NSQIP

Chuqi Wang

2024-09-19

```r
library(MASS)
library(car)
```

```
## Loading required package: carData
```

```r
library(readr)
getwd()
```

```
## [1] "/Users/chuqiwang/Desktop/NSQIP"
```

```r
nsqip = read.csv('nsqip_logistic.csv', row.names = 1)
head(nsqip)
```

```
##   composite_outcome AGE OPERYR WEIGHT HEIGHT BMI   CPT CONCURR HXCOPD VENTILAT
## 0                 0  28   2019    250     70  35 57335       0      0        0
## 1                 0  33   2019    183     65  30 57335       0      0        0
## 2                 0  55   2019    183     74  23 57335       0      0        0
## 3                 1  47   2019    192     71  26 57335       0      0        0
## 4                 0  49   2019    144     69  21 57335       0      0        0
## 5                 0  34   2019    203     66  32 57335       0      0        0
##   DIALYSIS STEROID BLEEDDIS HYPERMED DISCANCR major_medical_comorbidity
## 0        0       0        0        0        0                         0
## 1        0       0        0        0        0                         0
## 2        0       0        0        0        0                         0
## 3        0       0        0        0        0                         0
## 4        0       1        0        0        0                         1
## 5        0       1        0        0        0                         1
##   major_complications minor_complications SEX_male SEX_non.binary
## 0                   0                   0        0              0
## 1                   0                   0        0              0
## 2                   0                   0        1              0
## 3                   0                   0        0              0
## 4                   0                   0        0              0
## 5                   0                   0        1              0
##   SURGSPEC_Plastics SURGSPEC_Urology ASACLAS_2.Mild.Disturb
## 0                 1                0                      1
## 1                 1                0                      0
## 2                 1                0                      1
## 3                 1                0                      1
## 4                 1                0                      0
## 5                 1                0                      1
##   ASACLAS_3.Severe.Disturb SMOKE_Yes PODIAG10_F64.1 PODIAG10_F64.9
## 0                        0         0              0              0
## 1                        1         0              1              0
```

```
## 2                              0          0               0                0
## 3                              0          0               0                0
## 4                              1          0               0                0
## 5                              0          0               0                0
##    PODIAG10_Z87.890 DIABETES_INSULIN DIABETES_NON.INSULIN
## 0                 0                0                    0
## 1                 0                0                    0
## 2                 0                0                    0
## 3                 0                0                    0
## 4                 0                0                    0
## 5                 0                0                    0
```

```r
model_full <- glm(composite_outcome ~ ., data = nsqip, family = binomial(link = "logit"))
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```r
summary(model_full)
```

```
##
## Call:
## glm(formula = composite_outcome ~ ., family = binomial(link = "logit"),
##     data = nsqip)
##
## Coefficients: (4 not defined because of singularities)
##                             Estimate Std. Error z value Pr(>|z|)
## (Intercept)                1.043e+03  4.716e+02   2.212   0.0270 *
## AGE                        3.175e-02  2.136e-02   1.486   0.1372
## OPERYR                    -5.112e-01  2.328e-01  -2.196   0.0281 *
## WEIGHT                     3.105e-02  6.372e-02   0.487   0.6261
## HEIGHT                    -2.093e-01  3.526e-01  -0.593   0.5529
## BMI                       -1.095e-01  4.258e-01  -0.257   0.7971
## CPT                       -2.455e-05  1.710e-05  -1.435   0.1512
## CONCURR                   -4.887e-01  8.217e-01  -0.595   0.5520
## HXCOPD                           NA         NA      NA       NA
## VENTILAT                         NA         NA      NA       NA
## DIALYSIS                         NA         NA      NA       NA
## STEROID                   -2.605e-01  2.121e+00  -0.123   0.9023
## BLEEDDIS                  -1.329e+01  4.212e+03  -0.003   0.9975
## HYPERMED                   1.727e-01  1.762e+00   0.098   0.9219
## DISCANCR                         NA         NA      NA       NA
## major_medical_comorbidity  1.168e-01  1.932e+00   0.060   0.9518
## major_complications        1.978e+01  2.489e+03   0.008   0.9937
## minor_complications        2.350e+00  5.642e-01   4.165 3.11e-05 ***
## SEX_male                   3.460e-02  5.992e-01   0.058   0.9540
## SEX_non.binary             1.862e+00  1.077e+00   1.730   0.0836 .
## SURGSPEC_Plastics         -2.984e+00  1.902e+00  -1.569   0.1166
## SURGSPEC_Urology          -3.406e+00  1.968e+00  -1.731   0.0835 .
## ASACLAS_2.Mild.Disturb     8.207e-01  8.718e-01   0.941   0.3465
## ASACLAS_3.Severe.Disturb   7.651e-01  1.097e+00   0.698   0.4853
## SMOKE_Yes                  1.469e+00  8.760e-01   1.677   0.0936 .
## PODIAG10_F64.1            -1.614e+01  2.062e+03  -0.008   0.9938
## PODIAG10_F64.9             6.805e-01  5.615e-01   1.212   0.2255
## PODIAG10_Z87.890          -1.460e+01  3.150e+03  -0.005   0.9963
## DIABETES_INSULIN           8.166e-01  1.352e+00   0.604   0.5458
## DIABETES_NON.INSULIN      -1.677e+01  1.687e+03  -0.010   0.9921
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 224.82  on 410  degrees of freedom
## Residual deviance: 133.34  on 385  degrees of freedom
## AIC: 185.34
##
## Number of Fisher Scoring iterations: 17
```

```r
model_stepwise <- stepAIC(model_full, direction = "both")
```

```
## Start:  AIC=185.34
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + HXCOPD + VENTILAT + DIALYSIS + STEROID + BLEEDDIS +
##     HYPERMED + DISCANCR + major_medical_comorbidity + major_complications +
##     minor_complications + SEX_male + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + ASACLAS_2.Mild.Disturb + ASACLAS_3.Severe.Disturb +
##     SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 + PODIAG10_Z87.890 +
##     DIABETES_INSULIN + DIABETES_NON.INSULIN
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##
## Step:  AIC=185.34
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + HXCOPD + VENTILAT + DIALYSIS + STEROID + BLEEDDIS +
##     HYPERMED + major_medical_comorbidity + major_complications +
##     minor_complications + SEX_male + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + ASACLAS_2.Mild.Disturb + ASACLAS_3.Severe.Disturb +
##     SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 + PODIAG10_Z87.890 +
##     DIABETES_INSULIN + DIABETES_NON.INSULIN

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## Step:  AIC=185.34
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + HXCOPD + VENTILAT + STEROID + BLEEDDIS + HYPERMED +
##     major_medical_comorbidity + major_complications + minor_complications +
##     SEX_male + SEX_non.binary + SURGSPEC_Plastics + SURGSPEC_Urology +
##     ASACLAS_2.Mild.Disturb + ASACLAS_3.Severe.Disturb + SMOKE_Yes +
##     PODIAG10_F64.1 + PODIAG10_F64.9 + PODIAG10_Z87.890 + DIABETES_INSULIN +
##     DIABETES_NON.INSULIN

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##
## Step:  AIC=185.34
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + HXCOPD + STEROID + BLEEDDIS + HYPERMED + major_medical_comorbidity +
##     major_complications + minor_complications + SEX_male + SEX_non.binary +
##     SURGSPEC_Plastics + SURGSPEC_Urology + ASACLAS_2.Mild.Disturb +
##     ASACLAS_3.Severe.Disturb + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
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##
## Step:  AIC=185.34
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + STEROID + BLEEDDIS + HYPERMED + major_medical_comorbidity +
##     major_complications + minor_complications + SEX_male + SEX_non.binary +
##     SURGSPEC_Plastics + SURGSPEC_Urology + ASACLAS_2.Mild.Disturb +
##     ASACLAS_3.Severe.Disturb + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     PODIAG10_Z87.890 + DIABETES_INSULIN + DIABETES_NON.INSULIN

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##                                   Df Deviance    AIC
```

```
## - SEX_male                     1    133.35 183.35
## - major_medical_comorbidity    1    133.35 183.35
## - HYPERMED                      1    133.35 183.35
## - STEROID                       1    133.36 183.36
## - BLEEDDIS                      1    133.37 183.37
## - BMI                           1    133.41 183.41
## - PODIAG10_Z87.890              1    133.50 183.50
## - WEIGHT                        1    133.58 183.58
## - HEIGHT                        1    133.69 183.69
## - DIABETES_INSULIN              1    133.70 183.70
## - CONCURR                       1    133.72 183.72
## - ASACLAS_3.Severe.Disturb      1    133.84 183.84
## - ASACLAS_2.Mild.Disturb        1    134.34 184.34
## - PODIAG10_F64.1                1    134.63 184.63
## - PODIAG10_F64.9                1    134.78 184.78
## - CPT                           1    135.30 185.30
## <none>                               133.34 185.34
## - AGE                           1    135.50 185.50
## - SURGSPEC_Plastics             1    135.51 185.51
## - SMOKE_Yes                     1    135.60 185.60
## - DIABETES_NON.INSULIN          1    135.96 185.96
## - SEX_non.binary                1    135.96 185.96
## - SURGSPEC_Urology              1    135.98 185.98
## - OPERYR                        1    138.37 188.37
## - major_complications           1    145.48 195.48
## - minor_complications           1    149.86 199.86
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##
## Step:  AIC=183.35
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + STEROID + BLEEDDIS + HYPERMED + major_medical_comorbidity +
##     major_complications + minor_complications + SEX_non.binary +
##     SURGSPEC_Plastics + SURGSPEC_Urology + ASACLAS_2.Mild.Disturb +
##     ASACLAS_3.Severe.Disturb + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     PODIAG10_Z87.890 + DIABETES_INSULIN + DIABETES_NON.INSULIN

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##                            Df Deviance    AIC
## - major_medical_comorbidity  1   133.35 181.35
## - HYPERMED                   1   133.36 181.36
## - STEROID                    1   133.36 181.36
## - BLEEDDIS                   1   133.37 181.37
## - BMI                        1   133.41 181.41
## - PODIAG10_Z87.890           1   133.50 181.50
## - WEIGHT                     1   133.58 181.58
## - HEIGHT                     1   133.69 181.69
## - DIABETES_INSULIN           1   133.71 181.71
## - CONCURR                    1   133.73 181.73
## - ASACLAS_3.Severe.Disturb   1   133.84 181.84
## - ASACLAS_2.Mild.Disturb     1   134.35 182.35
## - PODIAG10_F64.1             1   134.65 182.65
## - PODIAG10_F64.9             1   134.80 182.80
```

```
## - CPT                       1   135.30 183.30
## <none>                          133.35 183.35
## - SURGSPEC_Plastics         1   135.51 183.51
## - AGE                       1   135.52 183.52
## - SMOKE_Yes                  1   135.62 183.62
## - SEX_non.binary            1   135.96 183.96
## - DIABETES_NON.INSULIN      1   135.96 183.96
## - SURGSPEC_Urology          1   135.98 183.98
## + SEX_male                  1   133.34 185.34
## - OPERYR                    1   138.37 186.37
## - major_complications       1   145.50 193.50
## - minor_complications       1   149.86 197.86

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##
## Step:  AIC=181.35
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + STEROID + BLEEDDIS + HYPERMED + major_complications +
##     minor_complications + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + ASACLAS_2.Mild.Disturb + ASACLAS_3.Severe.Disturb +
##     SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 + PODIAG10_Z87.890 +
##     DIABETES_INSULIN + DIABETES_NON.INSULIN

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##                                Df Deviance    AIC
## - STEROID                       1   133.37 179.37
## - BLEEDDIS                      1   133.37 179.37
## - BMI                           1   133.43 179.43
## - HYPERMED                      1   133.47 179.47
## - PODIAG10_Z87.890              1   133.51 179.51
## - WEIGHT                        1   133.61 179.61
## - HEIGHT                        1   133.72 179.72
## - CONCURR                       1   133.73 179.73
## - ASACLAS_3.Severe.Disturb      1   133.87 179.87
## - DIABETES_INSULIN              1   133.99 179.99
## - ASACLAS_2.Mild.Disturb        1   134.36 180.36
## - PODIAG10_F64.1                1   134.68 180.68
## - PODIAG10_F64.9                1   134.85 180.85
## - CPT                           1   135.32 181.32
## <none>                              133.35 181.35
## - SURGSPEC_Plastics             1   135.51 181.51
## - AGE                           1   135.53 181.53
## - SMOKE_Yes                     1   135.62 181.62
## - SEX_non.binary                1   135.97 181.97
## - SURGSPEC_Urology              1   135.98 181.98
## - DIABETES_NON.INSULIN          1   136.04 182.04
## + major_medical_comorbidity     1   133.35 183.35
## + SEX_male                      1   133.35 183.35
## - OPERYR                        1   138.37 184.37
## - major_complications           1   145.53 191.53
## - minor_complications           1   150.12 196.12

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## 
## Step:  AIC=179.36
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + BLEEDDIS + HYPERMED + major_complications + minor_complications +
##     SEX_non.binary + SURGSPEC_Plastics + SURGSPEC_Urology + ASACLAS_2.Mild.Disturb +
##     ASACLAS_3.Severe.Disturb + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     PODIAG10_Z87.890 + DIABETES_INSULIN + DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

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## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

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## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                              Df Deviance    AIC
## - BLEEDDIS                    1   133.39 177.39
## - BMI                         1   133.44 177.44
## - HYPERMED                    1   133.50 177.50
## - PODIAG10_Z87.890            1   133.52 177.52
## - WEIGHT                      1   133.62 177.62
## - HEIGHT                      1   133.74 177.74
## - CONCURR                     1   133.75 177.75
## - ASACLAS_3.Severe.Disturb    1   133.89 177.89
## - DIABETES_INSULIN            1   134.01 178.01
## - ASACLAS_2.Mild.Disturb      1   134.38 178.38
## - PODIAG10_F64.1              1   134.69 178.69
## - PODIAG10_F64.9              1   134.90 178.90
## - CPT                         1   135.34 179.34
## <none>                            133.37 179.37
## - SURGSPEC_Plastics           1   135.53 179.53
## - AGE                         1   135.54 179.54
## - SMOKE_Yes                   1   135.65 179.65
## - SEX_non.binary              1   135.97 179.97
## - SURGSPEC_Urology            1   135.98 179.98
## - DIABETES_NON.INSULIN        1   136.04 180.04
## + STEROID                     1   133.35 181.35
## + SEX_male                    1   133.36 181.36
## + major_medical_comorbidity   1   133.36 181.36
## - OPERYR                      1   138.38 182.38
## - major_complications         1   145.62 189.62
## - minor_complications         1   150.13 194.13
##
## Step:  AIC=177.39
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + BMI + CPT +
##     CONCURR + HYPERMED + major_complications + minor_complications +
##     SEX_non.binary + SURGSPEC_Plastics + SURGSPEC_Urology + ASACLAS_2.Mild.Disturb +
##     ASACLAS_3.Severe.Disturb + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     PODIAG10_Z87.890 + DIABETES_INSULIN + DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                              Df Deviance    AIC
## - BMI                         1   133.46 175.46
## - HYPERMED                    1   133.52 175.52
## - PODIAG10_Z87.890            1   133.55 175.55
## - WEIGHT                      1   133.65 175.65
## - HEIGHT                      1   133.76 175.76
## - CONCURR                     1   133.77 175.77
## - ASACLAS_3.Severe.Disturb    1   133.91 175.91
```

```
## - DIABETES_INSULIN           1    134.03 176.03
## - ASACLAS_2.Mild.Disturb      1    134.40 176.40
## - PODIAG10_F64.1              1    134.72 176.72
## - PODIAG10_F64.9              1    134.93 176.93
## - CPT                         1    135.36 177.36
## <none>                             133.39 177.39
## - SURGSPEC_Plastics           1    135.55 177.55
## - AGE                         1    135.56 177.56
## - SMOKE_Yes                   1    135.67 177.67
## - SEX_non.binary              1    135.99 177.99
## - SURGSPEC_Urology            1    136.01 178.01
## - DIABETES_NON.INSULIN        1    136.11 178.11
## + BLEEDDIS                    1    133.37 179.37
## + STEROID                     1    133.37 179.37
## + major_medical_comorbidity   1    133.38 179.38
## + SEX_male                    1    133.38 179.38
## - OPERYR                      1    138.40 180.40
## - major_complications         1    145.64 187.64
## - minor_complications         1    150.16 192.16
##
## Step:  AIC=175.46
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + CPT + CONCURR +
##      HYPERMED + major_complications + minor_complications + SEX_non.binary +
##      SURGSPEC_Plastics + SURGSPEC_Urology + ASACLAS_2.Mild.Disturb +
##      ASACLAS_3.Severe.Disturb + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##      PODIAG10_Z87.890 + DIABETES_INSULIN + DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                               Df Deviance    AIC
## - HYPERMED                    1    133.57 173.57
## - PODIAG10_Z87.890            1    133.61 173.61
## - CONCURR                     1    133.85 173.85
## - ASACLAS_3.Severe.Disturb    1    133.96 173.96
## - DIABETES_INSULIN            1    134.25 174.25
## - ASACLAS_2.Mild.Disturb      1    134.44 174.44
## - PODIAG10_F64.1              1    134.75 174.75
## - PODIAG10_F64.9              1    135.06 175.06
## - HEIGHT                      1    135.24 175.24
## <none>                             133.46 175.46
## - CPT                         1    135.55 175.55
## - SURGSPEC_Plastics           1    135.56 175.56
## - AGE                         1    135.81 175.81
## - SMOKE_Yes                   1    135.83 175.83
## - SURGSPEC_Urology            1    136.02 176.02
## - SEX_non.binary              1    136.03 176.03
## - DIABETES_NON.INSULIN        1    136.40 176.40
## + BMI                         1    133.39 177.39
## + BLEEDDIS                    1    133.44 177.44
## + STEROID                     1    133.45 177.45
## + SEX_male                    1    133.46 177.46
## + major_medical_comorbidity   1    133.46 177.46
## - WEIGHT                      1    138.09 178.09
## - OPERYR                      1    138.50 178.50
## - major_complications         1    145.69 185.69
```

```
## - minor_complications          1   150.52 190.52
##
## Step:  AIC=173.57
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + CPT + CONCURR +
##     major_complications + minor_complications + SEX_non.binary +
##     SURGSPEC_Plastics + SURGSPEC_Urology + ASACLAS_2.Mild.Disturb +
##     ASACLAS_3.Severe.Disturb + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     PODIAG10_Z87.890 + DIABETES_INSULIN + DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                                 Df Deviance    AIC
## - PODIAG10_Z87.890               1   133.73 171.73
## - CONCURR                        1   133.97 171.97
## - ASACLAS_3.Severe.Disturb       1   134.16 172.16
## - DIABETES_INSULIN               1   134.50 172.50
## - ASACLAS_2.Mild.Disturb         1   134.57 172.57
## - PODIAG10_F64.1                 1   134.97 172.97
## - PODIAG10_F64.9                 1   135.07 173.07
## - HEIGHT                         1   135.55 173.55
## <none>                               133.57 173.57
## - CPT                            1   135.62 173.62
## - SURGSPEC_Plastics              1   135.69 173.69
## - SMOKE_Yes                      1   135.95 173.95
## - AGE                            1   136.19 174.19
## - SEX_non.binary                 1   136.21 174.21
## - SURGSPEC_Urology               1   136.23 174.23
## - DIABETES_NON.INSULIN           1   136.44 174.44
## + HYPERMED                       1   133.46 175.46
## + major_medical_comorbidity      1   133.52 175.52
## + BMI                            1   133.52 175.52
## + STEROID                        1   133.55 175.55
## + BLEEDDIS                       1   133.55 175.55
## + SEX_male                       1   133.57 175.57
## - WEIGHT                         1   138.52 176.52
## - OPERYR                         1   138.63 176.63
## - major_complications            1   145.75 183.75
## - minor_complications            1   151.99 189.99
##
## Step:  AIC=171.73
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + CPT + CONCURR +
##     major_complications + minor_complications + SEX_non.binary +
##     SURGSPEC_Plastics + SURGSPEC_Urology + ASACLAS_2.Mild.Disturb +
##     ASACLAS_3.Severe.Disturb + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     DIABETES_INSULIN + DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                                 Df Deviance    AIC
## - CONCURR                        1   134.17 170.17
## - ASACLAS_3.Severe.Disturb       1   134.29 170.29
## - DIABETES_INSULIN               1   134.69 170.69
## - ASACLAS_2.Mild.Disturb         1   134.72 170.72
## - PODIAG10_F64.1                 1   135.10 171.10
## - PODIAG10_F64.9                 1   135.25 171.25
## <none>                               133.73 171.73
```

```
## - HEIGHT                        1    135.74 171.74
## - CPT                           1    135.82 171.82
## - SURGSPEC_Plastics             1    135.88 171.88
## - SMOKE_Yes                     1    136.13 172.13
## - AGE                           1    136.39 172.39
## - SEX_non.binary                1    136.42 172.42
## - SURGSPEC_Urology              1    136.46 172.46
## - DIABETES_NON.INSULIN          1    136.59 172.59
## + PODIAG10_Z87.890              1    133.57 173.57
## + HYPERMED                      1    133.61 173.61
## + major_medical_comorbidity     1    133.67 173.67
## + BMI                           1    133.68 173.68
## + STEROID                       1    133.70 173.70
## + BLEEDDIS                      1    133.71 173.71
## + SEX_male                      1    133.73 173.73
## - WEIGHT                        1    138.74 174.74
## - OPERYR                        1    138.92 174.92
## - major_complications           1    145.99 181.99
## - minor_complications           1    152.15 188.15
## 
## Step:  AIC=170.17
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + CPT + major_complications +
##     minor_complications + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + ASACLAS_2.Mild.Disturb + ASACLAS_3.Severe.Disturb +
##     SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 + DIABETES_INSULIN +
##     DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                               Df Deviance    AIC
## - ASACLAS_3.Severe.Disturb     1    134.78 168.78
## - DIABETES_INSULIN             1    135.20 169.20
## - ASACLAS_2.Mild.Disturb       1    135.26 169.26
## - PODIAG10_F64.1               1    135.48 169.48
## - PODIAG10_F64.9               1    135.75 169.75
## - SURGSPEC_Plastics            1    136.03 170.03
## <none>                              134.17 170.17
## - CPT                          1    136.34 170.34
## - SURGSPEC_Urology             1    136.59 170.59
## - HEIGHT                       1    136.63 170.63
## - SMOKE_Yes                    1    136.66 170.66
## - AGE                          1    136.74 170.74
## - SEX_non.binary               1    136.87 170.87
## - DIABETES_NON.INSULIN         1    137.03 171.03
## + CONCURR                      1    133.73 171.73
## + PODIAG10_Z87.890             1    133.97 171.97
## + HYPERMED                     1    134.04 172.04
## + major_medical_comorbidity    1    134.11 172.11
## + BMI                          1    134.12 172.12
## + STEROID                      1    134.14 172.14
## + BLEEDDIS                     1    134.15 172.15
## + SEX_male                     1    134.16 172.16
## - OPERYR                       1    138.97 172.97
## - WEIGHT                       1    139.52 173.52
## - major_complications          1    146.84 180.84
```

```
## - minor_complications        1    152.25 186.25
##
## Step:  AIC=168.78
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + CPT + major_complications +
##     minor_complications + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + ASACLAS_2.Mild.Disturb + SMOKE_Yes + PODIAG10_F64.1 +
##     PODIAG10_F64.9 + DIABETES_INSULIN + DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                                Df Deviance    AIC
## - ASACLAS_2.Mild.Disturb        1    135.26 167.26
## - PODIAG10_F64.1                1    135.92 167.92
## - DIABETES_INSULIN              1    136.04 168.04
## - PODIAG10_F64.9                1    136.29 168.29
## - CPT                          1    136.64 168.64
## <none>                              134.78 168.78
## - SURGSPEC_Plastics            1    137.00 169.00
## - SMOKE_Yes                    1    137.33 169.33
## - DIABETES_NON.INSULIN         1    137.48 169.48
## - SURGSPEC_Urology             1    137.51 169.51
## - SEX_non.binary               1    137.83 169.83
## - HEIGHT                       1    137.95 169.95
## + ASACLAS_3.Severe.Disturb     1    134.17 170.17
## + CONCURR                      1    134.29 170.29
## - AGE                          1    138.41 170.41
## + HYPERMED                     1    134.55 170.55
## + PODIAG10_Z87.890             1    134.62 170.62
## + major_medical_comorbidity    1    134.64 170.64
## + STEROID                      1    134.75 170.75
## + BMI                          1    134.76 170.76
## + BLEEDDIS                     1    134.76 170.76
## + SEX_male                     1    134.78 170.78
## - OPERYR                       1    139.62 171.62
## - WEIGHT                       1    141.14 173.14
## - major_complications          1    147.75 179.75
## - minor_complications          1    152.59 184.59
##
## Step:  AIC=167.26
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + CPT + major_complications +
##     minor_complications + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     DIABETES_INSULIN + DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                                Df Deviance    AIC
## - DIABETES_INSULIN              1    136.36 166.36
## - PODIAG10_F64.1                1    136.66 166.66
## - PODIAG10_F64.9                1    136.81 166.81
## - CPT                          1    136.95 166.95
## <none>                              135.26 167.26
## - SURGSPEC_Plastics            1    137.61 167.61
## - SMOKE_Yes                    1    137.65 167.65
## - DIABETES_NON.INSULIN         1    138.06 168.06
## - SURGSPEC_Urology             1    138.09 168.09
```

```
## - HEIGHT                          1    138.18 168.18
## - SEX_non.binary                  1    138.25 168.25
## + CONCURR                         1    134.72 168.72
## + ASACLAS_2.Mild.Disturb          1    134.78 168.78
## + PODIAG10_Z87.890                1    135.08 169.08
## + HYPERMED                        1    135.09 169.09
## + major_medical_comorbidity       1    135.19 169.19
## + STEROID                         1    135.22 169.22
## + SEX_male                        1    135.24 169.24
## + BLEEDDIS                        1    135.24 169.24
## + BMI                             1    135.25 169.25
## - AGE                             1    139.26 169.26
## + ASACLAS_3.Severe.Disturb        1    135.26 169.26
## - OPERYR                          1    140.01 170.01
## - WEIGHT                          1    141.37 171.37
## - major_complications             1    148.26 178.26
## - minor_complications             1    153.31 183.31
##
## Step:  AIC=166.36
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + CPT + major_complications +
##     minor_complications + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                              Df Deviance    AIC
## - CPT                         1    137.82 165.82
## - PODIAG10_F64.1              1    137.97 165.97
## - PODIAG10_F64.9              1    138.18 166.18
## <none>                             136.36 166.36
## - SMOKE_Yes                   1    138.65 166.65
## - SURGSPEC_Plastics           1    138.69 166.69
## - SEX_non.binary              1    139.00 167.00
## - SURGSPEC_Urology            1    139.13 167.13
## + DIABETES_INSULIN            1    135.26 167.26
## - HEIGHT                      1    139.43 167.43
## - DIABETES_NON.INSULIN        1    139.67 167.67
## + CONCURR                     1    135.76 167.76
## + major_medical_comorbidity   1    135.90 167.90
## + HYPERMED                    1    135.98 167.98
## + ASACLAS_2.Mild.Disturb      1    136.04 168.04
## + PODIAG10_Z87.890            1    136.15 168.15
## + BMI                         1    136.26 168.26
## + STEROID                     1    136.29 168.29
## + ASACLAS_3.Severe.Disturb    1    136.32 168.32
## + BLEEDDIS                    1    136.35 168.35
## + SEX_male                    1    136.36 168.36
## - OPERYR                      1    140.48 168.48
## - AGE                         1    140.85 168.85
## - WEIGHT                      1    143.91 171.91
## - major_complications         1    148.73 176.73
## - minor_complications         1    156.18 184.18
##
## Step:  AIC=165.82
```

```
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + major_complications +
##     minor_complications + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + SMOKE_Yes + PODIAG10_F64.1 + PODIAG10_F64.9 +
##     DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                                Df Deviance    AIC
## - PODIAG10_F64.1                1   139.50 165.50
## <none>                              137.82 165.82
## - SEX_non.binary                1   140.30 166.30
## - PODIAG10_F64.9                1   140.31 166.31
## - SURGSPEC_Plastics             1   140.36 166.36
## + CPT                           1   136.36 166.36
## - SMOKE_Yes                     1   140.49 166.49
## - SURGSPEC_Urology              1   140.69 166.69
## - HEIGHT                        1   140.85 166.85
## + DIABETES_INSULIN              1   136.95 166.95
## - DIABETES_NON.INSULIN          1   141.11 167.11
## + CONCURR                       1   137.17 167.17
## - OPERYR                        1   141.33 167.33
## + PODIAG10_Z87.890              1   137.56 167.56
## + major_medical_comorbidity     1   137.56 167.56
## + HYPERMED                      1   137.58 167.58
## + BMI                           1   137.59 167.59
## + ASACLAS_2.Mild.Disturb        1   137.60 167.60
## + STEROID                       1   137.77 167.77
## + BLEEDDIS                      1   137.80 167.80
## + ASACLAS_3.Severe.Disturb      1   137.81 167.81
## + SEX_male                      1   137.82 167.82
## - AGE                           1   143.01 169.01
## - WEIGHT                        1   144.82 170.82
## - major_complications           1   149.32 175.32
## - minor_complications           1   157.21 183.21
##
## Step:  AIC=165.5
## composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + major_complications +
##     minor_complications + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + SMOKE_Yes + PODIAG10_F64.9 + DIABETES_NON.INSULIN

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

##                                Df Deviance    AIC
## <none>                              139.50 165.50
## + PODIAG10_F64.1                1   137.82 165.82
## + CPT                           1   137.97 165.97
## - SURGSPEC_Plastics             1   142.05 166.05
## - SEX_non.binary                1   142.21 166.21
## - SMOKE_Yes                     1   142.27 166.27
## + DIABETES_INSULIN              1   138.41 166.41
## - PODIAG10_F64.9                1   142.50 166.50
## - SURGSPEC_Urology              1   142.51 166.51
## - DIABETES_NON.INSULIN          1   142.59 166.59
## - HEIGHT                        1   142.65 166.65
## - OPERYR                        1   142.76 166.76
## + CONCURR                       1   138.94 166.94
```

```
## + major_medical_comorbidity  1   139.06 167.06
## + ASACLAS_2.Mild.Disturb     1   139.09 167.09
## + HYPERMED                   1   139.10 167.10
## + PODIAG10_Z87.890           1   139.26 167.26
## + BMI                        1   139.36 167.36
## + STEROID                    1   139.44 167.44
## + BLEEDDIS                   1   139.47 167.47
## + ASACLAS_3.Severe.Disturb   1   139.49 167.49
## + SEX_male                   1   139.49 167.49
## - AGE                        1   144.90 168.90
## - WEIGHT                     1   145.73 169.73
## - major_complications        1   151.34 175.34
## - minor_complications        1   158.62 182.62
```

```r
summary(model_stepwise)
```

```
##
## Call:
## glm(formula = composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT +
##     major_complications + minor_complications + SEX_non.binary +
##     SURGSPEC_Plastics + SURGSPEC_Urology + SMOKE_Yes + PODIAG10_F64.9 +
##     DIABETES_NON.INSULIN, family = binomial(link = "logit"),
##     data = nsqip)
##
## Coefficients:
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)          762.92662  422.48496   1.806   0.0709 .
## AGE                    0.04469    0.01892   2.363   0.0182 *
## OPERYR                -0.37527    0.20894  -1.796   0.0725 .
## WEIGHT                 0.01575    0.00626   2.516   0.0119 *
## HEIGHT                -0.14440    0.08134  -1.775   0.0759 .
## major_complications   19.53772 2489.09210   0.008   0.9937
## minor_complications    2.30022    0.51138   4.498 6.86e-06 ***
## SEX_non.binary         1.83402    1.03053   1.780   0.0751 .
## SURGSPEC_Plastics     -3.04675    1.80739  -1.686   0.0918 .
## SURGSPEC_Urology      -3.43698    1.87310  -1.835   0.0665 .
## SMOKE_Yes              1.62006    0.84943   1.907   0.0565 .
## PODIAG10_F64.9         0.91666    0.52196   1.756   0.0791 .
## DIABETES_NON.INSULIN -16.82580 1717.05110  -0.010   0.9922
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 224.82  on 410  degrees of freedom
## Residual deviance: 139.50  on 398  degrees of freedom
## AIC: 165.5
##
## Number of Fisher Scoring iterations: 17
```

```r
library(caret)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: lattice
```

```r
# Predict class labels (0 or 1)
predicted_class <- ifelse(predict(model_stepwise, type = "response") > 0.3, 1, 0)

# Create confusion matrix
confusionMatrix(factor(predicted_class), factor(nsqip$composite_outcome))
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   0   1
##          0 372  14
##          1   7  18
##
##                Accuracy : 0.9489
##                  95% CI : (0.923, 0.9681)
##     No Information Rate : 0.9221
##     P-Value [Acc > NIR] : 0.02178
##
##                   Kappa : 0.6046
##
##  Mcnemar's Test P-Value : 0.19043
##
##             Sensitivity : 0.9815
##             Specificity : 0.5625
##          Pos Pred Value : 0.9637
##          Neg Pred Value : 0.7200
##              Prevalence : 0.9221
##          Detection Rate : 0.9051
##    Detection Prevalence : 0.9392
##       Balanced Accuracy : 0.7720
##
##        'Positive' Class : 0
##
```
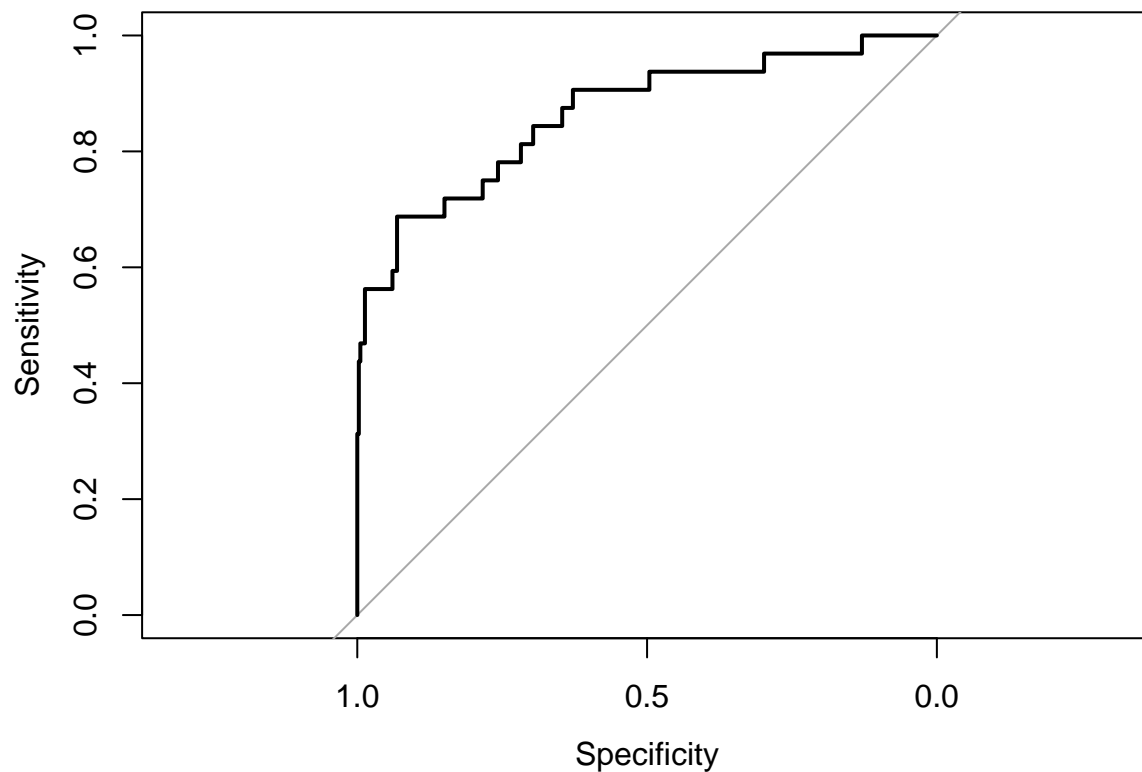
```r
library(pROC)
```

```
## Type 'citation("pROC")' for a citation.
```

```
##
## Attaching package: 'pROC'
```

```
## The following objects are masked from 'package:stats':
##
##     cov, smooth, var
```

```r
predicted_prob <- predict(model_stepwise, type = "response")

roc_curve <- roc(nsqip$composite_outcome, predicted_prob)
```

```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```

```r
plot(roc_curve)
```

```r
auc(roc_curve)
```

```
## Area under the curve: 0.865
```

```r
predicted_probs = predict(model_stepwise, type = "response")
nsqip$predicted_probability <- predicted_probs
```

```r
library(boot)
```

```
##
## Attaching package: 'boot'
```

```
## The following object is masked from 'package:lattice':
##
##     melanoma
```

```
## The following object is masked from 'package:car':
##
##     logit
```

```r
# 10-fold cross-validation
cv_result <- cv.glm(nsqip, model_stepwise, K=10)

# Mean cross-validation error
print(cv_result$delta[1])
```

```
## [1] 0.05623827
```

```r
library(lmtest)
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```r
# Compare the stepwise model with a null model (only intercept)
null_model <- glm(composite_outcome ~ 1, data = nsqip, family = binomial)

# Perform likelihood ratio test
lrtest(model_stepwise, null_model)
```

```
## Likelihood ratio test
##
## Model 1: composite_outcome ~ AGE + OPERYR + WEIGHT + HEIGHT + major_complications +
##     minor_complications + SEX_non.binary + SURGSPEC_Plastics +
##     SURGSPEC_Urology + SMOKE_Yes + PODIAG10_F64.9 + DIABETES_NON.INSULIN
## Model 2: composite_outcome ~ 1
##   #Df    LogLik  Df  Chisq Pr(>Chisq)
## 1  13   -69.748
## 2   1 -112.412 -12 85.329  3.935e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
library(car)

# Check VIF for multicollinearity
vif(model_stepwise)
```

```
##                  AGE               OPERYR               WEIGHT
##             1.182900             1.126846             1.350154
##               HEIGHT  major_complications  minor_complications
##             1.318242             1.000000             1.103568
##       SEX_non.binary    SURGSPEC_Plastics     SURGSPEC_Urology
##             1.050651            11.562677            11.820324
##            SMOKE_Yes       PODIAG10_F64.9 DIABETES_NON.INSULIN
##             1.100596             1.193939             1.000000
```