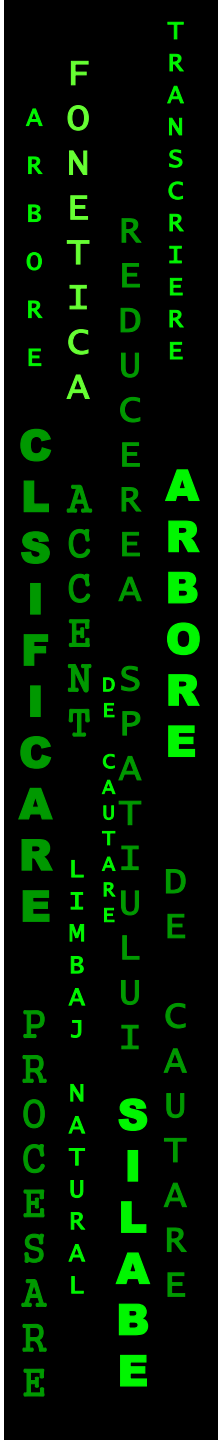

On Phonetic Transcription for Romanian – a Comparison of Five Algorithms

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OVERVIEW

Romanian phonetics

Presentation of the LTS tested

- expert system
- neural networks
- decision trees
- support vector machines
- pronunciation by analogy

Test setup

Experimental results

Conclusion

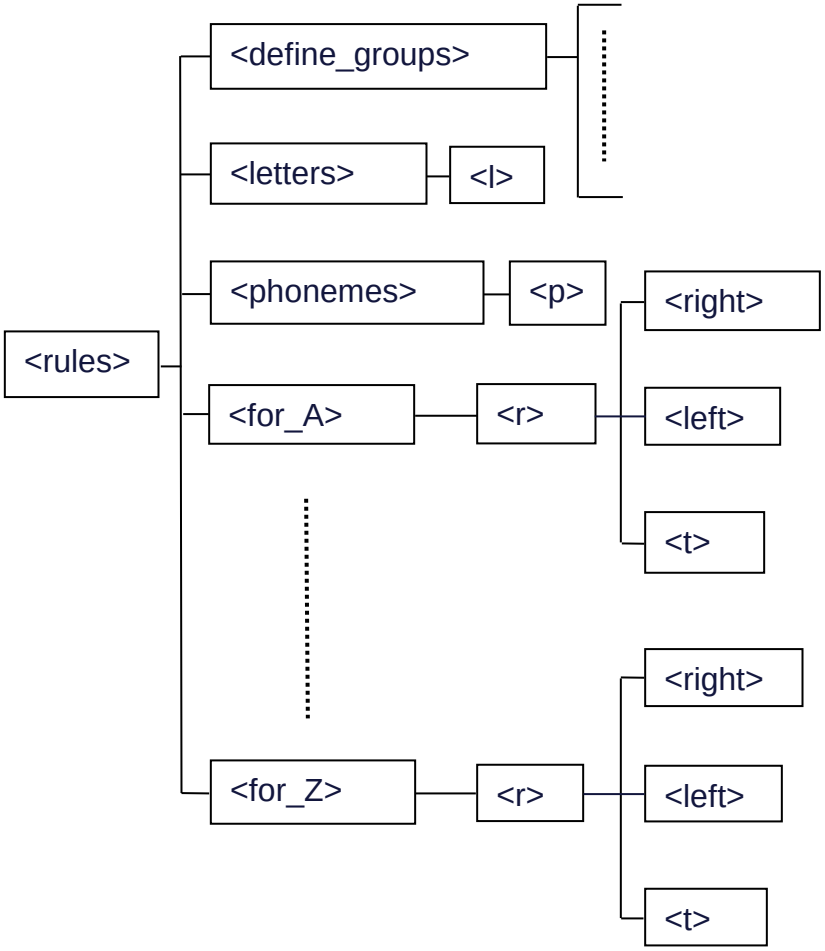
ROMANIAN PHONETICS

- Romanian is a major Romance language, along with Italian, French, Spanish and Portuguese.
- Mostly phonetic
- 31 letters corresponding to 34 phonemes: 22 consonants, 7 vowels, 4 semivowels and 1 non-syllabic vowel.
- There are letters pronounced in several ways.
- Semivowels are the most difficult to identify.

THE LTS ALGORITHMS

- Expert system (ES)
- Neural networks (NN)
- Decision trees (DT)
- Support vector machines (SVM)
- Pronunciation by analogy (PbA)

THE EXPERT SYSTEM



THE EXPERT SYSTEM

M	= = **M** A M
A	= M **A** M A
M	M A **M** A =
A	A M **A** = =

THE EXPERT SYSTEM

```
<rules>
   <define_groups>
     <cons>B,C,D,F,G,H,J,K,L,M,N,P,R,S,S',T,T',V,X,Z</cons>
          ...
     <gr_AOU> A,O,U </gr_AOU>
   </define_groups>
   <phonemes>
          <p>a</p>
            ....
          <p>v</p>
   </phonemes>
   <letters>
          <l>A</l>
             .....
          <l>Z</l>
   </letters>
   <for_A>
      <r>
         <t>a</t>
     </r>
   </for_A>
   <for_E>
       .....
      <r>
         <left>cons</left>
         <right>cons|=</right>
         <t>e</t>
      </r>
         .....
      <r>
         <right>A</right>
         <right>=</right>
         <t>e_X</t>
      </r>
          .....
    </for_E>
     .......
</rules>
```

102 rules

NEURAL NETWORK BASED LTS

Tool: WEKA – open source, easy to use
Data presented as ARFF files. It is possible to use Weka classes in Java application.

M	= = **M** A M
A	= M **A** M A
M	M A **M** A =
A	A M **A** = =

M,=,=,A,M,m
A,=,M,M,A,a
M,M,A,A,=,m
A,A,M,=,=,a

Feature vectors

NEURAL NETWORK BASED LTS

Several configurations were tested until a network with 23 neurons in one hidden layer and a learning rate of 0.1 produced the best results (regarding both error rate and training time).

The parameters were found using an automatic grid search on a subset of the training set. We then applied the parameters on the whole training set.

NEURAL NETWORK BASED LTS

Increasing the number of neurons in the hidden layer leads to some small improvement but the training time made it impractical for us.

In light with the results obtained by other authors we decided to keep 23 neurons, and not increase this number.

NN used by other authors for LTS conversion in Romanian.

D. Burileanu. “Basic research and implementation decisions for a text-to-speech synthesis system in Romanian”. *International Journal of Speech Technology*, Vol. 5(3), pp. 211-225, 2002.

DECISION TREES BASED LTS

Tool: WEKA, C4.5 algorithm (J48)
Data presented as ARFF files. It is possible to use Weka classes in Java application.

M	= = **M** A M
A	= M **A** M A
M	M A **M** A =
A	A M **A** = =

M,=,=,A,M,m
A,=,M,M,A,a
M,M,A,A,=,m
A,A,M,=,=,a

Feature vectors

DECISION TREES BASED LTS

The best results for decision trees were obtained for a pruned tree with binary splits and a minimum number of objects of one in any leaf.

SVM BASED LTS

Tool: libSVM (& WEKA)
Data presented as ARFF files. It is possible to use Weka classes in Java application.

M	= = **M** A M
A	= M **A** M A
M	M A **M** A =
A	A M **A** = =

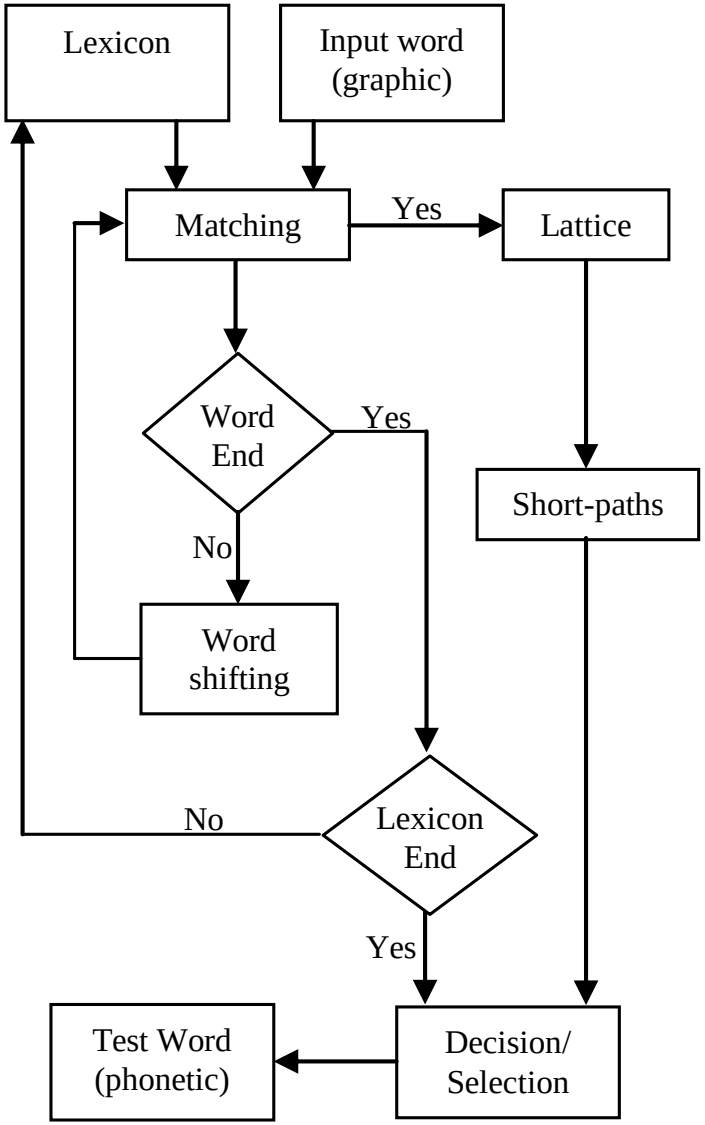
M,=,=,A,M,m
A,=,M,M,A,a
M,M,A,A,=,m
A,A,M,=,=,a

Feature vectors

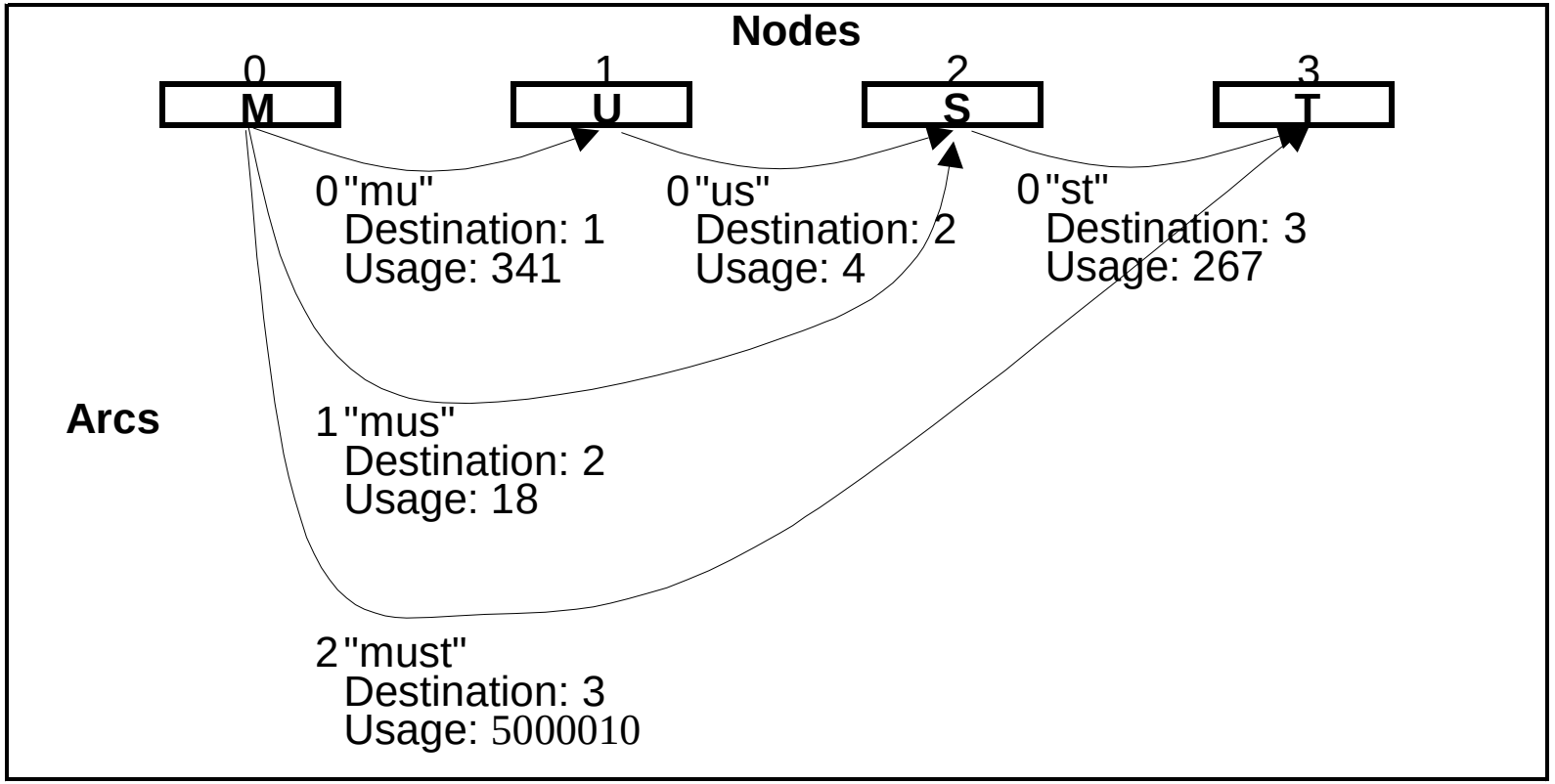
SVM BASED LTS

- In our implementation of a LTS converter with SVMs, we used libSVM.
- First try – linear kernel ☹
- Second try – Gaussian kernel – ☺
- accuracy of the model is highly dependent on γ and on the tradeoff between training error and margin (denoted by *C*)
- grid search for finding a suitable pair (γ, *C*)
- Best results for C=40 and γ=1

PRONUNCIATION BY ANALOGY



PRONUNCIATION BY ANALOGY



Decision based on most common pronunciation.

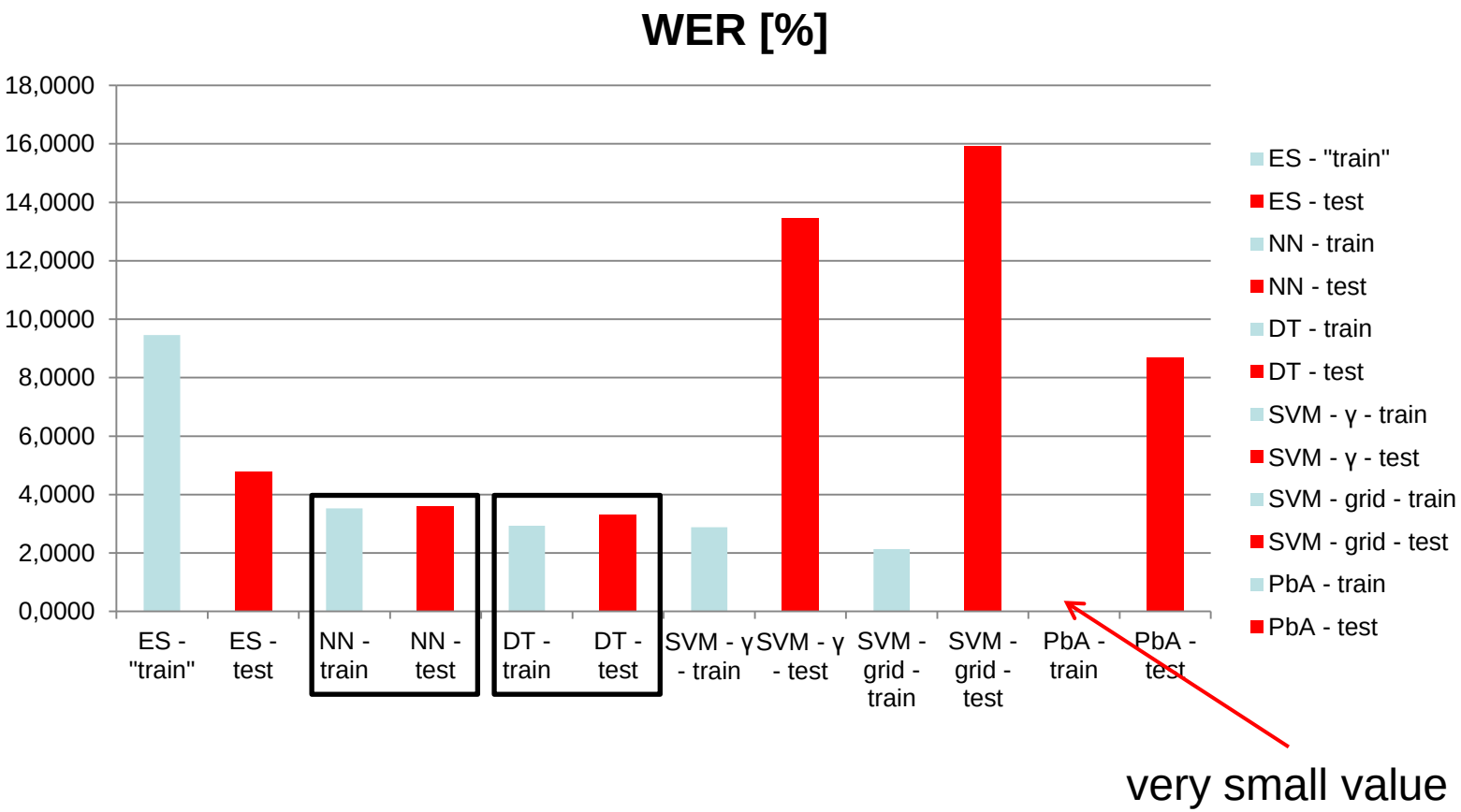
TEST SETUP

- 2 phonetic dictionaries
- “training” dictionary 15,517 words and 114,044 letters
- test dictionary - most frequent 4779 words (31,483 letters) in 93 Romanian books (literary works and science literature)
- SAMPA notation
- although they seem small, they retain the important characteristics of Romanian pronunciation

EXPERIMENTAL RESULTS

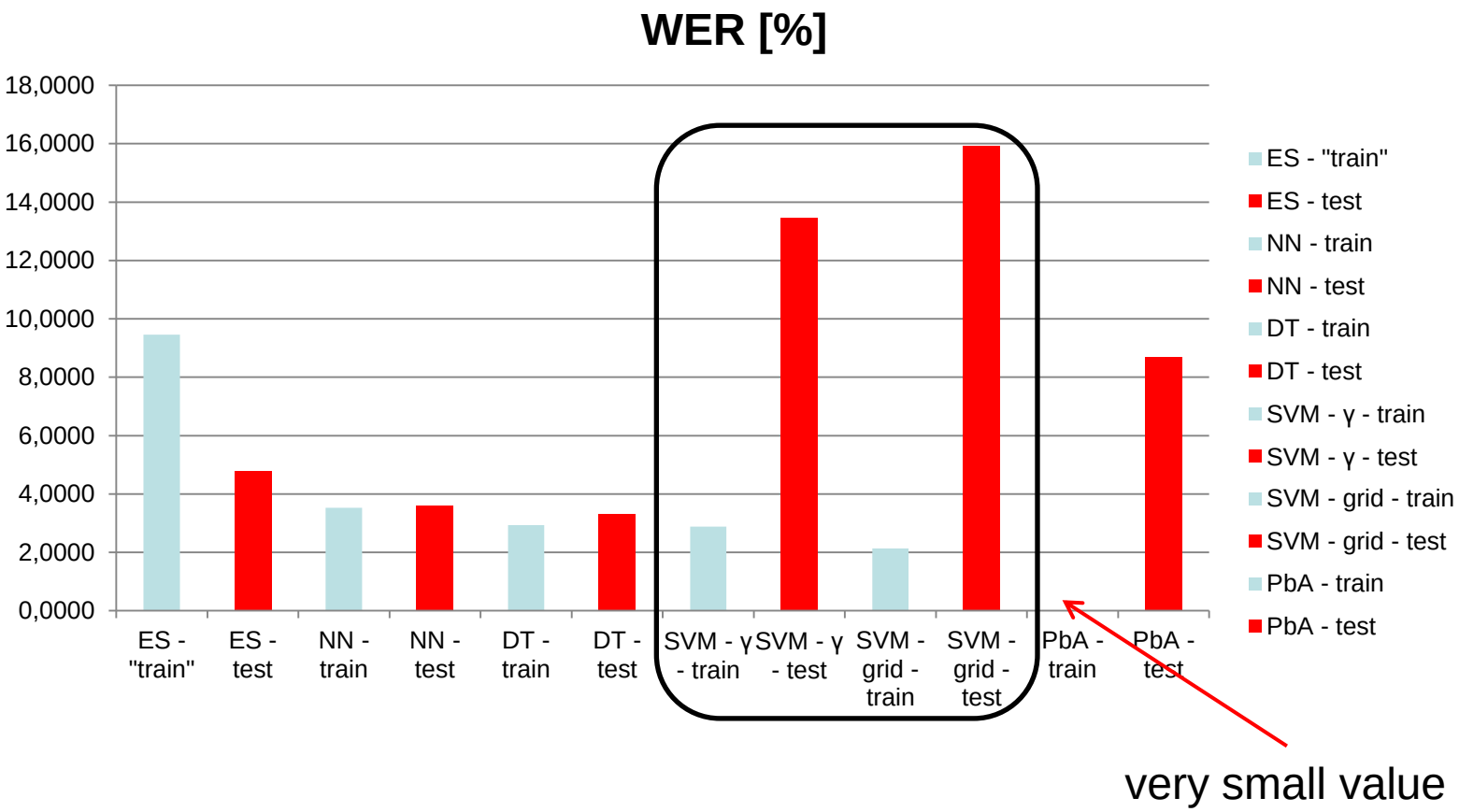
LTS conversion method		Train 15.517	Test 4779
Rule-based	LER	1.3	0.72
	WER	9.46	4.79
MLP 1 layer	LER	0.5393	0.6096
	WER	3.5294	3.6185
Decision tree	LER	0.4419	0.5177
	WER	2.9313	3.3273
SVM γ search	LER	0.4226	3.100
	WER	2.8787	13.455
SVM grid search	LER	0.3183	4.2892
	WER	2.1295	15.938
PbA	LER	0.00087	1.3213
	WER	0.0064	8.7047

EXPERIMENTAL RESULTS



very small value

EXPERIMENTAL RESULTS



very small value

EXPERIMENTAL RESULTS

Burileanu, 1999	**dictionary**	**4.000**	**1.000**
	WER [%]	1,6	**2,9**
Jitca, 2003	dicţionar	1.000	**4.00**
	WER [%]	-	**5,00**
Ordean, 2009	dicţionar	200	**1000**
	WER [%]	**0% la 25%**	**min. 5,00**

- statistical machine translation based LTS conversion which was applied to Romanian by H. Cucu, L. Besacier, C. Burileanu, A. Buzo in Investigating the role of machine translated text in ASR domain adaptation: Unsupervised and semi-supervised methods.(2011)

CONCLUSION

- the decision tree and neural network approaches to phonetic transcription provide the best results, for Romanian
- PbA is promising; this is still work in progress
- NN results consistent with other work

Thank you!