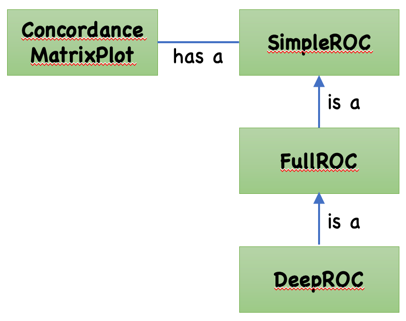
# Deep ROC v2.0 (for Python 3)

André Carrington, April 23, 2022

The second release of Deep ROC code for Python 3, implements functions discussed in a paper about Deep ROC analysis [1] and the Concordant Partial AUC and Partial C Statistic [2].

This code is a complete refactoring of the earlier release, from procedural to object-oriented, and written to simplify use, understanding, extension and management.

Figure Class Hierarchy

SimpleROC is the base class in a series of classes (Figure 1). SimpleROC provides an ROC plot and AUC and C as measures for a single test set or a set of folds or bootstraps. For folds, each fold’s ROC curve is shown in a light colour, while the mean ROC curve is highlighted along with confidence intervals.

FullROC is a subclass of SimpleROC that shows a more informative ROC plot.

DeepROC is a subclass of FullROC that implements pre-test and post-test measures, normalized or not, such as the Concordant Partial AUC and Partial C Statistic, for the whole ROC curve or parts which we call groups. Groups are contiguous groups of predicted risk or probability (e.g., ranges of FPR or TPR) or non-contiguous demographic groups or clinical groups/arms. Groups may be overlapping and not cover the whole ROC curve, or they may be mutually exclusive and perfectly cover the ROC curve. In the latter case, equalities are checked between the sum of parts and the whole, as applicable.

Key methods (or function calls) for each class are summarized below (Tables 1, 2 and 3)

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Table 1. Functionality in the SimpleROC class

|  |  |  |
| --- | --- | --- |
| **SimpleROC** | | |
| Functionality | Short name | Description |
| Measures | AUC  C  U | Area under the ROC curve  The C statistic (concordance statistic)  The corrected U statistic (includes ties) |
| Plots | ROC | A plot of a receiver operating characteristic (ROC) curve, with the optimal ROC point (Metz) based on sample prevalence by default, or specified costs and prevalence. |
|  | Mean ROC | A plot of the mean ROC curve, and individual folds, with confidence intervals. Folds may be cross-validation folds, bootstraps, train-test splits, etc. |
|  | ROC comparison | A plot of multiple ROC curves on top of each other for comparison. |

Table 2. Functionality in the FullROC class

|  |  |  |
| --- | --- | --- |
| **FullROC** | | |
| Functionality | Short name | Description |
| Plots | Full ROC[[1]](#footnote-1) | An ROC plot, with the optimal ROC point (Metz), with thresholds shown, and with all intermediate points (including ties in classification score or probability). |

Table 3. Functionality in the DeepROC class

|  |  |  |
| --- | --- | --- |
| **DeepROC** |  |  |
| Functionality | Short name | Description |
| Plots | Deep ROC plot  for each group | An ROC plot with partial area measures.  for acontiguous group of risk,  in a range of FPR, TPR, threshold, or percentile threshold. |
|  | Deep mean ROC plot  for each group | A mean ROC plot with partial area measures.  for acontiguous group of risk,  ina range of FPR or TPR. |
| Pre-Test Measures  (discrete) | Partial C statistics  for an ROC plot  Ci, Cn  Cyi, Cyn  Cxi, Cxn | Partial C statistics,  for a non-contiguous group by demographics, or  for a selected subset of whole instances, or  for a contiguous group of risk in a range of FPR, TPR, threshold or percentile threshold  The partial C statistic, normalized (group C)  Vertical partial C, normalized (avg group sensitivity)  Horizontal partial C, normalized (avg group specificity) |
| Pre-Test Measures  (continuous) | Partial area measures  for an ROC plot, or for a mean ROC plot  AUCi, AUCni  pAUC, pAUCn  pAUCx, pAUCxn | Partial area measures  for a contiguous group of risk  in a range of FPR, TPR, threshold, or percentile threshold.  analyzeGroupVs( )  analyzeGroupVsChance( )  analyzeGroupFoldsVsChance( )  analyzeGroupVsPrior( )  analyzeGroupFoldsVsPrior( )  Concordant partial AUC, normalized (group AUC).  Partial AUC (vertical), normalized (avg group sensitivity)  Horizontal partial AUC, normalized (avg group specificity) |
| Post-Test Measures (discrete) | Other deep measures  for an ROC plot  avgPPV, avgNPV  avgLRp, avgLRn  avgOR | Other deep measures  for a non-contiguous group by demographics, or  for a selected subset of whole instances, or  for a contiguous group of risk with whole instances in a range of FPR, TPR, threshold or percentile threshold.  Group average positive and negative predictive value  Group average likelihood ratio positive and negative  Group average odds ratio  (these measures currently need a little fixing) |

## Creating an ROC object

Method 1.

Create an object with ROC data as classification scores (probabilities) and labels.

import SimpleROC

roc = SimpleROC(predicted\_scores=scores, labels=labels, poslabel=1)

Method 2.

Create an empty object, then set the ROC data with as classification scores (probabilities) and labels.

import SimpleROC

roc = SimpleROC(predicted\_scores=None, labels=None, poslabel=None)

roc.set\_scores\_labels(predicted\_scores=scores, labels=labels, poslabel=1)

Method 3.

Create an empty object, then set the ROC data with known points in ROC space: (fpr, tpr).

import SimpleROC

roc = SimpleROC(predicted\_scores=None, labels=None, poslabel=None)

roc.set\_fpr\_tpr(fpr=fpr, tpr=tpr)

Now use it…

roc.plot(plotTitle, saveFileName=’plot.png’, showPlot=True)

auc = roc.getAUC()

c = roc.getC()

Creating an object from the other classes, FullROC, DeepROC and BayesianROC is similar.

## Groups

With DeepROC, you can define one group (like a region of interest) or as many groups as you like to measure in an ROC plot. The groups can be overlapping or not. Group measures can be compared to each other and to the whole. See hardcoded below.

## Example Use of the Classes in Test Functions

TestDeepROC.py, creates objects from each of the classes and performs tests on them with data. It currently results from machine learning methods applied to Ljubljana Breast Cancer recurrence data.

1. provides useful threshold information, shows points that other functions omit and permits the proper calculation of some discrete measures in the DeepROC class. [↑](#footnote-ref-1)