



# Generating Faithful Text From a Knowledge Graph with Noisy Reference Text

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# Outline

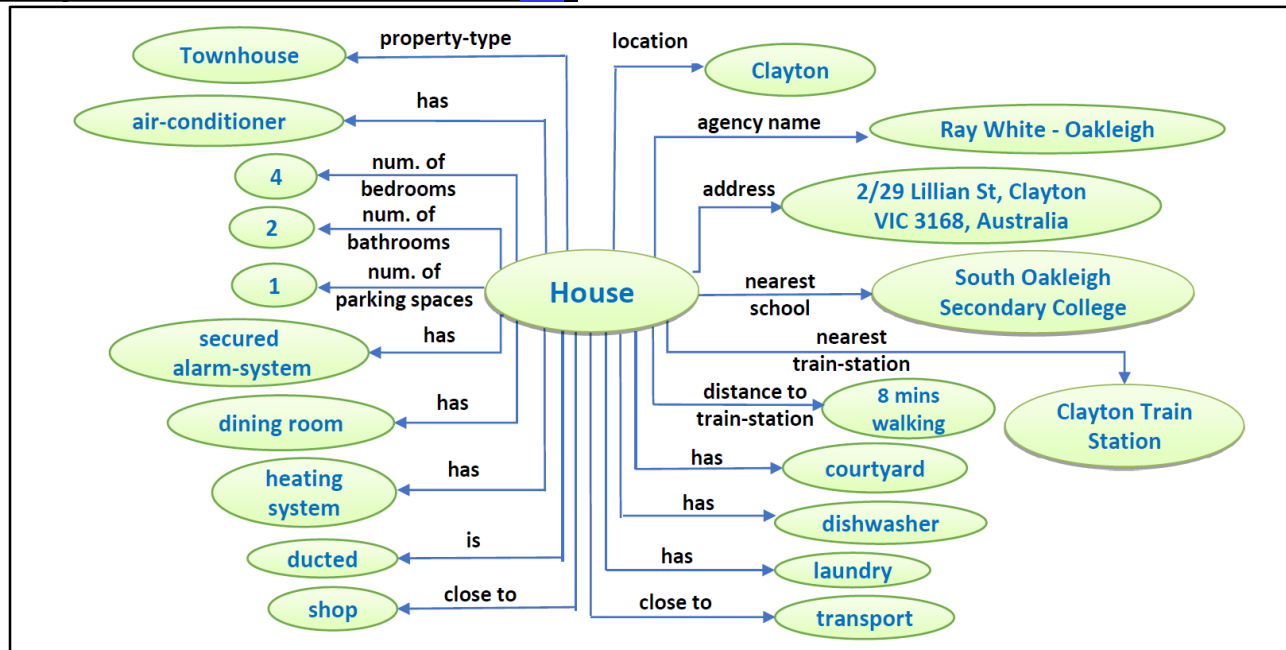
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- Motivating Scenarios
- Problem Definition
- Literature Review
- Research Contributions
- Proposed Approach
- Experiments
- Conclusions



# Motivating Example: Generating Faithful Text From a Knowledge Graph

## A Knowledge Graph from House Dataset<sup>[1]</sup>:

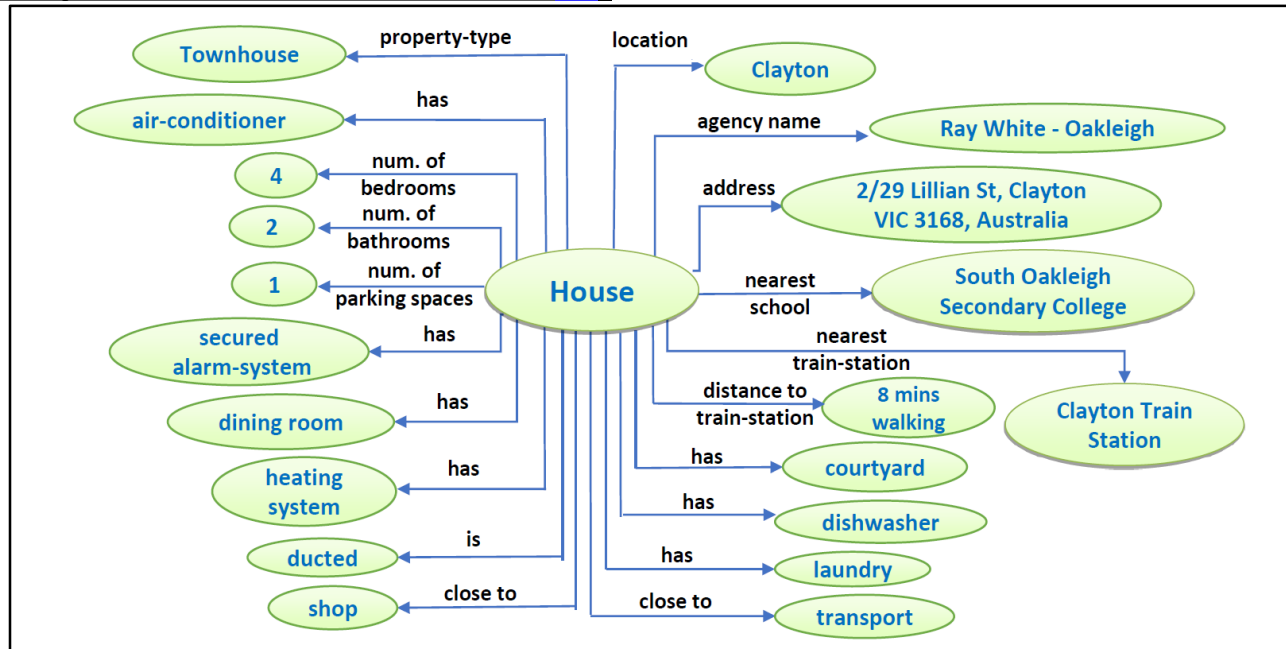


<sup>1</sup> Das et al. *Data Mining and Knowledge Discovery*, 2021



# Motivating Example: Generating Faithful Text From a Knowledge Graph

## A Knowledge Graph from a House Dataset<sup>[1]</sup>:



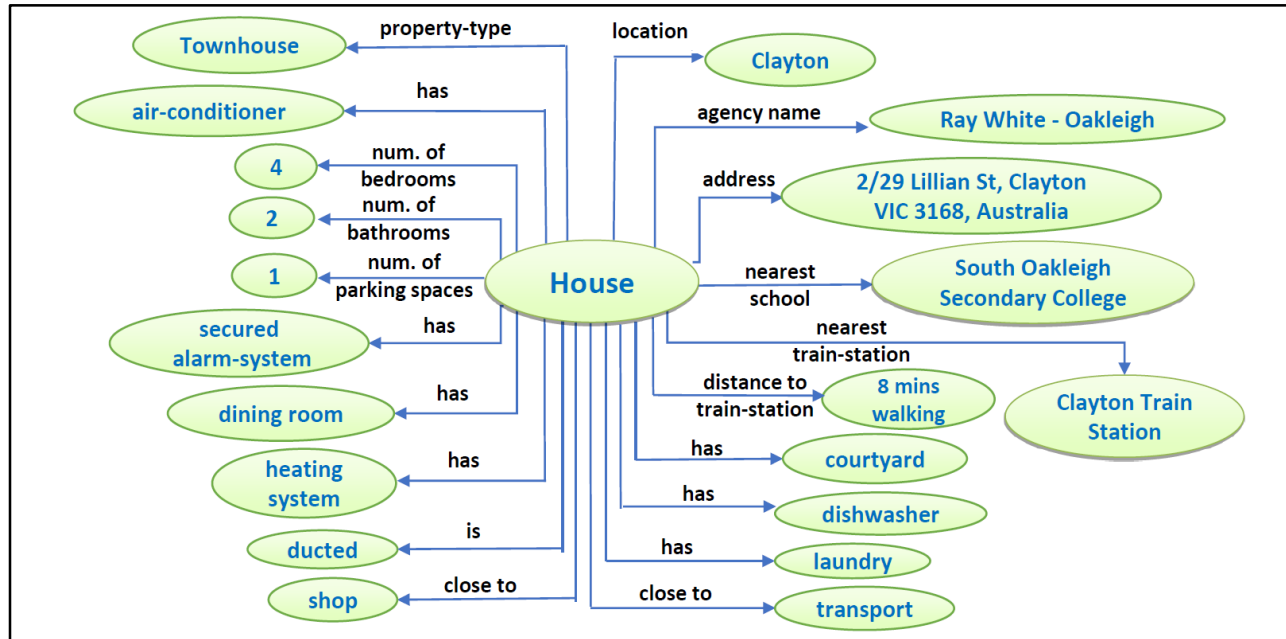
## Text Representation of a Graph:

**Exceptional Modern Elegance! Luxury living in top location!**: Fantastic opportunity available for the first-home buyer or astute investor to secure this beautiful double storey residence situated within few minute walk to Monash Medical Centre and Clayton train station, and minutes away from Clayton Shopping Centre, Clayton Community Centre and Monash University, you will not find a better growth location for this exclusive masterpiece. This architecturally-designed 4 bedrooms townhouse, with spacious living room and dining area, large open-plan U-shaped kitchen, downstairs huge master bedroom with walk-in-robe and superb en-suite come with spa bath, and upstairs three other large bedrooms all with built-in-ropes, separate retreat areas, central bathroom and a separate toilet. Comprises: 900mm cook top and range hood, two drawer dishwasher, Jarrah Hardwood staircase and flooring, large separate laundry room, separate powder room, ducted heating, separate air-conditioning, single lock-up garage with internal access, security alarm system, private rear courtyard.



# Motivating Example: Generating Faithful Text From a Knowledge Graph

## A Knowledge Graph from a House Dataset<sup>[1]</sup>:



**Extrinsic  
Hallucination!!**

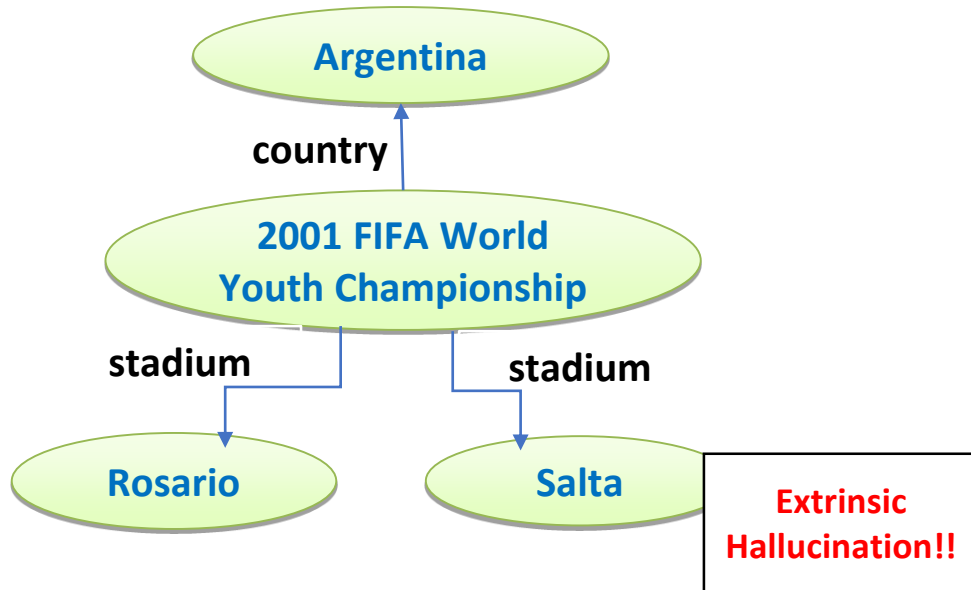
### Ground-Truth Text:

**Exceptional Modern Elegance! Luxury living in top location!** Fantastic opportunity available for the first-home buyer or astute investor to secure this beautiful **double storey** residence situated within **few minute walk to Monash Medical Centre** and Clayton train station, and minutes away from Clayton Shopping Centre, **Clayton Community Centre and Monash University**, you will not find a better growth location for this exclusive masterpiece. This architecturally-designed 4 bedrooms townhouse, with spacious **living room** and dining area, **large open-plan U-shaped kitchen**, **down stairs huge master bedroom with walk-in-robe and superb en-suite** come with spa bath, and upstairs three other large bedrooms all with built-in-ropes, separate retreat areas, central bathroom and a separate toilet. **Comprises: 900mm cook top and range hood, two drawer dishwasher, Jarrah Hardwood staircase and flooring, large separate laundry room, separate powder room**, ducted heating, separate air-conditioning, **single lock-up garage with internal access**, security alarm system, private rear courtyard.



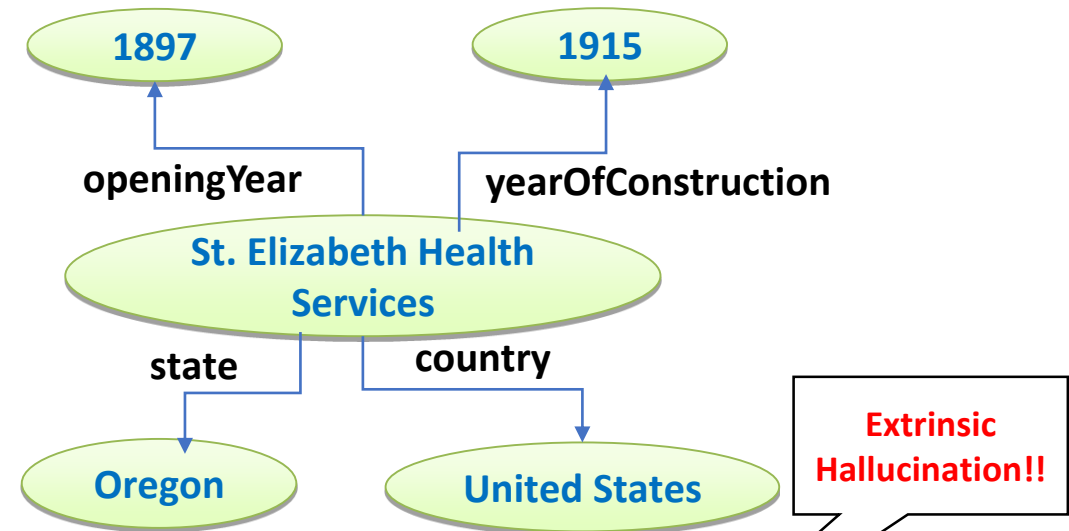
# Motivating Example: Generating Faithful Text From a Knowledge Graph

Two Knowledge Graphs from a benchmark Genwiki Dataset <sup>[2]</sup>:



### Ground-Truth Text:

The 2001 FIFA World Youth Championship took place in Argentina **between 17 June and 8 July 2001** . The 2001 championship was the **13th contested** . The tournament **took part in six cities , Buenos Aires , Córdoba , Mendoza , Rosario , Salta , and Mar del Plata** .



### Ground-Truth Text:

St. Elizabeth Health Services is a **private Roman Catholic hospital** in **Baker City** , Oregon , United States . It opened **August 24 , 1897** as St. Elizabeth Hospital .

<sup>2</sup> Jin et al., COLING 2020




# Problem Definition: Generating Faithful Text From a Knowledge Graph

## INPUT:

- ❖ A Training dataset consists of a list of **Graph-Text Pairs**
- ❖ We can represent every sample as:
  - ❑ A Knowledge Graph,  $G = (V, E)$  :
    - $V = \{e_1, e_2, \dots, e_{|V|}\} \rightarrow$  Represents the **Entity set**
    - $E = \{r_{ij}\} \subseteq V \times V \rightarrow$  Represents the **Relations** connecting the Entities
  - ❑ The **Reference Text/Ground-Truth Text**,  $Y \rightarrow$  Describes the features of a Graph
    - $\rightarrow$  **May contain hallucinated information.**

## OUTPUT:

- ❑ A passage of **Text**,  $\hat{Y} = (y_1, y_2, \dots, y_n)$  generated from a given Knowledge Graph  $G$ 
  -  The **text should faithfully represents the information** contained in a  $G$

# Literature Review: Graph-to-Text Generation

- ❑ **Graph-to-Text Generation Models Using Pre-trained Language Models (PLMs)** [\[12,13,14\]](#)
  - Limitation:
    - Struggling to encode the graph structure and fails to learn the alignment between input graph and the ground-truth text.
    - No hallucination information is considered in the ground-truth text
- ❑ **Graph-to-Text Generation Models Using Graph Neural Network and Graph Transformer** [\[8,9,10,11\]](#)
  - Limitation: No hallucination information is considered in the ground-truth text
- ❑ **Graph-to-Text Generation Models in Using PLMs with Graph structure aware Module** [\[5,6,3,4\]](#)
  - Limitation: No hallucination information is considered in the ground-truth text

<sup>3</sup> Colas et al. *COLING* 2022, <sup>4</sup> Han and Shareghi et al. *EMNLP* 2022, <sup>5</sup> Ke et al. *ACL-IJCNLP* 2021, <sup>6</sup> Li et al. *ACL-IJCNLP* 2021, <sup>8</sup> Ribeiro et al. *ACL* 2020, <sup>9</sup> Philipp et al. *NAACL-HLT* 2021, <sup>10</sup> Zhao et al. *ACL* 2020, <sup>11</sup> Song et al. *ACL* 2020, <sup>12</sup> Ribeiro et al. workshop NLP for convAI 2021(a), <sup>13</sup> Ribeiro et al. *EMNLP* 2021(b), <sup>14</sup> Chen et al. *EMNLP* 2020.



# Literature Review: Graph-to-Text Generation

## ❑ Graph-to-Text Generation Models Using Pre-trained Language Models (PLMs) [\[12,13,14\]](#)

### ➤ Limitation:

- Struggling to encode the graph structure and fails to learn the alignment between input graph and the ground-truth text.
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## ❑ Graph-to-Text Generation Models Using Graph Neural Network and Graph Transformer [\[8,9,10,11\]](#)

### ➤ Limitation: No hallucination information is considered in the ground-truth text

## ❑ Graph-to-Text Generation Models in Using PLMs with Graph structure aware Module [\[5,6,3,4\]](#)

### ➤ Limitation: No hallucination information is considered in the ground-truth text

**Existing KG-to-text models fall short of generating faithful text when the ground-truth text of the training dataset contains hallucinated information that is not consistent with the input graph!!**

<sup>3</sup> Colas et al. *COLING* 2022, <sup>4</sup> Han and Shareghi et al. *EMNLP* 2022, <sup>5</sup> Ke et al. *ACL-IJCNLP* 2021, <sup>6</sup> Li et al. *ACL-IJCNLP* 2021, <sup>8</sup> Ribeiro et al. *ACL* 2020, <sup>9</sup> Philipp et al. *NAACL-HLT* 2021, <sup>10</sup> Zhao et al. *ACL* 2020, <sup>11</sup> Song et al. *ACL* 2020, <sup>12</sup> Ribeiro et al. workshop NLP for convAI 2021(a), <sup>13</sup> Ribeiro et al. *EMNLP* 2021(b), <sup>14</sup> Chen et al. *EMNLP* 2020.



# Research Contributions

- ❖ **Propose a framework to handle the Hallucination problem.**

Our Framework incorporates **two core ideas**:

- (i) **Contrastive learning**

- Enhance the model's ability to **differentiate between faithful and hallucinated information**
    - Encourage the decoder to **generate text that aligns with the input graph**

- (ii) **A Controllable text generation technique**

- Empower the decoder to **control the level of hallucination** in the generated text

- ❖ Conduct experiments on **two noisy datasets** and evaluate our model's performance through the **standard quantitative metrics** as well as a **ChatGPT-based quantitative and qualitative analysis.**

- ❖ The evaluation **demonstrates the superior performance** of our proposed model over the state-of-art KG-to-text generation models on **faithfulness metrics.**



# Proposed Approach

## To Address the Issue of Hallucination problem:

1. Minimizing Hallucinations with **Contrastive Learning**
2. Controlling Hallucinations with **Control Feature Token**

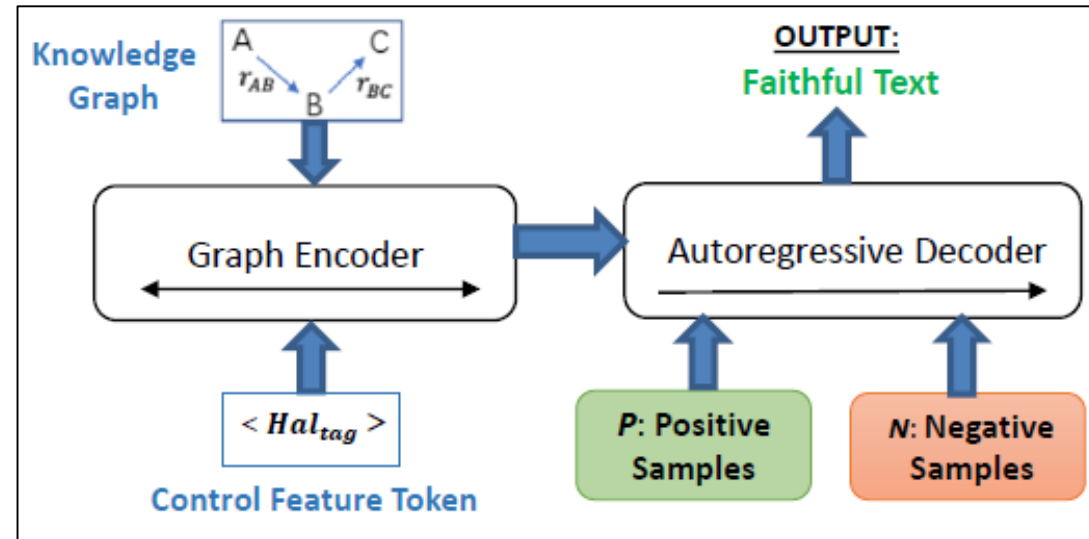


Fig: Block Diagram of Our Proposed Full Model

# Proposed Approach: Minimizing Hallucinations using Contrastive Learning

## Contrastive Learning (CL) Framework:

### Main Idea:

- ✓ CL<sup>[19,20]</sup> significantly improves representation learning<sup>[16,21]</sup> by compacting **positive samples** while **contrasting** them with **negative samples**.
- ✓ We can utilize this framework to **teach a generation model to expand the margin between faithful text/positive samples and their corresponding hallucinated text/negative samples**.
- ✓ This framework is **recently successfully applied to generate faithful text** in the areas of abstract summarization<sup>[17, 7]</sup> and dialogue generation tasks<sup>[18]</sup>

<sup>7</sup> Wang and Bansal *et al.* *NAACL* 2022, <sup>16</sup> Gao *et al.* *EMNLP* 2021, <sup>17</sup> Cao *et al.* *EMNLP* 2021, <sup>18</sup> Tang *et al.* *NAACL* 2022, <sup>19</sup> Khosla *et al.* *NeurIPS* 2020, <sup>20</sup> Yang *et al.* *CPVR* 2022, <sup>21</sup> Zhang *et al.* *NAACL* 2021



# Proposed Approach: Minimizing Hallucinations using Contrastive Learning

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## Goal of Contrastive Learning task:

- Enables the model to differentiate between faithful text and hallucinated text
- Encourage decoder to generate faithful text that should be free of hallucinations



# Proposed Approach: Minimizing Hallucinations using Contrastive Learning

## Goal of Contrastive Learning task:

- Enables the model to **differentiate between faithful text and hallucinated text**
- Encourage decoder to **generate faithful text that should be free of hallucinations**

## Contrastive Learning (CL) Objective Function:

Let, an input pair of a graph and an anchor reference text  $(G_i, Y_i)$  from **the training data  $D$** , has:

A set of **Positive samples**  $\rightarrow P_i$

A set of **Hallucinated/Negative samples**  $\rightarrow N_i$

Thus, the **InfoNCE loss** <sup>[22,23]</sup> function :

$$L_{CL} = - \sum_{(G_i, Y_i) \in D} \sum_{Y_j \in P_i} \log \frac{\exp(\cos(h_i, h_j))}{\sum_{Y_k \in N_i} \exp(\cos(h_i, h_k))}$$

Similarity function

← **Positive Pairs**

← **Negative Pairs**

Here,  
 $Y_j \rightarrow$  A **Positive sample** from the set  $P_i$   
 $Y_k \rightarrow$  A **Negative sample** from the set  $N_i$   
 $h_i, h_j, h_k \rightarrow$  BART decoder representations of  $Y_i, Y_j,$   
 and  $Y_k$  respectively

<sup>22</sup> Oord et al. *arXiv* 2018, <sup>23</sup> Chen et al. *PMLR* 2020



# Proposed Approach

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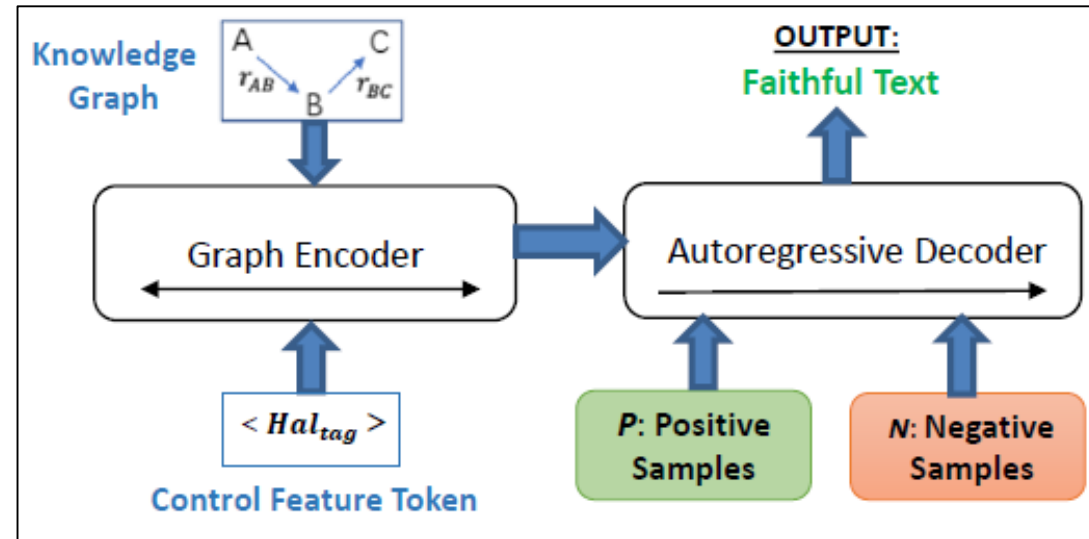


Fig: Block Diagram of Our Proposed Full Model

# Proposed Approach: Finetuning the Pre-trained Model with Control Feature Token

## A Controllable Text Generation Approach

- This technique is introduced in CTRL<sup>[24]</sup> and recently applied by researchers for **minimizing hallucinations**<sup>[25,26,27,29]</sup>
- **Append controllable features to the input graph in training in order to control the level of hallucination**

## Control Feature Token:

- We used **BARTScore**<sup>[15]</sup> as a **Control Feature Token**. It utilizes **pre-trained BART transformer model**.
- Researchers shown<sup>[18,15,28]</sup> that **this metric is closely associated with human evaluations of faithfulness.**

<sup>24</sup> Keskar et al. *Salesforce Research* 2019, <sup>25</sup> Wang et al. *EMNLP* 2022, <sup>26</sup> Rashkin et al. *ACL* 2021, <sup>27</sup> Fillippova et al. *EMNLP* 2020,

<sup>15</sup> Yuan et al. *NeurIPS* 2021, <sup>18</sup> Tang et al. *NAACL* 2022, <sup>28</sup> Gao et al. *NAACL* 2022, <sup>29</sup> Zhang *NAACL* 2022

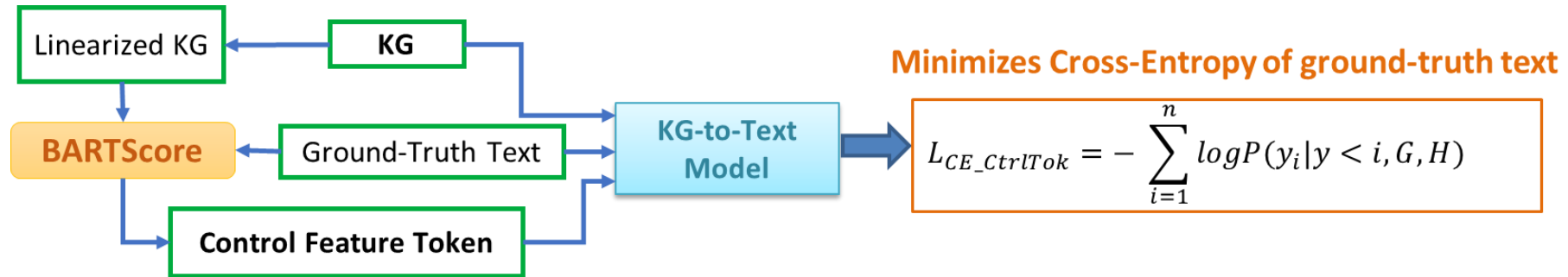




# Proposed Approach: Finetuning the Pre-trained Model with Control Feature Token

## Controllable Text Generation with Control Feature Token:

- ✓ Include this **Control Feature Token** as a **Control Input** with every sample Graph-Text pair.
- **Training Phase** → The **model learns the mapping** between the graph-text pair ( $G, Y$ ) and its corresponding control token  $H$

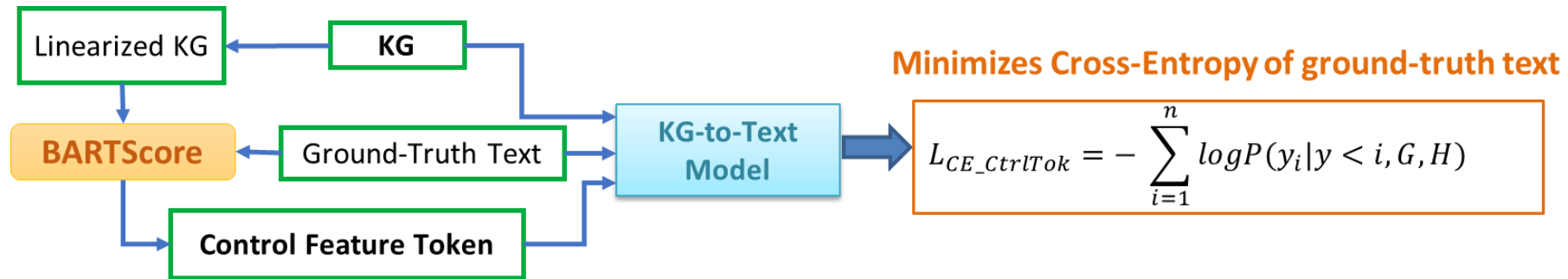




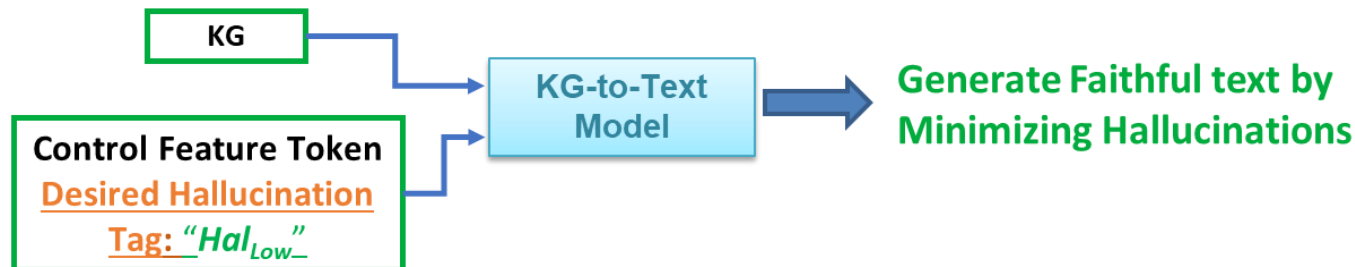
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- **Inference Phase** → Set the Control features token's category → **Desired Hallucination Tag ("Hal<sub>Low</sub>")**





# Proposed Approach

## To Address the Issue of Hallucination problem:

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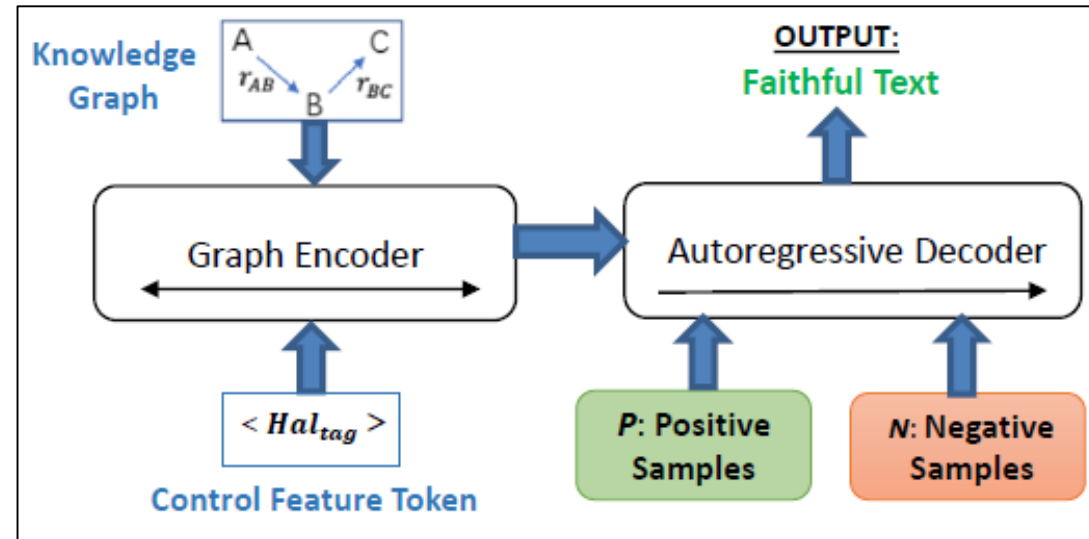


Fig: Block Diagram of Our Proposed Full Model

## The Overall Training Objective

- ✓ The sum of the contrastive loss and the cross-entropy loss with the control token:

$$L = L_{CL} + L_{CE\_CtrlTok}$$



# Experiments: Datasets

## □ Two KG-to-text generation datasets:

- The **House dataset** (Das et al., 2021), prepared from real-estate house listing and
- The **GenWiki dataset** (Jin et al., 2020), prepared by matching Wikipedia articles with DBpedia entities

□ In **both datasets**, the ground-truth text contains a significant amount of hallucinated information, making the task of generating faithful text especially challenging.

Table: Statistics of the datasets, including the total number relations and the data split

<b>Dataset</b>	<b>#Relations</b>	<b>#KG-Text Pairs</b> (Train / Valid / Test)
House	68	33K / 10K / 10, 219
GenWiki <sub>FINE</sub>	287	750K / 7, 152 / 1, 000



# Experiments: Baseline Models

- ❑ On the **House dataset**, we choose **three state-of-the-art** models:
  - (i) **JointGT model** (Ke et al., ACL-IJCNLP 2021)
  - (ii) **GAP** (Colas et al., COLING 2022)
  - (iii) **GMP** (Han and Shareghi, EMNLP 2022)
  
- ❑ On the **Gen-Wiki dataset**, we compare the results of the following models:
  - (i) The **state-of-the-art unsupervised model CycleGT** (Guo et al., COLING 2020)
  - (ii) **JointGT model** (Ke et al., ACL-IJCNLP 2021)
  - (iii) **GMP** (Han and Shareghi, EMNLP 2022)

***\*\*Note that in addition to the existing state-of-the art model, GMP, we also include **CycleGT** as it **has the best reported performance on GenWiki dataset*****



# Experiments: Finetuning Settings

- We adopt **JointGT (Ke et al., 2021)** → As our base model for fine-tuning for both datasets .

## For House Dataset:

- JointGT is **initialized** → with the Hugging Face's **pre-trained BART-base checkpoint** [\*]

## For GenWiki dataset

- JointGT is **initialized** → with the Hugging Face's **pre-trained T5-base checkpoint** [\*\*]

- Pre-trained LM BART-base or T5-base is chosen in order to do a fair comparison with the baseline models
- JointGT is **pre-trained** with a **KGTEXT dataset** (Chen et al., EMNLP 2020)
- Further Implementation details are available in our paper.

\* <https://huggingface.co/facebook/bart-base> , \*\* <https://huggingface.co/t5-base>



# Experiments: Evaluation Using Automatic Metrics

## ❑ Evaluation of Generated Text against Ground-Truth Text:

- BLEU <sup>[31]</sup> : Measures the degree of n-gram overlap between texts, utilizing precision scores and includes a penalty for brevity
- METEOR <sup>[32]</sup> : Aligns two texts by mapping their unigrams.
- ROUGE\_L <sup>[33]</sup> : Measures the degree of longest common sequence between two texts

## ❑ Evaluation of Generated Text against Linearized Graph:

- BARTScore <sup>[15]</sup> : Evaluates text in the form of NLG task by utilizing a pre-trained BART model
- FactCC Score <sup>[30]</sup> : Evaluates text using Entailment classification model.

- ❑ These metrics are **widely used in recent research works** <sup>[17, 18, 34]</sup> to **verify the faithfulness** of text generation tasks

<sup>15</sup> Yuan *et al.* *NeurIPS* 2021, <sup>30</sup> Kryscinski *et al.* *EMNLP* 2022, <sup>31</sup> Papineni, *et al.* *ACL* 2002, <sup>32</sup> Banerjee *et al.* *ACL workshop* 2005,

<sup>33</sup> Lin *et al.* *ACL* 2004, <sup>17</sup> Cao *et al.* *EMNLP* 2021, <sup>18</sup> Tang *et al.* *NAACL* 2022, <sup>34</sup> Van der Poel *et al.* *EMNLP* 2022



# Experiments: Results (1)

## □ Main Results

House Dataset					
Model	Comparison with ground-truth text			Comparison with linearized graph	
	BLEU ↑	METEOR ↑	ROUGE-L ↑	BARTScore ↑	FactCC ↑
<u>Ground-truth text (5K samples)</u>	-	-	-	<u>-4.564</u>	<u>48.48</u>
JointGT (Ke et al., 2021)	<b>3.61</b>	11.96	<b>18.62</b>	-3.685	49.53
<u>GAP (Colas et al., 2022)</u>	3.47	<b>12.05</b>	18.16	<u>-3.666</u>	<u>52.71</u>
GMP (Han and Shareghi, 2022)	3.09	10.73	16.23	-3.941	48.47
<b><u>Our Full Model</u></b>	2.54	11.06	16.86	<b>-3.245</b>	<b>63.61</b>
<u>Control token only</u>	2.88	11.2	17.35	-3.567	52.97
<u>Contrastive learning only</u>	2.56	11.04	16.89	-3.247	63.04

- ✓ The reference text contains **significant amounts of hallucination** (**low BARTScore** and **FactCC scores**)
- ✓ **Our full model** achieves **best results on faithfulness** measures (i.e. when **compared with the linearized graph**), **outperforming the best baseline model** on **BARTScore** and **FactCC score** by **0.421** and **10.9 absolute points** respectively
- ✓ For BLEU, METEOR and ROUGE-L, the **baseline models perform modestly better** than our model when **comparing with the ground-truth text**. Due to the **noisy nature of the reference text**, **a high similarity also indicates high hallucination**
- ✓ **Ablation Study: Both model components contribute to our model's better faithfulness**





# Experiments: Results (2)

## □ Main Results

GenWiki Dataset					
Model	Comparison with ground-truth text			Comparison with linearized graph	
	BLEU ↑	METEOR ↑	ROUGE-L ↑	BARTScore ↑	FactCC ↑
<u>Ground-truth text (5K samples)</u>	-	-	-	<u>-3.464</u>	<u>53.80</u>
<u>CycleGT (Guo et al., 2020)</u>	<b>41.59</b>	<b>35.72</b>	<b>63.31</b>	-3.276	76.86
<u>JointGT (Ke et al., 2021)</u>	37.93	32.60	59.06	-2.299	<u>79.94</u>
<u>GMP (Han and Shareghi, 2022)</u>	35.43	32.68	57.63	<u>-1.601</u>	76.62
<b>Our Full Model</b>	37.48	32.70	60.40	-2.182	<b>82.85</b>
<u>Control token only</u>	37.01	32.38	59.57	-2.268	81.98
<u>Contrastive learning only</u>	35.19	31.33	57.89	-2.309	81.48

- ✓ The **reference text** contains **significant amounts of hallucination** (**low BARTScore** and **FactCC scores**)
- ✓ The **performance delta on faithfulness** measures in this dataset is **smaller**; where **our model** achieves the **best performance on FactCC of 2.91 points and second best performance on BARTScore**
- ✓ For **BLEU, METEOR and ROUGE-L**, the **baseline models** perform modestly better than our model when **comparing with the ground-truth text**. Due to the **noisy nature of the reference text**, **a high similarity also indicates high hallucination**
- ✓ **Ablation Study: Both model components contribute to our model's better faithfulness**



# Experiments: Results (3)

## □ ChatGPT-based Evaluation

- Large language models such as ChatGPT have recently been employed <sup>[35,36]</sup> for evaluating the quality and factual consistency of the generated text with respect to the source input
- We further measure the faithfulness and fluency of generated text with ChatGPT as the oracle.

### Fluency Measure:

- Similar to the approach <sup>[37]</sup>, we prompt ChatGPT to score the fluency of the generated text.

### Factual Consistency Measure:

- We carefully design prompts to instruct ChatGPT to enumerate:
  - ✓ Facts in the (linearized) graph (**# input facts**),
  - ✓ The common facts between the graph and generated text (**# common facts**), and
  - ✓ The hallucinated facts in the generated text (**# hallucinated facts**)
- Our ChatGPT based evaluation provides → **better explainability of models' faithfulness.**

<sup>35</sup> Kocmi and Federmann *et al.*, *arXiv* 2023, <sup>36</sup> Luo et al. *arXiv* 2023, <sup>37</sup> Wang et al., *arXiv* 2023,



# Experiments: Results (4)

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### Fluency Measure:

- Similar to the approach <sup>[37]</sup>, we **prompt ChatGPT to score the fluency** of the generated text.

### Factual Consistency Measure:

$$\text{Precision } (P) = \frac{\# \text{ common facts}}{\# \text{ output facts}} \quad \text{Recall } (R) = \frac{\# \text{ common facts}}{\# \text{ input facts}} \quad \text{Hallucination } (H) = \frac{\# \text{ hallucinated facts}}{\# \text{ output facts}}$$

Here, **# output facts = # hallucinated facts + # common facts**

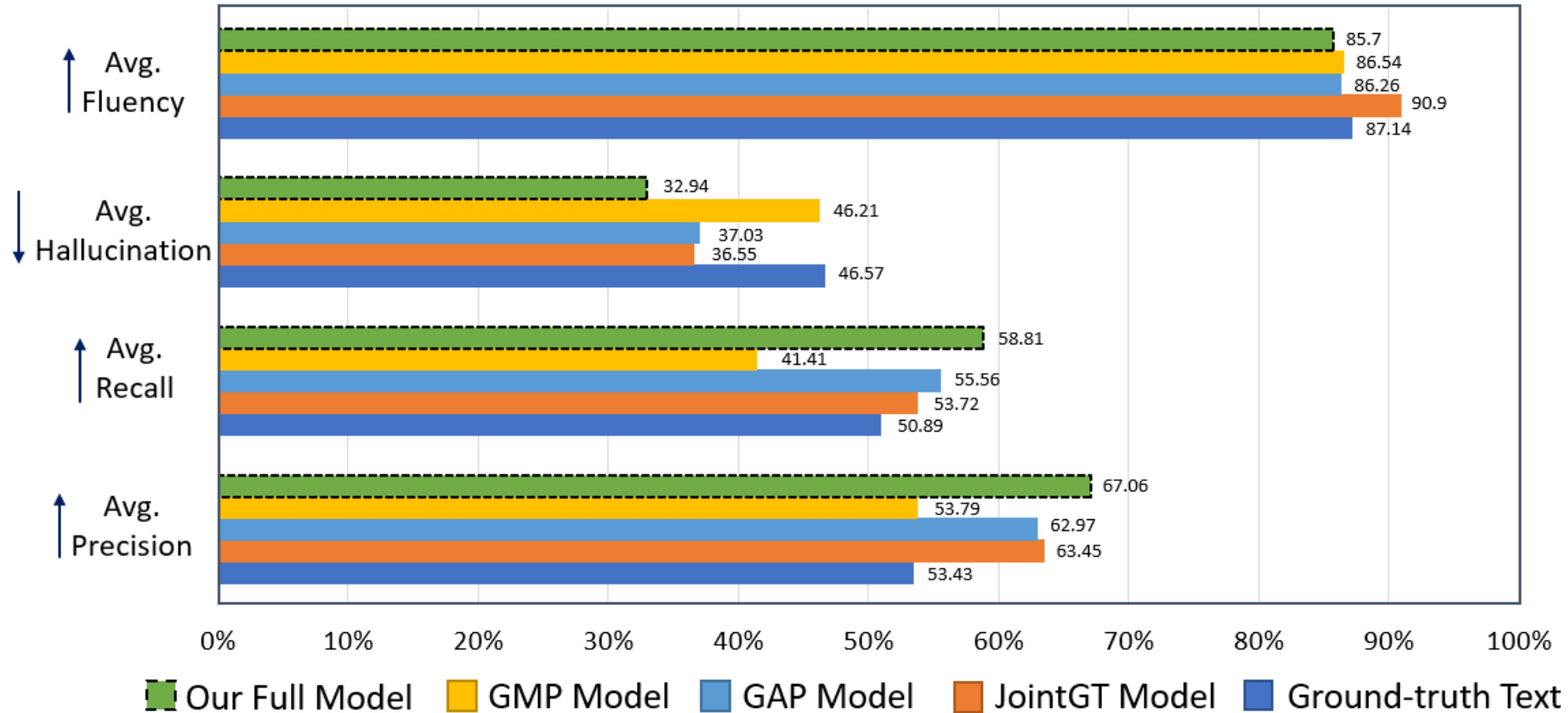
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# Experiments: Results (5)

## ChatGPT-based evaluation on 50 samples from the House Test set



✓ Our model **outperforms all the baseline KG-to-text generation models** on **precision, recall and faithfulness (i.e. low hallucination)** and **achieves competitive scores** in terms of **fluency**.

## □ An Example of ground-truth and generated text on the House dataset

**Red colored text** → **Hallucinated information**  
**Blue colored text** → **Faithful information**

### Ground-truth text:

**AUCTION THIS SATURDAY 10TH OCTOBER AT 1PM:**

Superbly blending charm with a modern sensibility and fresh infusion of light, this **fully renovated three bedroom Californian Bungalow** offers stylish family living in a sought after locale. An expansive **open plan lounge** and **dining room** provides spacious living while showcasing a **marvellous kitchen boasting 700mm stainless steel appliances, abundant storage and feature island bench, ensuring effortless entertaining. A serene second living room, boasting leafy garden views** offers retreat from the bustle of family life. **Three spacious bedrooms** are serviced by a **modern bathroom**, which cleverly incorporates an **oversized European laundry**. **Brilliantly positioned to transport, schools, cafes, vibrant Sydney Road, CityLink and featuring ducted heating, alarm, split system air-conditioning, BIR's, ceiling fans and carport with OSP,** stylish family living starts here.

### Our model:

**Renovated Family Home in the Heart of Brunswick West:** This beautifully **renovated** family home is set on a generous allotment of **444 sqm (approx)** and is ideal for first home buyers, downsizers or investors looking for a low maintenance lifestyle. Comprising of **3 spacious bedrooms (master with WIR and walk in robe), formal lounge and dining room, updated kitchen with stainless steel appliances, central bathroom and laundry.** Other features include **ducted heating, evaporative cooling, split system air conditioner, ducted cooling, alarm system, double garage and much more.**

### JointGT model:

**AUCTION THIS SATURDAY AT 11:00AM:** This **renovated three bedroom brick veneer home** is sure to appeal to first home buyers, downsizers and investors alike. The home comprises of **three double bedrooms (all with built-in robes), spacious lounge and dining room, renovated kitchen with stainless steel appliances, separate laundry, ducted heating, evaporative cooling, alarm system and a single garage with internal access.** The property also features **a large rear garden with established gardens and a bungalow.**

### GAP model:

**Renovated And Ready To Move In:** This beautifully **renovated** brick veneer home is ready to move in and enjoy. Featuring a spacious **living/dining area, renovated kitchen with stainless steel appliances and adjoining meals area, three double bedrooms with built-in robes, central bathroom and separate laundry.** Other features include **ducted heating, evaporative cooling, alarm system, double garage with internal access, polished floorboards, polished hardwood floors, security shutters** and much more. **Close to Sydney Road shops, schools, public transport and easy access to CBD.**

### GMP model:

**SOLD BY HARRY KONTOSSIS:** Sale by **SET DATE 10/10/2015 (unless sold prior)** Situated in a quiet cul-de-sac in the **heart of Brunswick West,** this immaculately presented **three bedroom, two bathroom home** is sure to appeal to first home buyers, investors and downsizers alike. Accommodation includes **a formal lounge and dining room, well-appointed kitchen with stainless steel appliances, adjoining family/meals area, three double bedrooms with built-in robes, central bathroom, separate toilet.**



# Experiments: Results (7)

## □ An Example of ground-truth and generated text on the Genwiki dataset

**Red colored text** → Hallucinated information

**Blue colored text** → Faithful information

### Ground-truth text:

Daniel Monte McLain ( May 11 , 1955 – November 8 , 1995 ) , known by the **stage name** Country Dick Montana , was a **musician** best known as a **member of The Beat Farmers** . Montana was **born in Carmel , California** .

### Our model:

Daniel Monte McLain ( May 11 , 1955 – November 8 , 1995 ) was an American musician .

### JointGT model:

Montana was born on May 11 , 1955 in Carmel , California .

### CycleGT model:

Daniel Monte McLain ( May 11 , 1955 in Carmel , Montana – November 8 , 1995 in Carmel , California ) was a musician , best known as **the founder of the band Country Dick Montana** .

### GMP model:

Daniel Monte McLain ( May 11 , 1955 – November 8 , 1995 ) , known professionally as Country Dick Montana , was an American singer, **songwriter**, and musician.



# Conclusions

- ❑ We have **proposed a novel approach, to generate faithful text from a knowledge graph having noisy ground-truth text**. We have introduced **two key ideas**:
  - (i) **Contrastive learning** to better differentiate between faithful and hallucinated information and
  - (ii) **Control token** to regulate the level of hallucination in the generated text.
- ❑ **Experimental results** on two noisy KG-to-text datasets demonstrates that KG-to-text model with **our framework outperforms all the baseline models in terms of faithfulness metrics**.
- ❑ We have **proposed a novel Chat-GPT based evaluation technique** for an in-depth **quantitative and qualitative analysis**, which further verifies the superior performance of our model on **precision, recall and faithfulness**.

## Limitations and Future work

- ❑ We have applied our proposed framework **only in PLM based KG-to-text encoder-decoder model**
- ❑ In future, we plan to explore the hallucination problem in **AMR (Abstract Meaning Representations) graph datasets**

# **Thank You!**

Any questions are welcomed!





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# Backup Slides

# Literature Review: Hallucinations in Text Generation

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- Hallucination in Abstractive Summarization<sup>[18,19]</sup>
- Hallucination in Dialogue Generation<sup>[21,22]</sup>
- Hallucination in Question Answering<sup>[23,24]</sup>
- Hallucination in Table-to-Text Generation<sup>[26,28]</sup>
- Hallucination in Neural Machine Translation<sup>[29,30]</sup>

<sup>18</sup> Wang *et al.* 2022, <sup>19</sup> Zhang *et al.* 2022 , <sup>20</sup> Tang *et al.* 2022 , <sup>22</sup> Sun *et al.* 2023 , <sup>23</sup> Nakano *et al.* 2021, <sup>24</sup> Kim *et al.* 2022,, <sup>26</sup> Rebuffel *et al.* 2022, <sup>28</sup> Wang *et al.* 2022, <sup>29</sup> Tang *et al.* 2022 , <sup>30</sup> Miao *et al.* 2021.

# Motivating Example: Generating Faithful Text From a Knowledge Graph

## House Dataset:

- The dataset is prepared from the large real-estate and POI datasets of Melbourne, Australia <sup>[1]</sup>
- It includes on average **53,220** records of house sales transactions from **2013 to 2015**
- The dataset consists of **three types of point-of-interests (POIs)**:
  - **Regions, Schools, and Train stations** and their corresponding Features
- **The Ground truth Advertisement text → Describes the features of the House**

The Ground-truth text contains a significant level of **Extrinsic Hallucination Information**, that **is not present in the House Records !!**

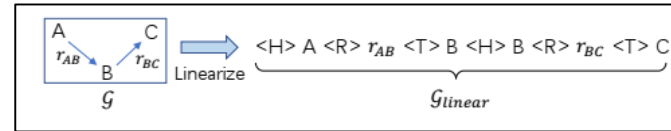
<sup>1</sup> Das *et al.* “Boosting house price predictions using geospatial network embedding”, 2021





# Performance of Existing State-of-the-Art Graph-to-Text Generation Model on House Dataset

## Test Sample-1: Extrinsic Hallucination Problem



<H> Head  
<R> Relation  
<T> Tail

### INPUT: Linearized House Graph

<H>This house<R>location<T>Niddrie. <H>This house<R>property type<T>House. <H>This house<R>address<T>39 Pearl St, Niddrie VIC 3042, Australia. <H>This house<R>sold price<T>835000. <H>This house<R> leased date<T>Sat 23-May-15. <H>This house<R>agency name<T>Frank Dowling Real Estate - Essendon. <H>This house<R>agency address<T>1047 Mt. Alexander Rd. Essendon Vic 3040 . <H>This house<R>number of bedrooms<T>5. <H>This house<R>number of bathrooms<T>1. <H>This house<R>number of parking spaces<T> 3. <H>This house <R> has air-conditioner<T> yes. <H>This house<R>has courtyard<T>yes. <H>This house<R>has fireplace<T>yes. <H>This house<R>has heating system<T>yes. <H>This house<R> has wardrobe<T>yes. <H> This house<R>Close to Shop <T> yes. <H> This house <R>Close to Transport <T> yes. <H> This house <R>Close to School/College<T> yes. <H> This house<R>number of carport spaces<T>1. <H>This house <R> number of garage spaces <T> 2. <H>This house<R>building size<T>169.62 sqm (18 squares) approx. <H>This house <R>land size <T> 665 sqm (approx). <H>This house<R> number of toilets<T> 1. <H> This house<R>nearest Train station<T>Essendon Railway Station. <H>This house<R>distance to closest railway station<T>Approximately 2 mins driving distance. <H>This house<R>nearest school<T>Rosehill Secondary College. <H>Rosehill Secondary College<R>gender-type<T>CoEd school. <H>Rosehill Secondary College<R>school-type<T>Secondary. <H>Rosehill Secondary College<R>ranking <T> 189. <H> Rosehill Secondary College<R>Total Enrolled Students<T>180.

### OUTPUT: Generated Text

**AUCTION THIS SATURDAY AT 11:30AM!**In one of Niddrie’s most sought-after pockets, this solid-brick home presents an exciting opportunity to renovate and extend (STCA) on a deep block of land (**approx 690sqm**). Current floorplan includes five bedrooms (all with built-in robes) and central bathroom, **formal lounge** through to the **kitchen/meals area**, as well as a separate toilet. Other features of the home include gas heating and split-system air conditioning, plus a **north-facing** backyard complete with double garage (remote-controlled

### Result Analysis:

**Red Colored Text** → **Extrinsic hallucinations**....no information about this topic in the Input Graph.  
**Green Colored Text** → Information is **correctly appeared** from the Input Graph



# Proposed Approach: Minimizing Hallucinations using Contrastive Learning

## ✓ Positive Sample Construction Strategy:

- We consider **two positive samples** for every House Graph:
  - (i) Firstly, given ground-truth/reference text.
  - (ii) Secondly, **create a pair using back translation**<sup>[34]</sup> of the reference text



# Proposed Approach: Minimizing Hallucinations using Contrastive Learning

## ✓ Positive Sample Construction Strategy:

- We consider **two positive samples** for every House Graph:
  - (i) Firstly, given ground-truth/reference text.
  - (ii) Secondly, **create a pair using back translation**<sup>[34]</sup> of the reference text

## ✓ Negative Sample Construction Strategy:

- For the anchor text of a given graph, we treat the text of any other graph in  $D$  as a **potential negative sample**.
- We randomly select four such text to construct negative samples for each anchor text

For the House dataset, we adopt a simple heuristic:

*“If all the six major features of a house differ from the anchor house, then the house’s paired text is selected as the negative sample for the anchor house”*

The Six Major Features :

- House Location
- House Address
- Number of Bedrooms
- Number of Bathrooms
- Number of Parking Spaces
- House Property Type



# Proposed Approach: Finetuning the Pre-trained Model with Control Feature Token

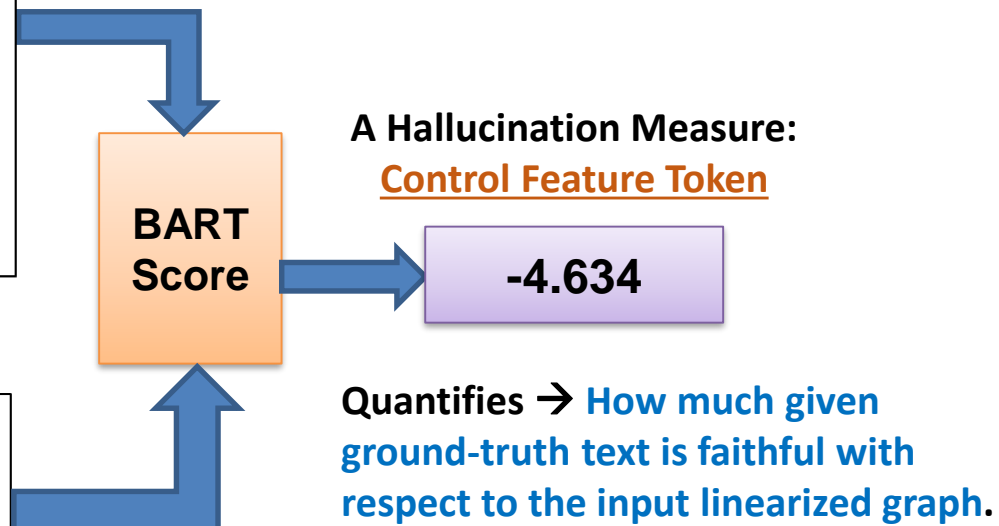
## Control Feature Token:

### Linearized House Graph

This house location Clayton. This house property type Unit. This house address 1/76 Scotsburn Ave, Clayton VIC 3168, Australia. This house sold price 560000. This house leased date Sat 07-Dec-13. This house number of bedrooms 3. This house number of bathrooms 1. This house number of parking spaces 2. This house has air-conditioner yes. This house has a Dishwasher yes. This house is ducted yes. This house has fireplace yes. This house has heating system yes. This house has laundry yes. This house is fully renovated yes. This house has wardrobe yes. This house nearest Train station Clayton Railway Station. This house distance to closest railway station 18 mins walking distance. This house nearest school South Oakleigh Secondary College. South Oakleigh Secondary College gender-type CoEd school. South Oakleigh Secondary College type Secondary.

### Ground-truth Text

Excellent opportunity available for the home buyer or astute investor to secure this spacious **fully renovated** home situated within walking distance to **Huntingdale train station (Zone 1)**, **Clayton Train Station**, **local schools** & **parklands**, **bus stops**, **Clayton shopping district**, **Clayton Community Centre** and **only minutes away from Monash Medical Centre & Monash University**. This fantastic home boasts **3 spacious bedrooms** (2 with mirror **BIR's**), modern fully tiled **bathroom** with spa, and separate **laundry** with **additional toilet**, **fully landscaped rear garden with water tank leading to the remote control double lock up garage**. With everything at your fingertips and close to all amenities, this stylish and modern home will be your next dream residence! As you walk into this fabulous home with showcase downlights throughout that leads to the **sunfilled formal lounge** with a feature **fireplace**, reverse cycle **air conditioning** in **master bedroom**, immaculate polished floorboards spread to the **stunning fully renovated kitchen with stone benchtops**, **gas Smeg stainless-steel appliances**, **Blanco dishwasher**, **ample cupboard space**, **ducted heating**, **evaporate cooling system** and much more.



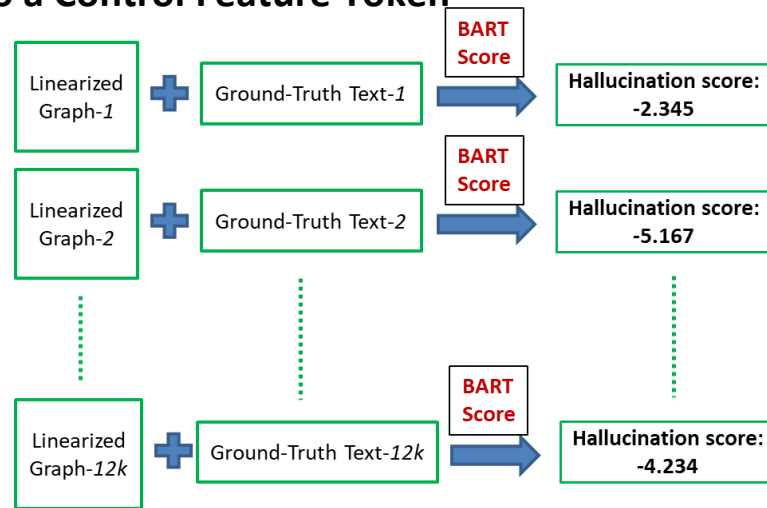
<sup>36</sup> Yuan et al. "Bartscore: Evaluating generated text as text generation" NeurIPS 2021,



# Proposed Approach: Finetuning the Pre-trained Model with Control Feature Token

## Controllable Text Generation with Control Feature Token:

- **Step-1:** For every sample **Graph-Text** training pair  $\rightarrow$  we measure hallucination using **BARTScore**, which is then converted into a **Control Feature Token**

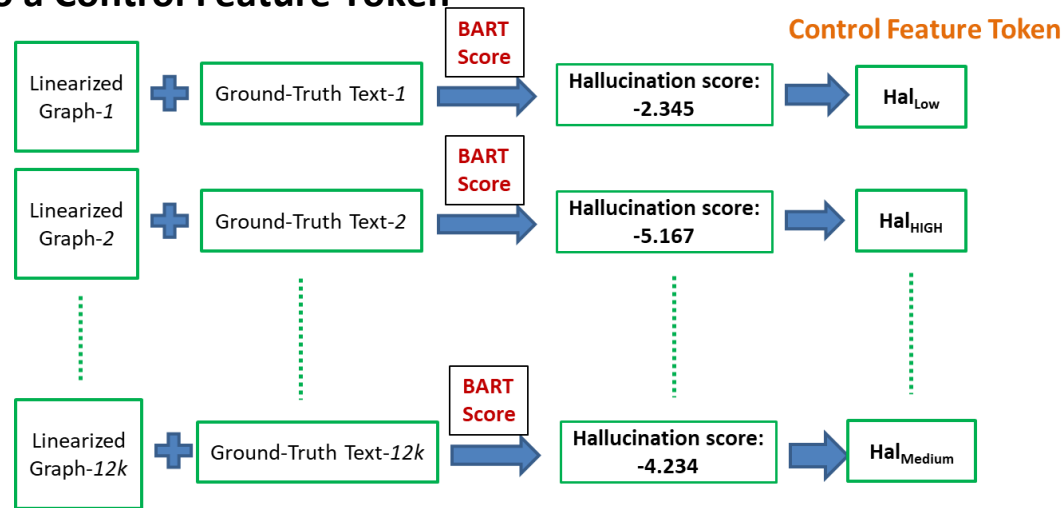




# Proposed Approach: Finetuning the Pre-trained Model with Control Feature Token

## Controllable Text Generation with Control Feature Token:

- Step-1: For every sample **Graph-Text** training pair → we measure hallucination using **BARTScore**, which is then converted into a **Control Feature Token**



- Step-2: Split the training samples into three buckets according to the BARTScore → where each bucket contains a list of training samples at a specific range of BARTScore.

**Three Control Feature Token Buckets: Hallucination Range**

- Hal<sub>Low</sub> : -2.02 to -4.0 → List of Training Samples having **Low Hallucination**
- Hal<sub>Medium</sub> : -4.1 to -4.5 → List of Training Samples having **Medium Hallucination**
- Hal<sub>High</sub> : -4.6 to -7.9 → List of Training Samples having **High Hallucination**





## □ An Example of ground-truth and generated text on the House dataset

**Red colored text** → Hallucinated information

**Blue colored text** → Faithful information

### Ground-truth text:

#### **Exceptional potential with elevated outlook:**

Set on the high side in a wonderfully quiet and convenient cul-de-sac location, this clinker-brick home provides an ideal opportunity to renovate and extend, rebuild or redevelop (STCA) and capture the city skyline views. Immediately comfortable, the home currently offers five bedrooms (two with built-in robes) and central bathroom, two living areas and well-appointed kitchen. Other features include heating and cooling, expansive backyard, plus garage and carport via full-length side driveway. Close to Rosehill Road/Hoffmans Road buses, shops and cafes, walking distance to St Bernard's College and Rosehill Secondary College. Currently tenanted at \$1653.00pm. Land size 15.8m x 42.1m 665sqm (approx). This is the one!

### Our model:

**SOLD by Frank Dowling Real Estate:** Located in a quiet pocket of Niddrie, this immaculately presented family home is sure to impress. Comprising of 5 good sized bedrooms with BIRs, master with WIR and walk in robe, central bathroom, open plan living and dining area, central kitchen with stainless steel appliances, family bathroom and separate toilet. Other features include gas heating, evaporative cooling, split system air conditioner, double garage with internal access and a large rear yard with rear access. Close to schools, shops and transport.

### JointGT model:

**AUCTION THIS SATURDAY AT 11:30AM!** In one of Niddrie's most sought-after pockets, this solid-brick home presents an exciting opportunity to renovate and extend (STCA) on a deep block of land (approx 690sqm). Current floorplan includes five bedrooms (all with built-in robes) and central bathroom, formal lounge through to the kitchen/meals area, as well as a separate toilet. Other features of the home include gas heating and split-system air conditioning, plus a north-facing backyard complete with double garage (remote-controlled)

### GAP model:

**Spacious family home in a sought-after Niddrie location!** Set on a large block of land (approx 697sqm), this solid-brick home presents an exciting opportunity to renovate, extend or redevelop (STCA). Current floorplan includes five bedrooms (two with BIRs) and central bathroom, open-plan living/meals area and updated kitchen with stainless steel appliances. Other features include split-system heating/cooling, polished floorboards, polished hardwood floors and a double garage with internal access. Close to schools, shops and public transport, it's a must-see

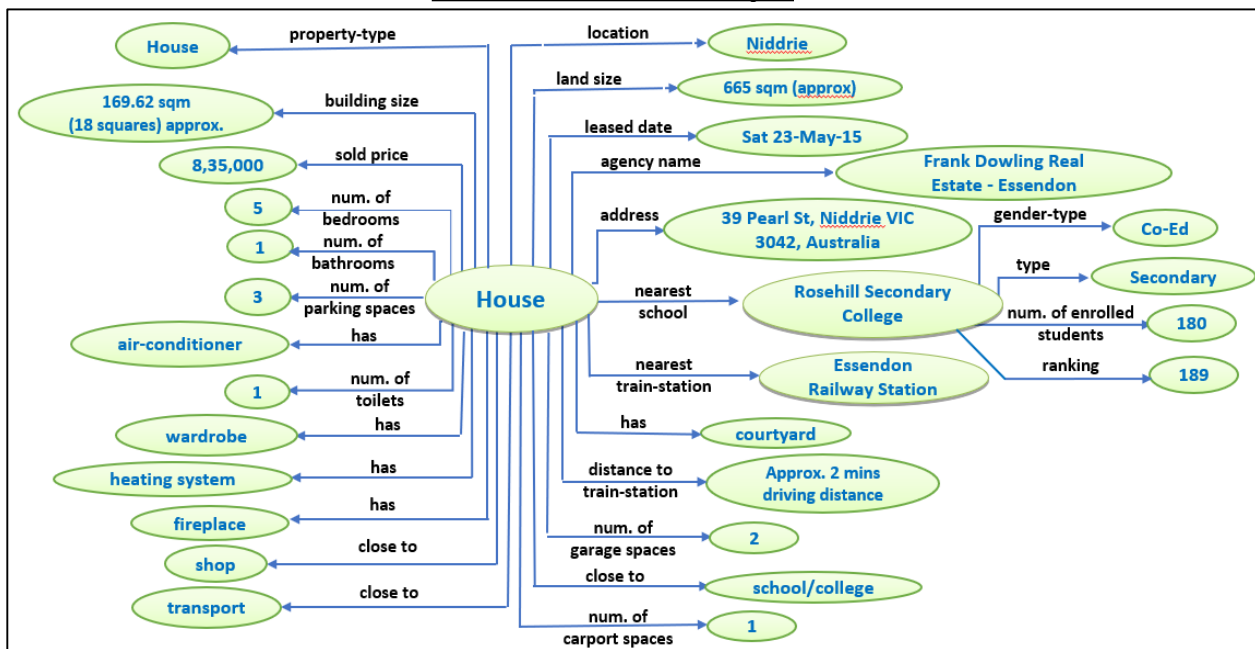
### GMP model:

**Exceptional family living in a prime Niddrie location!** In a quiet cul-de-sac close to schools, shops and transport, this impressive home offers an immediately comfortable family lifestyle with plenty of scope to further improve and extend (STCA). Beyond its attractive facade, the home's inviting interior comprises five bedrooms (all with built-in robes) and stylish central bathroom, spacious lounge through to the kitchen/meals area and adjoining family room. Other highlights include ducted heating and evaporative cooling, polished hardwood floors, plus a double garage (with

# Performance of Existing State-of-the-Art Knowledge Graph-to-Text Generation Models on House Dataset

## Test Sample: Extrinsic Hallucination Problem

### INPUT: House Graph



### Result Analysis:

**Red Colored Text** → **Extrinsic hallucinations**....no information about this topic in the Input Graph.

**Green Colored Text** → **Faithful Information**....Information is correctly appeared from the Input Graph

### Ground-truth Text and Generated OUTPUT Text

#### Ground-truth text:

**Exceptional potential with elevated outlook:**Set on the high side in a wonderfully quiet and convenient cul-de-sac location, this clinker-brick home provides an ideal opportunity to renovate and extend, rebuild or redevelop (STCA) and capture the city skyline views. Immediately comfortable, the home currently offers five bedrooms (two with built-in robes) and central bathroom, two living areas and well-appointed kitchen. Other features include heating and cooling, expansive backyard, plus garage and carport via full-length side driveway. Close to Rosehill Road/Hoffmans Road buses, shops and cafes, walking distance to St Bernard???'s College and Rosehill Secondary College. Currently tenanted at \$1653.00pm. Land size 15.8m x 42.1m ??? 665sqm (approx). This is the one!

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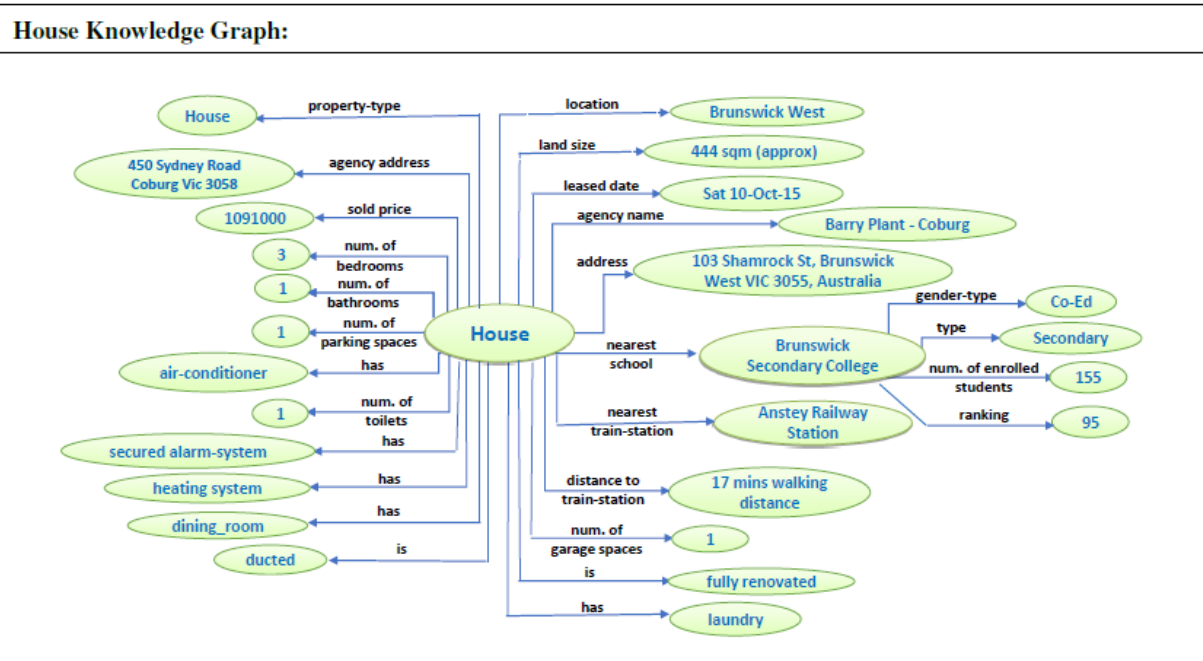
<sup>5</sup> Ke et al. JointGT Model 2021, <sup>2</sup> Colas et al. GAP Model 2022, <sup>3</sup> Han and Shareghi et al. GMP Model 2022





# Experiments: Results

## Example of generated text on the House dataset



**Ground-truth text:**  
**AUCTION THIS SATURDAY 10TH OCTOBER AT 1PM:** Superbly blending charm with a modern sensibility and fresh infusion of light, this fully renovated three bedroom Californian Bungalow offers stylish family living in a sought after locale. An expansive open plan lounge and dining room provides spacious living while showcasing a marvellous kitchen boasting 700mm stainless steel appliances, abundant storage and feature island bench, ensuring effortless entertaining. A serene second living room, boasting leafy garden views offers retreat from the bustle of family life. Three spacious bedrooms are serviced by a modern bathroom, which cleverly incorporates an oversized European laundry. Brilliantly positioned to transport, schools, cafes, vibrant Sydney Road, CityLink and featuring ducted heating, alarm, split system air-conditioning, BIR's, ceiling fans and carport with OSP, stylish family living starts here.

**JointGT model:**  
**AUCTION THIS SATURDAY AT 11:00AM:** This renovated three bedroom brick veneer home is sure to appeal to first home buyers, downsizers and investors alike. The home comprises of three double bedrooms (all with built-in robes), spacious lounge and dining room, renovated kitchen with stainless steel appliances, separate laundry, ducted heating, evaporative cooling, alarm system and a single garage with internal access. The property also features a large rear garden with established gardens and a bungalow.

**GAP model:**  
**Renovated And Ready To Move In:** This beautifully renovated brick veneer home is ready to move in and enjoy. Featuring a spacious living/dining area, renovated kitchen with stainless steel appliances and adjoining meals area, three double bedrooms with built-in robes, central bathroom and separate laundry. Other features include ducted heating, evaporative cooling, alarm system, double garage with internal access, polished floorboards, polished hardwood floors, security shutters and much more. Close to Sydney Road shops, schools, public transport and easy access to CBD.

**GMP model:**  
**SOLD BY HARRY KONTOSSIS:** Sale by SET DATE 10/10/2015 (unless sold prior) Situated in a quiet cul-de-sac in the heart of Brunswick West, this immaculately presented three bedroom, two bathroom home is sure to appeal to first home buyers, investors and downsizers alike. Accommodation includes a formal lounge and dining room, well-appointed kitchen with stainless steel appliances, adjoining family/meals area, three double bedrooms with built-in robes, central bathroom, separate toilet.

**Our model:**  
**Renovated Family Home in the Heart of Brunswick West:** This beautifully renovated family home is set on a generous allotment of 444 sqm (approx) and is ideal for first home buyers, downsizers or investors looking for a low maintenance lifestyle. Comprising of 3 spacious bedrooms (master with WIR and walk in robe), formal lounge and dining room, updated kitchen with stainless steel appliances, central bathroom and laundry. Other features include ducted heating, evaporative cooling, split system air conditioner, ducted cooling, alarm system, double garage and much more.

## ❑ An Example of ground-truth and generated text on the Genwiki dataset

**Red colored text** → Hallucinated information  
**Blue colored text** → Faithful information

### **Ground-truth text:**

Former South Africa all-rounder Jacques Kallis achieved the top bid of the player auction , joining the Libra Legends . Former Australia wicketkeeper-batsman Adam Gilchrist was the second-highest signing , purchased by the Sagittarius Strikers .

### **Our model:**

Jacques Kallis is an Australian cricketer who plays as a wicketkeeper-batsman for the Libra Legends .

### **JointGT model:**

Jacques Kallis is an Australian cricketer who plays as a wicketkeeper-batsman for the Libra Legends .

### **CycleGT model:**

Libra Legends is an all-rounder based in Australia . It was founded by Adam Gilchrist and Jacques Kallis in South Africa by Adam Gilchrist , who is the founder and owner of the Sagittarius Strikers .

### **GMP model:**

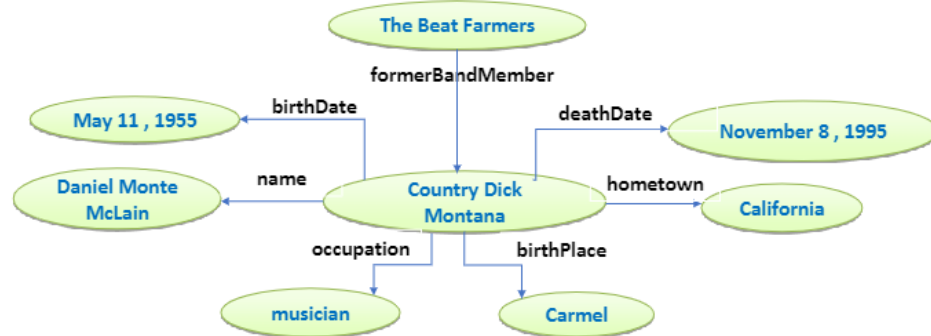
Jacques Kallis is an Australian-born Australian cricketer, wicketkeeper-batsman and all-rounder.



# Experiments: Results

## Example of generated text on the Genwiki dataset

Genwiki Knowledge Graph:



**Ground-truth text:**

Daniel Monte McLain ( May 11 , 1955 – November 8 , 1995 ) , known by the stage name Country Dick Montana , was a musician best known as a member of The Beat Farmers . Montana was born in Carmel , California .

**JointGT model:**

Montana was born on May 11 , 1955 in Carmel , California .

**CycleGT model:**

Daniel Monte McLain ( May 11 , 1955 in Carmel , Montana – November 8 , 1995 in Carmel , California ) was a musician , best known as the founder of the band Country Dick Montana .

**GMP model:**

Daniel Monte McLain ( May 11 , 1955 – November 8 , 1995 ) , known professionally as Country Dick Montana , was an American singer, songwriter, and musician.

**Our framework:**

Daniel Monte McLain ( May 11 , 1955 – November 8 , 1995 ) was an American musician .



# Prompt Templates for ChatGPT Based Evaluation (1)

Consider the Following **INPUT**:

**INPUT:** Linearized Graph

List the features one by one from the **INPUT**.

(a) Template-1

Consider the Following **OUTPUT**:

**OUTPUT:** Generated Text

Q1. Is the feature 'X' supported by the **OUTPUT**?

Q2. Is the feature 'Y' supported by the **OUTPUT**?

.....

Here, 'X' and 'Y' are features from **INPUT**

(b) Template-2

Consider the Following **INPUT** and **OUTPUT**:

**INPUT:** Linearized Graph

**OUTPUT:** Generated Text

List the features one by one from the **OUTPUT** that is not mentioned in the **INPUT**.

List the features one by one from the **OUTPUT** that is contradictory according to **INPUT**.

(c) Template-3

Figure 5: Prompt templates for enumerating facts using ChatGPT. Template-1 (left) is to enumerate facts in the input (linearized graph). Template-2 (middle) is to enumerate common facts between the input (linearized graph) and the output (generated text). Template-3 (right) is to enumerate hallucinated facts in the output (generated text).



# Prompt Templates for ChatGPT Based Evaluation (2)

Consider the Following **INPUT**:

**INPUT:** This house location Elwood. This house property type Apartment. This house address 6/4 Poets Grove, Elwood VIC 3184, Australia. This house sold price 334000. This house leased date Mon 18-May-15. This house agency name Gary Peer & Associates - Caulfield North. This house agency address 348 Orrong Road Caulfield North Vic 3161 . This house number of bedrooms 1. This house number of bathrooms 1. This house number of parking spaces 1. This house has intercom yes. This house has its nearest park yes. This house number of carport spaces 1. This house nearest Train station Ripponlea Railway Station. This house distance to closest railway station 15 mins walking distance. This house nearest school Elwood College. Elwood College gender-type CoEd school. Elwood College school-type Secondary. Elwood College ranking 252. Elwood College Total Enrolled Students 124.

List the features one by one from the **INPUT**

(a) Prompt to ChatGPT

Here are the features listed in the **INPUT**:

1. Location: Elwood
2. Property type: Apartment
3. Address: 6/4 Poets Grove, Elwood VIC 3184, Australia
4. Sold price: 334000
5. Leased date: Mon 18-May-15
6. Agency name: Gary Peer & Associates - Caulfield North
7. Agency address: 348 Orrong Road Caulfield North Vic 3161
8. Number of bedrooms: 1
9. Number of bathrooms: 1
10. Number of parking spaces: 1
11. Has intercom: yes
12. Has nearest park: yes
13. Number of carport spaces: 1
14. Nearest train station: Ripponlea Railway Station
15. Distance to closest railway station: 15 mins walking distance
16. Nearest school: Elwood College
17. Gender-type of school: CoEd school
18. School-type: Secondary
19. Ranking of school: 252
20. Total enrolled students: 124

(b) Response from ChatGPT

Figure 6: An Example of Template-1





# Prompt Templates for ChatGPT Based Evaluation (3)

Consider the Following **OUTPUT**:

**OUTPUT:** AUCTION THIS SATURDAY AT 11.00AM: This one bedroom apartment is a must see for first home buyers, investors or those looking to downsize. Located in one of Elwood's most sought after tree lined streets, this apartment is within walking distance to Ripponlea train station, Elwood Village and the beach. Comprising of a spacious living room, kitchen/meals area, bedroom with built in robes, bathroom with separate toilet, intercom entry and car space on title. This is an opportunity not to be missed.

- Q1. Is the feature 'This house location Elwood.' supported by the OUTPUT?
- Q2. Is the feature 'This house property type Apartment.' supported by the OUTPUT?
- Q3. Is the feature 'This house address 6/4 Poets Grove, Elwood VIC 3184, Australia.' supported by the OUTPUT?
- Q4. Is the feature 'This house sold price 334000.' supported by the OUTPUT?
- Q5. Is the feature 'This house leased date Mon 18-May-15.' supported by the OUTPUT?
- Q6. Is the feature 'This house agency name Gary Peer & Associates - Caulfield North.' supported by the OUTPUT?
- Q7. Is the feature 'This house agency address 348 Orrong Road Caulfield North Vic 3161 .' supported by the OUTPUT?
- Q8. Is the feature 'This house number of bedrooms 1.' supported by the OUTPUT?
- Q9. Is the feature 'This house number of bathrooms 1.' supported by the OUTPUT?
- Q10. Is the feature 'This house number of parking spaces 1.' supported by the OUTPUT?
- Q11. Is the feature 'This house has intercom yes.' supported by the OUTPUT?
- Q12. Is the feature 'This house has its nearest park yes.' supported by the OUTPUT?
- Q13. Is the feature 'This house number of carport spaces 1.' supported by the OUTPUT?
- Q14. Is the feature 'This house nearest Train station Ripponlea Railway Station.' supported by the OUTPUT?
- Q15. Is the feature 'This house distance to closest railway station 15 mins walking distance.' supported by the OUTPUT?
- Q16. Is the feature 'This house nearest school Elwood College.' supported by the OUTPUT?
- Q17. Is the feature 'Elwood College gender-type CoEd school.' supported by the OUTPUT?
- Q18. Is the feature 'Elwood College school-type Secondary.' supported by the OUTPUT?
- Q19. Is the feature 'Elwood College ranking 252.' supported by the OUTPUT?
- Q20. Is the feature 'Elwood College Total Enrolled Students 124.' supported by the OUTPUT?

(a) Prompt to ChatGPT

- Q1. Yes, the feature 'This house location Elwood.' is supported by the OUTPUT.
- Q2. Yes, the feature 'This house property type Apartment.' is supported by the OUTPUT.
- Q3. Yes, the feature 'This house address 6/4 Poets Grove, Elwood VIC 3184, Australia.' is supported by the OUTPUT.
- Q4. No, the feature 'This house sold price 334000.' is not supported by the OUTPUT.
- Q5. No, the feature 'This house leased date Mon 18-May-15.' is not supported by the OUTPUT.
- Q6. Yes, the feature 'This house agency name Gary Peer & Associates - Caulfield North.' is supported by the OUTPUT.
- Q7. Yes, the feature 'This house agency address 348 Orrong Road Caulfield North Vic 3161 .' is supported by the OUTPUT.
- Q8. Yes, the feature 'This house number of bedrooms 1.' is supported by the OUTPUT.
- Q9. Yes, the feature 'This house number of bathrooms 1.' is supported by the OUTPUT.
- Q10. Yes, the feature 'This house number of parking spaces 1.' is supported by the OUTPUT.
- Q11. Yes, the feature 'This house has intercom yes.' is supported by the OUTPUT.
- Q12. Yes, the feature 'This house has its nearest park yes.' is supported by the OUTPUT.
- Q13. Yes, the feature 'This house number of carport spaces 1.' is supported by the OUTPUT.
- Q14. Yes, the feature 'This house nearest Train station Ripponlea Railway Station.' is supported by the OUTPUT.
- Q15. Yes, the feature 'This house distance to closest railway station 15 mins walking distance.' is supported by the OUTPUT.
- Q16. Yes, the feature 'This house nearest school Elwood College.' is supported by the OUTPUT.
- Q17. No, the feature 'Elwood College gender-type CoEd school.' is not supported by the OUTPUT.
- Q18. No, the feature 'Elwood College school-type Secondary.' is not supported by the OUTPUT.
- Q19. No, the feature 'Elwood College ranking 252.' is not supported by the OUTPUT.
- Q20. No, the feature 'Elwood College Total Enrolled Students 124.' is not supported by the OUTPUT.

(b) Response from ChatGPT

Figure 7: An Example of Template-2



# Prompt Templates for ChatGPT Based Evaluation (4)

Consider the Following **INPUT** and **OUTPUT**:

**INPUT:** This house location Elwood. This house property type Apartment. This house address 6/4 Poets Grove, Elwood VIC 3184, Australia. This house sold price 334000. This house leased date Mon 18-May-15. This house agency name Gary Peer & Associates - Caulfield North. This house agency address 348 Orrong Road Caulfield North Vic 3161 . This house number of bedrooms 1. This house number of bathrooms 1. This house number of parking spaces 1. This house has intercom yes. This house has its nearest park yes. This house number of carport spaces 1. This house nearest Train station Ripponlea Railway Station. This house distance to closest railway station 15 mins walking distance. This house nearest school Elwood College. Elwood College gender-type CoEd school. Elwood College school-type Secondary. Elwood College ranking 252. Elwood College Total Enrolled Students 124.

**OUTPUT:** AUCTION THIS SATURDAY AT 11.00AM:This one bedroom apartment is a must see for first home buyers, investors or those looking to downsize. Located in one of Elwood's most sought after tree lined streets, this apartment is within walking distance to Ripponlea train station, Elwood Village and the beach. Comprising of a spacious living room, kitchen/meals area, bedroom with built in robes, bathroom with separate toilet, intercom entry and car space on title. This is an opportunity not to be missed.

List the features one by one from the **OUTPUT** that is not mentioned in the **INPUT**.

List the features one by one from the **OUTPUT** that is contradictory according to **INPUT**

**(a) Prompt to ChatGPT**

Features not mentioned in the **INPUT** but mentioned in the **OUTPUT**:

1. The apartment is a "must see" for certain types of buyers (first home buyers, investors or downsizers)
2. The apartment is located on one of Elwood's most sought after tree-lined streets
3. The apartment is within walking distance to Elwood Village and the beach
4. The apartment has a bedroom with built-in robes
5. The bathroom has a separate toilet
6. The apartment has intercom entry
7. The car space is on title

There are no features in the **OUTPUT** that are contradictory according to the **INPUT**.

**(b) Response from ChatGPT**

Figure 8: An Example of Template-3



# Comparing Our Result with ChatGPT (1)

- We randomly take **1000 sample graphs** from the House dataset.
- Our experiments are conducted using the **API of Chat- GPT (gpt-3.5-turbo)** model.
- We **input** ChatGPT the sample graphs in a linearized format and asked to summarize the linearized graphs in a real-estate advertising format
- We experiment with **ChatGPT-ZeroShot** (without giving any reference text) , **ChatGPT-k-FewShot**, (where **k** represents the number of noisy ground-truth text sample is given to ChatGPT as a reference in addition to the input linearized graph\_and compare these with our full model.

Generation Model	Comparison with ground-truth text			Comparison with linearized graph	
	BLEU ↑	METEOR ↑	ROUGE-L ↑	BARTScore ↑	FactCC ↑
ChatGPT-ZeroShot	1.21	11.86	12.91	<b>-2.389</b>	71.02
ChatGPT-1-Shot	1.95	12.73	15.02	-2.872	<b>76.34</b>
ChatGPT-2-Shot	2.06	12.67	15.58	-2.937	72.02
ChatGPT-3-Shot	2.25	<b>13.31</b>	15.76	-3.036	73.88
<b>Our Full Model</b>	<b>2.68</b>	11.21	<b>17.10</b>	-3.246	62.84

Table 4: Results on 1000 test samples from the House dataset. **Bold** fonts denote the best results.





# Comparing Our Result with ChatGPT (2)

- We also compare the results using **ChatGPT based evaluation**.
- **Table 5 shows** the average of precision, recall and hallucinations which we compute using ChatGPT.
- The results also show that **ChatGPT-ZeroShot performs best in all metrics as usual.**
- **Our model outperforms ChatGPT-3-FewShot in terms of precision (higher precision) and hallucination (lower hallucination).**

Generation Model	Avg. Precision	Avg. Recall	Avg. Hallucination
ChatGPT-ZeroShot	<b>73.28</b>	<b>88.21</b>	<b>26.71</b>
ChatGPT-3-Shot	65.45	64.39	34.55
<b>Our Full Model</b>	67.06	58.81	32.94

Table 5: ChatGPT Evaluation Results based on 50 samples from the House Dataset. **Bold** fonts denote the best results.



# Comparing Our Result with ChatGPT (3)

## Performance Based on Salient Facts:

- We rank in descending order the features (type-wise) of the house graph based on their frequency of occurrence in the House training dataset.
- We take top ten features as salient facts. The salient facts are: 1) house location, 2) house property-type, 3) num. of bedrooms, 4) num. of bathrooms, 5) num of parkingspaces, 6) has ac, 7) has dining, 8) has heating, 9) has garage spaces and 10) nearest train station.

Generation Model	Avg. Salient Precision	Avg. Salient Recall
ChatGPT-ZeroShot	26.75	<b>92.66</b>
ChatGPT-3-FewShot	30.27	86.36
<b>Our Full Model</b>	<b>31.64</b>	77.16

Table 6: ChatGPT Evaluation Results based on 50 samples from the House dataset considering salient features. **Bold** fonts denote the best results.

- Using ChatGPT, we enumerate the presence of these top ten facts and measure salient precision,  $P_{salient}$  and salient recall,  $R_{salient}$  as follows:

$$P_{salient} = \frac{\# \text{ salient common facts}}{\# \text{ output facts}}$$

$$R_{salient} = \frac{\# \text{ salient common facts}}{\# \text{ salient input facts}}$$



# Positive Sample

## **INPUT: Linearized Graph-10**

This house location Parkdale. This house property type House. This house address 16 Seventh St, Parkdale VIC 3195, Australia. This house sold price 820000. This house leased date Wed 29-Jan-14. This house number of bedrooms 3. This house number of bathrooms 2. This house number of parking spaces 2. This house has air-conditioner yes. This house has courtyard yes. This house has dining\_room yes. This house has a DishWasher yes. This house has ensuite facility yes. This house has family\_room yes. This house has fireplace yes. This house is fully fenced yes. This house is fully renovated yes. This house has wardrobe yes. This house nearest Train station Parkdale Railway Station. This house distance to closest railway station 6 mins walking distance. This house nearest school Parkdale Secondary College.Parkdale Secondary College gender-type CoEd school. Parkdale Secondary College type Secondary.

## **Given Ground-Truth Text**

Prime beach side brick residence extensively renovated and refurbished featuring entrance foyer, formal lounge-dining with open fire place, 3-bedrooms, 2-bathrooms (en suite to master with spa), modern fully appointed galley style kitchen, open plan family room and double doors which lead out onto a timber deck - ideal for all year round alfresco entertaining. The rear yard is generous and would suit most active young families - even comes complete with a children's cubby-house. Positioned perfectly within easy walking distance to shops, station, schools and beach.

## **Positive Pair using BackTranslation:**

First class beachfront brick residence, extensively renovated and refurbished with entrance foyer, formal living-dining room with open fireplace, 3 bedrooms, 2 bathrooms (en suite with whirlpool), modern fitted kitchen in galley style, open family room and double doors leading to a wooden deck - ideal for outdoors all year round. The backyard is spacious and would accommodate most active young families - even with a children's cubby house. Perfectly located within walking distance to shops, train station, schools and beach.



MONASH University

# Negative Sample

## **INPUT: Linearized Graph-10**

This house location Parkdale. This house property type House. This house address 16 Seventh St, Parkdale VIC 3195, Australia. This house sold price 820000. This house leased date Wed 29-Jan-14. This house number of bedrooms 3. This house number of bathrooms 2. This house number of parking spaces 2. This house has air-conditioner yes. This house has courtyard yes. This house has dining\_room yes. This house has a DishWasher yes. This house has ensuite facility yes. This house has family\_room yes. This house has fireplace yes. This house is fully fenced yes. This house is fully renovated yes. This house has wardrobe yes. This house nearest Train station Parkdale Railway Station. This house distance to closest railway station 6 mins walking distance. This house nearest school Parkdale Secondary College.Parkdale Secondary College gender-type CoEd school. Parkdale Secondary College type Secondary.

## **Neg Sample-1:**

This great location is only a short walk to Monash University and offers comfortable modern accommodation. . Consisting of 2 bedrooms with BIR, huge lounge, modern kitchen with meals area, excellent bathroom and laundry. Features: Polished floors, split heating and cooling and car space. Ideal for investors. Leased to March, 2014 at \$1434 pcm. PRIVATE INSPECTION CALL CHRIS - 0417 333 200 OR DENNY 0418 333 319 for more go to [www.darraszervas.com.au](http://www.darraszervas.com.au)

## **Neg Sample-2:**

Whether starting out or downsizing, this immaculate one bedroom apartment, in the stylish Vue Grande residential tower offers you the perfect inner city lifestyle! Just moments from the best of Melbourne including restaurants, cafes, boutique shopping and the iconic Crown Entertainment Complex. Accommodation: Entry opens to large open plan living and dining area with heating and air conditioning that opens up to your very own private balcony. A modern gourmet kitchen with stainless steel appliances and a dishwasher. Offering a generous sized bedroom with a built in wardrobe. Central bathroom with concealed laundry facilities.Features: 1 secure car space and access to facilities including a glass roofed indoor pool, gymnasium and concierge services.



# Negative Sample

## **INPUT: Linearized Graph-10**

This house location Parkdale. This house property type House. This house address 16 Seventh St, Parkdale VIC 3195, Australia. This house sold price 820000. This house leased date Wed 29-Jan-14. This house number of bedrooms 3. This house number of bathrooms 2. This house number of parking spaces 2. This house has air-conditioner yes. This house has courtyard yes. This house has dining\_room yes. This house has a DishWasher yes. This house has ensuite facility yes. This house has family\_room yes. This house has fireplace yes. This house is fully fenced yes. This house is fully renovated yes. This house has wardrobe yes. This house nearest Train station Parkdale Railway Station. This house distance to closest railway station 6 mins walking distance. This house nearest school Parkdale Secondary College. Parkdale Secondary College gender-type CoEd school. Parkdale Secondary College type Secondary.

## **Neg Sample-3:**

Leaving no stone unturned in the pursuit for quality, excellence and design, this new stunning unit is a remarkable achievement in stylish easy-care luxury in a pocket close to Reservoir Train Station (Zone 1), Edwardes St shops and cafes, Edwardes Park Lake and schools. Glossy tiled flooring and deluxe appointments including Caesar Stone Benches define the sun-filled flowing design of this streamlined residence featuring two extremely large bedrooms serviced by chic and modern bathroom which include a bath and separate shower, expansive storage space and superb living area which seamlessly blend with either a large courtyard. An endless list of luxury extras includes heating and cooling, video intercom and undercover car parking.

## **Neg Sample-4:**

Stylish in design, this one bedroom Southbank beauty will sure to impress. With a great location and Floorplan design all you will have to do is move in, sit back, relax and enjoy this fantastic apartment. Accommodation: Entry opens to spacious open plan living and dining area with air conditioning and heating that opens to a good sized balcony. Modern kitchen overlooking the living area and featuring stainless steel appliances, ample bench and cupboard space and a dishwasher. Bedroom is generous in size with a mirrored built in wardrobe. A central bathroom with concealed laundry facilities. Features: Single car space, use of the complex facilities including indoor swimming pool, fully fitted gymnasium and BBQ area. Great location just a short distance from the best that Southbank and the CBD has to offer.



MONASH University

# Positive Sample

## **INPUT: Linearized Graph-15**

This house location Seabrook. This house property type House. This house address 76 Mintaro Way, Seabrook VIC 3028, Australia. This house sold price 455000. This house leased date Mon 10-Aug-15. This house number of bedrooms 3. This house number of bathrooms 2. This house number of parking spaces 3. This house has air-conditioner yes. This house has secured alarm-system yes. This house has courtyard yes. This house has heating system yes. This house has wardrobe yes. This house Close to Shop yes. This house Close to Transport yes. This house Close to School/College yes. This house nearest Train station Aircraft Railway Station. This house distance to closest railway station Approximately 1 mins driving distance. This house nearest school Laverton P-12 College Laverton Primary School. Laverton P-12 College Laverton Primary School gender-type CoEd school. Laverton P-12 College Laverton Primary School type Combined.

## **Given Ground-Truth Text**

This stunning and well-kept 3 bedroom 2 bathroom home is perfect for any astute buyer. Featuring tiles and carpet throughout, huge kitchen/meals area and large living space this home has everything you need to call home. It has a four car lock up driveway with double lock up garage plus carport & a good sized backyard, which is great for the kids to play around in, leaves this place a great buy for any young family, professional couple or investment opportunity. Located in the same street as the Seabrook Primary School and with the Wetlands, Shops and easy freeway access just around the corner puts this home in one of Seabrooks prime location and well sort after destinations.

## **Positive Pair using BackTranslation:**

This stunning and well maintained 3 bedroom and 2 bathroom house is perfect for any savvy buyer. With tiled and carpeted throughout the house, huge kitchen / dining area and large living room, this home has everything you need to call home. It has a four car driveway with double garage plus carport and a well sized backyard where the children can play, making it a great purchase for any young family, professional couple or investment opportunity. It is located on the same street as Seabrook Primary School and with the wetlands, shops and easy access to the highway just around the corner.



MONASH University

# Negative Sample

## **INPUT: Linearized Graph-15**

This house location Seabrook. This house property type House. This house address 76 Mintaro Way, Seabrook VIC 3028, Australia. This house sold price 455000. This house leased date Mon 10-Aug-15. This house number of bedrooms 3. This house number of bathrooms 2. This house number of parking spaces 3. This house has air-conditioner yes. This house has secured alarm-system yes. This house has courtyard yes. This house has heating system yes. This house has wardrobe yes. This house Close to Shop yes. This house Close to Transport yes. This house Close to School/College yes. This house nearest Train station Aircraft Railway Station. This house distance to closest railway station Approximately 1 mins driving distance. This house nearest school Laverton P-12 College Laverton Primary School. Laverton P-12 College Laverton Primary School gender-type CoEd school. Laverton P-12 College Laverton Primary School type Combined.

## **Neg Sample-1:**

This beautiful unit is situated within walking distance to transport & local shops at your door step. Featuring two bedrooms with built in robes, open plan living with light filled lounge room which opens up into timber kitchen with plenty of cupboard space & s/s appliances with meals area. Modern bathroom, sep laundry, ducted heating, reverse cycle air-conditioner, security doors back & front, private yard and double lock up garage.

## **Neg Sample-2:**

This fantastic two bedroom brand new residences will appeal to both the first homebuyer and the astute investor. Presenting a rare and fantastic opportunity within walking distance to Westall Train Station, 2 minute drive to Clayton Community Centre (with swimming pool and library), Clayton Central Shopping District, Monash Medical Centre and Monash University Featuring: 2 large bedrooms with built-in-robes, split system, spacious kitchen with stone bench tops, modern central bathroom, gas stainless steel appliances, large private courtyard, separate laundry areas, single car port.



MONASH University

# Negative Sample

## **INPUT: Linearized Graph-15**

This house location Seabrook. This house property type House. This house address 76 Mintaro Way, Seabrook VIC 3028, Australia. This house sold price 455000. This house leased date Mon 10-Aug-15. This house number of bedrooms 3. This house number of bathrooms 2. This house number of parking spaces 3. This house has air-conditioner yes. This house has secured alarm-system yes. This house has courtyard yes. This house has heating system yes. This house has wardrobe yes. This house Close to Shop yes. This house Close to Transport yes. This house Close to School/College yes. This house nearest Train station Aircraft Railway Station. This house distance to closest railway station Approximately 1 mins driving distance. This house nearest school Laverton P-12 College Laverton Primary School.Laverton P-12 College Laverton Primary School gender-type CoEd school. Laverton P-12 College Laverton Primary School type Combined.

## **Neg Sample-3:**

Unsuity Student AccommodationJust a few hundred meters from Victoria University, this is apartment is a home away from home for many students to Melbourne and with transport and all services at the doorstep.Other highlights include heating, high speed internet and cable tv available, gas cooking and security entry intercom. Surrounded by all key amenities Victoria University, schools, transport, shops, restaurants, Highpoint shopping centre and parklands.Managed by Colliers International and rents collected deposited directly to your bank account.\$1560 PCMTThis low cost investment will suit investors looking for strong investment with great returns.For a full list of furnished items and inclusions, please contact our office.Depreciation scheduling is available for tax benefits.Inspections by appointment only, please contact agent.

## **Neg Sample-4:**

PRICE JUST REDUCED BY \$30,000...BE QUICK VENDOR VERY KEEN TO SELL....1 bedroom apartment with small study on the 2nd level of this superb 2 tower complex which has just been completed, offers the ideal location for investment or to live in. Separate living and kitchen, separate bathroom, sparkling kitchen, balcony and an underground car space and storage cage (living 36.9M2). Just off Dandenong Rd and directly opposite East Caulfield reserve, Monash Uni and within an easy stroll to Caulfield Station.





# Features of House Dataset

House Internal Features			House Neighborhood Features
location	has home theatre	has laundry	Close to Shop Close to Transport Close to School/College offers mountain view has its nearest park offers river view has city view nearest train station nearest school distance to closest railway station
property type	has outside spa	has swimming pool	
address	has shed	is fully renovated	<b>House Nearest School Features</b>
sold price	has roller shutters	has study room	
leased date	has built-in-wardrobe	has wardrobe	gender-type type of school (primary or secondary) ranking total enrolled students
agency name	has a dishwasher	has its tennis court	
agency address	has garden	has ducted vacuum system	
#no. of bedrooms	has Solar Panels	has living areas	
#no. of bathrooms	has deck	has dining room	
#no. of toilets	has outdoor entertaining area	has openable windows	
#no. of parking/ carport spaces	is ducted	has sunroom	
building size	has ensuite facility	has rumpus room	
land size	has family room	has sauna	
has air-conditioner	has fireplace	has remote garage	
has secured alarm-system	is fully fenced	has formal lounge	
has balcony	has gymnasium	has floorboards	
has BBQ facility	has heating system		
has dining-room	has courtyard		
	has intercom		