TOWARDS ARTIFICIAL GENERAL INTELLIGENCE *WITH APPLICATIONS*

ANDRÁS LŐRINCZ
NEURAL INFORMATION PROCESSING GROUP
DEPARTMENT OF ARTIFICIAL INTELLIGENCE
FACULTY OF INFORMATICS, EÖTVÖS LORÁND UNIVERSITY

THEMATIC EXCELLENCE PROGRAM 2019

INDUSTRY AND DIGITALISATION

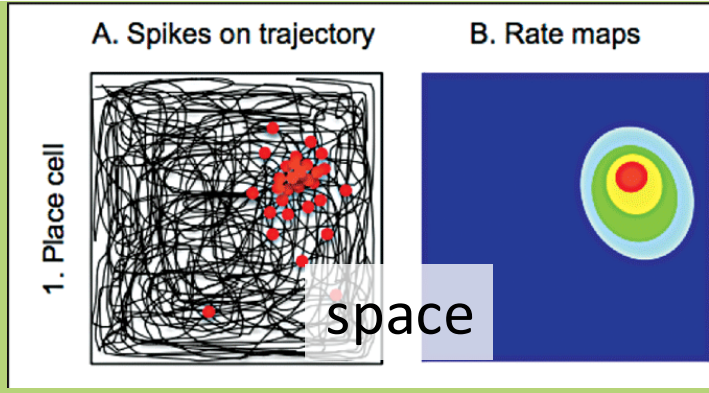
APPLICATION DOMAIN SPECIFIC HIGHLY RELIABLE IT SOLUTIONS

NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION OFFICE HUNGARY

PROJECT FINANCED FROM THE NRDI FUND

Manpower	
Doctor of the Academy	1
PhDs	3
PhD students	9
Programmer	1
BSc and MSc students	15

Is it time to go for AGI?



- We have always been looking at neuroscience
  - to understand intelligence and cognition in mammalian evolution
  - to see missing components necessary for AGI
- Particular components
  - developing abstractions (e.g., 2D space for rodents, 3D space for bats)
  - developing metric in abstract spaces (hexagonal grid for rodents plus the *numbers for humans*)
  - goal oriented behavior and planning
  - columnar organization in the neocortex (none in rodents, abundant in primates)
- Evolution in deep learning follows intriguingly similar routes
  - in progress:
    - abstraction is called „disentanglement”, goal oriented behavior is called „learning to learn”
  - column-like structures overcome honoured convolutional neural networks – a breakthrough

From basic research to products

(a) Characterization of humans

- Intentions (gaze), activities (hand and body), content (speech and natural language processing), mood (facial expression, prosody, blinking).
  - Joint work with Rush Medical School, Chicago and Argus Cognitive, Ltd (ELTE startup)

(b) Human-machine collaboration

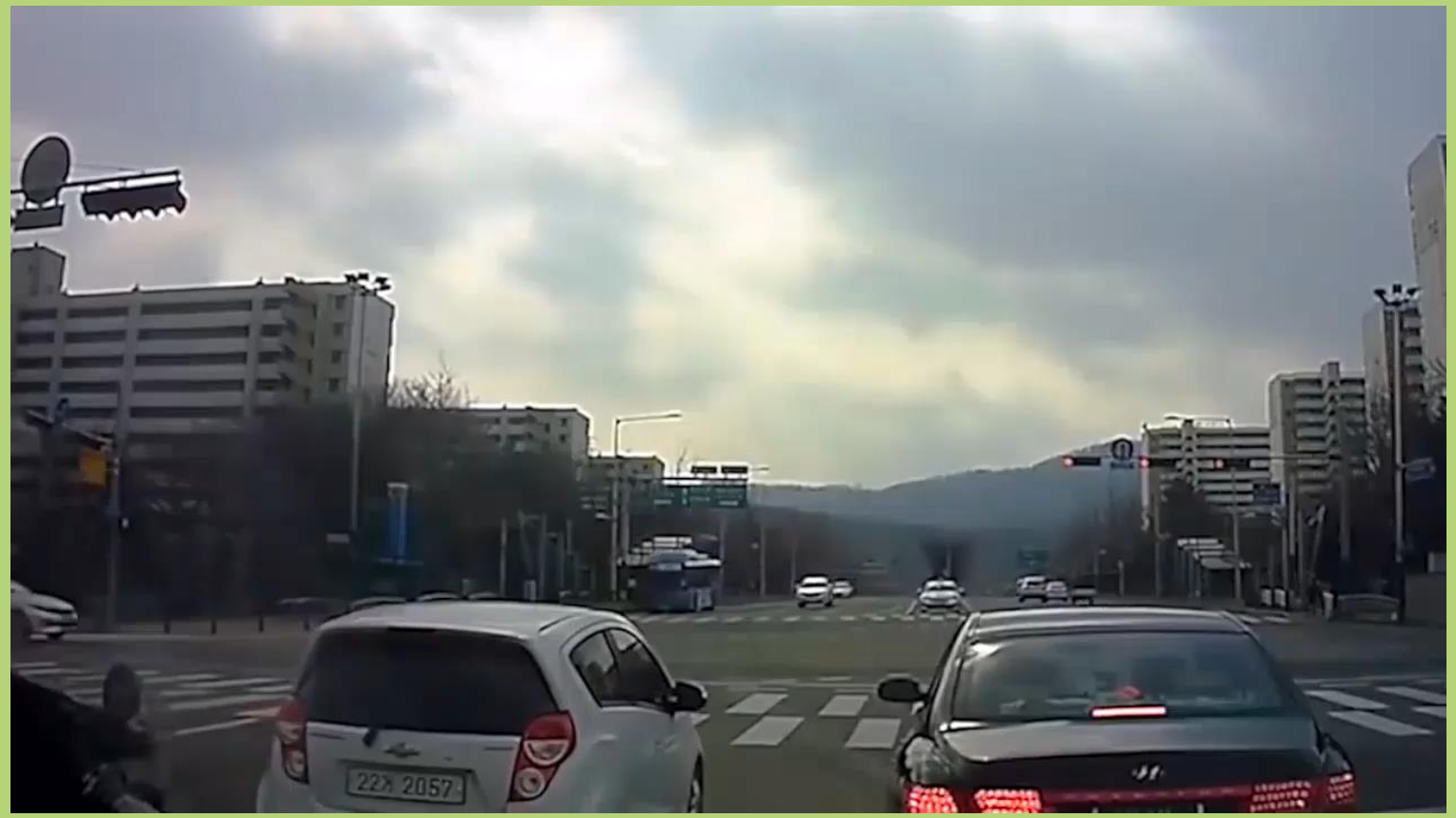
- Interaction in diverse environments.
  - HumanE-AI-Net is one of the five Flagship projects of the EU ICT-48 call. Starts in September 2020. It is led by DFKI and has 53 partners from Aalto to VW.
  - SkinCare. Mobile application for Skin Cancer detection. EIT Digital project led by Degetel

(c) Industrial applications of AI

- Self-driving cars, image processing and others
  - Bosch, Hungary supports the Department → It is starting now

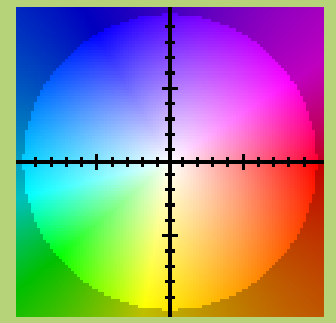
Example #1 – Bosch

- Detection of distance and speed of unknown objects



Example #1 – Bosch

→ Safer products

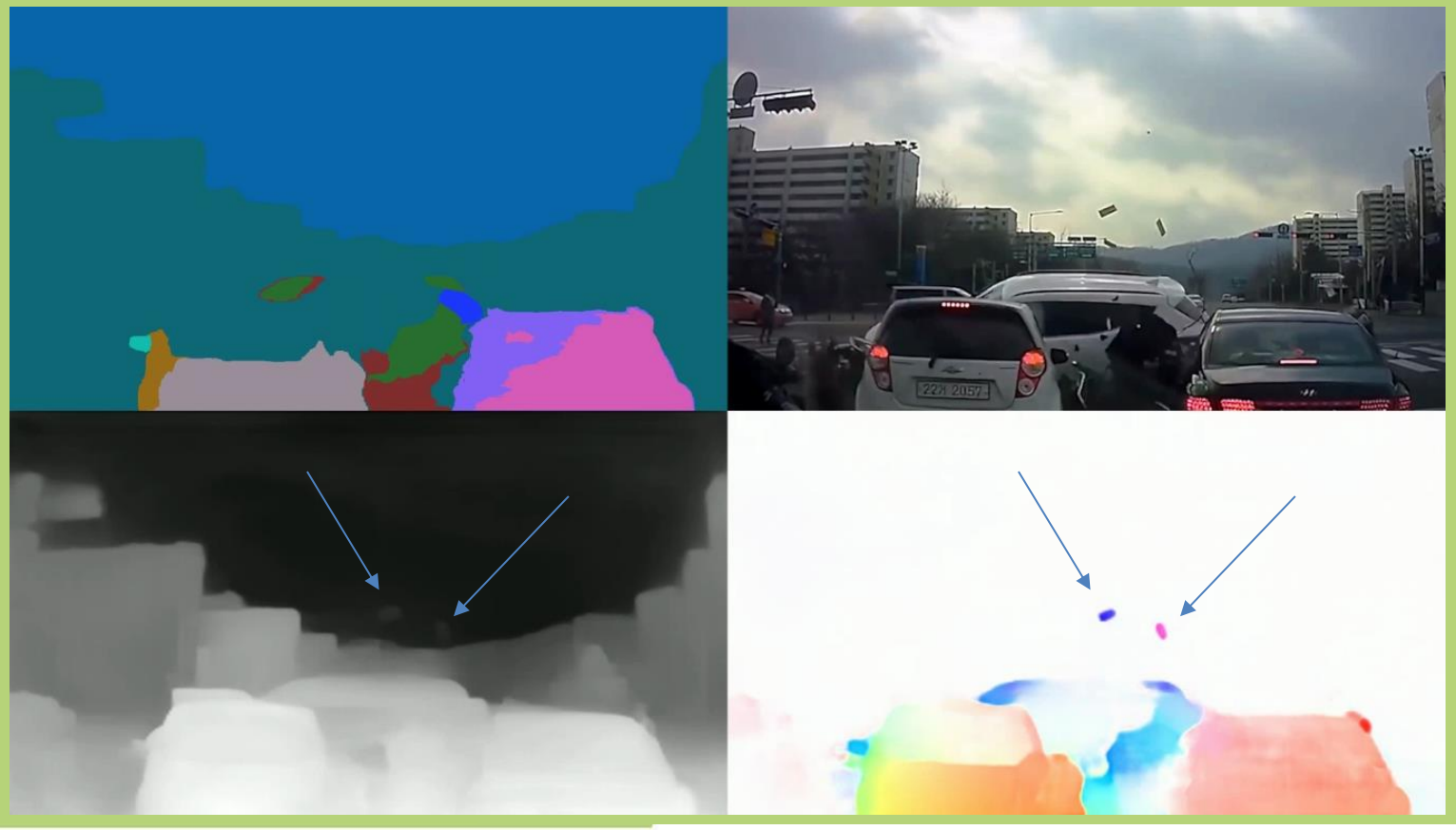


(1,1) Depth+Optical Flow→SuperVoxel

(1,2) RGB

(2,1) 2D camera 3D depth estimation

(2,2) Optical Flow



Example #2 – ELTE

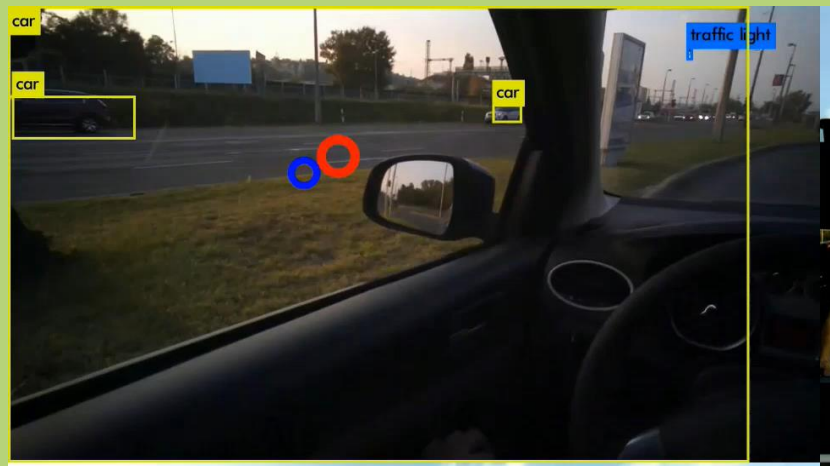
→ More comfort

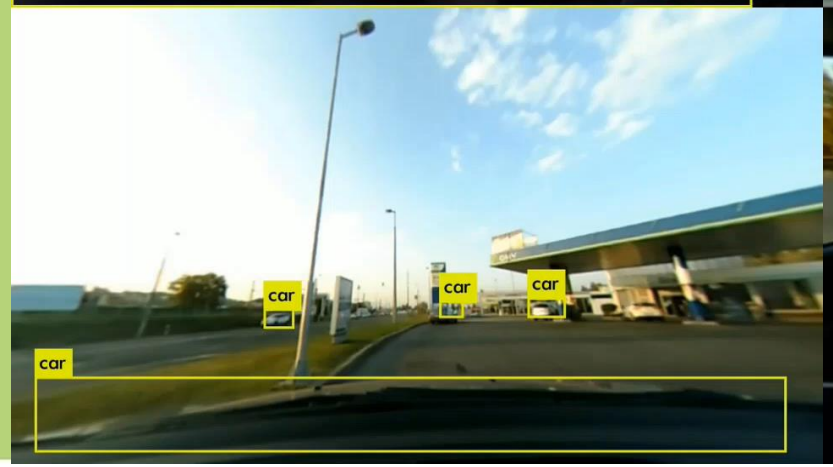
Driver's gaze

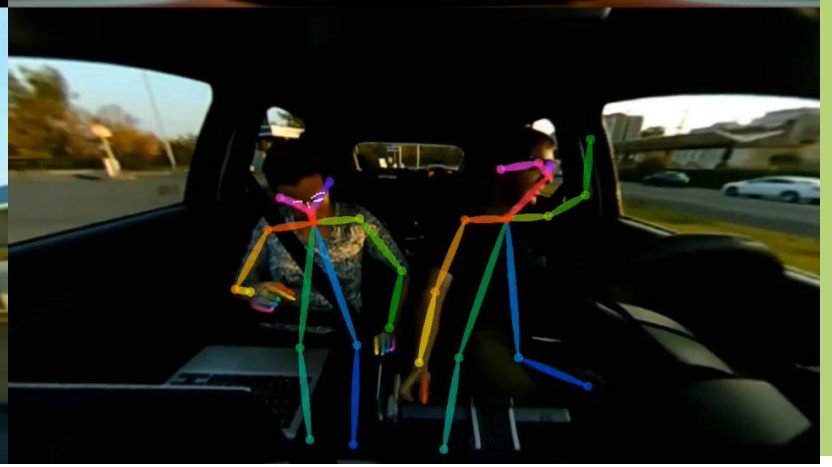
Front view from 360^0 camera

360^0 camera

Back view from 360^0 camera



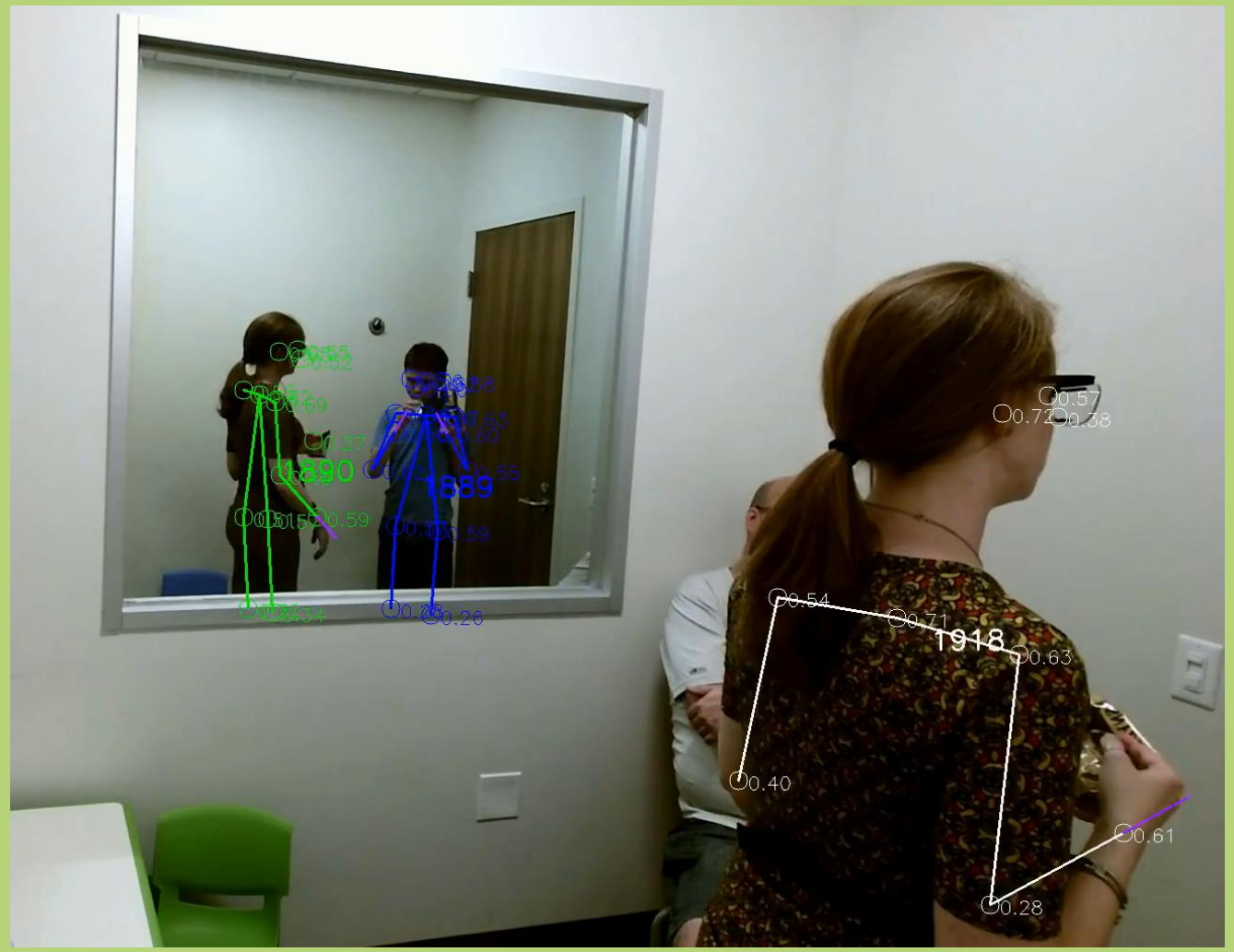




Visually enhanced speaker separation

Example #3 – Rush Med School → NIH, SBIR, USA

- Autism
- Quantifying diagnosis
  - interaction and
  - collaboration



Example #4

→ Next: Covid EU proposal

SkinCare: An EIT Digital project

Mobile application

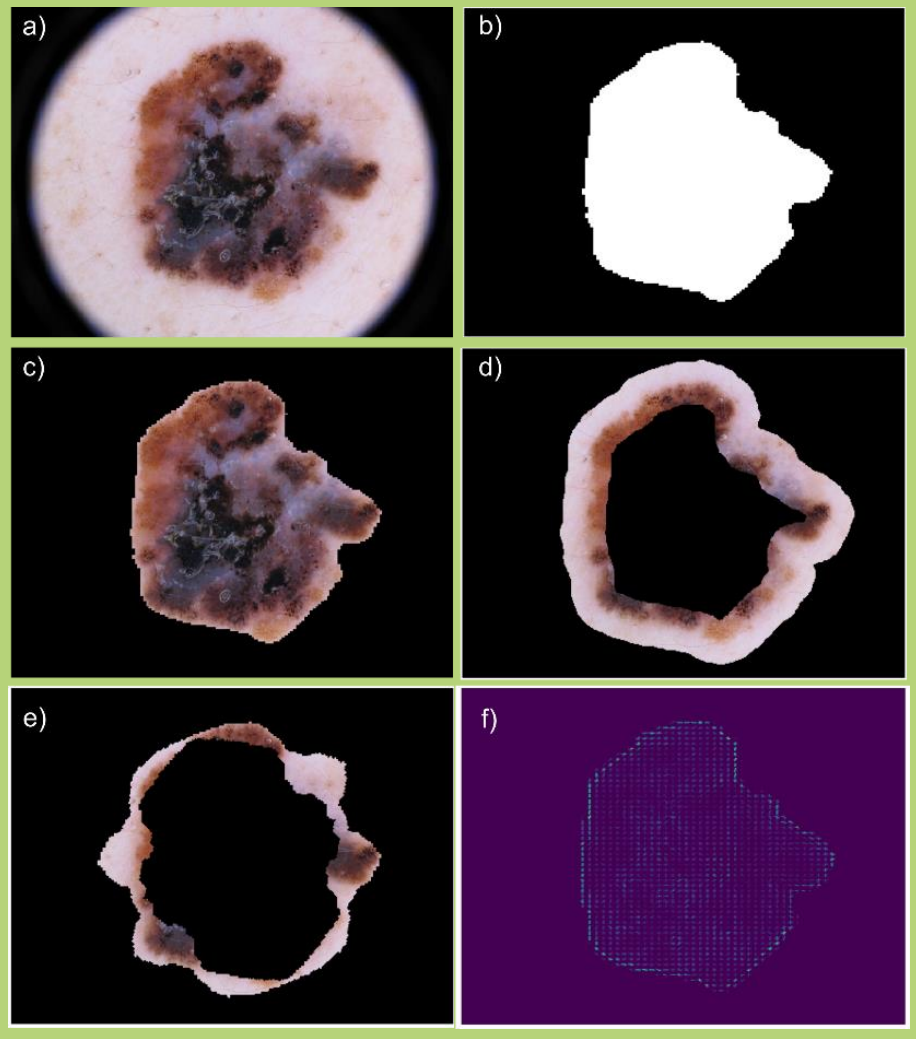
Approach: Information Fusion

Leader: Degetel (France)

Partners

- DFKI Saarbrücken
- Semmelweis University

- **Diverse expertise are to be combined**
  - Data sharing is a critical bottleneck
  - Similar problems arise in many industrial applications



Example #5

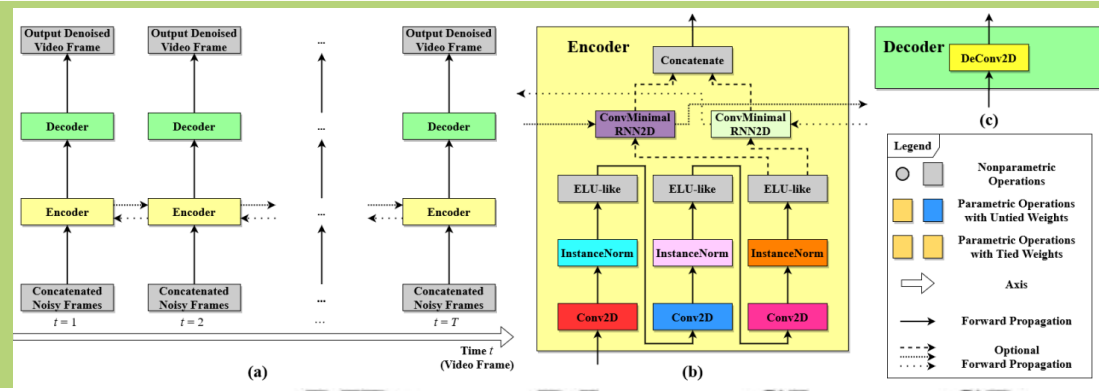
→ Bosch, Rush, Semmelweis

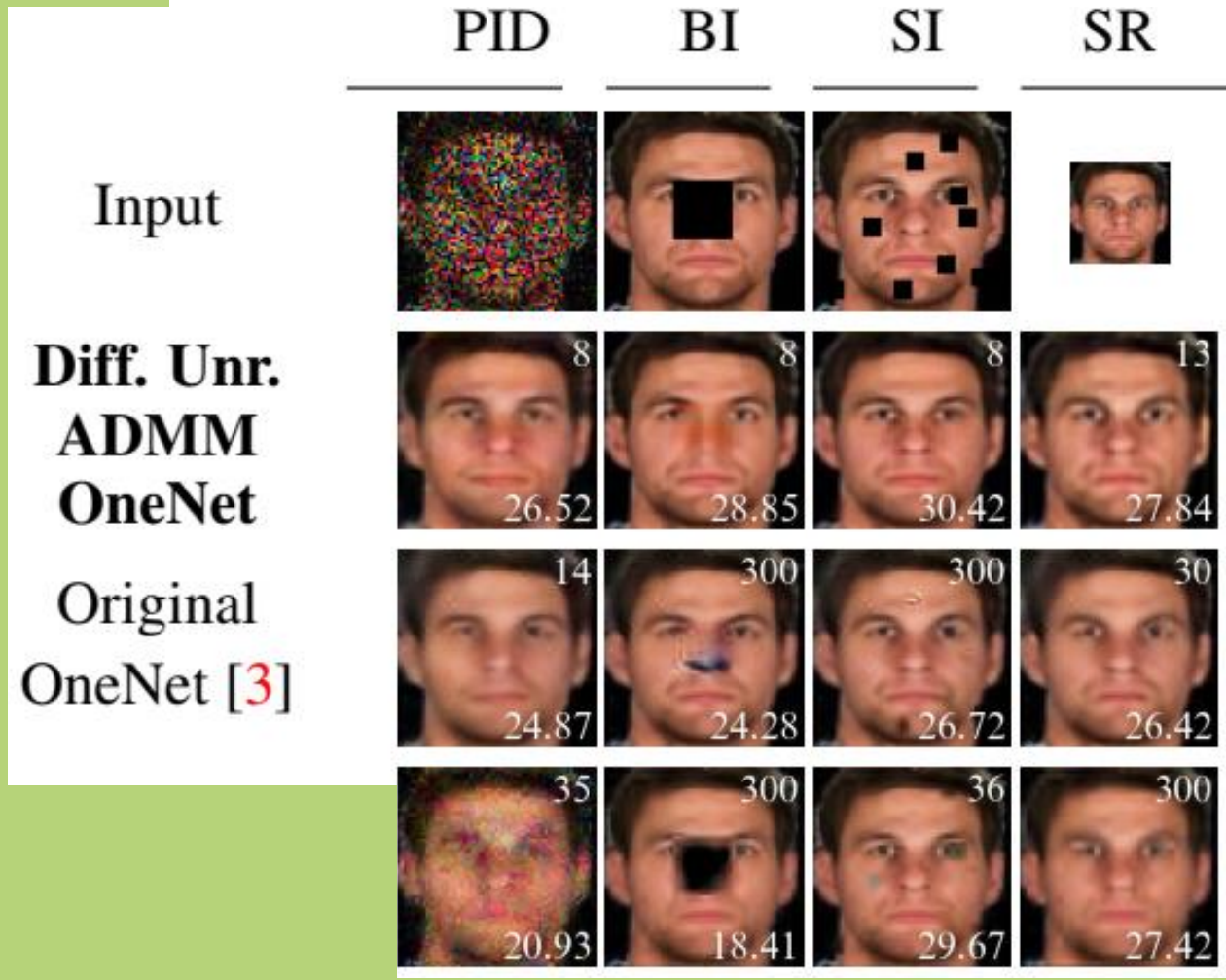
- Combining expertise of
  - AI experts
  - Domain experts
  - Programmers

Underlying basic research

- Single network solves many tasks
  - One Network solves them all
- Single networks learns and solves many tasks
  - One Network learns them all

- **Ongoing and future directions**
  - Multi-Task Learning (1)
  - Meta-Learning
  - Reinforcement learning (2)





PLANS

WE JUST KEEP WALKING:

- Multi-Task Learning
  - single network – single architecture made of many subnetworks
- Meta-Learning
  - guessing novel networks from previously learned ones
- Seeking consistence among the networks of the architecture (1)
- Reinforcement Learning

HTTPS://TINYURL.HU/FDUY/

APPLICATION DOMAIN SPECIFIC HIGHLY RELIABLE IT SOLUTIONS

NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION OFFICE HUNGARY

PROJECT FINANCED FROM THE NRDI FUND

(1) Lőrincz, A et al. Towards reasoning based representations: Deep consistence seeking machine. *Cognitive Systems Research*, *47*, pp.92-108 (2018)