

Bosch Data Analysis

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Bosch Production Line Performance - Dataset Analysis

Read the dataset

```
library(data.table)

system.time(train <- fread("../dataset/train_numeric.csv", header = TRUE))
```

```
##
Read 0.0% of 1183747 rows
Read 1.7% of 1183747 rows
Read 3.4% of 1183747 rows
Read 5.1% of 1183747 rows
Read 6.8% of 1183747 rows
Read 8.4% of 1183747 rows
Read 10.1% of 1183747 rows
Read 11.8% of 1183747 rows
Read 13.5% of 1183747 rows
Read 15.2% of 1183747 rows
Read 16.9% of 1183747 rows
Read 18.6% of 1183747 rows
Read 20.3% of 1183747 rows
Read 22.0% of 1183747 rows
Read 23.7% of 1183747 rows
Read 25.3% of 1183747 rows
Read 27.0% of 1183747 rows
Read 28.7% of 1183747 rows
Read 30.4% of 1183747 rows
Read 32.1% of 1183747 rows
Read 33.8% of 1183747 rows
Read 35.5% of 1183747 rows
Read 37.2% of 1183747 rows
Read 38.9% of 1183747 rows
Read 40.5% of 1183747 rows
Read 42.2% of 1183747 rows
Read 43.9% of 1183747 rows
Read 45.6% of 1183747 rows
Read 47.3% of 1183747 rows
Read 49.0% of 1183747 rows
Read 50.7% of 1183747 rows
Read 52.4% of 1183747 rows
Read 54.1% of 1183747 rows
Read 55.8% of 1183747 rows
Read 57.4% of 1183747 rows
Read 59.1% of 1183747 rows
```

```

Read 60.8% of 1183747 rows
Read 62.5% of 1183747 rows
Read 64.2% of 1183747 rows
Read 65.9% of 1183747 rows
Read 67.6% of 1183747 rows
Read 69.3% of 1183747 rows
Read 71.0% of 1183747 rows
Read 72.7% of 1183747 rows
Read 74.3% of 1183747 rows
Read 76.0% of 1183747 rows
Read 77.7% of 1183747 rows
Read 79.4% of 1183747 rows
Read 81.1% of 1183747 rows
Read 82.8% of 1183747 rows
Read 84.5% of 1183747 rows
Read 86.2% of 1183747 rows
Read 87.9% of 1183747 rows
Read 89.5% of 1183747 rows
Read 91.2% of 1183747 rows
Read 92.9% of 1183747 rows
Read 94.6% of 1183747 rows
Read 96.3% of 1183747 rows
Read 98.0% of 1183747 rows
Read 99.7% of 1183747 rows
Read 1183747 rows and 970 (of 970) columns from 1.993 GB file in 00:01:12

```

```

##      user  system elapsed
## 69.488   2.216  85.846

```

```

system.time(train_date <- fread("../dataset/train_date.csv", header = TRUE, nrow = 2000))

```

```

##      user  system elapsed
##   1.084   0.136  20.391

```

```

system.time(train_cat <- fread("../dataset/train_categorical.csv", header = TRUE) )

```

```

##
Read 0.0% of 1183747 rows

```

```

## Warning in fread("../dataset/train_categorical.csv", header = TRUE): Bumped
## column 808 to type character on data row 8, field contains 'T3'. Coercing
## previously read values in this column from logical, integer or numeric back
## to character which may not be lossless; e.g., if '00' and '000' occurred
## before they will now be just '0', and there may be inconsistencies with
## treatment of ',', 'NA,' too (if they occurred in this column before
## the bump). If this matters please rerun and set 'colClasses' to 'character'
## for this column. Please note that column type detection uses the first
## 5 rows, the middle 5 rows and the last 5 rows, so hopefully this message
## should be very rare. If reporting to datatable-help, please rerun and
## include the output from verbose=TRUE.

```

```

## Warning in fread("../dataset/train_categorical.csv", header = TRUE): Bumped

```

```
## be inconsistencies with treatment of '.,' and ',NA,' too (if they occurred
## in this column before the bump). If this matters please rerun and set
## 'colClasses' to 'character' for this column. Please note that column type
## detection uses the first 5 rows, the middle 5 rows and the last 5 rows, so
## hopefully this message should be very rare. If reporting to datatable-help,
## please rerun and include the output from verbose=TRUE.
```

```
## Warning in fread("../dataset/test_categorical.csv", header = TRUE, nrows
## = 2000): Bumped column 1379 to type character on data row 647, field
## contains 'T1'. Coercing previously read values in this column from logical,
## integer or numeric back to character which may not be lossless; e.g., if
## '00' and '000' occurred before they will now be just '0', and there may
## be inconsistencies with treatment of '.,' and ',NA,' too (if they occurred
## in this column before the bump). If this matters please rerun and set
## 'colClasses' to 'character' for this column. Please note that column type
## detection uses the first 5 rows, the middle 5 rows and the last 5 rows, so
## hopefully this message should be very rare. If reporting to datatable-help,
## please rerun and include the output from verbose=TRUE.
```

```
## Warning in fread("../dataset/test_categorical.csv", header = TRUE, nrows
## = 2000): Bumped column 1382 to type character on data row 647, field
## contains 'T1'. Coercing previously read values in this column from logical,
## integer or numeric back to character which may not be lossless; e.g., if
## '00' and '000' occurred before they will now be just '0', and there may
## be inconsistencies with treatment of '.,' and ',NA,' too (if they occurred
## in this column before the bump). If this matters please rerun and set
## 'colClasses' to 'character' for this column. Please note that column type
## detection uses the first 5 rows, the middle 5 rows and the last 5 rows, so
## hopefully this message should be very rare. If reporting to datatable-help,
## please rerun and include the output from verbose=TRUE.
```

```
## Warning in fread("../dataset/test_categorical.csv", header = TRUE, nrows
## = 2000): Bumped column 1385 to type character on data row 647, field
## contains 'T1'. Coercing previously read values in this column from logical,
## integer or numeric back to character which may not be lossless; e.g., if
## '00' and '000' occurred before they will now be just '0', and there may
## be inconsistencies with treatment of '.,' and ',NA,' too (if they occurred
## in this column before the bump). If this matters please rerun and set
## 'colClasses' to 'character' for this column. Please note that column type
## detection uses the first 5 rows, the middle 5 rows and the last 5 rows, so
## hopefully this message should be very rare. If reporting to datatable-help,
## please rerun and include the output from verbose=TRUE.
```

```
## Warning in fread("../dataset/test_categorical.csv", header = TRUE, nrows
## = 2000): Bumped column 1388 to type character on data row 647, field
## contains 'T1'. Coercing previously read values in this column from logical,
## integer or numeric back to character which may not be lossless; e.g., if
## '00' and '000' occurred before they will now be just '0', and there may
## be inconsistencies with treatment of '.,' and ',NA,' too (if they occurred
## in this column before the bump). If this matters please rerun and set
## 'colClasses' to 'character' for this column. Please note that column type
## detection uses the first 5 rows, the middle 5 rows and the last 5 rows, so
## hopefully this message should be very rare. If reporting to datatable-help,
## please rerun and include the output from verbose=TRUE.
```

```
## Warning in fread("../dataset/test_categorical.csv", header = TRUE, nrows
## = 2000): Bumped column 1391 to type character on data row 647, field
## contains 'T1'. Coercing previously read values in this column from logical,
## integer or numeric back to character which may not be lossless; e.g., if
## '00' and '000' occurred before they will now be just '0', and there may
## be inconsistencies with treatment of ',', and ',NA,' too (if they occurred
## in this column before the bump). If this matters please rerun and set
## 'colClasses' to 'character' for this column. Please note that column type
## detection uses the first 5 rows, the middle 5 rows and the last 5 rows, so
## hopefully this message should be very rare. If reporting to datatable-help,
## please rerun and include the output from verbose=TRUE.
```

```
## Warning in fread("../dataset/test_categorical.csv", header = TRUE, nrows
## = 2000): Bumped column 1394 to type character on data row 647, field
## contains 'T1'. Coercing previously read values in this column from logical,
## integer or numeric back to character which may not be lossless; e.g., if
## '00' and '000' occurred before they will now be just '0', and there may
## be inconsistencies with treatment of ',', and ',NA,' too (if they occurred
## in this column before the bump). If this matters please rerun and set
## 'colClasses' to 'character' for this column. Please note that column type
## detection uses the first 5 rows, the middle 5 rows and the last 5 rows, so
## hopefully this message should be very rare. If reporting to datatable-help,
## please rerun and include the output from verbose=TRUE.
```

```
##      user  system elapsed
##    0.164   0.148   0.314
```

```
# # create the sample train
# library(dplyr)
# new_train_numeric <- sample_frac(train, 0.15) # get 15% of train
# #
# write.csv(new_train_numeric, file = "../dataset/sample_train_numeric", row.names = FALSE, quote = FALSE)
```

```
# perform PCA analysis

features <- train[,2:969, with= FALSE]

features[is.na(features)] <- 0.0

#pca <- prcomp(features, center = TRUE, scale = TRUE, na.action = na.omit)
pca <- prcomp(features, center = TRUE)
# plot pca
plot(pca, type = "l")

# biplot - what does it show?
biplot(pca)
```

Look at train_numeric data

```
# from the variables - extract the line # station # and features
cols <- colnames(train)
```

```

# get the line #
#line_num <- unique(sub("_.*", "", cols[2:969]))

line_num <- unique(gsub("(L.*)_.*_.*", '\\\\1', cols[2:969]))
line_num

## [1] "L0" "L1" "L2" "L3"

# get the station #
station_num <- unique(gsub(".*_(S.*)_.*", '\\\\1', cols[2:969]))

# get the features
feature_names <- unique(gsub(".*_.*(.*)", '\\\\1', cols[2:969]))
feature_names

```

```

## [1] "F0" "F2" "F4" "F6" "F8" "F10" "F12" "F14"
## [9] "F16" "F18" "F20" "F22" "F24" "F28" "F32" "F36"
## [17] "F40" "F44" "F48" "F52" "F56" "F60" "F64" "F68"
## [25] "F72" "F76" "F80" "F84" "F88" "F92" "F96" "F100"
## [33] "F104" "F109" "F114" "F116" "F118" "F122" "F132" "F136"
## [41] "F138" "F142" "F144" "F146" "F149" "F155" "F160" "F165"
## [49] "F170" "F175" "F180" "F185" "F190" "F195" "F200" "F205"
## [57] "F210" "F219" "F224" "F229" "F234" "F239" "F244" "F249"
## [65] "F254" "F259" "F264" "F269" "F274" "F282" "F286" "F290"
## [73] "F294" "F298" "F302" "F306" "F310" "F314" "F318" "F322"
## [81] "F326" "F330" "F332" "F334" "F336" "F338" "F340" "F342"
## [89] "F344" "F346" "F348" "F350" "F352" "F354" "F356" "F358"
## [97] "F362" "F366" "F370" "F374" "F378" "F382" "F386" "F390"
## [105] "F394" "F397" "F400" "F403" "F406" "F409" "F412" "F415"
## [113] "F418" "F421" "F426" "F431" "F433" "F435" "F439" "F449"
## [121] "F453" "F455" "F459" "F461" "F463" "F466" "F472" "F477"
## [129] "F482" "F487" "F492" "F497" "F502" "F507" "F512" "F517"
## [137] "F522" "F527" "F532" "F537" "F546" "F551" "F556" "F561"
## [145] "F566" "F571" "F576" "F581" "F586" "F591" "F596" "F601"
## [153] "F606" "F611" "F619" "F623" "F627" "F631" "F635" "F639"
## [161] "F643" "F647" "F651" "F655" "F659" "F663" "F667" "F671"
## [169] "F679" "F683" "F687" "F691" "F700" "F719" "F728" "F733"
## [177] "F746" "F751" "F756" "F761" "F766" "F775" "F780" "F785"
## [185] "F790" "F795" "F800" "F802" "F806" "F808" "F810" "F812"
## [193] "F814" "F816" "F829" "F834" "F839" "F844" "F857" "F862"
## [201] "F867" "F872" "F877" "F882" "F887" "F892" "F897" "F902"
## [209] "F907" "F920" "F925" "F930" "F935" "F948" "F953" "F958"
## [217] "F963" "F968" "F973" "F978" "F983" "F988" "F993" "F998"
## [225] "F1000" "F1002" "F1004" "F1006" "F1008" "F1010" "F1012" "F1014"
## [233] "F1016" "F1021" "F1026" "F1031" "F1036" "F1041" "F1046" "F1051"
## [241] "F1056" "F1068" "F1072" "F1079" "F1083" "F1087" "F1094" "F1098"
## [249] "F1102" "F1106" "F1110" "F1118" "F1122" "F1126" "F1130" "F1134"
## [257] "F1145" "F1148" "F1161" "F1166" "F1170" "F1172" "F1174" "F1176"
## [265] "F1180" "F1184" "F1197" "F1202" "F1207" "F1212" "F1225" "F1230"
## [273] "F1235" "F1240" "F1245" "F1250" "F1255" "F1260" "F1265" "F1270"
## [281] "F1275" "F1288" "F1293" "F1298" "F1303" "F1316" "F1321" "F1326"
## [289] "F1331" "F1336" "F1341" "F1346" "F1351" "F1356" "F1361" "F1366"

```

[297] "F1371" "F1376" "F1381" "F1386" "F1391" "F1396" "F1401" "F1406"
 ## [305] "F1411" "F1416" "F1421" "F1426" "F1431" "F1436" "F1441" "F1446"
 ## [313] "F1451" "F1463" "F1467" "F1474" "F1478" "F1482" "F1486" "F1490"
 ## [321] "F1494" "F1498" "F1502" "F1506" "F1512" "F1514" "F1516" "F1518"
 ## [329] "F1520" "F1539" "F1544" "F1565" "F1567" "F1569" "F1571" "F1573"
 ## [337] "F1575" "F1578" "F1581" "F1594" "F1599" "F1604" "F1609" "F1622"
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 ## [721] "F3303" "F3307" "F3311" "F3315" "F3318" "F3321" "F3324" "F3327"

```
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## [737] "F3354" "F3357" "F3360" "F3367" "F3370" "F3373" "F3376" "F3379"
## [745] "F3382" "F3385" "F3388" "F3395" "F3398" "F3401" "F3404" "F3407"
## [753] "F3412" "F3421" "F3424" "F3427" "F3430" "F3433" "F3436" "F3439"
## [761] "F3442" "F3449" "F3452" "F3455" "F3458" "F3461" "F3464" "F3467"
## [769] "F3470" "F3473" "F3476" "F3479" "F3482" "F3485" "F3488" "F3491"
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## [785] "F3534" "F3539" "F3544" "F3549" "F3554" "F3559" "F3564" "F3569"
## [793] "F3574" "F3579" "F3584" "F3589" "F3594" "F3599" "F3604" "F3609"
## [801] "F3614" "F3619" "F3624" "F3629" "F3634" "F3639" "F3644" "F3649"
## [809] "F3654" "F3659" "F3664" "F3669" "F3674" "F3679" "F3684" "F3689"
## [817] "F3694" "F3699" "F3704" "F3709" "F3714" "F3719" "F3724" "F3729"
## [825] "F3734" "F3739" "F3744" "F3749" "F3754" "F3759" "F3764" "F3769"
## [833] "F3774" "F3779" "F3784" "F3789" "F3794" "F3799" "F3804" "F3809"
## [841] "F3814" "F3819" "F3824" "F3829" "F3834" "F3838" "F3842" "F3846"
## [849] "F3850" "F3855" "F3857" "F3859" "F3861" "F3863" "F3865" "F3867"
## [857] "F3869" "F3871" "F3873" "F3876" "F3878" "F3880" "F3882" "F3884"
## [865] "F3889" "F3894" "F3896" "F3898" "F3903" "F3908" "F3913" "F3918"
## [873] "F3920" "F3922" "F3924" "F3926" "F3930" "F3934" "F3938" "F3944"
## [881] "F3946" "F3948" "F3950" "F3952" "F3956" "F3960" "F3964" "F3968"
## [889] "F3972" "F3976" "F3980" "F3982" "F3984" "F3986" "F3988" "F3990"
## [897] "F3992" "F3994" "F3996" "F3998" "F4000" "F4002" "F4004" "F4006"
## [905] "F4008" "F4011" "F4014" "F4016" "F4018" "F4020" "F4023" "F4026"
## [913] "F4060" "F4065" "F4070" "F4075" "F4080" "F4085" "F4090" "F4095"
## [921] "F4100" "F4103" "F4106" "F4109" "F4112" "F4115" "F4118" "F4121"
## [929] "F4124" "F4126" "F4128" "F4130" "F4132" "F4138" "F4143" "F4148"
## [937] "F4153" "F4158" "F4163" "F4168" "F4173" "F4178" "F4183" "F4188"
## [945] "F4193" "F4196" "F4198" "F4200" "F4202" "F4204" "F4206" "F4211"
## [953] "F4216" "F4221" "F4226" "F4231" "F4236" "F4241" "F4243" "F4245"
## [961] "F4247" "F4249" "F4251" "F4253" "F4256" "F4258" "F4260" "F4262"
```

```
#number of features
length(feature_names)
```

```
## [1] 968
```

```
## train features vs test features
test_cols <- colnames(test)
#cols[1:969] == test_cols

identical(cols[1:969], test_cols)
```

```
## [1] TRUE
```

Look at the train_categorical data

```
cat_cols <- colnames(train_cat)
intersect(cols[2:969], cat_cols)
```

```
## character(0)
```

```
# exclude the first column - Id
# get the line num
cat_line_num <- unique(gsub("(L.*)_*_*", '\\1', cat_cols[-1]))
cat_line_num
```

```
## [1] "L0" "L1" "L2" "L3"
```

```
# stations in categorical dataset
cat_station_num <- unique(gsub(".*(S.*)_*_*", '\\1', cat_cols[-1]))
cat_station_num
```

```
## [1] "S1" "S2" "S3" "S4" "S6" "S9" "S10" "S11" "S14" "S15" "S16"
## [12] "S18" "S21" "S22" "S23" "S24" "S25" "S26" "S27" "S28" "S29" "S30"
## [23] "S31" "S32" "S35" "S36" "S38" "S39" "S42" "S43" "S44" "S46" "S47"
## [34] "S49"
```

```
total_station <- sort(union(station_num, cat_station_num))
```

```
# total number of stations
length(union(station_num, cat_station_num))
```

```
## [1] 52
```

```
# cat features
cat_feature_names <- unique(gsub(".*_.*_(.*)", '\\1', cat_cols[-1]))
cat_feature_names
```

```
## [1] "F25" "F27" "F29" "F31" "F33" "F35" "F37" "F39"
## [9] "F41" "F43" "F45" "F47" "F49" "F51" "F53" "F55"
## [17] "F57" "F59" "F61" "F63" "F65" "F67" "F69" "F71"
## [25] "F73" "F75" "F77" "F79" "F81" "F83" "F85" "F87"
## [33] "F89" "F91" "F93" "F95" "F97" "F99" "F101" "F103"
## [41] "F105" "F107" "F108" "F110" "F112" "F113" "F119" "F121"
## [49] "F123" "F125" "F126" "F128" "F129" "F131" "F133" "F135"
## [57] "F151" "F153" "F154" "F156" "F158" "F159" "F161" "F163"
## [65] "F164" "F166" "F168" "F169" "F171" "F173" "F174" "F176"
## [73] "F178" "F179" "F181" "F183" "F184" "F186" "F188" "F189"
## [81] "F191" "F193" "F194" "F196" "F198" "F199" "F201" "F203"
## [89] "F204" "F206" "F208" "F209" "F211" "F213" "F214" "F215"
## [97] "F217" "F218" "F220" "F222" "F223" "F225" "F227" "F228"
## [105] "F230" "F232" "F233" "F235" "F237" "F238" "F240" "F242"
## [113] "F243" "F245" "F247" "F248" "F250" "F252" "F253" "F255"
## [121] "F257" "F258" "F260" "F262" "F263" "F265" "F267" "F268"
## [129] "F270" "F272" "F273" "F275" "F277" "F278" "F279" "F281"
## [137] "F283" "F285" "F287" "F289" "F291" "F293" "F295" "F297"
## [145] "F299" "F301" "F303" "F305" "F307" "F309" "F311" "F313"
## [153] "F315" "F317" "F319" "F321" "F323" "F325" "F327" "F329"
## [161] "F359" "F361" "F363" "F365" "F367" "F369" "F371" "F373"
## [169] "F375" "F377" "F379" "F381" "F383" "F385" "F387" "F389"
## [177] "F391" "F393" "F396" "F399" "F402" "F405" "F408" "F411"
## [185] "F414" "F417" "F420" "F422" "F424" "F425" "F427" "F429"
```


##	[193]	"F430"	"F436"	"F438"	"F440"	"F442"	"F443"	"F445"	"F446"
##	[201]	"F448"	"F450"	"F452"	"F468"	"F470"	"F471"	"F473"	"F475"
##	[209]	"F476"	"F478"	"F480"	"F481"	"F483"	"F485"	"F486"	"F488"
##	[217]	"F490"	"F491"	"F493"	"F495"	"F496"	"F498"	"F500"	"F501"
##	[225]	"F503"	"F505"	"F506"	"F508"	"F510"	"F511"	"F513"	"F515"
##	[233]	"F516"	"F518"	"F520"	"F521"	"F523"	"F525"	"F526"	"F528"
##	[241]	"F530"	"F531"	"F533"	"F535"	"F536"	"F538"	"F540"	"F541"
##	[249]	"F542"	"F544"	"F545"	"F547"	"F549"	"F550"	"F552"	"F554"
##	[257]	"F555"	"F557"	"F559"	"F560"	"F562"	"F564"	"F565"	"F567"
##	[265]	"F569"	"F570"	"F572"	"F574"	"F575"	"F577"	"F579"	"F580"
##	[273]	"F582"	"F584"	"F585"	"F587"	"F589"	"F590"	"F592"	"F594"
##	[281]	"F595"	"F597"	"F599"	"F600"	"F602"	"F604"	"F605"	"F607"
##	[289]	"F609"	"F610"	"F612"	"F614"	"F615"	"F616"	"F618"	"F620"
##	[297]	"F622"	"F624"	"F626"	"F628"	"F630"	"F632"	"F634"	"F636"
##	[305]	"F638"	"F640"	"F642"	"F644"	"F646"	"F648"	"F650"	"F652"
##	[313]	"F654"	"F656"	"F658"	"F660"	"F662"	"F664"	"F666"	"F668"
##	[321]	"F670"	"F672"	"F674"	"F675"	"F676"	"F678"	"F680"	"F682"
##	[329]	"F684"	"F686"	"F688"	"F690"	"F692"	"F694"	"F695"	"F696"
##	[337]	"F698"	"F699"	"F701"	"F703"	"F704"	"F705"	"F706"	"F708"
##	[345]	"F709"	"F710"	"F711"	"F713"	"F714"	"F715"	"F717"	"F718"
##	[353]	"F720"	"F722"	"F723"	"F724"	"F726"	"F727"	"F729"	"F731"
##	[361]	"F732"	"F734"	"F736"	"F737"	"F738"	"F740"	"F741"	"F742"
##	[369]	"F744"	"F745"	"F747"	"F749"	"F750"	"F752"	"F754"	"F755"
##	[377]	"F757"	"F759"	"F760"	"F762"	"F764"	"F765"	"F767"	"F769"
##	[385]	"F770"	"F771"	"F773"	"F774"	"F776"	"F778"	"F779"	"F781"
##	[393]	"F783"	"F784"	"F786"	"F788"	"F789"	"F791"	"F793"	"F794"
##	[401]	"F796"	"F798"	"F799"	"F803"	"F805"	"F817"	"F819"	"F820"
##	[409]	"F821"	"F823"	"F824"	"F825"	"F827"	"F828"	"F830"	"F832"
##	[417]	"F833"	"F835"	"F837"	"F838"	"F840"	"F842"	"F843"	"F845"
##	[425]	"F847"	"F848"	"F849"	"F851"	"F852"	"F853"	"F855"	"F856"
##	[433]	"F858"	"F860"	"F861"	"F863"	"F865"	"F866"	"F868"	"F870"
##	[441]	"F871"	"F873"	"F875"	"F876"	"F878"	"F880"	"F881"	"F883"
##	[449]	"F885"	"F886"	"F888"	"F890"	"F891"	"F893"	"F895"	"F896"
##	[457]	"F898"	"F900"	"F901"	"F903"	"F905"	"F906"	"F908"	"F910"
##	[465]	"F911"	"F912"	"F914"	"F915"	"F916"	"F918"	"F919"	"F921"
##	[473]	"F923"	"F924"	"F926"	"F928"	"F929"	"F931"	"F933"	"F934"
##	[481]	"F936"	"F938"	"F939"	"F940"	"F942"	"F943"	"F944"	"F946"
##	[489]	"F947"	"F949"	"F951"	"F952"	"F954"	"F956"	"F957"	"F959"
##	[497]	"F961"	"F962"	"F964"	"F966"	"F967"	"F969"	"F971"	"F972"
##	[505]	"F974"	"F976"	"F977"	"F979"	"F981"	"F982"	"F984"	"F986"
##	[513]	"F987"	"F989"	"F991"	"F992"	"F994"	"F996"	"F997"	"F1017"
##	[521]	"F1019"	"F1020"	"F1022"	"F1024"	"F1025"	"F1027"	"F1029"	"F1030"
##	[529]	"F1032"	"F1034"	"F1035"	"F1037"	"F1039"	"F1040"	"F1042"	"F1044"
##	[537]	"F1045"	"F1047"	"F1049"	"F1050"	"F1052"	"F1054"	"F1055"	"F1057"
##	[545]	"F1059"	"F1060"	"F1061"	"F1063"	"F1064"	"F1065"	"F1067"	"F1069"
##	[553]	"F1071"	"F1073"	"F1075"	"F1076"	"F1078"	"F1080"	"F1082"	"F1084"
##	[561]	"F1086"	"F1088"	"F1090"	"F1091"	"F1093"	"F1095"	"F1097"	"F1099"
##	[569]	"F1101"	"F1103"	"F1105"	"F1107"	"F1109"	"F1111"	"F1113"	"F1114"
##	[577]	"F1115"	"F1117"	"F1119"	"F1121"	"F1123"	"F1125"	"F1127"	"F1129"
##	[585]	"F1131"	"F1133"	"F1136"	"F1137"	"F1139"	"F1140"	"F1142"	"F1144"
##	[593]	"F1147"	"F1150"	"F1152"	"F1154"	"F1156"	"F1157"	"F1159"	"F1160"
##	[601]	"F1162"	"F1164"	"F1165"	"F1167"	"F1169"	"F1177"	"F1179"	"F1181"
##	[609]	"F1183"	"F1185"	"F1187"	"F1188"	"F1189"	"F1191"	"F1192"	"F1193"
##	[617]	"F1195"	"F1196"	"F1198"	"F1200"	"F1201"	"F1203"	"F1205"	"F1206"

[625] "F1208" "F1210" "F1211" "F1213" "F1215" "F1216" "F1217" "F1219"
 ## [633] "F1220" "F1221" "F1223" "F1224" "F1226" "F1228" "F1229" "F1231"
 ## [641] "F1233" "F1234" "F1236" "F1238" "F1239" "F1241" "F1243" "F1244"
 ## [649] "F1246" "F1248" "F1249" "F1251" "F1253" "F1254" "F1256" "F1258"
 ## [657] "F1259" "F1261" "F1263" "F1264" "F1266" "F1268" "F1269" "F1271"
 ## [665] "F1273" "F1274" "F1276" "F1278" "F1279" "F1280" "F1282" "F1283"
 ## [673] "F1284" "F1286" "F1287" "F1289" "F1291" "F1292" "F1294" "F1296"
 ## [681] "F1297" "F1299" "F1301" "F1302" "F1304" "F1306" "F1307" "F1308"
 ## [689] "F1310" "F1311" "F1312" "F1314" "F1315" "F1317" "F1319" "F1320"
 ## [697] "F1322" "F1324" "F1325" "F1327" "F1329" "F1330" "F1332" "F1334"
 ## [705] "F1335" "F1337" "F1339" "F1340" "F1342" "F1344" "F1345" "F1347"
 ## [713] "F1349" "F1350" "F1352" "F1354" "F1355" "F1357" "F1359" "F1360"
 ## [721] "F1362" "F1364" "F1365" "F1367" "F1369" "F1370" "F1372" "F1374"
 ## [729] "F1375" "F1377" "F1379" "F1380" "F1382" "F1384" "F1385" "F1387"
 ## [737] "F1389" "F1390" "F1392" "F1394" "F1395" "F1397" "F1399" "F1400"
 ## [745] "F1402" "F1404" "F1405" "F1407" "F1409" "F1410" "F1412" "F1414"
 ## [753] "F1415" "F1417" "F1419" "F1420" "F1422" "F1424" "F1425" "F1427"
 ## [761] "F1429" "F1430" "F1432" "F1434" "F1435" "F1437" "F1439" "F1440"
 ## [769] "F1442" "F1444" "F1445" "F1447" "F1449" "F1450" "F1452" "F1454"
 ## [777] "F1455" "F1456" "F1458" "F1459" "F1460" "F1462" "F1464" "F1466"
 ## [785] "F1468" "F1470" "F1471" "F1473" "F1475" "F1477" "F1479" "F1481"
 ## [793] "F1483" "F1485" "F1487" "F1489" "F1491" "F1493" "F1495" "F1497"
 ## [801] "F1499" "F1501" "F1503" "F1505" "F1507" "F1509" "F1510" "F1521"
 ## [809] "F1523" "F1524" "F1525" "F1526" "F1528" "F1529" "F1530" "F1531"
 ## [817] "F1533" "F1534" "F1535" "F1537" "F1538" "F1540" "F1542" "F1543"
 ## [825] "F1545" "F1547" "F1548" "F1549" "F1551" "F1552" "F1553" "F1555"
 ## [833] "F1556" "F1557" "F1559" "F1560" "F1561" "F1563" "F1564" "F1577"
 ## [841] "F1580" "F1582" "F1584" "F1585" "F1586" "F1588" "F1589" "F1590"
 ## [849] "F1592" "F1593" "F1595" "F1597" "F1598" "F1600" "F1602" "F1603"
 ## [857] "F1605" "F1607" "F1608" "F1610" "F1612" "F1613" "F1614" "F1616"
 ## [865] "F1617" "F1618" "F1620" "F1621" "F1623" "F1625" "F1626" "F1628"
 ## [873] "F1630" "F1631" "F1633" "F1635" "F1636" "F1638" "F1640" "F1641"
 ## [881] "F1643" "F1645" "F1646" "F1648" "F1650" "F1651" "F1653" "F1655"
 ## [889] "F1656" "F1658" "F1660" "F1661" "F1663" "F1665" "F1666" "F1668"
 ## [897] "F1670" "F1671" "F1673" "F1675" "F1676" "F1677" "F1679" "F1680"
 ## [905] "F1681" "F1683" "F1684" "F1686" "F1688" "F1689" "F1691" "F1693"
 ## [913] "F1694" "F1696" "F1698" "F1699" "F1701" "F1703" "F1704" "F1705"
 ## [921] "F1707" "F1708" "F1709" "F1711" "F1712" "F1714" "F1716" "F1717"
 ## [929] "F1719" "F1721" "F1722" "F1724" "F1726" "F1727" "F1729" "F1731"
 ## [937] "F1732" "F1734" "F1736" "F1737" "F1739" "F1741" "F1742" "F1744"
 ## [945] "F1746" "F1747" "F1749" "F1751" "F1752" "F1754" "F1756" "F1757"
 ## [953] "F1759" "F1761" "F1762" "F1764" "F1766" "F1767" "F1769" "F1771"
 ## [961] "F1772" "F1774" "F1776" "F1777" "F1779" "F1781" "F1782" "F1784"
 ## [969] "F1786" "F1787" "F1789" "F1791" "F1792" "F1794" "F1796" "F1797"
 ## [977] "F1799" "F1801" "F1802" "F1804" "F1806" "F1807" "F1827" "F1852"
 ## [985] "F1853" "F1856" "F1859" "F1861" "F1863" "F1866" "F1868" "F1870"
 ## [993] "F1872" "F1874" "F1876" "F1878" "F1880" "F1882" "F1884" "F1886"
 ## [1001] "F1888" "F1889" "F1897" "F1899" "F1901" "F1903" "F1904" "F1905"
 ## [1009] "F1907" "F1908" "F1910" "F1912" "F1913" "F1915" "F1917" "F1918"
 ## [1017] "F1920" "F1922" "F1923" "F1925" "F1927" "F1928" "F1930" "F1932"
 ## [1025] "F1933" "F1934" "F1936" "F1937" "F1939" "F1941" "F1942" "F1944"
 ## [1033] "F1946" "F1947" "F1949" "F1951" "F1952" "F1954" "F1956" "F1957"
 ## [1041] "F1959" "F1961" "F1962" "F1964" "F1966" "F1967" "F1969" "F1971"
 ## [1049] "F1972" "F1974" "F1976" "F1977" "F1979" "F1981" "F1982" "F1983"

[1057] "F1985" "F1986" "F1988" "F1990" "F1991" "F1993" "F1995" "F1996"
 ## [1065] "F1998" "F2000" "F2001" "F2003" "F2005" "F2006" "F2008" "F2010"
 ## [1073] "F2011" "F2012" "F2014" "F2015" "F2017" "F2019" "F2020" "F2022"
 ## [1081] "F2024" "F2025" "F2027" "F2029" "F2030" "F2032" "F2034" "F2035"
 ## [1089] "F2037" "F2039" "F2040" "F2042" "F2044" "F2045" "F2047" "F2049"
 ## [1097] "F2050" "F2052" "F2054" "F2055" "F2057" "F2059" "F2060" "F2062"
 ## [1105] "F2064" "F2065" "F2067" "F2069" "F2070" "F2072" "F2074" "F2075"
 ## [1113] "F2077" "F2079" "F2080" "F2082" "F2084" "F2085" "F2087" "F2089"
 ## [1121] "F2090" "F2092" "F2094" "F2095" "F2097" "F2099" "F2100" "F2102"
 ## [1129] "F2104" "F2105" "F2107" "F2109" "F2110" "F2112" "F2114" "F2115"
 ## [1137] "F2117" "F2119" "F2120" "F2122" "F2124" "F2125" "F2127" "F2129"
 ## [1145] "F2130" "F2132" "F2134" "F2135" "F2137" "F2139" "F2141" "F2142"
 ## [1153] "F2145" "F2148" "F2150" "F2153" "F2156" "F2159" "F2162" "F2165"
 ## [1161] "F2168" "F2171" "F2174" "F2177" "F2179" "F2182" "F2185" "F2188"
 ## [1169] "F2191" "F2194" "F2197" "F2200" "F2203" "F2205" "F2208" "F2211"
 ## [1177] "F2213" "F2215" "F2218" "F2221" "F2224" "F2227" "F2229" "F2250"
 ## [1185] "F2252" "F2253" "F2254" "F2256" "F2257" "F2259" "F2261" "F2262"
 ## [1193] "F2264" "F2266" "F2267" "F2269" "F2271" "F2272" "F2274" "F2276"
 ## [1201] "F2277" "F2279" "F2281" "F2282" "F2283" "F2285" "F2286" "F2288"
 ## [1209] "F2290" "F2291" "F2293" "F2295" "F2296" "F2298" "F2300" "F2301"
 ## [1217] "F2303" "F2305" "F2306" "F2308" "F2310" "F2311" "F2313" "F2315"
 ## [1225] "F2316" "F2318" "F2320" "F2321" "F2323" "F2325" "F2326" "F2328"
 ## [1233] "F2330" "F2331" "F2332" "F2334" "F2335" "F2337" "F2339" "F2340"
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## [1985] "F3851" "F3853" "F3854" "F3885" "F3887" "F3888" "F3890" "F3892"
## [1993] "F3893" "F3899" "F3901" "F3902" "F3904" "F3906" "F3907" "F3909"
## [2001] "F3911" "F3912" "F3914" "F3916" "F3917" "F3927" "F3929" "F3931"
## [2009] "F3933" "F3935" "F3937" "F3939" "F3941" "F3954" "F3955" "F3958"
## [2017] "F3959" "F3962" "F3963" "F3965" "F3967" "F3969" "F3971" "F3973"
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## [2105] "F4169" "F4171" "F4172" "F4174" "F4176" "F4177" "F4179" "F4181"
## [2113] "F4182" "F4184" "F4186" "F4187" "F4189" "F4191" "F4192" "F4207"
## [2121] "F4209" "F4210" "F4212" "F4214" "F4215" "F4217" "F4219" "F4220"
## [2129] "F4222" "F4224" "F4225" "F4227" "F4229" "F4230" "F4232" "F4234"
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union(feature_names, cat_feature_names)
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##      [1] "F0"      "F2"      "F4"      "F6"      "F8"      "F10"     "F12"     "F14"
##      [9] "F16"     "F18"     "F20"     "F22"     "F24"     "F28"     "F32"     "F36"
##     [17] "F40"     "F44"     "F48"     "F52"     "F56"     "F60"     "F64"     "F68"
##     [25] "F72"     "F76"     "F80"     "F84"     "F88"     "F92"     "F96"     "F100"
##     [33] "F104"    "F109"    "F114"    "F116"    "F118"    "F122"    "F132"    "F136"
##     [41] "F138"    "F142"    "F144"    "F146"    "F149"    "F155"    "F160"    "F165"
##     [49] "F170"    "F175"    "F180"    "F185"    "F190"    "F195"    "F200"    "F205"
##     [57] "F210"    "F219"    "F224"    "F229"    "F234"    "F239"    "F244"    "F249"
##     [65] "F254"    "F259"    "F264"    "F269"    "F274"    "F282"    "F286"    "F290"
##     [73] "F294"    "F298"    "F302"    "F306"    "F310"    "F314"    "F318"    "F322"
##     [81] "F326"    "F330"    "F332"    "F334"    "F336"    "F338"    "F340"    "F342"
##     [89] "F344"    "F346"    "F348"    "F350"    "F352"    "F354"    "F356"    "F358"
##     [97] "F362"    "F366"    "F370"    "F374"    "F378"    "F382"    "F386"    "F390"
##    [105] "F394"    "F397"    "F400"    "F403"    "F406"    "F409"    "F412"    "F415"
##    [113] "F418"    "F421"    "F426"    "F431"    "F433"    "F435"    "F439"    "F449"
##    [121] "F453"    "F455"    "F459"    "F461"    "F463"    "F466"    "F472"    "F477"
##    [129] "F482"    "F487"    "F492"    "F497"    "F502"    "F507"    "F512"    "F517"
##    [137] "F522"    "F527"    "F532"    "F537"    "F546"    "F551"    "F556"    "F561"
##    [145] "F566"    "F571"    "F576"    "F581"    "F586"    "F591"    "F596"    "F601"
##    [153] "F606"    "F611"    "F619"    "F623"    "F627"    "F631"    "F635"    "F639"
##    [161] "F643"    "F647"    "F651"    "F655"    "F659"    "F663"    "F667"    "F671"
##    [169] "F679"    "F683"    "F687"    "F691"    "F700"    "F719"    "F728"    "F733"
##    [177] "F746"    "F751"    "F756"    "F761"    "F766"    "F775"    "F780"    "F785"

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##	[185]	"F790"	"F795"	"F800"	"F802"	"F806"	"F808"	"F810"	"F812"
##	[193]	"F814"	"F816"	"F829"	"F834"	"F839"	"F844"	"F857"	"F862"
##	[201]	"F867"	"F872"	"F877"	"F882"	"F887"	"F892"	"F897"	"F902"
##	[209]	"F907"	"F920"	"F925"	"F930"	"F935"	"F948"	"F953"	"F958"
##	[217]	"F963"	"F968"	"F973"	"F978"	"F983"	"F988"	"F993"	"F998"
##	[225]	"F1000"	"F1002"	"F1004"	"F1006"	"F1008"	"F1010"	"F1012"	"F1014"
##	[233]	"F1016"	"F1021"	"F1026"	"F1031"	"F1036"	"F1041"	"F1046"	"F1051"
##	[241]	"F1056"	"F1068"	"F1072"	"F1079"	"F1083"	"F1087"	"F1094"	"F1098"
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##	[289]	"F1331"	"F1336"	"F1341"	"F1346"	"F1351"	"F1356"	"F1361"	"F1366"
##	[297]	"F1371"	"F1376"	"F1381"	"F1386"	"F1391"	"F1396"	"F1401"	"F1406"
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##	[401]	"F1869"	"F1873"	"F1877"	"F1881"	"F1885"	"F1890"	"F1892"	"F1894"
##	[409]	"F1896"	"F1900"	"F1909"	"F1914"	"F1919"	"F1924"	"F1929"	"F1938"
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##	[425]	"F1987"	"F1992"	"F1997"	"F2002"	"F2007"	"F2016"	"F2021"	"F2026"
##	[433]	"F2031"	"F2036"	"F2041"	"F2046"	"F2051"	"F2056"	"F2061"	"F2066"
##	[441]	"F2071"	"F2076"	"F2081"	"F2086"	"F2091"	"F2096"	"F2101"	"F2106"
##	[449]	"F2111"	"F2116"	"F2121"	"F2126"	"F2131"	"F2136"	"F2144"	"F2147"
##	[457]	"F2152"	"F2155"	"F2158"	"F2161"	"F2164"	"F2167"	"F2170"	"F2173"
##	[465]	"F2176"	"F2181"	"F2184"	"F2187"	"F2190"	"F2193"	"F2196"	"F2199"
##	[473]	"F2202"	"F2207"	"F2210"	"F2217"	"F2220"	"F2223"	"F2226"	"F2231"
##	[481]	"F2233"	"F2237"	"F2239"	"F2241"	"F2243"	"F2245"	"F2247"	"F2249"
##	[489]	"F2258"	"F2263"	"F2268"	"F2273"	"F2278"	"F2287"	"F2292"	"F2297"
##	[497]	"F2302"	"F2307"	"F2312"	"F2317"	"F2322"	"F2327"	"F2336"	"F2341"
##	[505]	"F2346"	"F2351"	"F2356"	"F2365"	"F2370"	"F2375"	"F2380"	"F2385"
##	[513]	"F2390"	"F2395"	"F2400"	"F2405"	"F2408"	"F2411"	"F2414"	"F2417"
##	[521]	"F2420"	"F2423"	"F2426"	"F2429"	"F2431"	"F2433"	"F2435"	"F2437"
##	[529]	"F2439"	"F2441"	"F2443"	"F2449"	"F2451"	"F2454"	"F2456"	"F2458"
##	[537]	"F2460"	"F2462"	"F2464"	"F2466"	"F2468"	"F2472"	"F2475"	"F2478"
##	[545]	"F2481"	"F2484"	"F2487"	"F2490"	"F2493"	"F2498"	"F2500"	"F2504"
##	[553]	"F2506"	"F2508"	"F2510"	"F2512"	"F2514"	"F2516"	"F2525"	"F2530"
##	[561]	"F2535"	"F2540"	"F2545"	"F2554"	"F2559"	"F2564"	"F2569"	"F2574"
##	[569]	"F2579"	"F2584"	"F2589"	"F2594"	"F2603"	"F2608"	"F2613"	"F2618"
##	[577]	"F2623"	"F2632"	"F2637"	"F2642"	"F2647"	"F2652"	"F2657"	"F2662"
##	[585]	"F2667"	"F2672"	"F2677"	"F2682"	"F2687"	"F2692"	"F2697"	"F2702"
##	[593]	"F2707"	"F2712"	"F2714"	"F2716"	"F2718"	"F2720"	"F2722"	"F2724"
##	[601]	"F2726"	"F2732"	"F2734"	"F2737"	"F2739"	"F2741"	"F2743"	"F2745"
##	[609]	"F2747"	"F2749"	"F2751"	"F2755"	"F2758"	"F2761"	"F2764"	"F2767"

[617] "F2770" "F2773" "F2776" "F2781" "F2783" "F2787" "F2789" "F2791"
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 ## [873] "F3920" "F3922" "F3924" "F3926" "F3930" "F3934" "F3938" "F3944"
 ## [881] "F3946" "F3948" "F3950" "F3952" "F3956" "F3960" "F3964" "F3968"
 ## [889] "F3972" "F3976" "F3980" "F3982" "F3984" "F3986" "F3988" "F3990"
 ## [897] "F3992" "F3994" "F3996" "F3998" "F4000" "F4002" "F4004" "F4006"
 ## [905] "F4008" "F4011" "F4014" "F4016" "F4018" "F4020" "F4023" "F4026"
 ## [913] "F4060" "F4065" "F4070" "F4075" "F4080" "F4085" "F4090" "F4095"
 ## [921] "F4100" "F4103" "F4106" "F4109" "F4112" "F4115" "F4118" "F4121"
 ## [929] "F4124" "F4126" "F4128" "F4130" "F4132" "F4138" "F4143" "F4148"
 ## [937] "F4153" "F4158" "F4163" "F4168" "F4173" "F4178" "F4183" "F4188"
 ## [945] "F4193" "F4196" "F4198" "F4200" "F4202" "F4204" "F4206" "F4211"
 ## [953] "F4216" "F4221" "F4226" "F4231" "F4236" "F4241" "F4243" "F4245"
 ## [961] "F4247" "F4249" "F4251" "F4253" "F4256" "F4258" "F4260" "F4262"
 ## [969] "F25" "F27" "F29" "F31" "F33" "F35" "F37" "F39"
 ## [977] "F41" "F43" "F45" "F47" "F49" "F51" "F53" "F55"
 ## [985] "F57" "F59" "F61" "F63" "F65" "F67" "F69" "F71"
 ## [993] "F73" "F75" "F77" "F79" "F81" "F83" "F85" "F87"
 ## [1001] "F89" "F91" "F93" "F95" "F97" "F99" "F101" "F103"
 ## [1009] "F105" "F107" "F108" "F110" "F112" "F113" "F119" "F121"
 ## [1017] "F123" "F125" "F126" "F128" "F129" "F131" "F133" "F135"
 ## [1025] "F151" "F153" "F154" "F156" "F158" "F159" "F161" "F163"
 ## [1033] "F164" "F166" "F168" "F169" "F171" "F173" "F174" "F176"
 ## [1041] "F178" "F179" "F181" "F183" "F184" "F186" "F188" "F189"

##	[1049]	"F191"	"F193"	"F194"	"F196"	"F198"	"F199"	"F201"	"F203"
##	[1057]	"F204"	"F206"	"F208"	"F209"	"F211"	"F213"	"F214"	"F215"
##	[1065]	"F217"	"F218"	"F220"	"F222"	"F223"	"F225"	"F227"	"F228"
##	[1073]	"F230"	"F232"	"F233"	"F235"	"F237"	"F238"	"F240"	"F242"
##	[1081]	"F243"	"F245"	"F247"	"F248"	"F250"	"F252"	"F253"	"F255"
##	[1089]	"F257"	"F258"	"F260"	"F262"	"F263"	"F265"	"F267"	"F268"
##	[1097]	"F270"	"F272"	"F273"	"F275"	"F277"	"F278"	"F279"	"F281"
##	[1105]	"F283"	"F285"	"F287"	"F289"	"F291"	"F293"	"F295"	"F297"
##	[1113]	"F299"	"F301"	"F303"	"F305"	"F307"	"F309"	"F311"	"F313"
##	[1121]	"F315"	"F317"	"F319"	"F321"	"F323"	"F325"	"F327"	"F329"
##	[1129]	"F359"	"F361"	"F363"	"F365"	"F367"	"F369"	"F371"	"F373"
##	[1137]	"F375"	"F377"	"F379"	"F381"	"F383"	"F385"	"F387"	"F389"
##	[1145]	"F391"	"F393"	"F396"	"F399"	"F402"	"F405"	"F408"	"F411"
##	[1153]	"F414"	"F417"	"F420"	"F422"	"F424"	"F425"	"F427"	"F429"
##	[1161]	"F430"	"F436"	"F438"	"F440"	"F442"	"F443"	"F445"	"F446"
##	[1169]	"F448"	"F450"	"F452"	"F468"	"F470"	"F471"	"F473"	"F475"
##	[1177]	"F476"	"F478"	"F480"	"F481"	"F483"	"F485"	"F486"	"F488"
##	[1185]	"F490"	"F491"	"F493"	"F495"	"F496"	"F498"	"F500"	"F501"
##	[1193]	"F503"	"F505"	"F506"	"F508"	"F510"	"F511"	"F513"	"F515"
##	[1201]	"F516"	"F518"	"F520"	"F521"	"F523"	"F525"	"F526"	"F528"
##	[1209]	"F530"	"F531"	"F533"	"F535"	"F536"	"F538"	"F540"	"F541"
##	[1217]	"F542"	"F544"	"F545"	"F547"	"F549"	"F550"	"F552"	"F554"
##	[1225]	"F555"	"F557"	"F559"	"F560"	"F562"	"F564"	"F565"	"F567"
##	[1233]	"F569"	"F570"	"F572"	"F574"	"F575"	"F577"	"F579"	"F580"
##	[1241]	"F582"	"F584"	"F585"	"F587"	"F589"	"F590"	"F592"	"F594"
##	[1249]	"F595"	"F597"	"F599"	"F600"	"F602"	"F604"	"F605"	"F607"
##	[1257]	"F609"	"F610"	"F612"	"F614"	"F615"	"F616"	"F618"	"F620"
##	[1265]	"F622"	"F624"	"F626"	"F628"	"F630"	"F632"	"F634"	"F636"
##	[1273]	"F638"	"F640"	"F642"	"F644"	"F646"	"F648"	"F650"	"F652"
##	[1281]	"F654"	"F656"	"F658"	"F660"	"F662"	"F664"	"F666"	"F668"
##	[1289]	"F670"	"F672"	"F674"	"F675"	"F676"	"F678"	"F680"	"F682"
##	[1297]	"F684"	"F686"	"F688"	"F690"	"F692"	"F694"	"F695"	"F696"
##	[1305]	"F698"	"F699"	"F701"	"F703"	"F704"	"F705"	"F706"	"F708"
##	[1313]	"F709"	"F710"	"F711"	"F713"	"F714"	"F715"	"F717"	"F718"
##	[1321]	"F720"	"F722"	"F723"	"F724"	"F726"	"F727"	"F729"	"F731"
##	[1329]	"F732"	"F734"	"F736"	"F737"	"F738"	"F740"	"F741"	"F742"
##	[1337]	"F744"	"F745"	"F747"	"F749"	"F750"	"F752"	"F754"	"F755"
##	[1345]	"F757"	"F759"	"F760"	"F762"	"F764"	"F765"	"F767"	"F769"
##	[1353]	"F770"	"F771"	"F773"	"F774"	"F776"	"F778"	"F779"	"F781"
##	[1361]	"F783"	"F784"	"F786"	"F788"	"F789"	"F791"	"F793"	"F794"
##	[1369]	"F796"	"F798"	"F799"	"F803"	"F805"	"F817"	"F819"	"F820"
##	[1377]	"F821"	"F823"	"F824"	"F825"	"F827"	"F828"	"F830"	"F832"
##	[1385]	"F833"	"F835"	"F837"	"F838"	"F840"	"F842"	"F843"	"F845"
##	[1393]	"F847"	"F848"	"F849"	"F851"	"F852"	"F853"	"F855"	"F856"
##	[1401]	"F858"	"F860"	"F861"	"F863"	"F865"	"F866"	"F868"	"F870"
##	[1409]	"F871"	"F873"	"F875"	"F876"	"F878"	"F880"	"F881"	"F883"
##	[1417]	"F885"	"F886"	"F888"	"F890"	"F891"	"F893"	"F895"	"F896"
##	[1425]	"F898"	"F900"	"F901"	"F903"	"F905"	"F906"	"F908"	"F910"
##	[1433]	"F911"	"F912"	"F914"	"F915"	"F916"	"F918"	"F919"	"F921"
##	[1441]	"F923"	"F924"	"F926"	"F928"	"F929"	"F931"	"F933"	"F934"
##	[1449]	"F936"	"F938"	"F939"	"F940"	"F942"	"F943"	"F944"	"F946"
##	[1457]	"F947"	"F949"	"F951"	"F952"	"F954"	"F956"	"F957"	"F959"
##	[1465]	"F961"	"F962"	"F964"	"F966"	"F967"	"F969"	"F971"	"F972"
##	[1473]	"F974"	"F976"	"F977"	"F979"	"F981"	"F982"	"F984"	"F986"

[1481] "F987" "F989" "F991" "F992" "F994" "F996" "F997" "F1017"
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 ## [1985] "F1920" "F1922" "F1923" "F1925" "F1927" "F1928" "F1930" "F1932"
 ## [1993] "F1933" "F1934" "F1936" "F1937" "F1939" "F1941" "F1942" "F1944"
 ## [2001] "F1946" "F1947" "F1949" "F1951" "F1952" "F1954" "F1956" "F1957"
 ## [2009] "F1959" "F1961" "F1962" "F1964" "F1966" "F1967" "F1969" "F1971"
 ## [2017] "F1972" "F1974" "F1976" "F1977" "F1979" "F1981" "F1982" "F1983"
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## [3073] "F4169" "F4171" "F4172" "F4174" "F4176" "F4177" "F4179" "F4181"
## [3081] "F4182" "F4184" "F4186" "F4187" "F4189" "F4191" "F4192" "F4207"
## [3089] "F4209" "F4210" "F4212" "F4214" "F4215" "F4217" "F4219" "F4220"
## [3097] "F4222" "F4224" "F4225" "F4227" "F4229" "F4230" "F4232" "F4234"
## [3105] "F4235" "F4237" "F4239" "F4240"
```

```
# total features
length(unique(union(feature_names, cat_feature_names)))
```

```
## [1] 3108
```

```
# get the unique categorical levels
cat_values <- unique(train_cat[, 2:2141, with=FALSE])

unique_levels <- unique(unlist(cat_values))
unique_levels
```

```
## [1] "" "T1" "T9" "T24"
## [5] "T48" "T32" "T96" "T64"
## [9] "T128" "T4" NA "T97"
## [13] "T98" "T16" "T8" "T48576"
## [17] "T512" "T16777248" "T16777232" "T16777557"
## [21] "T12582912" "T65536" "T6553" "T16779428"
## [25] "T16777472" "T33554448" "T-18748192" "T33554944"
## [29] "T1372" "T56" "T589824" "T178258"
## [33] "T52" "T18436" "T2" "T16384"
## [37] "T3" "T5" "T-2147483648" "T-2147483647"
## [41] "T8389632" "T262144" "T26808" "T83888"
## [45] "T618624" "T8651776" "T33554432" "T134217728"
## [49] "T8768" "T748928" "T16777216" "T331648"
## [53] "T6" "T7" "T-2147483646" "T786432"
## [57] "T524288" "T8912896" "T9174" "T917"
## [61] "T91764" "T11141888" "T2516" "T86752"
## [65] "T41944" "T113776" "T4718592" "T524544"
## [69] "T256" "T786944" "T1132" "T25165824"
## [73] "T96112" "T145" "T143" "T678864"
## [77] "T268435456" "T-2147482816" "T1310" "T-21474819"
## [81] "T32896" "T-2147482432" "T-2147482688" "T-21474872"
## [85] "T-2147481664" "T1152" "T-21474825" "T492"
## [89] "T36992" "T55424" "T16512" "T63616"
## [93] "T-2147482944" "T-2147482176" "T514"
```

Look at the info about train_date & test_date

```
# date info

# about line info
# get the line num
date_cols <- colnames(train_date)
date_line_num <- unique(gsub("(L.*)_.*_.*", '\\1', date_cols[-1]))
date_line_num

## [1] "L0" "L1" "L2" "L3"

# station numbers
date_station_num <- unique(gsub(".*(S.*)_.*", '\\1', date_cols[-1]))
date_station_num

## [1] "S0" "S1" "S2" "S3" "S4" "S5" "S6" "S7" "S8" "S9" "S10"
## [12] "S11" "S12" "S13" "S14" "S15" "S16" "S17" "S18" "S19" "S20" "S21"
## [23] "S22" "S23" "S24" "S25" "S26" "S27" "S28" "S29" "S30" "S31" "S32"
## [34] "S33" "S34" "S35" "S36" "S37" "S38" "S39" "S40" "S41" "S42" "S43"
## [45] "S44" "S45" "S46" "S47" "S48" "S49" "S50" "S51"

# stations in train_numeric + train_cat vs. train_date
identical(total_station, sort(date_station_num))

## [1] TRUE
```

```

#number of stations in *_date dataset
#length(date_station_num)

# extract the date info.
date_features <- unique(gsub(".*_.*_(.*)", '\\1', date_cols[-1]))
date_features

```

```

##      [1] "D1"      "D3"      "D5"      "D7"      "D9"      "D11"     "D13"     "D15"
##      [9] "D17"     "D19"     "D21"     "D23"     "D26"     "D30"     "D34"     "D38"
##     [17] "D42"     "D46"     "D50"     "D54"     "D58"     "D62"     "D66"     "D70"
##     [25] "D74"     "D78"     "D82"     "D86"     "D90"     "D94"     "D98"     "D102"
##     [33] "D106"    "D111"    "D115"    "D117"    "D120"    "D124"    "D127"    "D130"
##     [41] "D134"    "D137"    "D139"    "D140"    "D141"    "D143"    "D145"    "D147"
##     [49] "D148"    "D150"    "D152"    "D157"    "D162"    "D167"    "D172"    "D177"
##     [57] "D182"    "D187"    "D192"    "D197"    "D202"    "D207"    "D212"    "D216"
##     [65] "D221"    "D226"    "D231"    "D236"    "D241"    "D246"    "D251"    "D256"
##     [73] "D261"    "D266"    "D271"    "D276"    "D280"    "D284"    "D288"    "D292"
##     [81] "D296"    "D300"    "D304"    "D308"    "D312"    "D316"    "D320"    "D324"
##     [89] "D328"    "D331"    "D333"    "D335"    "D337"    "D339"    "D341"    "D343"
##     [97] "D345"    "D347"    "D349"    "D351"    "D353"    "D355"    "D357"    "D360"
##    [105] "D364"    "D368"    "D372"    "D376"    "D380"    "D384"    "D388"    "D392"
##    [113] "D395"    "D398"    "D401"    "D404"    "D407"    "D410"    "D413"    "D416"
##    [121] "D419"    "D423"    "D428"    "D432"    "D434"    "D437"    "D441"    "D444"
##    [129] "D447"    "D451"    "D454"    "D456"    "D457"    "D458"    "D460"    "D462"
##    [137] "D464"    "D465"    "D467"    "D469"    "D474"    "D479"    "D484"    "D489"
##    [145] "D494"    "D499"    "D504"    "D509"    "D514"    "D519"    "D524"    "D529"
##    [153] "D534"    "D539"    "D543"    "D548"    "D553"    "D558"    "D563"    "D568"
##    [161] "D573"    "D578"    "D583"    "D588"    "D593"    "D598"    "D603"    "D608"
##    [169] "D613"    "D617"    "D621"    "D625"    "D629"    "D633"    "D637"    "D641"
##    [177] "D645"    "D649"    "D653"    "D657"    "D661"    "D665"    "D669"    "D673"
##    [185] "D677"    "D681"    "D685"    "D689"    "D693"    "D697"    "D702"    "D707"
##    [193] "D712"    "D716"    "D721"    "D725"    "D730"    "D735"    "D739"    "D743"
##    [201] "D748"    "D753"    "D758"    "D763"    "D768"    "D772"    "D777"    "D782"
##    [209] "D787"    "D792"    "D797"    "D801"    "D804"    "D807"    "D809"    "D811"
##    [217] "D813"    "D815"    "D818"    "D822"    "D826"    "D831"    "D836"    "D841"
##    [225] "D846"    "D850"    "D854"    "D859"    "D864"    "D869"    "D874"    "D879"
##    [233] "D884"    "D889"    "D894"    "D899"    "D904"    "D909"    "D913"    "D917"
##    [241] "D922"    "D927"    "D932"    "D937"    "D941"    "D945"    "D950"    "D955"
##    [249] "D960"    "D965"    "D970"    "D975"    "D980"    "D985"    "D990"    "D995"
##    [257] "D999"    "D1001"   "D1003"   "D1005"   "D1007"   "D1009"   "D1011"   "D1013"
##    [265] "D1015"   "D1018"   "D1023"   "D1028"   "D1033"   "D1038"   "D1043"   "D1048"
##    [273] "D1053"   "D1058"   "D1062"   "D1066"   "D1070"   "D1074"   "D1077"   "D1081"
##    [281] "D1085"   "D1089"   "D1092"   "D1096"   "D1100"   "D1104"   "D1108"   "D1112"
##    [289] "D1116"   "D1120"   "D1124"   "D1128"   "D1132"   "D1135"   "D1138"   "D1141"
##    [297] "D1143"   "D1146"   "D1149"   "D1151"   "D1153"   "D1155"   "D1158"   "D1163"
##    [305] "D1168"   "D1171"   "D1173"   "D1175"   "D1178"   "D1182"   "D1186"   "D1190"
##    [313] "D1194"   "D1199"   "D1204"   "D1209"   "D1214"   "D1218"   "D1222"   "D1227"
##    [321] "D1232"   "D1237"   "D1242"   "D1247"   "D1252"   "D1257"   "D1262"   "D1267"
##    [329] "D1272"   "D1277"   "D1281"   "D1285"   "D1290"   "D1295"   "D1300"   "D1305"
##    [337] "D1309"   "D1313"   "D1318"   "D1323"   "D1328"   "D1333"   "D1338"   "D1343"
##    [345] "D1348"   "D1353"   "D1358"   "D1363"   "D1368"   "D1373"   "D1378"   "D1383"
##    [353] "D1388"   "D1393"   "D1398"   "D1403"   "D1408"   "D1413"   "D1418"   "D1423"
##    [361] "D1428"   "D1433"   "D1438"   "D1443"   "D1448"   "D1453"   "D1457"   "D1461"

```

[369] "D1465" "D1469" "D1472" "D1476" "D1480" "D1484" "D1488" "D1492"
 ## [377] "D1496" "D1500" "D1504" "D1508" "D1511" "D1513" "D1515" "D1517"
 ## [385] "D1519" "D1522" "D1527" "D1532" "D1536" "D1541" "D1546" "D1550"
 ## [393] "D1554" "D1558" "D1562" "D1566" "D1568" "D1570" "D1572" "D1574"
 ## [401] "D1576" "D1579" "D1583" "D1587" "D1591" "D1596" "D1601" "D1606"
 ## [409] "D1611" "D1615" "D1619" "D1624" "D1629" "D1634" "D1639" "D1644"
 ## [417] "D1649" "D1654" "D1659" "D1664" "D1669" "D1674" "D1678" "D1682"
 ## [425] "D1687" "D1692" "D1697" "D1702" "D1706" "D1710" "D1715" "D1720"
 ## [433] "D1725" "D1730" "D1735" "D1740" "D1745" "D1750" "D1755" "D1760"
 ## [441] "D1765" "D1770" "D1775" "D1780" "D1785" "D1790" "D1795" "D1800"
 ## [449] "D1805" "D1809" "D1811" "D1813" "D1815" "D1817" "D1819" "D1821"
 ## [457] "D1823" "D1825" "D1826" "D1828" "D1830" "D1832" "D1833" "D1835"
 ## [465] "D1837" "D1839" "D1841" "D1843" "D1845" "D1847" "D1849" "D1851"
 ## [473] "D1854" "D1857" "D1860" "D1862" "D1864" "D1867" "D1871" "D1875"
 ## [481] "D1879" "D1883" "D1887" "D1891" "D1893" "D1895" "D1898" "D1902"
 ## [489] "D1906" "D1911" "D1916" "D1921" "D1926" "D1931" "D1935" "D1940"
 ## [497] "D1945" "D1950" "D1955" "D1960" "D1965" "D1970" "D1975" "D1980"
 ## [505] "D1984" "D1989" "D1994" "D1999" "D2004" "D2009" "D2013" "D2018"
 ## [513] "D2023" "D2028" "D2033" "D2038" "D2043" "D2048" "D2053" "D2058"
 ## [521] "D2063" "D2068" "D2073" "D2078" "D2083" "D2088" "D2093" "D2098"
 ## [529] "D2103" "D2108" "D2113" "D2118" "D2123" "D2128" "D2133" "D2138"
 ## [537] "D2140" "D2143" "D2146" "D2149" "D2151" "D2154" "D2157" "D2160"
 ## [545] "D2163" "D2166" "D2169" "D2172" "D2175" "D2178" "D2180" "D2183"
 ## [553] "D2186" "D2189" "D2192" "D2195" "D2198" "D2201" "D2204" "D2206"
 ## [561] "D2209" "D2212" "D2214" "D2216" "D2219" "D2222" "D2225" "D2228"
 ## [569] "D2230" "D2232" "D2234" "D2235" "D2236" "D2238" "D2240" "D2242"
 ## [577] "D2244" "D2246" "D2248" "D2251" "D2255" "D2260" "D2265" "D2270"
 ## [585] "D2275" "D2280" "D2284" "D2289" "D2294" "D2299" "D2304" "D2309"
 ## [593] "D2314" "D2319" "D2324" "D2329" "D2333" "D2338" "D2343" "D2348"
 ## [601] "D2353" "D2358" "D2362" "D2367" "D2372" "D2377" "D2382" "D2387"
 ## [609] "D2392" "D2397" "D2402" "D2406" "D2409" "D2412" "D2415" "D2418"
 ## [617] "D2421" "D2424" "D2427" "D2430" "D2432" "D2434" "D2436" "D2438"
 ## [625] "D2440" "D2442" "D2444" "D2445" "D2446" "D2448" "D2450" "D2452"
 ## [633] "D2453" "D2455" "D2457" "D2459" "D2461" "D2463" "D2465" "D2467"
 ## [641] "D2469" "D2471" "D2474" "D2477" "D2480" "D2483" "D2486" "D2489"
 ## [649] "D2492" "D2495" "D2497" "D2499" "D2501" "D2502" "D2503" "D2505"
 ## [657] "D2507" "D2509" "D2511" "D2513" "D2515" "D2518" "D2522" "D2527"
 ## [665] "D2532" "D2537" "D2542" "D2547" "D2551" "D2556" "D2561" "D2566"
 ## [673] "D2571" "D2576" "D2581" "D2586" "D2591" "D2596" "D2600" "D2605"
 ## [681] "D2610" "D2615" "D2620" "D2625" "D2629" "D2634" "D2639" "D2644"
 ## [689] "D2649" "D2654" "D2659" "D2664" "D2669" "D2674" "D2679" "D2684"
 ## [697] "D2689" "D2694" "D2699" "D2704" "D2709" "D2713" "D2715" "D2717"
 ## [705] "D2719" "D2721" "D2723" "D2725" "D2727" "D2728" "D2729" "D2731"
 ## [713] "D2733" "D2735" "D2736" "D2738" "D2740" "D2742" "D2744" "D2746"
 ## [721] "D2748" "D2750" "D2752" "D2754" "D2757" "D2760" "D2763" "D2766"
 ## [729] "D2769" "D2772" "D2775" "D2778" "D2780" "D2782" "D2784" "D2785"
 ## [737] "D2786" "D2788" "D2790" "D2792" "D2794" "D2796" "D2798" "D2801"
 ## [745] "D2805" "D2810" "D2815" "D2820" "D2825" "D2830" "D2834" "D2839"
 ## [753] "D2844" "D2849" "D2854" "D2859" "D2864" "D2869" "D2874" "D2879"
 ## [761] "D2883" "D2888" "D2893" "D2898" "D2903" "D2908" "D2912" "D2917"
 ## [769] "D2922" "D2927" "D2932" "D2937" "D2942" "D2947" "D2952" "D2957"
 ## [777] "D2962" "D2967" "D2972" "D2977" "D2982" "D2987" "D2992" "D2996"
 ## [785] "D2998" "D3000" "D3002" "D3004" "D3006" "D3008" "D3010" "D3011"
 ## [793] "D3012" "D3014" "D3016" "D3018" "D3019" "D3021" "D3023" "D3025"

```

## [801] "D3027" "D3029" "D3031" "D3033" "D3035" "D3037" "D3041" "D3044"
## [809] "D3048" "D3052" "D3056" "D3059" "D3063" "D3066" "D3070" "D3074"
## [817] "D3078" "D3081" "D3084" "D3087" "D3090" "D3093" "D3096" "D3100"
## [825] "D3103" "D3107" "D3110" "D3114" "D3118" "D3122" "D3126" "D3130"
## [833] "D3134" "D3137" "D3141" "D3145" "D3149" "D3152" "D3156" "D3159"
## [841] "D3163" "D3167" "D3171" "D3174" "D3177" "D3180" "D3183" "D3186"
## [849] "D3189" "D3193" "D3196" "D3200" "D3203" "D3207" "D3211" "D3215"
## [857] "D3219" "D3223" "D3227" "D3230" "D3234" "D3238" "D3242" "D3245"
## [865] "D3249" "D3252" "D3256" "D3260" "D3264" "D3267" "D3270" "D3273"
## [873] "D3276" "D3279" "D3282" "D3286" "D3289" "D3293" "D3296" "D3300"
## [881] "D3304" "D3308" "D3312" "D3316" "D3319" "D3322" "D3325" "D3328"
## [889] "D3331" "D3334" "D3337" "D3340" "D3343" "D3346" "D3349" "D3352"
## [897] "D3355" "D3358" "D3361" "D3363" "D3365" "D3368" "D3371" "D3374"
## [905] "D3377" "D3380" "D3383" "D3386" "D3389" "D3391" "D3393" "D3396"
## [913] "D3399" "D3402" "D3405" "D3408" "D3410" "D3413" "D3415" "D3417"
## [921] "D3419" "D3422" "D3425" "D3428" "D3431" "D3434" "D3437" "D3440"
## [929] "D3443" "D3445" "D3447" "D3450" "D3453" "D3456" "D3459" "D3462"
## [937] "D3465" "D3468" "D3471" "D3474" "D3477" "D3480" "D3483" "D3486"
## [945] "D3489" "D3492" "D3496" "D3501" "D3506" "D3511" "D3516" "D3521"
## [953] "D3526" "D3531" "D3536" "D3541" "D3546" "D3551" "D3556" "D3561"
## [961] "D3566" "D3571" "D3576" "D3581" "D3586" "D3591" "D3596" "D3601"
## [969] "D3606" "D3611" "D3616" "D3621" "D3626" "D3631" "D3636" "D3641"
## [977] "D3646" "D3651" "D3656" "D3661" "D3666" "D3671" "D3676" "D3681"
## [985] "D3686" "D3691" "D3696" "D3701" "D3706" "D3711" "D3716" "D3721"
## [993] "D3726" "D3731" "D3736" "D3741" "D3746" "D3751" "D3756" "D3761"
## [1001] "D3766" "D3771" "D3776" "D3781" "D3786" "D3791" "D3796" "D3801"
## [1009] "D3806" "D3811" "D3816" "D3821" "D3826" "D3831" "D3836" "D3840"
## [1017] "D3844" "D3848" "D3852" "D3856" "D3858" "D3860" "D3862" "D3864"
## [1025] "D3866" "D3868" "D3870" "D3872" "D3874" "D3875" "D3877" "D3879"
## [1033] "D3881" "D3883" "D3886" "D3891" "D3895" "D3897" "D3900" "D3905"
## [1041] "D3910" "D3915" "D3919" "D3921" "D3923" "D3925" "D3928" "D3932"
## [1049] "D3936" "D3940" "D3942" "D3943" "D3945" "D3947" "D3949" "D3951"
## [1057] "D3953" "D3957" "D3961" "D3966" "D3970" "D3974" "D3978" "D3981"
## [1065] "D3983" "D3985" "D3987" "D3989" "D3991" "D3993" "D3995" "D3997"
## [1073] "D3999" "D4001" "D4003" "D4005" "D4007" "D4009" "D4010" "D4012"
## [1081] "D4013" "D4015" "D4017" "D4019" "D4021" "D4022" "D4024" "D4025"
## [1089] "D4027" "D4029" "D4033" "D4037" "D4041" "D4045" "D4049" "D4053"
## [1097] "D4057" "D4062" "D4067" "D4072" "D4077" "D4082" "D4087" "D4092"
## [1105] "D4097" "D4101" "D4104" "D4107" "D4110" "D4113" "D4116" "D4119"
## [1113] "D4122" "D4125" "D4127" "D4129" "D4131" "D4133" "D4135" "D4140"
## [1121] "D4145" "D4150" "D4155" "D4160" "D4165" "D4170" "D4175" "D4180"
## [1129] "D4185" "D4190" "D4194" "D4195" "D4197" "D4199" "D4201" "D4203"
## [1137] "D4205" "D4208" "D4213" "D4218" "D4223" "D4228" "D4233" "D4238"
## [1145] "D4242" "D4244" "D4246" "D4248" "D4250" "D4252" "D4254" "D4255"
## [1153] "D4257" "D4259" "D4261" "D4263"

```

```

# number of date features
length(date_features)

```

```
## [1] 1156
```