CEM: Commonsense-aware Empathetic Response Generation

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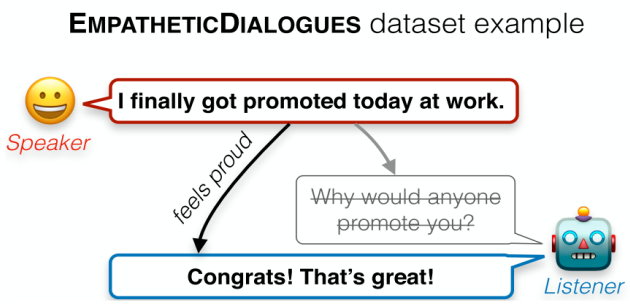
Background

- The main objective of building a dialogue system is to model human behavior.
- As humans, one of our unique abilities is empathy.
  - The ability to understand, perceive, and respond appropriately to the situation and feelings of others.
  - For example
    - When other people tell us about their lives, we think about how we would feel if we were them.
    - We feel sad if our classmates tell us about their sadness.
    - We feel happy when our friends tells us they won a competition.
- Previous research shows empathy can also improve user satisfaction and build rapport.
- Therefore, it is important to implement empathy in dialogue systems.

Empathy in Dialogue Systems

- Empathy is the ability that enables us to experience the feelings of another person.
- A complex multi-dimensional construct with broad aspects of **affect and cognition**.
  - Affective Empathy: emotional simulation in reaction to the experience of others.
  - Cognitive Empathy: understanding the situation and the implied feelings of others.

- Research on this topic began with the EmpatheticDialogues dataset (2019).



Label: Proud
Situation: Speaker felt this when...
"I finally got that promotion at work! I have tried so hard for so long to get it!"
Conversation:
Speaker: I finally got promoted today at work!
Listener: Congrats! That's great!
Speaker: Thank you! I've been trying to get it for a while now!
Listener: That is quite an accomplishment and you should be proud!

Rashkin et al. Towards Empathetic Open-domain Conversation Models: a New Benchmark and Dataset. ACL 2019.

Empathy in Dialogue Systems

We should generate responses based on how our users would feel towards them (look-ahead).

Shin et al. (2019)

We should understand user's emotions and respond appropriately.

Lin et al. (2019)

How about generating responses by mimicing the user's emotion to a degree?

Majumder et al. (2020)

We need external knowledge to understand emotions, right?

Li et al. (2020)

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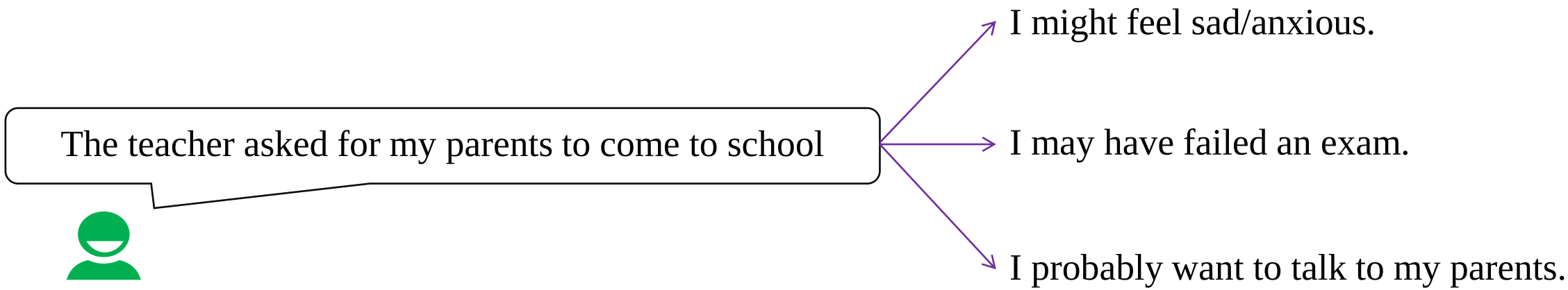
Is emotion all we need?

Sabour et al. (2021)

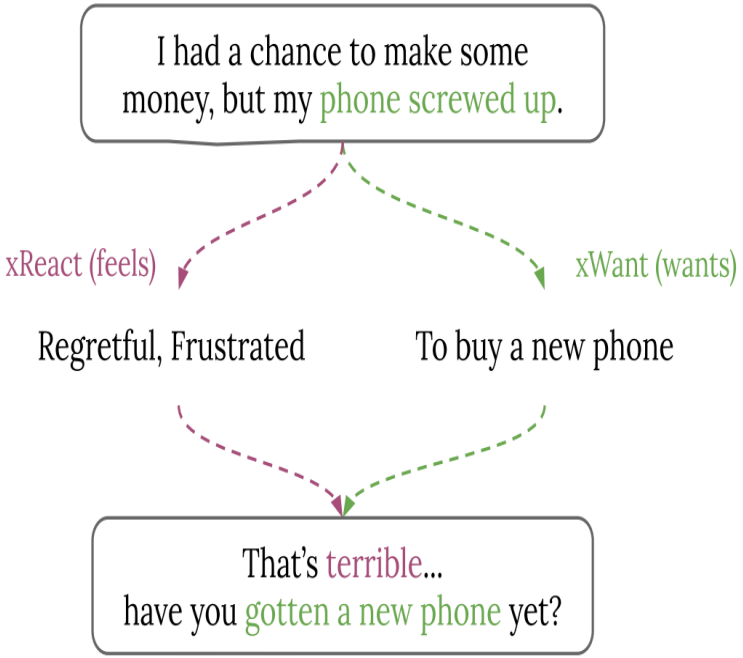
CEM (Motivation)

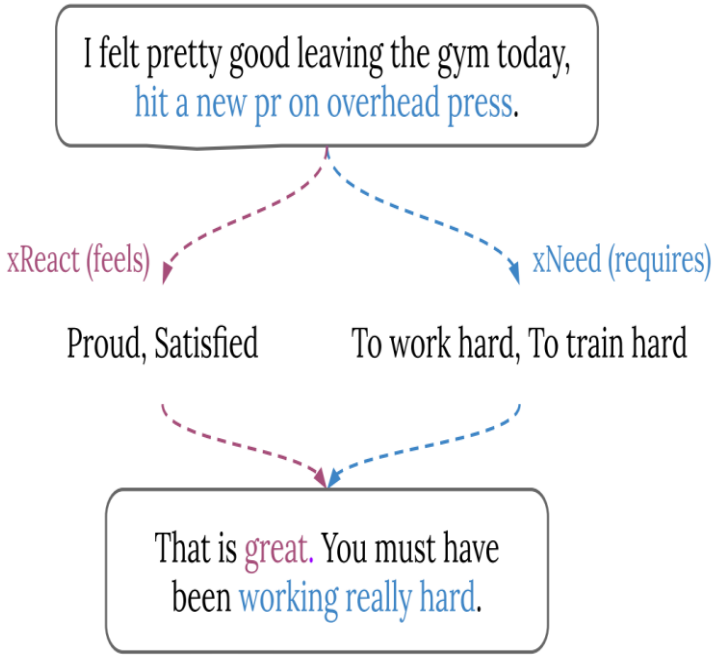
- Detecting the user's emotion is an important part of empathy, but not the only part.
- Empathy consists of affective and cognitive aspects.
  - Affective Empathy: emotional simulation in reaction to the experience of others.
  - Cognitive Empathy: understanding the **situation and the implied feelings** of others.
- In many situations, the user might not explicitly talk about their situation and feelings.



CEM (Motivation)

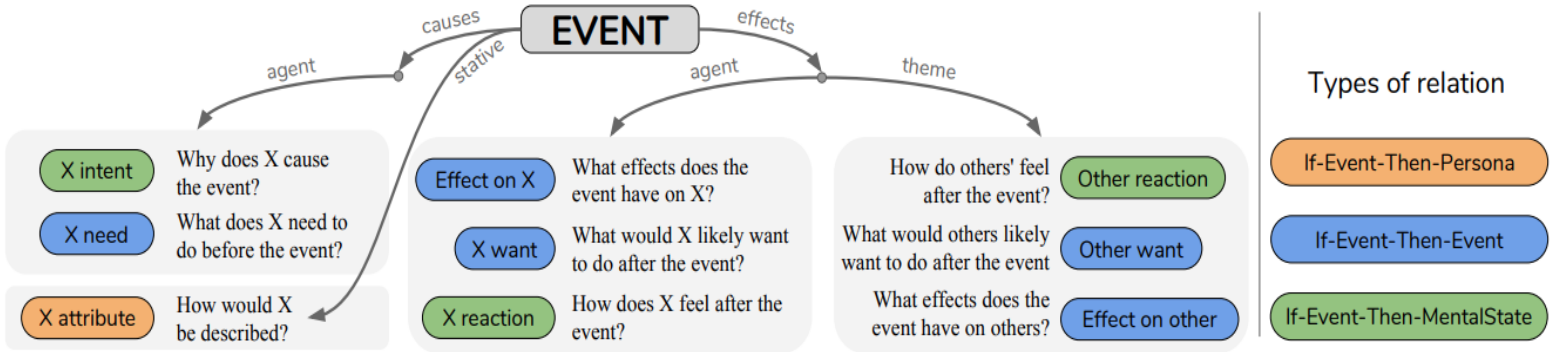
- As humans, we use our Commonsense Reasoning to realize such implications.
- However, this knowledge is not readily available to dialogue models.



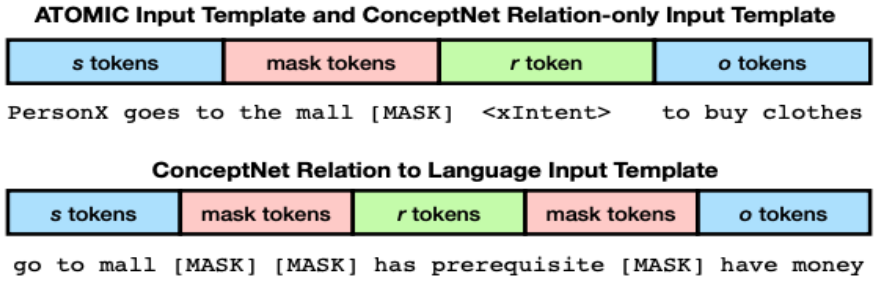


Commonsense Knowledge base

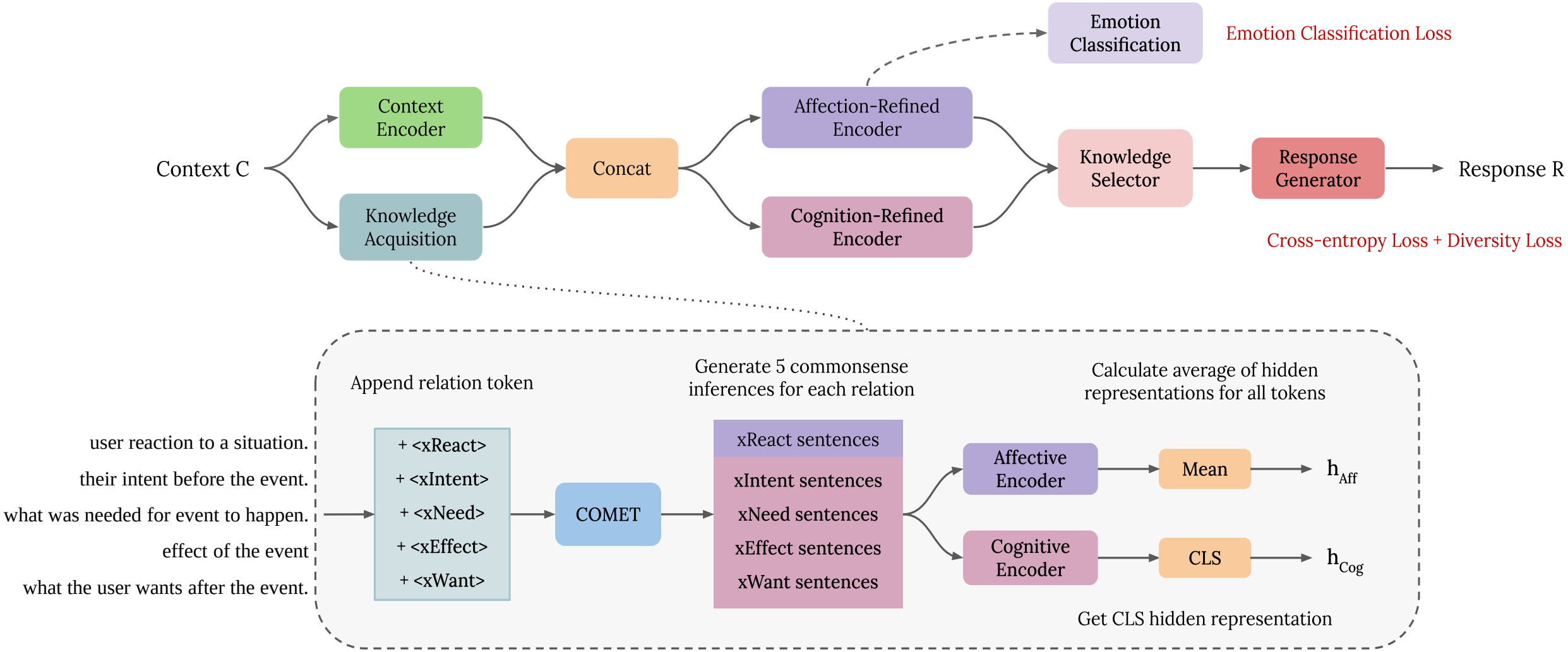
- ATOMIC



- CoMET: GPT-2 trained on ATOMIC for generating commonsense inferences.



CEM (Architecture)



CEM (Experiments)

- Automatic Evaluation
  - Perplexity -> fluency
  - Distinct -> diversity
  - Emotion prediction accuracy (%)

- Manual Evaluation
  - Coherence -> more coherent and relevant
  - Empathy -> better understanding of the situation and appropriate emotion
  - Informativeness -> carries more information

Models	PPL	Dist-1	Dist-2	Acc (%)
Transformer	37.62	0.45	2.02	-
Multi-TRS	37.75	0.41	1.67	33.57
MoEL	36.93	0.44	2.10	30.62
MIME	37.09	0.47	1.90	31.36
EmpDG	37.29	0.46	2.02	30.41
CEM	36.11	**0.66**	**2.99**	**39.11**
w/o Aff	36.49	0.56	2.52	33.76
w/o Cog	36.63	0.56	2.47	36.42
w/o Div	**35.60**	0.48	1.96	38.82

Comparisons	Aspects	Win	Lose	κ
CEM vs. MoEL	Coh.	**53.6**‡	37.6	0.57
	Emp.	**52.0**‡	38.0	0.57
	Inf.	**61.0**‡	30.6	0.51
CEM vs. MIME	Coh.	**52.0**‡	42.3	0.44
	Emp.	**50.3**‡	41.6	0.57
	Inf.	**48.6**	45.0	0.51
CEM vs. EmpDG	Coh.	**46.3**†	42.6	0.52
	Emp.	**54.3**‡	33.3	0.51
	Inf.	**47.6**†	43.3	0.41

Table 3: Human evaluation results (%). Ties are not shown. κ denotes the inter-annotator agreement measured by Fleiss's kappa, where $0.4 < \kappa < 0.6$ indicates moderate agreement. †,‡ represent significant improvement with p-value $< 0.1/0.05$ respectively (sign test).

CEM (Case Study)

Emotion	Sentimental
Context	Every time I look through older photos of my children, I am taken right back to the time they were that size, and what we were doing ! It is a bittersweet feeling, for sure.
MoEL	I am sorry to hear that, I am sorry to hear that.
MIME	That is so sweet. I am sure you miss them.
EmpDG	I am so happy for you.
Affect	**Nostalgic**, Happy, Sad
Cognition	**To reminisce memories**, Look at old photos, To remember the past
CEM	Yeah, it is always **nice to have those memories.**
Gold	Oh, it sure is, I feel the same way. They grow up so fast.

Emotion	Guilty
Context	*Speaker:* Yeah about 10 years ago I had a horrifying experience. It was 100% their fault but they hit the water barrels and survived. They had no injuries but they almost ran me off the road. *Listener:* Did you suffer any injuries? *Speaker:* No I was not hit. It turned out they were drunk. I felt guilty but realized it was his fault.
MoEL	That is so scary! I hope you are okay!
MIME	I am sorry to hear that. I hope you can find someone else to do that.
EmpDG	Oh no! I am sorry to hear that. I hope you were able to get it fixed.
Affect	Remorseful, **Guilty**, Sorry
Cognition	To be safe, **No harm done**, **No one hit**
CEM	I am glad you **did not get hurt**.
Gold	Why did you feel guilty? People really shouldn't drive drunk.

Thanks for Your Attention!

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