

A Appendices

A.1 Data Statistics

As shown in Table 5, there are 30 (*domain, slot*) pairs on MultiWOZ (Budzianowski et al., 2018) dataset, including 10 slots in the *hotel* domain, 6 slots in the *train* domain, 3 slots in the *attraction* domain, 7 slots in the *restaurant* domain, and 4 slots in the *taxi* domain. *hotel* and *restaurant* domains, in particular, have the most dialogues in the dataset. *Taxi* domain, on the other hand, is the one with less data.

	Hotel	Train	Attraction	Restaurant	Taxi
Slots	price, type, parking, stay, day, people, area, stars, internet, name	destination, departure, day, arrive by, leave at, people	area, name, type	food, price, area, name, time, day, people	destination, departure, arrive by, leave at
Train	3381	3103	2717	3813	1654
Dev	416	484	401	438	207
Test	394	494	395	437	195

Table 5: In total, there are 30 (*domain, slot*) pairs from the selected five domains on MultiWOZ. The numbers in the last three rows indicate the number of dialogues.

	Dialogue History
100% Data	<p>hi i need to take a train from cambridge , i need to arrive at my destination by 17:00 and ; okay , what day did you have in mind ? ; i would like to leave on saturday . ; what station would you like to arrive at ? ; i need to get to norwich please . ;</p>
1% Data w/o SSL	<p>; hi hi need to take a train from cambridge , i need to arrive at my destination by 17:00 and ; okay , what day did you have in mind ? ; i would like to leave on saturday . ; what station would you like to arrive at ? ; i need to get to norwich please . ;</p>
1% Data w/ SSL	<p>hi ; i need to take a train from cambridge , i need to arrive at my destination by 17:00 and ; okay , what day did you have in mind ? ; i would like to leave on saturday . ; what station would you like to arrive at ? ; i need to get to norwich please . ;</p>

Figure 6: Attention Visualization

	Dialogue History
100% Data	<p>hi ; hello , i would like to find a hotel that include -s free parking . ; most of the hotel -s in town offer free parking . is there a certain area you would like to stay in , or do you have a price range in mind ? ; yes . the centre would be nice and also free wifi . ; the university arms is an expensive , 4 star hotel with free wifi . comparatively , the alexander bed and breakfast is a cheap -ly priced guesthouse , also 4 stars . ; please book me some rooms for the university arms to accommodate 8 people for 3 nights starting on wednesday . can you also provide me the reference number after you book ? ; your reference number is x5ny66zv . ; thank you . can you please help me find a place to go in town in the same area as the hotel ? preferably a college . ; there are no colleges close to the area you are requesting , would you like to chose another destination ? ; i believe there are some colleges in the centre of town . can you please check again ? ; i am sorry but i rechecked and there are no colleges in that area . is there anything else that i can do for you ? ; hmmm , i was looking for the phone number and postcode of a college in the centre area . could you help me with that ? ; i have 5 colleges in the centre area . what specific college are you looking for ? ; i am looking for cambridge . ; i am sorry , there are no listings for cambridge college in the centre area . is there another college you would like me to look for ? ; oh , it could be anyone then . just a college . ;</p>
1% Data w/o SSL	<p>; hi hi hello , i would like to find a hotel that include -s free parking . ; most of the hotel -s in town offer free parking . is there a certain area you would like to stay in , or do you have a price range in mind ? ; yes . the centre would be nice and also free wifi . ; the university arms is an expensive , 4 star hotel with free wifi . comparatively , the alexander bed and breakfast is a cheap -ly priced guesthouse , also 4 stars . ; please book me some rooms for the university arms to accommodate 8 people for 3 nights starting on wednesday . can you also provide me the reference number after you book ? ; your reference number is x5ny66zv . ; thank you . can you please help me find a place to go in town in the same area as the hotel ? preferably a college . ; there are no colleges close to the area you are requesting , would you like to chose another destination ? ; i believe there are some colleges in the centre of town . can you please check again ? ; i am sorry but i rechecked and there are no colleges in that area . is there anything else that i can do for you ? ; hmmm , i was looking for the phone number and postcode of a college in the centre area . could you help me with that ? ; i have 5 colleges in the centre area . what specific college are you looking for ? ; i am looking for cambridge . ; i am sorry , there are no listings for cambridge college in the centre area . is there another college you would like me to look for ? ; oh , it could be anyone then . just a college . ;</p>
1% Data w/ SSL	<p>hi ; hello , i would like to find a hotel that include -s free parking . ; most of the hotel -s in town offer free parking . is there a certain area you would like to stay in , or do you have a price range in mind ? ; yes . the centre would be nice and also free wifi . ; the university arms is an expensive , 4 star hotel with free wifi . comparatively , the alexander bed and breakfast is a cheap -ly priced guesthouse , also 4 stars . ; please book me some rooms for the university arms to accommodate 8 people for 3 nights starting on wednesday . can you also provide me the reference number after you book ? ; your reference number is x5ny66zv . ; thank you . can you please help me find a place to go in town in the same area as the hotel ? preferably a college . ; there are no colleges close to the area you are requesting , would you like to chose another destination ? ; i believe there are some colleges in the centre of town . can you please check again ? ; i am sorry but i rechecked and there are no colleges in that area . is there anything else that i can do for you ? ; hmmm , i was looking for the phone number and postcode of a college in the centre area . could you help me with that ? ; i have 5 colleges in the centre area . what specific college are you looking for ? ; i am looking for cambridge . ; i am sorry , there are no listings for cambridge college in the centre area . is there another college you would like me to look for ? ; oh , it could be anyone then . just a college . ;</p>

Figure 7: Attention Visualization

	1%	5%	10%	25%
TRADE (w/o Ont.)	10.35 (12.58)	27.70 (31.17)	32.61 (36.18)	38.46 (42.71)
+ Consistency	13.77 (15.58)	27.95 (31.89)	33.64 (37.40)	40.06 (43.45)
+ Behavior	18.69 (22.10)	29.95 (34.30)	34.57 (38.43)	39.42 (42.45)
Consistency + Behavior	19.50 (21.90)	30.59 (35.13)	34.50 (38.12)	40.15 (43.40)

Table 6: Semi-supervised learning joint goal accuracy (and its fuzzy matching version in parentheses) on MultiWOZ-2.1 test set from 1% to 25% training data.

	Dialogue History
100% Data	<p>hi i need a train leaving king s lynn after 13:45 . ; what day will you be traveling ? ; this will be for wednesday . ; there is tr9057 which is at 9.80 pounds and takes 47 minutes . will you book that ? ; no that will not be necessary . can you just tell me what the arrival time is ? ; no train leaving kings lynn at 13.45 . do you want to change the departure time ? ; i can leave any time after 13:45 going to cambridge . will you check the schedule again , please ? ; sorry , there are actually 10 entries here . shall i book 1 for you ? ; just the first departure after 13:45 please , no booking , just the price and arrival time . ; tr8143 will cost 9.80 pounds and arrives by 14:58 . anything else i can do for you ? ; i also need to find a place to stay . ; what area of town would you like to be in ? ; it doesnt matter . i just want it to be a cheap guesthouse with wifi included . ; i can recommend the allenbell . it s in the east , is cheap yet has a 4 star rating and free wifi and parking . can i help you book ? ; no i just need the phone number . thanks ;</p>
1% Data w/o SSL	<p>hi i need a train leaving king s lynn after 13:45 . ; what day will you be traveling ? ; this will be for wednesday . ; there is tr9057 which is at 9.80 pounds and takes 47 minutes . will you book that ? ; no that will not be necessary . can you just tell me what the arrival time is ? ; no train leaving kings lynn at 13.45 . do you want to change the departure time ? ; i can leave any time after 13:45 going to cambridge . will you check the schedule again , please ? ; sorry , there are actually 10 entries here . shall i book 1 for you ? ; just the first departure after 13:45 please , no booking , just the price and arrival time . ; tr8143 will cost 9.80 pounds and arrives by 14:58 . anything else i can do for you ? ; i also need to find a place to stay . ; what area of town would you like to be in ? ; it doesnt matter . i just want it to be a cheap guesthouse with wifi included . ; i can recommend the allenbell . it s in the east , is cheap yet has a 4 star rating and free wifi and parking . can i help you book ? ; no i just need the phone number . thanks ;</p>
1% Data w/ SSL	<p>hi ; i need a train leaving king s lynn after 13:45 . ; what day will you be traveling ? ; this will be for wednesday . ; there is tr9057 which is at 9.80 pounds and takes 47 minutes . will you book that ? ; no that will not be necessary . can you just tell me what the arrival time is ? ; no train leaving kings lynn at 13.45 . do you want to change the departure time ? ; i can leave any time after 13:45 going to cambridge . will you check the schedule again , please ? ; sorry , there are actually 10 entries here . shall i book 1 for you ? ; just the first departure after 13:45 please , no booking , just the price and arrival time . ; tr8143 will cost 9.80 pounds and arrives by 14:58 . anything else i can do for you ? ; i also need to find a place to stay . ; what area of town would you like to be in ? ; it doesnt matter . i just want it to be a cheap guesthouse with wifi included . ; i can recommend the allenbell . it s in the east , is cheap yet has a 4 star rating and free wifi and parking . can i help you book ? ; no i just need the phone number . thanks ;</p>

Figure 8: Attention Visualization

	Dialogue History
100% Data	<p>hi hey i am looking for a train from cambridge to bishops stortford . mind helping out ? ; many trains are leaving on friday . mind choosing the time ? ; i want to leave on monday and arrive by 18:45 . ; i have train tr4283 that leaves cambridge at 5:29 and arrives in bishops stortford at 6:07 . would you like to make reservations ? ; could you give me the travel time and price of that train please ? ; the cost is 10.10 pounds . the duration of the trip is 38 minutes , leaving cambridge at 5:29 and arriving at 6:07 in bishops stortford . ; i also want a cheap chinese restaurant . ; there are 4 great restaurant -s to choose from . do you prefer 1 on the south side of town or in the centre ? ; i would like to be in the centre please . ; i recommend charlie chan . would you like to reserve a table ? ; yes . monday , 8 people , 10:30 . ;</p>
1% Data w/o SSL	<p>hi hey i am looking for a train from cambridge to bishops stortford . mind helping out ? ; many trains are leaving on friday . mind choosing the time ? ; i want to leave on monday and arrive by 18:45 . ; i have train tr4283 that leaves cambridge at 5:29 and arrives in bishops stortford at 6:07 . would you like to make reservations ? ; could you give me the travel time and price of that train please ? ; the cost is 10.10 pounds . the duration of the trip is 38 minutes , leaving cambridge at 5:29 and arriving at 6:07 in bishops stortford . ; i also want a cheap chinese restaurant . ; there are 4 great restaurant -s to choose from . do you prefer 1 on the south side of town or in the centre ? ; i would like to be in the centre please . ; i recommend charlie chan . would you like to reserve a table ? ; yes . monday , 8 people , 10:30 . ;</p>
1% Data w/ SSL	<p>hi ; hey i am looking for a train from cambridge to bishops stortford . mind helping out ? ; many trains are leaving on friday . mind choosing the time ? ; i want to leave on monday and arrive by 18:45 . ; i have train tr4283 that leaves cambridge at 5:29 and arrives in bishops stortford at 6:07 . would you like to make reservations ? ; could you give me the travel time and price of that train please ? ; the cost is 10.10 pounds . the duration of the trip is 38 minutes , leaving cambridge at 5:29 and arriving at 6:07 in bishops stortford . ; i also want a cheap chinese restaurant . ; there are 4 great restaurant -s to choose from . do you prefer 1 on the south side of town or in the centre ? ; i would like to be in the centre please . ; i recommend charlie chan . would you like to reserve a table ? ; yes . monday , 8 people , 10:30 . ;</p>

Figure 9: Attention Visualization