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# Semantic Frame Forecast

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**Crowd-AI Lab**

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**PennState**

# Introduction

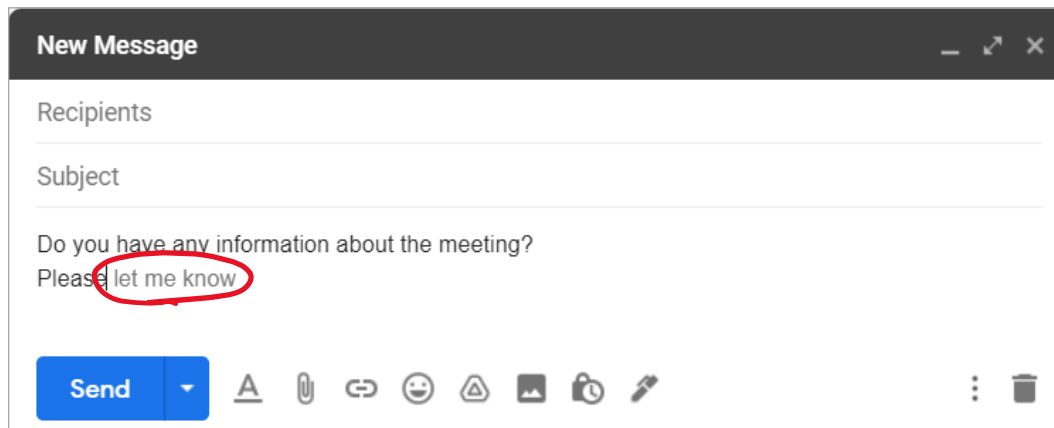
- Story writing is hard. Writers can struggle to develop the follow-up scenes.

*“Anyone who says writing is easy isn’t doing it right.” - Amy Joy.*

➡ Provide hints or texts to help!

# Introduction

- However, most of the tools aim at providing ideas or texts for **the immediate future** (one to a few sentences later).



New Message

Recipients

Subject

Do you have any information about the meeting?

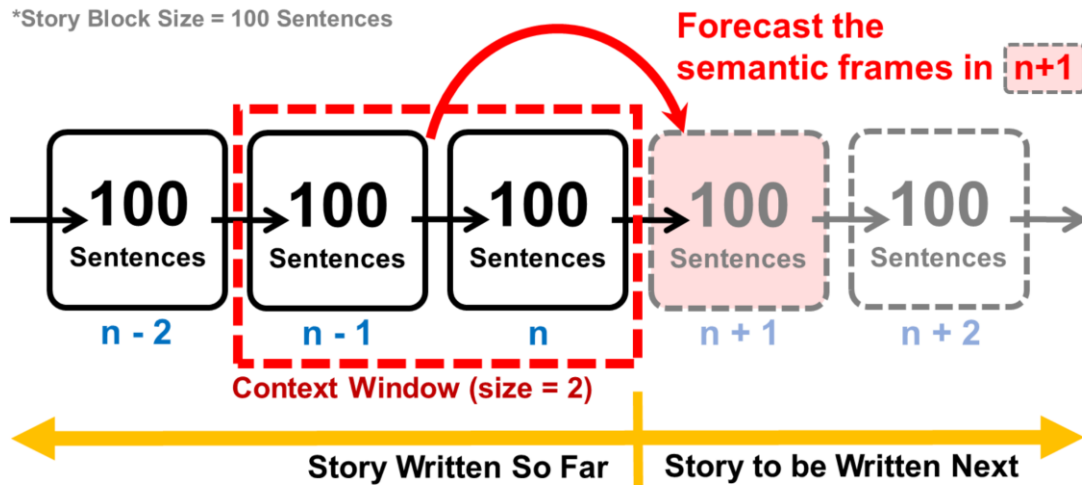
Please let me know

Send

Icons: Underline, Bold, Italic, Link, Emoji, Attachment, Image, Video, Trash

# Introduction

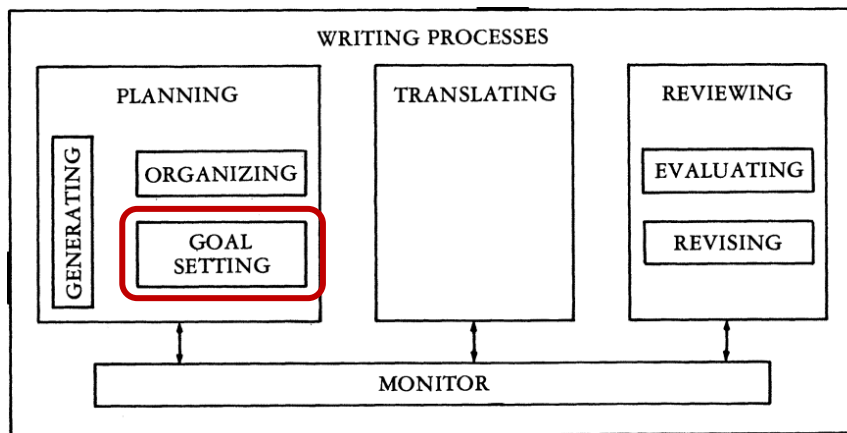
- We present a **frame representation** on **story blocks** to handle (1) a longer history and (2) a longer future.



# What To Predict?

- Semantic frames are high-level concepts of **things**.
- Forecasting a frame means predicting what would happen next!

➡ **Goal setting** in the writing process theory [1]!



# Semantic Frame Representation

## A Story Block (20 Sentences)

His mouth turned up slightly at the corners. "Are you really."

\*\*\*

*Meanwhile, in the city center...*

too small for his enormous hands. There were two huge guns strapped in leather holsters on his hips.

## B Semantic Frames

His mouth turned up slightly at the corners. "Are you really."

\*\*\*

*Meanwhile, [in] the [city] [center]...*

[There] [were] [two] [huge] [guns] strapped [in] leather holsters [on] his hips.

Parse Semantic Frame using Open-Sesame [2]

\* **FrameNet** [3] defines a total of 1,221 high-level conceptual units, which are called **frames**.

[2] Baker, Collin F., Charles J. Fillmore, and John B. Lowe. "The berkeley framenet project." 36th Annual Meeting of the Association for Computational Linguistics and 17th International Conference on Computational Linguistics, Volume 1. 1998.

[3] Swayamdipta, Swabha, et al. "Frame-semantic parsing with softmax-margin segmental rnns and a syntactic scaffold." arXiv preprint arXiv:1706.09528 (2017).

# A Semantic Frame

His mouth turned up slightly at the corners. “Are you really.”

\*\*\*

Meanwhile, [*in*] the [*city*] [*center*]...

[*There*] [*were*] [*two*] [*huge*] [*guns*] strapped [*in*] leather holsters [*on*] his hips.

## • Political\_locales

**Definition** This frame covers words that name Locations as defined politically, or administratively.

**Lexical Units**  
(Words that can trigger the frame.)

*barony.n, borough.n, city-state.n, **city.n**, commonwealth.n, country.n, county.n, diocese.n, district.n, duchy.n, empire.n, federal.a, fiefdom.n, global.a, international.a, internationally.adv, jurisdiction.n, kingdom.n, land.n, local.a, locality.n, megalopolis.n, metropolis.n, multinational.a, municipal.a, municipality.n, nation.n, national.a, parish.n, principality.n, province.n, provincial.a, realm.n, state [internal].n, state [sovereign].n, territorial.a, territory.n, town.n, township.n, village.n, viscountcy.n, world.n*

# Semantic Frame Representation

## B Semantic Frames

His mouth turned up slightly at the corners. “Are you really.”

\*\*\*

Meanwhile, [in] the [city] [center]...

[There] [were] [two] [huge] [guns] strapped [in] leather holsters [on] his hips.

## C Frame Representation (TF-IDF)

Prohibiting_or_licensing	: 8.37
Size	: 6.47
Rebellion	: 6.31
Local_by_use	: 3.96
Achieving_first	: 3.74
...	

Convert to TF-IDF vector  
over semantic frames

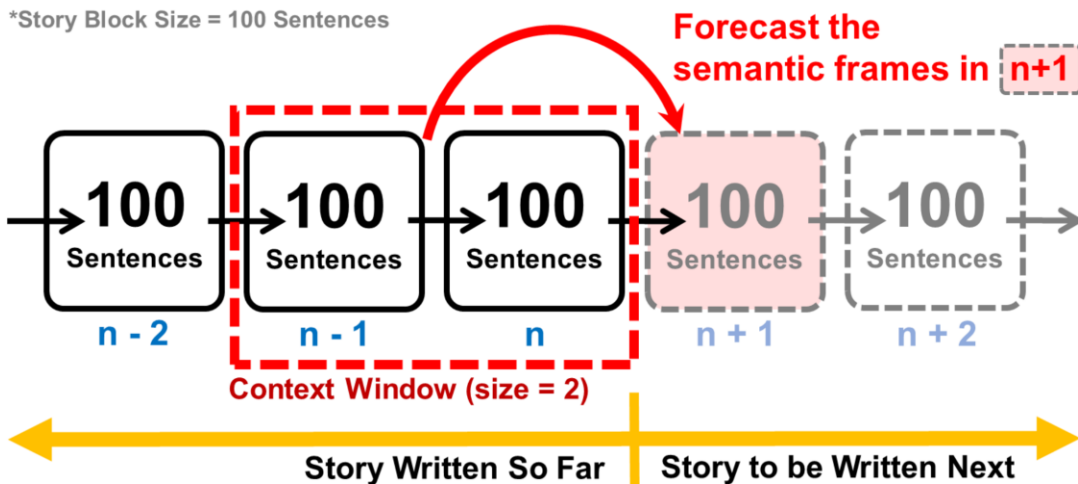
\* IDF is computed on all the corpus!





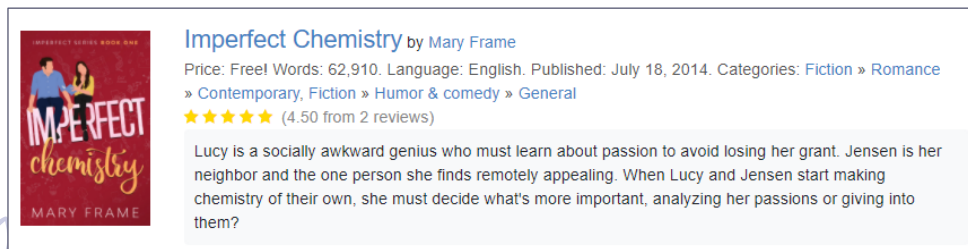
# Semantic Frame Forecast

- Using the existing information (block  $n-1$ , block  $n$ ) to predict the **frame representation** in block  $n+1$ .
- Cosine similarity for evaluation.



# Dataset

- **Bookcorpus** [4]: A total of 4,794 real **fictions** are selected.
- **CODA-19** [5]: A total of 7,962 scholar **abstracts** are selected.



[4] Zhu, Yukun, et al. "Aligning books and movies: Towards story-like visual explanations by watching movies and reading books." *Proceedings of the IEEE international conference on computer vision*. 2015.

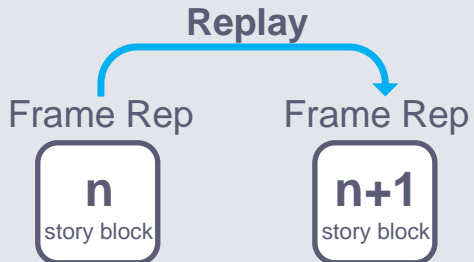
[5] Huang, Ting-Hao, et al. "CODA-19: Using a Non-Expert Crowd to Annotate Research Aspects on 10,000+ Abstracts in the COVID-19 Open Research Dataset." *Proceedings of the 1st Workshop on NLP for COVID-19 at ACL 2020*. 2020.

For successful infection, viruses must recognize their respective host cells. A common mechanism of host recognition by viruses is to utilize a portion of the host cell as a receptor. Bacteriophage Sf6, which infects Shigella flexneri, uses lipopolysaccharide as a primary receptor and then requires interaction with a secondary receptor, a role that can be fulfilled by either outer membrane proteins (Omp) A or C. Our previous work showed that specific residues in the loops of OmpA mediate Sf6 infection. To better understand Sf6 interactions with OmpA loop variants, we determined the kinetics of these interactions through the use of biolayer interferometry, an optical biosensing technique that yields data similar to surface plasmon resonance. Here, we successfully tethered whole Sf6 virions, determined the binding constant of Sf6 to OmpA to be 36 nM. Additionally, we showed that Sf6 bound to five variant OmpAs and the resulting kinetic parameters varied only slightly. Based on these data, we propose a model in which Sf6: Omp receptor recognition is not solely based on kinetics, but likely also on the ability of an Omp to induce a conformational change that results in productive infection. All rights reserved. No reuse allowed without permission.	Background
	Purpose
	Method
	Finding/Contribution
	Other

# Models

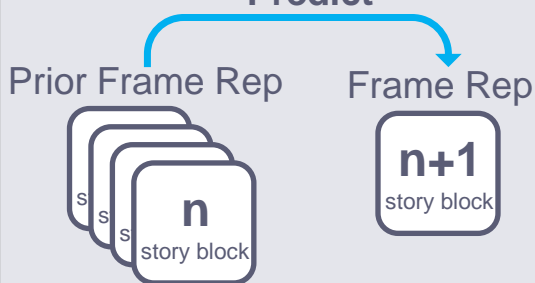
1

## Replay Baseline



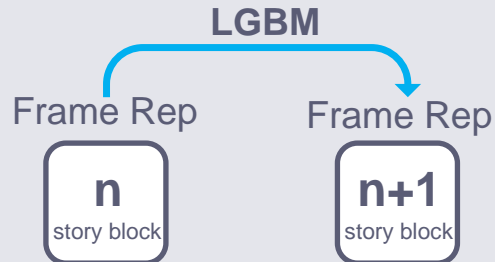
2

## Prior Baseline



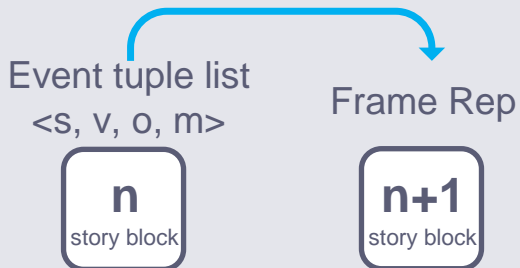
3

## LGBM + Frame



4

## Event-Rep [6]



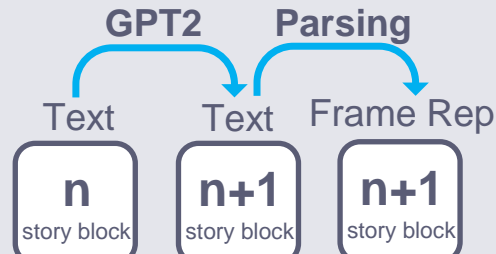
5

## BERT



6

## GPT2



# Evaluation

\* *Cosine Similarity*

Feature	Model	Block Size									
		5	10	20	50	100	150	200	300	500	1000
-	Replay Baseline	.0654	.0915	.1237	.1737	.2163	.2448	.2665	.3000	.3462	.4155
-	Prior Baseline	.2029	.2435	.2857	.3389	.3754	.3962	.4105	.4302	.4528	.4776
Frame	LGBM	.2072	.2506	.2967	.3564	.3995	<b>.4255</b>	<b>.4441</b>	<b>.4711</b>	<b>.5048</b>	<b>.5510</b>
Event	Event-Rep	.2111	.2541	.2994	.3532	.3929	.4126	.4280	.4453	.4626	.4792
Text	BERT	<b>.2172</b>	<b>.2611</b>	<b>.3073</b>	<b>.3637</b>	<b>.4012</b>	.4229	.4371	.4559	.4779	.5057
Text	GPT-2	.0519	.0739	.0990	.1402	-	-	-	-	-	-

- **BERT+text** works better when story block is smaller.
- **LGBM+frame** performs better when story block is larger.

# Evaluation (cont.)

\* *Cosine Similarity*

Feature	Model	Block Size									
		5	10	20	50	100	150	200	300	500	1000
-	Replay Baseline	.0654	.0915	.1237	.1737	.2163	.2448	.2665	.3000	.3462	.4155
-	Prior Baseline	.2029	.2435	.2857	.3389	.3754	.3962	.4105	.4302	.4528	.4776
Frame	LGBM	.2072	.2506	.2967	.3564	.3995	<b>.4255</b>	<b>.4441</b>	<b>.4711</b>	<b>.5048</b>	<b>.5510</b>
Event	Event-Rep	.2111	.2541	.2994	.3532	.3929	.4126	.4280	.4453	.4626	.4792
Text	BERT	<b>.2172</b>	<b>.2611</b>	<b>.3073</b>	<b>.3637</b>	<b>.4012</b>	.4229	.4371	.4559	.4779	.5057
Text	GPT-2	.0519	.0739	.0990	.1402	-	-	-	-	-	-

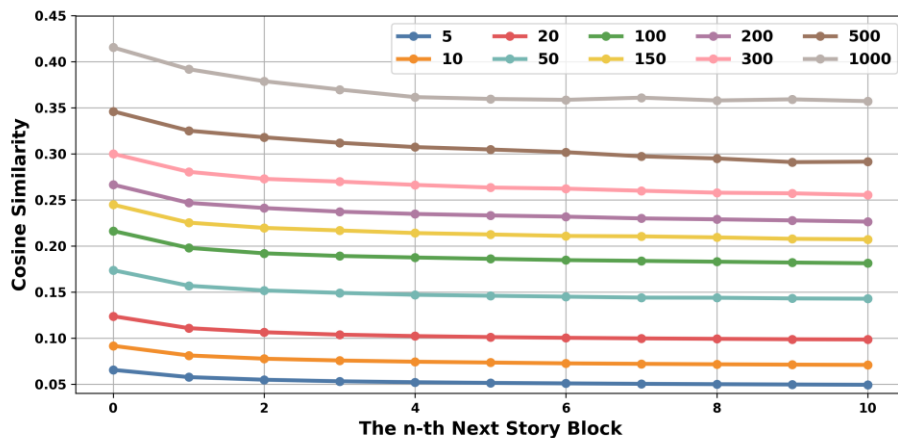
- **Event-Rep** works better in short stories.
- **Prior** is a robust and strong baseline.
- **GPT-2** is not effective => GPT2 fails to maintain coherence among sentences or events.

# Is it harder to predict the farther future?

\* *Cosine Similarity*

Feature	Model	Block Size									
		5	10	20	50	100	150	200	300	500	1000
-	Replay Baseline	.0654	.0915	.1237	.1737	.2163	.2448	.2665	.3000	.3462	.4155

- **Yes! Replay** tells us that things happen now will likely to happen again **shortly**.



# Does a longer history help?

- Yes, **LGBM+frame** can **benefit** from using a longer history!

*\* Cosine Similarity*

window	Feature	Model	Block Size		
			20	50	100
1	Frame	LGBM	.2967	.3564	.3995
	Text	BERT	.3073	.3637	.4012
2	Frame	LGBM	.2989	.3590	.4029
	Text	BERT	.3081	.3625	.4002
5	Frame	LGBM	.2989	.3617	.4065
	Text	BERT	.3082	.3618	.3985

**Increase!!**

# How do we show the prediction to writers?

- **Heteroglossia** [7] suggests follow-up ideas as a short paragraph using a crowdsourcing method.

The screenshot displays the Heteroglossia web interface. The main text area on the left shows a story snippet about villagers and dumplings. Several lines of text are highlighted in blue, indicating suggestions from the crowd. On the right, a sidebar titled 'Heteroglossia' lists recent suggestions with timestamps and roles. Below this, a 'Dashboard' panel shows the 'Role Play' section, the 'Content' of the story, the 'Team' (Ban Pin Shan), and a 'Note' section. The interface includes a standard web browser menu at the top and a 'Share' button in the top right corner.

Ban Pin Shan

File Edit View Insert Format Tools Add-ons Help Last edit was made 3 days ago by Heteroglossia

100% Normal text Arial 11 B U A

1 2 3 4 5 6 7

What is going on?" the villagers asked surprised.

"Hot and delicious dumplings! Red beans and sesame. One for ten cents, two for twenty cents and three for free!" the crazy old man yelled again.

More and more villagers began to gather around. They whispered in low voices, "Can this be true? Three dumplings for free? Is this old man tricking us?"

"Who cares! I'll eat three dumplings first and see whether it's free or not." BigHead Wang said.

"Mmmm, these dumplings are so good!" BigHead Wang said while he was eating the dumplings. The old man's dumplings were as big as chicken eggs. When BigHead Wang finished his second dumpling, he was so full that he could not eat anymore. However, he asked the old man, "If I eat three dumplings, I don't have to pay right?"

"I never tell lies. I already said three for free." the old man replied.

BigHead Wang stuffed down another dumpling just so he could have the dumplings for free. The old man kept his word and didn't charge BigHead Wang any money.

The other villagers began to order the old man's dumplings. Everyone ordered three free dumplings; no one ordered either one or two dumplings. After a while, the load of dumplings was all eaten by the villagers. "You all do have a good appetite," the old man said smilingly. People who did not get any dumplings watched the old man leave with disappointment.

A villager who just ate three dumplings cried out suddenly, "Look! How is it that the mountain behind the village is missing a part?"

"Stop talking nonsense! From the way I see it, I think you ate too many dumplings which has made your mind confused," someone replied.

The villagers began to talk about the old man." Ha! I can't believe there is a stupid person who would sell three dumplings for free."

Heteroglossia

1:31 AM Sep 13 Resolve

Task\_ID: 5d7b298cd03504140789cd82

Type: role\_play

Team: Ban Pin Shan

Roles: "The Old Man", "BigHead Wang"

Heteroglossia

1:47 AM Sep 13

[role - The Old Man]

I am the Old Man, and I know some sorcery. I recently went to a small

Show more

Heteroglossia

2:38 AM Sep 13

[role - BigHead Wang]

BigHead Wang was angry that they were making fun of the old man.

Show more

Heteroglossia

2:48 AM Sep 13

[role - The Old Man]

If I were the old man in this story I would laugh and move on to another

Show more

Heteroglossia

3:02 AM Sep 13

[role - BigHead Wang]

BigHead Wang was very pleased with himself after he ate his three delicious

Show more

Dashboard

Role Play

Content

BigHead Wang stuffed down another dumpling just so he could have the dumplings for free. The old man ..... the old man." Ha! I can't believe there is a stupid person who would sell three dumplings for free."

Team

Ban Pin Shan

Note

All the villagers are eating the dumplings. Please tell me what will The Old Man and BigHead Wang do next?

Cancel Submit

[7] Chieh-Yang Huang, Shih-Hong Huang, and Ting-Hao Kenneth Huang. 2020. Heteroglossia: In-Situ Story Ideation with the Crowd. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20).



# What to display?

- Semantic concepts!
- Importance!

➡ How to combine these information together?

# A Possibility: Wordcloud

## Noun

object faith hindrance  
extent blind existence degree  
seizure reprocessing incapacity  
subset why front capability  
faithful organism lifeform amount  
**ineffability** **magic**  
insult **magicalness**  
life  
commitment motivation rot reason  
confirmation institutionalization

## Verb

go under  
address there be believe  
affront get up  
delay perish decompose desist  
shun expunge number commandeer  
break out hit erase kill plan  
trammel brand grab wake up  
clear up etch confirm term weaponize  
call insult strike rouse  
fold live front admit keep away  
do something about free flop

## Adjective

effective powerless  
severe real  
void strict  
authoritarian null  
bent unconfirmed

# Wordcloud Visualization

## A Top 30 Frames

Ineffability : 16.04  
Biological\_entity : 7.31  
Be\_subset\_of : 4.88  
Negative\_Conditional : 4.85  
Erasing : 4.62  
...

## B Corresponding 3 Lexical Units

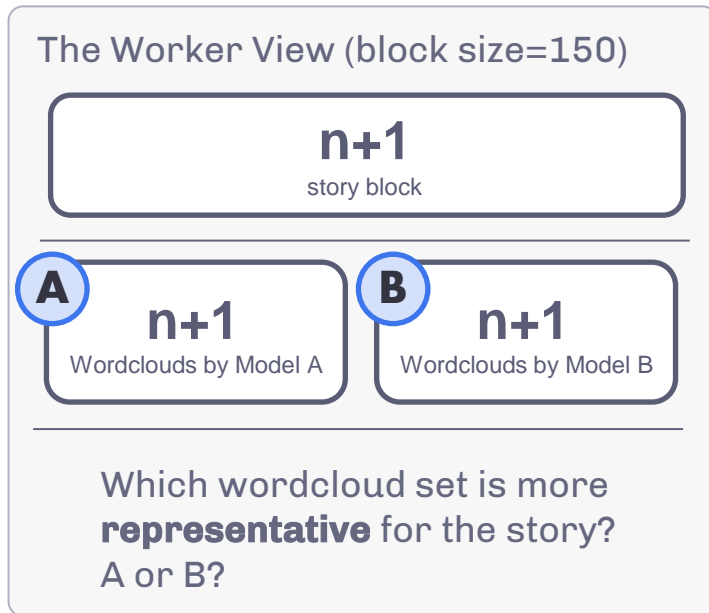
magicalness.n / ineffability.n / magic.n  
organism.n / life.n / lifeform.n  
number.v / subset.n  
otherwise.adv  
expunge.v / kill.v / erase.v

## C Compute Size and Color according to the TF-IDF

Size  $\propto$  TF-IDF  
Color  $\propto$  -TF-IDF

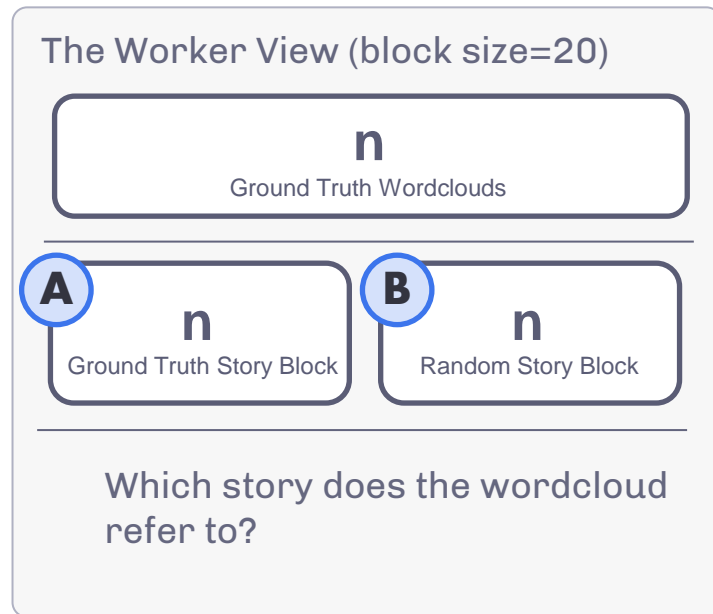
# Human Evaluation

- Which model generate a more **representative** word cloud?
- (**Ground**, LGBM, BERT) = (**32**, 15, 16)  
→ The result makes sense!
- (**LGBM**, BERT) = (**59**, 41)  
→ LGBM is better!



# Human Evaluation

- Does the wordcloud **specific** enough for human to understand?
- YES!! 74% of 50 HITs were answered correctly!



# Thanks

Find our code and dataset on GitHub!

<https://github.com/appleternity/FrameForecasting>



Scan for the code!



Chieh-Yang Huang



Ting-Hao Kenneth Huang