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!
**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 it is full. How about Sunday? 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 |
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?
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?
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** |
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.
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.

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!

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”, ...

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**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.

**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", ...
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!
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.

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.

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Discourse Template Construction

Mind change

+ What cuisine would you like to try?
- Let's 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.

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

+ 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.
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.

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

2. Choose a request-response template
   a. If it has a recurring slot label ignore.
   b. Otherwise add it to the dialogue.

   + 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.
...
- 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

MultiWOZ

Train
Dev
Test

MRCWOZ

Velocidapter Development (1 %)
Train (99 %)
Dev
Test

Low Resource Development Set

Velocidapter_Dev Train Split
Velocidapter_Dev Validation Split

Synthetic Set

Synthetic Train
Synthetic Validation
We conduct experiments on MRCWOZ:
- 2,409 dialogues in total.
- 8.92 turns on average per dialogue
- 12.2 tokens on average per turn.

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<thead>
<tr>
<th>Domain</th>
<th>Train</th>
<th>Test</th>
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<tbody>
<tr>
<td>Hotel</td>
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<td>71</td>
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<td>Restaurant</td>
<td>1250</td>
<td>65</td>
</tr>
<tr>
<td>Taxi</td>
<td>321</td>
<td>52</td>
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<table>
<thead>
<tr>
<th>Domain</th>
<th>Train</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel</td>
<td>2859</td>
<td>318</td>
</tr>
<tr>
<td>Restaurant</td>
<td>4495</td>
<td>316</td>
</tr>
<tr>
<td>Taxi</td>
<td>965</td>
<td>157</td>
</tr>
</tbody>
</table>

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

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Results

<table>
<thead>
<tr>
<th>Training Setting</th>
<th>Restaurant F1</th>
<th>Restaurant EM</th>
<th>Hotel F1</th>
<th>Hotel EM</th>
<th>Taxi F1</th>
<th>Taxi EM</th>
<th>Restaurant F1</th>
<th>Restaurant EM</th>
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<tbody>
<tr>
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<td>WOZ_Small</td>
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(a) BERT-Base, all three domains.

(b) BiDAF, restaurant domain.
## Taxi Domain Error Analysis

<table>
<thead>
<tr>
<th>Error type</th>
<th>SQ + WOZ_Small</th>
<th>SQ + Velocidapter</th>
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<tbody>
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<td>1. Partial value match</td>
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<td>2. Value mismatch</td>
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<td>3. Slot mismatch</td>
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<td>5. Overly long match</td>
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<td>7*. Capital letter mistakes</td>
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<td>8*. Punctuation mistakes</td>
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<td>9. Unrelated</td>
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<td><strong>Total</strong></td>
<td><strong>54</strong></td>
<td><strong>49</strong></td>
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### 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
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?” ...