Introduction

Many approaches were introduced for automatic classification of brain tumors using MR spectroscopy and pattern recognition [1,2]. Little effort has been paid regarding the interpretability of such classification systems, which might be one reason that none of these approaches found its way into a clinical application.

In this work, we introduce a novel reliability measure for a classifier’s decision and propose a visualization method for a linear decision boundary directly in the spectral domain.

Materials and Methods

Classifier comparison to confirm previous results [1]

- Four classifiers with and without feature extraction (PCA): LDA, ν-SVM, RBF-SVM, Random Forests (RF)
- Evaluation: 10x10-fold CV / Measure: Balanced error rate

Visualization of linear classifiers in the spectral domain

Decision Boundary:

\[ C(x) = \alpha^T x + \alpha \]

- \( \alpha \) encodes regions that are important for the classifier and can be visualized directly in the spectral domain
- Also works with prior feature extraction or feature selection

New reliability measure for newly classified samples

\[ S = \{(x_1,y_1), \ldots,(x_N,y_N)\} \]
\[ S^p = \{(x_1,y_1), \ldots,(x_N,y_N), (x_{N+1},y_{N+1})\} \]

- Classification of new sample \( \hat{x} \) yields a quality measure \( \hat{q} \)
  - Extract all training samples that had a lower quality measure \( S_{\text{low}} \)
    \[ S_{\text{low}} = \{(x,y) \mid x \in S^p \land y \leq \hat{q}\} \]
    - Correct (\( \hat{y} = y \)) and incorrect outcome binomial distributed
    - Binomial confidence interval based on \( S_{\text{low}} \) yields a lower bound for the accuracy of this particular classification

Results and Discussion

- Spectral representation clearly depicts metabolites that are important for a classifier’s decision (cf. Fig.1)
- We propose a reliability measure that yields the lower bound of the accuracy for a particular classification
- Reliability measure is more stable than the posterior probability and in good agreement with the real accuracy (cf. Fig.3)
- Combination of reliability measure and spectral weight vector gives further insight into a classifiers decision (cf. Fig.2)

Conclusion

- We introduce a novel reliability measure and propose a classifier visualization directly in the spectral domain
- Combination of reliability measure and spectral weights could help to further improve clinical acceptance of automatic classification systems
- For future work we plan a more profound evaluation of the reliability measure

References