Lab 9

Jaime Lin

11:59PM May 10, 2021

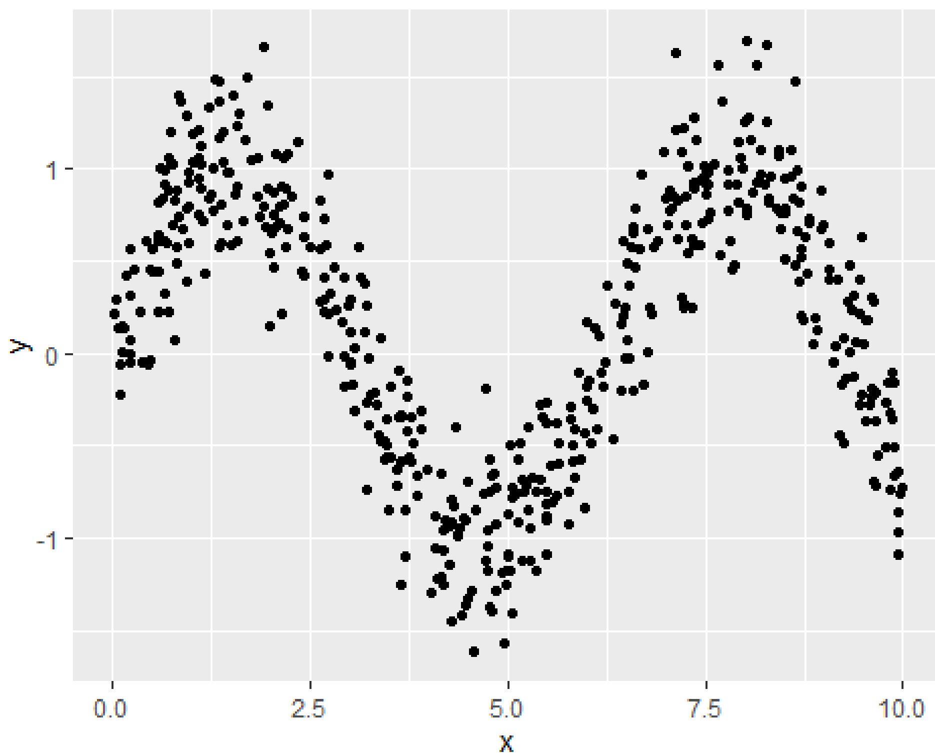
Here we will learn about trees, bagged trees and random forests. You can use the `YARF` package if it works, otherwise, use the `randomForest` package (the standard).

Let's take a look at the simulated sine curve data from practice lecture 12. Below is the code for the data generating process:

```
rm(list = ls())
n = 500
sigma = 0.3
x_min = 0
x_max = 10
f_x = function(x){sin(x)}
y_x = function(x, sigma){f_x(x) + rnorm(n, 0, sigma)}
x_train = runif(n, x_min, x_max)
y_train = y_x(x_train, sigma)
```

Plot an example dataset of size 500:

```
pacman::p_load(ggplot2)
ggplot(data.frame(x = x_train, y = y_train)) +
  geom_point(aes(x = x, y = y))
```



Create a test set of size 500 as well

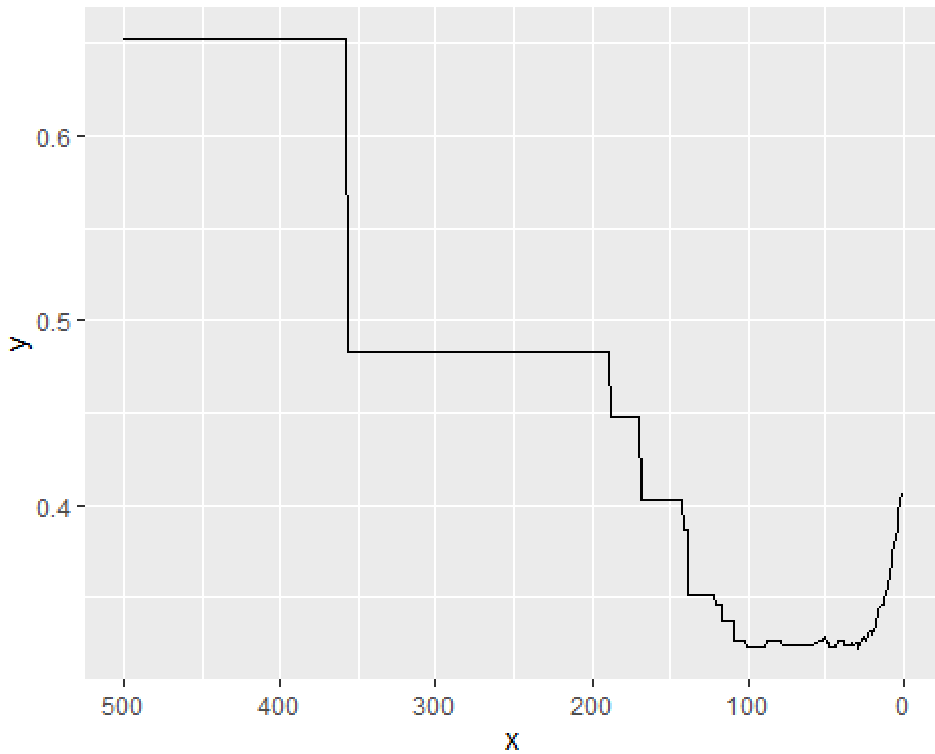
```
x_test = runif(n, x_min, x_max)
y_test = y_x(x_test, sigma)
```

Locate the optimal node size hyperparameter for the regression tree model. I believe you can use `randomForest` here by setting `ntree = 1`, `replace = FALSE`, `sampsize = n` (`mtry` is already set to be 1 because there is only one feature) and then you can set `nodesize`. Plot node size by out of sample SE

```
pacman::p_load(randomForest)

node_sizes = 1:n
node_sizes

##   [1]   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17
18
##  [19]  19  20  21  22  23  24  25  26  27  28  29  30  31  32  33  34  35
36
##  [37]  37  38  39  40  41  42  43  44  45  46  47  48  49  50  51  52  53
54
##  [55]  55  56  57  58  59  60  61  62  63  64  65  66  67  68  69  70  71
72
##  [73]  73  74  75  76  77  78  79  80  81  82  83  84  85  86  87  88  89
90
##  [91]  91  92  93  94  95  96  97  98  99 100 101 102 103 104 105 106 107
108
```

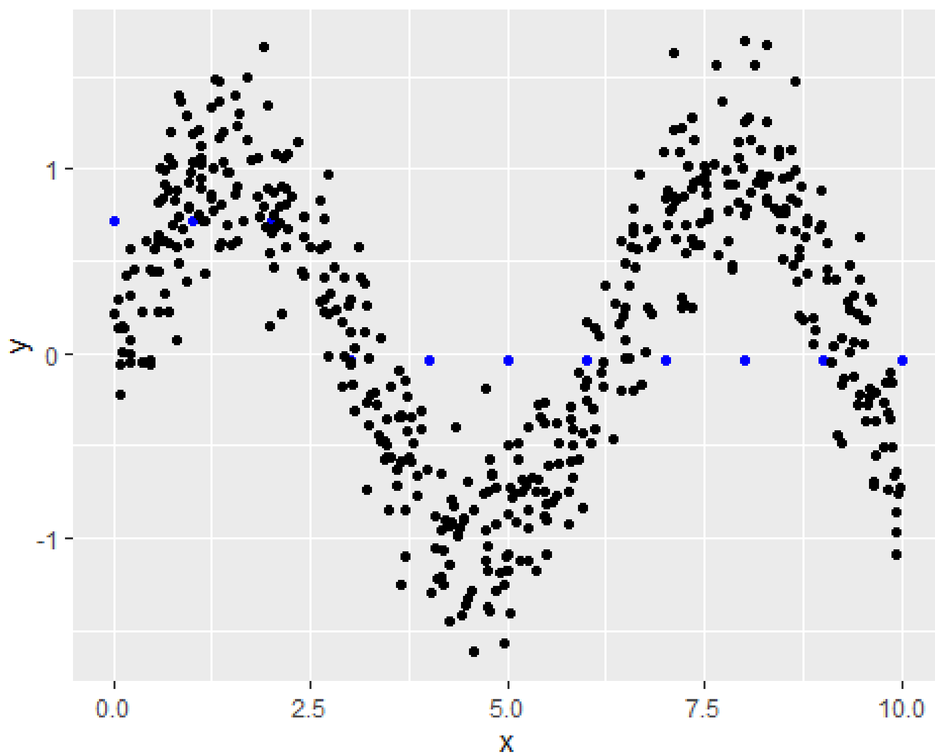
```
## [109] 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126
## [127] 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143
144
## [145] 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161
162
## [163] 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179
180
## [181] 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197
198
## [199] 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215
216
## [217] 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233
234
## [235] 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251
252
## [253] 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269
270
## [271] 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287
288
## [289] 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305
306
## [307] 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323
324
## [325] 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341
342
## [343] 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359
360
## [361] 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377
378
## [379] 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395
396
## [397] 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413
414
## [415] 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431
432
## [433] 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449
450
## [451] 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467
468
## [469] 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485
486
## [487] 487 488 489 490 491 492 493 494 495 496 497 498 499 500

se_by_node_sizes = array(NA, length(node_sizes))
for (i in 1:length(node_sizes)) {
  rf_mod = randomForest(x = data.frame(x = x_train), y = y_train, ntree = 1,
replace = FALSE, sampsize = n, nodesize = node_sizes[i])
  y_hat_test = predict(rf_mod,data.frame(x = x_test))
  se_by_node_sizes[i] = sd(y_test - y_hat_test)
```

```
}

ggplot(data.frame(x = node_sizes, y = se_by_node_sizes)) +
  geom_line(aes(x = x, y = y)) +
  scale_x_reverse()
```



Plot the regression tree model with the optimal node size.

```
 rf_mod = randomForest(x = data.frame(x = x_train), y = y_train, ntree = 1,
replace = FALSE, sampsize = n, nodesize = node_sizes[i])
resolution = 1
x_grid = seq(from = x_min, to = x_max, by = resolution)
g_x = predict(rf_mod,data.frame(x = x_grid))
ggplot(data.frame(x = x_grid, y = g_x)) +
  aes(x = x, y = y) +
  geom_point(color = "blue") +
  geom_point( data = data.frame(x = x_train, y = y_train), )
```



Provide the bias-variance decomposition of this DGP fit with this model. It is a lot of code, but it is in the practice lectures. If your three numbers don't add up within two significant digits, increase your resolution.

```
#TO-DO

rm(list = ls())
```

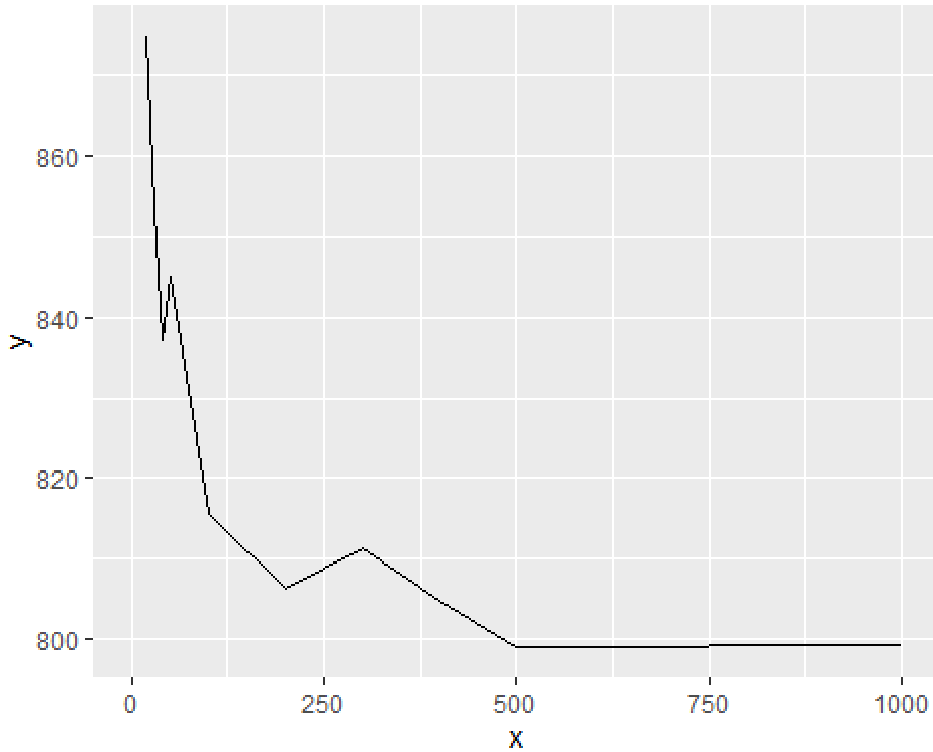
Take a sample of n = 2000 observations from the diamonds data.

```
pacman::p_load(dplyr)
diamond_samp = diamonds %>%
  sample_n(2000)
```

find the bootstrap s_e for a RF model using 1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000 trees. If you are using the `randomForest` package, you can calculate oob residuals via `e_oob = y_train - rf_mod$predicted`.

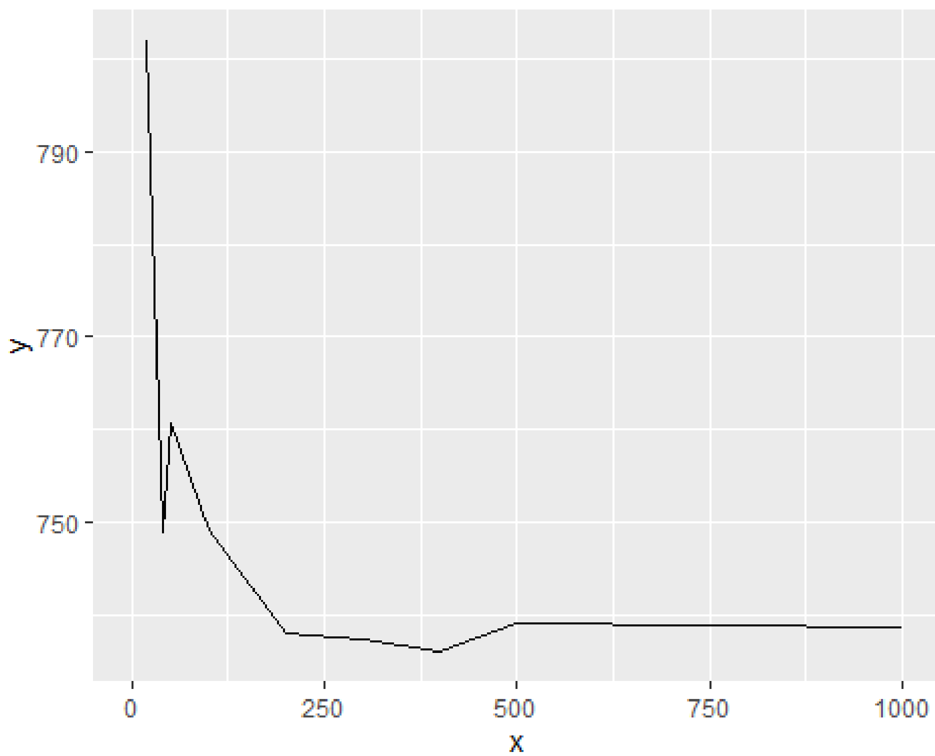
```
num_trees = c(1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000)
oob_se_by_num_trees = array(NA, length(num_trees))
for (i in 1:length(num_trees)) {
  rf_mod = randomForest(price ~., data = diamond_samp, ntree = num_trees[i])
  oob_se_by_num_trees[i] = sd(diamond_samp$price - rf_mod$predicted)
}

ggplot(data.frame(x = num_trees, y = oob_se_by_num_trees)) +
```

```
  aes(x = x, y = y) +
  geom_line()

## Warning: Removed 4 row(s) containing missing values (geom_path).
```



Using the diamonds data, find the bootstrap s_e for a bagged-tree model using 1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000 trees. If you are using the `randomForest` package, you can create the bagged tree model via setting an argument within the RF constructor function.

```
num_trees = c(1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000)
oob_se_by_num_trees_bag = array(NA, length(num_trees))
for (i in 1:length(num_trees)) {

  rf_mod = randomForest(price ~., data = diamond_samp, ntree = num_trees[i],
mtry = ncol(diamond_samp)- 1)
  oob_se_by_num_trees_bag[i] = sd(diamond_samp$price - rf_mod$predicted)
}

ggplot(data.frame(x = num_trees, y = oob_se_by_num_trees_bag)) +
  aes(x = x, y = y) +
  geom_line()

## Warning: Removed 4 row(s) containing missing values (geom_path).
```

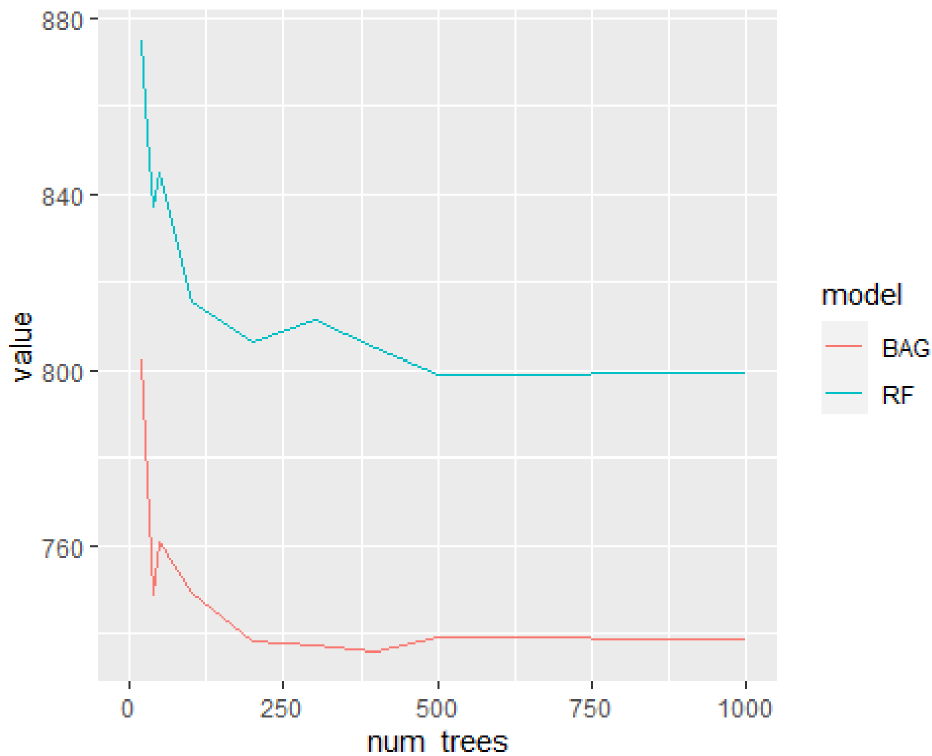


What is the percentage gain / loss in performance of the RF model vs bagged trees model?

```
(oob_se_by_num_trees - oob_se_by_num_trees_bag) / oob_se_by_num_trees_bag *
100

##  [1]        NA        NA        NA        NA  9.070582 10.096128 11.771930
##  [8] 11.068934  8.862912  9.237647 10.041291  9.357293  8.126215  8.223638
```

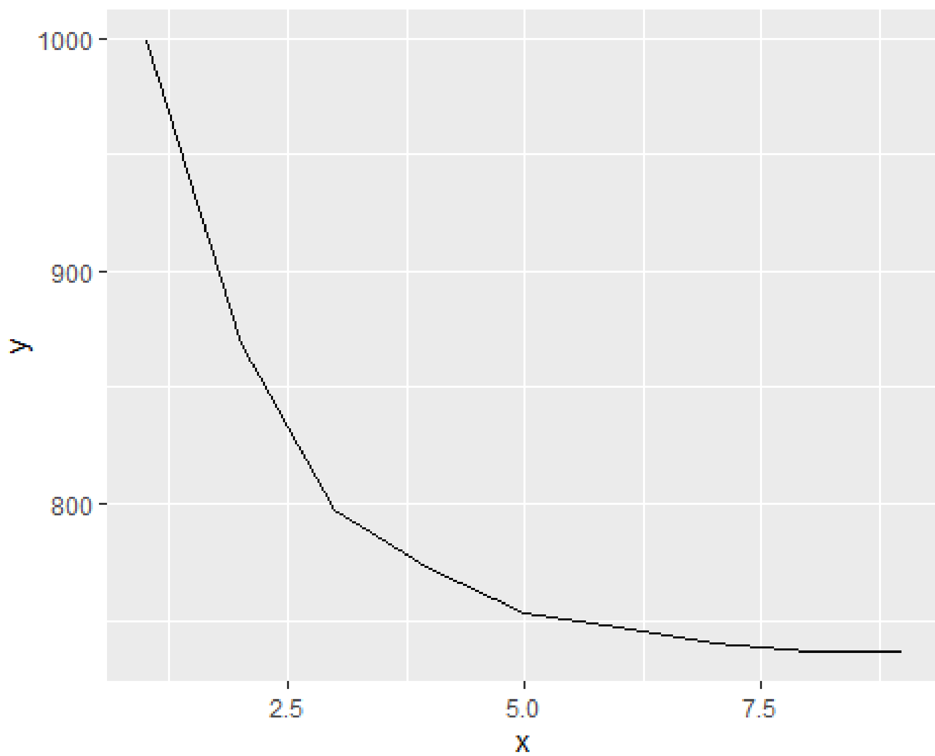
Plot bootstrap s_e by number of trees for both RF and bagged trees.

```
ggplot(rbind(data.frame(num_trees = num_trees, value = oob_se_by_num_trees,
model = "RF"), data.frame(num_trees = num_trees, value =
oob_se_by_num_trees_bag, model = "BAG"))) +
  geom_line(aes(x= num_trees, y = value, color = model))

## Warning: Removed 8 row(s) containing missing values (geom_path).
```



Build RF models for 500 trees using different `mtry` values: 1, 2, ... the maximum. That maximum will be the number of features assuming that we do not binarize categorical features if you are using `randomForest` or the number of features assuming binarization of the categorical features if you are using `YARF`. Calculate bootstrap s_e for all mtry values.

```
mtrys = 1: (ncol(diamond_samp)-1)
oob_se_by_mtrys = array(NA, length(mtrys))
for (i in 1:length(mtrys)) {

  rf_mod = randomForest(price ~., data = diamond_samp, mtry = mtrys[i])
  oob_se_by_mtrys[i] = sd(diamond_samp$price - rf_mod$predicted)
}

ggplot(data.frame(x = mtrys, y = oob_se_by_mtrys)) +
  aes(x = x, y = y) +
  geom_line()
```



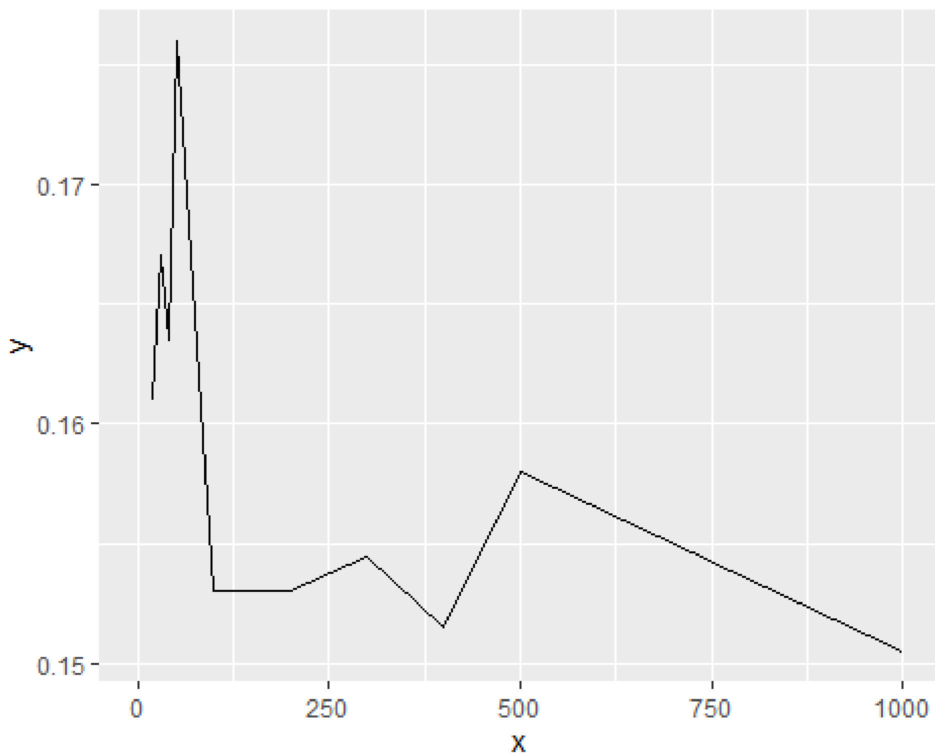

```
rm(list = ls())
```

Take a sample of n = 2000 observations from the adult data.

```
pacman::p_load_gh("coatless/ucidata")
data(adult)
adult = na.omit(adult)

adult_samp = adult %>%
  sample_n(2000)
```

Using the adult data, find the bootstrap misclassification error for an RF model using 1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000 trees.

```
num_trees = c(1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000)
oob_se_by_num_trees = array(NA, length(num_trees))
for (i in 1:length(num_trees)) {
  rf_mod = randomForest(income ~., data = adult_samp, ntree = num_trees[i])
  oob_se_by_num_trees[i] = mean(adult_samp$income != rf_mod$predicted)
}

ggplot(data.frame(x = num_trees, y = oob_se_by_num_trees)) +
  aes(x = x, y = y) +
  geom_line()

## Warning: Removed 4 row(s) containing missing values (geom_path).
```



Using the adult data, find the bootstrap misclassification error for a bagged-tree model using 1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000 trees.

```
# I get a error when I knit this part
# oob_se_by_num_trees_bag = array(NA, length(num_trees))
#for (i in 1:length(num_trees)) {

 # rf_mod = randomForest(income ~., data = adult_samp, ntree = num_trees[i], mtry = ncol(diamond_samp)- 1)
  #oob_se_by_num_trees_bag[i] = mean(adult_samp$income != rf_mod$predicted)
#}

#ggplot(data.frame(x = num_trees, y = oob_se_by_num_trees_bag)) +
#  aes(x = x, y = y) +
#  geom_line()
```

What is the percentage gain / loss in performance of the RF model vs bagged trees model?

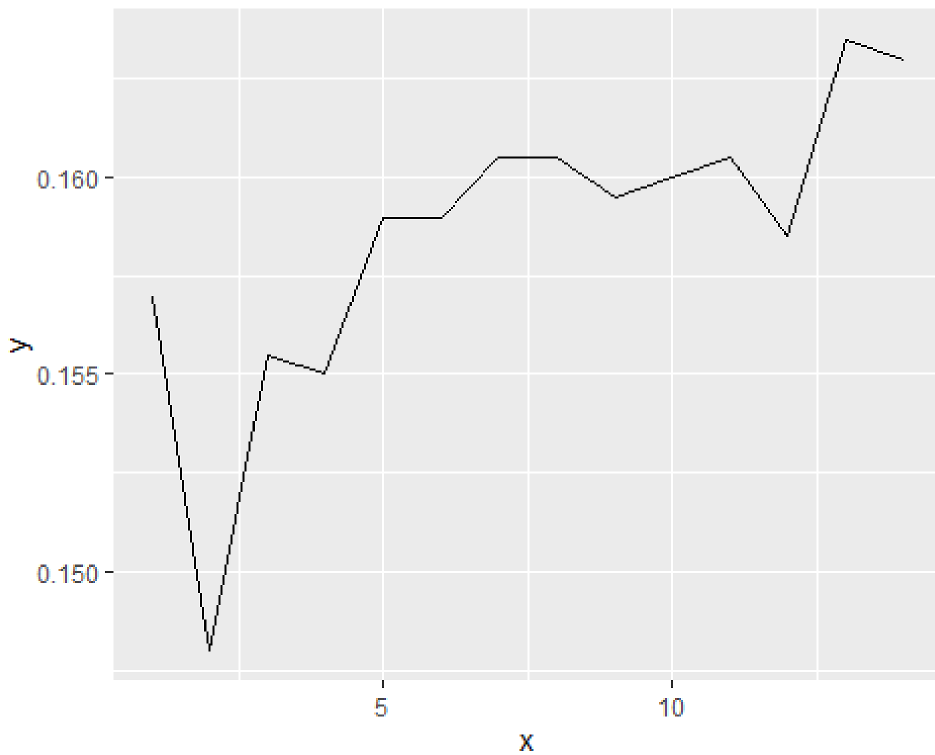
```
# Error when try to knit
#ggplot(rbind(data.frame(num_trees = num_trees, value = oob_se_by_num_trees, model = "RF"), data.frame(num_trees = num_trees, value = oob_se_by_num_trees_bag, model = "BAG"))) +
#  geom_line(aes(x= num_trees, y = value, color = model))
```

Plot bootstrap misclassification error by number of trees for both RF and bagged trees.

```
#TO-DO
```

Build RF models for 500 trees using different `mtry` values: 1, 2, ... the maximum (see above as maximum is defined by the specific RF algorithm implementation).

```
mtrys = 1: (ncol(adult_samp)-1)
oob_se_by_mtrys = array(NA, length(mtrys))
for (i in 1:length(mtrys)) {

  rf_mod = randomForest(income ~., data = adult_samp, mtry = mtrys[i])
  oob_se_by_mtrys[i] = mean(adult_samp$income != rf_mod$predicted)
}

ggplot(data.frame(x = mtrys, y = oob_se_by_mtrys)) +
  aes(x = x, y = y) +
  geom_line()
```




```
rm(list = ls())
```

Write a function `random_bagged_ols` which takes as its arguments `X` and `y` with further arguments `num_ols_models` defaulted to 100 and `mtry` defaulted to NULL which then gets set within the function to be 50% of available features. This argument builds an OLS on a bootstrap sample of the data and uses only `mtry < p` of the available features. The function then returns all the `lm` models as a list with size `num_ols_models`.

```
#num_ols_models = array(NA, 100)
#mtry = 1: ((ncol(adult_samp)-1)/2)

#random_bagged_ols = function(x, y){
```

```
#  p = x / y
#  for (i in 1: 100) {
#    if(mtry[i] < p){
#    num_ols_models[i] = mtry[i]
#  }
# }
#}
```

Load up the Boston Housing Data and separate into `X` and y.

```
pacman::p_load(MASS)
y = Boston$medv
X = Boston[,1:13]
```

Similar to lab 1, write a function that takes a matrix and punches holes (i.e. sets entries equal to `NA`) randomly with an argument `prob_missing`.

```
punch_hole = function(X,prob_missing){
  n_r = nrow(X)
  n_c = ncol(X)
  M = matrix(rbinom(n_r *n_c, 1, prob_missing), nrow = n_r, ncol = n_c)
  X[M == 1] = NA
  X
}
```

Create a matrix `Xmiss` which is `X` but has missingness with probability of 10%.

```
Xmiss = punch_hole(X, 0.10)
Xmiss

##          crim   zn indus chas    nox    rm   age     dis rad tax ptratio
black
## 1     0.00632 18.0  2.31    0 0.5380 6.575  65.2  4.0900   1 296    15.3
396.90
## 2     0.02731  0.0  7.07    0 0.4690 6.421  78.9  4.9671   2 242    17.8
396.90
## 3     0.02729  0.0  7.07    0 0.4690 7.185  61.1  4.9671   2 242    17.8
392.83
## 4          NA  0.0  2.18    0     NA 6.998  45.8  6.0622   3  NA    18.7
394.63
## 5     0.06905  0.0  2.18    0 0.4580 7.147  54.2      NA   3 222    18.7
396.90
## 6     0.02985  0.0  2.18    0 0.4580 6.430  58.7  6.0622   3 222    18.7
394.12
## 7     0.08829   NA  7.87    0 0.5240 6.012  66.6  5.5605   5 311    15.2
395.60
## 8     0.14455 12.5  7.87    0 0.5240 6.172  96.1  5.9505  NA 311    15.2
396.90
## 9          NA 12.5    NA    0 0.5240 5.631 100.0  6.0821   5 311    15.2
386.63
## 10    0.17004 12.5  7.87    0 0.5240 6.004  85.9  6.5921   5 311    15.2
```

```
NA
## 11   0.22489  12.5  7.87    0 0.5240 6.377  94.3  6.3467   5 311    15.2
392.52
## 12   0.11747  12.5  7.87    0 0.5240 6.009  82.9  6.2267  NA 311    15.2
396.90
## 13   0.09378  12.5  7.87    0 0.5240 5.889  39.0  5.4509   5  NA    15.2
390.50
## 14   0.62976    NA  8.14    0 0.5380 5.949  61.8  4.7075   4 307    21.0
396.90
## 15   0.63796   0.0  8.14   NA 0.5380 6.096  84.5  4.4619   4 307    21.0
380.02
## 16   0.62739   0.0  8.14    0 0.5380    NA  56.5  4.4986   4 307    21.0
395.62
## 17   1.05393   0.0  8.14   NA 0.5380 5.935  29.3  4.4986   4  NA    21.0
386.85
## 18   0.78420   0.0  8.14    0 0.5380 5.990    NA  4.2579   4 307      NA
386.75
## 19   0.80271   0.0    NA   NA 0.5380 5.456  36.6      NA   4 307    21.0
288.99
## 20        NA   0.0  8.14    0 0.5380 5.727  69.5  3.7965   4 307    21.0
390.95
## 21   1.25179   0.0    NA    0     NA 5.570  98.1  3.7979   4  NA    21.0
376.57
## 22   0.85204   0.0  8.14    0 0.5380 5.965  89.2  4.0123   4 307    21.0
392.53
## 23   1.23247    NA  8.14    0 0.5380 6.142  91.7  3.9769   4 307    21.0
396.90
## 24   0.98843   0.0  8.14    0 0.5380 5.813 100.0  4.0952   4 307    21.0
394.54
## 25   0.75026   0.0  8.14   NA 0.5380 5.924    NA  4.3996   4 307    21.0
394.33
## 26   0.84054   0.0  8.14    0 0.5380 5.599  85.7  4.4546   4 307    21.0
303.42
## 27   0.67191   0.0  8.14    0 0.5380 5.813  90.3      NA   4 307    21.0
376.88
## 28   0.95577   0.0  8.14    0 0.5380    NA  88.8  4.4534  NA 307    21.0
306.38
## 29   0.77299   0.0  8.14    0 0.5380 6.495  94.4  4.4547   4 307    21.0
387.94
## 30   1.00245   0.0  8.14    0 0.5380 6.674    NA      NA   4 307    21.0
380.23
## 31   1.13081   0.0  8.14    0 0.5380 5.713  94.1  4.2330   4 307    21.0
360.17
## 32        NA   0.0  8.14    0 0.5380 6.072 100.0  4.1750   4 307    21.0
376.73
## 33   1.38799   0.0  8.14    0 0.5380 5.950  82.0  3.9900   4 307    21.0
232.60
## 34        NA   0.0  8.14    0 0.5380 5.701  95.0  3.7872   4 307    21.0
358.77
## 35   1.61282   0.0  8.14    0 0.5380 6.096  96.9  3.7598   4  NA    21.0
```

```
248.31
## 36   0.06417   0.0  5.96    0 0.4990 5.933    NA  3.3603   5 279    19.2
396.90
## 37   0.09744   0.0  5.96    0 0.4990 5.841  61.4  3.3779   5 279    19.2
377.56
## 38   0.08014   0.0  5.96    0 0.4990 5.850  41.5      NA   5 279      NA
396.90
## 39   0.17505   0.0  5.96    0 0.4990    NA  30.2  3.8473   5  NA    19.2
393.43
## 40   0.02763    NA  2.95    0 0.4280    NA  21.8  5.4011   3 252    18.3
395.63
## 41   0.03359  75.0  2.95    0 0.4280 7.024  15.8  5.4011   3 252    18.3
395.62
## 42        NA   0.0  6.91    0 0.4480 6.770   2.9  5.7209   3 233    17.9
385.41
## 43   0.14150    NA  6.91    0 0.4480 6.169    NA  5.7209   3 233    17.9
383.37
## 44   0.15936    NA  6.91    0 0.4480 6.211   6.5  5.7209   3 233    17.9
394.46
## 45   0.12269   0.0    NA    0 0.4480 6.069  40.0  5.7209  NA 233    17.9
389.39
## 46   0.17142   0.0  6.91    0 0.4480 5.682  33.8  5.1004   3 233    17.9
NA
## 47   0.18836   0.0  6.91    0 0.4480 5.786  33.3  5.1004   3 233    17.9
396.90
## 48   0.22927   0.0  6.91    0 0.4480 6.030  85.5  5.6894   3  NA    17.9
392.74
## 49   0.25387   0.0  6.91    0 0.4480 5.399  95.3  5.8700   3 233    17.9
396.90
## 50   0.21977   0.0  6.91    0 0.4480 5.602  62.0  6.0877  NA 233    17.9
396.90
## 51        NA  21.0  5.64    0 0.4390 5.963  45.7  6.8147   4 243    16.8
NA
## 52        NA  21.0  5.64    0     NA 6.115  63.0  6.8147   4 243    16.8
393.97
## 53        NA    NA  5.64    0 0.4390 6.511  21.1  6.8147   4 243    16.8
396.90
## 54   0.04981  21.0  5.64    0 0.4390 5.998    NA  6.8147   4 243      NA
NA
## 55        NA  75.0  4.00    0 0.4100 5.888  47.6  7.3197   3 469    21.1
396.90
## 56   0.01311  90.0    NA    0 0.4030 7.249  21.9  8.6966  NA  NA    17.9
395.93
## 57   0.02055  85.0  0.74   NA 0.4100 6.383  35.7  9.1876   2 313    17.3
NA
## 58   0.01432 100.0  1.32   NA 0.4110 6.816  40.5  8.3248   5 256    15.1
392.90
## 59   0.15445  25.0  5.13    0 0.4530 6.145  29.2  7.8148   8  NA    19.7
390.68
## 60   0.10328  25.0  5.13    0 0.4530 5.927  47.2  6.9320   8 284    19.7
```

```
396.90
## 61   0.14932  25.0  5.13    0 0.4530 5.741  66.2  7.2254   8 284      NA
395.11
## 62   0.17171  25.0  5.13    0 0.4530 5.966  93.4  6.8185   8 284    19.7
378.08
## 63   0.11027  25.0  5.13    0 0.4530 6.456  67.8      NA   8 284    19.7
NA
## 64   0.12650  25.0  5.13    0 0.4530 6.762  43.4  7.9809   8 284    19.7
395.58
## 65   0.01951  17.5  1.38    0 0.4161 7.104  59.5  9.2229   3 216    18.6
393.24
## 66   0.03584  80.0  3.37    0 0.3980 6.290  17.8  6.6115   4 337    16.1
396.90
## 67   0.04379  80.0  3.37    0     NA 5.787    NA  6.6115   4 337    16.1
396.90
## 68   0.05789  12.5  6.07    0 0.4090 5.878  21.4  6.4980  NA 345    18.9
396.21
## 69   0.13554  12.5  6.07    0 0.4090 5.594  36.8  6.4980   4 345      NA
396.90
## 70   0.12816  12.5  6.07    0     NA 5.885  33.0  6.4980   4 345    18.9
396.90
## 71   0.08826   0.0 10.81   NA 0.4130 6.417   6.6  5.2873   4 305    19.2
383.73
## 72   0.15876    NA 10.81    0     NA    NA  17.5  5.2873   4 305    19.2
376.94
## 73        NA   0.0 10.81    0 0.4130 6.065   7.8  5.2873   4  NA    19.2
390.91
## 74   0.19539   0.0 10.81    0 0.4130 6.245   6.2  5.2873   4 305    19.2
377.17
## 75   0.07896   0.0 12.83    0 0.4370 6.273   6.0  4.2515   5 398    18.7
394.92
## 76   0.09512   0.0 12.83    0 0.4370 6.286  45.0  4.5026   5 398    18.7
383.23
## 77   0.10153   0.0    NA    0 0.4370 6.279  74.5  4.0522  NA 398    18.7
373.66
## 78   0.08707   0.0 12.83    0 0.4370    NA  45.8  4.0905   5 398    18.7
386.96
## 79   0.05646   0.0 12.83    0 0.4370 6.232  53.7  5.0141   5 398    18.7
386.40
## 80   0.08387   0.0 12.83   NA 0.4370 5.874  36.6  4.5026   5 398      NA
396.06
## 81   0.04113    NA    NA    0 0.4260    NA  33.5  5.4007   4 281    19.0
396.90
## 82   0.04462    NA  4.86    0 0.4260    NA  70.4      NA   4 281    19.0
395.63
## 83   0.03659  25.0  4.86    0     NA 6.302  32.2      NA   4  NA    19.0
396.90
## 84   0.03551  25.0  4.86    0 0.4260 6.167    NA  5.4007   4  NA    19.0
390.64
## 85   0.05059   0.0  4.49    0 0.4490 6.389  48.0  4.7794   3 247    18.5
```

```
396.90
## 86   0.05735   0.0  4.49   NA 0.4490 6.630  56.1  4.4377   3 247    18.5
392.30
## 87        NA   0.0  4.49    0 0.4490 6.015  45.1  4.4272   3 247    18.5
395.99
## 88   0.07151   0.0  4.49    0     NA 6.121  56.8  3.7476   3 247    18.5
395.15
## 89   0.05660   0.0  3.41    0 0.4890 7.007  86.3  3.4217   2 270    17.8
NA
## 90   0.05302   0.0  3.41    0 0.4890 7.079  63.1  3.4145   2 270    17.8
396.06
## 91   0.04684   0.0  3.41   NA 0.4890 6.417  66.1  3.0923   2  NA    17.8
392.18
## 92   0.03932   0.0  3.41    0     NA 6.405    NA  3.0921   2 270      NA
393.55
## 93   0.04203    NA 15.04    0 0.4640 6.442  53.6  3.6659   4 270    18.2
395.01
## 94   0.02875  28.0 15.04   NA 0.4640 6.211  28.9  3.6659   4  NA    18.2
NA
## 95   0.04294  28.0 15.04    0     NA 6.249  77.3  3.6150  NA 270    18.2
396.90
## 96        NA   0.0  2.89    0 0.4450    NA  57.8  3.4952   2 276    18.0
357.98
## 97   0.11504   0.0  2.89    0 0.4450    NA  69.6  3.4952   2 276      NA
391.83
## 98   0.12083   0.0  2.89    0     NA    NA    NA  3.4952   2 276    18.0
396.90
## 99   0.08187   0.0  2.89    0 0.4450 7.820    NA      NA   2 276    18.0
393.53
## 100  0.06860   0.0  2.89    0 0.4450 7.416    NA  3.4952   2 276      NA
396.90
## 101  0.14866   0.0  8.56    0 0.5200 6.727  79.9      NA   5 384    20.9
394.76
## 102  0.11432   0.0  8.56    0 0.5200 6.781  71.3  2.8561   5  NA    20.9
395.58
## 103  0.22876   0.0  8.56    0 0.5200 6.405  85.4  2.7147   5  NA    20.9
70.80
## 104  0.21161   0.0    NA    0 0.5200 6.137  87.4  2.7147   5 384      NA
394.47
## 105  0.13960   0.0  8.56    0 0.5200 6.167  90.0      NA   5 384    20.9
392.69
## 106  0.13262   0.0  8.56    0 0.5200 5.851  96.7  2.1069   5 384    20.9
394.05
## 107  0.17120   0.0  8.56    0 0.5200 5.836  91.9  2.2110   5 384    20.9
395.67
## 108       NA   0.0  8.56    0 0.5200 6.127    NA  2.1224  NA 384    20.9
387.69
## 109  0.12802   0.0  8.56    0 0.5200 6.474  97.1  2.4329   5 384    20.9
395.24
## 110  0.26363   0.0  8.56    0 0.5200 6.229  91.2  2.5451   5 384    20.9
```

```
391.23
## 111  0.10793   0.0  8.56    0 0.5200 6.195  54.4  2.7778   5 384    20.9
393.49
## 112  0.10084   0.0 10.01    0 0.5470 6.715  81.6  2.6775   6 432    17.8
395.59
## 113  0.12329   0.0 10.01    0 0.5470 5.913    NA  2.3534   6 432    17.8
NA
## 114  0.22212   0.0    NA   NA 0.5470 6.092  95.4  2.5480   6 432    17.8
396.90
## 115  0.14231   0.0 10.01   NA 0.5470 6.254  84.2  2.2565   6 432    17.8
388.74
## 116  0.17134   0.0 10.01    0     NA 5.928  88.2  2.4631   6 432    17.8
344.91
## 117  0.13158   0.0 10.01    0 0.5470 6.176  72.5      NA   6 432      NA
393.30
## 118       NA   0.0    NA    0 0.5470 6.021  82.6  2.7474  NA 432    17.8
NA
## 119  0.13058   0.0 10.01    0 0.5470 5.872    NA      NA  NA 432    17.8
338.63
## 120  0.14476   0.0 10.01    0 0.5470 5.731  65.2  2.7592   6 432    17.8
391.50
## 121  0.06899   0.0 25.65    0 0.5810 5.870  69.7      NA   2 188    19.1
389.15
## 122       NA    NA 25.65   NA 0.5810 6.004  84.1  2.1974   2 188    19.1
377.67
## 123  0.09299   0.0 25.65    0 0.5810 5.961  92.9  2.0869   2 188    19.1
378.09
## 124  0.15038   0.0 25.65    0 0.5810 5.856  97.0      NA   2 188    19.1
370.31
## 125  0.09849   0.0 25.65    0 0.5810 5.879  95.8      NA   2 188      NA
379.38
## 126  0.16902   0.0 25.65    0     NA 5.986  88.4  1.9929   2 188    19.1
385.02
## 127  0.38735   0.0 25.65    0 0.5810 5.613  95.6  1.7572   2 188    19.1
359.29
## 128  0.25915   0.0 21.89    0 0.6240 5.693    NA  1.7883   4 437    21.2
392.11
## 129  0.32543    NA 21.89   NA 0.6240 6.431  98.8  1.8125   4 437    21.2
396.90
## 130  0.88125   0.0 21.89    0 0.6240 5.637  94.7      NA   4 437    21.2
396.90
## 131  0.34006   0.0 21.89    0 0.6240 6.458  98.9  2.1185   4  NA    21.2
395.04
## 132  1.19294   0.0 21.89    0 0.6240    NA  97.7      NA   4 437    21.2
NA
## 133  0.59005   0.0 21.89    0 0.6240 6.372    NA  2.3274   4 437    21.2
385.76
## 134       NA   0.0 21.89    0 0.6240 5.822  95.4  2.4699   4 437    21.2
388.69
## 135       NA   0.0 21.89    0 0.6240 5.757    NA  2.3460   4 437    21.2
```

```
262.76
## 136  0.55778   0.0 21.89    0     NA 6.335  98.2  2.1107   4 437    21.2
394.67
## 137       NA   0.0 21.89   NA 0.6240 5.942  93.5      NA   4 437      NA
378.25
## 138  0.35233   0.0 21.89    0 0.6240 6.454  98.4  1.8498   4 437    21.2
394.08
## 139  0.24980   0.0 21.89    0 0.6240 5.857  98.2  1.6686   4 437    21.2
392.04
## 140  0.54452    NA 21.89    0 0.6240 6.151  97.9  1.6687   4  NA    21.2
396.90
## 141  0.29090   0.0 21.89    0 0.6240 6.174  93.6  1.6119   4  NA    21.2
388.08
## 142  1.62864   0.0 21.89    0 0.6240    NA 100.0  1.4394   4 437      NA
396.90
## 143  3.32105   0.0 19.58    1 0.8710 5.403 100.0  1.3216   5  NA    14.7
396.90
## 144       NA   0.0 19.58    0 0.8710 5.468 100.0  1.4118   5 403    14.7
396.90
## 145  2.77974   0.0 19.58    0 0.8710 4.903  97.8  1.3459  NA  NA    14.7
396.90
## 146  2.37934   0.0 19.58    0 0.8710 6.130 100.0  1.4191  NA 403    14.7
172.91
## 147  2.15505   0.0 19.58    0 0.8710 5.628 100.0  1.5166   5 403    14.7
169.27
## 148       NA   0.0 19.58    0 0.8710 4.926  95.7  1.4608   5 403    14.7
391.71
## 149  2.33099   0.0 19.58    0 0.8710 5.186    NA  1.5296   5  NA    14.7
356.99
## 150  2.73397   0.0 19.58    0 0.8710 5.597  94.9  1.5257   5 403      NA
351.85
## 151  1.65660   0.0 19.58    0 0.8710 6.122    NA  1.6180   5 403    14.7
372.80
## 152  1.49632   0.0 19.58    0 0.8710 5.404 100.0  1.5916  NA 403    14.7
341.60
## 153  1.12658   0.0 19.58    1 0.8710 5.012  88.0      NA   5 403    14.7
NA
## 154  2.14918    NA 19.58    0 0.8710 5.709  98.5  1.6232  NA 403      NA
261.95
## 155  1.41385    NA 19.58    1     NA 6.129    NA  1.7494   5 403    14.7
321.02
## 156       NA   0.0 19.58    1 0.8710 6.152  82.6  1.7455   5 403      NA
88.01
## 157       NA   0.0 19.58    0 0.8710 5.272  94.0      NA   5 403    14.7
88.63
## 158  1.22358   0.0    NA    0 0.6050 6.943  97.4      NA   5 403    14.7
363.43
## 159  1.34284   0.0 19.58    0 0.6050 6.066 100.0  1.7573   5 403    14.7
353.89
## 160  1.42502   0.0 19.58    0 0.8710 6.510 100.0  1.7659   5 403    14.7
```

```
364.31
## 161  1.27346   0.0 19.58    1 0.6050 6.250  92.6  1.7984   5 403    14.7
338.92
## 162  1.46336   0.0 19.58    0     NA 7.489  90.8  1.9709   5 403    14.7
374.43
## 163  1.83377   0.0 19.58    1 0.6050 7.802  98.2  2.0407   5 403    14.7
389.61
## 164  1.51902   0.0 19.58    1 0.6050 8.375  93.9      NA   5 403    14.7
388.45
## 165  2.24236    NA 19.58    0 0.6050 5.854  91.8  2.4220   5 403    14.7
395.11
## 166  2.92400   0.0 19.58    0 0.6050 6.101  93.0  2.2834   5 403    14.7
240.16
## 167  2.01019    NA 19.58   NA 0.6050 7.929  96.2  2.0459   5  NA    14.7
369.30
## 168  1.80028   0.0    NA    0 0.6050 5.877  79.2  2.4259   5 403    14.7
227.61
## 169  2.30040   0.0 19.58    0 0.6050 6.319  96.1  2.1000   5 403      NA
297.09
## 170  2.44953   0.0 19.58    0 0.6050 6.402  95.2  2.2625   5 403    14.7
330.04
## 171  1.20742   0.0 19.58    0 0.6050 5.875    NA  2.4259   5 403    14.7
292.29
## 172  2.31390   0.0 19.58    0 0.6050 5.880  97.3  2.3887   5 403    14.7
348.13
## 173  0.13914   0.0  4.05    0     NA 5.572  88.5  2.5961   5  NA    16.6
396.90
## 174  0.09178   0.0  4.05    0 0.5100    NA  84.1  2.6463   5 296    16.6
395.50
## 175  0.08447   0.0  4.05    0 0.5100    NA  68.7  2.7019   5 296      NA
393.23
## 176  0.06664   0.0  4.05    0     NA 6.546    NA  3.1323   5 296    16.6
390.96
## 177       NA   0.0  4.05    0 0.5100 6.020  47.2      NA   5 296    16.6
393.23
## 178  0.05425   0.0  4.05   NA 0.5100 6.315  73.4      NA   5  NA    16.6
395.60
## 179  0.06642   0.0    NA    0 0.5100 6.860  74.4  2.9153   5 296    16.6
NA
## 180  0.05780   0.0  2.46    0 0.4880 6.980  58.4  2.8290   3 193    17.8
396.90
## 181  0.06588   0.0  2.46    0 0.4880 7.765  83.3  2.7410  NA 193    17.8
NA
## 182       NA   0.0  2.46    0 0.4880 6.144  62.2  2.5979  NA  NA    17.8
396.90
## 183  0.09103   0.0    NA    0 0.4880    NA  92.2  2.7006   3 193      NA
394.12
## 184  0.10008   0.0  2.46    0     NA 6.563  95.6  2.8470   3 193    17.8
396.90
## 185  0.08308   0.0  2.46    0 0.4880 5.604  89.8  2.9879   3 193    17.8
```

```
391.00
## 186  0.06047   0.0  2.46    0 0.4880 6.153  68.8  3.2797   3 193    17.8
387.11
## 187  0.05602   0.0  2.46    0 0.4880 7.831  53.6  3.1992   3 193    17.8
392.63
## 188  0.07875  45.0  3.44   NA 0.4370 6.782  41.1  3.7886   5 398      NA
393.87
## 189  0.12579  45.0  3.44    0 0.4370 6.556  29.1  4.5667   5 398    15.2
382.84
## 190  0.08370  45.0  3.44    0 0.4370 7.185  38.9  4.5667   5 398    15.2
396.90
## 191  0.09068  45.0  3.44    0 0.4370    NA  21.5  6.4798   5 398    15.2
377.68
## 192  0.06911  45.0  3.44    0 0.4370 6.739  30.8  6.4798   5  NA      NA
389.71
## 193       NA  45.0  3.44   NA 0.4370 7.178  26.3  6.4798   5 398    15.2
390.49
## 194  0.02187  60.0  2.93    0 0.4010 6.800   9.9  6.2196   1 265    15.6
393.37
## 195  0.01439  60.0  2.93    0 0.4010 6.604  18.8  6.2196   1 265    15.6
376.70
## 196  0.01381  80.0  0.46    0 0.4220 7.875    NA  5.6484   4 255    14.4
394.23
## 197  0.04011  80.0  1.52    0 0.4040 7.287  34.1  7.3090   2 329    12.6
396.90
## 198  0.04666  80.0  1.52    0 0.4040 7.107  36.6  7.3090   2 329    12.6
354.31
## 199  0.03768  80.0    NA    0 0.4040 7.274  38.3  7.3090   2 329    12.6
392.20
## 200  0.03150  95.0  1.47    0 0.4030    NA  15.3  7.6534  NA 402    17.0
396.90
## 201  0.01778  95.0  1.47    0 0.4030 7.135  13.9  7.6534   3 402    17.0
NA
## 202  0.03445  82.5  2.03    0     NA 6.162  38.4  6.2700   2 348    14.7
393.77
## 203  0.02177  82.5  2.03    0 0.4150 7.610  15.7  6.2700   2 348    14.7
NA
## 204  0.03510  95.0  2.68   NA 0.4161 7.853  33.2  5.1180   4 224    14.7
392.78
## 205  0.02009  95.0  2.68    0 0.4161 8.034    NA  5.1180   4 224      NA
390.55
## 206  0.13642   0.0 10.59    0 0.4890 5.891  22.3  3.9454   4 277    18.6
396.90
## 207  0.22969   0.0 10.59    0 0.4890 6.326  52.5      NA   4 277    18.6
394.87
## 208  0.25199   0.0 10.59    0 0.4890 5.783  72.7  4.3549   4 277    18.6
NA
## 209  0.13587   0.0 10.59    1 0.4890 6.064    NA  4.2392   4 277    18.6
381.32
## 210  0.43571   0.0 10.59    1 0.4890 5.344 100.0  3.8750   4 277    18.6
```

```
NA
## 211  0.17446   0.0 10.59    1 0.4890 5.960  92.1  3.8771   4 277    18.6
393.25
## 212  0.37578   0.0 10.59    1 0.4890 5.404  88.6  3.6650   4 277    18.6
395.24
## 213  0.21719   0.0 10.59    1 0.4890 5.807  53.8  3.6526   4 277    18.6
390.94
## 214  0.14052    NA 10.59    0 0.4890 6.375  32.3      NA   4 277    18.6
385.81
## 215  0.28955    NA 10.59    0 0.4890 5.412   9.8  3.5875   4 277      NA
348.93
## 216  0.19802   0.0 10.59    0 0.4890 6.182  42.4  3.9454   4  NA    18.6
393.63
## 217       NA    NA 13.89    1 0.5500 5.888  56.0      NA   5 276    16.4
NA
## 218       NA    NA 13.89    0     NA 6.642  85.1  3.4211   5 276    16.4
392.78
## 219  0.11069   0.0 13.89    1 0.5500 5.951  93.8  2.8893   5 276    16.4
NA
## 220  0.11425   0.0 13.89    1 0.5500    NA    NA  3.3633   5 276    16.4
393.74
## 221       NA   0.0  6.20    1 0.5070 6.951  88.5  2.8617   8 307      NA
NA
## 222  0.40771    NA  6.20    1 0.5070 6.164  91.3  3.0480   8 307    17.4
395.24
## 223  0.62356   0.0  6.20    1 0.5070 6.879  77.7  3.2721   8 307    17.4
390.39
## 224  0.61470   0.0  6.20    0 0.5070 6.618  80.8  3.2721   8  NA    17.4
396.90
## 225  0.31533    NA  6.20    0 0.5040 8.266    NA  2.8944  NA 307    17.4
385.05
## 226  0.52693   0.0  6.20    0 0.5040 8.725  83.0      NA   8 307    17.4
382.00
## 227  0.38214   0.0  6.20    0 0.5040 8.040  86.5      NA   8 307    17.4
387.38
## 228  0.41238    NA  6.20    0 0.5040 7.163  79.9  3.2157   8 307    17.4
372.08
## 229  0.29819   0.0  6.20   NA 0.5040 7.686  17.0  3.3751   8 307    17.4
377.51
## 230  0.44178   0.0  6.20    0     NA 6.552  21.4  3.3751   8 307    17.4
380.34
## 231       NA   0.0  6.20    0 0.5040 5.981  68.1  3.6715   8 307    17.4
378.35
## 232  0.46296   0.0  6.20    0 0.5040    NA  76.9  3.6715   8 307    17.4
376.14
## 233  0.57529   0.0  6.20   NA 0.5070 8.337  73.3  3.8384   8 307    17.4
385.91
## 234  0.33147   0.0  6.20    0 0.5070 8.247  70.4  3.6519   8 307    17.4
378.95
## 235  0.44791   0.0  6.20    1 0.5070 6.726  66.5  3.6519   8 307    17.4
```

```
360.20
## 236  0.33045   0.0  6.20    0 0.5070    NA    NA  3.6519   8 307    17.4
376.75
## 237  0.52058   0.0  6.20    1 0.5070    NA  76.5  4.1480   8 307    17.4
388.45
## 238  0.51183   0.0  6.20    0 0.5070 7.358  71.6  4.1480   8 307    17.4
390.07
## 239  0.08244  30.0  4.93    0 0.4280 6.481  18.5  6.1899   6 300    16.6
379.41
## 240  0.09252  30.0    NA    0 0.4280 6.606  42.2  6.1899   6 300    16.6
383.78
## 241  0.11329  30.0  4.93    0     NA 6.897  54.3  6.3361   6 300    16.6
391.25
## 242  0.10612  30.0  4.93    0 0.4280 6.095  65.1  6.3361   6 300    16.6
394.62
## 243  0.10290  30.0  4.93   NA 0.4280 6.358  52.9  7.0355  NA 300    16.6
NA
## 244       NA  30.0  4.93    0 0.4280    NA   7.8  7.0355   6  NA    16.6
374.71
## 245  0.20608  22.0  5.86    0 0.4310 5.593  76.5  7.9549   7 330    19.1
372.49
## 246  0.19133  22.0  5.86    0     NA 5.605  70.2  7.9549   7 330    19.1
389.13
## 247  0.33983  22.0  5.86    0 0.4310 6.108  34.9  8.0555   7 330    19.1
NA
## 248  0.19657  22.0  5.86    0 0.4310 6.226    NA  8.0555   7 330    19.1
376.14
## 249  0.16439  22.0  5.86    0 0.4310 6.433  49.1  7.8265  NA 330    19.1
374.71
## 250       NA  22.0  5.86    0     NA 6.718    NA  7.8265   7 330    19.1
NA
## 251       NA  22.0  5.86    0 0.4310 6.487  13.0      NA   7 330    19.1
396.28
## 252  0.21409  22.0  5.86    0 0.4310 6.438    NA  7.3967   7 330      NA
377.07
## 253  0.08221  22.0  5.86    0 0.4310 6.957   6.8  8.9067  NA 330    19.1
386.09
## 254       NA  22.0  5.86    0 0.4310 8.259    NA  8.9067   7 330    19.1
396.90
## 255  0.04819  80.0  3.64    0 0.3920 6.108  32.0  9.2203   1 315    16.4
392.89
## 256  0.03548  80.0  3.64    0 0.3920 5.876  19.1  9.2203   1 315    16.4
395.18
## 257  0.01538  90.0  3.75    0 0.3940 7.454  34.2  6.3361   3 244    15.9
386.34
## 258  0.61154  20.0  3.97    0 0.6470 8.704  86.9  1.8010   5 264    13.0
389.70
## 259  0.66351  20.0  3.97    0 0.6470    NA 100.0  1.8946   5 264    13.0
383.29
## 260  0.65665    NA  3.97    0 0.6470 6.842    NA  2.0107   5 264    13.0
```

```
391.93
## 261  0.54011  20.0  3.97   NA 0.6470 7.203  81.8      NA   5 264    13.0
392.80
## 262       NA  20.0  3.97    0     NA 7.520  89.4  2.1398   5 264    13.0
388.37
## 263  0.52014  20.0  3.97    0 0.6470 8.398  91.5  2.2885   5 264    13.0
NA
## 264  0.82526  20.0  3.97    0     NA 7.327  94.5  2.0788   5 264    13.0
393.42
## 265  0.55007  20.0  3.97    0 0.6470 7.206  91.6  1.9301   5 264    13.0
387.89
## 266  0.76162  20.0  3.97    0 0.6470 5.560    NA  1.9865   5 264    13.0
NA
## 267  0.78570  20.0  3.97    0 0.6470 7.014  84.6  2.1329   5 264    13.0
384.07
## 268       NA  20.0  3.97   NA 0.5750 8.297  67.0  2.4216   5 264    13.0
384.54
## 269  0.54050  20.0  3.97    0 0.5750 7.470  52.6  2.8720   5 264    13.0
390.30
## 270  0.09065  20.0  6.96    1 0.4640 5.920  61.5  3.9175   3 223      NA
391.34
## 271  0.29916  20.0  6.96    0 0.4640 5.856  42.1  4.4290   3  NA    18.6
NA
## 272  0.16211  20.0  6.96   NA 0.4640 6.240  16.3  4.4290   3 223    18.6
396.90
## 273  0.11460  20.0  6.96    0 0.4640 6.538  58.7  3.9175   3 223    18.6
394.96
## 274  0.22188  20.0  6.96    1 0.4640 7.691  51.8  4.3665   3 223    18.6
NA
## 275  0.05644  40.0  6.41    1 0.4470    NA  32.9  4.0776   4 254    17.6
396.90
## 276  0.09604  40.0  6.41    0 0.4470 6.854  42.8  4.2673   4 254    17.6
396.90
## 277  0.10469    NA  6.41   NA 0.4470 7.267  49.0  4.7872   4 254    17.6
NA
## 278  0.06127  40.0  6.41    1 0.4470 6.826  27.6  4.8628   4 254    17.6
393.45
## 279  0.07978  40.0  6.41    0 0.4470 6.482  32.1  4.1403   4 254    17.6
396.90
## 280  0.21038  20.0  3.33    0 0.4429 6.812  32.2  4.1007   5 216    14.9
396.90
## 281       NA  20.0  3.33    0 0.4429 7.820  64.5  4.6947   5 216    14.9
387.31
## 282  0.03705  20.0  3.33    0 0.4429 6.968  37.2  5.2447   5 216    14.9
392.23
## 283  0.06129  20.0  3.33    1 0.4429 7.645    NA      NA   5 216    14.9
NA
## 284  0.01501  90.0  1.21    1 0.4010    NA  24.8  5.8850   1 198    13.6
395.52
## 285  0.00906  90.0  2.97    0 0.4000 7.088  20.8  7.3073   1 285    15.3
```

```
394.72
## 286  0.01096    NA  2.25    0 0.3890 6.453  31.9  7.3073   1 300      NA
NA
## 287  0.01965  80.0    NA    0 0.3850 6.230  31.5  9.0892   1 241    18.2
341.60
## 288  0.03871  52.5    NA    0 0.4050 6.209  31.3  7.3172   6 293      NA
396.90
## 289       NA  52.5  5.32   NA 0.4050 6.315  45.6  7.3172   6 293    16.6
396.90
## 290  0.04297  52.5  5.32    0     NA 6.565  22.9  7.3172   6 293      NA
371.72
## 291  0.03502  80.0  4.95   NA 0.4110 6.861  27.9  5.1167   4 245    19.2
396.90
## 292  0.07886    NA  4.95    0 0.4110 7.148  27.7  5.1167   4 245    19.2
396.90
## 293       NA  80.0  4.95    0 0.4110 6.630  23.4  5.1167   4 245    19.2
396.90
## 294  0.08265   0.0 13.92    0 0.4370 6.127  18.4  5.5027  NA 289    16.0
396.90
## 295  0.08199   0.0 13.92    0 0.4370 6.009  42.3      NA   4 289    16.0
NA
## 296  0.12932   0.0 13.92    0 0.4370 6.678  31.1  5.9604   4 289    16.0
396.90
## 297  0.05372   0.0 13.92    0 0.4370 6.549  51.0  5.9604   4 289    16.0
392.85
## 298       NA   0.0 13.92    0     NA 5.790  58.0  6.3200   4 289    16.0
396.90
## 299  0.06466  70.0    NA    0 0.4000 6.345  20.1  7.8278   5 358    14.8
368.24
## 300  0.05561  70.0  2.24    0 0.4000 7.041  10.0  7.8278   5 358    14.8
371.58
## 301  0.04417    NA  2.24    0 0.4000 6.871  47.4  7.8278   5 358    14.8
390.86
## 302  0.03537  34.0  6.09    0 0.4330 6.590  40.4  5.4917   7 329    16.1
395.75
## 303       NA  34.0  6.09    0 0.4330    NA    NA  5.4917  NA 329    16.1
383.61
## 304  0.10000  34.0  6.09    0 0.4330 6.982  17.7  5.4917   7 329    16.1
390.43
## 305  0.05515  33.0  2.18    0 0.4720 7.236  41.1  4.0220   7  NA    18.4
393.68
## 306  0.05479  33.0  2.18    0 0.4720 6.616  58.1  3.3700   7 222    18.4
NA
## 307  0.07503  33.0  2.18    0     NA 7.420  71.9  3.0992   7 222    18.4
396.90
## 308       NA  33.0  2.18    0 0.4720 6.849  70.3  3.1827   7  NA      NA
NA
## 309  0.49298   0.0  9.90    0 0.5440 6.635  82.5  3.3175   4 304    18.4
396.90
## 310  0.34940   0.0  9.90    0 0.5440 5.972  76.7  3.1025   4 304    18.4
```

```
396.24
## 311  2.63548   0.0    NA    0 0.5440 4.973  37.8  2.5194   4 304    18.4
350.45
## 312  0.79041   0.0    NA    0 0.5440 6.122  52.8  2.6403   4 304      NA
396.90
## 313  0.26169   0.0  9.90   NA 0.5440 6.023  90.4  2.8340   4 304    18.4
396.30
## 314  0.26938   0.0  9.90    0 0.5440 6.266  82.8  3.2628   4 304    18.4
393.39
## 315  0.36920   0.0  9.90    0 0.5440 6.567  87.3  3.6023   4 304      NA
NA
## 316  0.25356   0.0  9.90    0 0.5440 5.705  77.7  3.9450   4 304    18.4
396.42
## 317  0.31827   0.0  9.90    0 0.5440 5.914  83.2  3.9986   4 304    18.4
390.70
## 318  0.24522   0.0  9.90    0 0.5440 5.782  71.7  4.0317   4 304    18.4
396.90
## 319  0.40202   0.0  9.90    0 0.5440 6.382    NA  3.5325  NA  NA    18.4
395.21
## 320  0.47547   0.0  9.90   NA 0.5440 6.113  58.8      NA   4 304    18.4
396.23
## 321  0.16760   0.0  7.38    0 0.4930 6.426  52.3  4.5404   5 287    19.6
396.90
## 322  0.18159   0.0  7.38   NA 0.4930 6.376  54.3  4.5404   5 287    19.6
396.90
## 323  0.35114   0.0  7.38    0 0.4930 6.041    NA  4.7211   5 287    19.6
396.90
## 324  0.28392   0.0  7.38    0 0.4930 5.708  74.3  4.7211   5 287    19.6
391.13
## 325  0.34109   0.0  7.38    0 0.4930 6.415  40.1  4.7211   5 287    19.6
396.90
## 326  0.19186   0.0  7.38    0     NA 6.431  14.7  5.4159   5  NA      NA
393.68
## 327       NA   0.0  7.38    0 0.4930    NA  28.9      NA   5 287      NA
396.90
## 328  0.24103   0.0  7.38    0 0.4930 6.083  43.7  5.4159   5 287      NA
396.90
## 329  0.06617   0.0  3.24    0 0.4600 5.868  25.8  5.2146   4  NA    16.9
382.44
## 330  0.06724   0.0  3.24    0 0.4600 6.333  17.2  5.2146   4 430    16.9
375.21
## 331  0.04544   0.0  3.24    0 0.4600 6.144  32.2  5.8736   4 430      NA
NA
## 332  0.05023  35.0  6.06    0 0.4379 5.706  28.4  6.6407   1 304    16.9
394.02
## 333  0.03466  35.0  6.06    0 0.4379 6.031  23.3  6.6407   1 304      NA
362.25
## 334  0.05083   0.0  5.19   NA 0.5150 6.316  38.1  6.4584   5 224    20.2
389.71
## 335       NA   0.0  5.19    0 0.5150 6.310  38.5  6.4584   5 224    20.2
```

```
NA
## 336  0.03961   0.0    NA    0 0.5150 6.037  34.5  5.9853   5 224    20.2
396.90
## 337  0.03427   0.0  5.19    0     NA 5.869  46.3  5.2311   5  NA    20.2
396.90
## 338  0.03041   0.0  5.19    0     NA 5.895  59.6      NA   5 224    20.2
394.81
## 339  0.03306   0.0  5.19    0 0.5150 6.059  37.3  4.8122   5 224    20.2
396.14
## 340  0.05497   0.0  5.19    0 0.5150 5.985  45.4  4.8122   5 224      NA
396.90
## 341  0.06151   0.0  5.19    0 0.5150 5.968  58.5  4.8122   5 224      NA
396.90
## 342  0.01301  35.0  1.52    0 0.4420 7.241  49.3  7.0379   1 284    15.5
394.74
## 343  0.02498   0.0  1.89   NA 0.5180    NA    NA  6.2669   1 422    15.9
389.96
## 344  0.02543  55.0  3.78    0 0.4840 6.696  56.4  5.7321   5 370    17.6
396.90
## 345  0.03049    NA  3.78   NA 0.4840 6.874  28.1  6.4654   5 370    17.6
387.97
## 346  0.03113   0.0  4.39    0     NA 6.014  48.5      NA   3 352    18.8
385.64
## 347  0.06162   0.0  4.39    0 0.4420 5.898  52.3  8.0136   3 352    18.8
364.61
## 348  0.01870    NA    NA    0 0.4290 6.516  27.7  8.5353   4 351    17.9
NA
## 349  0.01501  80.0  2.01    0     NA 6.635  29.7  8.3440  NA 280    17.0
390.94
## 350       NA  40.0  1.25    0 0.4290 6.939  34.5  8.7921   1 335    19.7
389.85
## 351  0.06211  40.0  1.25    0 0.4290 6.490  44.4  8.7921   1 335    19.7
396.90
## 352  0.07950  60.0  1.69    0 0.4110 6.579  35.9 10.7103  NA 411      NA
370.78
## 353  0.07244  60.0  1.69    0 0.4110 5.884  18.5 10.7103  NA 411    18.3
NA
## 354  0.01709  90.0  2.02    0     NA 6.728    NA 12.1265   5 187    17.0
384.46
## 355  0.04301  80.0  1.91    0 0.4130 5.663  21.9 10.5857   4 334    22.0
382.80
## 356  0.10659  80.0  1.91    0 0.4130 5.936  19.5 10.5857   4 334    22.0
376.04
## 357  8.98296   0.0 18.10    1 0.7700    NA  97.4  2.1222  24 666    20.2
377.73
## 358  3.84970   0.0 18.10    1 0.7700 6.395  91.0  2.5052  24 666    20.2
391.34
## 359  5.20177   0.0    NA    1 0.7700 6.127  83.4  2.7227  24 666    20.2
395.43
## 360  4.26131   0.0 18.10    0 0.7700 6.112  81.3  2.5091  24 666    20.2
```

```
390.74
## 361  4.54192   0.0 18.10    0 0.7700    NA  88.0  2.5182  24 666    20.2
374.56
## 362  3.83684   0.0 18.10    0 0.7700 6.251  91.1  2.2955  24 666    20.2
350.65
## 363  3.67822   0.0    NA    0 0.7700 5.362  96.2  2.1036  24 666    20.2
380.79
## 364  4.22239   0.0 18.10    1 0.7700 5.803    NA  1.9047  24 666    20.2
353.04
## 365  3.47428   0.0 18.10    1 0.7180    NA  82.9  1.9047  24 666    20.2
354.55
## 366  4.55587   0.0 18.10    0 0.7180 3.561  87.9  1.6132  24 666      NA
354.70
## 367  3.69695   0.0 18.10   NA 0.7180 4.963  91.4  1.7523  24 666    20.2
316.03
## 368 13.52220   0.0    NA    0 0.6310 3.863 100.0  1.5106  24 666    20.2
131.42
## 369  4.89822   0.0    NA    0 0.6310    NA 100.0  1.3325  24 666    20.2
375.52
## 370  5.66998   0.0 18.10    1 0.6310 6.683  96.8  1.3567  24 666    20.2
375.33
## 371       NA   0.0 18.10   NA 0.6310 7.016  97.5  1.2024  24 666    20.2
392.05
## 372  9.23230   0.0 18.10    0     NA 6.216 100.0  1.1691  NA 666    20.2
366.15
## 373  8.26725   0.0 18.10    1 0.6680 5.875  89.6  1.1296  24  NA    20.2
347.88
## 374 11.10810   0.0 18.10    0 0.6680 4.906 100.0  1.1742  24 666      NA
396.90
## 375 18.49820   0.0 18.10    0 0.6680 4.138 100.0  1.1370  24 666    20.2
396.90
## 376 19.60910   0.0    NA    0 0.6710 7.313  97.9  1.3163  24 666    20.2
396.90
## 377 15.28800   0.0 18.10    0 0.6710    NA  93.3  1.3449  NA 666    20.2
363.02
## 378  9.82349   0.0 18.10    0 0.6710    NA  98.8  1.3580  24 666    20.2
NA
## 379 23.64820   0.0 18.10    0 0.6710 6.380  96.2  1.3861  24 666    20.2
396.90
## 380       NA   0.0 18.10    0 0.6710 6.223 100.0  1.3861  24 666    20.2
393.74
## 381 88.97620   0.0 18.10    0 0.6710 6.968  91.9  1.4165  24 666    20.2
396.90
## 382 15.87440   0.0 18.10    0 0.6710 6.545  99.1  1.5192  24 666    20.2
396.90
## 383  9.18702   0.0 18.10   NA 0.7000 5.536 100.0  1.5804  24 666    20.2
NA
## 384  7.99248   0.0 18.10    0 0.7000 5.520 100.0  1.5331  24 666    20.2
396.90
## 385 20.08490   0.0 18.10    0 0.7000 4.368  91.2  1.4395  24  NA    20.2
```

```
285.83
## 386 16.81180    NA 18.10    0 0.7000 5.277  98.1  1.4261  24 666      NA
396.90
## 387 24.39380   0.0 18.10    0     NA 4.652 100.0  1.4672  NA 666    20.2
396.90
## 388 22.59710   0.0 18.10    0 0.7000 5.000  89.5      NA  24 666    20.2
396.90
## 389 14.33370   0.0 18.10    0 0.7000 4.880 100.0  1.5895  24 666    20.2
372.92
## 390  8.15174   0.0 18.10    0 0.7000 5.390  98.9  1.7281  24  NA    20.2
396.90
## 391  6.96215   0.0 18.10    0 0.7000 5.713  97.0  1.9265  24 666    20.2
394.43
## 392  5.29305    NA    NA    0     NA 6.051  82.5  2.1678  24 666    20.2
NA
## 393 11.57790   0.0 18.10    0     NA 5.036  97.0  1.7700  24 666    20.2
396.90
## 394  8.64476   0.0 18.10    0 0.6930 6.193  92.6  1.7912  24 666    20.2
396.90
## 395 13.35980   0.0 18.10    0 0.6930 5.887    NA  1.7821  24 666      NA
396.90
## 396  8.71675   0.0 18.10    0 0.6930 6.471  98.8  1.7257  24 666      NA
391.98
## 397  5.87205   0.0 18.10    0 0.6930 6.405  96.0      NA  24 666    20.2
396.90
## 398  7.67202    NA 18.10    0 0.6930    NA    NA  1.6334  24 666    20.2
393.10
## 399 38.35180   0.0 18.10    0 0.6930 5.453 100.0  1.4896  24  NA    20.2
NA
## 400  9.91655   0.0 18.10    0 0.6930 5.852  77.8  1.5004  24 666    20.2
NA
## 401 25.04610   0.0 18.10    0 0.6930 5.987 100.0  1.5888  24 666    20.2
396.90
## 402 14.23620   0.0 18.10    0 0.6930    NA 100.0  1.5741  24 666    20.2
NA
## 403  9.59571   0.0 18.10    0     NA 6.404 100.0  1.6390  NA 666    20.2
376.11
## 404 24.80170   0.0    NA    0 0.6930 5.349    NA  1.7028  24 666    20.2
396.90
## 405 41.52920   0.0 18.10    0 0.6930 5.531    NA  1.6074  NA 666    20.2
329.46
## 406 67.92080   0.0 18.10    0 0.6930 5.683 100.0      NA  24 666      NA
384.97
## 407 20.71620   0.0 18.10    0 0.6590 4.138 100.0  1.1781  24 666    20.2
370.22
## 408 11.95110   0.0 18.10    0 0.6590 5.608 100.0  1.2852  24 666    20.2
332.09
## 409  7.40389   0.0 18.10    0     NA 5.617    NA  1.4547  NA 666    20.2
314.64
## 410 14.43830   0.0 18.10    0 0.5970    NA 100.0  1.4655  24 666    20.2
```

```
NA
## 411 51.13580   0.0 18.10    0 0.5970 5.757 100.0  1.4130  24 666    20.2
NA
## 412 14.05070   0.0 18.10    0 0.5970 6.657 100.0  1.5275  24 666    20.2
35.05
## 413 18.81100   0.0 18.10    0 0.5970 4.628 100.0  1.5539  NA 666      NA
28.79
## 414 28.65580   0.0 18.10    0 0.5970 5.155 100.0  1.5894  24 666    20.2
210.97
## 415       NA    NA 18.10   NA 0.6930 4.519 100.0  1.6582  24  NA    20.2
88.27
## 416 18.08460   0.0 18.10    0 0.6790 6.434 100.0  1.8347  24  NA    20.2
27.25
## 417 10.83420   0.0 18.10    0 0.6790 6.782  90.8      NA  NA 666    20.2
21.57
## 418 25.94060   0.0 18.10    0 0.6790    NA    NA  1.6475  24 666    20.2
127.36
## 419 73.53410   0.0 18.10    0 0.6790 5.957 100.0  1.8026  24 666    20.2
16.45
## 420 11.81230   0.0 18.10    0 0.7180 6.824  76.5  1.7940  24 666    20.2
48.45
## 421 11.08740   0.0 18.10    0 0.7180 6.411 100.0  1.8589  24 666    20.2
318.75
## 422  7.02259   0.0 18.10    0 0.7180 6.006  95.3  1.8746  24 666    20.2
319.98
## 423 12.04820   0.0 18.10    0 0.6140 5.648    NA  1.9512  24 666    20.2
NA
## 424  7.05042   0.0 18.10   NA 0.6140 6.103  85.1  2.0218  24 666    20.2
2.52
## 425  8.79212   0.0 18.10    0 0.5840 5.565  70.6  2.0635  24 666    20.2
3.65
## 426 15.86030   0.0 18.10    0 0.6790 5.896    NA  1.9096  NA 666      NA
7.68
## 427 12.24720    NA 18.10   NA 0.5840 5.837  59.7  1.9976  24 666    20.2
24.65
## 428 37.66190   0.0 18.10    0 0.6790    NA    NA  1.8629  24 666    20.2
NA
## 429  7.36711   0.0 18.10    0 0.6790 6.193  78.1      NA  NA 666    20.2
96.73
## 430  9.33889   0.0 18.10    0 0.6790 6.380    NA  1.9682  24 666    20.2
60.72
## 431  8.49213   0.0 18.10    0 0.5840    NA  86.1      NA  24 666    20.2
83.45
## 432 10.06230   0.0 18.10    0 0.5840    NA  94.3  2.0882  24 666    20.2
81.33
## 433  6.44405   0.0 18.10    0 0.5840 6.425  74.8  2.2004  24 666    20.2
NA
## 434  5.58107   0.0 18.10    0 0.7130 6.436  87.9  2.3158  24 666    20.2
100.19
## 435 13.91340   0.0 18.10    0 0.7130 6.208  95.0  2.2222  24 666    20.2
```

```
100.63
## 436 11.16040   0.0 18.10    0 0.7400 6.629  94.6  2.1247  NA 666    20.2
109.85
## 437       NA   0.0 18.10    0 0.7400 6.461  93.3  2.0026  24 666    20.2
27.49
## 438 15.17720   0.0 18.10    0 0.7400 6.152 100.0  1.9142  24 666    20.2
9.32
## 439       NA   0.0 18.10    0 0.7400 5.935  87.9  1.8206  24 666    20.2
68.95
## 440  9.39063    NA 18.10   NA 0.7400 5.627  93.9  1.8172  24 666    20.2
396.90
## 441       NA   0.0 18.10   NA 0.7400 5.818    NA  1.8662  NA 666    20.2
391.45
## 442  9.72418   0.0 18.10    0 0.7400 6.406  97.2  2.0651  24 666    20.2
385.96
## 443       NA   0.0 18.10    0     NA 6.219 100.0  2.0048  24 666    20.2
395.69
## 444  9.96654   0.0 18.10    0 0.7400 6.485    NA  1.9784  24  NA    20.2
386.73
## 445       NA   0.0 18.10    0 0.7400 5.854  96.6  1.8956  24 666    20.2
240.52
## 446 10.67180   0.0 18.10    0 0.7400 6.459  94.8  1.9879  24 666    20.2
43.06
## 447  6.28807   0.0 18.10    0 0.7400 6.341  96.4  2.0720  24 666      NA
NA
## 448  9.92485   0.0 18.10    0 0.7400 6.251  96.6  2.1980  24 666    20.2
388.52
## 449  9.32909   0.0 18.10    0 0.7130 6.185  98.7  2.2616  24 666    20.2
396.90
## 450  7.52601   0.0 18.10    0     NA 6.417  98.3  2.1850  24 666    20.2
304.21
## 451  6.71772   0.0 18.10    0 0.7130 6.749    NA  2.3236  24 666    20.2
0.32
## 452       NA   0.0 18.10   NA 0.7130 6.655  98.2  2.3552  24 666    20.2
355.29
## 453  5.09017   0.0 18.10    0 0.7130 6.297  91.8  2.3682  24 666    20.2
385.09
## 454  8.24809   0.0 18.10    0 0.7130 7.393  99.3  2.4527  NA 666    20.2
375.87
## 455  9.51363   0.0 18.10    0 0.7130 6.728  94.1  2.4961  24 666    20.2
6.68
## 456  4.75237   0.0    NA    0 0.7130 6.525  86.5      NA  24 666    20.2
50.92
## 457       NA    NA 18.10    0 0.7130 5.976    NA  2.5806  24 666    20.2
10.48
## 458  8.20058    NA 18.10    0 0.7130 5.936  80.3  2.7792  24  NA    20.2
3.50
## 459  7.75223   0.0 18.10    0 0.7130 6.301  83.7  2.7831  24 666    20.2
272.21
## 460  6.80117    NA 18.10    0 0.7130 6.081  84.4  2.7175  24  NA    20.2
```

```
396.90
## 461  4.81213   0.0 18.10    0 0.7130 6.701  90.0  2.5975  24 666    20.2
255.23
## 462       NA   0.0 18.10    0 0.7130 6.376    NA  2.5671  24 666    20.2
391.43
## 463  6.65492   0.0 18.10    0 0.7130 6.317  83.0  2.7344  24  NA    20.2
NA
## 464  5.82115   0.0 18.10    0 0.7130 6.513  89.9  2.8016  24 666    20.2
393.82
## 465  7.83932   0.0 18.10    0 0.6550 6.209  65.4  2.9634  24 666    20.2
396.90
## 466  3.16360   0.0    NA    0 0.6550 5.759  48.2  3.0665  24 666    20.2
334.40
## 467  3.77498   0.0 18.10    0     NA 5.952  84.7  2.8715  24 666    20.2
22.01
## 468  4.42228   0.0 18.10    0 0.5840 6.003  94.5  2.5403  24 666    20.2
331.29
## 469 15.57570   0.0 18.10    0 0.5800    NA  71.0  2.9084  24 666    20.2
368.74
## 470 13.07510   0.0 18.10    0 0.5800 5.713  56.7  2.8237  24 666    20.2
396.90
## 471  4.34879   0.0 18.10    0 0.5800 6.167  84.0  3.0334  24 666    20.2
396.90
## 472  4.03841    NA 18.10   NA 0.5320 6.229  90.7  3.0993  24 666    20.2
395.33
## 473  3.56868   0.0 18.10    0 0.5800 6.437  75.0  2.8965  24 666    20.2
393.37
## 474  4.64689   0.0    NA    0 0.6140 6.980    NA  2.5329  24 666    20.2
374.68
## 475  8.05579   0.0 18.10   NA 0.5840 5.427  95.4  2.4298  24 666    20.2
352.58
## 476       NA   0.0 18.10    0 0.5840 6.162  97.4  2.2060  24 666    20.2
302.76
## 477  4.87141   0.0 18.10    0 0.6140 6.484  93.6  2.3053  24 666    20.2
NA
## 478 15.02340    NA 18.10    0 0.6140 5.304  97.3  2.1007  24 666    20.2
349.48
## 479 10.23300   0.0 18.10    0 0.6140 6.185  96.7  2.1705  24 666    20.2
379.70
## 480 14.33370   0.0 18.10    0 0.6140 6.229  88.0  1.9512  24 666    20.2
383.32
## 481  5.82401   0.0 18.10    0 0.5320 6.242  64.7      NA  24 666    20.2
396.90
## 482  5.70818   0.0 18.10    0 0.5320 6.750    NA  3.3317  24 666    20.2
393.07
## 483  5.73116    NA 18.10    0 0.5320 7.061  77.0  3.4106  24 666      NA
395.28
## 484  2.81838   0.0 18.10    0 0.5320 5.762  40.3  4.0983  24 666    20.2
392.92
## 485  2.37857   0.0 18.10    0     NA 5.871  41.9  3.7240  24 666    20.2
```

```
370.73
## 486  3.67367   0.0 18.10    0 0.5830    NA  51.9  3.9917  24 666    20.2
388.62
## 487  5.69175   0.0 18.10    0 0.5830 6.114  79.8  3.5459  NA 666    20.2
392.68
## 488       NA   0.0 18.10    0     NA 5.905  53.2  3.1523  24 666    20.2
388.22
## 489  0.15086   0.0 27.74    0 0.6090 5.454  92.7  1.8209   4 711      NA
395.09
## 490  0.18337   0.0 27.74    0 0.6090 5.414  98.3  1.7554   4 711      NA
344.05
## 491  0.20746   0.0 27.74    0 0.6090 5.093  98.0  1.8226   4 711    20.1
318.43
## 492  0.10574   0.0    NA    0 0.6090 5.983  98.8  1.8681   4 711    20.1
390.11
## 493  0.11132   0.0 27.74    0 0.6090 5.983  83.5  2.1099   4 711    20.1
396.90
## 494  0.17331   0.0    NA    0 0.5850 5.707  54.0  2.3817   6 391    19.2
396.90
## 495  0.27957   0.0  9.69    0     NA    NA  42.6  2.3817   6 391    19.2
396.90
## 496  0.17899   0.0  9.69    0     NA 5.670  28.8      NA   6 391    19.2
393.29
## 497  0.28960   0.0    NA    0 0.5850 5.390  72.9  2.7986   6 391    19.2
396.90
## 498  0.26838   0.0  9.69    0 0.5850 5.794  70.6  2.8927   6 391    19.2
NA
## 499  0.23912    NA  9.69    0     NA 6.019  65.3  2.4091  NA 391    19.2
NA
## 500  0.17783   0.0  9.69    0 0.5850 5.569  73.5  2.3999   6 391    19.2
395.77
## 501  0.22438   0.0  9.69    0 0.5850 6.027  79.7  2.4982   6 391    19.2
396.90
## 502  0.06263   0.0 11.93    0 0.5730 6.593  69.1  2.4786   1 273    21.0
391.99
## 503  0.04527   0.0 11.93    0 0.5730 6.120  76.7  2.2875   1 273    21.0
396.90
## 504       NA    NA 11.93    0 0.5730    NA  91.0  2.1675   1 273    21.0
396.90
## 505  0.10959   0.0 11.93    0 0.5730 6.794    NA  2.3889   1 273      NA
393.45
## 506  0.04741   0.0 11.93    0 0.5730 6.030  80.8  2.5050   1 273    21.0
396.90
##     lstat
## 1    4.98
## 2    9.14
## 3    4.03
## 4    2.94
## 5    5.33
## 6    5.21
```

```
## 7   12.43
## 8      NA
## 9   29.93
## 10  17.10
## 11  20.45
## 12  13.27
## 13  15.71
## 14   8.26
## 15  10.26
## 16   8.47
## 17   6.58
## 18  14.67
## 19  11.69
## 20  11.28
## 21  21.02
## 22  13.83
## 23  18.72
## 24  19.88
## 25  16.30
## 26  16.51
## 27  14.81
## 28  17.28
## 29  12.80
## 30  11.98
## 31  22.60
## 32      NA
## 33  27.71
## 34  18.35
## 35  20.34
## 36   9.68
## 37  11.41
## 38   8.77
## 39  10.13
## 40   4.32
## 41   1.98
## 42      NA
## 43   5.81
## 44   7.44
## 45   9.55
## 46  10.21
## 47  14.15
## 48      NA
## 49  30.81
## 50  16.20
## 51  13.45
## 52   9.43
## 53   5.28
## 54   8.43
## 55  14.80
## 56   4.81
```

```
## 57   5.77
## 58   3.95
## 59   6.86
## 60   9.22
## 61     NA
## 62  14.44
## 63   6.73
## 64     NA
## 65     NA
## 66     NA
## 67  10.24
## 68   8.10
## 69  13.09
## 70   8.79
## 71   6.72
## 72   9.88
## 73   5.52
## 74   7.54
## 75   6.78
## 76   8.94
## 77  11.97
## 78  10.27
## 79  12.34
## 80     NA
## 81   5.29
## 82   7.22
## 83     NA
## 84   7.51
## 85   9.62
## 86   6.53
## 87  12.86
## 88   8.44
## 89   5.50
## 90   5.70
## 91     NA
## 92   8.20
## 93   8.16
## 94   6.21
## 95  10.59
## 96   6.65
## 97  11.34
## 98   4.21
## 99   3.57
## 100  6.19
## 101  9.42
## 102    NA
## 103 10.63
## 104 13.44
## 105 12.33
## 106 16.47
```

```
## 107 18.66
## 108 14.09
## 109 12.27
## 110 15.55
## 111 13.00
## 112 10.16
## 113 16.21
## 114 17.09
## 115 10.45
## 116 15.76
## 117 12.04
## 118 10.30
## 119 15.37
## 120    NA
## 121 14.37
## 122    NA
## 123 17.93
## 124 25.41
## 125 17.58
## 126 14.81
## 127 27.26
## 128 17.19
## 129 15.39
## 130 18.34
## 131 12.60
## 132 12.26
## 133 11.12
## 134 15.03
## 135 17.31
## 136 16.96
## 137 16.90
## 138    NA
## 139 21.32
## 140 18.46
## 141 24.16
## 142 34.41
## 143 26.82
## 144 26.42
## 145 29.29
## 146 27.80
## 147    NA
## 148 29.53
## 149 28.32
## 150 21.45
## 151 14.10
## 152    NA
## 153 12.12
## 154 15.79
## 155 15.12
## 156 15.02
```

```
## 157 16.14
## 158  4.59
## 159  6.43
## 160  7.39
## 161    NA
## 162  1.73
## 163  1.92
## 164  3.32
## 165 11.64
## 166  9.81
## 167  3.70
## 168 12.14
## 169 11.10
## 170 11.32
## 171 14.43
## 172 12.03
## 173 14.69
## 174  9.04
## 175  9.64
## 176  5.33
## 177 10.11
## 178  6.29
## 179  6.92
## 180  5.04
## 181  7.56
## 182  9.45
## 183  4.82
## 184  5.68
## 185    NA
## 186    NA
## 187  4.45
## 188  6.68
## 189  4.56
## 190  5.39
## 191    NA
## 192  4.69
## 193  2.87
## 194  5.03
## 195  4.38
## 196  2.97
## 197  4.08
## 198  8.61
## 199  6.62
## 200  4.56
## 201  4.45
## 202  7.43
## 203  3.11
## 204  3.81
## 205    NA
## 206 10.87
```

```
## 207 10.97
## 208 18.06
## 209 14.66
## 210 23.09
## 211 17.27
## 212 23.98
## 213 16.03
## 214  9.38
## 215 29.55
## 216  9.47
## 217 13.51
## 218    NA
## 219 17.92
## 220 10.50
## 221  9.71
## 222 21.46
## 223  9.93
## 224  7.60
## 225  4.14
## 226  4.63
## 227  3.13
## 228  6.36
## 229  3.92
## 230  3.76
## 231 11.65
## 232    NA
## 233  2.47
## 234  3.95
## 235  8.05
## 236 10.88
## 237  9.54
## 238    NA
## 239  6.36
## 240  7.37
## 241    NA
## 242 12.40
## 243 11.22
## 244  5.19
## 245 12.50
## 246 18.46
## 247  9.16
## 248 10.15
## 249  9.52
## 250  6.56
## 251  5.90
## 252    NA
## 253  3.53
## 254  3.54
## 255  6.57
## 256  9.25
```

```
## 257  3.11
## 258  5.12
## 259  7.79
## 260  6.90
## 261  9.59
## 262  7.26
## 263  5.91
## 264 11.25
## 265  8.10
## 266 10.45
## 267 14.79
## 268  7.44
## 269    NA
## 270 13.65
## 271 13.00
## 272  6.59
## 273  7.73
## 274  6.58
## 275    NA
## 276  2.98
## 277  6.05
## 278  4.16
## 279  7.19
## 280  4.85
## 281  3.76
## 282  4.59
## 283    NA
## 284  3.16
## 285  7.85
## 286    NA
## 287 12.93
## 288  7.14
## 289  7.60
## 290  9.51
## 291  3.33
## 292  3.56
## 293  4.70
## 294  8.58
## 295 10.40
## 296  6.27
## 297  7.39
## 298 15.84
## 299  4.97
## 300  4.74
## 301    NA
## 302  9.50
## 303  8.67
## 304  4.86
## 305  6.93
## 306  8.93
```

```
## 307  6.47
## 308  7.53
## 309  4.54
## 310  9.97
## 311 12.64
## 312  5.98
## 313 11.72
## 314  7.90
## 315  9.28
## 316 11.50
## 317 18.33
## 318 15.94
## 319 10.36
## 320    NA
## 321  7.20
## 322  6.87
## 323  7.70
## 324 11.74
## 325  6.12
## 326  5.08
## 327  6.15
## 328 12.79
## 329  9.97
## 330  7.34
## 331  9.09
## 332 12.43
## 333  7.83
## 334  5.68
## 335  6.75
## 336    NA
## 337  9.80
## 338 10.56
## 339  8.51
## 340  9.74
## 341  9.29
## 342  5.49
## 343  8.65
## 344  7.18
## 345  4.61
## 346 10.53
## 347    NA
## 348  6.36
## 349  5.99
## 350  5.89
## 351  5.98
## 352  5.49
## 353    NA
## 354  4.50
## 355  8.05
## 356  5.57
```

```
## 357 17.60
## 358 13.27
## 359 11.48
## 360 12.67
## 361  7.79
## 362 14.19
## 363 10.19
## 364    NA
## 365  5.29
## 366  7.12
## 367 14.00
## 368 13.33
## 369  3.26
## 370  3.73
## 371  2.96
## 372  9.53
## 373  8.88
## 374    NA
## 375 37.97
## 376    NA
## 377 23.24
## 378 21.24
## 379 23.69
## 380    NA
## 381 17.21
## 382 21.08
## 383 23.60
## 384 24.56
## 385 30.63
## 386 30.81
## 387 28.28
## 388 31.99
## 389    NA
## 390 20.85
## 391    NA
## 392 18.76
## 393 25.68
## 394 15.17
## 395 16.35
## 396 17.12
## 397    NA
## 398 19.92
## 399 30.59
## 400 29.97
## 401 26.77
## 402 20.32
## 403 20.31
## 404 19.77
## 405 27.38
## 406 22.98
```

```
## 407    NA
## 408 12.13
## 409 26.40
## 410 19.78
## 411 10.11
## 412 21.22
## 413 34.37
## 414 20.08
## 415 36.98
## 416 29.05
## 417 25.79
## 418 26.64
## 419 20.62
## 420 22.74
## 421 15.02
## 422 15.70
## 423 14.10
## 424 23.29
## 425 17.16
## 426 24.39
## 427 15.69
## 428 14.52
## 429 21.52
## 430 24.08
## 431 17.64
## 432 19.69
## 433 12.03
## 434 16.22
## 435 15.17
## 436 23.27
## 437 18.05
## 438 26.45
## 439 34.02
## 440 22.88
## 441 22.11
## 442 19.52
## 443 16.59
## 444 18.85
## 445    NA
## 446 23.98
## 447 17.79
## 448 16.44
## 449 18.13
## 450 19.31
## 451 17.44
## 452 17.73
## 453 17.27
## 454 16.74
## 455 18.71
## 456 18.13
```

```
## 457    NA
## 458 16.94
## 459 16.23
## 460 14.70
## 461 16.42
## 462 14.65
## 463 13.99
## 464    NA
## 465    NA
## 466 14.13
## 467 17.15
## 468 21.32
## 469    NA
## 470    NA
## 471 16.29
## 472 12.87
## 473 14.36
## 474 11.66
## 475 18.14
## 476    NA
## 477 18.68
## 478    NA
## 479 18.03
## 480 13.11
## 481 10.74
## 482  7.74
## 483    NA
## 484 10.42
## 485 13.34
## 486 10.58
## 487 14.98
## 488 11.45
## 489 18.06
## 490 23.97
## 491 29.68
## 492 18.07
## 493    NA
## 494 12.01
## 495 13.59
## 496 17.60
## 497 21.14
## 498 14.10
## 499 12.92
## 500 15.10
## 501 14.33
## 502    NA
## 503  9.08
## 504  5.64
## 505  6.48
## 506  7.88
```

Use a random forest modeling procedure to iteratively fill in the `NA`'s by predicting each feature of X using every other feature of X. You need to start by filling in the holes to use RF. So fill them in with the average of the feature.