Artificial Intelligence for the automatic recognition of ancient Egyptian hieroglyphs

A research highlights how 'Deep Learning', which uses algorithms based on convolutional neural networks for image analysis, can be applied to classify ancient Egyptian hieroglyphs. The study is a collaboration between Cnr- 'Nello Carrara' Institute of Applied Physics, the Department of Information Engineering of the University of Florence and the Center for Ancient Mediterranean and Near Eastern Studies- The paper is published in the Ieee Access journal

A paper published in the *Ieee Access journal* analyzes through Deep Learning the possibility of automatically classifying - with very high accuracy and precision - the images of ancient Egyptian hieroglyphs, independently from the support on which they are written or inscribed (papyrus, stone, wood). The research was carried out by by Andrea Barucci and Costanza Cucci of the "Nello Carrara" Institute of Applied Physics of the National Research Council of Italy (Cnr-Ifac), by Prof. Fabrizio Argenti and Marco Loschiavo of the Department of Information Engineering of the University of Florence, in collaboration with the Egyptologist Massimiliano Franci of the Center for Ancient Mediterranean and Near Eastern Studies (Camnes).

"Nowadays, the application of such techniques based on deep neural networks pervades all fields of knowledge", explains Dr. Barucci, an expert in the analysis of biomedical images with Machine and Deep Learning techniques. "We asked ourselves if this paradigm could be translated in an apparently far and different context, such as the recognition of ancient symbols. Our experience in clinical imaging suggested that deep convolutional neural networks are extremely powerful and versatile tools, yet the challenge was open."

"Cnr-Ifac has a highly multidisciplinary character", says Costanza Cucci, an expert in data analysis in the Cultural Heritage field, "facilitating the exchange and cross-fertilization between different research fields, exactly as it happened for this work, where skills in Egyptology, computer engineering and applied physics were integrated."

"This study was born from the Master's degree thesis of Marco Loschiavo", continues Prof. Argenti "From the engineering point of view, we were sure of the potential of the analysis tools chosen, however this was an important test, because the type of application was completely different from our direct experience. However, we were curious to explore a new fascinating area of research, which turned out to be extremely interesting and promising."

"This study", explains Prof. Franci, "demonstrates not only the possibility of automatic translation of ancient Egyptian documents, but there are several other open issues that may benefit from the use of the proposed approach such as: coding, recognition and transliteration of hieroglyphic signs; recognition of determinatives and their semantic field; toposyntax of the hieroglyphic signs combined to form words; linguistics analysis of the hieroglyphic texts; recognition of corrupt, rewritten, and erased signs, towards even the identification of the "hand" of the scribe or the school of the sculptor."

"The intuition of the Egyptologist is still fundamental in the complex integration of Artificial Intelligence and human analysis", concludes Prof. Franci. "Our study aims to highlight how these analysis tools based on AI could support investigations in the Egyptological field, integrating with

the work of the archaeologist (human in the loop)."

"The hope", concludes Dr. Barucci, is that this first study can open the way towards a collaboration between the communities working on Artificial Intelligence and Archaeology respectively, with the aim to create new tools that facilitate the work of experts of ancient civilizations."

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In brief

Who: Institute of Applied Physics of the National Research Council (Cnr-Ifac), Department of Information Engineering of the University of Florence, Center for Ancient Mediterranean and Near Eastern Studies (Camnes)

What: use of Artificial Intelligence in the recognition and analysis of images of ancient Egyptian hieroglyphs. https://ieeexplore.ieee.org/document/9528382

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