

Velocidapter: Task-oriented Dialogue Comprehension Modeling Pairing Synthetic Text Generation with Domain Adaptation

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Can current MRC models comprehend task-oriented dialogues?

Motivation:

- We collaborate on common tasks daily through conversation:
 - Email Threads, Nurse-patient conversations, customer service chat
- Current MRC models focus on → **Written forms** of text:
 - News articles, Wikipedia articles, etc.

There is no dialogue comprehension data to adapt these models.

#1 → Annotate slots within a DST dataset with a few questions to build a TOD comprehension dataset.

TOD Comprehension - Challenges

U1: Hi I would like a British food restaurant in the *centre*.

S1: Sure, do you have a preference over the price range?

U2: Only the best for my family, we'll take the *expensive* one. Book us a table for 5 at 14:00 today.

S2: Sorry, I am afraid there is no such place, shall we try another cuisine?

U3: Let's try Italian instead.

S3: Caffe Uno is a very nice, expensive Italian restaurant in the center. Would you like a table?

U4: Actually, I think I will stick with *British* food.

S4: *Fitzbillies Restaurant* is an expensive place centrally located and serves British.

U5: Can you book me a table for Thursday for 5 people at *13:00*?

S5: Your reservation at Fitzbillies Restaurant is successful for 5 people at 13:00 today. Anything else I can help you with?

U6: No, that's all I need. Thanks for your help!

Q1: What type of food does the user want to have?

A1: *British*

Q2: What part of town is the restaurant located at?

A2: *Centre*

Q3: What is the preferred price range of the user?

A3: *Expensive*

Q4: What time is the reservation for?

A4: *13:00*

Q5: What is the name of the booked restaurant?

A5: *Fitzbillies Restaurant*

Mind Change

U1: Hi I would like a British food restaurant in the *centre*.

S1: Sure, do you have a preference over the price range?

U2: Only the best for my family, we'll take the *expensive* one. Book us a table for 5 at 14:00 today.

S2: Sorry, I am afraid there is no such place, shall we try another cuisine?

U3: Let's try **Italian** instead.

S3: Caffe Uno is a very nice, expensive Italian restaurant in the center. Would you like a table?

U4: Actually, I think I will stick with *British* food.

S4: *Fitzbillies Restaurant* is an expensive place centrally located and serves British.

U5: Can you book me a table for Thursday for 5 people at *13:00*?

S5: Your reservation at Fitzbillies Restaurant is successful for 5 people at 13:00 today. Anything else I can help you with?

U6: No, that's all I need. Thanks for your help!

Q1: What type of food does the user want to have?

A1: *British*

Q2: What part of town is the restaurant located at?

A2: *Centre*

Q3: What is the preferred price range of the user?

A3: *Expensive*

Q4: What time is the reservation for?

A4: *13:00*

Q5: What is the name of the booked restaurant?

A5: *Fitzbillies Restaurant*

Topic Drift

U1: Hi I would like a British food restaurant in the *centre*.

S1: Sure, do you have a preference over the price range?

U2: Only the best for my family, we'll take the *expensive* one. Book us a table for 5 at 14:00 today.

S2: Sorry, I am afraid *there is no table* available. Shall we try another cuisine?

U3: Let's try Italian instead.

S3: Caffe Uno is a very nice, expensive Italian restaurant in the center. Would you like a table?

U4: Actually, I think I will stick with *British* food.

S4: *Fitzbillies Restaurant* is an expensive place centrally located and serves British.

U5: Can you book me a table for Thursday for 5 people at *13:00*?

S5: Your reservation at Fitzbillies Restaurant is successful for 5 people at 13:00 today. Anything else I can help you with?

U6: No, that's all I need. Thanks for your help!

Price

Date & Time

Q1: What type of food does the user want to have?

A1: *British*

Q2: What part of town is the restaurant located at?

A2: *Centre*

Q3: What is the preferred price range of the user?

A3: *Expensive*

Q4: What time is the reservation for?

A4: *13:00*

Q5: What is the name of the booked restaurant?

A5: *Fitzbillies Restaurant*

Zero Anaphora

U1: Hi I would like a British food restaurant in the *centre*.

S1: Sure, do you have a preference over the price range?

U2: Only the best for my family, we'll take the *expensive* one. Book us a table for 5 at 14:00 today.

S2: Sorry, I am afraid there is no such place, shall we try another cuisine?

U3: Let's try Italian instead.

S3: Caffe Uno is a very nice, expensive Italian restaurant in the center. Would you like a table?

U4: Actually, I think I will stick with *British* food.

S4: *Fitzbillies Restaurant* is an expensive place centrally located and serves British.

U5: Can you book me a table for Thursday for 5 people at *13:00*?

@Fitzbillies

S5: Your reservation at *Fitzbillies Restaurant* is successful for 5 people at 13:00 today. Anything else I can help you with?

U6: No, that's all I need. Thanks for your help!

Q1: What type of food does the user want to have?

A1: *British*

Q2: What part of town is the restaurant located at?

A2: *Centre*

Q3: What is the preferred price range of the user?

A3: *Expensive*

Q4: What time is the reservation for?

A4: *13:00*

Q5: What is the name of the booked restaurant?

A5: *Fitzbillies Restaurant*

Over Explanation

U1: Hi I would like a British food restaurant in the *centre*.

S1: Sure, do you have a preference over the price range?

U2: **Only the best for my family,** we'll take the *expensive* one. Book us a table for 5 at 14:00 today.

S2: Sorry, I am afraid there is no such place, shall we try another cuisine?

U3: Let's try Italian instead.

S3: Caffe Uno is a very nice, expensive Italian restaurant in the center. Would you like a table?

U4: Actually, I think I will stick with *British* food.

S4: *Fitzbillies Restaurant* is an expensive place centrally located and serves British.

U5: Can you book me a table for Thursday for 5 people at *13:00*?

S5: Your reservation at Fitzbillies Restaurant is successful for 5 people at 13:00 today. Anything else I can help you with?

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Q1: What type of food does the user want to have?

A1: *British*

Q2: What part of town is the restaurant located at?

A2: *Centre*

Q3: What is the preferred price range of the user?

A3: *Expensive*

Q4: What time is the reservation for?

A4: *13:00*

Q5: What is the name of the booked restaurant?

A5: *Fitzbillies Restaurant*

Few-shot Scenario

How to adapt to emerging domains with only few dialogues?

#2 → Extract **chunks** from a few development dialogues then simulate larger datasets by combining them.

Velocidapter

Dialogue #1

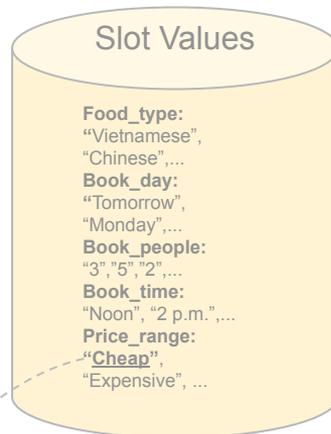
U: Hi I would like to eat **Vietnamese** food.
S: Sorry there are no restaurants that serves that in the town.
U: How about **Italian** food?
S: Yes plenty, Luigi's is an expensive restaurant you might like.
U: Book me a table for **3** people, **tomorrow 2 p.m.**
S: Sure thing, your table is booked.

Dialogue #2

U: I want to book a table for 2 tomorrow at 6 p.m.
anywhere in the south area.
S: What price range are we looking for?
U: Anything really.
S: There is an one **expensive** restaurant that is a fit.
U: Please go ahead and book it.
S: Your table is booked, enjoy your dinner!

Generated Dialogue

U: Hi I would like to eat **Chinese** food.
S: Sorry there are no restaurants that serves that in the town.
U: How about **Mexican** food?
S: What price range are we looking for?
U: Anything really.
S: There is one **cheap** restaurant that is a fit.
U: Book me a table for **5** people, **Monday 7 p.m.**
S: Sure thing, your table is booked.



- Corpus Construction.
- Dialogue Template Generation.
- Dialogue Corpus Generation.

Dialogue #1

U: Hi I would like to eat **Vietnamese** food.
S: Sorry there are no restaurants that serves that in the town.
U: How about **Italian** food?
S: Yes plenty, Luigi's is an expensive restaurant you might like.
U: Book me a table for **3** people, **tomorrow 2 p.m.**
S: Sure thing, your table is booked.

Dialogue #2

U: I want to book a table for 2 tomorrow at 6 p.m.
anywhere in the south area.
S: What price range are we looking for?
U: Anything really.
S: There is an one **expensive** restaurant that is a fit.
U: Please go ahead and book it.
S: Your table is booked, enjoy your meal.

Generated Dialogue

U: Hi I would like to eat **Chinese** food.
S: Sorry there are no restaurants that serves that in the town.
U: How about **Mexican** food?
S: What price range are we looking for?
U: Anything really.
S: There is one **cheap** restaurant that is a fit.
U: Book me a table for **5** people, **Monday 7 p.m.**
S: Sure thing, your table is booked.

Slot Values

Food_type:
"Vietnamese",
"Chinese", ...
Book_day:
"Tomorrow",
"Monday", ...
Book_people:
"3", "5", "2", ...
Book_time:
"Noon", "2 p.m.", ...
Price_range:
"**Cheap**",
"Expensive", ...

Corpus Construction

U1: Hello, I would like a british food restaurant in the **centre**.

S1: Sure, there are 7 restaurants. Do you have a preference for price?

U2: Only the best for my family .. we'll take an **expensive** one. Book us a table for 5 at 14:00 on Thursday.

S2: I'm sorry I am having difficulty making a reservation for you. Shall we try another time or restaurant type?

U3: Let's try Italian instead.

S3: Caffe Uno is a very nice, expensive Italian restaurant in the center of town. Would you like a table there?

U4: Actually, I change my mind. I think I want to stick with **British food** after all. Can you suggest any one that is in the centre of town?

S4: The Cambridge Chop House is centrally located and british but does not have a table for 5 available on Thursday at 14:00.

U5: Can you try there for **Thursday for 5 people at 13:00 instead?**

S5: Your reservation was successful. Your reference number is U6GV5ZZV. Is there anything else I can help you with today?

U6: No, that's all I need. Thanks for your help!

Corpus Construction

U1: Hello, I would like a british food restaurant in the **centre**.

S1: Sure, there are 7 restaurants. Do you have a preference for price?

U2: Only the best for my family .. we'll take an **expensive** one. Book us a table for 5 at 14:00 on Thursday.

S2: I'm sorry I am having difficulty making a reservation for you. Shall we try another time or restaurant type?

U3: Let's try Italian instead.

S3: Caffe Uno is a very nice, expensive Italian restaurant in the center of town. Would you like a table there?

U4: Actually, I change my mind. I think I want to stick with **British food** after all. Can you suggest any one that is in the centre of town?

S4: The Cambridge Chop House is centrally located and british but does not have a table for 5 available on Thursday at 14:00.

U5: Can you try there for **Thursday for 5 people at 13:00 instead?**

S5: Your reservation was successful. Your reference number is U6GV5ZZV. Is there anything else I can help you with today?

U6: No, that's all I need. Thanks for your help!

Discourse Template Construction

Request-Response templates are merely about information exchange through requests (either by system or user).

- + How many people are you reserving for?
- For *restaurant-bookpeople*.
- + Okay, does *restaurant-bookday* sound good?
- Yes, it should work.

Discourse Template Construction

Mind change

- + What cuisine would you like to try?
- Lets try *arbitrary-cuisine-type*.
- + Okay, sounds good.
- Sorry can I have **cuisine-type** instead?

- + Which part of city would you favor?
- The *arbitrary-city-area* is too far from my place, I think **city-area** would work the best.

Over explanation

Cross-utterance reasoning

- + What day are you planning to eat on?
- We will eat on the first day of holiday.
- + Okay, I will take note of that.
- So, that would be **restaurant-bookday**.

Discourse Template Construction

Mind change

- + What cuisine would you like to try?
- Lets try *arbitrary-cuisine-type*.
- + Okay, sounds good.
- Sorry can I have *cuisine-type* instead?

- + Which part of city would you favor?
- The *arbitrary-city-area* is too far from my place, I think *city-area* would work the best.

Over explanation

Cross-utterance reasoning

- + What day are you planning to eat on?
- We will eat on the first day of holiday.
- + Okay, I will take note of that.
- So, that would be *restaurant-bookday*.

Discourse Template Construction

Mind change

- + What cuisine would you like to try?
- Lets try *arbitrary-cuisine-type*.
- + Okay, sounds good.
- Sorry can I have *cuisine-type* instead?

- + Which part of city would you favor?
- The *arbitrary-city-area* is too far from my place, I think *city-area* would work the best.

Over explanation

Cross-utterance reasoning

- + What day are you planning to eat on?
- We will eat on the first day of holiday.
- + Okay, I will take note of that.
- So, that would be *restaurant-bookday*.

Dialogue Template Generation

1. Choose a salutation discourse template from the templates pool.

- Hello, I would like a ***cuisine-type*** food restaurant in the ***city-area***.

....

Dialogue Template Generation

1. Choose a salutation discourse template from the templates pool.
2. Choose a request-response template
 - a. If it has a recurring slot label ignore.
 - b. Otherwise add it to the dialogue.

- Hello, I would like a ***cuisine-type*** food restaurant in the ***city-area***.

+What would you like to have today?

- ***Cuisine-type*** food please

Dialogue Template Generation

1. Choose a salutation discourse template from the templates pool.
2. Choose a request-response template
 - a. If it has a recurring slot label ignore.
 -  b. Otherwise add it to the dialogue.

- Hello, I would like a **cuisine-type** food restaurant in the **city-area**.

+ How many people are you reserving for?

- For **restaurant-bookpeople**.

+ Okay, does **restaurant-bookday** sound good?

- Yes, it should work.

Dialogue Template Generation

1. Choose a salutation discourse template from the templates pool.
2. Choose a request-response template
 - a. If it has a recurring slot label ignore.
 - b. Otherwise add it to the dialogue.
3. Repeat 2 until a predetermined size is reached.

- Hello, I would like a **cuisine-type** food restaurant in the **city-area**.
+ How many people are you reserving for?
- For **restaurant-bookpeople**.
+ Okay, does **restaurant-bookday** sound good?
- Yes, it should work.
...

Dialogue Corpus Generation

- Hello, I would like a **mediterranean** food restaurant in the **south**.

+ How many people are you reserving for?

- For **3**.

+ Okay, does **Tuesday** sound good?

- Yes, it should work.

....

Cuisine-type : *What cuisine does the user want to eat?*

City-area: *Which part of the town does the user want to eat at?*

Restaurant-bookpeople: *How many people are there in the reservation?*

Restaurant-bookday: *What day is the reservation for?*

Experiments

MultiWOZ 2.1:

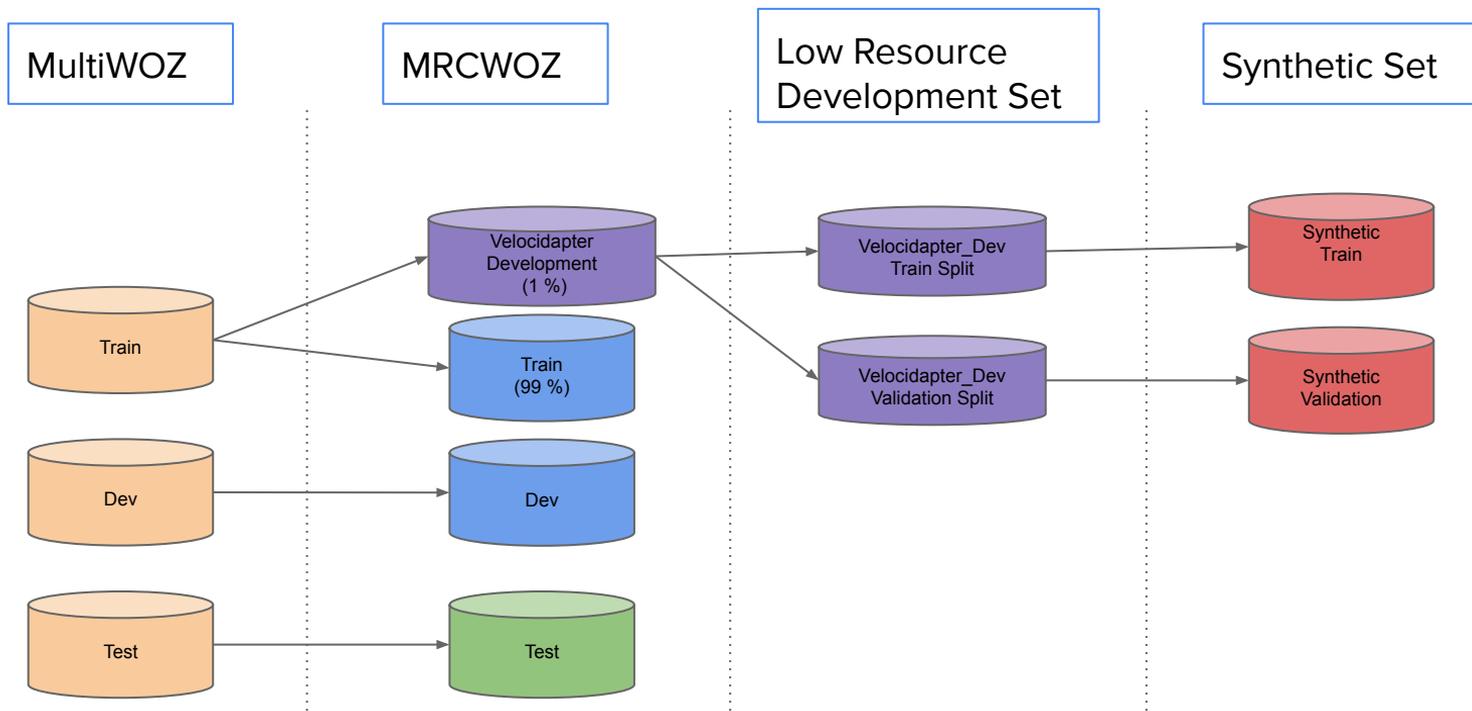
- DST dataset with dialogues from 7 domains.
- Each utterance pair is annotated with slot labels, belief states, and system acts.

Restaurant, hotel and taxi domains.

Each slot → list of few questions.

Match dialogues to questions, to get MRCWOZ.

Experiments



Dataset and models

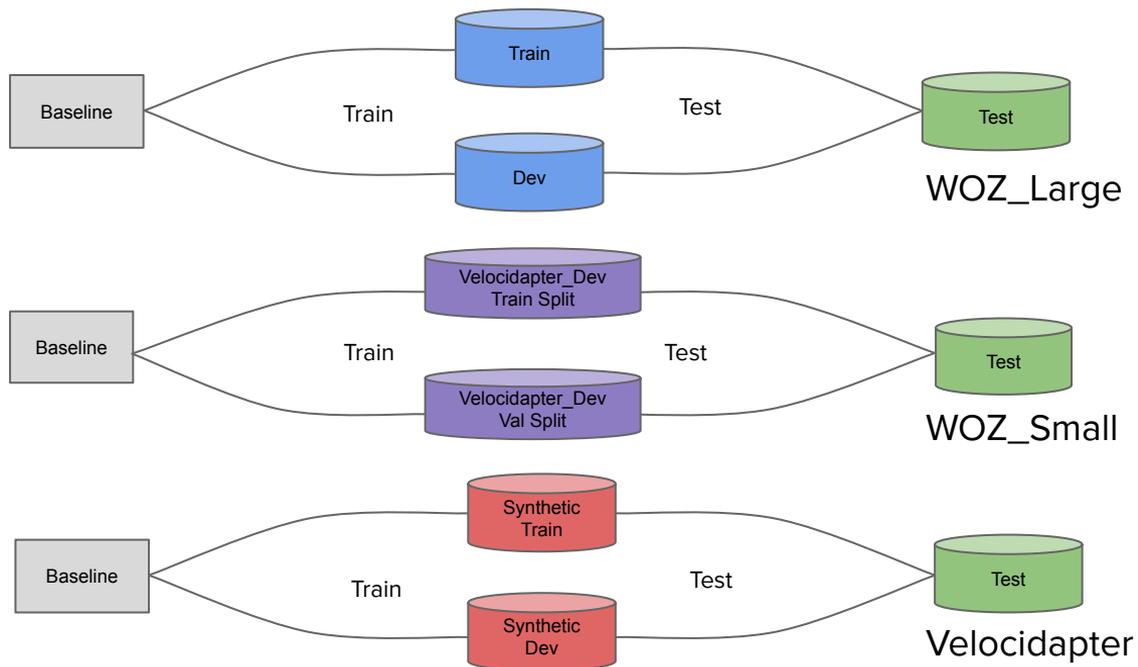
We conduct experiments on MRCWOZ:

- 2,409 dialogues in total.
- 8.92 turns on average per dialogue
- 12.2 tokens on average per turn.

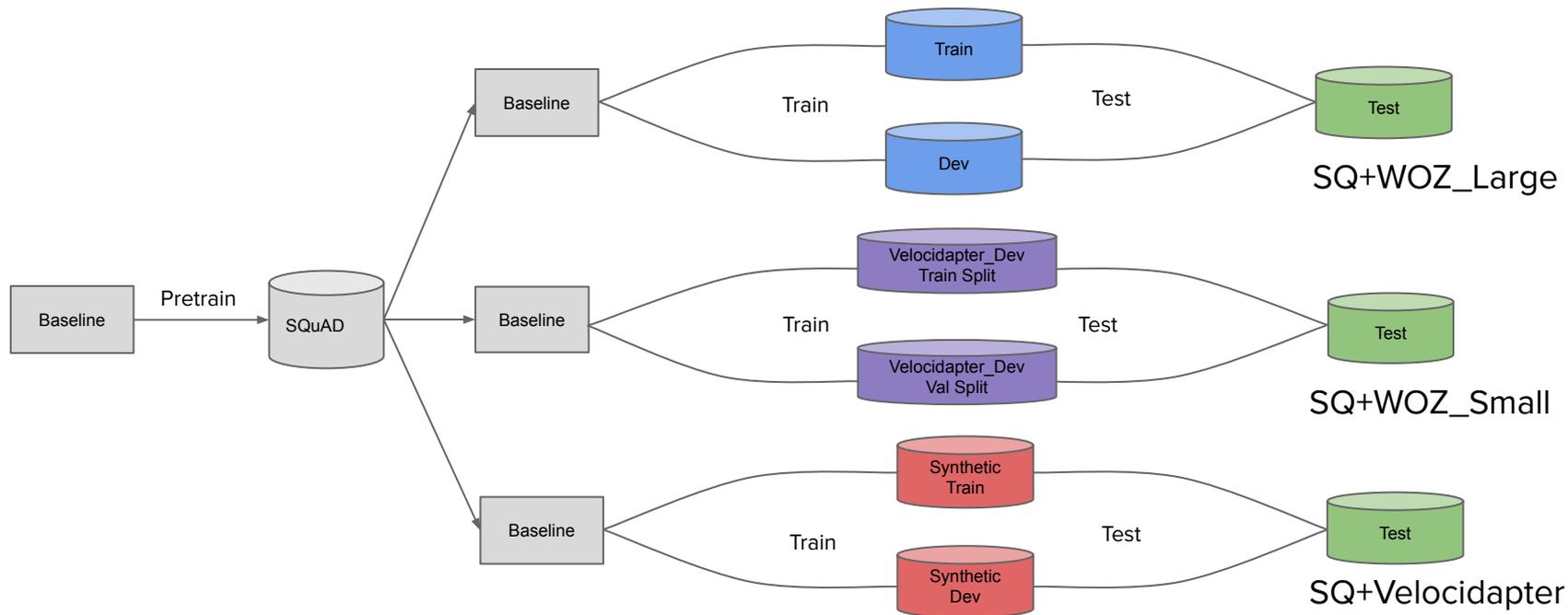
	Train		Test	
Domain	# Dial	# S-Q	# Dial	# S-Q
Hotel	650	2859	71	318
Restaurant	1250	4495	65	316
Taxi	321	965	52	157

1. BERT-Base
 - Transformer based language representation.
 - Large portion of experiments.
2. BiDAF
 - Hierarchical, both ways attention.
 - Demonstrating model agnostic feature.

Models



Fine-tuned Models



Results

Training Setting	Restaurant		Hotel		Taxi	
	F1	EM	F1	EM	F1	EM
High Resource						
WOZ_Large	<u>97.99</u>	<u>97.78</u>	94.99	94.63	<u>99.78</u>	<u>99.35</u>
SQ+WOZ_Large	97.27	96.51	<u>97.27</u>	<u>96.51</u>	98.18	97.43
Low Resource						
WOZ_Small	55.21	52.23	23.28	21.45	46.38	39.10
SQ+WOZ_Small	84.14	81.01	81.40	79.8	70.19	67.30
Velocidapter	70.46	66.77	80.45	78.54	64.24	62.17
SQ+Velocidapter	84.40	81.70	85.22*	84.85*	83.42*	81.40*
User Study						
SQ+Velocidapter	83.50	81.50	86.0*	84.80*	75.30*	70.0

(a) BERT-Base, all three domains.

Training Setting	Restaurant	
	F1	EM
High Resource		
WOZ_Large	97.93	<u>97.46</u>
SQ+WOZ_Large	<u>98.02</u>	<u>97.46</u>
Low Resource		
WOZ_Small	14.51	12.65
SQ+WOZ_Small	30.23	27.84
Velocidapter	22.93	21.20
SQ+Velocidapter	36.15*	31.64*

(b) BiDAF, restaurant domain.

Taxi Domain Error Analysis

Error type	SQ + WOZ_Small	SQ + Velocidapter
1. Partial value match	6	1
2. Value mismatch	28	7
3. Slot mismatch	7	5
4. Former value match	3	3
5. Overly long match	2	-
6*. Missing article "the"	3	21
7*. Capital letter mistakes	1	1
8*. Punctuation mistakes	1	9
9. Unrelated	3	2
Total	54	49

TOD Specific challenges

Minor Errors

Summary

1. Current MRC models focus on written forms of text and there is no data to adapt them for dialogue comprehension.

→ Capture DST task as dialogue comprehension by annotation a few questions for each slot: MRCWOZ.

2. How to adapt models to emerging domains with only a few dialogues.

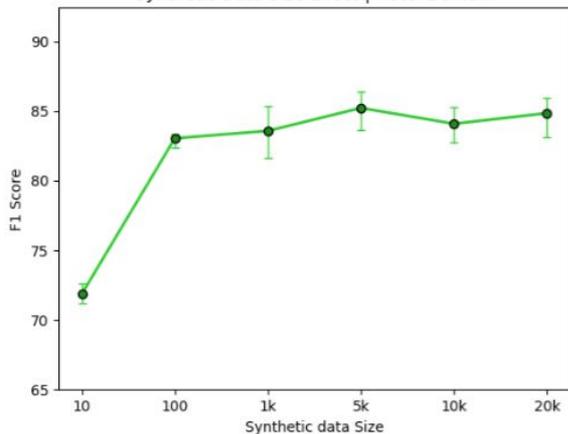
→ **Velocidapter**: Bring human in the loop to create magnitudes of larger datasets.

Future work:

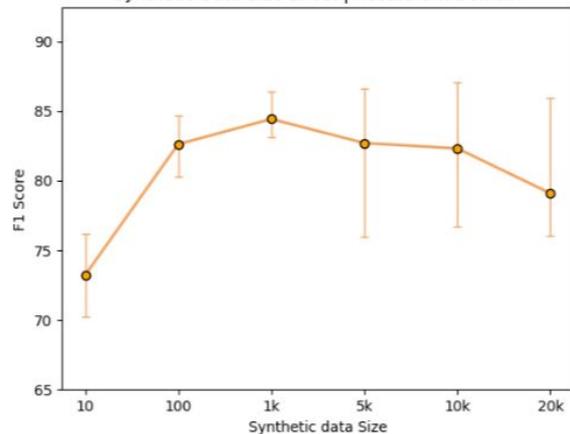
- Apply Velocidapter to other task-oriented dialogue problems.
- Automated extraction of dialogue chunks and template generation.

Synthetic Data Size Effect

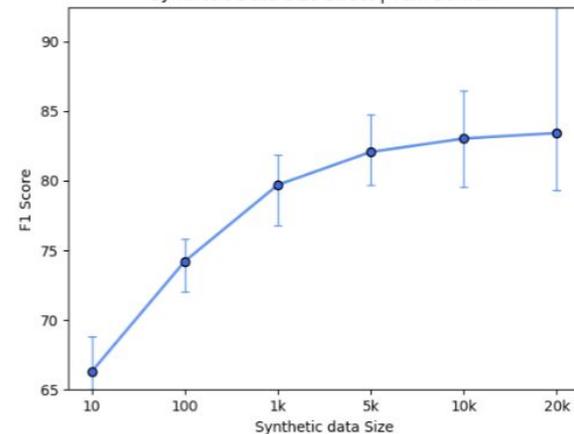
Synthetic Data Size Effect | Hotel Domain



Synthetic Data Size Effect | Restaurant Domain



Synthetic Data Size Effect | Taxi Domain



Slot Label-Value List Construction

Cuisine-type : Italian, barbeque, modern, mediterranean...

City-area: east, west, centre, north, south...

Restaurant-bookday: friday, monday, ...

Restaurant-bookpeople: 8, 7, 1, 5 ...

Slot Label-Question List Construction

Cuisine-type : “What cuisine does the user want to eat?”, ...

City-area: “Which part of the town does the user want to eat at?”, ...

Restaurant-bookday: “What day is the reservation for?”, ...

Restaurant-bookpeople: “How many people are there in the reservation?” ...