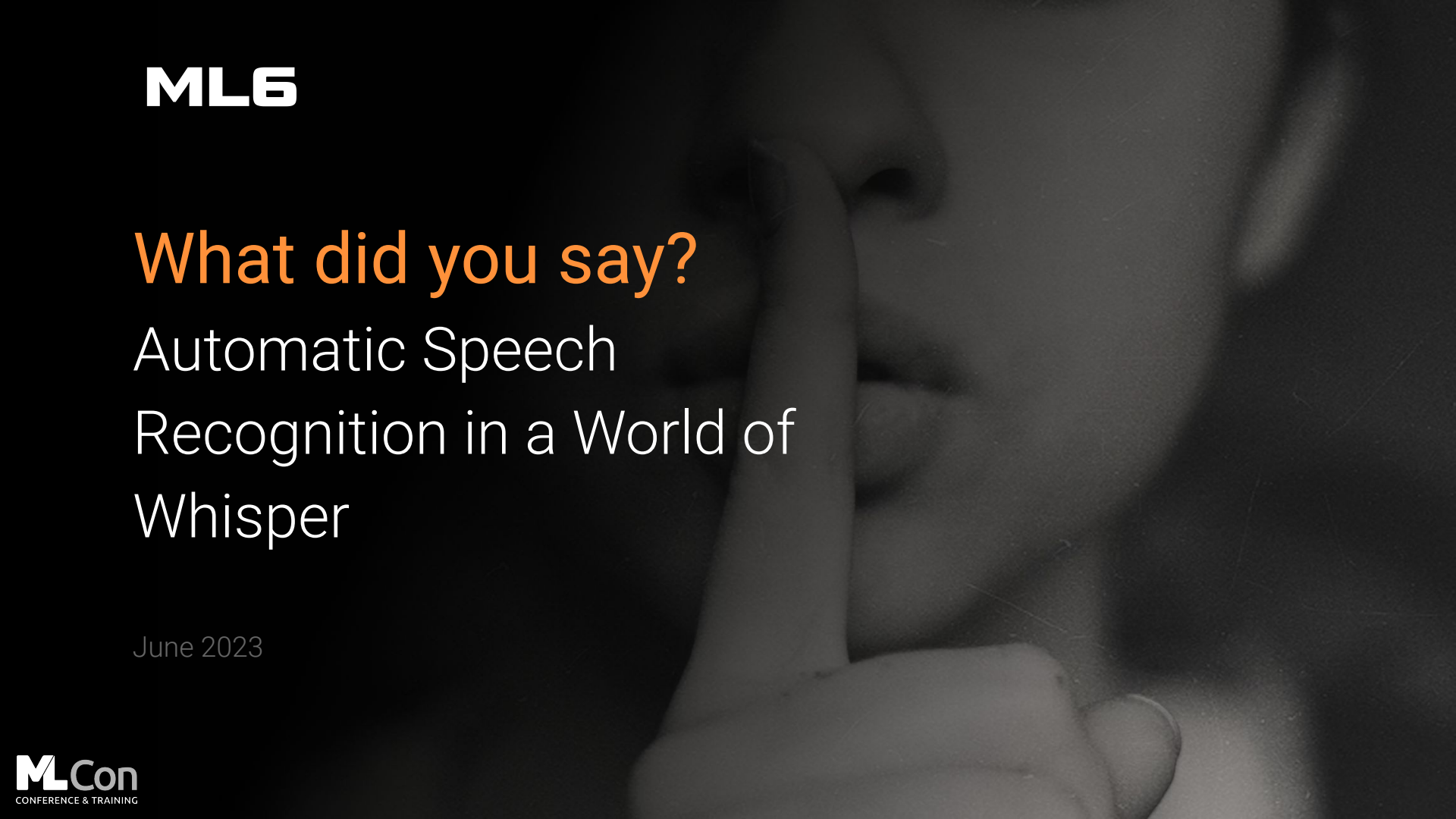

ML6

What did you say?

Automatic Speech Recognition in a World of Whisper

June 2023

MLCon
CONFERENCE & TRAINING

Lisa Becker

Machine Learning Engineer

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Voice & Sound

Natural Language Processing

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Agenda.

1. What is Automatic Speech Recognition (ASR)?
2. ASR at ML6
3. Why is Whisper so good?
4. Optimising Whisper for your use case
5. Practical use cases

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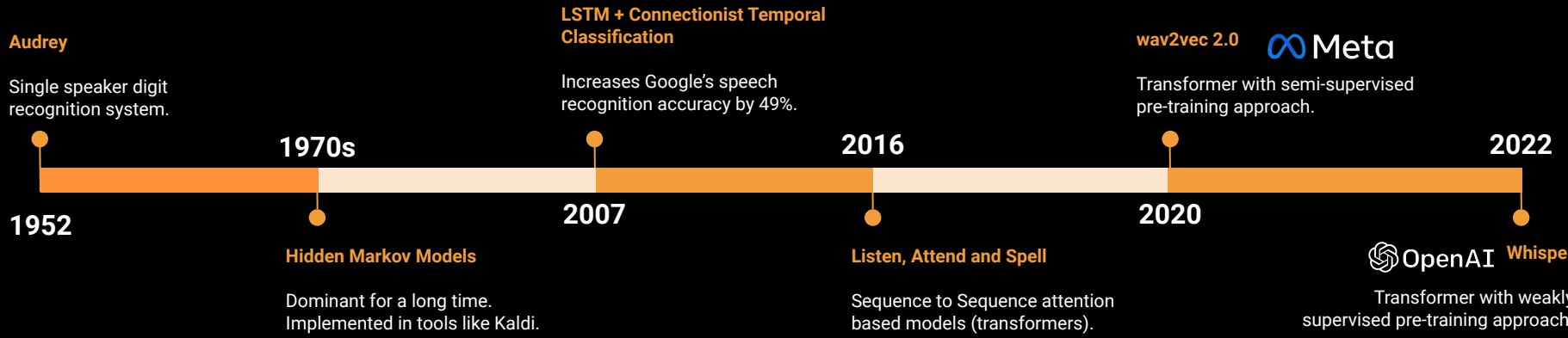
What is ASR?
An overview

1. Automatic Speech Recognition ≈ Speech-to-Text
2. Recognition & translation of spoken language into text
3. Downstream NLP tasks



ASR at ML6

Phase 1: DPV & Memo (2020)

1. Transcription of customer calls
2. dpv: German
3. Memo: Flemish
4. wav2vec 2.0 finetuned on custom labelled data

memo+

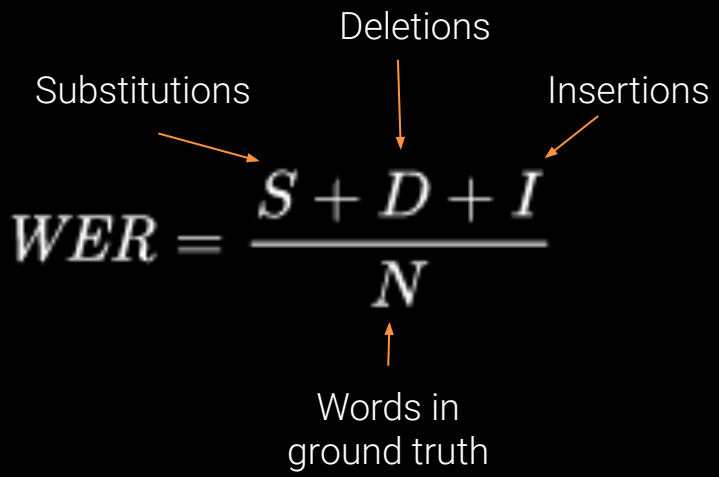
dpv Deutscher Pressevertrieb

ASR at ML6

Phase 1: DPV & Memo (2020)

WER: Word Error Rate

CER: Character Error Rate



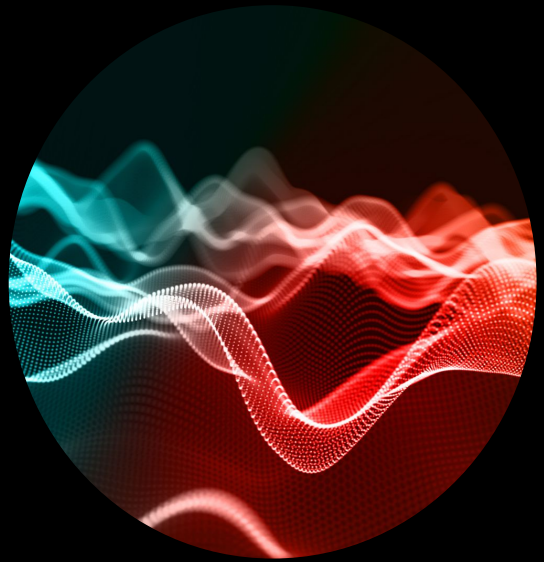
Ground Truth	"Word error rate is a metric of the performance of a speech recognition system."
Hypothesis (= ASR result)	Substitution, Insertion "Ward error rate is a common metric of the performance of a speech recognition _." Deletion

1 + 1 + 1 / 14 = 21% WER

→ **goal is to minimize WER**

ASR at ML6

Phase 1: DPV & Memo (2020)



	dpv Phase 1	memo+ Phase 1
Model	wav2vec 2.0	wav2vec 2.0
Finetuned	~10 hrs	~20 hrs
WER (word)	32%	32%
CER (letter)	20%	19%

ASR at ML6

Phase 2: Memo (2022/2023)

1. Whisper (large v2)
2. No finetuning

   (Generating insights from call transcriptions)

	dpv Phase 1	memo Phase 1	memo Phase 2
Model	wav2vec 2.0	wav2vec 2.0	**Whisper large**
Finetuned	~10 hrs	~20 hrs	❌
WER (word)	32%	32%	**27%**
CER (letter)	20%	19%	**17%**
Size	14GB	14GB	**10GB**
Multitask	❌	❌	✅

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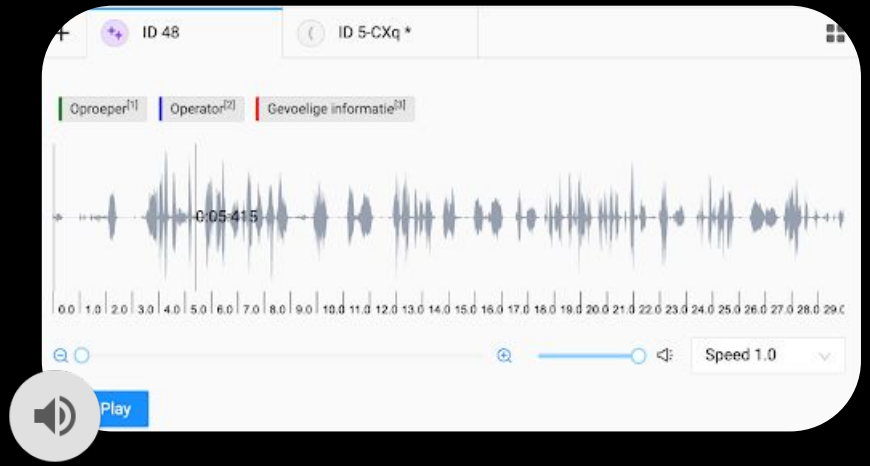
Why is Whisper so good?

Multitask

- ASR
- Voice activity detection
- Language detection
- Language translation




```
of wat informatie? Ik zou graag willen... Ik was een keer op dit appartement en nu is het
ongeveer een paar weken en dit appartement is nog steeds beschikbaar dus ik heb de vraag, als het
nog steeds beschikbaar is, kan ik deze huis afwachten?
```

- Whisper large, 2022

Why is Whisper so good?

Whisper beats wav2vec 2.0 on many benchmark datasets

Dataset	wav2vec 2.0 Meta WER (word)	Whisper OpenAI WER (word)
LibriSpeech	2.7	2.7
Artie	24.5	6.7
Fleurs (EN)	14.6	4.6
Common Voice	29.9	9.5
Tedlium	10.5	4.0
ChiME6	65.8	25.6
WSJ	7.7	3.1
…		
Average	29.5	12.9

Why is Whisper so good?

Let's compare:

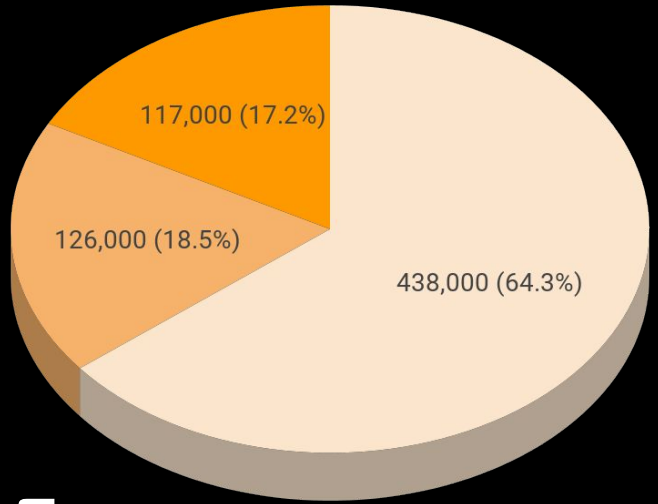
Model	wav2vec 2.0 Meta	Whisper OpenAI
Released	2020	2022
# languages	53	99
Language detection	❌	✅
Language translation	❌	✅
Timestamps	(✅)	✅
Diarization	❌	❌
Casing	❌	✅
Punctuation	❌	✅
On 🤗	✅	✅
Training data	56k hours	680k hours

Why is Whisper so good?

Because of the training data

Paper: Robust Speech Recognition via Large-Scale Weak Supervision

"If an acronym or basis for the name is desired,
WSPSR *standing for Web-scale Supervised*
Pretraining for Speech Recognition can be used."



- Hours English audio + English transcript
- Hours non-English audio + English transcript
- Hours non-English audio + corresponding transcript

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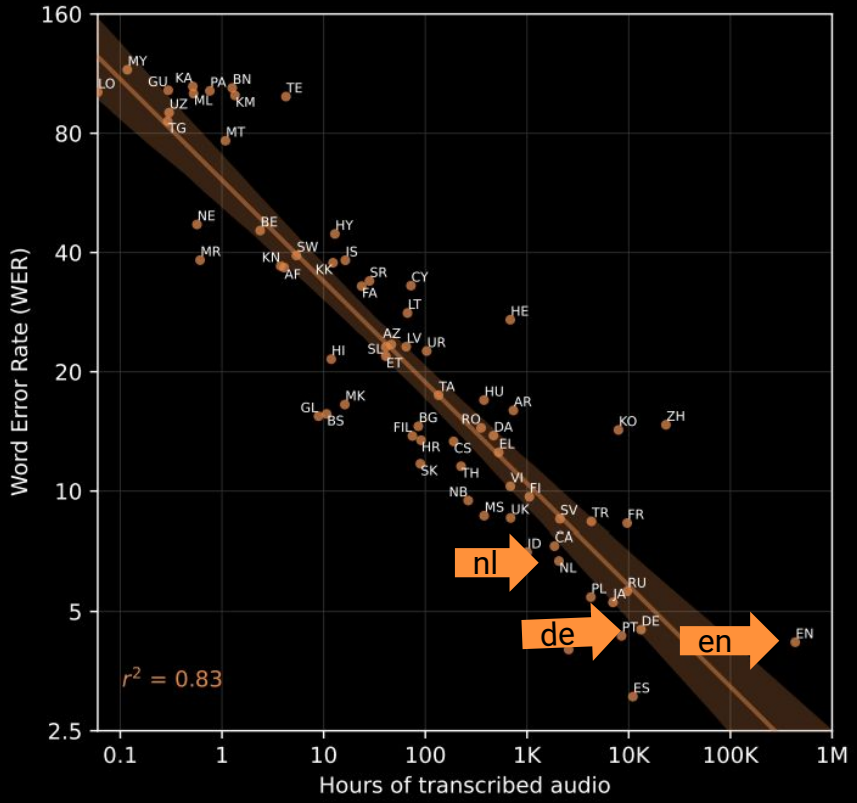
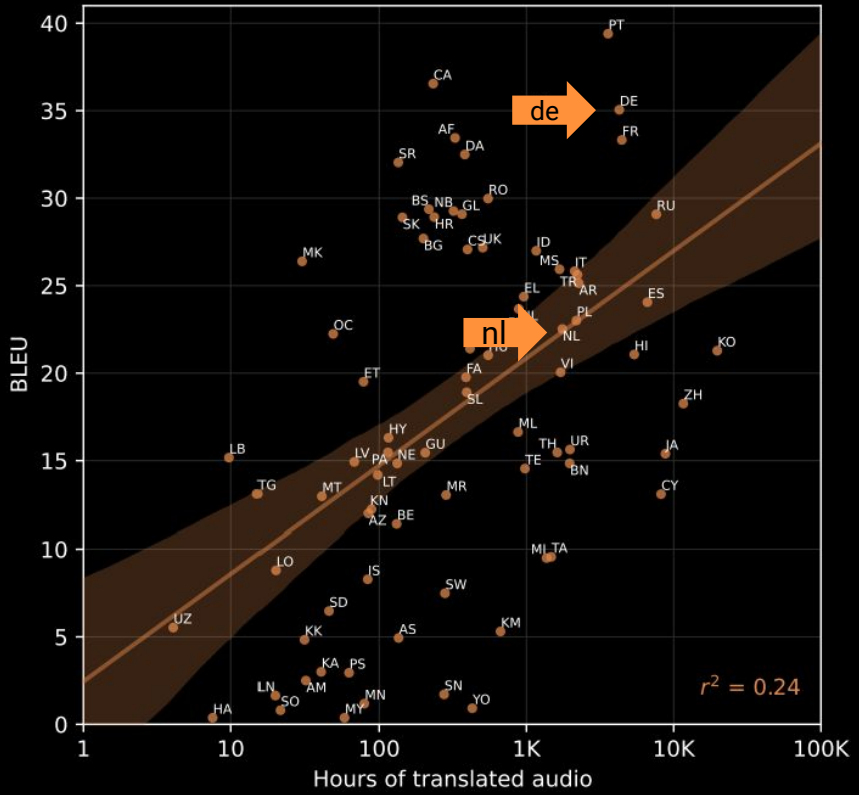
Why is Whisper so good?

More data == better?



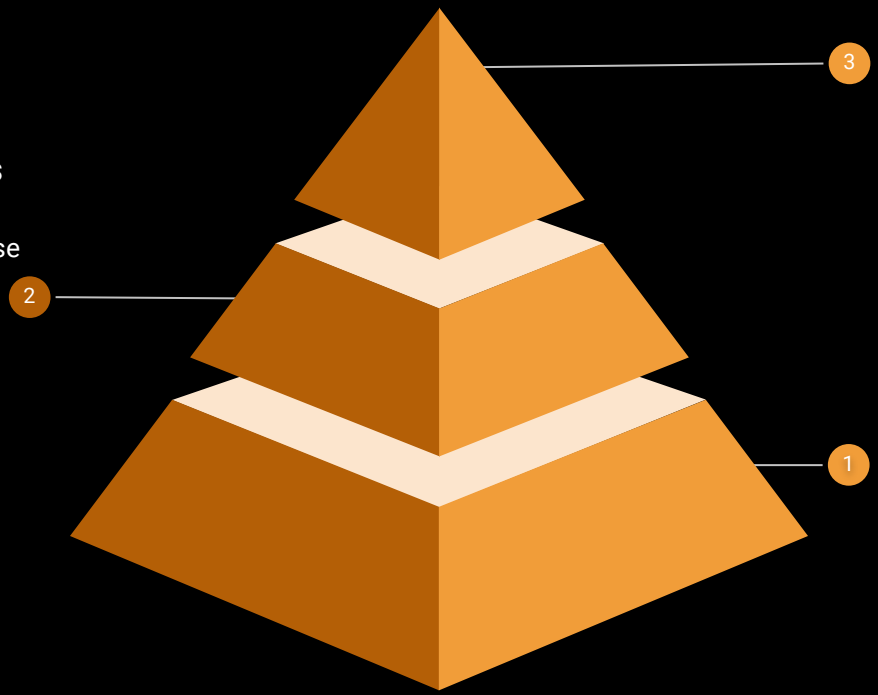


Why is Whisper so good?

Because of the training data

Automated filtering methods

- Exclude if all upper-/ lowercase
- Exclude if no punctuation
- Check if language matches metadata
- Fuzzy de-duping
- …



Initial training & manual inspection

Identify and remove low-quality samples.

Scraping

“Audio that is paired with transcripts on the Internet… from many environments, recording setups, speakers, and languages.”

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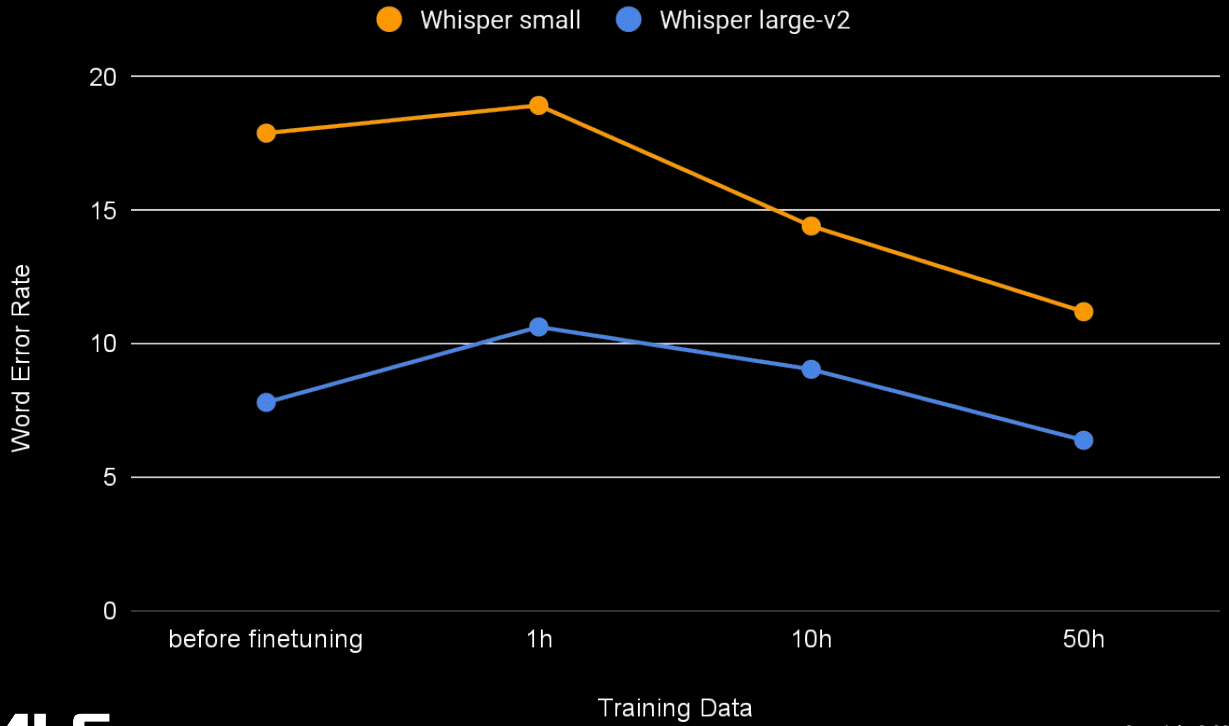
Optimising Whisper for your use case

"We are family" 🎶

Size	Parameters	Required VRAM	Relative speed
tiny	39 M	~1 GB	~32x
base	74 M	~1 GB	~16x
small	244 M	~2 GB	~6x
medium	769 M	~5 GB	~2x
large	1550 M	~10 GB	1x

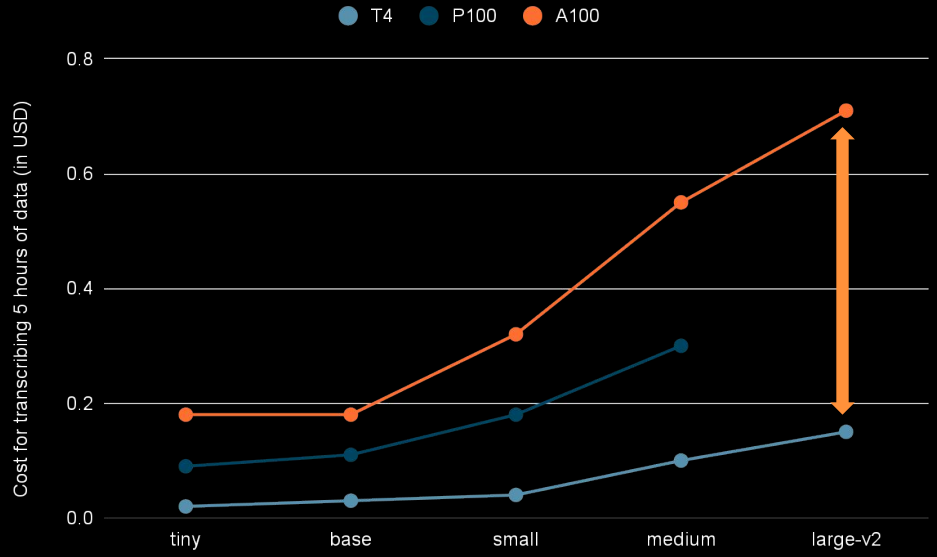
Optimising Whisper for your use case

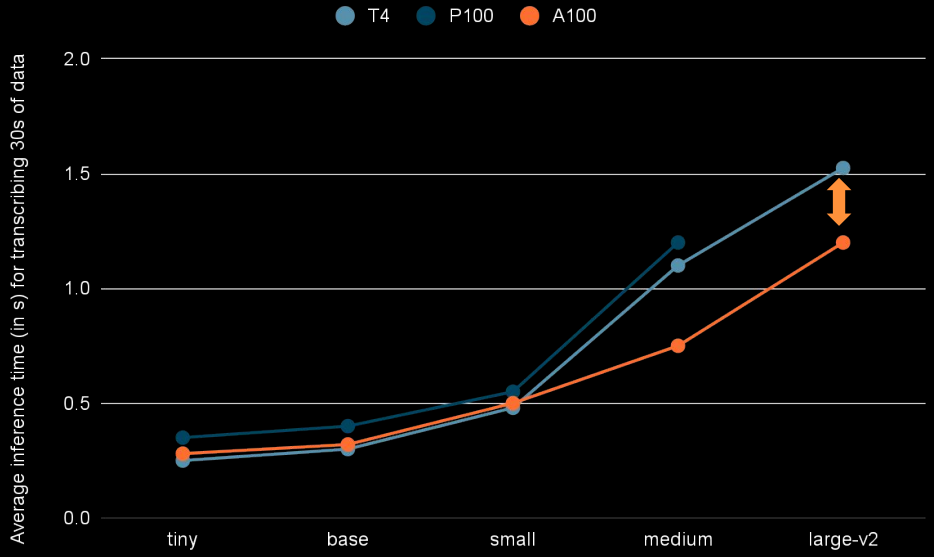
Error rate decreases for non-English languages through finetuning



Optimising Whisper for your use case

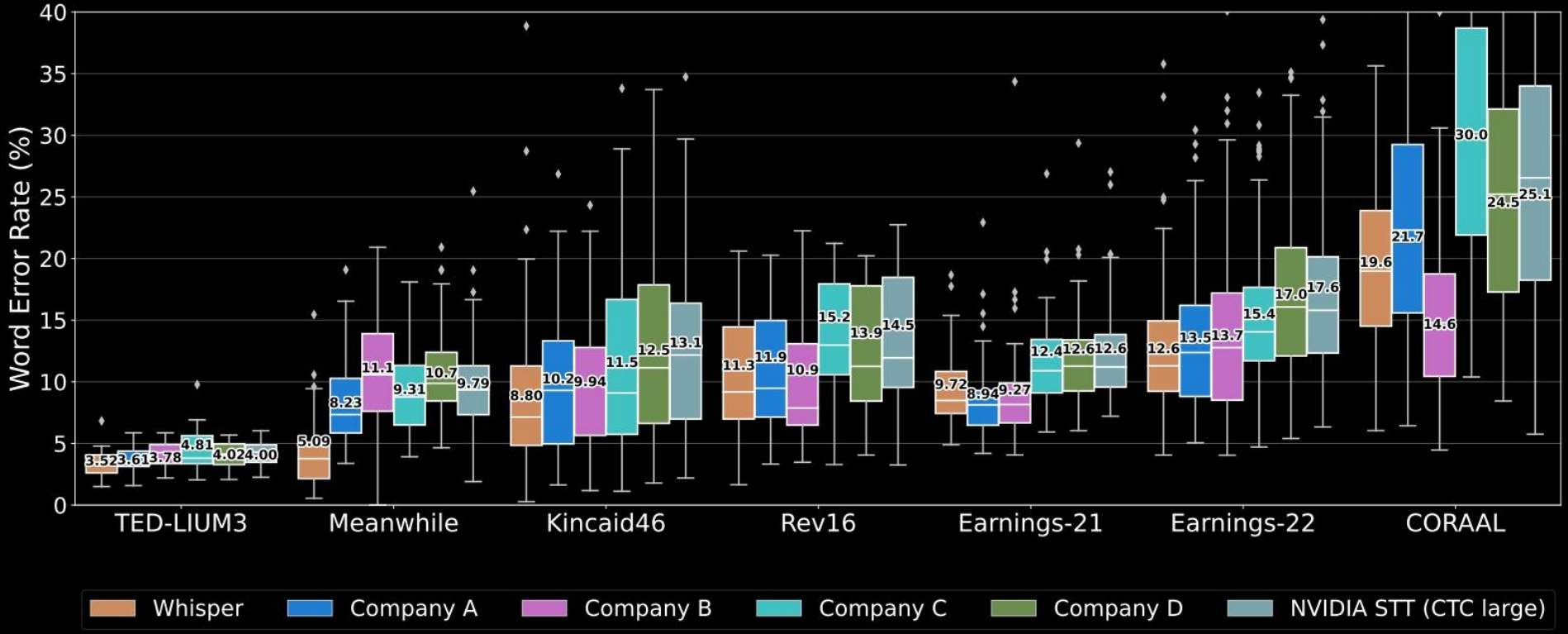
T4 has best trade-off for cost and latency





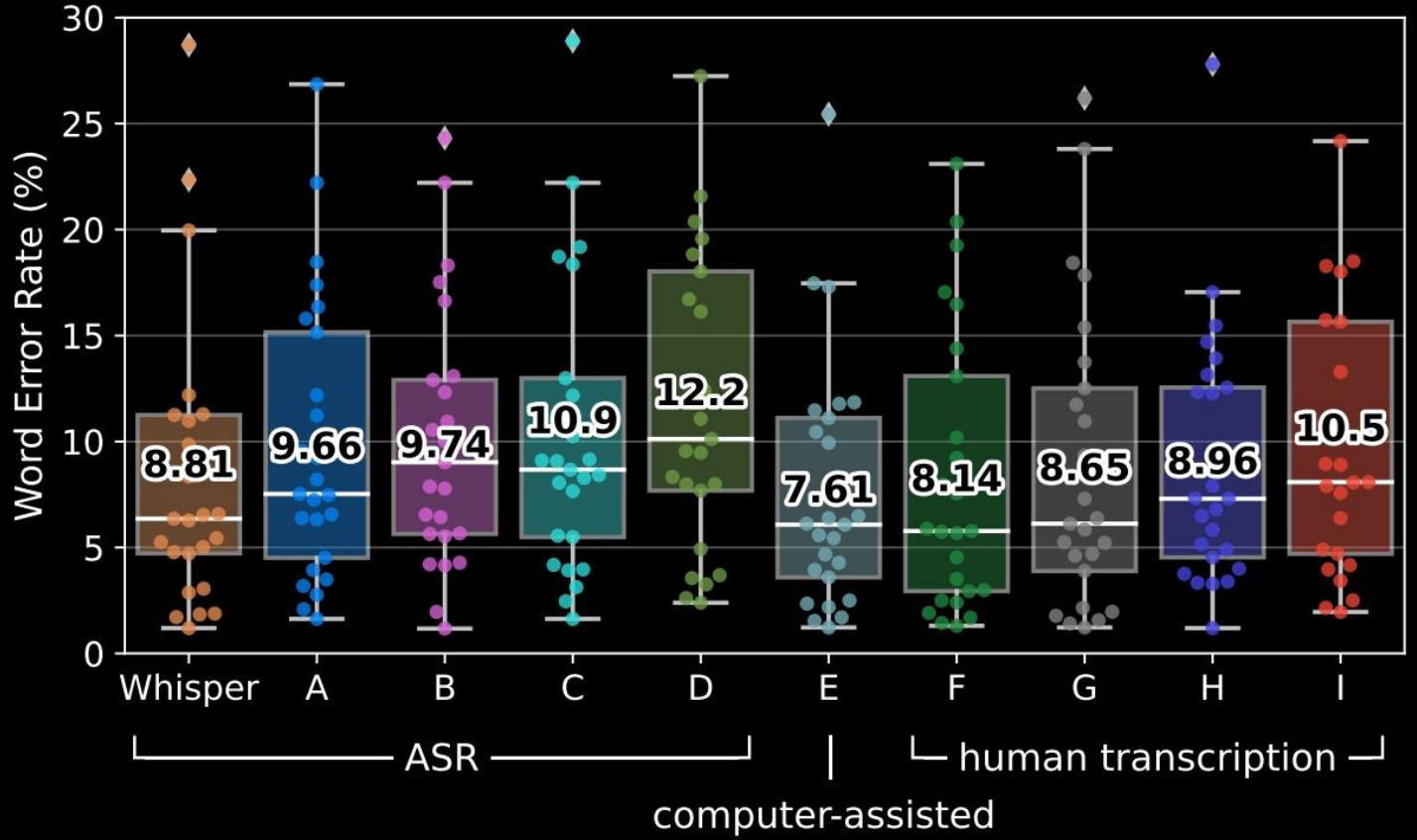
Optimising Whisper for your use case

Comparable / better to commercial models, similarly costly



Optimising Whisper for your use case

Comparable to human transcription



Recap
ASR in a World of Whisper

Given enough high quality data, we can achieve human performance.

When should we use what?

1

Whisper & wav2vec 2.0:

- Easy to use
- Easy to finetune

2

Whisper

- Multitask
- Better accuracy out-of-the-box
- Best for English
- T4 best trade-off between cost & inference time

3

wav2vec 2.0

- Lower GPU utilization
- Significantly faster (15x - 40x more throughput)

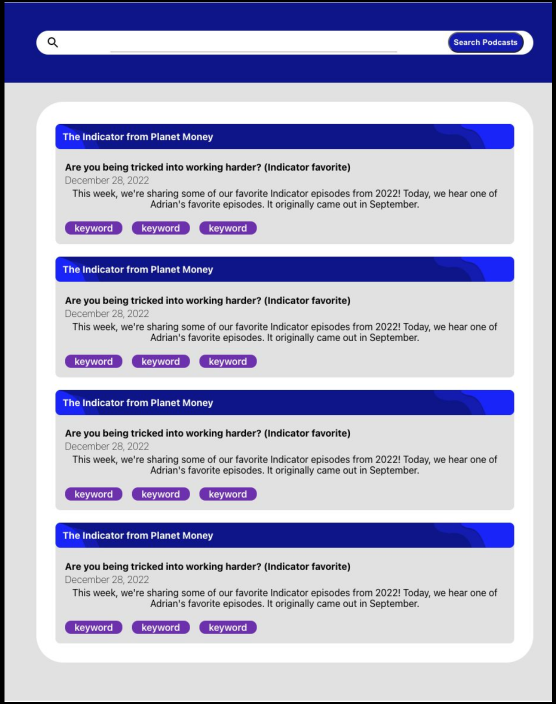
Practical use cases

Internal Project: “Make podcasts searchable”

Idea:

Tool for searching podcasts (+ summary & keywords)

Checkpod
data acquisition → transcription with Whisper → haystack by deepset
summarization, … →



Takeaways:

1. Only large model yields acceptable multilingual results
2. Processing time on GPU ≈ 3% of audio input duration (1.5 min for 1 hr in EN compared to 100% for NL)

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Practical use cases
Finetuning Event

- 2-week sprint in December 2022
- Hugging Face: Training scripts, notebooks, events…
- Lambda: A100 GPUs
- Very active, supportive community on Discord

- Evaluated on Common Voice 11
- 🔗Blog post, leaderboard, winners

🤗 Whisper Event: Final Leaderboard

This is the leaderboard for Common Voice 11 Dutch (nl).

Please click on the model's name to be redirected to its model card.

Want to beat the leaderboard? Don't see your model here? Ensure...

model_id	wer	cer
GeoffVdr/output1	5.90	-
GeoffVdr/whisper-medium-nlcv11	7.51	-
pplantinga/whisper-small-nl	11.51	-
thomashaas/parla-nl-v1	11.62	-
sanchit-gandhi/whisper-small-nl-1k-...	11.79	-
BerB2000/whisper-small-nl-last	307.71	-

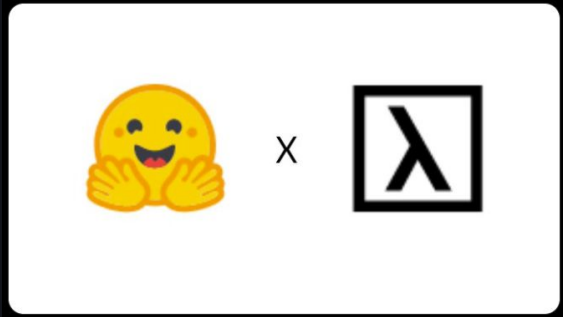
🤗 Lambda

Lambda
@LambdaAPI

Results from the Lambda x 🤗@huggingface sprint to fine-tune @OpenAI's Whisper model:

- 20K+ A100 hours provided for community use via Lambda Cloud credits
- 100+ languages covered
- 650 models created

Beyond impressed by the community. Giveaway announcement coming Friday!



8:55 pm · 4 Jan 2023 · **31.3K** Views

Practical use cases

Lex Fridman podcast transcriptions: “Lexicap”

Lex Fridman podcast:

- Since 2018
- Originally AI, nowadays wide ranging topics

Lexicap:

- Andrej Karpathy
- Database of all episodes transcribed
- Whisper large

Lexicap: Lex Fridman Podcast Whisper captions

These are transcripts for Lex Fridman episodes. First we get all the episodes in the playlist (ty youtubesearchpython), see their docs.
Then we download the audio for all of them (ty yt-dlp): `yt-dlp -x --audio-format mp3 -o {mp3_file} -- {youtube_video_id}`
Then we transcribe them (ty OpenAI Whisper): `whisper --language en --model large -o {out_dir} -- {mp3_file}`
Download the raw captions data as a zip file here.
Send comments to @karpathy on Twitter.

Episodes:

1 Max Tegmark: Life 3.0 | Lex Fridman Podcast #1
2 Christof Koch: Consciousness | Lex Fridman Podcast #2
3 Steven Pinker: AI in the Age of Reason | Lex Fridman Podcast #3
4 Yoshua Bengio: Deep Learning | Lex Fridman Podcast #4
5 Vladimir Vapnik: Statistical Learning | Lex Fridman Podcast #5
6 Guido van Rossum: Python | Lex Fridman Podcast #6
7 Jeff Atwood: Stack Overflow and Coding Horror | Lex Fridman Podcast #7
8 Eric Schmidt: Google | Lex Fridman Podcast #8
9 Stuart Russell: Long-Term Future of Artificial Intelligence | Lex Fridman Podcast #9
10 Pieter Abbeel: Deep Reinforcement Learning | Lex Fridman Podcast #10

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By Lisa Becker

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GET IN TOUCH WITH THE SPEAKER

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Resources

- Whisper paper
- wav2vec 2.0 paper
- Whisper & wav2vec 2.0 benchmarking
- Whisper finetuning blog post, leaderboard, winners
- Lex Fridman podcast & transcripts
- Connectionist Temporal Classification blog post