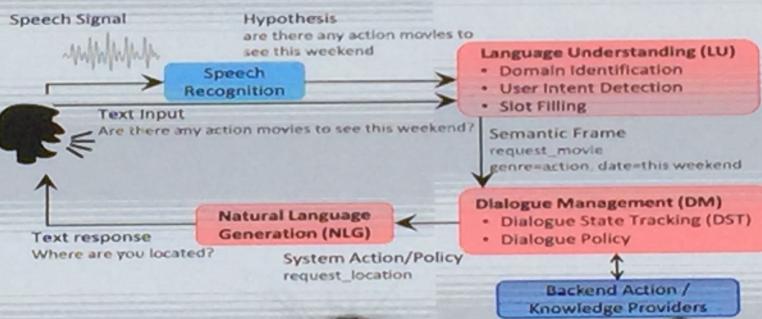
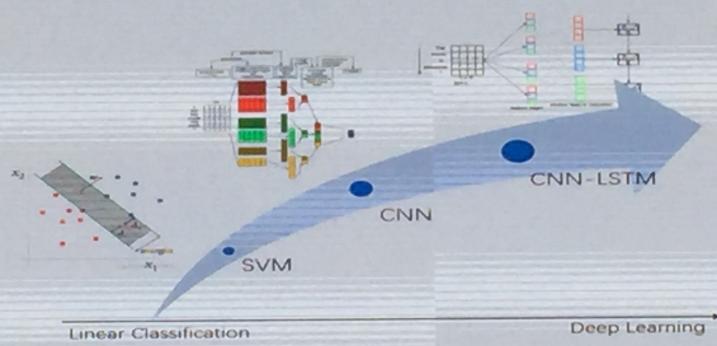
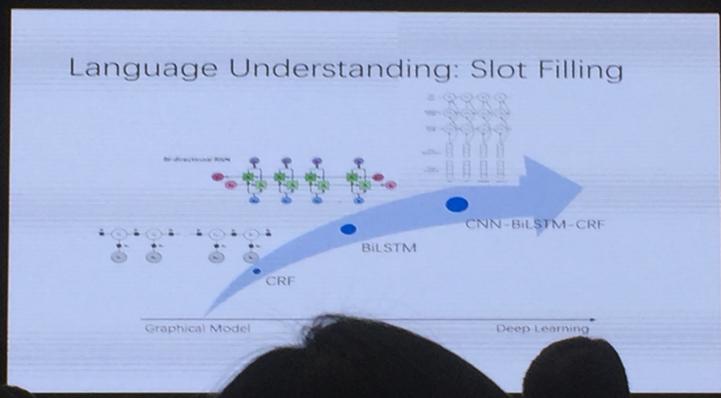


Pipeline Systems (Young, 2000)

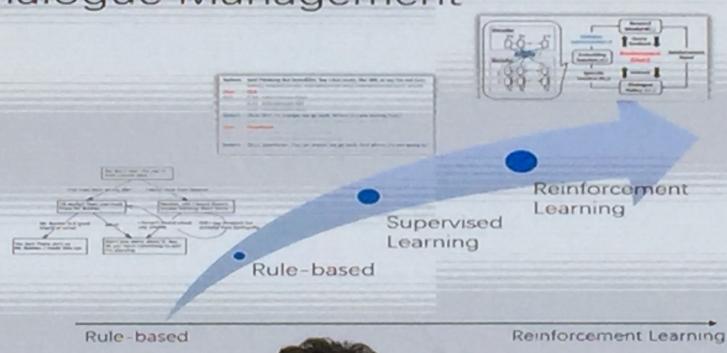


Language Understanding: Intent Detection



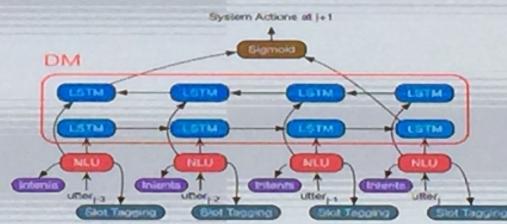


Dialogue Management



Joint LU and DM (Yang et al. 2017)

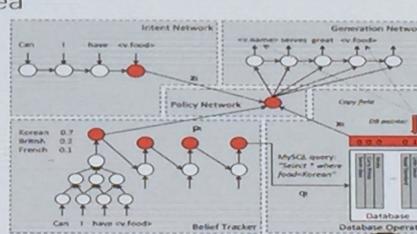
- Errors from DM can be propagated to NLU for regularization+ robustness
- Both DM and LU performance (frame accuracy) is improved



<https://arxiv.org/pdf/1612.00913.pdf>

End-to-End Trainable System (Wen et al. 2016)

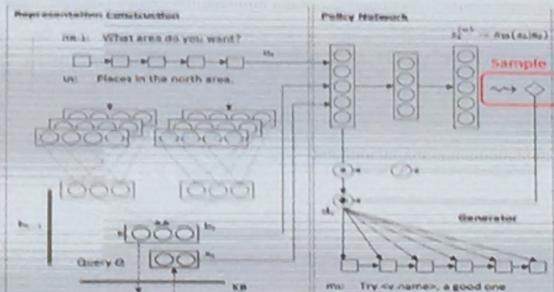
- A straightforward idea
 - Connecting pipeline modules
 - End-to-end supervised training



<https://arxiv.org/pdf/1604.04562.pdf>

Latent Intention Dialogue Models (Wen et al. 2017)

- Introduce latent variable
 - Learn underlying dialogue intention with variational inference
 - Without hand-craft action space

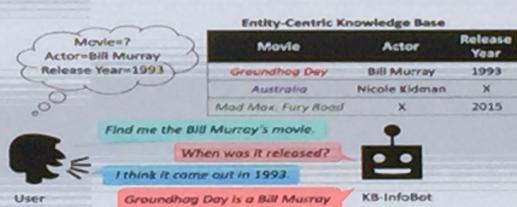


<https://arxiv.org/pdf/1705.10229.pdf>

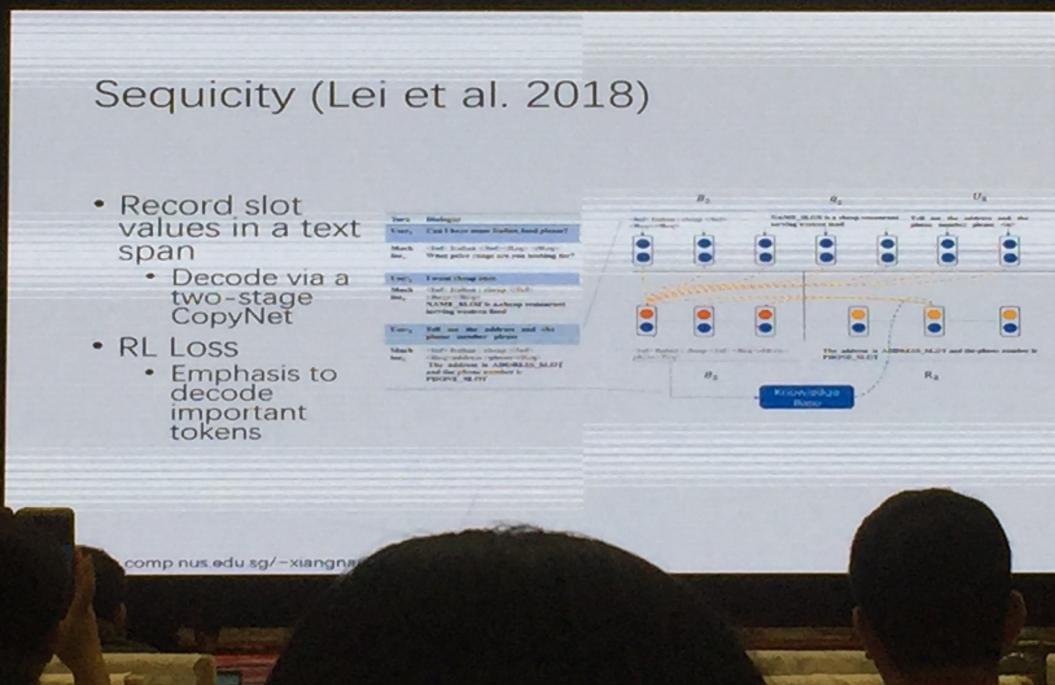
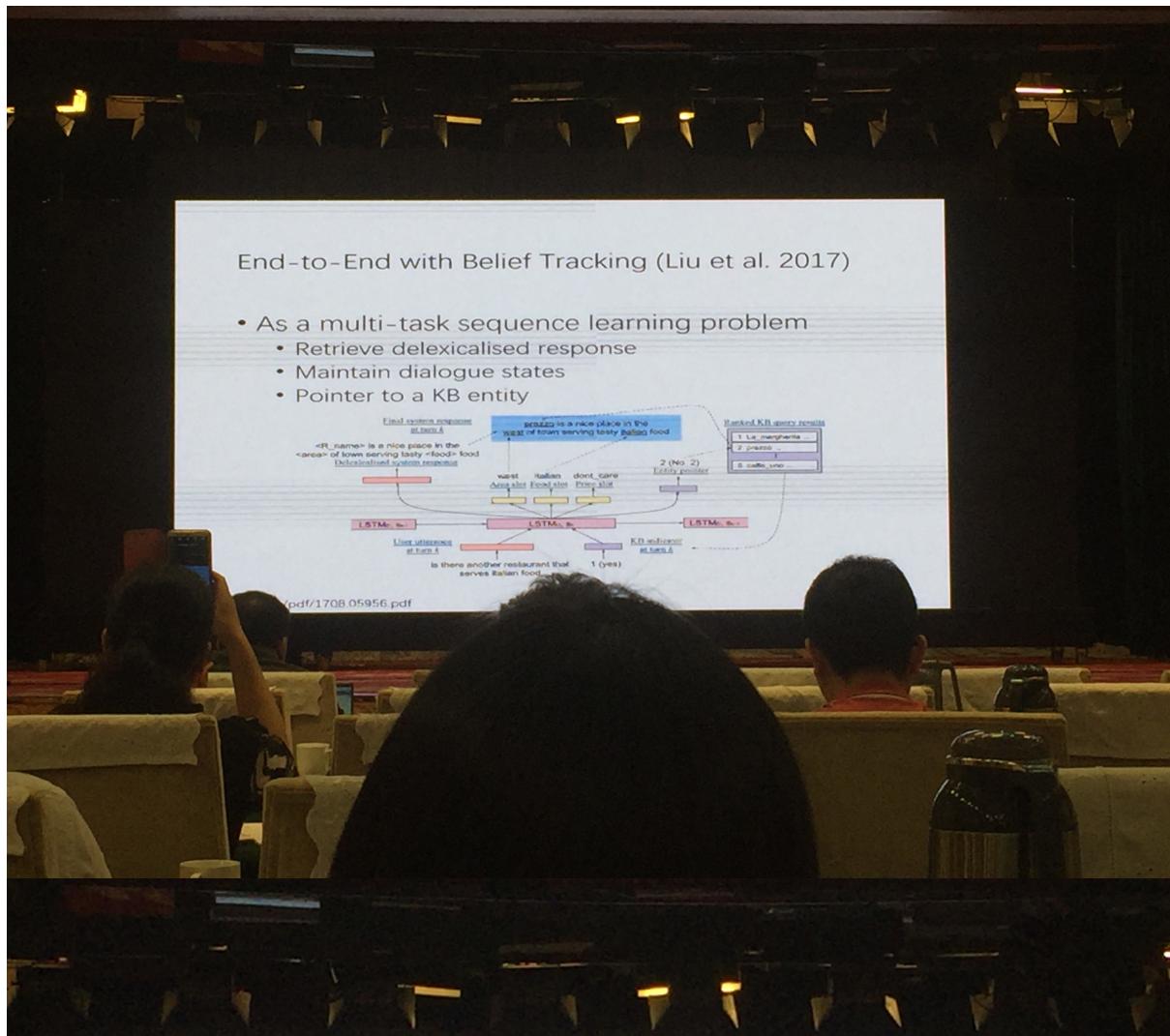
KB-Info Bots (Dhingra et al. 2017)

- Posterior Probability in Entity-Centric KB
 - $P(\text{Groundhog Day}) \propto P(\text{Actor} = \text{"Bill Murray"}) \cdot P(\text{Release Year} = \text{"1993"})$

- Soft-KB Lookup
 - Keep differentiability
 - "Soft"

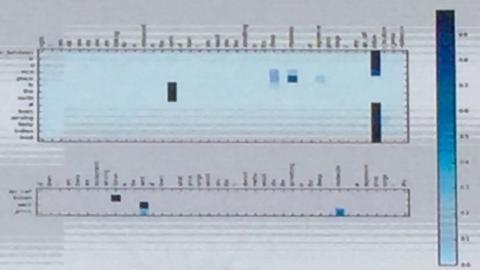


<https://arxiv.org/pdf/1609.00777.pdf>



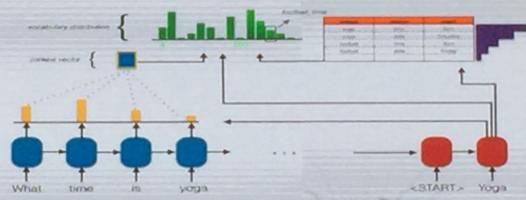
Seq2Seq with Copy (Eric and Manning 2017)

- Using simple Seq2Seq
- Attention-copy from
 - Words both in KB and input



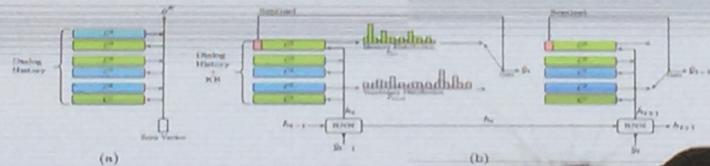
Key-value Retrieval Network (Eric et al. 2017)

- Using keys to retrieve entity-centric KB



Mem2Seq (Madotto et al. 2018)

- Model dialogue history as memories using MemNN
- Model KB as memories using key-value representation
- Decode with copying from memories



<https://arxiv.org/pdf/1804.08217.pdf>

Summary

- End-to-End training for pipelines
 - For entity retrieval
 - API Call for KB
 - Soft-KB Lookup
- Without user simulators
 - Responses retrieval
 - Seq2Seq
 - Retrieve entities from KB
 - Model the dialogue state

Our Recent Work

Sequence-to-Sequence for Dialogue System with Dialogue State Representation

Haoyang Wen, Yijia Liu, Wanxiang Che, Libo Qin, Ting Liu

COLING 2018

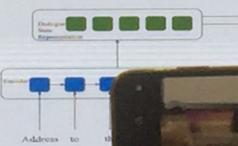
Seq2Seq for Task-oriented Dialogue

- Seq2Seq
 - Machine translation, chit-chat, ...
 - Require a minimum amount of hand-crafting
- Seq2Seq for task-oriented dialogue
 - How to model the exterior data retrieval?
 - Copy mechanism (Eric and Manning, 2017)
 - Key-value retrieval Network (Eric et al., 2017)
 - How to model the dialogue state tracker?
 - Our motivation

Dialogue State Representation

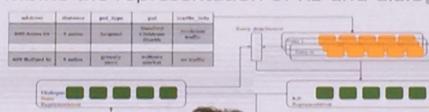
- We modeled the dialogue state as a group of distributed representations:

$$u_k^{DN} = \sum_{t=1}^m a_k^{DN}(t) h_t^{ENC}, \quad \text{SCOREIN}(w_k^S, h_t^{ENC}) = w_k^S h_t^{ENC}, \\ a_k^{DN}(t) = \frac{\exp(\text{SCOREIN}(w_k^S, h_t^{ENC}))}{\sum_{k'} \exp(\text{SCOREIN}(w_k^S, h_t^{ENC}))}.$$



Soft KB Attention

- Table Encoder
 - Concatenation of the column name and the cell value embedding
- Entry and KB Representation
 - Calculate the similarity between dialogue state and entries
 - Combine the representation of KB and dialogue state



Decoder

- Hidden state is the combination of
 - Decoder hidden state
 - Conventional attention from input
 - Attention over dialogue state
- Copy mechanism for output

$$p(y_t = y \mid \bar{y}_t, \mathbf{x}_{<t}, \mathbf{y}_{<t}) = p(\bar{y}_t = y \mid \mathbf{x}_{<t}, \mathbf{y}_{<t}) + \sum_{y^S \in \mathcal{V}^{SPLIT}} p(\bar{y}_t = y^S \mid \mathbf{x}_{<t}, \mathbf{y}_{<t}) \sum_{k=1}^{|T|} \mathbb{1}\{e_k(y^S) = y\} p(e = e_k \mid \mathbf{x}_{<t}).$$

Training

- Conventional negative log likelihood loss
- Reinforcement learning for KB attention
$$J_{RL} = -\mathbb{E}_{p(e \mid \mathbf{x}_{<t})} [R(e) - b]$$
 - Reward is defined as the number of entities that appear in previous dialogue history or current gold response
- Combine these two loss

Conclusion

- We proposed a framework
 - Leverage dialogue state representations
 - Soft attention over knowledge base
 - Copy from state representation for output
- Experiment
 - Outperform other Seq2Seq-based task-oriented dialogue models
 - Effectiveness of dialogue state representation and entity retrieval