

Guiding Mathematical Reasoning via Mastering Commonsense Formula Knowledge

Jiayu Liu^{1,3}, Zhenya Huang^{2,3*}, Zhiyuan Ma^{2,3}, Qi Liu^{2,3}, Enhong Chen^{3,4*}, Tianhuang Su⁵, Haifeng Liu⁶

¹ School of Data Science, University of Science and Technology of China (USTC);

² School of Computer Science and Technology, University of Science and Technology of China (USTC);

³ State Key Laboratory of Cognitive Intelligence;

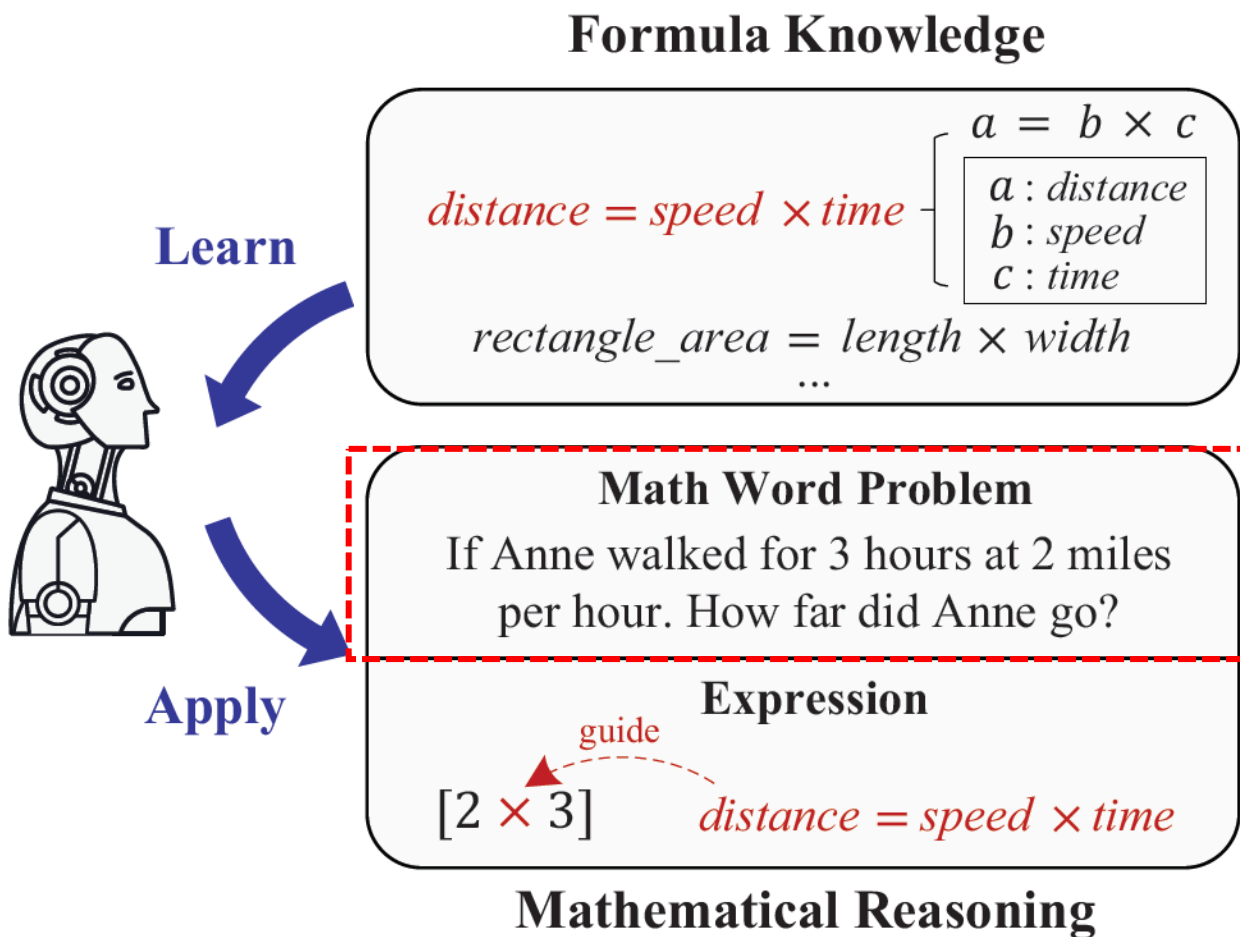
⁴ Anhui Province Key Laboratory of Big Data Analysis and Application;

⁵ OPPO Mobile Telecommunications;

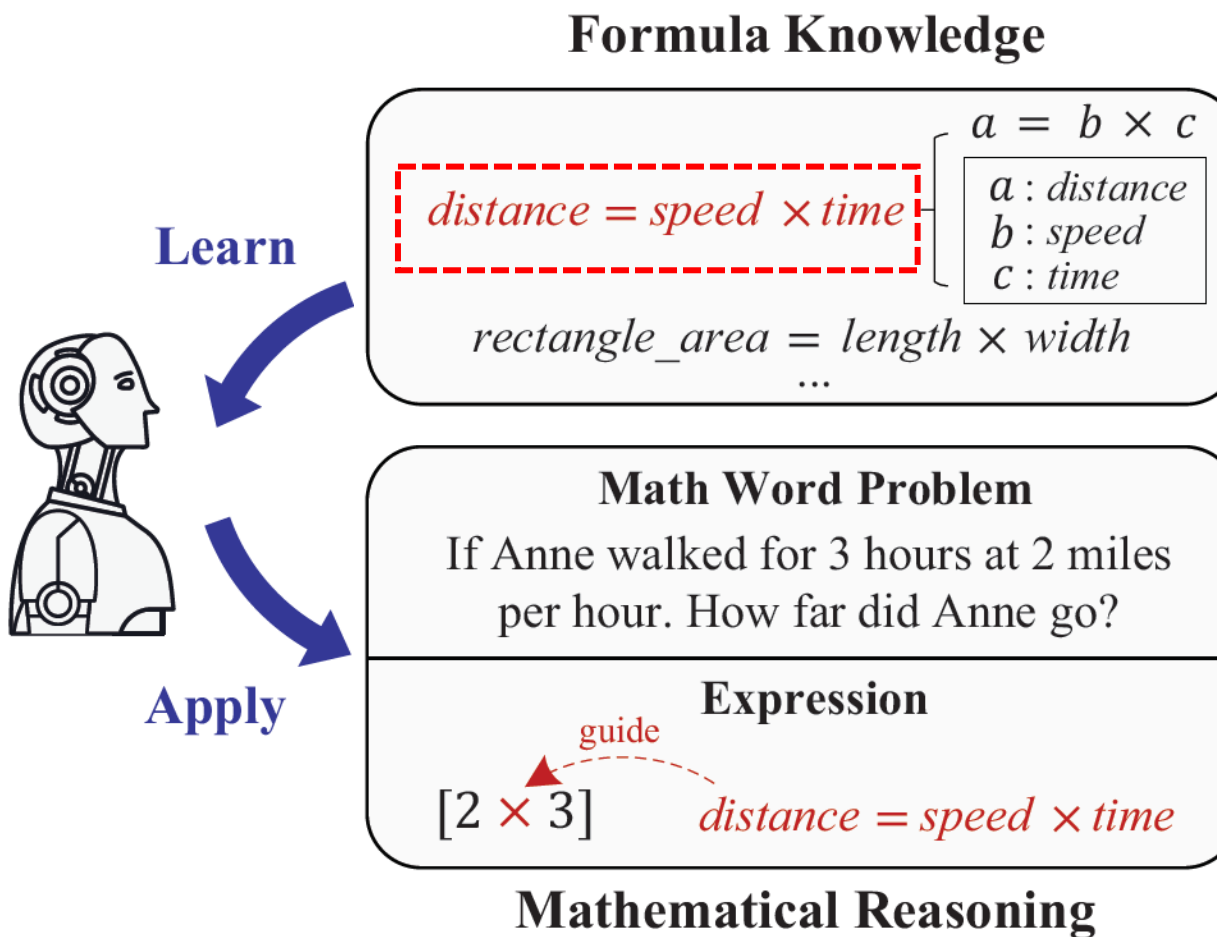
⁶ University of Science and Technology of China (USTC)



Background

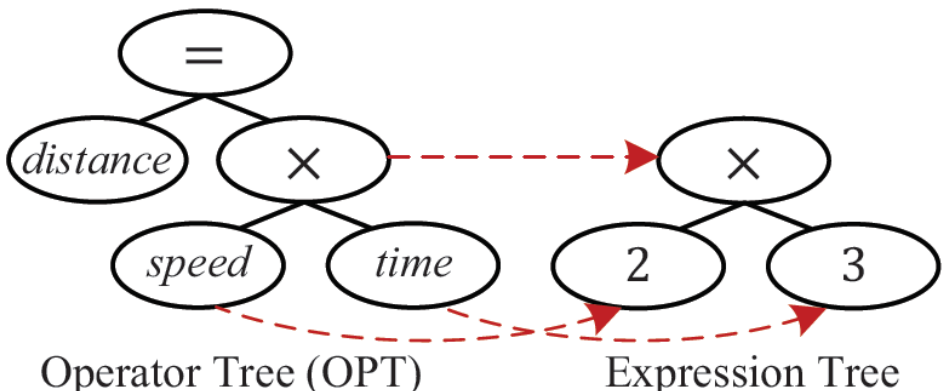


Background



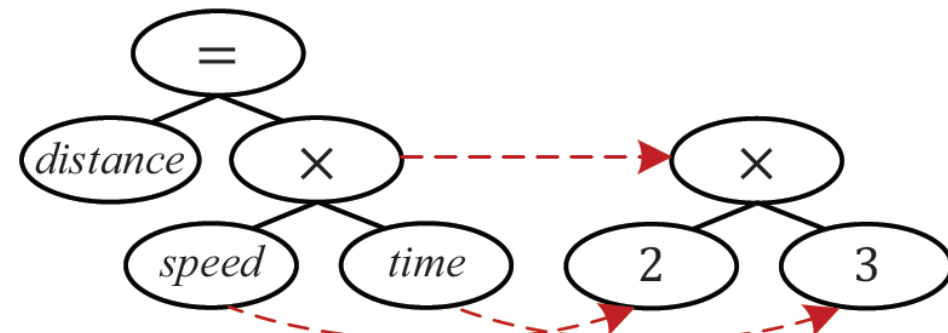
Our datasets: Math23K-F and MAWPS-F

- Existing benchmarks do not provide a label for formula usage in reasoning process.

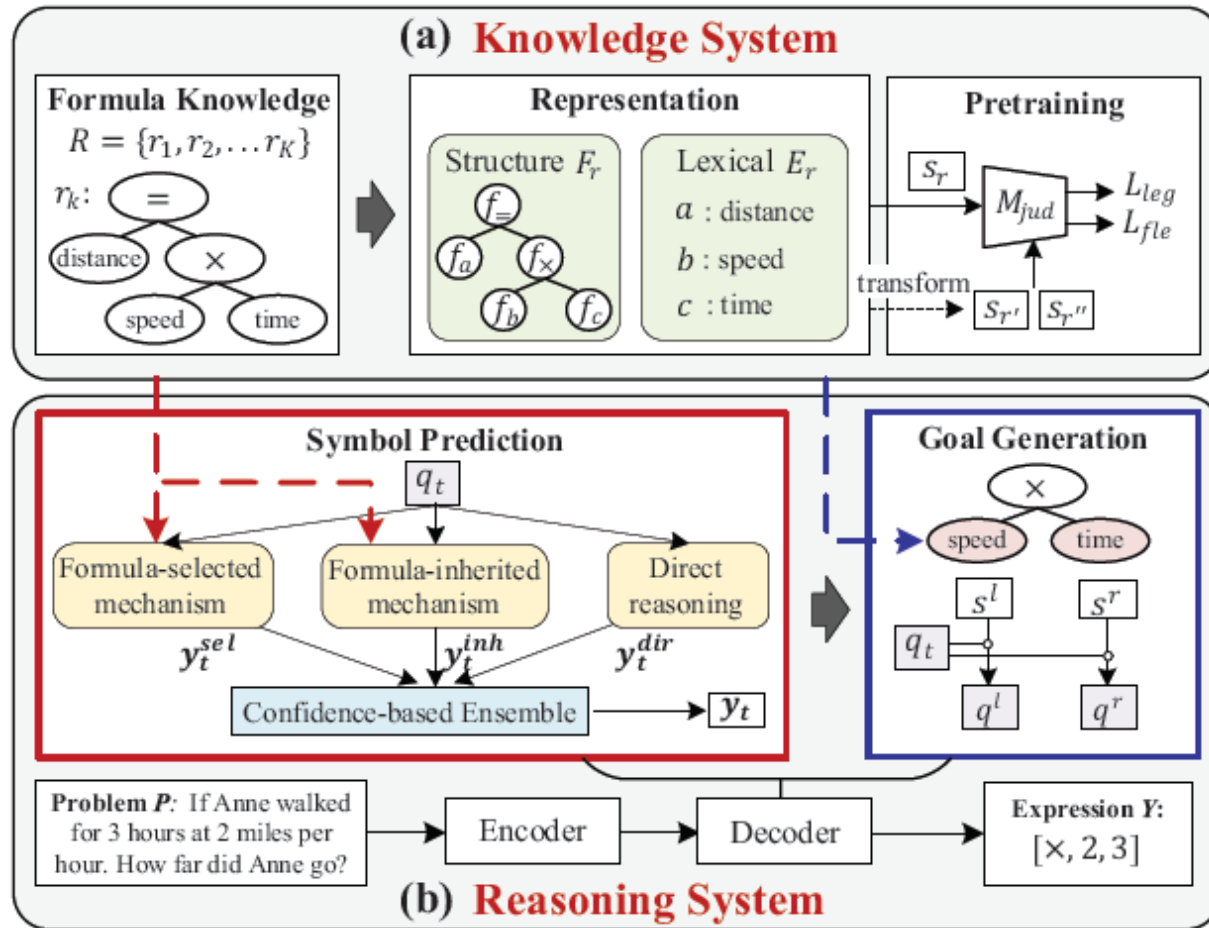
Problem	If Anne walked for 3 hours at 2 miles per hour. How far did Anne go?
Answer	6
Expression	$[2 \times 3]$
Formula	$[\emptyset, distance = speed \times time, \emptyset]$
Explanation	 <p>Operator Tree (OPT) Expression Tree</p>

Our datasets: Math23K-F and MAWPS-F

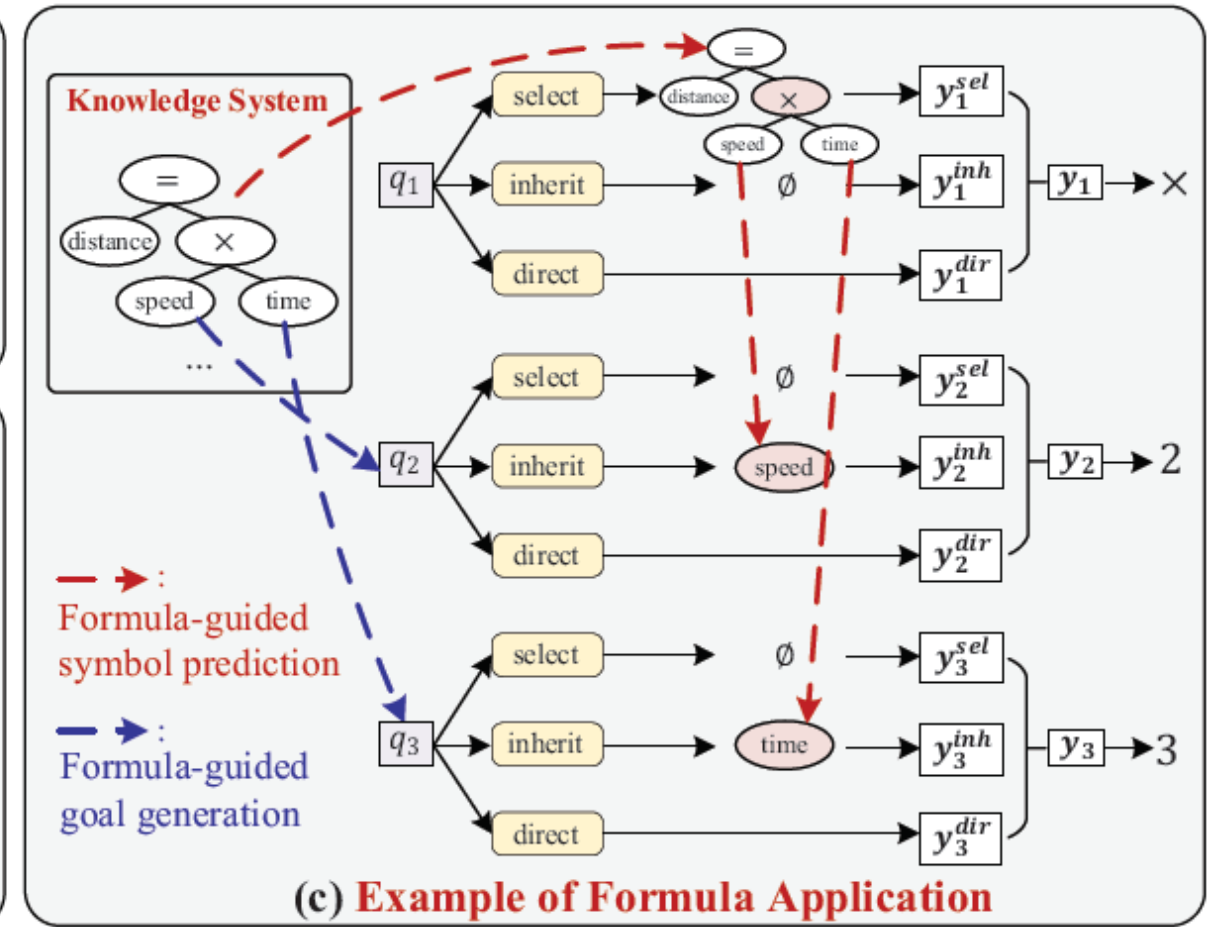
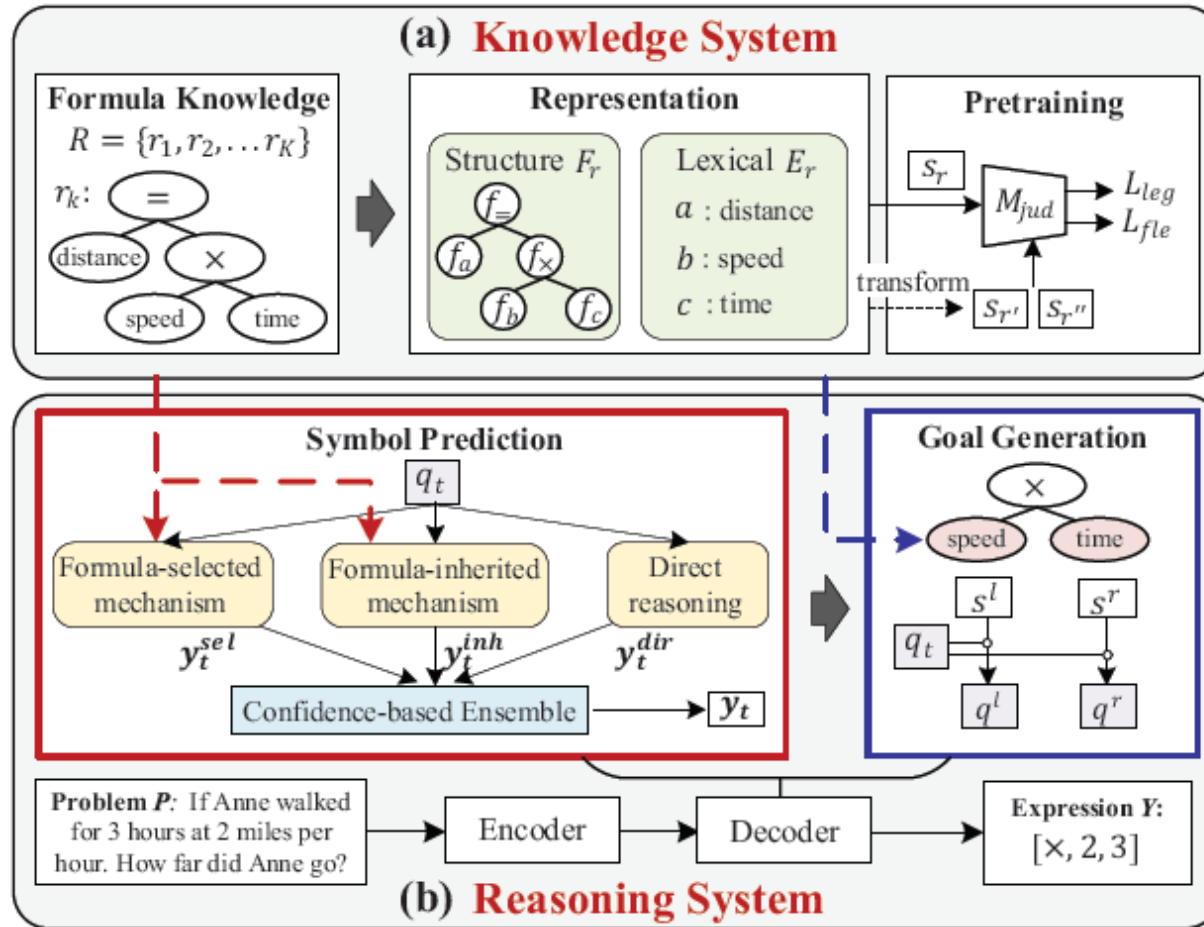
- Existing benchmarks do not provide a label for formula usage in reasoning process.

Problem	If Anne walked for 3 hours at 2 miles per hour. How far did Anne go?
Answer	6
Expression	$[2 \times 3]$
Formula	$[\emptyset, distance = speed \times time, \emptyset]$
Explanation	 <p>Operator Tree (OPT) Expression Tree</p>

Our Formula-mastered Solver (FOMAS)



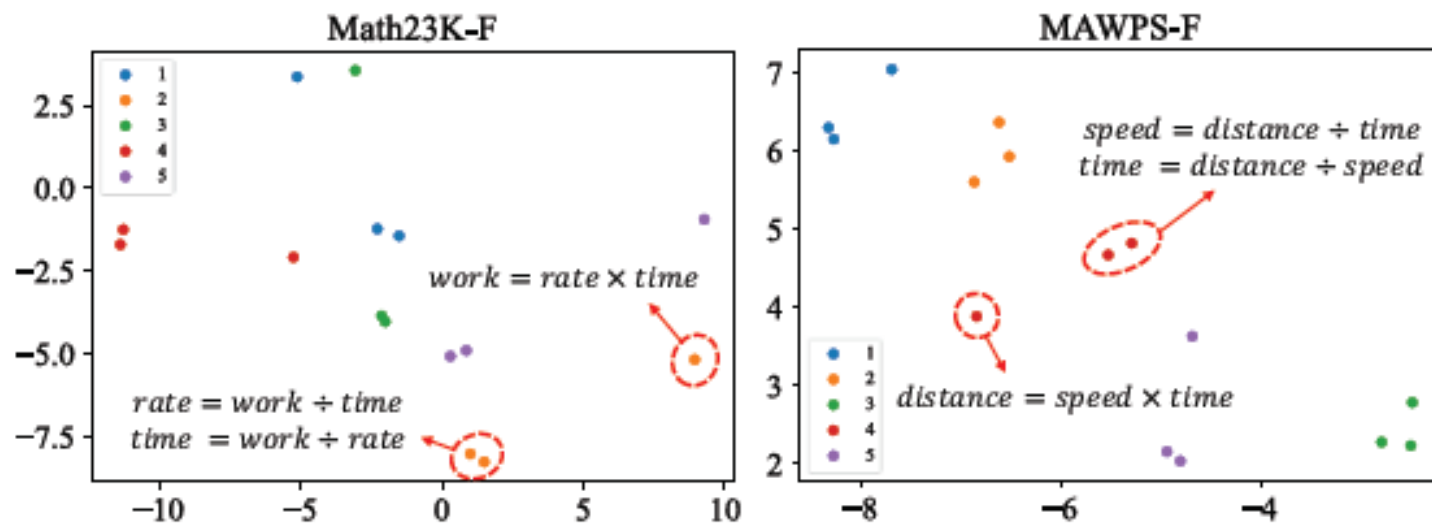
Our Formula-mastered Solver (FOMAS)



Experiments



	Math23K-F	MAWPS-F
Seq2Seq	0.640	0.797
GTS	0.756	0.826
Graph2Tree	0.774	0.837
HMS	0.761	0.803
NS-Solver	0.757	/
BERT-Tree	0.833	0.872
SUMC	0.825	0.820
LogicSolver	0.834	/
ChatGPT	0.649	0.883
FOMAS	0.848*	0.886*



	Math23K-F		MAWPS-F	
	FOMAS	IP	FOMAS	IP
ACC(↑)	0.954	0.950	0.961	0.957
Precision(↑)	0.749	0.731	0.808	0.776
Recall(↑)	0.687	0.621	0.758	0.742
	FOMAS		FOMAS	
	BT		BT	
PIF(↓)	0.112	0.220	0.134	0.257

Guiding Mathematical Reasoning via Mastering Commonsense Formula Knowledge

Jiayu Liu^{1,3}, Zhenya Huang^{2,3*}, Zhiyuan Ma^{2,3}, Qi Liu^{2,3}, Enhong Chen^{3,4*}, Tianhuang Su⁵, Haifeng Liu⁶

¹ School of Data Science, University of Science and Technology of China (USTC);

² School of Computer Science and Technology, University of Science and Technology of China (USTC);

³ State Key Laboratory of Cognitive Intelligence;

⁴ Anhui Province Key Laboratory of Big Data Analysis and Application;

⁵ OPPO Mobile Telecommunications;

⁶ University of Science and Technology of China (USTC)

