

Dialog Systems

18/3/2025

Christos Vlachos

Date



What we'll see today

Part 1: Dialog Systems

- Categories of Dialog Systems
- Chatbots
 - Data/Evaluation
 - InstructGPT/ChatGPT
- (Conversational QA Systems)
- Task-oriented Dialog Systems (ToDSs)
 - Data/Evaluation
 - The Pipeline

Part 2: Building our own Dialog System

- Building a Chatbot using LangChain
- Building a ToDS using LangChain
- Building a Chatbot from scratch

1. Dialog Systems

Categories of Dialog Systems

“Dialog systems are computer-based systems that interact or converse with humans in a form that both parties can understand. They communicate with humans through speech, text, gestures, graphics, haptics, etc.”

Dialog Systems :

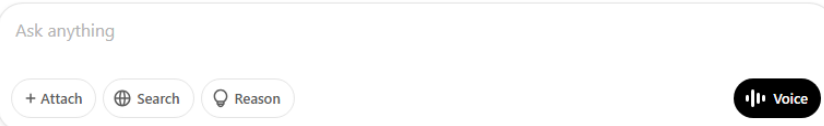
Chatbots

- **Simply converse** with a human.
- May also provide **advice**.
- Answers are based on their **training or prompting**.
- Cannot rely on **outside sources**.

Example:

- ChatGPT

What can I help with?



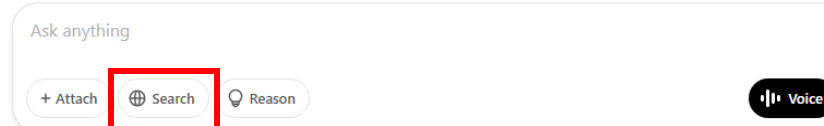
Conversational QA Systems

- **Answer** user question grounded in given (large) KB.
- Need to **access/retrieve** from KB.
- **Not** intended **for** general **conversations**.

Example:

- ChatGPT + Search

What can I help with?



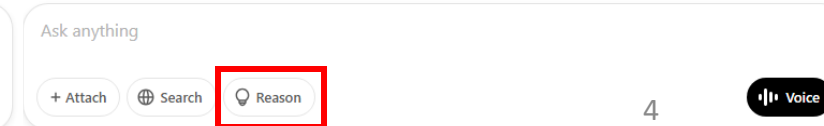
ToDSs

- **Fulfil** a user goal (e.g., book a ticket).
- **Understand** the goal and provide answers/recommendations from an ontology.

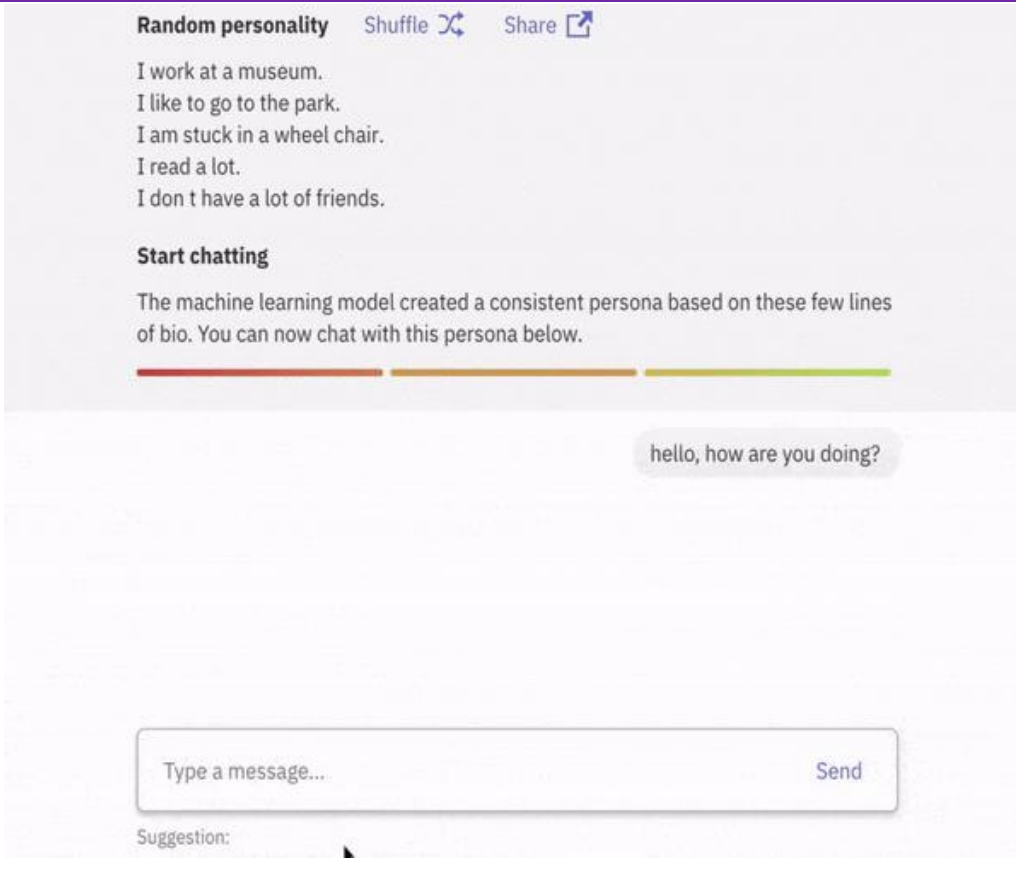
Example:

- ChatGPT + Ontology + Reason(?)

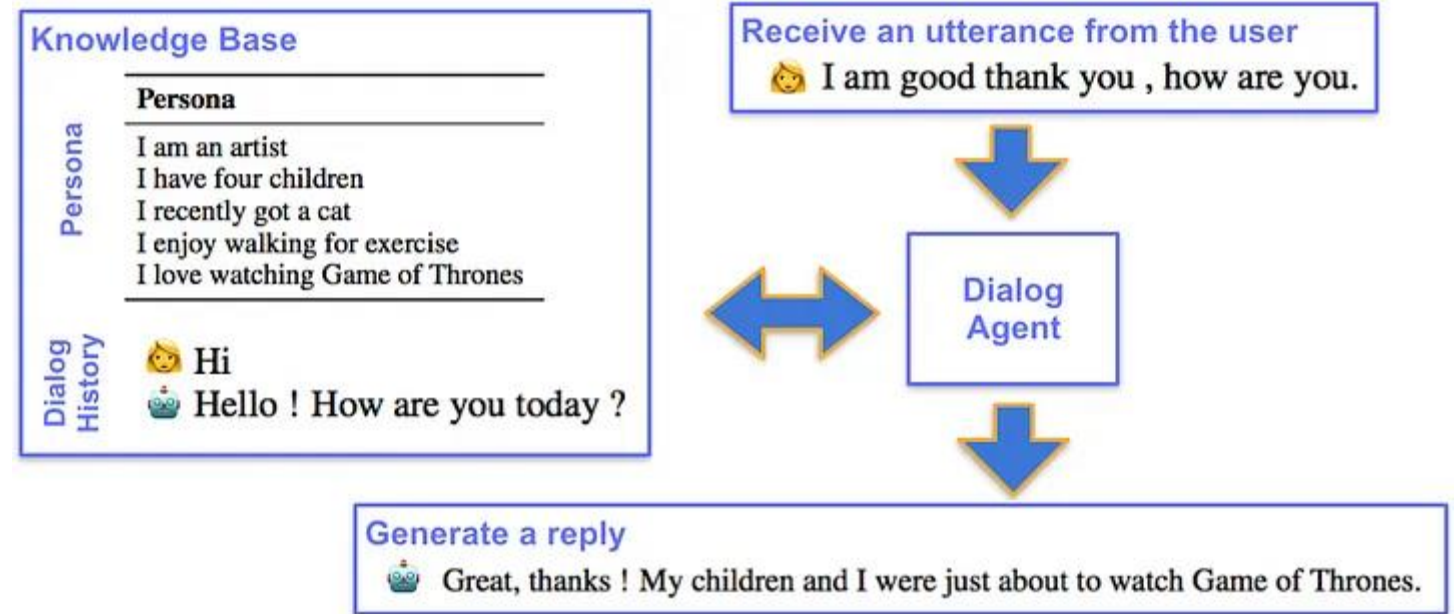
What can I help with?



Chatbots



- Modern chatbots are based on Large Language Models (LLMs), trained on large volumes of data (trillions of tokens).
- Requires **many** resources.



How can we evaluate the performance of a Chatbot?

(not as easy as it seems, check out recent ongoing research <https://arxiv.org/abs/2503.01513>)

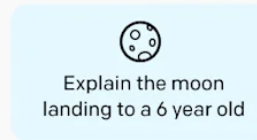
- BLEU score : Check overlap of the generated response and the ground truth.
- BERTScore : Let an LM check the semantic similarity between the two.
- How to measure helpfulness, toxicity, safety...
- In the end, the best judges are humans...

InstructGPT

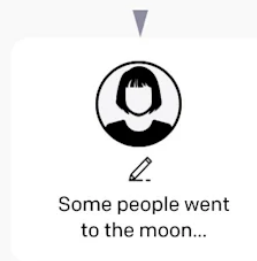
Step 1

Collect demonstration data, and train a supervised policy.

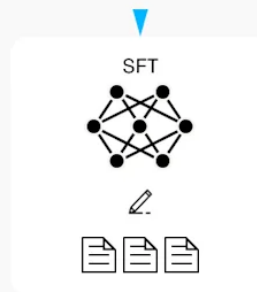
A prompt is sample from our prompt dataset.



A labeler demonstrates the desired output behavior.



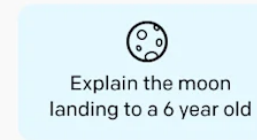
This data is used to fine-tune GPT-3 with supervised learning.



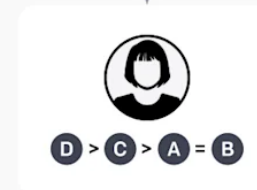
Step 2

Collect comparison data, and train a reward model.

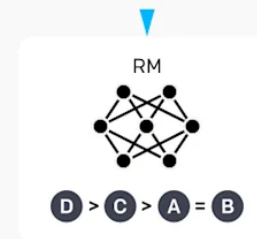
A prompt and several model outputs are sampled.



A labeler ranks the outputs from best to worst.



This data is used to train our reward model.



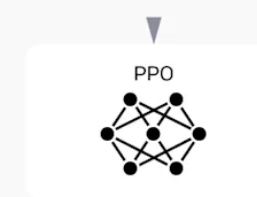
Step 3

Optimize a policy against the reward model using reinforcement learning.

A new prompt is sampled from the dataset.

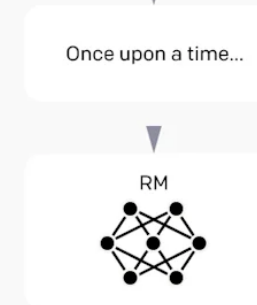


The policy generates an output.

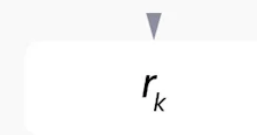


Once upon a time...

The reward model calculates a reward for the output.



The reward is used to update the policy using PPO.



(Conversational QA Systems)

Sample dialog:

USER: Where is the **Eiffel Tower** located?
ASSISTANT : ... **in Paris, France**.

Machine Reading Comprehension LM



Eiffel Tower

Article Talk

From Wikipedia, the free encyclopedia

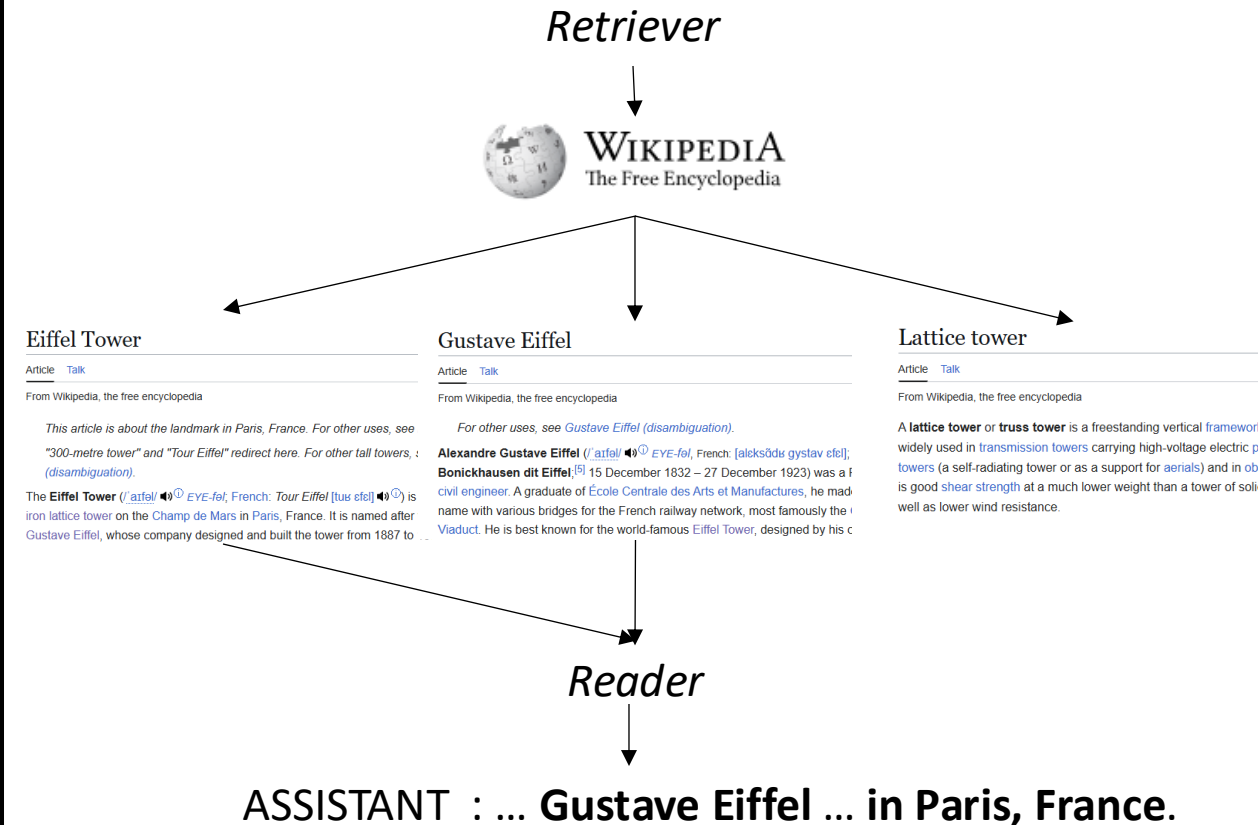
This article is about the landmark in Paris, France. For other uses, see [Eiffel Tower \(disambiguation\)](#). "300-metre tower" and "Tour Eiffel" redirect here. For other tall towers, see [List of tall towers](#).

The **Eiffel Tower** (/ˈaɪfəl/ ⓘ EYE-fəl; French: *Tour Eiffel* [tur ɛfɛl] ⓘ) is a wrought-iron lattice tower on the Champ de Mars in **Paris, France**. It is named after the engineer Gustave Eiffel, whose company designed and built the tower from **1887 to 1889**.

Locally nicknamed "*La dame de fer*" (French for "Iron Lady"), it was constructed as the centerpiece of the **1889 World's Fair**, and to crown the centennial anniversary of the **French Revolution**. Although initially criticised by some of France's leading artists and intellectuals for its design, it has since become a global **cultural icon** of France and one of the most recognisable structures in the world.^[5] The tower received 5,889,000 visitors in 2022.^[6] The Eiffel Tower is the most visited monument with an entrance fee in the world:^[7] 6.91 million people ascended it in 2015. It was designated a *monument historique* in 1964, and was named part of a **UNESCO World Heritage Site** ("Paris, Banks of the Seine") in 1991.^[8]

Sample dialog:

USER: **Who** designed the **Eiffel Tower** and where is it located?



ToDSs – The MultiWOZ 2.0 dataset

select * from restaurant

Dialogue turns

[usr] Are there any restaurants that serve proper **British** food in town?

[sys] Oh yes quite a few. Which part of town will you be dining in?

[usr] **West**, if possible.

[sys] We have three: Graffiti, Saint John's Chop House, and Traveller.

[usr] Will you give me the **phone number**, **address**, and **postcode** for Graffiti?

[sys] The phone number is **01223277977**. The address is **Hotel Felix Whitehouse Lane Hunthindon Road** and post code is **cb30lx**. Want to book?

[usr] 6 people, please.

[sys] Booking is successful. Reference number is **00000081**.

Blue : Informable slot

Yello-Green : Requestable slot name

Orange : Requestable slot value

ToDSs – The MultiWOZ 2.0 dataset

select * from restaurant where food="british" and area="west"

Goal

Domain : "restaurant"

Informable	"food" : "british" "area" : "west"
Requestable	
Book	

Database (restaurant)

```
"ref" : "00000081"  
  "name" : "graffiti"  
  "phone" : "01223277977"  
  "postcode" : "cb30lx"  
  "address" : "Hotel Felix Whitehouse Lane Hunthindon Road"  
  "food" : "british"  
  "area" : "west"      :  
  
"ref" : "00000084"  
  "name" : "grifton hotel restaurant"  
  "phone" : "01223241387"  
  "postcode" : "cb580a"  
  "address" : "Grifton Hotel 619 Newmarket Road Fen Ditton"  
  "food" : "british"  
  "area" : "east"      :
```

Dialogue turns

[usr] Are there any restaurants that serve proper **British** food in town?
[sys] Oh yes quite a few. Which part of town will you be dining in?
[usr] **West**, if possible.
[sys] We have three: Graffiti, Saint John's Chop House, and Traveller.
[usr] Will you give me the **phone number**, **address**, and **postcode** for Graffiti?
[sys] The phone number is **01223277977**. The address is **Hotel Felix Whitehouse Lane Hunthindon Road** and post code is **cb30lx**. Want to book?
[usr] 6 people, please.
[sys] Booking is successful. Reference number is **00000081**.

Blue : Informable slot

Yello-Green : Requestable slot name

Orange : Requestable slot value

ToDSs – The MultiWOZ 2.0 dataset

select **phone**, **address**, **postcode** from restaurant where ...

Goal

Domain : "restaurant"

Informable	"food" : "british" "area" : "west"
Requestable	"phone" "address" "postcode"
Book	

Database (restaurant)

```
"ref" : "00000081"  
  "name" : "graffiti"  
  "phone" : "01223277977"  
  "postcode" : "cb30lx"  
  "address" : "Hotel Felix Whitehouse Lane Hunthindon Road"  
  "food" : "british"  
  "area" : "west"      :  
  
"ref" : "00000084"  
  "name" : "grifton hotel restaurant"  
  "phone" : "01223241387"  
  "postcode" : "cb580a"  
  "address" : "Grifton Hotel 619 Newmarket Road Fen Ditton"  
  "food" : "british"  
  "area" : "east"      :
```

Dialogue turns

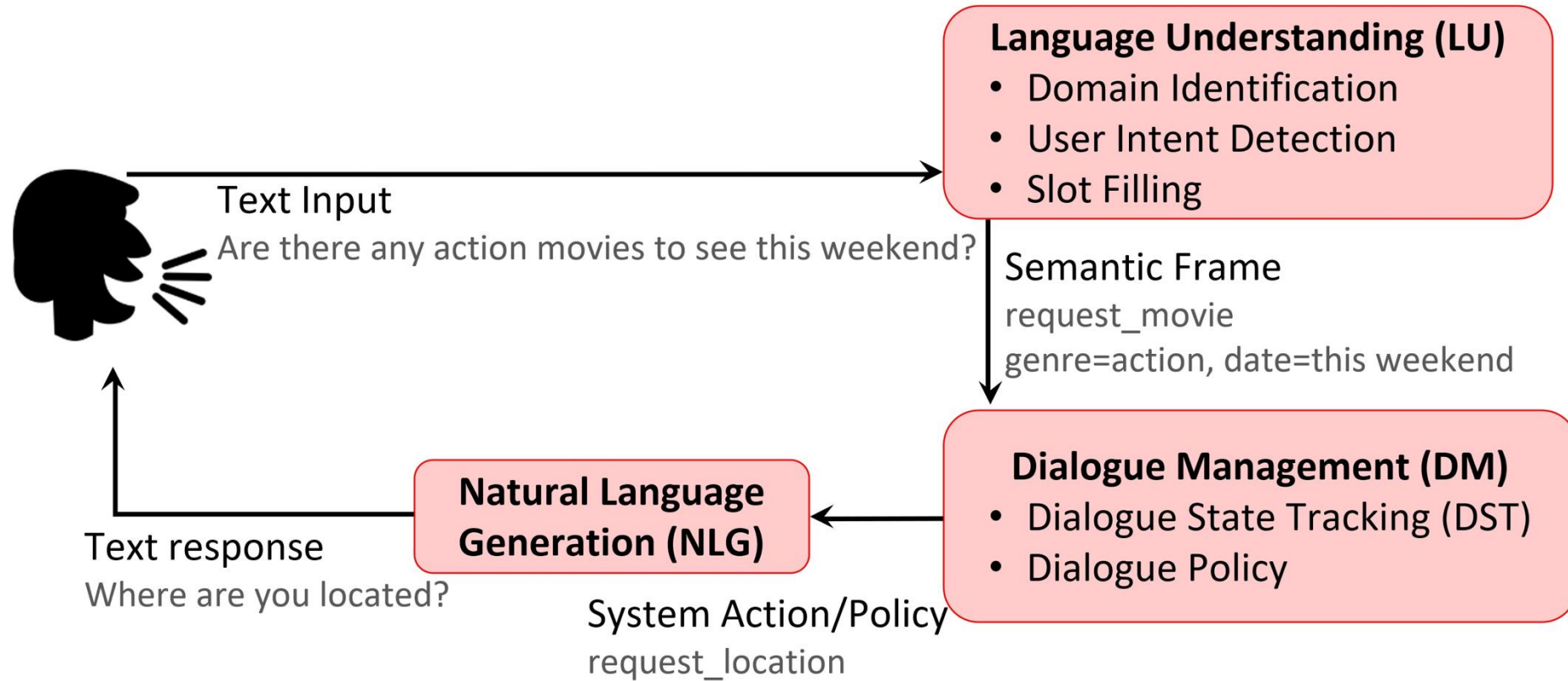
[usr] Are there any restaurants that serve proper **British** food in town?
[sys] Oh yes quite a few. Which part of town will you be dining in?
[usr] **West**, if possible.
[sys] We have three: Graffiti, Saint John's Chop House, and Traveller.
[usr] Will you give me the **phone number**, **address**, and **postcode** for Graffiti?
[sys] The phone number is **01223277977**. The address is **Hotel Felix Whitehouse Lane Hunthindon Road** and post code is **cb30lx**. Want to book?
[usr] 6 people, please.
[sys] Booking is successful. Reference number is **00000081**.

Blue : Informable slot

Yello-Green : Requestable slot name

Orange : Requestable slot value

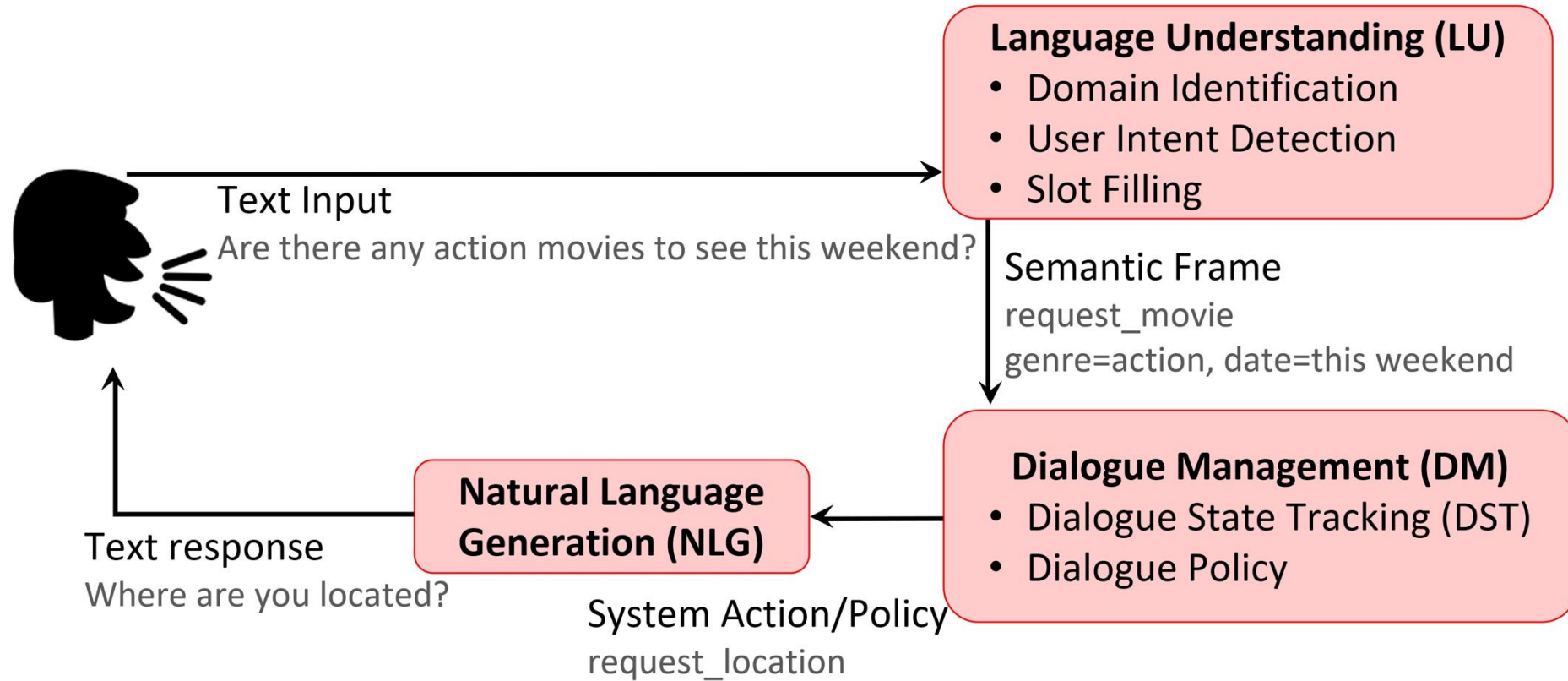
The traditional ToDS pipeline



(Natural) Language Understanding:

- Accuracy, F1, ... for Domain and Intent
- Slot accuracy for slots (per utterance)

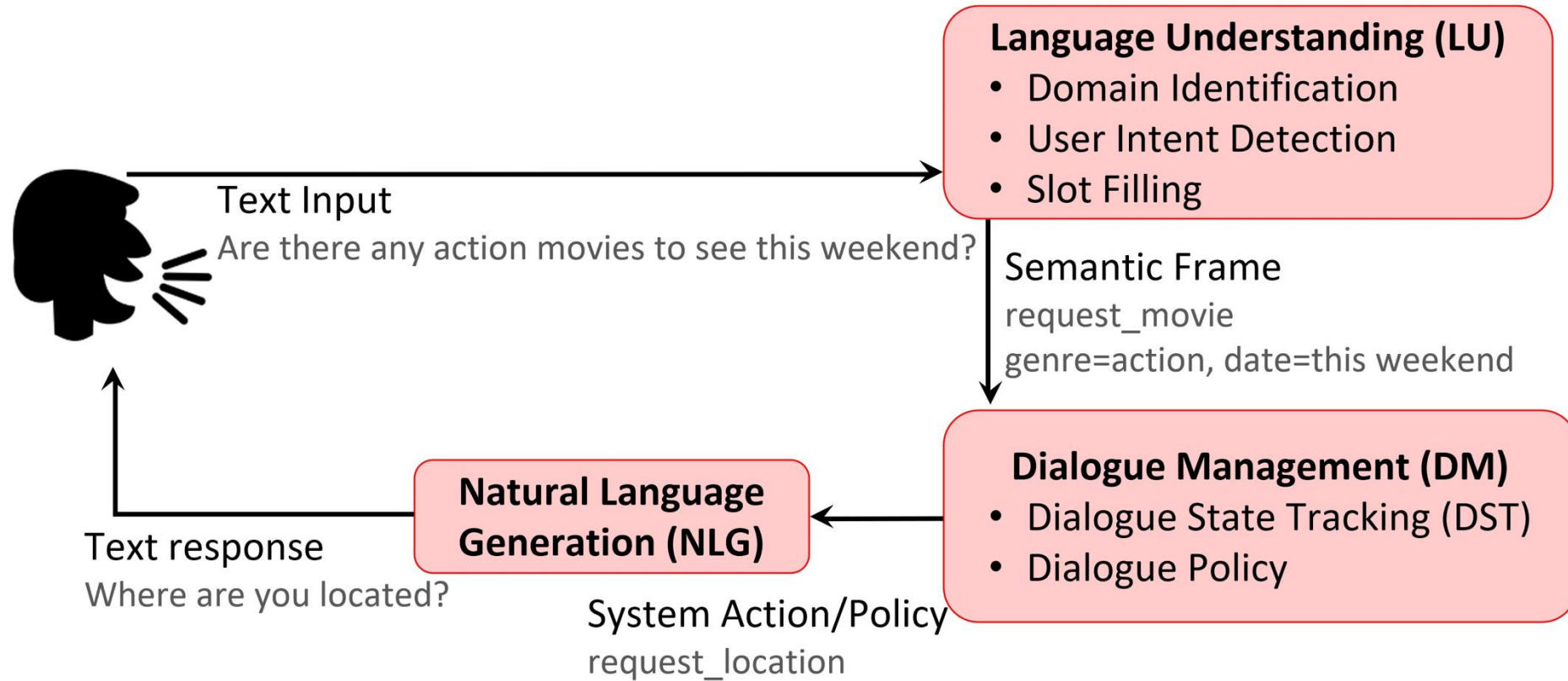
The traditional ToDS pipeline



Dialog Manager:

- Joint Accuracy for DST
- Accuracy, F1, ... for Policy

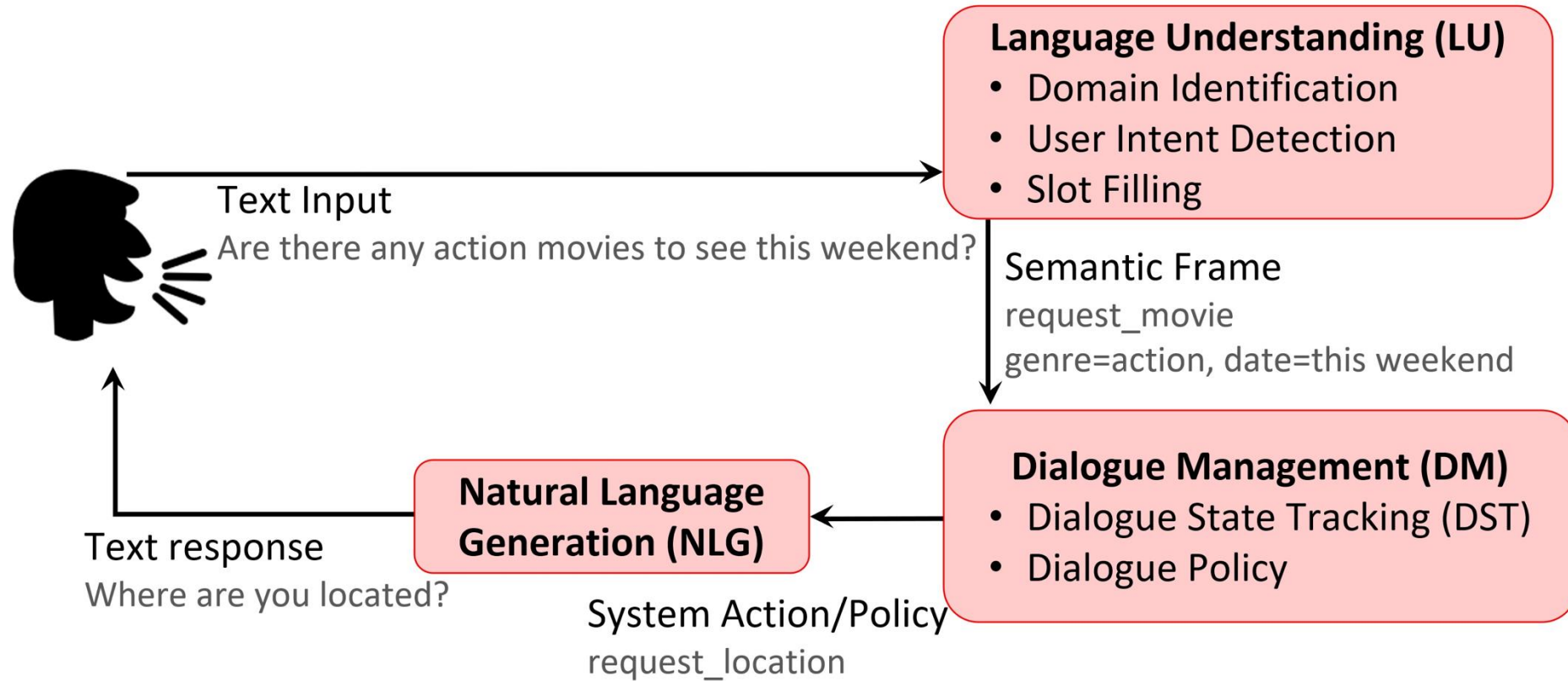
The traditional ToDS pipeline



Natural Language Generation:

- BLEU, BERTScore, ... as we did for Chatbots

The traditional ToDS pipeline



End-to-End (for MultiWOZ):

- BLEU (fluency)
- Inform (correct entity/entities)
- Success (all information provided)

$$(\text{INFORM} + \text{SUCCESS}) * 0.5 + \text{BLEU}$$

Modern Task-oriented Dialog Systems

