

# Efficient TrustworthY and rObuSt Artificial Intelligence (ETHOS AI)

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Ing. Martina Billichova, PhD

Ing. Dmytro Furman, PhD

Ing. Michal Luley - PhD student

Ing. Dominik Pallo - PhD student

Ing. Lenka Husarova - PhD student

Ing. Martin Dubovsky - PhD student

Ing. Erika Vaczlavova - PhD student

Ing. Darina Dvorecka - PhD student

## Collaborators:

U of Southampton, Prof Roxana Carare

U of Liverpool, Dr Neeru Valabh

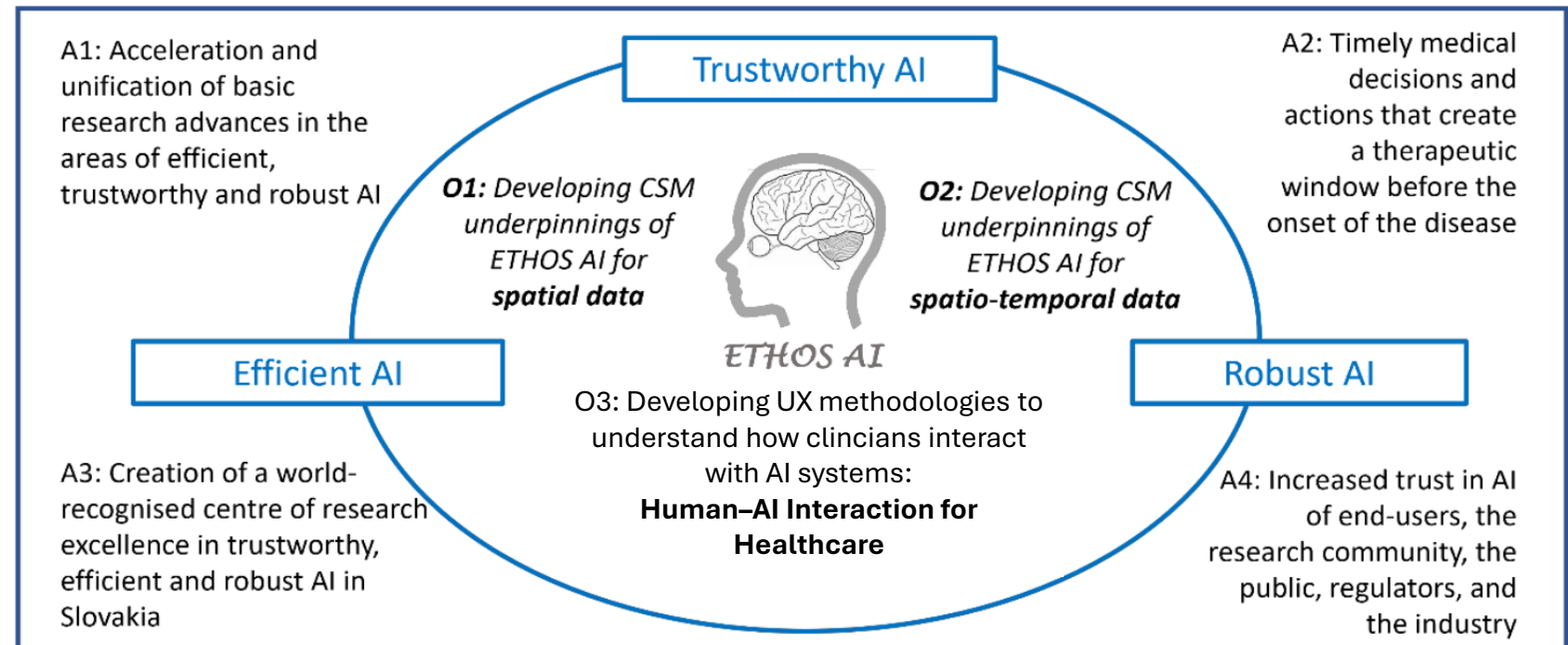
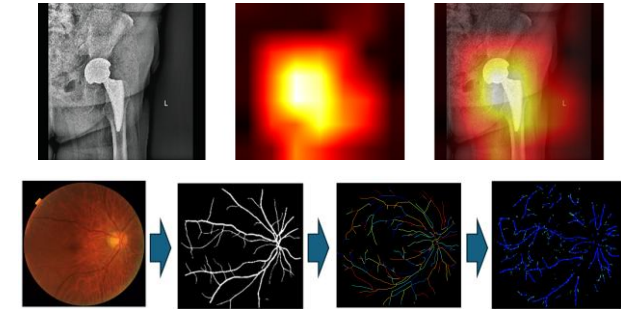
MIT, Prof Emery N Brown

U of Brescia, Italy, Dr Vito Romano

U of Lancaster, Dr Bryan Williams

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MUDr Doc Jana Stefanickova, National Institute of Children's Diseases, Slovak Republic



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MISTI MIT fund - 30K US Dolars

Siemens - 12k/year

TIC 09I02-03-V01-00012 - 700k Euro

# Research focus

## Artificial Intelligence for Modelling Progression to Mild Cognitive Impairment

Ing. Martina Billichová, PhD

### 1. MODEL CHOICE

#### Survival analysis

Testing statistical, machine learning and deep learning survival models across different scenarios (e.g. sample size).

**MATCH MODEL COMPLEXITY TO THE DATA**

### 2. INFORMATION VALUE

#### Clinical data + structural MRI

Evaluate whether MRI-derived biomarkers provide additional predictive information beyond demographic and clinical predictors.

**TEST WHETHER NEW INFORMATION ADDS REAL VALUE**

### 3. UNCERTAINTY

#### Patient-level uncertainty

Quantifying epistemic and aleatoric uncertainty to identify which individual predictions can be trusted and which should be flagged for further review.

**KNOW WHEN A PREDICTION CAN BE TRUSTED**

- Billichová M, Coan LJ, Czanner S, Kováčová M, Sharifian F and Czanner G. "Comparing the performance of statistical, machine learning, and deep learning algorithms to predict time-to-event: A simulation study for conversion to mild cognitive impairment". (2024) In: PLOS ONE 19(1): e0297190. <https://doi.org/10.1371/journal.pone.0297190>

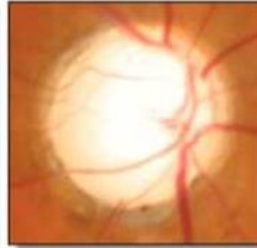
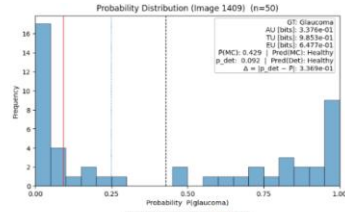
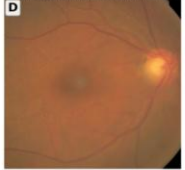
- Billichová M, Bruno D, Sharifian F, Czanner S and Czanner G. "On the Value of MRI in Early Cognitive Risk Prediction: Survival Analysis Comparing Statistical and Machine Learning Models". Submitted to the journal BMC Medical Informatics and Decision Making on 1 April 2026, Status: Accepted for publication

- Czanner G, Billichová M, Furman D, Lüley M, Orguc S, Czanner S, Brown EN. "Hierarchical Structural Uncertainty: A General Framework for Representing Uncertainty in Predictive Models". Submitted to the journal Communications AI & Computing on 23 July 2026, Status: Under editorial consideration (27 July 2026)

# Ing. Dmytro Furman, PhD. — Uncertainty-Aware AI for Ophthalmic Decision Support

Medical Image Analysis • Deep Learning • Uncertainty Quantification • Clinical Decision Support

High EU misclass (GT=G, Pred=H) | 1563.jpg | idx=1409 | GT: Glaucoma

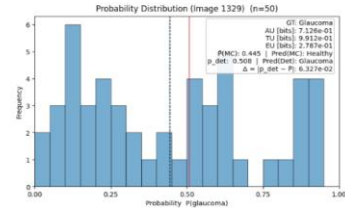


ADVANCED GLAUCOMA

EXTREME GLAUCOMA



High AU, High EU (forced 1341) | 1341.jpg | idx=1329 | GT: Glaucoma



## Glaucoma

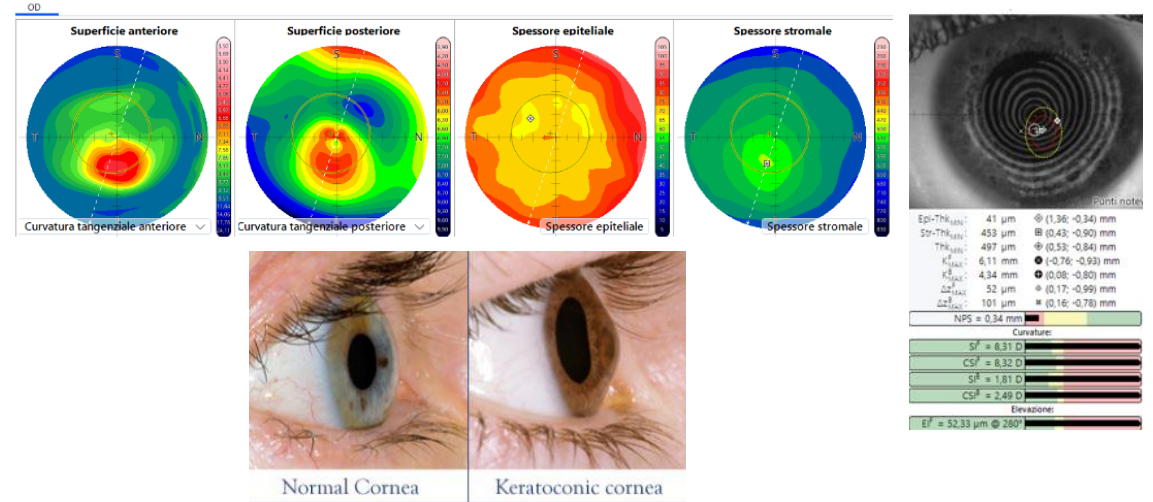
- Color fundus image classification
- MC Dropout uncertainty quantification
- Selective prediction/expert referral
- Entropy, variance, IQR, and WOP
- AUC → 96.3% after uncertainty referral

**Predict → Quantify uncertainty → Refer uncertain cases**

Furman et al., *Support Classification System for Glaucoma Detection*, **Frontiers in Medical Technology / MIUA 2024**.

Furman et al., *Personalised Uncertainty Quantification for Glaucoma Detection*, **PLOS ONE, 2026**, under revision.

Furman et al., *Uncertainty-Aware Keratoconus Classification for Clinical Triage*, **Springer LNCS / MIUA 2026**.



**Ing. Michal Lüley**

**DizP topic:** Towards Robust, Safe and Transparent AI in Medicine: Bayesian Deep Learning and Uncertainty Quantification for Ophthalmic Imaging

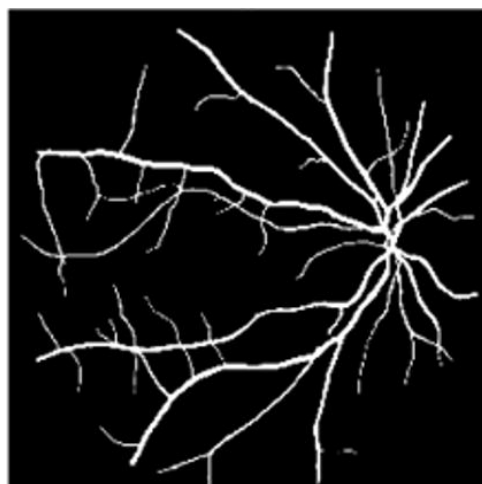
**Publications:**

- Comparative Evaluation of U-Net Architectures and Entropy-Regularised MC Dropout for Hip Implant Segmentation in Radiographs, submitted

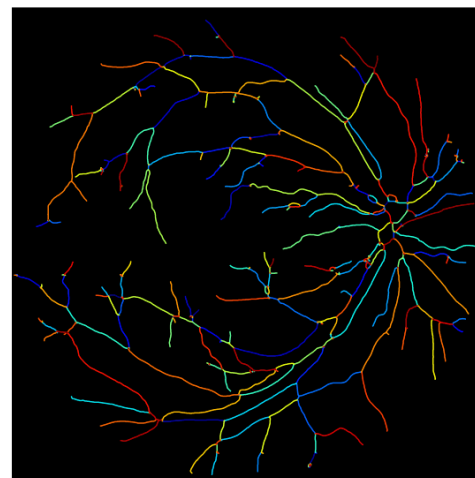
**Actual Research at FIIT STU**



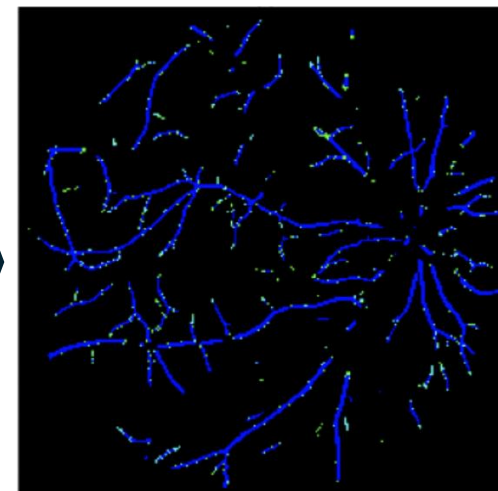
Fundus image



Segmentation



Branches separation



Uncertainty estimation

# Machine Learning for Orthopedic Implant Detection

Semantic segmentation of hip implants in pelvic X-rays under limited annotations

# 0.983

Dice

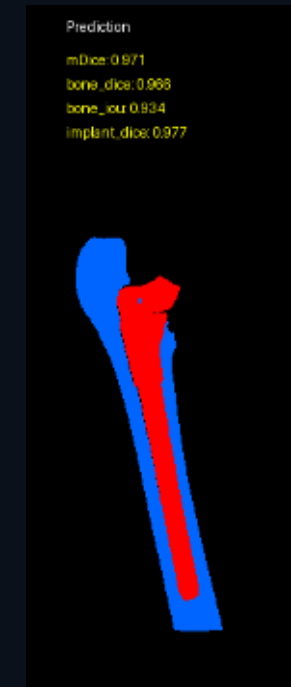
implant segmentation

X-ray → ROI localization → U-Net → mask → clinical support

- U-Net semantic segmentation
- Coarse-to-fine ROI refinement
- Semi-supervised pseudo-labeling + uncertainty estimation

Ing. Dominik Pallo · FIIT STU

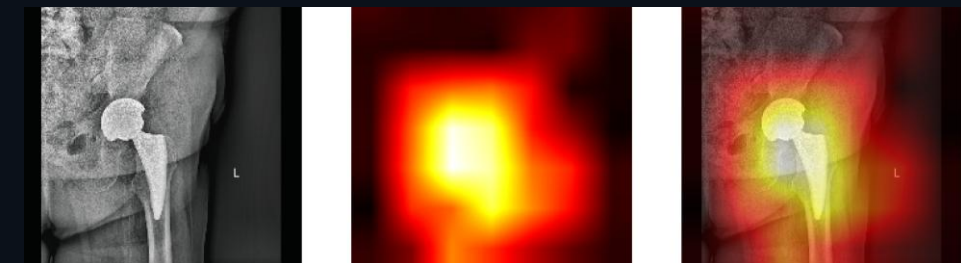
Publication: Comparative Evaluation of U-Net Architectures and Entropy-Regularised MC Dropout for Hip Implant Segmentation in Radiographs  
D Pallo, M Luley, P Hlavínová, M Billichová, D Furman... - IFIP International Conference on Artificial Intelligence ..., 2026



Predicted mask



Overlay



Interpretability: Grad-CAM highlights implant-relevant regions

**Ing. Lenka Husárová**

**Research focus:** Neurodegenerative brain diseases, with an emphasis on predicting disease progression and improving diagnostics.

The aim is to increase reliability and interpretability and to support clinical decision-making, including uncertainty quantification and explainable AI.

Bachelor's thesis (BP): Automatic prediction of whether and when a person will progress to amnesic mild cognitive impairment

Master's thesis (DP): Automatic detection of progression to mild cognitive impairment using MRI data

**Dissertation thesis (DizP):** Artificial intelligence for the analysis of longitudinal data to understand disease progression and predict human diseases

Publications:

L. Husárová, D. Furman and M. Billichová, "Automatic Detection of Progression to Mild Cognitive Impairment Using MRI Data." 2026 Information Technology Scientific Research Conference (IIT.SRC), Bratislava, Slovakia, 2026, pp. 1–6, doi: 10.1109/IIT.SRC67760.2026.11628879.

→ The paper received the Best Paper Award.