AbstractID: 11472 Title: Three-class Classification for Binary Decision Making

Purpose: The goal of this work is to prove theoretically, and demonstrate in an example application, that 3-class classification in a 2D decision space results in an equal or higher data concordance value than 2-class classification in a 1D decision space. **Material and Methods**: Most medical diagnostic tests are interpreted using binary classification methods, i.e., patients are classified into normal vs. abnormal. Most of these tests, however, are not strictly binary since both normal and abnormal classes often contain distinct sub-groups. Here, we will provide theoretical proof that, for a 3-class problem, 3-class classification in a 2D decision space results in an equal or higher data concordance value than 2-class classification in a 1D decision space, and that, in order to take advantage of the 3-class classification, the decision must be made in a 2D decision space. We applied the theory to computerized lesion classification in breast ultrasound imaging. The database consisted of sonographic images of 128 cancerous, 168 benign solid and 74 cystic lesions. We used 4 lesion descriptors as inputs for 3-class and 2-class Bayesian neural network (BNN) classifiers. The 3- and 2-class BNNs were trained and tested in leave-one-case-out analyses for the task of differentiating among 3 (cancerous, benign solid, and cystic) and 2 classes (cancerous vs. non-cancerous), respectively. We performed a 2-alternative-forced-choice (2AFC) experiment to assess the performance of both classifiers for the task of classifying cancerous vs. non-cancerous. **Results**: In the 2AFC experiment, the percent correct was 92% using 3-class classification in a 2D decision space, which was significantly higher than the 85% obtained using binary classification in a 1D decision space. **Conclusion**: This work demonstrates that 3-class classification in a 2D decision space has the potential to improve computer-aided diagnosis.