Computer-Aided Hieroglyphs Translation: CNN deserve your Deep Attention

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Abstract

Convolutional Neural Networks (CNN) with Attention Mechanisms have proven to be an essential computational tool for sign recognition. After summarizing the state of the art on the subject, we justify our intention to combine CNN and Attention Mechanisms within Deep Learning to design an embedded application on smartphones and tablets to read, decipher and translate hieroglyphic texts on the fly.

Keywords: CNN, Attention Mechanisms, Deep Learning, Hieroglyphs, Computer-Aided Translation

1. Introduction

The history of reading, transcribing and translating Egyptian hieroglyphs has evolved dramatically over the five millennia since the advent of writing.

Stéphane Polis, professor of Egyptology at the University of Liège, taught us, for example, that the emergence of writing in the Nile Valley (Polis 2024) occurred around 3150 BCE.

Around 2800 BCE, we then observed the emergence of ancient Egyptian.

With the arrival of Alexander the Great in 333 BCE, and then of Rome, national knowledge of the ancient Egyptian language gradually disappeared in favor of Greek, then Arabic, with a little Coptic remaining in Christian religious ceremonies.

Then, four thousand nine hundred and seventy-two years after the appearance of writing in Egypt, in 1822, Jean-François Champollion understood the secrets of Egyptian hieroglyphics and wrote to his brother Jacques-Joseph Champollion-Figeac: “I got it” (Champollion 1822).

2. Context

In 1922, Howard Carter discovered the tomb of Tutankhamun and, thanks to the work of Champollion, the human decipherment of the inscriptions it contained was easily achieved at the cost of the efforts we know.

Technological developments from the 1970s onwards, marked by the arrival of the Apple II (1977) and the IBM PC (1981), opened up new perspectives for Egyptology, particularly in analysis and transliteration. The availability of the computing power of personal

computers gave rise, in June 1984, to an International Round Table organized by the Hugo Foundation of the Collège de France, following which a working group named Egyptology and Computer Science was formed, composed of Jan Buurman, Nicolas Grimal, Michael Hainsworth, Jochen Hallof and Dirk van der Plas, which group published shortly after the first version of a fundamental document commonly called the Manuel de codage (Buurman 1985). This document notably allowed Serge Rosmorduc to undertake in 1994 the design of a syntactic analyzer of Middle Egyptian within the Laboratoire d'Informatique Fondamentale et Appliquée of Cachan (Rosmorduc 1994).

In 1995, Christopher Bishop published a book on the use of neural networks for pattern recognition (Bishop 1995) and, the following year, Serge Rosmorduc defended his thesis on the Morpho-syntactic Analysis of non-punctuated texts (Rosmorduc 1996).

Knowledge in computer science had progressed, artificial intelligence was taking its first steps and neural networks were gaining importance. In 2006, Christopher Bishop published a new book on pattern recognition and machine learning (Bishop 2006). We then began to hear everywhere about convolutional neural networks (which had nevertheless been invented in Japan by Kunihiko Fukushima in 1980) and attention mechanisms within Deep Learning. All these advances allowed Serge Rosmorduc to publish in 2008 a Paper on the automated transliteration of Egyptian hieroglyphs (Rosmorduc 2008), which was echoed in 2012 by Sezer Karaoglu on text recognition applied to object recognition (Karaoglu 2012), which marked the beginning of a long and fruitful list of publications on the subject up to the present day:

Thesis by Morris Franken on the automatic recognition of hieroglyphs by assimilating images to text (Franken 2013).

Dzmitry Bahdanau's paper on machine translation using neural networks without using fixed-length vectors (Bahdanau 2015).

Karen Simonyan's paper on the application of convolutional neural networks to image recognition (Simonyan 2015).

Minh-Thang Luong's thesis on machine translation using neural networks (Luong 2016).

Kelvin Xu's paper on attention mechanisms applied to image recognition via neural networks (Xu 2016).

Ashish Vaswani's paper on the contribution of attention mechanisms to the use of neural networks for computer-assisted translation (Vaswani 2017).

Pirmin Lemberger's article on the attention mechanism (Lemberger 2018).

Article by Serge Rosmorduc on the automated transliteration of Neo-Egyptian using neural networks within Deep Learning (Rosmorduc 2020).

Paper by Andrea Barucci et al. on the contribution of Deep Learning to the classification of ancient Egyptian hieroglyphs (Barucci 2021).

2022: Start of the Loracrafft project to design an embedded smartphone application to read, decipher and translate hieroglyphic texts on the fly.

2023: Paper by Asmaa Sobhy on automatic translation of hieroglyphs using artificial intelligence (Sohby 2023).

Publication of a new book by Christopher Bishop on Deep Learning (Bishop 2024).

3. Projects

A project to design hieroglyph recognition software for Apple iPhone/iPad and Android is currently under study. There are others: In 2015, two researchers from the University of Amsterdam, Morris Franken and Jan van Gemert, designed a fully functional prototype, Tomb Reader, which runs on Android (not yet on macOS but, its development having ceased due to lack of funding, it is no longer relevant, hence the launch of the Loracrafft project). But Tomb Reader only reads and deciphers one sign at a time.

In 2017, Google teamed up with the French company Ubisoft to launch the Fabricius project, which recognizes signs from images imported onto a computer.

In 2020, Evgeniy and Alexander Sulimov published Hieroglyphs AI , a powerful Android application limited to recognizing one sign at a time

Also in this field are the Pixoglyph prototype by Fleur Brun et al., from the Paul Valéry University of Montpellier (UPVM3), DeepScribe by Sanjay Krishnan et al. also published in 2020, then GlyphNet by Andrea Barucci et al. in 2022.

All these projects are precursors to Loracrafft, which does not intend to decipher hieroglyphs one by one, but whole words. This approach seems new and we have consulted a number of experts in the field, specifying our intention to combine convolutional neural networks and attention mechanisms within Deep Learning, all using dictionaries to form the corpus such as those of Budge 1920, Faulkner 1962 and Hannig 2006.

4. Problematic

The objective of the project being to allow the on-the-fly translation of texts appearing on monuments or documents, we did not see the point of developing yet another sign recognition software. Our innovative approach is structured in ten phases:

phase 1: Collect the source texts

- mural painting
- wall engraving
- stone engraving
- papyrus painting
- ostraca painting
- wood painting
- photos

phase 2: Conversion of the captured source text into high-quality images to be processed by the machine (computer, tablet, smartphone, etc.)

phase 3: Recognition of the sign(s) indicating the reading direction

phase 4: Recognition of signs in a grouped way (quadrats, etc.)

phase 5: Grammatical classification

phase 6: Word division

phase 7: Conversion of words into MdC codes

phase 8: Transliteration

phase 9: Translation into French/English

phase 10: Audio reading of the resulting text

The idea behind the design of this application is to federate existing ”building blocks” to carry out some of the above phases:

For phase 4, we are considering using Morris Franken and Jan van Gemert’s Tomb Reader tool.

For phases 5 and 6, we are considering following the work of Serge Rosmorduc.

For phases 3 and 7, we are considering Evgeniy and Alexander Sulimov’s Hieroglyphs AI tool.

For phase 8, we will use a table provided by Raymond Monfort.

For phase 9, production has already started based on the appendix ”Lexique égyptien-franc¸ais” of Jean-Pierre Guglielmi’s book, L’égyptien hiéroglyphique, (c) 2021 Méthode Assimil, with written permission (could be cleverly replaced by an online version of Faulkner as it exists on the Projet Rosette website).

For phase 10, our computers will take care of the work.

5. Conclusion

The stage is set, knowledge is being refined, for the project to move forward, we now need to form a team with at least one or two computer Scientists who master Python, Pillow, Keras, CNNs and attention mechanisms within Deep Learning.

With these solid foundations, the Loracrafft project aims to transform the approach to hieroglyphic reading. We invite computer Scientists and Egyptologists to join us to make this vision a reality.

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