EMOTION3D
www.emotion3d.ai

SETTING NEW STANDARDS
IN DRIVING SAFETY & USER EXPERIENCE

camera-based in-cabin monitoring software

Dr. Michael Hödlmoser, CTO

Our **Human AI model** analysis camera images and provides unlimited data points on human bodies enabling a new level of **human-machine interaction** as well as **supporting** and **protecting humans** in **every situation**.

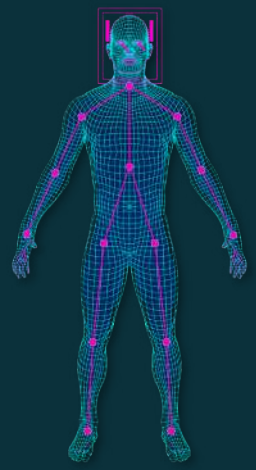
Facial keypoints (customizable)

Custom 2D/3D body joints for full body

Body size, weight, circumferences, etc.

Attention level, drowsiness level

HUMAN AI MODEL



A POWERFUL NETWORK FOR HUMAN AI

- Unique hierarchical network architecture
- Unlimited data points on human body
- Single network, lowest processing & memory requirements
- Cost efficient model deployment on the edge
- Wide range of 2D & 3D sensors supported, highest HW flexibility

Head position & orientation

Eye position, gaze direction & openness

Mouth position, openness & state

Body posture

Creating Human AI models required special data in large quantities. Our proprietary ***Virtual Human Simulator*** is our unique **in-house** tool for simulation of virtual humans and **synthetic human body data generation**. It enables us to **purely virtually develop** camera-based Human AI models in a never-before-seen comprehensiveness and robustness, fully GDPR-compliant, while requiring minimal resources & time for data creation.

Simulation-driven synthetic data generation

Human character simulation

Virtual sensor simulation (2D & 3D, NIR/RGB/ToF)

Environment simulation (Lighting, camera position, etc.)

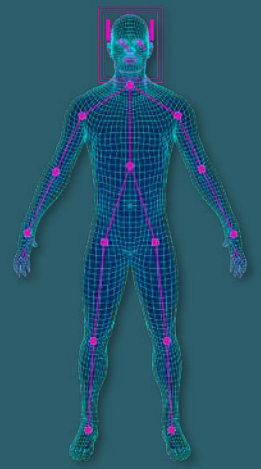
VIRTUAL HUMAN SIMULATOR

UNLIMITED DATA – FAST AND GDPR COMPLIANT

- Single source for synthetic data
- Unlimited data points – quickly and efficiently, no data bias
- GDPR compliant, no privacy complications

Generate data for AI model training

HUMAN AI MODEL



→ ***Highest flexibility, cost-efficient Human AI development***

→ ***Enabling previously impossible Human AI models***

Our CABIN EYE software stack analyses **human characteristics & action** in real-time inside vehicles via cameras. This enables **innovative safety, user experience and automation capabilities** inside vehicles and addresses nowadays as well as future occupants' needs.

CABIN EYE

POWERFUL & VERSATILE IN-CABIN HUMAN ANALYTICS PLATFORM

CABIN EYE – safety

THE WORLD'S FIRST PERSONALIZED PASSIVE SAFETY SYSTEM

CABIN EYE – ux

ADVANCING USER EXPERIENCE AND ENABLING EMPHATIC VEHICLES

CABIN EYE – driver

PUSHING THE BOUNDARIES OF DRIVER MONITORING

CABIN EYE – automation

OPERATIONAL EFFICIENCY & SAFETY FOR SHARED MOBILITY

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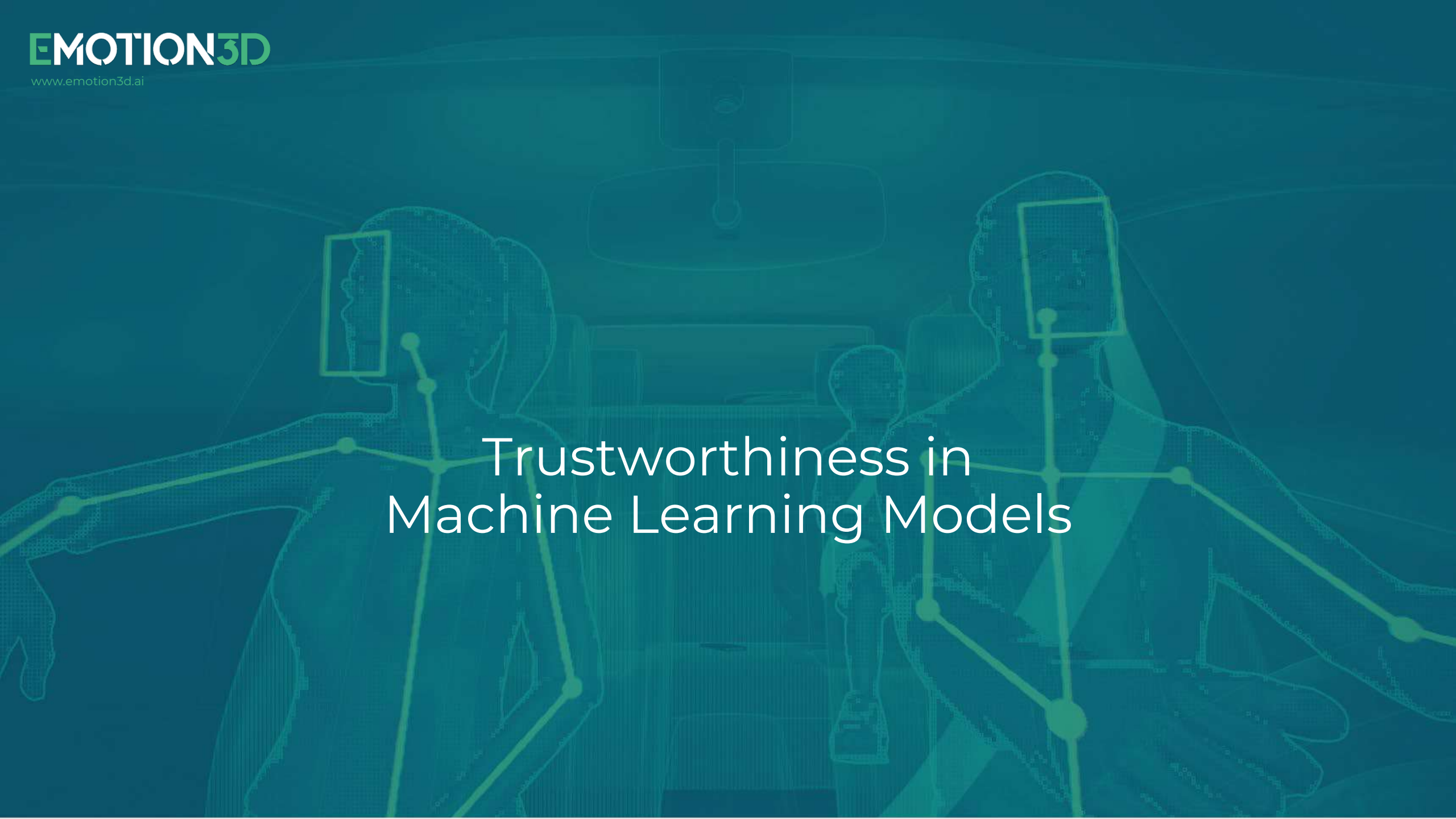
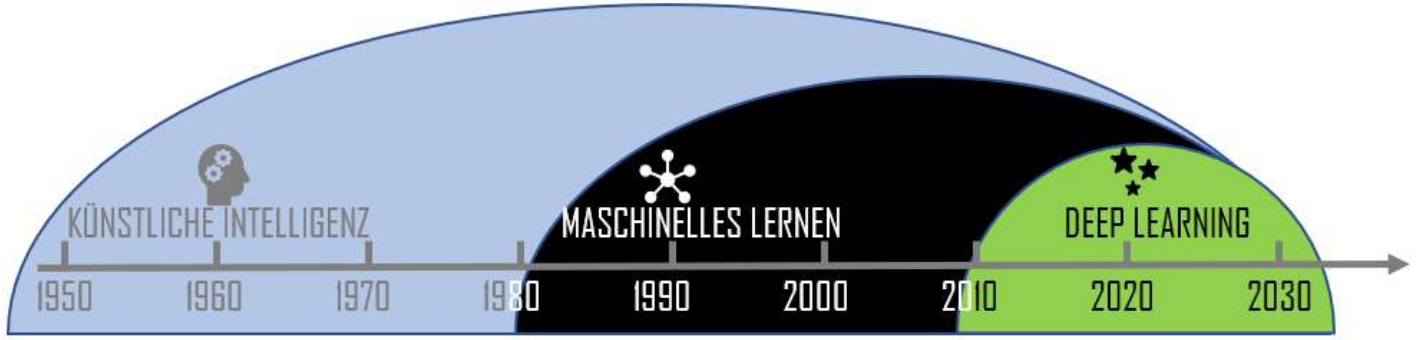
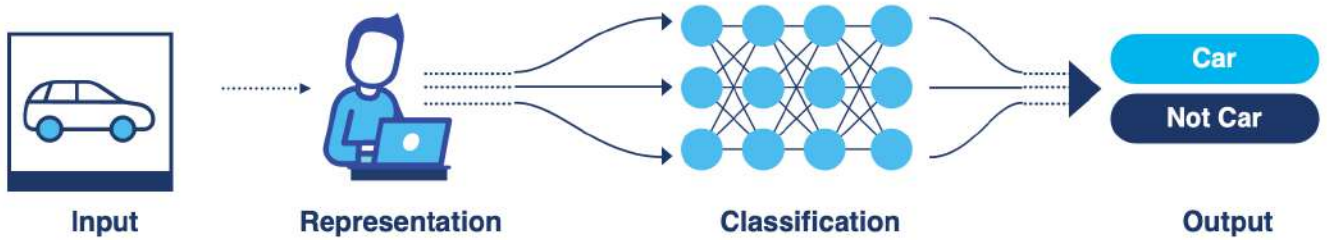


Trustworthiness in Machine Learning Models



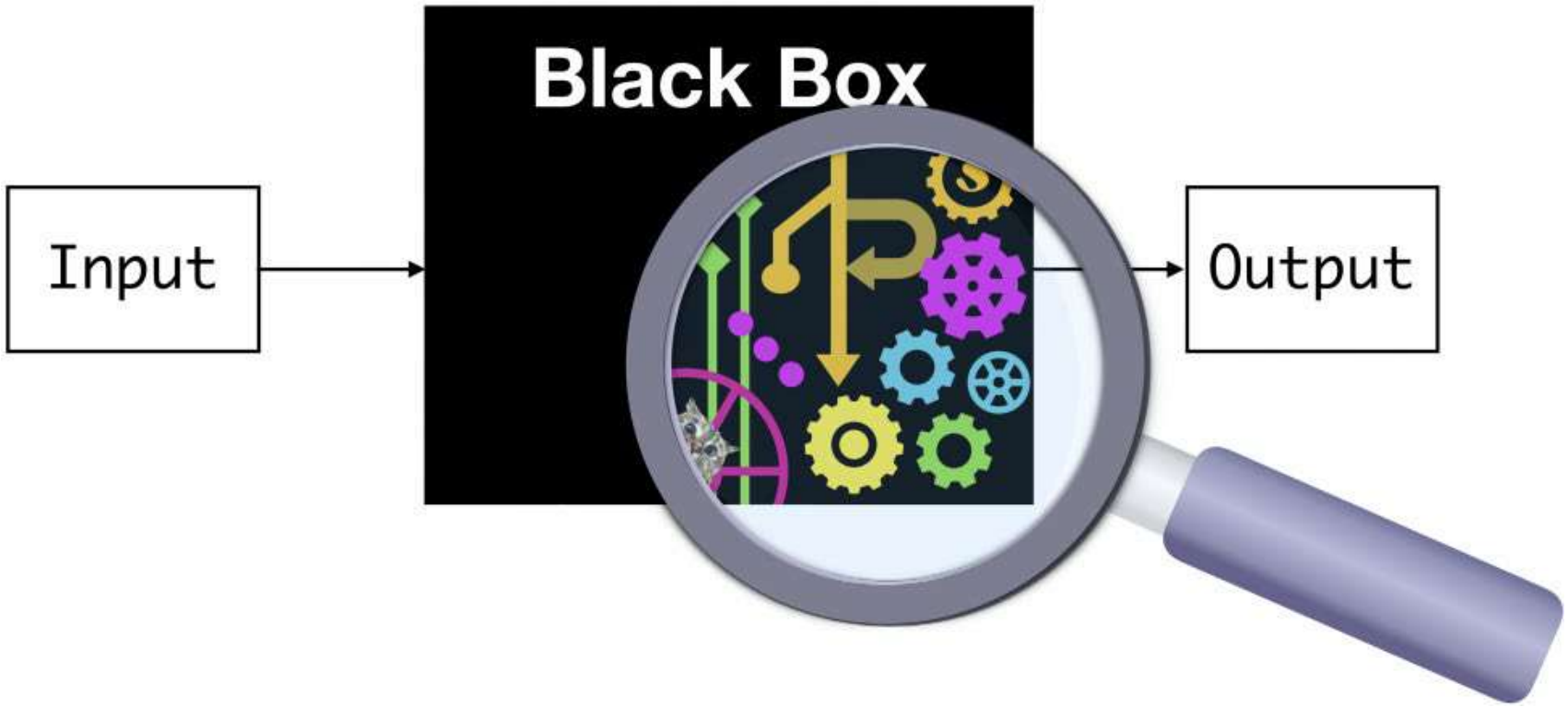
Classical ML



- ▼ Hard to develop
- ▼ Limited to numbers
- ▼ Slow
- ▼ error-prone

DL

- ▲ Scalable
- ▲ Unstructured Data
- ▲ fast, accurate
- ▼ harder to understand
- ▼ Needs much more data



- **How to achieve trustworthiness?***

*Parts of the work were funded by aws, project Safe.ICM

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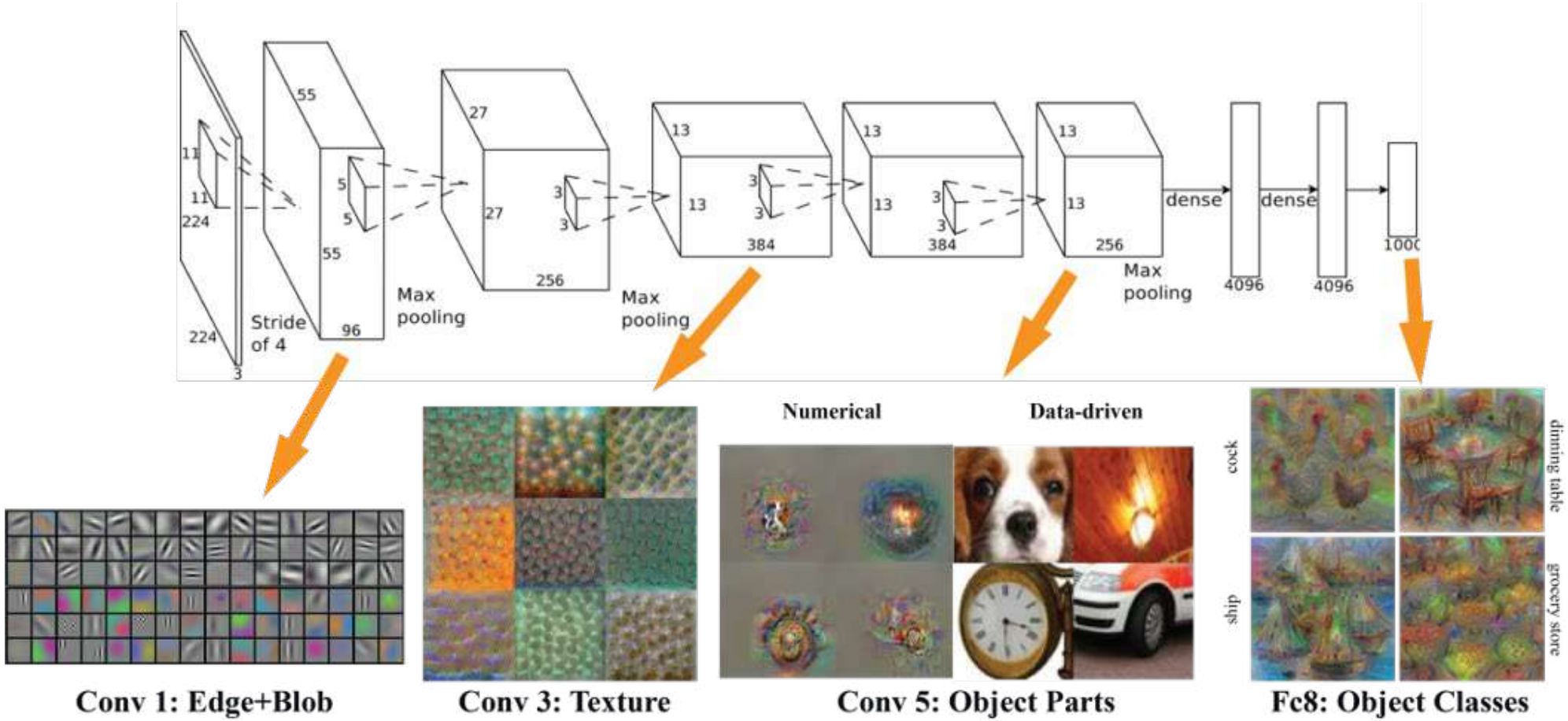
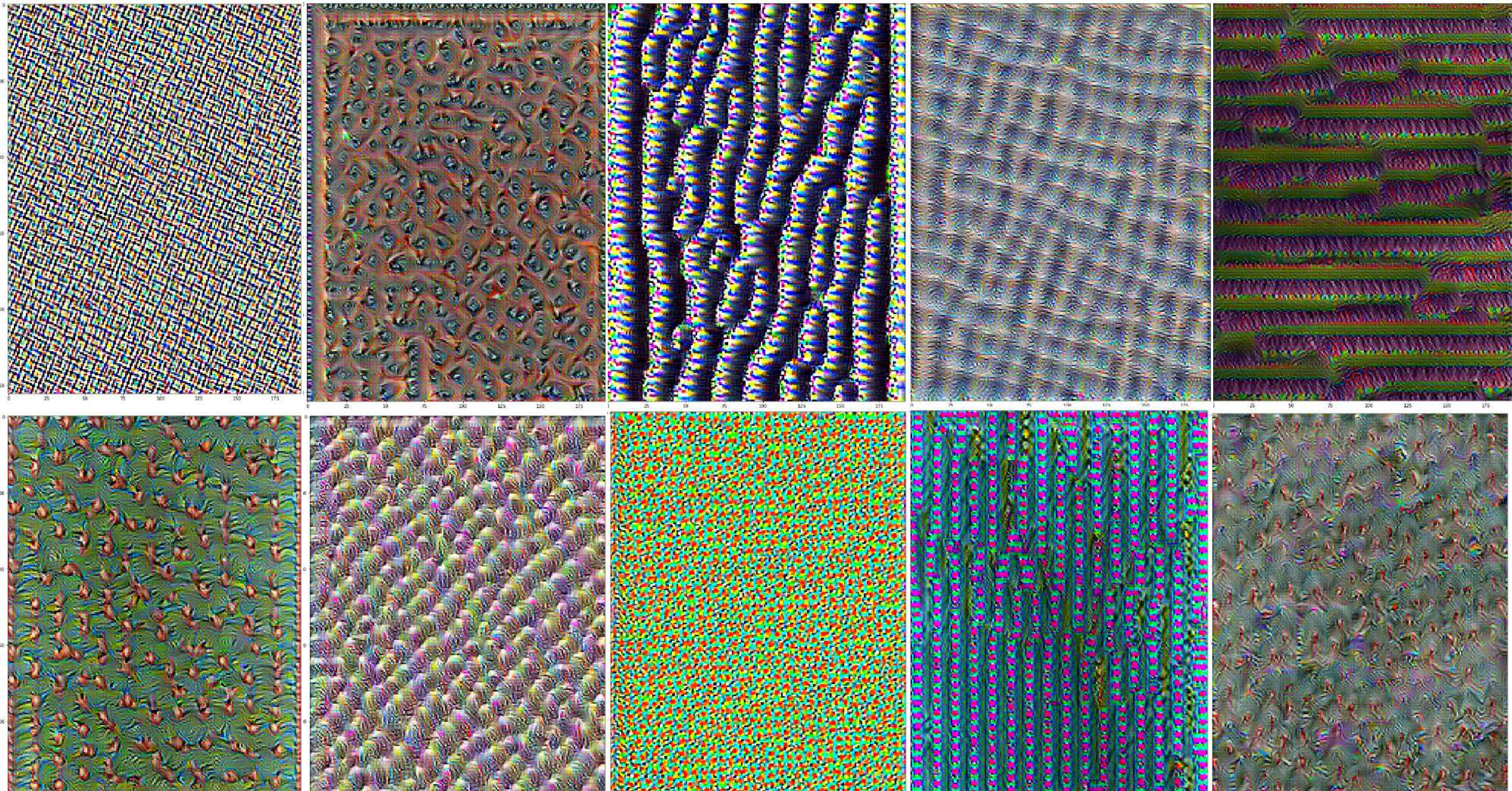
Technical solutions

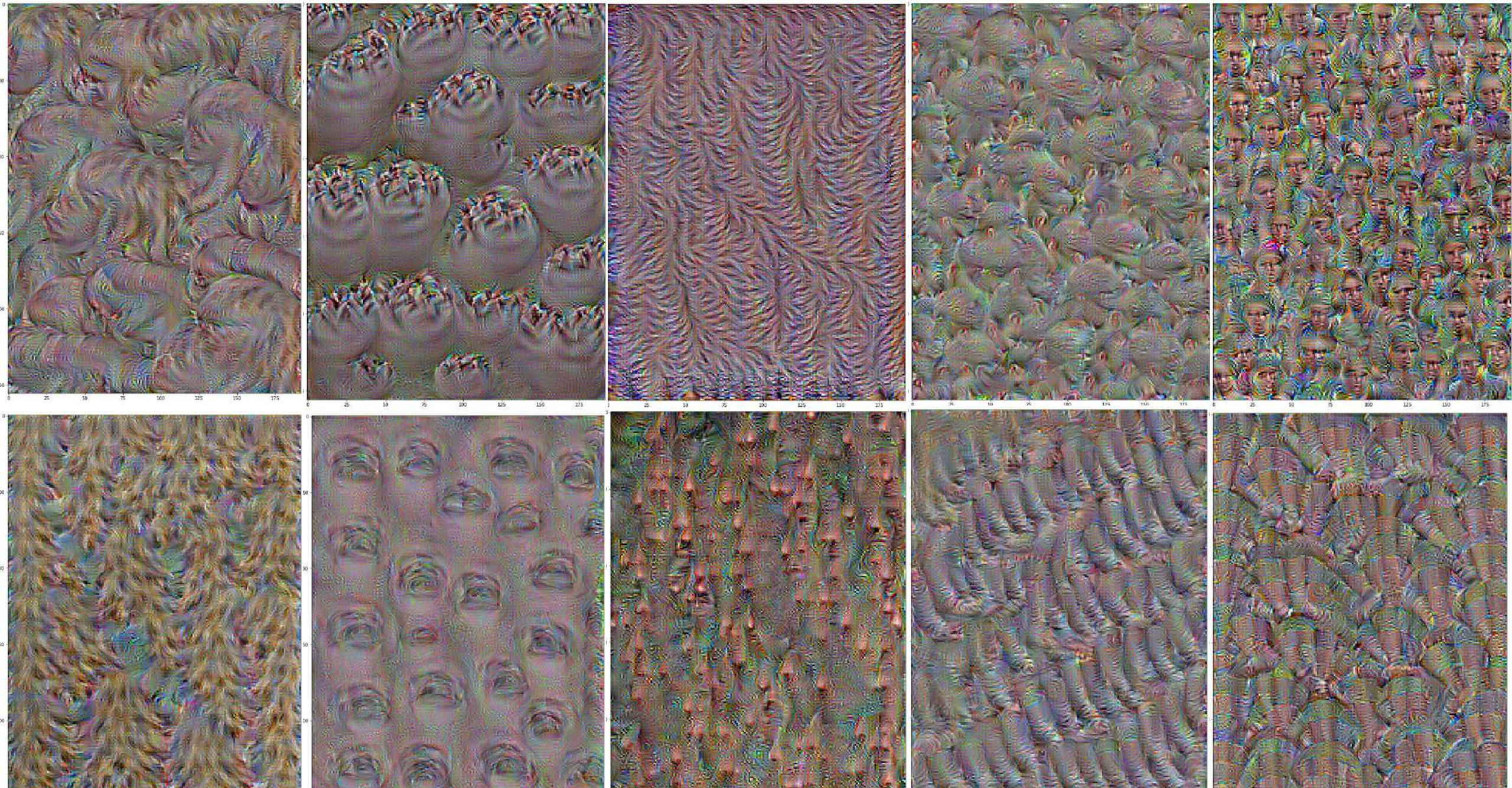
Technical solution 1: feature visualization



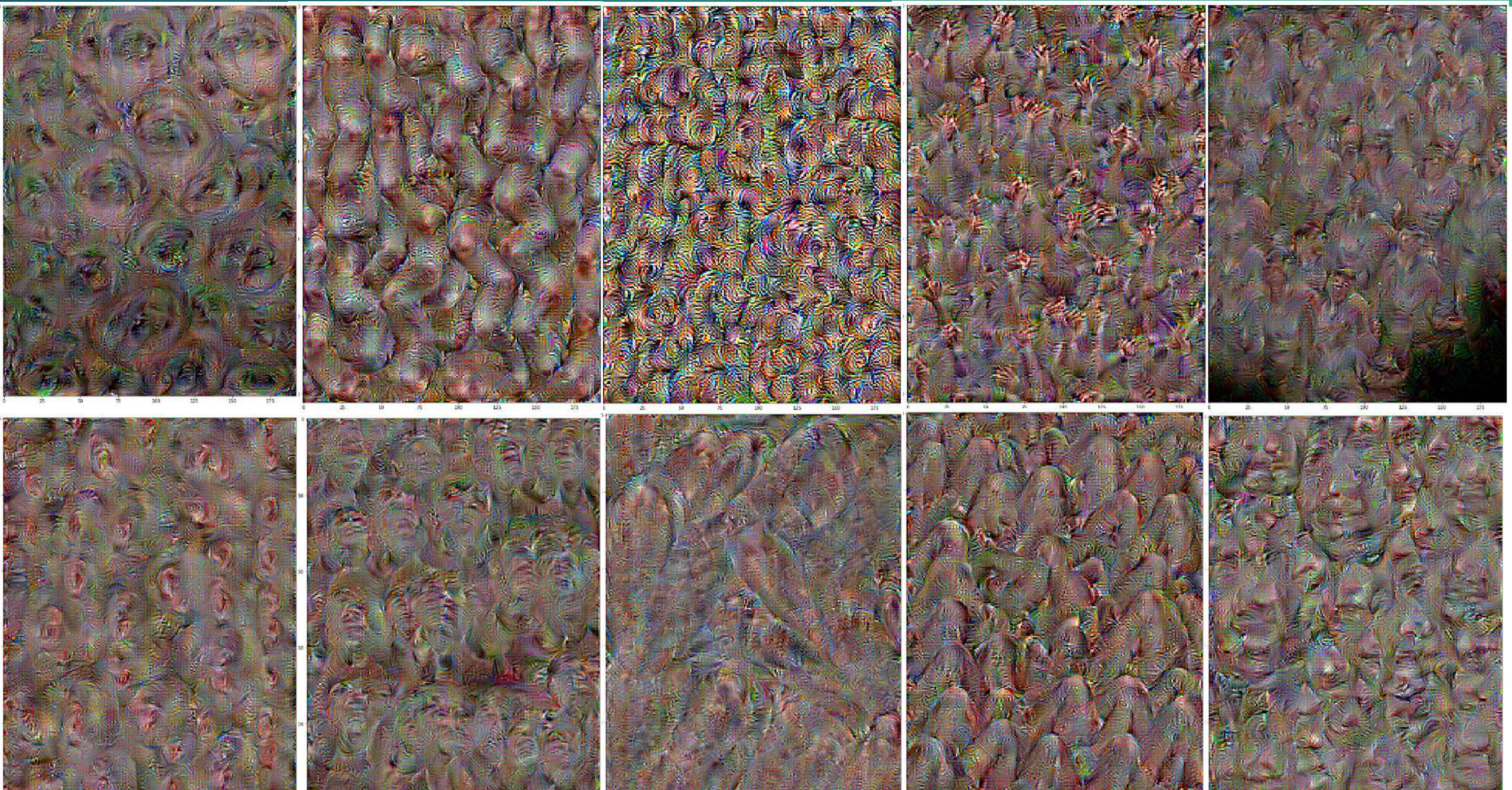
Technical solution 1: feature visualization – first layers



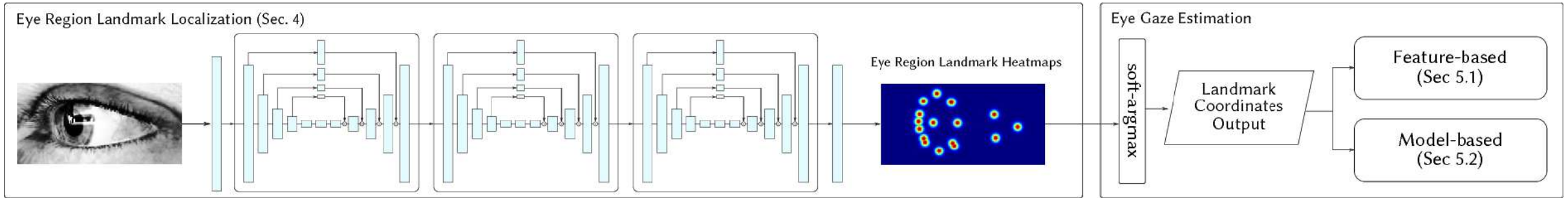
Technical solution 1: feature visualization – intermediate layers



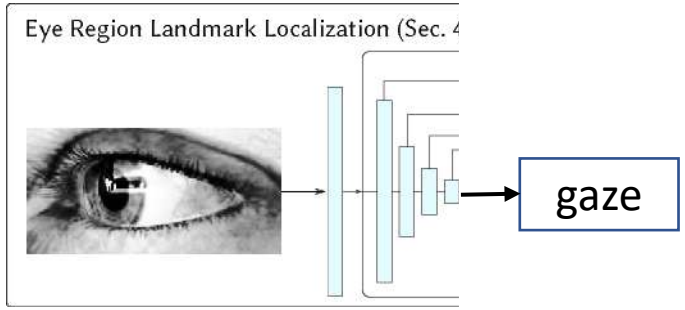
Technical solution 1: feature visualization – last layers



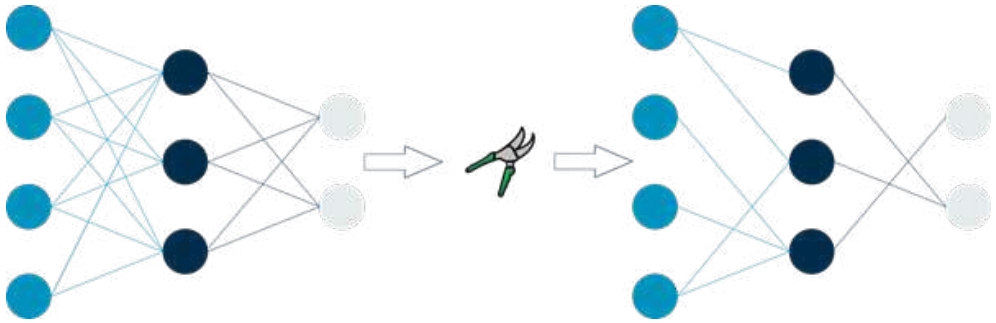
Before optimization



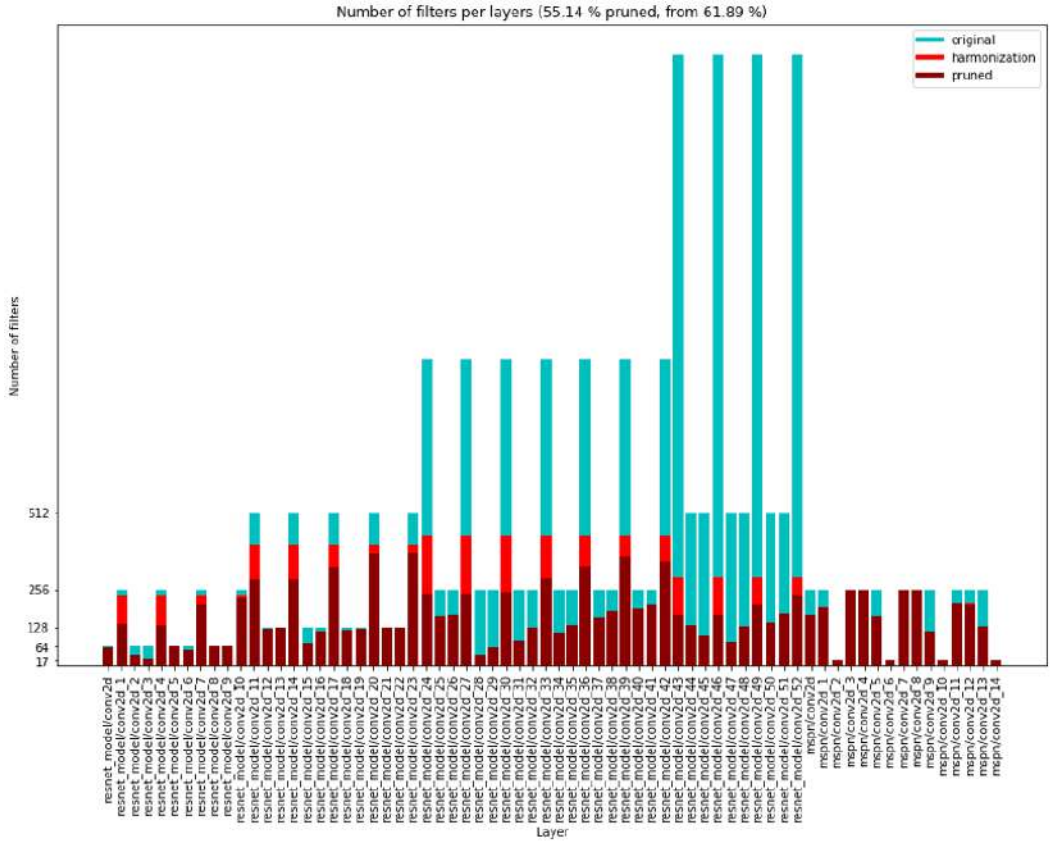
After optimization



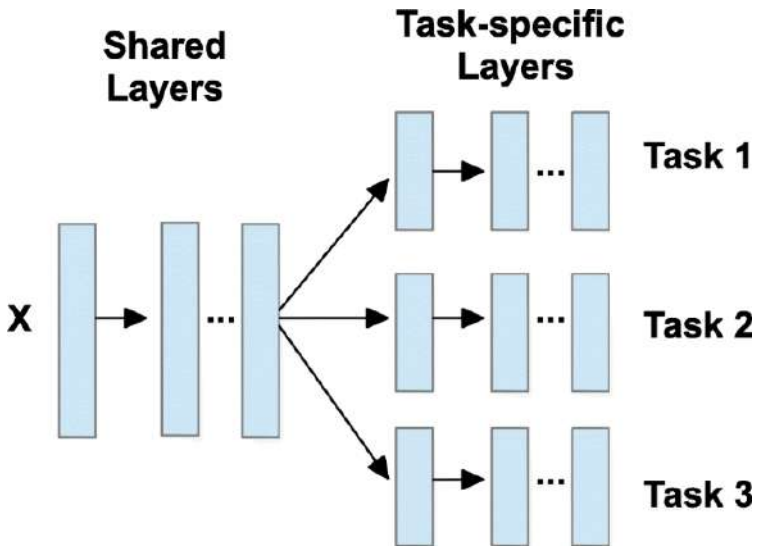
- **Which layers do provide meaningful content for the final result?**
- **Sort out irrelevant operations**

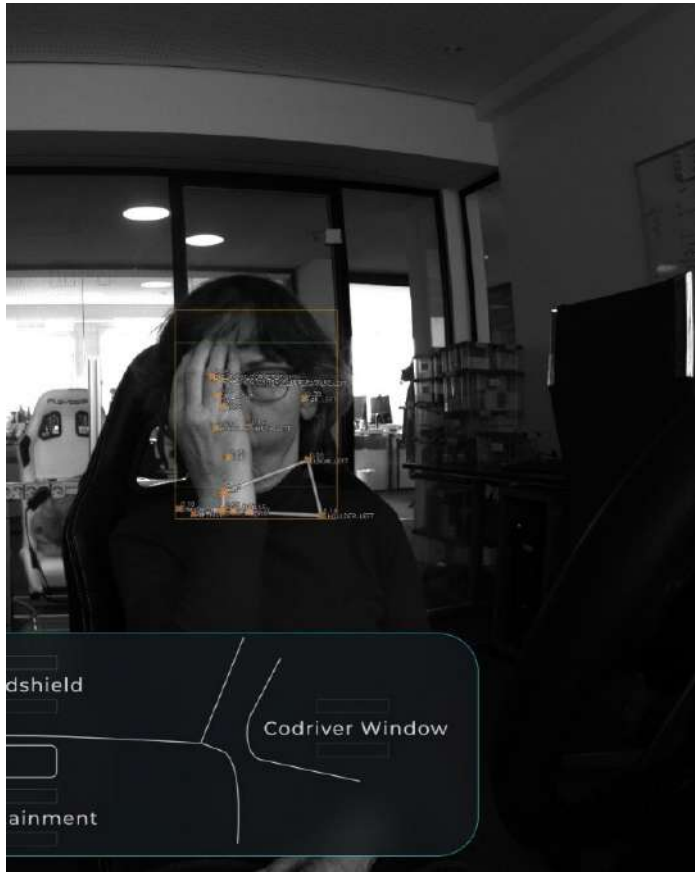


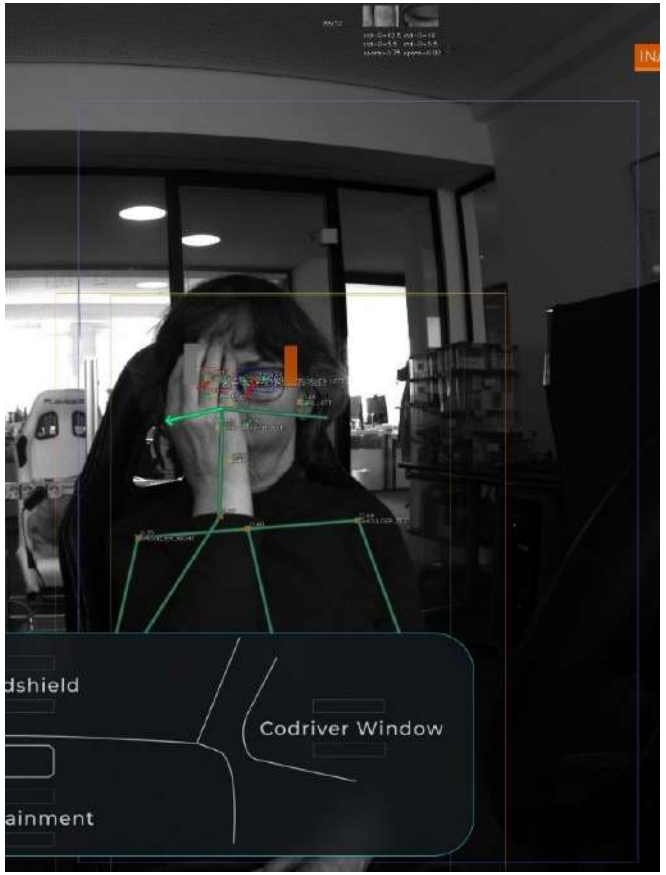
- **Intelligent / optimized pruning**
  - Remove weights
  - Remove connections
  - Remove complete layers



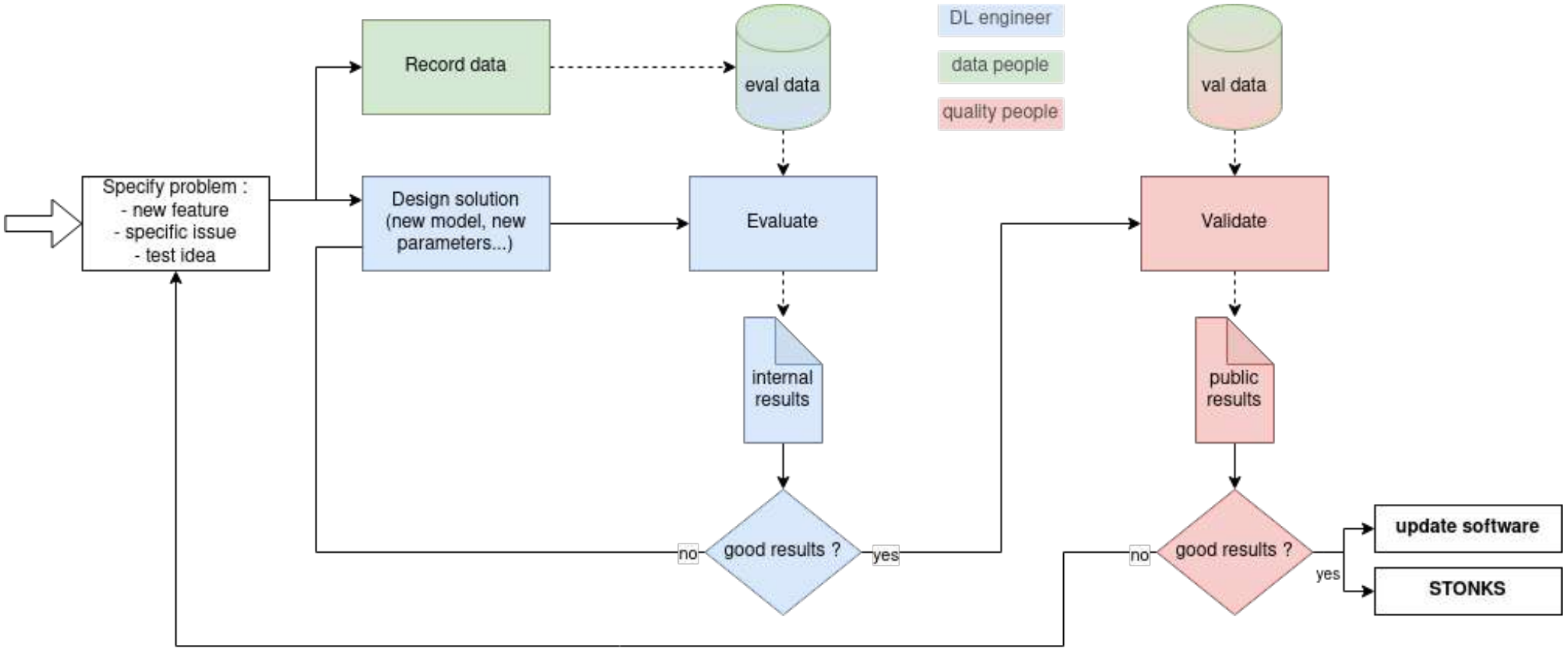
- **Improve the outcome of one task by solving multiple tasks at the same time**



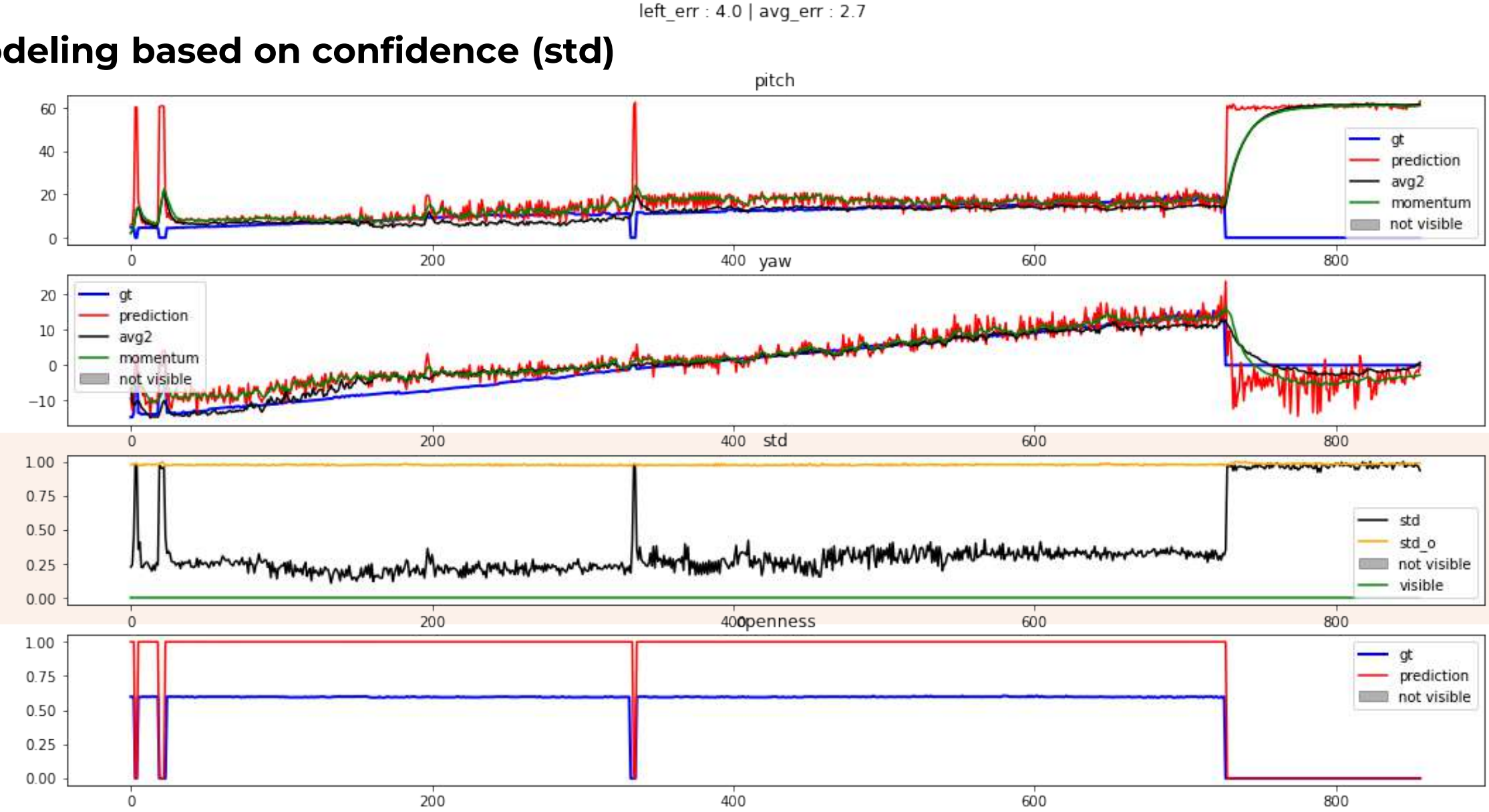




Technical solution 5: Validation workflow for NN design



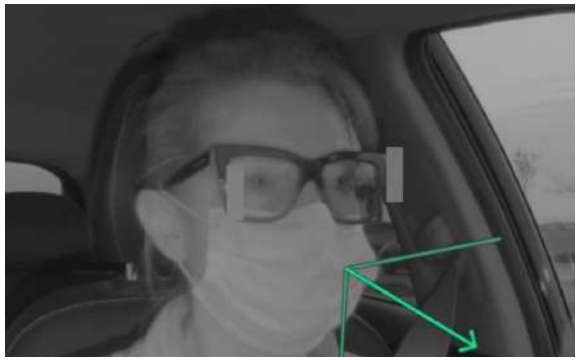
- **Modeling based on confidence (std)**



Examples for improvements over time

Initial

Optimized



Optimized results for e.g. occlusions → Integration of occlusion level

Optimized eye openness

Optimized results for extreme head poses

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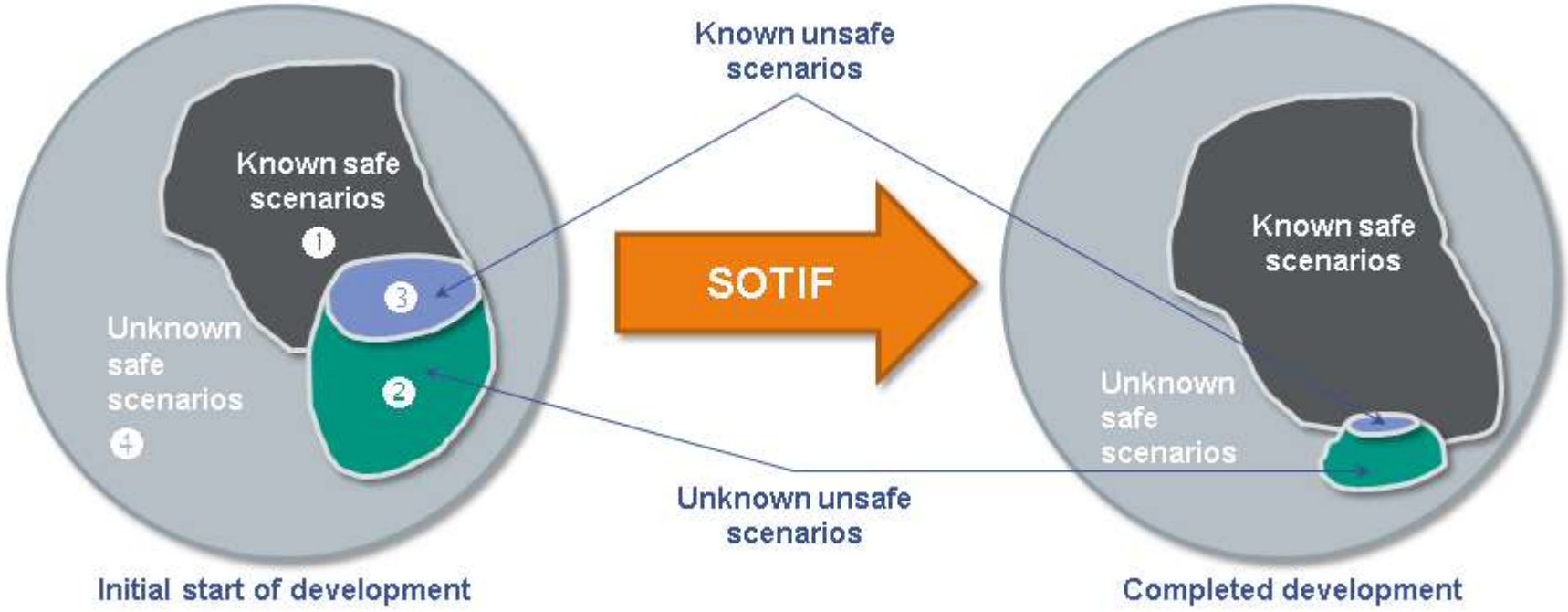
Data

- **Unknown unsafe scenarios (2) can be reduced by means of suitable tests**
- **Known unsafe scenarios (3) are eliminated by design measures (e.g. shutting down the system, etc.)**



Driver out of FoV

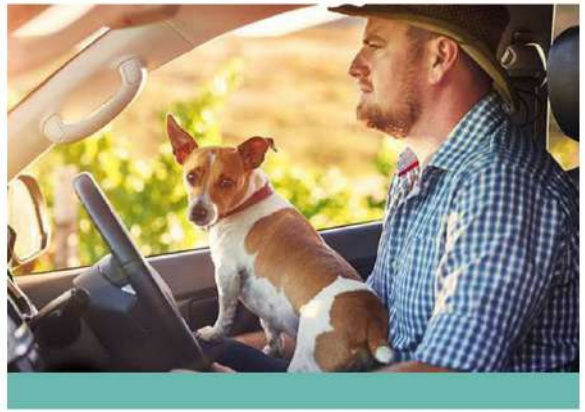
Overloaded car

Rear passengers at same distance as front passengers

Weird costumes

Feet on dashboard

Looking on phone



Animals not in carriers

Data quality – variation

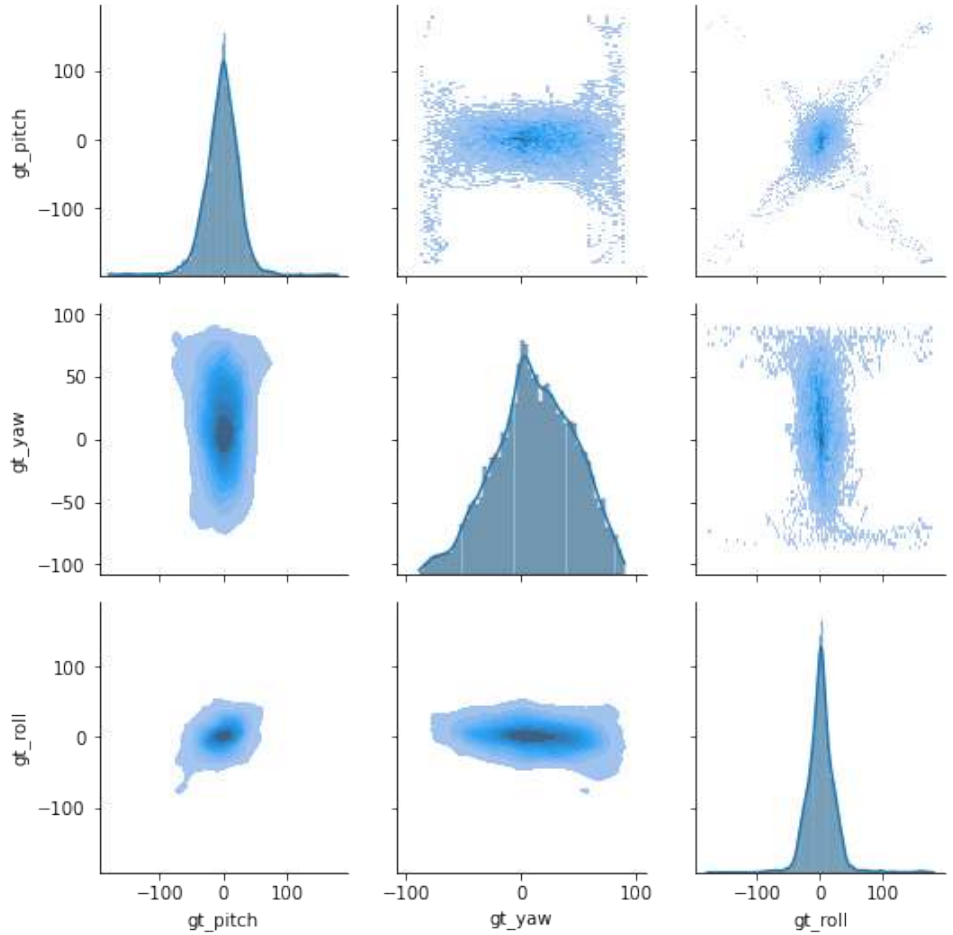
- **Get as varied as possible**
- **Save all possible parameters :**
  - Ethnicity
  - Age
  - Gender
  - Camera
  - Weight
  - Height
  - Head orientation
  - Keypoints
  - Exposure time
  - …

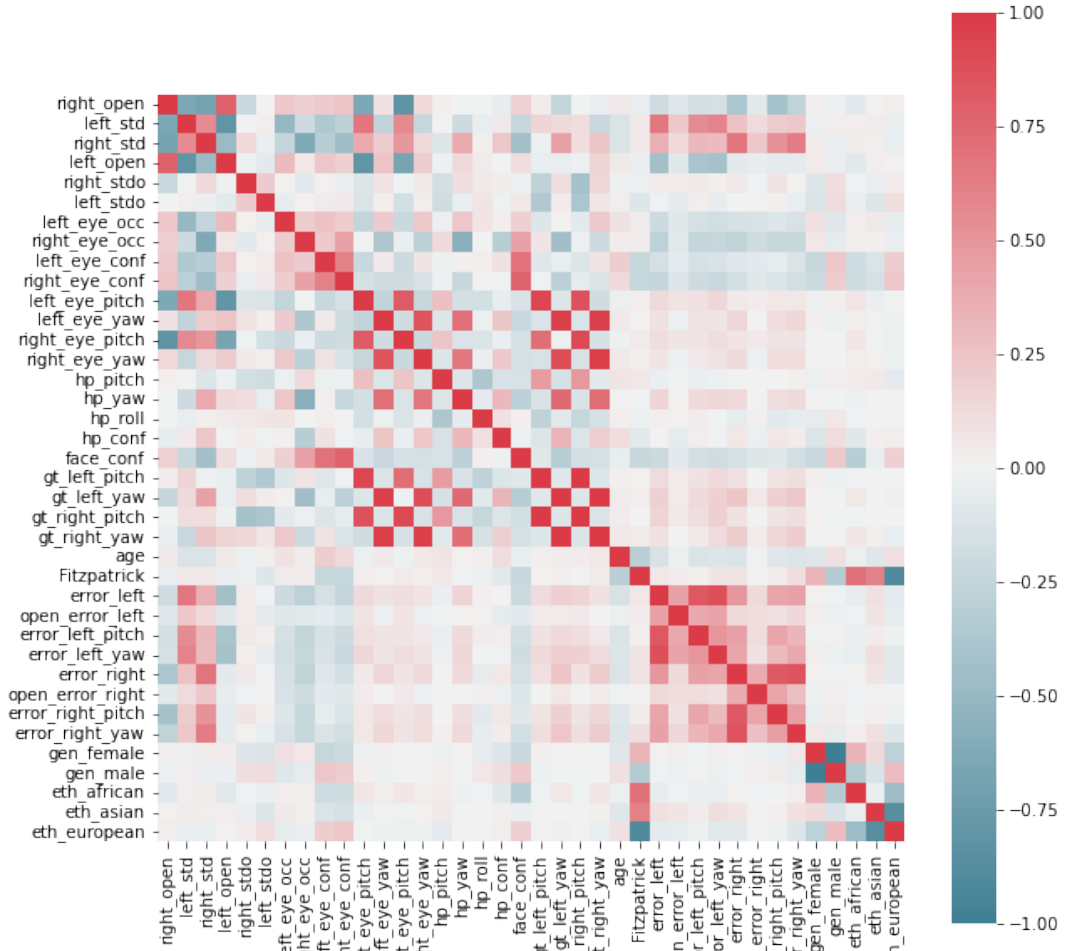
Numeric Features (11)

Chart to show: Standard (log, expand)

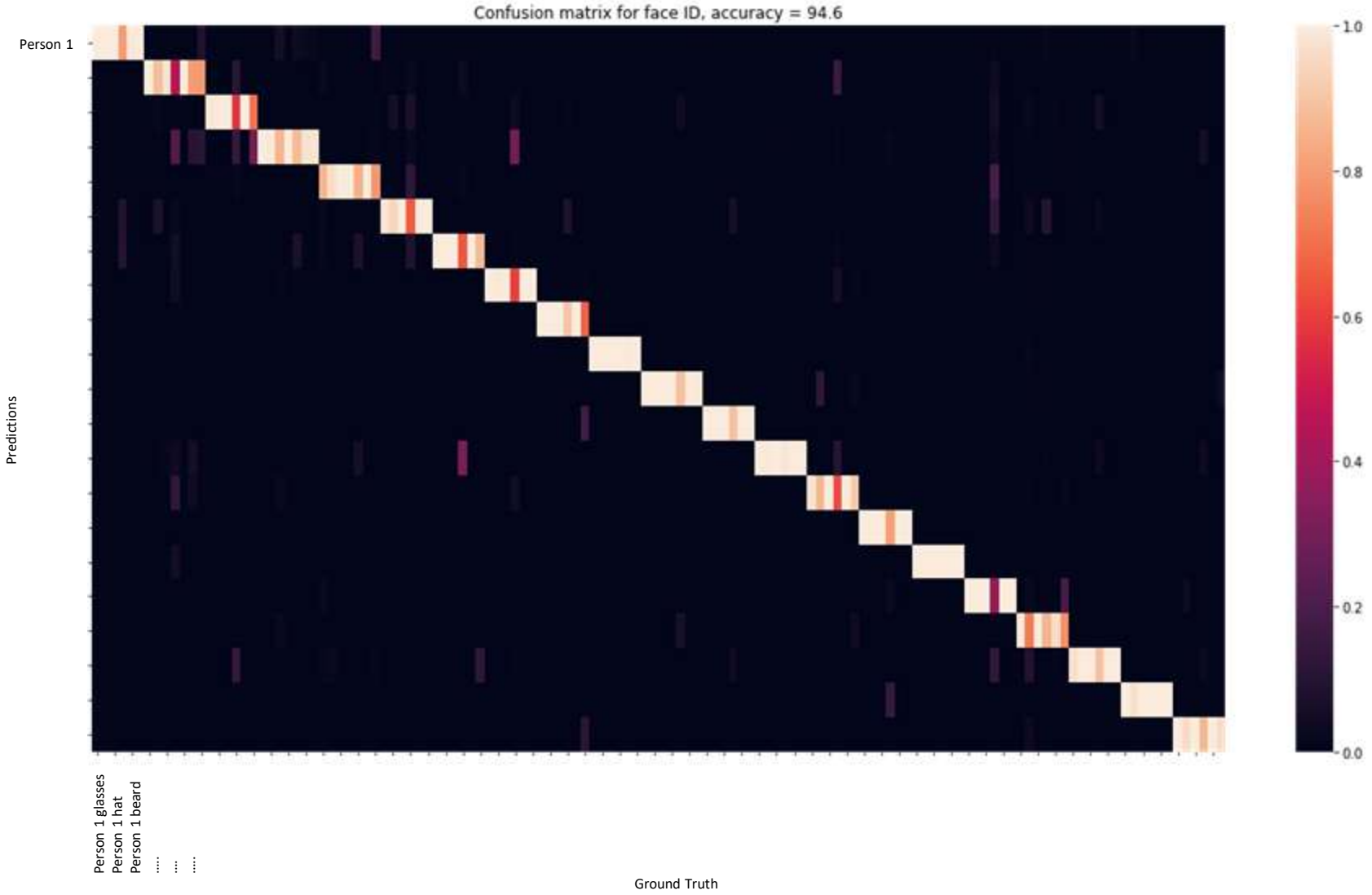
	count	missing	mean	std dev	zeros	min	median	max
skin_type	7	0%	2,43	0,49	0%	2	2	3
precision_closed	7	0%	0,77	0,14	0%	0,46	0,79	0,97
f1_score_closed	7	0%	0,81	0,12	0%	0,62	0,85	0,97
recall_closed	7	0%	0,88	0,11	0%	0,64	0,93	0,97
precision_open	7	0%	0,96	0,03	0%	0,9	0,97	0,99
f1_score_open	7	0%	0,86	0,07	0%	0,77	0,85	0,98
recall_open	7	0%	0,79	0,12	0%	0,65	0,77	0,96
precision_occluded	3	57.14%	0,3	0,24	33.33%	0	0,3	0,59

Data quality – variation





Data quality – variation



Data quality – synthetic data

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