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Experiences with the retraining of NFIQ

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Agenda

1. **Why retrain NFIQ?**
2. Training approach and results
2. Wrap-up / discussion of next steps

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Why retrain the NFIQ?

Widely used reference

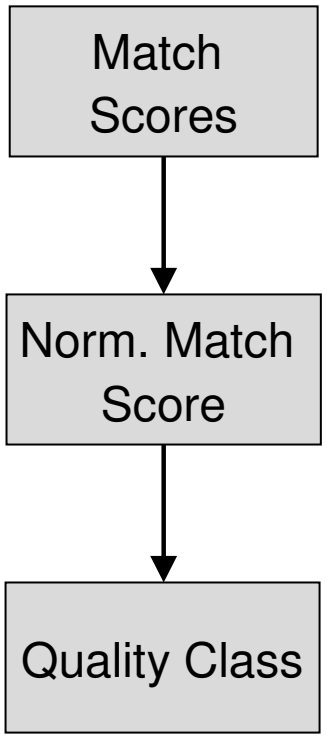
- Recognized as a reference in fingerprint quality estimation
- Used for ePassport application e.g. in Germany
- Used for Visa application e.g. in Germany
- Often coded as quality estimate in fingerprint reference data
- Seen as a reference compared to alternative approaches

Potential improvements

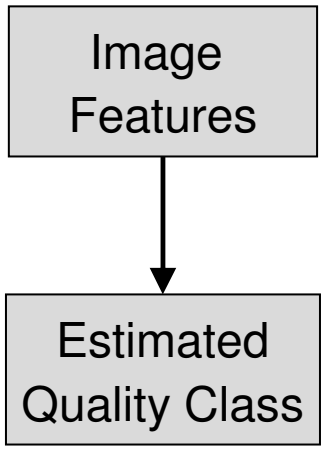
- Strange behaviour in some cases
  - E. g. quality values for fingertips only
- Increase speed
- More granular quality estimation
  - Definition of more classes
  - More homogenous distribution of classes
- Better suited training base for the target application
  - E.g. no rolled or paper scanned fingerprints for eDocuments

General Approach

Statistical Evaluation



Estimation by Neural Network



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Thoughts on influences and parameters for the retraining

- rolled / plain
- sensors
- no. of imprints per finger

- matching algorithms
- size of the similarity matrix
- error handling
- definition of norm. match scores

- fusing matching algorithms
- number & size of classes

- selection of features
- no. of features
- extraction algorithm

- size of network
- error function
- network optimization parameters

Main changes in BSI/secunet retraining

Different database (live scan, plain)

Up-to-date matcher

Increase no. of classes (10)

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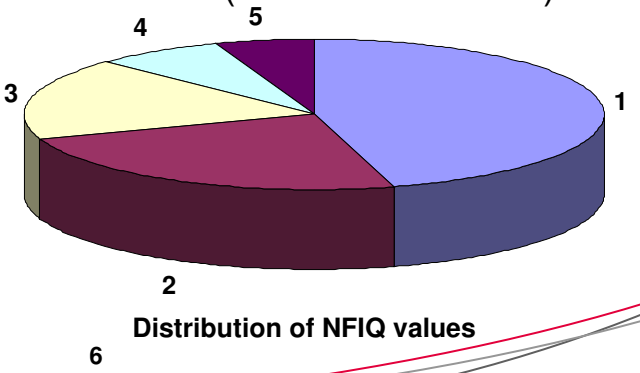
Data basis

- Original NFIQ used several databases
  - Both live-scans and inked imprints → Inked imprints not relevant for border control
  - two imprints per finger → only one genuine score per finger
  - 50% as training set, 50% as test set
- We used 9 live-scans of 8784 fingers, captured with 3 different sensors
  - 8 genuine scores per finger
    - →allows careful consideration of genuine score deviation by robust measures (15% quantil)
  - Computation of 450 match scores per imprint
- We used 5 matching algorithms
  - NIST, Neurotechnology, L1/Identix, Dermalog, NEC
  - NEC SDK returns match score „0“ in case of non-match (internal threshold)
    - → match score statistics less significant
- 5 classes, resembling original NFIQ



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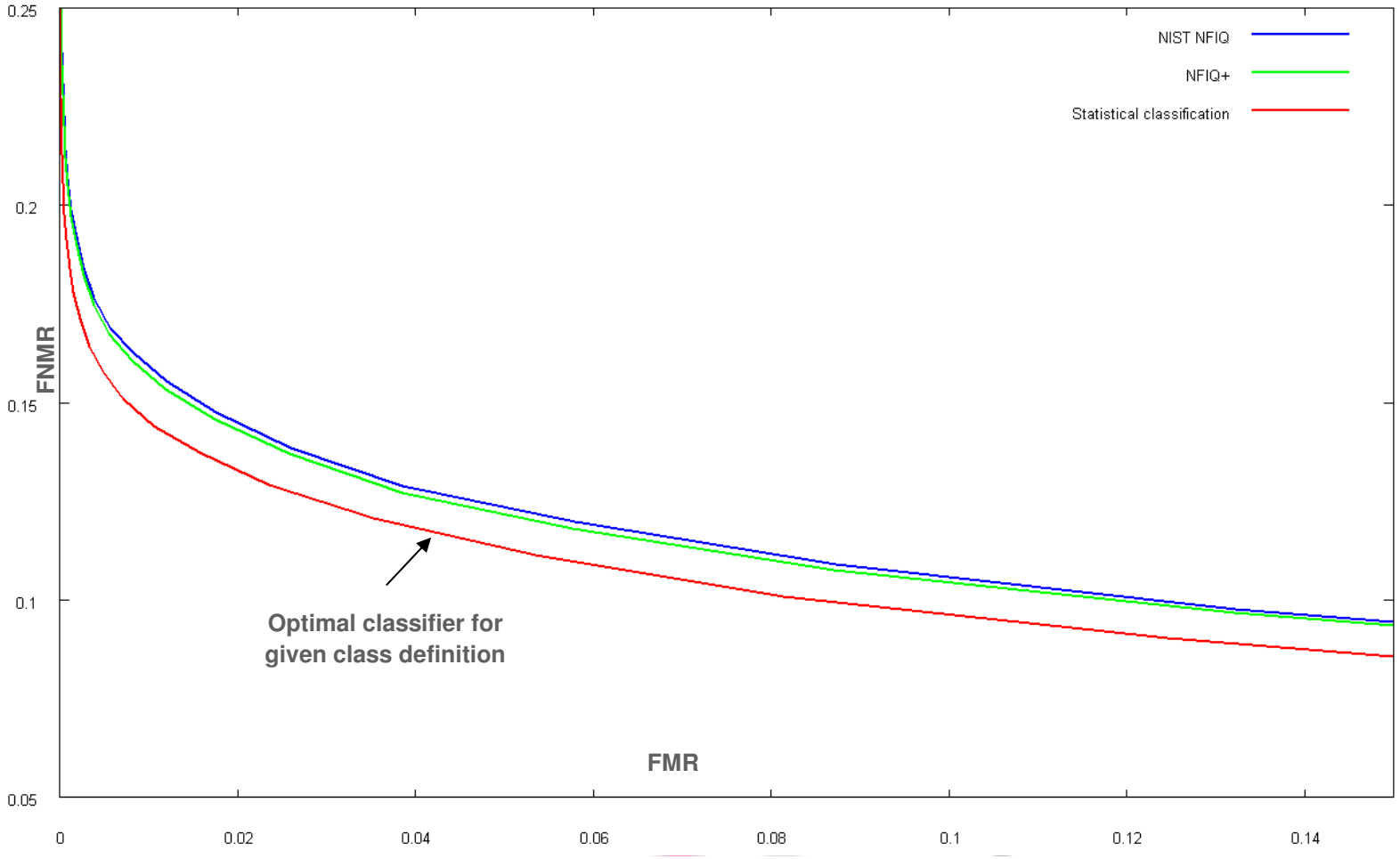
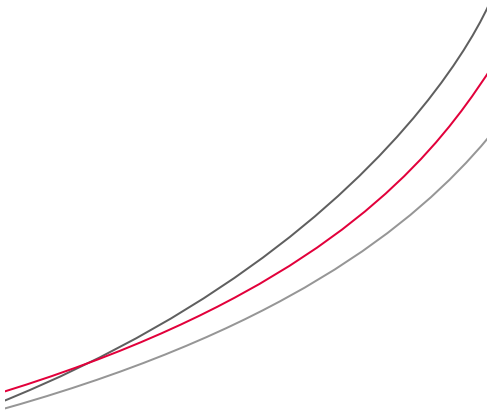
Result

- Impact of neural network training parameters were small
- Evaluation on test-set shows slight improvement



- DET curves for fingerprint selection based on NFIQ+ and NFIQ algorithms
- As reference, DET curve of selector based on real classes



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Promising optimization potential

- adapt variety of sensors
- exact scores (NEC)
- more matching algorithms
- definition of normalized comparison score
- more classes
- better or different features
- error function (approximation, not classification)

- DET curves show: 10 classes bear more potential than 5
- Optimize class definition first
- Feature vector definition could have great optimization potential
  - E.g. apply neural network for quality assessment of minutiae

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Leasons learned

- Retraining is possible ..
- But: No ready to use toolbox

- Documentation should be extended for NFIQ 2.0
  - Detailed documentation of the training process is missing
  - Information needs to be gathered by source code examination
  - Results of the original NFIQ training process are not available in detail
    - would be useful for comparing results

- Big improvement of NFIQ performance seems to be possible
  - More examination necessary

Wrap-up

- NFIQ is highly needed
- Clear potential for optimization
- NIST's ideas for NFIQ 2.0 highly appreciated
- Vendor-independent but modular NFIQ upgrade suggested

▶ Looking forward to an interesting discussion

Thank you for your attention!

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