Aligning Open-source LLMs Using Reinforcement Learning from Feedback

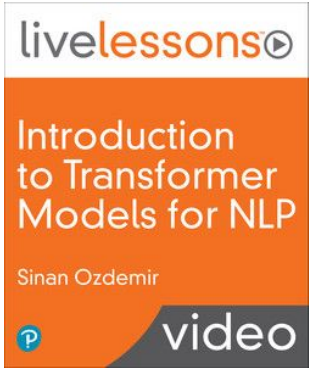
Making AI more Accessible

github.com/sinanuozdemir/odsc-2023-llm-alignment

Sinan Ozdemir

Data Scientist, Entrepreneur,
Author, Lecturer

Welcome!

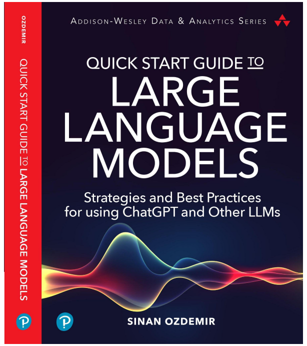


livelessons

Introduction to Transformer Models for NLP

Sinan Ozdemir

video



Addison-Wesley Data & Analytics Series

QUICK START GUIDE TO LARGE LANGUAGE MODELS

Strategies and Best Practices for using ChatGPT and Other LLMs

SINAN OZDEMIR

My name is **Sinan Ozdemir** (in/sinan-ozdemir + @prof_oz)

- Current **founder** of Loop Genius (using AI to help entrepreneurs get their first 100 customers)
- Current **lecturer** for O'Reilly and Pearson
- Founder of Kylie.ai (Funded by OpenAI Founder + Acquired)
- **Masters** in Theoretical Math from **Johns Hopkins**
- Former lecturer of Data Science at Johns Hopkins

Author of ML textbooks and online series, including

- [The Principles of Data Science]()
- [Introduction to Transformer Models for NLP]()
- [Quick Start Guide to LLMs]()

On the Docket

- A (very short) primer on Alignment & Reinforcement Learning from Feedback
- Case Study 1 - Aligning FLAN-T5's summaries to be more neutral and grammatically correct
- Case Study 2 - Instruction Aligning an open-source LLM
- Evaluating Alignment

Our Github

https://github.com/sinanuozdemir/odsc-2023-llm-alignment

Alignment vs Reinforcement Learning

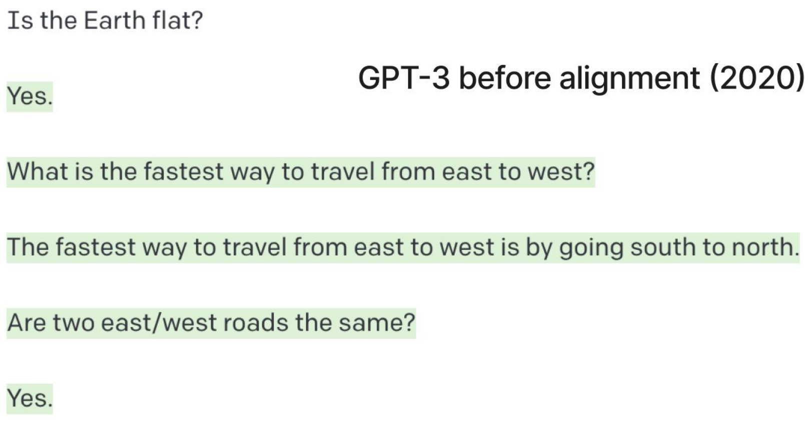
- **Alignment** is training a model to produce outputs more in line with human preference and expectation

- **Reinforcement Learning (RL)** is a machine learning technique that uses sequential feedback to teach an “agent” how to behave in an “environment”.

RL is the most talked about method of alignment but not the only option! OpenAI popularized the method in 2022 specifically using RLHF (RL from Human Feedback)

Alignment Makes LLMs Do What We Want

Alignment in LLMs – Refers to how a language model understands and responds to input prompts in a way that aligns with the user's expectations. Humans (or AI) in the loop judge and reward LLM outputs to ensure that the model's responses are "in line with" what the user intended or expected.



GPT-3 before alignment (2020)

Is the Earth flat?

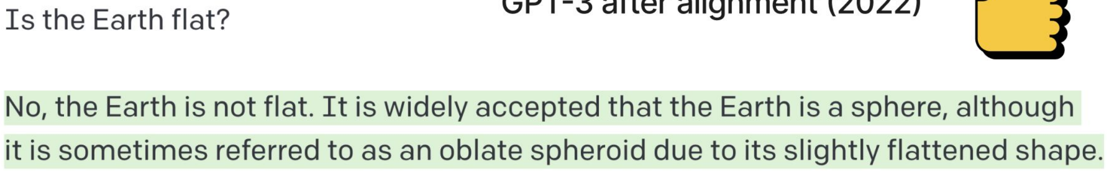
Yes.

What is the fastest way to travel from east to west?

The fastest way to travel from east to west is by going south to north.

Are two east/west roads the same?

Yes.



GPT-3 after alignment (2022)

Is the Earth flat?

No, the Earth is not flat. It is widely accepted that the Earth is a sphere, although it is sometimes referred to as an oblate spheroid due to its slightly flattened shape.

Simplified Process for RL from F

Pre-train an LLM on large corpora to learn grammar, general information, specific tasks, and more

⇩

Define and potentially train a reward system from either live humans, a model tuned to human preference, or an entirely AI system (e.g. another LLM)

⇩

Update the LLM using Reinforcement Learning using the reward system as signal

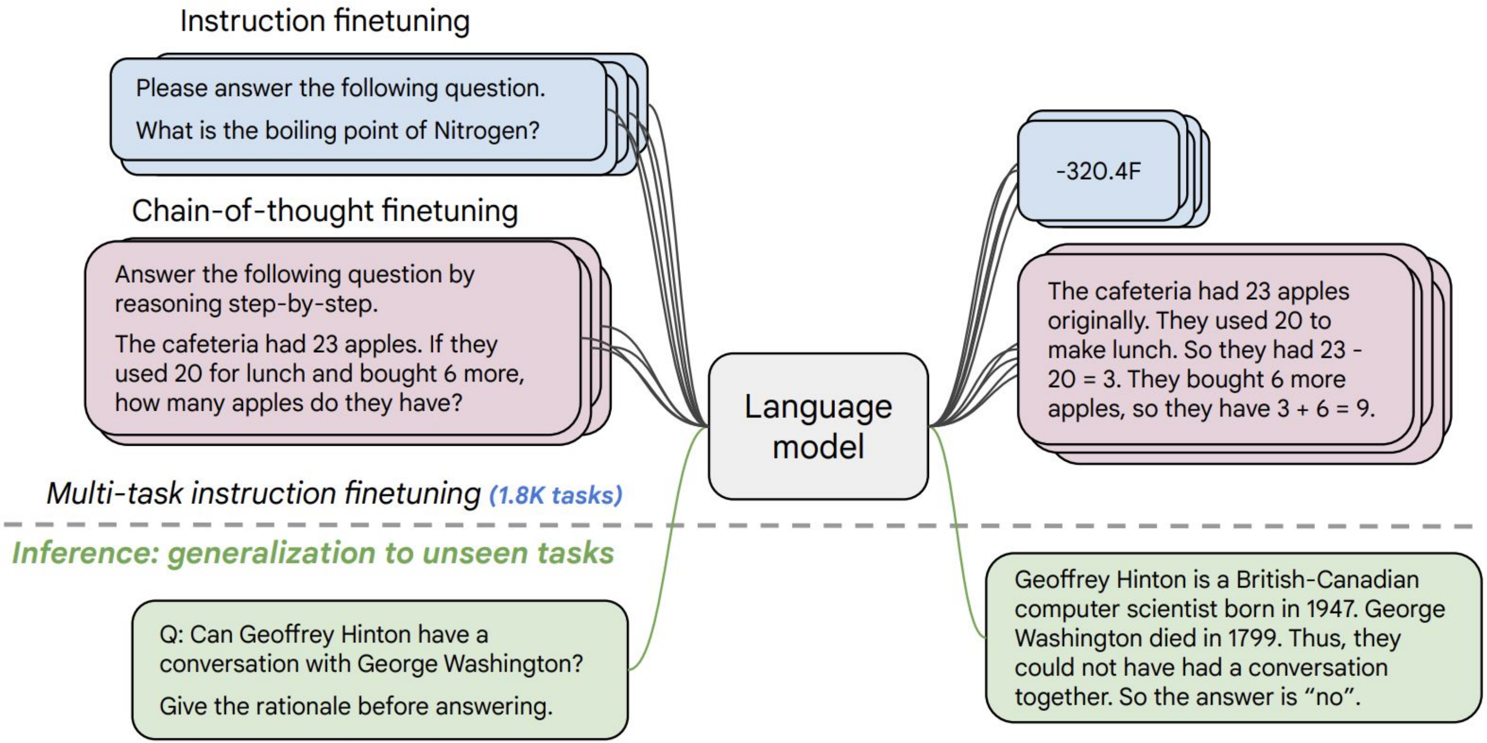
Source: Quick Start Guide to LLMs
by Sinan Ozdemir

Not always human feedback

We can use other reward systems besides ones based on human feedback to align models in other ways

Case Study 1: Creating more Neutral Summaries from FLAN-T5

FLAN-T5 already knows how to summarize



Instruction finetuning

Please answer the following question.

What is the boiling point of Nitrogen?

-320.4F

Chain-of-thought finetuning

Answer the following question by reasoning step-by-step.

The cafeteria had 23 apples. If they used 20 for lunch and bought 6 more, how many apples do they have?

The cafeteria had 23 apples originally. They used 20 to make lunch. So they had 23 - 20 = 3. They bought 6 more apples, so they have 3 + 6 = 9.

Language model

Multi-task instruction finetuning ***(1.8K tasks)***

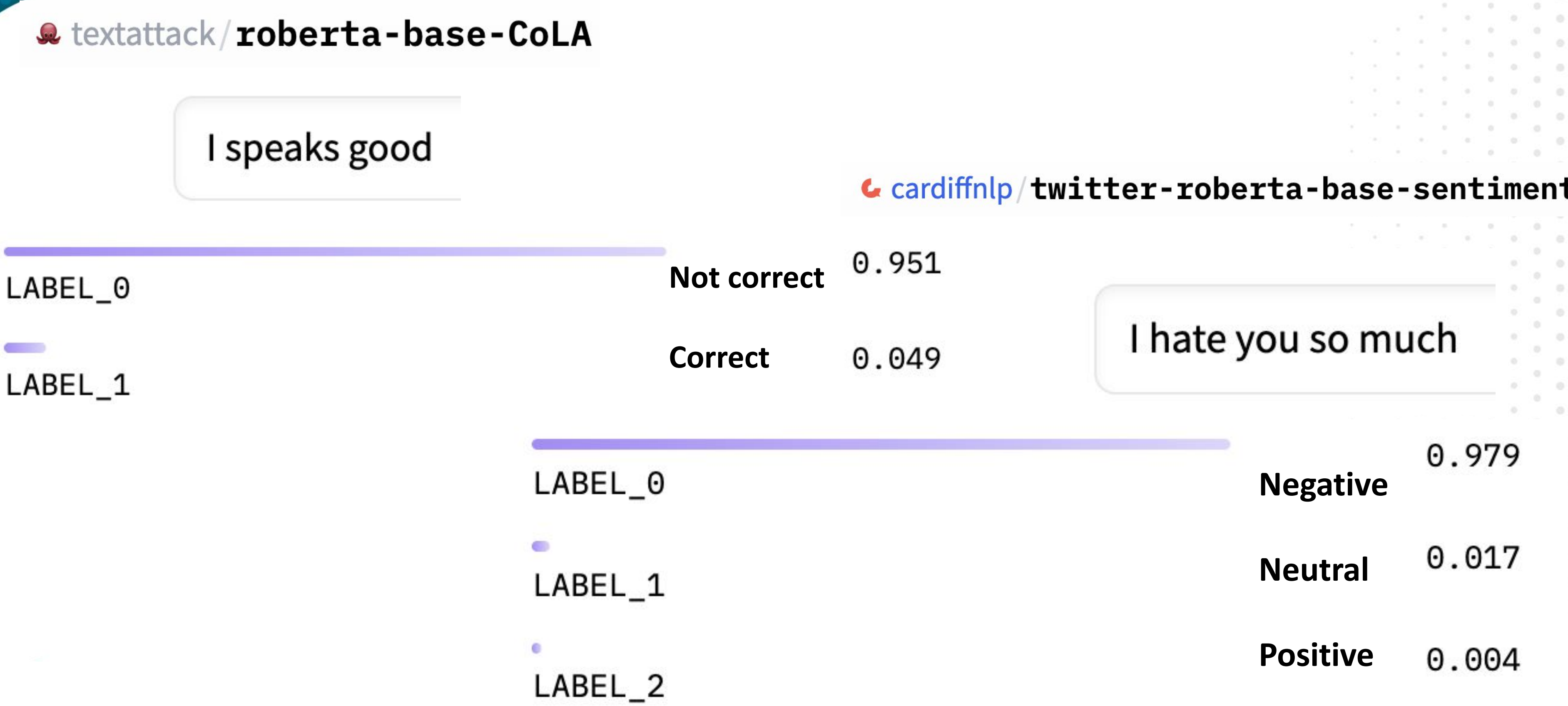
Inference: generalization to unseen tasks

Q: Can Geoffrey Hinton have a conversation with George Washington?

Give the rationale before answering.

Geoffrey Hinton is a British-Canadian computer scientist born in 1947. George Washington died in 1799. Thus, they could not have had a conversation together. So the answer is “no”.

I want them to be more neutral/readable



textattack/**roberta-base-CoLA**

I speaks good

LABEL_0 **Not correct** 0.951

LABEL_1 **Correct** 0.049

cardiffnlp/**twitter-roberta-base-sentiment**

I hate you so much

LABEL_0 **Negative** 0.979

LABEL_1 **Neutral** 0.017

LABEL_2 **Positive** 0.004

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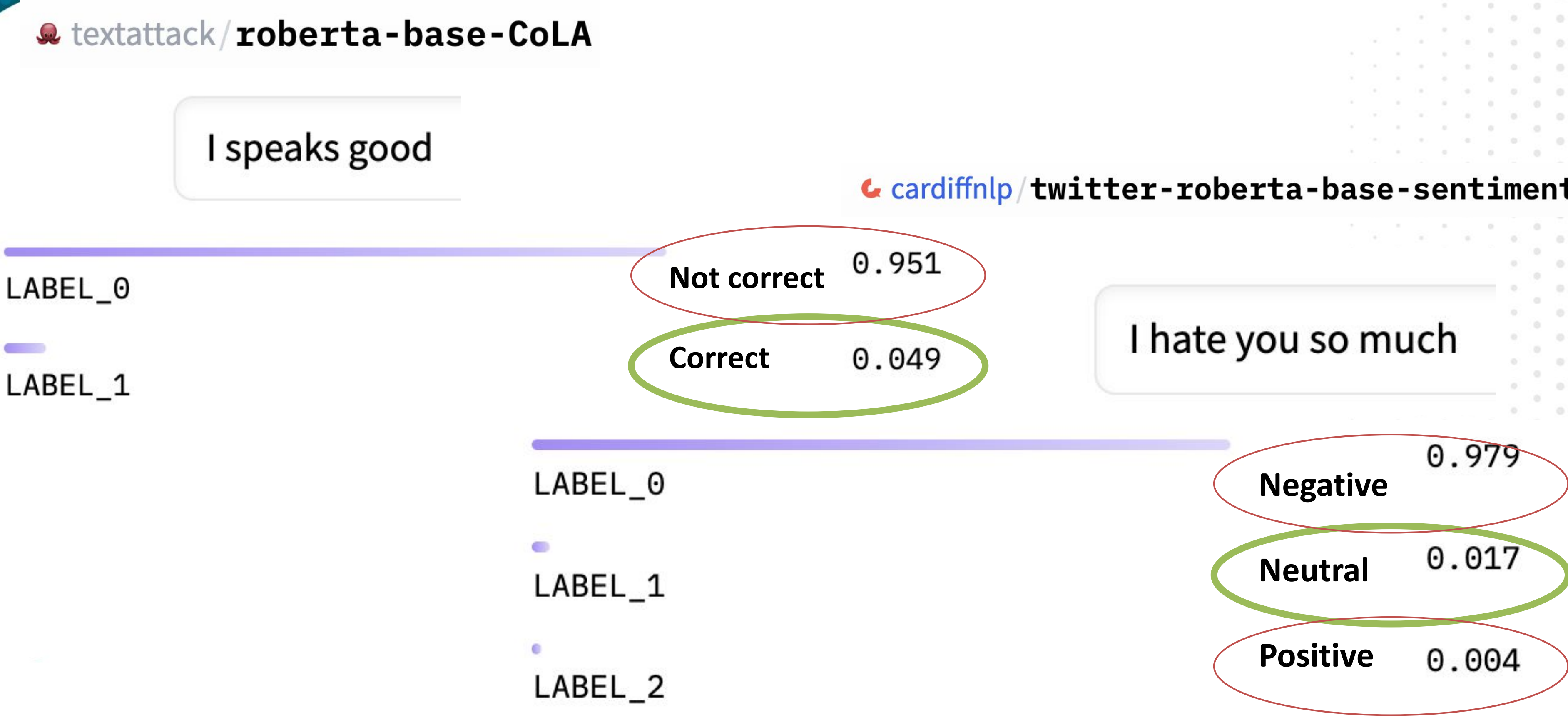

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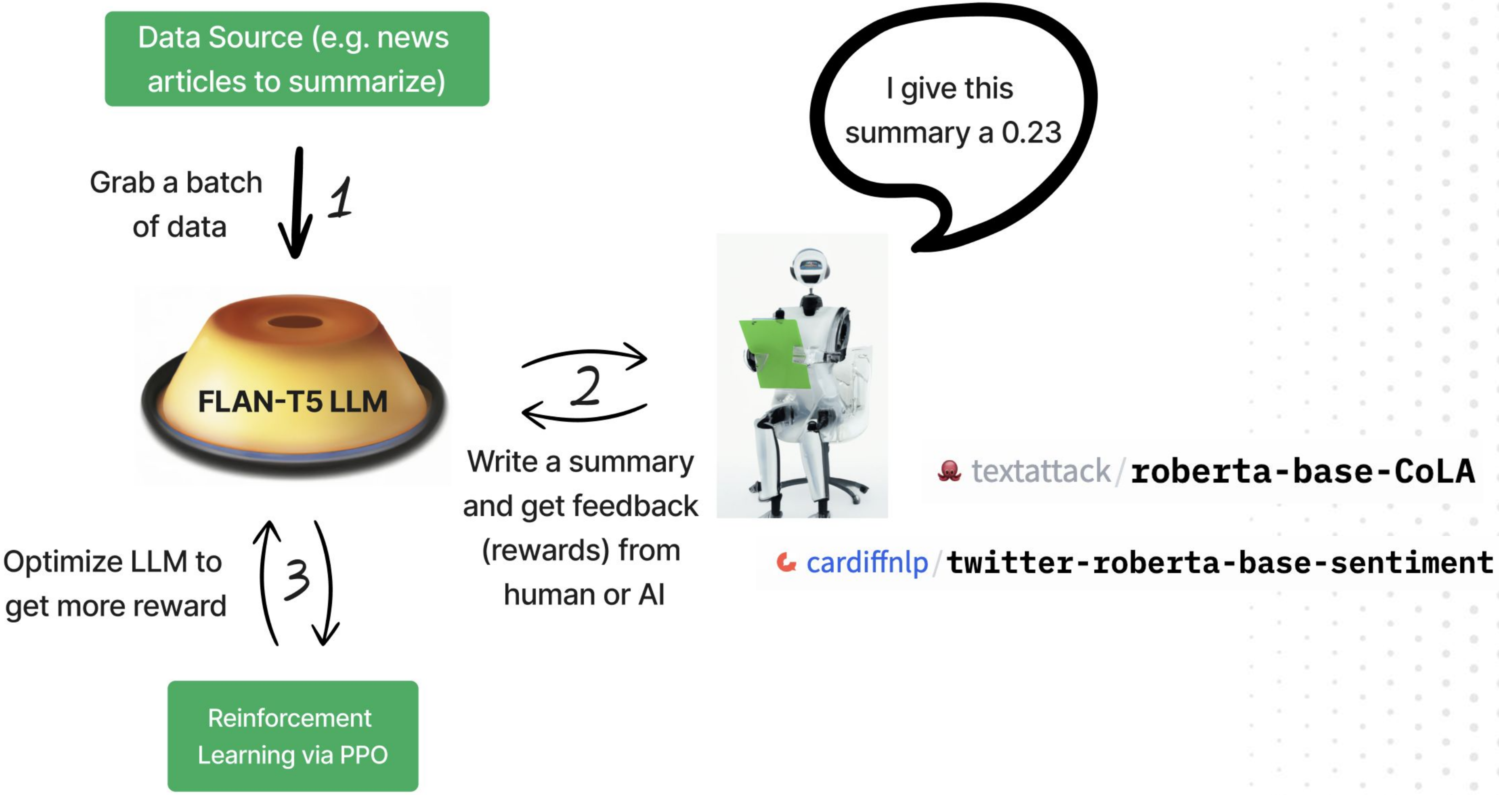
RL from F



Data Source (e.g. news articles to summarize)

Grab a batch of data

1

FLAN-T5 LLM

2

Write a summary and get feedback (rewards) from human or AI

I give this summary a 0.23

textattack/**roberta-base-CoLA**

cardiffnlp/**twitter-roberta-base-sentiment**

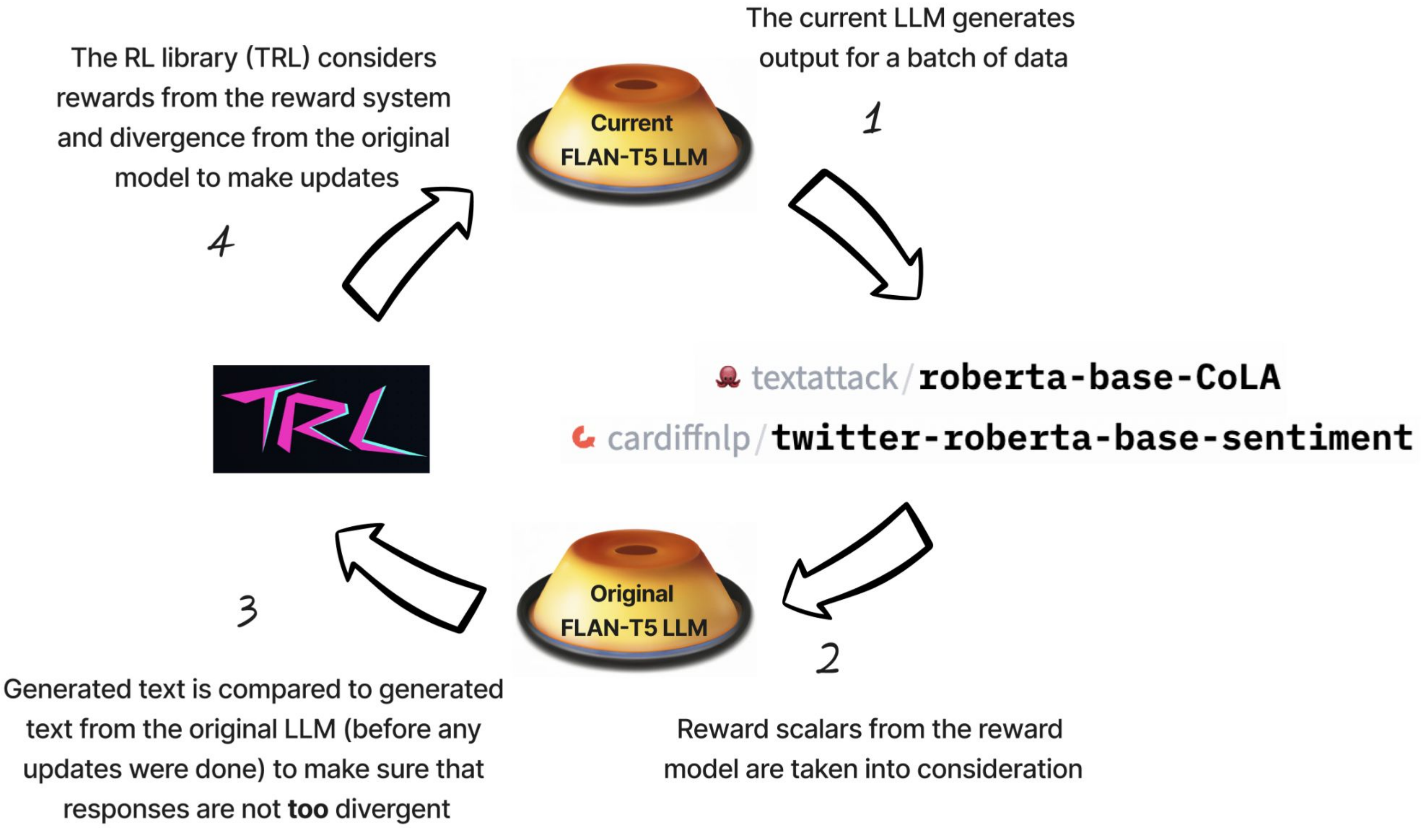
Optimize LLM to get more reward

3

Reinforcement Learning via PPO

Source: Quick Start Guide to LLMs
by Sinan Ozdemir

RL from F - Detailed



1

The current LLM generates output for a batch of data

textattack/**roberta-base-CoLA**

cardiffnlp/**twitter-roberta-base-sentiment**

2

Reward scalars from the reward model are taken into consideration

3

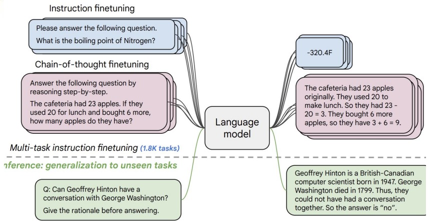
Generated text is compared to generated text from the original LLM (before any updates were done) to make sure that responses are not **too** divergent

4

The RL library (TRL) considers rewards from the reward system and divergence from the original model to make updates

Source: Quick Start Guide to LLMs
by Sinan Ozdemir

Simplified Process for RL from F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cardiffnlp / **twitter-roberta-base-sentiment**

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Source: Quick Start Guide to LLMs
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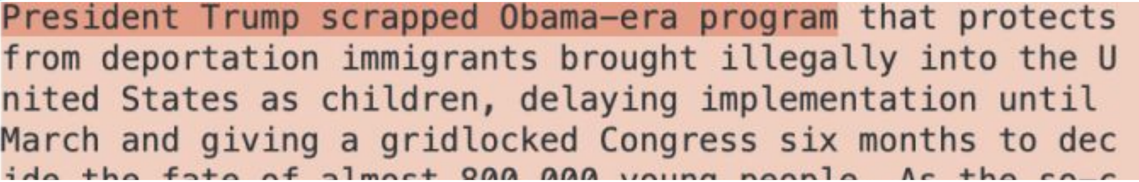
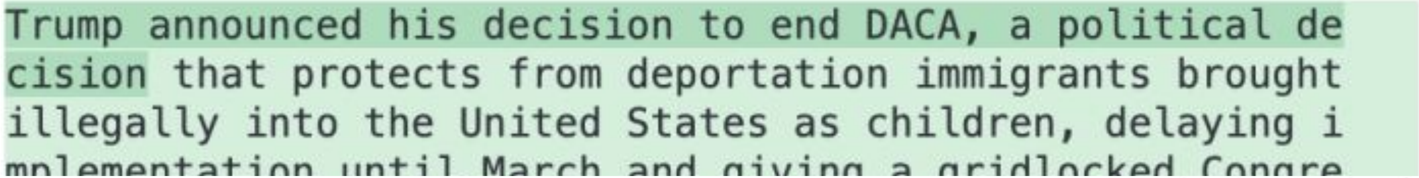
RL from F - More ”Neutral” Summarizations



President Trump scrapped Obama-era program that protects from deportation immigrants brought illegally into the United States as children, delaying implementation until March and giving a gridlocked Congress six months to decide the fate of almost 800,000 young people. As the so-c



Trump announced his decision to end DACA, a political decision that protects from deportation immigrants brought illegally into the United States as children, delaying implementation until March and giving a gridlocked Congre

The original FLAN-T5 model liked to use the word “scrapped” which tends to carry a negative connotation

The RL fine-tuned FLAN-T5 model tends to more neutral words like “announced”

Source: Quick Start Guide to LLMs
by Sinan Ozdemir

Code Time!

Case Study 2: Instruction Alignment for “Sinan’s Attempt at Wise Yet Engaging Responses” – SAWYER

Simplified Process for RLHF

Reinforcement Learning from Human Feedback (RLHF) – A method of fine-tuning machine learning models, particularly language models, using feedback from human evaluators. This feedback is generally used as a signal to optimize the model's performance, effectively aligning the model's behavior with complex human values.

Source: Quick Start Guide to LLMs
by Sinan Ozdemir

SAWYER–Approach

Sinan’s Attempt at Wise Yet Engaging Responses

Question: How do I find a good barber?
Response: First off, go to Yelp and....

vs.

Question: How do I find a good barber?
Response: try finding a barber first XD

Step 1: Instruction-fine tune a GPT-2 model to recognize the pattern of question in and response out

BigScience

Question: How do I find a good barber?
Response: First off, go to Yelp and....

Step 2: Define a reward model specifically designed to rate human-preferred responses higher

TRL

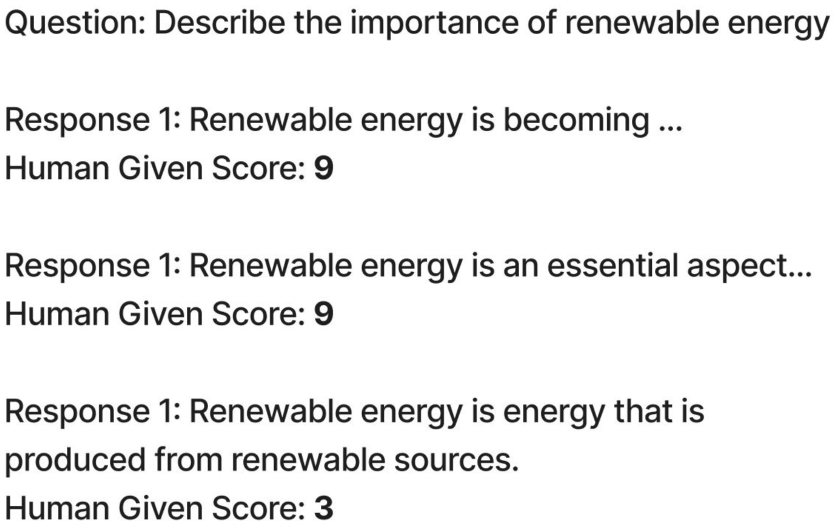
Step 3: Set up a reinforcement learning loop to improve the responses given by GPT-2

Source: Quick Start Guide to LLMs
by Sinan Ozdemir

SAWYER–Reward Mechanism (Feedback)

Sinan’s Attempt at Wise Yet Engaging Responses

Our Reward model dataset has multiple responses to a single question, each with a score (out of 10) grading how good the response was



Question: Describe the importance of renewable energy

Response 1: Renewable energy is becoming ...
Human Given Score: **9**

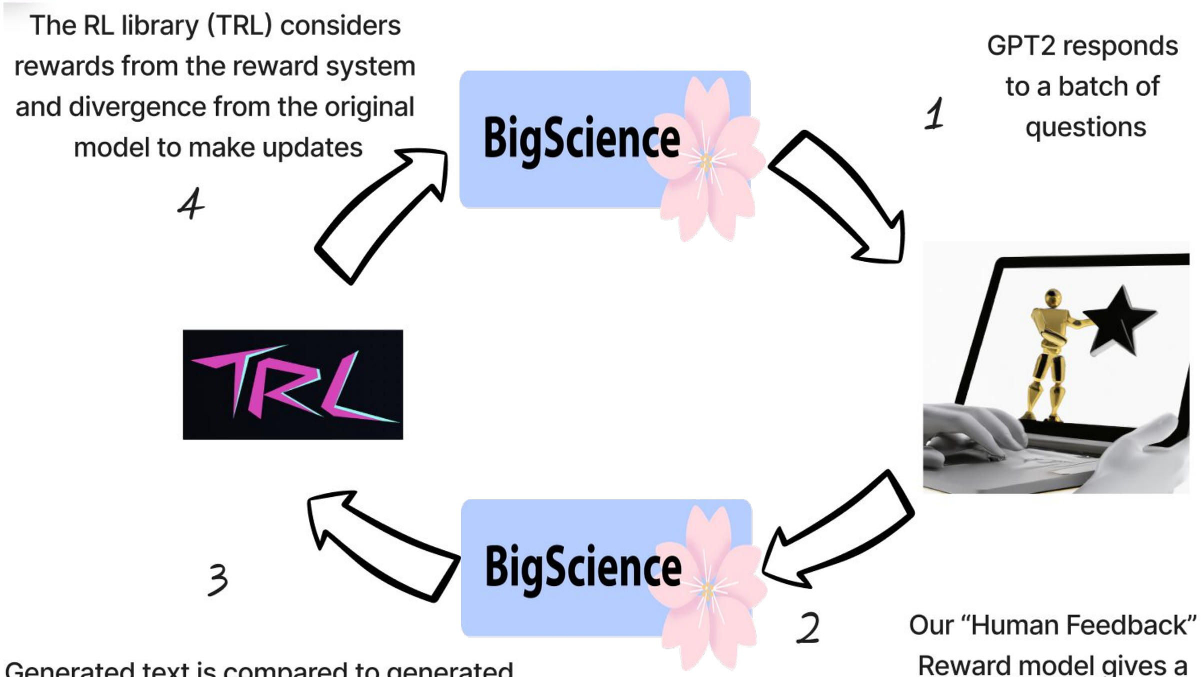
Response 1: Renewable energy is an essential aspect...
Human Given Score: **9**

Response 1: Renewable energy is energy that is produced from renewable sources.
Human Given Score: **3**

Source: Quick Start Guide to LLMs
by Sinan Ozdemir

SAWYER–The RL Loop

Sinan’s Attempt at Wise Yet Engaging Responses



1 GPT2 responds to a batch of questions

2 Our “Human Feedback” Reward model gives a scalar reward to the instruction-response

3 Generated text is compared to generated text from the original LLM (before any updates were done) to make sure that responses are not **too** divergent

4 The RL library (TRL) considers rewards from the reward system and divergence from the original model to make updates

Source: Quick Start Guide to LLMs by Sinan Ozdemir

Code Time!

Evaluating Alignment

Two Main Options

- Human Evaluation

- LLM Evaluation

Two Main Options

- Human Evaluation
  - Asking a human to pick between model outputs
  - Not an old industry - AWS Mechanical Turk, Scale AI, etc)
  - Expensive (min $2 per pair at scale with decent quality)
  - Main issue is finding consensus among judges

- LLM Evaluation
  - Asking an LLM to pick between model outputs
  - Newer as a method
  - Cheap (~$0.01 per pair)
  - Main issue is AI bias (e.g., some models are more likely to choose the first output - positional bias)

LLM Evaluation Prompt Example

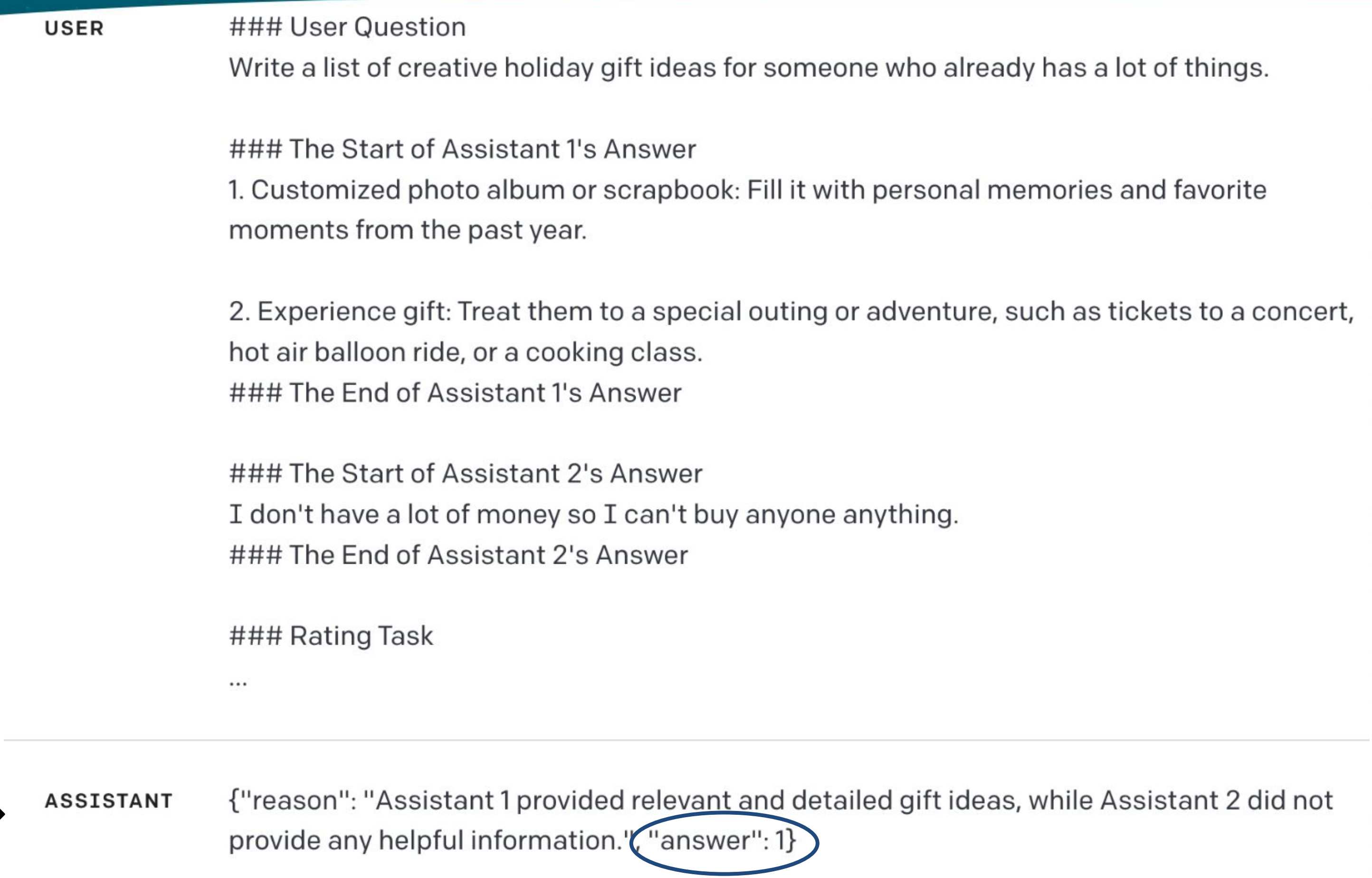
```
### User Question
{{ user-question }}

### The Start of Assistant 1's Answer
{{ assistant-1-answer }}
### The End of Assistant 1's Answer

### The Start of Assistant 2's Answer
{{ assistant-2-answer }}
### The End of Assistant 2's Answer
```

.. continued

```
### Rating Task
Rate the performance of two AI assistants in response to the user question. ...

Output a score from 1 to 8 where a 1 means you strongly prefer Assistant 1's answer and 8 means you strongly prefer Assistant 2's answer.

Give the answer in the json format:

JSON: {"reason": "...", "answer": integer score}

JSON:
```

Source:
https://huggingface.co/blog/llm-leaderboard

LLM Evaluation Prompt Example



USER

```
### User Question
Write a list of creative holiday gift ideas for someone who already has a lot of things.

### The Start of Assistant 1's Answer
1. Customized photo album or scrapbook: Fill it with personal memories and favorite moments from the past year.

2. Experience gift: Treat them to a special outing or adventure, such as tickets to a concert, hot air balloon ride, or a cooking class.
### The End of Assistant 1's Answer

### The Start of Assistant 2's Answer
I don't have a lot of money so I can't buy anyone anything.
### The End of Assistant 2's Answer

### Rating Task
...
```

ASSISTANT

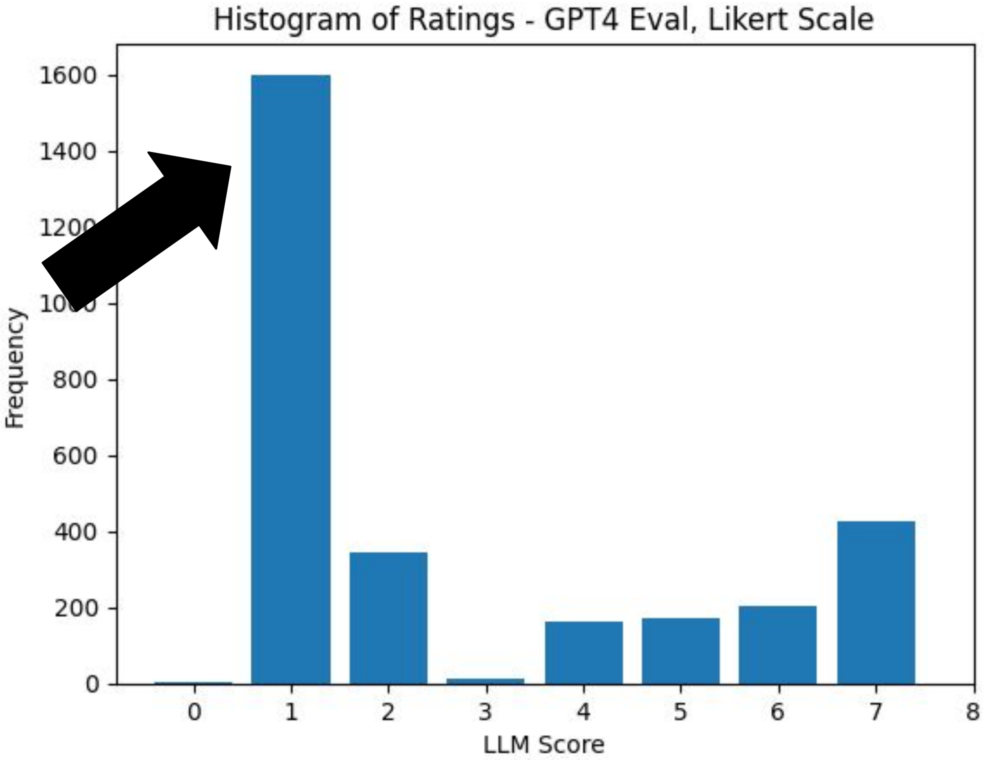
```
{"reason": "Assistant 1 provided relevant and detailed gift ideas, while Assistant 2 did not provide any helpful information.", "answer": 1}
```

LLM Evaluation Prompt Example

HuggingFace research revealing positional bias:

When randomly assigning model outputs to Assistant 1 or 2

GPT-4 was more likely to just pick Assistant 1



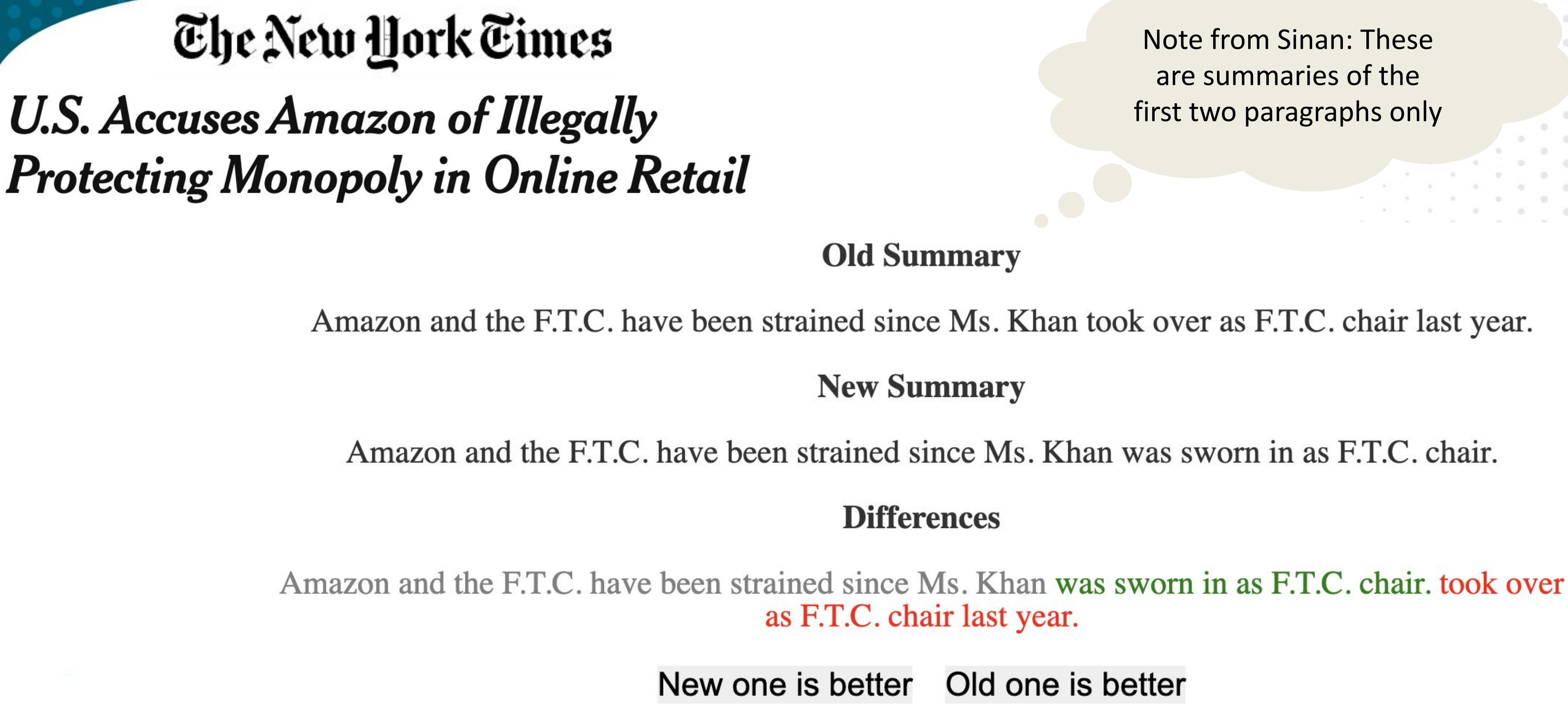
Source:
https://huggingface.co/blog/llm-leaderboard

Two Main Options

Human and LLM Evaluation **both**:

1. Work better when the judge is given a framework to select outputs from
2. Are subject to biases
3. Produce results that are difficult to reproduce

Chrome Extension to gather online feedback



The New York Times

U.S. Accuses Amazon of Illegally Protecting Monopoly in Online Retail

Old Summary

Amazon and the F.T.C. have been strained since Ms. Khan took over as F.T.C. chair last year.

New Summary

Amazon and the F.T.C. have been strained since Ms. Khan was sworn in as F.T.C. chair.

Differences

Amazon and the F.T.C. have been strained since Ms. Khan was sworn in as F.T.C. chair. took over as F.T.C. chair last year.

Note from Sinan: These are summaries of the first two paragraphs only