Section 2

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Part B: Logistic Regression

Introduction

Breast cancer was the second most commonly diagnosed cancer in Australia in 2013 [1]. The most effecitive method for breast cancer screening is Mammography. To confirm the diagnoisis, invasive biopsies are perfomed. However, 70% of biopsies come back benign, indicating a high false positive rate in Mammography. To improve this process several computer-aided diagnosis (CAD) systems have been developed to help aid clinicians in making informed diagnoses.

The data in this examination contains 961 mammographic mass lesions with 445 of those lesions being malignant, given by the indicator varible Severity. Addionally for each of these lesions there are three attributes from the Breast Imaging Reporting and Data System (BI-RADS), including the lesion shape (round= 1, oval= 2, lobular= 3, irregular= 4), the margin (circumscribed= 1, microlobulated= 2, obscured= 3, ill-defined= 4, spiculated= 5) and the density (high= 1, iso= 2, low= 3, fat-containing= 4).

This apprach will attempt to develop a logistic predictive model for mammographic mass severity using the available predictor variables and to obtain predicted probabilities of mass severity that can used by clinicians to make informed diagnoses.

Data cleaning

```
mammo <- read.csv('mammo.txt', header = TRUE)
head(mammo)
```

```
##   BI.RADS Age Shape Margin Density Severity
## 1       5  67     3      5       3        1
## 2       4  43     1      1       ?        1
## 3       5  58     4      5       3        1
## 4       4  28     1      1       3        0
## 5       5  74     1      5       ?        1
## 6       4  65     1      ?       3        0
```

After taking the data it is clear there are a few key issues to deal with in cleaning the data. The first is the incorrect classes of several of the varibles and, as can be seen below, there are a number of data points that are missing certain attributes, these are currently set to "?". but should be set to "NA", for approciate use within the models. These data points could be removed as they are missing some data, however this should not be done for two reasons. Firstly, incomplete data should not be thrown away as it may still contain valueble ifnormation. Furturemore, the final model may not include some of the predicor attributes, and some of the currently incomplete data may not be missing infomartion in any of the include attributes.

```
table(mammo$Severity)
```

[1] Australian Institute of Health and Welfare, Cancer compendium: information and trends by cancer type, https://www.aihw.gov.au/reports/cancer/cancer-compendium-information-and-trends-by-cancer-type/report-contents/breast-cancer-in-australia, [Accessed May 2018].

```
##
##   0   1
## 516 445
```

Severity has no missing data.

```
table(mammo$Age)
```

```
##
##  ? 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
##  5  1  4  1  6  3  7  4  3  2  6  5  3  3  7  6  9  9 13 11  8  9 11 19 16
## 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66
## 19 20 18 21 28 13 11 23 21 16 20 24 25 26 23 32 23 36 25 13 25 24 27 25 31
## 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 93 96
## 32 20 12 13 22 17  9 12  7 17  9  4  8 11  2  1  5  3  4  5  5  1  1  1
```

Age has 5 missing data points.

```
table(mammo$Shape)
```

```
##
##   ?   1   2   3   4
##  31 224 211  95 400
```

Shape has 31 missing data points.

```
table(mammo$Margin)
```

```
##
##   ?   1   2   3   4   5
##  48 357  24 116 280 136
```

Margin has 48 missing data points.

```
table(mammo$Density)
```

```
##
##   ?   1   2   3   4
##  76  16  59 798  12
```

Density has 76 missing data points.

```
table(mammo$BI.RADS)
```

```
##
##   ?   0   2   3   4   5  55   6
##   2   5  14  36 547 345   1  11
```

BI-RADS has 2 missing data points, but this class will not be used in our model, and is not of high importance.

This data is now cleaned by setting "?"'s to NA's and fixing the attribute classes.

```
class(mammo$Age)
```

```
## [1] "factor"
```

```
mammo$Age[mammo$Age == "?"] <- NA
mammo$Age <- as.numeric(mammo$Age)
summary(mammo$Age, exclude = FALSE)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    2.00   29.00   41.00   39.48   50.00   74.00       5
```

Age has its 5 missing data points set to NA and the varible is set to numeric.

```
class(mammo$Shape)
```

```
## [1] "factor"
```

```
mammo$Shape <- as.character(mammo$Shape)
mammo$Shape[mammo$Shape == "?"] <- NA
mammo$Shape <- factor(mammo$Shape)
summary(mammo$Shape, exclude = FALSE)
```

```
##    1    2    3    4 NA's
##  224  211   95  400   31
```

Shape has its 31 missing data points set to NA and the varible is set to a factor

```
class(mammo$Margin)
```

```
## [1] "factor"
```

```
mammo$Margin <- as.character(mammo$Margin)
mammo$Margin[mammo$Margin == "?"] <- NA
mammo$Margin <- factor(mammo$Margin)
summary(mammo$Margin, exclude = FALSE)
```

```
##    1    2    3    4    5 NA's
##  357   24  116  280  136   48
```

Margin has its 48 missing data points set to NA and the varible is set to a factor

```
class(mammo$Density)
```

```
## [1] "factor"
```

```
mammo$Density <- as.character(mammo$Density)
mammo$Density[mammo$Density == "?"] <- NA
mammo$Density <- factor(mammo$Density)
summary(mammo$Density, exclude = FALSE)
```

```
##    1    2    3    4 NA's
##   16   59  798   12   76
```

Density has its 76 missing data points set to NA and the varible is set to a factor

```
class(mammo$Severity)
```

```
## [1] "integer"
```

```
mammo$Severity <- as.numeric(mammo$Severity)
summary(mammo$Severity, exclude = FALSE)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.0000  0.0000  0.0000  0.4631  1.0000  1.0000
```

Severity is set to a integer.

Finally, BI-RADS has it's 2 missing data points set to NA. Addintioally, the data has a clear outlier in it that is set to NA aswell. Again, this is not overly important as BI-RADS will not be used as a predictor in this model.

```
class(mammo$BI.RADS)
```

```
## [1] "factor"
```

```r
mammo$BI.RADS <- as.character(mammo$BI.RADS)
mammo$BI.RADS[mammo$BI.RADS == "?"] <- NA
mammo$BI.RADS <- factor(mammo$BI.RADS)
summary(mammo$BI.RADS, exclude = FALSE) # 2 NAs, 1 outlier
```

```
##    0    2    3    4    5   55    6 NA's
##    5   14   36  547  345    1   11    2
```

```r
mammo$BI.RADS[mammo$BI.RADS == 55] <- NA # Set outlier to NA
mammo$BI.RADS <- as.numeric(mammo$BI.RADS)
summary(mammo$BI.RADS, exclude = FALSE) # 3 NAs
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   1.000   4.000   4.000   4.312   5.000   7.000       3
```

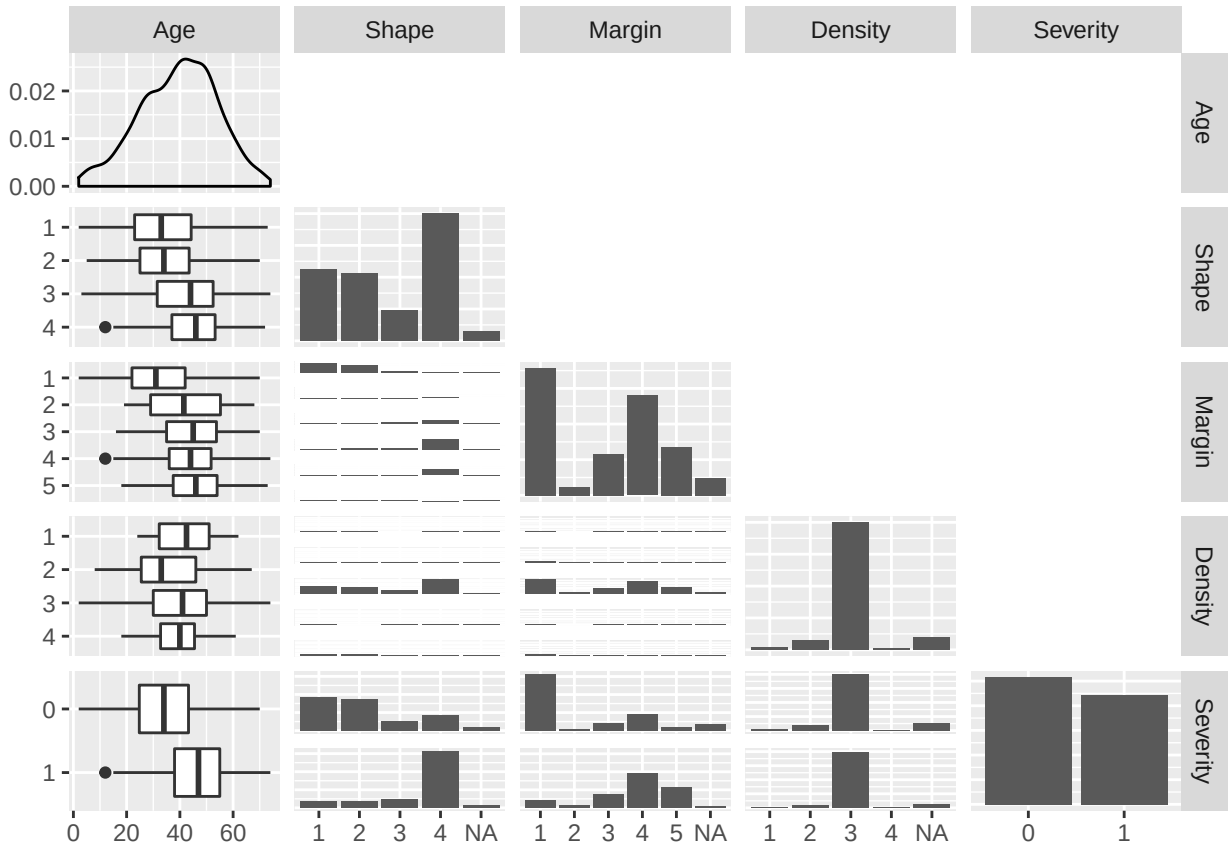
TODO: Ask if Age is forced to be a parameter

Can these varibles be interpolated

Data Visualisation

To examine the relationship between each of the indivual varibles, a plot of the relationships between the varible is made.

```r
mammo %>%
  mutate(Severity = as.factor(Severity)) %>%
  select(2:6) %>%
  ggpairs(upper = list(continuous = "blank",
                       combo ="blank",
                       discrete = "blank",
                       na = "blank"),
          lower = list(continuous = "cor",
                       combo = "box_no_facet",
                       discrete = "facetbar",
                       na = "na"))
```



Now I'll talk about the relationships between varibles but I'm sleepy and frankly that density is giving me the middle finger so I'll do it tomorrow.

Anyway,