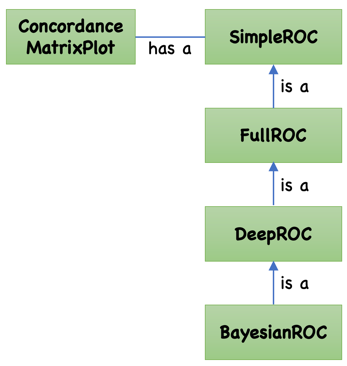
# Code for Deep ROC and Binary Chance ROC papers

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The code for the Deep ROC paper [1] and the Binary Chance ROC paper [2] is written in Python 3.8. It is object oriented with SimpleROC being a base class for FullROC, DeepROC and BayesianROC in turn as subclasses of each other sequentially (Figure 1). Each subclass offers additional functionality (Tables 1 and 2).

Binary chance is a specific choice of a Bayesian prior, so it does not have its own class for functionality (just a unique one for testing).

DeepROC implements pre-test and post-test measures, for the whole ROC plot or for groups, where groups are contiguous risk groups or non-contiguous demographic groups (or groups as any selection of instances). 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.

Figure 1 Class Hierarchy

Table 1. Functionality in the SimpleROC and FullROC classes

|  |  |  |
| --- | --- | --- |
| **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. |
| **FullROC** | | |
| 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 2. 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  cpAUC, AUCi  pAUC, pAUCn  pAUCx, pAUCxn | Partial area measures  for a contiguous group of risk  in a range of FPR, TPR, threshold, or percentile threshold.  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 |

Table 3. Functionality in the BayesianROC class

|  |  |  |
| --- | --- | --- |
| **BayesianROC** |  |  |
| Functionality | Short name | Description |
| Plots | Chance ROC plot  for each group | An ROC plot with partial area measures and a binary chance baseline,  for a contiguous group of risk,  in a range of FPR, TPR, threshold, or percentile threshold. |
|  | Chance mean ROC plot  for each group | A mean ROC plot with partial area measures and a binary chance baseline or Bayesian prior baseline,  for acontiguous group of risk,  ina range of FPR or TPR. |
| Pre-Test Measures  (continuous) | Partial area measures  for an ROC plot, or for a mean ROC plot  cpAUCΩ, AUCiΩ  pAUCΩ+, pAUCΩ-  pAUCxΩ+, pAUCxΩ- | Partial area measures with  for a contiguous group of risk  in a range of FPR, TPR, threshold, or percentile threshold.  Relative to binary chance Ω:  Concordant partial AUC, normalized (group AUC).  Partial AUC (vertical) positive, negative  Horizontal partial AUC positive, negative |

## 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 as classification scores (probabilities) and labels.

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

## Example Use of the Classes in Test Functions

TestChanceROC.py, creates a BayesianROC object and performs tests for the Chance ROC paper  
Alter parameters at the start of the file:

quiet = False  
testNum = 1  
useFile = False  
resultType = 'matlab' # matlab or python  
matlabResults = ['040', '356', '529', '536', '581', '639', '643']  
pythonResults = ['009']  
resultIndex = 5  
pythonMinor = ['nnReLU', 'svcRBF', 'plogr1']  
indexMinor = 0  
groupAxis = 'TPR'  
groups = [[0.0, 0.8], [0.8, 1]]  
#groups = [[0.0, 1/3], [1/3, 2/3], [2/3, 1.0]]  
#groups = [[0, 1], [0.0, 1/3], [1/3, 2/3], [2/3, 1.0]]  
costs = dict(cFP=1, cFN=4, cTP=0, cTN=0, costsAreRates=False) # depends on the dataset  
popPrevalence = 0.3 # None uses sample prevalence. population depends on the dataset,  
# 0.297 for LBC data in 536 and 639, 0.345 for WBC 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)