Speech Technology Center

USING STATISTICAL METHODS FOR PROSODIC BOUNDARY DETECTION AND BREAK DURATION PREDICTION IN A RUSSIAN TTS SYSTEM

Olga Khomitsevich, Pavel Chistikov
{khomitsevich,chistikov}@speechpro.com
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Prosodic boundaries in TTS

- Natural-sounding prosody is key for Text-to-Speech (TTS).
- Prosodic boundaries help to:
  - Make speech more comfortable for the listener;
  - Disambiguate sentences and make speech more intelligible.
- It is difficult to predict correct break placement and duration automatically because many factors are at play:
  - Syntactic structure of the sentence;
  - Sentence length;
  - Semantics, emphasis;
  - Etc...

Methods for break prediction in TTS

- **Rule-based** methods (*used in baseline Vital Voice TTS*):
  - Rely on expert knowledge;
  - Take a long time to develop;
  - Are difficult to develop due to the complexity of the data.
- **Statistical** methods (*present work*):
  - Easy and fast to train given large annotated corpora;
  - But: subject to data sparceness problem;
  - May be difficult for languages with free word order and rich morphology due to large numbers of feature combinations.

Experimental setup: classifiers

- **CART**: predicting break placement and break duration.
  - CART is a recursive partitioning method based on minimization of partition goodness criterion.
- **Random Forest**: predicting break placement.
  - A Random Forest classifies data using a given set of features by means of a hierarchy (a "tree") of queries, based on the predictive value of each feature at each point;
  - We use a forest containing 100 trees; each tree is built on the basis of 60% of randomized training data.
- The classifiers are used to predict the probability of a break after a word and/or the duration of the break.

Experimental setup

- Word **features** used for classification:
  - Punctuation;
  - Sentence length and position of the word in the sentence;
  - Morphological features, capitalization;
  - Features are computed for the current word and two previous/following words.
- Speech **database**:
  - Read speech (TTS Unit Selection database);
  - Over 50 hrs of speech (over 38000 phrasal breaks);
  - Divided into training and testing datasets.

Experimental results: break placement

	Baseline TTS	CART	Random Forest
Correct junctures	43254 (90.45%)	44358 (92.76%)	44865 (93.82%)
Correct breaks	5042 (81.51%)	5176 (83.67%)	4695 (75.90%)
FA	3421 (55.30%)	2451 (39.62%)	1463 (23.65%)
FR	1144 (18.49%)	1010 (16.33%)	1491 (24.10%)
Recall	0.82	0.84	0.76
Precision	0.60	0.68	0.76
F-score	0.69	0.75	**0.76**

Experimental results: break placement

- Both classifiers show an improvement on the baseline;
- **Random Forest** yields the best results;
- F-score values are comparable with those reported in the literature for English.
- **However**, automatic testing does not reflect possible variations in break placement.
- It is important to avoid "serious" errors:
  - Breaks in impossible locations;
  - Omission of necessary breaks.
- Combination of rules and statistical models may be needed.

Experimental results: break duration

	Sentence-external breaks	Sentence-internal breaks
General model	0.25	0.23
Specialized models	0.19	0.16

Break durations were predicted for break positions in the database;

The table shows:

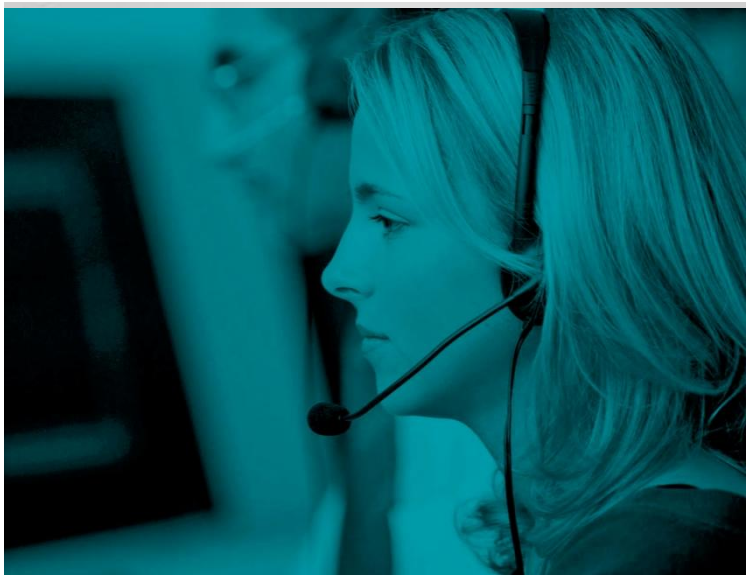
- A model for predicting break durations both between and inside sentences (general model);
- A combination of two separate models for intra-sentential and inter-sentential breaks (specialized models);
- NRMSD (Normalized Root-Mean-Square Deviation) measure was used.

The specialized models give a better approximation both for sentence-internal and sentence-external breaks.

Conclusions

- Break placement models based on CART and RF classifiers give more accurate test results than the baseline rule-based algorithm.
- The CART model displays more errors than the Random Forest model.
- Break duration prediction works better when sentence-internal and sentence-external breaks are modeled separately.
- A hybrid algorithm combining statistical models and rules may be efficient for applied TTS systems.

Thank you for your attention!



ABOUT THE COMPANY

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Speech Technology Center (STC) is an international leader in speech technology and multimodal biometrics. It has over 20 years of research, development and implementation experience in Russia and internationally.

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CONTACTS

Russia
4 Krasutskogo street, St. Petersburg, 196084
Tel.: +7 812 331 0665
Fax: +7 812 327 9297
Email: info@speechpro.com

USA
Suite 316, 369 Lexington ave
New York, NY, 10017
Tel.: +1 646 237 7895
Email: sales-usa@speechpro.com