Artificial intelligence, neural networks, and real-time image and data analysis

Brief description

The significant advances in Artificial Intelligence in recent years are opening up endless new possibilities for analyzing data and images. We offer our experience (over 20 years) in software development, high-performance scientific computing (with clusters and GPUs), realistic simulations (digital twin), and in the development of models using neural networks and deep learning (over 8 years) within the field of artificial intelligence to accelerate and improve the analysis of images and data.

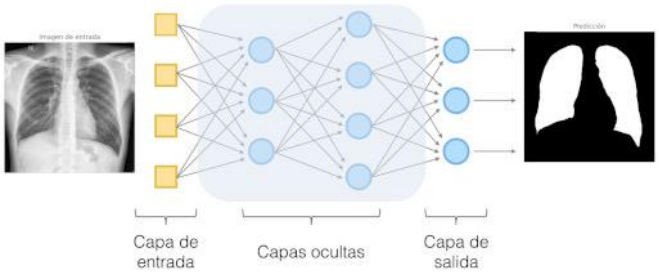

Figura 1: *Example of automatic classification and segmentation of images with neural networks*

How does it work?

Artificial intelligence techniques, and more specifically neural networks, are capable of creating models that transform input data (images, data tables, etc.) into output results (images, labels, etc.). These models are trained using a series of available images and data and can then be applied to new cases. Our group has experience with a wide variety of these methods, keeping up with the latest developments. In particular, we are experienced in generating realistic simulations that take into account all the relevant variables of the problem. The combination of these simulators with the techniques offered by AI is what provides us with excellent results.

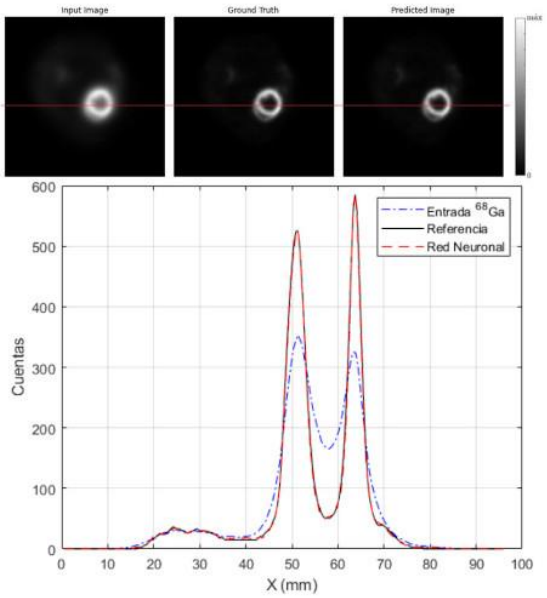

Figura 2: *Example of automatic resolution improvement of images and comparison with the reference image. This corresponds to a preclinical PET image.*

In an initial phase, an analysis of the proposed problem would be conducted (considering the available data, objectives, metrics, and deadlines). Once the problem is analyzed, a proof of concept would be developed to demonstrate the potential of the proposed solution. If the results are satisfactory, an advisory or research contract could be established through OTRI with our group to continue its development, or the developed software could be licensed.

Medicine Faculty. Entrepabellones building 7 y 8.
C/ Doctor Severo Ochoa, 7. 28040 Madrid.
comercia@ucm.es

What problem does it solve?

One of the major challenges in creating artificial intelligence models is that a large amount of high-quality, diverse data is generally needed for training. This is not always possible, which generates biases and limits the quality of the results. On the other hand, training AI models solely with simulated (synthetic) data does not yield good results when applying those models to real cases. The combination of realistic simulated data and real data when training these AI models allows for successfully addressing many problems where real data is insufficient.

What future products will it develop?

There are many applications that arise from the ability to train neural networks by mixing synthetic and real data. Among the applications we are working on are image classification, motion detection, region segmentation, data cleaning and selection, analysis of main features, and guidance for ultrasound acquisitions. In all of these, the same principles and techniques described above are applied.

Competitive advantages compared to other research

The use of realistic simulations and synthetic data to complement real data is a field that is being intensely researched worldwide. For example, in the area of language models (LLM), one of the challenges is combining real texts with AI-generated texts to obtain even more data for training current models. Therefore, significant advances are expected in this field in the coming years. In our case, our extensive experience in the most fundamental aspects (realistic simulations, high-performance computing, training of AI models, and development of business-adapted software) allows us to tackle these types of problems with confidence.

Where has it been developed?

At the Nuclear Physics Group (GFN) of UCM, we have extensive experience in software development as well as in applying neural networks for the analysis of images and data from collaborations with companies and research centers worldwide. Our expertise has been developed in the fields of medical imaging research (PET, CT, Ultrasounds), radiotherapy (proton therapy, protoacoustics), and experimental nuclear physics (CERN, Jefferson Lab (USA)). The use of these techniques has improved the performance of many systems by making more efficient use of the acquired data. In 2020, we were the outright winners at the CodeTheCurve Hackathon organized by UNESCO, IBM, and SAP with an AI application for COVID-19 patients.

And moreover…

The extensive experience of GFN-UCM in developing simulators allows us to realistically model a large number of processes in various fields such as nuclear physics and medical physics.

Researcher in charge

Joaquín López Herraiz, jlopezhe@ucm.es
Department: **Structure of Matter, Thermal and Electronic Physics**
Faculty: **Physical Sciences**