Improved Surname Pronunciation Using Decision Trees

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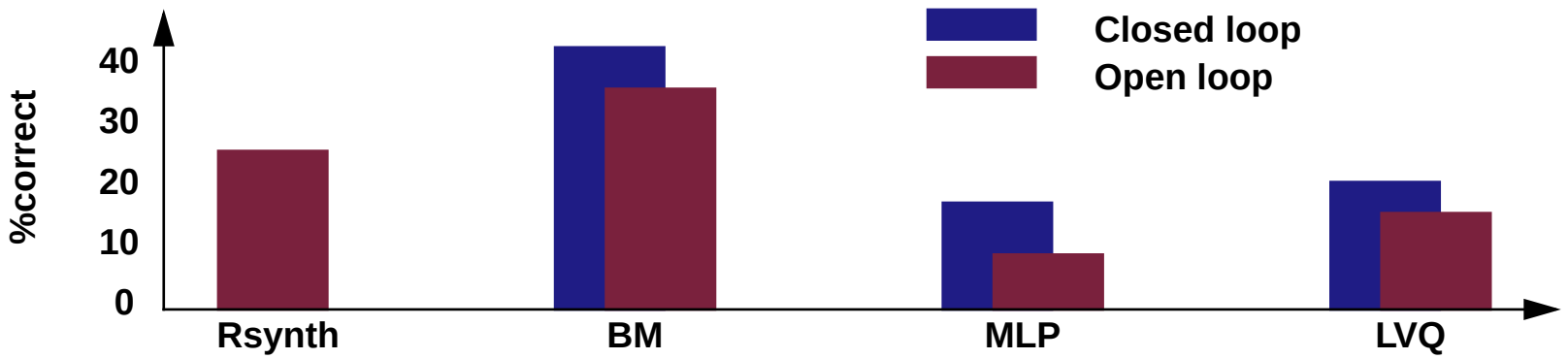
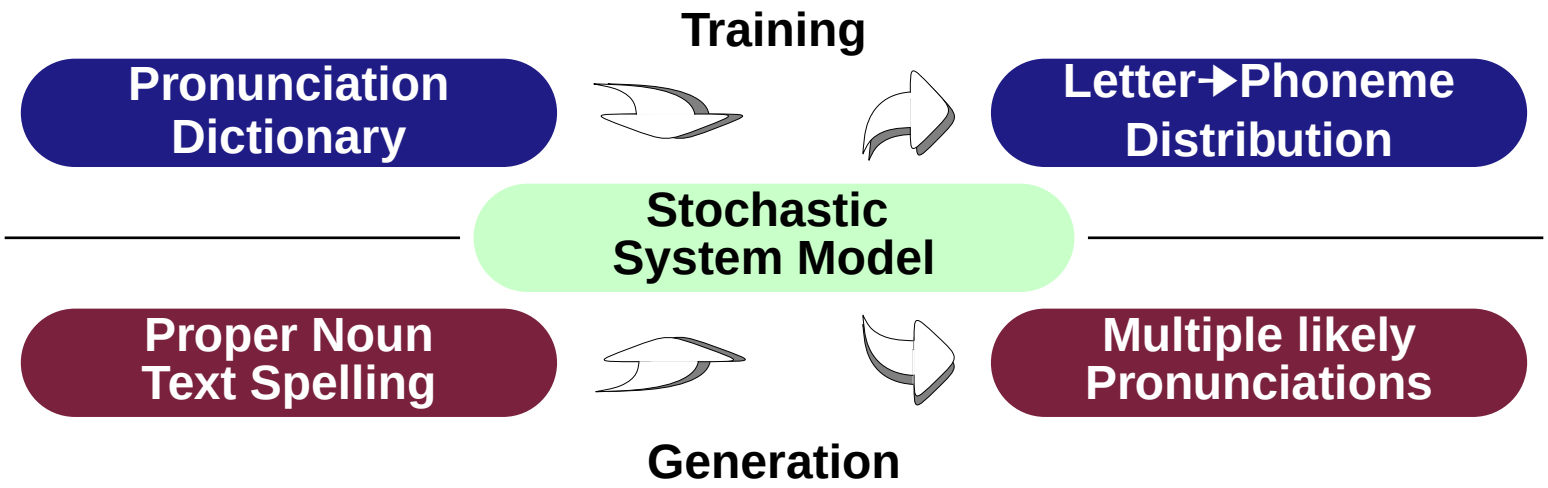
Introduction

- Proper nouns and errors in LVCSR
- Pronunciation networks needed
- Direct letter-to-sound rules do not apply
- Rule-based systems are unsuitable, NN-based systems do not work



Motivation

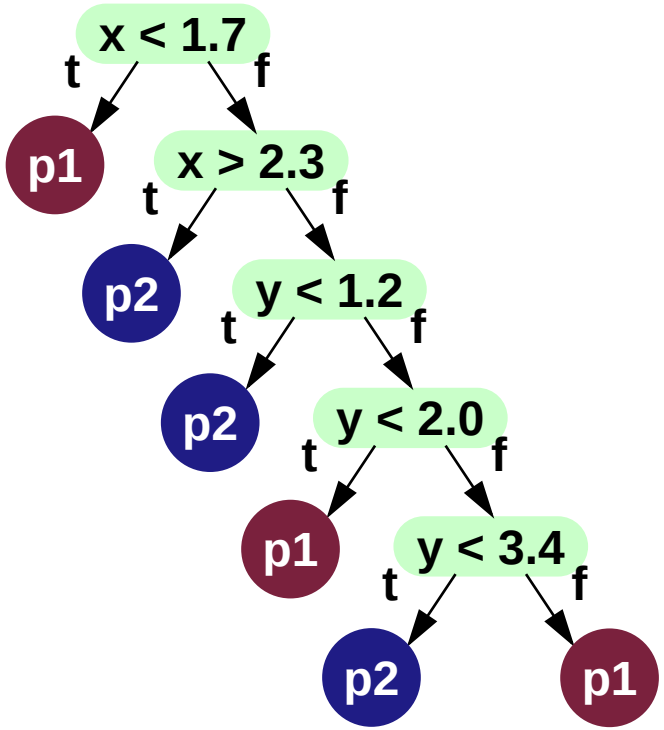
- Classify groups of letters into phonemes using nonlinear stochastic models

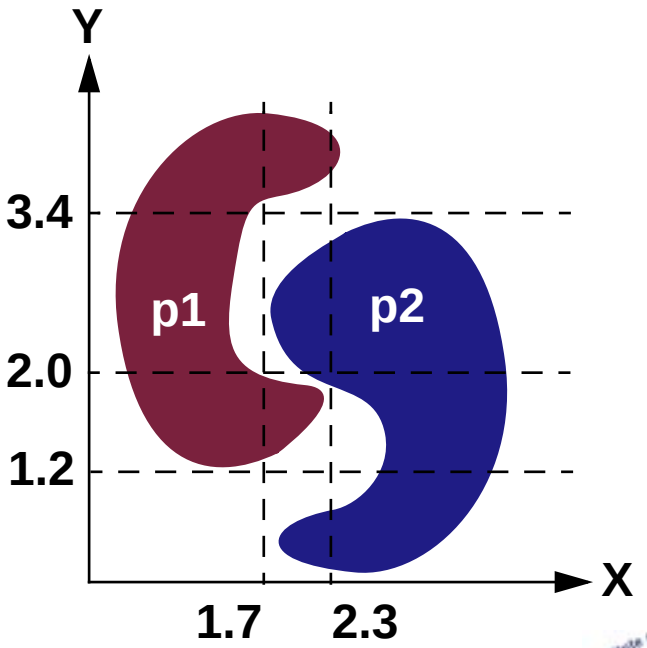


- Statistical neural networks fail to generalize on large data sets

Decision Tree Classifiers

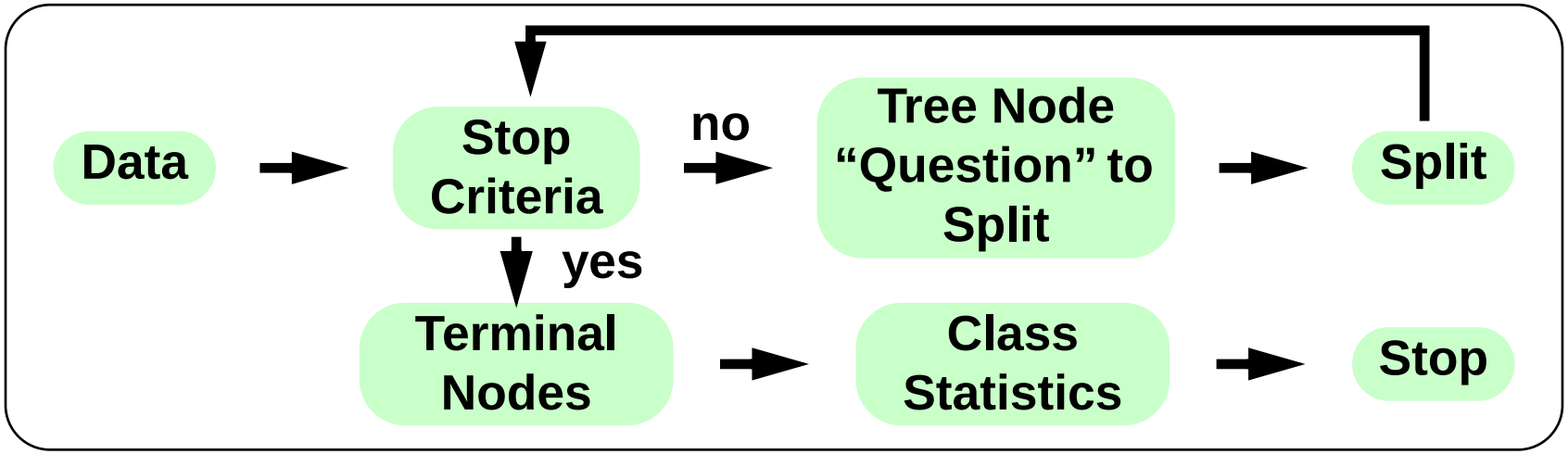
- Combine heuristics and statistics
- Ideally suited for nonlinear classification
- Classification based on data attributes





Decision Tree Overview

- Recursively partition data into groups



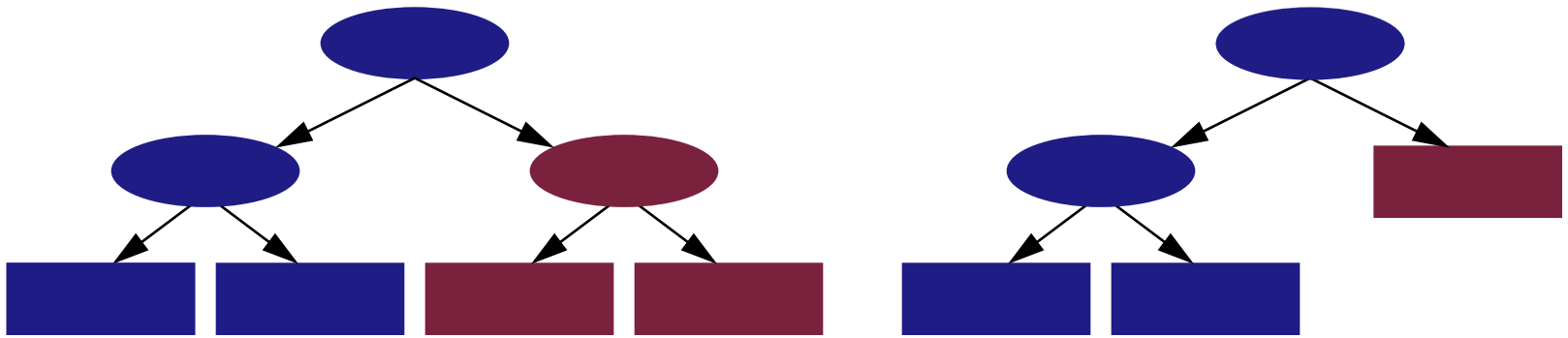
- Overfitting data — tree pruning
- Information theoretic basis for splitting, stopping, and pruning
- Capture complex relationships

DT Splitting Criteria

- Used to design "questions" at each node
- Bayesian splitting
  - — maximize *a posteriori* class likelihoods
- Information gain splitting
  - — maximize the information gain
- Information gain ratio splitting
  - — maximize information gain normalized by the total information in split
- Maximum entropy splitting

DT Pruning Criteria

- Collapse subtree into a terminal node if it results in lower predicted error
- Cost-complexity — trade off tree size and error rate
- Pessimistic pruning — statistical error estimates at node adjusted as per bias



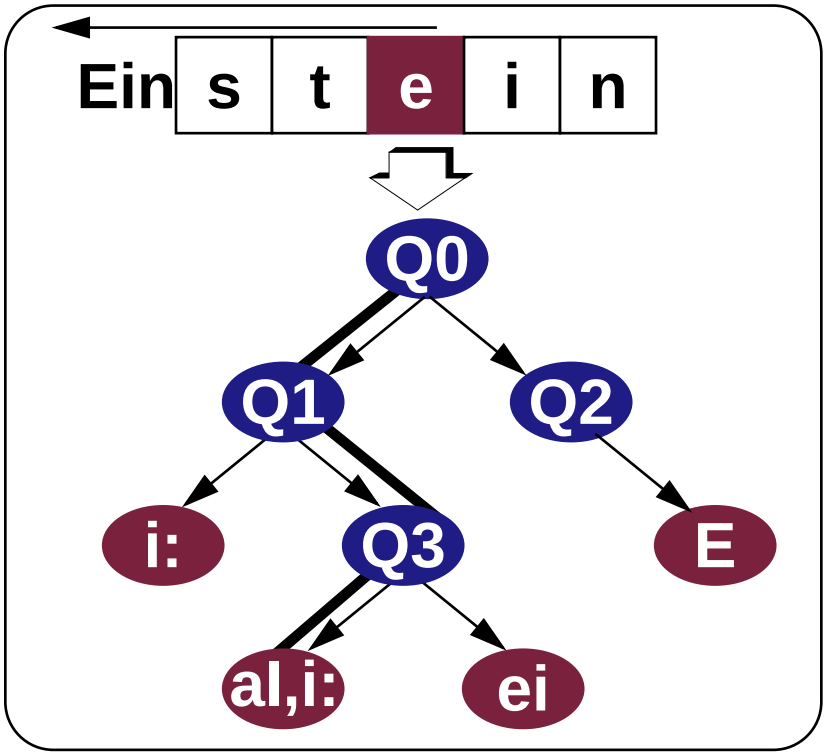
ISIP DT Toolkit

- Limitations of existing free software
  - — small number of classes
  - — number and values of attributes
  - — restrictions on class labels
  - — not amenable to text-based processing
- ISIP DT toolkit allows user-defined criteria for splitting, pruning, and stopping
- Data tagging allows selective attribute usage without reformatting

Surname Pronunciations

- Train DT on name-pronunciation pairs
- Sliding window of letter context

_	_	E	i	n	al
_	E	i	n	s	_
E	i	n	s	t	n
i	n	s	t	e	s
n	s	t	e	i	t
s	t	e	i	n	al
t	e	i	n	_	_
e	i	n	_	_	n



Pronunciation Dictionary

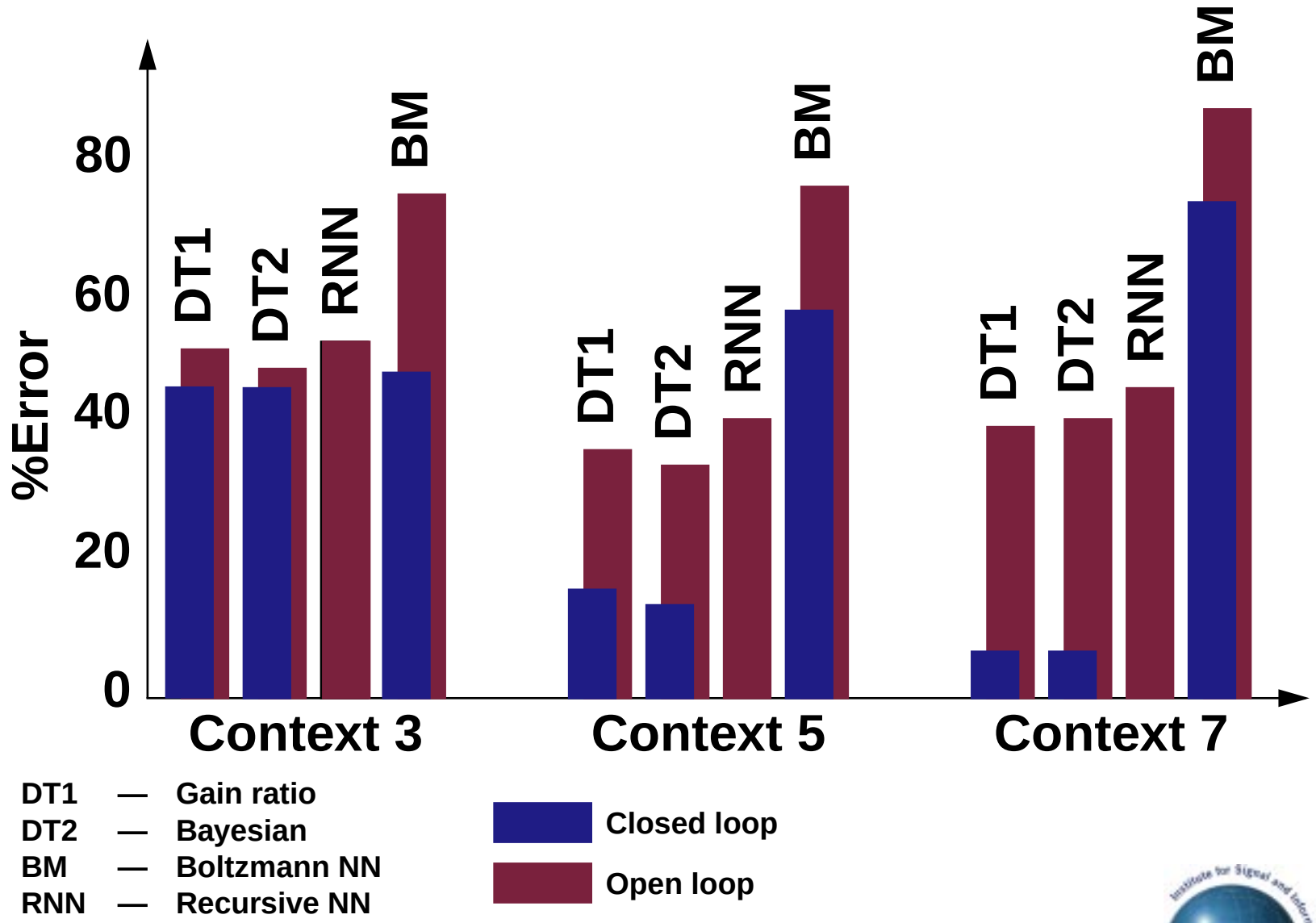
- 18494 surnames, 25648 pronunciations
- Worldbet phonetic convention to handle multilingual data
- Hand-transcribed pronunciations
- Automatic letter-to-phoneme alignment
- Public domain resource

Einstein	al _ n s t al _ n
Einstein	al _ n s t i: _ n
Fermi	f _ er m i:

Experiments

- Training set of 15000 names (3494 names held out for testing)
- Three such partitions for cross-validation of results
- Context lengths of 3, 5 and 7
- Binary univariate tree, single (1-best) pronunciation output
- Bayesian and gain ratio splitting
- Pessimistic pruning

Results



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Analysis

- DTs try to model letter context-to-sound relationship
- As context size increases
  - — closed loop performance improves
  - — open loop performance decreases due to overfitting
- Extremely confusible classification space
- Performance of both splitting criteria is comparable
- Pruning only helps marginally

General English

- Used best surname-trained DT
- 8000 word subset from Switchboard lexicon as test data
- Word error rate 83%!!!
- Pruning makes no difference
- Letter-to-sound mapping for names is radically different from general English
- Issue — can a single tree be trained for both types of data?

Conclusions

- Decision tree systems perform better — 38% error
- Generation of multiple pronunciations will further improve error rate
- Highly nonlinear letter-to-phone maps — need more data for effective training
- Future plans — extend DT application to general English
- Public domain resources — DT toolkit, pronunciation dictionary

References

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