The RJafroc Book

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Preface

- This book, an extended documentation of the **RJafroc** package, is currently (as of April 2020) in preperation. It is intended to bypass the file size limits of **CRAN**, which severely limits the extent of the documentation that can be included with the CRAN package.

A note on the online distribution mechanism of the book

- In the hard-copy version of my book (**?**) the online distribution mechanisms was `BitBucket`.
- `BitBucket` allows code sharing within a *closed* group of a few users (e.g., myself and a student).
- Since the purpose of open-source code is to encourage collaborations, this was, in hindsight, an unfortunate choice. Moreover, as my experience with R-packages grew, it became apparent to me that the vast majority of R-packages are shared on `GitHub`, not `BitBucket`.
- For these reasons I have switched to `GitHub`. Any previous instructions pertaining to `BitBucket` are obsolete.
- In order to access `GitHub` material one needs to create a (free) account.
- Go to this link and click on `Sign Up`.

Contributing to this book

- I would greatly appreciate any feedback on this document. I welcome corrections and comments.

- The simplest way to do this is to raise an `Issue` on the `GitHub` interface.
- Click on `Issues` tab under `dpc10ster/RJafrocBook`, then click on `New issue`.
- Contributions from users then automatically become part of the `GitHub` documentation/history of the book.

Chapter 1

Introduction

- This is the book desribing the **RJafroc** package.
- The name of the book is **The RJafroc Book**.
- Modality and treatment are used interchangeably.
- Reader is a generic radiologist, or a computer aided detection algorithm, or any algorithmic "reader"
- TBA

Chapter 2

Negative and Positive Predictive Values

2.1 Introduction

Sensitivity and specificity have desirable characteristics, insofar as they reward the observer for correct decisions on actually diseased and actually non-diseased cases, respectively, so these quantities are expected to be independent of disease prevalence. Stated simply, one is dividing by the relevant denominator, so increased numbers of non-diseased cases are balanced by a corresponding increased number of correct decisions on non-diseased cases, and likewise for diseased cases. However, radiologists interpret cases in a "mixed" situation where cases could be positive or negative for disease and disease prevalence plays a crucial role in their decision-making – this point will be clarified shortly. Therefore, a measure of performance that is desirable from the researcher's point of view is not necessarily desirable from the radiologist's point of view. It should be obvious that if most cases are non-diseased, i.e., disease prevalence is close to zero, specificity, being correct on non-diseased cases, is more important to the radiologist. Otherwise, the radiologist would figuratively be crying "wolf" most of the time. The radiologist who makes too many FPs would discover it from subsequent clinical audits or daily case conferences, which are held in most large imaging departments. There is a cost to unnecessary false positives – the cost of additional imaging and / or needle-biopsy to rule out cancer, not to mention the pain and emotional trauma inflicted on the patient. Conversely, if disease prevalence is high, then sensitivity, being correct on diseased cases, is more important to the radiologist. With intermediate disease prevalence a weighted average of sensitivity and specificity, where the weighting involves disease prevalence, is desirable from the radiologist's point of view.

The radiologist is less interested in the normalized probability of a correct deci-

sion on non-diseased cases. Rather interest is in the probability that a patient diagnosed as non-diseased is actually non-diseased. The reader should notice how the two probability definitions are "turned around" - more on this below. Likewise, the radiologist is less interested in the normalized probability of correct decisions on diseased cases; rather interest is in the probability that a patient diagnosed as diseased is actually diseased. These are termed negative and positive predictive values, respectively, and denoted NPV and PPV

2.2 Relevant equations

- These are from Chapter 2 of my book.
- PPV = Positive Predictive Value
- NPV = Negative Predictive Value
- Acc = Accuracy
- $P(D)$ is the disease prevalence and $P(!D)$ is the complement, i.e., $P(!D) = 1 - P(D)$.

$$NPV = \frac{P(!D)(1 - FPF)}{P(!D)(1 - FPF) + P(D)(1 - TPF)}$$

$$PPV = \frac{P(D)(TPF)}{P(D)(TPF) + P(!D)FPF}$$

$$Acc = P(!D)(1 - FPF) + P(D)(TPF)$$

2.3 Example calculation of PPV, NPV and accuracy

- Typical disease prevalence in the US in screening mammography is 0.005.
- A typical operating point, for an expert mammographer, is FPF = 0.1, TPF = 0.8. What are NPV and PPV?

```
# disease prevalence in
# USA screening mammography
prevalence <- 0.005
FPF <- 0.1 # typical operating point
TPF <- 0.8 #        do:
specificity <- 1-FPF
sensitivity <- TPF
NPV <- (1-prevalence)*(specificity)/
```