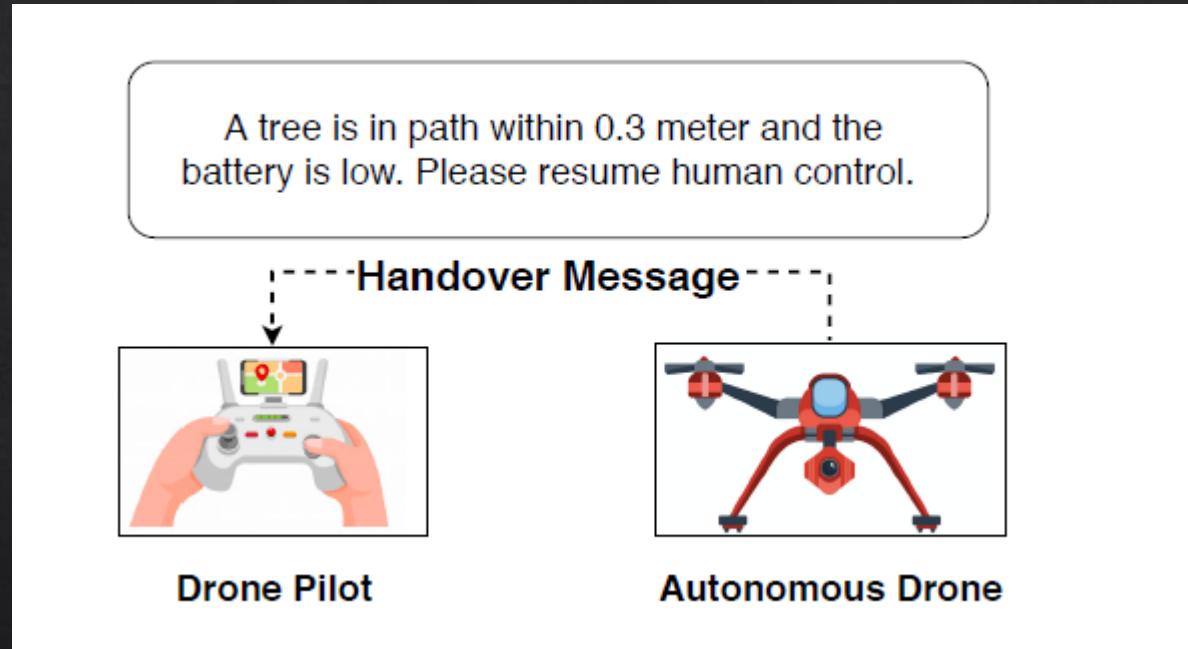


# Current project: Drone Handover message generation

- Data augmentation
- DL+NLG model

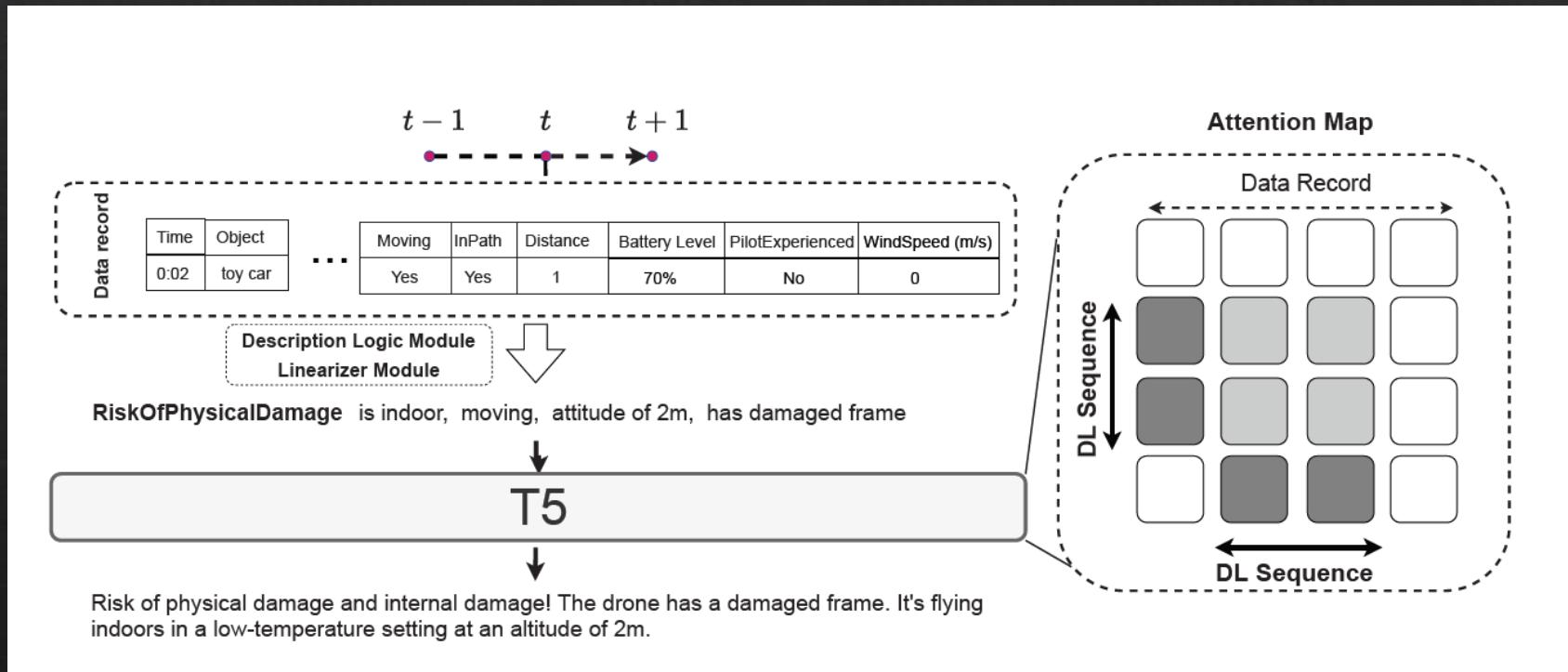
# Drone Handover message generation



Handover message is generated to assist human pilots in performing dedicated task.

It should verbalizes messages from sensor data records in order to perform a controlled handover to a human drone pilot

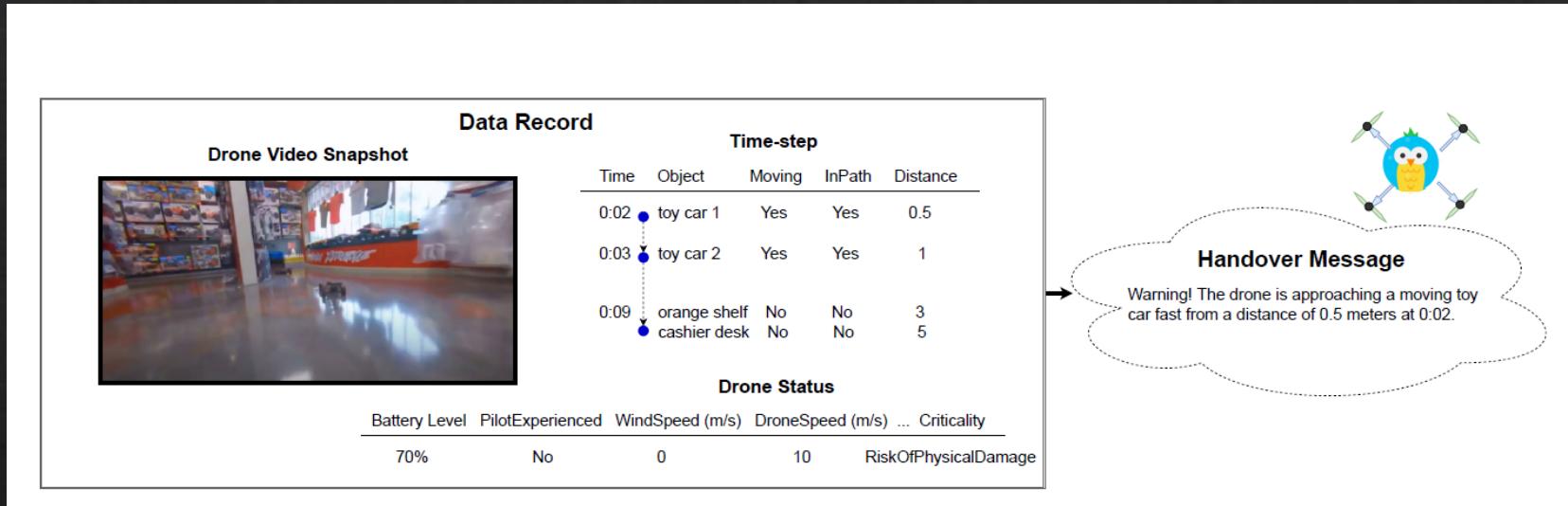
# Previous work: Logic-Guided Message Generation from Raw Real Time Sensor Data



Novelty:

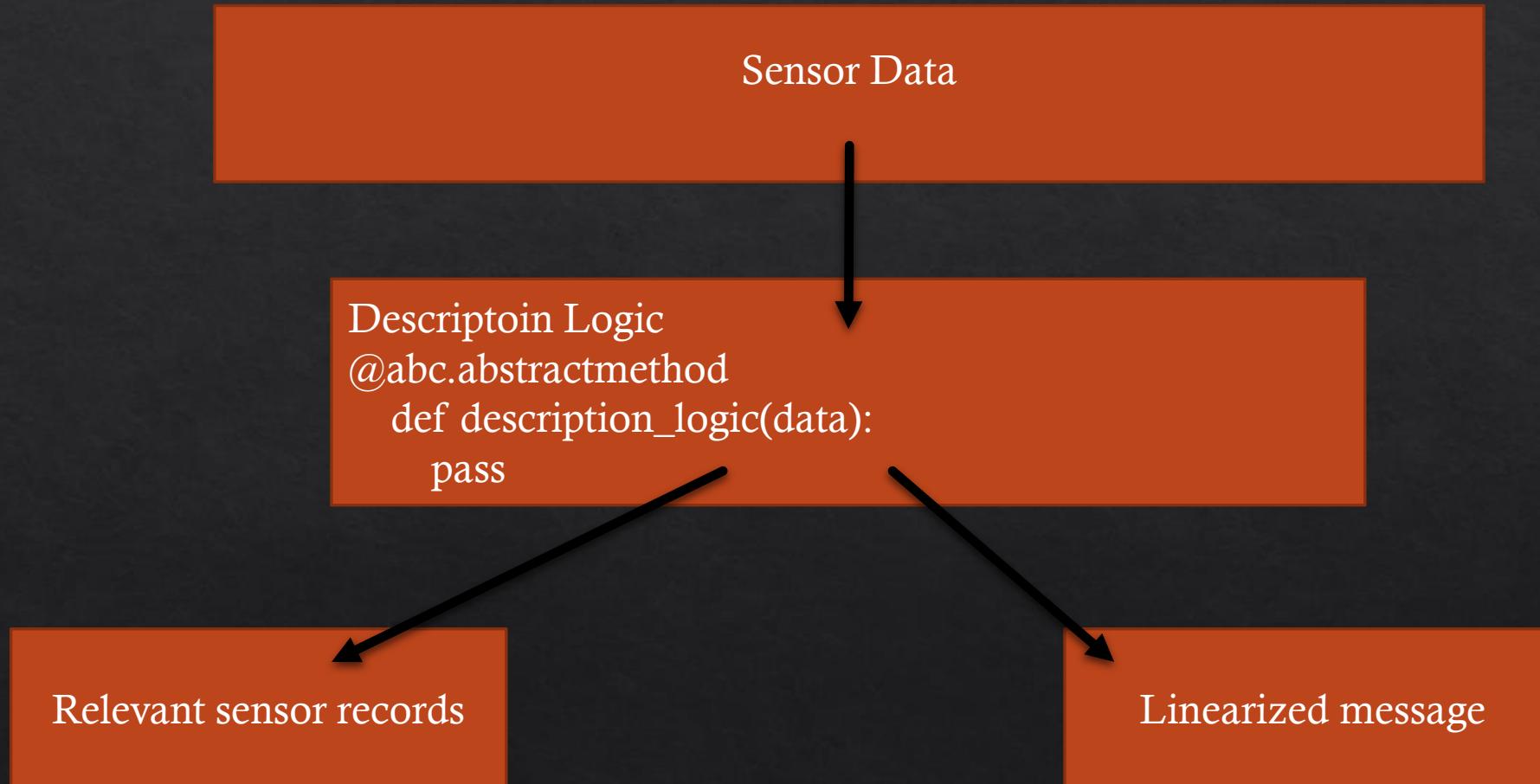
1. Collects the Drone Sensor Data dataset.
2. Uses Description logic (DL) as content selection module.
3. Trains a T5 model to rewrite the template into a human-readable sentence.

# Drone Sensor Data dataset



1. The sensor data is structured
  - > data2text generation
2. The sensor data is redundant
  - > content selection
3. The handover utterances is diverse
  - > train a neural generation model

# Description Logic as content selection



# Description Logic

<b>name</b>	<b>ID_obj</b>	<b>Type</b>	<b>Moving</b>	<b>InPath</b>	<b>Distance</b>	<b>time_stamp</b>	<b>Link</b>
person with a controller	1	Human	FALSE	FALSE	8	0:00	<a href="https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing">https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing</a>
gravestone 1	2	Object	FALSE	TRUE	3	0:01	<a href="https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing">https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing</a>
gravestone 2	3	Object	FALSE	TRUE	3	0:01	<a href="https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing">https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing</a>
castle	4	Building	FALSE	FALSE	5	0:01	<a href="https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing">https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing</a>
castle	4	Building	FALSE	TRUE	1	0:05	<a href="https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing">https://drive.google.com/file/d/1oJ6t-VJN3rAmslsXszkVUzTZl4LJujeM/view?usp=sharing</a>

DL Query

**very\_close\_human:**

[ rdf:type owl:Restriction ;

owl:onProperty <http://www.semanticweb.org/alisa/ontologies/2021/3/veryClose> ;

owl:someValuesFrom <http://www.semanticweb.org/alisa/ontologies/2021/3/Human> ;

rdfs:subClassOf <http://www.semanticweb.org/alisa/ontologies/2021/3/RiskOfHumanDamage>

]

Content Selection

DL Linearizer

<b>name</b>	<b>Distance</b>	<b>time_stamp</b>
person with a controller	8	0:00

"(0:00) The drone is flying very close to a human at a distance of 8m, and might cause human injury."

# T5

RiskOfPhysicalDamage is indoor, moving, attitude of 2m, has damaged frame



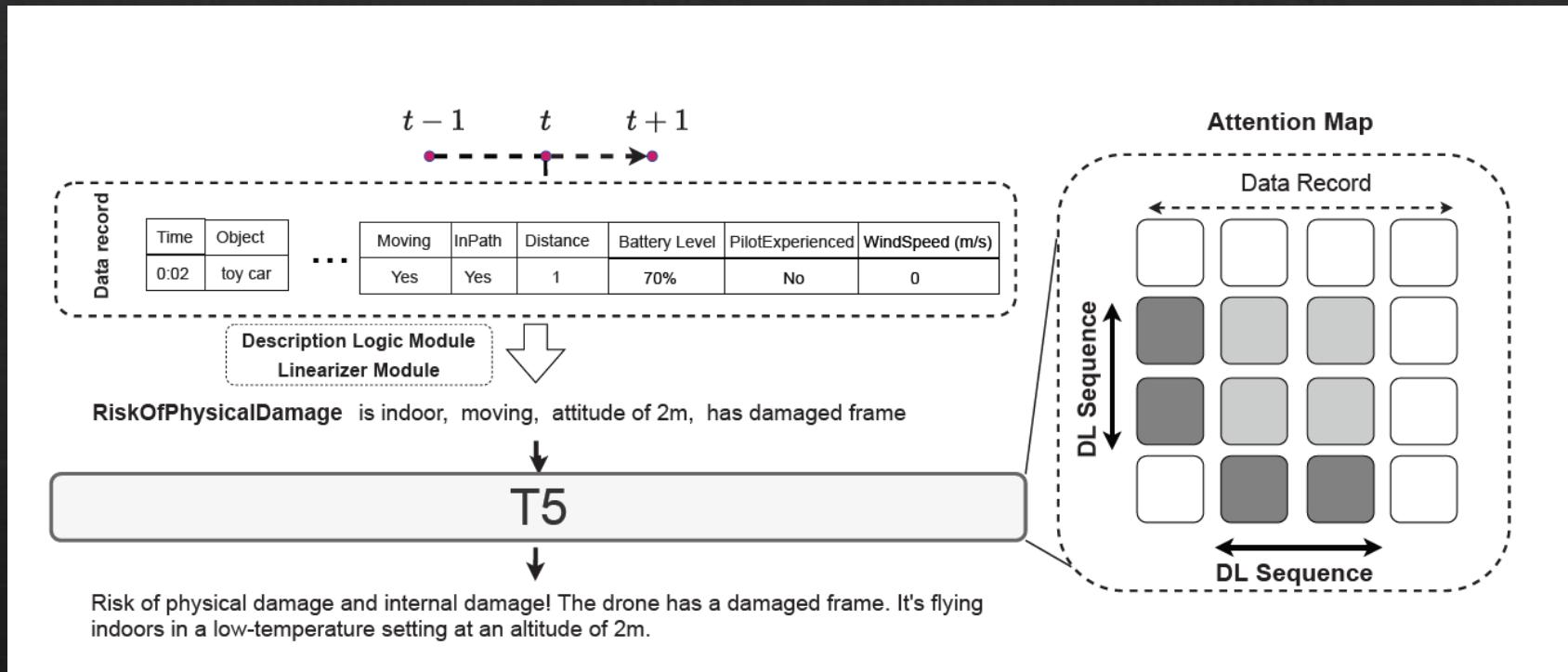
T5



Risk of physical damage and internal damage! The drone has a damaged frame. It's flying indoors in a low-temperature setting at an altitude of 2m.

DL-to-text rewriter:  
transforms the linearized  
sequence into a human-readable  
sentence

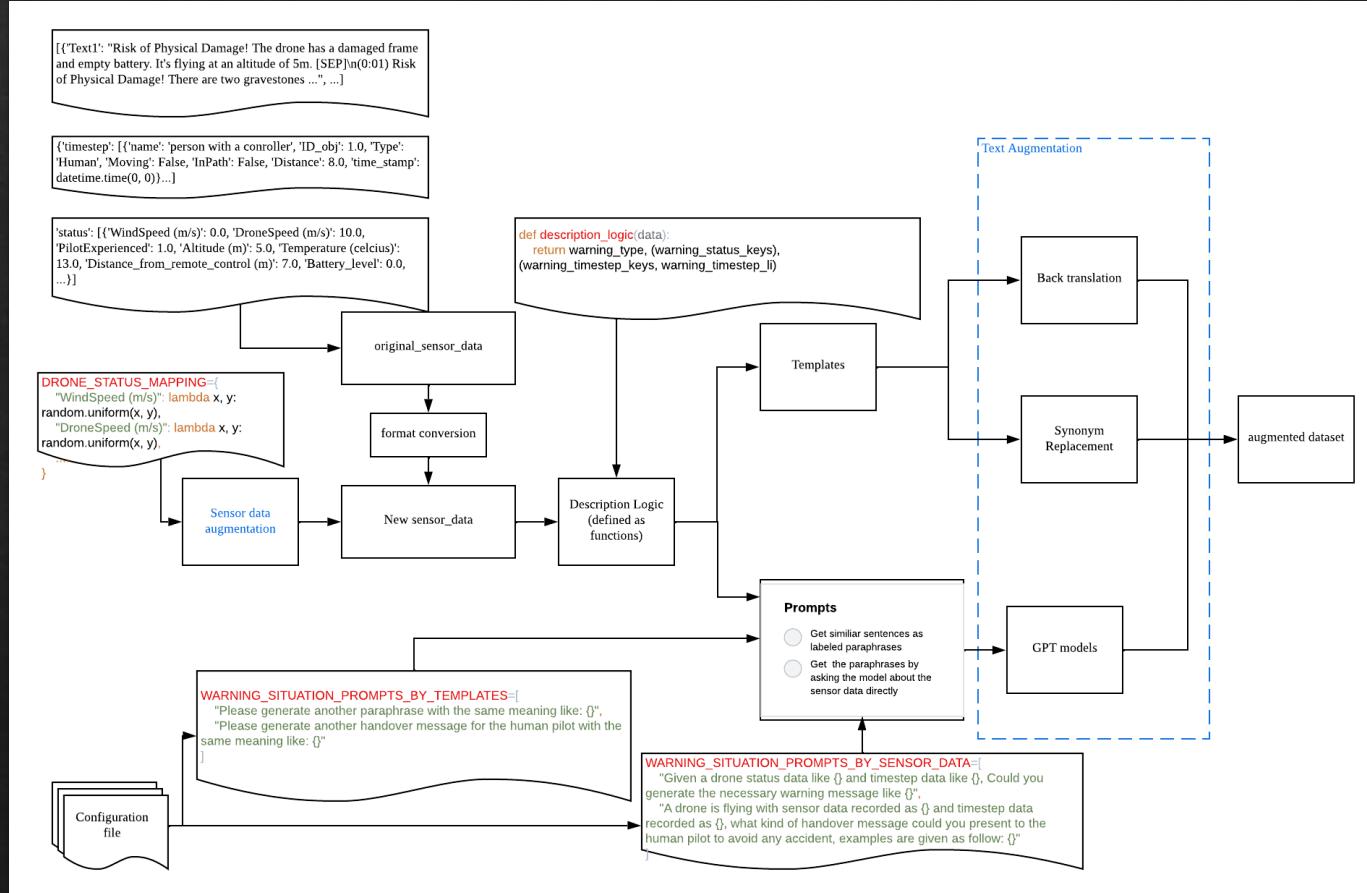
# Previous work: Logic-Guided Message Generation from Raw Real Time Sensor Data



## Limitations:

1. Manually collected data with only 316 data records.
2. Limited DL queries
3. Lack of extensibility to multi-modal setting (since the dataset contains snapshot videos for each data record)

# Data augmentation



1. Sensor data Augmentation
2. Text Augmentation
  1. Back translation
  2. Synonym Replacement
  3. Prompt-based learning

# Sensor data Augmentation

```
DRONE_STATUS_MAPPING={
```

```
    "WindSpeed (m/s)": lambda x, y: random.uniform(x, y),
```

```
    "DroneSpeed (m/s)": lambda x, y: random.uniform(x, y),
```

```
....
```

```
    "weather": lambda x: random.choice(x)
```

```
}
```

```
DRONE_STATUS_PARA_MAPPING_RURAL={
```

```
    "WindSpeed (m/s)": (0, 10),
```

```
    "DroneSpeed (m/s)": (0, 20),
```

```
....
```

```
    "weather": ([{'sunny': 'sunny', 'gloomy': 'gloomy', 'dark': 'dark', 'sandy': 'sandy', 'rainy': 'rainy', 'snowy': 'snowy', 'windy': 'windy'}])
```

```
}
```



```
    "WindSpeed (m/s)": lambda x, y: random.uniform(0, 10),
```

```
    "DroneSpeed (m/s)": lambda x, y: random.uniform(0, 20),
```

```
....
```

```
    "weather": lambda x: random.choice(['sunny', 'gloomy', 'dark',  
    'sandy', 'rainy', 'snowy', 'windy'])
```

WindSpee d (m/s)	DroneSpee d (m/s)	...	weather
0	10	...	sunny

# Text augmentation

Text Example:

Risk of physical damage! The drone is flying with an empty battery. The frame is also damaged and the altitude is 5m. [SEP]

(0:01) Risk of physical damage! There are two gravestones 3m away and in the drone's path. [SEP]

(0:05) Risk of physical damage! The drone is flying toward a castle in its path which is only 1m away. [SEP]

Back translation

Synonym  
replacement

There is a risk of physical damage! Drone air batteries fly. The framework is also damaged and the height is 5m.

(0:01) The risk of physical damage! There are two tombstones 3m, in the path of the drone.

(0:05) The risk of physical damage! The drone is flying towards the castle with only 1m far.

There is a risk of physical damage! Drone air batteries fly. The framework is also damaged and the height is 5m.

(0:01) The risk of physical damage! There are two tombstones 3m, in the path of the drone.

(0:05) The risk of physical damage! The drone is flying towards the castle with only 1m far.

# Prompt-based augmentation

1. Manually create prompt templates:

["Given a flying drone status data like '{}', and timestep data like '{}', Could you generate a handover message with only necessary crucial information like '{}'",

"A drone encountered some crucial situations and needed to hand the manipulation over to the human pilot. The related drone status data was recorded as '{}', and timestep data was recorded as '{}'. What kind of handover message could we present to the human pilot to avoid any accidents? An example is given as follows: '{}'.",

"A flying drone encountered an emergency and needed to be handover to a human pilot. The emergence-related status data is recorded as '{}', and related timestep data is recorded as '{}'. Please generate the handover message for the human pilot that is similar to the example '{}'",

"Related drone status data: '{}'; Related timestep data: '{}', Handover message example: '{}', please generate another handover message for the human pilot after colon:",

]

# Prompt-based augmentation

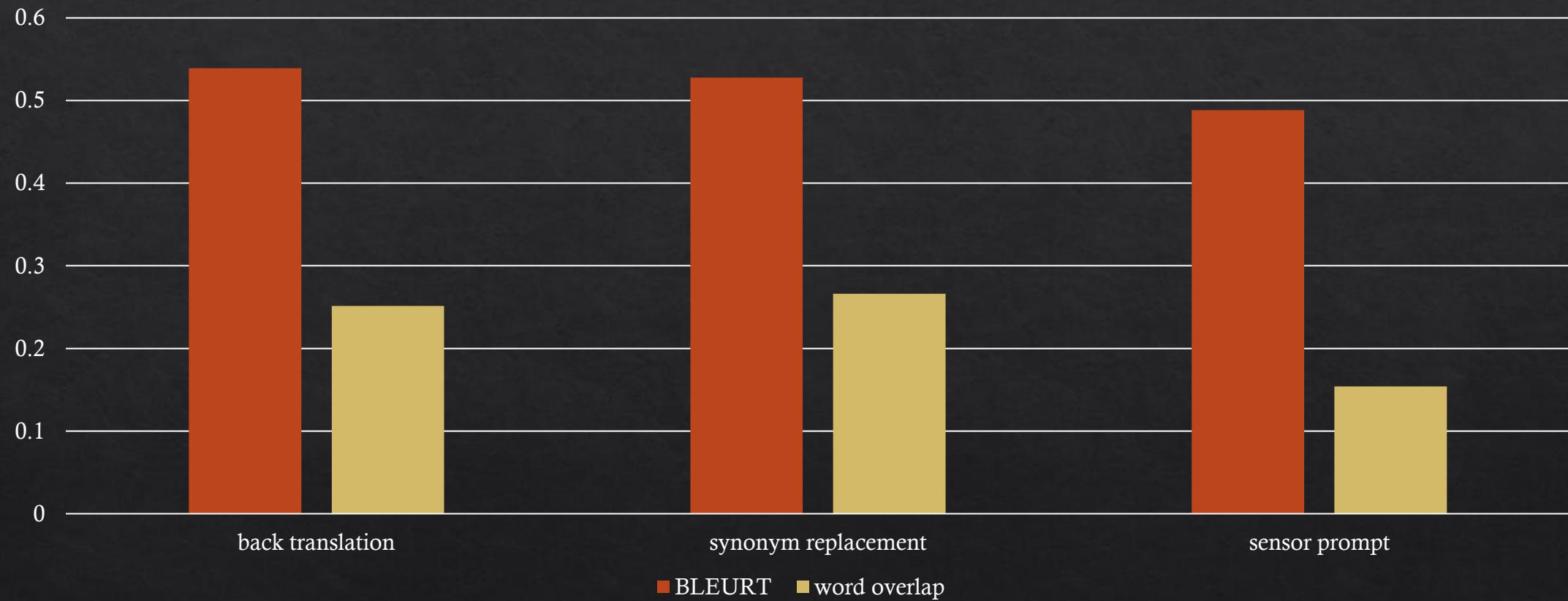
2. Fill the template with sensor data:

["Given a flying drone status data like {"Normal\_frame": false} and timestep data like {"reachable\_inpath": [{"time\_stamp": "0:01", "name": "gravestone 1", "Distance": 3.0}, {"time\_stamp": "0:01", "name": "gravestone 2", "Distance": 3.0}, {"time\_stamp": "0:05", "name": "castle ", "Distance": 1.0}]}, Could you generate a handover message with only necessary crucial information like The flying drone is runing out of battery with only 0% charge. The drone is flying with a damaged frame. (0:01) The drone is facing the risk of physical damage. There is a gravestone 1 in the drone's flight path at a distance of 3.0m. (0:01) The drone is facing the risk of physical damage. There is a gravestone 2 in the drone's flight path at a distance of 3.0m. (0:05) The drone is facing the risk of physical damage. There is a castle in the drone's flight path at a distance of 1.0m"]  
.....  
]

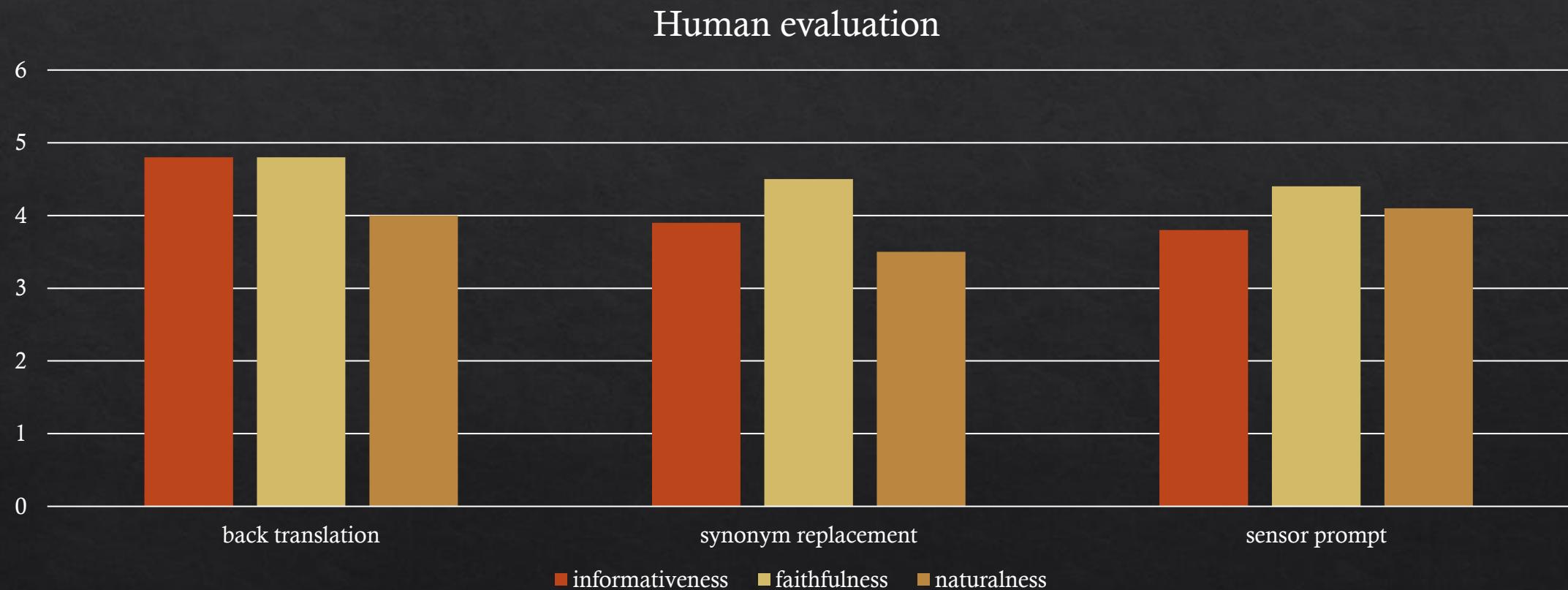
# Prompt-based augmentation

3. Evaluate the response from generation model:
  1. BLEURT score, similarity between the response and the annotated text
  2. Human evaluation:
    1. Naturalness (0-5)
    2. Informativeness (0-5)
    3. Faithfulness (0-5)

# Overall data augmentation performance



# Overall data augmentation performance: Human Evaluation



# Current Problems

- ❖ Empty response (OpenAI )
  - ❖ **Prompt:** Given a flying drone status data like {"Normal\_frame": false} and timestep data like {"reachable\_inpath": [{"time\_stamp": "0:01", "name": "gravestone 1", "Distance": 3.0}, {"time\_stamp": "0:01", "name": "gravestone 2", "Distance": 3.0}, {"time\_stamp": "0:05", "name": "castle ", "Distance": 1.0}]} , Could you generate a handover message with only necessary crucial information like The flying drone is runing out of battery with only 0% charge. The drone is flying with a damaged frame. (0:01) The drone is facing the risk of physical damage. There is a gravestone 1 in the drone's flight path at a distance of 3.0m. (0:01) The drone is facing the risk of physical damage. There is a gravestone 2 in the drone's flight path at a distance of 3.0m. (0:05) The drone is facing the risk of physical damage. There is a castle in the drone's flight path at a distance of 1.0m.
  - ❖ **Response:**
  - ❖ Solution: Use other generation model like T5 and Bart (Currently we are using GPT-3, in the hope of using ChatGPT API as soon as OpenAI release the access)
- ❖ Hallucination
- ❖ Truncated prompt

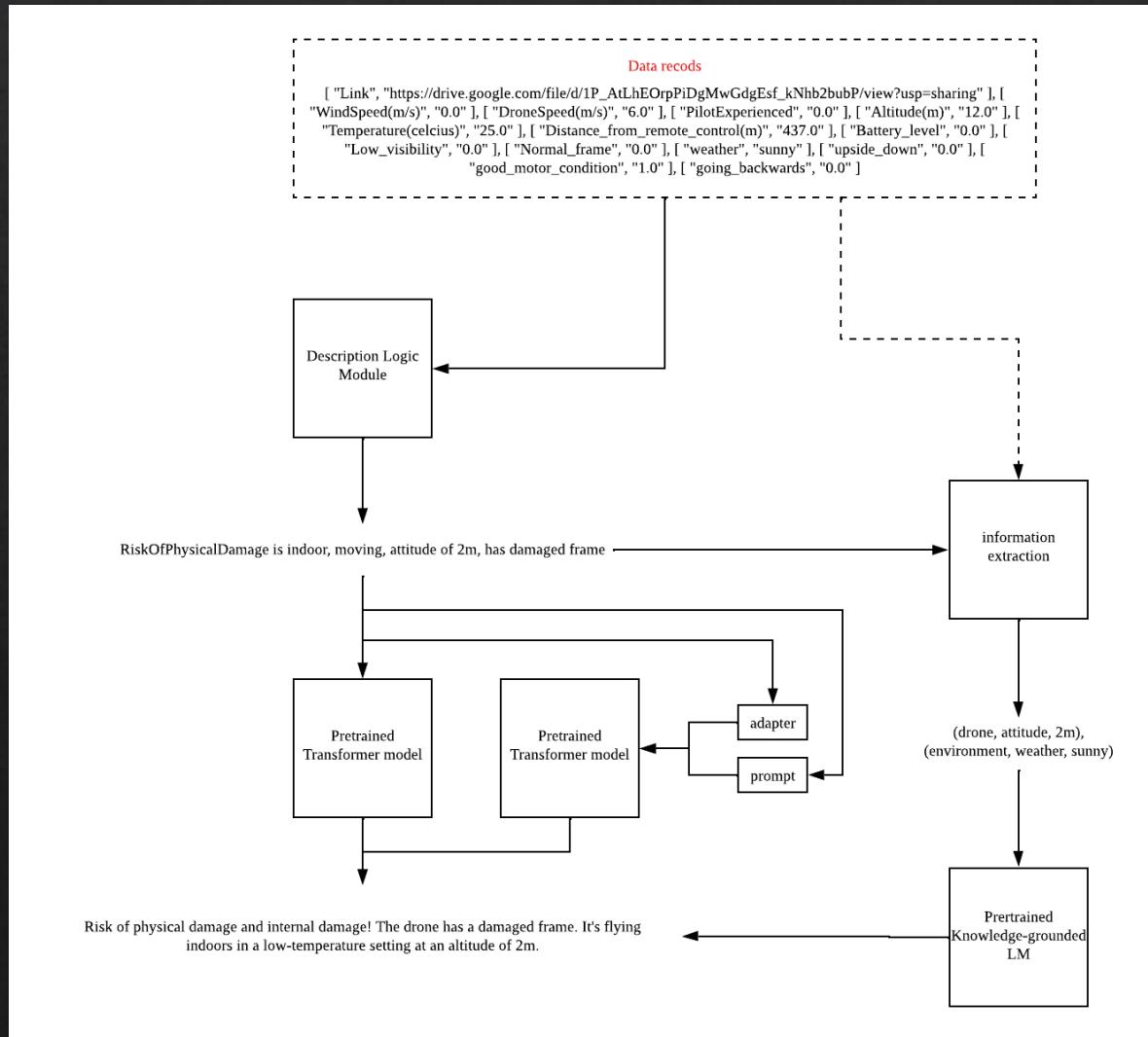
# Current Problems

- ❖ Empty response (OpenAI )
- ❖ Hallucination
  - ❖ **Prompt:** Related drone status data: '>{"Normal\_frame": false}'; Related timestep data: '>{"reachable\_inpath": [{"time\_stamp": "0:01", "name": "gravestone 1", "Distance": 3.0}, {"time\_stamp": "0:01", "name": "gravestone 2", "Distance": 3.0}, {"time\_stamp": "0:05", "name": "castle ", "Distance": 1.0}]}', Handover message example: 'The flying drone is runing out of battery with only 0% charge. The drone is flying with a damaged frame. (0:01) The drone is facing the risk of physical damage. There is a gravestone 1 in the drone's flight path at a distance of 3.0m. (0:01) The drone is facing the risk of physical damage. There is a gravestone 2 in the drone's flight path at a distance of 3.0m. (0:05) The drone is facing the risk of physical damage. There is a castle in the drone's flight path at a distance of 1.0m.', please generate another handover message for the human pilot after colon:
  - ❖ **Response:** 'The flying drone is running out of battery with only 10% charge. The drone is flying with a damaged frame. (10:01) The drone is facing the risk of physical damage. There is a gravestone 1 in the drone's flight path at a distance of 3.0m. (10:01) The drone is facing the risk of physical damage. There is a gravestone 2 in the drone's flight path at a distance of 3.0m. (10:05) The drone is facing the risk of physical damage. There is a castle in the drone's flight path at a distance of 1.0m.
  - ❖ Solution: Omit the
  - ❖ Truncated prompt

# Current Problems

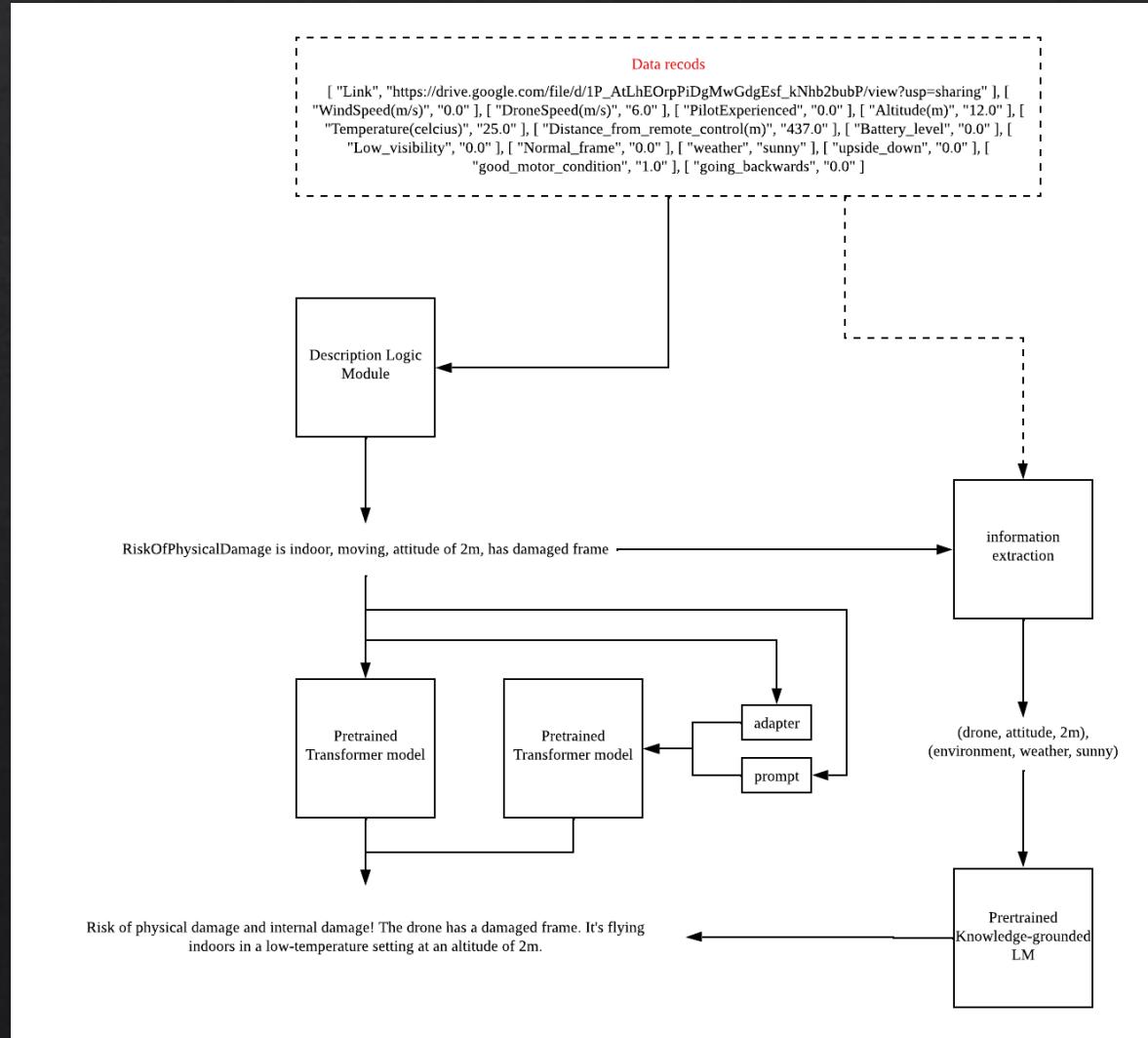
- ◊ Empty response
- ◊ Hallucination
- ◊ Truncated prompt
  - ◊ **Prompt:** A drone encountered some crucial situations and needed to hand the manipulation over to the human pilot. The related drone status data was recorded as '{
 "Normal\_frame": false
}', and timestep data was recorded as '{
 "reachable\_inpath": [
 {
 "time\_stamp": "0:01",
 "name": "gravestone 1",
 "Distance": 3.0
 },
 {
 "time\_stamp": "0:01",
 "name": "gravestone 2",
 "Distance": 3.0
 },
 {
 "time\_stamp": "0:05",
 "name": "castle",
 "Distance": 1.0
 }
 ]
}'. What kind of handover message could we present to the human pilot to avoid any accidents? An example is given as follows: "The flying drone is running out of battery with only 0% charge. The drone is flying with a damaged frame. (0:01) The drone is facing the risk of physical damage. There is a gravestone 1 in the drone's flight path at a distance of 3.0m. (0:01) The drone is facing the risk of physical damage. There is a gravestone 2 in the drone's flight path at a distance of 3.0m. (0:05) The drone is facing the risk of physical damage. There is a castle in the drone's flight path at a d.."
  - ◊ **Response:** {"message":"The flying drone is running out of battery with only 0% charge. The drone is flying with a damaged frame. (0:01) The drone is facing the risk of physical damage. There is a gravestone 1 in the drone's flight path at a distance of 3.0m. (0:01) The drone is facing the risk of physical damage. There is a gravestone 2 in the drone's flight path at a distance of 3.0m."}
  - ◊ Solution:
    - ◊ switch to other model that allows for more token limit
    - ◊ Try more prompt templates

# DL+NLG model



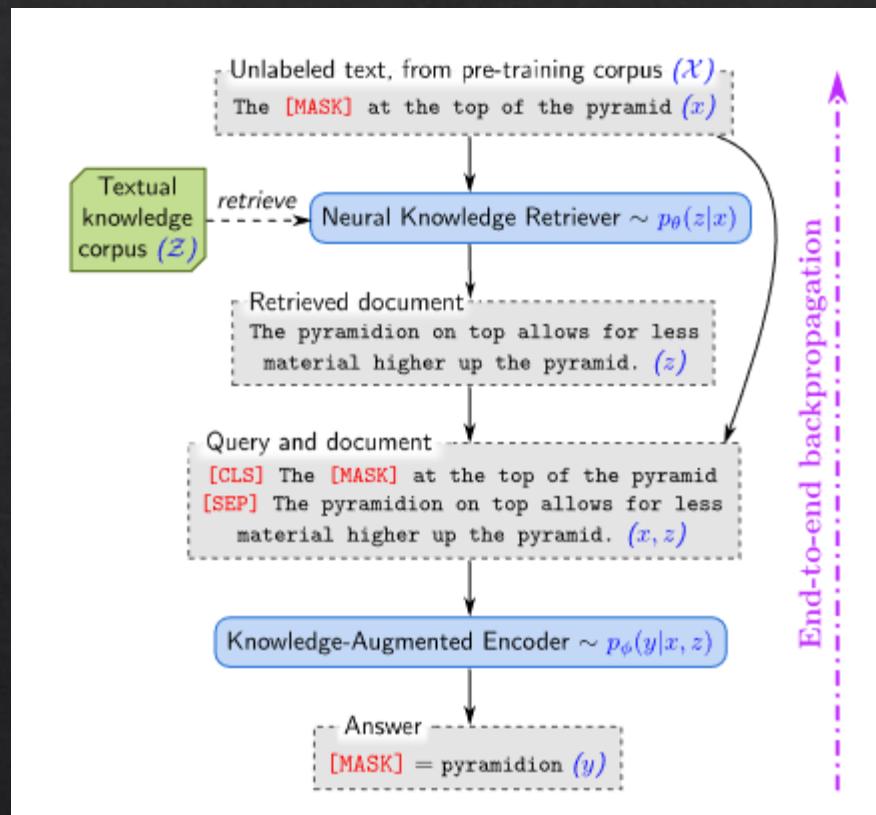
- Motivation
  - 1. Continue to use DL as content selection module
  - 2. Apply parameter-efficient methods for the limited number of training samples

# DL+NLG model



- **Prompt**  
Logic-guided retrieval augmented prompt
- LoRA
- Adapter

# Retrieval-Augmented Generation



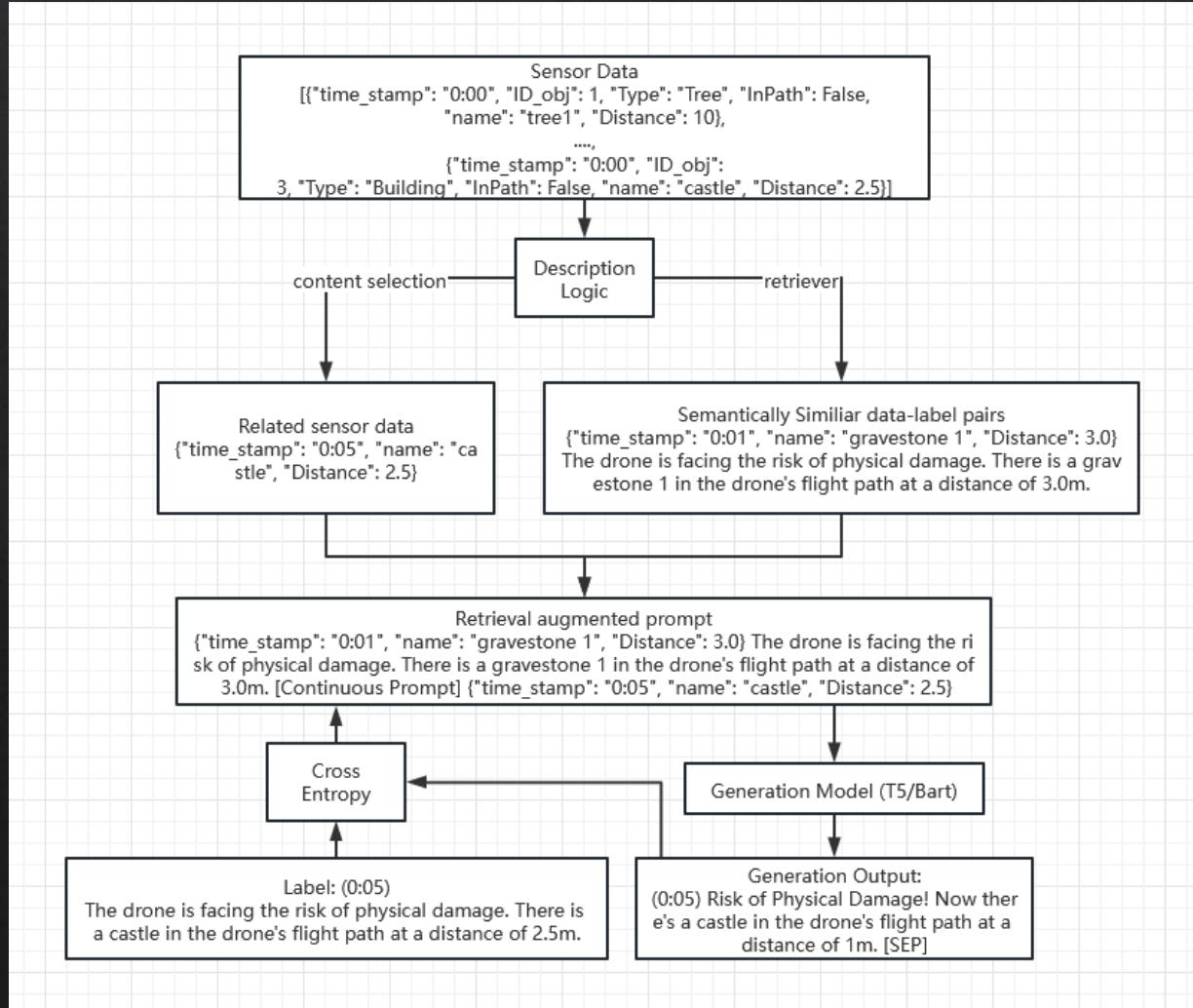
Motivation: Knowledge-intensive tasks like open-domain question answering would need to world knowledge to predict the answer. But the world knowledge is implicitly stored in the neural network and limited by the size of network.

Solution: To capture knowledge in a more modular and interpretable way, we augment language model pretraining explicitly with a learned knowledge retriever

# Retrieval augmented prompt by semantically similar sentences

Name	Notation	Example
Input Sample	$x$	ప్రచారం చేయబడిన వాటిని ఖచ్చితంగా చేస్తుంది! <i>'absolutely does what was advertised!'</i>
Retrieved Sample Label	$x_r$ $y_r$	<i>Great! Works as stated.</i> 1
Template Verbalizer	$f_p(x)$ $v(y)$	[X] <i>In summary, the product was [MASK].</i> 0 → ‘terrible’, 1 → ‘great’
Prompted Input	$x'$	<i>Great! Works as stated. In summary, the product was great!</i> ప్రచారం చేయబడిన వాటిని ఖచ్చితంగా చేస్తుంది! <i>In summary, the product was [MASK].</i>

# Logic-guided retrieval augmented prompt Aggregation solution: another prompt



# Logic-guided retrieval augmented prompt DL as a Retriever

Name	Notation	Example
Related Sensor Data	x	{"time_stamp": "0:05", "name": "castle", "Distance": 2.5}
Retrieved Sample	x <sub>r</sub>	{"time_stamp": "0:01", "name": "gravestone 1", "Distance": 3.0}
Retrieved text	y <sub>r</sub>	The drone is facing the risk of physical damage. There is a gravestone 1 in the drone's flight path at a distance of 3.0m.
Prompted Input	x'	{"time_stamp": "0:01", "name": "gravestone 1", "Distance": 3.0} The drone is facing the risk of physical damage. There is a gravestone 1 in the drone's flight path at a distance of 3.0m. [Continuous Prompt] {"time_stamp": "0:05", "name": "castle", "Distance": 2.5}
Expected text		The drone is facing the risk of physical damage. There is a castle in the drone's flight path at a distance of 2.5m.

# Logic-guided retrieval augmented prompt Summarization problem

<a href="https://drive.google.com/file/d/1_iqwxrNaYtIcvWkYecEPWoGzoEuX77cd/view?usp=sharing">https://drive.google.com/file/d/1_iqwxrNaYtIcvWkYecEPWoGzoEuX77cd/view?usp=sharing</a>	tree 1	1	Tree	FALSE	TRUE	5	00:03
	tree 1	1	Tree	FALSE	TRUE	1	00:05
	tree 1	1	Tree	FALSE	FALSE	2	00:06
	tree 2	2	Tree	FALSE	TRUE	10	00:08
	tree 3	3	Tree	FALSE	FALSE	8	00:11
	tree 4	4	Tree	FALSE	TRUE	7	00:14
	tree 4	4	Tree	FALSE	FALSE	1	00:16

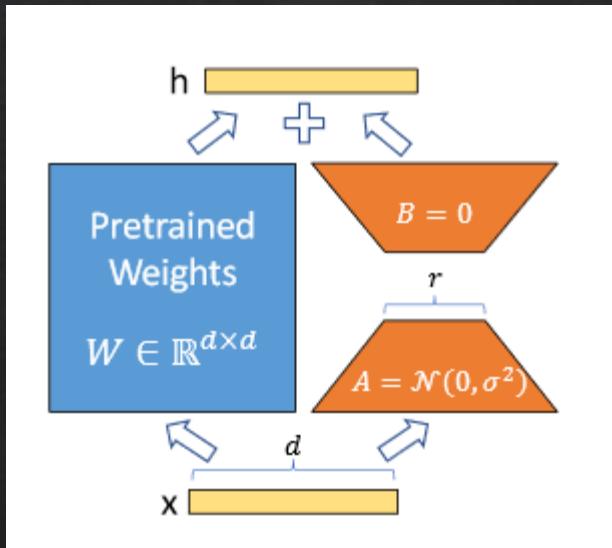
- (0:03) Risk of physical damage! There's a tree in the drone's flight path at a distance of 5m. [SEP]  
(0:05) Risk of physical damage! Now the tree is in the drone's flight path at a distance of 1m. [SEP]  
(0:06) Risk of physical damage! Now the tree is only 2m away. [SEP]  
(0:14) Risk of physical damage! There's another tree in the drone's flight path at a distance of 7m.  
[SEP]  
(0:16) Risk of physical damage! Now the tree is only 1m away. [SEP]

# Logic-guided retrieval augmented prompt

## Aggregation solution: another prompt

Name	Notation	Example
Sentence 1	$s_1$	(0:01) The drone is facing the risk of physical damage. There is a <b>gravestone 1</b> in the drone's flight path at a distance of <b>3.0m</b> .
Sentence 2	$s_2$	(0:01) The drone is facing the risk of physical damage. There is a <b>gravestone 2</b> in the drone's flight path at a distance of <b>3.0m</b> .
Prompted Input	$x'$	(0:01) The drone is facing the risk of physical damage. There is a <b>gravestone 1</b> in the drone's flight path at a distance of <b>3.0m</b> . [Continuous Prompt] (0:01) The drone is facing the risk of physical damage. There is a <b>gravestone 2</b> in the drone's flight path at a distance of <b>3.0m</b> .
label	$s$	(0:01) Risk of physical damage! There are <b>two gravestones 3m</b> away and in the drone's path.

# LoRA



Motivation:

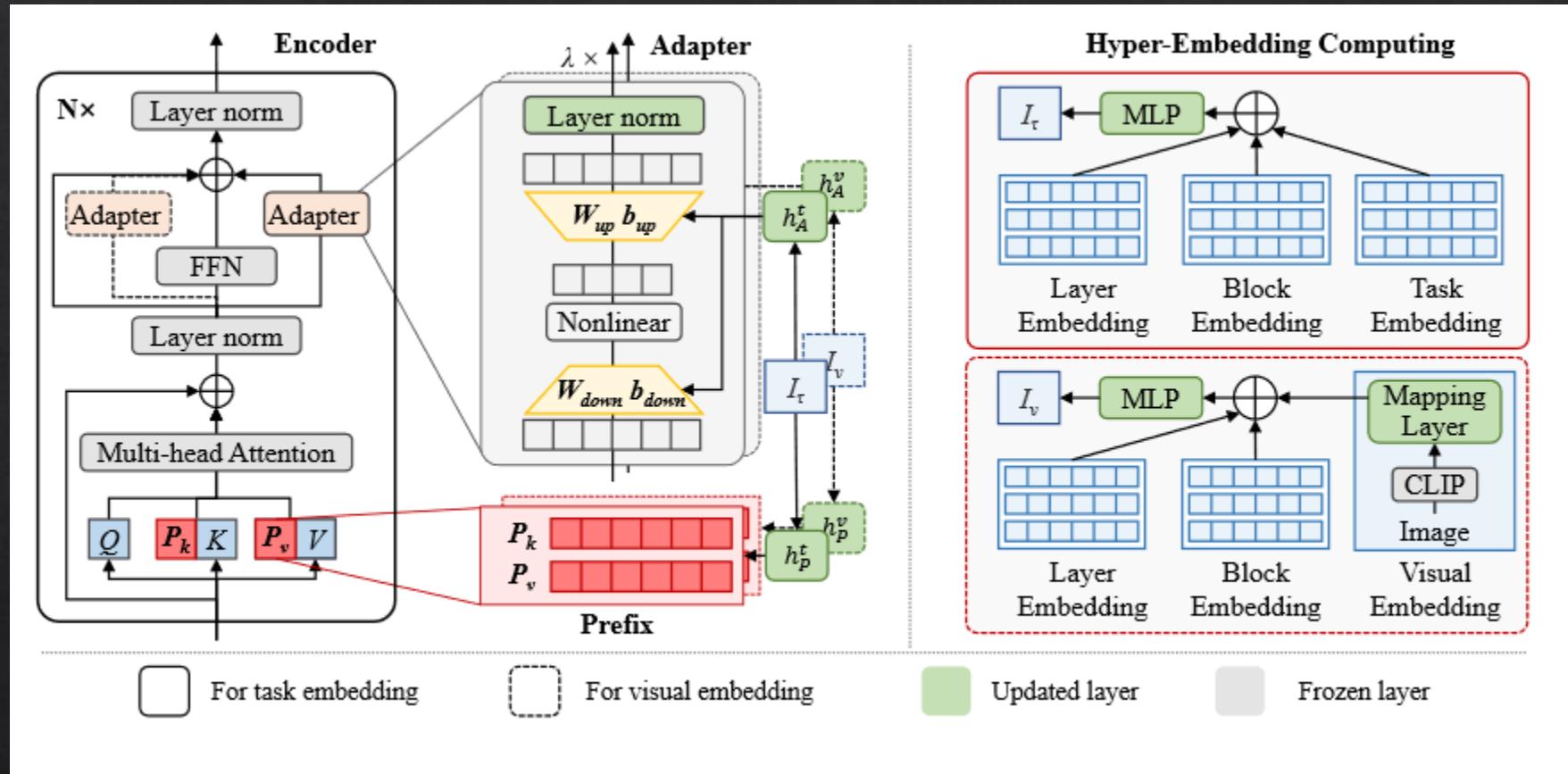
We take inspiration from Li et al. (2018a); Aghajanyan et al. (2020) which show that the learned **over-parametrized models in fact reside on a low intrinsic dimension**.

We hypothesize that the change in weights during model adaptation also has a low “intrinsic rank”, leading to our proposed Low-Rank Adaptation (LoRA) approach.

Advantages:

1. LoRA only optimize the injected, much smaller low-rank matrices
2. LoRA is orthogonal to many prior methods and can be combined with many of them, suchas prefix-tuning

# Extension: Modular Multi-modalities



# Thank you



# Deadline

Conference Name	Submission deadline	Conference date
<b>COLING</b>	*May 17, 2022	October 12-17, 2022
<b>EACL</b>	*20 October 2022	Feb 10, 2023
<b>EMNLP</b>	*1 December 2022	TBD
<b>TACL</b>		
<b>ACL</b>		July 9-14, 2023