

Lab 9

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11:59PM May 10, 2021

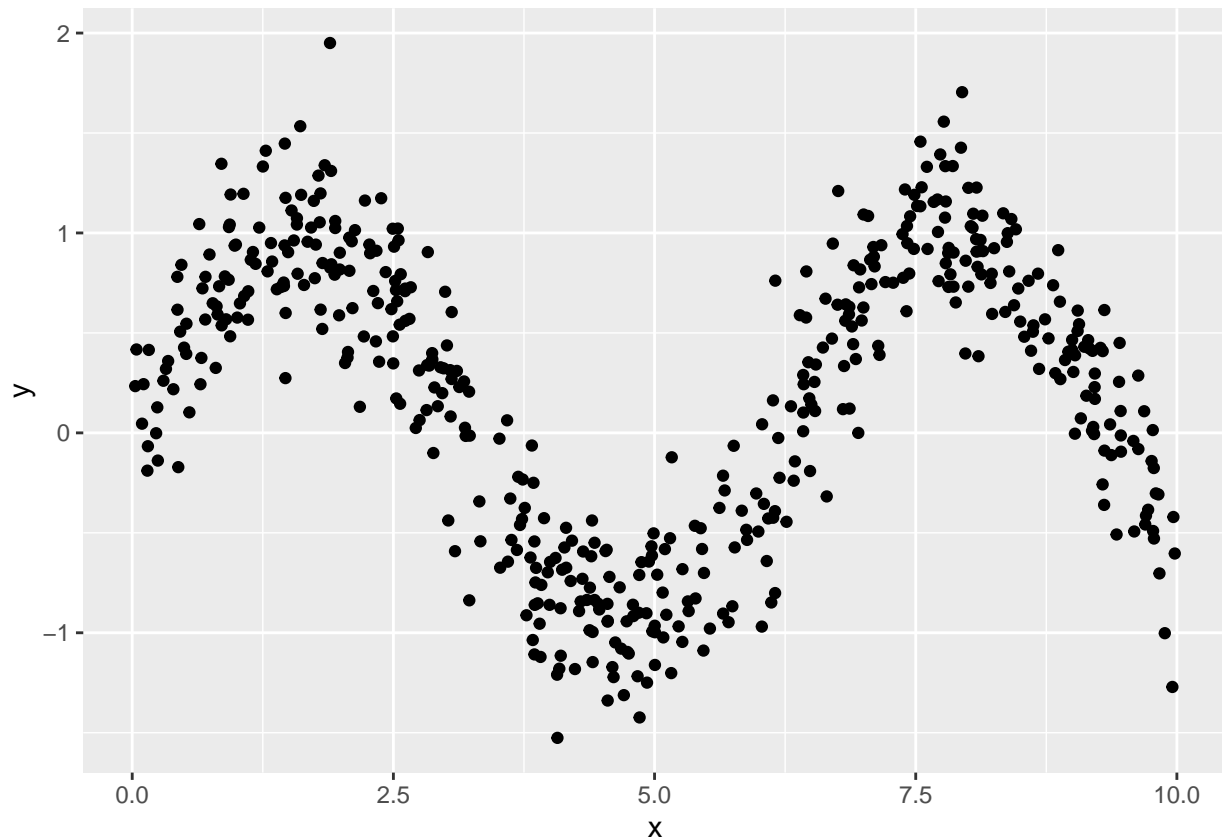
Here we will learn about trees, bagged trees and random forests. You can use the **YARF** package if it works, otherwise, use the **randomForest** package (the standard).

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))
```



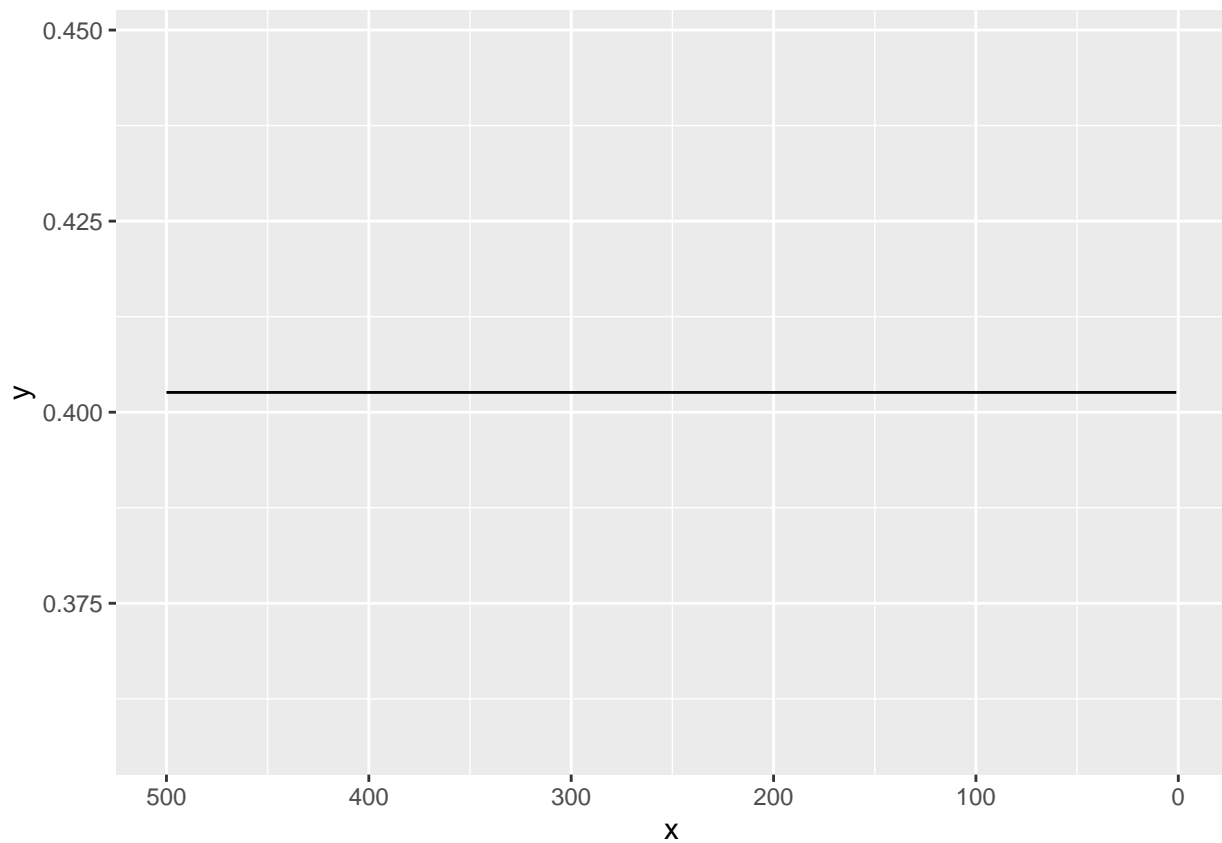
Create a test set of size 500 as well

```
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`, `sampsiz = n` (`mtry` is already set to be 1 because there is only one feature) and then you can set `nodesize`. plot node size out of sample

```
pacman ::p_load (randomForest)

node_sizes = 1:n
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, node
  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 ()
```

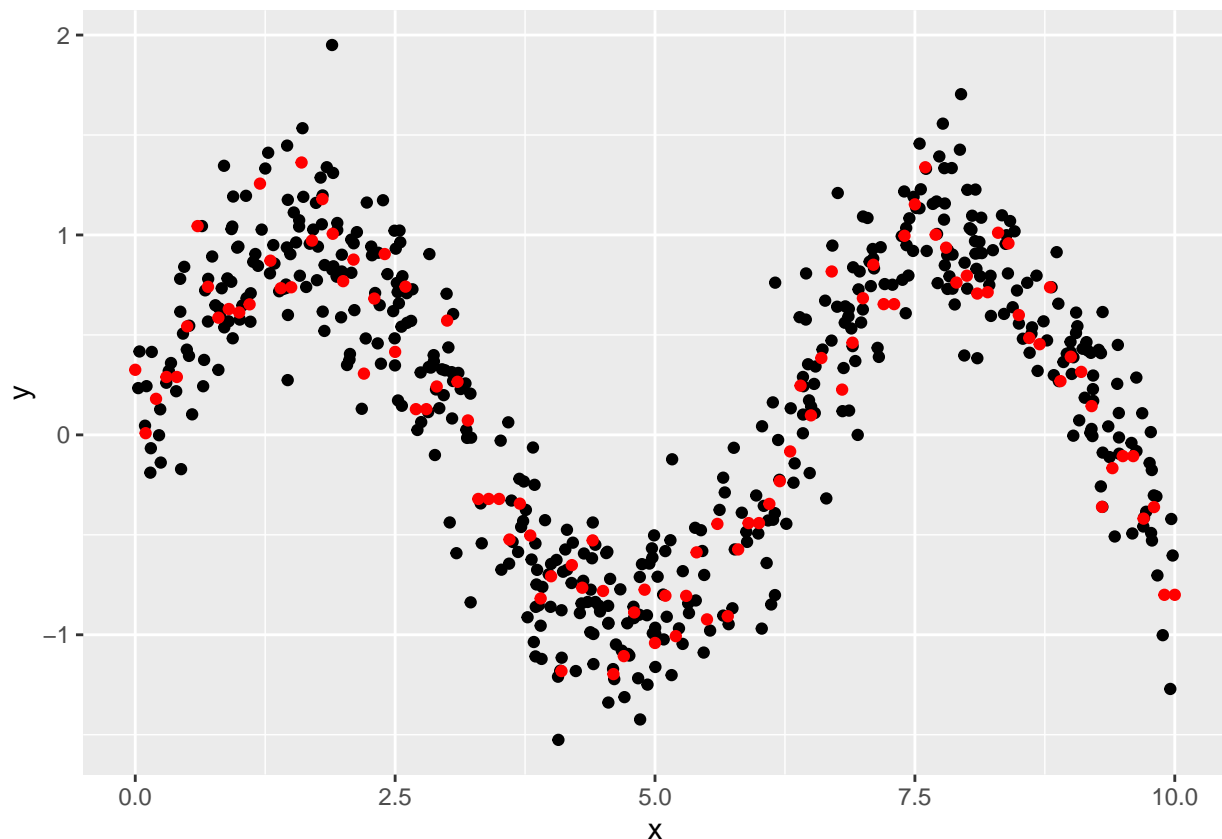


```
which.min(se_by_node_sizes)
```

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

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, node.
resolution = 0.1
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(data= data.frame(x=x_train,y=y_train)) +
  geom_point(color = "red")
```



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.

```
#T0-D0
```

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

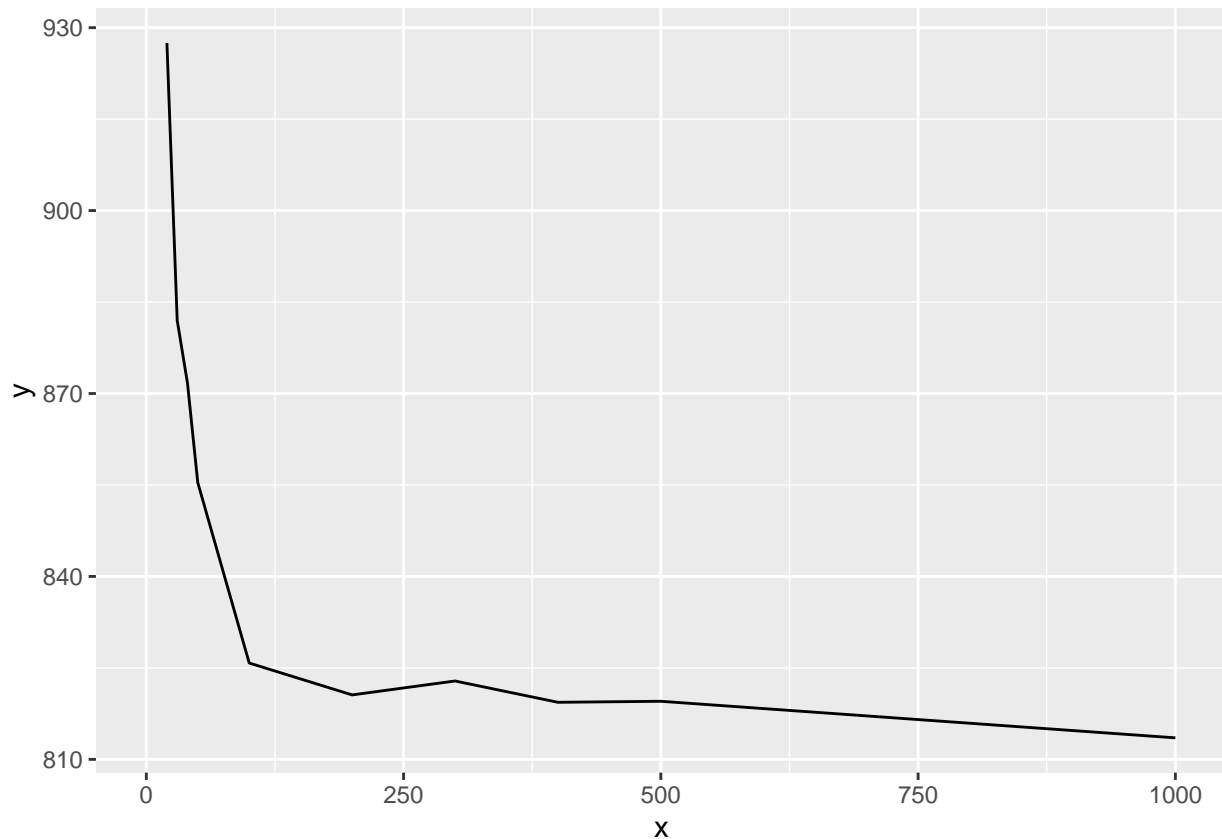
Take a sample of $n = 2000$ observations from the diamonds data.

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

find the oob 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= diamonds_samp, ntree = num_trees[i])
  oob_se_by_num_trees[i] = sd(diamonds_samp$price - rf_mod$predicted)
}
ggplot(data.frame(x= num_trees,y= oob_se_by_num_trees)) +
  geom_line(aes(x= x,y=y))
```

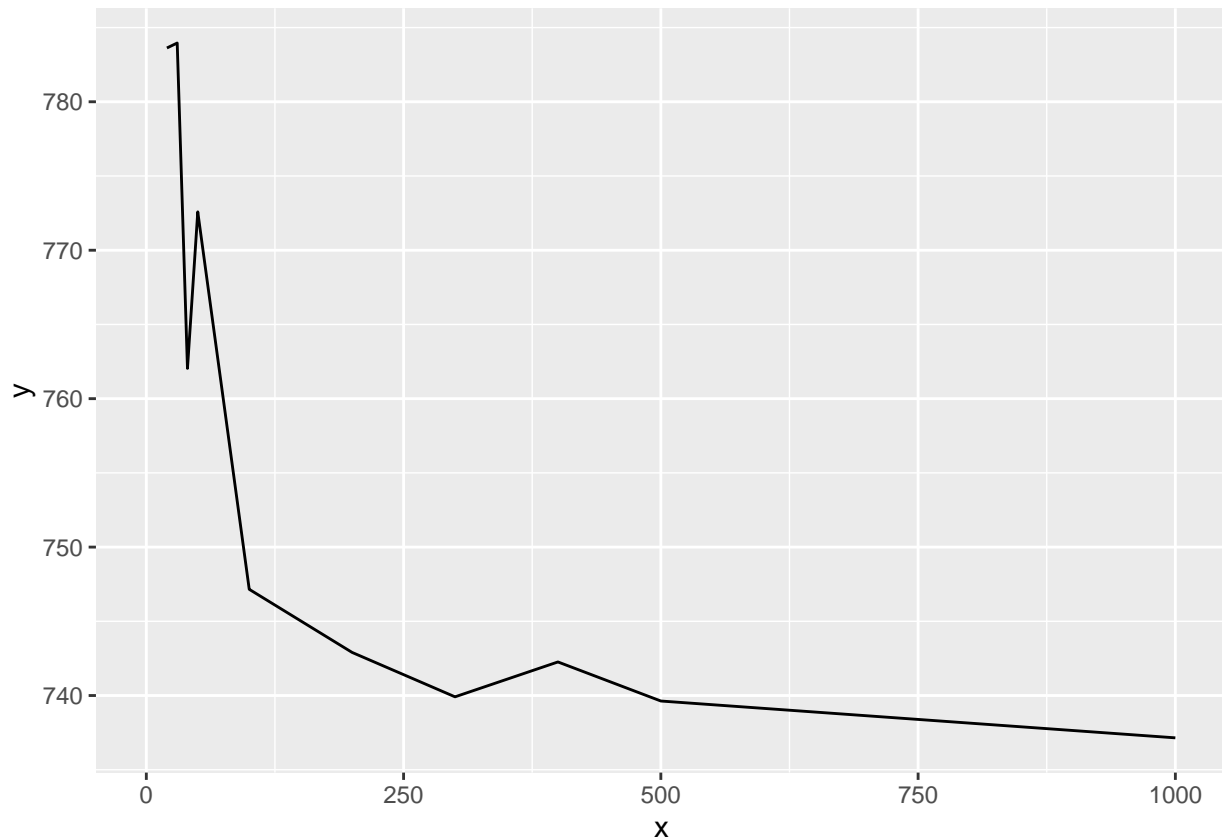
```
## Warning: Removed 4 row(s) containing missing values (geom_path).
```



Using the diamonds data, find the oob 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_bag = array(NA,length(num_trees))
for (i in 1:length(num_trees)) {
  rf_mod = randomForest(price~., data= diamonds_samp, ntree = num_trees[i], mtry =ncol(diamonds_samp)-
  oob_se_by_num_bag[i] = sd(diamonds_samp$price - rf_mod$predicted)
}
ggplot(data.frame(x= num_trees,y= oob_se_by_num_bag)) +
  geom_line(aes(x= x,y=y))
```

```
## 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?

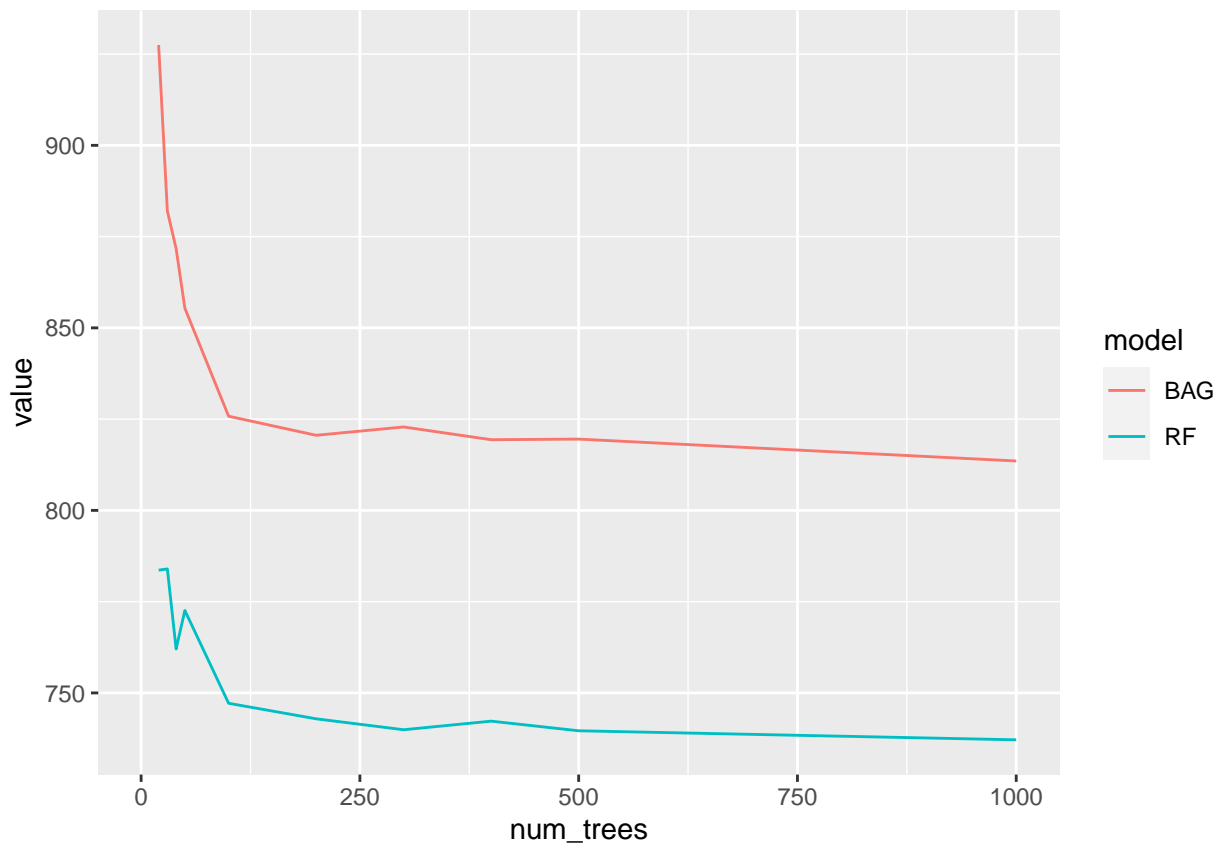
```
(oob_se_by_num_trees - oob_se_by_num_bag) / oob_se_by_num_bag * 100
```

```
## [1]      NA      NA      NA      NA 18.35793 12.50557 14.39160 10.71883
## [9] 10.52545 10.45473 11.20922 10.38672 10.80217 10.36138
```

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_bag, model = "RF"), data.frame (num_trees = num_trees, value = oob_se_by_num_trees, model = "bagged")),
  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 `oob se` for all `mtry` values.

```
#mtrys = 1:(ncol(diamonds_samp)-1)
#oob_se_by_mtrys = array(NA,length(mtrys))
#for (i in 1:length(oob_se_by_mtrys)) {
#  rf_mod = randomForest(price~. , data = diamonds_samp, mtry = mtrys[i])
#  oob_se_by_mtrys[i] = sd(diamonds_samp$price - rf_mod$predicted)
#}
#ggplot(data.frame(x= mtrys,y= oob_se_by_mtrys)) +
#  # geom_line(aes(x= x,y=y))
```

```
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) #kill any observations with missingness

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

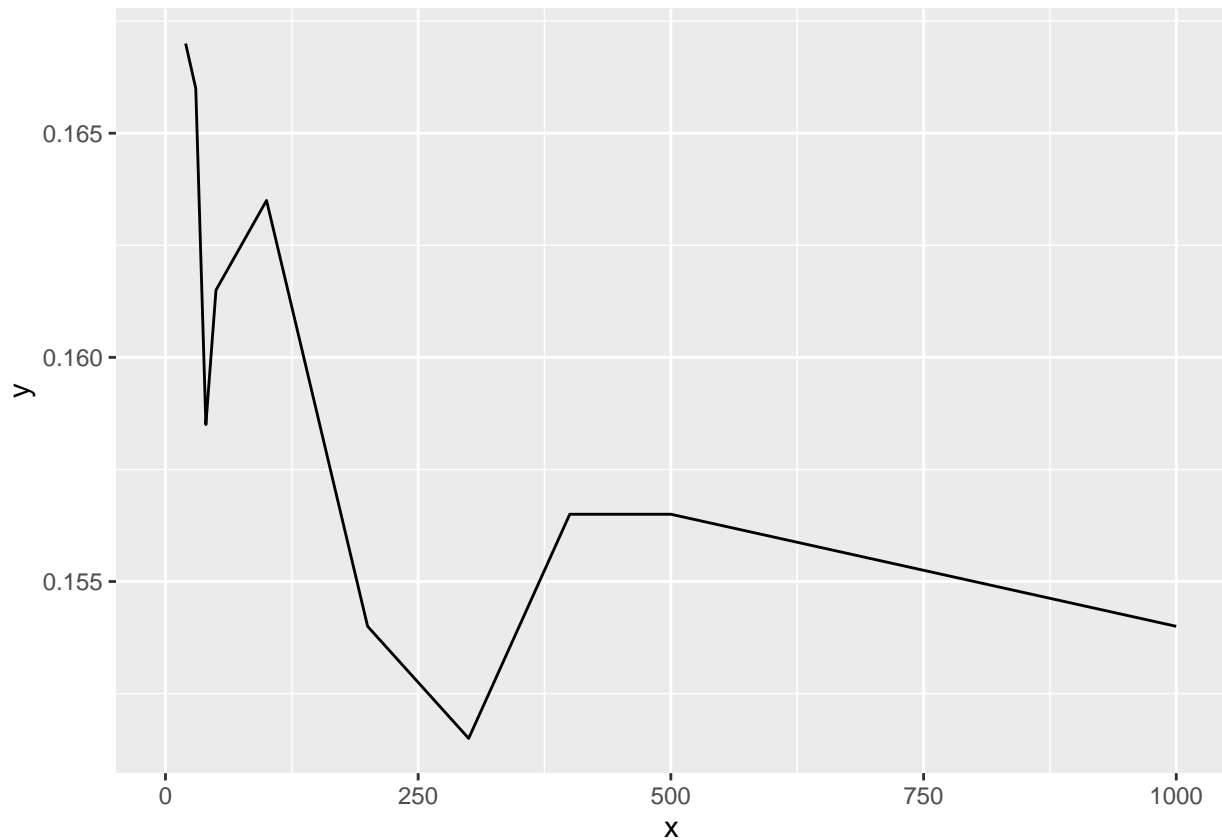
Using the adult data, find the bootstrap misclassification error for an RF model using 1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000 trees.

```

num_trees = c(1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000)
oob_me_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_me_by_num_trees[i] = mean(adult_samp$income!= rf_mod$predicted)
}
ggplot(data.frame(x= num_trees,y= oob_me_by_num_trees)) +
  geom_line(aes(x= x,y=y))

```

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



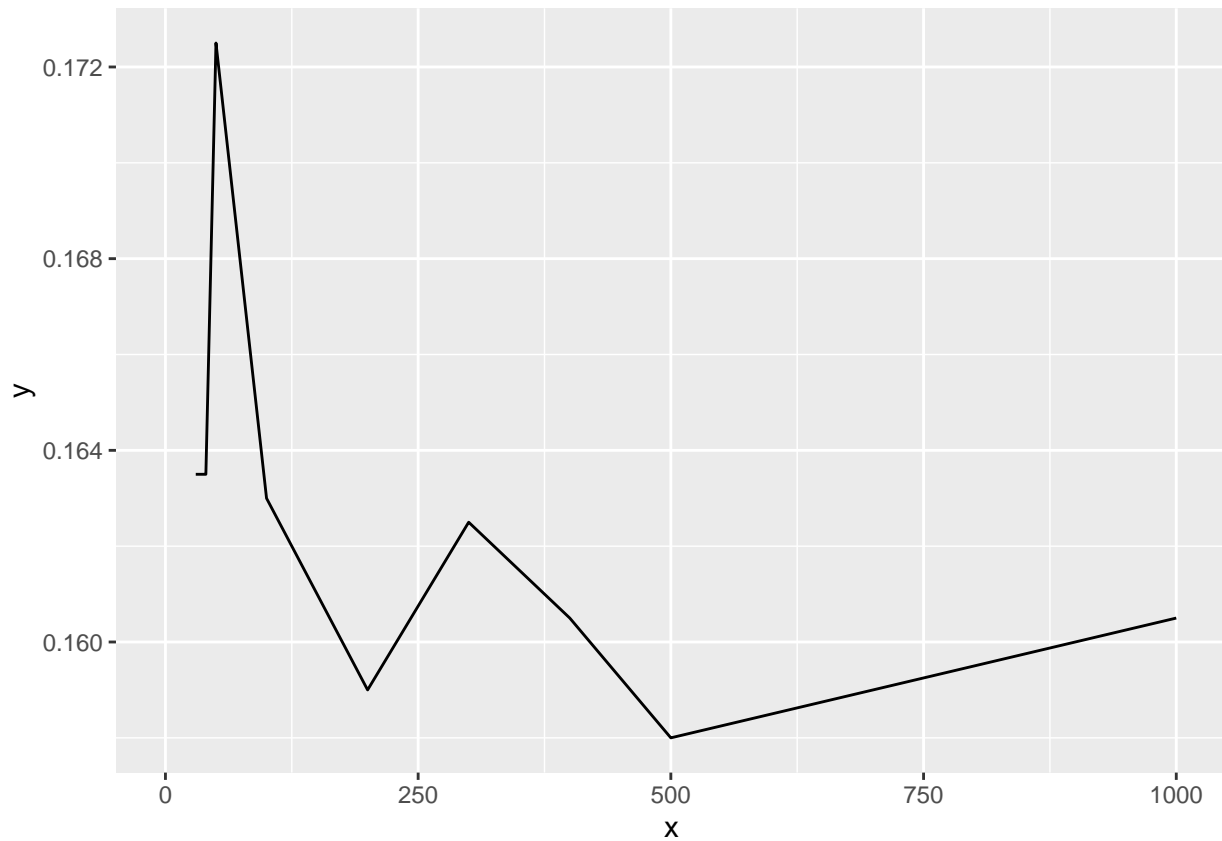
Using the adult data, find the bootstrap misclassification error for a bagged-tree model using 1, 2, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000 trees.

```

oob_me_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(adult)-1)
  oob_me_by_num_trees_bag[i] = mean(adult_samp$income!= rf_mod$predicted)
}
ggplot(data.frame(x= num_trees,y= oob_me_by_num_trees_bag)) +
  geom_line(aes(x= x,y=y))

```

Warning: Removed 5 row(s) containing missing values (geom_path).

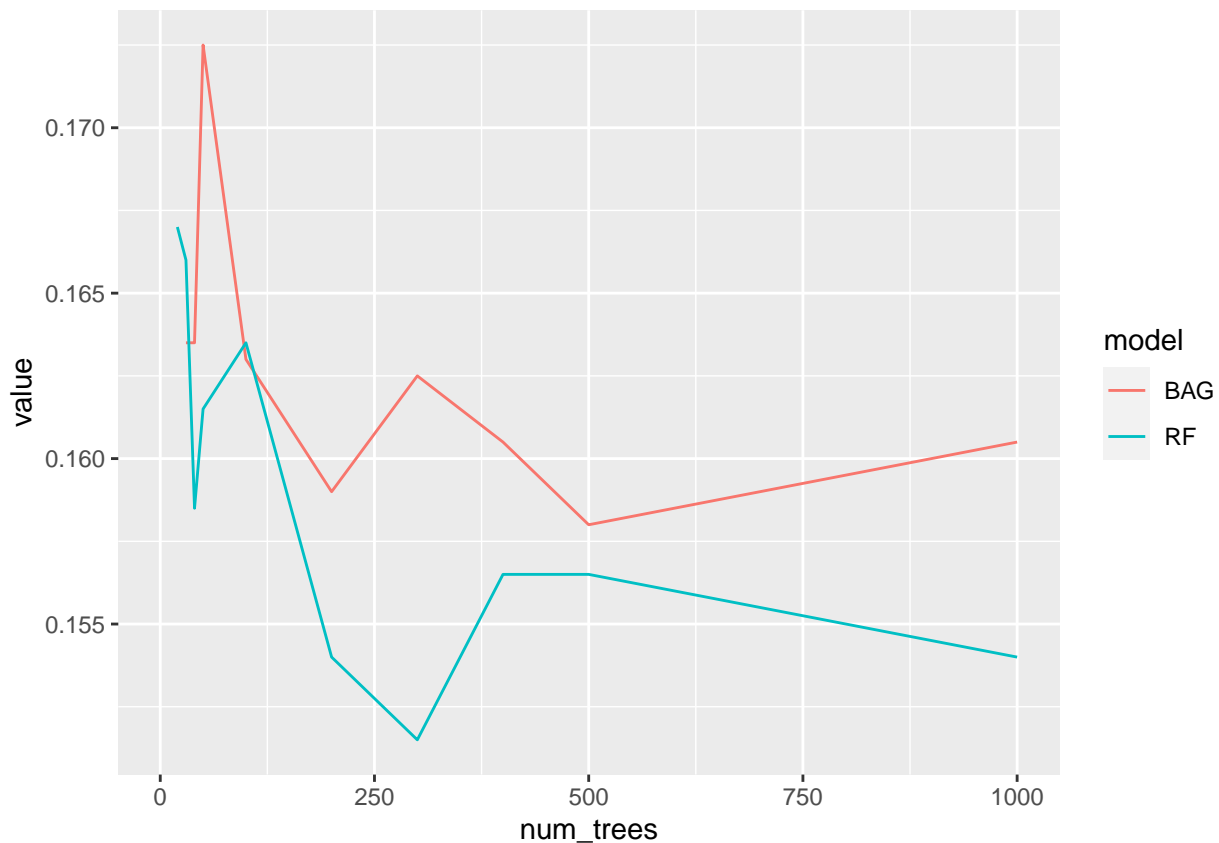


What is the percentage gain / loss in performance of the RF model vs bagged trees model?

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

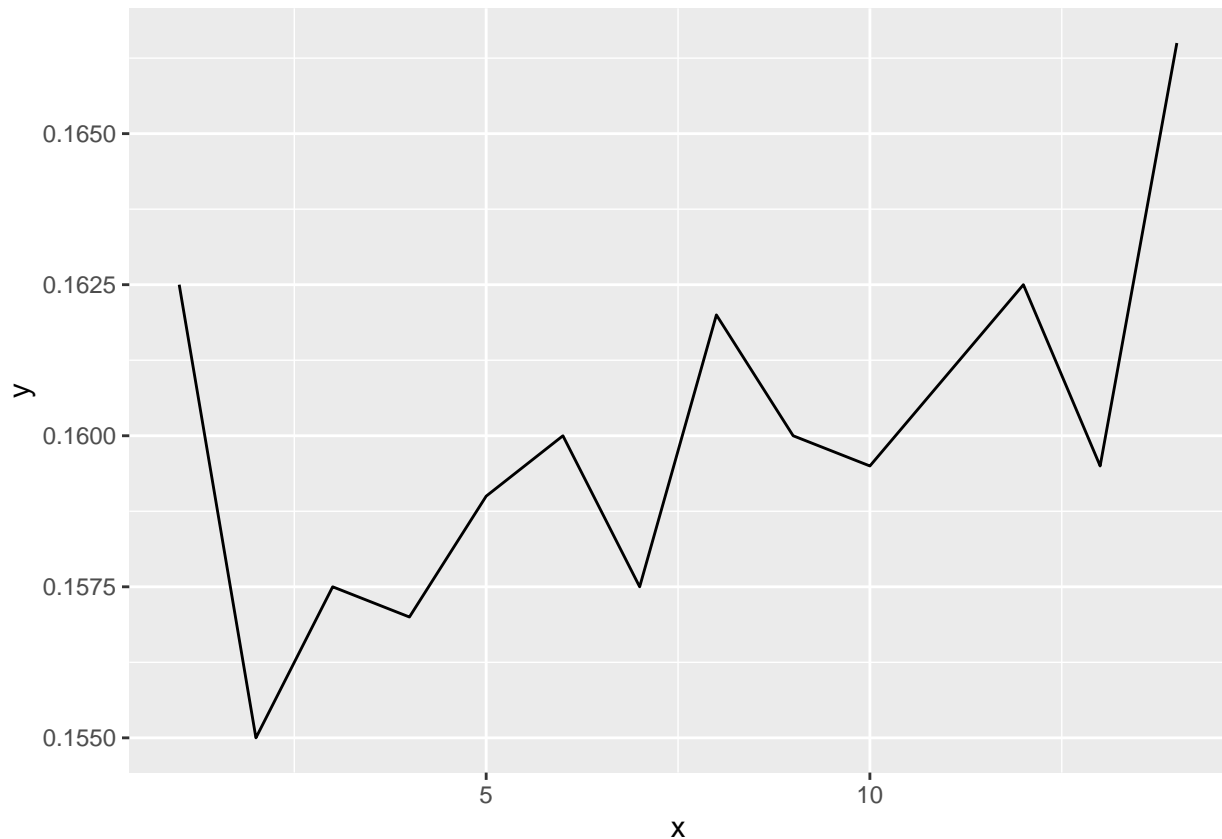
```
ggplot(rbind(data.frame(num_trees = num_trees,value = oob_me_by_num_trees,model = "RF"),data.frame (num_trees = num_trees,value = oob_me_by_num_trees,model = "bagged trees")),
  geom_line (aes(x= num_trees, y = value, color = model))
```

Warning: Removed 9 row(s) containing missing values (geom_path).



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_me_by_mtrys = array(NA,length(mtrys))
for (i in 1:length(mtrys)) {
  rf_mod = randomForest(income~. , data = adult_samp, mtry = mtrys[i])
  oob_me_by_mtrys[i] = mean(adult_samp$income!= rf_mod$predicted)
}
ggplot(data.frame(x= mtrys,y= oob_me_by_mtrys)) +
  geom_line(aes(x= x,y=y))
```



```
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`.

#TO-DO

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

```
library(MASS)
```

```
##
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':
##
##   select
```

```
data(Boston)
Boston
```

##	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	0.03237	0.0	2.18	0	0.4580	6.998	45.8	6.0622	3	222	18.7	394.63
## 5	0.06905	0.0	2.18	0	0.4580	7.147	54.2	6.0622	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	12.5	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	5	311	15.2	396.90
## 9	0.21124	12.5	7.87	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	386.71
## 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	5	311	15.2	396.90
## 13	0.09378	12.5	7.87	0	0.5240	5.889	39.0	5.4509	5	311	15.2	390.50
## 14	0.62976	0.0	8.14	0	0.5380	5.949	61.8	4.7075	4	307	21.0	396.90
## 15	0.63796	0.0	8.14	0	0.5380	6.096	84.5	4.4619	4	307	21.0	380.02
## 16	0.62739	0.0	8.14	0	0.5380	5.834	56.5	4.4986	4	307	21.0	395.62
## 17	1.05393	0.0	8.14	0	0.5380	5.935	29.3	4.4986	4	307	21.0	386.85
## 18	0.78420	0.0	8.14	0	0.5380	5.990	81.7	4.2579	4	307	21.0	386.75
## 19	0.80271	0.0	8.14	0	0.5380	5.456	36.6	3.7965	4	307	21.0	288.99
## 20	0.72580	0.0	8.14	0	0.5380	5.727	69.5	3.7965	4	307	21.0	390.95
## 21	1.25179	0.0	8.14	0	0.5380	5.570	98.1	3.7979	4	307	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	0.0	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	0	0.5380	5.924	94.1	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	4.6820	4	307	21.0	376.88
## 28	0.95577	0.0	8.14	0	0.5380	6.047	88.8	4.4534	4	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	87.3	4.2390	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	1.35472	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	1.15172	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	307	21.0	248.31
## 36	0.06417	0.0	5.96	0	0.4990	5.933	68.2	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	3.9342	5	279	19.2	396.90
## 39	0.17505	0.0	5.96	0	0.4990	5.966	30.2	3.8473	5	279	19.2	393.43
## 40	0.02763	75.0	2.95	0	0.4280	6.595	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	0.12744	0.0	6.91	0	0.4480	6.770	2.9	5.7209	3	233	17.9	385.41
## 43	0.14150	0.0	6.91	0	0.4480	6.169	6.6	5.7209	3	233	17.9	383.37
## 44	0.15936	0.0	6.91	0	0.4480	6.211	6.5	5.7209	3	233	17.9	394.46
## 45	0.12269	0.0	6.91	0	0.4480	6.069	40.0	5.7209	3	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	396.90
## 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	233	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	3	233	17.9	396.90
## 51	0.08873	21.0	5.64	0	0.4390	5.963	45.7	6.8147	4	243	16.8	395.56
## 52	0.04337	21.0	5.64	0	0.4390	6.115	63.0	6.8147	4	243	16.8	393.97
## 53	0.05360	21.0	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	21.4	6.8147	4 243	16.8	396.90
## 55	0.01360	75.0	4.00	0 0.4100	5.888	47.6	7.3197	3 469	21.1	396.90
## 56	0.01311	90.0	1.22	0 0.4030	7.249	21.9	8.6966	5 226	17.9	395.93
## 57	0.02055	85.0	0.74	0 0.4100	6.383	35.7	9.1876	2 313	17.3	396.90
## 58	0.01432	100.0	1.32	0 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	8 284	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	19.7	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	7.2255	8 284	19.7	396.90
## 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 0.3980	5.787	31.1	6.6115	4 337	16.1	396.90
## 68	0.05789	12.5	6.07	0 0.4090	5.878	21.4	6.4980	4 345	18.9	396.21
## 69	0.13554	12.5	6.07	0 0.4090	5.594	36.8	6.4980	4 345	18.9	396.90
## 70	0.12816	12.5	6.07	0 0.4090	5.885	33.0	6.4980	4 345	18.9	396.90
## 71	0.08826	0.0	10.81	0 0.4130	6.417	6.6	5.2873	4 305	19.2	383.73
## 72	0.15876	0.0	10.81	0 0.4130	5.961	17.5	5.2873	4 305	19.2	376.94
## 73	0.09164	0.0	10.81	0 0.4130	6.065	7.8	5.2873	4 305	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	12.83	0 0.4370	6.279	74.5	4.0522	5 398	18.7	373.66
## 78	0.08707	0.0	12.83	0 0.4370	6.140	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	0 0.4370	5.874	36.6	4.5026	5 398	18.7	396.06
## 81	0.04113	25.0	4.86	0 0.4260	6.727	33.5	5.4007	4 281	19.0	396.90
## 82	0.04462	25.0	4.86	0 0.4260	6.619	70.4	5.4007	4 281	19.0	395.63
## 83	0.03659	25.0	4.86	0 0.4260	6.302	32.2	5.4007	4 281	19.0	396.90
## 84	0.03551	25.0	4.86	0 0.4260	6.167	46.7	5.4007	4 281	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	0 0.4490	6.630	56.1	4.4377	3 247	18.5	392.30
## 87	0.05188	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 0.4490	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	396.90
## 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	0 0.4890	6.417	66.1	3.0923	2 270	17.8	392.18
## 92	0.03932	0.0	3.41	0 0.4890	6.405	73.9	3.0921	2 270	17.8	393.55
## 93	0.04203	28.0	15.04	0 0.4640	6.442	53.6	3.6659	4 270	18.2	395.01
## 94	0.02875	28.0	15.04	0 0.4640	6.211	28.9	3.6659	4 270	18.2	396.33
## 95	0.04294	28.0	15.04	0 0.4640	6.249	77.3	3.6150	4 270	18.2	396.90
## 96	0.12204	0.0	2.89	0 0.4450	6.625	57.8	3.4952	2 276	18.0	357.98
## 97	0.11504	0.0	2.89	0 0.4450	6.163	69.6	3.4952	2 276	18.0	391.83
## 98	0.12083	0.0	2.89	0 0.4450	8.069	76.0	3.4952	2 276	18.0	396.90
## 99	0.08187	0.0	2.89	0 0.4450	7.820	36.9	3.4952	2 276	18.0	393.53
## 100	0.06860	0.0	2.89	0 0.4450	7.416	62.5	3.4952	2 276	18.0	396.90
## 101	0.14866	0.0	8.56	0 0.5200	6.727	79.9	2.7778	5 384	20.9	394.76
## 102	0.11432	0.0	8.56	0 0.5200	6.781	71.3	2.8561	5 384	20.9	395.58
## 103	0.22876	0.0	8.56	0 0.5200	6.405	85.4	2.7147	5 384	20.9	70.80
## 104	0.21161	0.0	8.56	0 0.5200	6.137	87.4	2.7147	5 384	20.9	394.47
## 105	0.13960	0.0	8.56	0 0.5200	6.167	90.0	2.4210	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	0.13117	0.0	8.56	0	0.5200	6.127	85.2	2.1224	5	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	92.9	2.3534	6	432	17.8	394.95
## 114	0.22212	0.0	10.01	0	0.5470	6.092	95.4	2.5480	6	432	17.8	396.90
## 115	0.14231	0.0	10.01	0	0.5470	6.254	84.2	2.2565	6	432	17.8	388.74
## 116	0.17134	0.0	10.01	0	0.5470	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	2.7301	6	432	17.8	393.30
## 118	0.15098	0.0	10.01	0	0.5470	6.021	82.6	2.7474	6	432	17.8	394.51
## 119	0.13058	0.0	10.01	0	0.5470	5.872	73.1	2.4775	6	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	2.2577	2	188	19.1	389.15
## 122	0.07165	0.0	25.65	0	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	1.9444	2	188	19.1	370.31
## 125	0.09849	0.0	25.65	0	0.5810	5.879	95.8	2.0063	2	188	19.1	379.38
## 126	0.16902	0.0	25.65	0	0.5810	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	96.0	1.7883	4	437	21.2	392.11
## 129	0.32543	0.0	21.89	0	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	1.9799	4	437	21.2	396.90
## 131	0.34006	0.0	21.89	0	0.6240	6.458	98.9	2.1185	4	437	21.2	395.04
## 132	1.19294	0.0	21.89	0	0.6240	6.326	97.7	2.2710	4	437	21.2	396.90
## 133	0.59005	0.0	21.89	0	0.6240	6.372	97.9	2.3274	4	437	21.2	385.76
## 134	0.32982	0.0	21.89	0	0.6240	5.822	95.4	2.4699	4	437	21.2	388.69
## 135	0.97617	0.0	21.89	0	0.6240	5.757	98.4	2.3460	4	437	21.2	262.76
## 136	0.55778	0.0	21.89	0	0.6240	6.335	98.2	2.1107	4	437	21.2	394.67
## 137	0.32264	0.0	21.89	0	0.6240	5.942	93.5	1.9669	4	437	21.2	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	0.0	21.89	0	0.6240	6.151	97.9	1.6687	4	437	21.2	396.90
## 141	0.29090	0.0	21.89	0	0.6240	6.174	93.6	1.6119	4	437	21.2	388.08
## 142	1.62864	0.0	21.89	0	0.6240	5.019	100.0	1.4394	4	437	21.2	396.90
## 143	3.32105	0.0	19.58	1	0.8710	5.403	100.0	1.3216	5	403	14.7	396.90
## 144	4.09740	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	5	403	14.7	396.90
## 146	2.37934	0.0	19.58	0	0.8710	6.130	100.0	1.4191	5	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	2.36862	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	93.8	1.5296	5	403	14.7	356.99
## 150	2.73397	0.0	19.58	0	0.8710	5.597	94.9	1.5257	5	403	14.7	351.85
## 151	1.65660	0.0	19.58	0	0.8710	6.122	97.3	1.6180	5	403	14.7	372.80
## 152	1.49632	0.0	19.58	0	0.8710	5.404	100.0	1.5916	5	403	14.7	341.60
## 153	1.12658	0.0	19.58	1	0.8710	5.012	88.0	1.6102	5	403	14.7	343.28
## 154	2.14918	0.0	19.58	0	0.8710	5.709	98.5	1.6232	5	403	14.7	261.95
## 155	1.41385	0.0	19.58	1	0.8710	6.129	96.0	1.7494	5	403	14.7	321.02
## 156	3.53501	0.0	19.58	1	0.8710	6.152	82.6	1.7455	5	403	14.7	88.01
## 157	2.44668	0.0	19.58	0	0.8710	5.272	94.0	1.7364	5	403	14.7	88.63
## 158	1.22358	0.0	19.58	0	0.6050	6.943	97.4	1.8773	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	0.6050	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	2.1620	5	403	14.7	388.45
## 165	2.24236	0.0	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	0.0	19.58	0	0.6050	7.929	96.2	2.0459	5	403	14.7	369.30
## 168	1.80028	0.0	19.58	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	14.7	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	94.6	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	0.5100	5.572	88.5	2.5961	5	296	16.6	396.90
## 174	0.09178	0.0	4.05	0	0.5100	6.416	84.1	2.6463	5	296	16.6	395.50
## 175	0.08447	0.0	4.05	0	0.5100	5.859	68.7	2.7019	5	296	16.6	393.23
## 176	0.06664	0.0	4.05	0	0.5100	6.546	33.1	3.1323	5	296	16.6	390.96
## 177	0.07022	0.0	4.05	0	0.5100	6.020	47.2	3.5549	5	296	16.6	393.23
## 178	0.05425	0.0	4.05	0	0.5100	6.315	73.4	3.3175	5	296	16.6	395.60
## 179	0.06642	0.0	4.05	0	0.5100	6.860	74.4	2.9153	5	296	16.6	391.27
## 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	3	193	17.8	395.56
## 182	0.06888	0.0	2.46	0	0.4880	6.144	62.2	2.5979	3	193	17.8	396.90
## 183	0.09103	0.0	2.46	0	0.4880	7.155	92.2	2.7006	3	193	17.8	394.12
## 184	0.10008	0.0	2.46	0	0.4880	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	0	0.4370	6.782	41.1	3.7886	5	398	15.2	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	6.951	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	398	15.2	389.71
## 193	0.08664	45.0	3.44	0	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	32.0	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	1.52	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	6.975	15.3	7.6534	3	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	384.30
## 202	0.03445	82.5	2.03	0	0.4150	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	395.38
## 204	0.03510	95.0	2.68	0	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	31.9	5.1180	4	224	14.7	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	4.3549	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	389.43
## 209	0.13587	0.0	10.59	1	0.4890	6.064	59.1	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	396.90
## 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	0.0	10.59	0	0.4890	6.375	32.3	3.9454	4	277	18.6	385.81
## 215	0.28955	0.0	10.59	0	0.4890	5.412	9.8	3.5875	4	277	18.6	348.93

## 216	0.19802	0.0	10.59	0	0.4890	6.182	42.4	3.9454	4	277	18.6	393.63
## 217	0.04560	0.0	13.89	1	0.5500	5.888	56.0	3.1121	5	276	16.4	392.80
## 218	0.07013	0.0	13.89	0	0.5500	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	396.90
## 220	0.11425	0.0	13.89	1	0.5500	6.373	92.4	3.3633	5	276	16.4	393.74
## 221	0.35809	0.0	6.20	1	0.5070	6.951	88.5	2.8617	8	307	17.4	391.70
## 222	0.40771	0.0	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	307	17.4	396.90
## 225	0.31533	0.0	6.20	0	0.5040	8.266	78.3	2.8944	8	307	17.4	385.05
## 226	0.52693	0.0	6.20	0	0.5040	8.725	83.0	2.8944	8	307	17.4	382.00
## 227	0.38214	0.0	6.20	0	0.5040	8.040	86.5	3.2157	8	307	17.4	387.38
## 228	0.41238	0.0	6.20	0	0.5040	7.163	79.9	3.2157	8	307	17.4	372.08
## 229	0.29819	0.0	6.20	0	0.5040	7.686	17.0	3.3751	8	307	17.4	377.51
## 230	0.44178	0.0	6.20	0	0.5040	6.552	21.4	3.3751	8	307	17.4	380.34
## 231	0.53700	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	7.412	76.9	3.6715	8	307	17.4	376.14
## 233	0.57529	0.0	6.20	0	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	6.086	61.5	3.6519	8	307	17.4	376.75
## 237	0.52058	0.0	6.20	1	0.5070	6.631	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	4.93	0	0.4280	6.606	42.2	6.1899	6	300	16.6	383.78
## 241	0.11329	30.0	4.93	0	0.4280	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	0	0.4280	6.358	52.9	7.0355	6	300	16.6	372.75
## 244	0.12757	30.0	4.93	0	0.4280	6.393	7.8	7.0355	6	300	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	0.4310	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	390.18
## 248	0.19657	22.0	5.86	0	0.4310	6.226	79.2	8.0555	7	330	19.1	376.14
## 249	0.16439	22.0	5.86	0	0.4310	6.433	49.1	7.8265	7	330	19.1	374.71
## 250	0.19073	22.0	5.86	0	0.4310	6.718	17.5	7.8265	7	330	19.1	393.74
## 251	0.14030	22.0	5.86	0	0.4310	6.487	13.0	7.3967	7	330	19.1	396.28
## 252	0.21409	22.0	5.86	0	0.4310	6.438	8.9	7.3967	7	330	19.1	377.07
## 253	0.08221	22.0	5.86	0	0.4310	6.957	6.8	8.9067	7	330	19.1	386.09
## 254	0.36894	22.0	5.86	0	0.4310	8.259	8.4	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	7.333	100.0	1.8946	5	264	13.0	383.29
## 260	0.65665	20.0	3.97	0	0.6470	6.842	100.0	2.0107	5	264	13.0	391.93
## 261	0.54011	20.0	3.97	0	0.6470	7.203	81.8	2.1121	5	264	13.0	392.80
## 262	0.53412	20.0	3.97	0	0.6470	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	386.86
## 264	0.82526	20.0	3.97	0	0.6470	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	62.8	1.9865	5	264	13.0	392.40
## 267	0.78570	20.0	3.97	0	0.6470	7.014	84.6	2.1329	5	264	13.0	384.07
## 268	0.57834	20.0	3.97	0	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	18.6	391.34
## 271	0.29916	20.0	6.96	0	0.4640	5.856	42.1	4.4290	3	223	18.6	388.65
## 272	0.16211	20.0	6.96	0	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	390.77
## 275	0.05644	40.0	6.41	1	0.4470	6.758	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	40.0	6.41	1	0.4470	7.267	49.0	4.7872	4	254	17.6	389.25
## 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	0.03578	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	49.7	5.2119	5	216	14.9	377.07
## 284	0.01501	90.0	1.21	1	0.4010	7.923	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	55.0	2.25	0	0.3890	6.453	31.9	7.3073	1	300	15.3	394.72
## 287	0.01965	80.0	1.76	0	0.3850	6.230	31.5	9.0892	1	241	18.2	341.60
## 288	0.03871	52.5	5.32	0	0.4050	6.209	31.3	7.3172	6	293	16.6	396.90
## 289	0.04590	52.5	5.32	0	0.4050	6.315	45.6	7.3172	6	293	16.6	396.90
## 290	0.04297	52.5	5.32	0	0.4050	6.565	22.9	7.3172	6	293	16.6	371.72
## 291	0.03502	80.0	4.95	0	0.4110	6.861	27.9	5.1167	4	245	19.2	396.90
## 292	0.07886	80.0	4.95	0	0.4110	7.148	27.7	5.1167	4	245	19.2	396.90
## 293	0.03615	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	4	289	16.0	396.90
## 295	0.08199	0.0	13.92	0	0.4370	6.009	42.3	5.5027	4	289	16.0	396.90
## 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	0.14103	0.0	13.92	0	0.4370	5.790	58.0	6.3200	4	289	16.0	396.90
## 299	0.06466	70.0	2.24	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	70.0	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	0.09266	34.0	6.09	0	0.4330	6.495	18.4	5.4917	7	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	222	18.4	393.68
## 306	0.05479	33.0	2.18	0	0.4720	6.616	58.1	3.3700	7	222	18.4	393.36
## 307	0.07503	33.0	2.18	0	0.4720	7.420	71.9	3.0992	7	222	18.4	396.90
## 308	0.04932	33.0	2.18	0	0.4720	6.849	70.3	3.1827	7	222	18.4	396.90
## 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	9.90	0	0.5440	4.973	37.8	2.5194	4	304	18.4	350.45
## 312	0.79041	0.0	9.90	0	0.5440	6.122	52.8	2.6403	4	304	18.4	396.90
## 313	0.26169	0.0	9.90	0	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	18.4	395.69
## 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	67.2	3.5325	4	304	18.4	395.21
## 320	0.47547	0.0	9.90	0	0.5440	6.113	58.8	4.0019	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	0	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	49.9	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	0.4930	6.431	14.7	5.4159	5	287	19.6	393.68
## 327	0.30347	0.0	7.38	0	0.4930	6.312	28.9	5.4159	5	287	19.6	396.90
## 328	0.24103	0.0	7.38	0	0.4930	6.083	43.7	5.4159	5	287	19.6	396.90
## 329	0.06617	0.0	3.24	0	0.4600	5.868	25.8	5.2146	4	430	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	16.9	368.57
## 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	16.9	362.25
## 334	0.05083	0.0	5.19	0	0.5150	6.316	38.1	6.4584	5	224	20.2	389.71
## 335	0.03738	0.0	5.19	0	0.5150	6.310	38.5	6.4584	5	224	20.2	389.40
## 336	0.03961	0.0	5.19	0	0.5150	6.037	34.5	5.9853	5	224	20.2	396.90
## 337	0.03427	0.0	5.19	0	0.5150	5.869	46.3	5.2311	5	224	20.2	396.90
## 338	0.03041	0.0	5.19	0	0.5150	5.895	59.6	5.6150	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	20.2	396.90
## 341	0.06151	0.0	5.19	0	0.5150	5.968	58.5	4.8122	5	224	20.2	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	0	0.5180	6.540	59.7	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	55.0	3.78	0	0.4840	6.874	28.1	6.4654	5	370	17.6	387.97
## 346	0.03113	0.0	4.39	0	0.4420	6.014	48.5	8.0136	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	85.0	4.15	0	0.4290	6.516	27.7	8.5353	4	351	17.9	392.43
## 349	0.01501	80.0	2.01	0	0.4350	6.635	29.7	8.3440	4	280	17.0	390.94
## 350	0.02899	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	4	411	18.3	370.78
## 353	0.07244	60.0	1.69	0	0.4110	5.884	18.5	10.7103	4	411	18.3	392.33
## 354	0.01709	90.0	2.02	0	0.4100	6.728	36.1	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	6.212	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	18.10	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	6.398	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	18.10	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	89.0	1.9047	24	666	20.2	353.04
## 365	3.47428	0.0	18.10	1	0.7180	8.780	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	20.2	354.70
## 367	3.69695	0.0	18.10	0	0.7180	4.963	91.4	1.7523	24	666	20.2	316.03
## 368	13.52220	0.0	18.10	0	0.6310	3.863	100.0	1.5106	24	666	20.2	131.42
## 369	4.89822	0.0	18.10	0	0.6310	4.970	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	6.53876	0.0	18.10	1	0.6310	7.016	97.5	1.2024	24	666	20.2	392.05
## 372	9.23230	0.0	18.10	0	0.6310	6.216	100.0	1.1691	24	666	20.2	366.15
## 373	8.26725	0.0	18.10	1	0.6680	5.875	89.6	1.1296	24	666	20.2	347.88
## 374	11.10810	0.0	18.10	0	0.6680	4.906	100.0	1.1742	24	666	20.2	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	18.10	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	6.649	93.3	1.3449	24	666	20.2	363.02

## 378	9.82349	0.0	18.10	0	0.6710	6.794	98.8	1.3580	24	666	20.2	396.90
## 379	23.64820	0.0	18.10	0	0.6710	6.380	96.2	1.3861	24	666	20.2	396.90
## 380	17.86670	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	0	0.7000	5.536	100.0	1.5804	24	666	20.2	396.90
## 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	666	20.2	285.83
## 386	16.81180	0.0	18.10	0	0.7000	5.277	98.1	1.4261	24	666	20.2	396.90
## 387	24.39380	0.0	18.10	0	0.7000	4.652	100.0	1.4672	24	666	20.2	396.90
## 388	22.59710	0.0	18.10	0	0.7000	5.000	89.5	1.5184	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	666	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	0.0	18.10	0	0.7000	6.051	82.5	2.1678	24	666	20.2	378.38
## 393	11.57790	0.0	18.10	0	0.7000	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	94.7	1.7821	24	666	20.2	396.90
## 396	8.71675	0.0	18.10	0	0.6930	6.471	98.8	1.7257	24	666	20.2	391.98
## 397	5.87205	0.0	18.10	0	0.6930	6.405	96.0	1.6768	24	666	20.2	396.90
## 398	7.67202	0.0	18.10	0	0.6930	5.747	98.9	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	666	20.2	396.90
## 400	9.91655	0.0	18.10	0	0.6930	5.852	77.8	1.5004	24	666	20.2	338.16
## 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	6.343	100.0	1.5741	24	666	20.2	396.90
## 403	9.59571	0.0	18.10	0	0.6930	6.404	100.0	1.6390	24	666	20.2	376.11
## 404	24.80170	0.0	18.10	0	0.6930	5.349	96.0	1.7028	24	666	20.2	396.90
## 405	41.52920	0.0	18.10	0	0.6930	5.531	85.4	1.6074	24	666	20.2	329.46
## 406	67.92080	0.0	18.10	0	0.6930	5.683	100.0	1.4254	24	666	20.2	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	0.5970	5.617	97.9	1.4547	24	666	20.2	314.64
## 410	14.43830	0.0	18.10	0	0.5970	6.852	100.0	1.4655	24	666	20.2	179.36
## 411	51.13580	0.0	18.10	0	0.5970	5.757	100.0	1.4130	24	666	20.2	2.60
## 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	24	666	20.2	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	45.74610	0.0	18.10	0	0.6930	4.519	100.0	1.6582	24	666	20.2	88.27
## 416	18.08460	0.0	18.10	0	0.6790	6.434	100.0	1.8347	24	666	20.2	27.25
## 417	10.83420	0.0	18.10	0	0.6790	6.782	90.8	1.8195	24	666	20.2	21.57
## 418	25.94060	0.0	18.10	0	0.6790	5.304	89.1	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	87.6	1.9512	24	666	20.2	291.55
## 424	7.05042	0.0	18.10	0	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	95.4	1.9096	24	666	20.2	7.68
## 427	12.24720	0.0	18.10	0	0.5840	5.837	59.7	1.9976	24	666	20.2	24.65
## 428	37.66190	0.0	18.10	0	0.6790	6.202	78.7	1.8629	24	666	20.2	18.82
## 429	7.36711	0.0	18.10	0	0.6790	6.193	78.1	1.9356	24	666	20.2	96.73
## 430	9.33889	0.0	18.10	0	0.6790	6.380	95.6	1.9682	24	666	20.2	60.72
## 431	8.49213	0.0	18.10	0	0.5840	6.348	86.1	2.0527	24	666	20.2	83.45

## 432	10.06230	0.0	18.10	0	0.5840	6.833	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	97.95
## 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	24	666	20.2	109.85
## 437	14.42080	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	13.67810	0.0	18.10	0	0.7400	5.935	87.9	1.8206	24	666	20.2	68.95
## 440	9.39063	0.0	18.10	0	0.7400	5.627	93.9	1.8172	24	666	20.2	396.90
## 441	22.05110	0.0	18.10	0	0.7400	5.818	92.4	1.8662	24	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	5.66637	0.0	18.10	0	0.7400	6.219	100.0	2.0048	24	666	20.2	395.69
## 444	9.96654	0.0	18.10	0	0.7400	6.485	100.0	1.9784	24	666	20.2	386.73
## 445	12.80230	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	20.2	318.01
## 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	0.7130	6.417	98.3	2.1850	24	666	20.2	304.21
## 451	6.71772	0.0	18.10	0	0.7130	6.749	92.6	2.3236	24	666	20.2	0.32
## 452	5.44114	0.0	18.10	0	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	24	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	18.10	0	0.7130	6.525	86.5	2.4358	24	666	20.2	50.92
## 457	4.66883	0.0	18.10	0	0.7130	5.976	87.9	2.5806	24	666	20.2	10.48
## 458	8.20058	0.0	18.10	0	0.7130	5.936	80.3	2.7792	24	666	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	0.0	18.10	0	0.7130	6.081	84.4	2.7175	24	666	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	3.69311	0.0	18.10	0	0.7130	6.376	88.4	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	666	20.2	396.90
## 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	18.10	0	0.6550	5.759	48.2	3.0665	24	666	20.2	334.40
## 467	3.77498	0.0	18.10	0	0.6550	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	5.926	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	0.0	18.10	0	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	18.10	0	0.6140	6.980	67.6	2.5329	24	666	20.2	374.68
## 475	8.05579	0.0	18.10	0	0.5840	5.427	95.4	2.4298	24	666	20.2	352.58
## 476	6.39312	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	396.21
## 478	15.02340	0.0	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	3.4242	24	666	20.2	396.90
## 482	5.70818	0.0	18.10	0	0.5320	6.750	74.9	3.3317	24	666	20.2	393.07
## 483	5.73116	0.0	18.10	0	0.5320	7.061	77.0	3.4106	24	666	20.2	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	0.5830	5.871	41.9	3.7240	24	666	20.2	370.73

##	486	3.67367	0.0	18.10	0	0.5830	6.312	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	24	666	20.2	392.68
##	488	4.83567	0.0	18.10	0	0.5830	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	20.1	395.09
##	490	0.18337	0.0	27.74	0	0.6090	5.414	98.3	1.7554	4	711	20.1	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	27.74	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	9.69	0	0.5850	5.707	54.0	2.3817	6	391	19.2	396.90
##	495	0.27957	0.0	9.69	0	0.5850	5.926	42.6	2.3817	6	391	19.2	396.90
##	496	0.17899	0.0	9.69	0	0.5850	5.670	28.8	2.7986	6	391	19.2	393.29
##	497	0.28960	0.0	9.69	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	396.90
##	499	0.23912	0.0	9.69	0	0.5850	6.019	65.3	2.4091	6	391	19.2	396.90
##	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	0.06076	0.0	11.93	0	0.5730	6.976	91.0	2.1675	1	273	21.0	396.90
##	505	0.10959	0.0	11.93	0	0.5730	6.794	89.3	2.3889	1	273	21.0	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 medv												
##	1	4.98	24.0										
##	2	9.14	21.6										
##	3	4.03	34.7										
##	4	2.94	33.4										
##	5	5.33	36.2										
##	6	5.21	28.7										
##	7	12.43	22.9										
##	8	19.15	27.1										
##	9	29.93	16.5										
##	10	17.10	18.9										
##	11	20.45	15.0										
##	12	13.27	18.9										
##	13	15.71	21.7										
##	14	8.26	20.4										
##	15	10.26	18.2										
##	16	8.47	19.9										
##	17	6.58	23.1										
##	18	14.67	17.5										
##	19	11.69	20.2										
##	20	11.28	18.2										
##	21	21.02	13.6										
##	22	13.83	19.6										
##	23	18.72	15.2										
##	24	19.88	14.5										
##	25	16.30	15.6										
##	26	16.51	13.9										
##	27	14.81	16.6										
##	28	17.28	14.8										
##	29	12.80	18.4										
##	30	11.98	21.0										
##	31	22.60	12.7										
##	32	13.04	14.5										

##	33	27.71	13.2
##	34	18.35	13.1
##	35	20.34	13.5
##	36	9.68	18.9
##	37	11.41	20.0
##	38	8.77	21.0
##	39	10.13	24.7
##	40	4.32	30.8
##	41	1.98	34.9
##	42	4.84	26.6
##	43	5.81	25.3
##	44	7.44	24.7
##	45	9.55	21.2
##	46	10.21	19.3
##	47	14.15	20.0
##	48	18.80	16.6
##	49	30.81	14.4
##	50	16.20	19.4
##	51	13.45	19.7
##	52	9.43	20.5
##	53	5.28	25.0
##	54	8.43	23.4
##	55	14.80	18.9
##	56	4.81	35.4
##	57	5.77	24.7
##	58	3.95	31.6
##	59	6.86	23.3
##	60	9.22	19.6
##	61	13.15	18.7
##	62	14.44	16.0
##	63	6.73	22.2
##	64	9.50	25.0
##	65	8.05	33.0
##	66	4.67	23.5
##	67	10.24	19.4
##	68	8.10	22.0
##	69	13.09	17.4
##	70	8.79	20.9
##	71	6.72	24.2
##	72	9.88	21.7
##	73	5.52	22.8
##	74	7.54	23.4
##	75	6.78	24.1
##	76	8.94	21.4
##	77	11.97	20.0
##	78	10.27	20.8
##	79	12.34	21.2
##	80	9.10	20.3
##	81	5.29	28.0
##	82	7.22	23.9
##	83	6.72	24.8
##	84	7.51	22.9
##	85	9.62	23.9
##	86	6.53	26.6

##	87	12.86	22.5
##	88	8.44	22.2
##	89	5.50	23.6
##	90	5.70	28.7
##	91	8.81	22.6
##	92	8.20	22.0
##	93	8.16	22.9
##	94	6.21	25.0
##	95	10.59	20.6
##	96	6.65	28.4
##	97	11.34	21.4
##	98	4.21	38.7
##	99	3.57	43.8
##	100	6.19	33.2
##	101	9.42	27.5
##	102	7.67	26.5
##	103	10.63	18.6
##	104	13.44	19.3
##	105	12.33	20.1
##	106	16.47	19.5
##	107	18.66	19.5
##	108	14.09	20.4
##	109	12.27	19.8
##	110	15.55	19.4
##	111	13.00	21.7
##	112	10.16	22.8
##	113	16.21	18.8
##	114	17.09	18.7
##	115	10.45	18.5
##	116	15.76	18.3
##	117	12.04	21.2
##	118	10.30	19.2
##	119	15.37	20.4
##	120	13.61	19.3
##	121	14.37	22.0
##	122	14.27	20.3
##	123	17.93	20.5
##	124	25.41	17.3
##	125	17.58	18.8
##	126	14.81	21.4
##	127	27.26	15.7
##	128	17.19	16.2
##	129	15.39	18.0
##	130	18.34	14.3
##	131	12.60	19.2
##	132	12.26	19.6
##	133	11.12	23.0
##	134	15.03	18.4
##	135	17.31	15.6
##	136	16.96	18.1
##	137	16.90	17.4
##	138	14.59	17.1
##	139	21.32	13.3
##	140	18.46	17.8

141 24.16 14.0
142 34.41 14.4
143 26.82 13.4
144 26.42 15.6
145 29.29 11.8
146 27.80 13.8
147 16.65 15.6
148 29.53 14.6
149 28.32 17.8
150 21.45 15.4
151 14.10 21.5
152 13.28 19.6
153 12.12 15.3
154 15.79 19.4
155 15.12 17.0
156 15.02 15.6
157 16.14 13.1
158 4.59 41.3
159 6.43 24.3
160 7.39 23.3
161 5.50 27.0
162 1.73 50.0
163 1.92 50.0
164 3.32 50.0
165 11.64 22.7
166 9.81 25.0
167 3.70 50.0
168 12.14 23.8
169 11.10 23.8
170 11.32 22.3
171 14.43 17.4
172 12.03 19.1
173 14.69 23.1
174 9.04 23.6
175 9.64 22.6
176 5.33 29.4
177 10.11 23.2
178 6.29 24.6
179 6.92 29.9
180 5.04 37.2
181 7.56 39.8
182 9.45 36.2
183 4.82 37.9
184 5.68 32.5
185 13.98 26.4
186 13.15 29.6
187 4.45 50.0
188 6.68 32.0
189 4.56 29.8
190 5.39 34.9
191 5.10 37.0
192 4.69 30.5
193 2.87 36.4
194 5.03 31.1

195 4.38 29.1
196 2.97 50.0
197 4.08 33.3
198 8.61 30.3
199 6.62 34.6
200 4.56 34.9
201 4.45 32.9
202 7.43 24.1
203 3.11 42.3
204 3.81 48.5
205 2.88 50.0
206 10.87 22.6
207 10.97 24.4
208 18.06 22.5
209 14.66 24.4
210 23.09 20.0
211 17.27 21.7
212 23.98 19.3
213 16.03 22.4
214 9.38 28.1
215 29.55 23.7
216 9.47 25.0
217 13.51 23.3
218 9.69 28.7
219 17.92 21.5
220 10.50 23.0
221 9.71 26.7
222 21.46 21.7
223 9.93 27.5
224 7.60 30.1
225 4.14 44.8
226 4.63 50.0
227 3.13 37.6
228 6.36 31.6
229 3.92 46.7
230 3.76 31.5
231 11.65 24.3
232 5.25 31.7
233 2.47 41.7
234 3.95 48.3
235 8.05 29.0
236 10.88 24.0
237 9.54 25.1
238 4.73 31.5
239 6.36 23.7
240 7.37 23.3
241 11.38 22.0
242 12.40 20.1
243 11.22 22.2
244 5.19 23.7
245 12.50 17.6
246 18.46 18.5
247 9.16 24.3
248 10.15 20.5

249 9.52 24.5
250 6.56 26.2
251 5.90 24.4
252 3.59 24.8
253 3.53 29.6
254 3.54 42.8
255 6.57 21.9
256 9.25 20.9
257 3.11 44.0
258 5.12 50.0
259 7.79 36.0
260 6.90 30.1
261 9.59 33.8
262 7.26 43.1
263 5.91 48.8
264 11.25 31.0
265 8.10 36.5
266 10.45 22.8
267 14.79 30.7
268 7.44 50.0
269 3.16 43.5
270 13.65 20.7
271 13.00 21.1
272 6.59 25.2
273 7.73 24.4
274 6.58 35.2
275 3.53 32.4
276 2.98 32.0
277 6.05 33.2
278 4.16 33.1
279 7.19 29.1
280 4.85 35.1
281 3.76 45.4
282 4.59 35.4
283 3.01 46.0
284 3.16 50.0
285 7.85 32.2
286 8.23 22.0
287 12.93 20.1
288 7.14 23.2
289 7.60 22.3
290 9.51 24.8
291 3.33 28.5
292 3.56 37.3
293 4.70 27.9
294 8.58 23.9
295 10.40 21.7
296 6.27 28.6
297 7.39 27.1
298 15.84 20.3
299 4.97 22.5
300 4.74 29.0
301 6.07 24.8
302 9.50 22.0

303 8.67 26.4
304 4.86 33.1
305 6.93 36.1
306 8.93 28.4
307 6.47 33.4
308 7.53 28.2
309 4.54 22.8
310 9.97 20.3
311 12.64 16.1
312 5.98 22.1
313 11.72 19.4
314 7.90 21.6
315 9.28 23.8
316 11.50 16.2
317 18.33 17.8
318 15.94 19.8
319 10.36 23.1
320 12.73 21.0
321 7.20 23.8
322 6.87 23.1
323 7.70 20.4
324 11.74 18.5
325 6.12 25.0
326 5.08 24.6
327 6.15 23.0
328 12.79 22.2
329 9.97 19.3
330 7.34 22.6
331 9.09 19.8
332 12.43 17.1
333 7.83 19.4
334 5.68 22.2
335 6.75 20.7
336 8.01 21.1
337 9.80 19.5
338 10.56 18.5
339 8.51 20.6
340 9.74 19.0
341 9.29 18.7
342 5.49 32.7
343 8.65 16.5
344 7.18 23.9
345 4.61 31.2
346 10.53 17.5
347 12.67 17.2
348 6.36 23.1
349 5.99 24.5
350 5.89 26.6
351 5.98 22.9
352 5.49 24.1
353 7.79 18.6
354 4.50 30.1
355 8.05 18.2
356 5.57 20.6

357 17.60 17.8
358 13.27 21.7
359 11.48 22.7
360 12.67 22.6
361 7.79 25.0
362 14.19 19.9
363 10.19 20.8
364 14.64 16.8
365 5.29 21.9
366 7.12 27.5
367 14.00 21.9
368 13.33 23.1
369 3.26 50.0
370 3.73 50.0
371 2.96 50.0
372 9.53 50.0
373 8.88 50.0
374 34.77 13.8
375 37.97 13.8
376 13.44 15.0
377 23.24 13.9
378 21.24 13.3
379 23.69 13.1
380 21.78 10.2
381 17.21 10.4
382 21.08 10.9
383 23.60 11.3
384 24.56 12.3
385 30.63 8.8
386 30.81 7.2
387 28.28 10.5
388 31.99 7.4
389 30.62 10.2
390 20.85 11.5
391 17.11 15.1
392 18.76 23.2
393 25.68 9.7
394 15.17 13.8
395 16.35 12.7
396 17.12 13.1
397 19.37 12.5
398 19.92 8.5
399 30.59 5.0
400 29.97 6.3
401 26.77 5.6
402 20.32 7.2
403 20.31 12.1
404 19.77 8.3
405 27.38 8.5
406 22.98 5.0
407 23.34 11.9
408 12.13 27.9
409 26.40 17.2
410 19.78 27.5

411 10.11 15.0
412 21.22 17.2
413 34.37 17.9
414 20.08 16.3
415 36.98 7.0
416 29.05 7.2
417 25.79 7.5
418 26.64 10.4
419 20.62 8.8
420 22.74 8.4
421 15.02 16.7
422 15.70 14.2
423 14.10 20.8
424 23.29 13.4
425 17.16 11.7
426 24.39 8.3
427 15.69 10.2
428 14.52 10.9
429 21.52 11.0
430 24.08 9.5
431 17.64 14.5
432 19.69 14.1
433 12.03 16.1
434 16.22 14.3
435 15.17 11.7
436 23.27 13.4
437 18.05 9.6
438 26.45 8.7
439 34.02 8.4
440 22.88 12.8
441 22.11 10.5
442 19.52 17.1
443 16.59 18.4
444 18.85 15.4
445 23.79 10.8
446 23.98 11.8
447 17.79 14.9
448 16.44 12.6
449 18.13 14.1
450 19.31 13.0
451 17.44 13.4
452 17.73 15.2
453 17.27 16.1
454 16.74 17.8
455 18.71 14.9
456 18.13 14.1
457 19.01 12.7
458 16.94 13.5
459 16.23 14.9
460 14.70 20.0
461 16.42 16.4
462 14.65 17.7
463 13.99 19.5
464 10.29 20.2

```
## 465 13.22 21.4
## 466 14.13 19.9
## 467 17.15 19.0
## 468 21.32 19.1
## 469 18.13 19.1
## 470 14.76 20.1
## 471 16.29 19.9
## 472 12.87 19.6
## 473 14.36 23.2
## 474 11.66 29.8
## 475 18.14 13.8
## 476 24.10 13.3
## 477 18.68 16.7
## 478 24.91 12.0
## 479 18.03 14.6
## 480 13.11 21.4
## 481 10.74 23.0
## 482 7.74 23.7
## 483 7.01 25.0
## 484 10.42 21.8
## 485 13.34 20.6
## 486 10.58 21.2
## 487 14.98 19.1
## 488 11.45 20.6
## 489 18.06 15.2
## 490 23.97 7.0
## 491 29.68 8.1
## 492 18.07 13.6
## 493 13.35 20.1
## 494 12.01 21.8
## 495 13.59 24.5
## 496 17.60 23.1
## 497 21.14 19.7
## 498 14.10 18.3
## 499 12.92 21.2
## 500 15.10 17.5
## 501 14.33 16.8
## 502 9.67 22.4
## 503 9.08 20.6
## 504 5.64 23.9
## 505 6.48 22.0
## 506 7.88 11.9
```

```
Boston = Boston [sample(1:nrow(Boston)),]
Boston_train = Boston [1:380, ]
Boston_test = Boston[380 : nrow(Boston),]
```

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`.

#TO-DO

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

#TO-DO

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.

#TO-DO