# Handwritten Mathematical Expression Recognition via Attention Aggregation Based Bi-directional Mutual Learning

**类型** 期刊文章
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**作者** Yanfeng Wang
**摘要** Handwritten mathematical expression recognition aims to automatically generate LaTeX sequences from given images. Currently, attention-based encoder-decoder models are widely used in this task. They typically generate target sequences in a left-to-right (L2R) manner, leaving the right-toleft (R2L) contexts unexploited. In this paper, we propose an Attention aggregation based Bi-directional Mutual learning Network (ABM) which consists of one shared encoder and two parallel inverse decoders (L2R and R2L). The two decoders are enhanced via mutual distillation, which involves one-to-one knowledge transfer at each training step, making full use of the complementary information from two inverse directions. Moreover, in order to deal with mathematical symbols in diverse scales, an Attention Aggregation Module (AAM) is proposed to effectively integrate multi-scale coverage attentions. Notably, in the inference phase, given that the model already learns knowledge from two inverse directions, we only use the L2R branch for inference, keeping the original parameter size and inference speed. Extensive experiments demonstrate that our proposed approach achieves the recognition accuracy of 56.85 % on CROHME 2014, 52.92 % on CROHME 2016, and 53.96 % on CROHME 2019 without data augmentation and model ensembling, substantially outperforming the state-of-the-art methods. The source code is available in https://github.com/XH-B/ABM.
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**短标题** ABM
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ABM

**附件**

- Bian 等。 - 2022 - Handwritten Mathematical Expression Recognition vi.pdf

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# Handwritten Mathematical Expression Recognition with Bidirectionally Trained Transformer

| | |
|---|---|
| **类型** | 预印本 |
| **作者** | Wenqi Zhao |
| **作者** | Liangcai Gao |
| **作者** | Zuoyu Yan |
| **作者** | Shuai Peng |
| **作者** | Lin Du |
| **作者** | Ziyin Zhang |
| **摘要** | Encoder-decoder models have made great progress on handwritten mathematical expression recognition recently. However, it is still a challenge for existing methods to assign attention to image features accurately. Moreover, those encoder-decoder models usually adopt RNNbased models in their decoder part, which makes them inefficient in processing long LATEX sequences. In this paper, a transformer-based decoder is employed to replace RNN-based ones, which makes the whole model architecture very concise. Furthermore, a novel training strategy is introduced to fully exploit the potential of the transformer in bidirectional language modeling. Compared to several methods that do not use data augmentation, experiments demonstrate that our model improves the ExpRate of current state-of-the-art methods on CROHME 2014 by 2.23%. Similarly, on CROHME 2016 and CROHME 2019, we improve the ExpRate by 1.92% and 2.28% respectively. |
| **日期** | 2021-05-16 |
| **语言** | en |
| **短标题** | BTTR |
| **馆藏目录** | arXiv.org |
| **URL** | http://arxiv.org/abs/2105.02412 |
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| **其它** | arXiv:2105.02412 [cs] |
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**标签：**

Computer Science - Computer Vision and Pattern Recognition, BTTR

**笔记：**

Comment: Accept by ICDAR 2021

**附件**

- Zhao 等。 - 2021 - Handwritten Mathematical Expression Recognition wi.pdf

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## Multi-Scale Attention with Dense Encoder for Handwritten Mathematical Expression Recognition

**类型** 预印本
**作者** Jianshu Zhang
**作者** Jun Du
**作者** Lirong Dai
**摘要** Handwritten mathematical expression recognition is a challenging problem due to the complicated two-dimensional structures, ambiguous handwriting input and variant scales of handwritten math symbols. To settle this problem, recently we propose the attention based encoder-decoder model that recognizes mathematical expression images from two-dimensional layouts to one-dimensional LaTeX strings. In this study, we improve the encoder by employing densely connected convolutional networks as they can strengthen feature extraction and facilitate gradient propagation especially on a small training set. We also present a novel multi-scale attention model which is employed to deal with the recognition of math symbols in different scales and restore the fine-grained details dropped by pooling operations. Validated on the CROHME competition task, the proposed method significantly outperforms the state-of-theart methods with an expression recognition accuracy of 52.8% on CROHME 2014 and 50.1% on CROHME 2016, by only using the official training dataset.
**日期** 2018-01-30
**语言** en
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**URL** http://arxiv.org/abs/1801.03530
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**其它** arXiv:1801.03530 [cs]
**仓库** arXiv
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**添加日期** 2022/7/27 下午6:17:41
**修改日期** 2022/8/8 上午10:27:29

**标签：**

Computer Science - Computer Vision and Pattern Recognition, WAP

**附件**

- arXiv.org Snapshot
- Zhang 等。 - 2018 - Multi-Scale Attention with Dense Encoder for Handw.pdf

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## Syntax-Aware Network for Handwritten Mathematical Expression Recognition

**类型** 期刊文章
**作者** Ye Yuan
**作者** Xiao Liu
**作者** Wondimu Dikubab
**作者** Hui Liu
**作者** Zhilong Ji
**作者** Zhongqin Wu
**作者** Xiang Bai
**摘要** Handwritten mathematical expression recognition (HMER) is a challenging task that has many potential applications. Recent methods for HMER have achieved outstanding performance with an encoder-decoder architecture. However, these methods adhere to the paradigm that the prediction is made “from one character to another”, which inevitably yields prediction errors due to the complicated structures of mathematical expressions or crabbed handwritings. In this paper, we propose a simple and efficient method for HMER, which is the first to incorporate syntax information into an encoder-decoder network. Specifically, we present a set of grammar rules for converting the LaTeX markup sequence of each expression into a parsing tree; then, we model the markup sequence prediction as a tree traverse process with a deep neural network. In this way, the proposed method can effectively describe the syntax context of expressions, alleviating the structure prediction errors of HMER. Experiments on three benchmark datasets demonstrate that our method achieves better recognition performance than prior arts. To further validate the effectiveness of our method, we create a largescale dataset consisting of 100k handwritten mathematical expression images acquired from ten thousand writers. The source code, new dataset†, and pre-trained models of this work will be publicly available.
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**语言** en
**短标题** SAN
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Computer Science - Computer Vision and Pattern Recognition

笔记：

Comment: CVPR 2022

附件

- Yuan 等。 - 2022 - Syntax-Aware Network for Handwritten Mathematical .pdf

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## Watch, attend and parse: An end-to-end neural network based approach to handwritten mathematical expression recognition

| | |
|---|---|
| 类型 | 期刊文章 |
| 作者 | Jianshu Zhang |
| 日期 | 2017 |
| 语言 | en |
| 短标题 | WAP |
| 馆藏目录 | Zotero |
| 页码 | 11 |
| 期刊 | Pattern Recognition |
| 添加日期 | 2022/9/7 下午10:32:41 |
| 修改日期 | 2022/9/7 下午10:33:25 |

附件

- Zhang - 2017 - Watch, attend and parse An end-to-end neural netw.pdf

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## When Counting Meets HMER: Counting-Aware Network for Handwritten Mathematical Expression Recognition

| | |
|---|---|
| 类型 | 会议论文 |
| 作者 | Bohan Li |
| 作者 | Ye Yuan |
| 作者 | Dingkang Liang |
| 作者 | Xiao Liu |
| 作者 | Zhilong Ji |
| 作者 | Jinfeng Bai |
| 作者 | Wenyu Liu |
| 作者 | Xiang Bai |
| 摘要 | Recently, most handwritten mathematical expression recognition (HMER) methods adopt the encoder-decoder networks, which directly predict the markup sequences from formula images with the attention mechanism. However, such methods may fail to accurately read formulas with complicated structure or generate long |

markup sequences, as the attention results are often inaccurate due to the large variance of writing styles or spatial layouts. To alleviate this problem, we propose an unconventional network for HMER named Counting-Aware Network (CAN), which jointly optimizes two tasks: HMER and symbol counting. Specifically, we design a weakly-supervised counting module that can predict the number of each symbol class without the symbol-level position annotations, and then plug it into a typical attention-based encoderdecoder model for HMER. Experiments on the benchmark datasets for HMER validate that both joint optimization and counting results are beneficial for correcting the prediction errors of encoder-decoder models, and CAN consistently outperforms the state-of-the-art methods. In particular, compared with an encoder-decoder model for HMER, the extra time cost caused by the proposed counting module is marginal. The source code is available at https://github.com/LBH1024/CAN.

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| **语言** | en |
| **短标题** | CAN |
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## 笔记：

Comment: ECCV 2022

## 附件

- Li 等。 - 2022 - When Counting Meets HMER Counting-Aware Network f.pdf
- Snipaste_2022-08-11_14-50-32.png