Large-Scale Multi-Domain Belief Tracking with Knowledge Sharing

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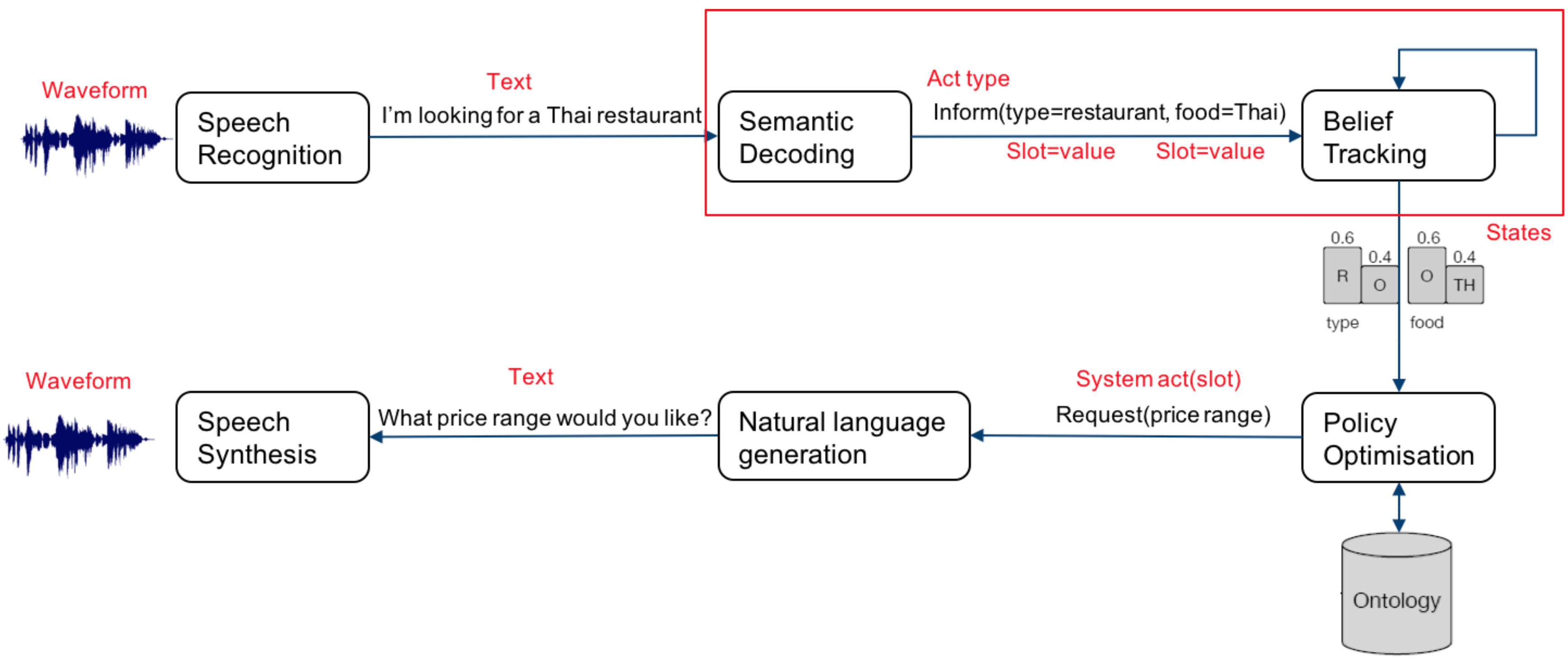
Main Components of Spoken Dialogue Systems



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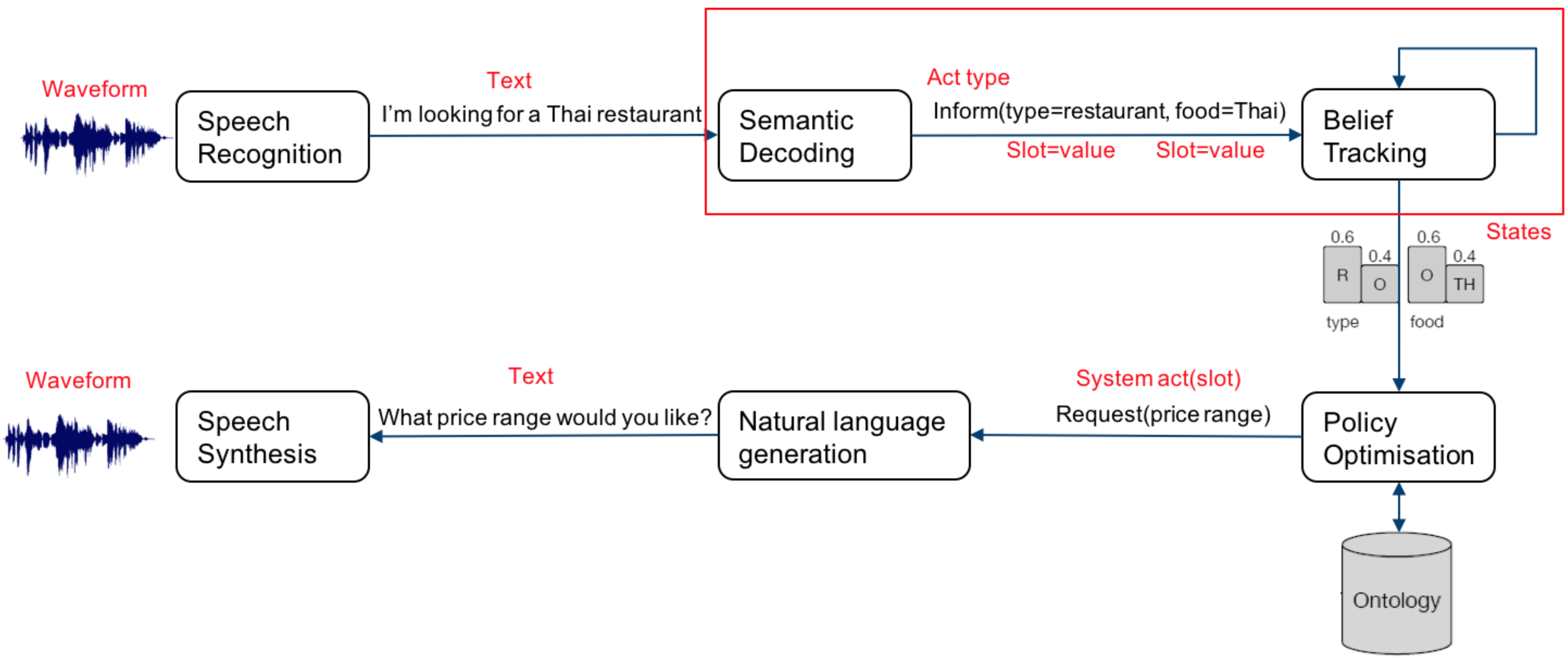

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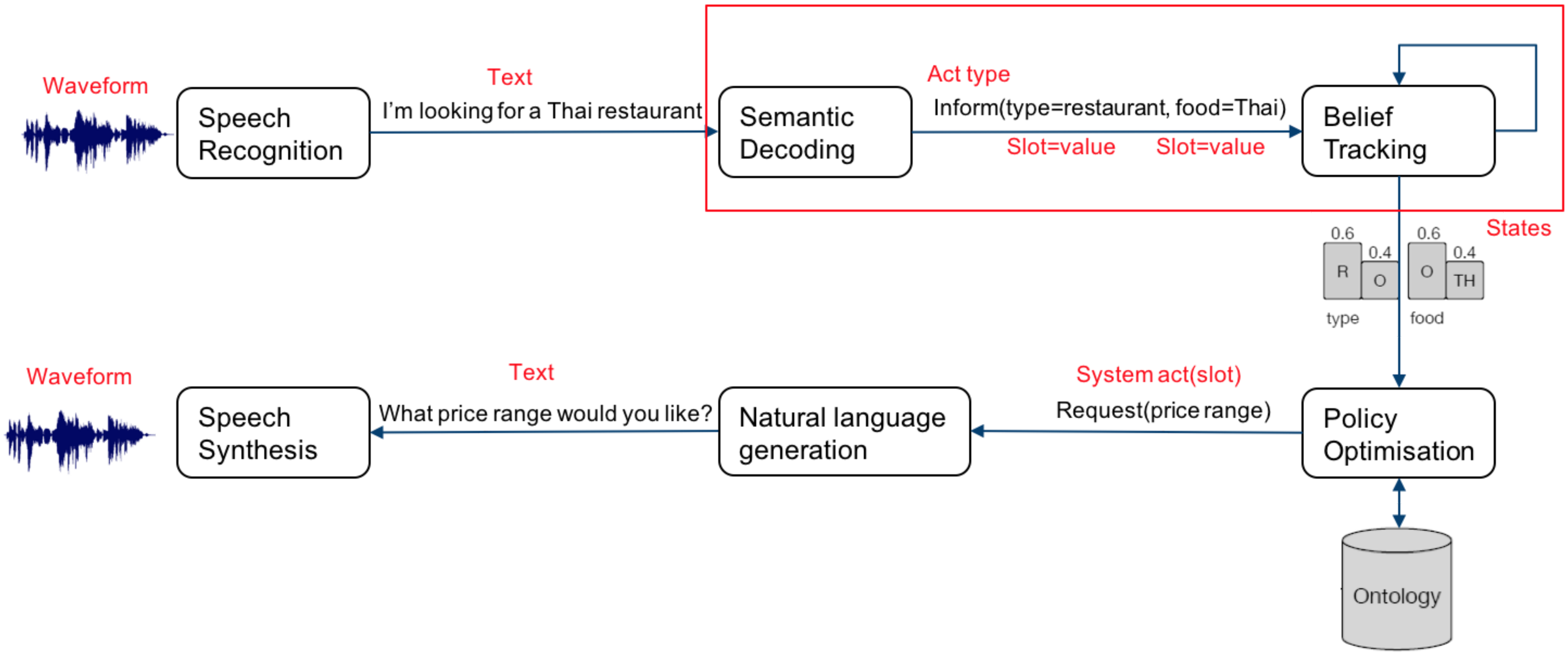

- Semantic decoding and belief tracking require different type of **labelled data**
- Combining these two units, reduces the **amount of labelled data** required and avoid possibility of information loss in the SD stage.

Belief Tracking

Belief Tracking

`Turn 2:`
System: There are nine guesthouse hotels in various areas. What part of town are you hoping for?
User: I just need it booked for 6 people for a total of 4 nights starting from sunday.

Labels: `hotel:{internet=yes, type=guesthouse, parking=yes, pricerange=cheap Book=day, Book=people, Book=stay}`

`Turn 3:`
System: You're booked at the Alexander Bed and Breakfast, 517a coldham lane,
for 6 people for four nights starting Sunday.
User: Thank you! I'm also looking for a restaurant. Ideally an Italian place in the same price range in the centre.

Labels: `hotel:{internet=yes, type=guesthouse, parking=yes pricerange=cheap Book=day, Book=people, Book=stay}, restaurant: {area=centre, food=Italian, pricerange=cheap}`
...

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This causes a **bottleneck in scaling** the belief tracker to larger domains and complex dialogues

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4. How do we track the dialogue context?
5. How do we handle many domains?

Belief Tracking with Knowledge Sharing

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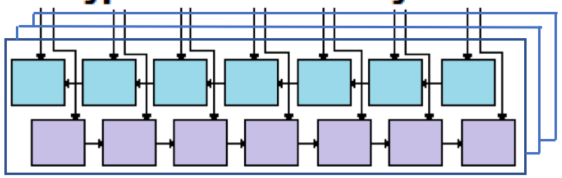
System

What type of food would you like



3 Bidirectional LSTMs

(domain, slot, value)

restaurant
food
thai

Ontology

restuarant-food-Thai
restaurant-area-west
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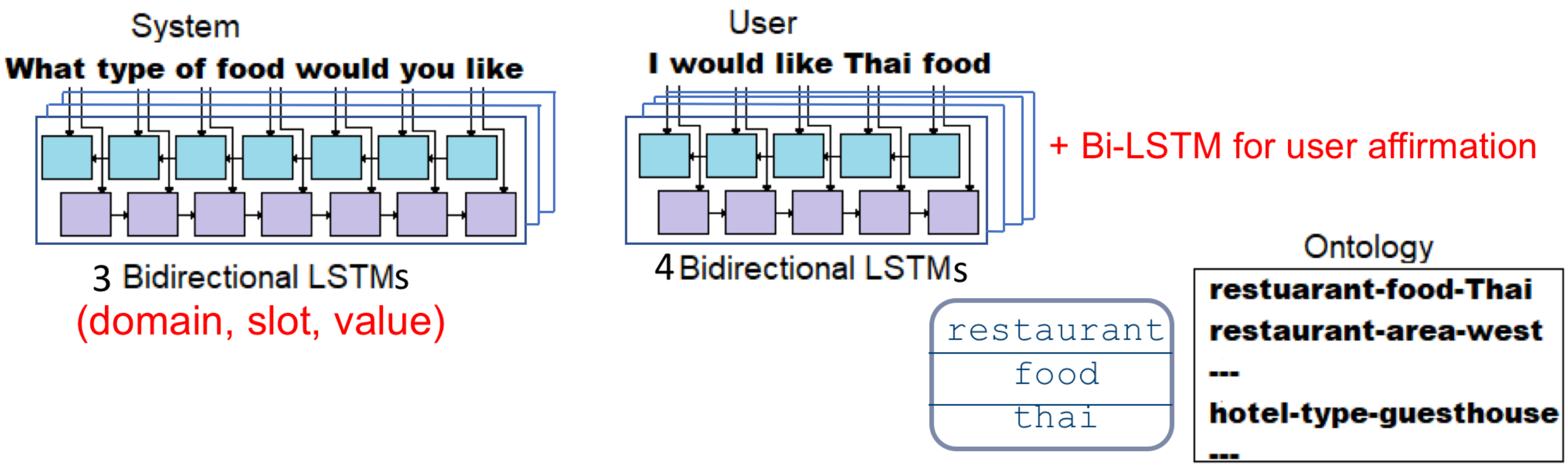
hotel-type-guesthouse

Belief Tracking with Knowledge Sharing



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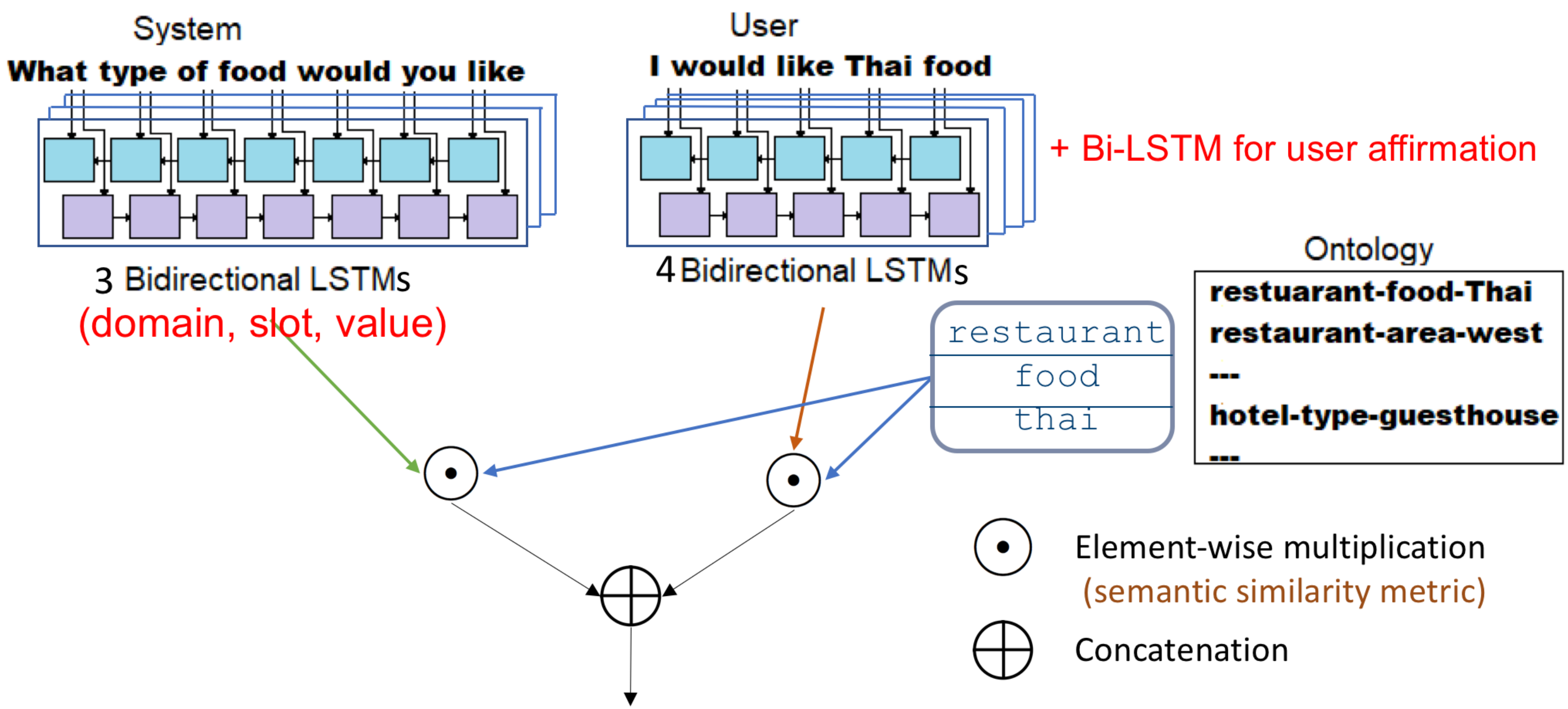

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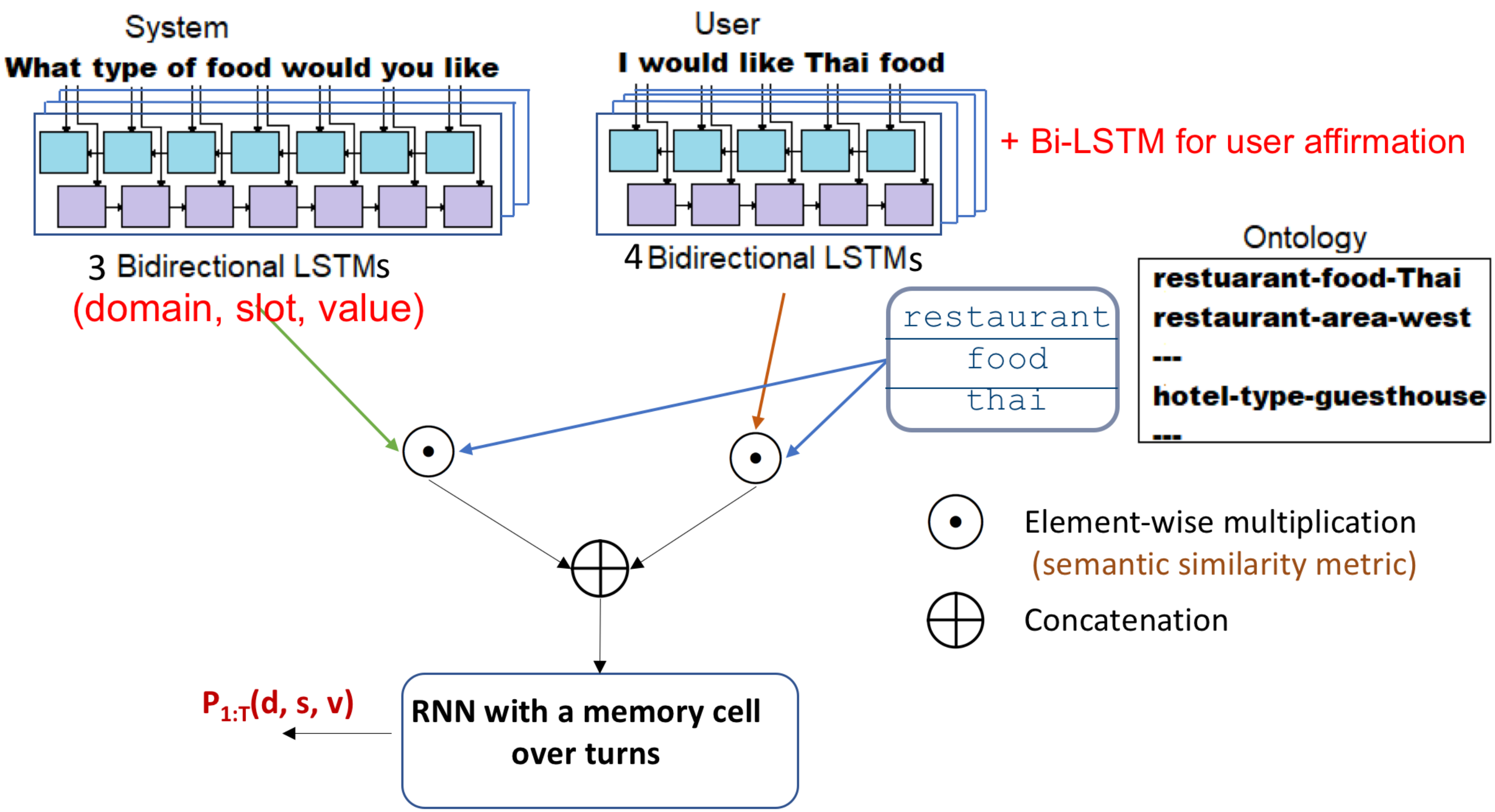

Belief State Update

- Use a **statistical belief update** mechanism modelled by a RNN

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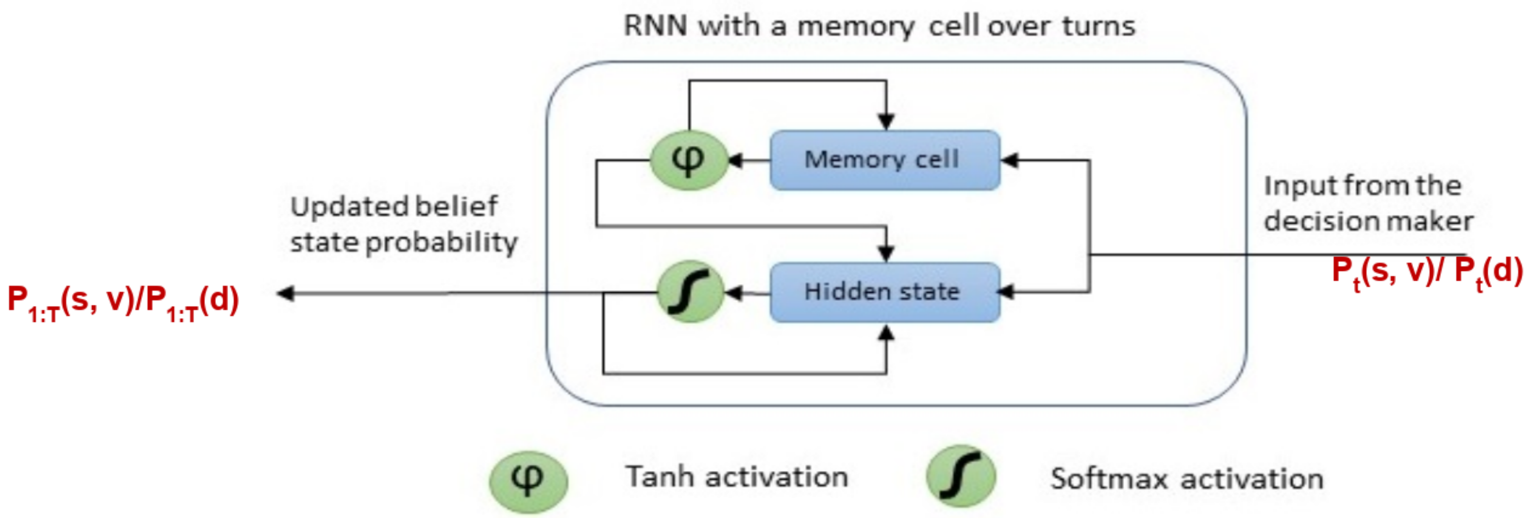

Datasets

- Wizard of Oz framework for collecting data for belief tracking
- Amazon MTurk users given tasks to complete, access to the database
- They produce dialogues and annotate them
- Single-domain dataset WOZ 2.0 (Wen et al 2016)
- New multi-domain dataset MultiWOZ

Datasets

	WOZ 2.0	New Dataset
# of dialogues	1200	9855
# of domains	1	5
Avg. # of turns	7.45	14.30
# of slots	7	27
# of values	99	663

Results

1. Single-domain Dialogues:

	WOZ 2.0			MultiWOZ (only restaurants)		
Slot	**NBT-CNN**	**Bi-LSTM**	**CNN**	**NBT-CNN**	**Bi-LSTM**	**CNN**
Food	88.9	96.1	**96.4**	78.3	84.7	**85.3**
Price range	93.7	**98.0**	97.9	92.6	**95.6**	93.6
Area	94.3	97.8	**98.1**	78.3	82.6	**86.4**
Joint goals	84.2	85.1	**85.5**	57.7	59.9	**63.7**

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2. Multi-Domain Dialogues:

MultiWOZ (multi-domain)		
Model	**F1 score**	**Accuracy %**
Uniform Sampling	0.108	10.8
Bi-LSTM	0.876	**93.7**
CNN	**0.878**	93.2

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The data collection was funded through Google Faculty Award