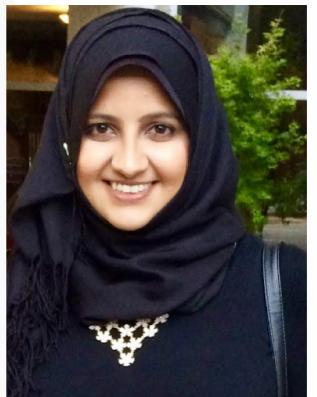
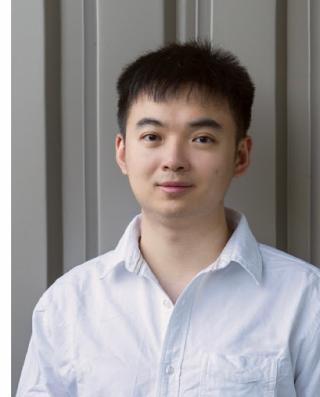


## EMNLP 2021 Tutorial

# Knowledge-Enriched Natural Language Generation



Wenhao Yu<sup>1</sup>,

Meng Jiang<sup>1</sup>,

Zhitong Hu<sup>2</sup>,

Qingyun Wang<sup>3</sup>,

Heng Ji<sup>3,4</sup>,

Nazneen Rajani<sup>5</sup>

1 University of Notre Dame 2 University of California San Diego

3 University of Illinois at Urbana-Champaign 4 Amazon scholar 4 Salesforce Research

# Knowledge-enhanced NLG tutorial (Outline)



Time (AST / EST)	Content	Tutor
09:00 am – 09:10 am (08:00 am – 08:10 am)	Motivation and Key Questions	Meng Jiang
09:10 am – 09:50 am (08:10 am – 08:50 am)	General Methods of Integrating Knowledge into NLG	Zhiting Hu, Nazneen Rajani
09:50 am – 10:15 am (08:50 am – 09:15 am)	NLG Methods Enhanced by Various Knowledge Source	Wenhao Yu
10:15 am – 10:45 am (09:15 am – 09:45 am)	Coffee break	
10:45 am – 11:10 am (09:45 am – 10:10 am)	NLG Methods Enhanced by Various Knowledge Source	(cont.)
11:10 am – 12:10 pm (10:10 am – 11:10 am)	Applications, Benchmark Datasets, Code Library	Qingyun Wang
12:10 pm – 12:30 pm (11:10 am – 11:30 am)	Remaining Challenges and Future Directions	Heng Ji

- Leveraging machine intelligence to make many things EASY and FAST



*What should I wear outside today?*

*The temperature will be 85 at noon.  
You can wear short sleeve shorts.*



## Dialog systems

*... (Two years after, Maria was born ... ) ...  
Her brother gave her a hug. ...*



*... 她的哥哥给了她一个大大的拥抱. ...*

## Machine Translation

*... Her husband was one of 17 people killed in January's terror attacks in Paris. ... Valerie Braham said to the assembled crowd. ...*



*... Philippe Braham was killed in the January's terror attacks.*  
...  
...

## Summarization

*... The game ended with the umpire making a bad call, and if the call had gone the other way, the Blue Whales might have actually won the game. It wasn't a victory, but I say the Blue Whales look like they have a shot at the championship, especially if they continue to improve.*



*... The match ended with the referee calling wrongly, and if the call went the other way, the Blue Whales could already win the match. It was not a victory, but I say that the Blue Whales seem to have a chance in the championship, especially if they keep improving.*

## Paraphrasing

Text generation is needed everywhere in our life!



## Image Captioning: Image-to-Text Generation

*Not the main focus of this tutorial.*

Final		Final	
ROCKETS	LAKERS	STATS	NEWS
<hr/>			
Player		Min	Reb
6 LeBron James · F		35	7
9 Kent Bazemore · F		27	2
3 Anthony Davis · C		33	13
0 Russell Westbrook · G		35	8
20 Avery Bradley · G		30	3
7 Carmelo Anthony		25	0
15 Austin Reaves		20	2
11 Malik Monk		19	2
10 DeAndre Jordan		17	3
		Ast	Pts
6 LeBron James · F		8	15
9 Kent Bazemore · F		1	9
3 Anthony Davis · C		2	16
0 Russell Westbrook · G		9	20
20 Avery Bradley · G		0	2
7 Carmelo Anthony		0	23
15 Austin Reaves		0	2
11 Malik Monk		0	0
10 DeAndre Jordan		2	8

HOU 1-5	85	Final	95	LAL 4-3
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LOS ANGELES -- Carmelo Anthony scored 23 points in a reserve role and Russell Westbrook added 20 points in the Los Angeles Lakers' 95-85 victory over the Houston Rockets on Sunday night.

Anthony Davis had 16 points and 13 rebounds, and LeBron James scored 15 points in the Lakers' fourth win in five games after opening the season with two losses. Westbrook added eight rebounds and nine assists.

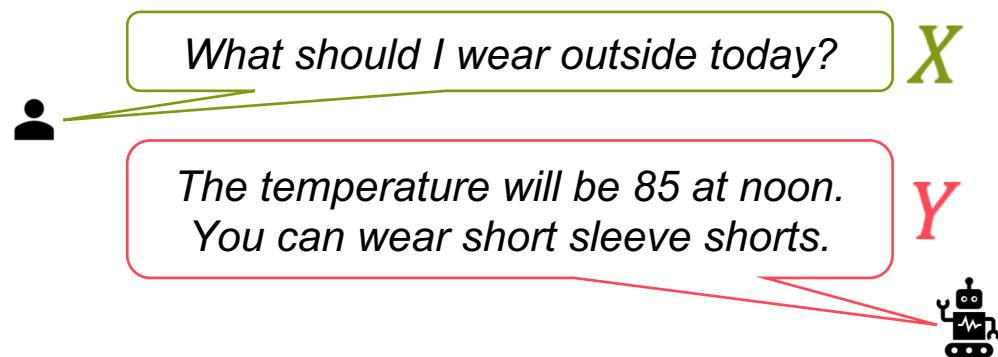
Eric Gordon scored 17 points and Christian Wood had 16 for the Rockets, who lost their fourth straight at the start of a five-game road trip.

## Sports News Generation: Table-to-Text Generation

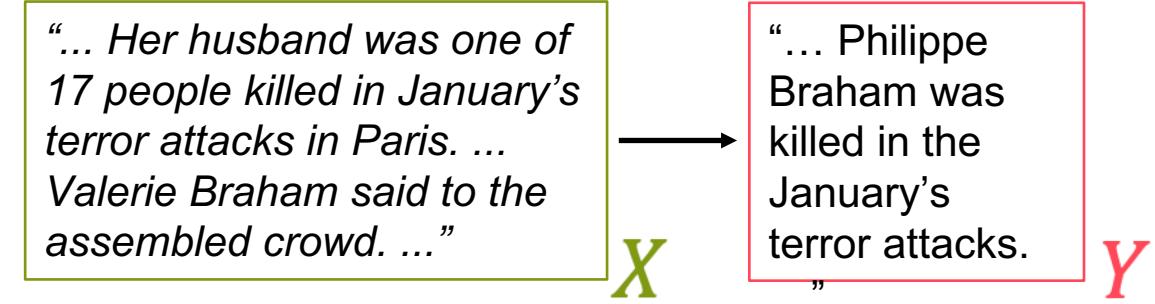
# Text-to-text generation is needed everywhere!



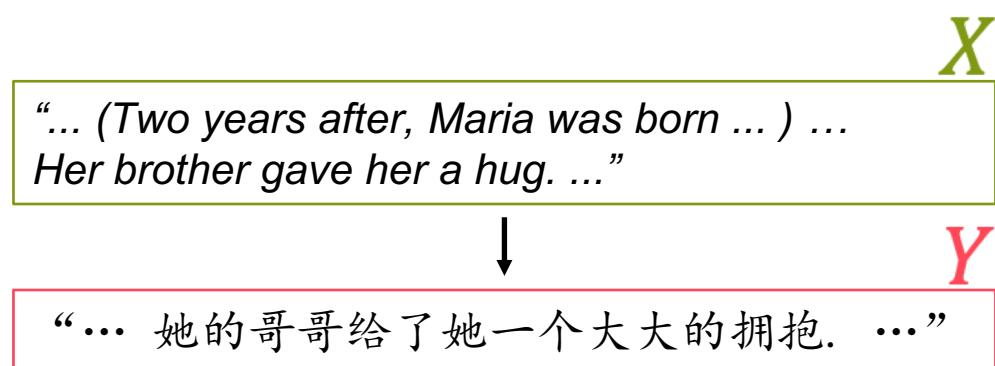
- $P(Y|X) = P(y_1, \dots, y_m|x_1, \dots, x_n) = \prod_{t=1}^m p(y_t|X, y_1, \dots, y_{t-1})$ , when **Y** is text and **X** is text.



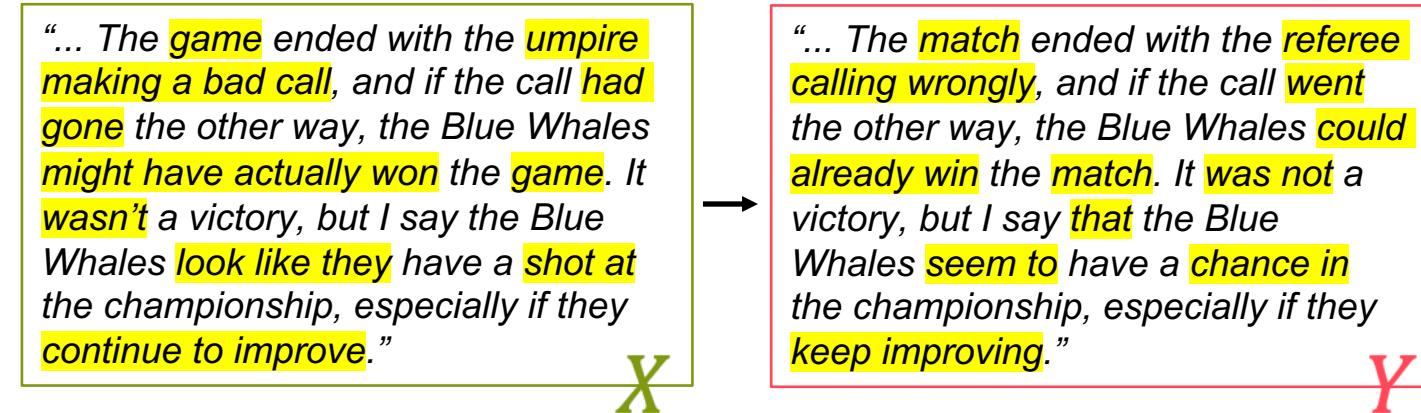
Dialog systems



Summarization



Machine Translation



Paraphrasing

- Mistakes may occur due to lack of knowledge.

*What should I wear outside today?*

The temperature will be ~~65~~ 85 at noon.  
You can wear short sleeve shorts.

## Dialog systems

... (Two years after, Maria was born ... ) ...  
Her brother gave her a hug. ...

... 她的弟弟哥哥给了她一个大大的拥抱. ...



... Her husband was one of 17 people killed in January's terror attacks in Paris. ... Valerie Braham said to the assembled crowd. ...

## Summarization

... The game ended with the umpire making a bad call, and if the call had gone the other way, the Blue Whales might have actually won the game. It wasn't a victory, but I say the Blue Whales look like they have a shot at the championship, especially if they continue to improve.

... Valerie Braham  
Philippe Braham was killed in the January's terror attacks. ...



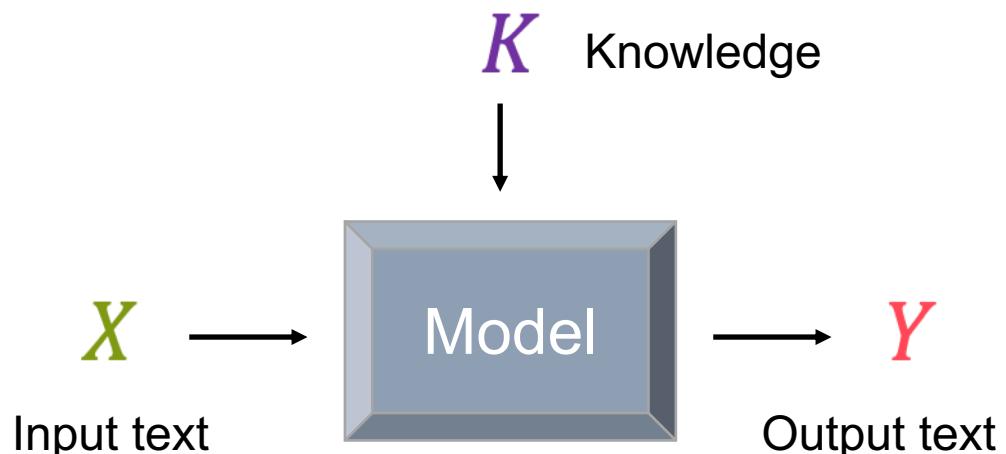
... The match ended with the referee calling wrongly, and if the call went the other way, the Blue Whales could never already win the match. It was not a victory, but I say that the Blue Whales seem to have a chance in the championship, especially if they keep improving."

## Machine Translation

## Paraphrasing

# Knowledge-enhanced natural language generation (KE-NLG)

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- Key questions: (Outline of this tutorial)
- **Where** does the Knowledge come from? In other words, what are the **Knowledge sources**?
  - **What** are the **data/representations** of Knowledge?
  - **What** are the **methods** for integrating Knowledge into NLG models? **How** to utilize different types of Knowledge?
  - **What** are the concrete NLG **models/techniques** that have been enhanced by Knowledge? **What** are their **advantages** and **disadvantages**?
  - **Where** can we find **benchmark datasets**, **code library**, and **hands-on tutorial** for doing research on this topic?
  - **What** are the remaining **challenges** and **future directions**?

# Material for this tutorial



- Website: <https://kenlg-tutorial.github.io/>
  - Schedule
  - Slides
  - Tutor information
- A pre-print survey on the topic of Knowledge-enhanced NLG:
  - <https://arxiv.org/abs/2010.04389>
- A reading list and a collection of open-source code:
  - <https://github.com/wyu97/KENLG-Reading>



enJOY

A large, stylized black smiley face icon with two dots for eyes and a curved line for a mouth. Below it, the word "enJOY" is written in a bold, black, sans-serif font.