

Automatic Evaluation and Moderation of Open-domain Dialogue Systems

Chen Zhang¹, João Sedoc², Luis Fernando D’Haro³, Rafael Banchs⁴, Alexander Rudnicky⁵

¹National University of Singapore, Singapore

²Department of Technology, Operations, and Statistics, New York University, USA

³Speech Technology and Machine Learning Group - Universidad Politécnica de Madrid, Spain

⁴Intapp Inc., USA

⁵Carnegie Mellon University, USA

Abstract

The development of Open-Domain Dialogue Systems (ODS) is a trending topic due to the large number of research challenges, large societal and business impact, and advances in the underlying technology. However, the development of these kinds of systems requires two important characteristics: 1) automatic evaluation mechanisms that show high correlations with human judgements across multiple dialogue evaluation aspects (with explainable features for providing constructive and explicit feedback on the quality of generative models’ responses for quick development and deployment) and 2) mechanisms that can help to control chatbot responses, while avoiding toxicity and employing intelligent ways to handle toxic user comments and keeping interaction flow and engagement. This track at the 10th Dialogue System Technology Challenge (DSTC10) is part of the ongoing effort to promote scalable and toxic-free ODS. This paper describes the datasets and baselines provided to participants, as well as submission evaluation results for each of the two proposed subtasks.

1 Introduction

In recent years, dialogue systems have attracted significant academic and industry interest. Especially the discipline of open-domain dialogue systems, aka chatbots, which has gained great momentum. Yet, a long-standing challenge that concerns researchers is the lack of effective automatic evaluation metrics, which results in a significant research impediment (Yeh, Eskenazi, and Mehri 2021). Common practice in assessing the performance of open-domain dialogue models involves extensive human evaluation of the final deployed models, which is both time- and cost- intensive. During the model development phase, researchers must rely on standard automatic metrics, such as BLEU (Papineni et al. 2002) and perplexity, to tune the performance of their models. However, these metrics correlate poorly with human judgements (Liu et al. 2016) resulting in suboptimal dialogue systems.

Moreover, a recent trend in building open-domain chatbots involves pretraining dialogue models with a large amount of social media conversation data (Zhang et al. 2019; Adiwardana et al. 2020; Smith et al. 2020). However, the interaction data from social media conversations may include

offensive and inappropriate content. Indiscriminate usage of such data can result in insensitive and toxic generative models. Recently, (Xu et al. 2020) proposes recipes for safety in open-domain chatbots, such as unsafe utterance detection and safe utterance generation. Although these recipes help provide safe responses to toxic comments, the safe chatbot tends to avoid directly responding to these comments by switching to other topics. Sometimes, simply ignoring such comments may not be enough. Especially in the domain of customer support where customer service personnel must answer occasional offensive complaints in a polite and appropriate way.

This paper provides a comprehensive overview of Track 5 on “Automatic Evaluation and Moderation of Open-domain Dialogue Systems” organized as part of the 10th Dialogue System Technology Challenge (DSTC10). The paper is structured as follows. In section 2, we completely describe our first subtask on automatic evaluation metrics, including datasets, baseline, and participants’ results. Then, in section 3, we describe the datasets, baselines, and subjective and objective evaluation metrics for our second subtask on safe chatbot development. Finally, section 4 presents our main conclusions and directions for future work.

2 Automatic Evaluation Metrics

The goal of this subtask is for participants to design robust automatic dialogue evaluation metrics that correlate well with human judgements across multiple dialogue domains as well as across different dialogue evaluation dimensions, such as naturalness, appropriateness, etc. We allow the participants to use any existing resources (open-source human-human dialogue datasets, pretrained models, existing metrics, etc) for designing their own model-based evaluation metrics. There is one exception: the participants are not allowed to directly train supervised models on datasets containing human-annotated quality scores. The reason is that such models can easily overfit to the training datasets and hence, lose generalizability for performing evaluation of dialogues in new domains.

2.1 Datasets

During the system development phase, an evaluation benchmark, which consists of 14 publicly available datasets, was released for the participants to tune the performance of their

Name	#Instances	Avg.#Utts.	Avg.#Ctx/Hyp Words	Type	#Criteria	#Annotations	Used NLG models
Persona-USR (2020b)	300	9.3	98.4 / 12.0	Turn	6	5,400	Transformer Seq2Seq, LSTM LM, Memory Network
ConvAI2-GRADE (2020)	600	3.0	24.4 / 11.3	Turn	1	3,000	Transformer Seq2Seq, DialogPT, BERT/Transformer Ranker
Persona-Zhao (2020)	900	5.1	48.8 / 11.5	Turn	1	3,600	LSTM Seq2Seq, and GPT-2
DailyDialog-GRADE (2020)	300	3.0	26.0 / 10.8	Turn	1	3,000	Transformer Seq2Seq, Transformer Ranker
DailyDialog-Zhao (2020)	900	4.7	47.5 / 11.0	Turn	4	14,400	LSTM Seq2Seq, Random, and GPT-2
DailyDialog-Gupta (2019)	500	4.92	49.9 / 10.9	Turn	1	2,500	LSTM Seq2Seq, Conditional VAE
Topical-USR (2020b)	360	11.2	236.3 / 22.4	Turn	6	6,480	Transformers
Empathetic-GRADE (2020)	300	3.0	29.0 / 15.6	Turn	1	3,000	Transformer Seq2Seq, Transformer Ranker
Reddit-DSTC7 (2019)	9,990	3.5	35.3 / 11.2	Turn	3	29,700	RNN, LSTM Seq2Seq, Memory Network, Pointer-generator
Twitter-DSTC6 (2017)	40,000	2.0	27.74 / 20.77	Turn	1	400,000	LSTM Seq2Seq Variants
FED-Turn (2020a)	375	10.4	87.3 / 13.3	Turn	9	16,863	Meena, Mitsuku
HUMOD (2020)	9,500	3.9	17.0 / 6.1	Turn	2	57,000	Random sampling
FED-Dial (2020a)	125	12.7	113.8 / -	Dialogue	11	6,720	Meena, Mitsuku
Persona-See (2019)	3316	12.0	91.07 / -	Dialogue	9	29,844	LSTM Seq2Seq with Different Controlling Strategies

Table 1: Summary of the development datasets. Some information are from (Yeh, Eskenazi, and Mehri 2021).

proposed metrics. During the final evaluation phase, we have collected five hidden test evaluation datasets for assessing participants’ submissions.

Development Datasets The detailed statistics of the 14 development evaluation datasets are outlined in Table 1 and each dataset is outlined as follows:

The GRADE Datasets Huang et al. (2020) collected three evaluation datasets, Empathetic-GRADE, DailyDialog-GRADE and ConvAI2-GRADE, which are collected based on dialogues in the test sets of EmpatheticDialogues (Rashkin et al. 2019), DailyDialog (Li et al. 2017a) and ConvAI2¹ (Dinan et al. 2020) respectively. Each context-response pair is annotated by 8-10 different AMT turkers. The turkers are asked to assess the coherence between a context and the corresponding response on a scale of 1-5 (not coherent at all to very coherent). Since only the human scores for each pair are publicly available and there is no information regarding the annotators, we assume that the same group of annotators consistently annotated all context-response pairs. Hence, the inter-annotator agreements of Empathetic-GRADE, DailyDialog-GRADE and ConvAI2-GRADE in terms of Spearman correlations are 0.376, 0.423 and 0.453 respectively.

DailyDialog-Zhao (Zhao, Lala, and Kawahara 2020) evaluation dataset is collected based on 100 dialogues sampled from the test set of the DailyDialog corpus (Li et al. 2017b). In DailyDialog-Zhao, four criteria are assessed: appropriateness, language usage, relevance, and content. Each context-response pair is rated by four annotators on a 5-point Likert scale. The Krippendorff’s α along appropriateness after removal of outliers is above 0.8.

DailyDialog-Gupta (Gupta et al. 2019) is constructed based on 100 dialogue contexts from the test set of DailyDialog. In DailyDialog-Gupta, each context-response pair is annotated by 5 different AMT workers along the appropriateness dimension (from 1-5). According to the original paper, ratings of annotators with a Cohen’s Kappa inter-annotator agreement of less than 0.2 are removed. The remaining workers have a mean kappa of 0.43, indicating moderate agreement.

Persona-Zhao (Zhao, Lala, and Kawahara 2020) evaluation dataset is constructed in a similar manner as

DailyDialog-Eval. The context-response pairs of Persona-Zhao are collected based on dialogues from the test set of the PersonaChat corpus (Zhang et al. 2018). Only the appropriateness quality of the response is annotated in Persona-Zhao, with an inter-annotator agreement above 0.8 in terms of Krippendorff’s α .

The USR Datasets Mehri and Eskenazi (2020b) developed two high-quality human evaluation datasets, Topical-USR and Persona-USR. The same annotation schemes are applied to both datasets. Each context-response pair is annotated by three dialogue researchers along six different dialogue quality categories: Understandable (0-1), Natural (1-3), Maintains Context (1-3), Interesting (1-3), Uses Knowledge (0-1), Overall Quality (1-5)². The inter-annotator agreements for the above six annotation categories of USR-Topical are: 0.5102, 0.4871, 0.5599, 0.5811, 0.7090, and 0.7183 respectively in terms of Spearman correlation scores. For USR-Persona, the inter-annotator agreements of the six annotation categories are: 0.2984, 0.4842, 0.6125, 0.4318, 0.8115 and 0.6577 respectively.

HUMOD (Merdivan et al. 2020) is a high-quality human annotated multi-turn movie dialogue dataset developed from the Cornell Movie-Dialogs Corpus (Danescu-Niculescu-Mizil and Lee 2011). HUMOD contains human annotations on fictional conversations of the movie scripts and diverse human generated replies. Each context-response pair in HUMOD is annotated by three different annotators. The annotators provide scores between 1 and 5 to indicate the degree of relevance between a response w.r.t. the corresponding context. The inter-annotator agreements of HUMOD along the relevance criteria are 0.836 and 0.836 respectively, in terms of Pearson and Spearman correlations.

Twitter-DSTC6 (Hori and Hori 2017) is the largest among all evaluation datasets (40000 context-response pairs). Each context-response pair in Twitter-DSTC6 is annotated by 10 different Turkers using 5-point Likert Scale. The annotation is based on whether the responses are relevant to the respective dialogue context. The inter-annotator agreement of Twitter-Eval is 0.421 and 0.476, respectively, in terms of Pearson and Spearman correlations.

Reddit-DSTC7 (Galley et al. 2019) consists of knowledge-grounded conversations. For each context-

¹Dev set of ConvAI2

²The numbers in the bracket are the Likert scales.

response pair, three crowd-sourced annotators provide scores based on two criteria, relevance and informativeness. The scores for each criterion are based on the 5-point Likert scale. The overall score is obtained by combining the two judgments with equal weights.

Persona-See (See et al. 2019) evaluation dataset contains 3,316 conversations from 26 model configurations including a human agent. The annotation is performed at the dialogue level in an interactive fashion. An annotator chats with one model configuration for 6 conversational exchanges. At the end of the conversation, the annotator rates the interaction based on eight criteria: avoiding repetition, interestingness, making sense, fluency, listening, inquisitiveness, humanness and engagingness. All questions use a 1-4 Likert scale³, the higher, the better. On average, there are 114 conversations per model configuration and each model configuration has been evaluated by over 100 annotators.

FED (Mehri and Eskenazi 2020a) consists of 124 conversations: 40 come from Meena, 44 come from Mitsuku and another 40 are drawn from human-human conversations. Quality annotations are performed at both the dialogue level and turn level. There were 9 turn-level criteria, and 11 dialog-level criteria. We denote the turn- and dialogue-level evaluation datasets FED-Dial and FED-Turn respectively. The inter-annotator agreements of FED-Turn and FED-Dial along each evaluation criteria range from approximately 0.70 to 0.85 in terms of Spearman correlations, indicating high agreement⁴.

Test Datasets

CHANEL-JSALT-2020 (JSALT) The JSALT dataset includes validity annotations on a 3 point-scale of dialog segments (Kong-Vega et al. 2019) from the EmpatheticDialogues and the TopicalChat datasets. They take each dialog segment and have it annotated by four different annotators. This dataset consists of only human continuations of the dialogues.

ChatEval Datasets – Neural Conversation Model (NCM) & English As a Second Language (ESL) We also evaluate against several datasets released by Sedoc et al. (2019) including the Neural Conversational Model (NCM) and ESL three turn dialogue segment datasets. The NCM dataset is a collection of hand-crafted 200 single turn prompts developed by Vinyals and Le (2015). The 200 ESL dialogue segments are from an English learning website.⁵ NCM and ESL datasets contain pairwise comparisons between system responses. NCM has 59 comparisons between 11 systems and 2 human baselines with at least 3 annotators for each prompt. The dataset has over 33K pairwise comparisons. ESL has 21 comparisons of 5 systems and a human baseline with just over 13K judgements (Lee, Lim, and Sedoc 2020). We compute the win ratio for each human reference-model response pair and normalize by the number of comparisons. The win ratio most closely represents the *Overall Quality*

³Except for avoiding repetition and inquisitiveness

⁴Except understandability for turn-level, and consistency for dialogue-level

⁵<https://www.eslfast.com/>

since it captures human preference between two candidate responses.

DSTC10-T5.1 Evaluation Set (Topical-DTSC10 & Persona-DSTC10) As part of DSTC10 Track 5, we create a new dataset. We use the framework provided by Zhao, Lala, and Kawahara (2020). Our only change to the survey is that we include 8 systems, a human baseline, and a random utterance instead of 3 at a time. Specifically, the 8 systems are LSTM Seq2Seq, attention-based LSTM Seq2Seq, HRED, VHRED, BlenderBot (400M-Distill) (Roller et al. 2021), DialoGPT (medium) (Zhang et al. 2019), T5 (base) (Raffel et al. 2020), and GPT-3 (Brown et al. 2020). They cover a wide quality spectrum of dialogue systems.

Our dataset can be divided into two sub-datasets based on the domains. We denote them Topical-DTSC10 and Persona-DSTC10. For both datasets, we sample 500 dialogue segments from the conversations in the test set of TopicalChat and PersonaChat, respectively. In total, we collected 4500 context-response pairs (9 responses per context) for Topical-DTSC10 and 5000 context-response pairs (10 responses per context) for Persona-DSTC10. Each context-response pair is rated by four annotators following Zhao, Lala, and Kawahara (2020). After applying mean average deviation filtering, the annotator agreement as measured by Krippendorff’s alpha is 0.688.

2.2 Baseline

We adopt the deep AM-FM framework (Zhang et al. 2021b), an ensemble metric, as the baseline for the automatic dialogue evaluation task⁶. We modify the framework to a reference-free version whereby for AM, we compute the cosine similarity between the sentence-level embedding of the response and that of the last sentence in the corresponding dialogue context. For FM, we follow the formulation of the context-response coherence metric in HolisticEval (Pang et al. 2020). Motivated by (Zhang et al. 2021c), we choose RoBERTa-base (Liu et al. 2019) as the backbone pretrained language model of AM. We further adapt the pretrained model to a combination of four dialogue corpora: DailyDialog (Li et al. 2017b), TopicalChat (Gopalakrishnan et al. 2019), ConvAI2 (Dinan et al. 2020), and EmpatheticDialogues (Rashkin et al. 2019) with the mask language modeling objective. The backbone of FM is a GPT2-medium model (Radford et al. 2019) that has adapted to the same above-mentioned combination of dialogue corpora with the causal language modeling objective.

2.3 Participants

In total, we received 21 and 35 submissions from nine different teams for development and testing, respectively. We request each team to provide a short system description w.r.t. their submissions. Below is the list of descriptions collected from the participants:

Team 1 System Description Team 1 experimented with a broad range of ideas, ranging from a single DynaEval model (Zhang et al. 2021a) to the ensemble of multiple

⁶https://github.com/e0397123/dstc10_metric_track

metrics. Team 1 improves DyanEval’s performance on turn-level evaluation by adding auxiliary objectives such as next sentence prediction, and response selection. In their ensemble approach, team 1 combines USL-H (Phy, Zhao, and Aizawa 2020), DEB (Sai et al. 2020), and the improved DyanEval metric with weights determined by the characteristics of input dialogue data.

Team 4 System Description Inspired by a recent work on characterizing Twitter SpamBots as humans (Giorgi, Ungar, and Schwartz 2021), team 4 employs five human-centered metrics, including *emotional entropy*, *linguistic style matching*, *emotion matching*, *agreeableness*, and *empathy*. These metrics are proposed based on the assumption that dialogues are part of a psychologically grounded hierarchical process.

Team 5 System Description Team 5 proposes an ensemble metric consisting of 5 metric categories with 7 distinct sub-metrics, to holistically evaluate the quality of dialogues. A novel score composition method, Correlation Re-Scaling (CRS), is adopted to model the relationship between the sub-metrics and various dialogue qualities.

Team 8 System Description Team 8 proposes a framework named IM^2 (Interpretable and Multi-category Integrated Metric) to tackle the multi-dimensional, and multi-datasets automatic dialogue evaluation task. Firstly, team 8 groups a list of evaluation metrics into four categories with each target one aspect of the dialogues, specifically, FI-Metric for first impression, NUF-metric for response quality, CR-metric for context relevance, and IES-Metric for specificity. The scores w.r.t. each category are combined with linear regression to derive the final IM^2 metric score.

Team 9 System Description For turn-level evaluation datasets, team 9 employs two QuantiDCE (Ye et al. 2021) variants: (1) QuantiDCE model pretrained on the DailyDialog++ dataset (Sai et al. 2020). (2) QuantiDCE modelc finetuned with the respective evaluation datasets via knowledge distillation. For dialogue-level evaluation datasets, DynaEval (Zhang et al. 2021a) is adopted for correlation analysis.

2.4 Results

Table 2 presents the main correlation results of each team on the five test datasets. For each row in the table, we show the Spearman rank correlation w.r.t. each team’s best submission. Each entry at row 6 is computed by averaging the 11 dimension-wise correlation scores over all the five datasets. Each dimension-wise correlation score is computed between the metric scores assigned to all the data instances within a test dataset and the corresponding human annotated scores along one evaluation criteria of that particular dataset.

Based on the results in row 6, Teams 5, 8, and 1 rank first, second, and third, respectively. Team 5 performs the best on Topical-DSTC10 and Persona-DSTC10. Team 1 performs the best on JSALT and NCM. Team 9 performs the best on ESL. Remarkably, Team 1, 5, and 8 all rely on ensembling multiple sub-metrics for evaluation. The weights of combining different sub-metrics are dynamically learnt from the data. This finding is inline with the observation made in Yeh,

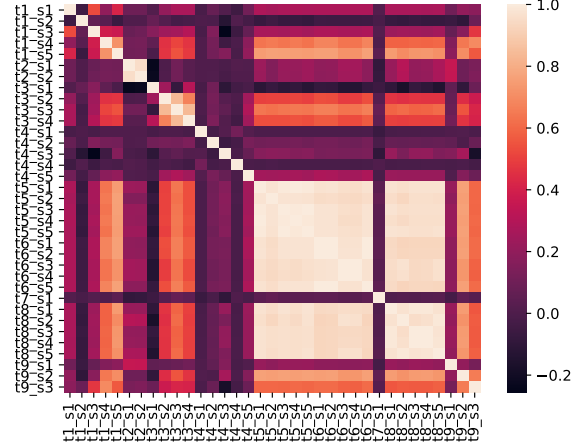


Figure 1: Spearman correlations w.r.t. different pairs of test submissions. The name of each submission is denoted as $t\{x\}_s\{y\}$ where x is the team number and y is the submission number.

Eskenazi, and Mehri (2021), which highlights the advantage of combining multiple sub-metrics.

Table 3 presents the correlation results of each team on the 14 development datasets. It can be observed that Team 7 performs exceptionally well with an average correlation score of 52.15%, outperforming the second best team by a large margin of around 13%, and achieving the best performance on 11 datasets. Team 8 and Team 6 rank the second, and the third respectively.

In general, all teams’ performance on the test datasets is worse compared to that on the development datasets (Table 3). Surprisingly, the performance of Team 7 on the test datasets is significantly worse compared to their performance on the development datasets. All teams’ performance drop is expected as the test datasets and development datasets are of different distributions. This not only showcases that the test datasets are challenging, but also highlights the need to continue developing robust metrics that can generalize to unseen evaluation datasets.

Figure 1 demonstrates the pairwise Spearman correlation of all 35 submissions. Each submission contains 18,641 metric scores w.r.t test instances of all five test datasets. Interestingly, we can observe clusters (Teams 5,6, and 8), thus indicating effectively similar approaches. However, some teams submitted quite different metrics even within the team (e.g., Teams 1 and 4). This points out that there may be value in ensembling these metrics.

3 Safe Chatbot Development

The goal of this subtask is for participants to build generative models that first detect a toxic user’s comment, and then generate appropriate and polite responses that keep the dialogue fluid and nontoxic.

In the literature, we find different definitions of toxicity and related terms such as offensive, hateful, abusive, insult-

Row	Datasets	Baseline	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8	Team 9
1	JSALT	5.09	27.74	3.10	10.54	4.96	11.66	<i>12.73</i>	4.07	8.75	<u>26.42</u>
2	ESL	32.29	43.18	19.86	28.75	9.34	<i>40.01</i>	32.92	3.28	36.10	45.58
3	NCM	16.49	29.91	1.98	22.08	8.24	<u>29.60</u>	26.60	2.01	25.57	19.11
4	Topical-DSTC10	17.48	<i>21.32</i>	10.85	14.56	8.33	23.68	20.00	1.43	<u>22.77</u>	17.41
5	Persona-DSTC10	19.61	30.67	7.77	25.80	16.59	37.50	35.78	2.54	<u>37.22</u>	33.82
6	Average	18.38	<i>27.81</i>	8.95	20.20	10.29	29.63	26.86	2.30	<u>28.19</u>	26.89

Table 2: Average Spearman correlations (%) of the baseline as well as the best submission from each team on 5 test datasets. The best score for each row is highlighted in bold. The second best is underlined. The third best is italicized. Note that each entry at row 6 is averaged over 11 dimension-wise correlation scores of all five datasets instead of over the entries of rows 1-5 in the same column.

Row	Datasets	Baseline	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7	Team 8	Team 9
1	ConvAI2-GRADE	9.38	50.43	7.23	41.01	17.31	<i>58.43</i>	<u>60.42</u>	57.00	60.43	53.07
2	DailyDialog-GRADE	15.48	<i>36.30</i>	3.45	11.16	19.86	33.42	30.00	64.42	30.06	41.89
3	DailyDialog-Gupta	17.70	56.78	2.76	38.16	11.39	<u>63.25</u>	<i>61.37</i>	78.85	60.84	46.69
4	DailyDialog-Zhao	22.25	36.94	20.96	33.09	19.85	48.03	<u>52.99</u>	54.50	52.79	28.70
5	Twitter-DSTC6	9.96	<i>24.46</i>	8.05	<u>47.95</u>	4.26	17.94	<u>18.35</u>	61.63	18.31	18.54
6	Reddit-DSTC7	2.67	33.97	19.78	<u>25.75</u>	12.14	32.48	34.15	31.30	<u>34.12</u>	<i>33.16</i>
7	Empathetic-GRADE	2.51	<u>39.52</u>	6.38	22.59	4.70	30.57	24.62	50.10	<u>24.65</u>	<i>36.50</i>
8	FED-Turn	5.09	23.85	9.49	11.96	19.27	30.38	<u>33.01</u>	35.15	32.88	19.87
9	HUMOD	11.73	32.86	1.93	31.11	4.16	33.20	33.83	22.45	33.83	22.28
10	Persona-USR	14.42	27.25	12.22	21.61	26.69	<u>40.36</u>	35.51	47.88	<i>36.17</i>	22.60
11	Persona-Zhao	46.79	55.21	24.23	50.19	5.23	61.32	<i>64.24</i>	76.40	64.58	55.70
12	Topical-USR	14.10	21.84	29.59	17.06	27.79	<i>39.08</i>	38.68	45.49	<u>40.24</u>	13.73
13	FED-Dial	11.18	26.92	25.22	5.70	5.93	46.89	<u>49.31</u>	77.42	<u>49.31</u>	40.26
14	Persona-See	8.08	5.70	3.50	6.95	3.69	8.78	<u>12.92</u>	27.52	<u>12.92</u>	6.27
15	Average	13.67	33.72	12.48	26.02	13.02	38.87	<i>39.24</i>	52.15	<u>39.37</u>	31.38

Table 3: Average Spearman correlations (%) of the baseline as well as the best submission from each team on 14 development evaluation datasets. The best score for each row is highlighted in bold. The second best is underlined. The third best is italicized.

ing, etc. (Fortuna, Soler, and Wanner 2020). For this task, we use the term toxic to refer to intentional and even nonintentional usage of words, terms, or expressions that are frequently used in the context of offensive speech. Due to the high subjectivity for considering a comment toxic or not, but also the difficulty for most current chatbots to clearly distinguish intentional from nonintentional toxic comments, we prefer the usage of toxic as a more general term, while the track promotes the creation of chatbots that can be safely used across all environments and audiences (i.e., that can be used by large corporations and even for kids).

3.1 Datasets and Baseline

To allow participants to train and evaluate their models, we collected data from four different datasets. These datasets are preprocessed and formatted from their original sources as part of the Chat/Dialogue Modeling and Evaluation task (CHANEL) held during the 2020 Seventh Frederick Jelinek Memorial Summer Workshop⁷. The datasets are publicly available at the CHANEL repository⁸. All the selected datasets are organized into turn of pairs (prompt-answer)

and processed using Microsoft Azure Cognitive Services⁹ to automatically detect toxic turns. Then, we select those pairs where the prompt was detected as toxic but the answer was not. To reduce false positives in the prompts or false negatives in the answers, we filter the Azure results by passing all detected turns through a dictionary consisting of 320 most common swear words in English. The dictionary is manually created from different lists on Internet including Wikipedia¹⁰, NoSwearing¹¹, SlangDictionary¹² and Hatebase¹³. In concrete, the datasets we used are:

MovieDic Originally released by (Banchs 2012), this dataset consists of 65,215 dialogues (512k turns). The final selected set consists of 5,9k toxic pair turns.

Cornell Movie Dataset Originally released by (Danescu-Niculescu-Mizil and Lee 2011), this dataset consists of 83,097 dialogues (304k turns). The final selected set consists of 3,2k turns.

⁷<https://www.clsp.jhu.edu/workshops/20-workshop/>

⁸<https://github.com/CHANEL-JSALT-2020/datasets>

⁹<https://azure.microsoft.com/en-us/services/cognitive-services/>

¹⁰https://en.wiktionary.org/wiki/Category:English_swear_words

¹¹<https://www.noswearing.com/dictionary>

¹²<http://onlineslangdictionary.com/>

¹³<https://hatebase.org/>

ChatCorpus This dataset consists of dialogues from different datasets including movies, lyrics, and Twitter. We use the Twitter.En.Big dataset consisting of 754,5k turns)¹⁴ organized into a single file where odd lines are considered the prompts and even lines are considered the answers. The final selected set consisted of 105,9k turns.

DSTC8-Reddit This dataset consists of 5,085,113 dialogues¹⁵ collected from Reddit conversations and used during DSTC8 (Li et al. 2020). Our final selected set consists of 47,1k turns.

Besides the toxicity detection process, we extract additional features for the selected pairs to allow participants to apply additional filters for selecting data for training. In concrete, we remove entities (for anonymization purposes) using the Stanza library¹⁶. We also extract humour score by using Colbert pretrained model¹⁷ (Annamoradnejad and Zoghi 2020), natural language inference for detecting entailment, contradiction and neutrality between prompts and answers¹⁸ and sarcasm¹⁹. Next, we perform emotion detection²⁰ distinguishing up to 7 different emotions: happiness, sadness, fear, angry, surprise, disgust, and neutral (Rodríguez-Cantelar et al. 2021). The use model is trained on four different datasets: Carer (Saravia et al. 2018), DailyDialog (Li et al. 2017a), EmpathicDialogs (Rashkin et al. 2018), and EmotionLines (Chen et al. 2018). Finally, we also apply the Perspective API²¹ to detect the level of toxicity for both prompts and answers. More detailed statistics for the four datasets are presented in Table 4.

Finally, participants are given as baseline a pretrained GPT-2 model trained on 147M multiturn dialogues from Reddit discussion threads (Zhang et al. 2019) and finetuned on all our provided training data²².

3.2 Annotations

To further assess the difficulty of the task, we manually annotate a subset of the test data. In total, 1290 prompt-answer pairs are annotated by 7 annotators from three different geographical zones (3 in the USA, 3 in Europe, and 1 in Asia). An annotation guideline, with no examples, is prepared to avoid biasing their responses. Only the toxic prompt is given as context and annotators are asked to annotate the answers in one of the following categories:

Category “1” 1. Any response that defuses toxicity or is a deflection. 2. Any reasonable response that is non-committal. 3. Any response that a corporate chatbot could

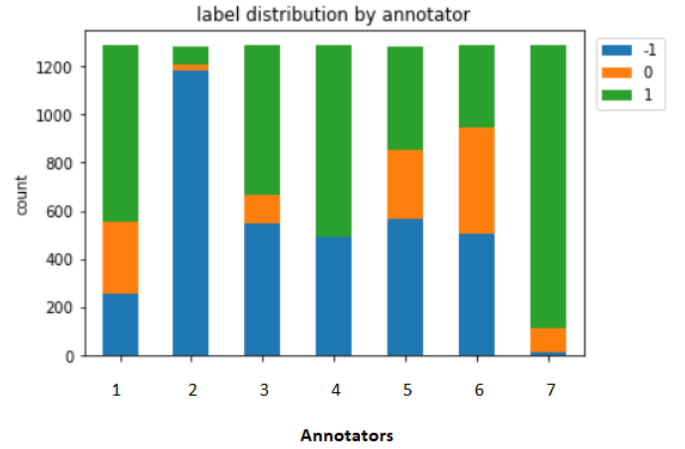


Figure 2: Label distribution between annotators

say with +80% confidence if the exact or similar toxic utterance is given to it.

Category “0” 1. A response that a noncorporate or less restricted chatbot might say. 2. An answer that could be used after some minor manual fix or edition. 3. When the toxic comment is not clear, too general, or very domain specific, but the answer still could be used in general situations.

Category “-1” 1. In case that the prompt, the answer, or both are ungrammatical sentences requiring several manual editions to be considered relevant. 2. Answers that are overly general, therefore they are not engaging or they do not limit subsequent toxic behaviour. 3. When neither the toxic comment nor the answer are good enough. 4. When either the prompt or answer utterances are too long.

Then, we use the Fleiss’ Kappa to measure the inter-annotator agreement. Unfortunately, the result is 0.1 which, after deeper analysis and discussion, is attributed to cultural differences between the annotators (i.e., differences in the consideration that something is toxic or not due to specific swearing words, intention or usability of the answers) as it has been pointed also by (Leonardelli et al. 2021). Figure 2 shows the label distribution among annotators.

3.3 Results

As there was no submission in this subtask, we decided to perform some objective and human evaluations by taking a selected set of toxic-answer prompts as described below.

Data preparation Table 5 shows the number of turn pairs where more than 3 annotators agreed on the three possible labels (-1, 0, and 1) as described in section 3.2. Based on these statistics, and with the purpose of comparing the output of different existing SotA chatbot models, we selected a subset of pairs where more than 5 annotators agreed. In this case, for label 1 we selected a total of 297 turns, while for label -1 we selected a total of 62.

The toxic prompts for the 359 selected turns were used as seeds to three different pretrained models: a) the pretrained baseline released to the participants (see section 3.1 based

¹⁴https://github.com/Marsan-Ma/chat_corpus/

¹⁵<https://github.com/microsoft/dstc8-reddit-corpus>

¹⁶<https://stanfordnlp.github.io/stanza/ner.html>

¹⁷<https://github.com/Moradnejad/ColBERT-Using-BERT-Sentence-Embedding-for-Humor-Detection>

¹⁸<https://huggingface.co/microsoft/deberta-large-mnli>

¹⁹<https://huggingface.co/mrm8488/t5-base-finetuned-sarcasm-twitter>

²⁰<https://drive.google.com/file/d/1lbEHWOQ6t66n-T06cLYDbEhSmXlJu4vx/view?usp=sharing>

²¹<https://developers.perspectiveapi.com/s/about-the-api>

²²<https://github.com/lfdharo/DSTC10.Track5.Toxicity>

	MovieDic			Cornell			ChatCorpus			Reddit		
	Train	Dev	Test	Train	Dev	Test	Train	Dev	Test	Train	Dev	Test
No. Turns	3359	720	1822	1829	392	995	74093	15877	15879	32977	7066	7067
Avg. turn length toxic	16.3	16.3	20.6	17.3	17.5	15.3	15.5	15.5	15.5	24.1	24.1	24
Avg. turn length answer	9.3	9.5	9.1	9.5	9.4	8.7	11.7	11.8	11.6	15.8	15.8	15.7
Avg. humour toxic	0.95	0.94	0.96	0.95	0.95	0.92	0.92	0.92	0.92	0.95	0.95	0.95
Avg. humour answer	0.78	0.78	0.78	0.79	0.8	0.77	0.81	0.81	0.8	0.85	0.85	0.84
Avg. sarcasm toxic	0.53	0.55	0.51	0.53	0.53	0.53	0.61	0.62	0.61	0.62	0.63	0.61
Avg. sarcasm answer	0.45	0.45	0.42	0.44	0.45	0.44	0.51	0.51	0.51	0.54	0.53	0.53
Avg. contradiction	0.41	0.44	0.41	0.41	0.42	0.41	0.31	0.31	0.32	0.26	0.26	0.26
Avg. neutral	0.55	0.51	0.55	0.55	0.53	0.54	0.66	0.66	0.66	0.72	0.71	0.72
Avg. entailment	0.03	0.04	0.05	0.04	0.05	0.05	0.03	0.03	0.02	0.03	0.03	0.03
Major emotion toxic	A	A	A	A	A	N	A	A	A	A	A	A
	38.7%	40.8%	36.3%	37.8%	37.0%	39.1%	35.2%	35.9%	35.7%	33.7%	33.9%	34.5%
Major emotion answer	N	N	N	N	N	N	H	H	H	N	N	N
	62.4%	61.5%	57.1%	61.2%	65.0%	63.8%	29.3%	29.4%	29.7%	28.4%	14.9%	28.3%
Avg. Perspective toxic	0.79	0.8	0.79	0.77	0.77	0.65	0.81	0.8	0.81	0.8	0.8	0.8
Avg. Perspective answer	0.15	0.16	0.15	0.15	0.14	0.14	0.22	0.22	0.22	0.16	0.16	0.16

Table 4: Statistics for the datasets used in Task 2. In the emotion rows, A, N and H mean Anger, Neutral and Happiness respectively.

	3	4	5	6	7
-1	57	220	164	62	0
0	59	4	0	0	0
1	192	232	176	102	19

Table 5: Statistics for the human annotation of 1290 prompts-answers turns.

on a finetuned version of DialogGPT, b) BlenderBot vs 2.0 including its safety layer (Xu, Szlam, and Weston 2021; Komeili, Shuster, and Weston 2021), and c) GPT-3 (Brown et al. 2020) available using the OpenAI API²³ and obtaining the response of the DaVinci version using as input prompt “The following is a conversation with an AI assistant. The assistant is helpful, creative, clever, and very friendly”, followed by the toxic prompt and saving the provided answer.

Subjective Metrics In this case, we performed manual annotations on a subset of the 359 selected turns from test and performed the binary task of assessing the quality of a pair of system answers given the toxic prompt. Below we describe the process in detail.

From the 359 sentences, we randomly selected 160 toxic prompts and created all possible pair combinations from the three possible chatbot responses. Then, we asked 7 annotators to perform the binary task of indicating which system was providing a better answer to the given toxic prompt. To avoid any bias, we randomly distributed the answers given by any of the selected chatbots. In addition, we asked the

annotators to indicate whether the answer provided by any or both chatbots was also toxic or could promote the user’s misbehavior. Finally, and as a control measure, we added 60 random pairs where the original human answer was compared against the three selected chatbots. Therefore, the total number of annotated items per annotator was 510 pairs.

A guideline was given to the annotators indicating to analyze the toxic prompt against the two possible answers and then selecting among these three options: a) A or B: to select the winner system, b) T (for tied): in case both answers were good, and c) U (for unrelated): in case both answers were completely unrelated to the prompt, wrong or unnatural. Moreover, we asked annotators to flag any of the answers in case they contain toxicity or promote the user’s misbehavior. Table 6 shows the statistics of the annotation where we compare the number of times a given system was selected over others, as well as the number of times it was not selected, or its response tied with another, or was unrelated/bad to the given prompt. Take into account that for human statistics only 60 sentences per annotator were annotated. Percentages are calculated over the total number of items annotated.

From the table, we can see that BlenderBot vs 2.0 performs the best (i.e., wins 44.3% of the times and with the same result as the original human answer) when compared with the other options, while GPT-3 is selected in the second place (27.3% of the times). The baseline is third with 17.9% of its answer being unrelated. Surprisingly, human answers are not always selected (i.e., they lose 16.2% of the time) and even they can be as good as other chatbots answers 16.9% of the time. In addition, human answers are considered not good (i.e., unrelated) 22.6% of the time which is a similar

²³<https://beta.openai.com/?app=chat>



Figure 3: Comparative performance between the different chatbots and human answers on the annotated test set

percentage obtained by the other chatbots. Refer to figure 3 for detailed information about the performance of each chatbot in comparison with the others or the human answer.

On the other hand, the results about how many times a response given by a chatbot was flagged (i.e., containing toxic or not engaging answers) show that our baseline was flagged 13.8% of the time, BlenderBot vs 2.0 9.9%, GPT-3 at 14.9%, and human answers were flagged 7.8% of the time.

These results probe the difficulty of the task due to the lack of context and how difficult it is to provide answers that are simultaneously informative, engaging, and nontoxic.

	Wins	Tied	Unrelated	Loses
Baseline	425 17.9%	335 14.1%	631 26.5%	989 41.6%
BlenderBot Vs 2.0	1054 44.3%	347 14.6%	505 21.2%	474 19.9%
GPT-3	650 27.3%	341 14.3%	605 25.4%	784 32.9%
Human	186 44.3%	71 16.9%	95 22.6%	68 16.2%
Total	2315	1094	1836	2315

Table 6: Comparison of the human selections for the test set on subtask 2. Percentage are over total no. annotated items for each chatbot.

Objective Metrics In this case, we took the same 359 sentences selected from the test set and the three generated chatbot outputs, comparing the outputs with the original ground truth (i.e., human answers) through four different objective metrics: a) BLEU: proposed by (Papineni et al. 2002), and more specifically through the SacreBleu implementation (Post 2018) providing scores from 0.0 to 1.0, b) ROUGE: proposed by (Lin 2004), which calculates the longest common subsequence (LCS) between each pair of reference and candidate sentences providing scores c) BERT-Score: proposed by (Zhang* et al. 2020) which uses pretrained contextual embeddings from BERT and then matching words in

System	BLEU	ROUGE	BERTScore	BLEURT
Baseline	0.008	0.072	0.832	-1.180
BlenderBot Vs 2.0	0.009	0.097	0.836	-1.183
GPT-3	0.008	0.065	0.831	-1.201

Table 7: Objective metrics for tested chatbots in subtask 2.

both the candidate and reference sentences by cosine similarity (i.e., provide values scores between 0.0 and 1.0), and d) BLEURT: proposed by (Sellam, Das, and Parikh 2020), a BERT-based model pretrained on synthetic data and fine-tuned on human annotations; in this model, positive scores are related with better responses.

Table 7 shows the results obtained for each of the evaluated chatbots. The results for the word-matching metrics (BLEU and ROUGE) are very low due to the high differences in the chatbot generated responses and the human ones, which does not necessarily mean they are bad, but syntactically different. On the other hand, semantic metrics (i.e., BERTScore and BLEURT) show marginal differences between chatbots, with a slight advantage for BlenderBot.

4 Conclusions and Future Work

This paper presents a comprehensive overview of Track 5 on “Automatic Evaluation and Moderation of Open-domain Dialogue Systems” organized as part of the 10th Dialogue System Technology Challenge (DSTC10). The track was organized in two subtasks aimed at addressing two important problems of the state-of-the-art in Dialogue Systems: the design of automatic evaluation metrics to propel the research and development cycles of dialogue technologies, and the management and moderation of offensive and toxic interactions to increase the safety of conversational systems.

The first subtask included active participation from nine teams, resulting in interesting contributions to the state-of-the-art on the specific problem of automatic evaluation of chat-oriented dialogue systems; however, these still seems to be room for significant improvements. The subtask assessed the performance of the submitted evaluation metrics against a reference-free deep AMFM baseline (Zhang et al. 2021b) over a collection of 19 different chatbot datasets (14 development and 5 test).

The second subtask, focused on the moderation of dialogue systems, ended up without submissions. However, the organizing team managed to propose and evaluate three different baseline systems, setting up a reference framework for an eventual rerun of the subtask in future editions of DSTC or similar venues. The management and moderation of offensive and toxic interactions is a nascent area of research of fundamental importance for ensuring the development of safe conversational system technologies.

As future work, we plan to continue increasing the coverage of the current datasets, as well as improving the baseline systems to make both challenge subtasks more competitive and attract new participants to the corresponding future editions. In detail, for subtask 1 we plan to include the unification of dimensions across existing datasets, the generation of annotations at dialogue level, and the incorporation of new

dimensions like toxicity and bias. As for subtask 2, we plan to include splitting the subtask into two parts: classification of the toxic comment and controlled generation based on the detected toxicity type.

Acknowledgments

We want to thank Mario Rodríguez-Cantelar and Marcos Es-techa for their contribution to the annotation of data for sub-task 2. We want to thank the JSALT2020 organizers: Sanjeev Khudanpur, Najim Dehak, Jan Trmal, and Piotr Żelasko, as well as the JSALT2020 workshop sponsors: Amazon and Microsoft, and Ms Azure services (especially Irving Kwong) for their support to collect, process, and automatically annotate the datasets used in subtask 2. We want to thank Seunggun Lee for his help with curating data and supporting the ChatEval website development. We want to thank Claire Daniele for her editorial support.

References

- Adiwardana, D.; Luong, M.-T.; So, D. R.; Hall, J.; Fiedel, N.; Thoppilan, R.; Yang, Z.; Kulshreshtha, A.; Nemade, G.; Lu, Y.; et al. 2020. Towards a human-like open-domain chatbot. *arXiv preprint arXiv:2001.09977*.
- Annamoradnejad, I.; and Zoghi, G. 2020. Colbert: Using bert sentence embedding for humor detection. *arXiv preprint arXiv:2004.12765*.
- Banchs, R. E. 2012. Movie-DiC: a movie dialogue corpus for research and development. In *Proceedings of the 50th Annual Meeting of ACL (Volume 2: Short Papers)*, 203–207.
- Brown, T. B.; Mann, B.; Ryder, N.; Subbiah, M.; Kaplan, J.; Dhariwal, P.; Neelakantan, A.; Shyam, P.; Sastry, G.; Askell, A.; et al. 2020. Language models are few-shot learners. *arXiv preprint arXiv:2005.14165*.
- Chen, S.-Y.; Hsu, C.-C.; Kuo, C.-C.; Ku, L.-W.; et al. 2018. Emotionlines: An emotion corpus of multi-party conversations. *arXiv preprint arXiv:1802.08379*.
- Danescu-Niculescu-Mizil, C.; and Lee, L. 2011. Chameleons in imagined conversations: A new approach to understanding coordination of linguistic style in dialogs. *arXiv preprint arXiv:1106.3077*.
- Dinan, E.; Logacheva, V.; Malykh, V.; Miller, A.; Shuster, K.; Urbanek, J.; Kiela, D.; Szlam, A.; Serban, I.; Lowe, R.; et al. 2020. The second conversational intelligence challenge (convai2). In *The NeurIPS’18 Competition*, 187–208. Springer.
- Fortuna, P.; Soler, J.; and Wanner, L. 2020. Toxic, hateful, offensive or abusive? what are we really classifying? an empirical analysis of hate speech datasets. In *Proceedings of the 12th language resources and evaluation conference*, 6786–6794.
- Galley, M.; Brockett, C.; Gao, X.; Gao, J.; and Dolan, B. 2019. Grounded Response Generation Task at DSTC7. In *AAAI Dialog System Technology Challenges Workshop*.
- Giorgi, S.; Ungar, L.; and Schwartz, H. A. 2021. Characterizing Social Spambots by their Human Traits. In *Findings of ACL: ACL-IJCNLP 2021*, 5148–5158. Online: Association for Computational Linguistics.
- Gopalakrishnan, K.; Hedayatnia, B.; Chen, Q.; Gottardi, A.; Kwatra, S.; Venkatesh, A.; Gabriel, R.; Hakkani-Tür, D.; and Al, A. A. 2019. Topical-Chat: Towards Knowledge-Grounded Open-Domain Conversations. In *INTERSPEECH*, 1891–1895.
- Gupta, P.; Mehri, S.; Zhao, T.; Pavel, A.; Eskenazi, M.; and Bigham, J. 2019. Investigating Evaluation of Open-Domain Dialogue Systems With Human Generated Multiple References. In *Proceedings of the 20th Annual SIGdial Meeting on Discourse and Dialogue*, 379–391. Stockholm, Sweden: Association for Computational Linguistics.
- Hori, C.; and Hori, T. 2017. End-to-end conversation modeling track in DSTC6. *arXiv preprint arXiv:1706.07440*.
- Huang, L.; Ye, Z.; Qin, J.; Lin, L.; and Liang, X. 2020. GRADE: Automatic Graph-Enhanced Coherence Metric for Evaluating Open-Domain Dialogue Systems. In *Proceedings of the 2020 Conference on Empirical Methods in Natural Language Processing (EMNLP)*.
- Komeili, M.; Shuster, K.; and Weston, J. 2021. Internet-augmented dialogue generation. *arXiv preprint arXiv:2107.07566*.
- Kong-Vega, N.; Shen, M.; Wang, M.; and D’Haro, L. F. 2019. Subjective annotation and evaluation of three different chatbots WOCHAT: shared task report. In *9th International Workshop on Spoken Dialogue System Technology*, 371–378. Springer.
- Lee, S.; Lim, H.; and Sedoc, J. 2020. An Evaluation Protocol for Generative Conversational Systems. *arXiv preprint arXiv:2010.12741*.
- Leonardelli, E.; Menini, S.; Aprosio, A. P.; Guerini, M.; and Tonelli, S. 2021. Agreeing to Disagree: Annotating Offensive Language Datasets with Annotators’ Disagreement. In *Proceedings of the 2021 Conference on Empirical Methods in Natural Language Processing*, 10528–10539.
- Li, J.; Peng, B.; Lee, S.; Gao, J.; Takanobu, R.; Zhu, Q.; Huang, M.; Schulz, H.; Atkinson, A.; and Adada, M. 2020. Results of the multi-domain task-completion dialog challenge. In *Proceedings of the 34th AAAI Conference on Artificial Intelligence, Eighth Dialog System Technology Challenge Workshop*.
- Li, Y.; Su, H.; Shen, X.; Li, W.; Cao, Z.; and Niu, S. 2017a. Dailydialog: A manually labelled multi-turn dialogue dataset. *arXiv preprint arXiv:1710.03957*.
- Li, Y.; Su, H.; Shen, X.; Li, W.; Cao, Z.; and Niu, S. 2017b. DailyDialog: A Manually Labelled Multi-turn Dialogue Dataset. In *Proceedings of the Eighth International Joint Conference on Natural Language Processing*, 986–995.
- Lin, C.-Y. 2004. ROUGE: A Package for Automatic Evaluation of Summaries. In *Text Summarization Branches Out*, 74–81. Barcelona, Spain: Association for Computational Linguistics.
- Liu, C.-W.; Lowe, R.; Serban, I. V.; Noseworthy, M.; Charlin, L.; and Pineau, J. 2016. How not to evaluate your dialogue system: An empirical study of unsupervised evaluation metrics for dialogue response generation. *arXiv preprint arXiv:1603.08023*.

- Liu, Y.; Ott, M.; Goyal, N.; Du, J.; Joshi, M.; Chen, D.; Levy, O.; Lewis, M.; Zettlemoyer, L.; and Stoyanov, V. 2019. RoBERTa: A Robustly Optimized BERT Pretraining Approach. *arXiv preprint arXiv:1907.11692*.
- Mehri, S.; and Eskenazi, M. 2020a. Unsupervised Evaluation of Interactive Dialog with DialoGPT. In *Proceedings of the 21th Annual Meeting of the SigDial*, 225–235.
- Mehri, S.; and Eskenazi, M. 2020b. USR: An Unsupervised and Reference Free Evaluation Metric for Dialog Generation. In *Proceedings of the 58th Annual Meeting of ACL*.
- Merdivan, E.; Singh, D.; Hanke, S.; Kropf, J.; Holzinger, A.; and Geist, M. 2020. Human Annotated Dialogues Dataset for Natural Conversational Agents. *Applied Sciences*, 10.
- Pang, B.; Nijkamp, E.; Han, W.; Zhou, L.; Liu, Y.; and Tu, K. 2020. Towards Holistic and Automatic Evaluation of Open-Domain Dialogue Generation. In *Proceedings of the 58th Annual Meeting of ACL*, 3619–3629. Online: Association for Computational Linguistics.
- Papineni, K.; Roukos, S.; Ward, T.; and Zhu, W.-J. 2002. Bleu: a method for automatic evaluation of machine translation. In *Proceedings of the 40th annual meeting of ACL*, 311–318.
- Phy, V.; Zhao, Y.; and Aizawa, A. 2020. Deconstruct to Reconstruct a Configurable Evaluation Metric for Open-Domain Dialogue Systems. In *Proceedings of the 28th International Conference on Computational Linguistics*, 4164–4178. Barcelona, Spain (Online): International Committee on Computational Linguistics.
- Post, M. 2018. A Call for Clarity in Reporting BLEU Scores. In *Proceedings of the Third Conference on Machine Translation: Research Papers*, 186–191. Belgium, Brussels: Association for Computational Linguistics.
- Radford, A.; Wu, J.; Child, R.; Luan, D.; Amodei, D.; Sutskever, I.; et al. 2019. Language models are unsupervised multitask learners. *OpenAI blog*.
- Raffel, C.; Shazeer, N.; Roberts, A.; Lee, K.; Narang, S.; Matena, M.; Zhou, Y.; Li, W.; and Liu, P. J. 2020. Exploring the Limits of Transfer Learning with a Unified Text-to-Text Transformer. *Journal of Machine Learning Research*, 21(140): 1–67.
- Rashkin, H.; Smith, E. M.; Li, M.; and Boureau, Y.-L. 2018. Towards empathetic open-domain conversation models: A new benchmark and dataset. *arXiv preprint arXiv:1811.00207*.
- Rashkin, H.; Smith, E. M.; Li, M.; and Boureau, Y.-L. 2019. Towards Empathetic Open-domain Conversation Models: A New Benchmark and Dataset. In *Proceedings of the 57th Annual Meeting of ACL*, 5370–5381.
- Rodríguez-Cantelar, M.; de la Cal, D.; Estechea, M.; Gutiérrez, A. G.; Martín, D.; Milara, N. R. N.; Jiménez, R. M.; and D’Haro, L. F. 2021. Genuine²: An open domain chatbot based on generative models. *Proceedings Alexa Socialbot Grand Challenge SGC4*.
- Roller, S.; Dinan, E.; Goyal, N.; Ju, D.; Williamson, M.; Liu, Y.; Xu, J.; Ott, M.; Smith, E. M.; Boureau, Y.-L.; and Weston, J. 2021. Recipes for Building an Open-Domain Chatbot. In *Proceedings of the 16th Conference of the European Chapter of ACL: Main Volume*, 300–325. Online: Association for Computational Linguistics.
- Sai, A. B.; Mohankumar, A. K.; Arora, S.; and Khapra, M. M. 2020. Improving Dialog Evaluation with a Multi-reference Adversarial Dataset and Large Scale Pretraining. *Trans. Assoc. Comput. Linguistics*, 8: 810–827.
- Saravia, E.; Liu, H.-C. T.; Huang, Y.-H.; Wu, J.; and Chen, Y.-S. 2018. Carer: Contextualized affect representations for emotion recognition. In *Proceedings of the 2018 Conference on Empirical Methods in Natural Language Processing*, 3687–3697.
- Sedoc, J.; Ippolito, D.; Kirubarajan, A.; Thirani, J.; Ungar, L.; and Callison-Burch, C. 2019. ChatEval: A Tool for Chatbot Evaluation. In *Proceedings of the 2019 Conference of the North American Chapter of ACL (Demonstrations)*, 60–65. Minneapolis, Minnesota: Association for Computational Linguistics.
- See, A.; Roller, S.; Kiela, D.; and Weston, J. 2019. What makes a good conversation? How controllable attributes affect human judgments. In *Proceedings of the 2019 Conference of the North American Chapter of ACL: Human Language Technologies, Volume 1 (Long and Short Papers)*, 1702–1723. Minneapolis, Minnesota: Association for Computational Linguistics.
- Sellam, T.; Das, D.; and Parikh, A. P. 2020. BLEURT: Learning Robust Metrics for Text Generation. In *ACL*.
- Smith, E. M.; Williamson, M.; Shuster, K.; Weston, J.; and Boureau, Y.-L. 2020. Can you put it all together: Evaluating conversational agents’ ability to blend skills. *arXiv preprint arXiv:2004.08449*.
- Vinyals, O.; and Le, Q. 2015. A neural conversational model. *arXiv preprint arXiv:1506.05869*.
- Xu, J.; Ju, D.; Li, M.; Boureau, Y.-L.; Weston, J.; and Dinan, E. 2020. Recipes for safety in open-domain chatbots. *arXiv preprint arXiv:2010.07079*.
- Xu, J.; Szlam, A.; and Weston, J. 2021. Beyond goldfish memory: Long-term open-domain conversation. *arXiv preprint arXiv:2107.07567*.
- Ye, Z.; Lu, L.; Huang, L.; Lin, L.; and Liang, X. 2021. Towards Quantifiable Dialogue Coherence Evaluation. In Zong, C.; Xia, F.; Li, W.; and Navigli, R., eds., *Proceedings of the 59th Annual Meeting of ACL and 11th International Joint Conference on Natural Language Processing, ACL/IJCNLP 2021, (Volume 1: Long Papers), August 1-6, 2021*, 2718–2729. Association for Computational Linguistics.
- Yeh, Y.-T.; Eskenazi, M.; and Mehri, S. 2021. A Comprehensive Assessment of Dialog Evaluation Metrics. *arXiv preprint arXiv:2106.03706*.
- Zhang, C.; Chen, Y.; D’Haro, L. F.; Zhang, Y.; Friedrichs, T.; Lee, G.; and Li, H. 2021a. DynaEval: Unifying Turn and Dialogue Level Evaluation. In Zong, C.; Xia, F.; Li, W.; and Navigli, R., eds., *Proceedings of the 59th Annual Meeting of ACL and the 11th International Joint Conference on Natural Language Processing, ACL/IJCNLP 2021, (Volume 1: Long Papers), Virtual Event, August 1-6, 2021*, 5676–5689. Association for Computational Linguistics.

Zhang, C.; D’Haro, L. F.; Banchs, R. E.; Friedrichs, T.; and Li, H. 2021b. *Deep AM-FM: Toolkit for Automatic Dialogue Evaluation*, 53–69. Singapore: Springer Singapore. ISBN 978-981-15-8395-7.

Zhang, C.; D’Haro, L. F.; Chen, Y.; Friedrichs, T.; and Li, H. 2021c. Investigating the Impact of Pre-trained Language Models on Dialog Evaluation. *arXiv preprint arXiv:2110.01895*.

Zhang, S.; Dinan, E.; Urbanek, J.; Szlam, A.; Kiela, D.; and Weston, J. 2018. Personalizing dialogue agents: I have a dog, do you have pets too? *arXiv preprint arXiv:1801.07243*.

Zhang*, T.; Kishore*, V.; Wu*, F.; Weinberger, K. Q.; and Artzi, Y. 2020. BERTScore: Evaluating Text Generation with BERT. In *International Conference on Learning Representations*.

Zhang, Y.; Sun, S.; Galley, M.; Chen, Y.-C.; Brockett, C.; Gao, X.; Gao, J.; Liu, J.; and Dolan, B. 2019. DialoGPT: Large-scale generative pre-training for conversational response generation. *arXiv preprint arXiv:1911.00536*.

Zhao, T.; Lala, D.; and Kawahara, T. 2020. Designing Precise and Robust Dialogue Response Evaluators. In *Proceedings of the 58th Annual Meeting of ACL*, 26–33.