

Building Intelligent Chatting Machines: Emotion, Personality, and Commonsense Knowledge

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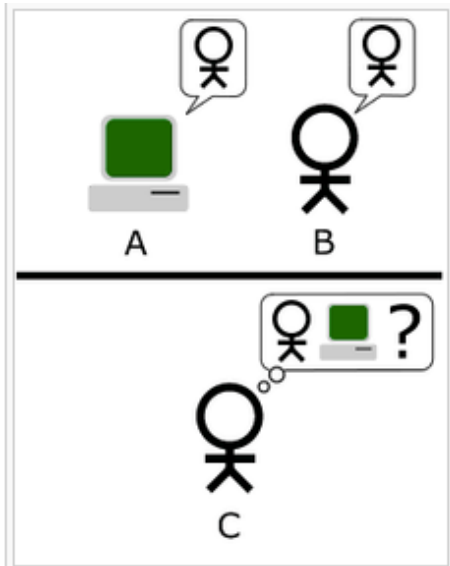
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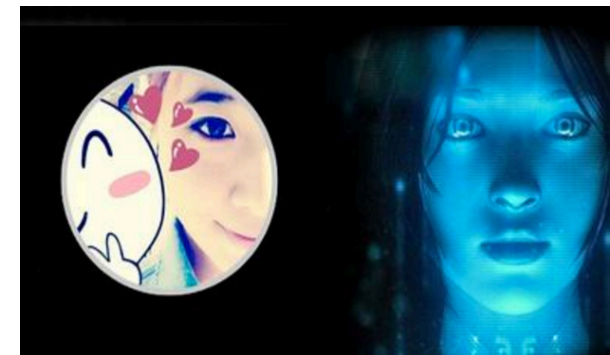
<http://coai.cs.tsinghua.edu.cn/hml/>

Joint work with Prof Xiaoyan Zhu

Open-domain Chatting and Conversational AI



2010 IBM Watson: Human-level knowledge QA



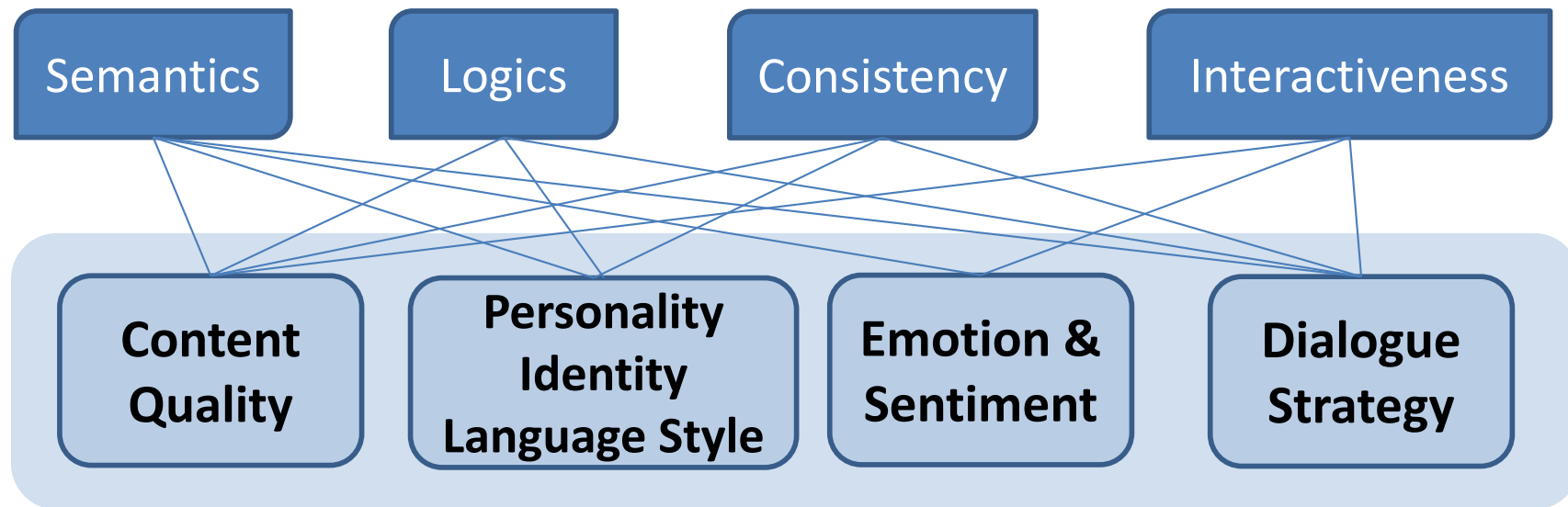
2014 Xiaoice: virtual partner

Since 1950, Turing Test

Building open domain chatting machines is one of the most challenging AI tasks.



Challenges in Chatting Machine



Open-domain, open-topic conversational systems



Challenges in Chatting Machine

- ◎ **One-to-many**: one input, many many possible responses
- ◎ **Knowledge & Reasoning**: real understanding requires various knowledge, world facts, or backgrounds
- ◎ **Situational Context**
 - ◆ Who are you talking with?
 - Stranger, or friend?
 - Boss, or subordinate
 - ◆ Her mood and emotion?
 - ◆ Unknown backgrounds that are only shared by two acquaintances



Open-domain Chatting Machines

- ⊙ Emotional Chatting Machine (**AAAI 2018**)
- ⊙ Personality Assignment (**IJCAI-ECAI 2018**)
- ⊙ Commonsense Knowledge (**IJCAI-ECAI 2018**)
- ⊙ Asking Good Questions (**ACL 2018**)

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.
-

Emotion



Emotional Chatting Machine

- ◉ **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
- ◉ Traditional emotion adaptation is **Rule-based**
 - ◆ 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.

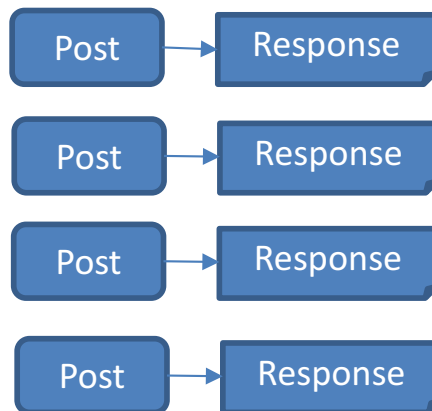
ECM (*Anger*): The traffic is too bad!



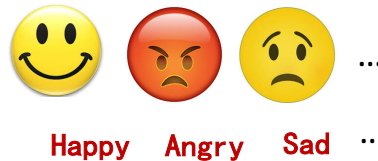
Emotional Chatting Machine

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

Social Interaction Data



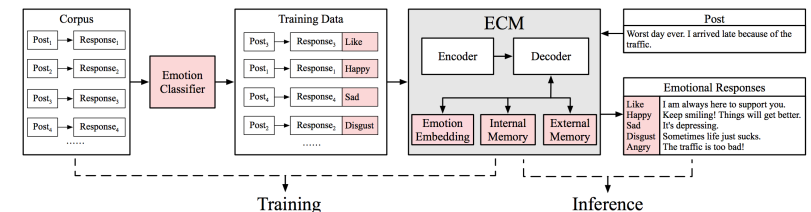
Emotion Classifier



Emotion Tagged data

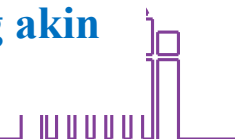
今天领导前来视察工作！
Happy: 哈哈，领导视察工作辛苦了
Like: 这是一个很有特色的领导人
Sad: 我想知道，谁来帮我干活？
Angry: 这是要干什么？领导？

Emotional Chatting Machine



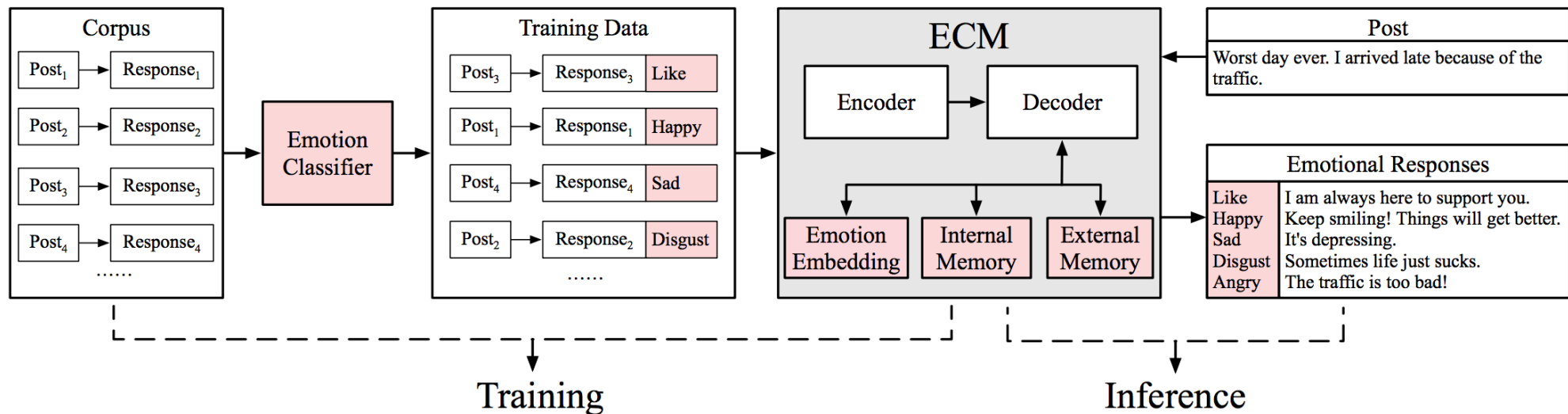
Our work was reported by **MIT Technology Review, the Guardian, Cankao News, Xinhua News Agency etc.**

Prof Björn Schuller: “an important step” towards personal assistants that could read the emotional undercurrent of a conversation and respond with something akin to empathy.



Emotional Chatting Machine

- ◉ **Emotion category embedding:** High level abstraction of emotions
- ◉ **Emotion internal state:** Capturing the change of emotion state during decoding
- ◉ **Emotion external memory:** Treating emotion/generic words differentially



•Hao Zhou, Minlie Huang, Xiaoyan Zhu, Bing Liu. Emotional Chatting Machine: Emotional Conversation Generation with Internal and External Memory. **AAAI 2018**.



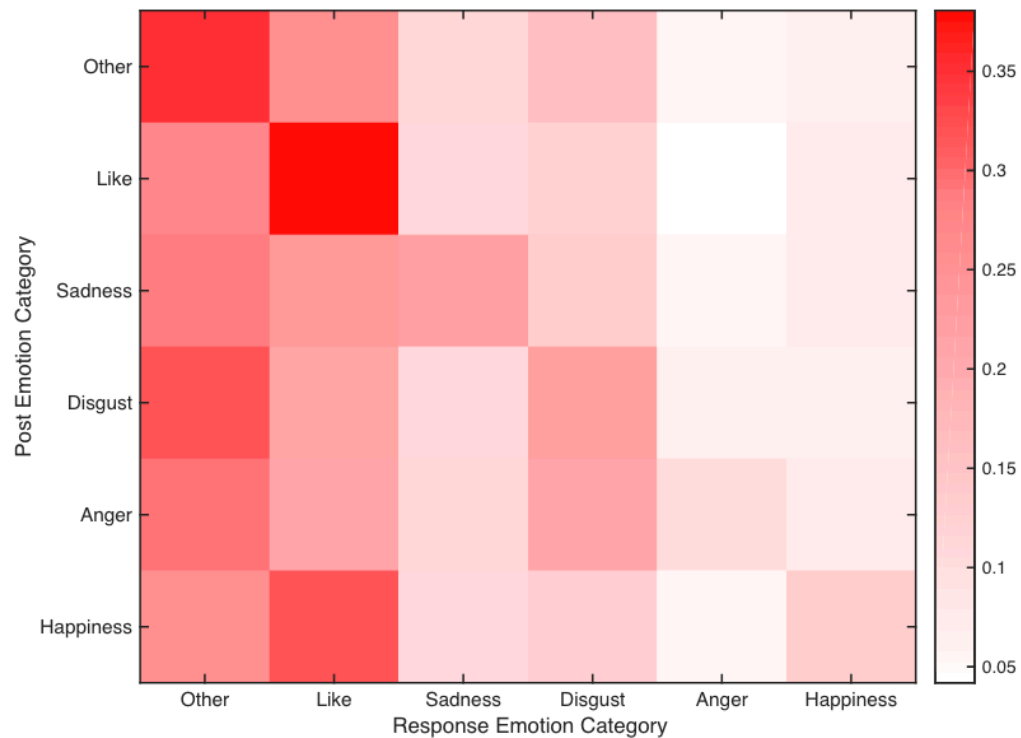
Emotional Chatting Machine

Post	Model	Response(Original)	Response(Translated)	
承诺，就是一个骗子说给一个傻子听的。 A promise is what a cheater says to a fool.	Seq2Seq	承诺，就是一个骗子说给一个傻子听的。	A promise is what a cheater says to a fool.	
	ECM	Like	承诺是一个 专一 的傻子	Promise is a single-minded fool
		Happy	我就是个 开心 的傻子	I'm just a happy fool
		Sad	我就是个 悲伤 的傻子	I am a sad fool
		Disgust	一个 骗子 说给一个 傻子 听	A cheater says to a fool
		Angry	不管你信不信，反正我信了！	Whatever you believe or not, I trust in it!
知道真相的我眼泪笑下来 Knowing the truth, I laughed myself to tears	Seq2Seq	知道真相的我眼泪掉下来。	After knowing the truth, I burst into tears.	
	ECM	Like	太 可爱 了，太 可爱 了！	Too lovely , it's too lovely .
		Happy	笑得我眼泪都出来了。	I can't help laugh myself to tears.
		Sad	知道真相的我 眼泪 掉下来。	After knowing the truth, I burst into tears .
		Disgust	这是真的还是假的？	Is this true?
		Angry	什么意思？没看懂。	What do you mean? I don't understand.

•Hao Zhou, Minlie Huang, Xiaoyan Zhu, Bing Liu. Emotional Chatting Machine: Emotional Conversation Generation with Internal and External Memory. **AAAI 2018**.



Emotion Interaction Patterns



Like → Like (**empathy**)

Sadness → Sadness (**empathy**)

Sadness → Like (**comfort**)

Disgust → Disgust (**empathy**)

Disgust → Like (**comfort**)

Anger → Disgust

Happiness → Like

•Hao Zhou, Minlie Huang, Xiaoyan Zhu, Bing Liu. Emotional Chatting Machine: Emotional Conversation Generation with Internal and External Memory. **AAAI 2018.**



Personality



Personality of Chatting Machine

- ◎ Passing the **Turning Test?**
 - ◆ **Deep semantic understanding**
 - ◆ Existing chatting machine lacks **identity or personality**

Conversation without Chatbot's personality by general sequence-to-sequence models.
User: Are you a boy or a girl? Chatbot: I am a boy. User: Are you a girl? Chatbot: Yes, I am a girl.
Conversation with Chatbot's personality by our model.
User: Are you a boy or a girl? Chatbot: I am a three-year old boy. User: Are you a girl? Chatbot: I am a three-year old boy.

- ◎ Existing works
 - ◆ User embedding: learn **implicit** conversation style ([Li et al., 2016](#); [Al-Rfou et al., 2016](#))
 - ◆ Require dialogue data from different users with **user attributes tagged**



Personality of Chatting Machine

- Generating coherent conversation w.r.t. **identity/personality**

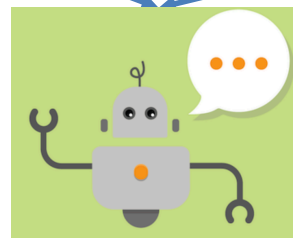
Generic Dialogue Data for Training

UserA: how old are you?
UserB: I am six.

UserA: do you like to play piano?
UserB: I play violin.

Pre-specified Chatbot Profile

Profile key	Profile value
Name	汪仔(Wang Zai)
Age	三岁(3)
Gender	男孩(Boy)
Hobbies	动漫(Cartoon)
Speciality	钢琴(Piano)



Identity-coherent Chatbot

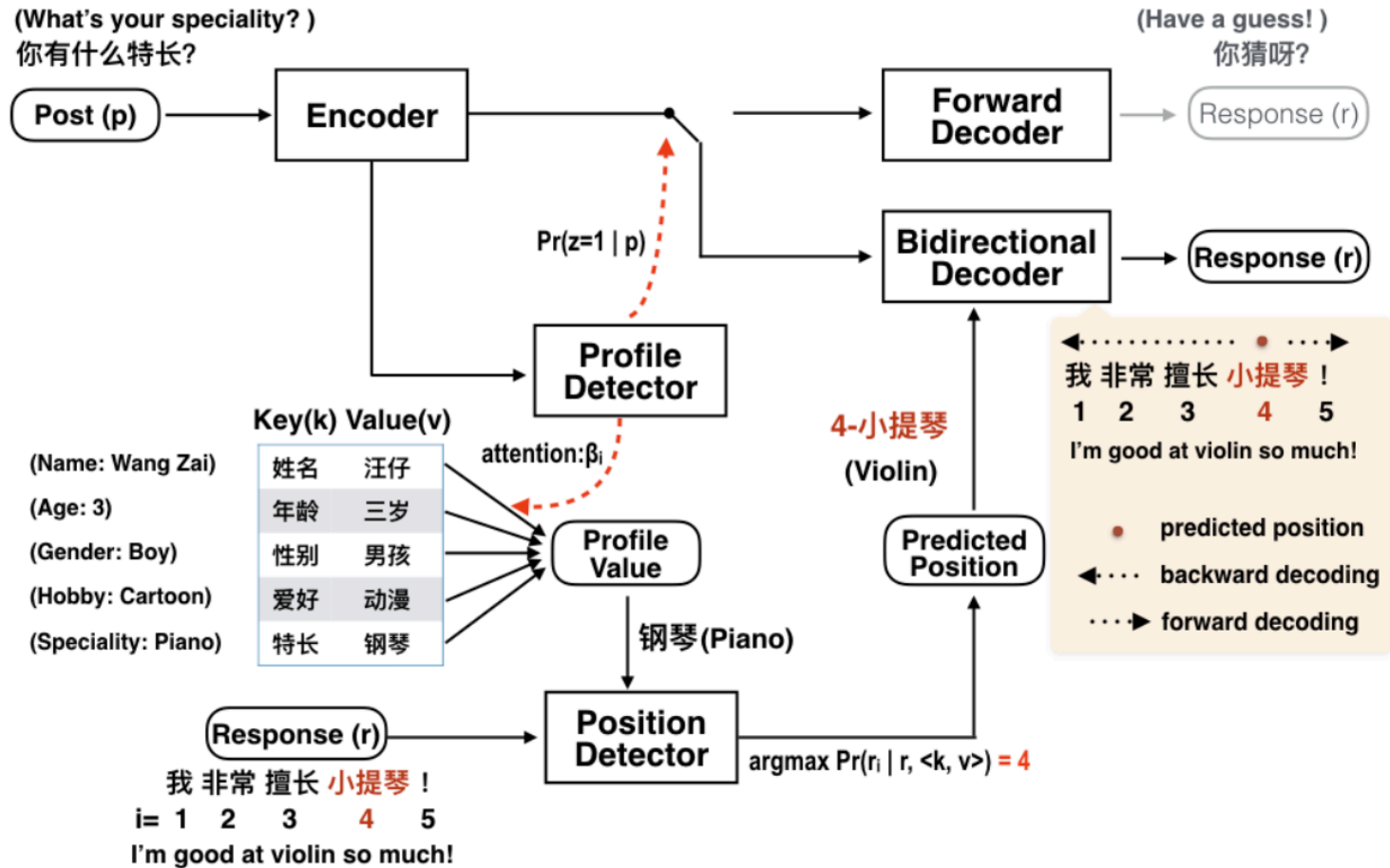
User: how old are you?
Machine: I am **three years old**.

User: do you like to play piano?
Machine: Yes, I play **piano**.



Personality of Chatting Machine

- Encoder
- Profile detector
- Position detector
- Decoder



•Qiao Qian, Minlie Huang, Haizhou Zhao, Jingfang Xu, Xiaoyan Zhu. *Assigning personality/identity to a chatting machine for coherent conversation generation.* **IJCAI-ECAL 2018.**



Personality of Chatting Machine

Post-level evaluation

Method	Nat.	Logic	Cor.
Seq2Seq	71.8%	56.0%	23.8%
Seq2Seq +PV	72.0%	56.0%	41.3%
Seq2Seq +PVD	73.3%	52.5%	38.0%
Our Model -PD	82.7%	51.7%	38.3%
Our Model	83.3%	59.5%	45.8%

Session-level evaluation

Method	Consistency	Variety
Seq2Seq	1.3%	1.0%
Seq2Seq +PV	47.0%	1.3%
Seq2Seq +PVD	40.0%	7.5%
Our Model -PD	38.8%	16.0%
Our Model	49.5%	27.8%

Generated sample responses that exhibit session-level consistency

Chinese	English(Translated)
U:你对什么事感兴趣 S:打篮球	U:What are you interested in? S:Playing basketball.
U:你都有啥爱好呀 S:篮球	U:What's your hobby? S:Basketball.
U:告诉我你兴趣所在 S:我喜欢篮球	U:Tell me your interest. S:I like to play basketball.
U:你还没说你几岁呢 S:我三岁了	U:You haven't told me your age. S:I'm three years old.
U:你今年有15了不 S:我还没到呢	U:Are you 15 years old or not? S:I'm not yet.
U:你多大啦 S:3岁了	U:How old are you? S:Three years old.

•Qiao Qian, Minlie Huang, Haizhou Zhao, Jingfang Xu, Xiaoyan Zhu. *Assigning personality/identity to a chatting machine for coherent conversation generation.* **IJCAI-ECAI 2018.**



Personality of Chatting Machine

Generating responses that are coherent to robot's profile

	Chinese	English (Translated)
	Post:能再说一遍你的年龄吗?	Post: Could you tell me your age again?
Seq2Seq	我0岁	I'm zero
Seq2Seq +PV	三岁	Three
Seq2Seq +PVD	三岁了	Just three years old
Our Model -PD	我三岁了	I'm three years old
Our Model	我三岁了, 你呢?	I'm three years old, and you?
	Post:我觉得你的偶像应该是贝多芬。	Post: I think your idol is Beethoven.
Seq2Seq	我也觉得	I think so
Seq2Seq +PV	比尔盖茨	Bill Gates
Seq2Seq +PVD	比尔盖茨是我偶像	My idol is Bill Gates
Our Model -PD	比尔盖茨是谁?	Who is Bill Gates ?
Our Model	比尔盖茨是我偶像	My idol is Bill Gates .

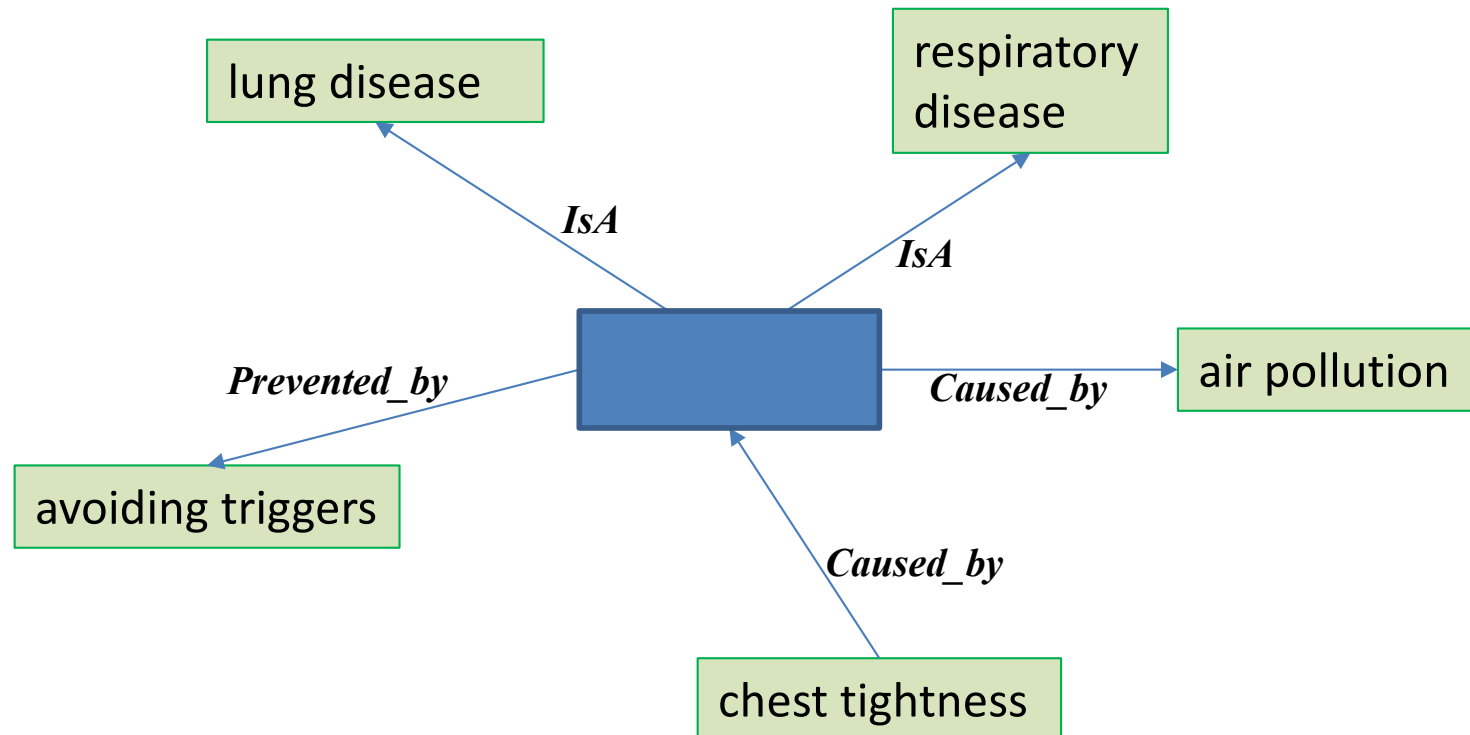
•Qiao Qian, Minlie Huang, Haizhou Zhao, Jingfang Xu, Xiaoyan Zhu. *Assigning personality/identity to a chatting machine for coherent conversation generation.* **IJCAI-ECAI 2018.**



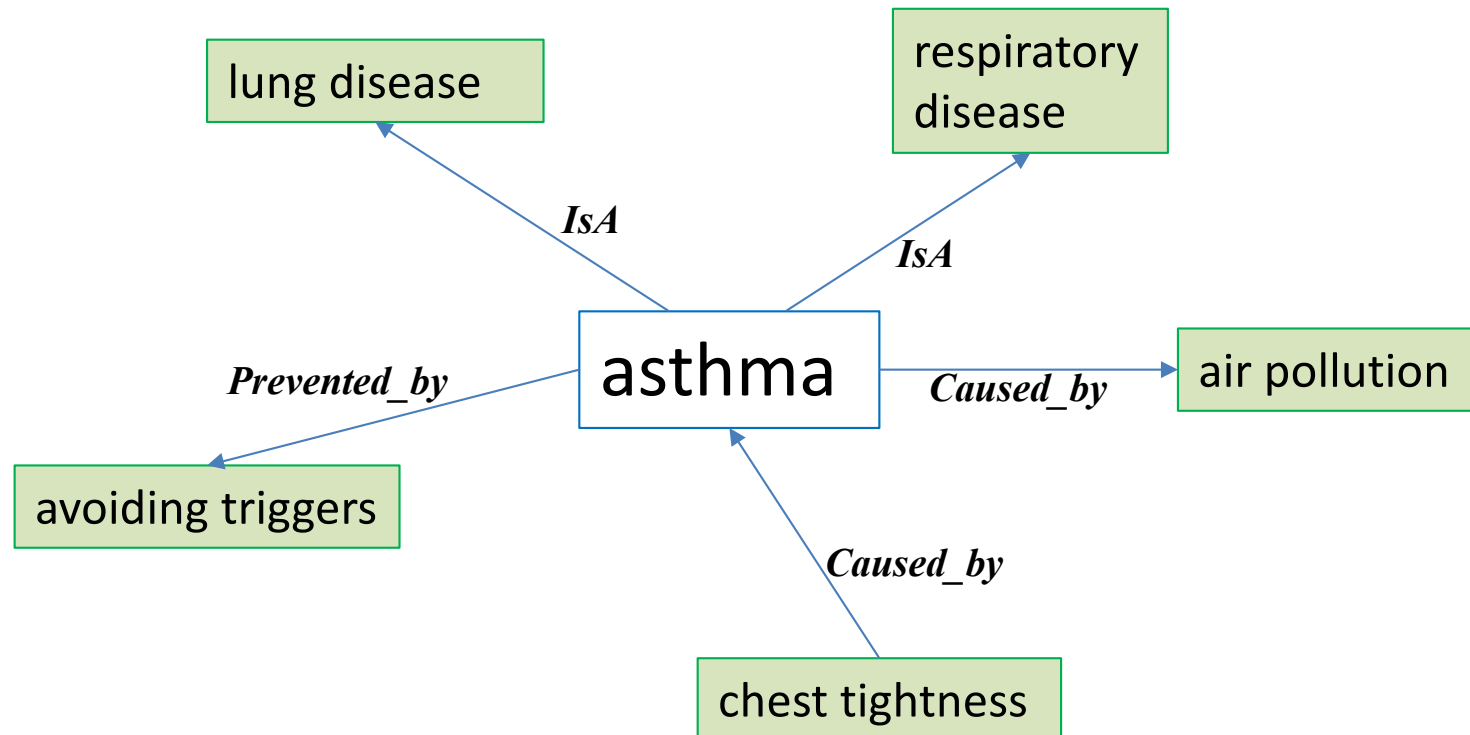
Commonsense Knowledge



Commonsense Knowledge in Chatbots



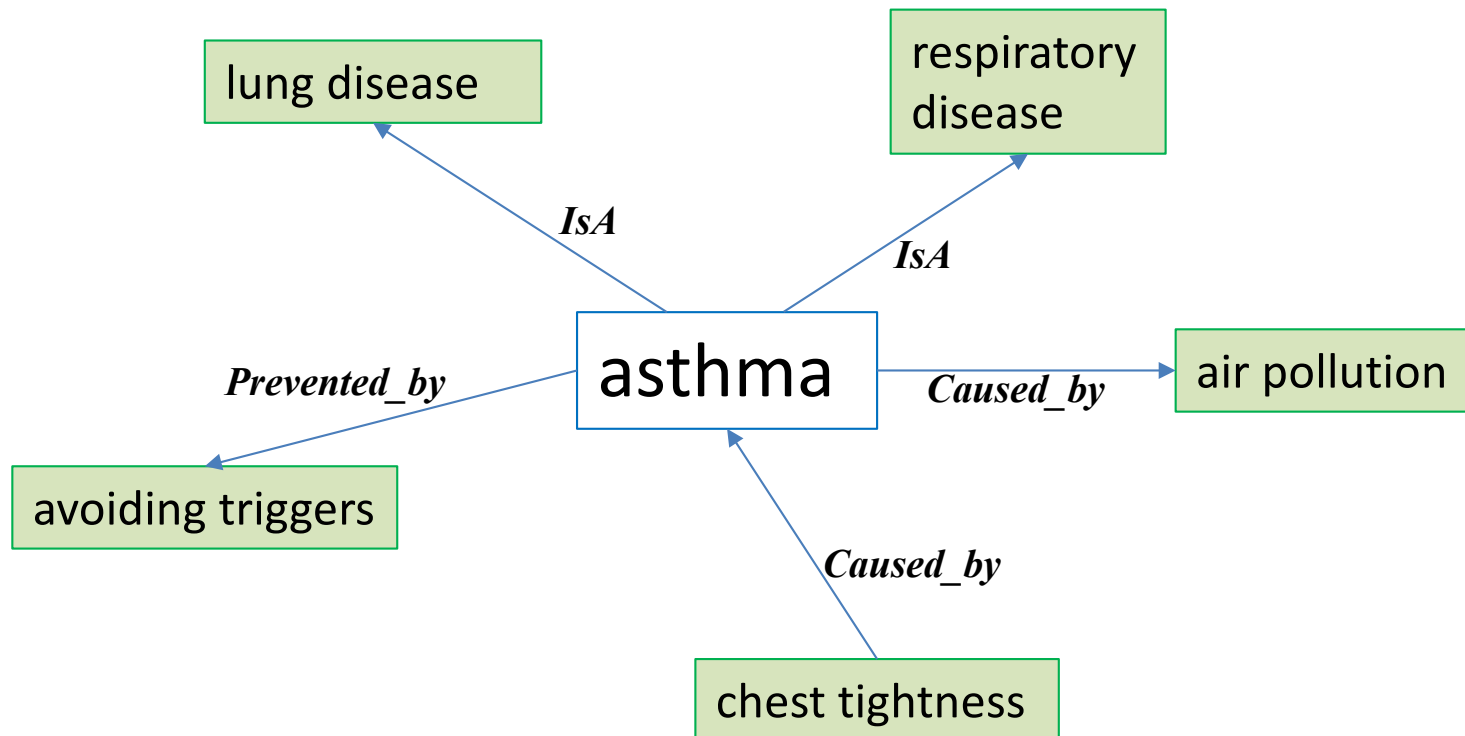
Commonsense Knowledge in Chatbots



Commonsense Knowledge in Chatbots

I have an **asthma** since three years old.

Triples in knowledge graph:
(lung disease, *IsA*, **asthma**)
(**asthma**, *Caused-by*, chest tightness)



Commonsense Knowledge in Chatbots

- Conversation is a **semantic** activity
- Commonsense knowledge is important for **language understanding and generation**

Post	Why are you so breakable ?
Knowledge	(glass , RelatedTo, breakable), (brittle , RelatedTo, breakable), (rule , RelatedTo, breakable)
Seq2Seq	I'm not a OOV , i 'm just a OOV .
MemNet	I'm not OOV . I'm just a really nice person.
CopyNet	I'm not. I'm just a lurker.
CCM	Because I'm a brittle man .

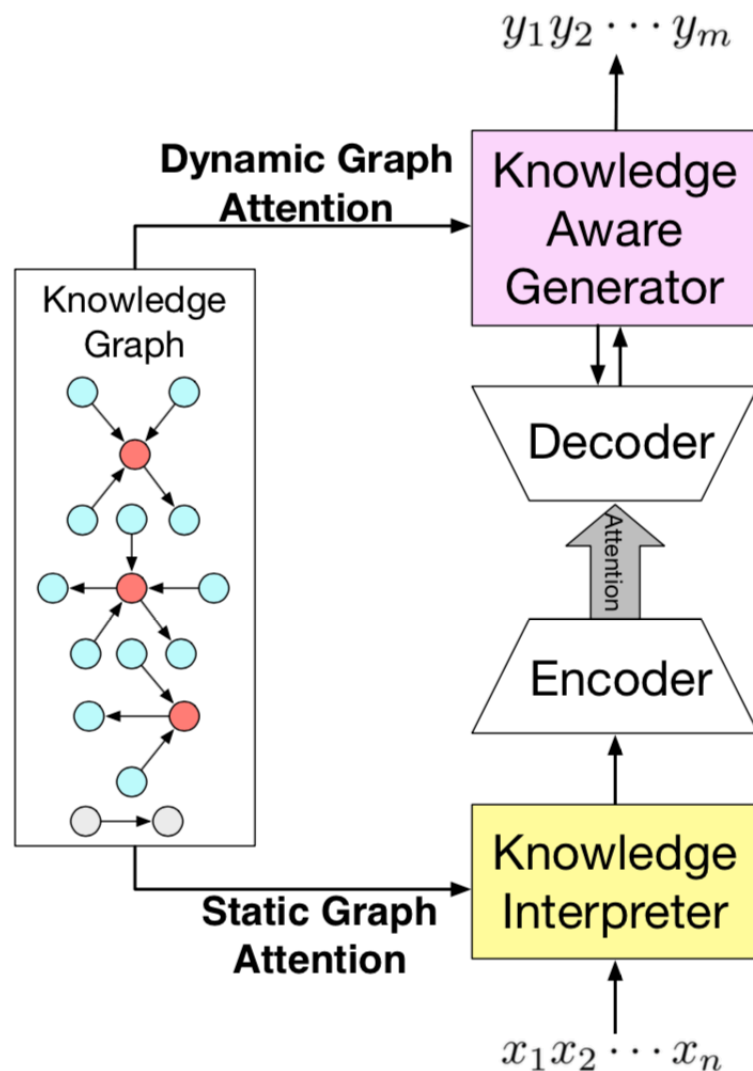


Commonsense Knowledge in Chatbots

- ⊙ **Challenge I:** applying large-scale, high-quality commonsense knowledge
- ⊙ **Challenge II:** an elegant way of using commonsense knowledge in open-domain, open-topic conversation generation
- ⊙ **Our solution:**
 - ◆ Static graph attention
 - ◆ Dynamic graph attention
 - ◆ **Treating a knowledge graph as a whole**



Commonsense Knowledge in Chatbots



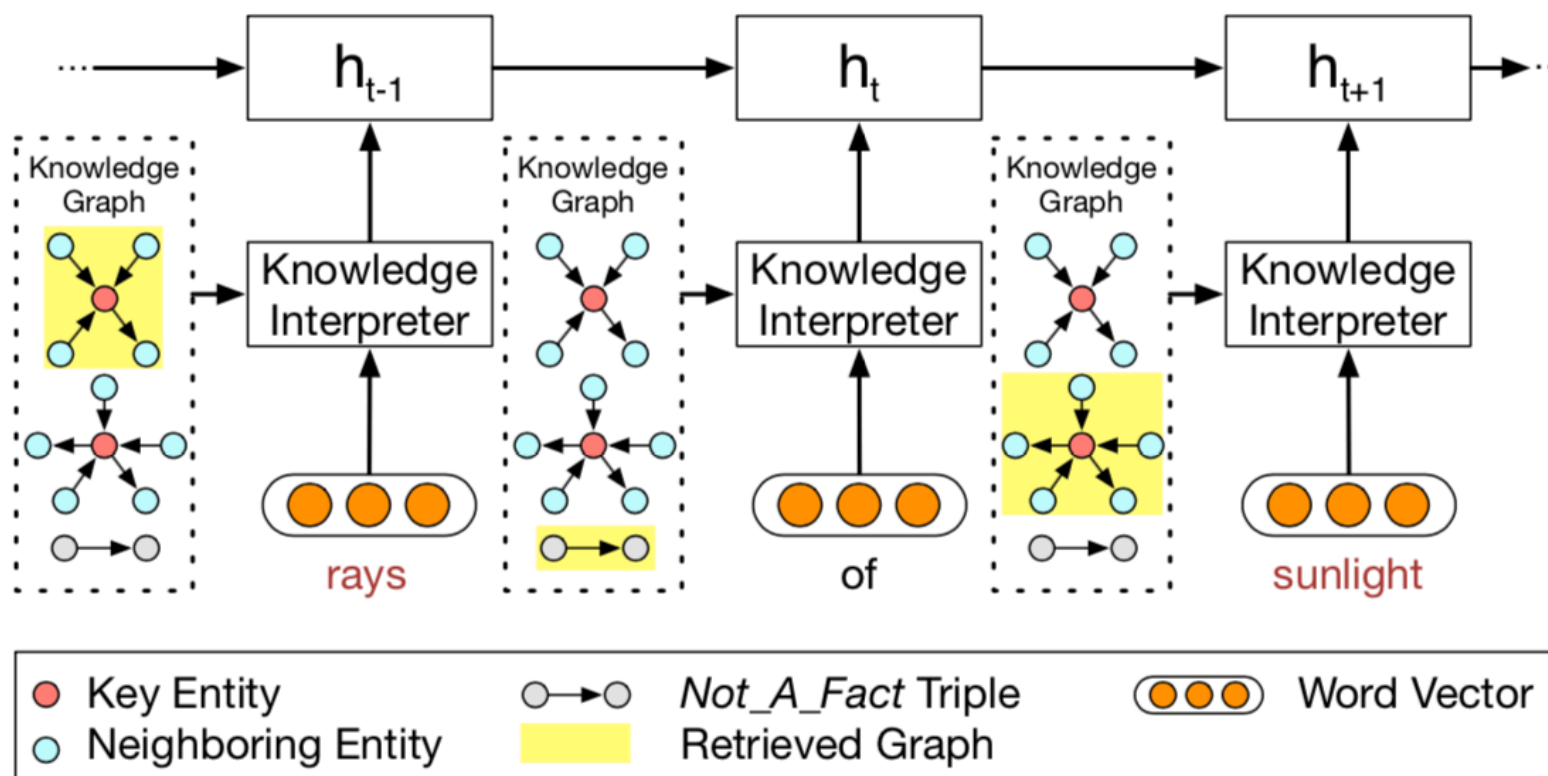
Decoding words by attending to knowledge graphs and then to triples

Encoding the retrieved knowledge graphs for each word



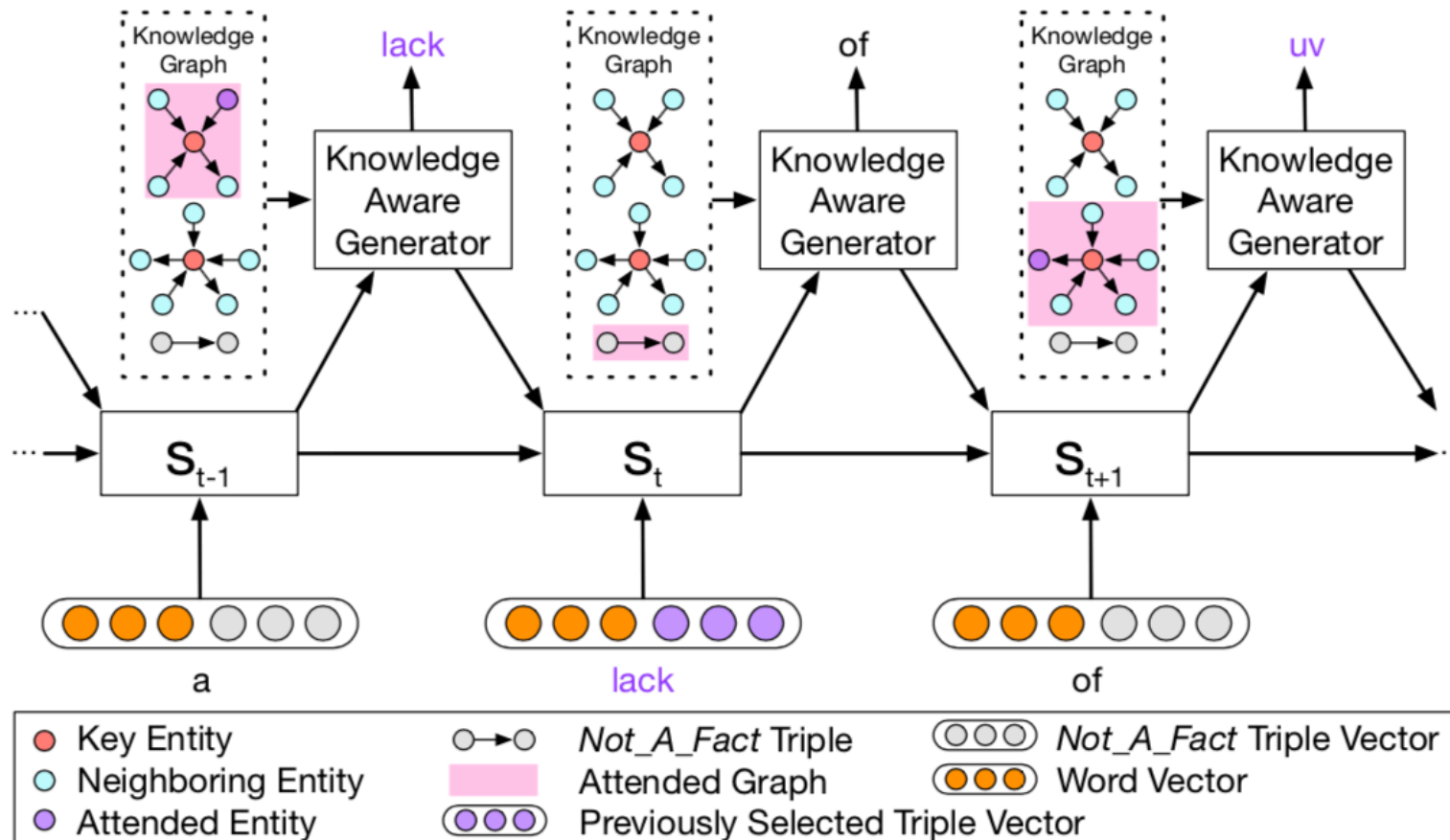
Commonsense Knowledge in Chatbots

Static graph attention: encoding semantics in graph,
Feeding knowledge-enhanced info. into the encoder



Commonsense Knowledge in Chatbots

Dynamic graph attention: first attend a graph, then to a triple within that graph, finally generate with the words in a graph



Commonsense Knowledge in Chatbots

Automatic evaluation

Model	Overall		High Freq.		Medium Freq.		Low Freq.		OOV	
	ppx.	ent.	ppx.	ent.	ppx.	ent.	ppx.	ent.	ppx.	ent.
Seq2Seq	47.02	0.717	42.41	0.713	47.25	0.740	48.61	0.721	49.96	0.669
MemNet	46.85	0.761	41.93	0.764	47.32	0.788	48.86	0.760	49.52	0.706
CopyNet	40.27	0.96	36.26	0.91	40.99	0.97	42.09	0.96	42.24	0.96
CCM	39.18	1.180	35.36	1.156	39.64	1.191	40.67	1.196	40.87	1.162

Manual evaluation

(Sign-test, p-value<0.005)

Model	Overall		High Freq.		Medium Freq.		Low Freq.		OOV	
	app.	inf.	app.	inf.	app.	inf.	app.	inf.	app.	inf.
CCM vs. Seq2Seq	0.616	0.662	0.605	0.656	0.549	0.624	0.636	0.650	0.673	0.716
CCM vs. MemNet	0.602	0.647	0.593	0.656	0.566	0.640	0.622	0.635	0.626	0.657
CCM vs. CopyNet	0.600	0.640	0.606	0.669	0.586	0.619	0.610	0.633	0.596	0.640

Hao Zhou, Tom Yang, Minlie Huang, Haizhou Zhao, Jingfang Xu, Xiaoyan Zhu.
Commonsense Knowledge Aware Conversation Generation with Graph
Attention. **IJCAI-ECAI 2018**, Stockholm, Sweden.



Generation Examples 1

Post: He proposed **March** 5th. We will be **married** October 10th.

So 7 months

Knowledge: (**engaged**, RelatedTo, **married**), (**wedding**, RelatedTo, **married**), (**miss**, DistinctFrom, **married**), (**March**, RelatedTo, **months**)

- ◉ **Seq2Seq:** I'm not sure how to answer that. I'm not sure how to make a date.
- ◉ **MemNet:** I'm assuming he's married to a gay marriage?
- ◉ **CopyNet:** I'm sorry, I'm not sure what you mean by that.
- ◉ **CCM:** I'm pretty sure he's going to be **engaged** in the next 6 **months**.



Generation Examples 2

Post: Totally **thought** it was going to be **doug's grave**.

Knowledge: (**thought**, RelatedTo, **thinking**), (**doug**, HasProperty, **dead**), (**dead**, RelatedTo, **grave**), (**grave**, RelatedTo, **death**)

- **Seq2Seq:** I was **thinking** the same thing.
- **MemNet:** I thought it was a **dead** end.
- **CopyNet:** I think it's a bit of a stretch.
- **CCM:** I thought it was doug's **death**. I was **thinking** the same thing.



Summary

- ◎ **Emotion, personality, and knowledge** is important to Chatbots
- ◎ Open-domain chatting machine is one of the most challenging AI tasks
 - ◆ Requires the ability of understanding **semantics, knowledge, and situational context**
 - ◆ Ability of making **reasoning**
- ◎ Still a long way to go: existing generation models are still far from the expectation of real-world applications



Future Research Problems

- ◎ **Multi-modality** emotion perception and expression (**voice, vision, text**)
- ◎ **Personality, identity, style** → **“human-like robot”**
 - ◆ **Introvert or extrovert**
 - ◆ **Personalized (style, or profile)**
- ◎ **Learning to learn**
 - ◆ **Grow up from interactions with human partners and environment**



Thanks for Your Attention

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- ◎ <http://coai.cs.tsinghua.edu.cn/hml>
- ◎ Recruiting post-doctors and international PhDs!

