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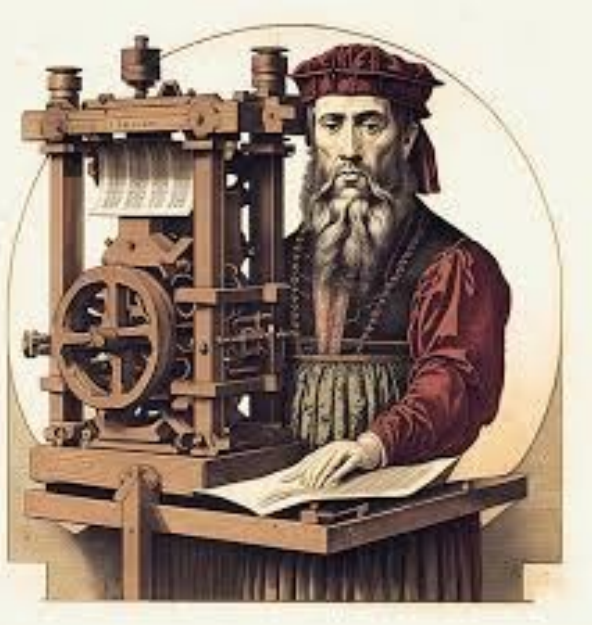
Factuality Challenges in the Era of Large Language Models

Preslav Nakov, MBZUAI

Information Gyroscope Symposium on Mis-, Dis-, and Mal-Information (iGYRO SMDM 2025)

April 28, 2025

Three Revolutions in Information Production



Old gate-keepers: removed

Public: unprepared & unprotected

Evolution of the Factuality-Related Terminology

1. **Fake news**: factuality
2. **Disinformation**: factuality + harm
3. **Infodemic**: harm



World Health
Organization

To help alleviate suffering and save lives, WHO has been working night and day in five key ways:

1. Helping build countries' capacity to prepare and respond
2. Providing accurate information and fight the infodemic, together with numerous partners
3. Ensuring supplies of essential medical equipment for frontline health workers.
4. Training and mobilizing health workers.
5. Accelerating research and development.

Evolution of the Factuality-Related Terminology

1. **Fake news**: factuality
2. **Disinformation**: factuality + harm
3. **Infodemic**: harm
4. **Hallucination**: factuality (*GenAI made it great again?*)

'Hallucinate' chosen as Cambridge dictionary's word of the year

The psychological verb gained an extra meaning in 2023 that 'gets to the heart of why people are talking about artificial intelligence'



📷 'It's so easy to anthropomorphise these systems' ... large language model AIs are notorious for 'hallucinating' false information. Photograph: Andrew Ostrovsky/Alamy

Factuality challenges in the era of large language models and opportunities for fact-checking

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Check for updates

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The emergence of tools based on large language models (LLMs), such as OpenAI's ChatGPT and Google's Gemini, has garnered immense public attention owing to their advanced natural language generation capabilities.

Nature Machine Intelligence (2024): *Factuality Challenges in the Era of Large Language Models and Opportunities for Fact-Checking*

Isabelle Augenstein, Timothy Baldwin, Meeyoung Cha, Tanmoy Chakraborty, Giovanni Luca, Ciampaglia, David Corney, Renee DiResta, Emilio Ferrara, Scott Hale, Alon Halevy, Eduard Hovy, Heng Ji, Filippo Menczer, Ruben Miguez, Preslav Nakov, Dietram Scheufele, Shivam Sharma, Giovanni Zagni

Threats of Malicious GenAI

- **Tone**
 - coherent, fluent, persuasive: “authoritative liars”
- **Public perception**
 - *halo effect*: if good in some cases, assumed always good
- **Style impersonation**
 - journalists, politicians
 - e.g., using text from emails, social media posts
- **Fake user profiles**
 - large network of ChatGPT-generated fake profiles found on X
- **Fake websites**
 - Newsguard identified 487 AI-generated fake news sites
- **Disinformation pollution on the Web**
 - targeting LLM training and RAG

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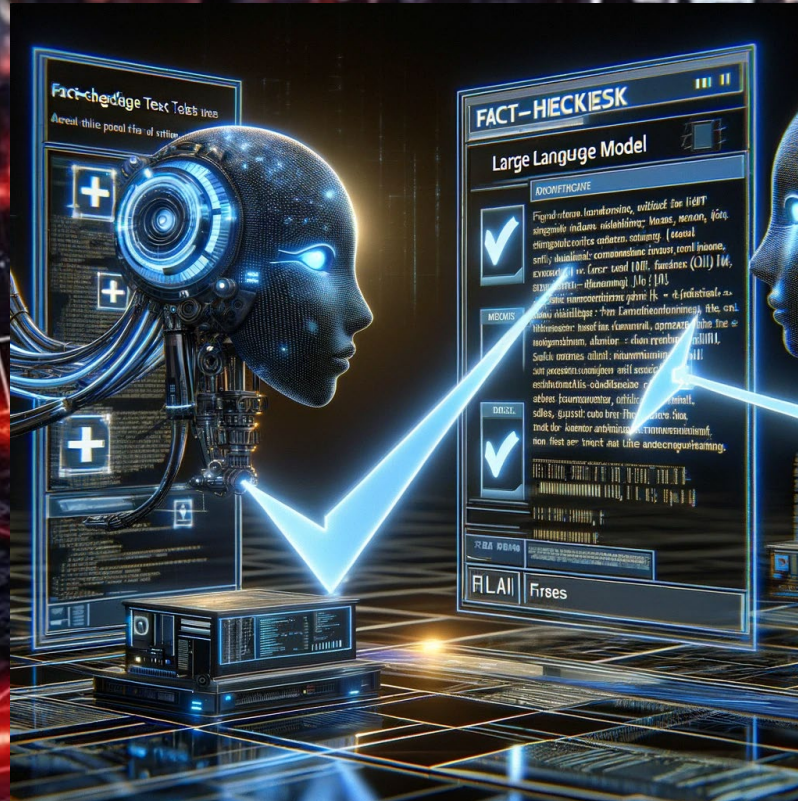
Addressing the Threats

- Alignment and safety of LLMs
- Retrieval-augmented generation
- Using a larger model
- Fact-checking
- Detecting machine-generated content
- Checking content authenticity and provenance
- Regulation
- Promoting AI Literacy

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Fact-Checking



Fact-Checking: Question-Guided Automation

Claim: Sunlight can travel to the deepest part of the Black Sea.



Q1: What is the greatest depth of the Black Sea?



search

What is the greatest depth of the Black Sea in meters?

Images Videos News Shopping Books Maps Flights Finance

About 185,000,000 results (0.70 seconds)

2,212 m

Black Sea	
Average depth	1,253 m (4,111 ft)
Max. depth	2,212 m (7,257 ft)
Water volume	547,000 km ³ (131,200 cu mi)
Islands	10+



A1: Black sea has a maximum depth of **2,212** meters.



Q2: How far can sunlight penetrate water?



search

How far can sunlight penetrate water?

In meters Videos Images Shopping News Books Maps Flights

About 8,720,000 results (0.38 seconds)

Sunlight entering the water may travel about 1,000 meters into the ocean under the right conditions, but there is rarely any significant light beyond 200 meters. The ocean is divided into three zones based on depth and light level. The upper 200 meters of the ocean is called the euphotic, or "sunlight," zone. JAN 20, 2023

National Oceanic and Atmospheric Administration (.gov)
<https://oceanservice.noaa.gov/facts/light.html>

How far does light travel in the ocean? - National Ocean Service

About featured snippets · Feedback



A2: Sunlight does not penetrate water below **1,000** meters.



2,212 is greater than 1,000. Therefore, the claim is **FALSE**

Fact-Checking: Reasoning Program Generation

Claim: Both James Cameron and the director of the film Interstellar were born in Canada.



```
'''Generate a python-like program that describes the reasoning steps
required to verify the claim step-by-step. You can call three functions
in the program: 1. Question() to answer a question; 2. Verify() to
verify a simple claim; 3. Predict() to predict the veracity label.'''

# The claim is that Both James Cameron and the director of the film
Interstellar were born in Canada.
def program():
    fact_1 = Verify("James Cameron was born in Canada.")
    Answer_1 = Question("Who is the director of the film Interstellar?")
    fact_2 = Verify("{Answer_1} was born in Canada.")
    label = Predict(fact_1 and fact_2)

(... more in-context examples here ...)

# The claim is that <input_claim>
def program():
```


Factcheck-Bench: Fine-Grained Evaluation Benchmark for Automatic Fact-Checking

Factcheck-GPT: End-to-End Fine-Grained Document-Level Fact-Checking and Correction of LLM Output

Question: Who is the king of Canada?

LLM: As an AI language model, I cannot access to recent events. However, to the best of my knowledge, Canada is a constitutional monarchy, and as such, it does not have a king. The head of the Republic of Canada in 2021 was Queen Elizabeth II, who was also the queen of 15 other Commonwealth realms. She has been the head of state of Canada for 20 years. She is arguably the most popular monarch in Canadian history, she is featured in Canada's Walk of Fame (among many other prominent people).

Is it factually TRUE?

EMNLP-2024 (Findings): Factcheck-Bench: fine-grained evaluation benchmark for automatic fact-checkers

Yuxia Wang, Revanth Gangi Reddy, Zain Muhammad Mujahid, Arnav Arora, Aleksandr Rubashevskii, Jiahui Geng, Osama Mohammed Afzal, Liangming Pan, Nadav Borenstein, Aditya Pillai, Isabelle Augenstein, Iryna Gurevych, Preslav Nakov (<https://aclanthology.org/2024.findings-emnlp.830/>)

Factcheck-GPT: End-to-End Fine-Grained Document-Level Fact-Checking and Correction of LLM Output

Decompose and Decontextualize into Atomic Claims

C11: Canada is a constitutional monarchy.
C12: **Constitutional monarchies** do not have a king. (*Implicit causality, time-sensitive*)
C21: Canada is a Republic.
C22: The head of Canada in 2021 was Queen Elizabeth II. (Time-sensitive claim)
C23: **Elizabeth II** was the queen of 15 Commonwealth realms other than Canada.
(Reasoning is required in Decontextualization)
C31: Elizabeth II has been the head of state of Canada for 20 years.
C41: *Queen Elizabeth II is arguably the most popular ... Canadian history. (opinion)*
C42: **Queen Elizabeth II** is featured in Canada's Walk of Fame.
C43: *Many prominent people were featured Canada's Walk of Fame. (not checkworthy)*

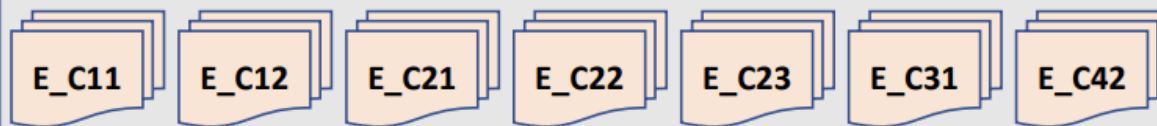
C41 is an opinion, and C43 is a claim but not check-worthy.
The rest are check-worthy claims.

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Retrieve, Collect Evidence, and Detect the Stance *(support, partially support, refute, irrelevant)*

1. Generate questions given a claim
2. Google search and rank the most relevant top5 evidence



Q: Does the evidence support the claim?
CS. completely support PS. partially support . refute D. irrelevant

C11:	C12:	C21:	C22:	C23:	C31:	C42:
CS	R	R	CS	PS	PS	IR
CS	R	R	PS	CS	R	IR
CS	R	R	PS	IR	R	IR
CS	IR	R	IR	PS	IR	IR
IR	IR	R	IR	IR	IR	IR

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Decide True/False and Correction Operation *(delete, replace A with B)*

Q: Can you determine if the claim is true or false by evidence above?

A. Yes B. No C. Not Enough Evidence (NEE)

C11: Yes
True

C12: Yes
False

C21: Yes
False

C22: Yes
True

C23: Yes
True

C31: No
False

C42: NEE
False

**Collect extra evidence
to verify for C31, C42.**

Q: How to make edits? Revise/delete

C12: Constitutional monarchy Canada has **King Charles III**.

C21: Hallucination, **delete**

C22: The current monarch of Canada is King Charles III.

C31: With the death of Queen Elizabeth II, Elizabeth II has been the head of state of Canada for **70** years.

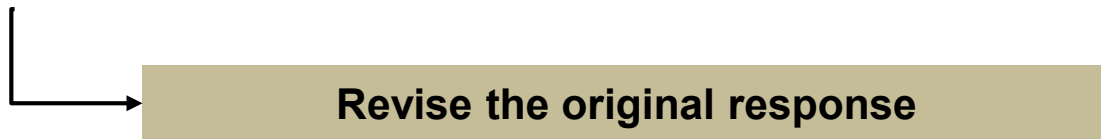
C42: Hallucination, **delete**

EMNLP-2024 (Findings): Factcheck-Bench: fine-grained evaluation benchmark for automatic fact-checkers

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Factcheck-GPT: End-to-End Fine-Grained Document-Level Fact-Checking and Correction of LLM Output

Is it factually TRUE?



Merge and Deduplicate: As an AI language model, I cannot access to recent events. However, to the best of my knowledge, Canada is a constitutional monarchy, **it has King Charles III**. The head of ~~the Republic of~~ Canada in 2021 was Queen Elizabeth II, who was also the queen of 15 other Commonwealth realms. She has been the head of state of Canada for **70 years to her death**. She is arguably the most popular monarch in Canadian history, ~~she is featured in Canada's Walk of Fame (among many other prominent people).~~

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OPEN**FactCheck**

<https://openfactcheck.com/>

Tool: *OpenFactCheck*

OpenFactCheck: A Unified Framework for Factuality Evaluation of LLMs

Hasan Iqbal^{1,*}, Yuxia Wang^{1,*}, Minghan Wang², Georgi Georgiev³, Jiahui Geng¹, Preslav Nakov¹

¹ Mohamed bin Zayed University of AI, ² Monash University, ³ Sofia University

*Equal contribution

➤ Main Paper

📄 Demo Paper

🔗 Code

📖 Docs

📺 Video

🌐 Web App

📖 BibTex

Abstract

The increased use of large language models (LLMs) across a variety of real-world applications calls for automatic tools to check the factual accuracy of their outputs, as LLMs often hallucinate. This is difficult as it requires assessing the factuality of free-form open-domain responses. While there has been a lot of research on this topic, different papers use different evaluation benchmarks and measures, which makes them hard to compare and hampers future progress. To mitigate these issues, we developed **OpenFactCheck**, a unified framework, with three modules: (i) *Response Evaluator*, which allows users to easily customize an automatic fact-checking system and to assess the factuality of all claims in an input document using that system, (ii) *LLM Evaluator*, which assesses the overall factuality of an LLM, and (iii) *Fact Checker Evaluator*, a module to evaluate automatic fact-checking systems. OpenFactCheck is open-sourced and publicly released as a Python library and also as a web service.

📖 README 📄 Code of conduct 📄 Apache-2.0 license

You can install the package from PyPI using pip:

```
pip install openfactcheck
```

Usage

First, you need to initialize the OpenFactCheckConfig object and then the OpenFactCheck object.

```
from openfactcheck import OpenFactCheck, OpenFactCheckConfig

# Initialize the OpenFactCheck object
config = OpenFactCheckConfig()
ofc = OpenFactCheck(config)
```

Response Evaluation

You can evaluate a response using the `ResponseEvaluator` class.

```
# Evaluate a response
result = ofc.ResponseEvaluator.evaluate(response: str)
```

LLM Evaluation

We provide [FactQA](#), a dataset of 6480 questions for evaluating LLMs. Once you have the responses from the LLM, you can evaluate them using the `LLMEvaluator` class.

```
# Evaluate an LLM
result = ofc.LLMEvaluator.evaluate(model_name: str,
                                   input_path: str)
```

Checker Evaluation

We provide [FactBench](#), a dataset of 4507 claims for evaluating fact-checkers. Once you have the responses from the fact-checker, you can evaluate them using the `CheckerEvaluator` class.

```
# Evaluate a fact-checker
result = ofc.CheckerEvaluator.evaluate(checker_name: str,
                                       input_path: str)
```

EMNLP'2024 (demo): *OpenFactCheck: A Unified Framework for Factuality Evaluation of LLMs*. (<https://aclanthology.org/2024.emnlp-demo.23/>)

Yuxia Wang, Minghan Wang, Hasan Iqbal, Georgi Georgiev, Jiahui Geng, Preslav Nakov

Tool: *OpenFactCheck*

OpenFactCheck Dashboard

<https://openfactcheck.com/>

An Open-source Factuality Evaluation Demo for LLMs

 Evaluate LLM Response

☒ Evaluate LLM

 Evaluate FactChecker

 Leaderboards

 About

This is where you can check factuality of a LLM response.

Customize FactChecker

Select Claim Processor

factool_claimprocessor

Select Retriever

factool_retriever

Select Verifier

factcheckgpt_verifier

factcheckgpt_verifier

factool_verifier

rarr_verifier

Enter LLM response here

Elon Musk bought Twitter in 2020 and renamed it to X.

Check Factuality

✓ Factuality checked...

Pipeline: factool_claimprocessor → factool_retriever → factcheckgpt_verifier

EMNLP'2024 (demo): *OpenFactCheck*: A Unified Framework for Factuality Evaluation of LLMs. (<https://aclanthology.org/2024.emnlp-demo.23/>)

Yuxia Wang, Minghan Wang, Hasan Iqbal, Georgi Georgiev, Jiahui Geng, Preslav Nakov

Tool: *OpenFactCheck*

<https://openfactcheck.com/>

Pipeline: factool_claimprocessor → factool_retriever → factcheckgpt_verifier

Detected Claims

1. Elon Musk bought Twitter in 2020
2. Elon Musk renamed Twitter to X

Factuality Detail

Factuality of each claim is color-coded (red means false, green means true, orange means controversial, violet means unverified).

1. Elon Musk bought Twitter in 2020

- **Error:** The text states that Elon Musk bought Twitter in 2020, which contradicts the evidence.
- **Reasoning:** The given text is non-factual because the evidence clearly states that Elon Musk initiated the acquisition of Twitter in 2022, not in 2020.
- **Correction:** Elon Musk bought Twitter in 2022.
- **Evidence:**
 - Business magnate Elon Musk initiated an acquisition of American social media company Twitter, Inc. on April 14, 2022, and concluded it on October 27, 2022. Musk had begun buying shares of the company in January 2022, becoming its largest shareholder by April with a 9.1 percent ownership stake.
 - Musk closed his \$44 billion deal to buy the social media service, said three people with knowledge of the situation. He also began cleaning ...
 - Tesla CEO Elon Musk completed the deal to acquire Twitter at his original offer price of 54.20 a share at a total cost of roughly 44 billion.
 - Business magnate Elon Musk initiated an acquisition of American social media company Twitter, Inc. on April 14, 2022, and concluded it on October 27, 2022.

Loki Fact-Verification

An Open-source Tool for Fact Verification

Tool: *Loki*

Check History

Single Check Summarization

<https://github.com/Libr-AI/OpenFactVerification>

App / Fact-checking

New Check

by Frank O'Hara

Here's the poem "Poem (Lan...

Known for its longstanding co...

In 2016, we learned Anthony ...

In 2016, we learned Anthony ...

Fifth generation (5G) of wirel...

Known for its longstanding co...

In 2016, we learned Anthony ...

Elon Musk bought twitter in 2...

Known for its longstanding co...

Following #1152 we'll be willin...

The United Arab Emirates (U...

The current President of the ...

Deepfakes can be easily spot...

Elon Musk bought Twitter in 2...

Loki is the god of fact checki...

The earth is very big.

Facial recognition technology...

Overall Credibility
60.00%

Detected claims
5

Supported Well
3

Conflict
2

Controversial
0

Unverifiable claim
0

Known for its longstanding contribution to research in the UAE, MBZUI is home to a vast team of experts across multiple disciplines. The institution is recognized for its comprehensive array of programs at both undergraduate and graduate levels, primarily focusing on the theoretical aspects of artificial intelligence.

Original Text

Claim: MBZUI offers programs at both undergraduate and graduate levels.

Decontextualized Claim

Evidence 8

REFUTES(4)

CONTEXTUALIZES(4)

SUPPORTS(0)

REFUTES - mbzui.ac.ae

Evidence: MBZUI offers the following Master of Science (M.Sc.) programs: Master of Science in Computer Vision Master of Science in Machine Learning ...

Reasoning: The evidence provided lists Master of Science (M.Sc.) programs offered by MBZUI but does not mention any undergraduate programs. Therefore, it does not support the claim that MBZUI offers programs at both undergraduate and graduate levels.

REFUTES - mbzui.ac.ae

REFUTES - Google Answer Box

REFUTES - mbzui.ac.ae

Evidences & Reasoning

What do you think of this checking?

like dislike

Comment

Add Comment

Feedback Collection

0 / 1000

Haonan Li, Xudong Han, Hao Wang, Yuxia Wang, Minghan Wang, Rui Xing, Yilin Geng, Zenan Zhai, Preslav Nakov, Timothy Baldwin

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466
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Tool: *Loki*

<https://github.com/Libr-AI/OpenFactVerification>

Used as a Library

```
from factcheck import FactCheck

factcheck_instance = FactCheck()

# Example text
text = "Your text here"

# Run the fact-check pipeline
results = factcheck_instance.check_response(text)
print(results)
```



Used as a Web App

```
python webapp.py --api_config demo_data/api_config.yaml
```



Multimodal Usage

```
# String
python -m factcheck --modal string --input "MBZUAI is the first AI university in the world"
# Text
python -m factcheck --modal text --input demo_data/text.txt
# Speech
python -m factcheck --modal speech --input demo_data/speech.mp3
# Image
python -m factcheck --modal image --input demo_data/image.webp
# Video
python -m factcheck --modal video --input demo_data/video.m4v
```



COLING'2025 (demo): *Loki: An Open-Source Tool for Fact Verification* (<https://arxiv.org/abs/2410.01794v1>)

Haonan Li, Xudong Han, Hao Wang, Yuxia Wang, Minghan Wang, Rui Xing, Yilin Geng, Zenan Zhai, Preslav Nakov, Timothy Baldwin

LM-Polygraph



stablediffusionweb.com

<https://github.com/INemo/lm-polygraph>

Tool: *LM-Polygraph*

<https://github.com/INemo/lm-polygraph>



Translate into Wizzaggjanian language: I want a small cup of coffee.

GPT-3.5-turbo
Lexical Similarity



Bi-gizz wizzant to wizzave a wizzmall wizzup of wizzoffee.

Confidence: 0%



Translate into French language: I want a small cup of coffee.

GPT-3.5-turbo
Lexical Similarity



Je veux une petite tasse de café.

Confidence: 96%

ACL'2024 (Findings): Fact-Checking the Output of Large Language Models via Token-Level Uncertainty Quantification
Ekaterina Fadeeva, Aleksandr Rubashevskii, Artem Shelmanov, Sergey Petrakov, Haonan Li, Hamdy Mubarak, Evgenii Tsymbalov, Gleb Kuzmin, Alexander Panchenko, Timothy Baldwin, Preslav Nakov, Maxim Panov (<https://aclanthology.org/2024.findings-acl.558/>)

Tool: *LM-Polygraph*

<https://github.com/IIINemo/lm-polygraph>



Tell me a bio of Madonna.



Madonna is an American singer, songwriter, actress, and businesswoman. She was born on August 16, 1958, in Bay City, Michigan, and is best known for her provocative image and music. Madonna has sold over 300 million records worldwide, making her one of the best-selling music artists of all time. She has won numerous awards, including **20 Grammy Awards**, a Golden Globe Award, and an Emmy Award. Madonna is also known for her philanthropic work and her activism on various social issues.

ACL'2024 (Findings): *Fact-Checking the Output of Large Language Models via Token-Level Uncertainty Quantification*

Ekaterina Fadeeva, Aleksandr Rubashevskii, Artem Shelmanov, Sergey Petrakov, Haonan Li, Hamdy Mubarak, Evgenii Tsymbalov, Gleb Kuzmin, Alexander Panchenko, Timothy Baldwin, Preslav Nakov, Maxim Panov (<https://aclanthology.org/2024.findings-acl.558/>)

LM-Polygraph (Python Library)

<https://github.com/INemo/lm-polygraph>

```
from lm_polygraph import estimate_uncertainty
from lm_polygraph.models import WhiteboxModel
from lm_polygraph.estimators import *

model = WhiteboxModel.from_pretrained(
    "mistralai/Mistral-7B-Instruct-v0.2",
    device="cuda:0"
)

ue_method = MeanPointwiseMutualInformation()
input_text = "Who is George Bush?"
estimate_uncertainty(model, ue_method, input_text=input_text)
```

TACL journal (2025): Benchmarking Uncertainty Quantification Methods for Large Language Models with LM-Polygraph

Roman Vashurin, Ekaterina Fadeeva, Artem Vazhentsev Lyudmila Rvanova, Akim Tsvigun, Daniil Vasilev, Rui Xing, Abdelrahman Sadallah, Kirill Grishchenkov, Sergey Petrakov, Alexander Panchenko, Timothy Baldwin, Preslav Nakov, Maxim Panov, Artem Shelmanov (<https://arxiv.org/pdf/2406.15627>)

LM-Polygraph (Python Library)

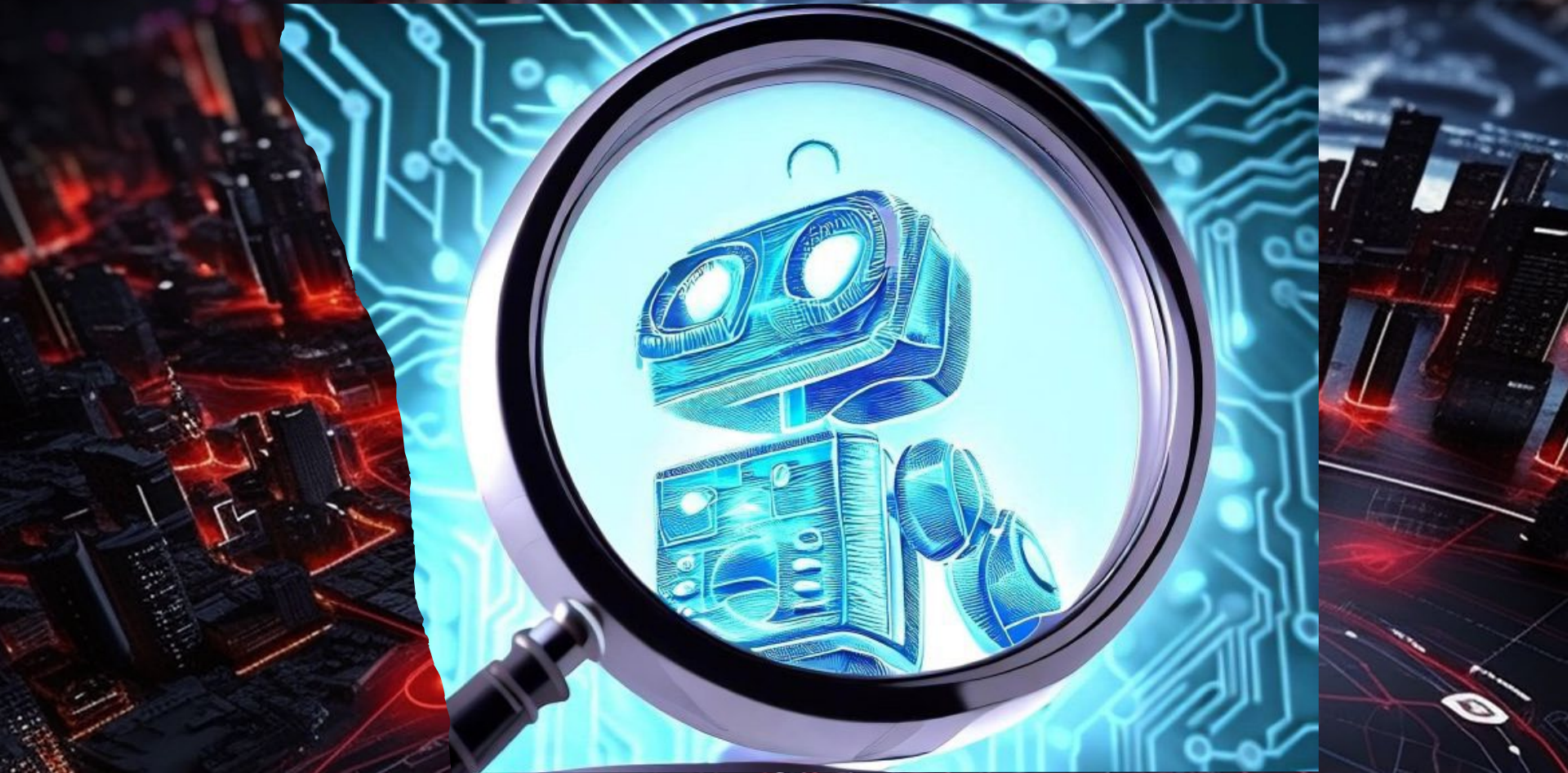
<https://github.com/IINemo/lm-polygraph>

Uncertainty Quantification Method	Type	Category	Compute	Memory	Need Training Data?
Maximum sequence probability	White-box	Information-based	Low	Low	No
Perplexity (Fomicheva et al., 2020)			Low	Low	No
Mean token entropy (Fomicheva et al., 2020)			Low	Low	No
Monte Carlo sequence entropy (Kuhn et al., 2023)			High	Low	No
Pointwise mutual information (PMI) (Takayama and Arase, 2019)			Medium	Low	No
Conditional PMI (van der Poel et al., 2022)			Medium	Medium	No
Rényi divergence (Darrin et al., 2023)			Low	Low	No
Fisher-Rao distance (Darrin et al., 2023)			Low	Low	No
TokenSAR (Duan et al., 2023)			Medium	Low	No
Semantic entropy (Kuhn et al., 2023)	White-box	Meaning diversity	High	Low	No
SentenceSAR (Duan et al., 2023)			High	Low	No
SAR (Duan et al., 2023)			High	Low	No
Sentence-level ensemble-based measures (Malinin and Gales, 2021)	White-box	Ensembling	High	High	Yes
Token-level ensemble-based measures (Malinin and Gales, 2021)			High	High	Yes
Mahalanobis distance (MD) (Lee et al., 2018)	White-box	Density-based	Low	Low	Yes
Robust density estimation (RDE) (Yoo et al., 2022)			Low	Low	Yes
Relative Mahalanobis distance (RMD) (Ren et al., 2023)			Low	Low	Yes
Hybrid Uncertainty Quantification (HUQ) (Vazhentsev et al., 2023a)			Low	Low	Yes
p(True) (Kadavath et al., 2022)	White-box	Reflexive	Medium	Low	No
Number of semantic sets (NumSets) (Lin et al., 2023)	Black-box	Meaning diversity	High	Low	No
Sum of eigenvalues of the graph Laplacian (EigV) (Lin et al., 2023)			High	Low	No
Degree matrix (Deg) (Lin et al., 2023)			High	Low	No
Eccentricity (Ecc) (Lin et al., 2023)			High	Low	No
Lexical similarity (LexSim) (Fomicheva et al., 2020)			High	Low	No

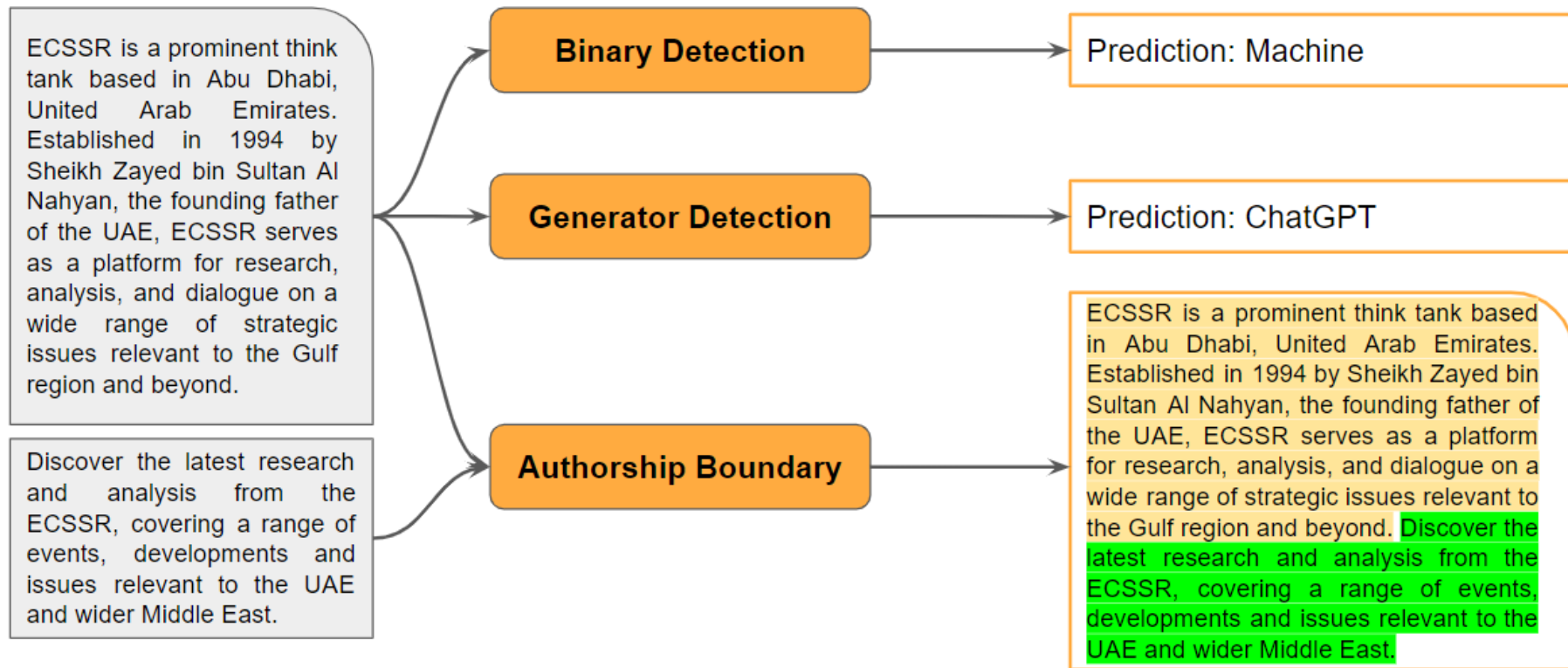
TACL journal (2025): Benchmarking Uncertainty Quantification Methods for Large Language Models with LM-Polygraph

Roman Vashurin, Ekaterina Fadeeva, Artem Vazhentsev Lyudmila Rvanova, Akim Tsvigun, Daniil Vasilev, Rui Xing, Abdelrahman Sadallah, Kirill Grishchenkov, Sergey Petrakov, Alexander Panchenko, Timothy Baldwin, Preslav Nakov, Maxim Panov, Artem Shelmanov (<https://arxiv.org/pdf/2406.15627>)

Detecting Machine-Generated Content



Detecting Machine-Generated Text



ACL'2024: M4GT-Bench: Evaluation Benchmark for Black-Box Machine-Generated Text Detection

Yuxia Wang, Jonibek Mansurov, Petar Ivanov, Jinyan Su, Artem Shelmanov, Akim Tsvigun, Osama Mohammed Afzal, Tarek Mahmoud, Giovanni Puccetti, Thomas Arnold, Alham Fikri Aji, Nizar Habash, Iryna Gurevych, Preslav Nakov (<https://aclanthology.org/2024.acl-long.218/>)

LLM-DetectAlve



<https://github.com/mbzuai-nlp/LLM-DetectAlve>

LLM-DetectAlve

Try it!

Challenge Yourself!

Text Classes

Human-Written: Original text created by humans.

Machine-Generated: Text created by AI from basic prompts, without style instructions.

Human-Written, Machine-Polished: Human text refined by AI for grammar and flow, without new content.

Machine-Written, Machine-Humanized: AI-generated text modified to mimic human writing style.

EMNLP'2024 (demo): *LLM-DetectAlve: a Tool for Fine-Grained Machine-Generated Text Detection*

Bimarsha Adhikari, Saad El Dine Ahmed, Yuxia Wang, Osama Mohammed Afzal, Zhuohan Xie, Jonibek Mansurov, Ekaterina Artemova, Vladislav Mikhailov, Rui Xing, Jiahui Geng, Hasan Iqbal, Zain Muhammad Mujahid, Tarek Mahmoud, Akim Tsvigun, Alham Fikri Aji, Artem Shelmanov, Nizar Habash, Iryna Gurevych, Preslav Nakov

Let Us Take Some Human Text...

<https://www.essayedge.com/blog/jump-right-in-essay/>



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When I'm with my classmates, I'm one of them—a cultivated, upper-class young man. I'm invited to their houses and speak to their parents on a polite first name basis. When I hang out with boarders and jocks, I'm invited to their refuges and speak the rapidly shifting socialect. Very few of the students in my school drift socially as I do. As a result of the recent American infatuation with the alternative sub-culture, my classmates give me respect for embodying an unconventional trend while preserving my proper social standing. In the same sense, my clan from the wrong end of the school respects me for remaining faithful to our culture while succeeding academically: in their eyes I have found a way to get out of the social hole without selling out.

I'm perfectly comfortable with the fact that I don't have one single social identity. I think that if I only felt comfortable among kids from a certain end of the school, my life would be less interesting.

If you think that everything is good with this paper, move to check a well-done sample. Writing an essay on social essay this way is awful. Submitting such an essay as a part of an application is the worst mistake you can make. Use the help of our college essay revisor to make sure your paper will be appreciated by admissions officers.

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Let Us Check It with the LLM-DetectAlve...

Try it!

Challenge Yourself!

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Text

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133/500 words (Minimum 50 words)

Check Origin

Clear

Result

Human-Written

Now, Let Us Ask Jais to “Humanize” It...

Jais 30B ▾



You

Can you polish this text? When I'm with my classmates, I'm one of them—a cultivated, upper-class young man. I'm invited to their houses and speak to their parents on a polite first name basis. When I hang out with boarders and jocks, I'm invited to their refuges and speak the rapidly shifting socialect. Very few of the students in my school drift socially as I do. As a result of the recent American infatuation with the alternative sub-culture, my classmates give me respect for embodying an unconventional trend while preserving my proper social standing. In the same sense, my clan from the wrong end of the school respects me for remaining faithful to our culture while succeeding academically; in their eyes I have found a way to get out of the social hole without selling out.

Source: <https://www.essayedge.com/blog/jump-right-in-essay>



Jais

When I am among my classmates, I identify with them - a refined, affluent youth. My presence is welcomed in their homes, and conversations flow freely, conducted on a familiar, intimate level with their parents, all under the guise of courteous address. This atmosphere shifts dramatically when I find myself amidst the boarding student body and athletes. Here, I am accepted into their sanctuaries, where the dialect of camaraderie is fast-paced and ever-changing. A scant handful of my educational cohort navigates such fluidly social terrain. The current American fascination with nonconformist culture has engendered a unique respect amongst my peers. They acknowledge my embodiment of an avant-garde trend whilst maintaining my respectable societal status. Conversely, my kin hailing from the less privileged fringes of the school perceive my academic success within our cultural framework as a testament to my resilience. To them, I represent a viable pathway out of socio-economic disadvantage, achieved without compromising one's values.

[Copy](#) [Regenerate](#)



Let Us Check It with the LLM-DetectAlve...

Try it!

Challenge Yourself!

Text Classes

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156/500 words (Minimum 50 words)

Check Origin

Clear

Result

Human-Written, Machine-Polished

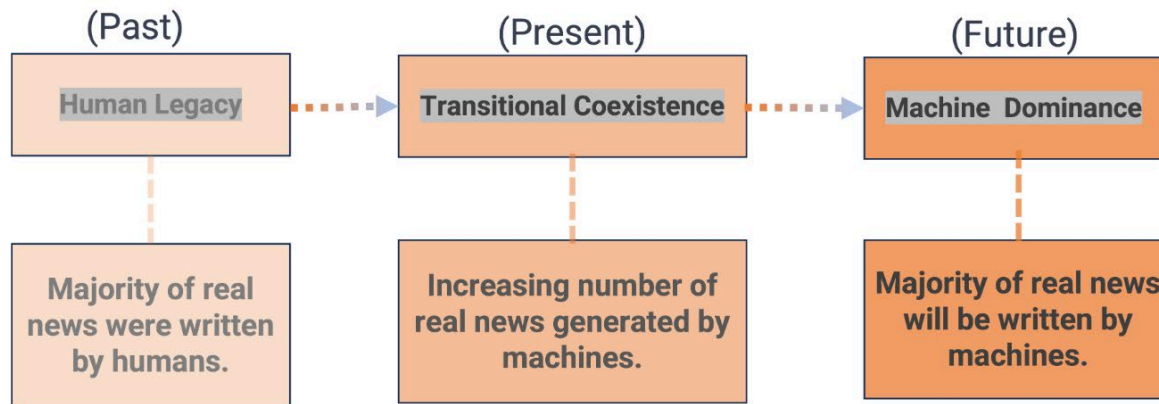
Biases of Fake News Detectors When Seeing Machine-Generated text

- Machine-generated real news → fake news
- Human-written fake news → real news

(Arxiv) Fake News Detectors are Biased against Texts Generated by Large Language Models

Jinyan Su, Terry Yue Zhuo, Jonibek Mansurov, Di Wang, Preslav Nakov (<https://arxiv.org/abs/2309.08674>)

Past to Present Progression



Will fake news detector still work well?

If not, how should we adapt fake news detectors to the era of LLMs?

NAACL'2024 (Findings): Adapting Fake News Detection to the Era of Large Language Models

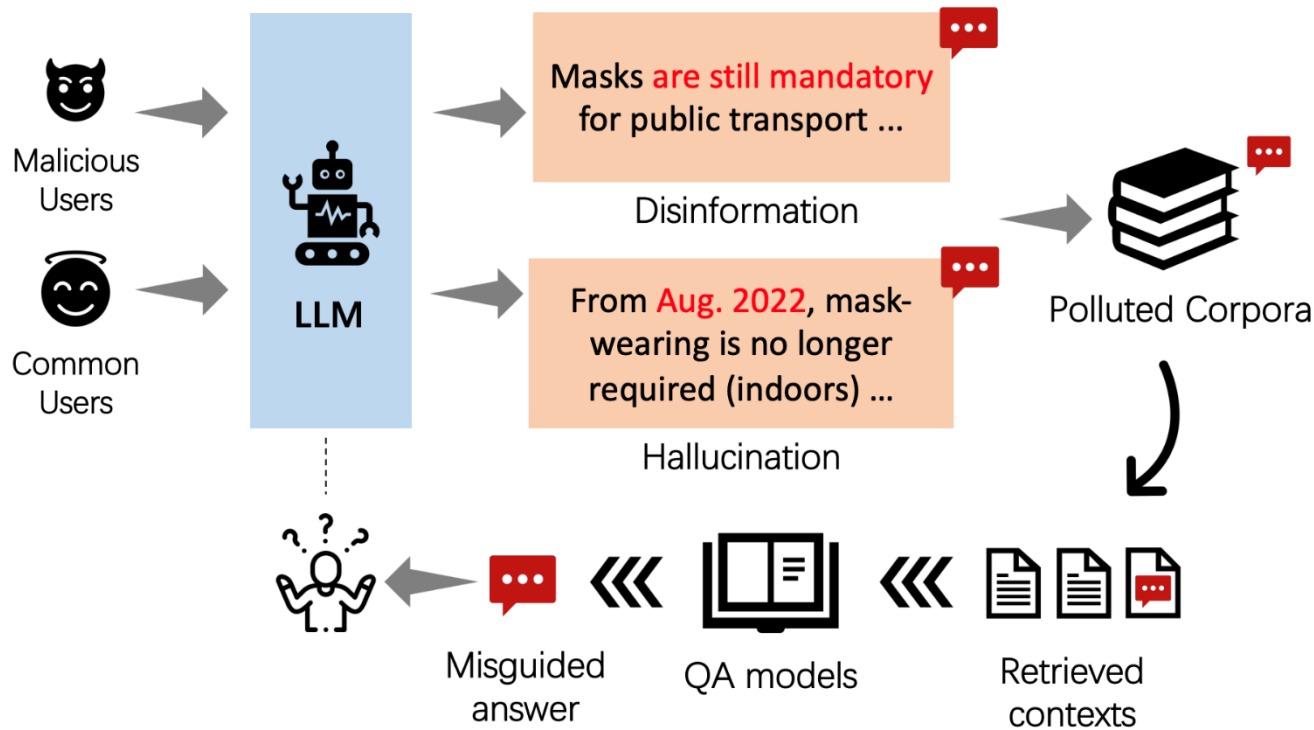
Jinyan Su, Claire Cardie, Preslav Nakov (<https://aclanthology.org/2024.findings-naacl.95>)

Disinformation Pollution Targeting LLMs





When did mask-wearing cease to be mandatory on public transport in Singapore? (Answer: Feb. 2023)



EMNLP2023 (Findings): On the Risk of Misinformation Pollution with Large Language Models

Yikang Pan, Liangming Pan, Wenhui Chen, Preslav Nakov, Min-Yen Kan, William Yang Wang (<https://aclanthology.org/2023.findings-emnlp.97>)

Defense Strategies

1. Misinformation detection

2. Prompting (BEST)

- e.g., *“Be aware that a minor portion of the passages may contain misinformation. Please ignore them when answering the question.”*

3. Voting (BEST)

- Segment the context into k groups.
- Generate an answer for each group
- Apply majority voting

Propaganda, Framing



Propaganda



The Evolution of Terminology

1. **Fake news**: focus on *factuality*
2. **Disinformation**: *factuality* + *harm*
3. **Infodemic**: focus on *harm*

**But, the goal is not just to lie or to harm;
It is also to persuade, which is often about emotions!**

Propaganda Techniques

Black-and-white Fallacy/Dictatorship **Repetition**
Obfuscation, Intentional vagueness, Confusion **Thought-terminating cliché**
Slogans **Causal Oversimplification** **Flag-waving**
Appeal to authority **Transfer**
Presenting Irrelevant Data (Red Herring)
Smears **Exaggeration/Minimisation** **Whataboutism**
Misrepresentation of Someone's Position (Straw Man)
Name calling/Labeling **Appeal to fear/prejudice**
Reductio ad hitlerum **Glittering generalities (Virtue)**
Bandwagon **Appeal to (Strong) Emotions** **Doubt**
Loaded Language

**Emotional
appeals**

**Logical
fallacies**

**Personal
attacks/praises**

- "Be careful, a limited aggression will not remain limited. We will pursue any aggressor,"¹ the head of the Guards, Major General Hossein Salami, said in remarks broadcast on state TV. "We are after punishment and we will continue until the¹ full destruction⁸ of any aggressor."¹

U.S. President Donald Trump on Friday approved sending American troops to bolster Saudi Arabia's air and missile defences after the Sept. 14 attacks.

Iran denies involvement in the attack, which was claimed by Yemen's Houthi movement, a group aligned with Iran and currently fighting a Saudi-led alliance in Yemen's civil war.

- Trump's move drew fire in Washington on Saturday from U.S. House of Representatives Speaker Nancy Pelosi, who called it his "latest outrageous attempt"⁸ to circumvent Congress.

- "These unacceptable actions are cause for alarm," Pelosi said in a statement accusing Trump of turning "a blind eye"⁸ to Saudi violence against innocent Yemenis, human rights abuses and the murder of journalist Jamal Khashoggi.

- "The United States⁷ cannot enable more brutality and bloodshed,"⁸ she added. "Congress will do our job to uphold the Constitution, defend our national security and protect the American people."⁷

☒ ☐ 1 - Appeal to fear prejudice

☒ ☐ 7 - Flag Waving

☒ ☐ 8 - Loaded Language

☐ 0 - Appeal to Authority

☐ 2 - Bandwagon

☐ 3 - Black and White Fallacy

☐ 4 - Causal/Oversimplification

☐ 5 - Doubt

☐ 6 - Exaggeration, Minimisation

☐ 9 - Name Calling, Labeling

☐ 10 - Obfuscation, Intentional Vagueness, Confusion

☐ 11 - Red Herring

☐ 12 - Reduction ad hitlerum

☐ 13 - Repetition

☐ 14 - Slogans

☐ 15 - Straw Men

☐ 16 - Thought terminating Cliches

☐ 17 - Whataboutism

Tool: *FRAPPE* (FRAming, Persuasion, and Propaganda Explorer)

Physician Says Coronavirus Likely Caused by 5G (Video). \ Super-Vaccination Agenda First, it's of paramount importance to understand that the Super-Vaccination Agenda has been implemented since World War I. Secondly, that vaccines represent a profound assault against the human body often with consequences that are irreversible.

Appeal to Fear-Prejudice 88.79% Loaded Language 45.65% Repetition 29.58% Exaggeration-Minimisation 28.12%

In numerous cases, children are killed by these toxic formulations, just as adults can be debilitated for life by a single flu vaccine.

Appeal to Fear-Prejudice 70.99% Loaded Language 44.67% Repetition 20.66%

Does anyone know for sure what's in these Big Pharma-manufactured chemical and biological time bombs?!

Appeal to Fear-Prejudice 59.08% Name Calling-Labeling 40.65% Doubt 25.79%

Vaccines, especially flu shots, play an integral part in this Quaternary Weapon System. Appeal to Fear-Prejudice 28.88%

The annual flu vaccine, that's aggressively pushed each and every year because it's so vital to this global depopulation scheme, contains a cocktail of harmful biological material and unsafe chemical compounds.

Appeal to Fear-Prejudice 66.06% Loaded Language 64.18% Repetition 28.86%

Some of the vaccine ingredients are nano-sized particles that are both digitized and controllable by remote, which can wreak havoc with the human immune system.

Appeal to Fear-Prejudice 68.53% Loaded Language 32.59% Repetition 22.53%

EACL'2024 (demo): *FRAPPE: FRAming, Persuasion, and Propaganda Explorer* (<https://aclanthology.org/2024.eacl-demo.22/>)

Ahmed Sajwani, Alaa El Setohy, Ali Mekky, Diana Turmakhan, Lara Hassan, Mohamed El Zeftawy, Omar El Herraoui, Osama Mohammed Afzal, Qisheng Liao, Tarek Mahmoud, Zain Muhammad Mujahid, Muhammad Umar Salman, Muhammad Arslan Manzoor, Massa Baali, Jakub Piskorski, Nicolas Stefanovitch, Giovanni Da San Martino, Preslav Nakov

Tool: *FRAPPE* (FRAMing, Persuasion, and Propaganda Explorer)

<https://frappe.streamlit.app/>

Home

Article On the Fly

Visualization of 2M Articles

Navigation

- ☒ Framings and Persuasion Techniques:
Countries
- ☐ Framings: Countries and Sources
- ☐ Persuasion Techniques: Fine-Grained
Propaganda
- ☐ Persuasion Techniques: Coarse-
Grained Propaganda
- ☐ Persuasion Techniques: Ethos, Logos,
Pathos

Number of countries

186

Number of articles

2515227

Number of media sources

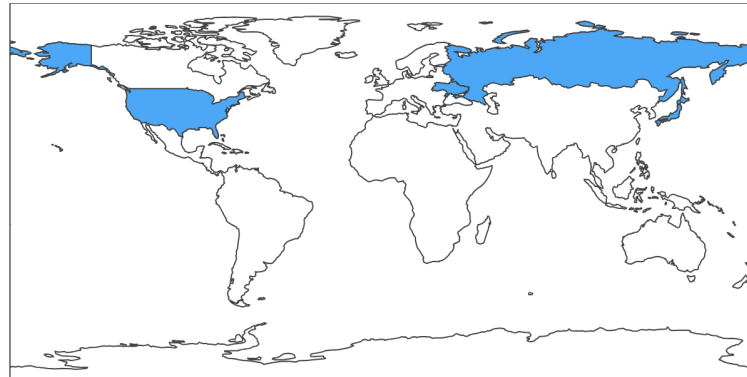
8693

Select country

Japan (15652)

Add selection

Remove last selection



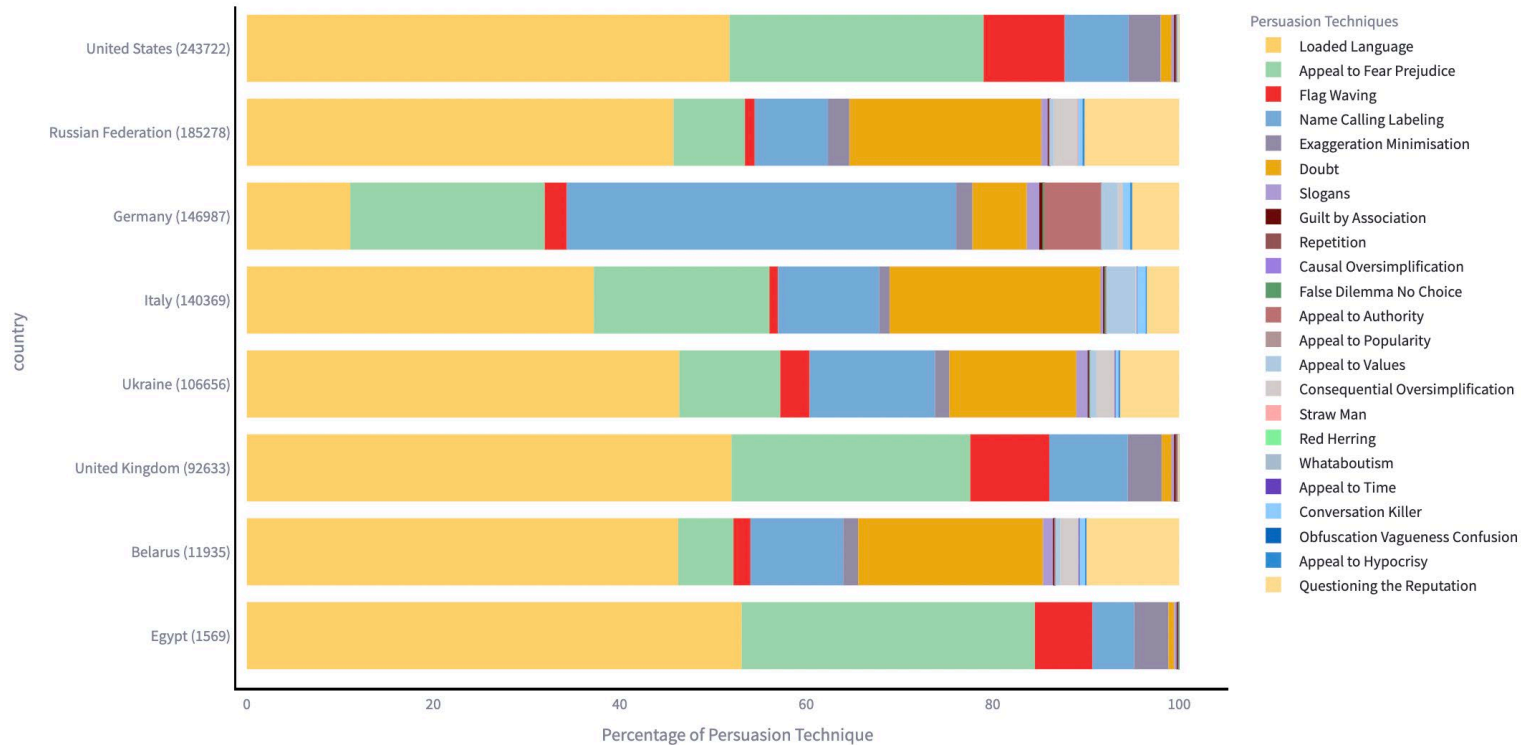
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Tool: *FRAPPE* (FRAMing, Persuasion, and Propaganda Explorer)

Distribution of Persuasion Techniques by Country

<https://frappe.streamlit.app/>



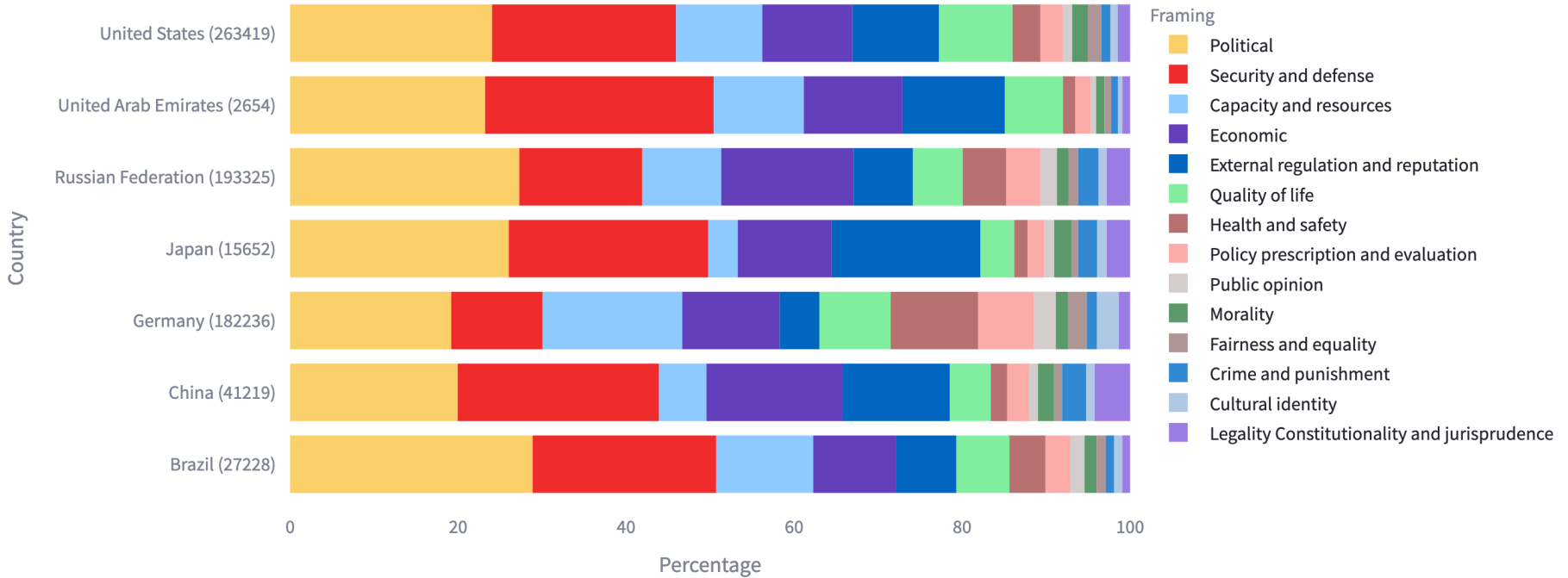
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<https://frappe.streamlit.app/>

Distribution of Frames by Country



EACL'2024 (demo): *FRAPPE: FRAMing, Persuasion, and Propaganda Explorer* (<https://aclanthology.org/2024.eacl-demo.22/>)

Ahmed Sajwani, Alaa El Setohy, Ali Mekky, Diana Turmakhan, Lara Hassan, Mohamed El Zeftawy, Omar El Herraoui, Osama Mohammed Afzal, Qisheng Liao, Tarek Mahmoud, Zain Muhammad Mujahid, Muhammad Umar Salman, Muhammad Arslan Manzoor, Massa Baali, Jakub Piskorski, Nicolas Stefanovitch, Giovanni Da San Martino, Preslav Nakov

Complex Problem

- Web-scale
- Multi-platform
- Multi-lingual
- Multi-modal
- Multi-aspect: Factuality, Harm, Bias, Propaganda, Framing, Narratives





MOHAMED BIN ZAYED
UNIVERSITY OF
ARTIFICIAL INTELLIGENCE

Thank you

Mohamed bin Zayed University of Artificial Intelligence
Masdar City, Abu Dhabi, United Arab Emirates



mbzuai.ac.ae