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Optimization of future multi-filter surveys towards asteroid characterisation

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Colors have been commonly used by researchers to assign taxonomic class to asteroids. Furthermore, the optical design of future space surveys should account for a large number of incidental asteroid observations that they will likely make. It is thus crucial to consider a use of an optimal filter setup for asteroid taxonomic classification. Following the work from Klimczak et al. 2021 which compared different machine learning algorithms (Naive Bayes, Logistic Regression, Support Vector Machine (SVM), Gradient-boosting, Multilayer Perceptrons) on two different parameter sets: principal component directions (PCA) and reflectance values spaced 0.05μm in the 0.45-2.5μm range and spectral slope, we extend this analysis to reflectance colors. We aim to study the most efficient way to link colors to the Bus-DeMeo taxonomy and obtain a set of narrow band filters that should be used to correctly detect the taxonomic type of an object.

The set of features used in this work consists of 35 reflectance colors that were selected across the wide range of spectroscopic measurements. All aforementioned machine learning methods are trained to predict taxonomic types on this set, and Feature Selection is performed to assess the importance of individual features and decrease the redundancy of the set.

We find that Multilayer Perceptron and Support Vector Machines provide the best results on the whole feature set, with 85% balanced accuracy for taxonomic types and 93% for complexes. These results slightly outperform the results from our previous work. Furthermore, we find that satisfactory results can be obtained by reducing the feature set to top 5 features for taxonomic types (retaining 80% balanced accuracy), and top 3 features for complexes (retaining 89% balanced accuracy).

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