

Emotional Chatting Machine: Emotional Conversation Generation with Internal and External Memory

Tsinghua University

University of Illinois at Chicago

Hao Zhou, **Minlie Huang**, Xiaoyan Zhu, Bing Liu.

Challenges in Chatting Machines

IJCAI-ECAI 2018

Semantics

IJCAI-ECAI 2018

Consistency

AAAI 2018
SIGIR 2018
ACL 2018 (2)

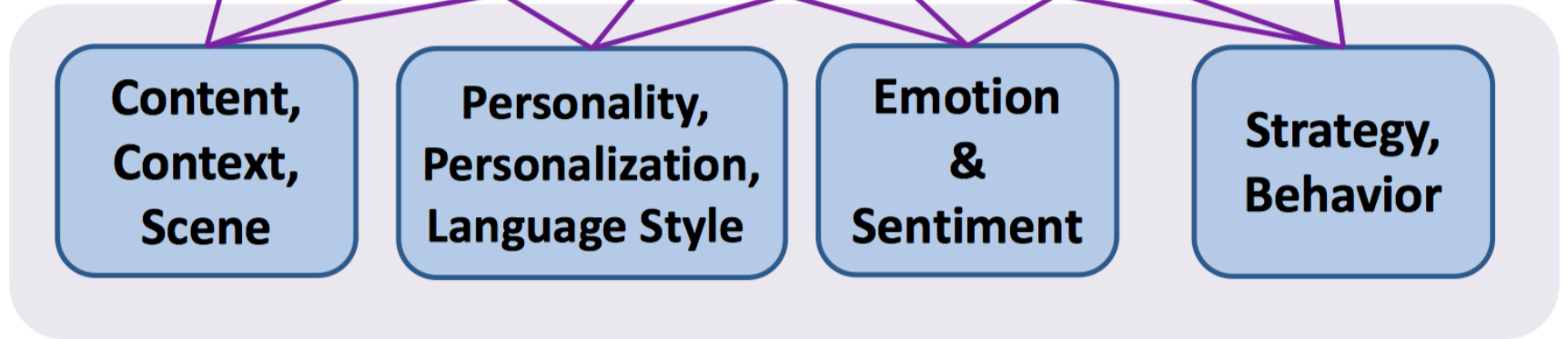
Interactiveness

**Content,
Context,
Scene**

**Personality,
Personalization,
Language Style**

**Emotion
&
Sentiment**

**Strategy,
Behavior**



Challenges in Chatting Machines

- Behaving more **interactively**:

- ◆ Perceiving and Expressing **Emotions** (**AAAI 2018**)
- ◆ Proactive Behavior by **Asking Good Questions** (**ACL 2018**)
- ◆ Controlling **sentence function** (**ACL 2018**)
- ◆ Topic change (**SIGIR 2018**)

- Behaving more **consistently**:

- ◆ **Explicit Personality** Assignment (**IJCAI-ECAI 2018**)

- Behaving more **intelligently** with **semantics**:

- ◆ Better Understanding and Generation Using **Commonsense Knowledge** (**IJCAI-ECAI 2018 distinguished paper**)

References:

- ① Emotional Chatting Machine: Emotional Conversation Generation with Internal and External Memory. **AAAI 2018**.
- ② Assigning personality/identity to a chatting machine for coherent conversation generation. **IJCAI-ECAI 2018**.
- ③ Commonsense Knowledge Aware Conversation Generation with Graph Attention. **IJCAI-ECAI 2018**.
- ④ Learning to Ask Questions in Open-domain Conversational Systems with Typed Decoders. **ACL 2018**.
- ⑤ Generating Informative Responses with Controlled Sentence Function. **ACL 2018**.
- ⑥ Chat more: deepening and widening the chatting topic via a deep model. **SIGIR 2018**.

Emotional Chatting Machine

Example:

| |
|---------------------|
| 今天领导前来视察工作！ |
| Happy: 哈哈，领导视察工作辛苦了 |
| Like: 这是一个很有特色的领导人 |
| Sad: 我想知道，谁来帮我干活？ |
| Angry: 这是要干什么？领导？ |

Challenge

- Emotion-labeled data are difficult to obtain in a large-scale corpus.
- Balance grammaticality and expressions of emotions.
- Existing methods cannot produce desirable emotional responses but just hard-to-perceive general expressions.

Importance

- ⊙ **Emotion intelligence** is a key human behavior for intelligence (Salovey and Mayer, 1990; Picard and Picard, 1997)
- ⊙ Understanding **emotion and affect** is important for dialogue and conversation
 - ◆ Enhance user performance
 - ◆ Improve user satisfaction
 - ◆ Less breakdowns
- ⊙ **Rule-based** emotion adaptation is widely seen in early dialogue systems

User: Worst day ever. I arrived late because of the traffic.

Chatbot (Basic Seq2seq): You were late.

ECM (*Like*): I am always here to support you.

ECM (*Happiness*): Keep smiling! Things will get better.

ECM (*Sadness*): It's depressing.

ECM (*Disgust*): Sometimes life just sucks.

ECM (*Anger*): The traffic is too bad!

Task Definition

Encoder-Decoder Framework:

$$\begin{aligned}y_t \sim \mathbf{o}_t &= P(y_t \mid y_1, y_2, \dots, y_{t-1}, \mathbf{c}_t), \\ &= \text{softmax}(\mathbf{W}_o \mathbf{s}_t).\end{aligned}$$

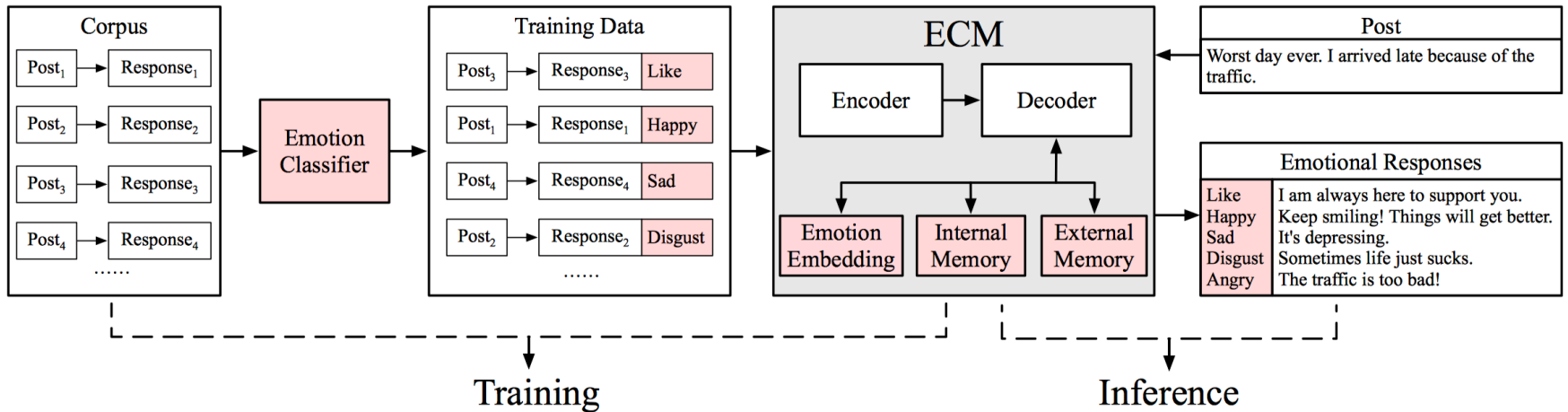
Emotional Chatting Machine(ECM):

$$\tilde{P}(\tilde{\mathbf{Y}} \mid \tilde{\mathbf{X}}, e) = \prod_{t=1}^{m'} P(y_t \mid y_{<t}, \tilde{\mathbf{X}}, e)$$

emotion category

{Angry, Disgust, Happy, Like, Sad, Other}

Overview



1. First, since the **emotion category** is a **high-level abstraction of an emotion expression**, ECM embeds the emotion category and feeds the **emotion category embedding** to the decoder.
2. Second, we assume that during decoding, there is an **internal emotion state**, and in order to capture the implicit change of the state and to balance the weights between the grammar state and the emotion state dynamically, ECM adopts an **internal memory module**.
3. Third, an explicit expression of an emotion is modeled through an **explicit selection of a generic (non-emotion) or emotion word** by an **external memory module**.

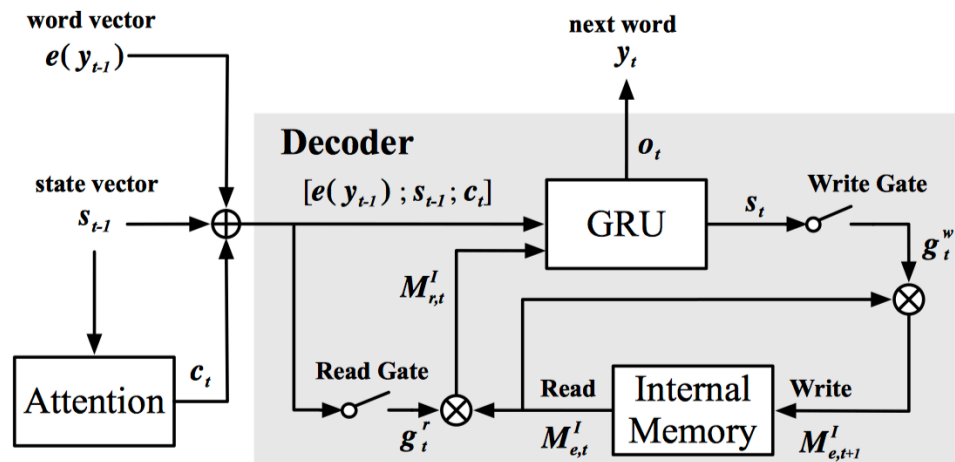
Emotion Category Embedding

1. Each emotion category is represented by a **real-valued, low dimensional vector**
2. For each emotion category e , we **randomly initialize** the vector of an emotion category v_e
3. learn the vectors of the emotion category through **training**
4. **Note that : static** the emotion category embedding will not change during the generation process which may sacrifice grammatical correctness of sentences

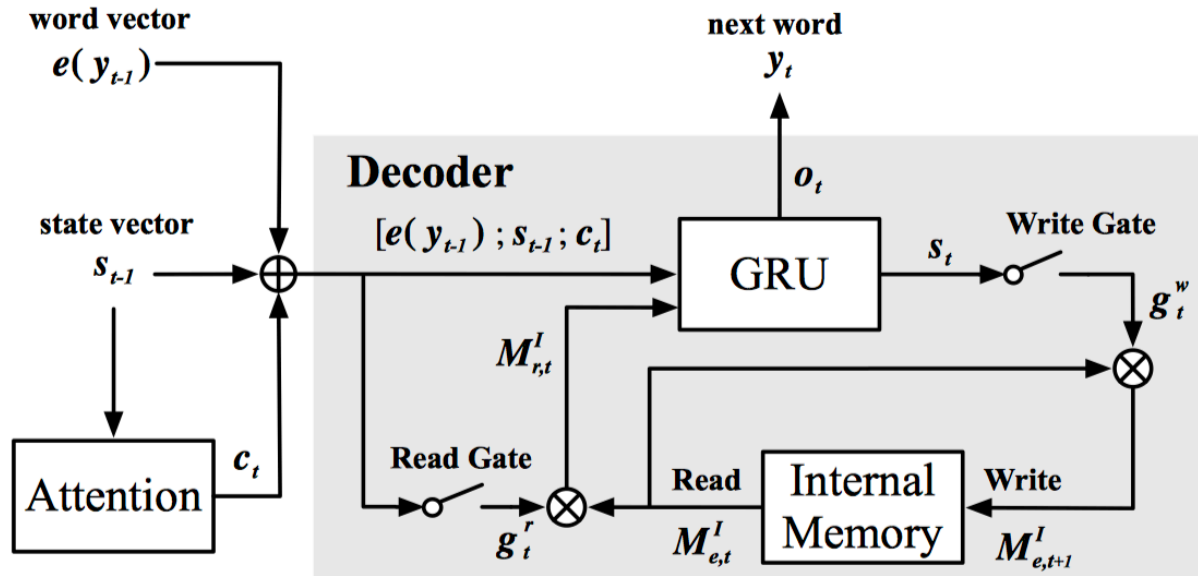
$$s_t = \text{GRU}(s_{t-1}, [c_t; e(y_{t-1}); \underline{v_e}]).$$

Internal Memory

- **Psychological (emotional responses)**
 - Relatively short lived
 - Involve changes
 - Dynamic emotion situation
- **Goal: capture the emotion dynamics during decoding**
- **Process:**
 - **Init** internal emotion state for each category
 - At each step the emotion state **decays** by a certain amount
 - The emotion state should **decay to zero** indicating the emotion is completely expressed when decoding finished



Internal Memory



$$g_t^r = \text{sigmoid}(\mathbf{W}_g^r [e(y_{t-1}); s_{t-1}; c_t]), \text{ Read gate}$$

$$g_t^w = \text{sigmoid}(\mathbf{W}_g^w s_t). \text{ Write gate}$$

read from and write into the internal memory, respectively

$$M_{r,t}^I = g_t^r \otimes M_{e,t}^I, \text{ Init at first step}$$

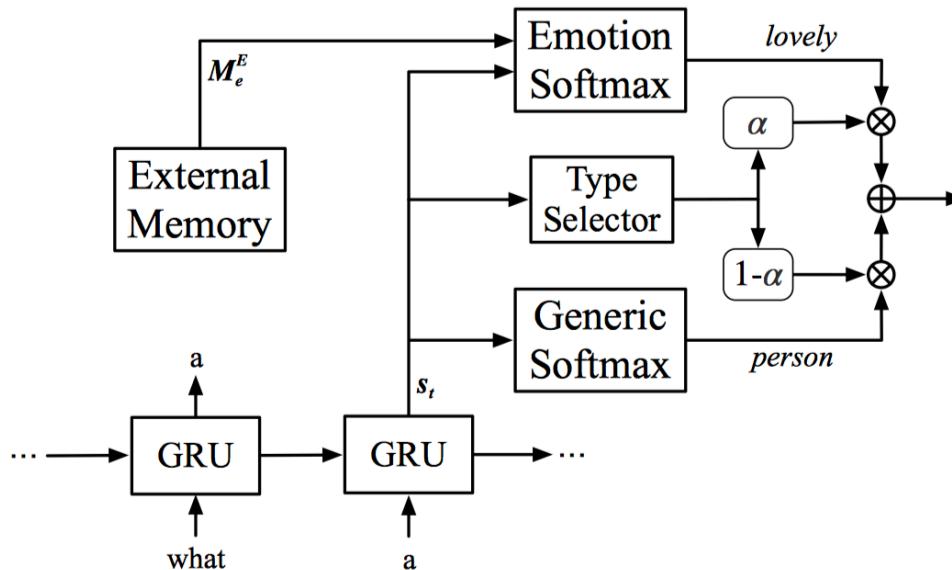
$$M_{e,t+1}^I = g_t^w \otimes M_{e,t}^I,$$

Information of internal state

$$s_t = \text{GRU}(s_{t-1}, [c_t; e(y_{t-1}); M_{r,t}^I]).$$

External Memory

- **Motivation**
 - Emotion expressions are quite distinct with **emotion words**
- **Goal**
 - Model emotion expressions explicitly by **assigning different generation probabilities to emotion words and generic words**
- Choose to generate words from an **emotion vocabulary** a **generic vocabulary**.
- final distribution $P(y_t)$ is a **concatenation** of two distributions.



$$\alpha_t = \text{sigmoid}(\mathbf{v}_u^\top \mathbf{s}_t),$$

$$P_g(y_t = w_g) = \text{softmax}(\mathbf{W}_g^o \mathbf{s}_t),$$

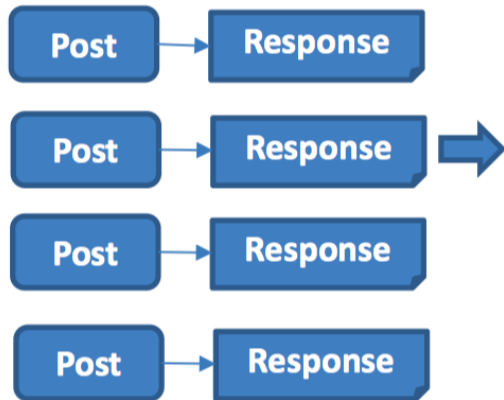
$$P_e(y_t = w_e) = \text{softmax}(\mathbf{W}_e^o \mathbf{s}_t),$$

$$y_t \sim \mathbf{o}_t = P(y_t) = \begin{bmatrix} (1 - \alpha_t)P_g(y_t = w_g) \\ \alpha_t P_e(y_t = w_e) \end{bmatrix},$$

Conclusion

**Perceiving and Expressing emotion by machine
Closer to human-level intelligence**

Social Interaction Data



Emotion Classifier

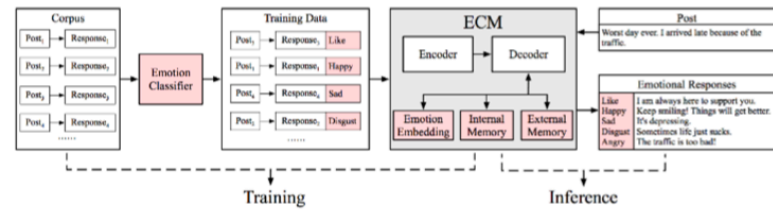


Emotion Tagged data



今天领导前来视察工作！
 Happy: 哈哈，领导视察工作辛苦了
 Like: 这是一个很有特色的领导人
 Sad: 我想知道，谁来帮我干活？
 Angry: 这是要干什么？领导？

Emotional Chatting Machine



Thanks!