# 国际人工智能会议 AAAI 2021论文北京预讲会

A Bottom-Up DAG Structure Extraction Model for Math Word Problems 曹逸轩、洪峰、李宏伟、罗平 中科院计算所

#### What is Math Word Problem (MWP)?

Math Problem expressed in natural language:

The ages of Tom and his father are in the ratio of 1: 5, half of their sum is 24. Find their ages.

Steps to automatically solve MWP

**Detect quantities** 

## **Our solution**

Extract a Direct Acyclic Graph (DAG) In bottom-up fashion, layer by layer



The ages of Tom and his father are in the ratio of **1**: **5**, **1/2** of their sum is **24**. Find their ages.

#### Translate into equations

 $\begin{cases} x \div y = 1 \div 5 \\ \frac{1}{2} \times (x + y) = 24 \end{cases}$ 

Solve the system of equations

x = 8 y = 40

#### **Related work**

Existing work focus on arithmetic problem (one variable) whose result is an expression

Seq2Seq

direct:  $(n_2 + n_3) \div n_1$ suffix:  $\div + n_2 n_3 n_1$ Left to Right

• Seq2Tree

It can intrinsically

- extract any number of equations,
- satisfy the commutative law,
- consider the structure information

#### **Experiments**

	Model	Acc.(%)
Similarity	SIM (Huang et al. 2016)	25.5*
Template	KAZB (Kushman et al. 2014)	43.2*
	MixedSP (Upadhyay et al. 2016)	59.5
Deep	DNS (Wang, Liu, and Shi 2017)	31.0*
Learning	Seq2DAG	44.4
	w/o BERT	37.5
	Table 2: Results on DRAW1K.	

Model	Acc.(%)
DNS (Wang, Liu, and Shi 2017)	64.7
T-RNN (Wang et al. 2019)	68.7
Ensemble (Wang et al. 2018)	68.4
Seq2Tree (Xie and Sun 2019)	74.3
Graph2Tree (Zhang et al. 2020)	75.5
Seq2DAG	77.1
-Attention	76.1
-BERT	72.5

Table 3: Results on Math23K

Acc. (%)	



#### What is missed?

- Algebra problems (multiple variables) whose result is a system of equations has multiple roots, is a DAG instead of Tree
- Mathematical properties
  commutative law: a+b ⇔ b+a

Not consider CL	41.9
Not consider CL & order disruption	41.0

Table 5: Results on whether considering the commutative law (CL).

### A General Framework

This bottom-up DAG extraction model is a general framework used in many tasks:

- Towards Automatic Numerical Cross-Checking: Extracting Formulas from Text. In WWW 2018
- Nested Relation Extraction with Iterative Neural Network, In CIKM 2019

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