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Key to post-stroke survival: data and algorithms to improve the quality of life of stroke victims

According to the study '**The impact of stroke in Europe**', by King's College for the European Stroke Alliance, between 2015 and 2035 there will be a 34% increase in the number of cases in Europe (up to 819,771). And in Spain, more than 100,000 people suffer from it (50% have disabling sequelae or die). Therefore, if prevention is fundamental, rehabilitation becomes a decisive factor in survival and quality of life.

The **MAESTRO project** ('**New machine learning techniques to improve the prediction of post-stroke outcomes**') focuses on solving the lack of reliable systems to monitor patient adherence to rehabilitation, as well as the effectiveness of the process. IMDEA Networks is the beneficiary of this EU-funded project (H2020-MSCA-IF-2020 - Marie Skłodowska Curie Individual Global Grant), running from March 2022 to February 2025, with [Antonio Fernández Anta](#) as principal investigator on behalf of the IMDEA Networks team. The project is in line with the H2020 objectives in Area III (digitization, research, and innovation) as well as in healthcare.

The researcher [Augusto García-Agúndez](#) will work at Brown University (USA) for the first two years, and the last one at the Madrid institution. In this context, the experience of working in the emergency department with biosensors and gamification, **the experience in outlier detection and machine learning of IMDEA Networks**, and the **knowledge in deep learning applied to medicine** of the AI Lab at Brown University are combined to develop algorithms capable of determining adherence to rehabilitation and its effectiveness using wearables. This will optimize rehabilitation and predict recovery by providing information to both the neurology team and feedback to patients and caregivers.

MAESTRO will recruit 50 patients from Rhode Island Hospital over four months in the first of three development cycles, with mobile apps, IoT devices, and questionnaires as analytical tools (in addition, the infrastructure, and connections of an existing stroke-related project at the hospital will be used). The innovation in MAESTRO lies in the development of software solutions to monitor post-stroke rehabilitation of patients remotely and passively using commercial hardware and gamification (data collection will start in April 2023).

The most innovative aspect of the project will be the ability to predict what the range of recovery will be in different stroke-affected domains throughout the rehabilitation process. **"We also hope to develop an application that allows for more continuous monitoring of the rehabilitation process.** The main challenge addressed by the project is to explore how a combination of traditional methods of monitoring the rehabilitation of patients, based on questionnaires and observations of the neurologist (combined with other sources of information obtained, for example, with sensors), can offer a more accurate prediction of the degree of recovery of the

patient after rehabilitation," says García-Agúndez. A process in which the greatest difficulty will be "distinguishing informative sources of information from those that are not and determining what the minimum level of information is (i.e., how far in advance can sufficiently accurate predictions be produced to be clinically useful).

As García-Agúndez points out, **"the interaction between the group led by Dr. Fernández Anta (IMDEA Networks) and that of Prof. Eickhoff (Brown University) has great potential**, because they are complementary areas. In addition, both centers are very focused on research and are very competitive internationally. It is these kinds of synergies that allow for the greatest advances to be made at both centers". One direct application of the research in a clinical setting is in the process of being evaluated by the ethics committees of the two institutions involved and is currently in the analysis phase with the neurologist who will collaborate with both organizations on the appropriate inclusion and exclusion criteria for patient recruitment.

Methods such as **deep learning allow automated classification of extremely complex data** which, in the case of MAESTRO, becomes a unique scientific advance, providing the medical team, patients, and caregivers with specific levels of feedback, with algorithms developed specifically within the project that can be the basis for novel developments with different objectives, such as translation into clinical practice and expansion to other neurodegenerative diseases.

Looking to the future, the IMDEA Networks researcher is optimistic about the road ahead: **"Data analysis has enormous potential for assessing patients' condition**, prognosis and adherence to treatment, and allows for breakthroughs in diagnostic procedures and treatments. At this stage, it is difficult to guess where the limit may lie, because in a few years we will have applications that we cannot even imagine now. Moreover, it is likely that the same ideas on which MAESTRO is based can be extended (with appropriate modifications) to other neurodegenerative diseases that also involve rehabilitation/therapy, such as Parkinson's disease.

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IMDEA Networks Institute, promoted by the Regional Government of Madrid, is a research organization on computer and communication networks whose multinational team is engaged in cutting-edge fundamental science and technology. As a growing, English speaking institute located in Madrid, Spain, IMDEA Networks offers a unique opportunity for pioneering scientists to develop their ideas. IMDEA Networks has established itself internationally at the forefront in the **development of future network principles and technologies**. Our team of highly-reputed researchers is designing and creating today the networks of tomorrow.

Some keywords that define us: 5G, Big Data, blockchains and distributed ledgers, cloud computing, content delivery networks, data analytics, energy-efficient networks, fog and edge computing, indoor positioning, Internet of Things (IoT), machine learning, millimeter-wave communication, mobile computing, network economics, network measurements, network security, networked systems, network protocols and algorithms, network virtualization (software

defined networks – SDN and network function virtualization – NFV), privacy, social networks, underwater networks, vehicular networks, wireless networks and more...

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