GenAI HW7
Understanding what AI is thinking

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Deadline: 2024/5/16 23:59:59 (UTC+8)

Outline

- Introduction
- Task 1: Token Importance Analysis
- Task 2: LLM Explanation
- Submission & Deadline
- Contact

Link

[Colab]

[COOL Quiz]

[Questions]

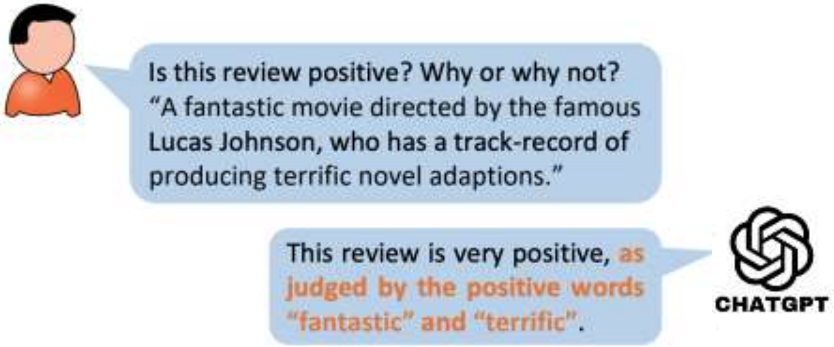
Introduction

Why should we know what generative AI is thinking?

- Correct answer ≠ Intelligent
- Explanation is essential in high-stakes applications, e.g., medicine and law.
- We can improve our model based on our explanation.

Model Explanation

This is a "cat" .
Because ...
Classifier



Is this review positive? Why or why not? "A fantastic movie directed by the famous Lucas Johnson, who has a track-record of producing terrific novel adaptions."

This review is very positive, as judged by the positive words "fantastic" and "terrific".

Image source: 2310.11207.pdf (arxiv.org), Interpreting Neural Network (ntu.edu.tw)

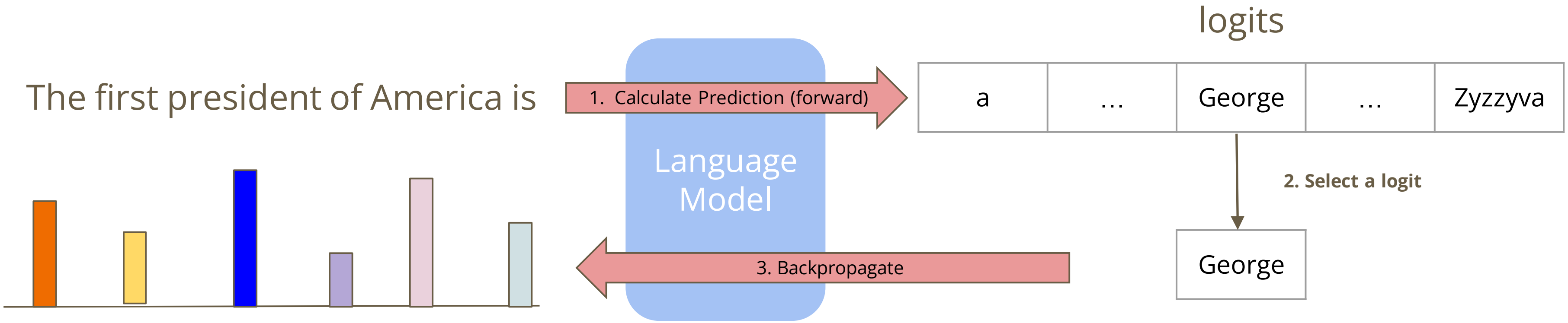
Task 1: Token Importance Analysis

Task Description

- In this task, we aim to understand what tokens play important roles in generating the response.
- We utilize **feature attribution methods** to analyze the importance.
  - Gradient-based approach
  - Attention-mechanism
- Run the sample code and finish question 1 to 7.

Gradient-based Approach (saliency)

- Compute the gradient of the target logit with respect to the input tokens.



The first president of America is

1. Calculate Prediction (forward)

Language Model

logits

a	…	George	…	Zyzzyva

2. Select a logit

George

3. Backpropagate

Image modified from jalammar.github.io

Attention-mechanism

- Commonly used in transformer-based models.
- Shows which tokens the model attends to when generating the output.

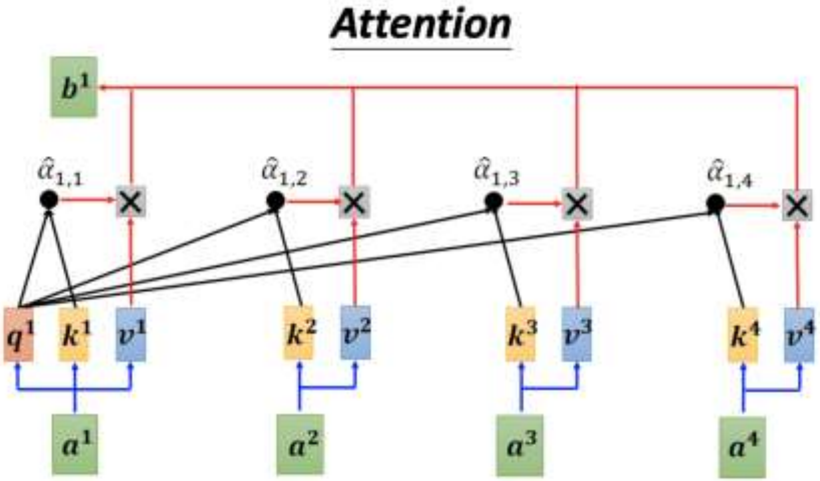
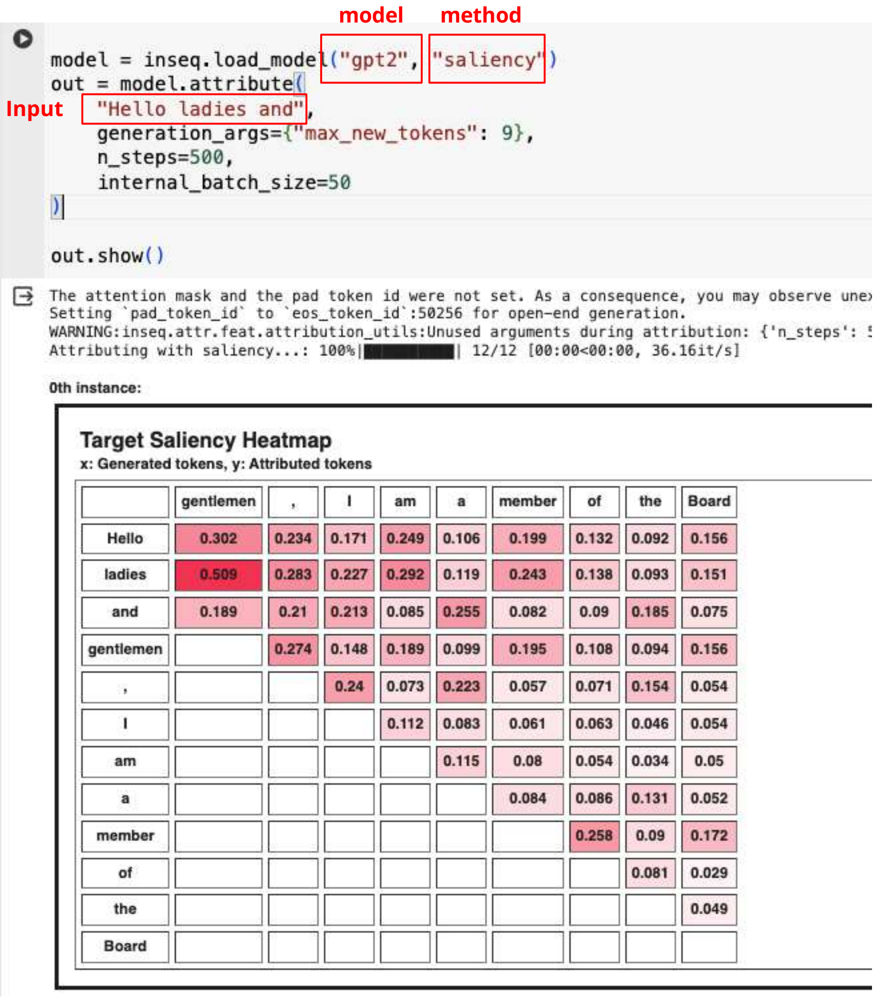


Image source: Interpreting Neural Network (ntu.edu.tw)

Token Visualization

- In this task, we use https://github.com/inseq-team/inseq/ to visualize the importance of token when generating the response.
- It supports many feature attribution methods, including gradient and attention, which we will use in this homework.

Inseq



model

method

Input

```
model = inseq.load_model("gpt2", "saliency")
out = model.attribute(
    "Hello ladies and",
    generation_args={"max_new_tokens": 9},
    n_steps=500,
    internal_batch_size=50
)

out.show()
```

```
The attention mask and the pad token id were not set. As a consequence, you may observe unex
Setting `pad_token_id` to `eos_token_id`:50256 for open-end generation.
WARNING:inseq.attr.feat.attribution_utils:Unused arguments during attribution: {'n_steps': 5
Attributing with saliency...: 100%|██████████| 12/12 [00:00<00:00, 36.16it/s]
```

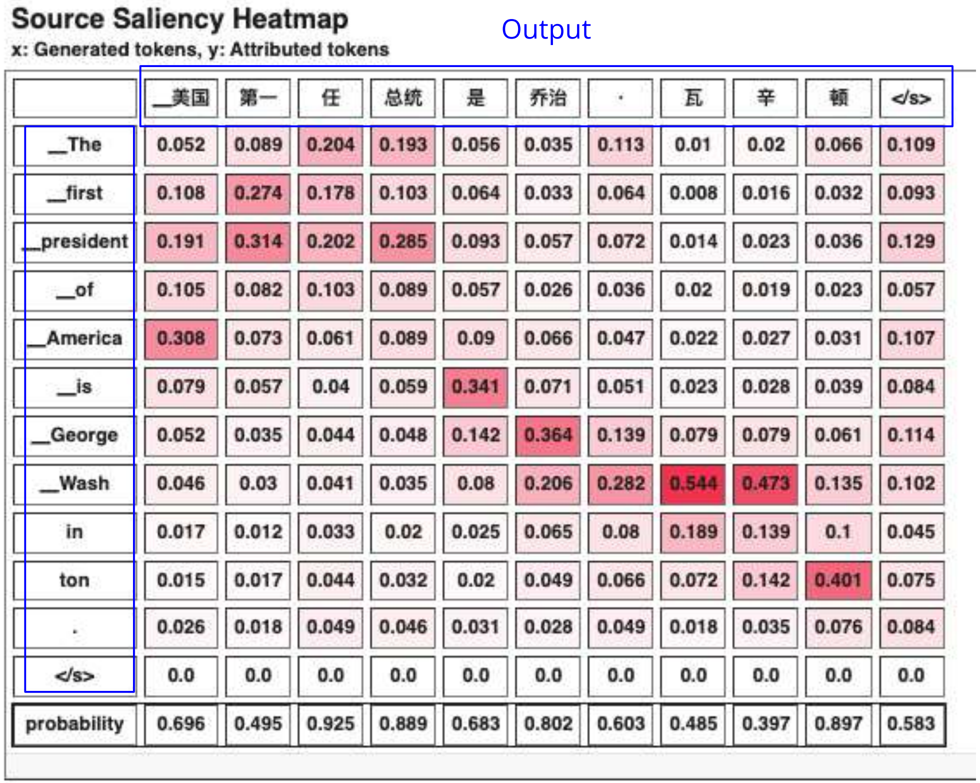
0th instance:

Target Saliency Heatmap

x: Generated tokens, y: Attributed tokens

	gentlemen	,	I	am	a	member	of	the	Board
Hello	0.302	0.234	0.171	0.249	0.106	0.199	0.132	0.092	0.156
ladies	0.509	0.283	0.227	0.292	0.119	0.243	0.138	0.093	0.151
and	0.189	0.21	0.213	0.085	0.255	0.082	0.09	0.185	0.075
gentlemen		0.274	0.148	0.189	0.099	0.195	0.108	0.094	0.156
,			0.24	0.073	0.223	0.057	0.071	0.154	0.054
I				0.112	0.083	0.061	0.063	0.046	0.054
am					0.115	0.08	0.054	0.034	0.05
a						0.084	0.086	0.131	0.052
member							0.258	0.09	0.172
of								0.081	0.029
the									0.049
Board									

Saliency map of machine translation task



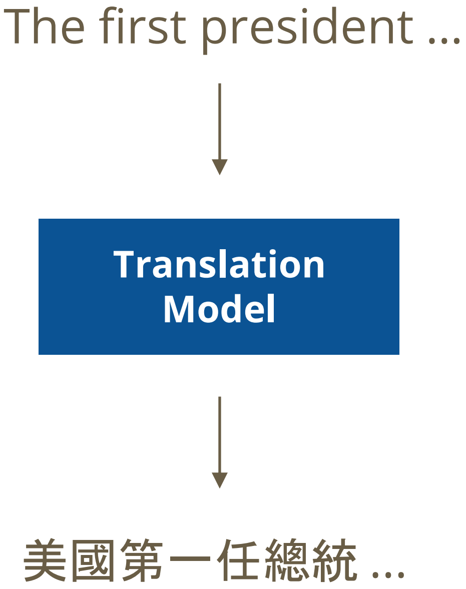
Source Saliency Heatmap

x: Generated tokens, y: Attributed tokens

Output

Input

	_美国	第一	任	总统	是	乔治	·	瓦	辛	顿	</s>
_The	0.052	0.089	0.204	0.193	0.056	0.035	0.113	0.01	0.02	0.066	0.109
_first	0.108	0.274	0.178	0.103	0.064	0.033	0.064	0.008	0.016	0.032	0.093
_president	0.191	0.314	0.202	0.285	0.093	0.057	0.072	0.014	0.023	0.036	0.129
_of	0.105	0.082	0.103	0.089	0.057	0.026	0.036	0.02	0.019	0.023	0.057
_America	0.308	0.073	0.061	0.089	0.09	0.066	0.047	0.022	0.027	0.031	0.107
_is	0.079	0.057	0.04	0.059	0.341	0.071	0.051	0.023	0.028	0.039	0.084
_George	0.052	0.035	0.044	0.048	0.142	0.364	0.139	0.079	0.079	0.061	0.114
_Wash	0.046	0.03	0.041	0.035	0.08	0.206	0.282	0.544	0.473	0.135	0.102
in	0.017	0.012	0.033	0.02	0.025	0.065	0.08	0.189	0.139	0.1	0.045
ton	0.015	0.017	0.044	0.032	0.02	0.049	0.066	0.072	0.142	0.401	0.075
.	0.026	0.018	0.049	0.046	0.031	0.028	0.049	0.018	0.035	0.076	0.084
</s>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
probability	0.696	0.495	0.925	0.889	0.683	0.802	0.603	0.485	0.397	0.897	0.583

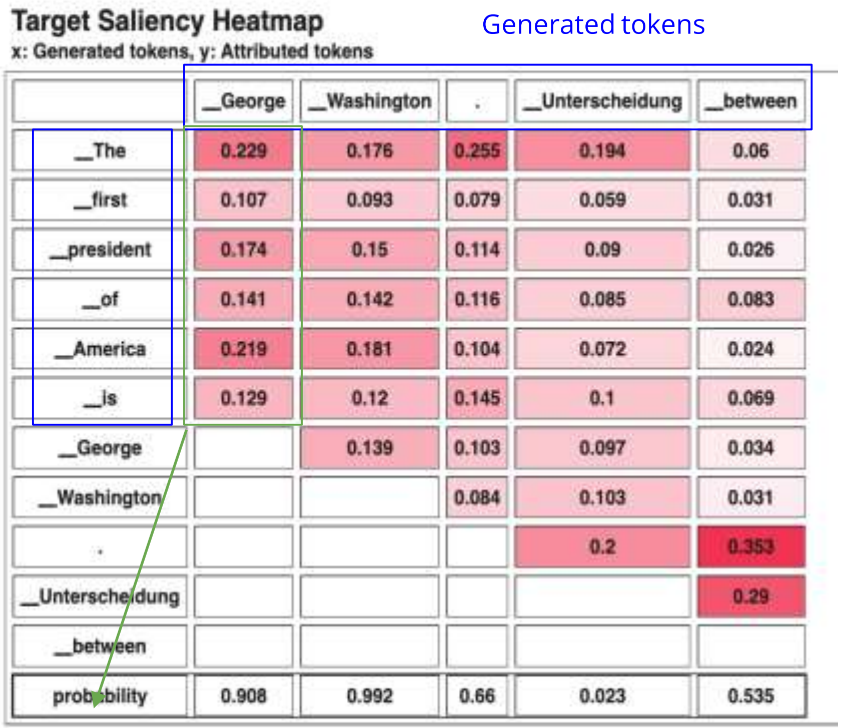


The first president ...

Translation Model

美國第一任總統 ...

Saliency map of sentence completion task



Target Saliency Heatmap

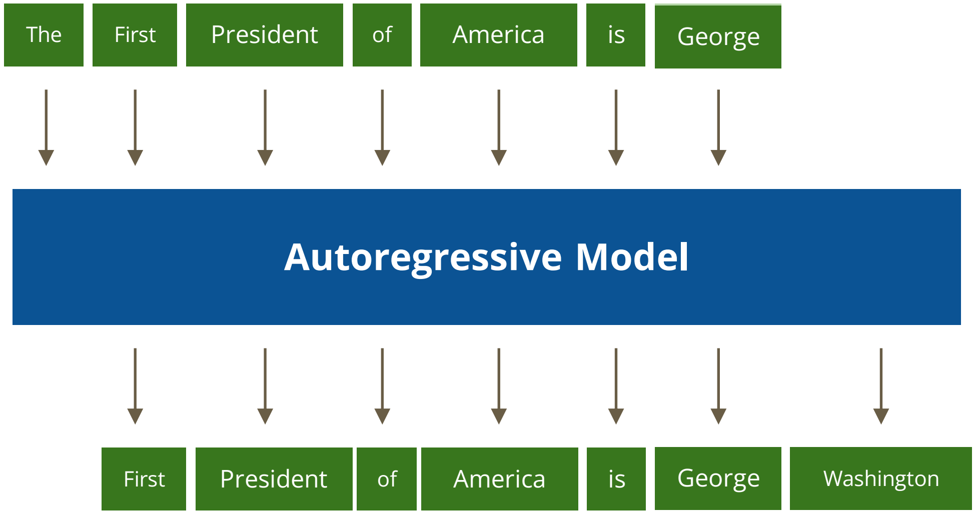
x: Generated tokens, y: Attributed tokens

Generated tokens

Input

	_George	_Washington	.	_Unterscheidung	_between
_The	0.229	0.176	0.255	0.194	0.06
_first	0.107	0.093	0.079	0.059	0.031
_president	0.174	0.15	0.114	0.09	0.026
_of	0.141	0.142	0.116	0.085	0.083
_America	0.219	0.181	0.104	0.072	0.024
_is	0.129	0.12	0.145	0.1	0.069
_George		0.139	0.103	0.097	0.034
_Washington			0.084	0.103	0.031
.				0.2	0.353
_Unterscheidung					0.29
_between					
probability	0.908	0.992	0.66	0.023	0.535

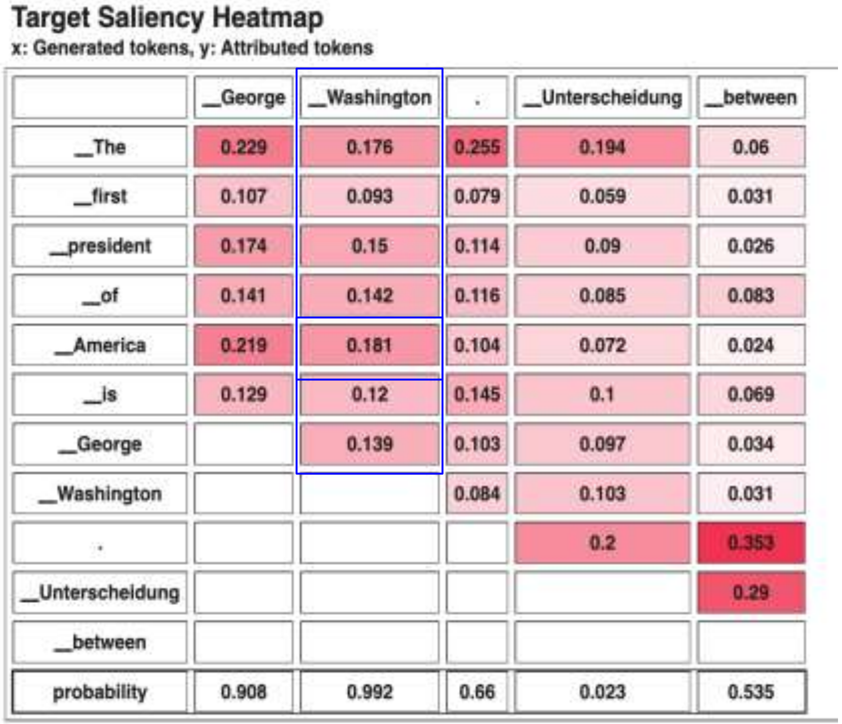
Importance score



Example of saliency map

Q: When generating the word "Washington", what's the importance score of "America"?

A: 0.181



Target Saliency Heatmap

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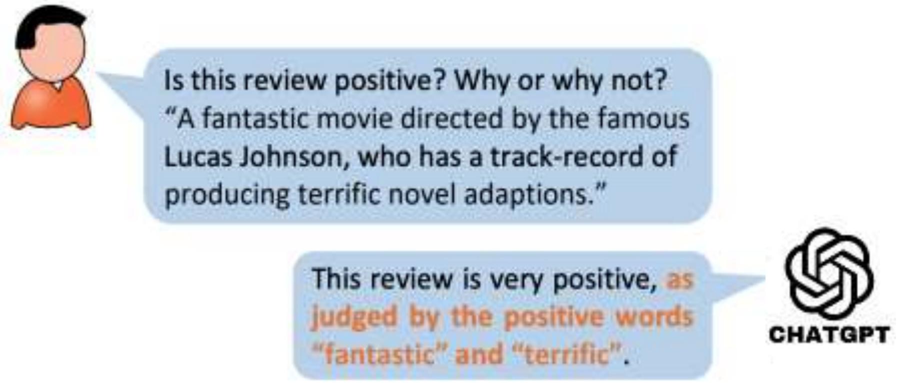
_is	0.129	0.12	0.145	0.1	0.069
_George		0.139	0.103	0.097	0.034
_Washington			0.084	0.103	0.031
.				0.2	0.353
_Unterscheidung					0.29
_between					
probability	0.908	0.992	0.66	0.023	0.535

Task 2: LLM Explanation

LLM Explanation

- LLMs have the ability to explain in **natural language.**
- It is much more straightforward to understand than prior methods.



Is this review positive? Why or why not? “A fantastic movie directed by the famous Lucas Johnson, who has a track-record of producing terrific novel adaptions.”

This review is very positive, as judged by the positive words “fantastic” and “terrific”.

Image source: 2310.11207.pdf (arxiv.org)

Task Description

- In this task, we aim to assess the effectiveness of LLM explanation.
- We will explore two LLM explanation approaches.
  - Providing the explanation for the model's answer.
  - Simulating the feature attribution method in task 1 to see the importance of tokens.
- Run the given prompts on ChatGPT and finish Question 8 to 10.

  (No need of Colab)

Explain the model’s answer

- Directly ask the LLM to explain its answer.

Prompt:

You are a creative and intelligent movie review analyst, whose purpose is to aid in sentiment analysis of movie reviews. Determine whether the review below is positive or negative, and explain your answers.

Review: This film is a compelling drama that captivates audiences with its intricate storytelling and powerful performances.

Simulate feature attribution methods with LLM explanation

- Ask the LLM to explain the importance of the input tokens in contributing to the answer, similar to what we do in task 1.

2310.11207.pdf (arxiv.org)

Simulate feature attribution methods with LLM explanation

Prompt:

You are a movie review analyst tasked with sentiment analysis. For each review, provide a list of tuples representing the importance of each word and punctuation, with values ranging from -1 (negative) to 1 (positive). Then, classify the review as positive (1) or negative (-1). The review is within <review> tags.

Example output:

[(<word or punctuation>, <float importance>), ...]

<int classification>

<review> This film is a compelling drama that captivates audiences with its intricate storytelling and powerful performances. <review>

Note: ChatGPT's responses may vary due to randomness. If the format isn't as desired, please try again.

2310.11207.pdf (arxiv.org)

Submission & Deadline

Submission

- Finish questions on NTU COOL Quiz
- Unlimited times of submissions for the quiz, but only the **latest submission** will be considered when grading
- No late submission is allowed

Important dates

- Deadline for Submission (NTU Cool)

2024/05/16 23:59:59 (UTC+8)

- Grading Release Date

2024/05/31 23:59:59 (UTC+8)

Contact

If You Have Any Questions

- NTU Cool HW7 作業討論區
    - 如果同學的問題不涉及作業答案或隱私，請**一律使用**NTU Cool 討論區
    - 助教們會優先回答NTU Cool討論區上的問題
- Email: ntu-gen-ai-2024-spring-ta@googlegroups.com
    - Title should start with [GenAI 2024 Spring HW7]
    - Email with the wrong title will be moved to trash automatically
- TA Hours
    - Time:
        - 5/3, 16:30 ~ 17:20
        - 5/10 13:20~14:10, 16:30 ~ 17:20
    - Location: 綜合大講堂