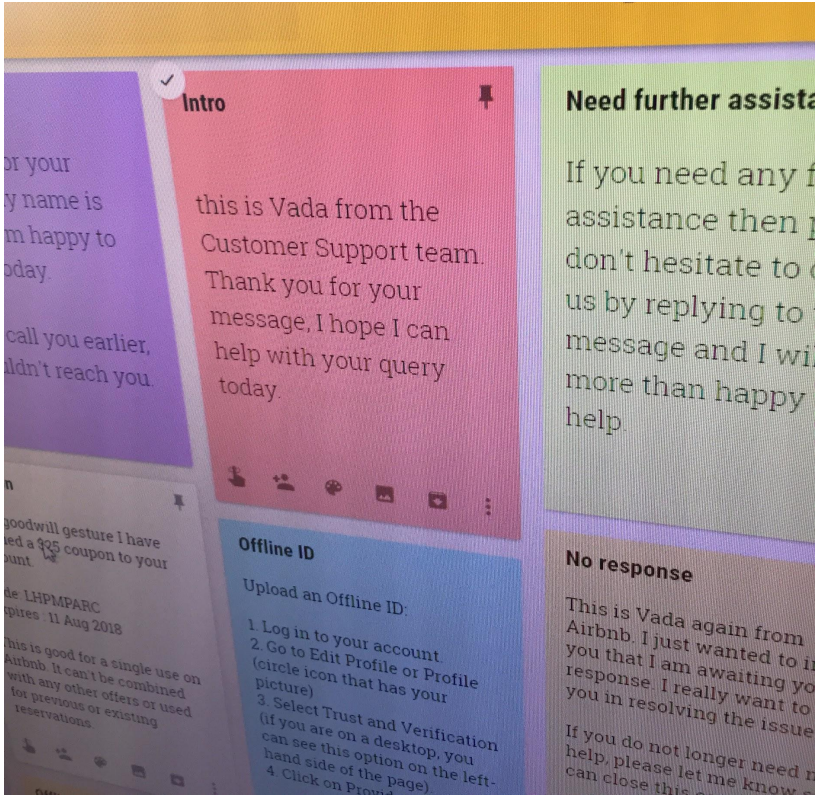
CINDY CHEN / APRIL 2018

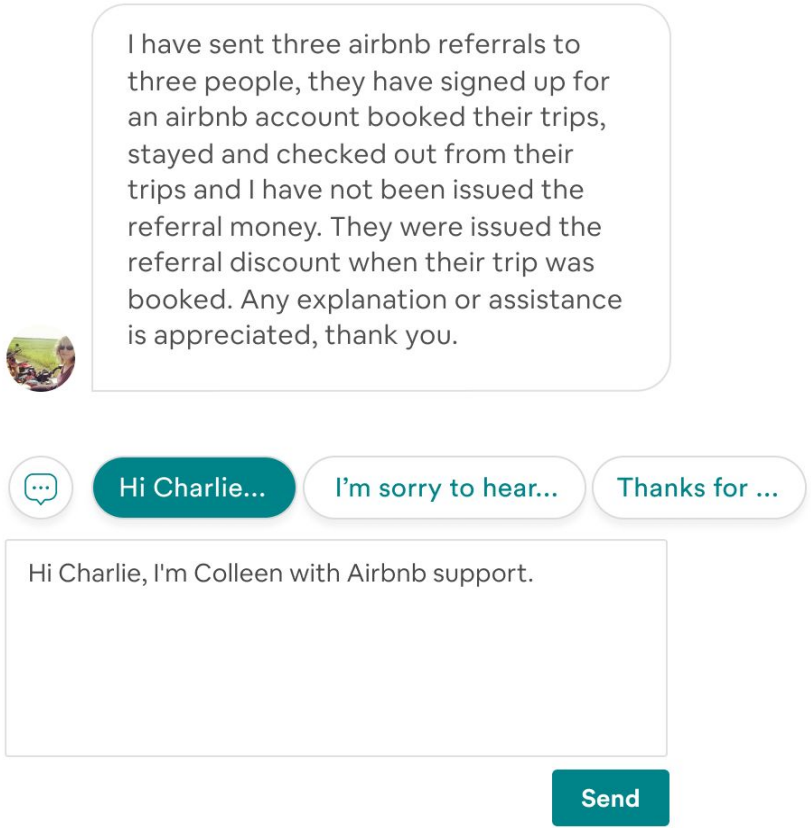
Dialog Assistant for Customer Service at Airbnb

Opportunity: Inefficiency in CX Agents Work

- Inefficient composing of repeated messages
- Outdated and confusing reply templates
- Agents develop their own “snippets” outside of the agent tool



Dialog Assistant Suggests Responses



Goal

- Increase customer service agents efficiency
- Maintain the service quality, increase customer satisfaction
- Reduce cost $

Two Things Agent Does in a Conversation:

- Keep an engaging and empathetic conversation
- Solve the problem

Landscape of Types of CX Agent Replies

Keep an Engaged and Sympathetic Conversation

Solve The Problem

Conversational Elements
Intros
Courtesies
Expectations
Closes

Investigative Questions
Universal
Solutions-based

Solutions Content
Macros + tokens
Help center articles
Interactive features

Landscape of Types of CX Agent Replies

Keep an Engaged and Sympathetic Conversation		Solve The Problem
Conversational Elements Intros Courtesies Expectations Closes	**Investigative Questions** Universal Solutions-based	**Solutions Content** Macros + tokens Help center articles Interactive features

Conversational Elements - Courtesy Responses

- Hi XX, I’m XX from Airbnb support. I will help you today.
- “You are welcome”, “You are most welcome”, “You are always welcome”, “No problem”, “No worries”, “My pleasure”
- “Thank you”, “Thanks”, “Thank you very much”
- “Thank you for being a part of Airbnb”, “Thank you for being a valuable member of our community”
- “All the best”, “Have a nice trip”, “Have a nice day”
- Sorry for the inconvenience.
- Thank you for the patience.
- ...

Conversational Elements - Notify Status (a lot of these contain actions)

- I’ve escalated your case. ...
- I’m handing this off to a case manager...
- I’m going to contact your host/guest.
- I’m calling you.
- I’ve tried to call you but no answer.
- I am closing your case, let me know if I can help with anything else.
- ...

Conversational Elements - Setting Expectations

- “Please allow me some time to investigate.” “One moment please.”
- “I’m going to take my week offs for the next 2 days, I will help you on Monday”
- “I’m able to help you in XX language, are you comfortable converse in that language?”

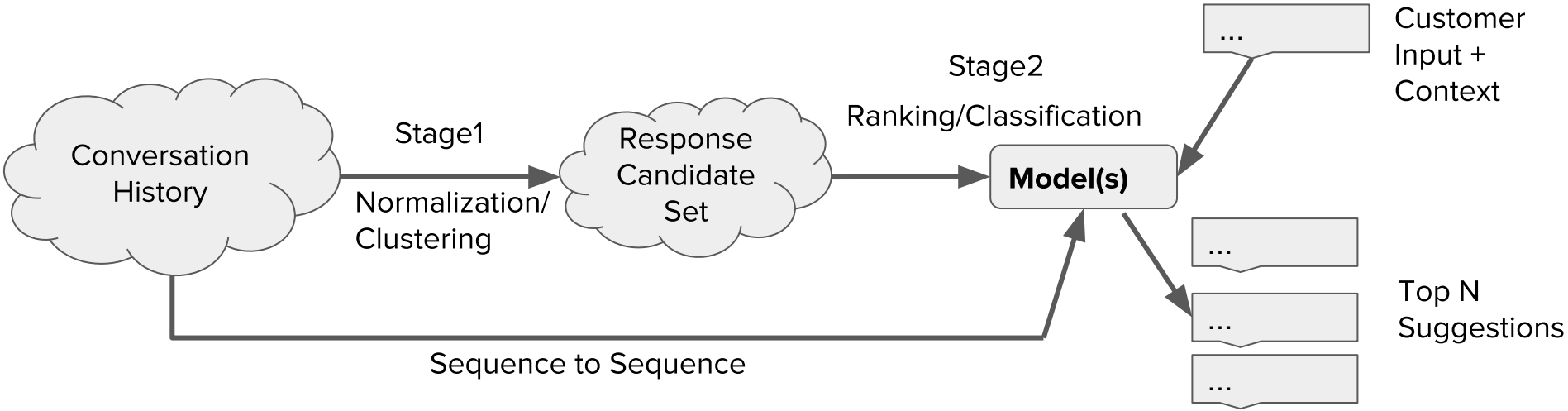
Problem Solving - Investigative Questions

- Which browser are you using?
- Are you using the desktop or mobile app?
- Which reservation that is for?
- Could you send me screenshot?
- ...

Methods

Two Stages

- **Stage 1: Response Candidate Set Generation**
  - **Goal:** Learn a set of commonly used responses from historical conversations
- **Stage 2: Response Suggestion**
  - **Goal:** suggest top N responses for every customer input message



Stage 1. Response Candidates Set Generation

Generate Semantic Clusters

- Avoid redundancy among the 3 suggestions at one time
- Increase variability at different times

Stage 1. Response Candidates Set Generation

Step 1.1 TF-IDF Based Clustering

Cluster responses with small variances in word usages together.

- Messages to sentences
- Preprocessing
- Replace names, emails, urls, and phone numbers
- TF-IDF Vectors
- Clustering based on Cosine distance

Stage 1. Response Candidates Set Generation

Step 1.1 Examples

“Thank you.” “Oki, thank you.”

“You are welcome”. “You’re welcome, {customer_name}”, “You are very welcome”

“Hi {customer_name}, thank you for reaching out to us. My name is {agent_name} from customer experience team and it's my pleasure to help you today.”

“Hi {customer_name}, thank you for reaching out to Airbnb. My name is {agent_name}, one of the customer experience specialists, and I will help you today.”

Stage 1. Response Candidates Set Generation

Step 1.2 Word Embedding Based Clustering

-- Identify semantic clusters and meaningful variations

[0.2, 0.1, 0, ..., 0.002]

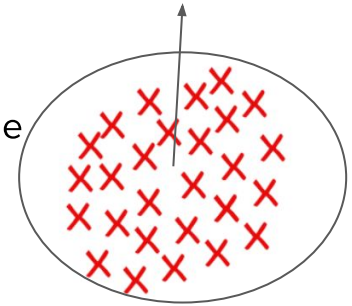
Centroid of TF-IDF representation, 1xp

X

[[0.1, -0.2, ..., -0.03],
[0.01, 0.05, ..., 0.01],
...,
[0.04, 0.02, ..., 0.3]]

Word embeddings for each word id, pxd

Cluster from the previous step



p: TF-IDF vocabulary size
d: Embedding dimension

Use the new cluster level representation to do another round of clustering

Stage 1. Response Candidates Set Generation

Step 1.2 Examples

“Is there anything else I can help you out today? ” “Is there anything else I can assist you with?”

“I’m sorry for that.” “I apologize for the inconvenience.”

```
model.wv.most_similar('help')
```

```
[('assist', 0.744277834892273),
 ('assistance', 0.5544239878654
 ('assisting', 0.48176926374435
 ('helping', 0.4735117554664612
 ('assit', 0.43267425894737244)
 ('clarify', 0.4172865748405456
 ('reach', 0.3933323323726654),
 ('provide', 0.3914804458618164
 ('speak', 0.3771812319755554),
 ('hep', 0.3721386790275574)]
```

```
model.wv.most_similar('sorry')
```

```
[('apologize', 0.5666943192481995),
 ('saddened', 0.5537199974060059),
 ('sor', 0.5529327392578125),
 ('glad', 0.5211688876152039),
 ('disappointed', 0.4884432554244995
 ('apologetic', 0.47890573740005493)
 ('apologise', 0.4765419363975525),
 ('sad', 0.4677164554595947),
 ('afraid', 0.4432731866836548),
 ('apologies', 0.43972256779670715)]
```

Stage 1. Response Candidates Set Generation

Step 1.2 Examples

A side benefit of using word embeddings:
Find typos and give them similar representations, while TF-IDF will treat them as completely different words

```
model.wv.most_similar('airbnb')
```

```
[('aribnb', 0.5326067805290222),
 ('aibnb', 0.46161675453186035),
 ('bnb', 0.4071008563041687),
 ('abnb', 0.39804476499557495),
 ('airbnb`s', 0.3884303867816925),
 ('airbn', 0.3838478922843933),
 ('airbnb´s', 0.38077694177627563),
 ('airb', 0.379798948764801),
 ('our', 0.3770841360092163),
 ('airnb', 0.3749414384365082)]
```

Stage 1. Response Candidates Set Generation

Step 1.3 Manual Curation--Approval Process by Content Team

To avoid not recommended practices from agent responses:

you are always welcome {customer_name}! if you need anything, please do not hesitate to contact us. see you in the future! 😉

thank you for your blessings, ma'am. 😇😇😇😇😇

Stage 1. Response Candidates Set Generation

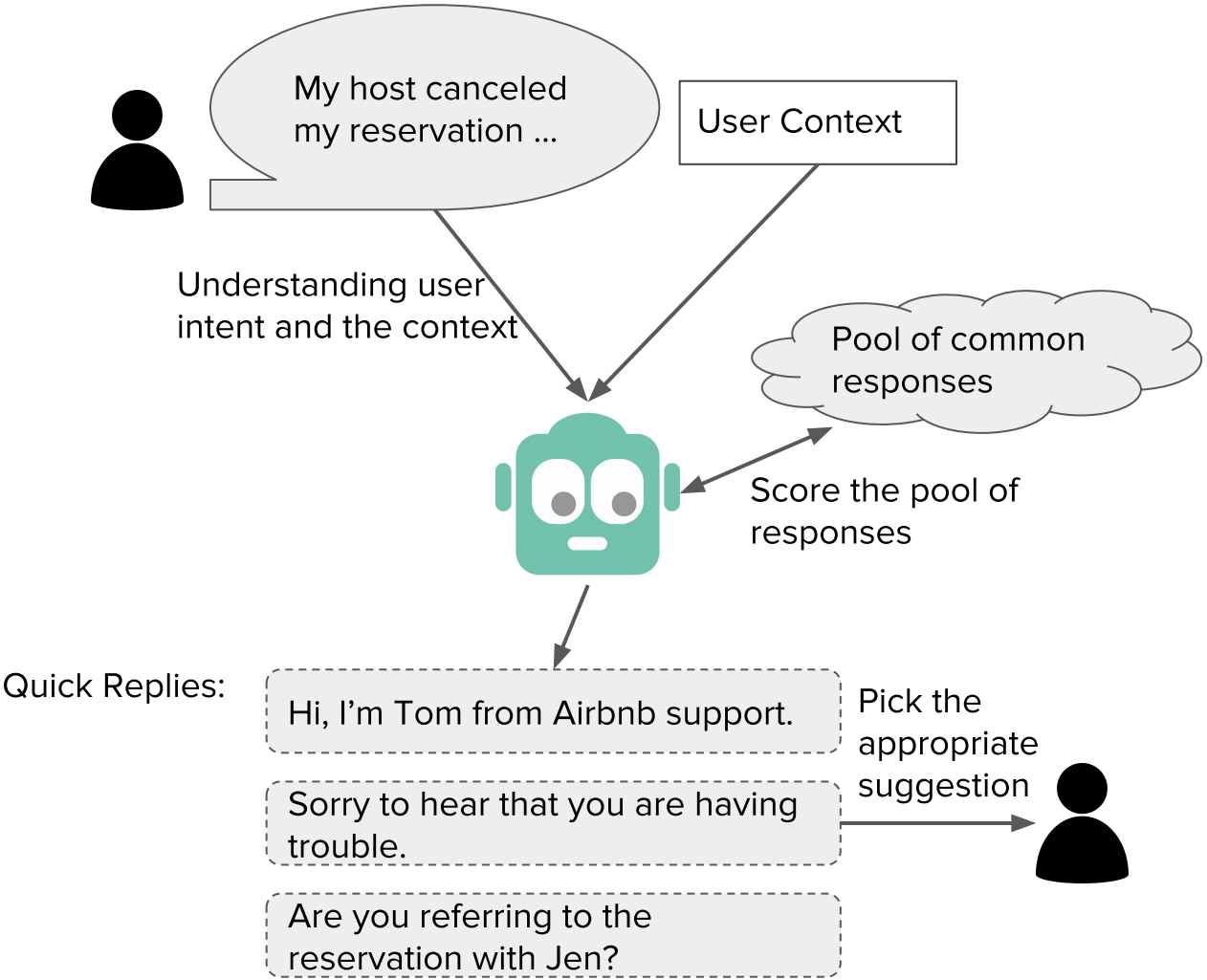
Step 1.3 Manual Curation--Approval Process by Content Team

Complement with Clustering results:

“Please allow me some time to investigate the issue.”

“Let me take a look at that for you.”

Stage 2


My host canceled my reservation ...
User Context
Understanding user intent and the context
Pool of common responses
Score the pool of responses
Quick Replies:
Hi, I'm Tom from Airbnb support.
Sorry to hear that you are having trouble.
Are you referring to the reservation with Jen?
Pick the appropriate suggestion

Stage 1. Response Candidates Set Generation

Stage 2. Response Suggestion

Sequence To Sequence Model: Training

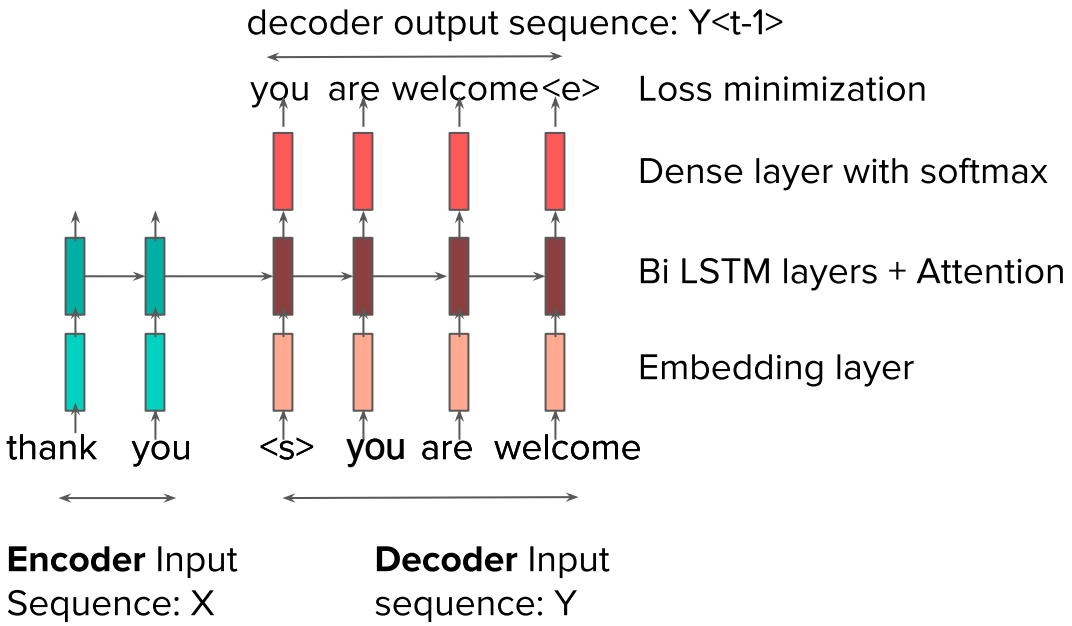
Create Input/Output Pairs:
Last two sentences from customer, first two sentences from agent

Customer Input: Hi David, thank you so much for helping us with this situation. I greatly appreciate your professionalism and understanding. Best,
Bot output: No worries. Glad that I was able to assist! It means alot to me when I'm able to positively affect someone's day.

Stage 1. Response Candidates Set Generation

Stage 2. Response Suggestion

Sequence To Sequence Model: Training



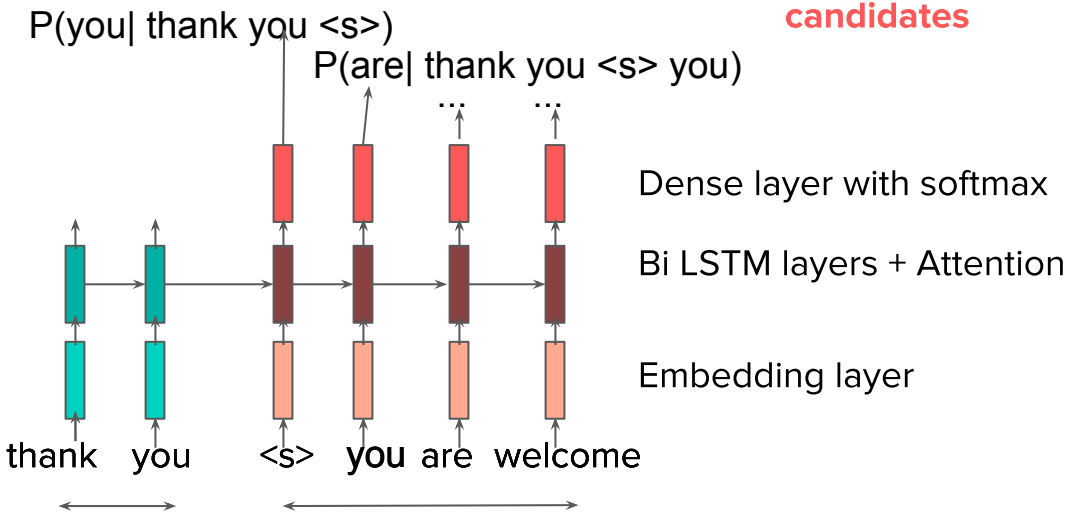
Stage 1. Response Candidates Set Generation

Stage 2. Response Suggestion

Sequence To Sequence Model: Inference (Prediction)

Candidate sequence probiligy = ∑logP(yi| x1, ..., xn, y1, ..., yi-1)

Score and rank all candidates



Encoder Input Sequence: X

Decoder Candidate sequence: Y

Stage 1. Response Candidates Set Generation

Stage 2. Response Suggestion

- **Challenges**

Performance Limitation

Scoring might be too slow for live chat

Potential Solution:

- Nearest Neighbor
- Beam search
- Cache

Stage 1. Response Candidates Set Generation

Stage 2. Response Suggestion

- **Challenges**

Proactive vs. Reactive Messaging

Proactive

- Hi, I'm XX from Airbnb.
- Is there anything else I can help you with?
- Are you comfortable converse in English?

Reactive:

- "Thank you" -- "You are welcome"
- "I'm very confused." -- "Sorry for the confusion."

Proactive messages require other context information to learn well.

Stage 1. Response Candidates Set Generation

Stage 2. Response Suggestion

- **Challenges**

Position of message and other meta data

Beginning:
“Hi {customer_name}, thank you for reaching out to us. My name is {agent_name} from customer experience team and it's my pleasure to help you today.”

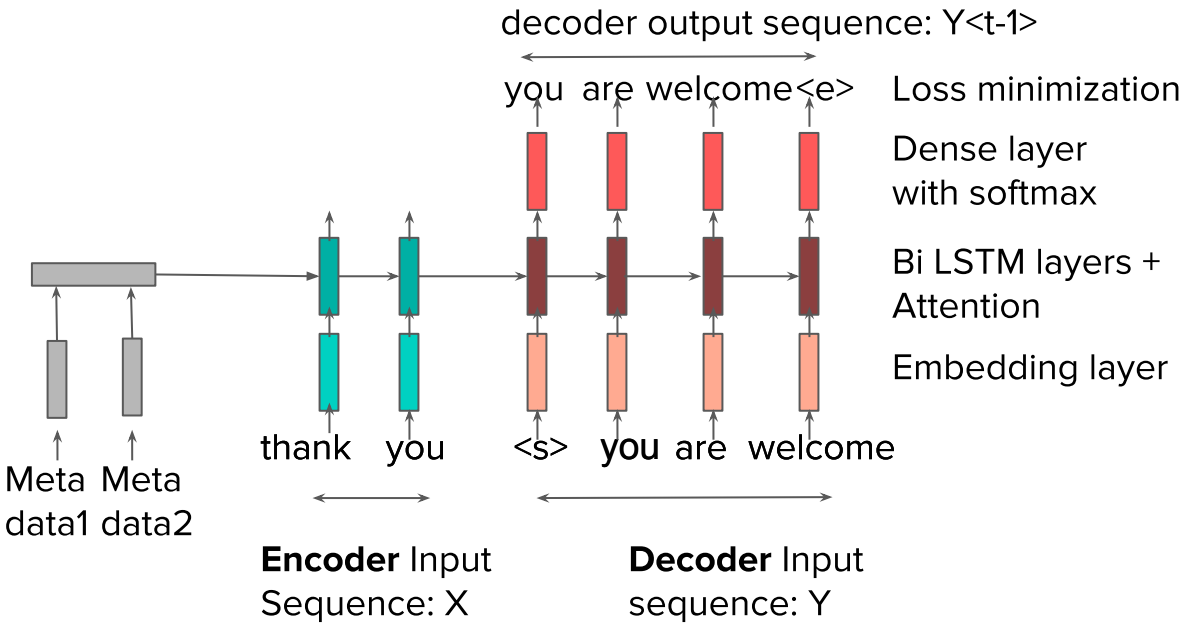
End:
“Anything else I can help you with?”
“Please let me if everything is sorted. I’m closing your case now.”

Stage 1. Response Candidates Set Generation

Stage 2. Response Suggestion

- **Challenges**

Incorporating Meta Data Other Than Text



Stage 1. Response Candidates Set Generation

Stage 2. Response Suggestion

- **Challenges**

Live chat vs. Async Messaging

Large volume of training data from async messaging
May not applicable for live chat, but model first pilot on live chat:

- Thank you for your response.
- Sorry for the delayed response.
- Hi, this is XX again. Following up to our previous conversation ...
- May I call you?
- I called you earlier, but you were not available.

Questions?