CROSSFIT: A Few-shot Learning Challenge for Cross-task Generalization in NLP

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Abstract

Humans can learn a new language task more efficiently than machines, conceivably by leveraging their prior experience and knowledge in learning other tasks. In this paper, we explore whether such *cross-task generalization* ability can be acquired, and further applied to build better *few-shot learners* across diverse NLP tasks. We introduce CROSSFIT, a task setup for studying cross-task few-shot learning ability, which standardizes seen/unseen task splits, data access during different learning stages, and the evaluation protocols. In addition, we present NLP Few-shot Gym, a repository of 160 few-shot NLP tasks, covering diverse task categories and applications, and converted to a unified text-to-text format.

Our empirical analysis reveals that the few-shot learning ability on unseen tasks can be improved via an upstream learning stage using a set of seen tasks. Additionally, the advantage lasts into medium-resource scenarios when thousands of training examples are available. We also observe that selection of upstream learning tasks can significantly influence few-shot performance on unseen tasks, asking further analysis on task similarity and transferability.[1]

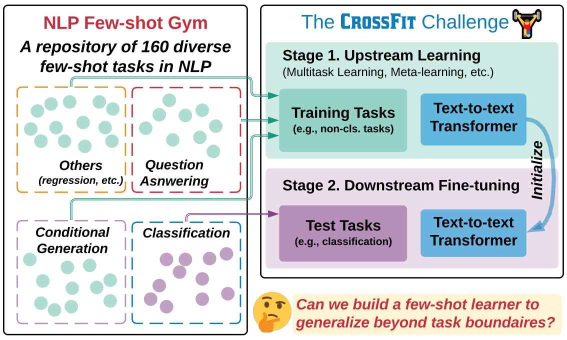

Figure 1: We present the CROSSFIT Challenge to study cross-task few-shot learning ability of a system, where the tasks are selected from a diverse distribution. To support this problem setting, we introduce NLP Few-shot Gym, a repository of 160 diverse few-shot tasks in NLP, formulated in a unified text-to-text format.

1 Introduction

With recent progress in pre-trained language representations, models can learn to perform a new natural language processing (NLP) task competently with only a handful of examples (*i.e.*, few-shot learning). Moving towards this direction, researchers have developed approaches to further improve learning efficiency by re-formulating the target task into cloze questions (Schick and Schütze, 2020a,b), generating prompts and using demonstrations (Gao et al., 2020), and densifying the supervision signals (Tam et al., 2021).

Recent advances in pre-training and fine-tuning have primarily focused on improving *instance-level generalization*, *i.e.*, within the scope of one task (dataset), how to make predictions about unseen instances given only few demonstrations. On the other hand, few-shot learning ability can potentially be improved with *task-level generalization*[2], *i.e.*, how to learn a new task efficiently given previous experiences on learning tasks. This idea of "learning to learn" has been widely explored in computer vision and robotics community (Yu et al., 2020; Triantafillou et al., 2020). For language tasks, the same intuition holds: human learners develop high-level skills by learning language tasks and apply these skills when encountering new tasks. For example, a good text classification learner may become a good reading comprehension learner, since

[1] Our code and data are publicly available at https://github.com/INK-USC/CrossFit/

[2] We use the term "task-level generalization" and "cross-task generalization" interchangeably. The former is mainly used for comparison with "instance-level generalization"

both tasks require language understanding; to learn to answer open-ended questions, experiences in learning summarization may help, since both tasks need writing coherent and informative sentences.

In fact, several attempts have already been made towards this direction in NLP. However, the tasks of interests are usually drawn from a narrow distribution. For example, both Han et al. (2018) and Bansal et al. (2020a) focus on generalization within the scope of classification tasks. We anticipate more human-like learning ability that allows generalization across different task formats (classification, span extraction, multiple choice, generation, etc.), goals (question answering, summarization, fact checking, etc.) and domains (academic, biomedical, social media, etc.).

Towards acquiring and evaluating such generalization, we propose the CROSSFIT Challenge, a task setup to investigate a system's cross-task few-shot learning ability, with standardized training pipeline, data access and evaluation protocol. In short, a system for the CROSSFIT challenge may go through an upstream learning stage on a set of seen tasks, and is then evaluated on a set of unseen tasks in few-shot scenario, as illustrated in Fig. 1. To further analyze the capability and limitation of existing approaches, we present NLP Few-shot Gym, a repository of 160 open-access NLP tasks covering a wide range of formats and goals, and formulated into a unified text-to-text few-shot setting. We then instantiate the CROSSFIT challenge with eight different seen/unseen task partitions created with NLP Few-shot Gym. With these resources, we investigate the following research questions:

- **Q1.** Do upstream learning methods, such as multitask learning and meta-learning, improve few-shot learning ability on unseen tasks?
- **Q2.** How does the selection of seen tasks influence unseen tasks performance?
- **Q3.** Does improved few-shot learning ability last when more data is available?

To answer the first two questions, we empirically analyze the performance of multi-task learning and MAML (Finn et al., 2017), a meta-learning algorithm, in the CROSSFIT setup and with the eight different task partitions. For Q1, we found that the few-shot performance is improved on a wide range of tasks after upstream learning, with significant boost on CommonsenseQA, Ropes, MNLI. These encouraging observations showcase the potential power of acquiring and leveraging cross-task generalization for few-shot learning. For Q2, we observe that performance of individual unseen tasks varies with different selection of seen tasks. In addition, we observe that non-classification tasks and classification tasks are equivalently helpful for a set of held-out unseen classification tasks. There observations call for more thorough investigation of the relationship between task similarity and transferability. For Q3, we take the three successful cases in Q1 and further examine the performance when "more shots" become available. We find that the improvements brought by upstream learning last in medium-resource scenarios (e.g., 2048 examples). For CommonsenseQA, this lasts when the full dataset is available. These findings suggest the wide use cases of CROSSFIT systems, as the improvement lasts beyond the few-shot setting.

2 Related Work

Few-shot Fine-tuning. Few-shot learning is the problem to teach models a new task with an extremely small number of annotated examples. Large-scale pre-trained language models (e.g., BERT (Devlin et al., 2019), T5 (Raffel et al., 2020)) have demonstrated great ability to learn new tasks efficiently via *fine-tuning*. Zhang et al. (2021) empirically examined fine-tuning BERT models in few-shot scenarios and provided practical suggestions to improve performance and reduce instability. Schick and Schütze (2020a,b) proposed *pattern-exploiting training* (PET), which formulates text classification and NLI tasks into cloze questions (or "prompts"). These prompts share the same format of masked language modeling, the pre-training tasks of many pre-trained LMs, and thus leads to improved few-shot performance. Extending from PET, Gao et al. (2020) proposed LM-BFF which learns to generate prompts *automatically* and incorporates demonstrations into the input; Tam et al. (2021) proposed ADAPET which densifies the supervision signal with a label conditioning objective.

While successful, in these approaches the downstream tasks are learned in isolation. Our work aims to boost few-shot learning ability on unseen tasks via acquiring cross-task generalization ability from diverse seen tasks.

Meta-learning in NLP. Recent works have explored meta-learning methods for relation classification (Han et al., 2018; Gao et al., 2019), general text classification tasks (Dou et al., 2019;

Bansal et al., 2020a,b), low-resource machine translation (Gu et al., 2018), cross-lingual NLI/QA (Nooralahzadeh et al., 2020), and syllable structure learning (McCoy et al., 2020). In general, these works formulate sub-tasks and apply meta-learning algorithms; however the sub-tasks are either *synthetic* (e.g., a new set of five relations for classification is a new sub-task) or drawn from a rather *narrow* distribution (e.g., QA in one language is a sub-task). In our work, we explore a more realistic setting of learning from a much more *diverse* set of NLP tasks: classification, question answering in different formats, conditional generation (e.g., summarization), etc.

Unifying NLP Task Formats. Recent works explored unifying the formats of different tasks, in order to better enable transfer learning. DecaNLP (McCann et al., 2018) is a benchmark including 10 different and complex NLP tasks, and all tasks are processed into a unified question answering format. UFO-Entail (Yin et al., 2020) formulates multiple-choice QA and co-reference resolution as textual entailment tasks and examines the performance in few-shot settings. T5 (Raffel et al., 2020) studies unifying all tasks in text-to-text format, including discriminative tasks that were typically solved with classification heads attached to the pre-trained model. UnifiedQA (Khashabi et al., 2020) further examines the feasibility of training a general, cross-format QA model. Our work also extends the idea of unifying different tasks into a general text-to-text format, and we significantly enlarge the task repository to 160 to broaden the coverage, in hope of building a general-purpose few-shot learner.

3 The CrossFit Challenge

In this section, we present the CrossFit Challenge, a task setup for acquiring and evaluating cross-task few-shot learning ability. Ideally, a strong CrossFit system can capture cross-task generalization ability from a set of seen tasks and adapts to new unseen tasks efficiently.

In the following, we first introduce the notations and definitions in §3.1, then present the formulation of our CrossFit challenge (§3.2) with its two learning stages (§3.3), and finally present the evaluation protocol in §3.4.

3.1 Preliminaries

Task. We define a task T as a tuple of $(\mathcal{D}_{train}, \mathcal{D}_{dev}, \mathcal{D}_{test}, E)$. Each set $\mathcal{D}$ consists of a set of annotated examples $\{(x_i, y_i)\}$. As we reformulate each task into text-to-text format, x_i and y_i are both sequences of tokens in a shared vocabulary. E denotes a function to *evaluate* the performance of a system on a task based on certain metrics of interest. We use $E(M, \mathcal{D}_{test})$ to represent the performance of a model M based on its predictions and ground-truth labels in $\mathcal{D}_{test}$.

Few-shot Task. For few-shot tasks, the size of $\mathcal{D}_{train}$ and $\mathcal{D}_{dev}$ are required to be small. For classification and regression tasks, we follow (Gao et al., 2020) and include $K = 16$ training examples *per class* in $\mathcal{D}_{train}$. For other types of tasks, we include $K = 32$ examples in $\mathcal{D}_{train}$. In conformity with real-world situations where labeled data are scarce, we assume a development set $\mathcal{D}_{dev}$ which shares the same size with $\mathcal{D}_{train}$, following (Gao et al., 2020). We defer the details of gathering different few-shot tasks from existing open-source datasets in §4.

3.2 Problem Formulation

To acquire and evaluate cross-task generalization ability, we build three non-overlapping sets of *few-shot tasks*, $\mathcal{T}_{train}$, $\mathcal{T}_{dev}$, $\mathcal{T}_{test}$. A CrossFit approach is expected to first learn from the **training tasks** $\mathcal{T}_{train}$, and (optionally) tune the hyper-parameters with **developing tasks** $\mathcal{T}_{dev}$. Finally, we evaluate the few-shot learning ability on all **test tasks** in $\mathcal{T}_{test}$. Specifically, for each test task $T = (\mathcal{D}^T_{train}, \mathcal{D}^T_{dev}, \mathcal{D}^T_{test}, E^T) \in \mathcal{T}_{test}$, we apply a few-shot fine-tuning method to obtain a model M, and assess its performance on $\mathcal{D}^T_{test}$ by executing $E^T(M, \mathcal{D}^T_{test})$.

In our experiments, we manually design several different partitions of $\mathcal{T}_{train}$, $\mathcal{T}_{dev}$, $\mathcal{T}_{test}$ (e.g., random partition, withholding a specific subcategory of tasks, etc.), in hope to examine the capability and limitation of a CrossFit approach in different settings and answer our research questions. More details are deferred in §4.4 and Table 1.

3.3 The Two Learning Stages

A CrossFit system may learn from $\mathcal{T}_{train}$ in the upstream learning stage; it is then evaluated for task-specific few-shot learning with $\mathcal{T}_{test}$:

- **Upstream learning stage.** At first, the algorithm only has access to the $\mathcal{D}_{train}$ and $\mathcal{D}_{dev}$ for each training task in $\mathcal{T}_{train}$, while the performance on $\mathcal{D}_{test}$ is not available at this stage.

- **Few-shot learning stage.** Then, the $\mathcal{T}_{dev}$ and $\mathcal{T}_{test}$ are available for the model to be fine-tuned on. A few-shot learning method (e.g., direct fine-tuning) is applied for the model to learn from $\mathcal{D}_{train}$. The few-shot learning performance is reported on $\mathcal{D}_{test}$. [3]

3.4 Evaluation Protocol

Evaluating the few-shot learning ability over a list of diverse NLP tasks can be tricky, because different tasks use different evaluation metrics. For example, classification tasks typically use *F1* score or *accuracy*, while conditional generation tasks use *exact match* or *BLEU/Rouge*. To develop a unified evaluation protocol for analyzing the performance on 160 different datasets, as shown in §4, we narrow down to a collection of 7 evaluation metrics: classification F1, accuracy, question answering F1, exact match (EM), Matthew correlation, and Pearson correlation. These metrics cover all tasks we considered in the NLP Few-shot Gym benchmark.

To aggregate over multiple tasks in evaluation, we define *Average Relative Gain* (**ARG**), a metric that computes the average relative performance changes between with/without the *upstream learning* stage for each task in evaluation. Suppose we have $\mathcal{T}_{test} = \{T_A, T_B\}$. If an upstream learning algorithm helps improve the few-shot learning performance from 50% F1 score to 70% *F1 score* on task T_A (i.e., a 40% relative improvement), and from 40% accuracy to 30% *accuracy* on task T_B (i.e., -25% relative improvement), the final ARG on $\mathcal{T}_{test}$ would be computed as $\frac{40\%+(-25\%)}{2} = 7.5\%$.

The ARG metric reflects the *overall* performance gain on all tasks in $\mathcal{T}_{dev}$ or $\mathcal{T}_{test}$, no matter what specific metrics each task uses. We use ARG for a high-level comparison, and we still report the improvement on each task for in-depth analysis.

4 NLP Few-shot Gym

In support of CROSSFIT learning, we introduce the NLP Few-shot Gym, a repository of 160 few-shot learning tasks in NLP, covering a wide range of NLP applications and language skills in multiple distinct task formats. In this section, we introduce the dataset selection criteria as well as the ontology we create to facilitate analysis (§4.1), and the

[3]The performance on the $\mathcal{D}_{dev}$ of a task in $\mathcal{T}_{dev}$ or $\mathcal{T}_{test}$ will be used for tuning task-specific model-level hyper-parameters. The overall performance on $\mathcal{T}_{dev}$ is used for tuning the hyper-parameters for upstream learning.

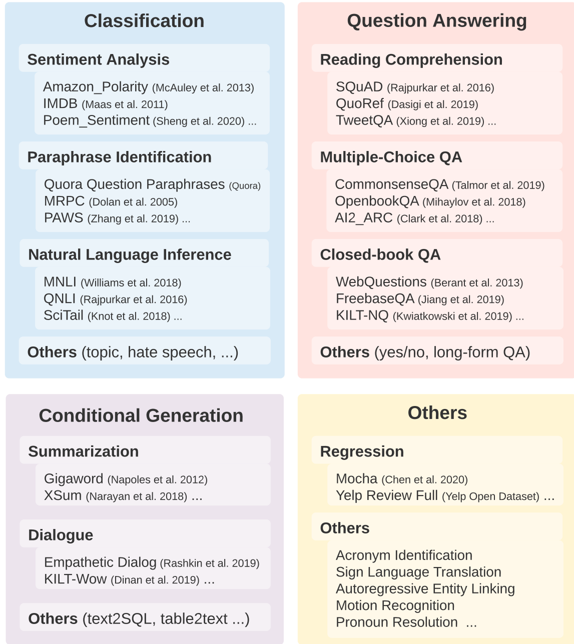

Figure 2: Task Ontology for NLP Few-shot Gym

details about unifying task formats (§4.2) and data sampling (§4.3).

4.1 Dataset Selection

We choose to use *Huggingface Datasets* [4] as the pool of our candidate tasks and datasets. *Huggingface Datasets* is an extensible and open-source library and provides access to numerous open-access NLP tasks with a unified API. We further select datasets based on the following criteria:

1. We focus on English monolingual datasets.
2. We exclude tasks leveraging external knowledge sources or information retrieval technique.
3. We exclude sequence labeling tasks (e.g., dependency parsing, NER), which is highly dependent on tokenization, and is hard to evaluate when converted into sequence-to-sequence format.
4. We exclude datasets that aim for special domains, e.g., COVID-19 related dataset;
5. We exclude datasets dealing with extremely long documents (e.g., a scientific paper) as input, as most pre-trained models cannot process such long input sequences.

After filtering tasks that conflict with any criteria, we finalize with 160 datasets, the details of which

[4]https://huggingface.co/datasets. As of February 25, 2021, there are 626 datasets on Huggingface Datasets

are listed in Appendix. We manually classify the 160 datasets and form a **task ontology** with categories and sub-categories as, shown in Fig. 2. This ontology enables us to analyze the cross-task generalization performance grouped by their categories.

4.2 A Unified Sequence-to-Sequence Format

We follow Raffel et al. (2020) to convert all of our tasks into one unified *text-to-text format* similar to the T5 model's fine-tuning. For example, the task of natural language inference (originally a sentence-pair classification format) becomes: `premise: <premise> hypothesis: <hypothesis>`, and the target sequence is either the word `entailment`, `contradiction` or `neutral`. As for machine reading comprehension tasks, the input format is `question: <question> context: <context>` and the target sequence is the correct answer span. We also reference the format for QA tasks from (Khashabi et al., 2020).

4.3 Few-shot Sampling

We mainly follow the practice in (Gao et al., 2020) by randomly sampling $\mathcal{D}_{train}$ and $\mathcal{D}_{dev}$ splits from each dataset's original train set with 5 different random seeds. This helps us reduce variance during evaluation, and also enlarges the number of few-shot tasks used for learning. Consequently, the "effective size" of the NLP Few-shot Gym is $160 \times 5 = 800$, while we use the number 160 in the following to avoid possible confusion.

We use the original development set for each dataset as $\mathcal{D}_{test}$, or held-out 20% of the dataset when the official development split is not available. The held-out test examples are sampled *once* before sampling $\mathcal{D}_{train}$ and $\mathcal{D}_{dev}$.

4.4 Task Partitions

To comprehensively evaluate a CrossFit system in different scenarios we design 8 different partitions of $(\mathcal{T}_{train}, \mathcal{T}_{dev}, \mathcal{T}_{test})$. We list the details in 1. Our Partition 1 randomly split all 160 few-shot tasks into the three sets, where $|\mathcal{T}_{train}| = 120$ and $|\mathcal{T}_{dev}| = |\mathcal{T}_{test}| = 20$. The design of Partition 1 mimics the real-world language learning environment where the goal is to build a general purpose few-shot learner, and a set of diverse tasks are seen to the learner.

Our Partition 2.1-2.3 withhold 10 classification tasks for development and 10 more for testing. The $|\mathcal{T}_{train}|$ is controlled to have either 100% classification tasks, 100% non-classification tasks, or half-and-half. These three partitions help us to understand the influence brought by different task distribution in $\mathcal{T}_{train}$. These experiments will also help us to examine the capability of a CrossFit system's task-level generalization across drastically different task formats.

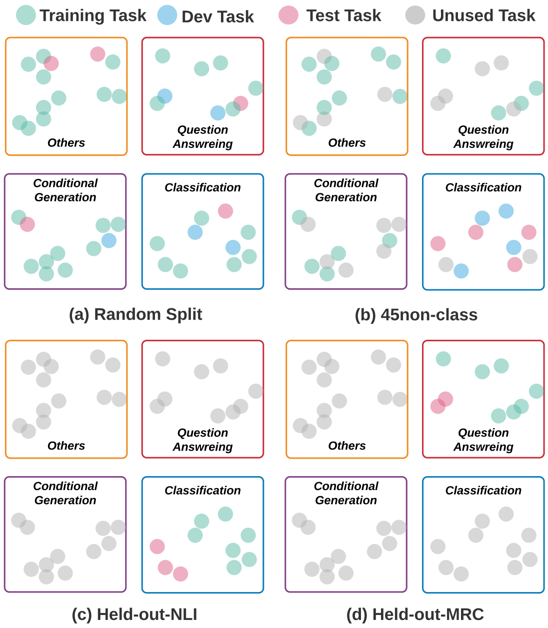

Figure 3: **Illustration for different task partitions.** We evaluate a CrossFit approach on different task partitions to examine its generalization ability in different scenarios. Full details in Table 1.

The remaining four partitions still focus on cross-task generalization, but in a finer granularity: seen and unseen tasks are still in the same category, but not the same sub-category. For example, Partition 3.1 has 57 non-NLI classification tasks as $\mathcal{T}_{train}$, and 8 NLI tasks as $\mathcal{T}_{test}$. These partitions help us to understand whether cross-task generalization in this finer granularity is easier for model to acquire.

5 Methods to CrossFit

We use BART-Base (Lewis et al., 2020) as the text-to-text transformer for our initial analysis in the CrossFit setup.[5] We compare the following three methods.

Direct Fine-tuning. This serves as the basic baseline method for the CrossFit challenge, which does not make use of the training or development tasks $(\mathcal{T}_{train}, \mathcal{T}_{dev})$ at all. For each task

[5]We plan to extend to T5 (non-multitask) models in our future version, which share similar techniques as BART.

No.	Shorthand	$\mathcal{T}_{train}$	$\mathcal{T}_{dev}$	$\mathcal{T}_{test}$	ARG(Multi,$\mathcal{T}_{test}$)	ARG(Meta,$\mathcal{T}_{test}$)	Details
1	Random	120	20	20	35.06%	28.50%	Fig. 4(a)
2.1	45cls	45 cls.	10 cls.	10 cls.	11.68%	9.37%	Fig. 6
2.2	23cls+22non-cls	23 cls. + 22 non-cls.	10 cls.	10 cls.	11.82%	9.69%	
2.3	45non-cls	45 non-cls.	10 cls.	10 cls.	11.91%	9.33%	
3.1	Held-out-NLI	57 non-NLI cls.	/	8 NLI	16.94%	12.30%	Fig. 4(b)
3.2	Held-out-Para	61 non-Paraphrase cls.	/	4 Para. Iden.	18.21%	17.90%	Fig. 4(c)
4.1	Held-out-MRC	42 non-MRC QA	/	9 MRC	32.81%	27.28%	Fig. 4(d)
4.2	Held-out-MCQA	29 non-MC QA	/	22 MC QA	12.20%	4.69%	Fig. 4(e)

Table 1: Details about ($\mathcal{T}_{train}$,$\mathcal{T}_{dev}$,$\mathcal{T}_{test}$) splits used in the study, and their results. "cls." stands for "classification", "Para. Iden." stands for "paraphrase identification", "MRC" for "machine reading comprehension" and "MCQA" for "multiple-choice QA".

$T \in \mathcal{T}_{test}$, we directly fine-tune the BART-Base model with its $\mathcal{D}_{train}$, tune the hyper-parameters on the $\mathcal{D}_{dev}$, and assess its performance on T with the test dataset $\mathcal{D}_{test}$. Note that this method does nothing in the first *upstream learning* stage (§3.3), and thus an effective method to the CROSSFIT challenge should have better performance on testing tasks than it. Therefore, we choose to use the performance of direct fine-tuning as the base for computing **ARG** (§3.4) scores of other CROSSFIT approaches.

Multi-task Learning. A straightforward yet effective method is to combine the data[6] in the training tasks to learn a multi-task model, before fine-tuning it on each test task. Specifically, we gather source-target examples for all tasks in $\mathcal{T}_{train}$ and fine-tune the BART-Base model with these examples. Then we use the resulting checkpoint as initialization and perform the same procedure in "direct fine-tuning" for each test task T in $\mathcal{T}_{test}$. The performance gain over the *direct fine-tuning* is thus used for computing its overall ARG score.

Meta-Learning. We use MAML (Finn et al., 2017), a representative meta-learning approach, which trains the model to adapt fast to new tasks. In MAML training, we iterate through tasks in $\mathcal{T}_{train}$ to update the model. For each train task $(\mathcal{D}_{train}, \mathcal{D}_{dev})$, we first sample a support batch $\mathcal{B}_{support}$ from $\mathcal{D}_{train}$ and a query batch $\mathcal{B}_{query}$ from $\mathcal{D}_{dev}$. We use f_θ to denote the text-to-text model with parameters θ. Using $\mathcal{B}_{support}$, we first compute the updated parameters θ' with gradient descent (*i.e.*, the inner loop). Due to the size of pre-trained text-to-text models, we use one gradient update in the inner loop.

$$\theta' = \theta - \alpha \nabla_\theta \mathcal{L}(f_\theta, \mathcal{B}_{support}). \quad (1)$$

Then we apply the updated text-to-text model $f_{\theta'}$ to $\mathcal{B}_{query}$, and do one step of meta-optimization (*i.e.*, the outer loop),

$$\theta \leftarrow \theta - \beta \nabla_\theta \mathcal{L}(f_{\theta'}, \mathcal{B}_{query}). \quad (2)$$

After the meta-learning stage, we use "direct fine-tuning" for each task in $\mathcal{T}_{test}$, similar to the practice in multi-task learning.

6 Empirical Analysis

We list the ARG results in Table 1 and we plot the performance of each test task in each partition in Fig. 4 and Fig. 6. We aim to interpret the results and answer the research questions we raised.

Q1. Do upstream learning methods help address the CROSSFIT challenge? From Table 1, we observe that, on average, both upstream learning methods (i.e., *multi-task learning* and *meta-learning*) are helpful — both ARG scores are positive, meaning that they are better than *direct fine-tuning* (ARG=0%). In addition, we have the following observations:

(1) There are a few cases with negative performance gain, such as `Glue-COLA` (measuring linguistic acceptability) and `Domain Crawl` (separating domain names into tokens) in the setting with *Random* train/test split. For `Glue-COLA`, similar observations are reported by (Pruksachatkun et al., 2020) in an intermediate-task transfer learning setting, where the authors conjecture *catastrophic forgetting* of the masked language modeling (MLM) tasks may be the cause. The BART model that we use in our study uses denoising pre-training

[6]Both $\mathcal{D}_{train}$ and $\mathcal{D}_{dev}$ are used, as $\mathcal{D}_{dev}$ is used for gradient updates in meta-learning algorithm. We do so to make sure that the data access for the two methods is fair.

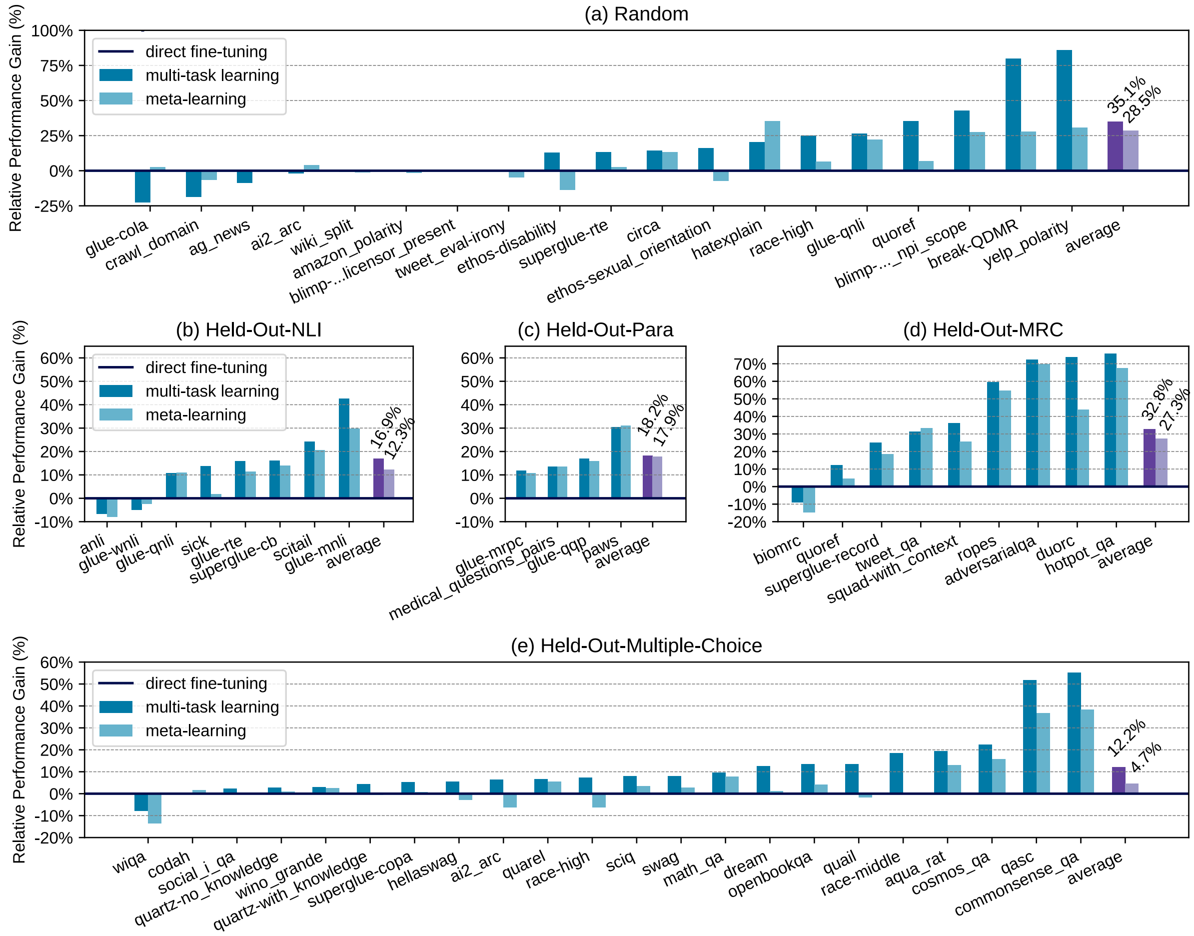

Figure 4: Experimental results for the CrossFit challenge with different task partitions. The details of each partition is shown in Table 1. Relative performance gain is computed based on the results of *direct fine-tuning*.

objective, a variant of MLM. Intuitively, `Domain Crawl` is also one of the most similar tasks to denoising in all test tasks, which further supports this conjecture. We thus conclude that for test tasks that resemble pre-training objectives (e.g., MLM), upstream learning could hurt performance due to the *catastrophic forgetting* phenomena.

(2) The performance gain obtained with the two upstream learning methods are correlated with each other — i.e., tasks that benefit from multi-task learning is likely to also benefit from meta-learning. For the *Random partition*, the *Spearman Correlation* between the improvement brought by multi-task learning and meta-learning is 0.66, with p value equals to 0.0015. This suggests that the two methods, while being significantly different, are capturing similar inductive bias from $\mathcal{T}_{train}$.

(3) Surprisingly, the multi-task learning method generally outperforms the MAML method, even though MAML is designed for fast adaptation to unseen tasks, a similar objective to our CrossFit Challenge. We conjecture there are two possible reasons: a) we suspect MAML is not used to its full extend (e.g., we use only one inner loop update), due to computation constraints; b) alternatively, MAML may struggle to learn from $\mathcal{T}_{train}$ that contains highly-diverse tasks (Yu et al., 2020). We leave further analysis as future work, and we believe it is promising to improve the performance by applying memory-efficient approaches or customized upstream learning algorithms.

Q2. How does the distribution in $\mathcal{T}_{train}$ influence the performance on unseen tasks? To study this, we first look at the tasks that appear in the $\mathcal{T}_{test}$ of more than one partitions. For example, `AI2_ARC` and `Race-High` are in the $\mathcal{T}_{test}$ of both *Random* partition and *Held-out-MCQA* partition. We present the results in Table 2. The performance of these tasks vary when different $\mathcal{T}_{train}$ sets are used. Notably, we observe significant performance drop with *Held-out-MCQA* par-

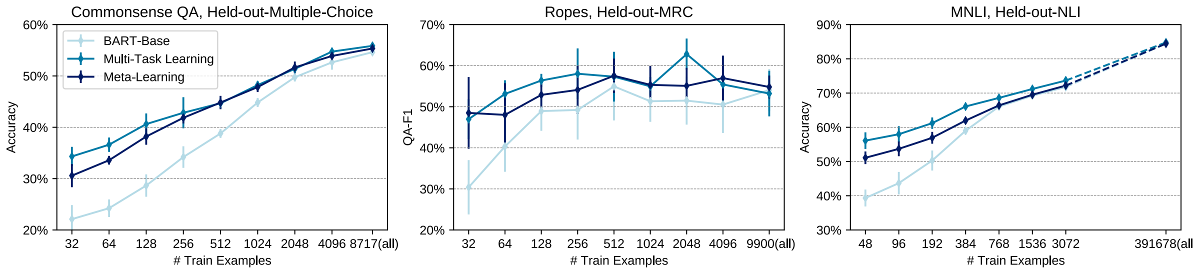

Figure 5: Performance comparisons in medium and high-resource scenarios. Benefits brought by upstream learning lasts in medium-resource scenarios.

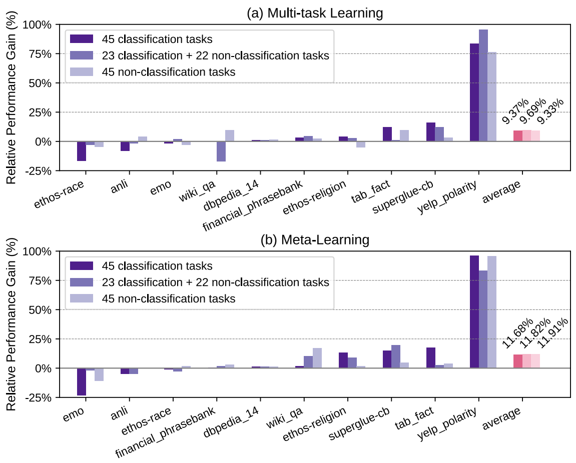

Figure 6: Performance comparison for the controlled experiment on Partition 2.1-2.3. $\mathcal{T}_{test}$ is a fixed set of 10 classification tasks, while $\mathcal{T}_{train}$ varies.

tition and meta-learning. We suspect this is due to the smaller size of $\mathcal{T}_{train}$ in *Held-out-MCQA* partition, as 22 QA tasks may not be sufficient for the meta-learning method to capture task-level generalization ability, especially when the train and test tasks have different formats (non-MCQA vs. MCQA). Apart from that, we have not found consistent patterns of what type of $\mathcal{T}_{train}$ lead to better performance for a specific test task.

We also conduct a set of controlled experiments with *Partition 2.1-2.3*, where $\mathcal{T}_{test}$ is a fixed set of classification tasks, and $\mathcal{T}_{train}$ varies. The performance analysis is plotted in Fig. 6. Ideally, we would expect upstream learning with all classification tasks (*Partition 2.1*) to achieve the best performance, while upstream learning with all non-classification tasks (*Partition 2.3*) to be the worst. However, the three partitions achieved comparable improvement in terms of the ARG score. Meanwhile, we observe several counter-intuitive cases: `ANLI` benefits most from *Partition 2.3* (all non-classification tasks) and least from *Partition 2.1* with multi-task learning, and similarly for WikiQA

Test Task	Partition	Δ_{multi}	Δ_{meta}
Glue-QNLI	Random	15.89%	11.55%
	Held-Out-NLI	10.88%	10.94%
AI2_ARC	Random	1.30%	4.22%
	Held-Out-MCQA	6.49%	−6.22%
Race-High	Random	26.71%	6.59%
	Held-Out-MCQA	7.27%	−6.28%
QuoRef	Random	25.47%	3.99%
	Held-Out-MRC	12.25%	4.64%

Table 2: Performance comparison of test task performance when different $\mathcal{T}_{train}$ sets are used in upstream learning. See text in Q2 for in-depth analysis.

with meta-learning.[7]

Firstly, it is encouraging that non-classification tasks and classification tasks are equivalently helpful in the controlled experiment, demonstrating that acquiring cross-task generalization is feasible and promising. Yet, the two counter-intuitive cases suggest that we still lack clear understanding of these upstream learning methods, and our conventional perception about task affinity may not align with how models learn during upstream learning: selecting $\mathcal{T}_{train}$ tasks that have similar task format as the test task may not be an optimal solution. We believe that selecting appropriate $\mathcal{T}_{train}$ to learn for a target set of tasks is an interesting open problem. In addition, a more thorough investigation for the inner mechanism of upstream learning should be obtained by extending our study.

Improvements

Q3. Does improved few-shot learning ability last when more data is available? We observe significant improvement for CommonsenseQA in *Held-out-Multiple-Choice* setting (Δ_{multi}=55.19% / Δ_{meta}=38.30%), ROPES in *Held-out-MRC* setting (Δ_{multi}=59.59% / Δ_{meta}=54.58%), and MNLI in *Held-out-NLI* setting (Δ_{multi}=42.61%

[7]We formulate WikiQA as a classification task to determine whether an answer is correct.

/ Δ_{meta}=29.87%). We further take these initialization and conduct experiments in medium and high-resource scenarios. That is, we randomly sample $\{32, 64, \ldots, 4096\}$ examples from these three datasets, and use them as $\mathcal{D}_{train}$. We then sample a $\mathcal{D}_{dev}$ which has the same size as $\mathcal{D}_{train}$, or has the size of 1024 if $|\mathcal{D}_{train}| > 1024$. We also try using the full dataset.[8] The performance of these settings is shown in Fig. 5. From the results we see that the benefits brought by upstream learning methods extend into medium resource cases with up to 2048 training examples. For CommonsenseQA, checkpoints from upstream learning outperform direct fine-tuning significantly, even when the full dataset is used (Multi: $p = 0.01$ / Meta: $p = 0.07$). This generalization ability is particularly useful when users continue to collect more data to improve downstream performance.

7 Conclusion and Future Work

In this paper, we study the problem of building better few-shot learners via acquiring cross-task generalization ability from diverse NLP tasks. Towards our goal, we introduce the CrossFit Challenge, an task setup that standardizes the training pipeline, data access and evaluation protocol. We also present NLP Few-shot Gym, a repository of 160 diverse few-shot NLP tasks, to support CrossFit learning in different scenarios. We empirically demonstrated that cross-task generalization can be acquired via multi-task learning and meta-learning; confirmed that the selection of seen tasks would influence the few-shot performance on unseen tasks; and observed that the performance gain in few-shot scenarios last in medium-resource scenarios.

Our work focuses on cross-task generalization, which is non-conflicting to few-shot fine-tuning methods that focus on instance-level generalization; combining these two and check whether they're complementary to each other would be an interesting future direction. We also hope the CrossFit Challenge and NLP Few-shot Gym can serve as the testbed for many interesting "meta-problems", such as (1) learning to generate prompt for diverse task formats and further improve learning efficiency; (2) learning to select appropriate source tasks to learn from during upstream learning; (3) learning to accumulate knowledge and avoid catastrophic forgetting in an continual learning setup.

[8]We do five random samples of 1024 examples as $\mathcal{D}_{dev}$ and use the remaining examples in the original train set as $\mathcal{D}_{train}$. We use the original dev set for testing.

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A Selected Tasks in NLP Few-shot Gym

Table 3: Tasks in NLP Few-shot Gym.

Task Name	Ontology	Reference
acronym_identification	other	Pouran Ben Veyseh et al. 2020
ade_corpus_v2-classification	cls/other	Gurulingappa et al. 2012
ade_corpus_v2-dosage	other/slot filling	Gurulingappa et al. 2012
ade_corpus_v2-effect	other/slot filling	Gurulingappa et al. 2012
adversarialqa	qa/machine reading comprehension	Bartolo et al. 2020
aeslc	cg/summarization	Zhang and Tetreault 2019
ag_news	cls/topic	Gulli (link)
ai2_arc	qa/multiple-choice qa	Clark et al. 2018
amazon_polarity	cls/sentiment analysis	McAuley and Leskovec 2013
anli	cls/nli	Nie et al. 2020
app_reviews	other/regression	Missing
aqua_rat	qa/multiple-choice qa	Ling et al. 2017
art (abductive nli)	other	Bhagavatula et al. 2020
aslg_pc12	other	Othman and Jemni 2012
biomrc	qa/machine reading comprehension	Pappas et al. 2020
blimp-anaphor_gender_agreement	other/linguistic phenomenon	Warstadt et al. 2020
blimp-anaphor_number_agreement	other/linguistic phenomenon	Warstadt et al. 2020
blimp-determiner_noun_agreement_with_adj_irregular_1	other/linguistic phenomenon	Warstadt et al. 2020
blimp-ellipsis_n_bar_1	other/linguistic phenomenon	Warstadt et al. 2020
blimp-ellipsis_n_bar_2	other/linguistic phenomenon	Warstadt et al. 2020
blimp-existential_there_quantifiers_1	other/linguistic phenomenon	Warstadt et al. 2020
blimp-irregular_past_participle_adjectives	other/linguistic phenomenon	Warstadt et al. 2020
blimp-sentential_negation_npi_licensor_present	other/linguistic phenomenon	Warstadt et al. 2020
blimp-sentential_negation_npi_scope	other/linguistic phenomenon	Warstadt et al. 2020
blimp-wh_questions_object_gap	other/linguistic phenomenon	Warstadt et al. 2020
boolq	qa/binary	Clark et al. 2019
break-QDMR	other	Wolfson et al. 2020
break-QDMR-high-level	other	Wolfson et al. 2020
circa	cls/other	Louis et al. 2020
climate_fever	cls/fact checking	Diggelmann et al. 2020
codah	qa/multiple-choice qa	Chen et al. 2019
common_gen	other	Lin et al. 2020b
commonsense_qa	qa/multiple-choice qa	Talmor et al. 2019
cos_e	other/generate explanation	Rajani et al. 2019
cosmos_qa	qa/multiple-choice qa	Huang et al. 2019
crawl_domain	other	Zhang et al. 2020
crows_pairs	other	Nangia et al. 2020
dbpedia_14	cls/topic	Lehmann et al. 2015
definite_pronoun_resolution	other	Rahman and Ng 2012
discovery	cls/other	Sileo et al. 2019
dream	qa/multiple-choice qa	Sun et al. 2019
duorc	qa/machine reading comprehension	Saha et al. 2018
e2e_nlg_cleaned	other	Dušek et al. 2020, 2019
eli5-askh	qa/long-form qa	Fan et al. 2019
eli5-asks	qa/long-form qa	Fan et al. 2019
eli5-eli5	qa/long-form qa	Fan et al. 2019
emo	cls/emotion	Chatterjee et al. 2019
emotion	cls/emotion	Saravia et al. 2018
empathetic_dialogues	cg/dialogue	Rashkin et al. 2019
ethos-directed_vs_generalized	cls/hate speech detection	Mollas et al. 2020
ethos-disability	cls/hate speech detection	Mollas et al. 2020
ethos-gender	cls/hate speech detection	Mollas et al. 2020
ethos-national_origin	cls/hate speech detection	Mollas et al. 2020
ethos-race	cls/hate speech detection	Mollas et al. 2020
ethos-religion	cls/hate speech detection	Mollas et al. 2020
ethos-sexual_orientation	cls/hate speech detection	Mollas et al. 2020
financial_phrasebank	cls/sentiment analysis	Malo et al. 2014
freebase_qa	qa/closed-book qa	Jiang et al. 2019
gigaword	cg/summarization	Napoles et al. 2012
glue-cola	cls/other	Warstadt et al. 2019
glue-mnli	cls/nli	Williams et al. 2018
glue-mrpc	cls/paraphrase	Dolan and Brockett 2005
glue-qnli	cls/nli	Rajpurkar et al. 2016
glue-qqp	cls/paraphrase	(link)
glue-rte	cls/nli	Dagan et al. 2005; Bar-Haim et al. 2006 Giampiccolo et al. 2007; Bentivogli et al. 2009
glue-sst2	cls/sentiment analysis	Socher et al. 2013
glue-wnli	cls/nli	Levesque et al. 2012
google_wellformed_query	cls/other	Faruqui and Das 2018
hate_speech18	cls/hate speech detection	de Gibert et al. 2018
hate_speech_offensive	cls/hate speech detection	Davidson et al. 2017
hatexplain	cls/hate speech detection	Mathew et al. 2020
health_fact	cls/fact checking	Kotonya and Toni 2020
hellaswag	qa/multiple-choice qa	Zellers et al. 2019
hotpot_qa	qa/machine reading comprehension	Yang et al. 2018
imdb	cls/sentiment analysis	Maas et al. 2011
jeopardy	qa/closed-book qa	(link)
kilt_ay2	other/entity linking	Hoffart et al. 2011
kilt_fever	cls/fact checking	Thorne et al. 2018

Continued on next page

Task Name	Ontology	Reference
kilt_hotpotqa	qa/closed-book qa	Yang et al. 2018
kilt_nq	qa/closed-book qa	Kwiatkowski et al. 2019
kilt_trex	qa/closed-book qa	Elsahar et al. 2018
kilt_wow	cg/dialogue	Dinan et al. 2019
kilt_zsre	qa/closed-book qa	Levy et al. 2017
lama-conceptnet	qa/closed-book qa	Petroni et al. 2019, 2020
lama-google_re	qa/closed-book qa	Petroni et al. 2019, 2020
lama-squad	qa/closed-book qa	Petroni et al. 2019, 2020
lama-trex	qa/closed-book qa	Petroni et al. 2019, 2020
liar	cls/fact checking	Wang 2017
limit	other	Manotas et al. 2020
math_qa	qa/multiple-choice qa	Amini et al. 2019
mc_taco	qa/binary	Zhou et al. 2019
medical_questions_pairs	cls/paraphrase	McCreery et al. 2020
mocha	other/regression	Chen et al. 2020a
multi_news	cg/summarization	Fabbri et al. 2019
numer_sense	qa/closed-book qa	Lin et al. 2020a
onestop_english	cls/other	Vajjala and Lučić 2018
openbookqa	qa/multiple-choice qa	Mihaylov et al. 2018
paws	cls/paraphrase	Zhang et al. 2019
piqa	other	Bisk et al. 2020
poem_sentiment	cls/sentiment analysis	Sheng and Uthus 2020
proto_qa	other	Boratko et al. 2020
qa_srl	other	He et al. 2015
qasc	qa/multiple-choice qa	Khot et al. 2020
quail	qa/multiple-choice qa	Rogers et al. 2020
quarel	qa/multiple-choice qa	Tafjord et al. 2019a
quartz-no_knowledge	qa/multiple-choice qa	Tafjord et al. 2019b
quartz-with_knowledge	qa/multiple-choice qa	Tafjord et al. 2019b
quoref	qa/machine reading comprehension	Dasigi et al. 2019
race-high	qa/multiple-choice qa	Lai et al. 2017
race-middle	qa/multiple-choice qa	Lai et al. 2017
reddit_tifu-title	cg/summarization	Kim et al. 2019
reddit_tifu-tldr	cg/summarization	Kim et al. 2019
ropes	qa/machine reading comprehension	Lin et al. 2019
rotten_tomatoes	cls/sentiment analysis	Pang and Lee 2005
samsum	cg/summarization	Gliwa et al. 2019
scicite	cls/other	Cohan et al. 2019
sciq	qa/multiple-choice qa	Welbl et al. 2017
scitail	cls/nli	Khot et al. 2018
search_qa	qa/closed-book qa	Dunn et al. 2017
sick	cls/nli	Marelli et al. 2014
sms_spam	cls/other	Almeida et al. 2011
social_i_qa	qa/multiple-choice qa	Sap et al. 2019
spider	cg/other	Yu et al. 2018
squad-no_context	qa/closed-book qa	Rajpurkar et al. 2016
squad-with_context	qa/machine reading comprehension	Rajpurkar et al. 2016
superglue-cb	cls/nli	de Marneffe et al. 2019
superglue-copa	qa/multiple-choice qa	Gordon et al. 2012
superglue-multirc	qa/multiple-choice qa	Khashabi et al. 2018
superglue-record	qa/machine reading comprehension	Zhang et al. 2018
superglue-rte	cls/nli	Dagan et al. 2005; Bar-Haim et al. 2006 Giampiccolo et al. 2007; Bentivogli et al. 2009
superglue-wic	cls/other	Pilehvar and Camacho-Collados 2019
superglue-wsc	cls/other	Levesque et al. 2012
swag	qa/multiple-choice qa	Zellers et al. 2018
tab_fact	cls/fact checking	Chen et al. 2020b
trec	cls/other	Li and Roth 2002; Hovy et al. 2001
trec-finegrained	cls/other	Li and Roth 2002; Hovy et al. 2001
tweet_eval-emoji	cls/emotion	Barbieri et al. 2020
tweet_eval-emotion	cls/emotion	Barbieri et al. 2020
tweet_eval-hate	cls/emotion	Barbieri et al. 2020
tweet_eval-irony	cls/emotion	Barbieri et al. 2020
tweet_eval-offensive	cls/emotion	Barbieri et al. 2020
tweet_eval-sentiment	cls/emotion	Barbieri et al. 2020
tweet_eval-stance_abortion	cls/emotion	Barbieri et al. 2020
tweet_eval-stance_atheism	cls/emotion	Barbieri et al. 2020
tweet_eval-stance_climate	cls/emotion	Barbieri et al. 2020
tweet_eval-stance_feminist	cls/emotion	Barbieri et al. 2020
tweet_eval-stance_hillary	cls/emotion	Barbieri et al. 2020
tweet_qa	qa/machine reading comprehension	Xiong et al. 2019
web_questions	qa/closed-book qa	Berant et al. 2013
wiki_auto	cls/other	Jiang et al. 2020
wiki_bio	cg/other	Lebret et al. 2016
wiki_qa	cls/other	Yang et al. 2015
wiki_split	cg/other	Botha et al. 2018
wikisql	cg/other	Zhong et al. 2017
wino_grande	qa/multiple-choice qa	Sakaguchi et al. 2020
wiqa	qa/multiple-choice qa	Tandon et al. 2019
xsum	cg/summarization	Narayan et al. 2018
yahoo_answers_topics	cls/topic	(link)
yelp_polarity	cls/sentiment analysis	Zhang et al. 2015; (link)
yelp_review_full	other/regression	Zhang et al. 2015; (link)

B Details about Task Partition

B.1 Partition 1. Random

```
{
    "train": ['glue-mrpc', 'math_qa', 'quarel', 'e2e_nlg_cleaned', 'tweet_eval-stance_atheism', 'lama-squad'
        , 'tab_fact', 'aqua_rat', 'tweet_eval-emoji', 'glue-wnli', 'codah', 'tweet_eval-offensive', '
        wiki_qa', 'blimp-ellipsis_n_bar_1', 'openbookqa', 'sms_spam', 'acronym_identification', 'blimp-
        determiner_noun_agreement_with_adj_irregular_1', 'ethos-national_origin', 'spider', '
        definite_pronoun_resolution', 'hellaswag', 'superglue-wsc', 'numer_sense', 'ade_corpus_v2-dosage',
        'blimp-ellipsis_n_bar_2', 'kilt_ay2', 'squad-no_context', 'google_wellformed_query', 'xsum', 'wiqa'
        , 'tweet_eval-stance_abortion', 'reddit_tifu-tldr', 'ade_corpus_v2-effect', 'qa_srl', 'ethos-
        religion', 'commonsense_qa', 'jeopardy', 'biomrc', 'superglue-multirc', 'ethos-race', 'eli5-askh',
        'glue-qqp', 'paws', 'ethos-directed_vs_generalized', 'glue-sst2', 'mocha', 'tweet_eval-hate', 'glue
        -rte', 'blimp-anaphor_number_agreement', 'lama-conceptnet', 'hate_speech_offensive', 'superglue-wic
        ', 'boolq', 'kilt_hotpotqa', 'quartz-no_knowledge', 'aslg_pc12', 'sick', 'tweet_eval-stance_climate
        ', 'tweet_eval-sentiment', 'crows_pairs', 'glue-mnli', 'medical_questions_pairs', 'break-QDMR-high-
        level', 'qasc', 'imdb', 'ethos-gender', 'trec-finegrained', 'adversarialqa', 'onestop_english', '
        web_questions', 'duorc', 'yelp_review_full', 'swag', 'proto_qa', 'scitail', 'tweet_eval-
        stance_feminist', 'limit', 'common_gen', 'scicite', 'blimp-irregular_past_participle_adjectives', '
        social_i_qa', 'anli', 'kilt_zsre', 'cosmos_qa', 'superglue-record', 'squad-with_context', 'emotion'
        , 'blimp-existential_there_quantifiers_1', 'race-middle', 'kilt_wow', 'sciq', 'wino_grande', '
        rotten_tomatoes', 'superglue-cb', 'poem_sentiment', 'ropes', 'reddit_tifu-title', 'piqa', '
        climate_fever', 'lama-google_re', 'search_qa', 'wiki_auto', 'mc_taco', 'blimp-
        wh_questions_object_gap', 'hotpot_qa', 'emo', 'kilt_nq', 'kilt_trex', 'quartz-with_knowledge', '
        dbpedia_14', 'yahoo_answers_topics', 'app_reviews', 'superglue-copa', 'blimp-
        anaphor_gender_agreement', 'hate_speech18', 'gigaword', 'multi_news', 'aeslc', 'quail'],
    "dev": ['cos_e', 'kilt_fever', 'eli5-asks', 'trec', 'eli5-eli5', 'art', 'empathetic_dialogues', '
        tweet_qa', 'wikisql', 'lama-trex', 'tweet_eval-stance_hillary', 'discovery', 'tweet_eval-emotion',
        'liar', 'wiki_bio', 'dream', 'ade_corpus_v2-classification', 'health_fact', 'samsum', '
        financial_phrasebank'],
    "test": ['quoref', 'wiki_split', 'ethos-disability', 'yelp_polarity', 'superglue-rte', 'glue-cola', '
        ethos-sexual_orientation', 'blimp-sentential_negation_npi_scope', 'ai2_arc', 'amazon_polarity', '
        race-high', 'blimp-sentential_negation_npi_licensor_present', 'tweet_eval-irony', 'break-QDMR', '
        crawl_domain', 'freebase_qa', 'glue-qnli', 'hatexplain', 'ag_news', 'circa'],
}
```

B.2 Partition 2.1. 45cls

```
{
    "train": ["superglue-rte", "tweet_eval-sentiment", "discovery", "glue-rte", "superglue-wsc", "scicite",
        "glue-mrpc", "tweet_eval-stance_hillary", "tweet_eval-offensive", "emotion", "hatexplain", "glue-
        cola", "sick", "paws", "ethos-sexual_orientation", "glue-qqp", "tweet_eval-emotion", "sms_spam", "
        health_fact", "glue-mnli", "imdb", "ethos-disability", "glue-wnli", "scitail", "trec-finegrained",
        "yahoo_answers_topics", "liar", "glue-sst2", "tweet_eval-stance_abortion", "circa", "tweet_eval-
        stance_climate", "glue-qnli", "tweet_eval-emoji", "ethos-directed_vs_generalized", "ade_corpus_v2-
        classification", "wiki_auto", "hate_speech_offensive", "superglue-wic", "google_wellformed_query",
        "tweet_eval-irony", "ethos-gender", "onestop_english", "trec", "rotten_tomatoes", "kilt_fever"],
    "dev": ["tweet_eval-stance_feminist", "ethos-national_origin", "tweet_eval-hate", "ag_news", "
        amazon_polarity", "hate_speech18", "poem_sentiment", "climate_fever", "medical_questions_pairs", "
        tweet_eval-stance_atheism"],
    "test": ["superglue-cb", "dbpedia_14", "wiki_qa", "emo", "yelp_polarity", "ethos-religion", "
        financial_phrasebank", "tab_fact", "anli", "ethos-race"],
}
```

B.3 Partition 2.2. 23cls+22non-cls

```
{
    "train": ["ade_corpus_v2-dosage", "biomrc", "blimp-ellipsis_n_bar_2", "blimp-
        sentential_negation_npi_scope", "commonsense_qa", "crows_pairs", "duorc", "hellaswag", "kilt_zsre",
        "lama-google_re", "lama-squad", "math_qa", "numer_sense", "openbookqa", "piqa", "proto_qa", "
        quartz-no_knowledge", "race-high", "reddit_tifu-tldr", "ropes", "sciq", "wiki_bio", "discovery", "
        emotion", "ethos-disability", "ethos-sexual_orientation", "glue-cola", "glue-mnli", "glue-mrpc", "
        glue-qqp", "glue-rte", "glue-wnli", "hatexplain", "health_fact", "imdb", "paws", "scicite", "sick",
        "sms_spam", "superglue-rte", "superglue-wsc", "tweet_eval-emotion", "tweet_eval-offensive", "
        tweet_eval-sentiment", "tweet_eval-stance_hillary"],
    "dev": ["tweet_eval-stance_feminist", "ethos-national_origin", "tweet_eval-hate", "ag_news", "
        amazon_polarity", "hate_speech18", "poem_sentiment", "climate_fever", "medical_questions_pairs", "
        tweet_eval-stance_atheism"],
    "test": ["superglue-cb", "dbpedia_14", "wiki_qa", "emo", "yelp_polarity", "ethos-religion", "
        financial_phrasebank", "tab_fact", "anli", "ethos-race"]
}
```

B.4 Partition 2.3. 45non-cls

```
{
```

```
    "train": ["ade_corpus_v2-dosage", "art", "biomrc", "blimp-anaphor_number_agreement", "blimp-ellipsis_n_bar_2", "blimp-sentential_negation_npi_licensor_present", "blimp-sentential_negation_npi_scope", "break-QDMR-high-level", "commonsense_qa", "crows_pairs", "dream", "duorc", "eli5-asks", "eli5-eli5", "freebase_qa", "gigaword", "hellaswag", "hotpot_qa", "kilt_ay2", "kilt_hotpotqa", "kilt_trex", "kilt_zsre", "lama-conceptnet", "lama-google_re", "lama-squad", "math_qa", "numer_sense", "openbookqa", "piqa", "proto_qa", "qa_srl", "quarel", "quartz-no_knowledge", "race-high", "reddit_tifu-title", "reddit_tifu-tldr", "ropes", "sciq", "social_i_qa", "spider", "superglue-multirc", "wiki_bio", "wikisql", "xsum", "yelp_review_full"],
    "dev": ["tweet_eval-stance_feminist", "ethos-national_origin", "tweet_eval-hate", "ag_news", "amazon_polarity", "hate_speech18", "poem_sentiment", "climate_fever", "medical_questions_pairs", "tweet_eval-stance_atheism"],
    "test": ["superglue-cb", "dbpedia_14", "wiki_qa", "emo", "yelp_polarity", "ethos-religion", "financial_phrasebank", "tab_fact", "anli", "ethos-race"]
}
```

B.5 Partition 3.1. Held-out-NLI

```
{
    "train": [
        "ade_corpus_v2-classification",
        "ag_news",
        "amazon_polarity",
        "circa",
        "climate_fever",
        "dbpedia_14",
        "discovery",
        "emo",
        "emotion",
        "ethos-directed_vs_generalized",
        "ethos-disability",
        "ethos-gender",
        "ethos-national_origin",
        "ethos-race",
        "ethos-religion",
        "ethos-sexual_orientation",
        "financial_phrasebank",
        "glue-cola",
        "glue-mrpc",
        "glue-qqp",
        "glue-sst2",
        "google_wellformed_query",
        "hate_speech18",
        "hate_speech_offensive",
        "hatexplain",
        "health_fact",
        "imdb",
        "kilt_fever",
        "liar",
        "medical_questions_pairs",
        "onestop_english",
        "paws",
        "poem_sentiment",
        "rotten_tomatoes",
        "scicite",
        "sick",
        "sms_spam",
        "superglue-wic",
        "superglue-wsc",
        "tab_fact",
        "trec",
        "trec-finegrained",
        "tweet_eval-emoji",
        "tweet_eval-emotion",
        "tweet_eval-hate",
        "tweet_eval-irony",
        "tweet_eval-offensive",
        "tweet_eval-sentiment",
        "tweet_eval-stance_abortion",
        "tweet_eval-stance_atheism",
        "tweet_eval-stance_climate",
        "tweet_eval-stance_feminist",
        "tweet_eval-stance_hillary",
        "wiki_auto",
        "wiki_qa",
        "yahoo_answers_topics",
        "yelp_polarity"
    ],
    "dev": [],
    "test": ["anli", "glue-mnli", "glue-qnli", "glue-rte", "glue-wnli", "scitail", "sick", "superglue-cb"]
}
```

B.6 Partition 3.2. Held-out-Para

```
{
    "train": ["ade_corpus_v2-classification",
        "ag_news",
        "amazon_polarity",
        "anli",
        "circa",
        "climate_fever",
        "dbpedia_14",
        "discovery",
        "emo",
        "emotion",
        "ethos-directed_vs_generalized",
        "ethos-disability",
        "ethos-gender",
        "ethos-national_origin",
        "ethos-race",
        "ethos-religion",
        "ethos-sexual_orientation",
        "financial_phrasebank",
        "glue-cola",
        "glue-mnli",
        "glue-qnli",
        "glue-rte",
        "glue-sst2",
        "glue-wnli",
        "google_wellformed_query",
        "hate_speech18",
        "hate_speech_offensive",
        "hatexplain",
        "health_fact",
        "imdb",
        "kilt_fever",
        "liar",
        "onestop_english",
        "poem_sentiment",
        "rotten_tomatoes",
        "scicite",
        "scitail",
        "sick",
        "sms_spam",
        "superglue-cb",
        "superglue-rte",
        "superglue-wic",
        "superglue-wsc",
        "tab_fact",
        "trec",
        "trec-finegrained",
        "tweet_eval-emoji",
        "tweet_eval-emotion",
        "tweet_eval-hate",
        "tweet_eval-irony",
        "tweet_eval-offensive",
        "tweet_eval-sentiment",
        "tweet_eval-stance_abortion",
        "tweet_eval-stance_atheism",
        "tweet_eval-stance_climate",
        "tweet_eval-stance_feminist",
        "tweet_eval-stance_hillary",
        "wiki_auto",
        "wiki_qa",
        "yahoo_answers_topics",
        "yelp_polarity"],
    "dev": [],
    "test": [
        "glue-mrpc",
        "glue-qqp",
        "medical_questions_pairs",
        "paws"
    ]
}
```

B.7 Partition 4.1. Held-out-MRC

```
{
    "train": [
        "ai2_arc",
        "aqua_rat",
        "boolq",
        "codah",
        "commonsense_qa",
        "cosmos_qa",
        "dream",
        "eli5-askh",
        "eli5-asks",
```

```
        "eli5-eli5",
        "freebase_qa",
        "hellaswag",
        "jeopardy",
        "kilt_hotpotqa",
        "kilt_nq",
        "kilt_trex",
        "kilt_zsre",
        "lama-conceptnet",
        "lama-google_re",
        "lama-squad",
        "lama-trex",
        "math_qa",
        "mc_taco",
        "numer_sense",
        "openbookqa",
        "qasc",
        "quail",
        "quarel",
        "quartz-no_knowledge",
        "quartz-with_knowledge",
        "race-high",
        "race-middle",
        "sciq",
        "search_qa",
        "social_i_qa",
        "squad-no_context",
        "superglue-copa",
        "superglue-multirc",
        "swag",
        "web_questions",
        "wino_grande",
        "wiqa"
    ],
    "dev": [],
    "test": [
        "adversarialqa",
        "biomrc",
        "duorc",
        "hotpot_qa",
        "quoref",
        "ropes",
        "squad-with_context",
        "superglue-record",
        "tweet_qa"
    ],
}
```

B.8 Partition 4.2. Held-out-MCQA

```
{
    "train": [
        "adversarialqa",
        "biomrc",
        "boolq",
        "duorc",
        "eli5-askh",
        "eli5-asks",
        "eli5-eli5",
        "freebase_qa",
        "hotpot_qa",
        "jeopardy",
        "kilt_hotpotqa",
        "kilt_nq",
        "kilt_trex",
        "kilt_zsre",
        "lama-conceptnet",
        "lama-google_re",
        "lama-squad",
        "lama-trex",
        "mc_taco",
        "numer_sense",
        "quoref",
        "ropes",
        "search_qa",
        "squad-no_context",
        "squad-with_context",
        "superglue-multirc",
        "superglue-record",
        "tweet_qa",
        "web_questions"
    ],
    "dev": [],
    "test": [
        "ai2_arc",
```

```
        "aqua_rat",
        "codah",
        "commonsense_qa",
        "cosmos_qa",
        "dream",
        "hellaswag",
        "math_qa",
        "openbookqa",
        "qasc",
        "quail",
        "quarel",
        "quartz-no_knowledge",
        "quartz-with_knowledge",
        "race-high",
        "race-middle",
        "sciq",
        "social_i_qa",
        "superglue-copa",
        "swag",
        "wino_grande",
        "wiqa"
    ]
}
```