Empathetic Persuasion: Reinforcing Empathy and Persuasiveness in Dialogue Systems

Azlaan Mustafa Samad *† **Kshitij Mishra** * **Mauajama Firdaus,** **Asif Ekbal** ‡
Department of Computer Science and Engineering
Indian Institute of Technology Patna
Patna, India
{kshitij_1921cs23,mauajama.pcs16,asif}@iitp.ac.in
azlaanmsamad@gmail.com

Abstract

Persuasion is an intricate process involving empathetic connection between two individuals. Plain persuasive responses may make a conversation non-engaging. Even the most well-intended and reasoned persuasive conversations can fall through in the absence of empathetic connection between the speaker and listener. In this paper, we propose a novel task of incorporating empathy when generating persuasive responses. We develop an empathetic persuasive dialogue system by fine-tuning a Maximum Likelihood Estimation (MLE)-based language model in a Reinforcement Learning (RL) framework. To design feedbacks for our RL-agent, we define an effective and efficient reward function considering consistency, repetitiveness, emotion and persuasion rewards to ensure consistency, non-repetitiveness, empathy and persuasiveness in the generated responses. Due to lack of emotion annotated persuasive data, we first annotate the existing PERSUAION-FORGOOD dataset with emotions, then build transformer based classifiers to provide emotion based feedbacks to our RL agent. Experimental results confirm that our proposed model increases the rate of generating persuasive responses as compared to the available state-of-the-art dialogue models while making the dialogues empathetically more engaging and retaining the language quality in responses.

1 Introduction

While conversing with persuasive dialogue agents, on top of fluent and meaningful response generation, a high quality conversation is often derived by understanding and acknowledging implied feelings towards the conversing partner. People are more likely to engage in the conversation when they are motivated with empathetic responses. These persuasive responses can be associated with different emotions in consonance with the way people perceive and think about the world. For instance, in Figure 1, while the strike-through response is persuasive, the green box response may be more engaging, as it connects with the end-user and acknowledges the underlying emotion of *caring*. In this work, we investigate different generic and task specific rewards to reinforce a dialogue agent to generate fluent, persuasive and empathetic responses.

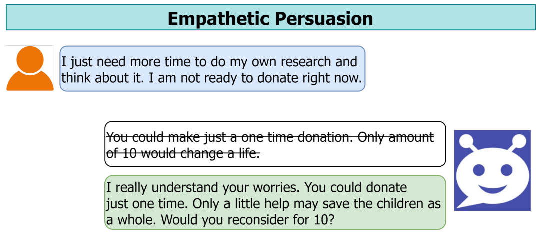

Figure 1: Example of persuasion with underlying caring emotion.

In recent studies on personalized conversational agents (Mazaré et al., 2018; Zheng et al., 2019; Wang et al., 2019; Zheng et al., 2020), it is suggested that adopting different human oriented chatbot identities or conversational strategies can significantly affect the responses of users and make the conversations more engaging. These dialogue agents greatly improved the user-targeted personalization. For instance, Shi and Yu (2018) include user sentiment to make an effective user-adaptive system. Li et al. (2019) takes both fine-grained token-level and coarse-grained sentence-level emotions to generate the responses. Mishra et al. (2022a) designed different rewards to reinforce politeness in a dialogue agent's responses. But, there is a subtle dependency between the different personalization techniques, such as empathy, sentiment and persuasion which can be used to generate better human-like responses. Therefore, we focus to incorporate emotions to generate more engaging and persuasive utterances.

* These authors are jointly first authors.
† Work done during an internship at IIT Patna.
‡ Corresponding author: asif@iitp.ac.in.

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Due to the paucity of available data and dynamic nature of attitude and emotions of users in an ongoing dialogue, it is a hard task to model a personalized dialogue agent in a Supervised Learning (SL) framework which can generalize to different users in different situations. These MLE-loss based models tend to suffer from exposure bias. Therefore, lately researchers have focused on RL to fine-tune these models due to its ability to learn from user interactions and improve based on user's feedbacks in the form of rewards (Singh et al., 1999; Li et al., 2016; Casanueva et al., 2018; Chen et al., 2019; Mesgar et al., 2020). An RL based dialogue agent treats dialog planning as a sequential decision problem and focuses on long-term rewards to decide the next action which helps in enhancing the performance compared to the earlier systems (Su et al., 2017).

Recently, there had been an effort made by Shi et al. (2020a) to refine an MLE-loss based language model without user simulators to generate persuasive responses. They focused to penalize repetitive and inconsistent utterance generation when persuading a persuadee. Our current work focuses on incorporating emotions to engage the end users empathetically as well as to persuade them for donation. We first design a reward function consisting of generic rewards i.e. consistency and repetitiveness, and the task specific rewards i.e. emotion and persuasiveness to explicitly assess the quality of a generated response as per consistency, repetition, emotion and persuasion. We then train a policy via RL to maximize the score given by our reward function. The policy generates a response at each turn, and is updated using the Proximal Policy Optimisation (PPO) algorithm (Schulman et al., 2017) based on the reward assigned to the entire generated response by the defined reward function .

As there is no relevant data that provides both emotion and persuasion, we extend the existing PERSUASIONFORGOOD (Wang et al., 2019) dataset to infuse empathy in the form of emotions. We assess the adequacy, fluency, empathy and persuasiveness of the generated responses from our RL-based model using both automatic as well human evaluation metrices. Our core contributions are *four-fold*:

1. To have persuasion with empathetic information, we manually annotate the PERSUASIONFORGOOD dataset with 23 different emotions.
2. We fine-tune transformers based pre-trained model to create robust and state-of-the-art models for emotion recognition and persuasive classification.
3. We propose an RL-based dialogue generation framework that makes use of two generic and two task specific rewards, to ensure fluency, non-repetitiveness, empathy and persuasiveness.
4. We use the automatic and human evaluation metrices to show that our RL-based system generates a response that is more consistent, fluent, empathetic and persuasive than the available state-of-the-art model (Shi et al., 2020a).

2 Related Work

Historically, there had been attempts made to model persuasions. Petty and Cacioppo's Elaboration Likelihood Model (ELM) (Petty and Cacioppo, 1986) argues that a person's persuasion depends on the varying degrees of thoughts of processing information and persuasive context. Friestad and Wright's Persuasion Knowledge Model (PKM) suggests that there is a inter-relationship between scientific persuasion knowledge and everyday persuasion knowledge (Friestad and Wright, 1994). Further, Dijkstra (2008) suggests that incorporation of personal factors with the persuasive information can enhance individual's motivation towards persuasive messages.

Recently, due to the increasing need for social chatbots, modelling empathy and persuasion has attracted much attention in the community. Rashkin et al. (2018) have proposed a EMPATHETICDIALOGUES dataset to generate empathetic dialogues grounded in emotional situations. To recognize user emotions and generate empathetic responses, Lin et al. (2020) developed an end-to-end dialogue system, CAiRE. Mishra et al. (2022b) predicted the politeness of utterances in goal-oriented conversations. While Hidey and McKeown (2018) modelled argument sequences in social media to predict the persuasiveness, the research reported in Yang et al. (2019) identified different persuasion strategies using a hierarchical neural network. Wang et al. (2019) proposed a multi-turn PERSUASIONFORGOOD dataset annotated with different persuasion strategies to model the persuasion classification. Using the same dataset, Shi et al. (2020b) randomly assigned 790 participants to different conditions to conduct an online study that whether they can be persuaded by a chatbot for charity donation or not. Lukin et al. (2017) considered personality traits in single-turn persuasion dialogues and found that personality factors such as emotional arguments on social and political issues can affect belief change, with conscientious, and can convince more people.

Recently, Wu et al. (2019) trained a MLE loss based language model while Shi et al. (2020a) fine-tuned this MLE loss based model in an RL-framework to generate persuasive responses. But, these research works focused on generating persuasive responses alone, whereas the persuasion, in itself, covers a vast domain space with different end-user attitudes. Further, a persuasive utterance cannot ensure engagement of user in an ongoing dialogue unless the user is connected emotionally with the cause s/he is persuaded for. Therefore, our work focuses here on the stylistic and engaging dialogue generation by incorporating empathy with persuasion. To the best of our knowledge, there has been no prior research that incorporated emotions for persuasive dialogue generation.

3 Methodology

3.1 Formal Definition

A multi-turn dialogue is defined as $d = \{p_1^e, p_1^r, p_2^e, p_2^r, ..., p_t^r, p_t^e\}$, where p_t^r and p_t^e are the utterances of the persuader and persuadee at turn t. The two individuals take turns to respond where a turn comprises of multiple sentences. Each utterance of the persuader in the dialogue has two labels, one for emotion $e = \{e_1^l, e_2^l, ..., e_t^l\}$ and the other for persuasion strategy $s = \{s_1^l, s_2^l, ..., s_t^l\}$ expressed by it. Here, l represents the label associated with the persuader's utterance p_i^r at the i^{th} turn. The sets $\mathbb{E} = \{e^{l_1}, e^{l_2}, ..., e^{l_{n_1}}\}$ and $\mathbb{S} = \{s^{l_1}, s^{l_2}, ..., s^{l_{n_2}}\}$ contain the different labels for emotion and persuasion strategy, where n_1 and n_2 denote the number of emotion and persuasion strategy labels, respectively.

3.2 Proposed Methodology

We first initialize our proposed model p_θ with a MLE loss pre-trained parameters q of ARDM model (Wu et al., 2019), then we fine-tune it by defining an efficient reward function in an RL framework. While fine-tuning, at each step RL-agent generates n candidate responses considering the entire dialogue history. These generated responses are compared with the gold human response and are assigned rewards based on the quality of the generated candidates. The model is rewarded for generating responses encompassing emotion and persuasion strategy while penalised for inconsistent and repetitive responses.

Emotion and Persuasion Classification: In order to receive persuasion and emotion reward feedbacks for RL-agent, we fine-tune a pre-trained RoBERTa (Liu et al., 2019) model to build two classifiers, *viz.* emotion and persuasion strategy classifiers. First, we fed the sampled batches to the model to obtain contextual representations $h_{<s>}$. Then $h_{<s>}$ is passed through a feed forward network which outputs a vector having scalar scores for all classes. Further, softmax function is applied to obtain the probability score of each class over all the classes. Lastly, highest probability score is chosen to represent the predicted class. The emotion (23 classes) and persuasion strategy classifiers (11 classes) achieve accuracy scores of 58.13% and 73.2%, respectively.

Reward: The reward function R is considered as a combination of multiple sub-rewards which serves to capture different aspects of an adequate response and assess the quality of the generated response candidates. The reward R consists of sub-rewards R_1 for repetitiveness, R_2 for consistency, R_3 for empathy and R_4 for persuasion. The final reward R is expressed as a weighted sum of these rewards as shown below:

$$R = \alpha_1 R_1 + \alpha_2 R_2 + \alpha_3 R_3 + \alpha_4 R_4 \quad (1)$$

Repetitiveness Reward: As pointed out by Shi et al. (2020a), the frequently occurring utterances in the dataset tend to be generated more by the models, and this repetition usually happens at the exact lexical level. Thus, we use Jaccard Score as a measure of similarity between the previous utterance p_{t-1}^r and the current generated response p_t^r based on unigrams. The sentences are first normalized using spaCy[1] and the generated score is then directly used as a sub-reward:

$$R_1 = \frac{p_{t-1}^r \cap p_t^r}{p_{t-1}^r \cup p_t^r} \quad (2)$$

Consistency Reward: In order to generate human-like responses, the Meteor score (Banerjee

[1]https://spacy.io/

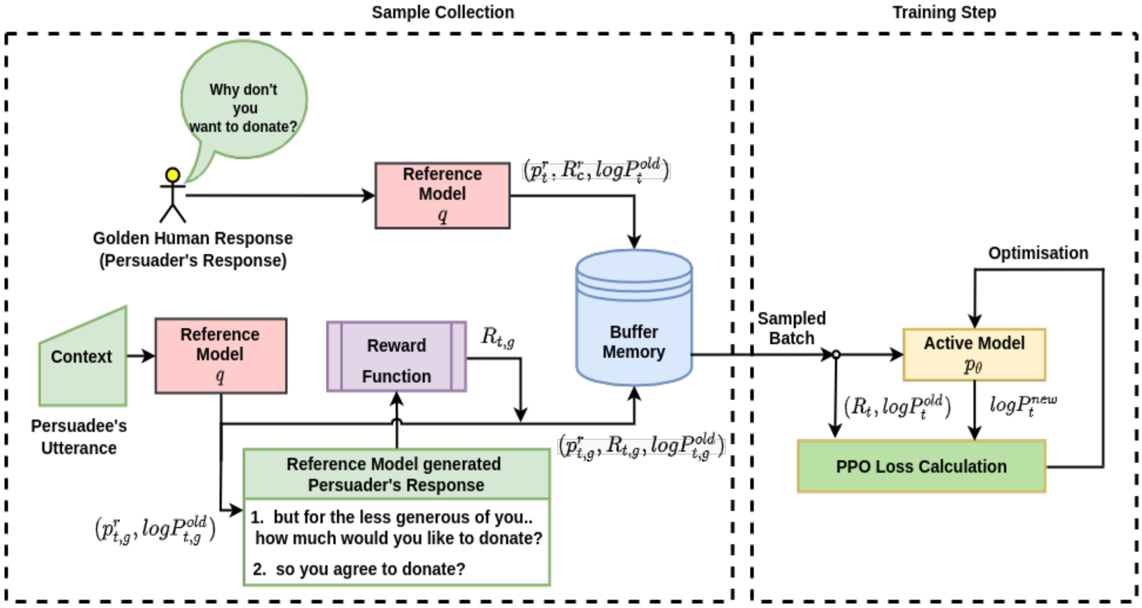

Figure 2: A skeleton of our overall system. Our architecture has two models: A Reference Model (RM) and an Active Model (AM). The RM is used for generating response candidate given a context (persuadee's utterance). It generates log probabilities for both the response candidates $(p_{t,g}^r, logP_{t,g}^{old})$ and the Golden Human Response $(p_t^r, logP_t^{old})$. Gold Human Response is the actual persuader's response present in the dataset. Rewards are then calculated for the generated candidates $R_{t,g}$ while the reward for gold human response R_c^r is a constant. These are then stored in the buffer memory, and sampled during the training. After sampling, the batch is inputted to the AM which outputs the new log probabilities $logP_t^{new}$ for the PPO loss calculation and finally optimisation is performed only for the Active Model.

and Lavie, 2005) is computed between the generated response p_t^r (hypothesis) and the gold human response ${p_g}_t^r$ (reference).

$$R_2 = MET(p_t^r, {p_g}_t^r) \tag{3}$$

We select Meteor score since it uses WordNet to match synonyms if exact match does not occur (Castillo and Estrella, 2012), and also because of its high correlation with human judgement in machine translation tasks (Banerjee and Lavie, 2005).

Emotion and Persuasion Reward: To design emotion and persuasion rewards, we use our emotion and persuasion strategy classifiers to predict the emotion and persuasion strategy of the generated candidates. These predicted labels are compared with ground truth emotion and persuasion strategy labels of the corresponding gold human response. The candidate with matching label is rewarded. For brevity, explanation is done in terms of emotion reward since both emotion and persuasion rewards are calculated in the exact same manner. In order to encourage emotion in the generated responses, the model is penalised for generating responses contradicting the gold human response label and encouraged for matching it:

$$R_3 = R_4 = \mathcal{P}_{e_j}(p_{t,g}^r) - \beta \sum_{i \in \mathcal{S} \setminus \{e_j\}} \mathcal{P}_i(p_{t,g}^r) \tag{4}$$

where $\mathcal{P}_i(p_{t,g}^r)$ is the probability of the generated response $p_{t,g}^r$ belonging to the class i where $i \in \mathcal{S}$ with $\mathcal{S} = \{e_1, e_2, ..., e_n\}$ being the set of all classes of size n. The term e_j in the above equation refers to the gold human response class at turn t. β is a scalar, which takes a value greater than or equal to 1. Increasing β would result in increased penalisation for contradiction.

Policy: Policy $\mathcal{P}_\theta$ is defined as the probability of generating a sentence y. The probability of the text sequence of length L is the joint probability of all the tokens that make up the entire text sequence.

$$\mathcal{P}_\theta(y_{1:L}|x) = \prod_{l=0}^{L} \mathcal{P}_\theta(y_l|y_{<l}, x) \tag{5}$$

Proximal Policy Optimisation: Proximal Policy Optimisation (PPO) (Schulman et al., 2017) is a policy gradient optimisation method which deals with the issues of sensitiveness, instability etc. faced by some of the policy gradient methods.

It is chosen because of ease of implementation and good performance on previous text generation task (Wu et al., 2020). The policy gradient methods maximize the expected reward following a parameterized policy using gradient ascent:

$$\nabla_\theta J(\theta) = \mathbb{E}_{y\sim\mathcal{P}_\theta}[\nabla_\theta \log \mathcal{P}_\theta(y)\hat{A}_y] \quad (6)$$

PPO replaces the log term in the above equation with an importance sampling term and clipping is performed in order to restrict the model from moving too much away from the policy, thus preventing catastrophic forgetting. In our implementation, we use the clipped version of PPO:

$$L^{\text{CLIP}}(\theta) = \hat{\mathbb{E}}[\min(r_y(\theta)\hat{A}_y, \text{clip}(r_y(\theta), 1-\varepsilon, 1+\varepsilon)\hat{A}_y)] \quad (7)$$

Here, $r_y(\theta)$ is the probability ratio of generating a response between new and old policies $\mathcal{P}_\theta^{new}/\mathcal{P}_\theta^{old}$. ε is a hyperparameter used to define the clipping range and $\hat{A}_y$ is the estimated advantage which is obtained by normalizing rewards in our case. Our architecture uses two models, *viz.* A Reference Model and an Active model as shown in Figure 2. Both the models are initialized with the same pre-trained parameters q, but only one is fine-tuned using RL. The Reference Model is used for the sample collection step, where the generated candidates and the golden human responses are stored along with their respective rewards and probabilities $\mathcal{P}_\theta^{old}$ in the buffer memory. During the training step, batch is sampled from the buffer memory and inputted to the Active Model to obtain the new probabilities$\mathcal{P}_\theta^{new}$. Finally, the loss is calculated as mentioned in equation 7 and the optimisation is performed.

$$\theta_{k+1} = \underset{\theta}{\text{argmax}} \underset{s,a\sim\mathcal{P}_{\theta_k}}{\mathbb{E}}[L^{\text{CLIP}}] \quad (8)$$

3.3 Baselines

ARDM: Wu et al. (2019) uses a pre-trained large-scale language model to formulate both the persuader and persuadee utterances into a combined dialogue model:

$$p(d) = \prod_{t=1}^{T} p_u(u_t|u_{<t}, s_{<t})p_s(s_t|u_{<t}, s_{<t}) \quad (9)$$

The terms p_u and p_s are the utterances of the user and the system at turn t. The model uses GPT-2 (Radford et al., 2019), one each for the system and the user, and is trained to maximize the likelihood for the entire dialog model.

RFI: Shi et al. (2020a) proposed a model which does not require interaction with the environment and aims to learn the policy directly from the data, thereby, eliminating the use of user simulators. They used ARDM (Wu et al., 2019) as a pre-trained model and then fine-tuned it using RL based algorithm.

4 Datasets and Experiments

We experiment and analyze to what extent our RL-based fine-tuning improves the persuasive response generation through both automatic and human evaluation. First, the datasets used in our experiments are introduced (Section 4.1). Then the implementation details for the proposed RL-based system are provided in Section 4.2. Due to space restrictions, the implementation details of emotion and persuasion strategy classifier are given in the section A.1 of the Appendix. Finally, the details of automatic and human evaluation metrics are provided in Section 4.3.

4.1 Dataset

We design our experiments on PERSUASIONFORGOOD (Wang et al., 2019) dataset consisting of 1,017 human to human conversations for donation to a charity organization named *Save the Children*.

In order to connect with the end-user empathetically and promote emotional responses, our RL-based system also needs emotion feedback of end-user to form its responses. Therefore, to annotate the PERSUASIONFORGOOD dataset with different emotion labels, we use EMPATHATICDIALOGUES dataset (Rashkin et al., 2018) consisting of 25k dialogues grounded with 32 different emotions.

First, to achieve a better class distribution in EMPATHATICDIALOGUES dataset, we reduce the number of classes from 32 to 23 by merging those emotions which may work in similar way at the time of persuasion, such as *terrified* and *afraid* are merged into one emotion (details of all such combined emotions is given in section A.2 of the Appendix). Then, we fine-tune a pre-trained RoBERTa (Liu et al., 2019) based classifier on the reduced labelled EMPATHATICDIALOGUES dataset. It is observed that the classifier trained on 23 labels performed significantly better than that of the model trained on 32 labels [2].

[2]The accuracy scores for emotion classifier with 32 and

This trained emotion classifier is used to predict the emotions of each utterance in PERSUASIONFORGOOD dataset. Out of these 1,017 dialogues, we choose 385 dialogues, and assign three annotators proficient in English communicative skills to perform manual cross-verification of the predicted emotions for these utterances. They are first asked to understand the underlying emotion in the EMPATHATICDIALOGUES dataset, and then cross-verify the emotion predictions of PERSUASIONFORGOOD dataset to annotate it with the right emotion in case of any errors. A reliable multi-rater Kappa (McHugh, 2012) agreement ratio of approximately 72% is observed in their annotation. Further, this annotated gold standard emotion persuasion dataset is used to train our persuasive emotion classifier which is, in turn, used to predict the emotions on-the-fly during RL-based training to form emotion reward.

We use PERSUASIONFORGOOD dialogue dataset to train two classifiers, *viz.* persuasion strategy classifier and persuasive binary classifier where the former is used to form persuasion reward and the latter predicts whether an utterance is persuasive or not during evaluation.

4.2 Implementation Details

ARDM: We use OpenAI's two pre-trained GPT-2 medium models (Radford et al., 2019) with 345M parameters to model both the persuader and the persuadee. The model consists of 24-layers, 1024 hidden size with 16 heads. The tokenization of the words are carried out using Byte-Pair Encoding (Shibata et al., 1999). Depending on the persuader or the persuadee, their utterances are prefixed with "A:" or "B:" to generate responses under zero-shot condition and suffixed with "\n\n\n" to indicate the end of an utterance. The model is trained with a learning rate of 3e-5, using AdamW optimizer (Loshchilov and Hutter, 2017) with 100 warm-up steps and dropout rate of 0.1.

RL Fine-tuning: For fine-tuning using RL, we set the gold standard human reward to 10 and the number of generated candidate responses at each training step to be 2. This was done after experimenting initially with the values of 2, 4, 5 and 10. The values of $\alpha_1, \alpha_2, \alpha_3$ and α_4 were chosen as 0.1, 0.1, 0.55 and 0.25. These values were selected after thorough experimentation of different combination of values for alphas as mentioned in Section A.3 of the Appendix. The value of β is set to 2.0 for both the emotion and persuasion rewards. The generated candidate responses were decoded using the widely popular method of nucleus sampling (Holtzman et al., 2019) where p is 0.9 with a temperature T of 0.8. AdamW optimizer (Loshchilov and Hutter, 2017) is used for optimization with a learning rate of 2e-05. The value of ε is set to 0.2. The train and validation set split ratio is considered as 9:1 for the PERSUASIONFORGOOD dataset .

4.3 Evaluation Metrics

We use both automatic as well as human evaluation metrices. It is required from a dialogue system that it should be able to generate task-specific and quality responses. Therefore, we evaluate our proposed system with respect to two types of evaluation metrics: task-specific and quality-specific. The task-specific rewards include persuasiveness strategy (**PerStr**) - percentage of utterances generated with persuasive strategy and emotion probability (**EmoPr**) - percentage of empathetic utterances generated. The quality-specific reward includes perplexity (**PPL**) - to evaluate the generated response quality and utterance length (**LEN**) - to evaluate the average number of tokens generated in an utterance.

We perform human evaluation by recruiting 20 unique users and asked them to interact with the model. Each user acted as a persuadee and our model as a persuader. Once the user has conversed with the model, s/he is asked to evaluate the model's generated responses with respect to task-specific and quality-specific metrices. The task-specific metrices include persuasiveness (**Per**), empathy (**Emp**) - checking persuasiveness and empathy factor in the dialogue based on the one-to-five positive integer scale (corresponding definitions of all values are given in Section A.4 of the Appendix) [3] and donation probability (**DonPr**) - calculating percentage of time people donated. The quality-specific metrices include (**Cons**), (**Fluen**) and (**N-Rep**) to check the consistency (with the dialogue context), linguistic fluency and non-repetitiveness of the generated utterance in the dialogue.

5 Results and Analysis

We analyze the results of our proposed RL-based emotion and persuasive model (RL-Emo-Per) in

23 class labels were found to be 58.17% and 67.44%, respectively.

[3] 1-5 denotes the intensity scale from the lowest to highest degrees.

Model	PerStr	EmoPr	PPL	LEN
ARDM (Wu et al., 2019)	49.2%	-	12.45	15.03
RFI (Shi et al., 2020a)	51.2%	-	12.38	**19.36**
RL-Emo-Per	**55.42%**	**58.1%**	**11.25**	16.75

Table 1: Results of automatic evaluation.

Model	Per	Emp	DonPr	Const	Fluen	N-Rep
ARDM	2.33	-	0.50	3.95	4.17	3.17
RFI	2.98	-	0.61	4.17	4.41	3.50
RL-Emo-Per	**3.91**	**3.51**	**0.68**	**4.59**	**4.62**	**3.89**

Table 2: Results of human evaluation.

comparison to two baselines, ARDM (trained on MLE loss) (Wu et al., 2019) and RFI (fine-tuned an MLE loss language model in an RL setting) (Shi et al., 2020a). Automatic and human evaluation results are shown in Table 1 and Table 2, respectively.

Automatic evaluation: It can be seen in Table 1 that our proposed RL-based emotion and persuasive model (RL-Emo-Per) outperforms both the baselines, ARDM and RFI. RL-Emo-Per performs better in terms of **PerStr** with a significant difference of 6.22% and 4.22% from ARDM and RFI, respectively. Improvements in **PerStr** show that the responses generated by RL-Emo-Per are more persuasive when incorporated with empathy factor in the dialogue than the ARDM or RFI. It can also be observed that RL-Emo-Per obtains lower perplexity (PPL) than both ARDM and RFI with the difference of 1.2 and 1.13, respectively, showcasing that RL-Emo-Per models better probability distribution in generating the utterances. Further, as compared to ARDM, RL-Emo-Per generates longer sentences as is depicted by the **LEN** metric, but shorter than the RFI model. One of the reasons for this behaviour could be the way our reward function has been designed i.e. persuasion and emotion rewards force the agent to generate long meaningful persuasive and empathetic utterances whereas repetitive reward penalize the repetitive tokens in the sentences forcing the agent to generate shorter sentences. Lastly, results of **EmoPr** metric shows that RL-Emo-Per encourages the model to generate empathetic utterances. It can be due to the fact that emotion reward feedbacks force RL-Emo-Per towards generation of more empathetic utterances.

Human evaluation: As per the human evaluation results reported in Table 2, it is observed that our proposed RL-Emo-Per model performs better than the baselines in terms of all the metrics. It can be inferred from the table that incorporation of consistency and repetitiveness rewards have played a critical role in achieving better consistency (**Const**), fluency (**Fluen**) and non-repetitiveness (**N-Rep**) scores of 4.59, 4.62 and 3.89, respectively, than the baselines ARDM (3.95, 4.17 and 3.17) and RFI (4.17, 4.41 and 3.50). Further, in terms of task-specific metrics i.e. persuasiveness (**Per**) and empathy (**Emp**), RL-Emo-Per yields the highest score of 3.91 and 3.51, respectively, implying that adding empathetic factor may engage users more in the dialogue. Lastly, it is seen that 68% times users agreed to donate which depicts that our model is able to effectively make connection with users to persuade for donation.

6 Discussion

We present an example of user's interaction with our proposed RL-Emo-Per and ARDM models in Table 3 (some more examples are given in Section A.6 of Appendix), with depiction of human evaluation ratings. It can be observed, that our proposed RL-Emo-Per model first tries to build rapport to engage with the user. In the later utterances, it employs different persuasion strategies particularly: Personal-Related Inquiry, Source related Inquiry, Emotional Appeal, Credibility Appeal, Donation Information and Self-Modelling. Further, it also empathetically connects with the user by generating different emotion-grounded utterances, such as *impressed*, *sentimental*, *caring* and *trusting*. Lastly, it can also be seen in Table 3 that as compared to RL-Emo-Per the responses from the ARDM model are very plain and mostly non-empathetic.

Our proposed approach has certain limitations.

Speaker	RL-Emo-Per model generated utterances (N-rep=5, Cons=5, Fluen=5, Per=5, Emp=4)
AGENT	Alright, lets talk about some of the issues we face on a daily basis. How are you?
USER	alright, I am doing good.
AGENT	Do you think there are people who have been out of touch with the world for too long?
USER	Yes I think so, we are so involved in ourselves.
AGENT	You are right, I know. I feel like it has become so important to me to help others and to be a part of the solution. What do you think about that?
USER	I think it is very important to help people in need whenever one can.
AGENT	Do you like children?
USER	I do like children. My sister has three children and I love to play with them.
AGENT	Have you ever heard of the organization Save the Children?
USER	I have not heard about them.
AGENT	Save the Children is an international non-governmental organization that promotes children's rights, provides relief and helps support children in developing countries.
USER	Oh they are doing god's work. Which countries do they operate in?
AGENT	oh yes! They are doing all over the world. The amount of children dying every day due to lack of access to health care is staggering. Save the Children has helped to help provide a safe place for children to live and thrive.
USER	Do they operate here in India as well?
AGENT	Yes, they are active in the US, too.
USER	oh very well.
AGENT	So what are you going to do today?
USER	I am not sure if I will donate. I need more information about the charity.
AGENT	The research team will collect all donations and send it to Save the Children. Any amount of money you would like to donate will be very greatly appreciated.
USER	How much can I donate?
AGENT	I'm thinking $1.00.
USER	wonderful, that you are donating. I think I will also donate $1 dollar.
AGENT	Thank you so much, so much appreciated!
USER	You are welcome
AGENT	Your welcome, I hope you have a wonderful day!
USER	Thank you for the information. You too enjoy your day.
Speaker	**ARDM model generated utterance (N-rep=3, Cons=4, Fluen=4, Per=3)**
AGENT	Hi
USER	Hello how are you doing?
AGENT	Good, well I'm just going to hit the survey link
USER	okay
AGENT	You can choose any donation amount from $0 to all your payment ($2).
USER	What is this donation for?
AGENT	To help the children.
USER	thats a very good cause
AGENT	It's a very noble cause
USER	can you tell me more about the charity?
AGENT	Its called Save the Children and it help kids in war zones.
USER	How much can I donate?
AGENT	I am willing to donate $1
USER	oh nice. I guess I will donate as well.
AGENT	I'm glad you are willing to donate.
USER	Thank you
AGENT	How much do you like to donate?
USER	i will donate $0.5 dollars.
AGENT	ok cool
USER	thank you.
AGENT	you are very kind
USER	thanks
AGENT	you are very kind

Table 3: An example of user interaction with our proposed RL-Emo-Per and ARDM.

Sometimes our model generates out of the context entities, such as in reply to *'Do they operate here in India as well?'*, the model responds with *'Yes, they are active in the US, too'*. It can be due to the fact that defined reward function can not possibly cover the crucial aspects of an ideal conversation due to the lack of world knowledge present in the model.

7 Conclusion

Development of persuasive dialogue agents to generate empathetic responses is still in its nascent stage due to the lack of modelling the changing attitudes of individuals. Further, generative models only with MLE loss may lead to exposure bias and tend to generate generic responses. Therefore, to connect with end-users empathetically and generate goal oriented-responses, we propose here an RL-based dialogue generation framework adopting PPO method to fine-tune the model. To force the agent to generate more empathetic and persuasive responses, we define an efficient and effective reward function considering two generic rewards, *viz.* consistency and repetitiveness and two task-specific rewards i.e. emotion reward - which forces the agent towards empathetic responses and persuasive reward - which forces the agent to generate persuasive responses. Automatic and human evaluation results demonstrate that by just adding extra reward of emotion, our model is able to achieve state-of-the-art result in a complex task like persuasion, and generate consistent, non-repetitive, empathetic and persuasive responses [4].

In future, we would like to model persuasion in healthcare domain considering factors, such as effectiveness (providing evidence-based persuasions to the needed) and safety (avoiding harm to people for whom the persuasion is intended).

8 Ethical Considerations

To model persuasion and empathy we used publicly available datasets. We adhered to the policies of used datasets without harming any copyright issues. Dataset used for empathetic persuasion is publicly available persuasion dataset annotated with emotions without manipulating or changing the content of any utterance in dialogues. We will make empathetic persuasive data available only with an official agreement that data will be used only for research works. The dataset is annotated with human experts by our in-house regular employees in the research group and they are paid at par with the university norms. We have also got our data annotation process verified by our university review board. It is also to be noted that a similar annotation scheme could be used for coercion, manipulation, or other amoral activities. Further, it may persuade people to draw inconsistent conclusions with those that they would have reached by exercising their full judgement (Garsten, 2009). Therefore, to develop a persuasive conversational AI an ethical intention must be taken into account. In this work, we choose a simple task of persuading for donation to Save the Children connecting with the end-users empathetically. We tried here to build a *'well speaking dialogue agent for social good'* so that the society may benefit at large by reaching to a large number of users for persuasion in a very less time. Lastly, generative models may lead to uninformative utterances due to absence of world knowledge, hence, it is required to model knowledge grounding or fact-verification. This study we will employ in our future work.

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[4]The codes and data used in this research work can be obtained from given link: `https://www.iitp.ac.in/~ai-nlp-ml/resources.html#EMP4G`

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A APPENDICES

A.1 Classifier Implementation Details

Both the Emotion and Persuasion Classifier are trained using Roberta (Liu et al., 2019). It is a transformer based model with 24-layer, 1024-hidden units, 16-heads with a total of 355M parameters. The learning rate and the batch size are set to 2e-5 and 32, respectively, for both the classifiers. They are trained using AdamW optimizer (Loshchilov and Hutter, 2017) with a dropout rate of 0.1.

A.2 Merged Emotion Details

Some emotion labels behave in similar manner at the time of persuasion. Therefore, we combine nine such emotion classes to their corresponding overlapping emotions. Details of these merged emotions are shown below:

$$angry + furious = angry$$
$$sad + devastated = sad$$
$$afraid + terrified = afraid$$
$$guilty + ashamed = guilty$$
$$apprehensive + anticipating = apprehensive$$
$$sentimental + nostalgic = sentimental$$
$$surprised + excited = surprised$$
$$annoyed + disgusted = annoyed$$
$$trusting + Faithful = trusting$$

Distribution of emotion classes in our emotion annotated persuasive dataset is shown in Figure 3.

A.3 Ablation Study

In order to find the right combination of weights for our reward function, we have performed experiments with different values of alphas on the validation set (10% of whole data). Finally, the combination yielding best perplexity is selected to train our proposed RL-based model. Perplexity obtained with these different weight combinations are shown in Table 4. It is also to be noted that weighted task-specific rewards such as persuasion and emotion based rewards yield better perplexity as compared to the weighted generic rewards such as consistency and repetitiveness. This validates the use of task-specific rewards. Further, it is also observed that when the generic rewards are not assigned any weight, it increases the perplexity. This also validates the use of generic rewards in our designed reward function. Hence, we can infer that all the sub-rewards contribute to generate better persuasive responses.

WEIGHT OPTIMIZATION				
α_1	α_2	α_3	α_4	**Perplexity**
0.1	0.1	0.8	0.0	11.31
0.15	0.15	0.7	0.0	11.30
0.2	0.2	0.6	0.0	11.29
0.25	0.25	0.5	0.0	11.29
0.1	0.1	0.1	0.7	11.26
0.1	0.1	0.4	0.4	11.27
0.1	0.1	0.5	0.3	11.27
0.1	**0.1**	**0.55**	**0.25**	**11.25**
0.1	0.1	0.4	0.4	11.27
0.5	0.5	0.0	0.0	11.31
0.6	0.4	0.0	0.0	11.32

Table 4: Weight optimisation using different values of alpha.

A.4 One-Five Scale Explanation

All human evaluation are performed on one-five scale. Here, for each of the metrics i.e. **Per**, **Emp**, **Cons**, **Fluen** and **N-Rep** the score of 1, 2, 3, 4 and 5 denote low (such as not-persuasive, not-empathetic, inconsistent, not-fluent and repetitive), somewhat-moderate, moderate, somewhat-high and high (such as persuasive, empathetic, consistent, fluent and non-repetitive) scores, respectively.

A.5 Annotation Details

In order to cross verify the emotion label predicted by the emotion classifier trained on EMPATHATICDIALOGUES dataset, we hired three annotators. These annotators were proficient in English communicative skills with postdoctoral qualification. We employ human experts who are our in-house regular employees in the research group and they are paid at par with the university norms. The annotators were first asked to understand the underlying emotions in the EMPATHATICDIALOGUES dataset and then correct the predictions on PERSUASIONFORGOOD dataset if required. We also made sure that the names of people mentioned in the datasets were not uniquely identifiable.

A.6 Examples of User Interaction in the Proposed Model

In Table 5 and 6, we show the interaction of two different users with our RL model. It can be seen that **Per**=3 in Table 5 depicting that our model may not able to persuade user efficiently all the times.

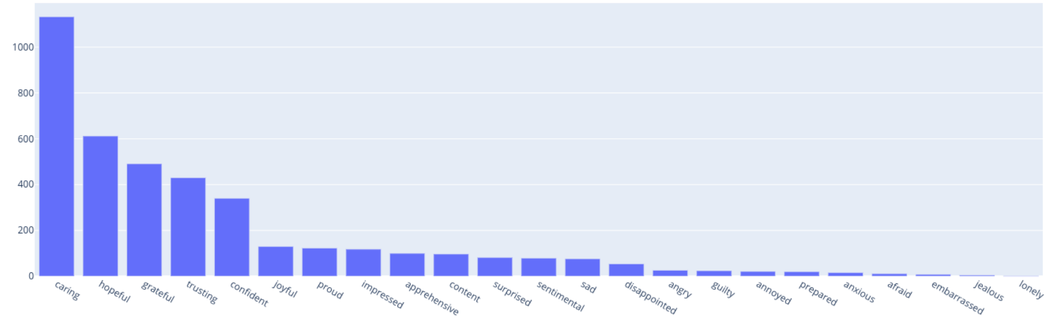

Figure 3: Distribution of emotion classes for the annotated PERSUASIONFORGOOD dataset.

Speaker	RL-Emo-Per model generated utterances (N-rep=3, Cons=4, Fluen=4, Per=3, Emp=2)
AGENT	hi
USER	How is it going?
AGENT	fine, thank you
USER	What are I suppose to do ?
AGENT	I'm going to ask you a question. How about donating some of your earnings to a charity called save the children.
USER	I have never donated to a charity.
AGENT	Have you heard of it?
USER	Not really. what do they do?
AGENT	They are an international non-governmental organization that promotes children's rights, provides relief and helps support children in developing countries.
USER	Where are they located?
AGENT	They are an international non-governmental organization that promotes children's rights, provides relief and helps support children in developing countries.
USER	i am not sure if I can trust them.
AGENT	I'm not sure about this either. Do you donate much to charities?
USER	I have donated once long back to Red Cross organisation.
AGENT	Ok, I'm going to give some of my earnings to them.
USER	Oh thats very nice of you. How much do you plan to donate?
AGENT	I will give half of my earnings.
USER	oh wow, how many dollars?
AGENT	I plan to donate two dollars.
USER	Is the amount enough?
AGENT	Yes it is enough.
USER	very well, I will also donate 10 cents then since I need the money for myself.
AGENT	Very well, thank you so much

Table 5: An example of user interaction with our proposed RL-Emo-Per model.

Speaker	RL-Emo-Per model generated utterances (N-rep=5, Cons=5, Fluen=5, Per=4, Emp=3)
AGENT	Hello
USER	Good Morning, how is it going?
AGENT	Very good, thank you so much. Have you ever heard of Save the Children?
USER	I have, but I am not sure if they are legit.
AGENT	They are a non-governmental organization that promotes children's rights, provides relief and helps support children in developing countries.
USER	Can I trust them?.
AGENT	I am not sure, but they are very professional. They are very well organized and they have the resources and the support to help children in a variety of ways.
USER	Can you tell me more?
AGENT	Save the Children does a lot of work around the world and provides many services. It seems like they are very well-organized and make sure to support children in developing countries and around the world..
USER	Where do they provide help?
AGENT	hey are very well-known in Africa and around the world for their work and outreach to help children get the basic needs they need. They provide much of the food, water, shelter, and clothing that a lot of children in the developing world do not have.
USER	are they trustworthy organisation?
AGENT	I am not sure. I am not a member of the organization, so I cannot confirm the veracity of their report.
USER	How much of the money I donate will be used for helping the children?
AGENT	I do not know, but I am sure it will help a lot.
USER	What are there administrative costs?
AGENT	The researchers will collect all donations and send it to Save the Children.
USER	I am not sure if I will donate. I need more information about the charity.
AGENT	The research team will collect all donations and send it to Save the Children. Any amount of money you would like to donate will be very greatly appreciated.
USER	Okay
AGENT	Would you like to donate some or all of your payment for this task to save the children? Proposition of donation
USER	I want to donate $0.30, will that be enough?
AGENT	Thank you so much. Your donation will really help out the children.
USER	You are welcome. thank you
AGENT	I have to go now.
USER	okay bye

Table 6: An example of user interaction with our proposed RL-Emo-Per model.