

FinMath: Injecting a Tree-structured Solver for Question Answering over Financial Reports

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Introduction

The sheer volume of financial statements and tables makes it difficult and time-consuming for humans to access and analyze financial reports. Robust numerical reasoning over hybrid data combining both tabular and textual content faces unique challenges in this domain. TAT-QA dataset focuses on questions that require numerical reasoning over financial report pages containing both paragraphs and tables.

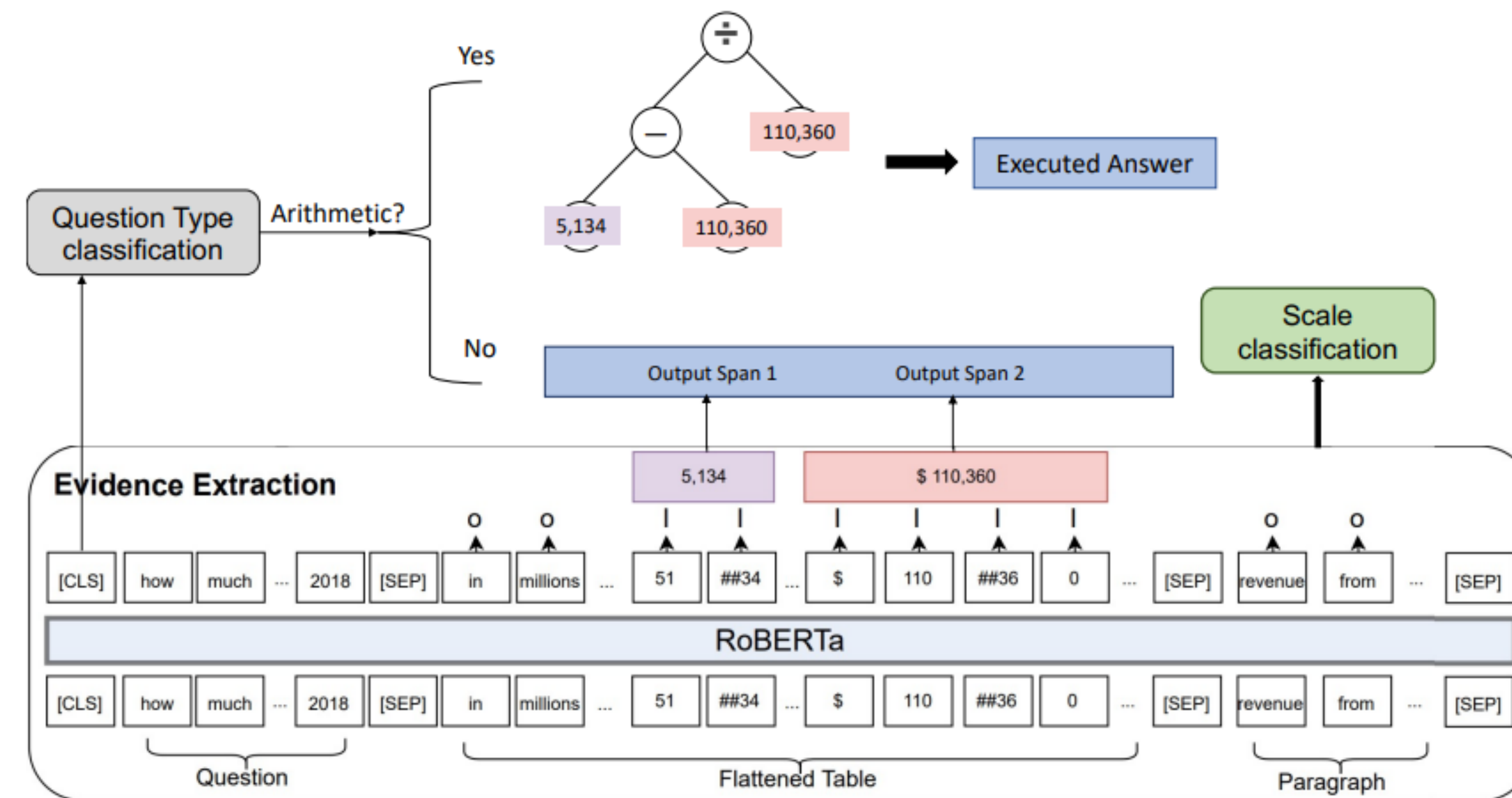
However, current best model over TAT-QA dataset, named TAGOP, can only perform symbolic reasoning with a single type of pre-defined aggregation operators (e.g. change ratio, division), and might fail to answer complex questions requiring multi-step reasoning. To address these shortcomings, we present a new framework called FinMath, which can perform arbitrary steps of numerical reasoning given the arithmetic questions.

Motivated by the recent works in the task of Math Word Problems (MWP) solving, a tree-structured neural model is applied in the FinMath framework. Specifically, for those arithmetic questions in TAT-QA, after extracting the supporting evidence, the tree-structured neural model uses top-down goal decomposition and bottom-up subtree embedding construction to directly predict the expression tree from questions and extracted evidence. Then the expression tree is executed to get the answer.

The FinMath Framework

To address the challenge of TAT-QA and improve the numerical reasoning capability of model, we propose a framework named FinMath. In the first phase, similar with TAGOP, a sequence tagging module is applied to extract relevant cells from the table T and text spans from the paragraphs P as supporting evidence. And it also predicts the type of give question Q as spans selection question QS or numerical reasoning (arithmetic) question QN. In the second phase, inspired by GTS, a tree-structured neural model is applied to perform numerical reasoning over arithmetic questions.

Tree-structured Neural Model



An auto-regressive sequence-to-tree model like GTS is applied in FinMath to generate a numerical expression tree. The generation process contains encoding, tree initialization and tree decoding. Then the shortcomings of current models over TAT-QA are addressed, and the new model can answer complex questions requiring multi-step reasoning.

	Dev		Test	
	EM	F1	EM	F1
HyBridr	6.6	8.3	6.3	7.5
BERT-RC	9.5	17.9	9.1	18.7
TaPas for WTQ	18.9	26.5	16.6	22.8
NumNet+V2	38.1	48.3	37.0	46.9
TAGOP	55.2	62.7	50.1	58.0
FinMath	60.5	66.3	58.6	64.1

Results

This table summarizes our evaluation results of of baseline models and FinMath. It is shown that our model performs better than any other baselines for both EM and F1 metrics. Specifically, FinMath improves the previous best result (TAGOP) by 8.5% for EM score and 6.1% for F1 score. The results demonstrates the effectiveness of FinMath in numerical reasoning over tabular and textual data. Overall, the proposed FinMath, with the tree-structured neural model to perform multi-step numerical reasoning, improves the previous best result.