

# Kernel Methods for Classifying Isolated Musical Instrument Sounds

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**Abstract** – This work-in-progress paper proposes a comparison of kernel classification methods, based on a set of five parameters. Support Vector Machines, Bayes Point Machines and Gaussian Process Classifiers are the three kernel classification methods to be compared. Two experiments are suggested to compare the accuracy, generalization capabilities, training time, computational complexity and memory requirements of the kernel methods. Isolated musical instrument sounds will be classified based on temporal and spectral features and these features will be identical for the three kernel methods. The three kernel methods were developed to overcome specific demerits of other classification methods and this study will indicate whether or not those goals have been achieved. Another kernel method, kernel Principal Component Analysis, will be applied to the test data to verify its contribution to increasing the performance of classification algorithms. The different kernel methods are expected to excel in different areas with comparable performances.

## I. INTRODUCTION

The accuracy of a classification algorithm is often the only parameter used to evaluate the performance of the algorithm [1], [2], [3]. Other parameters such as training time and computational complexity do however play a significant role and should not be ignored [4]. The study performed in [3] compared eight classification techniques used for the classification of monophonic sounds (containing only individual instrument sounds). The size of the databases, the accuracy of the algorithms and certain comments (if applicable) are provided. The comments provided give some indication of the importance of factors other than the accuracy, which need to be considered when comparing classification algorithms. Following is a list of some of the comments made.

- 1) Memory intensive.
- 2) Lack of generalization.
- 3) Fast computation.
- 4) Quantization of feature values required.
- 5) Better generalization than other techniques.
- 6) Very slow training procedure.

From this list of comments it is clear that the accuracy of a classification method cannot be the only parameter used for comparison with other methods. Other sources [5] specify that a classification algorithm is good if it classifies unseen data correctly. The following list is a suggestion of all the

parameters of classification methods which should be used to compare the methods.

- 1) Accuracy.
- 2) Generalization capabilities.
- 3) Training time.
- 4) Computational complexity.
- 5) Memory requirements.

The purpose of the proposed research is to compare the different kernel methods according to the five parameters mentioned above, with the exact same training and test data. The three kernel classifiers (SVM, BPM and GPC) will be applied to the same training and test data, with and without kernel PCA applied to the data prior to testing. It is expected that the accuracy and generalization capabilities of all three classifiers will increase when kernel PCA is applied to the data prior to testing, as opposed to testing without kernel PCA applied.

## II. PROBLEM STATEMENT

The three kernel classification methods, SVMs, BPMs and GPCs have not been compared based on parameters other than their accuracy. A comprehensive comparison is proposed, comparing the algorithms with the same training and test data, using the five parameters; accuracy, generalization capabilities, training time, computational complexity and memory requirements.

## III. METHODS

Two suggested experiments, a set of musical instrument descriptors and two sources of musical instrument sounds are discussed in the sections that follow.

### A. Methods for comparison of classification algorithms

To compare the parameters of the different methods, two experiments are suggested. The first experiment (Experiment 1) requires that the training data as well as the test data remain unchanged, in size as well as content, for all the classification methods. This does imply that a number of experiments be conducted with smaller and larger training and test sets, but that the same data be used for all the methods. This experiment will allow for comparison of the accuracy, training time, computational complexity and memory requirements of the classification algorithms. The second experiment (Experiment 2) will allow for

comparison of the generalization capabilities of the classification algorithms. Different test sets, varying in similarity with a training set, will be subject to classification. Both experiments will be conducted with and without kernel PCA applied to the test set prior to classification.

### B. Musical instrument feature descriptors

A large number of spectral and temporal descriptors have been used for classifying isolated musical instrument sounds [2]. Mel-frequency cepstral coefficients (MFCCs) [6], wavelets [7] and descriptors contained within the MPEG-7 standard [8] have been found to be adequate descriptors of musical instrument timbre for classification. These features will be combined in feature vectors which will be used for the classification of the isolated musical instrument sounds.

### C. Sources of musical instrument sounds

Two sources of musical instrument sound samples will be used. The first set of samples is from the McGill University Master Samples and the second set is from the University of Iowa Electronic Music Studios. More information on these samples, the recording techniques and the equipment used can be found in [9] and [10]. These two sources of musical instrument sounds will provide adequate similarities and differences for comparing the parameters of the classification methods.

## IV. CONCLUSION

The proposed research would be the first comprehensive comparison of SVMs, BPMs and GPCs. Where the SVM and BPM have been compared only the accuracy of the algorithms were provided. Comparing the three kernel classification methods with the proposed five parameters would therefore be a valuable research contribution to the field of kernel classification methods. The introduction of kernel PCA would also be a novel contribution to the research field.

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## BIOGRAPHY

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