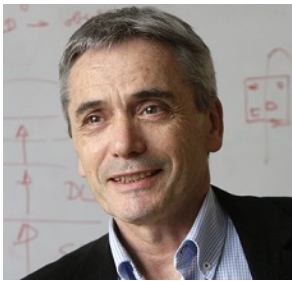# Intelligent human-machine interaction for quality assurance in the medical domain

Quality assurance in rehabilitation after knee injury

András Lőrincz

Department of Artificial Intelligence

Faculty of Informatics

NIPG

E·L·T·E
IK

ELTE
Faculty of Informatics
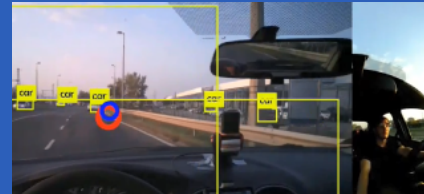EIT Digital CLC

Emotions

Intention

Interaction monitoring
Rush Medical School, Chicago

Driving situation
Bosch Hungary

Social behavior
Carnegie Mellon Univ

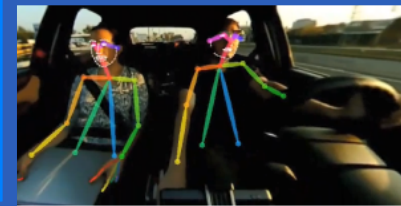**Divided attention**
German AI Research Center

Manipulation
TU Graz

Telepresence
Bliss Foundation

Navigation and game
German AI Research Center

Anomaly detection
VW AI Research

3D pose estimation from 2D camera

Temporal Smoothing for 3D Human Pose Estimation
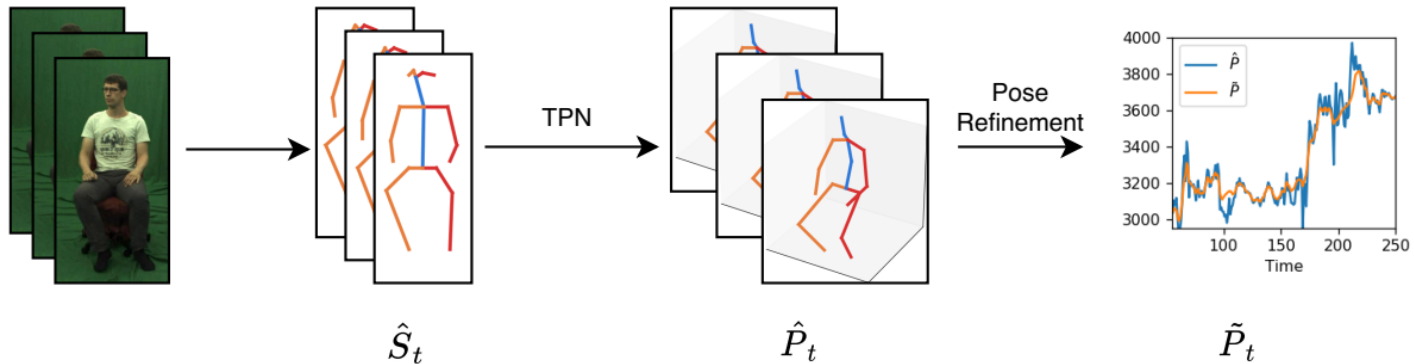and Localization for Occluded People

Márton Véges and András Lőrincz

ICONIP 2020

Multi-Person Absolute 3D Human PoseEstimation with
Weak Depth Supervision

Márton Véges and András Lőrincz

ICANN 2020

$$\hat{S}_t \qquad \hat{P}_t \qquad \tilde{P}_t$$

Absolute Human Pose Estimation with Depth
Prediction Network

M Véges, A Lőrincz

International Joint Conference on Neural Networks
2019

3D human pose estimation with siamese equivariant
embedding

M Véges, V Varga, A Lőrincz
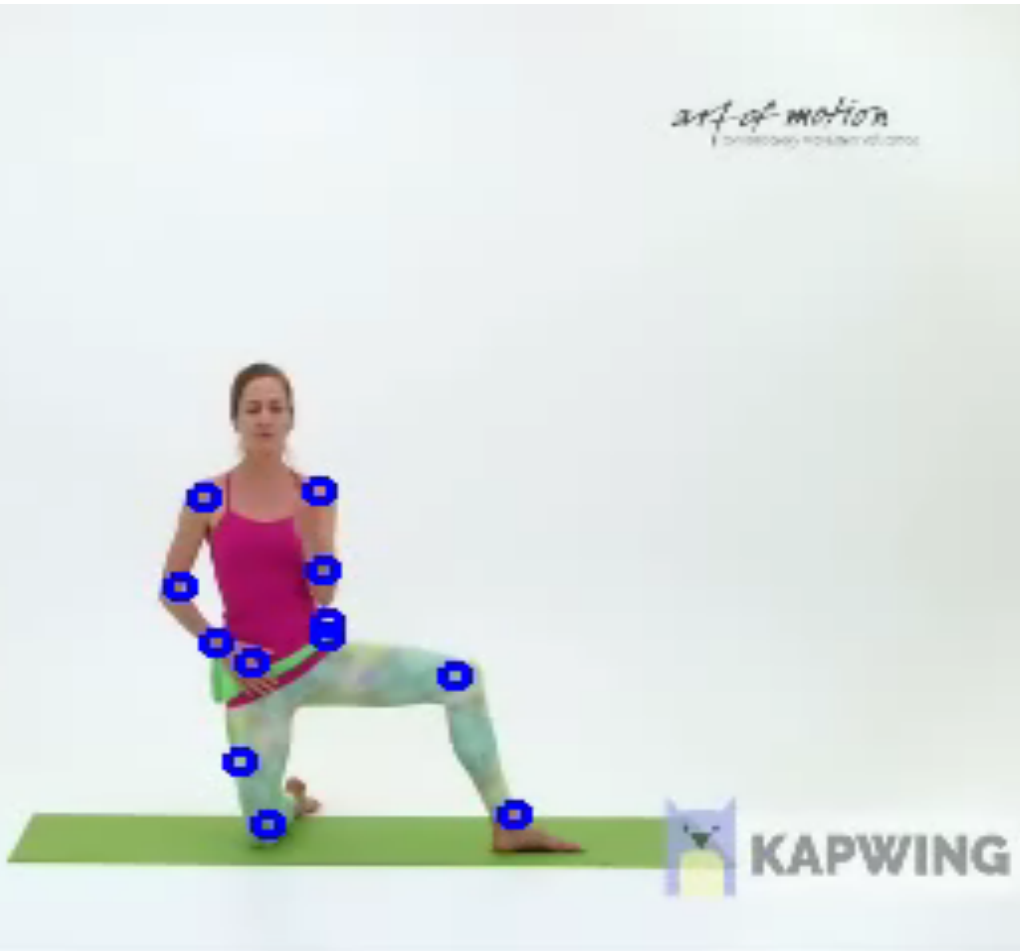
Neurocomputing 339, 194-201, 2019

Development in progress:
Compression into Edge TPU
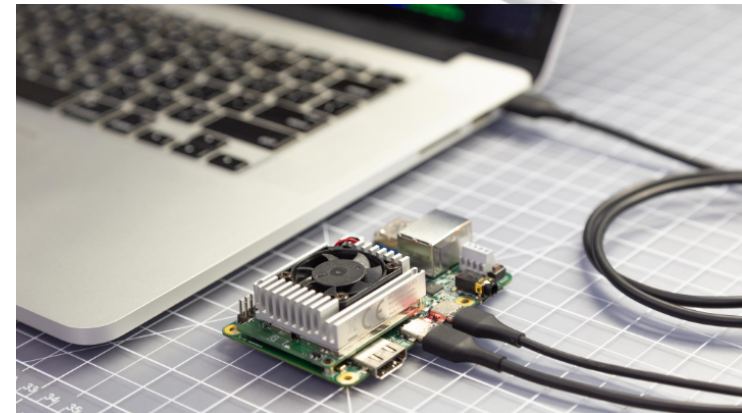➜ for real time interaction
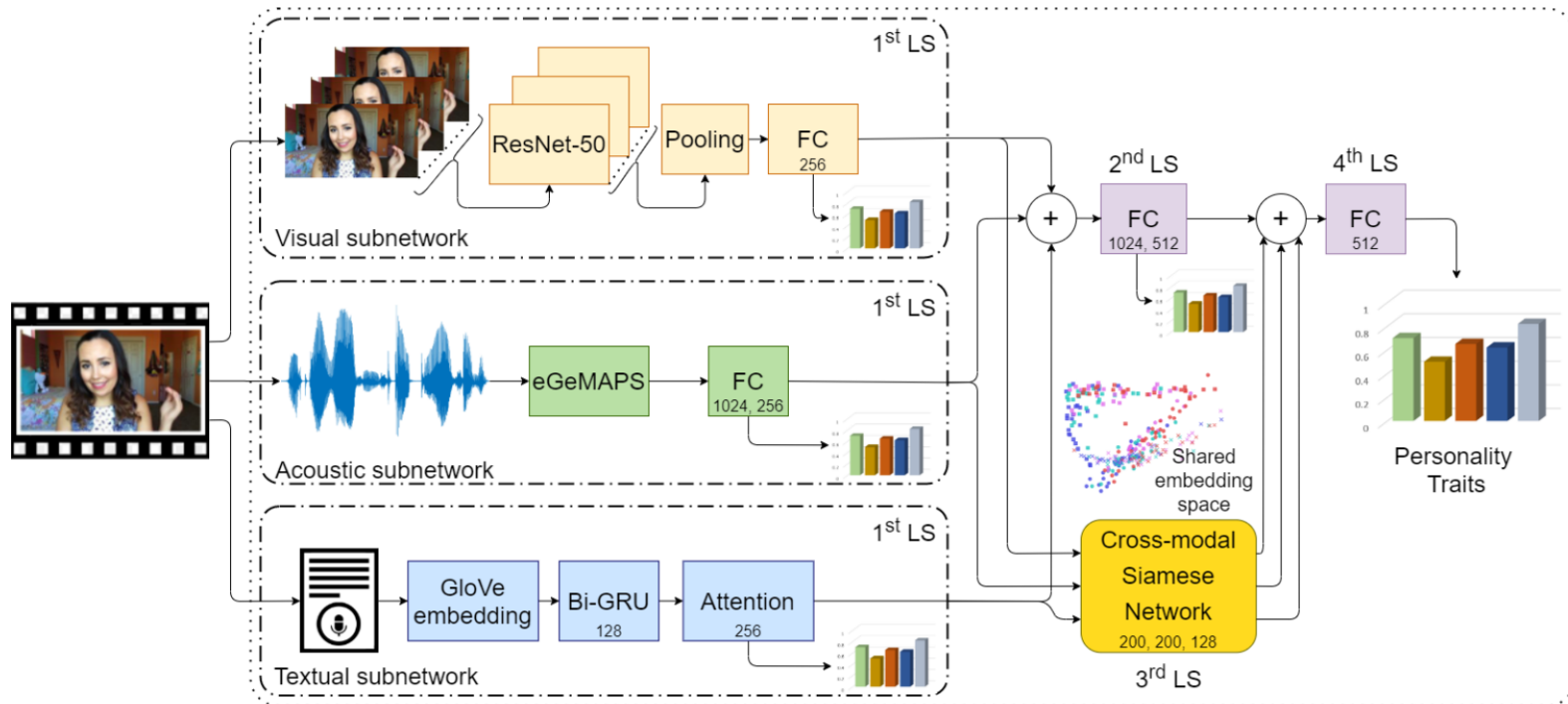➜ started, 'works', *needs improvements*

Coral & Edge TPU DevBoard

Research question:
Multi-modal fusion for pain estimation

Experiments on First Impression Database

HumanE-AI Micro-Project

Key external partner:

– Emineo Private Hospital, Budapest Hungary

- latest tech on total knee arthroplasty/replacement (TKA/TKR)
- physiotherapists, video production, expert dialogue system

Tasks ('*': in progress)

Task1 (*): Literature search.

- Standards of the rehabilitation need to be collected and discussed with the partner; a **clinic in Hungary** that does the surgeries and will have the latest J&J technology for TKA

Task 2 (*): Database A high quality sample videos are to be collected that show „what to do"

- There are two directions, both will be undertaken:
- D1. General rehabilitation, i.e., the most frequent, most relevant exercises
- D2. A series of videos according to the protocol of the clinic/J&J

Task3 (*): Compress **pose estimation** software into Coral Edge TPU for real time interaction.

%--------------------------------***Partner-is- needed***---

Task4: Use rule-based dialogue system for the **interaction with the patient**

Task5: develop methods for general video-grounded interaction with the patient

The project needs a partner in NLP

Options:

1. **Baseline is from ELTE:**

   – Rule-based dialogue according to the physiotherapist experts

2. **Partner:**

   – Deep technologies, such as BERT, NeMo, or Rasa

3. **A joint option (*)**

   – Use crowdsourced Intelligence for

   video-grounded situation understanding

(*) Lőrincz, A., Csákvári, M., Fóthi, Á., Milacski, Z.Á., Sárkány, A. and Tősér, Z., 2018. Towards reasoning based representations: Deep consistence seeking machine. *Cognitive Systems Research*, *47*, pp.92-108.

Self-training 1: **Inference** on NN outputs

Blue: right
Red: left
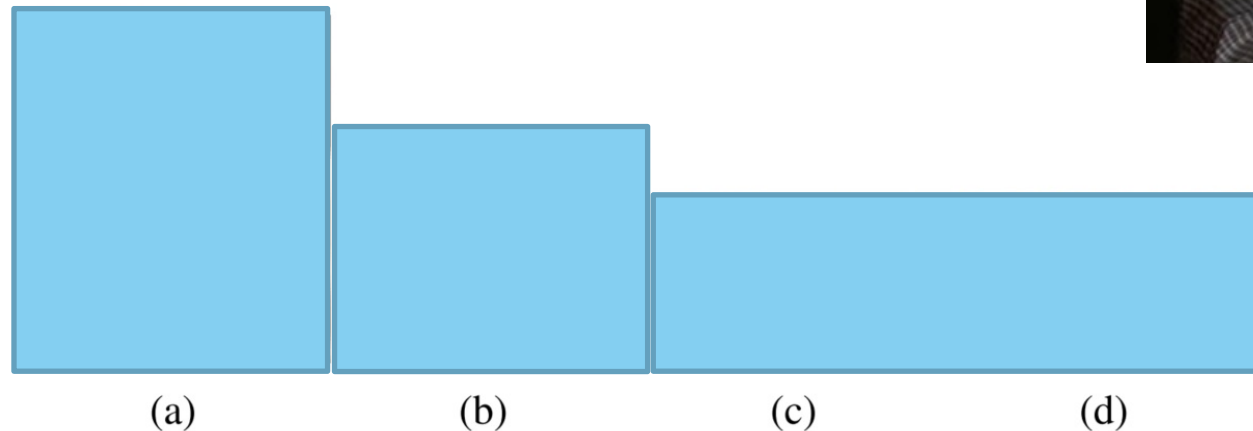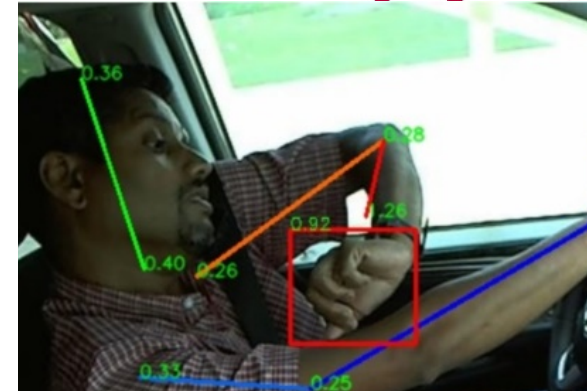
- Contradiction – he has two **right** hands!
- Score on the steering wheel is high: this is the **right hand…**
- The other one is the **left hand…**
- Evaluation should be constrained accordingly…
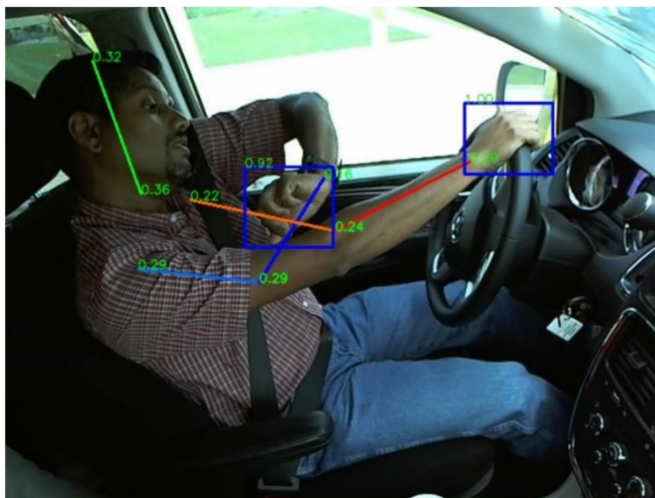
OK!!

Self-training 2: **Inference** on BIG DATA

- What is the driver looking at?
- Send to Google Images and read captions:
  - **it is an animal**
    - Hmmm… in a car, in the driver's seat?
- **Plus info:** the target of the gaze is close to the **wrist**

(a)   (b)   (c)   (d)

- Restrict search by the word wrist.
- Captions say: **wristwatch**

Lőrincz, A., Máté Csákvári, Áron Fóthi, Z. Ádám Milacski, András Sárkány, and Z. Tősér. "Towards reasoning based representations: Deep Consistence Seeking Machine." *Cognitive Systems Research* 47 (2018): 92-108.
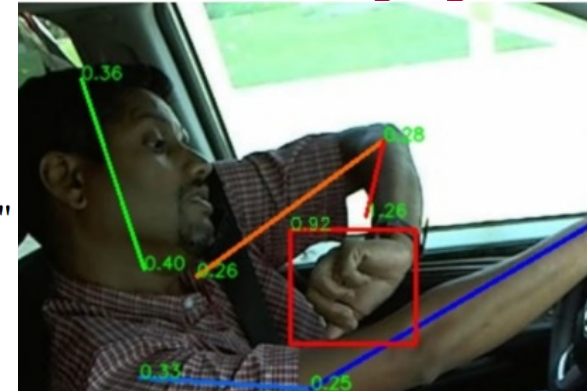
Self-training 3: **Inference** on knowledge base

Thus, he is looking at his wristwatch

What is the wristwatch used for? Ask ConceptNet:

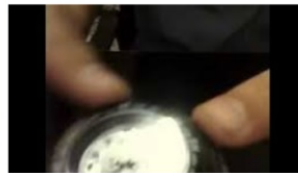"wristwatch $\xrightarrow{\text{UsedFor}}$ time something or somebody"

"wristwatch $\xrightarrow{\text{IsA}}$ way to tell time"

(a) (b) (c) (d)

⇒Puzzle solved, action has become possible…

⇒**MACHINE WILL LEARN FROM BEHAVIORAL FEEDBACK**

Thanks for your attention!

lorincz@inf.elte.hu