
Predicting misreadings from gaze in children with reading difficulties

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PREDICTING MISREADINGS FROM GAZE

Collaboration with Copenhagen-based startup

EyeJustRead: track and record reader's gaze, used in special-needs schools

Analysis of reading strategies, tracking reading skill progress

PREDICTING MISREADINGS FROM GAZE

[Video about EyeJustRead]

PREDICTING MISREADINGS FROM GAZE

TILBAGE TIL LISBETH SØRENSEN'S LÆSNINGER


Afspilning
05-01-17, 18:54, ★★★★★

Raw Scanpath
 Cleaned Scanpath

Interessepunkter


- Alle
- Billed Fiksering
- Spring Tilbage
- Lang Fiksering
- Perifer Læsning
- Søgning
- Kort Fiksering
- Lærer Note
- Læsefejl

På en ø i Ådal
kan man se
to små ræve.



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WHY IS THIS USEFUL?

USA: 17.5% of population is dyslexic [ICLD, 1987]

Manual reviewing of reading errors is expensive

Text simplification: personalized identification of difficult text material

PREDICTING MISREADINGS FROM GAZE



DATA PREPARATION

Standard in eye-tracking research: data collection under lab conditions

We have real-world data

- ▶ Students choose texts
- ▶ We don't know students' age, sex, reading skill, ...
- ▶ Noisy environment
- ▶ What is a misreading?

DATA PREPARATION

Clean for marked readings, bad calibrations, etc.

44 students reading 8,681 words

565 misreadings (2% – 40% per student)

LINGUISTIC AND GAZE FEATURES

BASIC

- ▶ Word length, sentence length, position in sentence, ...

LINGUISTIC

- ▶ POS tag, frequency, character perplexity, vowel count, ...

GAZE-WORD

- ▶ #fixations, 1st fixation duration, pupil size, fixation positions in word, ...

GAZE-CONTEXT

- ▶ incoming/outgoing direction, previous/next word fixated, ...

Experiment 1

Predicting misreadings across entire dataset

PREDICTING MISREADINGS FROM GAZE

Ensemble of 10 random forests and 10 feed-forward neural nets

Results are based on 10-fold cross validation across entire dataset

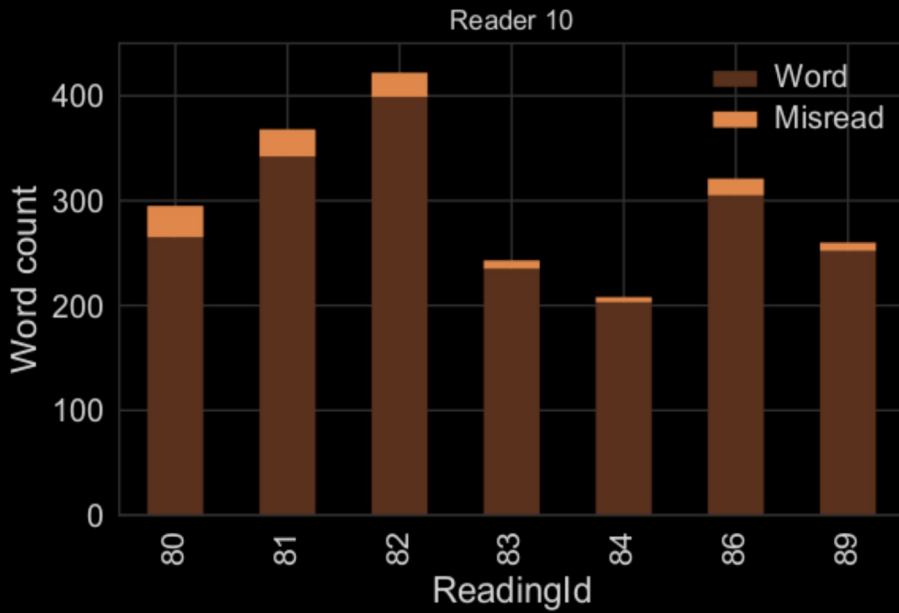
Feature Group	F_1
BASIC	18.56
+ GAZE (W)	39.00
+ GAZE (C)	25.13
+ LINGUISTIC	23.45
+ GAZE (W) + GAZE (C)	40.31
+ GAZE (W) + LINGUISTIC	41.25
+ GAZE (C) + LINGUISTIC	25.12
All features	40.12

Precision > Recall

Experiment 2

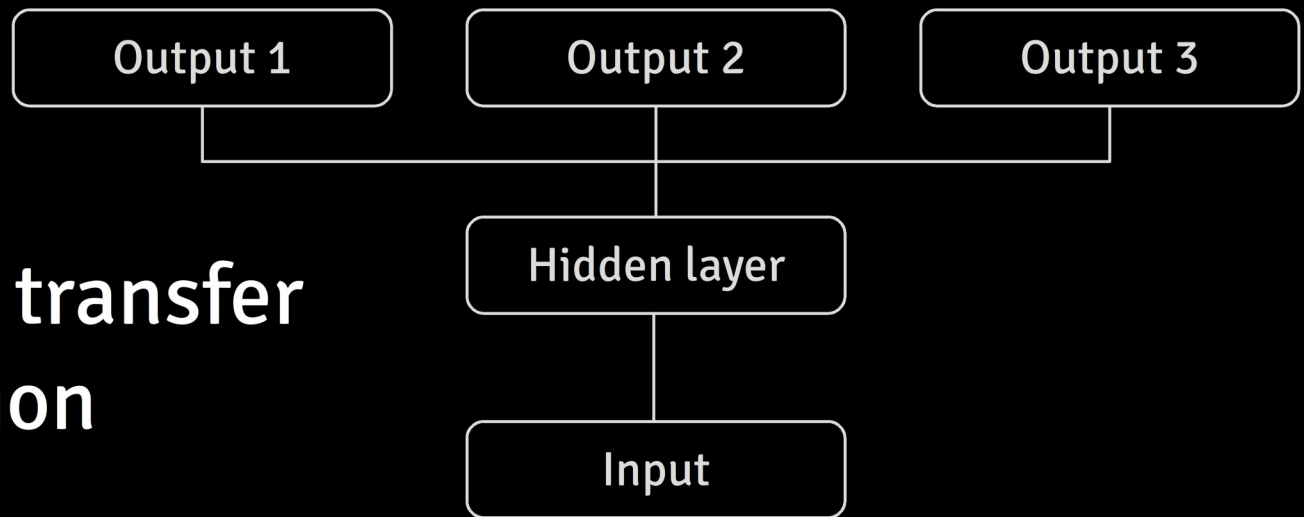
Predicting misreadings for individual users

HOW DOES THIS WORK FOR INDIVIDUAL USERS?



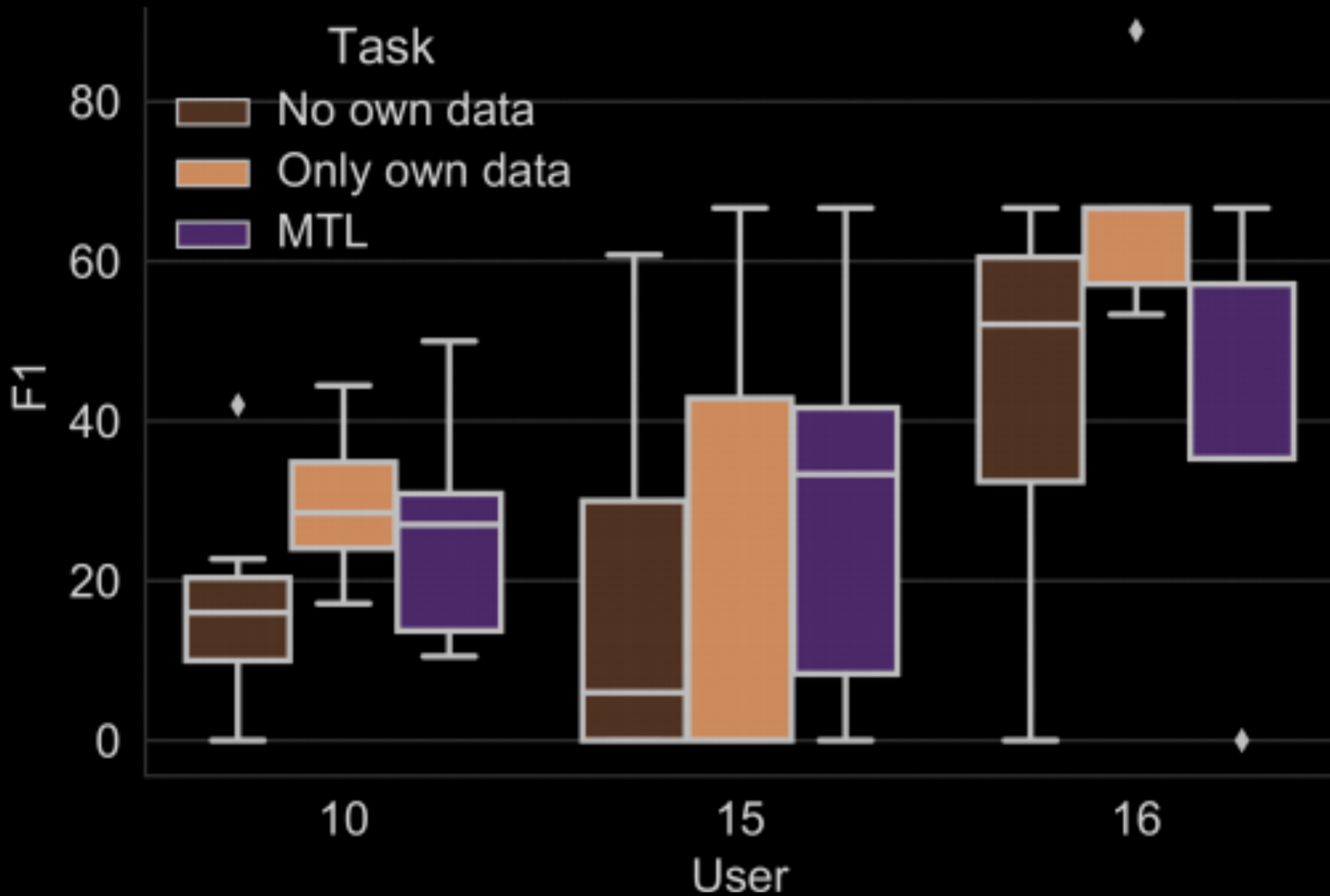
TRANSFER KNOWLEDGE ACROSS READERS

Multi-task learning: sharing parameters across tasks



- ▶ MTL for domain transfer and regularization
- ▶ Users are tasks
- ▶ Train MTL model by iteratively optimizing for individual users

TRANSFER KNOWLEDGE ACROSS READERS



REAL-LIFE APPLICABILITY

“But eye-tracking hardware is expensive and clunky!”

High-quality eye-trackers are now under \$100

Integration into phone/tablet cameras and webcams likely to happen soon (Skovgaard et al., 2013; Xu et al., 2015)

Conclusions

CONCLUSIONS

We can predict misreadings from gaze patterns despite noisy conditions

Misreadings manifest differently between readers

Multi-task learning helps share knowledge between users only in some cases

Future work

FUTURE WORK

More and cleaner data coming in

“Word help” function as signal for word difficulty

Thank you!

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