

Motivation

An important yet unexplored aspect of end-to-end trained dialog systems is the **personalization** of the model's responses based on the profile of who it is interacting with. There are **no open datasets** for analyzing this problem.

Contributions

- **New dataset** of goal-oriented dialogs influenced by speaker profiles
- Modification to **Memory Network** architecture to handle personalization
- Analysis of personalization as a **multi-task learning** problem

User Profile
Gender: **Male**, Age: **Elderly**, Favorite Food Item: **Shepherd's Pie**

Hi!
Greetings Sir, what may I assist you with today?
I'd like to book a table for six people in an expensive price range with British food.
I will start the request now.
May I know where the restaurant should be located?
In London.
Excellent Sir, please give me a moment to provide you with options
api_call(British, London, Six, Expensive)
Actually i would prefer for four.
I will modify your request, is there anything else to change?
No.
Excellent Sir, please give me a moment to provide you with options
api_call(British, London, Four, Expensive)
The Place R_phone The Place phone
The Place R_cuisine british
The Place R_address The Place_address
The Place R_location london
The Place R_availability four
The Place R_price expensive
The Place R_rating 7
The Place R_speciality fish_and_chips
The Fancy Pub R_phone The Fancy_Pub_phone
The Fancy Pub R_cuisine british
The Fancy Pub R_address The Fancy_Pub_address
The Fancy Pub R_location london
The Fancy Pub R_availability four
The Fancy Pub R_price expensive
The Fancy Pub R_rating 8
The Fancy Pub R_speciality english_breakfast
May I suggest this option: The Fancy_Pub
No, I don't like that.
Excellent Sir, please give me a moment to provide you with options
May I suggest this option: The Place
Let's do it!
Excellent, I will finalize your request
Can you provide me the address?
Here is the information you asked for: The Place_address
You rock!
May I help you in any other way, Sir
No thanks.
It was a pleasure to be of help to you, Sir

User Profile
Gender: **Male**, Age: **Young**, Favorite Food Item: **Fish and Chips**

Hi!
Hey dude, what's up?
I'd like to book a table for six people in an expensive price range with British food.
I'm on it!
Where should it be?
In London.
Ok, looking for options
api_call(British, London, Six, Expensive)
Actually i would prefer for four.
Cool! Anything else you want to update?
No.
Ok, looking for options
api_call(British, London, Four, Expensive)
The Place R_phone The Place phone
The Place R_cuisine british
The Place R_address The Place_address
The Place R_location london
The Place R_availability four
The Place R_price expensive
The Place R_rating 7
The Place R_speciality fish_and_chips
The Fancy Pub R_phone The Fancy_Pub_phone
The Fancy Pub R_cuisine british
The Fancy Pub R_address The Fancy_Pub_address
The Fancy Pub R_location london
The Fancy Pub R_availability four
The Fancy Pub R_price expensive
The Fancy Pub R_rating 8
The Fancy Pub R_speciality english_breakfast
Is this one cool: The Place
No, I don't like that.
Ok, looking for options
Is this one cool: The Fancy_Pub
Let's do it!
Cool, its done!
Can you provide me the address?
Here you go: The Fancy_Pub_address
You rock!
Want anything else?
No thanks.
No problem!

Task 1 Issuing API calls
Task 2 Updating API calls
Task 3 Displaying Options
Task 4 Providing Extra Information
Task 5 Conducting Full Dialog

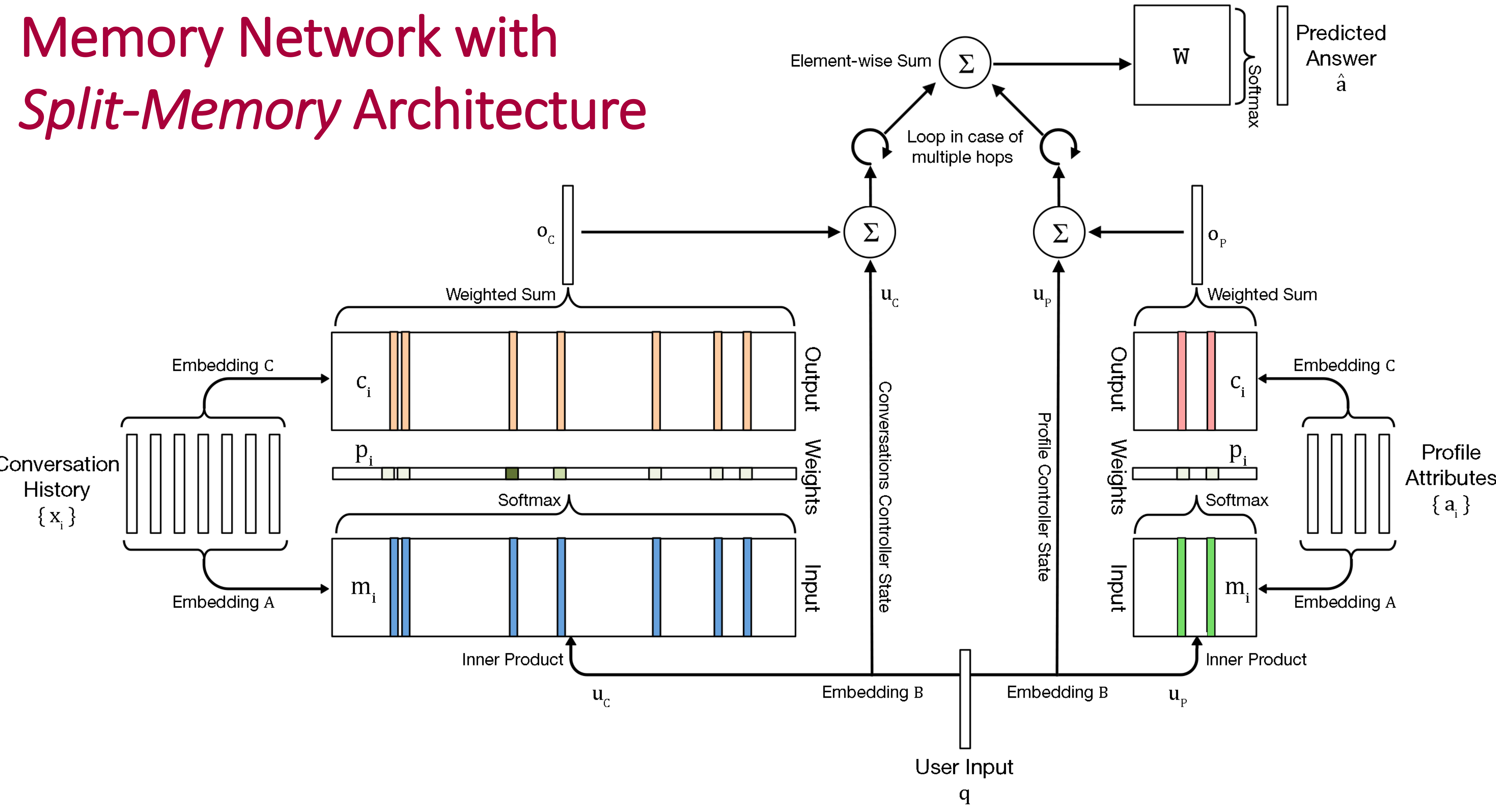
Personalized bAbI Dialog Dataset

We propose modifications to the bAbI dialog dataset by altering bot utterance patterns and KB entities. In addition to the goals of the original 5 tasks, the dialog system must read a user's profile:

1. **Alter speech style based on age and gender**
To test if model can form associations between language concepts (like formality or precision) and user attributes.
2. **Personalize suggestions based on dietary preference or favorite food item**
To test if model can perform reasoning, ranking and retrieval based on combination of user attributes and variable parameters from dialog.

Compared to bAbI dialogs, vocabulary size increased 4x and candidate set increased 10x.

Memory Network with Split-Memory Architecture



Results

Per-response accuracy on our tasks:

Task	Memory Network	Split-Memory Architecture
PT1	99.8	85.6
PT2	99.9	93.4
PT3	58.9	68.6
PT4	57.1	57.1
PT5	85.1	87.3

- Memory Network is able to track dialog state and personalizer speech style (PT1-2).
- *Split-memory* architecture is worse at simpler tasks (PT1-2) but improves accuracy on personalized reasoning tasks (PT3-5).
- Both mix up embeddings of KB entities.

Comparison of Attention Weights

- Split-memory* model is:
- Able to attend to and reason using user's profile in more meaningful ways
 - Better at interpreting facts and context from conversation history.

Time	Locutor	Dialog History	Standard Model			Split Memory Model		
			Hop #1	Hop #2	Hop #3	Hop #1	Hop #2	Hop #3
		Profile						
		female				0.011	0.571	0
		young				0.017	0.423	0
		non-veg	0.0001	0	0	0.442	0.006	0.999
		pizza				0.53	0	0
19	User	resto_rome_moderate_italian_8stars_1_R_rating 8	0.0001	0	0	0.0001	0	0
20	User	resto_rome_moderate_italian_8stars_1_R_type veg	0	0	0	0	0	0
21	User	resto_rome_moderate_italian_8stars_1_R_speciality pizza	0	0	0	0.0002	0	0
23	User	resto_rome_moderate_italian_8stars_1_R_parking	0	0	0	0.0127	0	0
29	User	resto_rome_moderate_italian_3stars_1_R_location Rome	0.879	0.999	0	0	0	0
31	User	resto_rome_moderate_italian_3stars_1_R_rating 3	0	0	0	0	0	0
33	User	resto_rome_moderate_italian_3stars_1_R_type veg	0.0001	0	0	0	0	0
43	User	resto_rome_moderate_italian_2stars_2_R_rating 2	0	0	0	0	0	0
44	User	resto_rome_moderate_italian_2stars_2_R_type non-veg	0.0001	0	0	0	0	0
45	User	resto_rome_moderate_italian_2stars_2_R_speciality pasta	0	0	0	0	0	0
51	User	resto_rome_moderate_italian_2stars_1_R_address	0	0	0	0.0184	0	0
73	User	hi	0	0	0	0.0002	0	0
74	Bot	hey girl how is it going	0	0	0	0.0006	0	0
75	User	may i have a table in rome with italian food in a moderate price range	0	0	0	0.0022	0	0
76	Bot	be right back with your reservation	0	0	0	0	0	0
80	Bot	sure finding some options	0	0	0	0.0002	0.0002	0.999
81	User	<SILENCE>	0	0	0	0.0008	0	0
82	Bot	how about this one: resto_rome_moderate_italian_8stars_2	0	0	0	0.3872	0.003	0
83	User	no i don't like that	0	0	0	0	0	0
84	Bot	sure finding something else	0	0	0	0.0001	0	0
85	User	<SILENCE>	0.0003	0	0	0.001	0	0
86	Bot	how about this one: resto_rome_moderate_italian_3stars_2	0	0	0	0.4834	0.9968	0
87	User	no i don't like that	0	0	0	0	0	0
88	Bot	sure finding something else	0	0	0	0.0001	0	0
	User Input	<SILENCE>						
	Answer	(Correct) how about this one: resto_rome_moderate_italian_8stars_1						
			what food are you looking for			how about this one: resto_paris_cheap_italian_2star_1		

Multi-task Learning

We compared 6 profile-specific Memory Network models trained on 1000 full dialogs each to a multi-profile model trained on 6000 full dialogs containing all 6 profiles (PT5).

Average per-response accuracy over 6 test sets of 1000 profile-specific dialogs:

Profile-specific: **80.3%** vs Multi-profile: **85.1%**

Better performance due to **learning shared features** among 6 user profiles:

Time	Locutor	Dialog History	Multi-profile model	Profile-specific model
1		female middle-aged non-veg pizza	0.044	0
2	User	good morning	0.397	0
3	Bot	hello maam how can i help you	0.005	0.012
4	User	can you make a restaurant reservation for two people in bombay with italian cuisine	0.533	0.987
5	Bot	give me a second for processing the reservation	0	0
	User Input	<SILENCE>		
	Correct answer	which price range are you looking for		
	Predicted answer	which price range are you looking for (for both models)		