# lex4all: A language-independent tool for building and evaluating pronunciation lexicons for small-vocabulary speech recognition

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## INTRODUCTION

This poster presents *lex4all,* an easy-to-use PC application that allows even non-expert users to quickly and easily create pronunciation lexicons for words in any low-resource language (LRL), using:

- a small number of audio recordings
- a pre-existing recognition engine in a high-resource language (HRL)

The resulting lexicon can then be used to add small-vocabulary speech recognition functionality to applications in the LRL.

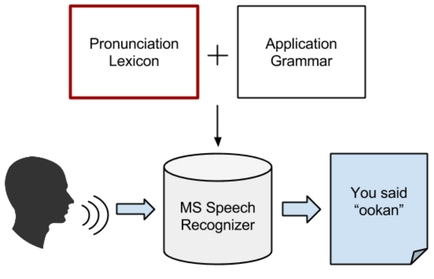
## BACKGROUND & GOAL

**Motivation**

- Speech interfaces beneficial for developing-world applications [1, 2]
- Training recognition engines for new languages typically requires:
  - Large collections of speech data (not available for LRLs)
  - Expertise with speech/language technologies

**Strategy**

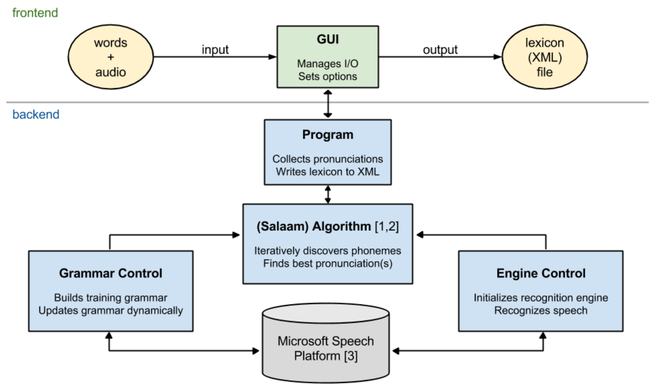
- Use existing recognizer trained for a HRL to recognize LRL speech
  - High-quality commercial engines available in languages such as English
  - e.g. Microsoft Speech Platform, 20+ HRLs [3]
- Recognition task requires:
  - Application-specific grammar (small vocabulary)
  - Pronunciation lexicon for terms in grammar
- Key component: lexicon
  - Maps each term in target vocabulary to sequence(s) of HRL phonemes
  - Recognizer can model these phonemes & recognize the sequences




**lex4all: Pronunciation Lexicons for Any Low-resource Language**

- Fast, user-friendly tool for lexicon building
- GUI-based desktop application for Windows
- Backend built using:
  - Microsoft Speech Platform [3]
  - Salaam algorithm for pronunciation mapping [1, 2] (see "Algorithm")

## SYSTEM OVERVIEW




## ALGORITHM

We use the Salaam method [1, 2] for the automatic discovery of the best pronunciation sequence for each word in the target vocabulary.

**The Salaam method [1, 2]:**

- *"Super-wildcard" grammar:*

  Instructs the recognizer to treat each audio sample as a "phrase" consisting of 0-10 "words", where each "word" is a sequence of 1-3 source-language phonemes, i.e.:

  $$\{*|**|***\}_{0}^{10}$$

  where * represents a single phoneme of the source language.

- *Iterative training algorithm*

  Uses this grammar and the HRL recognizer to discover the best pronunciation sequence(s) for each word in the target vocabulary, one phoneme at a time

- Yields more accurate recognition than expert-written pronunciations[1]

## ADDITIONAL FEATURES

- **Discriminative training** [2]

  An additional training step removes pronunciations in the lexicon that may reduce recognition accuracy by matching multiple words in the vocabulary

- **Evaluation module**

  Facilitates research by automatically simulating recognition on a test set of audio samples. Reports recognition accuracy rates and confusion matrix.

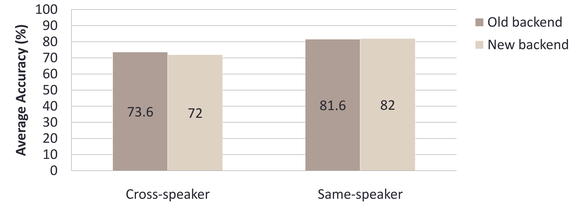
- **Built-in audio recorder**

## CHALLENGE: RUNNING TIME

The main challenge we faced in engineering a user-friendly application based on the Salaam algorithm (see above) was the long training time due to the large "super-wildcard" grammar required by the algorithm.

- Original backend: 1-3 phonemes per sub-word
  - 40 phonemes (English) → 64,000 possible combinations
  - Training time (25 words, 5 samples/word): approx. 60-120 minutes
- New backend: only 1 phoneme per sub-word
  - 40 phonemes → 40-line wildcard
  - Training time (25 words, 5 samples/word): approx 2-5 minutes (≈20x faster)
- Evaluation
  - Tested on Yoruba data (25 words, 2 speakers, 5 samples/word/speaker)
  - Result: no significant drop in recognition accuracy (see Figure 1)

**Figure 1. Evaluation of Word Recognition Accuracy**




## CONCLUSION & FUTURE WORK

The lex4all tool enables the rapid and automatic creation of pronunciation lexicons in any LRL, using an out-of-the-box commercial recognizer [3] for a HRL (English) and an existing algorithm for cross-language pronunciation mapping [1, 2].

We hope that this tool will help developers create speech interfaces for applications in LRL, as well as facilitate research in small-vocabulary speech recognition for such languages.

Possible future extensions of the project include:

- **Online lexicon repository**

  Adding an option for users to upload created lexicons to an online repository would allow sharing and re-use of lexicons across languages/language families.

- **Additional source-language recognizers**

  Microsoft offers recognizers in over 20 languages [3]. Using a source language that is more similar to the target language could improve recognition accuracy.

**References**

[1] Fang Qiao, Jahanzeb Sherwani, and Roni Rosenfeld, 2010. "Small-vocabulary speech recognition for resource- scarce languages," in *Proceedings of the First ACM Symposium on Computing for Development (ACM DEV '10).* ACM, New York, NY, USA, pp. 3:1–3:8.
[2] Hao Yee Chan and Roni Rosenfeld, 2012. "Discriminative pronunciation learning for speech recognition for resource scarce languages," in *Proceedings of the 2nd ACM Symposium on Computing for Development (ACM DEV '12).* ACM, New York, NY, USA, pp. 12:1–12:6.
[3] Microsoft, 2012. Microsoft Speech Platform SDK 11 Documentation. http://msdn.microsoft.com/en-us/library/dd266409

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