DSC291: Advanced Statistical Natural Language Processing

Text Generation

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Outline

- Controllable text generation
- 2 Paper presentations (15 x 2 mins)
    -
    -

Two Central Goals

- Generating human-like, grammatical, and readable text
  - I.e., generating **natural** language
- Generating text that contains desired information inferred from inputs
  - Machine translation
    - Source sentence --> target sentence w/ the same meaning
  - Data description
    - Table --> data report describing the table
  - Attribute control
    - Sentiment: positive --> ``I like this restaurant''
  - Conversation control
    - Control conversation strategy and topic

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- Generating human-like, grammatical, and readable text
  - Exposure bias, criteria mismatch: reinforcement learning (next lecture)

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- Generating human-like, grammatical, and readable text
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- Generating text that contains desired information inferred from inputs — #supervision data
  - Machine translation
    - Source sentence --> target sentence w/ the same meaning --> 10s of millions
  - Data description
    - Table --> data report describing the table --> 10s of 1000s
  - Attribute control
    - Sentiment: positive --> ``I like this restaurant'' --> 10s of 1000s
    - Modify sentiment from positive to negative --> 0
  - Conversation control
    - Control conversation strategy and topic --> 0

Two Central Goals

Controlled generation in unsupervised settings

- Generating human-like, grammatical, and readable text
  - Exposure bias, criteria mismatch: reinforcement learning (next lecture)

- Generating text that contains desired information inferred from inputs

#supervision data

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Unsupervised Controlled Generation of Text

- Sentence-level control
  - Text attribute transfer (style transfer)
  - Text content manipulation
- Conversation-level control
  - Target-guided open-domain conversation

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Text Attribute Transfer

- Modify a given sentence to
  - Have desired attribute values
  - While keeping all other aspects unchanged
- Attribute: sentment, tense, voice, gender, …

- E.g., transfer sentiment from negative to positive:
  - ``It was super dry and had a weird taste to the entire slice .''
  - ``It was super fresh and had a delicious taste to the entire slice .''

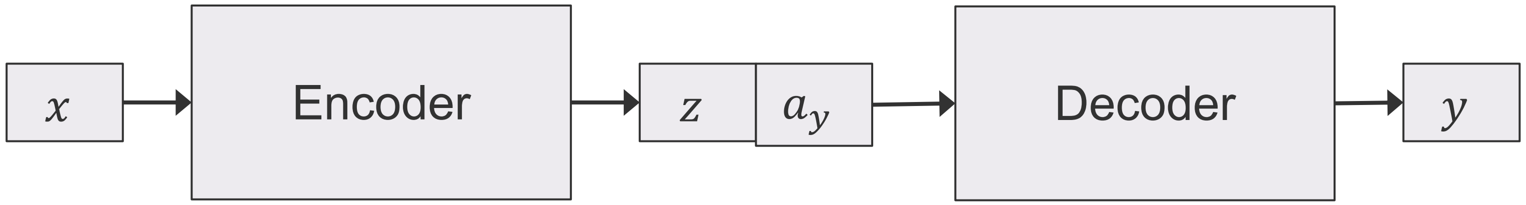
- Applications:
  - Personalized article writing, emotional conversation systems, …

[Hu et al., 17] Toward Controlled Generation of Text

Text Attribute Transfer

- Original sentence $\boldsymbol{x}$, original attribute $\boldsymbol{a}_x$
- Target sentence $\boldsymbol{y}$, target attribute $\boldsymbol{a}_y$
- Task: $(\boldsymbol{x}, \boldsymbol{a}_y) \rightarrow \boldsymbol{y}$
    - $\boldsymbol{y}$ has the desired attribute $\boldsymbol{a}_y$
    - $\boldsymbol{y}$ keeps all attribute-independent properties of $\boldsymbol{x}$
- Usually, only have pairs of $(\boldsymbol{x}, \boldsymbol{a}_x)$, but no $\big((\boldsymbol{x}, \boldsymbol{a}_x), (\boldsymbol{y}, \boldsymbol{a}_y)\big)$ for training
    - E.g., two sets of sentences: one with positive sentiment, the other with negative

Text Attribute Transfer: Solution



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- Model $p_\theta(\boldsymbol{y}|\boldsymbol{x}, \boldsymbol{a}_y)$

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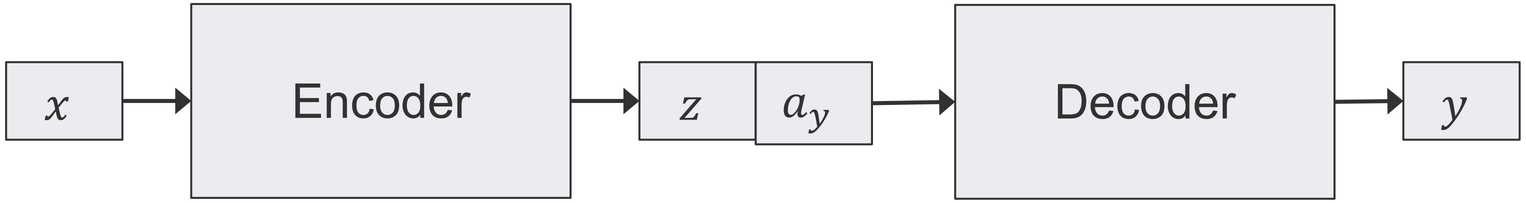

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  - Use direct supervision for each of the sub-objectives

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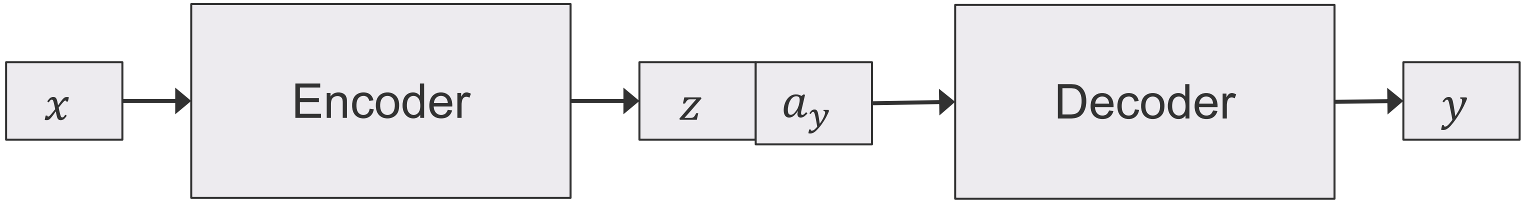

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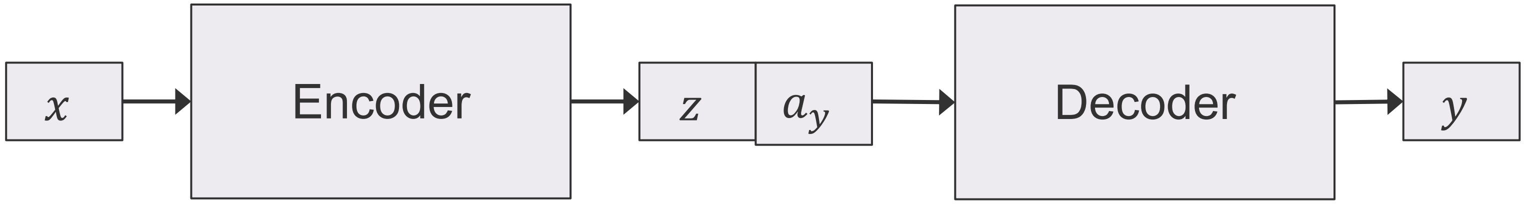

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- Classification loss: $\hat{y} \sim p_\theta\left(\boldsymbol{y}\middle|\boldsymbol{x}, \boldsymbol{a}_y\right),\ f(\hat{\boldsymbol{y}}) \rightarrow \boldsymbol{a}_y$
  - where f is a pre-trained attribute classifier

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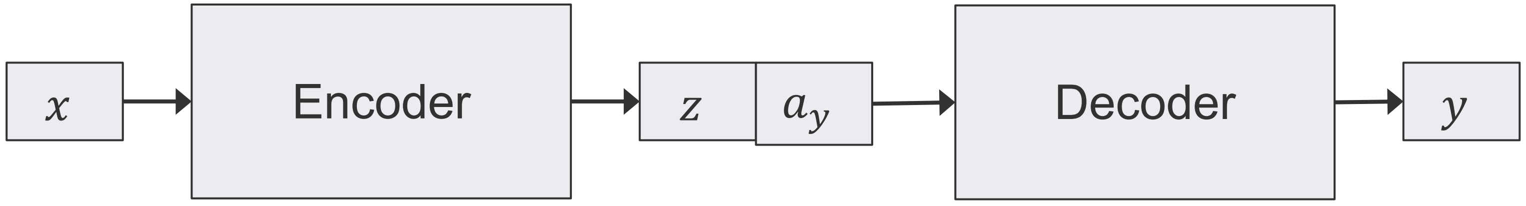

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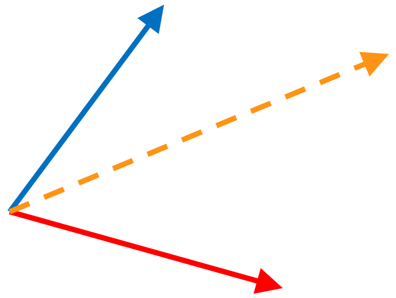

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- The above two losses are competitive; minimize jointly to avoid collapse

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Original: if i could give them a zero star review i would !
Output: if i lite give them a sweetheart star review i would !

Original: uncle george is very friendly to each guest
Output: uncle george is very lackluster to each guest

Original: the food is fresh and the environment is good
Output: the food is atrocious and the environment is atrocious

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- Improvement:
  - Use an LM as a direct supervision!
  - $\hat{\boldsymbol{y}} \sim p_\theta(\boldsymbol{y}|\boldsymbol{x}, \boldsymbol{a}_y)$, $\max_\theta \mathrm{LM}(\hat{\boldsymbol{y}})$
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  - BLEU against input sentence: 57
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[Yang et al., 18] Unsupervised text style transfer using language models as discriminators

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+ LM: if i can give them a great star review i would !

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Output: uncle george is very lackluster to each guest
+ LM: uncle george is very rude to each guest

Original: the food is fresh and the environment is good
Output: the food is atrocious and the environment is atrocious
+ LM: the food is bland and the environment is bad .

[Yang et al., 18] Unsupervised text style transfer using language models as discriminators

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Text Content Manipulation

- Generate a sentence to describe content in a given data record

Data Record

Name	Food	Area	Price	Near
Loch Fyne	Italian	Riverside	£20-25	Strada

[Lin et al., 20] Data-to-Text Generation with Style Imitation

Text Content Manipulation

- Generate a sentence to describe content in a given data record
- But language is rich with variation -- there are diverse possible ways of saying the same content (writing style):
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- But language is rich with variation -- there are diverse possible ways of saying the same content (writing style):
  - word choice, expressions, transitions, tones, …
- We want to control the **writing style**: use the writing style of a reference sentence

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Text Content Manipulation

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Exemplar 1	Zizzi is a pub providing fine French dining but with an expensive price, located near Cocum in the city center.
Generation 1	Loch Fyne provides fine Italian dining with a £20-25 price, located near Strada at the riverside.
Exemplar 2	Located near the Blue Spice, there is a highly-rated place, the Mill, as a choice that frugally priced.
Generation 2	Located near Strada by the river, there is a place with Italian foods, Loch Fyne, as a choice that priced £20-25.
Exemplar 3	With a family-friendly atmosphere and a 5-star rating, Aromi is a pub in the city center.
Generation 3	With Italian foods and a moderate price range, Loch Fyne is near Strada at the riverside.

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Text Content Manipulation

- Generate a sentence to describe content in a given data record

Content Record	**PLAYER**	**PT**	**RB**	**AS**	**PLAYER**	**PT**
	LeBron_James	32	4	7	Kyrie_Irving	20
Reference Sentence	Jrue_Holiday led the way with 26 points and 6 assists , while Goran_Dragic scored 23 points and pulled down 8 rebounds .					
Output	LeBron_James led the way with 32 points , 7 assists and 4 rebounds , while Kyrie_Irving scored 20 points .					

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Method

Record and exemplar:

	Name	Type	Rating
x	*Cocum*	*pub*	*low*

y_x: Cocum is a pub with a low customer rating.

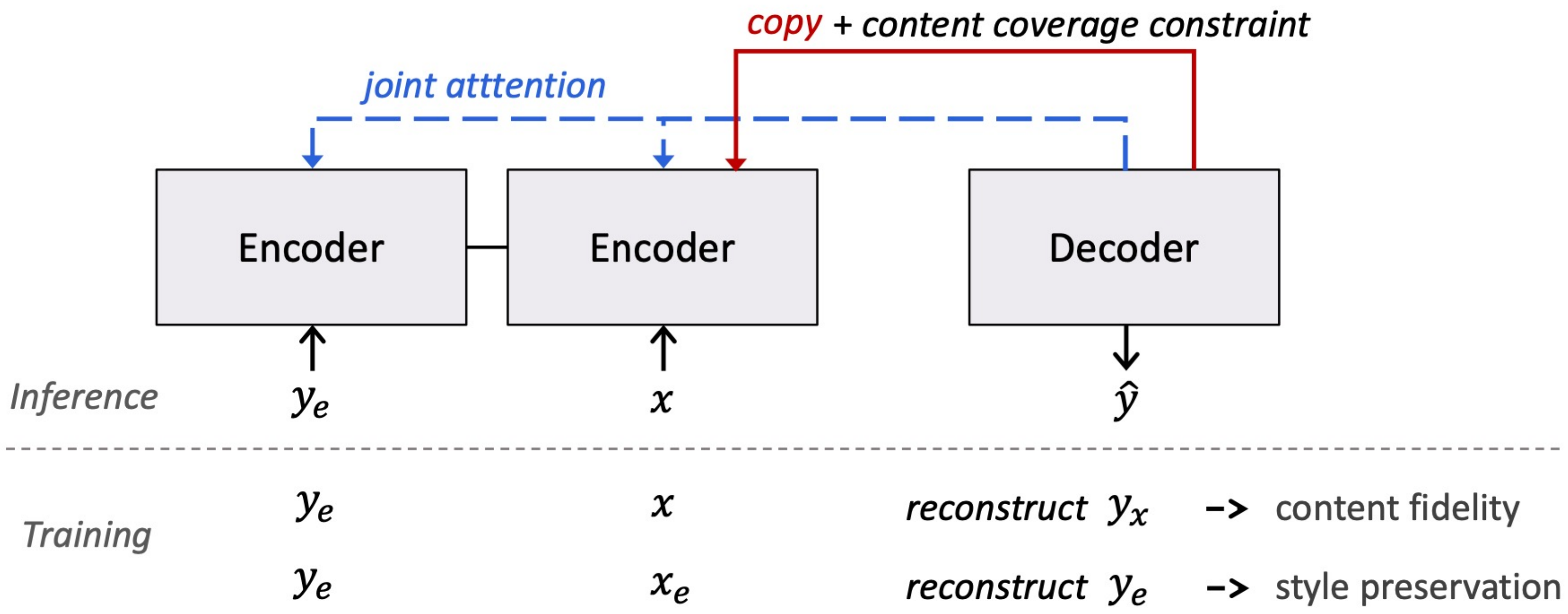
retrieve

	Name	Type
x_e	*Strada*	*coffee shop*

y_e: There is a coffee shop named Strada.

desired $\hat{y}$: There is a pub named Cocum with a low customer rating.

Model:



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Results

Content Record	Name Cocum	EatType coffee shop	Food Italian	PriceRange £20-25	CustomRating high	FamilyFriendly family friendly
Exemplar 1	Looking for French food near Zizzi? Come try Strada, which has a 3-star customer rating and priced lowly.					
Slot filling	Looking for Italian [...] food near Zizzi? Come try [...] Cocum, which has a high customer rating and priced £20-25.					
AdvST	For Italian [...] place near Zizzi? Come try [...] Cocum, which has a high customer rating with priced £20-25.					
Ours	Looking for an Italian coffee shop? Come try family-friendly Cocum, which has a high customer rating and priced £20-25.					
Exemplar 2	Along the riverside near Cafe Rouge, there is a Japanese food place called The Golden Curry. It has an average customer rating since it is not a family-friendly environment.					
Slot-filling	Along the riverside near Cafe Rouge [...], there is a Italian food [...] place called Cocum. It has an high customer rating since it is not a family-friendly environment.					
AdvST	Along the riverside near the Ranch [...], there is a Italian food [...] place called Cocum. It has [...] high customer rating since it is not a family-friendly environment.					
Ours	Priced £20-25, there is an Italian food coffee shop called Cocum. It has a high customer rating since it is a family-friendly environment.					

Results

	Method	Restaurant Recommendations			NBA Reports		
		Content		Style	Content		Style
		%Incl.-new	**%Excl.-old**	**m-BLEU**	**Precision**	**Recall**	**m-BLEU**
Reference	AttnCopy-S2S	78.88±2.08	99.71±0.06	13.95±0.52	81.62±3.25	75.65±7.42	45.5±0.71
	Slot-filling	61.23	66.2	100	56.69	71.34	100
Baselines	MAST	36.28±0.25	37.06±0.16	**91.76±0.28**	23.06±3.90	27.37±3.88	**95.43±2.71**
	AdvST	51.64±4.45	57.06±4.44	76.02±5.27	67.37±0.66	66.79±1.43	64.67±4.81
Ours	Transformer w/o Coverage	60.03±2.16	74.65±2.69	77.81±3.83	62.58±2.88	70.22±3.58	81.75±2.32
	+ Coverage	61.84±1.31	81.14±2.73	80.29±0.35	67.74±0.79	**74.35±1.22**	81.97±2.87
	LSTM w/o Coverage	60.83±1.29	81.45±1.10	78.91±1.05	68.74±3.07	69.35±3.30	79.88±2.44
	+ Coverage	**65.02±4.16**	**82.53±0.70**	82.92±3.18	**69.54±1.16**	73.27±1.18	80.66±1.89

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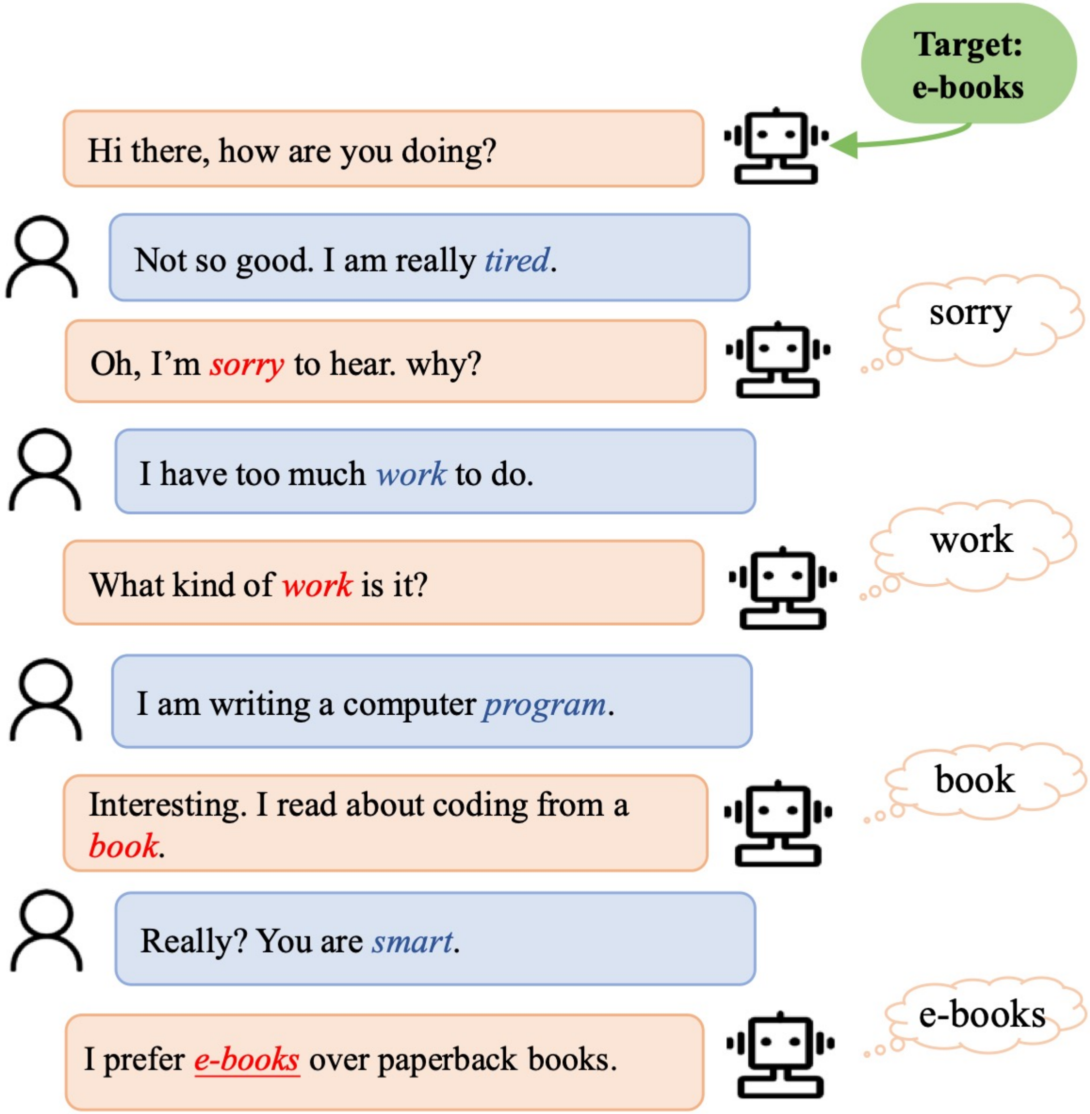
Target-guided Open-domain Conversation

- Task-oriented dialog:
  - Address a specific task, e.g., booking a flight
  - Close domain
- Open-domain chit-chat:
  - Improve user engagement
  - Random conversation, hard to control
- Target-guided conversation:
  - Open-domain conversation
  - Controlled conversation strategy to reach a *desired topic* in the end of conversation
  - Applications:
    - Bridges task-oriented dialog and open-domain chit-chat
    - Conversational recommender system, education, psychotherapy

Target-guided Open-domain Conversation

- Two goals:
  - Starting from any topic, reach a desired topic in the end of conversation
  - Natural conversation: smooth transition



Target-guided Open-domain Conversation

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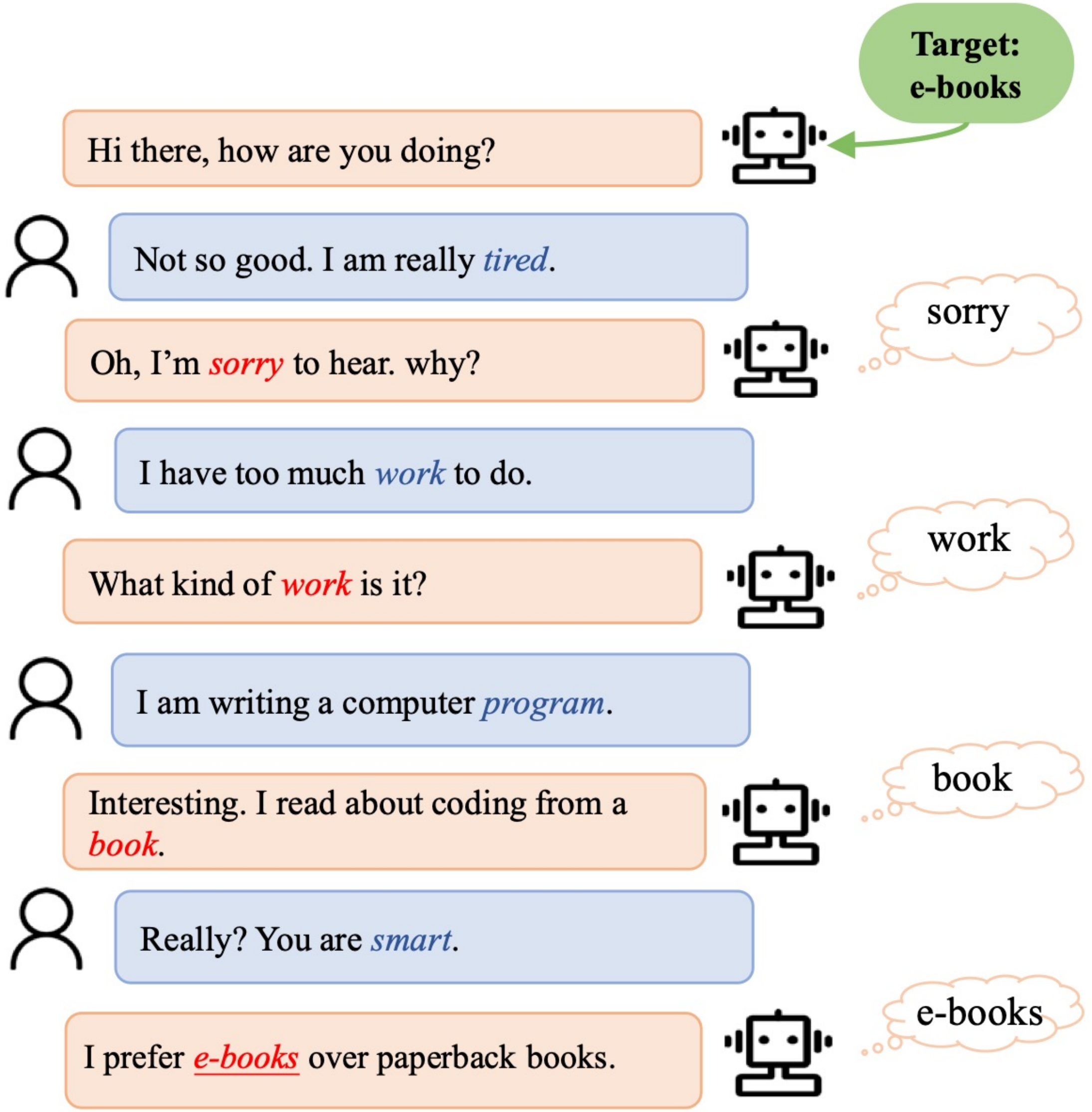
Challenge: No supervised data for the task

Solution: Use competitive sub-objectives and partial supervision

- **Natural conversation**: rich chit-chat data to learn smooth single-turn transition
- **Reaching desired target**: rule-based multi-turn planning



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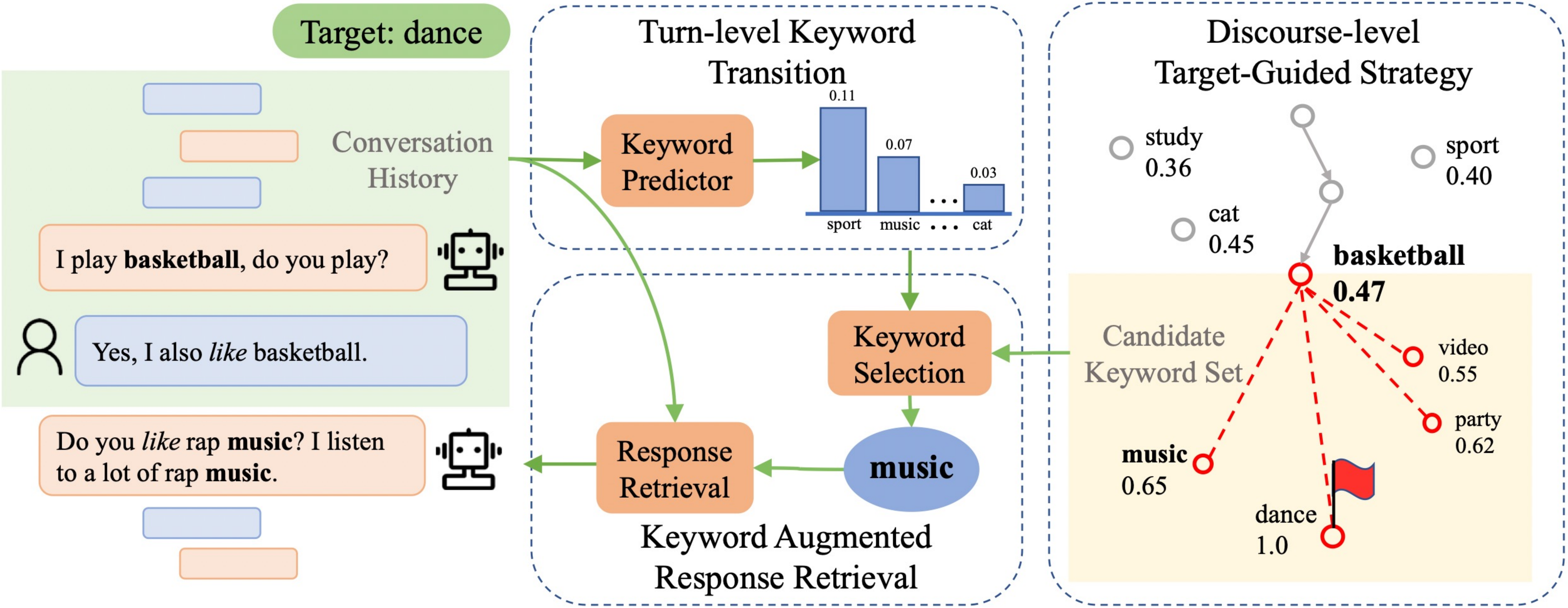

Target: dance
Conversation History
I play **basketball**, do you play?
Yes, I also *like* basketball.
Do you *like* rap **music**? I listen to a lot of rap **music**.
Turn-level Keyword Transition
Keyword Predictor
0.11
0.07
0.03
sport
music
cat
Keyword Selection
music
Response Retrieval
Keyword Augmented Response Retrieval
Discourse-level Target-Guided Strategy
study 0.36
sport 0.40
cat 0.45
basketball 0.47
Candidate Keyword Set
video 0.55
party 0.62
music 0.65
dance 1.0

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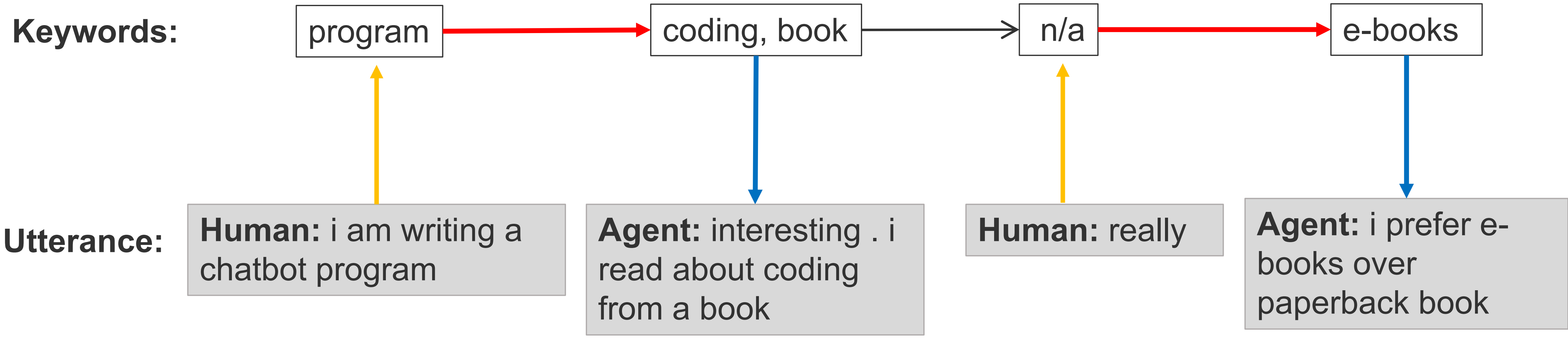
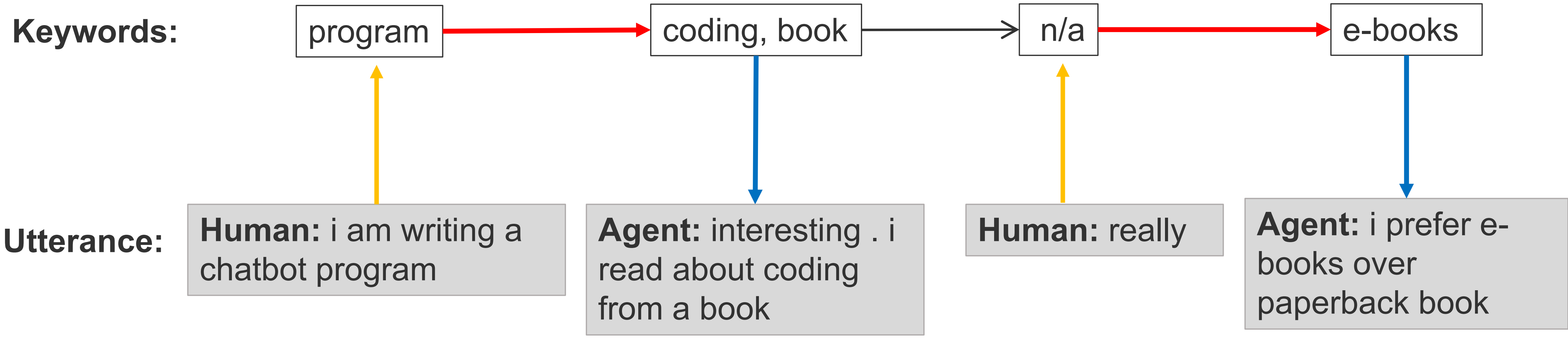


Keywords:
program
coding, book
n/a
e-books
Utterance:
Human: i am writing a chatbot program
Agent: interesting . i read about coding from a book
Human: really
Agent: i prefer e-books over paperback book

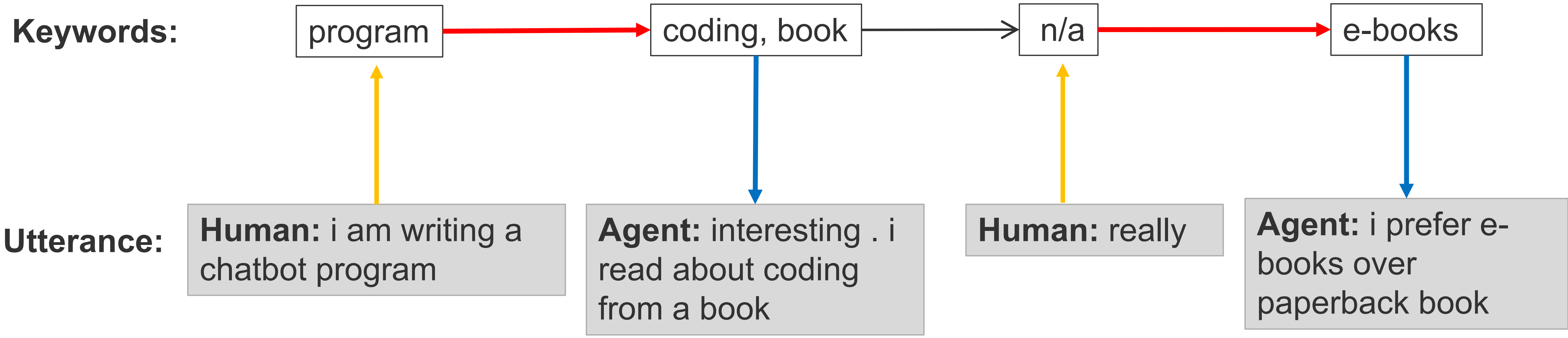
Method

- keyword extraction



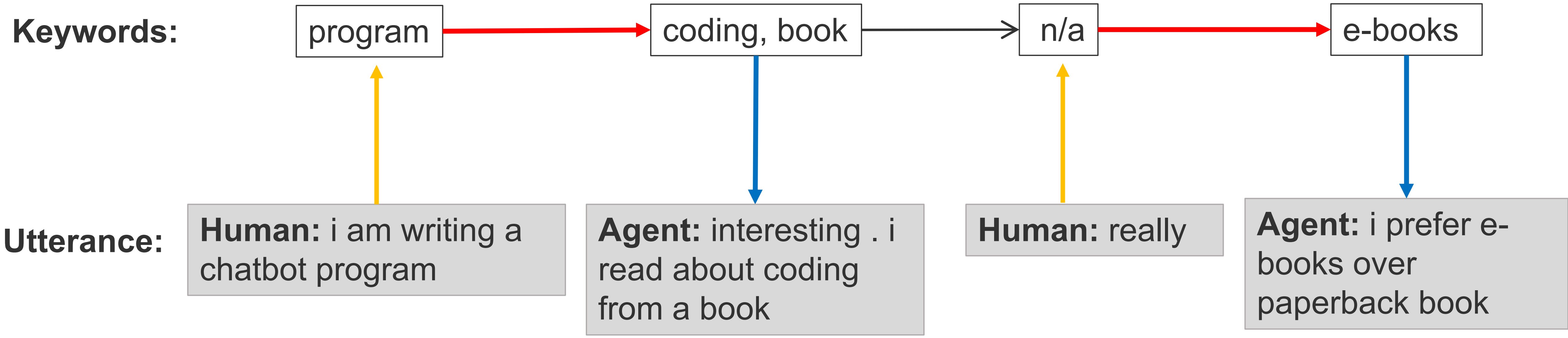
Method

- keyword extraction
- keyword conditional response retrieval



Method

- → keyword extraction
- → keyword conditional response retrieval
- → learned kernel-based topic transition + target-guided rule:
  - (1) transit to keywords that are close in the word embedding space – smooth
  - (2) next keywords must get closer to the target keyword – target-guided
  - Tune relative weight of (1) and (2) to control aggressiveness



Example Results

Target: dance

Agent : hi how is it going with you
Human : fine . I’m playing sports
Agent : i play basketball . u play ?
Human : yeah i also like basketball .
Agent : you like rap music ? i listen to a lot of rap music
Human : no i like classic music
Agent : its a taylor swift song
Human : taylor swift is a great singer
Agent : sing to me , what are you going to sing
Human : i know nothing about singing
Agent : oh i think i can dance lol

Example Results – Failure Case

Target: listen

Agent : hi ! how are you ? i am very exciting about my new job !
Human : fine . what is your new job ?
Agent : that sounds exciting .
Human : i like read books
Agent : what kind of books do you read ?
Human : i read comics
Agent : i do not have tv
Human : watch anime is fun
Agent : what position d you play ?
Human : i play a lot of sports
Agent : oh really ? what kind of music . i listen to classical

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Key Takeaways: Two Central Goals

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- Generating text that contains desired information inferred from inputs
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Questions?