Wav2Gloss: Generating Interlinear Glossed Text from Speech

ACL 2024 Main (Long Papers)
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Background

Field Linguistic Recordings

- Field data is collected by linguists for indigenous language documentation.
- It consists of audio and sometimes video recordings—crucial for documentation, preservation, revitalization of languages at risk.
- Needs expert annotations, and annotation process is expensive.

Credit: Jonathan Amith, Gettysburg College

Interlinear Glossed Text

- *Lingua franca* of documentary linguistics
- Especially important for illustrating the morphology of documented languages

Transcription (`wd`):	n	sìginde		yan	de
Surface (`sr`):	n	sìgi	-nde	yan	de
Underlying (`ur`):	n	sìgi	-len	yan	le
Gloss (`gl`):	1.SG	sit	-PC.RES	that	FOC
Translation (`tr`):	I live here.				

Segment by morphemes

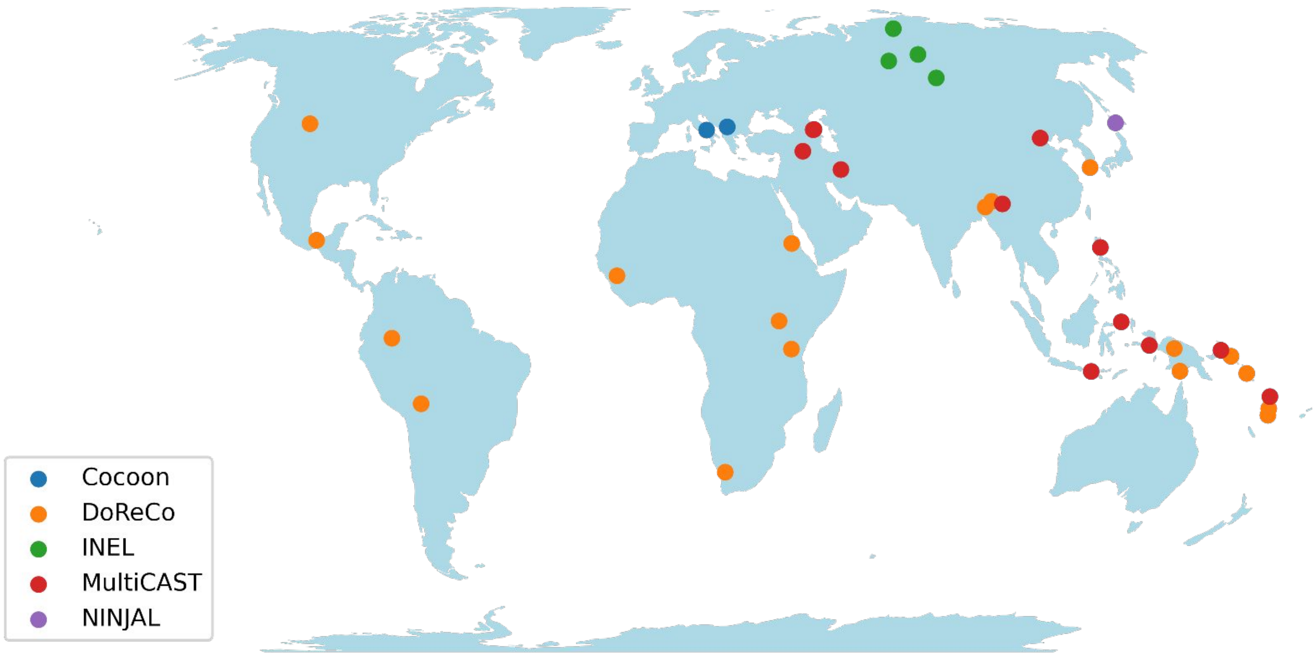
Abstract form of morpheme
(before applying phonological rules)

Morpheme-wise annotation
(with translation and/or grammatical function)

Kakabe (Vydrina, 2022)

Fieldwork Dataset

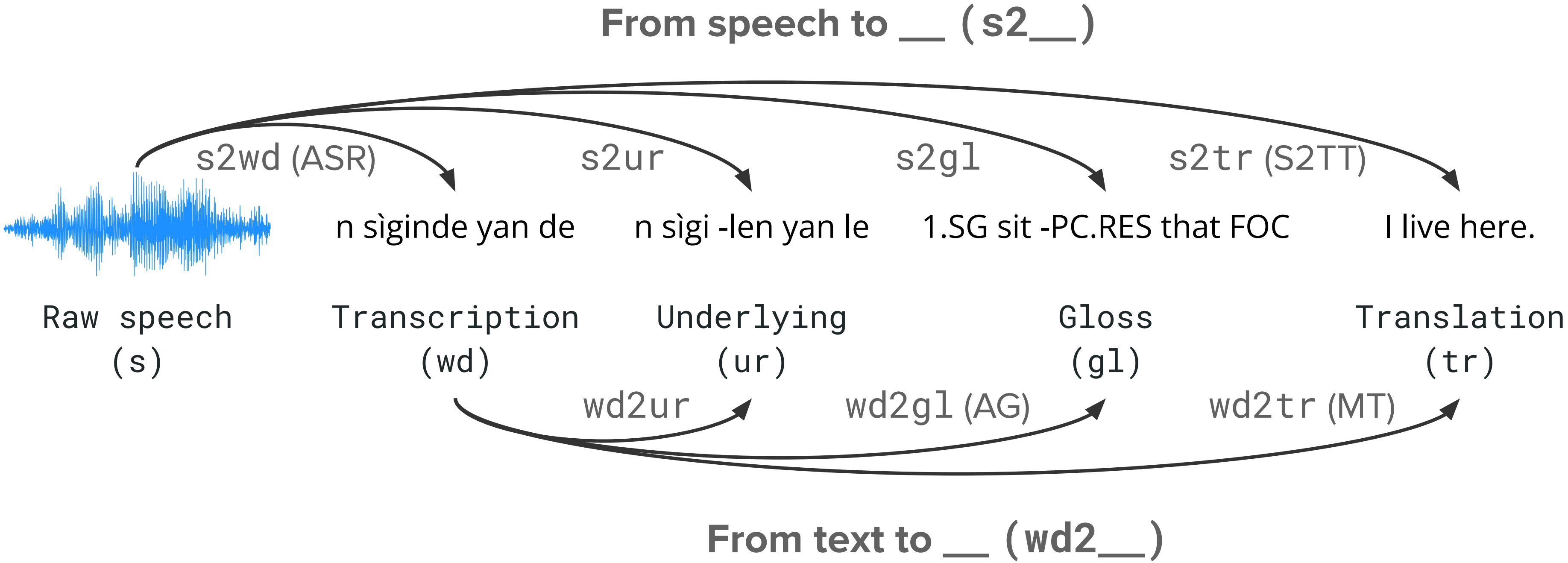
Fieldwork Dataset Statistics



- 37 Languages from 5 linguistic fieldwork repositories
- 71.35 hours of data in total
- Train/dev/test split
- 22 seen languages and 15 unseen languages
- May contain very personal information about the speakers and their families.

Wav2Gloss Task

Wav2Gloss Task Definition



From speech to __ (s2__)

s2wd (ASR)

s2ur

s2gl

s2tr (S2TT)

n sìginde yan de

n sìgi -len yan le

1.SG sit -PC.RES that FOC

I live here.

Raw speech (s)

Transcription (wd)

Underlying (ur)

Gloss (gl)

Translation (tr)

wd2ur

wd2gl (AG)

wd2tr (MT)

From text to __ (wd2__)

Experiments

Baseline design

E2E (End-to-end) vs. Cascade

- Can wav2gloss tasks be solved in an end-to-end manner?

Single task vs. Multi-task

- Do different tasks help each other?

Monolingual vs. Multilingual training

- Do languages benefit from other languages?

Self-supervised vs. Weakly supervised speech models

- How do the pre-trained speech models influence downstream performance?

Experimental results

E2E (End-to-end) vs. Cascade

- E2E models show better performance except for translation.

Multi-task vs. Single task

- Multi-task models usually performs worse.

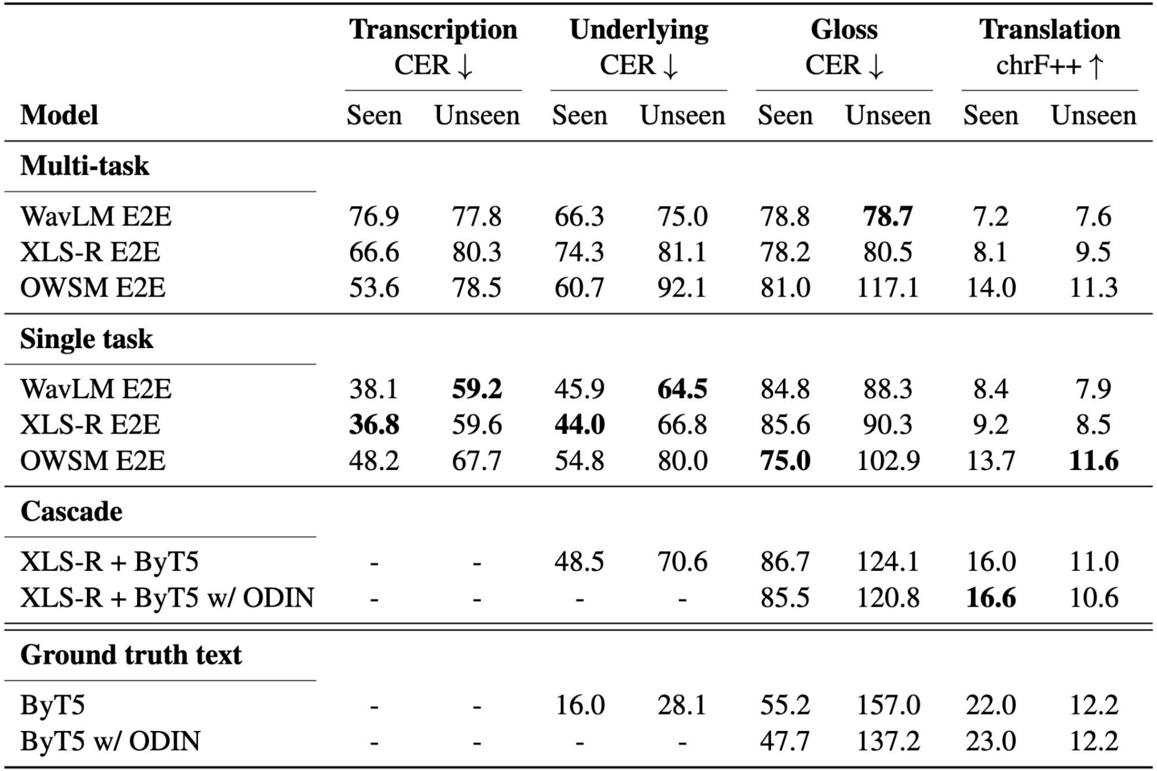
Monolingual vs. Multilingual training

- Only the lowest-resource languages benefit from multilingual training.

Self-supervised vs. Weakly supervised speech models

- Self-supervised models are better at transcription and underlying, weakly supervised models are better at gloss and translation.

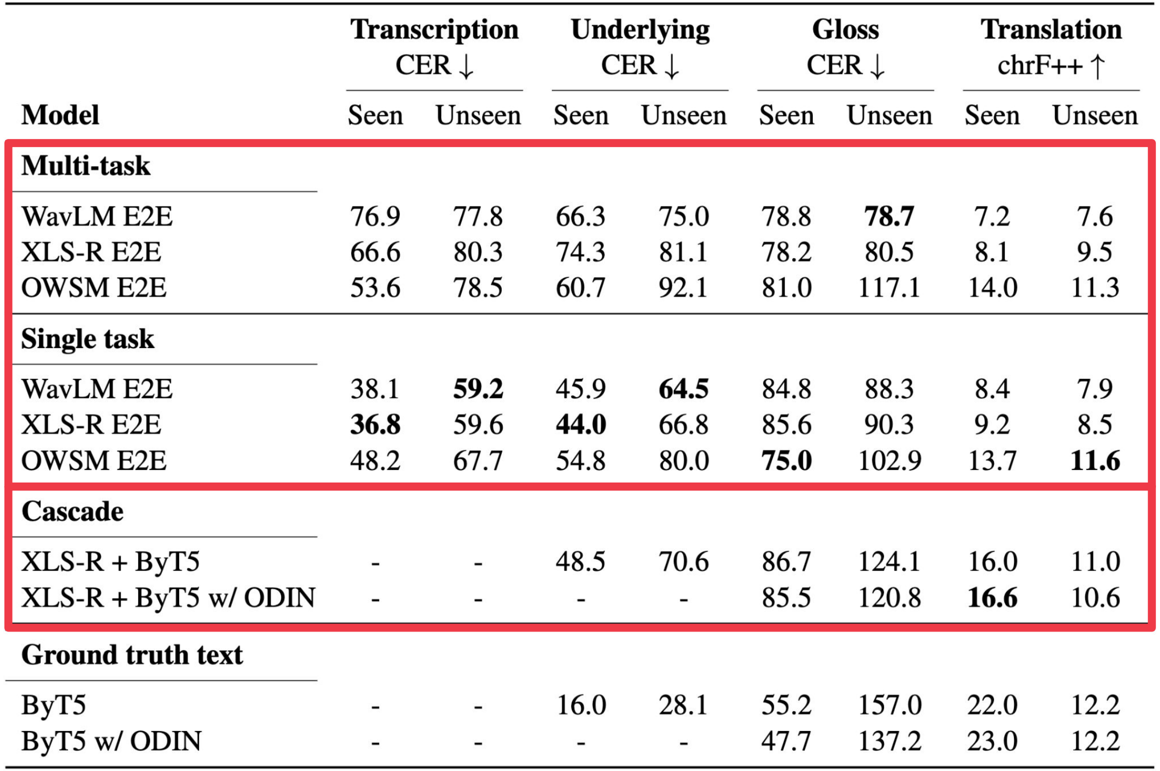
Experimental results



	Transcription CER ↓		Underlying CER ↓		Gloss CER ↓		Translation chrF++ ↑	
Model	Seen	Unseen	Seen	Unseen	Seen	Unseen	Seen	Unseen
Multi-task								
WavLM E2E	76.9	77.8	66.3	75.0	78.8	**78.7**	7.2	7.6
XLS-R E2E	66.6	80.3	74.3	81.1	78.2	80.5	8.1	9.5
OWSM E2E	53.6	78.5	60.7	92.1	81.0	117.1	14.0	11.3
Single task								
WavLM E2E	38.1	**59.2**	45.9	**64.5**	84.8	88.3	8.4	7.9
XLS-R E2E	**36.8**	59.6	**44.0**	66.8	85.6	90.3	9.2	8.5
OWSM E2E	48.2	67.7	54.8	80.0	**75.0**	102.9	13.7	**11.6**
Cascade								
XLS-R + ByT5	-	-	48.5	70.6	86.7	124.1	16.0	11.0
XLS-R + ByT5 w/ ODIN	-	-	-	-	85.5	120.8	**16.6**	10.6
Ground truth text								
ByT5	-	-	16.0	28.1	55.2	157.0	22.0	12.2
ByT5 w/ ODIN	-	-	-	-	47.7	137.2	23.0	12.2

Experimental results - E2E (End-to-end) vs. Cascade

E2E models show better performance except for translation.



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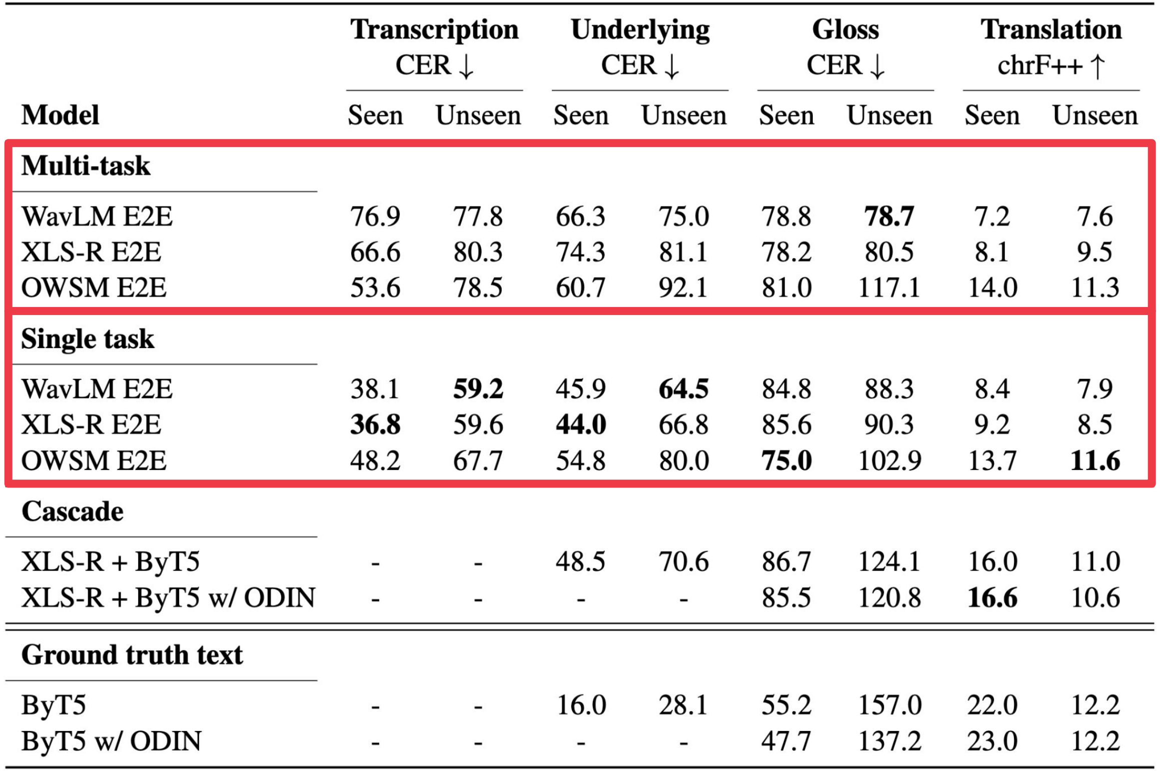
Experimental results - Multi-task vs. Single Task

Multi-task models usually performs worse.



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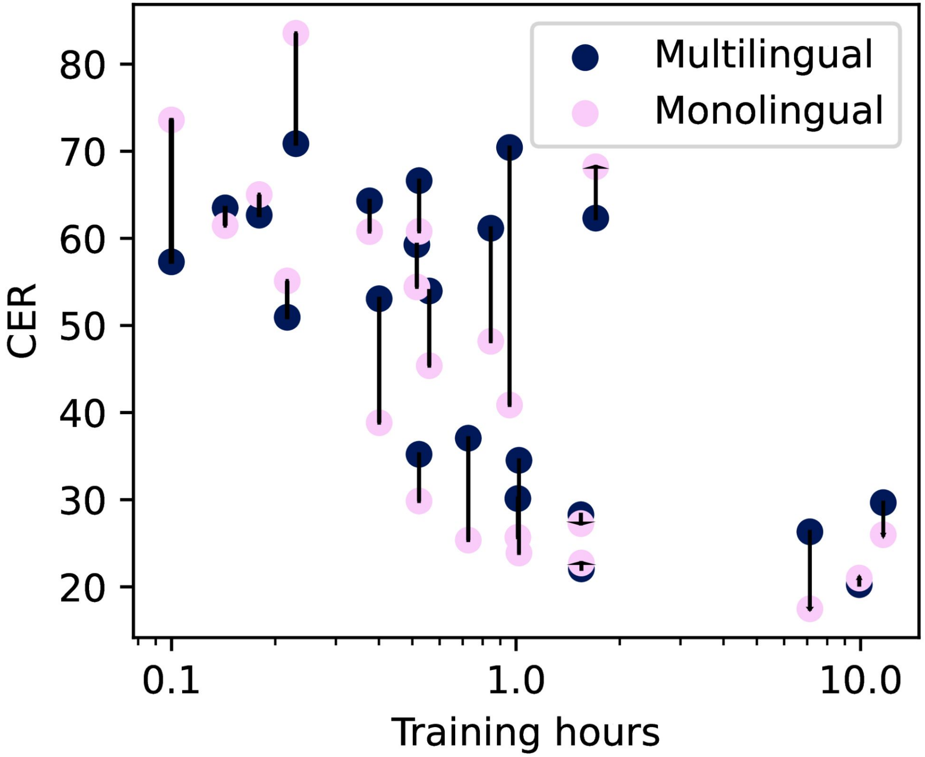
Experimental results - Monolingual vs. Multilingual

Only the lowest-resource languages benefit from multilingual training.



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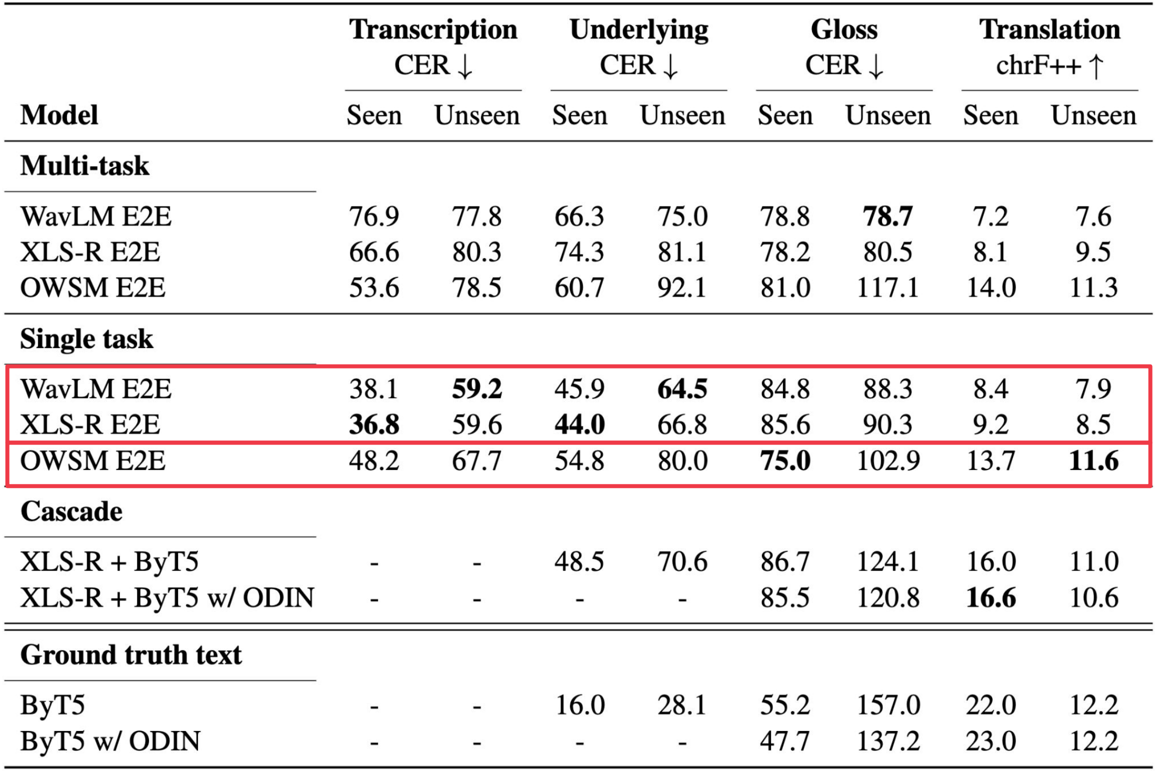

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Takeaways

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- Interlinear Glossed Text (IGT) is used to document endangered languages.
- Producing IGT from raw speech (Wav2Gloss) is a necessary, tractable, yet challenging problem.
- We provide the Fieldwork dataset and various baselines to lay the groundwork for future research on IGT.

Thank you!

Paper: https://arxiv.org/abs/2403.13169
Dataset: https://huggingface.co/datasets/wav2gloss/fieldwork
Code (SSL): https://github.com/juice500ml/espnet/tree/wav2gloss
Code (WSL): https://github.com/juice500ml/finetune_owsm