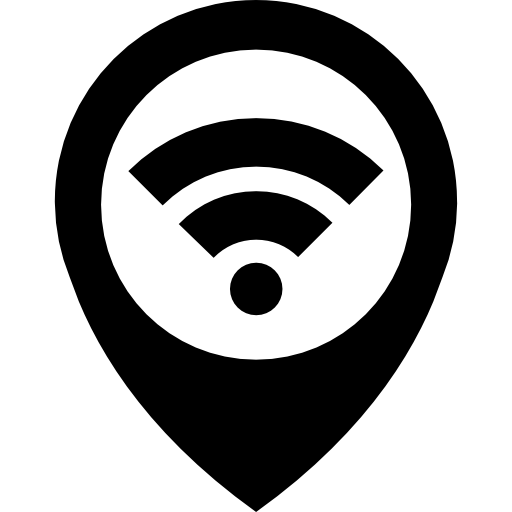
** WIFI**

**LOCATIONING**

**REPORT**

**Date: 10/16/2019**

**SUMMARY**

[UNDERSTANDING THE DATA 3](#_Toc22649635)

[Abstract: 3](#_Toc22649636)

[Data Set Information: 3](#_Toc22649637)

[Attribute Information: 4](#_Toc22649638)

[PRE PROCESS DATA 5](#_Toc22649639)

[1. Change Columns Order 5](#_Toc22649640)

[2. Import Data on R studio 5](#_Toc22649641)

[3. Composite Attribute 5](#_Toc22649642)

[4. Subset Data Frame 5](#_Toc22649643)

[5. Dropping Levels of Factor Attribute 5](#_Toc22649644)

[6. NearZeroVariances: 5](#_Toc22649645)

[MODELING 10](#_Toc22649646)

[BUILDING 0: 10](#_Toc22649647)

[a. RANDOM FOREST 10](#_Toc22649648)

[Predictions 12](#_Toc22649649)

[b. C5.0 23](#_Toc22649650)

[c. KNN 24](#_Toc22649651)

[BUILDING 1: 26](#_Toc22649652)

[a. RANDOM FOREST 26](#_Toc22649653)

[b. C5.0 27](#_Toc22649654)

[c. KNN 29](#_Toc22649655)

[BUILDING 2 35](#_Toc22649656)

[a. RANDOM FOREST 35](#_Toc22649657)

[b. C5.0 35](#_Toc22649658)

[c. KNN 35](#_Toc22649659)

[COMPARING MODELS 35](#_Toc22649660)

[SELECTED MODEL 38](#_Toc22649661)

[RECOMMENDATIONS 38](#_Toc22649662)

[APPENDIX 39](#_Toc22649663)

UNDERSTANDING THE DATA

|  |  |
| --- | --- |
| Abstract: The UJIIndoorLoc is a Multi-Building Multi-Floor indoor localization database to test Indoor Positioning System that rely on WLAN/WiFi fingerprint. |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Data Set Characteristics:** | Multivariate | **Number of Instances:** | 21048 | **Area:** | Computer |
| **Attribute Characteristics:** | Integer, Real | **Number of Attributes:** | 529 | **Date Donated** | 2014-09-18 |
| **Associated Tasks:** | Classification, Regression | **Missing Values?** | N/A | **Number of Web Hits:** | 85298 |

## Data Set Information:

Many real world applications need to know the localization of a user in the world to provide their services. Therefore, automatic user localization has been a hot research topic in the last years. Automatic user localization consists of estimating the position of the user (latitude, longitude and altitude) by using an electronic device, usually a mobile phone. Outdoor localization problem can be solved very accurately thanks to the inclusion of GPS sensors into the mobile devices. However, indoor localization is still an open problem mainly due to the loss of GPS signal in indoor environments. Although, there are some indoor positioning technologies and methodologies, this database is focused on WLAN fingerprint-based ones (also know as WiFi Fingerprinting).  
  
Although there are many papers in the literature trying to solve the indoor localization problem using a WLAN fingerprint-based method, there still exists one important drawback in this field which is the lack of a common database for comparison purposes. So, UJIIndoorLoc database is presented to overcome this gap. We expect that the proposed database will become the reference database to compare different indoor localization methodologies based on WiFi fingerprinting.  
  
The UJIIndoorLoc database covers three buildings of Universitat Jaume I with 4 or more floors and almost 110.000m2. It can be used for classification, e.g. actual building and floor identification, or regression, e.g. actual longitude and latitude estimation. It was created in 2013 by means of more than 20 different users and 25 Android devices. The database consists of 19937 training/reference records (trainingData.csv file) and 1111 validation/test records (validationData.csv file).  
  
The 529 attributes contain the WiFi fingerprint, the coordinates where it was taken, and other useful information.  
  
Each WiFi fingerprint can be characterized by the detected Wireless Access Points (WAPs) and the corresponding Received Signal Strength Intensity (RSSI). The intensity values are represented as negative integer values ranging -104dBm (extremely poor signal) to 0dbM. The positive value 100 is used to denote when a WAP was not detected. During the database creation, 520 different WAPs were detected. Thus, the WiFi fingerprint is composed by 520 intensity values.  
  
Then the coordinates (latitude, longitude, floor) and Building ID are provided as the attributes to be predicted.  
  
Additional information has been provided.

The particular space (offices, labs, etc.) and the relative position (inside/outside the space) where the capture was taken have been recorded.

Outside means that the capture was taken in front of the door of the space.  
  
Information about who (user), how (android device & version) and when (timestamp) WiFi capture was taken is also recorded.

## Attribute Information:

* **Attribute 001 (WAP001):** Intensity value for WAP001. Negative integer values from -104 to 0 and +100. Positive value 100 used if WAP001 was not detected.  
  ....  
  **Attribute 520 (WAP520):** Intensity value for WAP520. Negative integer values from -104 to 0 and +100. Positive Vvalue 100 used if WAP520 was not detected.
* **Attribute 521 (Longitude):** Longitude. Negative real values from -7695.9387549299299000 to -7299.786516730871000
* **Attribute 522 (Latitude):** Latitude. Positive real values from 4864745.7450159714 to 4865017.3646842018.
* **Attribute 523 (Floor):** Altitude in floors inside the building. Integer values from 0 to 4.
* **Attribute 524 (BuildingID):** ID to identify the building. Measures were taken in three different buildings. Categorical integer values from 0 to 2.
* **Attribute 525 (SpaceID):** Internal ID number to identify the Space (office, corridor, classroom) where the capture was taken. Categorical integer values.  
  Attribute 526 (RelativePosition): Relative position with respect to the Space (1 - Inside, 2 - Outside in Front of the door). Categorical integer values.
* **Attribute 527 (UserID):** User identifier (see below). Categorical integer values.
* **Attribute 528 (PhoneID):** Android device identifier (see below). Categorical integer values.
* **Attribute 529 (Timestamp):** UNIX Time when the capture was taken. Integer value.

# PRE PROCESS DATA

## Change Columns Order

Manually on the CSV File, move the last 9 attributes ahead.

## Import Data on R studio

Using function Readr() ,Import the Dataframe name “trainingData”.

## Composite Attribute

Create a combined the attributes BuildingID, Floor, SpaceID and Relativeposition and named it "Positionning" as a Factor and move it ahead.

> trainingData <-cbind(trainingData,paste(trainingData$BUILDINGID,trainingData$FLOOR, trainingData$SPACEID, trainingData$RELATIVEPOSITION), stringsAsFactors=TRUE)

> colnames(trainingData)[530] <-"Positionning"

> trainingData <- trainingData[,c(ncol(trainingData), 1:(ncol(trainingData)-1))]

## Subset Data Frame

We have created 3 Subsets by BuildingID : B0data, B1data and B2data

> B0data <- subset(trainingData, BUILDINGID == 0)

> B1data <- subset(trainingData, BUILDINGID == 1)

> B2data <- subset(trainingData, BUILDINGID == 2)

## Dropping Levels of Factor Attribute

Drop levels of the factor variable for each Training set of each BuildingID Subset

> Training0$Positionning <- factor(Training0$Positionning)

> Training1$Positionning <- factor(Training1$Positionning)

> Training2$Positionning <- factor(Training2$Positionning)

## NearZeroVariances:

Remove Near Zero Variances also for each subsets

# Remove Near Zero Var from Subset B0data

> nzr <- nearZeroVar(B0data, saveMetrics = TRUE)

> nzr

freqRatio percentUnique zeroVar nzv

Positionning 1.400000 4.93427319 FALSE FALSE

USERID 1.089570 0.03810250 FALSE FALSE

PHONEID 1.089570 0.03810250 FALSE FALSE

BUILDINGID 0.000000 0.01905125 TRUE TRUE

FLOOR 1.037383 0.07620499 FALSE FALSE

SPACEID 1.010101 1.48599733 FALSE FALSE

RELATIVEPOSITION 180.000000 0.03810250 FALSE TRUE

LONGITUDE 1.075949 3.06725090 FALSE FALSE

LATITUDE 1.196911 1.16212612 FALSE FALSE

TIMESTAMP 1.428571 58.88740713 FALSE FALSE

WAP001 653.875000 0.11430749 FALSE TRUE

WAP002 523.000000 0.05715374 FALSE TRUE

WAP003 0.000000 0.01905125 TRUE TRUE

WAP004 0.000000 0.01905125 TRUE TRUE

WAP005 0.000000 0.01905125 TRUE TRUE

WAP006 0.000000 0.01905125 TRUE TRUE

WAP007 133.457143 0.99066489 FALSE TRUE

WAP008 233.090909 0.41912745 FALSE TRUE

WAP009 105.772727 0.91445990 FALSE TRUE

WAP010 0.000000 0.01905125 TRUE TRUE

WAP011 0.000000 0.01905125 TRUE TRUE

WAP012 0.000000 0.01905125 TRUE TRUE

WAP013 43.078947 1.12402362 FALSE TRUE

WAP014 40.666667 1.10497238 FALSE TRUE

WAP015 0.000000 0.01905125 TRUE TRUE

WAP016 0.000000 0.01905125 TRUE TRUE

WAP017 323.000000 0.28576872 FALSE TRUE

WAP018 234.636364 0.30481997 FALSE TRUE

WAP019 178.925926 0.91445990 FALSE TRUE

WAP020 194.360000 0.93351114 FALSE TRUE

WAP021 0.000000 0.01905125 TRUE TRUE

WAP022 0.000000 0.01905125 TRUE TRUE

WAP023 113.275000 1.18117737 FALSE TRUE

WAP024 115.974359 1.16212612 FALSE TRUE

WAP025 102.622222 1.02876738 FALSE TRUE

WAP026 95.708333 1.02876738 FALSE TRUE

WAP027 129.457143 1.04781863 FALSE TRUE

WAP028 118.263158 1.04781863 FALSE TRUE

WAP029 64.948276 1.23833111 FALSE TRUE

WAP030 59.015873 1.31453610 FALSE TRUE

WAP031 232.000000 1.14307487 FALSE TRUE

WAP032 185.600000 1.12402362 FALSE TRUE

WAP033 49.106667 1.21927986 FALSE TRUE

WAP034 57.625000 1.21927986 FALSE TRUE

WAP035 55.609375 1.33358735 FALSE TRUE

WAP036 46.644737 1.31453610 FALSE TRUE

WAP037 0.000000 0.01905125 TRUE TRUE

WAP038 0.000000 0.01905125 TRUE TRUE

WAP039 69.333333 1.25738236 FALSE TRUE

WAP040 54.588235 1.25738236 FALSE TRUE

WAP041 40.425287 1.21927986 FALSE TRUE

WAP042 40.593023 1.20022861 FALSE TRUE

WAP043 82.714286 1.31453610 FALSE TRUE

WAP044 63.809524 1.33358735 FALSE TRUE

WAP045 125.189189 1.08592113 FALSE TRUE

WAP046 135.264706 1.06686988 FALSE TRUE

WAP047 68.160714 1.25738236 FALSE TRUE

WAP048 60.412698 1.23833111 FALSE TRUE

WAP049 210.956522 0.93351114 FALSE TRUE

WAP050 112.069767 0.91445990 FALSE TRUE

WAP051 32.655914 1.08592113 FALSE TRUE

WAP052 34.211111 1.08592113 FALSE TRUE

WAP053 104.950000 1.25738236 FALSE TRUE

WAP054 83.480000 1.27643361 FALSE TRUE

WAP055 0.000000 0.01905125 TRUE TRUE

WAP056 0.000000 0.01905125 TRUE TRUE

WAP057 189.320000 1.04781863 FALSE TRUE

WAP058 174.037037 1.02876738 FALSE TRUE

WAP059 0.000000 0.01905125 TRUE TRUE

WAP060 0.000000 0.01905125 TRUE TRUE

WAP061 0.000000 0.01905125 TRUE TRUE

WAP062 0.000000 0.01905125 TRUE TRUE

WAP063 0.000000 0.01905125 TRUE TRUE

WAP064 0.000000 0.01905125 TRUE TRUE

WAP065 0.000000 0.01905125 TRUE TRUE

WAP066 0.000000 0.01905125 TRUE TRUE

WAP067 0.000000 0.01905125 TRUE TRUE

WAP068 0.000000 0.01905125 TRUE TRUE

WAP069 0.000000 0.01905125 TRUE TRUE

WAP070 0.000000 0.01905125 TRUE TRUE

WAP071 389.923077 0.85730615 FALSE TRUE

WAP072 336.933333 0.87635740 FALSE TRUE

WAP073 0.000000 0.01905125 TRUE TRUE

WAP074 0.000000 0.01905125 TRUE TRUE

WAP075 94.413043 1.18117737 FALSE TRUE

WAP076 135.343750 1.18117737 FALSE TRUE

WAP077 0.000000 0.01905125 TRUE TRUE

WAP078 0.000000 0.01905125 TRUE TRUE

WAP079 5248.000000 0.03810250 FALSE TRUE

WAP080 82.784314 1.27643361 FALSE TRUE

WAP081 93.400000 1.25738236 FALSE TRUE

WAP082 0.000000 0.01905125 TRUE TRUE

WAP083 0.000000 0.01905125 TRUE TRUE

WAP084 0.000000 0.01905125 TRUE TRUE

WAP085 0.000000 0.01905125 TRUE TRUE

WAP086 0.000000 0.01905125 TRUE TRUE

WAP087 0.000000 0.01905125 TRUE TRUE

WAP088 0.000000 0.01905125 TRUE TRUE

WAP089 0.000000 0.01905125 TRUE TRUE

WAP090 0.000000 0.01905125 TRUE TRUE

WAP091 0.000000 0.01905125 TRUE TRUE

WAP092 0.000000 0.01905125 TRUE TRUE

WAP093 0.000000 0.01905125 TRUE TRUE

WAP094 0.000000 0.01905125 TRUE TRUE

WAP095 0.000000 0.01905125 TRUE TRUE

WAP096 0.000000 0.01905125 TRUE TRUE

WAP097 0.000000 0.01905125 TRUE TRUE

WAP098 0.000000 0.01905125 TRUE TRUE

WAP099 0.000000 0.01905125 TRUE TRUE

WAP100 435.750000 0.15240998 FALSE TRUE

WAP101 0.000000 0.01905125 TRUE TRUE

WAP102 0.000000 0.01905125 TRUE TRUE

WAP103 2621.500000 0.11430749 FALSE TRUE

WAP104 2622.000000 0.09525624 FALSE TRUE

WAP105 0.000000 0.01905125 TRUE TRUE

WAP106 0.000000 0.01905125 TRUE TRUE

WAP107 0.000000 0.01905125 TRUE TRUE

WAP108 0.000000 0.01905125 TRUE TRUE

WAP109 0.000000 0.01905125 TRUE TRUE

WAP110 0.000000 0.01905125 TRUE TRUE

WAP111 0.000000 0.01905125 TRUE TRUE

WAP112 0.000000 0.01905125 TRUE TRUE

WAP113 0.000000 0.01905125 TRUE TRUE

WAP114 0.000000 0.01905125 TRUE TRUE

WAP115 0.000000 0.01905125 TRUE TRUE

WAP116 0.000000 0.01905125 TRUE TRUE

WAP117 0.000000 0.01905125 TRUE TRUE

WAP118 0.000000 0.01905125 TRUE TRUE

WAP119 0.000000 0.01905125 TRUE TRUE

WAP120 0.000000 0.01905125 TRUE TRUE

WAP121 0.000000 0.01905125 TRUE TRUE

WAP122 0.000000 0.01905125 TRUE TRUE

WAP123 348.733333 0.05715374 FALSE TRUE

WAP124 1310.750000 0.05715374 FALSE TRUE

WAP125 0.000000 0.01905125 TRUE TRUE

WAP126 0.000000 0.01905125 TRUE TRUE

WAP127 0.000000 0.01905125 TRUE TRUE

WAP128 0.000000 0.01905125 TRUE TRUE

WAP129 0.000000 0.01905125 TRUE TRUE

WAP130 0.000000 0.01905125 TRUE TRUE

WAP131 0.000000 0.01905125 TRUE TRUE

WAP132 0.000000 0.01905125 TRUE TRUE

WAP133 0.000000 0.01905125 TRUE TRUE

WAP134 0.000000 0.01905125 TRUE TRUE

WAP135 0.000000 0.01905125 TRUE TRUE

WAP136 0.000000 0.01905125 TRUE TRUE

WAP137 0.000000 0.01905125 TRUE TRUE

WAP138 0.000000 0.01905125 TRUE TRUE

WAP139 0.000000 0.01905125 TRUE TRUE

WAP140 0.000000 0.01905125 TRUE TRUE

WAP141 0.000000 0.01905125 TRUE TRUE

WAP142 74.226415 1.31453610 FALSE TRUE

WAP143 58.393939 1.29548485 FALSE TRUE

WAP144 0.000000 0.01905125 TRUE TRUE

WAP145 0.000000 0.01905125 TRUE TRUE

WAP146 0.000000 0.01905125 TRUE TRUE

WAP147 0.000000 0.01905125 TRUE TRUE

WAP148 0.000000 0.01905125 TRUE TRUE

WAP149 0.000000 0.01905125 TRUE TRUE

WAP150 252.200000 0.47628120 FALSE TRUE

WAP151 281.000000 0.51438369 FALSE TRUE

WAP152 0.000000 0.01905125 TRUE TRUE

WAP153 5248.000000 0.03810250 FALSE TRUE

WAP154 112.763158 1.06686988 FALSE TRUE

WAP155 26.576577 1.14307487 FALSE TRUE

WAP156 22.589147 1.14307487 FALSE TRUE

WAP157 0.000000 0.01905125 TRUE TRUE

WAP158 0.000000 0.01905125 TRUE TRUE

WAP159 0.000000 0.01905125 TRUE TRUE

WAP160 0.000000 0.01905125 TRUE TRUE

WAP161 33.147368 1.12402362 FALSE TRUE

WAP162 39.209877 1.14307487 FALSE TRUE

WAP163 522.500000 0.09525624 FALSE TRUE

WAP164 0.000000 0.01905125 TRUE TRUE

WAP165 0.000000 0.01905125 TRUE TRUE

WAP166 305.529412 0.30481997 FALSE TRUE

WAP167 399.384615 0.30481997 FALSE TRUE

WAP168 1748.666667 0.03810250 FALSE TRUE

WAP169 1310.750000 0.05715374 FALSE TRUE

WAP170 5248.000000 0.03810250 FALSE TRUE

WAP171 5248.000000 0.03810250 FALSE TRUE

WAP172 211.916667 0.45722995 FALSE TRUE

WAP173 283.000000 0.51438369 FALSE TRUE

WAP174 0.000000 0.01905125 TRUE TRUE

WAP175 0.000000 0.01905125 TRUE TRUE

WAP176 0.000000 0.01905125 TRUE TRUE

WAP177 0.000000 0.01905125 TRUE TRUE

WAP178 0.000000 0.01905125 TRUE TRUE

WAP179 0.000000 0.01905125 TRUE TRUE

WAP180 0.000000 0.01905125 TRUE TRUE

WAP181 0.000000 0.01905125 TRUE TRUE

WAP182 5246.000000 0.07620499 FALSE TRUE

WAP183 581.333333 0.11430749 FALSE TRUE

WAP184 155.531250 0.57153744 FALSE TRUE

WAP185 165.933333 0.59058868 FALSE TRUE

WAP186 0.000000 0.01905125 TRUE TRUE

WAP187 0.000000 0.01905125 TRUE TRUE

WAP188 0.000000 0.01905125 TRUE TRUE

WAP189 0.000000 0.01905125 TRUE TRUE

WAP190 0.000000 0.01905125 TRUE TRUE

WAP191 582.222222 0.03810250 FALSE TRUE

WAP192 582.222222 0.03810250 FALSE TRUE

WAP193 0.000000 0.01905125 TRUE TRUE

WAP194 0.000000 0.01905125 TRUE TRUE

WAP195 0.000000 0.01905125 TRUE TRUE

WAP196 0.000000 0.01905125 TRUE TRUE

WAP197 0.000000 0.01905125 TRUE TRUE

WAP198 0.000000 0.01905125 TRUE TRUE

WAP199 0.000000 0.01905125 TRUE TRUE

WAP200 0.000000 0.01905125 TRUE TRUE

WAP201 654.250000 0.09525624 FALSE TRUE

WAP202 653.875000 0.09525624 FALSE TRUE

WAP203 0.000000 0.01905125 TRUE TRUE

WAP204 0.000000 0.01905125 TRUE TRUE

WAP205 5248.000000 0.03810250 FALSE TRUE

WAP206 0.000000 0.01905125 TRUE TRUE

WAP207 5245.000000 0.09525624 FALSE TRUE

WAP208 0.000000 0.01905125 TRUE TRUE

WAP209 0.000000 0.01905125 TRUE TRUE

WAP210 5248.000000 0.03810250 FALSE TRUE

WAP211 5248.000000 0.03810250 FALSE TRUE

WAP212 5247.000000 0.05715374 FALSE TRUE

WAP213 0.000000 0.01905125 TRUE TRUE

WAP214 0.000000 0.01905125 TRUE TRUE

WAP215 0.000000 0.01905125 TRUE TRUE

WAP216 0.000000 0.01905125 TRUE TRUE

WAP217 0.000000 0.01905125 TRUE TRUE

WAP218 0.000000 0.01905125 TRUE TRUE

WAP219 0.000000 0.01905125 TRUE TRUE

WAP220 0.000000 0.01905125 TRUE TRUE

WAP221 5248.000000 0.03810250 FALSE TRUE

WAP222 0.000000 0.01905125 TRUE TRUE

WAP223 0.000000 0.01905125 TRUE TRUE

WAP224 59.593750 1.08592113 FALSE TRUE

WAP225 42.823529 1.04781863 FALSE TRUE

WAP226 0.000000 0.01905125 TRUE TRUE

WAP227 0.000000 0.01905125 TRUE TRUE

WAP228 0.000000 0.01905125 TRUE TRUE

WAP229 0.000000 0.01905125 TRUE TRUE

WAP230 0.000000 0.01905125 TRUE TRUE

WAP231 0.000000 0.01905125 TRUE TRUE

WAP232 0.000000 0.01905125 TRUE TRUE

WAP233 0.000000 0.01905125 TRUE TRUE

WAP234 0.000000 0.01905125 TRUE TRUE

WAP235 0.000000 0.01905125 TRUE TRUE

WAP236 0.000000 0.01905125 TRUE TRUE

WAP237 0.000000 0.01905125 TRUE TRUE

WAP238 0.000000 0.01905125 TRUE TRUE

WAP239 0.000000 0.01905125 TRUE TRUE

WAP240 0.000000 0.01905125 TRUE TRUE

[ reached 'max' / getOption("max.print") -- omitted 280 rows ]

> summary(nzr) # There are 371 Rows with Near Zero Var to remove

freqRatio percentUnique zeroVar nzv

Min. : 0.0 Min. : 0.01905 Mode :logical Mode :logical

1st Qu.: 0.0 1st Qu.: 0.01905 FALSE:209 FALSE:8

Median : 0.0 Median : 0.01905 TRUE :321 TRUE :522

Mean : **371**.1 Mean : 0.32865

3rd Qu.: 149.3 3rd Qu.: 0.22385

Max. :5248.0 Max. :58.88741

> zerovardata <- which(nzr$zeroVar == T)

> zerovardata

[1] 4 13 14 15 16 20 21 22 25 26 31 32 47 48 65 66 69 70 71 72

[21] 73 74 75 76 77 78 79 80 83 84 87 88 92 93 94 95 96 97 98 99

[41] 100 101 102 103 104 105 106 107 108 109 111 112 115 116 117 118 119 120 121 122

[61] 123 124 125 126 127 128 129 130 131 132 135 136 137 138 139 140 141 142 143 144

[81] 145 146 147 148 149 150 151 154 155 156 157 158 159 162 167 168 169 170 174 175

[101] 184 185 186 187 188 189 190 191 196 197 198 199 200 203 204 205 206 207 208 209

[121] 210 213 214 216 218 219 223 224 225 226 227 228 229 230 232 233 236 237 238 239

[141] 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 259 260

[161] 264 265 266 267 268 269 270 271 272 273 284 287 288 289 292 294 296 298 303 305

[181] 306 311 313 314 317 320 321 322 323 324 325 326 327 328 339 342 343 344 345 348

[201] 350 352 354 359 361 363 370 375 376 377 378 379 380 381 382 383 384 385 396 399

[221] 400 401 404 406 408 410 415 417 426 427 428 429 430 431 432 433 434 435 437 438

[241] 439 440 441 442 443 445 446 447 448 449 450 451 452 454 455 456 458 459 460 461

[261] 463 464 465 466 467 468 470 471 472 473 474 475 476 477 478 479 480 481 482 483

[281] 484 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 505

[301] 506 507 508 509 511 512 513 514 515 516 517 519 520 521 522 523 524 526 527 528

[321] 530

> B0data <- B0data[, -(zerovardata)]

# Remove Near Zero Var from Subset B1data

> nzr1 <- nearZeroVar(B1data, saveMetrics = TRUE)

> zerovardata1 <- which(nzr1$zeroVar == T)

> B1data <- B1data[, -(zerovardata1)]

# Remove Near Zero Var from Subset B2data

> nzr2 <- nearZeroVar(B2data, saveMetrics = TRUE)

> zerovardata2 <- which(nzr2$zeroVar == T)

> B2data <- B2data[, -(zerovardata2)]

# MODELING

### BUILDING 0:

### RANDOM FOREST

>Library(caret)

>Set.seed(998)

>intraining<- createDataPartition(B0data$Positionning, p=.75, list=FALSE)

>Training <- completeResponses[intraining,]

>Testing <- completeResponses[intraining,]

>Fitcontrol<- traincontrol(method=”repeatdcv” , number = 10, repeats = 1)

> rfGrid<- expand.grid(mtry=c(1,2,3,4,5))

>

> system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

Error: One or more factor levels in the outcome has no data: '1 0 1 1', '1 0 1 2', '1 0 10 1', '1 0 10 2', '1 0 107 2', '1 0 108 2', '1 0 110 2', '1 0 111 2', '1 0 112 2', '1 0 113 2', '1 0 114 2', '1 0 115 2', '1 0 116 2', '1 0 117 2', '1 0 118 2', '1 0 119 2', '1 0 121 2', '1 0 122 2', '1 0 15 2', '1 0 16 2', '1 0 202 1', '1 0 202 2', '1 0 203 1', '1 0 203 2', '1 0 213 2', '1 0 216 1', '1 0 216 2', '1 0 217 1', '1 0 217 2', '1 0 218 1', '1 0 218 2', '1 0 219 1', '1 0 219 2', '1 0 220 1', '1 0 220 2', '1 0 222 1', '1 0 222 2', '1 0 224 1', '1 0 224 2', '1 0 225 1', '1 0 225 2', '1 0 226 1', '1 0 226 2', '1 0 227 1', '1 0 227 2', '1 0 228 1', '1 0 228 2', '1 0 229 1', '1 0 229 2', '1 0 230 1', '1 0 230 2', '1 0 231 1', '1 0 231 2', '1 0 235 2', '1 0 237 1', '1 0 237 2', '1 0 238 1', '1 0 238 2', '1 0 239 2', '1 0 243 2', '1 0 244 1', '1 0 244 2', '1 0 245 2', '1 0 246 2', '1 0 247 1', '1 0 247 2', '1 0 248 1', '1 0 248 2', '1 0 249 1', '1 0 249 2', '1 0 3 2', '1 0 6 2', '1 0 9 1', '1

Timing stopped at: 0.3 0 0.33

**🡺 This Error is because this code was run before refactor the factor variable in the training set**  
> system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

user system elapsed

1085.58 4.28 1143.05

#Running for 22 minutes

> rfBuild0

Random Forest

3996 samples

208 predictor

259 classes: '0 0 102 2', '0 0 106 2', '0 0 107 2', '0 0 110 2', '0 0 111 2', '0 0 112 2', '0 0 113 2', '0 0 114 2', '0 0 115 2', '0 0 116 2', '0 0 117 2', '0 0 118 2', '0 0 119 2', '0 0 120 2', '0 0 121 2', '0 0 122 2', '0 0 123 2', '0 0 125 2', '0 0 126 2', '0 0 127 2', '0 0 128 2', '0 0 129 2', '0 0 130 2', '0 0 131 2', '0 0 132 2', '0 0 133 2', '0 0 134 2', '0 0 201 2', '0 0 202 2', '0 0 208 2', '0 0 209 2', '0 0 211 2', '0 0 212 2', '0 0 213 2', '0 0 214 2', '0 0 215 2', '0 0 216 2', '0 0 218 2', '0 0 219 2', '0 0 220 2', '0 0 222 2', '0 0 224 2', '0 0 225 2', '0 0 226 2', '0 0 227 2', '0 0 229 2', '0 0 230 2', '0 0 231 2', '0 0 232 2', '0 0 233 2', '0 0 234 2', '0 0 235 2', '0 0 236 2', '0 0 237 2', '0 1 101 2', '0 1 102 2', '0 1 103 2', '0 1 104 2', '0 1 105 2', '0 1 106 2', '0 1 107 2', '0 1 108 2', '0 1 109 2', '0 1 110 2', '0 1 111 2', '0 1 112 2', '0 1 113 2', '0 1 114 2', '0 1 115 2', '0 1 116 2', '0 1 117 2', '0 1 118 2', '0 1 119 2', '0 1 120 2', '0 1 121 2', '0 1 122 2', '0 1 123 2', '0 1 124 2', '0 1 125 2', '0 1 126 2', '0 1 127 2', '0 1 128 2', '0 1 129 2', '0 1 130 2', '0 1 136 2', '0 1 137 2', '0 1 138 2', '0 1 201 2', '0 1 202 2', '0 1 203 2', '0 1 204 2', '0 1 205 1', '0 1 205 2', '0 1 206 2', '0 1 207 2', '0 1 208 2', '0 1 209 2', '0 1 210 2', '0 1 211 2', '0 1 212 2', '0 1 213 2', '0 1 214 2', '0 1 215 2', '0 1 216 2', '0 1 217 2', '0 1 218 2', '0 1 219 2', '0 1 220 2', '0 1 221 2', '0 1 222 2', '0 1 223 2', '0 1 224 2', '0 1 225 2', '0 1 226 2', '0 1 227 2', '0 1 228 2', '0 1 229 2', '0 1 230 2', '0 1 233 2', '0 1 234 2', '0 1 235 2', '0 2 101 2', '0 2 102 2', '0 2 103 2', '0 2 104 2', '0 2 105 2', '0 2 106 2', '0 2 107 2', '0 2 108 2', '0 2 109 2', '0 2 110 2', '0 2 111 2', '0 2 112 2', '0 2 113 2', '0 2 114 2', '0 2 115 2', '0 2 117 2', '0 2 118 2', '0 2 119 2', '0 2 120 2', '0 2 121 2', '0 2 122 2', '0 2 123 2', '0 2 124 2', '0 2 125 2', '0 2 126 2', '0 2 127 2', '0 2 128 1', '0 2 128 2', '0 2 129 2', '0 2 130 2', '0 2 132 2', '0 2 133 2', '0 2 134 2', '0 2 138 2', '0 2 139 2', '0 2 140 2', '0 2 201 2', '0 2 202 2', '0 2 203 2', '0 2 204 2', '0 2 205 2', '0 2 206 2', '0 2 207 2', '0 2 208 2', '0 2 209 2', '0 2 210 2', '0 2 211 2', '0 2 212 2', '0 2 213 2', '0 2 214 1', '0 2 214 2', '0 2 216 2', '0 2 217 2', '0 2 218 2', '0 2 219 2', '0 2 220 2', '0 2 221 2', '0 2 222 2', '0 2 223 2', '0 2 224 2', '0 2 225 2', '0 2 226 2', '0 2 227 2', '0 2 228 2', '0 2 229 2', '0 2 230 2', '0 2 231 2', '0 2 234 2', '0 2 235 2', '0 2 241 2', '0 3 101 2', '0 3 102 2', '0 3 103 2', '0 3 104 2', '0 3 105 2', '0 3 106 2', '0 3 107 2', '0 3 108 2', '0 3 109 2', '0 3 110 2', '0 3 111 2', '0 3 112 2', '0 3 113 2', '0 3 114 2', '0 3 115 2', '0 3 116 2', '0 3 117 2', '0 3 118 2', '0 3 119 2', '0 3 120 2', '0 3 121 2', '0 3 122 2', '0 3 123 2', '0 3 124 2', '0 3 125 2', '0 3 126 2', '0 3 127 2', '0 3 128 2', '0 3 129 2', '0 3 130 2', '0 3 131 2', '0 3 135 2', '0 3 136 2', '0 3 137 2', '0 3 201 2', '0 3 202 2', '0 3 203 2', '0 3 204 2', '0 3 205 2', '0 3 206 2', '0 3 207 2', '0 3 208 2', '0 3 209 2', '0 3 210 2', '0 3 211 2', '0 3 212 2', '0 3 213 2', '0 3 214 2', '0 3 215 2', '0 3 216 2', '0 3 217 2', '0 3 218 2', '0 3 219 2', '0 3 220 2', '0 3 221 2', '0 3 222 2', '0 3 223 2', '0 3 224 2', '0 3 225 2', '0 3 226 2', '0 3 227 2', '0 3 228 2', '0 3 229 2', '0 3 230 2', '0 3 231 2', '0 3 234 2', '0 3 235 2', '0 3 236 2'

No pre-processing

Resampling: Cross-Validated (10 fold, repeated 1 times)

Summary of sample sizes: 3591, 3598, 3599, 3611, 3589, 3598, ...

Resampling results across tuning parameters:

mtry Accuracy Kappa

1 0.01926849 0.01138666

2 0.25709415 0.25261654

3 0.54324448 0.54100121

4 0.69102514 0.68961174

**5 0.77962234 0.77864130**

Accuracy was used to select the optimal model using the largest value.

The final value used for the model was **mtry = 5**.

### Predictions

> ResultsrfBuild0<- predict(object = rfBuild0, newdata = Testing)

> postResample(ResultsrfBuild0, Testing$Positionning)

Accuracy Kappa

0.9629630 0.9628113

> table(ResultsrfBuild0, Testing$Positionning)

ResultsrfBuild0 0 0 102 2 0 0 106 2 0 0 107 2 0 0 110 2 0 0 111 2 0 0 112 2 0 0 113 2

0 0 102 2 15 0 0 0 0 0 0

ResultsrfBuild0 0 0 114 2 0 0 115 2 0 0 116 2 0 0 117 2 0 0 118 2 0 0 119 2 0 0 120 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 0 121 2 0 0 122 2 0 0 123 2 0 0 125 2 0 0 126 2 0 0 127 2 0 0 128 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 0 129 2 0 0 130 2 0 0 131 2 0 0 132 2 0 0 133 2 0 0 134 2 0 0 201 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 0 202 2 0 0 208 2 0 0 209 2 0 0 211 2 0 0 212 2 0 0 213 2 0 0 214 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 0 215 2 0 0 216 2 0 0 218 2 0 0 219 2 0 0 220 2 0 0 222 2 0 0 224 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 0 225 2 0 0 226 2 0 0 227 2 0 0 229 2 0 0 230 2 0 0 231 2 0 0 232 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 0 233 2 0 0 234 2 0 0 235 2 0 0 236 2 0 0 237 2 0 1 101 2 0 1 102 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 1 103 2 0 1 104 2 0 1 105 2 0 1 106 2 0 1 107 2 0 1 108 2 0 1 109 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 1 110 2 0 1 111 2 0 1 112 2 0 1 113 2 0 1 114 2 0 1 115 2 0 1 116 2

0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 1 117 2 0 1 118 2 0 1 119 2 0 1 120 2 0 1 121 2 0 1 122 2 0 1 123 2

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0 0 102 2 0 0 0 0 0 0 0

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0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 0 2 121 2 0 2 122 2 0 2 123 2 0 2 124 2 0 2 125 2 0 2 126 2 0 2 127 2

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ResultsrfBuild0 1 0 1 1 1 0 1 2 1 0 10 1 1 0 10 2 1 0 107 2 1 0 108 2 1 0 110 2

0 0 102 2 0 0 0 0 0 0 0

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0 0 102 2 0 0 0 0 0 0 0

ResultsrfBuild0 1 0 118 2 1 0 119 2 1 0 121 2 1 0 122 2 1 0 15 2 1 0 16 2 1 0 202 1

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ResultsrfBuild0 2 4 216 2 2 4 217 2 2 4 218 2 2 4 219 2 2 4 220 2

0 0 102 2 0 0 0 0 0

[ reached getOption("max.print") -- omitted 258 rows ]

> postResample(ResultsrfBuild0, Testing$Positionning)

Accuracy Kappa

0.9634635 0.9633139

### C5.0

> CBuild0<- train(Positionning ~ ., data = Training, method = "C5.0", trcontrol=fitControl, tuneLength = 5)

# 15 Minutes Running

> CBuild0

C5.0

3996 samples

208 predictor

259 classes: '0 0 102 2', '0 0 106 2', '0 0 107 2', '0 0 110 2', '0 0 111 2', '0 0 112 2', '0 0 113 2', '0 0 114 2', '0 0 115 2', '0 0 116 2', '0 0 117 2', '0 0 118 2', '0 0 119 2', '0 0 120 2', '0 0 121 2', '0 0 122 2', '0 0 123 2', '0 0 125 2', '0 0 126 2', '0 0 127 2', '0 0 128 2', '0 0 129 2', '0 0 130 2', '0 0 131 2', '0 0 132 2', '0 0 133 2', '0 0 134 2', '0 0 201 2', '0 0 202 2', '0 0 208 2', '0 0 209 2', '0 0 211 2', '0 0 212 2', '0 0 213 2', '0 0 214 2', '0 0 215 2', '0 0 216 2', '0 0 218 2', '0 0 219 2', '0 0 220 2', '0 0 222 2', '0 0 224 2', '0 0 225 2', '0 0 226 2', '0 0 227 2', '0 0 229 2', '0 0 230 2', '0 0 231 2', '0 0 232 2', '0 0 233 2', '0 0 234 2', '0 0 235 2', '0 0 236 2', '0 0 237 2', '0 1 101 2', '0 1 102 2', '0 1 103 2', '0 1 104 2', '0 1 105 2', '0 1 106 2', '0 1 107 2', '0 1 108 2', '0 1 109 2', '0 1 110 2', '0 1 111 2', '0 1 112 2', '0 1 113 2', '0 1 114 2', '0 1 115 2', '0 1 116 2', '0 1 117 2', '0 1 118 2', '0 1 119 2', '0 1 120 2', '0 1 121 2', '0 1 122 2', '0 1 123 2', '0 1 124 2', '0 1 125 2', '0 1 126 2', '0 1 127 2', '0 1 128 2', '0 1 129 2', '0 1 130 2', '0 1 136 2', '0 1 137 2', '0 1 138 2', '0 1 201 2', '0 1 202 2', '0 1 203 2', '0 1 204 2', '0 1 205 1', '0 1 205 2', '0 1 206 2', '0 1 207 2', '0 1 208 2', '0 1 209 2', '0 1 210 2', '0 1 211 2', '0 1 212 2', '0 1 213 2', '0 1 214 2', '0 1 215 2', '0 1 216 2', '0 1 217 2', '0 1 218 2', '0 1 219 2', '0 1 220 2', '0 1 221 2', '0 1 222 2', '0 1 223 2', '0 1 224 2', '0 1 225 2', '0 1 226 2', '0 1 227 2', '0 1 228 2', '0 1 229 2', '0 1 230 2', '0 1 233 2', '0 1 234 2', '0 1 235 2', '0 2 101 2', '0 2 102 2', '0 2 103 2', '0 2 104 2', '0 2 105 2', '0 2 106 2', '0 2 107 2', '0 2 108 2', '0 2 109 2', '0 2 110 2', '0 2 111 2', '0 2 112 2', '0 2 113 2', '0 2 114 2', '0 2 115 2', '0 2 117 2', '0 2 118 2', '0 2 119 2', '0 2 120 2', '0 2 121 2', '0 2 122 2', '0 2 123 2', '0 2 124 2', '0 2 125 2', '0 2 126 2', '0 2 127 2', '0 2 128 1', '0 2 128 2', '0 2 129 2', '0 2 130 2', '0 2 132 2', '0 2 133 2', '0 2 134 2', '0 2 138 2', '0 2 139 2', '0 2 140 2', '0 2 201 2', '0 2 202 2', '0 2 203 2', '0 2 204 2', '0 2 205 2', '0 2 206 2', '0 2 207 2', '0 2 208 2', '0 2 209 2', '0 2 210 2', '0 2 211 2', '0 2 212 2', '0 2 213 2', '0 2 214 1', '0 2 214 2', '0 2 216 2', '0 2 217 2', '0 2 218 2', '0 2 219 2', '0 2 220 2', '0 2 221 2', '0 2 222 2', '0 2 223 2', '0 2 224 2', '0 2 225 2', '0 2 226 2', '0 2 227 2', '0 2 228 2', '0 2 229 2', '0 2 230 2', '0 2 231 2', '0 2 234 2', '0 2 235 2', '0 2 241 2', '0 3 101 2', '0 3 102 2', '0 3 103 2', '0 3 104 2', '0 3 105 2', '0 3 106 2', '0 3 107 2', '0 3 108 2', '0 3 109 2', '0 3 110 2', '0 3 111 2', '0 3 112 2', '0 3 113 2', '0 3 114 2', '0 3 115 2', '0 3 116 2', '0 3 117 2', '0 3 118 2', '0 3 119 2', '0 3 120 2', '0 3 121 2', '0 3 122 2', '0 3 123 2', '0 3 124 2', '0 3 125 2', '0 3 126 2', '0 3 127 2', '0 3 128 2', '0 3 129 2', '0 3 130 2', '0 3 131 2', '0 3 135 2', '0 3 136 2', '0 3 137 2', '0 3 201 2', '0 3 202 2', '0 3 203 2', '0 3 204 2', '0 3 205 2', '0 3 206 2', '0 3 207 2', '0 3 208 2', '0 3 209 2', '0 3 210 2', '0 3 211 2', '0 3 212 2', '0 3 213 2', '0 3 214 2', '0 3 215 2', '0 3 216 2', '0 3 217 2', '0 3 218 2', '0 3 219 2', '0 3 220 2', '0 3 221 2', '0 3 222 2', '0 3 223 2', '0 3 224 2', '0 3 225 2', '0 3 226 2', '0 3 227 2', '0 3 228 2', '0 3 229 2', '0 3 230 2', '0 3 231 2', '0 3 234 2', '0 3 235 2', '0 3 236 2'

No pre-processing

Resampling: Bootstrapped (25 reps)

Summary of sample sizes: 3996, 3996, 3996, 3996, 3996, 3996, ...

Resampling results across tuning parameters:

model winnow trials Accuracy Kappa

rules FALSE 1 0.9925742 0.9925411

rules FALSE 10 0.9928349 0.9928030

rules FALSE 20 0.9928349 0.9928030

rules FALSE 30 0.9928349 0.9928030

rules FALSE 40 0.9928349 0.9928030

rules TRUE 1 0.9947453 0.9947219

rules TRUE 10 0.9949800 0.9949576

rules TRUE 20 0.9950061 0.9949838

rules TRUE 30 0.9949800 0.9949576

rules TRUE 40 0.9949800 0.9949576

tree FALSE 1 0.9925202 0.9924868

tree FALSE 10 0.9928070 0.9927749

tree FALSE 20 0.9928070 0.9927749

tree FALSE 30 0.9928070 0.9927749

tree FALSE 40 0.9928070 0.9927749

tree TRUE 1 0.9949997 0.9949774

tree TRUE 10 0.9952344 0.9952131

**tree TRUE 20 0.9952866 0.9952655**

tree TRUE 30 0.9952605 0.9952393

tree TRUE 40 0.9952605 0.9952393

Accuracy was used to select the optimal model using the largest value.

The final values used for the model were **trials = 20, model = tree and winnow = TRUE.**

> ResultsCBuild0<- predict(object = CBuild0, newdata = Testing)

> table(ResultsCBuild0, Testing$Positionning)

> postResample(ResultsCBuild0, Testing$Positionning)

Accuracy Kappa

**1 1**

### KNN

> set.seed(9999)

> knnBuild0 <- train(Positionning~., data = Training, method = "knn", trControl=fitControl, preProcess = c("center", "scale"), tuneLength = 10)

> knnBuild0

k-Nearest Neighbors

3996 samples

208 predictor

259 classes: '0 0 102 2', '0 0 106 2', '0 0 107 2', '0 0 110 2', '0 0 111 2', '0 0 112 2', '0 0 113 2', '0 0 114 2', '0 0 115 2', '0 0 116 2', '0 0 117 2', '0 0 118 2', '0 0 119 2', '0 0 120 2', '0 0 121 2', '0 0 122 2', '0 0 123 2', '0 0 125 2', '0 0 126 2', '0 0 127 2', '0 0 128 2', '0 0 129 2', '0 0 130 2', '0 0 131 2', '0 0 132 2', '0 0 133 2', '0 0 134 2', '0 0 201 2', '0 0 202 2', '0 0 208 2', '0 0 209 2', '0 0 211 2', '0 0 212 2', '0 0 213 2', '0 0 214 2', '0 0 215 2', '0 0 216 2', '0 0 218 2', '0 0 219 2', '0 0 220 2', '0 0 222 2', '0 0 224 2', '0 0 225 2', '0 0 226 2', '0 0 227 2', '0 0 229 2', '0 0 230 2', '0 0 231 2', '0 0 232 2', '0 0 233 2', '0 0 234 2', '0 0 235 2', '0 0 236 2', '0 0 237 2', '0 1 101 2', '0 1 102 2', '0 1 103 2', '0 1 104 2', '0 1 105 2', '0 1 106 2', '0 1 107 2', '0 1 108 2', '0 1 109 2', '0 1 110 2', '0 1 111 2', '0 1 112 2', '0 1 113 2', '0 1 114 2', '0 1 115 2', '0 1 116 2', '0 1 117 2', '0 1 118 2', '0 1 119 2', '0 1 120 2', '0 1 121 2', '0 1 122 2', '0 1 123 2', '0 1 124 2', '0 1 125 2', '0 1 126 2', '0 1 127 2', '0 1 128 2', '0 1 129 2', '0 1 130 2', '0 1 136 2', '0 1 137 2', '0 1 138 2', '0 1 201 2', '0 1 202 2', '0 1 203 2', '0 1 204 2', '0 1 205 1', '0 1 205 2', '0 1 206 2', '0 1 207 2', '0 1 208 2', '0 1 209 2', '0 1 210 2', '0 1 211 2', '0 1 212 2', '0 1 213 2', '0 1 214 2', '0 1 215 2', '0 1 216 2', '0 1 217 2', '0 1 218 2', '0 1 219 2', '0 1 220 2', '0 1 221 2', '0 1 222 2', '0 1 223 2', '0 1 224 2', '0 1 225 2', '0 1 226 2', '0 1 227 2', '0 1 228 2', '0 1 229 2', '0 1 230 2', '0 1 233 2', '0 1 234 2', '0 1 235 2', '0 2 101 2', '0 2 102 2', '0 2 103 2', '0 2 104 2', '0 2 105 2', '0 2 106 2', '0 2 107 2', '0 2 108 2', '0 2 109 2', '0 2 110 2', '0 2 111 2', '0 2 112 2', '0 2 113 2', '0 2 114 2', '0 2 115 2', '0 2 117 2', '0 2 118 2', '0 2 119 2', '0 2 120 2', '0 2 121 2', '0 2 122 2', '0 2 123 2', '0 2 124 2', '0 2 125 2', '0 2 126 2', '0 2 127 2', '0 2 128 1', '0 2 128 2', '0 2 129 2', '0 2 130 2', '0 2 132 2', '0 2 133 2', '0 2 134 2', '0 2 138 2', '0 2 139 2', '0 2 140 2', '0 2 201 2', '0 2 202 2', '0 2 203 2', '0 2 204 2', '0 2 205 2', '0 2 206 2', '0 2 207 2', '0 2 208 2', '0 2 209 2', '0 2 210 2', '0 2 211 2', '0 2 212 2', '0 2 213 2', '0 2 214 1', '0 2 214 2', '0 2 216 2', '0 2 217 2', '0 2 218 2', '0 2 219 2', '0 2 220 2', '0 2 221 2', '0 2 222 2', '0 2 223 2', '0 2 224 2', '0 2 225 2', '0 2 226 2', '0 2 227 2', '0 2 228 2', '0 2 229 2', '0 2 230 2', '0 2 231 2', '0 2 234 2', '0 2 235 2', '0 2 241 2', '0 3 101 2', '0 3 102 2', '0 3 103 2', '0 3 104 2', '0 3 105 2', '0 3 106 2', '0 3 107 2', '0 3 108 2', '0 3 109 2', '0 3 110 2', '0 3 111 2', '0 3 112 2', '0 3 113 2', '0 3 114 2', '0 3 115 2', '0 3 116 2', '0 3 117 2', '0 3 118 2', '0 3 119 2', '0 3 120 2', '0 3 121 2', '0 3 122 2', '0 3 123 2', '0 3 124 2', '0 3 125 2', '0 3 126 2', '0 3 127 2', '0 3 128 2', '0 3 129 2', '0 3 130 2', '0 3 131 2', '0 3 135 2', '0 3 136 2', '0 3 137 2', '0 3 201 2', '0 3 202 2', '0 3 203 2', '0 3 204 2', '0 3 205 2', '0 3 206 2', '0 3 207 2', '0 3 208 2', '0 3 209 2', '0 3 210 2', '0 3 211 2', '0 3 212 2', '0 3 213 2', '0 3 214 2', '0 3 215 2', '0 3 216 2', '0 3 217 2', '0 3 218 2', '0 3 219 2', '0 3 220 2', '0 3 221 2', '0 3 222 2', '0 3 223 2', '0 3 224 2', '0 3 225 2', '0 3 226 2', '0 3 227 2', '0 3 228 2', '0 3 229 2', '0 3 230 2', '0 3 231 2', '0 3 234 2', '0 3 235 2', '0 3 236 2'

Pre-processing: centered (208), scaled (208)

Resampling: Cross-Validated (10 fold, repeated 1 times)

Summary of sample sizes: 3585, 3587, 3607, 3597, 3602, 3606, ...

Resampling results across tuning parameters:

k Accuracy Kappa

**5 0.5201519 0.5181293**

7 0.4923431 0.4902144

9 0.4763440 0.4741642

11 0.4518687 0.4495970

13 0.4254563 0.4230840

15 0.3996620 0.3971992

17 0.3730306 0.3704379

19 0.3555357 0.3528728

21 0.3302781 0.3275108

23 0.3123363 0.3094891

Accuracy was used to select the optimal model using the largest value.

The final value used for the model was **k = 5**.

> ResultsknnBuild0<- predict(object = knnBuild0, newdata = Testing)

> postResample(ResultsknnBuild0, Testing$Positionning)

Accuracy Kappa

0.6789289 0.6776363

### BUILDING 1:

### RANDOM FOREST

> system.time(rfBuild1 <- train(Positionning~., data = Training1, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

user system elapsed

910.09 1.92 916.13

> rfBuild1

Random Forest

3964 samples

215 predictor

243 classes: '1 0 1 1', '1 0 1 2', '1 0 10 1', '1 0 10 2', '1 0 107 2', '1 0 108 2', '1 0 110 2', '1 0 111 2', '1 0 112 2', '1 0 113 2', '1 0 114 2', '1 0 115 2', '1 0 116 2', '1 0 117 2', '1 0 118 2', '1 0 119 2', '1 0 121 2', '1 0 122 2', '1 0 15 2', '1 0 16 2', '1 0 202 1', '1 0 202 2', '1 0 203 1', '1 0 203 2', '1 0 213 2', '1 0 216 1', '1 0 216 2', '1 0 217 1', '1 0 217 2', '1 0 218 1', '1 0 218 2', '1 0 219 1', '1 0 219 2', '1 0 220 1', '1 0 220 2', '1 0 222 1', '1 0 222 2', '1 0 224 1', '1 0 224 2', '1 0 225 1', '1 0 225 2', '1 0 226 1', '1 0 226 2', '1 0 227 1', '1 0 227 2', '1 0 228 1', '1 0 228 2', '1 0 229 1', '1 0 229 2', '1 0 230 1', '1 0 230 2', '1 0 231 1', '1 0 231 2', '1 0 235 2', '1 0 237 1', '1 0 237 2', '1 0 238 1', '1 0 238 2', '1 0 239 2', '1 0 243 2', '1 0 244 1', '1 0 244 2', '1 0 245 2', '1 0 246 2', '1 0 247 1', '1 0 247 2', '1 0 248 1', '1 0 248 2', '1 0 249 1', '1 0 249 2', '1 0 3 2', '1 0 6 2', '1 0 9 1', '1 0 9 2', '1 1 101 1', '1 1 101 2', '1 1 102 1', '1 1 102 2', '1 1 103 1', '1 1 103 2', '1 1 104 1', '1 1 104 2', '1 1 105 1', '1 1 105 2', '1 1 106 1', '1 1 106 2', '1 1 107 1', '1 1 107 2', '1 1 108 1', '1 1 108 2', '1 1 109 1', '1 1 109 2', '1 1 110 1', '1 1 110 2', '1 1 111 1', '1 1 111 2', '1 1 117 2', '1 1 12 2', '1 1 13 2', '1 1 16 1', '1 1 16 2', '1 1 17 2', '1 1 2 2', '1 1 201 2', '1 1 202 1', '1 1 202 2', '1 1 203 1', '1 1 203 2', '1 1 204 1', '1 1 204 2', '1 1 205 2', '1 1 206 2', '1 1 207 2', '1 1 208 2', '1 1 209 2', '1 1 210 2', '1 1 215 2', '1 1 25 2', '1 1 26 2', '1 1 27 2', '1 1 3 2', '1 1 30 2', '1 1 4 2', '1 1 5 2', '1 1 6 2', '1 1 7 2', '1 1 8 2', '1 2 10 1', '1 2 10 2', '1 2 101 1', '1 2 101 2', '1 2 102 1', '1 2 102 2', '1 2 103 1', '1 2 103 2', '1 2 104 1', '1 2 104 2', '1 2 105 1', '1 2 105 2', '1 2 106 1', '1 2 106 2', '1 2 107 2', '1 2 108 2', '1 2 109 2', '1 2 110 2', '1 2 111 2', '1 2 112 1', '1 2 112 2', '1 2 117 2', '1 2 15 1', '1 2 15 2', '1 2 16 1', '1 2 16 2', '1 2 17 1', '1 2 17 2', '1 2 18 1', '1 2 18 2', '1 2 2 1', '1 2 2 2', '1 2 201 1', '1 2 201 2', '1 2 202 1', '1 2 202 2', '1 2 203 1', '1 2 203 2', '1 2 204 1', '1 2 204 2', '1 2 205 2', '1 2 206 1', '1 2 206 2', '1 2 207 2', '1 2 208 2', '1 2 209 2', '1 2 210 2', '1 2 211 2', '1 2 212 1', '1 2 212 2', '1 2 216 2', '1 2 217 1', '1 2 217 2', '1 2 22 2', '1 2 26 2', '1 2 27 2', '1 2 28 1', '1 2 28 2', '1 2 29 1', '1 2 29 2', '1 2 3 1', '1 2 3 2', '1 2 4 1', '1 2 4 2', '1 2 5 1', '1 2 5 2', '1 2 6 1', '1 2 6 2', '1 2 7 1', '1 2 7 2', '1 2 8 1', '1 2 8 2', '1 2 9 1', '1 2 9 2', '1 3 1 2', '1 3 101 1', '1 3 101 2', '1 3 102 1', '1 3 102 2', '1 3 103 1', '1 3 103 2', '1 3 104 1', '1 3 104 2', '1 3 105 2', '1 3 106 2', '1 3 107 2', '1 3 108 2', '1 3 11 2', '1 3 112 2', '1 3 113 1', '1 3 113 2', '1 3 116 1', '1 3 116 2', '1 3 12 2', '1 3 13 2', '1 3 14 2', '1 3 2 2', '1 3 201 1', '1 3 201 2', '1 3 202 1', '1 3 202 2', '1 3 203 2', '1 3 204 2', '1 3 205 2', '1 3 206 2', '1 3 214 2', '1 3 216 2', '1 3 217 2', '1 3 3 1', '1 3 3 2', '1 3 4 1', '1 3 4 2', '1 3 5 1', '1 3 5 2', '1 3 6 1', '1 3 6 2'

No pre-processing

Resampling: Cross-Validated (10 fold, repeated 1 times)

Summary of sample sizes: 3575, 3580, 3570, 3572, 3563, 3573, ...

Resampling results across tuning parameters:

mtry Accuracy Kappa

1 0.08351966 0.06882733

2 0.27568117 0.26761464

3 0.46273375 0.45785883

4 0.65955150 0.65695712

**5 0.77930197 0.77776638**

Accuracy was used to select the optimal model using the largest value.

The final value used for the model was **mtry = 5**.

> ResultsrfBuild1<- predict(object = rfBuild1, newdata = Testing1)

> postResample(ResultsrfBuild1, Testing1$Positionning)

Accuracy Kappa

0.8592331 0.8583158

### C5.0

> CBuild1<- train(Positionning ~ ., data = Training1, method = "C5.0", trcontrol=fitControl)

> CBuild1

C5.0

3964 samples

215 predictor

243 classes: '1 0 1 1', '1 0 1 2', '1 0 10 1', '1 0 10 2', '1 0 107 2', '1 0 108 2', '1 0 110 2', '1 0 111 2', '1 0 112 2', '1 0 113 2', '1 0 114 2', '1 0 115 2', '1 0 116 2', '1 0 117 2', '1 0 118 2', '1 0 119 2', '1 0 121 2', '1 0 122 2', '1 0 15 2', '1 0 16 2', '1 0 202 1', '1 0 202 2', '1 0 203 1', '1 0 203 2', '1 0 213 2', '1 0 216 1', '1 0 216 2', '1 0 217 1', '1 0 217 2', '1 0 218 1', '1 0 218 2', '1 0 219 1', '1 0 219 2', '1 0 220 1', '1 0 220 2', '1 0 222 1', '1 0 222 2', '1 0 224 1', '1 0 224 2', '1 0 225 1', '1 0 225 2', '1 0 226 1', '1 0 226 2', '1 0 227 1', '1 0 227 2', '1 0 228 1', '1 0 228 2', '1 0 229 1', '1 0 229 2', '1 0 230 1', '1 0 230 2', '1 0 231 1', '1 0 231 2', '1 0 235 2', '1 0 237 1', '1 0 237 2', '1 0 238 1', '1 0 238 2', '1 0 239 2', '1 0 243 2', '1 0 244 1', '1 0 244 2', '1 0 245 2', '1 0 246 2', '1 0 247 1', '1 0 247 2', '1 0 248 1', '1 0 248 2', '1 0 249 1', '1 0 249 2', '1 0 3 2', '1 0 6 2', '1 0 9 1', '1 0 9 2', '1 1 101 1', '1 1 101 2', '1 1 102 1', '1 1 102 2', '1 1 103 1', '1 1 103 2', '1 1 104 1', '1 1 104 2', '1 1 105 1', '1 1 105 2', '1 1 106 1', '1 1 106 2', '1 1 107 1', '1 1 107 2', '1 1 108 1', '1 1 108 2', '1 1 109 1', '1 1 109 2', '1 1 110 1', '1 1 110 2', '1 1 111 1', '1 1 111 2', '1 1 117 2', '1 1 12 2', '1 1 13 2', '1 1 16 1', '1 1 16 2', '1 1 17 2', '1 1 2 2', '1 1 201 2', '1 1 202 1', '1 1 202 2', '1 1 203 1', '1 1 203 2', '1 1 204 1', '1 1 204 2', '1 1 205 2', '1 1 206 2', '1 1 207 2', '1 1 208 2', '1 1 209 2', '1 1 210 2', '1 1 215 2', '1 1 25 2', '1 1 26 2', '1 1 27 2', '1 1 3 2', '1 1 30 2', '1 1 4 2', '1 1 5 2', '1 1 6 2', '1 1 7 2', '1 1 8 2', '1 2 10 1', '1 2 10 2', '1 2 101 1', '1 2 101 2', '1 2 102 1', '1 2 102 2', '1 2 103 1', '1 2 103 2', '1 2 104 1', '1 2 104 2', '1 2 105 1', '1 2 105 2', '1 2 106 1', '1 2 106 2', '1 2 107 2', '1 2 108 2', '1 2 109 2', '1 2 110 2', '1 2 111 2', '1 2 112 1', '1 2 112 2', '1 2 117 2', '1 2 15 1', '1 2 15 2', '1 2 16 1', '1 2 16 2', '1 2 17 1', '1 2 17 2', '1 2 18 1', '1 2 18 2', '1 2 2 1', '1 2 2 2', '1 2 201 1', '1 2 201 2', '1 2 202 1', '1 2 202 2', '1 2 203 1', '1 2 203 2', '1 2 204 1', '1 2 204 2', '1 2 205 2', '1 2 206 1', '1 2 206 2', '1 2 207 2', '1 2 208 2', '1 2 209 2', '1 2 210 2', '1 2 211 2', '1 2 212 1', '1 2 212 2', '1 2 216 2', '1 2 217 1', '1 2 217 2', '1 2 22 2', '1 2 26 2', '1 2 27 2', '1 2 28 1', '1 2 28 2', '1 2 29 1', '1 2 29 2', '1 2 3 1', '1 2 3 2', '1 2 4 1', '1 2 4 2', '1 2 5 1', '1 2 5 2', '1 2 6 1', '1 2 6 2', '1 2 7 1', '1 2 7 2', '1 2 8 1', '1 2 8 2', '1 2 9 1', '1 2 9 2', '1 3 1 2', '1 3 101 1', '1 3 101 2', '1 3 102 1', '1 3 102 2', '1 3 103 1', '1 3 103 2', '1 3 104 1', '1 3 104 2', '1 3 105 2', '1 3 106 2', '1 3 107 2', '1 3 108 2', '1 3 11 2', '1 3 112 2', '1 3 113 1', '1 3 113 2', '1 3 116 1', '1 3 116 2', '1 3 12 2', '1 3 13 2', '1 3 14 2', '1 3 2 2', '1 3 201 1', '1 3 201 2', '1 3 202 1', '1 3 202 2', '1 3 203 2', '1 3 204 2', '1 3 205 2', '1 3 206 2', '1 3 214 2', '1 3 216 2', '1 3 217 2', '1 3 3 1', '1 3 3 2', '1 3 4 1', '1 3 4 2', '1 3 5 1', '1 3 5 2', '1 3 6 1', '1 3 6 2'

No pre-processing

Resampling: Bootstrapped (25 reps)

Summary of sample sizes: 3964, 3964, 3964, 3964, 3964, 3964, ...

Resampling results across tuning parameters:

model winnow trials Accuracy Kappa

rules FALSE 1 0.9736855 0.9735224

rules FALSE 10 0.9758197 0.9756699

rules FALSE 20 0.9769445 0.9768017

rules TRUE 1 0.9769144 0.9767713

rules TRUE 10 0.9796134 0.9794871

rules TRUE 20 0.9804109 0.9802895

tree FALSE 1 0.9734965 0.9733326

tree FALSE 10 0.9755764 0.9754253

tree FALSE 20 0.9755451 0.9753938

tree TRUE 1 0.9772684 0.9771277

tree TRUE 10 0.9796321 0.9795061

**tree TRUE 20 0.9806255 0.9805056**

Accuracy was used to select the optimal model using the largest value.

The final values used for the model were **trials = 20, model = tree and winnow = TRUE**.

> ResultsCBuild1<- predict(object = CBuild1, newdata = Testing1)

> postResample(ResultsCBuild1, Testing1$Positionning)

Accuracy Kappa

1 1

### KNN

> knnBuild1 <- train(Positionning~., data = Training1, method = "knn", trControl=fitControl, preProcess = c("center", "scale"), tuneLength = 10)

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

Warning in preProcess.default(thresh = 0.95, k = 5, freqCut = 19, uniqueCut = 10, :

These variables have zero variances: WAP050, WAP322, WAP343, WAP407

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>

> knnBuild1

k-Nearest Neighbors

3964 samples

215 predictor

243 classes: '1 0 1 1', '1 0 1 2', '1 0 10 1', '1 0 10 2', '1 0 107 2', '1 0 108 2', '1 0 110 2', '1 0 111 2', '1 0 112 2', '1 0 113 2', '1 0 114 2', '1 0 115 2', '1 0 116 2', '1 0 117 2', '1 0 118 2', '1 0 119 2', '1 0 121 2', '1 0 122 2', '1 0 15 2', '1 0 16 2', '1 0 202 1', '1 0 202 2', '1 0 203 1', '1 0 203 2', '1 0 213 2', '1 0 216 1', '1 0 216 2', '1 0 217 1', '1 0 217 2', '1 0 218 1', '1 0 218 2', '1 0 219 1', '1 0 219 2', '1 0 220 1', '1 0 220 2', '1 0 222 1', '1 0 222 2', '1 0 224 1', '1 0 224 2', '1 0 225 1', '1 0 225 2', '1 0 226 1', '1 0 226 2', '1 0 227 1', '1 0 227 2', '1 0 228 1', '1 0 228 2', '1 0 229 1', '1 0 229 2', '1 0 230 1', '1 0 230 2', '1 0 231 1', '1 0 231 2', '1 0 235 2', '1 0 237 1', '1 0 237 2', '1 0 238 1', '1 0 238 2', '1 0 239 2', '1 0 243 2', '1 0 244 1', '1 0 244 2', '1 0 245 2', '1 0 246 2', '1 0 247 1', '1 0 247 2', '1 0 248 1', '1 0 248 2', '1 0 249 1', '1 0 249 2', '1 0 3 2', '1 0 6 2', '1 0 9 1', '1 0 9 2', '1 1 101 1', '1 1 101 2', '1 1 102 1', '1 1 102 2', '1 1 103 1', '1 1 103 2', '1 1 104 1', '1 1 104 2', '1 1 105 1', '1 1 105 2', '1 1 106 1', '1 1 106 2', '1 1 107 1', '1 1 107 2', '1 1 108 1', '1 1 108 2', '1 1 109 1', '1 1 109 2', '1 1 110 1', '1 1 110 2', '1 1 111 1', '1 1 111 2', '1 1 117 2', '1 1 12 2', '1 1 13 2', '1 1 16 1', '1 1 16 2', '1 1 17 2', '1 1 2 2', '1 1 201 2', '1 1 202 1', '1 1 202 2', '1 1 203 1', '1 1 203 2', '1 1 204 1', '1 1 204 2', '1 1 205 2', '1 1 206 2', '1 1 207 2', '1 1 208 2', '1 1 209 2', '1 1 210 2', '1 1 215 2', '1 1 25 2', '1 1 26 2', '1 1 27 2', '1 1 3 2', '1 1 30 2', '1 1 4 2', '1 1 5 2', '1 1 6 2', '1 1 7 2', '1 1 8 2', '1 2 10 1', '1 2 10 2', '1 2 101 1', '1 2 101 2', '1 2 102 1', '1 2 102 2', '1 2 103 1', '1 2 103 2', '1 2 104 1', '1 2 104 2', '1 2 105 1', '1 2 105 2', '1 2 106 1', '1 2 106 2', '1 2 107 2', '1 2 108 2', '1 2 109 2', '1 2 110 2', '1 2 111 2', '1 2 112 1', '1 2 112 2', '1 2 117 2', '1 2 15 1', '1 2 15 2', '1 2 16 1', '1 2 16 2', '1 2 17 1', '1 2 17 2', '1 2 18 1', '1 2 18 2', '1 2 2 1', '1 2 2 2', '1 2 201 1', '1 2 201 2', '1 2 202 1', '1 2 202 2', '1 2 203 1', '1 2 203 2', '1 2 204 1', '1 2 204 2', '1 2 205 2', '1 2 206 1', '1 2 206 2', '1 2 207 2', '1 2 208 2', '1 2 209 2', '1 2 210 2', '1 2 211 2', '1 2 212 1', '1 2 212 2', '1 2 216 2', '1 2 217 1', '1 2 217 2', '1 2 22 2', '1 2 26 2', '1 2 27 2', '1 2 28 1', '1 2 28 2', '1 2 29 1', '1 2 29 2', '1 2 3 1', '1 2 3 2', '1 2 4 1', '1 2 4 2', '1 2 5 1', '1 2 5 2', '1 2 6 1', '1 2 6 2', '1 2 7 1', '1 2 7 2', '1 2 8 1', '1 2 8 2', '1 2 9 1', '1 2 9 2', '1 3 1 2', '1 3 101 1', '1 3 101 2', '1 3 102 1', '1 3 102 2', '1 3 103 1', '1 3 103 2', '1 3 104 1', '1 3 104 2', '1 3 105 2', '1 3 106 2', '1 3 107 2', '1 3 108 2', '1 3 11 2', '1 3 112 2', '1 3 113 1', '1 3 113 2', '1 3 116 1', '1 3 116 2', '1 3 12 2', '1 3 13 2', '1 3 14 2', '1 3 2 2', '1 3 201 1', '1 3 201 2', '1 3 202 1', '1 3 202 2', '1 3 203 2', '1 3 204 2', '1 3 205 2', '1 3 206 2', '1 3 214 2', '1 3 216 2', '1 3 217 2', '1 3 3 1', '1 3 3 2', '1 3 4 1', '1 3 4 2', '1 3 5 1', '1 3 5 2', '1 3 6 1', '1 3 6 2'

Pre-processing: centered (215), scaled (215)

Resampling: Cross-Validated (10 fold, repeated 1 times)

Summary of sample sizes: 3576, 3567, 3567, 3556, 3570, 3572, ...

Resampling results across tuning parameters:

k Accuracy Kappa

**5 0.6960561 0.6942148**

7 0.6650612 0.6630236

9 0.6337950 0.6315640

11 0.6068192 0.6044022

13 0.5826196 0.5800335

15 0.5508381 0.5480472

17 0.5309709 0.5280178

19 0.5195796 0.5165465

21 0.5093879 0.5062749

23 0.5008000 0.4975993

Accuracy was used to select the optimal model using the largest value.

The final value used for the model was **k = 5**.

> ResultsknnBuild1<- predict(object = knnBuild1, newdata = Testing1)

> postResample(ResultsknnBuild1, Testing1$Positionning)

Accuracy Kappa

0.8024723 0.8013157

### BUILDING 2

*Same codes apply on Subset “B2data”.*

### RANDOM FOREST

> system.time(rfBuild2 <- train(Positionning~., data = Training2, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

> rfBuild2

### C5.0

> CBuild2<- train(Positionning ~ ., data = Training2, method = "C5.0", trcontrol=fitControl)

> CBuild2

### KNN

> knnBuild2 <- train(Positionning~., data = Training2, method = "knn", trControl=fitControl, preProcess = c("center", "scale"), tuneLength = 10)

> knnBuild2

# COMPARING MODELS

Comparison of the models produced for classification algorithms Random Forest, C5.0 and KNN with the two performance metrics (Kappa and Accuracy) for each model built:

**BUILDING 0:**

> resamp0 <- resamples(list(C5.0 = CBuild0, knn=knnBuild0, rf=rfBuild0))

Error in resamples.default(list(C5.0 = CBuild0, knn = knnBuild0, rf = rfBuild0)) :

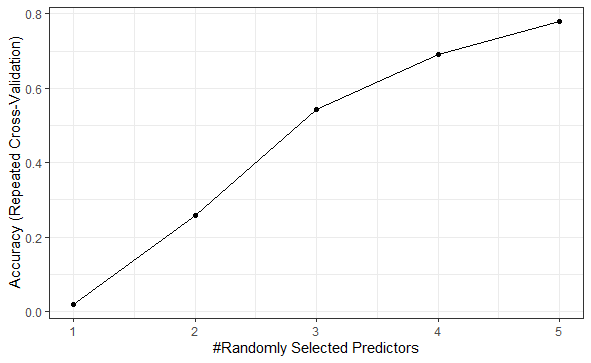
There are different numbers of resamples in each model

> postResample(ResultsrfBuild0, Testing$Positionning)

Accuracy Kappa

0.9629630 0.9628113

> ggplot(rfBuild0) + theme\_bw()

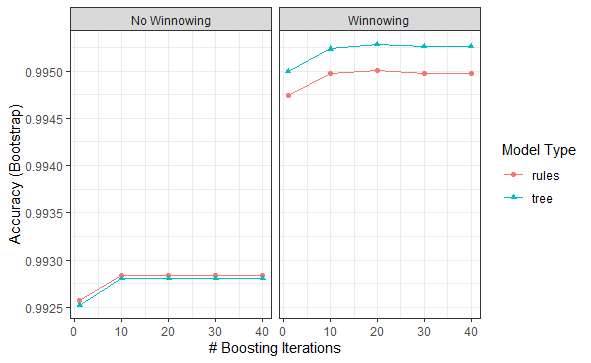


> postResample(ResultsCBuild0, Testing$Positionning)

Accuracy Kappa

**1 1**

> ggplot(CBuild0) + theme\_bw()

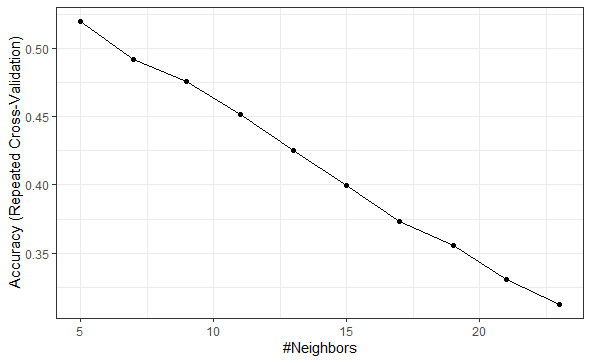


> postResample(ResultsknnBuild0, Testing$Positionning)

Accuracy Kappa

0.6789289 0.6776363

> ggplot(knnBuild0) + theme\_bw()



**BUILDING 1:**

> postResample(ResultsrfBuild1, Testing1$Positionning)

Accuracy Kappa

0.8592331 0.8583158

> postResample(ResultsCBuild1, Testing1$Positionning)

Accuracy Kappa

**1 1**

> postResample(ResultsknnBuild1, Testing1$Positionning)

Accuracy Kappa

0.8024723 0.8013157

**BUILDING 2:**

*Same codes apply on Subset “B2data”.*

# SELECTED MODEL

The algorithm that I believe to be best for this data is the **C5.0 model** as it shows on my performance metrics the Accuracy and Kappa came up with a value of 1, second alternative would be using Random Forest as it showed good results for both accuracy and kappa values.

# RECOMMENDATIONS

There are a large variety of techniques and devices that are used to provide indoor positioning ranging from reconfigured devices already deployed such as smartphones, WiFi same as our data but also Bluetooth antennas, digital cameras, and clocks… all these techniques can be other alternatives to indicate a person's current location..

Also Indoor positioning systems use different technologies, not only distance measurement to nearby anchor nodes (nodes with known fixed positions, e.g. WiFi / LiFi access points or Bluetooth beacons), but also magnetic positioning and dead reckoning. They either actively locate mobile devices and tags or provide ambient location or environmental context for devices to get sensed.

The localized nature of an IPS has resulted in design fragmentation, with systems making use of various optical, radio, or even acoustic technologies.

With that being said Detecting the device's orientation (often referred to as the compass direction in order to disambiguate it from smartphone vertical orientation) can be achieved either by detecting landmarks inside images taken in real time, or by using trilateration with beacons. There also exist technologies for detecting magnetometric information inside buildings or locations with steel structures or in iron ore mines.

# APPENDIX

library(readr)

trainingData <- read\_csv("~/UT Data Analytics Course/Course 3/Task 3 Wifi Locationing/UJIndoorLoc/UJIndoorLoc/trainingData.csv")

View(trainingData)

trainingData <-cbind(trainingData,paste(trainingData$BUILDINGID,trainingData$FLOOR, trainingData$SPACEID, trainingData$RELATIVEPOSITION), stringsAsFactors=TRUE)

colnames(trainingData)[530] <-"Positionning"

trainingData <- trainingData[,c(ncol(trainingData), 1:(ncol(trainingData)-1))]

head(trainingData)

B0data <- subset(trainingData, BUILDINGID == 0)

B1data <- subset(trainingData, BUILDINGID == 1)

B2data <- subset(trainingData, BUILDINGID == 2)

View(B0data)

View(B1data)

View(B2data)

install.packages("caret", dependencies = c("Depends", "Suggests"))

library(caret)

summary(trainingData)

str(trainingData)

str(B1data)

Set.seed(998)

Intraining<- createDataPartition(B0data$Positionning, p=.75, list=FALSE)

View(Intraining)

Intraining1<- createDataPartition(B1data$Positionning, p=.75, list=FALSE)

Intraining2<- createDataPartition(B2data$Positionning, p=.75, list=FALSE)

Training <- B0data[intraining,]

Training1 <- B1data[Intraining1,]

Training2 <- B2data[Intraining2,]

Testing <- B0data[Intraining,]

Testing1 <- B1data[Intraining1,]

Testing2 <- B2data[Intraining2,]

Fitcontrol<- traincontrol(method=”repeatdcv” , number = 10, repeats = 1)

install.packages("traincontrol")

library(traincontrol)

Fitcontrol<- traincontrol(method='repeatdcv', number = 10, repeats = 1)

**#Random Forest Building 0**

rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneLength = 1)

tuneLength = 1)

rfGrid<- expand.grid(mtry=c(1,2,3,4,5))

system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

Error: One or more factor levels in the outcome has no data: '1 0 1 1', '1 0 1 2', '1 0 10 1', '1 0 10 2', '1 0 107 2', '1 0 108 2', '1 0 110 2', '1 0 111 2', '1 0 112 2', '1 0 113 2', '1 0 114 2', '1 0 115 2', '1 0 116 2', '1 0 117 2', '1 0 118 2', '1 0 119 2', '1 0 121 2', '1 0 122 2', '1 0 15 2', '1 0 16 2', '1 0 202 1', '1 0 202 2', '1 0 203 1', '1 0 203 2', '1 0 213 2', '1 0 216 1', '1 0 216 2', '1 0 217 1', '1 0 217 2', '1 0 218 1', '1 0 218 2', '1 0 219 1', '1 0 219 2', '1 0 220 1', '1 0 220 2', '1 0 222 1', '1 0 222 2', '1 0 224 1', '1 0 224 2', '1 0 225 1', '1 0 225 2', '1 0 226 1', '1 0 226 2', '1 0 227 1', '1 0 227 2', '1 0 228 1', '1 0 228 2', '1 0 229 1', '1 0 229 2', '1 0 230 1', '1 0 230 2', '1 0 231 1', '1 0 231 2', '1 0 235 2', '1 0 237 1', '1 0 237 2', '1 0 238 1', '1 0 238 2', '1 0 239 2', '1 0 243 2', '1 0 244 1', '1 0 244 2', '1 0 245 2', '1 0 246 2', '1 0 247 1', '1 0 247 2', '1 0 248 1', '1 0 248 2', '1 0 249 1', '1 0 249 2', '1 0 3 2', '1 0 6 2', '1 0 9 1', '1

Timing stopped at: 0.3 0 0.33

B0data$Positionning <- factor(B0data$Positionning)

system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

**#Refactor attribute Positionning for the other subsets**

B1data$Positionning <- factor(B1data$Positionning)

str(B1data)

B2data$Positionning <- factor(B2data$Positionning)

str(B2data)

**#Near Zero Variences**

library(caret)

library(gdata)

set.seed(998)

apply(B0data, 2, var)

variances<-apply(GermanCredit, 2, var)

variances<-apply(B0data, 2, var)

variances

variances[which(variances<=0.0025)]

names(GermanCredit)[nearZeroVar(B0data)]

names(B0data)[nearZeroVar(B0data)]

B0data <- B0data[, -nearZeroVar(B0data)]

B1data <- B1data[, -nearZeroVar(B1data)]

B2data <- B2data[, -nearZeroVar(B2data)]

system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

Intraining<- createDataPartition(B0data$Positionning, p=.75, list=FALSE)

B0data$Positionning

Training

str(Training)

Training <- Training[, -nearZeroVar(Training)]

system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

str(Training)

Training$Positionning <- factor(Training$Positionning)

str(Training)

system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

rfBuild0

**#C5.0 Building 0**

CBuild0<- train(Positionning ~ ., data = Training, method = "C5.0", trcontrol=fitControl)

install.packages(C50)

library(C50)

install.packages("inum")

library(inum)

CBuild0<- train(Positionning ~ ., data = Training, method = "C5.0", trcontrol=fitControl)

warning()

warning(CBuild0)

CBuild0<- train(Positionning ~ ., data = Training, method = "C5.0", trcontrol=fitControltuneLength = 3)

CBuild0

CBuild0<- train(Positionning ~ ., data = Training, method = "C5.0", trcontrol=fitControl)

CBuild0

set.seed(999)

**#KNN Building 0**

knnBuild0 <- train(Positionning~., data = Training, method = "knn", trControl=fitControl, preProcess = c("center", "scale"), tuneLength = 10)

knnBuild0

Training1$Positionning <- factor(Training1$Positionning)

View(Training1)

Training1$Positionning <- factor(Training1$Positionning)

Training2$Positionning <- factor(Training2$Positionning)

str(Training1)

str(Training2)

Training1 <- Training1[, -nearZeroVar(Training1)]

Training2 <- Training2[, -nearZeroVar(Training2)]

**#Random Forest Building 1**

> system.time(rfBuild1 <- train(Positionning~., data = Training1, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

> system.time(rfBuild1 <- train(Positionning~., data = Training1, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

system.time(rfBuild1 <- train(Positionning~., data = Training1, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

rfBuild1

View(Training)

View(B2data)

View(B1data)

View(B0data)

View(B0data)

B0data <- subset(trainingData, BUILDINGID == 0)

library(caret)

library(gdata)

library(inum)

library(C50)

nzr <- nearZeroVar(B0data, saveMetrics = TRUE)

nzr

summary(nzr)

zerovardata <- which(nzr$zeroVar == T)

zerovardata

B0data <- B0data[, -(zerovardata)]

nzr1 <- nearZeroVar(B1data, saveMetrics = TRUE)

B1data <- subset(trainingData, BUILDINGID == 1)

B2data <- subset(trainingData, BUILDINGID == 2)

**#NearZeroVariance Training and Testing**

nzr1 <- nearZeroVar(B1data, saveMetrics = TRUE)

nzr2 <- nearZeroVar(B2data, saveMetrics = TRUE)

zerovardata1 <- which(nzr1$zeroVar == T)

zerovardata2 <- which(nzr2$zeroVar == T)

B1data <- B1data[, -(zerovardata1)]

B2data <- B2data[, -(zerovardata2)]

Intraining<- createDataPartition(B0data$Positionning, p=.75, list=FALSE)

Intraining1<- createDataPartition(B1data$Positionning, p=.75, list=FALSE)

Intraining2<- createDataPartition(B2data$Positionning, p=.75, list=FALSE)

Training <- B0data[intraining,]

View(Training)

View(Intraining)

View(Intraining)

View(Intraining2)

Training <- B0data[intraining,]

Training <- B0data[Intraining,]

Training1 <- B1data[Intraining1,]

Training2 <- B2data[Intraining2,]

Testing <- B0data[Intraining,]

Testing1 <- B1data[Intraining1,]

Testing2 <- B2data[Intraining2,]

**#Random Forest Building 1**

system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

str(Training)

Training$Positionning <- factor(Training$Positionning)

str(Training)

**#C5.0 Building 1**

system.time(rfBuild0 <- train(Positionning~., data = Training, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

rfBuild0

> CBuild0<- train(Positionning ~ ., data = Training, method = "C5.0", trcontrol=fitControl, tuneLength = 3)

CBuild0<- train(Positionning ~ ., data = Training, method = "C5.0", trcontrol=fitControl, tuneLength = 5)

Fitcontrol<- traincontrol(method='repeatdcv', number = 10, repeats = 1)

install.packages("traincontrol")

fitControl <- trainControl(method = "repeatedcv", number = 10, repeats = 1)

View(fitControl)

CBuild0

**#KNN Building 1**

set.seed(9999)

knnBuild0 <- train(Positionning~., data = Training, method = "knn", trControl=fitControl, preProcess = c("center", "scale"), tuneLength = 10)

knnBuild0

Training1$Positionning <- factor(Training1$Positionning)

Training2$Positionning <- factor(Training2$Positionning)

system.time(rfBuild1 <- train(Positionning~., data = Training1, method = "rf", trControl=fitControl, tuneGrid=rfGrid))

rfBuild1

CBuild1<- train(Positionning ~ ., data = Training1, method = "C5.0", trcontrol=fitControl)

CBuild1

knnBuild1 <- train(Positionning~., data = Training1, method = "knn", trControl=fitControl, preProcess = c("center", "scale"), tuneLength = 10)

knnBuild1

**#Predictions Building 0**

**#Random Forest**

>ResultsrfBuild0<- predict(object = rfBuild0, newdata = Testing)

ResultsrfBuild0<- predict(object = rfBuild0, newdata = Testing)

table(ResultsrfBuild0, Testing$Positionning)

ResultsrfBuild0

postResample(ResultsrfBuild0, Testing$Positionning)

**#C5.0**

ResultsCBuild0<- predict(object = CBuild0, newdata = Testing)

table(ResultsCBuild0, Testing$Positionning)

postResample(ResultsCBuild0, Testing$Positionning)

**#KNN**

ResultsknnBuild0<- predict(object = knnBuild0, newdata = Testing)

postResample(ResultsknnBuild0, Testing$Positionning)

ResultsrfBuild1<- predict(object = rfBuild1, newdata = Testing1)

**#Comparaison of all models**

postResample(ResultsrfBuild1, Testing1$Positionning)

ResultsCBuild1<- predict(object = CBuild1, newdata = Testing1)

postResample(ResultsCBuild1, Testing1$Positionning)

ResultsknnBuild1<- predict(object = knnBuild1, newdata = Testing1)

postResample(ResultsknnBuild1, Testing1$Positionning)

ModelData <- resamples(list(RF = rfBuild0, KNN = knnBuild0, C50 = CBuild0))

ModelData <- resamples(list(RF = rfBuild0, KNN = knnBuild0, C50 = CBuild0))

ModelData <- resamples(list(radom = rfBuild0, knn = knnBuild0, C50 = CBuild0))

ModelData <- resamples(list(rf = rfBuild0, knn = knnBuild0, C50 = CBuild0))

ModelData <- resamples(list(rf = rfBuild0, knn = knnBuild0, c50 = CBuild0))

set.seed(9978)

ModelData <- resamples(list(rf = rfBuild0, knn = knnBuild0, c50 = CBuild0))

ModelBuild0 <- resamples(list(C50 = CBuild0, knn=knnBuild0, rf=rfBuild0))

library(caret)

ModelBuild0 <- resamples(list(C50 = CBuild0, knn=knnBuild0, rf=rfBuild0))

resamp0 <- resamples(list(C50 = CBuild0, knn=knnBuild0, rf=rfBuild0))

library(mlbench)

resamp0 <- resamples(list(C50 = CBuild0, knn=knnBuild0, rf=rfBuild0))

library(sessioninfo)

library(dplyr)

resamp0 <- resamples(list(C50 = CBuild0, knn=knnBuild0, rf=rfBuild0))

sessionInfo()

library(caret)

resamp0 <- resamples(list(C5.0 = CBuild0, knn=knnBuild0, rf=rfBuild0))

library(caret)

ModelBuild0 <- resamples(list(C50 = CBuild0, knn=knnBuild0, rf=rfBuild0))

library(caret)

resamp0 <- resamples(list(C5.0 = CBuild0, knn=knnBuild0, rf=rfBuild0))

ResultsrfBuild0<- predict(object = rfBuild0, newdata = Testing)

table(ResultsrfBuild0, Testing$Positionning)

postResample(ResultsCBuild0, Testing$Positionning)

postResample(ResultrfCBuild0, Testing$Positionning)

postResample(ResultsrfBuild0, Testing$Positionning)

Training

**#Visualization Accuracy**

library(caret)

plot(ResultsCBuild0)

library(caret)

ggplot(ResultsCBuild0)

set.seed(998)

plot(fitControl)

plot(rfBuild0, plotType = "scatter", metric = x$metric[1],

digits = getOption("digits") - 3, xTrans = NULL,

nameInStrip = FALSE, ...)

plot(rfBuild0, plotType = "scatter", metric = x$metric[1],

digits = getOption("digits") - 3, xTrans = NULL,

nameInStrip = FALSE)

summary(ResultsCBuild0)

plot(ResultsCBuild0)

modelvalues<-data.frame(obs = B0data$Positionning, pred=ResultsrfBuild0)

plot(Testing,ResultsrfBuild0)

plot(Testing$Positionning,ResultsrfBuild0)

modelvalues<-data.frame(obs = Testing$Positionning, pred=ResultsrfBuild0)

defaultSummary(modelvalues)

plot(modelvalues)

plot()

plot(modelvalues)

plot(Intraining$Positionning,ResultsCBuild0)

plot(intraining$Positionning,ResultsCBuild0)

plot(Training$Positionning,ResultsCBuild0)

plot(Training$Positionning,residuals)

residuals<-resid(rfBuild0)

plot(rfBuild0, plotType = "level")

ggplot(rdaFit) + theme\_bw()

ggplot(rfBuild0) + theme\_bw()

ggplot(CBuild0) + theme\_bw()

ggplot(knnBuild0) + theme\_bw()