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Supplementary material for visualization and categorization of ecological acoustic events based on discriminant features

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1. Algorithm Illustration

The algorithm is formulated with 4 stages, which are briefly described below: (i) in the start, the stage of data pre-processing is define, in this stage the reading of the data, creation of the spectrum and spectrogram image are performed; (ii) after, features are extracted using feature descriptors based on images, spectrum and audio signal; (iii) after that, the stage of analysis of the features is defined to analyze and identify their discrimination capacity to categorize events in the acoustic landscape; to achieve this objective, various visual and numerical approaches would be employed that assisted in the evaluation and determination of the most discriminant features; (iv) finally the stage of visualization of the instances by multidimensional projections, allows the user to visually evaluate the quality of the features reflected in the visual separability between the categories of events. Further details are presented in the Algorithm (1).

Algorithm 1 Algorithm to identify discriminant features.

Input:

data: labeled set of sound files from an acoustic landscape.

model_embedded: Extra Trees Classifier (ETC) model to determine the importance of the features.

model_learn: Random Forest Classifier RFC, Support Vector Classifier SVC, k-nearest neighbors Classifier $KNNC$ ou Extreme Gradient Boosting Classifier $XBGC$.

Output:

$X_{discriminat}$: more discriminant features for a determinate acoustic landscape.

$Y \leftarrow \text{Labels}(data)$ *//sound file labels*
$repeat = True$
while $repeat == True$ **do**
    // Stage (1): pre-processing data
    $\widehat{X} \leftarrow \text{PreprocessinData}(data)$ *//pre-processing of data*
    // Stage (2): feature description
    $X_{index} \leftarrow \text{IndexFeatureDescription}(\widehat{X})$ *//acoustic index features*
    $X_{spectrum} \leftarrow \text{SpectrumFeatureDescription}(\widehat{X})$ *//spectrum features*
    $X_{image} \leftarrow \text{ImageFeatureDescription}(\widehat{X})$ *//spectrogram image features*
    $X_{raw} \leftarrow (X_{index} \cup X_{spectrum} \cup X_{image})$ *//total features*
    // Stage (3): discriminant feature analysis
    $X_{cleaned} \leftarrow \text{FeatureCleaning}(X_{raw})$ *//cleaning features*
    $X_{normalized} \leftarrow \text{FeatureNormalization}(X_{cleaned})$ *//normalization of features*
    $X_{analyzed} \leftarrow \text{FeatureAnalysis}(X_{normalized})$ *//analysis of features*
    $X_{important} \leftarrow \text{FeatureSelection}(model_embedded, X_{analyzed})$ *//importance of features*
    $X_{ranking} \leftarrow \text{FeatureRanking}(X_{important})$ *//ranking of features*
    $X_{discriminant} \leftarrow [\emptyset]$ *//to store the more discriminant features*
    $max_acc \leftarrow 0$ *//store value of maximum accuracy*
    for each $i \in \{0, ..., |X_{ranking}|\}$ **do** *//for each features of acording to ranking*
        $X \leftarrow ({X^0}_{ranking}, ..., {X^i}_{ranking})$ *//get be the first n features of the ranking*
        $acc \leftarrow \text{Learning}(model_learn, X, Y)$ *//train a model and compute test accuracy (acc)*
        if $acc > max_acc$ **then** *//compute the maximum accuracy value*
            $X_{discriminant} \leftarrow X$
            $max_acc \leftarrow acc$
        end if
    end for
    // Stage (4): visualization
    $view \leftarrow \text{Projection}(X_{discriminant})$ *//viusalization the data*
    $repeat \leftarrow \text{UserVisualEvaluation}(view)$ *//the user evaluates the repetition*
end while