Assignment 13.2

1. Use the given link below:
https://archive.ics.uci.edu/ml/machine-learning-databases/00304/

Problem- prediction of the number of comments in the upcoming 24 hours on those blogs, the train data was generated from different base times that may temporally overlap. Therefore, if you simply split the train into disjoint partitions, the underlying time intervals may overlap. Therefore, you should use the provided, temporally disjoint train and test splits to ensure that the evaluation is fair.

    a. Create a linear regression model to predict the number of comments in the next 24 hours (relative to base time).
    b. Fine tune the model and represent important features Visualize the dataset and make inferences from that.
    c. Interpret the summary of the linear model.
    d. Report the test accuracy vs. the training accuracy

```
### Data Preprocessing ###
library(data.table)
library(foreach)
library(readr)

setwd("C:/DataAnalytics/Projects/BlogFeedback")

blogData_train <-
read_csv("C:/DataAnalytics/Projects/BlogFeedback/blogData_train.csv")

## Warning: Duplicated column names deduplicated: '0.0' => '0.0_1' [8],
## '0.0' => '0.0_2' [13], '377.0' => '377.0_1' [14], '0.0' => '0.0_3' [18],
## '377.0' => '377.0_2' [24], '0.0' => '0.0_4' [25], '0.0' => '0.0_5' [28],
## '0.0' => '0.0_6' [30], '0.0' => '0.0_7' [33], '0.0' => '0.0_8' [35], '0.0'
## => '0.0_9' [38], '9.0' => '9.0_1' [39], '0.0' => '0.0_10' [40], '0.0'
## => '0.0_11' [43], '0.0' => '0.0_12' [45], '9.0' => '9.0_2' [49], '0.0'
## => '0.0_13' [50], '2.0' => '2.0_1' [51], '2.0' => '2.0_2' [52], '0.0'
## => '0.0_14' [53], '2.0' => '2.0_3' [54], '2.0' => '2.0_4' [55], '0.0' =>
## '0.0_15' [56], '0.0' => '0.0_16' [57], '0.0' => '0.0_17' [58], '0.0' =>
## '0.0_18' [59], '0.0' => '0.0_19' [60], '10.0' => '10.0_1' [61], '0.0' =>
## '0.0_20' [62], '0.0' => '0.0_21' [63], '0.0' => '0.0_22' [64], '0.0' =>
## '0.0_23' [65], '0.0' => '0.0_24' [66], '0.0' => '0.0_25' [67], '0.0' =>
## '0.0_26' [68], '0.0' => '0.0_27' [69], '0.0' => '0.0_28' [70], '0.0' =>
## '0.0_29' [71], '0.0' => '0.0_30' [72], '0.0' => '0.0_31' [73], '0.0' =>
## '0.0_32' [74], '0.0' => '0.0_33' [75], '0.0' => '0.0_34' [76], '0.0' =>
```

```
## '0.0_35' [77], '0.0' => '0.0_36' [78], '0.0' => '0.0_37' [79], '0.0' =>
## '0.0_38' [80], '0.0' => '0.0_39' [81], '0.0' => '0.0_40' [82], '0.0' =>
## '0.0_41' [83], '0.0' => '0.0_42' [84], '0.0' => '0.0_43' [85], '0.0' =>
## '0.0_44' [86], '0.0' => '0.0_45' [87], '0.0' => '0.0_46' [88], '0.0' =>
## '0.0_47' [89], '0.0' => '0.0_48' [90], '0.0' => '0.0_49' [91], '0.0' =>
## '0.0_50' [92], '0.0' => '0.0_51' [93], '0.0' => '0.0_52' [94], '0.0' =>
## '0.0_53' [95], '0.0' => '0.0_54' [96], '0.0' => '0.0_55' [97], '0.0' =>
## '0.0_56' [98], '0.0' => '0.0_57' [99], '0.0' => '0.0_58' [100], '0.0' =>
## '0.0_59' [101], '0.0' => '0.0_60' [102], '0.0' => '0.0_61' [103], '0.0' =>
## '0.0_62' [104], '0.0' => '0.0_63' [105], '0.0' => '0.0_64' [106], '0.0' =>
## '0.0_65' [107], '0.0' => '0.0_66' [108], '0.0' => '0.0_67' [109], '0.0' =>
## '0.0_68' [110], '0.0' => '0.0_69' [111], '0.0' => '0.0_70' [112], '0.0' =>
## '0.0_71' [113], '0.0' => '0.0_72' [114], '0.0' => '0.0_73' [115], '0.0' =>
## '0.0_74' [116], '0.0' => '0.0_75' [117], '0.0' => '0.0_76' [118], '0.0' =>
## '0.0_77' [119], '0.0' => '0.0_78' [120], '0.0' => '0.0_79' [121], '0.0' =>
## '0.0_80' [122], '0.0' => '0.0_81' [123], '0.0' => '0.0_82' [124], '0.0' =>
## '0.0_83' [125], '0.0' => '0.0_84' [126], '0.0' => '0.0_85' [127], '0.0' =>
## '0.0_86' [128], '0.0' => '0.0_87' [129], '0.0' => '0.0_88' [130], '0.0' =>
## '0.0_89' [131], '0.0' => '0.0_90' [132], '0.0' => '0.0_91' [133], '0.0' =>
## '0.0_92' [134], '0.0' => '0.0_93' [135], '0.0' => '0.0_94' [136], '0.0' =>
## '0.0_95' [137], '0.0' => '0.0_96' [138], '0.0' => '0.0_97' [139], '0.0' =>
## '0.0_98' [140], '0.0' => '0.0_99' [141], '0.0' => '0.0_100' [142], '0.0' =
>
## '0.0_101' [143], '0.0' => '0.0_102' [144], '0.0' => '0.0_103' [145], '0.0'
## => '0.0_104' [146], '0.0' => '0.0_105' [147], '0.0' => '0.0_106' [148],
## '0.0' => '0.0_107' [149], '0.0' => '0.0_108' [150], '0.0' =>
## '0.0_109' [151], '0.0' => '0.0_110' [152], '0.0' => '0.0_111' [153], '0.0'
## => '0.0_112' [154], '0.0' => '0.0_113' [155], '0.0' => '0.0_114' [156],
## '0.0' => '0.0_115' [157], '0.0' => '0.0_116' [158], '0.0' =>
## '0.0_117' [159], '0.0' => '0.0_118' [160], '0.0' => '0.0_119' [161], '0.0'
## => '0.0_120' [162], '0.0' => '0.0_121' [163], '0.0' => '0.0_122' [164],
## '0.0' => '0.0_123' [165], '0.0' => '0.0_124' [166], '0.0' =>
## '0.0_125' [167], '0.0' => '0.0_126' [168], '0.0' => '0.0_127' [169], '0.0'
## => '0.0_128' [170], '0.0' => '0.0_129' [171], '0.0' => '0.0_130' [172],
## '0.0' => '0.0_131' [173], '0.0' => '0.0_132' [174], '0.0' =>
## '0.0_133' [175], '0.0' => '0.0_134' [176], '0.0' => '0.0_135' [177], '0.0'
## => '0.0_136' [178], '0.0' => '0.0_137' [179], '0.0' => '0.0_138' [180],
## '0.0' => '0.0_139' [181], '0.0' => '0.0_140' [182], '0.0' =>
## '0.0_141' [183], '0.0' => '0.0_142' [184], '0.0' => '0.0_143' [185], '0.0'
## => '0.0_144' [186], '0.0' => '0.0_145' [187], '0.0' => '0.0_146' [188],
## '0.0' => '0.0_147' [189], '0.0' => '0.0_148' [190], '0.0' =>
## '0.0_149' [191], '0.0' => '0.0_150' [192], '0.0' => '0.0_151' [193], '0.0'
## => '0.0_152' [194], '0.0' => '0.0_153' [195], '0.0' => '0.0_154' [196],
## '0.0' => '0.0_155' [197], '0.0' => '0.0_156' [198], '0.0' =>
## '0.0_157' [199], '0.0' => '0.0_158' [200], '0.0' => '0.0_159' [201], '0.0'
## => '0.0_160' [202], '0.0' => '0.0_161' [203], '0.0' => '0.0_162' [204],
## '0.0' => '0.0_163' [205], '0.0' => '0.0_164' [206], '0.0' =>
## '0.0_165' [207], '0.0' => '0.0_166' [208], '0.0' => '0.0_167' [209], '0.0'
## => '0.0_168' [210], '0.0' => '0.0_169' [211], '0.0' => '0.0_170' [212],
## '0.0' => '0.0_171' [213], '0.0' => '0.0_172' [214], '0.0' =>
```

```
## '0.0_173' [215], '0.0' => '0.0_174' [216], '0.0' => '0.0_175' [217], '0.0'
## => '0.0_176' [218], '0.0' => '0.0_177' [219], '0.0' => '0.0_178' [220],
## '0.0' => '0.0_179' [221], '0.0' => '0.0_180' [222], '0.0' =>
## '0.0_181' [223], '0.0' => '0.0_182' [224], '0.0' => '0.0_183' [225], '0.0'
## => '0.0_184' [226], '0.0' => '0.0_185' [227], '0.0' => '0.0_186' [228],
## '0.0' => '0.0_187' [229], '0.0' => '0.0_188' [230], '0.0' =>
## '0.0_189' [231], '0.0' => '0.0_190' [232], '0.0' => '0.0_191' [233], '0.0'
## => '0.0_192' [234], '0.0' => '0.0_193' [235], '0.0' => '0.0_194' [236],
## '0.0' => '0.0_195' [237], '0.0' => '0.0_196' [238], '0.0' =>
## '0.0_197' [239], '0.0' => '0.0_198' [240], '0.0' => '0.0_199' [241], '0.0'
## => '0.0_200' [242], '0.0' => '0.0_201' [243], '0.0' => '0.0_202' [244],
## '0.0' => '0.0_203' [245], '0.0' => '0.0_204' [246], '0.0' =>
## '0.0_205' [247], '0.0' => '0.0_206' [248], '0.0' => '0.0_207' [249], '0.0'
## => '0.0_208' [250], '0.0' => '0.0_209' [251], '0.0' => '0.0_210' [252],
## '0.0' => '0.0_211' [253], '0.0' => '0.0_212' [254], '0.0' =>
## '0.0_213' [255], '0.0' => '0.0_214' [256], '0.0' => '0.0_215' [257], '0.0'
## => '0.0_216' [258], '0.0' => '0.0_217' [259], '0.0' => '0.0_218' [260],
## '0.0' => '0.0_219' [261], '0.0' => '0.0_220' [262], '0.0' =>
## '0.0_221' [263], '0.0' => '0.0_222' [264], '0.0' => '0.0_223' [265], '0.0'
## => '0.0_224' [266], '0.0' => '0.0_225' [268], '0.0' => '0.0_226' [269],
## '0.0' => '0.0_227' [270], '0.0' => '0.0_228' [271], '0.0' =>
## '0.0_229' [272], '1.0' => '1.0_1' [273], '0.0' => '0.0_230' [274], '0.0' =
## >
## '0.0_231' [275], '0.0' => '0.0_232' [276], '0.0' => '0.0_233' [277], '0.0'
## => '0.0_234' [278], '0.0' => '0.0_235' [279], '0.0' => '0.0_236' [280],
## '1.0' => '1.0_2' [281]

## Parsed with column specification:
## cols(
##    .default = col_double()
## )

## See spec(...) for full column specifications.

View(blogData_train)

   # retrieve filenames of test sets
   test_filenames = list.files(pattern = "blogData_test")

   # load and combine dataset
   train = fread("blogData_train.csv")
   test = foreach(i = 1:length(test_filenames), .combine = rbind) %do% {
     temp = fread(test_filenames[i], header = F)
   }

   # log-transform
   train[, V281 := log(1 + V281)]
   test[, V281 := log(1 + V281)]

   # drop continous variables without variation
```

```r
    drop = c(8, 13, 28, 33, 38, 40, 43, 50, 278)
    train[, (drop) := NULL]
    test[, (drop) := NULL]

    # write to files
    write.csv(train, "BlogFeedback-Train.csv", row.names = F)
    write.csv(test, "BlogFeedback-Test.csv", row.names = F)

train
```

```
##                V1       V2 V3  V4 V5       V6       V7 V9 V10       V11
##      1: 40.30467 53.84566  0 401 15 15.52416 32.44188 377   3 14.04423
##      2: 40.30467 53.84566  0 401 15 15.52416 32.44188 377   3 14.04423
##      3: 40.30467 53.84566  0 401 15 15.52416 32.44188 377   3 14.04423
##      4: 40.30467 53.84566  0 401 15 15.52416 32.44188 377   3 14.04423
##      5: 40.30467 53.84566  0 401 15 15.52416 32.44188 377   3 14.04423
##     ---
## 52393: 33.00000  0.00000 33  33 33 11.00000 15.55635  33   0 11.00000
## 52394: 33.00000  0.00000 33  33 33 11.00000 15.55635  33   0 11.00000
## 52395:  0.00000  0.00000  0   0  0  0.00000  0.00000   0   0  0.00000
## 52396:  0.00000  0.00000  0   0  0  0.00000  0.00000   0   0  0.00000
## 52397:  0.00000  0.00000  0   0  0  0.00000  0.00000   0   0  0.00000
##             V12 V14 V15      V16      V17 V18 V19 V20      V21      V22
##      1: 32.61542 377   2 34.56757 48.47518   0 378  12 1.479934 46.18691
##      2: 32.61542 377   2 34.56757 48.47518   0 378  12 1.479934 46.18691
##      3: 32.61542 377   2 34.56757 48.47518   0 378  12 1.479934 46.18691
##      4: 32.61542 377   2 34.56757 48.47518   0 378  12 1.479934 46.18691
##      5: 32.61542 377   2 34.56757 48.47518   0 378  12 1.479934 46.18691
##     ---
## 52393: 15.55635  33   0 33.00000  0.00000  33  33  33 0.000000 26.94439
## 52394: 15.55635  33   0 33.00000  0.00000  33  33  33 0.000000 26.94439
## 52395:  0.00000   0   0  0.00000  0.00000   0   0   0 0.000000  0.00000
## 52396:  0.00000   0   0  0.00000  0.00000   0   0   0 0.000000  0.00000
## 52397:  0.00000   0   0  0.00000  0.00000   0   0   0 0.000000  0.00000
##         V23 V24 V25      V26      V27 V29 V30       V31       V32 V34 V35
##      1: -356 377   0 1.076167 1.795416  11   0 0.4004914 1.0780969   9   0
##      2: -356 377   0 1.076167 1.795416  11   0 0.4004914 1.0780969   9   0
##      3: -356 377   0 1.076167 1.795416  11   0 0.4004914 1.0780969   9   0
##      4: -356 377   0 1.076167 1.795416  11   0 0.4004914 1.0780969   9   0
##      5: -356 377   0 1.076167 1.795416  11   0 0.4004914 1.0780969   9   0
##     ---
## 52393:  -33  33   0 0.000000 0.000000   0   0 0.0000000 0.0000000   0   0
## 52394:  -33  33   0 0.000000 0.000000   0   0 0.0000000 0.0000000   0   0
## 52395:    0   0   0 2.000000 0.000000   2   2 0.6666667 0.9428091   2   0
## 52396:    0   0   0 2.000000 0.000000   2   2 0.6666667 0.9428091   2   0
## 52397:    0   0   0 2.000000 0.000000   2   2 0.6666667 0.9428091   2   0
##             V36       V37 V39      V41      V42 V44 V45        V46
##      1: 0.3775594 1.0742100   9 0.972973 1.704671  10   0 0.02293202
##      2: 0.3775594 1.0742100   9 0.972973 1.704671  10   0 0.02293202
##      3: 0.3775594 1.0742100   9 0.972973 1.704671  10   0 0.02293202
```

```
##      4: 0.3775594 1.0742100     9 0.972973 1.704671   10    0 0.02293202
##      5: 0.3775594 1.0742100     9 0.972973 1.704671   10    0 0.02293202
##     ---
## 52393: 0.0000000 0.0000000     0 0.000000 0.000000    0    0 0.00000000
## 52394: 0.0000000 0.0000000     0 0.000000 0.000000    0    0 0.00000000
## 52395: 0.6666667 0.9428091     2 2.000000 0.000000    2    2 0.00000000
## 52396: 0.6666667 0.9428091     2 2.000000 0.000000    2    2 0.00000000
## 52397: 0.6666667 0.9428091     2 2.000000 0.000000    2    2 0.00000000
##              V47 V48 V49 V51 V52 V53 V54 V55 V56 V57 V58 V59 V60 V61   V62
##      1: 1.521174  -8   9   2   2   0   2   2   0   0   0   0   0  10     0
##      2: 1.521174  -8   9   6   2   4   5  -2   0   0   0   0   0  35     0
##      3: 1.521174  -8   9   6   2   4   5  -2   0   0   0   0   0  35     0
##      4: 1.521174  -8   9   2   2   0   2   2   0   0   0   0   0  10     0
##      5: 1.521174  -8   9   3   1   2   2  -1   0   0   0   0   0  34     0
##     ---
## 52393: 0.000000   0   0  33   0  33  33 -33   0   0   0   0   0  38  3137
## 52394: 0.000000   0   0  33   0   0  33   0   0   0   0   0   0  62  3137
## 52395: 1.632993  -2   2   0   0   0   0   0   2   2   0   2   2  13     0
## 52396: 1.632993  -2   2   0   0   0   0   0   2   0   2   2  -2  37     0
## 52397: 1.632993  -2   2   0   0   0   0   0   2   0   0   2   0  61     0
##        V63 V64 V65 V66 V67 V68 V69 V70 V71 V72 V73 V74 V75 V76 V77 V78 V79
##      1:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##      2:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##      3:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##      4:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##      5:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##     ---
## 52393:   0   1   0   0   0   0   1   0   0   0   0   0   0   0   0   0   0
## 52394:   0   1   0   0   0   0   1   0   0   0   0   0   0   0   0   0   0
## 52395:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
## 52396:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
## 52397:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##        V80 V81 V82 V83 V84 V85 V86 V87 V88 V89 V90 V91 V92 V93 V94 V95 V96
##      1:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##      2:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##      3:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##      4:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##      5:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##     ---
## 52393:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
## 52394:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
## 52395:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
## 52396:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
## 52397:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
##        V97 V98 V99 V100 V101 V102 V103 V104 V105 V106 V107 V108 V109 V110
##      1:   0   0   0    0    0    0    0    0    0    0    0    0    0    0
##      2:   0   0   0    0    0    0    0    0    0    0    0    0    0    0
##      3:   0   0   0    0    0    0    0    0    0    0    0    0    0    0
##      4:   0   0   0    0    0    0    0    0    0    0    0    0    0    0
##      5:   0   0   0    0    0    0    0    0    0    0    0    0    0    0
```

```
##      ---
## 52393:    0    0    0    0    1    0    0    0    0    0    0    0    0    0
## 52394:    0    0    0    0    1    0    0    0    0    0    0    0    0    0
## 52395:    0    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:    0    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:    0    0    0    0    0    0    0    0    0    0    0    0    0    0
##         V111 V112 V113 V114 V115 V116 V117 V118 V119 V120 V121 V122 V123
##     1:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     2:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     3:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     4:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     5:    0    0    0    0    0    0    0    0    0    0    0    0    0
##      ---
## 52393:    0    0    0    0    0    0    0    0    0    0    0    1    0
## 52394:    0    0    0    0    0    0    0    0    0    0    0    1    0
## 52395:    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:    0    0    0    0    0    0    0    0    0    0    0    0    0
##         V124 V125 V126 V127 V128 V129 V130 V131 V132 V133 V134 V135 V136
##     1:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     2:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     3:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     4:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     5:    0    0    0    0    0    0    0    0    0    0    0    0    0
##      ---
## 52393:    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52394:    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52395:    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:    0    0    0    0    0    0    0    0    0    0    0    0    0
##         V137 V138 V139 V140 V141 V142 V143 V144 V145 V146 V147 V148 V149
##     1:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     2:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     3:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     4:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     5:    0    0    0    0    0    0    0    0    0    0    0    0    0
##      ---
## 52393:    0    1    0    0    0    0    1    0    0    0    0    0    0
## 52394:    0    1    0    0    0    0    1    0    0    0    0    0    0
## 52395:    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:    0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:    0    0    0    0    0    0    0    0    0    0    0    0    0
##         V150 V151 V152 V153 V154 V155 V156 V157 V158 V159 V160 V161 V162
##     1:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     2:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     3:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     4:    0    0    0    0    0    0    0    0    0    0    0    0    0
##     5:    0    0    0    0    0    0    0    0    0    0    0    0    0
##      ---
## 52393:    0    0    0    0    0    0    0    0    0    0    0    0    0
```

```
## 52394:     0     0     0     0     0     0     0     0     0     0     0     0     0
## 52395:     0     0     0     0     0     0     0     0     0     0     0     0     0
## 52396:     0     0     0     0     0     0     0     0     0     0     0     0     0
## 52397:     0     0     0     0     0     0     0     0     0     0     0     0     0
##         V163 V164 V165 V166 V167 V168 V169 V170 V171 V172 V173 V174 V175
##     1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     2:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     3:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     4:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     5:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 52393:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52394:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52395:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:     0    0    0    0    0    0    0    0    0    0    0    0    0
##         V176 V177 V178 V179 V180 V181 V182 V183 V184 V185 V186 V187 V188
##     1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     2:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     3:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     4:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     5:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 52393:     0    0    0    0    0    1    0    0    0    0    0    0    0
## 52394:     0    0    0    0    0    1    0    0    0    0    0    0    0
## 52395:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:     0    0    0    0    0    0    0    0    0    0    0    0    0
##         V189 V190 V191 V192 V193 V194 V195 V196 V197 V198 V199 V200 V201
##     1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     2:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     3:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     4:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     5:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 52393:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52394:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52395:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:     0    0    0    0    0    0    0    0    0    0    0    0    0
##         V202 V203 V204 V205 V206 V207 V208 V209 V210 V211 V212 V213 V214
##     1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     2:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     3:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     4:     0    0    0    0    0    0    0    0    0    0    0    0    0
##     5:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 52393:     0    0    0    0    0    0    0    0    0    0    0    1    0
## 52394:     0    0    0    0    0    0    0    0    0    0    0    1    0
## 52395:     0    0    0    0    0    0    0    0    0    0    0    0    0
```

```
## 52396:      0     0     0     0     0     0     0     0     0     0     0     0     0
## 52397:      0     0     0     0     0     0     0     0     0     0     0     0     0
##           V215 V216 V217 V218 V219 V220 V221 V222 V223 V224 V225 V226 V227
##      1:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      2:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      3:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      4:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      5:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 52393:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52394:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52395:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:      0    0    0    0    0    0    0    0    0    0    0    0    0
##           V228 V229 V230 V231 V232 V233 V234 V235 V236 V237 V238 V239 V240
##      1:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      2:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      3:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      4:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      5:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 52393:      1    0    0    0    1    0    0    0    0    0    0    0    0
## 52394:      1    0    0    0    1    0    0    0    0    0    0    0    0
## 52395:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:      0    0    0    0    0    0    0    0    0    0    0    0    0
##           V241 V242 V243 V244 V245 V246 V247 V248 V249 V250 V251 V252 V253
##      1:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      2:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      3:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      4:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      5:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 52393:      0    0    0    0    0    1    0    0    0    0    0    0    0
## 52394:      0    0    0    0    0    1    0    0    0    0    0    0    0
## 52395:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:      0    0    0    0    0    0    0    0    0    0    0    0    0
##           V254 V255 V256 V257 V258 V259 V260 V261 V262 V263 V264 V265 V266
##      1:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      2:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      3:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      4:      0    0    0    0    0    0    0    0    0    0    0    0    0
##      5:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 52393:      0    0    0    0    0    0    0    0    0    0    0    1    0
## 52394:      0    0    0    0    0    0    0    0    0    0    0    0    1
## 52395:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52396:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 52397:      0    0    0    0    0    0    0    0    0    0    0    0    0
```

```
##        V267 V268 V269 V270 V271 V272 V273 V274 V275 V276 V277 V279 V280
##     1:    1    0    0    0    0    0    1    0    0    0    0    0    0
##     2:    1    0    0    0    0    1    0    0    0    0    0    0    0
##     3:    1    0    0    0    0    1    0    0    0    0    0    0    0
##     4:    1    0    0    0    0    0    1    0    0    0    0    0    0
##     5:    0    1    0    0    0    0    1    0    0    0    0    0    0
##    ---
## 52393:    0    0    0    1    0    0    0    0    0    0    0    0    0
## 52394:    0    0    0    1    0    0    0    0    0    0    0    0    0
## 52395:    1    0    0    0    0    0    1    0    0    0    0    0    0
## 52396:    0    1    0    0    0    0    1    0    0    0    0    0    0
## 52397:    0    0    1    0    0    0    1    0    0    0    0    0    0
##            V281
##     1: 0.6931472
##     2: 0.0000000
##     3: 0.0000000
##     4: 0.6931472
##     5: 3.3322045
##    ---
## 52393: 0.0000000
## 52394: 0.0000000
## 52395: 0.0000000
## 52396: 0.0000000
## 52397: 0.0000000
```

test

```
##              V1         V2 V3  V4   V5         V6       V7  V9 V10
##     1: 10.630660  17.882992  1 259  5.0  4.0182760 10.39679 235 1.0
##     2: 43.435825  75.590485  0 634 20.0 15.9985895 44.56087 473 2.0
##     3:  1.733333   3.043390  0   9  0.0  0.7333333  1.52607   5 0.0
##     4: 27.230215  45.970950  0 371 14.0 10.7841730 24.20994 228 4.0
##     5:  4.500000   6.677075  0  18  0.5  3.0000000  4.00000  10 0.5
##    ---
## 7620:  0.000000   0.000000  0   0  0.0  0.0000000  0.00000   0 0.0
## 7621: 56.512093  77.442830  0 438 32.0 19.2965300 49.22134 432 0.0
## 7622: 49.442368 112.620125  1 849  9.0 20.4454820 62.61939 506 2.0
## 7623: 16.593575  19.671364  1 144 10.0  6.5124497 11.05121 111 2.0
## 7624:  0.000000   0.000000  0   0  0.0  0.0000000  0.00000   0 0.0
##             V11        V12 V14 V15        V16        V17 V18 V19  V20
##     1:  3.8172395 10.297346 235   1  9.776869 16.073494   1 192  5.0
##     2: 15.4696760 44.685085 473   1 40.971790 70.307840   0 479 18.0
##     3:  0.6666667  1.534782   5   0  1.133333  1.820867   0   5  0.0
##     4:  9.9976015 24.400290 228   2 22.563549 39.761290   0 337 10.0
##     5:  1.3333334  2.560382   7   0  2.833333  3.670453   0   8  0.5
##    ---
## 7620:  0.0000000  0.000000   0   0  0.000000  0.000000   0   0  0.0
## 7621: 18.9663500 49.304424 432   0 55.904312 76.864080   0 438 31.0
## 7622: 19.2211840 62.536453 506   1 38.274143 85.508520   1 574  7.0
## 7623:  5.8257027 11.001102 111   1 13.765462 15.641400   1 112  9.0
```

```
## 7624:   0.0000000   0.000000    0    0  0.000000   0.000000    0    0  0.0
##              V21        V22   V23 V24 V25        V26        V27 V29 V30
##    1: 0.20103656 13.948867  -229 217 0.0 0.25177306 0.9038038   14   0
##    2: 0.52891400 62.134968  -461 473 0.0 0.19322990 0.4576994    2   0
##    3: 0.06666667  1.730767    -5   4 0.0 0.33333334 0.6992059    2   0
##    4: 0.78657070 30.358133  -156 228 0.0 0.11031175 0.3562584    2   0
##    5: 1.66666660  2.211083     0   6 0.5 0.00000000 0.0000000    0   0
##    ---
## 7620: 0.00000000  0.000000     0   0 0.0 0.00000000 0.0000000    0   0
## 7621: 0.33017877 72.227750  -426 432 0.0 0.00000000 0.0000000    0   0
## 7622: 1.22429910 78.975365  -474 506 0.0 1.07476640 2.2341206   16   0
## 7623: 0.68674700 14.777326  -104 111 0.0 0.01526104 0.1350592    2   0
## 7624: 0.00000000  0.000000     0   0 0.0 0.00000000 0.0000000    0   0
##              V31        V32 V34 V35        V36        V37 V39        V41
##    1: 0.09438080 0.50673160  12   0 0.09192581 0.50421600  12 0.23349700
##    2: 0.07334273 0.28647503   2   0 0.06770099 0.27788836   2 0.17630465
##    3: 0.13333334 0.33993465   1   0 0.13333334 0.33993465   1 0.20000000
##    4: 0.04316547 0.21470532   2   0 0.04076739 0.20952702   2 0.09832134
##    5: 0.00000000 0.00000000   0   0 0.00000000 0.00000000   0 0.00000000
##    ---
## 7620: 0.00000000 0.00000000   0   0 0.00000000 0.00000000   0 0.00000000
## 7621: 0.00000000 0.00000000   0   0 0.00000000 0.00000000   0 0.00000000
## 7622: 0.42679128 1.34016500  13   0 0.40809968 1.33201530  13 0.95015574
## 7623: 0.00562249 0.08483692   2   0 0.00562249 0.08483692   2 0.01526104
## 7624: 0.00000000 0.00000000   0   0 0.00000000 0.00000000   0 0.00000000
##           V42 V44 V45         V46       V47 V48 V49 V51 V52 V53 V54 V55
##    1: 0.8547111  13   0 0.002454992 0.6747285 -10  12  35  35   0  35  35
##    2: 0.4297832   2   0 0.005641749 0.4044489  -2   2  21   0   2  21  -2
##    3: 0.4000000   1   0 0.000000000 0.3651484  -1   1   2   2   0   2   2
##    4: 0.3210027   2   0 0.002398082 0.2897018  -2   2   3   3   0   3   3
##    5: 0.0000000   0   0 0.000000000 0.0000000   0   0   0   0   0   0   0
##    ---
## 7620: 0.0000000   0   0 0.000000000 0.0000000   0   0   1   1   0   0   1
## 7621: 0.0000000   0   0 0.000000000 0.0000000   0   0   2   1   1   1   0
## 7622: 1.9263725  14   0 0.018691588 1.7894533 -11  13   3   1   0   2   1
## 7623: 0.1350592   2   0 0.000000000 0.1202407  -2   2   8   8   0   8   8
## 7624: 0.0000000   0   0 0.000000000 0.0000000   0   0   1   1   0   1   1
##        V56 V57 V58 V59 V60 V61    V62 V63 V64 V65 V66 V67 V68 V69 V70 V71 V72
##    1:    0   0   0   0   0   9      0   0   0   0   0   0   0   0   0   0   0
##    2:    0   0   0   0   0  62    696   0   0   0   0   1   0   0   0   0   0
##    3:    2   2   0   2   2  13   8361   0   1   0   0   1   1   1   0   0   0
##    4:    0   0   0   0   0   9   2751   0   0   0   0   0   0   0   0   0   0
##    5:    0   0   0   0   0   5    187   0   0   0   0   0   0   0   0   0   0
##    ---
## 7620:    0   0   0   0   0  64   1478   0   0   0   0   0   0   0   0   0   0
## 7621:    0   0   0   0   0  47   4196   0   0   0   0   0   0   0   0   0   0
## 7622:    0   0   0   0   0  63      0   0   0   0   0   0   0   0   0   0   0
## 7623:    0   0   0   0   0  14      0   0   0   0   0   0   0   0   0   0   0
## 7624:    0   0   0   0   0   9      0   0   0   0   0   0   0   0   0   0   0
##        V73 V74 V75 V76 V77 V78 V79 V80 V81 V82 V83 V84 V85 V86 V87 V88 V89
```

```
##    1:    0  0  0  0  0  0  0  0  0  0  0  0  0  '  0  0  0
##    2:    0  0  0  0  0  0  0  0  0  0  0  0  0  '  0  0  0
##    3:    0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0
##    4:    0  0  0  0  0  0  0  0  0  0  0  0  0  '  0  0  0
##    5:    0  0  0  0  0  0  0  0  0  0  0  0  0  '  0  0  0
##    ---
## 7620:    0  0  0  0  0  0  0  0  0  0  0  0  0  '  0  0  0
## 7621:    0  0  0  0  0  0  1  0  0  0  0  0  0  '  0  0  0
## 7622:    0  0  0  0  0  0  0  0  0  0  0  0  0  '  0  0  0
## 7623:    0  0  0  0  0  0  0  0  0  0  0  0  0  '  0  0  0
## 7624:    0  0  0  0  0  0  0  0  0  0  0  0  0  '  0  0  0
##        V90 V91 V92 V93 V94 V95 V96 V97 V98 V99 V100 V101 V102 V103 V104
##    1:    0   0   0   0   0   0   0   0   0   0    0    0    0    0    0
##    2:    0   0   0   0   0   0   0   0   0   0    0    1    0    0    0
##    3:    0   0   0   0   0   0   1   0   0   0    0    1    1    0    0
##    4:    0   0   0   0   0   0   0   0   0   0    0    1    0    0    0
##    5:    0   0   0   0   0   0   0   0   0   0    0    0    0    0    0
##    ---
## 7620:    0   0   0   0   0   0   0   0   0   0    0    0    0    0    0
## 7621:    0   0   0   0   0   0   0   0   0   0    0    0    0    1    0
## 7622:    0   0   0   0   0   0   0   0   0   0    0    0    0    0    0
## 7623:    0   0   0   0   0   0   0   0   0   0    0    0    0    0    0
## 7624:    0   0   0   0   0   0   0   0   0   0    0    0    0    0    0
##        V105 V106 V107 V108 V109 V110 V111 V112 V113 V114 V115 V116 V117
##    1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    3:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    4:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    5:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 7620:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7622:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:     0    0    0    0    0    0    0    0    0    0    0    0    0
##        V118 V119 V120 V121 V122 V123 V124 V125 V126 V127 V128 V129 V130
##    1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    3:     0    0    1    0    1    0    0    0    0    0    0    0    0
##    4:     0    1    0    0    1    0    0    0    0    0    0    0    0
##    5:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    ---
## 7620:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:     0    0    1    0    0    0    0    0    0    0    0    0    0
## 7622:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:     0    0    0    0    0    0    0    0    0    0    0    0    0
##        V131 V132 V133 V134 V135 V136 V137 V138 V139 V140 V141 V142 V143
##    1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:     0    0    0    0    0    0    0    0    1    0    0    0    0
```

```
##    3:       0    0    0    0    0    0    0    0    0    0    0    0    1
##    4:       0    0    0    0    0    0    0    0    0    0    0    0    1
##    5:       0    0    0    0    0    0    0    0    0    0    0    0    1
##   ---
## 7620:       0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:       0    0    0    0    0    0    0    0    1    0    0    0    1
## 7622:       0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:       0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:       0    0    0    0    0    0    0    0    0    0    0    0    0
##         V144 V145 V146 V147 V148 V149 V150 V151 V152 V153 V154 V155 V156
##    1:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:      0    0    0    0    0    0    0    1    0    0    0    0    0
##    3:      0    0    0    0    0    0    0    1    0    1    0    0    0
##    4:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    5:      0    0    0    0    0    0    0    0    0    0    0    0    0
##   ---
## 7620:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7622:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:      0    0    0    0    0    0    0    0    0    0    0    0    0
##         V157 V158 V159 V160 V161 V162 V163 V164 V165 V166 V167 V168 V169
##    1:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    3:      0    1    1    0    0    0    0    0    0    0    0    0    0
##    4:      0    1    0    0    0    0    0    0    0    0    0    0    0
##    5:      0    0    0    0    0    0    0    0    0    0    0    0    0
##   ---
## 7620:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:      0    1    0    0    0    0    0    0    0    0    0    0    0
## 7622:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:      0    0    0    0    0    0    0    0    0    0    0    0    0
##         V170 V171 V172 V173 V174 V175 V176 V177 V178 V179 V180 V181 V182
##    1:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    3:      1    0    0    0    0    0    0    0    0    0    1    1    0
##    4:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    5:      0    0    0    0    0    0    0    0    0    0    0    0    0
##   ---
## 7620:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7622:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:      0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:      0    0    0    0    0    0    0    0    0    0    0    0    0
##         V183 V184 V185 V186 V187 V188 V189 V190 V191 V192 V193 V194 V195
##    1:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:      0    0    0    0    0    0    0    0    0    0    0    0    0
##    3:      0    0    0    0    0    0    0    0    1    0    0    0    0
##    4:      0    0    0    0    0    0    0    0    0    0    0    0    0
```

```
##    5:     0    0    0    0    0    0    0    0    0    0    0    0    0
## ---
## 7620:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:     0    0    0    0    0    0    0    0    0    0    1    1    0
## 7622:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:     0    0    0    0    0    0    0    0    0    0    0    0    0
##        V196 V197 V198 V199 V200 V201 V202 V203 V204 V205 V206 V207 V208
##    1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    3:     0    0    0    0    0    0    1    0    0    0    0    1    0
##    4:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    5:     0    0    0    0    0    0    0    0    0    0    0    0    0
## ---
## 7620:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:     0    1    0    0    0    0    1    0    0    0    0    0    0
## 7622:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:     0    0    0    0    0    0    0    0    0    0    0    0    0
##        V209 V210 V211 V212 V213 V214 V215 V216 V217 V218 V219 V220 V221
##    1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    3:     0    1    0    0    1    0    0    0    0    0    0    0    0
##    4:     0    0    0    0    1    0    0    0    0    0    0    0    0
##    5:     0    0    0    0    0    0    0    0    0    0    0    0    0
## ---
## 7620:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:     0    0    0    0    1    0    0    0    0    0    0    0    0
## 7622:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:     0    0    0    0    0    0    0    0    0    0    0    0    0
##        V222 V223 V224 V225 V226 V227 V228 V229 V230 V231 V232 V233 V234
##    1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:     0    0    0    0    1    0    0    0    0    0    1    0    0
##    3:     0    0    0    0    1    0    1    0    0    0    1    0    0
##    4:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    5:     0    0    0    0    0    0    0    0    0    0    0    0    0
## ---
## 7620:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7621:     0    0    0    0    0    0    0    0    1    0    1    0    0
## 7622:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7623:     0    0    0    0    0    0    0    0    0    0    0    0    0
## 7624:     0    0    0    0    0    0    0    0    0    0    0    0    0
##        V235 V236 V237 V238 V239 V240 V241 V242 V243 V244 V245 V246 V247
##    1:     0    0    0    0    0    0    0    0    0    0    0    0    0
##    2:     0    0    0    0    0    0    0    0    0    0    0    1    0
##    3:     0    0    0    0    0    0    0    0    0    0    0    1    0
##    4:     0    0    0    0    0    0    0    0    0    0    0    1    1
##    5:     0    0    0    0    0    0    0    0    0    0    0    1    0
## ---
```

```
## 7620:      0     0     0     0     0     0     0     0     0     0     0     0     0
## 7621:      0     0     0     0     0     0     0     0     0     0     0     1     0
## 7622:      0     0     0     0     0     0     0     0     0     0     0     0     0
## 7623:      0     0     0     0     0     0     0     0     0     0     0     0     0
## 7624:      0     0     0     0     0     0     0     0     0     0     0     0     0
##          V248 V249 V250 V251 V252 V253 V254 V255 V256 V257 V258 V259 V260
##    1:      0     0     0     0     0     0     0     0     0     0     0     0     0
##    2:      0     0     0     0     0     0     0     0     0     0     0     0     0
##    3:      1     0     0     0     0     0     1     0     0     0     0     0     0
##    4:      0     0     0     0     0     0     0     0     0     0     0     0     0
##    5:      0     0     0     0     0     0     0     0     0     0     0     0     0
##    ---
## 7620:      0     0     0     0     0     0     0     0     0     0     0     0     0
## 7621:      0     0     0     0     0     0     0     0     0     0     0     0     0
## 7622:      0     0     0     0     0     0     0     0     0     0     0     0     0
## 7623:      0     0     0     0     0     0     0     0     0     0     0     0     0
## 7624:      0     0     0     0     0     0     0     0     0     0     0     0     0
##          V261 V262 V263 V264 V265 V266 V267 V268 V269 V270 V271 V272 V273
##    1:      0     0     0     0     1     0     0     0     0     0     1     0     0
##    2:      0     0     0     0     1     0     0     0     0     0     0     0     0
##    3:      0     0     0     0     1     0     0     0     0     0     1     0     0
##    4:      0     0     0     0     1     0     0     0     0     0     1     0     0
##    5:      0     0     0     0     1     0     0     0     0     0     1     0     0
##    ---
## 7620:      0     0     0     0     0     0     0     1     0     0     0     1     0
## 7621:      0     0     0     0     0     0     0     1     0     0     0     0     1
## 7622:      0     0     0     0     0     0     0     1     0     0     0     1     0
## 7623:      0     0     0     0     0     0     0     1     0     0     0     0     0
## 7624:      0     0     0     0     0     0     0     1     0     0     0     0     0
##          V274 V275 V276 V277 V279 V280        V281
##    1:      0     0     0     0     0     0 1.6094379
##    2:      0     0     1     0     0     0 0.0000000
##    3:      0     0     0     0     0     0 0.6931472
##    4:      0     0     0     0     0     0 1.7917595
##    5:      0     0     0     0     0     0 0.0000000
##    ---
## 7620:      0     0     0     0     0     0 0.0000000
## 7621:      0     0     0     0     0     0 0.0000000
## 7622:      0     0     0     0     0     0 0.0000000
## 7623:      1     0     0     0     0     0 1.3862944
## 7624:      1     0     0     0     0     0 0.0000000

### Basic Models ###
library(data.table)
library(MatrixModels)

library(e1071)
library(FNN)
library(glmnet)
```

```
## Loading required package: Matrix

## Loaded glmnet 2.0-16

library(ranger)
library(xgboost)

# load and combine dataset
train = fread("BlogFeedback-Train.csv")
test = fread("BlogFeedback-Test.csv")

# error measure
mse = function(y_hat, y) {
  mse = mean((y - y_hat)^2)

  return(mse)
}

# create design matrices
train_x = model.Matrix(V281 ~ . - 1, data = train, sparse = F)
train_x_sparse = model.Matrix(V281 ~ . - 1, data = train, sparse = T)
train_y = train$V281

test_x = model.Matrix(V281 ~ . - 1, data = test, sparse = F)
test_y = test$V281

train_xgb = xgb.DMatrix(data = as.matrix(train_x), label = train_y)
test_xgb = xgb.DMatrix(data = as.matrix(test_x), label = test_y)

# try kNN
pred_knn = knn.reg(train_x, test_x, train_y, k = 19)$pred
mse(pred_knn, test_y)

## [1] 0.6383154

# try LASSO
mdl_lasso = cv.glmnet(train_x_sparse, train_y, family = "gaussian", alpha = 1
)
pred_lasso = predict(mdl_lasso, newx = test_x)
mse(pred_lasso, test_y)

## [1] 0.6365795

# try random forest
mdl_rf = ranger(V281 ~ ., data = train, num.trees = 1000, mtry = 120, write.f
orest = T)

## Growing trees.. Progress: 3%. Estimated remaining time: 21 minutes, 27 sec
onds.
## Growing trees.. Progress: 5%. Estimated remaining time: 19 minutes, 39 sec
onds.
```

```
## Growing trees.. Progress: 8%. Estimated remaining time: 18 minutes, 54 sec
onds.
## Growing trees.. Progress: 11%. Estimated remaining time: 18 minutes, 7 sec
onds.
## Growing trees.. Progress: 14%. Estimated remaining time: 17 minutes, 19 se
conds.
## Growing trees.. Progress: 17%. Estimated remaining time: 16 minutes, 36 se
conds.
## Growing trees.. Progress: 19%. Estimated remaining time: 16 minutes, 1 sec
onds.
## Growing trees.. Progress: 22%. Estimated remaining time: 15 minutes, 27 se
conds.
## Growing trees.. Progress: 25%. Estimated remaining time: 14 minutes, 51 se
conds.
## Growing trees.. Progress: 28%. Estimated remaining time: 14 minutes, 17 se
conds.
## Growing trees.. Progress: 30%. Estimated remaining time: 13 minutes, 41 se
conds.
## Growing trees.. Progress: 33%. Estimated remaining time: 13 minutes, 8 sec
onds.
## Growing trees.. Progress: 36%. Estimated remaining time: 12 minutes, 35 se
conds.
## Growing trees.. Progress: 39%. Estimated remaining time: 12 minutes, 2 sec
onds.
## Growing trees.. Progress: 42%. Estimated remaining time: 11 minutes, 29 se
conds.
## Growing trees.. Progress: 44%. Estimated remaining time: 10 minutes, 57 se
conds.
## Growing trees.. Progress: 47%. Estimated remaining time: 10 minutes, 25 se
conds.
## Growing trees.. Progress: 49%. Estimated remaining time: 10 minutes, 4 sec
onds.
## Growing trees.. Progress: 52%. Estimated remaining time: 9 minutes, 45 sec
onds.
## Growing trees.. Progress: 54%. Estimated remaining time: 9 minutes, 19 sec
onds.
## Growing trees.. Progress: 57%. Estimated remaining time: 8 minutes, 44 sec
onds.
## Growing trees.. Progress: 59%. Estimated remaining time: 8 minutes, 11 sec
onds.
## Growing trees.. Progress: 62%. Estimated remaining time: 7 minutes, 41 sec
onds.
## Growing trees.. Progress: 65%. Estimated remaining time: 7 minutes, 7 seco
nds.
## Growing trees.. Progress: 67%. Estimated remaining time: 6 minutes, 39 sec
onds.
## Growing trees.. Progress: 70%. Estimated remaining time: 6 minutes, 11 sec
onds.
## Growing trees.. Progress: 72%. Estimated remaining time: 5 minutes, 38 sec
onds.
```

```
## Growing trees.. Progress: 75%. Estimated remaining time: 5 minutes, 3 seco
nds.
## Growing trees.. Progress: 78%. Estimated remaining time: 4 minutes, 29 sec
onds.
## Growing trees.. Progress: 80%. Estimated remaining time: 3 minutes, 59 sec
onds.
## Growing trees.. Progress: 83%. Estimated remaining time: 3 minutes, 26 sec
onds.
## Growing trees.. Progress: 86%. Estimated remaining time: 2 minutes, 52 sec
onds.
## Growing trees.. Progress: 89%. Estimated remaining time: 2 minutes, 18 sec
onds.
## Growing trees.. Progress: 91%. Estimated remaining time: 1 minute, 44 seco
nds.
## Growing trees.. Progress: 94%. Estimated remaining time: 1 minute, 10 seco
nds.
## Growing trees.. Progress: 97%. Estimated remaining time: 36 seconds.
## Growing trees.. Progress: 100%. Estimated remaining time: 2 seconds.

pred_rf = predict(mdl_rf, test)
mse(pred_rf$predictions, test_y)

## [1] 0.397223

# try SVM
mdl_svm = svm(V281 ~ V52 + V55 + V61 + V51 + V54 + V21 + V6 + V10, data = tra
in, kernel = "radial", cost = 2, gamma = 0.25)
pred_svm = predict(mdl_svm, test)
mse(pred_svm, test_y)

## [1] 0.4454636

# try XGboost
mdl_xgb = xgboost(data = train_xgb, nround = 750, nthread = 4, max_depth = 6,
eta = 0.025, subsample = 0.7, gamma = 3)

## [1]  train-rmse:1.123211
## [2]  train-rmse:1.105587
## [3]  train-rmse:1.088751
## [4]  train-rmse:1.072364
## [5]  train-rmse:1.056541
## [6]  train-rmse:1.041299
## [7]  train-rmse:1.026474
## [8]  train-rmse:1.012151
## [9]  train-rmse:0.998236
## [10] train-rmse:0.984944
## [11] train-rmse:0.972046
## [12] train-rmse:0.959660
## [13] train-rmse:0.947695
## [14] train-rmse:0.936049
## [15] train-rmse:0.924799
```

```
## [16] train-rmse:0.913825
## [17] train-rmse:0.903303
## [18] train-rmse:0.893156
## [19] train-rmse:0.883414
## [20] train-rmse:0.874059
## [21] train-rmse:0.865047
## [22] train-rmse:0.856306
## [23] train-rmse:0.848055
## [24] train-rmse:0.840064
## [25] train-rmse:0.832164
## [26] train-rmse:0.824686
## [27] train-rmse:0.817432
## [28] train-rmse:0.810481
## [29] train-rmse:0.803617
## [30] train-rmse:0.797115
## [31] train-rmse:0.790814
## [32] train-rmse:0.784595
## [33] train-rmse:0.778755
## [34] train-rmse:0.773094
## [35] train-rmse:0.767748
## [36] train-rmse:0.762395
## [37] train-rmse:0.757345
## [38] train-rmse:0.752488
## [39] train-rmse:0.747817
## [40] train-rmse:0.743399
## [41] train-rmse:0.739041
## [42] train-rmse:0.734814
## [43] train-rmse:0.730827
## [44] train-rmse:0.726892
## [45] train-rmse:0.723121
## [46] train-rmse:0.719583
## [47] train-rmse:0.716088
## [48] train-rmse:0.712764
## [49] train-rmse:0.709580
## [50] train-rmse:0.706472
## [51] train-rmse:0.703511
## [52] train-rmse:0.700691
## [53] train-rmse:0.697894
## [54] train-rmse:0.695273
## [55] train-rmse:0.692620
## [56] train-rmse:0.690116
## [57] train-rmse:0.687650
## [58] train-rmse:0.685264
## [59] train-rmse:0.683066
## [60] train-rmse:0.680842
## [61] train-rmse:0.678713
## [62] train-rmse:0.676759
## [63] train-rmse:0.674839
## [64] train-rmse:0.672873
## [65] train-rmse:0.671013
```

```
## [66]  train-rmse:0.669334
## [67]  train-rmse:0.667636
## [68]  train-rmse:0.665990
## [69]  train-rmse:0.664497
## [70]  train-rmse:0.662978
## [71]  train-rmse:0.661438
## [72]  train-rmse:0.659984
## [73]  train-rmse:0.658645
## [74]  train-rmse:0.657361
## [75]  train-rmse:0.656081
## [76]  train-rmse:0.654839
## [77]  train-rmse:0.653571
## [78]  train-rmse:0.652382
## [79]  train-rmse:0.651310
## [80]  train-rmse:0.650165
## [81]  train-rmse:0.649082
## [82]  train-rmse:0.647973
## [83]  train-rmse:0.646989
## [84]  train-rmse:0.645910
## [85]  train-rmse:0.644910
## [86]  train-rmse:0.643895
## [87]  train-rmse:0.642963
## [88]  train-rmse:0.642045
## [89]  train-rmse:0.641064
## [90]  train-rmse:0.640266
## [91]  train-rmse:0.639491
## [92]  train-rmse:0.638624
## [93]  train-rmse:0.637817
## [94]  train-rmse:0.636958
## [95]  train-rmse:0.636172
## [96]  train-rmse:0.635401
## [97]  train-rmse:0.634687
## [98]  train-rmse:0.633978
## [99]  train-rmse:0.633370
## [100]     train-rmse:0.632676
## [101]     train-rmse:0.632104
## [102]     train-rmse:0.631501
## [103]     train-rmse:0.630874
## [104]     train-rmse:0.630224
## [105]     train-rmse:0.629601
## [106]     train-rmse:0.628939
## [107]     train-rmse:0.628386
## [108]     train-rmse:0.627850
## [109]     train-rmse:0.627310
## [110]     train-rmse:0.626764
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## [595]    train-rmse:0.562295
## [596]    train-rmse:0.562152
## [597]    train-rmse:0.562133
## [598]    train-rmse:0.562080
## [599]    train-rmse:0.562019
## [600]    train-rmse:0.561969
## [601]    train-rmse:0.561853
## [602]    train-rmse:0.561769
## [603]    train-rmse:0.561704
## [604]    train-rmse:0.561692
## [605]    train-rmse:0.561538
## [606]    train-rmse:0.561490
## [607]    train-rmse:0.561445
## [608]    train-rmse:0.561399
## [609]    train-rmse:0.561362
## [610]    train-rmse:0.561260
## [611]    train-rmse:0.561170
## [612]    train-rmse:0.561084
## [613]    train-rmse:0.561050
## [614]    train-rmse:0.561009
## [615]    train-rmse:0.560896
```

```
## [616]     train-rmse:0.560808
## [617]     train-rmse:0.560802
## [618]     train-rmse:0.560758
## [619]     train-rmse:0.560704
## [620]     train-rmse:0.560695
## [621]     train-rmse:0.560661
## [622]     train-rmse:0.560614
## [623]     train-rmse:0.560526
## [624]     train-rmse:0.560416
## [625]     train-rmse:0.560366
## [626]     train-rmse:0.560359
## [627]     train-rmse:0.560258
## [628]     train-rmse:0.560213
## [629]     train-rmse:0.560183
## [630]     train-rmse:0.560118
## [631]     train-rmse:0.560045
## [632]     train-rmse:0.560045
## [633]     train-rmse:0.560005
## [634]     train-rmse:0.559984
## [635]     train-rmse:0.559852
## [636]     train-rmse:0.559780
## [637]     train-rmse:0.559732
## [638]     train-rmse:0.559652
## [639]     train-rmse:0.559571
## [640]     train-rmse:0.559488
## [641]     train-rmse:0.559424
## [642]     train-rmse:0.559350
## [643]     train-rmse:0.559271
## [644]     train-rmse:0.559177
## [645]     train-rmse:0.559133
## [646]     train-rmse:0.559046
## [647]     train-rmse:0.558994
## [648]     train-rmse:0.558894
## [649]     train-rmse:0.558822
## [650]     train-rmse:0.558729
## [651]     train-rmse:0.558702
## [652]     train-rmse:0.558696
## [653]     train-rmse:0.558690
## [654]     train-rmse:0.558603
## [655]     train-rmse:0.558501
## [656]     train-rmse:0.558426
## [657]     train-rmse:0.558357
## [658]     train-rmse:0.558322
## [659]     train-rmse:0.558279
## [660]     train-rmse:0.558240
## [661]     train-rmse:0.558210
## [662]     train-rmse:0.558096
## [663]     train-rmse:0.558074
## [664]     train-rmse:0.557961
## [665]     train-rmse:0.557920
```

```
## [666]    train-rmse:0.557846
## [667]    train-rmse:0.557839
## [668]    train-rmse:0.557823
## [669]    train-rmse:0.557763
## [670]    train-rmse:0.557678
## [671]    train-rmse:0.557651
## [672]    train-rmse:0.557560
## [673]    train-rmse:0.557560
## [674]    train-rmse:0.557556
## [675]    train-rmse:0.557420
## [676]    train-rmse:0.557382
## [677]    train-rmse:0.557361
## [678]    train-rmse:0.557331
## [679]    train-rmse:0.557165
## [680]    train-rmse:0.557043
## [681]    train-rmse:0.557010
## [682]    train-rmse:0.556883
## [683]    train-rmse:0.556822
## [684]    train-rmse:0.556749
## [685]    train-rmse:0.556685
## [686]    train-rmse:0.556656
## [687]    train-rmse:0.556534
## [688]    train-rmse:0.556433
## [689]    train-rmse:0.556387
## [690]    train-rmse:0.556345
## [691]    train-rmse:0.556276
## [692]    train-rmse:0.556196
## [693]    train-rmse:0.556129
## [694]    train-rmse:0.556098
## [695]    train-rmse:0.556087
## [696]    train-rmse:0.556022
## [697]    train-rmse:0.555907
## [698]    train-rmse:0.555800
## [699]    train-rmse:0.555728
## [700]    train-rmse:0.555708
## [701]    train-rmse:0.555664
## [702]    train-rmse:0.555613
## [703]    train-rmse:0.555506
## [704]    train-rmse:0.555434
## [705]    train-rmse:0.555411
## [706]    train-rmse:0.555359
## [707]    train-rmse:0.555323
## [708]    train-rmse:0.555262
## [709]    train-rmse:0.555186
## [710]    train-rmse:0.555164
## [711]    train-rmse:0.555138
## [712]    train-rmse:0.555086
## [713]    train-rmse:0.555059
## [714]    train-rmse:0.555029
## [715]    train-rmse:0.554960
```

```
## [716]     train-rmse:0.554933
## [717]     train-rmse:0.554918
## [718]     train-rmse:0.554870
## [719]     train-rmse:0.554847
## [720]     train-rmse:0.554830
## [721]     train-rmse:0.554803
## [722]     train-rmse:0.554764
## [723]     train-rmse:0.554724
## [724]     train-rmse:0.554703
## [725]     train-rmse:0.554668
## [726]     train-rmse:0.554668
## [727]     train-rmse:0.554567
## [728]     train-rmse:0.554499
## [729]     train-rmse:0.554499
## [730]     train-rmse:0.554475
## [731]     train-rmse:0.554445
## [732]     train-rmse:0.554418
## [733]     train-rmse:0.554371
## [734]     train-rmse:0.554298
## [735]     train-rmse:0.554248
## [736]     train-rmse:0.554165
## [737]     train-rmse:0.554048
## [738]     train-rmse:0.553964
## [739]     train-rmse:0.553785
## [740]     train-rmse:0.553774
## [741]     train-rmse:0.553748
## [742]     train-rmse:0.553698
## [743]     train-rmse:0.553636
## [744]     train-rmse:0.553566
## [745]     train-rmse:0.553554
## [746]     train-rmse:0.553521
## [747]     train-rmse:0.553512
## [748]     train-rmse:0.553420
## [749]     train-rmse:0.553361
## [750]     train-rmse:0.553349

pred_xgb = predict(mdl_xgb, test_xgb)
mse(pred_xgb, test_y)

## [1] 0.3820247

### Stacked Generalization ###
library(data.table)
library(foreach)
library(MatrixModels)

library(e1071)
library(FNN)
library(glmnet)
library(ranger)
```

```r
library(xgboost)

# load and combine dataset
train = fread("BlogFeedback-Train.csv")
test = fread("BlogFeedback-Test.csv")

# error measure
mse = function(y_hat, y) {
  mse = mean((y - y_hat)^2)

  return(mse)
}

# create design matrices
test_x = model.Matrix(V281 ~ . - 1, data = test, sparse = F)
test_x_sparse = model.Matrix(V281 ~ . - 1, data = test, sparse = T)
#test_xgb = xgb.DMatrix(data = as.matrix(test_x), label = test_y)

train_y = train$V281
test_y = test$V281

# divide training set into k folds
k = 5
cv_index = 1:nrow(train)
cv_index_split = split(cv_index, cut(seq_along(cv_index), k, labels = FALSE))

# meta features from kNN
meta_knn_test = rep(0, nrow(test))
meta_knn_train = foreach(i = 1:k, .combine = c) %do% {
  # split the raining set into two disjoint sets
  train_index = setdiff(1:nrow(train), cv_index_split[[i]])
  train_set1 = model.Matrix(V281 ~ . - 1, data = train[train_index], sparse =
T)
  train_set2 = model.Matrix(V281 ~ . - 1, data = train[cv_index_split[[i]]],
sparse = T)

  # level 0 prediction
  meta_pred = knn.reg(train_set1, train_set2, train[train_index]$V281, k = 19
)$pred
  meta_knn_test = meta_knn_test + knn.reg(train_set1, test_x_sparse, train[tr
ain_index]$V281, k = 19)$pred / k

  return(meta_pred)
}

# meta features from LASSO
meta_glm_test = rep(0, nrow(test))
meta_glm_train = foreach(i = 1:k, .combine = c) %do% {
  # split the raining set into two disjoint sets
```

```r
  train_index = setdiff(1:nrow(train), cv_index_split[[i]])
  train_set1 = model.Matrix(V281 ~ . - 1, data = train[train_index], sparse =
T)
  train_set2 = model.Matrix(V281 ~ . - 1, data = train[cv_index_split[[i]]],
sparse = T)

  # level 0 prediction
  temp_glm = cv.glmnet(train_set1, train[train_index]$V281, family = "gaussia
n", alpha = 1)
  meta_pred = predict(temp_glm, newx = train_set2)
  meta_glm_test = meta_glm_test + predict(temp_glm, newx = test_x_sparse) / k

  return(meta_pred)
}


# meta features from SVM
meta_svm_test = rep(0, nrow(test))
meta_svm_train = foreach(i = 1:k, .combine = c) %do% {
  # split the raining set into two disjoint sets
  train_index = setdiff(1:nrow(train), cv_index_split[[i]])
  train_set1 = train[train_index]
  train_set2 = train[cv_index_split[[i]]]

  # level 0 prediction
  temp_svm = svm(V281 ~ V52 + V55 + V61 + V51 + V54 + V21 + V6 + V10, data =
train_set1,
               kernel = "radial", cost = 2, gamma = 0.25)
  meta_pred = predict(temp_svm, train_set2)
  meta_svm_test = meta_svm_test + predict(temp_svm, test) / k

  return(meta_pred)
}

# meta features from random forest
meta_rf_test = rep(0, nrow(test))
meta_rf_train = foreach(i = 1:k, .combine = c) %do% {
  # split the raining set into two disjoint sets
  train_index = setdiff(1:nrow(train), cv_index_split[[i]])
  train_set1 = train[train_index]
  train_set2 = train[cv_index_split[[i]]]

  # level 0 prediction
  temp_rf = ranger(V281 ~ ., data = train_set1, num.trees = 500, mtry = 120,
write.forest = T)
  meta_pred = predict(temp_rf, train_set2)$predictions
  meta_rf_test = meta_rf_test + predict(temp_rf, test)$predictions / k
```

```
  return(meta_pred)
}
```

Growing trees.. Progress: 7%. Estimated remaining time: 7 minutes, 18 seco
nds.
Growing trees.. Progress: 14%. Estimated remaining time: 6 minutes, 33 sec
onds.
Growing trees.. Progress: 21%. Estimated remaining time: 5 minutes, 57 sec
onds.
Growing trees.. Progress: 28%. Estimated remaining time: 5 minutes, 25 sec
onds.
Growing trees.. Progress: 35%. Estimated remaining time: 4 minutes, 51 sec
onds.
Growing trees.. Progress: 43%. Estimated remaining time: 4 minutes, 18 sec
onds.
Growing trees.. Progress: 50%. Estimated remaining time: 3 minutes, 45 sec
onds.
Growing trees.. Progress: 57%. Estimated remaining time: 3 minutes, 13 sec
onds.
Growing trees.. Progress: 64%. Estimated remaining time: 2 minutes, 40 sec
onds.
Growing trees.. Progress: 71%. Estimated remaining time: 2 minutes, 8 seco
nds.
Growing trees.. Progress: 79%. Estimated remaining time: 1 minute, 36 seco
nds.
Growing trees.. Progress: 86%. Estimated remaining time: 1 minute, 3 secon
ds.
Growing trees.. Progress: 93%. Estimated remaining time: 31 seconds.
Growing trees.. Progress: 7%. Estimated remaining time: 7 minutes, 18 seco
nds.
Growing trees.. Progress: 14%. Estimated remaining time: 6 minutes, 33 sec
onds.
Growing trees.. Progress: 21%. Estimated remaining time: 5 minutes, 57 sec
onds.
Growing trees.. Progress: 28%. Estimated remaining time: 5 minutes, 26 sec
onds.
Growing trees.. Progress: 35%. Estimated remaining time: 4 minutes, 56 sec
onds.
Growing trees.. Progress: 41%. Estimated remaining time: 4 minutes, 31 sec
onds.
Growing trees.. Progress: 48%. Estimated remaining time: 3 minutes, 58 sec
onds.
Growing trees.. Progress: 55%. Estimated remaining time: 3 minutes, 24 sec
onds.
Growing trees.. Progress: 62%. Estimated remaining time: 2 minutes, 51 sec
onds.
Growing trees.. Progress: 70%. Estimated remaining time: 2 minutes, 18 sec
onds.
Growing trees.. Progress: 77%. Estimated remaining time: 1 minute, 46 seco
nds.

```
## Growing trees.. Progress: 84%. Estimated remaining time: 1 minute, 13 seco
nds.
## Growing trees.. Progress: 91%. Estimated remaining time: 40 seconds.
## Growing trees.. Progress: 98%. Estimated remaining time: 8 seconds.
## Growing trees.. Progress: 7%. Estimated remaining time: 6 minutes, 51 seco
nds.
## Growing trees.. Progress: 14%. Estimated remaining time: 6 minutes, 20 sec
onds.
## Growing trees.. Progress: 21%. Estimated remaining time: 5 minutes, 45 sec
onds.
## Growing trees.. Progress: 29%. Estimated remaining time: 5 minutes, 9 seco
nds.
## Growing trees.. Progress: 36%. Estimated remaining time: 4 minutes, 39 sec
onds.
## Growing trees.. Progress: 43%. Estimated remaining time: 4 minutes, 8 seco
nds.
## Growing trees.. Progress: 51%. Estimated remaining time: 3 minutes, 34 sec
onds.
## Growing trees.. Progress: 58%. Estimated remaining time: 3 minutes, 3 seco
nds.
## Growing trees.. Progress: 65%. Estimated remaining time: 2 minutes, 33 sec
onds.
## Growing trees.. Progress: 71%. Estimated remaining time: 2 minutes, 5 seco
nds.
## Growing trees.. Progress: 78%. Estimated remaining time: 1 minute, 35 seco
nds.
## Growing trees.. Progress: 86%. Estimated remaining time: 1 minute, 2 secon
ds.
## Growing trees.. Progress: 93%. Estimated remaining time: 31 seconds.
## Growing trees.. Progress: 100%. Estimated remaining time: 0 seconds.
## Growing trees.. Progress: 7%. Estimated remaining time: 7 minutes, 32 seco
nds.
## Growing trees.. Progress: 14%. Estimated remaining time: 6 minutes, 46 sec
onds.
## Growing trees.. Progress: 21%. Estimated remaining time: 6 minutes, 4 seco
nds.
## Growing trees.. Progress: 28%. Estimated remaining time: 5 minutes, 33 sec
onds.
## Growing trees.. Progress: 35%. Estimated remaining time: 4 minutes, 57 sec
onds.
## Growing trees.. Progress: 43%. Estimated remaining time: 4 minutes, 22 sec
onds.
## Growing trees.. Progress: 50%. Estimated remaining time: 3 minutes, 51 sec
onds.
## Growing trees.. Progress: 57%. Estimated remaining time: 3 minutes, 18 sec
onds.
## Growing trees.. Progress: 63%. Estimated remaining time: 2 minutes, 47 sec
onds.
## Growing trees.. Progress: 70%. Estimated remaining time: 2 minutes, 15 sec
onds.
```

```
## Growing trees.. Progress: 77%. Estimated remaining time: 1 minute, 44 seco
nds.
## Growing trees.. Progress: 84%. Estimated remaining time: 1 minute, 14 seco
nds.
## Growing trees.. Progress: 91%. Estimated remaining time: 43 seconds.
## Growing trees.. Progress: 98%. Estimated remaining time: 11 seconds.
## Growing trees.. Progress: 7%. Estimated remaining time: 7 minutes, 32 seco
nds.
## Growing trees.. Progress: 14%. Estimated remaining time: 6 minutes, 46 sec
onds.
## Growing trees.. Progress: 20%. Estimated remaining time: 6 minutes, 19 sec
onds.
## Growing trees.. Progress: 27%. Estimated remaining time: 5 minutes, 39 sec
onds.
## Growing trees.. Progress: 34%. Estimated remaining time: 5 minutes, 7 seco
nds.
## Growing trees.. Progress: 41%. Estimated remaining time: 4 minutes, 36 sec
onds.
## Growing trees.. Progress: 48%. Estimated remaining time: 4 minutes, 1 seco
nds.
## Growing trees.. Progress: 55%. Estimated remaining time: 3 minutes, 28 sec
onds.
## Growing trees.. Progress: 62%. Estimated remaining time: 2 minutes, 54 sec
onds.
## Growing trees.. Progress: 69%. Estimated remaining time: 2 minutes, 23 sec
onds.
## Growing trees.. Progress: 76%. Estimated remaining time: 1 minute, 52 seco
nds.
## Growing trees.. Progress: 83%. Estimated remaining time: 1 minute, 18 seco
nds.
## Growing trees.. Progress: 90%. Estimated remaining time: 46 seconds.
## Growing trees.. Progress: 97%. Estimated remaining time: 14 seconds.

# meta features from XGBoost
meta_xgb_test = rep(0, nrow(test))
meta_xgb_train = foreach(i = 1:k, .combine = c) %do% {
  # split the raining set into two disjoint sets
  train_index = setdiff(1:nrow(train), cv_index_split[[i]])
  train_set1 = model.Matrix(V281 ~ . - 1, data = train[train_index], sparse =
F)
  train_set2 = model.Matrix(V281 ~ . - 1, data = train[cv_index_split[[i]]],
sparse = F)

  # xgb data
  train_set1_xgb = xgb.DMatrix(data = as.matrix(train_set1), label = train[tr
ain_index]$V281)
  train_set2_xgb = xgb.DMatrix(data = as.matrix(train_set2), label = train[cv
_index_split[[i]]]$V281)

  # level 0 prediction
```

```r
    temp_xgb = xgboost(data = train_set1_xgb, nround = 750, nthread = 4, max_de
pth = 6, eta = 0.025, subsample = 0.7, gamma = 3)
    meta_pred = predict(temp_xgb, train_set2_xgb)
    meta_xgb_test = meta_xgb_test + predict(temp_xgb, test_xgb) / k

    return(meta_pred)
}
```

```
## [1]  train-rmse:1.041304
## [2]  train-rmse:1.025138
## [3]  train-rmse:1.009468
## [4]  train-rmse:0.994396
## [5]  train-rmse:0.979805
## [6]  train-rmse:0.965819
## [7]  train-rmse:0.952242
## [8]  train-rmse:0.938961
## [9]  train-rmse:0.926142
## [10] train-rmse:0.913679
## [11] train-rmse:0.901632
## [12] train-rmse:0.890118
## [13] train-rmse:0.879104
## [14] train-rmse:0.868265
## [15] train-rmse:0.857938
## [16] train-rmse:0.847930
## [17] train-rmse:0.838117
## [18] train-rmse:0.828828
## [19] train-rmse:0.819844
## [20] train-rmse:0.811192
## [21] train-rmse:0.802804
## [22] train-rmse:0.794738
## [23] train-rmse:0.786939
## [24] train-rmse:0.779281
## [25] train-rmse:0.772032
## [26] train-rmse:0.765034
## [27] train-rmse:0.758150
## [28] train-rmse:0.751556
## [29] train-rmse:0.745162
## [30] train-rmse:0.738988
## [31] train-rmse:0.733033
## [32] train-rmse:0.727371
## [33] train-rmse:0.721907
## [34] train-rmse:0.716632
## [35] train-rmse:0.711528
## [36] train-rmse:0.706603
## [37] train-rmse:0.701833
## [38] train-rmse:0.697339
## [39] train-rmse:0.692959
## [40] train-rmse:0.688686
## [41] train-rmse:0.684591
## [42] train-rmse:0.680710
```

```
## [43] train-rmse:0.676987
## [44] train-rmse:0.673420
## [45] train-rmse:0.669937
## [46] train-rmse:0.666470
## [47] train-rmse:0.663170
## [48] train-rmse:0.659887
## [49] train-rmse:0.656942
## [50] train-rmse:0.654029
## [51] train-rmse:0.651252
## [52] train-rmse:0.648544
## [53] train-rmse:0.645853
## [54] train-rmse:0.643262
## [55] train-rmse:0.640855
## [56] train-rmse:0.638452
## [57] train-rmse:0.636037
## [58] train-rmse:0.633881
## [59] train-rmse:0.631824
## [60] train-rmse:0.629722
## [61] train-rmse:0.627795
## [62] train-rmse:0.625924
## [63] train-rmse:0.624025
## [64] train-rmse:0.622272
## [65] train-rmse:0.620612
## [66] train-rmse:0.618893
## [67] train-rmse:0.617301
## [68] train-rmse:0.615680
## [69] train-rmse:0.614201
## [70] train-rmse:0.612790
## [71] train-rmse:0.611406
## [72] train-rmse:0.609982
## [73] train-rmse:0.608664
## [74] train-rmse:0.607451
## [75] train-rmse:0.606257
## [76] train-rmse:0.605031
## [77] train-rmse:0.603883
## [78] train-rmse:0.602673
## [79] train-rmse:0.601605
## [80] train-rmse:0.600529
## [81] train-rmse:0.599481
## [82] train-rmse:0.598504
## [83] train-rmse:0.597522
## [84] train-rmse:0.596601
## [85] train-rmse:0.595565
## [86] train-rmse:0.594706
## [87] train-rmse:0.593736
## [88] train-rmse:0.592889
## [89] train-rmse:0.592043
## [90] train-rmse:0.591197
## [91] train-rmse:0.590398
## [92] train-rmse:0.589569
```

```
## [93] train-rmse:0.588803
## [94] train-rmse:0.588114
## [95] train-rmse:0.587365
## [96] train-rmse:0.586666
## [97] train-rmse:0.585963
## [98] train-rmse:0.585389
## [99] train-rmse:0.584810
## [100]     train-rmse:0.584207
## [101]     train-rmse:0.583510
## [102]     train-rmse:0.582837
## [103]     train-rmse:0.582250
## [104]     train-rmse:0.581665
## [105]     train-rmse:0.581103
## [106]     train-rmse:0.580512
## [107]     train-rmse:0.579937
## [108]     train-rmse:0.579300
## [109]     train-rmse:0.578757
## [110]     train-rmse:0.578228
## [111]     train-rmse:0.577688
## [112]     train-rmse:0.577155
## [113]     train-rmse:0.576657
## [114]     train-rmse:0.576173
## [115]     train-rmse:0.575697
## [116]     train-rmse:0.575326
## [117]     train-rmse:0.574880
## [118]     train-rmse:0.574347
## [119]     train-rmse:0.573986
## [120]     train-rmse:0.573505
## [121]     train-rmse:0.573115
## [122]     train-rmse:0.572708
## [123]     train-rmse:0.572298
## [124]     train-rmse:0.571827
## [125]     train-rmse:0.571466
## [126]     train-rmse:0.571032
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## [592]    train-rmse:0.559182
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## [11] train-rmse:1.031827
## [12] train-rmse:1.018114
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## [42] train-rmse:0.770240
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## [92] train-rmse:0.663404
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## [8]   train-rmse:1.063887
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## [592]      train-rmse:0.571984
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## [738]     train-rmse:0.562796
## [739]     train-rmse:0.562747
## [740]     train-rmse:0.562686
## [741]     train-rmse:0.562656
## [742]     train-rmse:0.562643
```

```
## [743]     train-rmse:0.562534
## [744]     train-rmse:0.562509
## [745]     train-rmse:0.562502
## [746]     train-rmse:0.562473
## [747]     train-rmse:0.562455
## [748]     train-rmse:0.562373
## [749]     train-rmse:0.562366
## [750]     train-rmse:0.562289

# combine meta features
sg_col = c("meta_knn", "meta_glm", "meta_svm", "meta_rf", "meta_xgb", "y")
train_sg = data.frame(meta_knn_train, meta_glm_train, meta_svm_train, meta_rf
_train, meta_xgb_train, train_y)
test_sg = data.frame(meta_knn_test, meta_glm_test, meta_svm_test, meta_rf_tes
t, meta_xgb_test, test_y)
colnames(train_sg) = sg_col
colnames(test_sg) = sg_col

# ensemble with elastic-net regression
train_sg_sparse = model.Matrix(y ~ . - 1, data = train_sg, sparse = T)
test_sg_sparse = model.Matrix(y ~ . - 1, data = test_sg, sparse = T)
mdl_glm = cv.glmnet(train_sg_sparse, train_y, family = "gaussian", alpha = 0.
2)
pred_glm = predict(mdl_glm, newx = test_sg_sparse, s = "lambda.min")
mse(pred_glm, test_y)

## [1] 0.3840147
```

```
library(data.table)

library(foreach)

library(MatrixModels)

library(xgboost)

library(ranger)

# load and combine dataset

train = fread("BlogFeedback-Train.csv")

test = fread("BlogFeedback-Test.csv")

# error measure

mse = function(y_hat, y) {   mse = mean((y - y_hat)^2)
```

```
return(mse)}

# create design matrices

train_x = model.Matrix(V281 ~ . - 1, data = train, sparse = F)

train_y = train$V281

test_x = model.Matrix(V281 ~ . - 1, data = test, sparse = F)

test_y = test$V281

train_xgb = xgb.DMatrix(data = as.matrix(train_x), label = train_y)

test_xgb = xgb.DMatrix(data = as.matrix(test_x), label = test_y)

# number of models

n = 5

# fit XGBoost

pred_xgb = foreach(i = 1:n, .combine = cbind) %do% {   mdl_xgb = xgboost(data
= train_xgb, nround = 750, nthread = 4, max_depth = 6, eta = 0.025, subsample
= 0.7, gamma = 3)

 return(predict(mdl_xgb, test_xgb))}

# fit random forest

pred_rf = foreach(i = 1:n, .combine = cbind) %do% { mdl_rf = ranger(V281 ~ .,
data = train, num.trees = 1000, mtry = 120, write.forest = T)

return(predict(mdl_rf, test)$predictions)}

# weighted average

mse(rowMeans(pred_rf) * 0.25 + rowMeans(pred_xgb) * 0.75, test_y)
```

```
|--------------------------------------------------|
|==================================================|
|--------------------------------------------------|
|==================================================|
[1]     train-rmse:1.123122
[2]     train-rmse:1.105641
[3]     train-rmse:1.088758
[4]     train-rmse:1.072427
[5]     train-rmse:1.056559
[6]     train-rmse:1.041096
[7]     train-rmse:1.026287
[8]     train-rmse:1.011939
```

```
[9]     train-rmse:0.998131
[10]    train-rmse:0.984787
[11]    train-rmse:0.971762
[12]    train-rmse:0.959325
[13]    train-rmse:0.947338
[14]    train-rmse:0.935682
[15]    train-rmse:0.924345
[16]    train-rmse:0.913451
[17]    train-rmse:0.903073
[18]    train-rmse:0.893087
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[20]    train-rmse:0.873861
[21]    train-rmse:0.864709
[22]    train-rmse:0.856002
[23]    train-rmse:0.847568
[24]    train-rmse:0.839455
[25]    train-rmse:0.831521
[26]    train-rmse:0.824004
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[30]    train-rmse:0.796569
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[36]    train-rmse:0.761938
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[57]    train-rmse:0.687291
[58]    train-rmse:0.684980
```

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Growing trees.. Progress: 1%. Estimated remaining time: 48 minutes, 5
seconds.
Growing trees.. Progress: 3%. Estimated remaining time: 42 minutes, 2
seconds.
Growing trees.. Progress: 4%. Estimated remaining time: 41 minutes, 42
seconds.
Growing trees.. Progress: 6%. Estimated remaining time: 39 minutes, 48
seconds.
```

Growing trees.. Progress: 7%. Estimated remaining time: 39 minutes, 17 seconds.
Growing trees.. Progress: 8%. Estimated remaining time: 38 minutes, 45 seconds.
Growing trees.. Progress: 10%. Estimated remaining time: 38 minutes, 8 seconds.
Growing trees.. Progress: 11%. Estimated remaining time: 36 minutes, 42 seconds.
Growing trees.. Progress: 12%. Estimated remaining time: 36 minutes, 44 seconds.
Growing trees.. Progress: 14%. Estimated remaining time: 35 minutes, 30 seconds.
Growing trees.. Progress: 15%. Estimated remaining time: 35 minutes, 25 seconds.
Growing trees.. Progress: 17%. Estimated remaining time: 34 minutes, 25 seconds.
Growing trees.. Progress: 18%. Estimated remaining time: 34 minutes, 5 seconds.
Growing trees.. Progress: 19%. Estimated remaining time: 33 minutes, 18 seconds.
Growing trees.. Progress: 21%. Estimated remaining time: 32 minutes, 48 seconds.
Growing trees.. Progress: 22%. Estimated remaining time: 32 minutes, 18 seconds.
Growing trees.. Progress: 24%. Estimated remaining time: 31 minutes, 31 seconds.
Growing trees.. Progress: 25%. Estimated remaining time: 31 minutes, 4 seconds.
Growing trees.. Progress: 26%. Estimated remaining time: 30 minutes, 37 seconds.
Growing trees.. Progress: 28%. Estimated remaining time: 29 minutes, 55 seconds.
Growing trees.. Progress: 29%. Estimated remaining time: 29 minutes, 22 seconds.
Growing trees.. Progress: 30%. Estimated remaining time: 29 minutes, 0 seconds.
Growing trees.. Progress: 31%. Estimated remaining time: 28 minutes, 32 seconds.
Growing trees.. Progress: 33%. Estimated remaining time: 28 minutes, 4 seconds.
Growing trees.. Progress: 34%. Estimated remaining time: 27 minutes, 25 seconds.
Growing trees.. Progress: 35%. Estimated remaining time: 26 minutes, 58 seconds.
Growing trees.. Progress: 37%. Estimated remaining time: 26 minutes, 18 seconds.
Growing trees.. Progress: 38%. Estimated remaining time: 25 minutes, 50 seconds.
Growing trees.. Progress: 39%. Estimated remaining time: 25 minutes, 18 seconds.

Growing trees.. Progress: 41%. Estimated remaining time: 24 minutes, 45 seconds.
Growing trees.. Progress: 42%. Estimated remaining time: 24 minutes, 11 seconds.
Growing trees.. Progress: 43%. Estimated remaining time: 23 minutes, 41 seconds.
Growing trees.. Progress: 45%. Estimated remaining time: 23 minutes, 1 seconds.
Growing trees.. Progress: 46%. Estimated remaining time: 22 minutes, 33 seconds.
Growing trees.. Progress: 47%. Estimated remaining time: 21 minutes, 58 seconds.
Growing trees.. Progress: 49%. Estimated remaining time: 21 minutes, 25 seconds.
Growing trees.. Progress: 50%. Estimated remaining time: 20 minutes, 53 seconds.
Growing trees.. Progress: 51%. Estimated remaining time: 20 minutes, 16 seconds.
Growing trees.. Progress: 53%. Estimated remaining time: 19 minutes, 44 seconds.
Growing trees.. Progress: 54%. Estimated remaining time: 19 minutes, 12 seconds.
Growing trees.. Progress: 55%. Estimated remaining time: 18 minutes, 34 seconds.
Growing trees.. Progress: 57%. Estimated remaining time: 18 minutes, 5 seconds.
Growing trees.. Progress: 58%. Estimated remaining time: 17 minutes, 35 seconds.
Growing trees.. Progress: 59%. Estimated remaining time: 16 minutes, 55 seconds.
Growing trees.. Progress: 61%. Estimated remaining time: 16 minutes, 13 seconds.
Growing trees.. Progress: 62%. Estimated remaining time: 15 minutes, 43 seconds.
Growing trees.. Progress: 64%. Estimated remaining time: 15 minutes, 4 seconds.
Growing trees.. Progress: 65%. Estimated remaining time: 14 minutes, 33 seconds.
Growing trees.. Progress: 66%. Estimated remaining time: 13 minutes, 56 seconds.
Growing trees.. Progress: 68%. Estimated remaining time: 13 minutes, 25 seconds.
Growing trees.. Progress: 69%. Estimated remaining time: 12 minutes, 57 seconds.
Growing trees.. Progress: 70%. Estimated remaining time: 12 minutes, 18 seconds.
Growing trees.. Progress: 72%. Estimated remaining time: 11 minutes, 47 seconds.
Growing trees.. Progress: 73%. Estimated remaining time: 11 minutes, 10 seconds.

Growing trees.. Progress: 74%. Estimated remaining time: 10 minutes, 38 seconds.
Growing trees.. Progress: 76%. Estimated remaining time: 10 minutes, 7 seconds.
Growing trees.. Progress: 77%. Estimated remaining time: 9 minutes, 31 seconds.
Growing trees.. Progress: 78%. Estimated remaining time: 8 minutes, 58 seconds.
Growing trees.. Progress: 80%. Estimated remaining time: 8 minutes, 26 seconds.
Growing trees.. Progress: 81%. Estimated remaining time: 7 minutes, 57 seconds.
Growing trees.. Progress: 82%. Estimated remaining time: 7 minutes, 21 seconds.
Growing trees.. Progress: 84%. Estimated remaining time: 6 minutes, 49 seconds.
Growing trees.. Progress: 85%. Estimated remaining time: 6 minutes, 17 seconds.
Growing trees.. Progress: 86%. Estimated remaining time: 5 minutes, 44 seconds.
Growing trees.. Progress: 88%. Estimated remaining time: 5 minutes, 11 seconds.
Growing trees.. Progress: 89%. Estimated remaining time: 4 minutes, 39 seconds.
Growing trees.. Progress: 90%. Estimated remaining time: 4 minutes, 7 seconds.
Growing trees.. Progress: 92%. Estimated remaining time: 3 minutes, 31 seconds.
Growing trees.. Progress: 93%. Estimated remaining time: 2 minutes, 59 seconds.
Growing trees.. Progress: 94%. Estimated remaining time: 2 minutes, 30 seconds.
Growing trees.. Progress: 95%. Estimated remaining time: 1 minute, 57 seconds.
Growing trees.. Progress: 97%. Estimated remaining time: 1 minute, 25 seconds.
Growing trees.. Progress: 98%. Estimated remaining time: 50 seconds.
Growing trees.. Progress: 99%. Estimated remaining time: 17 seconds.
Growing trees.. Progress: 1%. Estimated remaining time: 43 minutes, 54 seconds.
Growing trees.. Progress: 3%. Estimated remaining time: 43 minutes, 33 seconds.
Growing trees.. Progress: 4%. Estimated remaining time: 41 minutes, 4 seconds.
Growing trees.. Progress: 5%. Estimated remaining time: 40 minutes, 47 seconds.
Growing trees.. Progress: 7%. Estimated remaining time: 39 minutes, 27 seconds.
Growing trees.. Progress: 8%. Estimated remaining time: 38 minutes, 34 seconds.

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[1] 0.3810031
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Basic testing model

Model	Error
k-NN	0.638315
LASSO	0.635483
SVM	0.445464
Random Forest	0.396741
Boosting	0.382399

Weighted Average

Model	Error
Best RF	0.396415
Best BST	0.382642
Mean RF	0.396803
Mean BST	0.382934
Best RF + BST	0.380572
Mean RF + BST	0.381167

Stacked Generalization

1. Split the training dataset in to k folds.
2. For i-th fold of training data, train models with each of the level-0 learners on the rest of the training data.
3. Make predictions using the models we trained:

- make predictions on i-th fold of data.
- make predictions on the test set.

4. Repeat 2. and 3. until we used all k folds of training data.
5. Generate the level-1 data using predictions we obtained:

- generate level-1 training data by concatenating the predictions we made on each fold of the training data.
- generate level-1 test data by averaging the predictions we made on the test set.

6. Train a level-1 generalizer using the level-1 data and the correct responses, make predictions.

Model	Error
LV-1 k-NN	0.631110
LV-1 LASSO	0.624957
LV-1 SVM	0.443895
LV-1 RF	0.393018
LV-1 BST	0.379804
Stacked	0.382274

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.
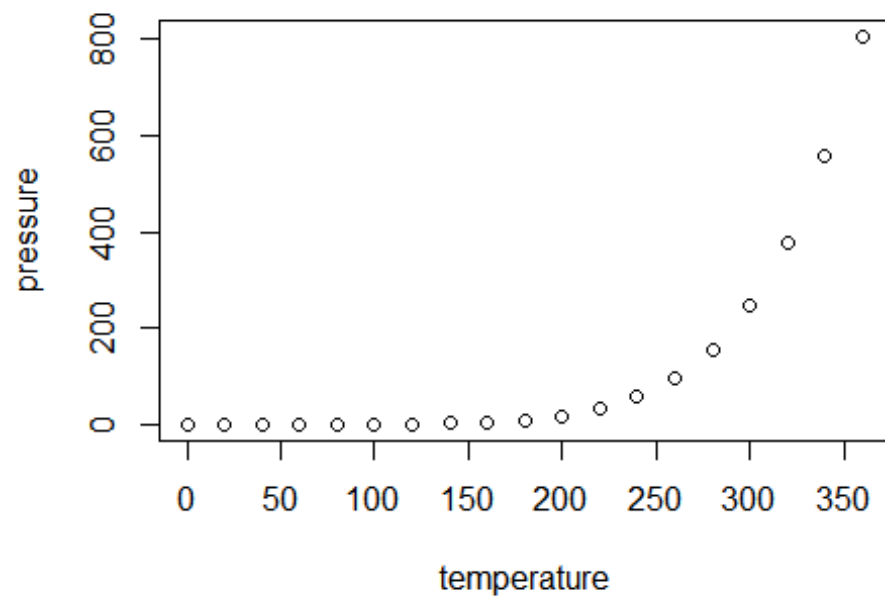
When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)

##      speed           dist
##  Min.   : 4.0   Min.   :  2.00
##  1st Qu.:12.0   1st Qu.: 26.00
##  Median :15.0   Median : 36.00
##  Mean   :15.4   Mean   : 42.98
##  3rd Qu.:19.0   3rd Qu.: 56.00
##  Max.   :25.0   Max.   :120.00
```

Including Plots

You can also embed plots, for example:

Note that the echo = FALSE parameter was added to the code chunk to prevent printing of the R code that generated the plot.