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Knowledge Bridging for Empathetic Dialogue Generation

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Outline

- Introduction
  - The Empathetic Dialogue Generation Task
- Our Work
  - Empathetic Generator
  - Interactive Discriminators
- Experiments
- Conclusions & Future Work

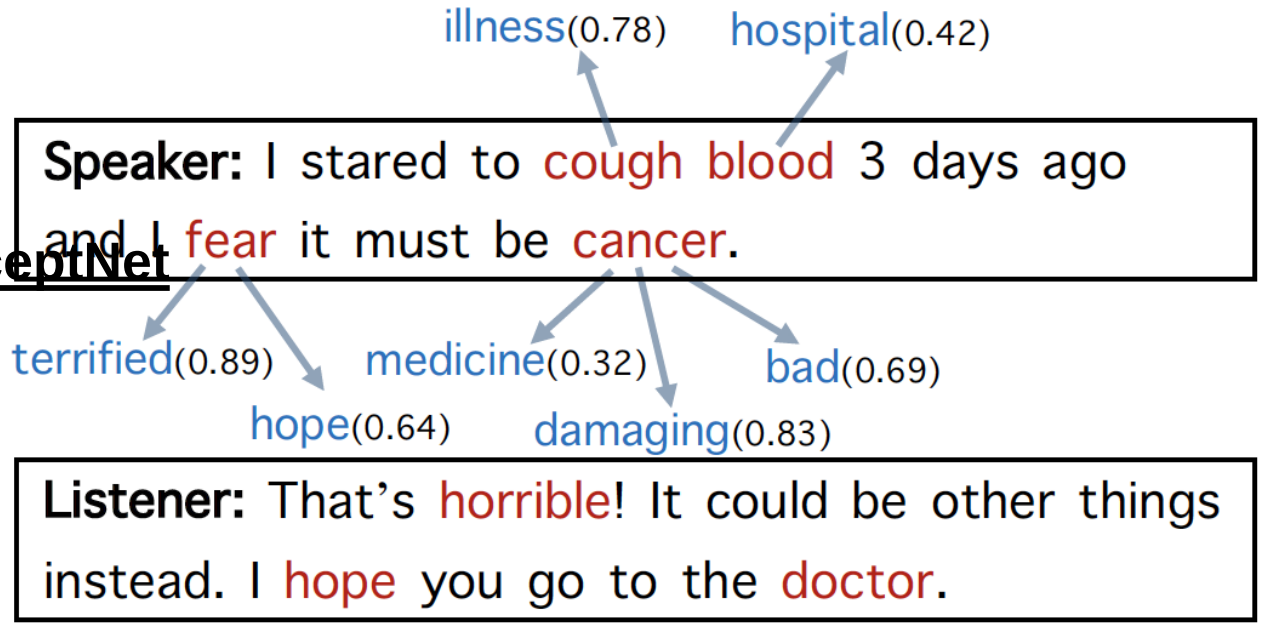
Introduction to Empathetic Dialogue Generation

"**Empathy**" is a crucial step towards a more humanized human-machine conversation. **Empathetic dialogue generation** aims to recognize feelings in the conversation partner and reply accordingly.

Challenges

- Humans usually rely on experience and external knowledge to acknowledge and express implicit emotions.
- Lacking external knowledge makes it difficult to perceive implicit emotions from limited dialogue history.

1. A commonsense knowledge graph **ConceptNet**
2. An emotional lexicon **NRC_VAD**



Introduction to Empathetic Dialogue Generation

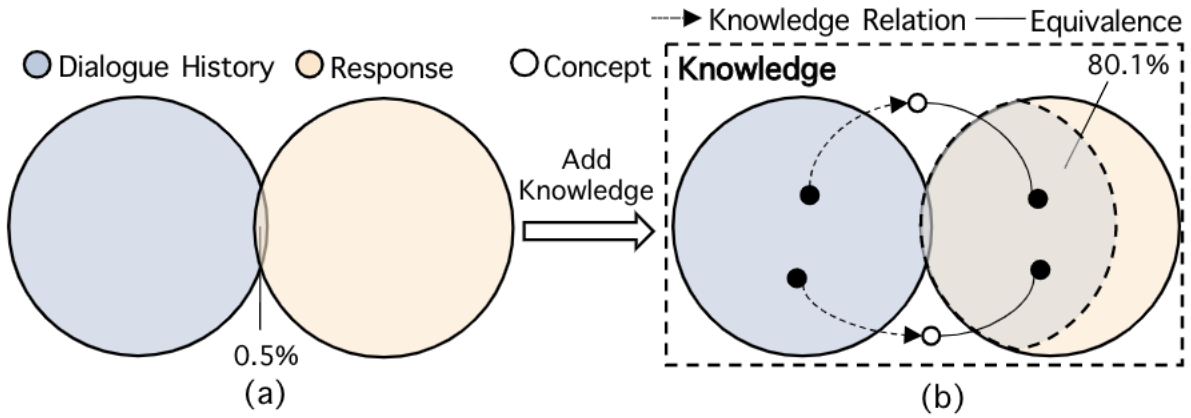


Figure 2: Relationships among dialogue history, responses, and knowledge.

1. This phenomenon demonstrates that humans need to infer more knowledge to conduct empathetic dialogues.
2. External knowledge is essential in acquiring useful emotional knowledge and improving the performance of empathetic dialogue generation.

Introduction to Empathetic Dialogue Generation

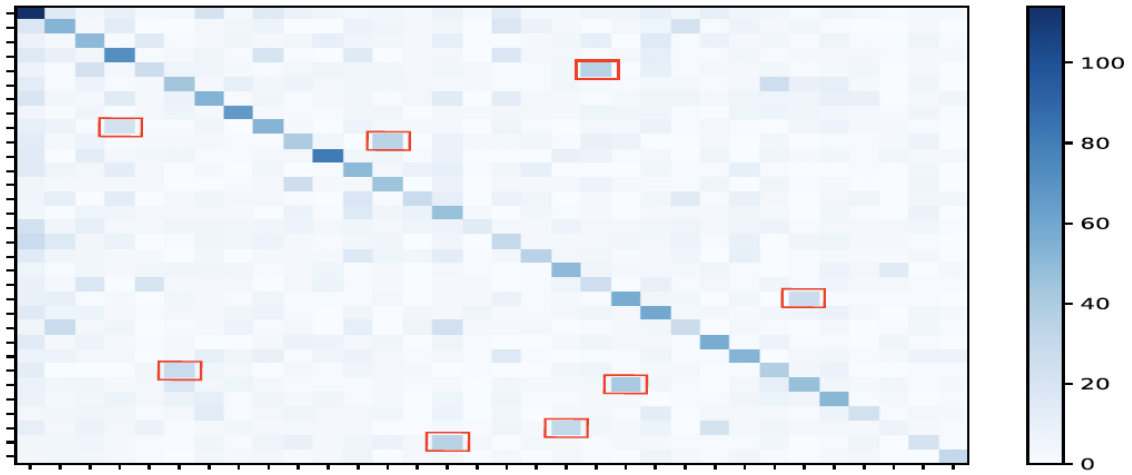


Figure 3: Emotion transition patterns. y-axis indicates the speaker's emotion label. x-axis indicates the listener's emotion label predicted by the classifier.

Modelling emotional dependencies between interlocutors is crucial to enhance the accuracy of external knowledge representation in empathetic dialogues.

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Knowledge-aware Empathetic Dialogue Generation - KEMP

A framework KEMP

- The early attempt to **leverage external knowledge** to enhance empathetic dialogue generation.

An emotional context encoder and an emotion-dependency decoder

- Learn the emotional dependencies between the dialogue history and target response **with bunches of external emotional concepts**.

Conducted on a benchmark dataset EMPATHETICDIALOGUES (Rashkin et al., 2019), experimental results confirm the effectiveness of KEMP.

Knowledge-aware Empathetic Dialogue Generation - KEMP

Preliminaries

- **ConceptNet**
  - A large-scale knowledge graph that describes general human knowledge in natural language. It comprises 5.9M tuples, 3.1M concepts, and 38 relation $\langle \text{birthday}, \text{RelatedTo}, \text{happy}, s \rangle$
- **NRC_VAD**
  - A lexicon of VAD (Valence-Arousal-Dominance) vectors with dimensions for 20k English words.

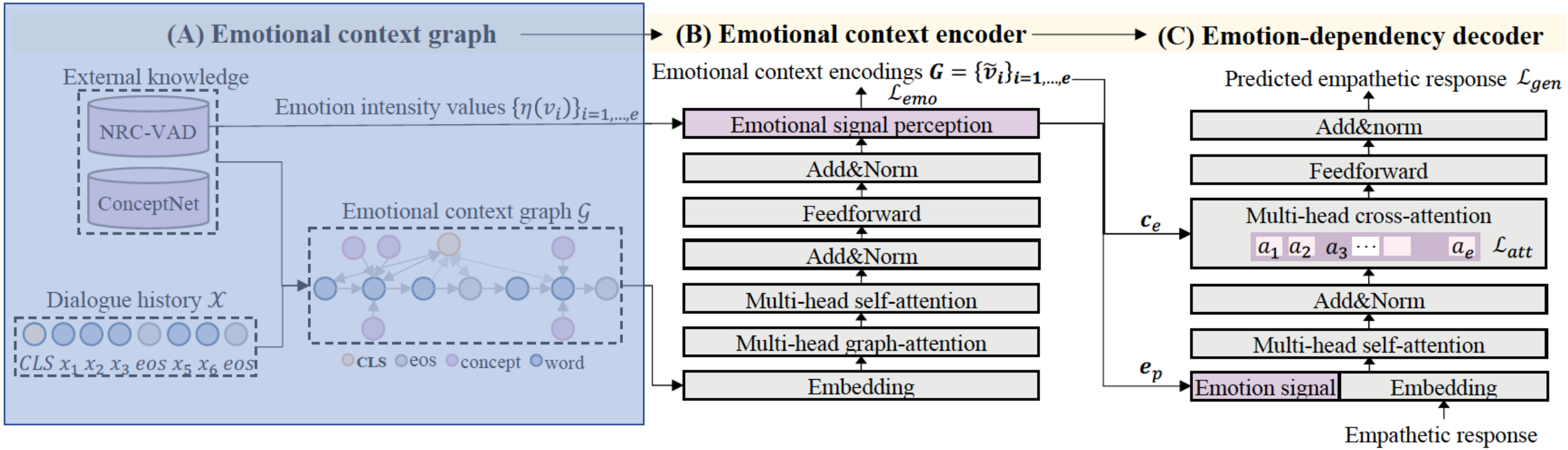
Table 1: Interpretations of NRC_VAD vectors.

Dimensions	Values	Interpretations
Valence	$[0, 1]$	Negative - Positive
Arousal	$[0, 1]$	Calm - Excited
Dominance	$[0, 1]$	Submissive - Dominant

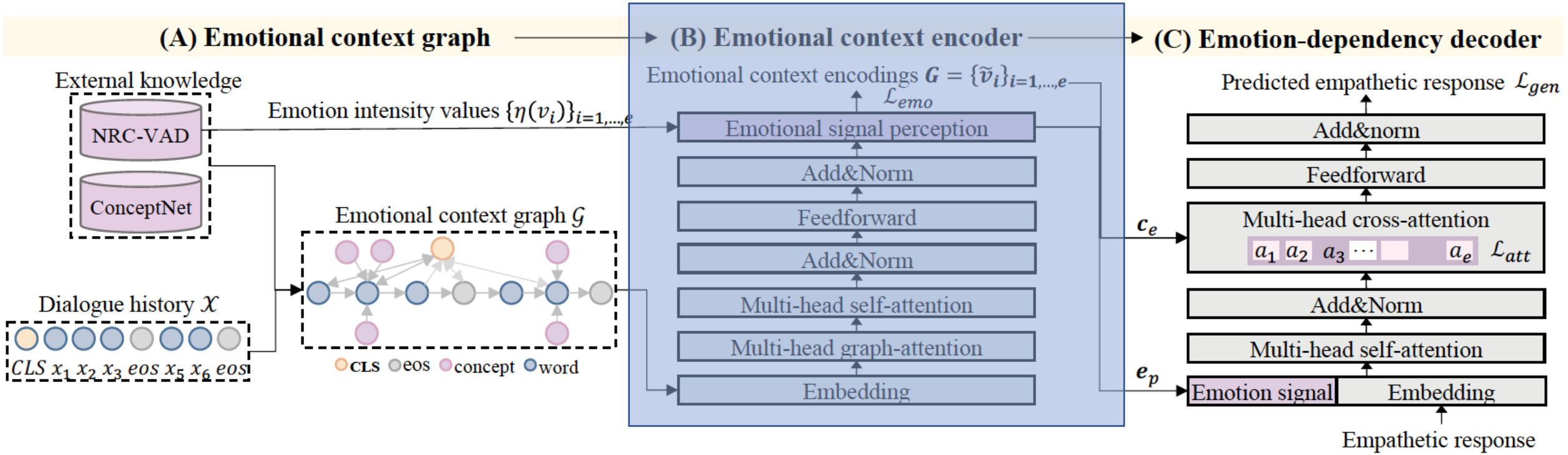
$$\eta(x_i) = \textit{min-max}(\left\| V_a(x_i) - \frac{1}{2}, \frac{A_r(x_i)}{2} \right\|_2),$$

Zhong, Wang, and Miao (2019)

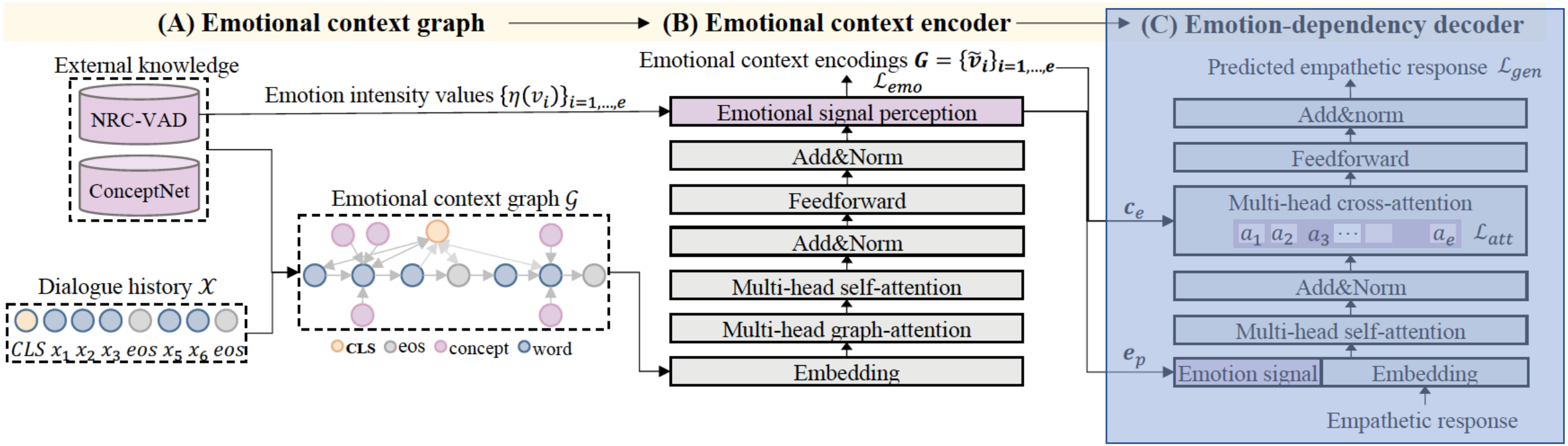
Knowledge-aware Empathetic Dialogue Generation - KEMP



Knowledge-aware Empathetic Dialogue Generation - KEMP



Knowledge-aware Empathetic Dialogue Generation - KEMP



Knowledge-aware Empathetic Dialogue Generation - KEMP

Task Definition

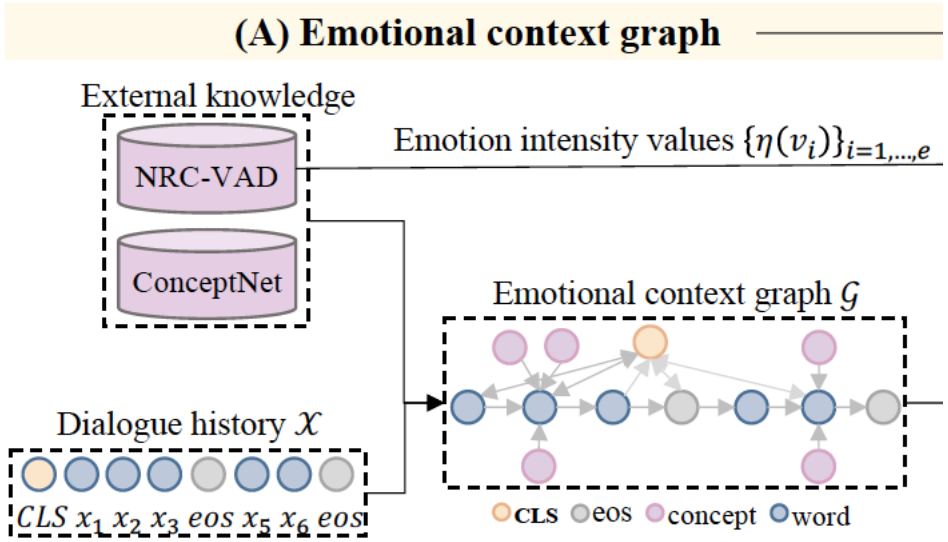
Input:

1. Multi-turn Dialogue History
2. ConceptNet
3. NRC_VAD

Output (two subtasks):

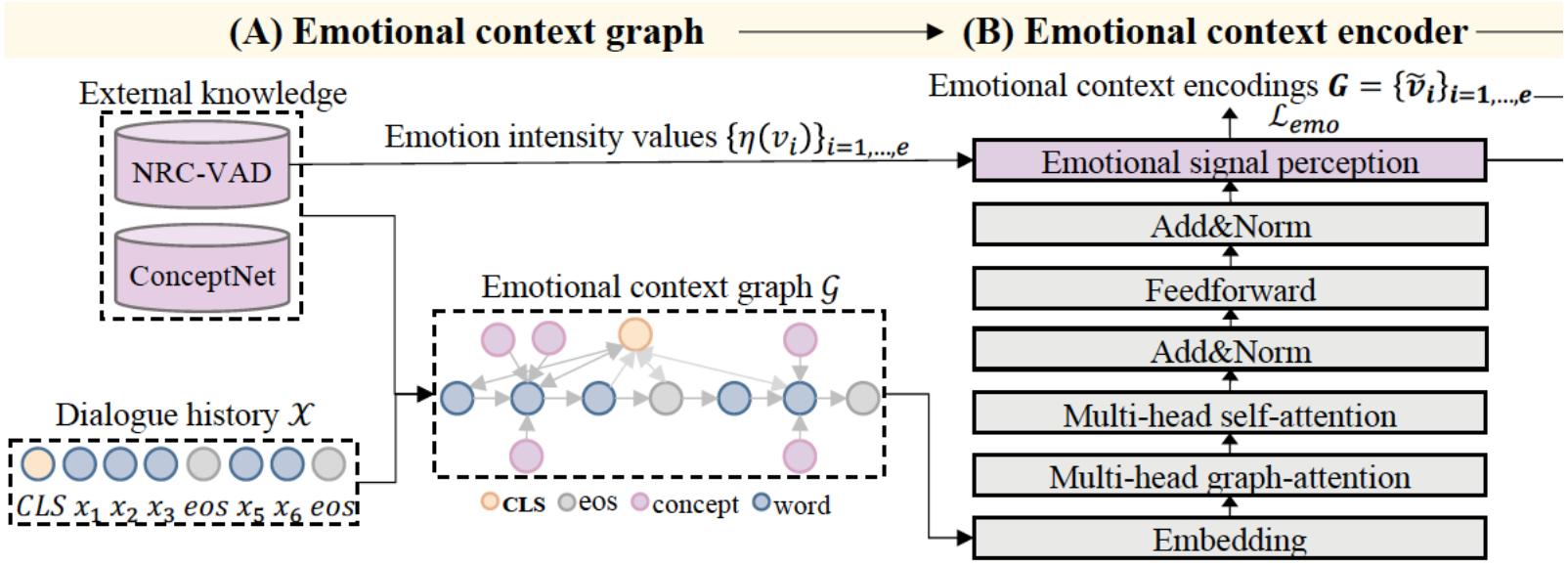
1. Predict the emotion expressed in the dialogue context.
2. Generate an empathetic response.

KEMP - Emotional Context Graph



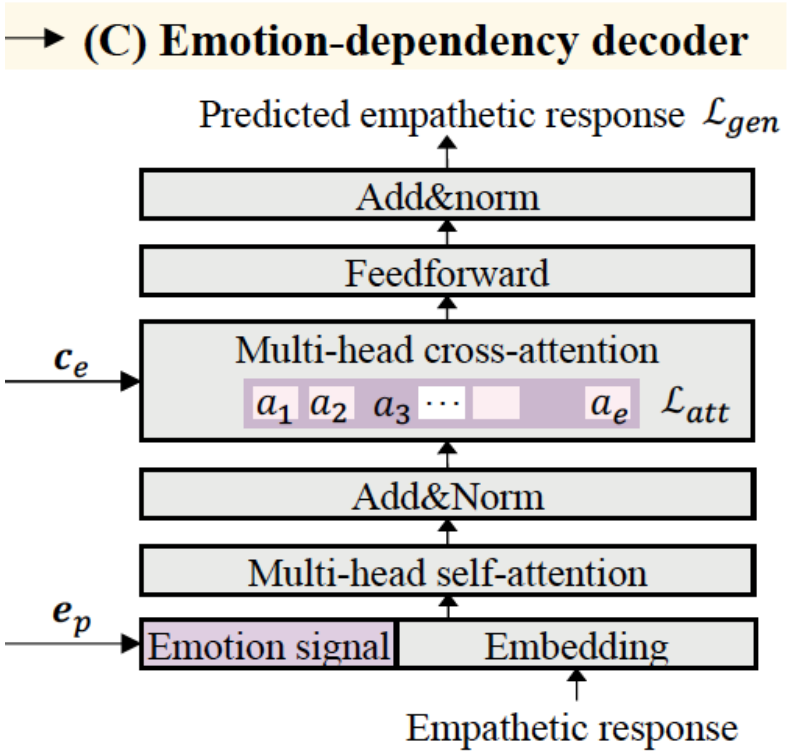
- Relation Filtering
- Concept Retrieval
- Concept Ranking
- Edge Completion

KEMP- Emotional Context Encoder



- Emotional context graph encoding
  - Graph-aware Transformer
- Emotional signal perception

KEMP – Emotion-dependency Decoder



- Incorporating emotional features
- Enforcing emotional attention on tokens with higher emotion-intensity values
- Copying external concepts

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Experiments

Dataset

- EMPATHETICDIALOGUES (Rashkin et al., 2019)

Automatic Metrics

- Emotion Accuracy
- Perplexity
- Distinct-1 and Distinct-2

Human Metrics

- Empathy
- Relevance
- Fluency

Experiments

Table 2: Performance of all models.

Models	Accuracy	Perplexity	Distinct-1	Distinct-2	Empathy	Relevance	Fluency
Transformer (Vaswani et al. 2017)	-	37.73	0.47	2.04	3.11	3.47	3.66
EmoPrepend-1 (Rashkin et al. 2019)	33.28	38.30	0.46	2.08	3.23	3.51	3.67
MoEL (Lin et al. 2019)	32.00	38.04	0.44	2.10	3.37	3.78	3.64
MIME (Majumder et al. 2020)	34.24	37.09	0.47	1.91	3.38	3.66	3.63
EmpDG (Li et al. 2020)	34.31	37.29	0.46	2.02	3.45	3.88	**3.67**
KEMP	**39.31**	**36.89**	**0.55**	**2.29**	**3.49**	**3.92**	3.65

Our model KEMP outperforms state-of-the-art baselines by a large margin in terms of all automatic metrics.

Experiments

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KEMP obtains the best performance on both Empathy and Relevance scores.

There is no obvious difference among models in terms of Fluency.

Experiments

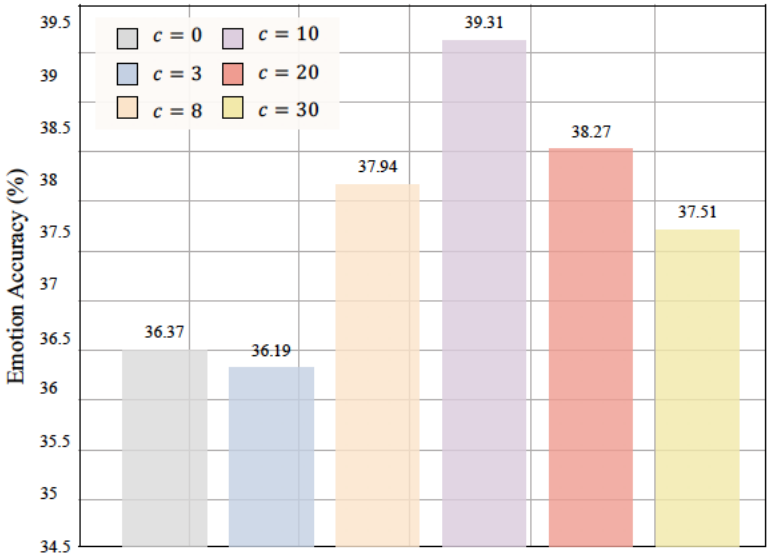

Figure 5: Emotion accuracy with respect to the number of external concepts. $c = 8$ indicates at most we introduce 8 external concepts for each dialogue.

Table 5: The visualization of the cross-attention weights in MoEL and MK-EDG.

Utterance	It inspires me to try and do something to keep healthy every day .
MoEL	I am sure they will be able to have a good time.
Utterance	It inspires me to try and do something to keep healthy every day .
Knowledge	effort , fight , good , life , raise , grow , protect , health
MK-EDG	I can not wait to try to get a little makes me feel better.

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Conclusions and future work

- A **K**nowledge-aware **EMP**athetic dialogue generation method leverages external knowledge to enhance empathetic dialogue generation.

- KEMP enhances the emotion perception and dependencies between dialogue history and empathetic response with **bunches of emotion-related concepts**.

- ❑ As for the future work, we plan to explore the emotional knowledge embedded in the parameters of large pre-trained language model for empathetic dialogue generation.

Thanks

Paper:

Code: