

i3S develops AI to turn microbiomes into forensic evidence

The community of microorganisms that inhabit our bodies, also known as the microbiome, could become a new source of evidence in criminal investigations. This is the challenge taken on by Ahmad Hassan's doctoral project, carried out at i3S and at the Faculty of Sciences of the University of Porto (FCUP) as part of the European NATURAL TRACES network, funded by the European Union through the Marie Skłodowska-Curie Actions – Doctoral Networks.

“This doctoral project aims to develop algorithms capable of turning complex microbiome data into robust, legally defensible forensic evidence”, explains i3S researcher Nádia Pinto. To this end, the work programme combines deep learning, generative artificial intelligence (AI), and bioinformatics to address challenges with a range of practical applications, such as the geolocation of biological traces, individual identification, and estimation of the post-mortem interval.

At i3S, doctoral student Ahmad Hassan will have access to an interdisciplinary environment bringing together specialists in forensic genetics, population genetics, mathematical modelling, and data science.

For Ahmad Hassan, joining this doctoral programme represents a unique opportunity for training and global scientific collaboration. “This doctoral project allows me to grow as an independent researcher, to collaborate with international partners, and to contribute to advancing forensic science so that, in the future, these tools can be applied by professionals in the field and by the justice system”, says the student. Enrolled in FCUP's Doctoral Programme in Computer Science, Ahmad Hassan is supervised by FCUP's Pedro Gabriel Ferreira, i3S's Nádia Pinto, and Universidad Autónoma de Madrid's Daniel Ramos.

The NATURAL TRACES network is coordinated by Goethe University Frankfurt and brings together ten doctoral students, along with beneficiaries and partners from fourteen countries. Its main goal is to develop new approaches to using environmental DNA (eDNA), microbiomes, and other non-human biological traces as forensic evidence. The network's research areas include forensic entomology; the analysis of pollen, fungi, and environmental DNA; and bioinformatics and AI methods for interpreting these complex data. Within the consortium, i3S and FCUP lead the development of bioinformatics and AI methods applied to microbiome analysis, strengthening Portugal's contribution to a new generation of tools to support forensic investigation.

According to Nádia Pinto, the project reinforces i3S's strategic commitment to genomic medicine and computational biology: “This doctoral project helps consolidate the institute's capacity to develop machine learning tools and probabilistic models for interpreting complex omics data, and it demonstrates how these technologies can have an impact beyond health, particularly in forensic science”.