

TeacherLM: Teaching to Fish Rather Than Giving the Fish, Language Modeling Likewise

marii

Contributions

- Generate fundamentals, chain of thought, and common mistakes
- Augmented 58 NLP datasets and taught various student models
- TeacherLM-7.1B model 52.3 on MMLU, surpassing models with over 100B parameters.
- Efficient inference speed and lower requirements. Augment NLP datasets rapidly.
- TeacherLM and augmented datasets should be release as open-source.

Technique overview

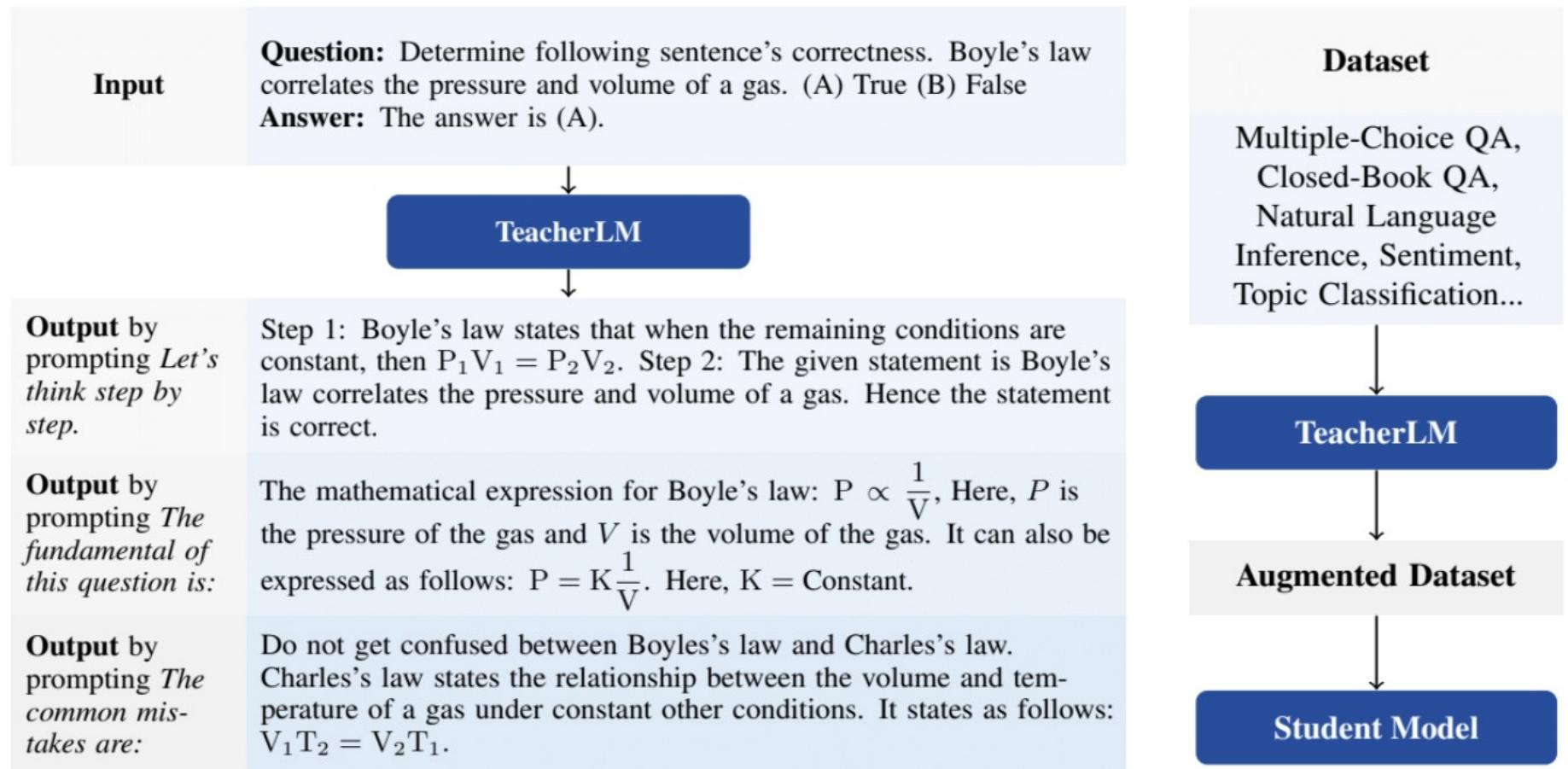


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TeacherData-2M

Question: Determine the correctness of the following sentence. Sam Cooke became a member of the Rock & Roll Hall of Fame.
(A) True (B) False

Answer: The answer is (A).

Manual Explanations

I know this to be true.

TeacherLM-7.1B by prompting *Let's think step by step.*

Step 1: The early 1970s saw the emergence of Rock & Roll as the leading music form in the United States. Step 2: Sam Cooke is known as the King of Soul. He became a Rock & Roll Hall of Fame member in 1995.

TeacherLM-7.1B by prompting *The fundamental of this question is:*

The United States established several organizations to recognize excellence in achievements. These organizations are the National Foundation for the Advancement of Arts and Sciences and the Rock and Roll Hall of Fame. In 1972, the Country Music Association introduced the first-ever Rock and Roll Hall of Fame. A rock music awards show named the BBC Radio 1 Big Weekend also emerged. This award show had several celebrities competing for the top honor: the Rock and Roll Hall of Fame. The first

TeacherLM-7.1B by prompting *The common mistakes are:*

Rock & Roll songs emerged in the 1950s and 1960s. Do not forget that Ray Charles and Sam Cooke are both in the Rock & Roll Hall of Fame.

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MMI 11/57 tasks zero-shot)

Speaker notes

Unsure if this dataset will be released. Not dataset, but pieces of our goal 2 million pieces of multi-domain data collected.

Has 5 pieces

Combination of data not in public datasets, manual annotations(answers,hints), and annotations generated by StaR(answer+rationale, if pred!=answer provide hint) (no examples?)

Teacher & Student Architecture

- BLOOM decoder-only models pre-trained for 350 billion tokens. (Student is 7B only)
- Pre-trained on the ROOTS corpus in 46 natural languages and 13 programming languages

Teacher Multi-Stage Training

1. Multi-task training
2. Personalization training
3. Specialization learning

Speaker notes

1. Multi-task training data shown to improve zero-shot. The authors combine multi-task datasets P3-Sense-3K and Muffin-3W.
2. TeacherData-2M, trains a single model to learn fundamentals, chain of thought, and common mis-takes
3. TeacherData-2M, three models fundamentals, chain of thought, and common mistake

Teacher Eval

$$P(\text{answer}_i | q) = \frac{1}{K} \sum_{k=1}^K \log P(a_k | q, a_1, \dots, a_{k-1})$$

Speaker notes

benchmark consists of exam-like questions on academic subjects suchas mathematics, history, law, and medicine.

Choose single answer for a question using above. Then average overall tasks.

Teacher performance by stage

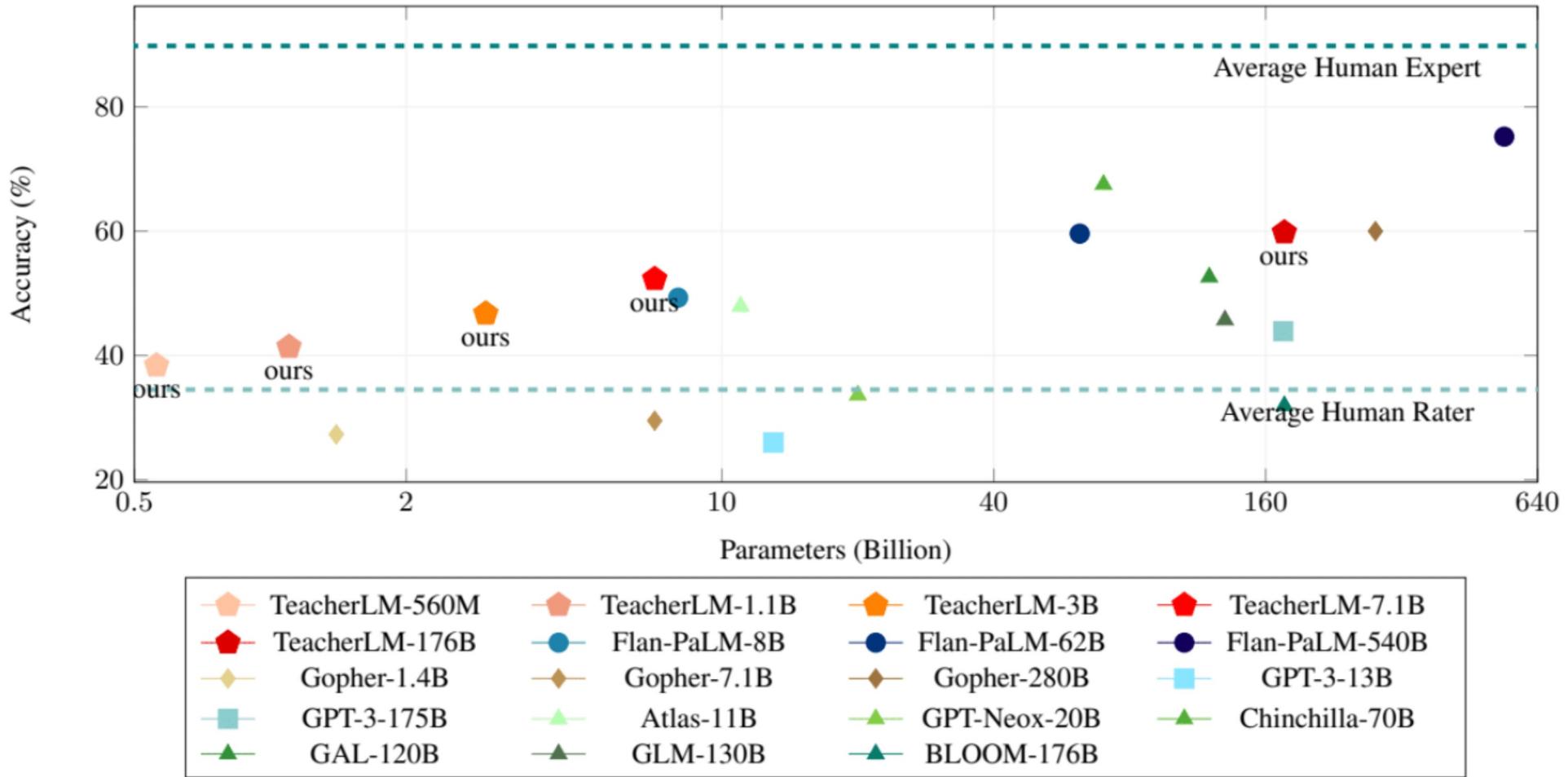
parameters	1st stage	2nd stage	3rd stage(C)	3rd stage(F)	3rd stage(M)	No stage
560M	31.00	36.47	<u>38.39</u>	34.65	34.85	35.27
1.1B	32.87	41.36	<u>41.38</u>	39.25	38.75	40.26
3B	36.51	46.34	<u>46.74</u>	45.22	45.1	46.01
7.1B	41.47	51.11	<u>52.30</u>	50.32	49.00	47.00
176B	/	<u>59.80</u>	/	/	/	/

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Speaker notes

Only CoT improved in the 3 from 2. Mixed means mixed all datasets from all stages.

Teacher Results



Speaker notes

Average MMLU scores (%) for 57 tasks with model and human accuracy comparisons. TeacherLMs are in the 0-shot setting, and the rest are in the 5-shot setting.

Generated Tokens for Student

DATASET	OPTIONS	EXMAPLE AMOUNTS				AVERAGE TOKENS				
		TRAIN	TEST	MANUAL	CoT	FUD	MIS	CoT-D	FUD-D	MIS-D
ECQA	5	7598	2194	59	75	186	53	47	27	32
STRATEGYQA	2	1832	228	28	90	192	55	73	48	31
CREAK	2	10174	1371	15	71	190	48	42	25	19
P3-SENSE-3K	/	1400364	/	/	49	135	54	/	/	/

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Speaker notes

Manual denotes human annotated rationales in original datasets

Examples - # items in dataset split

Used to train Student!

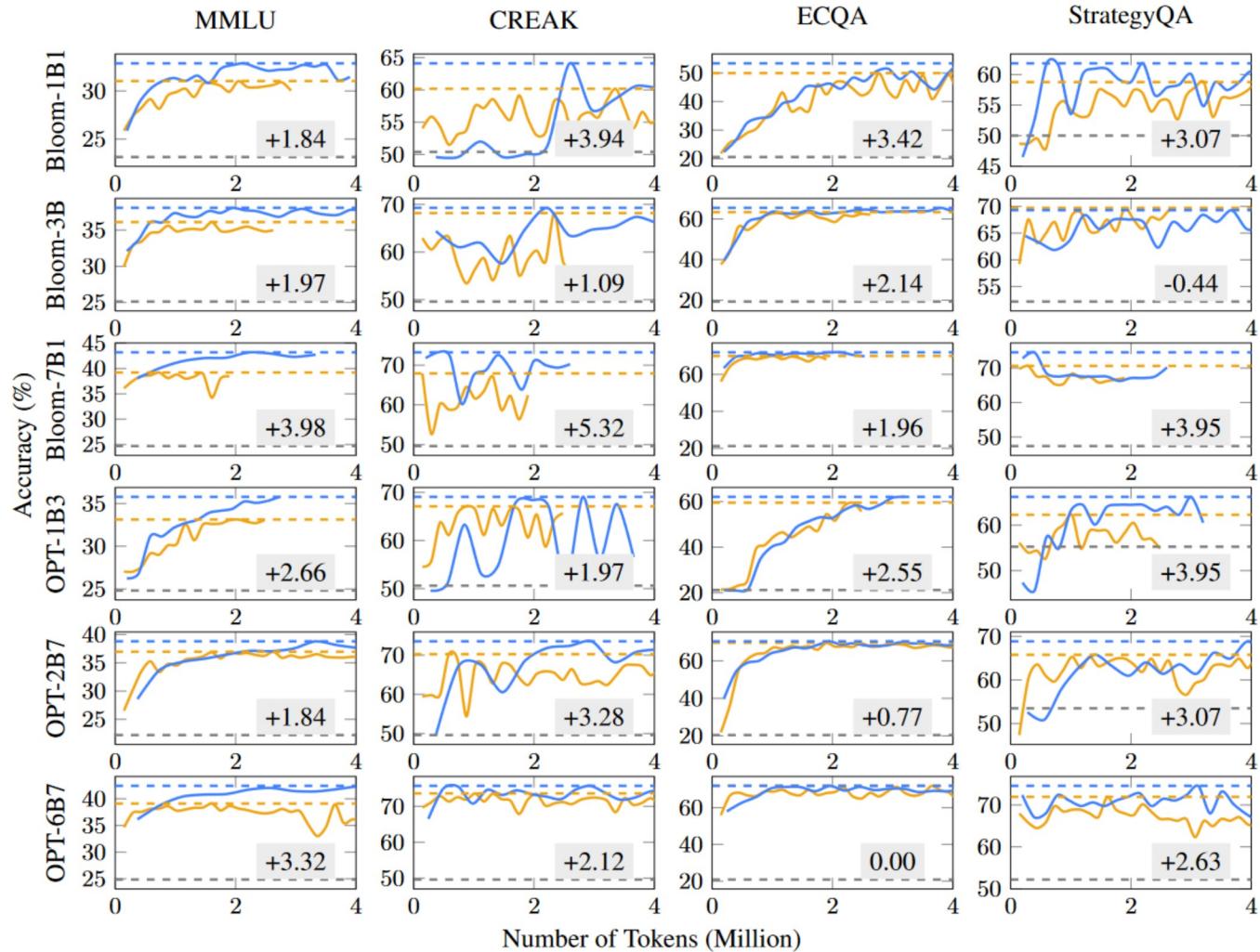
CoT, fundamentals and common mistakes

-D means text-davinci-003

text-davinci-003 reiterates the question limiting explanation

TeacherLM - very verbosely detailed

Multi-task Results.



Speaker notes

Train on P3-Sense unaugmented and augmented then evaluate on multi-task datasets.

Performance

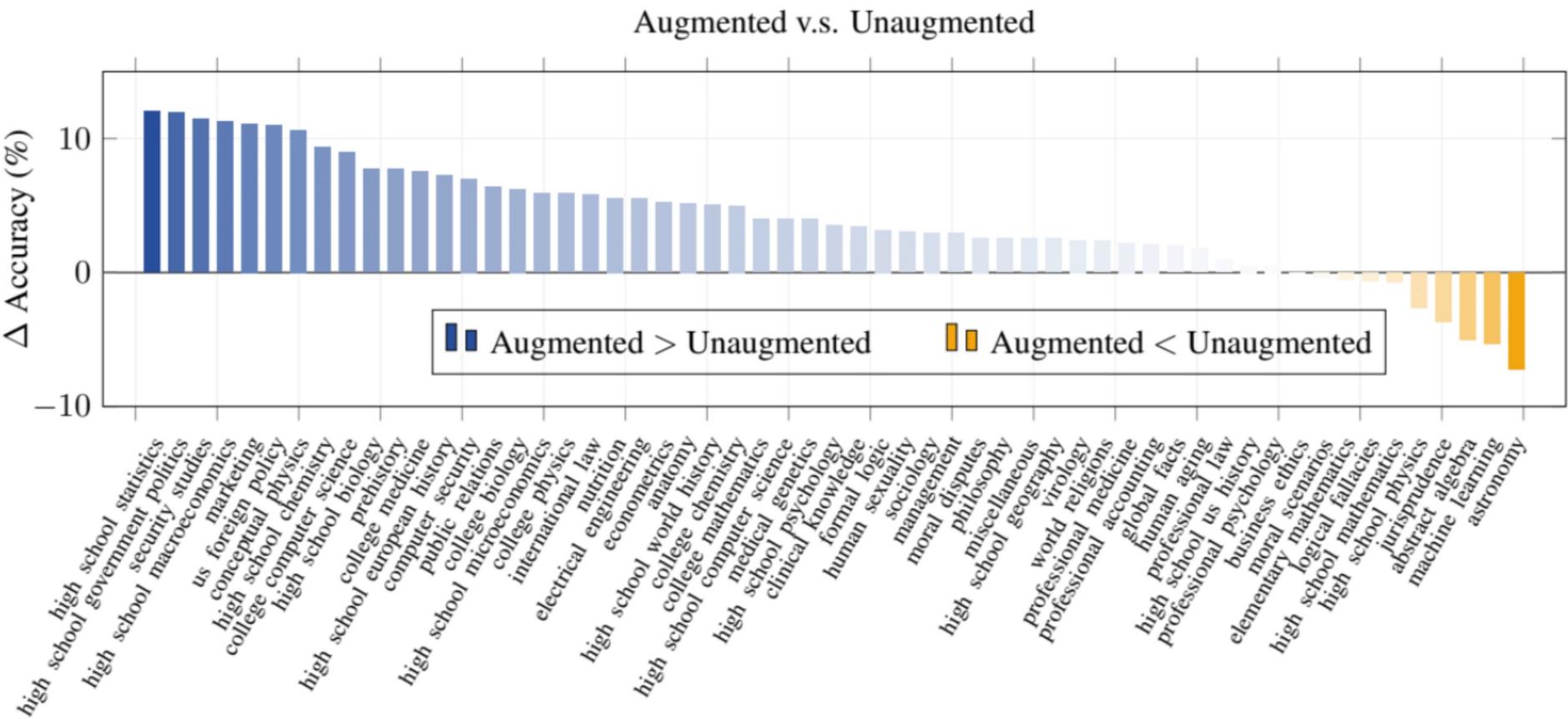


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Speaker notes

worse on math

Single Task Training

TASK	TEXT	MANUAL	TEACHERLM-7.1B	TEXT-DAVINCI-003
BLOOMZ-7.1B				
ECQA	<u>71.9</u>	61.9	61.9 / 61.9 / 61.9	64.0 / 64.0 / 64.4
STRATEGYQA	71.1	71.1	65.8 / 73.3 / 57.0 (+2.2)	66.7 / <u>79.0</u> / 69.3 (+7.9)
CREAK	64.0	73.3 (+9.3)	<u>77.0</u> / 54.8 / 58.2 (+13.0)	74.6 / 69.6 / 76.7 (+12.7)
P3-AUGMENTED-BLOOMZ-7.1B				
ECQA	<u>68.6</u>	53.1	60.5 / 58.3 / 65.0	60.1 / 67.7 / 56.6
STRATEGYQA	72.4	68.9	74.1 / <u>77.2</u> / 74.1 (+4.8)	65.8 / 75.4 / 71.9 (+3.0)
CREAK	76.7	78.6 (+1.9)	75.9 / 75.8 / <u>79.0</u> (+2.3)	70.9 / 70.0 / 70.3

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Speaker notes

bloomz is model to finetune on each task p3-augmented-bloomz was trained on authors P3-Sense-3K augmented dataset, BEFORE finetuning

teacher and davinici are use to generate CoT, fundamentals and common mistakes.

text is unaugmented, manual is manual CoT.

Example of what we have!

Question: Fact 1: Climate is generally described in terms of temperature and moisture. Fact 2: Humidity is a measure of moisture content of air. Climate is generally described in terms of temperature and what?

- (A) humidity (B) wind (C) warmer air (D) calibrated (E) percentages (F) matter (G) color (H) SI units

Answer: The answer is (A).

Manual Explanations

Climate is generally described in terms of temperature and humidity.

text-davinci-003 by prompting *Let's think step by step.*

Fact 1 states that climate is generally described in terms of temperature and moisture. Fact 2 states that humidity is a measure of moisture content of air. Therefore, the answer is (A) humidity.

text-davinci-003 by prompting *The fundamental of this question is:*

Climate is generally described in terms of temperature and moisture. Humidity is a measure of moisture content of air, so the correct answer is (A) humidity.

text-davinci-003 by prompting *The common mistakes are:*

(B) wind, (C) warmer air, (D) calibrated, (E) percentages, (F) matter, (G) color, and (H) SI units.

TeacherLM-7.1B by prompting *Let's think step by step.*

Various physical properties describe the climate. One of them is humidity. The climate is generally described in terms of temperature and humidity. So, option humidity is the correct answer.

TeacherLM-7.1B by prompting *The fundamental of this question is:*

Climate refers to the weather pattern in a long-term condition in a specific region. Several factors influence the climate of a specific region. Temperature, wind speed, humidity, precipitation, and solar radiation are the important significant factors that influence the climate of a specific region.

TeacherLM-7.1B by prompting *The common mistakes are:*

Do not think that climate is simply determined by temperature alone. Temperature, humidity, wind speed, and other factors also play an important role in the climate of a region. Do not consider that climate is not measured in humid regions. Climate is measured in terms of humidity also.

Speaker notes

Teacher LM tends to do worse on Math.

Questions?