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Cursive Word Recognition by Using a Reading Model

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Introduction

We present the adaptation and computer implementation of a reading model for the recognition of cursive handwriting. We follow an analytic implicit approach based on the extraction of the singular part of the word (Simon, 1992). The system has been entirely built on neural networks with the following stages: feature extraction based on sigma-pi neural network detectors, string pre-recognition based on a convolutional neural network and word recognition based on an interactive activation network. The results obtained on an English check amount database are among the best results available in the literature for the same database.

Background

The human visual system (HVS) is, without doubt, the best word recognition system, so it is natural to take inspiration from studies about the human reading process and in general from studies about the function and architecture of the HVS to develop automatic reading systems. Nowadays, thanks to advances in neurosciences and experimental psychology as well as the availability of powerful computer resources, it is possible to simulate more elaborate models of the functions of the HVS. Unfortunately, only a few automatic word recognition systems have explored the perception oriented approach, e.g. systems based on reading models (verification model, interactive activation model, PDP models) and systems based on features presumably used during the recognition process (word shape, first letter, ascenders, descenders, loops, word-length).

Mozer (1987) developed a system based on Parallel Distributed Processing models (PDP). The processing is strictly bottom-up, and the system is able to recognize many words simultaneously, and can explain some psychological effects, such as letter transpositions, incertitude in the position of letters and words, etc. The primitives utilized in this system are: vertical, horizontal and diagonal segments, and extreme points. LeColinet (1993) has developed a system based on top-down verification (backward-matching). Côté et al (1998) have developed a system based on the interactive activation model (IAM) and the verification mode.

The key idea of our approach is to have a totally connectionist model, from feature extraction to recognition; incorporating the notion of receptive fields, the pre-recognition of letter strings and word recognition by means of an interactive activation network. This choice is mainly due to the fact that the interactive activation model is able to account for most psychological effects in reading, in addition that it presents some practical advantages over other approaches.

System Description

Even when the global architecture of our system follows the classical approach (pre-processing, feature extraction, pre-recognition, and recognition), its implementation presents the following novel characteristics: the feature extraction stage extracts features presumably involved in human reading (line segments, closure), by using a feed-forward sigma-pi neural network, presenting a strong resemblance with the model of orientation selectivity (Hubel and Weasel, 1962); the string pre-recognition stage is performed by using a convolutional neural network; and the word recognition stage is performed by using an interactive activation network. Thus, this system is an extension McClelland and Rumelhart's model for the recognition of real cursive words.

Results

The recognition rate, tested on the CENPARMI database of English check amounts, reached 90.54%, which is among the highest results for this database. Additionally, important effects of the lexical access, such as the word superiority effect and the outside-in effect are naturally included as part of the architecture of the system. A practical advantage is that the system can be applied to large vocabulary applications.

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