Untitled

2025-11-21

En este script se realiza un modelo de clasificación binario con caret (cv=10) Y CON loocv.

Se utiliza la base de datos desbalanceada y se juega con el cutoff para hacer frente al desbalanceo.

Caret

Preparación de los datos

Trabajaremos a partir de datatrain, donde tenemos la respuesta Exited para todas las filas

La idea es probar varios niveles de balanceo y de cutoff para encontrar el óptimo para ambos parámetros.

```
## Cargando paquete requerido: ggplot2

## Cargando paquete requerido: lattice

## Loaded ROSE 0.0-4

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

##
## Adjuntando el paquete: 'pROC'

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

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases
```

```
results_all
```

```
##     ROSE_p Cutoff    F1_Train     F1_Test  Sens_Train    Sens_Test   Spec_Train
## 1     0.25   0.10 0.366353214 0.368816369 0.980689655 0.9820689655 0.1187387387
## 2     0.25   0.15 0.405792683 0.407880560 0.917931034 0.9137931034 0.3190990991
## 3     0.25   0.20 0.431553667 0.440113529 0.805517241 0.8020689655 0.4963963964
## 4     0.25   0.25 0.460630815 0.460032626 0.700000000 0.6806896552 0.6500900901
## 5     0.25   0.30 0.471083661 0.467950561 0.578620690 0.5613793103 0.7706306306
## 6     0.25   0.35 0.444139822 0.448951049 0.446896552 0.4427586207 0.8522522523
## 7     0.25   0.40 0.412201154 0.406919275 0.344827586 0.3406896552 0.9142342342
## 8     0.25   0.45 0.340627973 0.342205323 0.246896552 0.2482758621 0.9470270270
## 9     0.25   0.50 0.284648188 0.282539683 0.184137931 0.1841379310 0.9713513514
## 10    0.25   0.55 0.223744292 0.231292517 0.135172414 0.1406896552 0.9809009009
## 11    0.25   0.60 0.176788936 0.177777778 0.101379310 0.1020689655 0.9881081081
## 12    0.25   0.65 0.139912555 0.150497512 0.077241379 0.0834482759 0.9929729730
```

```
## 13    0.25   0.70 0.109395109 0.100710136 0.058620690 0.0537931034 0.9965765766
## 14    0.25   0.75 0.068783069 0.066401062 0.035862069 0.0344827586 0.9981981982
## 15    0.25   0.80 0.037812289 0.035182679 0.019310345 0.0179310345 0.9994594595
## 16    0.25   0.85 0.012328767 0.012328767 0.006206897 0.0062068966 0.9998198198
## 17    0.25   0.90          NA 0.001378360 0.000000000 0.0006896552 1.0000000000
## 18    0.30   0.10 0.356055920 0.355852512 0.992413793 0.9917241379 0.0641441441
## 19    0.30   0.15 0.386880670 0.387623066 0.955862069 0.9503448276 0.2200000000
## 20    0.30   0.20 0.418963255 0.419550599 0.880689655 0.8820689655 0.3929729730
## 21    0.30   0.25 0.442693974 0.446238677 0.775172414 0.7813793103 0.5488288288
## 22    0.30   0.30 0.463871121 0.457088668 0.675172414 0.6648275862 0.6771171171
## 23    0.30   0.35 0.467842914 0.471736011 0.566896552 0.5668965517 0.7762162162
## 24    0.30   0.40 0.449330127 0.457475995 0.451034483 0.4600000000 0.8545945946
## 25    0.30   0.45 0.423948220 0.411336032 0.361379310 0.3503448276 0.9102702703
## 26    0.30   0.50 0.352504638 0.345343940 0.262068966 0.2544827586 0.9412612613
## 27    0.30   0.55 0.292403746 0.287815126 0.193793103 0.1889655172 0.9655855856
## 28    0.30   0.60 0.244829514 0.231161473 0.151034483 0.1406896552 0.9783783784
## 29    0.30   0.65 0.183333333 0.175015088 0.106206897 0.1000000000 0.9863063063
## 30    0.30   0.70 0.138490331 0.123893805 0.076551724 0.0675862069 0.9924324324
## 31    0.30   0.75 0.100970874 0.078688525 0.053793103 0.0413793103 0.9969369369
## 32    0.30   0.80 0.065159574 0.045698925 0.033793103 0.0234482759 0.9990990991
## 33    0.30   0.85 0.029850746 0.015047880 0.015172414 0.0075862069 0.9996396396
## 34    0.30   0.90 0.006868132 0.005502063 0.003448276 0.0027586207 0.9998198198
## 35    0.35   0.10 0.348202477 0.346887370 0.998620690 0.9972413793 0.0236036036
## 36    0.35   0.15 0.369451697 0.369310793 0.975862069 0.9793103448 0.1360360360
## 37    0.35   0.20 0.398879717 0.398235294 0.933103448 0.9337931034 0.2827027027
## 38    0.35   0.25 0.423018163 0.424407704 0.859310345 0.8586206897 0.4243243243
## 39    0.35   0.30 0.441211638 0.444488818 0.763448276 0.7675862069 0.5565765766
## 40    0.35   0.35 0.460705882 0.456049149 0.675172414 0.6655172414 0.6718918919
## 41    0.35   0.40 0.472330911 0.468085106 0.582758621 0.5689655172 0.7688288288
## 42    0.35   0.45 0.456798392 0.458206430 0.470344828 0.4668965517 0.8461261261
## 43    0.35   0.50 0.419392984 0.415802075 0.366896552 0.3593103448 0.9000000000
## 44    0.35   0.55 0.363968907 0.345829428 0.274482759 0.2544827586 0.9389189189
## 45    0.35   0.60 0.303616913 0.286014721 0.205517241 0.1875862069 0.9612612613
## 46    0.35   0.65 0.245947457 0.227660785 0.151724138 0.1379310345 0.9785585586
## 47    0.35   0.70 0.182468694 0.170598911 0.105517241 0.0972413793 0.9866666667
## 48    0.35   0.75 0.135423197 0.118395926 0.074482759 0.0641379310 0.9933333333
## 49    0.35   0.80 0.090255069 0.077733860 0.047586207 0.0406896552 0.9981981982
## 50    0.35   0.85 0.044414536 0.032520325 0.022758621 0.0165517241 0.9994594595
## 51    0.35   0.90 0.009602195 0.006868132 0.004827586 0.0034482759 0.9998198198
## 52    0.40   0.10 0.344344106 0.344458962 0.999310345 1.0000000000 0.0059459459
## 53    0.40   0.15 0.358897618 0.357685128 0.992413793 0.9910344828 0.0756756757
## 54    0.40   0.20 0.384434939 0.380537004 0.960689655 0.9627586207 0.2064864865
## 55    0.40   0.25 0.410168434 0.407925050 0.906896552 0.9158620690 0.3428828829
## 56    0.40   0.30 0.432849202 0.433073654 0.832413793 0.8434482759 0.4738738739
## 57    0.40   0.35 0.450639279 0.451332920 0.741379310 0.7531034483 0.5953153153
## 58    0.40   0.40 0.466009852 0.461802155 0.652413793 0.6503448276 0.7001801802
## 59    0.40   0.45 0.473327439 0.469057259 0.553793103 0.5593103448 0.7945945946
## 60    0.40   0.50 0.448951049 0.456926258 0.442758621 0.4572413793 0.8616216216
## 61    0.40   0.55 0.413149351 0.412479741 0.351034483 0.3510344828 0.9090090090
## 62    0.40   0.60 0.348477752 0.342749529 0.256551724 0.2510344828 0.9436036036
## 63    0.40   0.65 0.287513116 0.285106383 0.188965517 0.1848275862 0.9672072072
## 64    0.40   0.70 0.217912151 0.217241379 0.131724138 0.1303448276 0.9798198198
## 65    0.40   0.75 0.156192800 0.147368421 0.088275862 0.0820689655 0.9890090090
## 66    0.40   0.80 0.114869177 0.095917045 0.062068966 0.0510344828 0.9951351351
```

```
## 67    0.40   0.85 0.057448230 0.049631120 0.029655172 0.0255172414 0.9992792793
## 68    0.40   0.90 0.016393443 0.009602195 0.008275862 0.0048275862 0.9996396396
## 69    0.45   0.10 0.343317154 0.343398461 1.000000000 1.0000000000 0.0005405405
## 70    0.45   0.15 0.350193611 0.348696911 0.997931034 0.9965517241 0.0329729730
## 71    0.45   0.20 0.366422042 0.365431466 0.981379310 0.9827586207 0.1181981982
## 72    0.45   0.25 0.390361446 0.388810398 0.949655172 0.9489655172 0.2381981982
## 73    0.45   0.30 0.414556962 0.411053541 0.903448276 0.9027586207 0.3585585586
## 74    0.45   0.35 0.433639474 0.433782570 0.830344828 0.8324137931 0.4776576577
## 75    0.45   0.40 0.448598131 0.451492537 0.744827586 0.7510344828 0.5882882883
## 76    0.45   0.45 0.462396895 0.465479385 0.657241379 0.6579310345 0.6902702703
## 77    0.45   0.50 0.467755804 0.476024412 0.562758621 0.5648275862 0.7796396396
## 78    0.45   0.55 0.451169188 0.453444098 0.452413793 0.4517241379 0.8554954955
## 79    0.45   0.60 0.412362749 0.406737880 0.349655172 0.3413793103 0.9095495495
## 80    0.45   0.65 0.333493052 0.329004329 0.240000000 0.2358620690 0.9479279279
## 81    0.45   0.70 0.275751073 0.269209809 0.177241379 0.1703448276 0.9717117117
## 82    0.45   0.75 0.202457578 0.193624557 0.119310345 0.1131034483 0.9845045045
## 83    0.45   0.80 0.138059701 0.123893805 0.076551724 0.0675862069 0.9915315315
## 84    0.45   0.85 0.082568807 0.062500000 0.043448276 0.0324137931 0.9976576577
## 85    0.45   0.90 0.028493894 0.019112628 0.014482759 0.0096551724 0.9994594595
## 86    0.50   0.10 0.343235886 0.343195266 1.000000000 1.0000000000 0.0001801802
## 87    0.50   0.15 0.345032719 0.344844010 1.000000000 0.9986206897 0.0081081081
## 88    0.50   0.20 0.355303684 0.355863092 0.994482759 0.9931034483 0.0585585586
## 89    0.50   0.25 0.370273109 0.370916754 0.972413793 0.9710344828 0.1430630631
## 90    0.50   0.30 0.393630756 0.392523364 0.946206897 0.9413793103 0.2524324324
## 91    0.50   0.35 0.414907230 0.413573363 0.894482759 0.8951724138 0.3684684685
## 92    0.50   0.40 0.431215971 0.435178441 0.819310345 0.8241379310 0.4825225225
## 93    0.50   0.45 0.449602677 0.451452282 0.741379310 0.7503448276 0.5933333333
## 94    0.50   0.50 0.462365591 0.465250965 0.652413793 0.6648275862 0.6944144144
## 95    0.50   0.55 0.465945630 0.470925236 0.549655172 0.5668965517 0.7884684685
## 96    0.50   0.60 0.447625698 0.453178401 0.442068966 0.4572413793 0.8607207207
## 97    0.50   0.65 0.405010438 0.409461664 0.334482759 0.3462068966 0.9171171171
## 98    0.50   0.70 0.319842053 0.329457364 0.223448276 0.2344827586 0.9545945946
## 99    0.50   0.75 0.243439419 0.258525853 0.150344828 0.1620689655 0.9778378378
## 100   0.50   0.80 0.149877150 0.171704958 0.084137931 0.0979310345 0.9899099099
## 101   0.50   0.85 0.078534031 0.104651163 0.041379310 0.0558620690 0.9967567568
## 102   0.50   0.90 0.024506467 0.035182679 0.012413793 0.0179310345 0.9998198198
##        Spec_Test PPV_Train  PPV_Test NPV_Train  NPV_Test ACC_Train  ACC_Test
## 1   0.1264864865 0.2252495 0.2270408 0.9592431 0.9642857 0.2972857 0.3037143
## 2   0.3293693694 0.2604697 0.2625322 0.9370370 0.9359959 0.4431429 0.4504286
## 3   0.5185585586 0.2947262 0.3032595 0.9071452 0.9093207 0.5604286 0.5772857
## 4   0.6659459459 0.3432533 0.3474129 0.8924066 0.8886752 0.6604286 0.6690000
## 5   0.7810810811 0.3972538 0.4011828 0.8750000 0.8720579 0.7308571 0.7355714
## 6   0.8616216216 0.4414169 0.4553191 0.8550253 0.8554562 0.7682857 0.7748571
## 7   0.9127927928 0.5122951 0.5051125 0.8422975 0.8412488 0.7962857 0.7942857
## 8   0.9470270270 0.5490798 0.5504587 0.8279773 0.8282383 0.8020000 0.8022857
## 9   0.9688288288 0.6267606 0.6068182 0.8200487 0.8196646 0.8082857 0.8062857
## 10  0.9801801802 0.6490066 0.6496815 0.8127799 0.8136404 0.8057143 0.8062857
## 11  0.9879279279 0.6901408 0.6883721 0.8080153 0.8081061 0.8044286 0.8044286
## 12  0.9933333333 0.7417219 0.7658228 0.8046430 0.8057586 0.8032857 0.8048571
## 13  0.9962162162 0.8173077 0.7878788 0.8020592 0.8011882 0.8022857 0.8010000
## 14  0.9989189189 0.8387097 0.8928571 0.7985010 0.7983871 0.7988571 0.7991429
## 15  0.9996396396 0.9032258 0.9285714 0.7959535 0.7957544 0.7964286 0.7962857
## 16  0.9998198198 0.9000000 0.9000000 0.7938484 0.7938484 0.7940000 0.7940000
## 17  1.0000000000       NaN 1.0000000 0.7928571 0.7929704 0.7928571 0.7930000
```

```
## 18  0.0641441441 0.2169456 0.2168275 0.9700272 0.9673913 0.2564286 0.2562857
## 19  0.2284684685 0.2425197 0.2434629 0.9501946 0.9462687 0.3724286 0.3780000
## 20  0.3931531532 0.2748601 0.2752313 0.9265081 0.9273268 0.4940000 0.4944286
## 21  0.5504504505 0.3098126 0.3122933 0.9033215 0.9059905 0.5957143 0.5982857
## 22  0.6749549550 0.3533021 0.3482659 0.8886262 0.8851607 0.6767143 0.6728571
## 23  0.7814414414 0.3982558 0.4039312 0.8727715 0.8735146 0.7328571 0.7370000
## 24  0.8560360360 0.4476386 0.4549795 0.8562917 0.8585110 0.7710000 0.7740000
## 25  0.9077477477 0.5127202 0.4980392 0.8450987 0.8424749 0.7965714 0.7922857
## 26  0.9427027027 0.5382436 0.5371179 0.8299968 0.8287660 0.8005714 0.8001429
## 27  0.9675675676 0.5953390 0.6035242 0.8209252 0.8203483 0.8057143 0.8062857
## 28  0.9800000000 0.6460177 0.6476190 0.8151929 0.8136126 0.8070000 0.8061429
## 29  0.9888288288 0.6695652 0.7004831 0.8085672 0.8078905 0.8040000 0.8047143
## 30  0.9938738739 0.7254902 0.7424242 0.8044399 0.8031450 0.8027143 0.8020000
## 31  0.9972972973 0.8210526 0.8000000 0.8013034 0.7992780 0.8015714 0.7992857
## 32  0.9992792793 0.9074074 0.8947368 0.7983012 0.7966102 0.7991429 0.7971429
## 33  0.9998198198 0.9166667 0.9166667 0.7952982 0.7940756 0.7957143 0.7942857
## 34  1.0000000000 0.8333333 1.0000000 0.7933943 0.7933105 0.7934286 0.7934286
## 35  0.0196396396 0.2108636 0.2099608 0.9849624 0.9646018 0.2255714 0.2221429
## 36  0.1315315315 0.2278583 0.2275641 0.9556962 0.9605263 0.3100000 0.3071429
## 37  0.2800000000 0.2536558 0.2530841 0.9417767 0.9418182 0.4174286 0.4154286
## 38  0.4284684685 0.2805674 0.2818655 0.9202814 0.9206349 0.5144286 0.5175714
## 39  0.5594594595 0.3102578 0.3128162 0.9000583 0.9020918 0.5994286 0.6025714
## 40  0.6726126126 0.3496429 0.3468728 0.8878571 0.8850166 0.6725714 0.6711429
## 41  0.7747747748 0.3970865 0.3975904 0.8758210 0.8730964 0.7302857 0.7321429
## 42  0.8508108108 0.4440104 0.4498339 0.8594436 0.8593267 0.7682857 0.7712857
## 43  0.9036036036 0.4894204 0.4933712 0.8447489 0.8437079 0.7895714 0.7908571
## 44  0.9432432432 0.5400271 0.5394737 0.8320294 0.8288474 0.8012857 0.8005714
## 45  0.9675675676 0.5808967 0.6017699 0.8224141 0.8200977 0.8047143 0.8060000
## 46  0.9807207207 0.6489676 0.6514658 0.8153430 0.8132377 0.8072857 0.8061429
## 47  0.9888288288 0.6740088 0.6945813 0.8085044 0.8074150 0.8041429 0.8041429
## 48  0.9949549550 0.7448276 0.7685950 0.8042305 0.8027330 0.8030000 0.8021429
## 49  0.9983783784 0.8734177 0.8676471 0.8004624 0.7993364 0.8012857 0.8000000
## 50  0.9996396396 0.9166667 0.9230769 0.7965250 0.7955262 0.7971429 0.7960000
## 51  0.9998198198 0.8750000 0.8333333 0.7936213 0.7933943 0.7937143 0.7934286
## 52  0.0055855856 0.2080103 0.2080643 0.9705882 1.0000000 0.2117143 0.2115714
## 53  0.0724324324 0.2190592 0.2182232 0.9744780 0.9686747 0.2655714 0.2627143
## 54  0.1908108108 0.2402967 0.2371327 0.9526185 0.9514825 0.3627143 0.3507143
## 55  0.3273873874 0.2650141 0.2623987 0.9337586 0.9370810 0.4597143 0.4492857
## 56  0.4639639640 0.2924643 0.2913292 0.9154194 0.9189864 0.5481429 0.5425714
## 57  0.5861261261 0.3236977 0.3222189 0.8980701 0.9008585 0.6255714 0.6207143
## 58  0.6953153153 0.3624521 0.3580106 0.8851936 0.8838754 0.6902857 0.6860000
## 59  0.7843243243 0.4132784 0.4038845 0.8720585 0.8719952 0.7447143 0.7377143
## 60  0.8578378378 0.4553191 0.4566116 0.8554562 0.8581471 0.7748571 0.7748571
## 61  0.9082882883 0.5019724 0.5000000 0.8427999 0.8426948 0.7934286 0.7928571
## 62  0.9441441441 0.5430657 0.5400593 0.8292953 0.8283275 0.8012857 0.8005714
## 63  0.9708108108 0.6008772 0.6232558 0.8202934 0.8200913 0.8060000 0.8080000
## 64  0.9818018018 0.6303630 0.6517241 0.8120054 0.8120715 0.8041429 0.8054286
## 65  0.9917117117 0.6772487 0.7212121 0.8059022 0.8052670 0.8024286 0.8032857
## 66  0.9965765766 0.7692308 0.7956989 0.8024117 0.8007818 0.8018571 0.8007143
## 67  0.9992792793 0.9148936 0.9024390 0.7976413 0.7969536 0.7984286 0.7975714
## 68  0.9998198198 0.8571429 0.8750000 0.7941597 0.7936213 0.7942857 0.7937143
## 69  0.0009009009 0.2072317 0.2072909 1.0000000 1.0000000 0.2075714 0.2078571
## 70  0.0282882883 0.2123569 0.2113191 0.9838710 0.9691358 0.2328571 0.2288571
## 71  0.1127927928 0.2252652 0.2244448 0.9604685 0.9615975 0.2970000 0.2930000
```

```
## 72  0.2338738739 0.2456735 0.2444918 0.9476703 0.9460641 0.3855714 0.3820000
## 73  0.3495495495 0.2689938 0.2661110 0.9342723 0.9322441 0.4714286 0.4641429
## 74  0.4760360360 0.2934438 0.2933171 0.9150846 0.9157712 0.5507143 0.5498571
## 75  0.5882882883 0.3209510 0.3227623 0.8982118 0.9004413 0.6207143 0.6220000
## 76  0.6945945946 0.3566617 0.3601359 0.8851664 0.8860032 0.6834286 0.6870000
## 77  0.7888288288 0.4001962 0.4113511 0.8722032 0.8740268 0.7347143 0.7424286
## 78  0.8587387387 0.4499314 0.4551772 0.8567304 0.8570401 0.7720000 0.7744286
## 79  0.9118918919 0.5024777 0.5030488 0.8425972 0.8412566 0.7935714 0.7937143
## 80  0.9482882883 0.5463108 0.5437202 0.8268113 0.8260870 0.8012857 0.8007143
## 81  0.9751351351 0.6207729 0.6415584 0.8188582 0.8181406 0.8071429 0.8084286
## 82  0.9855855856 0.6679537 0.6721311 0.8105622 0.8096507 0.8052857 0.8048571
## 83  0.9938738739 0.7025316 0.7424242 0.8042970 0.8031450 0.8020000 0.8020000
## 84  0.9987387387 0.8289474 0.8703704 0.7996823 0.7980132 0.8000000 0.7985714
## 85  0.9998198198 0.8750000 0.9333333 0.7951548 0.7944166 0.7954286 0.7947143
## 86  0.0000000000 0.2071725 0.2071429 1.0000000       NaN 0.2072857 0.2071429
## 87  0.0090090090 0.2084831 0.2084053 1.0000000 0.9615385 0.2135714 0.2140000
## 88  0.0625225225 0.2162892 0.2167695 0.9759760 0.9719888 0.2524286 0.2552857
## 89  0.1470270270 0.2286734 0.2292413 0.9520384 0.9510490 0.3148571 0.3177143
## 90  0.2540540541 0.2485057 0.2479564 0.9472617 0.9431438 0.3961429 0.3964286
## 91  0.3641441441 0.2700958 0.2689041 0.9303913 0.9300506 0.4774286 0.4741429
## 92  0.4870270270 0.2926108 0.2956457 0.9108844 0.9137931 0.5522857 0.5568571
## 93  0.5888288288 0.3226291 0.3228487 0.8977644 0.9002755 0.6240000 0.6222857
## 94  0.6882882883 0.3580621 0.3578322 0.8843506 0.8871342 0.6857143 0.6834286
## 95  0.7803603604 0.4043633 0.4027438 0.8701531 0.8733616 0.7390000 0.7361429
## 96  0.8535135135 0.4533239 0.4491870 0.8551736 0.8575308 0.7740000 0.7714286
## 97  0.9099099099 0.5132275 0.5009980 0.8406276 0.8419473 0.7964286 0.7931429
## 98  0.9506306306 0.5625000 0.5537459 0.8247198 0.8261823 0.8031429 0.8022857
## 99  0.9760360360 0.6392962 0.6385870 0.8149872 0.8167973 0.8064286 0.8074286
## 100 0.9888288288 0.6853933 0.6960784 0.8053357 0.8075338 0.8022857 0.8042857
## 101 0.9969369369 0.7692308 0.8265306 0.7991910 0.8016517 0.7988571 0.8020000
## 102 0.9996396396 0.9473684 0.9285714 0.7948718 0.7957544 0.7952857 0.7962857
##     AUC_Train  AUC_Test
## 1   0.7386711 0.7424001
## 2   0.7386711 0.7424001
## 3   0.7386711 0.7424001
## 4   0.7386711 0.7424001
## 5   0.7386711 0.7424001
## 6   0.7386711 0.7424001
## 7   0.7386711 0.7424001
## 8   0.7386711 0.7424001
## 9   0.7386711 0.7424001
## 10  0.7386711 0.7424001
## 11  0.7386711 0.7424001
## 12  0.7386711 0.7424001
## 13  0.7386711 0.7424001
## 14  0.7386711 0.7424001
## 15  0.7386711 0.7424001
## 16  0.7386711 0.7424001
## 17  0.7386711 0.7424001
## 18  0.7405182 0.7424534
## 19  0.7405182 0.7424534
## 20  0.7405182 0.7424534
## 21  0.7405182 0.7424534
## 22  0.7405182 0.7424534
```

```
## 23  0.7405182 0.7424534
## 24  0.7405182 0.7424534
## 25  0.7405182 0.7424534
## 26  0.7405182 0.7424534
## 27  0.7405182 0.7424534
## 28  0.7405182 0.7424534
## 29  0.7405182 0.7424534
## 30  0.7405182 0.7424534
## 31  0.7405182 0.7424534
## 32  0.7405182 0.7424534
## 33  0.7405182 0.7424534
## 34  0.7405182 0.7424534
## 35  0.7404411 0.7420498
## 36  0.7404411 0.7420498
## 37  0.7404411 0.7420498
## 38  0.7404411 0.7420498
## 39  0.7404411 0.7420498
## 40  0.7404411 0.7420498
## 41  0.7404411 0.7420498
## 42  0.7404411 0.7420498
## 43  0.7404411 0.7420498
## 44  0.7404411 0.7420498
## 45  0.7404411 0.7420498
## 46  0.7404411 0.7420498
## 47  0.7404411 0.7420498
## 48  0.7404411 0.7420498
## 49  0.7404411 0.7420498
## 50  0.7404411 0.7420498
## 51  0.7404411 0.7420498
## 52  0.7422414 0.7429893
## 53  0.7422414 0.7429893
## 54  0.7422414 0.7429893
## 55  0.7422414 0.7429893
## 56  0.7422414 0.7429893
## 57  0.7422414 0.7429893
## 58  0.7422414 0.7429893
## 59  0.7422414 0.7429893
## 60  0.7422414 0.7429893
## 61  0.7422414 0.7429893
## 62  0.7422414 0.7429893
## 63  0.7422414 0.7429893
## 64  0.7422414 0.7429893
## 65  0.7422414 0.7429893
## 66  0.7422414 0.7429893
## 67  0.7422414 0.7429893
## 68  0.7422414 0.7429893
## 69  0.7405699 0.7434156
## 70  0.7405699 0.7434156
## 71  0.7405699 0.7434156
## 72  0.7405699 0.7434156
## 73  0.7405699 0.7434156
## 74  0.7405699 0.7434156
## 75  0.7405699 0.7434156
## 76  0.7405699 0.7434156
```

```
## 77  0.7405699 0.7434156
## 78  0.7405699 0.7434156
## 79  0.7405699 0.7434156
## 80  0.7405699 0.7434156
## 81  0.7405699 0.7434156
## 82  0.7405699 0.7434156
## 83  0.7405699 0.7434156
## 84  0.7405699 0.7434156
## 85  0.7405699 0.7434156
## 86  0.7420794 0.7429501
## 87  0.7420794 0.7429501
## 88  0.7420794 0.7429501
## 89  0.7420794 0.7429501
## 90  0.7420794 0.7429501
## 91  0.7420794 0.7429501
## 92  0.7420794 0.7429501
## 93  0.7420794 0.7429501
## 94  0.7420794 0.7429501
## 95  0.7420794 0.7429501
## 96  0.7420794 0.7429501
## 97  0.7420794 0.7429501
## 98  0.7420794 0.7429501
## 99  0.7420794 0.7429501
## 100 0.7420794 0.7429501
## 101 0.7420794 0.7429501
## 102 0.7420794 0.7429501
```

ROSE 25, cutoff 25 ROSE 0.35 cutoff 0.35 ROSE 0.40 cutoff 0.40

#LOOCV (leave One Out Cross Validation)

```r
library(caret)
library(pROC)
library(ROSE)


# Diferents proporcions de balanceig ROSE
rose_ratios <- seq(0.25, 0.5, by = 0.05)

# Cutoffs per transformar probabilitats en classes
cutpoints <- seq(0.1, 0.9, by = 0.05)

# Dataframe final amb tots els resultats
results_all <- data.frame()

n <- nrow(datatrain)

for (p in rose_ratios) {

  cat("======= PROVANT BALANCEIG p =", p, "=======\n")

  # Probabilitats out-of-fold inicialitzades
  prob_loocv <- numeric(n)
```

```r
  # Loop LOOCV
  for (i in 1:n) {

    # Train = totes les files menys la i
    train_idx <- setdiff(1:n, i)
    test_idx  <- i

    train_data <- datatrain[train_idx, ]
    test_data  <- datatrain[test_idx, ]

    # Aplicar ROSE al training set
    train_bal <- ROSE(Exited ~ ., data = train_data, p = p, seed = 123)$data

    # Entrenar GLM
    fit <- glm(Exited ~ ., data = train_bal, family = binomial)

    # Predicció per la fila deixada fora
    prob_loocv[i] <- predict(fit, newdata = test_data, type = "response")

  }

  # Un cop tenim probabilitats out-of-fold, calculem KPI per cada cutoff
  for (c in cutpoints) {

    pred_class <- factor(ifelse(prob_loocv > c, "pos", "neg"),
                         levels = c("neg","pos"))

    kpi <- compute_kpis(datatrain$Exited, pred_class, prob_loocv)

    results_all <- rbind(results_all, data.frame(
      ROSE_p      = p,
      Cutpoint    = c,
      F1_Train    = kpi$F1,
      F1_Test     = kpi$F1,          # LOOCV només té out-of-fold
      Spec_Train  = kpi$Specificity,
      Spec_Test   = kpi$Specificity,
      Sens_Train  = kpi$Sensitivity,
      Sens_Test   = kpi$Sensitivity,
      PPV         = kpi$PPV,
      NPV         = kpi$NPV,
      Accuracy    = kpi$Accuracy,
      AUC         = kpi$AUC
    ))
  }
}
```

```
## ======= PROVANT BALANCEIG p = 0.25 =======

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## ======= PROVANT BALANCEIG p = 0.3 =======

## Setting levels: control = neg, case = pos
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## ======= PROVANT BALANCEIG p = 0.35 =======

## Setting levels: control = neg, case = pos
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## ======= PROVANT BALANCEIG p = 0.4 =======

## Setting levels: control = neg, case = pos
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## ======= PROVANT BALANCEIG p = 0.45 =======

## Setting levels: control = neg, case = pos
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases
## ======= PROVANT BALANCEIG p = 0.5 =======
```

```
## Setting levels: control = neg, case = pos
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos
```

```
## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases

## Setting levels: control = neg, case = pos

## Setting direction: controls < cases
```

```
results_all
```

```
##     ROSE_p Cutpoint    F1_Train     F1_Test  Spec_Train   Spec_Test  Sens_Train
## 1     0.25     0.10 0.400115892 0.400115892 0.266306306 0.266306306 0.952413793
## 2     0.25     0.15 0.432413793 0.432413793 0.442162162 0.442162162 0.864827586
## 3     0.25     0.20 0.451137062 0.451137062 0.580180180 0.580180180 0.759310345
## 4     0.25     0.25 0.467678746 0.467678746 0.697477477 0.697477477 0.658620690
## 5     0.25     0.30 0.469085631 0.469085631 0.786126126 0.786126126 0.557241379
## 6     0.25     0.35 0.453991881 0.453991881 0.849549550 0.849549550 0.462758621
## 7     0.25     0.40 0.423437500 0.423437500 0.897657658 0.897657658 0.373793103
## 8     0.25     0.45 0.367437722 0.367437722 0.930630631 0.930630631 0.284827586
## 9     0.25     0.50 0.310293386 0.310293386 0.955135135 0.955135135 0.215172414
## 10    0.25     0.55 0.267952840 0.267952840 0.970090090 0.970090090 0.172413793
## 11    0.25     0.60 0.212862834 0.212862834 0.978378378 0.978378378 0.128965517
## 12    0.25     0.65 0.173341303 0.173341303 0.985945946 0.985945946 0.100000000
## 13    0.25     0.70 0.138871668 0.138871668 0.990810811 0.990810811 0.077241379
## 14    0.25     0.75 0.100386100 0.100386100 0.995315315 0.995315315 0.053793103
## 15    0.25     0.80 0.063534083 0.063534083 0.997657658 0.997657658 0.033103448
## 16    0.25     0.85 0.028493894 0.028493894 0.999459459 0.999459459 0.014482759
## 17    0.25     0.90 0.008236102 0.008236102 0.999819820 0.999819820 0.004137931
## 18    0.30     0.10 0.376095618 0.376095618 0.159639640 0.159639640 0.976551724
## 19    0.30     0.15 0.408868502 0.408868502 0.323783784 0.323783784 0.922068966
## 20    0.30     0.20 0.434549356 0.434549356 0.472612613 0.472612613 0.837931034
## 21    0.30     0.25 0.449166667 0.449166667 0.590630631 0.590630631 0.743448276
## 22    0.30     0.30 0.466180049 0.466180049 0.693333333 0.693333333 0.660689655
## 23    0.30     0.35 0.467928793 0.467928793 0.772792793 0.772792793 0.571034483
## 24    0.30     0.40 0.459468330 0.459468330 0.838378378 0.838378378 0.482758621
## 25    0.30     0.45 0.428839655 0.428839655 0.884324324 0.884324324 0.393793103
## 26    0.30     0.50 0.388959660 0.388959660 0.919459459 0.919459459 0.315862069
## 27    0.30     0.55 0.325982742 0.325982742 0.946666667 0.946666667 0.234482759
## 28    0.30     0.60 0.279874214 0.279874214 0.965585586 0.965585586 0.184137931
## 29    0.30     0.65 0.230337079 0.230337079 0.977477477 0.977477477 0.141379310
## 30    0.30     0.70 0.179334917 0.179334917 0.985045045 0.985045045 0.104137931
```

```
## 31    0.30     0.75 0.136138614 0.136138614 0.989909910 0.989909910 0.075862069
## 32    0.30     0.80 0.093023256 0.093023256 0.995315315 0.995315315 0.049655172
## 33    0.30     0.85 0.052104208 0.052104208 0.998558559 0.998558559 0.026896552
## 34    0.30     0.90 0.019086571 0.019086571 0.999459459 0.999459459 0.009655172
## 35    0.35     0.10 0.361801438 0.361801438 0.091351351 0.091351351 0.988965517
## 36    0.35     0.15 0.392613636 0.392613636 0.241801802 0.241801802 0.953103448
## 37    0.35     0.20 0.419510625 0.419510625 0.376756757 0.376756757 0.898620690
## 38    0.35     0.25 0.439933567 0.439933567 0.499639640 0.499639640 0.822068966
## 39    0.35     0.30 0.454024209 0.454024209 0.605405405 0.605405405 0.737241379
## 40    0.35     0.35 0.470070853 0.470070853 0.697117117 0.697117117 0.663448276
## 41    0.35     0.40 0.475308642 0.475308642 0.771711712 0.771711712 0.584137931
## 42    0.35     0.45 0.466968912 0.466968912 0.834774775 0.834774775 0.497241379
## 43    0.35     0.50 0.437453738 0.437453738 0.880900901 0.880900901 0.407586207
## 44    0.35     0.55 0.395815900 0.395815900 0.915855856 0.915855856 0.326206897
## 45    0.35     0.60 0.340103921 0.340103921 0.944684685 0.944684685 0.248275862
## 46    0.35     0.65 0.293416278 0.293416278 0.964684685 0.964684685 0.195172414
## 47    0.35     0.70 0.237458194 0.237458194 0.976396396 0.976396396 0.146896552
## 48    0.35     0.75 0.180308422 0.180308422 0.984864865 0.984864865 0.104827586
## 49    0.35     0.80 0.134078212 0.134078212 0.990450450 0.990450450 0.074482759
## 50    0.35     0.85 0.081977879 0.081977879 0.995675676 0.995675676 0.043448276
## 51    0.35     0.90 0.032476319 0.032476319 0.999279279 0.999279279 0.016551724
## 52    0.40     0.10 0.353228963 0.353228963 0.048288288 0.048288288 0.995862069
## 53    0.40     0.15 0.375830013 0.375830013 0.159459459 0.159459459 0.975862069
## 54    0.40     0.20 0.402419236 0.402419236 0.285585586 0.285585586 0.940689655
## 55    0.40     0.25 0.424813896 0.424813896 0.403423423 0.403423423 0.885517241
## 56    0.40     0.30 0.440715884 0.440715884 0.507747748 0.507747748 0.815172414
## 57    0.40     0.35 0.454024209 0.454024209 0.605405405 0.605405405 0.737241379
## 58    0.40     0.40 0.468643656 0.468643656 0.693693694 0.693693694 0.664827586
## 59    0.40     0.45 0.476905954 0.476905954 0.768108108 0.768108108 0.591034483
## 60    0.40     0.50 0.469609725 0.469609725 0.830270270 0.830270270 0.506206897
## 61    0.40     0.55 0.441758242 0.441758242 0.878018018 0.878018018 0.415862069
## 62    0.40     0.60 0.399833403 0.399833403 0.915135135 0.915135135 0.331034483
## 63    0.40     0.65 0.341904762 0.341904762 0.947567568 0.947567568 0.247586207
## 64    0.40     0.70 0.291231733 0.291231733 0.966306306 0.966306306 0.192413793
## 65    0.40     0.75 0.225623583 0.225623583 0.979279279 0.979279279 0.137241379
## 66    0.40     0.80 0.157862781 0.157862781 0.987927928 0.987927928 0.089655172
## 67    0.40     0.85 0.095299420 0.095299420 0.994774775 0.994774775 0.051034483
## 68    0.40     0.90 0.046885466 0.046885466 0.998558559 0.998558559 0.024137931
## 69    0.45     0.10 0.347293892 0.347293892 0.020540541 0.020540541 0.997931034
## 70    0.45     0.15 0.362990227 0.362990227 0.099279279 0.099279279 0.986206897
## 71    0.45     0.20 0.385775564 0.385775564 0.210270270 0.210270270 0.961379310
## 72    0.45     0.25 0.406681853 0.406681853 0.316036036 0.316036036 0.923448276
## 73    0.45     0.30 0.427460264 0.427460264 0.423423423 0.423423423 0.871724138
## 74    0.45     0.35 0.443306788 0.443306788 0.521621622 0.521621622 0.806206897
## 75    0.45     0.40 0.453418803 0.453418803 0.609189189 0.609189189 0.731724138
## 76    0.45     0.45 0.468604935 0.468604935 0.696576577 0.696576577 0.661379310
## 77    0.45     0.50 0.475741614 0.475741614 0.765945946 0.765945946 0.591724138
## 78    0.45     0.55 0.472435897 0.472435897 0.831891892 0.831891892 0.508275862
## 79    0.45     0.60 0.443144424 0.443144424 0.877657658 0.877657658 0.417931034
## 80    0.45     0.65 0.401172529 0.401172529 0.917297297 0.917297297 0.330344828
## 81    0.45     0.70 0.333653846 0.333653846 0.949009009 0.949009009 0.239310345
## 82    0.45     0.75 0.280571731 0.280571731 0.968648649 0.968648649 0.182758621
## 83    0.45     0.80 0.203585888 0.203585888 0.981441441 0.981441441 0.121379310
## 84    0.45     0.85 0.127182045 0.127182045 0.990630631 0.990630631 0.070344828
```

```
## 85    0.45     0.90 0.065919578 0.065919578 0.996936937 0.996936937 0.034482759
## 86    0.50     0.10 0.344663656 0.344663656 0.006486486 0.006486486 1.000000000
## 87    0.50     0.15 0.355057287 0.355057287 0.058378378 0.058378378 0.993793103
## 88    0.50     0.20 0.372001573 0.372001573 0.142342342 0.142342342 0.978620690
## 89    0.50     0.25 0.393111301 0.393111301 0.244144144 0.244144144 0.952413793
## 90    0.50     0.30 0.410772326 0.410772326 0.336216216 0.336216216 0.915172414
## 91    0.50     0.35 0.428963624 0.428963624 0.436396396 0.436396396 0.862068966
## 92    0.50     0.40 0.446230387 0.446230387 0.529729730 0.529729730 0.804137931
## 93    0.50     0.45 0.457277802 0.457277802 0.613873874 0.613873874 0.734482759
## 94    0.50     0.50 0.469607843 0.469607843 0.698738739 0.698738739 0.660689655
## 95    0.50     0.55 0.476961743 0.476961743 0.769909910 0.769909910 0.588965517
## 96    0.50     0.60 0.470284238 0.470284238 0.834594595 0.834594595 0.502068966
## 97    0.50     0.65 0.443701226 0.443701226 0.883963964 0.883963964 0.411724138
## 98    0.50     0.70 0.392123288 0.392123288 0.922882883 0.922882883 0.315862069
## 99    0.50     0.75 0.322485207 0.322485207 0.954774775 0.954774775 0.225517241
## 100   0.50     0.80 0.257142857 0.257142857 0.975495495 0.975495495 0.161379310
## 101   0.50     0.85 0.166064982 0.166064982 0.986666667 0.986666667 0.095172414
## 102   0.50     0.90 0.085547634 0.085547634 0.995135135 0.995135135 0.045517241
##       Sens_Test       PPV       NPV  Accuracy       AUC
## 1   0.952413793 0.2532551 0.9553975 0.4084286 0.7460849
## 2   0.864827586 0.2882759 0.9260377 0.5297143 0.7460849
## 3   0.759310345 0.3208977 0.9022135 0.6172857 0.7460849
## 4   0.658620690 0.3625664 0.8866239 0.6894286 0.7460849
## 5   0.557241379 0.4050125 0.8717283 0.7387143 0.7460849
## 6   0.462758621 0.4455511 0.8582090 0.7694286 0.7460849
## 7   0.373793103 0.4882883 0.8458404 0.7891429 0.7460849
## 8   0.284827586 0.5175439 0.8327959 0.7968571 0.7460849
## 9   0.215172414 0.5561497 0.8232645 0.8018571 0.7460849
## 10  0.172413793 0.6009615 0.8177400 0.8048571 0.7460849
## 11  0.128965517 0.6091205 0.8112954 0.8024286 0.7460849
## 12  0.100000000 0.6502242 0.8074369 0.8024286 0.7460849
## 13  0.077241379 0.6871166 0.8043001 0.8015714 0.7460849
## 14  0.053793103 0.7500000 0.8010441 0.8002857 0.7460849
## 15  0.033103448 0.7868852 0.7979536 0.7978571 0.7460849
## 16  0.014482759 0.8750000 0.7951548 0.7954286 0.7460849
## 17  0.004137931 0.8571429 0.7935078 0.7935714 0.7460849
## 18  0.976551724 0.2328947 0.9630435 0.3288571 0.7447998
## 19  0.922068966 0.2626719 0.9408377 0.4477143 0.7447998
## 20  0.837931034 0.2933366 0.9177747 0.5482857 0.7447998
## 21  0.743448276 0.3217910 0.8980822 0.6222857 0.7447998
## 22  0.660689655 0.3601504 0.8866359 0.6865714 0.7447998
## 23  0.571034483 0.3963619 0.8733456 0.7310000 0.7447998
## 24  0.482758621 0.4383219 0.8611882 0.7647143 0.7447998
## 25  0.393793103 0.4707337 0.8481078 0.7827143 0.7447998
## 26  0.315862069 0.5060773 0.8372436 0.7944286 0.7447998
## 27  0.234482759 0.5345912 0.8255814 0.7991429 0.7447998
## 28  0.184137931 0.5829694 0.8191685 0.8037143 0.7447998
## 29  0.141379310 0.6212121 0.8133433 0.8042857 0.7447998
## 30  0.104137931 0.6452991 0.8080106 0.8025714 0.7447998
## 31  0.075862069 0.6626506 0.8039216 0.8005714 0.7447998
## 32  0.049655172 0.7346939 0.8003477 0.7994286 0.7447998
## 33  0.026896552 0.8297872 0.7970660 0.7972857 0.7447998
## 34  0.009655172 0.8235294 0.7943577 0.7944286 0.7447998
## 35  0.988965517 0.2213988 0.9694073 0.2772857 0.7467371
```

```
## 36  0.953103448 0.2472272 0.9517730 0.3891429 0.7467371
## 37  0.898620690 0.2736245 0.9343164 0.4848571 0.7467371
## 38  0.822068966 0.3003275 0.9148796 0.5664286 0.7467371
## 39  0.737241379 0.3280147 0.8981556 0.6327143 0.7467371
## 40  0.663448276 0.3639803 0.8879963 0.6901429 0.7467371
## 41  0.584137931 0.4006623 0.8765862 0.7328571 0.7467371
## 42  0.497241379 0.4401709 0.8640433 0.7648571 0.7467371
## 43  0.407586207 0.4720447 0.8505567 0.7828571 0.7467371
## 44  0.326206897 0.5031915 0.8387789 0.7937143 0.7467371
## 45  0.248275862 0.5397301 0.8278857 0.8004286 0.7467371
## 46  0.195172414 0.5908142 0.8210397 0.8052857 0.7467371
## 47  0.146896552 0.6191860 0.8141526 0.8045714 0.7467371
## 48  0.104827586 0.6440678 0.8081017 0.8025714 0.7467371
## 49  0.074482759 0.6708075 0.8037725 0.8007143 0.7467371
## 50  0.043448276 0.7241379 0.7993635 0.7984286 0.7467371
## 51  0.016551724 0.8571429 0.7954676 0.7957143 0.7467371
## 52  0.995862069 0.2146893 0.9781022 0.2445714 0.7473915
## 53  0.975862069 0.2327303 0.9619565 0.3285714 0.7473915
## 54  0.940689655 0.2559580 0.9485338 0.4212857 0.7473915
## 55  0.885517241 0.2794342 0.9309771 0.5032857 0.7473915
## 56  0.815172414 0.3019928 0.9131562 0.5714286 0.7473915
## 57  0.737241379 0.3280147 0.8981556 0.6327143 0.7473915
## 58  0.664827586 0.3618619 0.8879151 0.6877143 0.7473915
## 59  0.591034483 0.3997201 0.8778830 0.7314286 0.7473915
## 60  0.506206897 0.4379475 0.8655147 0.7631429 0.7473915
## 61  0.415862069 0.4710938 0.8519231 0.7822857 0.7473915
## 62  0.331034483 0.5047319 0.8396429 0.7941429 0.7473915
## 63  0.247586207 0.5523077 0.8281890 0.8025714 0.7473915
## 64  0.192413793 0.5987124 0.8207836 0.8060000 0.7473915
## 65  0.137241379 0.6337580 0.8128926 0.8048571 0.7473915
## 66  0.089655172 0.6598985 0.8059680 0.8018571 0.7473915
## 67  0.051034483 0.7184466 0.8004930 0.7992857 0.7473915
## 68  0.024137931 0.8139535 0.7966077 0.7967143 0.7473915
## 69  0.997931034 0.2102281 0.9743590 0.2230000 0.7467975
## 70  0.986206897 0.2224296 0.9649737 0.2830000 0.7467975
## 71  0.961379310 0.2413017 0.9542110 0.3658571 0.7467975
## 72  0.923448276 0.2607595 0.9404826 0.4418571 0.7467975
## 73  0.871724138 0.2831541 0.9266562 0.5162857 0.7467975
## 74  0.806206897 0.3057008 0.9115239 0.5805714 0.7467975
## 75  0.731724138 0.3284830 0.8968170 0.6345714 0.7467975
## 76  0.661379310 0.3628453 0.8873078 0.6892857 0.7467975
## 77  0.591724138 0.3977747 0.8777617 0.7298571 0.7467975
## 78  0.508275862 0.4413174 0.8662289 0.7648571 0.7467975
## 79  0.417931034 0.4715953 0.8523185 0.7824286 0.7467975
## 80  0.330344828 0.5106610 0.8398218 0.7957143 0.7467975
## 81  0.239310345 0.5507937 0.8268446 0.8020000 0.7467975
## 82  0.182758621 0.6036446 0.8193873 0.8058571 0.7467975
## 83  0.121379310 0.6308244 0.8104449 0.8032857 0.7467975
## 84  0.070344828 0.6623377 0.8030967 0.8000000 0.7467975
## 85  0.034482759 0.7462687 0.7980672 0.7975714 0.7467975
## 86  1.000000000 0.2082137 1.0000000 0.2122857 0.7475377
## 87  0.993793103 0.2161392 0.9729730 0.2521429 0.7475377
## 88  0.978620690 0.2296488 0.9622412 0.3155714 0.7475377
## 89  0.952413793 0.2476686 0.9515449 0.3908571 0.7475377
```

```
## 90  0.915172414 0.2648174 0.9381599 0.4561429 0.7475377
## 91  0.862068966 0.2855185 0.9237223 0.5245714 0.7475377
## 92  0.804137931 0.3087924 0.9119107 0.5865714 0.7475377
## 93  0.734482759 0.3319825 0.8984705 0.6388571 0.7475377
## 94  0.660689655 0.3642586 0.8874142 0.6908571 0.7475377
## 95  0.588965517 0.4007508 0.8775929 0.7324286 0.7475377
## 96  0.502068966 0.4422843 0.8651476 0.7657143 0.7475377
## 97  0.411724138 0.4810637 0.8518840 0.7861429 0.7475377
## 98  0.315862069 0.5169300 0.8377494 0.7971429 0.7475377
## 99  0.225517241 0.5657439 0.8251324 0.8037143 0.7475377
## 100 0.161379310 0.6324324 0.8165913 0.8068571 0.7475377
## 101 0.095172414 0.6509434 0.8067177 0.8020000 0.7475377
## 102 0.045517241 0.7096774 0.7996236 0.7984286 0.7475377
```

Bootsrap