Automatic classification of lexical stress errors for German CAPT

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Lexical stress [TODO (LS)] in German

Accentuation/prominence of syllable(s) in a word

In German:

- Variable placement, contrastive function

  um·FAHR·en vs. UM·fahr·en
  to drive around *to run over*

- Reflected by duration, fundamental frequency (F0), intensity[1]
- Impacts intelligibility of non-native (L2) speech[2]

[1] Dogil and Williams 1999.
[2] Hirschfeld 1994.

CAPT for lexical stress errors [TODO (LSEs)]

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- Contrastive LS notoriously difficult for French speakers[1]
- CAPT offers huge potential for individualized instruction

- Classification of LS errors in L2 German unexplored
- Promising recent work using machine learning for classification of English stress patterns[2]

Our goal: explore classification-based detection of lexical stress errors by French learners of German

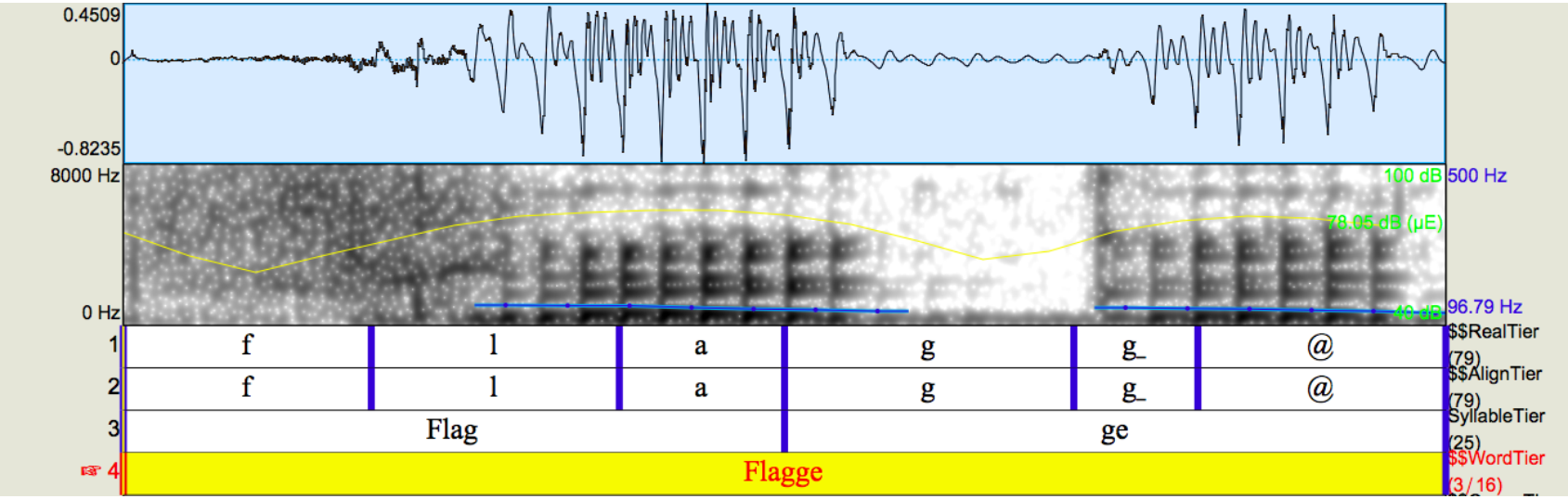
[1] Dupoux et al. 1997.

[2] Kim and Beutnagel 2011; Shahin et al. 2012.

Data

Subset of IFCASL corpus of French-German speech[1]

[TODO new screenshot]



- 12 bisyllabic, initial-stress words (word types) extracted automatically
- 668 tokens from ∼55 French speakers

[1] Fauth et al. 2014.

Data annotation

- Each token assigned a class label:

  3 stress classes:
  [correct], [incorrect], [none]

  2 error classes:
  [bad_nsylls], [bad_audio]

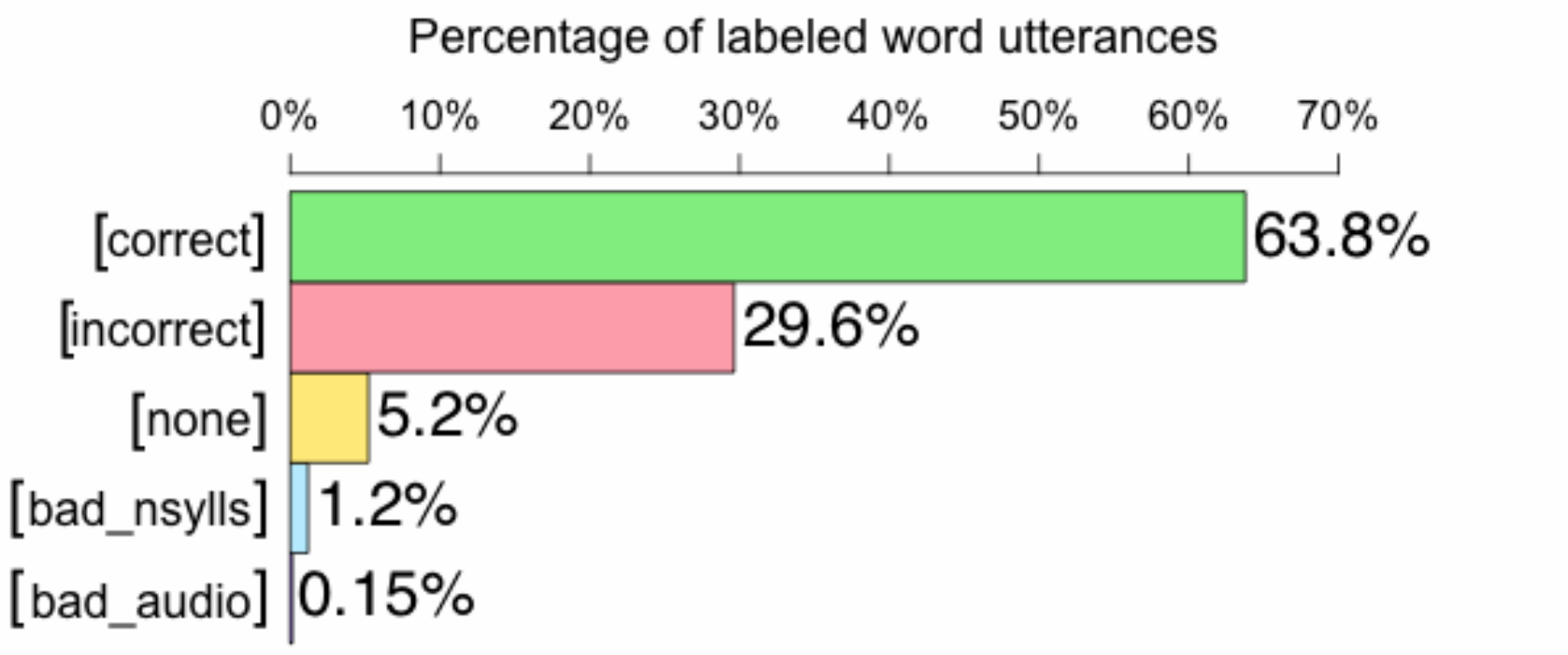
- 15 annotators (12 native), each token labeled by $\geq$2

Overall pairwise inter-annotator agreement

	Mean	Maximum	Median	Minimum
% Agreement	54.92%	83.93%	55.36%	23.21%
Cohen's κ	0.23	0.61	0.26	-0.01

- Variability not explained by L1 or expertise
- Single gold-standard label selected for each token

Data annotation results



Method

Experiments:

- Trained CART classifiers using WEKA toolkit[1]
- Used error-annotated dataset for training/test data (gold-standard labels)
- Used L1 utterances of the same words as training data (all automatically labeled [correct])

Evaluated in terms of:

- % accuracy (% agreement with gold-standard labels)
- κ with respect to gold standard

[1] www.cs.waikato.ac.nz/ml/weka

Feature sets

Which features are most useful for classification?

Feature set	Description
DUR	Duration features
F0	Fundamental frequency features
INT	Intensity features
WD	Uttered word (e.g. *Tatort*)
LV	Speaker's skill level (A2|B1|B2|C1)
AG	Speaker's age/gender (Girl|Boy|Woman|Man)

Feature sets

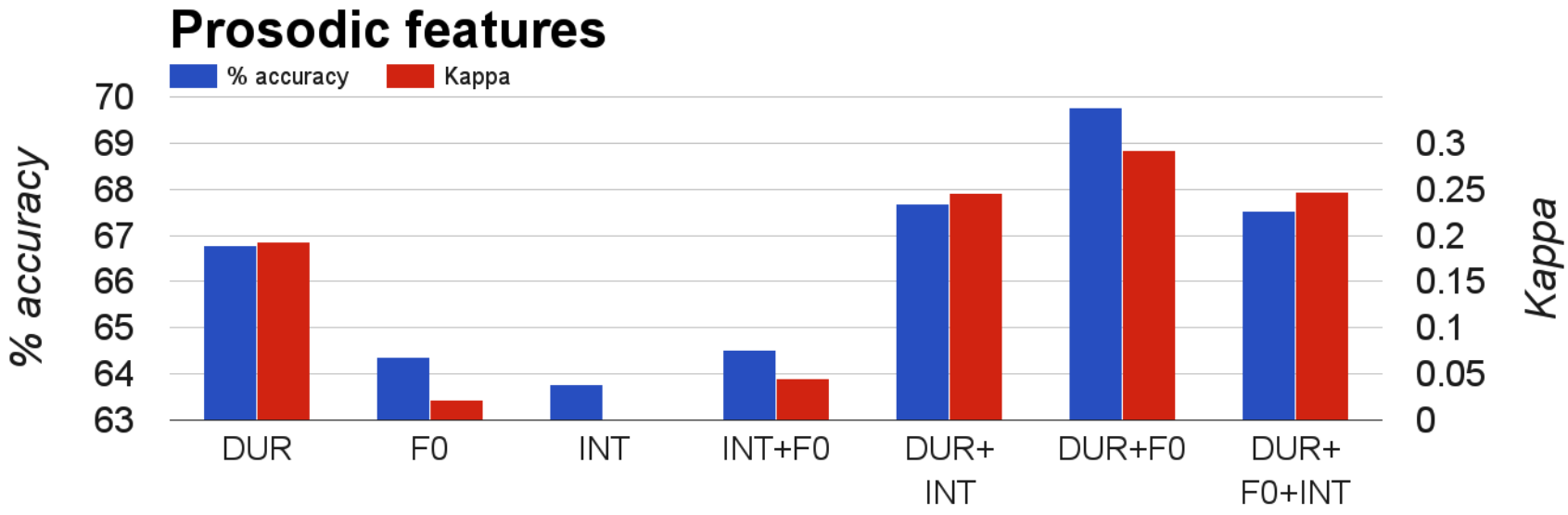
Which features are most useful for classification?

- Prosodic features
  - DUR -Duration
  - F0 - Fundamental frequency
  - INT - Intensity
- WD - Word type (e.g. *Flagge*)
- Speaker features
  - LV - German proficiency level (A2|B1|B2|C1)
  - AG - Age/gender (Girl|Boy|Woman|Man)

Training/testing datasets

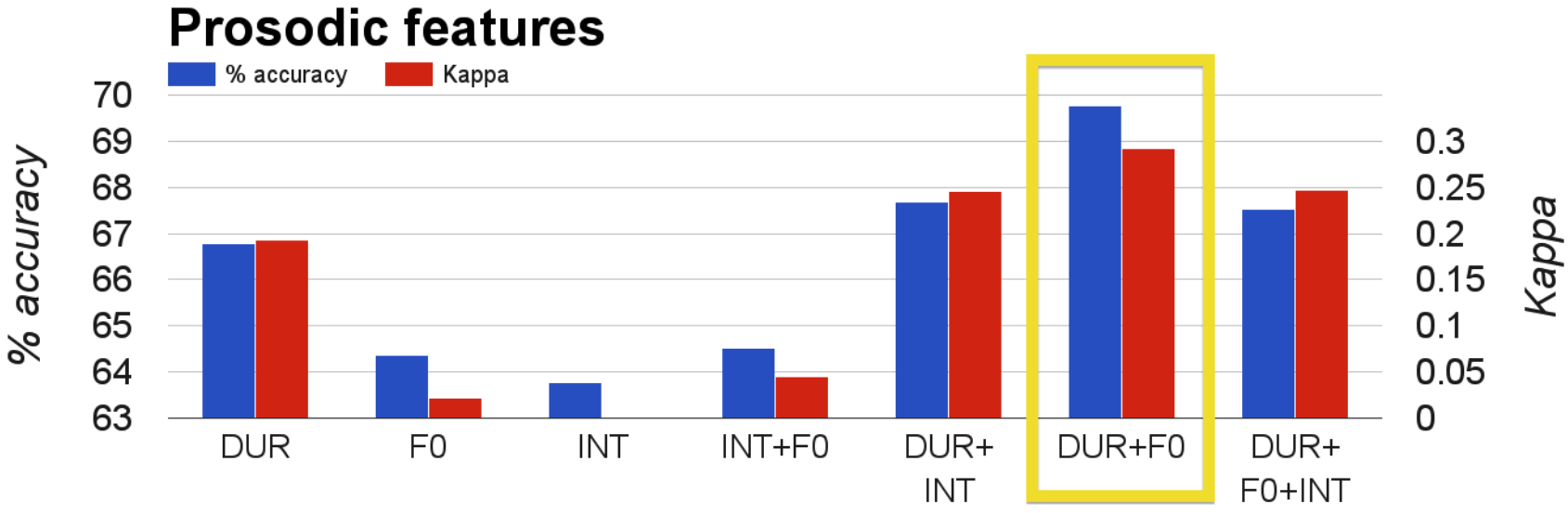
Results

How well can lexical stress errors be classified?



Results

How well can lexical stress errors be classified?

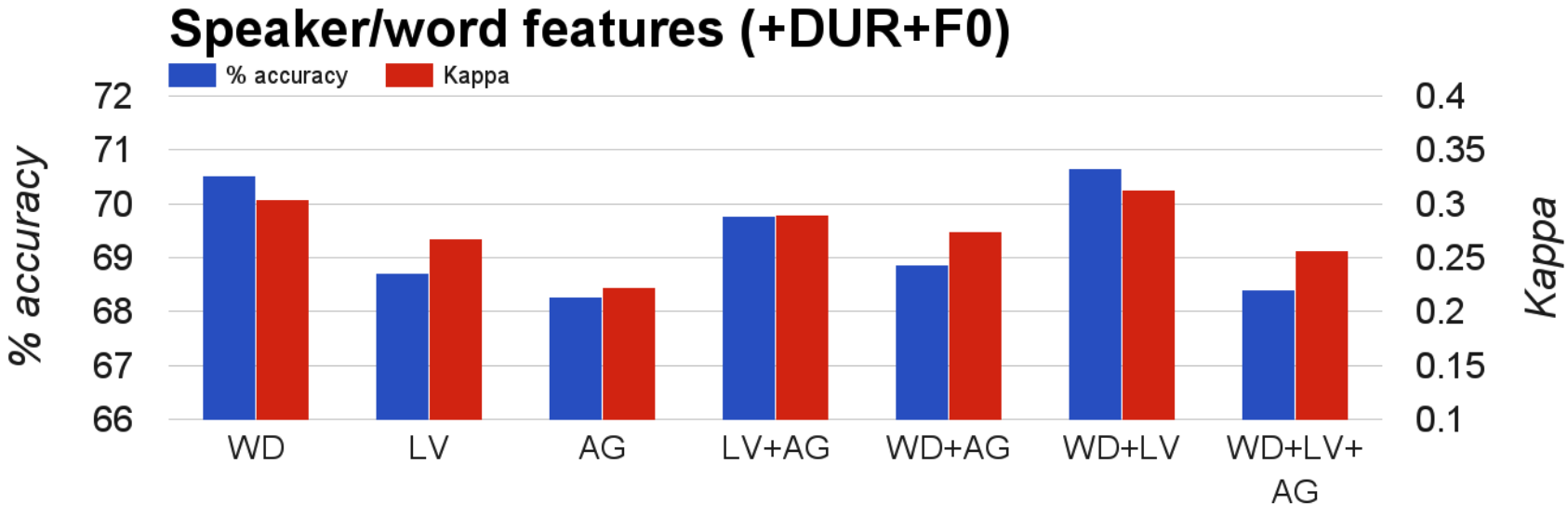


Best performance using only prosodic features: DUR+F0

- % Accuracy: 69.77%
- κ: 0.29

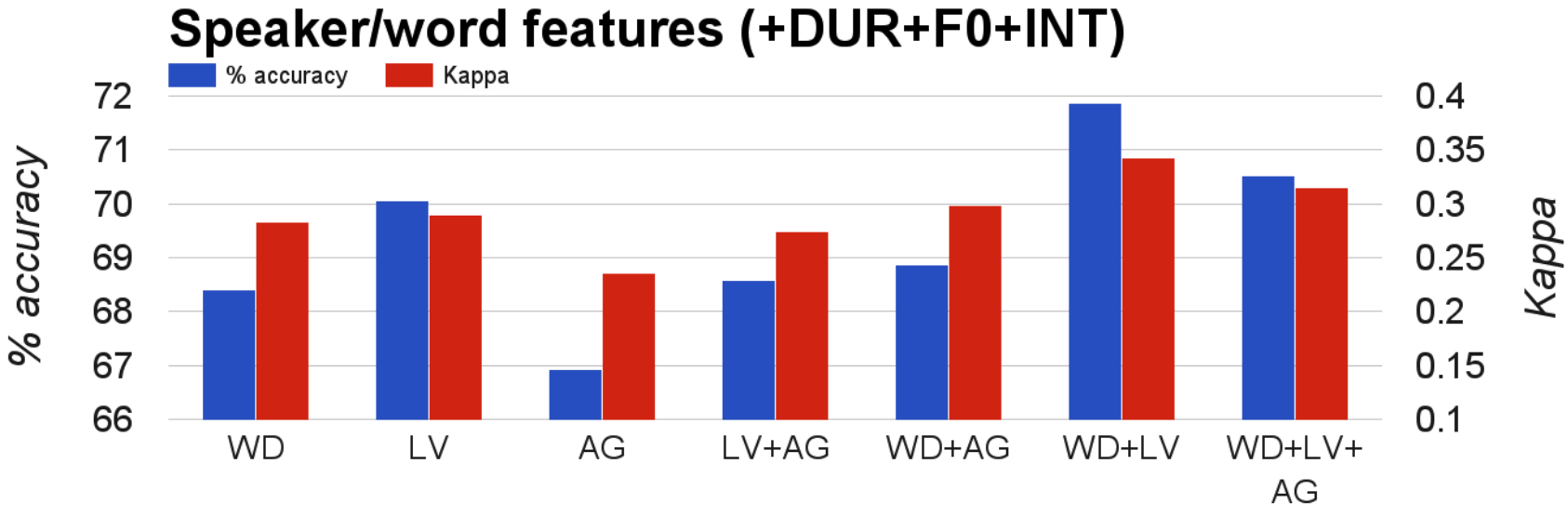
Results

How well can lexical stress errors be classified?



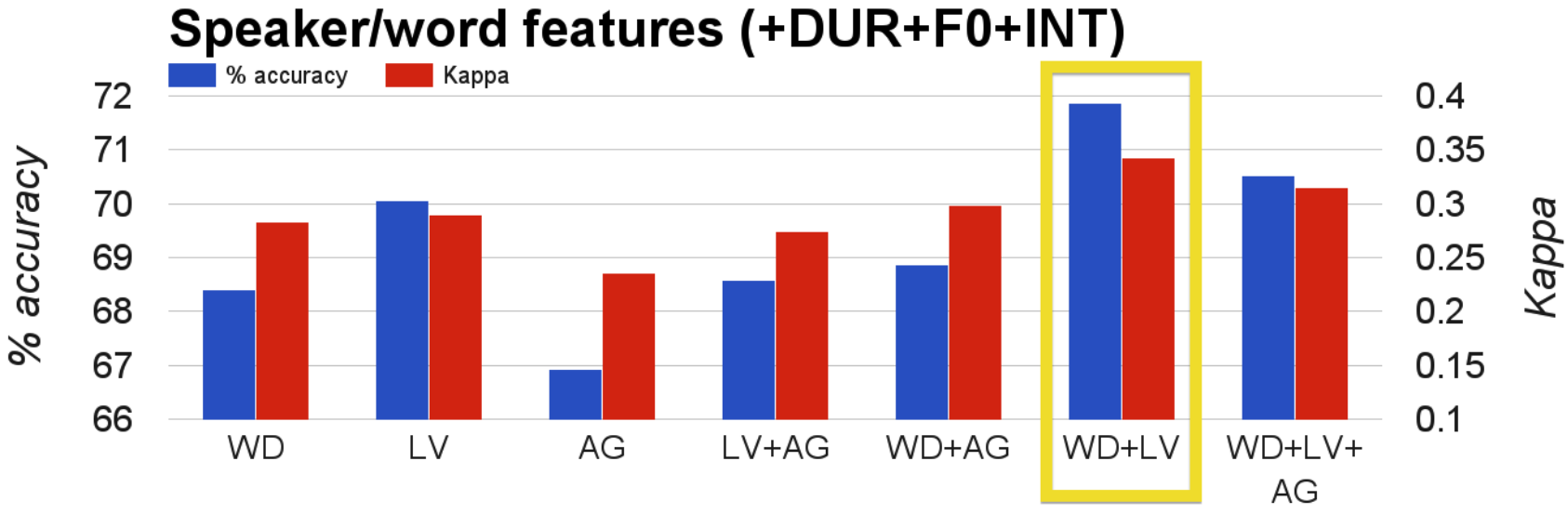
Results

How well can lexical stress errors be classified?



Results

How well can lexical stress errors be classified?



Best performance overall: WD+LV+DUR+F0+INT

- % Accuracy: 71.87%
- κ: 0.34

Results

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How does classification accuracy compare with human agreement?

	% agreement	κ
Best classifier vs. gold standard	71.87%	0.34
Mean human vs. human	54.92%	0.23

- Results are encouraging in this context
- Still want better performance for real-world use

Selected references

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