GPTScore: Evaluate as You Desire

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Abstract

Generative Artificial Intelligence (AI) has enabled the development of sophisticated models that are capable of producing high-caliber text, images, and other outputs through the utilization of large pre-trained models. Nevertheless, assessing the quality of the generation is an even more arduous task than the generation itself, and this issue has not been given adequate consideration recently. This paper proposes a novel evaluation framework, GPTSCORE, which utilizes the emergent abilities (e.g., zero-shot instruction) of **g**enerative **p**re-**t**rained models to **score** generated texts. There are 19 pre-trained models explored in this paper, ranging in size from 80M (e.g., FLAN-T5-small) to 175B (e.g., GPT3). Experimental results on four text generation tasks, 22 evaluation aspects, and corresponding 37 datasets demonstrate that this approach can effectively allow us to achieve what one desires to evaluate for texts simply by natural language instructions. This nature helps us overcome several long-standing challenges in text evaluation–how to achieve customized, multi-faceted evaluation without the need for annotated samples. We make our code publicly available. [1]

1. Introduction

The advent of generative pre-trained models, such as GPT3 (Brown et al., 2020), has precipitated a shift from *analytical* AI to *generative* AI across multiple domains (Sequoia, 2022). Take text as an example: the use of a large pre-trained model with appropriate prompts (Liu et al., 2021) has achieved superior performance in tasks defined both in academia (Sanh et al., 2021) and scenarios from the real world (Ouyang et al., 2022). While text generation technology is advancing rapidly, techniques for evaluating the quality of these texts lag far behind. This is especially evident in the following ways:

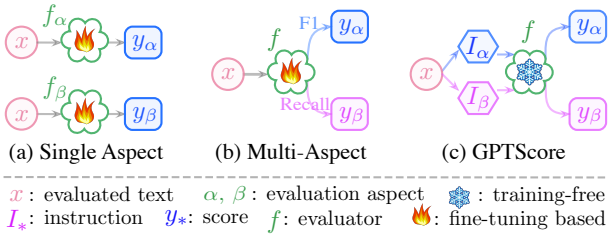

Figure 1. An overview of text evaluation approaches.

(a) Existing studies evaluate text quality with limited aspects (e.g., semantic equivalence, fluency) (Fig. 1-(a)), which are usually customized prohibitively, making it harder for users to evaluate aspects *as they need* (Freitag et al., 2021). (b) A handful of studies have examined multi-aspect evaluation (Yuan et al., 2021; Scialom et al., 2021; Zhong et al., 2022) but have not given adequate attention to the definition of the evaluation aspect and the latent relationship among them. Instead, the evaluation of an aspect is either empirically bound with metric variants (Yuan et al., 2021) or learned by supervised signals (Zhong et al., 2022). (c) Recently proposed evaluation methods (Mehri & Eskénazi, 2020; Rei et al., 2020; Li et al., 2021; Zhong et al., 2022) usually necessitate a complicated training procedure or costly manual annotation of samples (Fig. 1-(a,b)), which makes it hard to use these methods in industrial settings due to the amount of time needed for annotation and training to accommodate a new evaluation demand from the user.

In this paper, we demonstrated the talent of the super large pre-trained language model (e.g., GPT-3) in achieving multi-aspect, customized, and training-free evaluation (Fig. 1-(c)). In essence, it skillfully uses the pre-trained model's zero-shot instruction (Chung et al., 2022), and in-context learning (Brown et al., 2020; Min et al., 2022) ability to deal with complex and ever-changing evaluation needs so as to solve multiple evaluation challenges that have been plagued for many years at the same time.

Specifically, given a text generated from a certain context, and desirable evaluation aspects (e.g., fluency), the high-level idea of the proposed framework is that the higher-quality text of a certain aspect will be more likely generated than unqualified ones based on the given context, where the

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Preprint. Under review.

[1]https://github.com/jinlanfu/GPTScore

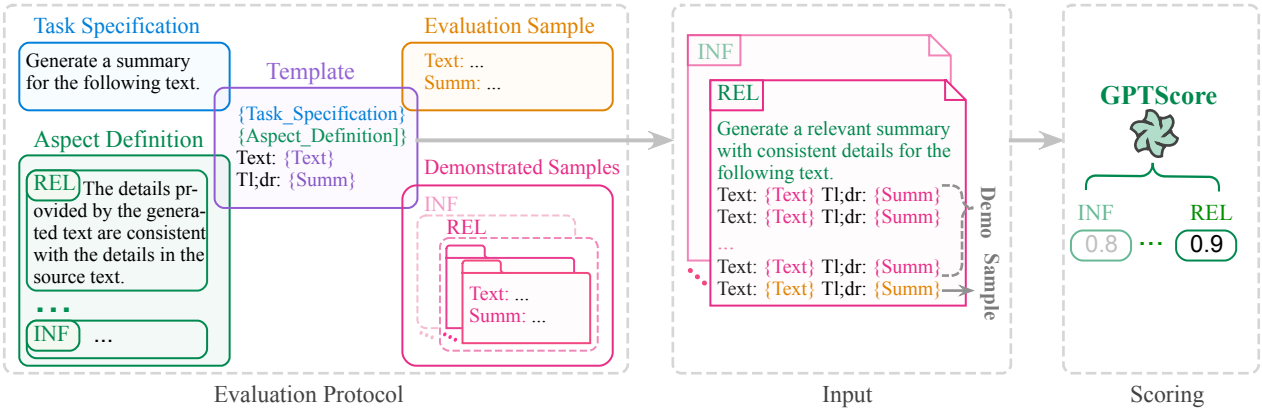


Figure 2. The framework of GPTSCORE. We include two evaluation aspects *relevance (REL)* and *informative (INF)* in this figure and use the evaluation of *relevance (REL)* of the text summarization task to exemplify our framework.

"likely" can be measured by the conditional generation probability. As illustrated in Fig. 2, to capture users' true desires, an ***evaluation protocol*** will be initially established based on (a) the *task specification*, which typically outlines how the text is generated (e.g., generate a response for a human based on the conversation.) (b) *aspect definition* that documents the details of desirable evaluation aspects (e.g., the response should be intuitive to understand). Subsequently, each evaluation sample will be presented with the evaluated protocol with optionally moderate exemplar samples, which could facilitate the model's learning. Lastly, a large **g**enerative **p**re-**t**rained model will be used to calculate how likely the text could be generated based on the above evaluation protocol, thus giving rise to our model's name: GPTSCORE. Given the plethora of pre-trained models, we instantiate our framework with different backbones: GPT2 (Radford et al., 2019), OPT (Zhang et al., 2022b), FLAN (Chung et al., 2022), and GPT3 (instruction-based (Ouyang et al., 2022)) due to their superior capacity for *zero-shot instruction* and their aptitude for *in-context learning*.

Experimentally, we ran through almost all common natural language generation tasks in NLP, and the results showed the power of this new paradigm. The main observations are listed as follows: (1) Evaluating texts with generative pre-training models can be more reliable when instructed by the definition of *task* and *aspect*, providing a degree of flexibility to accommodate various evaluation criteria. Furthermore, incorporating exemplified samples with in-context learning will further enhance the process. (2) Different evaluation aspects exhibit certain correlations. Combining definitions with other highly correlated aspects can improve evaluation performance. (3) The performance of `GPT3-text-davinci-003`, which is tuned based on human feedback, is inferior to `GPT3-text-davinci-001` in the majority of the evaluation settings, necessitating deep explorations on the working mechanism of human feedback-based instruction learning (e.g., when it will fail).

2. Preliminaries

2.1. Text Evaluation

Text evaluation aims to assess the quality of hypothesis text $\boldsymbol{h}$ in terms of certain aspect a (e.g., fluency), which is either measured manually with different protocols (Nenkova & Passonneau, 2004; Bhandari et al., 2020; Fabbri et al., 2021; Liu et al., 2022) or quantified by diverse automated metrics (Lin, 2004; Papineni et al., 2002; Zhao et al., 2019; Zhang et al., 2020; Yuan et al., 2021).

$$y = f(\boldsymbol{h}, a, \mathcal{S}) \tag{1}$$

where (1) $\boldsymbol{h}$ represents the text to be evaluated (hypothesis text, e.g., generated summary in text summarization task). (2) a denotes the evaluation aspect (e.g., fluency). (3) $\mathcal{S}$ is a collection of additional texts that are optionally used based on different scenarios. For example, it could be a source document or a reference summary in the text summarization task. (4) Function $f(\cdot)$ could be instantiated as a human evaluation process or automated evaluation metrics.

2.2. Meta Evaluation

Meta evaluation aims to evaluate the reliability of automated metrics by calculating how well automated scores (y_{auto}) correlate with human judgment (y_{human}) using correlation functions $g(y_{\text{auto}}, y_{\text{human}})$ such as spearman correlation. In this work, we adopt two widely-used correlation measures: (1) **Spearman** correlation (ρ) (Zar, 2005) measures the monotonic relationship between two variables based on their ranked values. (2) **Pearson** correlation (r) (Mukaka, 2012) measures the linear relationship based on the raw data values of two variables.

2.3. Evaluation Strategy

Evaluation strategies define different aggregation methods when we calculate the correlation scores. Specifically, suppose that for each source text $\boldsymbol{s}_i, i \in [1, 2, \cdots, n]$ (e.g., documents in text summarization task or dialogue histories for dialogue generation task), there are J system outputs $\boldsymbol{h}_{i,j}$, where $j \in [1, 2, \cdots, J]$. f_{auto} is an automatic scoring function (e.g., ROUGE (Lin, 2004)), and f_{human} is the gold human scoring function. For a given evaluation aspect a, the meta-evaluation metric F can be formulated as follows.

Sample-level defines that a correlation value is calculated for each sample separately based on outputs of multiple systems, then averaged across all samples.

$$F^{\text{sample}}_{f_{\text{auto}}, f_{\text{human}}} = \frac{1}{n}\sum_{i=1}^{n}\Big(g\big([f_{\text{auto}}(\boldsymbol{h}_{i,1}), \cdots, f_{\text{auto}}(\boldsymbol{h}_{i,J})], [f_{\text{human}}(\boldsymbol{h}_{i,1}), \cdots, f_{\text{human}}(\boldsymbol{h}_{i,J})]\big)\Big),$$

where g can be instantiated as Spearman or Pearson correlation.

Dataset-level indicates that the correlation value is calculated on system outputs of all n samples.

$$F^{\text{data}}_{f_{\text{auto}}, f_{\text{human}}} = g\Big([f_{\text{auto}}(\boldsymbol{h}_{1,1}), \cdots, f_{\text{auto}}(\boldsymbol{h}_{n,J})], [f_{\text{human}}(\boldsymbol{h}_{1,1}), \cdots, f_{\text{human}}(\boldsymbol{h}_{n,J})]\Big)$$

In this work, we select the evaluation strategy for a specific task based on previous works (Yuan et al., 2021; Zhang et al., 2022a). We use the sample-level evaluation strategy for text summarization, data-to-text, and machine translation tasks. For the dialogue response generation task, the dataset-level evaluation strategy is utilized.

3. GPTSCORE

3.1. Generative Pre-trained Language Models

Existing pre-trained language models could be classified into the following three categories: (a) encoder-only models (e.g., BERT (Devlin et al., 2019), RoBerta (Liu et al., 2019)) that encode inputs with bidirectional attention; (b) encoder-decoder models (e.g., BART (Lewis et al., 2020), T5 (Raffel et al., 2020)) that encode inputs with bidirectional attention and generate outputs autoregressively; (c) decoder-only models (e.g., GPT2 (Radford et al., 2019), GPT3 (Brown et al., 2020), PaLM (Chowdhery et al., 2022)) that generate the entire text sequence autoregressively, where pre-trained models with decoding abilities (b, c) have caught much attention since they show impressive performance on zero-shot instruction and in-context learning. Specifically, given a prompt text $\boldsymbol{x} = \{x_1, x_2, \cdots, x_n\}$, a generative pre-training language model can generate a textual continuation $\boldsymbol{y} = \{y_1, y_2, \cdots, y_m\}$ with the following generation probability:

$$p(\boldsymbol{y}|\boldsymbol{x}, \theta) = \prod_{t=1}^{m} p(y_t|\boldsymbol{y}_{<t}, \boldsymbol{x}, \theta)$$

Emergent Ability Recent works progressively reveal a variety of emergent abilities of generative pre-trained language models with appropriate tuning or prompting methods, such as in-context learning (Min et al., 2022), chain-of-thought reasoning (Wei et al., 2022), and zero-shot instruction (Ouyang et al., 2022). One core commonality of these abilities is to allow for handling customized requirements with a few or even zero annotated examples. It's the appearance of these abilities that allows us to re-invent a new way for text evaluation–evaluating from the textual description, which can achieve customizable, multi-faceted, and train-free evaluation.

3.2. Generative Pretraining Score (GPTScore)

The core idea of GPTSCORE is that a generative pre-training model will assign a higher probability of high-quality generated text following a given instruction and context. In our method, the instruction is composed of the task description d and the aspect definition a. Specifically, suppose that the text to be evaluated is $\boldsymbol{h} = \{h_1, h_2, \cdots, h_m\}$, the context information is $\mathcal{S}$ (e.g., source text or reference text), then GPTSCORE is defined as the following conditional probability:

$$\text{GPTScore}(\boldsymbol{h}|d, a, \mathcal{S}) = \sum_{t=1}^{m} w_t \log p(h_t|\boldsymbol{h}_{<t}, T(d, a, \mathcal{S}), \theta),$$

where w_t is the weight of the token at position t. In our work, we treat each token equally. $T(\cdot)$ is a prompt template that defines the evaluation protocol, which is usually task-dependent and specified manually through prompt engineering.

Few-shot with Demonstration The generative pre-trained language model can better perform tasks when prefixed with a few annotated samples (i.e., demonstrations). Our proposed framework is flexible in supporting this by extending the prompt template T with demonstrations.

Choice of Prompt Template Prompt templates define how task description, aspect definition, and context are organized. Minging desirable prompts itself is a non-trivial task and there are extensive research works there (Liu et al., 2021; Fu et al., 2022). In this work, for the GPT3-based model, we opt for prompts that are officially provided by OpenAI.[2] For instruction-based pre-trained

[2] https://beta.openai.com/examples

Aspect	Task	Definition
Semantic Coverage (COV)	Summ	How many semantic content units from the reference text are covered by the generated text?
Factuality (FAC)	Summ	Does the generated text preserve the factual statements of the source text?
Consistency (CON)	Summ, Diag	Is the generated text consistent in the information it provides?
Informativeness (INF)	Summ, D2T, Diag	How well does the generated text capture the key ideas of its source text?
Coherence (COH)	Summ, Diag	How much does the generated text make sense?
Relevance (REL)	Diag, Summ, D2T	How well is the generated text relevant to its source text?
Fluency (FLU)	Diag, Summ, D2T, MT	Is the generated text well-written and grammatical?
Accuracy (ACC)	MT	Are there inaccuracies, missing, or unfactual content in the generated text?
Multidimensional Quality Metrics (MQM)	MT	How is the overall quality of the generated text?
Interest (INT)	Diag	Is the generated text interesting?
Engagement (ENG)	Diag	Is the generated text engaging?
Specific (SPE)	Diag	Is the generated text generic or specific to the source text?
Correctness (COR)	Diag	Is the generated text correct or was there a misunderstanding of the source text?
Semantically appropriate (SEM)	Diag	Is the generated text semantically appropriate?
Understandability (UND)	Diag	Is the generated text understandable?
Error Recovery (ERR)	Diag	Is the system able to recover from errors that it makes?
Diversity (DIV)	Diag	Is there diversity in the system responses?
Depth (DEP)	Diag	Does the system discuss topics in depth?
Likeability (LIK)	Diag	Does the system display a likeable personality?
Flexibility (FLE)	Diag	Is the system flexible and adaptable to the user and their interests?
Inquisitiveness (INQ)	Diag	Is the system inquisitive throughout the conversation?

Table 1. The definition of aspects evaluated in this work. *Semantic App.* denotes *semantically appropriate* aspect. *Diag*, *Summ*, *D2T*, and *MT* denote the *dialogue response generation*, *text summarization*, *data to text* and *machine translation*, respectively.

models, we use prompts from NaturalInstruction (Wang et al., 2022) since it's the main training source for those instruction-based pre-train models. Taking the evaluation of the fluency of the text summarization task as an example, based on the prompt provided by OpenAI,[3] the task prompt is "{Text} Tl;dr {Summary}", the definition of fluency is "Is the generated text well-written and grammatical?" (in Tab. 1), and then the final prompt template is "`Generate a fluent and grammatical summary for the following text: {Text} Tl;dr {Summary}`", where demonstrations could be introduced by repeating instantiating "`{Text} Tl;dr {Summary}`" In Appendix D, we list the prompts for various aspects of all tasks studied in this work and leave a more comprehensive exploration on prompt engineering as a future work.

Selection of Scoring Dimension GPTSCORE exhibits different variants in terms of diverse choices of texts being calculated. For example, given a generated hypothesis, we can calculate GPTSCORE either based on the source text (i.e., *src->hypo*, $p(\text{hypo}|\text{src})$) or based on the gold reference (i.e., *ref->hypo*, $p(\text{hypo}|\text{ref})$). In this paper, the criteria for choosing GPTSCORE variants are mainly designed to align the protocol of human judgments (Liu et al., 2022) that are used to evaluate the reliability of automated metrics. We will detail this based on different human judgment datasets in the experiment section.

[3] https://beta.openai.com/examples/default-tldr-summary

4. Experimental Settings

4.1. Tasks, Datasets, and Aspects

To achieve a comprehensive evaluation, in this paper, we cover a broad range of natural language generation tasks: *Dialogue Response Generation*, *Text Summarization*, *Data-to-Text*, and *Machine Translation*, which involves 37 datasets and 22 evaluation aspects in total. Tab. 8 summarizes the tasks, datasets, and evaluation aspects considered by each dataset. The definition of different aspects can be found in Tab. 1. More detailed illustrations about the datasets can be found in Appendix B.

(1) **Dialogue Response Generation** aims to automatically generate an engaging and informative response based on the dialogue history. Here, we choose to use the `FED` (Mehri & Eskénazi, 2020) datasets and consider both turn-level and dialogue-level evaluations. (2) **Text Summarization** is a task of automatically generating informative and fluent summary for a given long text. Here, we consider the following four datasets, `SummEval` (Bhandari et al., 2020), `REALSumm` (Bhandari et al., 2020), `NEWSROOM` (Grusky et al., 2018), and `QAGS_XSUM` (Wang et al., 2020), covering 10 aspects. (3) **Data-to-Text** aims to automatically generate a fluent and factual description for a given table. Our work considered `BAGEL` (Mairesse et al., 2010) and `SFRES` (Wen et al., 2015) datasets. (4) **Machine Translation** aims to translate a sentence from one language to another. We consider a subdatasets of Multidimensional Quality Metrics (MQM) (Freitag et al., 2021), namely, `MQM-2020` (Chinese->English).

4.2. Scoring Models

ROUGE (Lin, 2004) is a popular automatic generation evaluation metric. We consider three variants ROUGE-1, ROUGE-2, and ROUGE-L. **PRISM** (Thompson & Post, 2020) is a reference-based evaluation method designed for machine translation with pre-trained paraphrase systems. **BERTScore** (Zhang et al., 2020) uses contextual representation from BERT to calculate the similarity between the generated text and the reference text. **MoverScore** (Zhao et al., 2019) considers both contextual representation and Word Mover's Distance (WMD, (Kusner et al., 2015)) **DynaEval** (Zhang et al., 2021) is a unified automatic evaluation framework for dialogue response generation tasks on the turn level and dialogue level. **BARTScore** (Yuan et al., 2021) is a text-scoring model based on BART (Lewis et al., 2020) without fine-tuning. **BARTScore+CNN** (Yuan et al., 2021) is based on BART fine-tuned on the CNNDM dataset (Hermann et al., 2015). **BARTScore+CNN+Para** (Yuan et al., 2021) is based on BART fine-tuned on CNNDM and Paraphrase2.0 (Hu et al., 2019). **GPTSCORE** is our evaluation method, which is designed based on different pre-trained language models. Specifically, we considered GPT3, OPT, FLAN-T5, and GPT2 in this work. Five variants are explored for each framework. For a fair comparison with the decoder-only model, such as GPT3 and OPT, only four variant models of GPT2 with a parameter size of at least 350M are considered. Tab. 2 shows all model variants we used in this paper and their number of parameters.

GPT3	Param.	OPT	Param.
text-ada-001	350M	OPT350M	350M
text-babbage-001	1.3B	OPT-1.3B	1.3B
text-curie-001	6.7B	OPT-6.7B	6.7B
text-davinci-001	175B	OPT-13B	13B
text-davinci-003	175B	OPT-66B	66B
FLAN-T5	**Param.**	**GPT2**	**Param.**
FT5-small	80M	GPT2-M	355M
FT5-base	250M	GPT2-L	774M
FT5-L	770M	GPT2-XL	1.5B
FT5-XL	3B	GPT-J-6B	6B
FT5-XXL	11B		

Table 2. Pre-trained backbones used in this work.

4.3. Scoring Dimension

Specifically, (1) For aspects INT, ENG, SPC, REL, COR, SEM, UND, and FLU of FED-Turn datasets from the open domain dialogue generation task, we choose the *src->hypo* variant since the human judgments of the evaluated dataset (i.e., FED-Turn) are also created based on the source. (2) For aspects COH, CON, and INF from SummEval and Newsroom, since data annotators labeled the data based on source and hypothesis texts, we chose *src->hypo* for these aspects. (3) For aspects INF, NAT, and QUA from the data-to-text task, we choose *src->hypo*. Because the source text of the data-to-text task is not in the standard text format, which will be hard to handle by the scoring function. (4) For aspects ACC, FLU, and MQM from the machine translation task, we also choose *src->hypo*. Because the source text of the machine translation is a different language from the translated text (hypo). In this work, we mainly consider the evaluation of the English text. In the future, we can consider designing a scoring function based on BLOOM (Scao et al., 2022) that can evaluate texts in a cross-lingual setting.

4.4. Evaluation Dataset Construction

Unlike previous works (Matiana et al., 2021; Xu et al., 2022a;b; Castricato et al., 2022) that only consider the overall text quality, we focus on evaluating multi-dimensional text quality. In this work, we studied 37 datasets according to 22 evaluation aspects. Due to the expensive API cost of GPT3, we randomly extract and construct sub-datasets for meta-evaluation. For the MQM dataset, since many aspects of samples lack human scores, we extract samples with human scores in ACC, MQM, and FLU as much as possible.

5. Experiment Results

In this work, we focus on exploring whether language models with different structures and sizes can work in the following three scenarios. (a) **vanilla (VAL)**: with non-instruction and non-demonstration; (b) **instruction (IST)**: with instruction and non-demonstration; (c) **instruction+demonstration (IDM)**: with instruction and demonstration.

Significance Tests To examine the reliability and validity of the experiment results, we conducted the significance test based on bootstrapping.[4] Our significance test is to check (1) whether the performance of IST (IDM) is significantly better than VAL, and values achieved with the IST (IDM) settings will be marked † if it passes the significant test (p-value <0.05). (2) whether the performance of IDM is significantly better than IST, if yes, mark the value with IDM setting with ‡.

Average Performance Due to space limitations, we keep the average performance of GPT3-based, GPT2-based, OPT-based, and FT5-based models. The full results of various variants can be found in Appendix E.

5.1. Text Summarization

The evaluation results of 28 (9 baseline models (e.g., ROUGE-1) and 19 variants of GPTScore (e.g., GPT3-d01))

[4] https://en.wikipedia.org/wiki/Bootstrapping_(statistics)

Model	SummEval								RSumm	
	COH		CON		FLU		REL		COV	
	VAL	IST	VAL	IST	VAL	IST	VAL	IST	VAL	IST
ROUGE-1	14.1	-	20.8	-	14.8	-	26.2	-	**46.4**	-
ROUGE-2	9.1	-	17.2	-	12.0	-	17.4	-	37.3	-
ROUGE-L	12.9	-	19.8	-	17.6	-	24.7	-	45.1	-
BERTSc	25.9	-	19.7	-	23.7	-	34.7	-	38.4	-
MoverSc	11.5	-	18.0	-	15.7	-	24.8	-	34.4	-
PRISM	26.5	-	29.9	-	26.1	-	25.2	-	32.3	-
BARTSc	29.7	-	30.8	-	24.6	-	28.9	-	43.1	-
+CNN	42.5	-	35.8	-	38.1	-	**35.9**	-	42.9	-
+CNN+Pa	**42.5**	-	**37.0**	-	**40.5**	-	33.9	-	40.9	-
GPT3-a01	39.3	39.8†	39.7	40.5†	36.1	35.9	28.2	27.6	29.5	29.8†
GPT3-b01	42.7	**45.2**†	41.0	41.4†	37.1	39.1†	32.0	33.4†	35.0	35.2†
GPT3-c01	41.3	40.8	44.6	45.1†	38.9	39.5†	31.6	33.2†	**36.1**	**45.1**†
GPT3-d01	40.0	40.1	**46.6**	**47.5**†	40.5	**41.0**†	32.4	34.3†	36.0	33.9
GPT3-d03	**43.7**	43.4	45.2	44.9	**41.1**	40.3	**36.3**	**38.1**†	35.2	38.0†
GPT2-M	36.0	39.2†	34.6	35.3†	28.1	30.7†	28.3	28.3	41.8	43.3†
GPT2-L	**36.4**	39.8†	33.7	34.4†	29.4	31.5†	27.8	28.1†	39.6	41.3†
GPT2-XL	35.3	**39.9**†	35.9	36.1†	31.2	33.1†	28.1	28.0	40.4	41.0†
GPT-J-6B	35.5	39.5†	**42.7**	**42.8**†	**35.5**	**37.4**†	**31.5**	**31.9**†	**42.8**	**43.7**†
OPT350m	33.4	37.6†	34.9	35.5†	29.6	31.4†	29.5	28.6	40.2	42.3†
OPT-1.3B	35.0	**37.8**†	40.0	42.0†	33.6	35.9†	33.5	34.2†	42.0	39.7
OPT-6.7B	**35.7**	36.8†	42.1	**45.7**†	35.5	37.6†	**35.4**	**35.4**	38.0	41.9†
OPT-13B	33.5	34.7†	42.5	45.2†	35.6	37.3†	33.6	33.9	37.6	41.0†
OPT-66B	32.0	35.9†	**44.0**	45.3†	**36.3**	**38.0**†	33.4	33.7†	**40.3**	41.3†
FT5-small	35.0	35.4†	37.0	38.0†	35.6	34.7	27.3	28.0†	33.6	35.7†
FT5-base	39.2	39.9†	36.7	37.2†	37.3	36.5	29.5	31.2†	36.7	38.6†
FT5-L	42.3	45.1†	41.0	42.5†	39.3	41.6†	31.2	**35.3**†	31.4	39.3†
FT5-XL	**42.8**	**47.0**†	41.0	43.6†	39.7	42.1†	31.4	34.4†	34.8	**43.8**†
FT5-XXL	42.1	45.6†	**43.7**	**43.8**	**39.8**	**42.4**†	**32.8**	34.3†	**40.2**	41.1†
Avg.	38.0	40.2	40.4	41.4	35.8	37.2	31.3	32.2	37.4	39.8

Table 3. Spearman correlation of different aspects on text summarization datasets. VAL and IST is the abbreviation of vanilla and instruction, respectively. Values with † denote the evaluator with instruction significantly outperforms with vanilla. Values in bold are the best performance in a set of variants (e.g., GPT3 family).

scoring functions for the text summarization task on SummEval and RealSumm datasets are shown in Tab. 3. Due to the space limitation, we move the performance of the NEWSROOM and QXSUM datasets to the Appendix E. Fig. 3 shows the evaluation results of five GPT3 variant models on four text summarization datasets, where QXSUM uses the Pearson correlation and other datasets use the Spearman correlation metric. The main observations are summarized as follows:

(1) **Evaluator with instruction significantly improves the performance** (values with † in Tab. 3). What's more, small models with instruction demonstrate comparable performance to supervised learning models. For example, OPT350m, FT5-small, and FT5-base outperform BARTScore+CNN on the CON aspect when using the instructions. (2) **The benefit from instruction is more stable for the decoder-only models.** In Tab. 3, the average Spearman score of both the GPT2 and OPT models, 9 out of 10 aspects are better than the vanilla setting (VAL) by using instruction (IST), while the equipment of instruction (IST) to the encoder-decoder model of FT5 on the NEWSROOM dataset fails to achieve gains. (3) As for the GPT3-based models, **(a) the performance of GPT3-d01 is barely significantly better than GPT3-c01**, which tries to balance power and speed. (b) **GPT3-d03 performs better than GPT3-d01 significantly.** We can observe these conclusions from Fig. 3, and both conclusions have passed the significance test at $p < 0.05$.

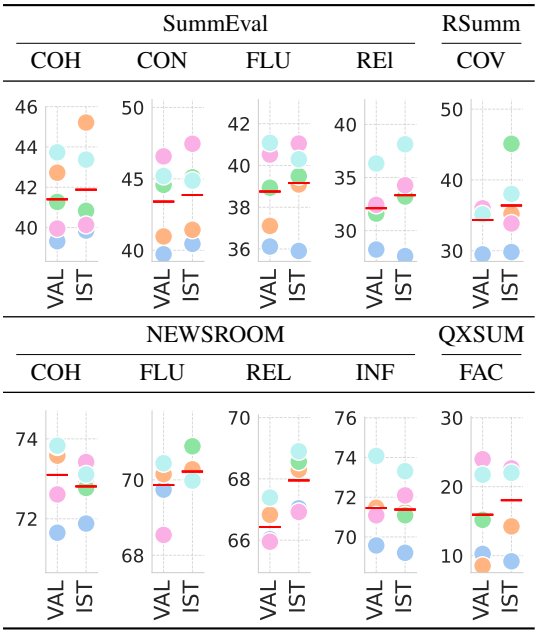


Figure 3. Experimental results for GPT3-based variants in text summarization task. Here, blue, orange, green, pink, and cyan dot denote that GPTSCORE is built based on a01 (●), b01 (●), c01 (●), d01 (●), and d03 (●), respectively. The red lines (—) denote the average performance of GPT3-based variants.

5.2. Machine Translation

The average sample-level Spearman (ρ) scores of GPT3-based, GPT2-based, OPT-based, and FT5-based models on the MQM-2020 machine translation dataset are shown in Tab. 4, where values with † denote that the evaluator equipped with IST (or IDM) significantly outperforms the VAL setting, and ‡ indicate that the evaluator equipped with IDM (the combination of IST and DM) significantly outperforms the IST setting. The Spearman correlations for the GPT3-based variants are shown in Fig. 4. For the full evaluation results of 28 models (including 9 baseline scoring models, such as ROUGE-1) can be found in Tab. 14. Following Thompson & Post (2020) and Yuan et al. (2021), we treat the evaluation of machine translation as the paraphrasing task. The main observations are listed as follows:

(1) **The introduction of instruction (IST) significantly improve the performance in three different aspects of ACC, FLU, and MQM.** In Tab. 4, the average performance of 19 GPTSCORE based evaluators with instruction (IST) significantly outperforms vanilla (VAL). (2) **The combination of instruction and demonstration (IDM) brings gains for the evaluator with different model structures.** In Tab. 4, the performance of GPT3, GPT2, OPT, and FT5 improves a lot when instruction and demonstration (IDM) are introduced. (3) **The evaluator built based on GPT3-c01 achieves comparable performance with GPT3-d01 and GPT3-d03.** This can be found in Fig. 4. Since the GPT3-d01 and GPT3-d03 are most expensive variant of GPT3, the cheaper and comparative GPT3-c01 is a good choice for machine translation task.

Model	ACC			FLU			MQM		
	VAL	IST	IDM	VAL	IST	IDM	VAL	IST	IDM
GPT3	27.2	27.1	29.7†,‡	**11.3**	10.4	**16.4**†,‡	30.3	31.2†	32.3†,‡
GPT2	25.8	27.0†	**30.3**†,‡	9.8	10.8†	15.8†,‡	30.1	30.3†	33.5†,‡
OPT	**28.7**	**29.4**†	30.3†,‡	10.0	**12.2**†	16.3†,‡	**32.5**	**34.6**†	**35.1**†,‡
FT5	27.7	27.8†	28.3†,‡	9.6	11.0†	15.4†,‡	31.0	32.3†	32.3
Avg.	27.4	27.8†	29.7†,‡	10.2	11.1†	16.0†,‡	31.0	32.1†	33.3†,‡

Table 4. The average Spearman correlation of the GPT3-based, GPT2-based, OPT-based, and FT5-based models in machine translation task of MQM-2020 dataset.

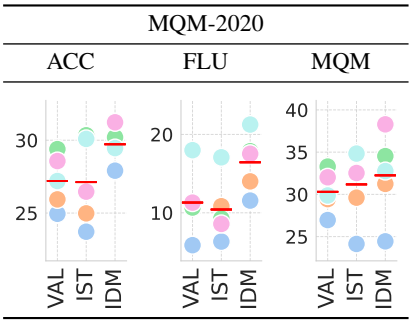


Figure 4. Experimental results for GPT3-based variants in the machine translation task. Here, blue, orange, green, pink, and cyan dot denote that GPTSCORE is built based on a01 (●), b01 (●), c01 (●), d01 (●), and d03 (●), respectively. The red lines (—) denote the average performance of GPT3-based variants.

5.3. Data to Text

We consider the BAGEL and SFRES datasets for the evaluation of data to text task. The average Spearman correlations of the GPT3-based, GPT2-based, OPT-based, and FT5-based models are listed in Tab. 5. VAL, IST, and IDM denote the vanilla, using instruction, and using both instruction and demonstration settings, respectively. Due to the space limitation, the detailed performance of each evaluator considered in this work can be found in Tab. 15 and Tab. 16.

The main observations are listed as follows:

(1) **Introducing instruction (IST) can significantly improve performance, and introducing demonstration (DM) will further improve performance.** In Tab. 5, the average performance on the three aspects is significantly improved when adapting to the instruction, and the performance of using demonstration on NAT and FLU has further significantly improved. (2) **The decoder-only model is better at utilizing demonstration to achieve high performance.** In Tab. 5, compare to the encoder-decoder model FT5, the performance has a more significant improvement for the decoder-only model of GPT2 and OPT on NAT and FLU aspects after introducing DM, which holds for both BAGEL and SFRES. (3) **GPT3 has strong compatibility with unformatted text.** Named entities of the BAGEL dataset are replaced with a special token (e.g, X and Y). For example, "X is a cafe restaurant", where "X" denotes the name of the cafe. When introducing IST and DM (IDM), the variants of GPT3 achieve much higher average performance than GPT2, OPT, and FT5.

Model	INF			NAT			FLU		
	VAL	IST	IDM	VAL	IST	IDM	VAL	IST	IDM
BAGEL									
GPT3	35.4	38.3†	43.6†,‡	21.7	26.5†	36.9†,‡	30.5	32.9†	43.4†,‡
GPT2	40.8	43.2†	40.2	31.4	33.0†	33.5†,‡	36.7	39.3†	41.3†,‡
OPT	38.7	39.3†	38.6	31.4	30.0	33.7†,‡	37.7	37.1†	41.5†,‡
FT5	41.5	41.5	39.1	26.5	29.7†	28.6†	38.1	41.1†	40.3†
Avg.	39.1	40.6†	40.3†	27.7	29.8†	33.2†,‡	35.8	37.6†	41.6†,‡
SFRES									
GPT3	30.4	25.1	31.5†,‡	25.0	30.4†	26.5†	31.2	30.9	26.1
GPT2	22.5	25.1†	20.5	31.0	31.9†	37.0†,‡	20.0	33.1†	36.2†,‡
OPT	25.2	26.9†	24.3	26.2	30.0†	36.6†,‡	21.3	25.6†	30.6†,‡
FT5	24.0	21.9	19.7	34.3	34.6†	36.8†,‡	22.0	17.8	19.7‡
Avg.	25.5	24.7	24.0	29.1	31.7†	34.2†,‡	23.6	26.8†	28.2†,‡

Table 5. The average of Spearman correlation the models based on GPT3, GPT2, OPT, and FT5 on BAGEL and SFRES datasets in data-to-text task.

5.4. Dialogue Response Generation

To test if GPTSCORE can generalize to more aspects, we choose the task of dialogue response generation as a testbed, which usually requires evaluating generated texts from a variety of dimensions (i.e., "interesting" and "fluent"). To reduce the computational cost, in this experiment, we focus on GPT3-based metrics since they have achieved superior performance as we observed in the previous experiments.

Tab. 6 shows the Spearman correlation of different aspects on FED turn- and dialogue-level datasets. The main observations are listed as follows.

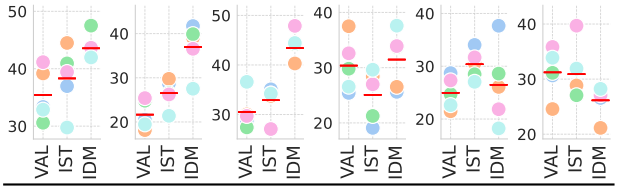


Figure 5. Experimental results for GPT3-based variants in data-to-text task. Here, blue, orange, green, pink, and cyan dot denote that GPTSCORE is built based on a01 (), b01 (), c01 (), d01 (), and d03 (), respectively. The red lines (—) denote the average performance of GPT3-based variants.

(1) **The performance of GPT3-d01 is much better than GPT3-d03, even though both of them have the same model size.** The average Spearman correlation of GPT3-d01 outperforms GPT3-d03 by **40.8** on the FED Turn-level dataset, and **5.5** on the FED dialogue-level. (2) **The GPT3-based model demonstrate stronger generalization ability.** BART-based models failed in the evaluation of the dialogue generation task, while the GPT3-a01 with 350M parameters achieved comparable performance to FED and DE models on both the FED turn-level and dialogue-level datasets.

Aspect	Baseline					GPTScore				
	BT	BTC	BTCP	FED	DE	a01	b01	c01	d01	d03
FED dialogue-level										
COH	1.7	-14.9	-18.9	25.7	43.7	18.7	15.0	22.5	**56.9**	13.4
ERR	9.4	-12.2	-13.7	12.0	30.2	35.2	16.8	21.3	**45.7**	9.40
CON	2.6	-6.7	-10.2	11.6	36.7	**33.7**	9.9	18.4	32.9	18.1
DIV	13.3	-2.5	-13.9	13.7	37.8	14.9	5.20	21.5	**62.8**	-6.6
DEP	8.2	-6.6	-17.6	10.9	49.8	9.00	12.9	28.2	**66.9**	34.1
LIK	9.9	-6.3	-11.8	37.4	41.6	26.2	22.0	32.1	**63.4**	18.4
UND	-11.5	-17.6	-18.2	-0.3	36.5	31.2	40.0	40.0	**52.4**	19.6
FLE	9.3	-10.2	-10.3	24.9	38.3	32.7	44.9	34.6	**51.5**	7.20
INF	9.2	-7.5	-10.5	42.9	42.6	6.80	8.0	18.8	**60.2**	31.7
INQ	6.2	-0.6	-14.8	24.7	41.0	44.2	38.7	49.2	**50.3**	-10.1
Avg.	5.8	-8.5	-14.0	20.4	39.8	25.3	21.3	28.6	**54.3**	13.5
FED turn-level										
INT	15.9	-3.3	-10.1	32.4	32.7	16.6	6.4	30.8	**50.1**	22.4
ENG	22.6	1.1	-2.5	24.0	30.0	10.2	6.2	29.4	**49.6**	35.5
SPE	8.3	-7.9	-16.2	14.1	**34.6**	33.7	16.1	31.7	21.4	15.1
REL	11.9	10.0	19.4	19.9	26.3	8.6	10.3	23.8	**45.2**	38.0
COR	7.6	1.8	12.4	26.2	24.2	29.7	11.2	27.0	**43.4**	42.8
SEM	10.0	18.8	26.1	-9.4	20.2	6.8	8.1	23.1	**44.4**	40.5
UND	12.0	8.1	4.5	1.3	20.0	6.6	14.8	23.4	**36.5**	31.1
FLU	14.0	17.2	28.4	-13.4	17.1	16.5	5.7	14.0	16.0	**36.7**
Avg.	12.8	5.7	7.7	11.9	25.6	16.1	9.9	25.4	**38.3**	32.8

Table 6. Spearman correlation of different aspects on the FED turn- and dialogue-level datasets. *BT*, *BTC*, *BTCP*, and *DE* denote BARTSCORE, BARTSCORE+CNN, BARTSCORE+CNN+Para, and DynaEval model, respectively. Values in bold indicate the best performance.

6. Ablation Study

6.1. Effectiveness of Demonstration

To investigate the relationship between the demonstration sample size (denote as K) and the evaluation performance, we choose the machine translation task and the GPT3-based variants with model sizes ranging from 350M to 175B for further study.

The change of Spearman correlation on the MQM-2020 dataset with different demonstration sample size are shown in Fig. 6. The main observations are summarized as follows: (1) The utilization of demonstration significantly improves the evaluation performance, which holds for these three aspects. (2) There is an upper bound on the performance gains from the introduction of the demonstration. For example, when K>4, the performance of ACC is hard to improve further. (3) When DM has only a few samples (such as K=1), small models (e.g., GPT3-a01) are prone to performance degradation due to the one-sidedness of the given examples.

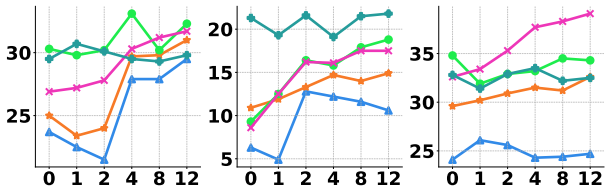
6.2. Partial Order of Evaluation Aspect

To explore the correlation between aspects, we conducted an empirical analysis with INT (*interesting*) on the dialogue response generation task of the FED-Turn dataset. Specifically, take INT as the target aspect and then combine the definitions of other aspects with the definition of INT as the final evaluation protocols. The x-axis of Fig. 7-(a) is the aspect order achieved based on the Spearman correlation between INT and that aspect's human score. Fig. 7-(b) is the Spearman correlation o INT as the modification of the INT definition, and the scoring function is GPT3-c01.

The following table illustrates the definition composition process, where Sp denotes Spearman.

X	Aspect	Aspect Definition	Sp
1	INT	Is this response interesting to the conversation?	30.8
3	INT, ENG, SPE	Is this an interesting response that is specific and engaging?	48.6

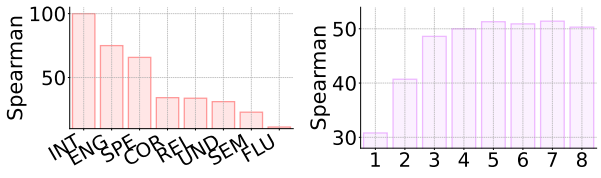
Specifically, the definition of INT is *"Is this response interesting to the conversation? "* at x=1 in Fig. 7-(b). When INT combines with ENG, SPE (at x=3 in Fig. 7-(b)), its definition can be *"Is this an interesting response that is specific and engaging?"*. And the new aspect definition boosts the performance from **30.8** (at x=1 in Fig. 7-(b)) to **48.6** (at x=3 in Fig. 7-(b)). The best performance of **51.4** (x=5 in Fig. 7-(b)) is achieved after combining five aspects (INT, ENG, SPE, COR, REL), which already exceeded **50.1**



(a) ACC (b) FLU (c) MQM

Figure 6. Results of the GPT3 family models with different numbers of examples (K) in the demonstration on the MQM-2020 dataset. Here, blue, orange, green, red, and cyan lines denote that GPTSCORE is built based on GPT3-a01 (▲), GPT3-b01 (★), GPT3-c01 (●), GPT3-d01 (✖), and GPT3-d03 (+), respectively.

of the most potent scoring model GPT3-d01 with aspect definition built only on `INT`. Therefore, combining definitions with other highly correlated aspects can improve evaluation performance.



(a) Aspect order (b) `INT` performance

Figure 7. (a) Descending order of Spearman correlation between `INT` and other aspects' human scoring. (b) The Spearman correlation of `INT` changes as its aspect definition is modified in combination with other aspects. The scoring model is GPT3-c01.

7. Conclusion

In this paper, we propose to leverage the emergent abilities from generative pre-training models to address intricate and ever-changing evaluation requirements. The proposed framework, GPTSCORE, is studied on multiple pre-trained language models with different structures, including the GPT3 with a model size of 175B. GPTSCORE has multiple benefits: customizability, multi-faceted evaluation, and train-free, which enable us to flexibly craft a metric that can support 22 evaluation aspects on 37 datasets without any learning process yet attain competitive performance. This work opens a new way to audit generative AI by utilizing generative AI.

Acknowledgements

We thank Chen Zhang for helpful discussion and feedback. This research / project is supported by the National Research Foundation, Singapore under its Industry Alignment Fund – Pre-positioning (IAF-PP) Funding Initiative. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not reflect the views of National Research Foundation, Singapore. Pengfei Liu is supported by a grant from the Singapore Defence Science and Technology Agency.

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A. Metric Comparison

Tab. 7 summarize several popular generated text evaluation methods.

Metrics	Custom	Function (f)		Additional text ($\mathcal{S}$)		Training-free	Application
		Representation	Formulation	Source	Reference		
ROUGE (Lin, 2004)	✗	Token	Matching	No	Required	✓	SUM
BLEU (Papineni et al., 2002)	✗	Token	Matching	No	Required	✓	MT
CHRF (Popovic, 2015)	✗	Character	Matching	No	Required	✓	MT
BERTScore (Zhang et al., 2020)	✗	BERT	Matching	No	Required	✓	MUL(2)
MoverScore (Zhao et al., 2019)	✗	BERT	Matching	No	Required	✓	MUL(4)
BLEURT (Sellam et al., 2020)	✗	BERT	Regression	No	Required	✓	MT
PRISM (Thompson & Post, 2020)	✗	Embedding	Paraphrase	Optional	Optional	✓	MT
UNIEVAL (Zhong et al., 2022)	✗	T5	Boolean QA	Optional	Optional	✗	MUL(2)
COMET (Rei et al., 2020)	✗	BERT	Regress, Rank	Optional	Optional	✗	MT
BARTScore (Yuan et al., 2021)	✗	BART	Generation	Optional	Optional	✓	MUL(3)
FED (Mehri & Eskénazi, 2020)	✗	DialoGPT	Generation	Required	Optional	✓	Dialogue
HolisticEval (Pang et al., 2020)	✗	GPT2	Generation	Optional	Optional	✓	Dialogue
GPTScore	✓	GPT3/OPT	Any	Optional	Optional	✓	MUL(5)

Table 7. A comprehensive comparison of existing research on automated evaluation of generated texts. MUL(k) denotes multiple (k) applications explored. *Custom* denotes *Custom Aspects*.

B. Tasks, Datasets, and Aspects

To achieve a more comprehensive evaluation, in this paper, we cover a broad range of natural language generation tasks: *Dialogue Response Generation*, *Text Summarization*, *Data-to-Text*, and *Machine Translation*, which involves 9 datasets and 22 evaluation aspects in total. Tab. 8 summarizes the tasks, datasets, and evaluation aspects considered by each dataset. The definition of different aspects can be found in Tab. 1.

Tasks	Dataset	Aspect
Diag	FED-Diag	COH, DIV, FLE, UND,INQ CON, INF, LIK, DEP, ERR
	FED-Turn	INT, ENG, SPE, REL, COR, SEM, UND, FLU
Summ	SummEval	COH, CON, FLU,REL
	Newsroom	FLU, REL, INF, COH
	REALSumm	COV
	Q-XSUM	FAC
D2T	BAGEL	FLU, REL, INF
	SFRES	FLU, REL, INF
MT	MQM-2020	FLU, COH, INF

Table 8. An overview of tasks, datasets, and evaluation aspects. *Summ.* denote the text summarization task, *D2T* denotes the Data-to-Text task, *MT* denotes the machine translation. Tab. 1 summarized the definitions of the aspects explored in this work.

Dialogue Response Generation aims to automatically generate an engaging and informative response based on the dialogue history. (1) FED (Mehri & Eskénazi, 2020) collects 124 conversations, including both human-machine (Meena (Adiwardana et al., 2020), Mitsuku[5]) and human-human dialogues, and manually annotated 9 and 11 evaluation aspects at the turn- and dialogue-level, respectively.

Text Summarization is a task of automatically generating an informative and fluent summary for a given long text. Here, we consider the following four datasets covering 6 evaluation aspects: *semantic coverage, informativeness, relevance,*

[5] https://medium.com/pandorabots-blog/mitsuku-wins-loebner-prize-2018-3e8d98c5f2a7

fluency, coherence, and *factuality*. (1) SummEval (Bhandari et al., 2020) collects human judgments on 16 model-generated summaries on the CNN/Daily Mail dataset, covering aspects of coherence, consistency, fluency, and relevance. (2) REALSumm (Bhandari et al., 2020) evaluates the reliability of automatic metrics by measuring the pyramid recall of text generated by 25 systems. (3) NEWSROOM (Grusky et al., 2018) covers news, sports, entertainment, finance, and other topics and evaluates the quality of summaries generated by 7 systems, including informativeness, relevance, fluency, and coherence. (4) QAGS_XSUM (Wang et al., 2020) is another dataset focusing on the factuality aspect. It has 239 samples from XSUM and their summaries are generated by a fine-tuned BART model.

Data-to-Text aims to automatically generate a fluent and factual description for a given table. (1) BAGEL (Mairesse et al., 2010) contains 202 samples about restaurants in Cambridge. (2) SFRES (Wen et al., 2015) contains 581 samples about restaurants in San Francisco. These two datasets consider three evaluation aspects: *informativeness*, *naturalness* (relevance), and *quality* (fluency).

Machine Translation aims to translate a sentence from one language to another. We consider a sub-datasets of Multidimensional Quality Metrics (MQM) (Freitag et al., 2021), namely, MQM-2020 (Chinese->English). Due to limited annotations, here, we only consider three evaluation aspects: *accuracy*, *fluency*, and *MQM* with diverse scores.

C. Ablation Study

C.1. Effectiveness of Demonstration

The in-context learning helps a lot to achieve a good performance. However, how does the number of samples in the demonstration impact the performance? We conduct a case study on the five GPT3-based models explored in this work. The experimental results are shown in Fig. 6, and the specific performance values can be seen in Tab. 9.

C.2. Partial Order of Evaluation Aspect

We have investigated the combination of different evaluation aspects to achieve further performance gains in § 6.2. Tab. 10 summarizes the aspect definition and Spearman correlation changes for INT, with the introduction of other aspects.

D. Prompt Design

In this work, we have studied four popular text generation tasks: text summarization, machine translation, data-to-text, and dialogue response generation. The instructions for these tasks on different evaluation aspects are summarized in Tab. 11 and Tab. 12. Here, we convert the dialogue response generation task as a boolean question-answering task and incorporate the aspect definition into the question of the boolean question-answering task.

E. Experiment Results

This section lists the full experimental results for the explored text generation tasks. The models considered here include the 9 baseline models: ROUGE-1, ROUGE-2, ROUGE-L, BERTScore, MoverScore, PRISM, BARTSCORE, BARTSCORE+CNN, and BARTSCORE+CNN+Para, and 19 GPTScore models built based on the GPT3-based, GPT2-based, OPT-based, and FLAN-T5-based pre-trained models.

Tab. 13 lists the results of the text summarization datasets. Tab. 14 lists the results of the machine translation datasets. Tab. 15 shows the results of the data-to-text task on the BAGEL dataset. Tab. 16 shows the results of the data-to-text task on the SFRES dataset.

Model	K	ACC	FLU	MQM
GPT3-ada	0	23.7	6.3	24.1
	1	22.5	4.9	26.1
	2	21.5	12.8	25.6
	4	27.9	12.2	24.3
	8	27.9	11.6	24.4
	12	29.5	10.6	24.7
GPT3-babbage	0	25.0	10.9	29.6
	1	23.4	11.9	30.2
	2	24.0	13.3	30.9
	4	29.7	14.7	31.5
	8	29.8	14.0	31.2
	12	31.0	14.9	32.6
GPT3-curie	0	30.3	9.3	34.8
	1	29.8	12.5	31.9
	2	30.2	16.4	32.9
	4	33.1	15.8	33.2
	8	30.2	17.9	34.5
	12	32.3	18.8	34.3
GPT3-davinci001	0	26.9	8.6	32.6
	1	27.2	12.5	33.4
	2	27.8	16.2	35.3
	4	30.3	16.1	37.7
	8	31.2	17.5	38.3
	12	31.7	17.5	39.1
GPT3-davinci003	0	29.5	21.3	32.8
	1	30.7	19.3	31.4
	2	30.1	21.6	32.9
	4	29.5	19.1	33.5
	8	29.3	21.5	32.2
	12	29.8	21.8	32.5

Table 9. Spearman correlation of the GPT3-based models (e.g, text-ada-001 and text-davinci-001) with different demonstration sample numbers on the MQM-2020 dataset .K denotes the number of samples in the demonstration.

X	Aspect	Aspect Definition	Spear
1	Interesting (INT)	Is this response interesting to the convsersation?	36.9
2	Engaging (ENG)	Is this an interesting response that is engaging?	40.7
3	Specific (SPE)	Is this an interesting response that is specific and engaging?	48.6
4	Correct (COR)	Is this an interesting response that is engaging, specific, and correct?	50.0
5	Relevant (REL)	Is this an interesting response that is specific, engaging, relevant, and correct?	**51.3**
6	Understandable (UND)	Is this an interesting response that is specific, engaging, relevant, correct, and understandable?	50.9
7	Semantically appropriate (SEM)	Is this an interesting response that is specific, engaging, relevant, correct, understandable, and semantically appropriate?	51.4
8	Fluent (FLU)	Is this an interesting response that is specific, engaging, relevant, correct, understandable, semantically appropriate, and fluent?	50.3

Table 10. The aspect definition and Spearman correlation of `INT`. *X* denotes the number of aspects combined with the `INT`. The scoring model is GPT3-c01.

Aspect	Function	Instruction
Text Summarization		
FAC	src->hypo	Generate a summary with consistent facts for the following text: {src}\n\nTl;dr{hypo}
	ref<->hypo	Rewrite the following text with consistent facts. {ref/hypo} In other words, {hypo/ref}
COV	src->hypo	Generate a summary with as much semantic coverage as possible for the following text: {src}\n\nTl;dr{hypo}
	ref<->hypo	Rewrite the following text with the same semantics. {ref/hypo} In other words, {hypo/ref}
CON	src->hypo	Generate factually consistent summary for the following text: {src}\n\nTl;dr{hypo}
	ref<->hypo	Rewrite the following text with consistent facts. {ref/hypo} In other words, {hypo/ref}
INF	src->hypo	Generate an informative summary that captures the key points of the following text: {src}\n\nTl;dr{hypo}
	ref<->hypo	Rewrite the following text with its core information. {ref/hypo} In other words, {hypo/ref}
COH	src->hypo	Generate a coherent summary for the following text: {src}\n\nTl;dr{hypo}
	ref<->hypo	Rewrite the following text into a coherent text. {ref/hypo} In other words, {hypo/ref}
REL	src->hypo	Generate a relevant summary with consistent details for the following text: {src}\n\nTl;dr{hypo}
	ref<->hypo	Rewrite the following text with consistent details. {ref/hypo} In other words, {hypo/ref}
FLU	src->hypo	Generate a fluent and grammatical summary for the following text: {src}\n\nTl;dr{hypo}
	ref<->hypo	Rewrite the following text into a fluent and grammatical text. {ref/hypo} In other words, {hypo/ref}
Machine Translation		
Acc	ref<->hypo	Rewrite the following text with its core information and consistent facts:{ref/hypo} In other words, {hypo/ref}
FLU	ref<->hypo	Rewrite the following text to make it more grammatical and well-written:{ref/hypo} In other words, {hypo/ref}
MQM	ref<->hypo	Rewrite the following text into high-quality text with its core information:{ref/hypo} In other words, {hypo/ref}
Data to Text		
INF	ref<->hypo	Convert the following text to another expression that preserves key information:\n\n{ref/hypo} In other words, {hypo/ref}
NAT	ref<->hypo	Convert the following text into another expression that is human-like and natural:\n\n{ref/hypo} In other words, {hypo/ref}
FLU	ref<->hypo	Convert the following text into another expression that preserves key information and is human-like and natural:\n\n{ref/hypo} In other words, {hypo/ref}

Table 11. Instruction design on different aspects for text summarization, machine translation, and data-to-text tasks. *src*, *hypo*, and *ref* denote the *source text*, *hypothesis text*, and *reference text*, respectively. *a->b* (*a<-b*) denotes to evaluate the quality of *b* (*a*) text based on the given *a* (*b*) text.

Aspect	Instruction
FED Turn-Level	
INT	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI interesting? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
ENG	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI engaging? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
UND	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI understandable? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
REL	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI relevant to the conversation? (a) Yes. (b) No.backslashnConversation: {History}\nAnswer: Yes.
SPE	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI generic or specific to the conversation? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
COR	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI correct to conversations? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.]
SEM	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI semantically appropriate? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
FLU	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI fluently written? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
FED Dialog-Level	
COH	Answer the question based on the conversation between a human and AI.\nQuestion: Is the AI coherent and maintains a good conversation flow throughout the conversation? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
DIV	Answer the question based on the conversation between a human and AI.\nQuestion: Is there diversity in the AI responses? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
FLE	Answer the question based on the conversation between a human and AI.\nQuestion: Is the AI flexible and adaptable to human and their interests? (a) Yes. (b) No. \nConversation: {History}\nAnswer: Yes.
UND	Answer the question based on the conversation between a human and AI.\nQuestion: Does the AI seem to understand the human? (a) Yes. (b) No. \nConversation: {History}\nAnswer: Yes.
INQ	Answer the question based on the conversation between a human and AI.\nQuestion: Is the AI inquisitive throughout the conversation? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
CON	Answer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI consistent in the information it provides throughout the conversation? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
INF	nswer the question based on the conversation between a human and AI.\nQuestion: Are the responses of AI informative throughout the conversation? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
LIK	Answer the question based on the conversation between a human and AI.\nQuestion: Does the AI display a likeable personality? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
DEP	Answer the question based on the conversation between a human and AI.\nQuestion: Does the AI discuss topics in depth? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.
ERR	Answer the question based on the conversation between a human and AI.\nQuestion: Is the AI able to recover from errors that it makes? (a) Yes. (b) No.\nConversation: {History}\nAnswer: Yes.

Table 12. Instruction design on various aspects for dialogue response generation task at the turn- and dialogue-level. *History* indicates the conversation history. We convert the evaluation of the response generation task as a question-answering task, and the aspect definition is incorporated into the question of the question-answering task.

Model	NEWSROOM								QXSUM	
	COH		CON		FLU		REL		COV	
	VAL	IST	VAL	IST	VAL	IST	VAL	IST	VAL	IST
ROUGE-1	27.3	-	26.1	-	25.9	-	34.4	-	3.6	-
ROUGE-2	10.9	-	11.7	-	11.2	-	14.4	-	9.9	-
ROUGE-L	24.7	-	25.7	-	24.4	-	32.5	-	5.2	-
BERTScore	31.7	-	31.7	-	27.2	-	33.7	-	-4.6	-
MoverScore	17.7	-	14.2	-	16.0	-	18.9	-	5.4	-
PRISM	60.7	-	56.5	-	59.2	-	61.9	-	2.5	-
BARTSCORE	70.3	-	67.2	-	63.1	-	68.8	-	0.9	-
+CNN	68.5	-	64.9	-	60.4	-	66.3	-	18.4	-
+CNN+Para	69.0	-	65.5	-	62.5	-	67.3	-	6.4	-
GPT3										
GPT3-a01	71.6	71.9†	69.7	70.0†	66.0	67.0†	69.6	69.2	10.3	9.2
GPT3-b01	73.6	72.9	70.2	70.3	66.8	68.3†	71.5	71.2	8.5	14.2
GPT3-c01	**73.8**	72.8	**70.5**	**70.9**†	65.9	68.6†	71.0	71.1	15.2	22.1†
GPT3-d01	72.6	**73.4**†	68.5	70.0†	65.9	66.9†	71.1	72.1†	**24.0**	**22.7**
GPT3-d03	73.8	73.1	70.4	70.0	**67.4**	**68.9**†	**74.1**	**73.3**	21.7	22.0†
Avg.	73.1	72.8	69.9	70.2†	66.4	67.9†	71.4	71.4	15.9	18.0†
GPT2										
GPT2-M	68.9	71.7†	66.4	68.0†	61.1	62.3†	67.0	66.8	18.1	18.7†
GPT2-L	70.5	**72.3**†	66.6	68.3†	60.2	61.4†	66.8	67.8†	19.2	19.6†
GPT2-XL	71.0	70.5	66.6	66.6	61.4	60.7	67.2	66.9	21.2	21.2
GPT-J-6B	**71.8**	71.4	**69.8**	**69.5**	**65.5**	**65.5**	**69.4**	**69.3**	**21.6**	**22.0**†
Avg.	70.5	71.5†	67.4	68.1†	62.0	62.5†	67.6	67.7	20.0	20.4†
OPT										
OPT-350M	70.6	71.5†	69.2	69.9†	67.3	68.1†	70.8	71.6†	13.5	13.3
OPT-1.3B	**73.2**	**73.6**†	**70.9**	**71.3**†	67.2	**67.8**†	**72.5**	**72.4**	21.1	19.9
OPT-6.7B	71.9	71.9	69.0	69.0	**67.7**	67.1	71.7	71.3	21.2	19.9
OPT-13B	71.9	71.9	68.9	69.6†	65.4	66.0†	71.2	71.5†	23.1	22.1
OPT-66B	72.8	72.8	70.0	69.5	66.0	65.9	71.9	71.9	**24.0**	**23.1**
Avg.	72.1	72.3†	69.6	69.9†	66.7	67.0†	71.6	71.8†	20.6	19.6
FLAN-T5										
FT5-S	68.3	69.2†	64.6	64.1	59.8	60.4†	64.6	65.5†	14.4	15.1†
FT5-B	68.9	69.0	64.8	64.6	59.6	59.9†	66.5	66.5	13.6	16.3†
FT5-L	70.5	69.1	66.1	64.6	60.9	60.0	66.6	65.4	**27.2**	**28.8**†
FT5-XL	**72.1**	**70.1**	**66.7**	**65.6**	**61.0**	**60.5**	**68.3**	67.5	18.9	25.6†
FT5-XXL	70.7	69.3	65.7	65.2	60.2	60.4†	67.6	**67.8**†	23.9	27.8†
Avg.	70.1	69.3	65.6	64.8	60.3	60.2	66.7	66.5	19.6	22.7†
Overall Avg	71.5	71.5	68.1	68.3	64.0	64.5†	69.4	69.4	19.0	20.2†

Table 13. Spearman correlations on NEWSROOM and QXSUM datasets for text summarization task. VAL and IST denote the evaluator with vanilla and instruction, respectively. Values with † denote the evaluator with instruction significantly outperforms with vanilla. Values in bold are the best performance in a set of variants (e.g., GPT3 family).

Model	ACC			FLU			MQM		
	VAL	IST	IDM	VAL	IST	IDM	VAL	IST	IDM
ROUGE-1	21.3	-	-	1.7	-	-	17.5	-	-
ROUGE-2	15.0	-	-	5.8	-	-	15.4	-	-
ROUGE-L	16.6	-	-	8.7	-	-	15.7	-	-
BERTScore	26.1	-	-	8.2	-	-	23.6	-	-
MoverScore	18.2	-	-	1.2	-	-	17.2	-	-
PRISM	25.9	-	-	9.1	-	-	27.4	-	-
BARTSCORE	26.1	-	-	8.2	-	-	23.6	-	-
+CNN	26.2	-	-	8.1	-	-	28.7	-	-
+CNN+Para	31.0	-	-	10.8	-	-	29.9	-	-
GPT3									
GPT3-a01	24.9	23.7	27.9†,‡	5.9	6.3†	11.6†,‡	27.0	24.1	24.4‡
GPT3-b01	25.9	25.0	29.8†,‡	10.7	10.8	14.0†,‡	29.4	29.6	31.2†,‡
GPT3-c01	**29.4**	**30.3**†	30.2†	10.7	9.3	17.9†,‡	**33.3**	34.8†	34.5†
GPT3-d01	28.6	26.5	**31.2**†,‡	11.3	8.6	17.5†,‡	32.0	32.5†	**38.3**†,‡
GPT3-d03	27.2	30.1†	29.5†	**18.0**	**17.1**	**21.3**†,‡	29.9	**34.8**†	32.8†
Avg.	27.2	27.1	29.7†,‡	11.3	10.4	16.4†,‡	30.3	31.2†	32.3†,‡
GPT2									
GPT2-M	25.7	24.6	29.6†,‡	8.6	9.4†	15.1†,‡	32.1	29.4	34.1†,‡
GPT2-L	27.2	28.5†	32.2†,‡	11.1	10.4	14.9†,‡	31.2	30.9	33.9†,‡
GPT2-XL	24.2	27.6†	29.7†,‡	9.4	12.0†	17.4†,‡	28.6	32.2†	35.8†,‡
GPT-J-6B	26.2	27.2†	29.5†,‡	9.9	11.2†	15.9†,‡	28.5	28.8†	30.3†,‡
Avg.	25.8	27.0†	30.3†,‡	9.8	10.8†	15.8†,‡	30.1	30.3†	33.5†,‡
OPT									
OPT-350M	29.3	28.1	28.6‡	11.7	11.9	15.7†,‡	31.5	32.5†	31.8
OPT-1.3B	27.9	27.7	28.0‡	8.8	13.3†	15.9†,‡	32.6	33.6†	32.9†
OPT-6.7B	29.6	30.7†	30.6†	10.7	12.2†	15.0†,‡	34.2	36.4†	36.9†,‡
OPT-13B	27.5	29.5†	30.8†,‡	9.6	11.7†	17.9†,‡	31.9	35.5†	37.5†,‡
OPT-66B	29.5	31.0†	33.4†,‡	9.1	12.1†	16.8†,‡	32.1	35.3†	36.4†,‡
Avg.	28.7	29.4†	30.3†,‡	10.0	12.2†	16.3†,‡	32.5	34.6†	35.1†,‡
FLAN-T5									
FT5-S	27.6	28.7†	27.0	12.6	9.4	15.0†,‡	33.5	33.3	31.3
FT5-B	25.5	25.4	27.4†,‡	10.4	10.2	15.9†,‡	29.8	29.6	30.0‡
FT5-L	28.5	28.5	28.8†,‡	7.9	13.0†	15.6†,‡	30.7	31.6†	32.1†,‡
FT5-XL	28.1	27.0	28.1‡	9.4	10.2†	14.0†,‡	30.4	33.5†	34.2†,‡
FT5-XXL	29.0	29.4†	30.5†,‡	7.6	12.2†	16.2†,‡	30.7	33.3†	33.8†,‡
Avg.	27.7	27.8	28.3†,‡	9.6	11.0†	15.4†,‡	31.0	32.3†	32.3†
Overall Avg	27.4	27.8†	29.7†,‡	10.2	11.1†	16.0†,‡	31.0	32.1†	33.3†,‡

Table 14. Spearman correlations on MQM-2020 dataset for machine translation task. VAL, IST, and IDM denote the evaluator with vanilla, instruction, and the combination of instruction and demonstration, respectively. Values with † denote the evaluator with instruction significantly outperforms with vanilla, and values with ‡ denote the evaluator with the combination of instruction and demonstration significantly outperforms with only instruction. Values in bold are the best performance in a set of variants (e.g., GPT3 family).

Model	INF			NAT			FLU		
	VAL	IST	IST+DM	VAL	IST	IST+DM	VAL	IST	IST+DM
ROUGE-1	28.7	-	-	5.0	-	-	8.3	-	-
ROUGE-2	24.0	-	-	15.2	-	-	16.0	-	-
ROUGE-L	26.3	-	-	10.5	-	-	11.0	-	-
BERTScore	37.2	-	-	16.0	-	-	18.7	-	-
MoverScore	30.7	-	-	20.4	-	-	14.8	-	-
PRISM	36.8	-	-	28.7	-	-	34.4	-	-
BARTSCORE	29.5	-	-	24.0	-	-	29.7	-	-
+CNN	37.7	-	-	30.1	-	-	34.4	-	-
+CNN+Para	39.2	-	-	31.0	-	-	44.9	-	-
GPT3									
GPT3-a01	33.3	37.0†	42.5†,‡	20.5	28.7†	**41.7**†,‡	28.8	**35.1**†	40.2†,‡
GPT3-b01	39.2	**44.5**†	42.2†	18.2	**29.8**†	39.1†,‡	30.0	33.8†	40.3†,‡
GPT3-c01	30.6	40.9†	**47.5**†,‡	24.8	26.5†	39.9†,‡	27.4	34.2†	44.2†,‡
GPT3-d01	**41.2**	39.4	43.6†,‡	**25.4**	26.2†	36.6†,‡	29.7	27.1	**47.9**†,‡
GPT3-d03	32.9	29.8	42.0†,‡	19.5	21.4†	27.5†,‡	**36.6**	34.2	44.4†,‡
Avg.	35.4	38.3†	43.6†,‡	21.7	26.5†	36.9†,‡	30.5	32.9†	43.4†,‡
GPT2									
GPT2-M	39.4	42.9†	38.6	31.2	33.2†	34.3†,‡	38.9	38.9	39.6†,‡
GPT2-L	39.7	42.2†	41.8†	30.1	33.5†	33.1†	34.0	40.0†	39.6†
GPT2-XL	41.2	42.0†	38.7	31.7	33.7†	34.8†,‡	38.0	40.6†	44.2†,‡
GPT-J-6B	42.8	45.6†	41.6	32.5	31.5	31.9‡	35.9	37.7†	42.0†,‡
Avg.	40.8	43.2†	40.2	31.4	33.0†	33.5†,‡	36.7	39.3†	41.3†,‡
OPT									
OPT-350M	37.0	36.8	37.9†,‡	33.9	32.5	31.1	39.9	39.5	39.9‡
OPT-1.3B	36.7	39.3†	38.2†	28.8	30.0†	32.9†,‡	37.3	34.9	40.9†,‡
OPT-6.7B	40.4	39.3	38.3	31.6	27.2	35.2†,‡	36.0	34.4	43.6†,‡
OPT-13B	37.9	37.6	38.9†,‡	31.4	30.3	34.6†,‡	39.2	39.0	41.2†,‡
OPT-66B	41.4	43.2†	39.6	31.3	30.2	34.7†,‡	36.3	37.6†	42.0†,‡
Avg.	38.7	39.3	38.6	31.4	30.0	33.7†,‡	37.7	37.1	41.5†,‡
FLAN-T5									
FT5-S	39.8	37.6	38.2	33.0	29.5	26.6	46.1	34.7	36.1‡
FT5-B	39.7	43.6†	37.7	26.4	30.3†	27.3†	37.8	40.6†	37.9
FT5-L	42.0	42.8†	38.9	23.6	31.0†	32.6†,‡	35.3	43.3†	44.5†,‡
FT5-XL	41.0	42.8†	43.3†,‡	24.8	28.9†	27.8†	37.4	44.4†	41.9†
FT5-XXL	44.9	40.7	37.4	24.8	28.8†	28.4†	34.2	42.5†	41.3†
Avg.	41.5	41.5	39.1	26.5	29.7†	28.6†	38.1	41.1†	40.3†
Overall Avg	39.1	40.6†	40.3†	27.7	29.8†	33.2†,‡	35.8	37.6†	41.6†,‡

Table 15. Spearman correlations on BAGEL dataset for data-to-text task. VAL, IST, and IDM denote the evaluator with vanilla, instruction, and the combination of instruction and demonstration, respectively. Values with † denote the evaluator with instruction significantly outperforms with vanilla, and values with ‡ denote the evaluator with the combination of instruction and demonstration significantly outperforms with only instruction. Values in bold are the best performance in a set of variants (e.g., GPT3 family).

Model	INF			NAT			FLU		
	VAL	IST	IST+DM	VAL	IST	IST+DM	VAL	IST	IST+DM
ROUGE-1	24.2	-	-	24.2	-	-	15.1	-	-
ROUGE-2	21.9	-	-	25.9	-	-	11.4	-	-
ROUGE-L	18.5	-	-	20.2	-	-	1.7	-	-
BERTScore	25.8	-	-	28.0	-	-	11.8	-	-
MoverScore	17.9	-	-	24.4	-	-	5.0	-	-
PRISM	27.4	-	-	33.1	-	-	14.2	-	-
BARTSCORE	22.4	-	-	25.5	-	-	6.9	-	-
+CNN	24.2	-	-	30.6	-	-	17.2	-	-
+CNN+Para	25.0	-	-	30.2	-	-	19.5	-	-
GPT3									
GPT3-a01	25.4	19.1	25.6‡	**28.7**	**34.0**†	**37.7**†,‡	30.7	27.0	26.6
GPT3-b01	**37.5**	28.4	26.5	21.5	30.6†	26.1†	24.6	28.9†	21.1
GPT3-c01	29.8	21.3	33.7†,‡	24.7	28.5†	28.6†	31.1	27.1	27.6‡
GPT3-d01	32.6	27.0	33.9†,‡	27.3	31.7†	21.9	**35.8**	**39.7**†	27.1
GPT3-d03	26.6	**29.6**†	**37.6**†,‡	22.6	27.0†	18.2	33.9	31.9	**28.2**
Avg.	30.4	25.1	31.5†,‡	25.0	30.4†	26.5†	31.2	30.9	26.1
GPT2									
GPT2-M	24.7	23.1	18.2	28.7	32.7†	35.2†,‡	18.7	34.8†	33.6†
GPT2-L	19.6	28.1†	20.2†	31.2	32.4†	37.8†,‡	18.6	33.1†	35.9†,‡
GPT2-XL	22.0	23.6†	23.8†	29.7	29.1	38.0†,‡	18.2	29.8†	37.1†,‡
GPT-J-6B	23.9	25.6†	19.6	34.3	33.3	36.8†,‡	24.4	34.5†	38.4†,‡
Avg.	22.5	25.1†	20.5	31.0	31.9†	37.0†,‡	20.0	33.1†	36.2†,‡
OPT									
OPT-350M	26.1	28.7†	25.4	27.0	29.5†	35.0†,‡	21.7	26.6†	27.3†,‡
OPT-1.3B	26.1	28.3†	23.5	26.0	30.5†	38.7†,‡	23.0	26.9†	29.8†,‡
OPT-6.7B	26.2	26.0	24.2	26.7	31.0†	36.5†,‡	21.7	25.8†	35.9†,‡
OPT-13B	27.7	26.9	26.0	24.4	30.1†	38.0†,‡	20.2	29.6†	34.9†,‡
OPT-66B	20.1	24.7†	22.4†	26.8	29.1†	34.6†,‡	19.8	19.1	25.3†,‡
Avg.	25.2	26.9†	24.3	26.2	30.0†	36.6†,‡	21.3	25.6†	30.6†,‡
FLAN-T5									
FT5-S	19.7	16.9	17.0	33.6	33.1	33.0	19.4	17.2	15.9
FT5-B	24.2	23.7	20.9	31.7	32.5†	33.4†,‡	14.2	15.5†	16.8†,‡
FT5-L	24.9	22.3	20.6	36.2	37.1†	38.6†,‡	24.3	18.1	21.1‡
FT5-XL	26.1	23.7	19.5	38.4	35.6	37.4‡	28.4	21.0	22.5‡
FT5-XXL	24.9	22.9	20.3	31.9	34.7†	41.7†,‡	23.8	16.9	22.2‡
Avg.	24.0	21.9	19.7	34.3	34.6†	36.8†,‡	22.0	17.8	19.7‡
Overall Avg	25.5	24.7	24.0	29.1	31.7	34.2†,‡	23.6	26.8†	28.2†,‡

Table 16. Spearman correlations on SFRES dataset for data-to-text task. VAL, IST, and IDM denote the evaluator with vanilla, instruction, and the combination of instruction and demonstration, respectively. Values with † denote the evaluator with instruction significantly outperforms with vanilla, and values with ‡ denote the evaluator with the combination of instruction and demonstration significantly outperforms with only instruction. Values in bold are the best performance in a set of variants (e.g., GPT3 family).