Recursive Recognition of Offline Handwritten Mathematical Expressions

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## Problem

Given an image depicting a mathematical expression decode it in a symbolic representation


More challenging that conventional OCR!

- non-sequential spatial layout
- little prior information from language models
- unknown trajectory of the pen (offline recognition)

Data
9100 photos of expressions written by more than 100 volunteers and including 99 different symbols


A CNN extracts image features, a RNN decode symbols, a deconvolutional module segments subexpressions that are processed recursively; modules are end-to-end trained to minimize the CTC loss


Results

| Category | Accuracy (\%) |
| :--- | ---: |
| Digits | 90.7 |
| English letters | 95.2 |
| Greek letters | 95.0 |
| Operators | 96.7 |
| Parentheses | 94.6 |
| Punctuation | 96.4 |
| Fractions | 98.4 |
| Roots | 94.7 |
| Integrals | 100.0 |
| Subscripts | 96.2 |
| Superscripts | 84.2 |

Method that are processed recursively, modules are end-to-end trained to minimize the CTC loss

## Errors

Errors typically occurs for low-quality images and badly written expressions


