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Task-oriented Neural Dialogue Systems

NTU Speech Lab, 05/01/2017
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Dialogue Systems Group

Outline

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- Intro
- Neural Dialogue System
- Wizard-of-Oz Data Collection
- Experiments
- Conclusion

Outline

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The two paradigms

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M: Hello, welcome to the Cambridge dialogue system, What kind of food would you like?
H: Yeah I want to find a restaurant that serves European food.
M: Hotel du Vin and Bistro is a nice place. It serves European food.
H: Uh what is the address and phone number?
M: Hotel du Vin and Bistro is a nice place. Their address is XXX and their phone is YYY.
H: Thank you goodbye.
M: Thank you for using this system.

[Su et al, 2016]

A: How old are you ?
B: I'm 16. Why are you asking ?
A: I thought you were 12.
B: What made you think so ?
A: I don't know what you are talking about.
B: You don't know what you are saying.

[Li et al, 2016]

The two paradigms

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- Task-Oriented Dialogue Systems
 - Goal-oriented
 - Require precise understanding, hard to collect data.
 - Modular, highly handcrafted, restricted ability, but meaningful/useful systems.
- Chat-based Conversational Agents
 - Chit-chat (non-goal).
 - Vast amount of data (but probably not helpful).
 - End-to-end, highly data-driven, but meaningless/inappropriate responses, unreliable systems.
- Can we train a useful (complete tasks) dialogue system directly from data?
- How can we collect the data to train this model?

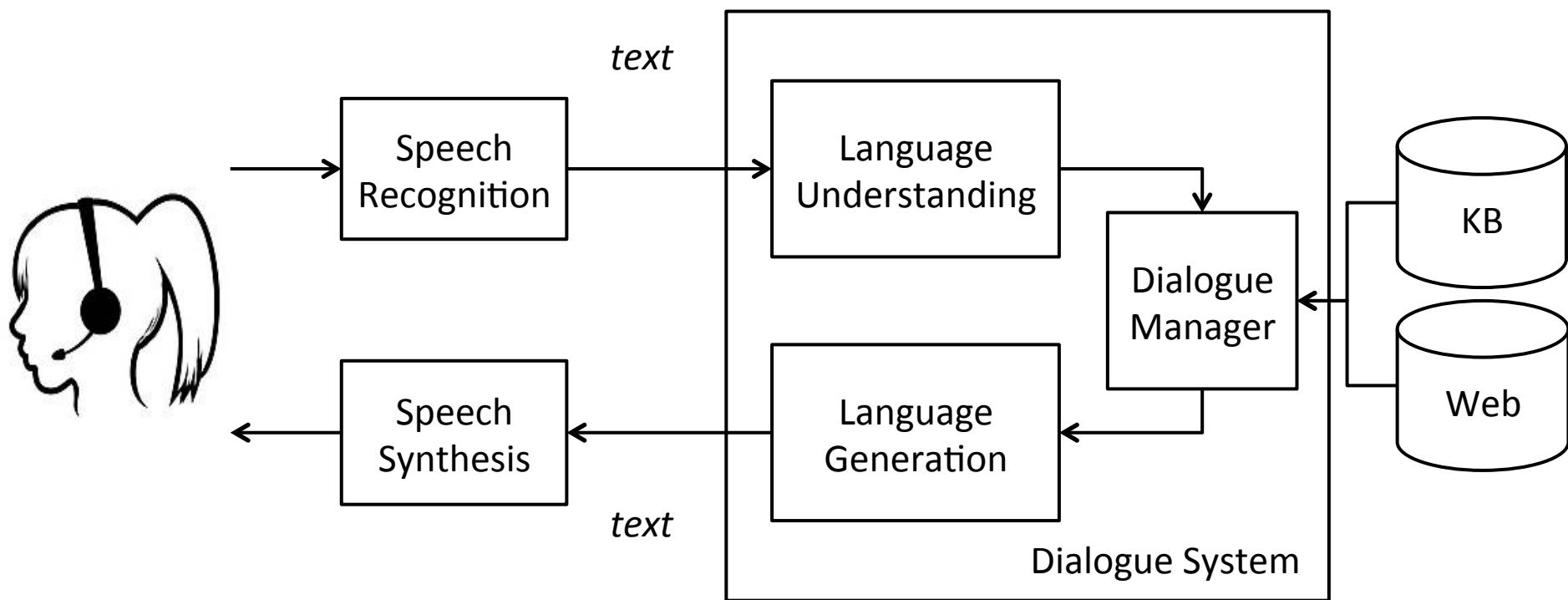
Outline

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- Intro
- Neural Dialogue System
- Wizard-of-Oz Data Collection
- Experiments
- Conclusion & Discussion

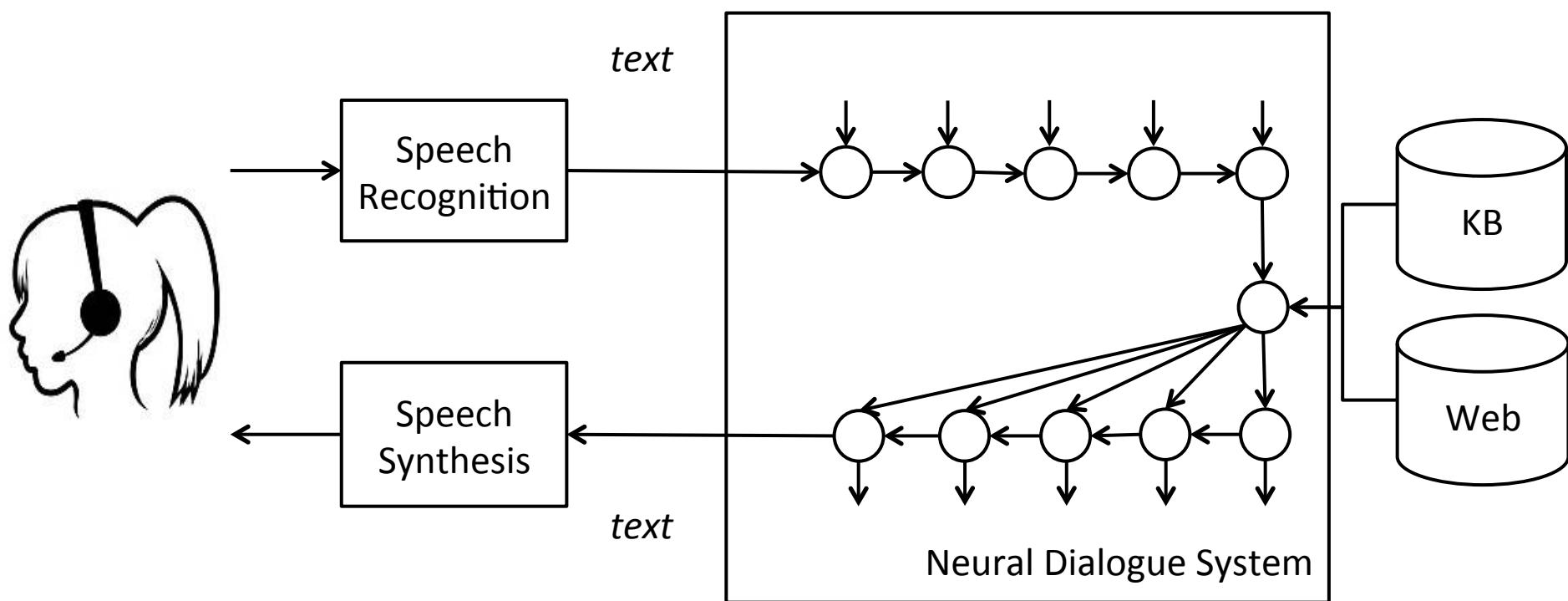
Traditional Dialogue Systems

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Neural Dialogue Systems

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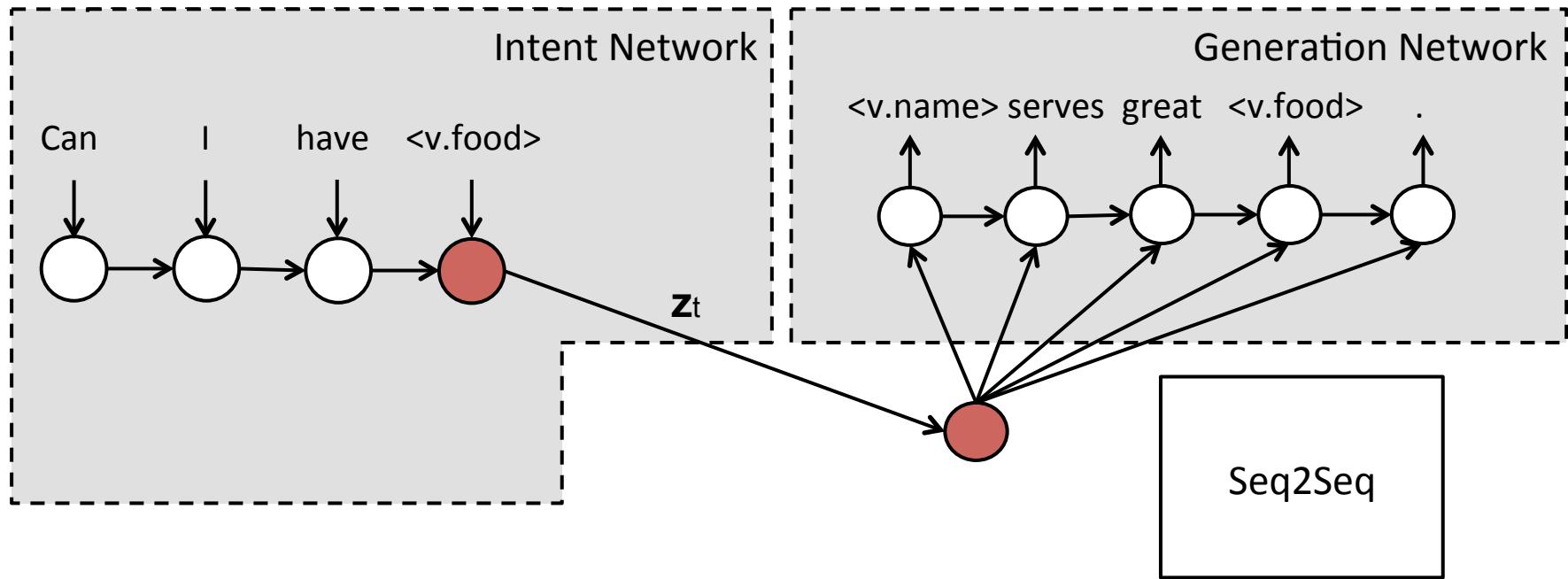
Can I have Korean

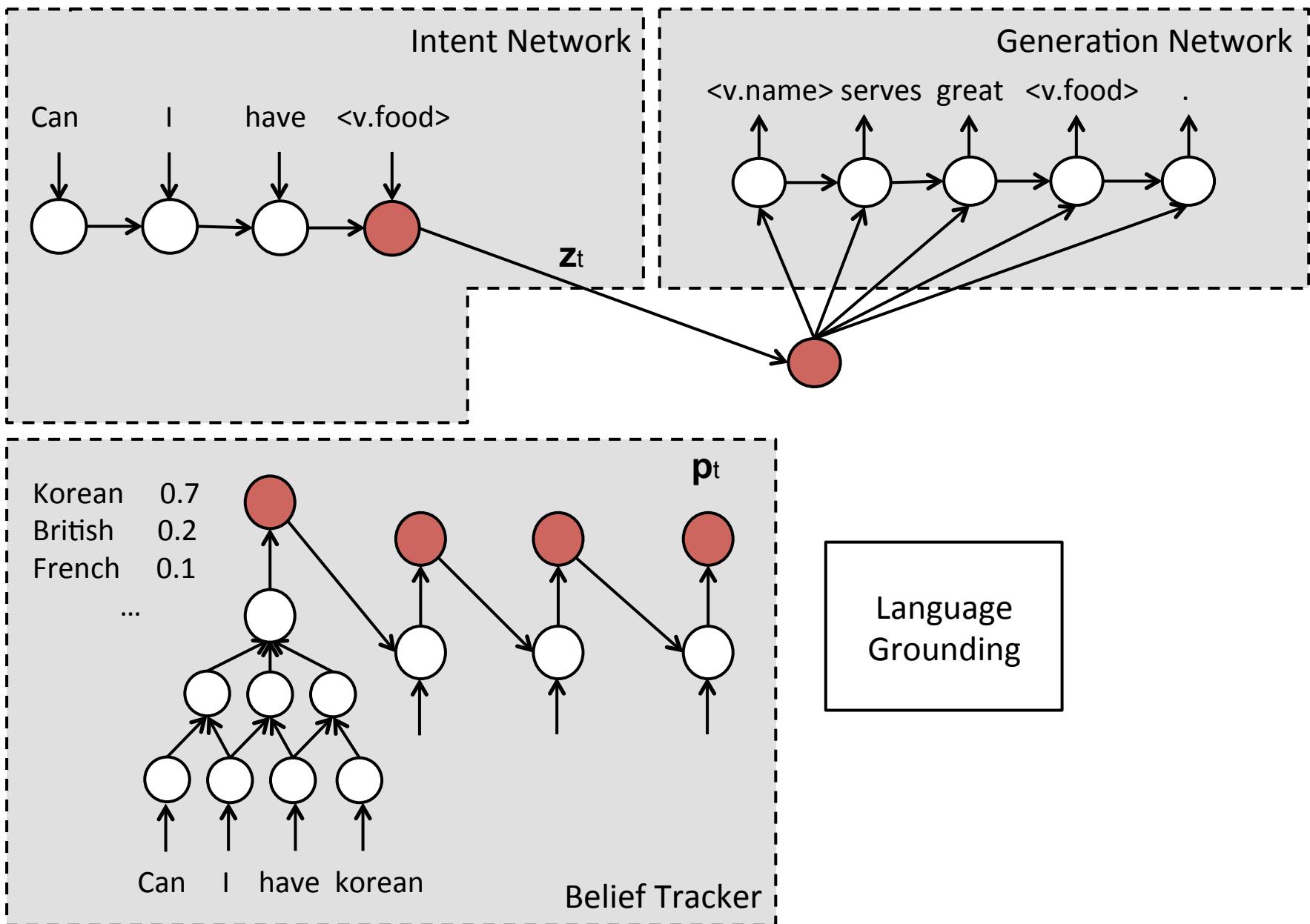
Little Seoul serves great Korean .

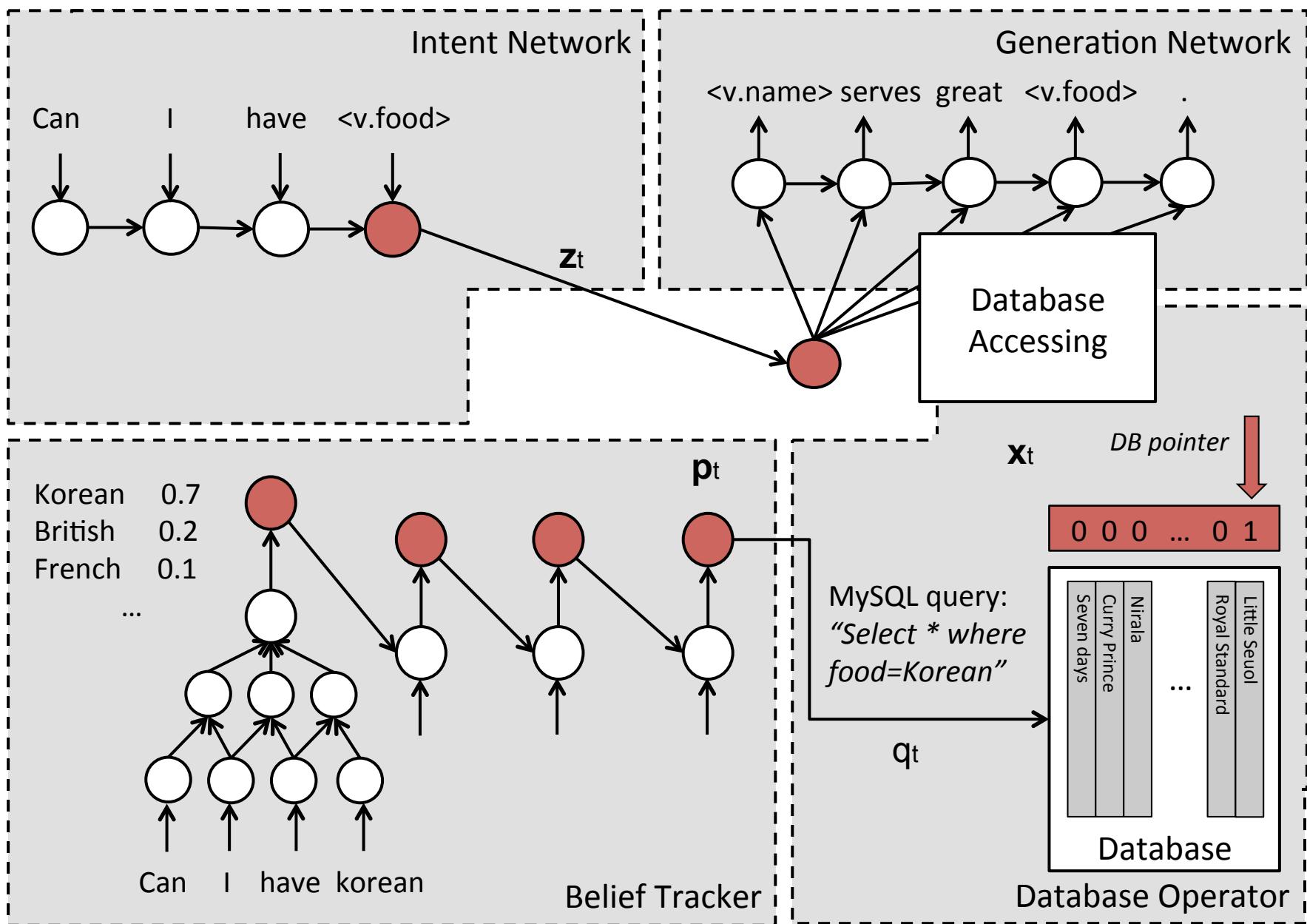
Can I have <v.food>

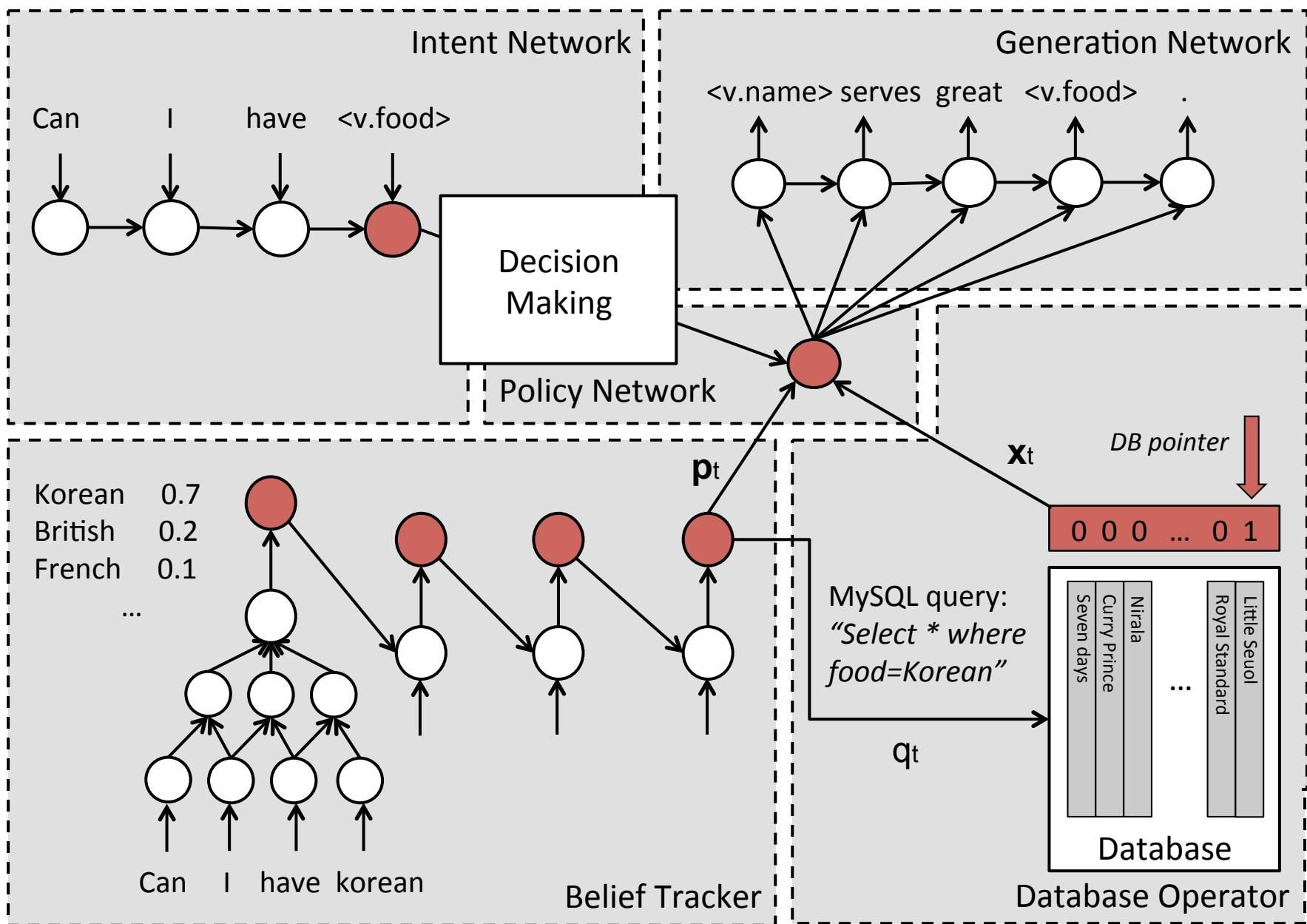
<v.name> serves great <v.food> .

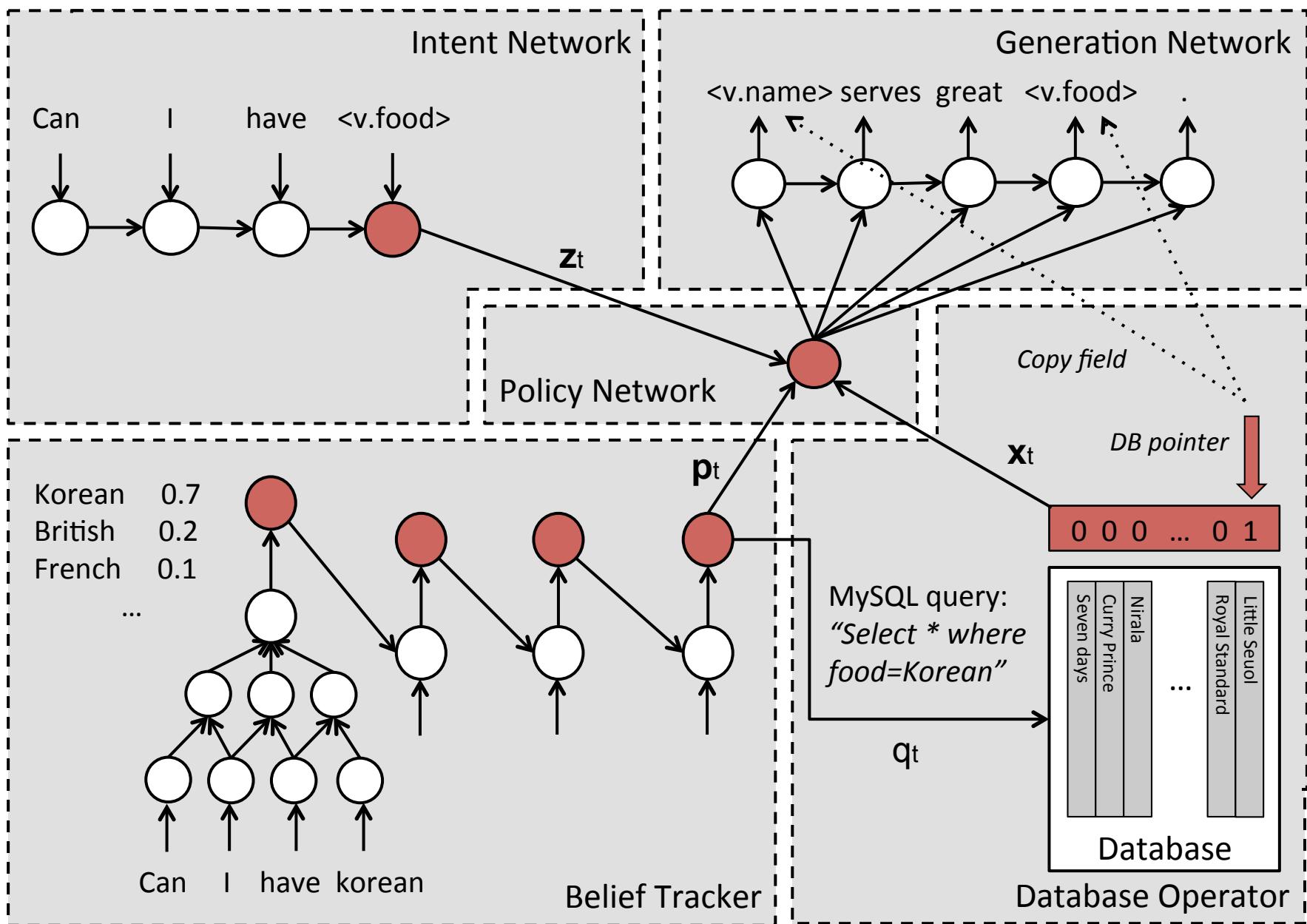
Delexicalisation











Outline

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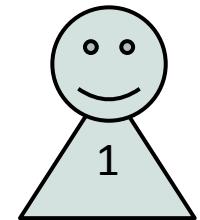
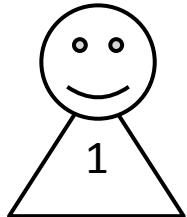
Wizard of Oz Data Collection

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Task:
Find a **restaurant**,
cheap, **Korean**, **North**
Ask **phone number**

*Hi, I want a **cheap Korean restaurant**.*

What area are you looking for ?



What user wants?

Food	Korean
Price	Cheap
Area	N/A

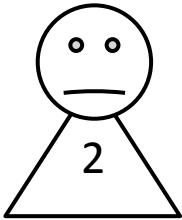
Search Table

Little Seoul	...
Best Korea	...
	...

Wizard of Oz Data Collection

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Task:
Find a ~~restaurant~~,
~~cheap~~, ~~Korean~~, North
Ask phone number

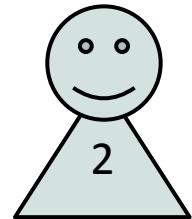


*Hi, I want a **cheap Korean restaurant**.*

What area are you looking for ?

*Somewhere in the **north**.*

Little Seoul is nice one in the north.



What user wants?

Food	Korean
------	--------

Price	Cheap
-------	-------

Area	North
------	-------

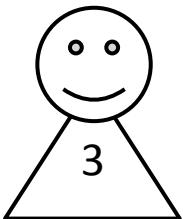
Search Table

Little Seoul	...
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Wizard of Oz Data Collection

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Task:
Find a ~~restaurant~~,
~~cheap~~, ~~Korean~~, ~~North~~
Ask phone number



*Hi, I want a **cheap Korean restaurant**.*

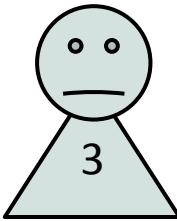
What area are you looking for ?

*Somewhere in the **north**.*

Little Seoul is nice one in the north.

*What is the **phone number**?*

*Its phone number is **01223456789**.*



What user wants?

Food	Korean
Price	Cheap
Area	North

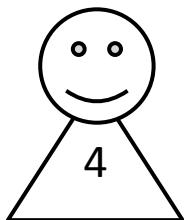
Search Table

Little Seoul ...

Wizard of Oz Data Collection

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Task:
Find a ~~restaurant~~,
~~cheap~~, ~~Korean~~, ~~North~~
Ask ~~phone number~~



*Hi, I want a **cheap Korean restaurant**.*

What area are you looking for ?

*Somewhere in the **north**.*

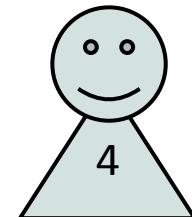
Little Seoul is nice one in the north.

*What is the **phone number**?*

*Its phone number is **01223456789**.*

Thank you very much, good bye.

Thank you for using the system.



What user wants?

Food	Korean
Price	Cheap
Area	North

Search Table

Little Seoul ...

Wizard of Oz Data Collection

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*Hi, I want a **cheap Korean restaurant**.*

*What **area** are you looking for ?*

*Somewhere in the **north**.*

Little Seoul is nice one in the north.

*What is the **phone number**?*

*Its phone number is **01223456789**.*

Thank you very much, good bye.

Thank you for using the system.

What user wants?

Food	Korean
Price	Cheap
Area	North

Wizard of Oz Data Collection

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- Online parallel version of WOZ on MTurk
 - Randomly hire a worker to be user/wizard.
 - Task: Enter an appropriate response for one turn.
 - Repeat the process until all dialogues are finished.
- Example user page

Task 02004: You are looking for and it should serve **gastropub food**. You don't care about the **price range**. You want to know the **address**.

Info Desk : Hello , welcome to the Cambridge restaurant system . You can ask for restaurants by area, price range or food type . How may I help you ?

Customer : I want a gastropub food

Info Desk : There are 4 restaurants serving gastropub food, what price range do you want ?

Next turn!

Customer : (Your response)

I dont care about the price range, just give me the address please.]

Submit the HIT

Wizard of Oz Data Collection

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○ Example wizard page

Info Desk : Hello , welcome to the Cambridge restaurant system . You can ask for restaurants by area, price range or food type . How may I help you ?
Customer : i want a gastropub food
Info Desk : There are 4 restaurants serving gastropub food, what price range do you want ?
Customer : i dont care

[Next turn!](#)

Please modify the following answers based on the latest customer response:

- What does user want?
What is the **food type** the user wants?
What is the **area** the user wants?
What is the **price range** the user wants?
- What does user ask?
Is the user asking for **food type** of an offered venue?
- Is the user asking for **price range** of an offered venue?
- Is the user asking for **area** of an offered venue?
- Is the user asking for **postcode** of an offered venue?
- Is the user asking for **phone number** of an offered venue?
- Is the user asking for **address** of an offered venue?
- Is the user mentioning any **restaurant names**?

[finish](#)

Info Desk : (Your response)

I would recommend backstreet bistro, a great gastropub restaurant in the centre. do you want their phone number ? end-of-dialogue? [Submit the HIT](#)

Name	Food	Area	Price Range	Phone	Address	Postcode
backstreet bistro	gastropub	centre	expensive	01223 306306	2 Sturton Street City Centre	C.B 1, 2 Q.A
royal standard	gastropub	east	expensive	01223 247877	290 Mill Road City Centre	C.B 1, 3 N.L
the cow pizza kitchen and bar	gastropub	centre	moderate	01223 308871	Corn Exchange Street	C.B 2, 3 Q.F
the slug and lettuce	gastropub	centre	expensive	--	34 - 35 Green Street	C.B 2, 3 J.U
nil	gastropub	nil	nil	nil	nil	nil

Showing 1 to 4 of 4 entries (filtered from 110 total entries) [Previous](#) [1](#) [Next](#)

CamRest676 dataset

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- Ontology:
 - Cambridge restaurant domain, 99 venues.
 - 3 informative slots: area, price range, food type
 - 3 requestable slots: address, phone, postcode
- Dataset
 - 676 dialogues, ~2750 turns
 - 3000 HITS, takes 3 days, costs ~400 USD
 - Data cleaning takes 2-3 days for one person

Link: <https://www.repository.cam.ac.uk/handle/1810/260970>

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Experiments

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- Experimental details
 - Train/valid/test: 3/1/1
 - SGD, l2 regularisation, early stopping, gradient clip=1
 - Hidden size = 50, Vocab size: ~500
- Two stage training:
 - Training trackers with label cross entropy
 - Training other parts with response cross entropy
- Decoding
 - Beam search w/ beam width 10
 - Decode with average word likelihood

Response Generation Task

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Model	Match (%)	Success (%)	BLEU
Seq2Seq [Sutskever et al, 2014]	-	-	0.1718
HRED [Serban et al, 2015]	-	-	0.1861
Our model w/o req. trackers	89.70	30.60	0.1799
Our full model	86.34	75.16	0.2313
Our full model + attention	90.88	80.02	0.2388

Human evaluation

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Quality assessment

Metric	NN
Success	98%
Comprehension	4.11
Naturalness	4.05
# of dialogues:	245

System Comparison

Metric	NN	HDC	Tie
Subj. Success	96.95%	95.12%	-
Avg. # of Turn	3.95	4.54	-
Comparisons(%)			
Naturalness	46.95*	25.61	27.44
Comprehension	45.12*	21.95	32.93
Preference	50.00*	24.39	25.61
Performance	43.90*	25.61	30.49

* p <0.005, # of comparisons: 164

Example dialogues

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Human : Restaurant in any area that serves Vietnamese food

Machine : thanh binh serves vietnamese food type , is there anything else i can help you with ?

Human : What is the phone number and post code

Machine : the number is 01223 362456 and the area code is c.b 3, 0 a.f . is there anything else i can do for you ?

Human : Good bye

Machine : thank you for using the cambridge restaurant system .

Human : Hi, I'm hungry for some Indonesian food

Machine : i am sorry , there are no indonesian restaurants . would you like a different food ?

Human : Oh no. How about Indian?

Machine : there are 9 restaurants serving indian types of food . do you have a preference on side of town ?

Human : East side please

Machine : sitar tandoori is a indian restaurant in the east side of town . would you like their information ?

Human : Yes, the address and phone number please

Machine : sitar tandoori is located at 43 high street cherry hinton cherry hinton and their phone number is 01223 249955 .

Human : Okay, thank you

Machine : thank you , goodbye .

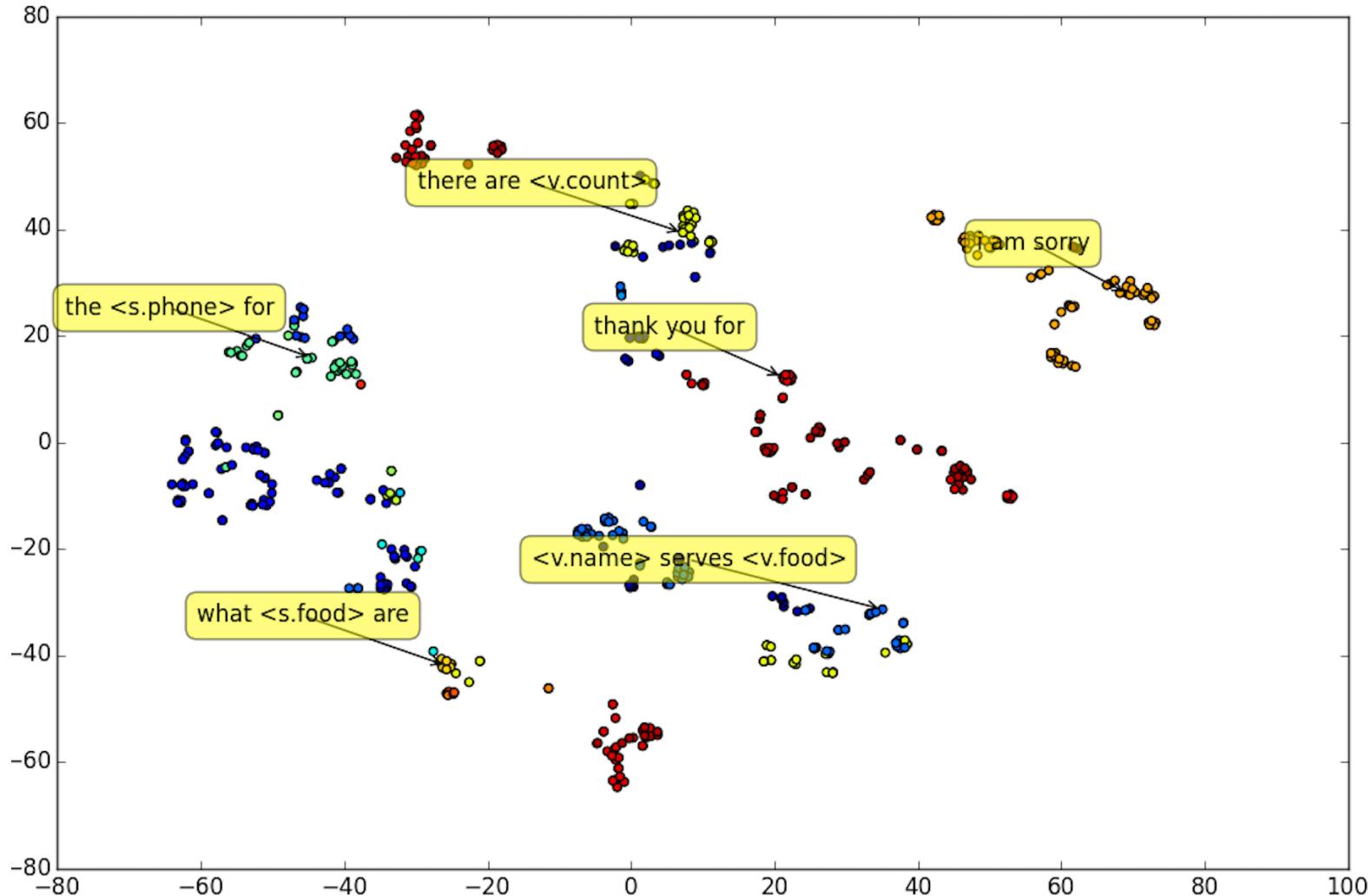
Example dialogues

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-
- Human : hello
Machine : what cuisine would you like ?
Human : afghan
Machine : i am sorry , there are no afghan restaurants . would you like something else ?
Human : korean
Machine : little seoul serves korean food , it is located at 108 regent street city centre .
Human : is it expensive?
Machine : little seoul serves korean food and is in the expensive price range .
Human : what area is that
Machine : little seoul is located in the centre area of town . would you like their number ?
Human : yes
Machine : the telephone number is 01223 308681 . is there anything else i can help you with today ?
Human : no goodbye
Machine : thank you for using the cambridge restaurant system , goodbye .
-

Visualising action embedding

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Conclusion

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- An end-to-end trainable task-oriented dialogue system architecture is proposed.
- A complementary WOZ data collection is also proposed (no latency, parallel, cheap).
- Results show that it can learn from human-human conversations and help users to complete tasks.
- Explicit language grounding is crucial, but what is the best way to represent semantics?

The paper

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- ◎ Tsung-Hsien Wen, David Vandyke, Nikola Mrksic, Milica Gasic, Lina M.R. Barahona, Pei-Hao Su, Stefan Ultes, and Steve Young. **A Network-based End-to-End Trainable Task-oriented Dialogue System.** To appear EACL 2017.
- ◎ Tsung-Hsien Wen, Milica Gasic, Nikola Mrksic, Lina M. Rojas-Barahona, Pei-Hao Su, Stefan Ultes, David Vandyke, Steve Young. **Conditional Generation and Snapshot Learning in Neural Dialogue Systems.** EMNLP 2016.

References

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- P-H. Su, M. Gasic, N. Mrksic, L. Rojas-Barahona, S. Ultes, D. Vandyke, T-H. Wen, and S. Young. **On-line Active Reward Learning for Policy Optimisation in Spoken Dialogue Systems**, ACL 2016.
- M. Henderson, B. Thomson and S. Young. **Word-Based Dialog State Tracking with Recurrent Neural Networks**, SigDial 2014.
- J. Li, W. Monroe, A. Ritter, D. Jurafsky. **Deep Reinforcement Learning for Dialogue Generation**, EMNLP 2016.



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Thank you! Questions?

Tsung-Hsien Wen is supported by a studentship funded by Toshiba Research Europe Ltd, Cambridge Research Laboratory

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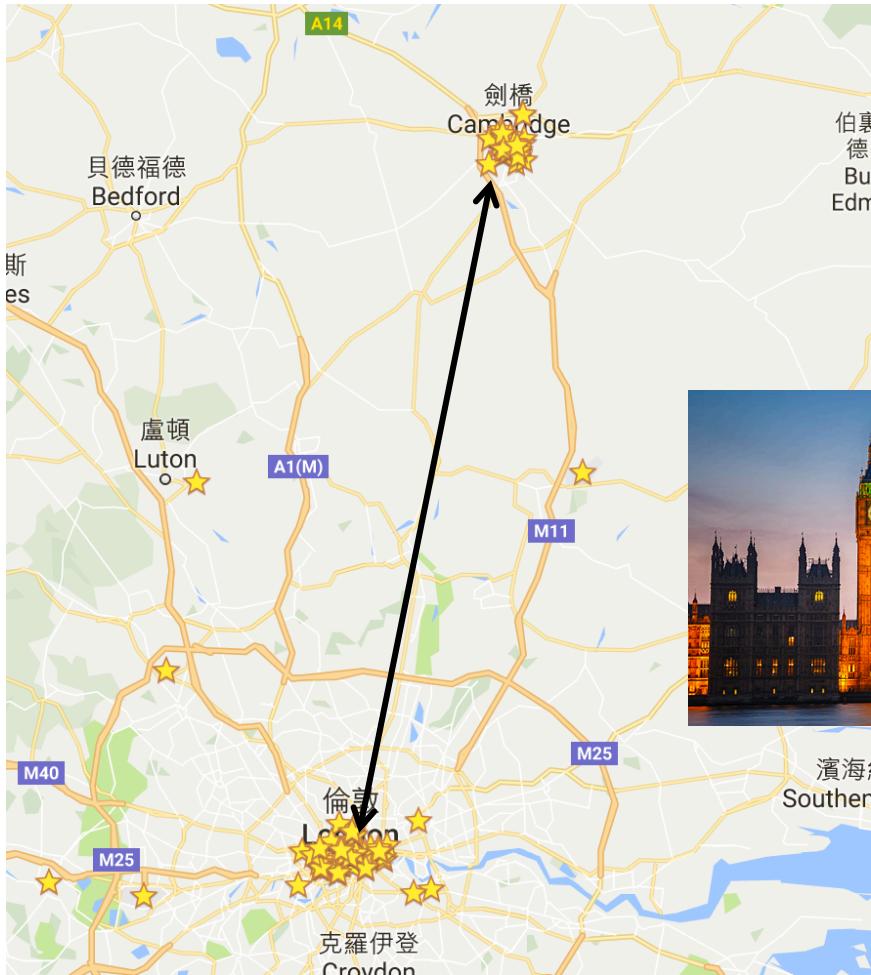
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Life in Cambridge

Dialogue Systems Group

Where is Cambridge?

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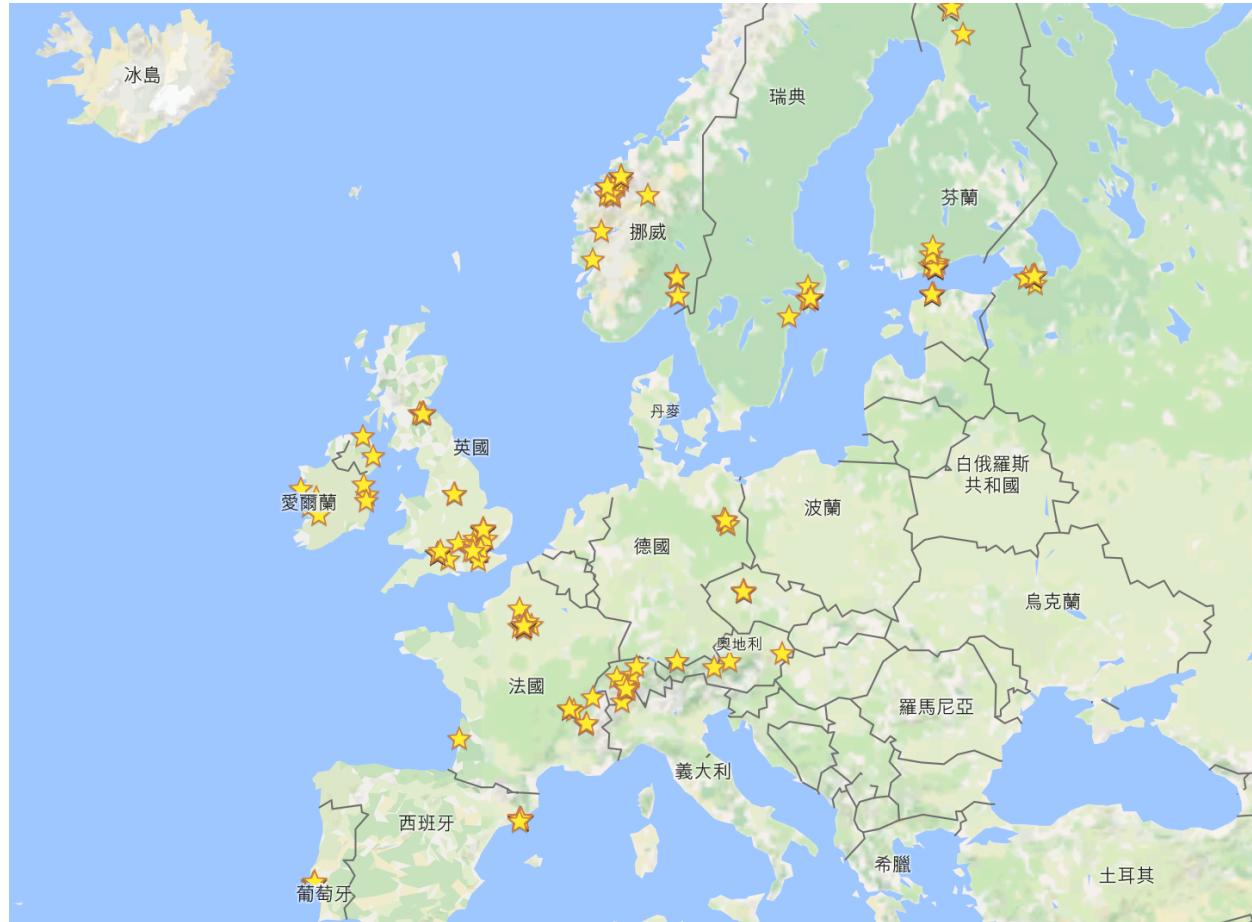


50 minutes by Train!



Hard to get bored because ...

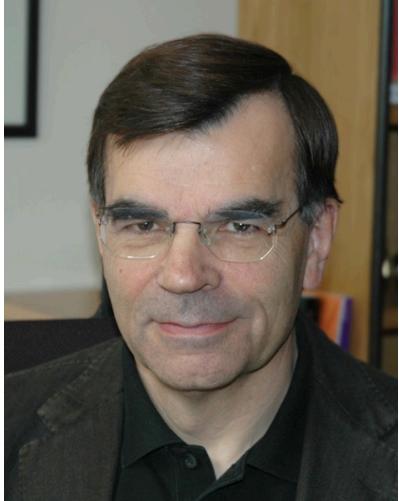
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Flight is so cheap !

The Dialogue Systems Group

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Research

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- We focus on Statistical Dialogue Systems, applying Machine Learning to
 - Language Understanding
 - Dialogue Management
 - Language Generation
 - End-to-end Dialogue Modeling

Resources

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- Computational Infrastructures
 - Personal laptop & desktop
 - Group Computation Clusters
 - High Performance Computing
- Travel funding, refreshments, other hardware spending, ... etc.

Related Research Groups

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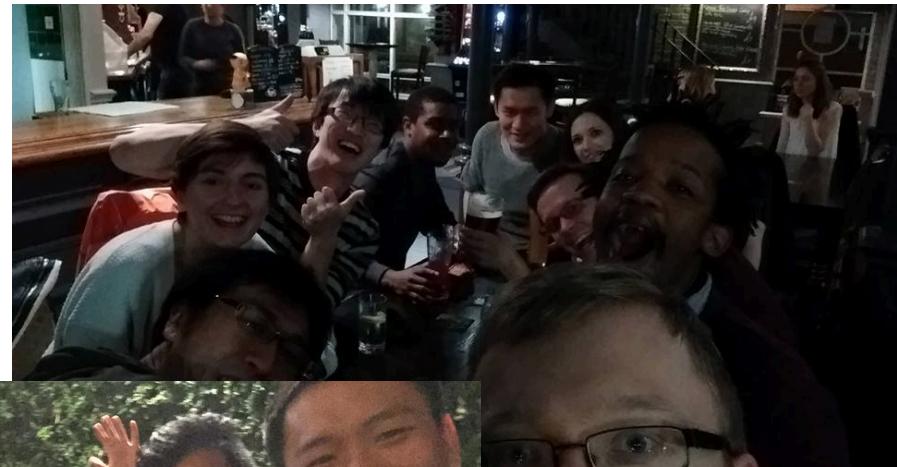
- Machine Learning Group
- Natural Language Processing Group
- Computational Linguistic Group
- Speech Group
- ... etc

Research Activities

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- Seminars, World-class speakers:

- Geoffrey Hinton
- Yoshua Bengio
- Ilya sutskever
- Chris Dyer ... etc



- Beer hangout ...



Other activities – Formal Dinner

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Other activities - Punting

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Questions !?