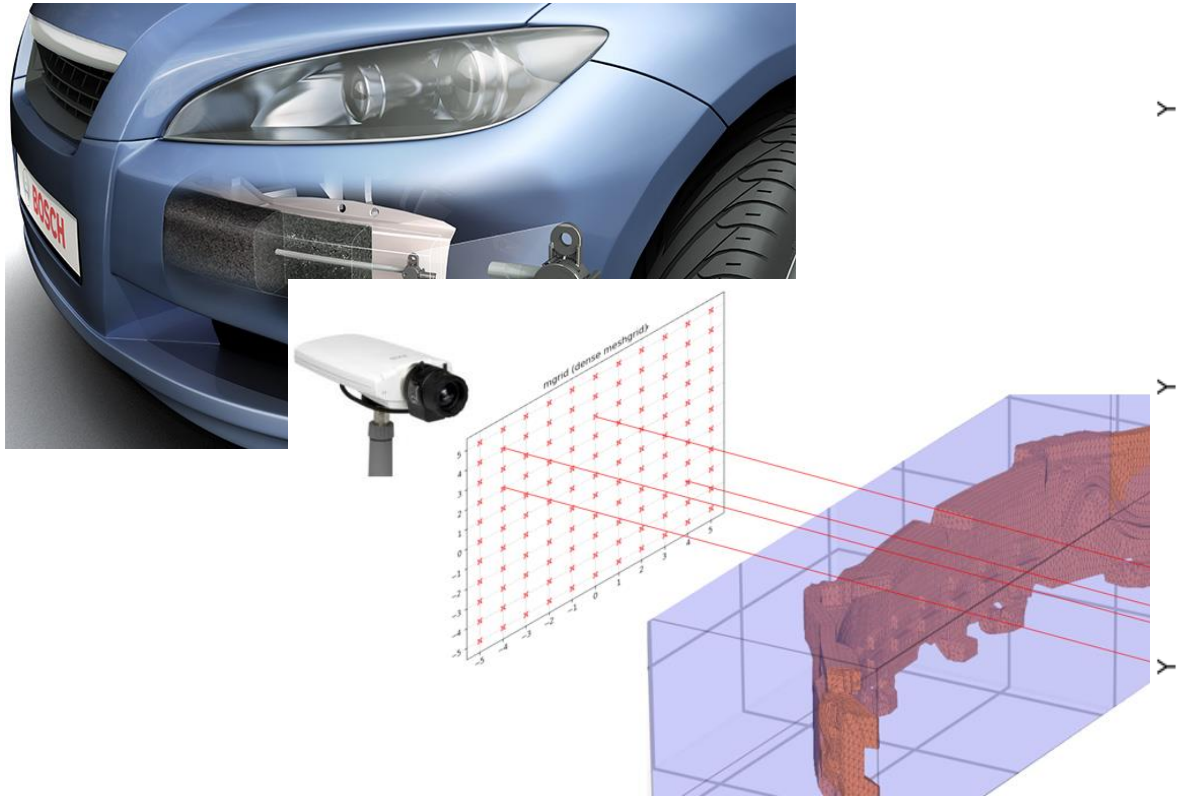


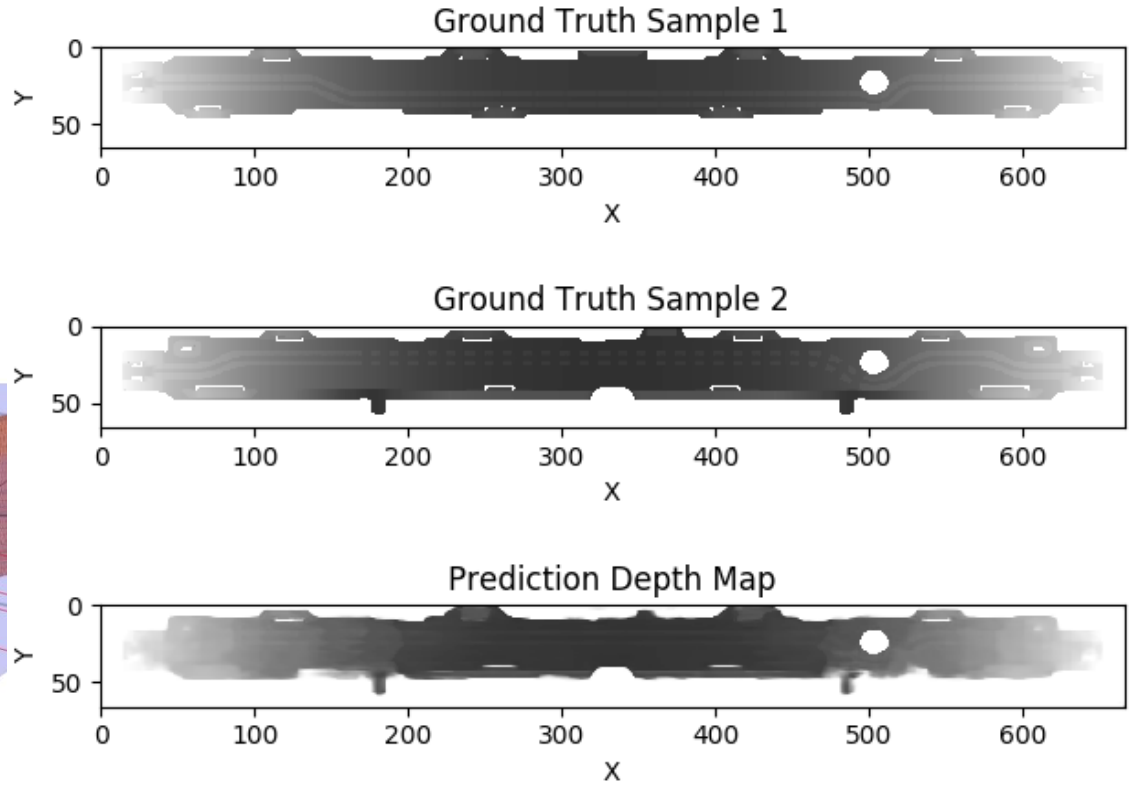




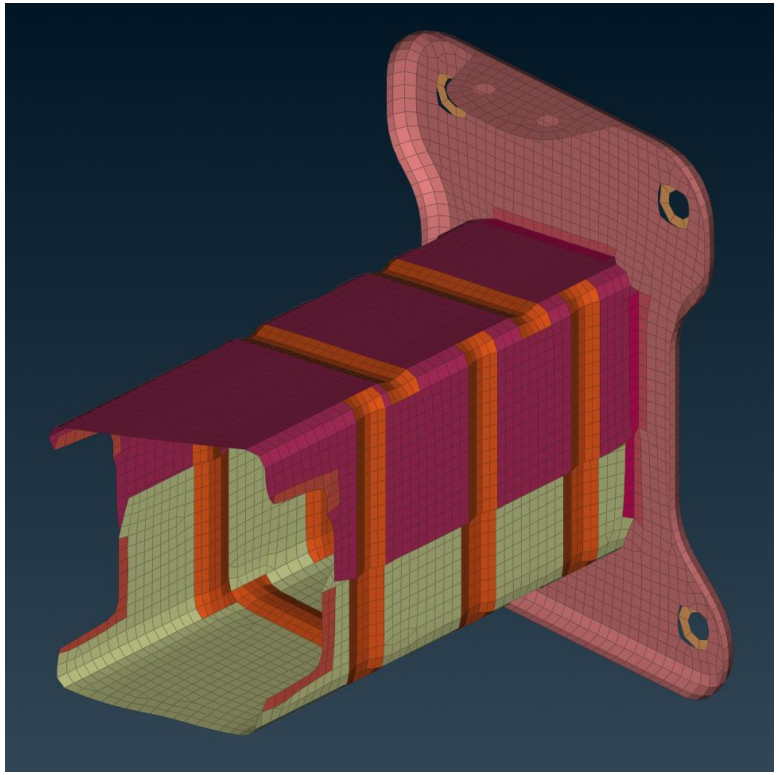
ARTIFICIAL INTELLIGENCE
USECASES IN ENGINEERING

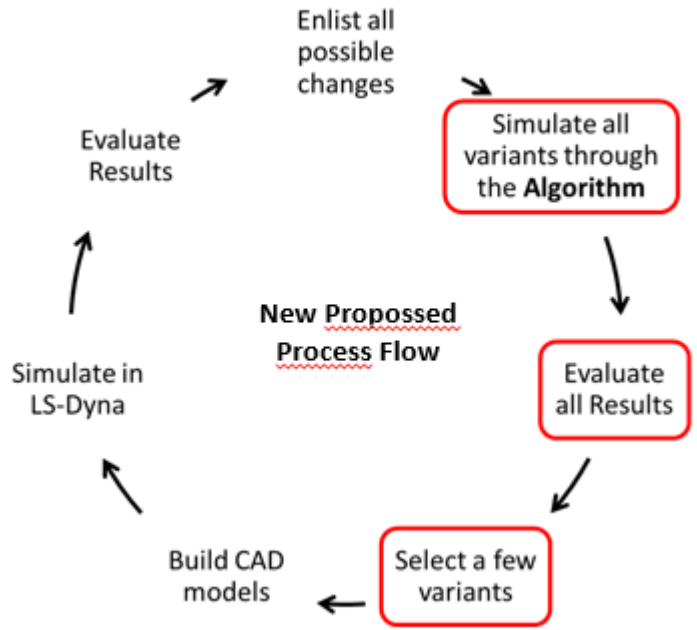
Our first steps in Pedpro





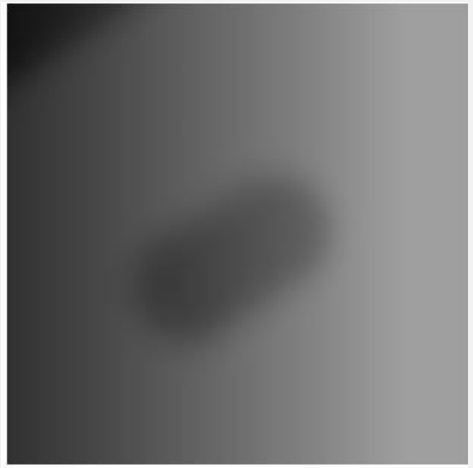
Design Optimization of Crash Box using Reinforcement Learning

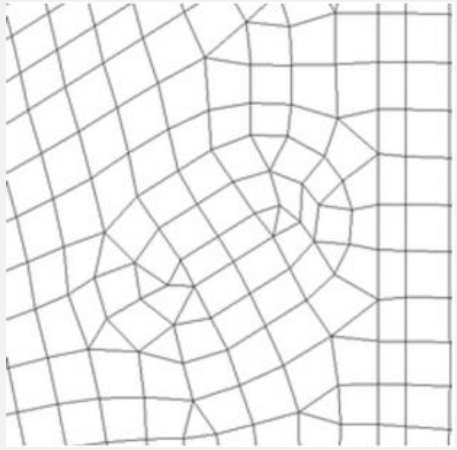




ARTIFICIAL INTELLIGENCE
USECASES IN ENGINEERING - MESHING

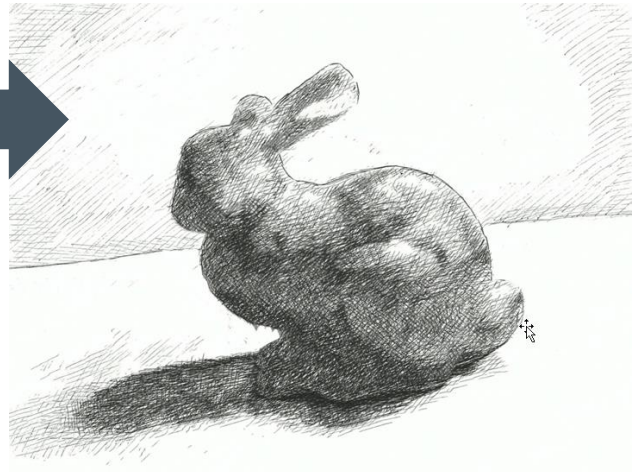
“Meshing” of CAD-Data with methods of image processing





ARTIFICIAL INTELLIGENCE
USECASES IN ENGINEERING - MESHING

Convolutional neural network – CNN for graphic rendering



General	Training input		Input	Output
Graphic	General object	Drawing style	New general object	Final result
FEM	CAD data	Correct mesh	New CAD data	Mesh

“Meshing” of CAD-Data with methods of image processing

ARTIFICIAL INTELLIGENCE
USECASES IN ENGINEERING - MESHING

CLASSIC PROCEDURE

PRE-PROCESSING SW

MANUAL WORK: CAD input → AUTOMATIC: Mid Surf generate → MANUAL WORK: Free mesh → MANUAL WORK: Reconstruct → MANUAL WORK: Quality criteria → MANUAL WORK: Manual Correction → Final Mesh

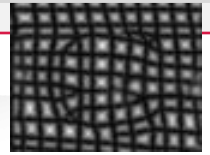
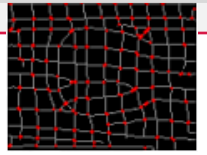
AI PROCEDURE
(CURRENT PROJECT)

PRE-PROCESSING SW

MANUAL WORK: CAD input → AUTOMATIC: Mid Surf generate

EDAG AI software

AUTOMATIC: 2D transformation → AUTOMATIC: Convolutional neural network → AUTOMATIC: Image processing

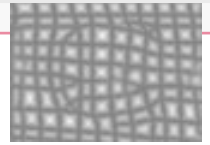
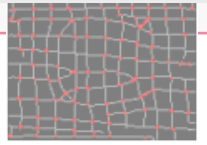
PRE-P. SW

Final Mesh

AI PROCEDURE
(FUTURE)

One click solution

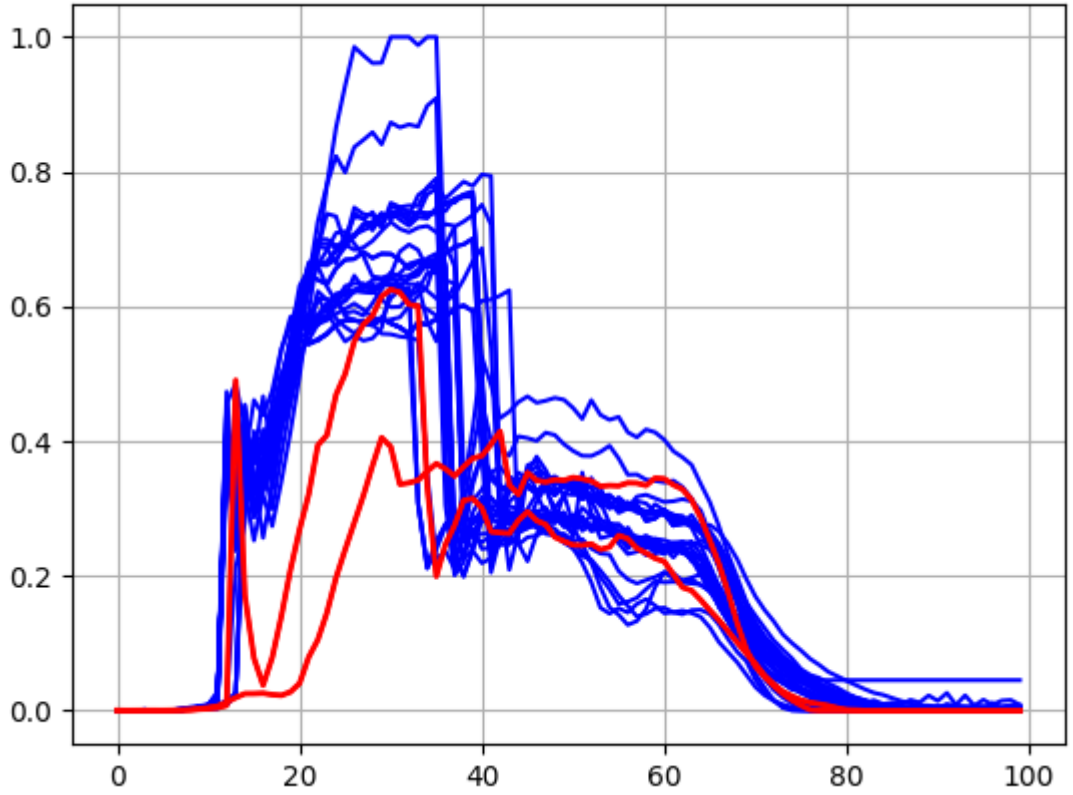
MANUAL WORK: CAD input → AUTOMATIC: Mid Surf generate → AUTOMATIC: 2D transformation → AUTOMATIC: Convolutional neural network → AUTOMATIC: Image processing → Final Mesh

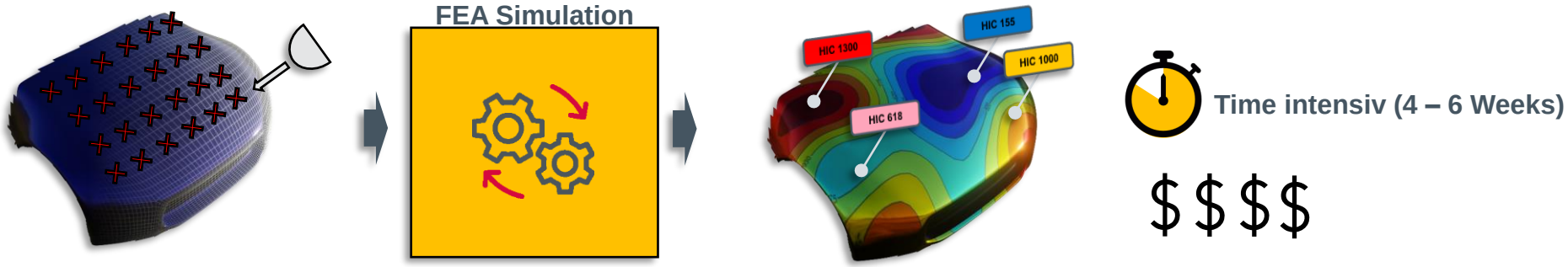
EVALUATION ASSISTANT
ANOMALY DETECTION

IO

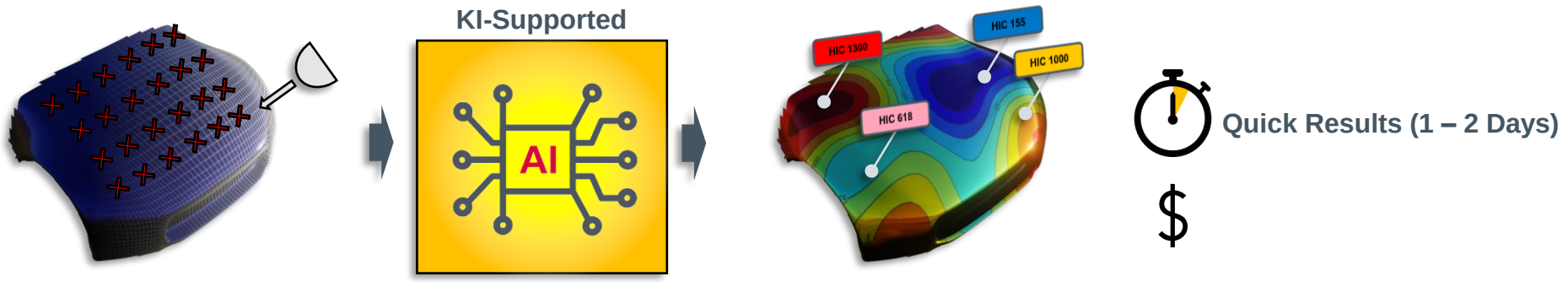
NIO



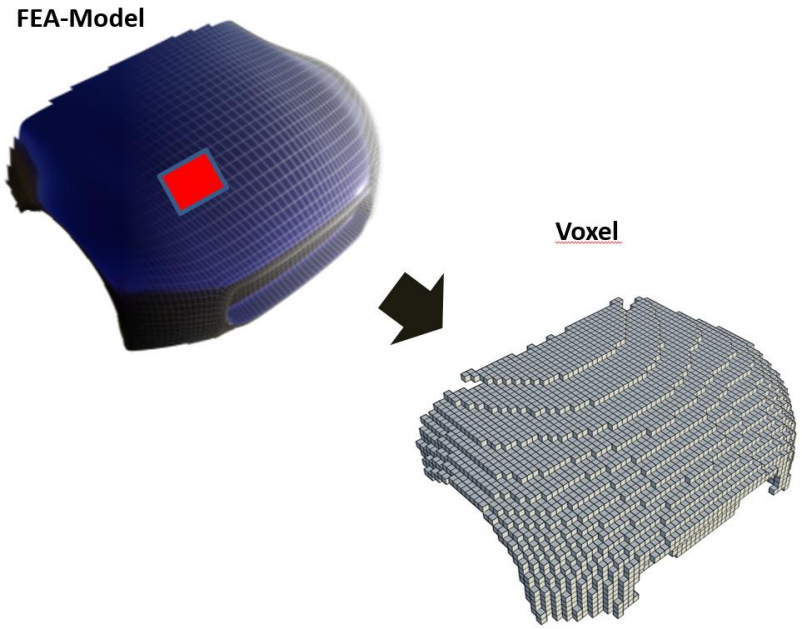
ARTIFICIAL INTELLIGENCE
IN PEDPRO – „KI CRASH“

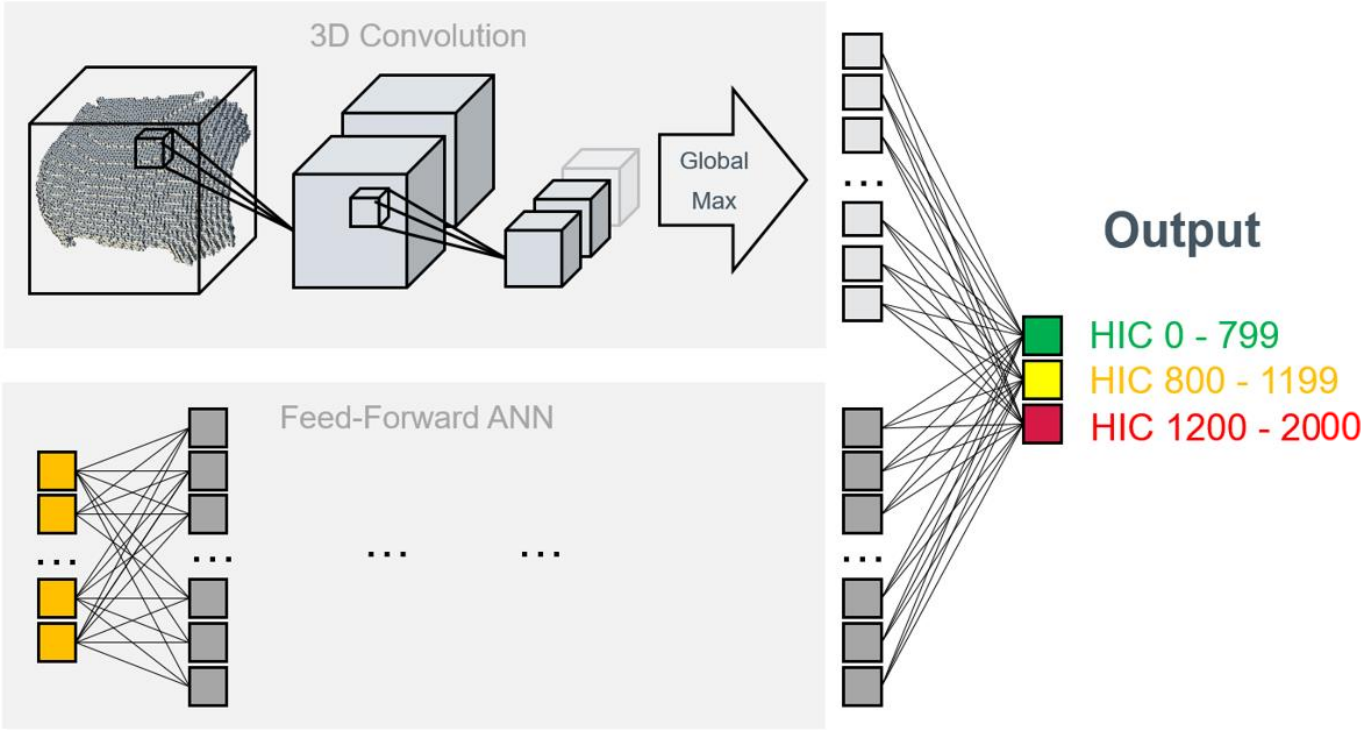


Concept Phase



KI CRASH
OVERVIEW

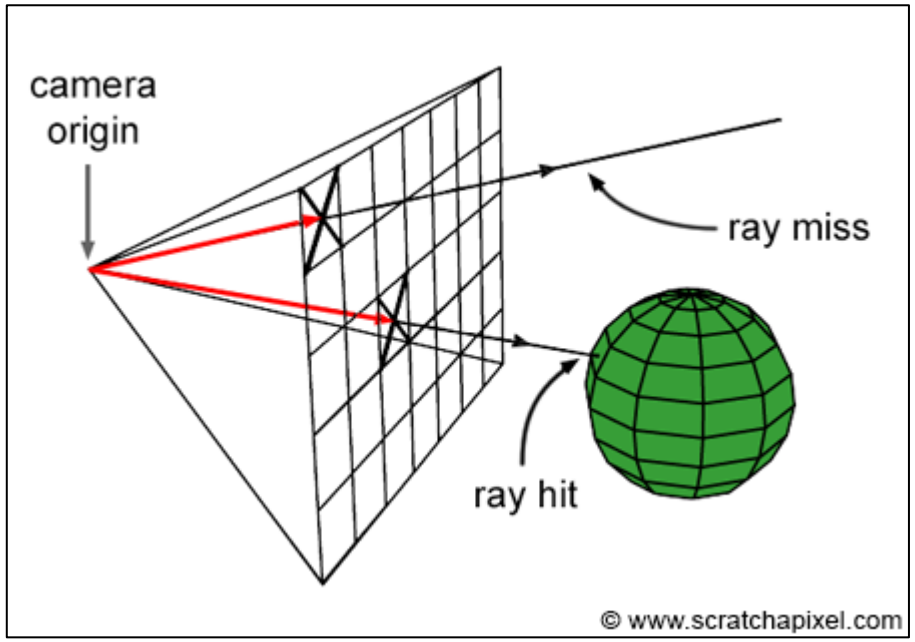




KI CRASH
FOCUSPOINTS DURING DEVELOPMENT

Looking for alternativ methods and algorithms -- e.g. Raytracing

- Very high lateral resolution in XY
- Functional characteristics as floats possible
- Transfer learning is available → Optimization
- Reduced simulation times for training
- Different inputs are possible



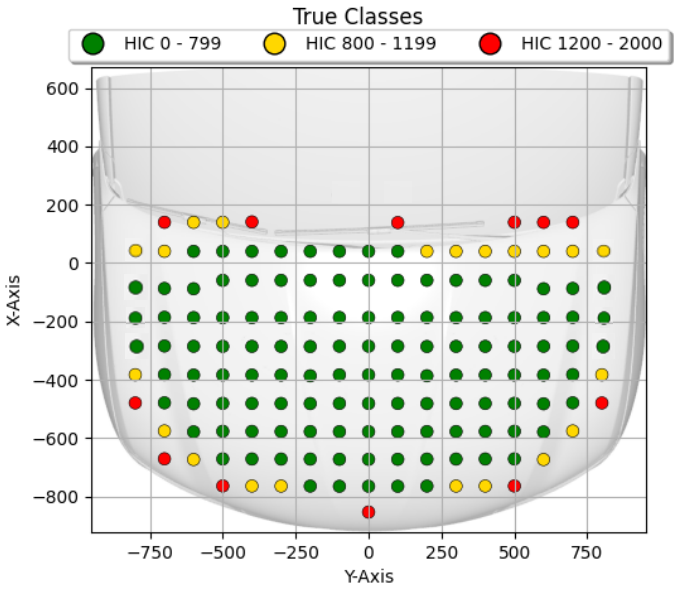
KI CRASH
EXAMPLE FOR A PREDICTION

Optimistic prediction

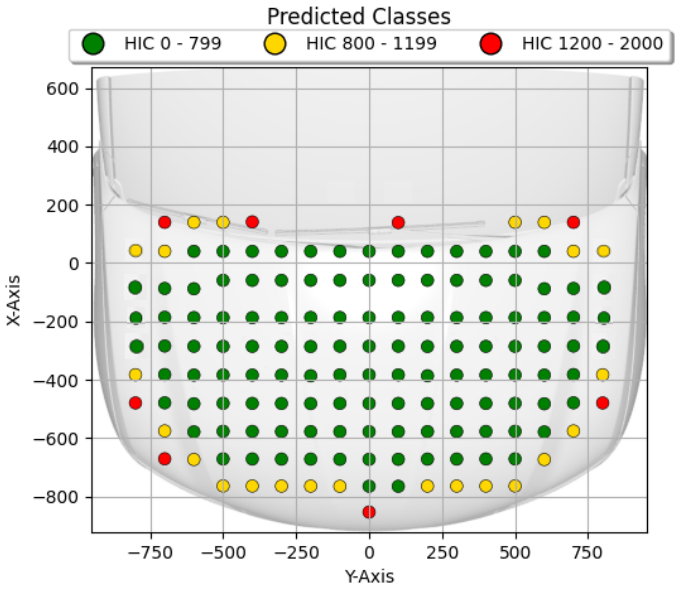
Conservative prediction

CHILD + ADULT

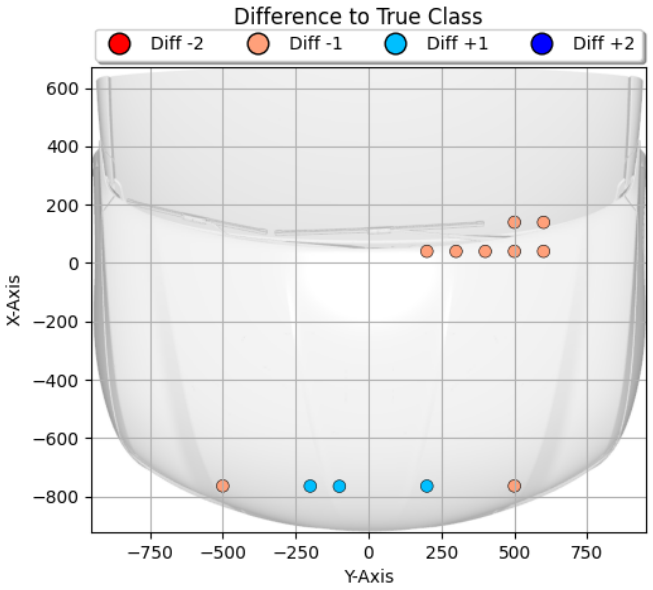
FEA Simulation
4-6 weeks



Neural network
1-2 days



Difference

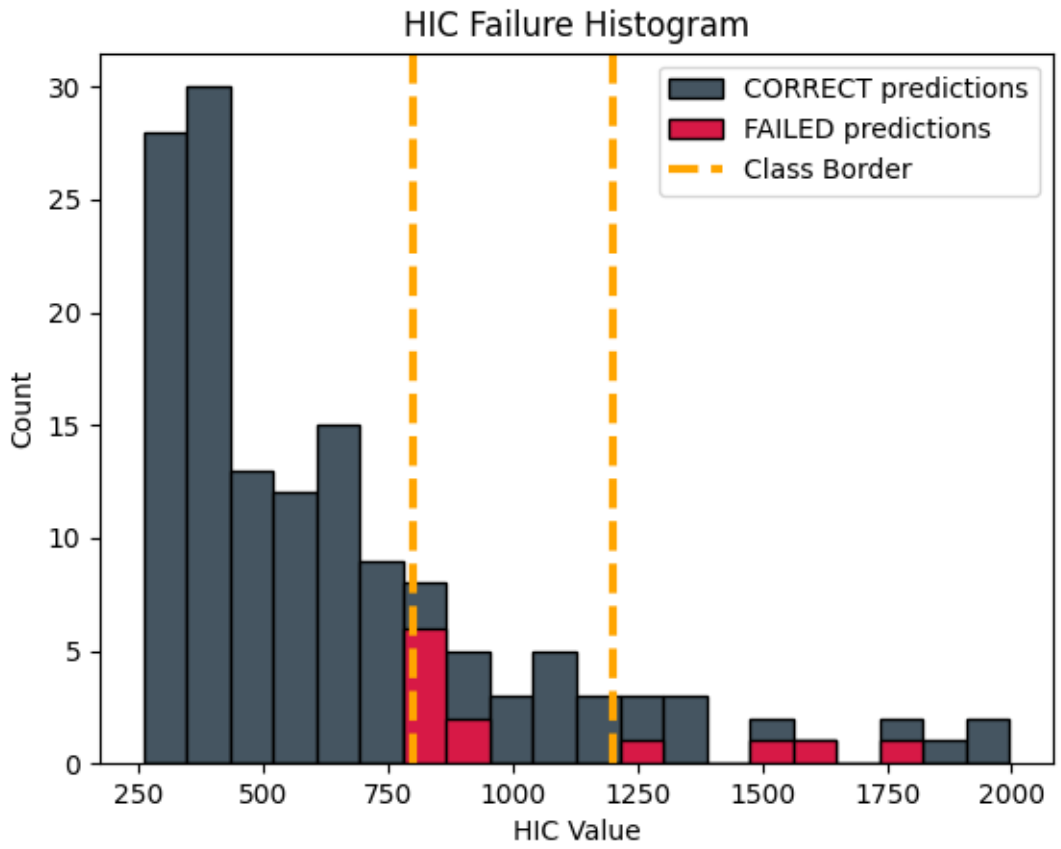


Total Results: Accuracy: **91.7 %** | F1 Score: 83.2 %

KI CRASH
EXAMPLE FOR A PREDICTION

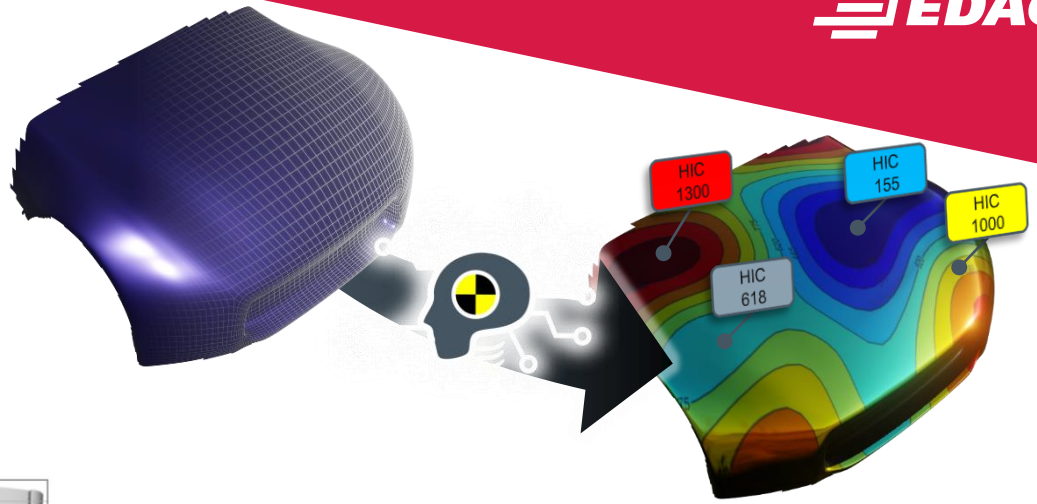
ADULT

Visualization of HIC-values in an histogramm

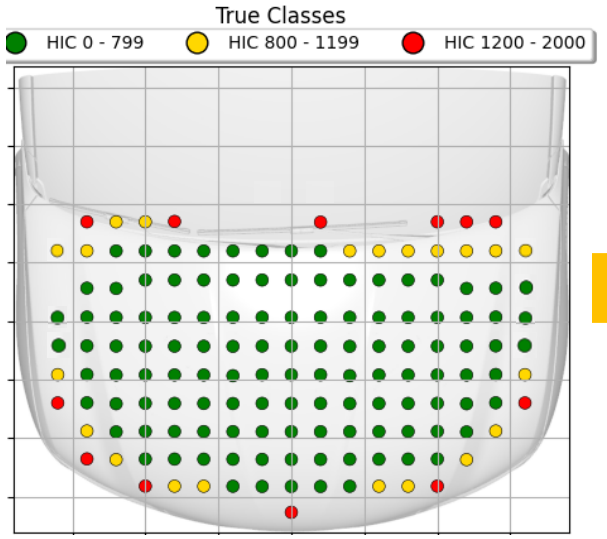


AI TOOLS @ EDAG

ONEPAGER: PEDPRO - HEAD IMPACT

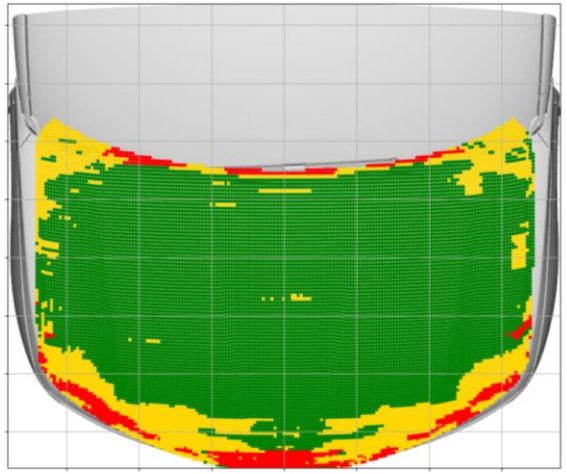


FEM Simulation



vs.

Neural Network (High Resolution)



Weeks | **Days**

Benefits:

- **Time saving**
  - Simulation
  - Computing
  - Development

→ **Better and safer product**
→ **Reduced Time-to-Market**
→ **Higher Resolution possible**

AI TOOLS @ EDAG

OUTLOOK

Pre development

- Usage of predecessor data
- continuously learning

During Development

- Usage of ongoing created data during a development
- Specific learning based on simulated variants

After development (usage)

- Digital twins e.g. for maintenance
- Specific learning based on finalized product

Success factors

- Consequent data management and storage of data
- Common definition of load cases between test and CAE (modeling, labeling/naming, sensor position, …)
  => consequent realization
- Open minded employees to detect the use cases
- Enough resources and management patience
- Availability of specialized AI experts for the mathematical background
- Applications in small pieces instead of the total vehicle or unrealistic targets
  => single applications/load cases e.g. ped. protection, head impact, front crash, side crash, …

YOUR GLOBAL **MOBILITY**
ENGINEERING EXPERTS

AI @ EDAG-CAE

22.04.2024

EDAG TECH INSIGHTS: Efficient Calculation for the Euro NCAP Crash Test (edag.com)

EDAG