

Enhancing Language Generation with Knowledge Graphs

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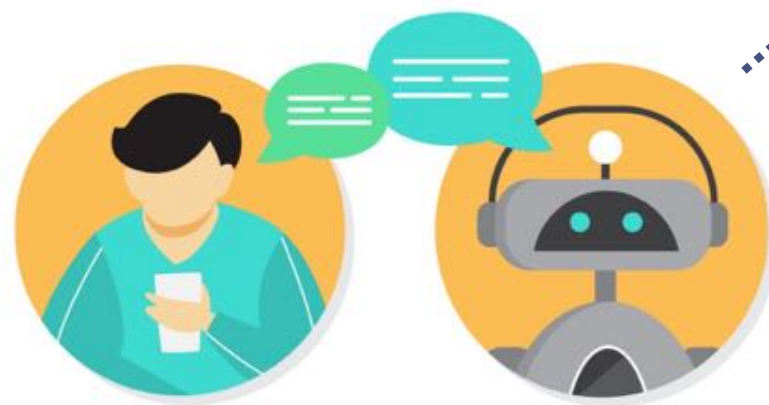
**Machine
Translation**

Input X

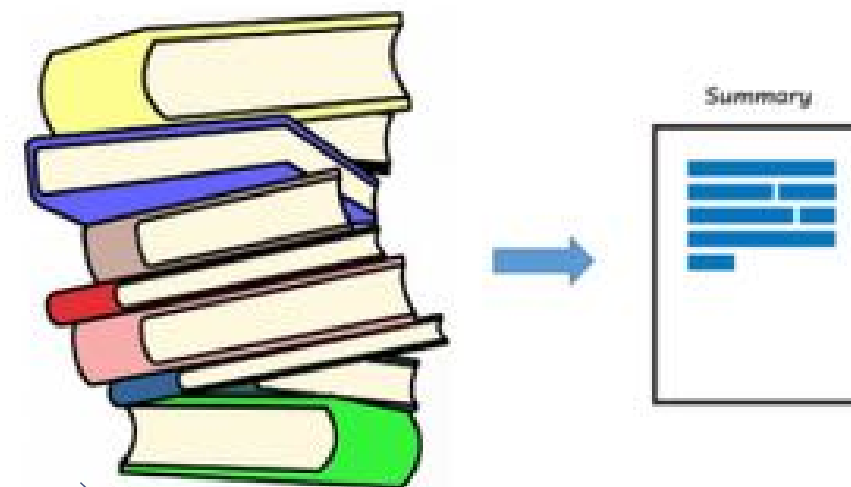


Language Generation Model
 $p_{\theta}(Y|X)$

Output Y



**Question
Answering**



**Abstractive
Summarization**



**Commonsense
Reasoning**

WHAT IS KNOWLEDGE GRAPH?

A graph is a conceptual representation of a group of things — called nodes — and the relationships between them — called edges.

A graph of general/specialized knowledge is constructed from a collection of databases in general/specialized domains.

It encodes relationships uncovered by billions of humans over thousands of years into a single resource.

Knowledge Graph G



Input X



Enhance the model
Language Generation Model

$p_{\theta}(Y|X)$

$p_{\theta}(Y|X, G)$

Output Y



Many possibilities that Y is too difficult
for a model to generate
(Examples come later)

When are Knowledge Graphs useful?

Given X only, it is too difficult for a model to generate a good Y .





Machine Translation

English to Chinese

Input:

*After Seth Curry tallied 24 points for the 76ers in game six against the Hawks, his **brother** Steph chimed in on social media with a reaction.*

Chinese vocabulary:

兄弟 (hsyon-dee) brothers/cousins; best friends; sworn brothers; buddies

哥哥 (ger-ger) elder brother

弟弟 (dee-dee) younger brother

In Chinese, the expression of “brother” relationship is often specified to 哥哥/弟弟.

GPT-3

Please translate into Chinese: "After Seth Curry tallied 24 points for the 76ers in game six against the Hawks, his brother Steph chimed in on social media with a reaction."

在赛克斯24分带领76人队对阵老鹰队的第六场比赛后，他的兄弟斯蒂芬在社交媒体上做出了反应。

Please precisely translate into Chinese: "After Seth Curry tallied 24 points for the 76ers in game six against the Hawks, his brother Steph chimed in on social media with a reaction."

在赛克斯24分带领76人队对阵老鹰队的第六场比赛后，他的兄弟斯蒂芬在社交媒体上做出了反应。

Please translate into Chinese precisely on "brother": "After Seth Curry tallied 24 points for the 76ers in game six against the Hawks, his brother Steph chimed in on social media with a reaction."

在赛克斯24分带领76人队对阵老鹰队的第六场比赛后，他的兄弟斯蒂芬在社交媒体上做出了反应。

Submit



405

When “elder” or “younger” specified ...

Please translate into Chinese: "After Seth Curry tallied 24 points for the 76ers in game six against the Hawks, his elder brother Steph chimed in on social media with a reaction."

在西斯·库里为76人在对阵老鹰的第六场比赛中获得24分之后，他的哥哥斯蒂芬在社交媒体上做出了反应。

Does GPT-3 know the fact?

Please answer this question: Is Seth Curry an elder brother or younger brother of Stephen Curry?

Seth Curry is a younger brother of Stephen Curry.

Please answer this question: Is Stephen Curry an elder brother or younger brother of Seth Curry?

Stephen Curry is an elder brother of Seth Curry.

Submit



138

Submit



63

ENHANCING TRANSLATION PRECISION

When knowledge was represented as billions of parameters in language models, one could hardly guarantee that there would be a general, effective method that could use the knowledge to generate precise language.

Solution: Roll back to where the knowledge was obtained to train the model. Enhance the model explicitly with the data.

Stephen Curry



Curry in 2019

No. 30 – Golden State Warriors

Position Point guard

League NBA

Personal Information

Born March 14, 1988 (age 34)
Akron, Ohio, U.S.

Listed height 6 ft 2 in (1.88 m)

Listed weight 185 lb (84 kg)

Career information

High school Charlotte Christian
(Charlotte, North Carolina)



Steph Curry
03/14/1988

Seth Curry
08/23/1990

Seth Curry



Curry with the Dallas Mavericks in 2020

No. 30 – Brooklyn Nets

Position Shooting guard

League NBA

Personal information

Born August 23, 1990 (age 31)
Charlotte, North Carolina, U.S.

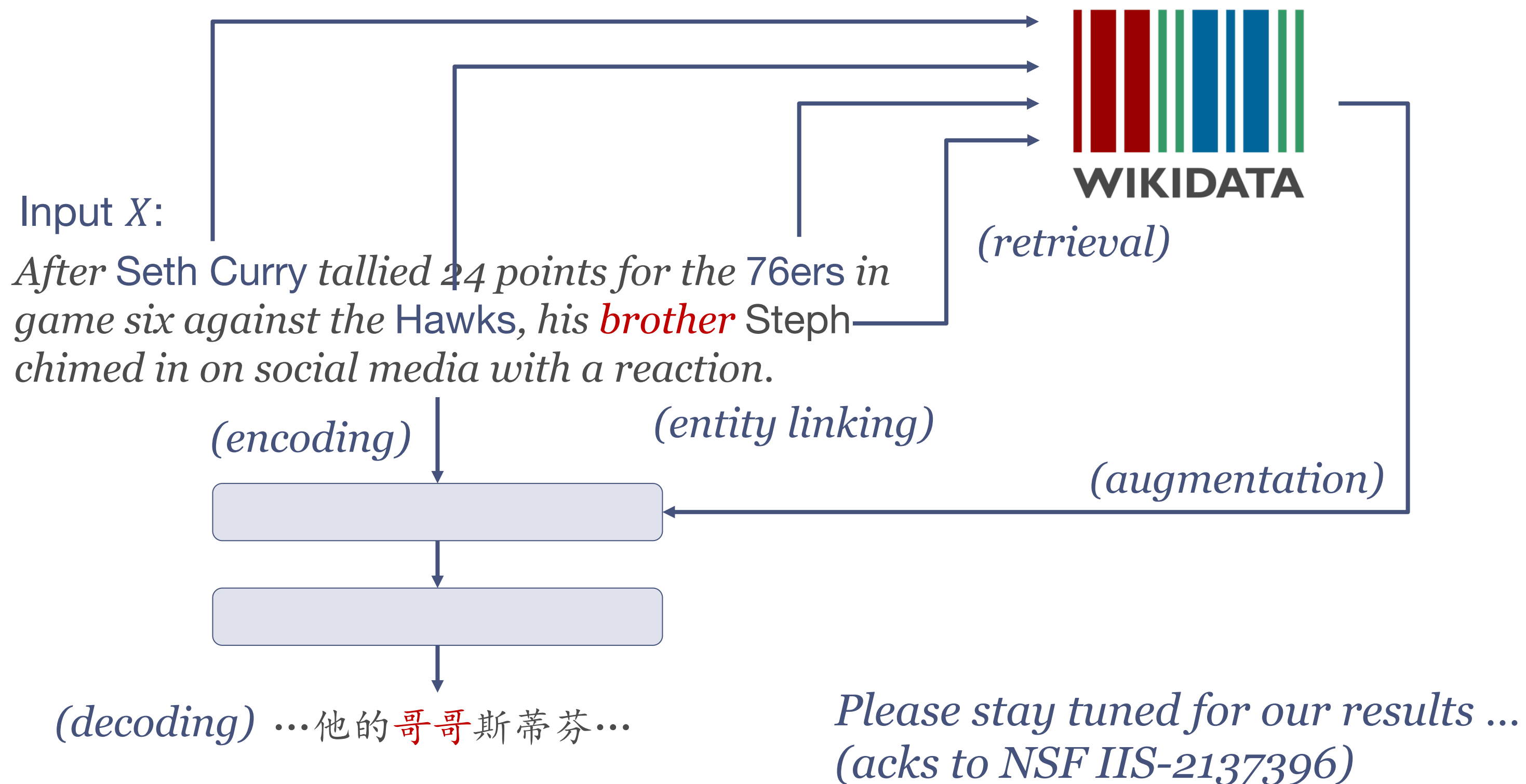
Listed height 6 ft 2 in (1.88 m)

Listed weight 185 lb (84 kg)

Career information

High school Charlotte Christian
(Charlotte, North Carolina)

Retrieval-Augmented NMT





Abstractive Summarization

Factual correctness matters!

Input:

... Her husband was one of 17 people killed in January's terror attacks in Paris ...

... Valerie Braham said to the assembled crowd ...

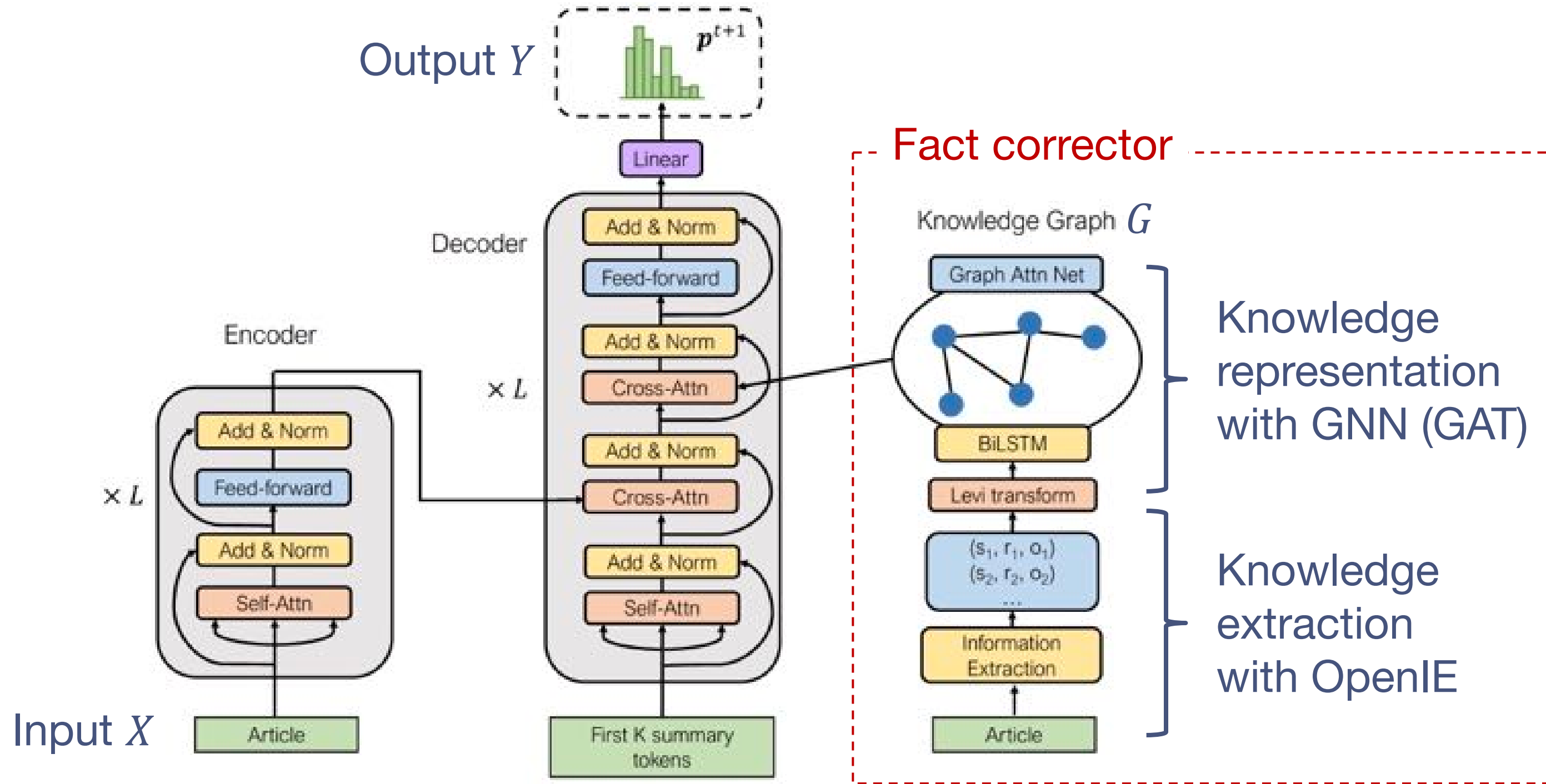
Possible incorrect outputs:

“Philippe Braham said that ...”

“Paris was killed in the January's terror attacks ...”

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

FASum: Fact-Aware Summarizer



Zhu, Hinthorn, Xu, Zeng, Zeng, Huang, Jiang. “Enhancing Factual Consistency of Abstractive Summarization.” In **NAACL**, pp. 718-733. **2021**.

Results: XSum

	Fact Score*	R-1	R-2	R-L
BottomUp	78.0	26.91	7.66	20.01
Seq2Seq	80.6	31.44	10.91	24.69
UniLM	83.2	42.14	19.53	34.13
FASum	83.4	42.18	19.53	34.15

*To evaluate factual consistency, we re-implemented and trained **FactCC** (Kryscinski et al., 2019). The model outputs a **Fact Score** between 0 and 1, where a higher score indicates better consistency between the input article and summary. The training of FactCC is independent of our summarizer so no parameters are shared.

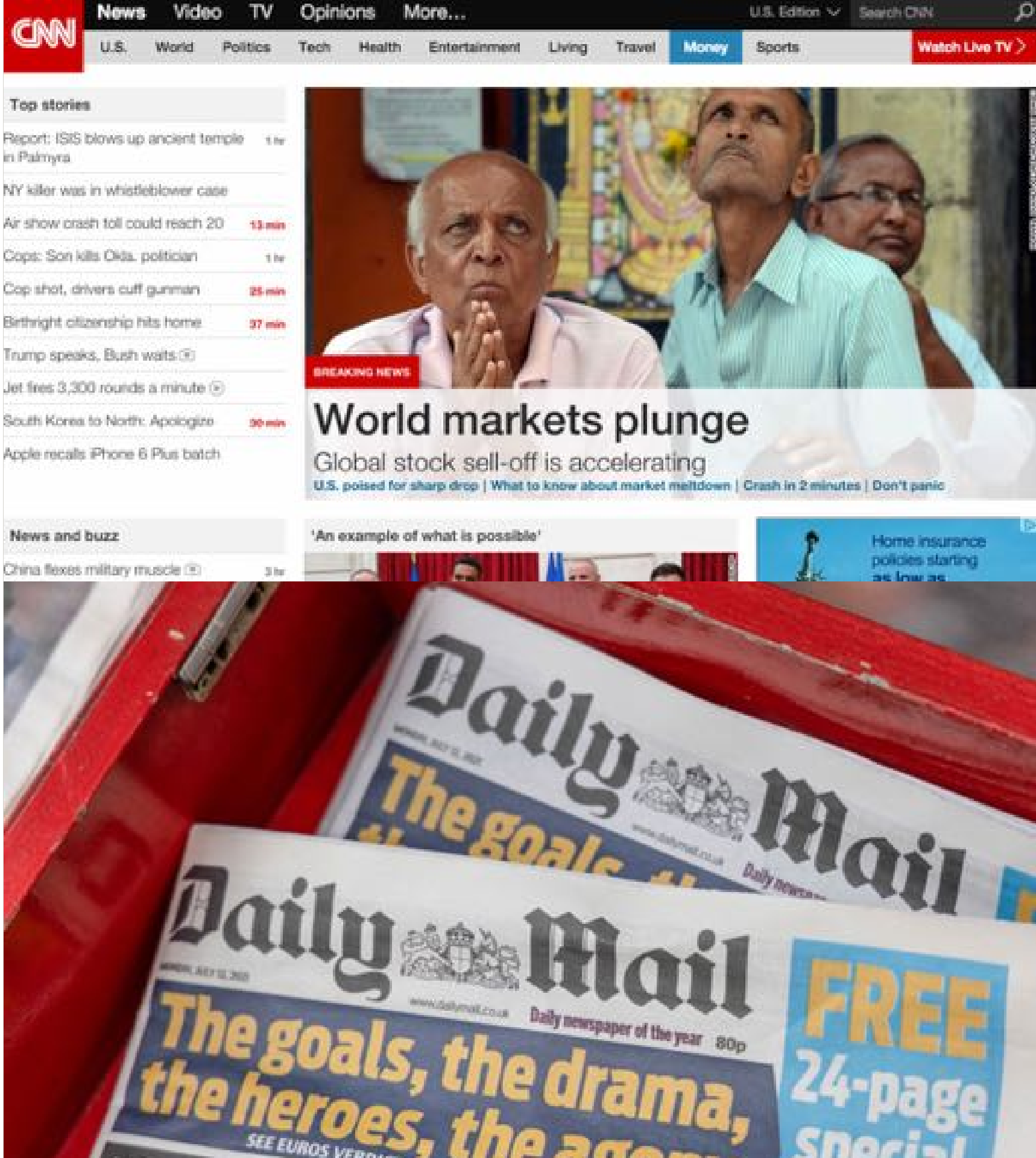


Results: CNN/DailyMail

	Fact Score	R-1	R-2	R-L
BottomUp	83.9	41.22	18.68	38.34
Seq2Seq	85.0	41.03	18.04	37.93
UniLM	87.2	43.33	20.21	40.51
FASum	88.1	40.53	17.84	37.40

Human evaluation:

	Factual Score	Informativeness
BottomUp	2.32	2.23
Seq2Seq	2.59	2.30
UniLM	2.65	2.45
FASum	2.74	2.42



Commonsense Reasoning

Explaining counterfactual statements

Input:

Piano is a kind of sport. This is False because _____

Annotators 1 and 4: *(what does it have?)*

you can produce music when pressing keys on the piano, so it is an instrument.

Annotators 3 and 5: *(what's it used for?)*

piano is a musical instrument used in songs to produce different musical tones.

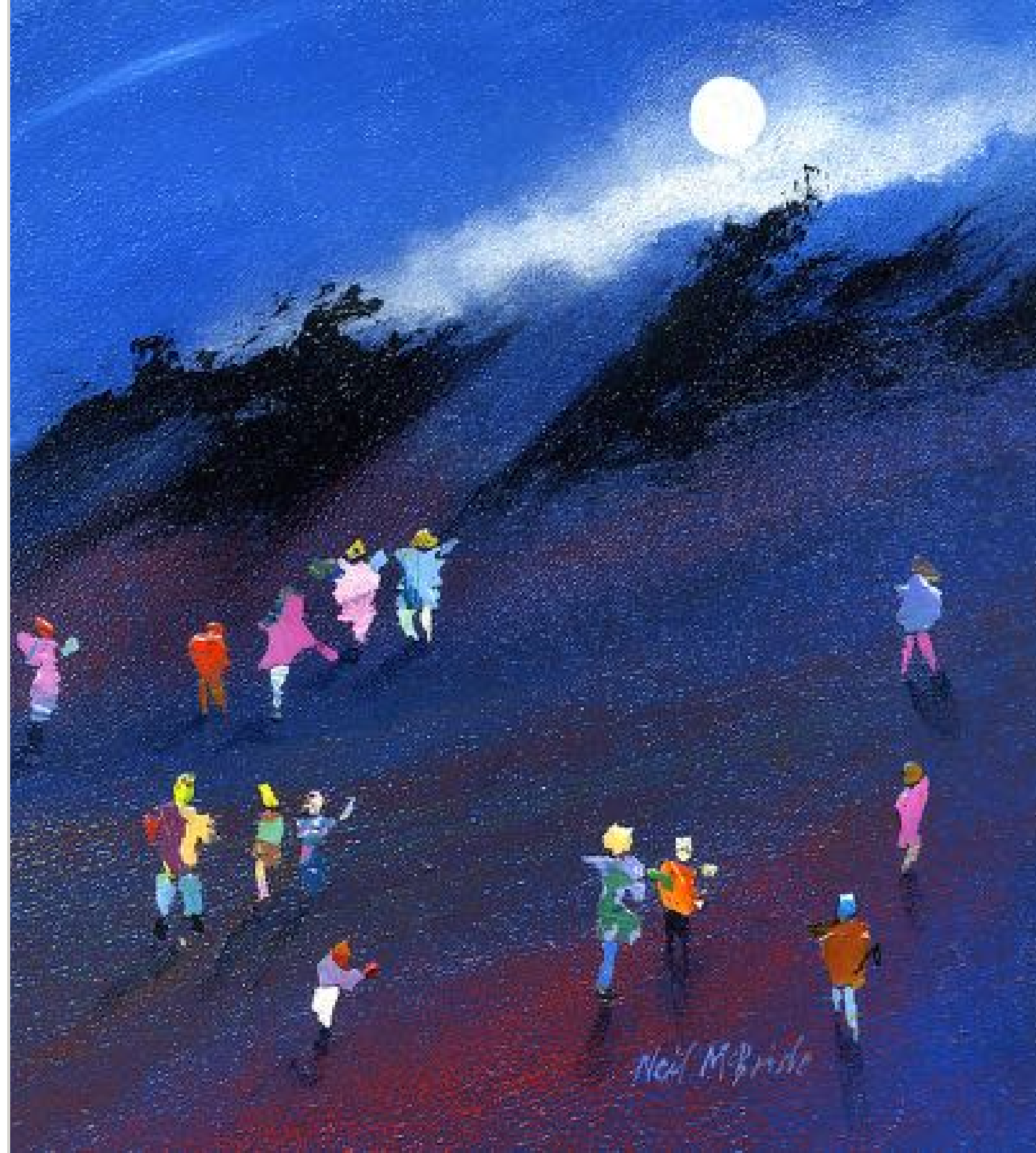
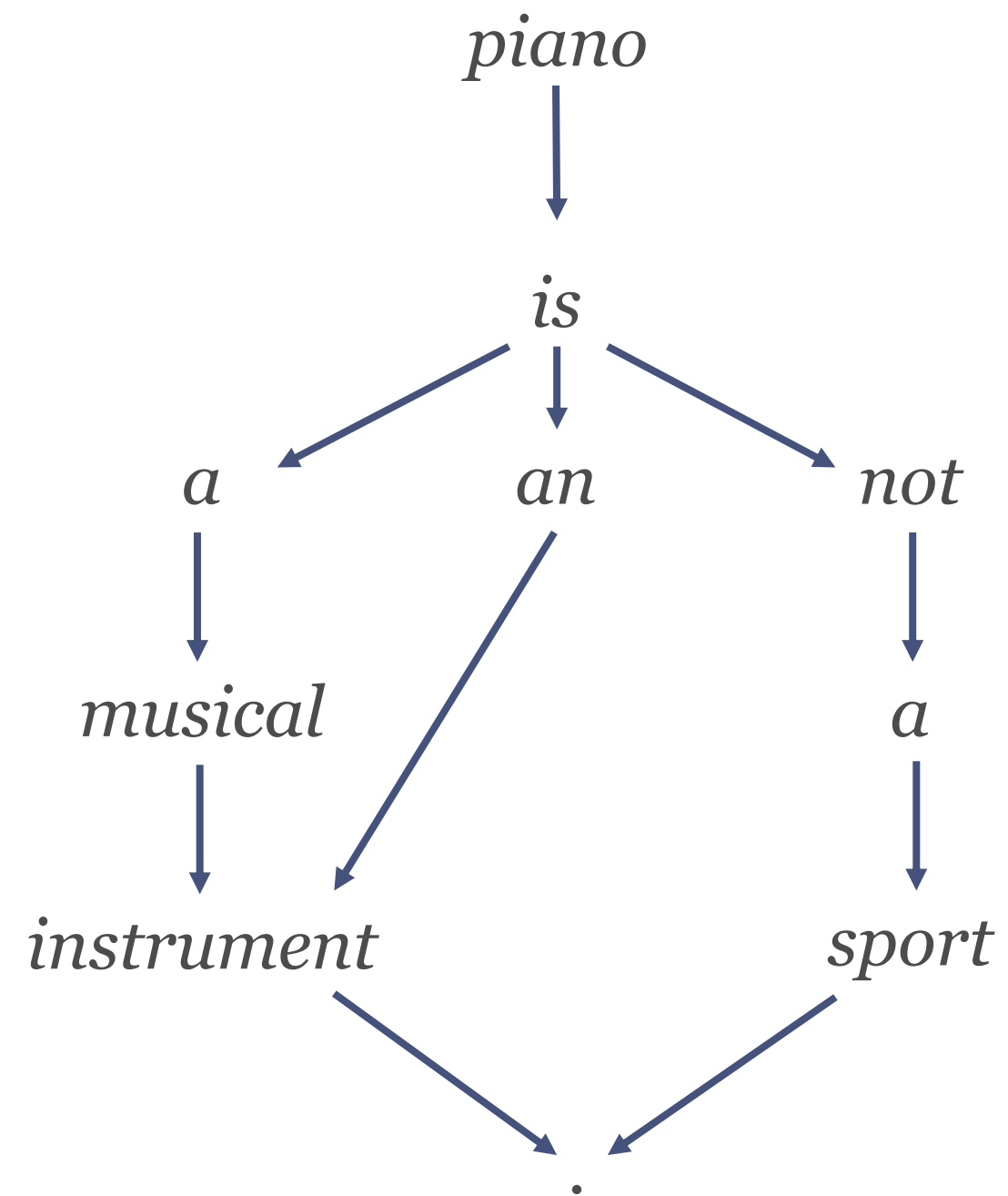
Annotator 2: *(what's its category?)*

piano is a kind of art form.

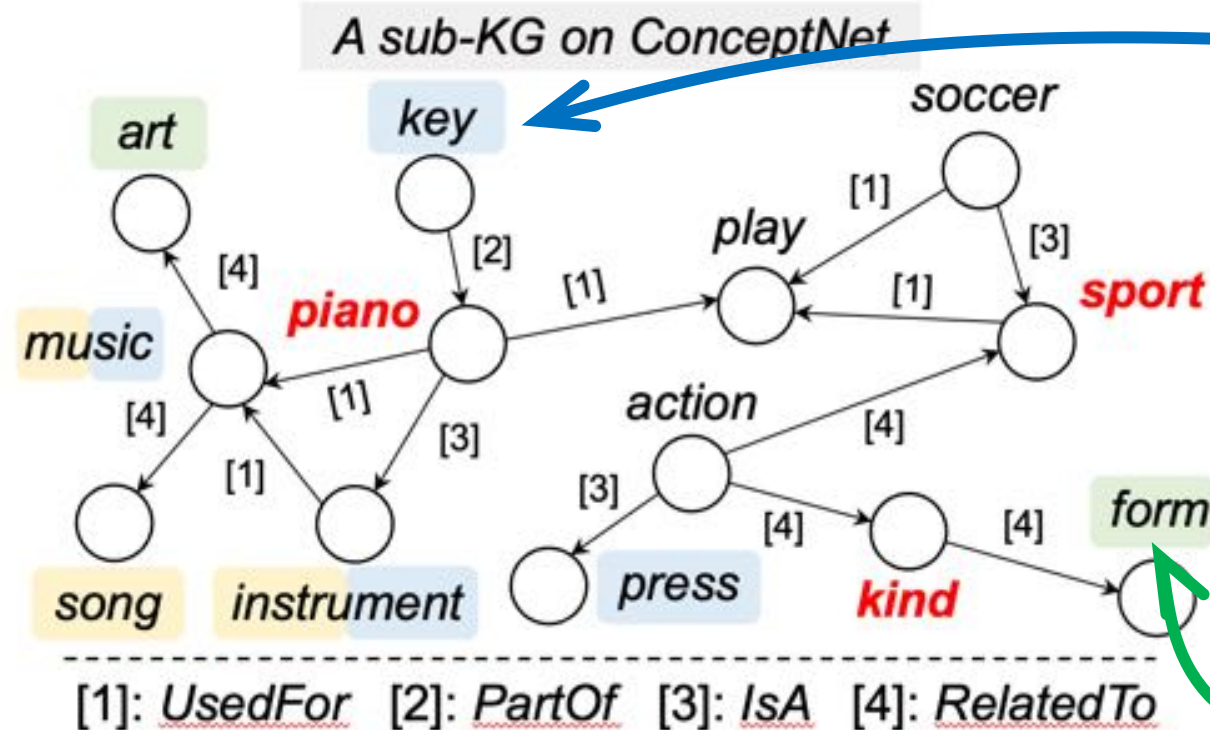


Beam Search with $p_{\theta}(Y|X)$

Greedy algorithm



ENHANCING GENERATION DIVERSITY



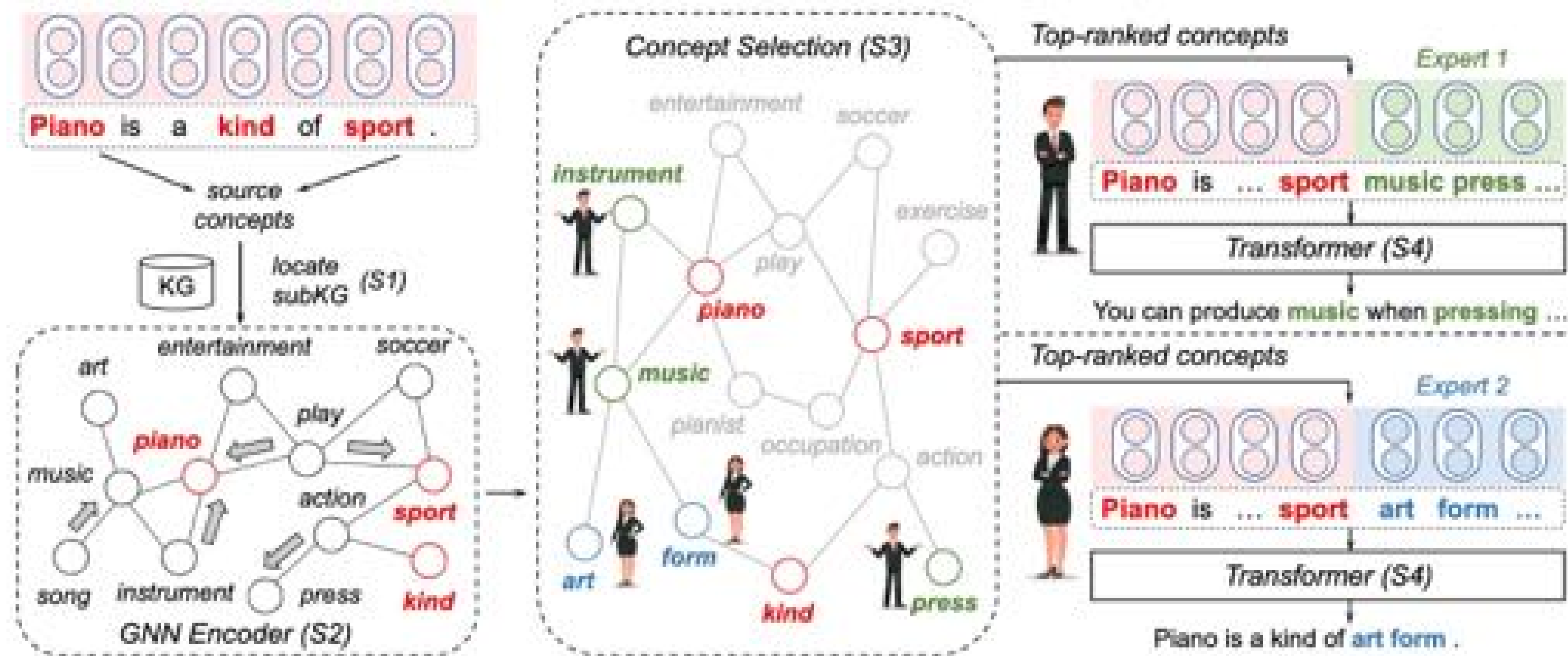
Input: **Piano** is a **kind** of **sport**.

Outputs: 3 different explanations

- (1) You can produce music when pressing keys on the piano, so it is an instrument.
- (2) Piano is a musical instrument used in songs to produce different musical tones.
- (3) Piano is a kind of art form.

Mixture of Knowledge Graph Experts (MoKGE)

Accepted to ACL 2022 and DLG4NLP@NAACL 2022

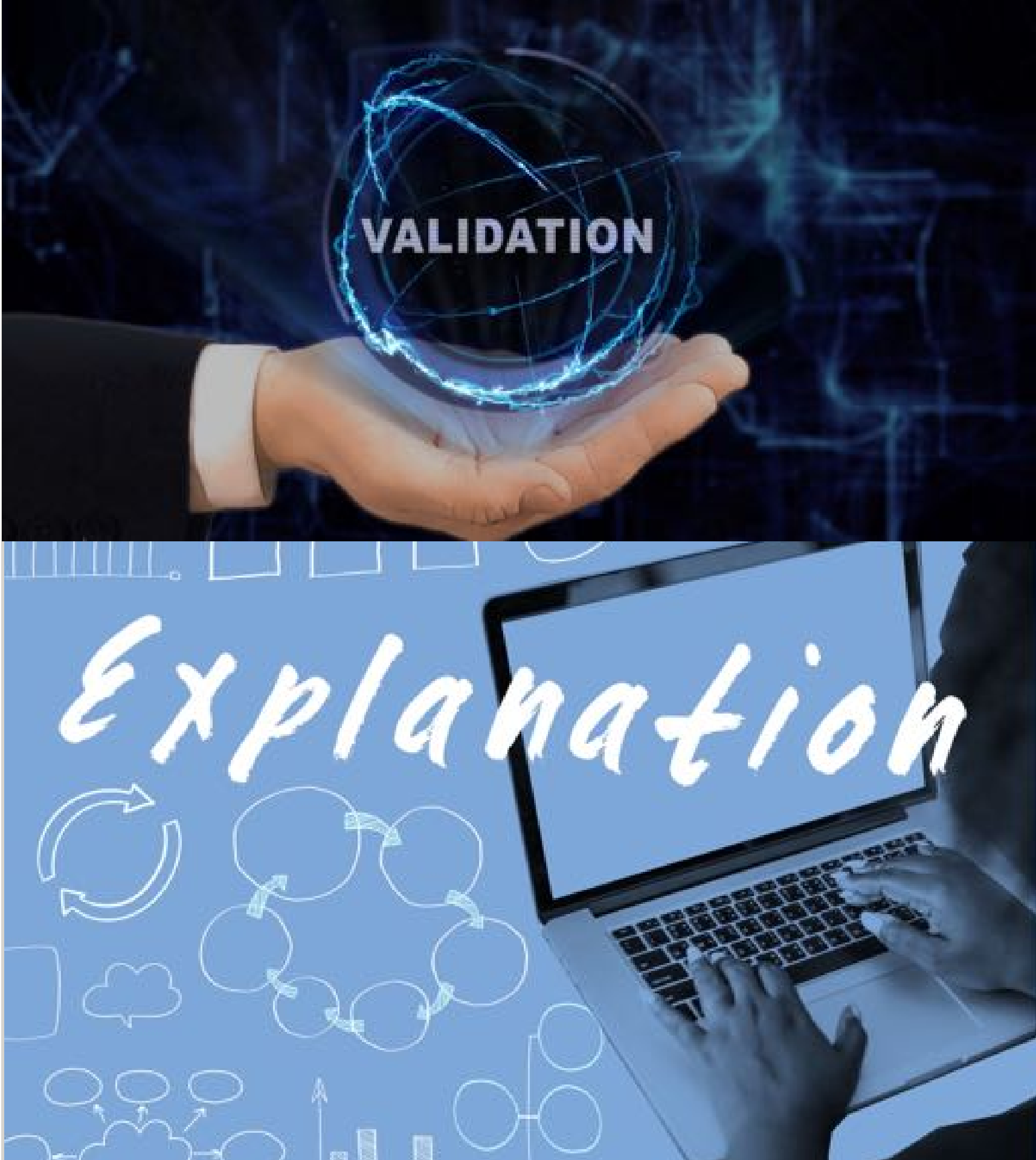


Results: ComVE (SemEval 2020: Task 4)

	SelfBERT (↓)	Distinct-2 (↑)	R-L (↑)
Truncated samp.	61.39	34.80	17.48
Nucleus samp.	63.43	34.17	17.68
MoKGE	30.93	48.44	19.13
Human	12.36	63.02	100.0

Human evaluation:

	Diversity	Quality
Truncated samp.	2.15 ± 0.76	2.22 ± 1.01
Nucleus samp.	2.03 ± 0.73	2.29 ± 1.03
MoKGE	2.63 ± 0.51	2.10 ± 0.99
Human	2.60 ± 0.59	3.00



Results: α -NLG (Abductive Commonsense Reasoning)

	SelfBERT (↓)	Distinct-2 (↑)	R-L (↑)
Truncated samp.	52.11	30.08	38.98
Nucleus samp.	56.32	29.92	13.53
MoKGE	27.40	38.15	38.82
Human	10.36	53.57	100.0

Human evaluation:

	Diversity	Quality
Truncated samp.	2.31 ± 0.76	2.63 ± 0.77
Nucleus samp.	2.39 ± 0.73	2.67 ± 0.72
MoKGE	2.66 ± 0.51	2.57 ± 0.71
Human	2.71 ± 0.57	3.00

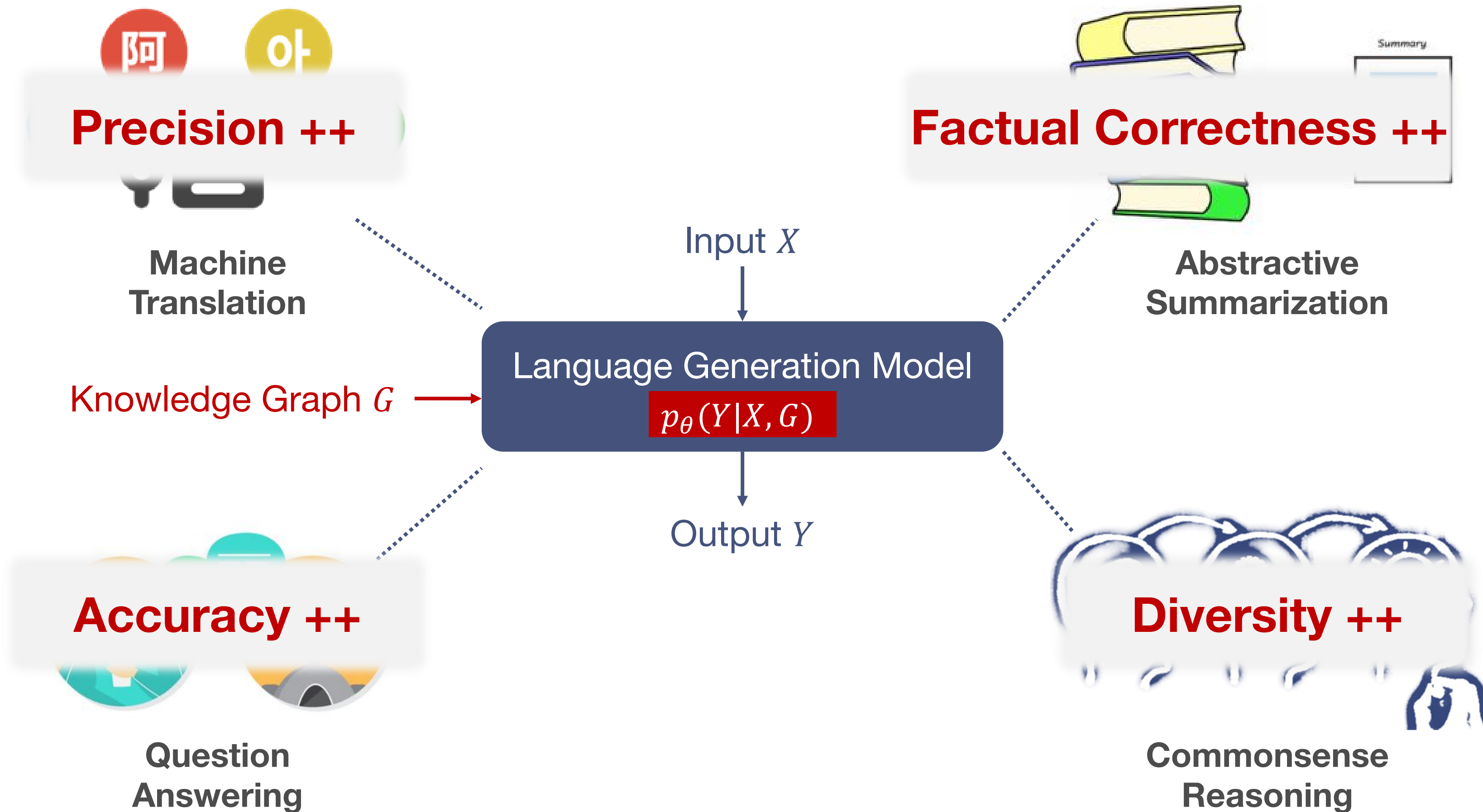


Cleaned house
Went to work
Left windows open



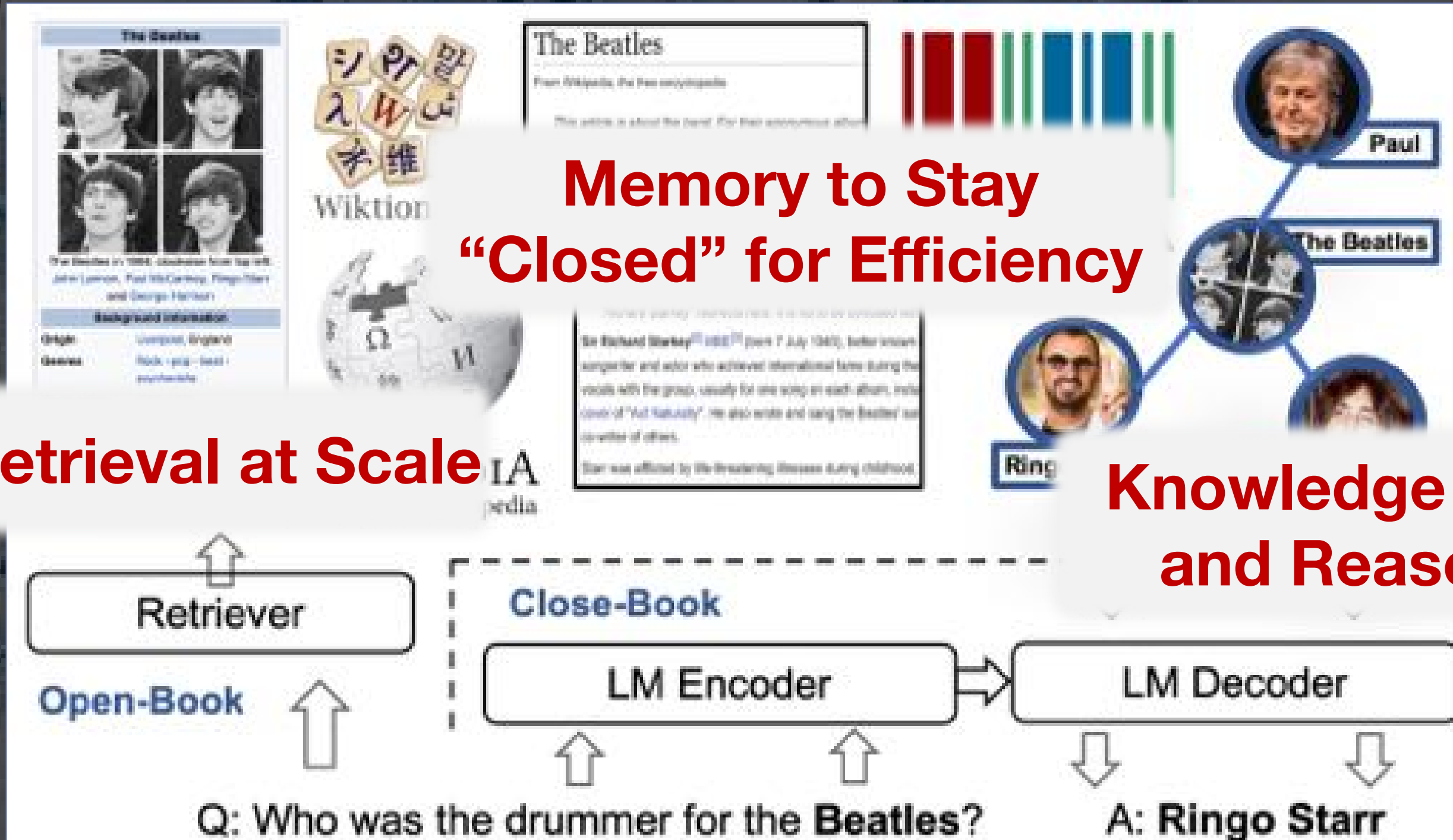
Back home
Found a mess



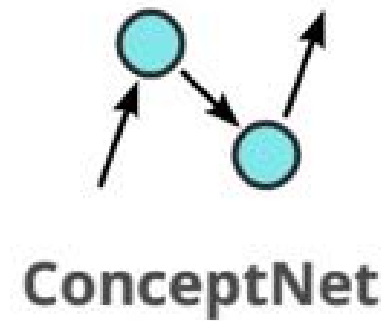


ENHANCING QA ACCURACY

Open-book vs Closed-book



Heterogeneity



“Books”





KGs

Q: ... I've lost contact with old friends, I don't see them or speak to them for months on end. I am truly alone. **I was kicked out of my old college because I never went to my lessons, and I've nearly been kicked out of my new one for the same reason, I just don't want to do anything, and my family are disappointed in me for this,** they want me to have a good future, when I don't see myself having one I don't see myself growing old and having a family with kids. I don't know what to do,



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