Mem2Seq: Effectively Incorporating Knowledge Bases into End-to-End Task-Oriented Dialog Systems

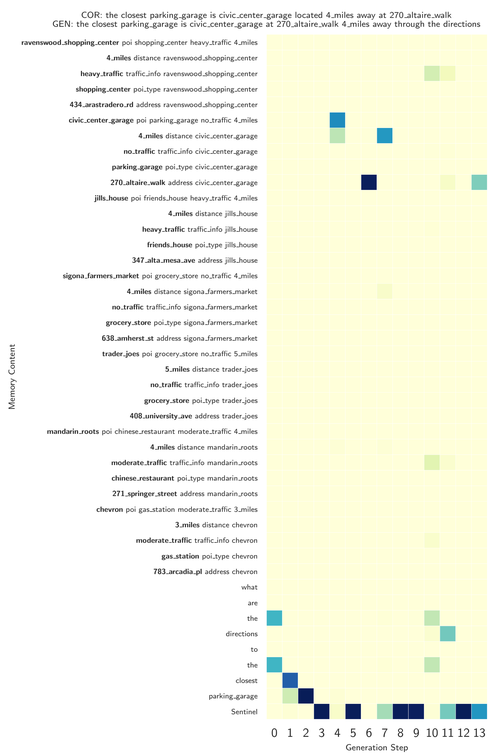
Andrea Madotto* , Chien-Sheng Wu*, Pascale Fung

Center for Artificial Intelligence Research (CAiRE)
Department of Electronic and Computer Engineering
The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong

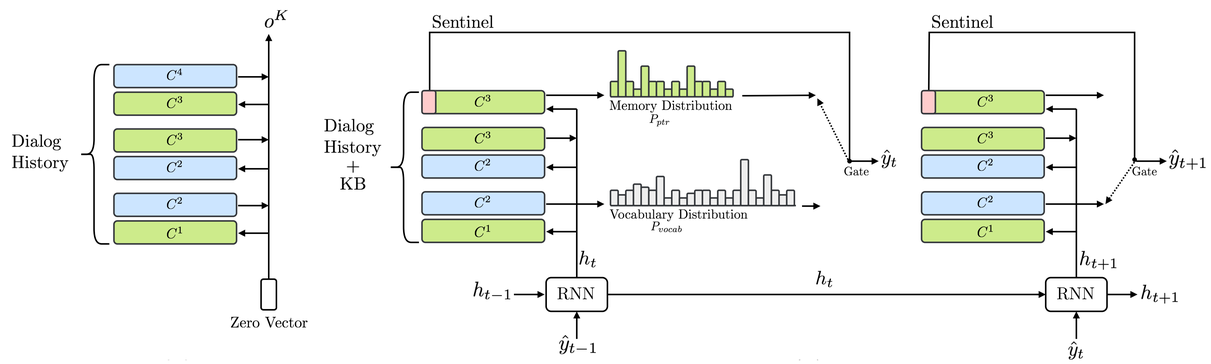
Introduction

- End-to-end task-oriented dialog systems usually suffer from the challenge of incorporating knowledge bases (KBs).
- **Mem2Seq** is the first neural generative model that combines the **multi-hop attention** over memories with the idea of **pointer network**.
- **Mem2Seq** can be **trained faster** and attain the **state-of-the-art** performance on three different task-oriented dialog datasets.
- We empirically proof that multi-hop attention mechanism helps in learning **correlations** between memories.
- The model is **general** without complicated task-specific designs.

Attention Read Out



Mem2Seq



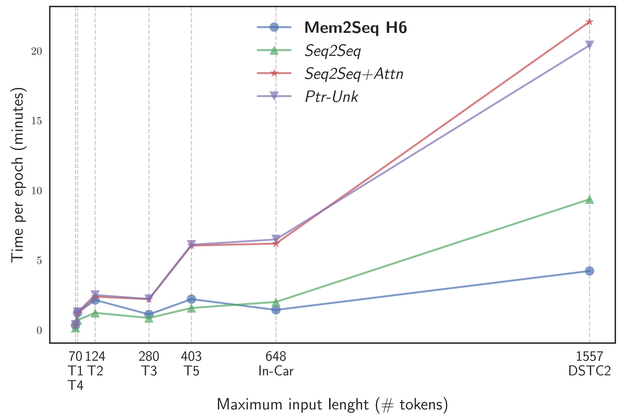
Results

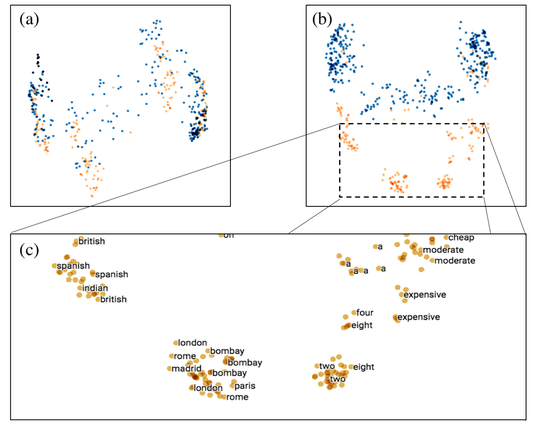
bAbI	QRN	MemNN	Seq2Seq	Ptr-Unk	**Mem2Seq**
T1	99.4	99.9	100	100	100
T2	99.5	100	100	100	100
T3	74.8	74.9	74.8	85.1	**94.7**
T4	57.2	59.5	57.2	**100**	**100**
T5	**99.6**	96.1	98.4	99.4	97.9
T1-OOV	83.1	72.3	81.7	92.5	**94.0**
T2-OOV	78.9	78.9	78.9	83.2	**86.5**
T3-OOV	75.2	74.4	75.3	82.9	**93.2**
T4-OOV	56.9	57.6	57	**100**	**100**
T5-OOV	67.8	65.5	65.7	73.6	**84.5**

DSTC-2	Ent. F1	BLEU	Per-Resp.
Rule-Based	-	-	33.3
QRN	-	-	43.8
MemNN	-	-	41.1
Seq2Seq	69.7	55.0	46.4
+Attn	67.1	**56.6**	46.0
+Copy	71.6	55.4	**47.3**
Mem2Seq	**75.3**	55.3	45.0

In-Car	BLEU	Ent. F1	Sch. F1	Wea. F1	Nav. F1
Human	13.5	60.7	64.3	61.6	55.2
Seq2Seq	8.4	10.3	9.7	14.1	7.0
+Attn	9.3	19.9	23.4	25.6	10.8
Ptr-Unk	8.3	22.7	26.9	26.7	14.9
Mem2Seq	**12.6**	**33.4**	**49.3**	**33.6**	**24.6**

- **bAbI** dialogs: we report the per-response and per-dialog accuracy.
- **DSTC2**: Seq2Seq (+attn and +copy) is reported from Eric et. al. (2017).
- **In-Car** Assistant: both BLEU and Entity F1 are improved without using canonical form.





Methodology

Mem2Seq is composed of two components: MemNN encoder, and memory decoder.

- The encoder uses a **MemNN** with adjacent weighted tying.
- The decoder uses a **RNN** to generating dynamic query for a **MemNN**.
- At each time step, two distributions are generated using the RNN hidden state h_t, one over all the words in the **vocabulary**,

$$P_{vocab}(\hat{y}_t) = \text{Softmax}(W_1[h_t; o^1])$$

and one over the **memory contents**

$$P_{ptr}(\hat{y}_t) = p_t^K$$

which p_t^K is the attention at the last MemNN hop. The next word is selected using an hard gating mechanism (i.e. **sentinel**).

- All the parameters are jointly learned by minimizing the sum of two standard cross-entropy losses.

Example

Point of interest (poi)	Distance	Traffic info	Poi type	Address
The Westin	5 miles	moderate traffic	rest stop	329 El Camino Real
Round Table	4 miles	no traffic	pizza restaurant	113 Anton Ct
Mandarin Roots	5 miles	no traffic	chinese restaurant	271 Springer Street
Palo Alto Cafe	4 miles	moderate traffic	coffee or tea place	436 Alger Dr
Dominos	6 miles	heavy traffic	pizza restaurant	776 Arastradero Rd
Stanford Express Care	6 miles	no traffic	hospital	214 El Camino Real
Hotel Keen	2 miles	heavy traffic	rest stop	578 Arbol Dr

1th Turn	**DRIVER**	Where can I get tea?
	Seq2Seq	I have a away from away would you like the address
	+Attn	I have a listing for a place that serves tea that is 5 miles away
	Ptr-Unk	There is a away you like would you like more info
	Mem2Seq	The nearest tea shop is Palo Alto Cafe located 4 miles away, would you like directions there?
	GOLD	Palo Alto Cafe is 4 miles away and serves coffee and tea. Do you want the address?
	DRIVER	Yes.
2th Turn	*Seq2Seq*	The is at at
	+Attn	The address is 329 El Camino Real and it's 3 miles away and there is no traffic
	Ptr-Unk	Palo Alto Cafe is 4 miles away and PAD is no traffic
	Mem2Seq	Palo Alto Cafe is 4 miles away at 436 Alger Drive
	GOLD	Palo Alto is located at 436 Alger Dr.