Reinforcement Learning for Personalized Dialogue Management

Floris den Hengst, Mark Hoogendoorn, Frank van Harmelen & Joost Bosman

VU VRIJE UNIVERSITEIT AMSTERDAM

ING

Dialogue Systems

Dialogflow

Language and context

[bransford1972]

The procedure is actually quite simple. First you arrange things into different groups. Of course, one pile may be sufficient, depending on how much there is to do.

If you have to go somewhere else due to lack of facilities, that is the next step. Otherwise you are pretty well set.

It is important not to overdo things – that is, it is better to do too few things at once than too many. In the short run, this might not seem important, but complications can easily arise. A mistake can be expensive as well.

After the procedure is completed, one arranges the materials into different groups again. Then they can be put into their appropriate places.

Eventually they'll be used once more and the whole cycle will have to be repeated. However, that is a part of life. So how do you do yours?

Language and context

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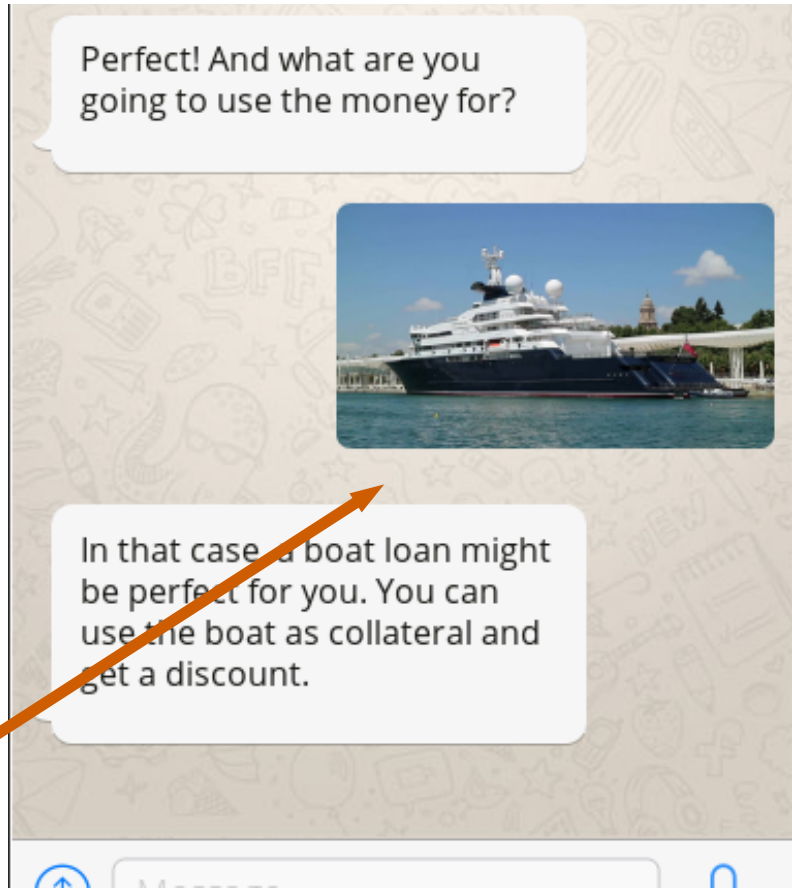
Intent

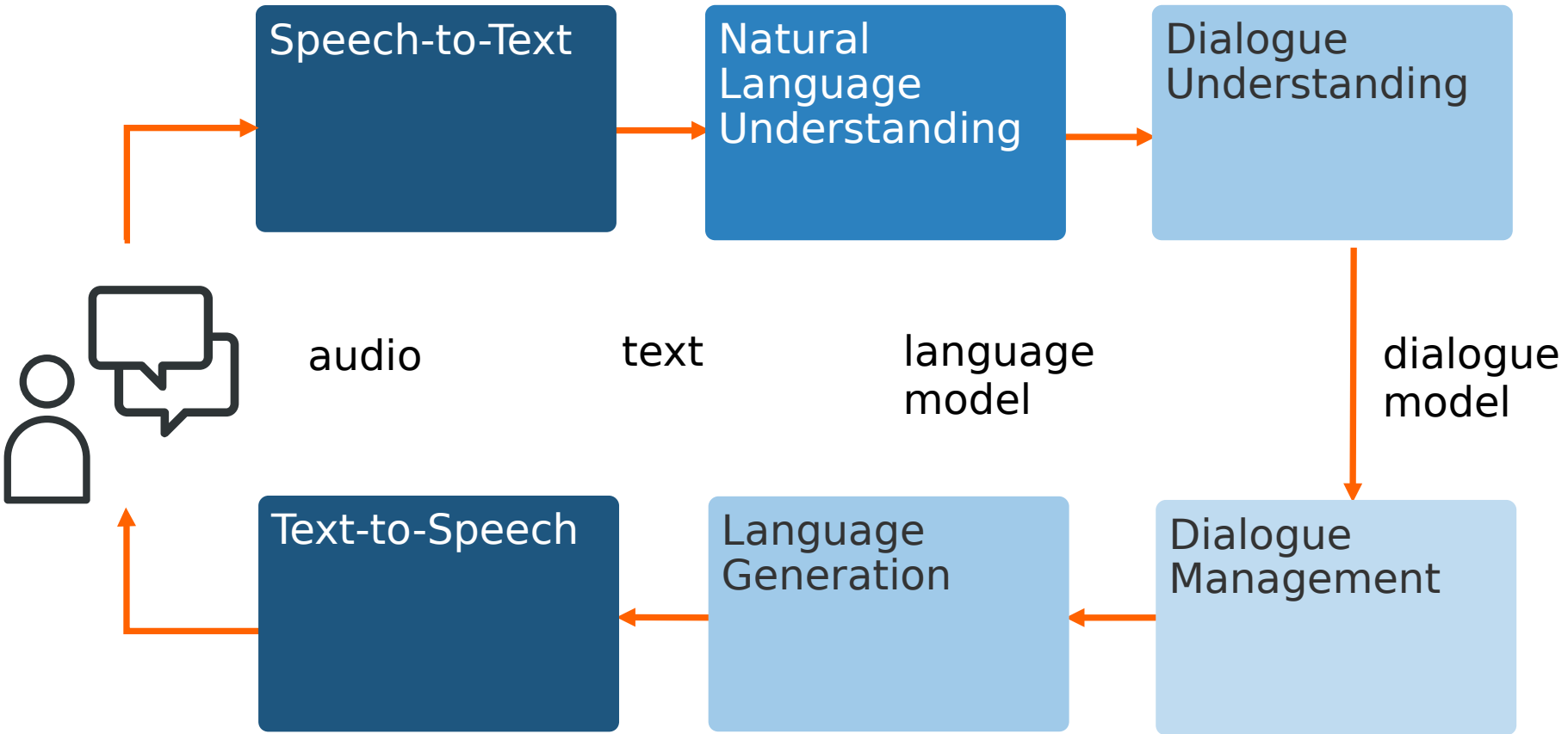
Slots:
duration & purpose

Values:
duration & purpose



Architecture

[peckham1991]
[ultes2017]



Sequential Model

1. Intent: “loan”
2. Purpose: “boat”
3. Duration: “16M”

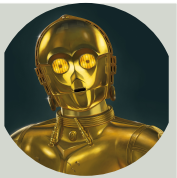
1. Intent: “loan”, purpose:”boat”
2. Duration: “16M”

Dialogue Management

1. Intent: “loan”, p: ”boat”, d: ”16M”

…..

How may I help you?



When are you going to pay the money back?

What are you going to use the money for?

A <…> might be good for you, …

….

FSM Model

Intent: loan
Duration: ?
Purpose: ?
....

Intent: loan
D: 12 M
P: ?
....

Intent: loan
D: ?
P: boat
....

Intent: loan
D: ?
P: home
....

Intent: loan
D: 12 M
P: boat
....

Dialogue Management

How may I help you?

When are you going to pay the money back?

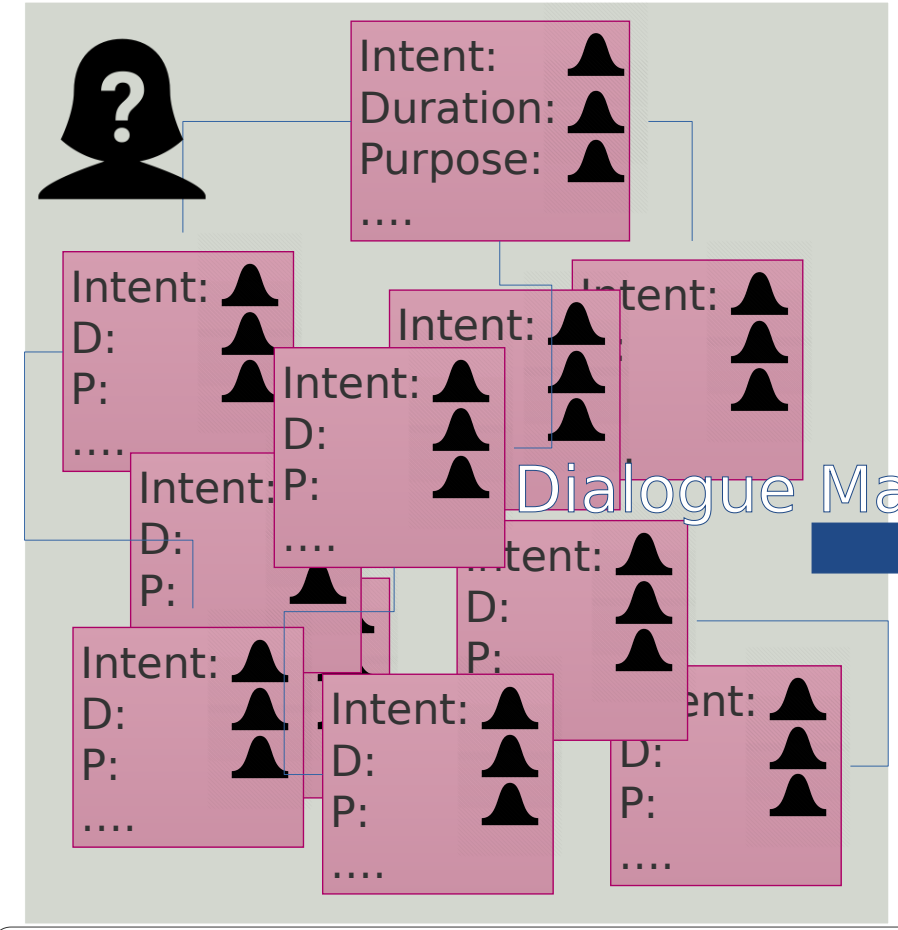
What are you going to use the money for?

....

A <...> might be good for you, ...

Belief State Model

[young2007]



How may I help you?

When are you going to pay the money back?

What are you going to use the money for?

....

Did you say “boat” or “home”

A <...> might be good for you, ...

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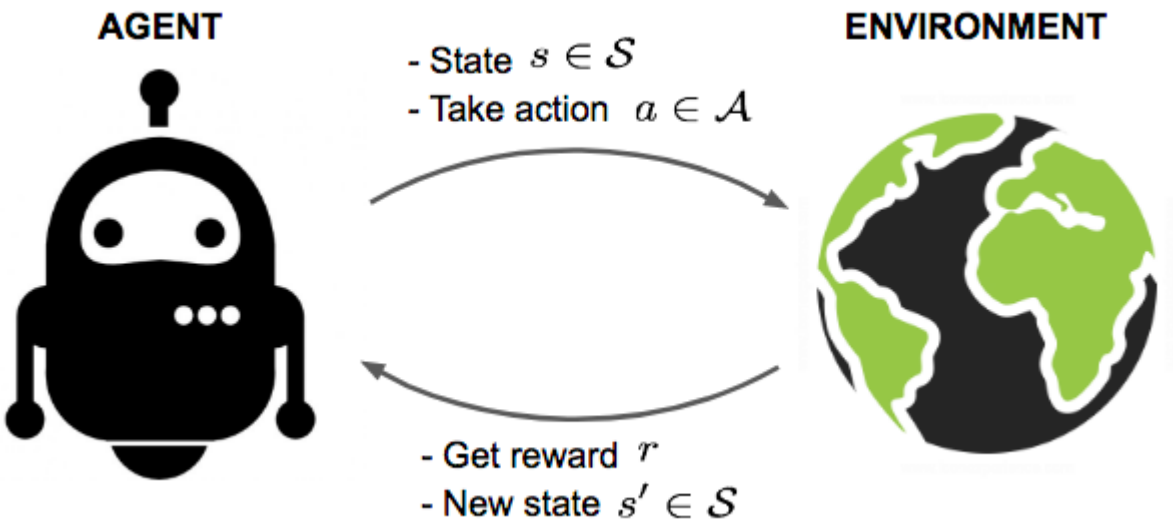
Reinforcement Learning (1/2)

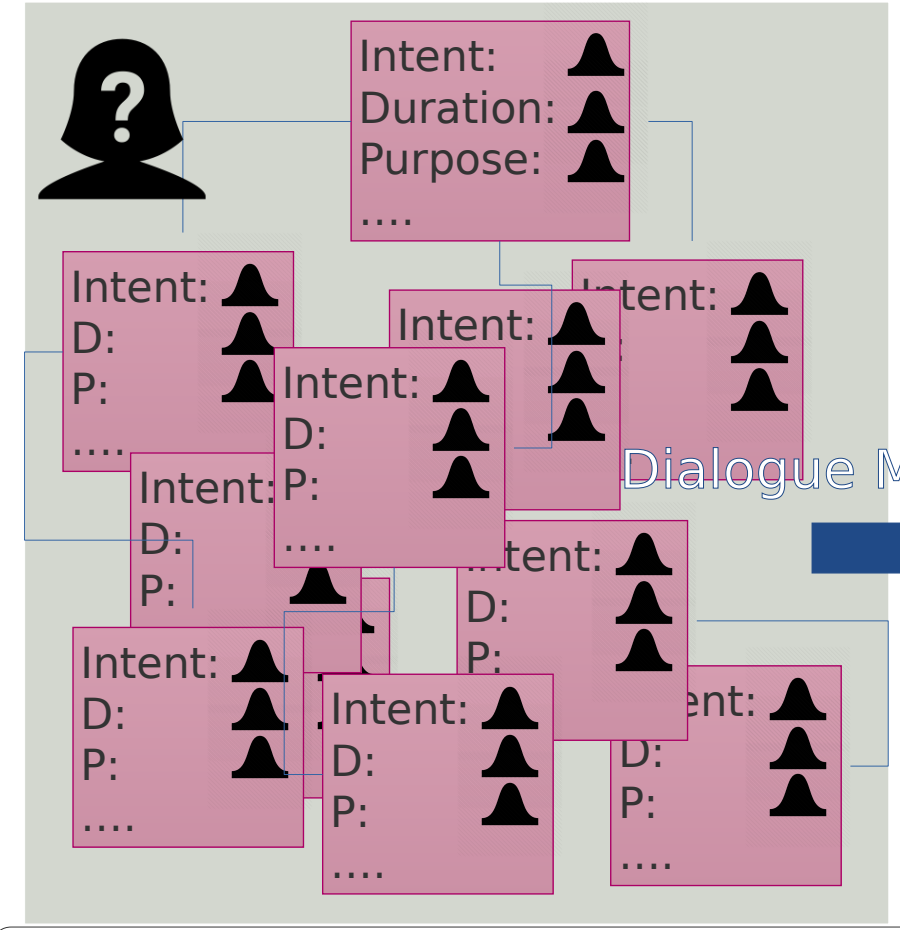


Trajectory $\langle s_0, a_0, r_0, s_1, \ldots, s_T, a_T, r_T \rangle, r_. \in \mathbb{R}$

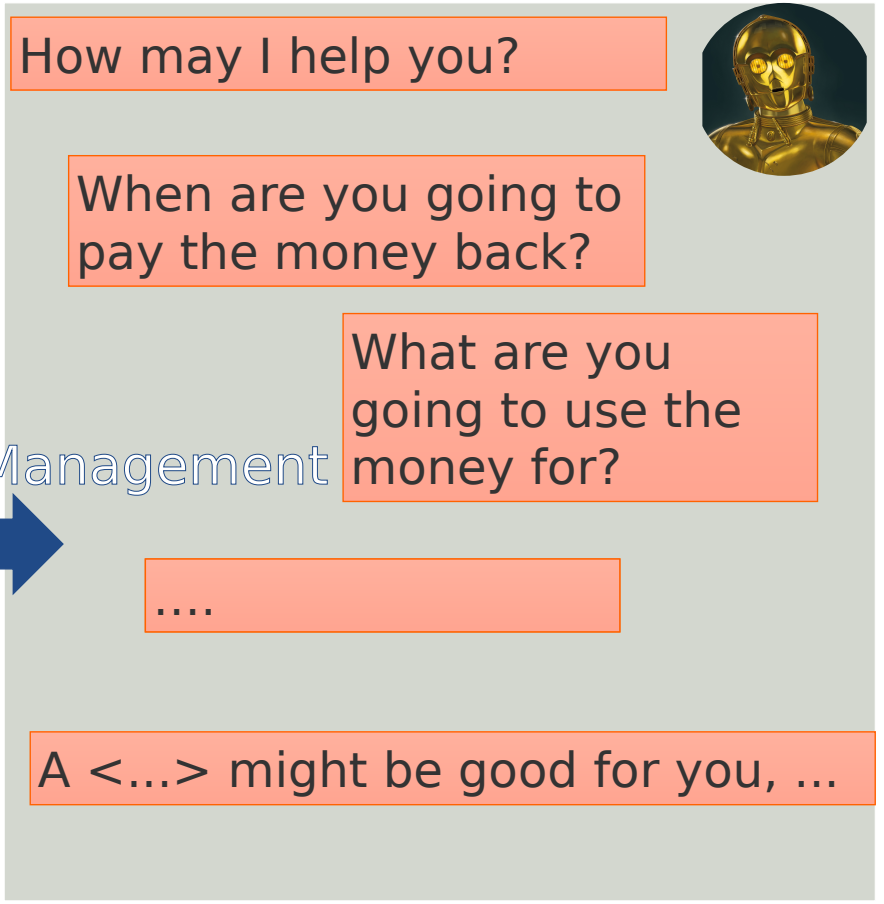
$$\text{Maximize} \sum_{t=0}^{t=T} \gamma^{t+1} r_t, \gamma \in [0,1]$$

Belief State Representation

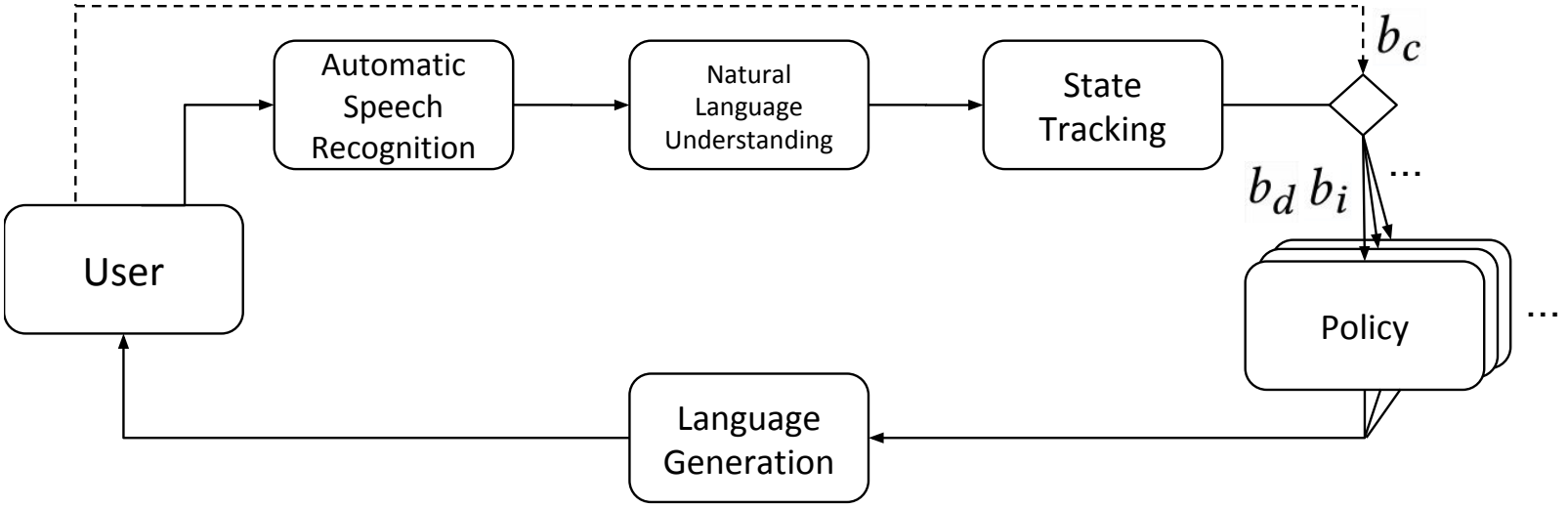
[young2007]



Dialogue Management

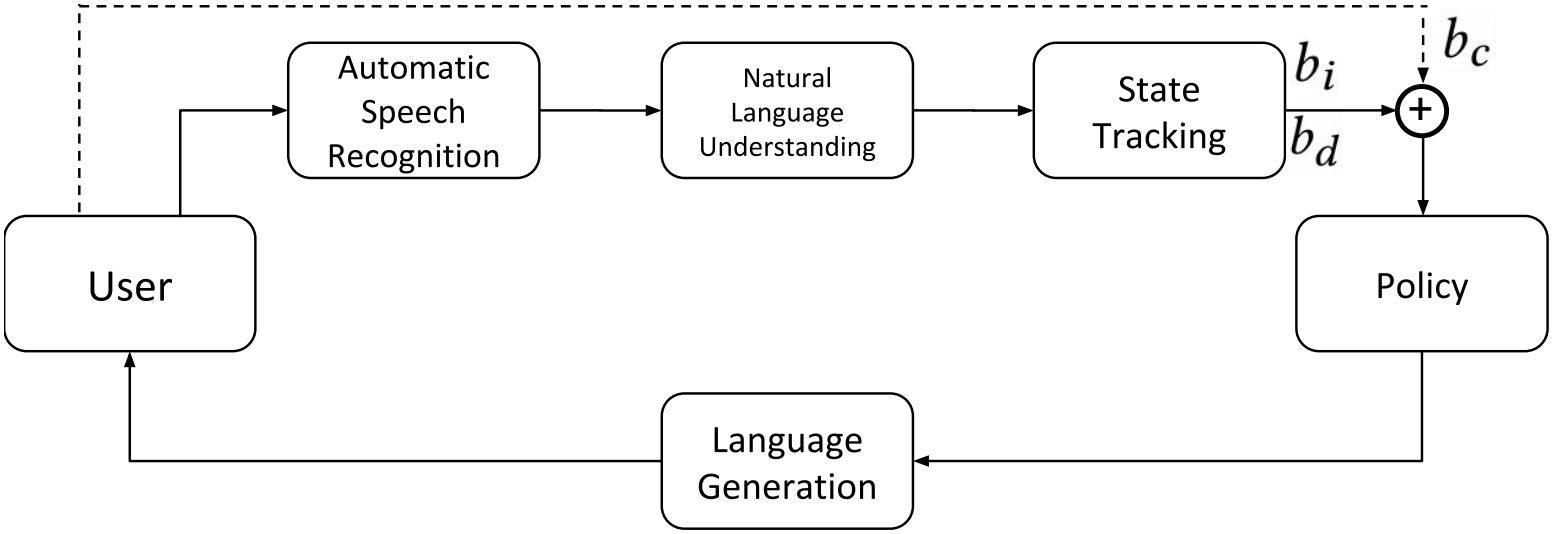


Segmentation-based Personalization



0. Maintain a belief over personal context
1. Segment users based on belief
2. Learn 1 DM policy per segment

Belief State-based Personalization



0. Maintain a belief over personal context
1. Include belief into DM policy input
2. Learn 1 DM policy across all users

Based on [ultes2017]

Experimental setup (1/2)

Recommendation scenarios

1. Restaurant 1
2. Restaurant 2
3. Laptop
4. Financial products

Reward based on task completion and # turns

Simulation

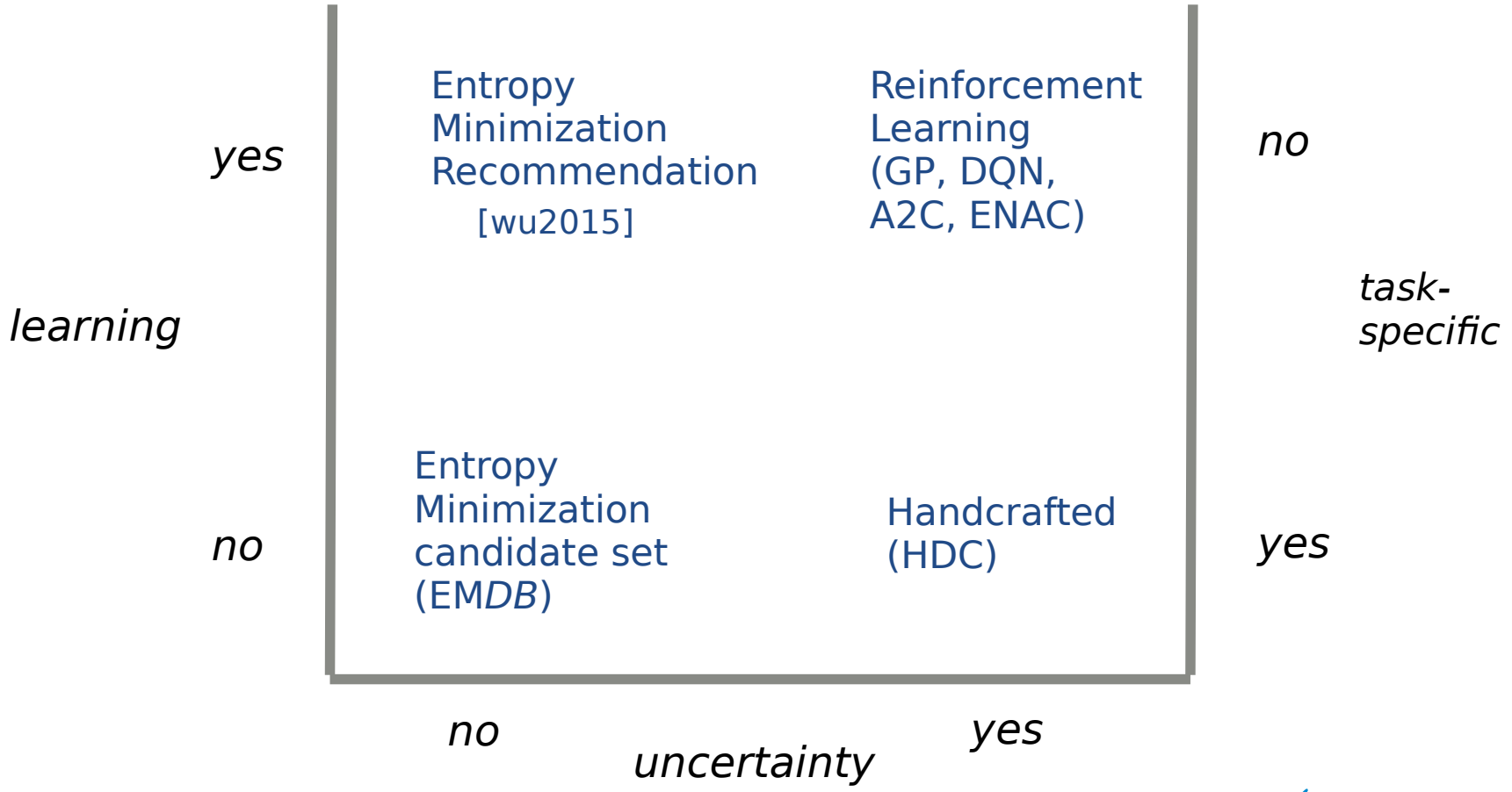
- different user behavior patterns 2
  1. Layperson
  2. Expert
- levels of S2T + NLU error .0, .15, .30
- total number of environments 24

Algorithms varying in

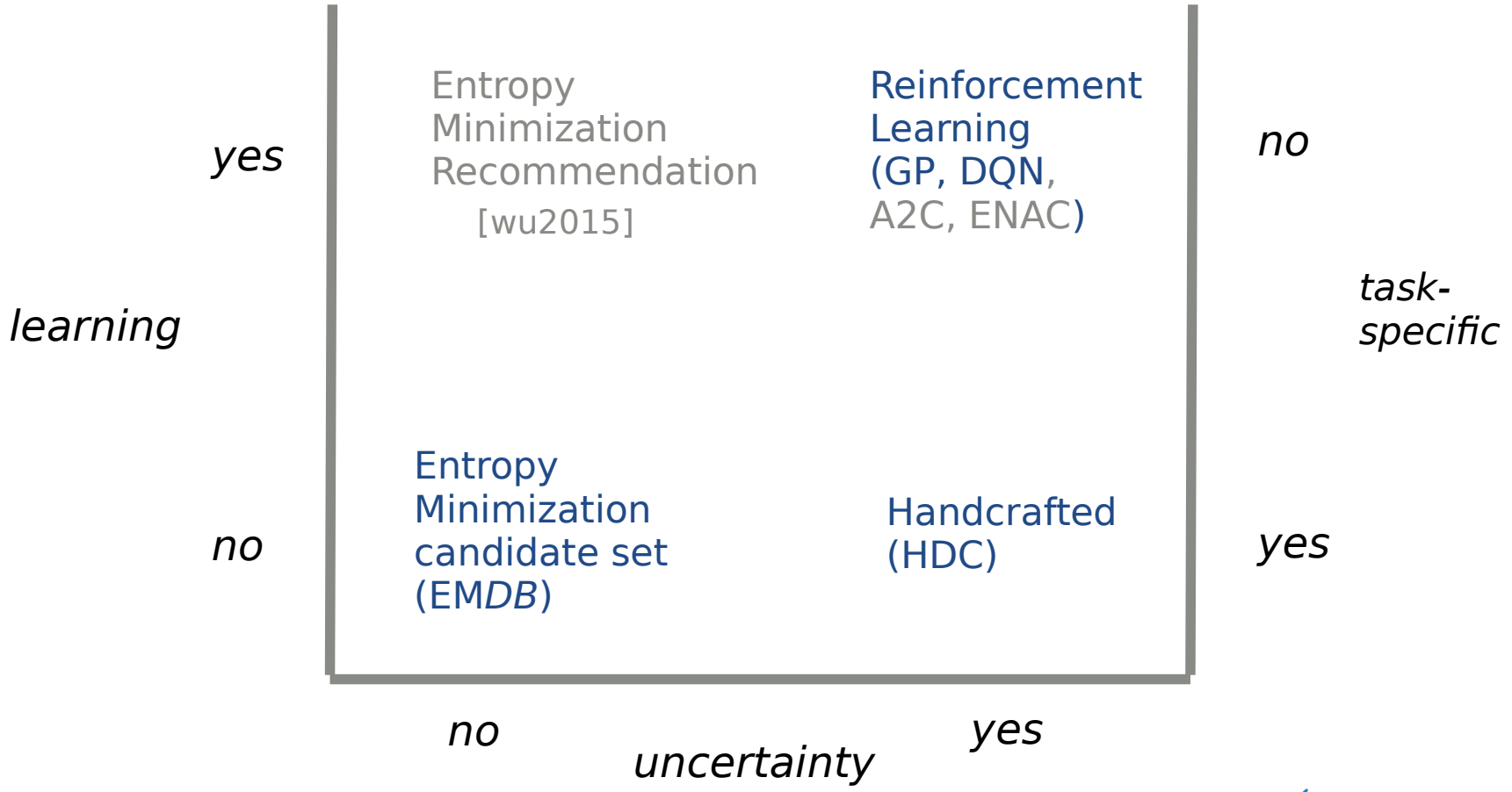
- Taking into account uncertainty
- Ability to learn from experience
- Using task-specific heuristics

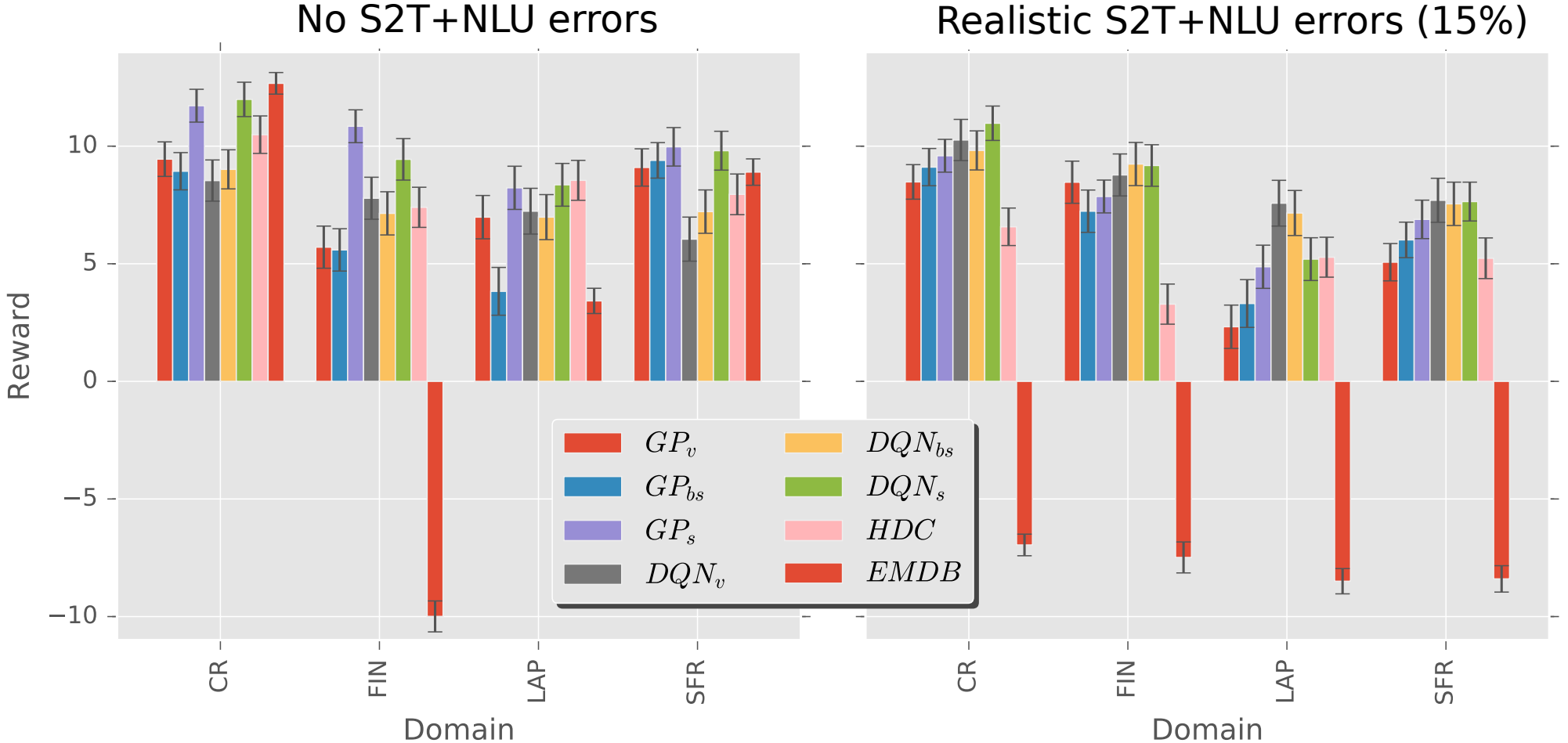
Total environment – algorithm pairs 384

Experimental setup (2/2)



Experimental setup (2/2)





Conclusions & Discussion

Take uncertainty into account

Learning approaches most robust to
- novel domain
- personalization setting

Personalized ≥ gold-standard handcrafted approach

Performance personalized approaches varies with
- environment
- algorithm
- available data

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Thank you

F.den.hengst@vu.nl

florisdh.nl/presentations/wi-2019.pdf

[ultes2017]

	hidden layer 1	hidden layer 2	ϵ
DQN	300	100	.5
A2C	200	75	.5
eNAC	130	50	.5

Personalizing DM

	[casanueva 2015]	[mo2018]	[genevay 2016]	This talk: segmentation based	This talk: belief-state based
Assumes pre-existing interactions with user		✓			
Assumes user similarity metric	✓			✓	
Small number of users			✓		
Assumes existing information on user	= personal context			✓	✓