Homework 2

Frank Chou, Milo Opdahl, Tejaswi Pukkalla

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Question 2: A Hospital Audit

Hospital Audits are important to determine the effectiveness of hospital operations from a objective standpoint. In this particular case, the goal is to determining the performance of radiologists using a statistical audit of their recent patient interactions - a crucial link between modern data-science and hospital operations. Two overall questions are posited:

1. First question: are some radiologists more clinically conservative than others in recalling patients, holding patient risk factors equal?
2. Second question: when the radiologists at this hospital interpret a mammogram to make a decision on whether to recall the patient, does the data suggest that they should be weighing some clinical risk factors more heavily than they currently are?

At the core of each question is reducing the number of false negatives - where a radiologist recommends a patient to conduct further tests and thereby allows a patient to begin immediately; and false positives - where a radiologist recommends further tests but ultimately turns out that there was no cancer. By introducing a statistical model, the goal is to augment the predictive capabilities of radiologist and offer a better standard of care for patients.

This audit is structured in four parts: first is a brief summary of the data and how it is structured, second is a demonstration and presentation of answering question one, third is a similar approach for question two, fourth is a conclusion of the audit's findings and recommendations for improvement of future radiologist performance or audit effectiveness.

Brief Summary of Data

```
##         radiologist      cancer            recall              age
##  radiologist13:198   Min.   :0.00000   Min.   :0.0000   age4049  :287
##  radiologist34:197   1st Qu.:0.00000   1st Qu.:0.0000   age5059  :284
##  radiologist66:198   Median :0.00000   Median :0.0000   age6069  :199
##  radiologist89:197   Mean   :0.03749   Mean   :0.1499   age70plus:217
##  radiologist95:197   3rd Qu.:0.00000   3rd Qu.:0.0000
##                      Max.   :1.00000   Max.   :1.0000
##     history          symptoms                menopause       density
##  Min.   :0.0000   Min.   :0.00000   postmenoHT     :321   density1: 89
##  1st Qu.:0.0000   1st Qu.:0.00000   postmenoNoHT   :360   density2:332
##  Median :0.0000   Median :0.00000   postmenounknown: 35   density3:460
##  Mean   :0.1763   Mean   :0.04863   premeno        :271   density4:106
##  3rd Qu.:0.0000   3rd Qu.:0.00000
##  Max.   :1.0000   Max.   :1.00000
```

The data of mammograms used in this audit were selected from a Hospital in Seattle, Washington. At this hospital, five radiologists were selected at random for the audit - where about 200 mammograms were randomly selected from the hospital for each. For a total of 987 mammograms covering 7 parameters:

- age: 40-49*, 50-59, 60-69, 70 and older
- family history of breast cancer: 0=No*, 1=Yes
- history of breast biopsy/surgery: 0=No*, 1=Yes

- breast cancer symptoms: 0=No*, 1=Yes
- menopause/hormone-therapy status: Pre-menopausal, Post-menopausal & no hormone replacement therapy (HT), Post-menopausal & HT*, Post-menopausal & unknown HT
- previous mammogram: 0=No*, 1=Yes
- breast density classification: 1=Almost entirely fatty, 2=Scattered fibroglandular tissue*, 3=Heterogeneously dense, 4=Extremely dense

Of these factors, two are of special interest: [recall] and [cancer]. In the abstract [recall] can be explained as the following: upon seeing the medical history of a patient, they can either recommend either one of two actions: recall for further screening or not. It is presumed that radiologists utilize all of the information available before they make a decision. This implies that there is a inherent correlative factor between recall and patient history. On the other hand [cancer] is whether or not a patient, whether through the recall screening process, or through another pathway of discovery - develops cancer within a 12 month window after seeing the radiologist.