OPT-R: Exploring the Role of Explanations in Finetuning and Prompting for Reasoning Skills of Large Language Models

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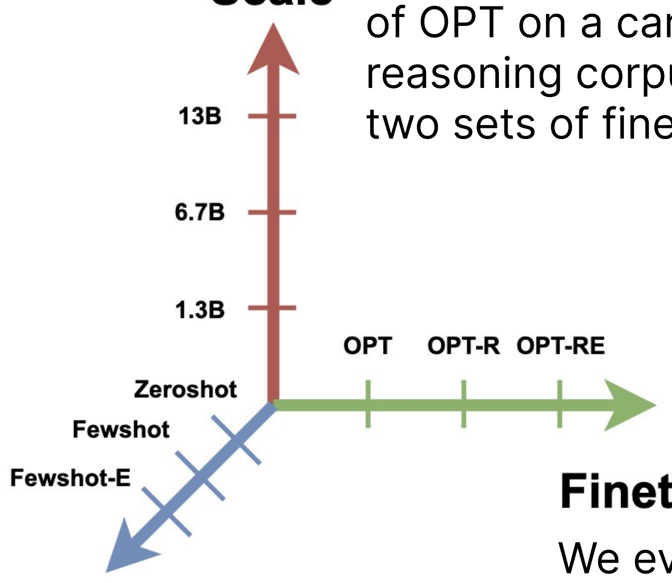
Introduction

We investigate the reasoning capabilities of LLMs, focusing on the OPT models. We ablate across the following dimensions.



Scale

We finetune three different sizes of OPT on a carefully curated reasoning corpus, resulting in two sets of fine-tuned models.

Finetuning

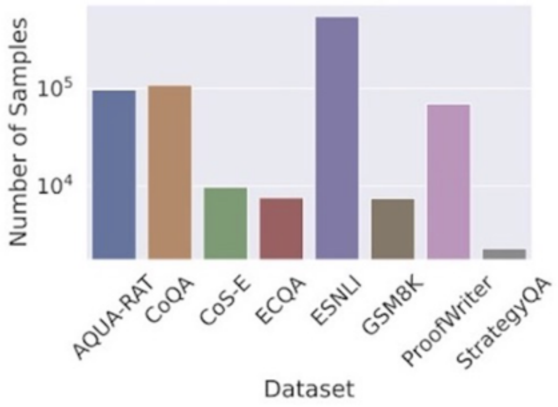
We evaluate all models on out-of-domain reasoning skills zero-shot, few-shot and few-shot with explanations.

Prompting

OPT-R, finetuned without explanations, and OPT-RE, finetuned with explanations.

This results in a comprehensive grid of 27 configurations and 6,156 test evaluations.

Finetuning Corpus



{Task Definition}

Provide your answer followed by a brief reasoning.

{In-Context Examples}

Input: {input}

Options: {options}

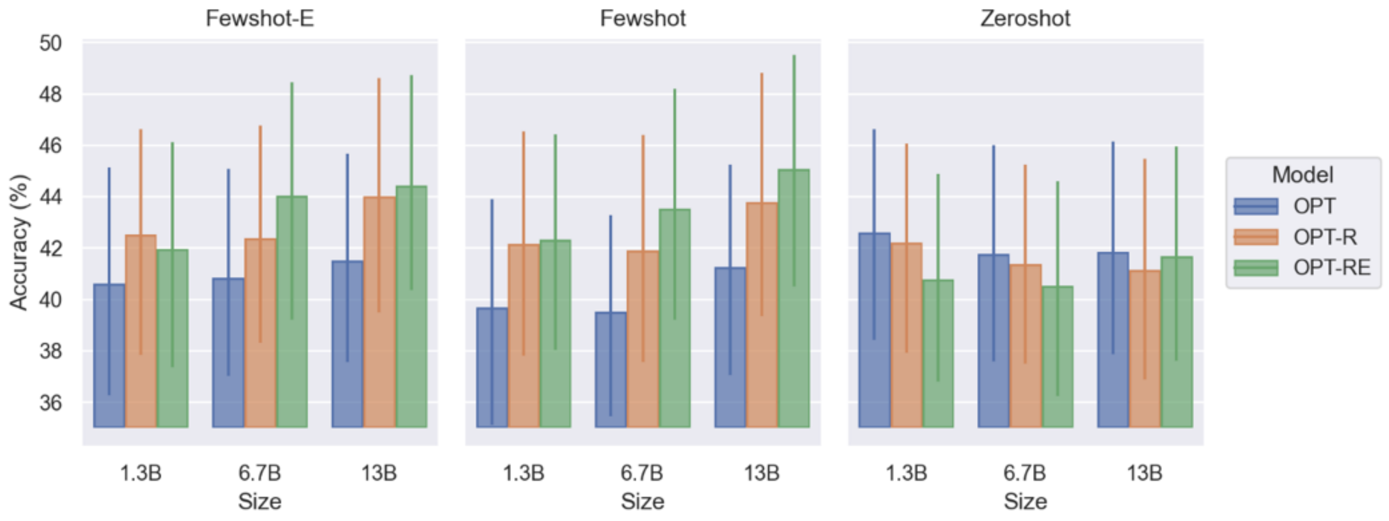
Output: The answer is {answer} because {explanation}

The finetuning corpus is comprised of 8 reasoning datasets with explanations that are either free-form or step-by-step. We format all datasets using the above prompt and generate two training corpuses, one with explanations for OPT-RE and one without explanations for OPT-R.

Evaluation

We evaluate OPT-R on 26 reasoning skills, sampled from a held-out set of 57 `Super-NaturalInstructions` tasks. Performance is measured by calculating the most likely output from a set of candidates (i.e. rank classification).

Explanations had a small effect on performance as we incorporate it during finetuning, prompting and as model size increases.



Skill Analysis

Classification accuracy achieved by different models as a function of the reasoning skill and few-shot prompting method employed. The cells are shaded to according to score, with the highest bolded. Results are grouped by which model performs best.

	OPT		OPT-*R*		OPT-*RE*	
Skill	**Fewshot**	**Fewshot-E**	**Fewshot**	**Fewshot-E**	**Fewshot**	**Fewshot-E**
Numerical	39.9	49.7	65.1	**65.3**	64.7	64.8
Analogical	51.9	46.2	**63.3**	62.5	60.7	60.9
Objects	53.5	55.1	61.4	**63.8**	60.0	59.7
Social Interactions	33.6	34.7	**43.8**	42.3	40.2	40.0
Textual Entailment	43.3	42.0	47.1	47.3	**51.9**	51.2
Grammatical	54.4	55.1	61.2	60.0	62.0	**63.1**
Multihop	36.6	31.7	38.9	**39.9**	39.5	37.0
Symbols	44.2	47.2	51.7	51.8	51.9	**52.4**
Spatial	44.1	47.1	49.8	**51.8**	49.6	49.2
Social Situations	46.3	46.6	53.2	53.2	51.9	52.3
Counting	19.6	20.0	13.5	12.7	29.8	**32.9**
Physical	35.8	40.6	36.9	38.8	48.1	**50.0**
Logical	31.7	33.4	33.7	34.1	36.9	**38.4**
Temporal	**50.7**	49.7	43.4	46.5	48.5	38.5
Argument	55.8	**60.1**	46.3	45.9	48.6	48.8
TE - Deductive	33.7	**38.3**	27.9	30.1	29.0	29.9
Relational	47.4	**51.1**	47.6	47.9	44.8	44.6
Commonsense	**35.0**	31.8	29.8	29.5	28.5	29.2
TE - Analogical	16.3	18.7	18.6	**20.7**	18.7	18.1
Abductive	33.9	36.1	**36.9**	34.4	34.2	35.3
Ethics	26.8	25.8	26.5	25.9	26.2	**27.6**
Deductive	39.4	40.4	39.4	40.4	40.0	**41.1**
Causal	50.2	**50.6**	49.1	48.9	50.1	50.5
Scientific	23.4	23.3	24.3	24.5	**25.0**	24.5
Numerical Commonsense	**59.5**	59.2	59.0	59.0	59.2	59.4
Strings	60.7	60.7	61.1	**61.2**	60.7	60.7

Further Analysis

Model	**Std(|F-FE|)**	**Avg(F)**	**Avg(FE)**
OPT	2.31	40.68	41.82
OPT-*R*	0.84	43.44	43.68
OPT-*RE*	0.78	44.49	44.86

Explanations during prompting does not significantly impact finetuned models on reasoning datasets but makes a difference for vanilla OPT.

Skill	**OPT**	**OPT-*R***	**OPT-*RE***
Numerical	44.8	**65.2***	64.7*
Analogical	49.0	**62.9***	60.8*
Counting	19.8	13.1	**31.3***
Physical	38.2	37.8	**49.1***
Entailment	42.6	47.2	**51.6***
Social Int	34.1	**43.0***	40.1
Objects	54.3	**62.6***	59.9*

Reasoning skills where either OPT-RE or OPT-R are **significantly better than the vanilla OPT**. Explanations help Counting, Physical Reasoning and Entailment.

Skill	**OPT**	**OPT-*R***	**OPT-*RE***
Argument	**57.9**	46.1^{-}	48.7^{-}
TE - Deductive	**36.0**	29.0^{-}	29.4^{-}
Commonsense	**33.4**	29.7	28.8^{-}

Reasoning skill where **OPT performs significantly better** than either OPT-R or OPT-RE

^ Signficance is measured by Welch's t-test ($p < 0.05$) denoted by the * symbol.