Fellow	Adebayo **Abayomi-Alli**

Host Organisation	Institute for System and Computer Engineering, Technology and Science (INESC TEC), Porto, Portugal.

Scientific coordinator	Artur **Rocha**

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

During the fellowship, I conducted research on privacy-preserving machine learning and federated learning for healthcare applications. The activities undertaken contributed to the advancement of trustworthy AI for medical imaging while aligning with the fellowship's objectives of developing and validating privacy-preserving machine learning approaches.

Key scientific activities and achievements include:

- Conducted research on privacy-preserving machine learning with a focus on federated learning for healthcare applications.
- Published a systematic review on federated learning in medical imaging, identifying current trends, challenges, and future research directions.
- Developed human-centred lung segmentation methods incorporating data augmentation and uncertainty-aware review mechanisms.
- Designed and evaluated a privacy-preserving federated learning framework (FedSeg) for 3D lung segmentation using real-world medical imaging datasets.
- Collaborated with researchers in an international and multidisciplinary research environment.
- Disseminated research findings through scientific publications and presentations.
- Strengthened expertise in trustworthy AI, medical image analysis, and privacy-preserving collaborative learning.

The scientific activities carried out during the fellowship were well aligned with the initial research plan on privacy-preserving machine learning. While the work evolved towards healthcare applications, the main objectives of investigating federated learning and validating privacy-preserving approaches on real-world data were successfully achieved.

Regarding the development of privacy-preserving machine learning approaches, the fellowship resulted in the publication of **"Unlocking Collaborative AI in Medicine: Systematic Review of Federated Learning for Imaging Applications"**, which reviewed the state of the art in federated learning for medical imaging, and **"FedSeg: Privacy-Preserving Federated Learning for 3D Lung Segmentation"**, which implemented and evaluated a federated learning framework for medical image segmentation.

The validation objective was addressed through experiments on real-world medical imaging datasets. The work **"Human-Centred Lung Segmentation with Data Augmentation and Uncertainty-Aware Review"** developed and evaluated robust lung segmentation methods, while **"FedSeg"** demonstrated the feasibility of privacy-preserving collaborative learning for lung segmentation.

Overall, the fellowship produced three scientific outputs that contributed to advancing privacy-preserving AI in healthcare, combining a systematic review, human-centred medical image analysis, and federated learning-based lung segmentation.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

1. Adebayo Abayomi-Alli, Artur Rocha, Olusola Abayomi-Alli (2026). Human-Centred Lung Segmentation with Data Augmentation and Uncertainty-Aware Review, in proceedings ICHCAI 2026, Halden, Norway, published by IEEE Xplore, **[In print].**

Unlocking Collaborative AI in Medicine: Systematic Review of Federated Learning for Imaging Applications

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Abstract
Federated Learning (FL) enables collaborative model development across health institutions without centralizing sensitive patient data. However, challenges such as data heterogeneity, privacy-utility trade-offs, communication overhead, and model convergence hinder clinical scalability. This systematic review analyses FL methods in medical imaging, identifying key methodologies, clinical applications, technical challenges, and emerging trends to guide future research. Following PRISMA guidelines, we reviewed studies (2019–2025) from PubMed, IEEE Xplore, and Scopus. We included 254 studies, with publications increasing from 5 in 2020 to 98 in 2024. Most used MRI, X-ray, or CT; CNNs and U-Nets dominated, with classification as the primary task. FL shows promise for secure, multi-institutional AI in imaging, but overcoming heterogeneity and communication challenges is key for scalability.

2. Adebayo Abayomi-Alli, Artur Rocha, Olusola Abayomi-Alli (2026). Human-Centred Lung Segmentation with Data Augmentation and Uncertainty-Aware Review, **[Pending]**

Human-Centred Lung Segmentation with Data Augmentation and Uncertainty-Aware Review

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Abstract—Automated lung CT segmentation is a prerequisite for quantitative pulmonary analysis. However, the standard "accuracy-first" development cycle often neglects clinical safety, as traditional metrics like the Dice Similarity Coefficient do not differentiate between benign boundary errors and serious omissions such as missed malignant nodules. This study proposes a human-centric framework to enhance the trustworthiness of lung segmentation by integrating annotation governance, predictive uncertainty quantification, and a risk-based evaluation taxonomy. A ResNet34 + U-Net hybrid model was developed. A specialized annotation harmonization protocol was implemented to ensure the consistent inclusion of juxta-pleural nodules. Predictive uncertainty was quantified via Monte Carlo Dropout to generate voxel-wise

predictive entropy maps. The system was evaluated using a proposed risk-based error taxonomy and simulated a human-AI triage workflow. Result obtained showed model M3, which incorporated annotation correction and data augmentation, achieved 0.66% Dice improvement over baseline M1. The framework reduced moderate-risk errors associated with non-lung inclusion by 30% (0.396% → 0.276%). From the human–AI triage simulation, 37.2%, 16.9% and 10.8% high-risk cases were recalled at operating thresholds (τ) of 0.0005, 0.003 and 0.01, respectively. Our framework provides a robust foundation for semi-autonomous clinical workflows by prioritizing error transparency and risk-aware evaluation. Thus, shifting the paradigm from opaque automation to trustworthy human-AI collaboration.

3. Poster paper at PHASE IV AI Final Conference – Advancing Privacy-Compliant Health Data for AI,

FedSeg: Privacy-Preserving Federated Learning for 2D Lung Segmentation – Performance and Privacy Trade-offs

Rui Jorge Ramos[1], Adebayo Abayomi-Alli[1], Pedro F. Sousa[1,2], Thierry Bossy[3], Mariya Georgieva[3], Gonçalo Gonçalves[1], Artur Rocha[1]

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Abstract
Accurate lung CT segmentation is essential for the diagnosis and management of pulmonary diseases, but the development of robust deep learning models is often hindered by healthcare data privacy regulations that restrict data sharing across institutions. This work presents FedSeg, a privacy-preserving federated learning framework for 2D lung segmentation that enables collaborative model training without exchanging sensitive patient data. A Residual U-Net architecture was implemented for lung parenchyma segmentation and integrated with privacy-preserving mechanisms, including Secure Multi-Party Computation (sMPC) and Differential Privacy. The study evaluates segmentation performance and computational efficiency across local and federated deployment scenarios. Preliminary results demonstrate strong segmentation performance in both local and federated environments, establishing a solid foundation for future evaluation of privacy–utility trade-offs in cross-institutional medical AI systems.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

1. One-day Workshop on Federated Learning and Synthetic Data in Health Data Analytics, VTT Technical Research Centre of Finland, Espoo, Finland, November 15, 2024 [Online]
2. IEEE Authorship and Open Access Symposium, IEEE Xplore (Online Webinar), 90 minutes, [April 2026] – Training on scholarly publishing, authorship best practices, open access publishing, and research dissemination.

3. Participant/Author, IEEE International conference on Human Centre Artificial Intelligence (ICHCAI), Halden, Norway. Organised by Institute for Energy Technology (IFE), May 27-28, 2026.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

Assinado por: **Artur Jorge da Silva Rocha**
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