Dr. Nicolas Müller

# Audio- und Video-Deepfakes – Erzeugen, Erkennen, Verstehen

Bucerius Law School
09-10.01.2026

Fraunhofer AISEC

Fraunhofer-Institut für Angewandte und Integrierte Sicherheit AISEC

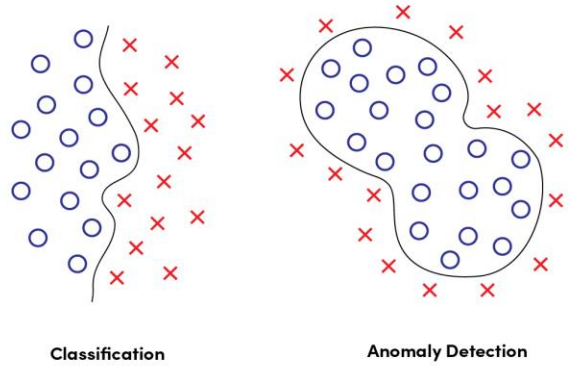
# Cognitive Security Technologies (CST)

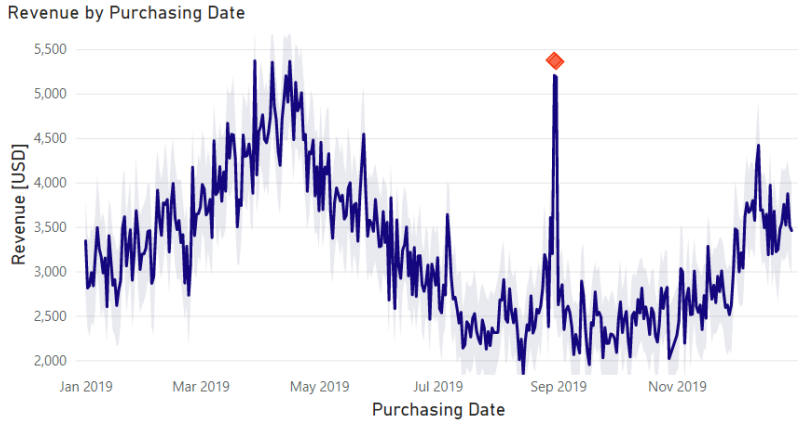
**Fraunhofer:**

- Auftragsforschung
- Prototypenbau
- Forschungsprojekte (EU/Bund)

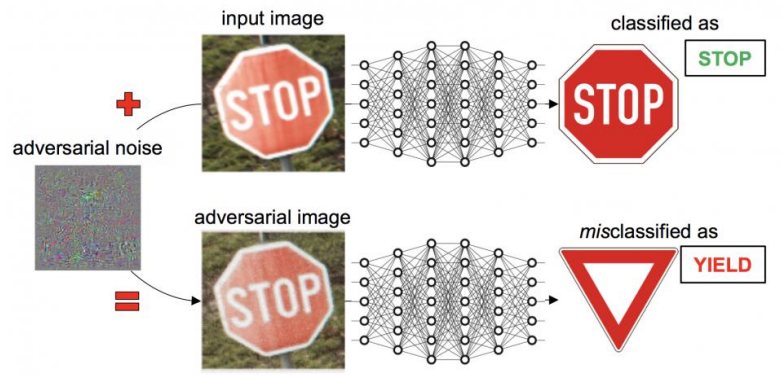
**Abteilung CST**

- Anomalieerkennung
- Adversarial Machine Learning
- Large Language Models
- Deepfakes







# Cognitive Security Technologies (CST)

**Theory:**

- **These slides**

**Practical: lets build DFD**

- **Students: Data collection via resemble TTS and running models from HF locally**
- **Students: Setup code for DFD via Google Colabs. Maybe Nicolas create MLAAD_mini (10%) s.t. MLAAD + MAILABS usable**
- **Pentest resemble DFD**
- **Prentest deepfake-total**

# Übersicht: Deepfakes @ Fraunhofer AISEC

1) Forschung

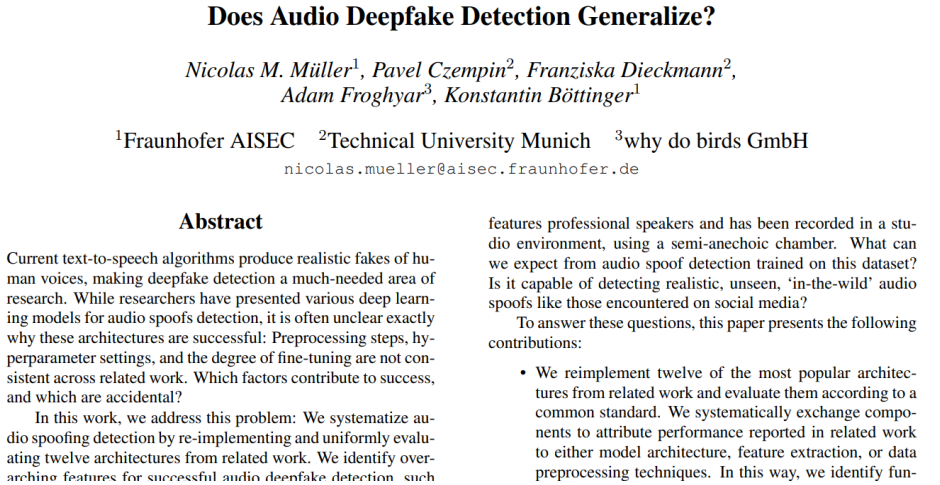
- Grundlagenforschung
- Research Management: Reviewer und Organisator bei internationalen Konferenzen

2) Softwarelösungen

- Forschung in die Anwendung bringen: Deepfake-Total.com
- Awareness schaffen: Interaktive Demonstatoren zur "Schulung des Auges / Ohrs"

3) Öffentlichkeitsarbeit

- Handelsblatt, Financial Times, ZDF, BR3-Nano, Staatsministerium BaWü, NTV, Tagesspiegel…
- Konferenzbesuche, Vorträge, Seminare, Schulungen (Industrie und TU-München)



**Does Audio Deepfake Detection Generalize?**

*Nicolas M. Müller[1], Pavel Czempin[2], Franziska Dieckmann[2], Adam Froghyar[3], Konstantin Böttinger[1]*

[1]Fraunhofer AISEC [2]Technical University Munich [3]why do birds GmbH

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**Abstract**

Current text-to-speech algorithms produce realistic fakes of human voices, making deepfake detection a much-needed area of research. While researchers have presented various deep learning models for audio spoofs detection, it is often unclear exactly why these architectures are successful: Preprocessing steps, hyperparameter settings, and the degree of fine-tuning are not consistent across related work. Which factors contribute to success, and which are accidental?

In this work, we address this problem: We systematize audio spoofing detection by re-implementing and uniformly evaluating twelve architectures from related work. We identify over-

features professional speakers and has been recorded in a studio environment, using a semi-anechoic chamber. What can we expect from audio spoof detection trained on this dataset? Is it capable of detecting realistic, unseen, 'in-the-wild' audio spoofs like those encountered on social media?

To answer these questions, this paper presents the following contributions:

- We reimplement twelve of the most popular architectures from related work and evaluate them according to a common standard. We systematically exchange components to attribute performance reported in related work to either model architecture, feature extraction, or data preprocessing techniques. In this way, we identify fun-

# Agenda des heutigen Vortrags

1) Einleitende Beispiele

2) Deepfake Erstellung

   - Wie einfach ist die Erstellung von Deepfakes?
   - Die Technik im Detail

3) Was tun?

   - Medienkompetenz
   - KI-gestütze Deepfake Erkennung
   - Content Credentials

4) Deepfake-Technologie für den guten Zweck

5) Fazit


https://www.youtube.com/watch?v=oxXpB9pSETo


https://www.youtube.com/watch?v=F4G6GNFz0O8


FAKE
REAL


Forbes

FORBES > INNOVATION > CONSUMER TECH

**A Voice Deepfake Was Used To Scam A CEO Out Of $243,000**

BIZTECH NEWS

**Audio deepfake scams: Criminals are using AI to sound like family and people are falling for it**

# Betrug, Enkelkindertrick 2.0

Telefon-Betrug

# KI-Betrüger kopieren Stimme von Polizeichefin

## Das Opfer war die Mutter der Top-Beamtin

Foto: Getty Images

Robin Mühlebach

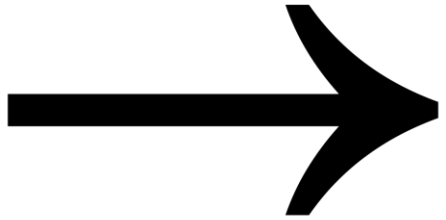
**04.01.2026 - 09:20 Uhr**

Die Stimme einer Polizeichefin aus Baden-Württemberg wurde mit KI-Technologie geklont, um einen perfiden Betrug zu begehen.

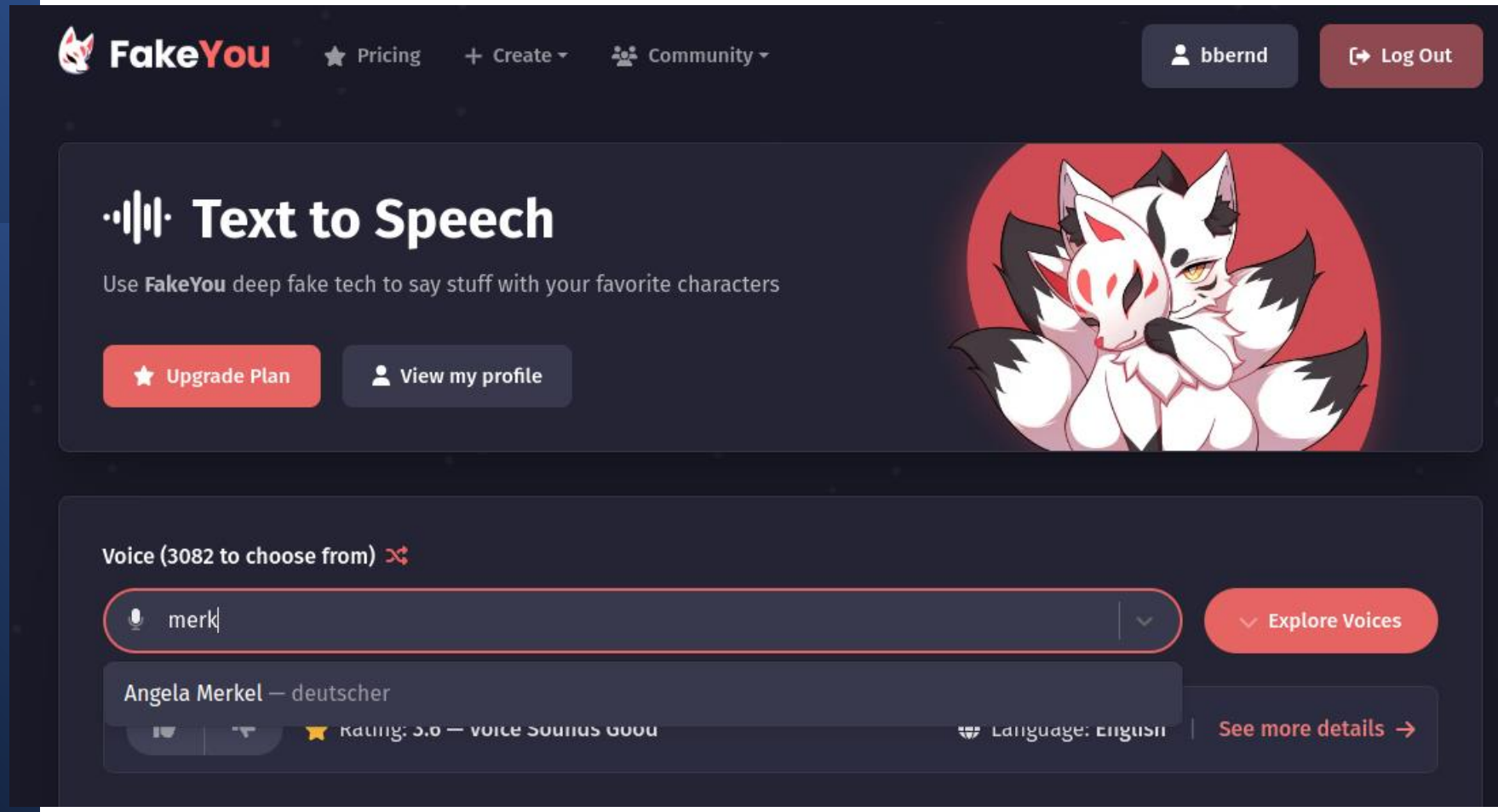

MAXFEED
live 13:13
liebe Abgeordnete des bumseltag
SNICKERS
für Linkshänder
SATIRE

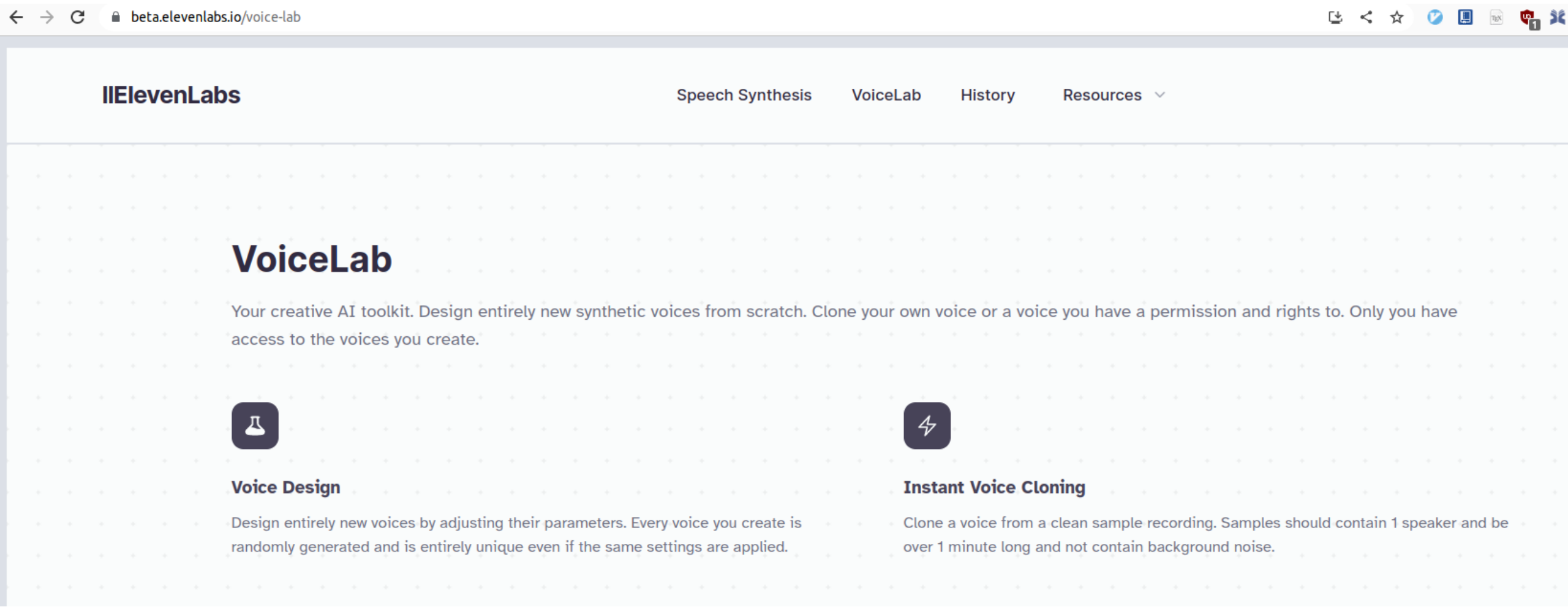
Fraunhofer AISEC

# Immer einfacher zu erstellen



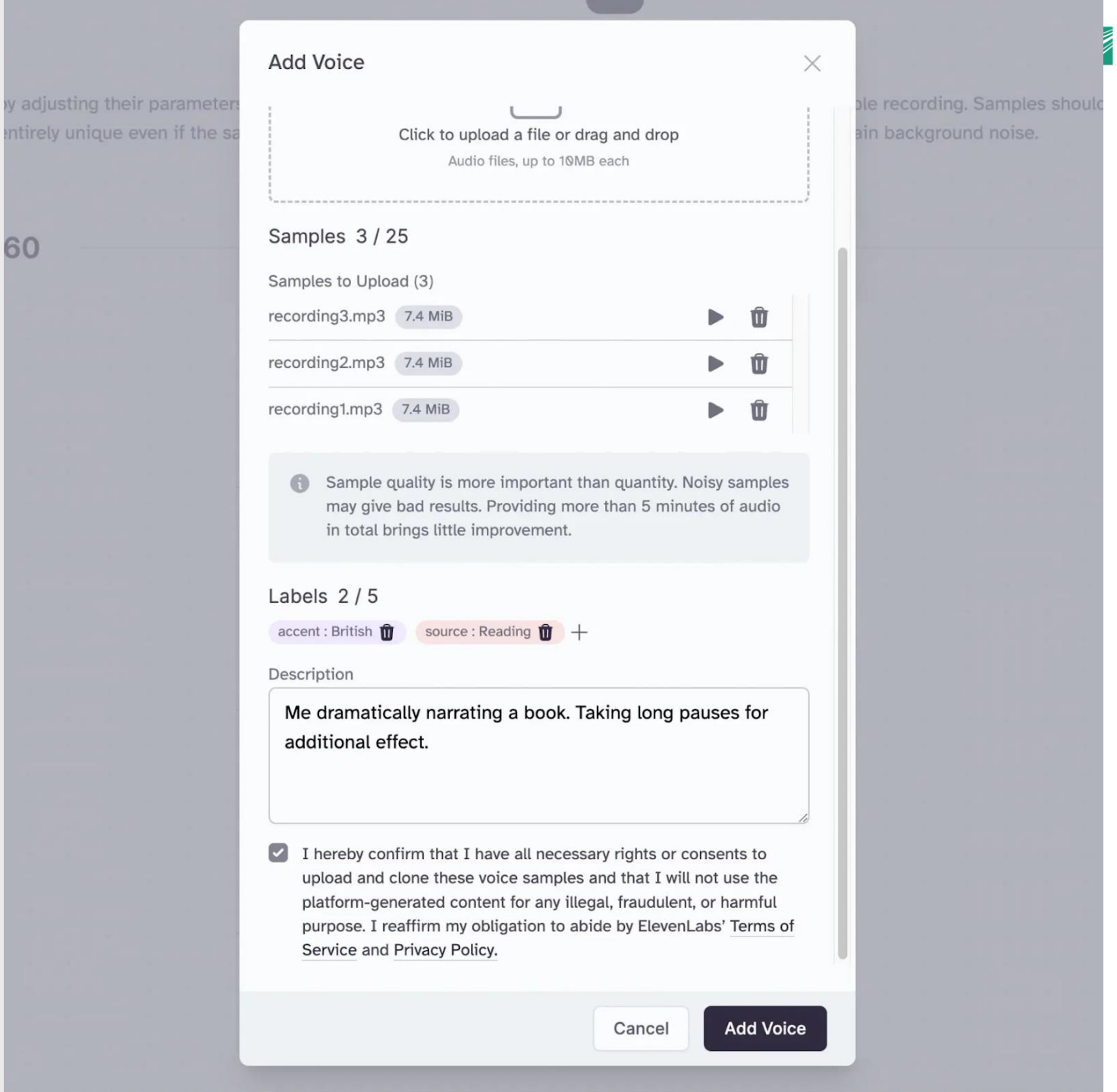
# Voice-Cloning "On Demand"




beta.elevenlabs.io/voice-lab
IIElevenLabs
Speech Synthesis
VoiceLab
History
Resources
VoiceLab
Your creative AI toolkit. Design entirely new synthetic voices from scratch. Clone your own voice or a voice you have a permission and rights to. Only you have access to the voices you create.
Voice Design
Design entirely new voices by adjusting their parameters. Every voice you create is randomly generated and is entirely unique even if the same settings are applied.
Instant Voice Cloning
Clone a voice from a clean sample recording. Samples should contain 1 speaker and be over 1 minute long and not contain background noise.

# Kommerzielle Anbieter

Eleven Labs

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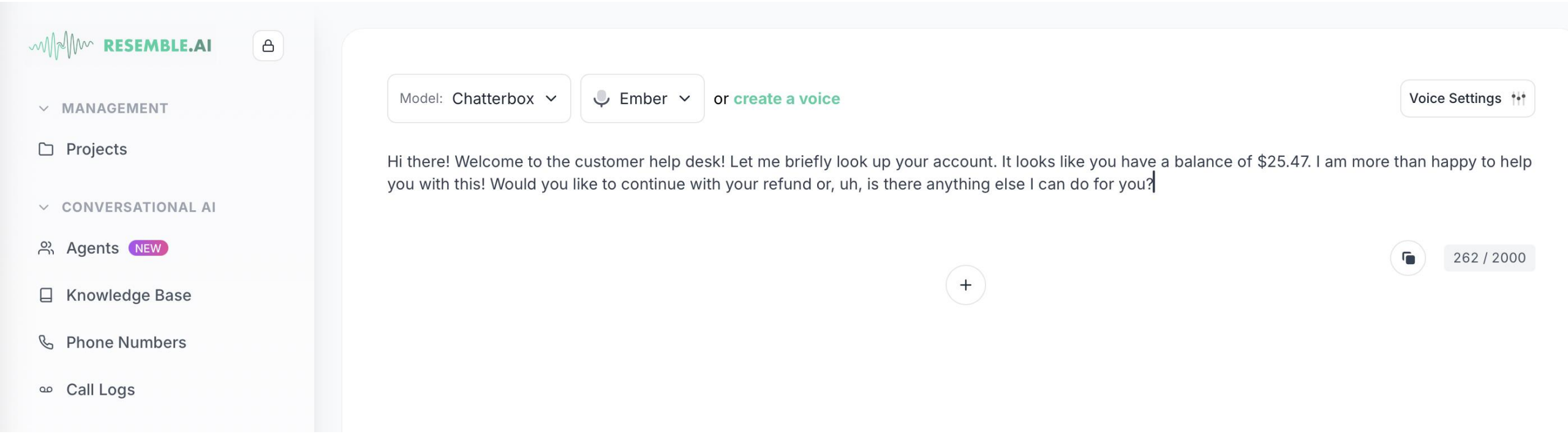
Version 1

Version 2

# Hands-on: Resemble.ai TTS



# Funktionsweise

Mustererkennung:
Text ~ Sprache

Herzliche
Willkommen

Schön Sie zu sehen

…

# Herausforderungen

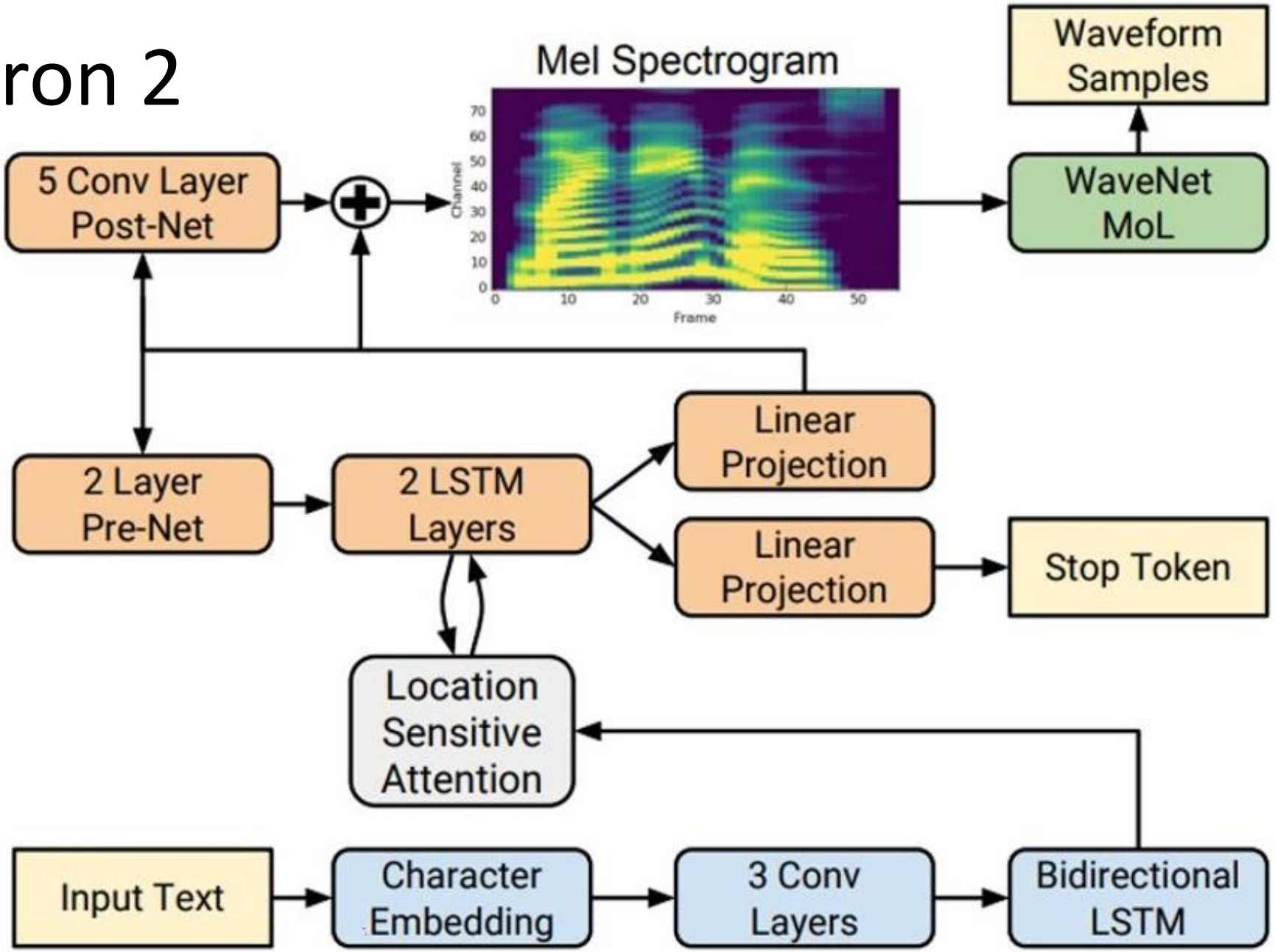
Information im Text:

- Was wird gesagt (Inhalt)

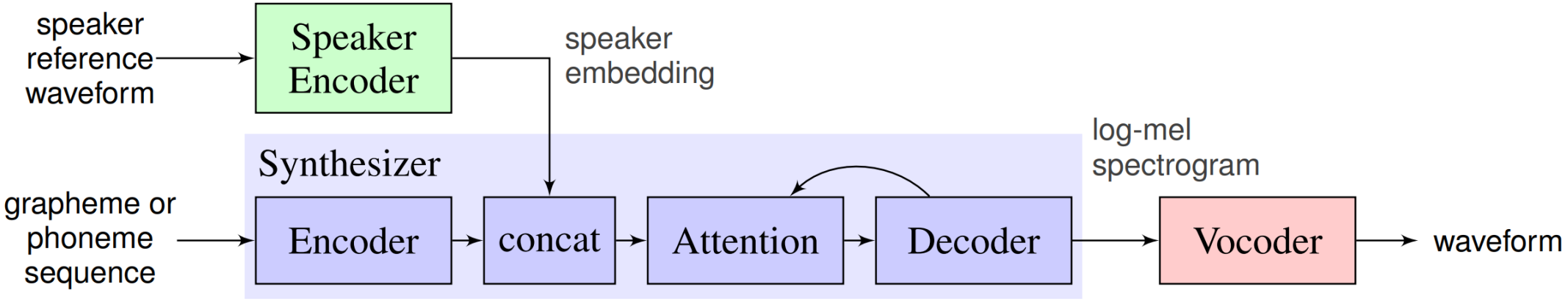
Information in der Stimme:

- Was wird gesagt (Inhalt)
- Wer sagt es (Sprecher)
- Wie wird es gesagt (Betonung)
- Wo wird es gesagt (Kanalinformation)

# Tacotron 2

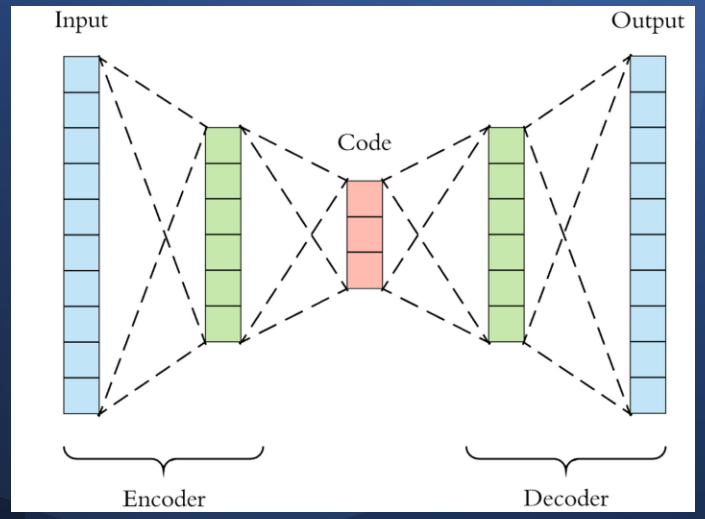

Mel Spectrogram
Channel
Frame
Waveform Samples
WaveNet MoL
5 Conv Layer Post-Net
Linear Projection
2 Layer Pre-Net
2 LSTM Layers
Linear Projection
Stop Token
Location Sensitive Attention
Input Text
Character Embedding
3 Conv Layers
Bidirectional LSTM

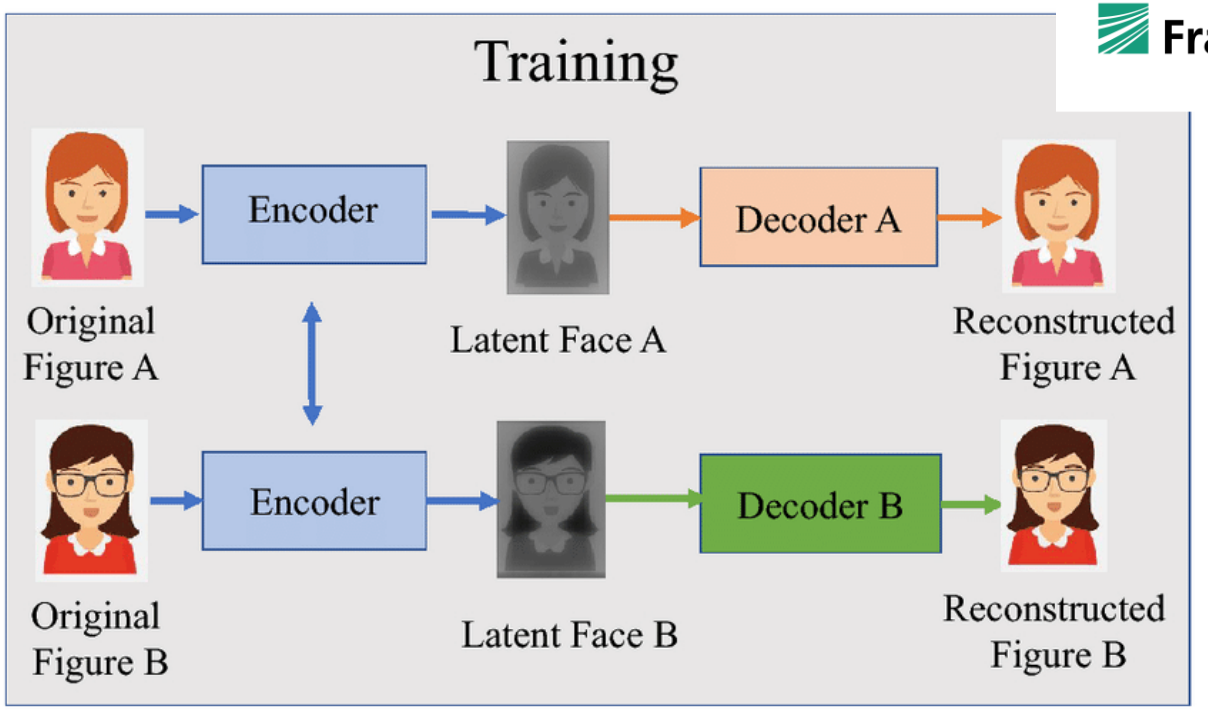
# Multispeaker TTS



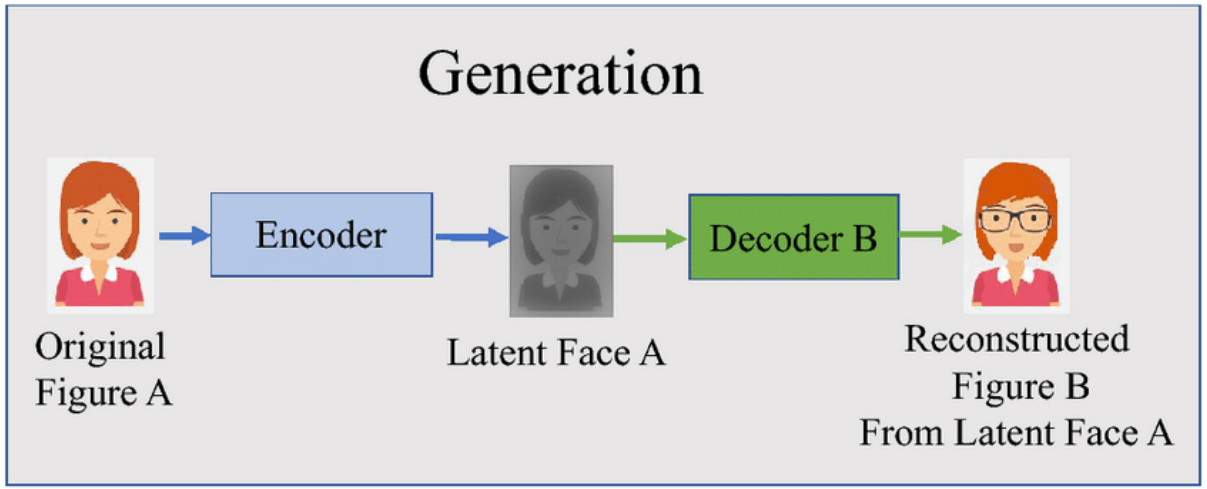

https://arxiv.org/abs/1806.04558

# Faceswap




(a) Training Phase




(b) Generation Phase

# Wie reagieren?

1) Medienkompetenz
2) Deepfake Erkennung
3) Signaturverfahren

# Medienkompetenz (Media literacy)

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ChatGPT 5.2


Google Nano Banana


ChatGPT 5.2


Google Nano Banana

# Der muss üben!

https://deepfake-total.com/spot_the_deepfake/


| Rounds Played | Your Score (Human) | Deepfake Detection AI Score |
|---|---|---|
| 1 | 1 | 0 |

# KI-basierte Deepfake Erkennung

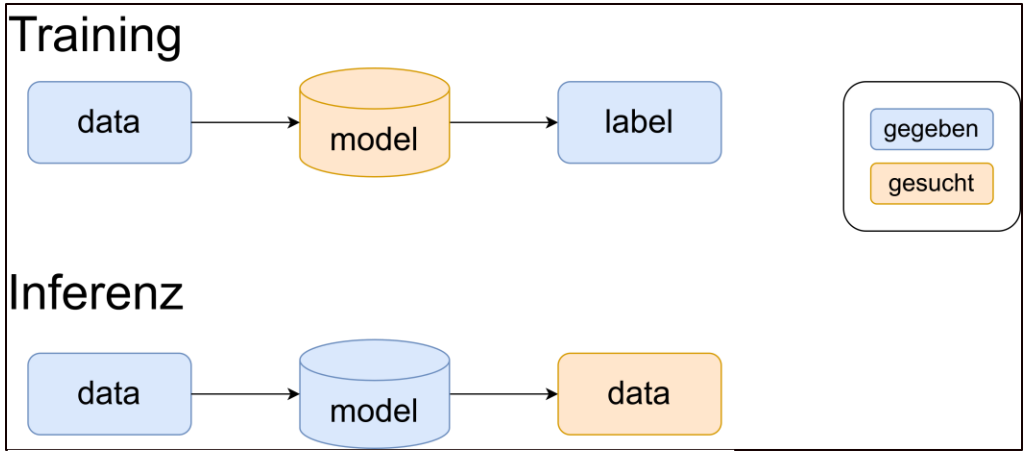
# KI-driven detection of audio deepfakes

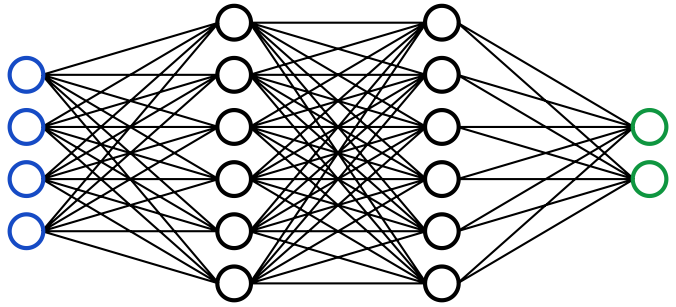
- Supervised Learning
  - Classification

- Datensatz:
  - Real and Fake audio
  - Balanced
  - Large (10s of thousands minimum)

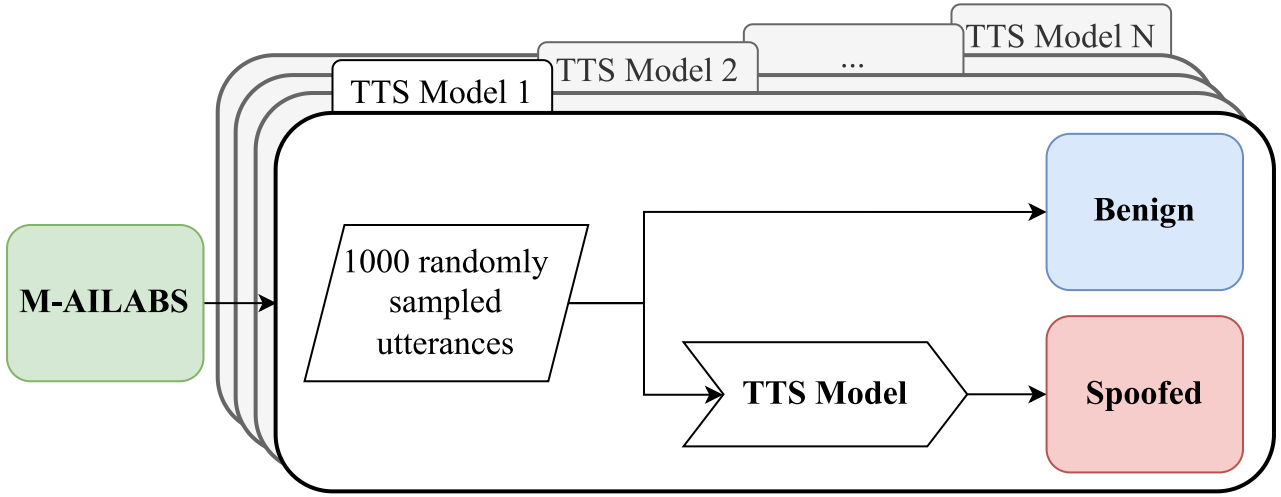
- Modelle:
  - Support Vector Maschine
  - KNN
  - …
  - Neuronales Netzwerk

| Data | Label |
|---|---|
| audio1.wav | real |
| audio2.wav | fake |
| audio3.wav | real |
| … | … |



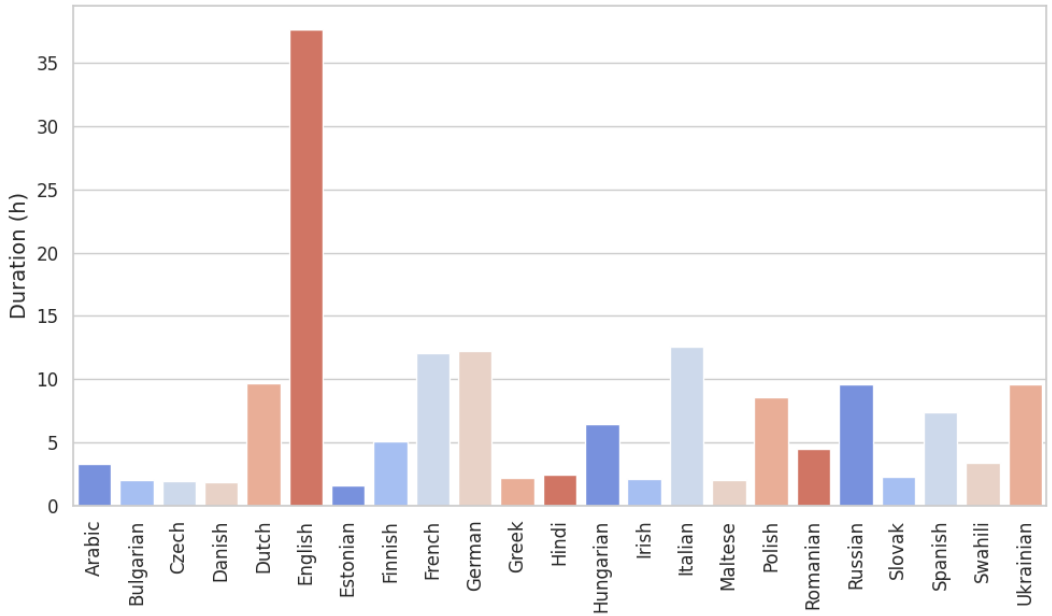



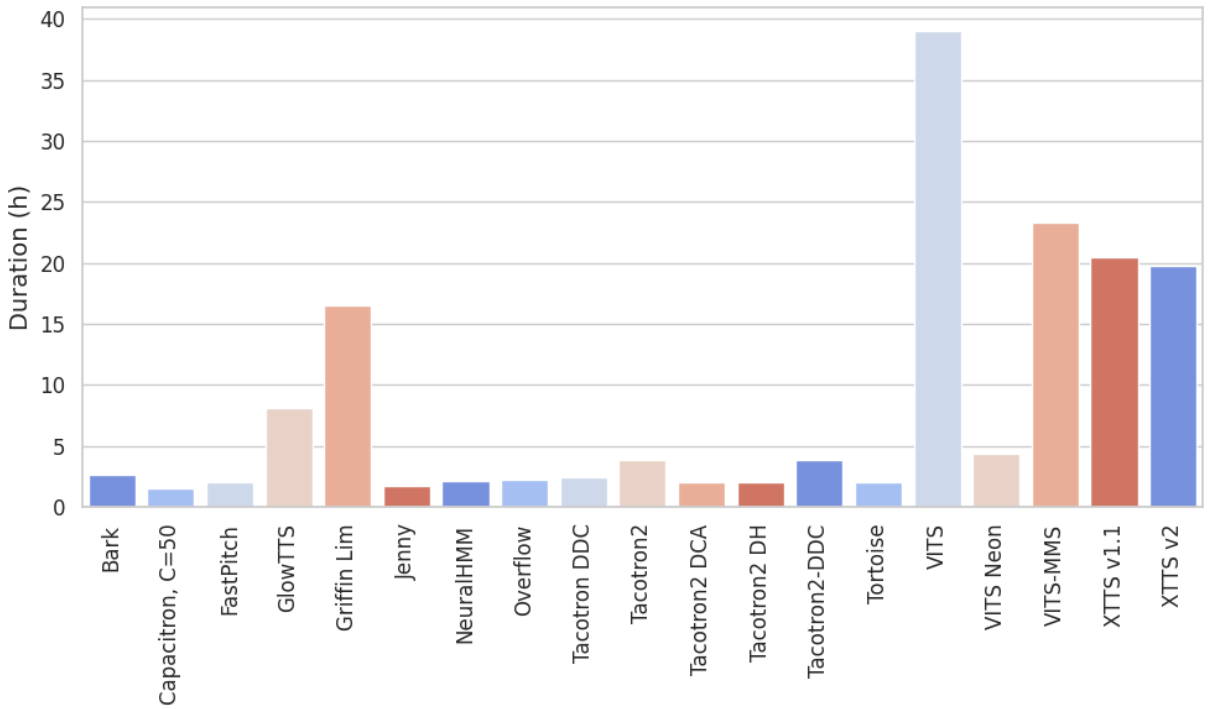
# MLAAD: Multi Language Audio Antispoof Dataset




https://arxiv.org/pdf/2203.16263.pdf

# MLAAD: Multi Language Audio Antispoof Dataset



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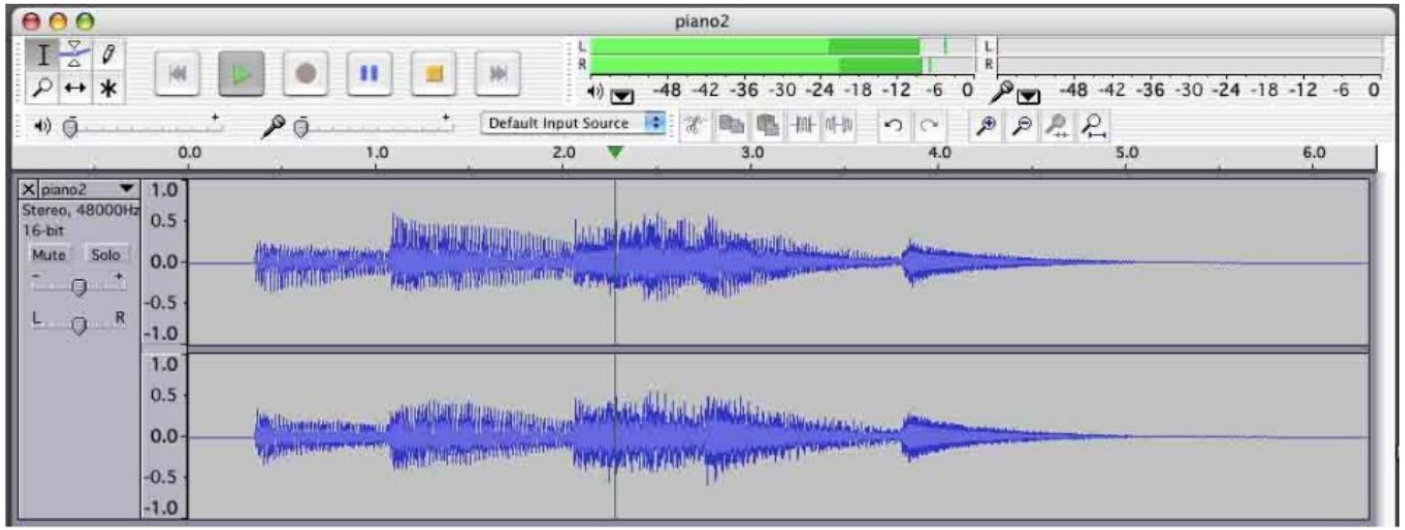
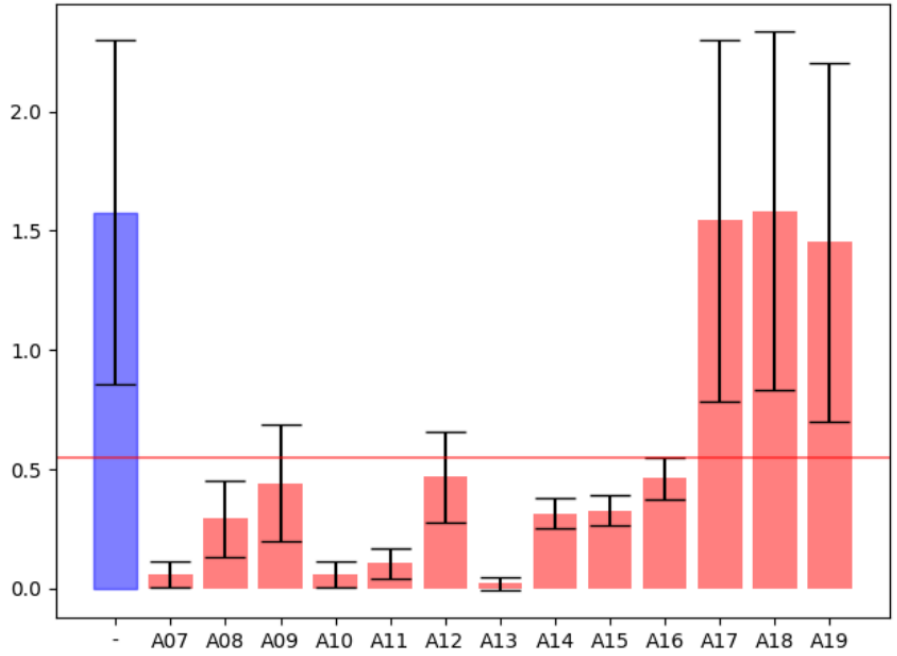
# What do models learn?



# Shortcut learning

Table 1: The results of training a dense neural network on only the *duration* of leading silence, compared against a random baseline. The network is able to significantly outperform the random baseline (see test EER, highlighted in blue). Results for the 2021 data (Deepfake and Logical Access) are copied verbatim from the submission platform (*progress* phase).

| Model | Dev EER | Eval EER | LA21 | DF21 |
|---|---|---|---|---|
| FCNN | 31.09±3.8 | 15.12±0.1 | 19.93 | 17.42 |
| Random | 50.0±0.0 | 50.0±0.0 | - | - |

https://arxiv.org/pdf/2106.12914.pdf

| Model Name | Feature Type | Input Length | ASVspoof19 eval EER% | ASVspoof19 eval t-DCF | In-the-Wild Data EER% |
|---|---|---|---|---|---|
| LCNN | cqtspec | Full | **6.354±0.39** | 0.174±0.03 | **65.559±11.14** |
| LCNN | cqtspec | 4s | 25.534±0.10 | 0.512±0.00 | 70.015±4.74 |
| LCNN | logspec | Full | 7.537±0.42 | **0.141±0.02** | 72.515±2.15 |
| LCNN | logspec | 4s | 22.271±2.36 | 0.377±0.01 | 91.110±2.17 |
| LCNN | melspec | Full | 15.093±2.73 | 0.428±0.05 | 70.311±2.15 |
| LCNN | melspec | 4s | 30.258±3.38 | 0.503±0.04 | 81.942±3.50 |

https://arxiv.org/pdf/2203.16263.pdf

# Erkennung von Audio Deepfakes

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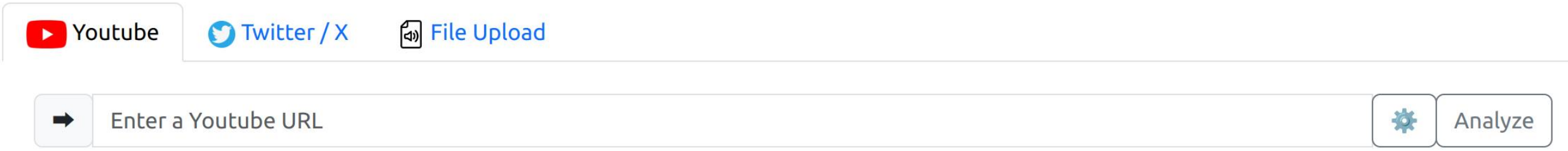
DEEPFAKE TOTAL

http://deepfake-total.com/

Analyze suspicious audio files to detect deepfakes, and automatically share them with the security community.



# Post

**ste is petitioning**
@chai_ste

🚨 BREAKING: A behind the scenes corridor recording of Starmer about the Rochdale Azhar Ali crisis has been leaked.


**Readers added context they thought people might want to know**

**Nicolas Müller**
@Nicolas15039314



## Relevant people

**ste is petitioning**
@chai_ste
Follow
🍉 marxist spiritual medium • daft leftist content for daft people

## Germany trends

1 · UEFA Champions League · Trending
**#FCBLAZ**
16.6K posts

2 · Automotive · Trending
**#Tesla**
23.8K posts

3 · Trending
**#XRATIOAI**
1,662 posts

4 · Technology · Trending
**#instagramdown**
346K posts

5 · Trending
**$zkhive**
18.5K posts

6 · Trending
**$BOODEN**

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# DEEPFAKE TOTAL

Analyze suspicious audio files to detect deepfakes, and automatically share them with the security community.

Youtube | Twitter / X | File Upload

https://twitter.com/chai_ste/status/1757717290865283282

Analyze

## TWITTER_chai_ste__1757717290865283282.mp3

0:01 / 0:13

| SSL-W2V2 | Analysing seconds 0 to 30 | Fake-O-Meter: 93.3% |
|---|---|---|

### Help us improve

Tell us if you think this audio is fake or authentic:

Authentic | Don't know | Fake

# Post

Olaf Scholz reposted

**Bundeskanzler Olaf Scholz**
@Bundeskanzler

Ohne Sicherheit ist alles andere nichts.

Translate post




Fraunhofer AISEC

## Relevant people

**Bundeskanzler Olaf Sc**
@Bundeskanzler
Follow

Bundeskanzler der Bundesrepublik Deutschland. Europäer. Demokrat. MdB-Account: @olafscholz Federal Chancellor of Germany

## Germany trends

1 · Trending
**$QORPO**
5,673 posts

2 · Trending
**$PRINT**
4,146 posts

3 · Trending
**#Nockherberg**
3,474 posts

4 · Trending
**#NEDGER**
3,426 posts

5 · Trending
**$linq**
1,210 posts

Fraunhofer AISEC

# DEEPFAKE TOTAL

Analyze suspicious audio files to detect deepfakes, and automatically share them with the security community.

## TWITTER_Bundeskanzler__1761315033802224008.mp3

0:01 / 4:04

SSL-W2V2 | Analysing seconds 0 to 30 | Fake-O-Meter: 22.4%

### Help us improve

Tell us if you think this audio is fake or authentic:

Authentic | Don't know | Fake

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README Apache-2.0 license

# 🦙🎧 LLaMA-Omni: Seamless Speech Interaction with Large Language Models

Authors: Qingkai Fang, Shoutao Guo, Yan Zhou, Zhengrui Ma, Shaolei Zhang, Yang Feng*

arXiv 2409.06666 | Hugging Face Model | Github Code

https://deepfake-total.com/analyze_upload/kmaemxsawcsmbkcwkzql___143e___llamaomni.mp3

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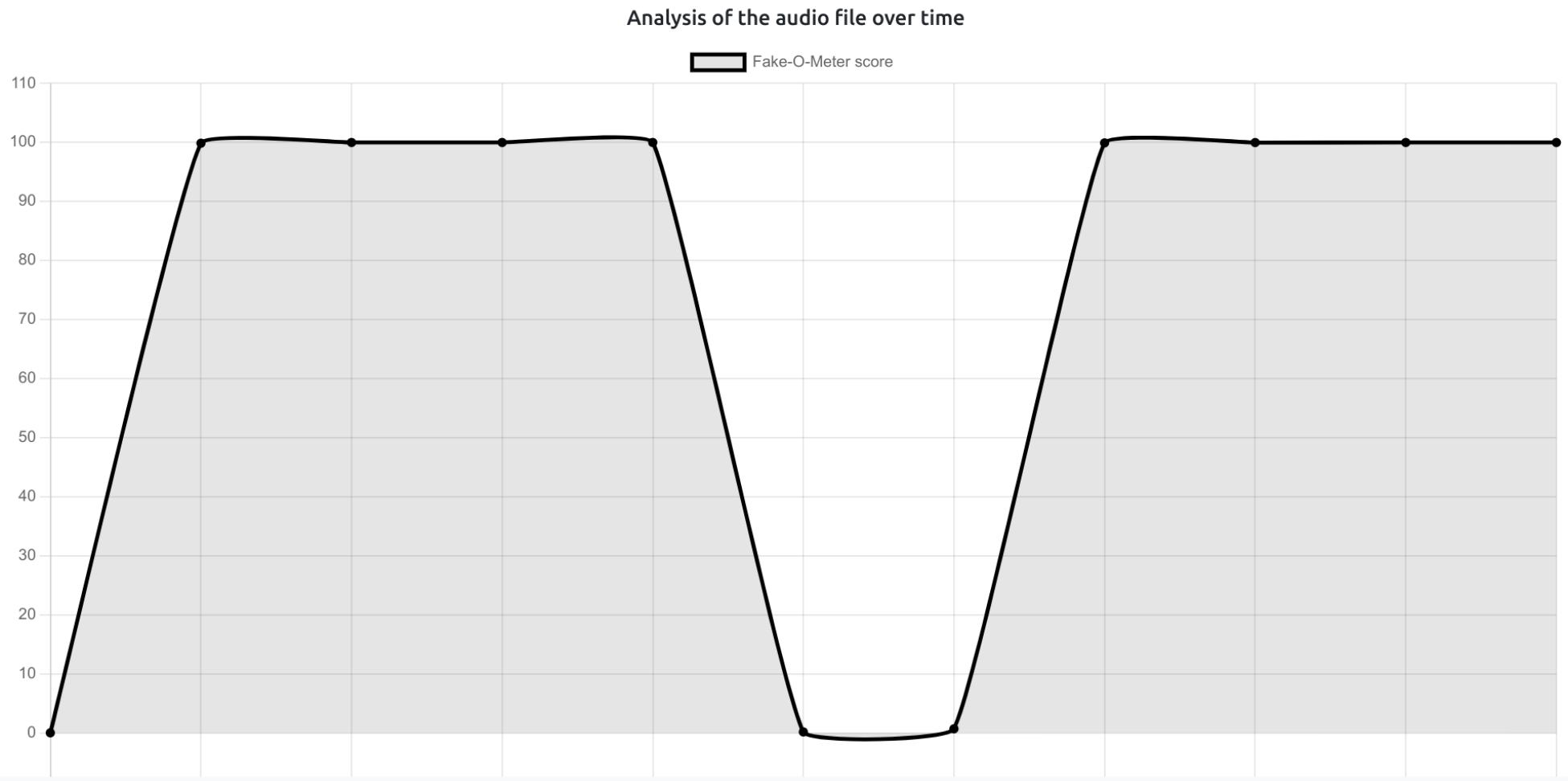
DeepfakeTotal | Analysing seconds 0 to 90 | Fake-O-Meter: 72.8% | More Info

The following chart illustrates the Fake-O-Meter score across the audio over different time slices, each a length of 3.23 seconds. This allows for a more fine-grained analysis of the audio file. The X-axis (left to right) represents the time, and the Y-axis (bottom to top) represents the Fake-O-Meter score. The higher the value, the more likely it is that the audio at this specific time is AI-generated.



# Examples

The following tables present a few examples of both synthetic audio (table 1) and authentic data (table 2). For each detection model (columns), the model score for the YouTube video (row) is shown via a color bar. Low scores (close to 0, green) indicate that the model considers the audio file authentic, while high scores (close to 1, yellow and red) indicate that the model considers the audio file a fake.

A perfect audio spoof detection model has high scores for the videos in the first table, visually represented by red bars. However, its scores would be low in the second table, i.e. predominantly green bars.

## Table 1: Synthetic Audio

The following are videos where the audio track is created by an AI. These videos can be considered 'audio deepfakes'. Ideally, these scores are high (i.e. red color bar).

| Youtube Video (click for details) | DeepfakeTotal |
|---|---|
| Jordan Peterson about the german government (DeepFake AI) |  |
| Google Text to Speech With WaveNet AI |  |
| TTS Forward-Tacotron + WaveRNN |  |
| WORST Things Doctors Overlooked! |  |
| Demonstration der Deepfake-Technologie im Kontext von Fake News |  |
| What "unwritten rule" should everyone know and follow? |  |
| Donald Trump Reads The Tragedy of Darth Plagueis The Wise #shorts |  |
| Donald Trump Says Jeffrey Epstein Didn't Kill Himself Deepfake |  |
| Two AIs talking to each other [Original] |  |

# Erkennungsraten

- **TestA:** 97,9%
- **TestB:** 91,9%
- **TestC:** 76,1%
- **TestD:** 82,9%
- **TestE:** 96,8%
- **TestF:** 98,0%
- **TestG:** 89,9%

# Google Synth ID

Füge Wasserzeichen zu KI-erstellten Inhalten hinzu:

- **Bild:** Wasserzeichen wird ins Bild eingebettet
- **Video:** Wasserzeichen wird in jedes einzelne Frame eingebettet
- **Audio:** In Spektrogramm umwandeln, Wasserzeichen einbetten, zurückkonvertieren
- **Text:** Wahrscheinlichkeit für Wortwahlen verändertn. Wenn ein Text viele „bevorzugte“ Wörter enthält, gilt er als watermarked.

Wasserzeichen nur erkennbar wenn man weiß, wonach man sucht

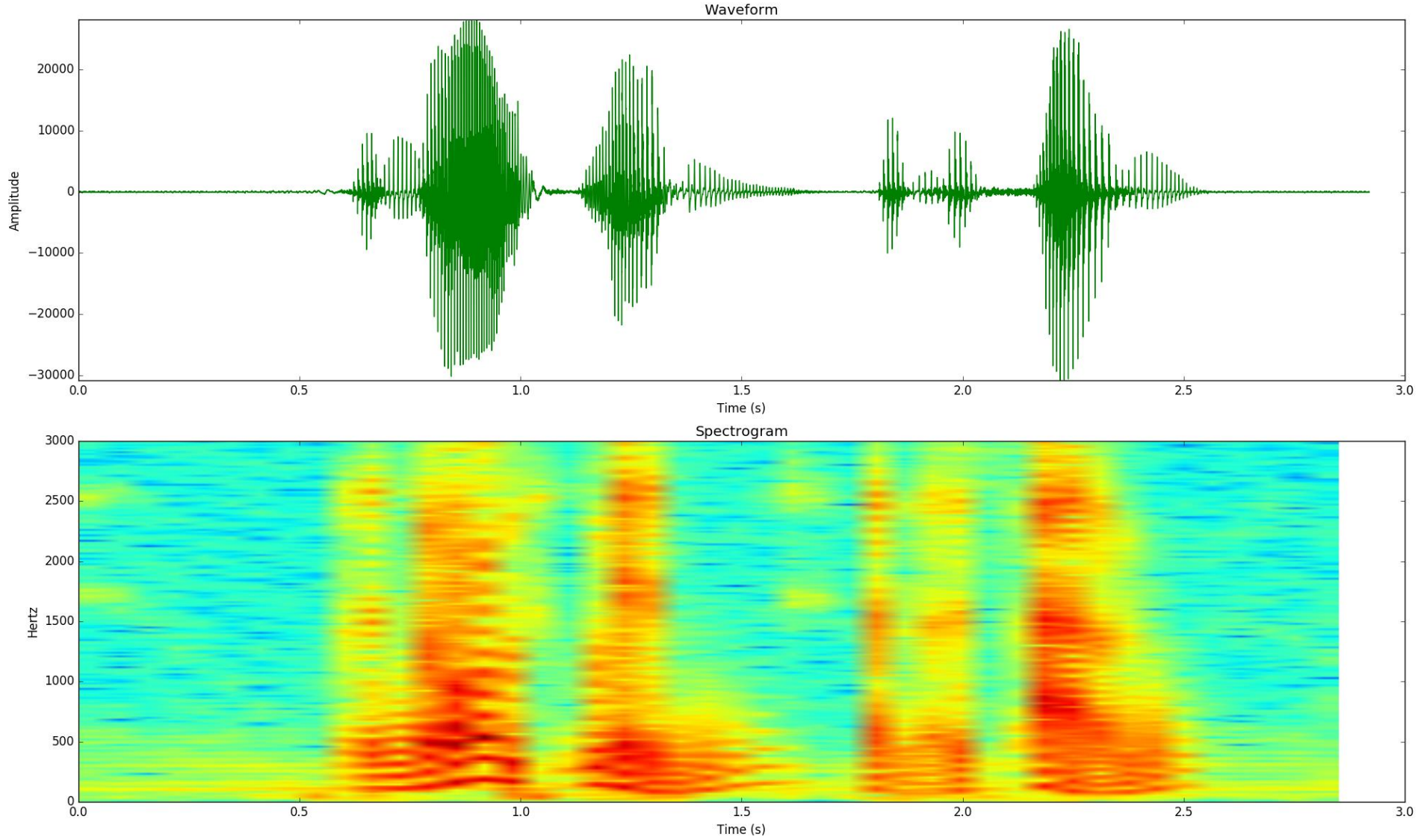
https://deepmind.google/science/synthid/

# Watermarking Images and Video



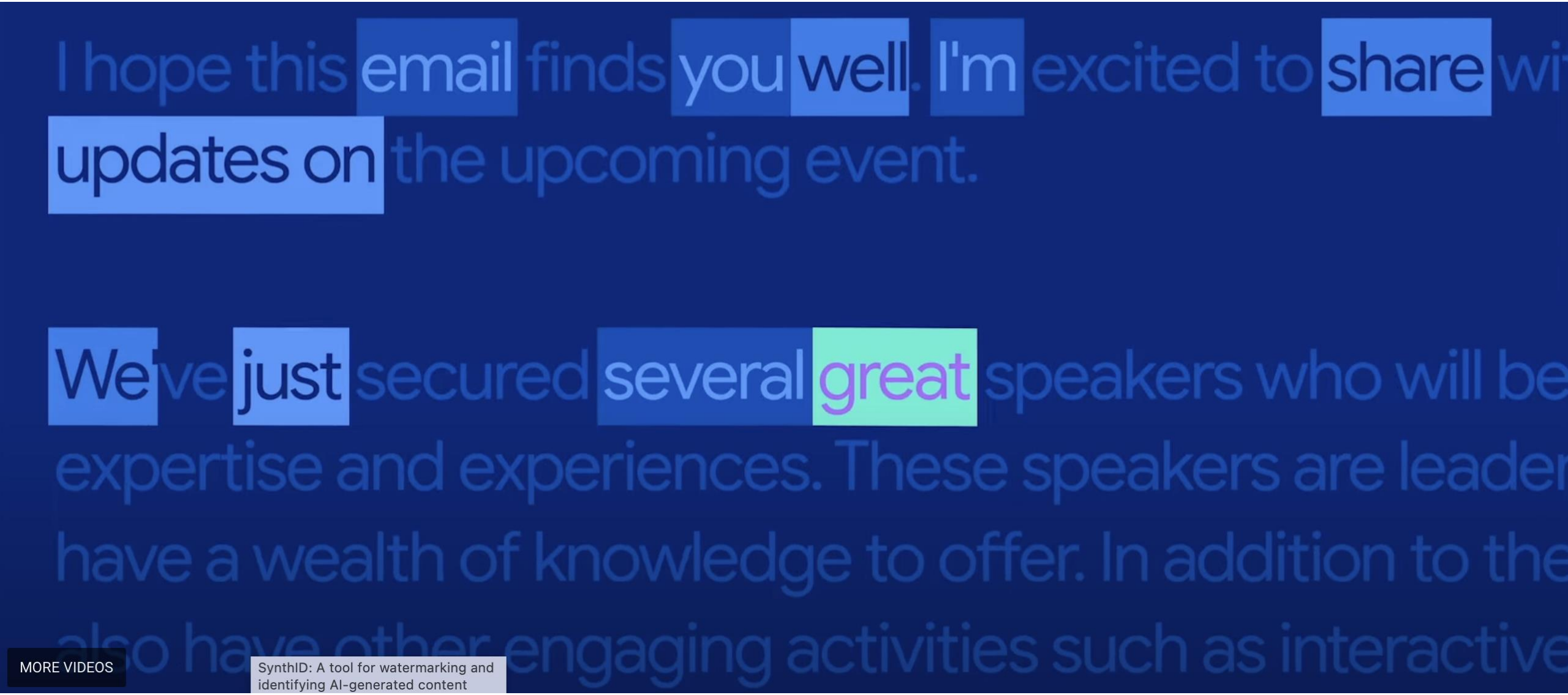
https://deepmind.google/science/synthid/

# Watermarking Audio




https://wwwhomes.uni-bielefeld.de/gibbon/ShanghaiSummerSchool2018/

# Watermarking Text




https://deepmind.google/science/synthid/

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https://deepmind.google/science/synthid/

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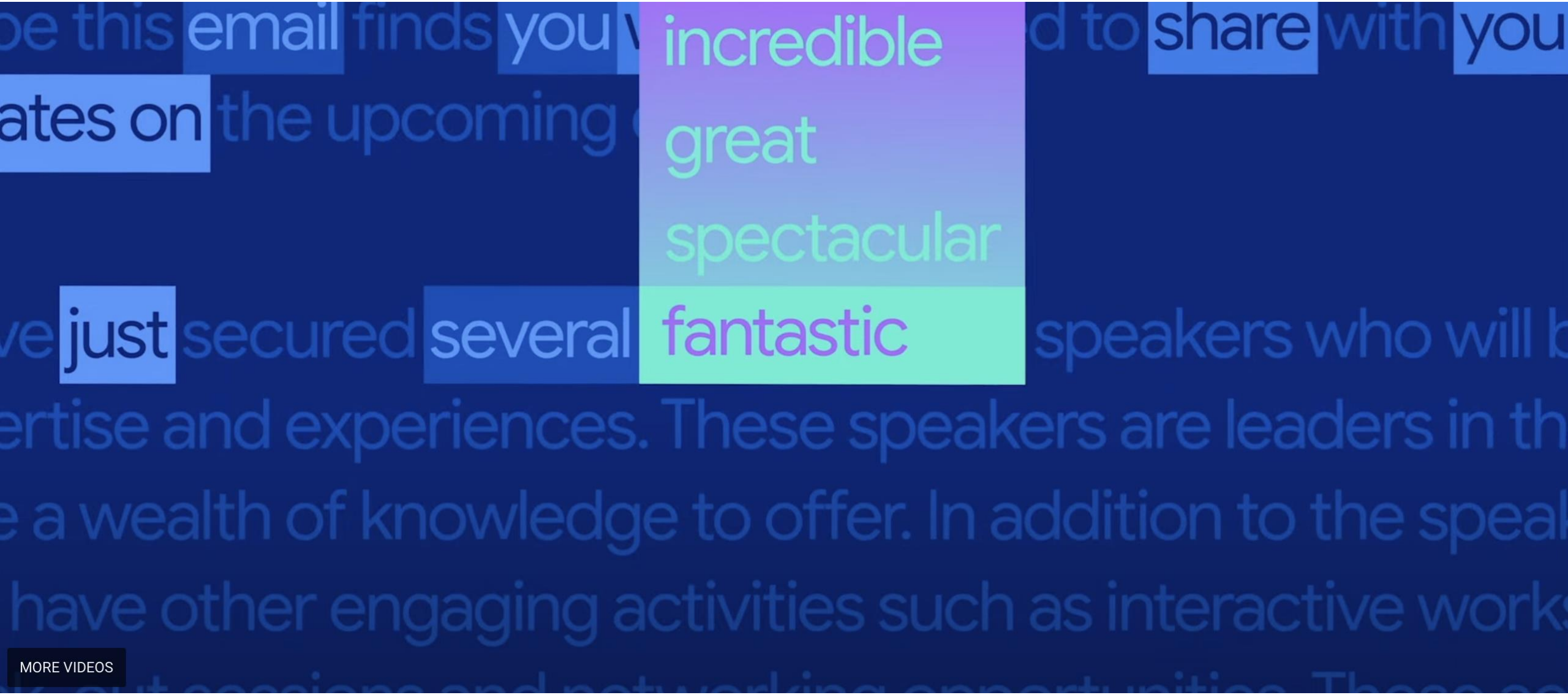


https://deepmind.google/science/synthid/

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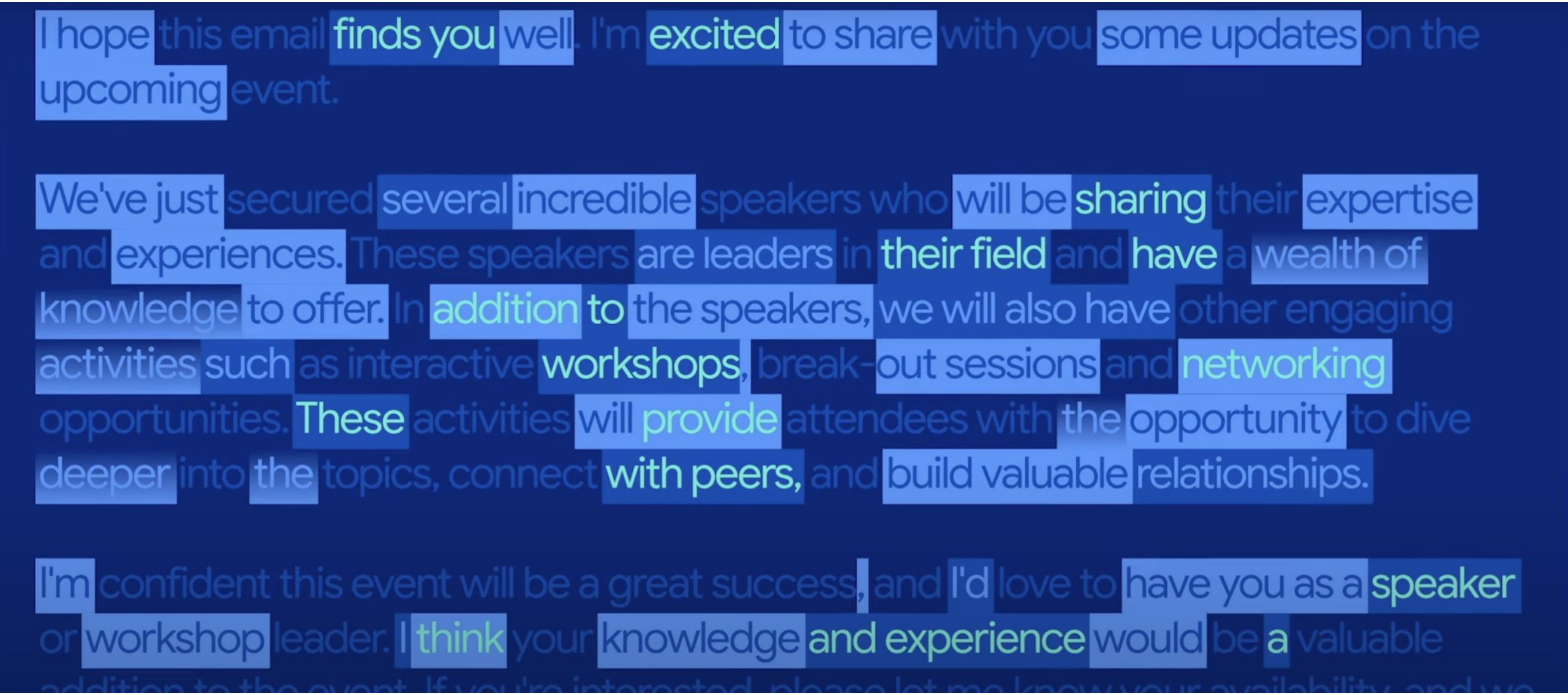
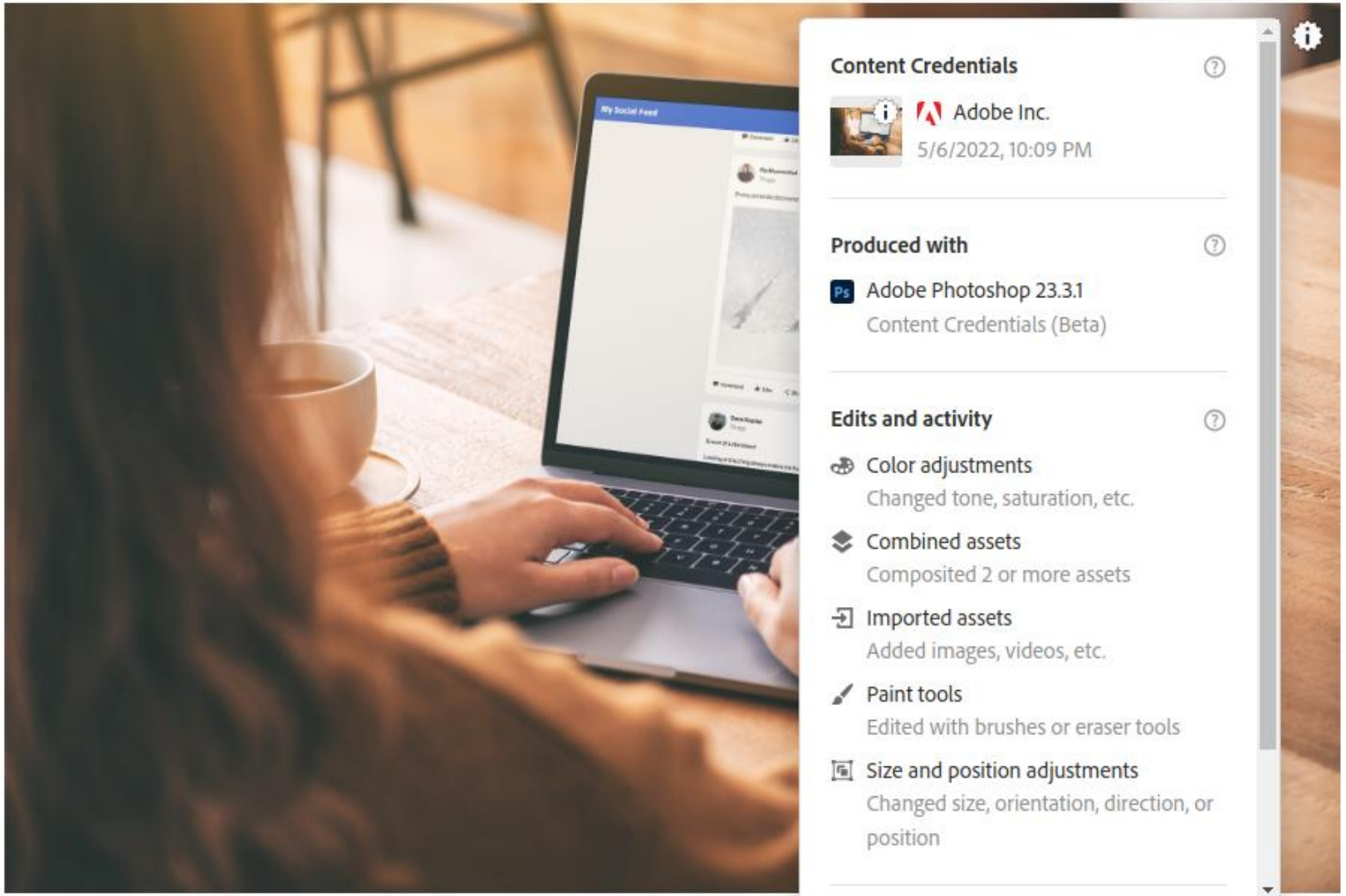



https://deepmind.google/science/synthid/

# Content Authenticity Initiative

- "Instead of guessing what's fake, let's prove what's true"
- Kryptographische Signatur
- "Herkunft", nicht "Wahrheit"




https://contentauthenticity.org/

**Andreas Hoinisch** • 2.

Präzision verkaufen, Innovation vorantreiben – Ihr Partner für sma...

14 Std. •

+ Folgen

Egal wo ich hier lese:
Alle haben eine Rolex, einen Porsche und arbeiten wann immer sie wollen von wo sie wollen. ... mehr

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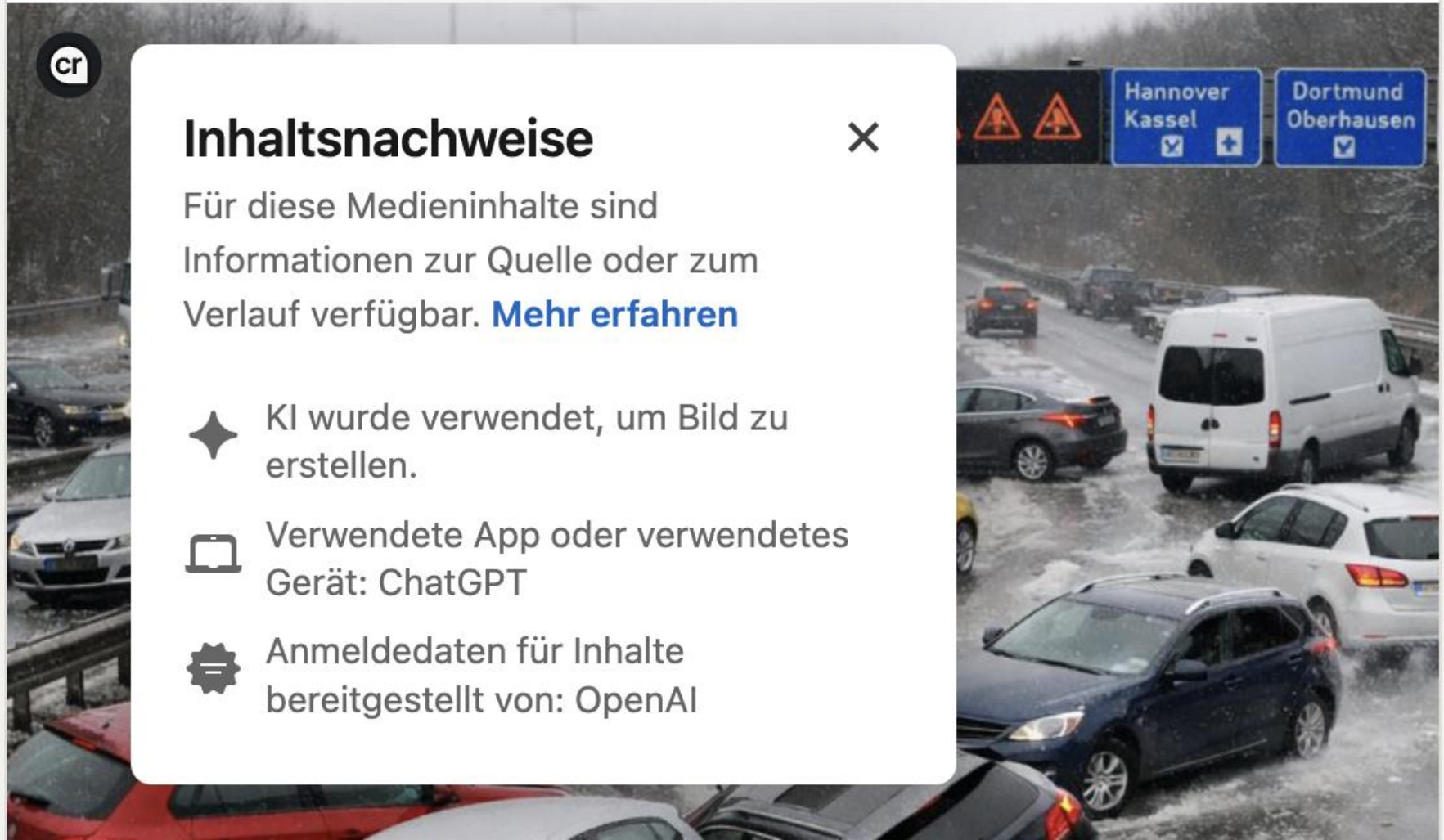
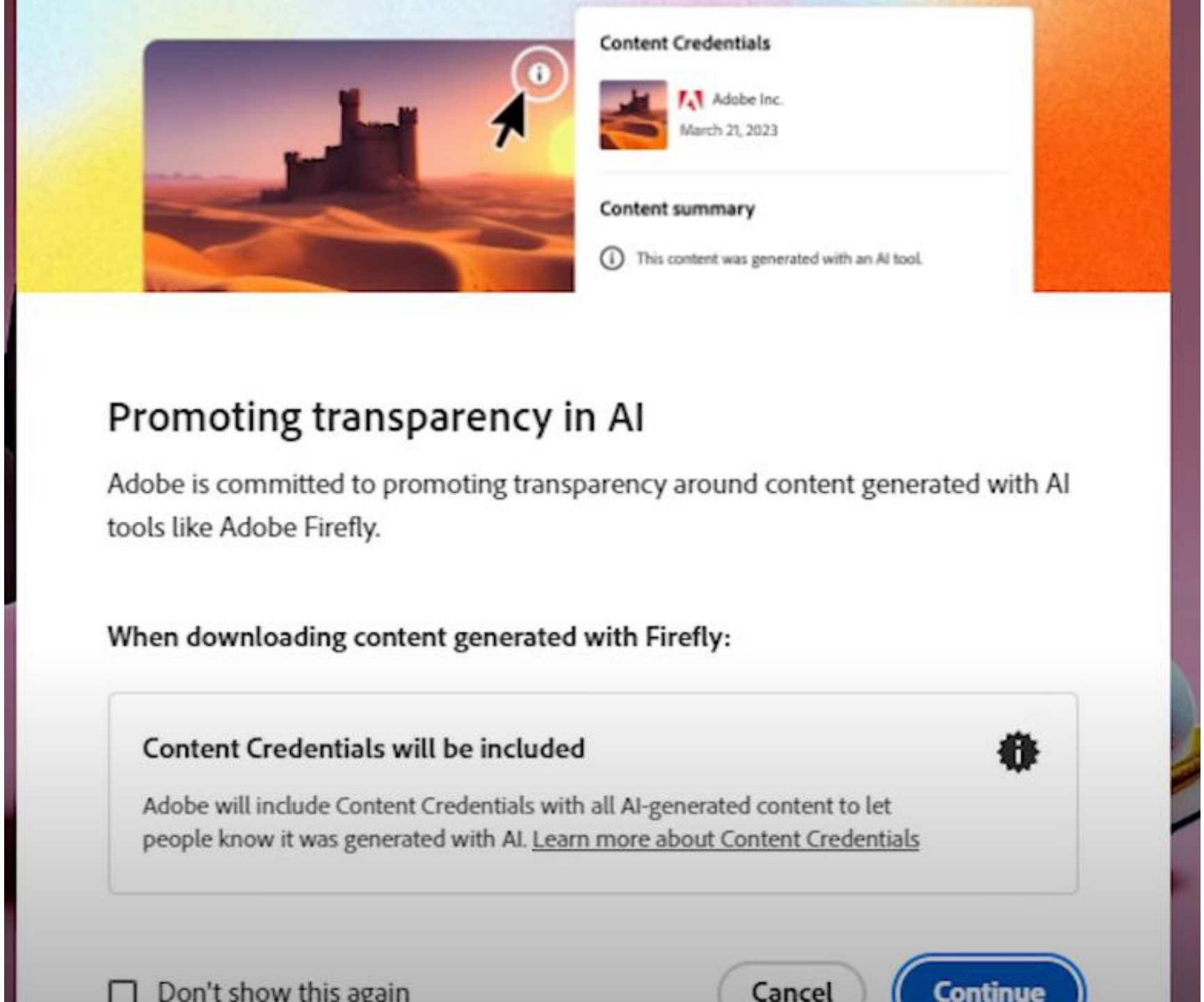



## Inhaltsnachweise

Für diese Medieninhalte sind Informationen zur Quelle oder zum Verlauf verfügbar. Mehr erfahren

- KI wurde verwendet, um Bild zu erstellen.
- Verwendete App oder verwendetes Gerät: ChatGPT
- Anmeldedaten für Inhalte bereitgestellt von: OpenAI


Content Credentials
Adobe Inc.
March 21, 2023
Content summary
This content was generated with an AI tool.
Promoting transparency in AI
Adobe is committed to promoting transparency around content generated with AI tools like Adobe Firefly.
When downloading content generated with Firefly:
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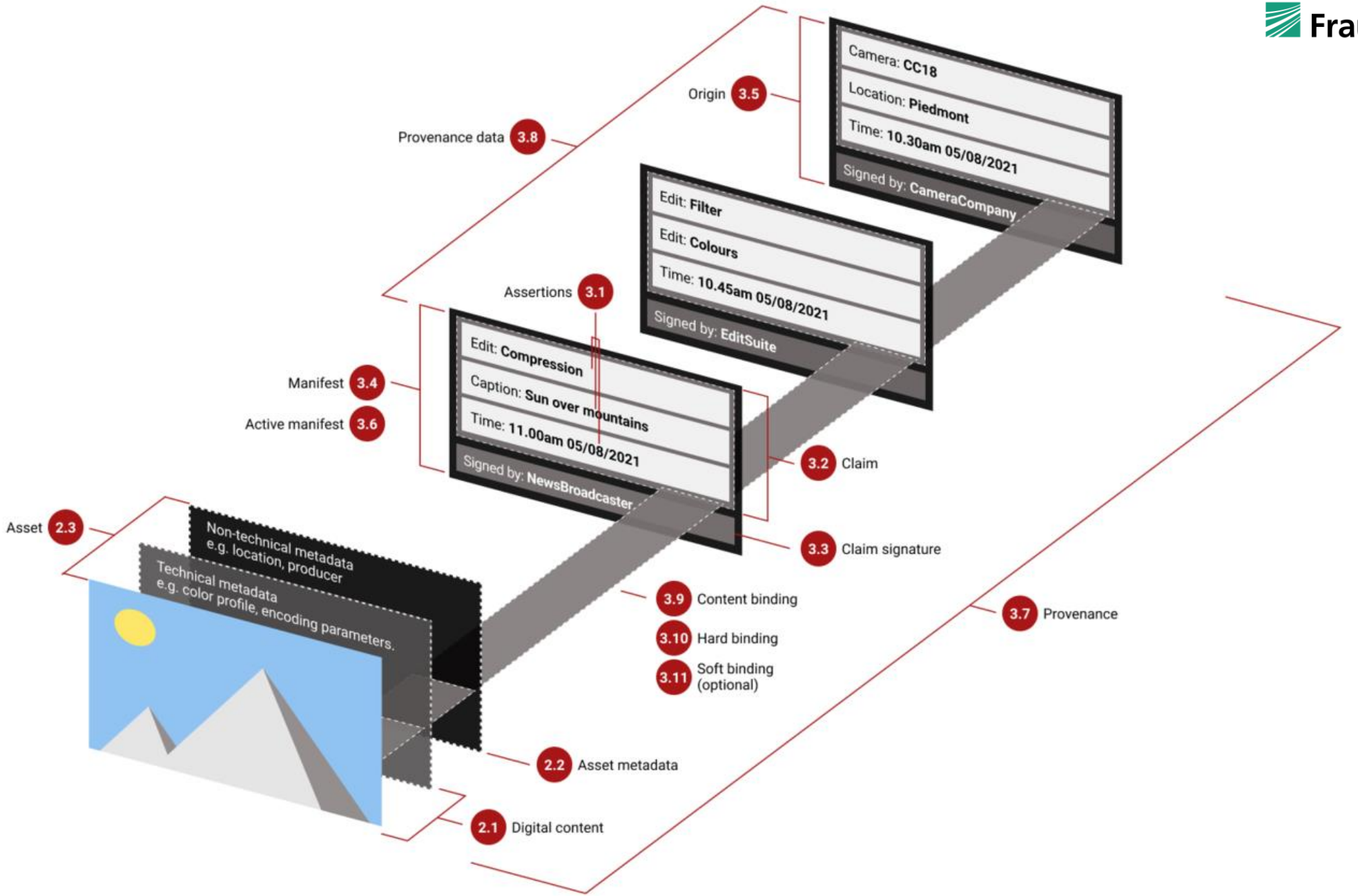


https://github.com/c2pa-org/public-draft/tree/main/docs/images

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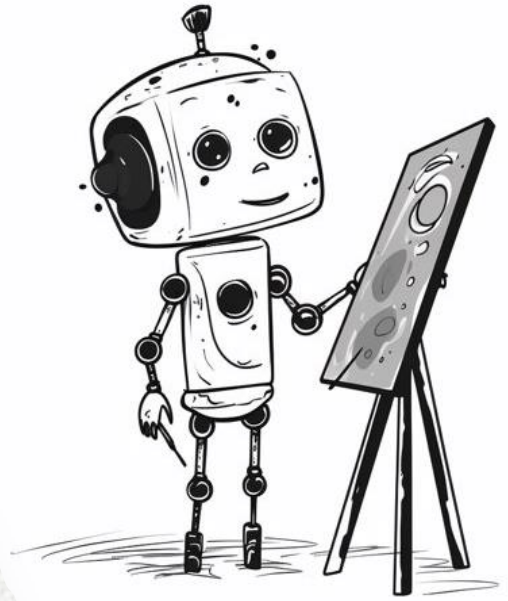
# Ethischer Nutzen von KI

Be-me-voice (Google Parrotron)

# Viele gutartige Use-Cases




Wii Sports
Full Series

# Kontakt

Fraunhofer AISEC

Fraunhofer-Institut für Angewandte und Integrierte Sicherheit AISEC


## Dr. Nicolas Müller

Cognitive Security Technologies
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Ressourcen:

- deepfake-total.com/
- deepfake-demo.aisec.fraunhofer.de/