DEEP CNN BASED FEATURE EXTRACTION FOR TEXT-PROMPTED SPEAKER RECOGNITION

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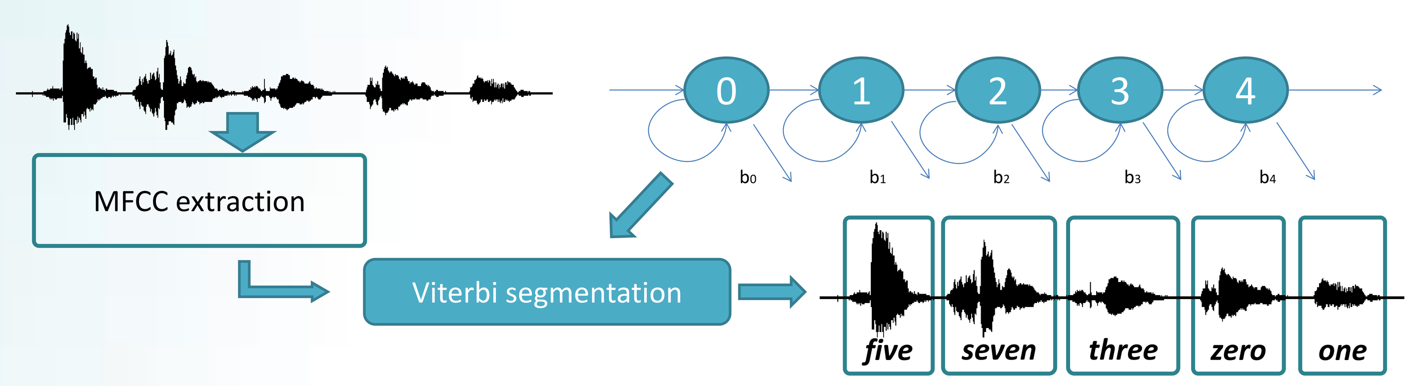
1 Introduction

- **Text-dependent** speaker recognition task [1,2,3,4] is studied
- **Deep convolutional neural network** based speaker specific features extractor in the text-prompted speaker verification task **is presented**
- The prompted **passphrase is segmented into word states** —i.e. digits — to test each digit utterance separately
- A **single high-level feature extractor for all states** is used and cosine similarity metric is applied for scoring
- **Multitask learning scheme** is used to train the high-level feature extractor

2 Features

Viterbi segmentation to word states



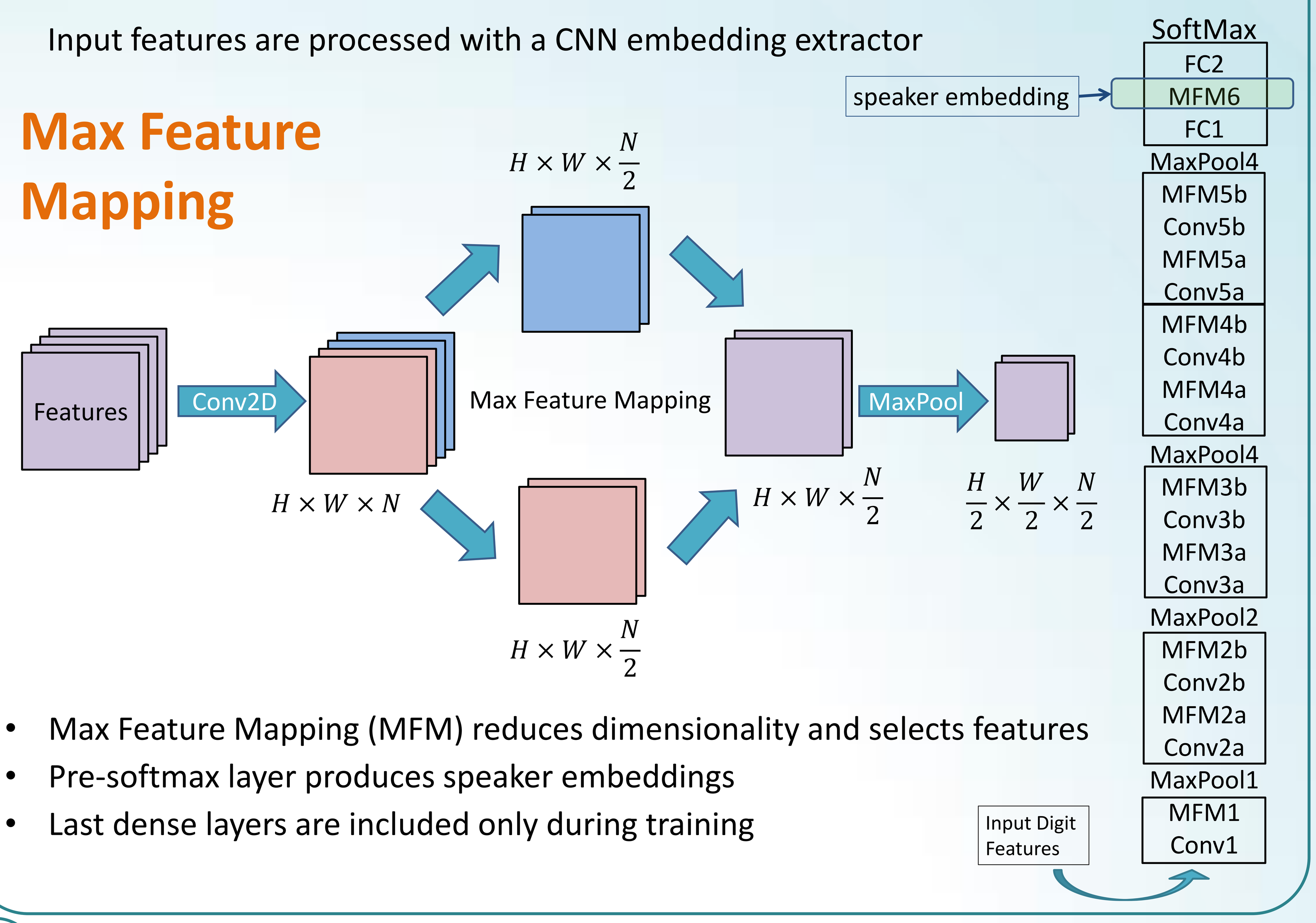
Input features for the CNN are 64×96 log mel power spectra:

- 64 frequency bands
- 96 frames (longest single digit utterance)
- Voice activity detector removes non-speech frames

3 Convolutional Neural Network

Input features are processed with a CNN embedding extractor

Max Feature Mapping

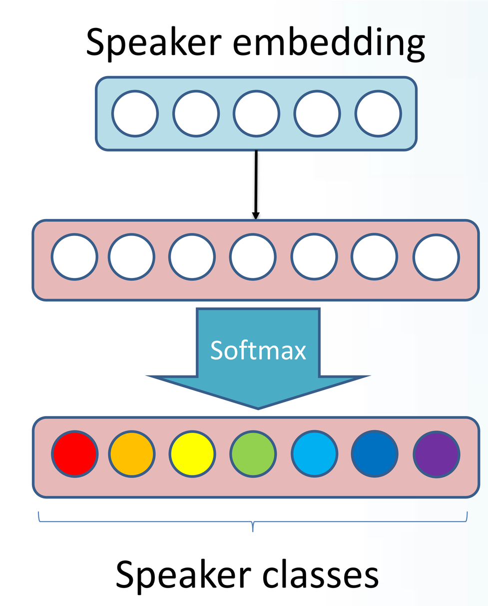


- Max Feature Mapping (MFM) reduces dimensionality and selects features
- Pre-softmax layer produces speaker embeddings
- Last dense layers are included only during training

4 Learning mode

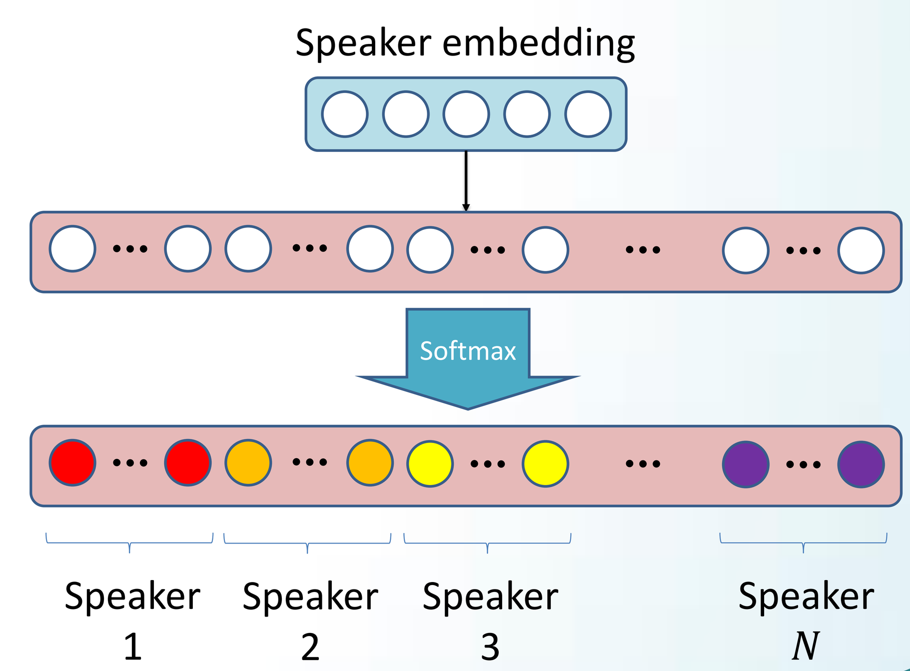
Single-task

- Extractor is trained to discriminate speakers
- $N_{speakers}$ neurons at softmax layer



Multi-task

- Extractor is trained to discriminate speakers and word states
- $N_{speakers} \times N_{digits}$ neurons at softmax layer



5 Experiments

We explored 5-digit password verification scenario when the speaker pronounces the correct passphrase. Training/evaluation bases consist of short digit passphrases

Training Datasets:

- **RSR2015** [1] **Part 3 train set** : 194 speakers (94 Female + 100 Male) - $RSR2015_{tr}$
- **Wells Fargo Bank set**: 300 speakers (150 Female + 150 Male) – WF
- **STC-Russian-digits train set**: 786 speakers (263 Female + 523 Male) – $STCRus_{tr}$

Evaluation Datasets:

- **RSR2015 Part 3 eval set** : 106 speakers (49 Female + 57 Male) - $RSR2015_{ev}$
- **STC-Russian-digits eval set**: 92 speakers (42 Female + 50 Male) - $STCRus_{ev}$

Results

Table 1. EER [%] and minDCF ($C_{miss} = 10, C_{fa} = 1, P_{tar} = 10^{-2}$) for 5-digit password verification

System	Multi-Task mode	Training data	Evaluation data	EER (%)	Min DCF
Baseline State-GMM-SVM[2]	None	$RSR2015_{tr}$ +WF	$RSR2015_{ev}$	3.11	0.14
State-CNN	None	$RSR2015_{tr}$		7.83	0.39
	Speaker & Digits			5.12	0.25
		$RSR2015_{tr}$ +WF		4.27	0.2
		$STCRus_{tr}$	$STCRus_{ev}$	5.86	0.29
	Speaker & Digits & Language	$RSR2015_{tr}$ +WF+$STCRus_{tr}$	$RSR2015_{ev}$	**2.85**	**0.13**
			$STCRus_{ev}$	**4.24**	**20.45**

Fusion results

Systems description:

State-GMM-SVM [2]:
Viterbi segmentation, state supervector extraction, state SVM based scoring, S-norm

State-GMM-PLDA [3]:
Viterbi segmentation, state supervector extraction, state TV space transform, state PLDA scoring

State-CNN:
Viterbi segmentation, state CNN deep speaker embedding extraction, cosine based scoring

Table 2. Fusion. EER [%] and minDCF for 5-digit password verification

System	EER (%)	Min DCF
State-CNN + StatePLDA	2.09	0.1
State-CNN + State-GMM-SVM	1.63	0.07
State-CNN + State-GMM-SVM	1.57	0.08
All	1.43	0.07

6 Conclusions

- A deep CNN based speaker feature extractor for speech digits is presented
- Multitask learning mode allows to train effective high-level speaker embeddings extractor for all states (digits)
- Discriminatively trained deep CNN based solution is able to surpass the classic baseline systems in terms of quality
- No complex trainable backend is needed for scoring. Speaker embeddings can be compared simply with cosine similarity metric
- CNN-based method fuses well with our previous methods [2,3]

7 References

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8 Acknowledgements

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