MEDICAL UNIVERSITY OF VIENNA

Speech and Hearing Science Lab

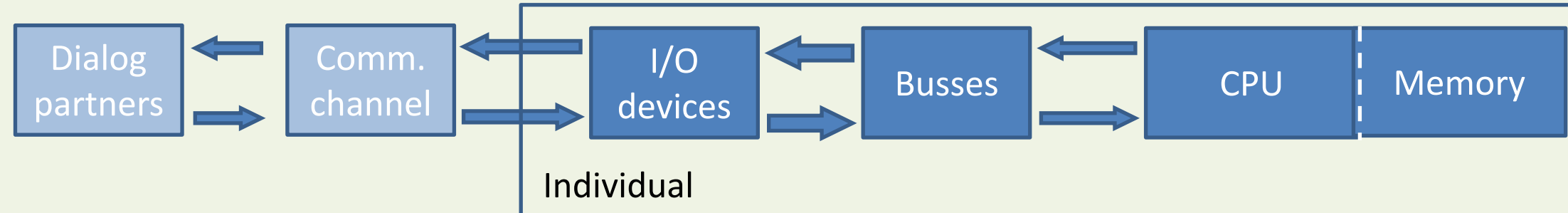Head: Ap.Prof. DI Dr.techn. Philipp Aichinger

General field of interest

Foundation ⟷ Application
Science ⟷ Technology

Medical applications:
Prevention, diagnosis, decision support, therapy and rehabilitation
eHealth, biosensors, wearables, implants, ass. devices, biomarkers, …

- Speech production
- Auditory perception

Periphery, nerves, brain

- Computer model:

Dialog partners ⟷ Comm. channel ⟷ I/O devices ⟷ Busses ⟷ CPU | Memory
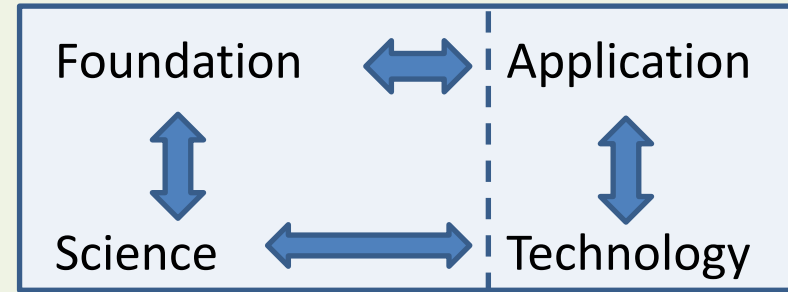
Individual

- Pathologies affecting speaking and/or hearing
  ⊂ communication disorders
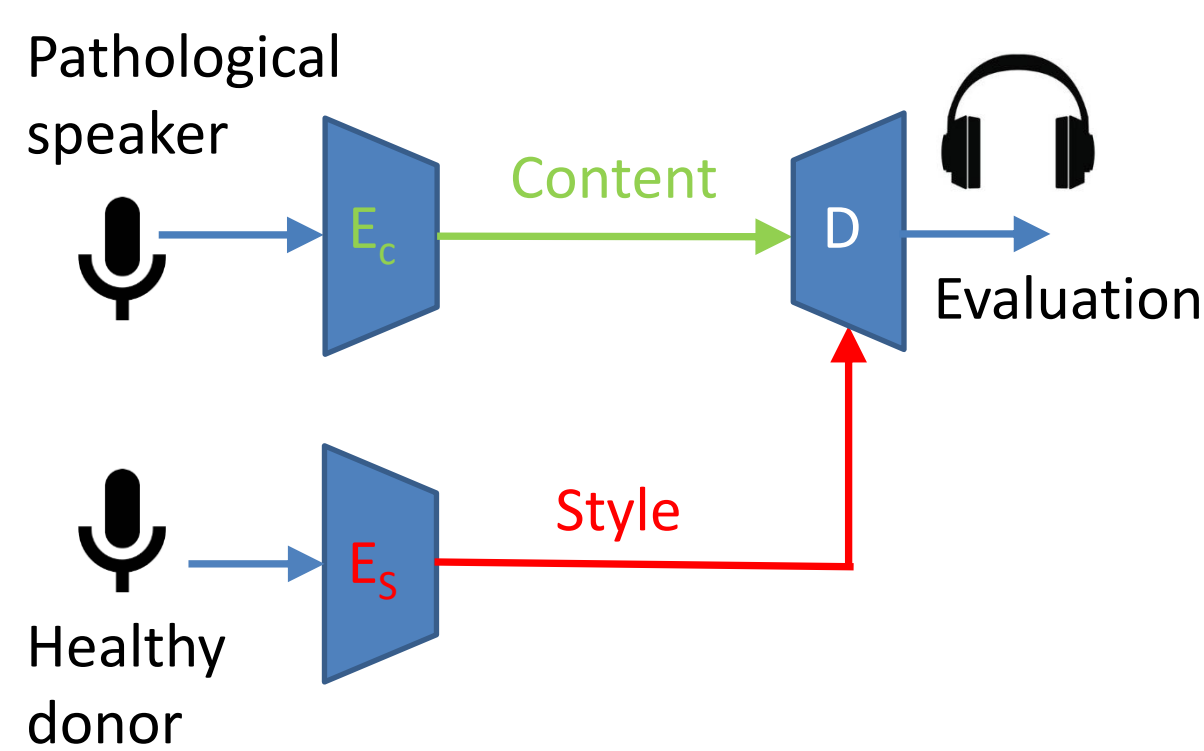
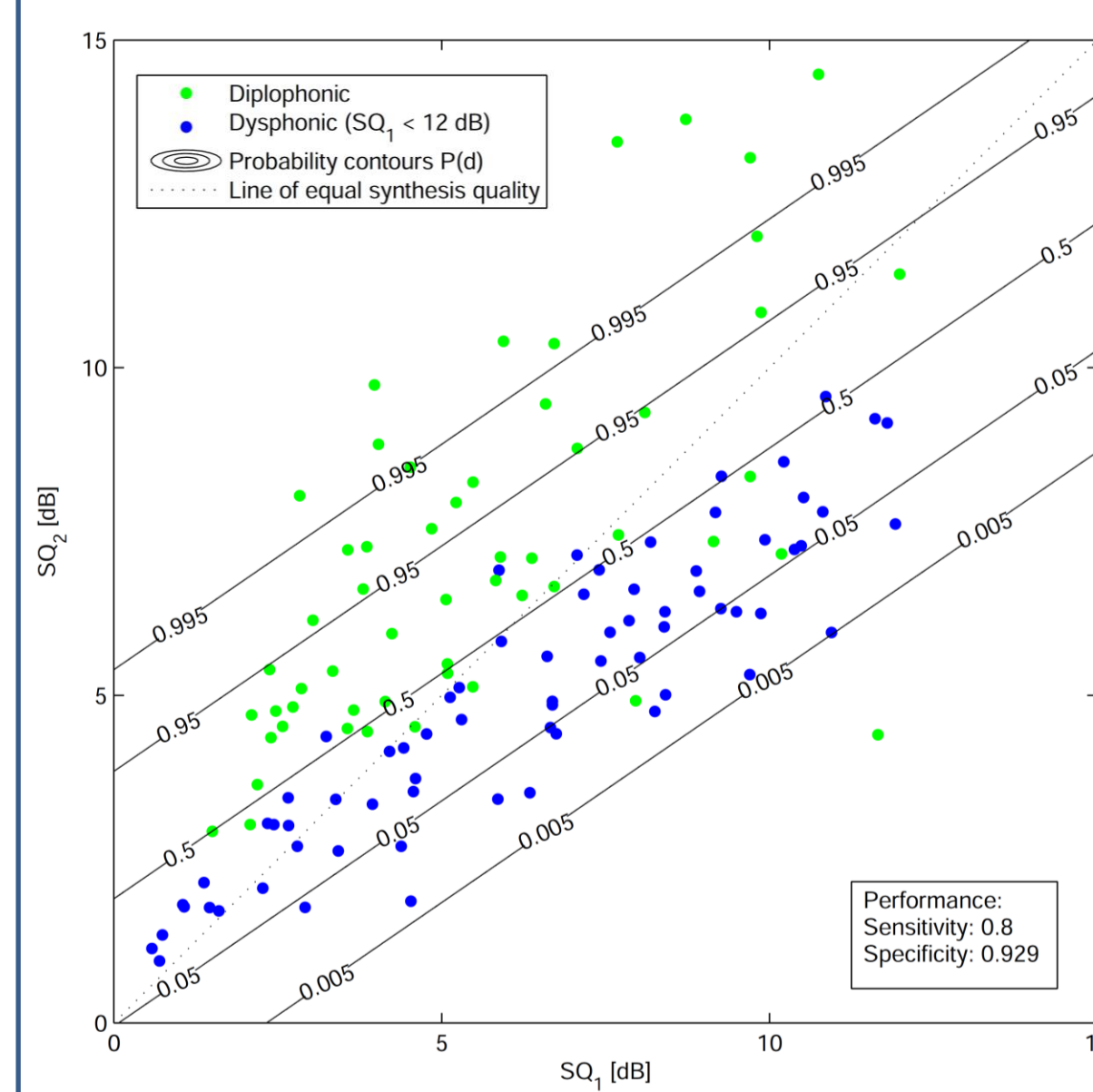## Data

Endoscope
Glottis
Vocal folds
Microphone
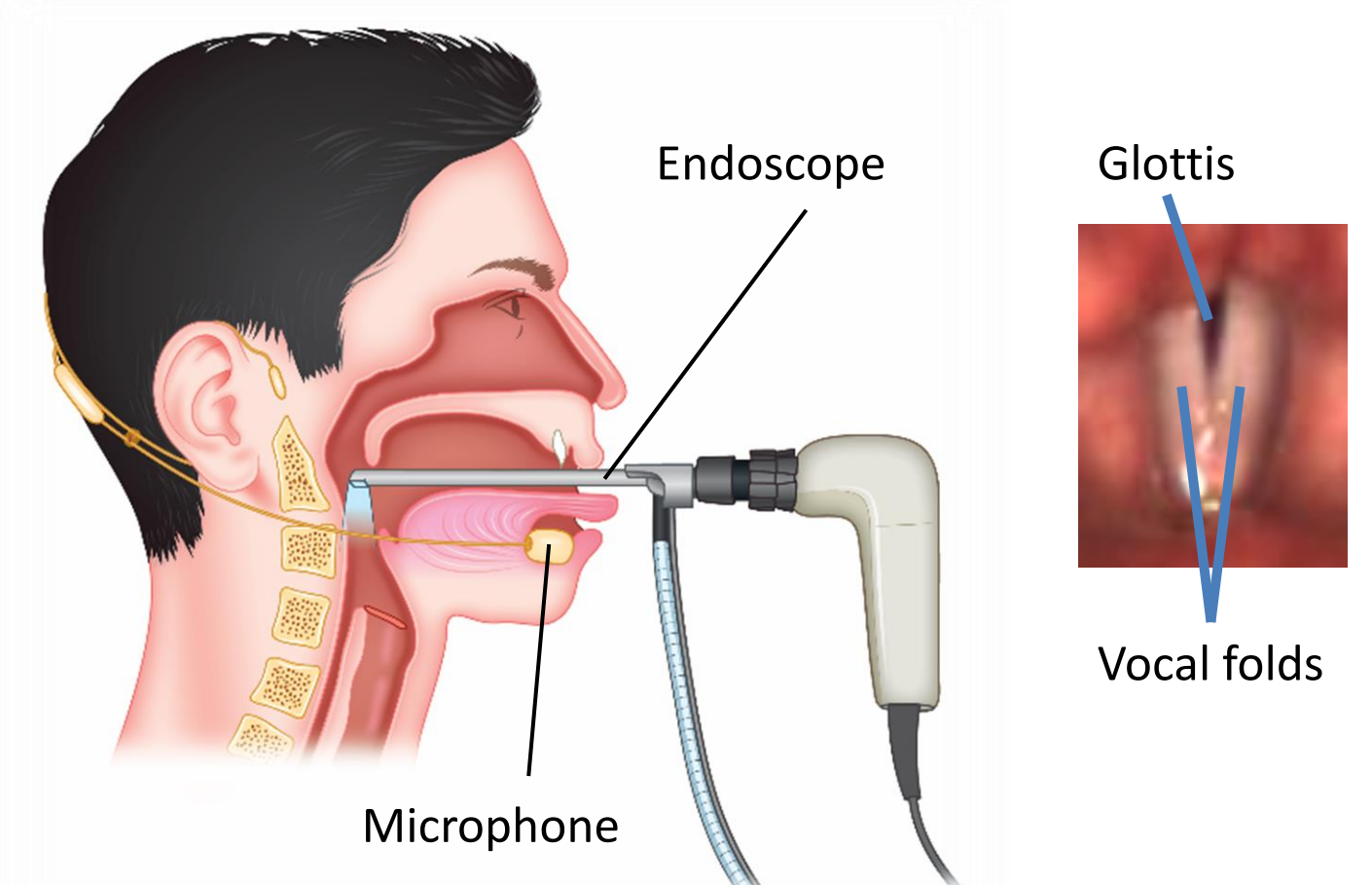
- Endoscopic high-speed videos
- Microphone recordings
- Electroglottography (cf. elec. impedance tomography)
- Electronic patient records (EPRs)
- Questionaires, patient reported outcomes (PROs)
- Action potentials / EEG
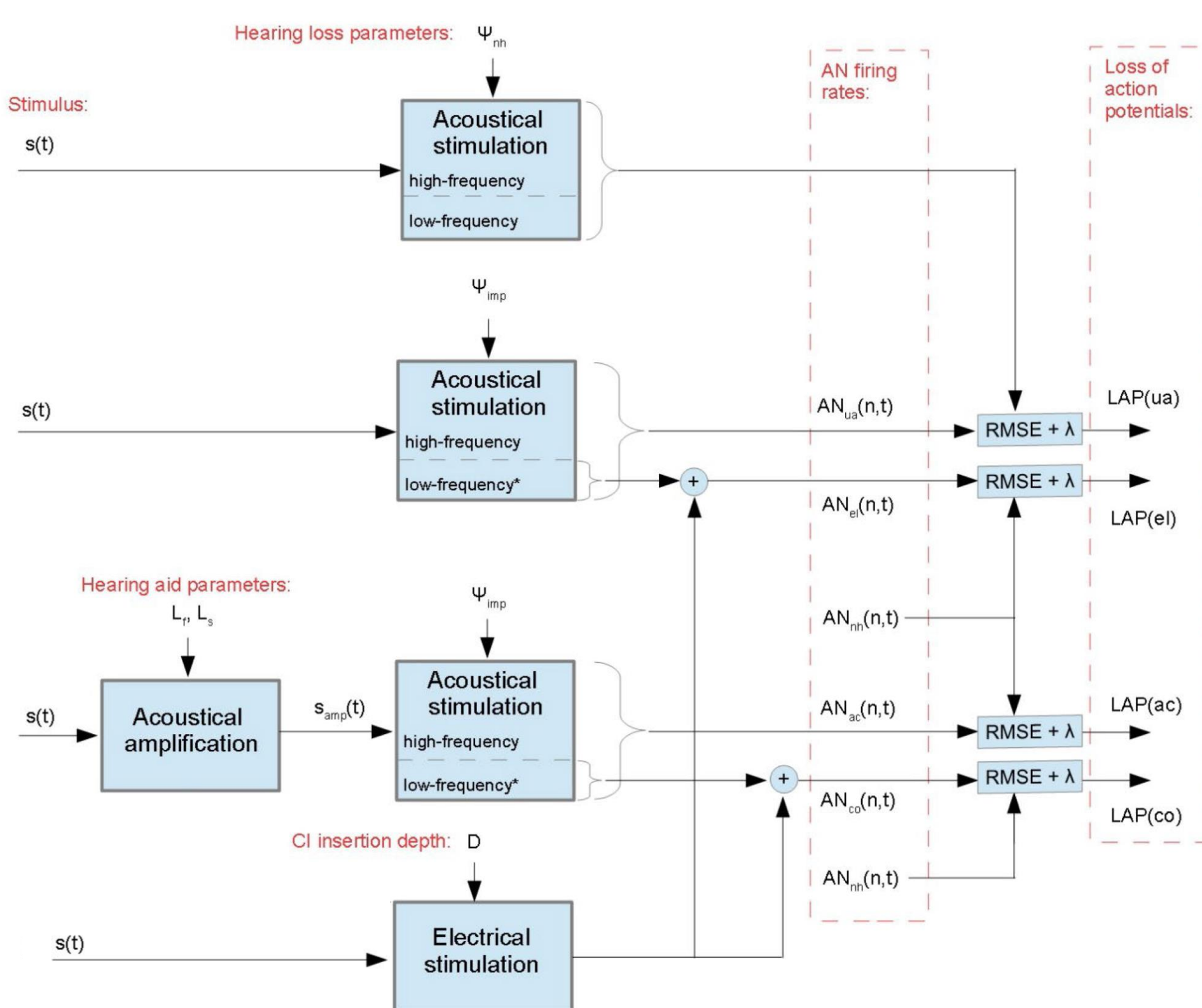- Brain imaging, …

Generation

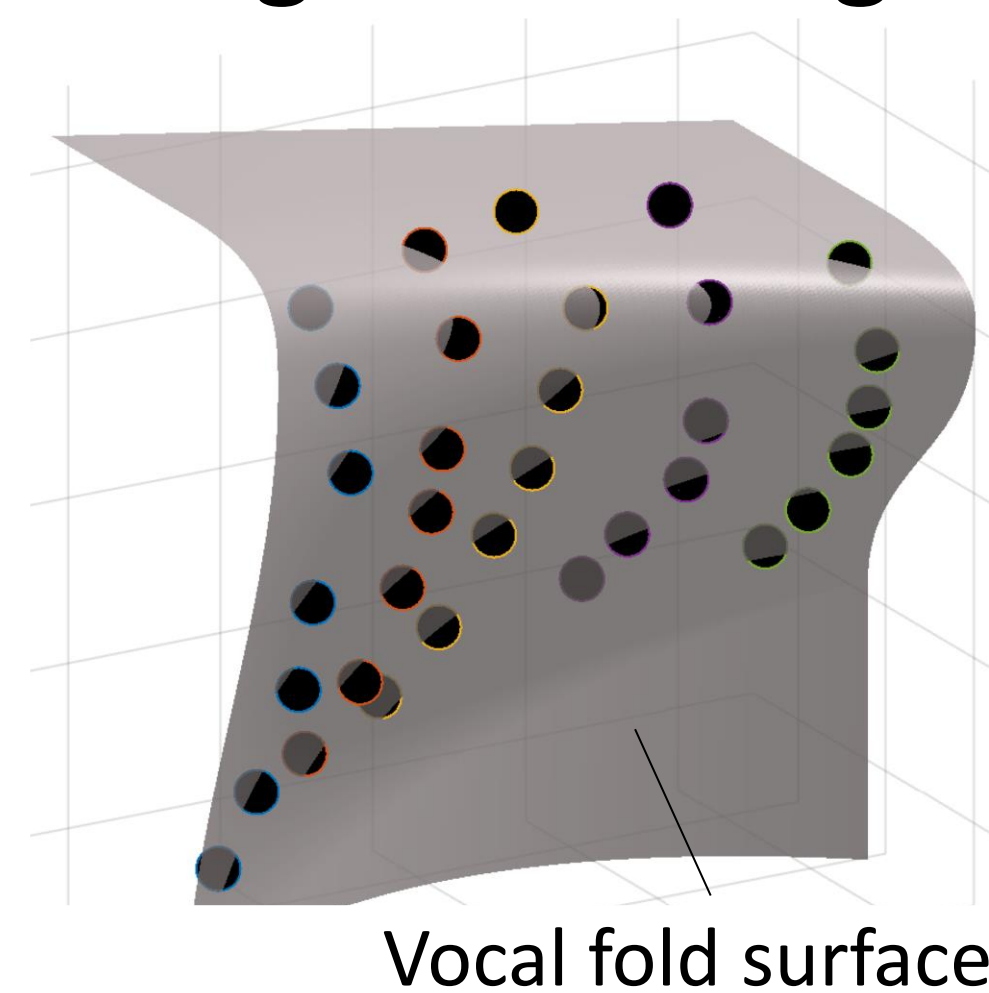Representation learning,
Transfer learning,
Domain translation, …

Pathological speaker
E_c — Content — D — Evaluation
E_s — Style
Healthy donor

Discrimination

Legend:
- Diplophonic
- Dysphonic ($SQ_1 < 12$ dB)
- Probability contours P(d)
- Line of equal synthesis quality

Axes: SQ_2 [dB] vs SQ_1 [dB]

Performance:
Sensitivity: 0.8
Specificity: 0.929

Simulation in digital twinning

Hearing loss parameters: Ψ_{nh}
Stimulus: s(t)
Acoustical stimulation — high-frequency — low-frequency
Ψ_{imp}
AN firing rates:
Loss of action potentials:
$AN_{ua}(n,t)$ → RMSE + λ → LAP(ua)
$AN_{el}(n,t)$ → RMSE + λ → LAP(el)
Hearing aid parameters: L_n, L_s
Acoustical amplification → $s_{amp}(t)$
$AN_{ca}(n,t)$
$AN_{ac}(n,t)$ → RMSE + λ → LAP(ac)
$AN_{co}(n,t)$ → RMSE + λ → LAP(co)
CI insertion depth: D
Electrical stimulation
$AN_{ce}(n,t)$

Inverse problem in digital twinnig

Vocal fold surface

3D visualization

P. Aichinger, R. Veltrup, M. Semmler, M. Döllinger, S. Lehoux, and Jan G. Švec, "Sinusoidal Modelling of Vocal Fold Medial Surface Vibration Trajectories", Adv. Quant. Laryngology, 2023.
P. Aichinger, "A modelling study on the comparison of predicted auditory nerve firing rates for the personalized indication of cochlear implantation", Applied Sciences, 2022.
P. Aichinger and F. Pernkopf, "Synthesis and Analysis-by-Synthesis of Modulated Diplophonic Glottal Area Waveforms," IEEE/ACM Trans. Audio Speech Lang. Process., 2021.
P. Aichinger, "Diplophonic Voice - Definitions, models, and detection", PhD dissertation, Graz University of Technology, Austria, 2015.
B. Mayrhofer, M. Metelka, M. Hagmüller, P. Aichinger, "From Silence to Sound: Developing a Voice Conversion System for Patients with Speech Disabilities", MSC theses, Graz University of Technology & Medical University of Vienna, in preparation.