Embeddings applied to information retrieval

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Agenda

Motivation
Talkdesk context

Embeddings
Representation and Models

Sentence Classification
Approach and Results

Moment Classification
Approach and Results

MOTIVATION

TALKDESK CONTEXT

Company

talkdesk

Empower companies to continuously improve customer experience.

Mission

1.800+

Customers

30.000+

Users

800+

People

Context

Talkdesk handles a **lot** of calls.

Each call has **information** that can be used.

Calls are transformed into text, called **transcripts**.

Call Transcript

Motivation

Why do we want to explore those transcripts?

Transcripts contain information that can provide **value** to clients.

Human agents **time** can be **saved** by automating some of their tasks.
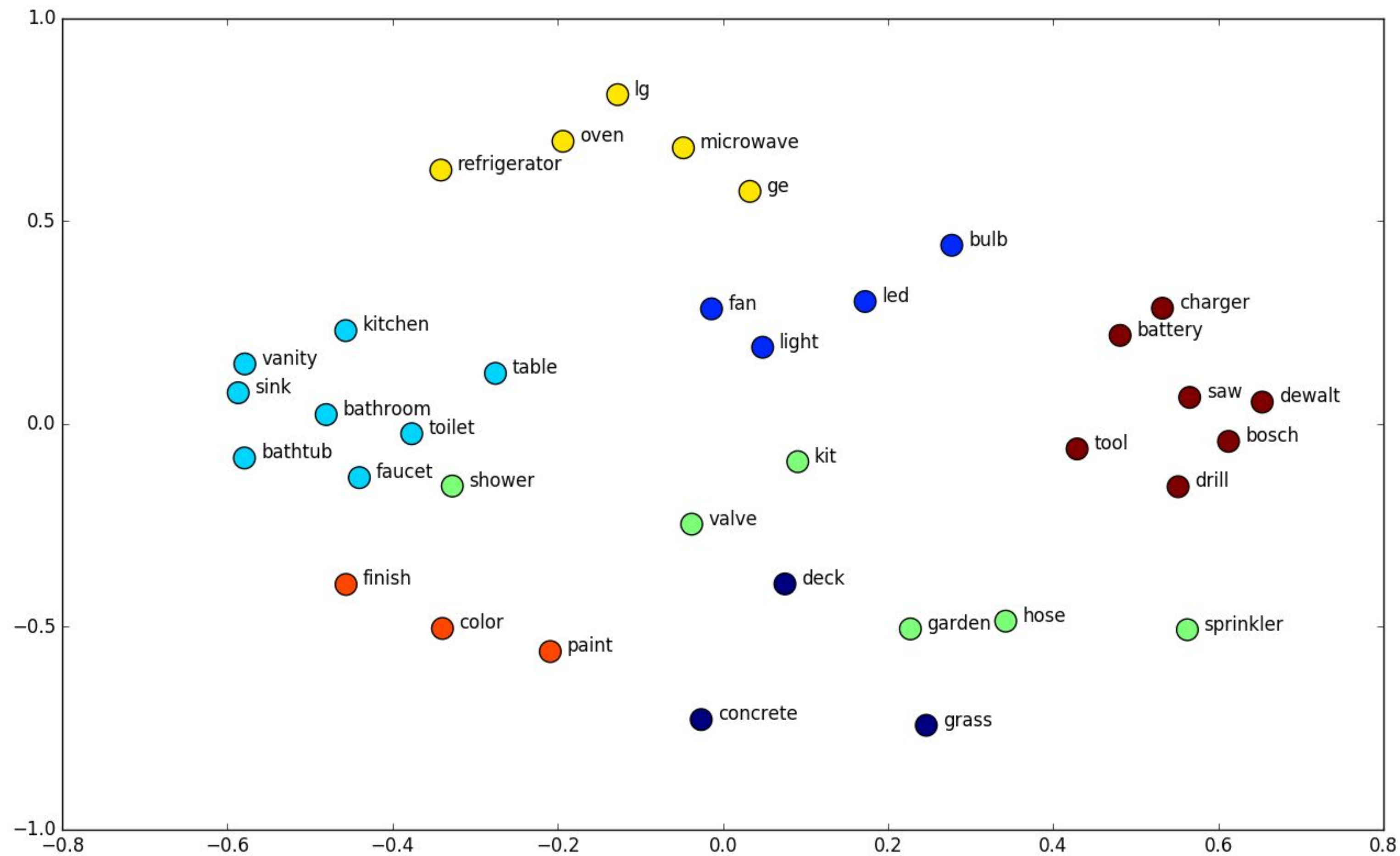
Embeddings

REPRESENTATION & MODELS

What are embeddings?

	Male	Noble	Transport
Man	1	0	0
Women	0	0	0
King	1	1	0
Queen	0	1	0
Horse	0.6	0	0.6
Mare	1	0	0.6
Car	0	0	1

What are embeddings?

Models: Word2Vec

Source Text

| The | quick | brown | fox jumps over the lazy dog. ⟹

Training Samples

(the, quick)
(the, brown)

| The | quick | brown | fox | jumps over the lazy dog. ⟹

(quick, the)
(quick, brown)
(quick, fox)

| The | quick | brown | fox | jumps | over the lazy dog. ⟹

(brown, the)
(brown, quick)
(brown, fox)
(brown, jumps)

The | quick | brown | fox | jumps | over | the lazy dog. ⟹

(fox, quick)
(fox, brown)
(fox, jumps)
(fox, over)

Models: Universal Sentence Encoder


```
"How old are you?"                            [0.3, 0.2, …]

"What is your age?"         ┌─────────┐       [0.2, 0.1, …]
                            │  Embed  │
"My phone is good."         └─────────┘       [0.9, 0.6, …]

...                                           ...
```
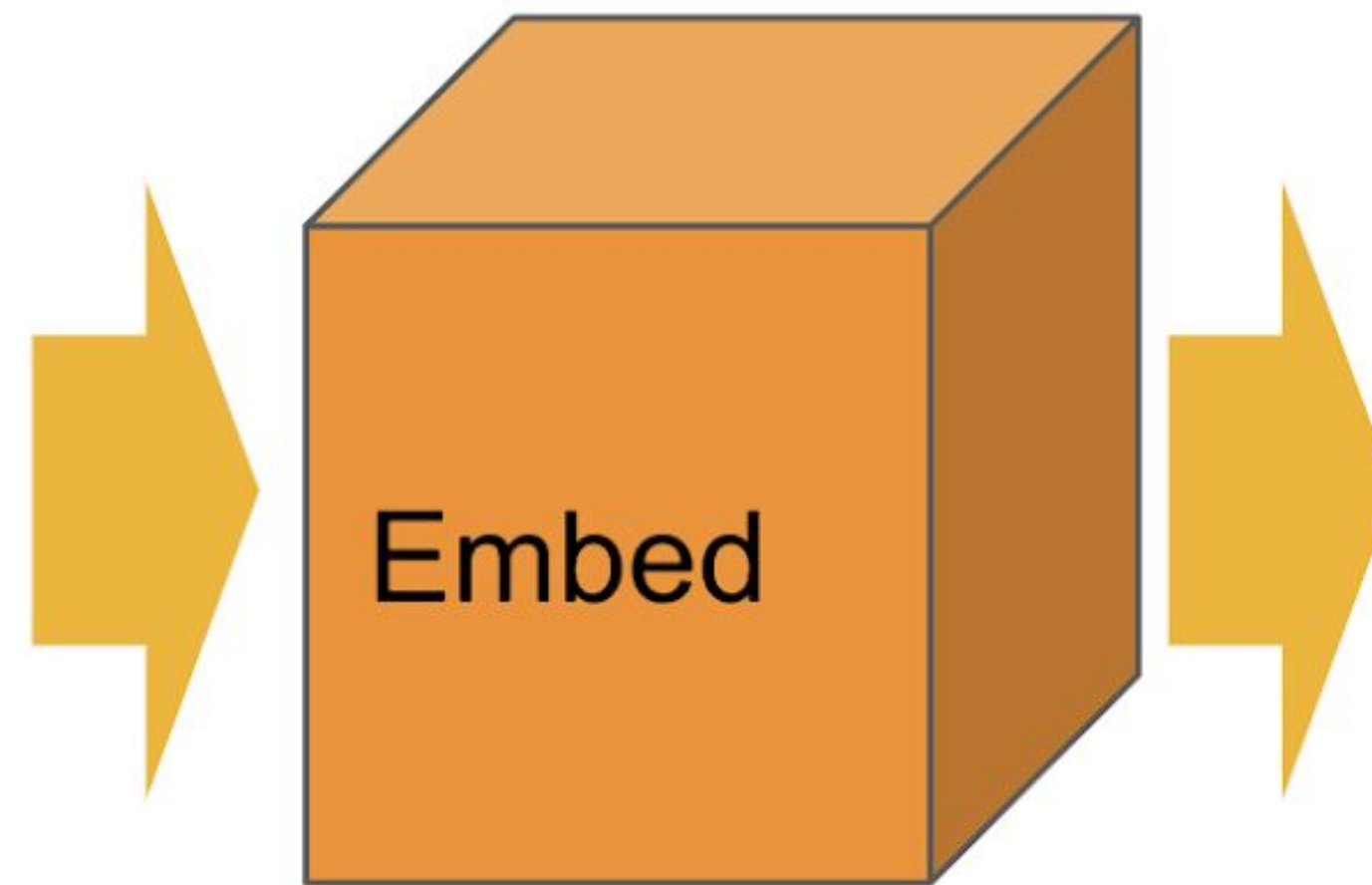
Models: Universal Sentence Encoder
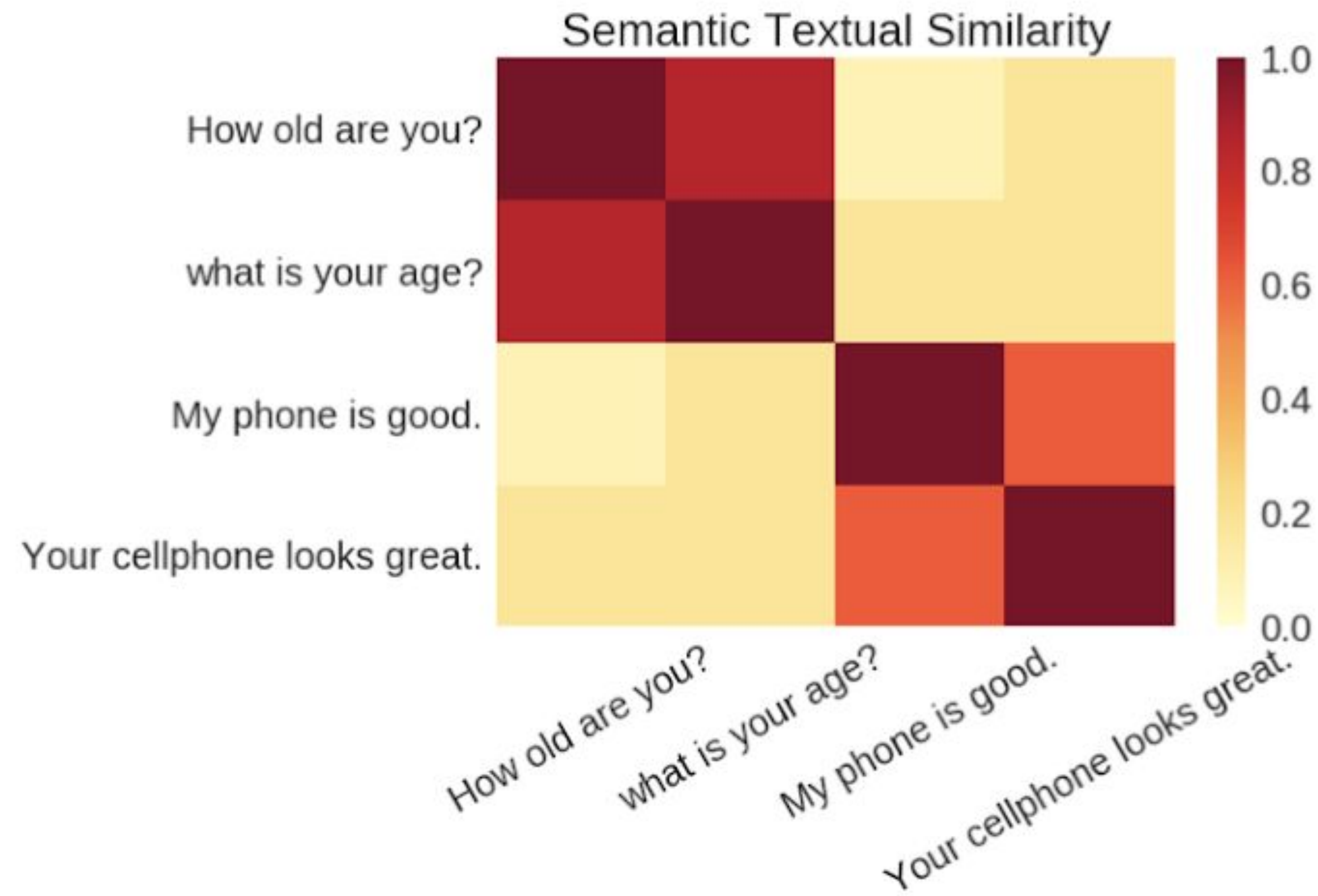
Semantic Textual Similarity

Models: Universal Sentence Encoder

(a) Transformer encoder   (b) DAN encoder

Models: BERT

Source: 2018, BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding

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Sentence Classification

APPROACH & RESULTS

Goal

Call Transcript

Sentence Classification

GREETINGS

INFO_REQUEST
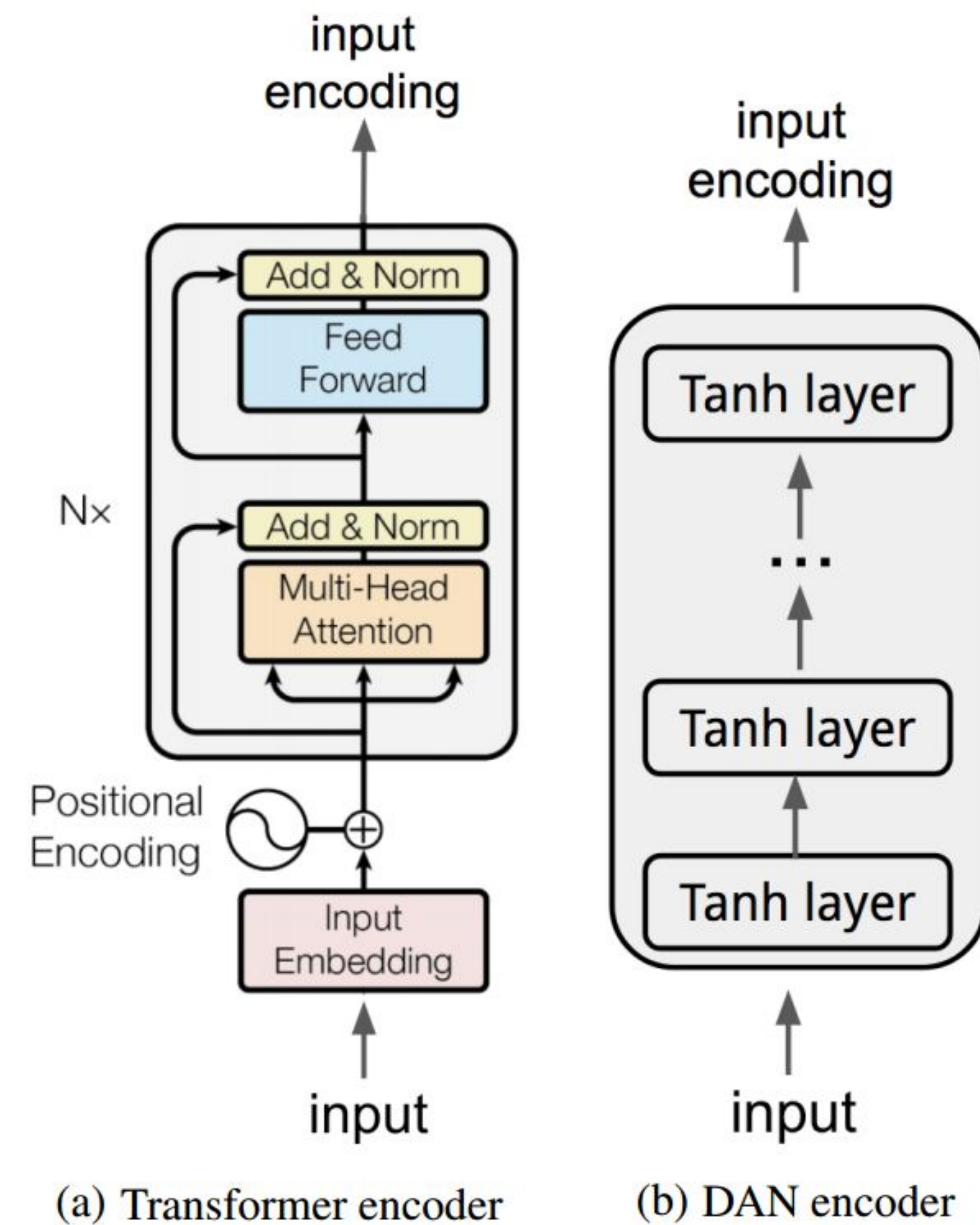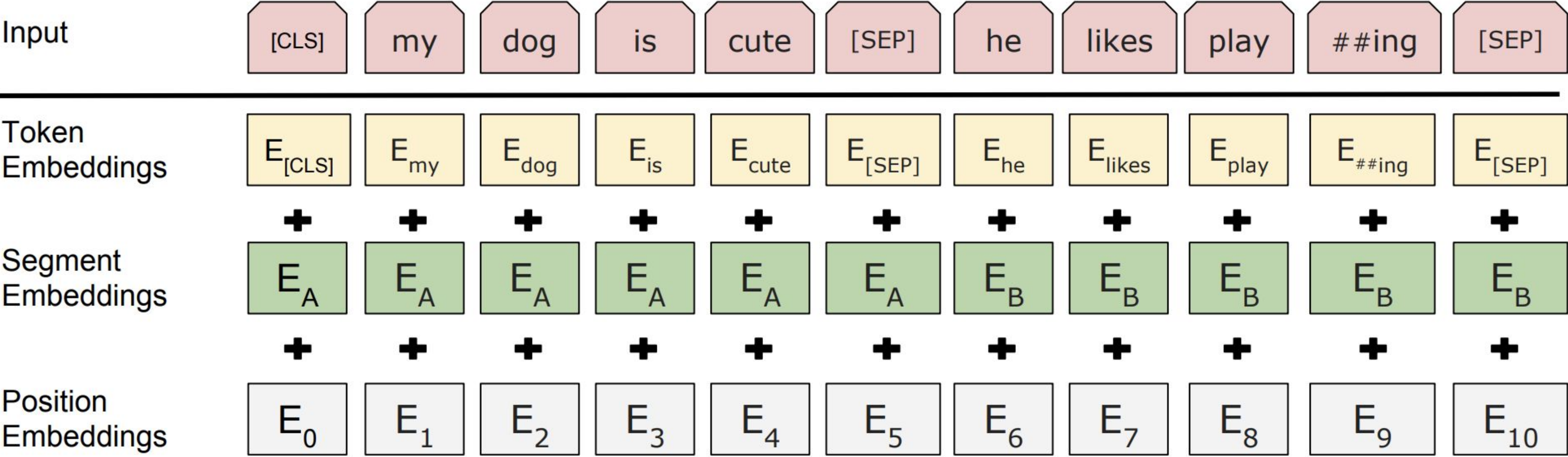
FAREWELL
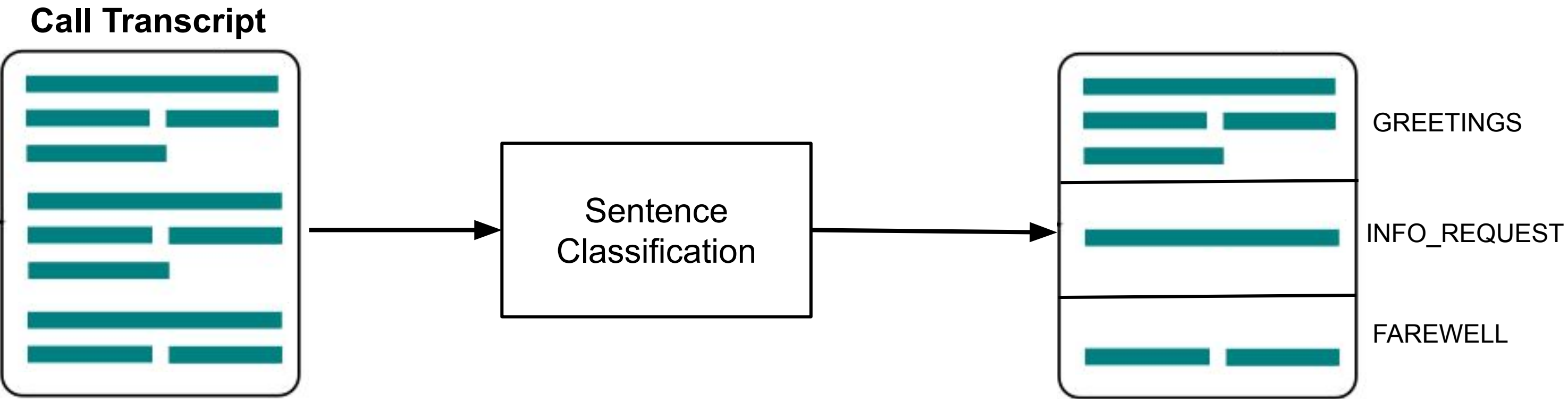
What do we have?

- Call **transcriptions**.

- Transcripts separated by **agent** and **caller**.

- **Intents** we want to detect.
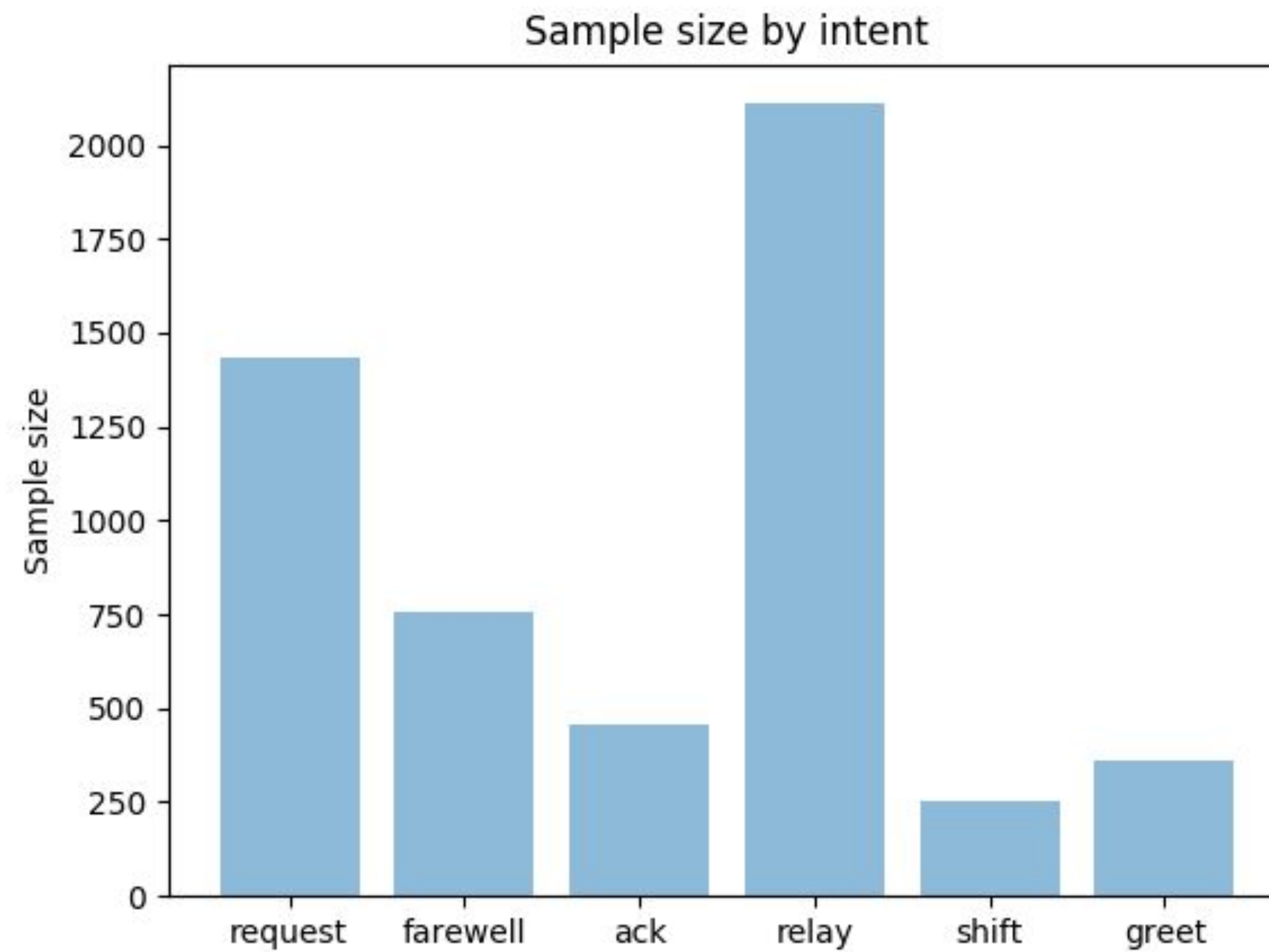
Approach: Dataset

MultiWOZ Dataset:

- Fully-labeled collection of written conversation.

- Conversations between a tourist and an agent from a touristic information center.

- Spanning over multiple domains and topics.

Approach: Dataset by intent

Sample size by intent

Approach: Intents

Each **sentence** we classify it with an **intent**:

GREETING
FAREWELL

INFORMATION_REQUEST
INFORMATION_RELAY
INFORMATION_ACKNOWLEDGEMENT

MOMENT_SHIFT

Example: Conversation With Intents

Transcript

Hi!
I am currently planning to come to Cambridge, and I was looking for a relatively inexpensive place to eat in the centre.
What would you suggest?
The Gardenia is an excellent and cheap place in the center of town, serving Mediterranean cuisine.
Yes, please book a table for 1 people at 19:15 on monday.
Reference number is : IU63HAEN.
Is there anything else I can help you with today?
I need a place to stay in the same part of town.
I must have free parking.
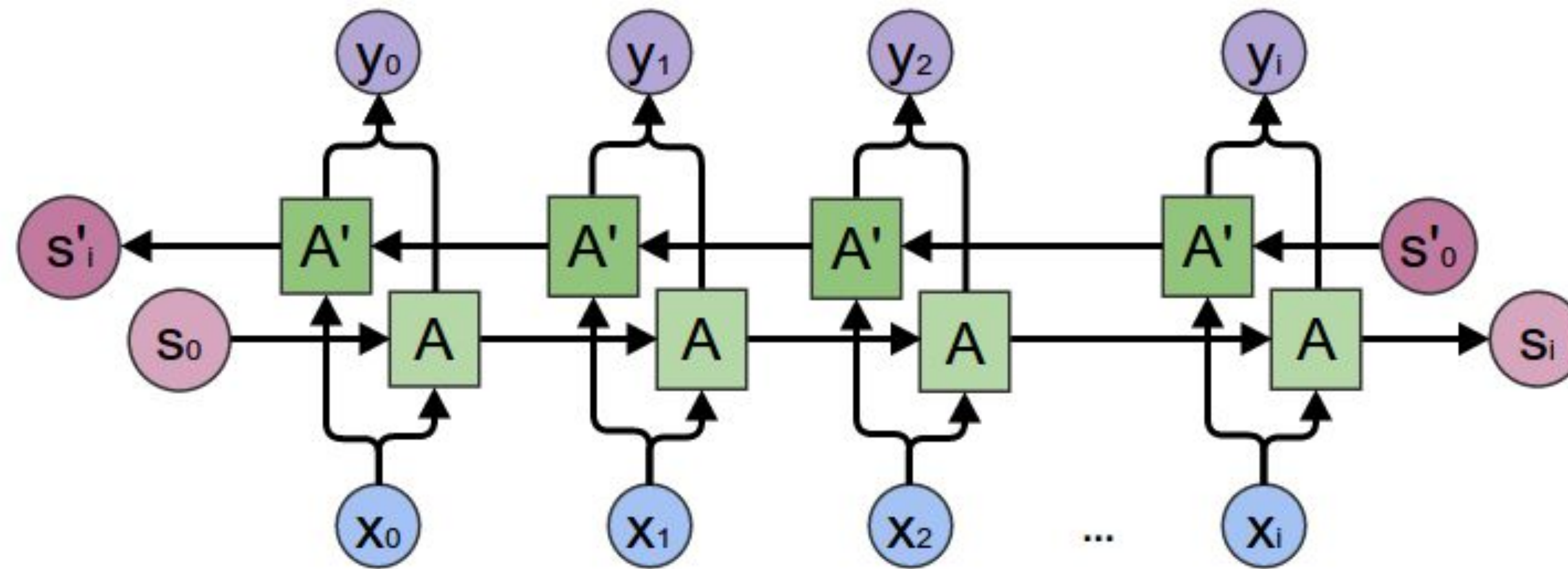We have two guesthouses and two hotels that meet your needs.
...

Intents

Greeting
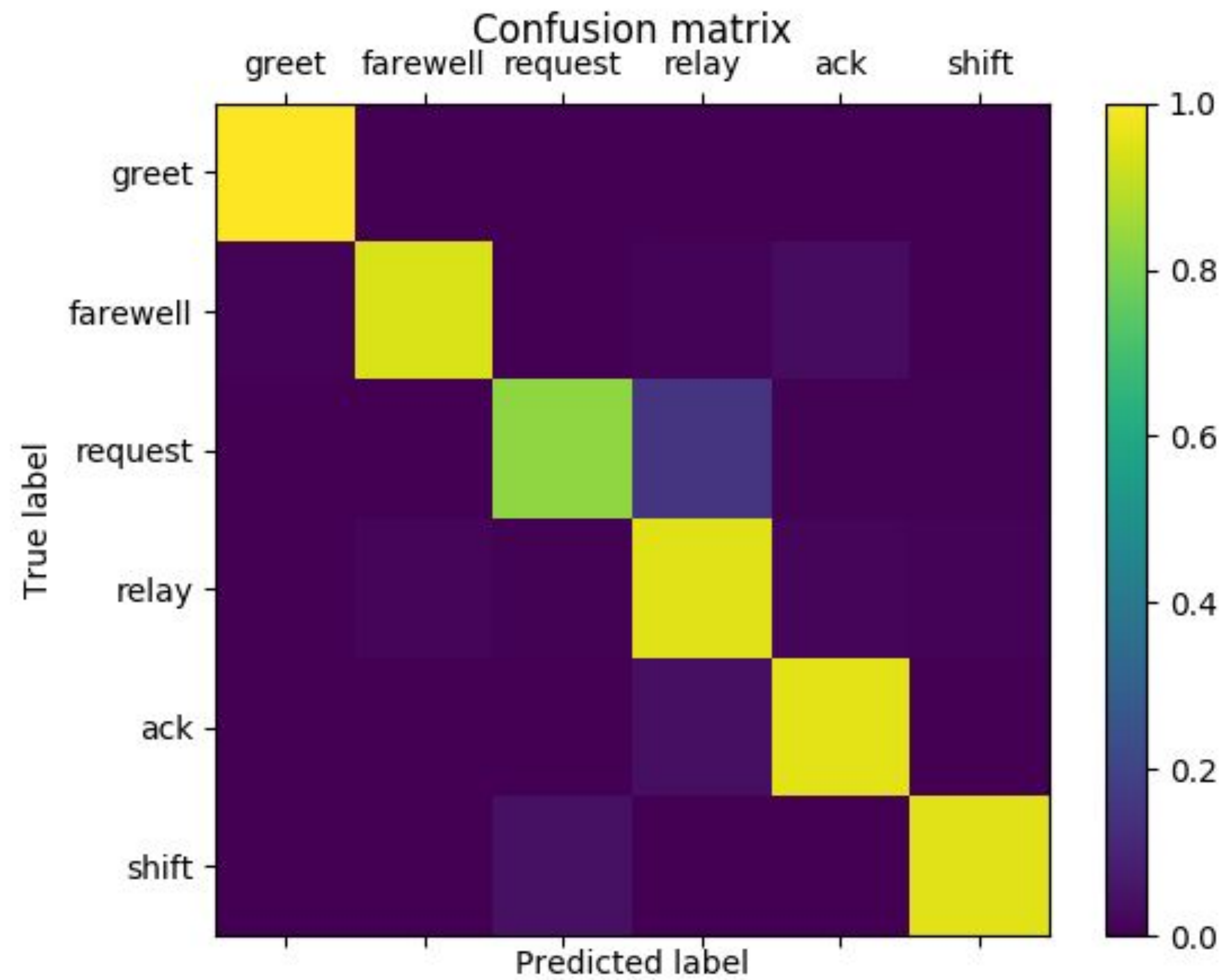
Information Relay
Information Request

Information Relay
Information Relay
Information Relay
Moment Shift
Information Relay
Information Relay
Information Relay

Approach: Architecture

Results: MultiWOZ

Confusion matrix

Results: Real Transcripts

Confusion matrix

MOMENT CLASSIFICATION

APPROACH & RESULTS

Recap

Call Transcript → Sentence Classification → GREETINGS / INFO_REQUEST / FAREWELL

Goal

Call Transcript

Sentence Classification

Moment 1

Moment 2

Moment 3
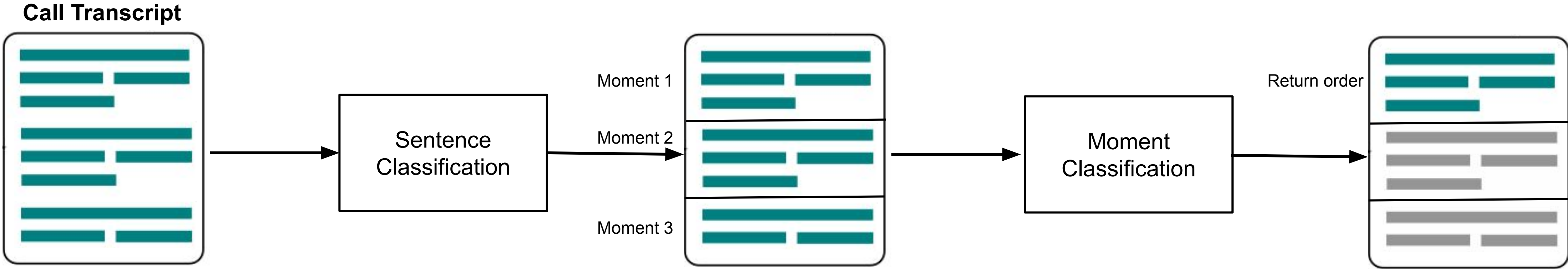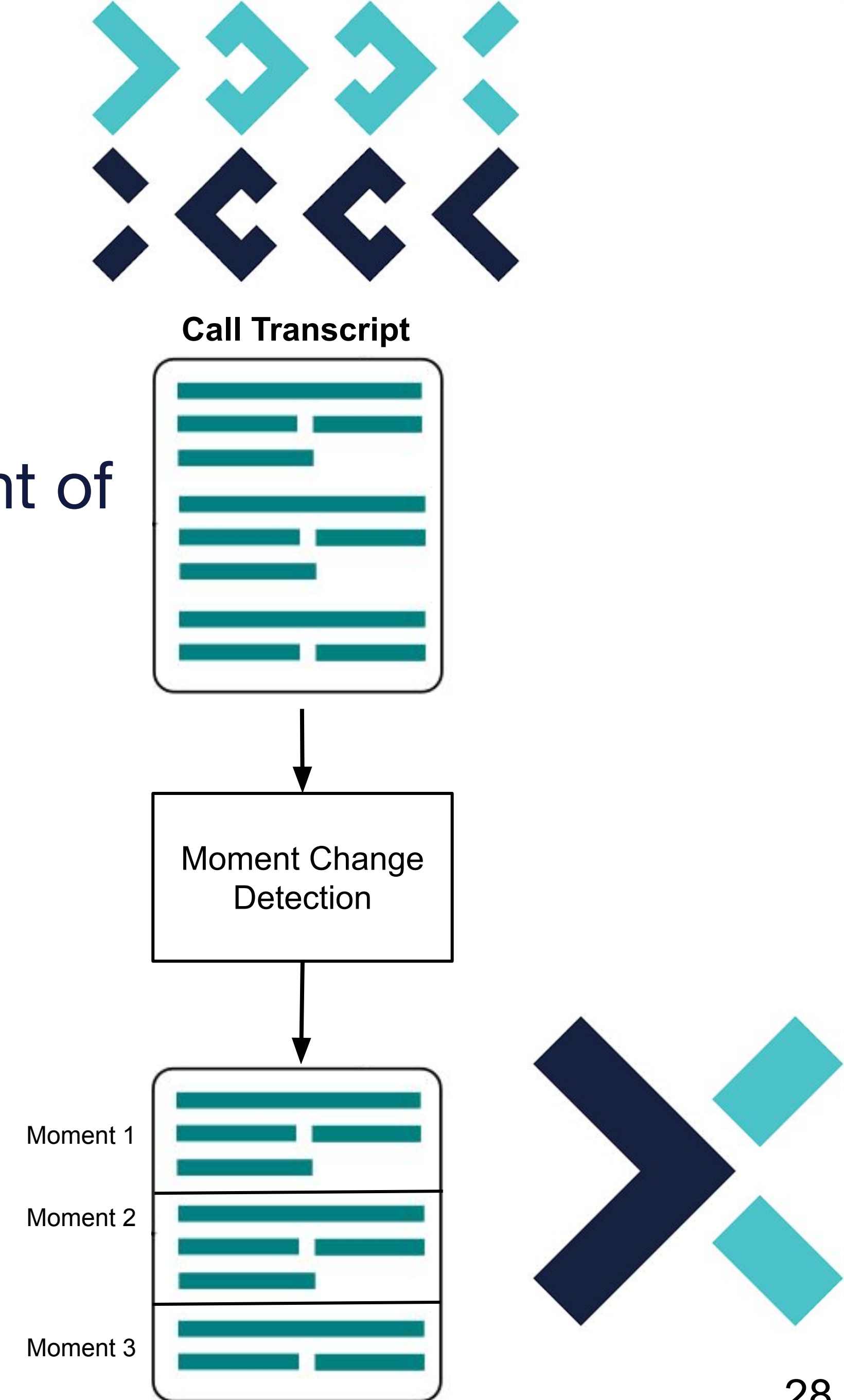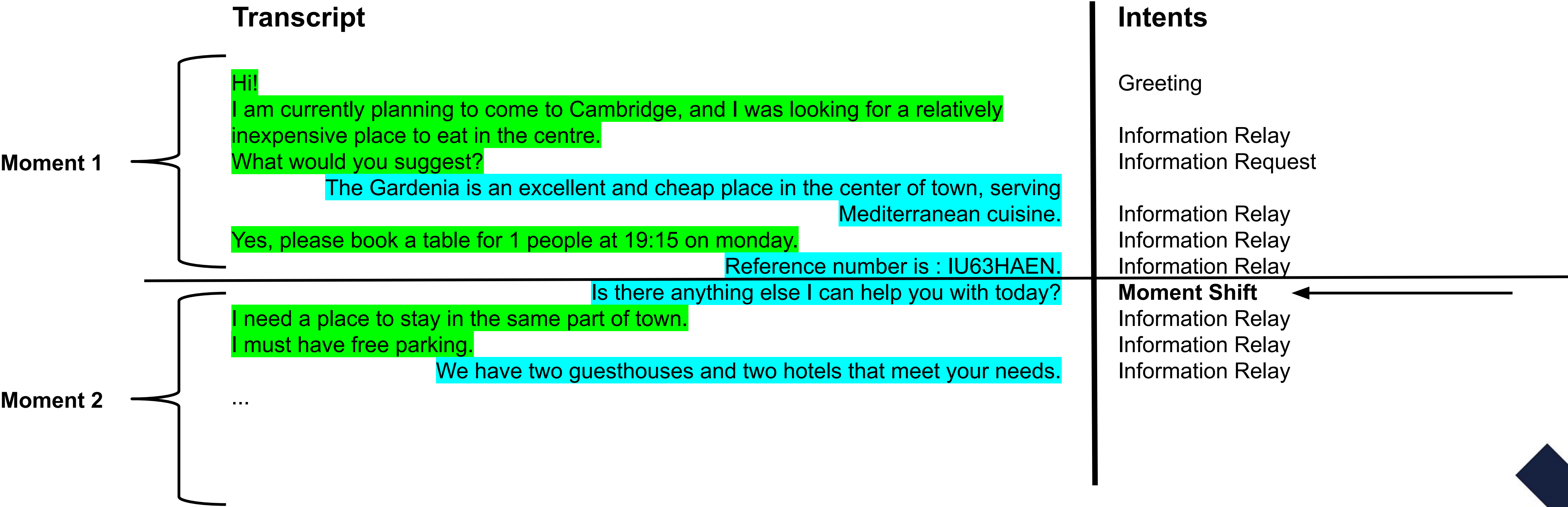
Moment Classification

Return order
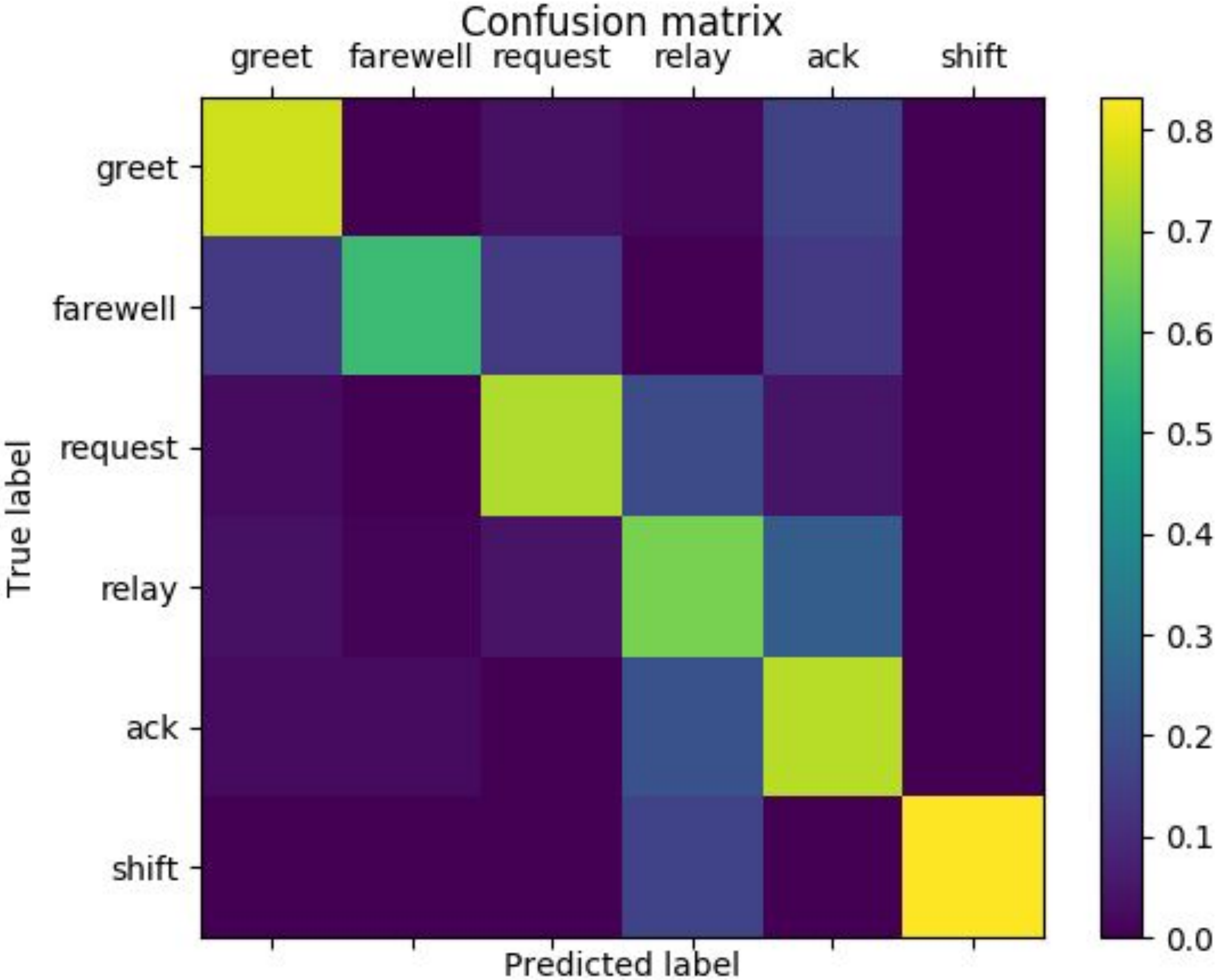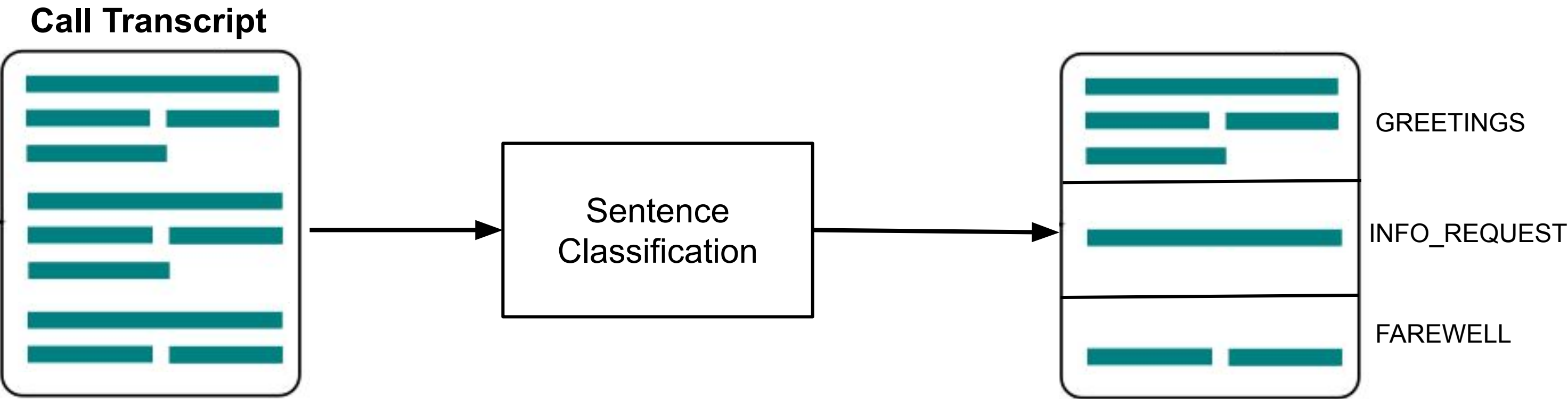
Approach: Moment Change Detection

Use the **Sentence Classification** to detect the intent of each sentence, and splits the conversations by the **Moment Shift intents**.

Call Transcript

Moment Change Detection

Moment 1

Moment 2

Moment 3

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Example: Moment Change Detection

Transcript

Intents

Moment 1

Hi!

Greeting

I am currently planning to come to Cambridge, and I was looking for a relatively inexpensive place to eat in the centre.

Information Relay

What would you suggest?

Information Request

The Gardenia is an excellent and cheap place in the center of town, serving Mediterranean cuisine.

Information Relay

Yes, please book a table for 1 people at 19:15 on monday.

Information Relay

Reference number is : IU63HAEN.

Information Relay

Is there anything else I can help you with today?

Moment Shift

Moment 2

I need a place to stay in the same part of town.

Information Relay

I must have free parking.

Information Relay

We have two guesthouses and two hotels that meet your needs.
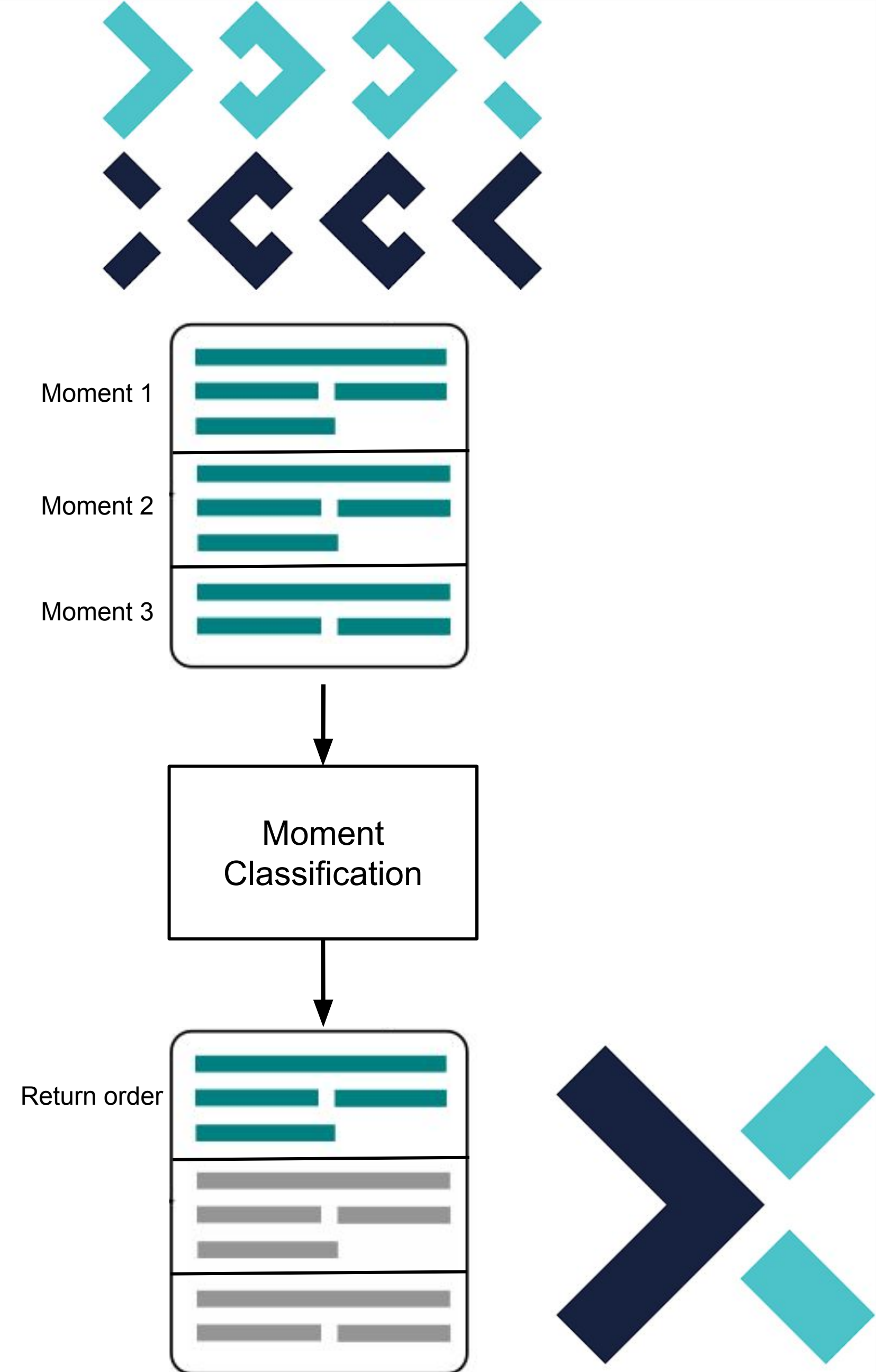
Information Relay

...

Approach: Moment Classification

Calculate **embeddings** of moments.

Store pre-calculated embeddings for **predefined classes** of moments.

For each **moment**, calculate the **embedding** and **classify** it by comparing with the pre-calculated embeddings for different classes.

Approach: Models

Using pre-trained embeddings:

BERT
https://github.com/UKPLab/sentence-transformers

InferSent
https://github.com/facebookresearch/InferSent

Universal Sentence Encoder
https://tfhub.dev/google/universal-sentence-encoder-large/3

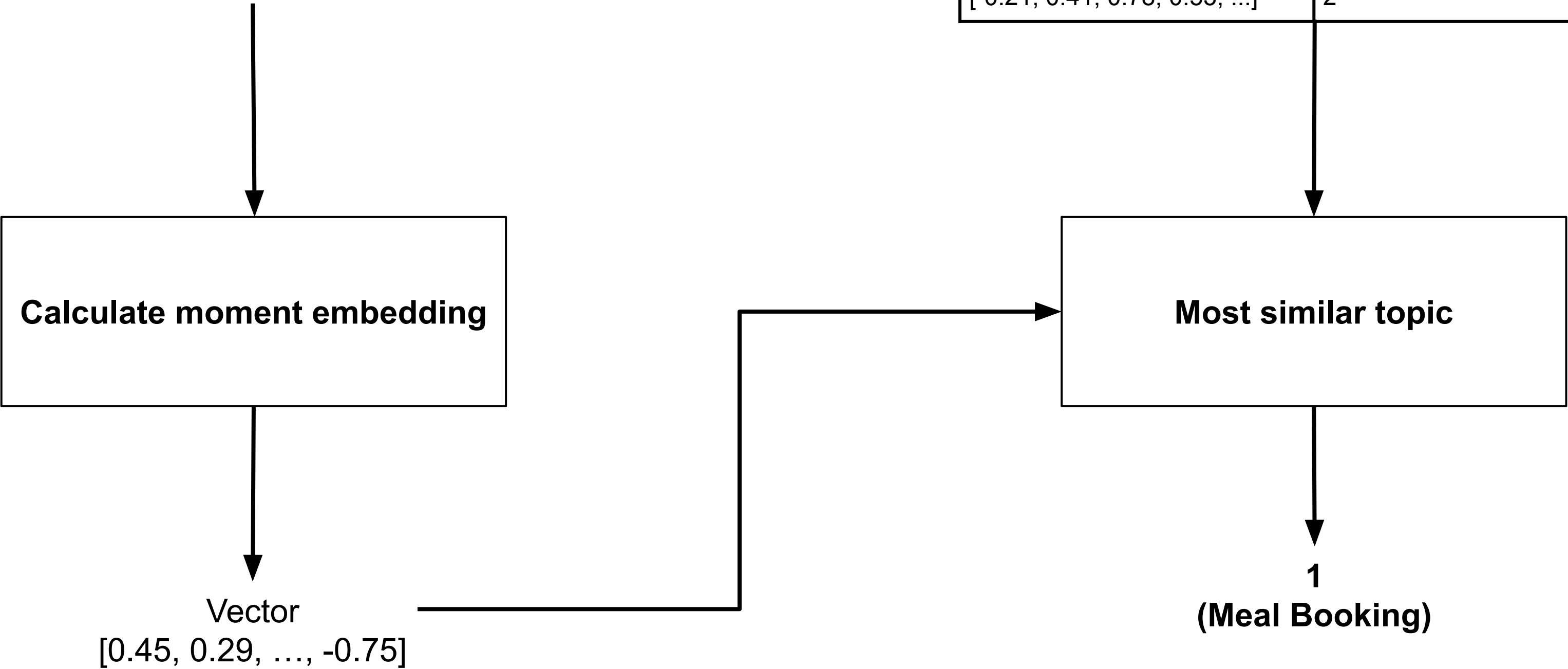# Example - Moment Classification

Moment transcript

Reference moment embeddings

Hi!
I am currently planning to come to Cambridge, and I was looking for a relatively inexpensive place to eat in the centre.
What would you suggest?
The Gardenia is an excellent and cheap place in the center of town, serving Mediterranean cuisine.

Yes, please book a table for 1 people at 19:15 on monday.
Reference number is : IU63HAEN.

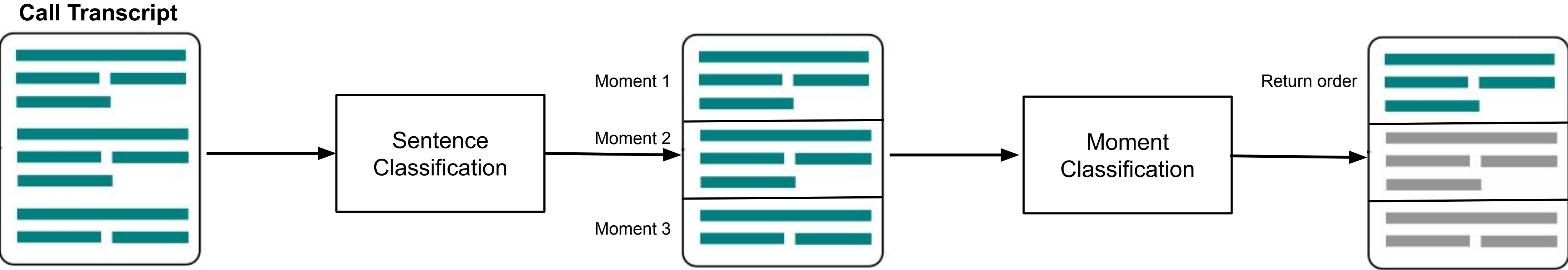| Moment Embedding	Topic
[0.24, 0.86, 0.12, -0.84, …]	1
[0.21, -0.32, -0.53, 0.43, ...]	2
[-0.42, 0.32, 0.32, 0.54, …]	1
[0.54, -0.68, 0.96, -0.12, …]	4
[-0.67, 0.94, -0.76, -0.42, ...]	3
[-0.21, 0.41, 0.78, 0.53, ...]	2

Calculate moment embedding

Vector
[0.45, 0.29, …, -0.75]

Most similar topic

**1
(Meal Booking)**

Results

	Accuracy	Prediction time (s)
BERT	83.76%	1.5076
InferSent	70.06%	0.869
Universal Sentence Encoder	82.48%	4.6024
TF-IDF	79.62%	0.22

Using moment embeddings.

Recap

Call Transcript

Sentence Classification

Moment 1

Moment 2

Moment 3

Moment Classification

Return order

Special Thanks

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Thank You!

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