MGMT 608 Project - Assignment 7

June 23, 2021

1 MGMT 608 Project - Assignment 7

1.1 Coded by Bryan Butto

1.2 Week 1

```
In [1]: install.packages("faraway")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [1]: library("faraway")
```

```
In [2]: uswages
        ?uswages
```

	wage	educ	exper	race	smsa	ne	mw	so	we	p
	<dbl>	<int>	<int>	<int>	<int>	<int>	<int>	<int>	<int>	<
6085	771.60	18	18	0	1	1	0	0	0	0
23701	617.28	15	20	0	1	0	0	0	1	0
16208	957.83	16	9	0	1	0	0	1	0	0
2720	617.28	12	24	0	1	1	0	0	0	0
9723	902.18	14	12	0	1	0	1	0	0	0
22239	299.15	12	33	0	1	0	0	0	1	0
14379	541.31	16	42	0	1	0	0	1	0	1
12878	148.39	16	0	0	1	0	1	0	0	1
23121	273.19	12	36	0	1	0	0	0	1	1
13086	666.67	12	37	0	0	0	1	0	0	0
19913	241.50	9	20	1	1	0	0	1	0	1
20055	703.79	14	29	0	1	0	0	1	0	0
6076	550.81	17	16	0	0	1	0	0	0	0
24050	807.22	14	21	0	1	0	0	0	1	1
11064	712.25	14	11	0	0	0	1	0	0	0
26395	351.46	10	10	0	1	0	0	0	1	0
15576	373.24	12	8	0	0	0	0	1	0	0
18936	759.73	13	19	0	1	0	0	1	0	0
4747	356.13	14	6	0	1	1	0	0	0	0
21572	308.64	16	0	0	1	0	0	1	0	0
14575	469.14	6	24	0	0	0	0	1	0	0
15065	617.28	16	-1	0	1	0	0	1	0	0
23270	123.46	16	1	0	1	0	0	0	1	1
11093	474.83	12	11	0	0	0	1	0	0	0
8830	261.16	12	40	0	1	0	1	0	0	0
9219	284.90	12	5	0	1	0	1	0	0	0
28065	1661.92	12	15	0	1	0	0	0	1	0
1339	629.15	12	44	0	1	1	0	0	0	0
13462	2374.15	12	35	0	1	0	0	1	0	0
A data.frame: 2000 Œ 10 10787	522.32	16	8	0	1	0	1	0	0	0
8999	132.10	11	14	1	1	0	1	0	0	0
1307	701.23	14	37	0	1	1	0	0	0	0
13591	222.22	9	24	0	0	0	0	1	0	0
7228	78.35	12	3	0	1	0	1	0	0	1
11663	332.38	10	9	0	1	0	1	0	0	0
1478	569.80	11	18	0	0	1	0	0	0	0
9668	130.58	17	-1	0	1	0	1	0	0	1
16375	891.47	12	47	0	1	0	0	1	0	0
5763	735.99	12	15	0	1	1	0	0	0	0
6188	427.35	8	48	0	1	1	0	0	0	0
21096	245.63	12	10	0	1	0	0	1	0	0
606	90.22	12	43	0	0	1	0	0	0	0
15222	546.06	12	39	0	1	0	0	1	0	0
20536	356.13	12	11	0	1	0	0	1	0	0
6113	385.09	13	13	0	1	1	0	0	0	0
23938	474.83	12	17	0	1	0	0	0	1	0
9690	1780.63	16	38	0	1	0	1	0	0	0
16173	118.71	13	10	1	1	0	0	1	0	0
12323	580.97	12	43	0	0	0	1	0	0	0
13197	494.78	18	38	0	0	0	1	0	0	0

1.2.1 The uswage dataset contains the weekly wages for US male workers surveyed in 1988.

1.2.2 The response variable is wage.

1.2.3 The predictor variables are educ, exper, race, smsa, ne, mw, so, we, and pt.

1.2.4 The null hypothesis is that we cannot predict wage from the predictor variables.

1.2.5 The alternative hypothesis is that we can predict wage using the predictor variables.

```
In [3]: head(uswages)
```

A data.frame: 6 Œ 10

	wage <dbl>	educ <int>	exper <int>	race <int>	smsa <int>	ne <int>	mw <int>	so <int>	we <int>	pt <int>
6085	771.60	18	18	0	1	1	0	0	0	0
23701	617.28	15	20	0	1	0	0	0	1	0
16208	957.83	16	9	0	1	0	0	1	0	0
2720	617.28	12	24	0	1	1	0	0	0	0
9723	902.18	14	12	0	1	0	1	0	0	0
22239	299.15	12	33	0	1	0	0	0	1	0

```
In [4]: str(uswages)
```

```
'data.frame':        2000 obs. of  10 variables:
 $ wage : num  772 617 958 617 902 ...
 $ educ : int  18 15 16 12 14 12 16 16 12 12 ...
 $ exper: int  18 20 9 24 12 33 42 0 36 37 ...
 $ race : int  0 0 0 0 0 0 0 0 0 0 ...
 $ smsa : int  1 1 1 1 1 1 1 1 1 0 ...
 $ ne   : int  1 0 0 1 0 0 0 0 0 0 ...
 $ mw   : int  0 0 0 0 1 0 0 1 0 1 ...
 $ so   : int  0 0 1 0 0 0 1 0 0 0 ...
 $ we   : int  0 1 0 0 0 1 0 0 1 0 ...
 $ pt   : int  0 0 0 0 0 0 1 1 1 0 ...
```

```
In [5]: summary(uswages)
```

```
      wage             educ           exper            race       
 Min.   :  50.39   Min.   : 0.00   Min.   :-2.00   Min.   :0.000  
 1st Qu.: 308.64   1st Qu.:12.00   1st Qu.: 8.00   1st Qu.:0.000  
 Median : 522.32   Median :12.00   Median :15.00   Median :0.000  
 Mean   : 608.12   Mean   :13.11   Mean   :18.41   Mean   :0.078  
 3rd Qu.: 783.48   3rd Qu.:16.00   3rd Qu.:27.00   3rd Qu.:0.000  
 Max.   :7716.05   Max.   :18.00   Max.   :59.00   Max.   :1.000  
      smsa             ne               mw               so        
 Min.   :0.000   Min.   :0.000   Min.   :0.0000   Min.   :0.0000  
 1st Qu.:1.000   1st Qu.:0.000   1st Qu.:0.0000   1st Qu.:0.0000  
 Median :1.000   Median :0.000   Median :0.0000   Median :0.0000  
 Mean   :0.756   Mean   :0.229   Mean   :0.2485   Mean   :0.3125  
 3rd Qu.:1.000   3rd Qu.:0.000   3rd Qu.:0.0000   3rd Qu.:1.0000  
```

```
 Max.   :1.000   Max.   :1.000   Max.   :1.0000   Max.   :1.0000
      we             pt
 Min.   :0.00   Min.   :0.0000
 1st Qu.:0.00   1st Qu.:0.0000
 Median :0.00   Median :0.0000
 Mean   :0.21   Mean   :0.0925
 3rd Qu.:0.00   3rd Qu.:0.0000
 Max.   :1.00   Max.   :1.0000
```

In [33]:
```
install.packages("pastecs")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

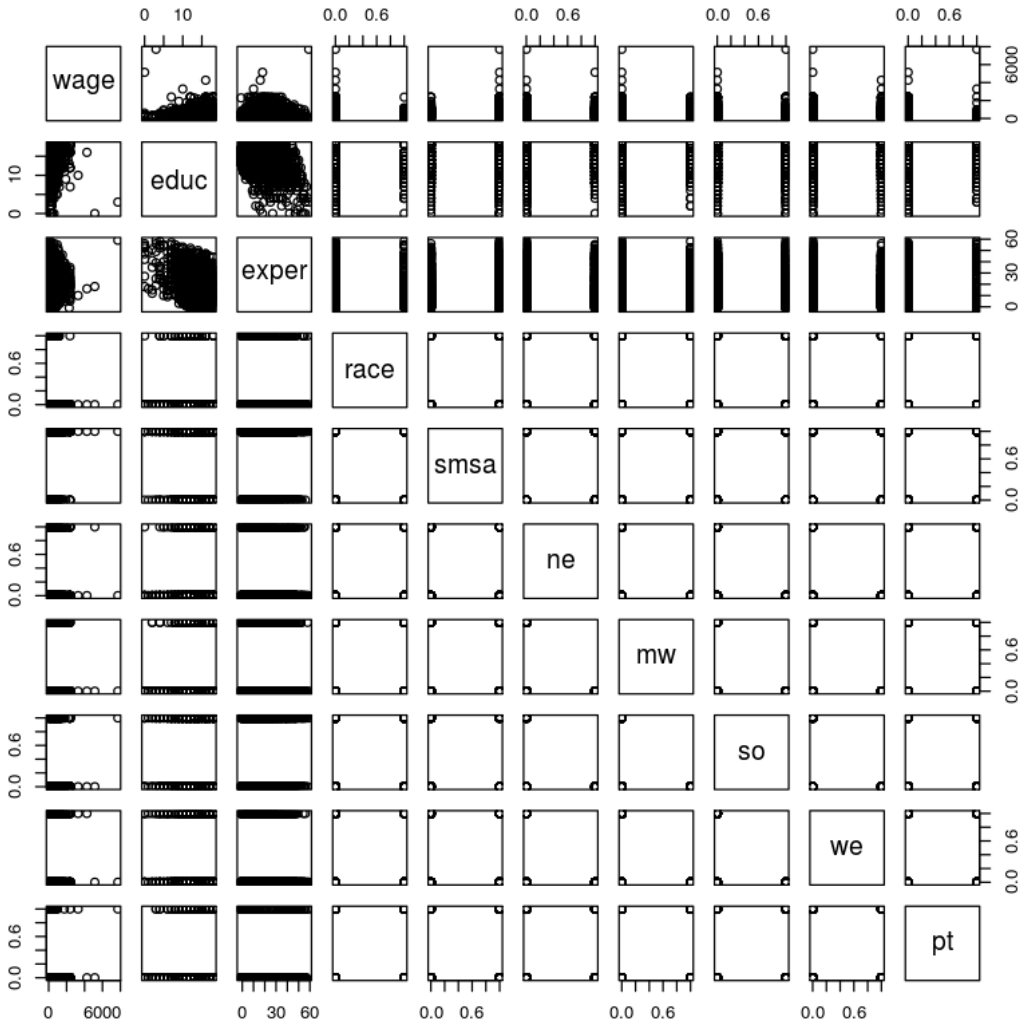
In [6]:
```
library(pastecs)
```

In [7]:
```
round(stat.desc(uswages),2)
```

A data.frame: 14 Œ 10

	wage <dbl>	educ <dbl>	exper <dbl>	race <dbl>	smsa <dbl>	ne <dbl>	mw <dbl
nbr.val	2000.00	2000.00	2000.00	2000.00	2000.00	2000.00	2000.
nbr.null	0.00	8.00	58.00	1844.00	488.00	1542.00	1503.
nbr.na	0.00	0.00	0.00	0.00	0.00	0.00	0.00
min	50.39	0.00	-2.00	0.00	0.00	0.00	0.00
max	7716.05	18.00	59.00	1.00	1.00	1.00	1.00
range	7665.66	18.00	61.00	1.00	1.00	1.00	1.00
sum	1216235.73	26222.00	36821.00	156.00	1512.00	458.00	497.0
median	522.32	12.00	15.00	0.00	1.00	0.00	0.00
mean	608.12	13.11	18.41	0.08	0.76	0.23	0.25
SE.mean	10.28	0.07	0.30	0.01	0.01	0.01	0.01
CI.mean.0.95	20.16	0.13	0.59	0.01	0.02	0.02	0.02
var	211446.05	9.03	178.91	0.07	0.18	0.18	0.19
std.dev	459.83	3.00	13.38	0.27	0.43	0.42	0.43
coef.var	0.76	0.23	0.73	3.44	0.57	1.84	1.74

In [19]:
```
pairs(uswages)
```



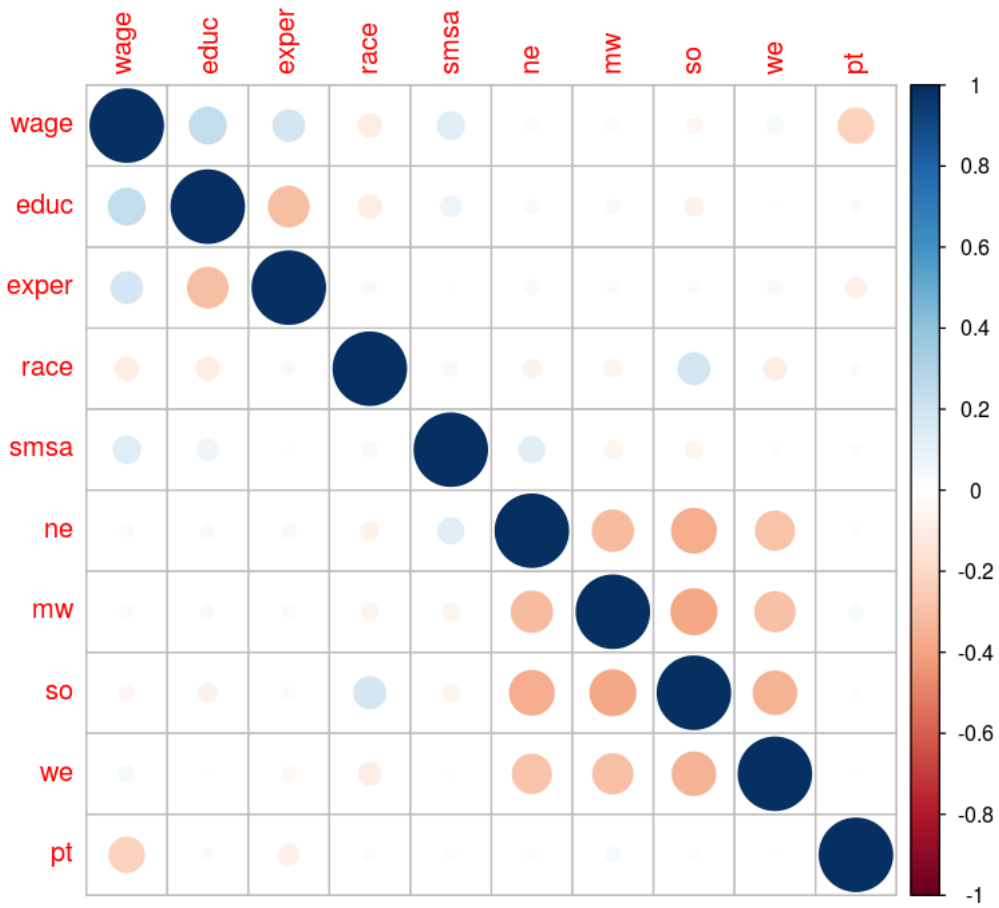

```
In [8]: round(cor(uswages),2)
```

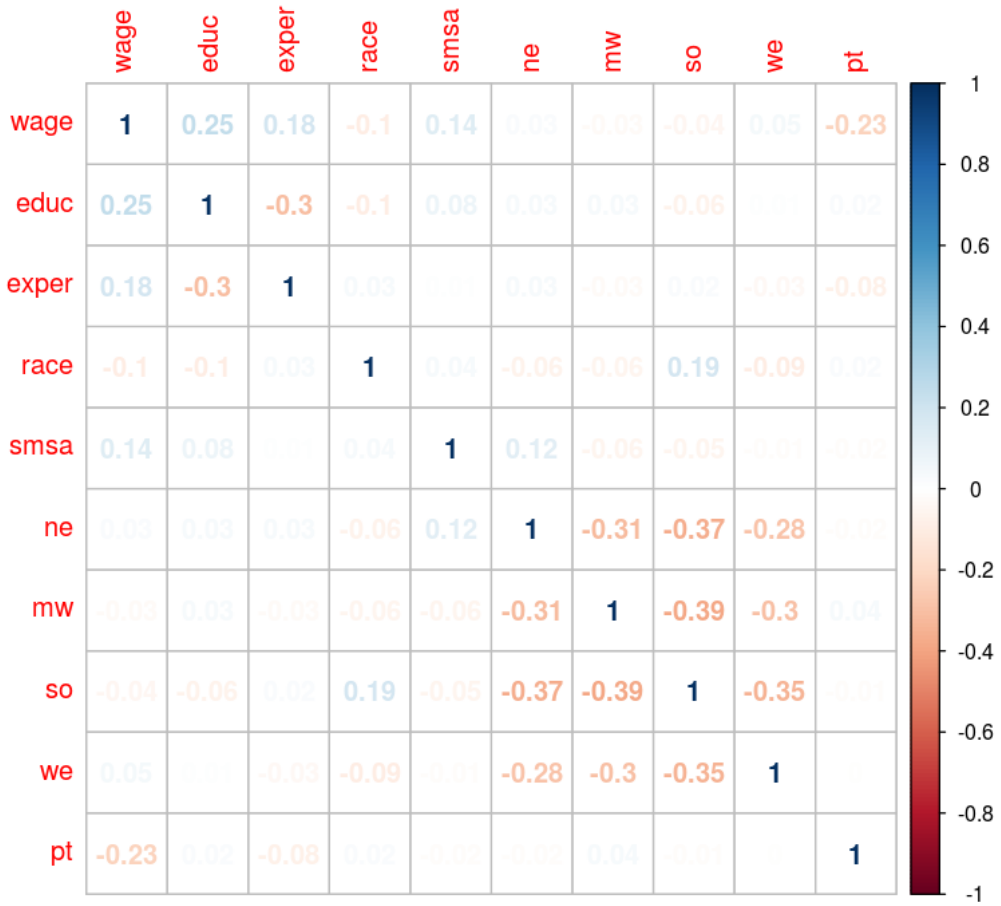
A matrix: 10 Œ 10 of type dbl

	wage	educ	exper	race	smsa	ne	mw	so	we	pt
wage	1.00	0.25	0.18	-0.10	0.14	0.03	-0.03	-0.04	0.05	-0.2
educ	0.25	1.00	-0.30	-0.10	0.08	0.03	0.03	-0.06	0.01	0.02
exper	0.18	-0.30	1.00	0.03	0.01	0.03	-0.03	0.02	-0.03	-0.0
race	-0.10	-0.10	0.03	1.00	0.04	-0.06	-0.06	0.19	-0.09	0.02
smsa	0.14	0.08	0.01	0.04	1.00	0.12	-0.06	-0.05	-0.01	-0.0
ne	0.03	0.03	0.03	-0.06	0.12	1.00	-0.31	-0.37	-0.28	-0.0
mw	-0.03	0.03	-0.03	-0.06	-0.06	-0.31	1.00	-0.39	-0.30	0.04
so	-0.04	-0.06	0.02	0.19	-0.05	-0.37	-0.39	1.00	-0.35	-0.0
we	0.05	0.01	-0.03	-0.09	-0.01	-0.28	-0.30	-0.35	1.00	0.00
pt	-0.23	0.02	-0.08	0.02	-0.02	-0.02	0.04	-0.01	0.00	1.00

```
In [4]: library(corrplot)
        cors <- cor(uswages)
        corrplot(cors)
        corrplot(cors, method = "number")
```

```
corrplot 0.84 loaded
```





In [8]: library(caret)

```
Loading required package: lattice

Attaching package: lattice

The following object is masked from package:faraway:

    melanoma
```

```
Loading required package: ggplot2
```

```
In [13]: featurePlot(x=uswages[,-1], y=uswages$wage, type = c("g", "smooth"))
         featurePlot(x=uswages[,-1], y=uswages$wage, type = c("g", "p", "smooth"))
```

```
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  0
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  1.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

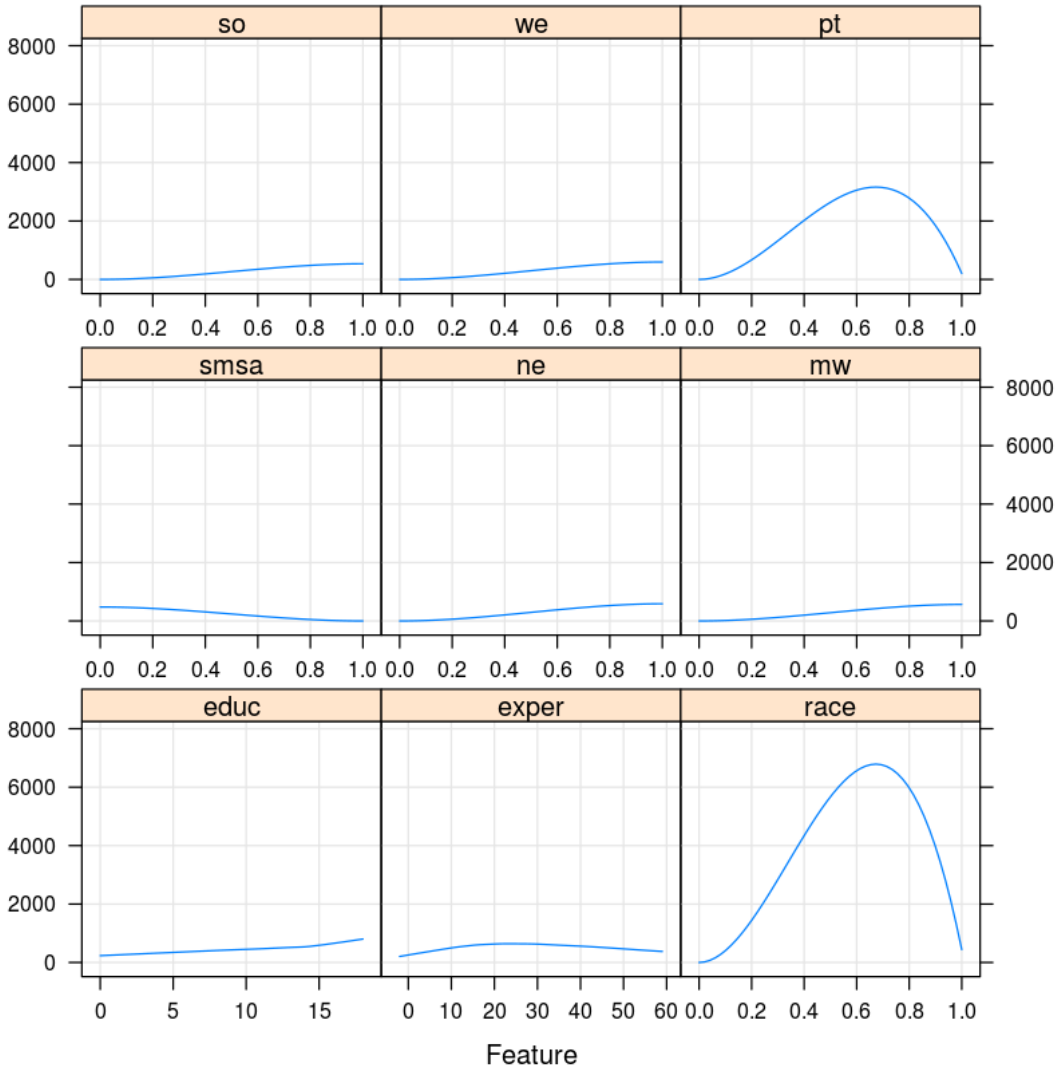
```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

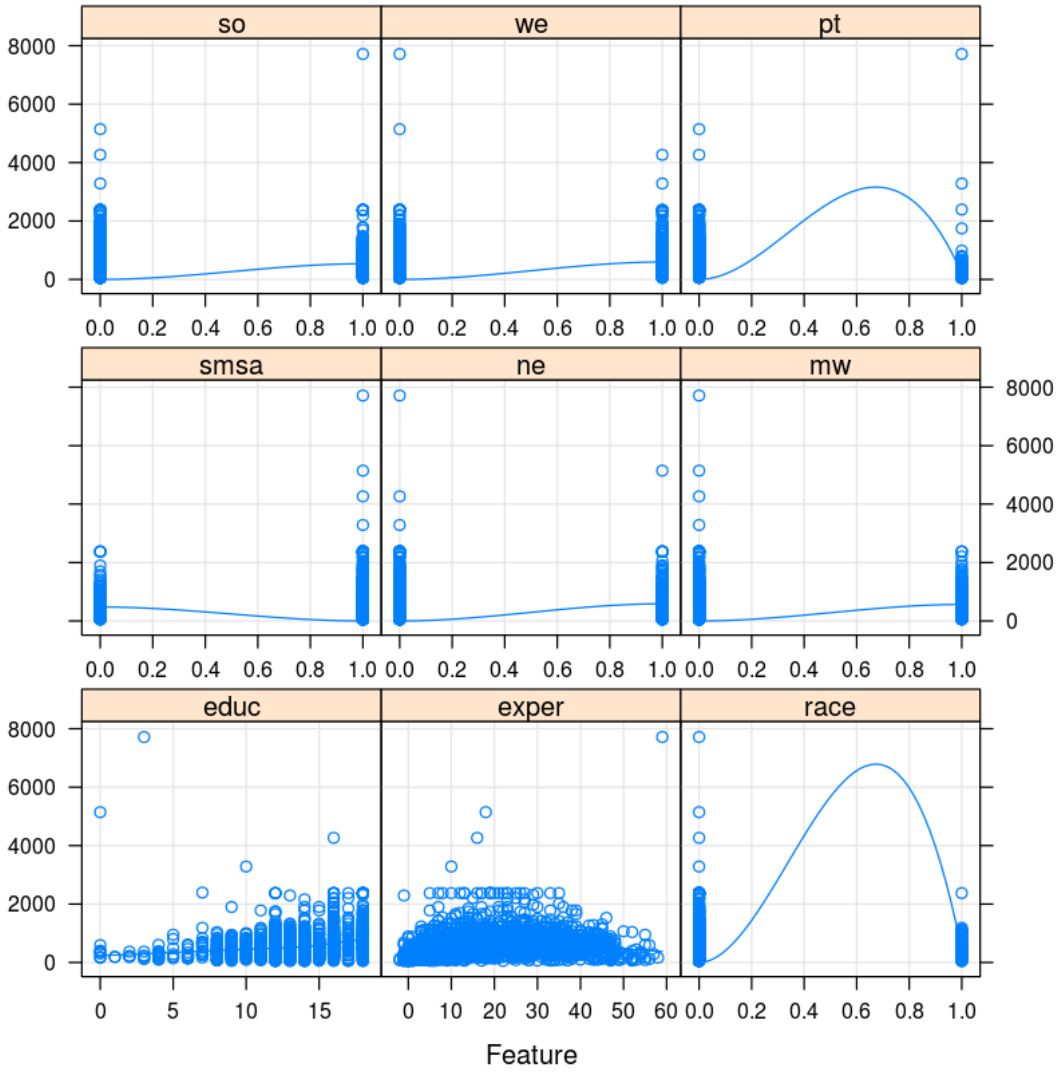
```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
```

```
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
at  -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
radius  2.5e-05
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
all data on boundary of neighborhood. make span bigger
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
pseudoinverse used at -0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
neighborhood radius 0.005
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
reciprocal condition number  1
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
There are other near singularities as well. 1.01
Warning message in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
zero-width neighborhood. make span bigger
```

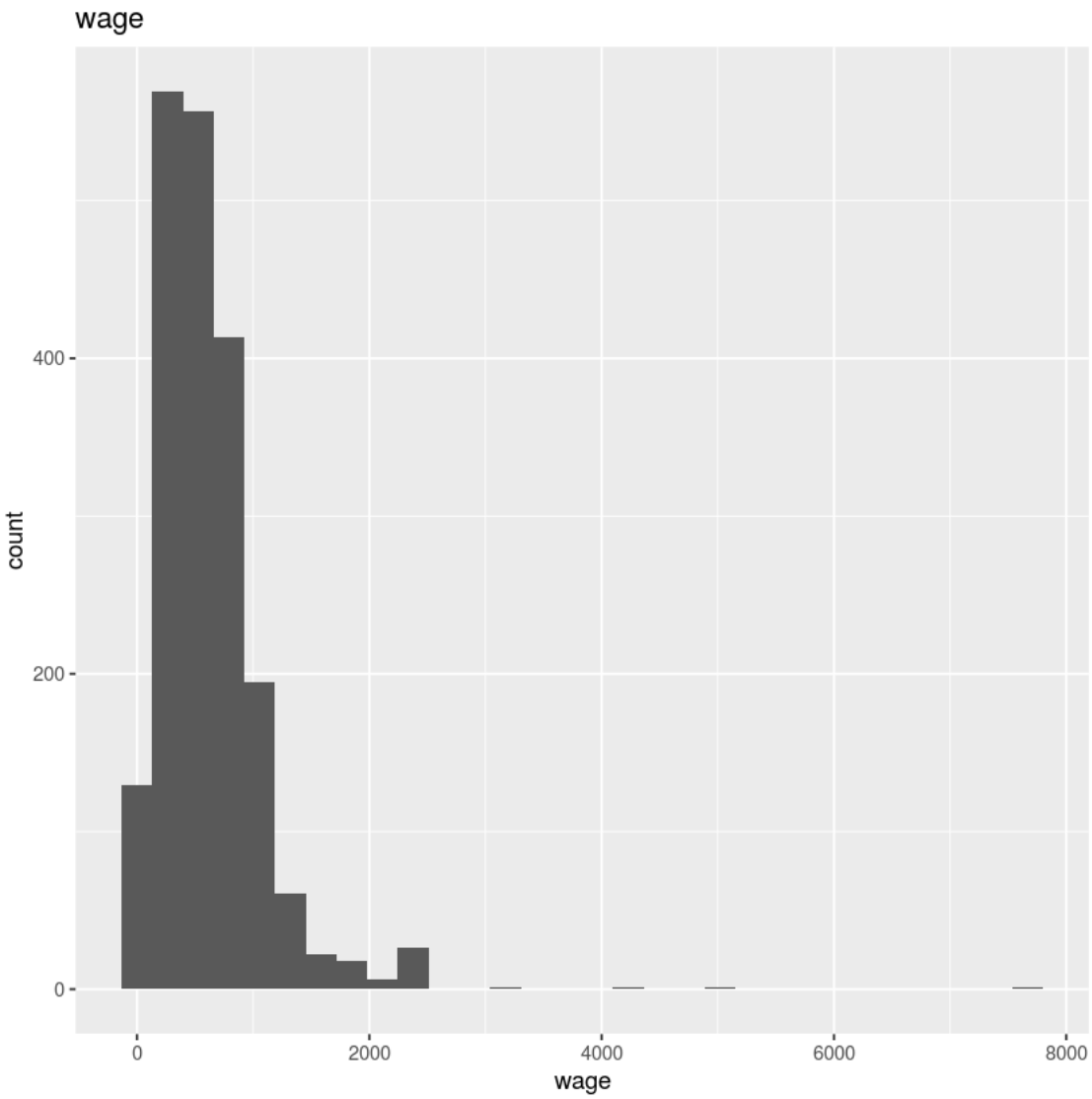

so
we
pt
smsa
ne
mw
educ
exper
race
Feature

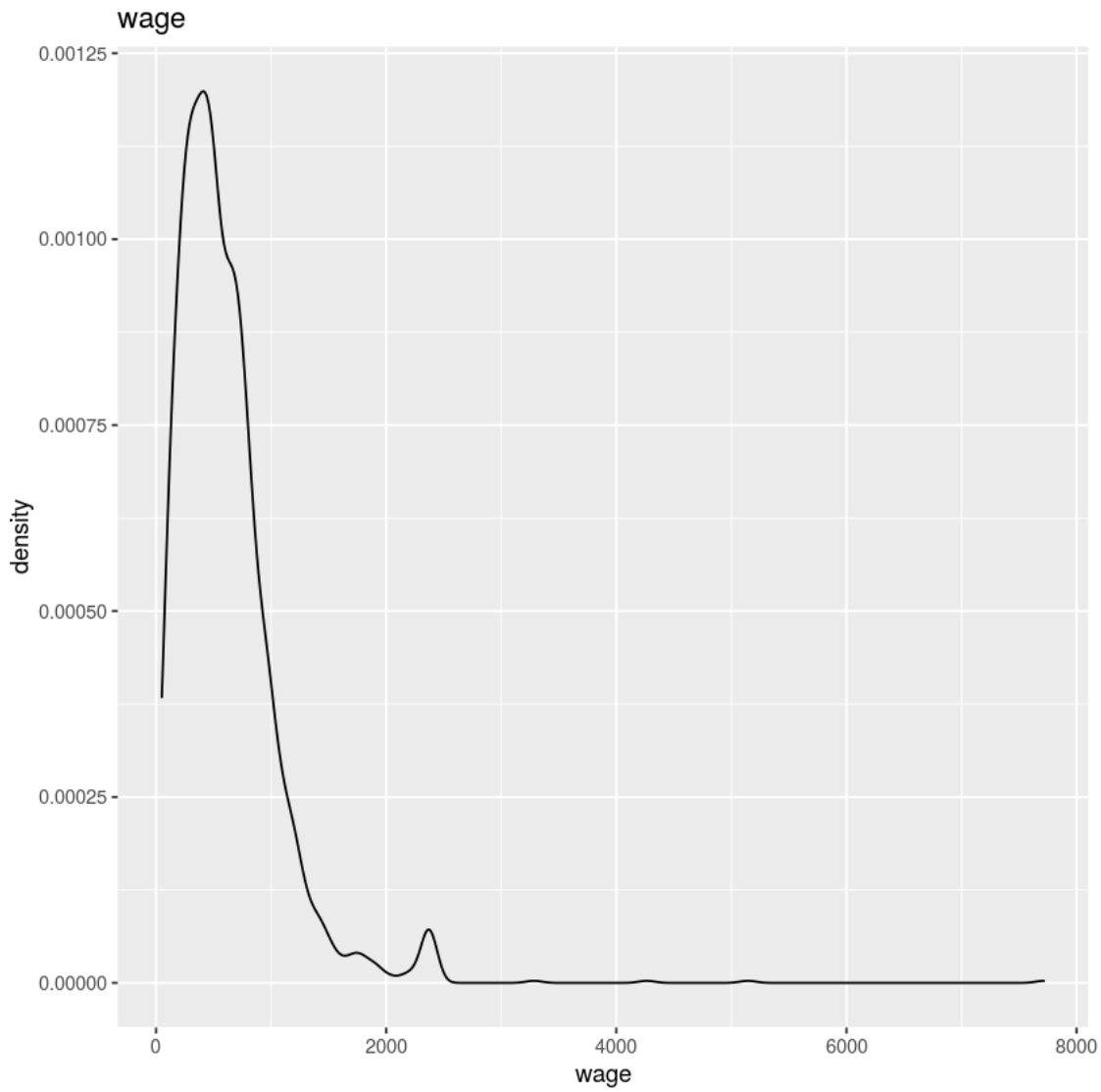



```
In [10]: library(ggplot2)
```

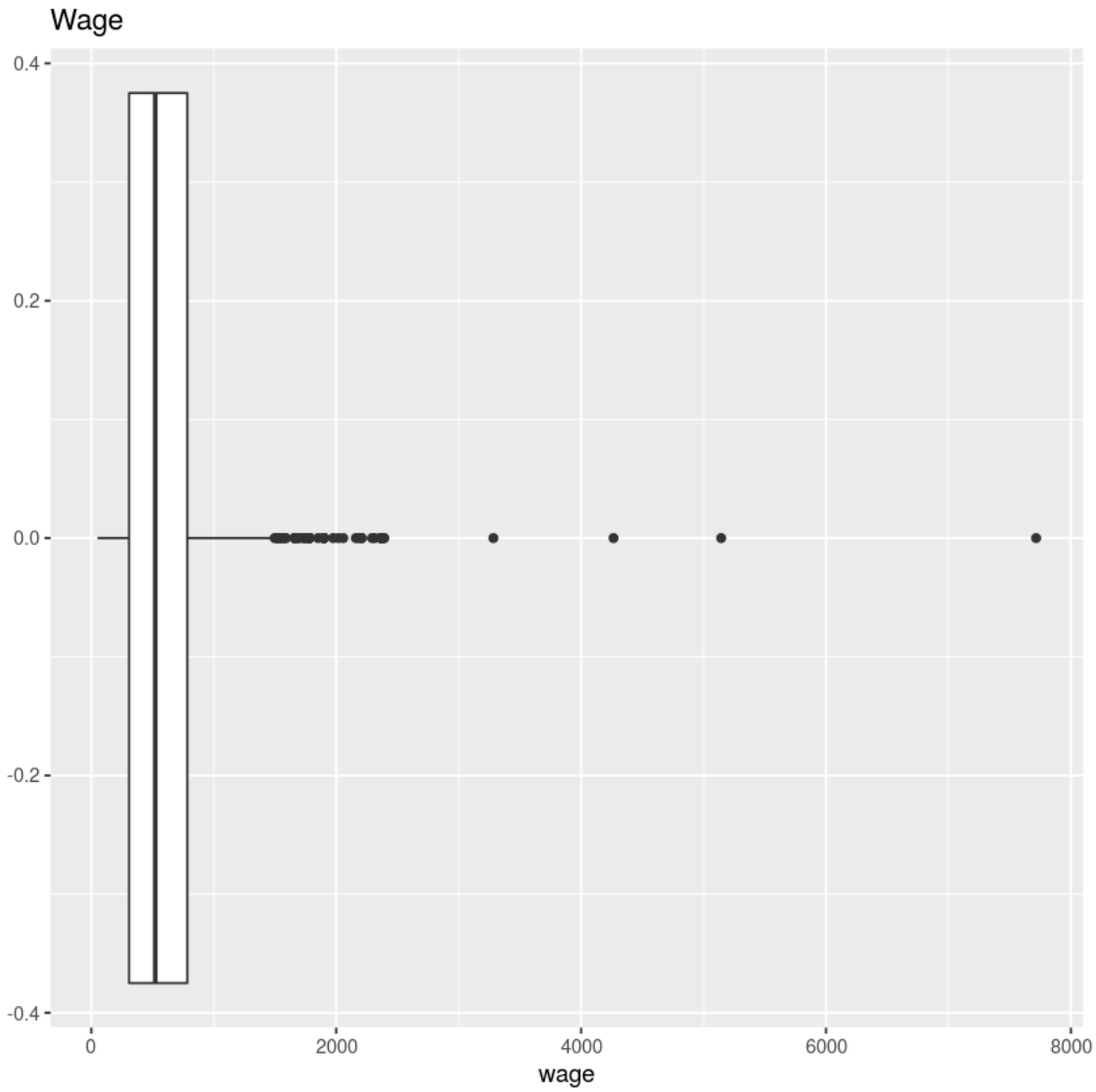
```
In [52]: ggplot(uswages, aes(x=wage)) + geom_histogram(alpha=2) + ggtitle("wage")
         ggplot(uswages, aes(x=wage)) + geom_density() + ggtitle("wage")
```

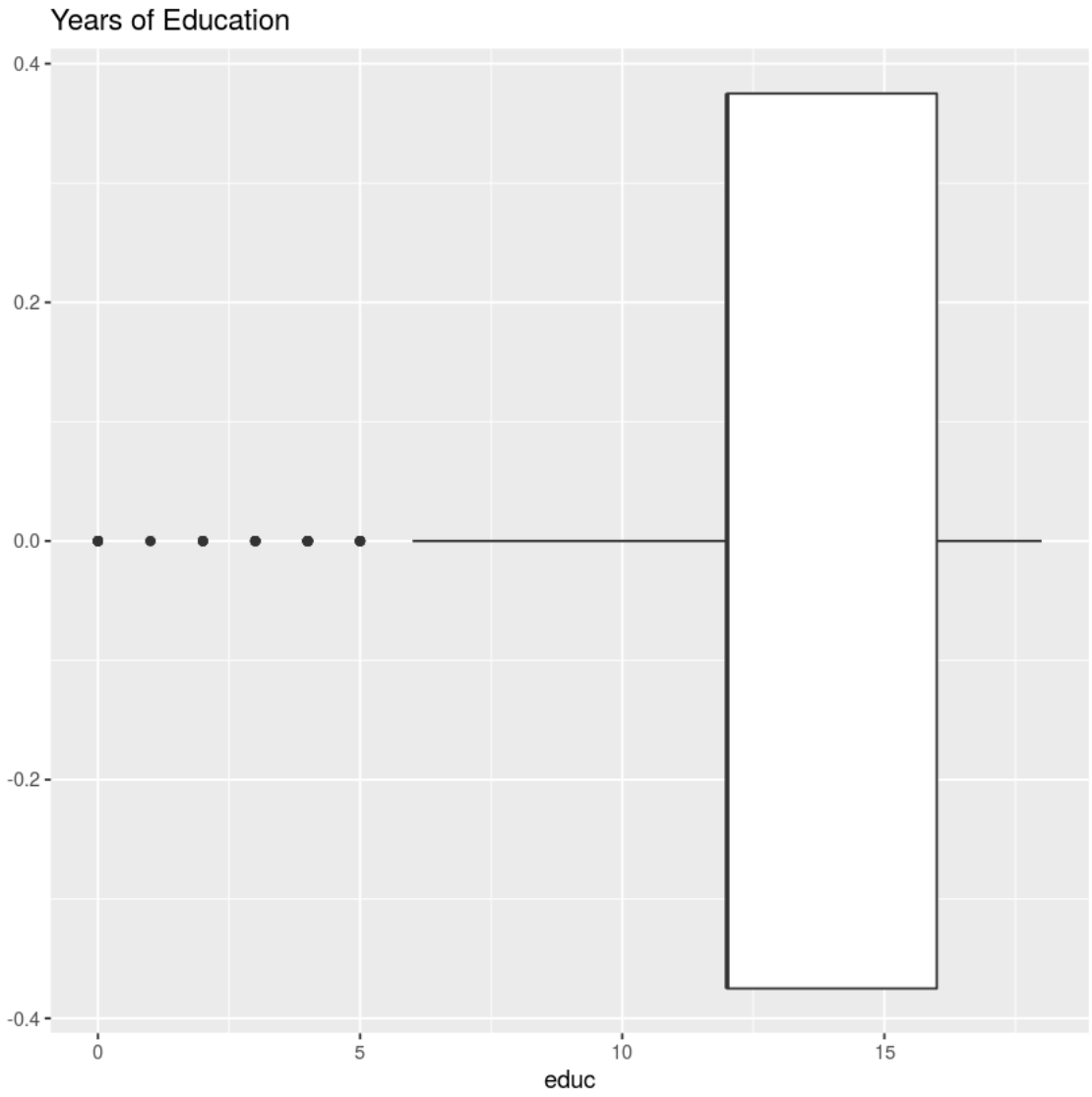
```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

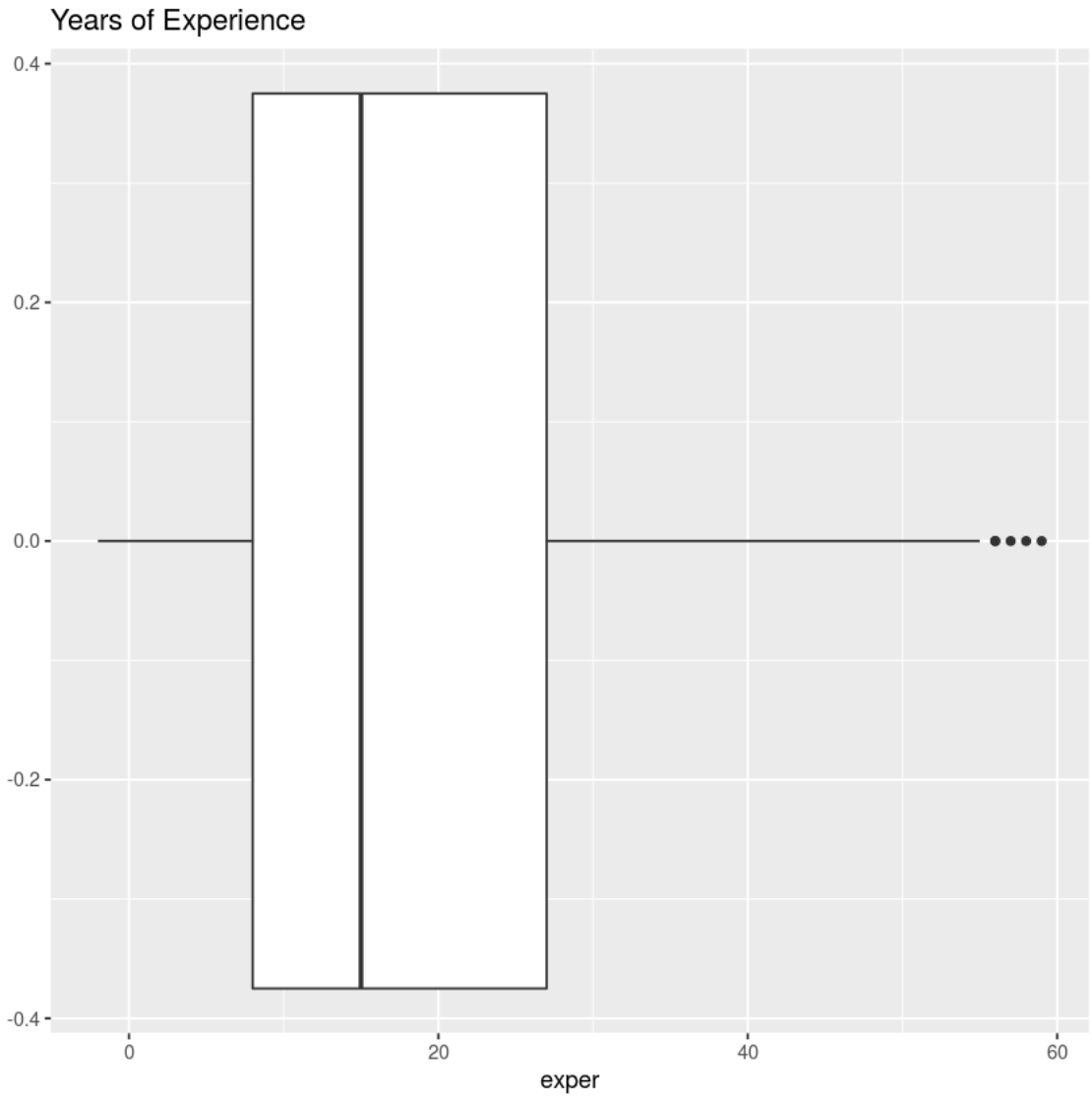

wage
400
200
0
count
0
2000
4000
6000
8000
wage



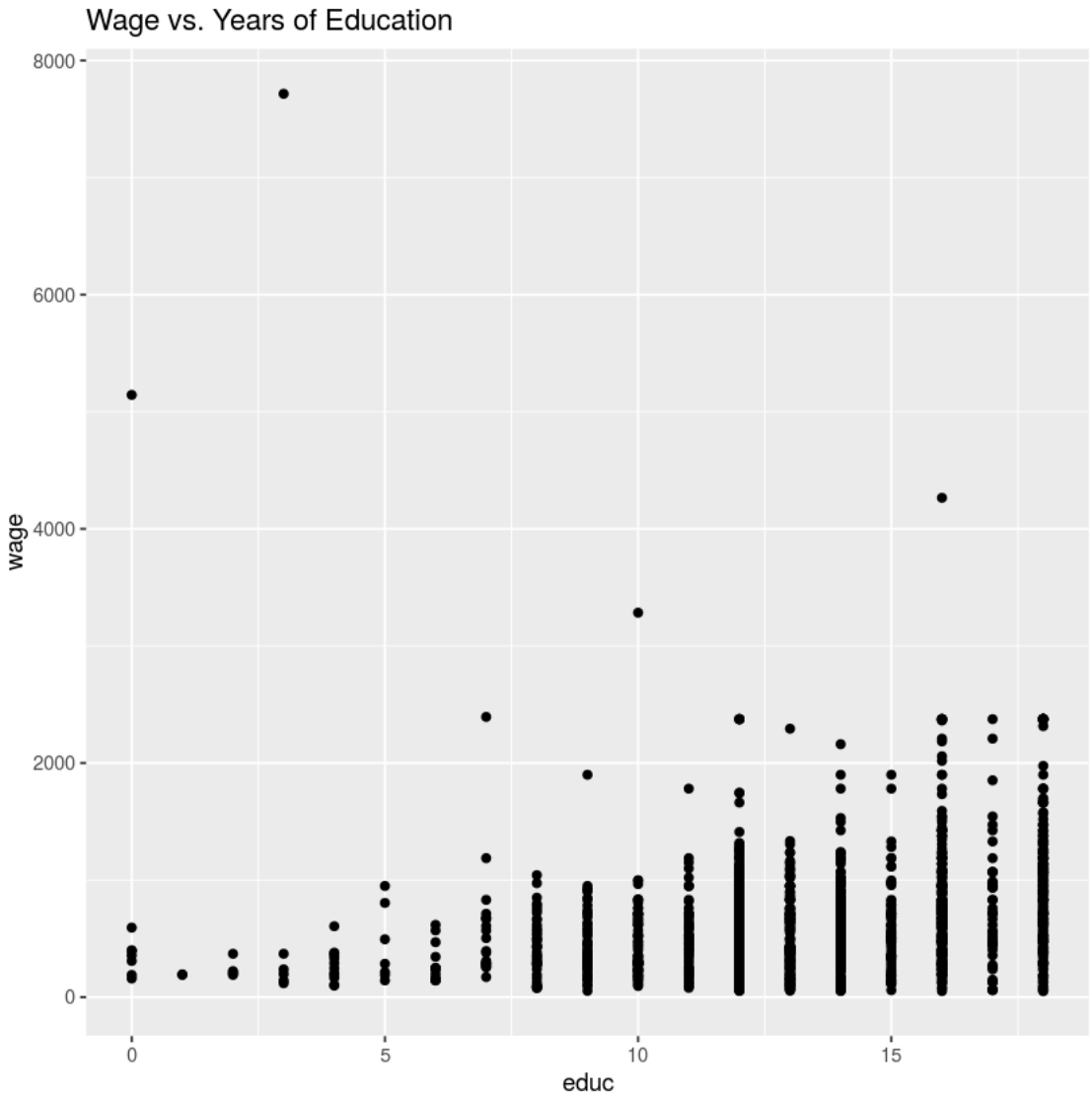

```
In [17]: ggplot(uswages, aes(wage)) + geom_boxplot() + ggtitle("Wage")
         ggplot(uswages, aes(educ)) + geom_boxplot() + ggtitle("Years of Education")
         ggplot(uswages, aes(exper)) + geom_boxplot() + ggtitle("Years of Experience")
```


Wage
0.4
0.2
0.0
-0.2
-0.4
0
2000
4000
6000
8000
wage

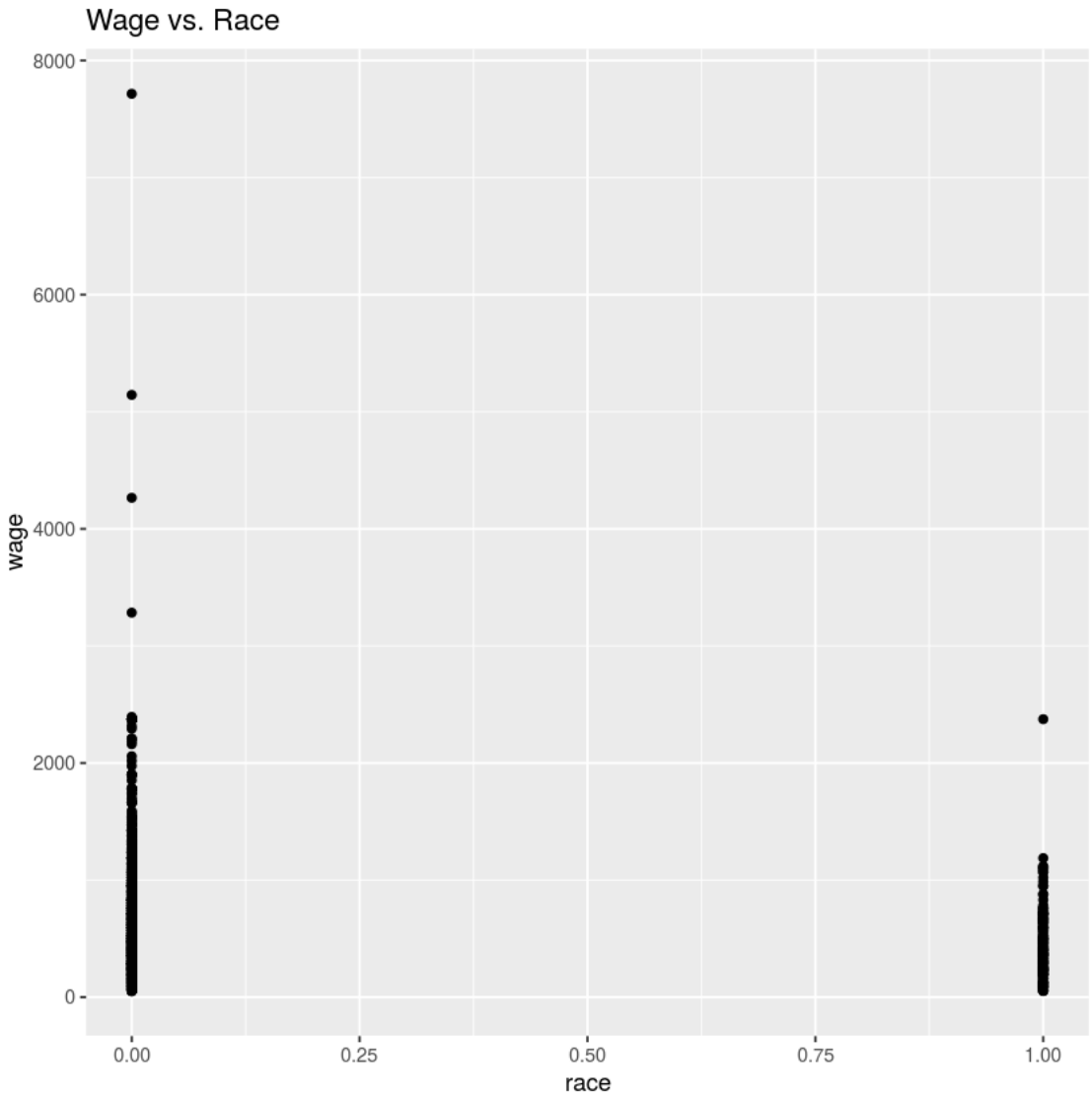

Years of Education
0.4
0.2
0.0
-0.2
-0.4
0
5
10
15
educ

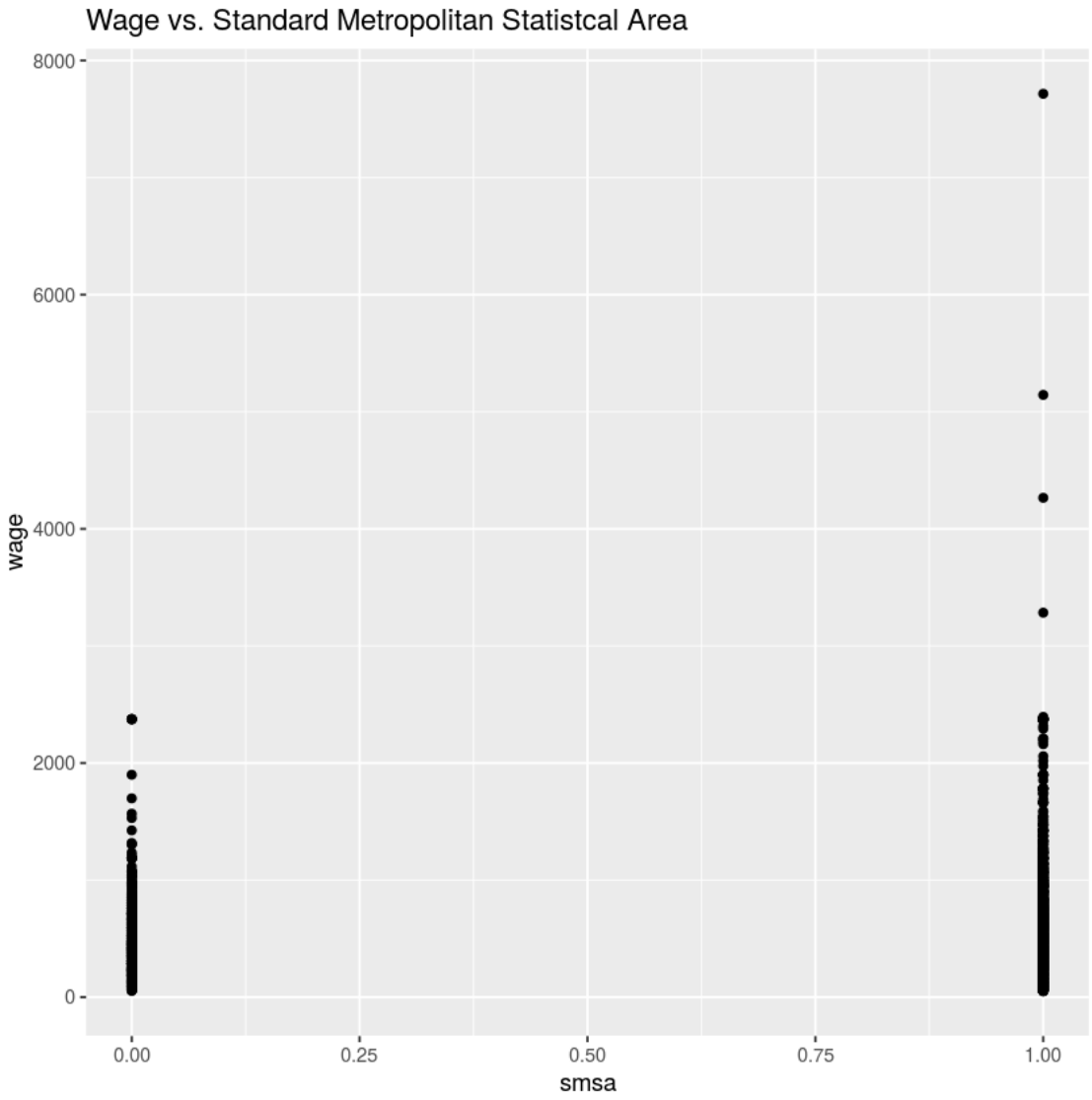


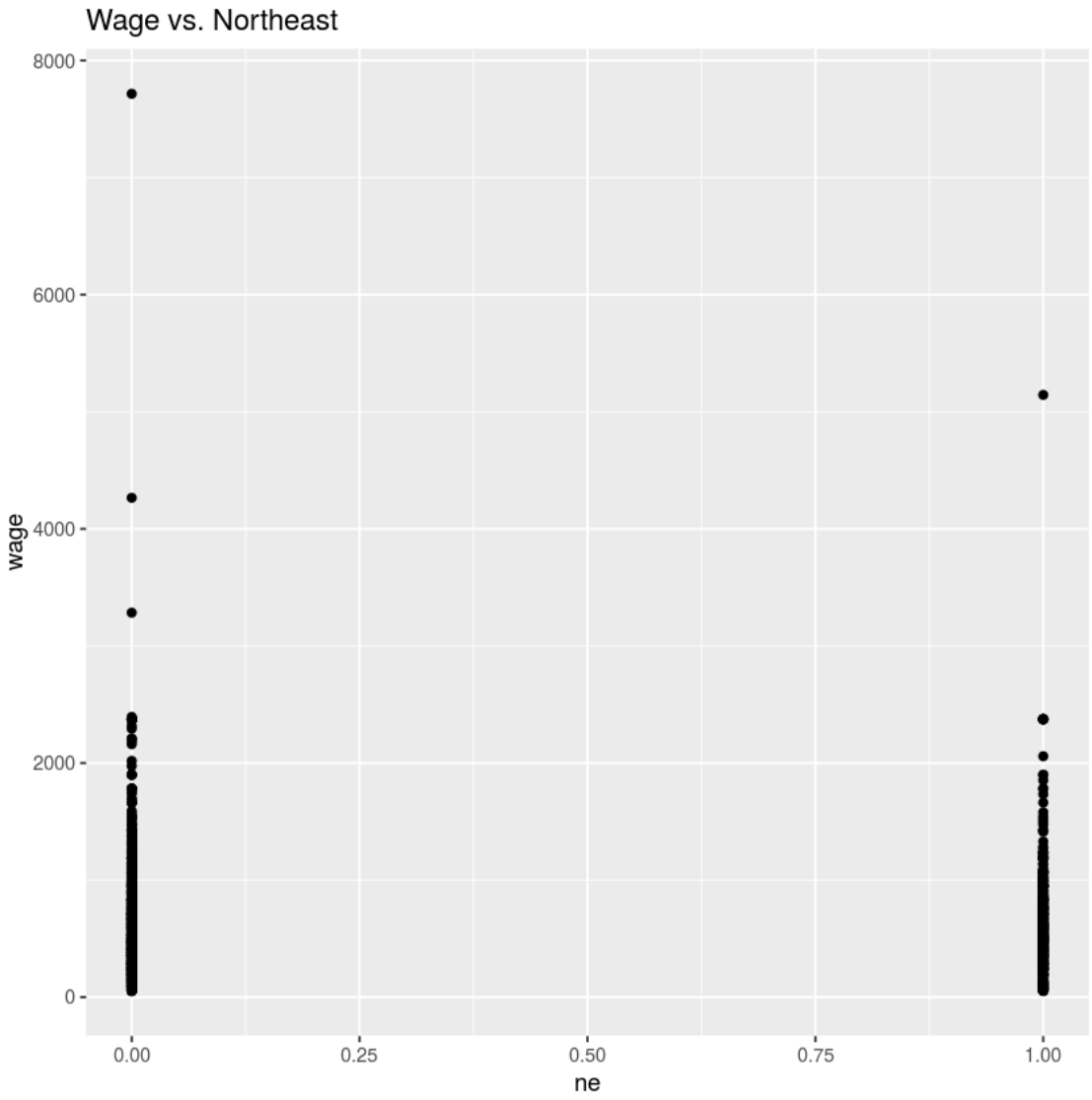

```
In [5]: ggplot(uswages, aes(x=educ, y=wage)) + geom_point() + ggtitle("Wage vs. Years of Educati
        ggplot(uswages, aes(x=exper, y=wage)) + geom_point() + ggtitle("Wage vs. Years of Experi
        ggplot(uswages, aes(x=race, y=wage)) + geom_point() + ggtitle("Wage vs. Race")
        ggplot(uswages, aes(x=smsa, y=wage)) + geom_point() + ggtitle("Wage vs. Standard Metropo
        ggplot(uswages, aes(x=ne, y=wage)) + geom_point() + ggtitle("Wage vs. Northeast")
        ggplot(uswages, aes(x=mw, y=wage)) + geom_point() + ggtitle("Wage vs. Midwest")
        ggplot(uswages, aes(x=we, y=wage)) + geom_point() + ggtitle("Wage vs. West")
        ggplot(uswages, aes(x=so, y=wage)) + geom_point() + ggtitle("Wage vs. South")
        ggplot(uswages, aes(x=pt, y=wage)) + geom_point() + ggtitle("Wage vs. Part time")
```

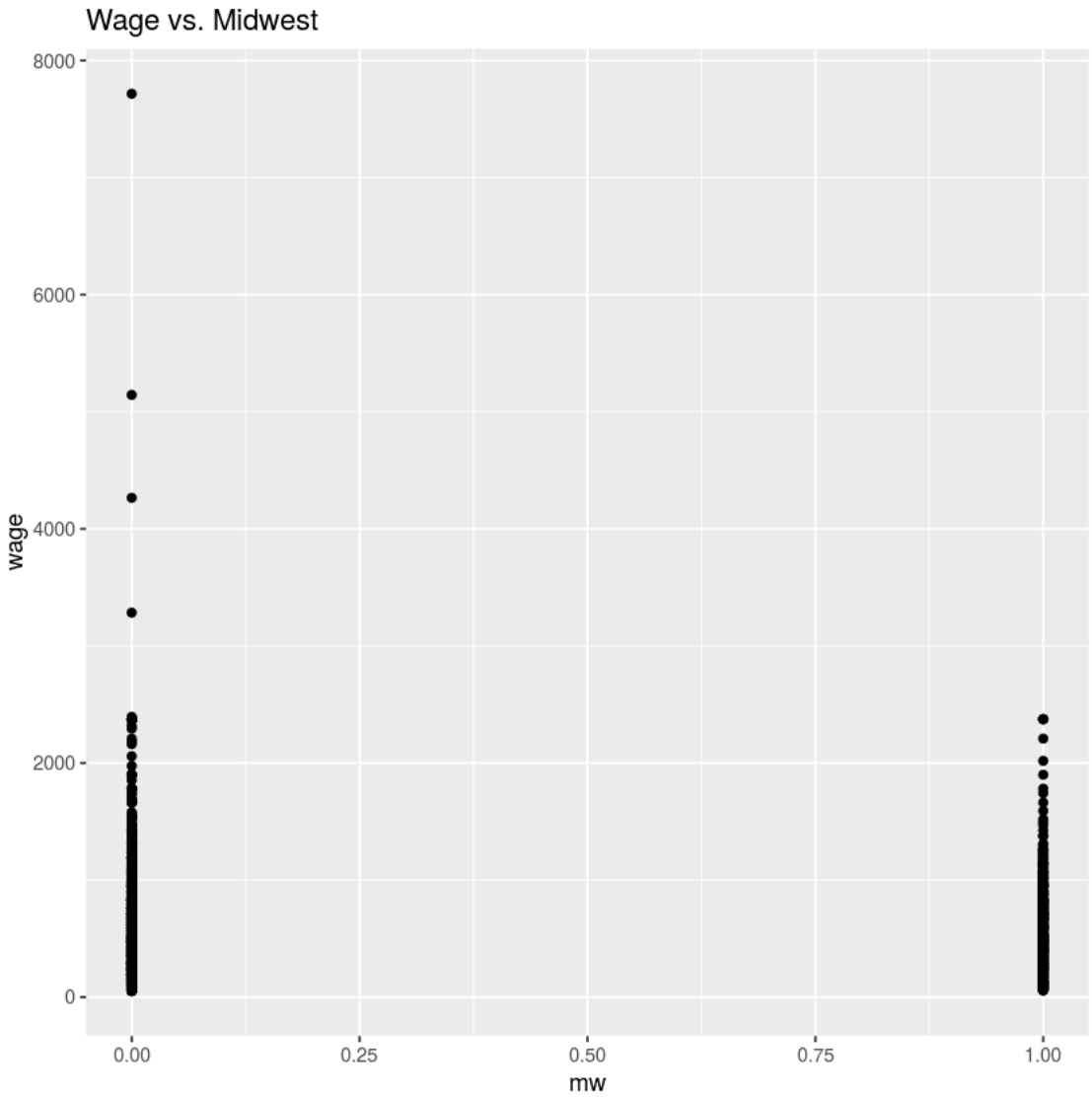

Wage vs. Years of Education
8000
6000
4000
2000
0
wage
0
5
10
15
educ

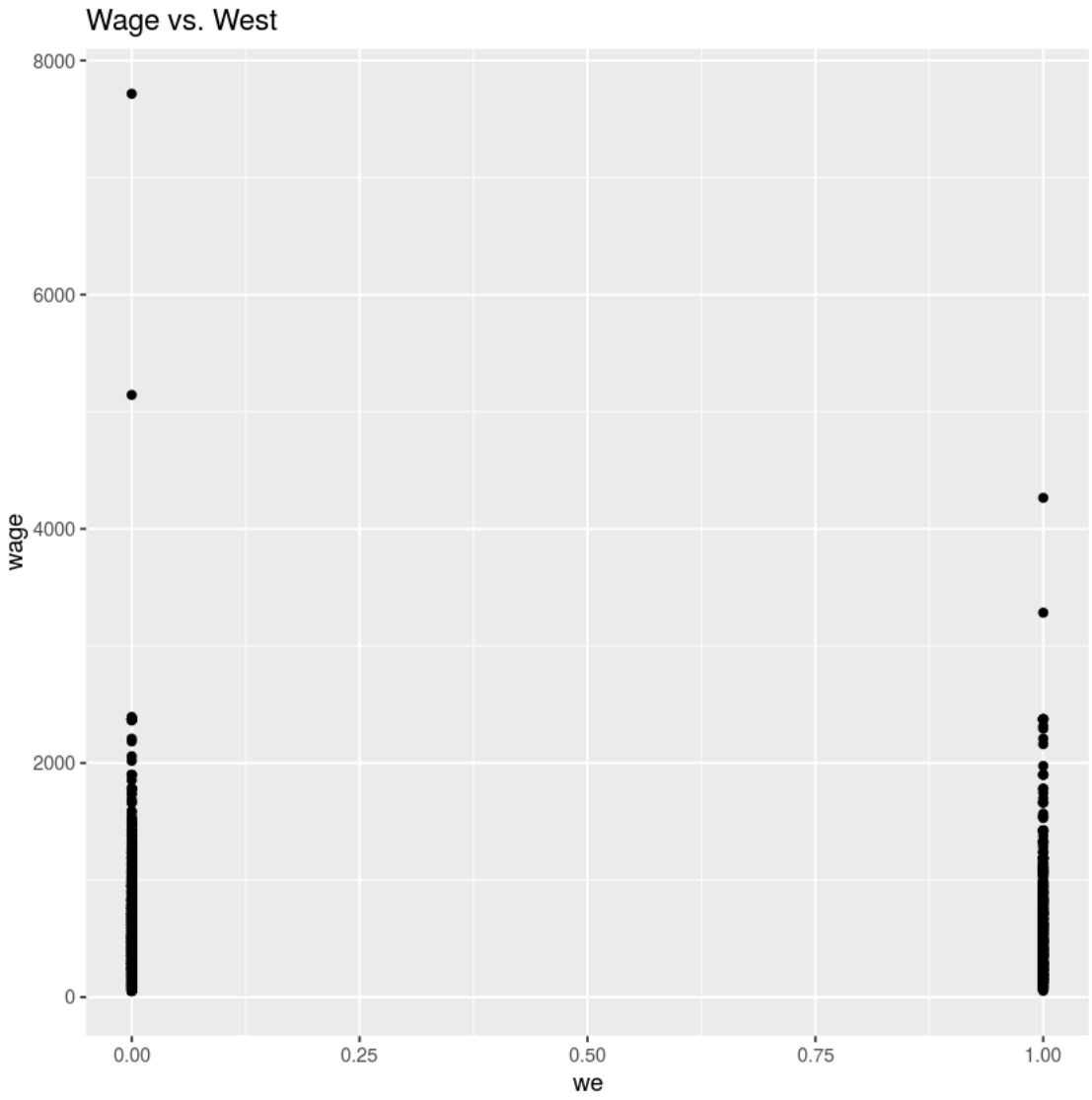

Wage vs. Years of Experience
wage
8000
6000
4000
2000
0
0
20
40
60
exper

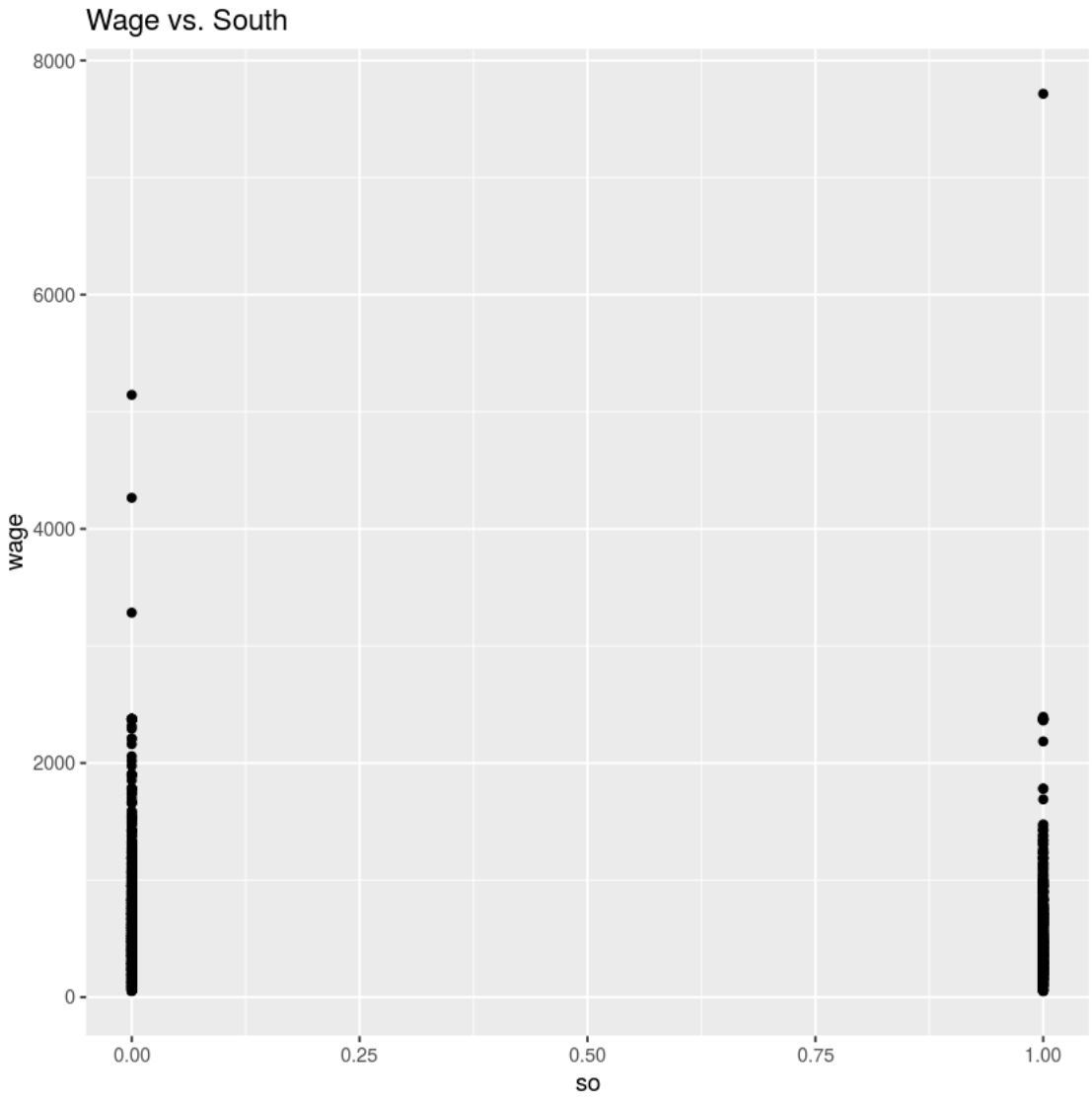

Wage vs. Race
8000
6000
4000
2000
0
wage
0.00
0.25
0.50
0.75
1.00
race

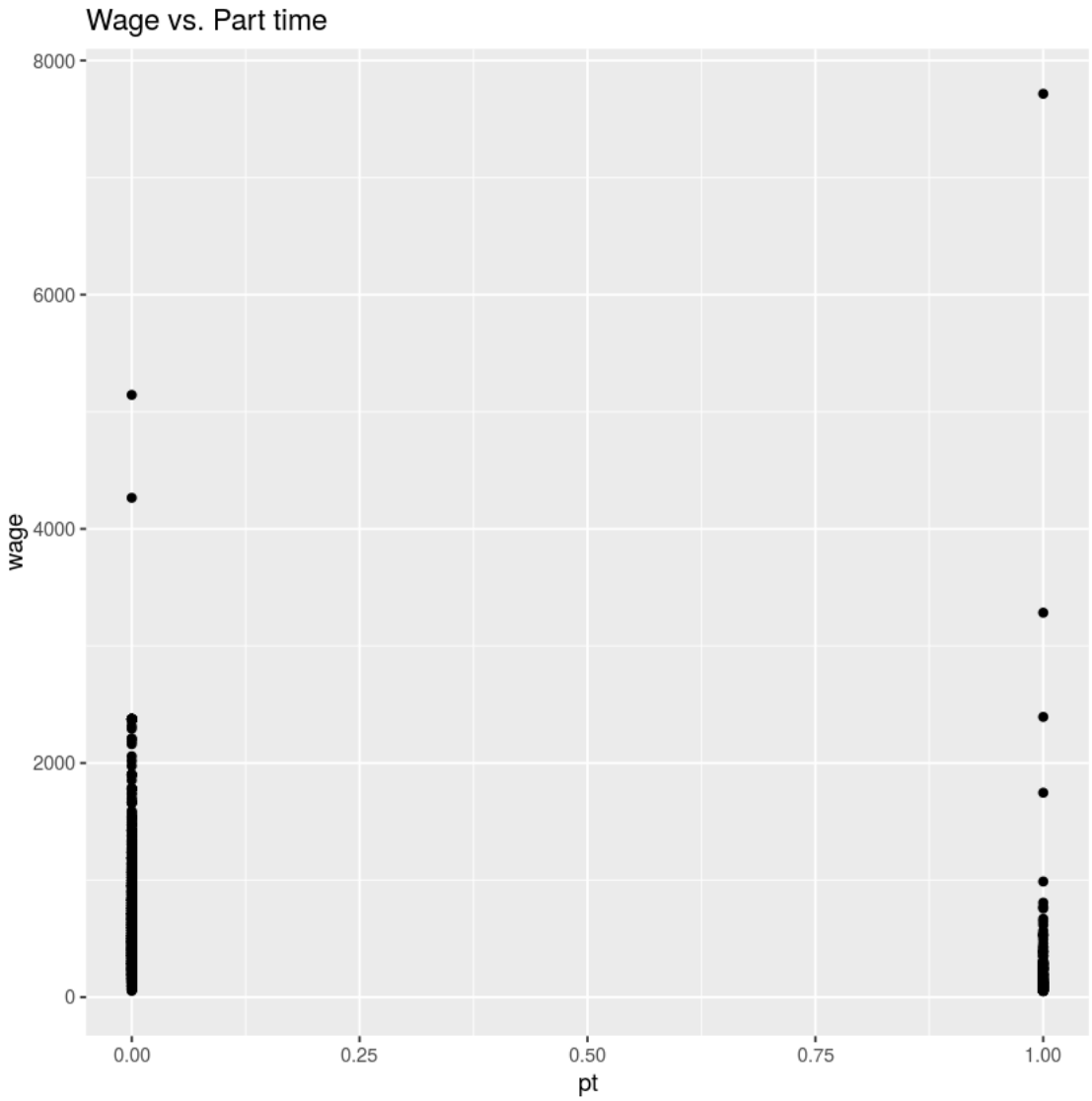

Wage vs. Standard Metropolitan Statistcal Area
8000
6000
4000
2000
0
wage
0.00
0.25
0.50
0.75
1.00
smsa


Wage vs. Northeast
8000
6000
4000
2000
0
wage
0.00
0.25
0.50
0.75
1.00
ne


Wage vs. Midwest
8000
6000
4000
2000
0
wage
0.00
0.25
0.50
0.75
1.00
mw


Wage vs. West
8000
6000
4000
2000
0
wage
0.00
0.25
0.50
0.75
1.00
we


Wage vs. South
8000
6000
4000
2000
0
wage
0.00
0.25
0.50
0.75
1.00
so




```
In [16]: uswages$race1 <- ifelse(uswages$race == 1, "Black", "White")
         uswages$smsa1 <- ifelse(uswages$smsa == 1, "Yes", "No")
         uswages$ne1 <- ifelse(uswages$ne == 1, "Yes", "No")
         uswages$mw1 <- ifelse(uswages$mw == 1, "Yes", "No")
         uswages$we1 <- ifelse(uswages$we == 1, "Yes", "No")
         uswages$so1 <- ifelse(uswages$so == 1, "Yes", "No")
         uswages$pt1 <- ifelse(uswages$pt == 1, "Yes", "No")
```

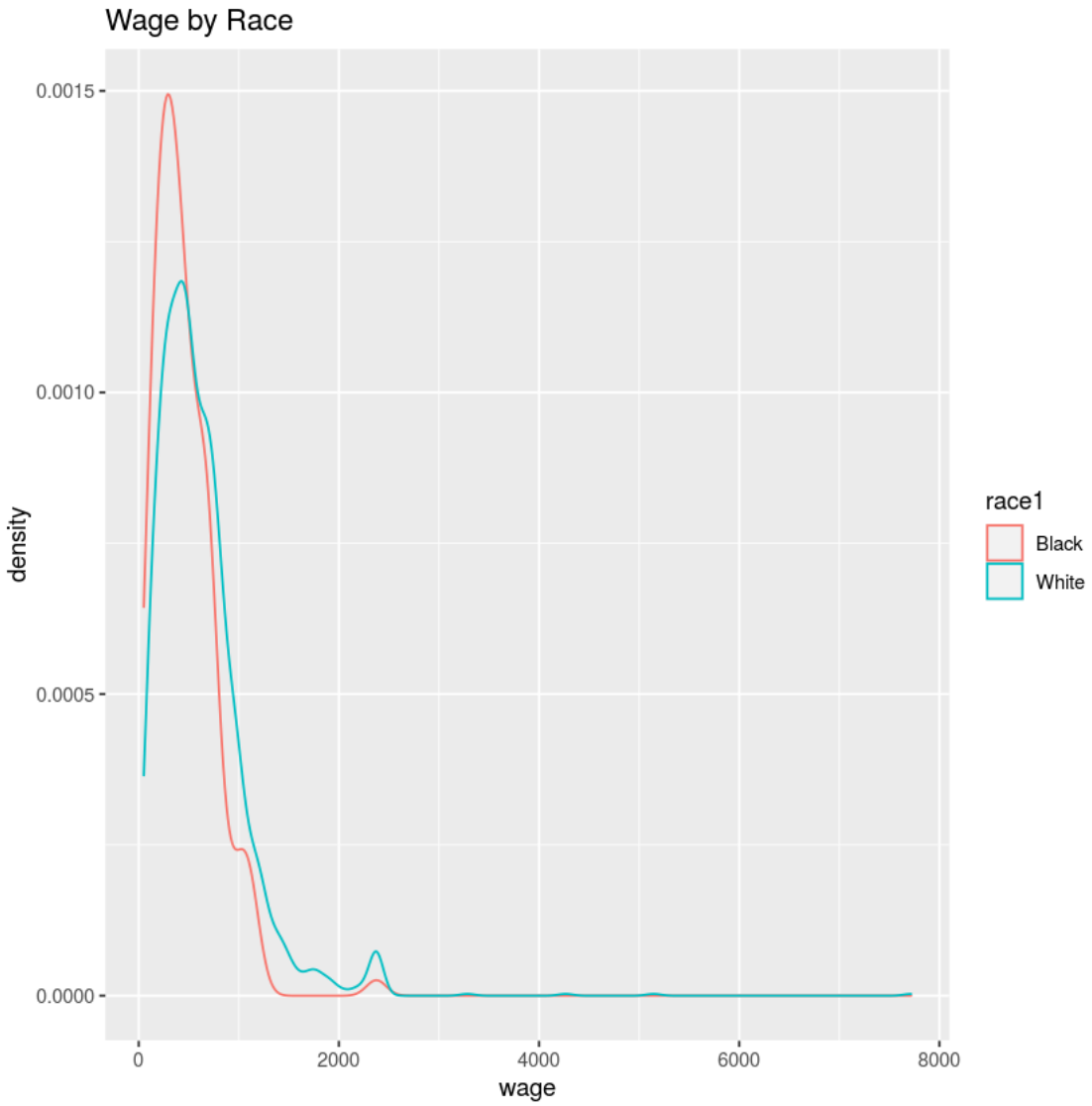
```
In [12]: head(uswages, 5)
```

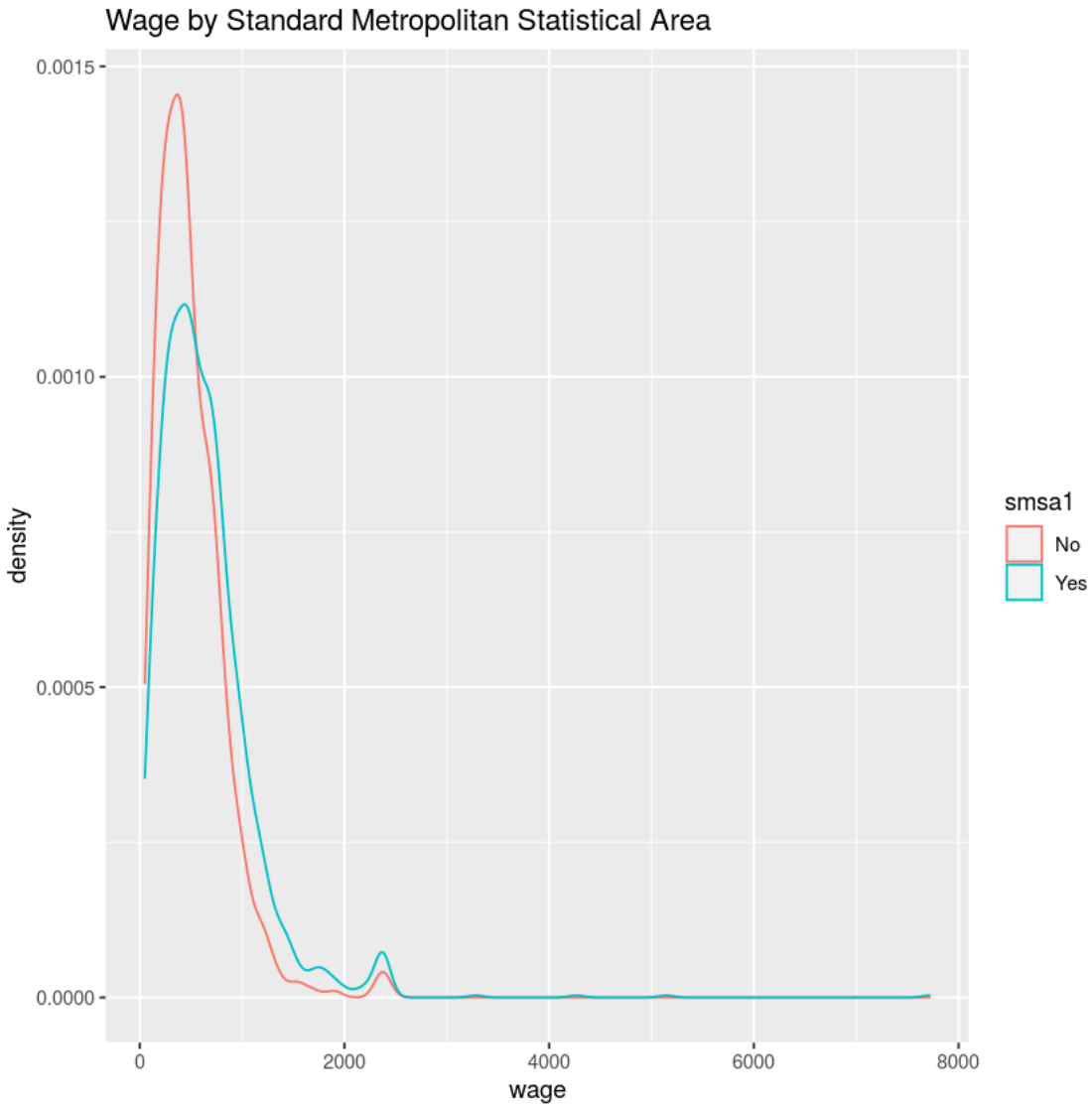
	wage	educ	exper	race	smsa	ne	mw	so	we	pt
	<dbl>	<int>	<int>	<int>	<int>	<int>	<int>	<int>	<int>	<int>
6085	771.60	18	18	0	1	1	0	0	0	0
A data.frame: 5 Œ 17 23701	617.28	15	20	0	1	0	0	0	1	0
16208	957.83	16	9	0	1	0	0	1	0	0
2720	617.28	12	24	0	1	1	0	0	0	0
9723	902.18	14	12	0	1	0	1	0	0	0

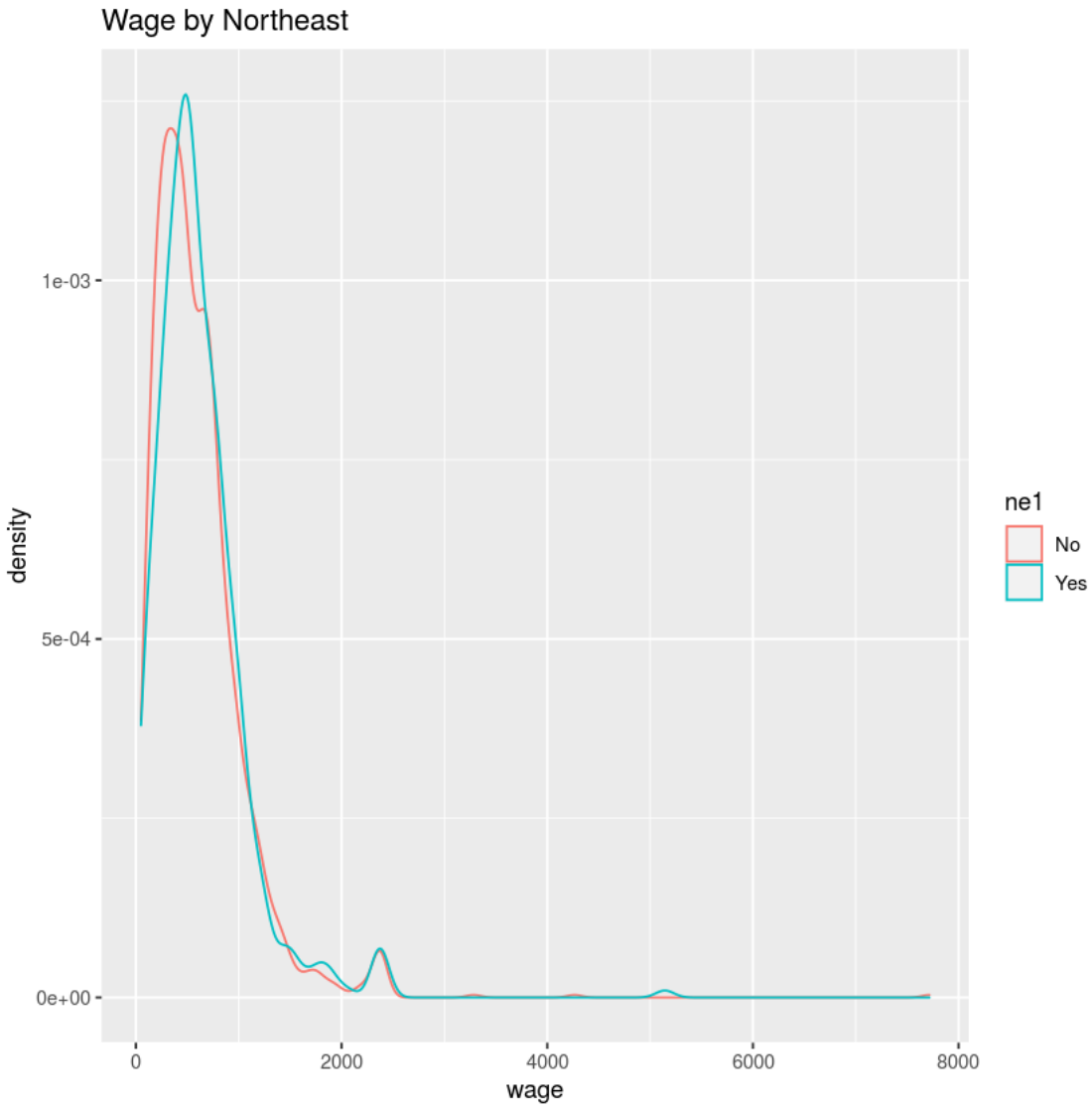
In [15]:
```
str(uswages)
```

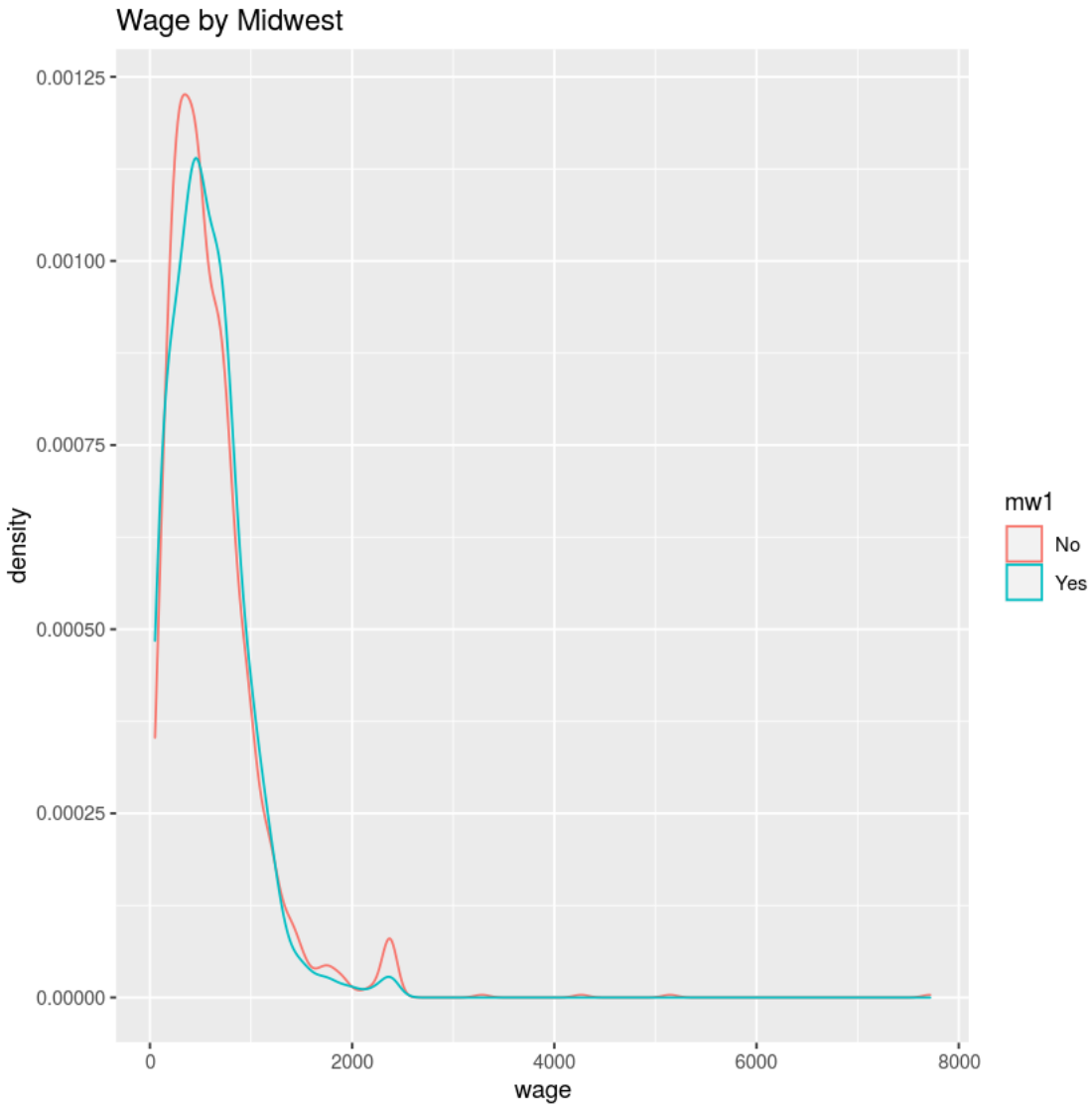
```
'data.frame':        2000 obs. of  17 variables:
 $ wage : num  772 617 958 617 902 ...
 $ educ : int  18 15 16 12 14 12 16 16 12 12 ...
 $ exper: int  18 20 9 24 12 33 42 0 36 37 ...
 $ race : int  0 0 0 0 0 0 0 0 0 0 ...
 $ smsa : int  1 1 1 1 1 1 1 1 1 0 ...
 $ ne   : int  1 0 0 1 0 0 0 0 0 0 ...
 $ mw   : int  0 0 0 0 1 0 0 1 0 1 ...
 $ so   : int  0 0 1 0 0 0 1 0 0 0 ...
 $ we   : int  0 1 0 0 0 1 0 0 1 0 ...
 $ pt   : int  0 0 0 0 0 0 1 1 1 0 ...
 $ race1: chr  "White" "White" "White" "White" ...
 $ smsa1: chr  "Yes" "Yes" "Yes" "Yes" ...
 $ ne1  : chr  "Yes" "No" "No" "Yes" ...
 $ mw1  : chr  "No" "No" "No" "No" ...
 $ we1  : chr  "No" "Yes" "No" "No" ...
 $ so1  : chr  "No" "No" "Yes" "No" ...
 $ pt1  : chr  "No" "No" "No" "No" ...
```

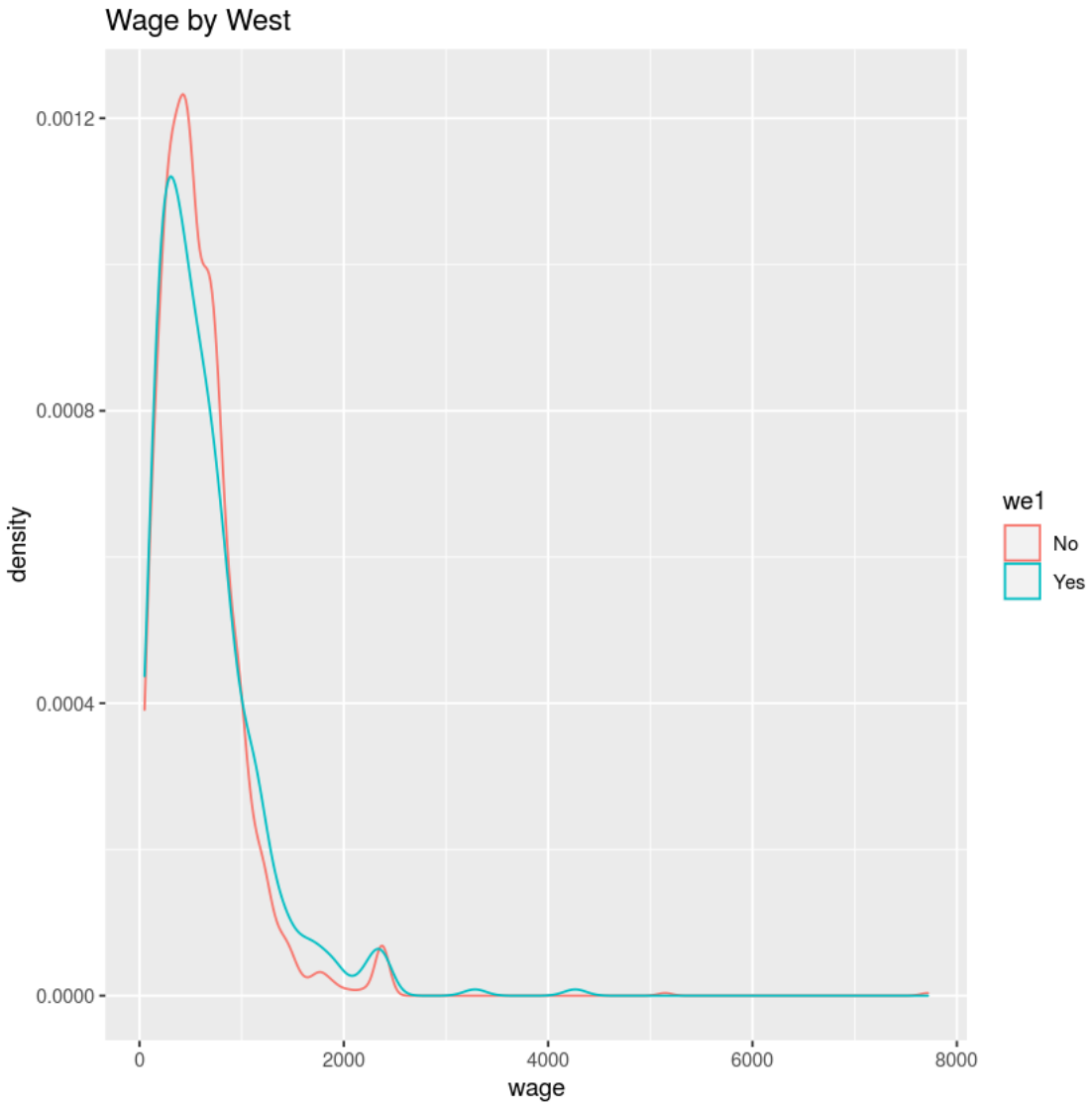
In [17]:
```
ggplot(uswages, aes(x=wage, color=race1)) + geom_density() + ggtitle("Wage by Race")
ggplot(uswages, aes(x=wage, color=smsa1)) + geom_density() + ggtitle("Wage by Standard
ggplot(uswages, aes(x=wage, color=ne1)) + geom_density() + ggtitle("Wage by Northeast")
ggplot(uswages, aes(x=wage, color=mw1)) + geom_density() + ggtitle("Wage by Midwest")
ggplot(uswages, aes(x=wage, color=we1)) + geom_density() + ggtitle("Wage by West")
ggplot(uswages, aes(x=wage, color=so1)) + geom_density() + ggtitle("Wage by South")
ggplot(uswages, aes(x=wage, color=pt1)) + geom_density() + ggtitle("Wage by Part time")
```

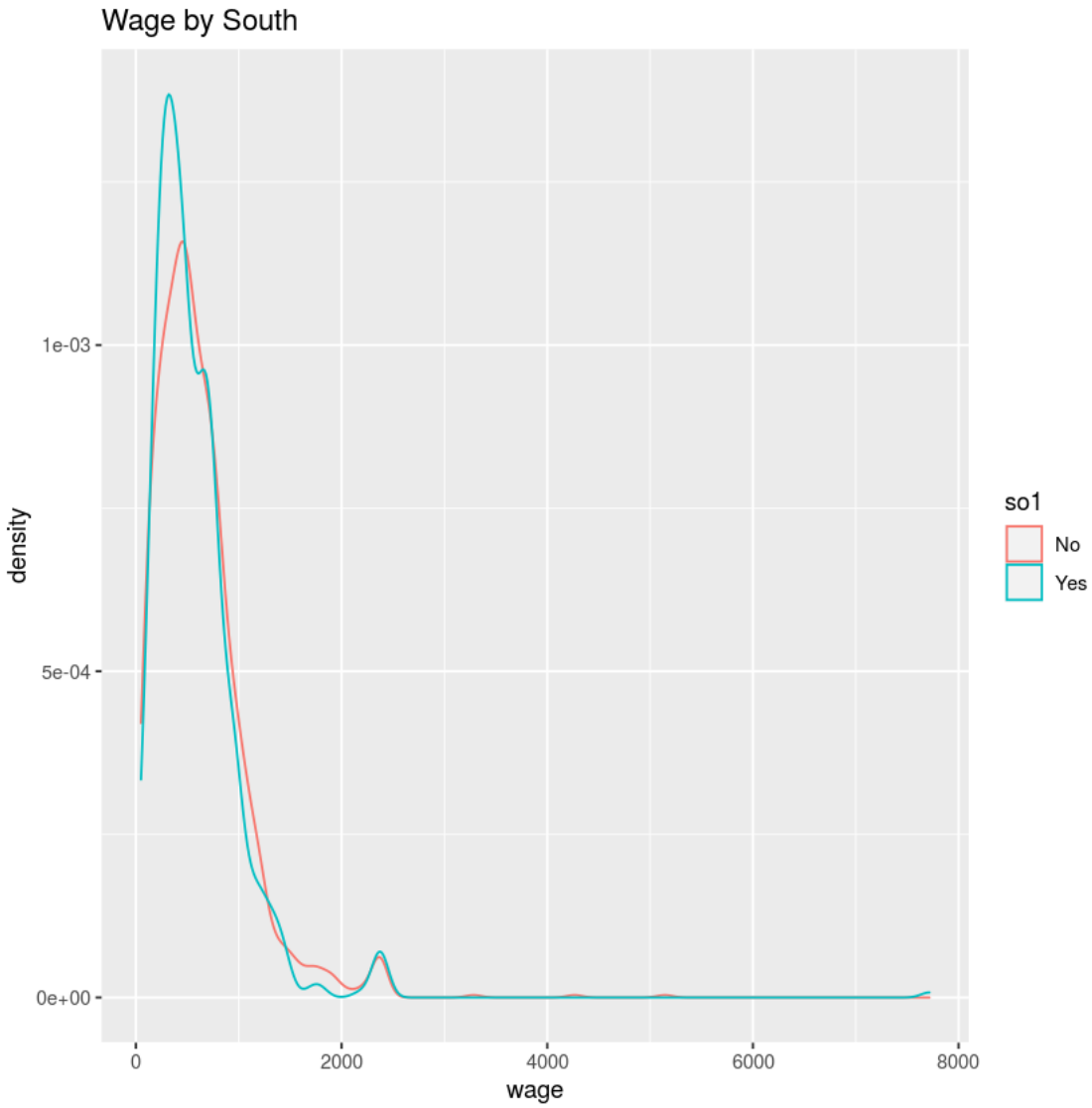

Wage by Race
0.0015
0.0010
0.0005
0.0000
density
0
2000
4000
6000
8000
wage
race1
Black
White

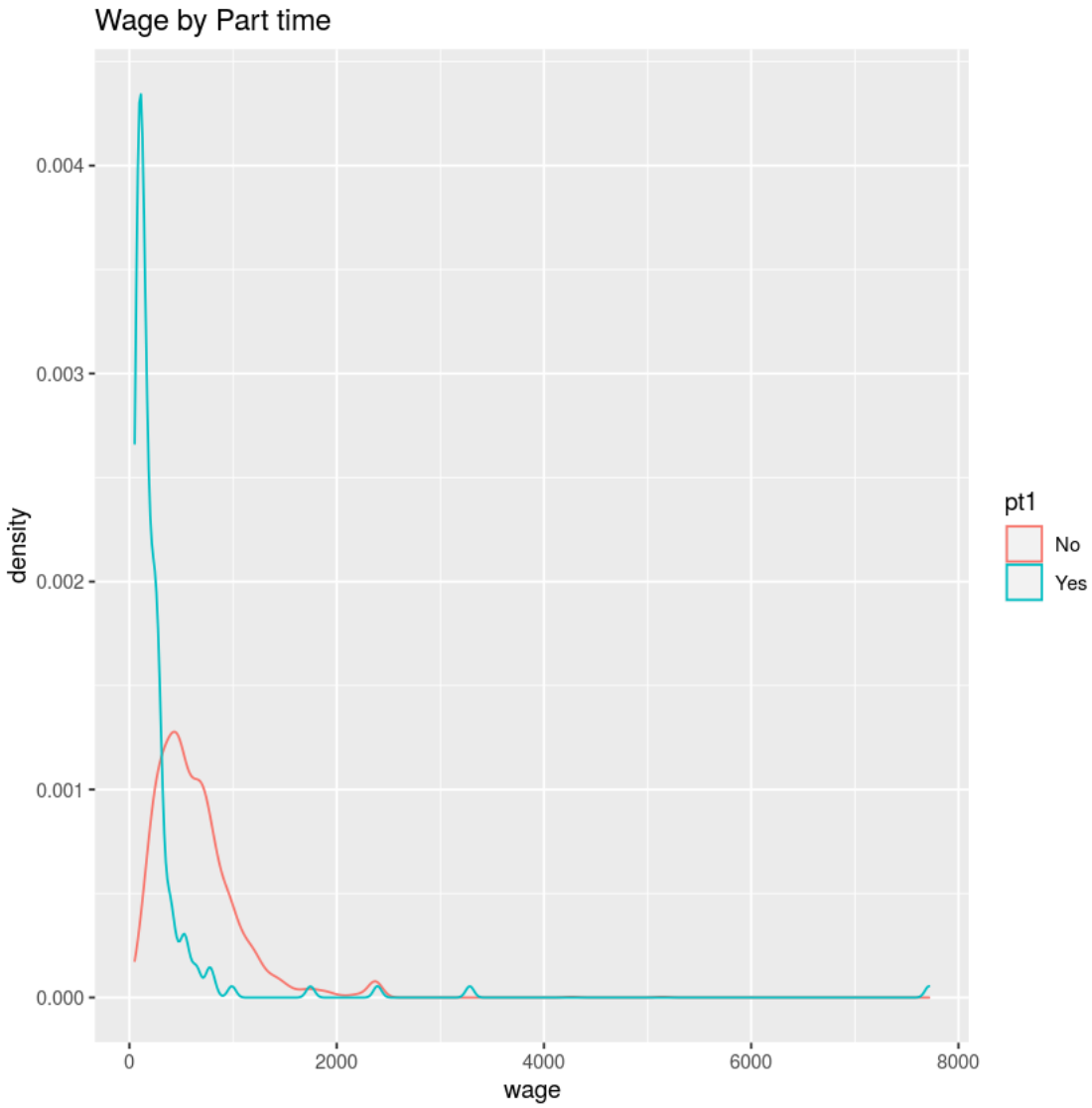

Wage by Standard Metropolitan Statistical Area
0.0015
0.0010
0.0005
0.0000
density
0
2000
4000
6000
8000
wage
smsa1
No
Yes


Wage by Northeast
density
1e-03
5e-04
0e+00
0
2000
4000
6000
8000
wage
ne1
No
Yes


Wage by Midwest
density
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
0
2000
4000
6000
8000
wage
mw1
No
Yes


Wage by West
0.0012
0.0008
0.0004
0.0000
density
0
2000
4000
6000
8000
wage
we1
No
Yes


Wage by South
density
1e-03
5e-04
0e+00
0
2000
4000
6000
8000
wage
so1
No
Yes




```
In [42]: install.packages("nortest")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [13]: library(nortest)
```

```
In [14]: pearson.test(uswages$wage)
```

```
Pearson chi-square normality test
```

```
data:  uswages$wage
P = 717.96, p-value < 2.2e-16
```

1.2.6 Using the Pearson Test for normality, the response variable wage is not normally distributed.

```
In [15]: mean(uswages$wage)+3*sd(uswages$wage)
```

1987.61575342129

```
In [16]: wage.outlier <- uswages[uswages$wage > 1987.61, ]
         show(wage.outlier)
```

	wage	educ	exper	race	smsa	ne	mw	so	we	pt	race1	smsa1	ne1	mw1	we1	so1
13462	2374.15	12	35	0	1	0	0	1	0	0	White	Yes	No	No	No	Yes
3303	2374.15	18	27	0	1	1	0	0	0	0	White	Yes	Yes	No	No	No
25909	4264.87	16	16	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No
19603	2374.15	12	5	1	0	0	0	1	0	0	Black	No	No	No	No	Yes
23716	2374.15	17	23	0	0	0	0	0	1	0	White	No	No	No	Yes	No
16041	2184.24	16	23	0	1	0	0	1	0	0	White	Yes	No	No	No	Yes
12283	2374.15	16	25	0	0	0	1	0	0	0	White	No	No	Yes	No	No
20946	2374.15	18	13	0	1	0	0	1	0	0	White	Yes	No	No	No	Yes
17014	2374.15	16	21	0	1	0	0	1	0	0	White	Yes	No	No	No	Yes
26993	2160.49	14	27	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No
27869	2374.15	16	20	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No
26088	2314.81	18	29	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No
4632	2374.15	18	8	0	1	1	0	0	0	0	White	Yes	Yes	No	No	No
10230	2018.04	16	35	0	1	0	1	0	0	0	White	Yes	No	Yes	No	No
20229	2374.15	12	23	0	1	0	0	1	0	0	White	Yes	No	No	No	Yes
27835	2374.15	18	33	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No
2780	5144.03	0	18	0	1	1	0	0	0	0	White	Yes	Yes	No	No	No
4867	2374.15	18	10	0	1	1	0	0	0	0	White	Yes	Yes	No	No	No
8367	2374.15	18	7	0	1	0	1	0	0	0	White	Yes	No	Yes	No	No
17940	2362.44	16	17	0	1	0	0	1	0	0	White	Yes	No	No	No	Yes
23883	2374.15	16	13	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No
9110	2207.98	16	15	0	1	0	1	0	0	0	White	Yes	No	Yes	No	No
25168	2374.15	18	19	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No
25276	3283.95	10	10	0	1	0	0	0	1	1	White	Yes	No	No	Yes	No
6253	2374.15	18	17	0	1	1	0	0	0	0	White	Yes	Yes	No	No	No
15387	7716.05	3	59	0	1	0	0	1	0	1	White	Yes	No	No	No	Yes
20945	2374.15	18	12	0	1	0	0	1	0	0	White	Yes	No	No	No	Yes
24807	2207.98	17	25	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No
7596	2374.15	18	30	0	0	0	1	0	0	0	White	No	No	Yes	No	No
1159	2057.61	16	27	0	1	1	0	0	0	0	White	Yes	Yes	No	No	No
4450	2374.15	18	19	0	1	1	0	0	0	0	White	Yes	Yes	No	No	No
969	2374.15	18	16	0	1	1	0	0	0	0	White	Yes	Yes	No	No	No
27883	2292.77	13	-1	0	1	0	0	0	1	0	White	Yes	No	No	Yes	No

```
15053 2374.15   16    22    0    1  0  0  1  0  0 White   Yes  No  No  No Yes
17882 2393.55    7    19    0    1  0  0  1  0  1 White   Yes  No  No  No Yes
4875  2374.15   12    26    0    1  1  0  0  0  0 White   Yes Yes  No  No  No
      pt1
13462  No
3303   No
25909  No
19603  No
23716  No
16041  No
12283  No
20946  No
17014  No
26993  No
27869  No
26088  No
4632   No
10230  No
20229  No
27835  No
2780   No
4867   No
8367   No
17940  No
23883  No
9110   No
25168  No
25276 Yes
6253   No
15387 Yes
20945  No
24807  No
7596   No
1159   No
4450   No
969    No
27883  No
15053  No
17882 Yes
4875   No
```

```
In [17]: str(uswages)
```

```
'data.frame':        2000 obs. of  17 variables:
 $ wage : num  772 617 958 617 902 ...
 $ educ : int  18 15 16 12 14 12 16 16 12 12 ...
 $ exper: int  18 20 9 24 12 33 42 0 36 37 ...
```

```
 $ race : int  0 0 0 0 0 0 0 0 0 0 ...
 $ smsa : int  1 1 1 1 1 1 1 1 1 0 ...
 $ ne   : int  1 0 0 1 0 0 0 0 0 0 ...
 $ mw   : int  0 0 0 0 1 0 0 1 0 1 ...
 $ so   : int  0 0 1 0 0 0 1 0 0 0 ...
 $ we   : int  0 1 0 0 0 1 0 0 1 0 ...
 $ pt   : int  0 0 0 0 0 0 1 1 1 0 ...
 $ race1: chr  "White" "White" "White" "White" ...
 $ smsa1: chr  "Yes" "Yes" "Yes" "Yes" ...
 $ ne1  : chr  "Yes" "No" "No" "Yes" ...
 $ mw1  : chr  "No" "No" "No" "No" ...
 $ we1  : chr  "No" "Yes" "No" "No" ...
 $ so1  : chr  "No" "No" "Yes" "No" ...
 $ pt1  : chr  "No" "No" "No" "No" ...
```

```
In [18]: uswages.omit <- na.omit(uswages)
         str(uswages.omit)
```

```
'data.frame':        2000 obs. of  17 variables:
 $ wage : num  772 617 958 617 902 ...
 $ educ : int  18 15 16 12 14 12 16 16 12 12 ...
 $ exper: int  18 20 9 24 12 33 42 0 36 37 ...
 $ race : int  0 0 0 0 0 0 0 0 0 0 ...
 $ smsa : int  1 1 1 1 1 1 1 1 1 0 ...
 $ ne   : int  1 0 0 1 0 0 0 0 0 0 ...
 $ mw   : int  0 0 0 0 1 0 0 1 0 1 ...
 $ so   : int  0 0 1 0 0 0 1 0 0 0 ...
 $ we   : int  0 1 0 0 0 1 0 0 1 0 ...
 $ pt   : int  0 0 0 0 0 0 1 1 1 0 ...
 $ race1: chr  "White" "White" "White" "White" ...
 $ smsa1: chr  "Yes" "Yes" "Yes" "Yes" ...
 $ ne1  : chr  "Yes" "No" "No" "Yes" ...
 $ mw1  : chr  "No" "No" "No" "No" ...
 $ we1  : chr  "No" "Yes" "No" "No" ...
 $ so1  : chr  "No" "No" "Yes" "No" ...
 $ pt1  : chr  "No" "No" "No" "No" ...
```

1.2.7 There are no missing values

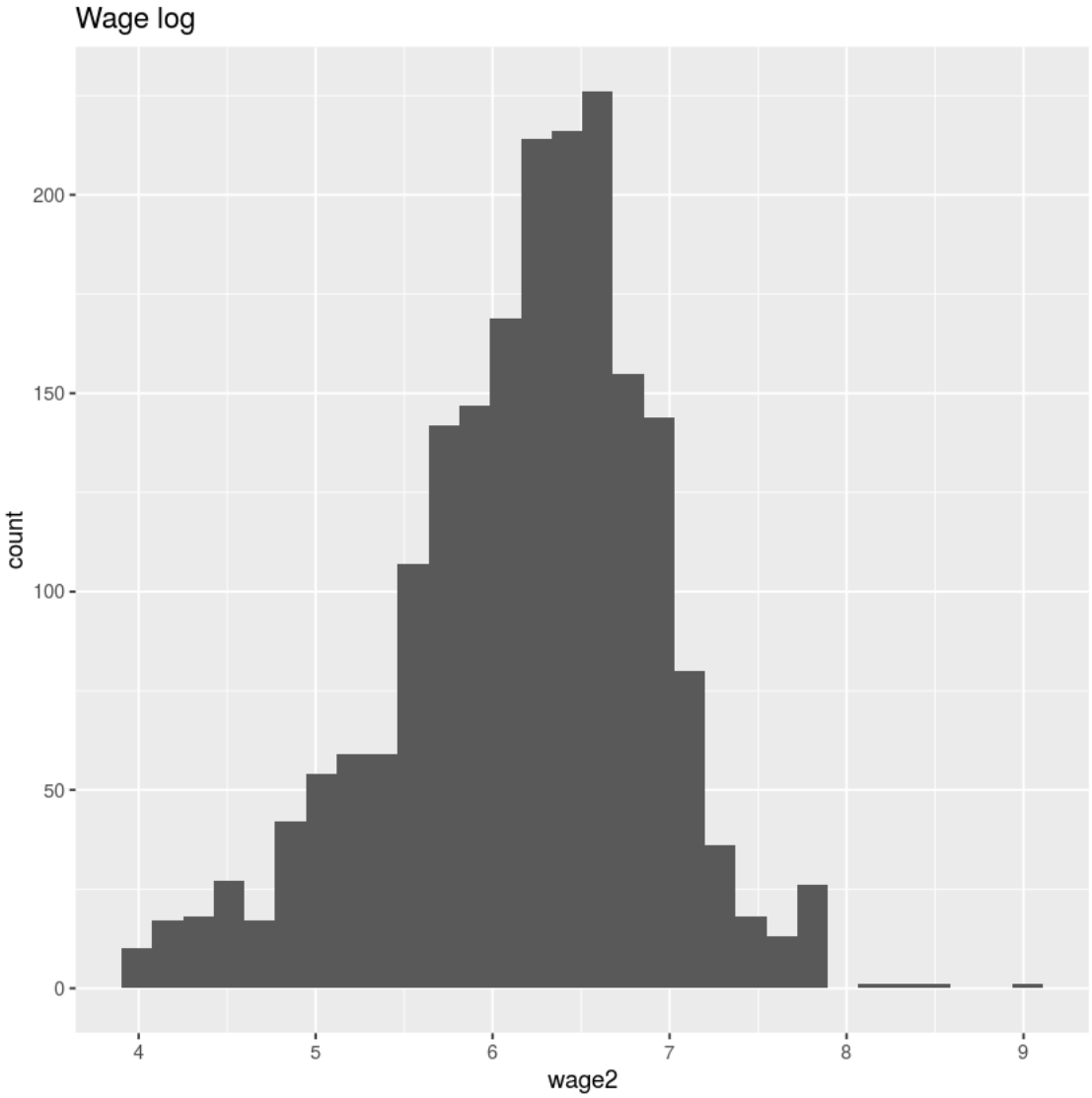
1.3 Week 2

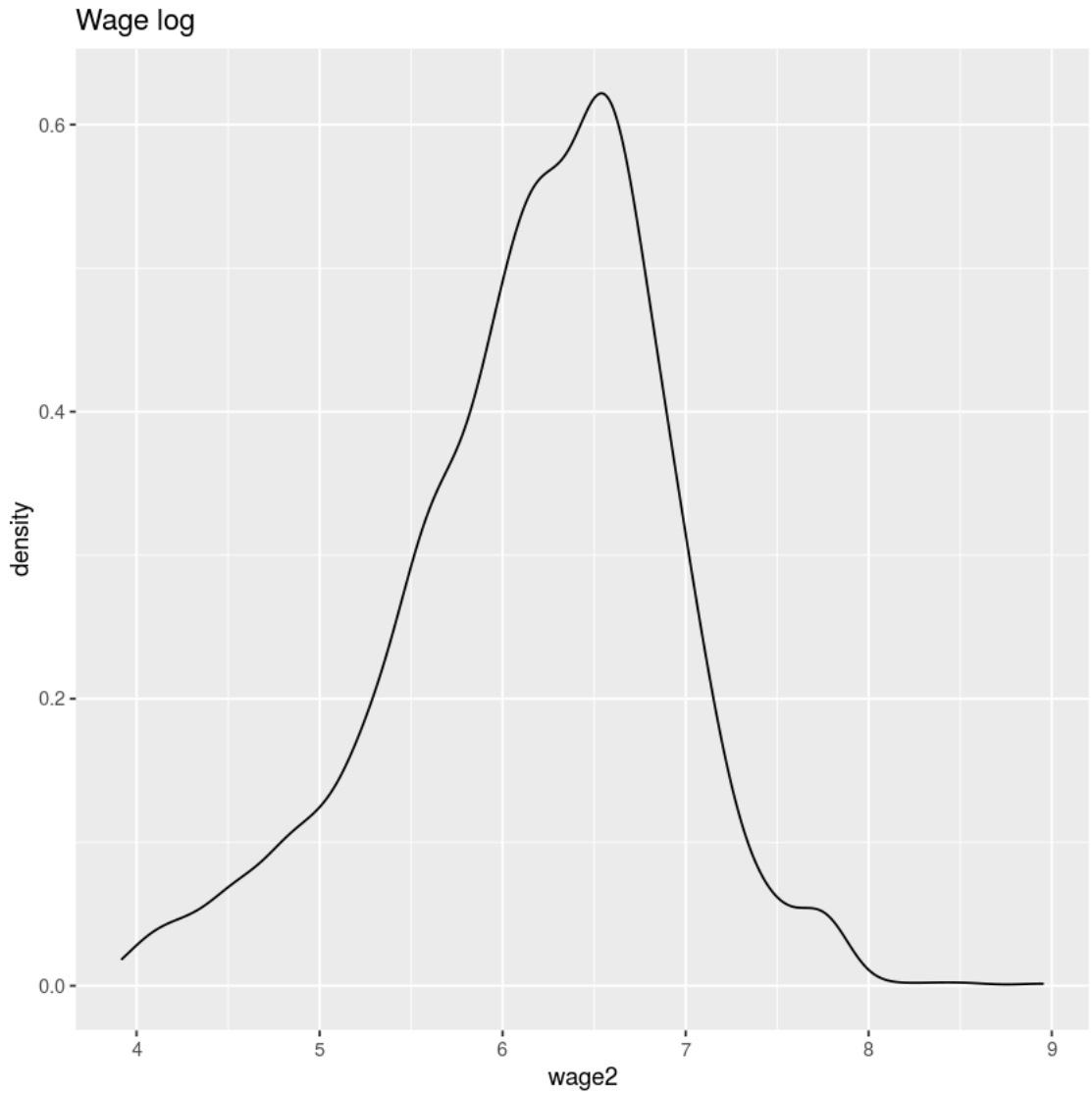
```
In [324]: wage2 <- log(uswages$wage)
          head(wage2)
```

1. 6.64846628103157 2. 6.42532272971736 3. 6.86467030919707 4. 6.42532272971736 5. 6.80481405669489 6. 5.70094511983604

```
In [325]: ggplot(uswages, aes(x=wage2)) + geom_histogram(alpha=2) + ggtitle("Wage log")
          ggplot(uswages, aes(x=wage2)) + geom_density() + ggtitle("Wage log")
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```






```
In [326]: pearson.test(wage2)
```

```
Pearson chi-square normality test

data:  wage2
P = 316.26, p-value < 2.2e-16
```

1.3.1 Using the Pearson Test for normality, the square root of wage is not normally distributed.

```
In [327]: mean(wage2)+3*sd(wage2)
```

8.35324576287491

```
In [328]: wage2.outlier <- uswages[wage2 > 8.35, ]
          show(wage2.outlier)
```

```
         wage educ exper race smsa ne mw so we pt race1 smsa1 ne1 mw1 we1 so1
25909 4264.87   16    16    0    1  0  0  0  1  0 White   Yes  No  No Yes  No
2780  5144.03    0    18    0    1  1  0  0  0  0 White   Yes Yes  No  No  No
15387 7716.05    3    59    0    1  0  0  1  0  1 White   Yes  No  No  No Yes
      pt1         RN        RN10
25909  No -0.3962542  19.3387212
2780   No -0.2779153   0.8292802
15387 Yes  0.2432041 -12.1133400
```

1.3.2 Taking the log of the response variable wage reduced the number of outliers from 36 to 3.

```
In [30]: install.packages("caret")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [349]: library(caret)
```

```
In [329]: set.seed(602)
          uswages.train <- createDataPartition(uswages$wage, p=3/4, list = FALSE)
          head(uswages.train, 10)
          tail(uswages.train, 10)
```

A matrix: 10 Œ 1 of type int

Resample1
2
3
4
5
6
7
8
9
10
11

	Resample1
[1493,]	1986
[1494,]	1987
[1495,]	1988
[1496,]	1991
A matrix: 10 Œ 1 of type int [1497,]	1992
[1498,]	1993
[1499,]	1995
[1500,]	1996
[1501,]	1997
[1502,]	1999

In [330]:
```
trainingset <- uswages[uswages.train,]
testingset <- uswages[-uswages.train, ]
str(trainingset)
str(testingset)
head(trainingset)
head(testingset)
```

```
'data.frame':        1502 obs. of  19 variables:
 $ wage : num  617 958 617 902 299 ...
 $ educ : int  15 16 12 14 12 16 16 12 12 9 ...
 $ exper: int  20 9 24 12 33 42 0 36 37 20 ...
 $ race : int  0 0 0 0 0 0 0 0 0 1 ...
 $ smsa : int  1 1 1 1 1 1 1 1 0 1 ...
 $ ne   : int  0 0 1 0 0 0 0 0 0 0 ...
 $ mw   : int  0 0 0 1 0 0 1 0 1 0 ...
 $ so   : int  0 1 0 0 0 1 0 0 0 1 ...
 $ we   : int  1 0 0 0 1 0 0 1 0 0 ...
 $ pt   : int  0 0 0 0 0 1 1 1 0 1 ...
 $ race1: chr  "White" "White" "White" "White" ...
 $ smsa1: chr  "Yes" "Yes" "Yes" "Yes" ...
 $ ne1  : chr  "No" "No" "Yes" "No" ...
 $ mw1  : chr  "No" "No" "No" "Yes" ...
 $ we1  : chr  "Yes" "No" "No" "No" ...
 $ so1  : chr  "No" "Yes" "No" "No" ...
 $ pt1  : chr  "No" "No" "No" "No" ...
 $ RN   : num  1.577 -0.957 -0.92 -1.998 -0.272 ...
 $ RN10 : num  11.97 5.8 15.47 13.76 -6.51 ...
'data.frame':        498 obs. of  19 variables:
 $ wage : num  772 551 807 309 617 ...
 $ educ : int  18 17 14 16 16 12 12 12 12 12 ...
 $ exper: int  18 16 21 0 -1 35 11 0 44 34 ...
 $ race : int  0 0 0 0 0 0 0 0 0 0 ...
 $ smsa : int  1 0 1 1 1 1 1 1 1 1 ...
 $ ne   : int  1 1 0 0 0 0 0 1 0 1 ...
 $ mw   : int  0 0 0 0 0 0 1 0 0 0 ...
 $ so   : int  0 0 0 1 1 1 0 0 0 0 ...
```

```
 $ we   : int  0 0 1 0 0 0 0 0 1 0 ...
 $ pt   : int  0 0 1 0 0 0 0 0 0 0 ...
 $ race1: chr  "White" "White" "White" "White" ...
 $ smsa1: chr  "Yes" "No" "Yes" "Yes" ...
 $ ne1  : chr  "Yes" "Yes" "No" "No" ...
 $ mw1  : chr  "No" "No" "No" "No" ...
 $ we1  : chr  "No" "No" "Yes" "No" ...
 $ so1  : chr  "No" "No" "No" "Yes" ...
 $ pt1  : chr  "No" "No" "Yes" "No" ...
 $ RN   : num  -1.481 -0.78 0.012 -0.293 2.007 ...
 $ RN10 : num  9.776 -4.659 -15.938 -0.569 8.668 ...
```

A data.frame: 6 Œ 19

	wage <dbl>	educ <int>	exper <int>	race <int>	smsa <int>	ne <int>	mw <int>	so <int>	we <int>	pt <int>
23701	617.28	15	20	0	1	0	0	0	1	0
16208	957.83	16	9	0	1	0	0	1	0	0
2720	617.28	12	24	0	1	1	0	0	0	0
9723	902.18	14	12	0	1	0	1	0	0	0
22239	299.15	12	33	0	1	0	0	0	1	0
14379	541.31	16	42	0	1	0	0	1	0	1

A data.frame: 6 Œ 19

	wage <dbl>	educ <int>	exper <int>	race <int>	smsa <int>	ne <int>	mw <int>	so <int>	we <int>	pt <int>
6085	771.60	18	18	0	1	1	0	0	0	0
6076	550.81	17	16	0	0	1	0	0	0	0
24050	807.22	14	21	0	1	0	0	0	1	1
21572	308.64	16	0	0	1	0	0	1	0	0
15065	617.28	16	-1	0	1	0	0	1	0	0
13462	2374.15	12	35	0	1	0	0	1	0	0

In [331]:
```
repeatedsplits <- createDataPartition(trainingset$wage,p=.8, times = 10)
str(repeatedsplits)
```

```
List of 10
 $ Resample01: int [1:1203] 4 5 7 8 9 11 12 13 14 15 ...
 $ Resample02: int [1:1203] 1 2 3 4 5 6 7 8 9 11 ...
 $ Resample03: int [1:1203] 1 3 4 5 6 7 8 9 10 12 ...
 $ Resample04: int [1:1203] 1 2 3 4 6 7 8 10 12 13 ...
 $ Resample05: int [1:1203] 2 3 5 6 7 8 9 10 11 12 ...
 $ Resample06: int [1:1203] 1 2 3 6 7 8 9 10 11 12 ...
 $ Resample07: int [1:1203] 1 2 3 4 7 8 9 10 11 12 ...
 $ Resample08: int [1:1203] 1 5 6 7 8 11 14 15 16 17 ...
 $ Resample09: int [1:1203] 1 2 3 4 5 7 8 9 10 12 ...
 $ Resample10: int [1:1203] 1 2 4 5 6 7 8 9 10 11 ...
```

In [332]:
```
repeatedsplits1 <- createFolds(trainingset$wage, k=10, returnTrain=TRUE)
str(repeatedsplits1)
```

```
List of 10
 $ Fold01: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
 $ Fold02: int [1:1352] 1 2 4 5 6 7 9 10 12 13 ...
 $ Fold03: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
 $ Fold04: int [1:1351] 1 2 3 4 5 6 7 8 9 10 ...
 $ Fold05: int [1:1351] 2 3 4 5 6 7 8 9 10 11 ...
 $ Fold06: int [1:1351] 1 2 3 5 6 7 8 9 10 11 ...
 $ Fold07: int [1:1353] 1 2 3 4 5 7 8 9 11 12 ...
 $ Fold08: int [1:1351] 1 3 4 5 6 8 10 11 12 13 ...
 $ Fold09: int [1:1353] 1 2 3 4 6 7 8 9 10 11 ...
 $ Fold10: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
```

In [333]:
```
controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
set.seed(444)
modtrainlm <- train(wage ~ ., data=trainingset, method="lm", trControl = controlobject
str(modtrainlm)
```

```
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
```

```
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
```

```
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
Warning message in predict.lm(modelFit, newdata):
prediction from a rank-deficient fit may be misleading
```

```
List of 24
 $ method      : chr "lm"
 $ modelInfo   :List of 13
  ..$ label     : chr "Linear Regression"
  ..$ library   : NULL
  ..$ loop      : NULL
  ..$ type      : chr "Regression"
  ..$ parameters:'data.frame':        1 obs. of  3 variables:
  .. ..$ parameter: chr "intercept"
  .. ..$ class    : chr "logical"
  .. ..$ label    : chr "intercept"
  ..$ grid      :function (x, y, len = NULL, search = "grid")
  .. ..- attr(*, "srcref")= 'srcref' int [1:8] 8 26 9 48 26 48 8 9
  .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x12962690>
  ..$ fit       :function (x, y, wts, param, lev, last, classProbs, ...)
  .. ..- attr(*, "srcref")= 'srcref' int [1:8] 10 25 27 19 25 19 10 27
  .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x12962690>
  ..$ predict   :function (modelFit, newdata, submodels = NULL)
  .. ..- attr(*, "srcref")= 'srcref' int [1:8] 28 29 31 19 29 19 28 31
  .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x12962690>
  ..$ prob      : NULL
  ..$ predictors:function (x, ...)
  .. ..- attr(*, "srcref")= 'srcref' int [1:8] 33 32 33 67 32 67 33 33
  .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x12962690>
```

```
 ..$ tags      : chr [1:2] "Linear Regression" "Accepts Case Weights"
 ..$ varImp    :function (object, ...)
 .. ..- attr(*, "srcref")= 'srcref' int [1:8] 35 28 43 19 28 19 35 43
 .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x12962690>
 ..$ sort      :function (x)
 .. ..- attr(*, "srcref")= 'srcref' int [1:8] 44 26 44 38 26 38 44 44
 .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x12962690>
$ modelType   : chr "Regression"
$ results     :'data.frame':        1 obs. of  7 variables:
 ..$ intercept : logi TRUE
 ..$ RMSE      : num 403
 ..$ Rsquared  : num 0.24
 ..$ MAE       : num 248
 ..$ RMSESD    : num 130
 ..$ RsquaredSD: num 0.115
 ..$ MAESD     : num 24.7
$ pred        : NULL
$ bestTune    :'data.frame':        1 obs. of  1 variable:
 ..$ intercept: logi TRUE
$ call        : language train.formula(form = wage ~ ., data = trainingset, method = "lm", trCo
$ dots        : list()
$ metric      : chr "RMSE"
$ control     :List of 28
 ..$ method           : chr "repeatedcv"
 ..$ number           : num 10
 ..$ repeats          : num 5
 ..$ search           : chr "grid"
 ..$ p                : num 0.75
 ..$ initialWindow    : NULL
 ..$ horizon          : num 1
 ..$ fixedWindow      : logi TRUE
 ..$ skip             : num 0
 ..$ verboseIter      : logi FALSE
 ..$ returnData       : logi TRUE
 ..$ returnResamp     : chr "final"
 ..$ savePredictions  : chr "none"
 ..$ classProbs       : logi FALSE
 ..$ summaryFunction  :function (data, lev = NULL, model = NULL)
 ..$ selectionFunction: chr "best"
 ..$ preProcOptions   :List of 6
 .. ..$ thresh   : num 0.95
 .. ..$ ICAcomp  : num 3
 .. ..$ k        : num 5
 .. ..$ freqCut  : num 19
 .. ..$ uniqueCut: num 10
 .. ..$ cutoff   : num 0.9
 ..$ sampling         : NULL
 ..$ index            :List of 50
```

```
.. ..$ Fold01.Rep1: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold02.Rep1: int [1:1351] 2 4 5 6 7 8 9 10 11 12 ...
.. ..$ Fold03.Rep1: int [1:1351] 1 2 3 4 6 7 8 10 11 12 ...
.. ..$ Fold04.Rep1: int [1:1353] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold05.Rep1: int [1:1351] 1 2 3 5 7 9 10 11 12 13 ...
.. ..$ Fold06.Rep1: int [1:1351] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold07.Rep1: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold08.Rep1: int [1:1352] 1 2 3 4 5 6 7 8 9 11 ...
.. ..$ Fold09.Rep1: int [1:1352] 1 3 4 5 6 8 9 10 11 12 ...
.. ..$ Fold10.Rep1: int [1:1353] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold01.Rep2: int [1:1352] 1 2 3 4 5 7 8 9 10 11 ...
.. ..$ Fold02.Rep2: int [1:1352] 1 3 4 5 6 7 8 9 10 11 ...
.. ..$ Fold03.Rep2: int [1:1353] 1 2 3 4 5 6 8 9 10 13 ...
.. ..$ Fold04.Rep2: int [1:1351] 2 3 4 5 6 7 8 9 10 11 ...
.. ..$ Fold05.Rep2: int [1:1352] 1 2 3 4 6 7 8 9 10 11 ...
.. ..$ Fold06.Rep2: int [1:1352] 1 2 3 5 6 7 8 11 12 13 ...
.. ..$ Fold07.Rep2: int [1:1351] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold08.Rep2: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold09.Rep2: int [1:1351] 1 2 3 4 5 6 7 9 10 11 ...
.. ..$ Fold10.Rep2: int [1:1352] 1 2 4 5 6 7 8 9 10 11 ...
.. ..$ Fold01.Rep3: int [1:1351] 1 2 3 4 6 7 8 9 11 12 ...
.. ..$ Fold02.Rep3: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold03.Rep3: int [1:1351] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold04.Rep3: int [1:1351] 1 2 4 5 6 7 8 9 10 11 ...
.. ..$ Fold05.Rep3: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold06.Rep3: int [1:1353] 1 2 3 4 5 7 10 11 12 13 ...
.. ..$ Fold07.Rep3: int [1:1354] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold08.Rep3: int [1:1351] 1 2 3 5 6 7 8 9 10 11 ...
.. ..$ Fold09.Rep3: int [1:1351] 3 4 5 6 7 8 9 10 11 12 ...
.. ..$ Fold10.Rep3: int [1:1352] 1 2 3 4 5 6 8 9 10 11 ...
.. ..$ Fold01.Rep4: int [1:1353] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold02.Rep4: int [1:1351] 1 2 3 4 5 6 7 8 9 11 ...
.. ..$ Fold03.Rep4: int [1:1351] 1 2 3 4 5 7 8 9 10 11 ...
.. ..$ Fold04.Rep4: int [1:1352] 1 3 5 6 7 8 9 10 11 12 ...
.. ..$ Fold05.Rep4: int [1:1351] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold06.Rep4: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold07.Rep4: int [1:1352] 1 2 3 4 5 6 7 10 11 13 ...
.. ..$ Fold08.Rep4: int [1:1353] 2 3 4 5 6 7 8 9 10 11 ...
.. ..$ Fold09.Rep4: int [1:1352] 1 2 4 6 8 9 10 12 13 14 ...
.. ..$ Fold10.Rep4: int [1:1351] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold01.Rep5: int [1:1351] 1 2 3 4 5 6 7 8 10 11 ...
.. ..$ Fold02.Rep5: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold03.Rep5: int [1:1351] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold04.Rep5: int [1:1352] 1 2 3 4 5 6 8 9 10 11 ...
.. ..$ Fold05.Rep5: int [1:1352] 1 2 3 4 5 6 7 8 9 10 ...
.. ..$ Fold06.Rep5: int [1:1352] 1 3 4 6 7 9 10 11 12 13 ...
.. ..$ Fold07.Rep5: int [1:1352] 2 4 5 6 7 8 9 10 11 12 ...
.. ..$ Fold08.Rep5: int [1:1351] 1 2 3 4 5 6 7 8 9 10 ...
```

```
.. ..$ Fold09.Rep5: int [1:1352] 1 2 3 5 7 8 9 11 12 13 ...
.. ..$ Fold10.Rep5: int [1:1353] 1 2 3 4 5 6 7 8 9 10 ...
..$ indexOut         :List of 50
.. ..$ Resample01: int [1:150] 15 19 22 26 32 48 52 57 61 62 ...
.. ..$ Resample02: int [1:151] 1 3 33 50 55 68 69 80 85 99 ...
.. ..$ Resample03: int [1:151] 5 9 40 42 71 79 81 94 104 107 ...
.. ..$ Resample04: int [1:149] 23 29 30 65 72 75 76 89 93 96 ...
.. ..$ Resample05: int [1:151] 4 6 8 14 47 58 66 70 84 87 ...
.. ..$ Resample06: int [1:151] 11 17 31 46 54 59 60 92 95 97 ...
.. ..$ Resample07: int [1:150] 13 18 20 27 36 37 39 45 64 74 ...
.. ..$ Resample08: int [1:150] 10 12 25 34 53 63 67 83 115 132 ...
.. ..$ Resample09: int [1:150] 2 7 24 28 43 51 56 77 88 102 ...
.. ..$ Resample10: int [1:149] 16 21 35 38 41 44 49 73 86 90 ...
.. ..$ Resample11: int [1:150] 6 15 16 21 28 29 33 49 66 67 ...
.. ..$ Resample12: int [1:150] 2 32 40 45 86 88 95 112 114 125 ...
.. ..$ Resample13: int [1:149] 7 11 12 18 31 50 60 64 79 104 ...
.. ..$ Resample14: int [1:151] 1 42 48 57 81 82 93 169 177 179 ...
.. ..$ Resample15: int [1:150] 5 23 24 34 37 43 46 51 55 58 ...
.. ..$ Resample16: int [1:150] 4 9 10 17 22 30 36 56 68 70 ...
.. ..$ Resample17: int [1:151] 13 14 44 65 74 87 98 101 107 119 ...
.. ..$ Resample18: int [1:150] 19 26 39 54 62 72 77 100 108 115 ...
.. ..$ Resample19: int [1:151] 8 25 47 52 59 73 75 80 85 94 ...
.. ..$ Resample20: int [1:150] 3 20 27 35 38 41 53 63 84 103 ...
.. ..$ Resample21: int [1:151] 5 10 15 24 47 60 61 68 72 97 ...
.. ..$ Resample22: int [1:150] 19 32 33 38 56 57 62 66 71 76 ...
.. ..$ Resample23: int [1:151] 14 18 29 41 45 46 51 58 64 69 ...
.. ..$ Resample24: int [1:151] 3 37 40 49 78 89 98 117 133 139 ...
.. ..$ Resample25: int [1:150] 12 13 28 30 35 70 73 81 102 109 ...
.. ..$ Resample26: int [1:149] 6 8 9 16 31 54 55 65 67 92 ...
.. ..$ Resample27: int [1:148] 11 22 26 42 43 75 77 84 87 93 ...
.. ..$ Resample28: int [1:151] 4 23 48 50 53 63 86 90 108 116 ...
.. ..$ Resample29: int [1:151] 1 2 17 21 27 34 36 44 52 59 ...
.. ..$ Resample30: int [1:150] 7 20 25 39 74 114 121 123 134 143 ...
.. ..$ Resample31: int [1:149] 15 20 26 37 67 72 93 100 105 115 ...
.. ..$ Resample32: int [1:151] 10 13 21 22 24 42 48 55 62 71 ...
.. ..$ Resample33: int [1:151] 6 16 17 27 28 30 32 41 43 61 ...
.. ..$ Resample34: int [1:150] 2 4 14 25 29 34 45 46 52 70 ...
.. ..$ Resample35: int [1:151] 54 64 65 80 99 104 108 135 136 161 ...
.. ..$ Resample36: int [1:150] 39 50 51 58 69 81 85 107 113 121 ...
.. ..$ Resample37: int [1:150] 8 9 12 19 23 31 35 44 59 68 ...
.. ..$ Resample38: int [1:149] 1 33 73 86 88 89 97 102 114 124 ...
.. ..$ Resample39: int [1:150] 3 5 7 11 36 38 40 49 56 63 ...
.. ..$ Resample40: int [1:151] 18 47 53 57 60 66 78 82 91 95 ...
.. ..$ Resample41: int [1:151] 9 22 32 77 79 108 109 121 148 150 ...
.. ..$ Resample42: int [1:150] 15 35 40 48 51 63 76 78 83 92 ...
.. ..$ Resample43: int [1:151] 11 16 20 27 30 33 49 56 74 89 ...
.. ..$ Resample44: int [1:150] 7 29 31 50 59 60 81 84 111 124 ...
.. ..$ Resample45: int [1:150] 12 21 25 43 54 75 90 93 101 103 ...
```

```
.. ..$ Resample46: int [1:150] 2 5 8 69 80 82 104 118 126 146 ...
.. ..$ Resample47: int [1:150] 1 3 23 34 36 38 41 46 53 66 ...
.. ..$ Resample48: int [1:151] 18 26 28 39 45 52 62 64 67 68 ...
.. ..$ Resample49: int [1:150] 4 6 10 19 42 65 70 71 72 94 ...
.. ..$ Resample50: int [1:149] 13 14 17 24 37 44 47 55 57 58 ...
..$ indexFinal       : NULL
..$ timingSamps      : num 0
..$ predictionBounds : logi [1:2] FALSE FALSE
..$ seeds            :List of 51
.. ..$ : int 155025
.. ..$ : int 168874
.. ..$ : int 462424
.. ..$ : int 804987
.. ..$ : int 479857
.. ..$ : int 408159
.. ..$ : int 844958
.. ..$ : int 58926
.. ..$ : int 672892
.. ..$ : int 629320
.. ..$ : int 144647
.. ..$ : int 730359
.. ..$ : int 839535
.. ..$ : int 172123
.. ..$ : int 493578
.. ..$ : int 817242
.. ..$ : int 552500
.. ..$ : int 221494
.. ..$ : int 70471
.. ..$ : int 485094
.. ..$ : int 785125
.. ..$ : int 662761
.. ..$ : int 808002
.. ..$ : int 377074
.. ..$ : int 218590
.. ..$ : int 960725
.. ..$ : int 402250
.. ..$ : int 29147
.. ..$ : int 993702
.. ..$ : int 898700
.. ..$ : int 876570
.. ..$ : int 439366
.. ..$ : int 636668
.. ..$ : int 667598
.. ..$ : int 991396
.. ..$ : int 132968
.. ..$ : int 564008
.. ..$ : int 653149
.. ..$ : int 666433
```

```
 .. ..$ : int 782367
 .. ..$ : int 732697
 .. ..$ : int 961865
 .. ..$ : int 423475
 .. ..$ : int 775495
 .. ..$ : int 454431
 .. ..$ : int 796323
 .. ..$ : int 231174
 .. ..$ : int 949076
 .. ..$ : int 682860
 .. ..$ : int 416745
 .. ..$ : int 119298
 ..$ adaptive         :List of 4
 .. ..$ min     : num 5
 .. ..$ alpha   : num 0.05
 .. ..$ method  : chr "gls"
 .. ..$ complete: logi TRUE
 ..$ trim             : logi FALSE
 ..$ allowParallel    : logi TRUE
 ..$ yLimits          : num [1:2] -333 8099
$ finalModel  :List of 17
 ..$ coefficients : Named num [1:19] -177.05 46.79 8.34 -105.33 115.03 ...
 .. ..- attr(*, "names")= chr [1:19] "(Intercept)" "educ" "exper" "race" ...
 ..$ residuals    : Named num [1:1502] -165 223 -62 239 -482 ...
 .. ..- attr(*, "names")= chr [1:1502] "X23701" "X16208" "X2720" "X9723" ...
 ..$ effects      : Named num [1:1502] -23554 -4216 -4588 -1066 -2028 ...
 .. ..- attr(*, "names")= chr [1:1502] "(Intercept)" "educ" "exper" "race" ...
 ..$ rank         : int 11
 ..$ fitted.values: Named num [1:1502] 782 735 679 663 781 ...
 .. ..- attr(*, "names")= chr [1:1502] "X23701" "X16208" "X2720" "X9723" ...
 ..$ assign       : int [1:19] 0 1 2 3 4 5 6 7 8 9 ...
 ..$ qr           :List of 5
 .. ..$ qr   : num [1:1502, 1:19] -38.7556 0.0258 0.0258 0.0258 0.0258 ...
 .. .. ..- attr(*, "dimnames")=List of 2
 .. .. .. ..$ : chr [1:1502] "X23701" "X16208" "X2720" "X9723" ...
 .. .. .. ..$ : chr [1:19] "(Intercept)" "educ" "exper" "race" ...
 .. .. ..- attr(*, "assign")= int [1:19] 0 1 2 3 4 5 6 7 8 9 ...
 .. ..$ qraux: num [1:19] 1.03 1.02 1.01 1.01 1.01 ...
 .. ..$ pivot: int [1:19] 1 2 3 4 5 6 7 8 10 18 ...
 .. ..$ tol  : num 1e-07
 .. ..$ rank : int 11
 .. ..- attr(*, "class")= chr "qr"
 ..$ df.residual  : int 1491
 ..$ xlevels      : Named list()
 ..$ call         : language lm(formula = .outcome ~ ., data = dat)
 ..$ terms        :Classes 'terms', 'formula'  language .outcome ~ educ + exper + race + smsa +
 .. .. ..- attr(*, "variables")= language list(.outcome, educ, exper, race, smsa, ne, mw, so, w
 .. .. ..- attr(*, "factors")= int [1:19, 1:18] 0 1 0 0 0 0 0 0 0 0 ...
```

```
.. .. .. ..- attr(*, "dimnames")=List of 2
.. .. .. .. ..$ : chr [1:19] ".outcome" "educ" "exper" "race" ...
.. .. .. .. ..$ : chr [1:18] "educ" "exper" "race" "smsa" ...
.. .. ..- attr(*, "term.labels")= chr [1:18] "educ" "exper" "race" "smsa" ...
.. .. ..- attr(*, "order")= int [1:18] 1 1 1 1 1 1 1 1 1 1 ...
.. .. ..- attr(*, "intercept")= int 1
.. .. ..- attr(*, "response")= int 1
.. .. ..- attr(*, ".Environment")=<environment: 0x22e74498>
.. .. ..- attr(*, "predvars")= language list(.outcome, educ, exper, race, smsa, ne, mw, so, we
.. .. ..- attr(*, "dataClasses")= Named chr [1:19] "numeric" "numeric" "numeric" "numeric" ...
.. .. .. ..- attr(*, "names")= chr [1:19] ".outcome" "educ" "exper" "race" ...
..$ model        :'data.frame':        1502 obs. of  19 variables:
.. ..$ .outcome  : num [1:1502] 617 958 617 902 299 ...
.. ..$ educ      : num [1:1502] 15 16 12 14 12 16 16 12 12 9 ...
.. ..$ exper     : num [1:1502] 20 9 24 12 33 42 0 36 37 20 ...
.. ..$ race      : num [1:1502] 0 0 0 0 0 0 0 0 0 1 ...
.. ..$ smsa      : num [1:1502] 1 1 1 1 1 1 1 1 0 1 ...
.. ..$ ne        : num [1:1502] 0 0 1 0 0 0 0 0 0 0 ...
.. ..$ mw        : num [1:1502] 0 0 0 1 0 0 1 0 1 0 ...
.. ..$ so        : num [1:1502] 0 1 0 0 0 1 0 0 0 1 ...
.. ..$ we        : num [1:1502] 1 0 0 0 1 0 0 1 0 0 ...
.. ..$ pt        : num [1:1502] 0 0 0 0 0 1 1 1 0 1 ...
.. ..$ race1White: num [1:1502] 1 1 1 1 1 1 1 1 1 0 ...
.. ..$ smsa1Yes  : num [1:1502] 1 1 1 1 1 1 1 1 0 1 ...
.. ..$ ne1Yes    : num [1:1502] 0 0 1 0 0 0 0 0 0 0 ...
.. ..$ mw1Yes    : num [1:1502] 0 0 0 1 0 0 1 0 1 0 ...
.. ..$ we1Yes    : num [1:1502] 1 0 0 0 1 0 0 1 0 0 ...
.. ..$ so1Yes    : num [1:1502] 0 1 0 0 0 1 0 0 0 1 ...
.. ..$ pt1Yes    : num [1:1502] 0 0 0 0 0 1 1 1 0 1 ...
.. ..$ RN        : num [1:1502] 1.577 -0.957 -0.92 -1.998 -0.272 ...
.. ..$ RN10      : num [1:1502] 11.97 5.8 15.47 13.76 -6.51 ...
.. ..- attr(*, "terms")=Classes 'terms', 'formula'  language .outcome ~ educ + exper + race +
.. .. .. ..- attr(*, "variables")= language list(.outcome, educ, exper, race, smsa, ne, mw, so
.. .. .. ..- attr(*, "factors")= int [1:19, 1:18] 0 1 0 0 0 0 0 0 0 0 ...
.. .. .. .. ..- attr(*, "dimnames")=List of 2
.. .. .. .. .. ..$ : chr [1:19] ".outcome" "educ" "exper" "race" ...
.. .. .. .. .. ..$ : chr [1:18] "educ" "exper" "race" "smsa" ...
.. .. .. ..- attr(*, "term.labels")= chr [1:18] "educ" "exper" "race" "smsa" ...
.. .. .. ..- attr(*, "order")= int [1:18] 1 1 1 1 1 1 1 1 1 1 ...
.. .. .. ..- attr(*, "intercept")= int 1
.. .. .. ..- attr(*, "response")= int 1
.. .. .. ..- attr(*, ".Environment")=<environment: 0x22e74498>
.. .. .. ..- attr(*, "predvars")= language list(.outcome, educ, exper, race, smsa, ne, mw, so,
.. .. .. ..- attr(*, "dataClasses")= Named chr [1:19] "numeric" "numeric" "numeric" "numeric"
.. .. .. .. ..- attr(*, "names")= chr [1:19] ".outcome" "educ" "exper" "race" ...
..$ xNames       : chr [1:18] "educ" "exper" "race" "smsa" ...
..$ problemType  : chr "Regression"
..$ tuneValue    :'data.frame':        1 obs. of  1 variable:
```

```
 .. ..$ intercept: logi TRUE
 ..$ obsLevels    : logi NA
 ..$ param        : list()
 ..- attr(*, "class")= chr "lm"
$ preProcess  : NULL
$ trainingData:'data.frame':        1502 obs. of  19 variables:
 ..$ .outcome: num [1:1502] 617 958 617 902 299 ...
 ..$ educ    : int [1:1502] 15 16 12 14 12 16 16 12 12 9 ...
 ..$ exper   : int [1:1502] 20 9 24 12 33 42 0 36 37 20 ...
 ..$ race    : int [1:1502] 0 0 0 0 0 0 0 0 0 1 ...
 ..$ smsa    : int [1:1502] 1 1 1 1 1 1 1 1 0 1 ...
 ..$ ne      : int [1:1502] 0 0 1 0 0 0 0 0 0 0 ...
 ..$ mw      : int [1:1502] 0 0 0 1 0 0 1 0 1 0 ...
 ..$ so      : int [1:1502] 0 1 0 0 0 1 0 0 0 1 ...
 ..$ we      : int [1:1502] 1 0 0 0 1 0 0 1 0 0 ...
 ..$ pt      : int [1:1502] 0 0 0 0 0 1 1 1 0 1 ...
 ..$ race1   : chr [1:1502] "White" "White" "White" "White" ...
 ..$ smsa1   : chr [1:1502] "Yes" "Yes" "Yes" "Yes" ...
 ..$ ne1     : chr [1:1502] "No" "No" "Yes" "No" ...
 ..$ mw1     : chr [1:1502] "No" "No" "No" "Yes" ...
 ..$ we1     : chr [1:1502] "Yes" "No" "No" "No" ...
 ..$ so1     : chr [1:1502] "No" "Yes" "No" "No" ...
 ..$ pt1     : chr [1:1502] "No" "No" "No" "No" ...
 ..$ RN      : num [1:1502] 1.577 -0.957 -0.92 -1.998 -0.272 ...
 ..$ RN10    : num [1:1502] 11.97 5.8 15.47 13.76 -6.51 ...
$ resample    :'data.frame':        50 obs. of  4 variables:
 ..$ RMSE    : num [1:50] 435 337 713 356 342 ...
 ..$ Rsquared: num [1:50] 0.2148 0.2935 0.0121 0.2612 0.3336 ...
 ..$ MAE     : num [1:50] 263 237 295 259 231 ...
 ..$ Resample: chr [1:50] "Fold01.Rep1" "Fold02.Rep1" "Fold03.Rep1" "Fold04.Rep1" ...
$ resampledCM : NULL
$ perfNames   : chr [1:3] "RMSE" "Rsquared" "MAE"
$ maximize    : logi FALSE
$ yLimits     : num [1:2] -333 8099
$ times       :List of 3
 ..$ everything: 'proc_time' Named num [1:5] 1.956 0.004 1.957 0 0
 .. ..- attr(*, "names")= chr [1:5] "user.self" "sys.self" "elapsed" "user.child" ...
 ..$ final     : 'proc_time' Named num [1:5] 0.008 0 0.009 0 0
 .. ..- attr(*, "names")= chr [1:5] "user.self" "sys.self" "elapsed" "user.child" ...
 ..$ prediction: logi [1:3] NA NA NA
$ levels      : logi NA
$ terms       :Classes 'terms', 'formula'  language wage ~ educ + exper + race + smsa + ne + mw
 .. ..- attr(*, "variables")= language list(wage, educ, exper, race, smsa, ne, mw, so, we, pt,
 .. ..- attr(*, "factors")= int [1:19, 1:18] 0 1 0 0 0 0 0 0 0 0 ...
 .. .. ..- attr(*, "dimnames")=List of 2
 .. .. .. ..$ : chr [1:19] "wage" "educ" "exper" "race" ...
 .. .. .. ..$ : chr [1:18] "educ" "exper" "race" "smsa" ...
 .. ..- attr(*, "term.labels")= chr [1:18] "educ" "exper" "race" "smsa" ...
```

```
  .. ..- attr(*, "order")= int [1:18] 1 1 1 1 1 1 1 1 1 1 ...
  .. ..- attr(*, "intercept")= int 1
  .. ..- attr(*, "response")= int 1
  .. ..- attr(*, ".Environment")=<environment: R_GlobalEnv>
  .. ..- attr(*, "predvars")= language list(wage, educ, exper, race, smsa, ne, mw, so, we, pt, r
  .. ..- attr(*, "dataClasses")= Named chr [1:19] "numeric" "numeric" "numeric" "numeric" ...
  .. .. ..- attr(*, "names")= chr [1:19] "wage" "educ" "exper" "race" ...
 $ coefnames   : chr [1:18] "educ" "exper" "race" "smsa" ...
 $ contrasts   :List of 7
  ..$ race1: chr "contr.treatment"
  ..$ smsa1: chr "contr.treatment"
  ..$ ne1  : chr "contr.treatment"
  ..$ mw1  : chr "contr.treatment"
  ..$ we1  : chr "contr.treatment"
  ..$ so1  : chr "contr.treatment"
  ..$ pt1  : chr "contr.treatment"
 $ xlevels     :List of 7
  ..$ race1: chr [1:2] "Black" "White"
  ..$ smsa1: chr [1:2] "No" "Yes"
  ..$ ne1  : chr [1:2] "No" "Yes"
  ..$ mw1  : chr [1:2] "No" "Yes"
  ..$ we1  : chr [1:2] "No" "Yes"
  ..$ so1  : chr [1:2] "No" "Yes"
  ..$ pt1  : chr [1:2] "No" "Yes"
 - attr(*, "class")= chr [1:2] "train" "train.formula"
```

```
In [334]: set.seed(12)
          uswages$RN <- rnorm(2000)
          uswages$RN10 <- rnorm(2000)*10
          fit <- lm(wage ~., data = uswages)
          summary(fit)
```

```
Call:
lm(formula = wage ~ ., data = uswages)

Residuals:
   Min     1Q Median     3Q    Max
-870.4 -215.0  -54.2  129.4 7506.3

Coefficients: (8 not defined because of singularities)
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -204.6032    53.6373  -3.815 0.000141 ***
educ          48.8493     3.2505  15.028  < 2e-16 ***
exper          9.1268     0.7265  12.562  < 2e-16 ***
race        -119.8659    35.2201  -3.403 0.000679 ***
smsa         115.5603    21.7496   5.313  1.2e-07 ***
```

```
ne           -53.5160    27.9910  -1.912 0.056033 .
mw           -59.7078    27.3887  -2.180 0.029373 *
so           -49.8758    26.4021  -1.889 0.059026 .
we                NA         NA      NA       NA
pt          -335.9335    31.9510 -10.514  < 2e-16 ***
race1White        NA         NA      NA       NA
smsa1Yes          NA         NA      NA       NA
ne1Yes            NA         NA      NA       NA
mw1Yes            NA         NA      NA       NA
we1Yes            NA         NA      NA       NA
so1Yes            NA         NA      NA       NA
pt1Yes            NA         NA      NA       NA
RN            -7.4645     9.2963  -0.803 0.422097
RN10          -0.1185     0.9052  -0.131 0.895860
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Residual standard error: 412.2 on 1989 degrees of freedom
Multiple R-squared:  0.2003,Adjusted R-squared:  0.1963
F-statistic: 49.83 on 10 and 1989 DF,  p-value: < 2.2e-16
```

```
In [57]: install.packages("leaps")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [30]: library(leaps)
```

```
In [335]: regfitfull <- regsubsets(wage ~ . , data=uswages)
          regsummary <- summary(regfitfull)
          regsummary
```

```
Warning message in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax, force.in = force.in,
8  linear dependencies found


Reordering variables and trying again:


Subset selection object
Call: regsubsets.formula(wage ~ ., data = uswages)
18 Variables  (and intercept)
           Forced in Forced out
educ           FALSE      FALSE
exper          FALSE      FALSE
```

```
race           FALSE      FALSE
smsa           FALSE      FALSE
ne             FALSE      FALSE
mw             FALSE      FALSE
so             FALSE      FALSE
pt             FALSE      FALSE
RN             FALSE      FALSE
RN10           FALSE      FALSE
we             FALSE      FALSE
race1White     FALSE      FALSE
smsa1Yes       FALSE      FALSE
ne1Yes         FALSE      FALSE
mw1Yes         FALSE      FALSE
we1Yes         FALSE      FALSE
so1Yes         FALSE      FALSE
pt1Yes         FALSE      FALSE
1 subsets of each size up to 9
Selection Algorithm: exhaustive
         educ exper race smsa ne  mw  so  we  pt  race1White smsa1Yes ne1Yes
1  ( 1 ) "*"  " "   " "  " "  " " " " " " " " " " " "        " "      " "
2  ( 1 ) "*"  "*"   " "  " "  " " " " " " " " " " " "        " "      " "
3  ( 1 ) "*"  "*"   " "  " "  " " " " " " " " " " " "        " "      " "
4  ( 1 ) "*"  "*"   " "  "*"  " " " " " " " " " "*" " "        " "      " "
5  ( 1 ) "*"  "*"   "*"  "*"  " " " " " " " " " " " "        " "      " "
6  ( 1 ) "*"  "*"   "*"  "*"  " " " " " " " "*" "*" " "        " "      " "
7  ( 1 ) "*"  "*"   "*"  "*"  " " " " " " " "*" " " " "        " "      " "
8  ( 1 ) "*"  "*"   "*"  "*"  " " " " " " " "*" " " " "        " "      " "
9  ( 1 ) "*"  "*"   "*"  "*"  "*" "*" " " " " " " " " "        " "      " "
         mw1Yes we1Yes so1Yes pt1Yes RN  RN10
1  ( 1 ) " "    " "    " "    " "    " " " "
2  ( 1 ) " "    " "    " "    " "    " " " "
3  ( 1 ) " "    " "    " "    "*"    " " " "
4  ( 1 ) " "    " "    " "    " "    " " " "
5  ( 1 ) " "    " "    " "    "*"    " " " "
6  ( 1 ) " "    " "    " "    " "    " " " "
7  ( 1 ) " "    " "    " "    "*"    "*" " "
8  ( 1 ) "*"    " "    " "    "*"    "*" " "
9  ( 1 ) " "    " "    "*"    "*"    "*" " "
```

In [336]:
```
names(regsummary)
```

1. 'which' 2. 'rsq' 3. 'rss' 4. 'adjr2' 5. 'cp' 6. 'bic' 7. 'outmat' 8. 'obj'

In [337]:
```
round(regsummary$rsq, 2)
round(regsummary$adjr2, 2)
round(regsummary$cp, 2)
round(regsummary$bic, 2)
```

1. 0.06 2. 0.14 3. 0.18 4. 0.19 5. 0.2 6. 0.2 7. 0.2 8. 0.2 9. 0.2
1. 0.06 2. 0.13 3. 0.18 4. 0.19 5. 0.2 6. 0.2 7. 0.2 8. 0.2 9. 0.2
1. 328.52 2. 148.57 3. 35.39 4. 10.56 5. -0.43 6. -4.18 7. -2.82 8. -0.96 9. 1.02
1. -112.11 2. -267.52 3. -370.43 4. -389.48 5. -394.91 6. -393.1 7. -386.15 8. -378.69 9. -371.11

In [338]: step(fit)

```
Start:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + mw1 + we1 + so1 + pt1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + mw1 + we1 + so1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + mw1 + we1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + mw1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    RN + RN10


Step:  AIC=24097.32
```

```
wage ~ educ + exper + race + smsa + ne + mw + so + pt + RN +
    RN10

        Df Sum of Sq       RSS   AIC
- RN10   1      2912 338004341 24095
- RN     1    109563 338110992 24096
<none>               338001429 24097
- so     1    606439 338607867 24099
- ne     1    621175 338622604 24099
- mw     1    807616 338809044 24100
- race   1   1968313 339969742 24107
- smsa   1   4797300 342798729 24124
- pt     1  18785491 356786920 24204
- exper  1  26816575 364818004 24248
- educ   1  38380698 376382127 24310

Step:  AIC=24095.33
wage ~ educ + exper + race + smsa + ne + mw + so + pt + RN

        Df Sum of Sq       RSS   AIC
- RN     1    110321 338114663 24094
<none>               338004341 24095
- so     1    604552 338608893 24097
- ne     1    622922 338627264 24097
- mw     1    813628 338817970 24098
- race   1   1970689 339975030 24105
- smsa   1   4803235 342807576 24122
- pt     1  18784581 356788922 24202
- exper  1  26818697 364823039 24246
- educ   1  38379115 376383457 24308

Step:  AIC=24093.99
wage ~ educ + exper + race + smsa + ne + mw + so + pt

        Df Sum of Sq       RSS   AIC
<none>               338114663 24094
- so     1    621152 338735814 24096
- ne     1    631096 338745759 24096
- mw     1    822806 338937469 24097
- race   1   1946924 340061587 24104
- smsa   1   4808776 342923438 24120
- pt     1  18819536 356934199 24200
- exper  1  26872523 364987185 24245
- educ   1  38320052 376434714 24307



Call:
```

```
lm(formula = wage ~ educ + exper + race + smsa + ne + mw + so +
    pt, data = uswages)

Coefficients:
(Intercept)         educ        exper         race         smsa           ne
   -203.918       48.803        9.135     -119.158      115.678      -53.927
         mw           so           pt
    -60.199      -50.433     -336.216
```

```
In [339]: step(fit, direction="backward")
```

```
Start:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + mw1 + we1 + so1 + pt1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + mw1 + we1 + so1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + mw1 + we1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + mw1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + ne1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + smsa1 + RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    race1 + RN + RN10
```

```
Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + we + pt +
    RN + RN10


Step:  AIC=24097.32
wage ~ educ + exper + race + smsa + ne + mw + so + pt + RN +
    RN10

        Df Sum of Sq       RSS   AIC
- RN10   1      2912 338004341 24095
- RN     1    109563 338110992 24096
<none>               338001429 24097
- so     1    606439 338607867 24099
- ne     1    621175 338622604 24099
- mw     1    807616 338809044 24100
- race   1   1968313 339969742 24107
- smsa   1   4797300 342798729 24124
- pt     1  18785491 356786920 24204
- exper  1  26816575 364818004 24248
- educ   1  38380698 376382127 24310

Step:  AIC=24095.33
wage ~ educ + exper + race + smsa + ne + mw + so + pt + RN

        Df Sum of Sq       RSS   AIC
- RN     1    110321 338114663 24094
<none>               338004341 24095
- so     1    604552 338608893 24097
- ne     1    622922 338627264 24097
- mw     1    813628 338817970 24098
- race   1   1970689 339975030 24105
- smsa   1   4803235 342807576 24122
- pt     1  18784581 356788922 24202
- exper  1  26818697 364823039 24246
- educ   1  38379115 376383457 24308

Step:  AIC=24093.99
wage ~ educ + exper + race + smsa + ne + mw + so + pt

        Df Sum of Sq       RSS   AIC
<none>               338114663 24094
- so     1    621152 338735814 24096
- ne     1    631096 338745759 24096
- mw     1    822806 338937469 24097
- race   1   1946924 340061587 24104
- smsa   1   4808776 342923438 24120
- pt     1  18819536 356934199 24200
```

```
- exper  1  26872523 364987185 24245
- educ   1  38320052 376434714 24307



Call:
lm(formula = wage ~ educ + exper + race + smsa + ne + mw + so +
    pt, data = uswages)

Coefficients:
(Intercept)         educ        exper         race         smsa           ne
   -203.918       48.803        9.135     -119.158      115.678      -53.927
         mw           so           pt
    -60.199      -50.433     -336.216
```

1.3.3 Using the step function, the AIC was reduced from 24,097.32 to 24,093.99 and the "we" variable was removed.

1.4 Week 3

1.5 Ordinary Least Squares (OLS)

```
In [340]: modols <- lm(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data = trainingset
          summary(modols)


Call:
lm(formula = wage ~ educ + exper + race + smsa + ne + mw + so +
    pt, data = trainingset)

Residuals:
   Min     1Q Median     3Q    Max
-805.4 -215.3  -54.9  133.5 7542.2

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -177.2497    62.9627  -2.815  0.00494 **
educ          46.7902     3.8659  12.103  < 2e-16 ***
exper          8.3503     0.8574   9.739  < 2e-16 ***
race        -104.7111    40.7631  -2.569  0.01030 *
smsa         115.4331    25.7529   4.482 7.95e-06 ***
ne           -22.8326    33.1639  -0.688  0.49126
mw           -46.3098    32.0514  -1.445  0.14871
so           -34.3372    31.1660  -1.102  0.27075
pt          -363.0319    37.3646  -9.716  < 2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
```

```
Residual standard error: 419.6 on 1493 degrees of freedom
Multiple R-squared:  0.189,Adjusted R-squared:  0.1847
F-statistic: 43.49 on 8 and 1493 DF,  p-value: < 2.2e-16
```

```
In [341]: names(modols)
```

1. 'coefficients' 2. 'residuals' 3. 'effects' 4. 'rank' 5. 'fitted.values' 6. 'assign' 7. 'qr' 8. 'df.residual' 9. 'xlevels' 10. 'call' 11. 'terms' 12. 'model'

```
In [342]: show(rmsemodols <- RMSE(trainingset$wage, modols$fitted.values))
```

```
[1] 418.3127
```

```
In [345]: show(maemodols <- MAE(trainingset$wage, modols$fitted.values))
```

```
[1] 247.0311
```

```
In [351]: show(r2modols <- (cor(trainingset$wage, modols$fitted.values))^2)
```

```
[1] 0.1889992
```

```
In [300]: varImp(modols)
```

A data.frame: 8 Œ 1

	Overall <dbl>
educ	12.1033928
exper	9.7388642
race	2.5687743
smsa	4.4823366
ne	0.6884776
mw	1.4448611
so	1.1017507
pt	9.7159294

```
In [301]: modolsp <- predict(modols, trainingset)
          head(modolsp)
```

23701 807.042542765635 **16208** 727.642270727845 **2720** 677.240520072958 **9723** 647.140111634725 **22239** 775.225840884817 **14379** 640.170329322436

```
In [302]: modolspm <- data.frame(obs=trainingset$wage, pred=modolsp)
          head(modolspm)
```

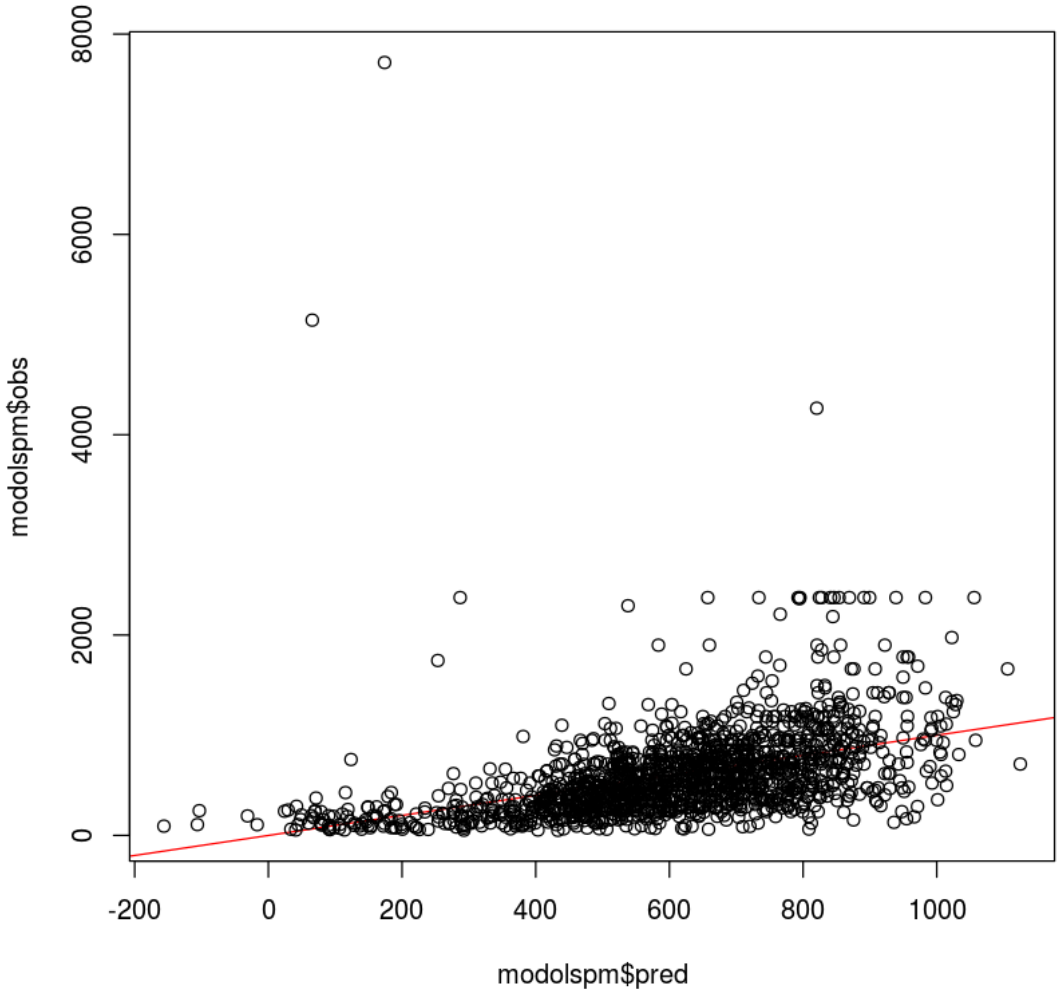
A data.frame: 6 Œ 2

	obs <dbl>	pred <dbl>
23701	617.28	807.0425
16208	957.83	727.6423
2720	617.28	677.2405
9723	902.18	647.1401
22239	299.15	775.2258
14379	541.31	640.1703

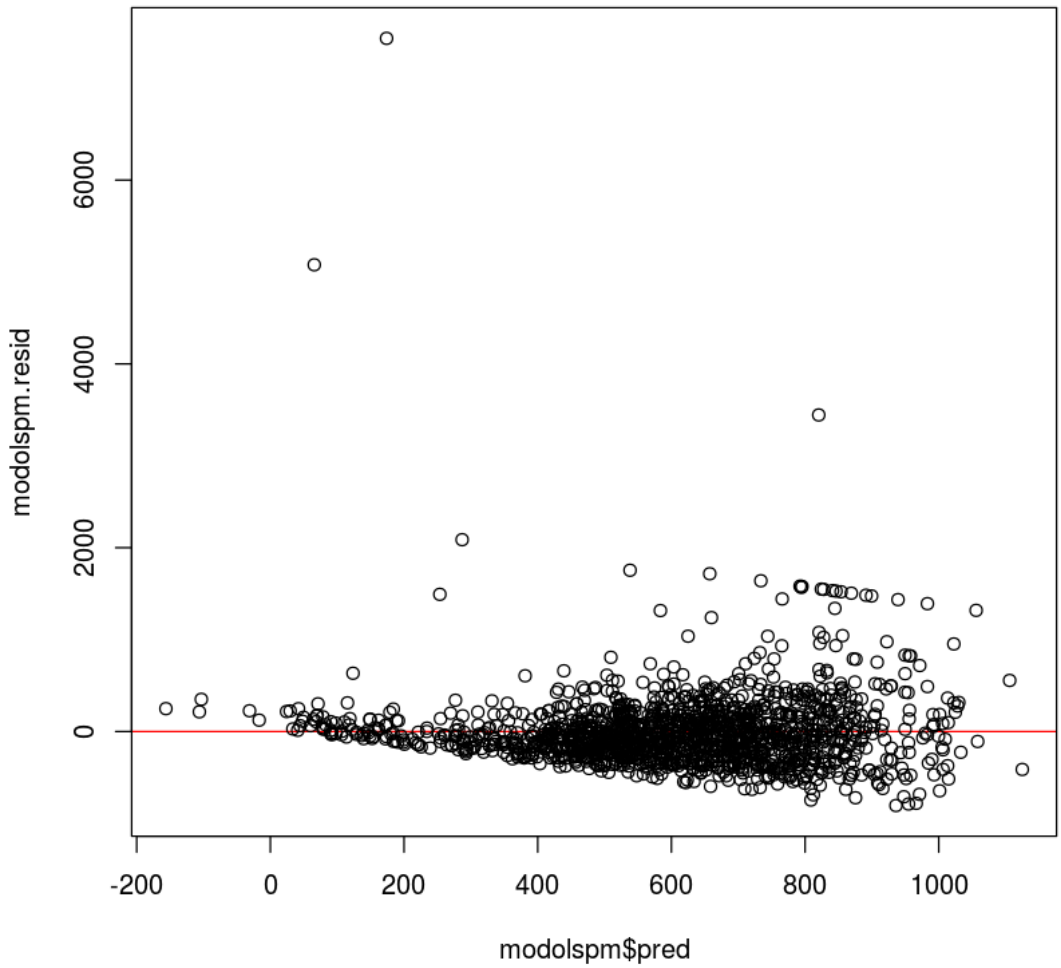
In [303]:
```
defaultSummary(modolspm)
```

RMSE 418.312739289081 **Rsquared** 0.188999185758383 **MAE** 247.031118416245

In [306]:
```
plot(modolspm$pred, modolspm$obs, abline(a=0, b=1, col="red"))
```



```
In [307]: modolspm.resid <- (modolspm$obs - modolspm$pred)
          plot(modolspm$pred, modolspm.resid, abline(h=0, col="red"))
```




```
In [308]: modolsp <- predict(modols, testingset)
          head(modolsp)
```

6085 907.879957150703 **6076** 728.956043944691 **24050** 405.570740209023 **21572** 652.489555735596 **15065** 644.13925406979 **13462** 757.589282657067

```
In [309]: modolspm <- data.frame(obs=testingset$wage, pred=modolsp)
          head(modolspm)
```

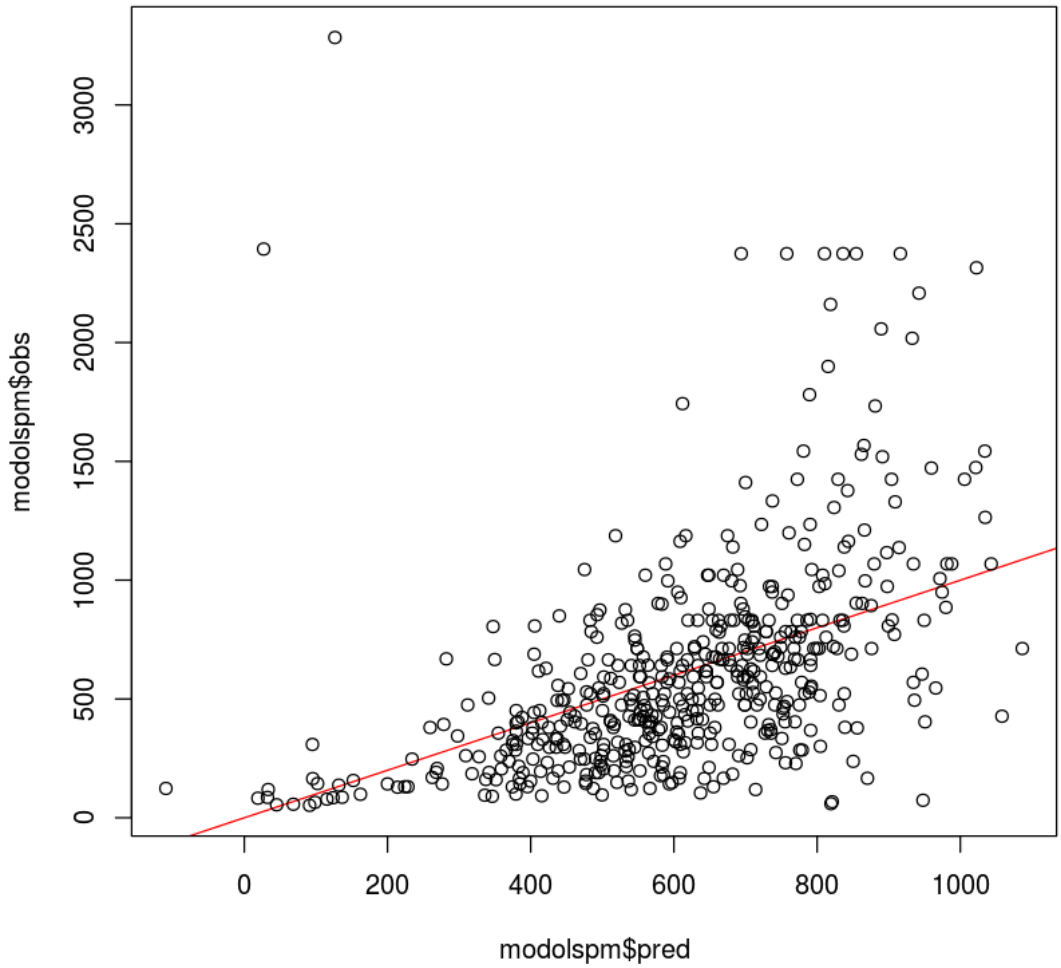
A data.frame: 6 Œ 2

	obs <dbl>	pred <dbl>
6085	771.60	907.8800
6076	550.81	728.9560
24050	807.22	405.5707
21572	308.64	652.4896
15065	617.28	644.1393
13462	2374.15	757.5893

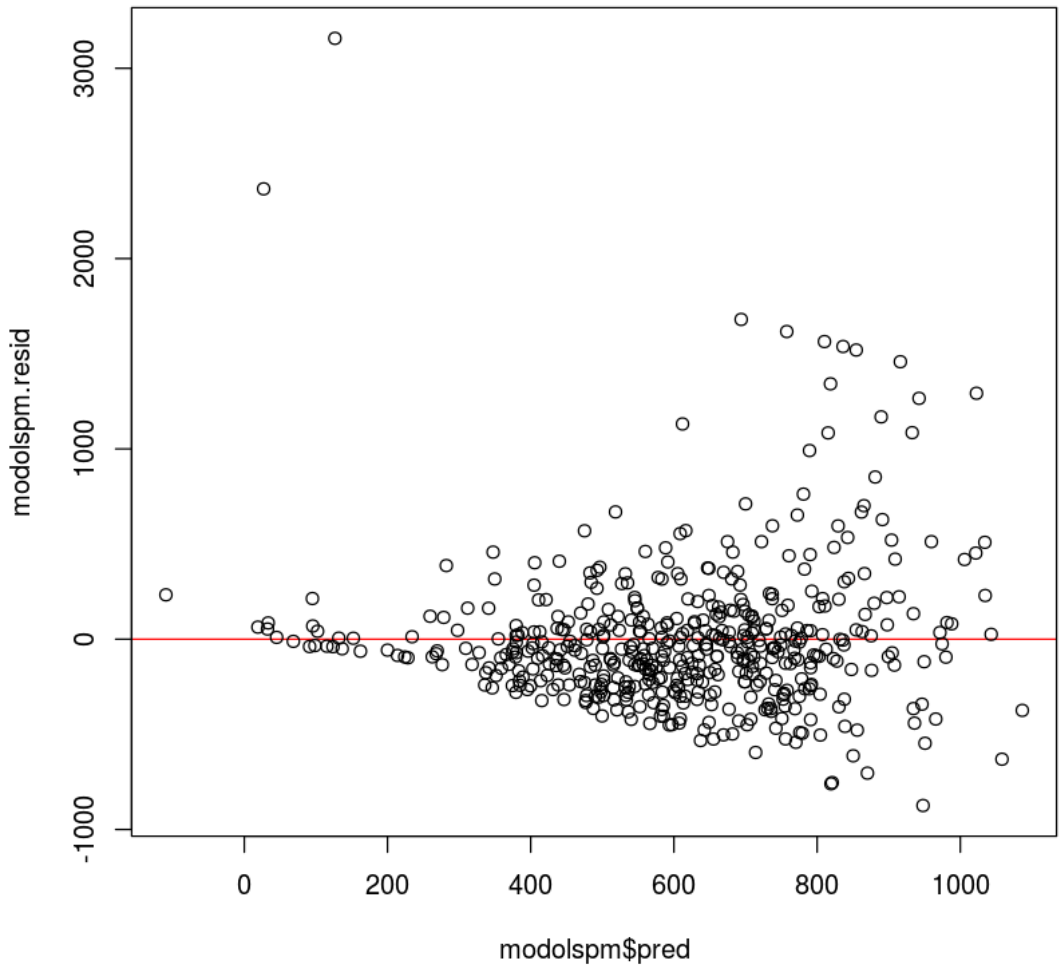
```
In [310]: defaultSummary(modolspm)
```

RMSE 390.223820466716 **Rsquared** 0.231937247709159 **MAE** 249.311118934362

```
In [311]: plot(modolspm$pred, modolspm$obs, abline(a=0, b=1, col="red"))
```



```
In [312]: modolspm.resid <- (modolspm$obs - modolspm$pred)
          plot(modolspm$pred, modolspm.resid, abline(h=0, col="red"))
```




```
In [313]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
          set.seed(444)
          modtrainols <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=train
                               trControl = controlobject)
          summary(modtrainols)
```

```
Call:
lm(formula = .outcome ~ ., data = dat)
```

```
Residuals:
   Min     1Q Median     3Q    Max
-805.4 -215.3  -54.9  133.5 7542.2

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -177.2497    62.9627  -2.815  0.00494 **
educ          46.7902     3.8659  12.103  < 2e-16 ***
exper          8.3503     0.8574   9.739  < 2e-16 ***
race        -104.7111    40.7631  -2.569  0.01030 *
smsa         115.4331    25.7529   4.482 7.95e-06 ***
ne           -22.8326    33.1639  -0.688  0.49126
mw           -46.3098    32.0514  -1.445  0.14871
so           -34.3372    31.1660  -1.102  0.27075
pt          -363.0319    37.3646  -9.716  < 2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Residual standard error: 419.6 on 1493 degrees of freedom
Multiple R-squared:  0.189,Adjusted R-squared:  0.1847
F-statistic: 43.49 on 8 and 1493 DF,  p-value: < 2.2e-16
```

```
In [314]: modtrainols
```

```
Linear Regression

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results:

  RMSE      Rsquared   MAE
  402.5543  0.2410713  248.4177

Tuning parameter 'intercept' was held constant at a value of TRUE
```

1.6 Robust Regression

```
In [48]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainrlm <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=traini
                              preProc = c("center", "scale"), trControl = controlobject)
         summary(modtrainrlm)
```

```
Call: rlm(formula = .outcome ~ ., data = dat, psi = psi)
Residuals:
    Min      1Q  Median      3Q     Max
-801.76 -177.14  -22.61  173.17 7683.32

Coefficients:
            Value     Std. Error t value
(Intercept)  570.0476    7.0346    81.0344
educ         144.7729    7.4224    19.5050
exper         99.7399    7.3984    13.4812
race         -21.1646    7.2382    -2.9240
smsa          37.7622    7.1459     5.2845
ne            -4.2417    8.9927    -0.4717
mw            -5.8811    9.0960    -0.6466
so           -10.3314    9.3878    -1.1005
pt          -117.2836    7.0834   -16.5574

Residual standard error: 260.6 on 1493 degrees of freedom
```

```
In [49]: modtrainrlm
```

```
Robust Linear Model

1502 samples
   8 predictors

Pre-processing: centered (8), scaled (8)
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  intercept  psi           RMSE      Rsquared   MAE
  FALSE      psi.huber     732.8286  0.2475979  609.3662
  FALSE      psi.hampel    733.0312  0.2476772  609.7551
  FALSE      psi.bisquare  732.6762  0.2479725  609.3482
   TRUE      psi.huber     402.3445  0.2470027  243.3635
   TRUE      psi.hampel    401.5975  0.2478663  243.8351
   TRUE      psi.bisquare  404.1237  0.2462795  243.0275

RMSE was used to select the optimal model using the smallest value.
The final values used for the model were intercept = TRUE and psi = psi.hampel.
```

1.7 Principal Components

```
In [50]: trainingsetx <- trainingset[,2:10]
         pctrainingsetx <- prcomp(trainingsetx)
```

```
summary(pctrainingsetx)
```

```
Importance of components:
                          PC1     PC2     PC3     PC4     PC5     PC6     PC7
Standard deviation     13.3070 2.82867 0.54092 0.49776 0.46310 0.41482 0.28992
Proportion of Variance  0.9512 0.04298 0.00157 0.00133 0.00115 0.00092 0.00045
Cumulative Proportion   0.9512 0.99420 0.99577 0.99710 0.99825 0.99918 0.99963
                           PC8       PC9
Standard deviation     0.26308 2.056e-16
Proportion of Variance 0.00037 0.000e+00
Cumulative Proportion  1.00000 1.000e+00
```

In [51]:
```
names(pctrainingsetx)
```

1. 'sdev' 2. 'rotation' 3. 'center' 4. 'scale' 5. 'x'

In [52]:
```
round(pctrainingsetx$rotation,2)
```

A matrix: 9 Œ 9 of type dbl

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
educ	-0.07	-1.00	-0.01	-0.01	0.01	-0.01	0.00	0.01	0.0
exper	1.00	-0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.0
race	0.00	0.01	-0.13	-0.01	-0.04	0.08	-0.09	0.98	0.0
smsa	0.00	-0.02	0.04	0.32	-0.16	0.93	-0.02	-0.08	0.0
ne	0.00	-0.01	0.22	0.61	-0.49	-0.30	0.00	0.04	-0.5
mw	0.00	0.00	0.45	-0.68	-0.23	0.17	0.02	0.03	-0.5
so	0.00	0.01	-0.84	-0.14	-0.10	0.06	0.00	-0.12	-0.5
we	0.00	0.00	0.16	0.21	0.82	0.06	-0.02	0.05	-0.5
pt	0.00	0.00	0.02	-0.02	-0.02	-0.02	-1.00	-0.09	0.0

In [53]:
```
round(pctrainingsetx$rot,2)
```

A matrix: 9 Œ 9 of type dbl

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
educ	-0.07	-1.00	-0.01	-0.01	0.01	-0.01	0.00	0.01	0.0
exper	1.00	-0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.0
race	0.00	0.01	-0.13	-0.01	-0.04	0.08	-0.09	0.98	0.0
smsa	0.00	-0.02	0.04	0.32	-0.16	0.93	-0.02	-0.08	0.0
ne	0.00	-0.01	0.22	0.61	-0.49	-0.30	0.00	0.04	-0.5
mw	0.00	0.00	0.45	-0.68	-0.23	0.17	0.02	0.03	-0.5
so	0.00	0.01	-0.84	-0.14	-0.10	0.06	0.00	-0.12	-0.5
we	0.00	0.00	0.16	0.21	0.82	0.06	-0.02	0.05	-0.5
pt	0.00	0.00	0.02	-0.02	-0.02	-0.02	-1.00	-0.09	0.0

In [54]:
```
controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
set.seed(444)
modtrainrlmpc <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=trai
                       preProc = "pca", trControl = controlobject)
summary(modtrainrlmpc)
```

```
Call:
lm(formula = .outcome ~ ., data = dat)

Residuals:
   Min     1Q Median     3Q    Max
-810.4 -211.4  -58.0  130.3 7536.4

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  607.747     10.831  56.113  < 2e-16 ***
PC1          -20.821      8.720  -2.388 0.017075 *
PC2          -54.341      9.213  -5.898 4.53e-09 ***
PC3            4.546      9.566   0.475 0.634705
PC4          -75.553     10.804  -6.993 4.04e-12 ***
PC5         -125.846     10.915 -11.530  < 2e-16 ***
PC6          -45.306     11.818  -3.834 0.000132 ***
PC7         -136.593     13.139 -10.396  < 2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Residual standard error: 419.8 on 1494 degrees of freedom
Multiple R-squared:  0.1877,Adjusted R-squared:  0.1839
F-statistic: 49.33 on 7 and 1494 DF,  p-value: < 2.2e-16



In [55]: modtrainrlmpc

Linear Regression

1502 samples
   8 predictors

Pre-processing: principal component signal extraction (8), centered (8),
 scaled (8)
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results:

  RMSE      Rsquared   MAE
  402.6435  0.2407236  248.5852

Tuning parameter 'intercept' was held constant at a value of TRUE


In [56]: varImp(modtrainrlmpc)

lm variable importance
```

```
    Overall
PC5  100.00
PC7   89.74
PC4   58.96
PC2   49.06
PC6   30.38
PC1   17.30
PC3    0.00
```

```
In [57]: names(modtrainrlmpc)
```

1. 'method' 2. 'modelInfo' 3. 'modelType' 4. 'results' 5. 'pred' 6. 'bestTune' 7. 'call' 8. 'dots' 9. 'metric' 10. 'control' 11. 'finalModel' 12. 'preProcess' 13. 'trainingData' 14. 'resample' 15. 'resampledCM' 16. 'perfNames' 17. 'maximize' 18. 'yLimits' 19. 'times' 20. 'levels' 21. 'terms' 22. 'coefnames' 23. 'xlevels'

```
In [58]: modtrainrlmpc$preProcess
```

```
Created from 1502 samples and 8 variables

Pre-processing:
  - centered (8)
  - ignored (0)
  - principal component signal extraction (8)
  - scaled (8)

PCA needed 7 components to capture 95 percent of the variance
```

1.7.1 7 principal components were used.

```
In [59]: names(testingset)
```

1. 'wage' 2. 'educ' 3. 'exper' 4. 'race' 5. 'smsa' 6. 'ne' 7. 'mw' 8. 'so' 9. 'we' 10. 'pt' 11. 'race1' 12. 'smsa1' 13. 'ne1' 14. 'mw1' 15. 'we1' 16. 'so1' 17. 'pt1'

```
In [60]: modtrainrlmpcp <- predict(modtrainrlmpc, testingset)
         modtrainrlmpcpm <- data.frame(obs = testingset$wage, pred = modtrainrlmpcp)
         modtrainrlmpcpm.sum <- defaultSummary(modtrainrlmpcpm)
         modtrainrlmpcpm.sum
```

RMSE 392.051798116448 **Rsquared** 0.224344302574832 **MAE** 249.947407629034

1.8 Partial Least Squares (PLS)

```
In [64]: install.packages("pls")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [61]: library(pls)
```

```
Attaching package: pls


The following object is masked from package:caret:

    R2


The following object is masked from package:corrplot:

    corrplot


The following object is masked from package:stats:

    loadings
```

```
In [62]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainrlmpls <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=tra
                                 trControl = controlobject)
         summary(modtrainrlmpls)
```

```
Data:         X dimension: 1502 8
        Y dimension: 1502 1
Fit method: oscorespls
Number of components considered: 3
TRAINING: % variance explained
          1 comps  2 comps  3 comps
X          94.658    99.51    99.59
.outcome    3.877    12.19    17.78
```

```
In [63]: modtrainrlmpls
```

```
Partial Least Squares

1502 samples
```

```
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  ncomp  RMSE      Rsquared    MAE
  1      444.3492  0.04713987  294.8411
  2      420.9513  0.16097617  267.9954
  3      406.9743  0.22010973  253.8543

RMSE was used to select the optimal model using the smallest value.
The final value used for the model was ncomp = 3.
```

```
In [64]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainrlmpls <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=tra
                                 tuneLength=15, trControl = controlobject)
         summary(modtrainrlmpls)
```

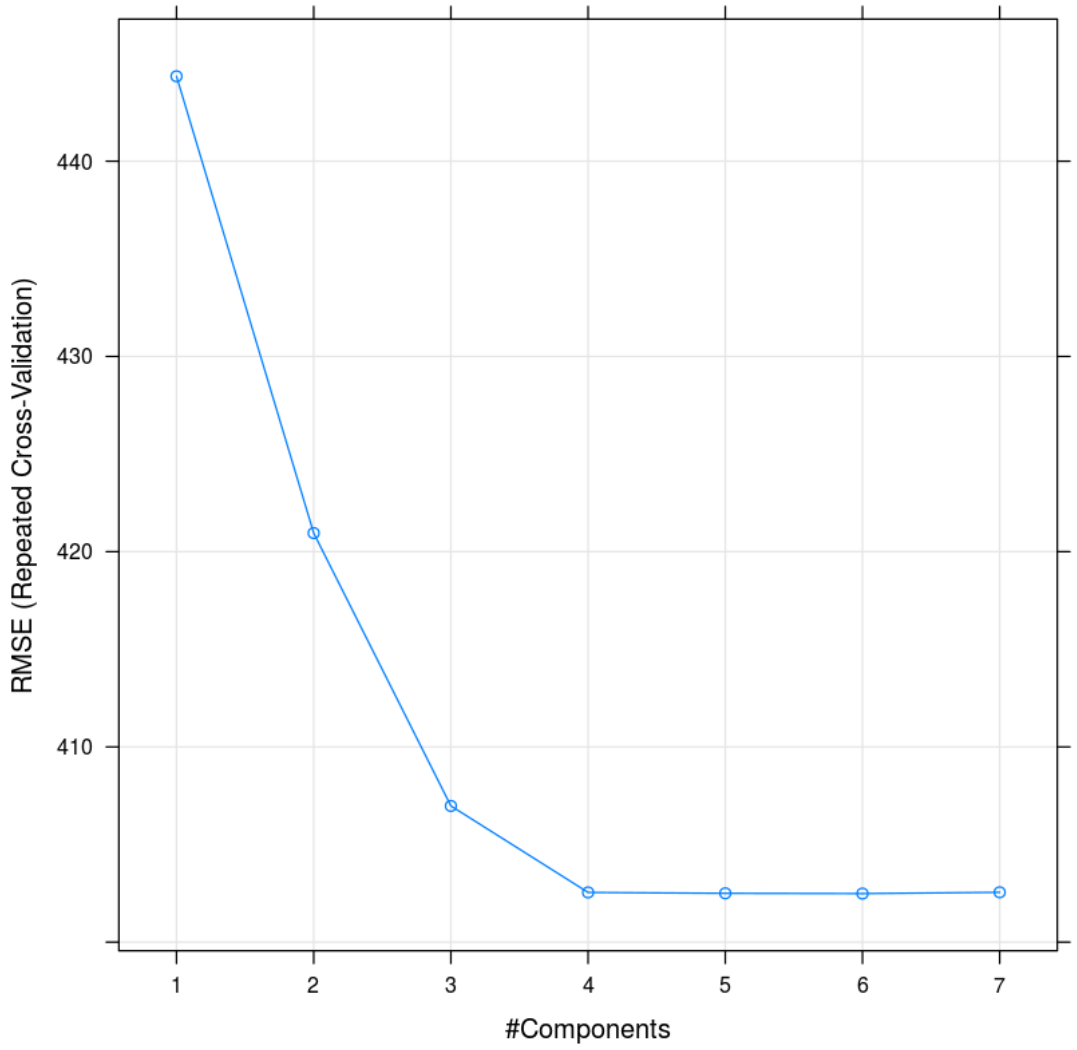
```
Data:         X dimension: 1502 8
        Y dimension: 1502 1
Fit method: oscorespls
Number of components considered: 6
TRAINING: % variance explained
          1 comps  2 comps  3 comps  4 comps  5 comps  6 comps
X          94.658    99.51    99.59    99.68    99.78    99.92
.outcome    3.877    12.19    17.78    18.84    18.90    18.90
```

```
In [65]: modtrainrlmpls
```

```
Partial Least Squares

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  ncomp  RMSE      Rsquared    MAE
  1      444.3492  0.04713987  294.8411
  2      420.9513  0.16097617  267.9954
  3      406.9743  0.22010973  253.8543
  4      402.5451  0.24083722  248.4906
```

```
  5      402.4999  0.24135851  248.3556
  6      402.4864  0.24135864  248.3610
  7      402.5514  0.24107960  248.4172

RMSE was used to select the optimal model using the smallest value.
The final value used for the model was ncomp = 6.
```

In [66]: `plot(modtrainrlmpls)`



In [67]: `varImp(modtrainrlmpls)`

```
pls variable importance
```

```
       Overall
pt      100.00
smsa     64.45
educ     25.07
race     22.12
mw       19.57
ne       12.61
so       10.85
exper     0.00
```

1.9 Ridge Regression

```
In [73]: install.packages("elasticnet")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)

also installing the dependency lars
```

```
In [68]: library(elasticnet)
```

```
Loading required package: lars

Loaded lars 1.2
```

```
In [69]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainrlmrr <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=trai
                                trControl = controlobject)
         summary(modtrainrlmrr)
```

```
            Length Class      Mode
call         4     -none-     call
actions      9     -none-     list
allset       8     -none-     numeric
beta.pure   72     -none-     numeric
vn           8     -none-     character
mu           1     -none-     numeric
normx        8     -none-     numeric
meanx        8     -none-     numeric
lambda       1     -none-     numeric
```

```
L1norm       9     -none-     numeric
penalty      9     -none-     numeric
df           9     -none-     numeric
Cp           9     -none-     numeric
sigma2       1     -none-     numeric
xNames       8     -none-     character
problemType  1     -none-     character
tuneValue    1     data.frame list
obsLevels    1     -none-     logical
param        0     -none-     list
```

```
In [70]: modtrainrlmrr
```

```
Ridge Regression

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  lambda  RMSE      Rsquared   MAE
  0e+00   402.5543  0.2410713  248.4177
  1e-04   402.5542  0.2410713  248.4179
  1e-01   402.5955  0.2408855  248.6502

RMSE was used to select the optimal model using the smallest value.
The final value used for the model was lambda = 1e-04.
```

1.10 Lasso Regression

```
In [71]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainrlmlasso <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=t
                                   trControl = controlobject)
         summary(modtrainrlmlasso)
```

```
            Length Class      Mode
call         4     -none-     call
actions      9     -none-     list
allset       8     -none-     numeric
beta.pure   72     -none-     numeric
vn           8     -none-     character
mu           1     -none-     numeric
normx        8     -none-     numeric
```

```
meanx        8     -none-     numeric
lambda       1     -none-     numeric
L1norm       9     -none-     numeric
penalty      9     -none-     numeric
df           9     -none-     numeric
Cp           9     -none-     numeric
sigma2       1     -none-     numeric
xNames       8     -none-     character
problemType  1     -none-     character
tuneValue    1     data.frame list
obsLevels    1     -none-     logical
param        0     -none-     list
```

```
In [72]: modtrainrlmlasso
```

```
The lasso

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  fraction  RMSE      Rsquared   MAE
  0.1       441.8094  0.1872128  296.8342
  0.5       412.3071  0.2414080  261.7236
  0.9       402.6429  0.2418335  248.6507

RMSE was used to select the optimal model using the smallest value.
The final value used for the model was fraction = 0.9.
```

1.11 Elastic Net Regression

```
In [73]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainrlmenet <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=tr
                                  trControl = controlobject)
         summary(modtrainrlmenet)
```

```
            Length Class      Mode
call         4     -none-     call
actions      9     -none-     list
allset       8     -none-     numeric
beta.pure   72     -none-     numeric
vn           8     -none-     character
```

```
mu           1     -none-     numeric
normx        8     -none-     numeric
meanx        8     -none-     numeric
lambda       1     -none-     numeric
L1norm       9     -none-     numeric
penalty      9     -none-     numeric
df           9     -none-     numeric
Cp           9     -none-     numeric
sigma2       1     -none-     numeric
xNames       8     -none-     character
problemType  1     -none-     character
tuneValue    2     data.frame list
obsLevels    1     -none-     logical
param        0     -none-     list
```

```
In [74]: modtrainrlmenet
```

```
Elasticnet

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  lambda  fraction  RMSE      Rsquared   MAE
  0e+00   0.050     447.1440  0.1694737  302.2632
  0e+00   0.525     411.1088  0.2416250  260.1293
  0e+00   1.000     402.5543  0.2410713  248.4177
  1e-04   0.050     447.1443  0.1694728  302.2634
  1e-04   0.525     411.1097  0.2416251  260.1306
  1e-04   1.000     402.5542  0.2410713  248.4179
  1e-01   0.050     447.3135  0.1686945  302.4267
  1e-01   0.525     411.8501  0.2416556  261.1287
  1e-01   1.000     402.5955  0.2408855  248.6502

RMSE was used to select the optimal model using the smallest value.
The final values used for the model were fraction = 1 and lambda = 1e-04.
```

1.12 Week 4

1.13 Neural Networks

```
In [75]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
```

```
        modtrainnn <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=trainin
                            linout=TRUE, trace=FALSE, trControl = controlobject)
        summary(modtrainnn)
```

```
Warning message:
executing %dopar% sequentially: no parallel backend registered
Warning message in nominalTrainWorkflow(x = x, y = y, wts = weights, info = trainInfo, :
There were missing values in resampled performance measures.
```

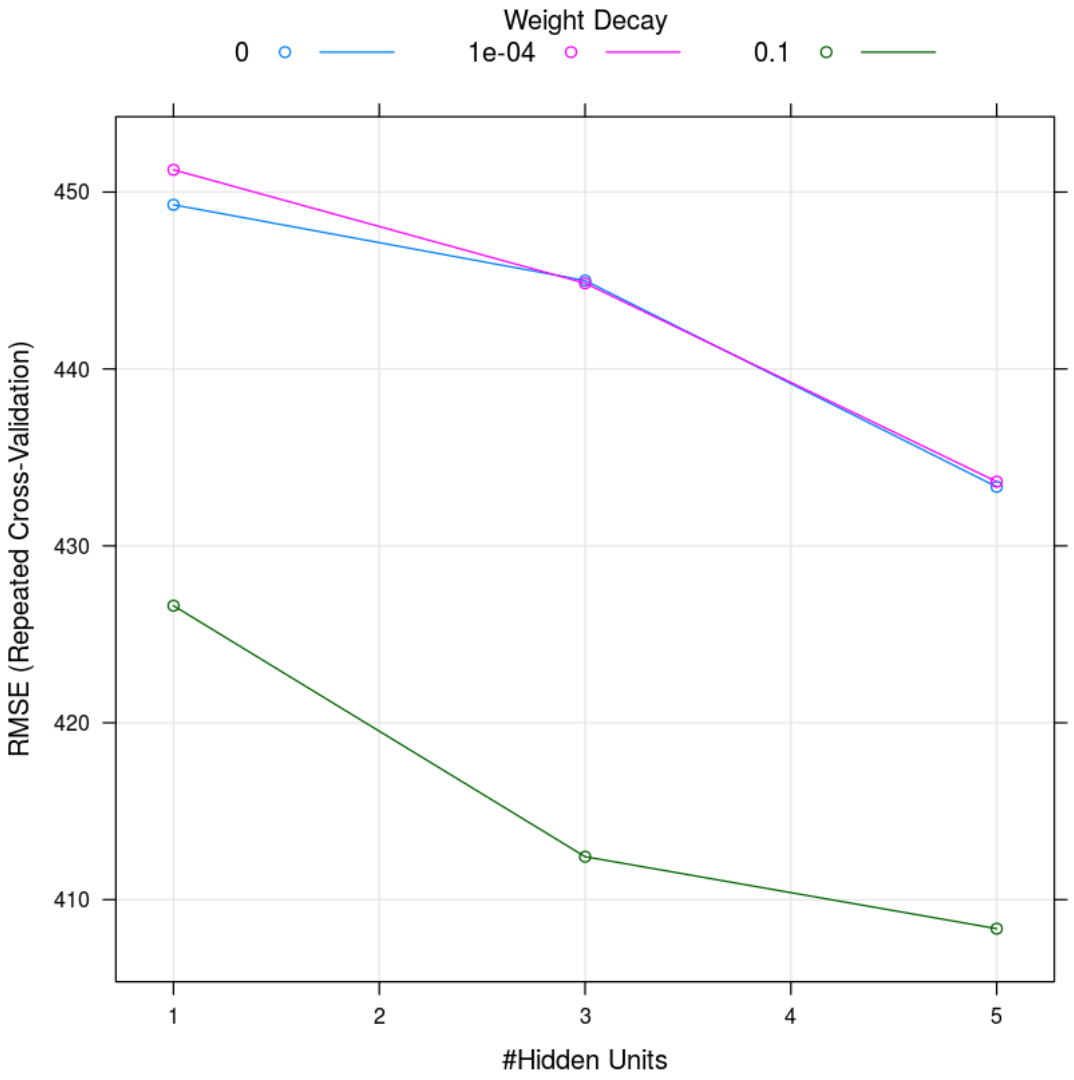
```
            Length Class      Mode
model       5      -none-     list
repeats     1      -none-     numeric
bag         1      -none-     logical
seeds       5      -none-     numeric
names       8      -none-     character
terms       3      terms      call
coefnames   8      -none-     character
xlevels     0      -none-     list
xNames      8      -none-     character
problemType 1      -none-     character
tuneValue   3      data.frame list
obsLevels   1      -none-     logical
param       2      -none-     list
```

In [76]: modtrainnn

```
Model Averaged Neural Network

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  size  decay  RMSE      Rsquared    MAE
  1     0e+00  449.2808  0.07812910  303.7614
  1     1e-04  451.2576  0.04637290  305.6150
  1     1e-01  426.6152  0.17555660  276.4219
  3     0e+00  444.9987  0.09573598  298.4190
  3     1e-04  444.8470  0.10835894  298.9472
  3     1e-01  412.4278  0.20763203  260.8920
  5     0e+00  433.3363  0.14877958  286.2806
  5     1e-04  433.6294  0.15515305  288.6129
  5     1e-01  408.3591  0.22009324  257.1537
```

```
Tuning parameter 'bag' was held constant at a value of FALSE
RMSE was used to select the optimal model using the smallest value.
The final values used for the model were size = 5, decay = 0.1 and bag = FALSE.
```

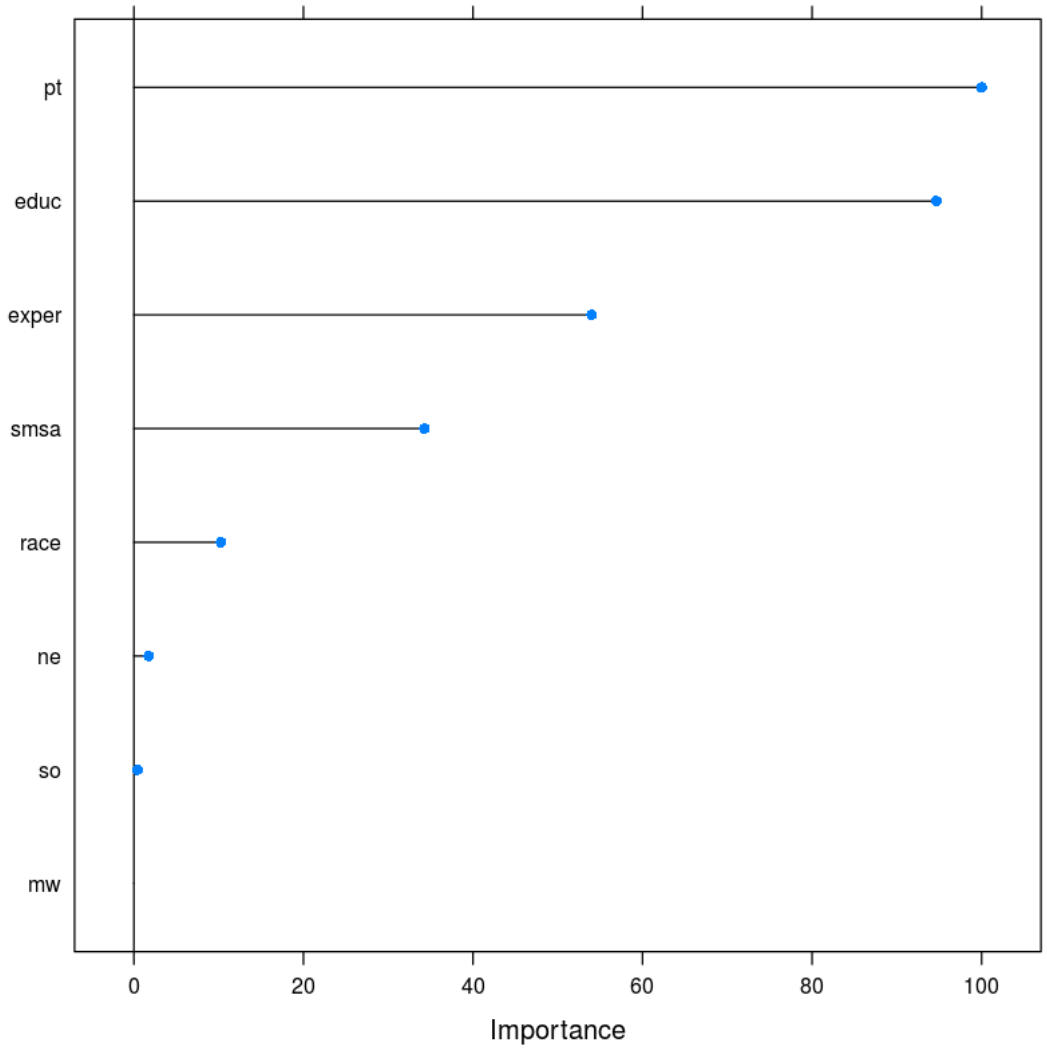
```
In [77]: plot(modtrainnn)
```




```
In [78]: varImp(modtrainnn)
         plot(varImp(modtrainnn))
```

```
loess r-squared variable importance

       Overall
```

```
pt    100.0000
educ   94.6507
exper  53.9982
smsa   34.2715
race   10.2629
ne      1.7458
so      0.4235
mw      0.0000
```

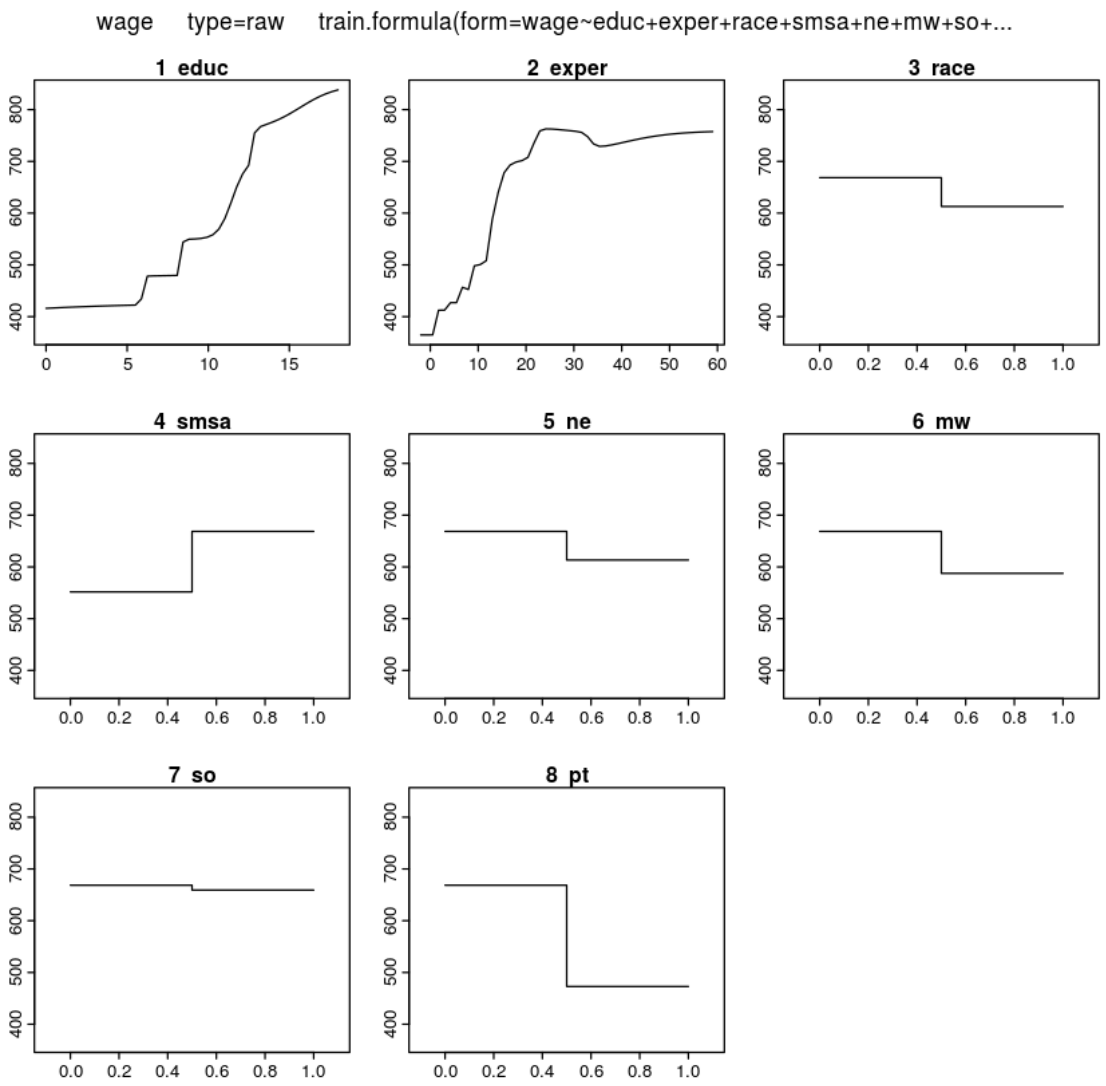



```
In [30]: install.packages("plotmo")

Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

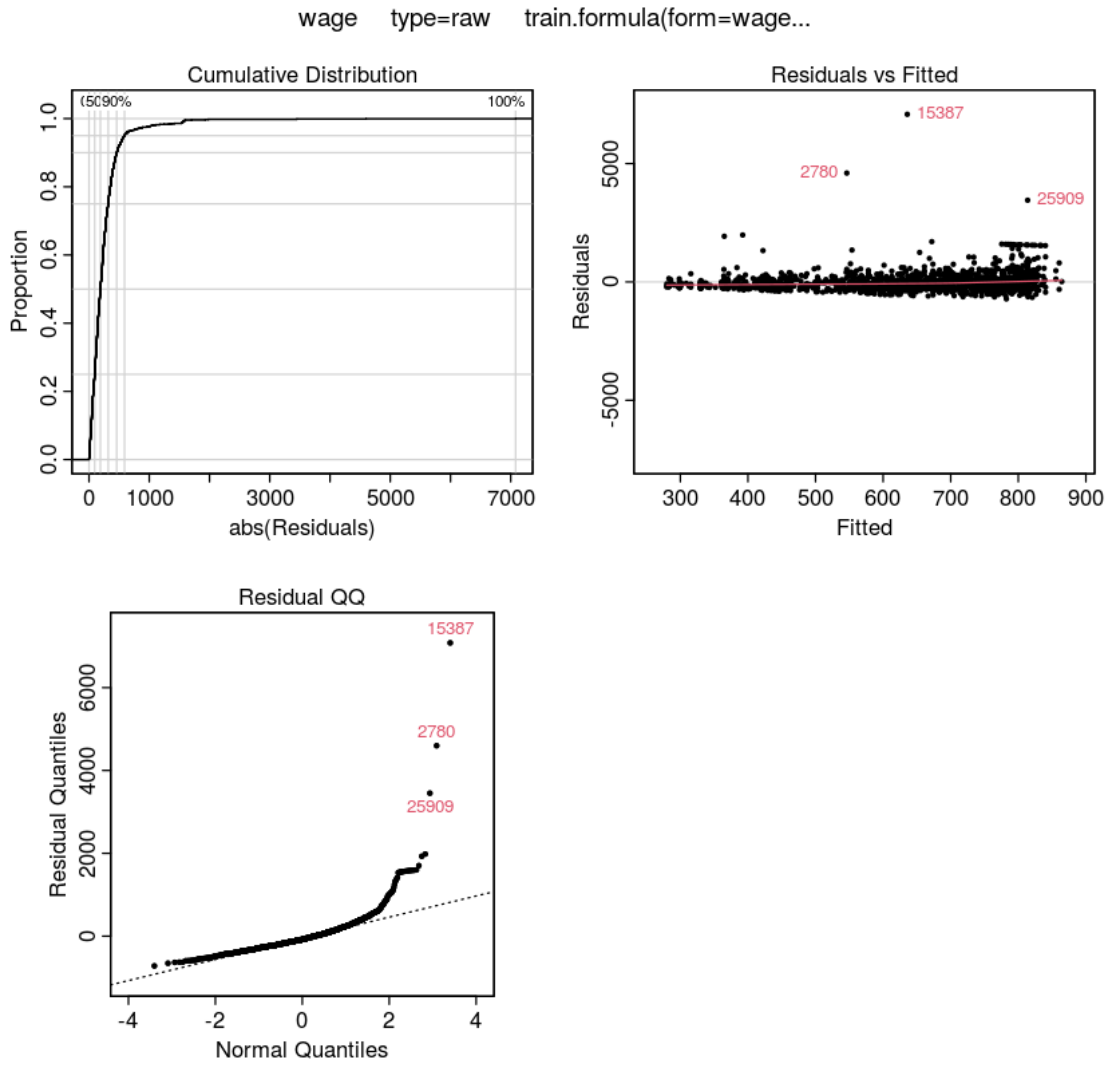
```
also installing the dependencies plotrix, TeachingDemos
```

```
In [79]: library(plotmo)

Loading required package: Formula

Loading required package: plotrix

Loading required package: TeachingDemos
```

```
In [80]: plotmo(modtrainnn)

 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```




```
In [81]: plotres(modtrainnn)
```



In [ ]:
```
controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
nnetgrid <- expand.grid(.decay = c(.001, .01, .1), .size = seq(1, 27, by = 2), .bag = "F
set.seed(444)
modtrainnn2 <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=trainin
                     linout=TRUE, trace=FALSE, maxit = 300, tuneGrid = nnetgrid, trContro
summary(modtrainnn2)
```

```
Warning message:
executing %dopar% sequentially: no parallel backend registered
```

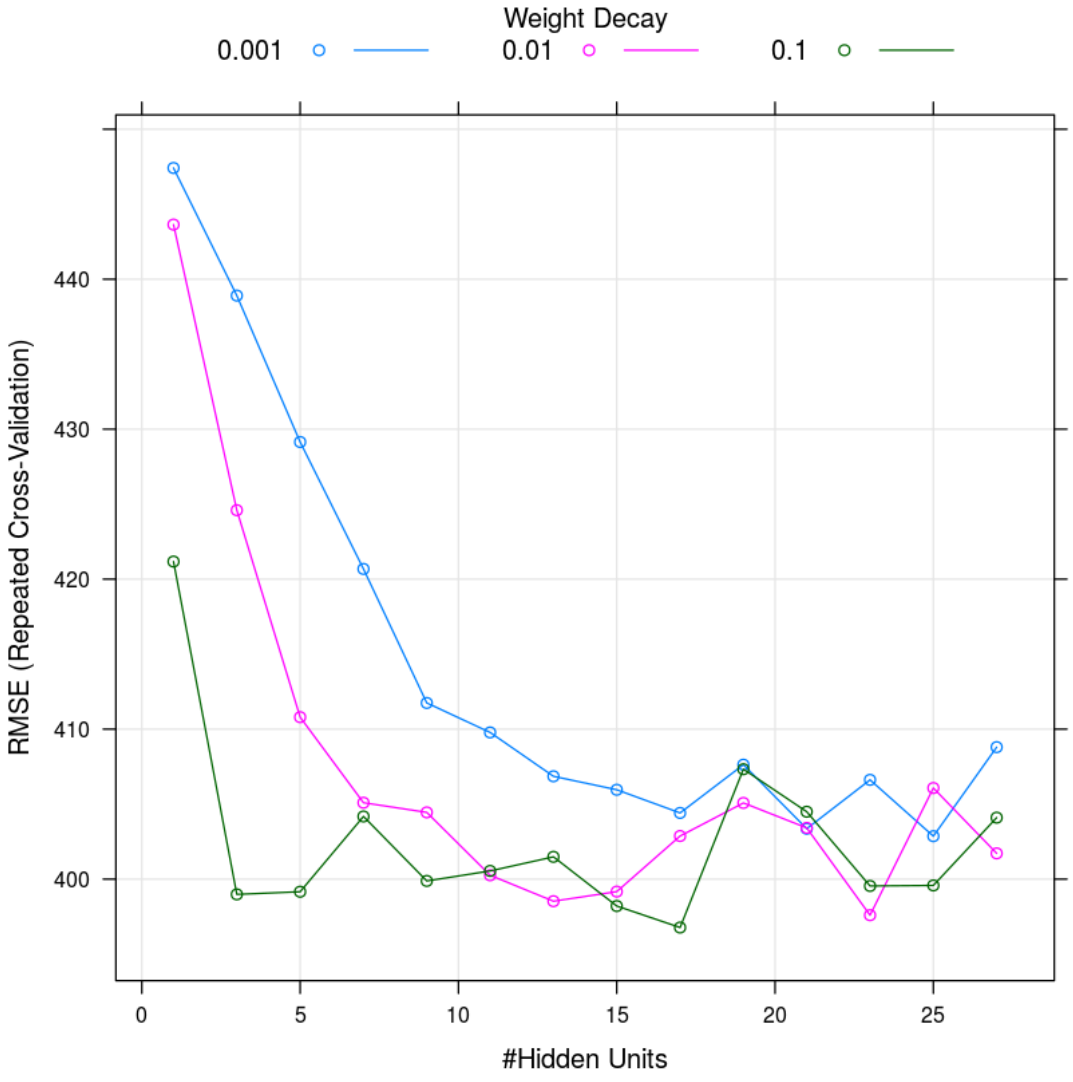
In [38]:
```
modtrainnn2
```

```
Model Averaged Neural Network
```

```
1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  decay  size  RMSE      Rsquared    MAE
  0.001   1    447.4146  0.09946967  302.2783
  0.001   3    438.9070  0.12861305  292.7381
  0.001   5    429.1459  0.16438070  280.8005
  0.001   7    420.6823  0.19063635  270.2074
  0.001   9    411.7463  0.22631357  263.9269
  0.001  11    409.7810  0.21902063  259.0794
  0.001  13    406.8567  0.22253950  255.1155
  0.001  15    405.9582  0.22729033  253.9464
  0.001  17    404.4130  0.23781404  255.6874
  0.001  19    407.6295  0.22228781  256.2199
  0.001  21    403.3624  0.23378017  252.9529
  0.001  23    406.6200  0.22392330  253.5024
  0.001  25    402.8641  0.23542292  252.6106
  0.001  27    408.8001  0.21292862  253.7254
  0.010   1    443.6409  0.12237156  297.5510
  0.010   3    424.5994  0.19851718  278.3241
  0.010   5    410.8001  0.23071908  260.4935
  0.010   7    405.0941  0.24418469  253.8014
  0.010   9    404.4498  0.23511093  251.4872
  0.010  11    400.2573  0.24545165  248.6737
  0.010  13    398.5286  0.25450556  249.0246
  0.010  15    399.1691  0.24737746  248.2545
  0.010  17    402.8751  0.23267458  249.5893
  0.010  19    405.0791  0.23393979  249.6743
  0.010  21    403.4160  0.23801062  249.7899
  0.010  23    397.5957  0.25556965  247.7059
  0.010  25    406.0742  0.23165564  250.4620
  0.010  27    401.7177  0.24339455  249.0116
  0.100   1    421.1741  0.19491138  272.8871
  0.100   3    398.9845  0.25284676  248.8020
  0.100   5    399.1592  0.25236365  247.1619
  0.100   7    404.1788  0.23454458  247.5176
  0.100   9    399.8798  0.24681268  245.3955
  0.100  11    400.5484  0.24854676  246.4105
  0.100  13    401.4869  0.24128665  246.4975
  0.100  15    398.2065  0.25439592  245.8281
  0.100  17    396.7736  0.25394461  246.1112
  0.100  19    407.3287  0.22387052  249.7436
```

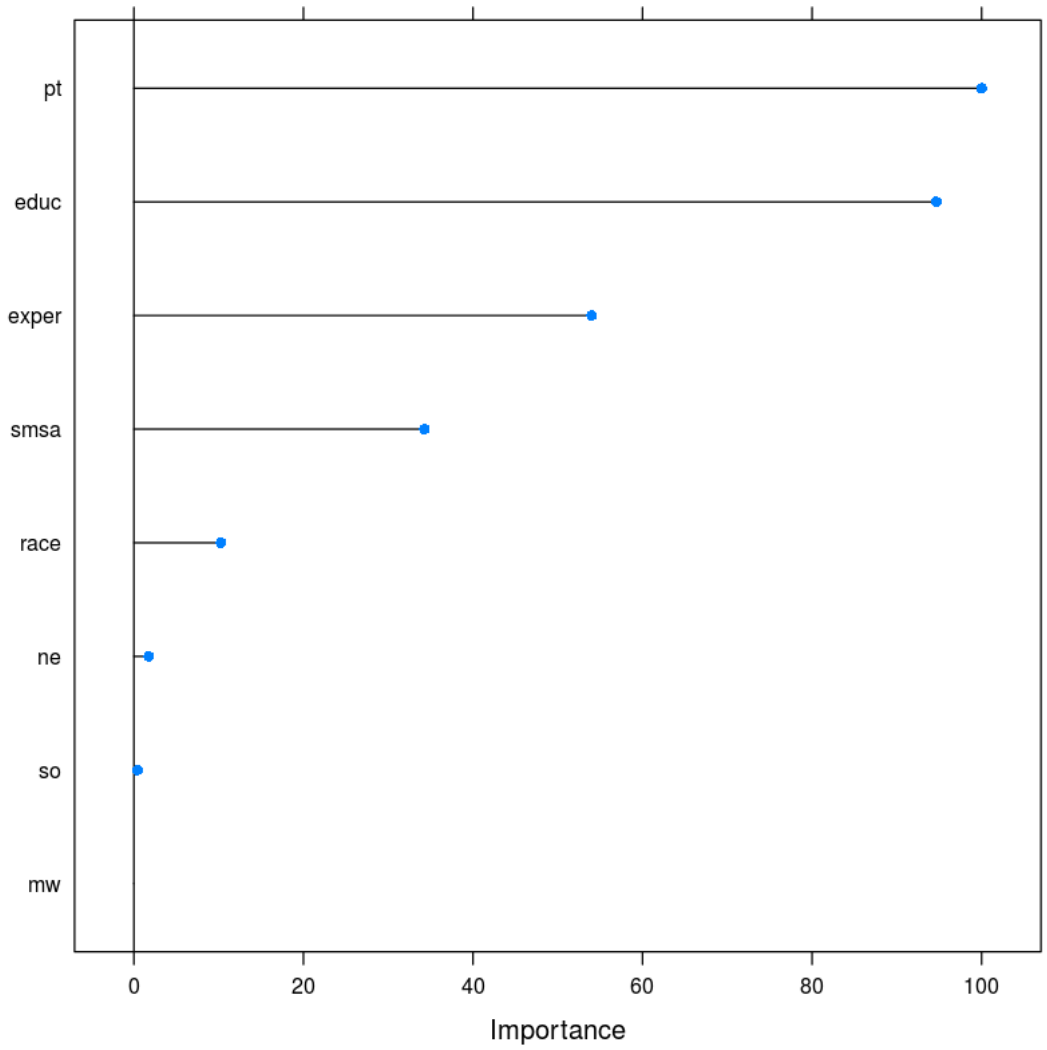
```
  0.100  21    404.4947  0.23249587  248.1279
  0.100  23    399.5446  0.24622004  246.4894
  0.100  25    399.5803  0.24511788  248.1500
  0.100  27    404.0995  0.23030917  248.8537

Tuning parameter 'bag' was held constant at a value of FALSE
RMSE was used to select the optimal model using the smallest value.
The final values used for the model were size = 17, decay = 0.1 and bag = FALSE.
```

In [39]:
```
plot(modtrainnn2)
```



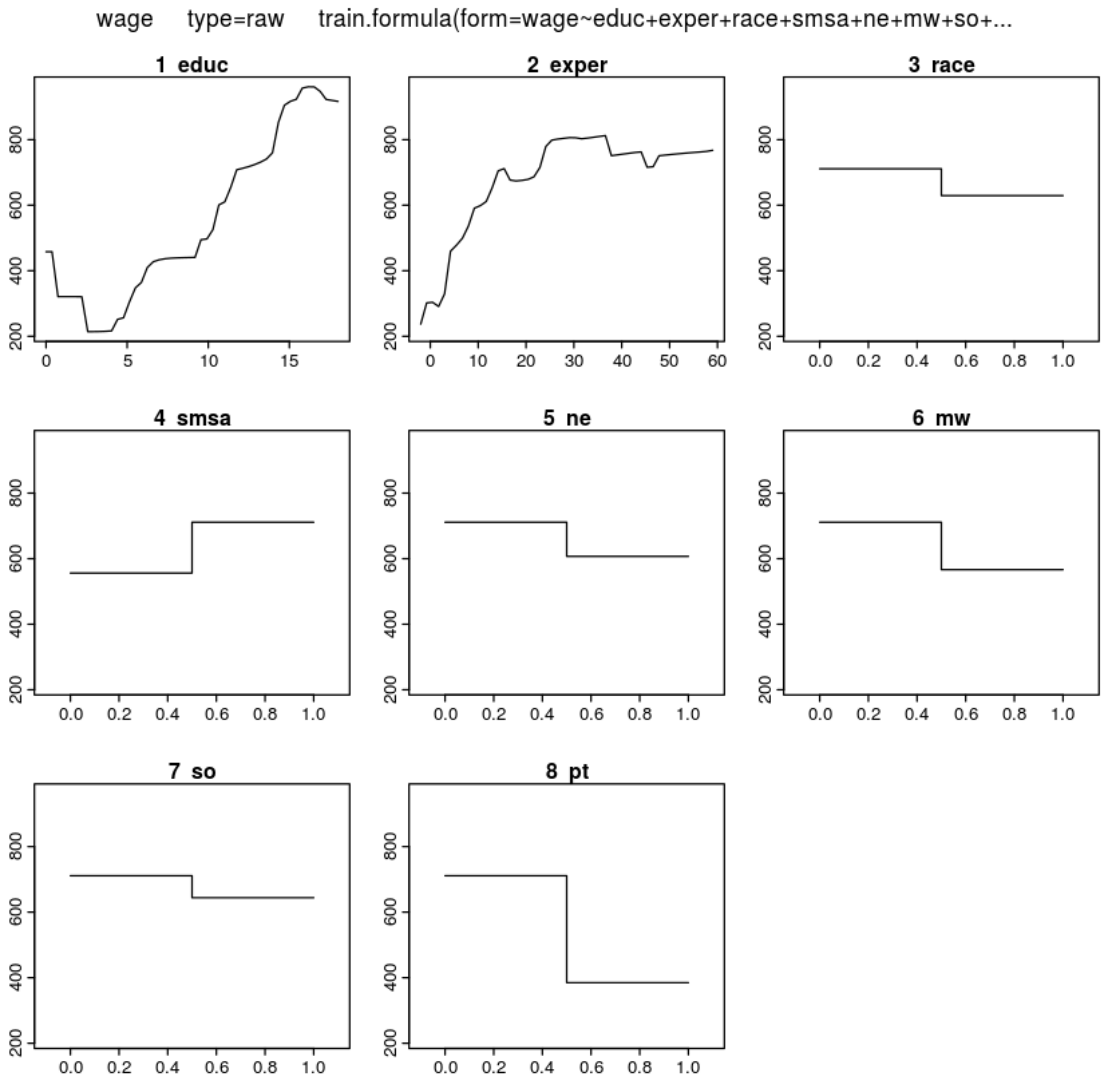
In [40]:
```
varImp(modtrainnn2)
plot(varImp(modtrainnn2))
```

```
loess r-squared variable importance

       Overall
pt    100.0000
educ   94.6507
exper  53.9982
smsa   34.2715
race   10.2629
ne      1.7458
so      0.4235
mw      0.0000
```

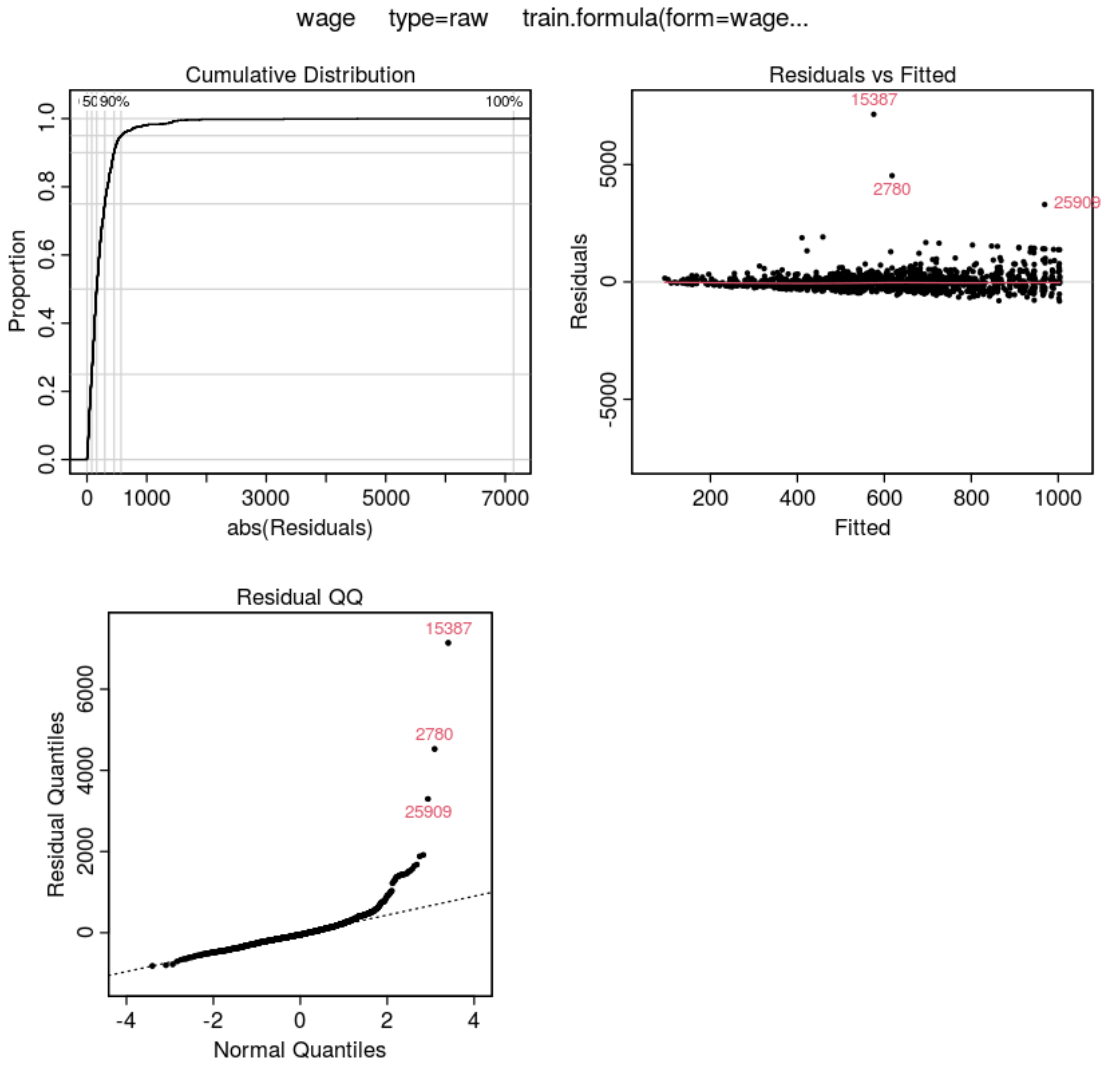


In [41]: `plotmo(modtrainnn2)`

```
plotmo grid:    educ exper race smsa ne mw so pt
                  12    15    0    1  0  0  0  0
```



In [42]: `plotres(modtrainnn2)`



1.13.1 Using an expanded grid for the Nueral Network reduced the RMSE from 408 to 404, increased the R2 from .22 to .23, and reduced the MAE from 257 to 248.

1.14 Multivariate Adaptive Regression Splines (MARS)

```
In [35]: install.packages("earth")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [82]: library(earth)
```

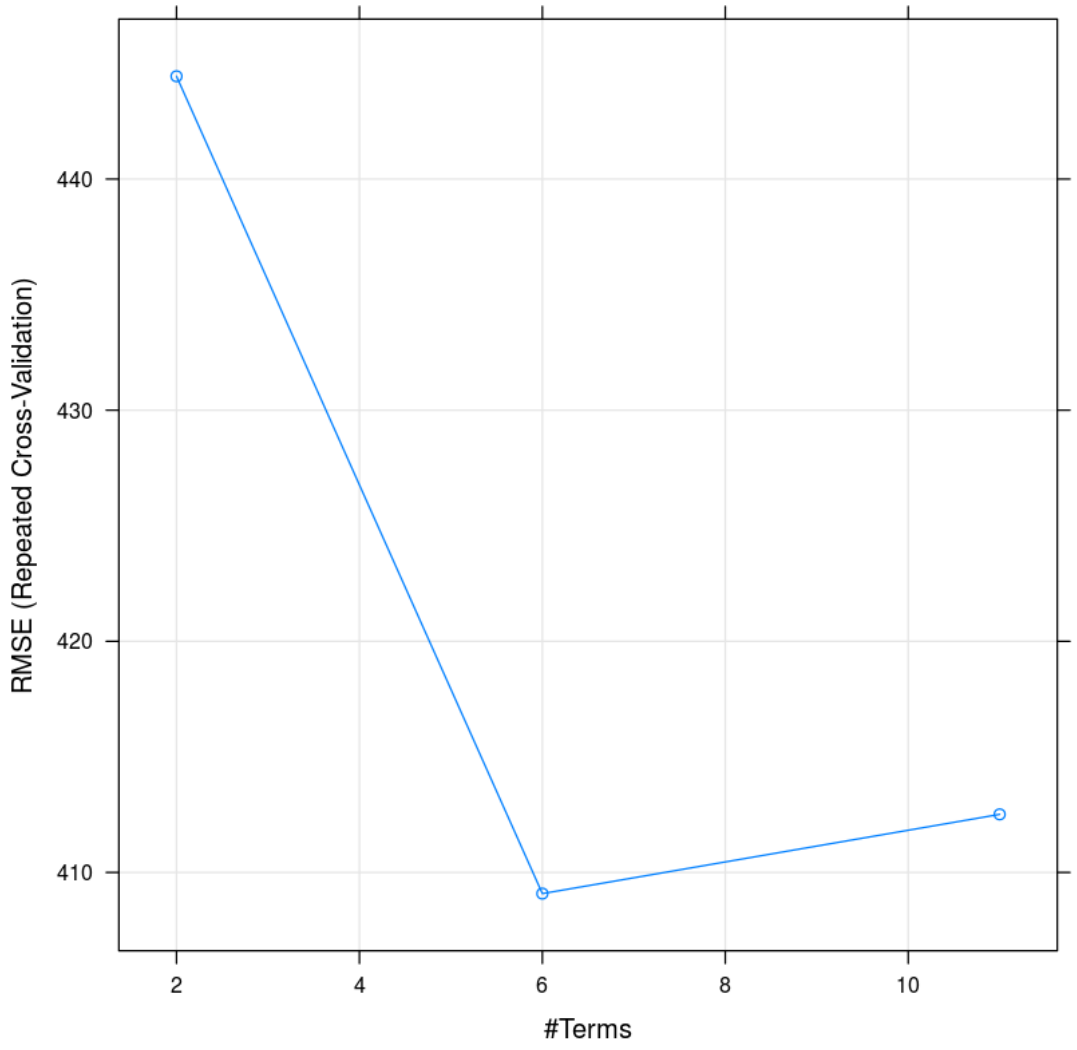
```
In [248]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
          set.seed(444)
          modtrainmars <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=trai
                                trControl = controlobject)
          summary(modtrainmars)
```

```
Warning message in nominalTrainWorkflow(x = x, y = y, wts = weights, info = trainInfo, :
There were missing values in resampled performance measures.


Call: earth(x=matrix[1502,8], y=c(617,958,617,9...), keepxy=TRUE, degree=1,
            nprune=6)

            coefficients
(Intercept)    268.95934
pt            -324.35204
h(educ-5)       58.84530
h(18-exper)    -22.09251
h(exper-49)   -222.82425
h(exper-52)    942.84853

Selected 6 of 13 terms, and 3 of 8 predictors (nprune=6)
Termination condition: Reached nk 21
Importance: exper, educ, pt, race-unused, smsa-unused, ne-unused, ...
Number of terms at each degree of interaction: 1 5 (additive model)
GCV 148656.7    RSS 220023851    GRSq 0.311942    RSq 0.3210795
```

```
In [249]: modtrainmars
```

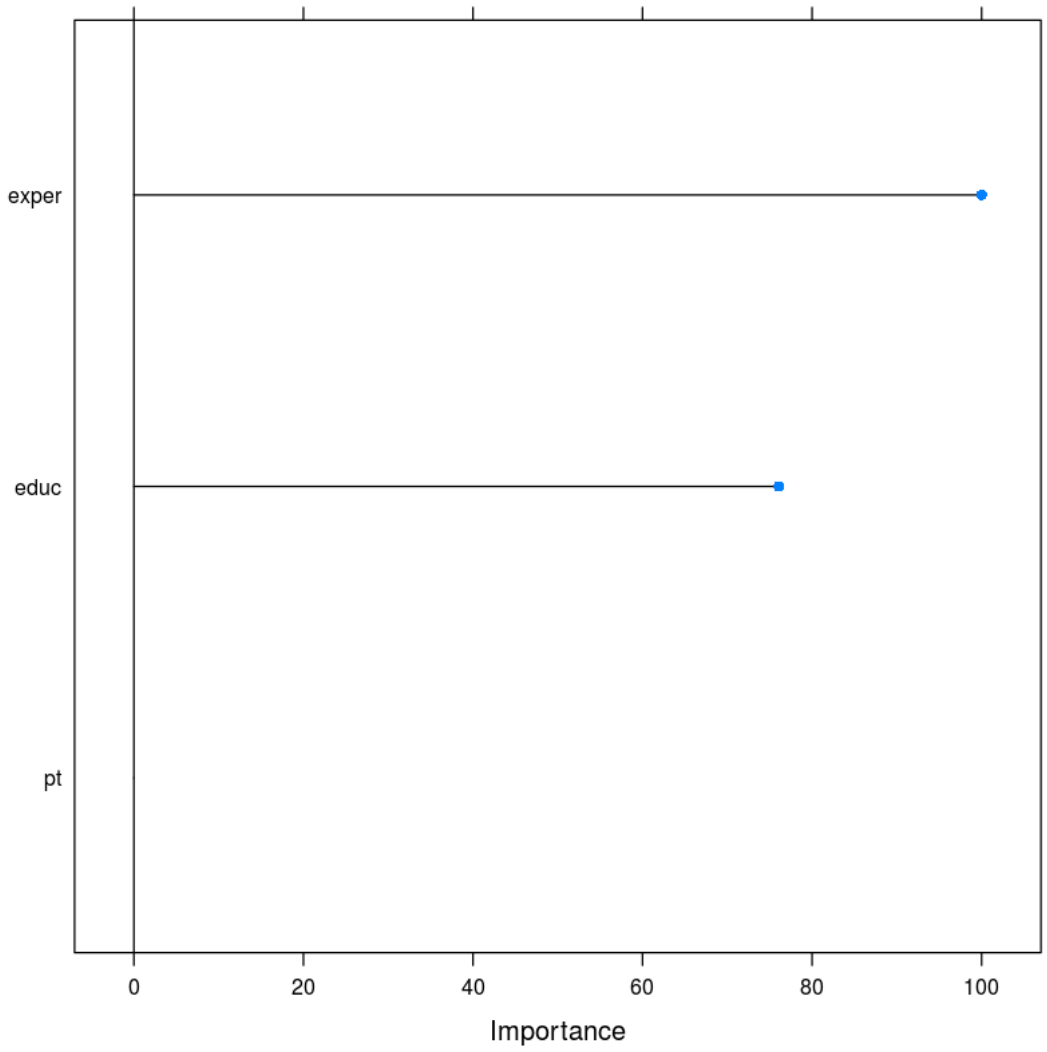
```
Multivariate Adaptive Regression Spline

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  nprune  RMSE      Rsquared    MAE
   2      444.4480  0.06741697  290.7518
   6      409.0863  0.23009618  247.7738
  11      412.5142  0.23339404  247.6904

Tuning parameter 'degree' was held constant at a value of 1
RMSE was used to select the optimal model using the smallest value.
The final values used for the model were nprune = 6 and degree = 1.
```

In [85]: plot(modtrainmars)

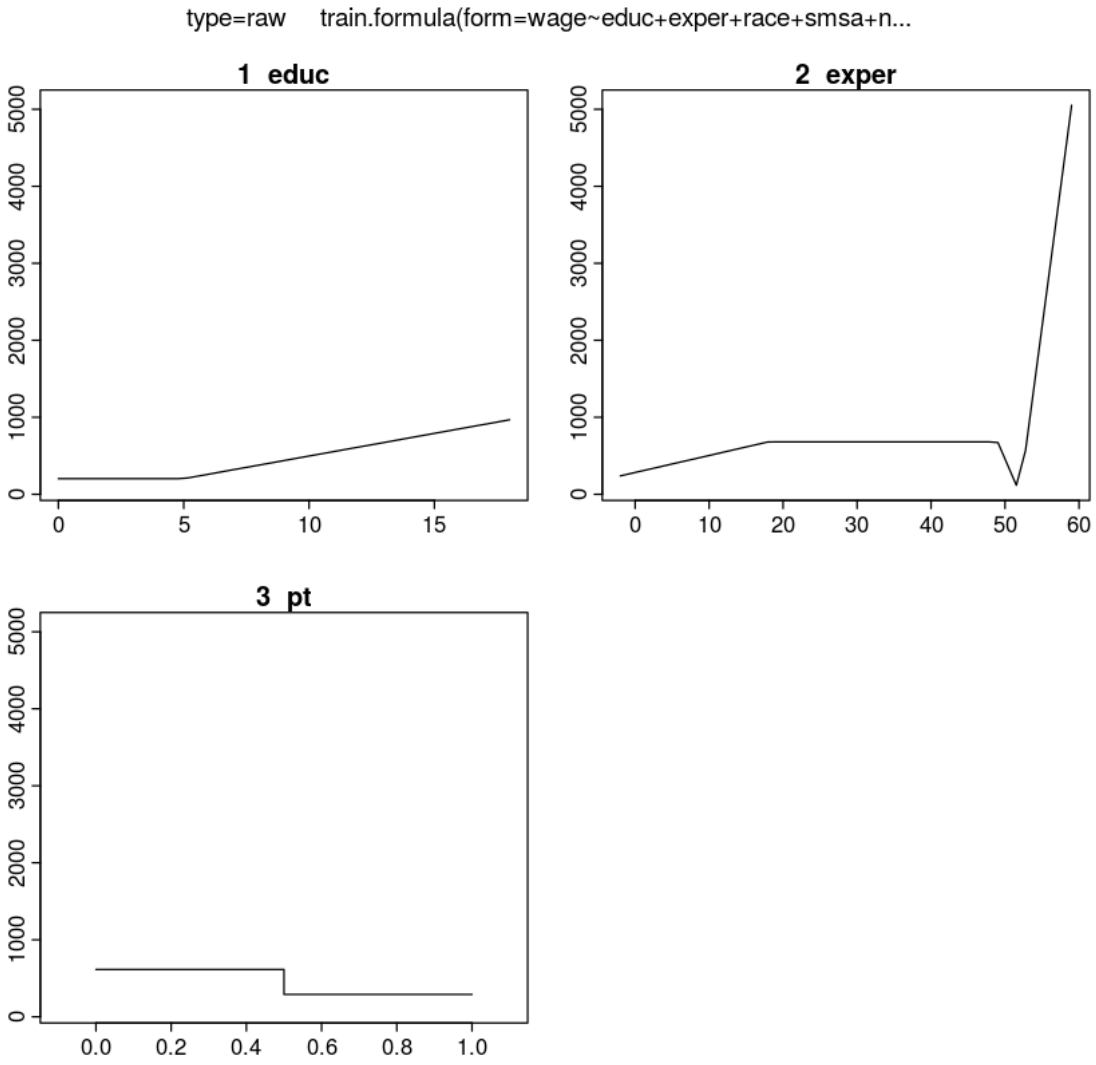


In [86]: varImp(modtrainmars)
         plot(varImp(modtrainmars))

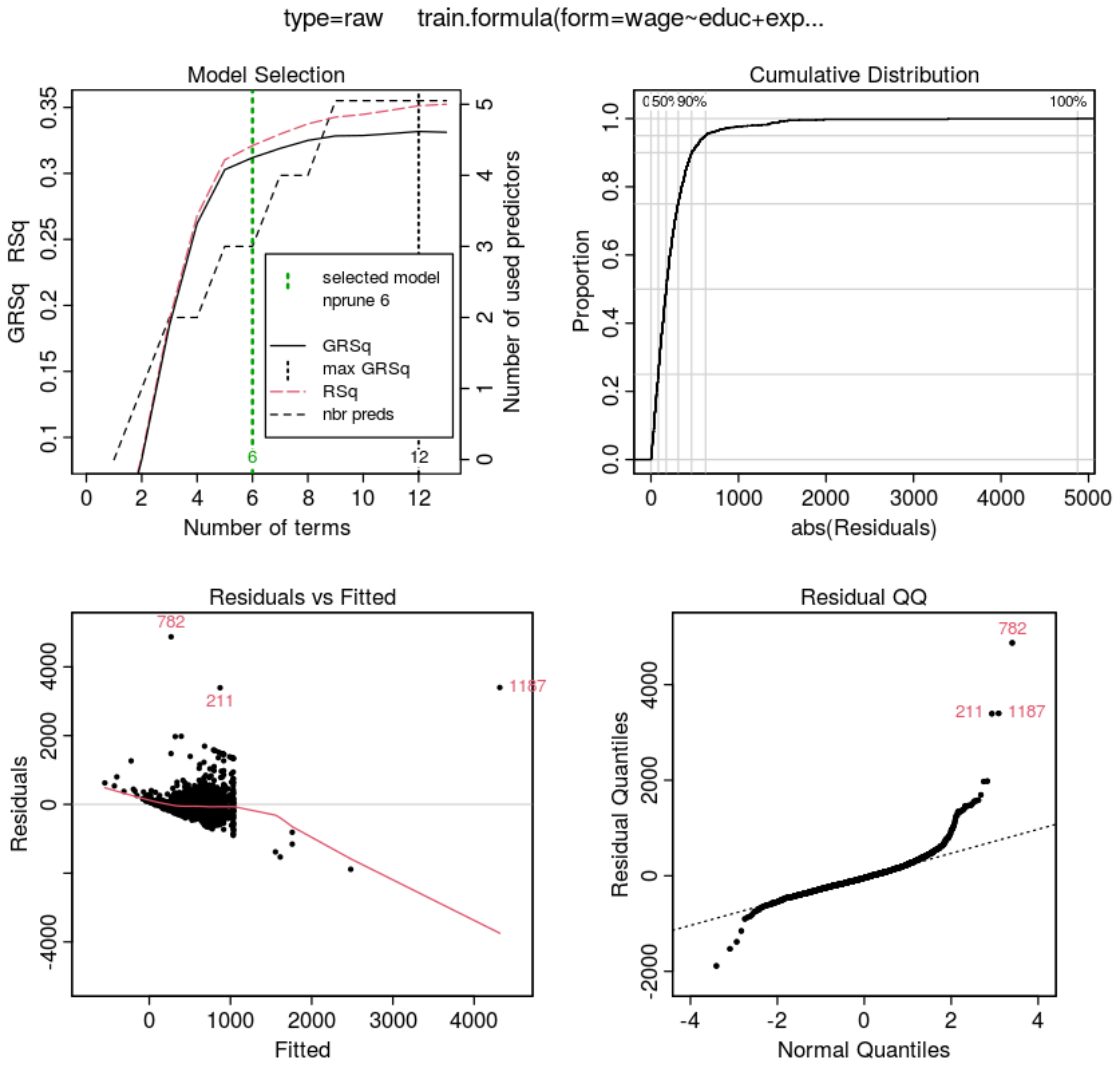
```
earth variable importance

      Overall
exper  100.00
educ    76.07
pt       0.00
```




```
In [87]: plotmo(modtrainmars)

 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```



In [88]: `plotres(modtrainmars)`



1.15 Support Vector Machines (SVM)

```
In [49]: install.packages("kernlab")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [89]: library(kernlab)
```

```
Attaching package: kernlab
```

```
The following object is masked from package:ggplot2:

    alpha
```

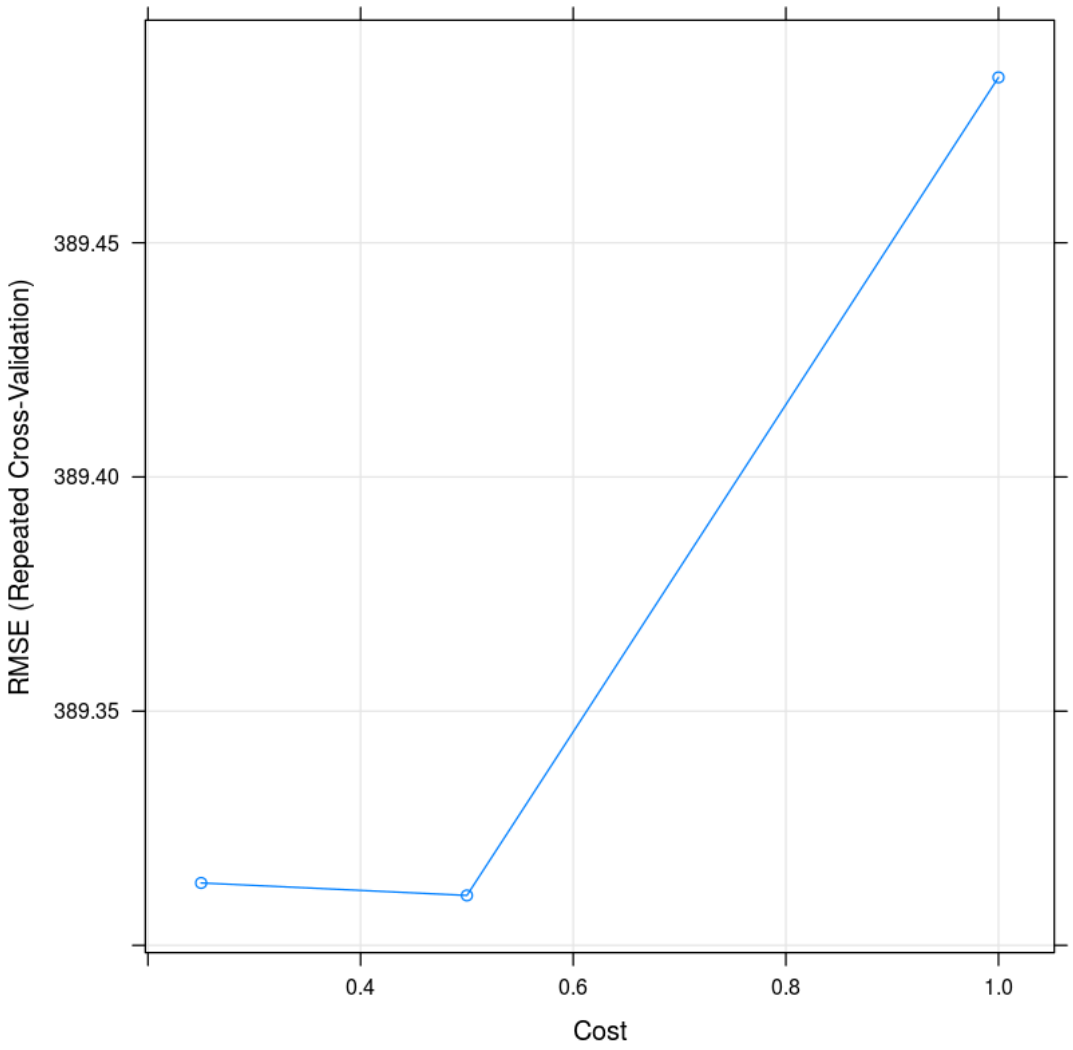
```
In [90]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainsvm <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=traini
                              trControl = controlobject)
         summary(modtrainsvm)
```

```
Length  Class   Mode
     1   ksvm     S4
```

```
In [91]: modtrainsvm
```

```
Support Vector Machines with Radial Basis Function Kernel

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  C     RMSE      Rsquared   MAE
  0.25  389.3133  0.2994972  228.6149
  0.50  389.3107  0.2970991  229.3377
  1.00  389.4853  0.2949734  230.4997

Tuning parameter 'sigma' was held constant at a value of 0.1230209
RMSE was used to select the optimal model using the smallest value.
The final values used for the model were sigma = 0.1230209 and C = 0.5.
```

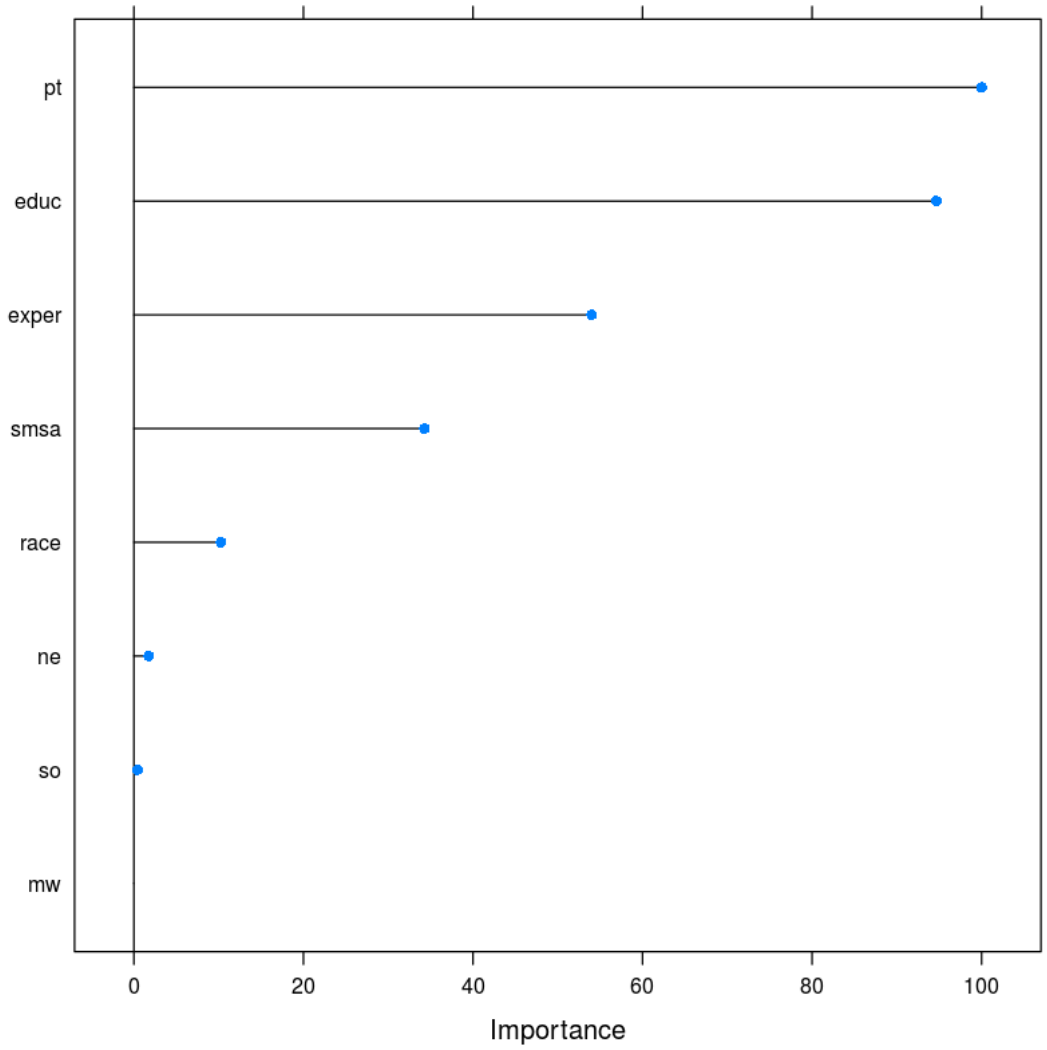
```
In [92]: plot(modtrainsvm)
```



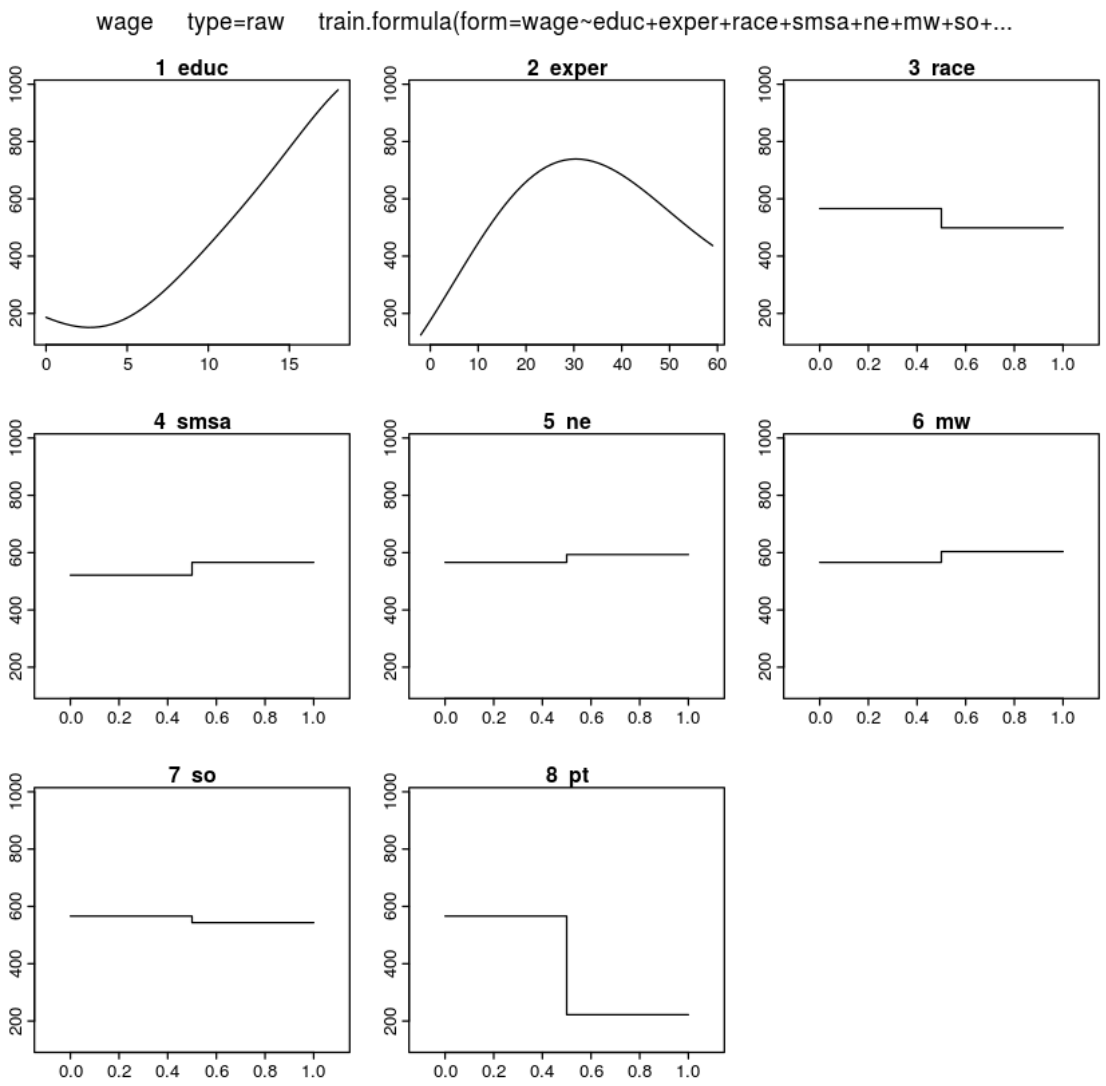

```
In [93]: varImp(modtrainsvm)
         plot(varImp(modtrainsvm))
```

```
loess r-squared variable importance

       Overall
pt    100.0000
educ   94.6507
exper  53.9982
smsa   34.2715
race   10.2629
ne      1.7458
so      0.4235
```

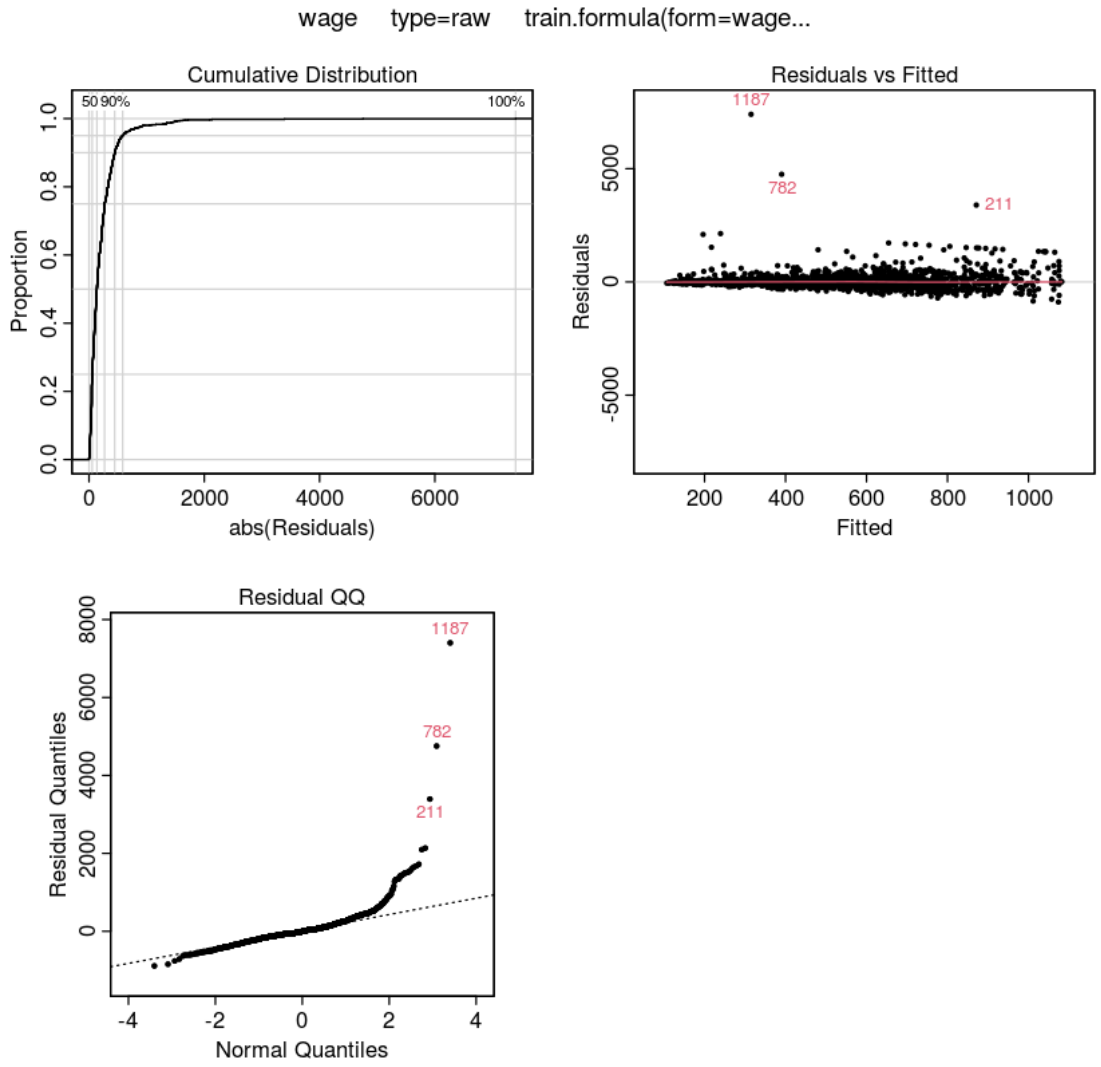
```
mw      0.0000
```




```
In [94]: plotmo(modtrainsvm)

 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```



In [95]: plotres(modtrainsvm)




```
In [31]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainsvm2 <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=train
                               trControl = controlobject, tuneLength = 15)
         summary(modtrainsvm2)
```

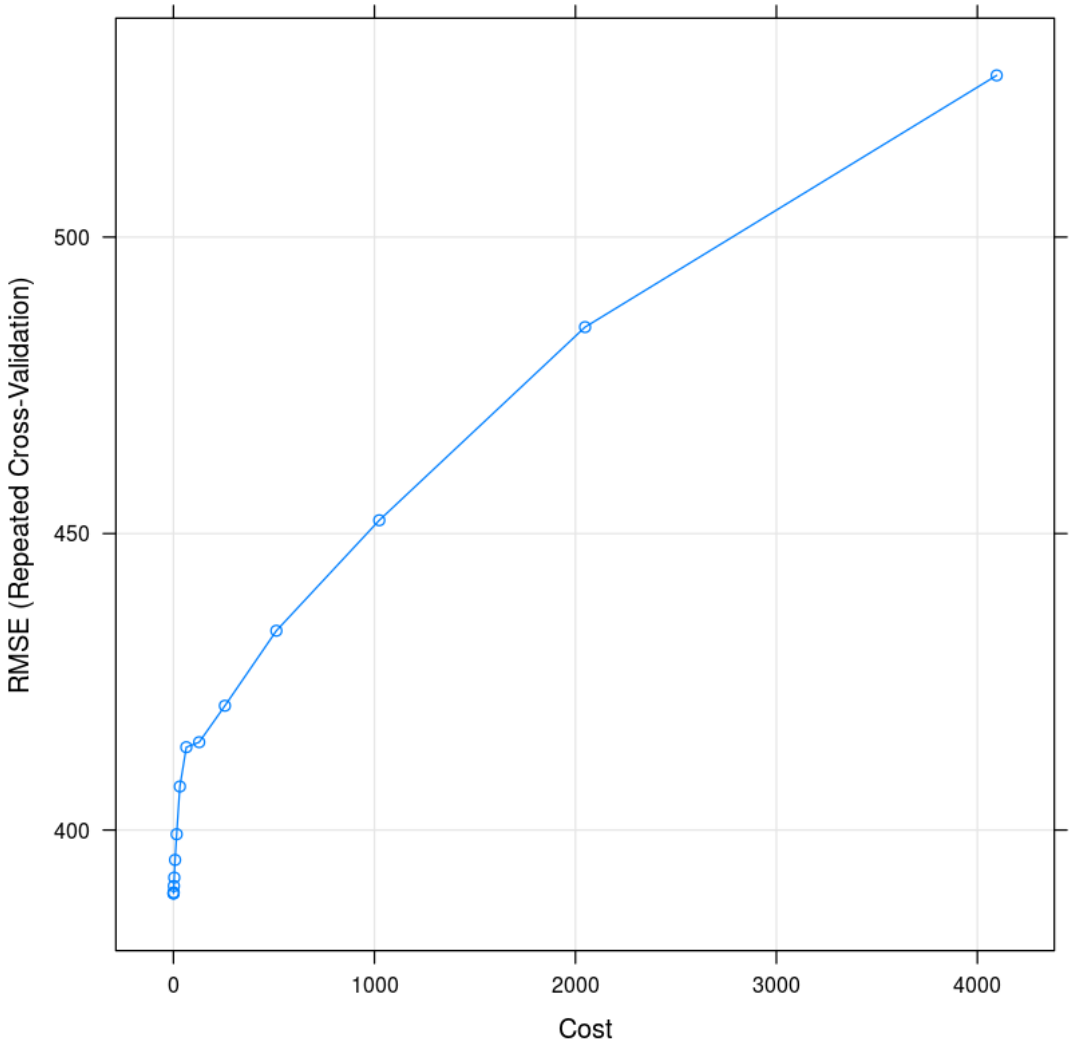
```
Length  Class   Mode
     1   ksvm     S4
```

```
In [32]: modtrainsvm2
```

```
Support Vector Machines with Radial Basis Function Kernel
```

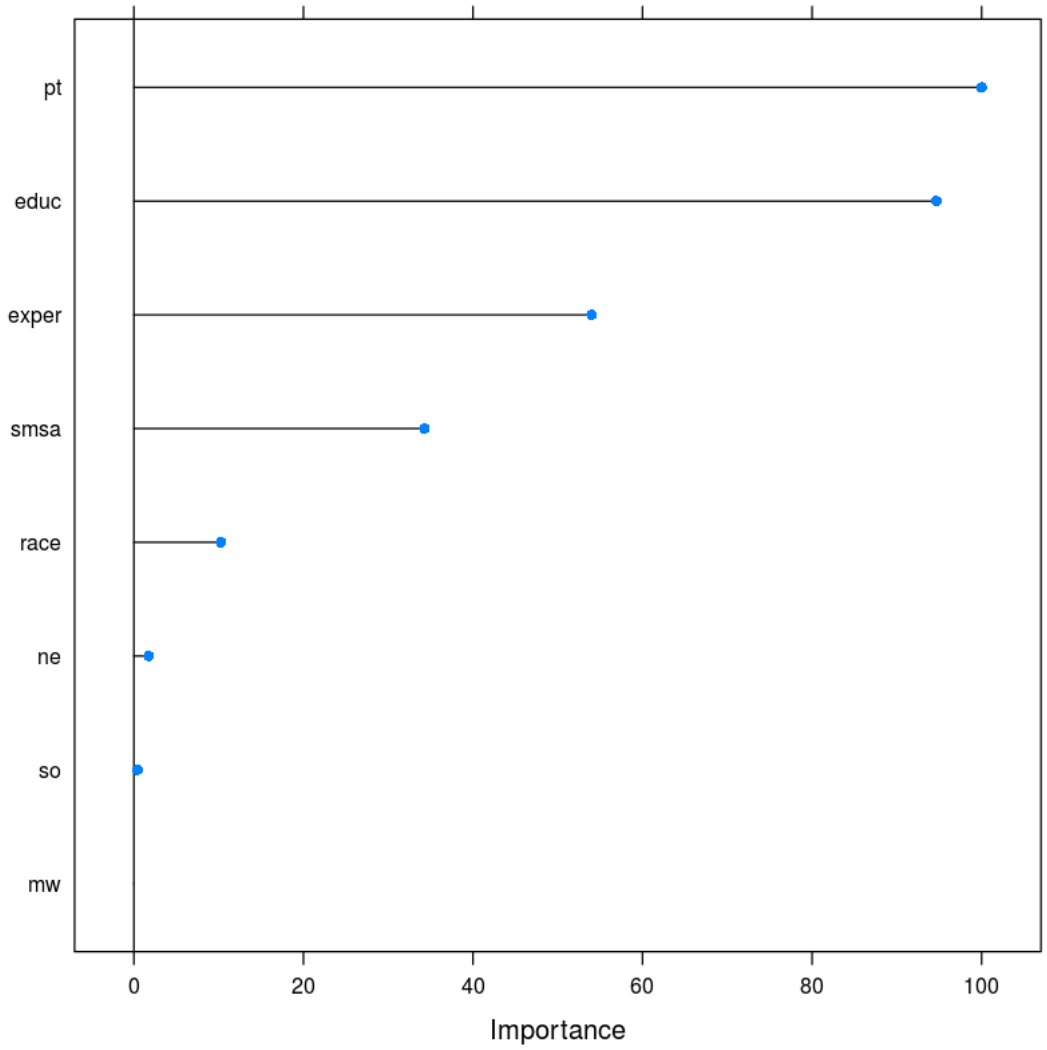
```
1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  C        RMSE      Rsquared   MAE
     0.25  389.3133  0.2994972  228.6149
     0.50  389.3107  0.2970991  229.3377
     1.00  389.4853  0.2949734  230.4997
     2.00  390.5651  0.2905226  232.4253
     4.00  391.9817  0.2851528  234.4987
     8.00  394.9623  0.2746505  237.6997
    16.00  399.2932  0.2594742  241.5122
    32.00  407.3425  0.2388670  245.6905
    64.00  413.9726  0.2221079  249.6119
   128.00  414.8164  0.2205068  251.9687
   256.00  420.9640  0.2082430  255.8906
   512.00  433.6120  0.1898270  262.2011
  1024.00  452.2414  0.1753337  270.1167
  2048.00  484.8215  0.1635310  280.8288
  4096.00  527.2674  0.1591411  293.6546

Tuning parameter 'sigma' was held constant at a value of 0.1230209
RMSE was used to select the optimal model using the smallest value.
The final values used for the model were sigma = 0.1230209 and C = 0.5.
```

In [33]:
```
plot(modtrainsvm2)
```



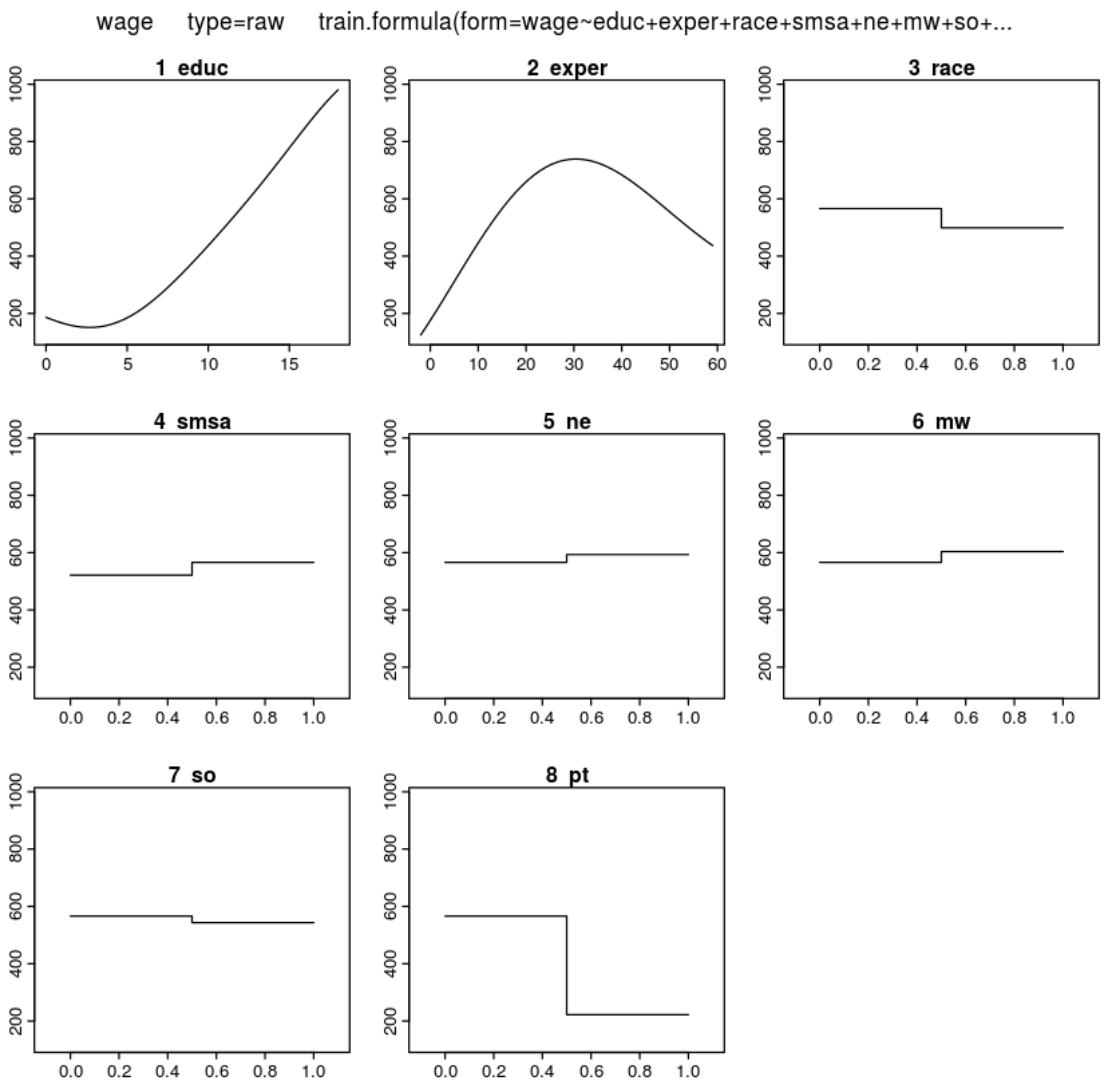

```
In [34]: varImp(modtrainsvm2)
         plot(varImp(modtrainsvm2))

loess r-squared variable importance

       Overall
pt    100.0000
educ   94.6507
exper  53.9982
smsa   34.2715
race   10.2629
ne      1.7458
so      0.4235
```

```
mw      0.0000
```

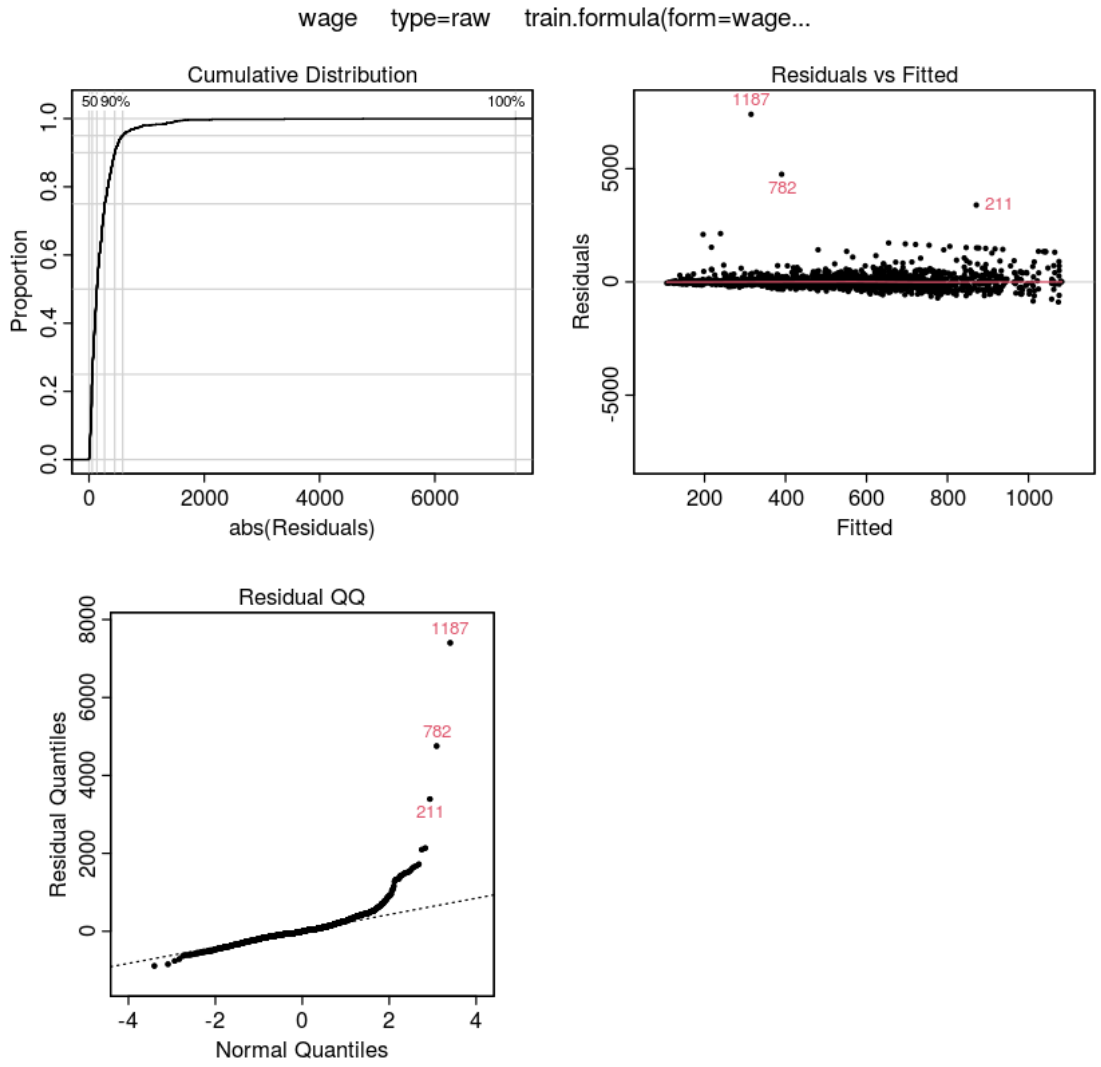


In [35]: `plotmo(modtrainsvm2)`

```
 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```




```
In [36]: plotres(modtrainsvm2)
```



1.15.1 Increasing the tuneLenght to 15 did not effect the model

1.16 K-Nearest Neighbors (KNN)

```
In [96]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
         set.seed(444)
         modtrainknn <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=traini
                              trControl = controlobject)
         summary(modtrainknn)
```

```
            Length Class      Mode
learn       2      -none-     list
k           1      -none-     numeric
```

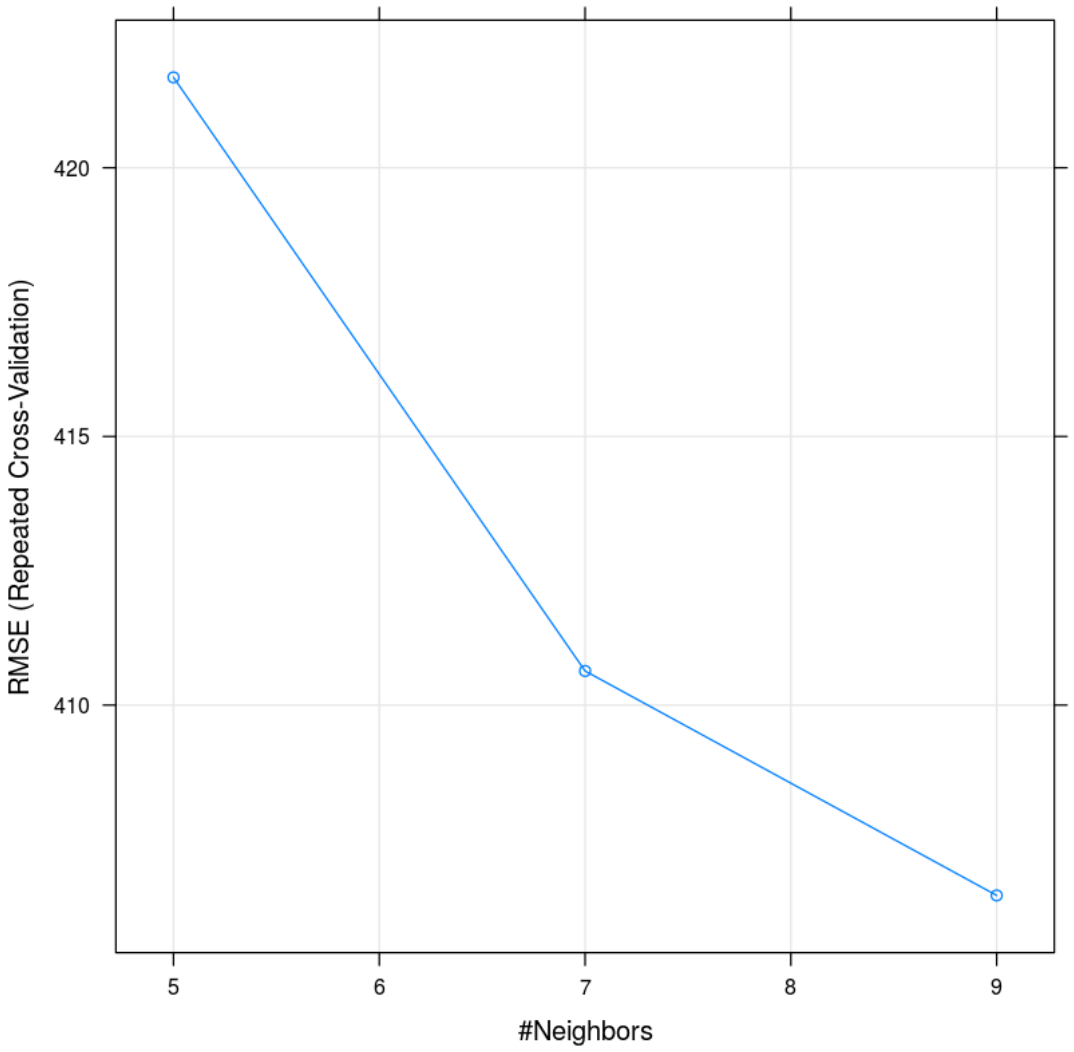
```
theDots     0      -none-     list
xNames      8      -none-     character
problemType 1      -none-     character
tuneValue   1      data.frame list
obsLevels   1      -none-     logical
param       0      -none-     list
```

```
In [97]: modtrainknn
```

```
k-Nearest Neighbors

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  k  RMSE      Rsquared   MAE
  5  421.6820  0.1867480  265.9308
  7  410.6348  0.2111718  259.4275
  9  406.4583  0.2222530  256.7665

RMSE was used to select the optimal model using the smallest value.
The final value used for the model was k = 9.
```

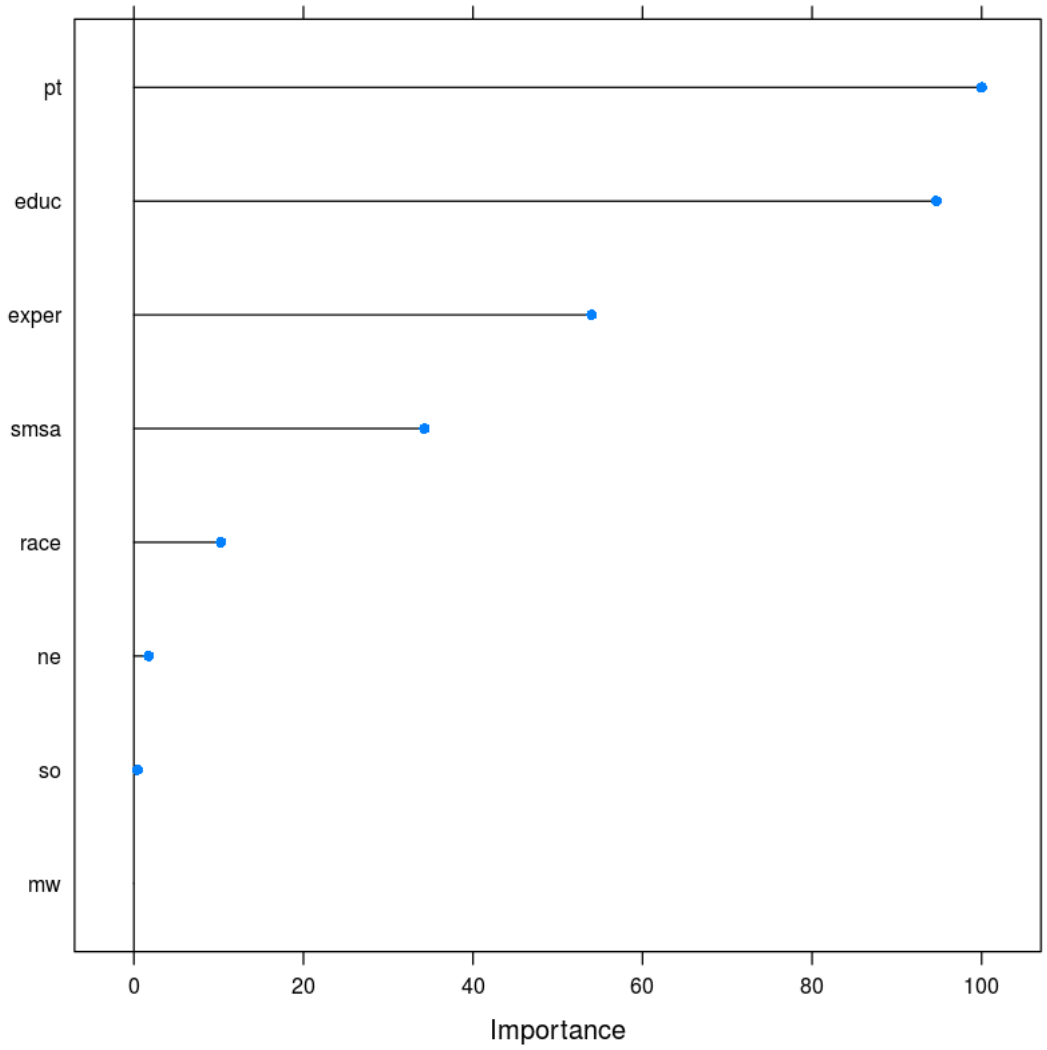
1.16.1 The model used k=9 nearest neighbors.

```
In [98]: plot(modtrainknn)
```



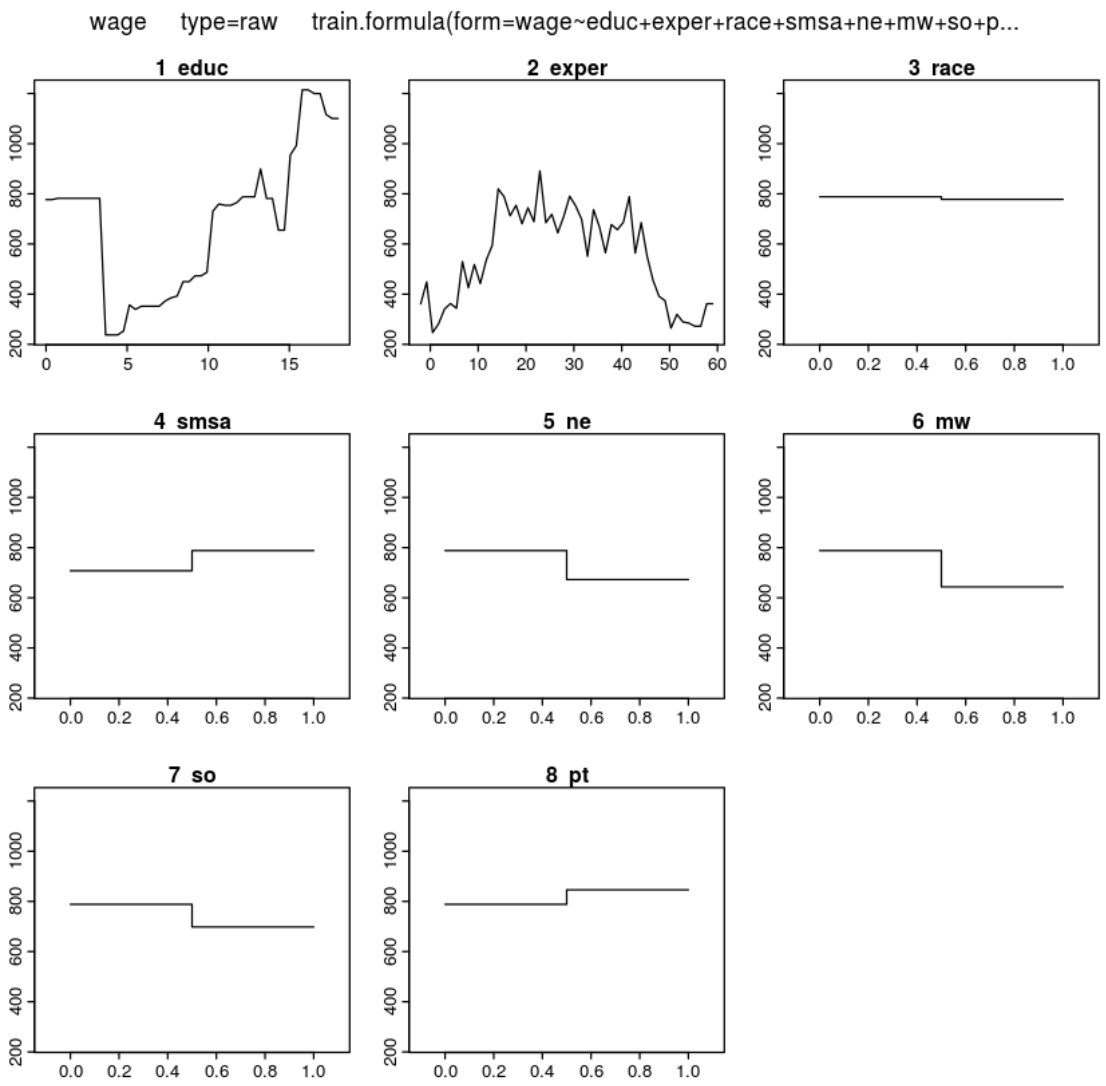

```
In [99]: varImp(modtrainknn)
         plot(varImp(modtrainknn))

loess r-squared variable importance

       Overall
pt    100.0000
educ   94.6507
exper  53.9982
smsa   34.2715
race   10.2629
ne      1.7458
so      0.4235
```

```
mw      0.0000
```

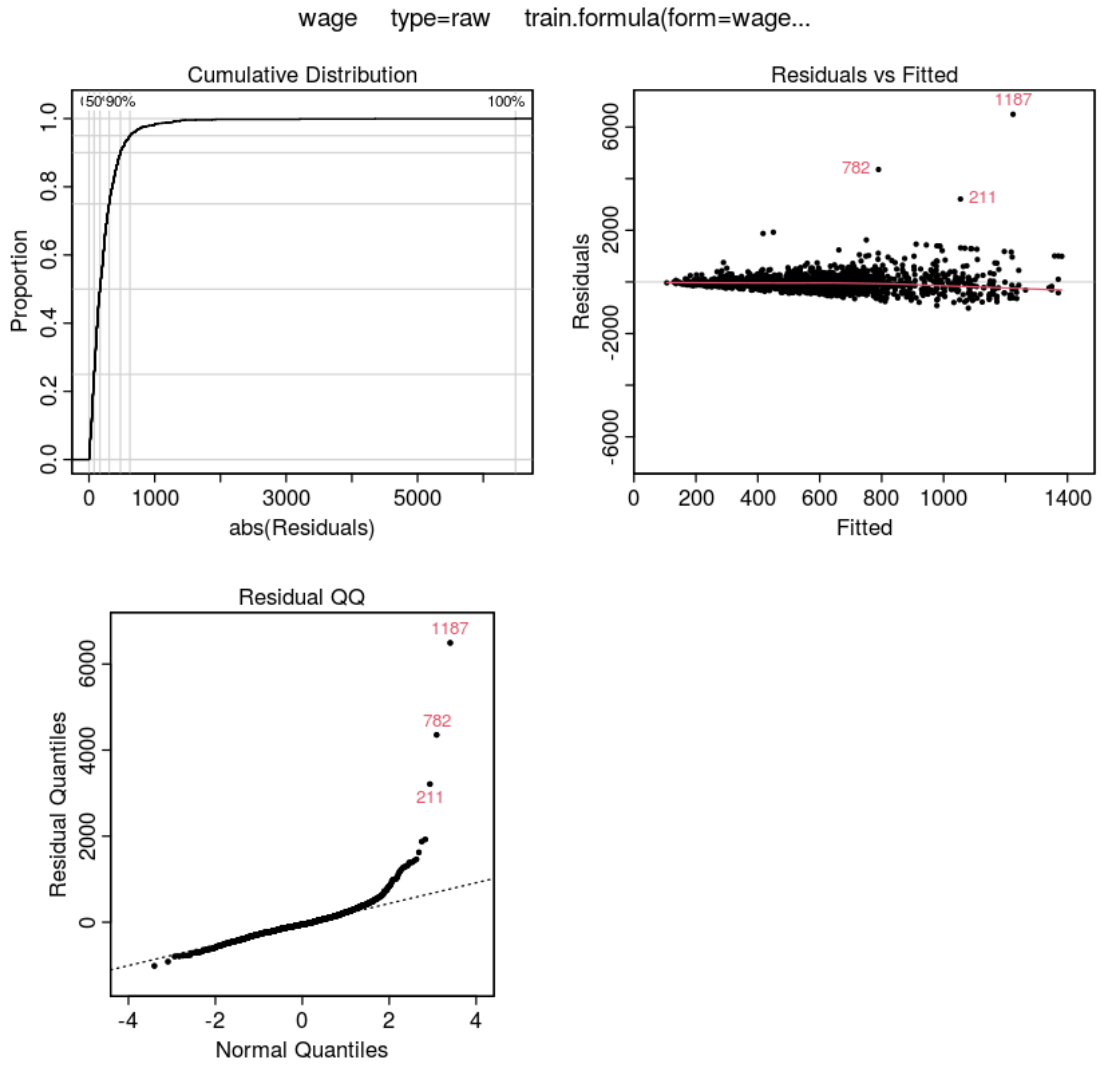


In [100]:
```
plotmo(modtrainknn)
```

```
 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```



In [101]: plotres(modtrainknn)



1.17 Week 5

1.18 Basic Regression Trees (CART)

```
In [91]: install.packages("rpart")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [102]: library(rpart)
```

```
Attaching package: rpart
```

```
The following object is masked from package:faraway:

    solder
```

```
In [103]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
          set.seed(444)
          modtraincart <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=trai
                               trControl = controlobject)
          summary(modtraincart)
```

```
Warning message in nominalTrainWorkflow(x = x, y = y, wts = weights, info = trainInfo, :
There were missing values in resampled performance measures.
```

```
Call:
(function (formula, data, weights, subset, na.action = na.rpart,
    method, model = FALSE, x = FALSE, y = TRUE, parms, control,
    cost, ...)
{
    Call <- match.call()
    if (is.data.frame(model)) {
        m <- model
        model <- FALSE
    }
    else {
        indx <- match(c("formula", "data", "weights", "subset"),
            names(Call), nomatch = 0)
        if (indx[1] == 0)
            stop("a 'formula' argument is required")
        temp <- Call[c(1, indx)]
        temp$na.action <- na.action
        temp[[1]] <- quote(stats::model.frame)
        m <- eval.parent(temp)
    }
    Terms <- attr(m, "terms")
    if (any(attr(Terms, "order") > 1))
        stop("Trees cannot handle interaction terms")
    Y <- model.response(m)
    wt <- model.weights(m)
    if (any(wt < 0))
        stop("negative weights not allowed")
    if (!length(wt))
        wt <- rep(1, nrow(m))
```

```
offset <- model.offset(m)
X <- rpart.matrix(m)
nobs <- nrow(X)
nvar <- ncol(X)
if (missing(method)) {
    method <- if (is.factor(Y) || is.character(Y))
        "class"
    else if (inherits(Y, "Surv"))
        "exp"
    else if (is.matrix(Y))
        "poisson"
    else "anova"
}
if (is.list(method)) {
    mlist <- method
    method <- "user"
    init <- if (missing(parms))
        mlist$init(Y, offset, wt = wt)
    else mlist$init(Y, offset, parms, wt)
    keep <- rpartcallback(mlist, nobs, init)
    method.int <- 4
    parms <- init$parms
}
else {
    method.int <- pmatch(method, c("anova", "poisson", "class",
        "exp"))
    if (is.na(method.int))
        stop("Invalid method")
    method <- c("anova", "poisson", "class", "exp")[method.int]
    if (method.int == 4)
        method.int <- 2
    init <- if (missing(parms))
        get(paste("rpart", method, sep = "."), envir = environment())(Y,
            offset, , wt)
    else get(paste("rpart", method, sep = "."), envir = environment())(Y,
        offset, parms, wt)
    ns <- asNamespace("rpart")
    if (!is.null(init$print))
        environment(init$print) <- ns
    if (!is.null(init$summary))
        environment(init$summary) <- ns
    if (!is.null(init$text))
        environment(init$text) <- ns
}
Y <- init$y
xlevels <- .getXlevels(Terms, m)
cats <- rep(0, ncol(X))
if (!is.null(xlevels))
```

```
    cats[match(names(xlevels), colnames(X))] <- unlist(lapply(xlevels,
        length))
extraArgs <- list(...)
if (length(extraArgs)) {
    controlargs <- names(formals(rpart.control))
    indx <- match(names(extraArgs), controlargs, nomatch = 0)
    if (any(indx == 0))
        stop(gettextf("Argument %s not matched", names(extraArgs)[indx ==
            0]), domain = NA)
}
controls <- rpart.control(...)
if (!missing(control))
    controls[names(control)] <- control
xval <- controls$xval
if (is.null(xval) || (length(xval) == 1 && xval == 0) ||
    method == "user") {
    xgroups <- 0
    xval <- 0
}
else if (length(xval) == 1) {
    xgroups <- sample(rep(1:xval, length = nobs), nobs, replace = FALSE)
}
else if (length(xval) == nobs) {
    xgroups <- xval
    xval <- length(unique(xgroups))
}
else {
    if (!is.null(attr(m, "na.action"))) {
        temp <- as.integer(attr(m, "na.action"))
        xval <- xval[-temp]
        if (length(xval) == nobs) {
            xgroups <- xval
            xval <- length(unique(xgroups))
        }
        else stop("Wrong length for 'xval'")
    }
    else stop("Wrong length for 'xval'")
}
if (missing(cost))
    cost <- rep(1, nvar)
else {
    if (length(cost) != nvar)
        stop("Cost vector is the wrong length")
    if (any(cost <= 0))
        stop("Cost vector must be positive")
}
tfun <- function(x) if (is.matrix(x))
    rep(is.ordered(x), ncol(x))
```

```
else is.ordered(x)
labs <- sub("^`(.*)`$", "\\1", attr(Terms, "term.labels"))
isord <- unlist(lapply(m[labs], tfun))
storage.mode(X) <- "double"
storage.mode(wt) <- "double"
temp <- as.double(unlist(init$parms))
if (!length(temp))
    temp <- 0
rpfit <- .Call(C_rpart, ncat = as.integer(cats * !isord),
    method = as.integer(method.int), as.double(unlist(controls)),
    temp, as.integer(xval), as.integer(xgroups), as.double(t(init$y)),
    X, wt, as.integer(init$numy), as.double(cost))
nsplit <- nrow(rpfit$isplit)
ncat <- if (!is.null(rpfit$csplit))
    nrow(rpfit$csplit)
else 0
if (nsplit == 0)
    xval <- 0
numcp <- ncol(rpfit$cptable)
temp <- if (nrow(rpfit$cptable) == 3)
    c("CP", "nsplit", "rel error")
else c("CP", "nsplit", "rel error", "xerror", "xstd")
dimnames(rpfit$cptable) <- list(temp, 1:numcp)
tname <- c("<leaf>", colnames(X))
splits <- matrix(c(rpfit$isplit[, 2:3], rpfit$dsplit), ncol = 5,
    dimnames = list(tname[rpfit$isplit[, 1] + 1], c("count",
        "ncat", "improve", "index", "adj")))
index <- rpfit$inode[, 2]
nadd <- sum(isord[rpfit$isplit[, 1]])
if (nadd > 0) {
    newc <- matrix(0, nadd, max(cats))
    cvar <- rpfit$isplit[, 1]
    indx <- isord[cvar]
    cdir <- splits[indx, 2]
    ccut <- floor(splits[indx, 4])
    splits[indx, 2] <- cats[cvar[indx]]
    splits[indx, 4] <- ncat + 1:nadd
    for (i in 1:nadd) {
        newc[i, 1:(cats[(cvar[indx])[i]])] <- -as.integer(cdir[i])
        newc[i, 1:ccut[i]] <- as.integer(cdir[i])
    }
    catmat <- if (ncat == 0)
        newc
    else {
        cs <- rpfit$csplit
        ncs <- ncol(cs)
        ncc <- ncol(newc)
        if (ncs < ncc)
```

```
            cs <- cbind(cs, matrix(0, nrow(cs), ncc - ncs))
        rbind(cs, newc)
    }
    ncat <- ncat + nadd
}
else catmat <- rpfit$csplit
if (nsplit == 0) {
    frame <- data.frame(row.names = 1, var = "<leaf>", n = rpfit$inode[,
        5], wt = rpfit$dnode[, 3], dev = rpfit$dnode[, 1],
        yval = rpfit$dnode[, 4], complexity = rpfit$dnode[,
            2], ncompete = 0, nsurrogate = 0)
}
else {
    temp <- ifelse(index == 0, 1, index)
    svar <- ifelse(index == 0, 0, rpfit$isplit[temp, 1])
    frame <- data.frame(row.names = rpfit$inode[, 1], var = tname[svar +
        1], n = rpfit$inode[, 5], wt = rpfit$dnode[, 3],
        dev = rpfit$dnode[, 1], yval = rpfit$dnode[, 4],
        complexity = rpfit$dnode[, 2], ncompete = pmax(0,
            rpfit$inode[, 3] - 1), nsurrogate = rpfit$inode[,
            4])
}
if (method.int == 3) {
    numclass <- init$numresp - 2
    nodeprob <- rpfit$dnode[, numclass + 5]/sum(wt)
    temp <- pmax(1, init$counts)
    temp <- rpfit$dnode[, 4 + (1:numclass)] %*% diag(init$parms$prior/temp)
    yprob <- temp/rowSums(temp)
    yval2 <- matrix(rpfit$dnode[, 4 + (0:numclass)], ncol = numclass +
        1)
    frame$yval2 <- cbind(yval2, yprob, nodeprob)
}
else if (init$numresp > 1)
    frame$yval2 <- rpfit$dnode[, -(1:3), drop = FALSE]
if (is.null(init$summary))
    stop("Initialization routine is missing the 'summary' function")
functions <- if (is.null(init$print))
    list(summary = init$summary)
else list(summary = init$summary, print = init$print)
if (!is.null(init$text))
    functions <- c(functions, list(text = init$text))
if (method == "user")
    functions <- c(functions, mlist)
where <- rpfit$which
names(where) <- row.names(m)
ans <- list(frame = frame, where = where, call = Call, terms = Terms,
    cptable = t(rpfit$cptable), method = method, parms = init$parms,
    control = controls, functions = functions, numresp = init$numresp)
```

```
    if (nsplit)
        ans$splits = splits
    if (ncat > 0)
        ans$csplit <- catmat + 2
    if (nsplit)
        ans$variable.importance <- importance(ans)
    if (model) {
        ans$model <- m
        if (missing(y))
            y <- FALSE
    }
    if (y)
        ans$y <- Y
    if (x) {
        ans$x <- X
        ans$wt <- wt
    }
    ans$ordered <- isord
    if (!is.null(attr(m, "na.action")))
        ans$na.action <- attr(m, "na.action")
    if (!is.null(xlevels))
        attr(ans, "xlevels") <- xlevels
    if (method == "class")
        attr(ans, "ylevels") <- init$ylevels
    class(ans) <- "rpart"
    ans
})(formula = .outcome ~ ., data = list(c(15, 16, 12, 14, 12,
16, 16, 12, 12, 9, 14, 14, 10, 12, 13, 14, 6, 16, 12, 12, 12,
12, 12, 16, 14, 9, 5, 14, 10, 14, 9, 12, 12, 10, 14, 9, 12, 14,
15, 12, 13, 16, 12, 16, 12, 18, 12, 16, 16, 12, 14, 8, 9, 13,
16, 12, 10, 18, 12, 12, 14, 18, 12, 12, 14, 15, 12, 13, 10, 16,
16, 9, 11, 18, 18, 12, 18, 14, 14, 13, 12, 13, 16, 8, 14, 13,
14, 16, 10, 14, 14, 12, 18, 14, 12, 14, 10, 9, 18, 12, 18, 16,
12, 12, 12, 16, 16, 17, 12, 13, 8, 10, 16, 12, 18, 12, 18, 11,
12, 13, 3, 12, 12, 12, 12, 12, 12, 12, 12, 18, 18, 12, 12, 1,
12, 16, 13, 12, 12, 16, 12, 12, 12, 13, 11, 5, 12, 12, 12, 14,
12, 12, 12, 18, 10, 14, 13, 10, 13, 18, 15, 13, 16, 16, 14, 8,
11, 16, 12, 13, 12, 13, 16, 14, 12, 18, 12, 18, 12, 18, 13, 13,
16, 12, 11, 8, 12, 16, 11, 12, 12, 10, 18, 14, 14, 12, 12, 12,
12, 12, 12, 9, 12, 18, 12, 9, 12, 16, 10, 12, 16, 12, 12, 12,
18, 18, 15, 16, 18, 12, 18, 14, 12, 16, 11, 12, 12, 12, 12, 14,
12, 13, 16, 16, 12, 16, 8, 14, 10, 14, 13, 18, 9, 11, 14, 10,
12, 12, 16, 16, 12, 13, 12, 13, 12, 14, 12, 16, 16, 12, 13, 11,
12, 16, 16, 8, 16, 14, 14, 12, 11, 9, 12, 11, 8, 12, 12, 12,
14, 16, 18, 10, 12, 12, 12, 13, 12, 16, 13, 16, 10, 13, 7, 16,
14, 12, 16, 12, 18, 11, 18, 12, 18, 16, 12, 13, 12, 12, 16, 12,
16, 12, 12, 14, 12, 12, 12, 12, 12, 16, 18, 12, 9, 11, 14, 13,
13, 12, 12, 12, 14, 12, 12, 12, 12, 15, 16, 13, 18, 12, 17, 14,
```

13, 17, 4, 14, 12, 14, 12, 15, 14, 16, 15, 14, 12, 14, 15, 16,
12, 9, 10, 13, 12, 16, 10, 12, 12, 12, 12, 13, 12, 12, 13, 14,
17, 16, 12, 13, 12, 11, 18, 16, 12, 13, 12, 16, 12, 13, 12, 16,
14, 12, 15, 12, 13, 12, 14, 16, 12, 10, 16, 16, 12, 4, 16, 13,
10, 13, 12, 16, 13, 12, 12, 16, 12, 16, 17, 16, 12, 10, 12, 12,
14, 14, 16, 13, 16, 16, 16, 12, 14, 14, 12, 12, 14, 13, 12, 16,
16, 18, 17, 12, 12, 12, 11, 18, 10, 12, 16, 12, 12, 17, 6, 8,
14, 12, 18, 16, 16, 12, 12, 18, 12, 9, 18, 18, 18, 12, 13, 14,
13, 12, 12, 12, 12, 16, 12, 14, 13, 16, 13, 12, 12, 14, 13, 16,
12, 10, 15, 15, 14, 18, 11, 16, 16, 10, 14, 13, 17, 16, 9, 12,
8, 14, 12, 16, 12, 9, 16, 18, 17, 18, 12, 18, 9, 10, 13, 0, 18,
12, 16, 12, 15, 12, 15, 12, 18, 10, 12, 12, 18, 16, 14, 14, 12,
12, 15, 12, 18, 13, 12, 11, 12, 14, 12, 12, 14, 12, 16, 12, 12,
18, 12, 9, 12, 12, 13, 16, 17, 18, 12, 15, 12, 14, 2, 12, 12,
18, 12, 18, 8, 12, 12, 11, 16, 12, 18, 13, 18, 17, 16, 18, 12,
16, 12, 12, 11, 17, 12, 16, 14, 12, 12, 14, 12, 12, 14, 12, 18,
12, 12, 14, 9, 16, 8, 12, 11, 18, 16, 12, 16, 14, 12, 11, 16,
18, 12, 16, 13, 12, 9, 17, 18, 11, 18, 12, 9, 12, 16, 14, 15,
15, 12, 16, 15, 13, 12, 16, 13, 12, 9, 14, 12, 16, 12, 14, 12,
16, 12, 12, 16, 12, 12, 12, 12, 18, 13, 12, 0, 16, 12, 16, 13,
12, 16, 10, 14, 10, 12, 6, 16, 11, 9, 12, 12, 13, 12, 14, 14,
14, 12, 12, 16, 13, 14, 4, 14, 16, 12, 18, 16, 12, 13, 18, 18,
14, 14, 12, 14, 12, 12, 16, 12, 13, 13, 16, 18, 12, 16, 18, 14,
13, 11, 12, 11, 16, 9, 10, 13, 16, 17, 7, 12, 12, 10, 14, 14,
14, 12, 12, 16, 14, 8, 16, 16, 12, 12, 18, 0, 12, 18, 14, 12,
8, 13, 12, 8, 6, 18, 12, 14, 12, 18, 9, 12, 16, 17, 14, 12, 13,
17, 12, 9, 12, 9, 16, 14, 17, 12, 12, 9, 16, 12, 18, 10, 12,
12, 12, 12, 12, 12, 0, 12, 11, 14, 12, 8, 12, 8, 8, 15, 16, 12,
16, 12, 12, 11, 12, 16, 11, 12, 12, 14, 12, 12, 12, 12, 18, 0,
10, 15, 12, 18, 12, 8, 14, 12, 14, 11, 12, 12, 14, 16, 12, 8,
16, 12, 18, 12, 15, 16, 14, 18, 12, 12, 10, 12, 15, 12, 12, 18,
12, 13, 18, 12, 14, 16, 16, 14, 18, 18, 17, 3, 12, 10, 8, 18,
8, 12, 13, 13, 11, 12, 12, 14, 12, 12, 12, 18, 16, 12, 11, 12,
13, 14, 15, 12, 18, 13, 12, 16, 12, 12, 12, 16, 16, 13, 7, 15,
12, 18, 13, 12, 16, 16, 12, 12, 12, 13, 14, 16, 15, 18, 14, 18,
10, 16, 12, 16, 14, 15, 12, 12, 16, 16, 13, 14, 18, 12, 11, 12,
9, 14, 18, 18, 12, 15, 18, 11, 3, 11, 16, 11, 12, 14, 12, 18,
16, 12, 8, 14, 12, 16, 15, 18, 14, 18, 15, 16, 16, 15, 18, 15,
18, 12, 12, 8, 14, 12, 9, 12, 12, 12, 12, 12, 12, 10, 14, 12,
16, 16, 12, 7, 9, 12, 12, 13, 12, 13, 12, 12, 12, 9, 13, 12,
13, 12, 13, 16, 12, 14, 12, 18, 13, 11, 16, 12, 13, 18, 16, 12,
8, 16, 16, 12, 12, 17, 13, 5, 14, 14, 8, 16, 18, 16, 13, 18,
12, 8, 12, 6, 18, 9, 11, 15, 12, 9, 17, 12, 5, 12, 16, 12, 18,
14, 12, 18, 13, 15, 16, 14, 18, 11, 14, 10, 12, 16, 12, 12, 12,
18, 12, 12, 12, 15, 12, 17, 7, 11, 12, 18, 13, 18, 15, 18, 12,
14, 5, 4, 16, 12, 17, 13, 12, 12, 13, 18, 16, 18, 12, 12, 8,
16, 12, 15, 12, 14, 12, 13, 13, 12, 15, 12, 11, 18, 16, 12, 14,
15, 11, 15, 12, 12, 10, 14, 7, 14, 14, 12, 12, 13, 12, 12, 16,

```
12, 12, 14, 16, 12, 12, 16, 17, 12, 16, 13, 14, 11, 15, 12, 16,
10, 18, 14, 16, 6, 12, 13, 1, 12, 12, 12, 12, 15, 14, 9, 12,
14, 12, 16, 12, 12, 10, 15, 4, 15, 13, 16, 14, 14, 12, 18, 14,
13, 16, 16, 11, 12, 12, 18, 12, 2, 14, 6, 12, 12, 16, 14, 12,
16, 12, 11, 10, 13, 12, 11, 18, 3, 12, 9, 13, 12, 14, 2, 12,
12, 16, 12, 10, 12, 15, 14, 18, 16, 16, 15, 14, 9, 14, 10, 12,
13, 12, 15, 12, 12, 12, 7, 15, 12, 12, 13, 12, 11, 10, 16, 12,
15, 12, 12, 16, 16, 14, 14, 7, 18, 12, 18, 18, 18, 11, 12, 15,
7, 8, 12, 14, 18, 12, 12, 13, 16, 16, 18, 18, 12, 12, 8, 14,
8, 12, 14, 18, 13, 15, 15, 12, 10, 12, 13, 17, 12, 12, 18, 18,
12, 12, 12, 13, 16, 12, 12, 12, 16, 12, 16, 12, 13, 17, 16, 18,
10, 11, 16, 18, 12, 18, 12, 16, 15, 12, 12, 12, 12, 12, 18, 12,
12, 7, 12, 10, 12, 12, 12, 13, 4, 12, 14, 16, 16, 12, 12, 12,
8, 7, 18, 12, 12, 12, 12, 18, 15, 12, 13, 14, 16, 14, 15, 12,
12, 16, 12, 15, 16, 12, 6, 12, 14, 13, 13, 12, 11, 13, 16, 18,
14, 15, 15, 18, 12, 11, 12, 12, 16, 12, 11, 14, 12, 12, 18, 14,
16, 14, 18, 16, 12, 13, 12, 14, 11, 14, 13, 12, 18, 12, 12, 16,
12, 16, 16, 12, 12, 15, 2, 14, 12, 12, 16, 12, 12, 14, 16, 13,
12, 12, 8, 16, 16, 18, 10, 12, 18, 18, 14, 12, 16, 12, 12, 12,
12, 13, 12, 12, 18, 12, 12, 15, 12, 18, 16, 2, 12, 12, 16, 10,
12, 12, 12, 11, 12, 12, 13, 13, 0, 12, 16, 12, 12, 18, 6, 14,
14, 12, 14, 18, 12, 12, 16, 18, 10, 14, 14, 11, 12, 13, 16, 12,
12, 5, 10, 12, 12, 12, 10, 16, 13, 16, 9, 18, 18, 18, 11, 14,
9, 11, 17, 12, 12, 8, 12, 12, 12, 13, 12, 16, 13, 16, 10, 16,
15, 16, 16, 18), c(20, 9, 24, 12, 33, 42, 0, 36, 37, 20, 29,
11, 10, 8, 19, 6, 24, 1, 11, 40, 5, 15, 44, 8, 12, 13, 55, 7,
52, 8, 19, 45, 9, 12, 11, 10, 10, 4, 15, 4, 16, 8, 35, 4, 8,
7, 9, 6, 9, 14, 11, 42, 22, 21, 21, 15, 51, 27, 23, 4, 4, 3,
15, 19, 31, -1, 37, 32, 8, 12, 27, 45, 19, 11, 32, 35, 12, 16,
16, 1, 10, 17, 4, 43, 3, -1, 0, 23, 10, 0, 30, 15, 0, 15, 2,
13, 6, 43, 25, 20, 3, 7, 19, 4, 42, 16, 10, 1, 12, 1, 47, 24,
9, 21, 12, 19, 14, 38, 38, 5, 49, 16, 18, 17, 0, 21, 25, 40,
27, 6, 28, 31, 13, 49, 17, 9, 13, 25, 25, 12, 9, 9, 2, 38, 15,
54, 23, 46, 3, 12, 47, 34, 22, 14, 27, 16, -1, 12, 42, 29, 21,
33, 17, 8, 32, 29, 42, 5, 40, 3, 0, 7, 4, 20, 44, 11, 7, 6, 19,
12, 10, 18, 8, 14, 24, 43, 28, 18, 1, 3, 0, 12, 27, 17, 11, 17,
27, 4, 11, 30, 21, 30, 11, 11, 34, 15, 29, 0, 8, 6, 16, 42, 31,
15, 16, 20, 33, 15, 16, 4, 36, 34, 44, 12, 12, 4, 6, 7, 5, 7,
11, 12, 10, 28, 4, 3, 39, 0, 6, 21, 14, 4, 16, 15, 1, 5, 23,
2, 11, 5, 3, 23, 4, 14, 38, 33, 19, 20, 19, 7, 9, 35, 32, 13,
22, 11, 9, 7, 12, 3, 6, 37, 4, 4, 48, 6, 7, 10, 19, 7, 5, 41,
17, 5, 5, 0, 25, 0, 2, 45, 24, 23, 29, 36, 27, 22, 9, 37, 3,
12, 18, 8, 37, 3, 10, 1, 8, 3, 16, 15, 28, 5, 43, 34, 20, 28,
36, 17, 36, 23, 7, 13, 15, 16, 24, 0, 14, 4, 17, 16, 0, 23, 6,
13, 5, 14, 0, 12, 44, 7, 18, 38, 7, 4, 28, 33, 7, 17, 18, 15,
7, 3, 31, 26, 18, 4, 4, 4, 25, 36, 24, 5, 6, 13, 48, 2, 8, 26,
14, -1, 48, 0, 31, 23, 26, 13, 43, 30, 28, 10, 16, 13, 14, 15,
39, 35, 22, 20, 9, 10, 20, 35, 36, 15, 10, 33, 4, 16, 16, 11,
```

37, 23, 32, 32, 11, 5, 36, 36, 41, 3, 6, 20, 16, 8, 6, 8, 31,
18, 45, 30, 33, 22, 48, 5, 25, 14, 7, 7, 31, 16, -1, 11, 22,
20, 3, 23, 29, 4, 21, 13, -1, 17, 7, 38, 39, 36, 47, 1, 30, 29,
21, 16, 48, 10, 8, 21, 31, 9, 15, 3, 11, 17, 29, 29, 11, 3, 38,
26, 20, 17, 20, 8, 4, 17, 10, 19, 21, 15, 33, 20, 32, 11, 25,
25, 13, 8, 26, 12, 2, 44, 11, 28, 26, 20, 0, 7, 17, 26, 4, 3,
26, 14, 24, 10, 26, 11, 5, 3, 25, 18, 18, 13, 11, 10, 27, 44,
33, 27, 32, 42, 20, 20, 10, 37, 14, 0, 32, 13, 10, 21, 4, 14,
22, 6, 9, 25, 39, 40, 26, 23, 13, 18, 45, 35, 12, 12, 3, 20,
18, 10, 16, 24, 4, 14, 37, 11, 29, -1, 12, 39, 14, 15, 8, 17,
41, 46, 43, 23, 15, 8, 44, 31, 28, 33, 28, 15, 9, 19, 33, 7,
24, 30, 9, 45, 12, 21, 9, 3, 31, 35, 12, 6, 30, 0, 0, 10, 32,
1, 9, 3, 3, 0, 45, 26, 40, 38, 23, 3, 41, 9, 37, 2, 1, 45, 47,
25, 14, 15, 12, 39, 15, 14, 44, 36, 0, 23, 40, 4, 2, 11, 46,
4, 6, 15, 18, 24, 47, 7, 5, 23, 33, 10, 21, 37, 2, 39, 7, 34,
15, 26, 9, 36, 7, 5, 18, 34, 17, 11, 52, 5, 2, 4, 17, 9, 0, 13,
33, 29, 5, 37, 10, 32, 40, 5, 14, 42, 12, -1, 16, 3, 8, 9, 25,
5, 22, 25, 23, -1, 25, 22, 18, 11, 22, 5, 20, 38, 27, 27, 9,
11, 1, 8, 17, 12, 14, 18, 33, 10, 7, 17, 48, 15, 3, 24, 9, 15,
42, 22, 8, 9, 25, 19, 38, 26, 39, 20, 6, 6, 10, 40, 10, 7, 52,
8, 42, 21, 13, 11, 47, 14, 10, 17, 11, 47, 7, 29, 55, 43, 23,
31, 39, 43, 28, 33, 0, 23, 19, 15, 10, 19, 10, 16, 31, 25, 15,
2, 9, 4, 9, 8, 43, 7, 26, 10, 3, 7, 21, 15, 27, 19, 5, 18, 7,
39, 1, 12, 28, 12, 38, 44, 7, 16, 28, 29, 22, 12, 32, 9, 11,
1, 4, 18, 11, 41, 8, 19, 10, 3, 42, 14, 5, 42, 29, 7, 47, 28,
42, 25, 21, 34, 12, 39, 9, 17, 29, 9, 9, 15, 8, 1, 24, 24, 10,
8, 9, 47, 47, 0, 16, 2, 6, 5, 4, 33, 4, 26, 6, 47, 25, 35, -1,
6, 19, 31, 8, 20, 7, 26, 0, 0, 0, 30, 11, 19, 19, 13, 40, 10,
22, 6, 26, 32, 9, 6, 23, 10, 1, 12, 7, 18, 5, 12, 0, 16, 29,
17, 6, 44, 4, 10, 19, 1, 2, 14, 4, 25, 32, 11, 21, 11, 18, -1,
26, 17, 32, 47, 19, 33, 13, 11, 16, 7, 26, 15, 0, 2, 6, 18, 7,
38, 38, 16, 5, 13, 13, 23, 41, 21, 17, 25, 13, 26, 46, 30, -1,
1, 13, 18, 47, 51, 5, 37, 25, 7, 12, 8, 17, 0, 5, 11, 25, 29,
9, 11, 14, 31, 42, 3, 34, 53, 3, 42, 8, 11, 24, 24, 11, 7, 7,
10, 38, 43, 30, 42, 4, 39, 26, 2, 0, 13, 4, 28, 19, 5, 40, 10,
12, 26, -1, 43, 0, 39, 17, 2, 7, 8, 4, 0, 30, 4, 14, 15, 7, 9,
30, 11, 9, 2, 16, 24, 14, 49, 9, 10, 3, 13, 19, 6, 52, 0, 14,
33, 10, 2, 6, 6, 41, 15, 20, 10, 42, 2, 11, 6, 21, 13, 10, 31,
0, 41, 1, 25, 43, 0, 35, 13, 25, 18, 12, 1, 21, 16, 11, 38, 19,
24, 2, 50, 23, 31, 17, 23, 16, 27, 19, 3, 7, 40, 36, 9, 40, 12,
1, 18, 16, -1, 13, 23, 4, 11, 12, 12, 3, 16, 2, 1, 24, 5, 26,
7, 45, 12, 16, 1, 23, 5, 14, 33, 8, 7, 46, 7, 37, 10, 32, 35,
18, 39, 1, 8, 13, 16, 50, 25, 6, 12, 17, 5, 13, 23, 2, -1, 3,
45, 32, 14, 27, 22, 7, 26, 9, 5, 5, 6, 19, 8, 28, 16, 25, 5,
12, 42, 5, 13, 28, 37, 34, 27, 12, 12, 30, 34, 9, 24, 0, 0, 0,
13, 10, 8, 21, 19, 13, 7, 22, 49, 16, 15, 32, 25, 51, 18, 28,
14, 22, 5, -1, 13, 15, 43, 31, 31, 39, 10, 14, 17, 59, 29, 36,
35, 7, -2, 15, 5, 13, 8, 31, 5, 13, 7, 9, 18, 0, 4, 12, 13, 19,

```
14, 20, 10, 26, 2, 17, 39, 31, 1, 41, 33, 27, 15, 4, 8, 32, 15,
22, 8, 15, 16, 22, 7, 43, 0, 17, 48, 28, 13, 10, 27, 0, 9, 43,
4, 55, 43, 12, 30, 27, 2, 36, 9, 23, 5, 19, 12, 15, 26, 32, 6,
45, 1, 26, 9, 2, 16, 40, 9, 4, 12, 13, 8, 40, 42, 9, 13, 7, 31,
28, 22, 20, 21, 42, 12, 7, 7, 15, 19, 22, 4, 26, 27, 43, 19,
7, 10, 34, 13, 37, 8, 8, 29, 11, 37, 39, 4, 24, 19, 13, 42, 6,
18, 44, 16, 46, 7, 55, 47, 11, 3, 9, 16, 23, 7, 33, 17, 6, 30,
12, 6, 8, 6, 14, 18, 9, 30, 8, 14, 11, 7, 32, 22, 13, 19, 33,
0, 11, 0, 9, 32, 20, 9, 16, 30, 19, 27, 8, -1, 10, 30, 7, 43,
30, 52, 6, 43, 20, 35, 23, 1, 23, 29, 19, 14, 4, 21, 2, 0, 35,
9, 1, 5, 17, 5, 7, 20, 12, 23, 10, 7, 32, 11, 28, 10, 12, 5,
9, 1, -1, 13, 11, -1, 6, 28, 1, 2, 18, 14, 2, 16, 10, 16, 29,
17, 10, 40, 5, 6, 7, 22, 10, -1, 3, 18, 20, 45, 26, 6, 20, 13,
13, 35, 24, 7, 24, 4, 3, 13, 16, 12, 8, 17, 19, 11, 56, 30, 10,
45, 37, 31, 9, 39, 22, 22, 11, 19, 17, 12, 12, 17, 34, 3, 27,
31, 27, 31, 32, 28, 16, 24, 28, 26, 25, 40, 45, 0, 15, 4, 8,
16, 19, 21, 14, 37, 24, 18, -1, 47, 15, 48, 10, 43, 11, 13, 17,
38, 10, 30, 16, 15, 10, 18, 15, 25), c(0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1,
0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1,
0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
```

```
0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0,
1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1,
0, 0, 0), c(1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 0,
1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1,
0, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 0,
1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 0, 1, 1,
1, 0, 0, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
```

0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1, 1,
1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1,
1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 0, 0,
1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1,
1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0,
1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1,
0, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0,
1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1,
1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1,
1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1,
0, 1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1,
0, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1,
1, 1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0,
1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 1, 0, 0, 1, 1,
0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1,
1, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0,
1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0,
1, 1, 1, 0, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1, 1, 0,
1, 1, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0,
1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1,
1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0,
1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1,
1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1,
1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 1, 0,
1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1,
1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1,
1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1,
0, 1, 0, 0, 1, 0, 1, 1, 1, 0, 0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1,
0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0,

```
1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0,
1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1,
1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1,
0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1,
1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 0, 1, 1,
1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
0, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1,
0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1,
0, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0,
1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1,
1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1), c(0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0,
1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0,
1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0,
0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 1, 1, 0, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1, 0,
1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0,
0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 0,
0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0,
0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0,
0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1,
0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0,
0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0,
0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 1,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0,
1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0,
1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1,
1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0,
0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1,
0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0,
```

```
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1,
1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0,
0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0,
0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0,
1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 1, 1,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0,
0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1, 0,
0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 1,
0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0,
0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0,
1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 1,
0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0,
0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1,
0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 0,
1, 1, 0, 0, 0, 1), c(0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0,
1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0,
0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 0, 0,
```

0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0,
0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0,
0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0,
1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0,
0, 1, 1, 0, 1, 1, 0, 1, 1, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0,
0, 0, 1, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0,
0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 0, 0,
0, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0,
1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1,
0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0,
0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1,
0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0,
1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0,
0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1,
1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1,
0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0,
1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0,
1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,

```
1, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0,
1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0,
0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 1,
0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0,
0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0,
1, 1, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 1,
0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0), c(0, 1,
0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
1, 0, 1, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0,
0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 0, 1,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 1, 1, 0,
1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1,
1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1,
0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0,
0, 1, 1, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0,
0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0,
0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0,
1, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 0,
0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1,
0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 1,
0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 1,
0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0,
0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0,
```

```
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0,
0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0,
0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1,
0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 0,
0, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0,
1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0,
1, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 0, 0,
1, 0, 1, 1, 0, 1, 0, 0, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0,
0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1,
1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1,
1, 0, 1, 1, 0, 1, 1, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 1, 0,
0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 0, 0, 0, 0,
1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 0, 1,
0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0,
1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0,
1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1, 0,
0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0,
0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0,
0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0,
0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0,
0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 1,
0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0,
0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0,
0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0,
1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0,
0, 1, 1, 0, 0, 1, 0, 0, 0), c(0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
```

0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1,
0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1,
0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,

```
0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0,
1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1,
0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
), c(617.28, 957.83, 617.28, 902.18, 299.15, 541.31, 148.39,
273.19, 666.67, 241.5, 703.79, 712.25, 351.46, 373.24, 759.73,
356.13, 469.14, 123.46, 474.83, 261.16, 284.9, 1661.92, 629.15,
522.32, 688.51, 246.91, 949.67, 261.16, 106.86, 379.87, 634.92,
1182.03, 740.74, 237.42, 406.96, 351.61, 593.54, 273.03, 569.8,
130.58, 641.03, 1073.12, 261.16, 783.48, 197.53, 1234.57, 533.87,
712.25, 909.31, 356.13, 759.73, 382.74, 53.7, 415.48, 949.67,
664.77, 308.64, 2374.15, 379.87, 142.45, 94.59, 1234.57, 391.74,
411.7, 1068.38, 123.46, 569.8, 94.97, 402.17, 1344.78, 474.83,
356.13, 949.67, 531.81, 356.13, 949.67, 1697.72, 451.09, 807.22,
271.6, 462.99, 336.7, 593.54, 189.93, 119.66, 76.43, 493.83,
679.01, 308.64, 56.79, 1899.34, 1316.87, 830.96, 784.69, 167.55,
845.2, 183.42, 337.08, 854.7, 885.57, 1033.01, 522.32, 197.53,
308.64, 521.94, 641.03, 783.48, 500.95, 593.54, 154.32, 721.45,
522.32, 123.46, 546.06, 522.32, 379.87, 866.57, 689.53, 346.63,
379.87, 370.37, 546.06, 1305.79, 498.58, 241.21, 160.49, 470.09,
415.48, 830.96, 997.15, 1111.11, 384.62, 462.96, 189.93, 61.73,
664.77, 740.74, 617.28, 830.96, 747.86, 284.9, 1049.38, 213.68,
854.7, 617.28, 284.9, 403.61, 498.58, 346.63, 403.61, 249.29,
664.77, 807.22, 1412.63, 807.22, 902.18, 98.77, 474.83, 1020.89,
830.96, 569.8, 1135.8, 379.87, 345.68, 593.54, 284.9, 712.25,
593.54, 1103.4, 199.12, 142.45, 261.16, 474.83, 641.03, 427.35,
1305.79, 629.39, 1258.31, 664.77, 363.25, 322.89, 597.27, 323.34,
522.32, 517.57, 664.77, 581.67, 493.83, 92.59, 325.26, 197.41,
226.76, 1471.98, 593.54, 403.61, 690.77, 296.77, 232.67, 415.48,
1210.83, 874.49, 830.96, 356.13, 546.06, 1020.89, 522.32, 712.25,
283.95, 165.43, 204.18, 4264.87, 422.36, 997.15, 474.83, 925.93,
1187.08, 474.83, 474.83, 1258.31, 237.42, 830.96, 466.39, 498.58,
308.64, 498.58, 123.46, 432.1, 92.59, 474.83, 546.06, 246.91,
427.35, 593.54, 949.67, 540.12, 391.74, 275.96, 347.22, 144.75,
978.16, 444.44, 186.71, 918.38, 1099.54, 205.76, 335.48, 949.67,
427.35, 1590.69, 356.13, 194.68, 1077.44, 332.38, 546.06, 522.32,
1780.63, 434.43, 760.78, 1187.08, 284.9, 498.58, 1187.08, 451.09,
```

949.67, 1042.52, 92.59, 474.83, 569.8, 830.96, 297.42, 118.71,
271.6, 462.96, 462.96, 534.19, 356.13, 155.27, 534.19, 854.7,
830.96, 949.67, 835.45, 812.32, 555.56, 2374.15, 61.73, 470.37,
189.93, 397.81, 617.28, 474.83, 1234.57, 379.87, 653.59, 712.25,
883.71, 356.13, 451.09, 1092.12, 522.32, 474.83, 231.48, 181.28,
1080.25, 474.83, 189.93, 345.68, 451.09, 878.44, 227.92, 188.46,
284.9, 391.74, 854.7, 688.51, 854.7, 277.78, 593.54, 514.4, 1497.13,
902.18, 532.56, 252.53, 408.36, 498.58, 892.59, 403.61, 408.73,
668.23, 354.94, 78.56, 455.84, 389.36, 474.83, 522.32, 353.75,
308.64, 254.04, 90.22, 121.91, 759.73, 1220.77, 712.25, 987.65,
356.13, 664.77, 451.09, 313.63, 386.99, 356.13, 474.83, 617.28,
188.27, 664.77, 735.99, 498.58, 506.49, 411.52, 688.51, 782.38,
439.22, 388.01, 216.05, 1068.38, 759.73, 295.22, 522.32, 807.22,
830.96, 121.08, 349.79, 335.1, 949.67, 427.35, 1424.5, 641.03,
1282.05, 664.77, 1246.44, 251.42, 630.03, 1140.74, 351.38, 1092.12,
617.28, 1187.08, 796.3, 902.18, 712.25, 795.35, 973.41, 712.25,
981.32, 757.58, 949.67, 213.68, 284.9, 284.9, 830.96, 185.19,
641.03, 2184.24, 617.28, 290.93, 537.51, 165.43, 712.25, 687.83,
332.38, 522.32, 498.58, 1025.64, 453.99, 255.34, 617.28, 320.99,
1068.38, 1234.57, 854.7, 709.62, 854.7, 783.48, 288.07, 498.58,
2374.15, 764.48, 735.99, 282.92, 1424.5, 997.15, 123.46, 332.38,
641.03, 664.77, 264.55, 949.67, 498.58, 381.43, 2374.15, 712.25,
65.43, 997.15, 759.73, 441.05, 1780.63, 949.67, 295.31, 179.63,
935.92, 759.73, 712.25, 1471.98, 250.47, 356.13, 795.35, 735.99,
522.32, 674.26, 619.66, 356.13, 474.83, 617.28, 546.06, 712.25,
997.15, 284.9, 130.58, 555.56, 308.64, 842.1, 1151.47, 854.7,
135.03, 444.44, 657.64, 1187.08, 593.54, 949.67, 329.3, 1020.89,
664.77, 359.26, 610.16, 230.29, 427.35, 830.96, 806.27, 284.9,
339.51, 142.11, 776.09, 1044.63, 688.51, 2374.15, 195.47, 123.46,
308.64, 593.54, 356.13, 356.13, 443.97, 474.83, 308.64, 438.4,
498.58, 299.15, 165.43, 108.02, 949.67, 1661.92, 1068.38, 1329.53,
152.09, 783.48, 847.25, 617.28, 308.95, 159.1, 1377.02, 878.44,
1068.38, 997.15, 346.63, 699.26, 973.41, 274.35, 1187.08, 222.22,
452.97, 878.44, 712.25, 625.66, 593.54, 557.93, 341.17, 854.7,
712.25, 783.48, 418.8, 370.37, 664.77, 237.42, 245.27, 347.22,
586.42, 195.47, 493.83, 944.28, 902.18, 474.83, 237.42, 481.96,
403.61, 474.83, 474.83, 586.42, 427.35, 238.68, 949.67, 1661.92,
284.9, 688.51, 284.9, 522.32, 370.37, 231.48, 379.87, 1579.1,
593.54, 2374.15, 783.48, 962.96, 522.32, 356.13, 770.09, 241.66,
1187.08, 867.59, 277.62, 274.69, 949.67, 65.1, 427.99, 771.6,
461.35, 664.77, 211.59, 617.28, 973.41, 546.06, 332.38, 1115.86,
462.96, 106.08, 474.83, 206.87, 548.88, 202.78, 1329.53, 284.9,
561.17, 174.9, 308.64, 370.37, 98.77, 949.67, 451.09, 712.25,
807.22, 379.87, 1377.02, 284.9, 462.96, 949.67, 199.43, 832.72,
1746.03, 949.67, 641.03, 320.51, 254.18, 1851.85, 712.25, 712.25,
474.83, 759.73, 949.67, 266.17, 270.06, 591.14, 687.56, 451.09,
221.5, 522.32, 1115.86, 593.54, 61.73, 1424.5, 379.87, 2374.15,
617.28, 712.25, 712.25, 226.27, 244.44, 645.77, 284.9, 474.83,

498.58, 474.83, 712.25, 664.77, 474.83, 363.25, 593.54, 1346.15,
712.25, 415.48, 400.26, 522.32, 284.9, 569.8, 569.8, 165.43,
246.91, 514.4, 391.74, 965.5, 167.76, 246.91, 471.88, 356.13,
902.18, 356.13, 396.49, 237.04, 513.46, 81.93, 1020.89, 546.06,
404.28, 516.55, 830.96, 403.61, 456.25, 189.93, 664.77, 200,
355.13, 617.28, 1234.57, 830.96, 1305.79, 233.2, 679.01, 332.38,
878.44, 593.54, 629.15, 237.42, 106.84, 664.77, 617.28, 403.61,
1234.57, 1092.12, 2374.15, 593.54, 411.52, 403.61, 237.42, 949.67,
177.78, 284.9, 204.18, 809.59, 394.11, 569.8, 403.61, 287.16,
1187.08, 265.91, 902.18, 617.28, 830.96, 997.15, 491.45, 234.31,
249.29, 1056.51, 735.99, 830.96, 77.78, 1543.21, 498.58, 484.14,
957.38, 379.87, 308.64, 949.67, 474.83, 807.22, 364.2, 94.97,
474.83, 237.42, 83.1, 154.32, 1780.63, 473.87, 1239.17, 446.13,
1175.78, 919.36, 66.14, 1187.08, 569.8, 484.33, 246.91, 427.35,
724.12, 522.32, 461.4, 1092.12, 284.9, 356.13, 830.96, 712.25,
308.64, 569.8, 569.8, 1899.34, 498.48, 296.3, 300.66, 448.72,
754.75, 830.96, 129.07, 498.58, 593.54, 5144.03, 1068.38, 830.96,
232, 697.7, 277.78, 546.06, 740.74, 795.35, 602.23, 522.32, 681.43,
749.03, 424.79, 613.3, 427.35, 421.56, 759.73, 79.37, 198.05,
569.8, 458.55, 449.64, 641.03, 759.73, 617.28, 508.07, 395.06,
536.77, 474.83, 902.18, 1334.67, 498.58, 498.58, 427.35, 1266.22,
1004.53, 627.36, 384.62, 238.37, 427.35, 688.51, 296.77, 498.58,
474.83, 427.35, 617.28, 403.61, 59.35, 1234.57, 676.64, 2374.15,
641.03, 377.93, 275.12, 393.95, 205.76, 472.46, 394.33, 388.62,
427.35, 356.13, 61.73, 261.16, 466.62, 593.54, 807.22, 759.73,
86.42, 123.46, 462.96, 142.45, 783.48, 148.15, 296.3, 2374.15,
439.22, 200.62, 284.9, 166.19, 332.38, 712.25, 593.54, 735.99,
356.13, 759.73, 394.11, 467.71, 669.52, 925.93, 641.03, 735.99,
220.16, 985.28, 546.06, 189.93, 1139.6, 664.77, 1120.09, 308.64,
759.73, 74.07, 427.35, 1424.5, 2362.44, 254.51, 503.91, 522.32,
356.13, 1187.08, 308.64, 259.26, 641.03, 474.83, 1139.6, 712.25,
105.62, 705.13, 284.9, 493.83, 271.6, 439.22, 641.03, 1234.57,
617.28, 612.54, 940.74, 2374.15, 154.32, 1115.86, 475.02, 1234.57,
2207.98, 237.42, 189.93, 546.06, 807.22, 830.96, 617.28, 237.42,
324.79, 524.69, 878.44, 1068.38, 636.28, 296.3, 1092.12, 246.91,
197.17, 593.54, 788.75, 522.32, 641.03, 71.23, 617.28, 1305.79,
617.28, 617.28, 284.9, 327.52, 688.51, 1020.89, 474.83, 902.18,
617.28, 728.87, 144.44, 676.64, 391.74, 1282.05, 906.93, 712.25,
1661.92, 427.35, 779.73, 540.12, 617.28, 919.36, 451.09, 254.04,
712.25, 569.8, 768.18, 1055.89, 854.7, 420.88, 664.77, 237.42,
735.99, 735.99, 830.96, 569.8, 720.94, 384.62, 807.22, 760.45,
109.21, 100.78, 878.44, 266.67, 183.39, 284.9, 320.51, 522.32,
216.05, 232.67, 664.77, 189.93, 411.52, 427.98, 652.9, 1187.08,
379.87, 225.13, 284.9, 717.77, 154.32, 641.03, 199.43, 555.56,
240.55, 203.75, 522.32, 797.65, 403.61, 63.24, 249.29, 142.45,
1187.08, 284.9, 79.77, 944.92, 498.46, 830.96, 427.35, 1092.12,
287.11, 1041.98, 92.59, 197.53, 925.93, 94.97, 160.49, 343.36,
253.24, 367.9, 1068.38, 593.54, 213.68, 1044.63, 284.9, 65.65,

50.39, 712.25, 498.58, 296.3, 712.25, 216.05, 593.54, 68.59,
166.19, 498.58, 77.16, 301.52, 569.8, 474.83, 536.56, 427.35,
192.04, 1780.63, 356.13, 246.91, 1251.89, 1187.08, 488.19, 148.15,
284.9, 589.21, 730.58, 1661.92, 1032.76, 1139.6, 795.35, 2374.15,
427.35, 308.64, 493.83, 104.3, 949.67, 591.93, 237.42, 356.13,
474.83, 546.06, 152.51, 740.74, 1899.34, 246.91, 543.54, 370.37,
338.9, 83.1, 735.99, 112.35, 220.46, 759.73, 67.02, 949.67, 126.61,
617.28, 712.25, 712.25, 92.59, 973.41, 987.65, 177.78, 237.42,
493.83, 284.9, 349.79, 498.58, 664.77, 237.42, 1187.08, 284.9,
474.83, 783.48, 213.99, 389.08, 284.59, 503.21, 142.45, 949.67,
251.4, 189.93, 493.83, 959.88, 759.73, 474.83, 498.58, 61.73,
493.83, 1305.79, 830.96, 527.07, 712.25, 955.79, 686.04, 436.85,
664.77, 1780.63, 356.13, 664.77, 569.8, 284.9, 71.23, 194.44,
522.32, 293.4, 617.28, 563.77, 522.32, 581.67, 546.06, 593.54,
1139.6, 284.9, 735.99, 356.13, 790.36, 830.96, 356.13, 372.84,
227.02, 108.02, 284.9, 403.61, 911.68, 617.28, 1384.57, 593.54,
712.25, 546.06, 345.68, 123.46, 709.88, 382.19, 641.03, 256.41,
213.68, 166.19, 237.42, 415.48, 415.48, 1092.12, 109.19, 347.79,
403.61, 451.09, 712.25, 293.21, 427.35, 304.8, 451.09, 2374.15,
7716.05, 830.96, 1899.34, 833.74, 370.37, 74.51, 199.43, 408.36,
810.47, 237.42, 733.88, 185.19, 237.42, 118.64, 308.64, 1056.51,
197.22, 261.16, 664.77, 73.6, 284.9, 741.41, 712.25, 592.59,
712.25, 182.72, 735.99, 830.96, 712.25, 106.84, 256.17, 997.15,
225.55, 1068.38, 691.36, 426.16, 664.77, 617.28, 767.08, 474.83,
712.25, 709.88, 356.05, 237.42, 949.67, 493.83, 735.99, 308.64,
961.54, 462.96, 830.96, 1115.86, 465.8, 416.67, 757.36, 118.71,
171.47, 973.41, 453.51, 771.6, 1092.12, 661.38, 1139.28, 432.1,
890.31, 284.9, 1424.5, 2374.15, 830.96, 569.8, 296.77, 617.28,
759.73, 233.99, 973.41, 1139.6, 96.23, 712.25, 617.28, 664.77,
290.49, 593.54, 1103.99, 933.71, 593.54, 303.7, 979.6, 664.77,
949.67, 498.58, 949.67, 189.93, 902.18, 486.7, 759.73, 899.81,
1139.6, 96.3, 712.25, 731.24, 366.26, 123.46, 1068.38, 1689.22,
997.15, 534.19, 902.18, 735.99, 115.74, 664.77, 712.25, 1187.08,
783.48, 1271.96, 227.92, 189.93, 474.83, 332.38, 712.25, 569.8,
261.16, 675.93, 320.99, 712.25, 522.32, 869.81, 623.77, 237.42,
605.53, 102.88, 800.74, 735.99, 783.48, 688.51, 370.37, 370.37,
493.83, 259.26, 411.52, 712.25, 432.31, 427.35, 261.16, 664.77,
750.42, 1187.08, 569.8, 1495.73, 819.09, 902.18, 118.71, 588.21,
231.48, 515.19, 759.73, 510.45, 759.73, 54.01, 148.15, 102.88,
498.58, 664.77, 679.01, 274.35, 459.94, 356.13, 1424.5, 949.67,
455.65, 329.22, 1329.53, 2374.15, 522.32, 949.67, 958.62, 66.48,
1266.22, 123.46, 759.73, 356.13, 854.7, 53.83, 1068.38, 752.54,
1056.51, 522.32, 1132.48, 1210.83, 284.9, 142.45, 740.74, 740.74,
252.06, 119.9, 621.31, 91.62, 498.58, 759.73, 740.74, 929.84,
347.22, 1448.24, 451.09, 213.68, 689.96, 498.58, 189.93, 58.1,
474.83, 253.24, 51.44, 949.67, 818.11, 157.02, 712.25, 420.88,
320.99, 92.59, 125.85, 451.09, 284.9, 2374.15, 284.9, 370.37,
1975.31, 1899.34, 1020.89, 765.43, 370.37, 590.08, 94.97, 807.22,

```
379.87, 2292.77, 237.42, 971.89, 878.44, 154.32, 231.48, 498.58,
617.28, 763.3, 783.48, 222.22, 688.51, 641.03, 1377.02, 282.47,
427.35, 759.73, 498.58, 410.73, 284.9, 546.06, 688.51, 405.64,
593.54, 902.18, 1519.47, 123.46, 759.73, 830.96, 246.91, 411.52,
759.73, 396.79, 406.33, 997.15, 1092.32, 365.62, 1187.08, 1187.08,
451.09, 546.06, 973.41, 415.48, 382.98, 379.87, 1377.02, 77.16,
680.27, 189.93, 284.9, 517.19, 261.16, 830.96, 308.64, 178.6,
281.48, 641.03, 158.72, 712.25, 296.3, 728.87, 132.1, 701.23,
222.22, 569.8, 130.58, 891.47, 735.99, 427.35, 245.63, 90.22,
356.13, 385.09, 474.83, 1780.63, 118.71, 961.54, 688.51, 807.22,
332.38, 468.09, 584, 185.19)), control = list(20, 7, 0, 4, 5,
    2, 0, 30, 0))
  n= 1502

          CP nsplit rel error
1 0.08742550      0 1.0000000
2 0.05075188      1 0.9125745
3 0.04636971      2 0.8618226

Variable importance
 educ    pt exper
   62    36     3

Node number 1: 1502 observations,    complexity param=0.0874255
  mean=607.7468, MSE=215764.9
  left son=2 (1116 obs) right son=3 (386 obs)
  Primary splits:
      educ  < 15.5 to the left,  improve=0.087425500, (0 missing)
      exper < 11.5 to the left,  improve=0.067149090, (0 missing)
      pt    < 0.5  to the right, improve=0.057903540, (0 missing)
      smsa  < 0.5  to the left,  improve=0.020502570, (0 missing)
      race  < 0.5  to the right, improve=0.006841117, (0 missing)

Node number 2: 1116 observations
  mean=526.9729, MSE=159366.3

Node number 3: 386 observations,    complexity param=0.05075188
  mean=841.2797, MSE=305423.4
  left son=6 (42 obs) right son=7 (344 obs)
  Primary splits:
      pt    < 0.5  to the right, improve=0.139512600, (0 missing)
      exper < 6.5  to the left,  improve=0.106049500, (0 missing)
      educ  < 17.5 to the left,  improve=0.031544970, (0 missing)
      smsa  < 0.5  to the left,  improve=0.012510150, (0 missing)
      mw    < 0.5  to the right, improve=0.006244652, (0 missing)
  Surrogate splits:
      exper < 0.5  to the left,  agree=0.899, adj=0.071, (0 split)
```

```
Node number 6: 42 observations
  mean=250.5179, MSE=37587

Node number 7: 344 observations
  mean=913.4076, MSE=290311.5
```

```
In [104]: modtraincart
```

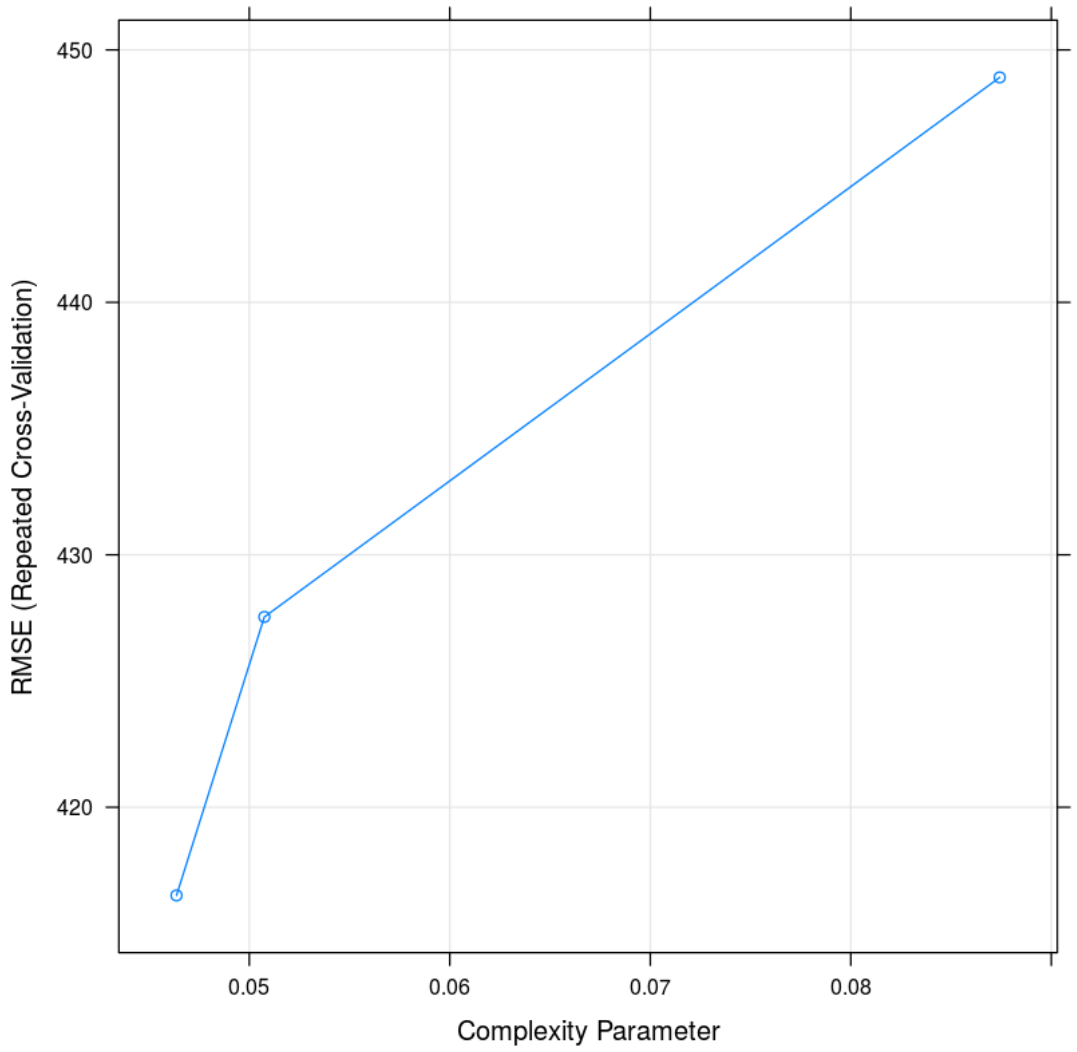
```
CART

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  cp          RMSE      Rsquared   MAE
  0.04636971  416.5082  0.1645059  276.6687
  0.05075188  427.5402  0.1180263  288.6272
  0.08742550  448.9104  0.0583743  302.6319

RMSE was used to select the optimal model using the smallest value.
The final value used for the model was cp = 0.04636971.
```

```
In [100]: install.packages("rpart.plot")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [105]: library(rpart.plot)
```

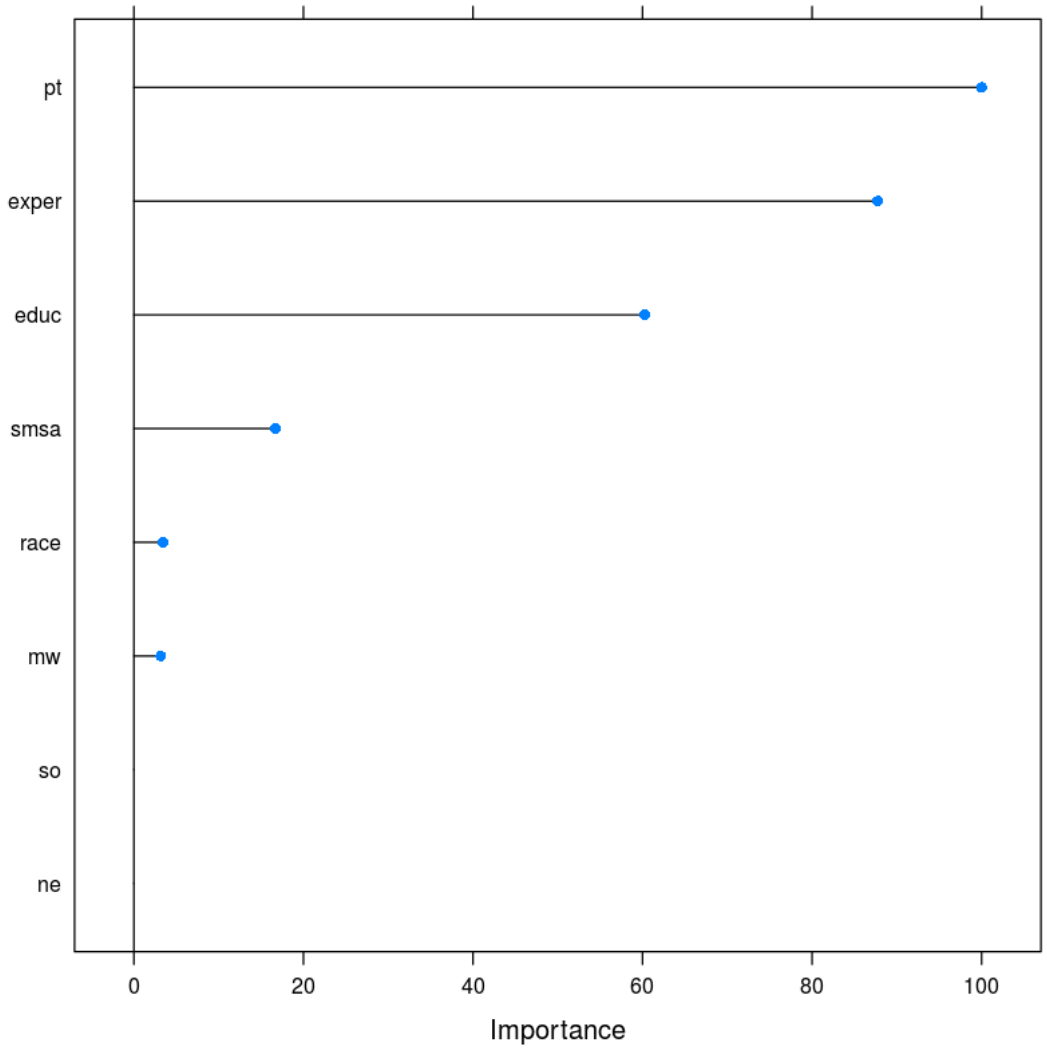
```
In [106]: plot(modtraincart)
```



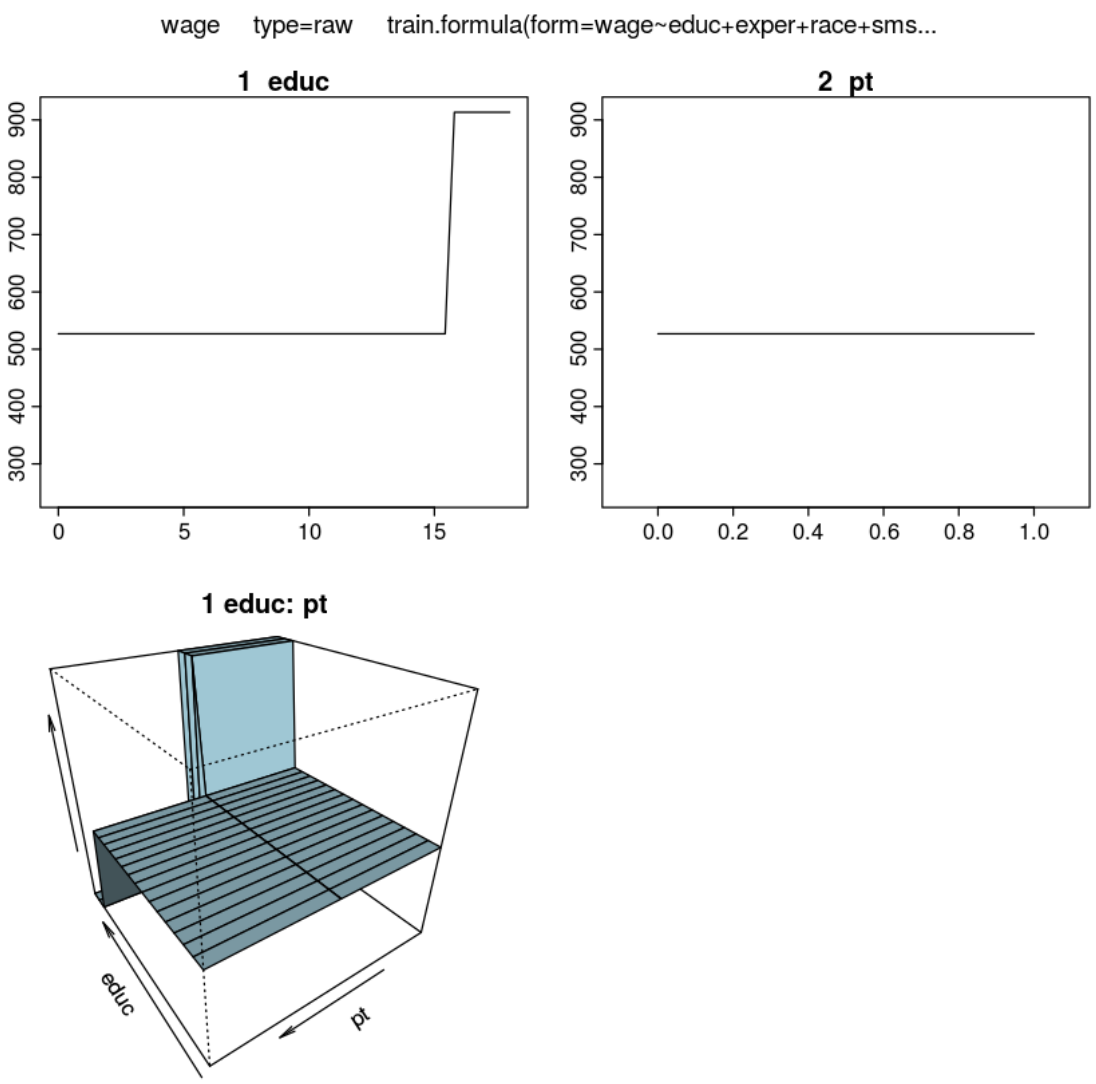

```
In [107]: varImp(modtraincart)
          plot(varImp(modtraincart))
```

```
rpart variable importance

      Overall
pt    100.000
exper  87.733
educ   60.264
smsa   16.722
race    3.465
mw      3.163
ne      0.000
```

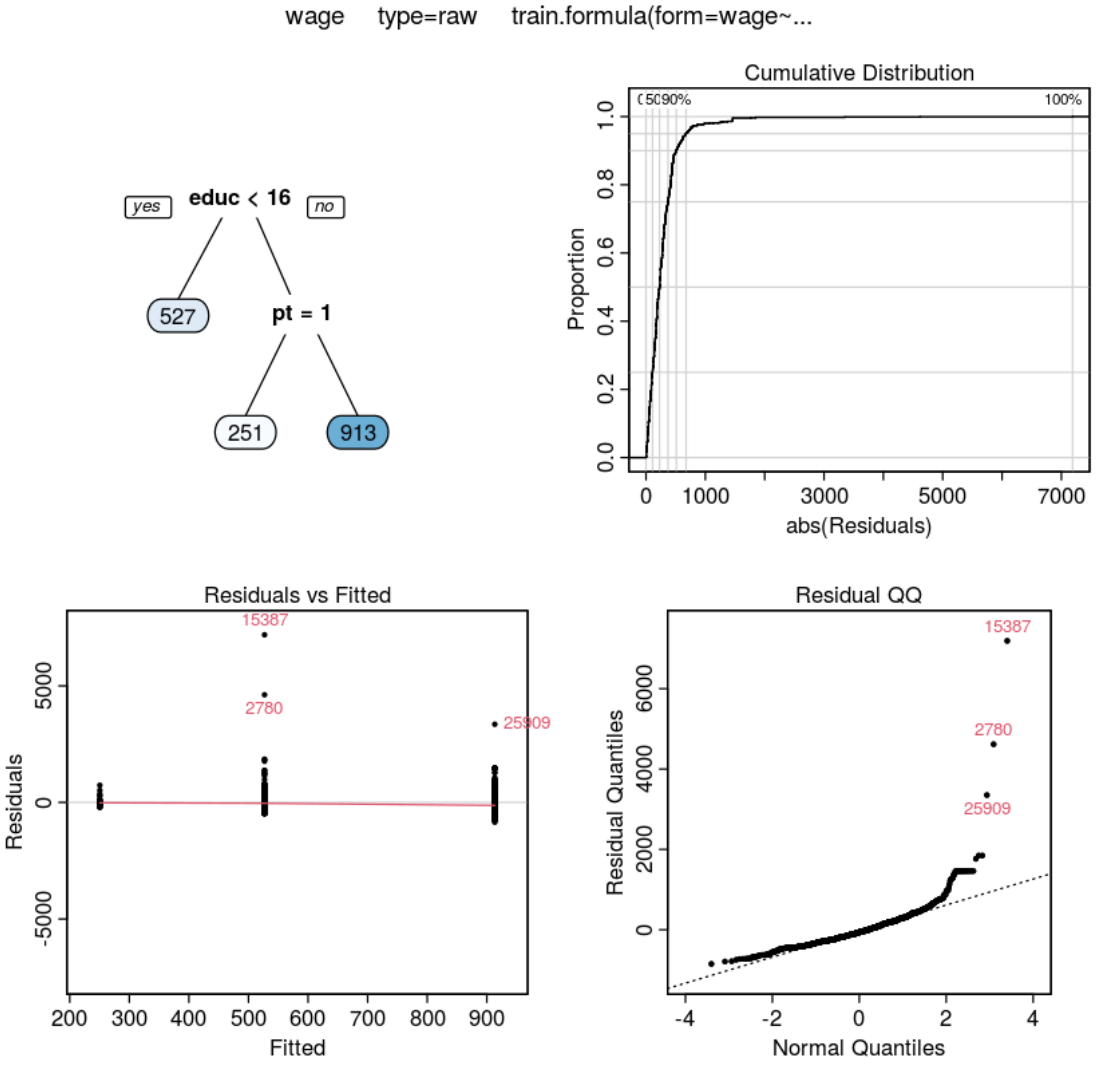
```
so      0.000
```




```
In [108]: plotmo(modtraincart)

 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```




```
In [109]: plotres(modtraincart)
```



1.19 Conditional Inference (ctree)

```
In [108]: install.packages("party")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)

also installing the dependencies TH.data, libcoin, multcomp, modeltools, strucchange, coin
```

```
In [110]: library(party)
```

```
Loading required package: grid

Loading required package: mvtnorm

Loading required package: modeltools

Loading required package: stats4


Attaching package: modeltools


The following object is masked from package:kernlab:

    prior


Loading required package: strucchange

Loading required package: zoo


Attaching package: zoo


The following objects are masked from package:base:

    as.Date, as.Date.numeric


Loading required package: sandwich
```

```
In [111]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
          set.seed(444)
          modtrainctree <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=tra
                                 trControl = controlobject)
          summary(modtrainctree)
```

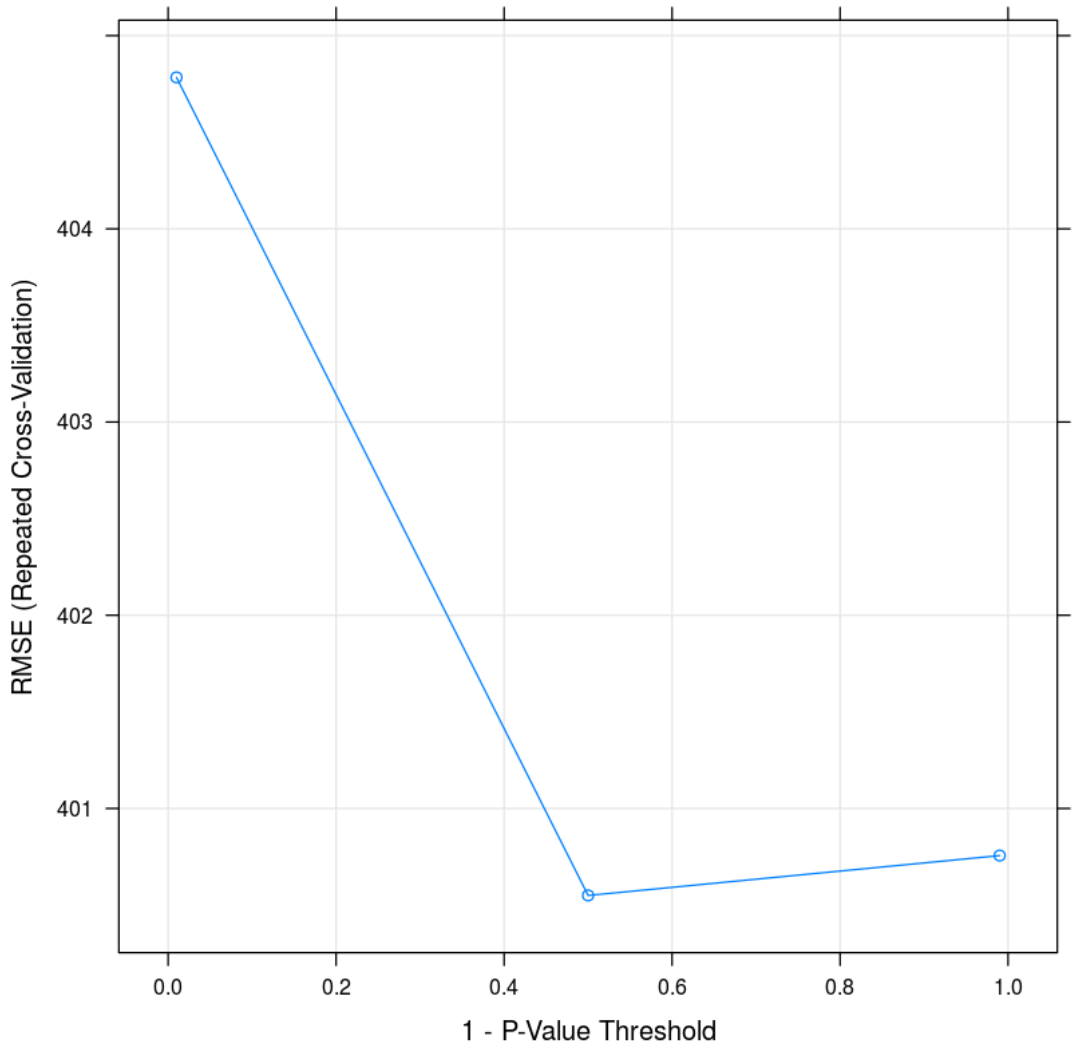
```
    Length      Class       Mode
         1 BinaryTree         S4
```

```
In [112]: modtrainctree
```

```
Conditional Inference Tree

1502 samples
```

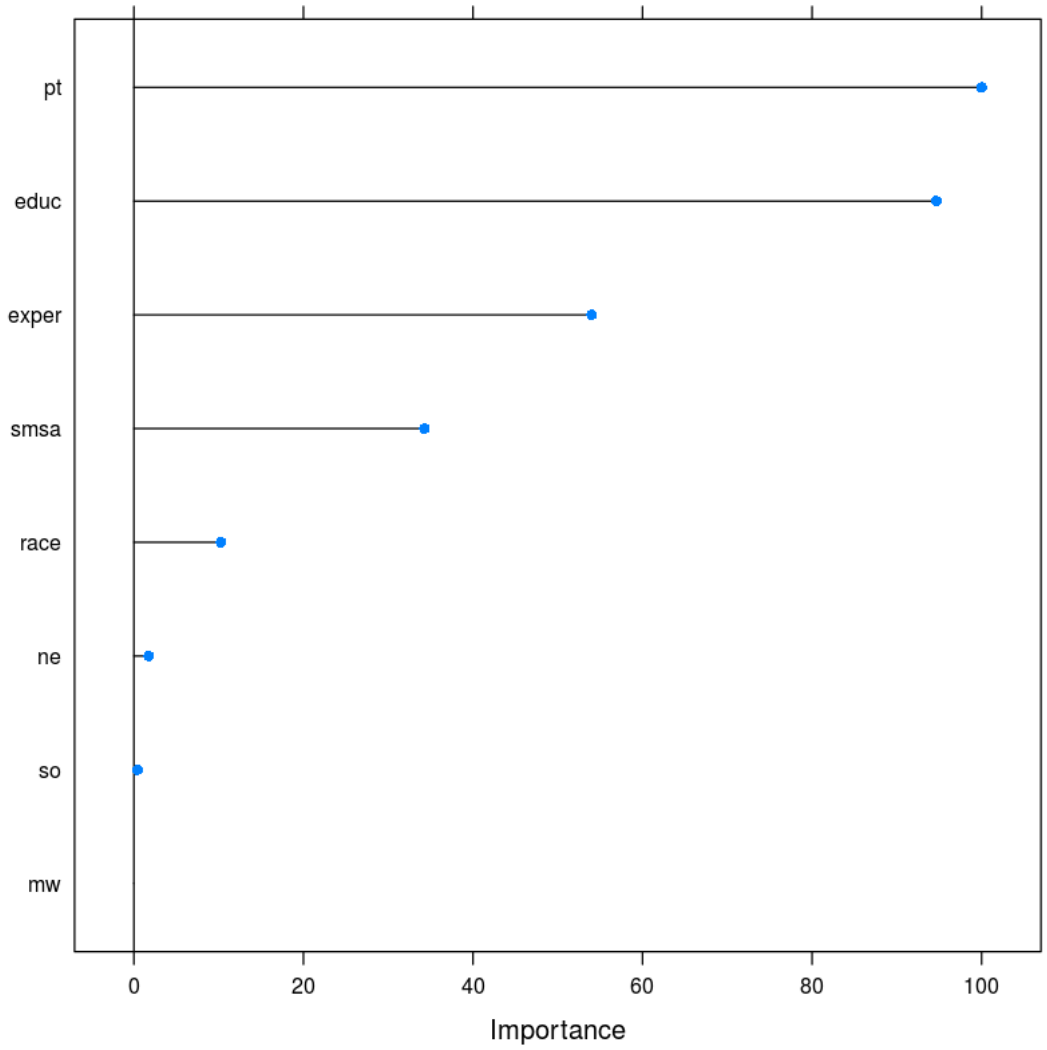
```
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  mincriterion  RMSE      Rsquared   MAE
  0.01          404.7838  0.2398596  251.8803
  0.50          400.5499  0.2469314  246.8693
  0.99          400.7563  0.2418129  249.9874

RMSE was used to select the optimal model using the smallest value.
The final value used for the model was mincriterion = 0.5.
```

```
In [113]: plot(modtrainctree)
```



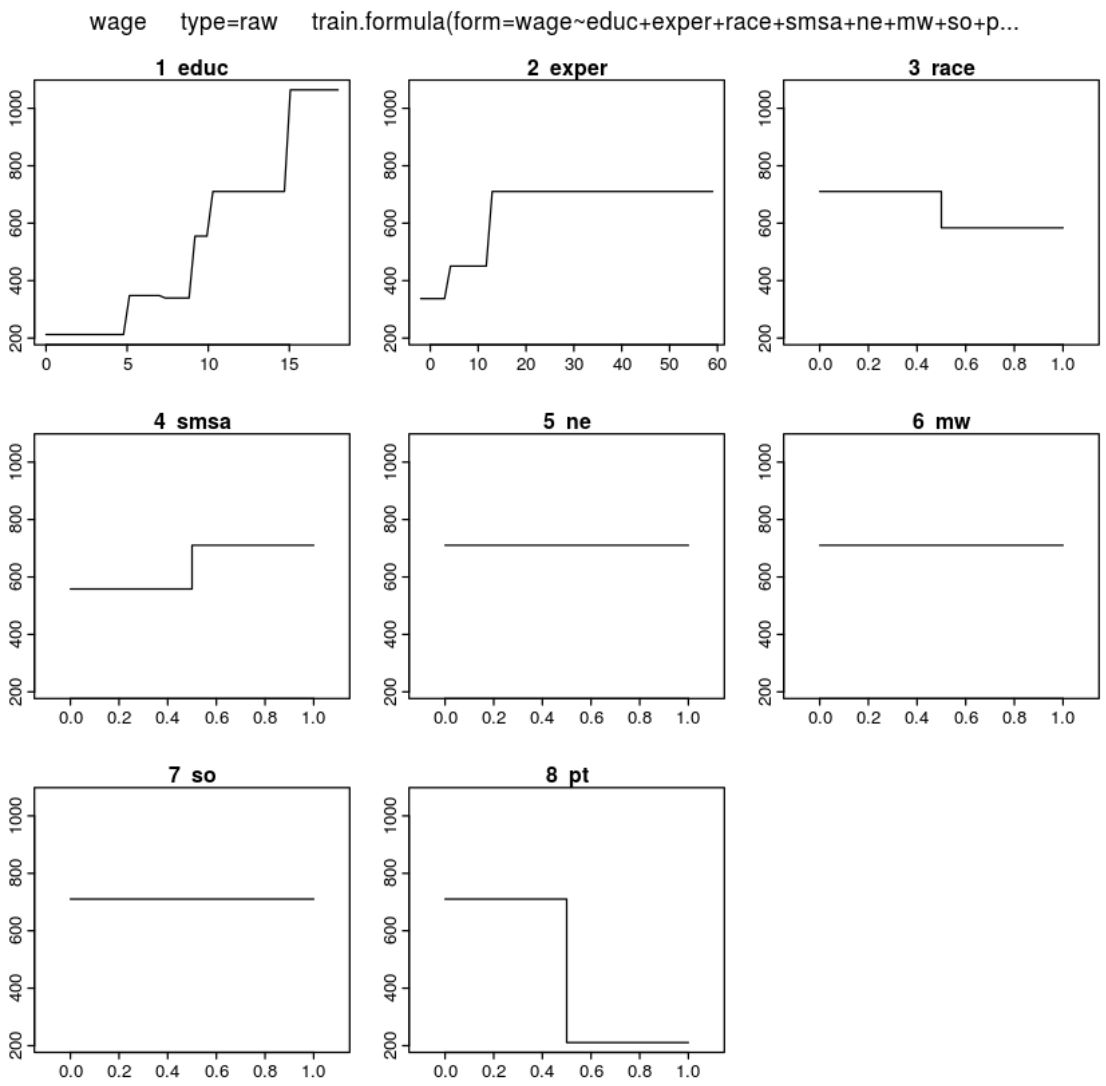

```
In [114]: varImp(modtrainctree)
          plot(varImp(modtrainctree))

loess r-squared variable importance

       Overall
pt    100.0000
educ   94.6507
exper  53.9982
smsa   34.2715
race   10.2629
ne      1.7458
so      0.4235
```

```
mw      0.0000
```

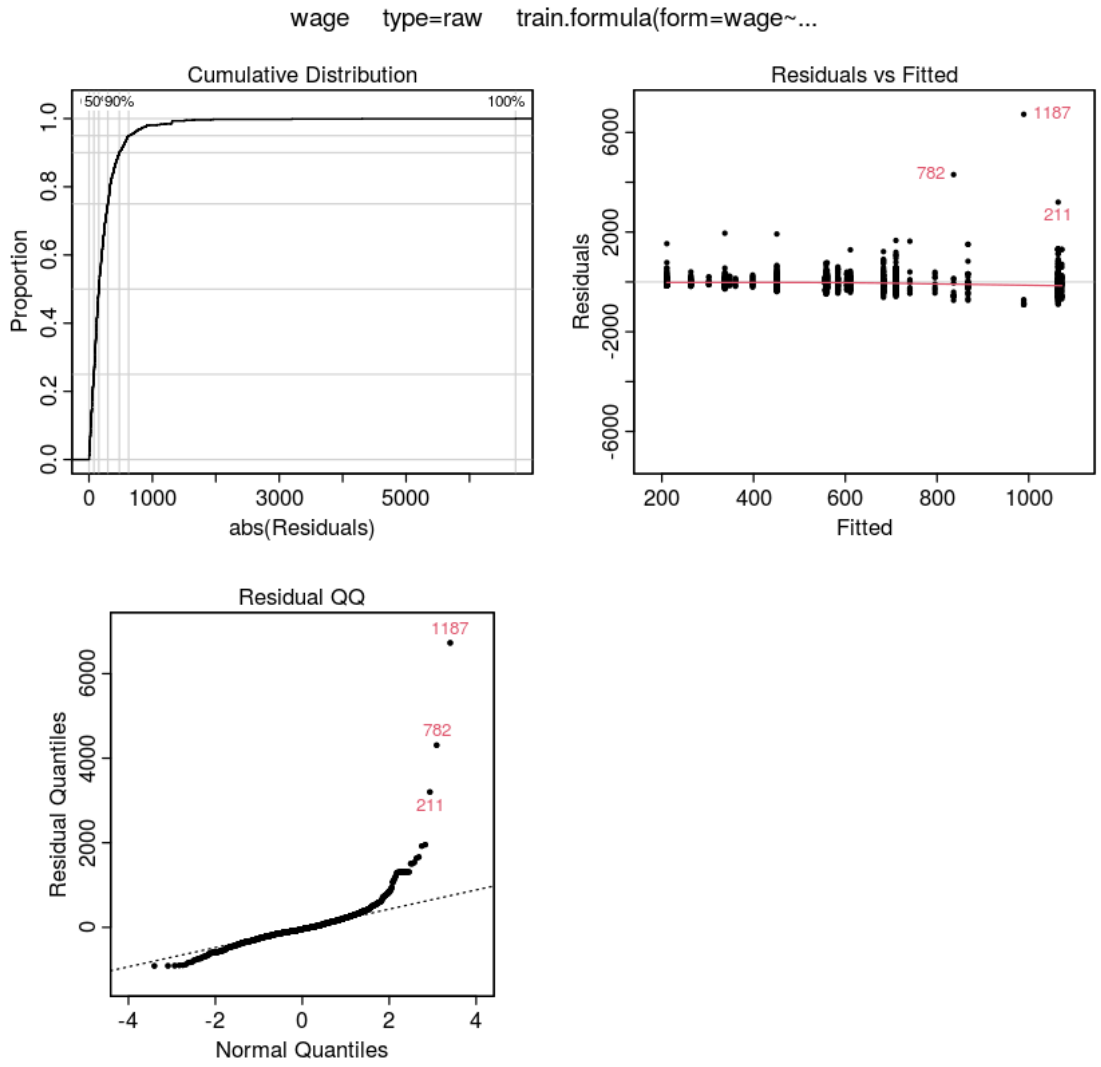


In [115]:
```
plotmo(modtrainctree)
```

```
 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```



In [116]: plotres(modtrainctree)



1.20 Bagged Trees

```
In [117]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
          set.seed(444)
          modtraintreebag <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=t
                                   trControl = controlobject)
          summary(modtraintreebag)
```

```
             Length Class      Mode
y            1502   -none-     numeric
X               0   -none-     NULL
mtrees         25   -none-     list
OOB             1   -none-     logical
```

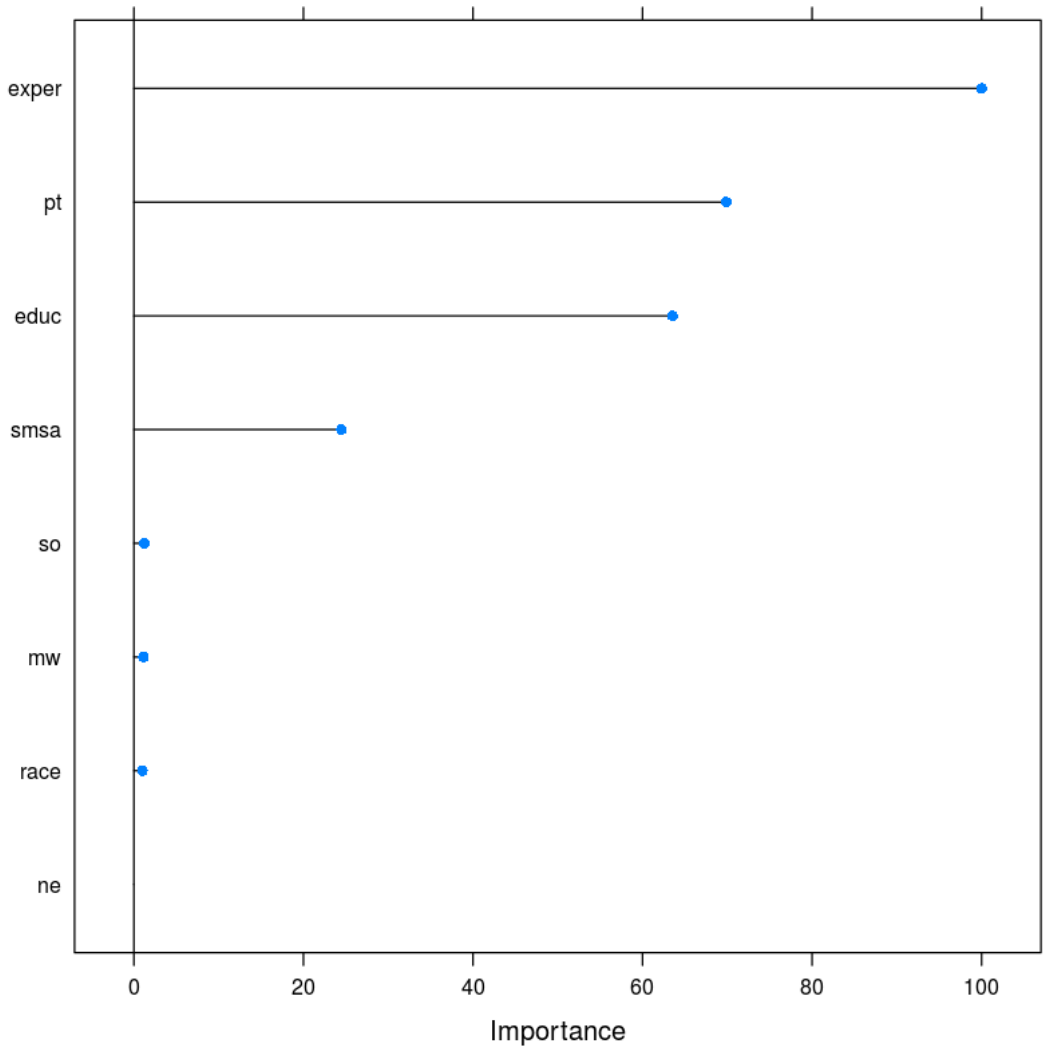
```
comb           1   -none-     logical
xNames         8   -none-     character
problemType    1   -none-     character
tuneValue      1   data.frame list
obsLevels      1   -none-     logical
param          0   -none-     list
```

```
In [118]: modtraintreebag
```

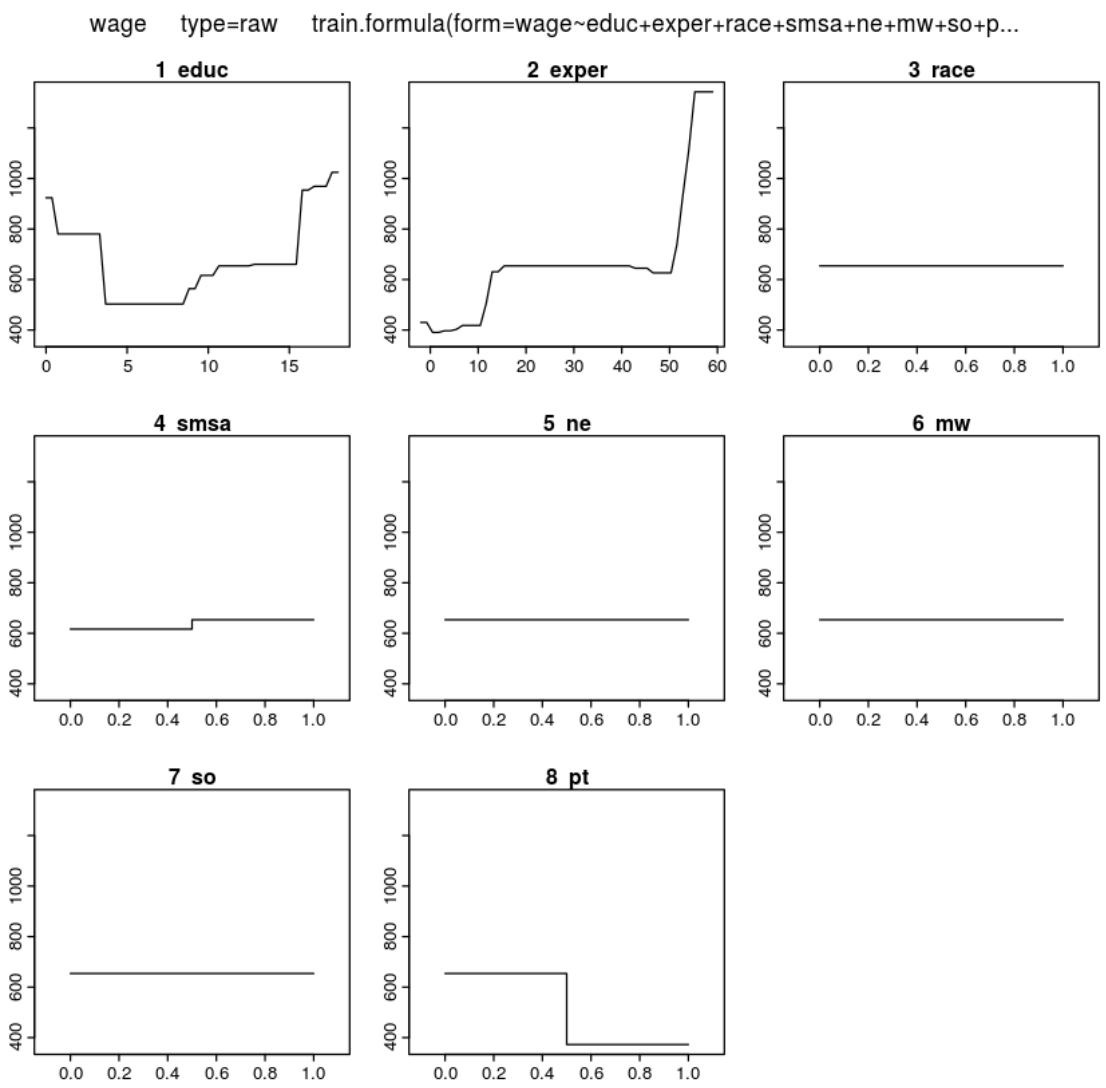
```
Bagged CART

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results:

  RMSE      Rsquared   MAE
  398.5609  0.2464921  251.2714
```

```
In [119]: varImp(modtraintreebag)
          plot(varImp(modtraintreebag))
```

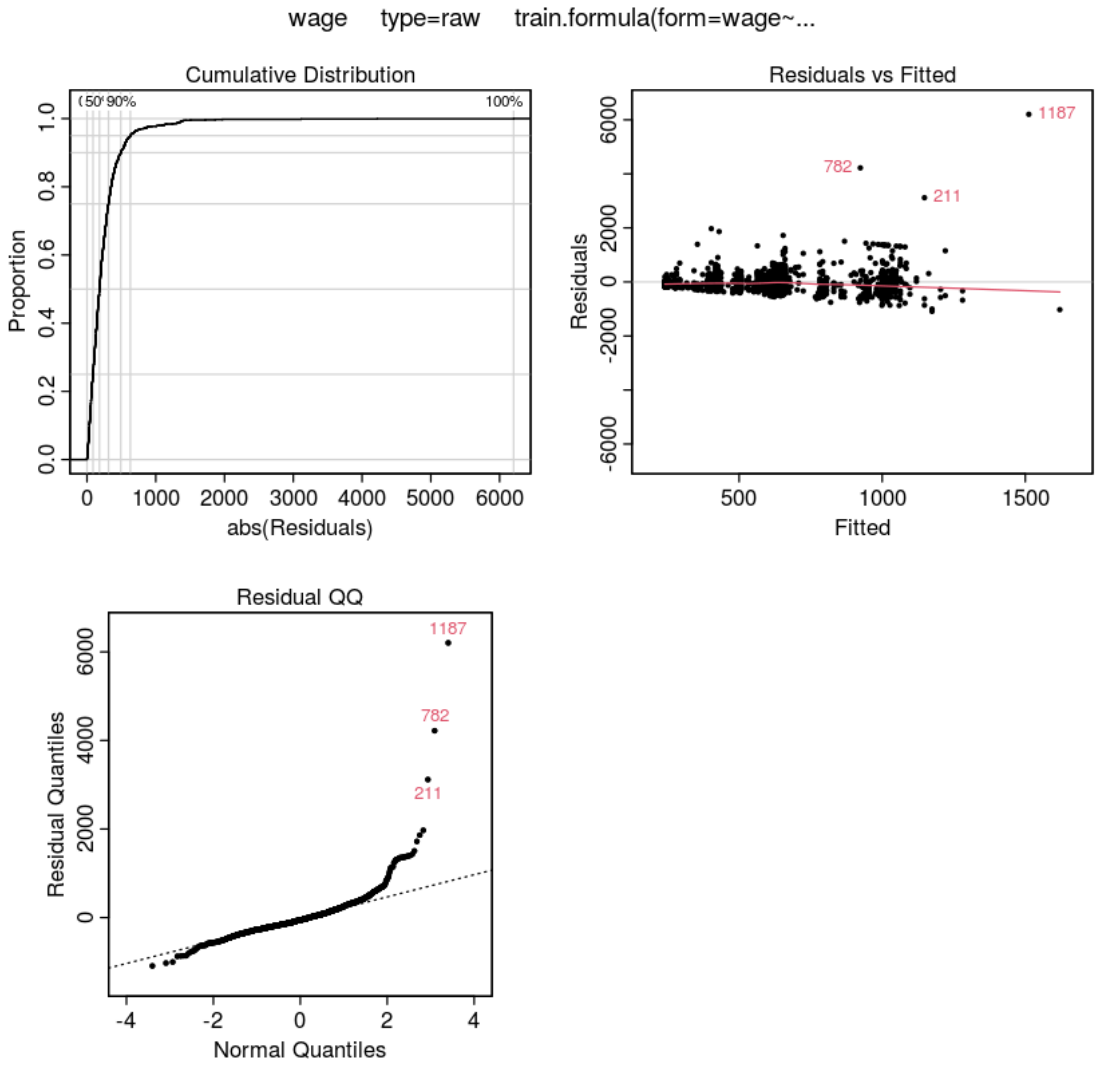
```
treebag variable importance

       Overall
exper 100.0000
pt     69.8791
educ   63.5392
smsa   24.4753
so      1.2456
mw      1.1359
race    0.9989
ne      0.0000
```




```
In [120]: plotmo(modtraintreebag)

 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```



In [121]: plotres(modtraintreebag)



1.21 Random Forests

```
In [124]: install.packages("randomForest")

Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [122]: library(randomForest)

randomForest 4.6-14
```

```
Type rfNews() to see new features/changes/bug fixes.


Attaching package: randomForest


The following object is masked from package:ggplot2:

    margin
```

```
In [123]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
          set.seed(444)
          modtrainrf <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=traini
                              trControl = controlobject)
          summary(modtrainrf)
```

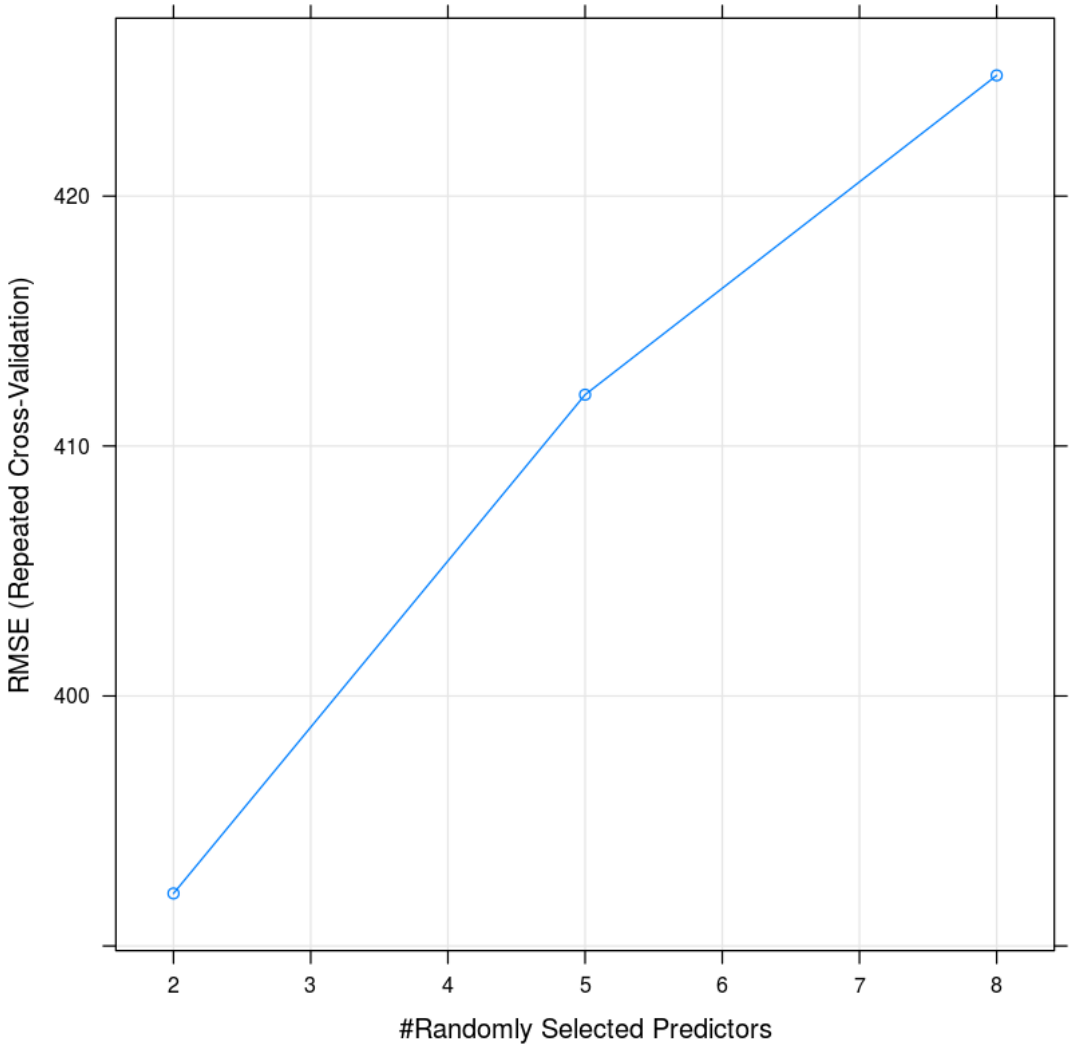
```
                Length Class      Mode
call               4   -none-     call
type               1   -none-     character
predicted       1502   -none-     numeric
mse              500   -none-     numeric
rsq              500   -none-     numeric
oob.times       1502   -none-     numeric
importance         8   -none-     numeric
importanceSD       0   -none-     NULL
localImportance    0   -none-     NULL
proximity          0   -none-     NULL
ntree              1   -none-     numeric
mtry               1   -none-     numeric
forest            11   -none-     list
coefs              0   -none-     NULL
y               1502   -none-     numeric
test               0   -none-     NULL
inbag              0   -none-     NULL
xNames             8   -none-     character
problemType        1   -none-     character
tuneValue          1   data.frame list
obsLevels          1   -none-     logical
param              0   -none-     list
```

```
In [124]: modtrainrf
```

```
Random Forest

1502 samples
```

```
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  mtry  RMSE      Rsquared   MAE
  2     392.1000  0.2795038  243.8947
  5     412.0538  0.2258285  253.8753
  8     424.8281  0.2008405  262.6160

RMSE was used to select the optimal model using the smallest value.
The final value used for the model was mtry = 2.
```

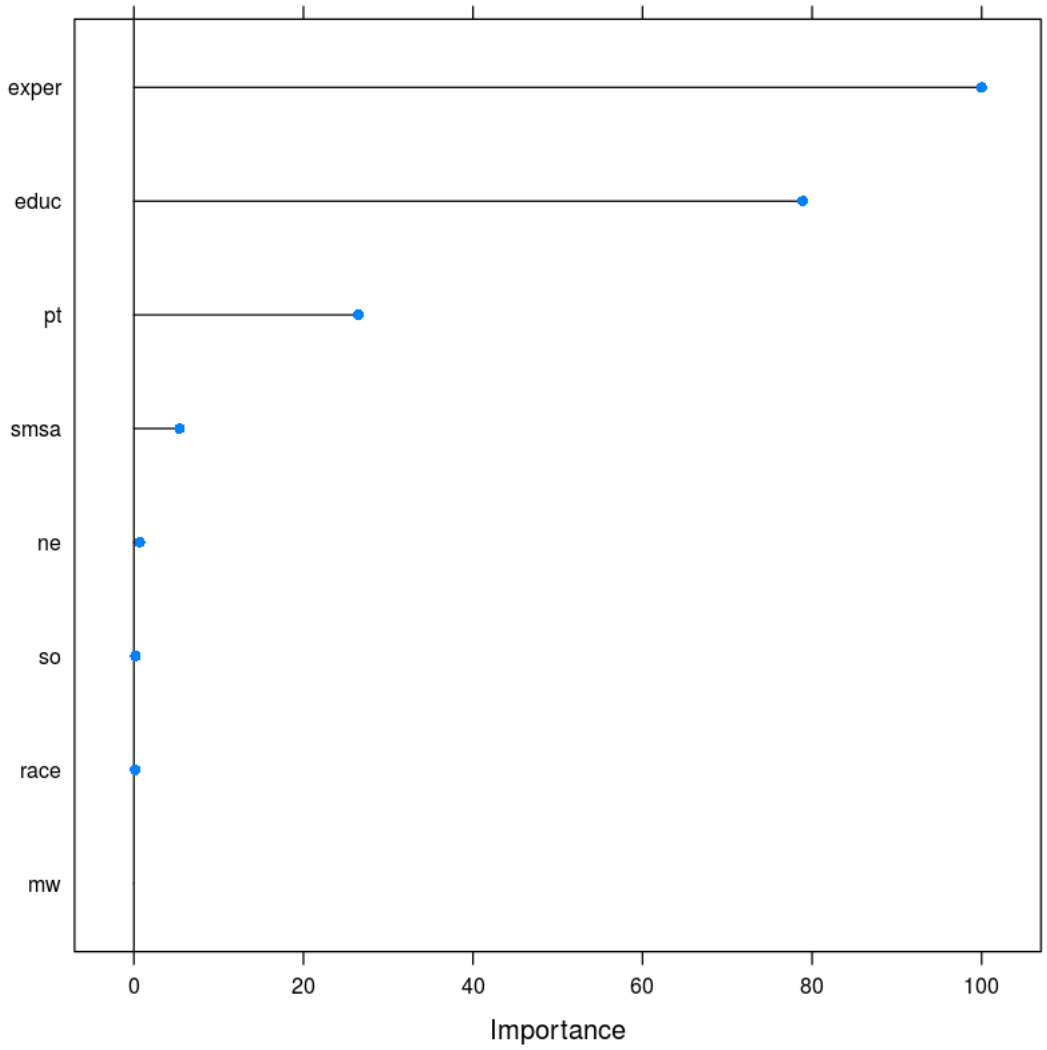
```
In [125]: plot(modtrainrf)
```



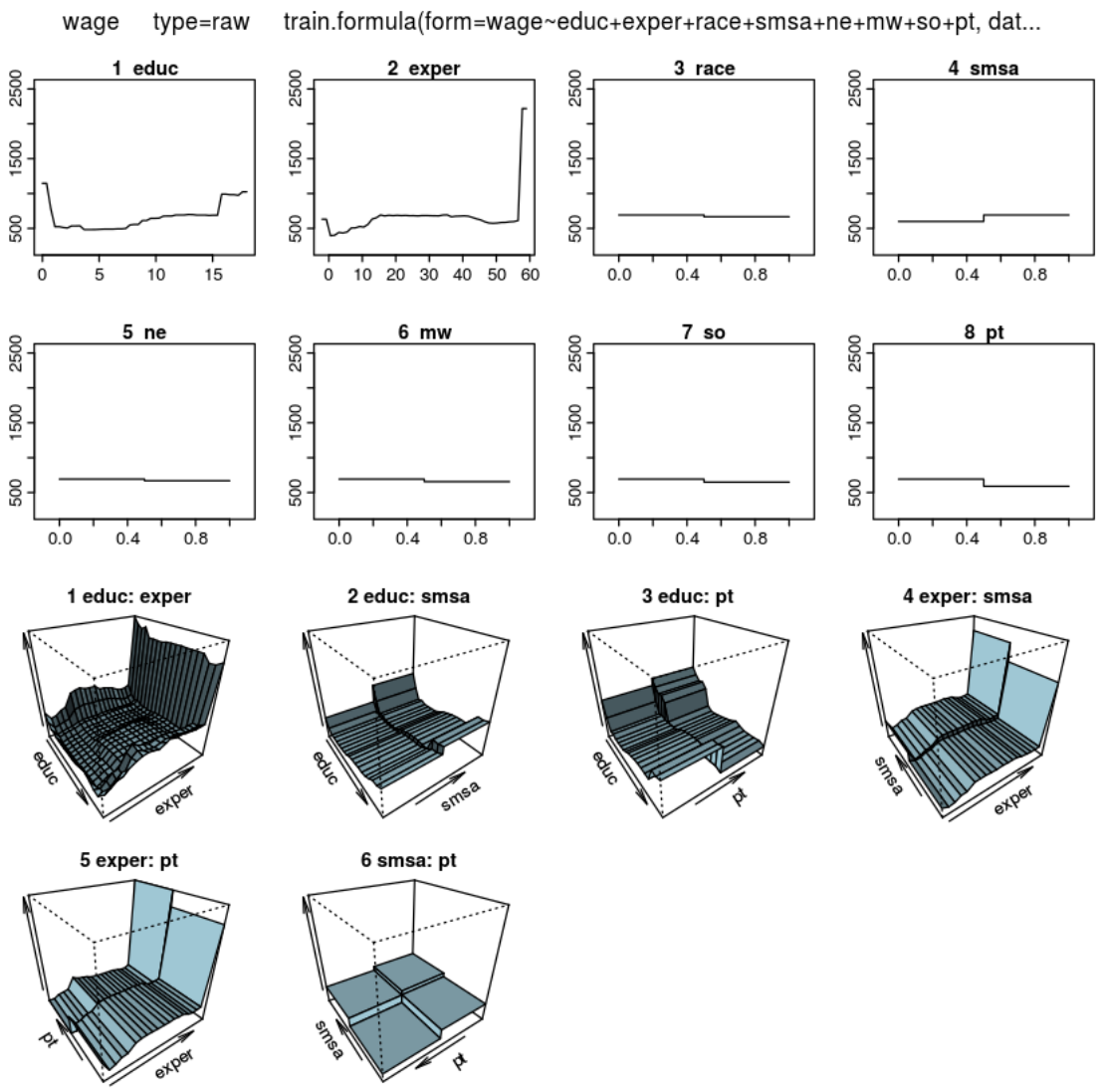

```
In [126]: varImp(modtrainrf)
          plot(varImp(modtrainrf))
```

```
rf variable importance

       Overall
exper 100.0000
educ   78.9012
pt     26.5070
smsa    5.3894
ne      0.6965
so      0.1878
race    0.1493
```

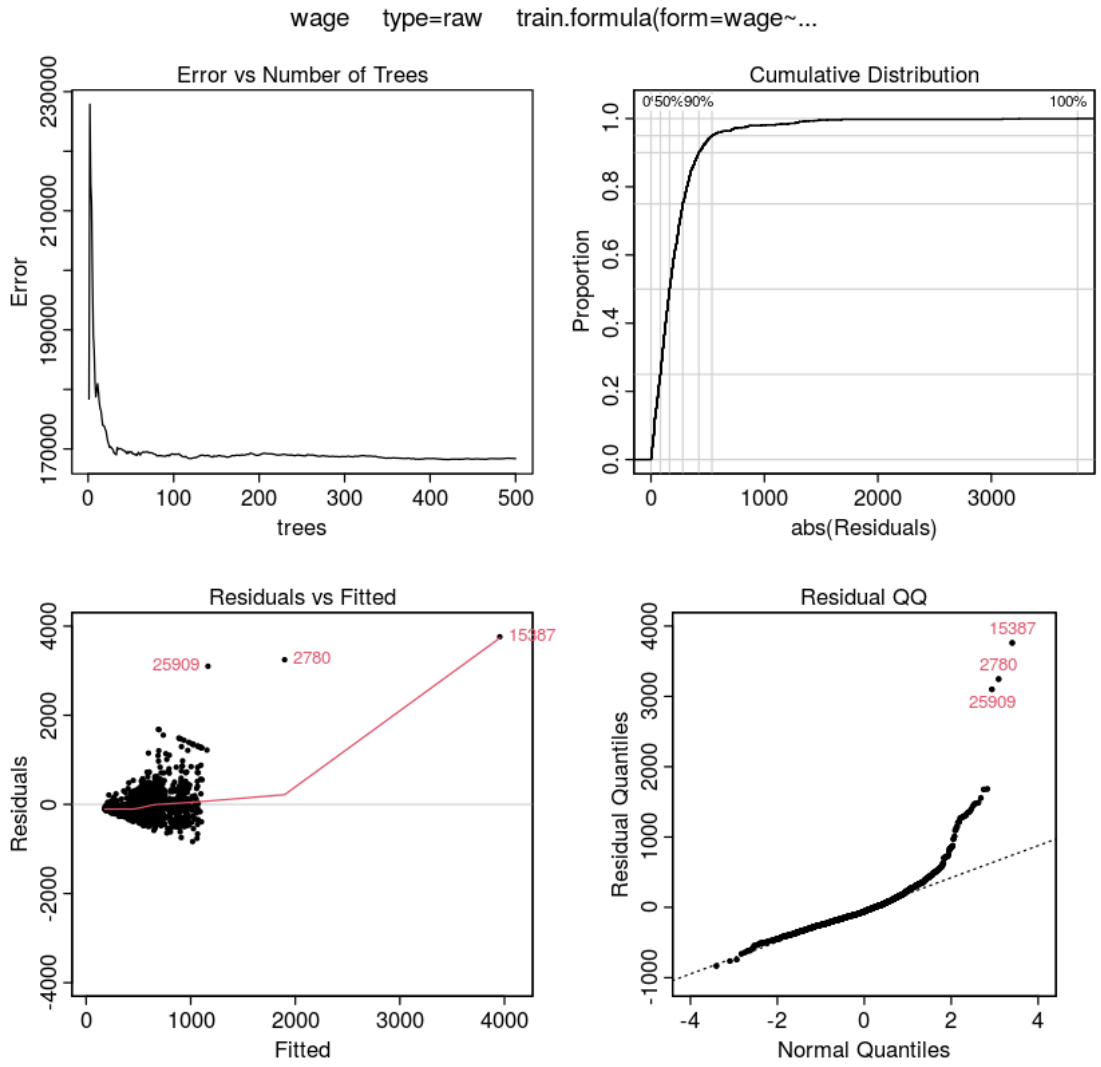
```
mw       0.0000
```




```
In [127]: plotmo(modtrainrf)

 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```



In [128]: plotres(modtrainrf)



1.22 Boosted Trees

```
In [133]: install.packages("gbm")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

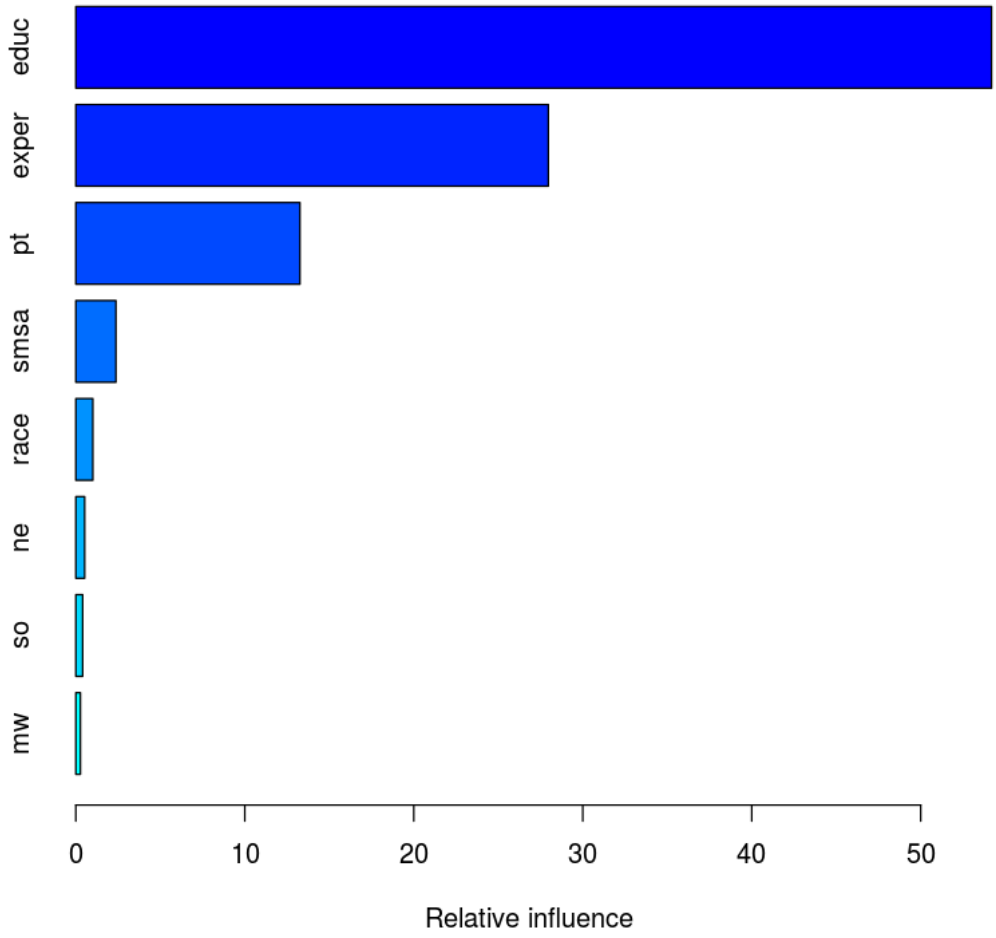
```
In [129]: library(gbm)
```

```
Loaded gbm 2.1.8
```

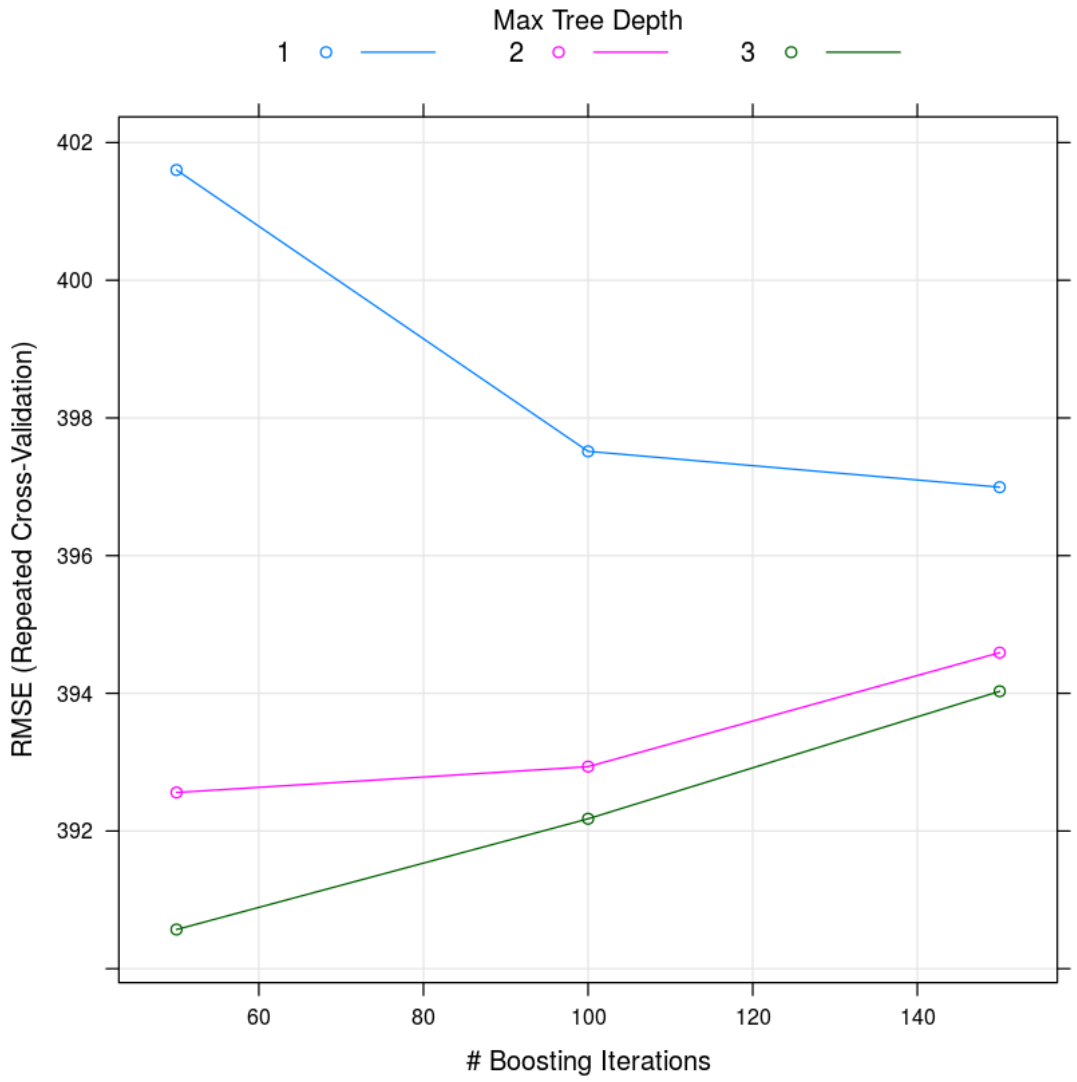
In [130]:
```
controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
set.seed(444)
modtrainboost <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=tra
                       verbose=FALSE, trControl = controlobject)
summary(modtrainboost)
```

A data.frame: 8 Œ 2

	var	rel.inf
	<chr>	<dbl>
educ	educ	54.1908165
exper	exper	27.9618006
pt	pt	13.2635849
smsa	smsa	2.3749159
race	race	1.0079429
ne	ne	0.5236326
so	so	0.4048040
mw	mw	0.2725025

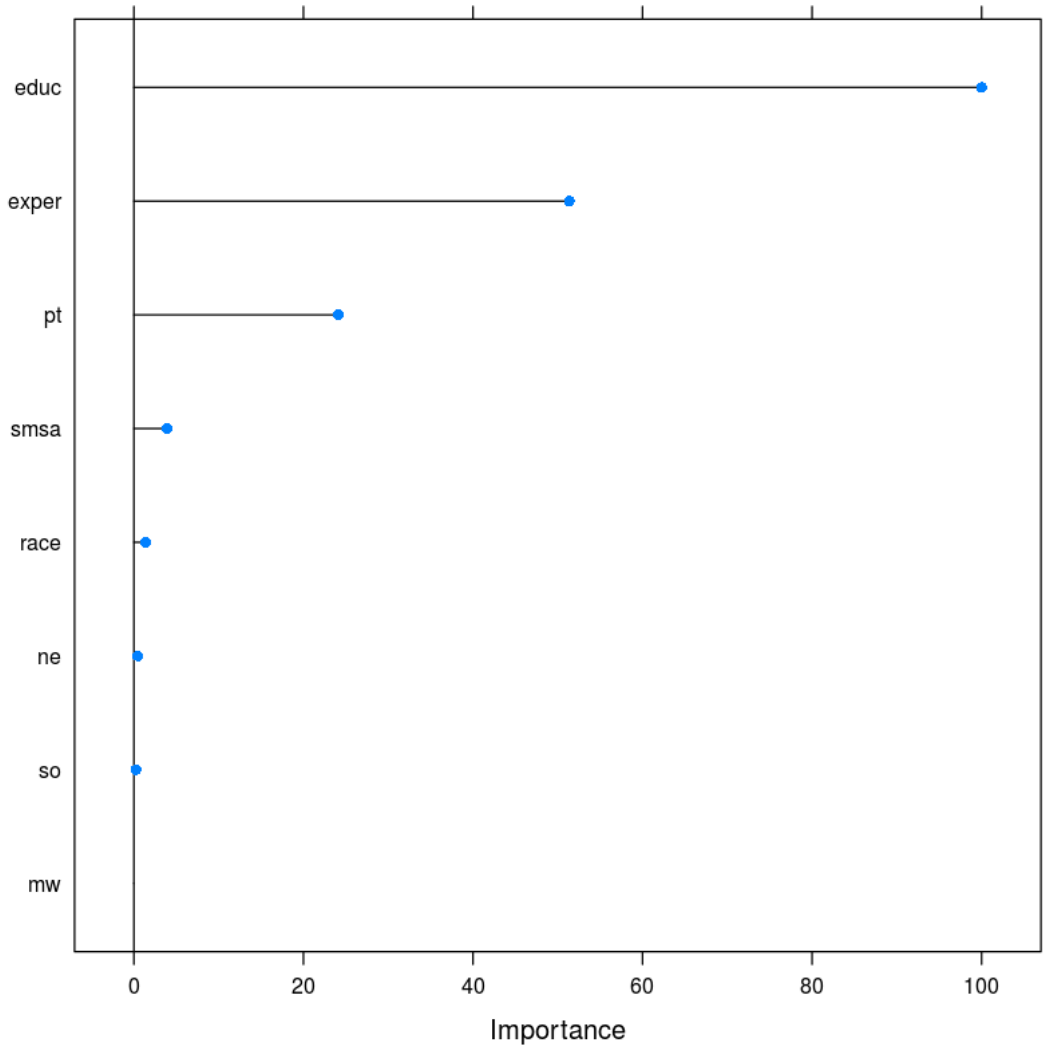


```
In [131]: modtrainboost

Stochastic Gradient Boosting

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  interaction.depth  n.trees  RMSE      Rsquared   MAE
  1                   50      401.6014  0.2439619  254.2492
  1                  100      397.5146  0.2543868  247.6780
  1                  150      396.9942  0.2546666  246.3407
  2                   50      392.5599  0.2720836  244.4601
  2                  100      392.9352  0.2708776  242.7066
  2                  150      394.5906  0.2669272  243.2320
  3                   50      390.5691  0.2792829  240.6793
  3                  100      392.1777  0.2753840  241.0741
  3                  150      394.0295  0.2706480  241.4174

Tuning parameter 'shrinkage' was held constant at a value of 0.1

Tuning parameter 'n.minobsinnode' was held constant at a value of 10
RMSE was used to select the optimal model using the smallest value.
The final values used for the model were n.trees = 50, interaction.depth =
 3, shrinkage = 0.1 and n.minobsinnode = 10.


In [132]: plot(modtrainboost)
```



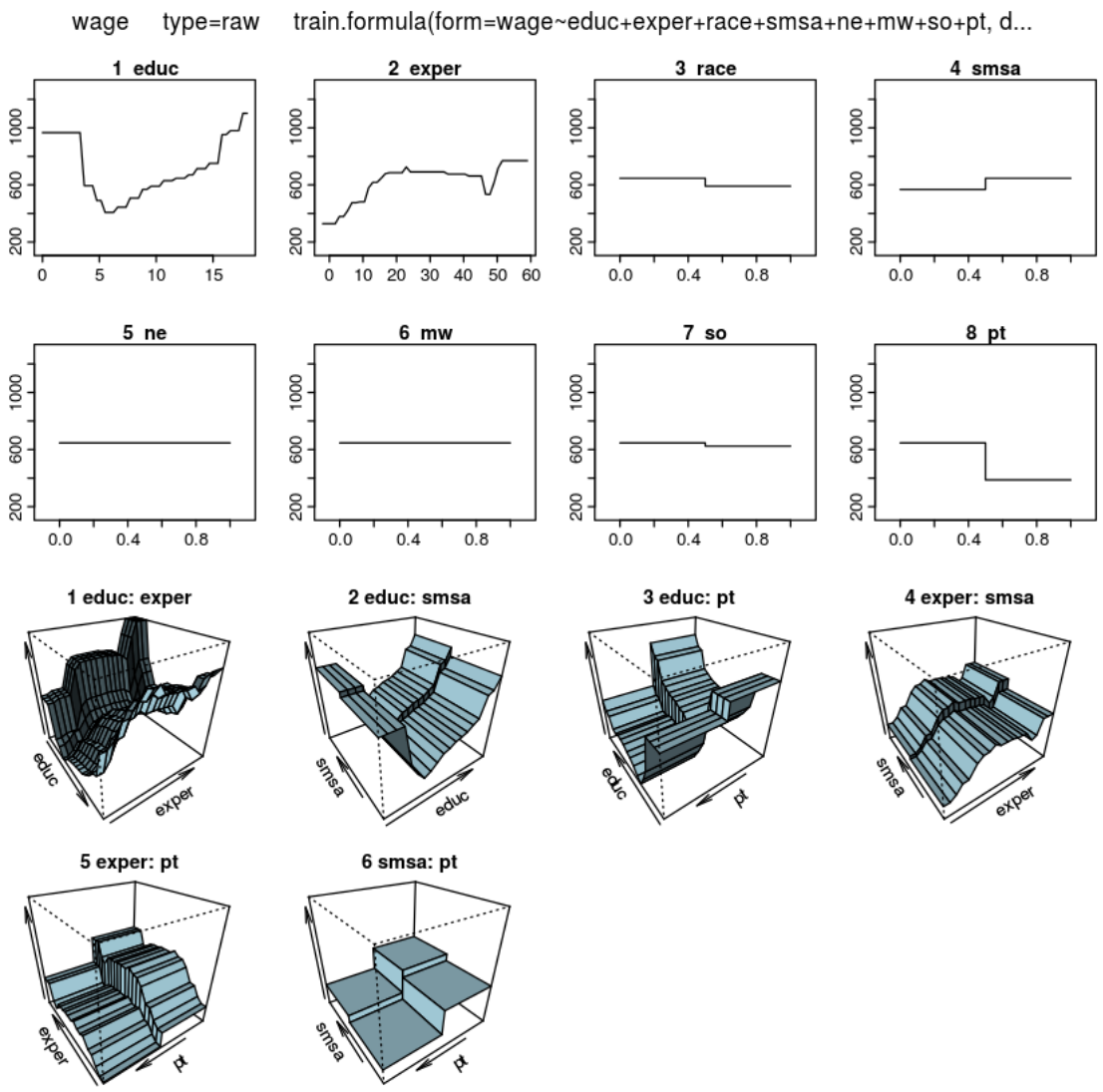

```
In [133]: varImp(modtrainboost)
          plot(varImp(modtrainboost))

gbm variable importance

       Overall
educ  100.0000
exper  51.3542
pt     24.0940
smsa    3.8993
race    1.3640
ne      0.4658
so      0.2454
```

```
mw       0.0000
```

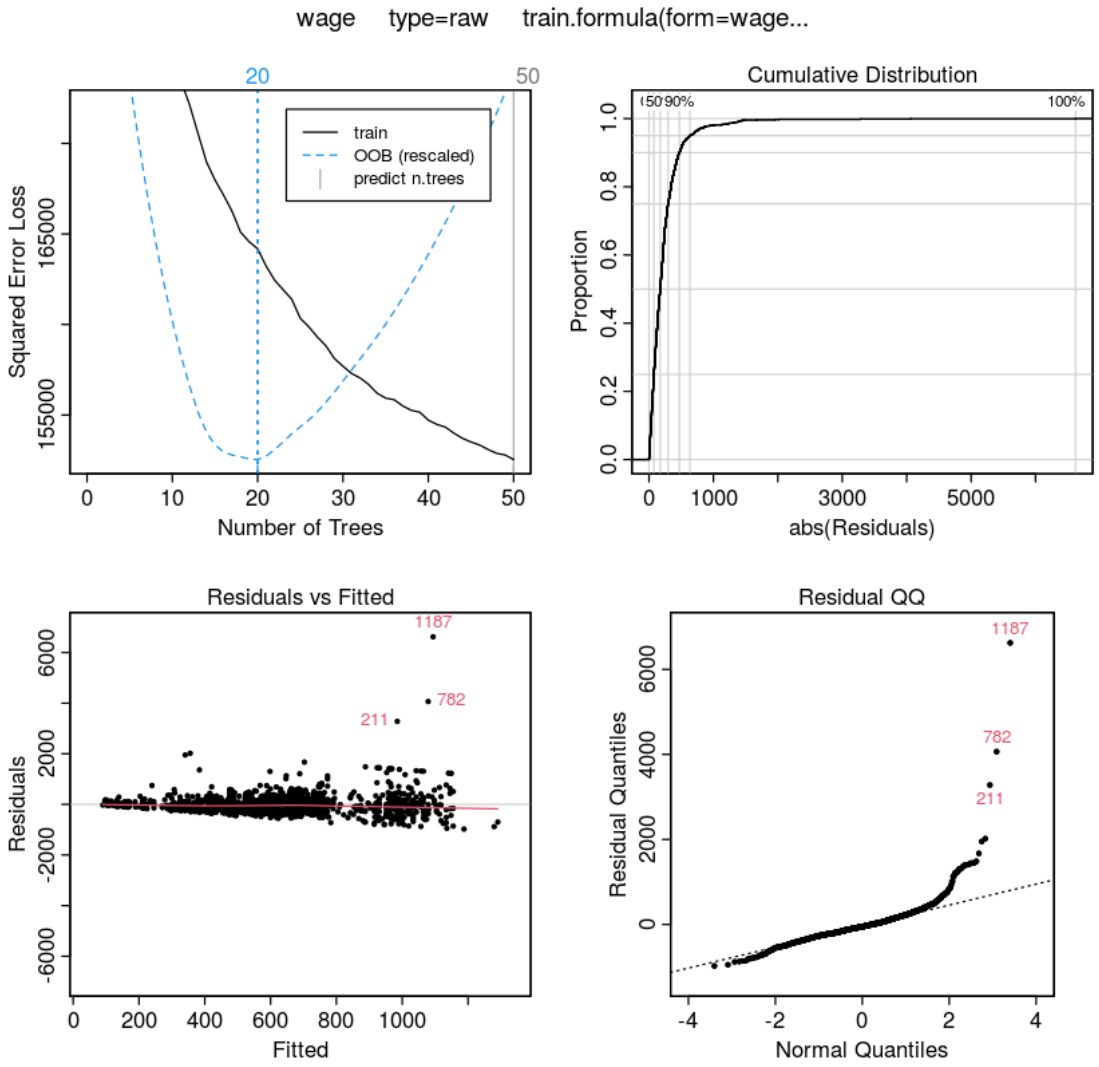


In [134]:
```
plotmo(modtrainboost)
```

```
 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```



In [135]: plotres(modtrainboost)



1.23 Cubist

```
In [142]: install.packages("Cubist")
```

```
Installing package into /home/buttob/R_libs
(as lib is unspecified)
```

```
In [136]: library(Cubist)
```

```
In [137]: controlobject <- trainControl(method="repeatedcv", number = 10, repeats = 5)
          set.seed(444)
```

```
modtraincubist <- train(wage ~ educ + exper + race + smsa + ne + mw + so + pt, data=tr
                        verbose=FALSE, trControl = controlobject)
summary(modtraincubist)
```

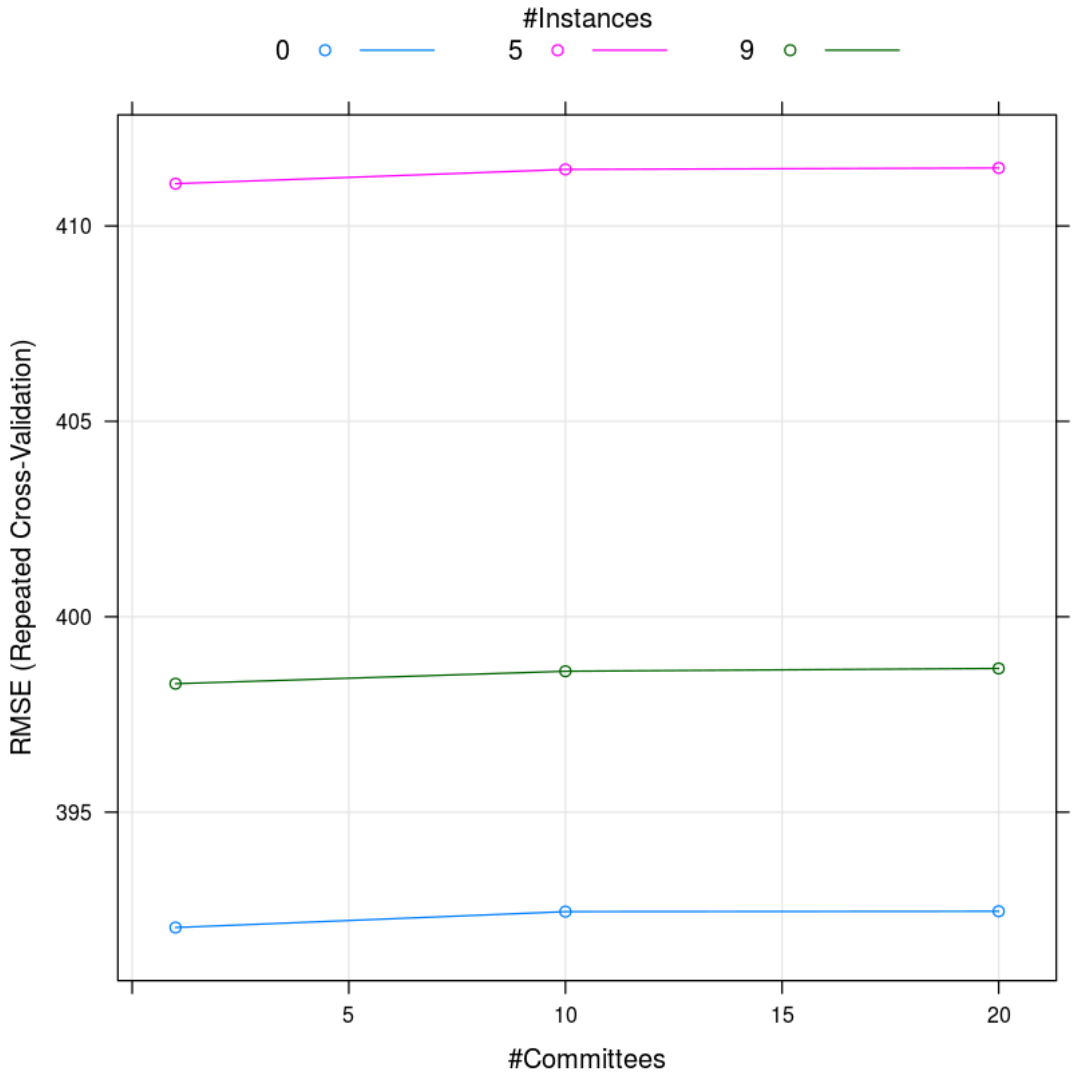
```
Call:
cubist.default(x = x, y = y, committees = param$committees, verbose = FALSE)


Cubist [Release 2.07 GPL Edition]  Tue Jun 15 17:38:36 2021
---------------------------------

    Target attribute `outcome'

Read 1502 cases (9 attributes) from undefined.data

Model:

  Rule 1: [753 cases, mean 503.240, range 50.39 to 2374.15, est err 198.411]

    if
educ > 3
exper <= 15
    then
outcome = -459.98 + 22.6 exper + 54 educ - 239 pt + 62 smsa - 81 race

  Rule 2: [732 cases, mean 706.133, range 53.7 to 4264.87, est err 255.088]

    if
educ > 3
exper > 15
    then
outcome = 15.99 - 474 pt + 45 educ + 139 smsa - 107 race

  Rule 3: [17 cases, mean 1000.392, range 142.45 to 7716.05, est err 914.042]

    if
educ <= 3
    then
outcome = 222.22


Evaluation on training data (1502 cases):

    Average  |error|            273.105
    Relative |error|              0.89
    Correlation coefficient       0.39
```

```
Attribute usage:
  Conds  Model

  100%    99%    educ
   99%    50%    exper
          99%    race
          99%    smsa
          99%    pt


Time: 0.0 secs
```

```
In [138]: modtraincubist
```

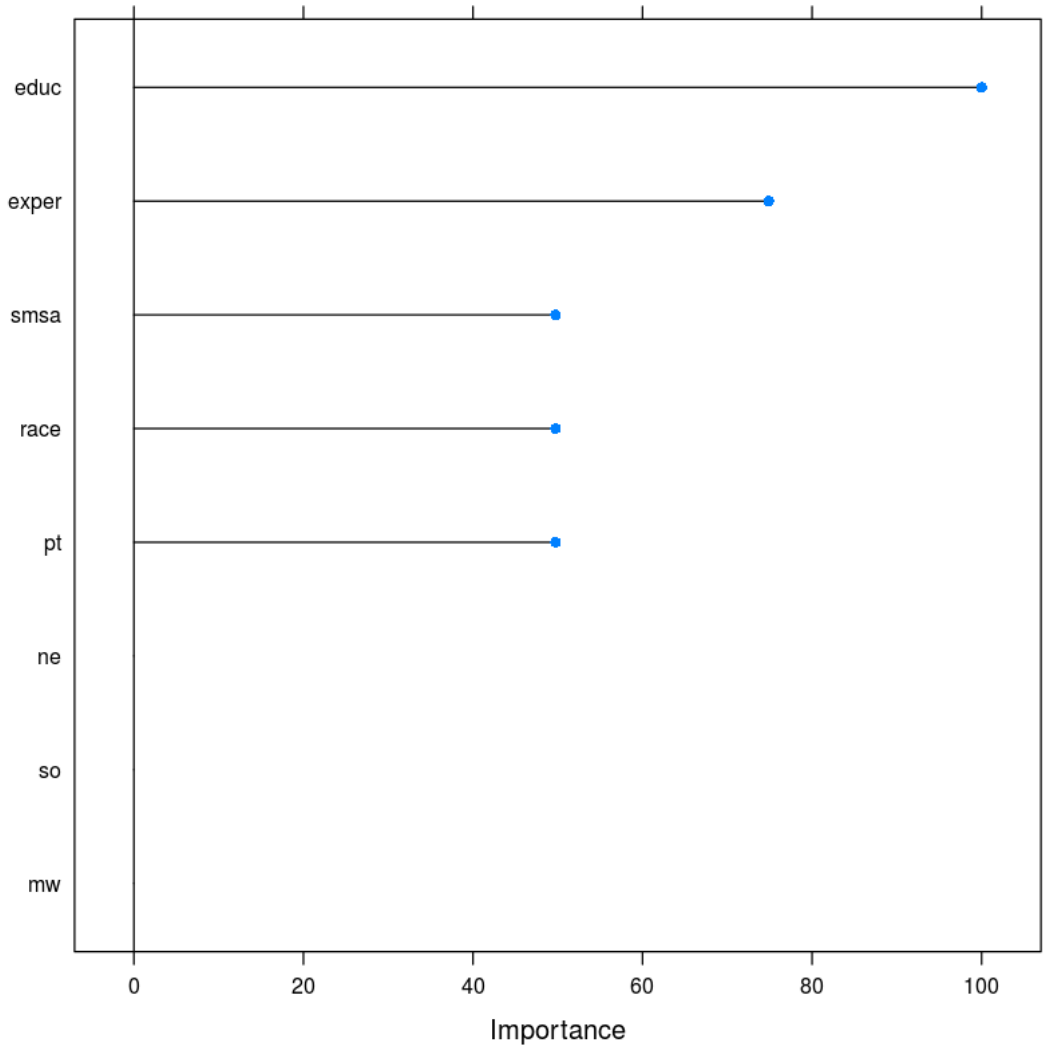
```
Cubist

1502 samples
   8 predictors

No pre-processing
Resampling: Cross-Validated (10 fold, repeated 5 times)
Summary of sample sizes: 1352, 1351, 1351, 1353, 1351, 1351, ...
Resampling results across tuning parameters:

  committees  neighbors  RMSE      Rsquared   MAE
   1          0          392.0485  0.2890985  233.0311
   1          5          411.0805  0.2311560  253.9112
   1          9          398.2870  0.2636226  245.8501
  10          0          392.4551  0.2885455  232.3563
  10          5          411.4450  0.2295322  254.2429
  10          9          398.6056  0.2619052  246.1306
  20          0          392.4637  0.2884092  232.3256
  20          5          411.4817  0.2294505  254.3380
  20          9          398.6776  0.2617350  246.2093

RMSE was used to select the optimal model using the smallest value.
The final values used for the model were committees = 1 and neighbors = 0.
```

```
In [139]: plot(modtraincubist)
```



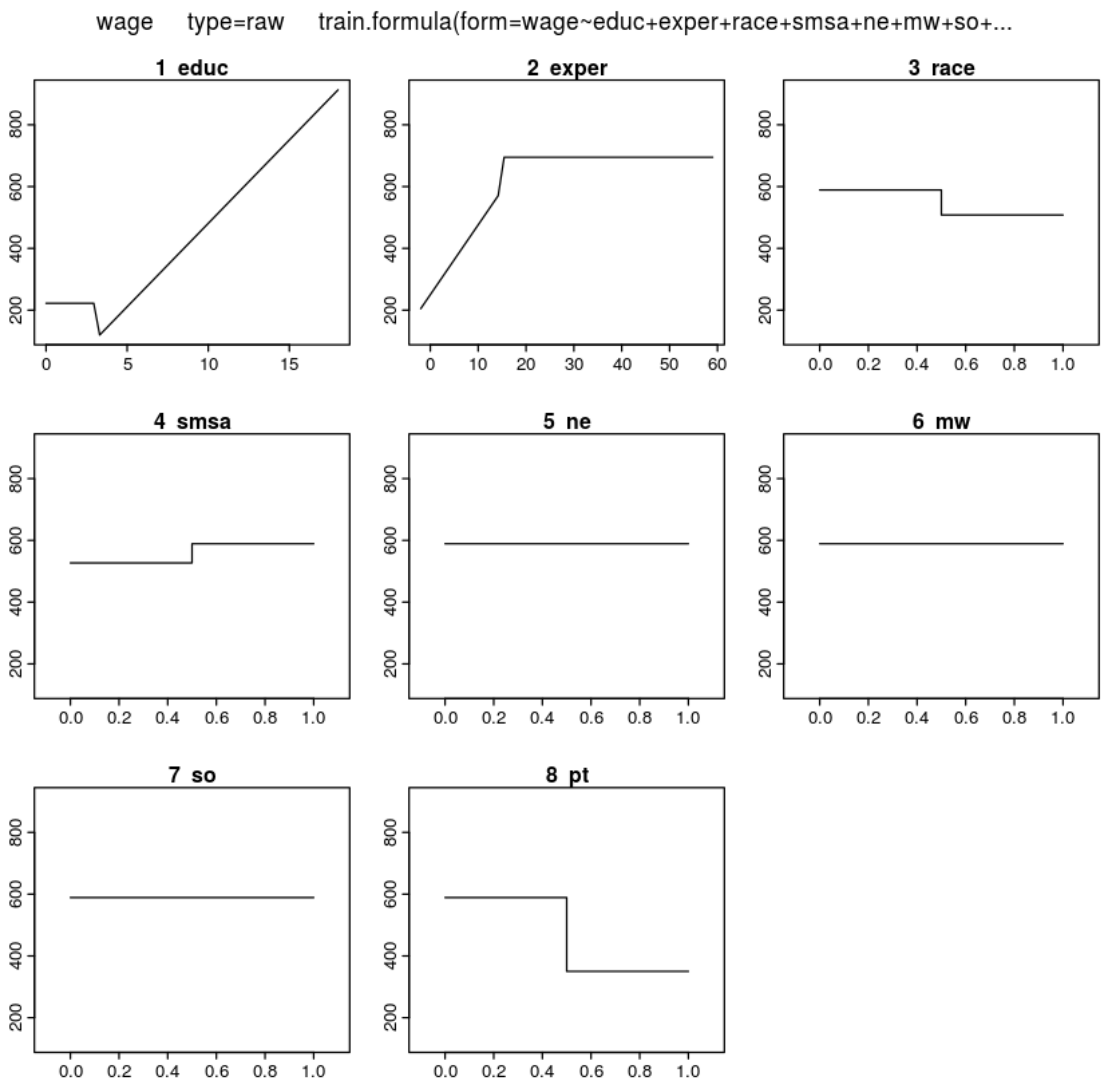

```
In [140]: varImp(modtraincubist)
          plot(varImp(modtraincubist))

cubist variable importance

      Overall
educ   100.00
exper   74.87
race    49.75
pt      49.75
smsa    49.75
ne       0.00
so       0.00
```

```
mw        0.00
```

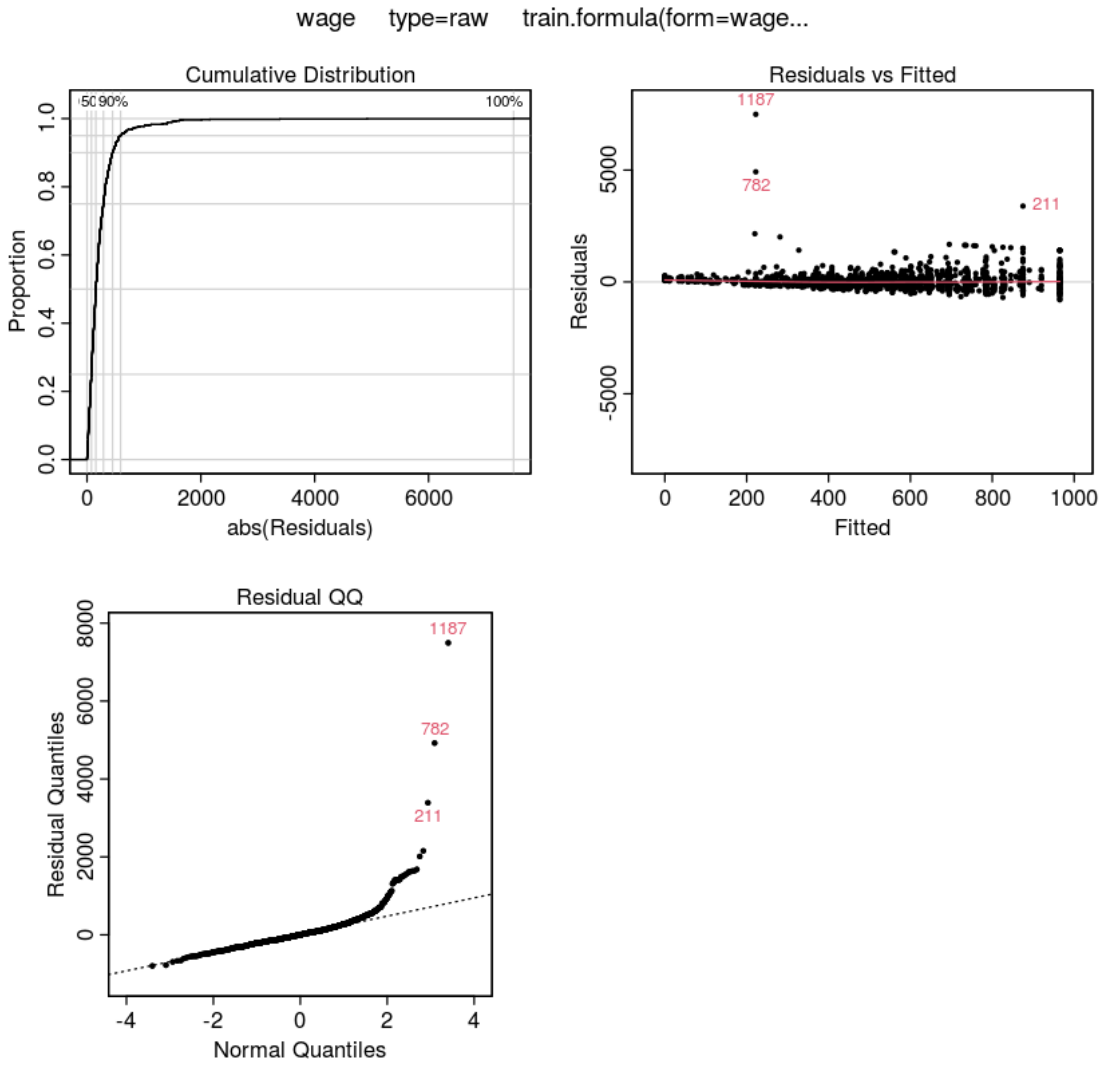


In [141]:
```
plotmo(modtraincubist)
```

```
 plotmo grid:    educ exper race smsa ne mw so pt
                   12    15    0    1  0  0  0  0
```



In [142]: plotres(modtraincubist)



1.24 Week 6

1.25 Stacked Results

```
In [158]: installed.packages()
```

A matrix: 287 Œ 16 of type chr

	Package	LibPath	Version	Pr
abind	abind	/home/buttob/R_libs	1.4-5	N
AER	AER	/home/buttob/R_libs	1.2-9	N
ape	ape	/home/buttob/R_libs	5.4-1	N
arm	arm	/home/buttob/R_libs	1.11-2	N
bayestestR	bayestestR	/home/buttob/R_libs	0.9.0	N
brew	brew	/home/buttob/R_libs	1.0-6	N
brio	brio	/home/buttob/R_libs	1.1.1	N
broom	broom	/home/buttob/R_libs	0.7.5	N
bslib	bslib	/home/buttob/R_libs	0.2.4	N
cachem	cachem	/home/buttob/R_libs	1.0.4	N
callr	callr	/home/buttob/R_libs	3.6.0	N
car	car	/home/buttob/R_libs	3.0-10	N
carData	carData	/home/buttob/R_libs	3.0-4	N
caret	caret	/home/buttob/R_libs	6.0-88	N
checkmate	checkmate	/home/buttob/R_libs	2.0.0	N
cli	cli	/home/buttob/R_libs	2.4.0	N
coda	coda	/home/buttob/R_libs	0.19-4	N
coin	coin	/home/buttob/R_libs	1.4-1	N
commonmark	commonmark	/home/buttob/R_libs	1.7	N
conquer	conquer	/home/buttob/R_libs	1.0.2	N
corpcor	corpcor	/home/buttob/R_libs	1.6.9	N
corrplot	corrplot	/home/buttob/R_libs	0.84	N
credentials	credentials	/home/buttob/R_libs	1.3.0	N
Cubist	Cubist	/home/buttob/R_libs	0.3.0	N
DAAG	DAAG	/home/buttob/R_libs	1.24	N
data.table	data.table	/home/buttob/R_libs	1.14.0	N
desc	desc	/home/buttob/R_libs	1.3.0	N
devtools	devtools	/home/buttob/R_libs	2.4.0	N
DHARMa	DHARMa	/home/buttob/R_libs	0.4.1	N
diffobj	diffobj	/home/buttob/R_libs	0.3.4	N
yaml	yaml	/usr/local/lib/R/site-library	2.2.1	N
base	base	/usr/lib/R/library	4.0.2	ba
boot	boot	/usr/lib/R/library	1.3-25	re
class	class	/usr/lib/R/library	7.3-17	re
cluster	cluster	/usr/lib/R/library	2.1.0	re
codetools	codetools	/usr/lib/R/library	0.2-16	re
compiler	compiler	/usr/lib/R/library	4.0.2	ba
datasets	datasets	/usr/lib/R/library	4.0.2	ba
foreign	foreign	/usr/lib/R/library	0.8-79	re
graphics	graphics	/usr/lib/R/library	4.0.2	ba
grDevices	grDevices	/usr/lib/R/library	4.0.2	ba
grid	grid	/usr/lib/R/library	4.0.2	ba
KernSmooth	KernSmooth	/usr/lib/R/library	2.23-17	re
lattice	lattice	/usr/lib/R/library	0.20-41	re
MASS	MASS	/usr/lib/R/library	7.3-53	re
Matrix	Matrix	/usr/lib/R/library	1.2-18	re
methods	methods	/usr/lib/R/library	4.0.2	ba
mgcv	mgcv	/usr/lib/R/library	1.8-33	re
nlme	nlme	/usr/lib/R/library	3.1-149	re
nnet	nnet	/usr/lib/R/library	7.3-14	re
parallel	parallel	/usr/lib/R/library	4.0.2	ba

```
In [156]: library(caret)
```

```
In [194]: ressum <- resamples(list("LMOLS" = modtrainols,
                                   "LMRobust" = modtrainrlm,
                                   "LMPCA" = modtrainrlmpc,
                                   "LMPLS" = modtrainrlmpls,
                                   "LMRidge" = modtrainrlmrr,
                                   "LMLasso" = modtrainrlmlasso,
                                   "LMENet" = modtrainrlmenet,
                                   "NLNN" = modtrainnn,
                                   "NLMars" = modtrainmars,
                                   "NLSVM" = modtrainsvm,
                                   "NLKNN" = modtrainknn,
                                   "TrCART" = modtraincart,
                                   "TrCTree" = modtrainctree,
                                   "TrBag" = modtraintreebag,
                                   "TrRF" = modtrainrf,
                                   "TrBoost" = modtrainboost,
                                   "TrCubist" = modtraincubist))
```

```
In [195]: names(ressum)
```

1. 'call' 2. 'values' 3. 'models' 4. 'metrics' 5. 'timings' 6. 'methods'

```
In [196]: ressum$metrics
```

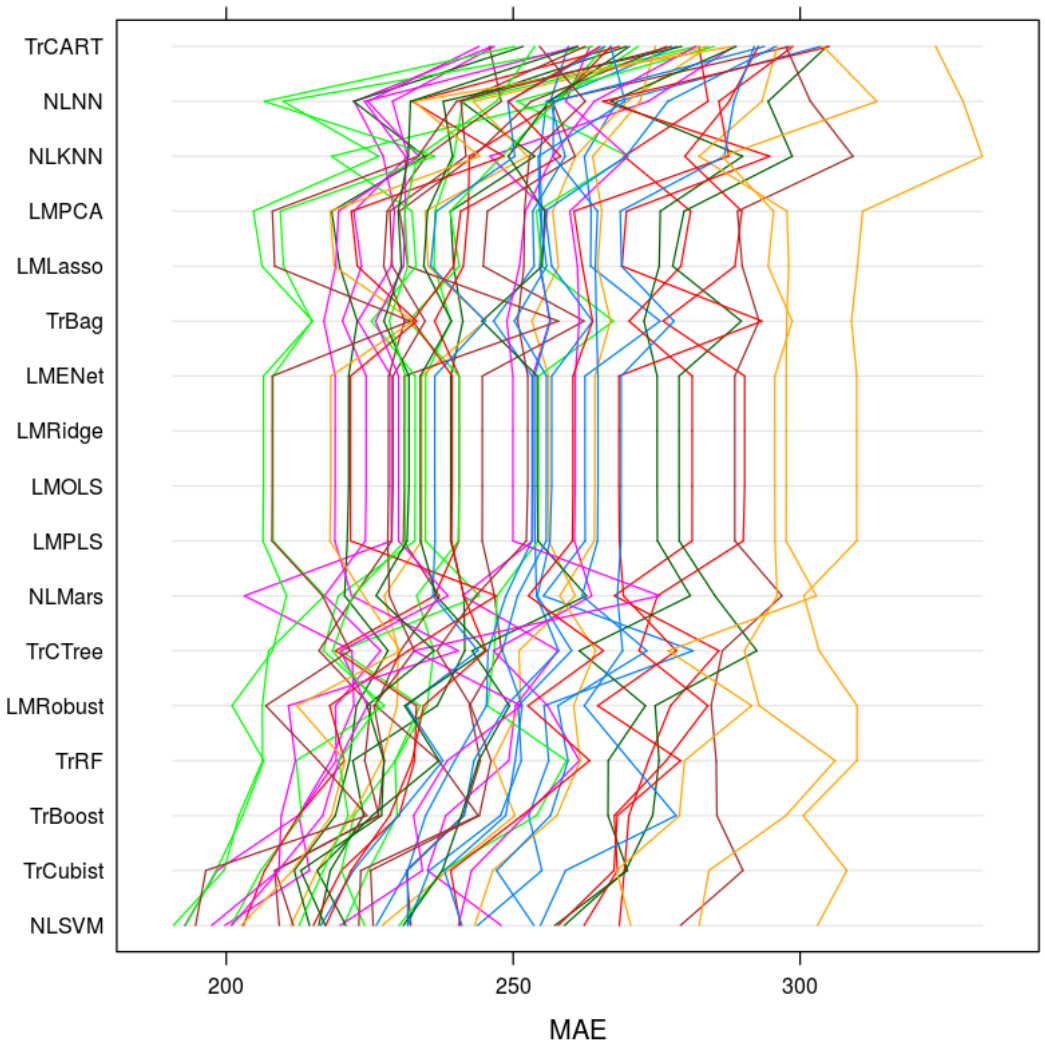
1. 'MAE' 2. 'RMSE' 3. 'Rsquared'

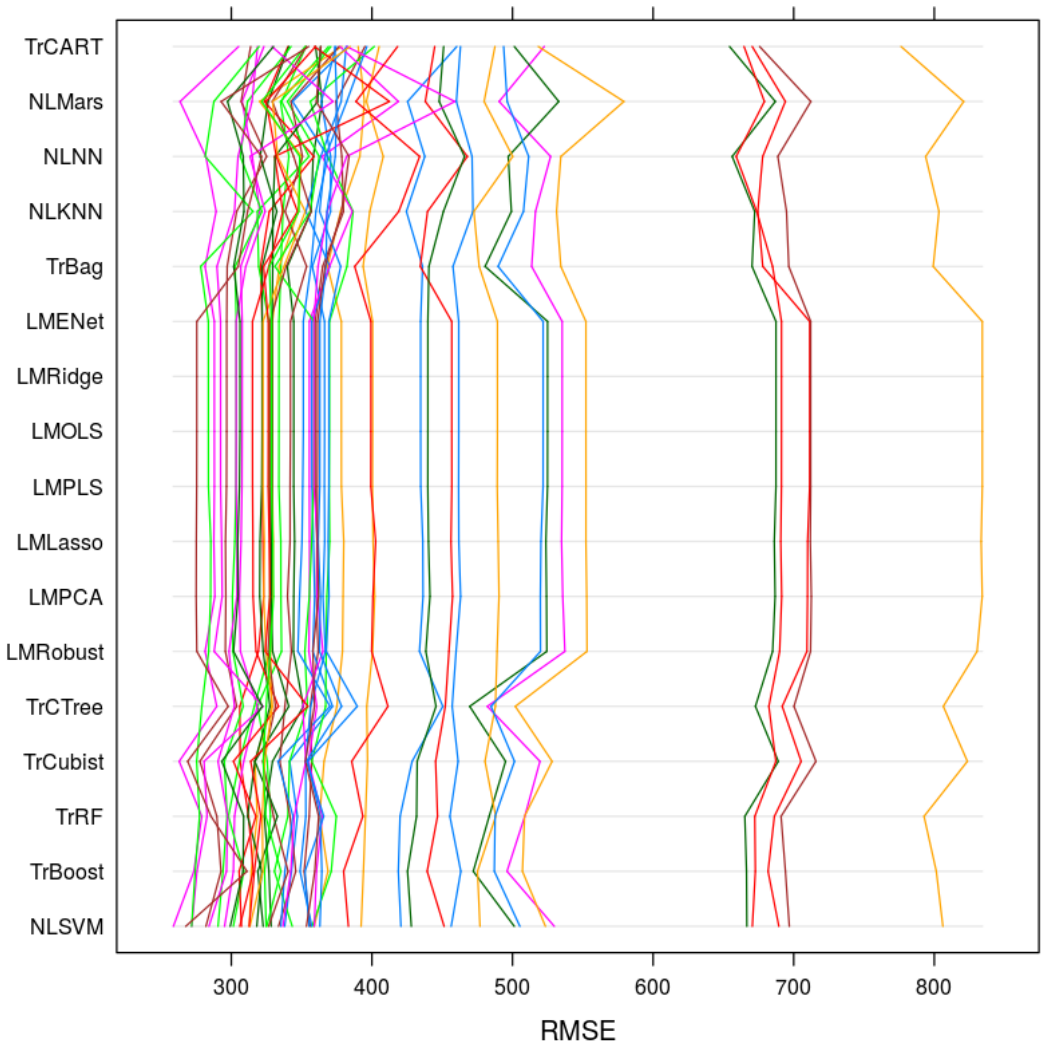
```
In [197]: ressum$values
```

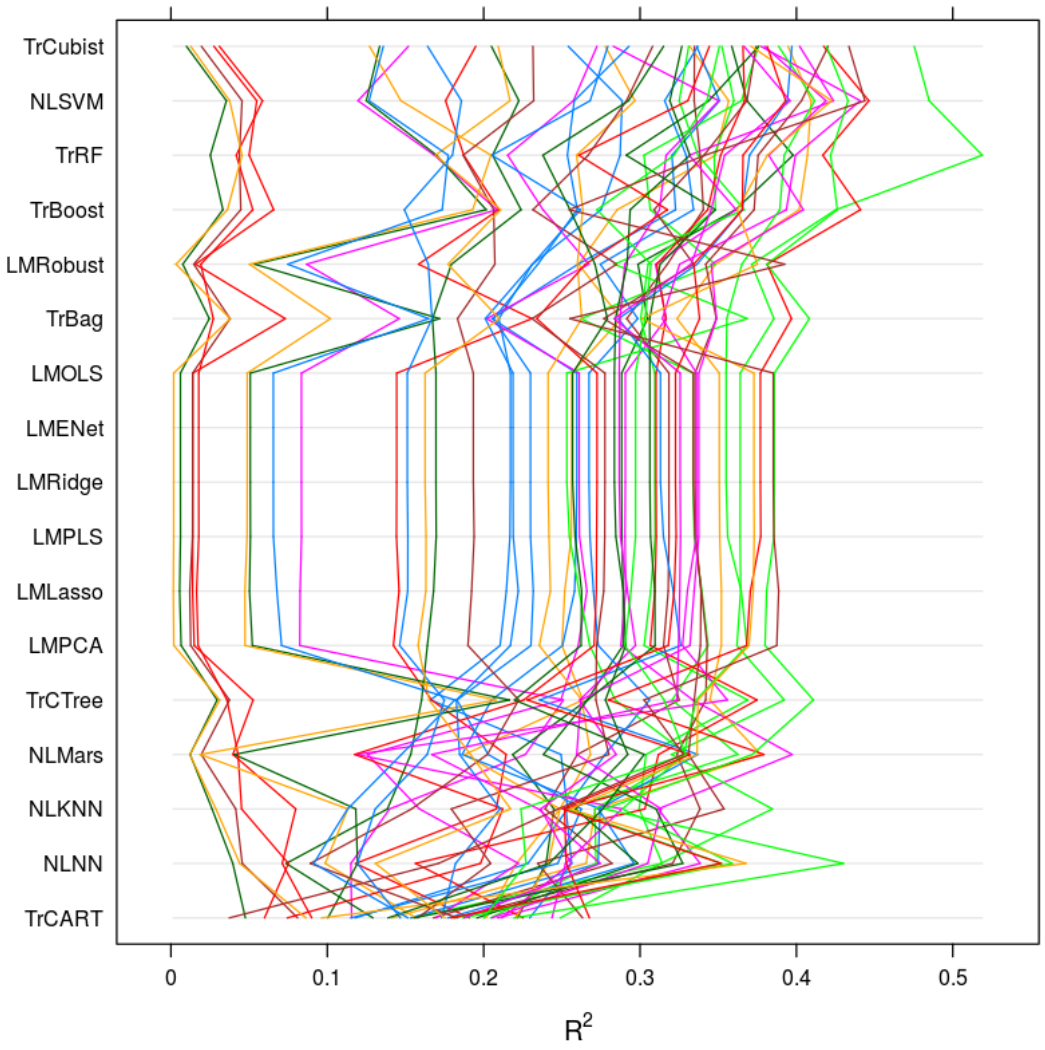
A data.frame: 50 Œ 52

Resample <chr>	LMOLS~MAE <dbl>	LMOLS~RMSE <dbl>	LMOLS~Rsquared <dbl>	LMRobust~M <dbl>
Fold01.Rep1	262.5051	434.6534	0.217126353	255.3818
Fold01.Rep2	253.3758	535.3203	0.083460175	250.4098
Fold01.Rep3	239.1257	344.4175	0.288250743	236.7566
Fold01.Rep4	281.1996	456.7936	0.144361637	277.4266
Fold01.Rep5	256.1798	378.2625	0.256217488	251.3062
Fold02.Rep1	234.7316	333.8640	0.309397071	233.8003
Fold02.Rep2	244.6278	359.6801	0.318464730	242.3788
Fold02.Rep3	253.6957	357.2532	0.259572130	248.7639
Fold02.Rep4	228.7468	287.9244	0.290598125	222.2403
Fold02.Rep5	278.9058	439.7981	0.169494020	274.7402
Fold03.Rep1	290.3424	711.3782	0.013994232	283.9194
Fold03.Rep2	234.0677	329.2189	0.350686393	229.7751
Fold03.Rep3	254.4231	369.7833	0.333830829	245.5297
Fold03.Rep4	288.6222	712.0939	0.013869770	284.4993
Fold03.Rep5	253.2861	366.3286	0.267376762	245.3471
Fold04.Rep1	260.8012	355.5213	0.261077419	255.9818
Fold04.Rep2	275.0903	687.3876	0.006083568	273.0444
Fold04.Rep3	240.5650	322.0271	0.310223823	233.1373
Fold04.Rep4	264.2354	400.4891	0.241189975	260.5379
Fold04.Rep5	240.5700	358.7468	0.253150467	235.0042
Fold05.Rep1	231.0498	342.0672	0.334051537	226.0611
Fold05.Rep2	256.7135	351.2063	0.313045664	250.8689
Fold05.Rep3	224.3756	307.7338	0.286673436	219.0542
Fold05.Rep4	254.1887	524.9365	0.050737866	249.3328
Fold05.Rep5	268.4214	691.3159	0.017797120	264.7307
Fold06.Rep1	297.5852	552.2118	0.048790454	291.5616
Fold06.Rep2	232.9226	326.7193	0.364085855	227.5585
Fold06.Rep3	228.2840	296.7152	0.335171626	225.7448
Fold06.Rep4	264.7719	369.4184	0.229919283	257.7759
Fold06.Rep5	249.9483	358.6755	0.336086214	251.3528
Fold07.Rep1	221.3321	321.8647	0.283582465	222.6810
Fold07.Rep2	221.6538	315.0567	0.272488031	218.0333
Fold07.Rep3	309.8647	834.1469	0.001745434	309.9256
Fold07.Rep4	206.4837	303.5019	0.355029754	201.0225
Fold07.Rep5	229.0575	327.3769	0.277556485	225.1539
Fold08.Rep1	236.3298	362.9758	0.218751488	231.3940
Fold08.Rep2	218.9888	292.3697	0.337568660	210.8478
Fold08.Rep3	233.8224	329.0218	0.306275979	231.0924
Fold08.Rep4	260.4138	399.2812	0.376968171	252.5699
Fold08.Rep5	218.2131	322.5174	0.372810875	212.3014
Fold09.Rep1	208.1489	283.6808	0.385868285	206.2935
Fold09.Rep2	252.5398	361.3297	0.193385662	242.6063
Fold09.Rep3	268.8066	461.7570	0.151178780	262.3909
Fold09.Rep4	230.0284	303.4390	0.325664831	224.5845
Fold09.Rep5	231.8388	306.1704	0.256895796	224.5498
Fold10.Rep1	239.3693	326.2903	0.322673464	234.3854
Fold10.Rep2	295.5966	489.2714	0.162515215	292.8644
Fold10.Rep3	231.2132	328.4897	0.297140839	226.5863
Fold10.Rep4	208.0273	275.4629	0.385187386	206.8918
Fold10.Rep5	255.7973	521.7666	0.065492417	251.5560

In [198]:
```
parallelplot(ressum, metric="MAE")
parallelplot(ressum, metric="RMSE")
parallelplot(ressum, metric="Rsquared")
```




TrCART
NLMars
NLNN
NLKNN
TrBag
LMENet
LMRidge
LMOLS
LMPLS
LMLasso
LMPCA
LMRobust
TrCTree
TrCubist
TrRF
TrBoost
NLSVM
300
400
500
600
700
800
RMSE




```
In [199]: ressum1 <- summary(ressum)
```

```
In [200]: names(ressum1)
```

1. 'values' 2. 'call' 3. 'statistics' 4. 'models' 5. 'metrics' 6. 'methods'

```
In [201]: names(ressum1$statistics)
```

1. 'MAE' 2. 'RMSE' 3. 'Rsquared'

```
In [211]: ressum.rmse <- round(ressum1$statistics$RMSE, 2)
          ressum.rmse
```

A matrix: 17 Œ 7 of type dbl

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
LMOLS	275.46	323.46	357.96	402.55	438.51	834.15	0
LMRobust	275.46	324.26	356.56	401.60	437.22	830.41	0
LMPCA	274.98	324.14	357.49	402.64	440.06	834.09	0
LMPLS	275.37	323.41	357.85	402.49	438.50	834.15	0
LMRidge	275.46	323.46	357.97	402.55	438.51	834.15	0
LMLasso	275.11	324.38	357.76	402.64	439.21	833.33	0
LMENet	275.46	323.46	357.97	402.55	438.51	834.15	0
NLNN	281.46	332.25	365.74	408.36	458.80	793.83	0
NLMars	263.55	326.89	368.48	409.09	445.38	820.91	0
NLSVM	258.77	312.75	340.65	389.31	426.18	806.11	0
NLKNN	289.20	333.41	361.46	406.46	435.80	803.35	0
TrCART	305.19	353.69	377.93	416.51	449.45	776.33	0
TrCTree	279.03	325.50	356.26	400.55	449.21	806.41	0
TrBag	278.18	323.89	359.64	398.56	435.62	799.22	0
TrRF	277.38	317.72	345.88	392.10	428.82	792.70	0
TrBoost	273.37	315.81	344.31	390.57	423.70	801.44	0
TrCubist	262.93	314.52	347.11	392.05	431.29	823.54	0

```
In [216]: ressum.rmse <- ressum.rmse[ , 4]
```

```
In [217]: ressum.rmse <- round(ressum.rmse, 2)
          ressum.rmse
```

LMOLS 402.55 **LMRobust** 401.6 **LMPCA** 402.64 **LMPLS** 402.49 **LMRidge** 402.55 **LMLasso** 402.64 **LMENet** 402.55 **NLNN** 408.36 **NLMars** 409.09 **NLSVM** 389.31 **NLKNN** 406.46 **TrCART** 416.51 **TrCTree** 400.55 **TrBag** 398.56 **TrRF** 392.1 **TrBoost** 390.57 **TrCubist** 392.05

```
In [212]: ressum.r2 <- round(ressum1$statistics$Rsquared, 2)
          ressum.r2
```

A matrix: 17 Œ 7 of type dbl

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
LMOLS	0.00	0.18	0.28	0.24	0.32	0.39	0
LMRobust	0.00	0.19	0.28	0.25	0.33	0.39	0
LMPCA	0.00	0.17	0.27	0.24	0.33	0.39	0
LMPLS	0.00	0.18	0.27	0.24	0.33	0.39	0
LMRidge	0.00	0.18	0.28	0.24	0.32	0.39	0
LMLasso	0.00	0.17	0.27	0.24	0.32	0.39	0
LMENet	0.00	0.18	0.28	0.24	0.32	0.39	0
NLNN	0.04	0.12	0.24	0.22	0.29	0.43	0
NLMars	0.01	0.16	0.25	0.23	0.33	0.40	0
NLSVM	0.04	0.22	0.33	0.30	0.39	0.48	0
NLKNN	0.03	0.16	0.25	0.22	0.27	0.38	0
TrCART	0.04	0.13	0.17	0.16	0.20	0.27	0
TrCTree	0.03	0.19	0.26	0.25	0.32	0.41	0
TrBag	0.02	0.20	0.28	0.25	0.31	0.41	0
TrRF	0.03	0.20	0.32	0.28	0.35	0.52	0
TrBoost	0.03	0.21	0.30	0.28	0.36	0.44	0
TrCubist	0.01	0.21	0.33	0.29	0.38	0.48	0

```
In [213]: ressum.r2 <- ressum.r2[ , 4]
```

```
In [214]: ressum.r2 <- round(ressum.r2, 2)
          ressum.r2
```

LMOLS 0.24 **LMRobust** 0.25 **LMPCA** 0.24 **LMPLS** 0.24 **LMRidge** 0.24 **LMLasso** 0.24 **LMENet** 0.24 **NLNN** 0.22 **NLMars** 0.23 **NLSVM** 0.3 **NLKNN** 0.22 **TrCART** 0.16 **TrCTree** 0.25 **TrBag** 0.25 **TrRF** 0.28 **TrBoost** 0.28 **TrCubist** 0.29

```
In [218]: ressum.train <- cbind(ressum.rmse, ressum.r2)
          ressum.train
```

A matrix: 17 Œ 2 of type dbl

	ressum.rmse	ressum.r2
LMOLS	402.55	0.24
LMRobust	401.60	0.25
LMPCA	402.64	0.24
LMPLS	402.49	0.24
LMRidge	402.55	0.24
LMLasso	402.64	0.24
LMENet	402.55	0.24
NLNN	408.36	0.22
NLMars	409.09	0.23
NLSVM	389.31	0.30
NLKNN	406.46	0.22
TrCART	416.51	0.16
TrCTree	400.55	0.25
TrBag	398.56	0.25
TrRF	392.10	0.28
TrBoost	390.57	0.28
TrCubist	392.05	0.29

1.25.1 Testing data

Linear Models

```
In [225]: ## LMOLS
          modtrainols.pred <- predict(modtrainols, testingset)
          modtrainols.test <- data.frame(obs = testingset$wage, pred = modtrainols.pred)
          modtrainols.stats <- defaultSummary(modtrainols.test)
          round(modtrainols.stats, 2)
```

RMSE 390.22 **Rsquared** 0.23 **MAE** 249.31

```
In [226]: ## LMRobust
          modtrainrlm.pred <- predict(modtrainrlm, testingset)
          modtrainrlm.test <- data.frame(obs = testingset$wage, pred = modtrainrlm.pred)
          modtrainrlm.stats <- defaultSummary(modtrainrlm.test)
          round(modtrainrlm.stats, 2)
```

RMSE 394.98 **Rsquared** 0.22 **MAE** 245.4

In [227]:
```
## LMPCA
modtrainrlmpc.pred <- predict(modtrainrlmpc, testingset)
modtrainrlmpc.test <- data.frame(obs = testingset$wage, pred = modtrainrlmpc.pred)
modtrainrlmpc.stats <- defaultSummary(modtrainrlmpc.test)
round(modtrainrlmpc.stats, 2)
```

RMSE	392.05	**Rsquared**	0.22	**MAE**	249.95

In [228]:
```
## LMPLS
modtrainrlmpls.pred <- predict(modtrainrlmpls, testingset)
modtrainrlmpls.test <- data.frame(obs = testingset$wage, pred = modtrainrlmpls.pred)
modtrainrlmpls.stats <- defaultSummary(modtrainrlmpls.test)
round(modtrainrlmpls.stats, 2)
```

RMSE	390.35	**Rsquared**	0.23	**MAE**	249.37

In [229]:
```
## LMRidge
modtrainrlmrr.pred <- predict(modtrainrlmrr, testingset)
modtrainrlmrr.test <- data.frame(obs = testingset$wage, pred = modtrainrlmrr.pred)
modtrainrlmrr.stats <- defaultSummary(modtrainrlmrr.test)
round(modtrainrlmrr.stats, 2)
```

RMSE	390.22	**Rsquared**	0.23	**MAE**	249.31

In [230]:
```
## LMLasso
modtrainrlmlasso.pred <- predict(modtrainrlmlasso, testingset)
modtrainrlmlasso.test <- data.frame(obs = testingset$wage, pred = modtrainrlmlasso.pre
modtrainrlmlasso.stats <- defaultSummary(modtrainrlmlasso.test)
round(modtrainrlmlasso.stats, 2)
```

RMSE	391.58	**Rsquared**	0.23	**MAE**	250.37

In [231]:
```
## LMENet
modtrainrlmenet.pred <- predict(modtrainrlmenet, testingset)
modtrainrlmenet.test <- data.frame(obs = testingset$wage, pred = modtrainrlmenet.pred)
modtrainrlmenet.stats <- defaultSummary(modtrainrlmenet.test)
round(modtrainrlmenet.stats, 2)
```

RMSE	390.22	**Rsquared**	0.23	**MAE**	249.31

Non Linear Models

In [235]:
```
## NLNN
modtrainnn.pred <- predict(modtrainnn, testingset)
modtrainnn.test <- data.frame(obs = testingset$wage, pred = modtrainnn.pred)
modtrainnn.stats <- defaultSummary(modtrainnn.test)
round(modtrainnn.stats, 2)
```

RMSE	394.2	**Rsquared**	0.24	**MAE**	262.18

In [252]:
```
## NLMars
modtrainmars.pred <- predict(modtrainmars, testingset)
modtrainmars.test <- data.frame(obs = testingset$wage, pred = modtrainmars.pred)
modtrainmars.test$pred <- modtrainmars.test$y
modtrainmars.stats <- defaultSummary(modtrainmars.test)
round(modtrainmars.stats, 2)
```

RMSE 452.23 **Rsquared** 0.1 **MAE** 269.65

In [237]:
```
## NLSVM
modtrainsvm.pred <- predict(modtrainsvm, testingset)
modtrainsvm.test <- data.frame(obs = testingset$wage, pred = modtrainsvm.pred)
modtrainsvm.stats <- defaultSummary(modtrainsvm.test)
round(modtrainsvm.stats, 2)
```

RMSE 375.82 **Rsquared** 0.3 **MAE** 236.67

In [238]:
```
## NLKNN
modtrainknn.pred <- predict(modtrainknn, testingset)
modtrainknn.test <- data.frame(obs = testingset$wage, pred = modtrainknn.pred)
modtrainknn.stats <- defaultSummary(modtrainknn.test)
round(modtrainknn.stats, 2)
```

RMSE 404.17 **Rsquared** 0.19 **MAE** 271.97

Tree Models

In [239]:
```
## TrCART
modtraincart.pred <- predict(modtraincart, testingset)
modtraincart.test <- data.frame(obs = testingset$wage, pred = modtraincart.pred)
modtraincart.stats <- defaultSummary(modtraincart.test)
round(modtraincart.stats, 2)
```

RMSE 423.5 **Rsquared** 0.1 **MAE** 301.63

In [240]:
```
## TrCTree
modtrainctree.pred <- predict(modtrainctree, testingset)
modtrainctree.test <- data.frame(obs = testingset$wage, pred = modtrainctree.pred)
modtrainctree.stats <- defaultSummary(modtrainctree.test)
round(modtrainctree.stats, 2)
```

RMSE 391.68 **Rsquared** 0.23 **MAE** 264.11

In [241]:
```
## TrBag
modtraintreebag.pred <- predict(modtraintreebag, testingset)
modtraintreebag.test <- data.frame(obs = testingset$wage, pred = modtraintreebag.pred)
modtraintreebag.stats <- defaultSummary(modtraintreebag.test)
round(modtraintreebag.stats, 2)
```

RMSE 406.71 **Rsquared** 0.17 **MAE** 273.4

In [242]:
```
## TrRF
modtrainrf.pred <- predict(modtrainrf, testingset)
modtrainrf.test <- data.frame(obs = testingset$wage, pred = modtrainrf.pred)
modtrainrf.stats <- defaultSummary(modtrainrf.test)
round(modtrainrf.stats, 2)
```

RMSE 399.48 **Rsquared** 0.19 **MAE** 261.14

In [243]:
```
## TrBoost
modtrainboost.pred <- predict(modtrainboost, testingset)
modtrainboost.test <- data.frame(obs = testingset$wage, pred = modtrainboost.pred)
modtrainboost.stats <- defaultSummary(modtrainboost.test)
round(modtrainboost.stats, 2)
```

RMSE 392.57 **Rsquared** 0.22 **MAE** 259.24

In [244]:
```
## TrCubist
modtraincubist.pred <- predict(modtraincubist, testingset)
modtraincubist.test <- data.frame(obs = testingset$wage, pred = modtraincubist.pred)
modtraincubist.stats <- defaultSummary(modtraincubist.test)
round(modtraincubist.stats, 2)
```

RMSE 383.28 **Rsquared** 0.28 **MAE** 235.88

In [284]:
```
ressum.test <- data.frame(modtrainols.stats,
                          modtrainrlm.stats,
                          modtrainrlmpc.stats,
                          modtrainrlmpls.stats,
                          modtrainrlmrr.stats,
                          modtrainrlmlasso.stats,
                          modtrainrlmenet.stats,
                          modtrainnn.stats,
                          modtrainmars.stats,
                          modtrainsvm.stats,
                          modtrainknn.stats,
                          modtraincart.stats,
                          modtrainctree.stats,
                          modtraintreebag.stats,
                          modtrainrf.stats,
                          modtrainboost.stats,
                          modtraincubist.stats)
ressum.test
```

A data.frame: 3 Œ 17

	modtrainols.stats <dbl>	modtrainrlm.stats <dbl>	modtrainrlmpc.stats <dbl>	modtrainrl <dbl>
RMSE	390.2238205	394.9838855	392.0517981	390.354615
Rsquared	0.2319372	0.2198506	0.2243443	0.2313847
MAE	249.3111189	245.3993849	249.9474076	249.372234

In [285]:
```
ressum.test1 <- t(ressum.test)
round(ressum.test1, 2)
```

A matrix: 17 Œ 3 of type dbl

	RMSE	Rsquared	MAE
modtrainols.stats	390.22	0.23	249.31
modtrainrlm.stats	394.98	0.22	245.40
modtrainrlmpc.stats	392.05	0.22	249.95
modtrainrlmpls.stats	390.35	0.23	249.37
modtrainrlmrr.stats	390.22	0.23	249.31
modtrainrlmlasso.stats	391.58	0.23	250.37
modtrainrlmenet.stats	390.22	0.23	249.31
modtrainnn.stats	394.20	0.24	262.18
modtrainmars.stats	452.23	0.10	269.65
modtrainsvm.stats	375.82	0.30	236.67
modtrainknn.stats	404.17	0.19	271.97
modtraincart.stats	423.50	0.10	301.63
modtrainctree.stats	391.68	0.23	264.11
modtraintreebag.stats	406.71	0.17	273.40
modtrainrf.stats	399.48	0.19	261.14
modtrainboost.stats	392.57	0.22	259.24
modtraincubist.stats	383.28	0.28	235.88

In [286]:
```
str(ressum.test1)
```

```
 num [1:17, 1:3] 390 395 392 390 390 ...
 - attr(*, "dimnames")=List of 2
  ..$ : chr [1:17] "modtrainols.stats" "modtrainrlm.stats" "modtrainrlmpc.stats" "modtrainrlmpls
  ..$ : chr [1:3] "RMSE" "Rsquared" "MAE"
```

In [287]:
```
ressum.test1 <- data.frame(ressum.test1)
str(ressum.test1)
```

```
'data.frame':        17 obs. of  3 variables:
 $ RMSE    : num  390 395 392 390 390 ...
 $ Rsquared: num  0.232 0.22 0.224 0.231 0.232 ...
 $ MAE     : num  249 245 250 249 249 ...
```

In [288]:
```
ressum.test1$RMSE <- round(ressum.test1$RMSE, 2)
ressum.test1$Rsquared <- round(ressum.test1$Rsquared, 2)
ressum.test1$MAE <- round(ressum.test1$MAE, 2)
```

In [289]:
```
ressum.test1$Model <- row.names(ressum.test1)
row.names(ressum.test1) <- seq(1:17)
ressum.test1$Model <- gsub(".stats", "", ressum.test1$Model)
ressum.test1$Model <- gsub("modtrain", "", ressum.test1$Model)
ressum.test1$Model <- format(ressum.test1$Model, justify="left")
ressum.test1[ , c(4, 1:3)]
```

A data.frame: 17 Œ 4

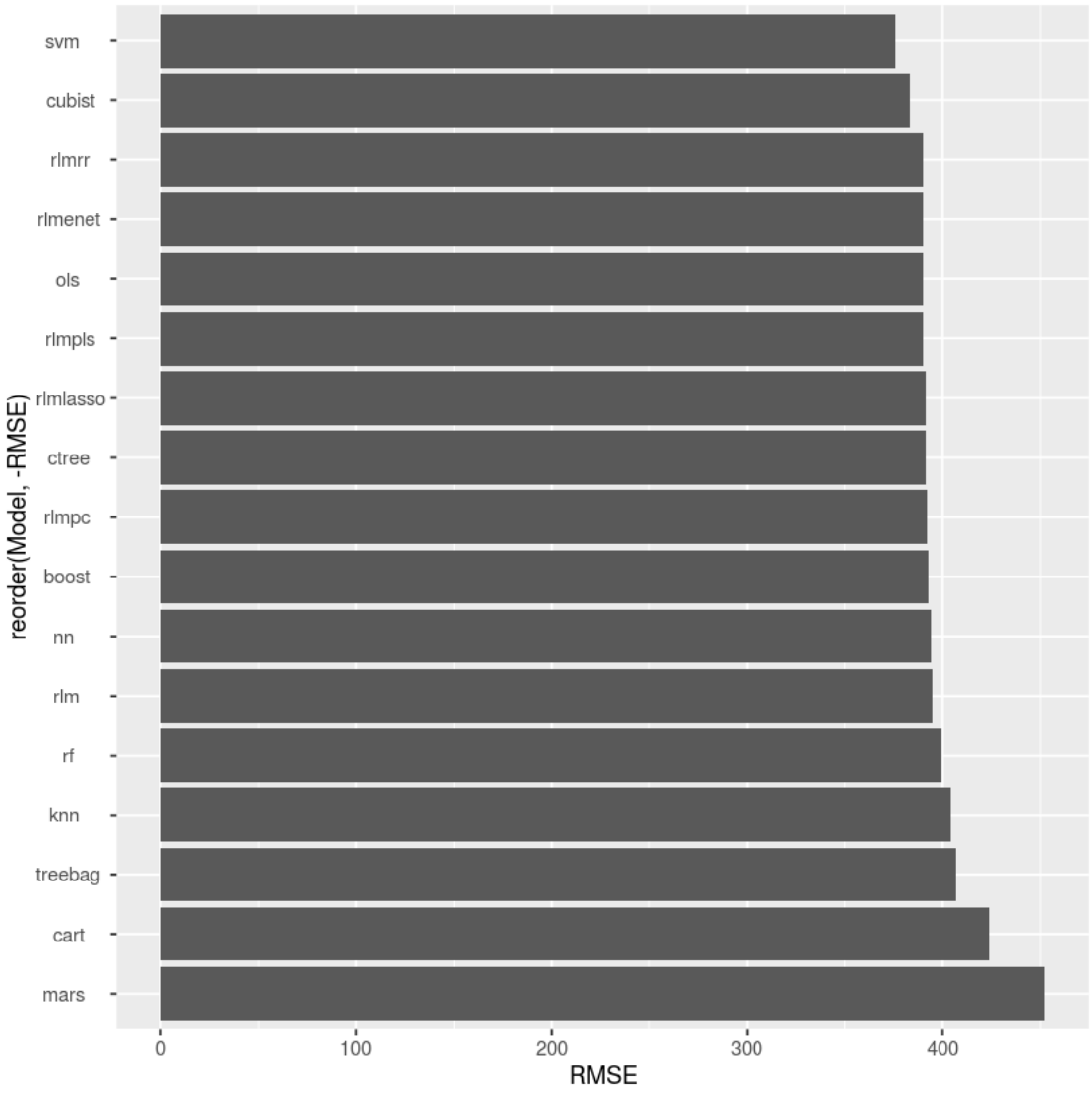
	Model <chr>	RMSE <dbl>	Rsquared <dbl>	MAE <dbl>
1	ols	390.22	0.23	249.31
2	rlm	394.98	0.22	245.40
3	rlmpc	392.05	0.22	249.95
4	rlmpls	390.35	0.23	249.37
5	rlmrr	390.22	0.23	249.31
6	rlmlasso	391.58	0.23	250.37
7	rlmenet	390.22	0.23	249.31
8	nn	394.20	0.24	262.18
9	mars	452.23	0.10	269.65
10	svm	375.82	0.30	236.67
11	knn	404.17	0.19	271.97
12	cart	423.50	0.10	301.63
13	ctree	391.68	0.23	264.11
14	treebag	406.71	0.17	273.40
15	rf	399.48	0.19	261.14
16	boost	392.57	0.22	259.24
17	cubist	383.28	0.28	235.88

In [290]:
```
ressum.test2 <- ressum.test1[order(ressum.test1$RMSE, decreasing = FALSE), ]
ressum.test2 [ , c(4,1:3)]
```

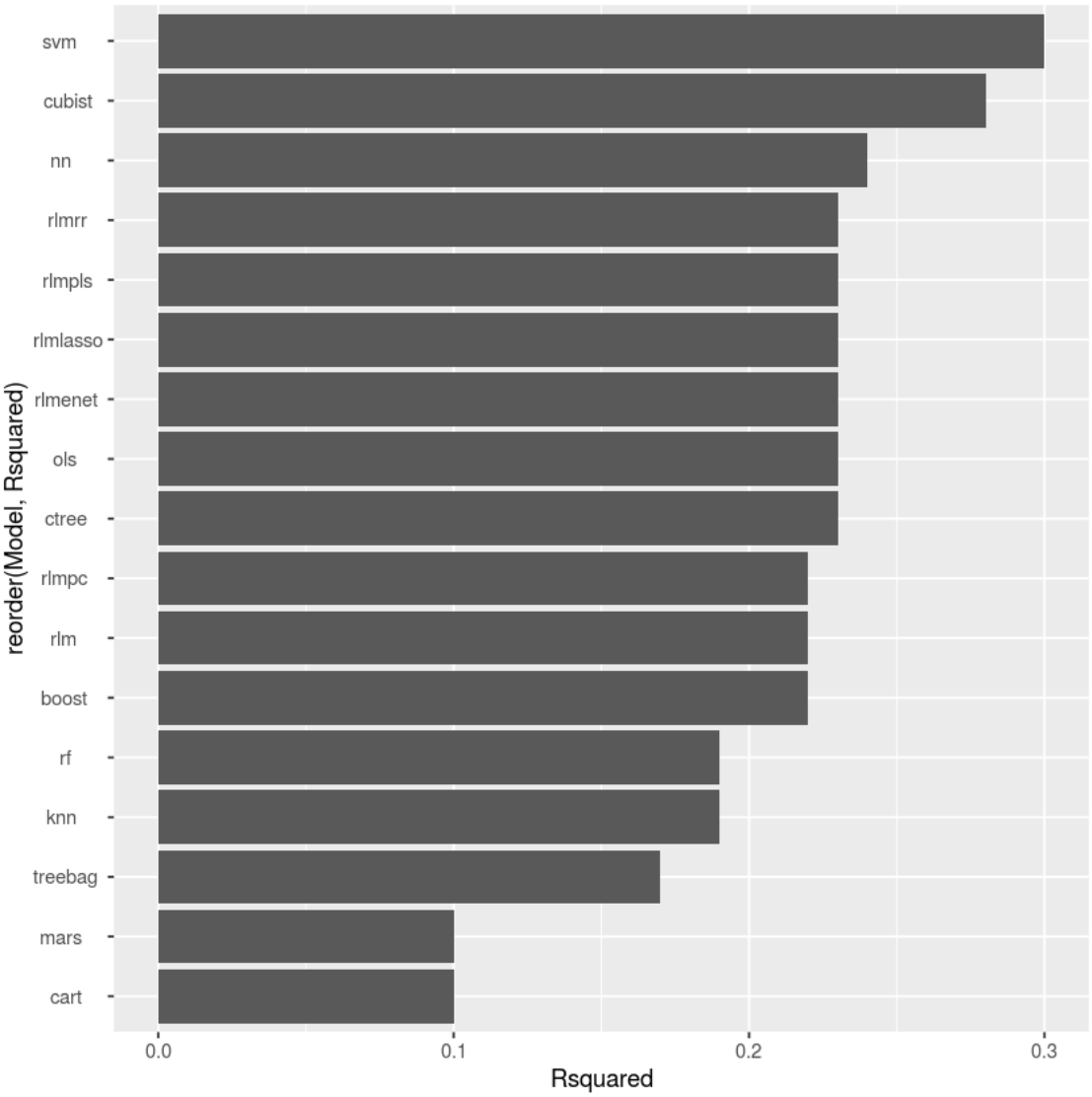
A data.frame: 17 Œ 4

	Model <chr>	RMSE <dbl>	Rsquared <dbl>	MAE <dbl>
10	svm	375.82	0.30	236.67
17	cubist	383.28	0.28	235.88
1	ols	390.22	0.23	249.31
5	rlmrr	390.22	0.23	249.31
7	rlmenet	390.22	0.23	249.31
4	rlmpls	390.35	0.23	249.37
6	rlmlasso	391.58	0.23	250.37
13	ctree	391.68	0.23	264.11
3	rlmpc	392.05	0.22	249.95
16	boost	392.57	0.22	259.24
8	nn	394.20	0.24	262.18
2	rlm	394.98	0.22	245.40
15	rf	399.48	0.19	261.14
11	knn	404.17	0.19	271.97
14	treebag	406.71	0.17	273.40
12	cart	423.50	0.10	301.63
9	mars	452.23	0.10	269.65

In [291]:
```
ggplot(ressum.test1,aes(x= reorder(Model,-RMSE), y=RMSE))+
geom_bar(stat ="identity") + coord_flip()
```




```
In [292]: ggplot(ressum.test1,aes(x= reorder(Model,Rsquared), y=Rsquared)) +
          geom_bar(stat ="identity") + coord_flip()
```


svm
cubist
nn
rlmrr
rlmpls
rlmlasso
rlmenet
ols
ctree
rlmpc
rlm
boost
rf
knn
treebag
mars
cart
reorder(Model, Rsquared)
0.0
0.1
0.2
0.3
Rsquared