

More the Merrier: Towards Multi-Emotion and Intensity Controllable Response Generation

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Abstract

The focus on conversational systems has recently shifted towards creating engaging agents by embedding emotions into them. Human emotions are highly complex as humans can express multiple emotions with varying intensity in a single utterance, whereas the conversational agents convey only one emotion in their responses. To infuse human-like behaviour in the agents, we introduce the task of multi-emotion controllable response generation with the ability to express different emotions with varying levels of intensity in an open-domain dialogue system. We introduce a Multiple Emotion Intensity aware Multi-party Dialogue (MEIMD) dataset having 34k conversations taken from 8 different TV Series. We propose a Multiple Emotion with Intensity-based Dialogue Generation (MEI-DG) framework. The system employs two novel mechanisms: (i). *Explicit Memory*: to determine whether to generate an emotion or generic word, while focusing on the intensity of the desired emotions; and (ii). *Implicit Memory*: to compute the number of words *remaining* to express the emotion completely, thereby regulating the generation accordingly. The detailed evaluation shows that our proposed approach attains superior performance compared to the baseline models.

Introduction

With the rapid growth in technology, the dependency of humans on technology has increased exponentially. Conversational agents in the form of personal assistants like Apple’s Siri, Microsoft’s Cortana, etc. not only assist human in completing their desired goals but also behaves as a companion to them. Therefore, it is essential to empower the conversational agents with the ability to perceive and express emotions to make them capable of interacting with the user at the human level. These agents help enhance user satisfaction (Prendinger, Mori, and Ishizuka 2005), while reducing the breakdowns in conversations (Martinovski and Traum 2003) and providing user retention. Hence, dialogue systems capable of generating replies while considering the user’s emotional state is the most desirable advancement in Artificial Intelligence (AI). Previously, researchers have focused upon classifying user emotions (Porcia et al. 2019; Chauhan et al. 2019) in conversations. For building an intelligent agent,

sheer understanding of emotions is insufficient; hence several works (Song et al. 2019; Colombo et al. 2019) have concentrated in inducing emotions into the dialogue system. Most of these existing research have focused on generating emotionally aware (Rashkin et al. 2019; Lin et al. 2019) or emotionally controlled responses (Zhou et al. 2018; Firdaus et al. 2020c) expressing a single emotion or a particular intensity of the emotion (Ghosh et al. 2017).

Though the existing systems can express a particular emotion, they lack completeness in terms of emotional content in the responses as humans inherently express multiple feelings in their day-to-day conversations. Recent research trends have focused on identifying multiple emotions in user utterances (Yu et al. 2018; Huang, Trabelsi, and Zaiane 2020; Firdaus et al. 2020b). This validates the fact that indeed human emotions are highly complex with the ability to express more than one emotion at an instant. In addition, the intensity of emotions fluctuates in an utterance providing variations for a particular emotion in conversations. The existing conversational agents are insufficient in generating responses like “It’s amazing, I am thrilled you got promoted” as shown in Table 1 since they are restricted in generating one emotion only, thereby being unable to generate emotionally rich responses. From this example, it is also evident that intensity is essential for generating such responses as the intensity level varies in joy and surprise emotions present in the utterance. Even if the complete set of emotions is provided, the agent will have difficulty generating the response mentioned above as one emotion has a higher intensity than the other. Consequently, conversational agents having the capability to express multiple emotions with corresponding intensity in their responses helps improve the emotional content, thereby providing an enriched affective outlook. To mimic this human-like behaviour in conversational agents, we propose the task of generating responses conditioned on different emotions along with intensity.

Due to the unavailability of multi-emotion intensity labeled data for our proposed task, we create a large-scale dialogue dataset, MEIMD from 8 English TV series having 34k conversations that have been labeled with multiple emotions and their intensities. Examples of multi-label emotion conversations from our dataset are shown in Table 1. To solve the task of emotional text generation conditioned on multiple emotions with intensity, we propose a novel neural ar-

Conversations		Emotions
1	It's amazing, I am thrilled you got promoted I have loads of work now and am afraid to complete it. Stop sulking, I am sure you will manage it.	Surprise (0.3), Joy (0.9) Disgust(0.3), Fear(0.6) Anger(0.3), Acceptance(0.6)
2	I am sorry this could be an infection or cancer. I am afraid but I know you could help me.	Sadness(0.6), Fear(0.3) Acceptance(0.3), fear(0.6)

Table 1: Multi-Emotion and Intensity labeled conversations from MEIMD dataset

chitecture, Multiple Emotion with Intensity-based Dialogue Generation (MEI-DG) framework having an implicit and explicit memory. An explicit memory governs the correct choice of words at every step for expressing the specified emotions. The implicit memory focuses on expressing the desired emotions in a response by utilizing the VAD lexicon (Mohammad 2018) of every emotion. The implicit memory also balances between the emotional expression and grammatical correctness dynamically for better generation.

The significant contributions of our current work are *four-folds*: (i). In our knowledge, we are first to propose the task of multiple emotion and intensity controlled dialogue generation; (ii). We create a large-scale Multiple Emotion and Intensity aware Multi-party Dialogue (MEIMD) dataset; (iii). We design a neural architecture, MEI-DG employing two novel memory-based mechanisms, *viz.* implicit memory and explicit memory to ensure the incorporation of multiple emotions with their corresponding intensity in the responses; (iv). Empirical analysis shows that our proposed MEI-DG framework outperforms the baseline models and generates emotionally rich responses.

Related Work

Recently, investigations on emotion detection in conversations (Yeh, Lin, and Lee 2019; Chauhan et al. 2019; Poria et al. 2019) has been an important research direction. Currently, multi-label emotion classification has been investigated in (Yu et al. 2018; Huang, Trabelsi, and Zaïane 2020; Firdaus et al. 2020b) for understanding different emotions present in an user utterance. Inspired by these current works on emotion classification has led to emotional response generation research for building intelligent conversational agents. Lately, emotional text generation has gained immense popularity (Li and Sun 2018; Lin et al. 2019; Li et al. 2017; Ghosh et al. 2017; Rashkin et al. 2019). In (Zhou et al. 2018), an emotional chatting machine (ECM) was built based on seq2seq framework for generating emotional responses. Recently, a lexicon-based attention framework was employed to generate responses with a specific emotion (Song et al. 2019). Emotional embedding, affective sampling and regularizer were employed to generate the affect driven dialogues in (Colombo et al. 2019). The authors employed curriculum dual learning (Shen and Feng 2020) for emotion controllable response generation. In (Asghar et al. 2018; Lubis et al. 2018; Zhong, Wang, and Miao 2019; Li et al. 2020), an end-to-end neural framework has been proposed that captures the emotional state of the user for generating empathetic responses.

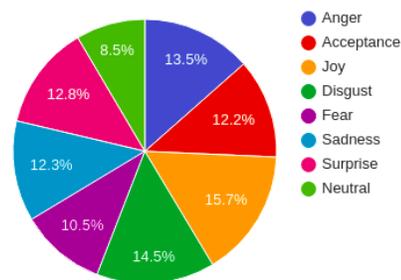


Figure 1: Emotion distribution of the MEIMD dataset

Multiple Emotion and Intensity aware Multi-party Dialogue (MEIMD) Dataset

The existing emotion labeled dialogue datasets (Rashkin et al. 2019; Li et al. 2017; Winata et al. 2019) have been marked with single emotions only without considering the intensity level of the emotion present in the utterance. For building a multi-emotion and intensity controlled framework, we create a large-scale multi-party dataset (MEIMD), one of the contributions of our current work. The MEIMD is a crowd-sourced dataset where every utterance in a given dialogue has been labeled with the corresponding emotions and intensity values to facilitate multi-emotion and intensity controlled response generation. The complete statistics of the MEIMD dataset are given in Table 2.

Data Collection: Previously Movie subtitles (Colombo et al. 2019; Asghar et al. 2018; Lubis et al. 2018; Moghe et al. 2018) and TV shows (Poria et al. 2019; Firdaus et al. 2020a) have been used for creating dialogue datasets for different Natural Language Processing (NLP) tasks. Inspired by these works, we create our MEIMD dataset by considering different TV shows having diverse conversations for building robust systems. For data collection, we consider 8 famous TV shows belonging to the different genres: (i). Drama: Breaking Bad, Castle, Game of Thrones, Grey’s Anatomy, and House M.D.; (ii). Comedy: Friends, How I Met Your Mother and The Big Bang Theory. In total, there are 507 episodes, spanning 456 hours. First, we extract all the subtitles and transcripts for every episode. Then we segment the episodes into scenes which were further divided into short clips representing a dialogue. The dialogues were created following the heuristics in which the time-stamps of the conversation’s utterances had to be in increasing order, and every statement in a dialogue should belong to the same scene of an episode by using the transcripts of every episode.

Data Preparation: To annotate the MEIMD dataset with

Show	Genre	# Seasons	# Episodes	# Dialogues	# Utterances	# Main Speakers	Avg. Turns per Dialogue	Avg. Utterance Length	# of Emotions per Dialogue	Avg. emotions per Utterance
Breaking Bad	Drama	5	62	1659	32653	11	20.16	14.2	3.5	2
Castle	Drama	5	105	5172	102394	9	21.11	13.8	4.2	2
Friends	Comedy	10	236	4228	82353	6	23.40	10.6	5.5	2
Game of Thrones	Drama	7	67	2263	47471	30	22.50	13.7	3.8	2
Grey's Anatomy	Drama	6	126	4428	86104	15	22.17	14.5	4.1	2
House M.D.	Drama	8	177	6476	126780	12	21.43	13.6	3.3	2
How I Met Your Mother	Comedy	9	208	4968	96314	6	22.33	12.8	5.4	2
The Big Bang Theory	Comedy	10	207	5410	86913	7	21.98	12.5	5.3	2
Total	-	60	1188	34604	660982	96	21.88	13.21	4.4	2

Table 2: Dataset statistics of the proposed MEIMD dataset for every TV show

multiple emotions and their corresponding intensity, we employ crowd-workers that label every utterance with the provided set of emotion labels and the intensity range. We consider 7 emotion labels (*anger, acceptance, disgust, fear, joy, sadness, surprise*) with intensity values ranging from 0-3¹ along with the “Neutral” label showcasing no emotion to annotate our MEIMD dataset. These emotion labels are chosen from Ekman’s six basic emotions (Ekman et al. 1987) and Plutchik’s wheel of emotions (Plutchik 2001). For labeling the utterances, the workers were asked to follow the instructions and guidelines provided for annotation. Some of the significant guidelines for annotation were as follows: (i). Every utterance of a given dialogue was to be marked with the provided emotion labels; (ii). In addition, the workers were asked to label as many emotions present in a given utterance capturing even the subtle emotion present. For cases where we found different annotations in emotions for a particular utterance, we remove them from the dataset, and we also drop the entire dialog to maintain coherence among the utterances. A majority voting scheme was used for selecting the final emotions for every utterance. We observed a multi-rater Kappa (McHugh 2012) agreement ratio of approximately 69% for the emotion, which can be considered reliable. (iii). After final emotion annotations the workers were also asked to annotate the intensity value of the given emotion from the specified range. Similarly, majority voting with the kappa ratio of 57% was observed for intensity which can be considered as reliable. The emotion distribution of the entire MEIMD dataset is provided in Figure 1. In Figure 1, we see that the MEIMD dataset is balanced, having almost equal representation of all the different emotions.

Methodology

For the given task, we assume that the emotion categories and the corresponding intensity will be provided to generate the response. Due to the intricacy in human emotions, we propose multiple emotions with intensity-dialogue generation (MEI-DG) network as our generation framework, as shown in Figure 2.

Problem Formalization: Given a dialogue having k turns $D = (U_1, U_2, \dots, U_k)$ as an input where each turn comprises of $U_k = (w_{k,1}, w_{k,2}, \dots, w_{k,n})$ words along with the emotion categories e_1, e_2, \dots, e_n and intensity I_1, I_2, \dots, I_n , the task is to generate the next response $Y = (y_1, y_2, \dots, y_{n'})$ which

¹Here, 0 means absence of emotion while 3 is the highest value of intensity expressing the maximum amount of that particular emotion.

is in accordance to the specified emotions and intensity and also coherent with the conversation, where $w_{k,n} \in V$ and $y_{n'} \in V$ are words in the conversational history and the generated response, respectively. Here, n and n' denote the given input utterance and response length, respectively, while n'' is the total number of desired emotions with their intensity. We design a vocabulary consisting of emotional words E_v and generic words G_v such that $V = E_v \cup G_v$ and $E_v \cap G_v = \phi$. The emotional vocab E_v is further split into multiple subsets E_v^i of words belonging to a particular emotion category i . For simplicity, we consider only two emotions and corresponding intensity. Hence $n'' = 2$.

Multiple Emotion with Intensity Dialogue Generation (MEI-DG) Framework: It is built upon the Hierarchical Encoder-Decoder (HRED) architecture (Serban et al. 2015) to incorporate multiple emotions with varying intensity in the generated responses. In our proposed framework, we use the RNN (LSTM) network for encoding the context and utterance information.

Utterance Encoder: Given an utterance U_k , a bidirectional LSTM (BiLSTM) is employed to encode each word $w_{k,i}$, $i \in (1, \dots, n)$ represented by d -dimensional embeddings. We concatenate the last hidden representation from both unidirectional LSTMs to form the utterance’s final hidden representation.

$$s_{u,k,i} = BiLSTM_u(w_{k,i}, s_{u,k,i-1}) \quad (1)$$

Context-level Encoder: The information of the utterance encoder for every dialog turn serves as input to the context encoder. We use uni-directional LSTM to model dialog history. The final hidden state of the context LSTM serves as the initial state of the decoder LSTM.

$$s_{c,i} = LSTM_c(s_{u,i,n}, s_{c,i-1}) \quad (2)$$

Decoder: In the decoding stage, we employ uni-directional LSTM that generates words sequentially conditioned on the context vector c_t , implicit memory states of previous time step M_{t-1} , the desired emotion embeddings, V_{e1}, V_{e2} with the corresponding intensity I_1, I_2 and the previously decoded words. We use randomly initialized embedding to represent the desired emotion labels. Global Attention mechanism (Luong, Pham, and Manning 2015) is incorporated to enhance the performance of the decoder. The attention layer is applied to the hidden state of context encoder using decoder state d_t as the query vector. The concatenation of the context vector and the decoder state is used to com-

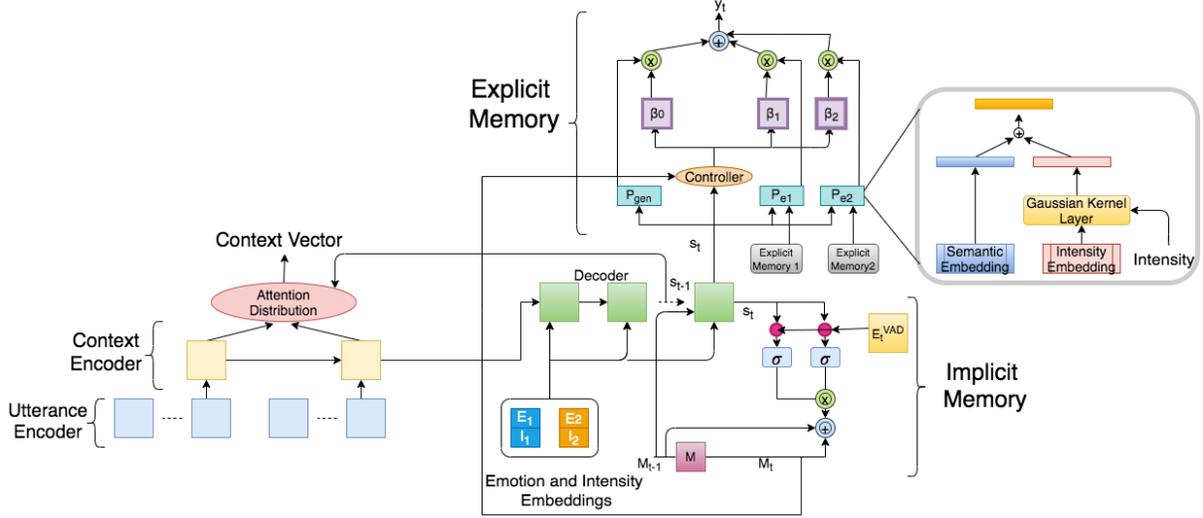


Figure 2: Architectural diagram of MEI-DG having a hierarchical encoder and decoder with explicit and implicit memory

pute the final probability distribution over the output tokens.

$$s_{d,t} = LSTM_d(y_{t-1}, [s_{d,t-1}, c_t, V_{e_1}, V_{e_2}, I_1, I_2, M_{t-1}])$$

$$c_t = \sum_{i=1}^k \alpha_{t,i} s_{c,i}, \quad (3)$$

$$\alpha_{t,i} = softmax(s_{c,i}^T W s_{d,t-1})$$

Implicit Memory: The emotion information in the form of embeddings provided to the decoder for generating emotional responses is static in nature. Thereby it fails to model the emotional dynamics. As discussed in (Ghosh et al. 2017), the above mentioned static approach decreases the fluency of the generated emotional response. Hence, in (Zhou et al. 2018), internal memory is designed to capture the emotional dynamics during decoding while maintaining fluency. Similarly, we incorporate an implicit memory to model the dynamics of the multiple emotions at the time of decoding. Before starting the decoding process, every conditioned emotion is assigned with an internal state initialized to 0, which at every step increases by a certain amount. Unlike (Zhou et al. 2018), the increment is measured by the amount of a given emotion left to be expressed in the generated response using VAD embeddings. At the end of decoding, the internal state should be equal to 1, indicating that the given emotion is completely expressed in the generated sentence. At every decoding step, to update the implicit memory state, we design an increase operation inc that decides the amount to be increased based upon the amount of emotion left to be expressed. A gate g_t is designed to control the usage of inc operation. Specifically, the internal state is updated as follows:

$$M_{e_i,t} = M_{e_i,t-1} + g_t(i) \circ \delta_t^{inc}(i) \quad (4)$$

where, \circ is the element-wise multiplication and $g_t(i)$ and $\delta_t^{inc}(i)$ are the i^{th} element of g_t and δ_t^{inc} , respectively. $M_{e_i,t}$

is the implicit memory of the given i^{th} emotion at time-step t . Hence, the g_t and δ_t^{inc} operations are computed as:

$$g_t(i) = \sigma(W_g[s_{d,t}; E_{i,t}^{VAD}] + b_g) \quad (5)$$

$$\delta_t^{inc}(i) = \sigma(W_{inc}[s_{d,t}; E_{i,t}^{VAD}] + b_{inc})$$

where, $W_g, b_g, W_{inc}, b_{inc}$ are the trainable parameters; and $E_{i,t}^{VAD}$ represents the amount of emotion left at a time-step t for the emotion e_i .

$$E_{i,t}^{VAD} = E_{i,t-1}^{VAD} - y_{t-1}^{VAD} - \sum_{j=1, j \neq i}^2 E_j \quad (6)$$

where, y_{t-1}^{VAD} is the Valence-Arousal-Dominance (VAD) embedding of the word generated at $t-1$ time-step. Here, E_j is the VAD embedding of a remaining set of emotions. The information of other emotions present in the generated sentence is subtracted to measure the amount of that particular emotion left to be expressed. For example, the given emotions are *surprise* and *joy*, and hence to incorporate the remaining amount of *surprise* in the response, we remove the information of *joy* from the given utterance to focus more on the emotion (*surprise*) left to be expressed in the response. To express *surprise* for a particular intensity the model should generate ‘‘Oh my God’’ instead it has only generated ‘‘Oh’’, then the implicit memory assists in incorporating the remaining amount of *surprise* emotion left to be expressed by generating ‘‘my God!’’. This facilitates in completely expressing a given emotion in the response.

Explicit Memory: Affect words, such as ‘‘great, wonderful’’, etc., provide strong emotional content to a response compared to generic words such as ‘‘book, night’’. Therefore, for expressing a given emotion, the model needs to have the ability to determine the trade-off between the generation of emotional words and generic words. Hence, two different sets of vocabularies are used to decide which words should be generated at a given time-step according to the specified

emotion for generating the emotional response.

$$P(y_t) = \beta_0 P_{gen}(y_t) + \sum_{i=1}^2 \beta_i P_{e_i}(y_t) \quad (7)$$

Here, P_{gen} is the probability of generating a generic word using the generic vocabulary computed as:

$$P_{gen}(y_t) = \text{softmax}(W_g s_{d,t}) \quad (8)$$

Though the similar idea of emotion versus generic words trade-off was considered previously (Zhou et al. 2018; Song et al. 2019), the authors did not account for intensity in emotions. For example, “wonderful, good, nice” all belong to the emotional category “joy”, yet are different with respect to the intensity of the given emotion. Hence, we also incorporate the intensity factor and the choice between emotional or generic word at a given time-step of the decoder. To include the intensity-based emotional words, we calculate two sets of probabilities for a given target word at every decoder-step as:

$$P_{e_i}(y_t) = \gamma P_R(y_t) + \kappa P_I(y_t) \quad (9)$$

where, γ and κ are the learnable parameters and $P_R(y_t)$ signifies the relevance based generation probability with respect to the contextual history. Precisely, $P_R(y_t)$ can be described as follows:

$$P_R(y_t) = \text{softmax}(W_s s_{d,t}) \quad (10)$$

where W_s is the learnable parameter and $P_I(y_t)$ measures the generation probability of the target word given the target emotion intensity I_i . We assume that every word has intensity embedding beyond its semantic embedding, which stands for its preference under different intensities. The corresponding VAD embedding initializes the intensity embedding of every word. In VAD embedding, arousal is analogous to the intensity of a particular emotion. For example, the VAD embedding of “great” is [0.95 0.66 0.81], while of “good” is [0.94 0.37 0.54]. Hence, we can conclude that “great” has a higher intensity in comparison to “good”. We employ a Gaussian Kernel Layer (Luong, Pham, and Manning 2015; Zhang et al. 2018; Luo et al. 2019) to encourage the words with intensity near the target intensity to be selected for generation. For example, if the specified target intensity for *sadness* is 0.9 then the words chosen should be “grief, misery, agony” than just “unhappy, sad” having lesser intensity.

$$P_I(y_t) = \frac{1}{\sqrt{2\pi\sigma}} \exp\left(-\frac{(\phi_I(UW) - I_i)^2}{2\sigma^2}\right) \quad (11)$$

$$\phi_I(U, W) = \sigma(W^T(U \cdot W_{e_i} + b_{e_i}))$$

where W is a one-hot indicator vector of the target word and ϕ_I maps the intensity embedding into real value, and the specified emotion intensity I_i is the mean of the Gaussian distribution. Here, σ^2 is the variance while W_{e_i} and b_{e_i} are the trainable parameters.

To ensure the incorporation of every conditioned emotion, we regulate β_0 , β_1 , and β_2 according to the implicit memory states that store the information of how much a particular

emotion has been expressed in the generated response. If a certain amount of conditioned emotion is expressed, it tries to generate the remaining portion of the sequence such that the given emotion is completely expressed. For example, if “joy” is not completely expressed (i.e., the implicit memory state for *joy* doesn’t change to 1), then the memory would select words that express this emotion. Also, if one of the emotions is expressed, the model needs to generate for the other emotions. For example, after “joy” getting completely expressed, the model focuses on generating other emotions like “surprise, sadness, etc”. Precisely, $\beta_0, \beta_1, \beta_2$ are computed as:

$$\beta_0, \beta_1, \beta_2 = \sigma(W_p[s_{d,t}; M_{e_i,t}] + b_p) \quad (12)$$

where, W_p and b_p are the trainable parameters.

Training and Inference: The model is trained using the cross-entropy loss between the predicted response and the gold response, where the gold response is defined by $y^* = \{y_1^*, y_2^*, \dots, y_m^*\}$. Apart from the cross-entropy loss, we add two regularization terms on the implicit and explicit memory. In implicit memory, the regularization term enforces the state to reach 1, indicating the desired emotion to be expressed entirely. Whereas, in explicit memory, it supervises the selection of the generic or word from a particular emotion. Finally, the loss is computed as:

$$\mathcal{L} = - \sum_{t=1}^{n'} \log p(y_t^* | y_1^*, \dots, y_{t-1}^*) + \sum_{i=1}^2 \|M_{e_i, n'}\| - \sum_{k=0}^2 o_k \log(\beta_k) \quad (13)$$

where $M_{e_i, n'}$ is the implicit emotion state at the last step M , o_k is true selection between the emotion and generic word and β_k is the probability of choosing a generic or emotion word.

Baseline Models: ECM (Zhou et al. 2018), EMOTI-CONS (Colombo et al. 2019), and EmoDS (Song et al. 2019) are the suitable baselines for single-emotion. Therefore, we use these existing baselines to compare in case of single emotions only (for single emotion, we consider the higher intensity emotion for generation). For single emotion with intensity, we compare with Affect-LM (Ghosh et al. 2017) framework to witness the effectiveness of incorporating intensity values with emotion labels. For our multi-emotion baselines, we implement the following models: **(i)**HRED: A general hierarchical encoder-decoder framework (Serban et al. 2015) and **(ii)** HRED+emb: Similar to (Song et al. 2019), we provide the multiple emotion categories in the form of vectors along with the corresponding intensity at each time-step of the decoder.

Experiments

Implementation details For all the models including baselines, the batch size is set to 32. The utterance encoder is a bidirectional GRU with 600 hidden units in each direction. The context encoder and decoder are both GRUs with 600 hidden units. All the model parameters are randomly

Models	PPL	Embedding			Emotion Content	
		Average	Greedy	Extreme	E-F1	IP-Corr
<i>No Emotion</i>						
HRED	80.7	0.491	0.360	0.371	0.39	0.26
<i>Single Emotion</i>						
HRED + emb	75.2	0.493	0.361	0.373	0.61	-
ECM (Zhou et al. 2018)	74.6	0.519	0.375	0.381	0.63	-
EMOTICONS (Colombo et al. 2019)	74.3	0.523	0.381	0.385	0.63	-
EmoDS (Song et al. 2019)	74.1	0.526	0.389	0.387	0.65	-
MEI-DG (Ours)	73.9	0.533	0.409	0.399	0.67	-
<i>Single Emotion + Intensity</i>						
HRED + emb	75.2	0.493	0.361	0.373	0.63	0.44
Affect-LM (Ghosh et al. 2017)	73.1	0.526	0.389	0.387	0.66	0.50
MEI-DG (Ours)	72.7	0.544	0.419	0.411	0.69	0.57
<i>Multiple Emotion + Intensity</i>						
HRED + emb	73.2	0.498	0.369	0.376	0.57	0.41
HRED + IM	72.9	0.512	0.396	0.413	0.59	0.48
HRED + EM - GK	74.1	0.531	0.412	0.407	0.60	0.43
HRED + EM	73.6	0.539	0.428	0.415	0.62	0.51
MEI-DG(HRED+EM+IM)	71.2	0.552	0.443	0.428	0.66	0.54

Table 3: Results for multiple emotions with intensity. HRED+EM-GK denotes the model having explicit memory without the Gaussian Kernel(GK), and HRED+EM: denotes the model having explicit memory with Gaussian Kernel

Models	Fluency	Relevance	Emotion	Intensity
<i>No Emotion</i>				
HRED	3.17	2.89	15.9%	13.6%
<i>Single Emotion</i>				
HRED + emb	3.25	2.93	28.3%	-
ECM (Zhou et al. 2018)	3.45	3.08	36.7%	-
EMOTICONS (Colombo et al. 2019)	3.48	3.05	37.5%	-
EmoDS (Song et al. 2019)	3.47	3.12	39.2%	-
MEI-DG (Ours)	3.49	3.13	45.1%	-
<i>Single Emotion + Intensity</i>				
HRED + emb	3.52	3.21	32.5%	30.6%
Affect LM (Ghosh et al. 2017)	3.58	3.26	41.7%	34.2%
MEI-DG (Ours)	3.60	3.28	47.3%	40.1%
<i>Multiple Emotion + Intensity</i>				
HRED + emb	3.66	3.33	35.4%	32.9%
HRED + IM	3.71	3.40	40.7%	35.4%
HRED + EM - GK	3.69	3.38	38.6%	33.1%
HRED + EM	3.73	3.41	42.9%	36.8%
MEI-DG(HRED+EM+IM)	3.82	3.48	43.9%	37.2%

Table 4: Human evaluation results for all the baseline and proposed framework

initialised using a Gaussian distribution with Xavier scheme (Glorot and Bengio 2010). We employ AMS-Grad (Reddi, Kale, and Kumar 2019) as the optimizer for model training to mitigate the slow convergence issues. The implicit memory is a trainable matrix of size 8300. The generic vocabulary is a list of 40,000 words and emotion words (but emotion words have different markers). We use 300-dimensional word-embedding initialised with Glove (Pennington, Socher, and Manning 2014) embedding pre-trained on Twitter. We use 0.45 as dropout rate and perform gradient clipping when gradient norm is over 3. The variance σ^2 of Gaussian Kernel Layer is set as 1.

Automatic Evaluation Metrics: We adopt perplexity, macro-average weighted F1 score and Pearson correlation co-efficient (Mohammad and Bravo-Marquez 2017) to evaluate the generated responses at content and emotional level, respectively. We also report embedding scores-based metrics (average, greedy, extreme) (Liu et al. 2016).

Human Evaluation Metrics: We sample 250 responses per model for evaluation with the specified emotion and in-

tensity provided for generation. First, we evaluate the quality of the response on two conventional criteria: *Fluency* and *Relevance*. These are rated on a five-scale, where 1, 3, 5 indicate unacceptable, moderate, and excellent performance, respectively, while 2 and 4 are used for unsure. Secondly, we evaluate the emotional quotient of a response by *Emotion* metric, to judge whether the emotional category of the generated response is consistent with the specified emotions; and *Intensity* metric, to decide whether the degree of a particular emotion expressed in the generated response is according to the intensity specified for the given emotion. Here, 0 indicates irrelevant or contradictory, and 1 indicates consistent with the provided emotions or intensity values.

Results and Discussion

We report the evaluation results in Table 3 and Table 4. We perform a comparative study on the MEIMD dataset, by providing single as well as multiple emotions with intensity. From the table, it can be seen that the models conditioned with single emotion outperform the model having no emo-

Conversational History	Model	Emotion	Intensity	Generated Response
It was an amazing night. You think it looked amazing?	HRED	-	-	Yes, I think so.
	MEI-DG	Joy	0.6	Yes it was really fascinating, I enjoyed it.
	MEI-DG	Joy	0.3	Yes it was a nice night.
	MEI-DG	Sadness	0.3	I found the night gloomy.
	MEI-DG	Sadness	0.9	The whole night I cried all alone.
	MEI-DG	Joy, Sadness	0.3, 0.6	It was nice but I terribly missed my friend.
I invented the game of Cups as a way to give Joey money. And now you want that money back.	HRED	-	-	The night was really great only had a little trouble in finding cab.
	MEI-DG	Anger	0.6	I want it back.
	MEI-DG	Anger	0.9	What the hell is wrong with you?
	MEI-DG	Surprise	0.3	I would kill you if I don't get my money back.
	MEI-DG	Surprise	0.9	Wow, I didn't know about it.
	MEI-DG	Anger, Surprise	0.3, 0.6	Oh my God! I left the money in the room.
	MEI-DG	Anger, Surprise	0.6, 0.3	It's not a game! Stop it and give me the money. Oh you please stop annoying me.

Table 5: Examples of responses generated by MEI-DG that are conditioned on single and multiple emotions with intensity.

tion information while the models conditioned with multiple emotions perform significantly better on all the metrics in case of both automatic and human evaluation. In Table 3 for response quality, our proposed MEI-DG framework conditioned with multiple emotions and their corresponding intensity values have a lower perplexity of 71.2 than all the other baseline methods. Additionally, our embedding metrics are significantly better than all the existing baselines designed to evaluate the relevance of the generated response.

The F1 score for emotion classification and Pearson correlation coefficient for intensity prediction for the proposed MEI-DG framework with responses conditioned on multiple emotions is less than the responses being conditioned with a single emotion. This performance reduction can be attributed to the fact that unlike dealing with single-emotion, handling multiple emotions is comparatively a harder task. Although there is a decrease in performance, in our multiple emotion-based MEI-DG framework, we see an absolute improvement of 3% in emotion F1-score in contrast to the existing ECM, EMOTICONS framework. Also, there is an increase of 4% in intensity prediction score compared to the Affect-LM network. This validates the fact that the proposed multi-emotion framework is capable of generating overall better responses. We perform ablation tests to quantify the contributions made by the different components, as shown in Table 3. From the ablation study results, we can conclude that the intensity performance of MEI-DG decreases in the absence of a Gaussian kernel that controls the intensity factor in the generated response. With the addition of Gaussian kernel along with the explicit memory *HRED+EM*, there is a significant improvement of 8% in the performance of our proposed framework compared to the *HRED+EM-GK* network. The final model, having both implicit and explicit memory, gives the best results than all the variants (*HRED+IM*, *HRED+EM-GK*, *HRED+EM*) of the proposed model.

The results of the human evaluation are presented in Table 4. Compared to the existing frameworks, our proposed model obtains the highest emotion and intensity score of 43.9% and 37.2%, respectively. The single emotion and intensity-based MEI-DG model has the highest score in terms of emotion and intensity instead of all the baseline and existing networks, and outperforms the final proposed framework, aligning with the automatic evaluation results. Though the emotion and intensity scores are less in multiple

emotion models than single emotion models, the fluency and relevance scores are better than the single emotion frameworks. One plausible explanation is that the responses are more coherent and relevant in expressing the speaker’s complete emotional state.

We provide some generated examples from the multiple emotion MEI-DG model and single emotion and no emotion baselines in Table 5. From the table, it is evident that our proposed framework is capable of inducing multiple emotions in the generated response (*joy and sadness* or *anger and surprise*). Besides, the generated responses can vary the different levels of intensity (0.3, 0.6, 0.9) for a particular emotion. For different emotions with the variation in intensity the choice of words changes, for example, low intensity *surprise* is expressed by “wow” while high intensity is expressed by the phrase “Oh my God!”. This validates the fact that the proposed network has fair understanding of the different levels of intensity for generation. Finally, in comparison to the single emotion models, the multi-emotion framework generates more comprehensive and emotionally complete responses relevant to the given dialogue context. After performing qualitative analysis, we came across some of the commonly occurring errors committed by MEI-DG that is at times MEI-DG is incapable of generating responses having emotions such as “joy, anger”, “surprise, sadness”, “acceptance, disgust” due to fewer occurrence of these emotions simultaneously in an utterance.

Conclusion and Future Work

In this work, we propose the task of generating responses conditioned on multiple emotions and their corresponding intensity. We have created a large-scale dataset, MEIMD labeled with multiple emotions and the corresponding intensity for generating emotionally enriched responses. We have designed a MEI-DG framework comprising of (i). *Explicit Memory*: to determine whether to generate an emotion or generic word, while focusing on the intensity of the desired emotions; and (ii). *Implicit Memory*: to compute the number of words *remaining* to express the emotion completely, thereby regulating the generation accordingly. From the experimental results, both quantitative and qualitative, we can conclude that MEI-DG can generate emotional responses in accordance with the specified emotions and the desired intensity.

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