Beyond Emotion: A Multi-Modal Dataset for Human Desire Understanding

Anonymous ACL submission

Abstract

Desire is a strong wish to do or have something, which involves not only a linguistic expression, but also underlying cognitive phenomena driving human feelings. As the most primitive and basic human instinct, conscious desire is often accompanied by a range of emotional responses. As a strikingly understudied task, it is difficult for machines to model and understand desire due to the unavailability of benchmarking datasets with desire and emotion labels. To bridge this gap, we present MSED, the first multi-modal and multi-task sentiment, emotion and desire dataset, which contains 9,190 text-image pairs, with English text. Each multi-modal sample is annotated with six desires, three sentiments and six emotions. We also propose the state-of-the-art baselines to evaluate the potential of MSED and show the importance of multi-task and multi-modal clues for desire understanding. We hope this study provides a benchmark for human desire analysis. MSED will be publicly available for research[1].

1 Introduction

Multi-modal sentiment and emotion analysis has immense potential in dialogue analysis and generation, emotion communication, etc., which has been an active field of research in natural language processing (NLP) (Liu et al., 2021; Jaiswal and Provost, 2020). Although numerous advanced models and datasets have been proposed, covering different levels of granularity, such as sentence, aspect, conversation, human desire behind emotions is still relatively unexplored. Human desire understanding models and datasets can benefit different areas of NLP and AI. Research in AI is a step closer to recognizing human emotional intelligence if a machine is able to achieve a deeper understanding of human desires and even make reasonable desire-aware responses (Hofmann and Nordgren, 2015). With researchers' increasing understanding of emotional intelligence and advancements in multi-modal language analysis, desire understanding and analysis comes into view (Goldberg et al., 2009; Ruffman et al., 2003).

Figure 1: Examples of multi-modal desire, sentiment and emotion.

Desire is a primitive instinct and a basic need for strongly expressing human wants to get or possess something, where its endless and insatiable attributes distinguish human beings from other animals (Portner and Rubinstein, 2020). It involves not only a linguistic expression, but also has underlying cognitive phenomena driving human sentiments and emotions (Robinson, 1983). Hence, we argue that there is a close relationship between human desire, sentiment and emotion, where desire stealthily dominates sentiment and emotion while sentiment and emotion also have influence on desire. Such three tasks are complementary in that desire analysis helps the understanding of the other two. For example, in Fig. 1 (a), three kids with a magnifying glass are smiling and observing something interesting. The positive sentiment and happy emotion are judged by means of the desire *curiosity*. Fig. 1 (b) depicts that a young lady and her two children are walking at a leisurely rate along a winding road. Their smiles in the image and the words in its text counterpart convey joyful emotion. Such feelings explains the lady's strong need to be in the company of the children, i.e., family desire. We also check whether our hypothesis is tenable in

[1] https://github.com/MSEDdataset/MSED.git

Dataset	Size	Modality	Resource	Annotation	Inter-Task Dependency
YouTube	47	Text, Image, Speech	YouTube	sentiment	✗
MOUD	498	Text, Image, Speech	YouTube	sentiment	✗
Multi-ZOL	5,288	Text, Image	Zol.com	sentiment	✗
MOSI	2,199	Text, Image, Speech	YouTube	sentiment	✗
MOSEI	23,453	Text, Image, Speech	YouTube	sentiment, emotion	✗
CH-SIMS	2,281	Text, Image, Speech	Movie, TV	sentiment	✗
IEMOCAP	302	Text, Image, Speech	Performance	emotion	✗
MELD	1,433	Text, Image, Speech	TV Show	sentiment, emotion	✗
ScenarioSA	2,214	Text	Social Media	sentiment	✗
MUStARD	690	Text, Image, Speech	TV Show	sarcasm	✗
MSED (Ours)	**9,190**	**Text, Image**	**Social Media**	**desire, sentiment, emotion**	✓

Table 1: Comparison of MSED with other datasets.

the experiments (c.f. Sec. 5.5).

Given the importance of desire understanding, numerous research results in psychology and philosophy have been proposed and are being actively studied to explain and analyze human desire, e.g., desire inference (Dong et al., 2013, 2010), the correlation between desire and love (Cacioppo et al., 2012; Kaunda and Kaunda, 2021), desire diagnosis (Mendelman, 2021). However, it is still an understudied new task in NLP and multi-modal affective computing. The lack of publicly available desire datasets has been the main issue in advancing multi-modal desire analysis models.

In this paper, we take the first step to overcome this limitation by presenting MSED, a novel multi-modal dataset manually annotated with sentiment, emotion and desire labels. MSED consists of 9,190 text-image pairs collected from a wide range of social media resources, e.g., Twitter, Getty Image, Flickr. It aims to extend the goal of human desire understanding within other disciplines and bring it to the NLP community. This dataset also facilitates the study of desire detection models by investigating both multi-task and multi-modal clues. Besides, MSED is also valuable for other NLP domains such as multi-modal language analysis, multi-task learning. In summary, the major contributions of the work are:

- The first multi-modal dataset annotated with three sentiment classes, six emotion classes and six desire classes is created and released publicly, aiming to open new doors to desire understanding.
- We present fine-grain multi-modal annotations of sentiment, emotion and desire categories. The quality control and agreement analysis are also described.
- Quantitative investigation shows the distribution of desire category, key words, whether desire affects the distribution of sentiment and emotion, and to what extent
- We propose three multi-modal tasks to evaluate MSED, which are desire detection, sentiment analysis and emotion recognition. Several strong baselines using different combinations of feature representations are reported to show the need of multi-modal desire analysis models and the potential of MSED to facilitate the development of such models.

2 Related Work

2.1 Sentiment, Emotion and Desire Datasets

Since there is no available desire dataset, we briefly review related work in multi-modal sentiment and emotion datasets. Previously, researchers have created various multi-modal datasets to provide experimental test beds for evaluating sentiment and emotion analysis models, including YouTube (Uryupina et al., 2014), MOUD (Pérez-Rosas et al., 2013), Multi-ZOL (Xu et al., 2019), CMU-MOSI (Zadeh et al., 2016), etc. In addition, Zadeh et al. (2018) proposed an extended version of MOSI, which consists of textual, acoustic and visual clues. Yu et al. (2020) collected 2,281 refined Chinese video segments in the wild with both multi-modal and independent unimodal annotations. It allowed researchers to study the difference between modalities. Zhang et al. (2021a) presented the first multi-modal metaphor dataset to facilitate understanding metaphor from texts and images.

Multi-modal emotion recognition in conversation (ERC) has increasingly become an active research topic. The community also established IEMOCAP (Busso et al., 2008) MELD (Poria et al., 2019), ScenarioSA (Zhang et al., 2020) and MUStARD (Castro et al., 2019), to show the impact of social interaction on human emotion evolution. However, the existing datasets only contain senti-

ment and emotion annotations. There is a lack of a dataset which provides insights into the desire behind human emotions. In contrast, MSED contains all of sentiment, emotion and desire multi-modal annotations to support and encourage future studies on the correlation between desire, sentiment and emotion. Table 1 compares all above mentioned datasets with their properties.

2.2 Sentiment, Emotion and Desire Analysis

The little work which exists on the automatic analysis of multi-modal desire has mainly been done in psychology, sociology and philosophy domains. Lim et al. (2012) designed a multi-modal desire analysis model that encompasses both audio and gesture modalities. However, they explained human desire in terms of emotions. Schutte and Malouff (2020) performed meta-analytic investigation on 2,692 individuals to explore the association between curiosity and creativity. Hoppe et al. (2015) used support vector machine (SVM) and eye movement data for automatic recognition of different levels of curiosity. But this work did not lie in the multi-modal domain. Cacioppo et al. (2012) presented a multilevel kernel density fMRI analysis approach to understand the differences and similarities in the interaction between sexual desire and love. Chauhan et al. (2020a) proposed a multi-task and multi-modal deep attentive framework for offensive, motivation and sentiment analysis. However, according to 16 basic desires theory (Steven, 2004), motivation and offense cannot be classified as desires.

Although remarkable progress has been made in the recent studies of multi-modal affect analysis, e.g., sentiment analysis (Ju et al., 2021), emotion recognition (Chauhan et al., 2020b; Wen et al., 2021), sarcasm detection (Liang et al., 2021; Zhang et al., 2021b), humor analysis (Hasan et al., 2019), etc., there is a gap in the understanding and detection of human desire. Our MSED dataset will contribute to the research in understanding and analysis of the desires behind human agency.

3 The MSED Dataset

The process of creating MSED, the annotation procedure and the basic features are detailed.

3.1 Data Acquisition

The rise of social media has provided a platform for an increasing number of people to fulfill their desires and exude their emotions by publishing diverse types of posts. Given that our aim is to create a multi-modal dataset, three well-known online photo-sharing resources, i.e., Getty Image, Flickr and Twitter, are chosen as our domain. In order to avoid noisy and irrelevant samples as much as possible, we prefer to set a filtering rule before collecting them.

Item	#
Total samples	9,190
Desire samples	4,683
Non-desire Samples	4,507
Total words	109,570
Average word count per text	12
Average size per image	612×408
Train set size	6,127
Validation set size	1,021
Test set size	2,042

Table 2: Statistics of MSED Dataset.

Specially, we set a list of keywords with a strong desire expression based on 16 basic desires theory (Steven, 2004), e.g., $curiosity$, $romance$, $family$, $vengeance$, etc. We query the social media platforms with such words, and only crawl the retrieved text-image posts on the first ten pages. Besides, we attempt to select the visual samples which include people and their facial expressions so that one can easily judge their emotions, sentiments and desires. After applying this first filtering step, we gather over 11,000 multi-modal posts[2].

Data Filter. All these raw posts are then pre-processed by employing the data filtering rule. For text data, we remove text with fewer than 3 words, correct the spelling mistakes, and check if each text is composed of illegible characters via the NLTK package (Bird et al., 2009). For their visual counterparts, we remove the images with low resolution and resize all images to the same size.

Finally, the MSED dataset contains 9,190 text-image pairs, with 109,570 word occurrences in total. The average number of words per text is 12. The detailed statistics are shown in Table 2.

3.2 Label Selection and Annotation Model

Since human desires are many and varied, this paper will focus on those desires that are emotionally related and divorced from the need for survival (e.g., eat). After early attempts to collect and analyze raw samples, we empirically select six typical human desires from sixteen basic de-

[2]Note that the original copyright of all the multi-modal samples belongs to the source owners, and no personal information of any participants was collected.

Desire	Explanation
Family	The need to take care of one's offspring.
Romance	A feeling of excitement and mystery associated with love.
Vengeance	The need to strike back against another person.
Curiosity	The wish to gain knowledge or explore the unexpected.
Tranquility	The wish to be secure, protected or company.
Social-contact	The need to communicate, converse and establish a relationship with others.

Table 3: Explanations of six desires.

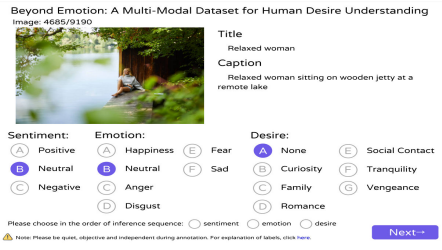


Figure 2: Layout of the annotation interface.

sires, which are $family$, $romance$, $vengeance$, $curiosity$, $tranquility$, $social\ contact$. Such desire attributions often are accompanied by sentimental and emotional expressions. Table 3 presents the detailed explanations of the selected desires.

Thus, each piece of multi-modal sample is manually annotated with desire category, sentiment category (i.e., $positive$, $neutral$ and $negative$) and emotion category ($happiness$, sad, $neutral$, $disgust$, $anger$ and $fear$). The annotation model is AnnotationModel = (DesireCategory, SentimentCategory, EmotionCategory, DataSource).

3.3 Human Annotation Process

We recruit five well-educated volunteers including three undergraduate and two master students to take part in data annotation. All of them signed and gave informed consents before the study and were paid equivalent of $1.5/hour in local currency. They had a professional background which ensured that they have a good knowledge of human desire and emotion analysis. Before labeling the whole dataset, they were instructed to independently annotate 50 examples first, in order to minimize ambiguity while strengthening the inter-annotator agreement, e.g., their agreement rate should reach 90%.

During the annotation process, the volunteers are randomly presented the text-image pairs. In this work, we argue that human desire is tightly intertwined with sentiment and emotion (Portner and Rubinstein, 2020), and therefore consider three inter-dependent annotation setups for desire, sentiment and emotion tasks. To emphasize such inter-dependency, the volunteers are asked to write their inference sequences, e.g., which task helps the other two tasks the most. For example, the inference sequence in Fig. 1 (a) is $(desire \rightarrow sentiment \rightarrow emotion)$. We define the gold standard of a text-image pair in terms of the label that receives the majority votes. The annotation interface is shown in Fig. 2.

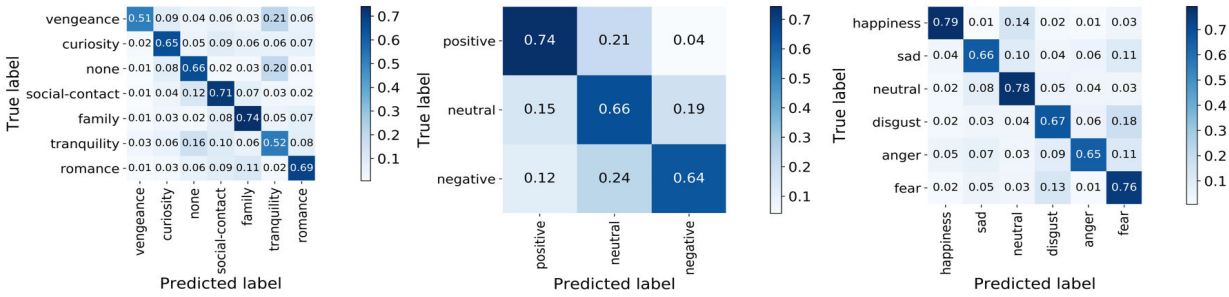
3.4 Quality Control

Since desire, sentiment and emotion annotation is a very subjective task, disputes and conflicts always exist and are difficult to erase. In order to guarantee the annotation quality, we develop a two-step validation paradigm. First, we calculate the average agreement among five annotators via the percent agreement calculation method (Hunt, 1986). The average agreements for desire, sentiment and emotion tasks are 71.4%, 83.6% and 72.1%. Next, to confirm this inter-rater agreement, the kappa score (Fleiss and Cohen, 1973) is introduced. The agreement scores of the annotation for desire, sentiment and emotion are $\kappa = 0.53$, $\kappa = 0.67$, $\kappa = 0.56$ respectively, which shows that five participators have reached moderate agreement on both desire and emotion annotations and substantial agreement on the sentiment annotation.

Moreover, the confusion matrices in Fig. 3 indicates the annotations difference between different labels for three tasks. From Fig. 3 (a), we can see that the differences between vengeance, none and tranquility are maximal (i.e., 0.21, 0.20), while the differences between vengeance and other categories are minimal. From Fig. 3 (b), we notice that one could easily distinguish positive from negative sentiment, but it is difficult to distinguish neutral from positive and negative sentiments. Fig. 3 (c) supports the above argument that the difference between neutral and happiness and the difference between neutral and sad are great.

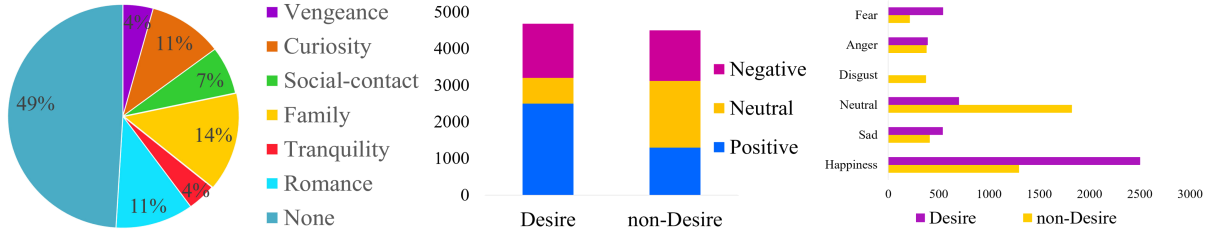
4 Dataset Analysis

Desire Analysis. We present the distribution of desire labels in MSED, as shown in Fig. 4. From



(a) Desire annotation. (b) Sentiment annotation. (c) Emotion annotation.

Figure 3: The confusion matrices show the annotations difference between different labels for three tasks.



(a) Desire category. (b) Desire and non-desire sentiment. (c) Desire and non-desire emotion.

Figure 4: Dataset distribution.

Fig. 4 (a), we observe that desire and non-desire samples account for 51% and 49% respectively. This shows that MSED is a well-proportioned and balanced dataset, which is suitable for machine or deep learning based analysis. Specially, the proportions of curiosity, family and romance are 11%, 14% and 11%. which are much larger than the proportions of vengeance and tranquility (i.e., 4%, 4%). This is also in line with our actual life where fewer people are ready to share their dark sides and flurried attitudes on social media platforms. More people are likely to publish tweets about family life, romantic love, etc.

Sentiment Analysis. Fig. 4 (b) shows how sentiment is entangled with desire and non-desire. We can see that positive sentiment accounts for the largest proportion of 53% in desire samples while negative sentiment is not far behind, i.e., 33%. Neutral polarity has the smallest proportion of 14%. The proportion of non-neutral sentiment towers over that of neutral polarity. In non-desire data, the proportion of neutral polarity (i.e., 42%) is more than the proportion of positive and negative sentiments (i.e., 28% and 30%). But the proportions of neutral and non-neutral sentiments turn out very close, which indicates that there is a poor correlation between non-desire and the different sentiment classes. These results have verified our previous arguments: (1) human desire is often accompanied by a range of sentiment responses; and (2) desire stealthily dominates emotion.

(a) Desire samples. (b) Non-desire samples.

Figure 5: Word cloud visualization.

Emotion Analysis. We also present that there are some differences in the distribution of emotion between the desire data and non-desire data in Fig. 4 (c). Fear, anger, sad and happy emotions are more likely to occur in the desire samples while neutral and disgust emotions occur more frequently in the non-desire samples. This implicates that people often automatically exude their emotions while expressing the desires. There is close relationship between desire and emotion, which agrees well with the above conclusion.

Key Word Analysis. We generate two word clouds to visually compare the usage of high-frequency words in desire and non-desire samples, as shown in Fig. 5. We notice that the most common words in the desire samples are couple, mother, father, shot, son, little, etc. Such words

		MSED		
		Train	Validation	Test
Sentiment	Positive	2524	419	860
	Neutral	1664	294	569
	Negative	1939	308	613
Emotion	Happiness	2524	419	860
	Sad	666	102	186
	Neutral	1664	294	569
	Disgust	251	44	80
	Anger	523	78	172
	Fear	499	84	175
Desire	Vengeance	277	39	75
	Curiosity	634	118	213
	Social-contact	437	59	138
	Family	873	152	288
	Tranquility	245	39	87
	Romance	692	107	210
	None	2969	507	1031

Table 4: Dataset statistics.

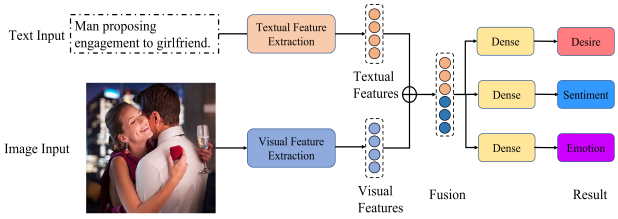


Figure 6: Multi-modal desire, sentiment and emotion analysis model.

are often used in the romance, family, vengeance related expressions. Fig 5 (b) shows the high frequency words in the non-desire samples, which are background, up, close, girl, senior, using, etc. Most of these words are verbs or nouns and are used as the description of a object or action, which do not often express human desires. This shows that the MSED dataset is accurately annotated and split.

5 Experiments and Evaluation

5.1 Dataset Split

In order to support model training and evaluation, we first shuffle the order of all multi-modal samples, and thus divide the MSED dataset into train, validation and test subsets according to the proportion of 70%, 10%, 20%. Table 4 shows the detailed statistics for train, validation and test subsets.

5.2 Experiment Settings

Evaluation metrics. We adopt *precision* (P), *recall* (R) and *macro-F1* (M_a-F1) as evaluation metrics in our experiments. We also introduce *weighted accuracy* metric for the ablation test, human evaluation study and inter-task correlation study.

Model architecture. To evaluate the created MSED dataset, we propose three tasks, i.e., desire detection, sentiment analysis and emotion recognition, and provide a wide range of strong baselines by using different combinations of features. Fig. 6 presents the proposed model architecture.

We feed the text and image into two encoders to obtain their features respectively. For text, three typical encoders are used, i.e., deep CNN (DCNN), bidirectional LSTM (BiLSTM), and the pre-trained language model, BERT (Devlin et al., 2018). For image, two widely used visual encoders, i.e., AlexNet (Alom et al., 2018) and ResNet (Szegedy et al., 2017) are selected. After that, we choose four multi-modal fusion strategies, i.e., concatenation, adding, element-wise multiply and maximum, to learn the multi-modal representation. This representation is then forwarded through three dense layers and softmax functions respectively for desire, sentiment and emotion detection. In addition, as a state-of-the-art multi-modal pre-trained language model, Multimodal Transformer (Gabeur et al., 2020) is also used as the baseline. The details of model building and training is provided in Appendix.

5.3 Results and Discussion

We present the experimental results in Table 5. For text classification, DCNN performs very poorly for all three tasks, and gets the worst macro-F1 of 29.55%, 51.19% and 41.60%. Through modeling of bi-directional contexts, BiLSTM outperforms DCNN significantly. BERT outperforms DCNN and BiLSTM by a large margin in terms of macro-F1. These results are thanks to strong representational ability of BERT. For image classification, ResNet performs very well against AlexNet, since it solves the problem of gradient disappearance and enriches the input signals by introducing the residual connection. For multi-modal setup, we compare six combinations and observe that BERT+ResNet achieves the best macro-F1 scores of 82.28%, 85.81% and 82.42%. It overcomes both BERT (1.7%, 1.7%, 1.6% ↑) and ResNet (62.0%, 20.8%, 44.5% ↑), which shows the importance of using multi-modal clues.

With the aim to explore the impact of different multi-modal fusion approaches on the classification performance, we also compare four fusion approaches in term of *weighted accuracy* in Table 6. We observe that feature concatenation achieves the best performance for sentiment analysis and emotion recognition while feature adding performs the best for desire detection. In contrast, another two fusion approaches may lose a drawerful of primor-

Model	Text	Image	Desire Detection			Sentiment Analysis			Emotion Recognition		
			P	R	M_a-F1	P	R	M_a-F1	P	R	M_a-F1
Text	DCNN	-	36.91	31.64	29.55	59.31	53.01	51.19	43.66	41.10	41.60
	BiLSTM	-	73.20	67.82	69.14	78.43	78.75	78.58	73.49	72.17	72.73
	BERT	-	81.74	80.39	80.88	84.43	84.28	84.35	81.76	80.57	81.10
Image	-	AlexNet	51.47	49.33	50.07	68.76	68.21	68.45	56.42	53.29	54.66
	-	ResNet	49.97	49.35	49.20	70.85	70.61	70.64	58.74	54.67	56.40
Text+Image	DCNN	AlexNet	59.42	52.02	52.35	71.02	70.09	70.31	49.56	42.77	43.76
	DCNN	ResNet	56.34	50.64	52.89	74.73	74.73	74.64	62.93	59.12	60.48
	BiLSTM	AlexNet	67.80	68.00	67.67	78.73	79.22	78.89	71.17	70.70	70.89
	BiLSTM	ResNet	54.97	49.94	51.99	75.89	75.27	75.25	63.63	60.80	61.98
	BERT	AlexNet	80.84	75.50	77.17	83.22	83.11	83.16	78.06	78.19	78.10
	BERT	ResNet	**83.42**	**82.43**	**82.28**	**85.83**	**85.79**	**85.81**	**83.54**	81.51	**82.42**
Multimodal Transformer	-	-	81.92	80.20	80.92	83.56	83.45	83.50	81.62	**81.61**	81.53

Table 5: Comparison of different models.

BERT+ResNet Multi-Modal Fusion	Desire Detection		Sentiment Analysis		Emotion Recognition	
	Validation	Test	Validation	Test	Validation	Test
Concatenate	83.55	85.21	83.64	85.95	79.63	82.91
Add	85.31	86.48	83.06	85.94	82.08	82.32
Multiply	83.64	83.99	85.21	85.50	78.65	81.59
Maximum	84.62	85.55	83.94	85.11	80.90	81.83

Table 6: Comparison of different multi-modal combinations.

dial features when performing multiply operation or selecting the maximum eigenvalues. In summary, feature concatenation and adding may be the best approaches for our three tasks.

5.4 Human Evaluation Results

Method	Desire	Sentiment	Emotion
Annotator 1	88.00	90.00	86.00
Annotator 2	84.00	88.00	86.00
Annotator 3	84.00	88.00	82.00
Avg.	85.33	88.67	84.67
BERT+ResNet	82.00	86.00	82.00

Table 7: The human evaluation results against BERT+ResNet for three tasks.

Next, we create a new test set including 50 multi-modal documents, and recruit three undergraduate volunteers to evaluate the desire, sentiment and emotion labels. We run the inter-annotator agreement study on three volunteers' scores and the average kappa scores are 0.80, 0.82 and 0.78 for our three tasks. We also choose the pre-trained BERT+ResNet (the state-of-art system) to make desire, sentiment and emotion predictions. Table 7 presents the comparative results.

We can see that although BERT+ResNet have attained the best classification scores before, they still perform worse than human evaluation. One possible reason is that multi-modal representation and fusion may miss some essential contents. This proves that such strong baselines can not guarantee a satisfactory result compared to human judgment. Desire understanding is thus an emerging, yet challenging task, where novel multi-modal desire understanding models are needed. The proposed MSED dataset will provide a available data bed for model evaluation.

Task Sequence	Desire	Sentiment	Emotion
$des \Rightarrow sen \Rightarrow emo$	84.82	85.46	82.13
$des \Rightarrow emo \Rightarrow sen$	84.82	85.06	82.22
$sen \Rightarrow des \Rightarrow emo$	85.85	82.73	82.62
$sen \Rightarrow emo \Rightarrow des$	85.90	82.73	82.08
$emo \Rightarrow sen \Rightarrow des$	85.60	85.16	80.80
$emo \Rightarrow des \Rightarrow sen$	84.18	84.87	80.80

Table 8: All the possible task inference sequences.

5.5 Discussion on Inter-Task Correlation

In order to verify the correlations across multiple tasks, e.g., which task offers the greatest help to other tasks, we improve BERT+ResNet by incorporating the inference sequence knowledge. We choose to merge the former task knowledge (the output of the dense layer) with the features of the latter task to construct a new input for the latter task. This action will naturally leverage the knowledge from other tasks. We have checked all the possible task combinations, e.g., $(des \Rightarrow sen \Rightarrow emo)$, $(sen \Rightarrow des \Rightarrow emo)$, etc. We show the obtained results in Table 8. We see that BERT+ResNet performs the best for the task of desire detection under the task sequence of $(sen \Rightarrow emo \Rightarrow des)$. This shows that sentiment and emotion knowledge indeed helps improve desire detection. By comparing the performance of three tasks, we notice that sentiment and emotion tasks gain

greater improvement over desire detection under the task sequences of $(des \Rightarrow sen \Rightarrow emo)$ and $(sen \Rightarrow des \Rightarrow emo)$. These results support our argument that desire, sentiment and emotion are not only inter-entangled, sentiment and emotion are but also actuated by human desire. In addition, the importance of multi-task clues is also investigated.

5.6 Ablation Study

From Table 5, we perform an ablation study by analyzing the effectiveness of different components of BERT+ResNet. By comparing the classification performance of BERT and ResNet, we see that using textual features is more effective than using visual features, as we expected. The main reasons are: (1) BERT contributes the most to overall framework, as it effectively captures the inter-dependencies between words and extracts refined features; (2) Text cue plays a more important role than visual cue for desire understanding, since visual desire analysis involves a higher level of abstraction. However, ResNet still outperforms DCNN and BiLSTM by a large margin (7%, 5% ↑), which shows the effectiveness of pre-trained visual model.

5.7 Error Analysis

Through presenting the confusion matrices of BERT+ResNet in Fig. 7, we perform an error analysis. We notice that misclassification for BERT+ResNet often happens in four categories of samples, i.e., non-desire, curiosity, social-contact and tranquility. About 10.6% non-desire samples are mis-classified as various desires. 29.5% curiosity samples are misdiagnosed. For tranquility detection, BERT+ResNet performs very poorly, which annotates almost half (36.8%) tranquility samples as non-desire labels. 15.2% social-contact desire is misdiagnosed as non-desire. This implicates that BERT+ResNet struggles in differentiating curiosity, social-contact and tranquility from non-desire. Further theoretical and empirical research is needed for better studying human desires. We also show a few misclassification cases for desire detection, as shown in Fig. 8.

6 Conclusions and Future work

Human desire understanding is a relatively unexplored task in NLP. To fill this gap, we expand desire research from psychology to multi-modal language analysis, and thus propose the first multi-modal multi-task dataset for desire, sentiment and emotion detection, MSED. Each sample is annotated with six basic desires, three sentiments and

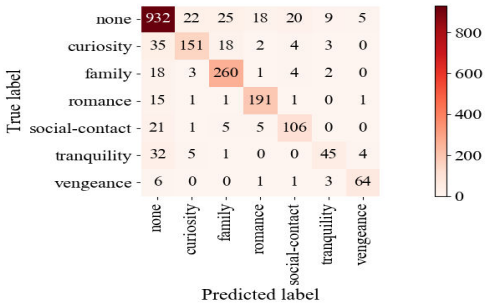


Figure 7: Wrongly classified multi-modal samples in MSED.

(a) Father with dog and two children relaxing in living room.

(b) Little boy observing insects with a magnifying glass.

(c) Young dominating woman pulling an injured man by tie and giving her thumb up.

(d) Girl closes her eyes tightly as she goes on a zip line.

Figure 8: Wrongly classified multi-modal samples.

six emotions. In addition, qualitative and quantitative studies are performed for analyzing the dataset. We also present a range of baselines to evaluate the potential of MSED. The comparative and human evaluation results demonstrate the need of new desire analysis models and the potential of MSED to facilitate the development of such models.

Our work has also a few limitations. The images available in platforms like Flickr and Getty may not express spontaneous human desire, as many of them are purposefully designed by professional photographers. Moreover, a larger scale multi-modal dataset with more desire categories is needed. The technique of human desire analysis based on online data also has the potential to be misused, e.g. by integrating them with facial recognition techniques to make interventions or decisions for humans.

In summary, we hope that the creation of MSED will provide a new perspective in NLP for research on human desire analysis. The dataset will be publicly available for research. Given the close relationship between desire, sentiment and emotion, a refined multi-modal multi-task learning framework is left to our future work.

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Appendix

A Model Building

We apply a bi-modal encoder architecture when building models. The bi-modal encoder consists of text (i.e., DCNN, BiLSTM and BERT) and image encoders (i.e., AlesNet and ResNet). The outputs from two encoders are concatenated to form the multi-modal representation, and thus are forwarded to a dense layer to make prediction of three tasks.

A.1 Text Encoder

We use GloVe 6B to initialize the 100 dimensional word embeddings as inputs for DCNN and BiLSTM. As for BERT, the dimension is 768.

DCNN. The first convolutional layer in the DCNN consists of 3 filters of size 2×2. The second convolutional layer consists of 3 filters of size 3×3. The third convolutional layer consists of 3 filters of size 4×4. This network is followed by the fully connected layer (size of 128) and the softmax layer. Finally, the activation values of the fully connected layer are used as the output of the encoder.

BiLSTM. It consists of two LSTM layers that read the input sequence forwardly and backwardly to generate a series of bidirectional hidden states. The i^{th} hidden representation is obtained by merging the bidirectional hidden states, e.g., $\boldsymbol{h}_i = \overrightarrow{\boldsymbol{h}_i} \,\|\, \overleftarrow{\boldsymbol{h}_i}$, where $i \in [1, 2, ..., n]$. In BiLSTM, the dimensions of forward and backward hidden states are set to 50 respectively. Finally, the final hidden sate $\boldsymbol{h}_n$ is used as the sequence representation.

BERT. We fine-tuned the BERT-base including 12 layers and 110M parameters as the text encoder. Each sequence will be padded or truncated to the size of 50 before it is input. The obtained representation of the first token in the sequence (i.e., the [CLS] token) is used as the output of the encoder, where the dimension is 768.

A.2 Image Encoder

Each image is pre-processed by using mean and standard deviation calculated by ImageNet.

AlexNet. The size of the input images is $408 \times 612 \times 3$. The first convolutional layer has 96 kernels of size $12 \times 40 \times 3$ with a stride of 4 pixels. The second convolutional layer has 256 kernels of size $5 \times 5 \times 96$ with a stride of 2 pixels. The third convolutional layer has 384 kernels of size $3 \times 3 \times 256$. The forth convolutional layer has 384 kernels of size $3 \times 3 \times 384$, and the fifth convolutional layer has 256 kernels of size $3 \times 3 \times 384$.

ResNet. The ResNet18 pre-trained model is used in our experiments. All the images are resized to $612 \times 612 \times 3$ before they are feed into the model.

B Model Training

We use Pytorch (Paszke et al., 2019) to build all models. To avoid overfitting, we choose to perform early stopping during training. During training, the optimal learning rate is set to 1×10^{-5} and the epoch is 40 if the encoder includes pre-trained model, otherwise they are set to 1×10^{-3} and 100 respectively. The dropout rate in the model is 0.5. In our models, cross entropy with $L2$ regularization is used as the loss function, as shown in Eq. 1:

$$\zeta_s = -\frac{1}{L} \sum_{\xi} Y_\xi log \hat{Y}_\xi + \tau_r \left\| \phi \right\|^2 \quad (1)$$

where $\zeta_s \in \{\zeta_{sen}, \zeta_{emo}, \zeta_{des}\}$, Y_ξ denotes the ground truth of the ξ^{th} sample, $\hat{Y}_\xi$ is the predicted distribution. ξ is the index of sample, and L is the total number of samples. τ_r is the coefficient for $L2$ regularization. As for optimizer, we choose Adam to optimize the loss function. We use the back propagation method to compute the gradients and update all the parameters. It takes about 50 minutes for the state-of-the-art system (i.e., BERT+ResNet) to train its best performance over MSED via 1×RTX A6000 GPU.