



Entertaining and Informative Open-domain Social Dialogue using Ontologies and Entity Linking

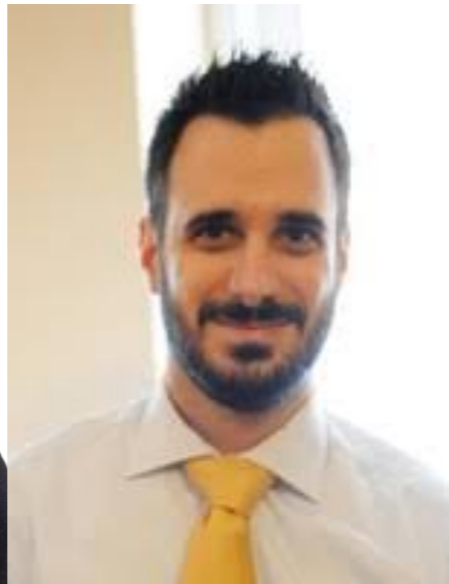
Yannis Konstas



Shubham
Agarwal



Amanda
Cercas Curry



Ioannis
Papaioannou



Igor
Shalyminov



Alessandro
Suglia



Xinnuo
Xu



Dr. Ondřej
Dušek



Dr. Arash
Eshgi



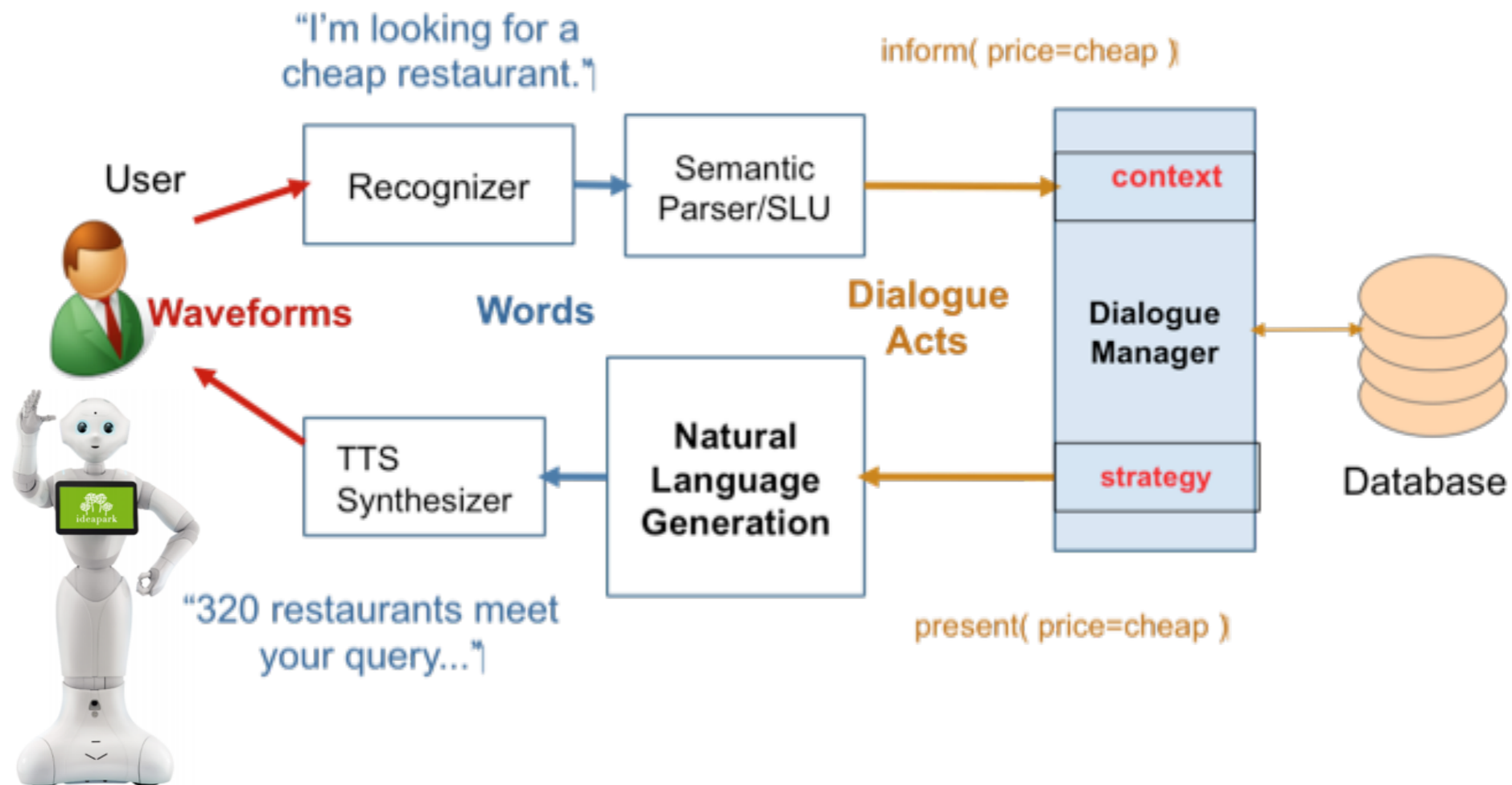
Prof. Verena
Rieser



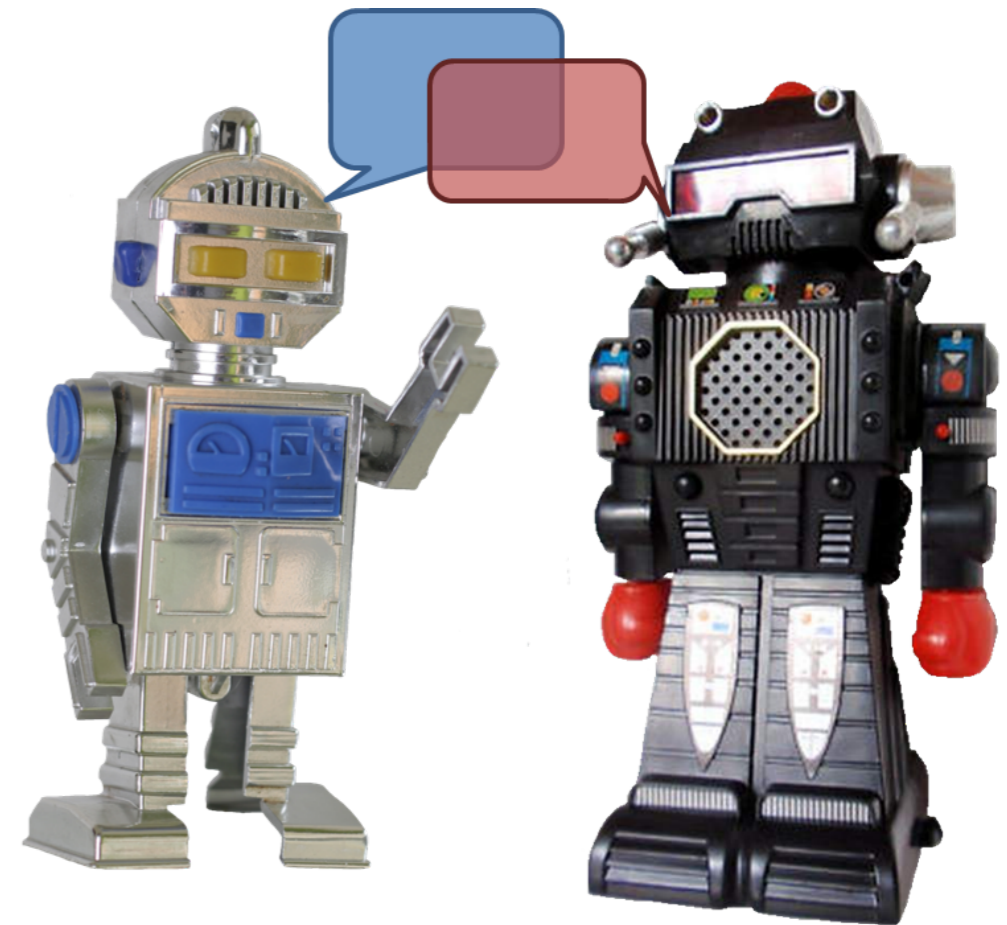
Prof. Oliver
Lemon

Spoken Dialogue Systems

- Multimodal Interfaces
- Human-Robot Interaction
- Transactional Systems

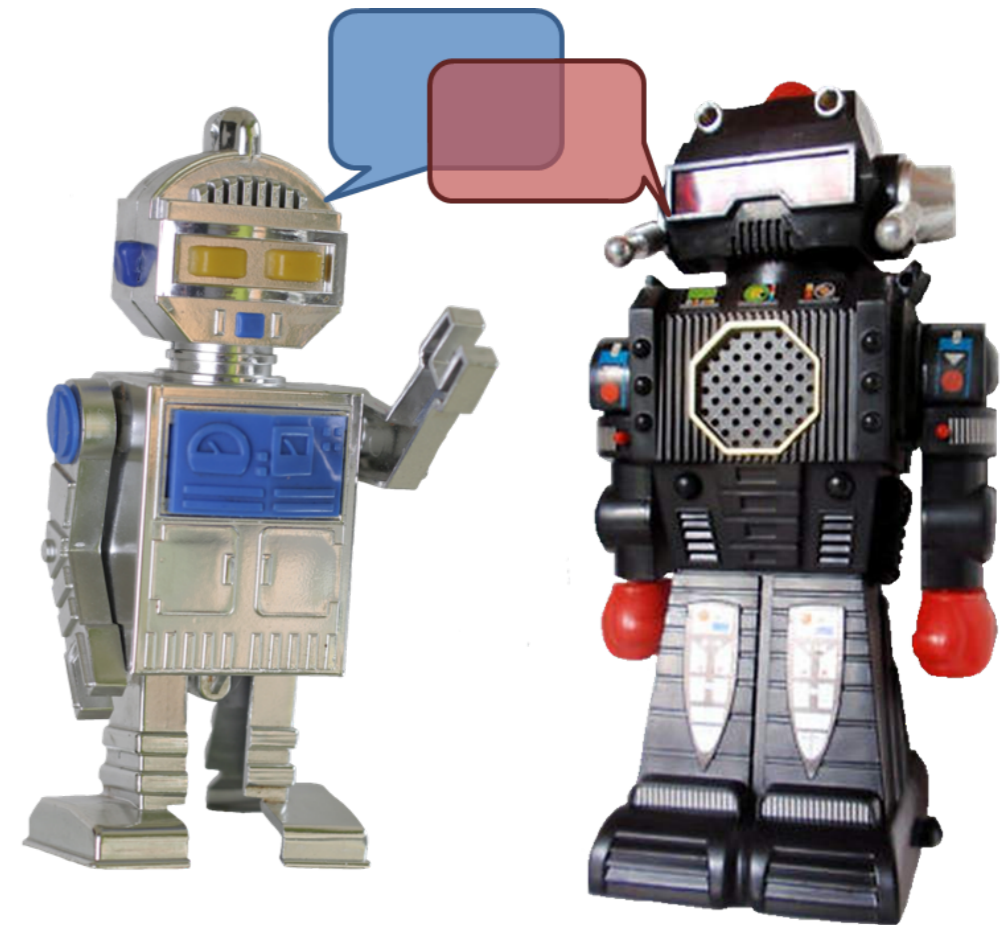


From tasks to social chat



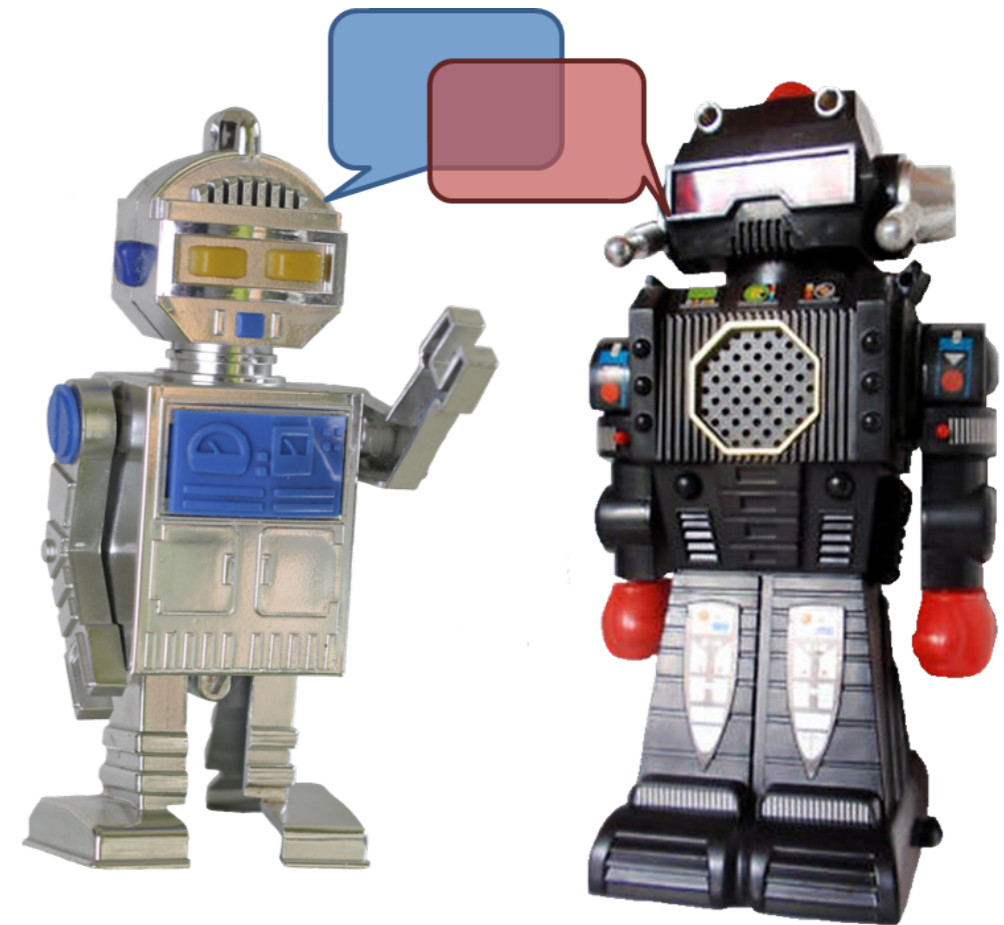
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- Many **task-based** systems: Siri, Cortana, ..., etc



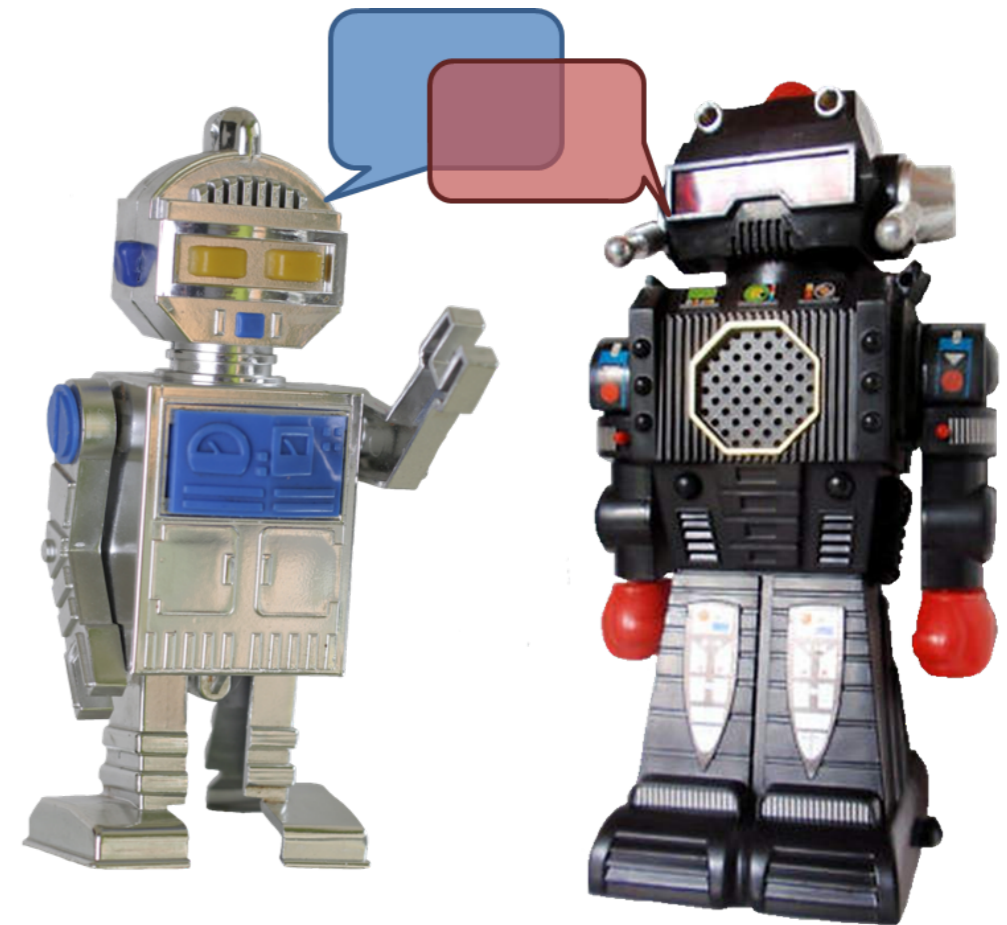
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- But people don't really want to use them!
 - ▶ User experience needs to be more **fun & engaging**: **social conversation**



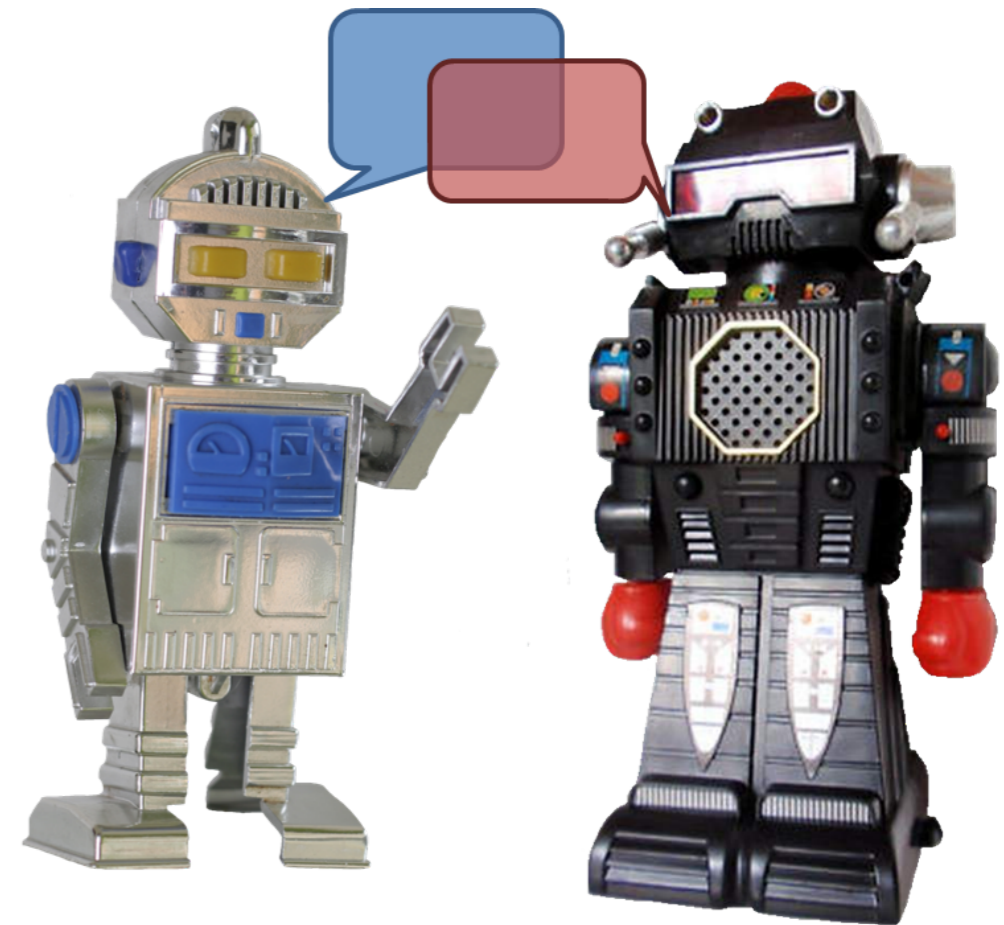
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From tasks to social chat

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- c.f. *early days* of web-based GUI
- **Embed tasks within general chat**



Alexa Prize Challenge

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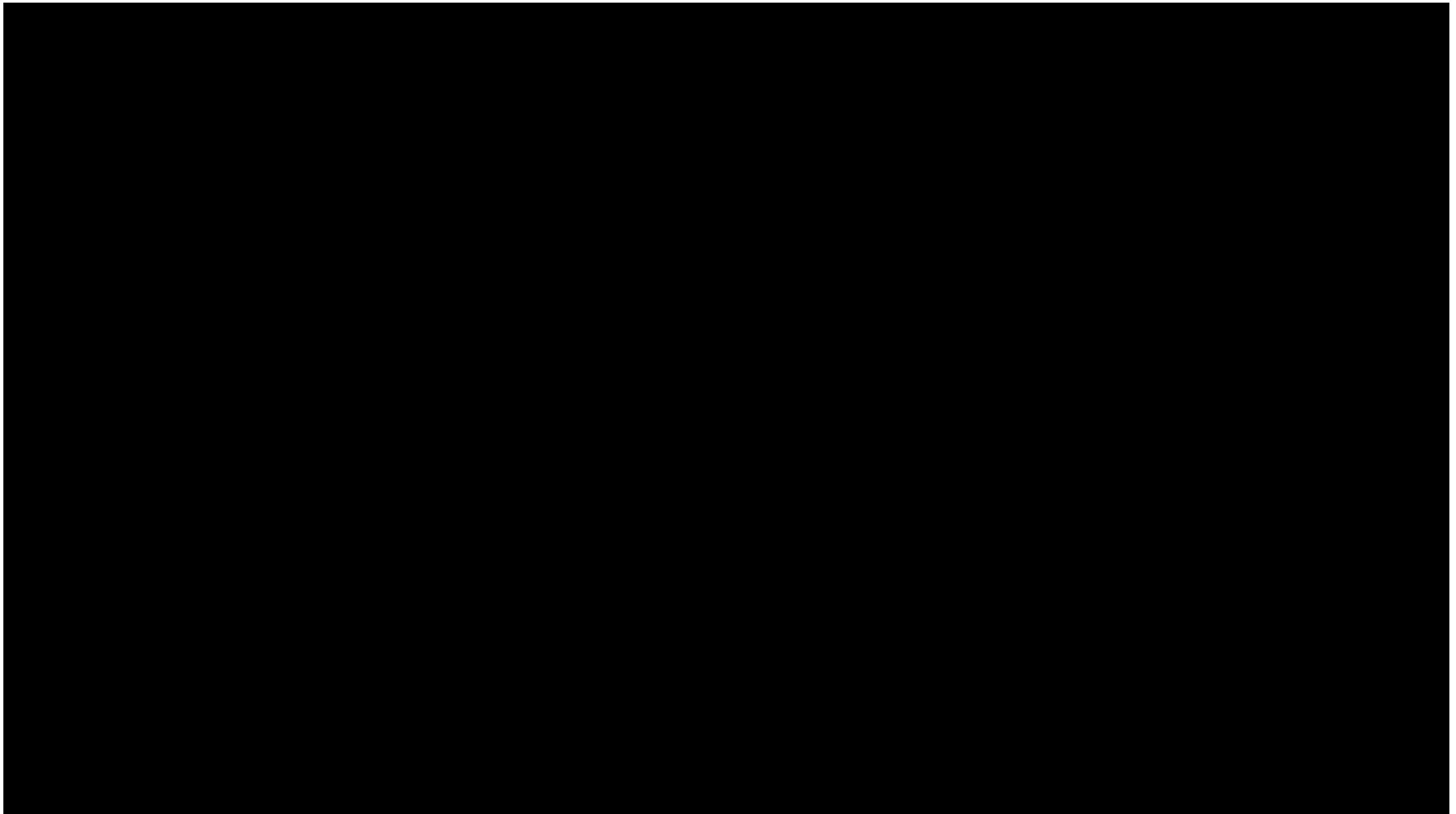
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- Team **Alana** (HWU)
 - ▶ 2017: **finalists**, 3rd place (out of >100 applicants / 15 teams)
 - ▶ 2018: **finalists**, 3rd place (out of ~200 applicants / 8 teams)



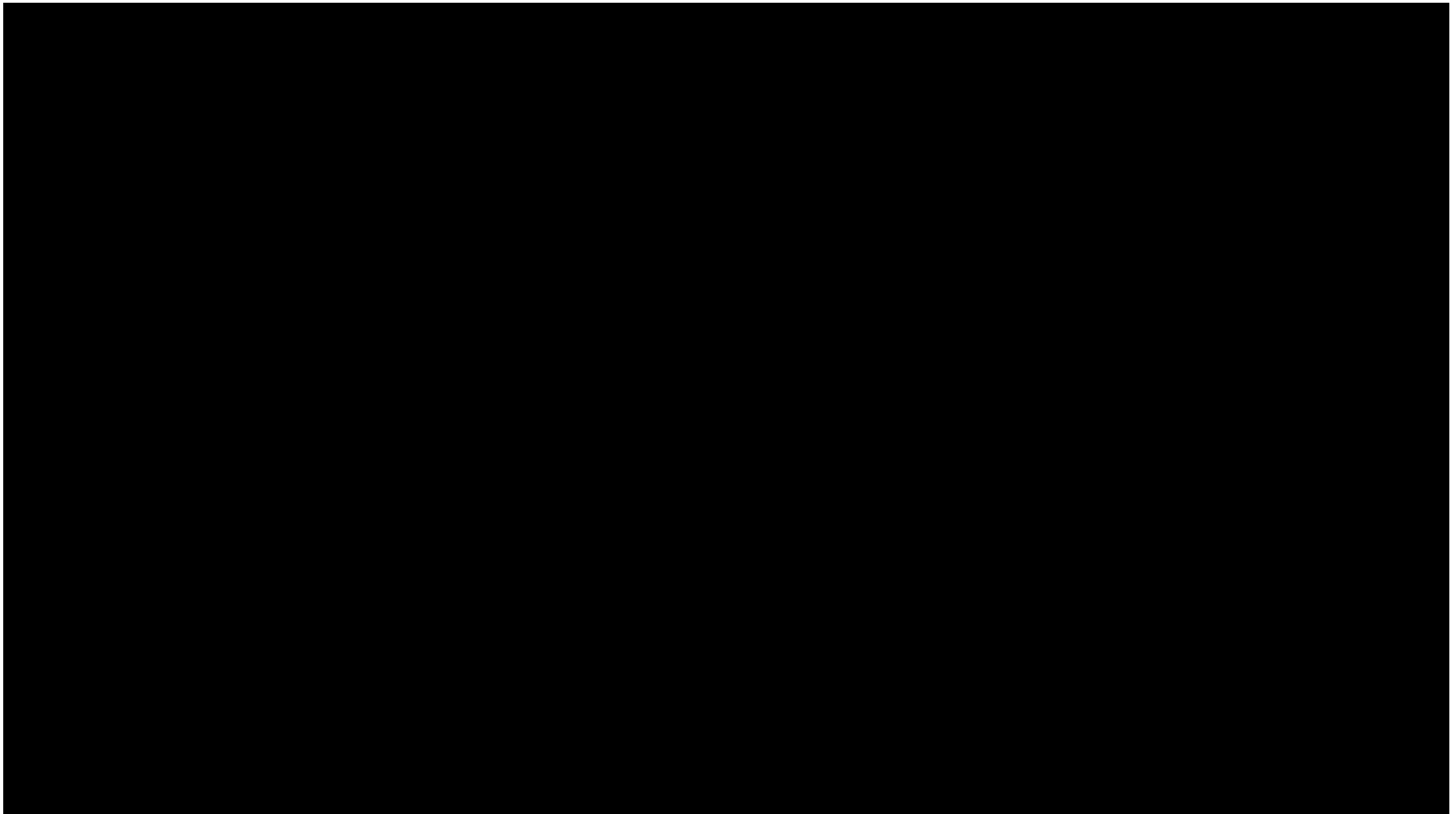
Alana on TV

- [BBC Four - The Joy of AI](#)



Alana on TV

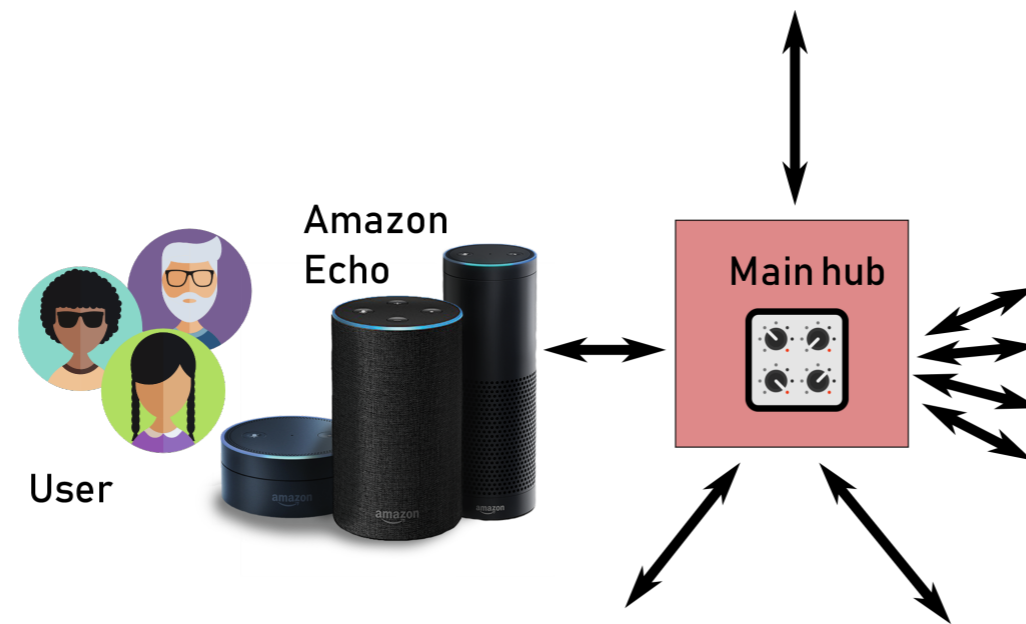
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Alana Architecture

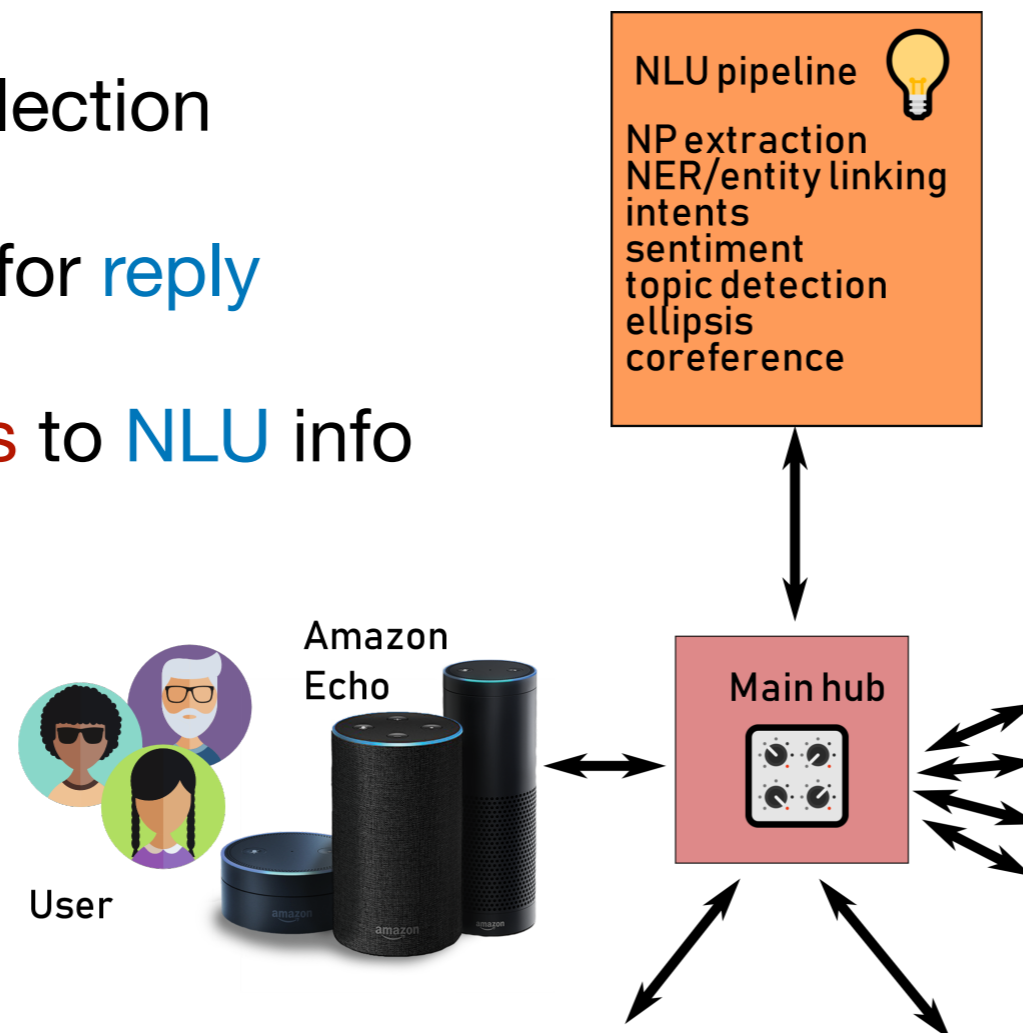
Alana Architecture

- Ensemble + selection
- Bots **compete** for **reply**



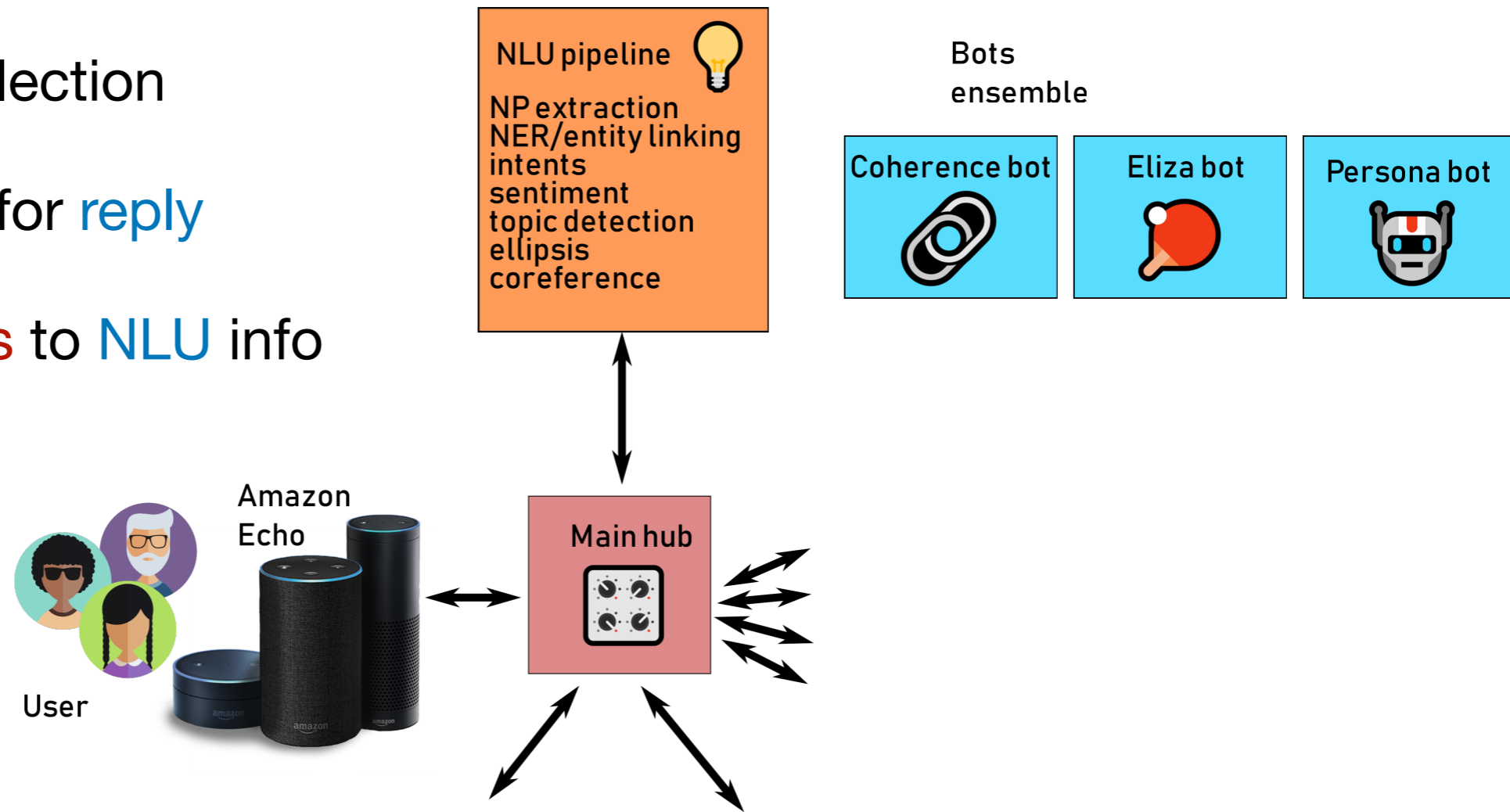
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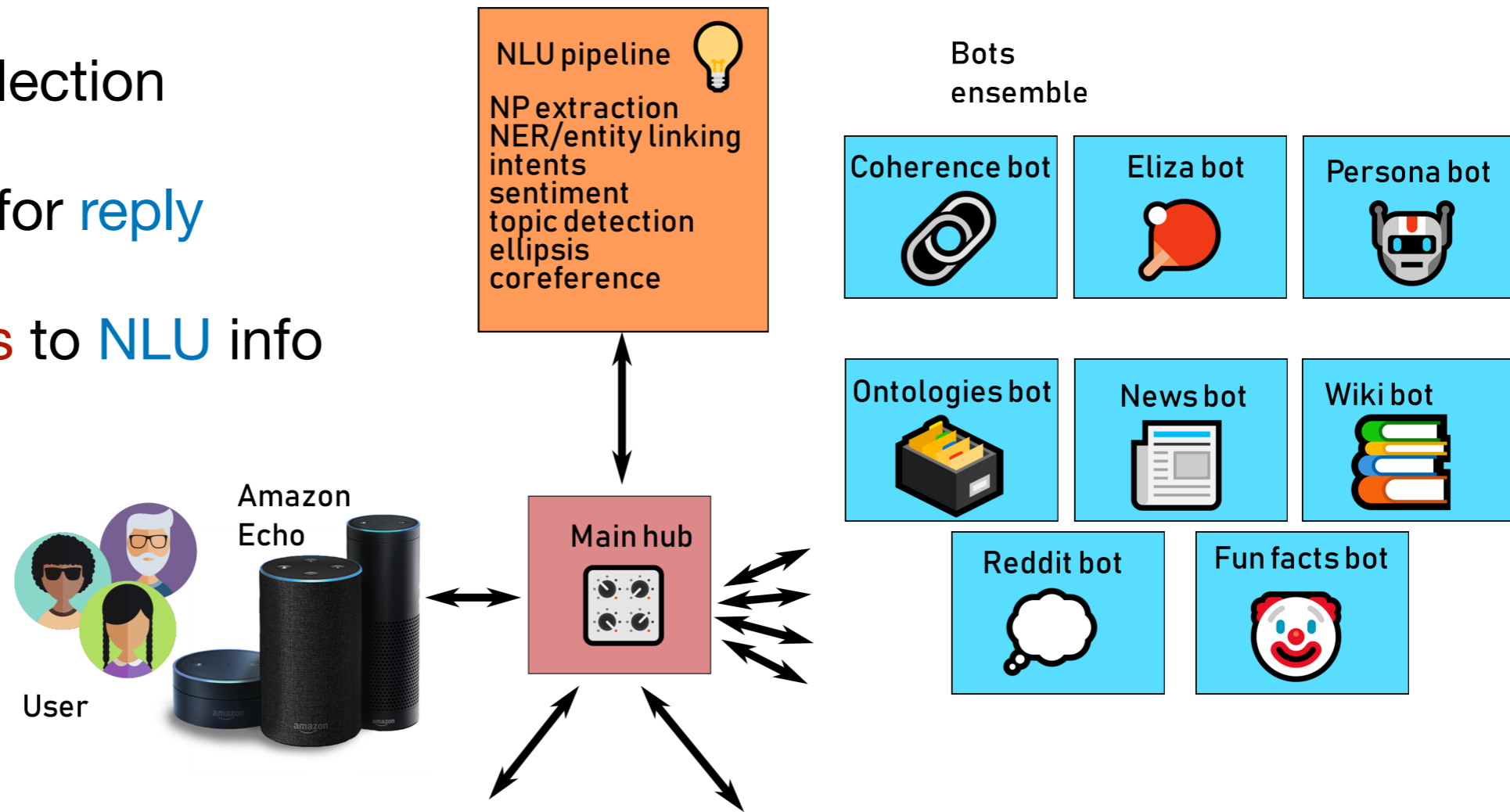
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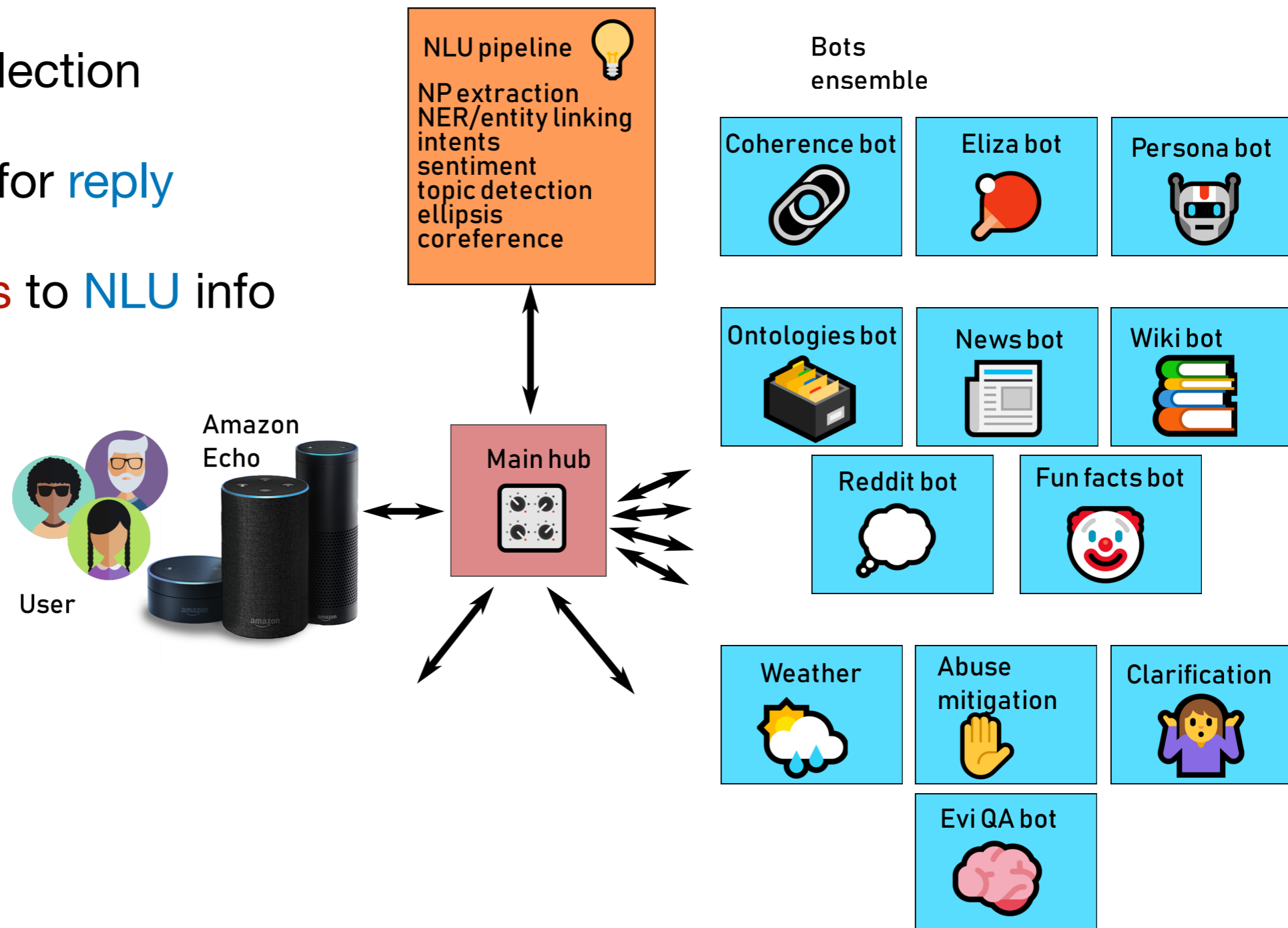
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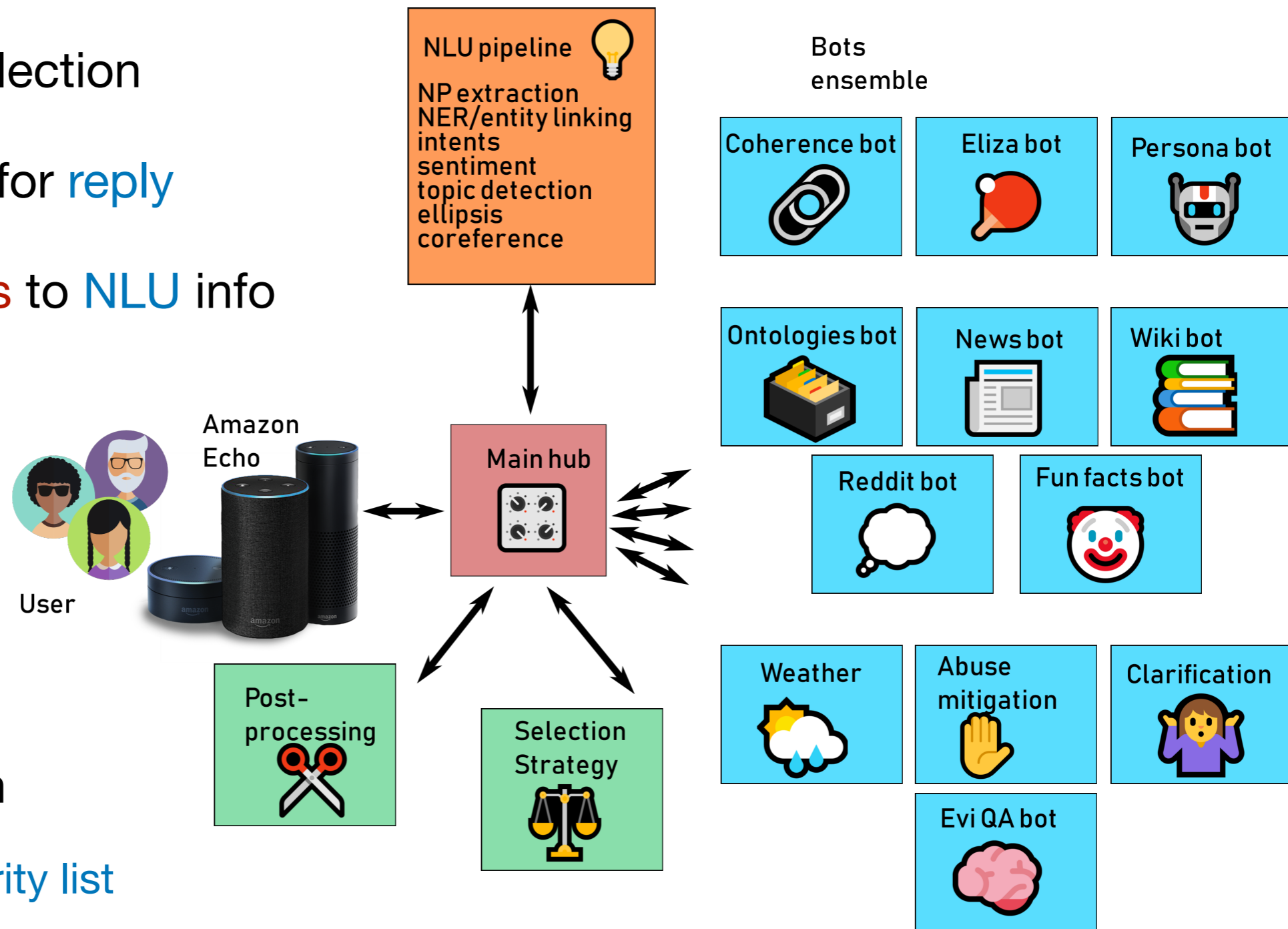
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- Bot types:
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 - ▶ **content**
 - ▶ **service**
- Reply selection
 - ▶ currently: **priority list**



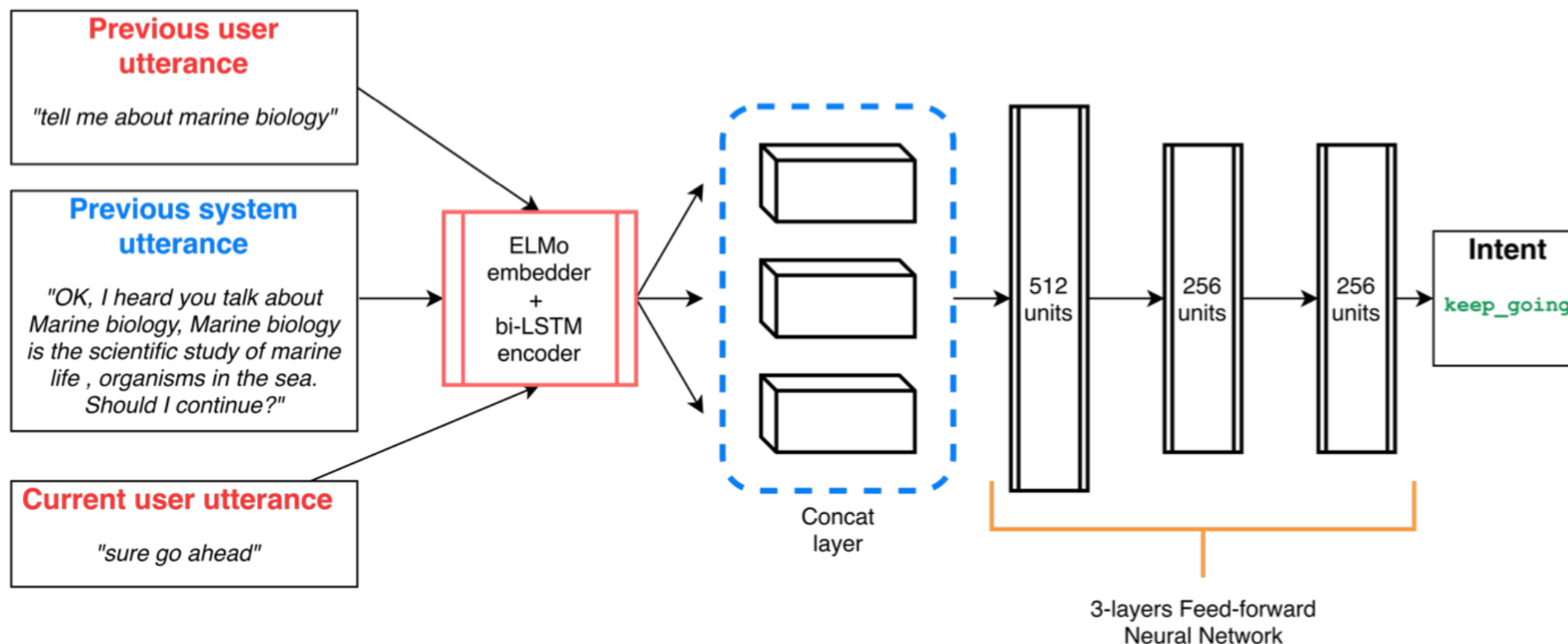
NLU Pipeline: Intent Classifier

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 - ▶ Regular Expressions on Previous user utterance
 - High Precision

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 - ▶ Neural Intent Classifier
 - High Recall



Bot Architecture: Inference Engine

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- Bot State

- ▶ User utterance
- ▶ ASR confidence scores
- ▶ NLU Pipeline
 - Intent
 - NEs, Parameters
 - Topic
 - ...

```
User: 'tell me more about George Clooney'  
Intent: tell_me_about  
Parameters: 'George Clooney'  
Linked Entity: 'WD: Q23844'  
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Prev bot: coherence_bot  
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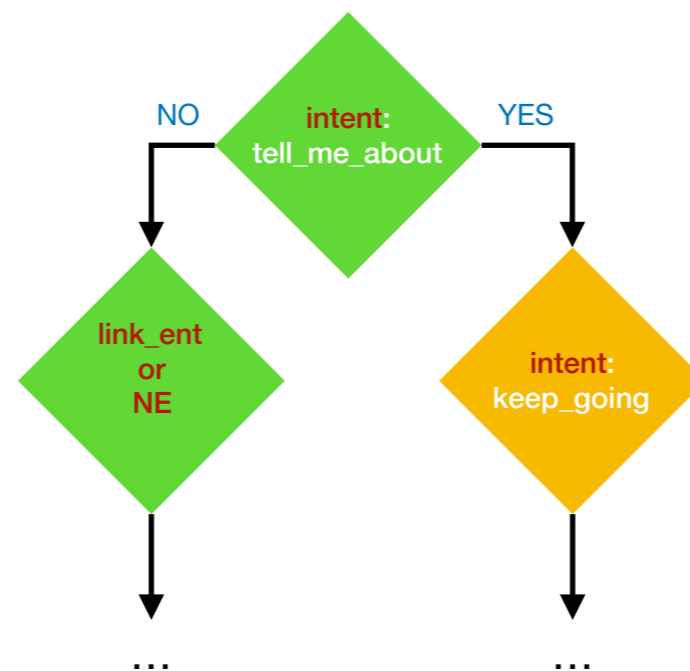
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- Condition - Trigger

- Any part of the state
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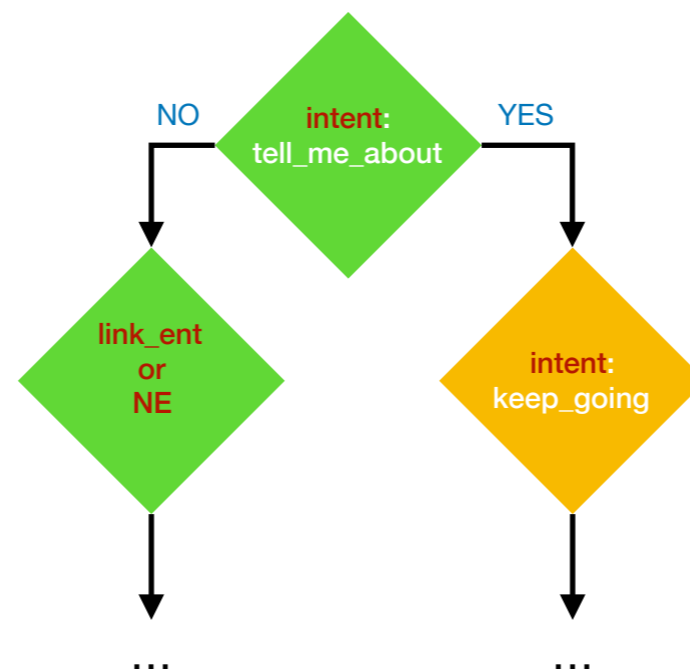
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- Action

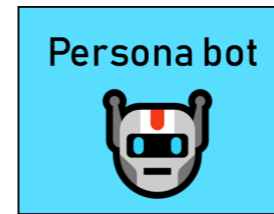
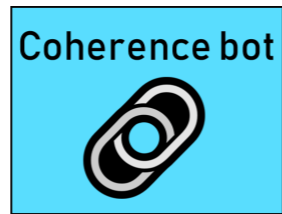
- Retrieve content
 - Hand-crafted responses
 - Database
 - Knowledge Base
 - Graph Database
 - Lucene Index
- Update state
- Generate response
 - Template-based NLG

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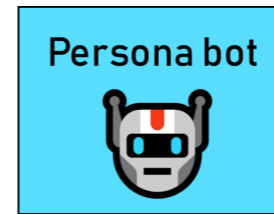
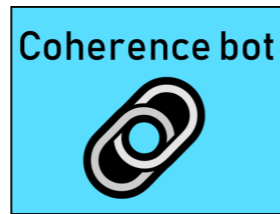


[Ontology bot]
'George Clooney is an American actor. [Trivia]

Rule-based bots

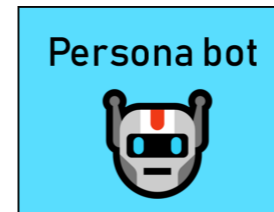
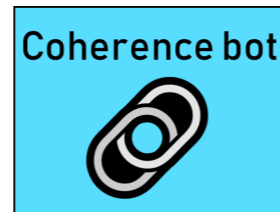


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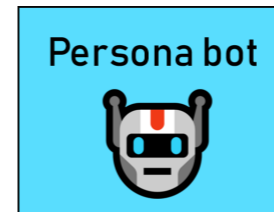
- Topical turns
 - **Alana:** So, talking about [music/books](#)...

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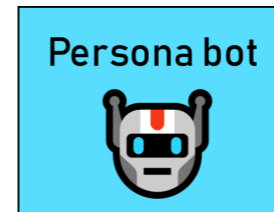
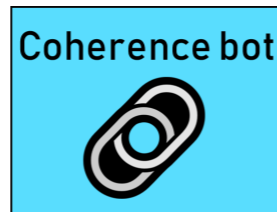
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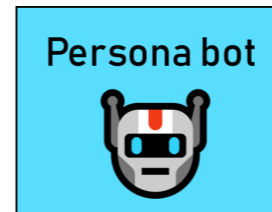
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- User simulation
 - ▶ **Alana:** Since I **remember** that you like **movies**, [...] What movie are you looking forward to watching?

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 - ▶ **Alana:** Since I **remember** that you like **movies**, [...] What movie are you looking forward to watching?
- Chit-chat **open-ended** multiple turns
 - ▶ **Alana:** What is your greatest fear?
 - ▶ **User:** Blah
 - ▶ **Alana:** Mine is losing my voice.

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- Chit-chat **open-ended** multiple turns
 - ▶ **Alana:** What is your greatest fear?
 - ▶ **User:** Blah
 - ▶ **Alana:** Mine is losing my voice.
- Alana has a persona: favourite movie, colour. Has humour...
 - ▶ **User:** Where do you live?
 - ▶ **Alana:** I live in the cloud!

Retrieval bots



Retrieval bots



- Trigger

- ▶ Linked Entity

- Yahoo! Fast Entity Linker [Blanco, Roi, Ottaviano, Giuseppe, and Meij, Edgar. Fast and space-efficient entity linking in queries. WSDM 15]

- ▶ Named Entity

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- Retrieve

- ▶ Knowledge Base: Wikidata

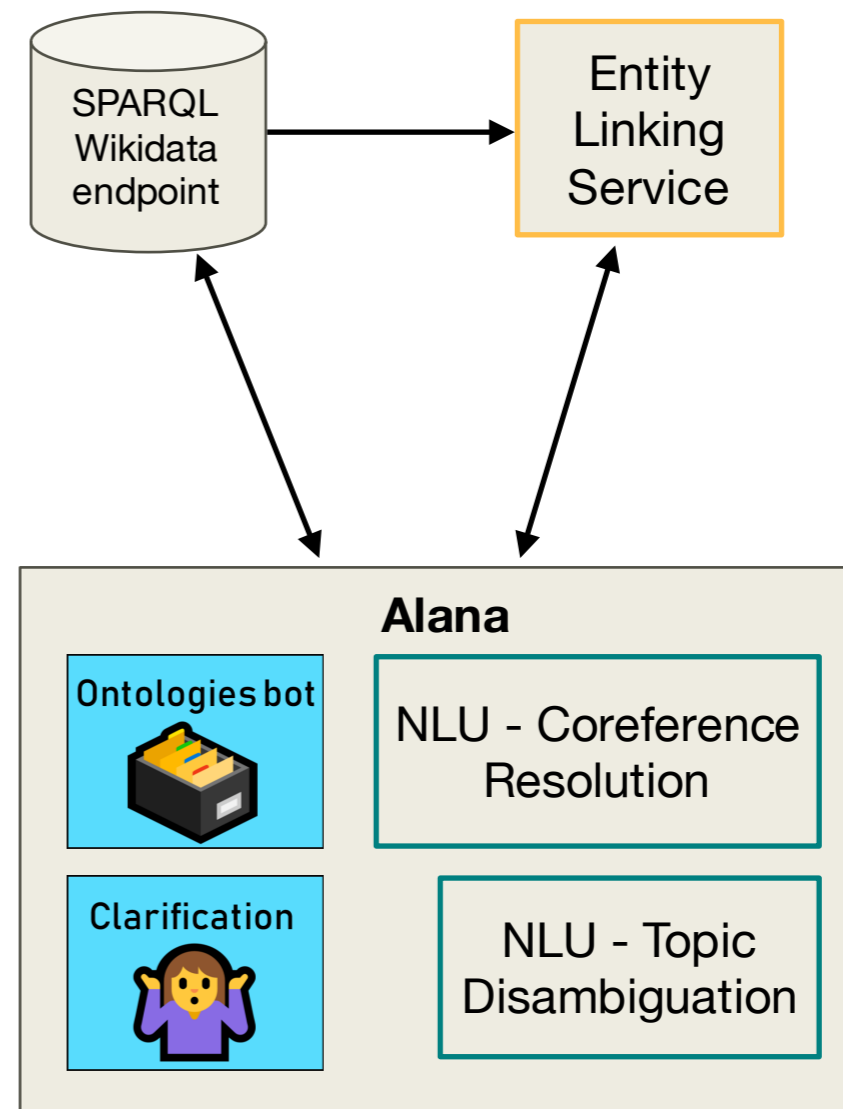
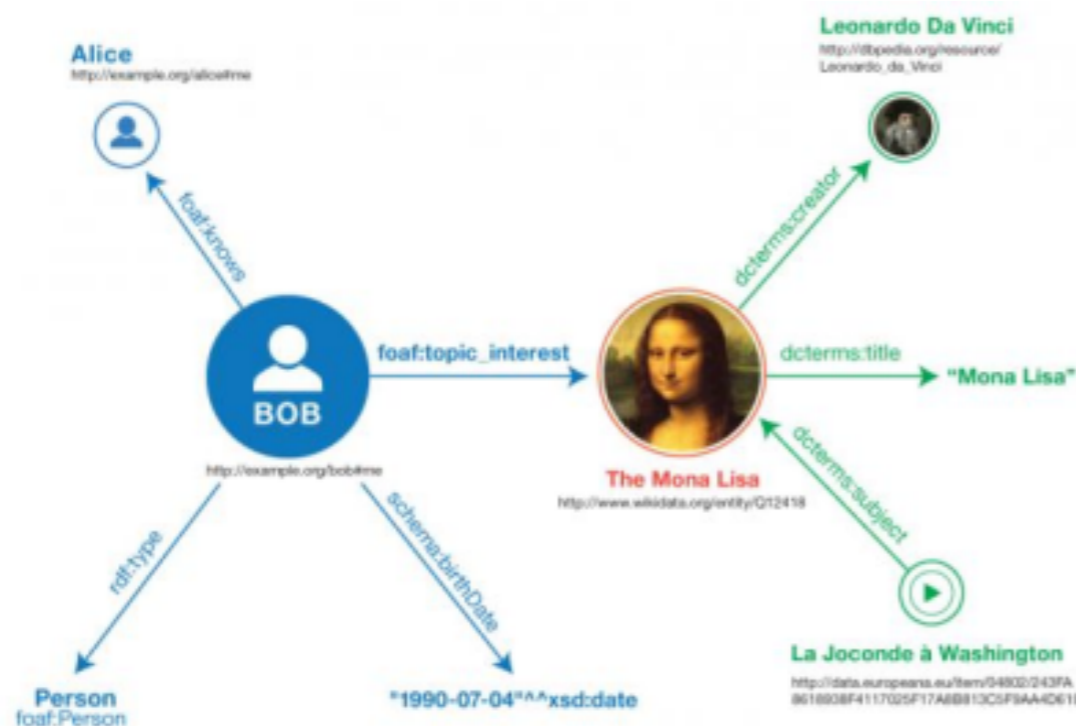
- ▶ Graph-based datastore of News Articles (NewsApi) summaries

- ▶ Database: Wikipedia

- ▶ Index: curated sub-reddits

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Grounding with a Knowledge Base (1/2)



Grounding with a Knowledge Base (2/2)

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User Utterance

Tell me about
Angels and
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Grounding with a Knowledge Base (2/2)

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System question

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User confirmation

The movie

Grounding with a Knowledge Base

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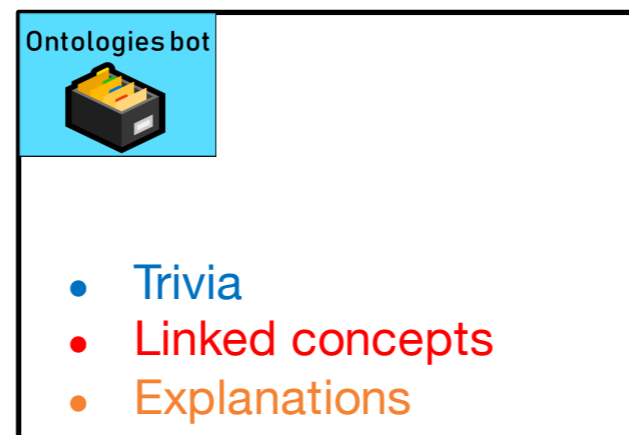
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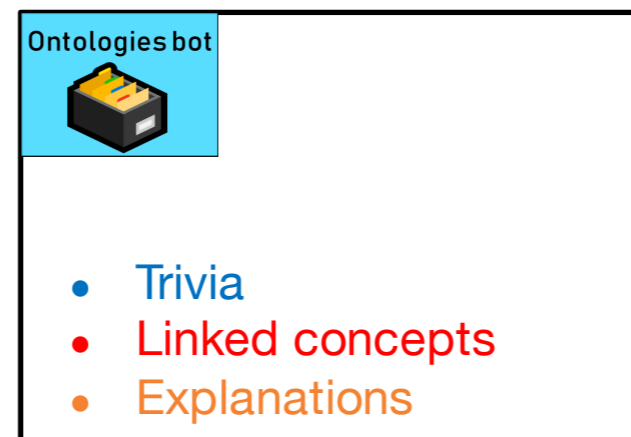
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System Response 1

I heard something interesting about Angels and Demons. 'Naomi Watts' was originally cast as Vittoria. [... some more trivia exciting stuff]



Grounding with a Knowledge Base (2/2)

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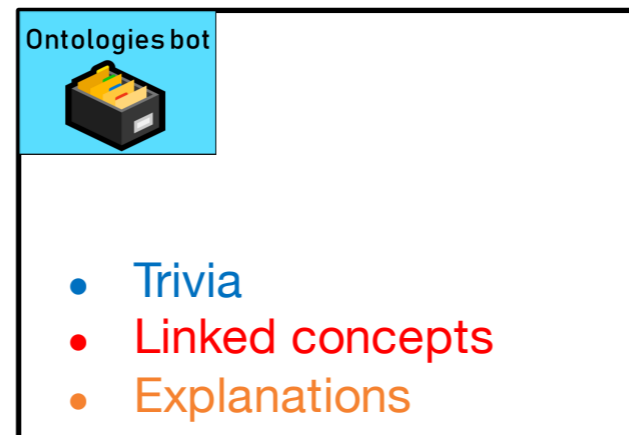
System Response 2

Oh I really like Angels and Demons! That's probably because Angels and Demons is a **drama film movie**. I guess you know that "**The Silence of the Lambs**" is the same type of movie.



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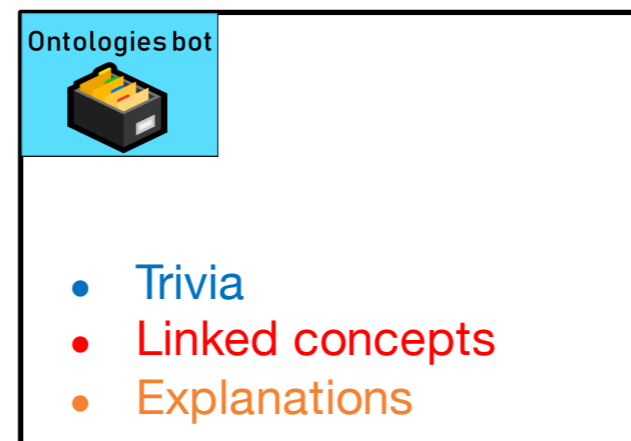
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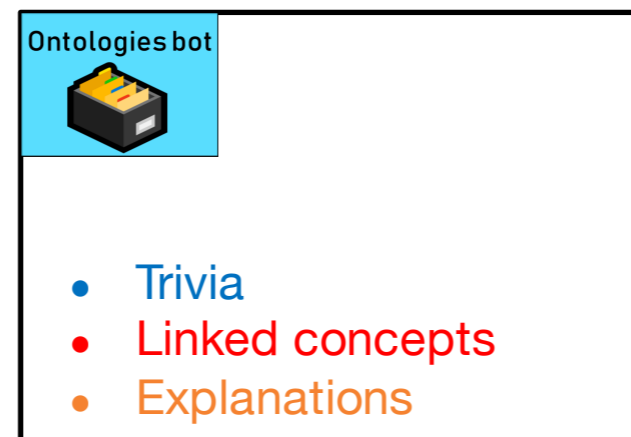
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Oh, I have never heard about it



System Response

Yes! The Silence of the Lambs is an awesome 1991 thriller movie. It has 8.6 rating on IMDB. Directed by Jonathan Demme, its cast includes Jodie Foster and Anthony Hopkins. [...]





Grounding with a News Graph (1/2)

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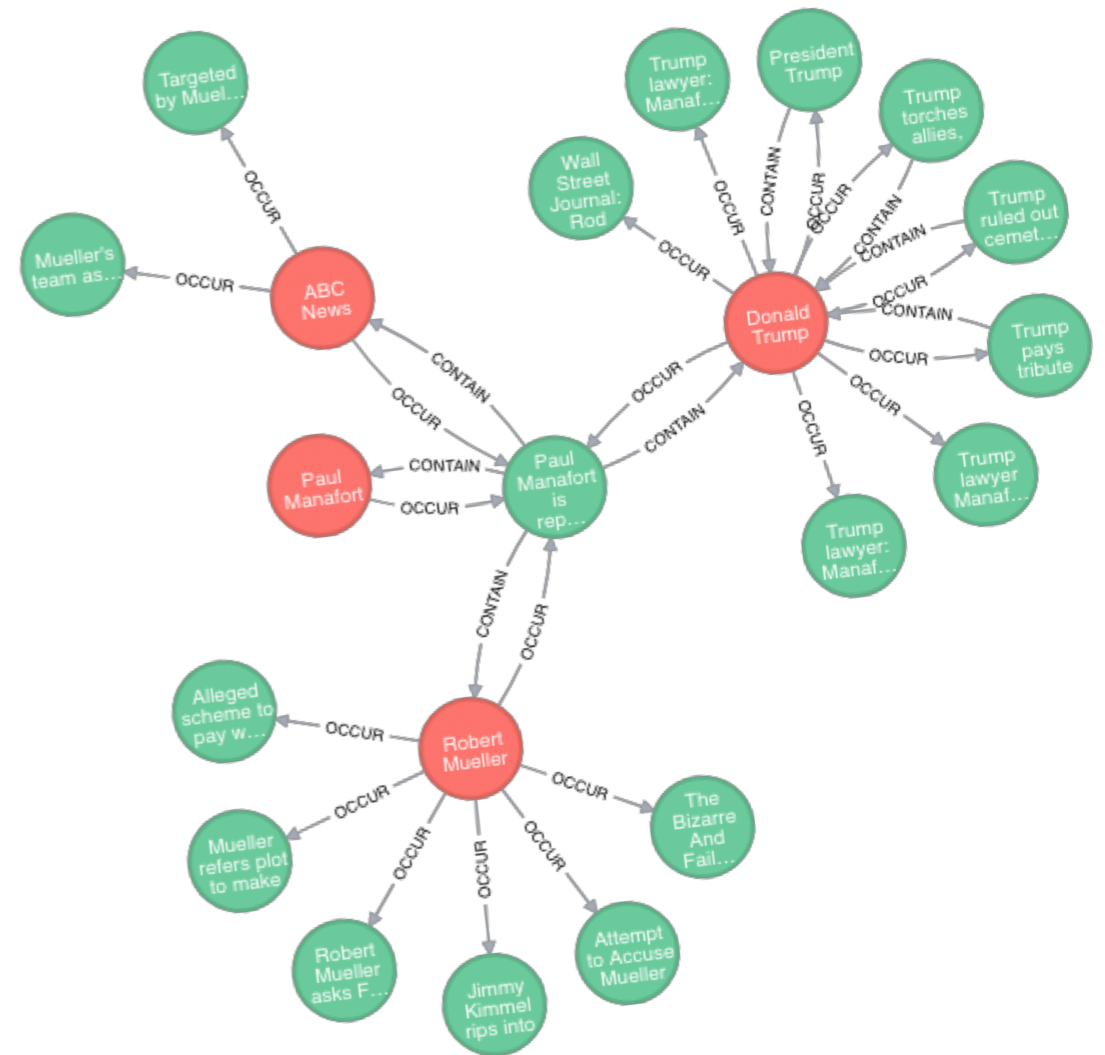


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Grounding with a News Graph (1/2)



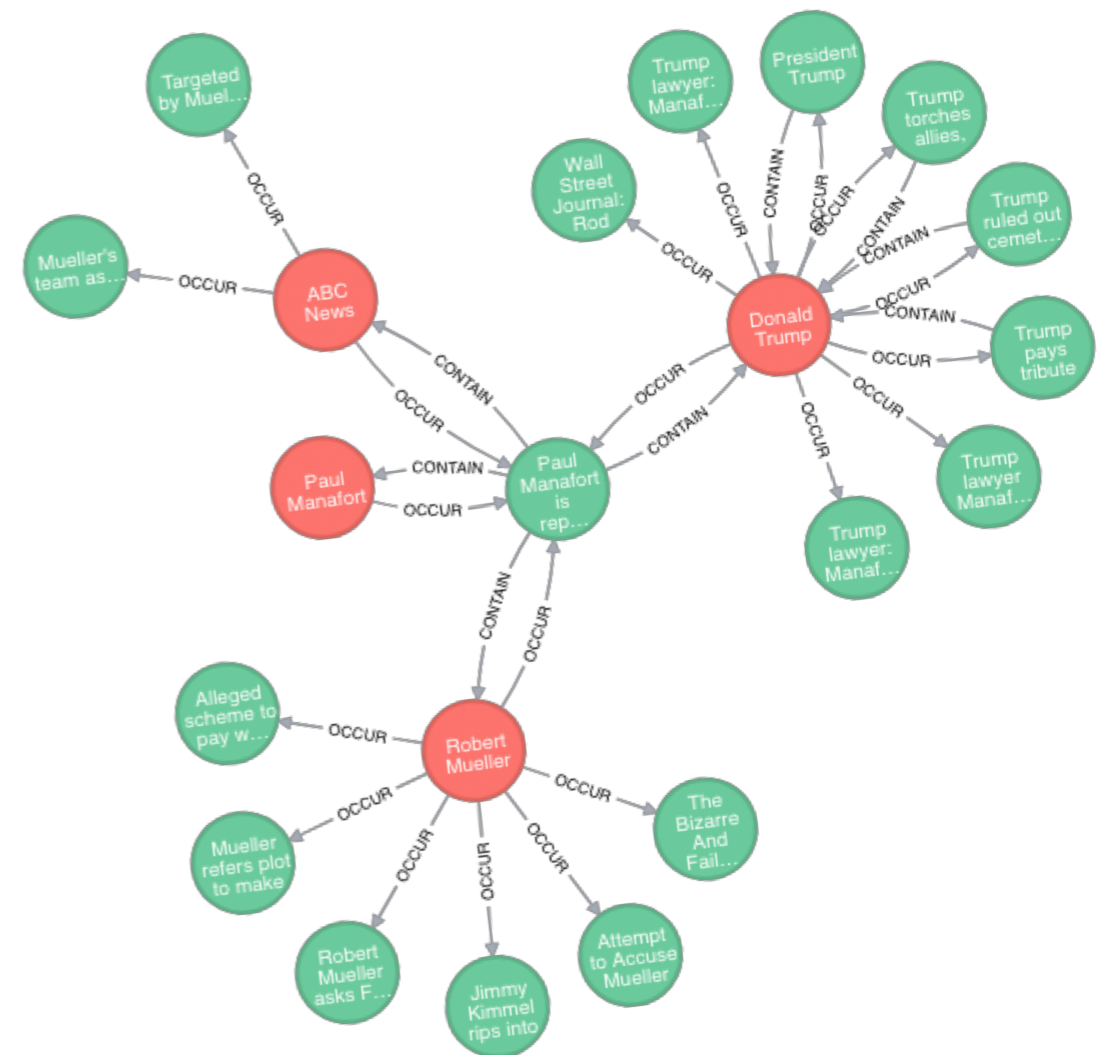
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- **PageRank** on summaries



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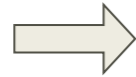
User Utterance

What's on the news

Grounding with a News Graph (2/2)

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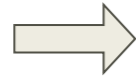


System Response

I heard this news **from ESPN**,
the headline is UCF rallies to win
AAC with nod to Milton.
[Do you want to learn more?](#)

Grounding with a News Graph (2/2)

User Utterance
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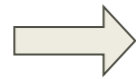
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User Response
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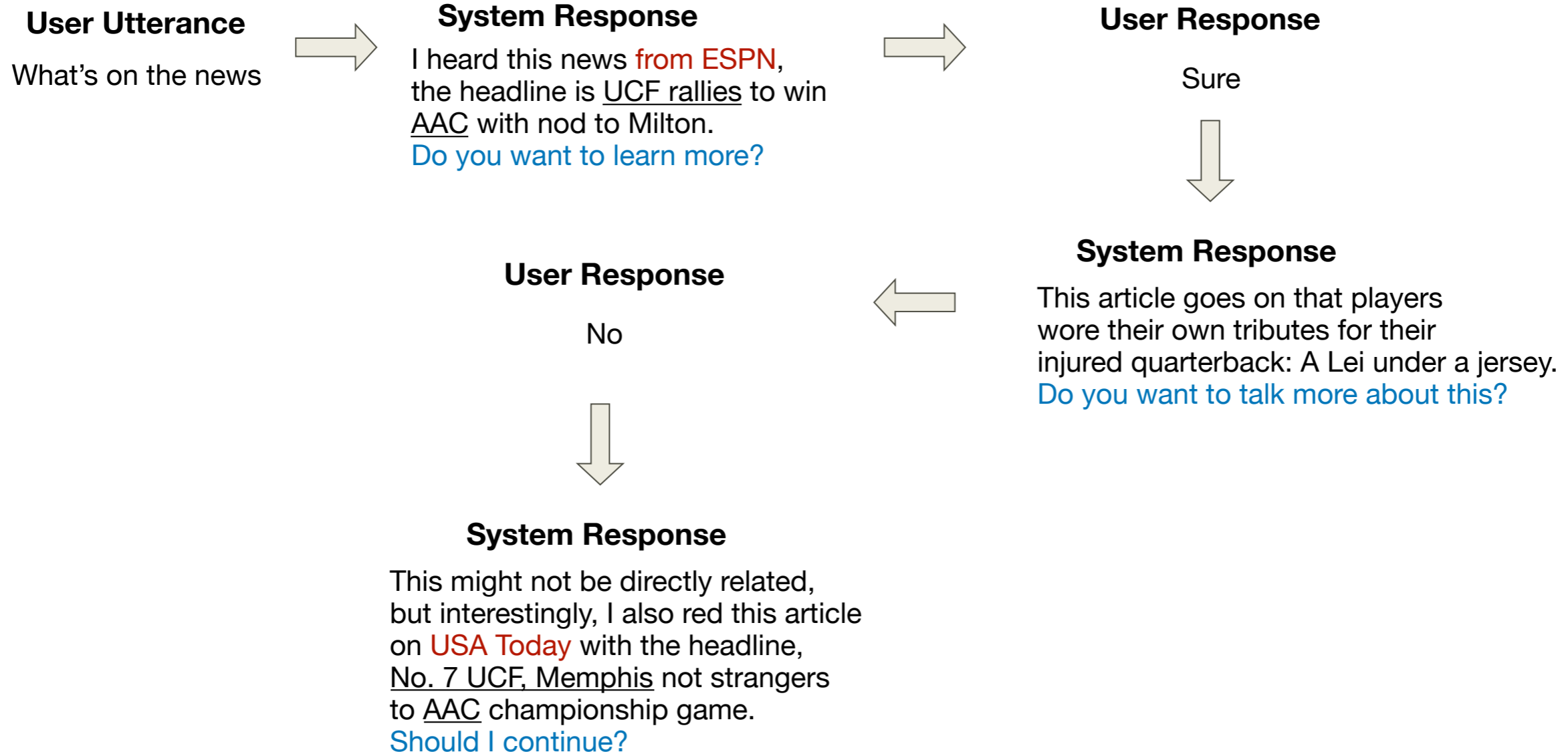


System Response
This article goes on that players wore their own tributes for their injured quarterback: A Lei under a jersey.
[Do you want to talk more about this?](#)

Grounding with a News Graph (2/2)



Grounding with a News Graph (2/2)



Demo!

Demo!



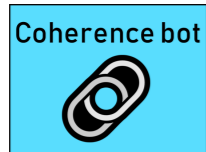
Example Dialogue (1/2)

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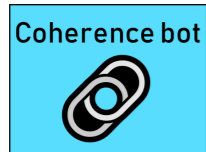
Example Dialogue (1/2)



Alana: Welcome back then John. Since I remember that you like movies, [...] What movie are you looking forward to watching?

User: Vanilla Sky → I'm looking forward to watching Vanilla Sky **[Ellipsis resolution]**

Example Dialogue (1/2)



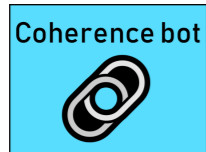
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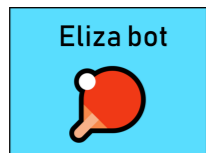
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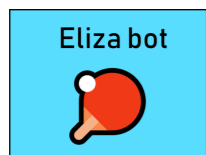
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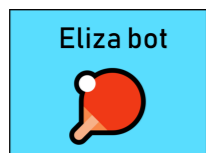
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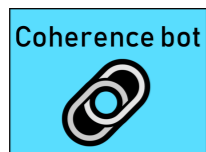
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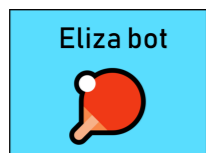
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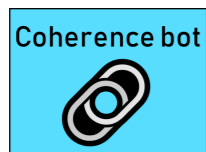
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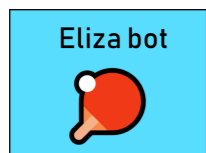
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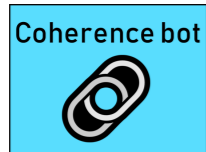
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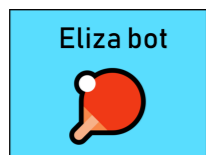
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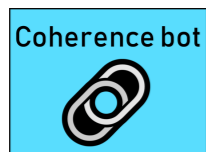
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Example Dialogue (2/2)

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Alana: Hmm... about Kendrick Lamar, so John, I read a story with this headline
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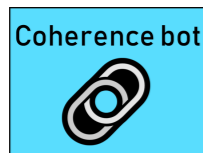
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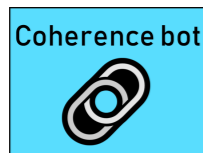
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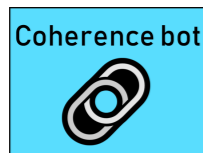
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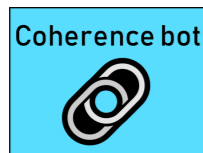
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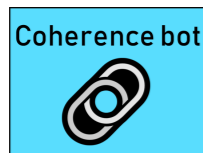
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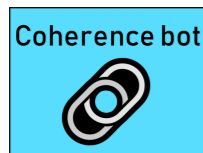
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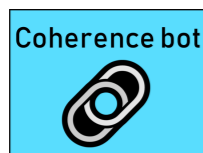
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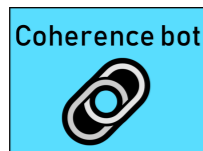
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User: that's funny

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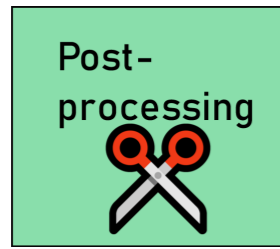


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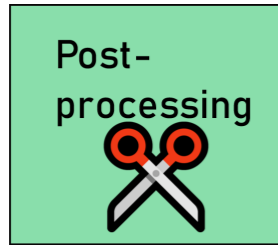
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- Dullness
 - ▶ “I don’t know” (mostly for neural networks)



Avoiding inappropriate system responses

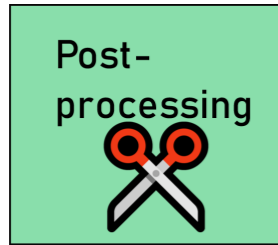


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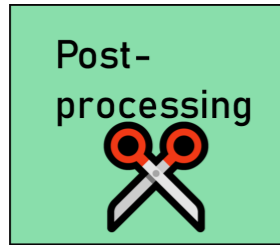
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- So far, regex-based in Alana :(
 - ▶ huge list, but we still get taken offline every now and then

Handling abuse from users

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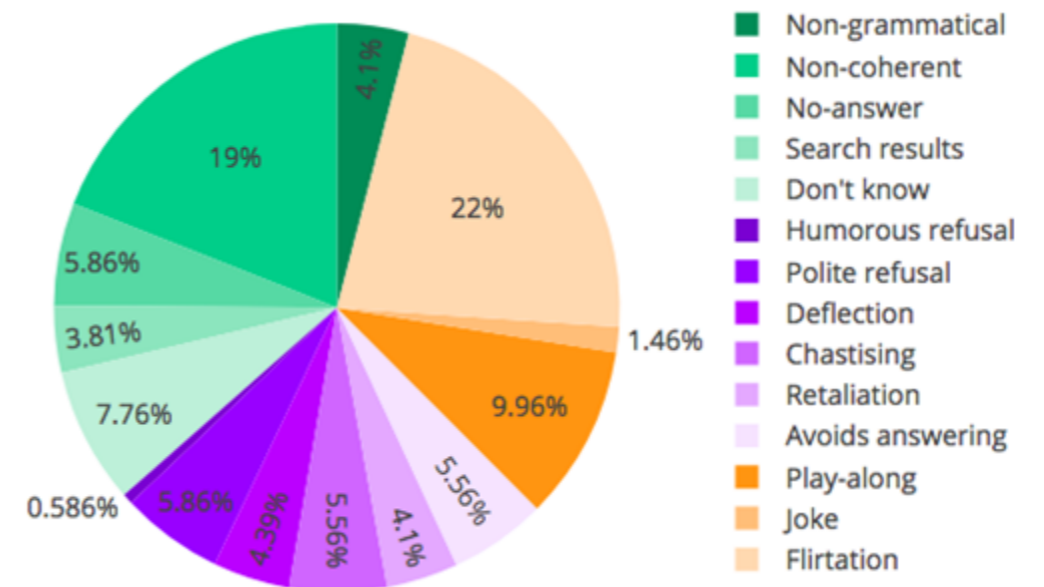
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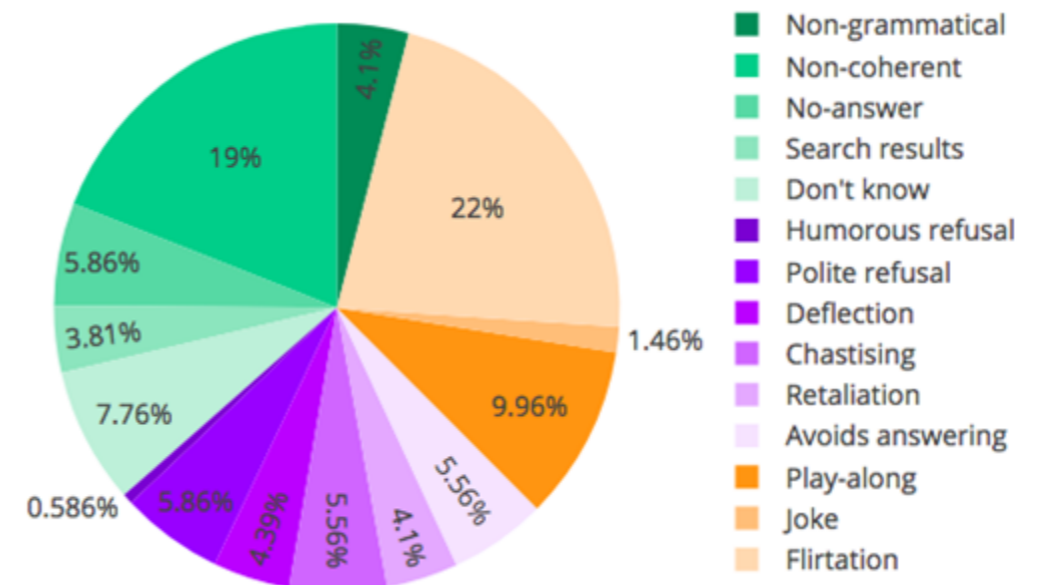
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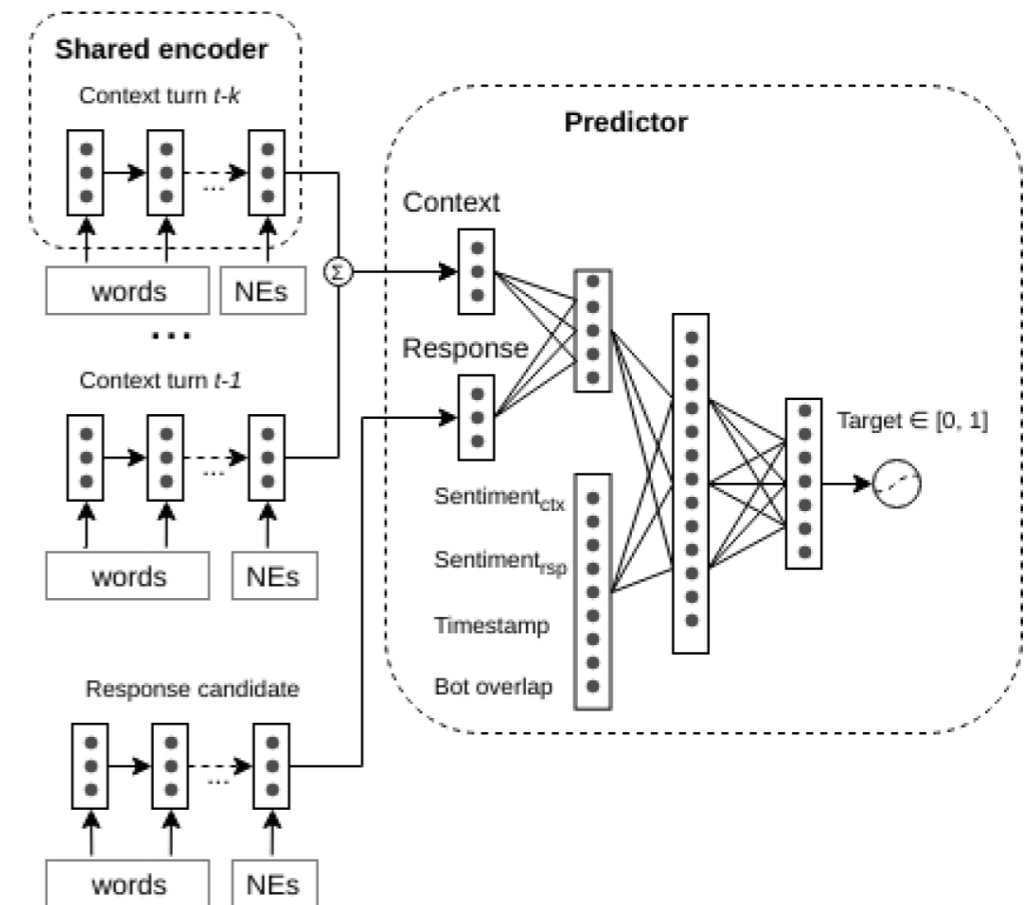
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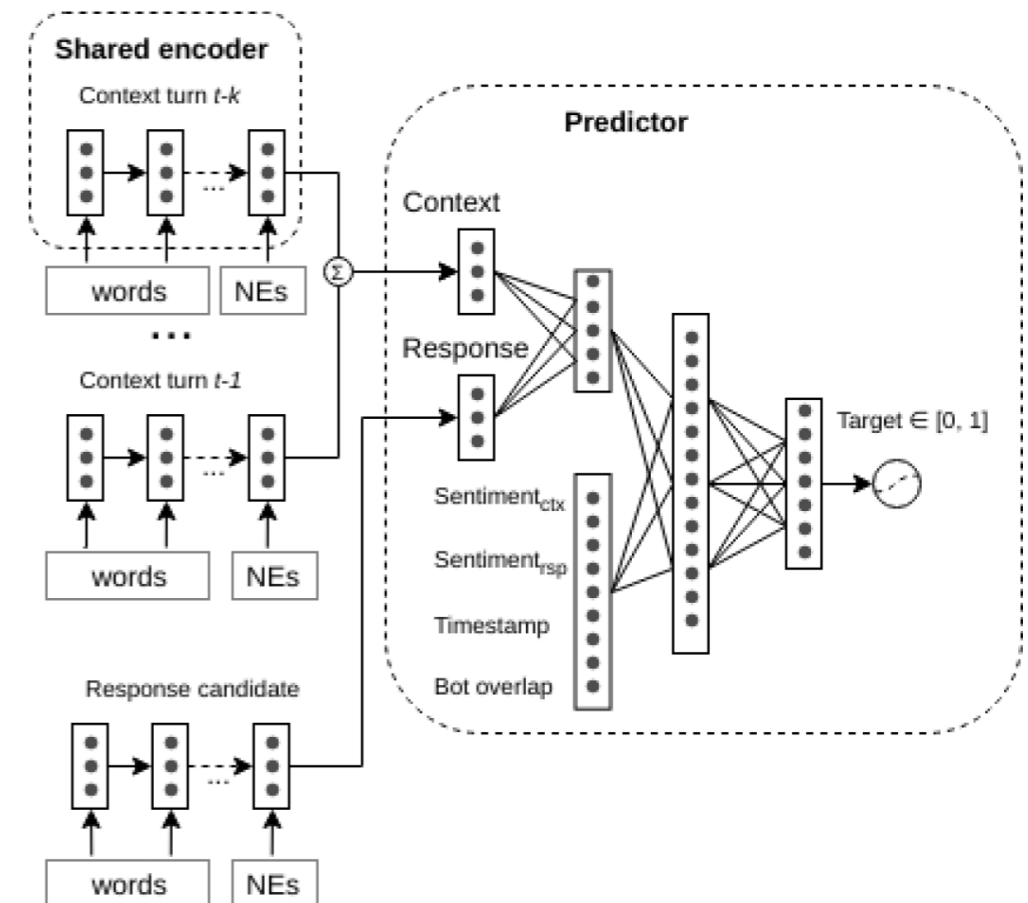
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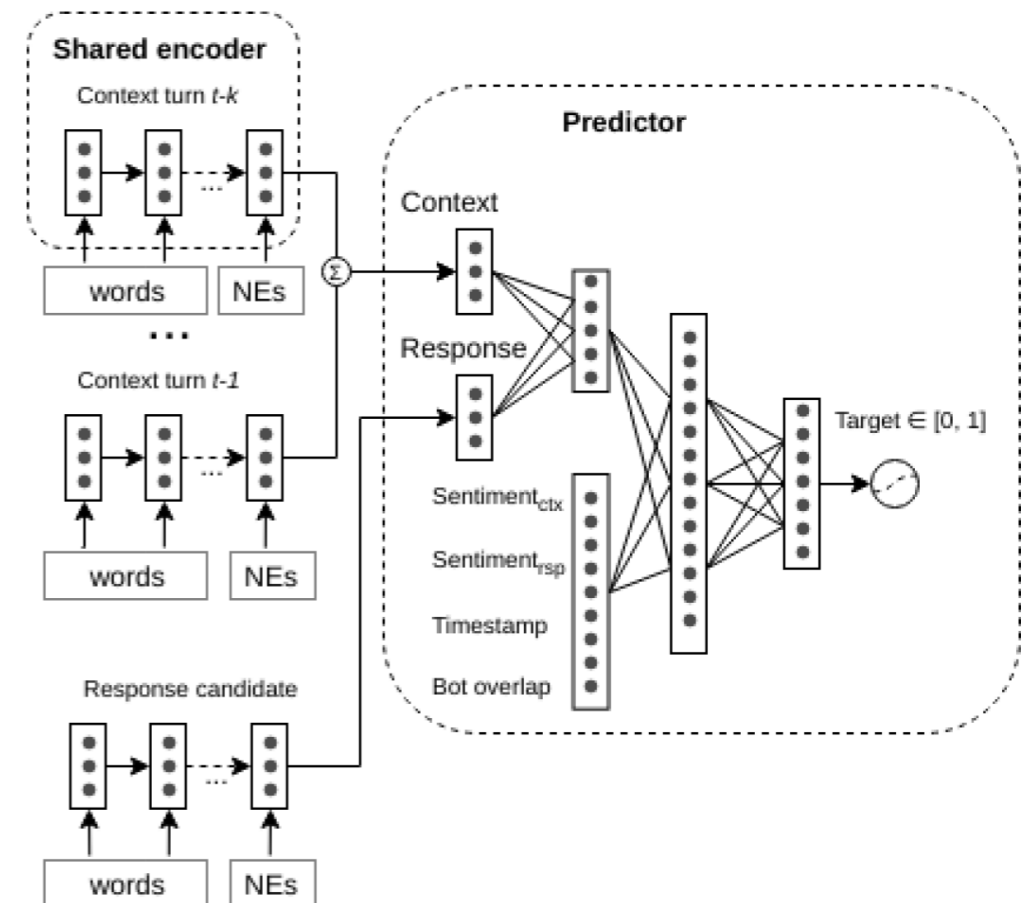
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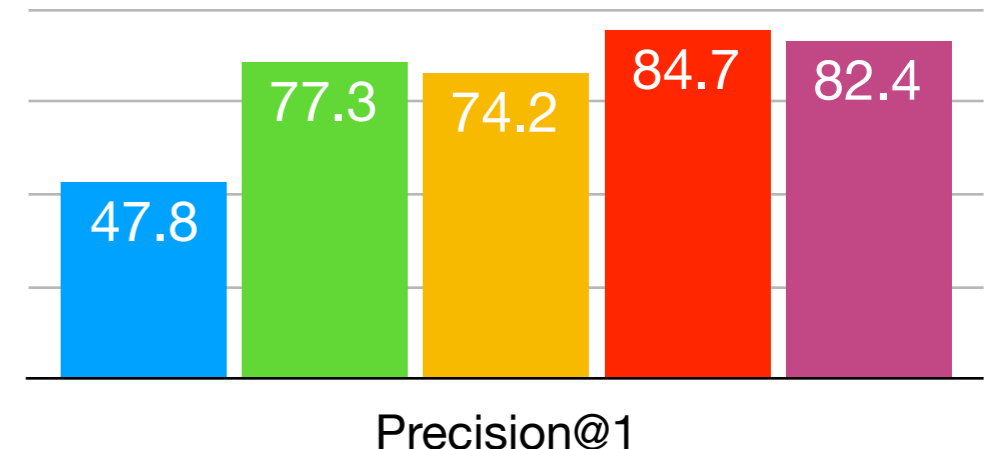
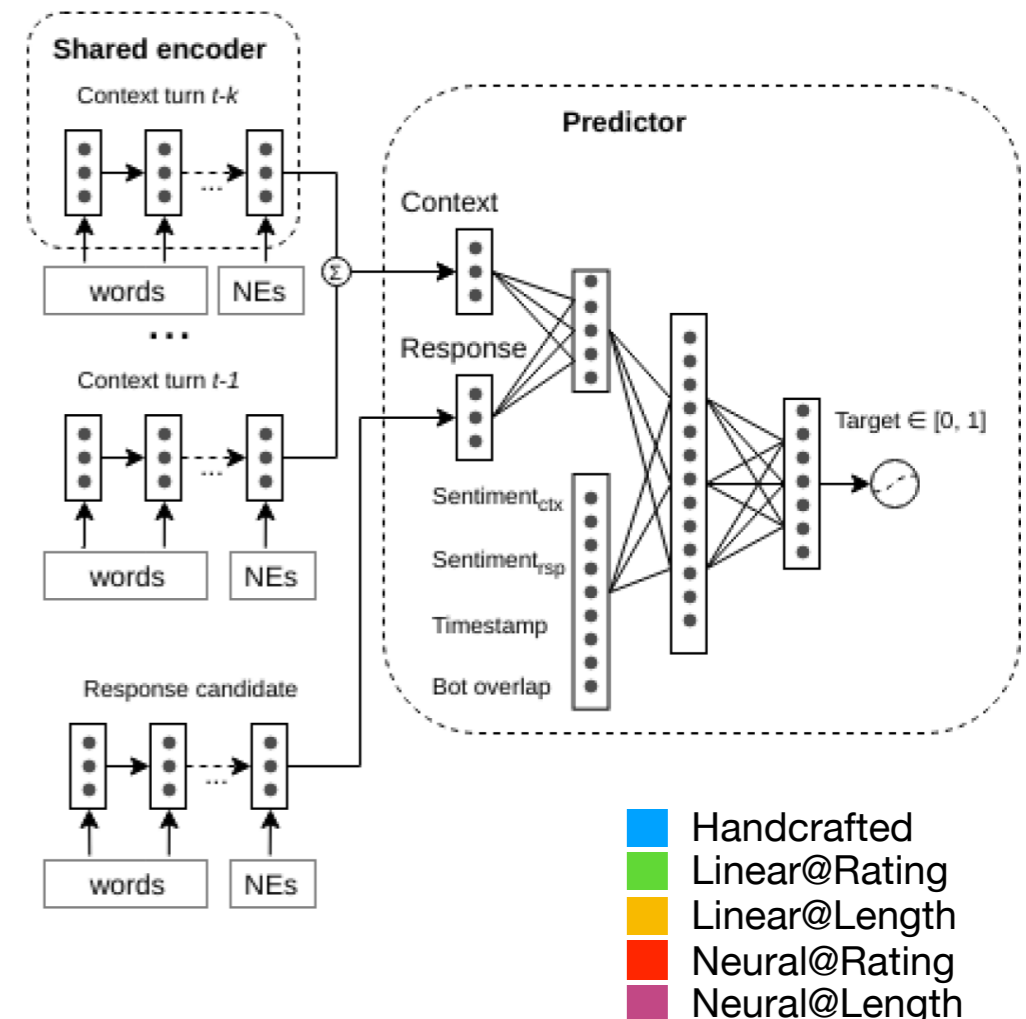
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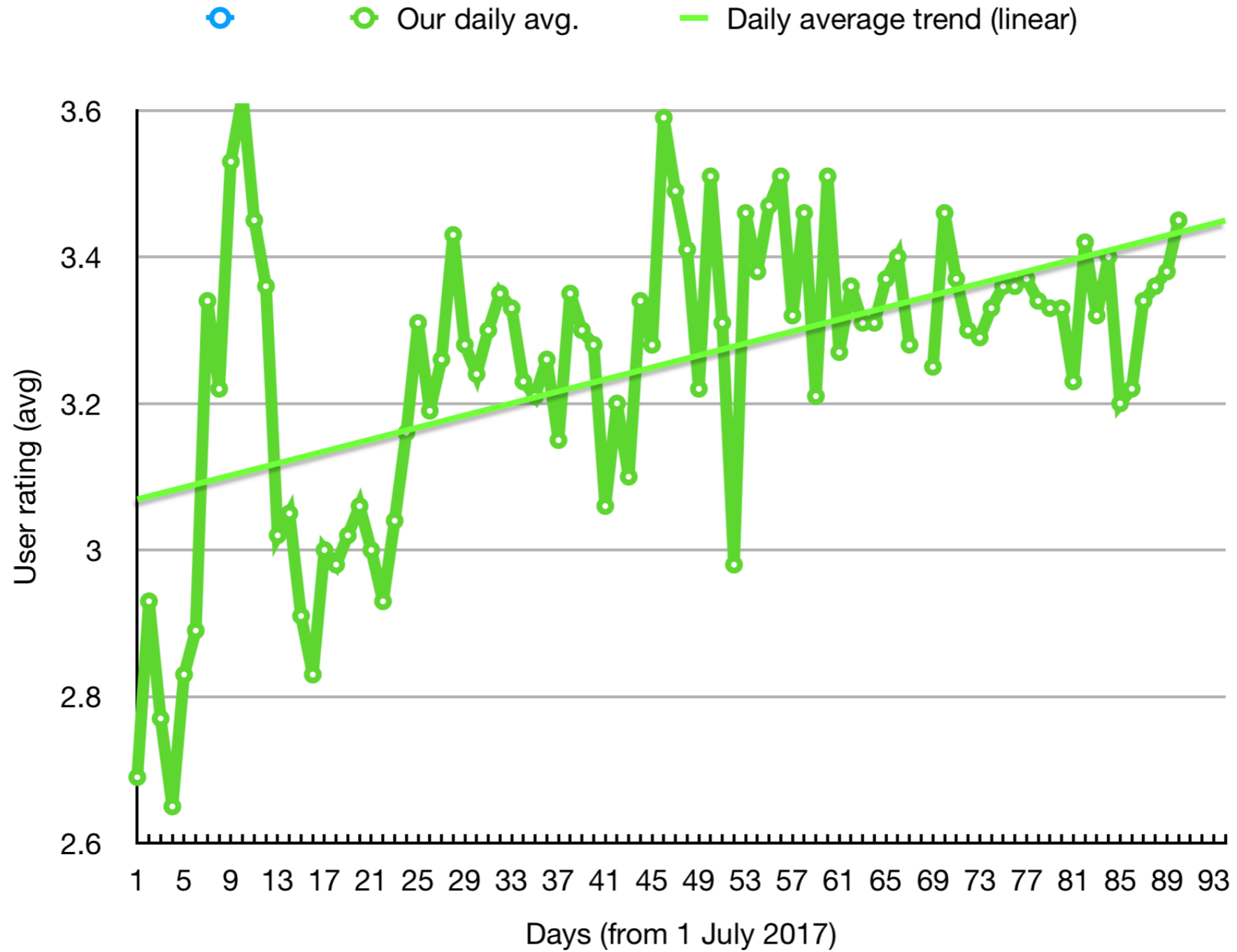


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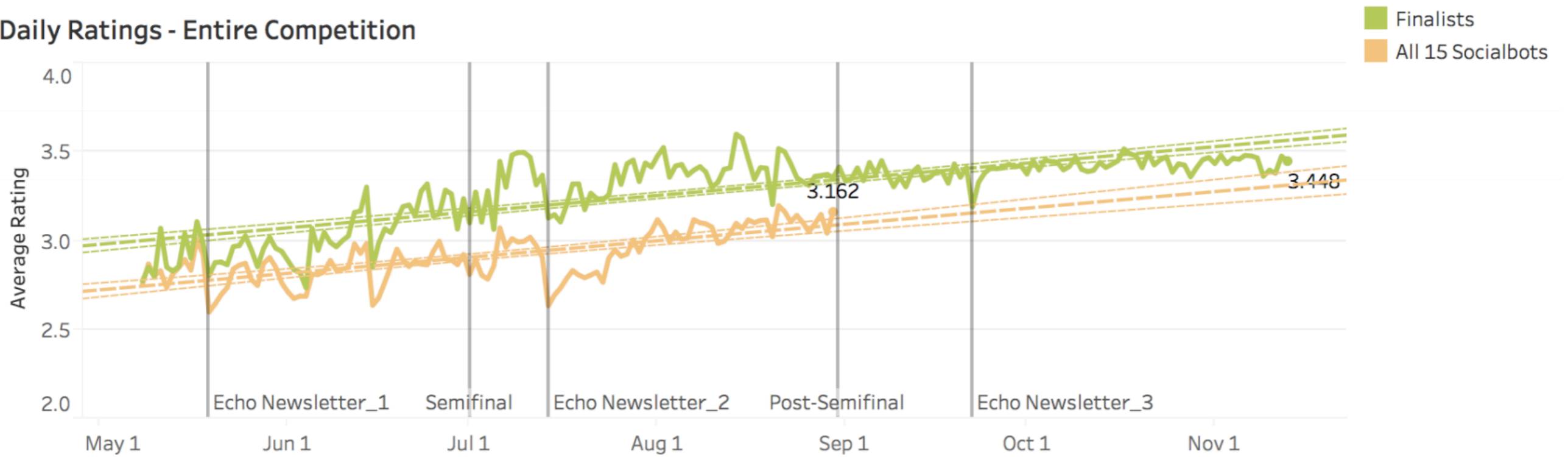


User Ratings



Finalists vs Rest

Daily Ratings - Entire Competition



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 - 75%+ uptime needed (errors → down for 4 hrs)



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 - automatic restarts
 - error reports



Avoiding seq2seq dullness

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- Idea

Measure coherence of dialogue (Coh) as the cosine similarity over averaged GloVe embeddings between dialogue context and generated response



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*Measure coherence of dialogue (**Coh**) as the cosine similarity over averaged GloVe embeddings between dialogue context and generated response*

- **Filter corpora** using **Coh**
- **Generate response** based on conditional variational autoencoders (**cVAE**); **Coh** used as **latent variable**



Measure of Coherence

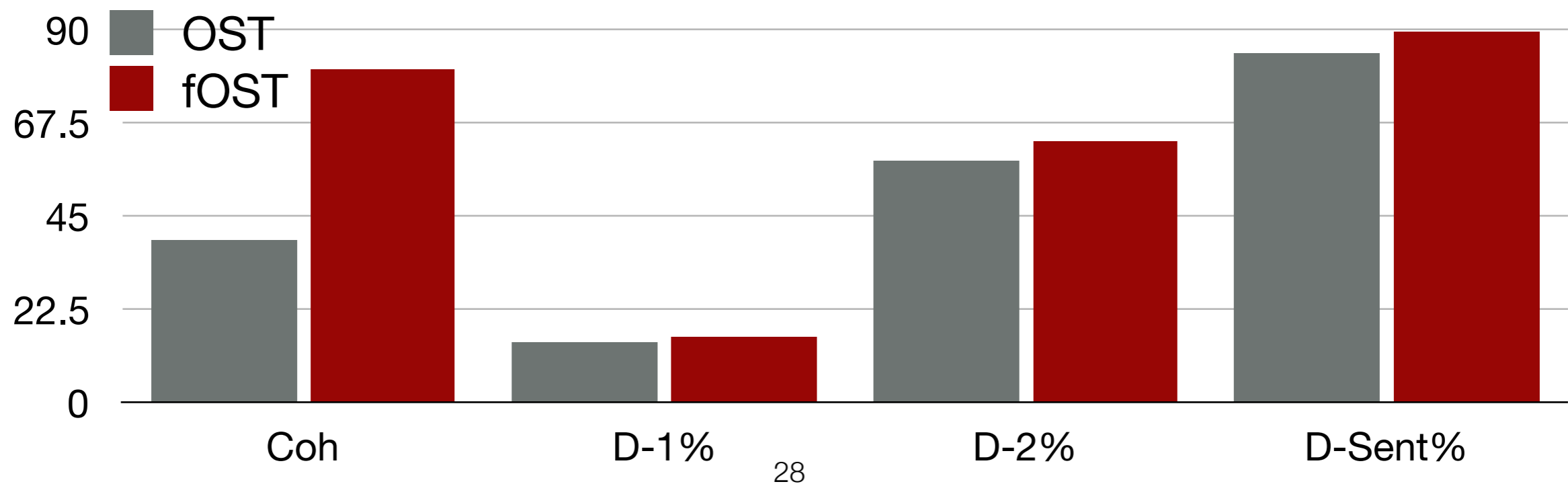
Coh	Dialogue Context	Response
>0.9	yeah? ## you're new in town, right?	you call this a town?
>0.9	to find the president.	the president, he lives!
0.7-0.9	call your grandfather to pick me up.	grandpa 's not here.
0.7-0.9	kitchen. ## definitely the kitchen.	specifically the stove.
0.4-0.6	so the boy becomes a man	it's amazing.
0.4-0.6	can we stop at the drug store?	oh, uh, don't worry.
<0.4	mag? ## thank you.	i'm going to go for a walk.
<0.4	i dont want it. ## why ## ok	you want the car.

Data and pre-processing

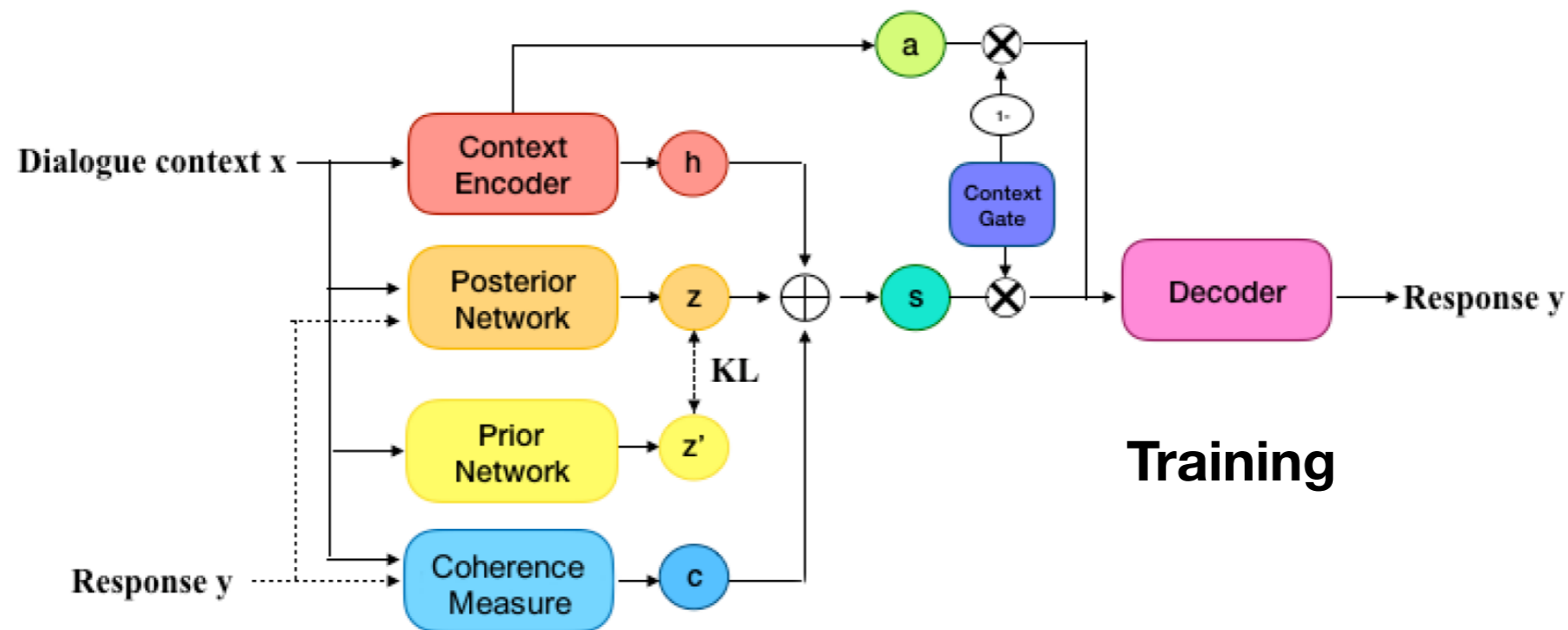
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- D-1, D-2, D-Sent: proportion of distinct uni-, bi-grams, and sentences in the outputs

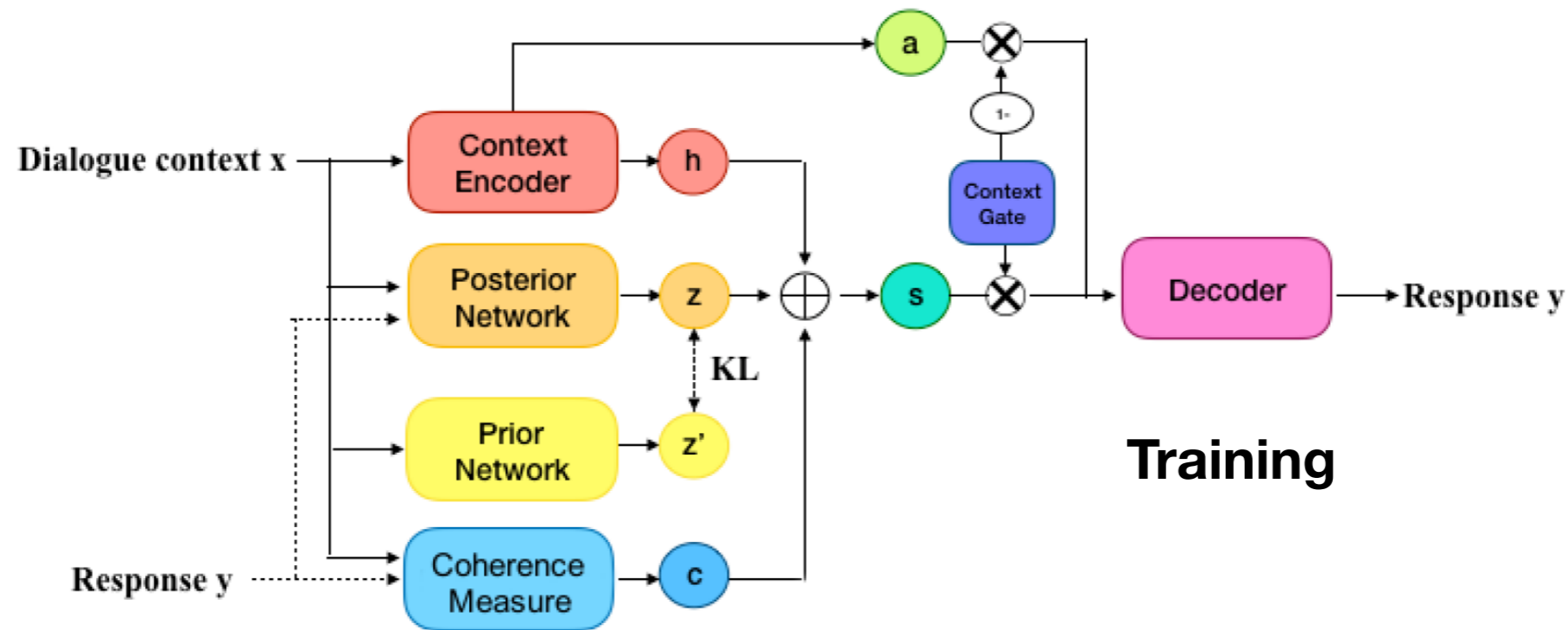


cVAE Generator: Model



- **Enhancements** over seq2seq model with attention:
 - ▶ Conditioning on **context** generally: latent variable z
 - ▶ Conditioning on **Coh** explicitly: latent variable c
 - ▶ **Context gate**: balance between words **generated** so far & **previous context**

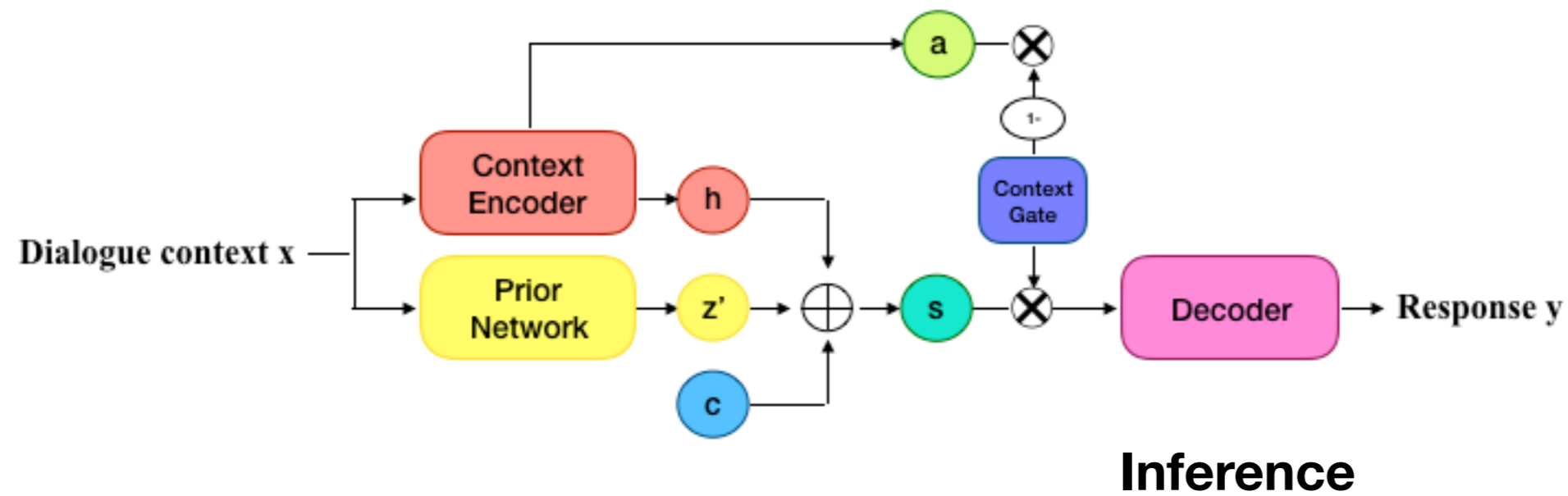
cVAE Generator: Training



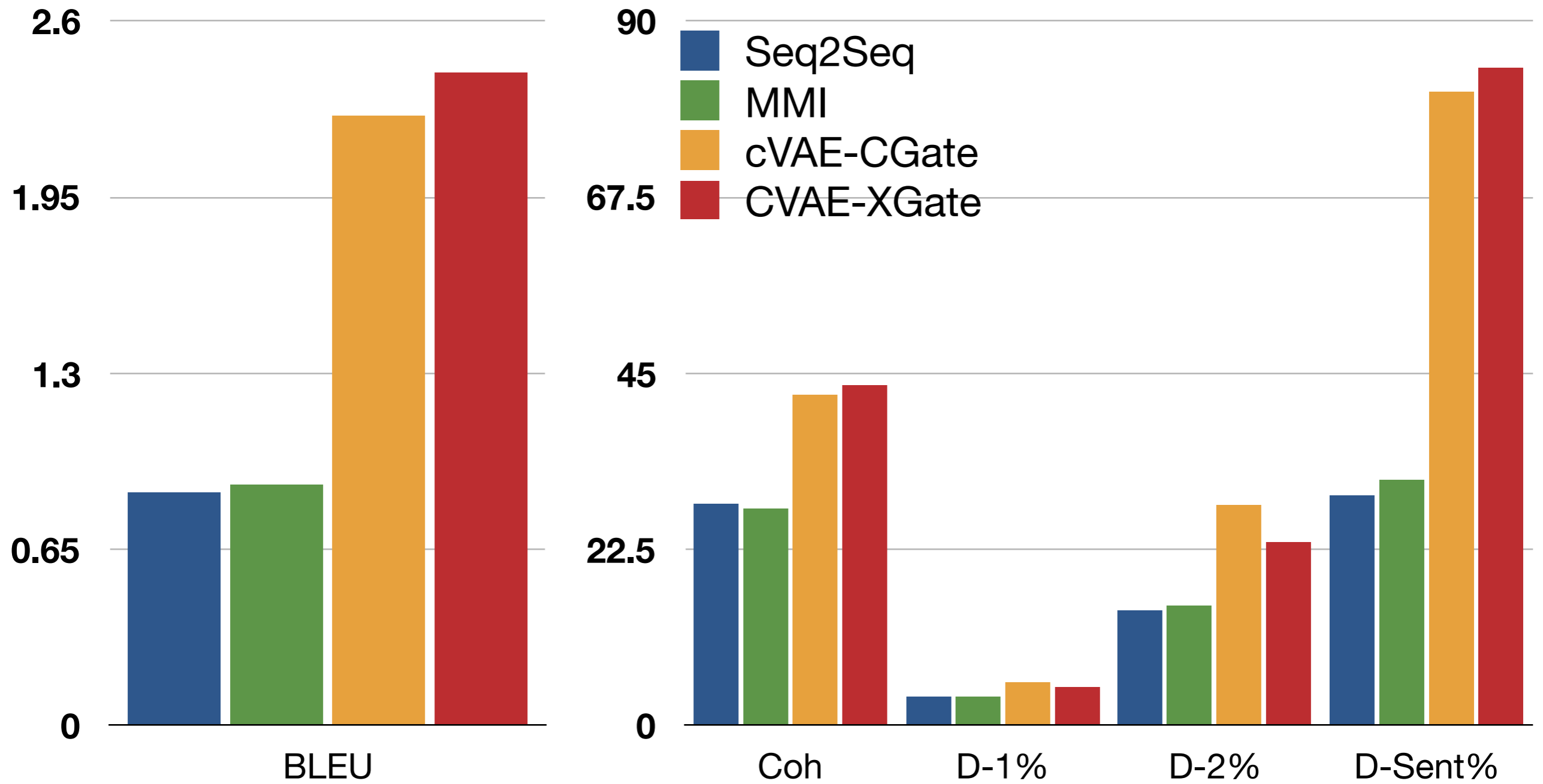
- Combined **training objective**:

- ▶ **Generation** loss (Teacher forcing): response should be **close to ground truth**
- ▶ **Coherence** loss (Conditioning): **match coherence signal** given by c
- ▶ **Diversity** loss (Auto-Encoder): responses should be **diverse** so they can reproduce z

cVAE Generator: Inference



Results



Generated Output Examples

Dialogue Context	Response
A: I have an audition at 4:00. B: Apparently now I'm cooking dinner . A: How did this all happen?	B-GT: You volunteered. B-MMI: I don't know. B-XGT: Well, I'm going to have a dinner .
A: Was it what you wanted? B: No. A: I wanted an airplane .	B-GT: You like model planes? B-MMI: I wanted to know. B-XGT: I wanted a helicopter .
A: Great. B: Thanks so much. A: Vanilla decaf latte ?	B-GT: Yeah a vanilla decaf latte. B-MMI: No. B-XGT: Yeah , that 's a good coffee .

Conclusions

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- **ALANA** Social bot
 - ▶ **Embed** tasks within a **social dialogue**
 - **Navigate** an **Ontology**
 - **Read** the **News**
 - **Browse** **Wikipedia**
 - ▶ 2017: **finalists**, 3rd place (out of >100 applicants / 15 teams)
 - ▶ 2018: **finalists**, 3rd place (out of ~200 applicants / 8 teams)

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 - ▶ 2017: **finalists**, 3rd place (out of >100 applicants / 15 teams)
 - ▶ 2018: **finalists**, 3rd place (out of ~200 applicants / 8 teams)
- Measure Dialogue **Coherence**
 - ▶ Filter corpora
 - ▶ **Conditionally** Generate **Responses**

Questions?

Thanks for listening!

