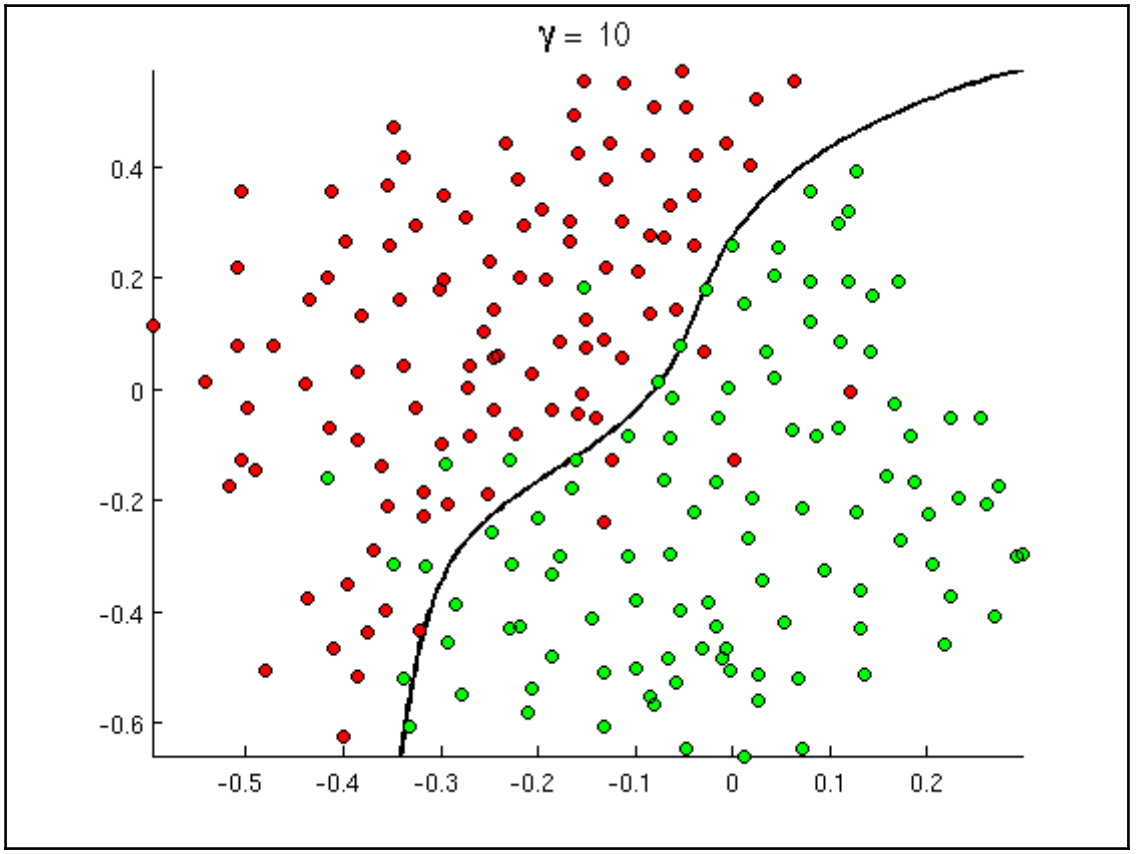
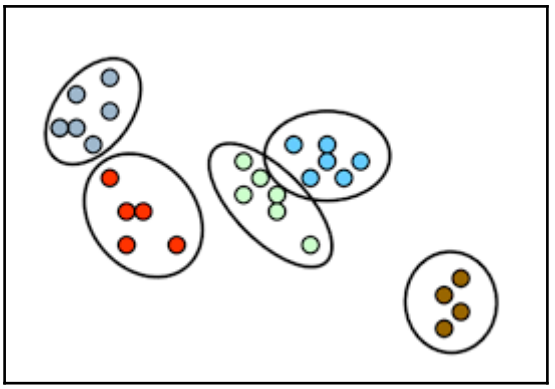
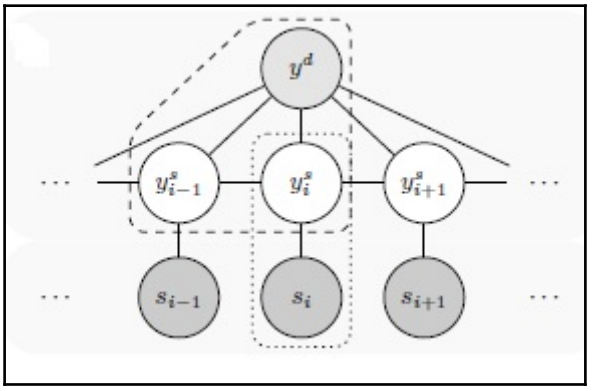
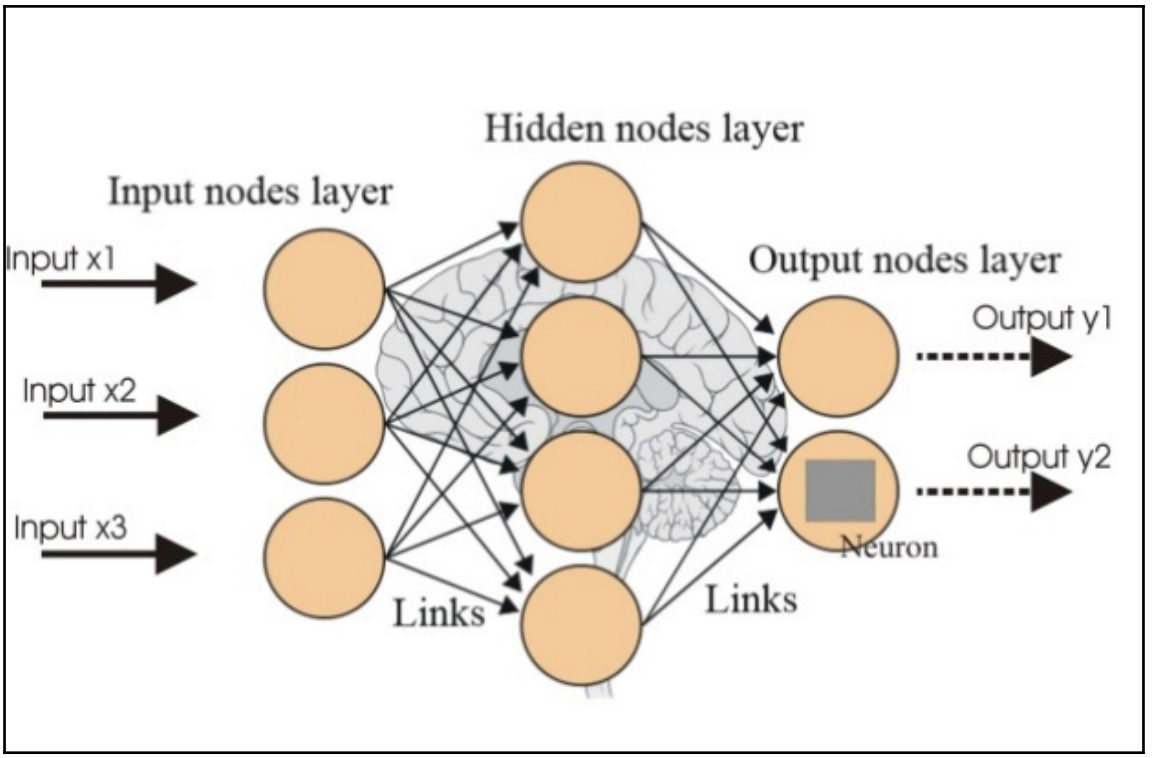
Graphic Bundle

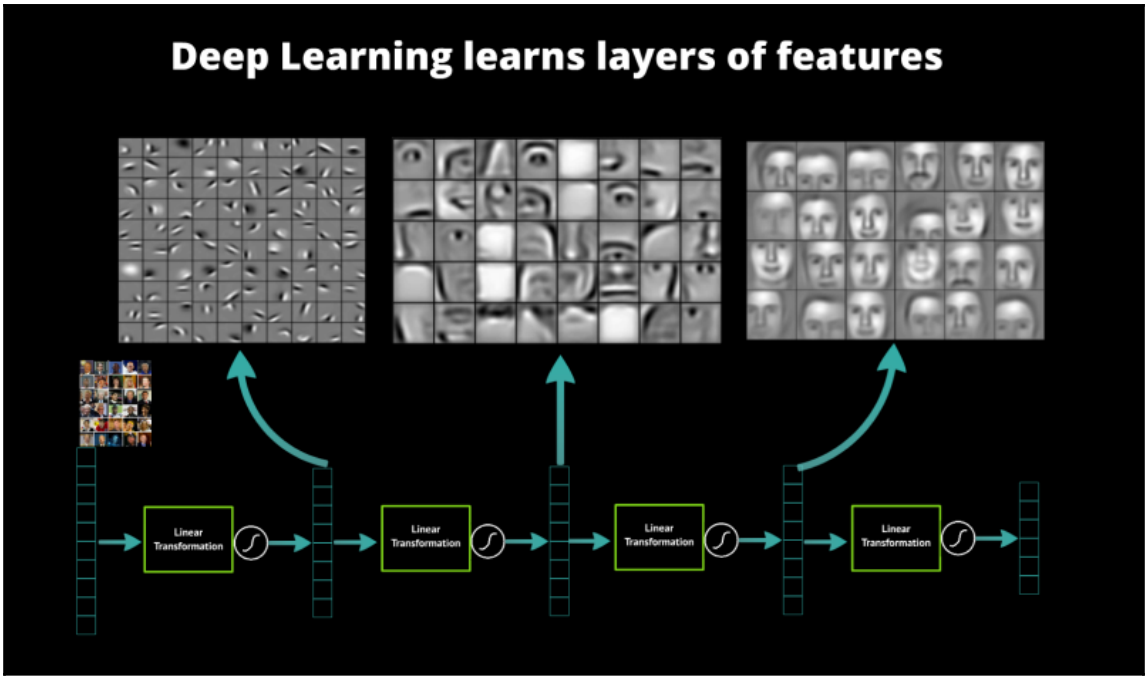
Chapter 1: Introduction to Machine Learning



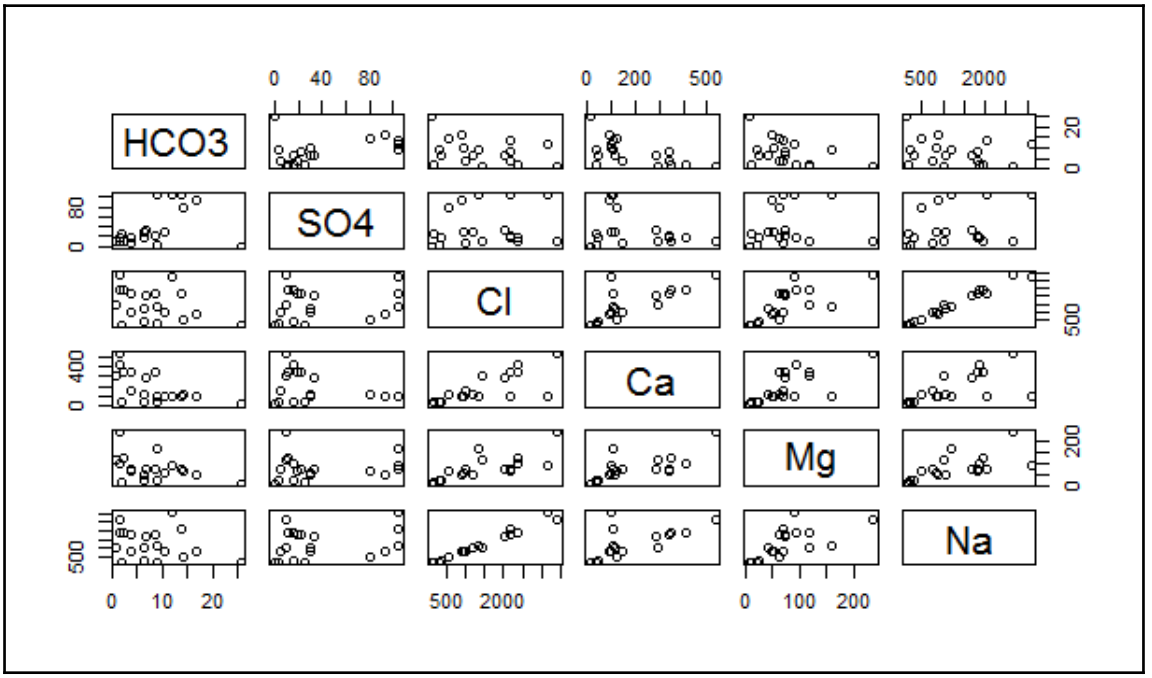


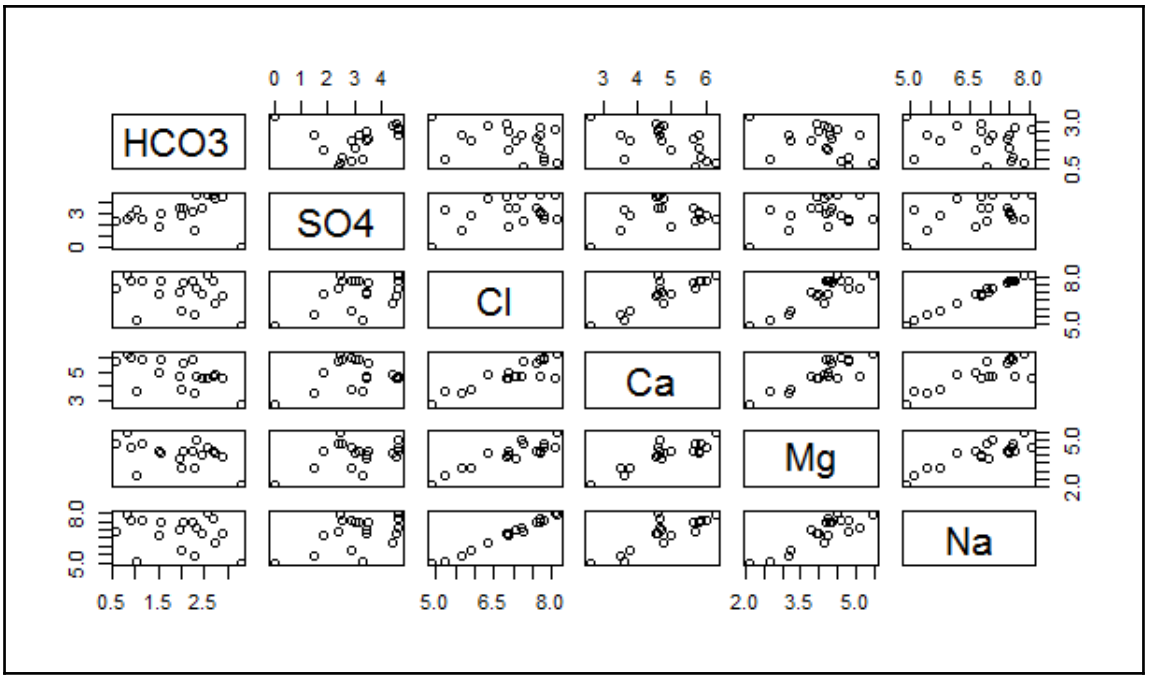

y^d
y^s_{i-1}
y^s_i
y^s_{i+1}
s_{i-1}
s_i
s_{i+1}

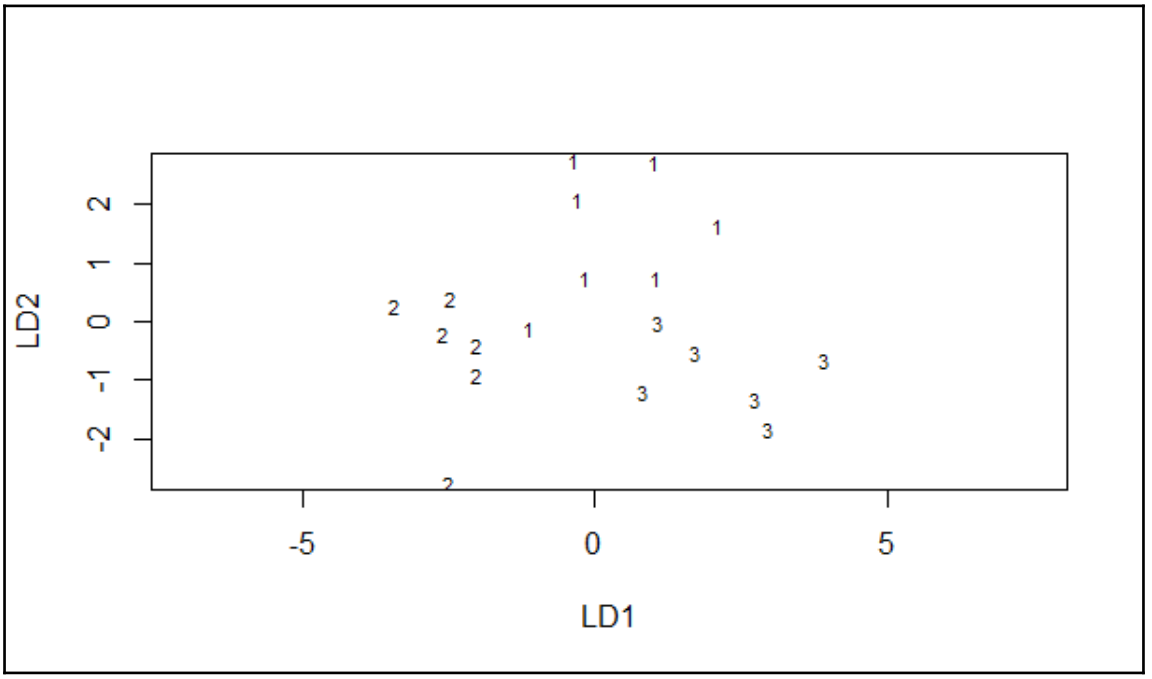

Hidden nodes layer
Input nodes layer
Input x1
Input x2
Input x3
Output nodes layer
Output y1
Output y2
Neuron
Links
Links

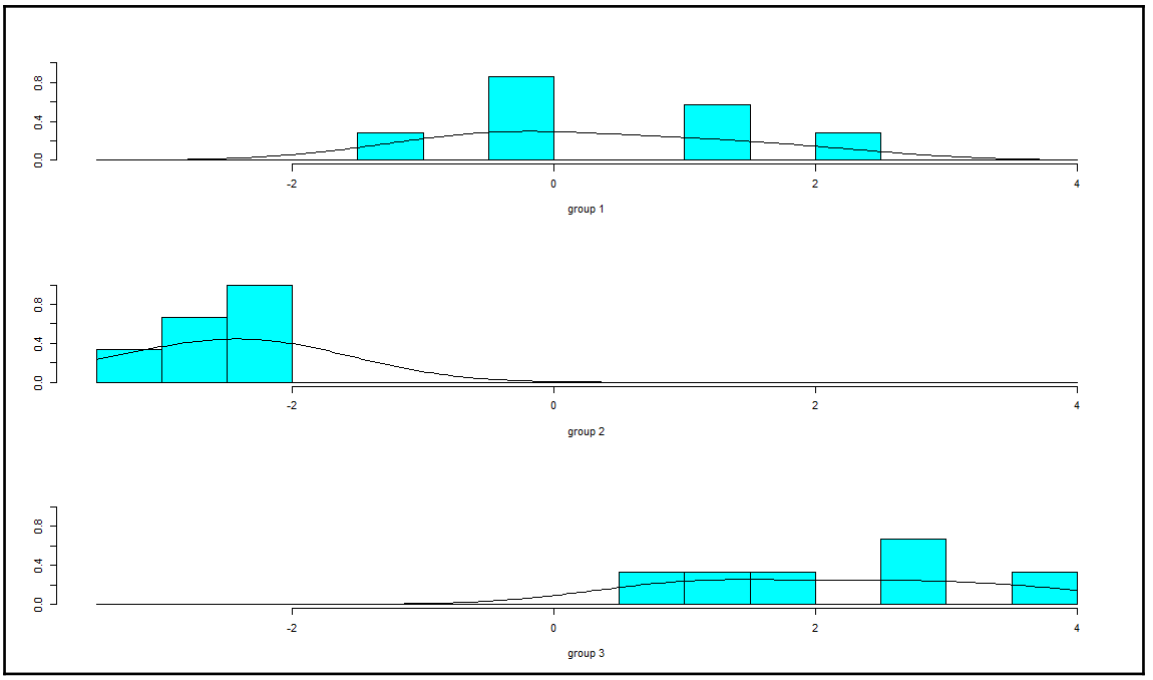

Deep Learning learns layers of features
Linear Transformation
Linear Transformation
Linear Transformation
Linear Transformation

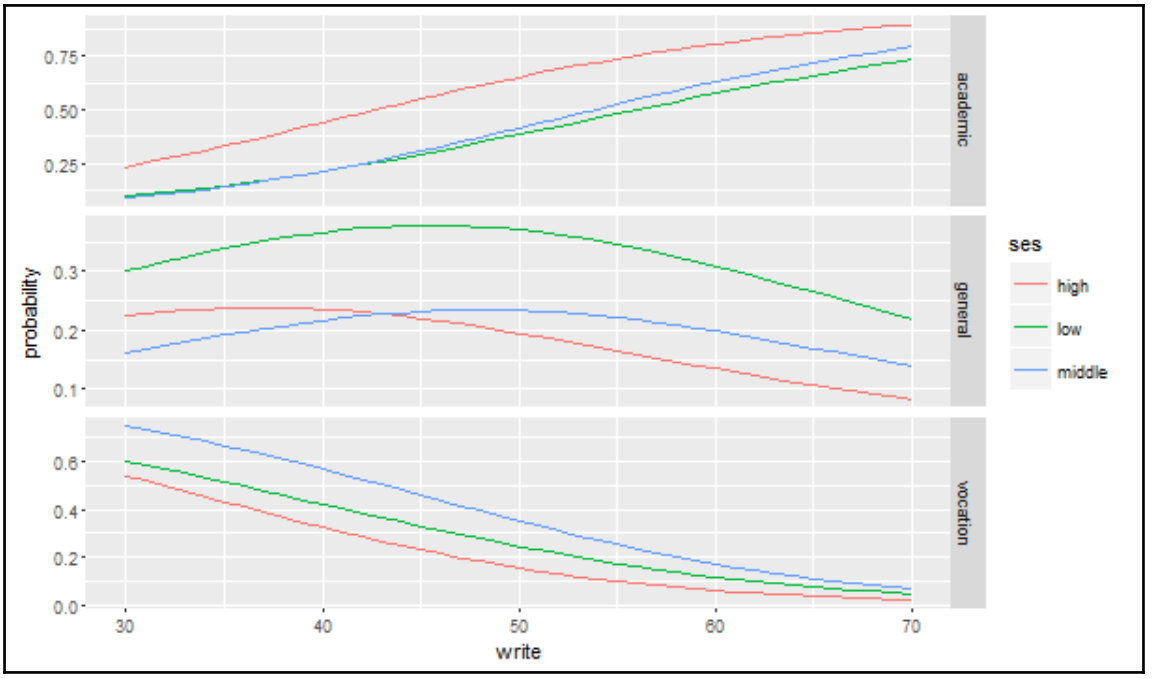
Chapter 2: Classification

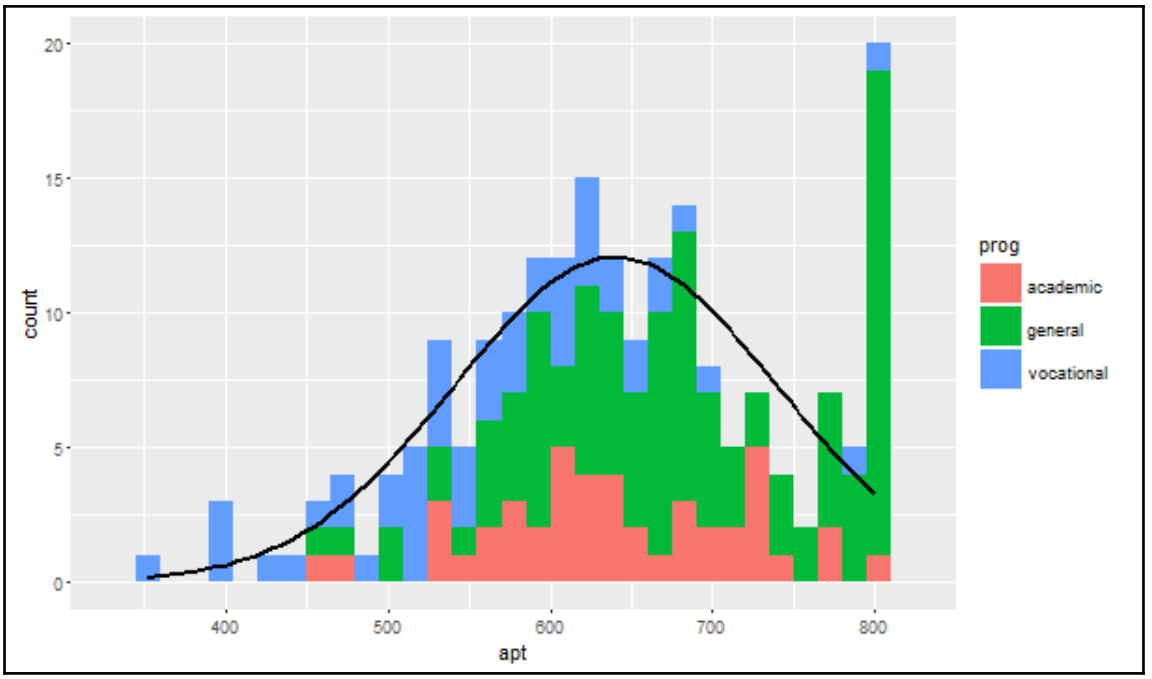


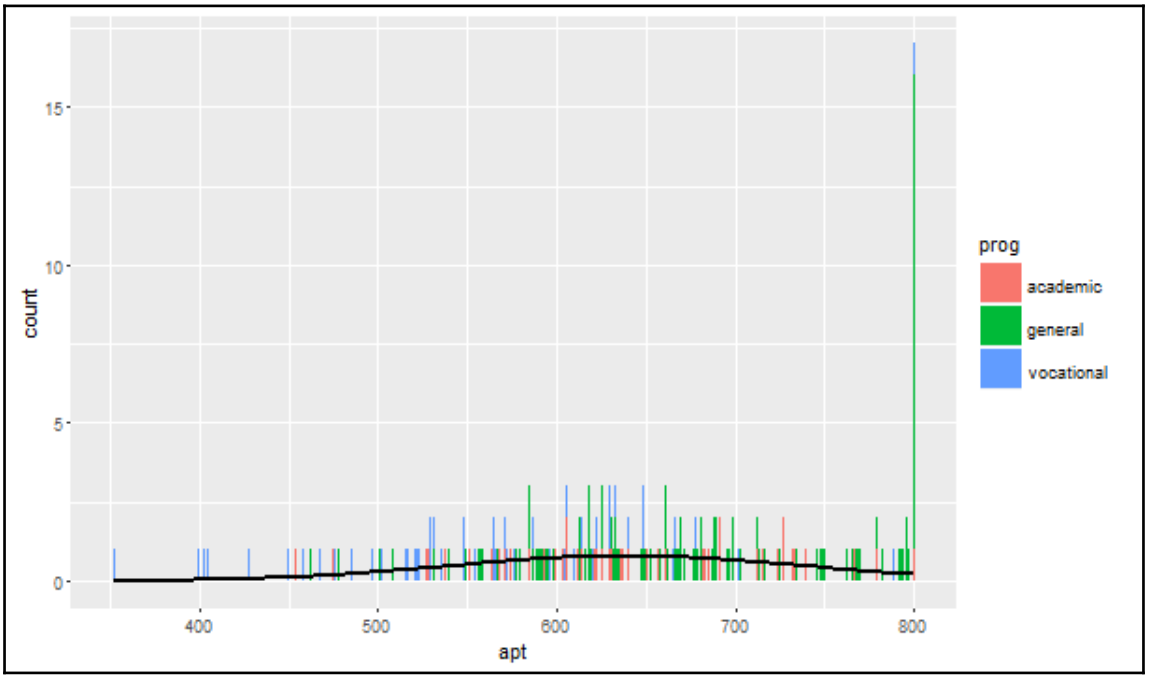

HCO3
SO4
Cl
Ca
Mg
Na
0 1 2 3 4
3 4 5 6
5.0 6.5 8.0
0 3
3 5
5.0 8.0
0.5 3.0
5.0 8.0
2.0 5.0
0.5 1.5 2.5
5.0 6.5 8.0
2.0 3.5 5.0

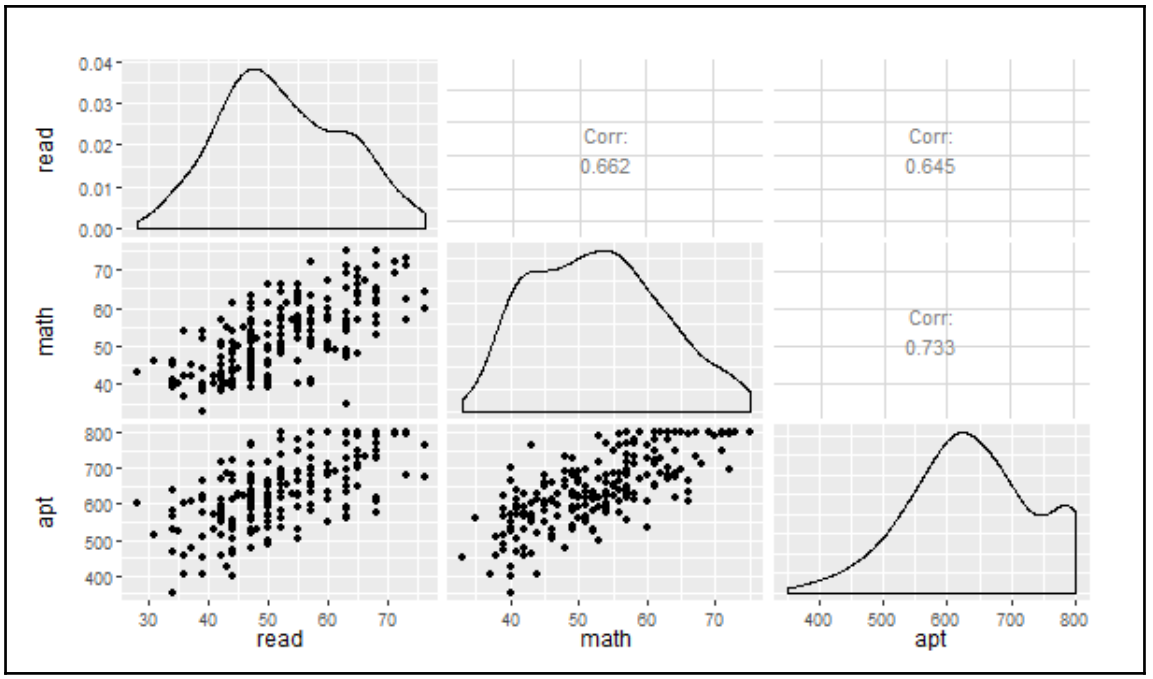

LD2
LD1
-2 -1 0 1 2
-5 0 5

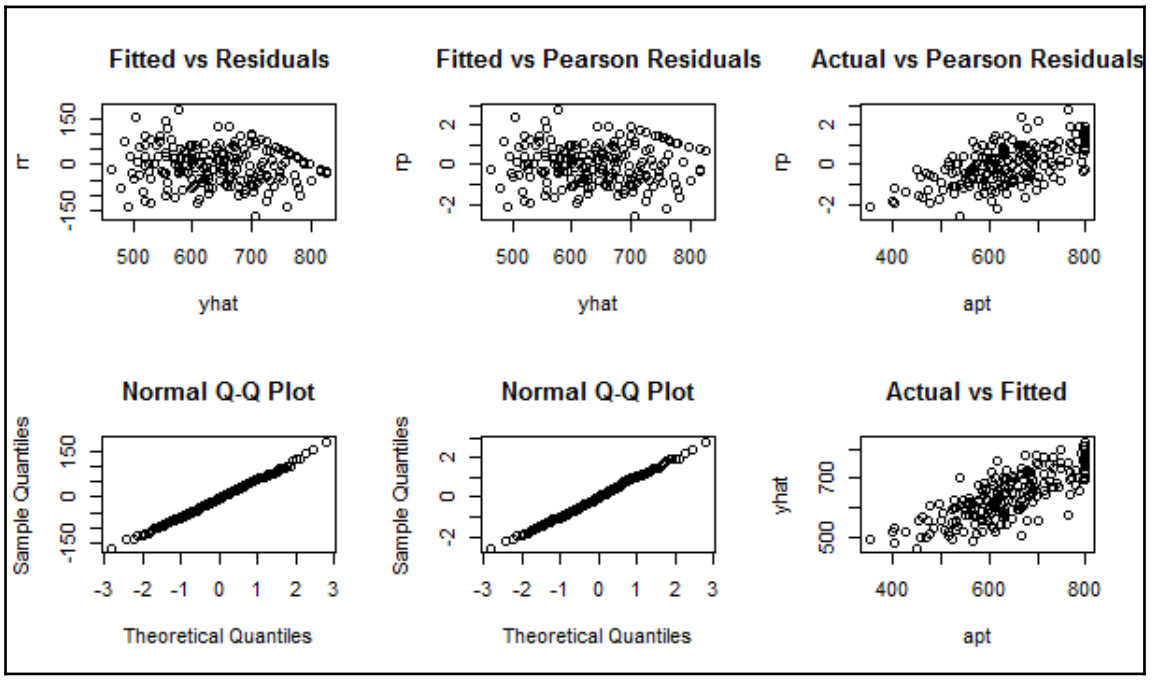

0.0
0.4
0.8
-2
0
2
4
group 1
group 2
group 3

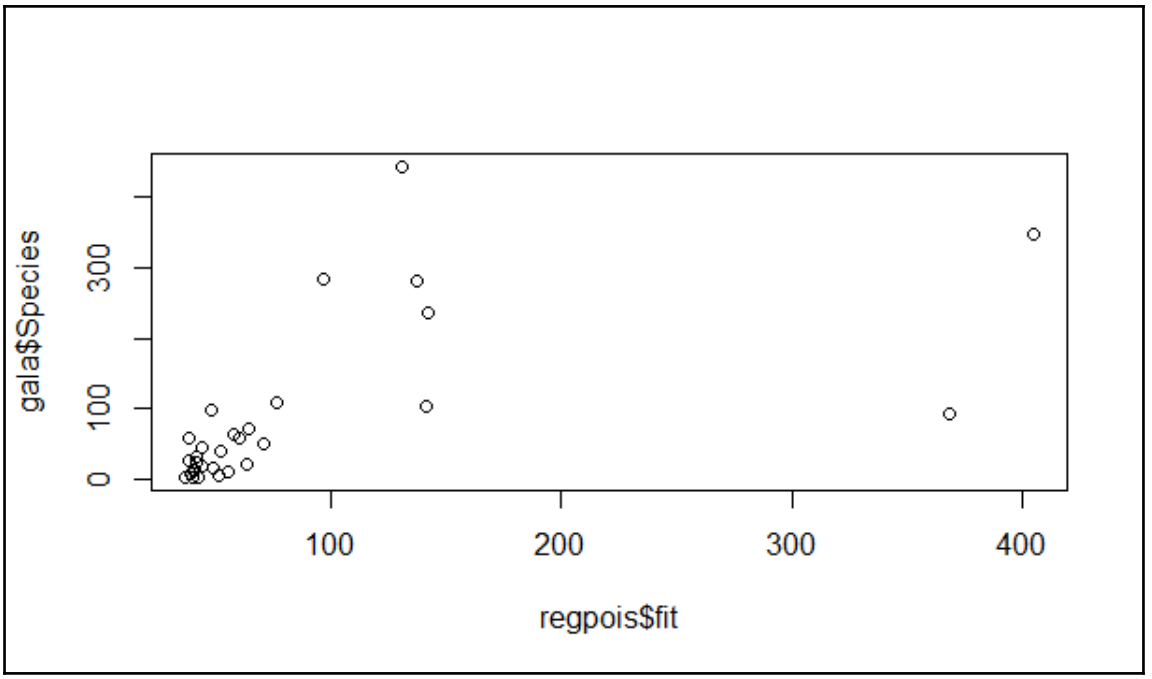

probability
0.75
0.50
0.25
0.3
0.2
0.1
0.6
0.4
0.2
0.0
30
40
50
60
70
write
academic
general
vocation
ses
high
low
middle

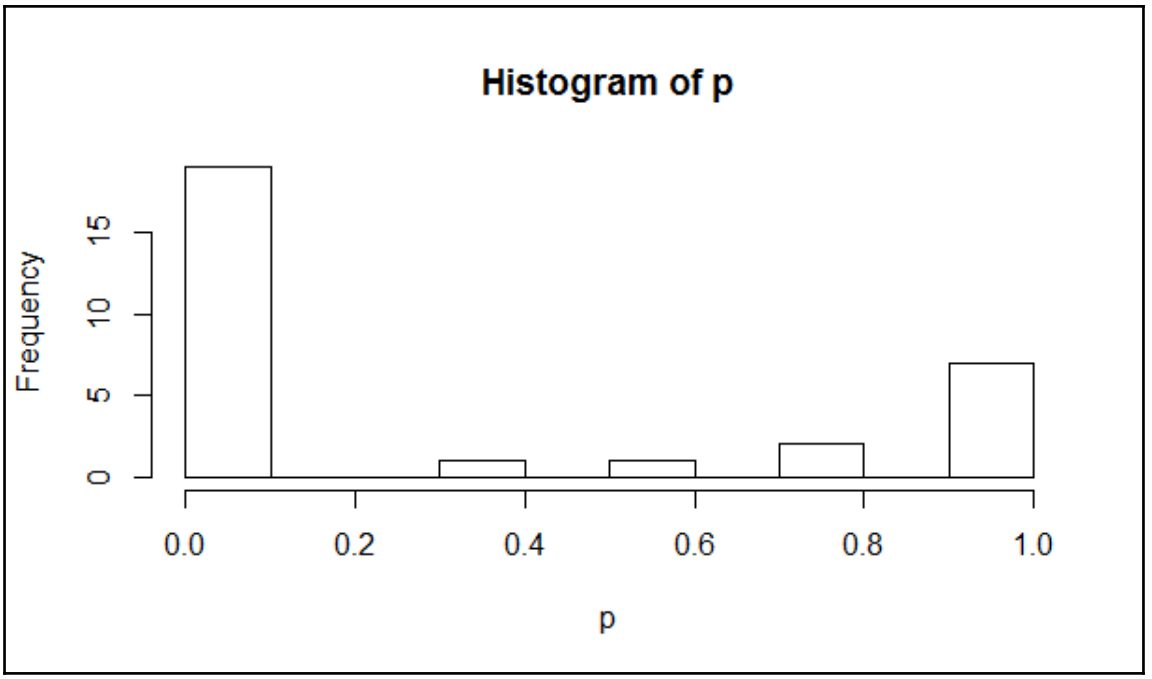

20
15
10
5
0
count
400
500
600
700
800
apt
prog
academic
general
vocational

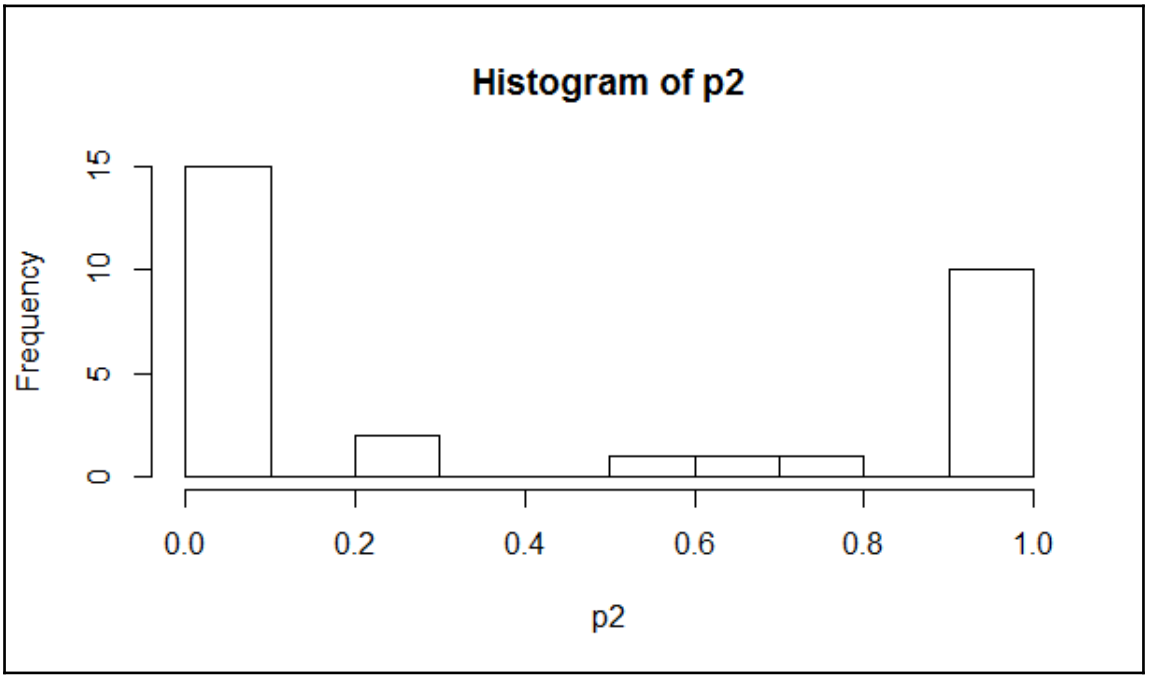

15
10
5
0
count
400
500
600
700
800
apt
prog
academic
general
vocational

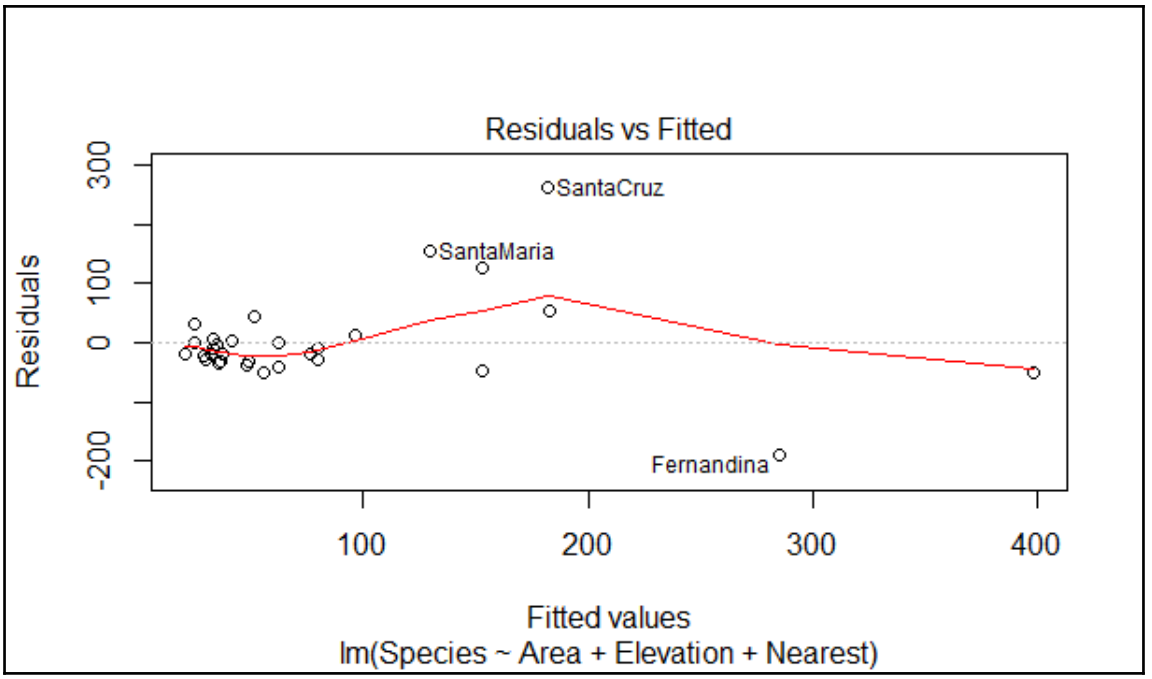

read
math
apt
Corr:
0.662
Corr:
0.645
Corr:
0.733
read
math
apt

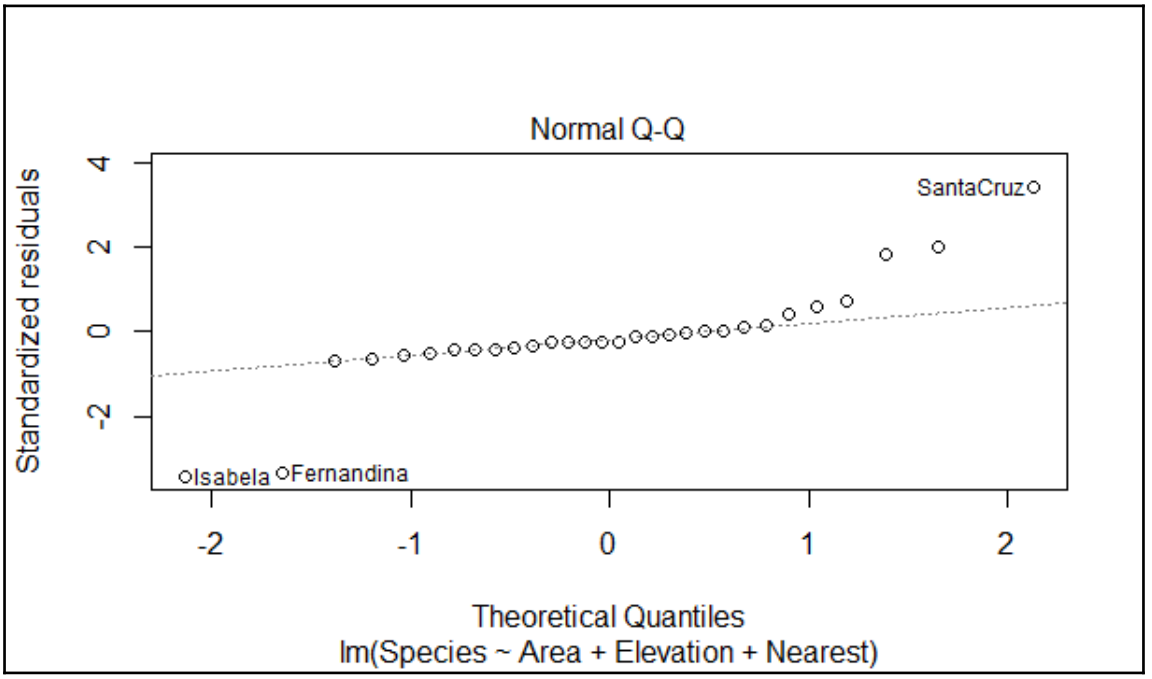

Fitted vs Residuals
rr
yhat
Fitted vs Pearson Residuals
rp
yhat
Actual vs Pearson Residuals
rp
apt
Normal Q-Q Plot
Sample Quantiles
Theoretical Quantiles
Normal Q-Q Plot
Sample Quantiles
Theoretical Quantiles
Actual vs Fitted
yhat
apt

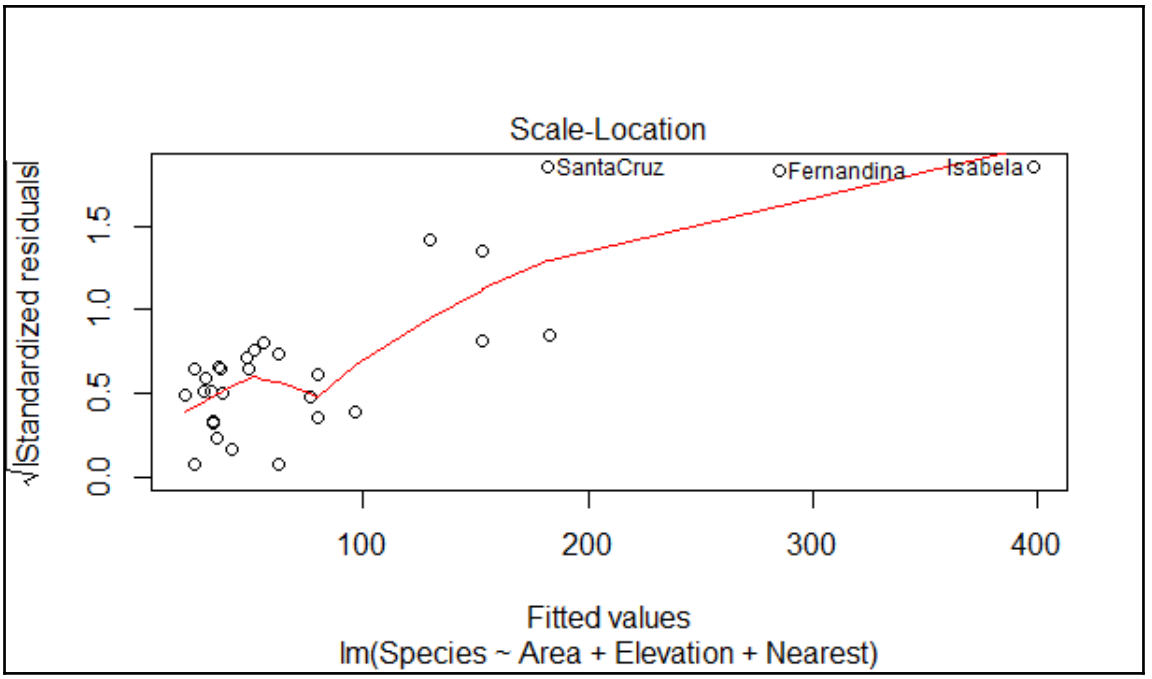

gala$Species
0
100
300
100
200
300
400
regpois$fit

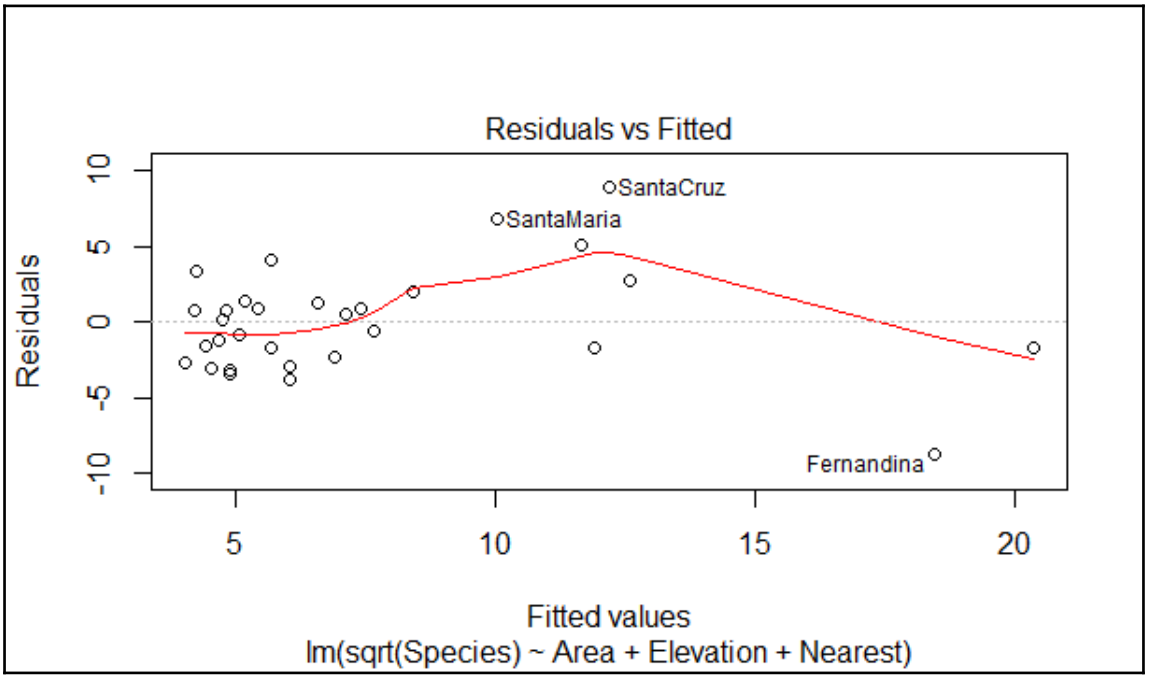

Histogram of p
Frequency
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0
p

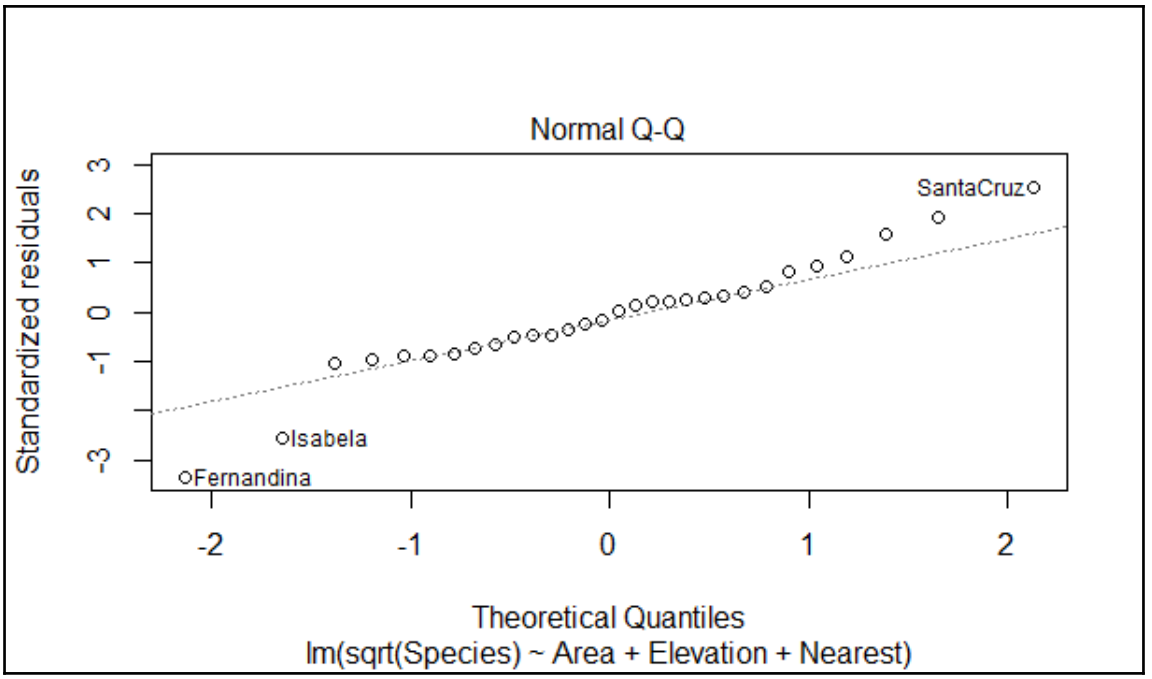

Histogram of p2
Frequency
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0
p2

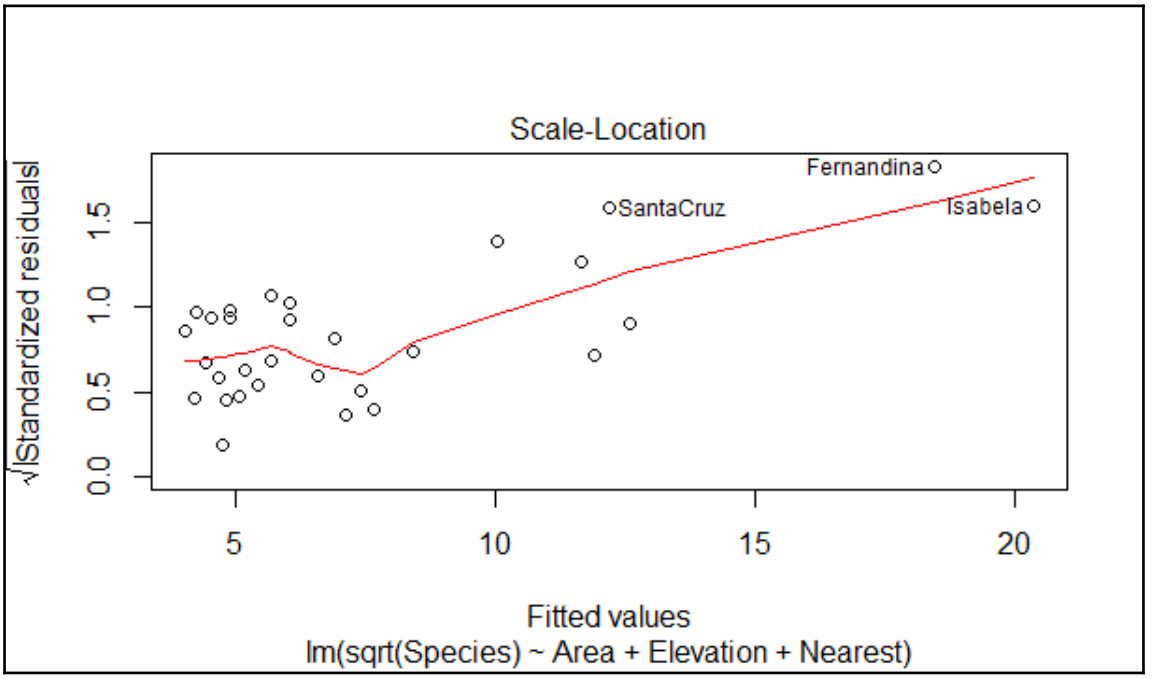

Residuals vs Fitted
Residuals
300
100
0
-200
SantaCruz
SantaMaria
Fernandina
100
200
300
400
Fitted values
lm(Species ~ Area + Elevation + Nearest)

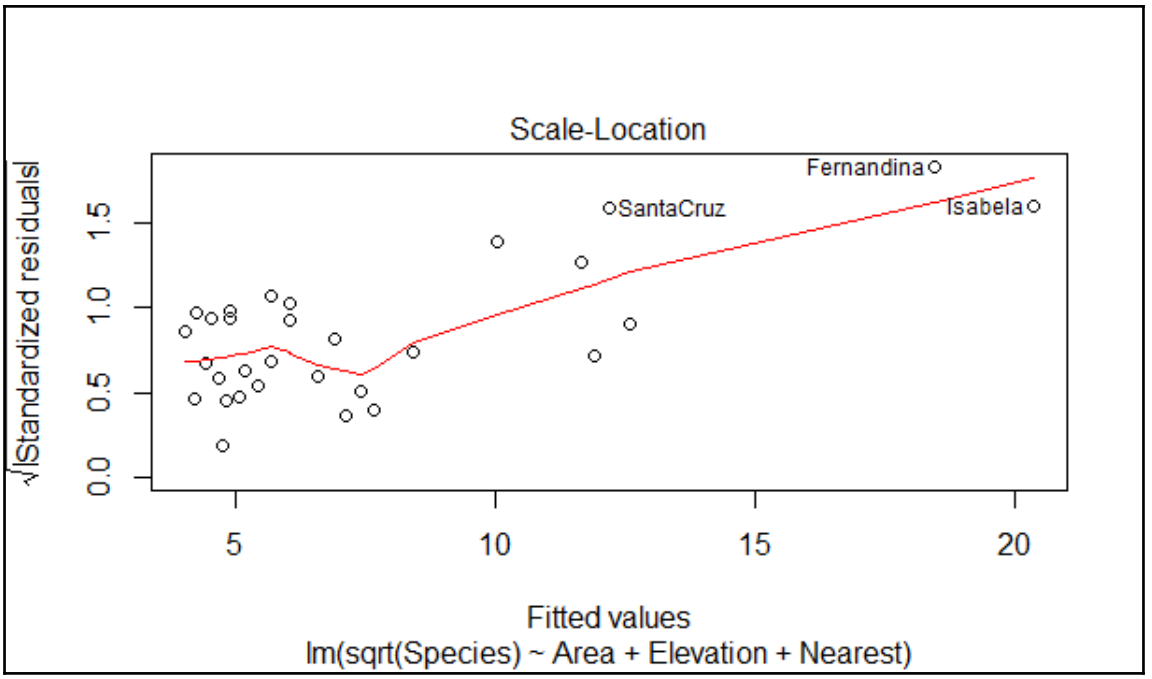

Normal Q-Q
Standardized residuals
4
2
0
-2
SantaCruz
Isabela
Fernandina
-2
-1
0
1
2
Theoretical Quantiles
lm(Species ~ Area + Elevation + Nearest)

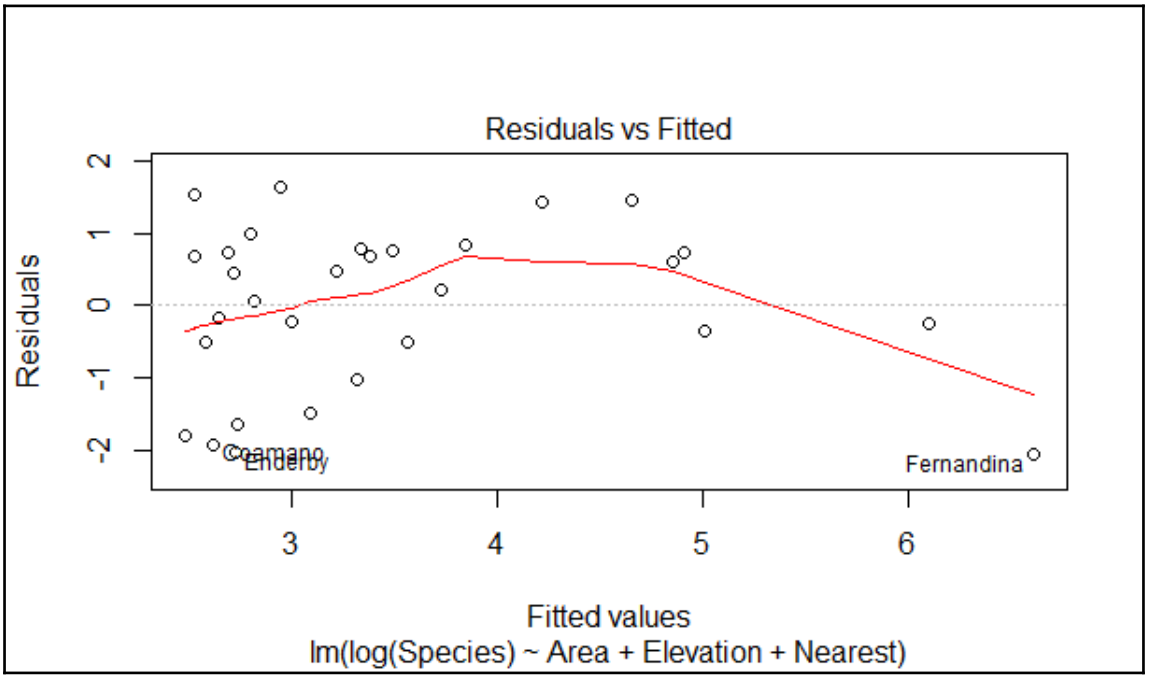

Scale-Location
√|Standardized residuals|
SantaCruz
Fernandina
Isabela
0.0
0.5
1.0
1.5
100
200
300
400
Fitted values
lm(Species ~ Area + Elevation + Nearest)

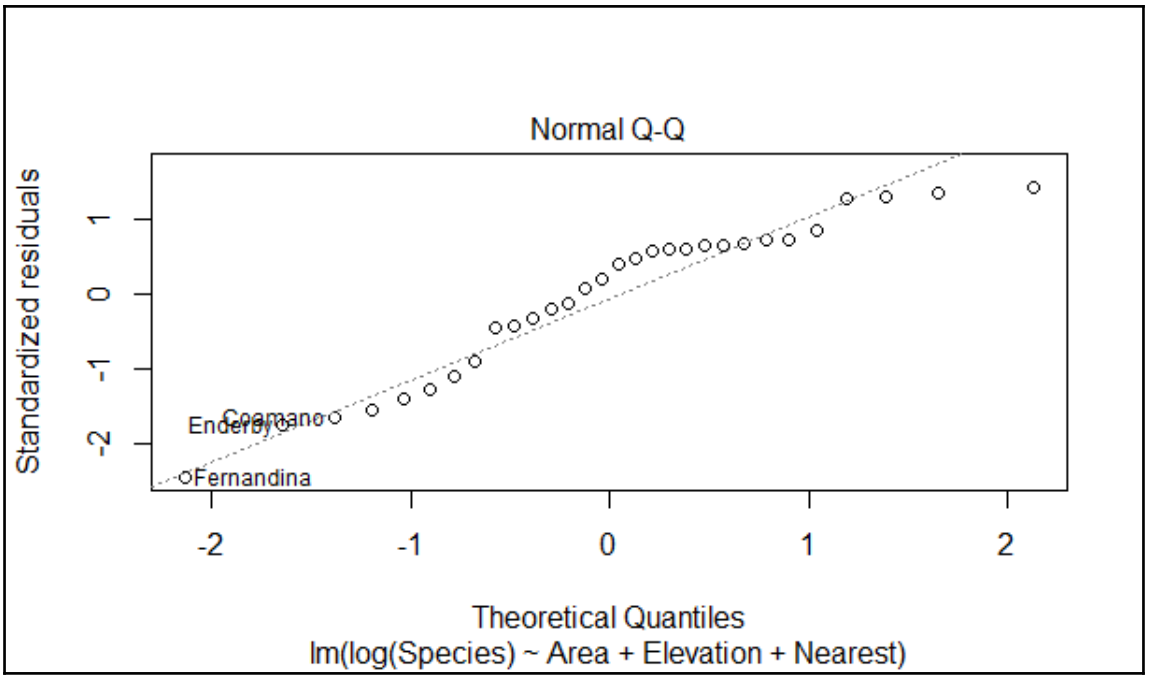

Residuals vs Fitted
Residuals
SantaCruz
SantaMaria
Fernandina
-10
-5
0
5
10
5
10
15
20
Fitted values
lm(sqrt(Species) ~ Area + Elevation + Nearest)

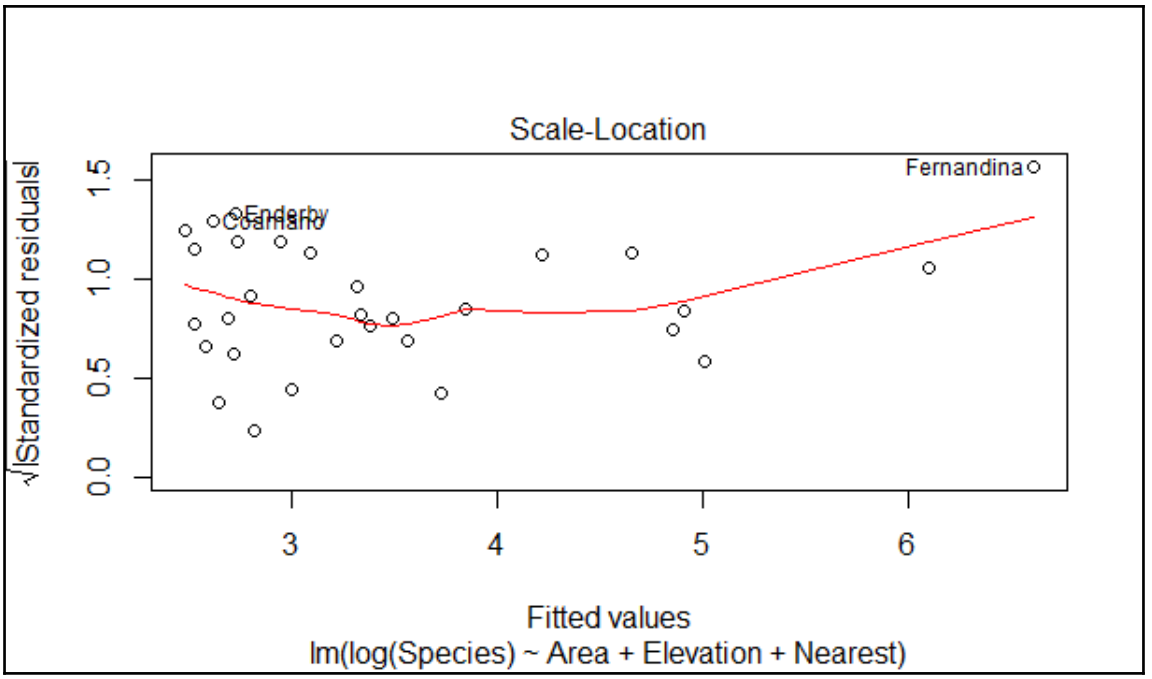

Normal Q-Q
Standardized residuals
SantaCruz
Isabela
Fernandina
-3
-1
0
1
2
3
-2
-1
0
1
2
Theoretical Quantiles
lm(sqrt(Species) ~ Area + Elevation + Nearest)


Scale-Location
√|Standardized residuals|
Fernandina
SantaCruz
Isabela
0.0
0.5
1.0
1.5
5
10
15
20
Fitted values
lm(sqrt(Species) ~ Area + Elevation + Nearest)


Scale-Location
√|Standardized residuals|
Fernandina
SantaCruz
Isabela
0.0
0.5
1.0
1.5
5
10
15
20
Fitted values
lm(sqrt(Species) ~ Area + Elevation + Nearest)


Residuals vs Fitted
Residuals
-2
-1
0
1
2
Enderby
Fernandina
3
4
5
6
Fitted values
lm(log(Species) ~ Area + Elevation + Nearest)


Normal Q-Q
Standardized residuals
-2
-1
0
1
Coamano
Enderby
Fernandina
-2
-1
0
1
2
Theoretical Quantiles
lm(log(Species) ~ Area + Elevation + Nearest)


Scale-Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
Fernandina
Enderby
Coamaño
3
4
5
6
Fitted values
lm(log(Species) ~ Area + Elevation + Nearest)

Chapter 3: Clustering

	Country	new.forest	Rural	log.CO2	log.GNI	log.Energy.2011	LifeExp	Fertility	InfMort	log.Exports
1	China	-5.929375	46.832	1.83973304	8.651724	7.615477	75.19951	1.6630	10.9	3.350966
2	India	-2.735634	68.006	0.56883558	7.346010	6.419537	66.21085	2.5050	41.4	3.172485
3	United States	-1.688899	18.723	2.87153773	10.865707	8.858293	78.74146	1.8805	5.9	2.604613
4	Indonesia	4.636429	47.748	0.64354020	8.137396	6.753775	70.60724	2.3700	24.5	3.271911
5	Brazil	3.222813	14.829	0.81104934	9.362203	7.223405	73.61788	1.8110	12.3	2.475628
6	Pakistan	6.053449	62.140	0.03161348	7.130899	6.177147	66.43588	3.2640	69.0	2.636213

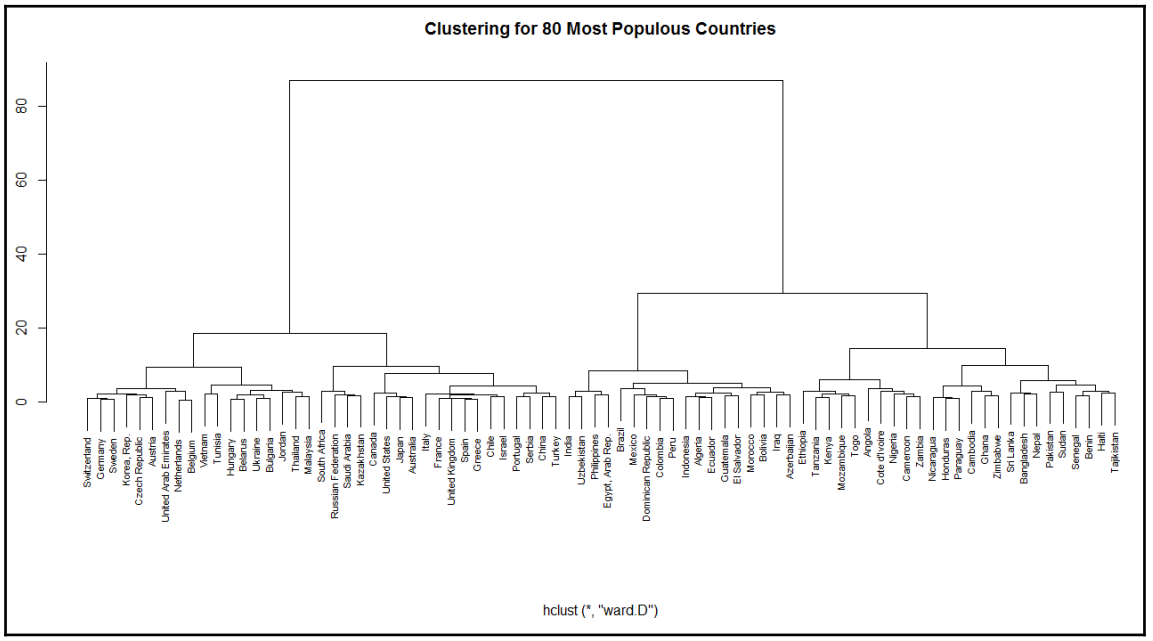
	log.Imports	CellPhone	RuralWater	Pop
1	3.259900	88.70833	84.9	1357380000
2	3.408213	70.78318	90.7	1252139596
3	2.844193	95.52955	98.0	316128839
4	3.216865	121.54341	76.4	249865631
5	2.535485	135.30505	85.3	200361925
6	2.942568	70.13038	89.0	182142594

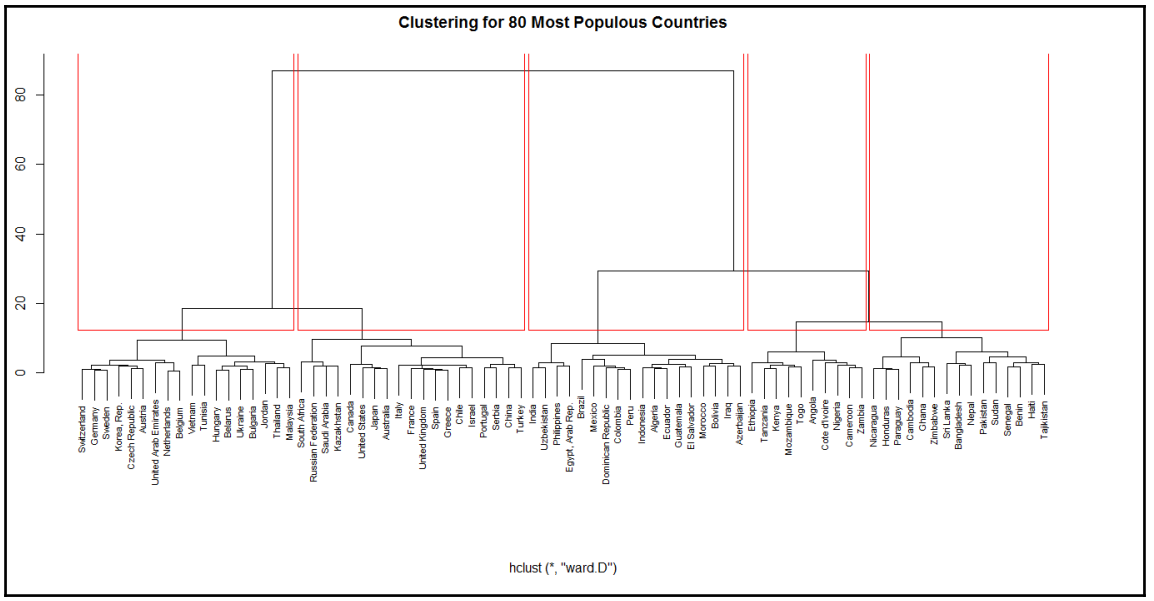
	new.forest	Rural	log.CO2	log.GNI	log.Energy.2011	LifeExp	Fertility
[1,]	-1.5868009	0.33809236	0.73384701	0.032982395	0.4788446547	0.442646915	-0.822234191
[2,]	-0.8025212	1.35749860	-0.24330597	-0.869172134	-0.7378944563	-0.593232631	-0.159983330
[3,]	-0.5454767	-1.01519422	1.52716910	1.562685765	1.7432739991	0.850831828	-0.651165827
[4,]	1.0078203	0.38219249	-0.18586795	-0.322381497	-0.3978432411	-0.086579641	-0.266163694
[5,]	0.6606817	-1.20266791	-0.05707545	0.523872116	0.0799536232	0.260374726	-0.705829052
[6,]	1.3557946	1.07508446	-0.65635910	-1.017798652	-0.9844993561	-0.567300156	0.436986270
[7,]	1.6450615	0.67866475	-1.08103307	-0.550027966	-0.5744934561	-2.218369068	2.590481349
[8,]	0.3497634	1.32095712	-1.25862465	-1.300715181	-1.8548802689	-0.122580415	-0.393580130
[9,]	-0.1747622	-0.65767506	1.25049678	0.586262385	1.4190262396	-0.103436031	-0.879650240
[10,]	-0.2368652	-1.55508378	1.03273482	1.498270384	1.0649522402	1.352672723	-1.021224058
[11,]	0.5746262	-0.89069320	0.35853091	0.399324140	0.2110563885	0.665706675	-0.387287961
[12,]	-1.1822396	0.74900349	-0.70159339	-0.424525130	-1.1103654624	-0.323232448	0.289120282
[13,]	1.1735015	2.00282406	-2.02269355	-1.788005101	-1.2227708545	-0.967184767	1.520812500
[14,]	-1.8746588	1.34233316	-0.21681716	-0.869172134	-0.6086747631	0.489570472	-0.739649464
[15,]	-2.0615030	0.82641943	0.08947721	-0.417534229	-0.2637797596	-0.052006755	0.077546076
[16,]	-0.5644195	-0.70769693	1.02684921	1.460760873	1.1200997628	1.098744717	-1.044819694
[17,]	-1.2162839	-0.58637343	0.42838526	0.472760143	0.1976392919	0.403801606	-0.509985270
[18,]	0.2801866	0.58964604	0.48373630	-0.026258292	0.3509491664	0.326074452	-1.019651015
[19,]	-0.9229715	-0.90821771	0.65157461	1.408179559	1.1353905714	1.291565851	-0.549311330
[20,]	-0.9411997	-1.05443178	0.91454541	1.346769294	0.8673628225	1.168733729	-0.635828664
[21,]	-1.2980378	-0.40901003	0.81045102	1.280754422	0.8133720930	1.334290068	-1.029089270
[22,]	-0.1307375	-0.17319952	1.02062379	0.216483671	0.7846175740	-1.758631201	-0.233129803
[23,]	0.2599093	-1.06199043	1.20295976	1.042015543	1.4423618992	1.153555388	-1.110100955
[24,]	1.0048703	1.44406195	-1.73971591	-1.560358631	-1.0590872047	-1.211443610	2.028118682
[25,]	0.3322161	-0.75550416	-0.25947626	0.173495699	-0.6463659711	0.278720842	-0.308635839
[26,]	-1.5639512	-0.91178038	0.68271981	1.162638223	0.7642100131	1.269922662	-1.092010967
[27,]	-0.6911546	-0.43731885	0.78693642	-0.279306870	0.7940268971	-0.047754009	-0.926054991
[28,]	0.5232651	1.70481118	-1.37793791	-1.268194911	-0.9876392491	-1.184161949	1.376879119
[29,]	0.7039651	-0.44868089	0.26734982	-0.064126848	-0.1365866710	-0.054896262	0.087770852
[30,]	2.3249406	1.28691914	-1.36457894	-0.910502419	-1.2946081464	-1.094182501	1.402047797
[31,]	-0.1307375	-1.02458235	1.39001657	1.539876352	1.7858879570	1.138545697	-0.863919815
[32,]	-0.5276118	-0.43674112	0.34646874	0.080812552	-0.0009236421	-0.243922811	1.083506706
[33,]	-0.4797723	0.04768627	-0.27296128	-0.433957743	-0.8698178137	-0.082444949	-0.001892567

```
 [1] "China"                "India"                "United States"        "Indonesia"            "Brazil"
 [6] "Pakistan"             "Nigeria"              "Bangladesh"           "Russian Federation"   "Japan"
[11] "Mexico"               "Philippines"          "Ethiopia"             "Vietnam"              "Egypt, Arab Rep."
[16] "Germany"              "Turkey"               "Thailand"             "France"               "United Kingdom"
[21] "Italy"                "South Africa"         "Korea, Rep."          "Tanzania"             "Colombia"
[26] "Spain"                "Ukraine"              "Kenya"                "Algeria"              "Sudan"
[31] "Canada"               "Iraq"                 "Morocco"              "Peru"                 "Uzbekistan"
[36] "Malaysia"             "Saudi Arabia"         "Nepal"                "Ghana"                "Mozambique"
[41] "Australia"            "Cameroon"             "Angola"               "Sri Lanka"            "Cote d'Ivoire"
[46] "Chile"                "Kazakhstan"           "Netherlands"          "Ecuador"              "Guatemala"
[51] "Cambodia"             "Zambia"               "Zimbabwe"             "Senegal"              "Belgium"
[56] "Greece"               "Tunisia"              "Bolivia"              "Czech Republic"       "Portugal"
[61] "Dominican Republic"   "Benin"                "Haiti"                "Hungary"              "Sweden"
[66] "Belarus"              "Azerbaijan"           "United Arab Emirates" "Austria"              "Tajikistan"
[71] "Honduras"             "Switzerland"          "Israel"               "Bulgaria"             "Serbia"
[76] "Togo"                 "Paraguay"             "Jordan"               "El Salvador"          "Nicaragua"
```

```
Call:
hclust(d = dist1, method = "ward.D")

Cluster method   : ward.D
Distance         : euclidean
Number of objects: 80
```





China	India	United States	Indonesia	Brazil
1	2	1	2	2
Pakistan	Nigeria	Bangladesh	Russian Federation	Japan
3	4	3	1	1
Mexico	Philippines	Ethiopia	Vietnam	Egypt, Arab Rep.
2	2	4	5	2
Germany	Turkey	Thailand	France	United Kingdom
5	1	5	1	1
Italy	South Africa	Korea, Rep.	Tanzania	Colombia
1	1	5	4	2
Spain	Ukraine	Kenya	Algeria	Sudan
1	5	4	2	3
Canada	Iraq	Morocco	Peru	Uzbekistan
1	2	2	2	2
Malaysia	Saudi Arabia	Nepal	Ghana	Mozambique
5	1	3	3	4
Australia	Cameroon	Angola	Sri Lanka	Cote d'Ivoire
1	4	4	3	4
Chile	Kazakhstan	Netherlands	Ecuador	Guatemala
1	1	5	2	2
Cambodia	Zambia	Zimbabwe	Senegal	Belgium
3	4	3	3	5
Greece	Tunisia	Bolivia	Czech Republic	Portugal
1	5	2	5	1
ominican Republic	Benin	Haiti	Hungary	Sweden
2	3	3	5	5
Belarus	Azerbaijan	United Arab Emirates	Austria	Tajikistan
5	2	5	5	3
Honduras	Switzerland	Israel	Bulgaria	Serbia
3	5	1	5	1
Togo	Paraguay	Jordan	El Salvador	Nicaragua
4	3	5	2	3

```
[1] "Countries in Cluster  1"
 [1] China              United States      Russian Federation Japan              Turkey
 [6] France             United Kingdom     Italy              South Africa       Spain
[11] Canada             Saudi Arabia       Australia          Chile              Kazakhstan
[16] Greece             Portugal           Israel             Serbia
80 Levels: Algeria Angola Australia Austria Azerbaijan Bangladesh Belarus Belgium Benin Bolivia ... Zimbabwe
[1] " "
[1] "Countries in Cluster  2"
 [1] India              Indonesia          Brazil             Mexico             Philippines
 [6] Egypt, Arab Rep.   Colombia           Algeria            Iraq               Morocco
[11] Peru               Uzbekistan         Ecuador            Guatemala          Bolivia
[16] Dominican Republic Azerbaijan         El Salvador
80 Levels: Algeria Angola Australia Austria Azerbaijan Bangladesh Belarus Belgium Benin Bolivia ... Zimbabwe
[1] " "
[1] "Countries in Cluster  3"
 [1] Pakistan   Bangladesh Sudan      Nepal      Ghana      Sri Lanka  Cambodia   Zimbabwe   Senegal
[10] Benin      Haiti      Tajikistan Honduras   Paraguay   Nicaragua
80 Levels: Algeria Angola Australia Austria Azerbaijan Bangladesh Belarus Belgium Benin Bolivia ... Zimbabwe
[1] " "
[1] "Countries in Cluster  4"
 [1] Nigeria       Ethiopia      Tanzania      Kenya         Mozambique    Cameroon      Angola
 [8] Cote d'Ivoire Zambia        Togo
80 Levels: Algeria Angola Australia Austria Azerbaijan Bangladesh Belarus Belgium Benin Bolivia ... Zimbabwe
[1] " "
[1] "Countries in Cluster  5"
 [1] Vietnam              Germany              Thailand             Korea, Rep.          Ukraine
 [6] Malaysia             Netherlands          Belgium              Tunisia              Czech Republic
[11] Hungary              Sweden               Belarus              United Arab Emirates Austria
[16] Switzerland          Bulgaria             Jordan
80 Levels: Algeria Angola Australia Austria Azerbaijan Bangladesh Belarus Belgium Benin Bolivia ... Zimbabwe
[1] " "
```

```
 [1] Sphagnum Moss          Brown Litter           Big-leaved Aster       Mosses (Non-Sphagnum)   Labrador Tea
 [6] Leatherleaf            Grasses (Unidentified) Sedges (Unidentified)  Bog False Solomon Seal   Bracken Fern
[11] Bunchberry             Lowbush Blueberry      Creeping Snowberry     Wild Sarsaparilla       Ground Pine
[16] Spruce (Black)         Brier                  Small Cranberry        Maple (Mountain)        Hazelnut (Beaked)
[21] Maple (Red)            Starflower             Canadian Mayflower     Blue-bead Lily          Twisted Stalk
[26] Fungi                  Bush Honeysuckle       Cotton Grass           Bedstraw (Narrow Leaves)
[31]
[36]
[41]
[46]
[51]
[56]
[61]
30 Levels: Bedstraw (Narrow Leaves) Big-leaved Aster Blue-bead Lily Bog False Solomon Seal Bracken Fern Brier Brown Litter   ... Wild Sarsaparilla
```

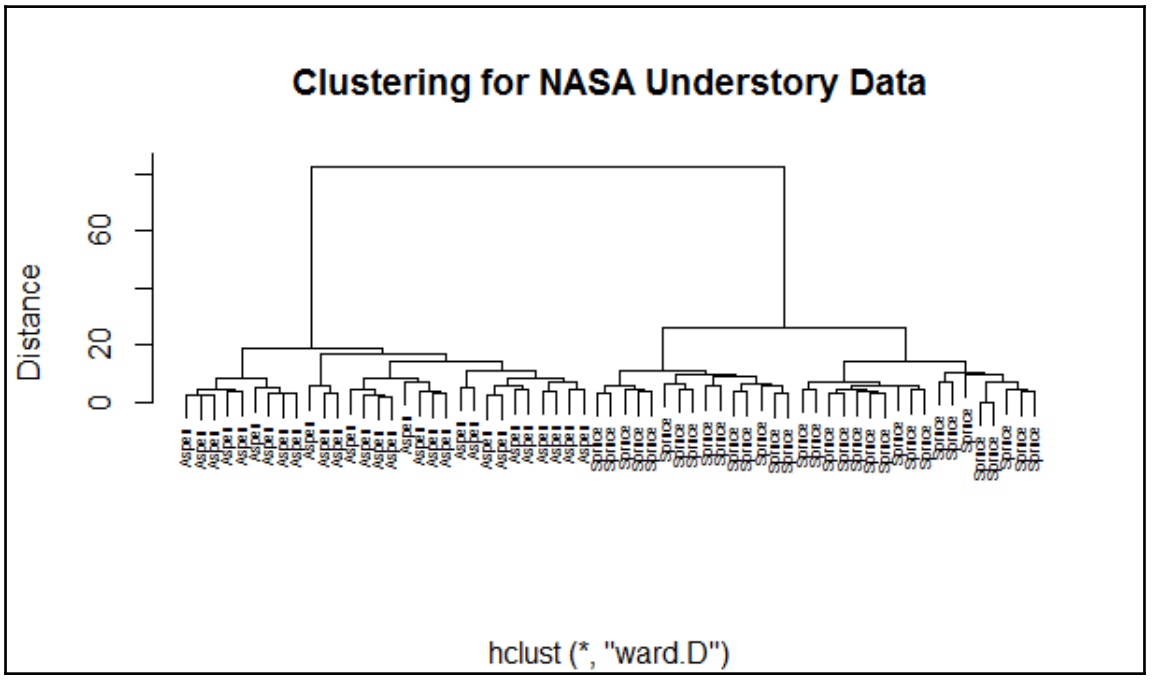
	PlotID	Overstory.Species	SPHA	BLIT	ASMA	MOSS	LEGR	CHCA	GRAS	SEDG	SMTR	PTAQ	COCA	VAAN	GAHI	ARNU	LYOB	PIMA	RUBU	VAOX	ACSP	COCO	ACRU	TRBO	MACA
1	2	Aspen	68	14	0	3	33	5	5	0	14	0	0	4	28	0	0	1	0	6	0	0	0	0	0
2	3	Spruce	0	6	18	2	0	0	5	0	0	2	0	0	0	7	0	0	6	0	2	1	2	2	2
3	12	Aspen	60	1	0	0	5	9	12	1	14	0	0	0	2	0	0	3	0	4	0	0	0	0	0
4	14	Aspen	16	14	0	72	14	1	2	0	13	0	0	5	7	0	0	2	0	1	0	0	0	0	0
5	15	Aspen	68	7	0	30	27	8	4	0	12	0	0	5	13	0	0	3	0	3	0	0	0	0	0
6	16	Spruce	0	14	14	3	0	0	2	0	0	1	0	0	0	2	1	0	1	0	17	6	10	1	0
7	18	Aspen	62	7	0	3	6	12	4	0	0	0	0	0	0	0	0	13	0	5	0	0	0	0	0
8	19	Aspen	62	5	0	0	6	28	1	0	0	0	0	0	0	0	0	15	0	5	0	0	0	0	0
9	20	Spruce	0	5	8	14	0	0	4	6	0	14	10	3	0	0	6	0	0	0	1	8	1	1	0
10	21	Spruce	0	16	26	5	0	0	1	0	0	18	6	10	0	10	11	0	3	0	1	5	5	4	4
11	36	Spruce	0	25	38	3	0	0	5	3	0	6	7	0	0	0	0	0	1	0	0	3	6	4	4
12	38	Aspen	82	10	0	10	24	12	8	0	6	0	0	4	2	0	0	2	0	1	0	0	0	0	0
13	39	Aspen	60	3	0	34	24	0	5	0	9	0	1	5	4	0	1	6	0	4	0	0	0	0	0
14	41	Aspen	72	17	0	4	6	0	3	0	5	0	0	5	6	0	1	1	0	0	0	0	0	0	0
15	42	Aspen	34	14	0	36	15	1	0	5	6	0	4	9	8	0	1	4	0	2	0	0	0	1	0
16	43	Aspen	32	13	0	34	28	3	0	0	6	0	0	5	5	0	0	2	0	1	0	0	0	0	0
17	45	Aspen	55	25	0	8	7	4	0	10	4	0	0	5	3	0	0	0	0	2	0	0	0	0	0
18	47	Aspen	64	8	0	5	9	8	1	32	20	0	0	5	4	0	0	2	0	5	0	0	0	0	0
19	48	Aspen	64	12	0	13	6	0	10	2	10	0	0	0	1	0	7	1	0	0	0	0	0	0	0
20	49	Aspen	48	5	0	6	1	0	5	14	5	0	1	2	2	0	0	0	0	1	0	0	0	0	0
21	50	Aspen	38	18	0	38	11	0	2	6	4	0	2	0	3	0	0	0	0	1	0	0	1	0	0
22	51	Aspen	74	3	0	2	34	17	1	0	2	0	0	0	0	0	0	6	0	3	0	0	0	0	0
23	52	Aspen	86	3	0	5	36	9	17	1	0	0	0	0	4	0	0	1	0	2	0	0	0	0	0
24	54	Aspen	62	16	0	0	22	10	5	0	7	1	0	4	3	0	0	1	0	2	0	0	0	0	0
25	55	Aspen	38	30	0	18	4	2	0	2	6	0	0	5	6	0	0	4	0	2	0	0	0	0	0
26	56	Aspen	68	13	0	6	34	5	0	5	2	0	0	2	3	0	0	6	0	4	0	0	0	0	0
27	57	Aspen	72	5	0	4	17	20	0	14	0	0	0	0	4	0	0	3	0	4	0	0	0	0	0
28	62	Aspen	66	1	0	12	7	20	17	6	0	0	0	0	0	0	0	4	0	4	0	0	0	0	0
29	63	Aspen	56	8	0	1	12	12	6	0	0	0	0	0	0	0	0	8	0	3	0	0	0	0	0
30	64	Aspen	56	0	0	6	6	24	0	34	0	0	0	0	0	0	0	7	0	4	0	0	0	0	0
31	68	Aspen	62	8	0	9	4	5	1	10	1	0	0	0	5	0	0	1	0	5	0	0	0	0	0
32	69	Spruce	1	15	11	5	0	0	2	0	0	2	17	7	1	1	3	0	0	0	0	2	1	1	3
33	71	Spruce	1	20	16	5	0	0	2	2	0	4	5	3	0	4	2	0	3	0	0	1	2	0	2
34	72	Spruce	0	32	14	4	0	0	1	0	0	0	4	0	0	5	5	0	4	0	3	2	2	5	4

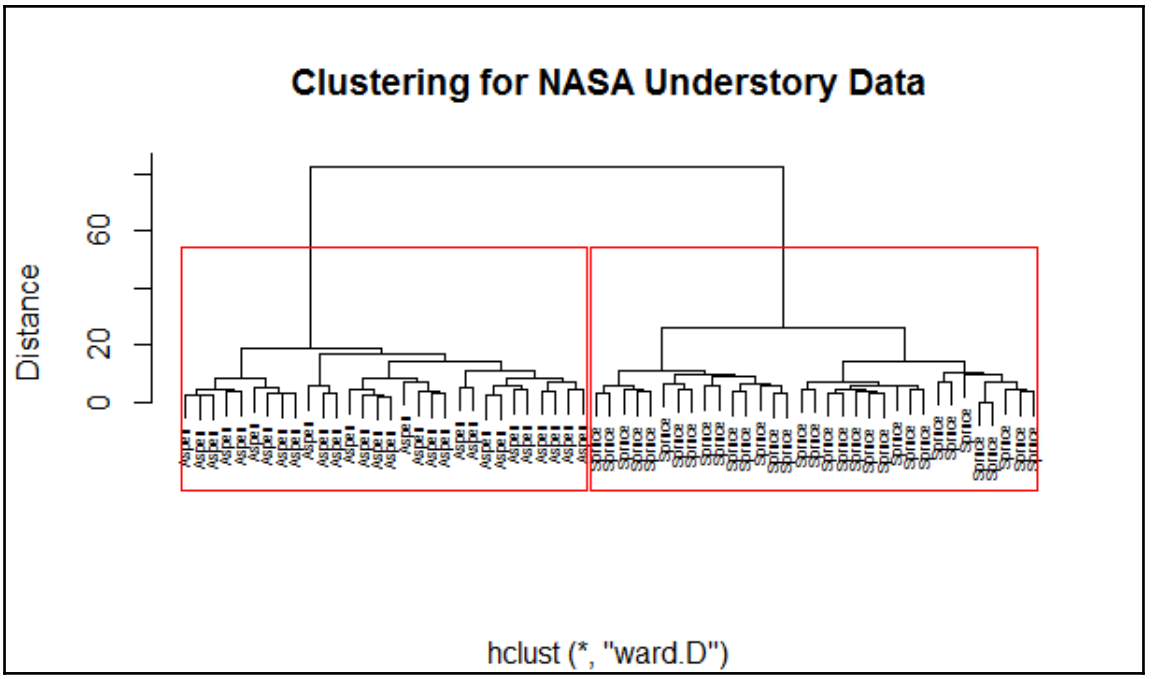
```
             SPHA       BLIT       ASMA       MOSS       LEGR       CHCA       GRAS       SEDG       SMTR
 [1,]  1.2641384 -0.24208432 -0.77255673 -0.50604541  2.54875930  0.19309198  0.36896403 -0.49052647  2.6140567
 [2,] -0.9204396 -0.95979313  0.65894545 -0.58972221 -0.65297519 -0.55782127  0.36896403 -0.49052647 -0.5529735
 [3,]  1.0071292 -1.40836113 -0.77255673 -0.75707581 -0.16786391  0.79382257  2.37776818 -0.35498626  2.6140567
 [4,] -0.4064213 -0.24208432 -0.77255673  5.26765381  0.70533641 -0.40763862 -0.49195204 -0.49052647  2.3878403
 [5,]  1.2641384 -0.87007953 -0.77255673  1.75322820  1.96662576  0.64363992  0.08199201 -0.49052647  2.1616238
 [6,] -0.9204396 -0.24208432  0.34083385 -0.50604541 -0.65297519 -0.55782127 -0.49195204 -0.49052647 -0.5529735
 [7,]  1.0713815 -0.87007953 -0.77255673 -0.50604541 -0.07084165  1.24437052  0.08199201 -0.49052647 -0.5529735
 [8,]  1.0713815 -1.04950673 -0.77255673 -0.75707581 -0.07084165  3.64729290 -0.77892406 -0.49052647 -0.5529735
 [9,] -0.9204396 -1.04950673 -0.13633354  0.41439939 -0.65297519 -0.55782127  0.08199201  0.32271478 -0.5529735
[10,] -0.9204396 -0.06265712  1.29516864 -0.33869181 -0.65297519 -0.55782127 -0.77892406 -0.49052647 -0.5529735
[11,] -0.9204396  0.74476529  2.24950342 -0.50604541 -0.65297519 -0.55782127  0.36896403 -0.08390584 -0.5529735
[12,]  1.7139045 -0.60093872 -0.77255673  0.07969219  1.67555898  1.24437052  1.22988009 -0.49052647  0.8043251
[13,]  1.0071292 -1.22893393 -0.77255673  2.08793540  1.67555898 -0.55782127  0.36896403 -0.49052647  1.4829745
[14,]  1.3926430  0.02705648 -0.77255673 -0.42236861 -0.07084165 -0.55782127 -0.20498002 -0.49052647  0.5781087
[15,]  0.1718494 -0.24208432 -0.77255673  2.25528900  0.80235867 -0.40763862 -1.06589608  0.18717457  0.8043251
[16,]  0.1075971 -0.33179792 -0.77255673  2.08793540  2.06364801 -0.10727332 -1.06589608 -0.49052647  0.8043251
[17,]  0.8464985  0.74476529 -0.77255673 -0.08766141  0.02618061  0.04290933 -1.06589608  0.86487561  0.3518923
[18,]  1.1356338 -0.78036593 -0.77255673 -0.33869181  0.22022512  0.64363992 -0.77892406  3.84676019  3.9713554
[19,]  1.1356338 -0.42151152 -0.77255673  0.33072259 -0.07084165 -0.55782127  1.80382414 -0.21944605  1.7091909
[20,]  0.6216155 -1.04950673 -0.77255673 -0.25501501 -0.55595294 -0.55782127  0.36896403  1.40703644  0.5781087
[21,]  0.3003540  0.11677008 -0.77255673  2.42264260  0.41426964 -0.55782127 -0.49195204  0.32271478  0.3518923
[22,]  1.4568953 -1.22893393 -0.77255673 -0.58972221  2.64578156  1.99528376 -0.77892406 -0.49052647 -0.1005406
[23,]  1.8424091 -1.22893393 -0.77255673 -0.33869181  2.83982607  0.79382257  3.81262829 -0.35498626 -0.5529735
[24,]  1.0713815 -0.06265712 -0.77255673 -0.75707581  1.48151447  0.94400522  0.36896403 -0.49052647  1.0305416
[25,]  0.3003540  1.19333330 -0.77255673  0.74910659 -0.26488616 -0.25745597 -1.06589608 -0.21944605  0.8043251
[26,]  1.2641384 -0.33179792 -0.77255673 -0.25501501  2.64578156  0.19309198 -1.06589608  0.18717457 -0.1005406
[27,]  1.3926430 -1.04950673 -0.77255673 -0.42236861  0.99640318  2.44583171 -1.06589608  1.40703644 -0.5529735
[28,]  1.1998861 -1.40836113 -0.77255673  0.24704579  0.02618061  2.44583171  3.81262829  0.32271478 -0.5529735
[29,]  0.8786246 -0.78036593 -0.77255673 -0.67339901  0.51129190  1.24437052  0.65593605 -0.49052647 -0.5529735
[30,]  0.8786246 -1.49807473 -0.77255673 -0.25501501 -0.07084165  3.04656230 -1.06589608  4.11784060 -0.5529735
[31,]  1.0713815 -0.78036593 -0.77255673 -0.00398461 -0.26488616  0.19309198 -0.77892406  0.86487561 -0.3267571
[32,] -0.8883135 -0.15237072  0.10225016 -0.33869181 -0.65297519 -0.55782127 -0.49195204 -0.49052647 -0.5529735
[33,] -0.8883135  0.29619729  0.49988965 -0.33869181 -0.65297519 -0.55782127 -0.49195204 -0.21944605 -0.5529735
```

```
 [1] "Aspen"  "Spruce" "Aspen"  "Aspen"  "Aspen"  "Spruce" "Aspen"  "Aspen"  "Spruce" "Spruce" "Spruce"
[12] "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"
[23] "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Aspen"  "Spruce" "Spruce"
[34] "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce"
[45] "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce" "Spruce"
[56] "Spruce" "Spruce" "Spruce" "Aspen"  "Spruce" "Aspen"  "Aspen"  "Aspen"
```

```
Call:
hclust(d = dist1, method = "ward.D")

Cluster method   : ward.D
Distance         : euclidean
Number of objects: 63
```

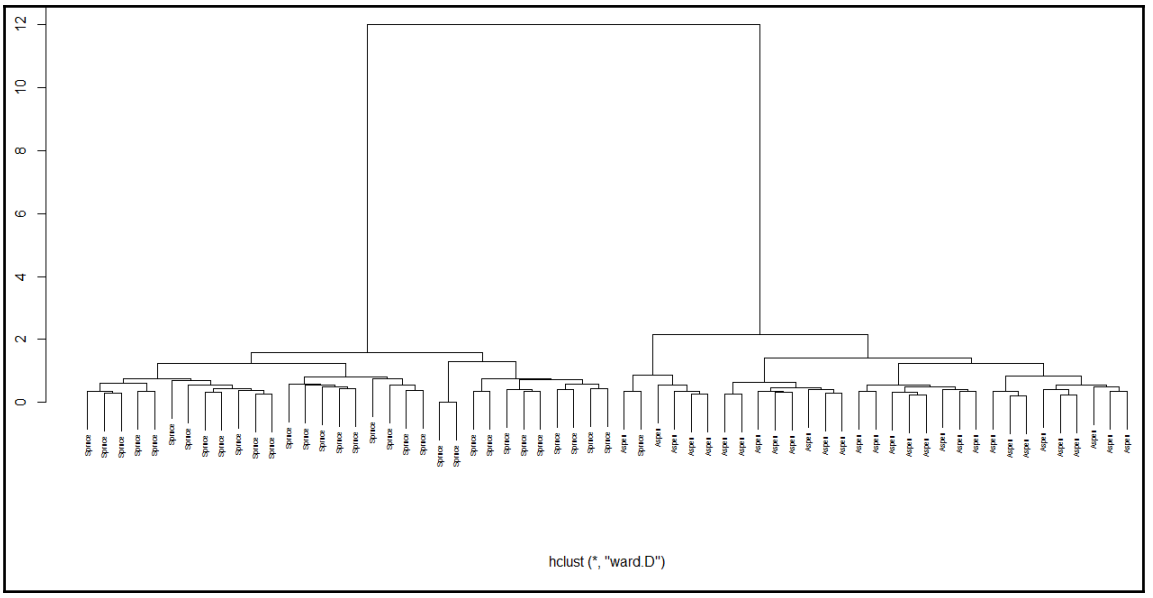


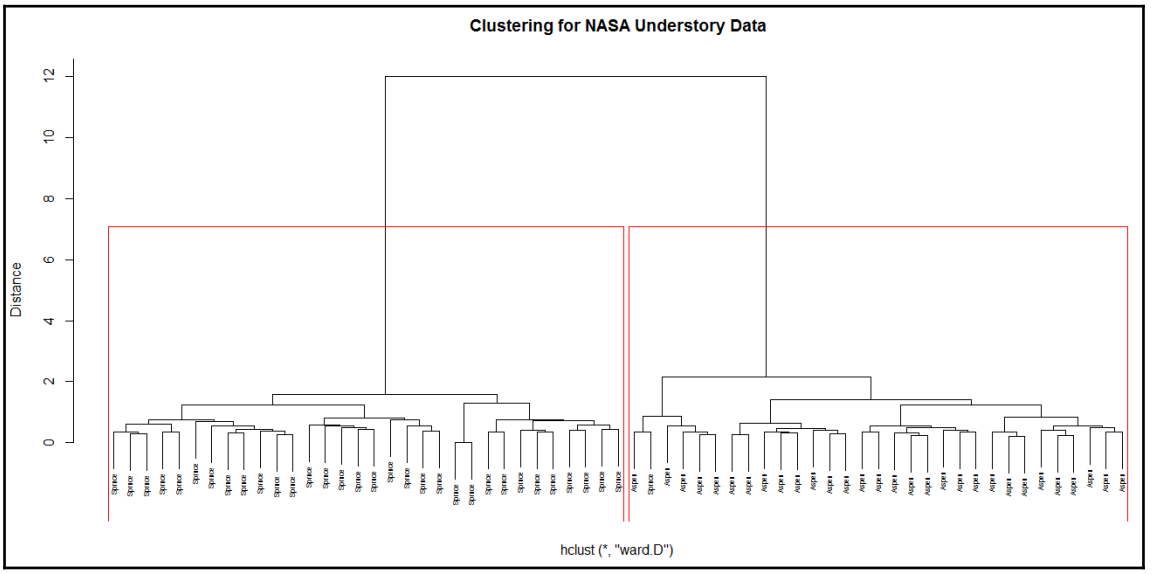



```
 Aspen Spruce  Aspen  Aspen  Aspen Spruce  Aspen  Aspen Spruce Spruce Spruce  Aspen  Asp
en  Aspen
     1      2      1      1      1      2      1      1      2      2      2      1
 1      1
 Aspen  Aspen  Aspen  Aspen  Aspen  Aspen  Aspen  Aspen  Aspen  Aspen  Aspen  Aspen  Asp
en  Aspen
     1      1      1      1      1      1      1      1      1      1      1      1
 1      1
 Aspen  Aspen  Aspen Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spru
ce Spruce
     1      1      1      2      2      2      2      2      2      2      2      2
 2      2
Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spruce Spru
ce Spruce
     2      2      2      2      2      2      2      2      2      2      2      2
 2      2
Spruce Spruce  Aspen Spruce  Aspen  Aspen  Aspen
     2      2      1      2      1      1      1
```

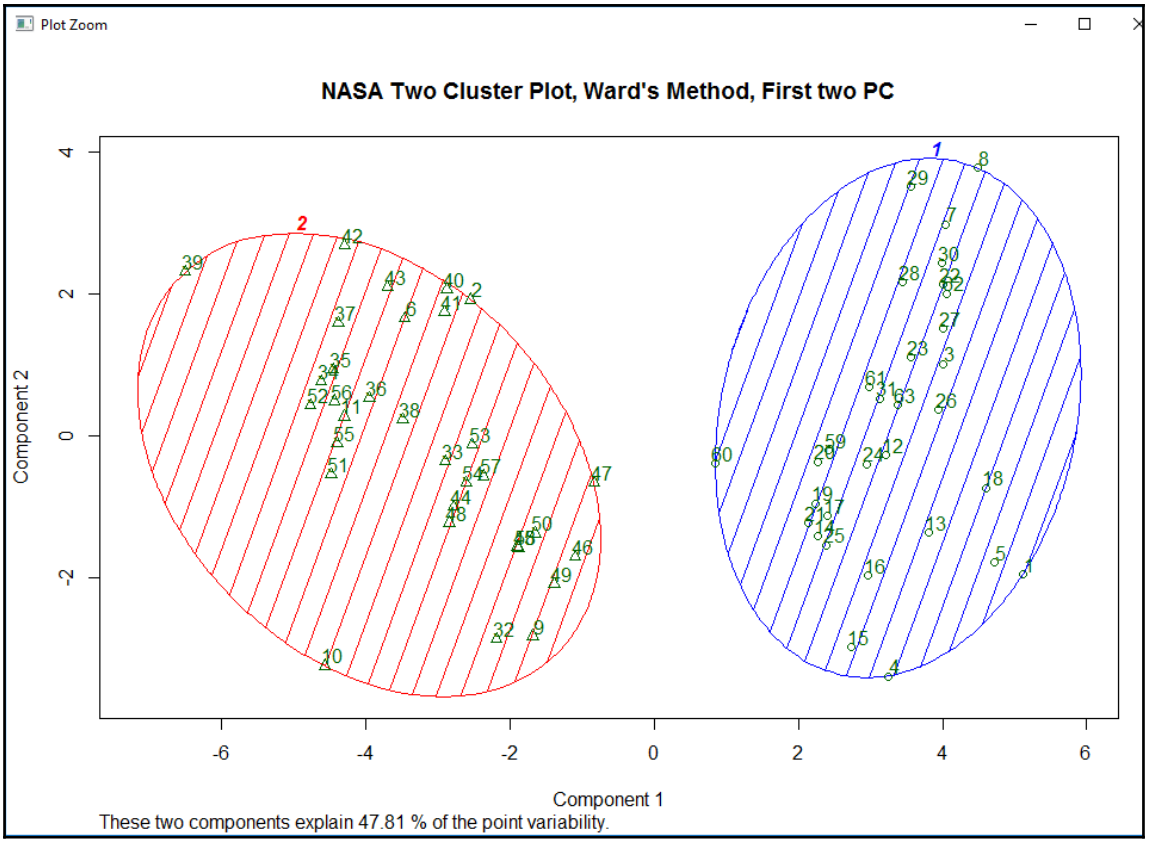
```
Call:
hclust(d = dist1, method = "ward.D")

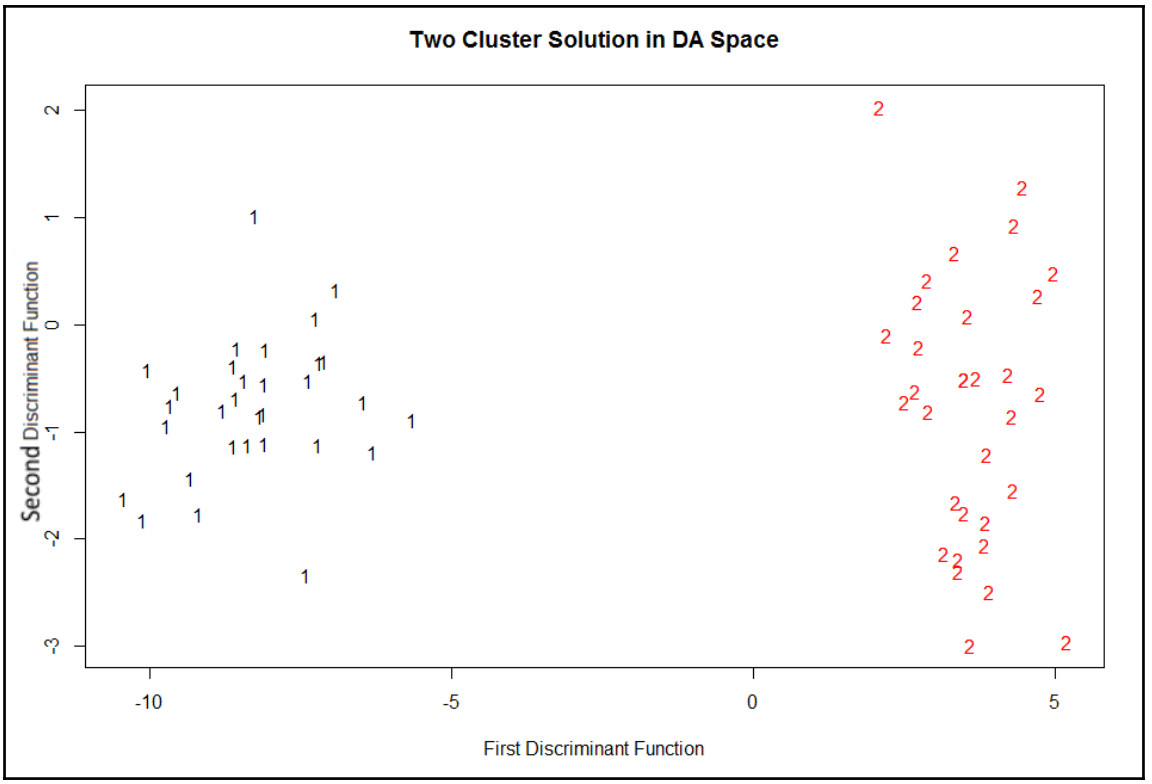
Cluster method   : ward.D
Distance         : jaccard
Number of objects: 63
```





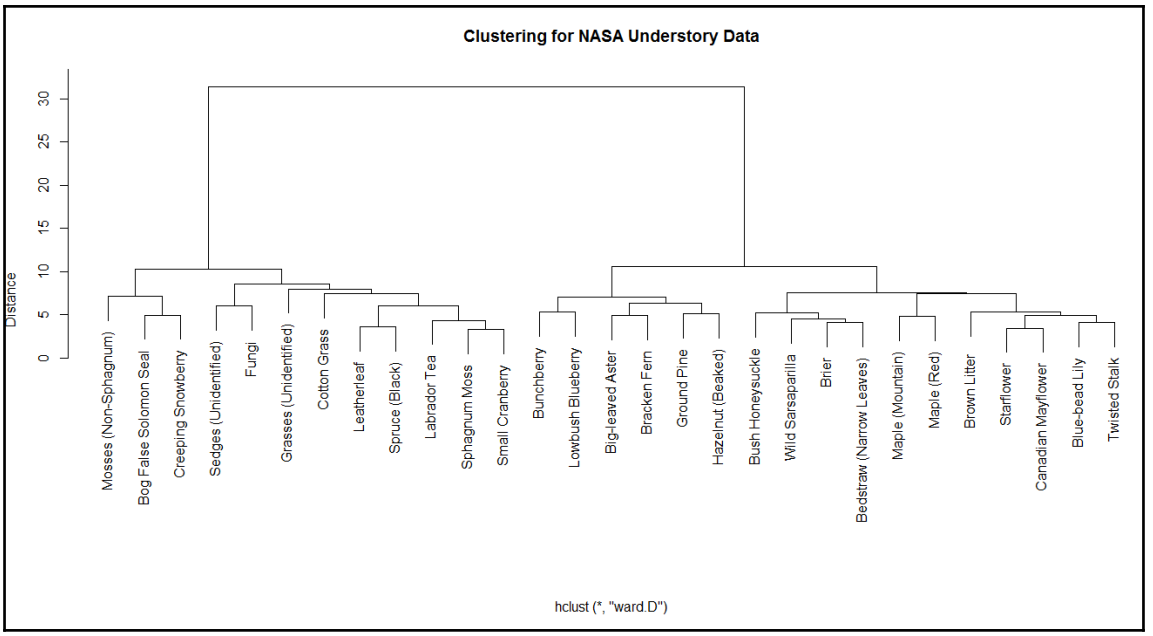

```
 [1] 1 2 1 1 1 2 1 1 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2
[47] 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1
```

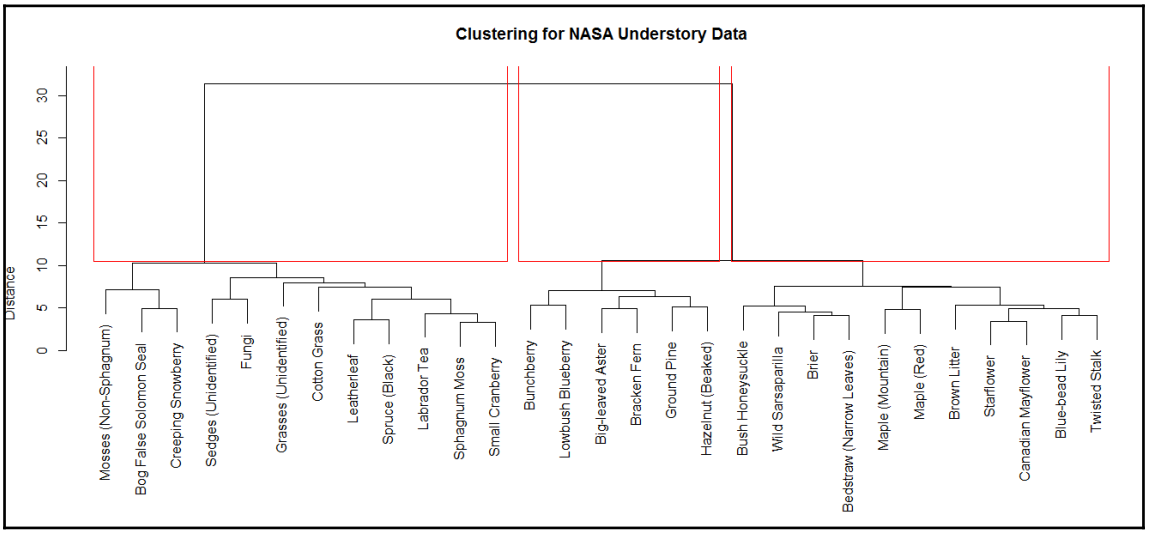

Plot Zoom
NASA Two Cluster Plot, Ward's Method, First two PC
Component 2
Component 1
These two components explain 47.81 % of the point variability.




```
Call:
hclust(d = dist1, method = "ward.D")

Cluster method   : ward.D
Distance         : minkowski
Number of objects: 29
```






```
SPHA BLIT ASMA MOSS LEGR CHCA GRAS SEDG SMTR PTAQ COCA VAAN GAHI ARNU LYOB PIMA RUBU VAOX ACSP COCO ACRU TRBO MACA CLBO
   1    2    3    1    1    1    1    1    1    3    3    3    1    2    3    1    2    1    2    3    2    2    2    2
STRO FUNG DILO ERIO GATR
   2    1    2    1    2
```

```
'data.frame':   29949 obs. of  39 variables:
```

```
'data.frame':   39 obs. of  4 variables:
 $ sidChar : Factor w/ 39 levels "Sample_1","Sample_10",..: 13 14 15 16 8 9 36 17 18 19 ...
 $ sidNum  : int  20 21 22 23 16 17 6 24 25 26 ...
 $ devStage: Factor w/ 5 levels "4_weeks","E16",..: 2 2 2 2 2 2 2 4 4 4 ...
 $ gType   : Factor w/ 2 levels "NrlKO","wt": 2 2 2 2 1 1 1 2 2 2 ...
```

```
 num [1:29949, 1:39] 0.0838 0.1758 0.7797 -0.3196 0.8358 ...
```

	avgBefore	avgAfter	varBefore	varAfter
1	7.22	0	0.02	1
2	9.37	0	0.35	1
3	9.70	0	0.15	1
4	8.42	0	0.03	1
5	8.47	0	0.02	1
6	9.67	0	0.03	1

```
NrlKO.4_weeks     wt.4_weeks      NrlKO.E16         wt.E16      NrlKO.P10         wt.P10      NrlKO.P2          wt.P2      NrlKO.P6 
            4              4              3              4              4              4              4              4 
        wt.P6 
            4 
```

```
Call:
hclust(d = pair_dist_GSE4051_data, method = "single")

Cluster method   : single
Distance         : euclidean
Number of objects: 39
```

```
Call:
hclust(d = pair_dist_GSE4051_data, method = "complete")

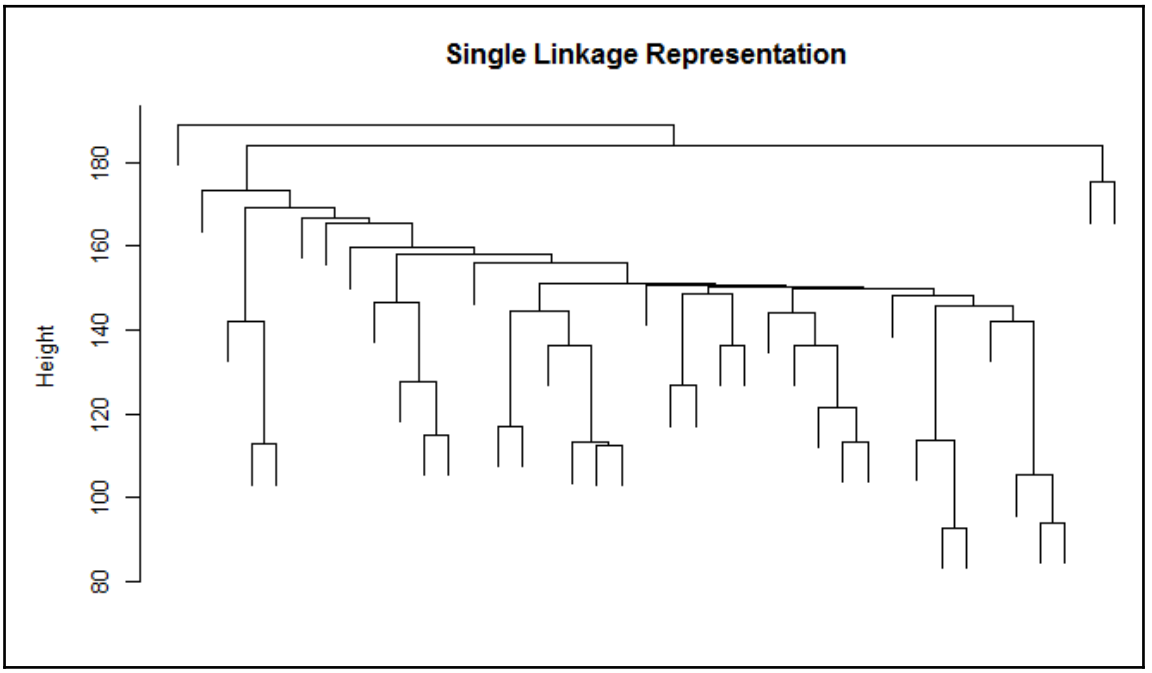
Cluster method   : complete
Distance         : euclidean
Number of objects: 39
```

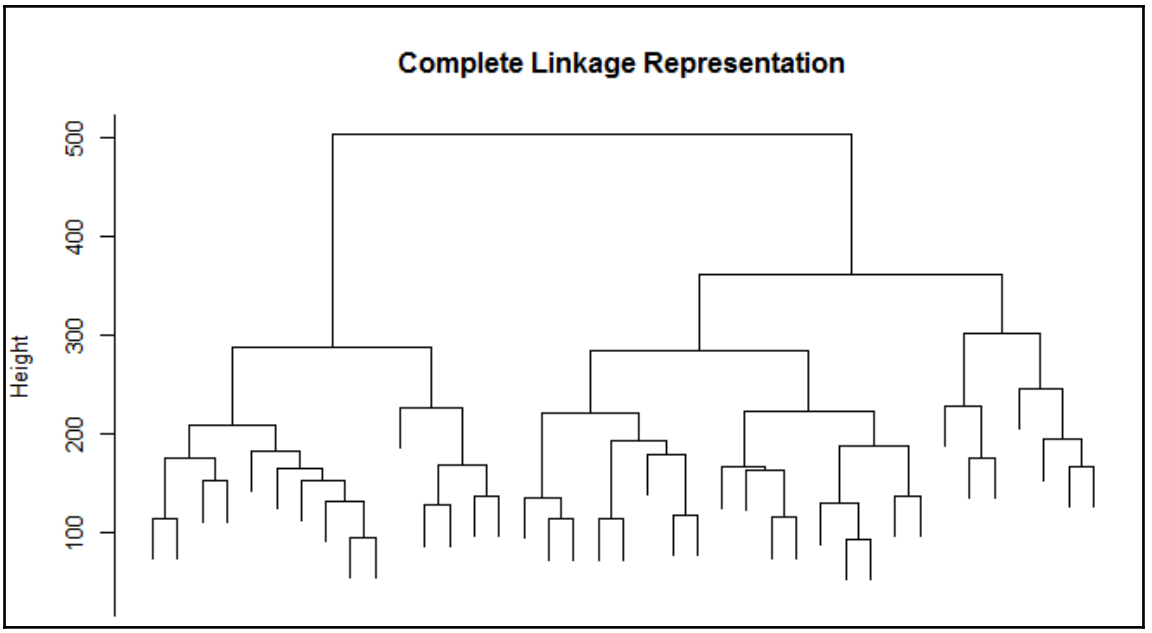
```
Call:
hclust(d = pair_dist_GSE4051_data, method = "average")

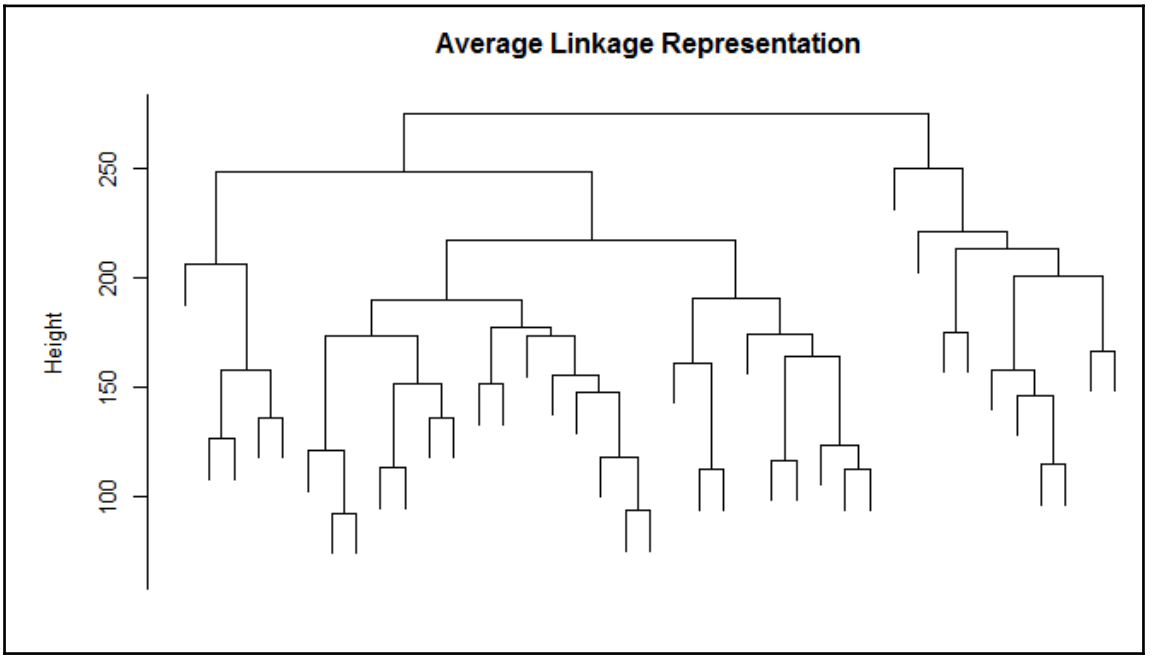
Cluster method   : average
Distance         : euclidean
Number of objects: 39
```

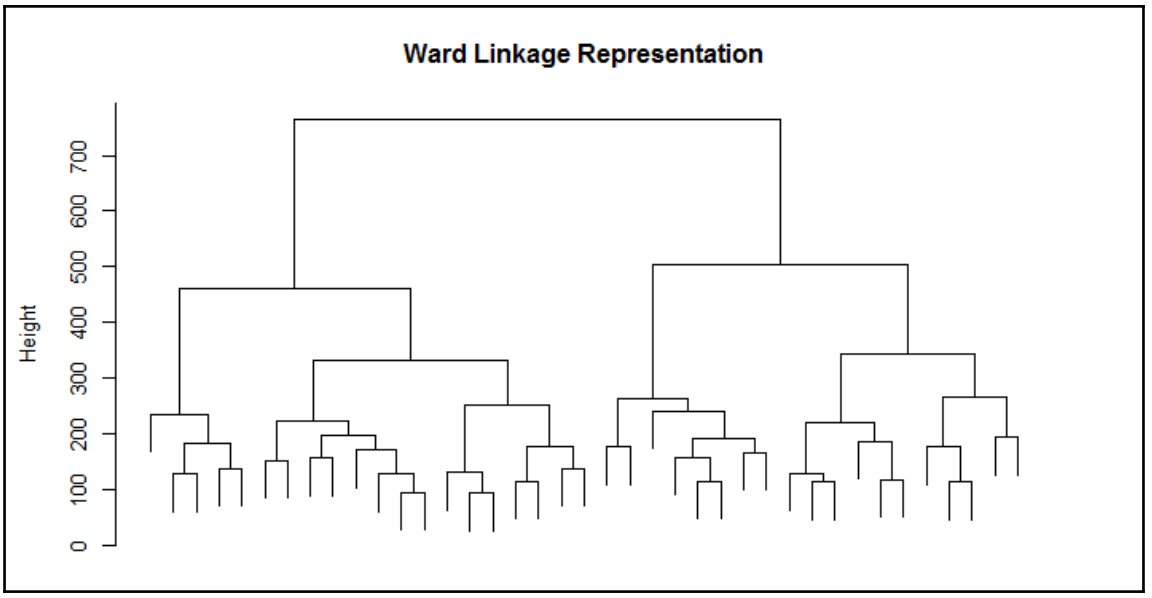
```
Call:
hclust(d = pair_dist_GSE4051_data, method = "ward.D2")

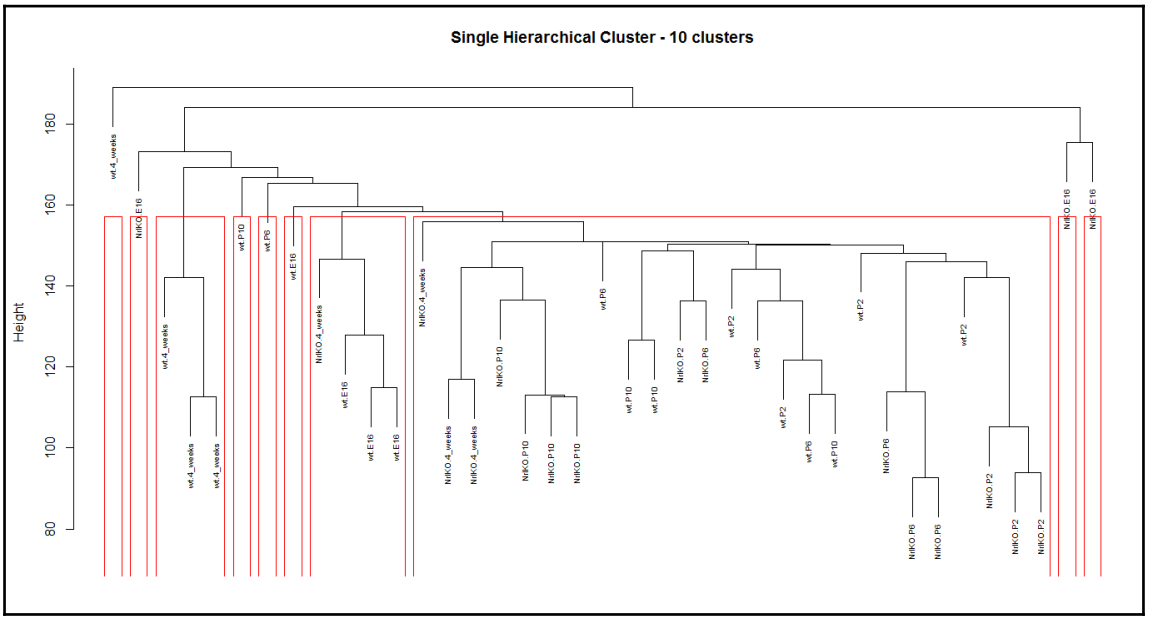
Cluster method   : ward.D2
Distance         : euclidean
Number of objects: 39
```

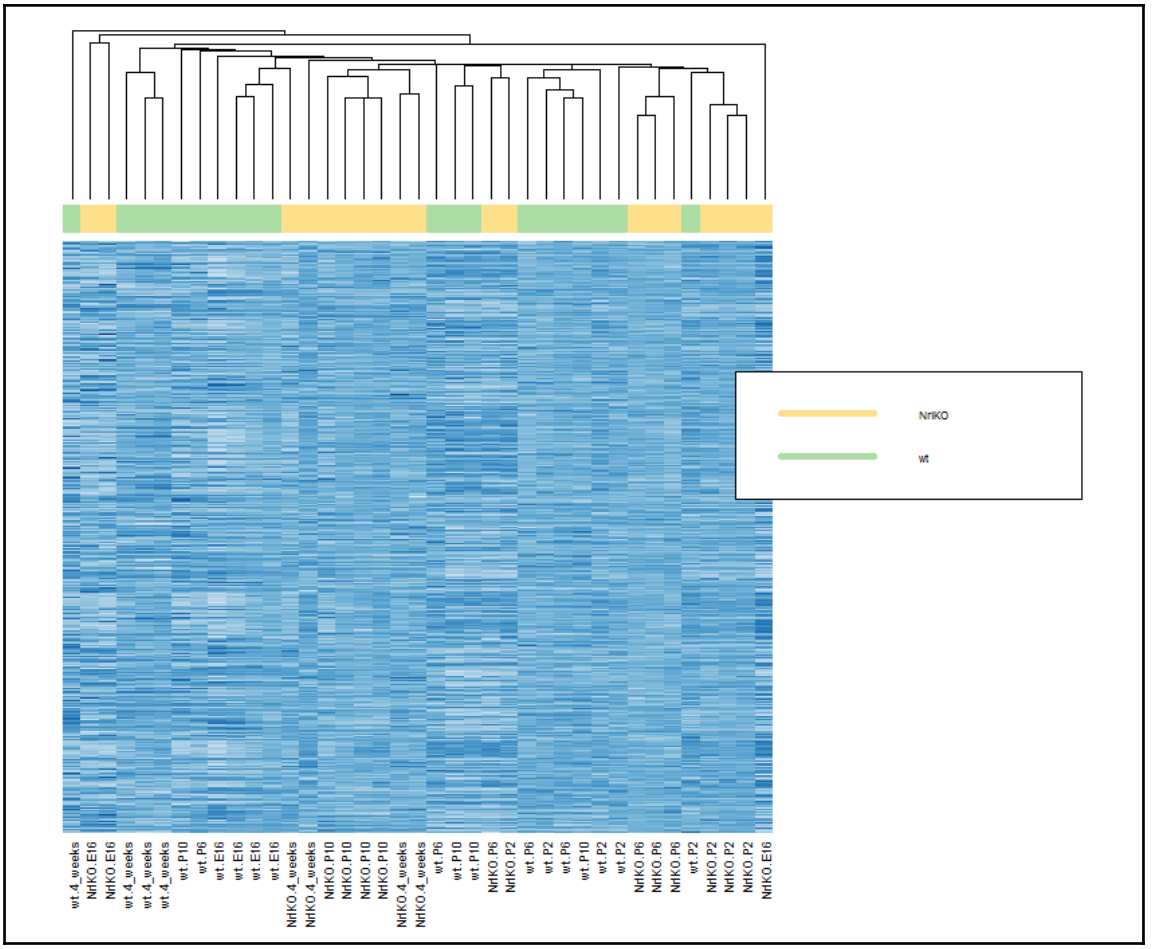


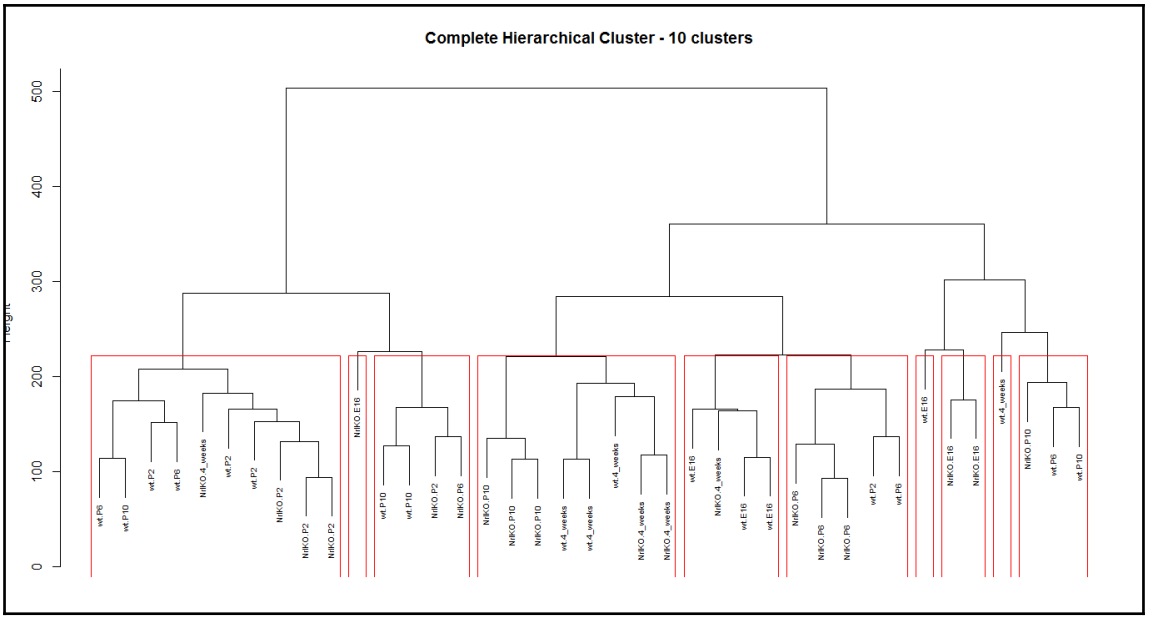

Complete Linkage Representation
Height
100
200
300
400
500

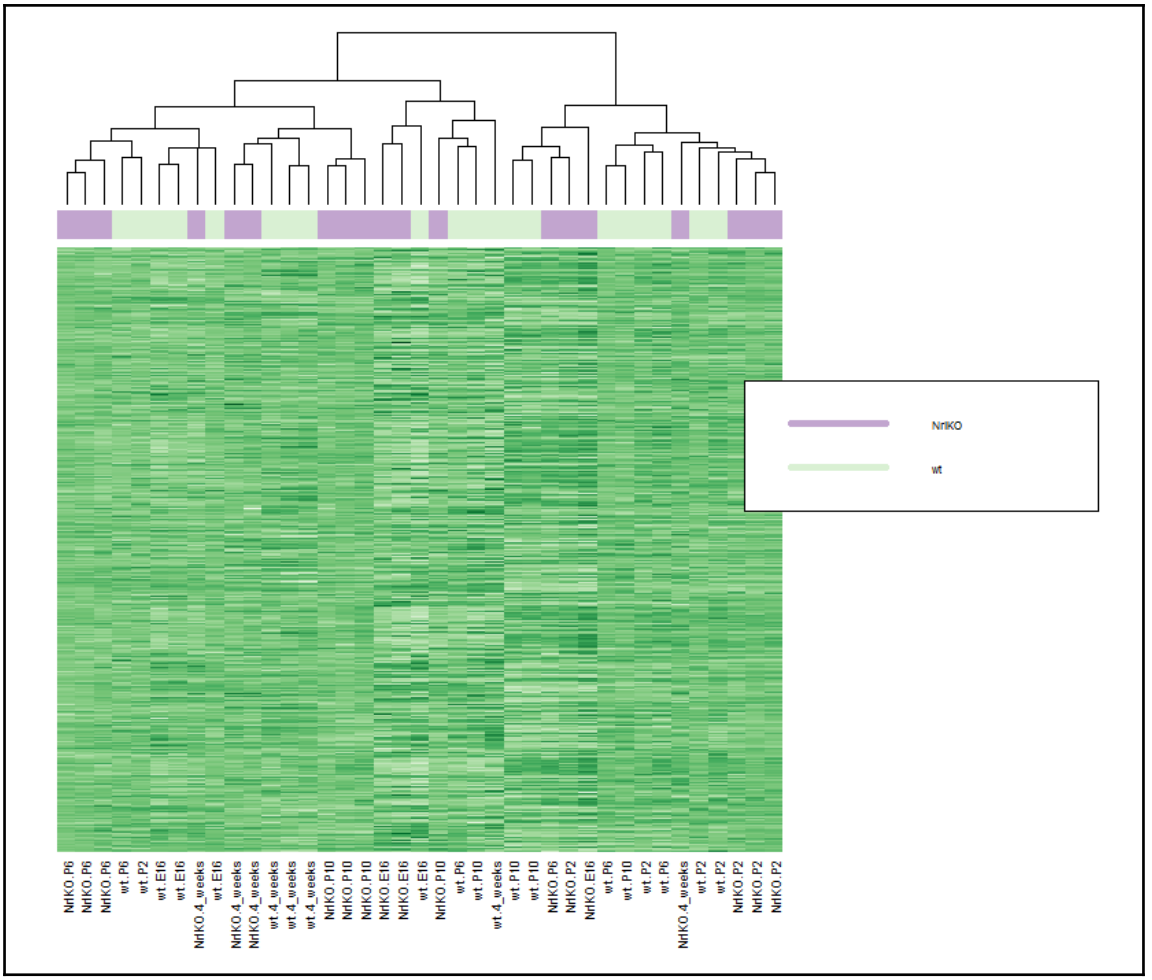

Average Linkage Representation
Height
100
150
200
250

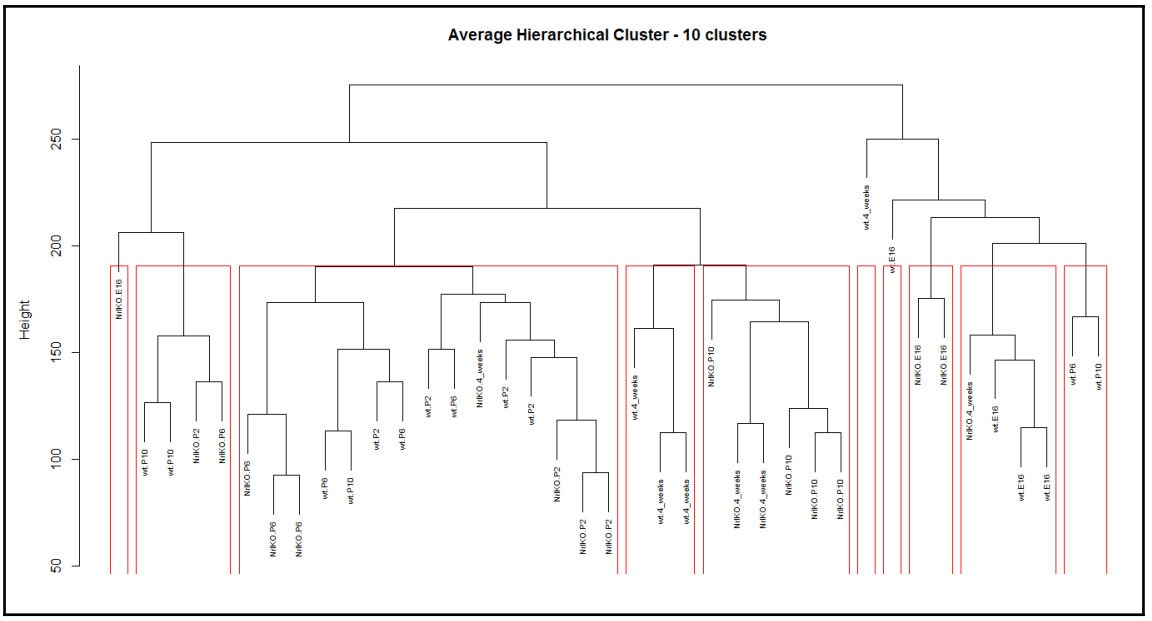

Ward Linkage Representation
Height
0
100
200
300
400
500
600
700

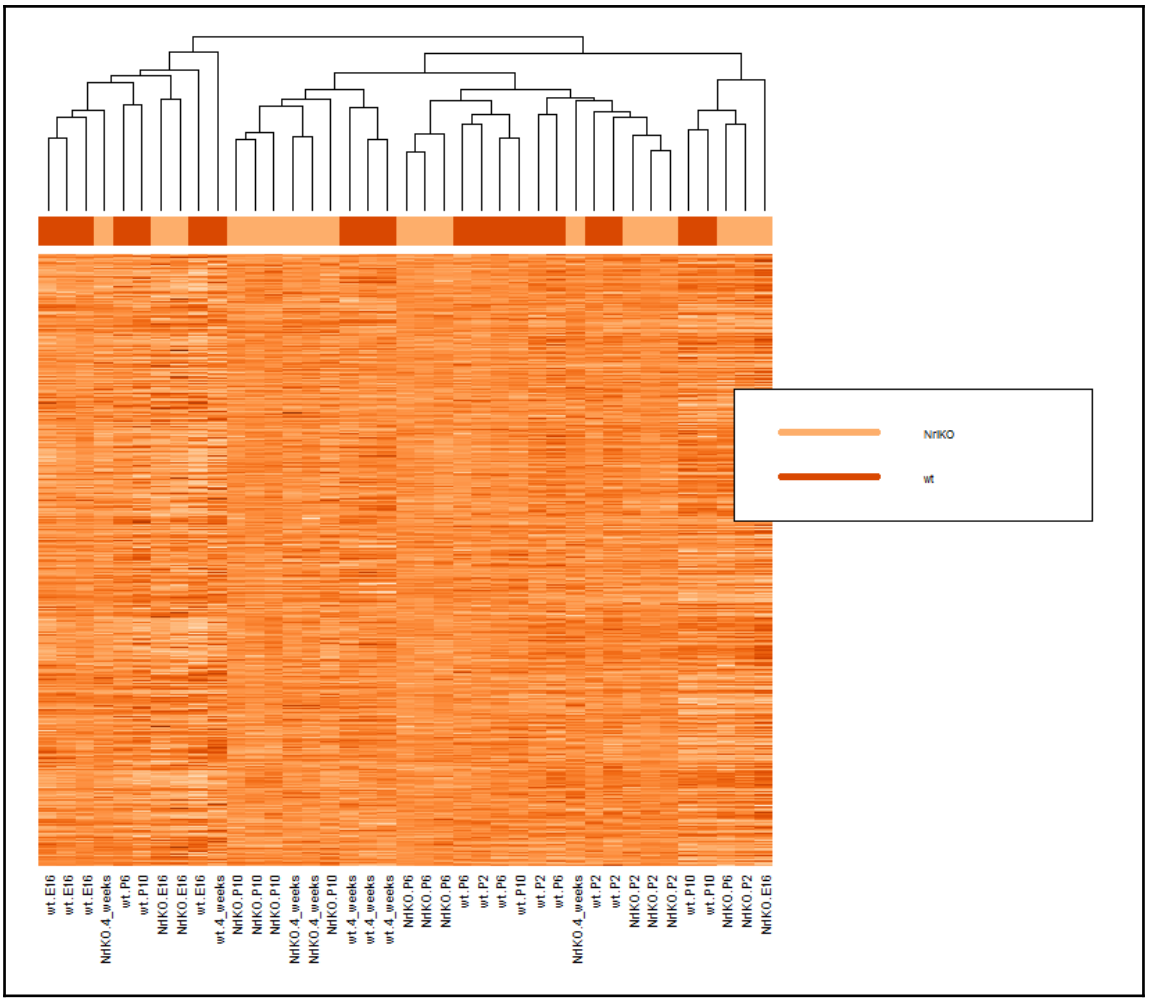

Single Hierarchical Cluster - 10 clusters
Height
80
100
120
140
160
180
wt.4_weeks
NitKO.E16
wt.P10
wt.P6
wt.E16
NitKO.4_weeks
NitKO.P10
wt.P6
wt.P2
NitKO.P2
NitKO.P6

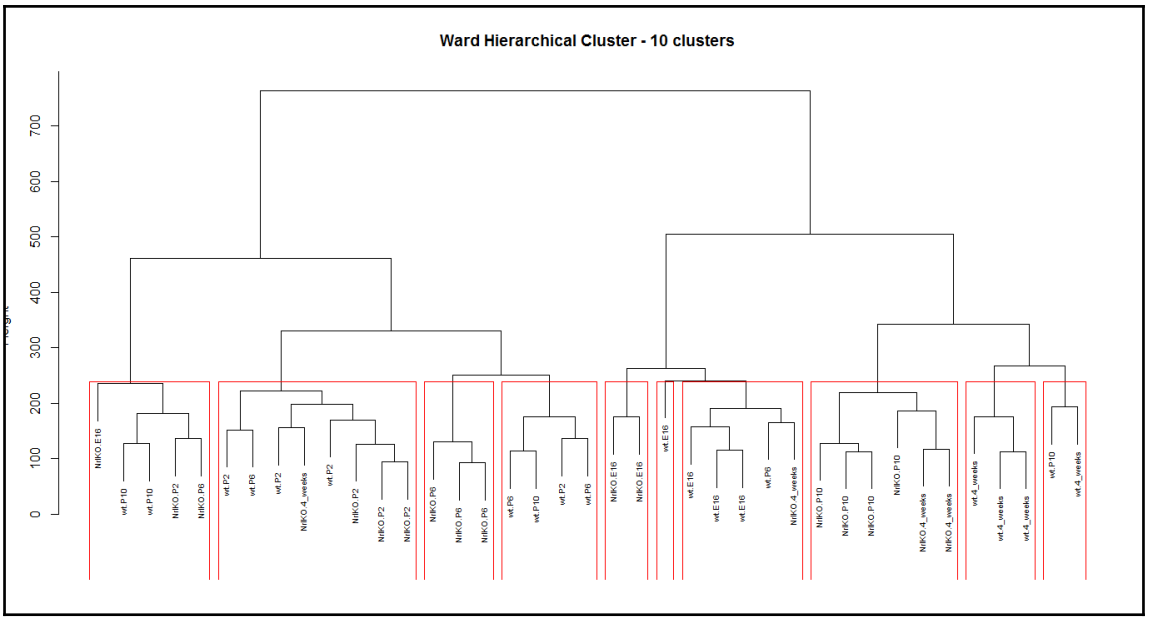

wt_4_weeks
NrlKO_E16
NrlKO_E16
wt_4_weeks
wt_4_weeks
wt_4_weeks
wt_P10
wt_P6
wt_E16
wt_E16
wt_E16
wt_E16
NrlKO_4_weeks
NrlKO_4_weeks
NrlKO_P10
NrlKO_P10
NrlKO_P10
NrlKO_P10
NrlKO_4_weeks
NrlKO_4_weeks
wt_P6
wt_P10
wt_P10
NrlKO_P6
NrlKO_P2
wt_P6
wt_P2
wt_P6
wt_P10
wt_P2
wt_P2
NrlKO_P6
NrlKO_P6
NrlKO_P6
wt_P2
NrlKO_P2
NrlKO_P2
NrlKO_P2
NrlKO_E16
NrlKO
wt

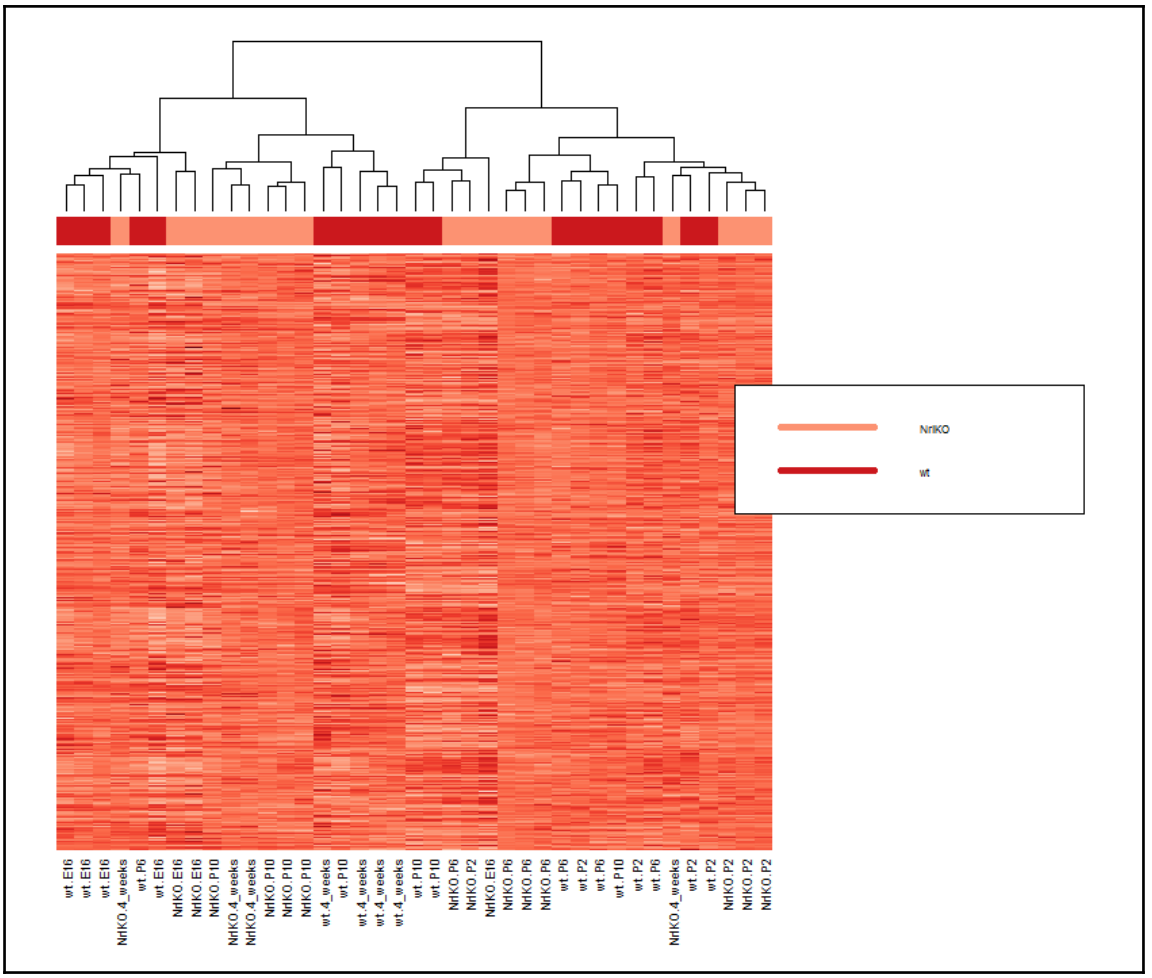

Complete Hierarchical Cluster - 10 clusters
Height
0
100
200
300
400
500
wt.P6
wt.P10
wt.P2
wt.P6
NdKO.4_weeks
wt.P2
wt.P2
NdKO.P2
NdKO.P2
NdKO.P2
NdKO.E16
wt.P10
wt.P10
NdKO.P2
NdKO.P6
NdKO.P10
NdKO.P10
NdKO.P10
wt.4_weeks
wt.4_weeks
wt.4_weeks
NdKO.4_weeks
NdKO.4_weeks
wt.E16
NdKO.4_weeks
wt.E16
wt.E16
NdKO.P6
NdKO.P6
NdKO.P6
wt.P2
wt.P6
wt.E16
NdKO.E16
NdKO.E16
wt.4_weeks
NdKO.P10
wt.P6
wt.P10


NrlKO
wt
NrlKO.P6
NrlKO.P6
NrlKO.P6
wt.P6
wt.P2
wt.E16
wt.E16
NrlKO.4_weeks
wt.E16
NrlKO.4_weeks
NrlKO.4_weeks
wt.4_weeks
wt.4_weeks
wt.4_weeks
NrlKO.P10
NrlKO.P10
NrlKO.P10
NrlKO.E16
NrlKO.E16
wt.E16
NrlKO.P10
wt.P6
wt.P10
wt.4_weeks
wt.P10
wt.P10
NrlKO.P6
NrlKO.P2
NrlKO.E16
wt.P6
wt.P10
wt.P2
wt.P6
NrlKO.4_weeks
wt.P2
wt.P2
NrlKO.P2
NrlKO.P2
NrlKO.P2


Average Hierarchical Cluster - 10 clusters
Height
50
100
150
200
250
NiKO.E16
wt.P10
wt.P10
NiKO.P2
NiKO.P6
NiKO.P6
NiKO.P6
NiKO.P6
wt.P6
wt.P10
wt.P2
wt.P6
wt.P2
wt.P6
NiKO.4_weeks
wt.P2
wt.P2
NiKO.P2
NiKO.P2
NiKO.P2
wt.4_weeks
wt.4_weeks
wt.4_weeks
NiKO.P10
NiKO.4_weeks
NiKO.4_weeks
NiKO.P10
NiKO.P10
NiKO.P10
wt.4_weeks
wt.E16
NiKO.E16
NiKO.E16
NiKO.4_weeks
wt.E16
wt.E16
wt.E16
wt.P6
wt.P10


NrlKO
wt
wt.E16
wt.E16
wt.E16
NrlKO.4_weeks
wt.P6
wt.P10
NrlKO.E16
NrlKO.E16
wt.E16
wt.4_weeks
NrlKO.P10
NrlKO.P10
NrlKO.P10
NrlKO.4_weeks
NrlKO.4_weeks
NrlKO.P10
wt.4_weeks
wt.4_weeks
wt.4_weeks
NrlKO.P6
NrlKO.P6
NrlKO.P6
wt.P6
wt.P2
wt.P6
wt.P10
wt.P2
wt.P6
NrlKO.4_weeks
wt.P2
wt.P2
NrlKO.P2
NrlKO.P2
NrlKO.P2
wt.P10
wt.P10
NrlKO.P6
NrlKO.P2
NrlKO.E16


Ward Hierarchical Cluster - 10 clusters
Height
0
100
200
300
400
500
600
700
NdKO.E16
wt.P10
wt.P10
NdKO.P2
NdKO.P6
wt.P2
wt.P6
wt.P2
NdKO.4_weeks
wt.P2
NdKO.P2
NdKO.P2
NdKO.P6
NdKO.P6
NdKO.P6
wt.P6
wt.P10
wt.P2
wt.P6
NdKO.E16
NdKO.E16
wt.E16
wt.E16
wt.E16
wt.E16
wt.P6
NdKO.4_weeks
NdKO.P10
NdKO.P10
NdKO.P10
NdKO.4_weeks
NdKO.4_weeks
wt.4_weeks
wt.4_weeks
wt.4_weeks
wt.P10
wt.4_weeks


NrlKO
wt
wt.E16
wt.E16
wt.E16
NrlKO.4_weeks
wt.P6
wt.E16
NrlKO.E16
NrlKO.E16
NrlKO.P10
NrlKO.4_weeks
NrlKO.4_weeks
NrlKO.P10
NrlKO.P10
NrlKO.P10
wt.4_weeks
wt.P10
wt.4_weeks
wt.4_weeks
wt.4_weeks
wt.P10
wt.P10
NrlKO.P6
NrlKO.P2
NrlKO.E16
NrlKO.P6
NrlKO.P6
NrlKO.P6
wt.P6
wt.P2
wt.P6
wt.P10
wt.P2
wt.P6
NrlKO.4_weeks
wt.P2
wt.P2
wt.P2
NrlKO.P2
NrlKO.P2
NrlKO.P2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
2	16																																								
3	17	17																																							
4	26	22	19																																						
5	17	9	12	19																																					
6	13	13	14	23	16																																				
7	16	16	17	18	21	15																																			
8	18	22	15	22	19	19	20																																		
9	19	15	14	23	14	10	17	21																																	
10	24	24	25	20	25	23	20	20	23																																
11	23	25	16	19	22	14	21	17	20	23																															
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13	25	19	14	17	16	20	21	21	20	21	18	25																													
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16	25	15	22	21	20	22	15	25	20	23	26	23	22	20	23																										
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36	30	26	25	24	23	27	26	18	29	24	23	22	17	33	22	25	20	22	27	22	26	22	27	28	25	28	17	23	18	22	28	24	25	25	21						
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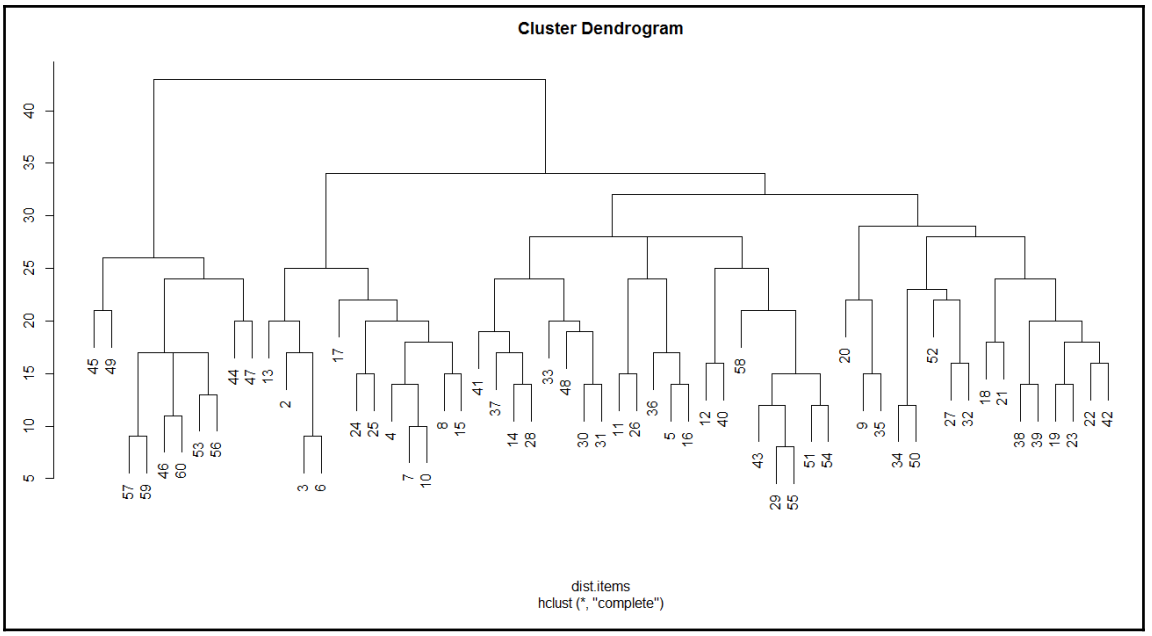
2	0.3018868						
3	0.3333333	0.3333333					
4	0.4814815	0.4230769	0.3958333				
5	0.3207547	0.1836735	0.2500000	0.3800000			
6	0.2549020	0.2549020	0.2857143	0.4423077	0.3076923		
7	0.3200000	0.3200000	0.3541667	0.3829787	0.4038462	0.3061224	
8	0.3829787	0.4489796	0.3488372	0.4888889	0.4042553	0.4042553	0.4444444
9	0.3725490	0.3061224	0.3043478	0.4693878	0.2916667	0.2173913	0.3617021
10	0.4800000	0.4800000	0.5208333	0.4545455	0.5000000	0.4693878	0.4444444
11	0.4600000	0.4901961	0.3636364	0.4318182	0.4489796	0.3111111	0.4565217
12	0.4081633	0.3750000	0.4468085	0.5416667	0.3958333	0.3260870	0.3636364
13	0.4807692	0.3877551	0.3181818	0.3863636	0.3404255	0.4081633	0.4468085
14	0.3400000	0.3400000	0.3404255	0.4375000	0.3600000	0.3265306	0.3260870
15	0.4400000	0.4400000	0.4130435	0.3333333	0.3958333	0.4285714	0.4680851
16	0.4716981	0.3125000	0.4489796	0.4468085	0.4000000	0.4313725	0.3333333
17	0.5882353	0.5306122	0.4047619	0.5777778	0.4893617	0.5208333	0.6530612
18	0.5714286	0.5416667	0.4883721	0.5238095	0.5000000	0.5319149	0.5454545
19	0.6078431	0.5510204	0.5000000	0.5348837	0.4782609	0.5106383	0.5555556
20	0.4166667	0.4489796	0.3863636	0.5531915	0.3695652	0.5000000	0.5416667
21	0.5714286	0.5416667	0.4883721	0.4878049	0.4666667	0.6200000	0.5777778
22	0.3829787	0.3829787	0.4222222	0.4888889	0.4375000	0.3695652	0.4444444
23	0.4509804	0.3541667	0.3181818	0.4222222	0.4081633	0.3404255	0.4130435
24	0.3846154	0.3200000	0.3541667	0.3829787	0.3400000	0.3400000	0.3404255
25	0.5686275	0.5102041	0.4888889	0.5227273	0.4680851	0.5000000	0.5744681
26	0.4255319	0.4255319	0.4666667	0.5333333	0.4468085	0.4791667	0.4545455
27	0.6078431	0.5510204	0.4285714	0.4250000	0.4782609	0.5416667	0.5555556
28	0.5208333	0.5208333	0.3500000	0.4634146	0.4782609	0.4782609	0.4523810
29	0.5833333	0.6666667	0.5681818	0.5714286	0.6326531	0.5434783	0.6222222
30	0.5000000	0.5000000	0.4772727	0.5454545	0.5208333	0.4222222	0.4651163
31	0.4583333	0.4583333	0.5000000	0.5957447	0.4791667	0.4468085	0.5217391
32	0.5416667	0.6000000	0.5555556	0.5581395	0.5625000	0.5625000	0.6666667
33	0.4375000	0.4693878	0.4444444	0.5434783	0.4897959	0.4255319	0.4318182
34	0.3958333	0.4600000	0.3636364	0.5319149	0.4166667	0.4166667	0.4893617
35	0.4285714	0.4901961	0.4000000	0.3953488	0.4166667	0.4489796	0.4565217
36	0.6000000	0.5416667	0.5555556	0.5581395	0.5000000	0.5625000	0.5777778

	1	2	3	4	5	6	7	8	9	10
2	0.8888889									
3	0.8095238	0.8095238								
4	0.9629630	0.8800000	0.7307692							
5	0.8947368	0.6000000	0.6315789	0.7916667						
6	0.7647059	0.7647059	0.7000000	0.8846154	0.8421053					
7	0.7619048	0.7619048	0.7083333	0.6923077	0.8750000	0.7142857				
8	0.6923077	0.7857143	0.5555556	0.6875000	0.7037037	0.7037037	0.6666667			
9	0.8260870	0.7142857	0.6086957	0.7931034	0.6666667	0.5263158	0.6800000	0.6774194		
10	0.8275862	0.8275862	0.7812500	0.6451613	0.8333333	0.7931034	0.6666667	0.5882353	0.7187500	
11	0.8214286	0.8620690	0.5925926	0.6333333	0.7857143	0.5833333	0.7000000	0.5312500	0.6666667	0.6571429
12	0.7692308	0.7200000	0.7241379	0.7878788	0.7307692	0.6250000	0.5925926	0.5161290	0.6551724	0.5625000
13	0.8928571	0.7600000	0.5600000	0.6071429	0.6666667	0.7692308	0.7241379	0.6363636	0.6896552	0.6363636
14	0.7727273	0.7727273	0.6666667	0.7500000	0.7826087	0.7272727	0.6250000	0.6333333	0.6923077	0.7941176
15	0.8148148	0.8148148	0.6785714	0.5185185	0.7307692	0.7777778	0.7333333	0.6060606	0.7419355	0.5625000
16	0.9259259	0.6818182	0.7857143	0.7241379	0.8000000	0.8461538	0.6000000	0.7352941	0.7142857	0.6969697
17	0.8823529	0.8125000	0.5666667	0.7222222	0.7419355	0.7812500	0.8421053	0.5945946	0.6363636	0.7317073
18	0.8235294	0.7878788	0.6363636	0.6285714	0.7187500	0.7575758	0.6857143	0.5405405	0.7297297	0.6500000
19	0.8857143	0.8181818	0.6666667	0.6571429	0.7096774	0.7500000	0.7142857	0.5675676	0.6470588	0.5675676
20	0.7407407	0.7857143	0.6071429	0.7647059	0.6538462	0.8333333	0.7878788	0.5000000	0.7187500	0.7368421
21	0.8235294	0.7878788	0.6363636	0.5882353	0.6774194	0.8611111	0.7222222	0.5000000	0.6944444	0.5789474
22	0.6923077	0.6923077	0.6551724	0.6875000	0.7500000	0.6538462	0.6666667	0.5454545	0.6774194	0.6285714
23	0.8518519	0.7083333	0.5600000	0.6551724	0.7692308	0.6666667	0.6785714	0.5937500	0.6428571	0.6363636
24	0.8695652	0.7619048	0.7083333	0.6923077	0.7727273	0.7727273	0.6666667	0.7096774	0.6800000	0.7878788
25	0.8787879	0.8064516	0.6875000	0.6764706	0.7333333	0.7741935	0.7714286	0.5833333	0.6666667	0.4545455
26	0.7142857	0.7142857	0.6774194	0.7058824	0.7241379	0.7666667	0.6451613	0.5714286	0.6562500	0.6111111
27	0.8857143	0.8181818	0.5806452	0.5312500	0.7096774	0.7878788	0.7142857	0.5277778	0.5625000	0.5675676
28	0.7812500	0.7812500	0.4827586	0.5757576	0.7096774	0.7096774	0.5937500	0.4857143	0.5625000	0.5675676
29	0.8000000	0.8947368	0.6944444	0.6486486	0.8378378	0.7352941	0.7368421	0.5263158	0.6756757	0.6666667
30	0.7741935	0.7741935	0.6562500	0.6857143	0.7812500	0.6551724	0.6250000	0.4705882	0.6363636	0.6315789
31	0.7586207	0.7586207	0.7187500	0.7777778	0.7666667	0.7241379	0.7272727	0.5714286	0.6969697	0.6111111
32	0.7878788	0.8571429	0.7142857	0.6666667	0.7941176	0.7941176	0.8205128	0.5000000	0.6944444	0.5000000
33	0.7500000	0.7931034	0.6666667	0.7352941	0.8000000	0.7142857	0.6333333	0.6000000	0.5517241	0.6000000
34	0.7307692	0.8214286	0.5925926	0.7575758	0.7407407	0.7407407	0.7419355	0.4838710	0.7500000	0.6944444
35	0.7777778	0.8620690	0.6428571	0.5862069	0.7407407	0.7857143	0.7000000	0.5312500	0.6666667	0.5757576
36	0.8571429	0.7878788	0.7142857	0.6666667	0.7187500	0.7941176	0.7222222	0.5000000	0.7631579	0.6153846

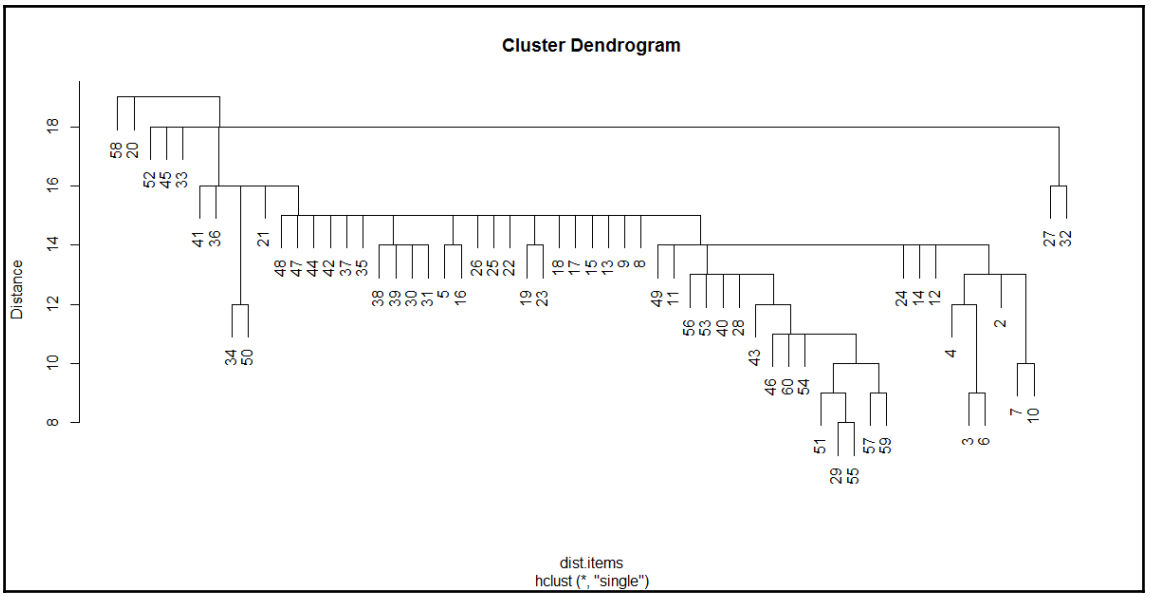
```
Call:
hclust(d = dist.items, method = "complete")

Cluster method   : complete
Distance         : euclidean
Number of objects: 59
```




```
Call:
hclust(d = dist.items, method = "single")

Cluster method   : single
Distance         : euclidean
Number of objects: 59
```




```
     my.k.choices avg.sil.width
[1,]            2    0.15613282
[2,]            3    0.09740046
[3,]            4    0.08061349
[4,]            5    0.07817696
[5,]            6    0.07483902
[6,]            7    0.07018717
[7,]            8    0.04567235
```

```
Medoids:
     ID
[1,]  3  3
[2,] 53 53
Clustering vector:
 [1] 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 1 2 2 1 2 1 1 1 2 2 2 2 2 2 2 2 1 1 2 2 1 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2
[58] 2 2
Objective function:
   build     swap
17.54237 16.98305

Available components:
[1] "medoids"    "id.med"     "clustering" "objective"  "isolation"  "clusinfo"   "silinfo"    "diss"

[9] "call"
```

```
[[1]]
 [1]  2  3  4  5  6  7  8  9 10 12 13 14 15 16 17 18 21 23 24 25 35 36 39

[[2]]
 [1] 11 19 20 22 26 27 28 29 30 31 32 33 34 37 38 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57
58 59 60
```

```
Medoids:
     ID
[1,]  6  6
[2,] 28 28
[3,] 56 56
Clustering vector:
 [1] 1 1 1 2 1 1 1 2 1 2 1 1 2 1 2 1 2 2 2 2 2 1 1 1 2 2 2 2 2 2 1 2 2 1 2 3 2 2 3 3 3 2 3 3 3 3 2 3 2 3
 3 3 3 2 3 3 2
[58] 3 3
Objective function:
   build     swap
15.81356 15.81356

Available components:
[1] "medoids"    "id.med"     "clustering" "objective"  "isolation"  "clusinfo"   "silinfo"    "diss"

[9] "call"
```

```
[[1]]
 [1]  2  3  4  6  7  8 10 12 13 15 17 23 24 25 32 35

[[2]]
 [1]  5  9 11 14 16 18 19 20 21 22 26 27 28 29 30 31 33 34 36 38 39 43 48 50 55 58

[[3]]
 [1] 37 40 41 42 44 45 46 47 49 51 52 53 54 56 57 59 60
```

	Country	RedMeat	WhiteMeat	Eggs	Milk	Fish	Cereals	Starch	Nuts	Fr.Veg
1	Albania	10.1	1.4	0.5	8.9	0.2	42.3	0.6	5.5	1.7
2	Austria	8.9	14.0	4.3	19.9	2.1	28.0	3.6	1.3	4.3
3	Belgium	13.5	9.3	4.1	17.5	4.5	26.6	5.7	2.1	4.0
4	Bulgaria	7.8	6.0	1.6	8.3	1.2	56.7	1.1	3.7	4.2
5	Czechoslovakia	9.7	11.4	2.8	12.5	2.0	34.3	5.0	1.1	4.0
6	Denmark	10.6	10.8	3.7	25.0	9.9	21.9	4.8	0.7	2.4

```
K-means clustering with 3 clusters of sizes 8, 12, 5

Cluster means:
  WhiteMeat   RedMeat
1 12.062500  8.837500
2  4.658333  8.258333
3  9.000000 15.180000

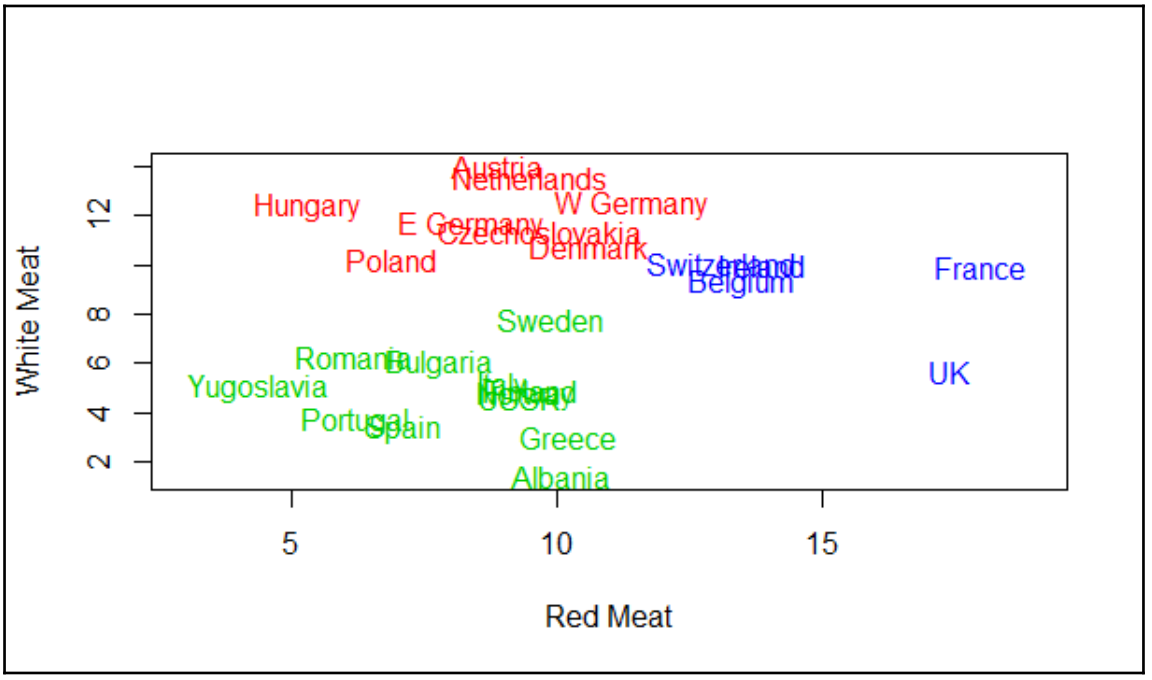
Clustering vector:
 [1] 2 1 3 2 1 1 1 2 3 2 1 3 2 1 2 1 2 2 2 2 3 3 2 1 2

Within cluster sum of squares by cluster:
[1] 39.45750 69.85833 35.66800
 (between_SS / total_SS =  75.7 %)

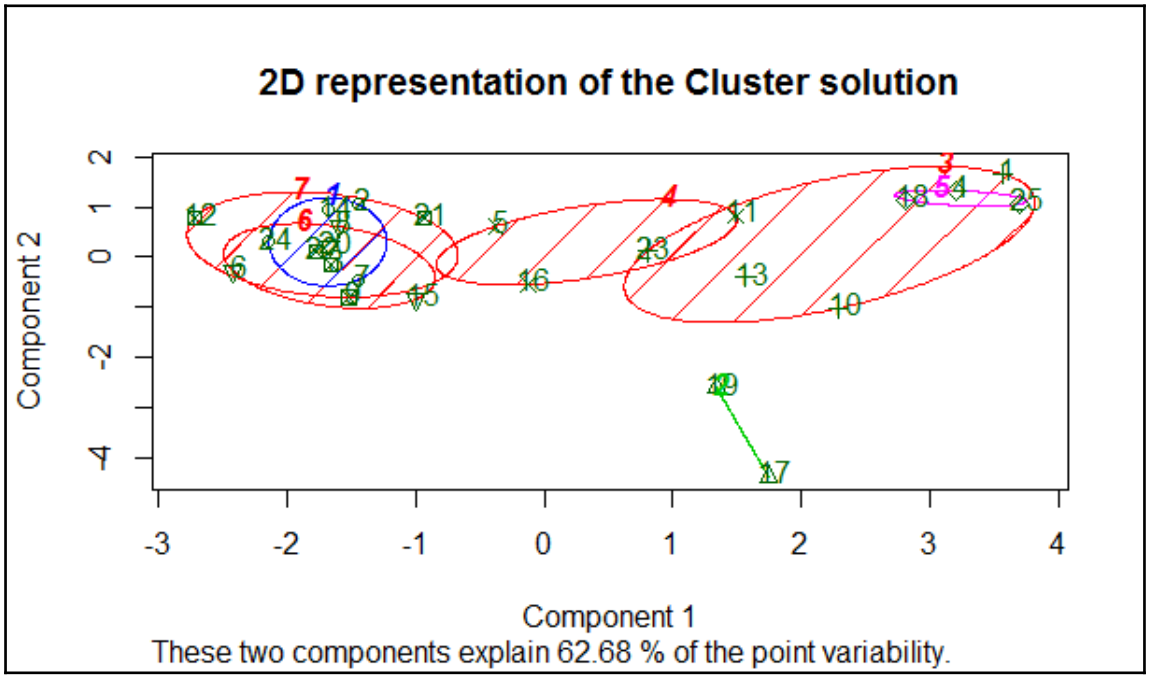
Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss" "betweens
s"
[7] "size"         "iter"         "ifault"
```

	protein.Country.o.	groupMeat.cluster.o.
1	Austria	1
2	Czechoslovakia	1
3	Denmark	1
4	E Germany	1
5	Hungary	1
6	Netherlands	1
7	Poland	1
8	W Germany	1
9	Albania	2
10	Bulgaria	2
11	Finland	2
12	Greece	2
13	Italy	2
14	Norway	2
15	Portugal	2
16	Romania	2
17	Spain	2
18	Sweden	2
19	USSR	2
20	Yugoslavia	2
21	Belgium	3
22	France	3
23	Ireland	3
24	Switzerland	3
25	UK	3



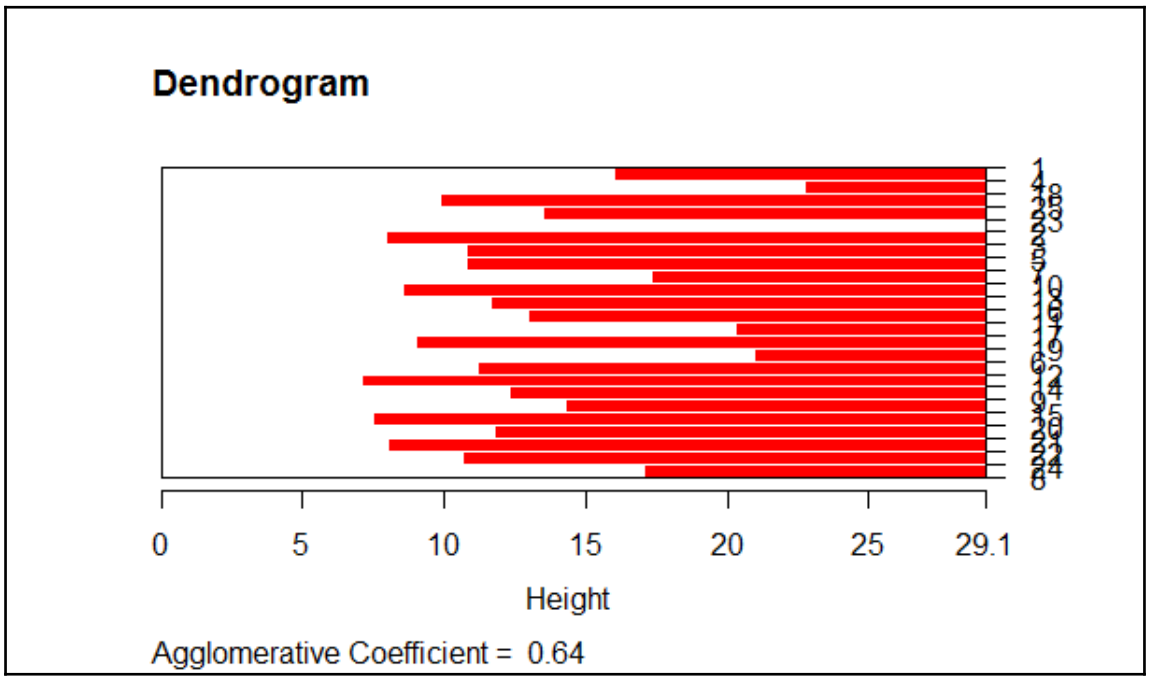
	protein.Country.o.	groupProtein.cluster.o.
1	Austria	1
2	E Germany	1
3	Netherlands	1
4	W Germany	1
5	Portugal	2
6	Spain	2
7	Albania	3
8	Greece	3
9	Italy	3
10	USSR	3
11	Czechoslovakia	4
12	Hungary	4
13	Poland	4
14	Bulgaria	5
15	Romania	5
16	Yugoslavia	5
17	Denmark	6
18	Finland	6
19	Norway	6
20	Sweden	6
21	Belgium	7
22	France	7
23	Ireland	7
24	Switzerland	7
25	UK	7

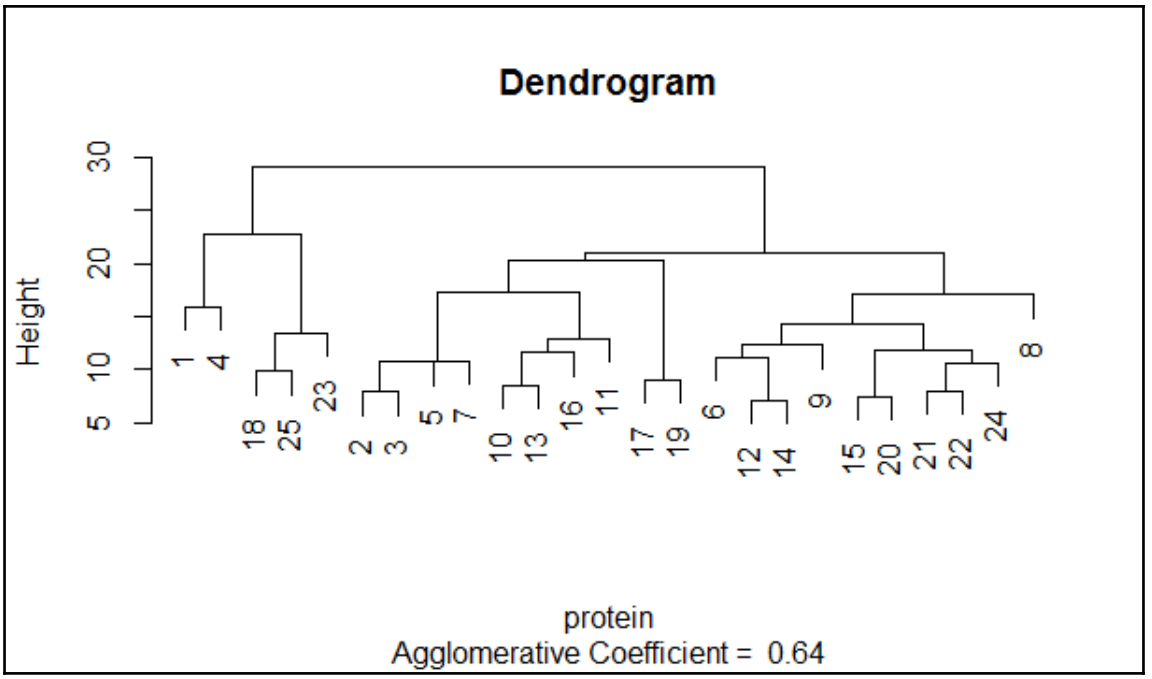


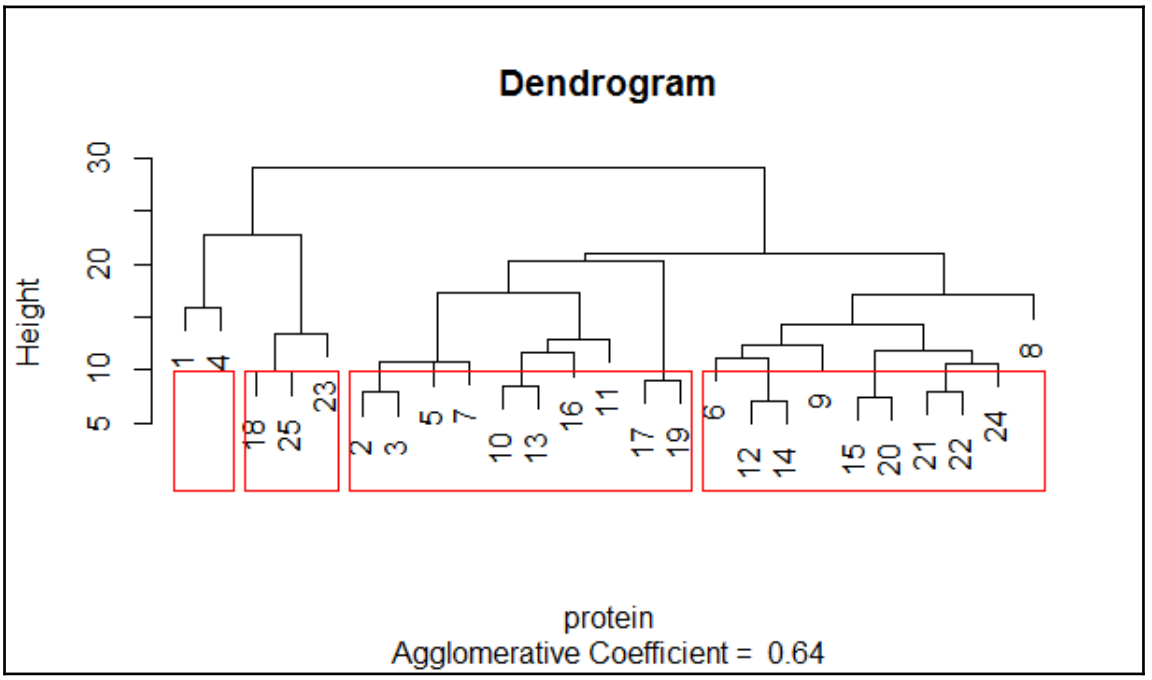
These two components explain 62.68 % of the point variability.

```
Call:    agnes(x = protein, diss = FALSE, metric = "euclidian")
Agglomerative coefficient:  0.6448106
Order of objects:
 [1]  1  4 18 25 23  2  3  5  7 10 13 16 11 17 19  6 12 14  9 15 20 21 22 24  8
Height (summary):
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  7.115   9.631  11.710  13.380  16.250  29.130

Available components:
[1] "order"  "height" "ac"     "merge"  "diss"   "call"   "method" "data"
```




Dendrogram
Height
30
20
10
5
1
4
18
25
23
2
3
5
7
10
13
16
11
17
19
6
12
14
9
15
20
21
22
24
8
protein
Agglomerative Coefficient = 0.64


Dendrogram
Height
30
20
10
5
1
4
18
25
23
2
3
5
7
10
13
16
11
17
19
6
12
14
9
15
20
21
22
24
8
protein
Agglomerative Coefficient = 0.64

```
  Food Energy Protein Fat Calcium Iron
1   BB    340      20  28       9  2.6
2   HR    245      21  17       9  2.7
3   BR    420      15  39       7  2.0
4   BS    375      19  32       9  2.5
5   BC    180      22  10      17  3.7
6   CB    115      20   3       8  1.4
```

```
'data.frame':   27 obs. of  6 variables:
 $ Food   : Factor w/ 27 levels "AC","AR","BB",..: 3 14 6 7 4 9 10 5 16 17 ...
 $ Energy : int  340 245 420 375 180 115 170 160 265 300 ...
 $ Protein: int  20 21 15 19 22 20 25 26 20 18 ...
 $ Fat    : int  28 17 39 32 10 3 7 5 20 25 ...
 $ Calcium: int  9 9 7 9 17 8 12 14 9 9 ...
 $ Iron   : num  2.6 2.7 2 2.5 3.7 1.4 1.5 5.9 2.6 2.3 ...
```

```
    Energy    Protein        Fat    Calcium       Iron
101.207806   4.251696  11.257033  78.034254   1.460857
```

```
       Energy  Protein        Fat    Calcium      Iron
1   3.3594247 4.704005 2.48733386 0.11533397 1.7797775
2   2.4207619 4.939205 1.51016699 0.11533397 1.8482304
3   4.1498775 3.528003 3.46450074 0.08970420 1.3690596
4   3.7052478 4.468804 2.84266727 0.11533397 1.7113245
5   1.7785189 5.174405 0.88833352 0.21785305 2.5327602
6   1.1362760 4.704005 0.26650006 0.10251908 0.9583417
7   1.6797123 5.880006 0.62183347 0.15377862 1.0267947
8   1.5809057 6.115206 0.44416676 0.17940839 4.0387258
9   2.6183751 4.704005 1.77666704 0.11533397 1.7797775
10 2.9641982 4.233604 2.22083381 0.11533397 1.5744185
11 3.3594247 4.704005 2.48733386 0.11533397 1.7113245
12 3.3594247 4.468804 2.57616721 0.11533397 1.7113245
13 3.5076346 4.468804 2.66500057 0.11533397 1.6428715
14 2.0255355 4.233604 1.24366693 0.08970420 1.7113245
15 1.8279223 5.409605 0.79950017 0.11533397 1.8482304
16 1.3338892 5.174405 0.35533341 0.32037213 0.4107179
17 0.6916463 2.587203 0.08883335 1.05082059 4.1071788
18 0.4446297 1.646402 0.08883335 0.94830150 3.6964609
19 0.8892595 3.292803 0.17766670 0.48696564 0.5476238
20 1.3338892 3.763204 0.44416676 0.19222328 0.3422649
21 1.9761322 4.468804 1.15483358 0.06407443 0.6845298
22 1.5315024 3.763204 0.79950017 2.01193697 1.2321536
23 1.9267289 3.763204 0.97716687 0.17940839 0.8898887
24 1.1856793 3.998404 0.44416676 2.03756674 0.4791709
25 1.7785189 5.174405 0.79950017 4.70306286 1.7113245
26 1.6797123 5.880006 0.62183347 0.08970420 0.8214358
27 1.0868727 5.409605 0.08883335 1.25585875 1.7797775
```

```
K-means clustering with 5 clusters of sizes 2, 8, 8, 8, 1

Cluster means:
    Energy  Protein        Fat   Calcium      Iron
1 0.568138 2.116802 0.08883335 0.9995610 3.9018198
2 1.414170 4.116004 0.57741679 0.6743833 0.6930864
3 1.759993 5.380205 0.77729183 0.2771219 1.9509099
4 3.377951 4.410004 2.56506304 0.1121302 1.6599848
5 1.778519 5.174405 0.79950017 4.7030629 1.7113245

Clustering vector:
 [1] 4 3 4 4 3 2 3 3 4 4 4 4 4 3 3 2 1 1 2 2 2 2 2 2 5 3 3

Within cluster sum of squares by cluster:
[1]  0.5626614 10.2035285 13.0477424  4.3254549  0.0000000
 (between_SS / total_SS =  78.4 %)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss" "betweens
s"
[7] "size"         "iter"         "ifault"
```

```
K-means clustering with 4 clusters of sizes 3, 8, 2, 14

Cluster means:
    Energy  Protein        Fat   Calcium     Iron
1 1.498567 4.312004 0.68105570 2.9175222 1.140883
2 3.377951 4.410004 2.56506304 0.1121302 1.659985
3 0.568138 2.116802 0.08883335 0.9995610 3.901820
4 1.619723 4.872005 0.68528586 0.2544670 1.388618

Clustering vector:
 [1] 2 4 2 2 4 4 4 4 2 2 2 2 2 4 4 4 3 3 4 4 4 1 4 1 1 4 4

Within cluster sum of squares by cluster:
[1]  6.9589520  4.3254549  0.5626614 28.9804747
 (between_SS / total_SS =  68.6 %)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss" "betweens
s"
[7] "size"         "iter"         "ifault"
```

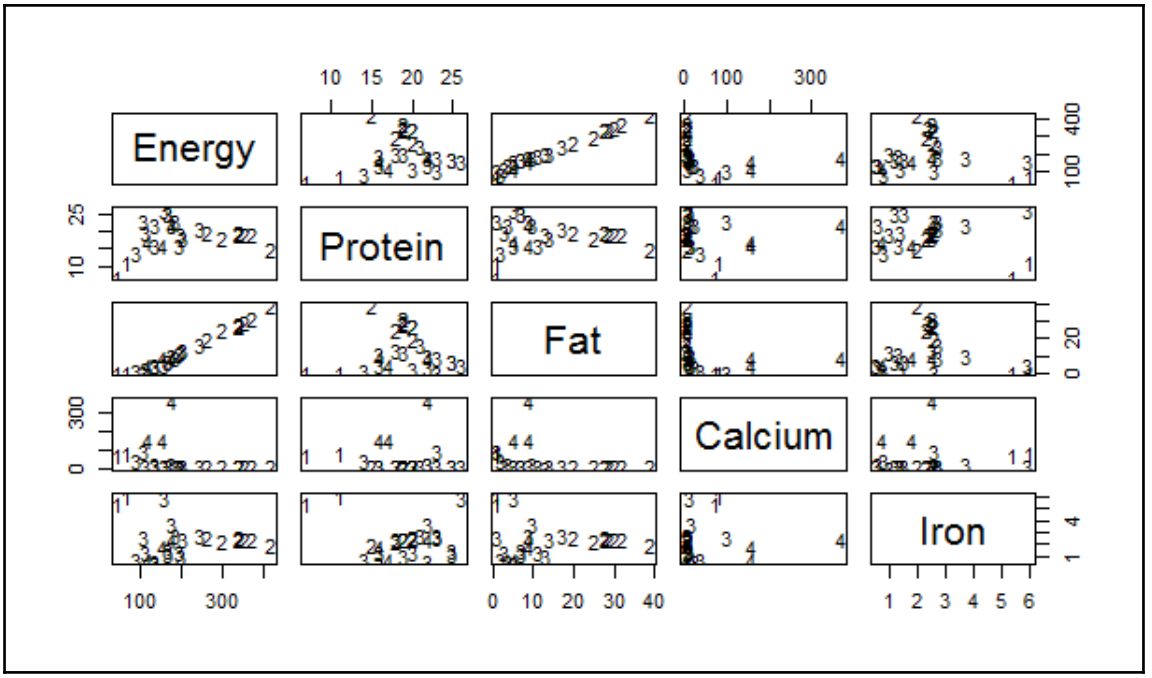
```
[1] 2 4 2 2 4 4 4 4 2 2 2 2 2 4 4 4 3 3 4 4 4 1 4 1 1 4 4
```

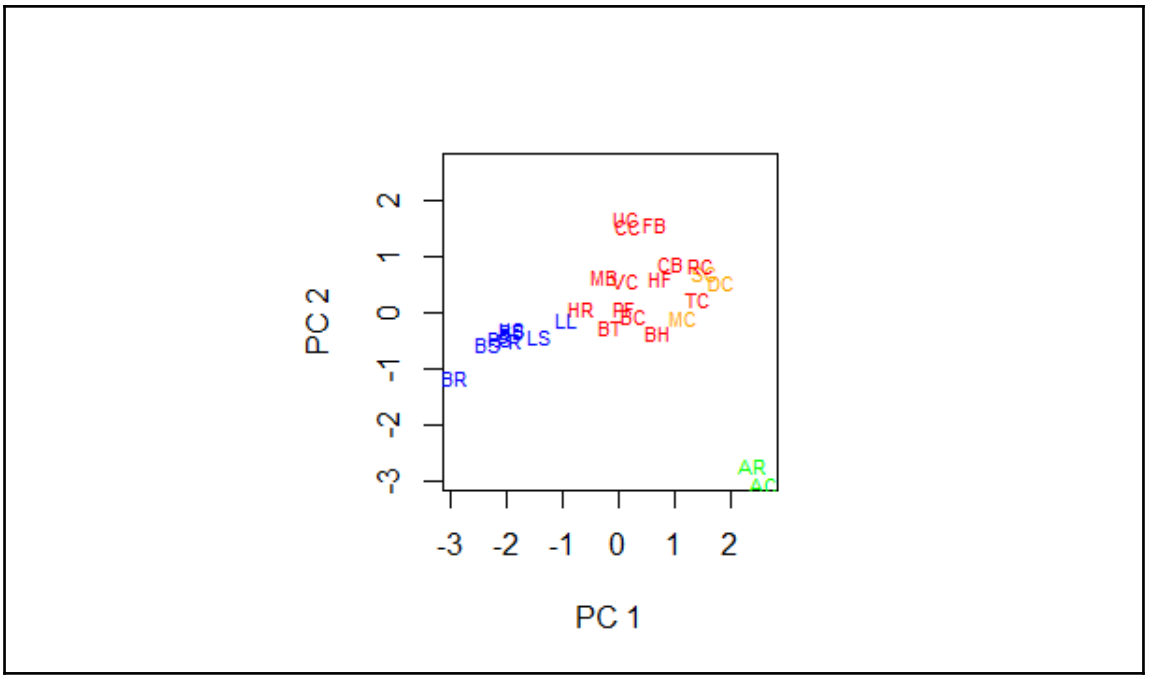
```
[[1]]
[1] MC SC DC
Levels: AC AR BB BC BH BR BS BT CB CC DC FB HF HR HS LL LS MB MC PF PR PS RC SC TC UC VC

[[2]]
[1] BB BR BS LL LS HS PR PS
Levels: AC AR BB BC BH BR BS BT CB CC DC FB HF HR HS LL LS MB MC PF PR PS RC SC TC UC VC

[[3]]
[1] AR AC
Levels: AC AR BB BC BH BR BS BT CB CC DC FB HF HR HS LL LS MB MC PF PR PS RC SC TC UC VC

[[4]]
 [1] HR BC CB CC BH BT VC FB TC HF MB PF UC RC
Levels: AC AR BB BC BH BR BS BT CB CC DC FB HF HR HS LL LS MB MC PF PR PS RC SC TC UC VC
```

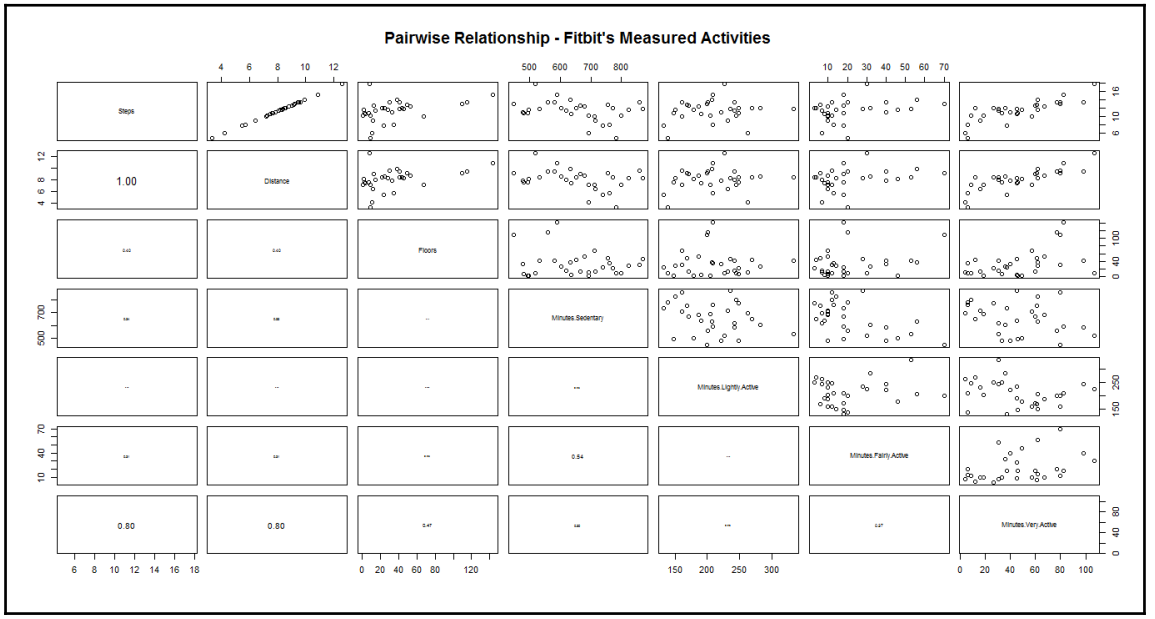


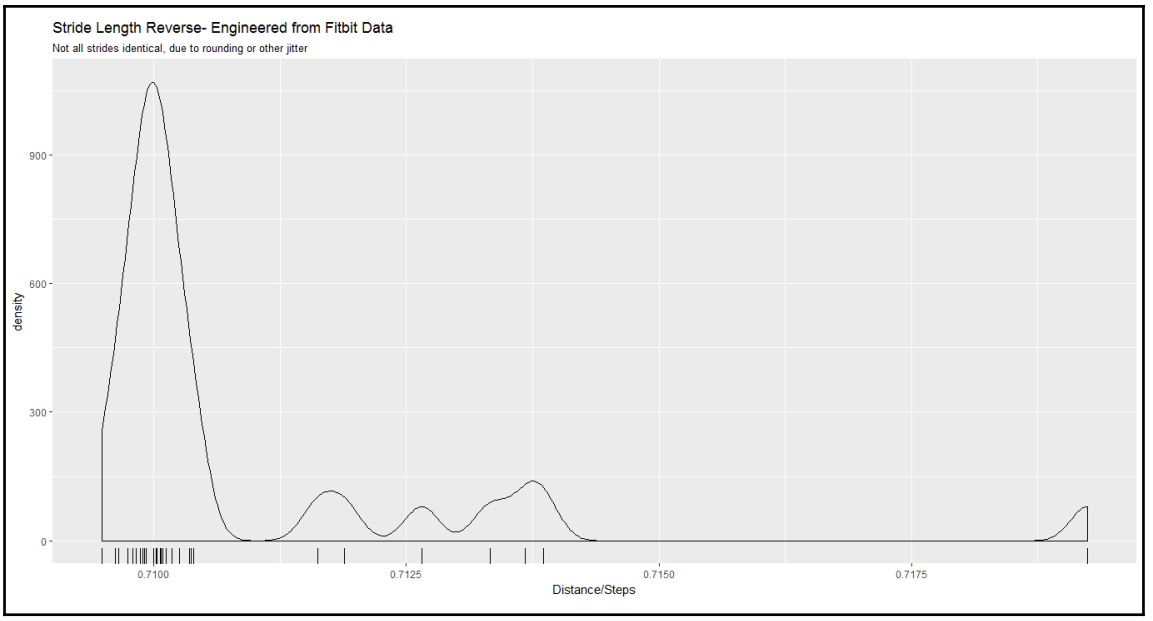

PC 2
PC 1
-3
-2
-1
0
1
2
HC
CC
FB
CB
RC
SC
DC
MB
VC
HF
TC
HR
RF
LL
BC
MC
BT
BH
LS
BR
AR
AC

Chapter 4: Model Selection and Regularization

	Date	Calories.Burned	Steps	Distance	Floors	Minutes.Sedentary	Minutes.Lightly.Active	Minutes.Fairly.Active	Minutes.Very.Active	Activity.Calories
1	2016-07-07	2682	12541	9.02	13	667	171	18	60	1248
2	2016-07-08	2423	8029	5.70	35	760	208	13	6	928
3	2016-07-09	2875	10801	7.67	3	496	148	18	46	1040
4	2016-07-10	2638	11997	8.52	22	771	248	3	27	1285
5	2016-07-11	2423	9039	6.42	12	714	232	10	16	1044
6	2016-07-12	3102	17721	12.58	8	519	226	30	107	1805

```
 [1] 12.541  8.029 10.801 11.997  9.039 17.721 10.544 10.047  4.733 12.056 11.791 10.721 13.007 13.401 15.281 11.337  7.738
[18] 11.767 13.324  5.957 10.206 11.557 11.013 10.168 11.686 13.991 13.444 12.398 11.986 12.858
```

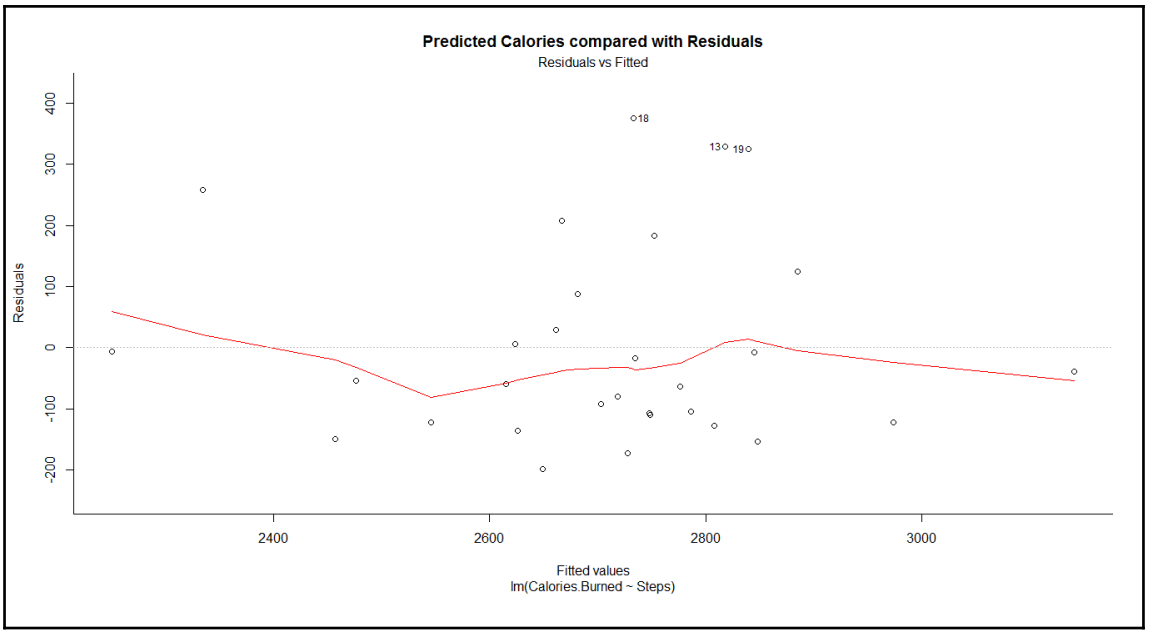


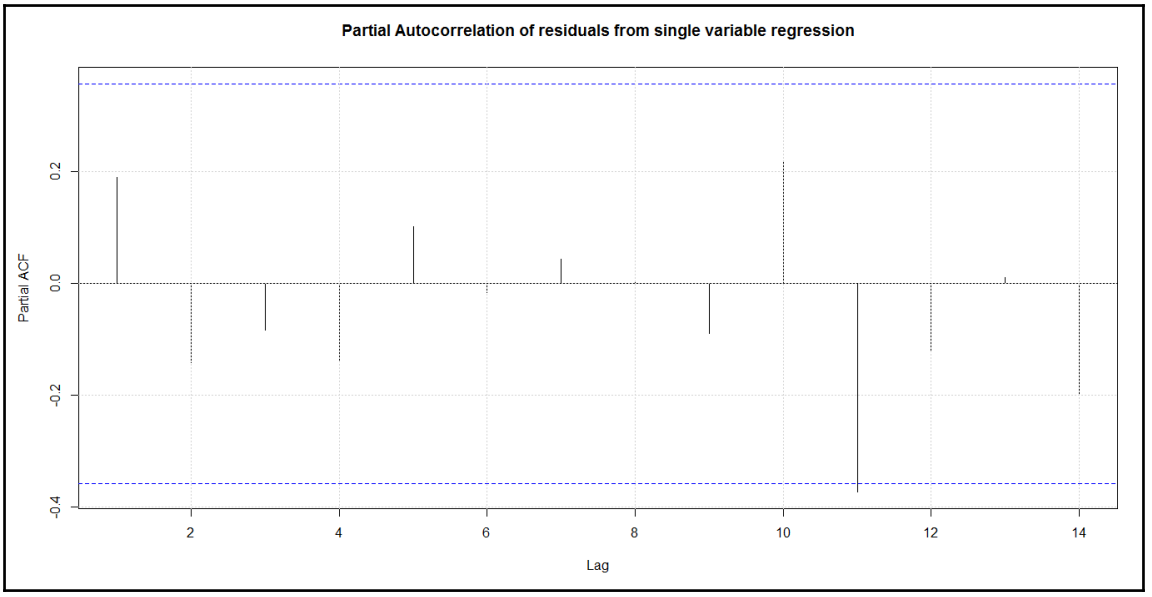



```
Call:
lm(formula = Calories.Burned ~ Steps, data = fitbit)

Coefficients:
(Intercept)        Steps
    1926.27        68.55
```

```
(Intercept)        Steps
       1926           69
```


Predicted Calories compared with Residuals
Residuals vs Fitted
Residuals
Fitted values
lm(Calories.Burned ~ Steps)
18
13
19
-200
-100
0
100
200
300
400
2400
2600
2800
3000


Partial Autocorrelation of residuals from single variable regression
Partial ACF
Lag
-0.4
-0.2
0.0
0.2
2
4
6
8
10
12
14

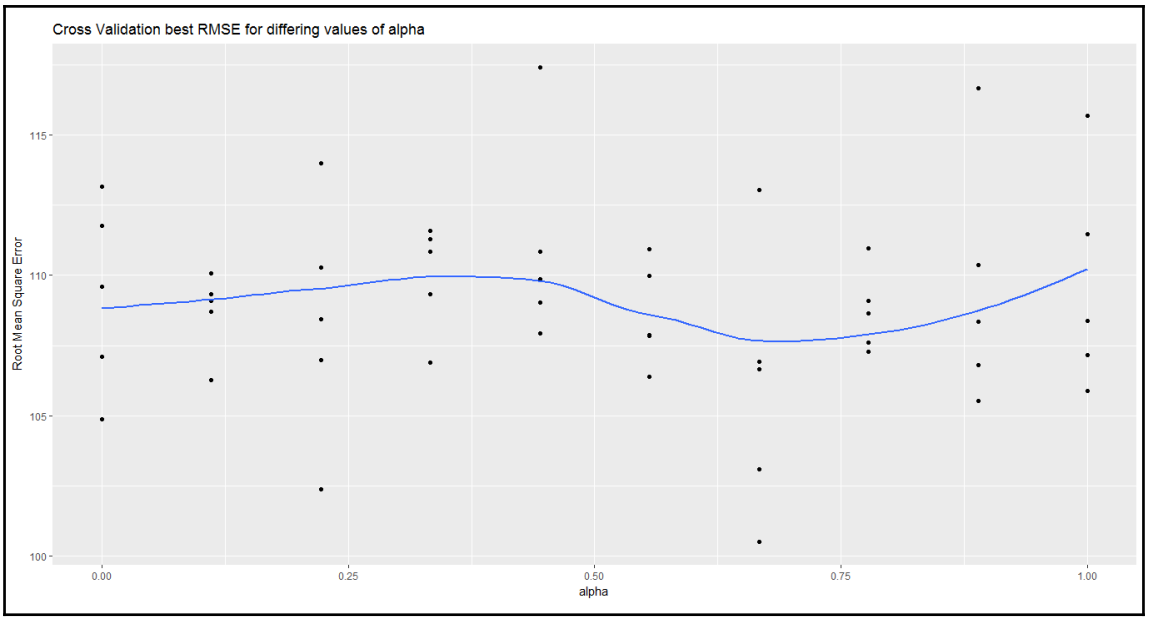
```
      Steps Distance Floors Minutes.Sedentary Minutes.Lightly.Active Minutes.Fairly.Active Minutes.Very.Active
[1,] 12.541     9.02     13               667                    171                    18                  60
[2,]  8.029     5.70     35               760                    208                    13                   6
[3,] 10.801     7.67      3               496                    148                    18                  46
[4,] 11.997     8.52     22               771                    248                     3                  27
[5,]  9.039     6.42     12               714                    232                    10                  16
[6,] 17.721    12.58      8               519                    226                    30                 107
```

```
 [1] 2682 2423 2875 2638 2423 3102 2450 2555 2245 2936 2717 2690 3147 2837 2851 2611 2307 3109 3164 2593 2490 263
8 2769 2629
[25] 2555 3010 2694 2713 2640 2680
```

	X1	X2	X3	X4	X5	X6
1	0.0000000	109.5889	107.0899	104.8613	111.7505	113.1563
2	0.1111111	108.6981	109.3370	110.0573	106.2842	109.0958
3	0.2222222	106.9779	108.4218	113.9708	102.3784	110.2811
4	0.3333333	111.2883	109.3242	106.8881	111.5851	110.8253
5	0.4444444	109.0175	110.8455	107.9398	117.3966	109.8615
6	0.5555556	107.8713	109.9792	106.3763	107.8555	110.9318
7	0.6666667	106.9289	113.0265	106.6506	103.0891	100.5173
8	0.7777778	108.6405	107.2741	110.9709	109.0754	107.5905
9	0.8888889	110.3589	116.6443	105.5138	108.3451	106.8064
10	1.0000000	105.8732	111.4563	107.1465	115.6756	108.3659

```
[1] 109.2894 108.6945 108.4060 109.9822 111.0122 108.6028 106.0425 108.7103 109.5337 109.7035
```

	X1	X2	X3	X4	X5	X6	average_rmse
7	0.6666667	106.9289	113.0265	106.6506	103.0891	100.5173	106.0425
3	0.2222222	106.9779	108.4218	113.9708	102.3784	110.2811	108.4060
6	0.5555556	107.8713	109.9792	106.3763	107.8555	110.9318	108.6028
2	0.1111111	108.6981	109.3370	110.0573	106.2842	109.0958	108.6945
8	0.7777778	108.6405	107.2741	110.9709	109.0754	107.5905	108.7103
1	0.0000000	109.5889	107.0899	104.8613	111.7505	113.1563	109.2894
9	0.8888889	110.3589	116.6443	105.5138	108.3451	106.8064	109.5337
10	1.0000000	105.8732	111.4563	107.1465	115.6756	108.3659	109.7035
4	0.3333333	111.2883	109.3242	106.8881	111.5851	110.8253	109.9822
5	0.4444444	109.0175	110.8455	107.9398	117.3966	109.8615	111.0122




```
[1] 0.6666667
```

```
Call:
lm(formula = Calories.Burned ~ ., data = fitbit)

Coefficients:
           (Intercept)                   Steps                Distance                  Floors       Minutes.Sedentary
            1941.1889                 -66.8266                 116.0772                   0.0274                  -0.2458
Minutes.Lightly.Active   Minutes.Fairly.Active   Minutes.Very.Active
                2.2466                   4.4016                   3.8955
```

	original	shrunk	very.shrunk
(Intercept)	1941.18889510	1953.9193828	2176.9301681
Steps	-66.82663867	7.7214570	15.9566697
Distance	116.07718793	14.3140006	22.1799747
Floors	0.02740202	0.0000000	0.0000000
Minutes.Sedentary	-0.24578123	-0.2388018	-0.1801439
Minutes.Lightly.Active	2.24661181	2.1139746	0.7914329
Minutes.Fairly.Active	4.40164035	4.4040703	3.7619668
Minutes.Very.Active	3.89545935	3.6009476	0.8484609

	original	shrunk	very.shrunk
(Intercept)	1941.189	1971.199	2157.172
Steps	-66.827	9.176	15.703
Distance	116.077	15.045	21.835
Floors	0.027	0.000	0.000
Minutes.Sedentary	-0.246	-0.236	-0.187
Minutes.Lightly.Active	2.247	1.985	0.888
Minutes.Fairly.Active	4.402	4.384	3.842
Minutes.Very.Active	3.895	3.295	1.019

```
Call:  glmnet(x = X, y = Y, lambda = 0)

     Df   %Dev Lambda
[1,]  7 0.8806      0
```

	elastic, lambda = 0	lm
(Intercept)	1937.924	1941.189
Steps	15.455	-66.827
Distance	0.653	116.077
Floors	0.011	0.027
Minutes.Sedentary	-0.241	-0.246
Minutes.Lightly.Active	2.236	2.247
Minutes.Fairly.Active	4.415	4.402
Minutes.Very.Active	3.894	3.895

```
Call:  glmnet(x = X[, -2], y = Y, lambda = 0)

     Df   %Dev Lambda
[1,]  6 0.8806      0
```

```
Call:
lm(formula = Y ~ X[, -2])

Coefficients:
                  (Intercept)                 X[, -2]Steps                X[, -2]Floors       X[, -2]Minutes.Sedentary
                    1.938e+03                    1.580e+01                    9.739e-03                   -2.406e-01
X[, -2]Minutes.Lightly.Active   X[, -2]Minutes.Fairly.Active     X[, -2]Minutes.Very.Active
                    2.239e+00                    4.413e+00                    3.906e+00
```

	elastic, lambda = 0	lm
(Intercept)	1938.103	1938.129
X[, -2]Steps	15.885	15.798
X[, -2]Floors	0.011	0.010
X[, -2]Minutes.Sedentary	-0.241	-0.241
X[, -2]Minutes.Lightly.Active	2.236	2.239
X[, -2]Minutes.Fairly.Active	4.415	4.413
X[, -2]Minutes.Very.Active	3.897	3.906

```
ORDINARY NONPARAMETRIC BOOTSTRAP


Call:
boot(data = fitbit, statistic = modellingfucn1, R = 99)


Bootstrap Statistics :
    original   bias    std. error
t1* 81.87882 13.92733    9.038867
```

```
ORDINARY NONPARAMETRIC BOOTSTRAP


Call:
boot(data = fitbit, statistic = modellingfucn2, R = 99)

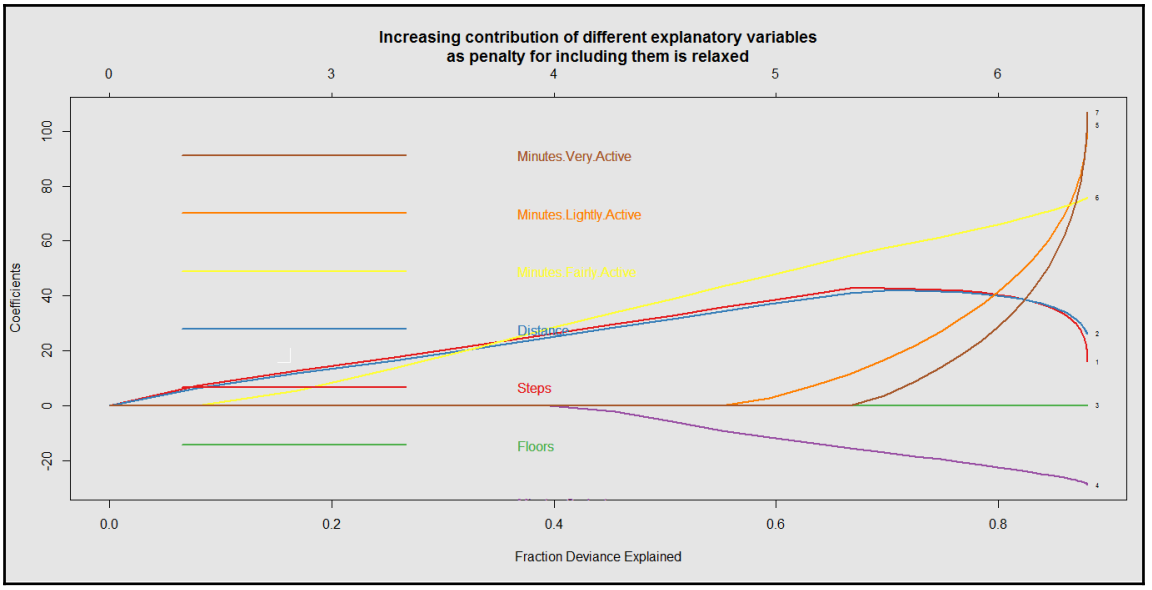

Bootstrap Statistics :
    original   bias    std. error
t1* 81.55149 18.15953    16.66511
```

```
ORDINARY NONPARAMETRIC BOOTSTRAP

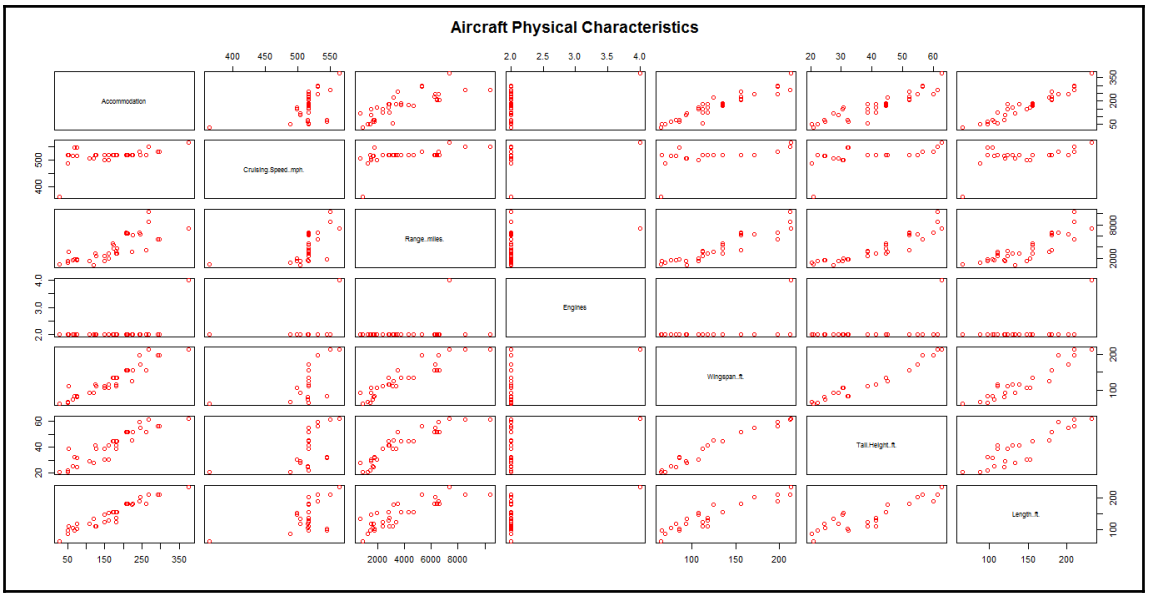

Call:
boot(data = fitbit, statistic = modellingOLS, R = 99)


Bootstrap Statistics :
    original  bias    std. error
t1* 159.7195       0           0
```

elastic modelling 95.8	OLS modelling 99.7
OLS modelling, only one explanatory variable 159.7	



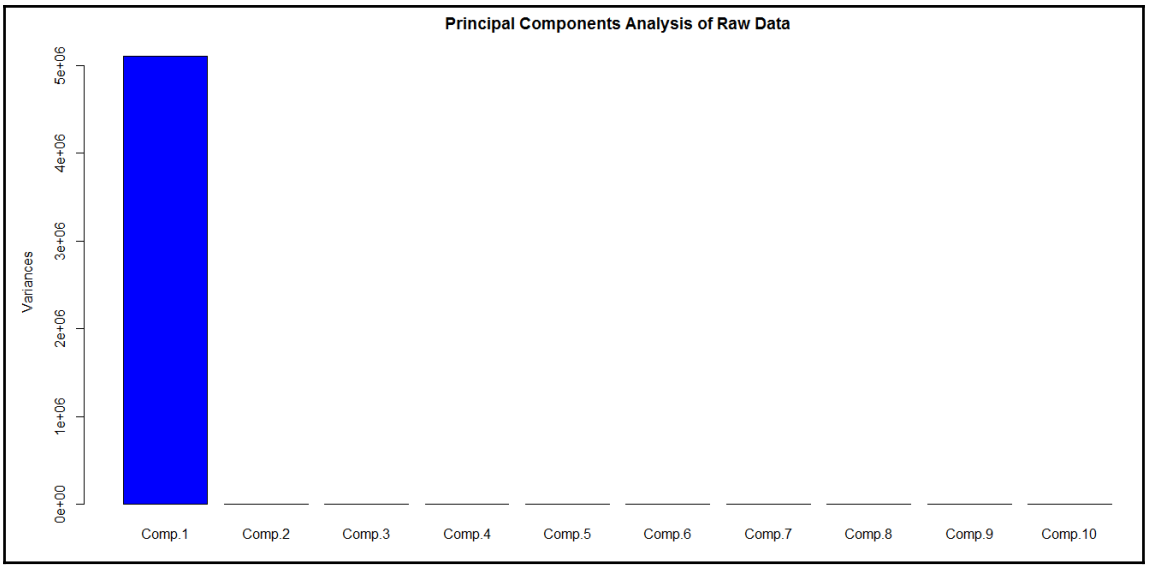
```
'data.frame':   44 obs. of  33 variables:
 $ Seat.Width..Club.        : num  0 19.4 0 0 0 0 0 0 0 0 ...
 $ Seat.Pitch..Club.        : int  0 44 0 0 0 0 0 0 0 0 ...
 $ Seat..Club.              : int  0 12 0 0 0 0 0 0 0 0 ...
 $ Seat.Width..First.Class.: num  21 19.4 21 21 0 0 0 0 19.6 21 ...
 $ Seat.Pitch..First.Class.: num  36 40 36 36 0 0 0 0 37 37 ...
 $ Seats..First.Class.      : int  12 28 12 12 0 0 0 0 12 12 ...
 $ Seat.Width..Business.    : num  0 21 0 0 21 21 21 20 0 0 ...
 $ Seat.Pitch..Business.    : num  0 59 0 0 60 80 80 60 0 0 ...
 $ Seats..Business.         : int  0 14 0 0 32 34 34 34 0 0 ...
 $ Seat.Width..Eco.Comfort.: num  17.2 0 17.2 17.2 18 18 18 18 18.1 17.2 ...
 $ Seat.Pitch..Eco.Comfort.: num  34 0 34 34 35 35 35 35 34 34 ...
 $ Seats..Eco.Comfort.      : int  18 0 18 18 30 32 32 32 15 18 ...
 $ Seat.Width..Economy.     : num  17.2 0 17.2 17.2 18 18 18 18 18.1 17.2 ...
 $ Seat.Pitch..Economy.     : num  30.5 0 31.5 31.5 30.5 30.5 30.5 30.5 31 30.5 ...
 $ Seats..Economy.          : int  96 0 120 120 181 168 227 232 83 94 ...
 $ Accommodation            : int  126 54 150 150 243 243 293 298 110 124 ...
 $ Cruising.Speed..mph.     : int  517 517 517 517 531 531 531 531 504 517 ...
 $ Range..miles.            : int  2399 3119 2420 2420 6536 6536 5343 5343 1510 2925 ...
 $ Engines                  : int  2 2 2 2 2 2 2 2 2 2 ...
 $ Wingspan..ft.            : num  112 112 112 112 198 ...
 $ Tail.Height..ft.         : num  38.6 38.6 38.6 38.6 59.8 ...
 $ Length..ft.              : num  111 111 123 123 189 ...
 $ Wifi                     : int  1 1 1 1 0 0 0 0 1 1 ...
 $ Video                    : int  0 1 0 0 1 1 1 1 0 1 ...
 $ Power                    : int  0 0 0 0 1 1 1 1 1 1 ...
 $ Satellite                : int  0 0 0 0 0 0 0 0 0 1 ...
 $ Flat.bed                 : int  0 0 0 0 1 0 1 0 0 0 ...
 $ Sleeper                  : int  0 0 0 0 0 1 0 1 0 0 ...
 $ Club                     : int  0 1 0 0 0 0 0 0 0 0 ...
 $ First.Class              : int  1 1 1 1 0 0 0 0 1 1 ...
 $ Business                 : int  0 1 0 0 1 1 1 1 0 0 ...
 $ Eco.Comfort              : int  1 0 1 1 1 1 1 1 1 1 ...
 $ Economy                  : int  1 0 1 1 1 1 1 1 1 1 ...
```




```
Call:
princomp(x = delta)

Standard deviations:
      Comp.1       Comp.2       Comp.3       Comp.4       Comp.5       Comp.6       Comp.7       Comp.8       Comp.9      Comp.10
Comp.11
2.259237e+03 6.907940e+01 2.871764e+01 2.259929e+01 1.482962e+01 1.049014e+01 9.152229e+00 7.937495e+00 4.523039e+00 3.623724e+00 2.606
872e+00
     Comp.12      Comp.13      Comp.14      Comp.15      Comp.16      Comp.17      Comp.18      Comp.19      Comp.20      Comp.21
Comp.22
1.929074e+00 1.760506e+00 1.563002e+00 1.245856e+00 4.772154e-01 3.806455e-01 3.493458e-01 2.724929e-01 2.153123e-01 1.991243e-01 1.669
167e-01
     Comp.23      Comp.24      Comp.25      Comp.26      Comp.27      Comp.28      Comp.29      Comp.30      Comp.31      Comp.32
Comp.33
1.340994e-01 1.209009e-01 6.524198e-02 4.241346e-02 2.373915e-02 2.016179e-03 2.452124e-05 0.000000e+00 0.000000e+00 0.000000e+00 0.000
000e+00

 33  variables and  44 observations.
```




```
Loadings:
                        Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8 Comp.9 Comp.10 Comp.11 Comp.12 Comp.13 Comp.14 Comp.15
 Comp.16
Seat.Width..Club.                                    -0.144 -0.110                             -0.165
  0.105
Seat.Pitch..Club.                                    -0.327 -0.248         0.189               -0.374           0.121   0.174   0.119
  0.239
Seat..Club.                                                                                    -0.102

Seat.Width..First.Class.                0.250        -0.160        -0.156  0.136        -0.246          0.341  -0.128   0.429   0.371
 -0.210
Seat.Pitch..First.Class.                0.515 -0.110 -0.386  0.112 -0.130  0.183  0.161 -0.307   0.211  -0.389                  -0.424

Seats..First.Class.                     0.258 -0.124 -0.307 -0.109  0.160  0.149         0.313          0.172  -0.242  -0.659   0.361

Seat.Width..Business.                  -0.154  0.142 -0.108                             0.244  -0.480          0.255  -0.232  -0.393
 -0.229
Seat.Pitch..Business.                  -0.514  0.446 -0.298  0.154 -0.172  0.379  0.285         0.401

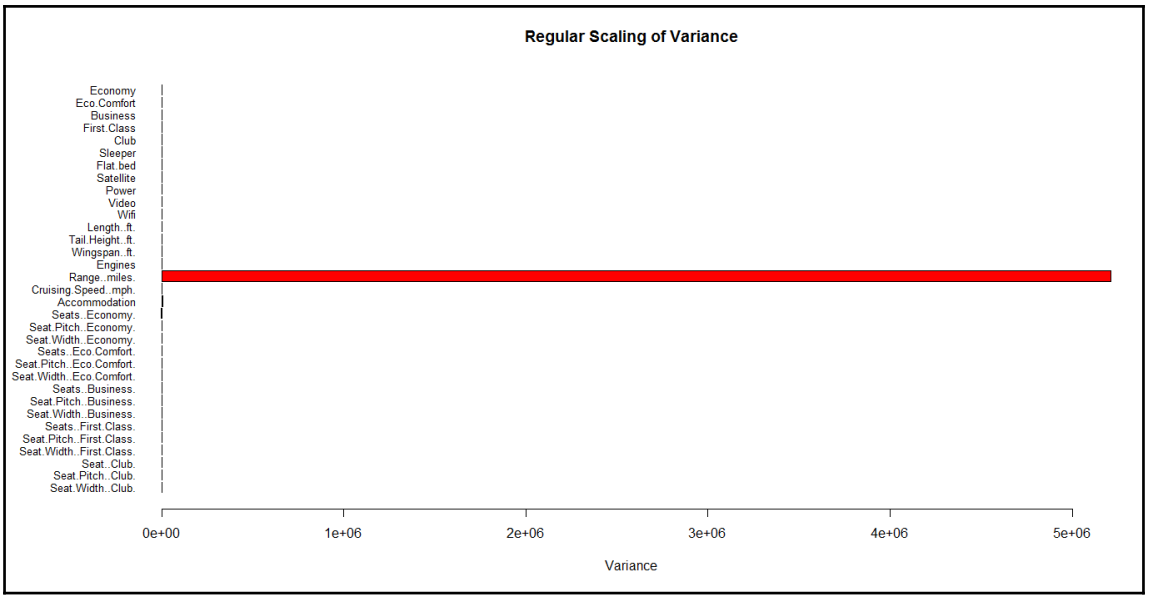
Seats..Business.                       -0.225  0.187                             -0.287 -0.608  -0.294  -0.133  -0.503  -0.294

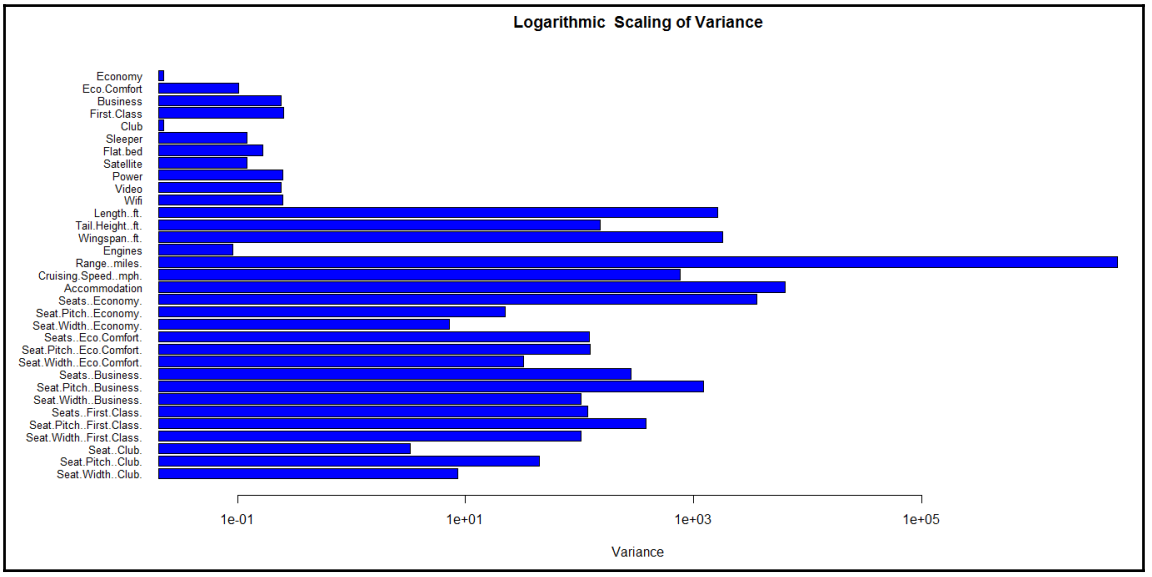
Seat.Width..Eco.Comfort.                                     0.285 -0.224                      -0.113   0.111
  0.546
Seat.Pitch..Eco.Comfort.                0.159                0.544 -0.442                      -0.268   0.260   0.120
 -0.124
Seats..Eco.Comfort.                                          0.200 -0.160        -0.208  0.318          -0.733           0.156   0.437
 -0.107
Seat.Width..Economy.                                  0.125  0.110                             0.186                   -0.110
  0.427
Seat.Pitch..Economy.                                  0.227  0.190        -0.130               0.262           -0.104  -0.132
 -0.165
Seats..Economy.                 0.597        -0.136  0.345 -0.165         0.168  0.597         -0.205  -0.127

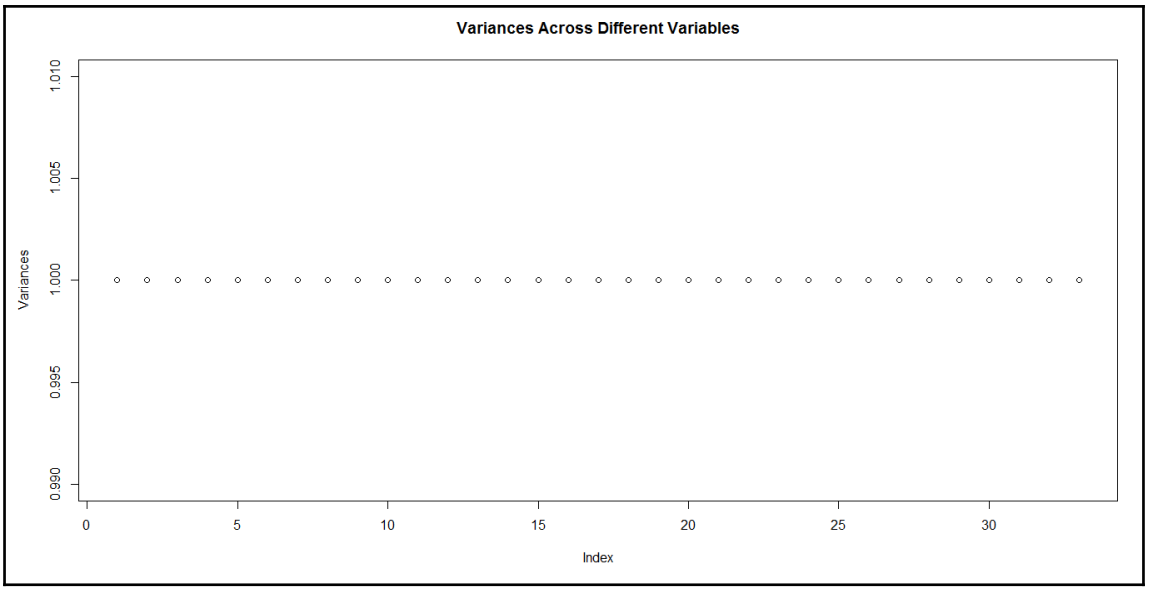
Accommodation                   0.697                -0.104                0.233 -0.592         0.183   0.153   0.152

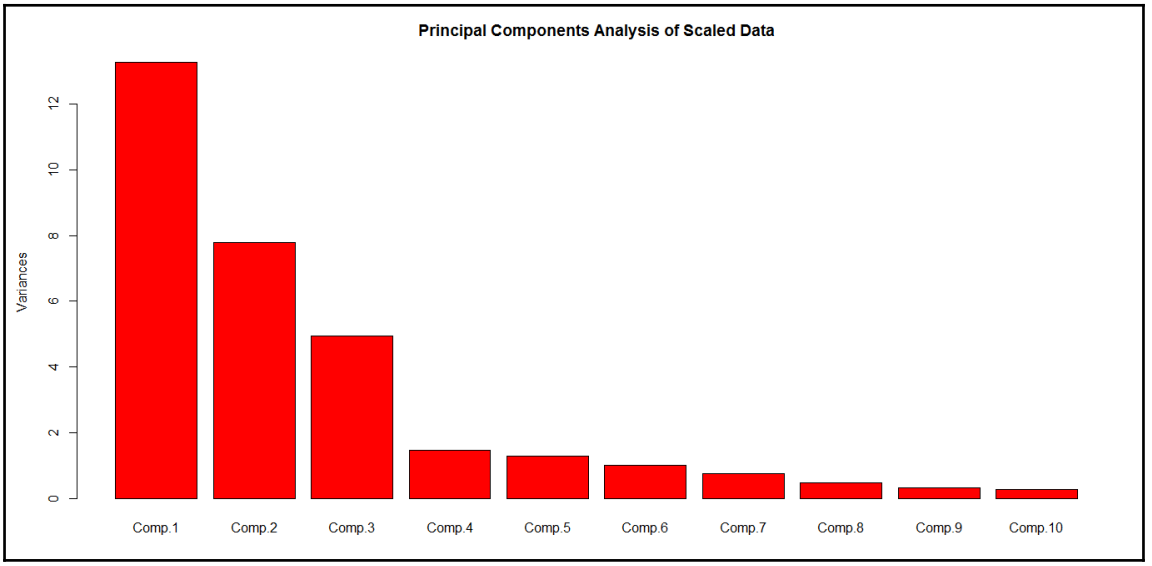
Cruising.Speed..mph.                    0.463  0.809  0.289 -0.144  0.115

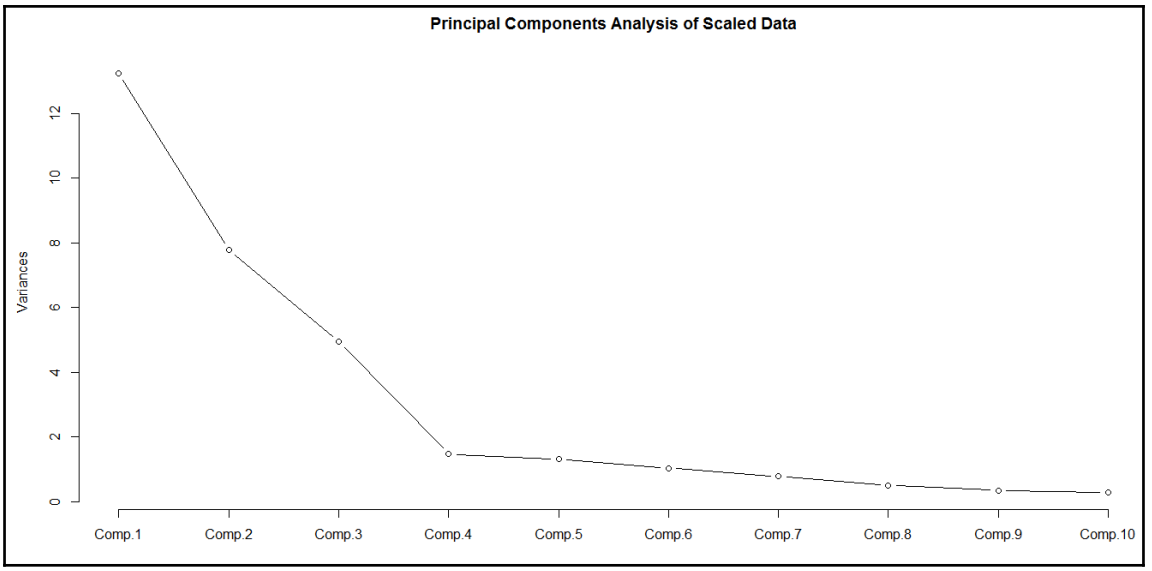
Range..miles.           0.999
```


Regular Scaling of Variance
Economy
Eco.Comfort
Business
First.Class
Club
Sleeper
Flat.bed
Satellite
Power
Video
Wifi
Length..ft.
Tail.Height..ft.
Wingspan..ft.
Engines
Range..miles.
Cruising.Speed..mph.
Accommodation
Seats..Economy.
Seat.Pitch..Economy.
Seat.Width..Economy.
Seats..Eco.Comfort.
Seat.Pitch..Eco.Comfort.
Seat.Width..Eco.Comfort.
Seats..Business.
Seat.Pitch..Business.
Seat.Width..Business.
Seats..First.Class.
Seat.Pitch..First.Class.
Seat.Width..First.Class.
Seat..Club.
Seat.Pitch..Club.
Seat.Width..Club.
0e+00
1e+06
2e+06
3e+06
4e+06
5e+06
Variance

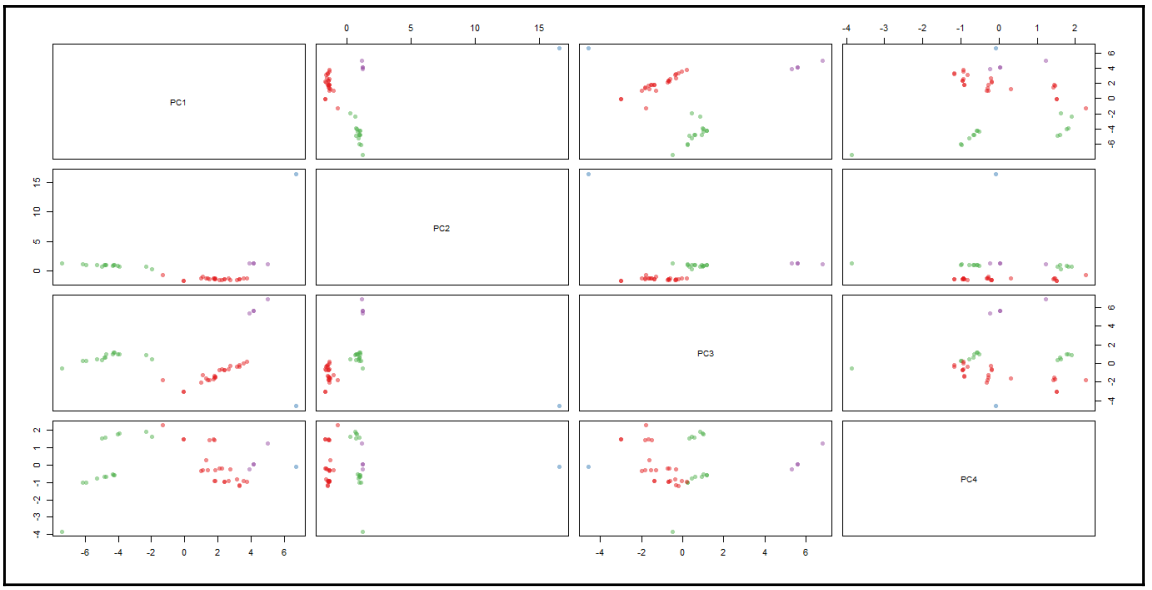

Logarithmic Scaling of Variance
Economy
Eco.Comfort
Business
First.Class
Club
Sleeper
Flat.bed
Satellite
Power
Video
Wifi
Length..ft.
Tail.Height..ft.
Wingspan..ft.
Engines
Range..miles.
Cruising.Speed..mph.
Accommodation
Seats..Economy.
Seat.Pitch..Economy.
Seat.Width..Economy.
Seats..Eco.Comfort.
Seat.Pitch..Eco.Comfort.
Seat.Width..Eco.Comfort.
Seats..Business.
Seat.Pitch..Business.
Seat.Width..Business.
Seats..First.Class.
Seat.Pitch..First.Class.
Seat.Width..First.Class.
Seat..Club.
Seat.Pitch..Club.
Seat.Width..Club.
1e-01
1e+01
1e+03
1e+05
Variance

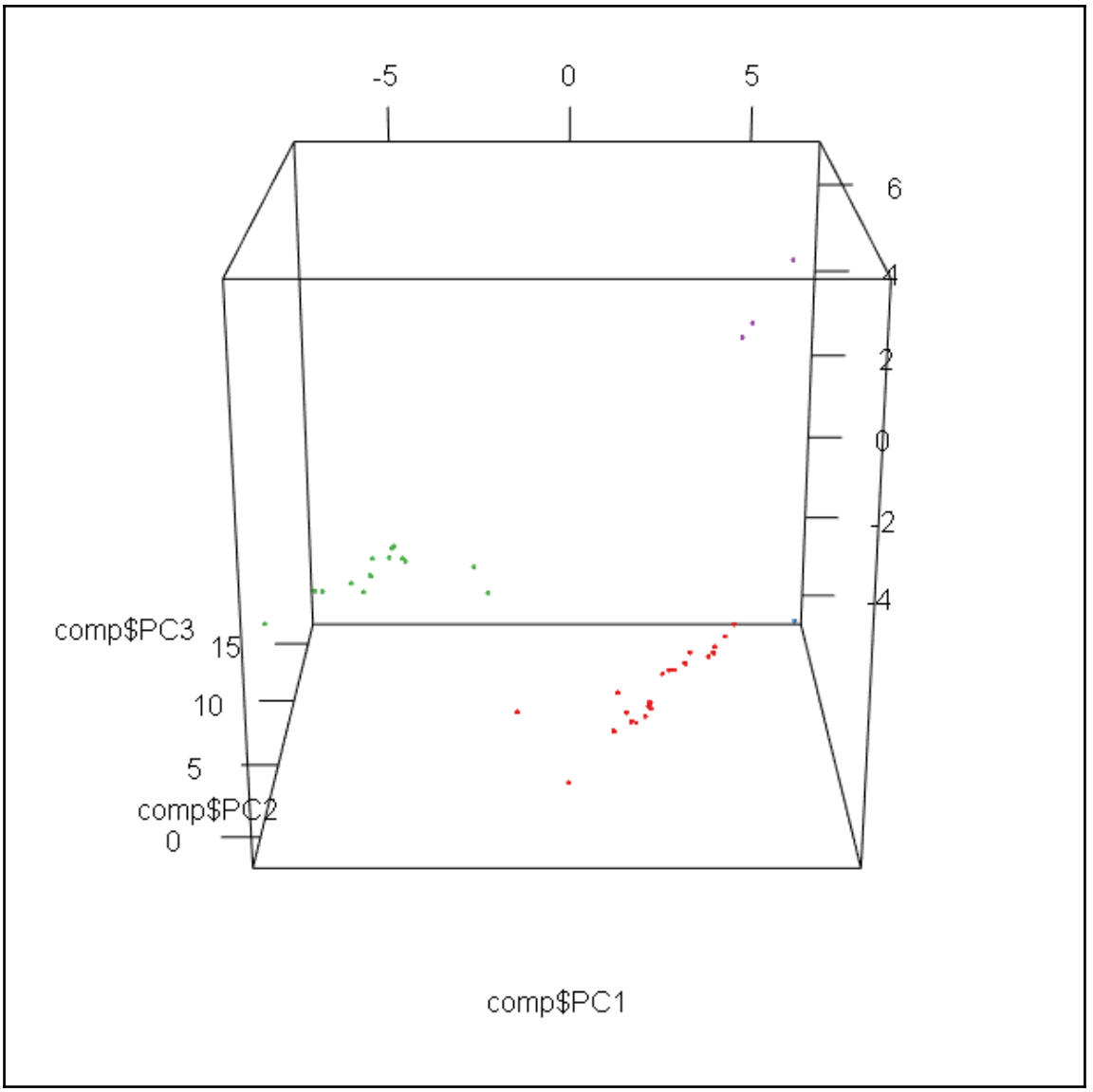

Variances Across Different Variables
Variances
1.010
1.005
1.000
0.995
0.990
0
5
10
15
20
25
30
Index

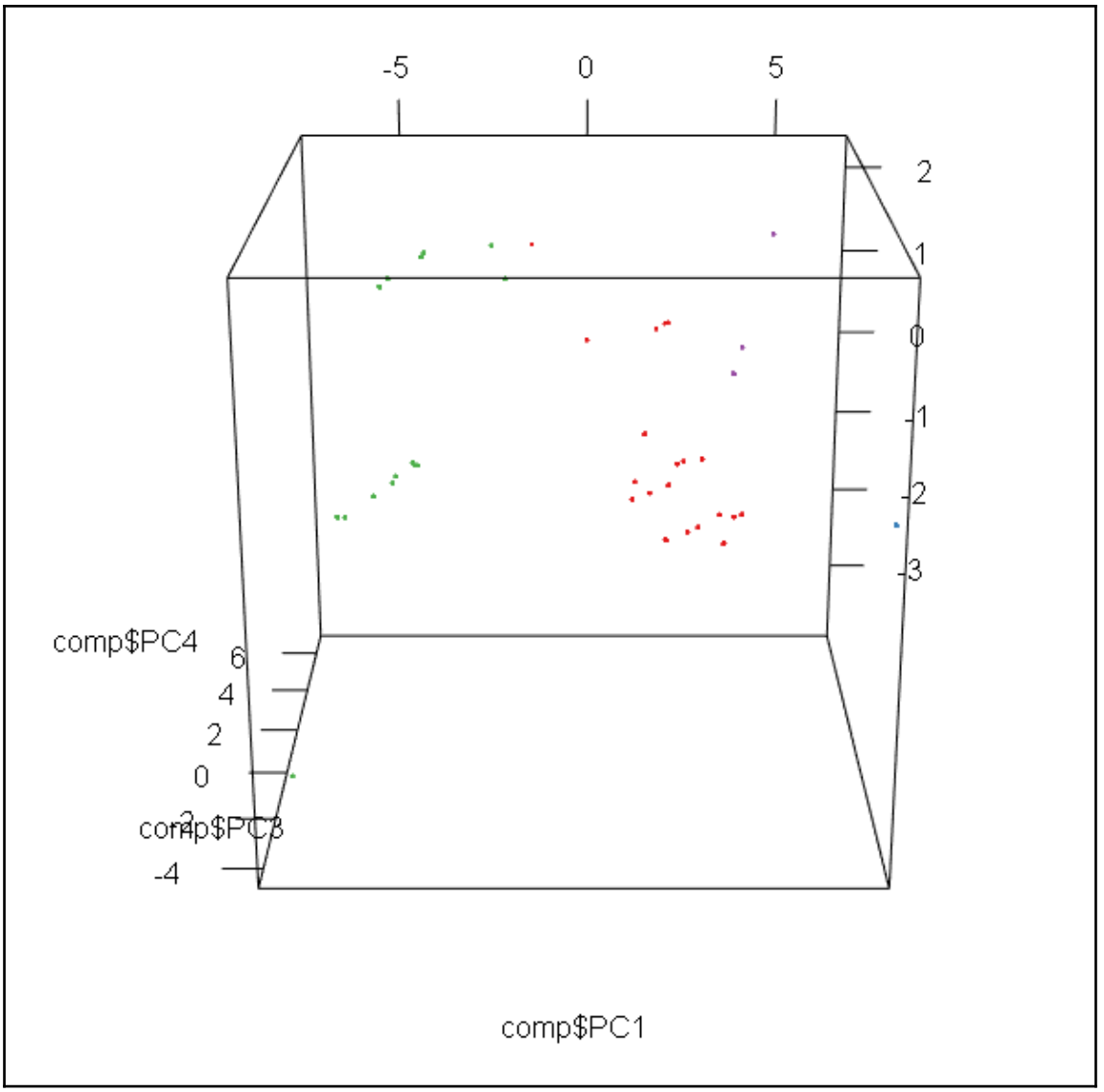

Principal Components Analysis of Scaled Data
Variances
0
2
4
6
8
10
12
Comp.1
Comp.2
Comp.3
Comp.4
Comp.5
Comp.6
Comp.7
Comp.8
Comp.9
Comp.10




```
Importance of components:
                          Comp.1    Comp.2    Comp.3     Comp.4     Comp.5     Comp.6     Comp.7     Comp.8    Comp.9     Comp.10     Comp.11
Standard deviation     3.6401340 2.7883991 2.2225223 1.21058843 1.14073049 1.01495084 0.87821658 0.70479857 0.5848836 0.529084330 0.407860804
Proportion of Variance 0.4108706 0.2410905 0.1531661 0.04544262 0.04034933 0.03194187 0.02391517 0.01540282 0.0106074 0.008680007 0.005158153
Cumulative Proportion  0.4108706 0.6519611 0.8051271 0.85056976 0.89091910 0.92286097 0.94677614 0.96217896 0.9727864 0.981466375 0.986624528
                          Comp.12     Comp.13     Comp.14    Comp.15     Comp.16     Comp.17     Comp.18     Comp.19     Comp.20      Comp.21
Standard deviation     0.362177038 0.298829473 0.238584294 0.1981036 0.1757588137 0.1444047596 0.1385927988 0.1173372505 0.1045097508 0.0853608392
Proportion of Variance 0.004067355 0.002768963 0.001765038 0.0012169 0.0009578654 0.0006465964 0.0005955958 0.0004269157 0.0003386756 0.0002259371
Cumulative Proportion  0.990691883 0.993460846 0.995225884 0.9964428 0.9974006493 0.9980472457 0.9986428415 0.9990697572 0.9994084328 0.9996343699
                          Comp.22      Comp.23      Comp.24      Comp.25      Comp.26      Comp.27      Comp.28      Comp.29      Comp.30
Standard deviation     0.0791201165 5.177928e-02 4.469526e-02 0.0221107242 1.530274e-02 1.080092e-02 3.619390e-03 4.267325e-08 4.071751e-08
Proportion of Variance 0.0001941083 8.313469e-05 6.194314e-05 0.0000151592 7.261202e-06 3.617359e-06 4.062012e-07 5.646532e-17 5.140824e-17
Cumulative Proportion  0.9998284782 9.999116e-01 9.999736e-01 0.9999887152 9.999960e-01 9.999996e-01 1.000000e+00 1.000000e+00 1.000000e+00
                          Comp.31      Comp.32 Comp.33
Standard deviation     9.643864e-09 7.10068e-09       0
Proportion of Variance 2.883848e-18 1.56340e-18       0
Cumulative Proportion  1.000000e+00 1.00000e+00       1
```


PC1
PC2
PC3
PC4


-5
0
5
6
4
2
0
-2
-4
comp$PC3
15
10
5
comp$PC2
0
comp$PC1




```
2  4  3  1
1  4 15 24
```

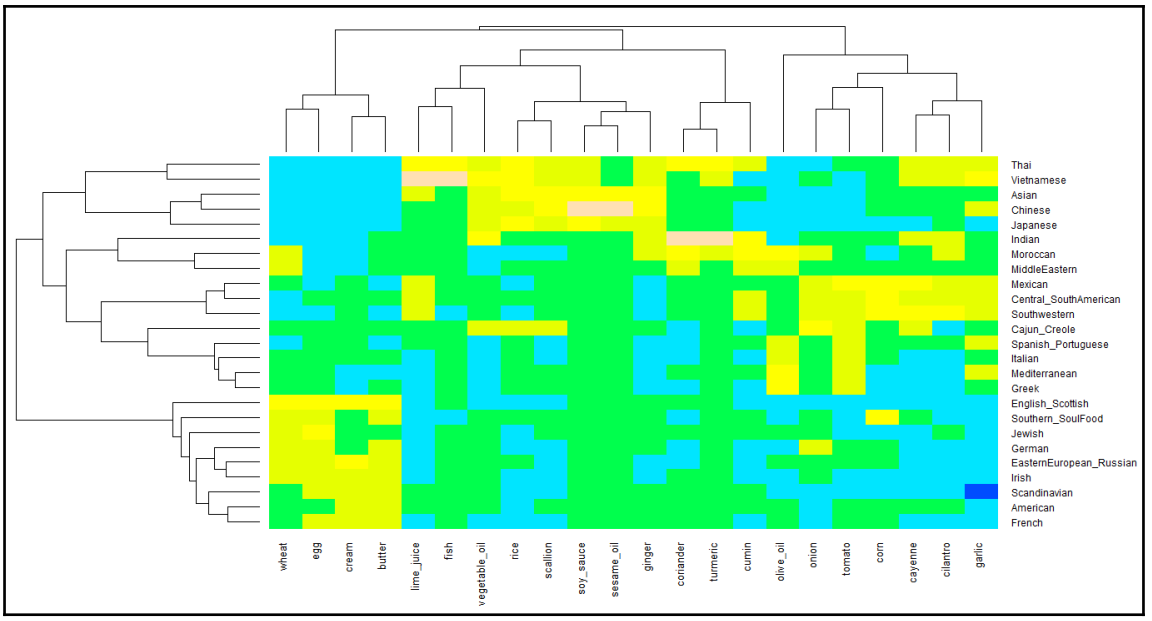
```
[1] "Airbus A319 VIP"
```

```
[1] "CRJ 100/200 Pinnacle/SkyWest" "CRJ 100/200 ExpressJet"       "E120"                          "ERJ-145"
```

```
 [1] "Airbus A330-200"          "Airbus A330-200 (3L2)"    "Airbus A330-200 (3L3)"    "Airbus A330-300"          "Boeing 747-400 (74S)"
 [6] "Boeing 757-200 (75E)"     "Boeing 757-200 (75X)"     "Boeing 767-300 (76G)"     "Boeing 767-300 (76L)"     "Boeing 767-300 (76T)"
[11] "Boeing 767-300 (76Z V.1)" "Boeing 767-300 (76Z V.2)" "Boeing 767-400 (76D)"     "Boeing 777-200ER"         "Boeing 777-200LR"
```

```
 [1] "Airbus A319"          "Airbus A320"          "Airbus A320 32-R"       "Boeing 717"           "Boeing 737-700 (73W)"
 [6] "Boeing 737-800 (738)" "Boeing 737-800 (73H)" "Boeing 737-900ER (739)" "Boeing 757-200 (75A)" "Boeing 757-200 (75M)"
[11] "Boeing 757-200 (75N)" "Boeing 757-200 (757)" "Boeing 757-200 (75V)"  "Boeing 757-300"       "Boeing 767-300 (76P)"
[16] "Boeing 767-300 (76Q)" "Boeing 767-300 (76U)" "CRJ 700"               "CRJ 900"              "E170"
[21] "E175"                 "MD-88"                "MD-90"                  "MD-DC9-50"
```

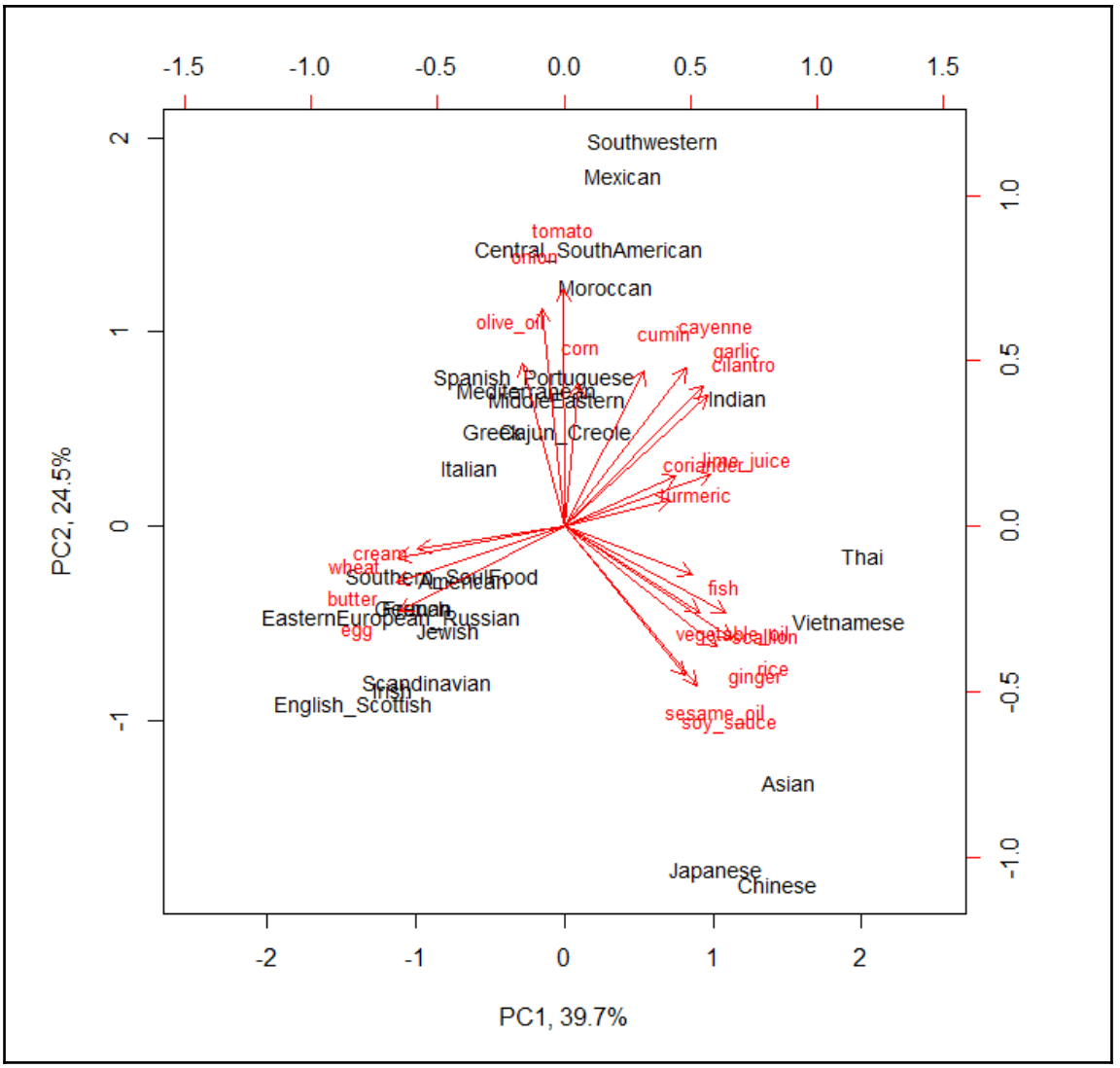
	Var1	Freq
1	African	115
2	American	4988
3	Asian	1176
4	Cajun_Creole	146
5	Central_SouthAmerican	241
6	Chinese	226
7	EasternEuropean_Russian	146
8	English_Scottish	204
9	French	996
10	German	52
11	Greek	225
12	Indian	274
13	Irish	86
14	Italian	1715
15	Japanese	136
16	Jewish	320
17	Mediterranean	289
18	Mexican	622
19	MiddleEastern	248
20	Moroccan	137
21	Scandinavian	92
22	Southern_SoulFood	346
23	Southwestern	108
24	Spanish_Portuguese	291
25	Thai	164
26	Vietnamese	65



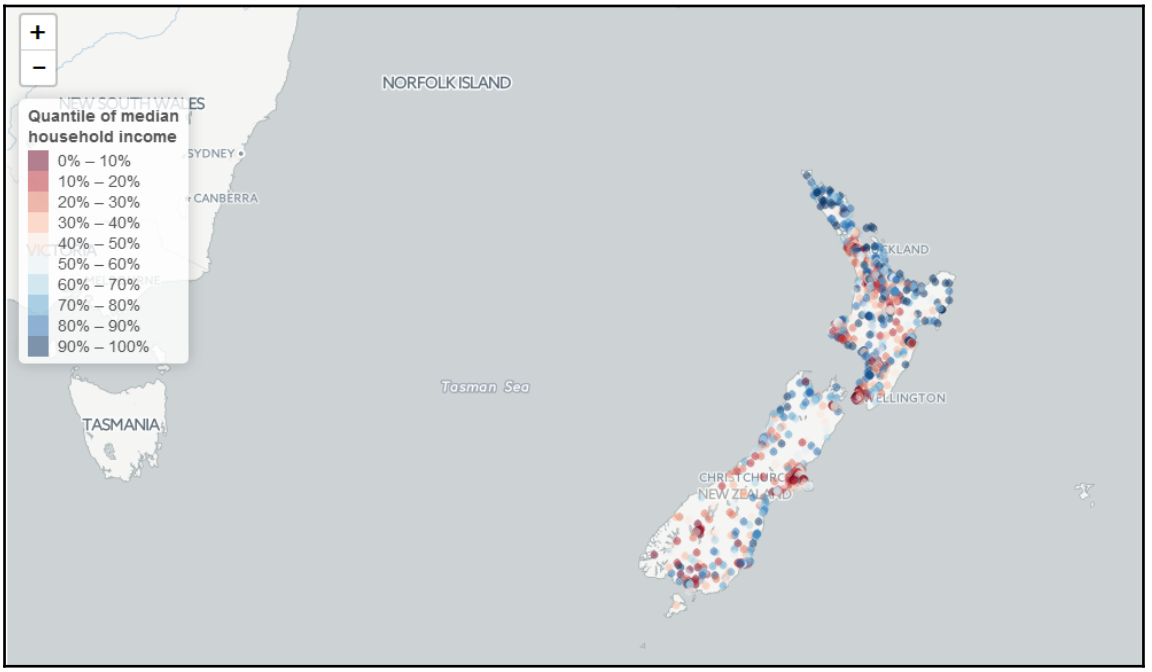

```
Call:
princomp(x = final_imp)

Standard deviations:
    Comp.1     Comp.2     Comp.3     Comp.4     Comp.5     Comp.6     Comp.7     Comp.8     Comp.9    Comp.10    Comp.11    Comp.12
Comp.13
2.95664772 2.22248409 1.54442468 1.44724581 1.10369661 0.75612298 0.57781510 0.47944174 0.42994264 0.39243338 0.30441262 0.24488043 0.1
9478279
   Comp.14    Comp.15    Comp.16    Comp.17    Comp.18    Comp.19    Comp.20    Comp.21    Comp.22
0.16134688 0.13102208 0.10750934 0.10266234 0.08372124 0.04197352 0.03426400 0.02328061 0.01466105

 22  variables and  25 observations.
```


-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2
1
0
-1
1.0
0.5
0.0
-0.5
-1.0
-2
-1
0
1
2
PC2, 24.5%
PC1, 39.7%
Southwestern
Mexican
tomato
onion
Central_SouthAmerican
Moroccan
olive_oil
corn
cumin
cayenne
garlic
cilantro
Spanish_Portuguese
MediterraneanMiddleEastern
Indian
Greek
Cajun_Creole
Italian
coriander
lime_juice
turmeric
cream
wheat
Southern_SoulFood
butter
French
EasternEuropean_Russian
egg
Jewish
fish
Thai
Vietnamese
vegetable_oil
soy_sauce
rice
ginger
Scandinavian
Irish
English_Scottish
sesame_oil
soy_sauce
Asian
Japanese
Chinese

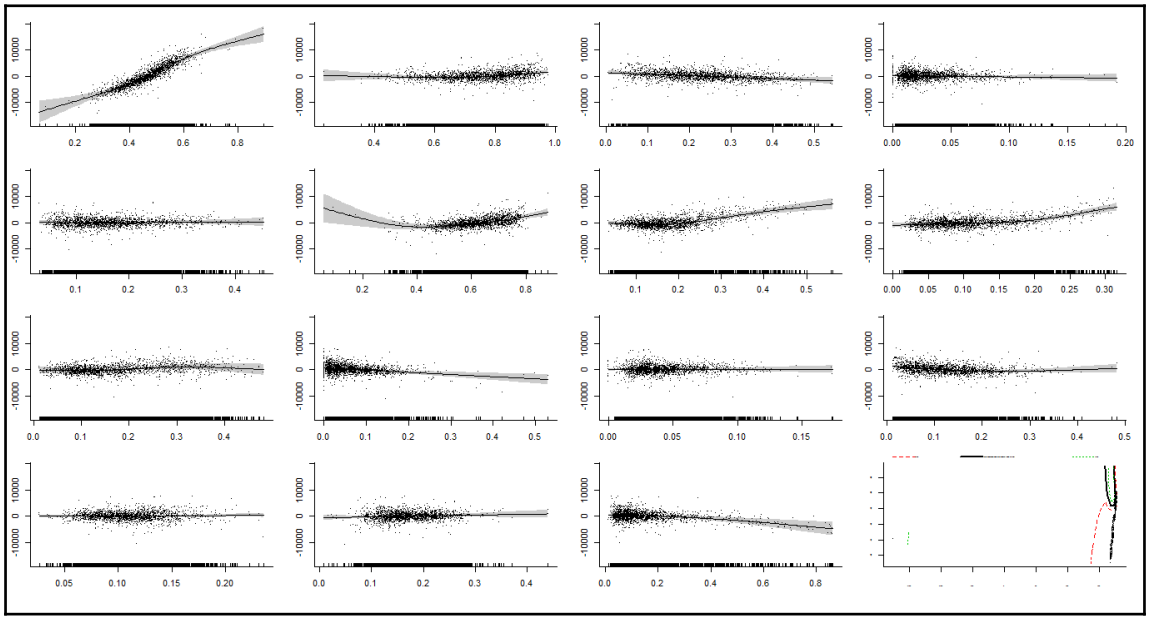
Chapter 5: Nonlinearity




```
[1] 1785   69
```

```
 [1] "MeanBedrooms"          "PrivateDwellings"      "SeparateHouse"         "NumberInHH"            "MultiPersonHH"
 [6] "InternetHH"            "NotOwnedHH"            "MedianRentHH"          "LandlordPublic"        "NoMotorVehicle"
[11] "AreChildren"           "SameResidence5YearsAgo" "Overseas5YearsAgo"    "NZBorn"                "European"
[16] "Maori"                 "Pacific"               "Asian"                 "Male"                  "X20to24"
[21] "X25to29"               "X30to34"               "X40to44"               "X45to49"               "X50to54"
[26] "X55to59"               "X60to64"               "X65AndOlder"           "NoReligion"            "Smoker"
[31] "Separated"             "Partnered"             "OwnResidence"          "NoChildren"            "NoQualification"
[36] "Bachelor"              "Doctorate"             "FTStudent"             "PTStudent"             "MedianIncome"
[41] "SelfEmployed"          "UnemploymentBenefit"   "StudentAllowance"      "FullTimeEmployed"      "PartTimeEmployed"
[46] "Unemployed"            "Employee"              "Employer"              "SelfEmployedNoEmployees" "Managers"
[51] "Professionals"         "Trades"                "Labourers"             "AgForFish"             "PubAdmin"
[56] "FinServices"           "ProfServices"          "Worked1_9hours"        "Worked10_19hours"      "Worked20_29hours"
[61] "Worked30_39hours"      "Worked50_59hours"      "WorkedOver60hours"     "WorkedHome"            "PublicTransport"
[66] "WalkJogBike"           "NoUnpaidActivities"    "WGS84Longitude"        "WGS84Latitude"
```

	rho2	F	df1	df2	P	Adjusted rho2	n
FullTimeEmployed	0.7129141	4427.6847	1	1783	0	0.7127531	1785
InternetHH	0.5834990	2497.9024	1	1783	0	0.5832654	1785
NoQualification	0.4470782	1441.6876	1	1783	0	0.4467681	1785
UnemploymentBenefit	0.4308350	1349.6595	1	1783	0	0.4305158	1785
Smoker	0.4094793	1236.3689	1	1783	0	0.4091481	1785
Partnered	0.3866362	1123.9207	1	1783	0	0.3862922	1785
Managers	0.3854095	1118.1189	1	1783	0	0.3850648	1785
Bachelor	0.3723224	1057.6304	1	1783	0	0.3719704	1785
SelfEmployed	0.3664151	1031.1455	1	1783	0	0.3660598	1785
NoMotorVehicle	0.3584018	995.9976	1	1783	0	0.3580419	1785
Unemployed	0.3570226	990.0367	1	1783	0	0.3566620	1785
Labourers	0.3378065	909.5664	1	1783	0	0.3374351	1785
Worked50_59hours	0.3311392	882.7264	1	1783	0	0.3307640	1785
WorkedOver60hours	0.3311392	882.7264	1	1783	0	0.3307640	1785
Separated	0.3122424	809.4831	1	1783	0	0.3118567	1785



```
ORDINARY NONPARAMETRIC BOOTSTRAP


Call:
boot(data = data_use, statistic = fit_gam, R = 99)


Bootstrap Statistics :
    original   bias    std. error
t1*  1639.39 244.9502    387.2537
```

```
[1] 1884.34
```

```
[1] 2
```

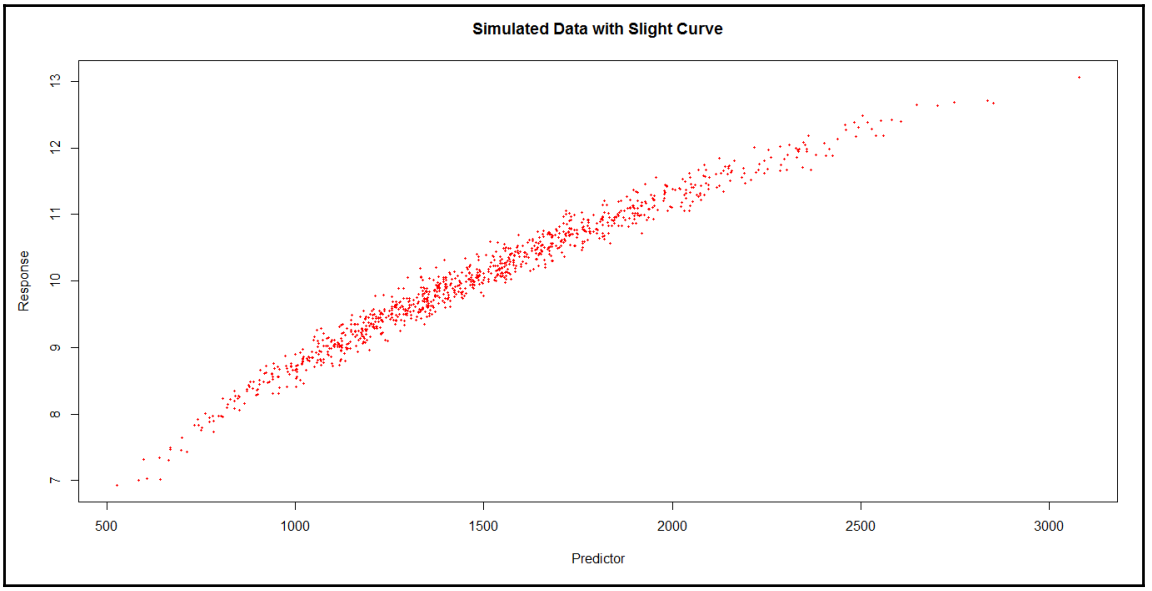
```
          V1        V2
1  9.113850 10.162218
2 11.619701 12.987429
3  9.944150 11.353624
4 10.053516 11.178816
5  7.876934  9.179485
6  9.687213 10.851732
```

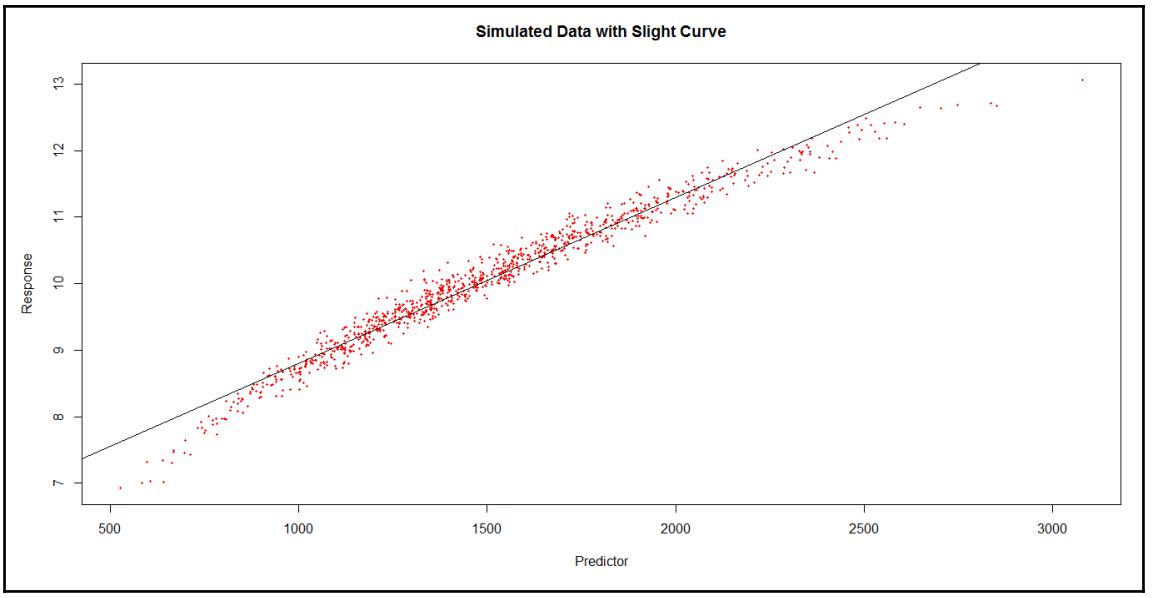
```
[1] 1049.4591 2190.6329 1463.5364 1396.9711  773.4905 1277.9010
```

```
[1] 103.27068 168.67332 128.90478 124.96592  84.26295 117.76010
```

```
Call:
lm(formula = raw$response ~ raw$predictor1_3)

Coefficients:
     (Intercept)  raw$predictor1_3
        6.304595          0.002496
```






```
$x
 [1]  4.000000  4.428571  4.857143  5.285714  5.714286  6.142857  6.571429  7.000000  7.428571  7.857143  8.285714  8.714286  9.142857
  9.571429
[15] 10.000000 10.428571 10.857143 11.285714 11.714286 12.142857 12.571429 13.000000 13.428571 13.857143 14.285714 14.714286 15.142857
 15.571429
[29] 16.000000 16.428571 16.857143 17.285714 17.714286 18.142857 18.571429 19.000000 19.428571 19.857143 20.285714 20.714286 21.142857
 21.571429
[43] 22.000000 22.428571 22.857143 23.285714 23.714286 24.142857 24.571429 25.000000

$y
 [1]  3.272340  4.649135  6.007926  7.355284  8.697776 10.041974 11.394447 12.761764 14.150494 15.567208 16.984996 18.326847 19.644429
 20.998786
[15] 22.450966 23.928844 25.355833 26.786293 28.274581 29.857278 31.391655 32.967213 34.604079 36.239846 37.998521 39.935642 41.616790
 43.001795
[29] 44.220676 45.361214 46.511191 47.778778 49.244460 50.845164 52.509776 54.167182 56.025692 58.263629 60.764900 63.413415 66.093080
 68.687803
[43] 71.081492 73.386173 75.774481 78.221236 80.701256 83.189361 85.660370 88.089103
```

```
Call:
loess(formula = y_axis ~ x_axis, span = 0.75, degree = 1, family = "gaussian")

Number of Observations: 50
Equivalent Number of Parameters: 3.13
Residual Standard Error: 15.25
```

```
 [1]  4.000000  4.428571  4.857143  5.285714  5.714286  6.142857  6.571429  7.000000  7.428571  7.857143  8.285714  8.714286  9.142857
  9.571429
[15] 10.000000 10.428571 10.857143 11.285714 11.714286 12.142857 12.571429 13.000000 13.428571 13.857143 14.285714 14.714286 15.142857
 15.571429
[29] 16.000000 16.428571 16.857143 17.285714 17.714286 18.142857 18.571429 19.000000 19.428571 19.857143 20.285714 20.714286 21.142857
 21.571429
[43] 22.000000 22.428571 22.857143 23.285714 23.714286 24.142857 24.571429 25.000000
```

```
Call:
lm(formula = y_axis ~ x_axis)

Coefficients:
(Intercept)       x_axis
    -17.579        3.932
```

```
Call:
lm(formula = y_axis ~ poly(x_axis, 3))

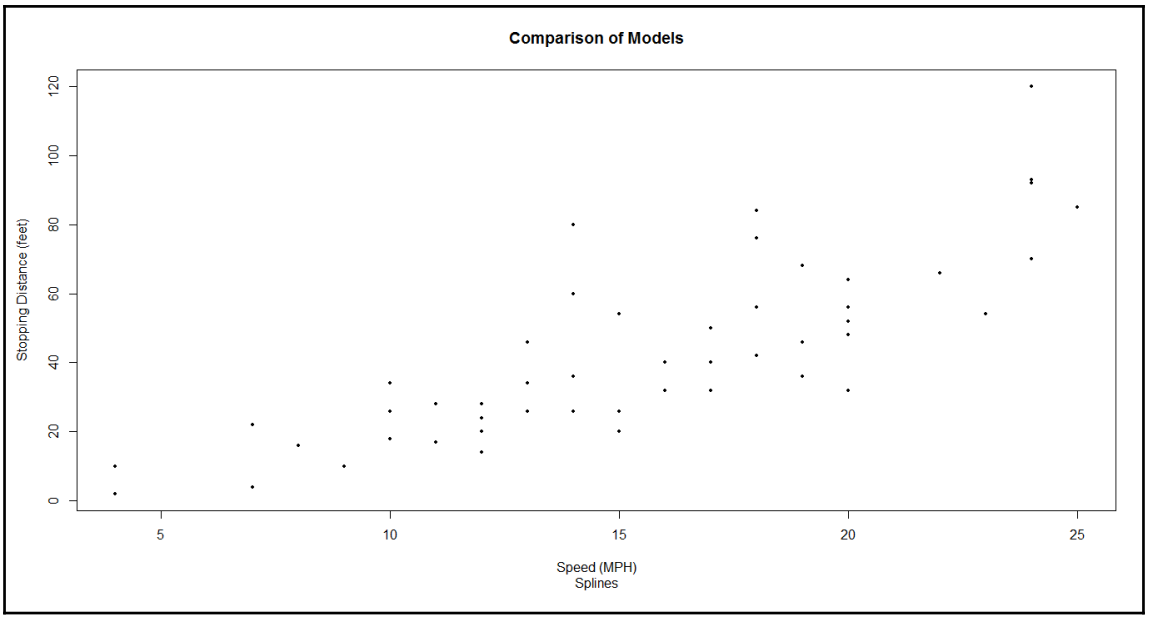
Coefficients:
     (Intercept)  poly(x_axis, 3)1  poly(x_axis, 3)2  poly(x_axis, 3)3
           42.98            145.55             23.00             13.80
```

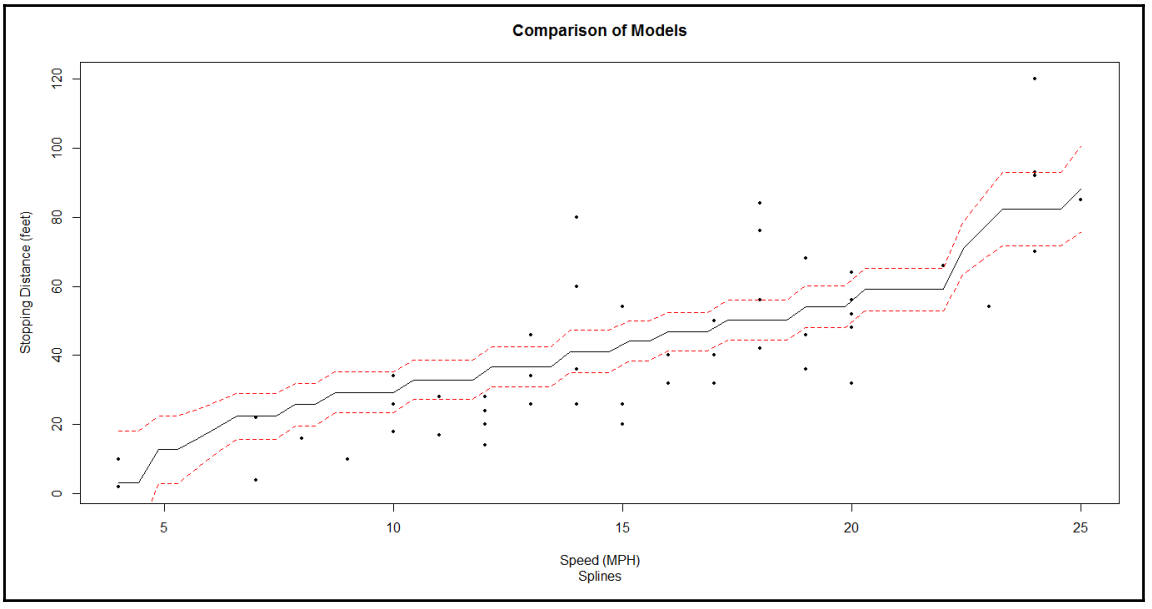
```
Call:
lm(formula = y_axis ~ ns(x_axis, 3))

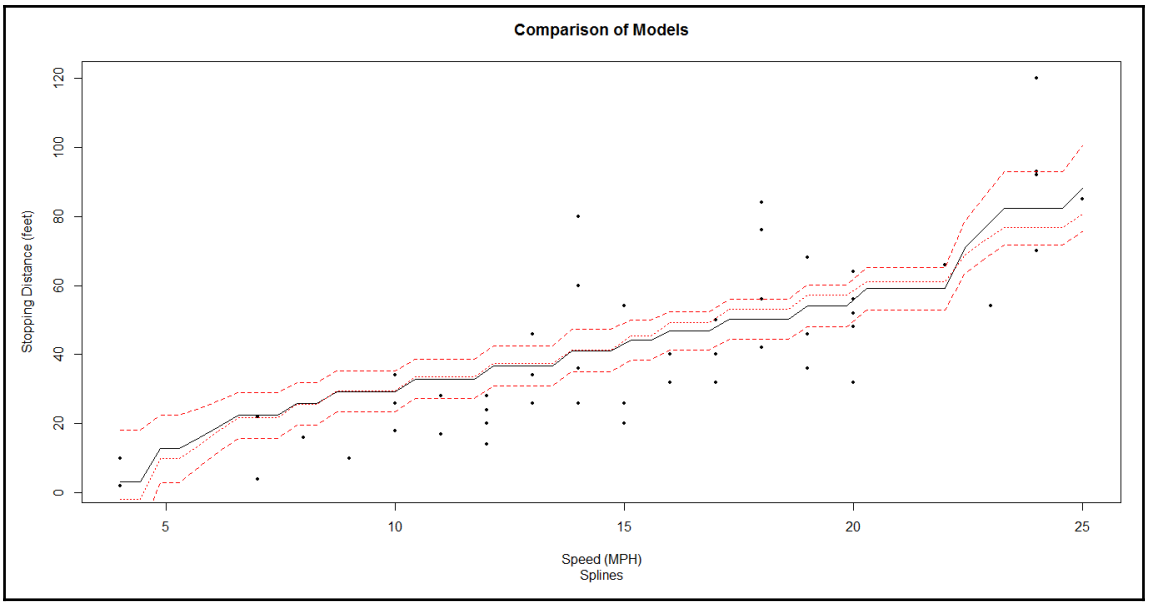
Coefficients:
   (Intercept)  ns(x_axis, 3)1  ns(x_axis, 3)2  ns(x_axis, 3)3
         2.594          35.959          96.444          72.986
```

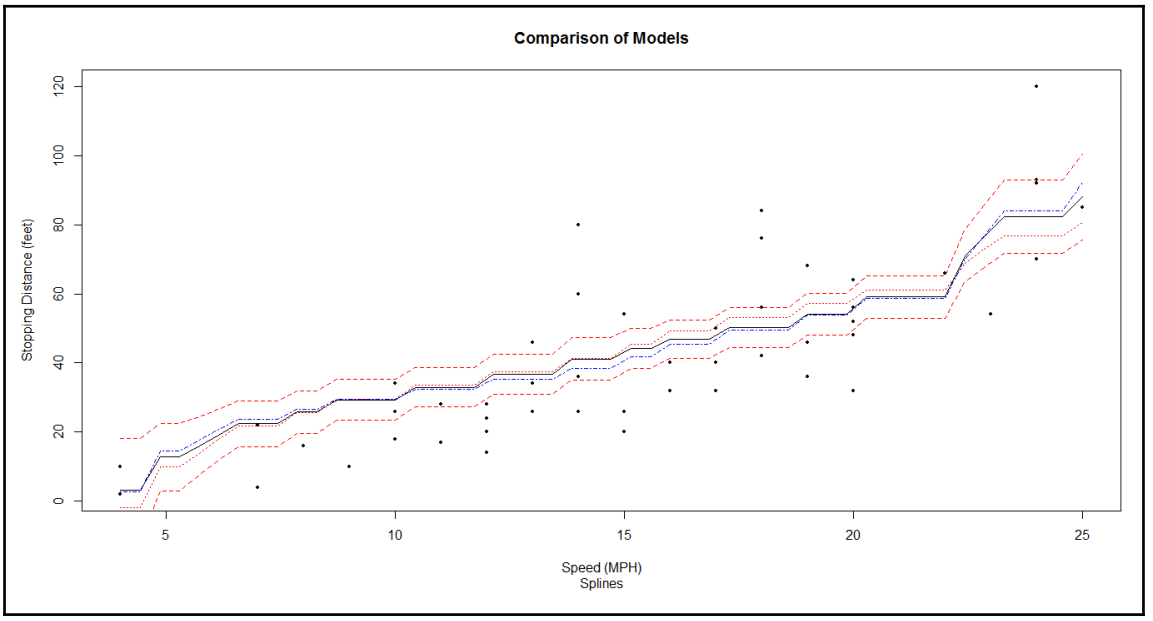
```
Call:
smooth.spline(x = y_axis ~ x_axis, nknots = 15)

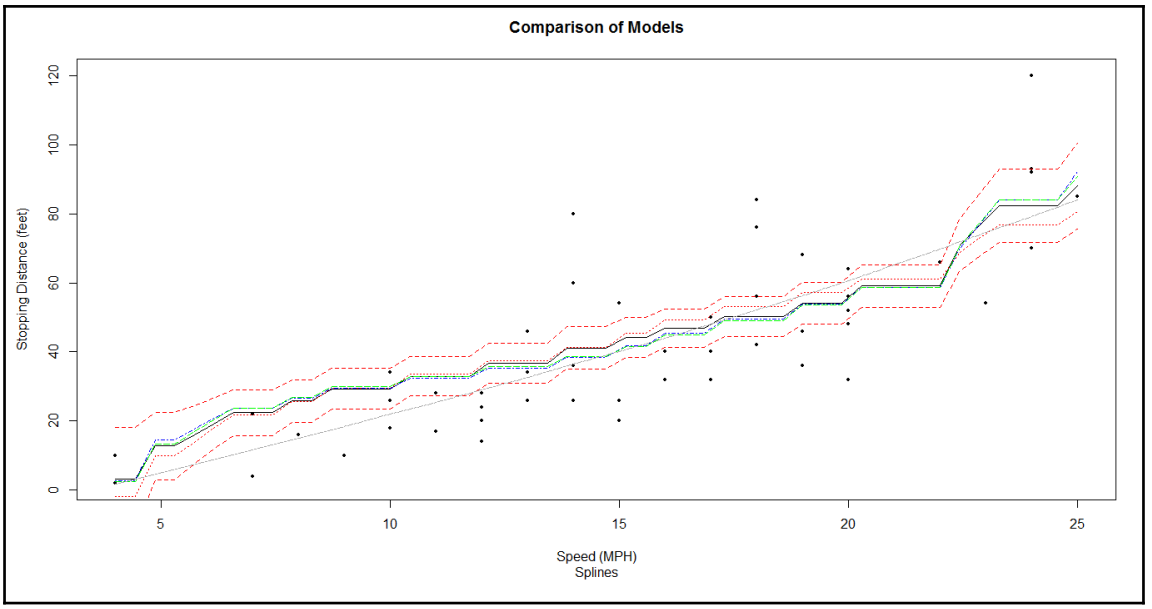
Smoothing Parameter  spar= 0.7274958  lambda= 0.1118473 (15 iterations)
Equivalent Degrees of Freedom (Df): 2.632293
Penalized Criterion: 4189.645
GCV: 244.1153
```

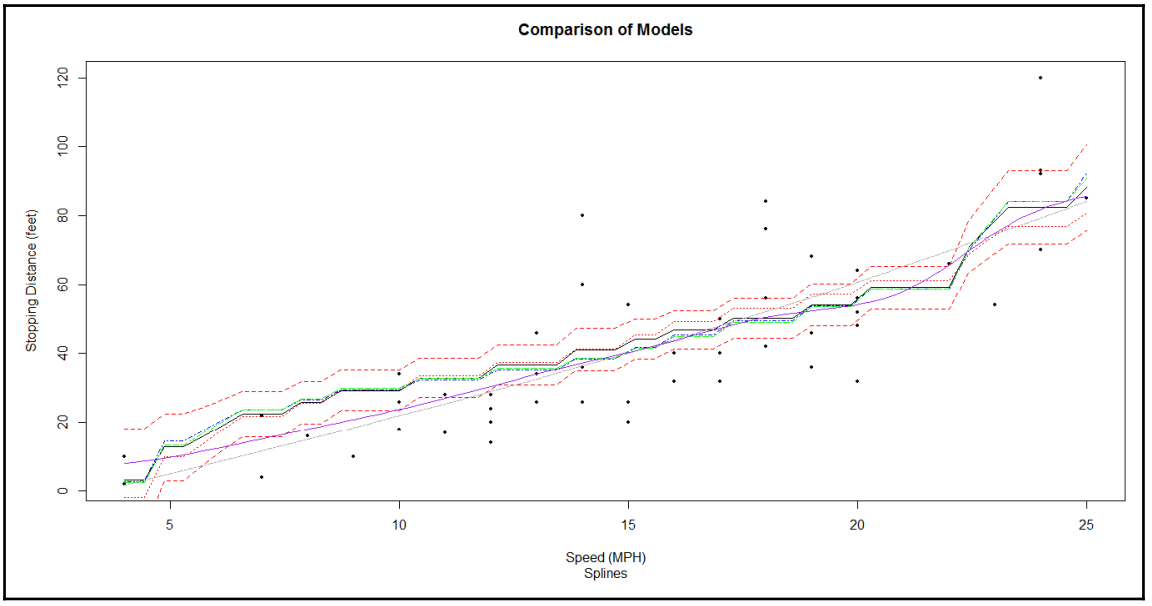

Comparison of Models
Stopping Distance (feet)
0
20
40
60
80
100
120
5
10
15
20
25
Speed (MPH)
Splines


Comparison of Models
Stopping Distance (feet)
0
20
40
60
80
100
120
5
10
15
20
25
Speed (MPH)
Splines


Comparison of Models
Stopping Distance (feet)
0
20
40
60
80
100
120
5
10
15
20
25
Speed (MPH)
Splines


Comparison of Models
Stopping Distance (feet)
0
20
40
60
80
100
120
5
10
15
20
25
Speed (MPH)
Splines


Comparison of Models
Stopping Distance (feet)
0
20
40
60
80
100
120
5
10
15
20
25
Speed (MPH)
Splines


Comparison of Models
Stopping Distance (feet)
0
20
40
60
80
100
120
5
10
15
20
25
Speed (MPH)
Splines

	agency_cd	site_no	Date	X_00060_00003	X_00060_00003_cd
35553	USGS	01538000	2017-01-31	71	P
35554	USGS	01538000	2017-02-01	66	P
35555	USGS	01538000	2017-02-02	61	P
35556	USGS	01538000	2017-02-03	-999999	P Ice
35557	USGS	01538000	2017-02-04	-999999	P Ice
35558	USGS	01538000	2017-02-05	-999999	P Ice

```
'data.frame':   35558 obs. of  5 variables:
 $ agency_cd       : chr  "USGS" "USGS" "USGS" "USGS" ...
 $ site_no         : chr  "01538000" "01538000" "01538000" "01538000" ...
 $ Date            : Date, format: "1919-10-01" "1919-10-02" "1919-10-03" "1919-10-04" ...
 $ X_00060_00003   : num  25 25 25 25 25 30 30 30 30 30 ...
 $ X_00060_00003_cd: chr  "A" "A" "A" "A" ...
 - attr(*, "url")= chr "https://waterservices.usgs.gov/nwis/dv/?site=01538000&format=waterml,1.1&ParameterCd=00060&StatCd=00003&startDT=1
851-01-01"
 - attr(*, "siteInfo")='data.frame':    1 obs. of  13 variables:
  ..$ station_nm          : chr "Wapwallopen Creek near Wapwallopen, PA"
  ..$ site_no             : chr "01538000"
  ..$ agency_cd           : chr "USGS"
  ..$ timeZoneOffset      : chr "-05:00"
  ..$ timeZoneAbbreviation: chr "EST"
  ..$ dec_lat_va          : num 41.1
  ..$ dec_lon_va          : num -76.1
  ..$ srs                 : chr "EPSG:4326"
  ..$ siteTypeCd          : chr "ST"
  ..$ hucCd               : chr "02050107"
  ..$ stateCd             : chr "42"
  ..$ countyCd            : chr "42079"
  ..$ network             : chr "NWIS"
 - attr(*, "variableInfo")='data.frame':        1 obs. of  7 variables:
  ..$ variableCode       : chr "00060"
  ..$ variableName       : chr "Streamflow, ft&#179;/s"
  ..$ variableDescription: chr "Discharge, cubic feet per second"
  ..$ valueType          : chr "Derived Value"
  ..$ unit               : chr "ft3/s"
  ..$ options            : chr "Mean"
  ..$ noDataValue        : logi NA
 - attr(*, "disclaimer")= chr "Provisional data are subject to revision. Go to http://waterdata.usgs.gov/nwis/help/?provisional for more
information."
 - attr(*, "statisticInfo")='data.frame':       1 obs. of  2 variables:
  ..$ statisticCd  : chr "00003"
  ..$ statisticName: chr "Mean"
 - attr(*, "queryTime")= POSIXct, format: "2017-02-06 23:42:00"
```

	agency_cd	site_no	Date	Flow	Flow_cd	rollMean	day.of.year
35552	USGS	01538000	2017-01-30	79	P	-199942.8	30
35553	USGS	01538000	2017-01-31	71	P	-199941.2	31
35554	USGS	01538000	2017-02-01	66	P	-199939.9	32
35555	USGS	01538000	2017-02-02	61	P	-199938.9	33
35556	USGS	01538000	2017-02-03	54	P	-199939.4	34
35557	USGS	01538000	2017-02-04	65	P	-199938.7	35

	agency_cd	site_no	Date	Flow	Flow_cd	rollMean	day.of.year
35552	USGS	01538000	2017-01-30	79	P	-199942.8	30
35553	USGS	01538000	2017-01-31	71	P	-199941.2	31
35554	USGS	01538000	2017-02-01	66	P	-199939.9	32
35555	USGS	01538000	2017-02-02	61	P	-199938.9	33
35556	USGS	01538000	2017-02-03	54	P	-199939.4	34
35557	USGS	01538000	2017-02-04	65	P	-199938.7	35

```
# A tibble: 1,098 x 7
   day.of.year       p75      p25      p10      p05       p00       Date
         <dbl>     <dbl>    <dbl>    <dbl>    <dbl>     <dbl>     <date>
1         -364 101.69167 40.11667 21.07333 14.30450 -233307.0 2015-01-01
2         -363 105.92500 41.60833 22.66567 16.89083 -233307.2 2015-01-02
3         -362 106.45000 41.31667 23.32900 17.16283 -233307.0 2015-01-03
4         -361 104.86667 40.76667 23.79767 17.22783 -233305.7 2015-01-04
5         -360 103.88333 41.01667 23.59900 17.33067 -233305.1 2015-01-05
6         -359 101.73333 41.61417 23.66900 17.77900 -233305.5 2015-01-06
7         -358  99.96667 42.16417 23.86900 19.86667 -233305.8 2015-01-07
8         -357 101.54167 42.05750 23.82867 20.04667 -266640.2 2015-01-08
9         -356  94.99167 41.66667 24.42333 20.98333 -299974.5 2015-01-09
10        -355  92.70000 41.41667 24.69333 20.83167 -333308.6 2015-01-10
# ... with 1,088 more rows
```

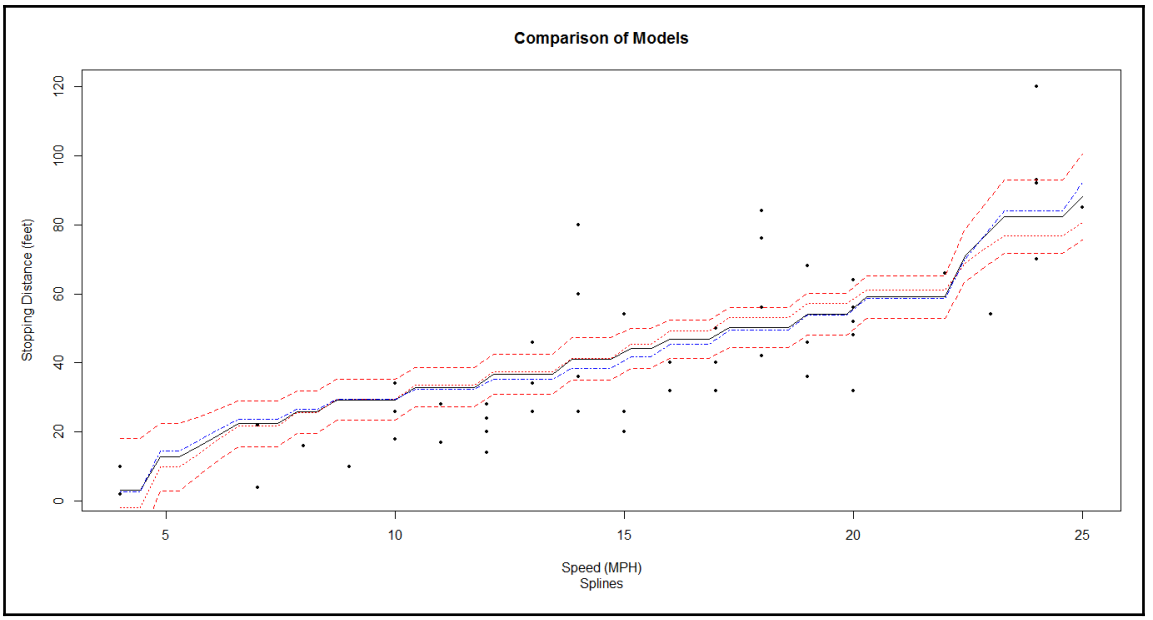
```
[1] 80.59694 81.44816 82.29218 83.12881 83.95787 84.77917
```

```
[1] 36.16151 36.16151 36.58664 37.00671 37.42077 37.82784
```

```
[1] 22.41312 22.41312 22.72999 23.04434 23.35553 23.66293
```

```
[1] 16.23024 16.23024 16.48055 16.73002 16.97826 17.22487
```

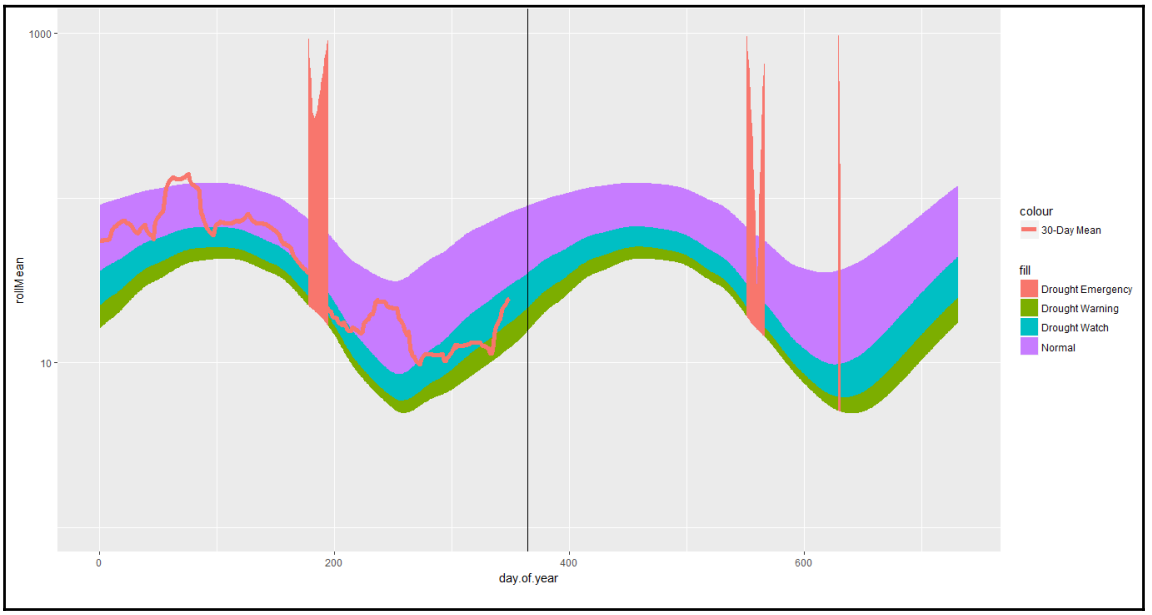
```
[1] -109716.7 -109716.7 -110200.7 -110650.7 -111063.8 -111437.1
```




```
# A tibble: 733 x 7
         Date day.of.year     sm.75     sm.25     sm.10     sm.05      sm.00
       <date>       <dbl>     <dbl>     <dbl>     <dbl>     <dbl>      <dbl>
1  2016-01-01           1 90.99353 36.16151 22.41312 16.23024 -109716.7
2  2016-01-01           1 90.99353 36.16151 22.41312 16.23024 -109716.7
3  2016-01-02           2 91.56954 36.58664 22.72999 16.48055 -110200.7
4  2016-01-03           3 92.13778 37.00671 23.04434 16.73002 -110650.7
5  2016-01-04           4 92.69719 37.42077 23.35553 16.97826 -111063.8
6  2016-01-05           5 93.24672 37.82784 23.66293 17.22487 -111437.1
7  2016-01-06           6 93.78531 38.22699 23.96590 17.46943 -111767.7
8  2016-01-07           7 94.31193 38.61726 24.26381 17.71154 -112052.9
9  2016-01-08           8 94.82552 38.99769 24.55602 17.95079 -112289.7
10 2016-01-09           9 95.32503 39.36733 24.84190 18.18678 -112475.3
# ... with 723 more rows
```

```
        Date day.of.year     sm.75     sm.25     sm.10     sm.05      sm.00
1 2016-01-01           1 90.99353 36.16151 22.41312 16.23024 -109716.7
2 2016-01-02           2 91.56954 36.58664 22.72999 16.48055 -110200.7
3 2016-01-03           3 92.13778 37.00671 23.04434 16.73002 -110650.7
4 2016-01-04           4 92.69719 37.42077 23.35553 16.97826 -111063.8
5 2016-01-05           5 93.24672 37.82784 23.66293 17.22487 -111437.1
6 2016-01-06           6 93.78531 38.22699 23.96590 17.46943 -111767.7
```

	Date	day.of.year	sm.75	sm.25	sm.10	sm.05	sm.00
1	2016-12-31	366	90.55267	35.63442	22.02318	15.95450	-109125.5
2	2017-01-01	366	90.55267	35.63442	22.02318	15.95450	-109125.5
3	2017-01-02	367	91.13212	36.10354	22.39240	16.25584	-109351.1
4	2017-01-03	368	91.71522	36.58013	22.76842	16.56302	-109564.3
5	2017-01-04	369	92.30089	37.06284	23.15014	16.87519	-109764.4
6	2017-01-05	370	92.88805	37.55033	23.53646	17.19149	-109951.0



Chapter 6: Supervised Learning

```
'data.frame':   303 obs. of  15 variables:
 $ X        : int  1 2 3 4 5 6 7 8 9 10 ...
 $ Age      : int  63 67 67 37 41 56 62 57 63 53 ...
 $ Sex      : int  1 1 1 1 0 1 0 0 1 1 ...
 $ ChestPain: Factor w/ 4 levels "asymptomatic",..: 4 1 1 2 3 3 1 1 1 1 ...
 $ RestBP   : int  145 160 120 130 130 120 140 120 130 140 ...
 $ Chol     : int  233 286 229 250 204 236 268 354 254 203 ...
 $ Fbs      : int  1 0 0 0 0 0 0 0 0 1 ...
 $ RestECG  : int  2 2 2 0 2 0 2 0 2 2 ...
 $ MaxHR    : int  150 108 129 187 172 178 160 163 147 155 ...
 $ ExAng    : int  0 1 1 0 0 0 0 1 0 1 ...
 $ Oldpeak  : num  2.3 1.5 2.6 3.5 1.4 0.8 3.6 0.6 1.4 3.1 ...
 $ Slope    : int  3 2 2 3 1 1 3 1 2 3 ...
 $ Ca       : int  0 3 2 0 0 0 2 0 1 0 ...
 $ Thal     : Factor w/ 3 levels "fixed","normal",..: 1 2 3 2 2 2 2 2 3 3 ...
 $ AHD      : Factor w/ 2 levels "No","Yes": 1 2 2 1 1 1 2 1 2 2 ...
```

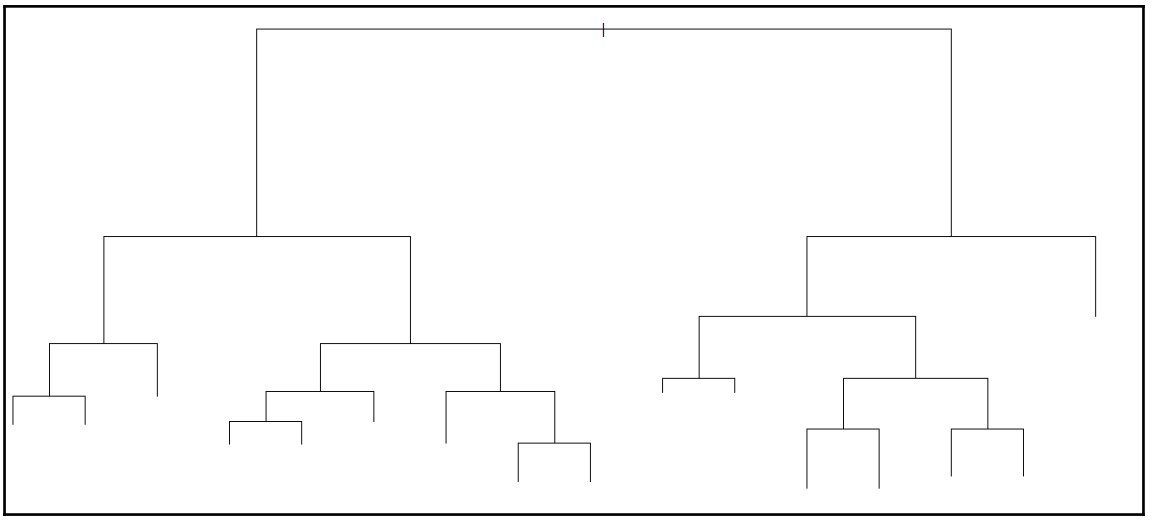
	X	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	Thal	AHD
1	1	63	1	typical	145	233	1	2	150	0	2.3	3	0	fixed	No
2	2	67	1	asymptomatic	160	286	0	2	108	1	1.5	2	3	normal	Yes
3	3	67	1	asymptomatic	120	229	0	2	129	1	2.6	2	2	reversable	Yes
4	4	37	1	nonanginal	130	250	0	0	187	0	3.5	3	0	normal	No
5	5	41	0	nontypical	130	204	0	2	172	0	1.4	1	0	normal	No
6	6	56	1	nontypical	120	236	0	0	178	0	0.8	1	0	normal	No

```
[1] 303  15
```

```
      Resample1
 [1,]         1
 [2,]         3
 [3,]         4
 [4,]         5
 [5,]         7
 [6,]         8
 [7,]        13
 [8,]        18
 [9,]        19
[10,]        21
[11,]        23
[12,]        24
[13,]        26
[14,]        27
[15,]        28
[16,]        29
[17,]        30
[18,]        31
[19,]        32
[20,]        33
[21,]        34
[22,]        37
[23,]        38
[24,]        40
[25,]        41
[26,]        43
[27,]        44
[28,]        45
[29,]        48
```

	X	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	Thal	AHD
1	1	63	1	typical	145	233	1	2	150	0	2.3	3	0	fixed	No
3	3	67	1	asymptomatic	120	229	0	2	129	1	2.6	2	2	reversable	Yes
4	4	37	1	nonanginal	130	250	0	0	187	0	3.5	3	0	normal	No
5	5	41	0	nontypical	130	204	0	2	172	0	1.4	1	0	normal	No
7	7	62	0	asymptomatic	140	268	0	2	160	0	3.6	3	2	normal	Yes
8	8	57	0	asymptomatic	120	354	0	0	163	1	0.6	1	0	normal	No
13	13	56	1	nonanginal	130	256	1	2	142	1	0.6	2	1	fixed	Yes
18	18	54	1	asymptomatic	140	239	0	0	160	0	1.2	1	0	normal	No
19	19	48	0	nonanginal	130	275	0	0	139	0	0.2	1	0	normal	No
21	21	64	1	typical	110	211	0	2	144	1	1.8	2	0	normal	No
23	23	58	1	nontypical	120	284	0	2	160	0	1.8	2	0	normal	Yes
24	24	58	1	nonanginal	132	224	0	2	173	0	3.2	1	2	reversable	Yes
26	26	50	0	nonanginal	120	219	0	0	158	0	1.6	2	0	normal	No
27	27	58	0	nonanginal	120	340	0	0	172	0	0.0	1	0	normal	No
28	28	66	0	typical	150	226	0	0	114	0	2.6	3	0	normal	No
29	29	43	1	asymptomatic	150	247	0	0	171	0	1.5	1	0	normal	No
30	30	40	1	asymptomatic	110	167	0	2	114	1	2.0	2	0	reversable	Yes
31	31	69	0	typical	140	239	0	0	151	0	1.8	1	2	normal	No
32	32	60	1	asymptomatic	117	230	1	0	160	1	1.4	1	2	reversable	Yes
33	33	64	1	nonanginal	140	335	0	0	158	0	0.0	1	0	normal	Yes
34	34	59	1	asymptomatic	135	234	0	0	161	0	0.5	2	0	reversable	No
37	37	43	1	asymptomatic	120	177	0	2	120	1	2.5	2	0	reversable	Yes
38	38	57	1	asymptomatic	150	276	0	2	112	1	0.6	2	1	fixed	Yes
40	40	61	1	nonanginal	150	243	1	0	137	1	1.0	2	0	normal	No
41	41	65	0	asymptomatic	150	225	0	2	114	0	1.0	2	3	reversable	Yes
43	43	71	0	nontypical	160	302	0	0	162	0	0.4	1	2	normal	No
44	44	59	1	nonanginal	150	212	1	0	157	0	1.6	1	0	normal	No
45	45	61	0	asymptomatic	130	330	0	2	169	0	0.0	1	0	normal	Yes

	X	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	Thal	AHD
2	2	67	1	asymptomatic	160	286	0	2	108	1	1.5	2	3	normal	Yes
6	6	56	1	nontypical	120	236	0	0	178	0	0.8	1	0	normal	No
9	9	63	1	asymptomatic	130	254	0	2	147	0	1.4	2	1	reversable	Yes
10	10	53	1	asymptomatic	140	203	1	2	155	1	3.1	3	0	reversable	Yes
11	11	57	1	asymptomatic	140	192	0	0	148	0	0.4	2	0	fixed	No
12	12	56	0	nontypical	140	294	0	2	153	0	1.3	2	0	normal	No
14	14	44	1	nontypical	120	263	0	0	173	0	0.0	1	0	reversable	No
15	15	52	1	nonanginal	172	199	1	0	162	0	0.5	1	0	reversable	No
16	16	57	1	nonanginal	150	168	0	0	174	0	1.6	1	0	normal	No
17	17	48	1	nontypical	110	229	0	0	168	0	1.0	3	0	reversable	Yes
20	20	49	1	nontypical	130	266	0	0	171	0	0.6	1	0	normal	No
22	22	58	0	typical	150	283	1	2	162	0	1.0	1	0	normal	No
25	25	60	1	asymptomatic	130	206	0	2	132	1	2.4	2	2	reversable	Yes
35	35	44	1	nonanginal	130	233	0	0	179	1	0.4	1	0	normal	No
36	36	42	1	asymptomatic	140	226	0	0	178	0	0.0	1	0	normal	No
39	39	55	1	asymptomatic	132	353	0	0	132	1	1.2	2	1	reversable	Yes
42	42	40	1	typical	140	199	0	0	178	1	1.4	1	0	reversable	No
46	46	58	1	nonanginal	112	230	0	2	165	0	2.5	2	1	reversable	Yes
47	47	51	1	nonanginal	110	175	0	0	123	0	0.6	1	0	normal	No
50	50	53	1	nonanginal	130	197	1	2	152	0	1.2	3	0	normal	No
55	55	60	1	asymptomatic	130	253	0	0	144	1	1.4	1	1	reversable	Yes
56	56	54	1	asymptomatic	124	266	0	2	109	1	2.2	2	1	reversable	Yes
60	60	51	1	typical	125	213	0	2	125	1	1.4	1	1	normal	No
61	61	51	0	asymptomatic	130	305	0	0	142	1	1.2	2	0	reversable	Yes
65	65	54	1	asymptomatic	120	188	0	0	113	0	1.4	2	1	reversable	Yes
66	66	60	1	asymptomatic	145	282	0	2	142	1	2.8	2	2	reversable	Yes
71	71	65	0	nonanginal	155	269	0	0	148	0	0.8	1	0	normal	No



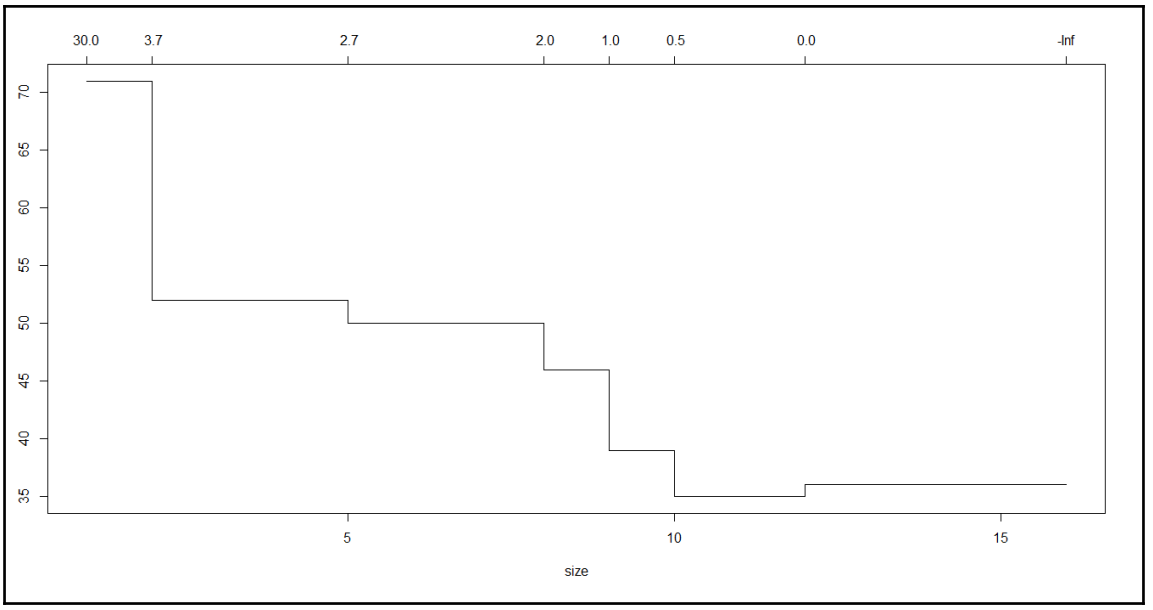
```
$size
[1] 16 12 10  9  8  5  2  1

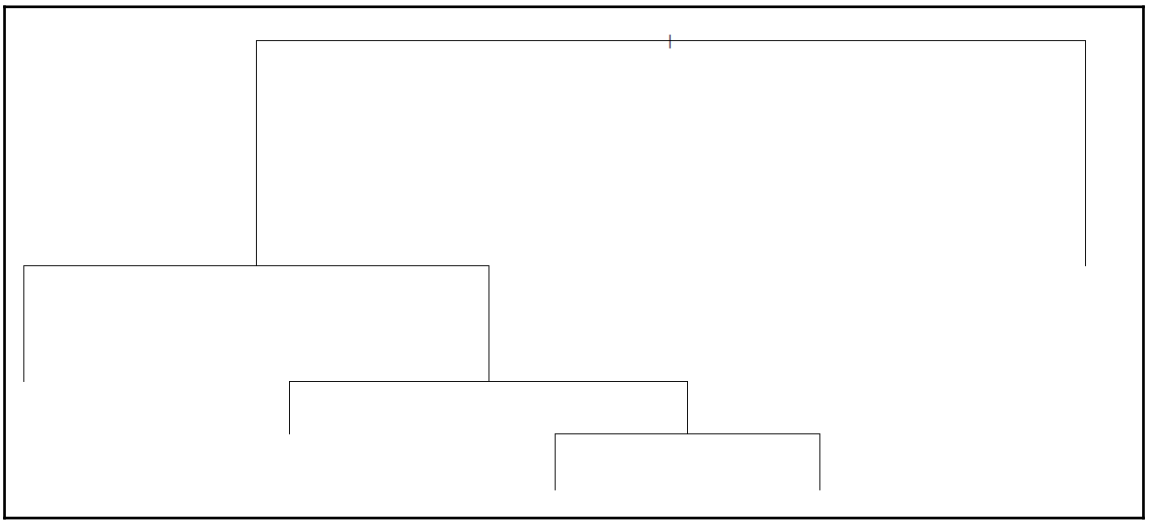
$dev
[1] 36 36 35 39 46 50 52 71

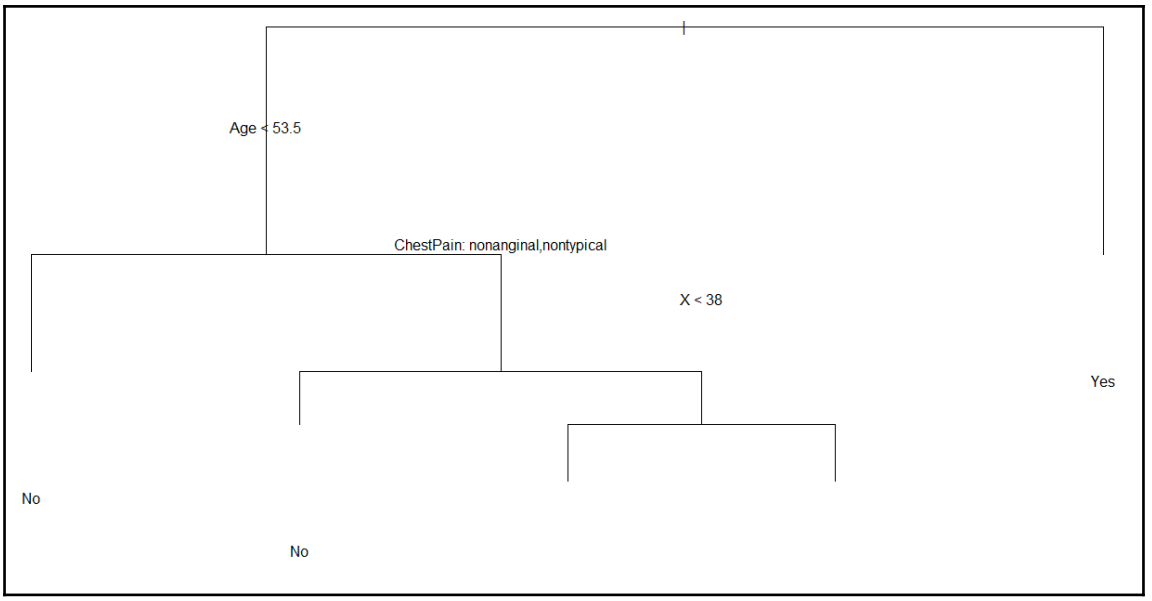
$k
[1]      -Inf  0.000000  0.500000  1.000000  2.000000  2.666667  3.666667 30.000000

$method
[1] "misclass"

attr(,"class")
[1] "prune"         "tree.sequence"
```


30.0
3.7
2.7
2.0
1.0
0.5
0.0
-Inf
70
65
60
55
50
45
40
35
5
10
15
size






```
  [1] No  No  Yes Yes Yes No  Yes Yes No  Yes No  No  Yes No  No  Yes Yes Yes No  No  Yes Yes No  Yes Yes Yes
No  Yes Yes Yes
 [31] No  Yes No  Yes No  No  No  Yes Yes Yes No  No  Yes No  No  No  Yes No  Yes Yes Yes Yes Yes Yes No  No
Yes Yes Yes Yes
 [61] No  Yes No  Yes Yes Yes Yes Yes No  No  Yes No  Yes Yes Yes Yes Yes Yes No  No  Yes Yes Yes Yes Yes Yes
Yes Yes No  Yes
 [91] Yes Yes No  Yes No  No  Yes Yes Yes Yes No  No  No  Yes Yes No  No  No  No  Yes No  Yes No  No  Yes No
No  No  Yes Yes
[121] No  Yes Yes Yes Yes No  Yes Yes No  Yes No  Yes Yes No  No  Yes Yes Yes No  Yes Yes No  Yes No  Yes Yes
No  Yes Yes Yes
[151] No
Levels: No Yes
```

```
Confusion Matrix and Statistics

          Reference
Prediction No Yes
       No  54   6
       Yes 28  63

               Accuracy : 0.7748
                 95% CI : (0.6998, 0.8387)
    No Information Rate : 0.543
    P-Value [Acc > NIR] : 2.86e-09

                  Kappa : 0.5575
 Mcnemar's Test P-Value : 0.0003164

            Sensitivity : 0.6585
            Specificity : 0.9130
         Pos Pred Value : 0.9000
         Neg Pred Value : 0.6923
             Prevalence : 0.5430
         Detection Rate : 0.3576
   Detection Prevalence : 0.3974
      Balanced Accuracy : 0.7858

       'Positive' Class : No
```

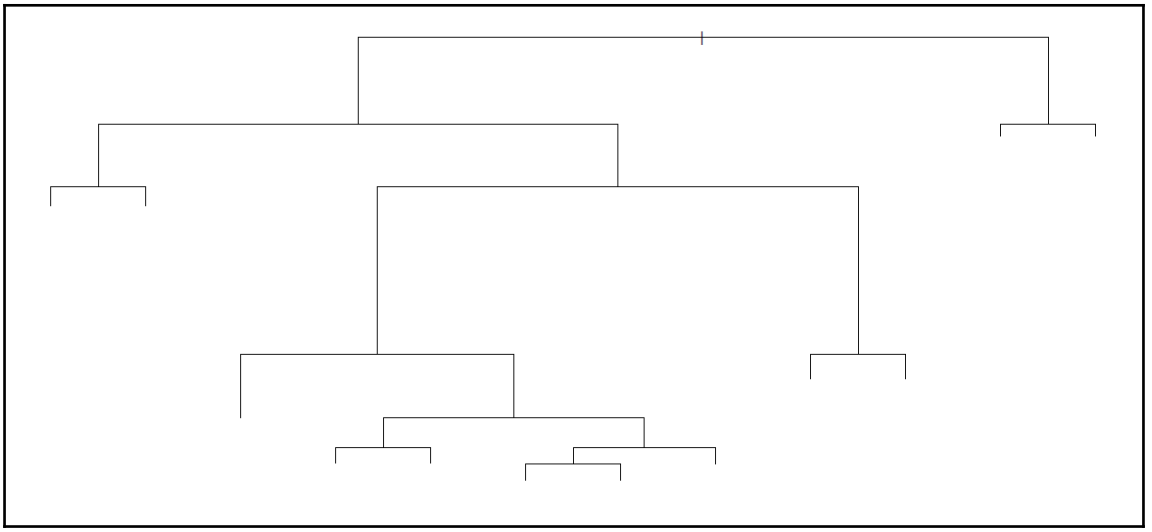
```
  [1] 20640     9
```

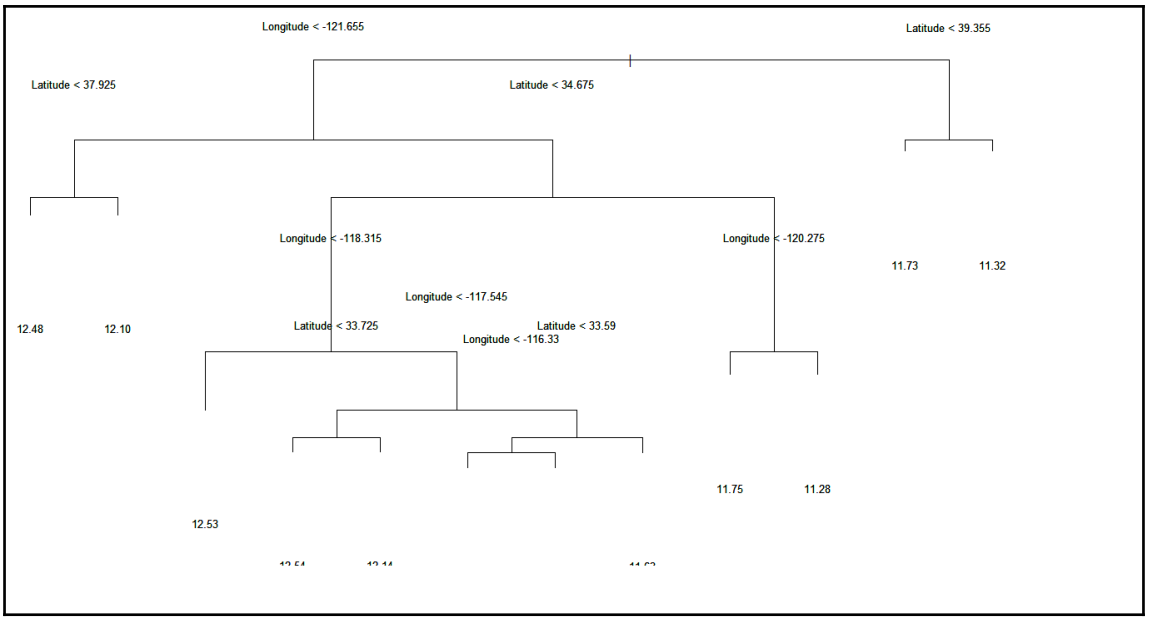
```
'data.frame':   20640 obs. of  9 variables:
 $ MedianHouseValue: num  452600 358500 352100 341300 342200 ...
 $ MedianIncome    : num  8.33 8.3 7.26 5.64 3.85 ...
 $ MedianHouseAge  : num  41 21 52 52 52 52 52 52 42 52 ...
 $ TotalRooms      : num  880 7099 1467 1274 1627 ...
 $ TotalBedrooms   : num  129 1106 190 235 280 ...
 $ Population      : num  322 2401 496 558 565 ...
 $ Households      : num  126 1138 177 219 259 ...
 $ Latitude        : num  37.9 37.9 37.9 37.9 37.9 ...
 $ Longitude       : num  -122 -122 -122 -122 -122 ...
```

	MedianHouseValue	MedianIncome	MedianHouseAge	TotalRooms	TotalBedrooms	Population	Households	Latitude	Longitude
1	452600	8.3252	41	880	129	322	126	37.88	-122.23
2	358500	8.3014	21	7099	1106	2401	1138	37.86	-122.22
3	352100	7.2574	52	1467	190	496	177	37.85	-122.24
4	341300	5.6431	52	1274	235	558	219	37.85	-122.25
5	342200	3.8462	52	1627	280	565	259	37.85	-122.25
6	269700	4.0368	52	919	213	413	193	37.85	-122.25

```
 MedianHouseValue  MedianIncome     MedianHouseAge    TotalRooms     TotalBedrooms      Population
 Min.    : 14999   Min.    : 0.4999   Min.    : 1.00   Min.    :    2   Min.    :   1.0   Min.    :    3
 1st Qu.:119600    1st Qu.: 2.5634    1st Qu.:18.00    1st Qu.: 1448    1st Qu.: 295.0    1st Qu.:  787
 Median :179700    Median : 3.5348    Median :29.00    Median : 2127    Median : 435.0    Median : 1166
 Mean   :206856    Mean   : 3.8707    Mean   :28.64    Mean   : 2636    Mean   : 537.9    Mean   : 1425
 3rd Qu.:264725    3rd Qu.: 4.7432    3rd Qu.:37.00    3rd Qu.: 3148    3rd Qu.: 647.0    3rd Qu.: 1725
 Max.    :500001   Max.    :15.0001   Max.    :52.00    Max.    :39320   Max.    :6445.0   Max.    :35682
   Households        Latitude       Longitude
 Min.    :   1.0   Min.    :32.54   Min.    :-124.3
 1st Qu.: 280.0    1st Qu.:33.93    1st Qu.:-121.8
 Median : 409.0    Median :34.26    Median :-118.5
 Mean   : 499.5    Mean   :35.63    Mean   :-119.6
 3rd Qu.: 605.0    3rd Qu.:37.71    3rd Qu.:-118.0
 Max.    :6082.0   Max.    :41.95   Max.    :-114.3
```

```
Regression tree:
tree(formula = log(MedianHouseValue) ~ Longitude + Latitude,
    data = realEstate)
Number of terminal nodes:  12
Residual mean deviance:  0.1662 = 3429 / 20630
Distribution of residuals:
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
-2.75900 -0.26080 -0.01359  0.00000  0.26310  1.84100
```



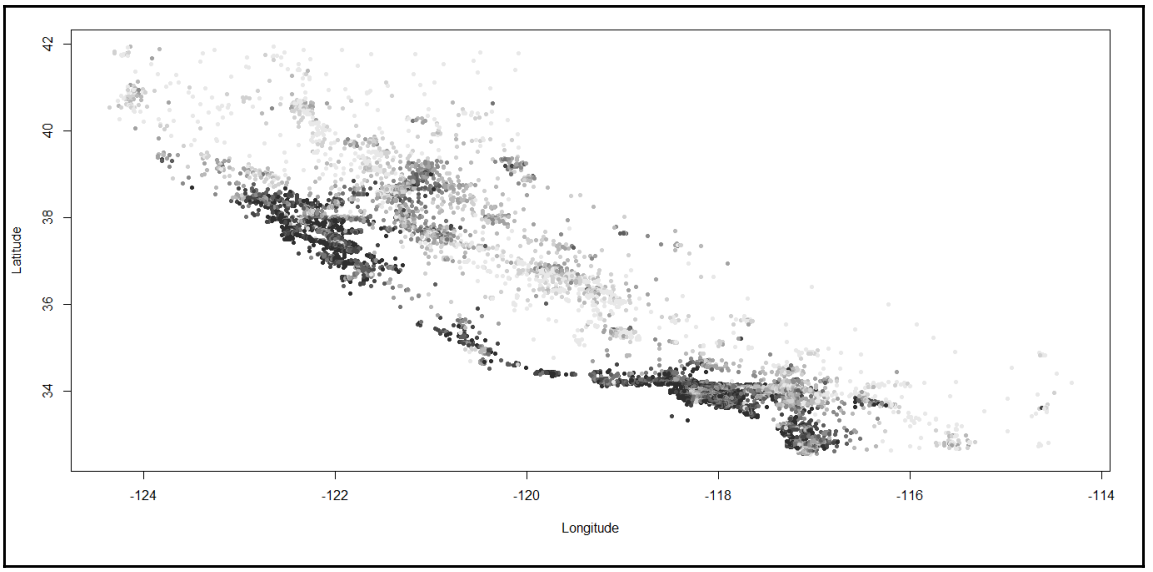



```
   0%    10%    20%    30%    40%    50%    60%    70%    80%    90%   100%
14999  82300 107200 134000 157300 179700 209400 241930 290000 376600 500001
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  15000  120600  179700  208500  266000  500000
```

```
[1] (3.77e+05,5e+05]   (2.9e+05,3.77e+05] (2.9e+05,3.77e+05] (2.9e+05,3.77e+05] (2.9e+05,3.77e+05]
[6] (2.42e+05,2.9e+05]
10 Levels: [1.5e+04,8.23e+04] (8.23e+04,1.07e+05] (1.07e+05,1.34e+05] ... (3.77e+05,5e+05]
```

```
 [1.5e+04,8.23e+04] (8.23e+04,1.07e+05] (1.07e+05,1.34e+05] (1.34e+05,1.57e+05]
               2066                2063                2064                2065
(1.57e+05,1.8e+05]  (1.8e+05,2.09e+05] (2.09e+05,2.42e+05]  (2.42e+05,2.9e+05]
               2065                2067                2058                2067
(2.9e+05,3.77e+05]    (3.77e+05,5e+05]
               2062                2063
```

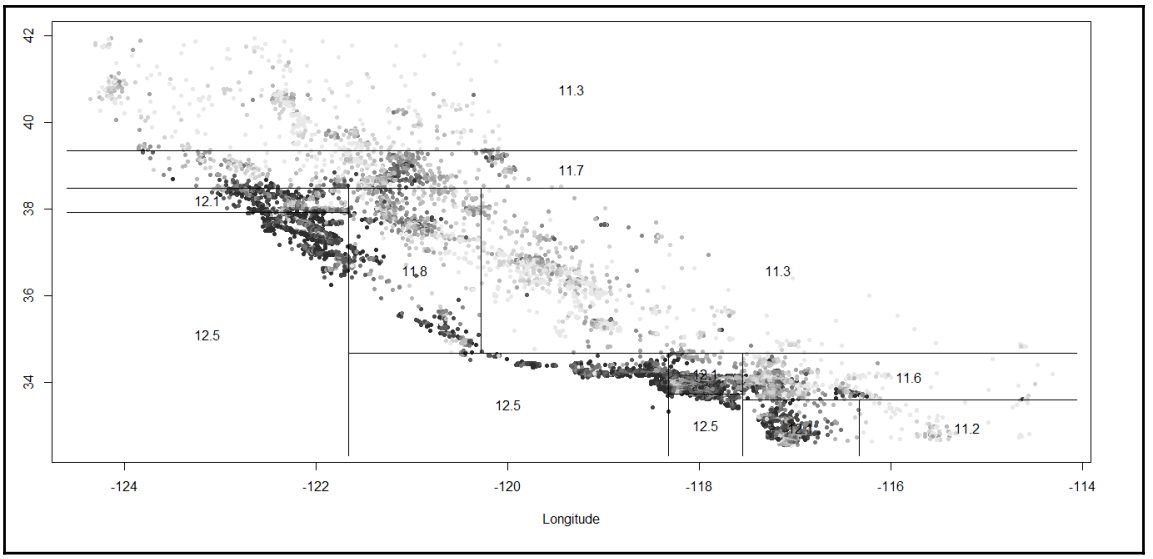



```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-124.4  -121.8  -118.5  -119.6  -118.0  -114.3
```

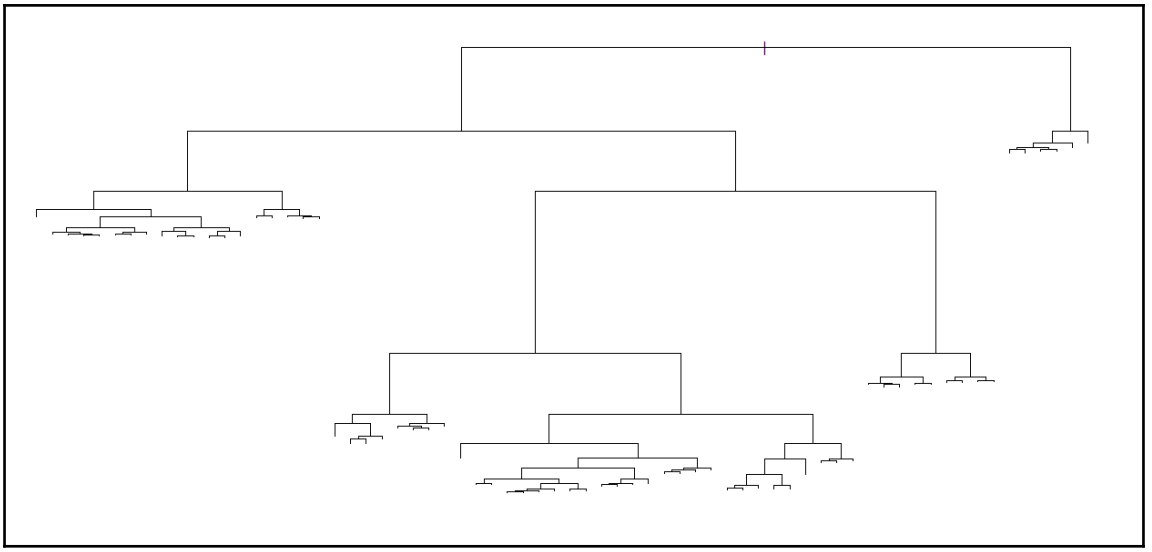
```
[1] -122.23 -122.22 -122.24 -122.25 -122.25 -122.25
```

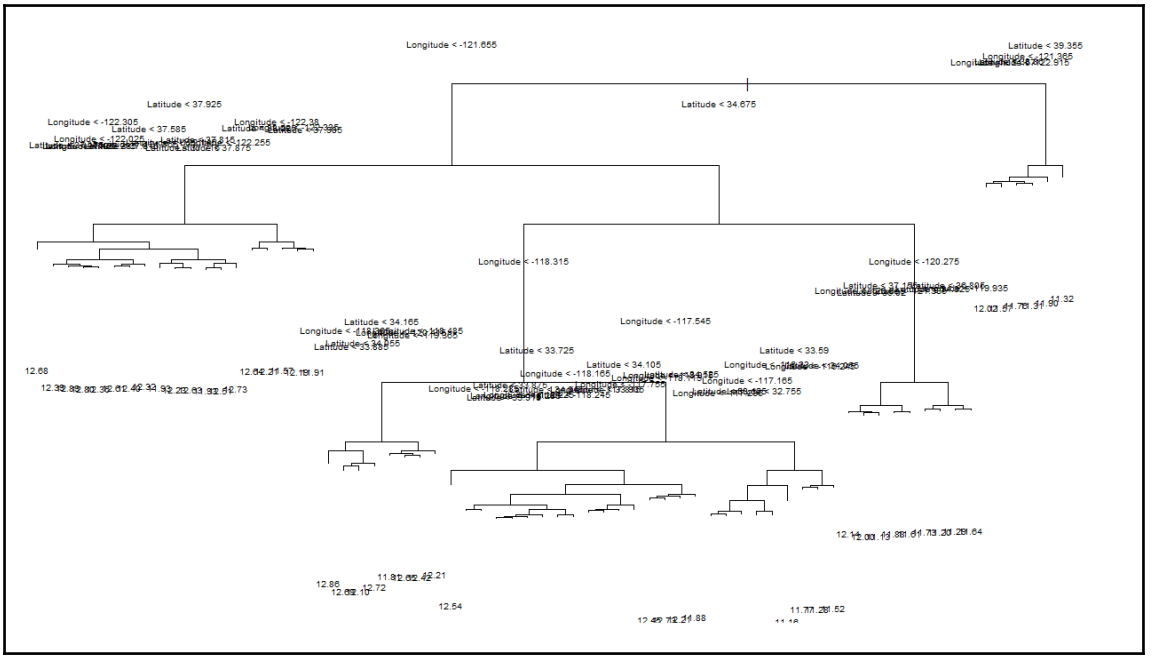
```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  32.54   33.93   34.26   35.63   37.71   41.95
```

```
[1] 37.88 37.86 37.85 37.85 37.85 37.85
```

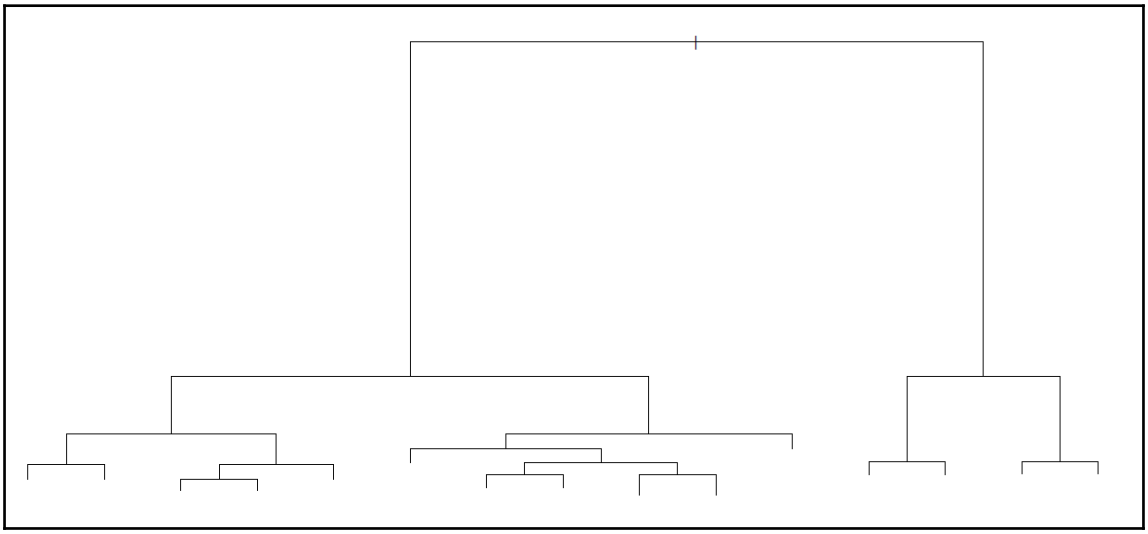


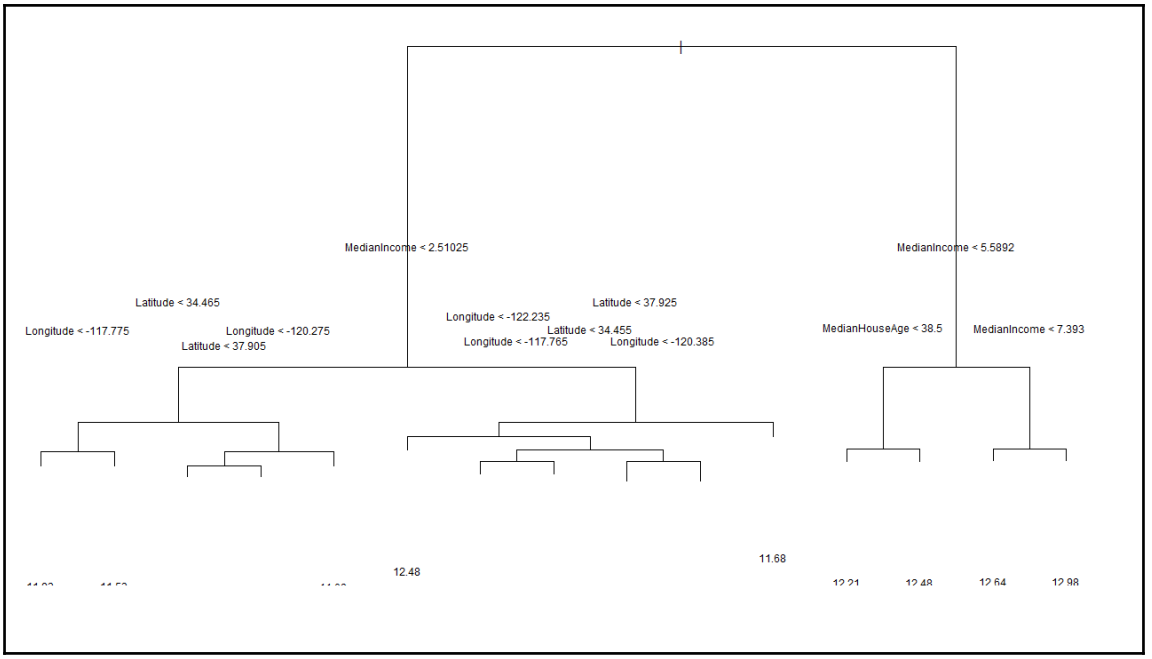

```
Regression tree:
tree(formula = log(MedianHouseValue) ~ Longitude + Latitude,
    data = realEstate, mindev = 0.001)
Number of terminal nodes:  68
Residual mean deviance:  0.1052 = 2164 / 20570
Distribution of residuals:
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
-2.94700 -0.19790 -0.01872  0.00000  0.19970  1.60600
```




Longitude < -121.655
Latitude < 39.355
Latitude < 37.925
Latitude < 34.675
Longitude < -122.305
Latitude < 37.585
Longitude < -118.315
Longitude < -120.275
Latitude < 34.165
Longitude < -117.545
Latitude < 33.725
Latitude < 34.105
Latitude < 33.59
Longitude < -118.165
Longitude < -117.165
12.68
32.755

```
Regression tree:
tree(formula = log(MedianHouseValue) ~ ., data = realEstate)
Variables actually used in tree construction:
[1] "MedianIncome"   "Latitude"       "Longitude"      "MedianHouseAge"
Number of terminal nodes:  15
Residual mean deviance:  0.1321 = 2724 / 20620
Distribution of residuals:
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
-2.86000 -0.22650 -0.01475  0.00000  0.20740  2.03900
```




MedianIncome < 2.51025
MedianIncome < 5.5892
Latitude < 34.465
Longitude < -117.775
Longitude < -120.275
Latitude < 37.905
Longitude < -122.235
Latitude < 37.925
Latitude < 34.455
Longitude < -117.765
Longitude < -120.385
MedianHouseAge < 38.5
MedianIncome < 7.393
12.48
11.68
12.21
12.48
12.64
12.98

	EMA
2012-01-03	NA
2012-01-04	NA
2012-01-05	NA
2012-01-06	92.592593
2012-01-09	93.495935
2012-01-10	96.078431
2012-01-11	97.435897
2012-01-12	98.868258
2012-01-13	47.664109
2012-01-17	57.014319
2012-01-18	45.653652
2012-01-19	79.354816
2012-01-20	59.192256
2012-01-23	67.711649
2012-01-24	65.434854
2012-01-25	71.828809
2012-01-26	84.090916
2012-01-27	51.691301
2012-01-30	43.341684
2012-01-31	49.463943
2012-02-01	61.835597
2012-02-02	79.102066
2012-02-03	88.807546
2012-02-06	91.969539
2012-02-07	94.722215
2012-02-08	94.886539
2012-02-09	98.059105
2012-02-10	57.977139
2012-02-13	72.331575
2012-02-14	56.532020
2012-02-15	40.898355
2012-02-16	21.651993
2012-02-17	55.896895
2012-02-21	54.807992

```
2012-01-13 -0.0130370370
2012-01-17  0.0846419753
2012-01-18 -0.0302386831
2012-01-19  0.4531742112
2012-01-20  0.1287828075
2012-01-23  0.2058552050
2012-01-24  0.1239034700
2012-01-25  0.1426023133
2012-01-26  0.2617348756
2012-01-27  0.0144899170
2012-01-30 -0.0436733886
2012-01-31 -0.0024489258
2012-02-01  0.0517007162
2012-02-02  0.1544671441
2012-02-03  0.2563114294
2012-02-06  0.2575409529
2012-02-07  0.2783606353
2012-02-08  0.1922404235
2012-02-09  0.3614936157
2012-02-10  0.0676624105
2012-02-13  0.1917749403
2012-02-14  0.0478499602
2012-02-15 -0.0614333599
2012-02-16 -0.2409555732
2012-02-17  0.0593629512
2012-02-21  0.0329086341
2012-02-22  0.0419390894
2012-02-23 -0.0320406071
2012-02-24  0.0319729286
2012-02-27 -0.1520180476
2012-02-28  0.0719879683
```

```
[1] 502   1
```

```
An 'xts' object on 2012-01-03/2013-12-31 containing:
  Data: num [1:502, 1] NA NA NA NA 5.94 ...
 - attr(*, "dimnames")=List of 2
  ..$ : NULL
  ..$ : chr "EMA"
  Indexed by objects of class: [Date] TZ: UTC
  xts Attributes:
List of 2
 $ src    : chr "yahoo"
 $ updated: POSIXct[1:1], format: "2016-07-22 15:13:25"
```

	macd	signal
2012-01-03	NA	NA
2012-01-04	NA	NA
2012-01-05	NA	NA
2012-01-06	NA	NA
2012-01-09	NA	NA
2012-01-10	NA	NA
2012-01-11	NA	NA
2012-01-12	NA	NA
2012-01-13	NA	NA
2012-01-17	NA	NA
2012-01-18	NA	NA
2012-01-19	NA	NA
2012-01-20	NA	NA
2012-01-23	NA	NA
2012-01-24	NA	NA
2012-01-25	NA	NA
2012-01-26	NA	NA
2012-01-27	NA	NA
2012-01-30	NA	NA
2012-01-31	NA	NA
2012-02-01	NA	NA
2012-02-02	NA	NA
2012-02-03	NA	NA
2012-02-06	NA	NA
2012-02-07	NA	NA
2012-02-08	7.805070032	NA
2012-02-09	8.085846209	NA
2012-02-10	7.922208050	NA
2012-02-13	7.922024506	NA
2012-02-14	7.696811589	NA
2012-02-15	7.283884784	NA
2012-02-16	6.569682439	NA
2012-02-17	6.272487938	NA
2012-02-21	5.955405657	7.279269023
2012-02-22	5.667469977	6.956909214

	macd	signal
2012-01-03	NA	NA
2012-01-04	NA	NA
2012-01-05	NA	NA
2012-01-06	NA	NA
2012-01-09	NA	NA
2012-01-10	NA	NA

2012-01-17	NA
2012-01-18	NA
2012-01-19	NA
2012-01-20	NA
2012-01-23	NA
2012-01-24	NA
2012-01-25	NA
2012-01-26	NA
2012-01-27	NA
2012-01-30	NA
2012-01-31	NA
2012-02-01	NA
2012-02-02	NA
2012-02-03	NA
2012-02-06	NA
2012-02-07	NA
2012-02-08	NA
2012-02-09	NA
2012-02-10	NA
2012-02-13	NA
2012-02-14	NA
2012-02-15	NA
2012-02-16	NA
2012-02-17	NA
2012-02-21	7.279269023
2012-02-22	6.956909214
2012-02-23	6.622470704
2012-02-24	6.298893029
2012-02-27	5.932154164
2012-02-28	5.596629643
2012-02-29	5.307348654

2012-01-12	NA	NA
2012-01-13	NA	NA
2012-01-17	NA	NA
2012-01-18	NA	NA
2012-01-19	NA	NA
2012-01-20	NA	NA
2012-01-23	NA	NA
2012-01-24	NA	NA
2012-01-25	NA	NA
2012-01-26	NA	NA
2012-01-27	NA	NA
2012-01-30	NA	NA
2012-01-31	NA	NA
2012-02-01	NA	NA
2012-02-02	NA	NA
2012-02-03	NA	NA
2012-02-06	NA	NA
2012-02-07	NA	NA
2012-02-08	80.3129074	NA
2012-02-09	82.8992932	NA
2012-02-10	81.1582428	NA
2012-02-13	81.7157047	NA
2012-02-14	81.1498062	NA
2012-02-15	78.4958391	NA
2012-02-16	71.6591168	NA
2012-02-17	68.1994284	NA
2012-02-21	65.4572862	76.78306943
2012-02-22	62.9139401	74.00924356
2012-02-23	59.2364325	71.05468134
2012-02-24	56.2995258	68.10365022
2012-02-27	50.2837296	64.53966610

2012-02-03	NA	NA
2012-02-06	NA	NA
2012-02-07	NA	NA
2012-02-08	80.3129074	NA
2012-02-09	82.8992932	NA
2012-02-10	81.1582428	NA
2012-02-13	81.7157047	NA
2012-02-14	81.1498062	NA
2012-02-15	78.4958391	NA
2012-02-16	71.6591168	NA
2012-02-17	68.1994284	NA
2012-02-21	65.4572862	76.78306943
2012-02-22	62.9139401	74.00924356
2012-02-23	59.2364325	71.05468134
2012-02-24	56.2995258	68.10365022
2012-02-27	50.2837296	64.53966610
2012-02-28	46.8890757	61.00954803
2012-02-29	46.3290434	58.07344711
2012-03-01	45.7386847	55.60649462
2012-03-02	46.5724049	53.79967668
2012-03-05	47.5768473	52.55511079
2012-03-06	43.9686727	50.83782317
2012-03-07	39.0152520	48.47330894
2012-03-08	37.8043691	46.33952098
2012-03-09	38.6988311	44.81138300
2012-03-12	38.4206230	43.53323099
2012-03-13	38.8030183	42.58718845
2012-03-14	43.5628586	42.78232248
2012-03-15	50.4453915	44.31493628
2012-03-16	58.2642458	47.10479819
2012-03-19	65.7203944	50.82791743

2012-01-26	NA
2012-01-27	NA
2012-01-30	NA
2012-01-31	NA
2012-02-01	NA
2012-02-02	NA
2012-02-03	NA
2012-02-06	NA
2012-02-07	NA
2012-02-08	80.3129074
2012-02-09	82.8992932
2012-02-10	81.1582428
2012-02-13	81.7157047
2012-02-14	81.1498062
2012-02-15	78.4958391
2012-02-16	71.6591168
2012-02-17	68.1994284
2012-02-21	65.4572862
2012-02-22	62.9139401
2012-02-23	59.2364325
2012-02-24	56.2995258
2012-02-27	50.2837296
2012-02-28	46.8890757
2012-02-29	46.3290434
2012-03-01	45.7386847
2012-03-02	46.5724049
2012-03-05	47.5768473
2012-03-06	43.9686727
2012-03-07	39.0152520
2012-03-08	37.8043691
2012-03-09	38.6988311

```
           BAC.Close
2012-01-03 "UP"
2012-01-04 "UP"
2012-01-05 "UP"
2012-01-06 "DOWN"
2012-01-09 "UP"
2012-01-10 "UP"
2012-01-11 "UP"
2012-01-12 "DOWN"
2012-01-13 "UP"
2012-01-17 "DOWN"
2012-01-18 "UP"
2012-01-19 "DOWN"
2012-01-20 "UP"
2012-01-23 "UP"
2012-01-24 "UP"
2012-01-25 "UP"
2012-01-26 "DOWN"
2012-01-27 "UP"
2012-01-30 "DOWN"
2012-01-31 "DOWN"
2012-02-01 "UP"
2012-02-02 "UP"
2012-02-03 "UP"
2012-02-06 "UP"
2012-02-07 "DOWN"
2012-02-08 "UP"
2012-02-09 "DOWN"
2012-02-10 "UP"
2012-02-13 "DOWN"
```

```
An 'xts' object on 2012-01-03/2013-12-31 containing:
  Data: chr [1:502, 1] "UP" "UP" "UP" "DOWN" "UP" "UP" "UP" "DOWN" "UP" "DOWN" "UP" ...
 - attr(*, "dimnames")=List of 2
  ..$ : NULL
  ..$ : chr "BAC.Close"
  Indexed by objects of class: [Date] TZ:
  xts Attributes:
NULL
```

	EMA	BAC.Open	signal	SMI	BAC.Close
2012-01-03	NA	NA	NA	NA	UP
2012-01-04	NA	NA	NA	NA	UP
2012-01-05	NA	NA	NA	NA	UP
2012-01-06	92.592593	NA	NA	NA	DOWN
2012-01-09	93.495935	0.3240000000	NA	NA	UP
2012-01-10	96.078431	0.3360000000	NA	NA	UP
2012-01-11	97.435897	0.3306666667	NA	NA	UP
2012-01-12	98.868258	0.4804444444	NA	NA	DOWN
2012-01-13	47.664109	-0.0130370370	NA	NA	UP
2012-01-17	57.014319	0.0846419753	NA	NA	DOWN
2012-01-18	45.653652	-0.0302386831	NA	NA	UP
2012-01-19	79.354816	0.4531742112	NA	NA	DOWN
2012-01-20	59.192256	0.1287828075	NA	NA	UP
2012-01-23	67.711649	0.2058552050	NA	NA	UP
2012-01-24	65.434854	0.1239034700	NA	NA	UP
2012-01-25	71.828809	0.1426023133	NA	NA	UP
2012-01-26	84.090916	0.2617348756	NA	NA	DOWN
2012-01-27	51.691301	0.0144899170	NA	NA	UP
2012-01-30	43.341684	-0.0436733886	NA	NA	DOWN
2012-01-31	49.463943	-0.0024489258	NA	NA	DOWN
2012-02-01	61.835597	0.0517007162	NA	NA	UP
2012-02-02	79.102066	0.1544671441	NA	NA	UP
2012-02-03	88.807546	0.2563114294	NA	NA	UP
2012-02-06	91.969539	0.2575409529	NA	NA	UP
2012-02-07	94.722215	0.2783606353	NA	NA	DOWN
2012-02-08	94.886539	0.1922404235	NA	80.3129074	UP
2012-02-09	98.059105	0.3614936157	NA	82.8992932	DOWN
2012-02-10	57.977139	0.0676624105	NA	81.1582428	UP
2012-02-13	72.331575	0.1917749403	NA	81.7157047	DOWN

	EMA	BAC.Open	signal	SMI	BAC.Close
2012-01-03	NA	NA	NA	NA	UP
2012-01-04	NA	NA	NA	NA	UP
2012-01-05	NA	NA	NA	NA	UP
2012-01-06	92.59259	NA	NA	NA	DOWN
2012-01-09	93.49593	0.324	NA	NA	UP
2012-01-10	96.07843	0.336	NA	NA	UP

```
'data.frame':   502 obs. of  5 variables:
 $ EMA      : num  NA NA NA 92.6 93.5 ...
 $ BAC.Open : num  NA NA NA NA 0.324 ...
 $ signal   : num  NA NA NA NA NA NA NA NA NA NA ...
 $ SMI      : num  NA NA NA NA NA NA NA NA NA NA ...
 $ BAC.Close: Factor w/ 2 levels "DOWN","UP": 2 2 2 1 2 2 2 1 2 1 ...
```

```
[1] "relativeStrengthIndex3"       "exponentialMovingAverageDiff" "MACDsignal"
[4] "stochasticOscillator"         "binaryClassification"
```

	relativeStrengthIndex3	exponentialMovingAverageDiff	MACDsignal	stochasticOscillator	binaryClassification
2012-02-21	54.807992	0.0329086341	7.279269023	65.4572862	UP
2012-02-22	58.450340	0.0419390894	6.956909214	62.9139401	DOWN
2012-02-23	42.893436	-0.0320406071	6.622470704	59.2364325	UP
2012-02-24	57.851032	0.0319729286	6.298893029	56.2995258	DOWN
2012-02-27	25.408018	-0.1520180476	5.932154164	50.2837296	UP
2012-02-28	59.487389	0.0719879683	5.596629643	46.8890757	UP
2012-02-29	68.593445	0.1213253122	5.307348654	46.3290434	DOWN
2012-03-01	56.476240	0.0342168748	5.035722759	45.7386847	UP
2012-03-02	59.539437	0.0361445832	4.781732933	46.5724049	UP
2012-03-05	53.854072	0.0107630555	4.537052201	47.5768473	DOWN
2012-03-06	16.724239	-0.1994912964	4.238735482	43.9686727	DOWN
2012-03-07	24.300395	-0.1129941976	3.918826916	39.0152520	UP
2012-03-08	65.318323	0.0980038683	3.645464627	37.8043691	DOWN
2012-03-09	70.006417	0.0986692455	3.417166445	38.6988311	DOWN
2012-03-12	48.411252	-0.0075538363	3.199182324	38.4206230	DOWN
2012-03-13	58.807692	0.0349641091	3.003753810	38.8030183	UP
2012-03-14	89.630630	0.4166427394	2.942658473	43.5628586	UP
2012-03-15	93.554439	0.4910951596	3.022805761	50.4453915	UP
2012-03-16	96.343401	0.6140634397	3.259451282	58.2642458	UP
2012-03-19	97.653738	0.6560422932	3.638235347	65.7203944	DOWN
2012-03-20	80.181102	0.3373615288	4.044359154	69.8327010	UP

```
           relativeStrengthIndex3 exponentialMovingAverageDiff MACDsignal stochasticOscillator
2012-02-21               54.80799                  0.03290863   7.279269              65.45729
2012-02-22               58.45034                  0.04193909   6.956909              62.91394
2012-02-23               42.89344                 -0.03204061   6.622471              59.23643
2012-02-24               57.85103                  0.03197293   6.298893              56.29953
2012-02-27               25.40802                 -0.15201805   5.932154              50.28373
2012-02-28               59.48739                  0.07198797   5.596630              46.88908
           binaryClassification
2012-02-21                   UP
2012-02-22                 DOWN
2012-02-23                   UP
2012-02-24                 DOWN
2012-02-27                   UP
2012-02-28                   UP
```

```
'data.frame':   469 obs. of  5 variables:
 $ relativeStrengthIndex3      : num  54.8 58.5 42.9 57.9 25.4 ...
 $ exponentialMovingAverageDiff: num  0.0329 0.0419 -0.032 0.032 -0.152 ...
 $ MACDsignal                  : num  7.28 6.96 6.62 6.3 5.93 ...
 $ stochasticOscillator        : num  65.5 62.9 59.2 56.3 50.3 ...
 $ binaryClassification        : Factor w/ 2 levels "DOWN","UP": 2 1 2 1 2 2 1 2 2 1 ...
```

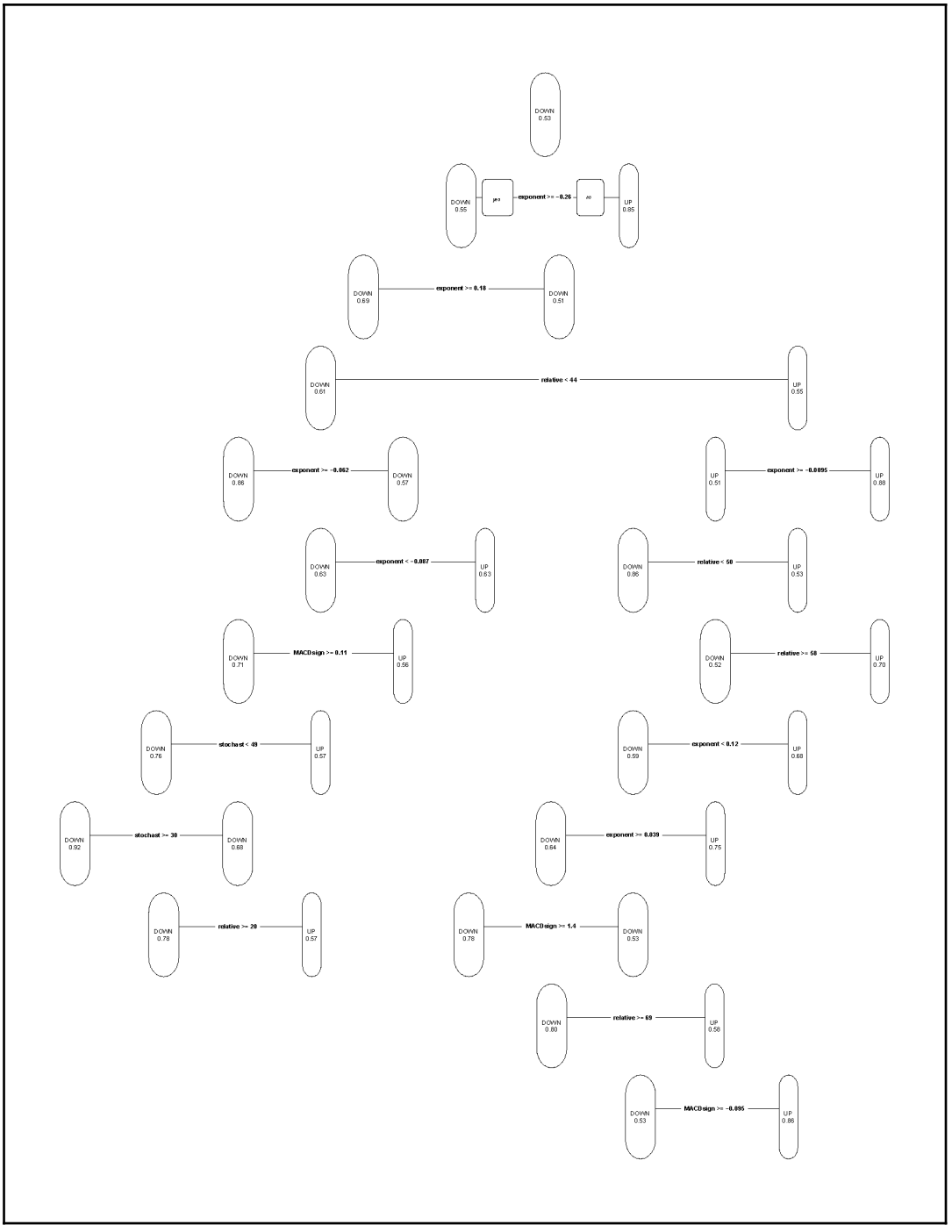
```
[1] 469   5
```

	relativeStrengthIndex3	exponentialMovingAverageDiff	MACDsignal	stochasticOscillator	binaryClassification
2012-02-21	54.807992	0.0329086341	7.279269023	65.4572862	UP
2012-02-22	58.450340	0.0419390894	6.956909214	62.9139401	DOWN
2012-02-23	42.893436	-0.0320406071	6.622470704	59.2364325	UP
2012-02-24	57.851032	0.0319729286	6.298893029	56.2995258	DOWN
2012-02-27	25.408018	-0.1520180476	5.932154164	50.2837296	UP
2012-02-28	59.487389	0.0719879683	5.596629643	46.8890757	UP
2012-02-29	68.593445	0.1213253122	5.307348654	46.3290434	DOWN
2012-03-01	56.476240	0.0342168748	5.035722759	45.7386847	UP
2012-03-02	59.539437	0.0361445832	4.781732933	46.5724049	UP
2012-03-05	53.854072	0.0107630555	4.537052201	47.5768473	DOWN
2012-03-06	16.724239	-0.1994912964	4.238735482	43.9686727	DOWN
2012-03-07	24.300395	-0.1129941976	3.918826916	39.0152520	UP
2012-03-08	65.318323	0.0980038683	3.645464627	37.8043691	DOWN
2012-03-09	70.006417	0.0986692455	3.417166445	38.6988311	DOWN
2012-03-12	48.411252	-0.0075538363	3.199182324	38.4206230	DOWN
2012-03-13	58.807692	0.0349641091	3.003753810	38.8030183	UP
2012-03-14	89.630630	0.4166427394	2.942658473	43.5628586	UP
2012-03-15	93.554439	0.4910951596	3.022805761	50.4453915	UP
2012-03-16	96.343401	0.6140634397	3.259451282	58.2642458	UP
2012-03-19	97.653738	0.6560422932	3.638235347	65.7203944	DOWN
2012-03-20	80.181102	0.3373615288	4.044359154	69.8327010	UP
2012-03-21	87.538815	0.4449076858	4.492232419	74.3646318	DOWN

```
'data.frame':   312 obs. of  5 variables:
 $ relativeStrengthIndex3      : num  54.8 58.5 42.9 57.9 25.4 ...
 $ exponentialMovingAverageDiff: num  0.0329 0.0419 -0.032 0.032 -0.152 ...
 $ MACDsignal                  : num  7.28 6.96 6.62 6.3 5.93 ...
 $ stochasticOscillator        : num  65.5 62.9 59.2 56.3 50.3 ...
 $ binaryClassification        : Factor w/ 2 levels "DOWN","UP": 2 1 2 1 2 2 1 2 2 1 ...
```

	relativeStrengthIndex3	exponentialMovingAverageDiff	MACDsignal	stochasticOscillator	binaryClassification
2013-05-20	65.325949	0.0730539531	1.98313400	69.6679580	UP
2013-05-21	78.156846	0.1420359687	2.13036094	72.0639927	DOWN
2013-05-22	67.458592	0.0680239792	2.25183036	73.9600584	DOWN
2013-05-23	17.410830	-0.3279840139	2.27747286	69.4201295	UP
2013-05-24	44.080812	-0.0586560093	2.26575090	65.3480900	UP
2013-05-28	66.024066	0.1742293272	2.26484286	64.7048951	DOWN
2013-05-29	49.601280	-0.0038471152	2.24360230	63.2583992	UP
2013-05-30	63.841750	0.1241019232	2.22847156	63.6817730	UP
2013-05-31	81.114361	0.3560679488	2.26183097	65.8115477	DOWN
2013-06-03	58.588063	0.0907119659	2.29181066	65.8819964	DOWN
2013-06-04	43.695489	-0.0595253561	2.29123360	63.3093314	DOWN
2013-06-05	29.805575	-0.1863502374	2.24007639	57.6419193	DOWN
2013-06-06	20.482875	-0.2642334916	2.12973132	49.0406161	UP
2013-06-07	48.979815	-0.0094889944	2.01314398	42.7848515	UP
2013-06-10	62.039679	0.1003406704	1.91329325	39.3458410	DOWN
2013-06-11	32.449075	-0.1864395531	1.77933613	32.8078058	UP
2013-06-12	45.731641	-0.0376263687	1.64254716	26.5032382	DOWN
2013-06-13	29.609063	-0.1850842458	1.47858272	18.2167820	UP
2013-06-14	53.284086	0.0299438361	1.33046817	12.2603547	DOWN
2013-06-17	47.086977	-0.0200374426	1.18979644	6.6571619	UP
2013-06-18	53.803044	0.0199750383	1.06447974	1.9930456	UP
2013-06-19	63.525236	0.0599833589	0.96136615	-0.1580052	DOWN

```
'data.frame':   157 obs. of  5 variables:
 $ relativeStrengthIndex3      : num  65.3 78.2 67.5 17.4 44.1 ...
 $ exponentialMovingAverageDiff: num  0.0731 0.142 0.068 -0.328 -0.0587 ...
 $ MACDsignal                  : num  1.98 2.13 2.25 2.28 2.27 ...
 $ stochasticOscillator        : num  69.7 72.1 74 69.4 65.3 ...
 $ binaryClassification        : Factor w/ 2 levels "DOWN","UP": 2 1 1 2 2 1 2 2 1 1 ...
```


DOWN 0.53
DOWN 0.55
exponent >= -0.26
UP 0.85
DOWN 0.69
exponent >= 0.18
DOWN 0.51
DOWN 0.61
relative < 44
UP 0.55
DOWN 0.66
exponent >= -0.062
DOWN 0.57
UP 0.51
exponent >= -0.0095
UP 0.88
DOWN 0.63
exponent < -0.087
UP 0.63
DOWN 0.66
relative < 58
UP 0.53
DOWN 0.71
MACDsign >= 0.11
UP 0.56
DOWN 0.52
relative >= 58
UP 0.70
DOWN 0.76
stochast < 49
UP 0.57
DOWN 0.59
exponent < 0.12
UP 0.68
DOWN 0.92
stochast >= 38
DOWN 0.68
DOWN 0.64
exponent >= 0.039
UP 0.75
DOWN 0.78
relative >= 20
UP 0.57
DOWN 0.76
MACDsign >= 1.4
DOWN 0.53
DOWN 0.80
relative >= 69
UP 0.58
DOWN 0.53
MACDsign >= -0.095
UP 0.86

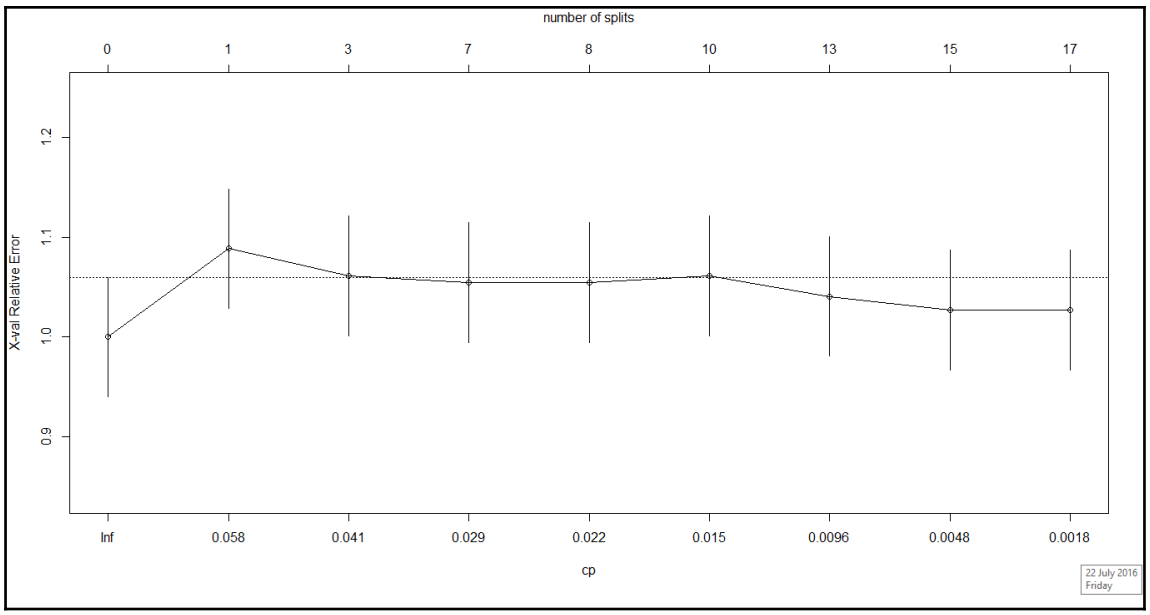
```
Regression tree:
rpart(formula = binaryClassification ~ relativeStrengthIndex3 +
    exponentialMovingAverageDiff + MACDsignal + stochasticOscillator,
    data = TrainingDataSet, cp = 0.001)

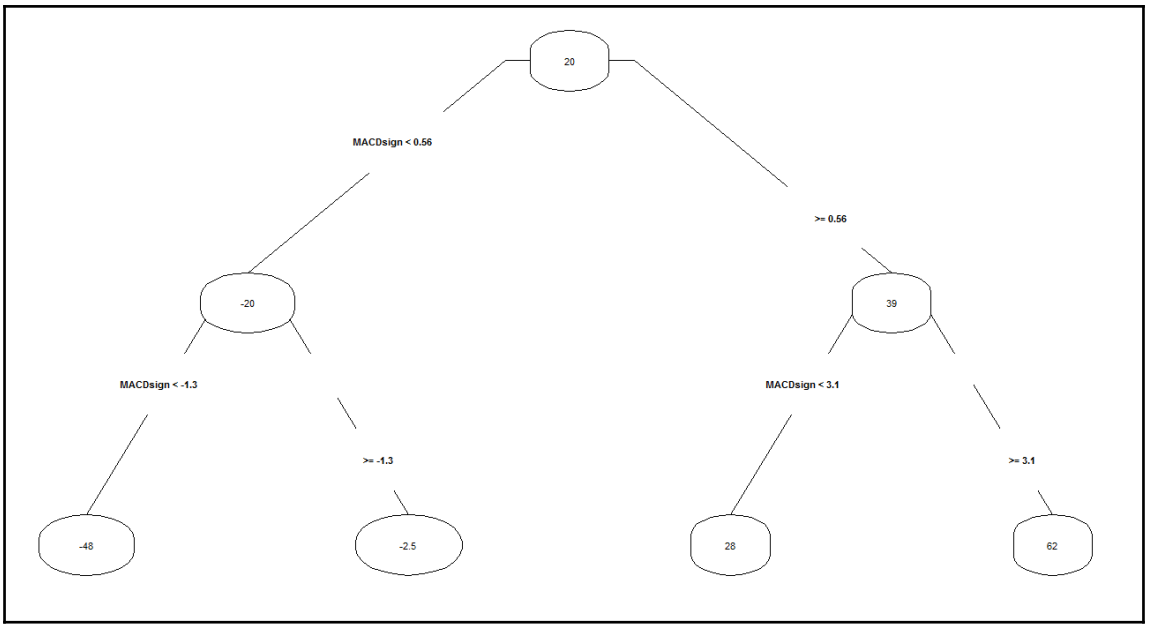
Variables actually used in tree construction:
[1] exponentialMovingAverageDiff MACDsignal                    stochasticOscillator

Root node error: 379763/312 = 1217.2

n= 312
```

	CP	nsplit	rel error	xerror	xstd
1	0.6161391	0	1.000000	1.006621	0.0805080
2	0.1385847	1	0.383861	0.425413	0.0258015
3	0.1279509	2	0.245276	0.239488	0.0171030
4	0.0234300	3	0.117325	0.148520	0.0100709
5	0.0184278	4	0.093895	0.112485	0.0088131
6	0.0139817	5	0.075468	0.093846	0.0074399
7	0.0114713	6	0.061486	0.090516	0.0073090
8	0.0109389	7	0.050015	0.083841	0.0068419
9	0.0024909	8	0.039076	0.055447	0.0044426
10	0.0020731	9	0.036585	0.049021	0.0037592
11	0.0018220	10	0.034512	0.047577	0.0036377
12	0.0017162	11	0.032690	0.046951	0.0036975
13	0.0015551	12	0.030973	0.045004	0.0034110
14	0.0015058	13	0.029418	0.044700	0.0034306
15	0.0010804	14	0.027913	0.042956	0.0032516
16	0.0010000	15	0.026832	0.041428	0.0032116






```
          actual
predicted DOWN UP
     DOWN   64 53
     UP     23 17
```

```
    As of 0.4-0, 'getSymbols' uses env=parent.frame() and
 auto.assign=TRUE by default.

 This  behavior  will be  phased out in 0.5-0  when the call  will
 default to use auto.assign=FALSE. getOption("getSymbols.env") and
 getOptions("getSymbols.auto.assign") are now checked for alternate defaults

 This message is shown once per session and may be disabled by setting
 options("getSymbols.warning4.0"=FALSE). See ?getSymbols for more details.
[1] "AAPL"
```

```
[1] Tues  Wed   Thurs Fri   Mon   Tues
Levels: Sun < Mon < Tues < Wed < Thurs < Fri < Sat
```

```
           AAPL.Close
2012-01-03   1.830002
2012-01-04   3.439999
2012-01-05   3.079990
2012-01-06   2.629994
2012-01-09  -3.769992
2012-01-10  -2.669994
```

```
     Index              AAPL.Close
 Min.   :2012-01-03   Min.   :-30.1200
 1st Qu.:2012-07-02   1st Qu.: -5.0075
 Median :2013-01-02   Median : -0.1500
 Mean   :2013-01-01   Mean   : -0.5479
 3rd Qu.:2013-07-02   3rd Qu.:  3.7325
 Max.   :2013-12-31   Max.   : 30.7600
```

```
[1] 502   1
```

```
           AAPL.Close
2012-01-03 "UP"
2012-01-04 "UP"
2012-01-05 "UP"
2012-01-06 "UP"
2012-01-09 "DOWN"
2012-01-10 "DOWN"
2012-01-11 "DOWN"
2012-01-12 "DOWN"
2012-01-13 "UP"
2012-01-17 "UP"
2012-01-18 "UP"
2012-01-19 "DOWN"
2012-01-20 "DOWN"
2012-01-23 "UP"
2012-01-24 "DOWN"
2012-01-25 "DOWN"
2012-01-26 "DOWN"
2012-01-27 "UP"
2012-01-30 "UP"
2012-01-31 "UP"
2012-02-01 "DOWN"
2012-02-02 "DOWN"
2012-02-03 "UP"
2012-02-06 "UP"
2012-02-07 "UP"
2012-02-08 "UP"
2012-02-09 "UP"
2012-02-10 "UP"
2012-02-13 "UP"
```

```
     Index              AAPL.Close
 Min.   :2012-01-03   DOWN:257
 1st Qu.:2012-07-02   UP  :245
 Median :2013-01-02
 Mean   :2013-01-01
 3rd Qu.:2013-07-02
 Max.   :2013-12-31
```

```
           weekDays AAPL.Close
2012-01-03     Tues          UP
2012-01-04      Wed          UP
2012-01-05    Thurs          UP
2012-01-06      Fri          UP
2012-01-09      Mon        DOWN
2012-01-10     Tues        DOWN
2012-01-11      Wed        DOWN
2012-01-12    Thurs        DOWN
2012-01-13      Fri          UP
2012-01-17     Tues          UP
2012-01-18      Wed          UP
2012-01-19    Thurs        DOWN
2012-01-20      Fri        DOWN
2012-01-23      Mon          UP
2012-01-24     Tues        DOWN
2012-01-25      Wed        DOWN
2012-01-26    Thurs        DOWN
2012-01-27      Fri          UP
2012-01-30      Mon          UP
2012-01-31     Tues          UP
2012-02-01      Wed        DOWN
2012-02-02    Thurs        DOWN
2012-02-03      Fri          UP
2012-02-06      Mon          UP
2012-02-07     Tues          UP
2012-02-08      Wed          UP
2012-02-09    Thurs          UP
2012-02-10      Fri          UP
```

```
           weekDays AAPL.Close
2012-01-03     Tues          UP
2012-01-04      Wed          UP
2012-01-05    Thurs          UP
2012-01-06      Fri          UP
2012-01-09      Mon        DOWN
2012-01-10     Tues        DOWN
```

```
[1] 502   2
```

```
Naive Bayes Classifier for Discrete Predictors

Call:
naiveBayes.default(x = AAPLDataSet[, 1], y = AAPLDataSet[, 2])

A-priori probabilities:
AAPLDataSet[, 2]
     DOWN        UP
0.5119522 0.4880478

Conditional probabilities:
                x
AAPLDataSet[, 2]       Sun       Mon      Tues       Wed     Thurs       Fri       Sat
            DOWN 0.0000000 0.1284047 0.1906615 0.2295720 0.2373541 0.2140078 0.0000000
            UP   0.0000000 0.2530612 0.2163265 0.1755102 0.1632653 0.1918367 0.0000000
```

	EMA
2012-01-03	NA
2012-01-04	NA
2012-01-05	NA
2012-01-06	NA
2012-01-09	415.9240
2012-01-10	419.2527
2012-01-11	420.3951
2012-01-12	421.0234
2012-01-13	420.5823
2012-01-17	421.7882
2012-01-18	423.5121
2012-01-19	425.7247
2012-01-20	426.3132
2012-01-23	425.0988
2012-01-24	425.0992
2012-01-25	434.8795
2012-01-26	439.3730
2012-01-27	441.0286
2012-01-30	442.5891
2012-01-31	446.9227
2012-02-01	450.7518
2012-02-02	452.4679
2012-02-03	454.0786
2012-02-06	455.5124
2012-02-07	458.7583
2012-02-08	462.6722
2012-02-09	468.7015
2012-02-10	476.1210
2012-02-13	483.9240
2012-02-14	490.8360
2012-02-15	498.6440
2012-02-16	496.2627
2012-02-17	498.5451
2012-02-21	501.3234

Index		EMA	
Min.	:2012-01-03	Min.	:400.1
1st Qu.	:2012-07-02	1st Qu.	:454.5
Median	:2013-01-02	Median	:522.1
Mean	:2013-01-01	Mean	:525.0
3rd Qu.	:2013-07-02	3rd Qu.	:581.8
Max.	:2013-12-31	Max.	:697.8
		NA's	:4

	EMA
2012-01-03	NA
2012-01-04	NA
2012-01-05	NA
2012-01-06	NA
2012-01-09	NA
2012-01-10	NA
2012-01-11	NA
2012-01-12	NA
2012-01-13	NA
2012-01-17	419.4390
2012-01-18	420.8065
2012-01-19	422.5053
2012-01-20	423.4116
2012-01-23	423.2768
2012-01-24	423.6083
2012-01-25	429.2140
2012-01-26	432.6951
2012-01-27	434.8124
2012-01-30	436.7938
2012-01-31	440.2112
2012-02-01	443.5201
2012-02-02	445.7710
2012-02-03	447.8672
2012-02-06	449.7786
2012-02-07	452.5916
2012-02-08	455.8477
2012-02-09	460.3772
2012-02-10	465.9377
2012-02-13	472.0454
2012-02-14	477.9753
2012-02-15	484.5725
2012-02-16	485.8321
2012-02-17	488.9735
2012-02-21	492.2292
2012-02-22	496.0203

```
     Index                  EMA        
 Min.   :2012-01-03   Min.   :408.2  
 1st Qu.:2012-07-02   1st Qu.:452.5  
 Median :2013-01-02   Median :521.4  
 Mean   :2013-01-01   Mean   :525.3  
 3rd Qu.:2013-07-02   3rd Qu.:579.2  
 Max.   :2013-12-31   Max.   :690.9  
                      NA's   :9      
```

```
[1] 502   1
```

	EMA
2012-01-03	NA
2012-01-04	NA
2012-01-05	NA
2012-01-06	NA
2012-01-09	NA
2012-01-10	NA
2012-01-11	NA
2012-01-12	NA
2012-01-13	NA
2012-01-17	2.349176968
2012-01-18	2.705663418
2012-01-19	3.219465214
2012-01-20	2.901570272
2012-01-23	1.822016650
2012-01-24	1.490928211
2012-01-25	5.665426292
2012-01-26	6.677857137
2012-01-27	6.216280801
2012-01-30	5.795342146
2012-01-31	6.711473809
2012-02-01	7.231704486
2012-02-02	6.696875947
2012-02-03	6.211406080
2012-02-06	5.733787451
2012-02-07	6.166676687
2012-02-08	6.824514652
2012-02-09	8.324272958
2012-02-10	10.183279127
2012-02-13	11.878594211
2012-02-14	12.860669002
2012-02-15	14.071458191
2012-02-16	10.430590131
2012-02-17	9.571593757
2012-02-21	9.094168840

Index	EMA
Min. :2012-01-03	Min. :-17.3855
1st Qu.:2012-07-02	1st Qu.: -4.3898
Median :2013-01-02	Median : 1.2982
Mean :2013-01-01	Mean : 0.7234
3rd Qu.:2013-07-02	3rd Qu.: 5.5539
Max. :2013-12-31	Max. : 15.0582
	NA's :9

```
      Index                  EMA
 Min.   :2012-01-03   Min.   :-17.3900
 1st Qu.:2012-07-02   1st Qu.: -4.3900
 Median :2013-01-02   Median :  1.3000
 Mean   :2013-01-01   Mean   :  0.7233
 3rd Qu.:2013-07-02   3rd Qu.:  5.5500
 Max.   :2013-12-31   Max.   : 15.0600
                      NA's   :9
```

	weekDays	EMA	AAPL.Close
2012-01-03	Tues	NA	UP
2012-01-04	Wed	NA	UP
2012-01-05	Thurs	NA	UP
2012-01-06	Fri	NA	UP
2012-01-09	Mon	NA	DOWN
2012-01-10	Tues	NA	DOWN
2012-01-11	Wed	NA	DOWN
2012-01-12	Thurs	NA	DOWN
2012-01-13	Fri	NA	UP
2012-01-17	Tues	2.35	UP
2012-01-18	Wed	2.71	UP
2012-01-19	Thurs	3.22	DOWN
2012-01-20	Fri	2.90	DOWN
2012-01-23	Mon	1.82	UP
2012-01-24	Tues	1.49	DOWN
2012-01-25	Wed	5.67	DOWN
2012-01-26	Thurs	6.68	DOWN
2012-01-27	Fri	6.22	UP
2012-01-30	Mon	5.80	UP
2012-01-31	Tues	6.71	UP
2012-02-01	Wed	7.23	DOWN
2012-02-02	Thurs	6.70	DOWN
2012-02-03	Fri	6.21	UP
2012-02-06	Mon	5.73	UP
2012-02-07	Tues	6.17	UP
2012-02-08	Wed	6.82	UP
2012-02-09	Thurs	8.32	UP
2012-02-10	Fri	10.18	UP
2012-02-13	Mon	11.88	UP
2012-02-14	Tues	12.86	UP
2012-02-15	Wed	14.07	DOWN
2012-02-16	Thurs	10.43	UP
2012-02-17	Fri	9.57	DOWN
2012-02-21	Tues	9.09	UP

```
  weekDays        EMA             AAPL.Close
 Sun   :  0   Min.    :-17.3900   DOWN:257
 Mon   : 95   1st Qu.: -4.3900   UP  :245
 Tues  :102   Median :  1.3000
 Wed   :102   Mean   :  0.7233
 Thurs:101    3rd Qu.:  5.5500
 Fri   :102   Max.   : 15.0600
 Sat   :  0   NA's   :9
```

	weekDays	EMA	AAPL.Close
2012-01-18	Wed	2.71	UP
2012-01-19	Thurs	3.22	DOWN
2012-01-20	Fri	2.90	DOWN
2012-01-23	Mon	1.82	UP
2012-01-24	Tues	1.49	DOWN
2012-01-25	Wed	5.67	DOWN
2012-01-26	Thurs	6.68	DOWN
2012-01-27	Fri	6.22	UP
2012-01-30	Mon	5.80	UP
2012-01-31	Tues	6.71	UP
2012-02-01	Wed	7.23	DOWN
2012-02-02	Thurs	6.70	DOWN
2012-02-03	Fri	6.21	UP
2012-02-06	Mon	5.73	UP
2012-02-07	Tues	6.17	UP
2012-02-08	Wed	6.82	UP
2012-02-09	Thurs	8.32	UP
2012-02-10	Fri	10.18	UP
2012-02-13	Mon	11.88	UP
2012-02-14	Tues	12.86	UP
2012-02-15	Wed	14.07	DOWN
2012-02-16	Thurs	10.43	UP
2012-02-17	Fri	9.57	DOWN
2012-02-21	Tues	9.09	UP
2012-02-22	Wed	9.22	DOWN
2012-02-23	Thurs	9.04	UP
2012-02-24	Fri	9.08	UP
2012-02-27	Mon	8.81	UP
2012-02-28	Tues	9.13	UP
2012-02-29	Wed	10.81	UP
2012-03-01	Thurs	12.08	DOWN
2012-03-02	Fri	11.44	UP
2012-03-05	Mon	10.58	DOWN
2012-03-06	Tues	6.17	UP

```
 weekDays        EMA            AAPL.Close
Sun   :  0   Min.    :-17.390   DOWN:253
Mon   : 94   1st Qu.: -4.395   UP   :239
Tues  : 99   Median :  1.285
Wed   :100   Mean   :  0.720
Thurs: 99    3rd Qu.:  5.553
Fri   :100   Max.   : 15.060
Sat   :  0
```

```
[1] 492   3
```

```
[1] 328   3
```

```
 weekDays        EMA            AAPL.Close
Sun   : 0    Min.    :-17.3900   DOWN:171
Mon   :62    1st Qu.: -5.5075   UP   :157
Tues  :65    Median :  0.7800
Wed   :68    Mean   :  0.1318
Thurs:67     3rd Qu.:  5.8125
Fri   :66    Max.   : 15.0600
Sat   : 0
```

```
[1] 164   3
```

```
 weekDays        EMA            AAPL.Close
Sun   : 0    Min.    :-10.470   DOWN:82
Mon   :32    1st Qu.: -0.535    UP   :82
Tues  :34    Median :  1.630
Wed   :32    Mean   :  1.896
Thurs:32     3rd Qu.:  4.418
Fri   :34    Max.   : 11.940
Sat   : 0
```

```
Naive Bayes Classifier for Discrete Predictors

Call:
naiveBayes.default(x = trainingDataSet[, 1:2], y = trainingDataSet[,
    3])

A-priori probabilities:
trainingDataSet[, 3]
     DOWN        UP
0.5213415 0.4786585

Conditional probabilities:
                   weekDays
trainingDataSet[, 3]       Sun       Mon      Tues       Wed     Thurs       Fri       Sat
                DOWN 0.0000000 0.1169591 0.1871345 0.2514620 0.2514620 0.1929825 0.0000000
                UP   0.0000000 0.2675159 0.2101911 0.1592357 0.1528662 0.2101911 0.0000000

                   EMA
trainingDataSet[, 3]       [,1]     [,2]
                DOWN -0.2464912 6.938301
                UP    0.5437580 7.209192
```

```
         Actual
Predicted DOWN UP
     DOWN   46 49
     UP     36 33
```

```
    X         Date    Open    High     Low   Close Volume
1 1  1/2/12 6:00 1.55051 1.55411 1.54845 1.55170   4803
2 2 1/2/12 10:00 1.55170 1.55230 1.54746 1.54797   2263
3 3 1/2/12 14:00 1.54797 1.55147 1.54668 1.55036   2375
4 4 1/2/12 18:00 1.55036 1.55155 1.54810 1.55095   1767
5 5 1/2/12 22:00 1.55095 1.55342 1.54967 1.55272   4271
6 6  1/3/12 2:00 1.55272 1.55547 1.55200 1.55457   4383
```

```
       X                    Date          Open            High            Low             Close           Volume
 Min.   :   1   1/10/12 10:00:   1   Min.   :1.459   Min.   :1.463   Min.   :1.456   Min.   :1.459   Min.   :     2
 1st Qu.:1315   1/10/12 14:00:   1   1st Qu.:1.550   1st Qu.:1.552   1st Qu.:1.548   1st Qu.:1.550   1st Qu.:  7106
 Median :2629   1/10/12 18:00:   1   Median :1.588   Median :1.590   Median :1.586   Median :1.588   Median : 14113
 Mean   :2629   1/10/12 2:00 :   1   Mean   :1.590   Mean   :1.592   Mean   :1.588   Mean   :1.590   Mean   : 17938
 3rd Qu.:3943   1/10/12 22:00:   1   3rd Qu.:1.626   3rd Qu.:1.627   3rd Qu.:1.624   3rd Qu.:1.626   3rd Qu.: 23321
 Max.   :5257   1/10/12 6:00 :   1   Max.   :1.717   Max.   :1.719   Max.   :1.716   Max.   :1.717   Max.   :155384
                (Other)      :5251
```

```
[1] 5257    7
```

```
      High     Low   Close
1 1.55411 1.54845 1.55170
2 1.55230 1.54746 1.54797
3 1.55147 1.54668 1.55036
4 1.55155 1.54810 1.55095
5 1.55342 1.54967 1.55272
6 1.55547 1.55200 1.55457
```

```
      High            Low            Close
 Min.   :1.463   Min.   :1.456   Min.   :1.459
 1st Qu.:1.552   1st Qu.:1.548   1st Qu.:1.550
 Median :1.590   Median :1.586   Median :1.588
 Mean   :1.592   Mean   :1.588   Mean   :1.590
 3rd Qu.:1.627   3rd Qu.:1.624   3rd Qu.:1.626
 Max.   :1.719   Max.   :1.716   Max.   :1.717
```

```
'data.frame':   5257 obs. of  3 variables:
 $ High : num  1.55 1.55 1.55 1.55 1.55 ...
 $ Low  : num  1.55 1.55 1.55 1.55 1.55 ...
 $ Close: num  1.55 1.55 1.55 1.55 1.55 ...
```

```
HighLowClosets

 3  Variables      5257  Observations
--------------------------------------------------------------------------------
High
      n missing  unique    Info    Mean     .05     .10     .25     .50     .75     .90     .95
   5257       0    4581       1   1.592   1.504   1.518   1.552   1.590   1.627   1.676   1.689

lowest : 1.463 1.463 1.464 1.465 1.465, highest: 1.717 1.717 1.718 1.718 1.719
--------------------------------------------------------------------------------
Low
      n missing  unique    Info    Mean     .05     .10     .25     .50     .75     .90     .95
   5257       0    4590       1   1.588   1.501   1.513   1.548   1.586   1.624   1.673   1.686

lowest : 1.456 1.458 1.459 1.460 1.460, highest: 1.715 1.715 1.715 1.716 1.716
--------------------------------------------------------------------------------
Close
      n missing  unique    Info    Mean     .05     .10     .25     .50     .75     .90     .95
   5257       0    4610       1    1.59   1.502   1.516   1.550   1.588   1.626   1.674   1.687

lowest : 1.459 1.460 1.461 1.462 1.462, highest: 1.716 1.716 1.717 1.717 1.717
--------------------------------------------------------------------------------
```

```
BollingerBands

 4  Variables      5257  Observations
---------------------------------------------------------------------------------------------------------------------------
dn
      n missing  unique    Info    Mean     .05     .10     .25     .50     .75     .90     .95
   5238      19    5238       1   1.582   1.489   1.506   1.541   1.581   1.618   1.669   1.681

lowest : 1.451 1.451 1.452 1.452 1.453, highest: 1.713 1.713 1.713 1.713 1.713
---------------------------------------------------------------------------------------------------------------------------
mavg
      n missing  unique    Info    Mean     .05     .10     .25     .50     .75     .90     .95
   5238      19    5235       1   1.591   1.504   1.515   1.551   1.588   1.624   1.675   1.687

lowest : 1.467 1.467 1.467 1.467 1.467, highest: 1.715 1.715 1.715 1.715 1.715
---------------------------------------------------------------------------------------------------------------------------
up
      n missing  unique    Info    Mean     .05     .10     .25     .50     .75     .90     .95
   5238      19    5238       1   1.599   1.516   1.525   1.559   1.597   1.633   1.681   1.692

lowest : 1.476 1.477 1.477 1.477 1.478, highest: 1.720 1.721 1.721 1.721 1.721
---------------------------------------------------------------------------------------------------------------------------
pctB
      n  missing   unique     Info     Mean      .05      .10      .25      .50      .75      .90      .95
   5238       19     5238        1   0.5018 -0.03586  0.04628  0.21201  0.50380  0.78954  0.94882  1.03015

lowest : -0.3462 -0.3427 -0.3341 -0.3166 -0.2988, highest:  1.3657  1.3718  1.3738  1.3972  1.4310
---------------------------------------------------------------------------------------------------------------------------
```

```
     Index                          up
Min.   :2012-01-02 06:00:00   Min.   :-0.012491
1st Qu.:2012-11-02 05:00:00   1st Qu.: 0.002766
Median :2013-09-03 01:00:00   Median : 0.006554
Mean   :2013-09-01 03:57:22   Mean   : 0.008594
3rd Qu.:2014-06-30 17:00:00   3rd Qu.: 0.012562
Max.   :2015-04-26 21:00:00   Max.   : 0.051020
                              NA's   :19
```

```
     Index                          dn
Min.   :2012-01-02 06:00:00   Min.   :-0.042220
1st Qu.:2012-11-02 05:00:00   1st Qu.:-0.012141
Median :2013-09-03 01:00:00   Median :-0.006606
Mean   :2013-09-01 03:57:22   Mean   :-0.008372
3rd Qu.:2014-06-30 17:00:00   3rd Qu.:-0.002868
Max.   :2015-04-26 21:00:00   Max.   : 0.008861
                              NA's   :19
```

```
     Index                          mavg
Min.   :2012-01-02 06:00:00   Min.   :-0.026222
1st Qu.:2012-11-02 05:00:00   1st Qu.:-0.004377
Median :2013-09-03 01:00:00   Median :-0.000038
Mean   :2013-09-01 03:57:22   Mean   : 0.000111
3rd Qu.:2014-06-30 17:00:00   3rd Qu.: 0.004425
Max.   :2015-04-26 21:00:00   Max.   : 0.025714
                              NA's   :19
```

```
PercentageChngpctB

 1  Variables      5257  Observations
--------------------------------------------------------------------------------------------------------------------------------------------------------
Delt.1.arithmetic
       n  missing   unique     Info     Mean      .05      .10      .25      .50      .75      .90      .95
    5237       20     5237        1   -2.016 -1.07295 -0.54484 -0.14324 -0.01858  0.16710  0.57484  1.13343

lowest : -8426.29 -2130.42   -83.18   -75.28   -74.12, highest:    36.73    37.56    57.70    58.12    74.48
--------------------------------------------------------------------------------------------------------------------------------------------------------
```

```
PercentageChngUp

 1  Variables      5257  Observations
--------------------------------------------------------------------------------------------------------------------------------------------------------
Delt.1.arithmetic
       n  missing   unique     Info     Mean      .05      .10      .25      .50      .75      .90      .95
    5237       20     5237        1  0.03257 -1.37131 -0.69452 -0.23013 -0.02814  0.19289  0.74148  1.50053

lowest : -1363.07  -861.89   -98.12   -48.49   -38.79, highest:    46.20    52.45    66.20   107.11  2230.24
--------------------------------------------------------------------------------------------------------------------------------------------------------
```

```
PercentageChngLow

 1  Variables      5257  Observations
--------------------------------------------------------------------------------------------------------------------------------------------------------
Delt.1.arithmetic
       n  missing   unique     Info     Mean      .05      .10      .25      .50      .75      .90      .95
    5237       20     5237        1   0.3371 -1.47272 -0.74089 -0.23429 -0.02817  0.17183  0.70740  1.43229

lowest : -278.00 -268.28 -217.24  -82.49  -71.47, highest:  105.26  251.08  507.36  868.97 1003.04
--------------------------------------------------------------------------------------------------------------------------------------------------------
```

```
PercentageChngMid

 1  Variables      5257  Observations
--------------------------------------------------------------------------------------------------------------------------------------------------------
Delt.1.arithmetic
       n  missing   unique     Info     Mean      .05      .10      .25      .50      .75      .90      .95
    5237       20     5237        1  -0.3783 -2.20895 -1.06928 -0.35203 -0.08207  0.19687  0.92735  2.15286

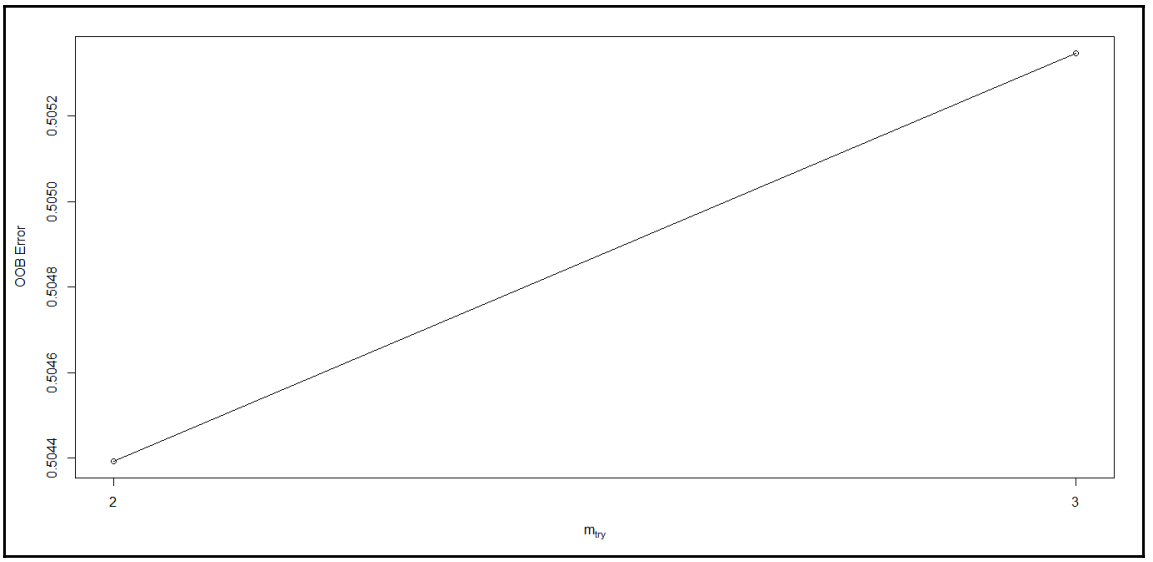
lowest : -959.5 -847.8 -737.4 -366.2 -227.7, highest:  152.7  241.3  312.5  377.0  591.9
--------------------------------------------------------------------------------------------------------------------------------------------------------
```

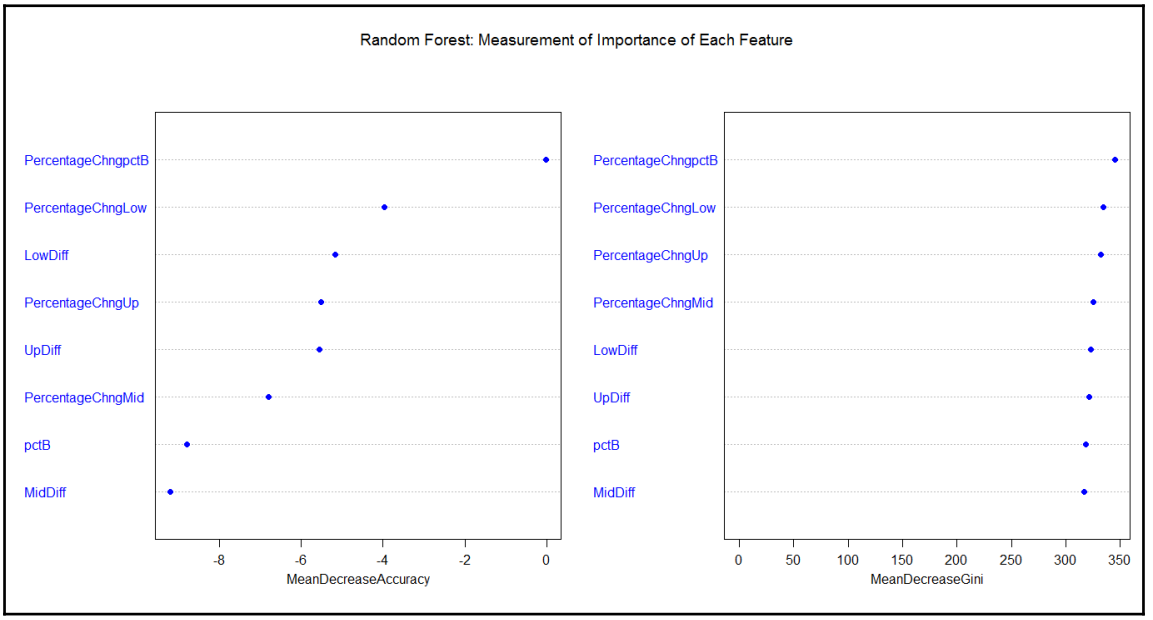
```
     Index                      Delt.1.arithmetic
 Min.   :2012-01-02 06:00:00   Down:2618
 1st Qu.:2012-11-02 05:00:00   Up  :2638
 Median :2013-09-03 01:00:00   NA's:   1
 Mean   :2013-09-01 03:57:22
 3rd Qu.:2014-06-30 17:00:00
 Max.   :2015-04-26 21:00:00
```

```
       up                dn                mavg              pctB          Delt.1.arithmetic  Delt.1.arithmetic.1 Delt.1.arithmetic.2
 Min.   :-0.012491   Min.   :-0.042220   Min.   :-0.026222   Min.   :-0.3462   Min.   :-8426.293   Min.   :-1363.0732   Min.   :-278.0016
 1st Qu.: 0.002766   1st Qu.:-0.012141   1st Qu.:-0.004377   1st Qu.: 0.2120   1st Qu.:   -0.143   1st Qu.:   -0.2301   1st Qu.:  -0.2343
 Median : 0.006554   Median :-0.006606   Median :-0.000038   Median : 0.5038   Median :   -0.019   Median :   -0.0281   Median :  -0.0282
 Mean   : 0.008594   Mean   :-0.008372   Mean   : 0.000111   Mean   : 0.5018   Mean   :   -2.016   Mean   :    0.0326   Mean   :   0.3371
 3rd Qu.: 0.012562   3rd Qu.:-0.002868   3rd Qu.: 0.004425   3rd Qu.: 0.7895   3rd Qu.:    0.167   3rd Qu.:    0.1929   3rd Qu.:   0.1718
 Max.   : 0.051020   Max.   : 0.008861   Max.   : 0.025714   Max.   : 1.4310   Max.   :   74.480   Max.   : 2230.2382   Max.   :1003.0420
 NA's   :19          NA's   :19          NA's   :19          NA's   :19        NA's   :20          NA's   :20           NA's   :20
 Delt.1.arithmetic.3
 Min.   :-959.4667
 1st Qu.:  -0.3520
 Median :  -0.0821
 Mean   :  -0.3783
 3rd Qu.:   0.1969
 Max.   : 591.9231
 NA's   :20
```

```
       up                dn                mavg              pctB          Delt.1.arithmetic  Delt.1.arithmetic.1 Delt.1.arithmetic.2
 Min.   :-0.012491   Min.   :-0.042220   Min.   :-0.026222   Min.   :-0.3462   Min.   :-8426.293   Min.   :-1363.0732   Min.   :-278.0016
 1st Qu.: 0.002766   1st Qu.:-0.012137   1st Qu.:-0.004376   1st Qu.: 0.2119   1st Qu.:   -0.143   1st Qu.:   -0.2301   1st Qu.:  -0.2343
 Median : 0.006555   Median :-0.006606   Median :-0.000037   Median : 0.5036   Median :   -0.019   Median :   -0.0282   Median :  -0.0282
 Mean   : 0.008595   Mean   :-0.008369   Mean   : 0.000113   Mean   : 0.5017   Mean   :   -2.017   Mean   :    0.0324   Mean   :   0.3372
 3rd Qu.: 0.012564   3rd Qu.:-0.002868   3rd Qu.: 0.004426   3rd Qu.: 0.7895   3rd Qu.:    0.167   3rd Qu.:    0.1922   3rd Qu.:   0.1718
 Max.   : 0.051020   Max.   : 0.008861   Max.   : 0.025714   Max.   : 1.4310   Max.   :   74.480   Max.   : 2230.2382   Max.   :1003.0420
 NA's   :19          NA's   :19          NA's   :19          NA's   :19        NA's   :20          NA's   :20           NA's   :20
 Delt.1.arithmetic.3 Delt.1.arithmetic.4
 Min.   :-959.4667   Down:2618
 1st Qu.:  -0.3520   Up  :2638
 Median :  -0.0821
 Mean   :  -0.3784
 3rd Qu.:   0.1969
 Max.   : 591.9231
 NA's   :20
```

```
'data.frame':   5236 obs. of  9 variables:
 $ pctB                : num  0.0198 0.0198 0.0191 0.0212 0.0197 ...
 $ LowDiff             : num  -0.00265 -0.00264 -0.00333 -0.0016 -0.00366 ...
 $ UpDiff              : num  0.00855 0.00859 0.00787 0.00981 0.00801 ...
 $ MidDiff             : num  0.096 0.111 0.136 0.103 0.163 ...
 $ PercentageChngpctB  : num  -0.564 0.159 0.221 -0.243 0.581 ...
 $ PercentageChngUp    : num  0.02176 0.00271 -0.0378 0.11363 -0.07314 ...
 $ PercentageChngLow   : num  0.1391 -0.00506 0.26256 -0.51833 1.2865 ...
 $ PercentageChngMid   : num  0.00572 0.00392 -0.08388 0.24726 -0.18416 ...
 $ binaryClassification: Factor w/ 2 levels "Down","Up": 1 2 1 2 1 1 2 1 2 2 ...
```


OOB Error
0.5044
0.5046
0.5048
0.5050
0.5052
2
3
mtry


Random Forest: Measurement of Importance of Each Feature
PercentageChngpctB
PercentageChngLow
LowDiff
PercentageChngUp
UpDiff
PercentageChngMid
pctB
MidDiff
-8
-6
-4
-2
0
MeanDecreaseAccuracy
PercentageChngpctB
PercentageChngLow
PercentageChngUp
PercentageChngMid
LowDiff
UpDiff
pctB
MidDiff
0
50
100
150
200
250
300
350
MeanDecreaseGini

```
  X          Date    Open    High     Low   Close Volume
1 1  1/2/12 6:00 1.55051 1.55411 1.54845 1.55170   4803
2 2 1/2/12 10:00 1.55170 1.55230 1.54746 1.54797   2263
3 3 1/2/12 14:00 1.54797 1.55147 1.54668 1.55036   2375
4 4 1/2/12 18:00 1.55036 1.55155 1.54810 1.55095   1767
5 5 1/2/12 22:00 1.55095 1.55342 1.54967 1.55272   4271
6 6  1/3/12 2:00 1.55272 1.55547 1.55200 1.55457   4383
```

```
'data.frame':   5257 obs. of  7 variables:
 $ X     : int  1 2 3 4 5 6 7 8 9 10 ...
 $ Date  : Factor w/ 5257 levels "1/10/12 10:00",..: 171 167 168 169 170 369 371 366 367 368 ...
 $ Open  : num  1.55 1.55 1.55 1.55 1.55 ...
 $ High  : num  1.55 1.55 1.55 1.55 1.55 ...
 $ Low   : num  1.55 1.55 1.55 1.55 1.55 ...
 $ Close : num  1.55 1.55 1.55 1.55 1.55 ...
 $ Volume: int  4803 2263 2375 1767 4271 4383 15191 22655 23244 10215 ...
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
 0.2408 29.2700 51.6300 50.5800 72.0000 99.7900       3
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  1.477   1.551   1.590   1.591   1.626   1.714      49
```

```
SeriesMeanAvg50
      n missing  unique    Info    Mean     .05     .10     .25     .50     .75     .90     .95
   5208      49    5204       1   1.591   1.505   1.516   1.551   1.590   1.626   1.676   1.688

lowest : 1.477 1.477 1.477 1.477 1.477, highest: 1.714 1.714 1.714 1.714 1.714
```

```
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.    NA's
-0.03636 -0.00725  0.00031 -0.00021  0.00745  0.03877      49
```

```
       Min.     1st Qu.      Median        Mean     3rd Qu.        Max.
 -1.844e-02 -1.220e-03  2.000e-05 -6.253e-06  1.200e-03  2.699e-02
```

```
      Length     Class      Mode
        5257 character character
```

```
relativeStrengthIndex3     Trend          binaryClassification
Min.    : 0.6199        Min.    :-0.03636   DOWN:2618
1st Qu.:28.8542         1st Qu.:-0.00725    UP  :2639
Median :50.6667         Median : 0.00031
Mean   :50.3598         Mean   :-0.00021
3rd Qu.:72.0845         3rd Qu.: 0.00745
Max.   :99.5032         Max.   : 0.03877
NA's   :3               NA's   :49
```

```
'data.frame':   5257 obs. of  3 variables:
 $ relativeStrengthIndex3: num  NA NA NA 49 54.5 ...
 $ Trend                 : num  NA NA NA NA NA NA NA NA NA NA ...
 $ binaryClassification  : Factor w/ 2 levels "DOWN","UP": 2 1 2 2 2 2 2 2 2 1 ...
```

```
[1] 5208    3
```

```
[1] 4528    3
```

```
relativeStrengthIndex3     Trend              binaryClassification
Min.    : 0.6199        Min.    :-0.0363598   DOWN:2247
1st Qu.:29.1705         1st Qu.:-0.0071439    UP  :2281
Median :50.8829         Median : 0.0006596
Mean   :50.7597         Mean   : 0.0001243
3rd Qu.:72.5465         3rd Qu.: 0.0077117
Max.   :99.5032         Max.   : 0.0387742
```

```
[1] 1510    3
```

```
relativeStrengthIndex3     Trend          binaryClassification
Min.    : 0.966         Min.    :-0.0363   DOWN:347
1st Qu.:26.358          1st Qu.:-0.0082    UP  :333
Median :49.089          Median :-0.0014    NA's:830
Mean   :48.071          Mean   :-0.0025
3rd Qu.:69.500          3rd Qu.: 0.0059
Max.   :96.014          Max.   : 0.0240
NA's   :830             NA's   :830
```

```
Call:
svm(formula = binaryClassification ~ relativeStrengthIndex3 + Trend, data = TrainingDataSet, kernel = "radial",
    cost = 1, gamma = 1/2)


Parameters:
   SVM-Type:  C-classification
 SVM-Kernel:  radial
       cost:  1
      gamma:  0.5

Number of Support Vectors:  4401

 ( 2202 2199 )


Number of Classes:  2

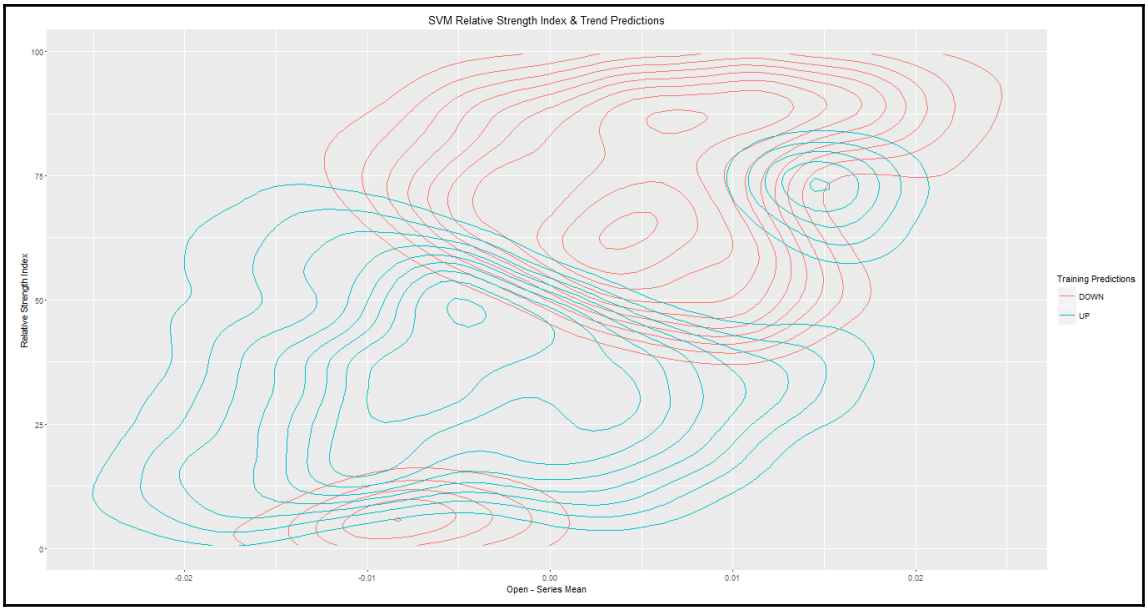
Levels:
 DOWN UP
```

```
DOWN   UP
2205 2323
```

```
TrainingPredictions
       n missing  unique
    4528       0       2

DOWN (2205, 49%), UP (2323, 51%)
```

```
relativeStrengthIndex3     Trend             binaryClassification TrainingPredictions
Min.    : 0.6199        Min.    :-0.0363598   DOWN:2247            DOWN:2205
1st Qu.:29.1705         1st Qu.:-0.0071439    UP  :2281            UP  :2323
Median :50.8829         Median : 0.0006596
Mean   :50.7597         Mean   : 0.0001243
3rd Qu.:72.5465         3rd Qu.: 0.0077117
Max.   :99.5032         Max.   : 0.0387742
```



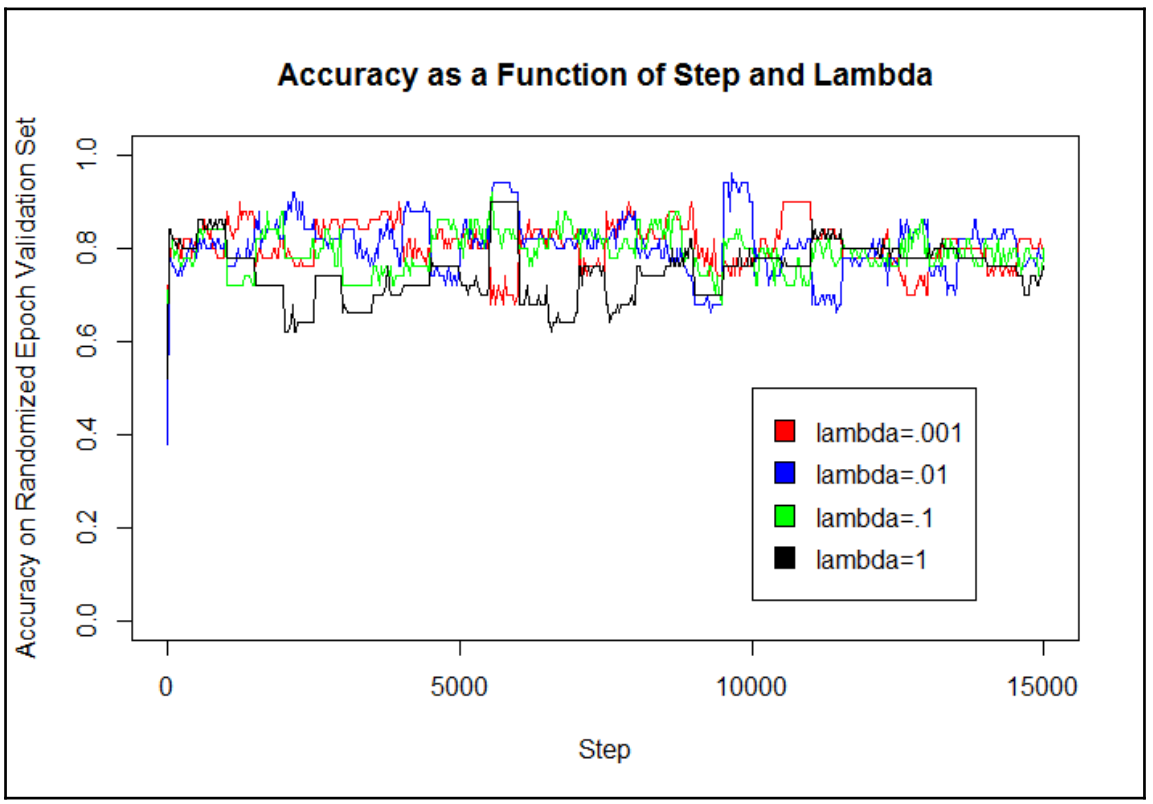

```
'data.frame':   32561 obs. of  15 variables:
 $ V1 : Factor w/ 73 levels "17","18","19",..: 23 34 22 37 12 21 33 36 15 26 ...
 $ V2 : Factor w/ 9 levels "?","Federal-gov",..: 8 7 5 5 5 5 5 7 5 5 ...
 $ V3 : Factor w/ 21648 levels "100009","100029",..: 20430 20692 10269 11554 16171 14136 4680 9797 18599 4604 ...
 $ V4 : Factor w/ 16 levels "10th","11th",..: 10 10 12 2 10 13 7 12 13 10 ...
 $ V5 : Factor w/ 16 levels "1","10","11",..: 5 5 16 14 5 6 12 16 6 5 ...
 $ V6 : Factor w/ 7 levels "Divorced","Married-AF-spouse",..: 5 3 1 3 3 3 4 3 5 3 ...
 $ V7 : Factor w/ 15 levels "?","Adm-clerical",..: 2 5 7 7 11 5 9 5 11 5 ...
 $ V8 : Factor w/ 6 levels "Husband","Not-in-family",..: 2 1 2 1 6 6 2 1 2 1 ...
 $ V9 : Factor w/ 5 levels "Amer-Indian-Eskimo",..: 5 5 5 3 3 5 3 5 5 5 ...
 $ V10: Factor w/ 2 levels "Female","Male": 2 2 2 2 1 1 1 2 1 2 ...
 $ V11: Factor w/ 119 levels "0","10520",..: 34 1 1 1 1 1 1 1 13 95 ...
 $ V12: Factor w/ 92 levels "0","1092","1138",..: 1 1 1 1 1 1 1 1 1 1 ...
 $ V13: Factor w/ 94 levels "1","10","11",..: 35 5 35 35 35 35 8 40 46 35 ...
 $ V14: Factor w/ 42 levels "?","Cambodia",..: 40 40 40 40 6 40 24 40 40 40 ...
 $ V15: Factor w/ 2 levels "<=50K",">50K": 1 1 1 1 1 1 1 2 2 2 ...
```

```
   V1                V2      V3         V4  V5                  V6                 V7             V8      V9     V10
1 39,         State-gov,  77516, Bachelors, 13,       Never-married,       Adm-clerical, Not-in-family, White,   Male,
2 50, Self-emp-not-inc,  83311, Bachelors, 13, Married-civ-spouse,    Exec-managerial,       Husband, White,   Male,
3 38,           Private, 215646,   HS-grad,  9,          Divorced, Handlers-cleaners, Not-in-family, White,   Male,
4 53,           Private, 234721,      11th,  7, Married-civ-spouse, Handlers-cleaners,       Husband, Black,   Male,
5 28,           Private, 338409, Bachelors, 13, Married-civ-spouse,    Prof-specialty,          Wife, Black, Female,
6 37,           Private, 284582,   Masters, 14, Married-civ-spouse,    Exec-managerial,          Wife, White, Female,
    V11 V12 V13           V14
1 2174,  0, 40, United-States,
2    0,  0, 13, United-States,
3    0,  0, 40, United-States,
4    0,  0, 40, United-States,
5    0,  0, 40,          Cuba,
6    0,  0, 40, United-States,
```

```
             V1         V3         V5         V11         V12         V13
[1,]  0.03067009 -1.0635944  1.1347213  0.1484506 -0.2166562 -0.0354289
[2,]  0.83709613 -1.0086915  1.1347213 -0.1459182 -0.2166562 -2.2221190
[3,] -0.04264137  0.2450747 -0.4200532 -0.1459182 -0.2166562 -0.0354289
[4,]  1.05703050  0.4257948 -1.1974404 -0.1459182 -0.2166562 -0.0354289
[5,] -0.77575595  1.4081541  1.1347213 -0.1459182 -0.2166562 -0.0354289
[6,] -0.11595283  0.8981871  1.5234150 -0.1459182 -0.2166562 -0.0354289
```

```
[1] 26049     1
```

```
 num [1:4] 0.001 0.01 0.1 1
```

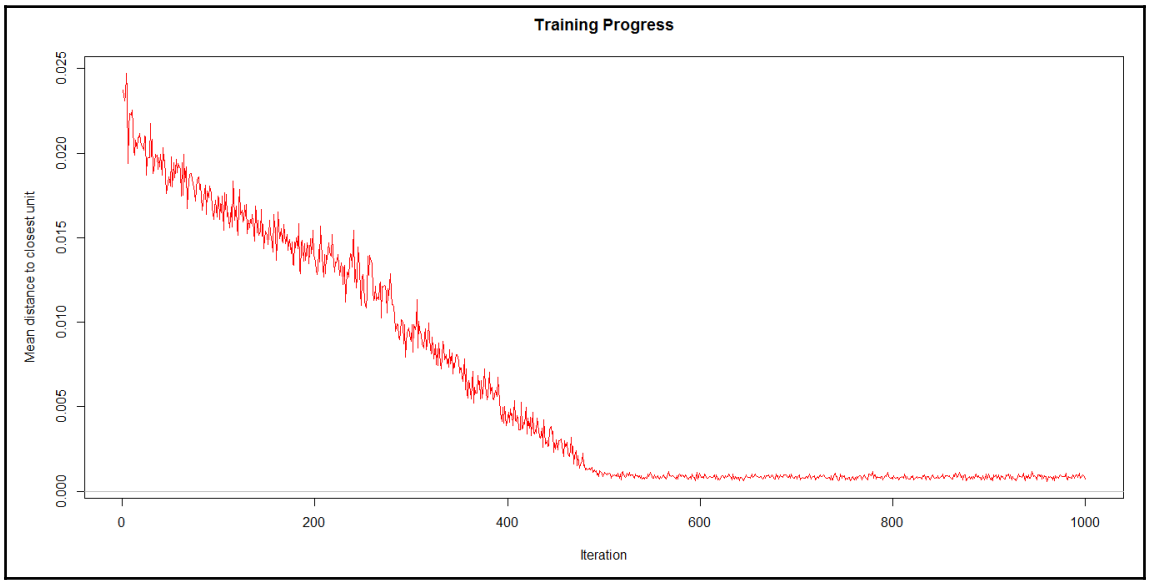


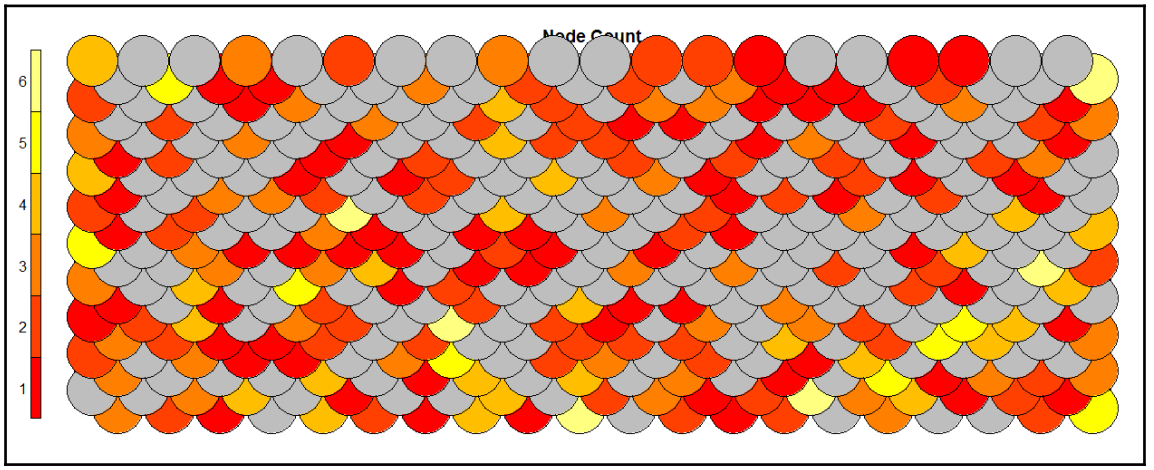
$$w := w - \alpha \nabla Q_i(w)$$

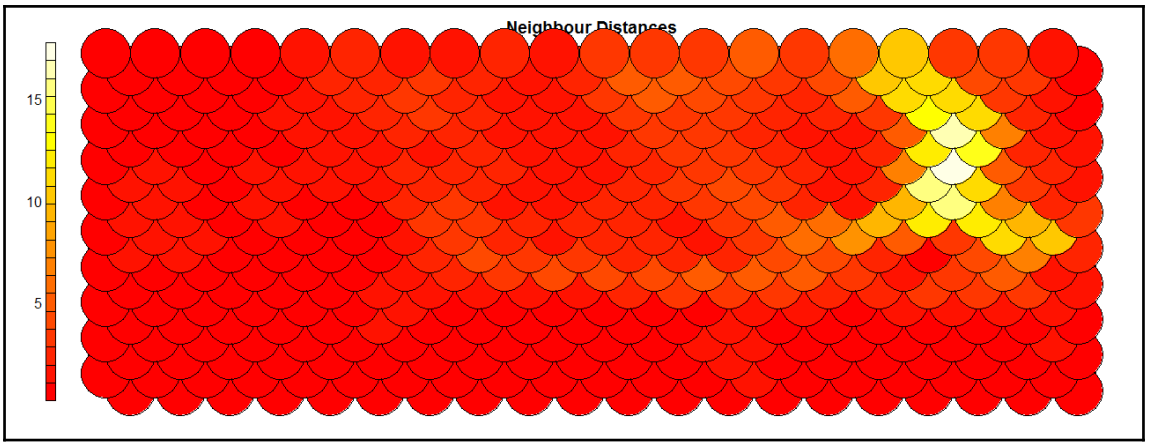
Chapter 7: Unsupervised Learning

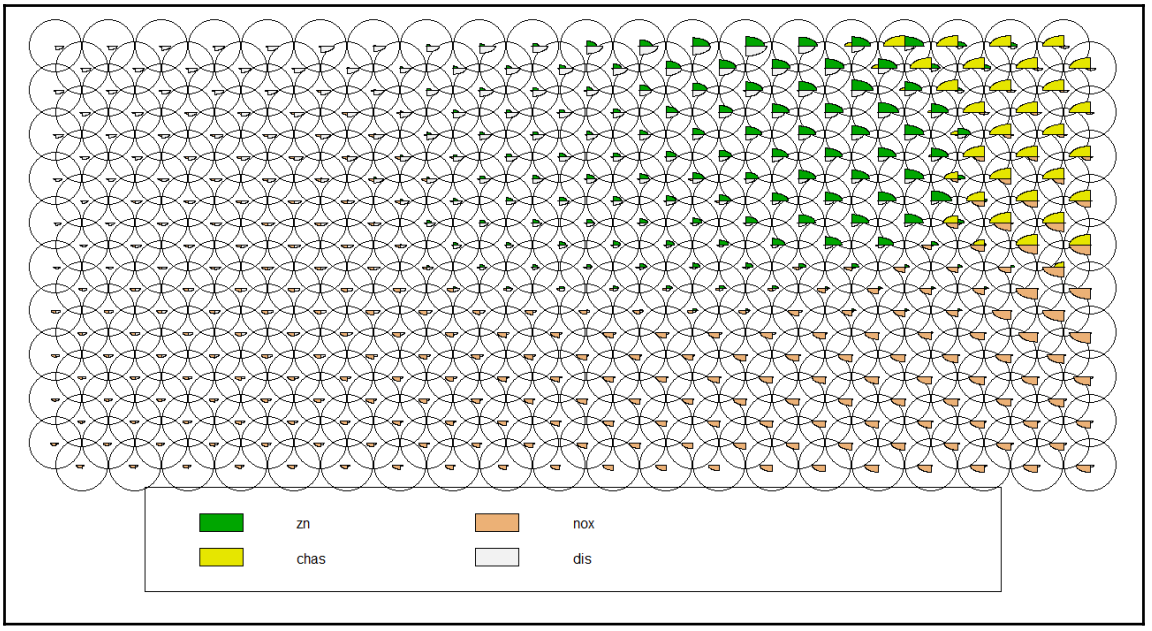
	zn	chas	nox	dis
1	0.28454827	-0.2723291	-0.14407485	0.1400749840
2	-0.48724019	-0.2723291	-0.73953036	0.5566090496
3	-0.48724019	-0.2723291	-0.73953036	0.5566090496
4	-0.48724019	-0.2723291	-0.83445805	1.0766711351
5	-0.48724019	-0.2723291	-0.83445805	1.0766711351
6	-0.48724019	-0.2723291	-0.83445805	1.0766711351
7	0.04872402	-0.2723291	-0.26489191	0.8384142195
8	0.04872402	-0.2723291	-0.26489191	1.0236248974
9	0.04872402	-0.2723291	-0.26489191	1.0861216287
10	0.04872402	-0.2723291	-0.26489191	1.3283202075
11	0.04872402	-0.2723291	-0.26489191	1.2117799501
12	0.04872402	-0.2723291	-0.26489191	1.1547920492
13	0.04872402	-0.2723291	-0.26489191	0.7863652700
14	-0.48724019	-0.2723291	-0.14407485	0.4333252240
15	-0.48724019	-0.2723291	-0.14407485	0.3166899868
16	-0.48724019	-0.2723291	-0.14407485	0.3341187865
17	-0.48724019	-0.2723291	-0.14407485	0.3341187865
18	-0.48724019	-0.2723291	-0.14407485	0.2198105553
19	-0.48724019	-0.2723291	-0.14407485	0.0006920764
20	-0.48724019	-0.2723291	-0.14407485	0.0006920764
21	-0.48724019	-0.2723291	-0.14407485	0.0013569352
22	-0.48724019	-0.2723291	-0.14407485	0.1031753182
23	-0.48724019	-0.2723291	-0.14407485	0.0863638874
24	-0.48724019	-0.2723291	-0.14407485	0.1425444597
25	-0.48724019	-0.2723291	-0.14407485	0.2871037683
26	-0.48724019	-0.2723291	-0.14407485	0.3132232229
27	-0.48724019	-0.2723291	-0.14407485	0.4212152950
28	-0.48724019	-0.2723291	-0.14407485	0.3126533438
29	-0.48724019	-0.2723291	-0.14407485	0.3132707128
30	-0.48724019	-0.2723291	-0.14407485	0.2108349609
31	-0.48724019	-0.2723291	-0.14407485	0.2079855659
32	-0.48724019	-0.2723291	-0.14407485	0.1804414138

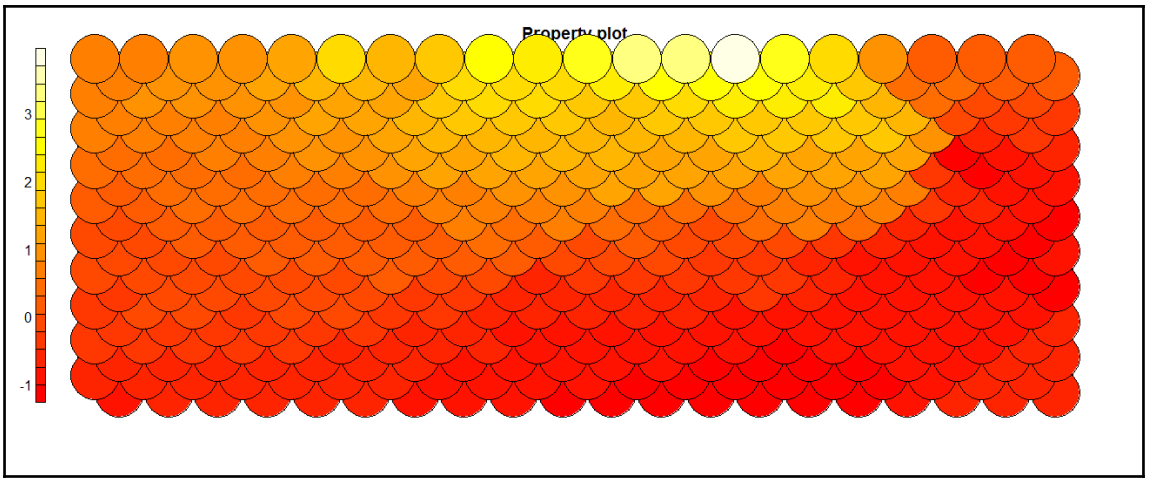
```
attr(,"scaled:center")
         zn        chas         nox         dis
11.36363636  0.06916996  0.55469506  3.79504269
attr(,"scaled:scale")
         zn        chas         nox         dis
23.3224530  0.2539940  0.1158777  2.1057101
```



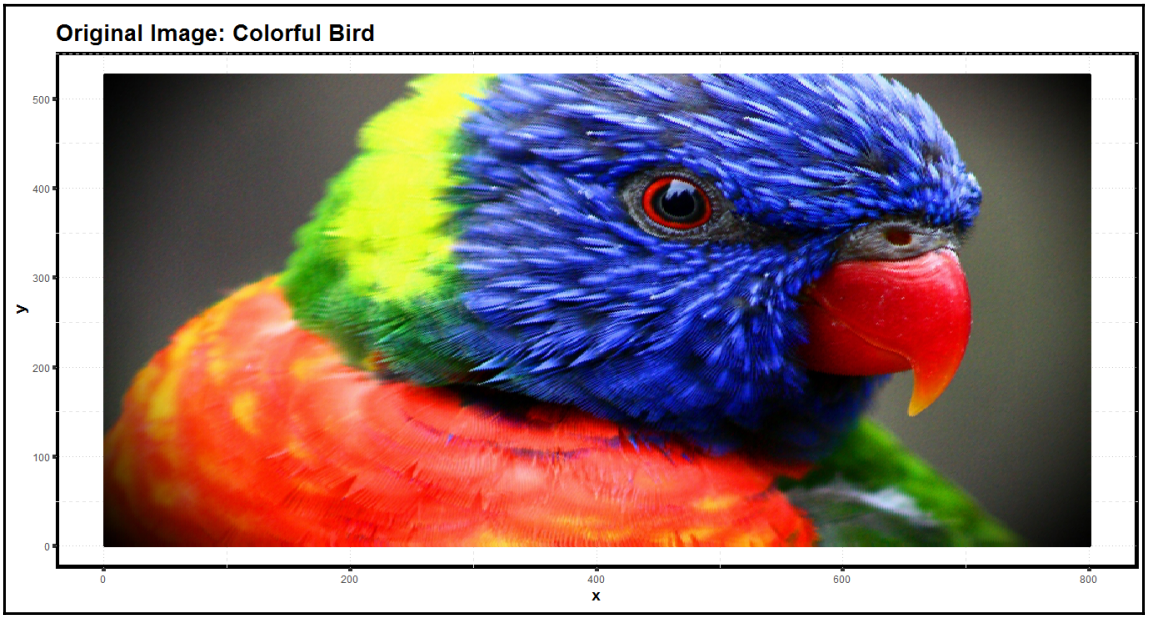


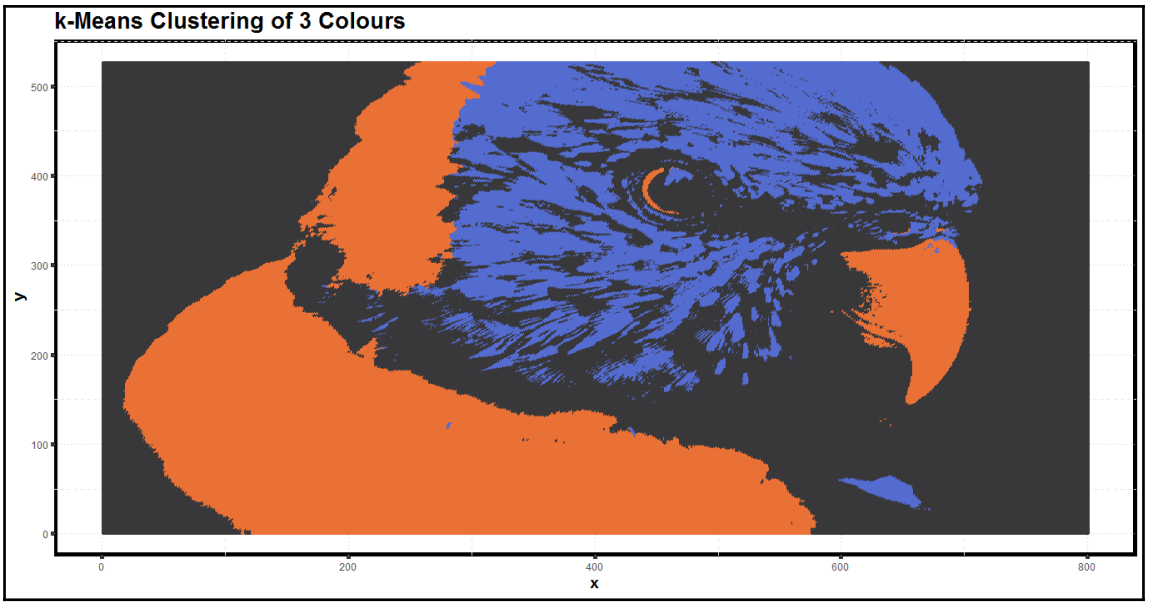

Neighbour Distances
15
10
5

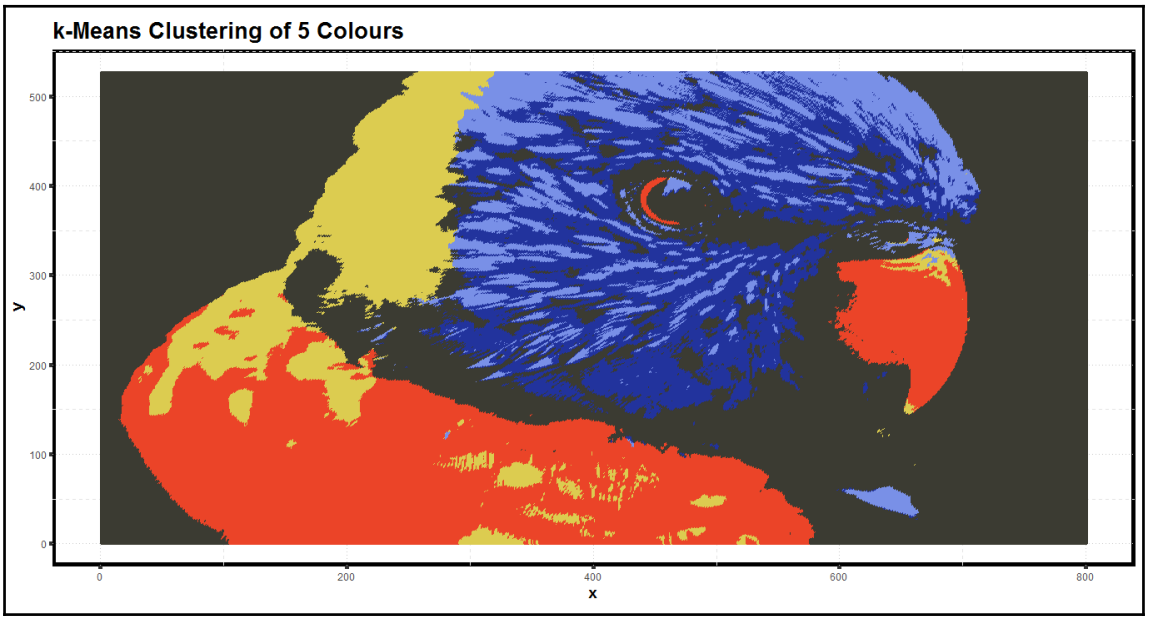

zn
nox
chas
dis


Property plot
3
2
1
0
-1

```
[1] 526 800   3
```


Original Image: Colorful Bird
500
400
300
200
100
0
y
0
200
400
600
800
x


k-Means Clustering of 3 Colours
500
400
300
200
100
0
y
0
200
400
600
800
x


k-Means Clustering of 5 Colours
500
400
300
200
100
0
y
0
200
400
600
800
x

Chapter 8: Reinforcement Learning

```
     DATE   LRY   LRV   INT   LRC  LVS  LGS
1 1997Q3 11.49  6.74 10.73 13.35 4.95 4.90
2 1997Q4 11.51 12.97 11.09 13.33 4.63 4.43
3 1998Q1 11.44 13.41 12.45 13.30 4.36 3.99
4 1998Q2 11.42  4.26 13.51 13.31 4.55 4.20
5 1998Q3 11.39 33.71 12.55 13.28 4.05 3.83
6 1998Q4 11.39  3.54 10.00 13.31 3.90 3.36
```

```
[1] 66  7
```

```
     DATE         LRY             LRV              INT             LRC             LVS
1997Q3 : 1   Min.   :11.39   Min.   : 0.1100   Min.   : 4.520   Min.   :13.22   Min.   :3.900
1997Q4 : 1   1st Qu.:11.57   1st Qu.: 0.3125   1st Qu.: 5.015   1st Qu.:13.31   1st Qu.:4.705
1998Q1 : 1   Median :11.83   Median : 0.6100   Median : 6.215   Median :13.36   Median :4.875
1998Q2 : 1   Mean   :11.80   Mean   : 1.9211   Mean   : 6.619   Mean   :13.43   Mean   :4.896
1998Q3 : 1   3rd Qu.:12.00   3rd Qu.: 1.5275   3rd Qu.: 7.025   3rd Qu.:13.54   3rd Qu.:5.170
1998Q4 : 1   Max.   :12.21   Max.   :33.7100   Max.   :13.510   Max.   :13.85   Max.   :5.400
(Other):60
      LGS
Min.   :3.360
1st Qu.:3.853
Median :3.935
Mean   :3.978
3rd Qu.:4.140
Max.   :4.900
```

```
      LVS
[1,] 4.95
[2,] 4.63
[3,] 4.36
[4,] 4.55
[5,] 4.05
[6,] 3.90
```

```
          LGS
[1,] 4.90
[2,] 4.43
[3,] 3.99
[4,] 4.20
[5,] 3.83
[6,] 3.36
```

```
Call:
lm(formula = yLogValueStocks ~ x)

Residuals:
     Min       1Q   Median       3Q      Max
-0.57390 -0.07711 -0.00725  0.07179  0.39578

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -9.151035   1.950114  -4.693 1.57e-05 ***
xLRY         1.043820   0.200840   5.197 2.48e-06 ***
xLRC         0.123601   0.210845   0.586   0.5599
xINT         0.013357   0.020907   0.639   0.5253
xLRV        -0.012112   0.005686  -2.130   0.0372 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1431 on 61 degrees of freedom
Multiple R-squared:  0.8042,    Adjusted R-squared:  0.7914
F-statistic: 62.64 on 4 and 61 DF,  p-value: < 2.2e-16
```

```
Call:
lm(formula = yLogGrowthStocks ~ x)

Residuals:
     Min       1Q   Median       3Q      Max
-0.62267 -0.11945  0.01245  0.07490  0.78002

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -7.711885   2.663863  -2.895  0.00525 **
xLRY         0.827857   0.274348   3.018  0.00371 **
xLRC         0.089680   0.288015   0.311  0.75658
xINT         0.110447   0.028559   3.867  0.00027 ***
xLRV        -0.009277   0.007767  -1.194  0.23691
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1954 on 61 degrees of freedom
Multiple R-squared:  0.2924,    Adjusted R-squared:  0.246
F-statistic: 6.303 on 4 and 61 DF,  p-value: 0.0002596
```

```
Markov Switching Model

Call: msmFit(object = olsLogValueStocks, k = 2, sw = rep(TRUE, 6))

        AIC       BIC   logLik
  -102.0478 -38.25474 61.02392

Coefficients:

Regime 1
---------
               Estimate Std. Error  t value  Pr(>|t|)
(Intercept)(S) -10.7330     0.5460 -19.6575 < 2.2e-16 ***
xLRY(S)          1.6984     0.0303  56.0528 < 2.2e-16 ***
xLRC(S)         -0.3478     0.0414  -8.4010 < 2.2e-16 ***
xINT(S)          0.0411     0.0020  20.5500 < 2.2e-16 ***
xLRV(S)         -0.0139     0.0015  -9.2667 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.03610862
Multiple R-squared: 0.9893

Standardized Residuals:
          Min            Q1           Med            Q3           Max
-8.340128e-02 -1.065220e-02 -3.682609e-16  1.117322e-02  7.650599e-02

Regime 2
---------
               Estimate Std. Error t value  Pr(>|t|)
(Intercept)(S)  13.6836     2.1896  6.2494 4.120e-10 ***
xLRY(S)          0.7522     0.1799  4.1812 2.900e-05 ***
xLRC(S)         -1.2801     0.1608 -7.9608 1.776e-15 ***
xINT(S)         -0.1005     0.0388 -2.5902  0.009592 **
xLRV(S)          0.0487     0.0201  2.4229  0.015397 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.1515668
Multiple R-squared: 0.5145

Standardized Residuals:
        Min          Q1         Med          Q3         Max
-0.48074613 -0.02481690  0.00113687  0.02751167  0.46264470

Transition probabilities:
          Regime 1  Regime 2
Regime 1 0.8255604 0.1692358
Regime 2 0.1744396 0.8307642
```

```
Markov Switching Model

Call: msmFit(object = olsLogGrowthStocks, k = 2, sw = rep(TRUE, 6))

        AIC       BIC   logLik
  -65.43317 -1.640072 42.71658

Coefficients:

Regime 1
---------
               Estimate Std. Error t value  Pr(>|t|)
(Intercept)(S)  14.9726     4.1217  3.6326 0.0002806 ***
xLRY(S)          1.4894     0.3053  4.8785 1.069e-06 ***
xLRC(S)         -2.1932     0.2741 -8.0015 1.332e-15 ***
xINT(S)          0.1022     0.0651  1.5699 0.1164384
xLRV(S)          0.0466     0.0309  1.5081 0.1315289
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2376528
Multiple R-squared: 0.4281

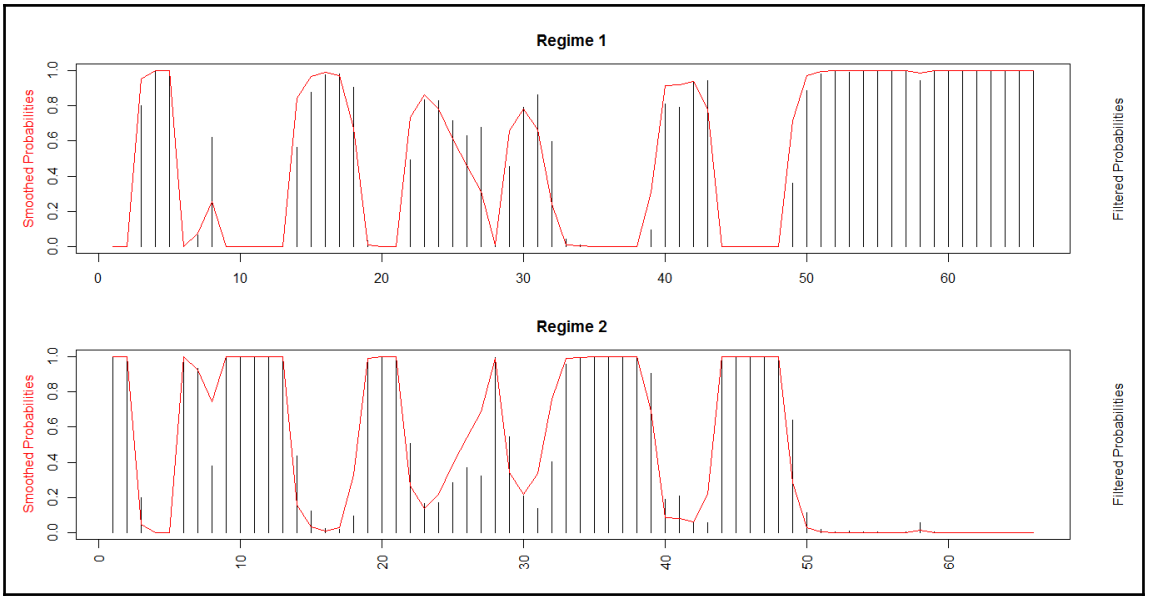
Standardized Residuals:
         Min           Q1          Med           Q3          Max
-0.573535743 -0.021589934  0.004829526  0.018767748  0.681347620

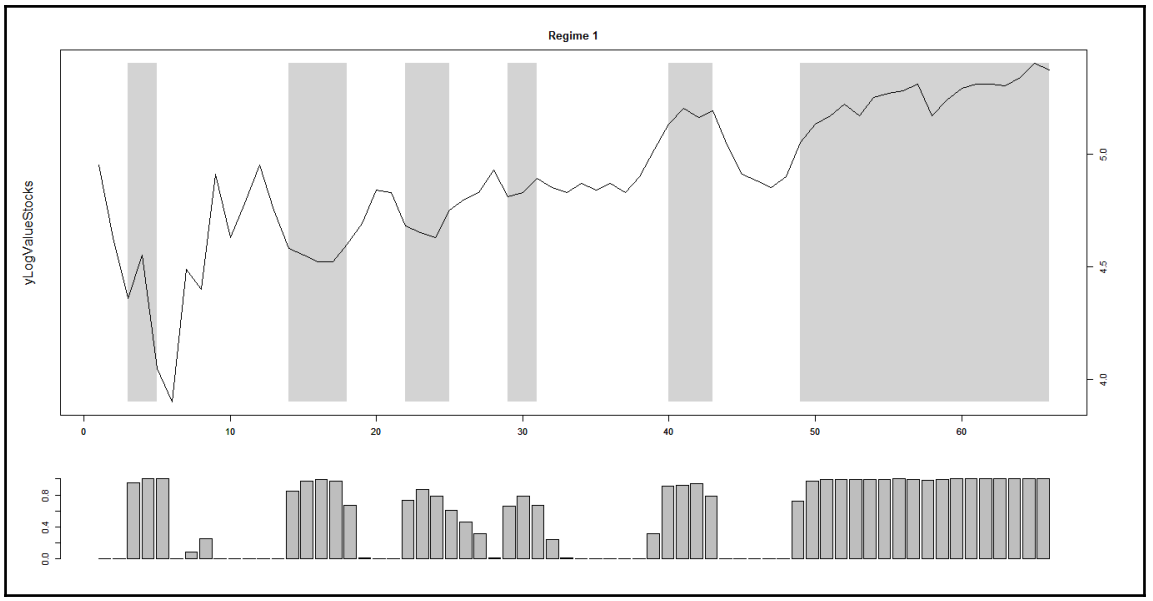
Regime 2
---------
               Estimate Std. Error  t value  Pr(>|t|)
(Intercept)(S)  -8.5099     0.8361 -10.1781 < 2.2e-16 ***
xLRY(S)          0.5287     0.0940   5.6245 1.860e-08 ***
xLRC(S)          0.4282     0.0871   4.9162 8.824e-07 ***
xINT(S)          0.0718     0.0100   7.1800 6.972e-13 ***
xLRV(S)         -0.0081     0.0029  -2.7931  0.005221 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

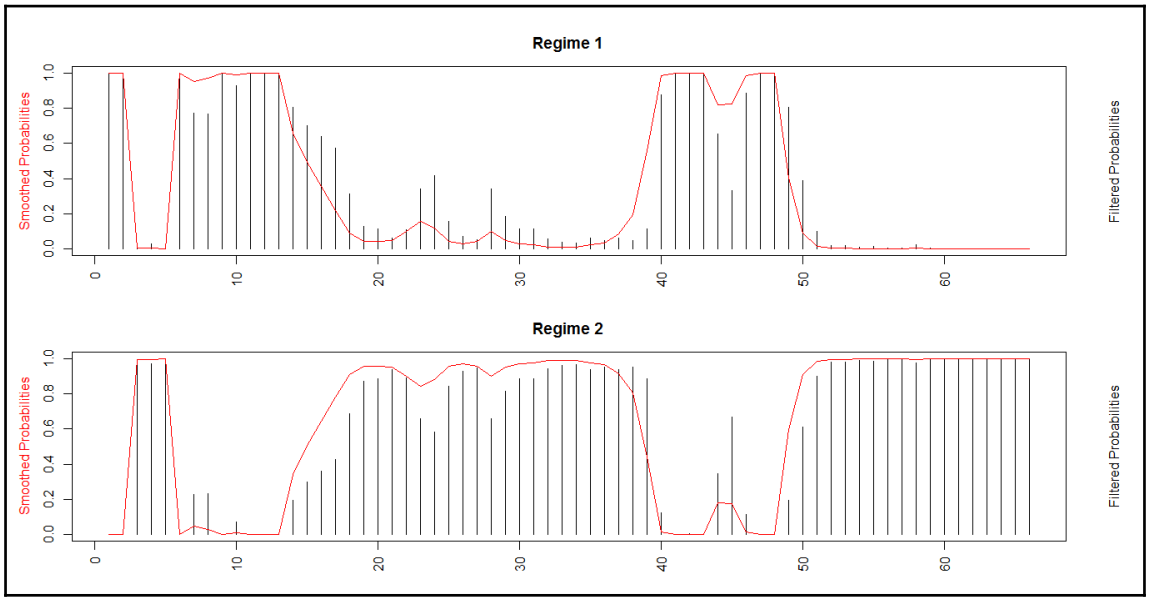
```
Residual standard error: 0.0676098
Multiple R-squared: 0.803

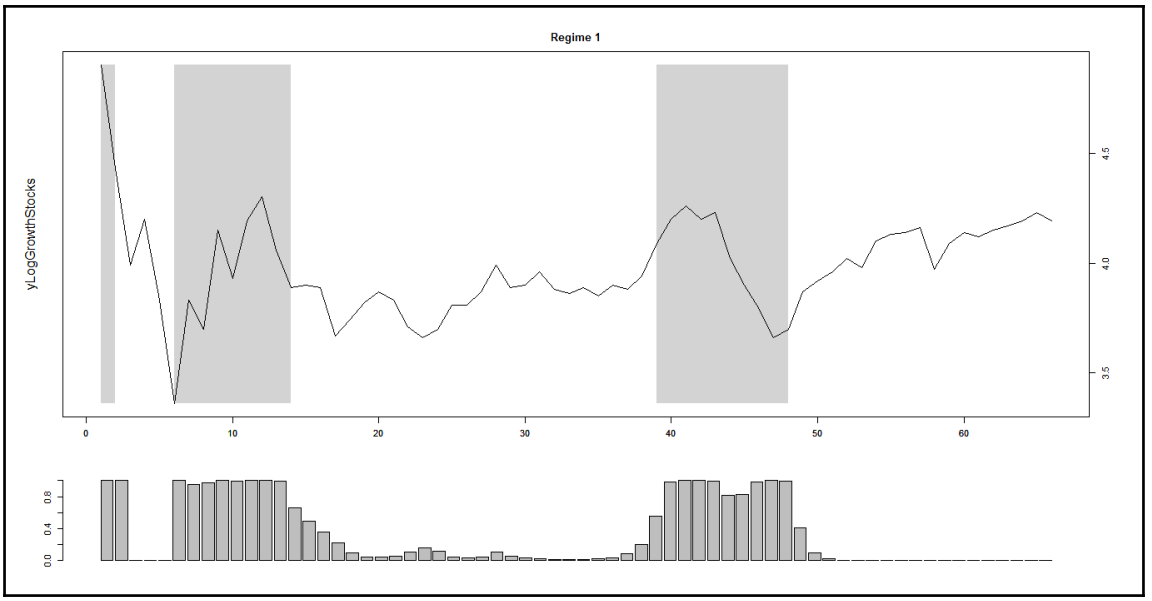
Standardized Residuals:
          Min            Q1           Med            Q3           Max
-1.356430e-01 -2.402493e-02  6.076829e-06  3.124204e-02  1.493800e-01

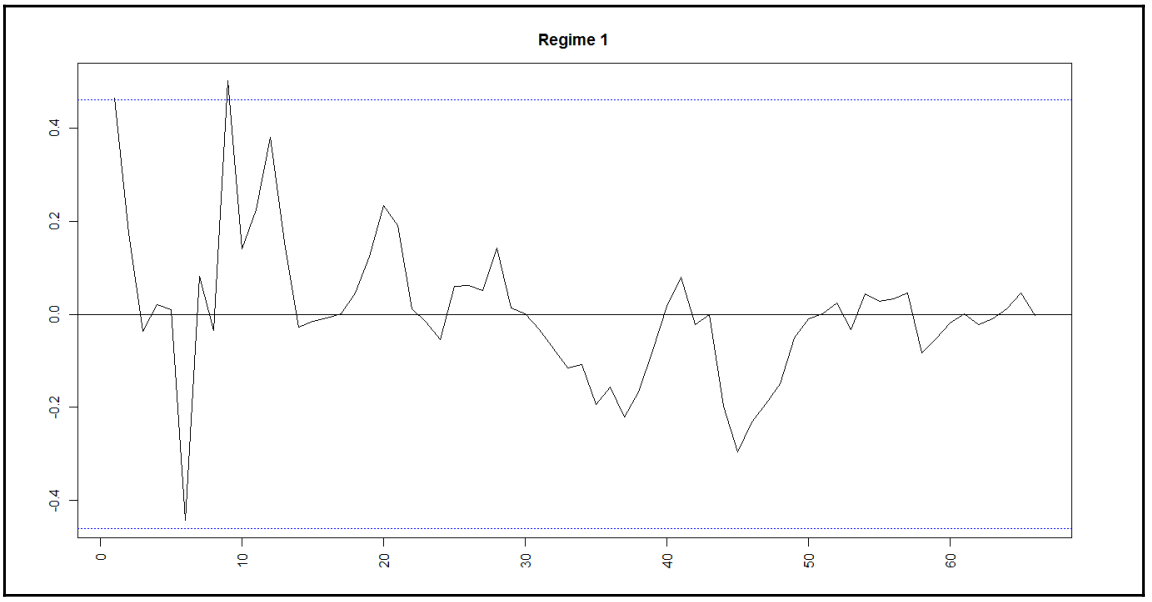
Transition probabilities:
          Regime 1   Regime 2
Regime 1 0.8809933 0.08517424
Regime 2 0.1190067 0.91482576
```

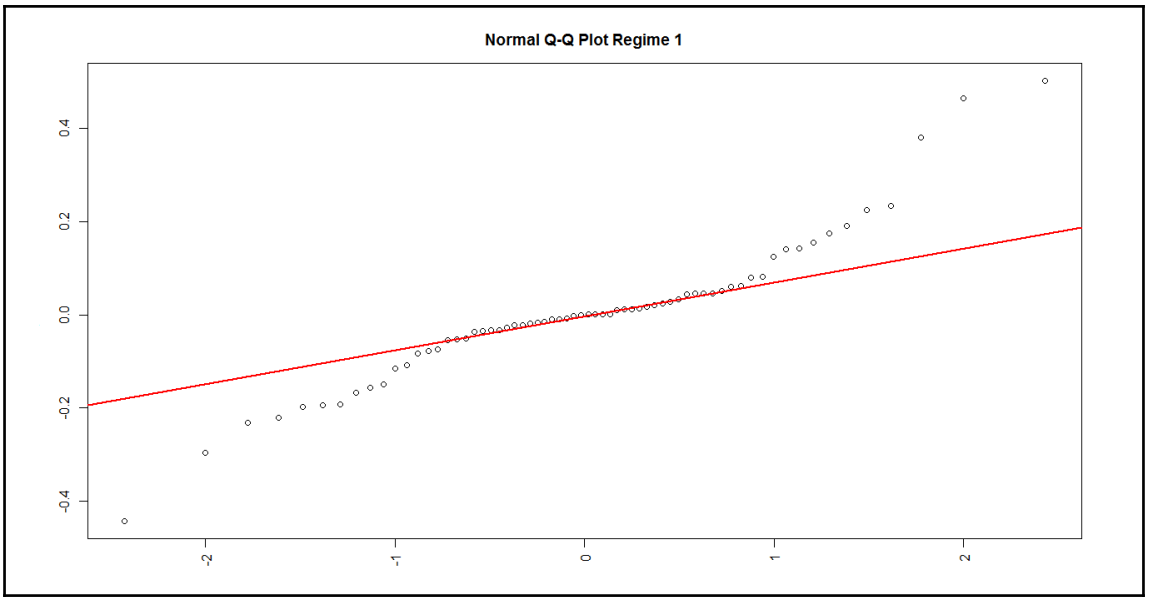


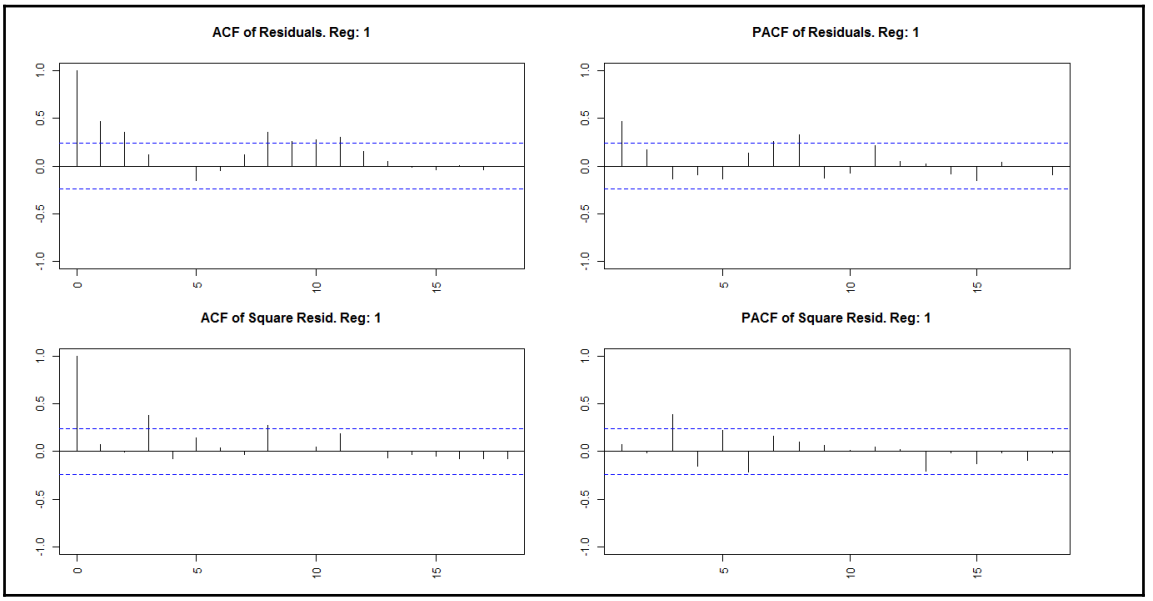

Regime 1
yLogValueStocks
4.0
4.5
5.0
0
10
20
30
40
50
60
0.0
0.4
0.8

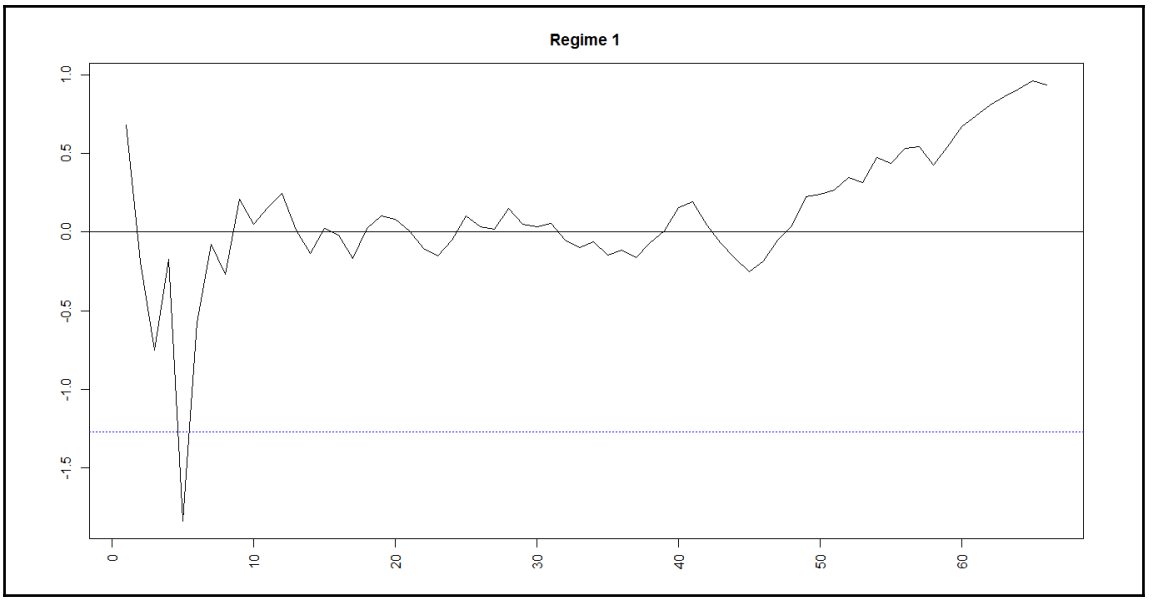

Regime 1
Smoothed Probabilities
Filtered Probabilities
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
60
Regime 2
Smoothed Probabilities
Filtered Probabilities

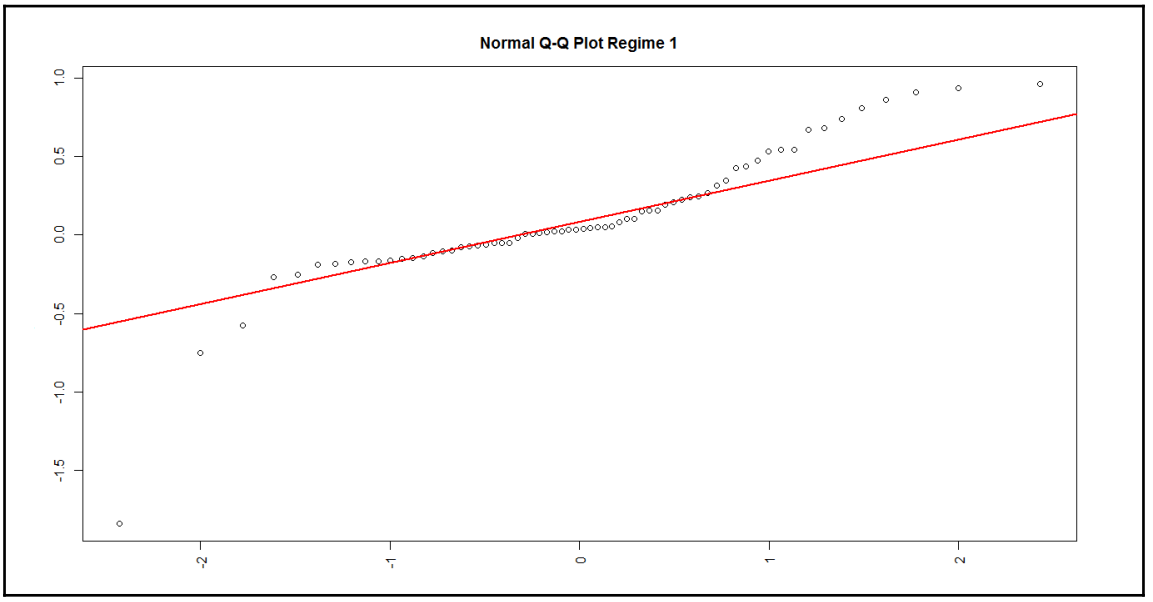

Regime 1
yLogGrowthStocks
4.5
4.0
3.5
0
10
20
30
40
50
60
0.0
0.4
0.8

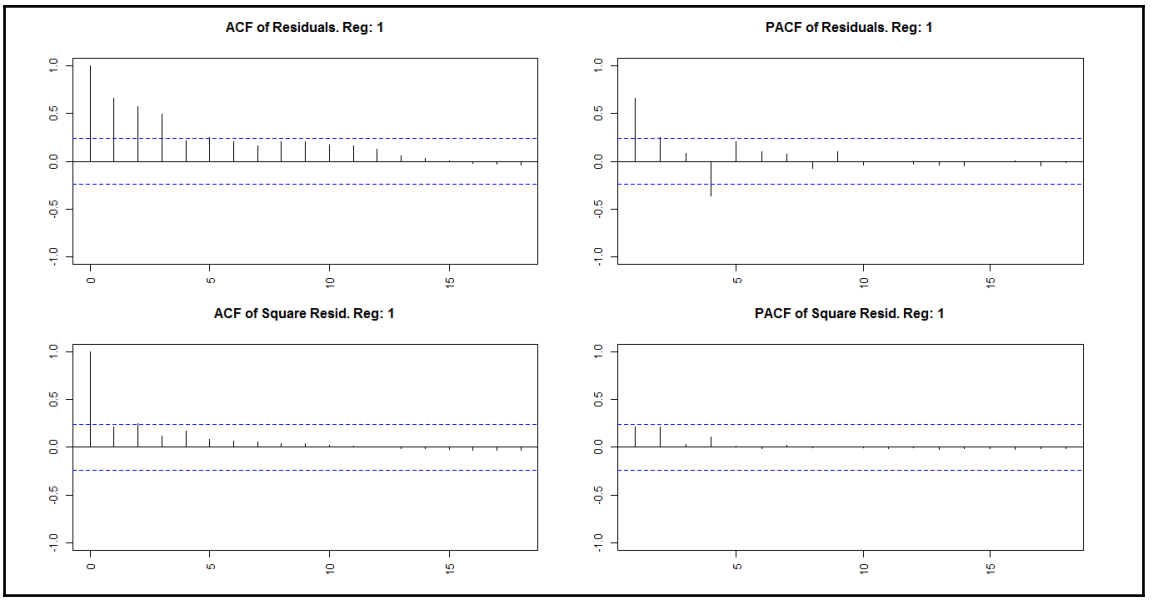

Regime 1
0.4
0.2
0.0
-0.2
-0.4
0
10
20
30
40
50
60


Normal Q-Q Plot Regime 1
0.4
0.2
0.0
-0.2
-0.4
-2
-1
0
1
2


ACF of Residuals. Reg: 1
PACF of Residuals. Reg: 1
ACF of Square Resid. Reg: 1
PACF of Square Resid. Reg: 1
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15


Regime 1
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
10
20
30
40
50
60


Normal Q-Q Plot Regime 1
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2
-1
0
1
2



	path	conv	conv_null
1	c1 > c2 > c3	1	0
2	c1	0	1
3	c2 > c3	0	1

```
$result
  channel_name total_conversions
1           c1         0.2001447
2           c2         0.3999276
3           c3         0.3999276

$transition_matrix
  channel_from   channel_to transition_probability
1      (start)           c1               0.6666667
2      (start)           c2               0.3333333
3           c1           c2               0.5000000
4           c1       (null)               0.5000000
5           c2           c3               1.0000000
6           c3 (conversion)               0.5000000
7           c3       (null)               0.5000000

$removal_effects
  channel_name removal_effects
1           c1       0.5004524
2           c2       1.0000000
3           c3       1.0000000
```

```
  channel_from (conversion) (null)        c1        c2 c3
1      (start)           NA     NA 0.6666667 0.3333333 NA
2           c1           NA    0.5        NA 0.5000000 NA
3           c2           NA     NA        NA        NA  1
4           c3          0.5    0.5        NA        NA NA
```

```
  channel_from   channel_to transition_probability
1      (start)           c1               0.6666667
2      (start)           c2               0.3333333
3           c1           c2               0.5000000
4           c1       (null)               0.5000000
5           c2           c3               1.0000000
6           c3 (conversion)               0.5000000
7           c3       (null)               0.5000000
```

	channel_from	channel_to	transition_probability
1	(start)	(start)	0
2	(conversion)	(conversion)	1
3	(null)	(null)	1

	channel_from	channel_to	transition_probability
1	(start)	c1	0.6666667
2	(start)	c2	0.3333333
3	c1	c2	0.5000000
4	c1	(null)	0.5000000
5	c2	c3	1.0000000
6	c3	(conversion)	0.5000000
7	c3	(null)	0.5000000
8	(start)	(start)	0.0000000
9	(conversion)	(conversion)	1.0000000
10	(null)	(null)	1.0000000

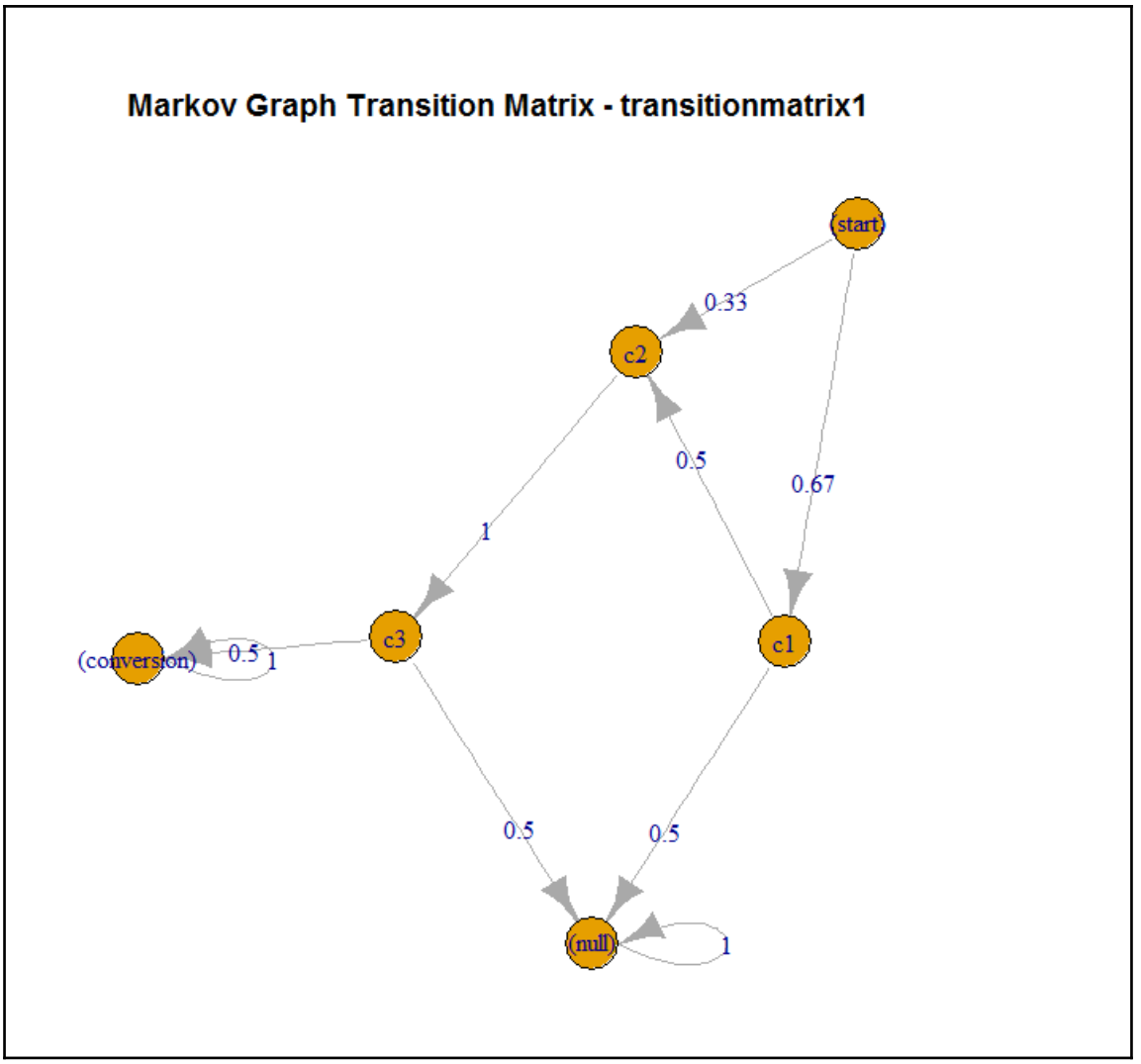
```
 [1] (start)      (start)      c1           c1           c2           c3           c3           (start)      (conversion)
[10] (null)
Levels: (start) (conversion) (null) c1 c2 c3
```

```
 [1] c1           c2           c2           (null)       c3           (conversion) (null)       (start)
 [9] (conversion) (null)
Levels: (start) (conversion) (null) c1 c2 c3
```

	channel_from	(start)	(conversion)	(null)	c1	c2	c3
1	(start)	0	NA	NA	0.6666667	0.3333333	NA
2	(conversion)	NA	1.0	NA	NA	NA	NA
3	(null)	NA	NA	1.0	NA	NA	NA
4	c1	NA	NA	0.5	NA	0.5000000	NA
5	c2	NA	NA	NA	NA	NA	1
6	c3	NA	0.5	0.5	NA	NA	NA

	(start)	(conversion)	(null)	c1	c2	c3
(start)	0	NA	NA	0.6666667	0.3333333	NA
(conversion)	NA	1.0	NA	NA	NA	NA
(null)	NA	NA	1.0	NA	NA	NA
c1	NA	NA	0.5	NA	0.5000000	NA
c2	NA	NA	NA	NA	NA	1
c3	NA	0.5	0.5	NA	NA	NA

```
Unnamed Markov chain
 A  6 - dimensional discrete Markov Chain defined by the following states:
 (start), (conversion), (null), c1, c2, c3
 The transition matrix  (by rows)  is defined as follows:
             (start) (conversion) (null)        c1        c2 c3
(start)            0          0.0    0.0 0.6666667 0.3333333  0
(conversion)       0          1.0    0.0 0.0000000 0.0000000  0
(null)             0          0.0    1.0 0.0000000 0.0000000  0
c1                 0          0.0    0.5 0.0000000 0.5000000  0
c2                 0          0.0    0.0 0.0000000 0.0000000  1
c3                 0          0.5    0.5 0.0000000 0.0000000  0
```



	client_id	date	channel
1	411	2016-01-05	5
2	761	2016-01-31	6
3	509	2016-01-09	6
4	541	2016-02-02	8
5	156	2016-01-04	9
6	934	2016-01-26	8

	client_id	date	channel
1	411	2016-01-05	channel_5
2	761	2016-01-31	channel_6
3	509	2016-01-09	channel_6
4	541	2016-02-02	channel_8
5	156	2016-01-04	channel_9
6	934	2016-01-26	channel_8

```
# A tibble: 990 × 4
   client_id
       <int>
1          1
2          2
3          3
4          4
5          5
6          6
7          7
8          8
9          9
10        10
# ... with 980 more rows, and 3 more variables: path <chr>, conv <dbl>, conv_null <dbl>
```

```
# A tibble: 990 × 6
   client_id                                                                                                path  conv conv_null
       <int>                                                                                                <chr> <dbl>     <dbl>
 1         1                                                                                            channel_3     1         0
 2         2                                channel_4 > channel_9 > channel_9 > channel_6 > channel_2 > channel_1 > channel_0     1         0
 3         3 channel_7 > channel_9 > channel_9 > channel_8 > channel_8 > channel_9 > channel_5 > channel_0 > channel_0     1         0
 4         4                                                                channel_1 > channel_9 > channel_0 > channel_6     1         0
 5         5                                        channel_4 > channel_6 > channel_4 > channel_9 > channel_2 > channel_7     1         0
 6         6                                                                channel_1 > channel_1 > channel_4 > channel_7 > channel_6     1         0
 7         7                                channel_6 > channel_5 > channel_6 > channel_6 > channel_7 > channel_7 > channel_6     1         0
 8         8 channel_4 > channel_5 > channel_5 > channel_3 > channel_5 > channel_6 > channel_8 > channel_4 > channel_1     1         0
 9         9                                                                                        channel_4 > channel_8     1         0
10        10                                                                channel_0 > channel_4 > channel_1 > channel_1     1         0
# ... with 980 more rows, and 2 more variables: channel_name_ft <chr>, channel_name_lt <chr>
```

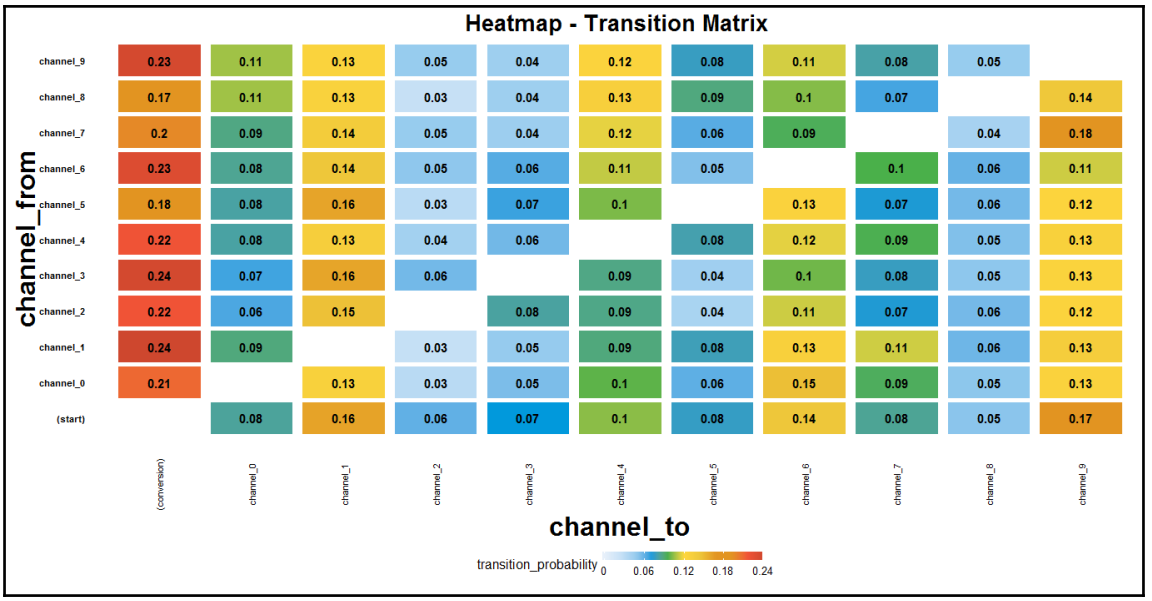
```
# A tibble: 10 × 2
   channel_name_ft first_touch_conversions
             <chr>                   <dbl>
1        channel_0                      82
2        channel_1                     159
3        channel_2                      60
4        channel_3                      71
5        channel_4                     102
6        channel_5                      75
7        channel_6                     142
8        channel_7                      83
9        channel_8                      50
10       channel_9                     166
```

```
# A tibble: 10 × 2
   channel_name_lt last_touch_conversions
             <chr>                  <dbl>
1        channel_0                     92
2        channel_1                    166
3        channel_2                     50
4        channel_3                     71
5        channel_4                    114
6        channel_5                     64
7        channel_6                    139
8        channel_7                     88
9        channel_8                     46
10       channel_9                    160
```

	channel_name_ft	first_touch_conversions	last_touch_conversions
1	channel_0	82	92
2	channel_1	159	166
3	channel_2	60	50
4	channel_3	71	71
5	channel_4	102	114
6	channel_5	75	64
7	channel_6	142	139
8	channel_7	83	88
9	channel_8	50	46
10	channel_9	166	160

	channel_name_ft	first_touch_conversions	last_touch_conversions	total_conversions
1	channel_0	82	92	97.59677
2	channel_1	159	166	139.07908
3	channel_2	60	50	57.98764
4	channel_3	71	71	73.53247
5	channel_4	102	114	110.94456
6	channel_5	75	64	82.25067
7	channel_6	142	139	126.11034
8	channel_7	83	88	98.86641
9	channel_8	50	46	65.69749
10	channel_9	166	160	137.93456

```
[1] 0.2391931
```

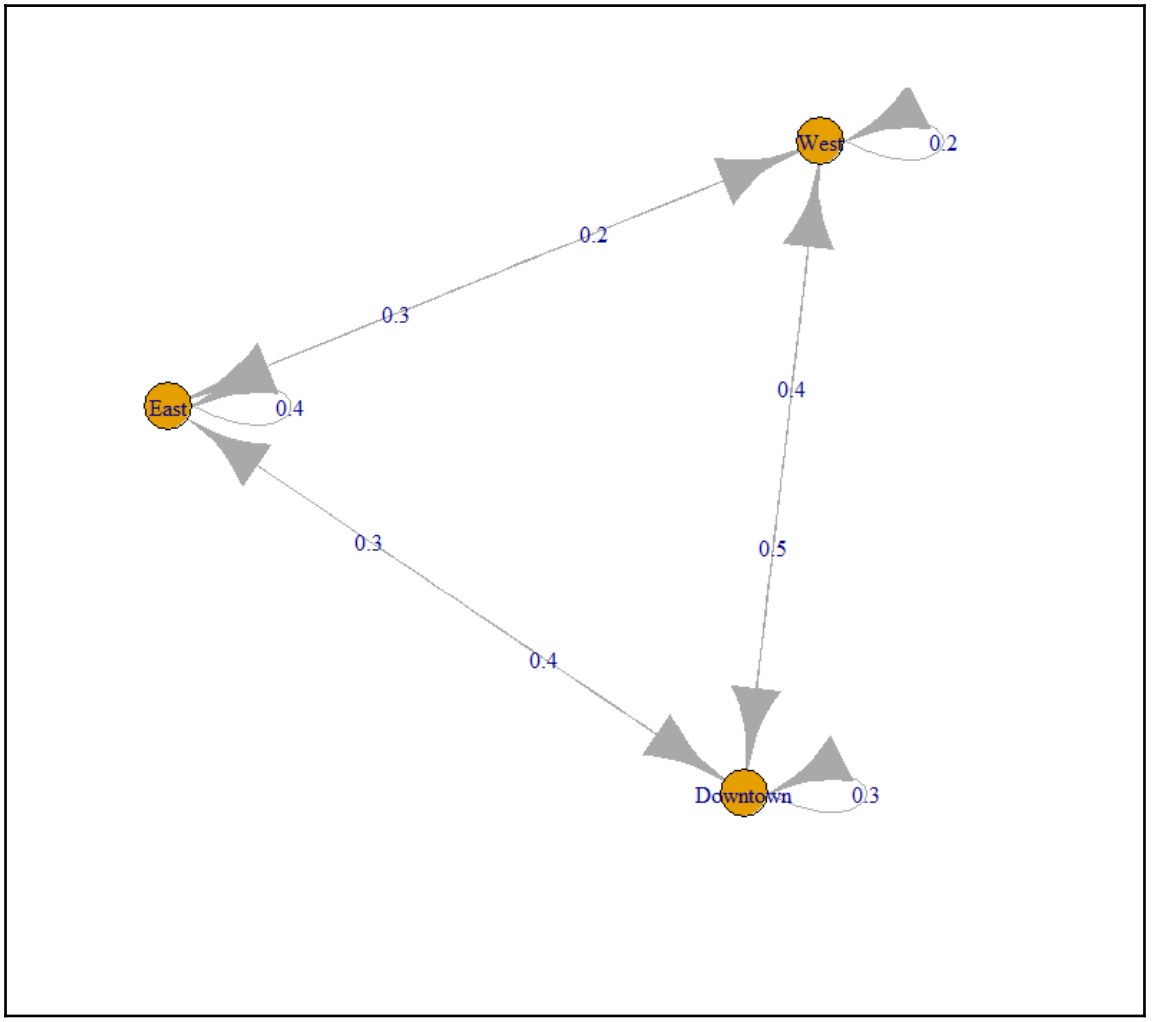



```
[1] "Downtown" "East"     "West"
```

	Downtown	East	West
Downtown	0.3	0.3	0.4
East	0.4	0.4	0.2
West	0.5	0.3	0.2

```
Rental Cars
 A  3 - dimensional discrete Markov Chain defined by the following states:
 Downtown, East, West
 The transition matrix  (by rows)  is defined as follows:
         Downtown East West
Downtown      0.3  0.3  0.4
East          0.4  0.4  0.2
West          0.5  0.3  0.2
```

Downtown	East	West
0.4	0.4	0.2



```
[1] 0.2
```

```
[1] 0.41
```

```
Rental Cars^2
 A  3 - dimensional discrete Markov Chain defined by the following states:
 Downtown, East, West
 The transition matrix  (by rows)  is defined as follows:
         Downtown East West
Downtown     0.41 0.33 0.26
East         0.38 0.34 0.28
West         0.37 0.33 0.30
```

```
Rental Cars^20
 A  3 - dimensional discrete Markov Chain defined by the following states:
 Downtown, East, West
 The transition matrix  (by rows)  is defined as follows:
          Downtown      East      West
Downtown 0.3888889 0.3333333 0.2777778
East     0.3888889 0.3333333 0.2777778
West     0.3888889 0.3333333 0.2777778
```

```
Rental Cars^30
 A  3 - dimensional discrete Markov Chain defined by the following states:
 Downtown, East, West
 The transition matrix  (by rows)  is defined as follows:
          Downtown      East      West
Downtown 0.3888889 0.3333333 0.2777778
East     0.3888889 0.3333333 0.2777778
West     0.3888889 0.3333333 0.2777778
```

```
     Downtown     East     West
[1,] 27.22222 23.33333 19.44444
```

```
Rental Cars  Markov chain that is composed by:
Closed classes:
Downtown East West
Recurrent classes:
{Downtown,East,West}
Transient classes:
NONE
The Markov chain is irreducible
The absorbing states are: NONE
```

```
Downtown      East      West
     0.3       0.3       0.4
```

```
Downtown      East      West
     0.5       0.3       0.2
```

```
Downtown      East      West
     0.4       0.4       0.2
```

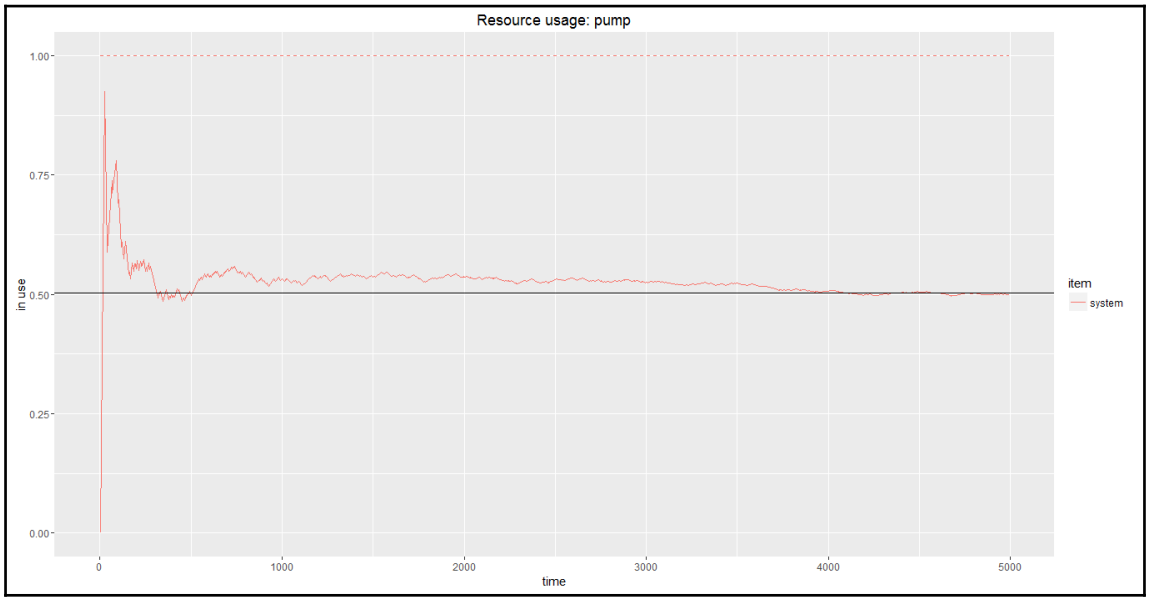
```
[1] 0.15
```

```
[1] 0.1250000 0.3333333
```

```
      [,1]       [,2]       [,3]
[1,]    1  0.1250000  0.0000000
[2,]    1 -0.1500000  0.0375000
[3,]    1  0.3333333 -0.3333333
```

```
[1] 0.44720497 0.49689441 0.05590062
```

```
[1] 0.5031056
```




```
[1] 0.08333333
```

```
[1] 1 2 3 4 5
```

```
[1] 1 2 3 4 5
```

```
Hull-White (analytic) calibration
0x0: model 0.106204, market 0.114800, diff -0.008596
0x0: model 0.106296, market 0.110800, diff -0.004504
0x0: model 0.106341, market 0.107000, diff -0.000659
0x0: model 0.106443, market 0.102100, diff 0.004343
0x0: model 0.106613, market 0.100000, diff 0.006613
```

```
        Summary of pricing results for Bermudan Swaption

Price (in bp) of Bermudan swaption is  24.92137
Stike is  NULL (ATM strike is  0.05 )
Model used is: Hull-White using analytic formulas
Calibrated model parameters are:
a =  0.04641
sigma =  0.005869
```

```
$a
[1] 0.04641377

$sigma
[1] 0.005869286

$price
[1] 24.92137

$ATMStrike
[1] 0.05000001

attr(,"class")
[1] "HWAnalytic"       "BermudanSwaption"
```

```
List of 7
 $ times     : num [1:60] 0.0833 0.1667 0.25 0.3333 0.4167 ...
 $ discounts : num [1:60] 0.997 0.994 0.991 0.988 0.985 ...
 $ forwards  : num [1:60] 0.0365 0.0358 0.0349 0.0342 0.0338 ...
 $ zerorates : num [1:60] 0.0376 0.037 0.0366 0.0362 0.0358 ...
 $ flatQuotes: logi FALSE
 $ params    :List of 8
  ..$ tradeDate : Date[1:1], format: "2002-02-15"
  ..$ settleDate: Date[1:1], format: "2002-02-19"
  ..$ payFixed  : logi TRUE
  ..$ dt        : num 0.0833
  ..$ strike    : num 0.06
  ..$ method    : chr "HWAnalytic"
  ..$ interpWhat: chr "zero"
  ..$ interpHow : chr "spline"
 $ table     :'data.frame':     183 obs. of  2 variables:
  ..$ date     : Date[1:183], format: "2002-02-19" "2002-03-20" "2002-04-22" "2002-05-22" ...
  ..$ zeroRates: num [1:183] 0.0387 0.0376 0.037 0.0366 0.0362 ...
 - attr(*, "class")= chr "DiscountCurve"
```

```
 [1] 0.08333333 0.16666667 0.25000000 0.33333333 0.41666667 0.50000000 0.58333333 0.66666667 0.75000000 0.83333333
 0.91666667
[12] 1.00000000 1.08333333 1.16666667 1.25000000 1.33333333 1.41666667 1.50000000 1.58333333 1.66666667 1.75000000
 1.83333333
[23] 1.91666667 2.00000000 2.08333333 2.16666667 2.25000000 2.33333333 2.41666667 2.50000000 2.58333333 2.66666667
 2.75000000
[34] 2.83333333 2.91666667 3.00000000 3.08333333 3.16666667 3.25000000 3.33333333 3.41666667 3.50000000 3.58333333
 3.66666667
[45] 3.75000000 3.83333333 3.91666667 4.00000000 4.08333333 4.16666667 4.25000000 4.33333333 4.41666667 4.50000000
 4.58333333
[56] 4.66666667 4.75000000 4.83333333 4.91666667 5.00000000
```

```
 [1] 0.03760349 0.03704203 0.03662016 0.03618554 0.03578598 0.03546280 0.03521342 0.03500431 0.03482148 0.03462910
0.03445629
[12] 0.03438130 0.03440817 0.03448436 0.03460322 0.03475813 0.03494245 0.03514953 0.03537275 0.03560546 0.03584102
0.03607281
[23] 0.03629418 0.03649850 0.03669634 0.03690156 0.03711288 0.03732899 0.03754861 0.03777043 0.03799317 0.03821553
0.03843622
[34] 0.03865395 0.03886741 0.03907533 0.03928021 0.03948630 0.03969335 0.03990105 0.04010912 0.04031728 0.04052524
0.04073270
[45] 0.04093939 0.04114501 0.04134928 0.04155191 0.04175261 0.04195110 0.04214709 0.04234029 0.04253041 0.04271717
0.04290028
[56] 0.04307945 0.04325440 0.04342484 0.04359047 0.04375102
```

```
 [1] 0.9968713 0.9938453 0.9908867 0.9880106 0.9851998 0.9824249 0.9796684 0.9769340 0.9742220 0.9715548 0.9689087
0.9662030
[13] 0.9634107 0.9605668 0.9576681 0.9547133 0.9517034 0.9486415 0.9455327 0.9423840 0.9392047 0.9360059 0.9328006
0.9296036
[25] 0.9263986 0.9231594 0.9198874 0.9165845 0.9132529 0.9098950 0.9065138 0.9031126 0.8996949 0.8962647 0.8928262
0.8893842
[37] 0.8859330 0.8824616 0.8789710 0.8754620 0.8719358 0.8683934 0.8648360 0.8612648 0.8576813 0.8540867 0.8504826
0.8468704
[49] 0.8432517 0.8396281 0.8360013 0.8323730 0.8287451 0.8251193 0.8214976 0.8178818 0.8142740 0.8106761 0.8070902
0.8035185
```

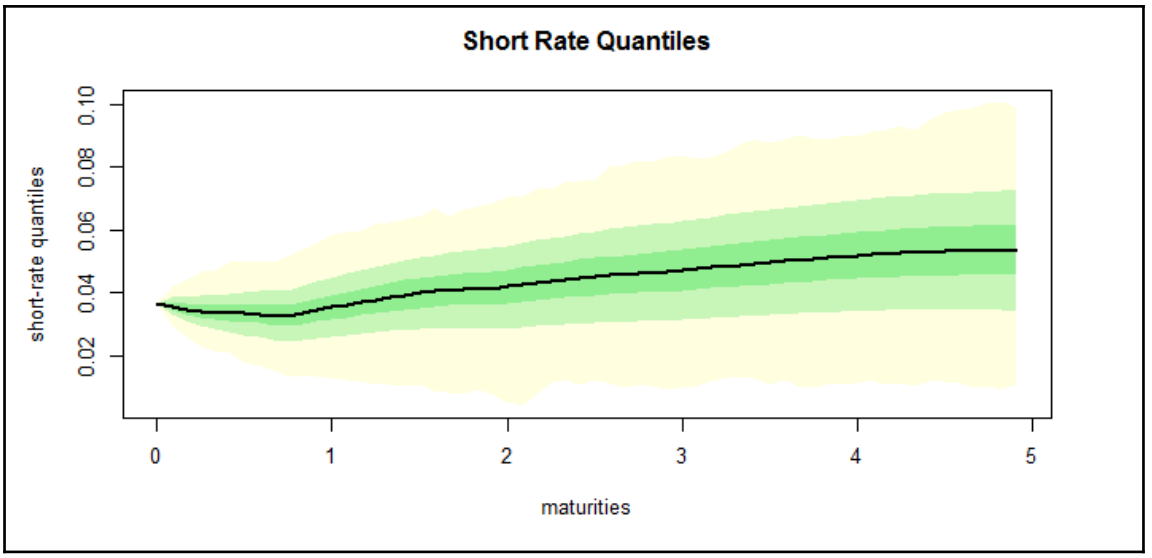
```
[1] 0.04641377
```

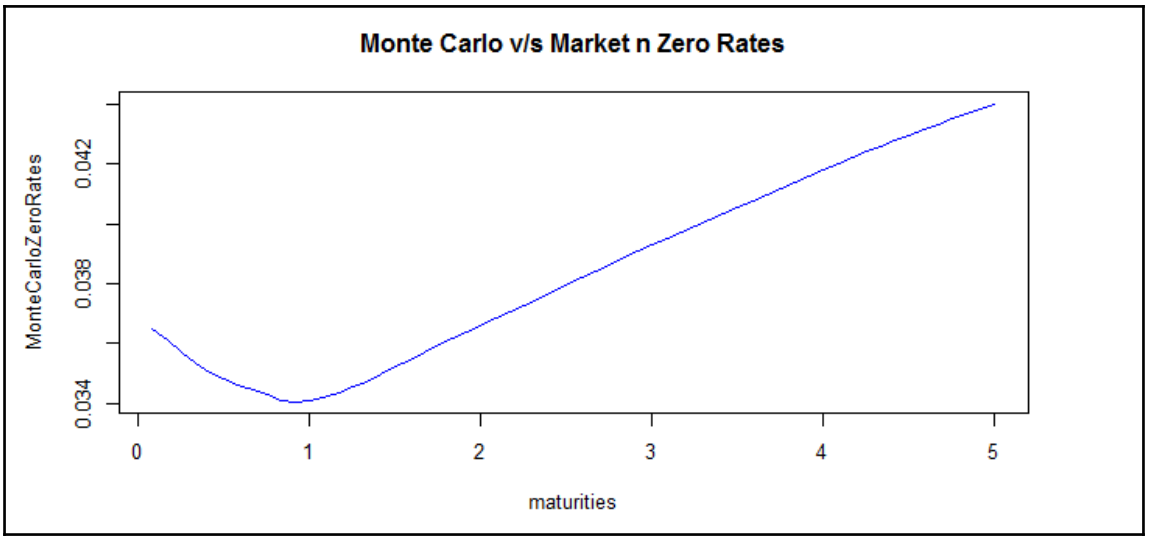
```
[1] 0.005869286
```

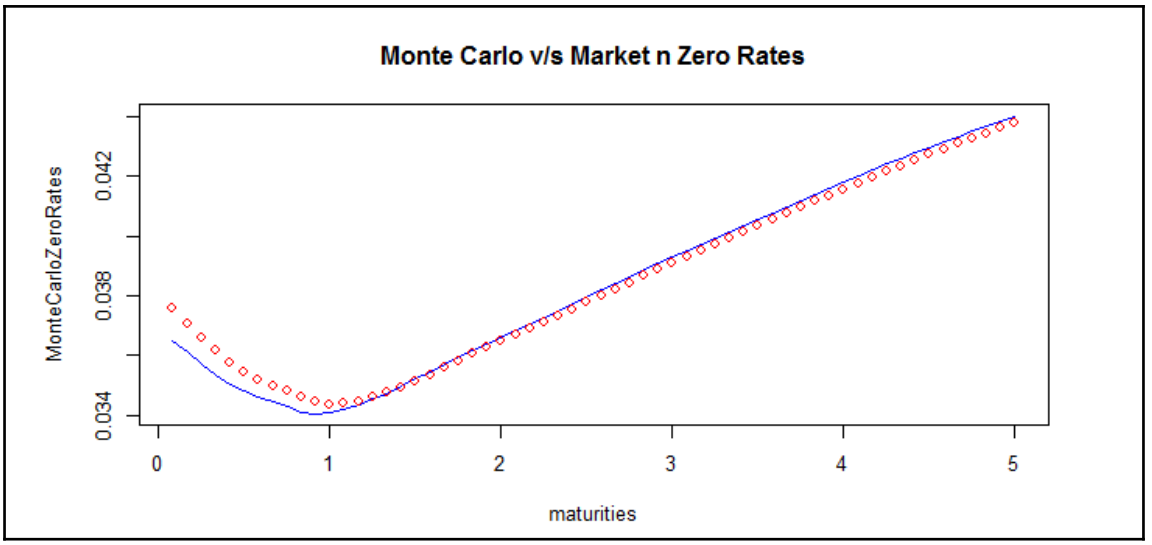
```
 [1] 0.9969646 0.9939972 0.9911117 0.9882912 0.9855078 0.9827449 0.9800036 0.9772856 0.9746132 0.9719634 0.9692537
 0.9664558
[13] 0.9636063 0.9607016 0.9577400 0.9547254 0.9516572 0.9485439 0.9453912 0.9422074 0.9390047 0.9357938 0.9325895
 0.9293760
[25] 0.9261312 0.9228538 0.9195472 0.9162110 0.9128457 0.9094549 0.9060440 0.9026178 0.8991789 0.8957324 0.8922809
 0.8888213
[37] 0.8853405 0.8818385 0.8783182 0.8747819 0.8712305 0.8676639 0.8640836 0.8604893 0.8568831 0.8532672 0.8496438
 0.8460148
[49] 0.8423810 0.8387448 0.8351062 0.8314680 0.8278328 0.8242010 0.8205761 0.8169591 0.8133518 0.8097557 0.8061732
 0.8025957
```

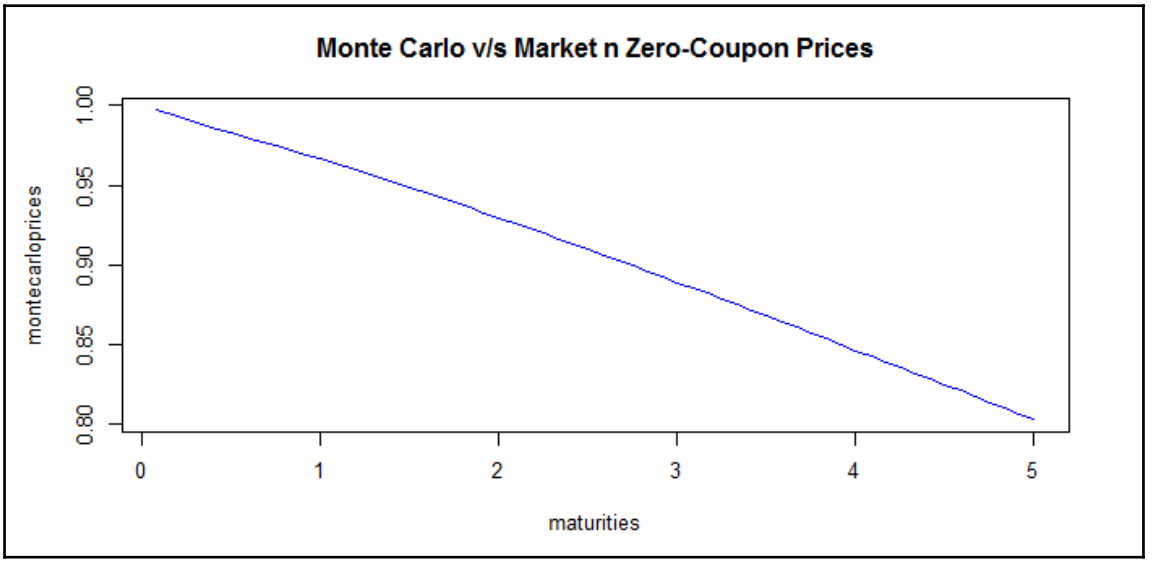
```
 [1] 0.03648056 0.03612541 0.03571211 0.03533363 0.03503568 0.03481134 0.03462698 0.03446451 0.03428612 0.03412455
 0.03406787
[12] 0.03411972 0.03422072 0.03436407 0.03454314 0.03474862 0.03497678 0.03521811 0.03546727 0.03571789 0.03596274
 0.03619645
[23] 0.03641224 0.03662097 0.03683488 0.03705436 0.03727730 0.03750368 0.03773315 0.03796394 0.03819385 0.03842104
 0.03864484
[34] 0.03886362 0.03907689 0.03928637 0.03949716 0.03970938 0.03992196 0.04013419 0.04034595 0.04055738 0.04076813
 0.04097840
[45] 0.04118768 0.04139545 0.04160121 0.04180462 0.04200561 0.04220371 0.04239914 0.04259133 0.04277979 0.04296464
 0.04314516
[56] 0.04332135 0.04349296 0.04365987 0.04382170 0.04398085
```

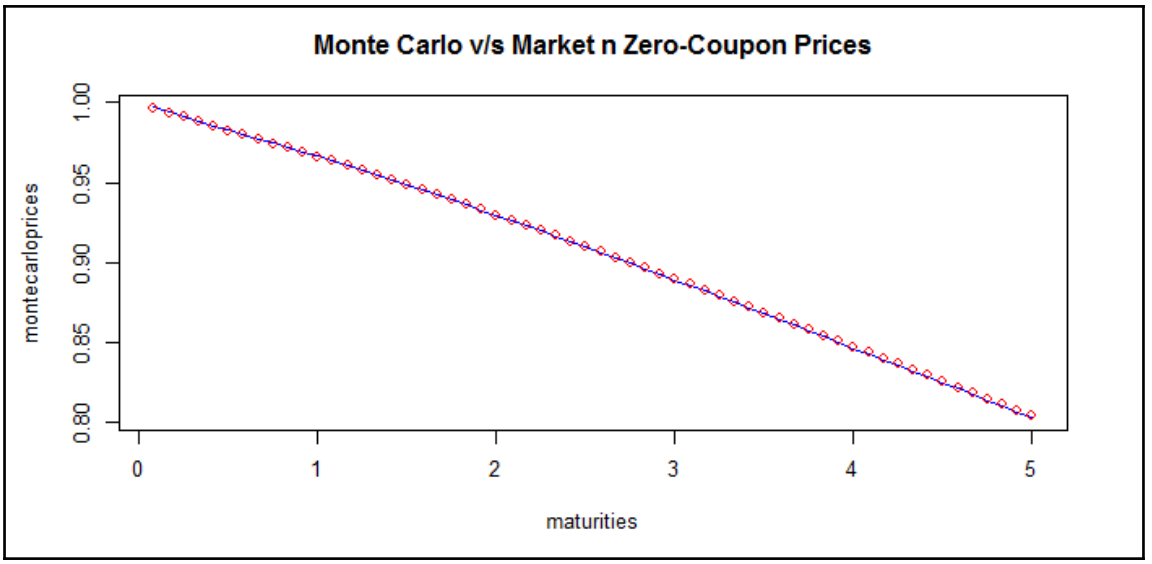
```
             [,1]         [,2]
[1,] 0.0001491098 0.0001545721
[2,] 0.0002189103 0.0002310291
[3,] 0.0002704573 0.0002907584
[4,] 0.0002932542 0.0003228398
[5,] 0.0003000920 0.0003400166
[6,] 0.0003095954 0.0003607932
```


Short Rate Quantiles
short-rate quantiles
0.02
0.04
0.06
0.08
0.10
0
1
2
3
4
5
maturities


Monte Carlo v/s Market n Zero Rates
MonteCarloZeroRates
0.034
0.038
0.042
0
1
2
3
4
5
maturities


Monte Carlo v/s Market n Zero Rates
MonteCarloZeroRates
0.034
0.038
0.042
0
1
2
3
4
5
maturities


Monte Carlo v/s Market n Zero-Coupon Prices
montecarloprices
0.80
0.85
0.90
0.95
1.00
0
1
2
3
4
5
maturities


Monte Carlo v/s Market n Zero-Coupon Prices
montecarloprices
1.00
0.95
0.90
0.85
0.80
0
1
2
3
4
5
maturities

Chapter 9: Structured Prediction

```
> head(EuroUSD)
       Open.Timestamp    Open    High     Low   Close
1 2012.01.03 00:00:00 1.29357 1.30760 1.29343 1.30528
2 2012.01.04 00:00:00 1.30528 1.30718 1.28967 1.29295
3 2012.01.05 00:00:00 1.29295 1.29427 1.27688 1.27905
4 2012.01.06 00:00:00 1.27905 1.28116 1.26961 1.27136
5 2012.01.08 00:00:00 1.27136 1.27136 1.26649 1.26778
6 2012.01.09 00:00:00 1.26778 1.27843 1.26762 1.27712
```

```
           Open.Timestamp      Open            High            Low             Close
2012.01.03 00:00:00:   1   Min.   :1.048   Min.   :1.050   Min.   :1.046   Min.   :1.048
2012.01.04 00:00:00:   1   1st Qu.:1.272   1st Qu.:1.277   1st Qu.:1.267   1st Qu.:1.272
2012.01.05 00:00:00:   1   Median :1.311   Median :1.316   Median :1.306   Median :1.311
2012.01.06 00:00:00:   1   Mean   :1.300   Mean   :1.304   Mean   :1.296   Mean   :1.300
2012.01.08 00:00:00:   1   3rd Qu.:1.349   3rd Qu.:1.353   3rd Qu.:1.346   3rd Qu.:1.349
2012.01.09 00:00:00:   1   Max.   :1.393   Max.   :1.399   Max.   :1.391   Max.   :1.393
(Other)            :1002
```

```
'data.frame':   1008 obs. of  5 variables:
 $ Open.Timestamp: Factor w/ 1008 levels "2012.01.03 00:00:00",..: 1 2 3 4 5 6 7 8 9 10 ...
 $ Open          : num  1.29 1.31 1.29 1.28 1.27 ...
 $ High          : num  1.31 1.31 1.29 1.28 1.27 ...
 $ Low           : num  1.29 1.29 1.28 1.27 1.27 ...
 $ Close         : num  1.31 1.29 1.28 1.27 1.27 ...
```

```
              Open    High     Low   Close
2012-01-03 1.29357 1.30760 1.29343 1.30528
2012-01-04 1.30528 1.30718 1.28967 1.29295
2012-01-05 1.29295 1.29427 1.27688 1.27905
2012-01-06 1.27905 1.28116 1.26961 1.27136
2012-01-08 1.27136 1.27136 1.26649 1.26778
2012-01-09 1.26778 1.27843 1.26762 1.27712
```

```
                tr atr trueHigh trueLow
2012-01-03      NA  NA       NA      NA
2012-01-04 0.01751  NA  1.30718 1.28967
2012-01-05 0.01739  NA  1.29427 1.27688
2012-01-06 0.01155  NA  1.28116 1.26961
2012-01-08 0.00487  NA  1.27136 1.26649
2012-01-09 0.01081  NA  1.27843 1.26762
```

```
               atr
2012-01-03  NA
2012-01-04  NA
2012-01-05  NA
2012-01-06  NA
2012-01-08  NA
2012-01-09  NA
```

```
      Min.    1st Qu.     Median       Mean    3rd Qu.       Max.
-2.335e-02 -2.347e-03 -4.967e-05 -1.779e-04  2.155e-03  2.624e-02
```

```
               LogReturns        atr
2012-01-19  0.0075360408 0.01244214
2012-01-20 -0.0025263367 0.01226342
2012-01-22 -0.0032387061 0.01176603
2012-01-23  0.0106681264 0.01213846
2012-01-24  0.0007752087 0.01205285
2012-01-25  0.0054554841 0.01254551
```

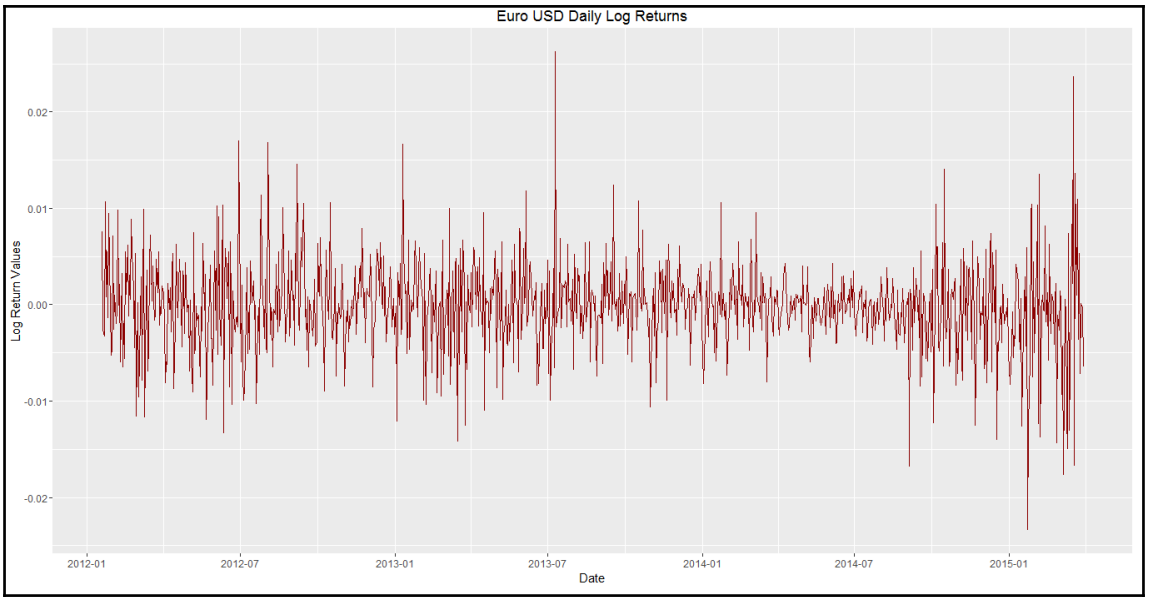
```
[1] "LogReturns" "TrueRange"
```

```
converged at iteration 29 with logLik: 9503.258
```

```
Convergence info: Log likelihood converged to within tol. (relative change)
'log Lik.' 9503.258 (df=20)
AIC:  -18966.52
BIC:  -18868.48
```

	state	S1	S2	S3
1	3	0.000000e+00	0.000000e+00	1
2	3	3.024478e-110	4.676808e-20	1
3	3	5.413285e-54	5.129597e-17	1
4	3	5.597014e-60	3.165933e-20	1
5	3	1.888606e-56	1.182525e-18	1
6	3	3.550974e-61	4.009794e-22	1

	state	S1	S2	S3
1	3	0.000000e+00	0.000000e+00	1
2	3	3.024478e-110	4.676808e-20	1
3	3	5.413285e-54	5.129597e-17	1
4	3	5.597014e-60	3.165933e-20	1
5	3	1.888606e-56	1.182525e-18	1
6	3	3.550974e-61	4.009794e-22	1



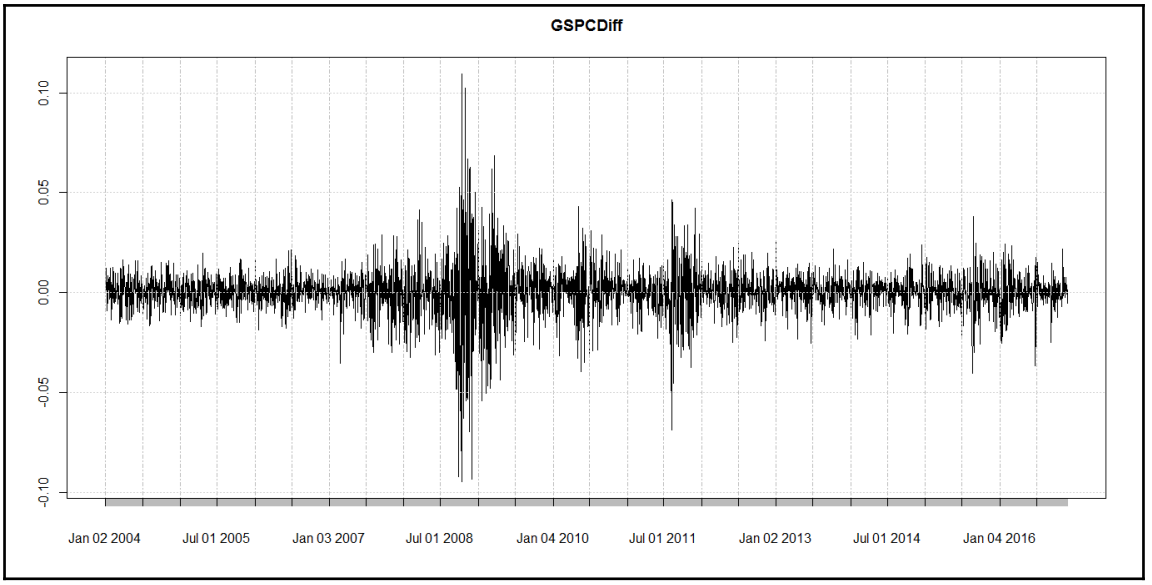

```
  As of 0.4-0, 'getSymbols' uses env=parent.frame() and
auto.assign=TRUE by default.

This  behavior  will be  phased out in 0.5-0  when the call  will
default to use auto.assign=FALSE. getOption("getSymbols.env") and
getOptions("getSymbols.auto.assign") are now checked for alternate defaults

This message is shown once per session and may be disabled by setting
options("getSymbols.warning4.0"=FALSE). See ?getSymbols for more details.
[1] "GSPC"
```

```
An 'xts' object on 2004-01-02/2016-11-30 containing:
  Data: num [1:3252, 1] NA 0.01232 0.00129 0.00236 0.00495 ...
 - attr(*, "dimnames")=List of 2
  ..$ : NULL
  ..$ : chr "GSPC.Close"
  Indexed by objects of class: [Date] TZ: UTC
  xts Attributes:
List of 2
 $ src    : chr "yahoo"
 $ updated: POSIXct[1:1], format: "2016-12-01 23:38:20"
```

	GSPC.Close
2004-01-02	NA
2004-01-05	0.012319151
2004-01-06	0.001291313
2004-01-07	0.002364367
2004-01-08	0.004950824
2004-01-09	-0.008927336




```
Initial state probabilties model
pr1 pr2
0.5 0.5

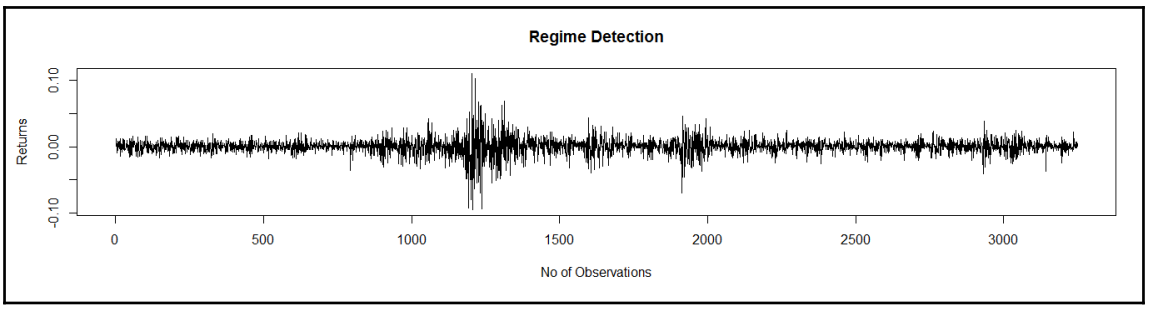
Transition matrix
       toS1 toS2
fromS1  0.5  0.5
fromS2  0.5  0.5

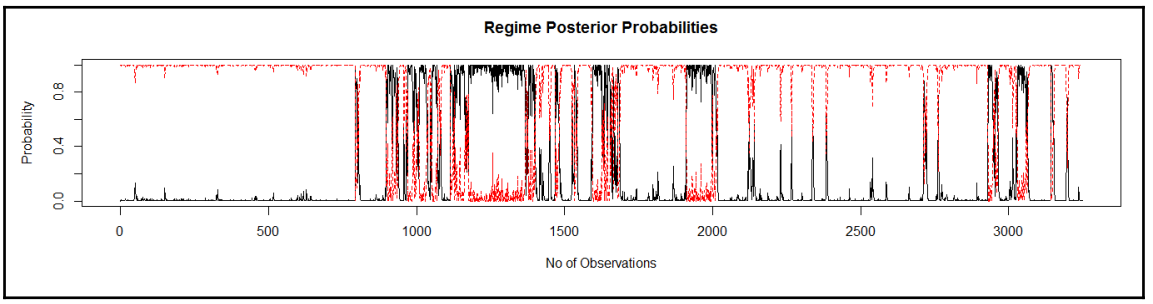
Response parameters
Resp 1 : gaussian
    Re1.(Intercept) Re1.sd
St1               0      1
St2               0      1
```

```
converged at iteration 37 with logLik: 10518.77
```

```
Convergence info: Log likelihood converged to within tol. (relative change)
'log Lik.' 10518.77 (df=7)
AIC:  -21023.55
BIC:  -20980.95
```

	state	S1	S2
1	2	0.000000000	1.0000000
2	2	0.007586430	0.9924136
3	2	0.002517719	0.9974823
4	2	0.002560062	0.9974399
5	2	0.002888478	0.9971115
6	2	0.005725764	0.9942742





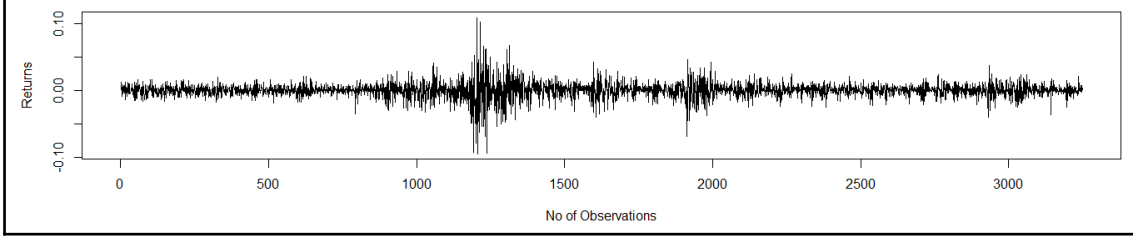
```
Initial state probabilties model
  pr1   pr2   pr3
0.333 0.333 0.333

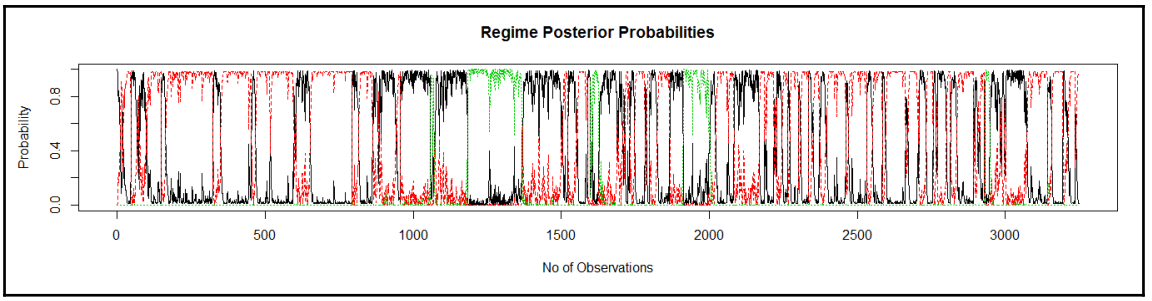
Transition matrix
        toS1  toS2  toS3
fromS1 0.333 0.333 0.333
fromS2 0.333 0.333 0.333
fromS3 0.333 0.333 0.333

Response parameters
Resp 1 : gaussian
    Re1.(Intercept) Re1.sd
St1               0      1
St2               0      1
St3               0      1
```

```
converged at iteration 102 with logLik: 10659.7
```

	state	S1	S2	S3
1	1	1.0000000	0.00000000	0.000000000
2	1	0.9780159	0.01904906	0.002935031
3	2	0.9196440	0.07866273	0.001693291
4	2	0.8488129	0.14960389	0.001583215
5	2	0.7605025	0.23798856	0.001508972
6	2	0.8433328	0.15467220	0.001995043



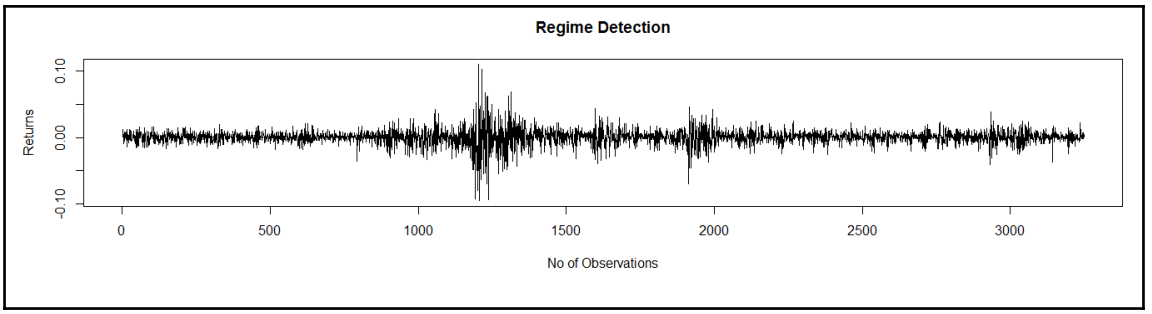


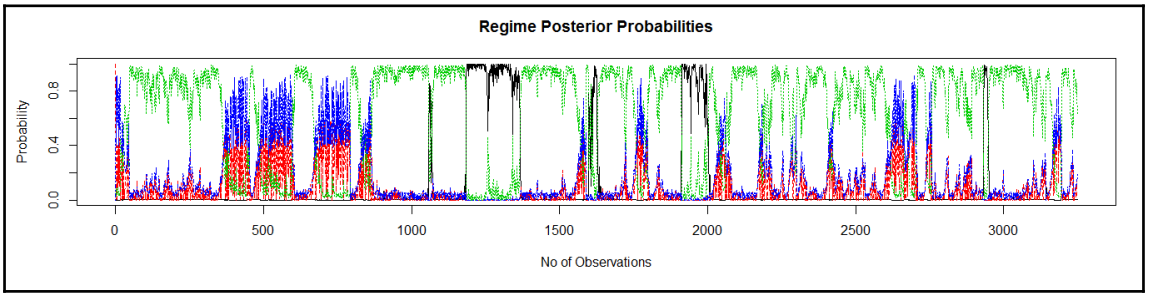

```
Initial state probabilties model
 pr1  pr2  pr3  pr4
0.25 0.25 0.25 0.25

Transition matrix
       toS1 toS2 toS3 toS4
fromS1 0.25 0.25 0.25 0.25
fromS2 0.25 0.25 0.25 0.25
fromS3 0.25 0.25 0.25 0.25
fromS4 0.25 0.25 0.25 0.25

Response parameters
Resp 1 : gaussian
    Re1.(Intercept) Re1.sd
St1               0      1
St2               0      1
St3               0      1
St4               0      1
```

```
converged at iteration 426 with logLik: 10684.96
```


Regime Detection
Returns
0.10
0.00
-0.10
0
500
1000
1500
2000
2500
3000
No of Observations


Regime Posterior Probabilities
Probability
0.0
0.4
0.8
0
500
1000
1500
2000
2500
3000
No of Observations

Chapter 10: Neural Networks

```
    As of 0.4-0, 'getSymbols' uses env=parent.frame() and
 auto.assign=TRUE by default.

 This  behavior  will be  phased out in 0.5-0  when the call  will
 default to use auto.assign=FALSE. getOption("getSymbols.env") and
 getOptions("getSymbols.auto.assign") are now checked for alternate defaults

 This message is shown once per session and may be disabled by setting
 options("getSymbols.warning4.0"=FALSE). See ?getSymbols for more details.
[1] "GSPC"
```

```
     Index                EMA
 Min.    :2009-01-02   Min.    : 1.244
 1st Qu.:2010-04-05   1st Qu.:35.562
 Median :2011-06-30   Median :61.666
 Mean    :2011-07-02   Mean    :57.358
 3rd Qu.:2012-09-27   3rd Qu.:80.360
 Max.    :2013-12-31   Max.    :99.364
                       NA's    :3
```

```
                 EMA
2009-01-02        NA
2009-01-05        NA
2009-01-06        NA
2009-01-07        NA
2009-01-08 919.3020
2009-01-09 916.1713
```

```
     Index                EMA
 Min.    :2009-01-02   Min.    : 692
 1st Qu.:2010-04-05   1st Qu.:1103
 Median :2011-06-30   Median :1281
 Mean    :2011-07-02   Mean    :1275
 3rd Qu.:2012-09-27   3rd Qu.:1411
 Max.    :2013-12-31   Max.    :1836
                       NA's    :4
```

```
            GSPC.Open
2009-01-02         NA
2009-01-05         NA
2009-01-06         NA
2009-01-07         NA
2009-01-08 -13.572010
2009-01-09  -6.261344
```

```
     Index              GSPC.Open
 Min.   :2009-01-02   Min.   :-75.717
 1st Qu.:2010-04-05   1st Qu.: -5.220
 Median :2011-06-30   Median :  3.261
 Mean   :2011-07-02   Mean   :  1.451
 3rd Qu.:2012-09-27   3rd Qu.:  8.777
 Max.   :2013-12-31   Max.   : 38.711
                      NA's   :4
```

```
                 macd    signal
2013-12-23 0.4584068 0.4360493
2013-12-24 0.5525735 0.4593541
2013-12-26 0.6503602 0.4975553
2013-12-27 0.7544246 0.5489292
2013-12-30 0.8202862 0.6032006
2013-12-31 0.8671819 0.6559969
```

```
     Index                macd               signal
 Min.   :2009-01-02   Min.   :-5.62181   Min.   :-4.77728
 1st Qu.:2010-04-05   1st Qu.:-0.09344   1st Qu.:-0.04305
 Median :2011-06-30   Median : 0.63804   Median : 0.61565
 Mean   :2011-07-02   Mean   : 0.39505   Mean   : 0.40129
 3rd Qu.:2012-09-27   3rd Qu.: 1.13639   3rd Qu.: 1.08340
 Max.   :2013-12-31   Max.   : 2.94747   Max.   : 2.63443
                      NA's   :25         NA's   :33
```

```
                 dn     mavg       up      pctB
2013-12-23 1773.709 1798.316 1822.924 0.9999155
2013-12-24 1771.752 1799.401 1827.050 1.0175470
2013-12-26 1769.309 1801.005 1832.701 1.0356273
2013-12-27 1766.374 1802.980 1839.586 1.0462175
2013-12-30 1764.382 1804.619 1844.856 0.9579193
2013-12-31 1762.902 1806.422 1849.942 0.9157658
```

```
     Index                dn              mavg            up              pctB        
 Min.   :2009-01-02   Min.   : 650.2   Min.   : 736.7   Min.   : 805.1   Min.   :-0.3308  
 1st Qu.:2010-04-05   1st Qu.:1060.2   1st Qu.:1103.0   1st Qu.:1141.1   1st Qu.: 0.3790  
 Median :2011-06-30   Median :1245.6   Median :1282.9   Median :1322.8   Median : 0.7077  
 Mean   :2011-07-02   Mean   :1232.2   Mean   :1273.7   Mean   :1315.1   Mean   : 0.6110  
 3rd Qu.:2012-09-27   3rd Qu.:1380.8   3rd Qu.:1408.0   3rd Qu.:1440.0   3rd Qu.: 0.8649  
 Max.   :2013-12-31   Max.   :1779.4   Max.   :1806.4   Max.   :1849.9   Max.   : 1.2875  
                      NA's   :19       NA's   :19       NA's   :19       NA's   :19       
```

```
                 pctB
2013-12-23 0.9999155
2013-12-24 1.0175470
2013-12-26 1.0356273
2013-12-27 1.0462175
2013-12-30 0.9579193
2013-12-31 0.9157658
```

```
     Index                pctB        
 Min.   :2009-01-02   Min.   :-0.3308  
 1st Qu.:2010-04-05   1st Qu.: 0.3790  
 Median :2011-06-30   Median : 0.7077  
 Mean   :2011-07-02   Mean   : 0.6110  
 3rd Qu.:2012-09-27   3rd Qu.: 0.8649  
 Max.   :2013-12-31   Max.   : 1.2875  
                      NA's   :19       
```

```
            GSPC.Close
2013-12-23   5.069946
2013-12-24   5.299926
2013-12-26   7.060059
2013-12-27  -1.569947
2013-12-30  -0.400025
2013-12-31   5.750000
```

```
'data.frame':   1258 obs. of  5 variables:
 $ EMA       : num  NA NA NA 88.3 43.7 ...
 $ GSPC.Open : num  NA NA NA NA -13.6 ...
 $ signal    : num  NA NA NA NA NA NA NA NA NA NA ...
 $ pctB      : num  NA NA NA NA NA NA NA NA NA NA ...
 $ GSPC.Close: num  28.81 -1.72 3.53 -20.8 4 ...
```

```
[1] 1176    5
```

```
'data.frame':   1225 obs. of  5 variables:
 $ RSI3      : num  6.99 6.32 2.47 46.69 41.4 ...
 $ EMAcross  : num  -21.45 -16.05 -29.74 -2.53 -4.94 ...
 $ MACDsignal: num  -1.78 -1.98 -2.24 -2.45 -2.64 ...
 $ BollingerB: num  -0.06817 -0.00641 -0.10584 0.138 0.1466 ...
 $ Price     : num  -5.82 -29.92 28.45 -5.74 -12.93 ...
```

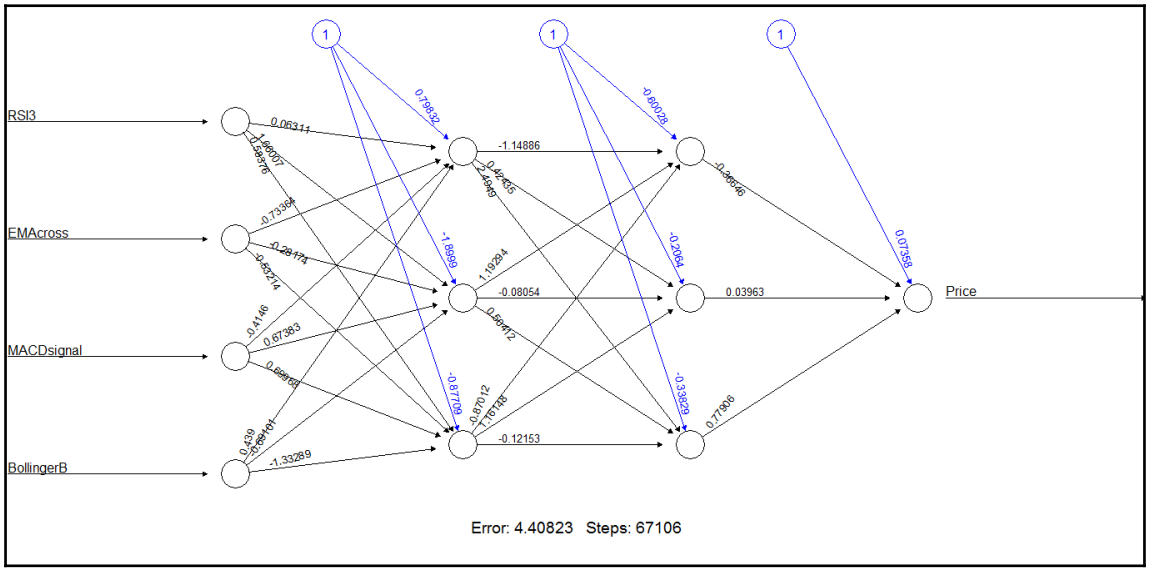
```
             RSI3     EMAcross   MACDsignal   BollingerB        Price
1220 0.8949682266 0.8039542230 0.7033909706 0.8223095381 0.6403435993
1221 0.9168950078 0.7862496259 0.7065352979 0.8332047211 0.6420948929
1222 0.9425533165 0.7851664068 0.7116894675 0.8443772077 0.6554982746
1223 0.9637450977 0.7906786046 0.7186209104 0.8509212683 0.5897809313
1224 0.8805725768 0.7389470017 0.7259432951 0.7963585576 0.5986898667
1225 0.8917172659 0.7198402887 0.7330666522 0.7703103038 0.6455221985
```

```
[1] 816   5
```

```
      RSI3              EMAcross          MACDsignal        BollingerB          Price        
 Min.   :0.004723371   Min.   :0.0000000   Min.   :0.0000000   Min.   :0.0000000   Min.   :0.0000000  
 1st Qu.:0.345216893   1st Qu.:0.6129767   1st Qu.:0.6219857   1st Qu.:0.4313891   1st Qu.:0.5609580  
 Median :0.621185723   Median :0.6903207   Median :0.7327540   Median :0.6440188   Median :0.6109499  
 Mean   :0.571760152   Mean   :0.6733781   Mean   :0.6966899   Mean   :0.5788036   Mean   :0.6071108  
 3rd Qu.:0.808167123   3rd Qu.:0.7399376   3rd Qu.:0.8091630   3rd Qu.:0.7358875   3rd Qu.:0.6604099  
 Max.   :1.000000000   Max.   :1.0000000   Max.   :1.0000000   Max.   :1.0000000   Max.   :1.0000000  
```

```
[1] 409   5
```

```
 Relative Strength Index3 Exp Moving Avg5Cross  MACD Signal      Bollinger Bands Percentage   Price Diff      
 Min.   : 4.671           Min.   :-30.553       Min.   :-1.0854   Min.   :-0.2714           Min.   :-36.480  
 1st Qu.:39.035           1st Qu.: -3.277       1st Qu.: 0.3320   1st Qu.: 0.4582           1st Qu.: -4.952  
 Median :64.992           Median :  3.927       Median : 0.6771   Median : 0.7307           Median :  1.360  
 Mean   :59.845           Mean   :  2.684       Mean   : 0.5522   Mean   : 0.6464           Mean   :  1.290  
 3rd Qu.:80.769           3rd Qu.:  8.664       3rd Qu.: 0.9498   3rd Qu.: 0.8767           3rd Qu.:  7.453  
 Max.   :98.988           Max.   : 28.171       Max.   : 1.3574   Max.   : 1.2709           Max.   : 36.230  
 NA's   :49               NA's   :49            NA's   :49        NA's   :49                NA's   :49       
```



	DATE	VALUE
443	1976-06-01	5.4
444	1976-05-01	5.5
445	1976-04-01	5.6
446	1976-03-01	5.7
447	1976-02-01	5.9
448	1976-01-01	6.0

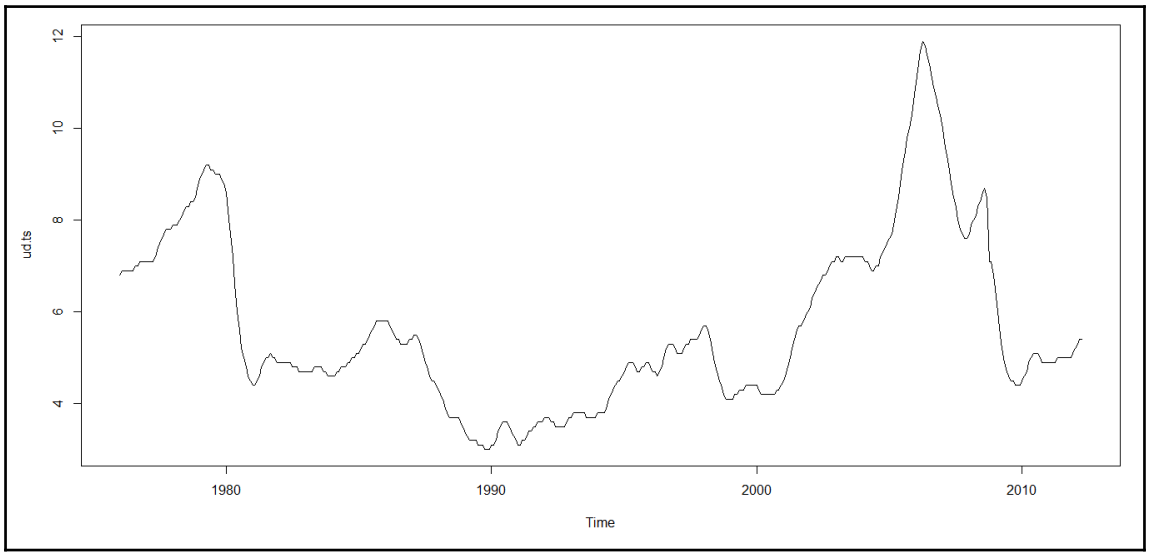
date		rate	
Min.	:1976-01-01	Min.	: 3.000
1st Qu.	:1985-04-23	1st Qu.	: 4.400
Median	:1994-08-16	Median	: 5.100
Mean	:1994-08-16	Mean	: 5.675
3rd Qu.	:2003-12-08	3rd Qu.	: 7.000
Max.	:2013-04-01	Max.	:11.900

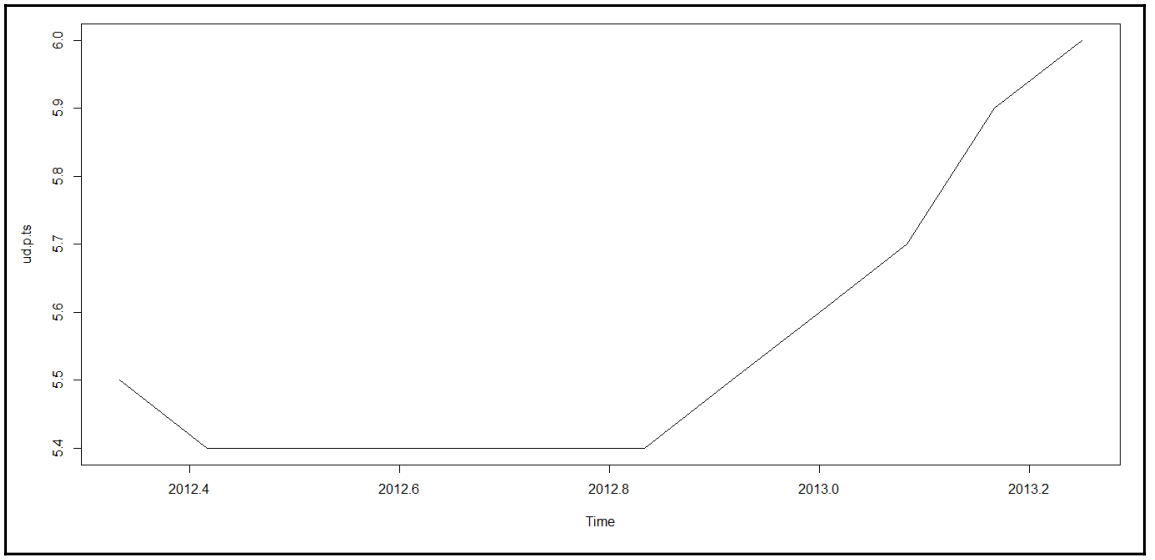
date		rate	
Min.	:1977-01-01	Min.	: 3.000
1st Qu.	:1986-01-24	1st Qu.	: 4.400
Median	:1995-02-15	Median	: 5.000
Mean	:1995-02-15	Mean	: 5.679
3rd Qu.	:2004-03-08	3rd Qu.	: 7.100
Max.	:2013-04-01	Max.	:11.900

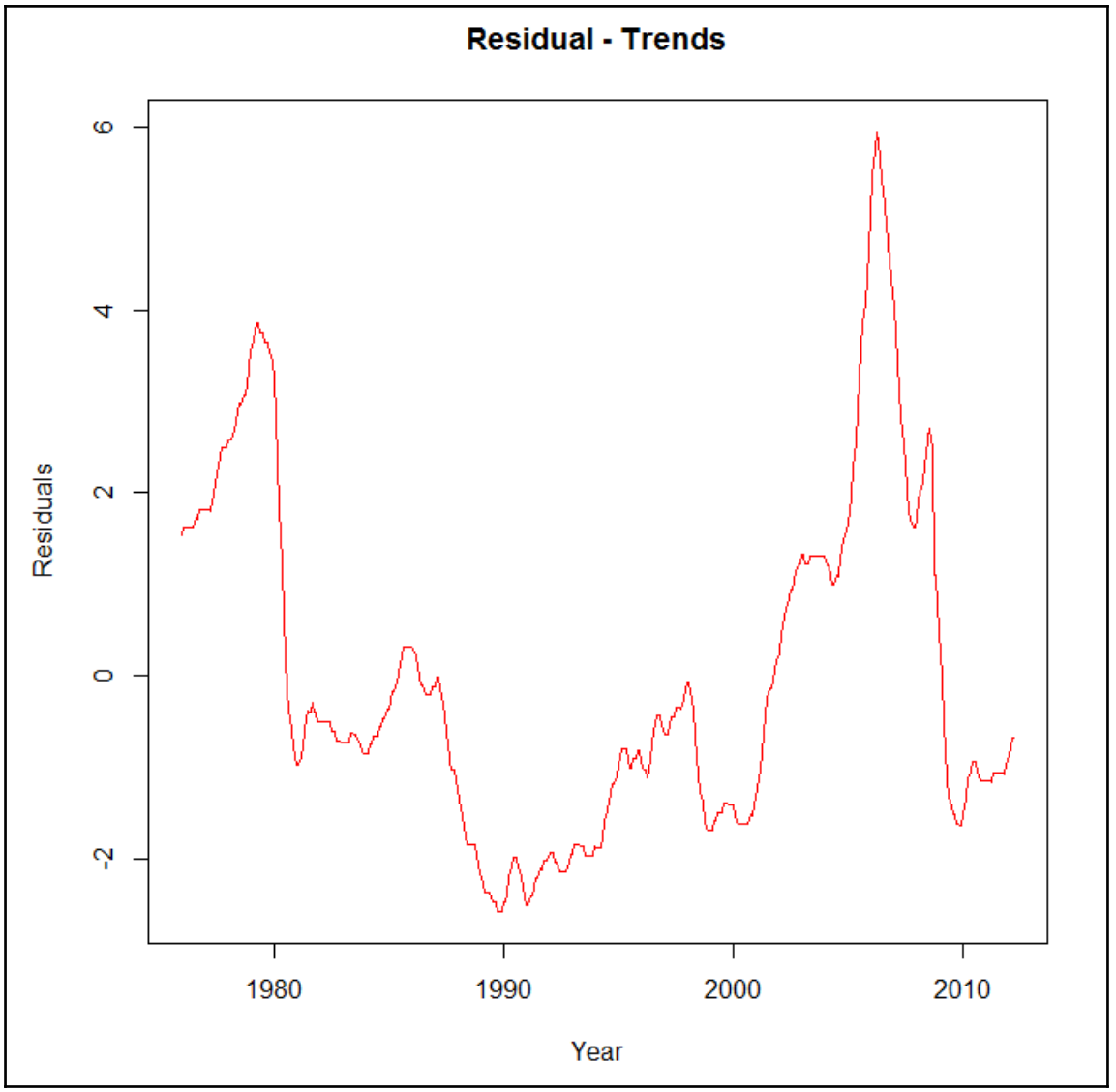
date		rate	
Min.	:1976-01-01	Min.	:5.400
1st Qu.	:1976-03-24	1st Qu.	:5.400
Median	:1976-06-16	Median	:5.450
Mean	:1976-06-16	Mean	:5.550
3rd Qu.	:1976-09-08	3rd Qu.	:5.625
Max.	:1976-12-01	Max.	:6.000

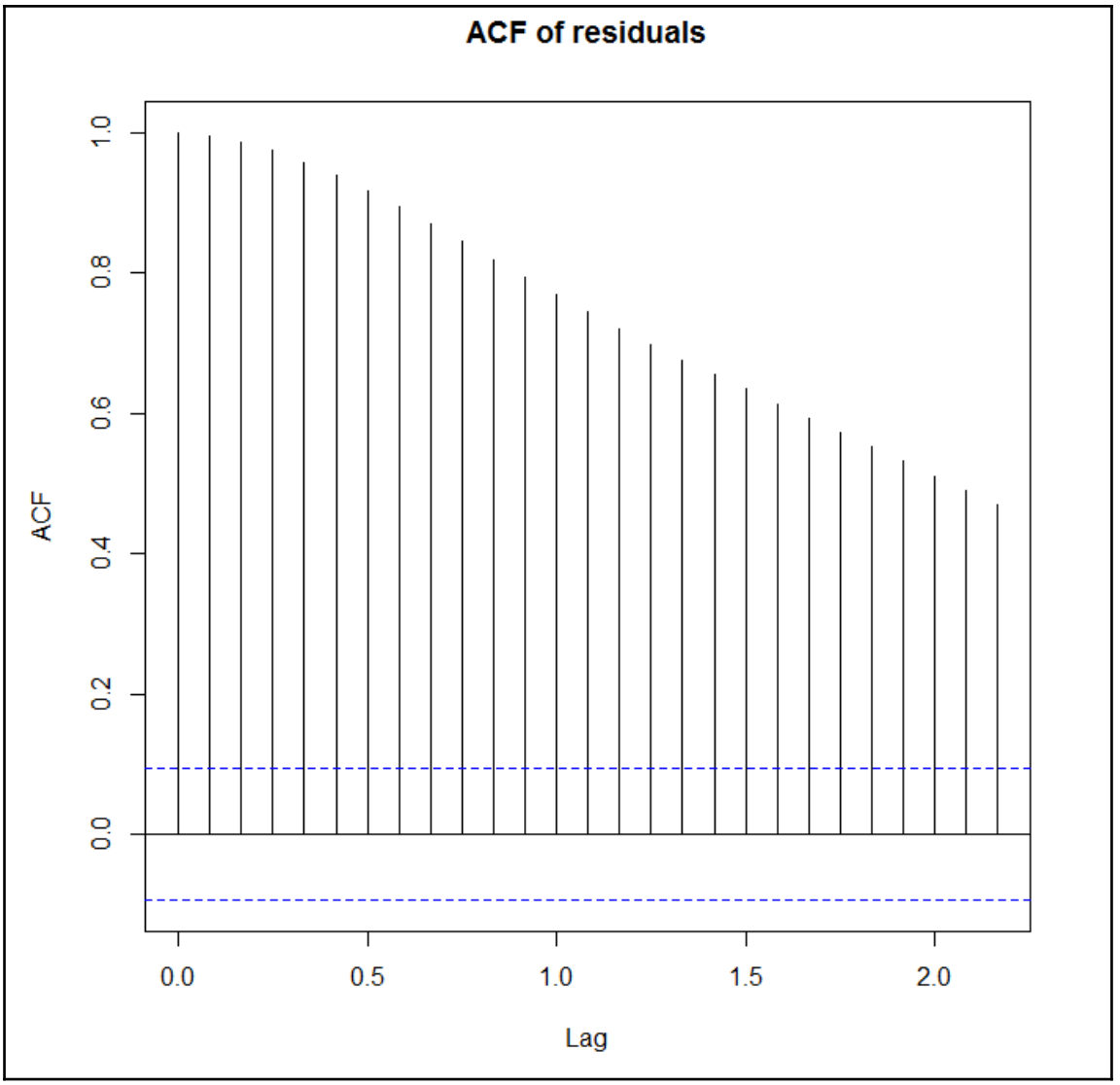
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	6.8	6.9	6.9	6.9	6.9	6.9	6.9	7.0	7.0	7.1	7.1	7.1
1977	7.1	7.1	7.1	7.1	7.2	7.4	7.5	7.6	7.7	7.8	7.8	7.8
1978	7.9	7.9	7.9	8.0	8.1	8.2	8.3	8.3	8.4	8.4	8.5	8.7
1979	8.9	9.0	9.1	9.2	9.2	9.1	9.1	9.0	9.0	9.0	8.9	8.8
1980	8.6	8.2	7.7	7.2	6.6	6.0	5.6	5.2	5.0	4.8	4.6	4.5
1981	4.4	4.4	4.5	4.6	4.8	4.9	5.0	5.0	5.1	5.0	5.0	4.9
1982	4.9	4.9	4.9	4.9	4.9	4.9	4.8	4.8	4.8	4.7	4.7	4.7
1983	4.7	4.7	4.7	4.7	4.8	4.8	4.8	4.8	4.7	4.7	4.6	4.6
1984	4.6	4.6	4.7	4.7	4.8	4.8	4.8	4.9	4.9	5.0	5.0	5.1
1985	5.1	5.2	5.3	5.3	5.4	5.5	5.6	5.7	5.8	5.8	5.8	5.8
1986	5.8	5.8	5.7	5.6	5.5	5.4	5.4	5.3	5.3	5.3	5.3	5.4
1987	5.4	5.5	5.5	5.4	5.3	5.1	4.9	4.8	4.6	4.5	4.5	4.4
1988	4.3	4.2	4.1	3.9	3.8	3.7	3.7	3.7	3.7	3.7	3.6	3.5

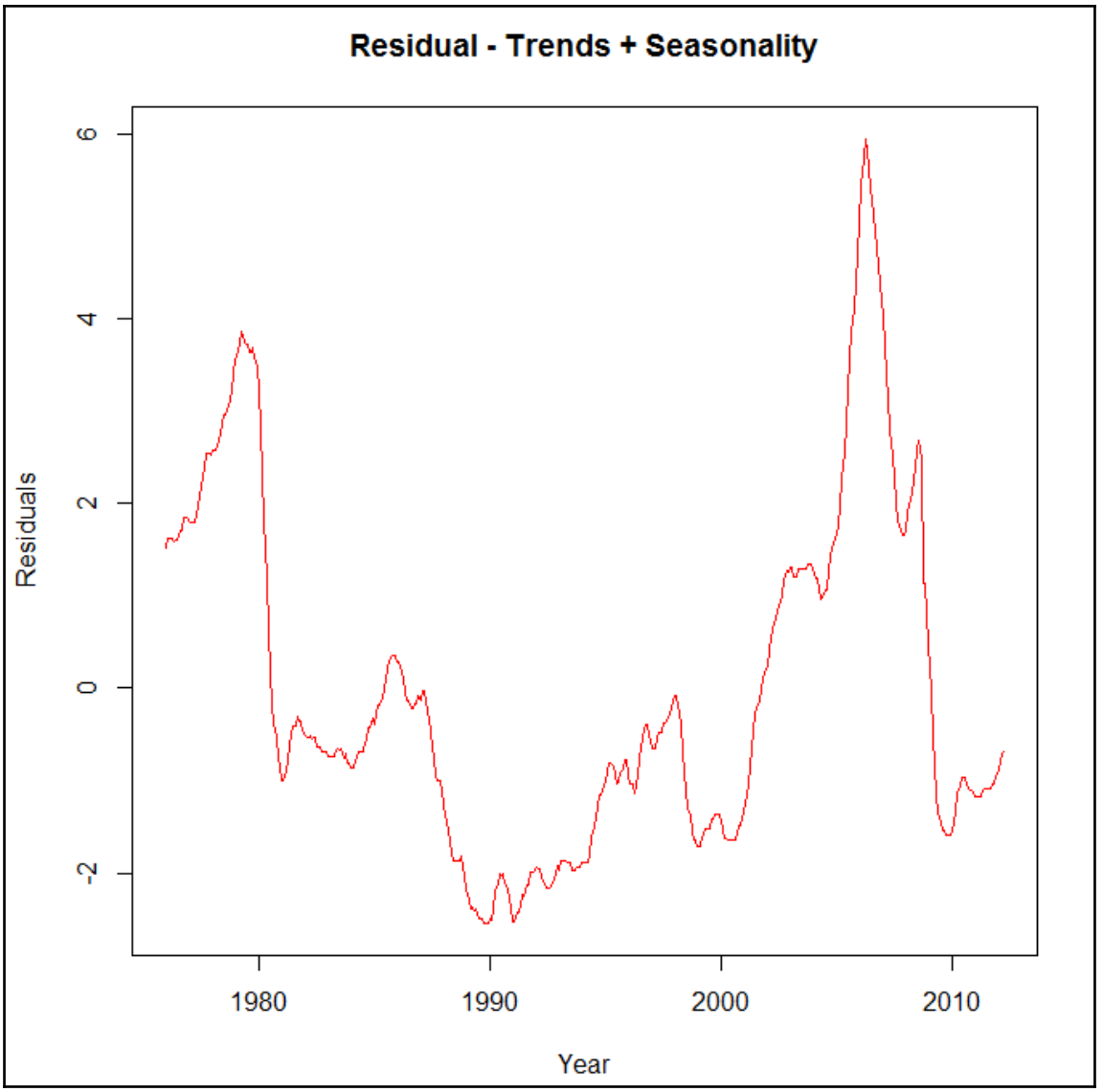
```
     Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
2012                 5.5 5.4 5.4 5.4 5.4 5.4 5.4 5.5
2013 5.6 5.7 5.9 6.0
```

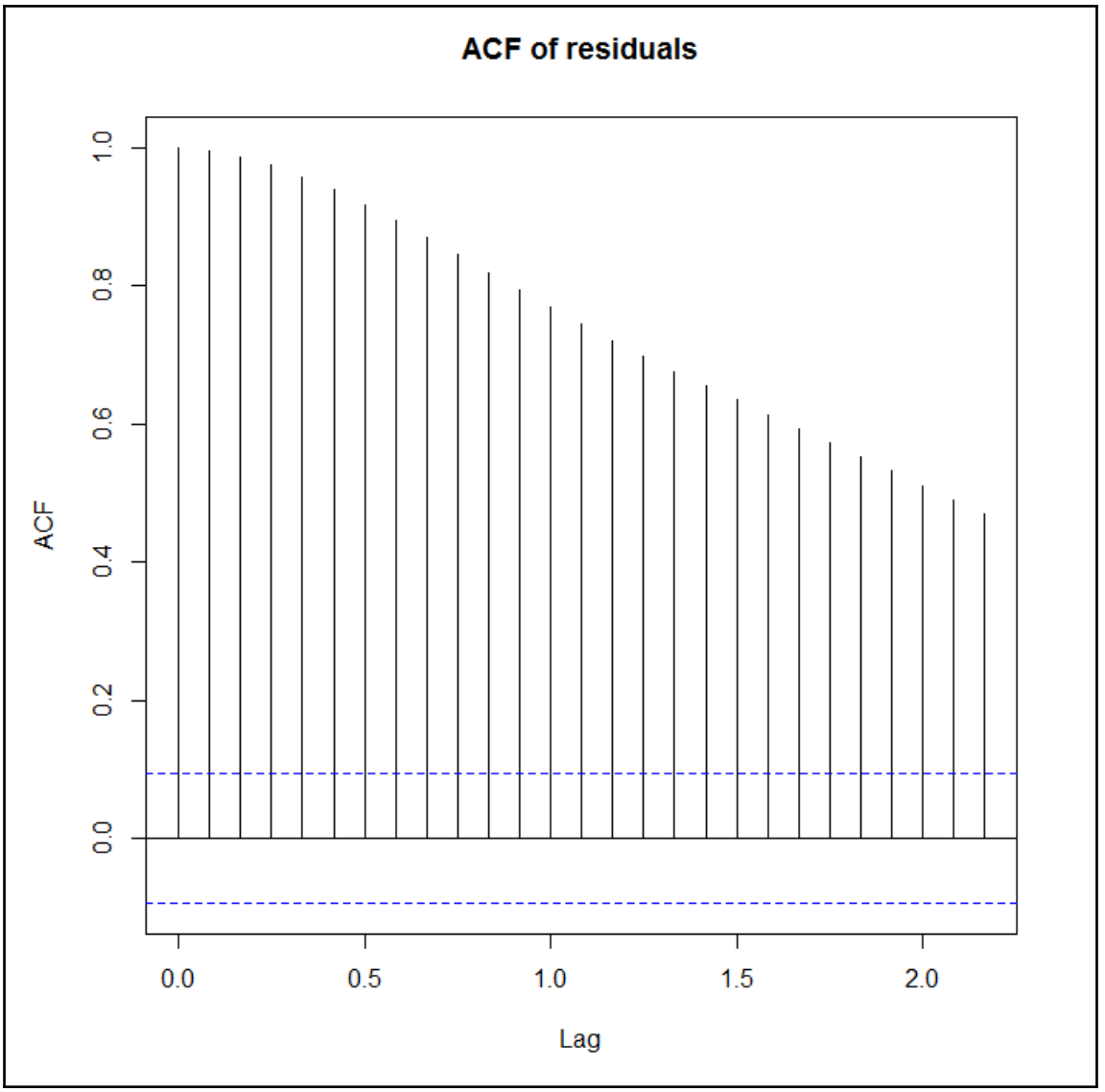





Residual - Trends
Residuals
6
4
2
0
-2
1980
1990
2000
2010
Year


ACF of residuals
ACF
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Lag


Residual - Trends + Seasonality
Residuals
6
4
2
0
-2
1980
1990
2000
2010
Year

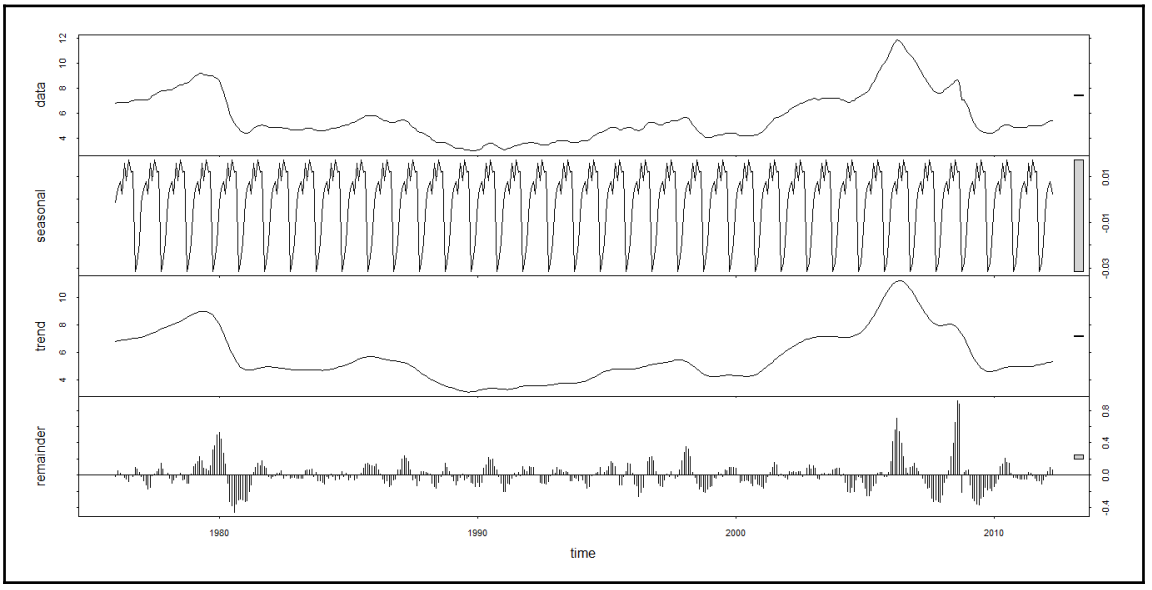

ACF of residuals
ACF
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Lag

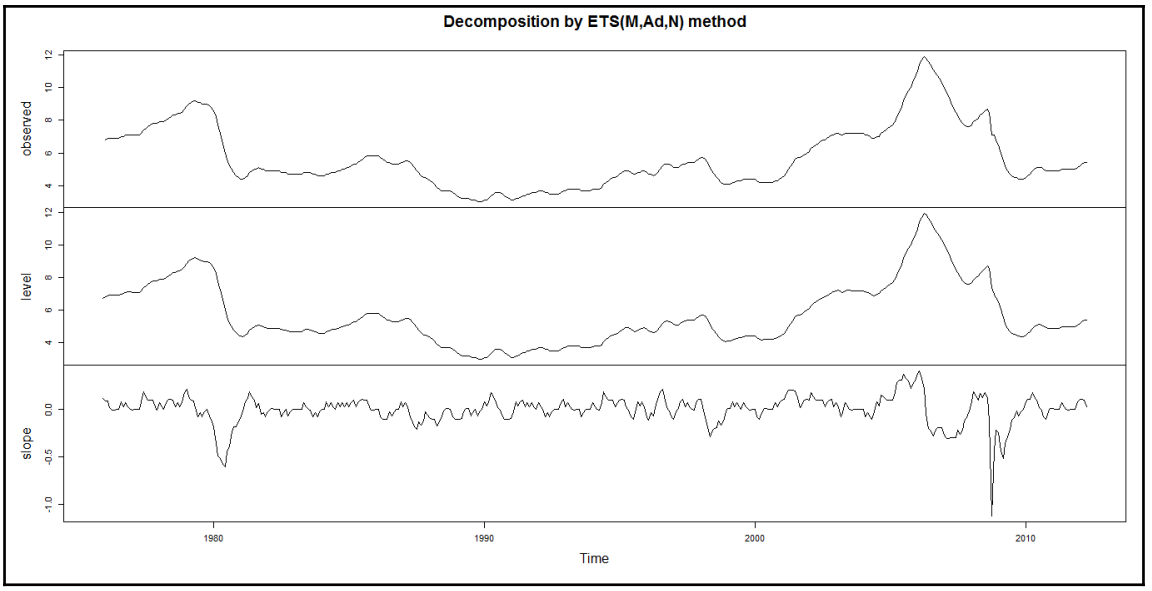
```
        Durbin-Watson test

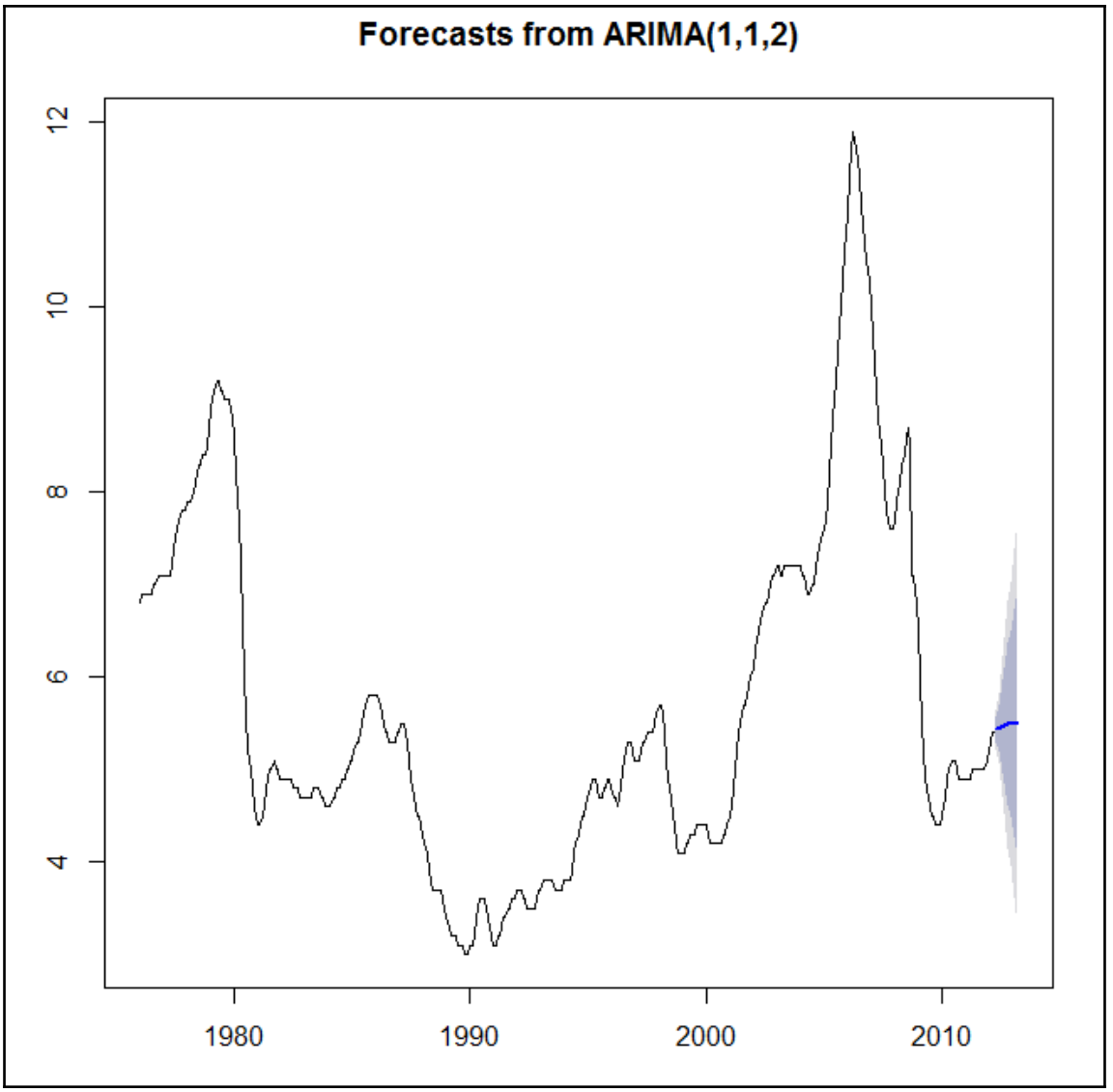
data:  m1
DW = 0.0065342, p-value < 2.2e-16
alternative hypothesis: true autocorrelation is not 0
```

```
        Durbin-Watson test

data:  m2
DW = 0.0065138, p-value < 2.2e-16
alternative hypothesis: true autocorrelation is not 0
```



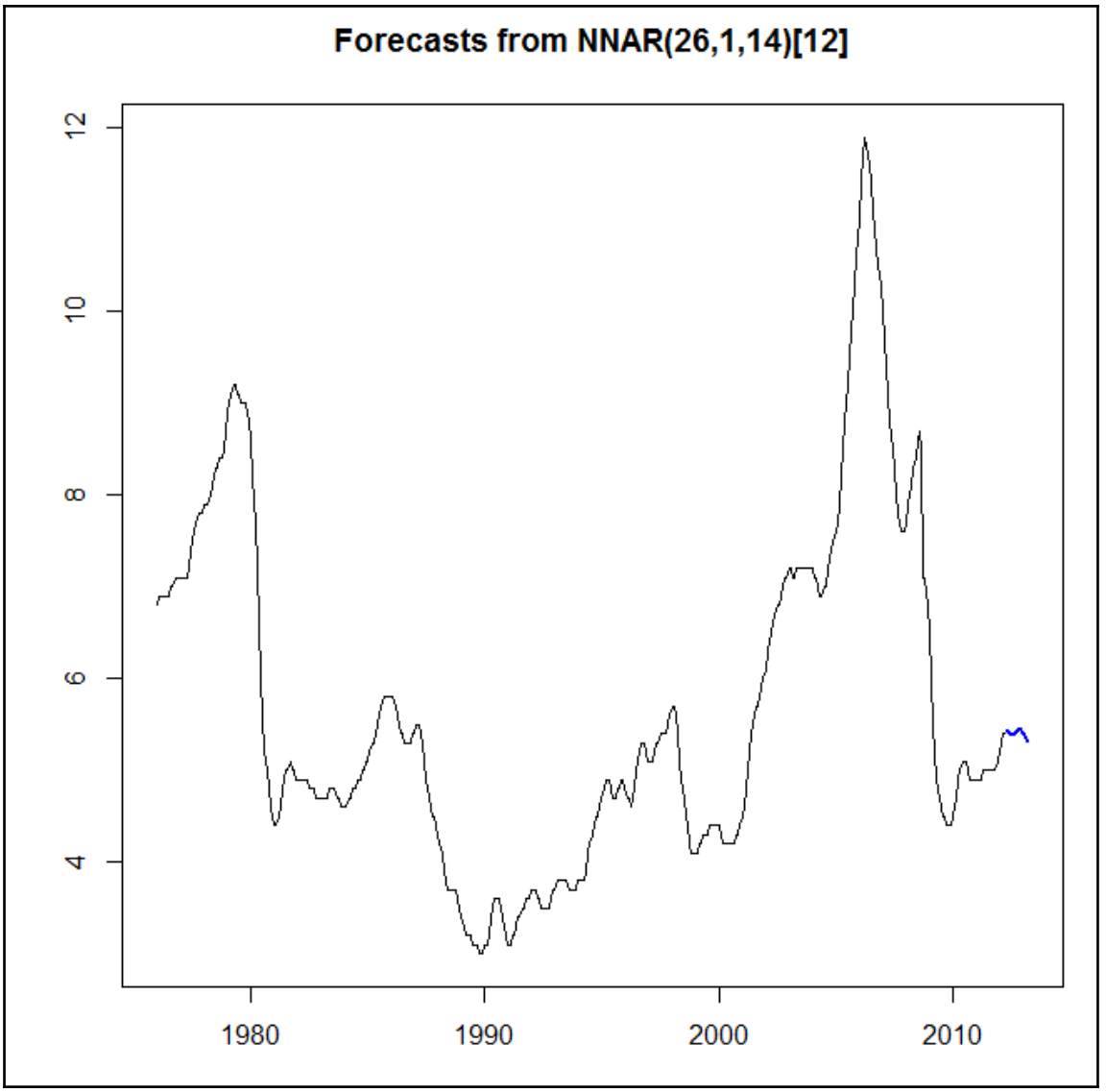

Decomposition by ETS(M,Ad,N) method
observed
level
slope
Time
1980
1990
2000
2010


Forecasts from ARIMA(1,1,2)
12
10
8
6
4
1980
1990
2000
2010

```
Series: ud.ts
Model:  NNAR(26,1,14)[12]
Call:   nnetar(y = ud.ts)

Average of 20 networks, each of which is
a 26-14-1 network with 393 weights
options were - linear output units

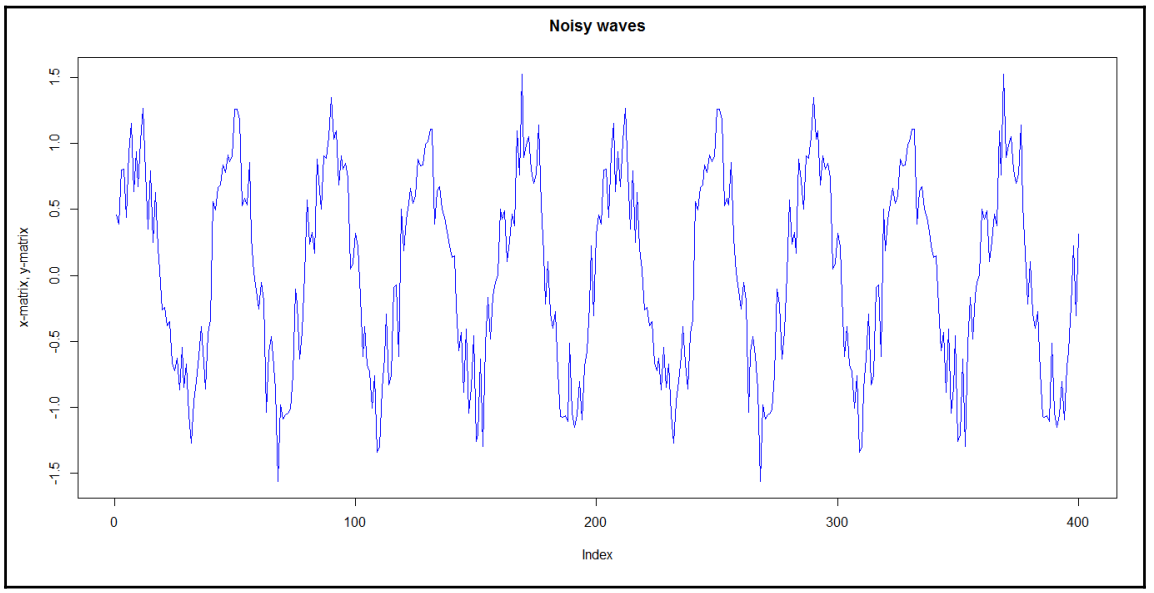
sigma^2 estimated as 0.002508
```

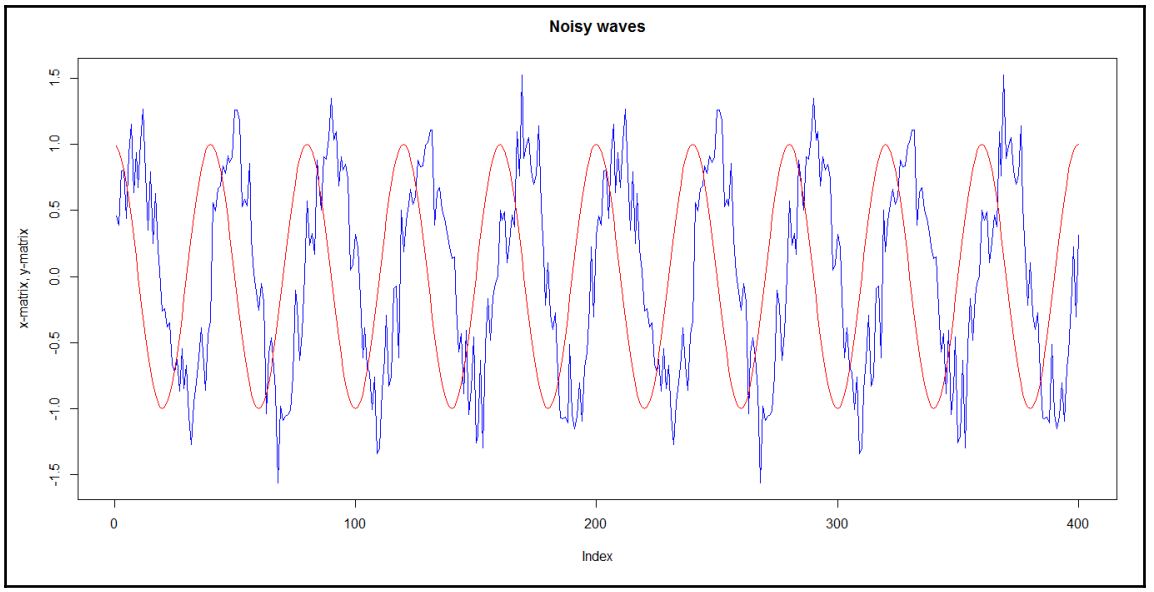


	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1	Theil's U
Training set	9.159009e-17	1.9019099	1.53702129	-10.31273981	28.302156	1.8593353	0.9963622	NA
Test set	-1.288991e-01	0.2396838	0.22278287	-2.45281447	4.031039	0.2695005	0.6989796	2.763092
Training set	-3.218391e-03	0.1526773	0.09287356	-0.08228355	1.582567	0.1123492	0.6931248	NA
Test set	1.500000e-01	0.2516611	0.15000000	2.57879386	2.578794	0.1814551	0.6989796	2.818489
Training set	-5.212264e-02	1.2587336	0.82665094	-2.87696955	14.538198	1.0000000	0.9830841	NA
Test set	4.333333e-01	0.4377975	0.43333333	7.78692151	7.786922	0.5242035	0.3333333	4.842820
Training set	1.837714e-16	0.1526433	0.09443467	-0.01973132	1.613285	0.1142377	0.6931248	NA
Test set	1.532184e-01	0.2535926	0.15321839	2.63685674	2.636857	0.1853484	0.6989796	2.839636

	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1	Theil's U
Training set	4.475375e-16	1.88722530	1.53083801	-10.161145296	28.1539971	1.85185539	0.995828645	NA
Test set	-5.487103e-01	0.58297971	0.54871027	-10.023338649	10.0233386	0.66377505	0.695878741	6.671710
Training set	-6.195430e-16	1.88705289	1.53086653	-10.158672457	28.1523947	1.85188990	0.995849775	NA
Test set	-5.492242e-01	0.58206536	0.54922422	-10.029107757	10.0291078	0.66439678	0.687555685	6.623429
Training set	-9.854464e-04	0.10432066	0.06381823	0.018096634	1.1601990	0.07720094	0.111597690	NA
Test set	6.097884e-02	0.19531345	0.13899105	0.983630329	2.4283009	0.16813754	0.683262346	2.197669
Training set	-1.015557e-03	0.10565958	0.06330050	0.017500191	1.1509450	0.07657464	0.094513111	NA
Test set	7.002618e-02	0.20305522	0.14225925	1.143733343	2.4813827	0.17209107	0.686501904	2.279852
Training set	-7.528991e-04	0.10522503	0.06285967	0.022495362	1.1488709	0.07604136	0.003619751	NA
Test set	7.395984e-02	0.20312273	0.14102062	1.215641649	2.4575079	0.17059271	0.685511079	2.277821
Training set	1.892526e-04	0.05007881	0.03839996	-0.007259723	0.7362521	0.04645245	-0.192874177	NA
Test set	1.551299e-01	0.27955692	0.16401471	2.652956228	2.8174896	0.19840867	0.676462478	3.137278

Chapter 11: Deep Learning

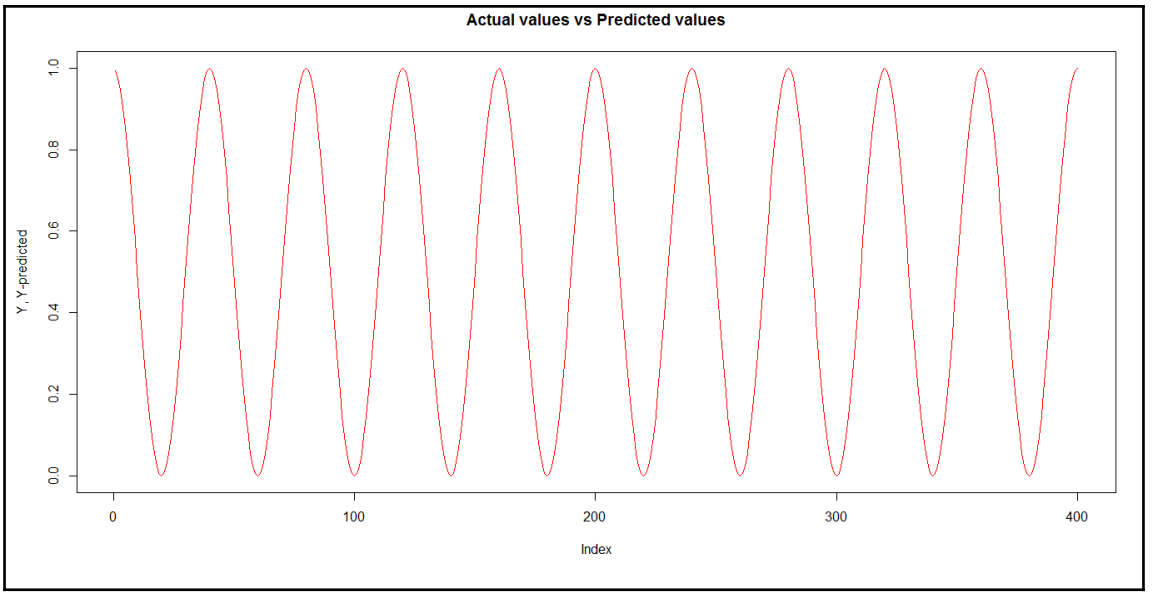


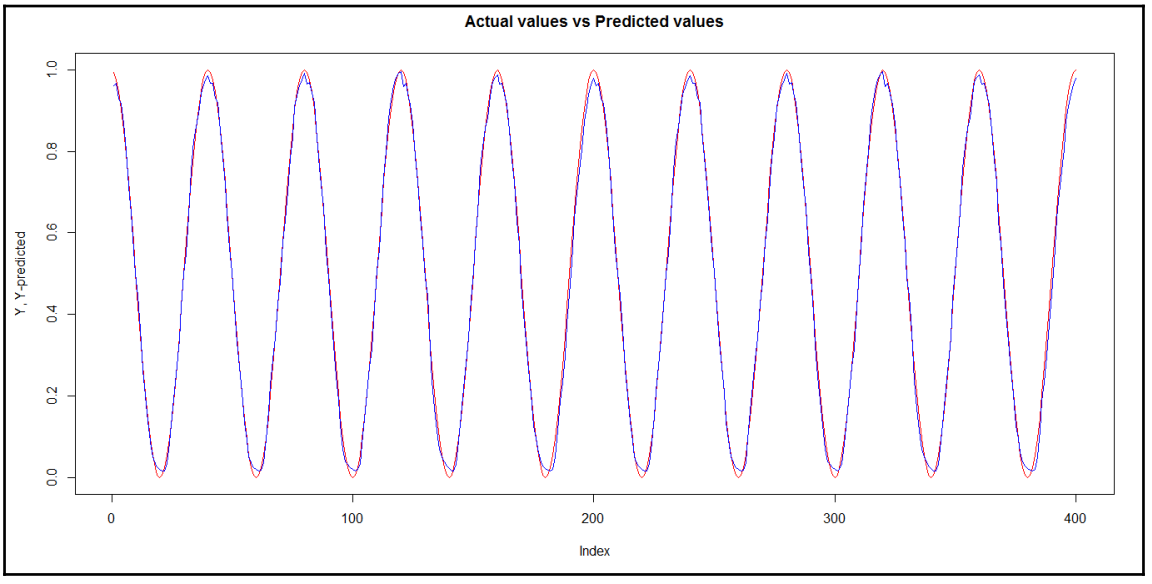


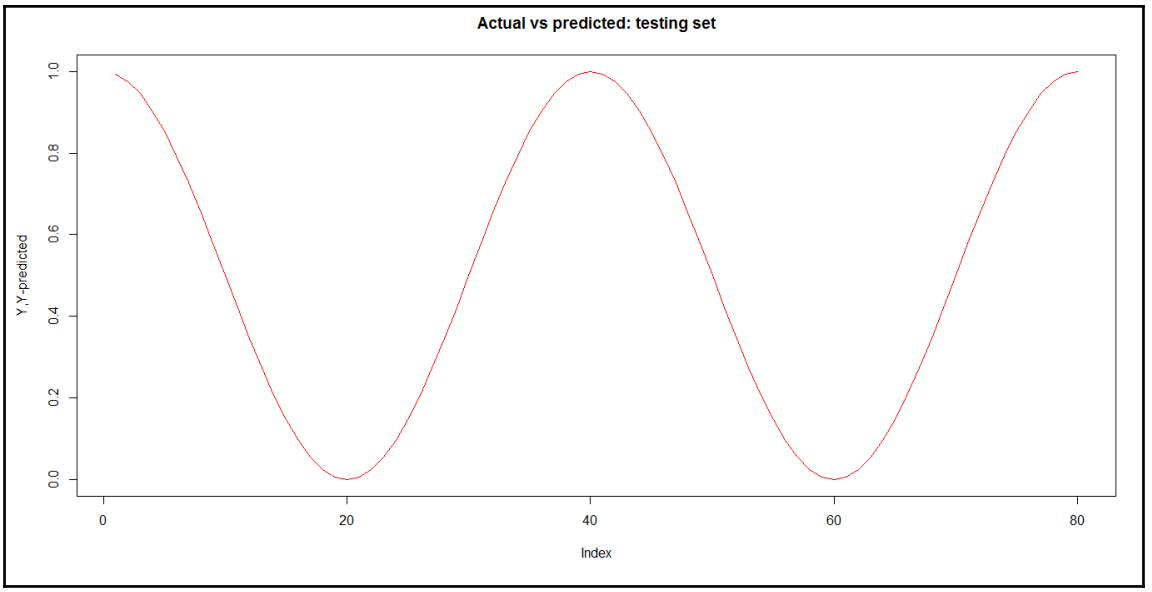
```
          [,1]      [,2]      [,3]      [,4]      [,5]      [,6]      [,7]      [,8]      [,9]     [,10]     [,11]     [,12]
 [1,] 0.5451726 0.5796069 0.5282779 0.6387957 0.7546948 0.7972073 0.6898536 0.7815417 0.6871595 0.8071538 0.9178127 0.8761765
 [2,] 0.6354409 0.5307202 0.5741530 0.7599904 0.6479934 0.7618196 0.8116367 0.7868224 0.7673894 0.8842260 0.7908040 0.7840033
 [3,] 0.5937034 0.5763600 0.7044705 0.7500259 0.7670115 0.7776825 0.8477539 1.0000000 0.7245861 0.8225836 0.7894753 0.7960983
 [4,] 0.5028951 0.6123338 0.6415219 0.5883772 0.7825188 0.6869214 0.8130090 0.7224553 0.7939027 0.7268006 0.9454927 0.8658338
 [5,] 0.5988042 0.5487380 0.6882531 0.6303222 0.6926913 0.7069975 0.8730621 0.6881716 0.8402071 0.7075135 0.7285208 0.7772329
 [6,] 0.5451726 0.5796069 0.5282779 0.6387957 0.7546948 0.7972073 0.6898536 0.7815417 0.6871595 0.8071538 0.9178127 0.8761765
 [7,] 0.6354409 0.5307202 0.5741530 0.7599904 0.6479934 0.7618196 0.8116367 0.7868224 0.7673894 0.8842260 0.7908040 0.7840033
 [8,] 0.5937034 0.5763600 0.7044705 0.7500259 0.7670115 0.7776825 0.8477539 1.0000000 0.7245861 0.8225836 0.7894753 0.7960983
 [9,] 0.5028951 0.6123338 0.6415219 0.5883772 0.7825188 0.6869214 0.8130090 0.7224553 0.7939027 0.7268006 0.9454927 0.8658338
[10,] 0.5988042 0.5487380 0.6882531 0.6303222 0.6926913 0.7069975 0.8730621 0.6881716 0.8402071 0.7075135 0.7285208 0.7772329
          [,13]     [,14]     [,15]     [,16]     [,17]     [,18]     [,19]     [,20]     [,21]     [,22]     [,23]     [,24]
 [1,] 0.7718405 0.8477304 0.7924695 0.6970002 0.5634776 0.5786857 0.6218280 0.5315196 0.3873829 0.2014617 0.2801250 0.1127961
 [2,] 0.9076216 0.9449744 0.7725552 0.7559216 0.5679354 0.6402321 0.4889864 0.5152894 0.3331712 0.3476343 0.2669833 0.3206857
 [3,] 0.7978590 0.8619244 0.7800906 0.5694356 0.5083825 0.6706676 0.5561135 0.5944188 0.3733927 0.4216502 0.2492627 0.3520874
 [4,] 0.6231765 0.7066160 0.6909037 0.6063421 0.6860786 0.6565409 0.5999989 0.5714045 0.2961664 0.2843159 0.1712096 0.4162656
 [5,] 0.8041476 0.8540351 0.6815423 0.7974153 0.6635038 0.5690770 0.6247283 0.5370858 0.4737641 0.4405969 0.2221804 0.2751527
 [6,] 0.7718405 0.8477304 0.7924695 0.6970002 0.5634776 0.5786857 0.6218280 0.5315196 0.3873829 0.2014617 0.2801250 0.1127961
 [7,] 0.9076216 0.9449744 0.7725552 0.7559216 0.5679354 0.6402321 0.4889864 0.5152894 0.3331712 0.3476343 0.2669833 0.3206857
 [8,] 0.7978590 0.8619244 0.7800906 0.5694356 0.5083825 0.6706676 0.5561135 0.5944188 0.3733927 0.4216502 0.2492627 0.3520874
 [9,] 0.6231765 0.7066160 0.6909037 0.6063421 0.6860786 0.6565409 0.5999989 0.5714045 0.2961664 0.2843159 0.1712096 0.4162656
[10,] 0.8041476 0.8540351 0.6815423 0.7974153 0.6635038 0.5690770 0.6247283 0.5370858 0.4737641 0.4405969 0.2221804 0.2751527
          [,25]     [,26]     [,27]      [,28]     [,29]      [,30]      [,31]     [,32]     [,33]     [,34]     [,35]      [,36]
 [1,] 0.1446305 0.1855372 0.1312774 0.09536614 0.1481058 0.13109154 7.508331e-17 0.1625059 0.2712798 0.2327581 0.1349303 0.17058057
 [2,] 0.3417331 0.3199320 0.2515934 0.12841562 0.2042807 0.04718597 1.889101e-01 0.0481722 0.1007691 0.1986537 0.1256320 0.39106986
 [3,] 0.1980562 0.2647339 0.2452782 0.02892975 0.2436258 0.24789822 4.848882e-02 0.2645255 0.1501646 0.1904320 0.3297219 0.29845516
 [4,] 0.2830731 0.3072307 0.2342600 0.17771651 0.2697995 0.15991971 1.236458e-01 0.1479723 0.2870491 0.1440244 0.1783199 0.09572346
 [5,] 0.3039392 0.3919639 0.1635932 0.19287067 0.2151497 0.15646443 1.662634e-01 0.2532369 0.1318188 0.1091675 0.1274274 0.26543369
 [6,] 0.1446305 0.1855372 0.1312774 0.09536614 0.1481058 0.13109154 0.000000e+00 0.1625059 0.2712798 0.2327581 0.1349303 0.17058057
 [7,] 0.3417331 0.3199320 0.2515934 0.12841562 0.2042807 0.04718597 1.889101e-01 0.0481722 0.1007691 0.1986537 0.1256320 0.39106986
 [8,] 0.1980562 0.2647339 0.2452782 0.02892975 0.2436258 0.24789822 4.848882e-02 0.2645255 0.1501646 0.1904320 0.3297219 0.29845516
 [9,] 0.2830731 0.3072307 0.2342600 0.17771651 0.2697995 0.15991971 1.236458e-01 0.1479723 0.2870491 0.1440244 0.1783199 0.09572346
[10,] 0.3039392 0.3919639 0.1635932 0.19287067 0.2151497 0.15646443 1.662634e-01 0.2532369 0.1318188 0.1091675 0.1274274 0.26543369
```

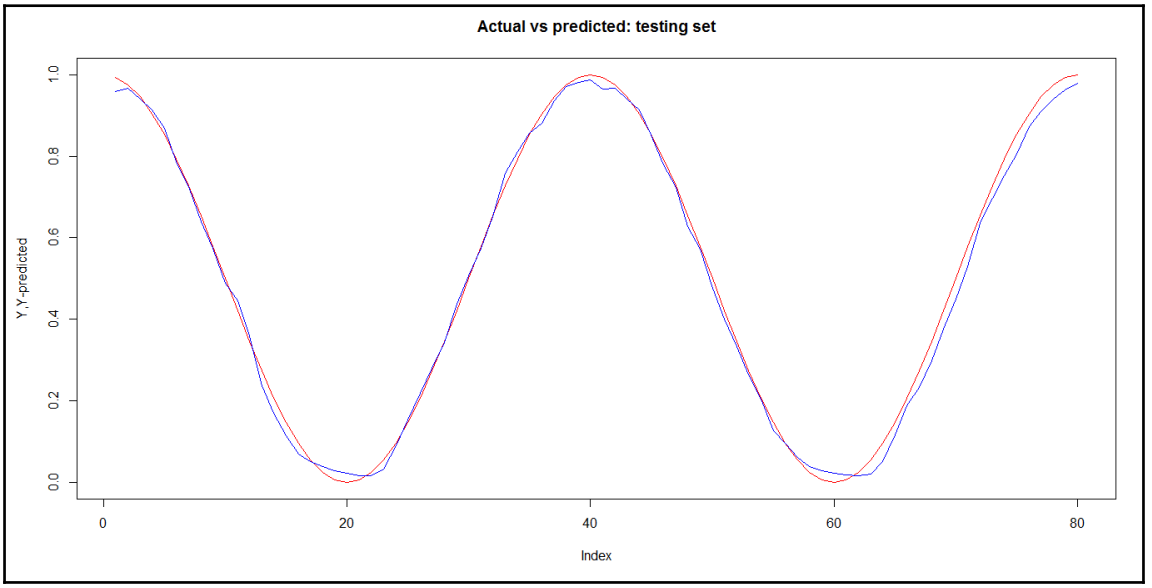
```
          [,1]      [,2]      [,3]      [,4]      [,5]      [,6]      [,7]      [,8]      [,9] [,10]     [,11]     [,12]     [,13]
 [1,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
 [2,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
 [3,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
 [4,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
 [5,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
 [6,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
 [7,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
 [8,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
 [9,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
[10,] 0.9938442 0.9755283 0.9455033 0.9045085 0.8535534 0.7938926 0.7269952 0.6545085 0.5782172   0.5 0.4217828 0.3454915 0.2730048
          [,14]     [,15]     [,16]     [,17]     [,18]     [,19] [,20]     [,21]     [,22]     [,23]     [,24]     [,25]     [,26]
 [1,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
 [2,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
 [3,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
 [4,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
 [5,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
 [6,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
 [7,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
 [8,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
 [9,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
[10,] 0.2061074 0.1464466 0.0954915 0.05449674 0.02447174 0.00615583     0 0.00615583 0.02447174 0.05449674 0.0954915 0.1464466 0.2061074
          [,27]     [,28]     [,29] [,30]     [,31]     [,32]     [,33]     [,34]     [,35]     [,36]     [,37]     [,38]     [,39] [,40]
 [1,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
 [2,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
 [3,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
 [4,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
 [5,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
 [6,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
 [7,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
 [8,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
 [9,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
[10,] 0.2730048 0.3454915 0.4217828   0.5 0.5782172 0.6545085 0.7269952 0.7938926 0.8535534 0.9045085 0.9455033 0.9755283 0.9938442     1
```

```
Trained epoch: 1310 - Learning rate: 0.05
Epoch error: 0.660961658599474
Trained epoch: 1311 - Learning rate: 0.05
Epoch error: 0.669677942923603
Trained epoch: 1312 - Learning rate: 0.05
Epoch error: 0.790488223916989
Trained epoch: 1313 - Learning rate: 0.05
Epoch error: 0.604705780466322
Trained epoch: 1314 - Learning rate: 0.05
Epoch error: 0.736036716583117
Trained epoch: 1315 - Learning rate: 0.05
Epoch error: 0.846403635114378
Trained epoch: 1316 - Learning rate: 0.05
Epoch error: 0.705399512762672
Trained epoch: 1317 - Learning rate: 0.05
Epoch error: 0.655253881236524
Trained epoch: 1318 - Learning rate: 0.05
Epoch error: 0.683256850600975
Trained epoch: 1319 - Learning rate: 0.05
Epoch error: 0.664219260959064
Trained epoch: 1320 - Learning rate: 0.05
Epoch error: 0.609030183713622
Trained epoch: 1321 - Learning rate: 0.05
Epoch error: 0.783214788737956
Trained epoch: 1322 - Learning rate: 0.05
Epoch error: 0.717855276763514
Trained epoch: 1323 - Learning rate: 0.05
Epoch error: 0.648403367406859
Trained epoch: 1324 - Learning rate: 0.05
Epoch error: 0.665843170375635
Trained epoch: 1325 - Learning rate: 0.05
Epoch error: 0.716409342111275
Trained epoch: 1326 - Learning rate: 0.05
Epoch error: 0.616071661248296
Trained epoch: 1327 - Learning rate: 0.05
Epoch error: 0.65502734088982
```


Actual values vs Predicted values
Y , Y-predicted
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
Index


Actual values vs Predicted values
Y , Y-predicted
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
Index


Actual vs predicted: testing set
Y, Y-predicted
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
Index


Actual vs predicted: testing set
Y, Y-predicted
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
Index

Chapter 12: Case Study - Exploring World Bank Data

```
[1] 41150     6
```

```
[1] 27023     6
```

```
[1] 31884     6
```

```
[1] 23994     6
```

```
'data.frame':	41150 obs. of  6 variables:
 $ value      : num  3.92e+08 3.84e+08 3.77e+08 3.69e+08 3.61e+08 ...
 $ date       : chr  "2015" "2014" "2013" "2012" ...
 $ indicatorID: chr  "SP.POP.TOTL" "SP.POP.TOTL" "SP.POP.TOTL" "SP.POP.TOTL" ...
 $ indicator  : chr  "Population, total" "Population, total" "Population, total" "Population, total" ...
 $ iso2c      : chr  "1A" "1A" "1A" "1A" ...
 $ country    : chr  "Arab World" "Arab World" "Arab World" "Arab World" ...
 - attr(*, ".internal.selfref")=<externalptr>
```

```
'data.frame':	27023 obs. of  6 variables:
 $ value      : num  3.92e+08 3.84e+08 3.77e+08 3.69e+08 3.61e+08 ...
 $ date       : chr  "2015" "2014" "2013" "2012" ...
 $ indicatorID: chr  "SP.POP.TOTL" "SP.POP.TOTL" "SP.POP.TOTL" "SP.POP.TOTL" ...
 $ indicator  : chr  "Population, total" "Population, total" "Population, total" "Population, total" ...
 $ iso2c      : chr  "1A" "1A" "1A" "1A" ...
 $ country    : chr  "Arab World" "Arab World" "Arab World" "Arab World" ...
 - attr(*, ".internal.selfref")=<externalptr>
```

```
Classes 'data.table' and 'data.frame':  31884 obs. of  6 variables:
 $ value      : num  3.92e+08 3.84e+08 3.77e+08 3.69e+08 3.61e+08 ...
 $ date       : chr  "2015" "2014" "2013" "2012" ...
 $ indicatorID: chr  "SP.POP.TOTL" "SP.POP.TOTL" "SP.POP.TOTL" "SP.POP.TOTL" ...
 $ indicator  : chr  "Population, total" "Population, total" "Population, total" "Population, total" ...
 $ iso2c      : chr  "1A" "1A" "1A" "1A" ...
 $ country    : chr  "Arab World" "Arab World" "Arab World" "Arab World" ...
 - attr(*, ".internal.selfref")=<externalptr>
```

```
Classes 'data.table' and 'data.frame':  23994 obs. of  6 variables:
 $ value      : num  2.57e+12 2.89e+12 2.83e+12 2.73e+12 2.50e+12 ...
 $ date       : chr  "2015" "2014" "2013" "2012" ...
 $ indicatorID: chr  "NY.GDP.MKTP.CD" "NY.GDP.MKTP.CD" "NY.GDP.MKTP.CD" "NY.GDP.MKTP.CD" ...
 $ indicator  : chr  "GDP (current US$)" "GDP (current US$)" "GDP (current US$)" "GDP (current US$)" ...
 $ iso2c      : chr  "1A" "1A" "1A" "1A" ...
 $ country    : chr  "Arab World" "Arab World" "Arab World" "Arab World" ...
 - attr(*, ".internal.selfref")=<externalptr>
```

```
Classes 'data.table' and 'data.frame':  23994 obs. of  6 variables:
 $ value      : num  2.57e+12 2.89e+12 2.83e+12 2.73e+12 2.50e+12 ...
 $ date       : chr  "2015" "2014" "2013" "2012" ...
 $ indicatorID: chr  "NY.GDP.MKTP.CD" "NY.GDP.MKTP.CD" "NY.GDP.MKTP.CD" "NY.GDP.MKTP.CD" ...
 $ indicator  : chr  "GDP (current US$)" "GDP (current US$)" "GDP (current US$)" "GDP (current US$)" ...
 $ iso2c      : chr  "1A" "1A" "1A" "1A" ...
 $ country    : chr  "Arab World" "Arab World" "Arab World" "Arab World" ...
 - attr(*, ".internal.selfref")=<externalptr>
```

```
       value date indicatorID         indicator iso2c    country
 1: 392022276 2015 SP.POP.TOTL Population, total    1A Arab World
 2: 384222592 2014 SP.POP.TOTL Population, total    1A Arab World
 3: 376504253 2013 SP.POP.TOTL Population, total    1A Arab World
 4: 368802611 2012 SP.POP.TOTL Population, total    1A Arab World
 5: 361031820 2011 SP.POP.TOTL Population, total    1A Arab World
 6: 353112237 2010 SP.POP.TOTL Population, total    1A Arab World
```

```
       value date indicatorID         indicator iso2c    country
1: 392022276 2015 SP.POP.TOTL Population, total    1A Arab World
2: 384222592 2014 SP.POP.TOTL Population, total    1A Arab World
3: 376504253 2013 SP.POP.TOTL Population, total    1A Arab World
4: 368802611 2012 SP.POP.TOTL Population, total    1A Arab World
5: 361031820 2011 SP.POP.TOTL Population, total    1A Arab World
6: 353112237 2010 SP.POP.TOTL Population, total    1A Arab World
```

```
       value date indicatorID         indicator iso2c    country
1: 392022276 2015 SP.POP.TOTL Population, total    1A Arab World
2: 384222592 2014 SP.POP.TOTL Population, total    1A Arab World
3: 376504253 2013 SP.POP.TOTL Population, total    1A Arab World
4: 368802611 2012 SP.POP.TOTL Population, total    1A Arab World
5: 361031820 2011 SP.POP.TOTL Population, total    1A Arab World
6: 353112237 2010 SP.POP.TOTL Population, total    1A Arab World
```

```
          value date    indicatorID         indicator iso2c    country
1: 2.565871e+12 2015 NY.GDP.MKTP.CD GDP (current US$)    1A Arab World
2: 2.889755e+12 2014 NY.GDP.MKTP.CD GDP (current US$)    1A Arab World
3: 2.830820e+12 2013 NY.GDP.MKTP.CD GDP (current US$)    1A Arab World
4: 2.733908e+12 2012 NY.GDP.MKTP.CD GDP (current US$)    1A Arab World
5: 2.497297e+12 2011 NY.GDP.MKTP.CD GDP (current US$)    1A Arab World
6: 2.103839e+12 2010 NY.GDP.MKTP.CD GDP (current US$)    1A Arab World
```

```
[1] 14623     6
```

```
[1] 13253     6
```

```
[1] 13274     6
```

```
[1] 11050     6
```

```
[1] 1350    6
```

```
[1] 6211    6
```

```
[1] 1032    6
```

```
[1] 11912     6
```

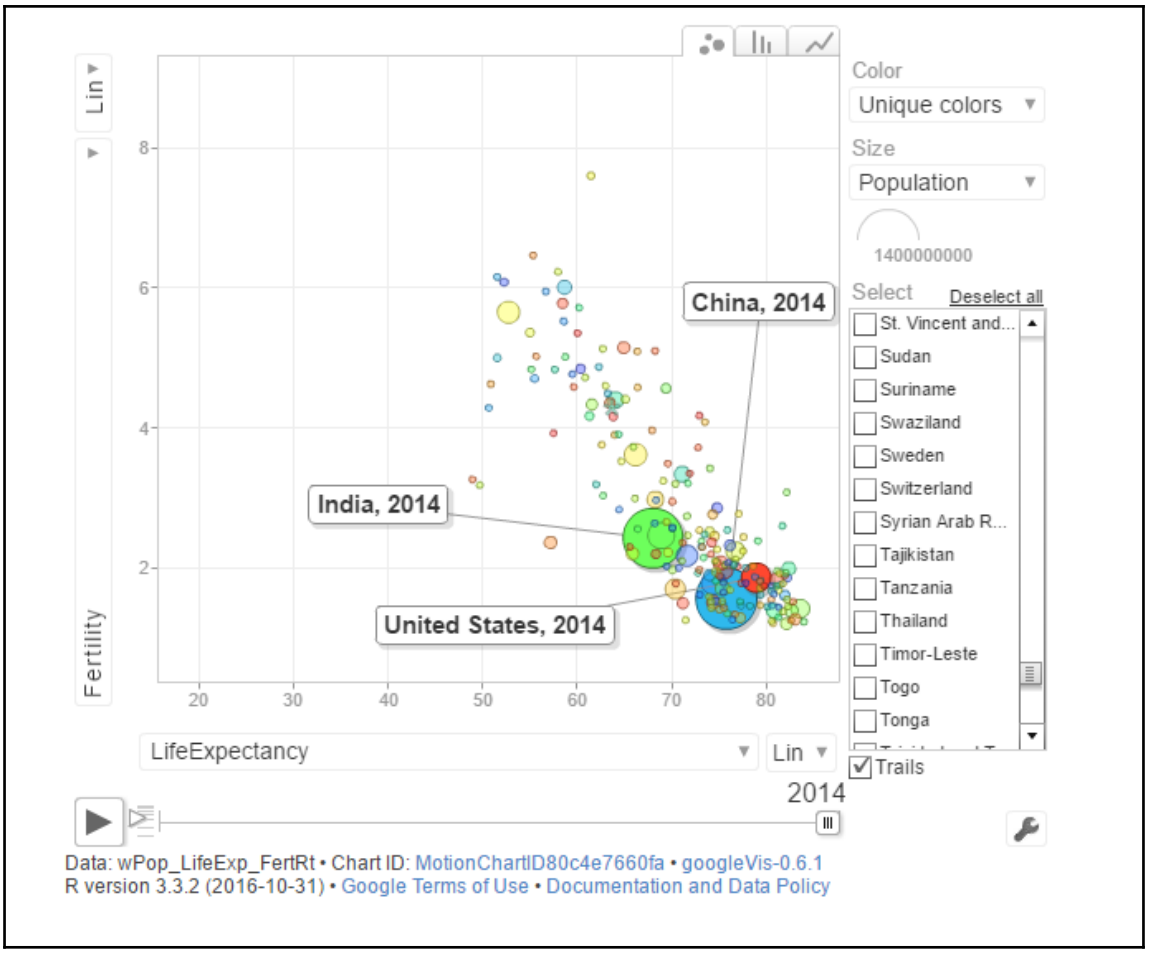
	iso3c	iso2c	country	capital	long	lat	regionID	region	adminID	admin	incomeID	income	lendingID	lending
1:	ABW	AW	Aruba	Oranjestad	-70.0167	12.5167	LCN	Latin America & Caribbean	NA		NA	HIC	High income	LNX Not classified
2:	AFG	AF	Afghanistan	Kabul	69.1761	34.5228	SAS	South Asia	SAS	South Asia	LIC	Low income	IDX	IDA
3:	AFR	A9	Africa	NA	NA	NA	NA	Aggregates	NA		NA	NA	Aggregates	NA
4:	AGO	AO	Angola	Luanda	13.242	-8.81155	SSF	Sub-Saharan Africa	SSA	Sub-Saharan Africa (excluding high income)	UMC	Upper middle income	IBD	IBRD
5:	ALB	AL	Albania	Tirane	19.8172	41.3317	ECS	Europe & Central Asia	ECA	Europe & Central Asia (excluding high income)	UMC	Upper middle income	IBD	IBRD
6:	AND	AD	Andorra	Andorra la Vella	1.5218	42.5075	ECS	Europe & Central Asia	NA		NA	HIC	High income	LNX Not classified

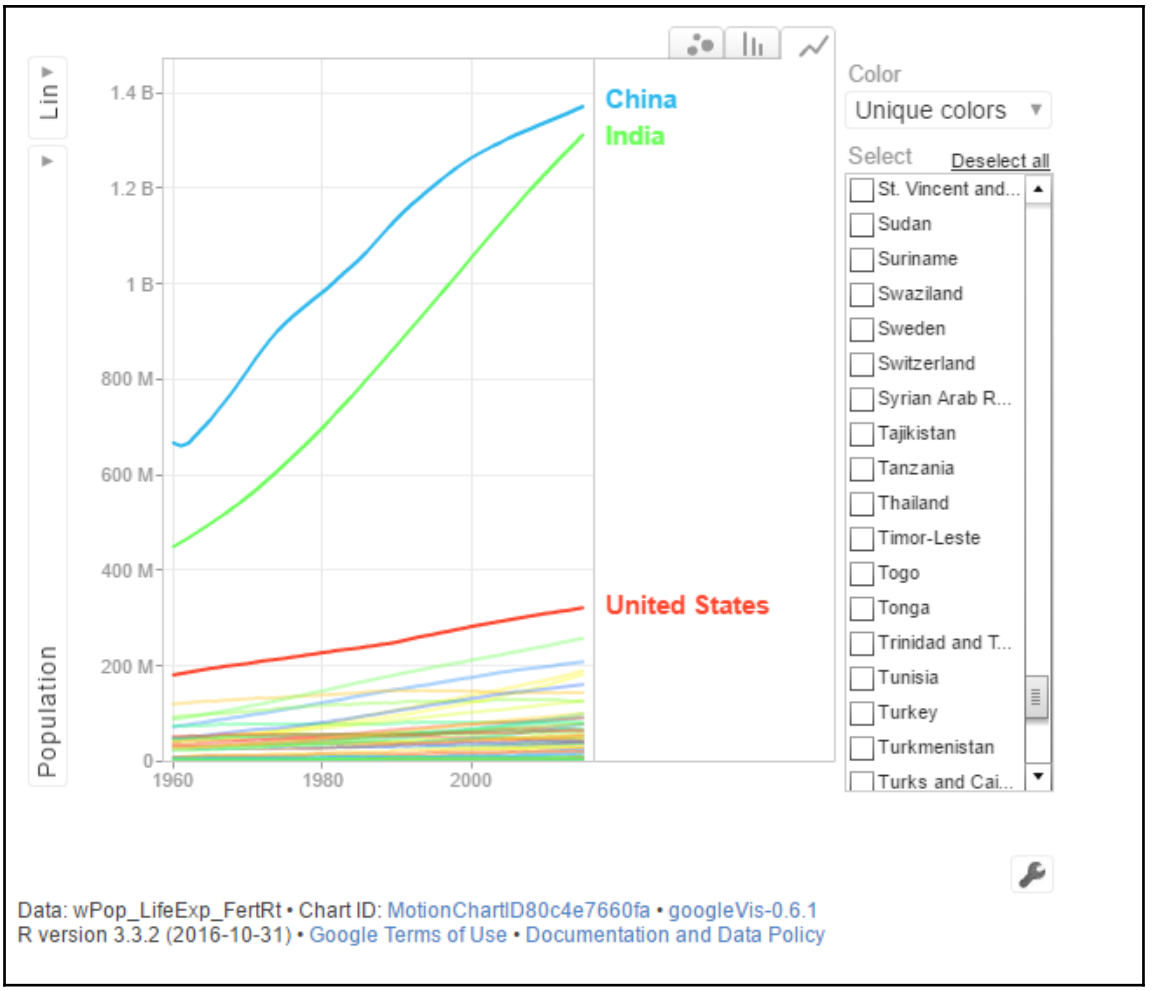
	iso3c	iso2c	country	capital	long	lat	regionID	region	adminID	admin	incomeID	income	lendingID	lending
1:	ARB	1A	Arab World		NA	NA	NA	Aggregates	NA		NA	Aggregates	NA	Aggregates
2:	WLD	1W	World		NA	NA	NA	Aggregates	NA		NA	Aggregates	NA	Aggregates
3:	EAP	4E	East Asia & Pacific (excluding high income)		NA	NA	NA	Aggregates	NA		NA	Aggregates	NA	Aggregates
4:	DXS	6D	IDA total, excluding Sub-Saharan Africa		NA	NA	NA	Aggregates	NA		NA	Aggregates	NA	Aggregates
5:	FXS	6F	IDA countries classified as fragile situations, excluding Sub-Saharan Africa		NA	NA	NA	Aggregates	NA		NA	Aggregates	NA	Aggregates
6:	NLS	6L	Non-resource rich Sub-Saharan Africa countries, of which landlocked		NA	NA	NA	Aggregates	NA		NA	Aggregates	NA	Aggregates

```
   iso3c iso2c country          capital   long     lat regionID               region adminID admin incomeID
1:   AND    AD Andorra Andorra la Vella 1.5218 42.5075      ECS Europe & Central Asia      NA    NA       HIC
2:   AND    AD Andorra Andorra la Vella 1.5218 42.5075      ECS Europe & Central Asia      NA    NA       HIC
3:   AND    AD Andorra Andorra la Vella 1.5218 42.5075      ECS Europe & Central Asia      NA    NA       HIC
4:   AND    AD Andorra Andorra la Vella 1.5218 42.5075      ECS Europe & Central Asia      NA    NA       HIC
5:   AND    AD Andorra Andorra la Vella 1.5218 42.5075      ECS Europe & Central Asia      NA    NA       HIC
6:   AND    AD Andorra Andorra la Vella 1.5218 42.5075      ECS Europe & Central Asia      NA    NA       HIC
       income lendingID        lending value date indicatorID        indicator i.country
1: High income       LNX Not classified 70473 2015 SP.POP.TOTL Population, total   Andorra
2: High income       LNX Not classified 72786 2014 SP.POP.TOTL Population, total   Andorra
3: High income       LNX Not classified 75902 2013 SP.POP.TOTL Population, total   Andorra
4: High income       LNX Not classified 79316 2012 SP.POP.TOTL Population, total   Andorra
5: High income       LNX Not classified 82326 2011 SP.POP.TOTL Population, total   Andorra
6: High income       LNX Not classified 84419 2010 SP.POP.TOTL Population, total   Andorra
```

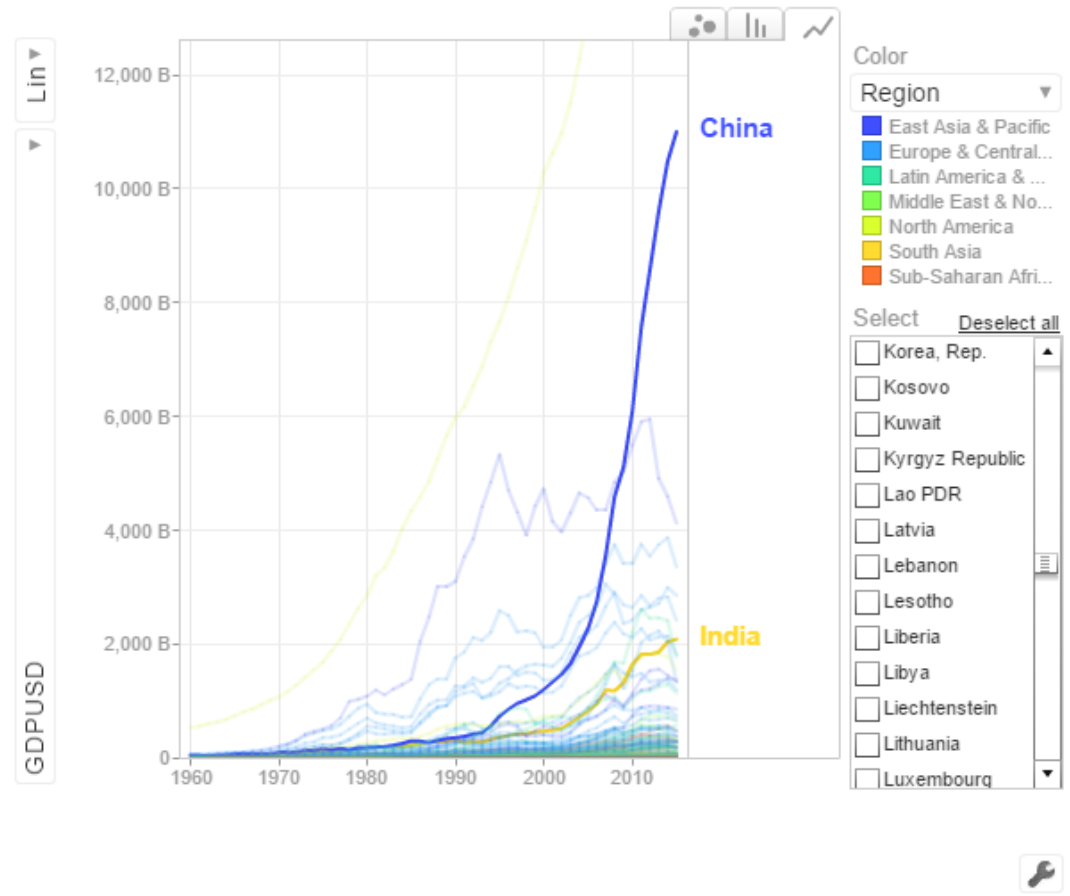
```
        country               region date value.Population, total value.Fertility rate, total (births per woman)
    1:  Andorra Europe & Central Asia 2015                   70473                                             NA
    2:  Andorra Europe & Central Asia 2014                   72786                                             NA
    3:  Andorra Europe & Central Asia 2013                   75902                                             NA
    4:  Andorra Europe & Central Asia 2012                   79316                                             NA
    5:  Andorra Europe & Central Asia 2011                   82326                                             NA
   ---
12053: Zimbabwe   Sub-Saharan Africa  1964                 4279561                                          7.347
12054: Zimbabwe   Sub-Saharan Africa  1963                 4140804                                          7.311
12055: Zimbabwe   Sub-Saharan Africa  1962                 4006262                                          7.267
12056: Zimbabwe   Sub-Saharan Africa  1961                 3876638                                          7.215
12057: Zimbabwe   Sub-Saharan Africa  1960                 3752390                                          7.158
       value.Life expectancy at birth, total (years)
    1:                                            NA
    2:                                            NA
    3:                                            NA
    4:                                            NA
    5:                                            NA
   ---
12053:                                      52.97166
12054:                                      52.62932
12055:                                      52.27790
12056:                                      51.91495
12057:                                      51.54246
```

```
        country               region date value.GDP (current US$) value.Access to electricity (% of population) value.CO2 emissions (kt)
    1:  Andorra Europe & Central Asia 2013             3248924588                                          NA                491.378
    2:  Andorra Europe & Central Asia 2012             3146151869                                         100                491.378
    3:  Andorra Europe & Central Asia 2011             3427022519                                          NA                491.378
    4:  Andorra Europe & Central Asia 2010             3346516556                                         100                517.047
    5:  Andorra Europe & Central Asia 2009             3650083356                                          NA                517.047
   ---
10483: Zimbabwe   Sub-Saharan Africa  1964             1217138000                                          NA               4473.740
10484: Zimbabwe   Sub-Saharan Africa  1963             1159511700                                          NA                     NA
10485: Zimbabwe   Sub-Saharan Africa  1962             1117601600                                          NA                     NA
10486: Zimbabwe   Sub-Saharan Africa  1961             1096646600                                          NA                     NA
10487: Zimbabwe   Sub-Saharan Africa  1960             1052990400                                          NA                     NA
```

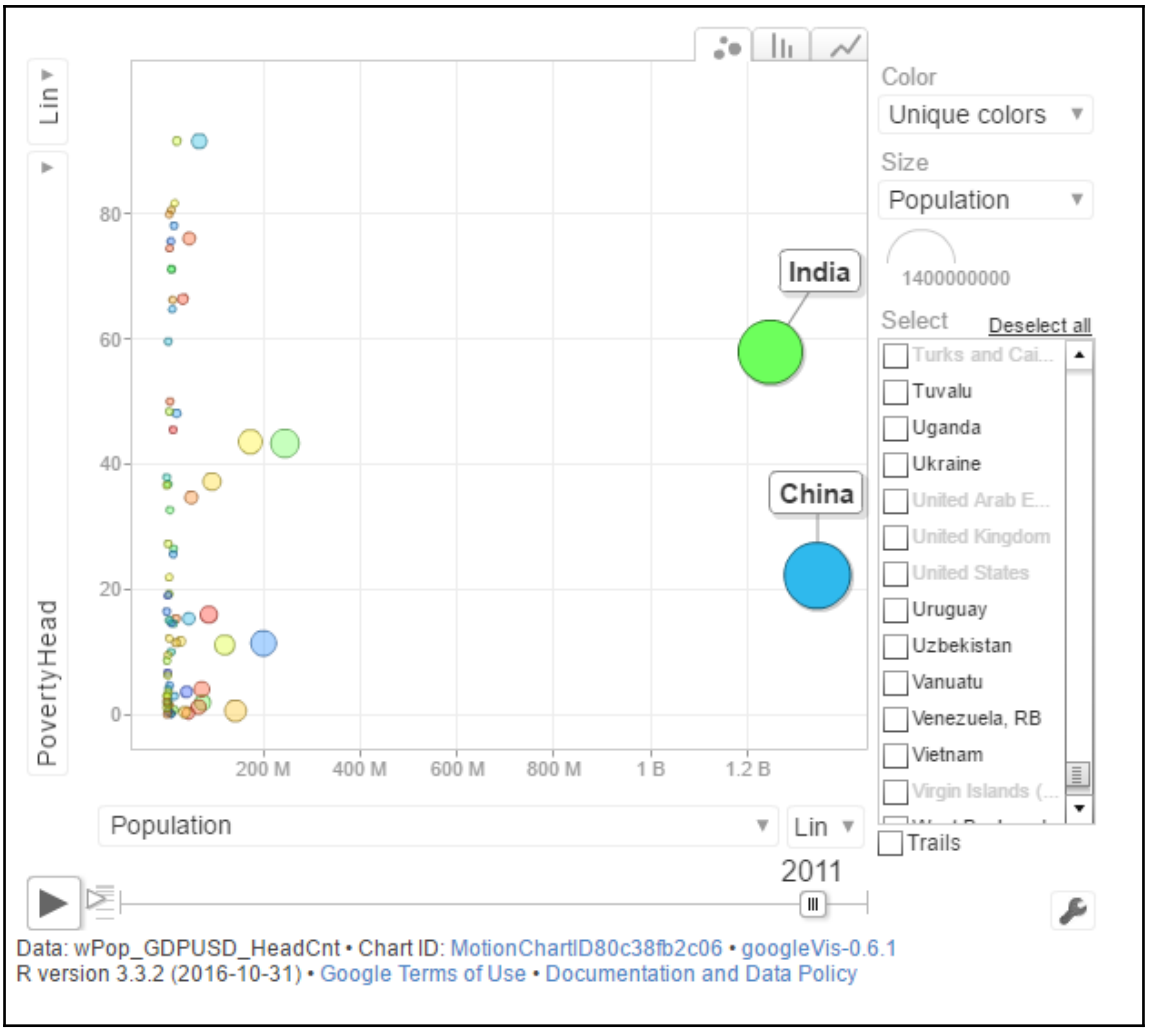

Lin
Fertility
8
6
4
2
20
30
40
50
60
70
80
China, 2014
India, 2014
United States, 2014
LifeExpectancy
Lin
2014
Color
Unique colors
Size
Population
1400000000
Select
Deselect all
St. Vincent and...
Sudan
Suriname
Swaziland
Sweden
Switzerland
Syrian Arab R...
Tajikistan
Tanzania
Thailand
Timor-Leste
Togo
Tonga
Trails
Data: wPop_LifeExp_FertRt • Chart ID: MotionChartID80c4e7660fa • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy

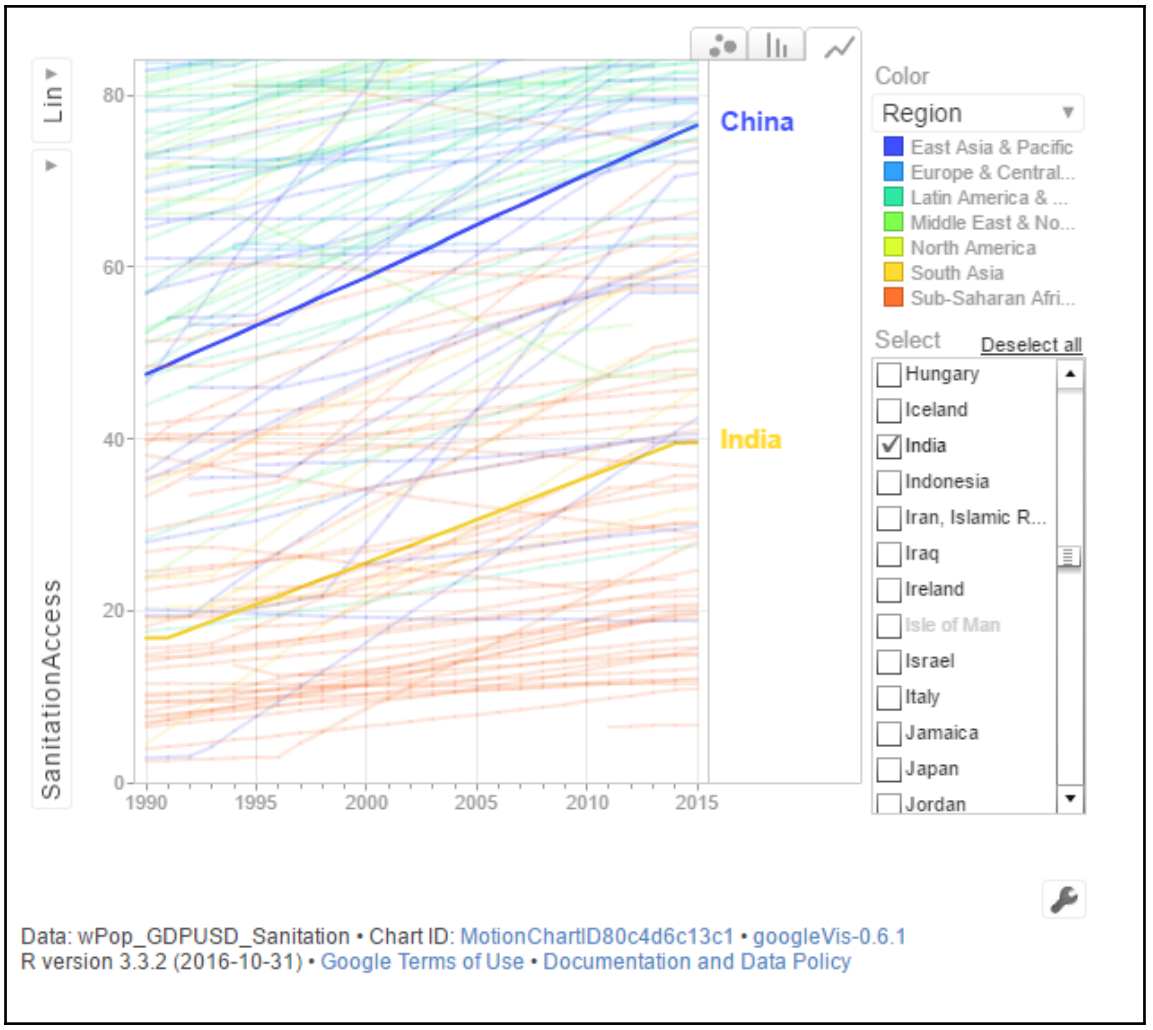


Data: wPop_LifeExp_FertRt • Chart ID: MotionChartID80c4e7660fa • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy

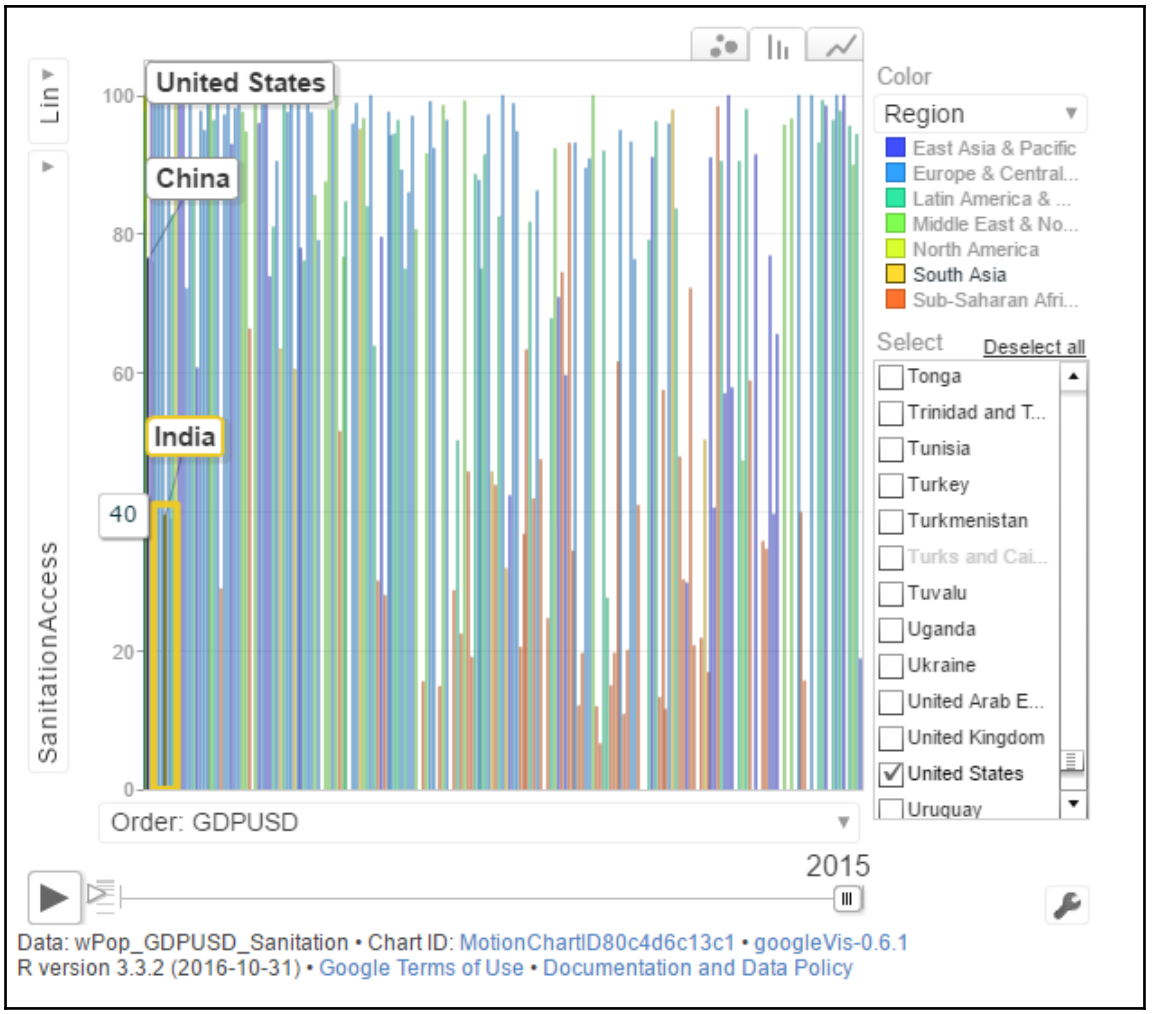


Data: wPop_GDPUSD_HeadCnt • Chart ID: MotionChartID80c38fb2c06 • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy


Lin
PovertyHead
80
60
40
20
0
200 M
400 M
600 M
800 M
1 B
1.2 B
India
China
Color
Unique colors
Size
Population
1400000000
Select
Deselect all
Turks and Cai...
Tuvalu
Uganda
Ukraine
United Arab E...
United Kingdom
United States
Uruguay
Uzbekistan
Vanuatu
Venezuela, RB
Vietnam
Virgin Islands (...
Trails
Population
Lin
2011
Data: wPop_GDPUSD_HeadCnt • Chart ID: MotionChartID80c38fb2c06 • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy



Data: wPop_GDPUSD_Sanitation • Chart ID: MotionChartID80c4d6c13c1 • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy



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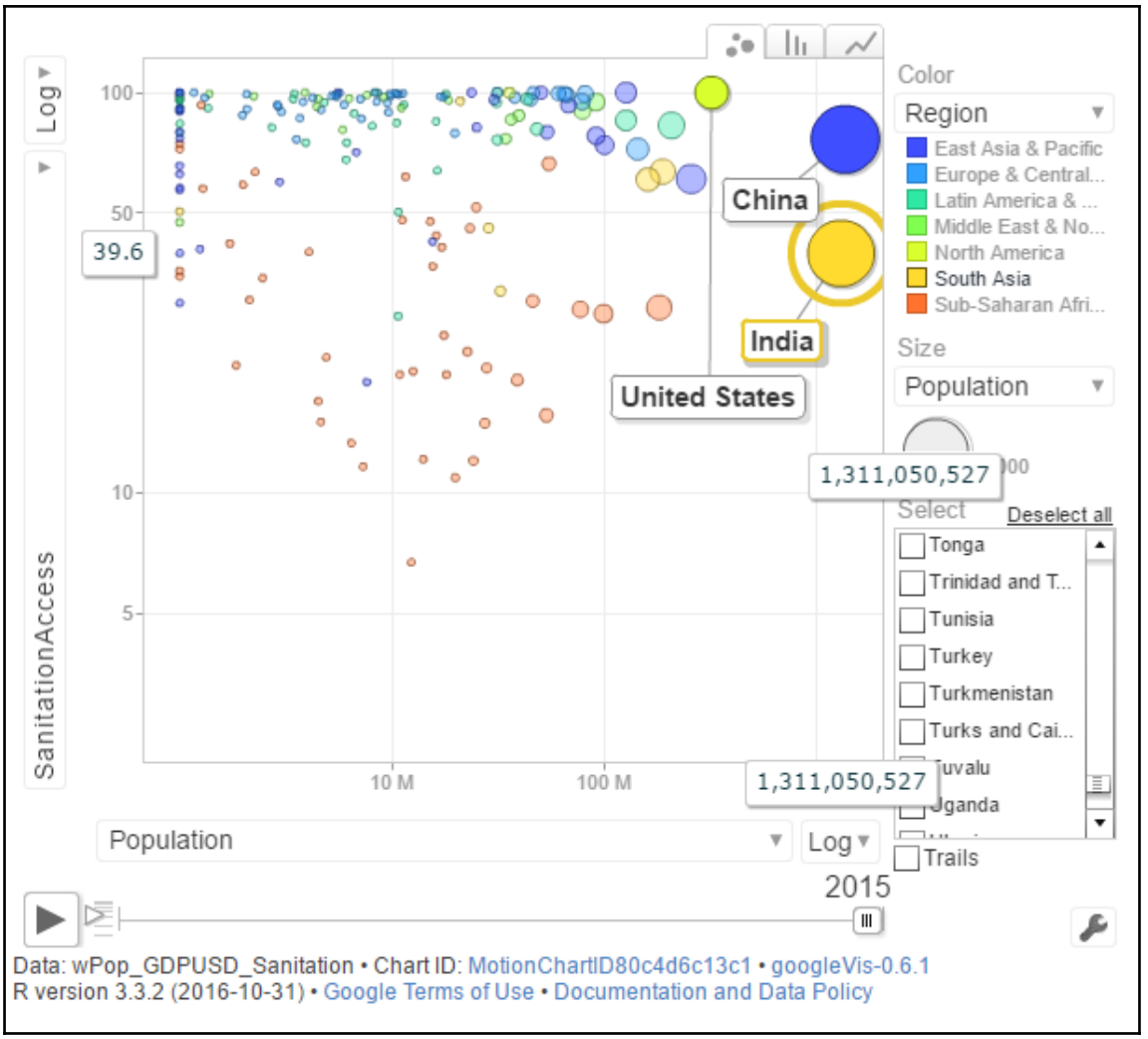
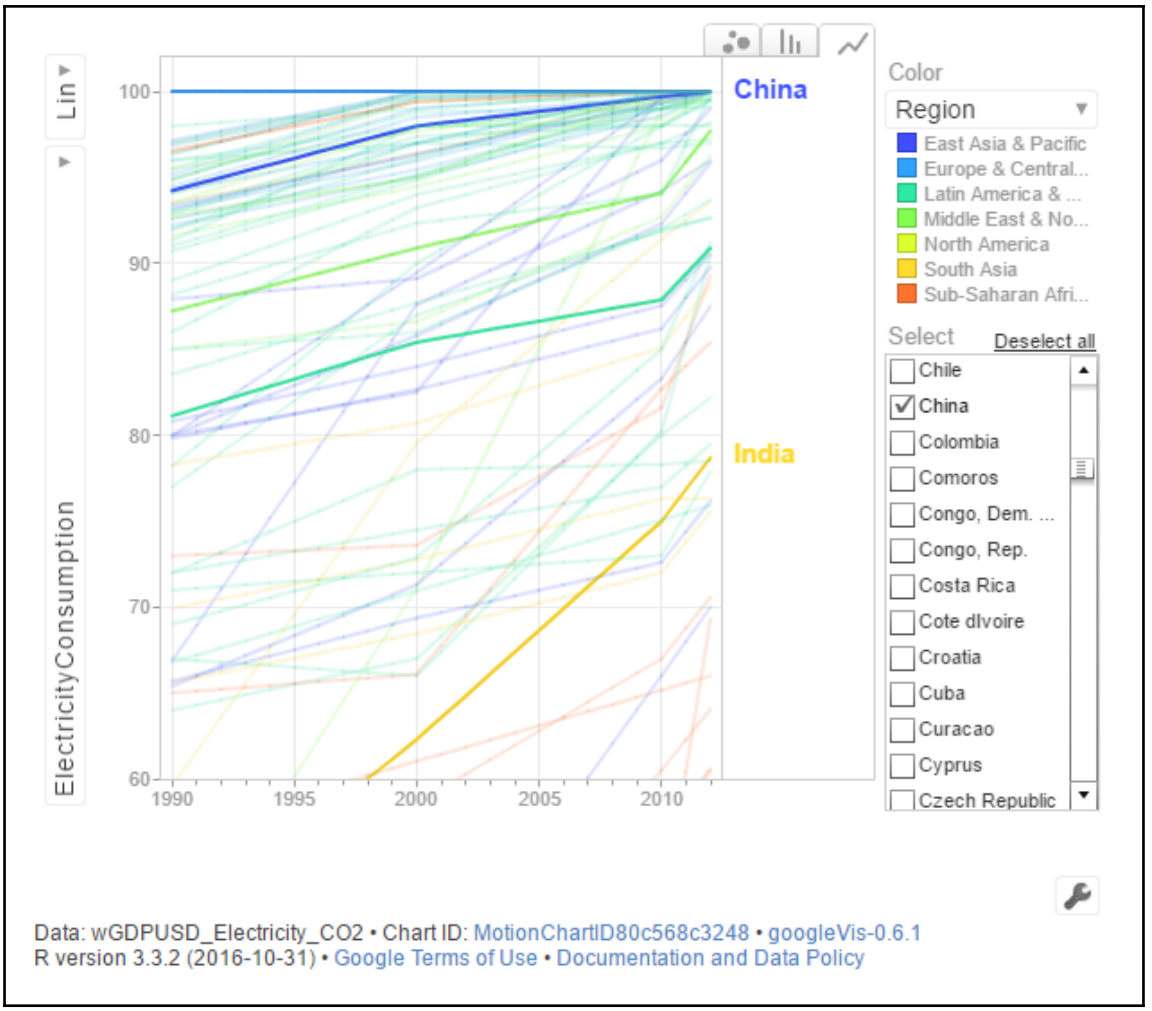
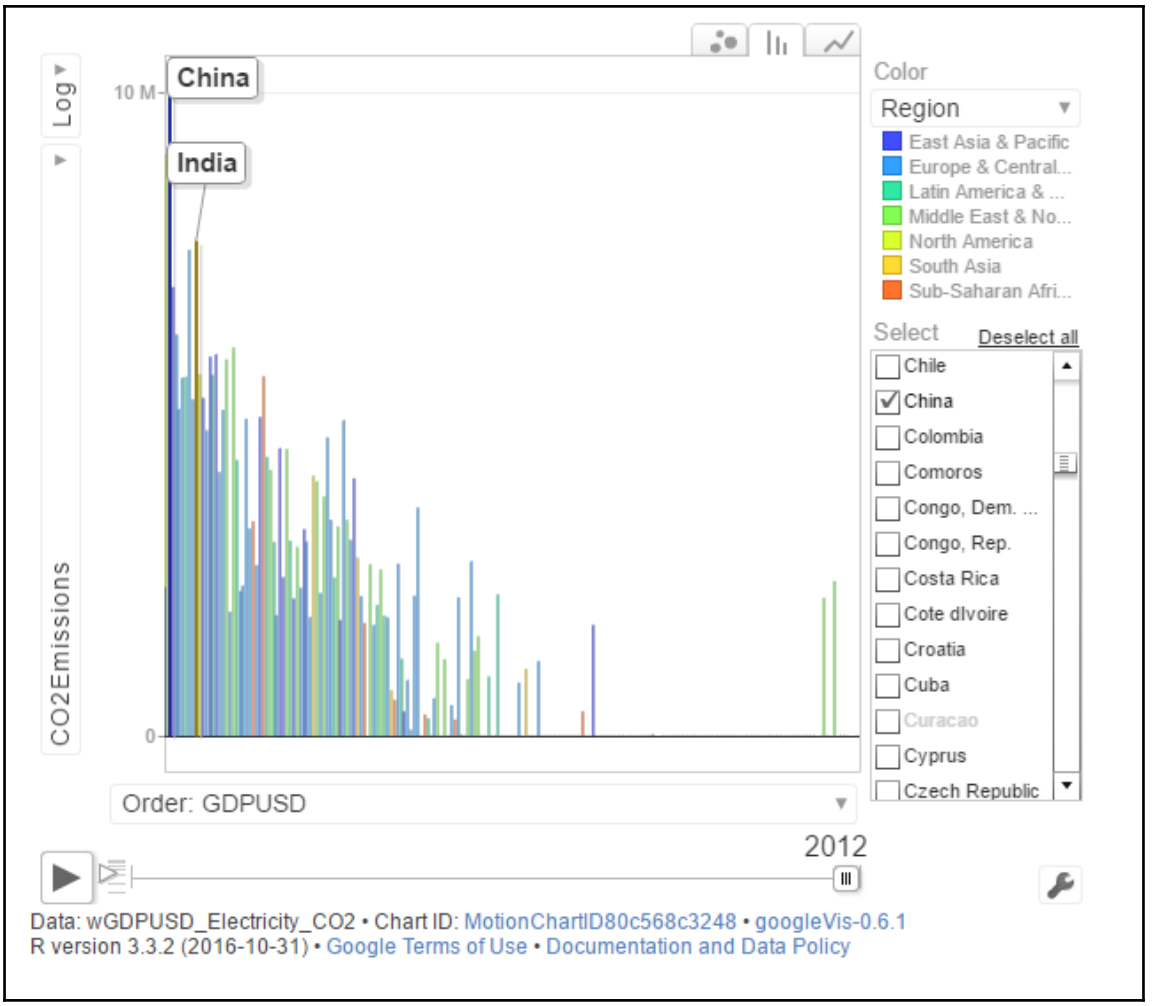
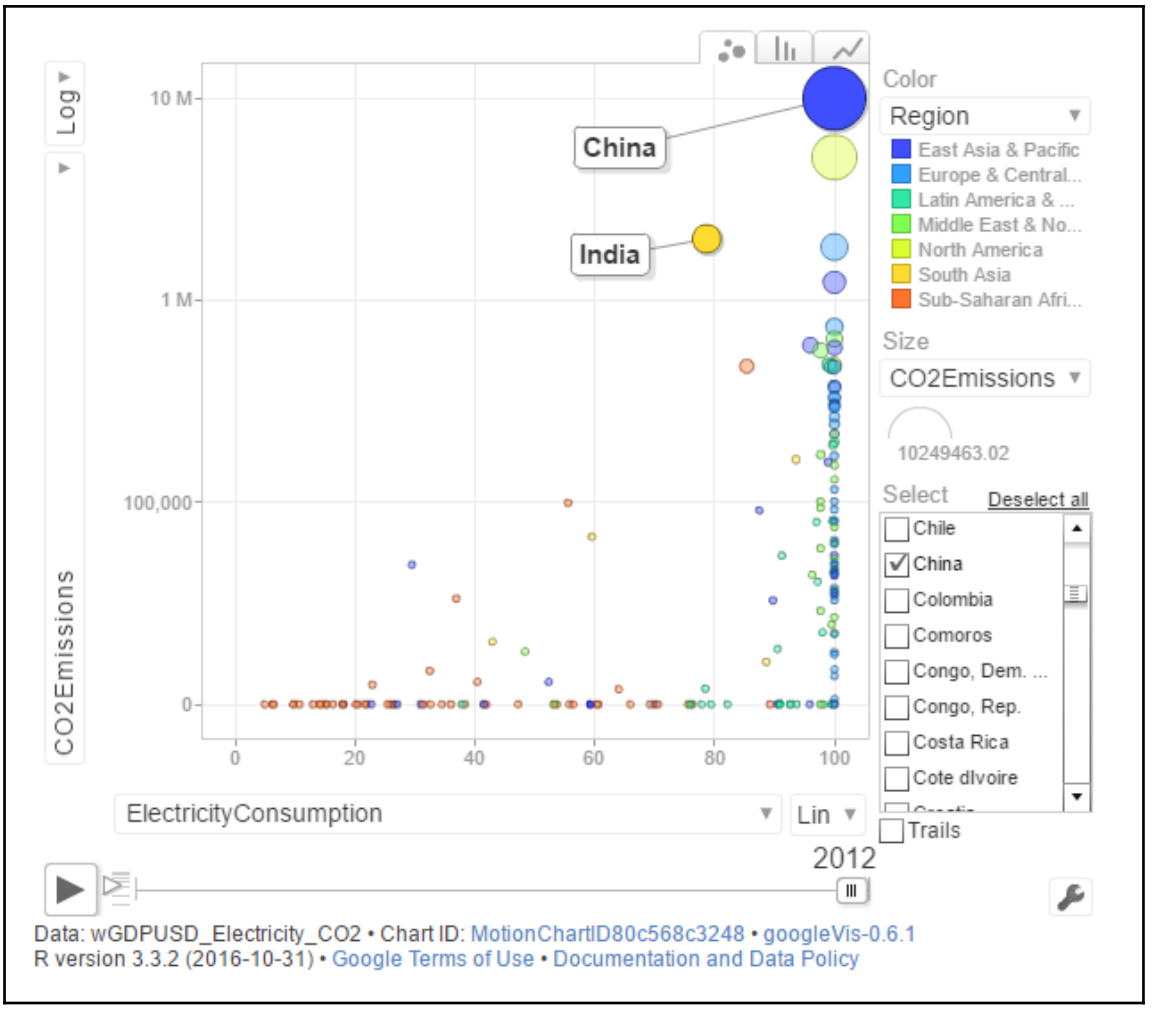

Log
SanitationAccess
100
50
39.6
10
5
10 M
100 M
China
India
United States
1,311,050,527
1,311,050,527
Color
Region
East Asia & Pacific
Europe & Central...
Latin America & ...
Middle East & No...
North America
South Asia
Sub-Saharan Afri...
Size
Population
Select
Deselect all
Tonga
Trinidad and T...
Tunisia
Turkey
Turkmenistan
Turks and Cai...
Trails
Population
Log
2015
Data: wPop_GDPUSD_Sanitation • Chart ID: MotionChartID80c4d6c13c1 • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy



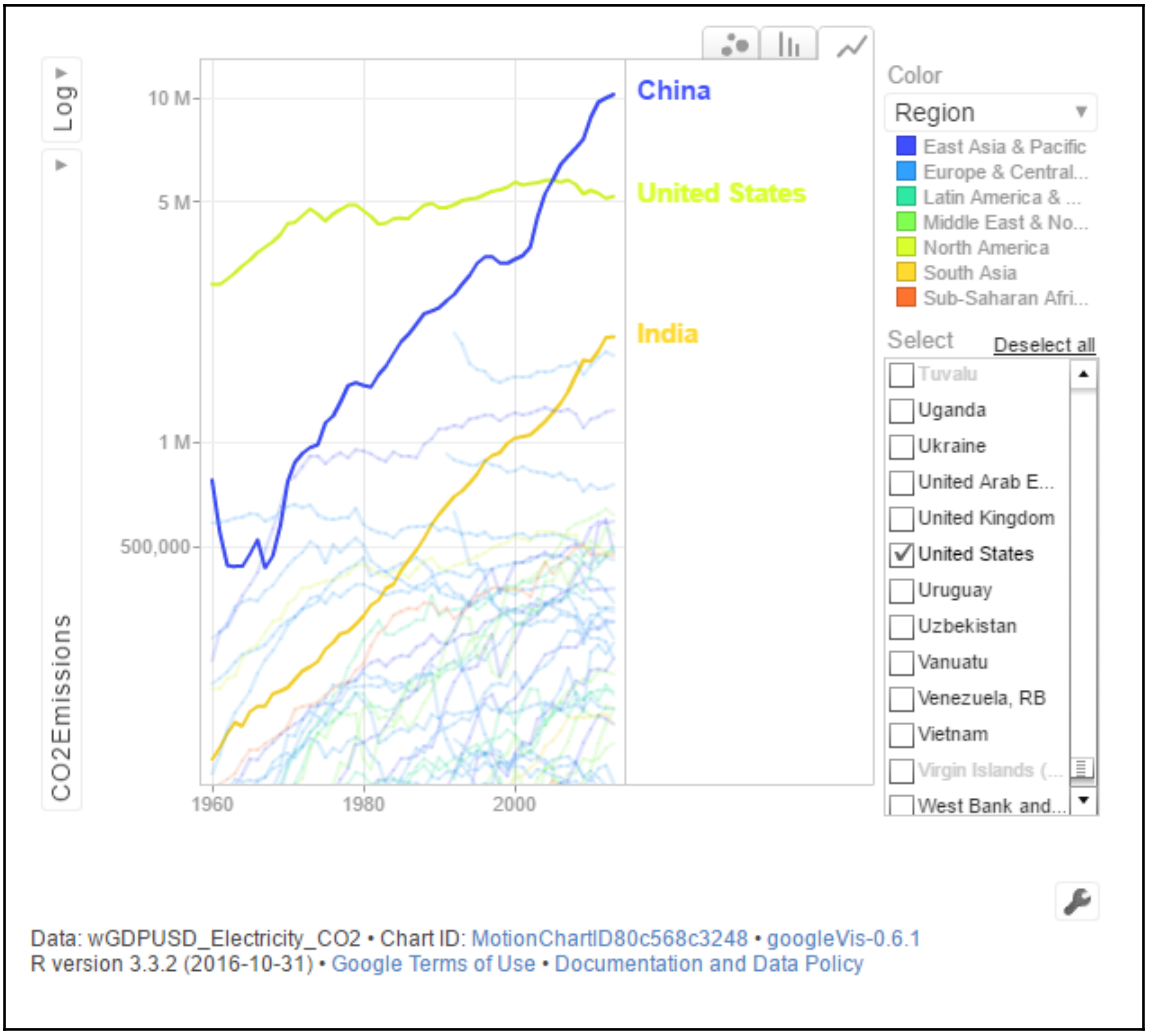
Data: wGDPUSD_Electricity_CO2 • Chart ID: MotionChartID80c568c3248 • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy



Data: wGDPUSD_Electricity_CO2 • Chart ID: MotionChartID80c568c3248 • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy



Data: wGDPUSD_Electricity_CO2 • Chart ID: MotionChartID80c568c3248 • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy



Data: wGDPUSD_Electricity_CO2 • Chart ID: MotionChartID80c568c3248 • googleVis-0.6.1
R version 3.3.2 (2016-10-31) • Google Terms of Use • Documentation and Data Policy

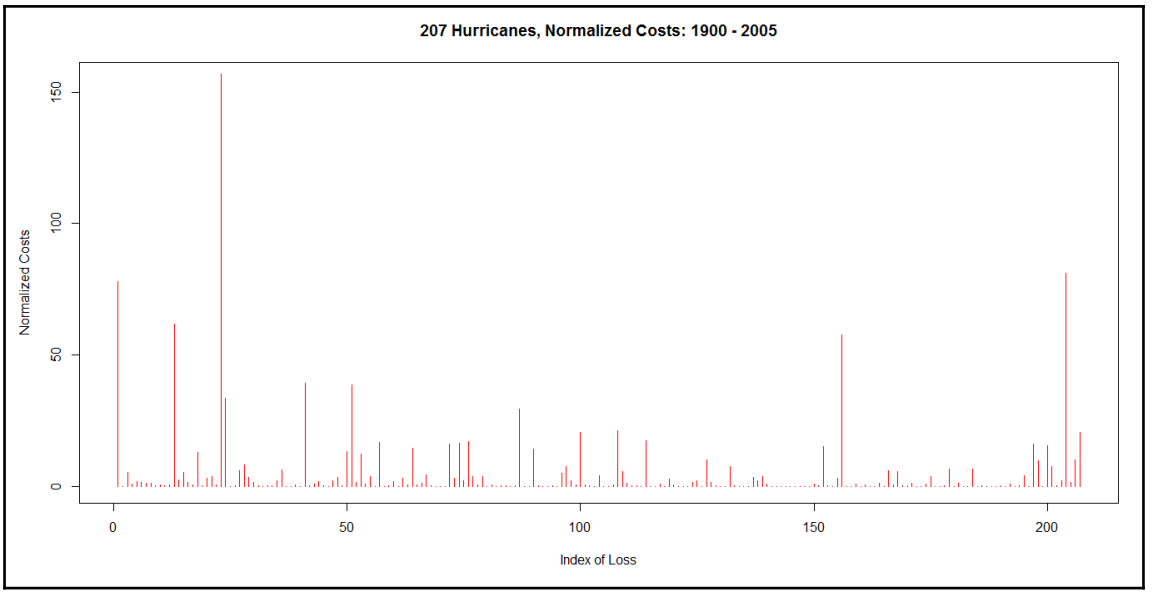
Chapter 13: Case Study - Pricing Reinsurance Contracts

	Year	Hurricane.Description	State	Category	Base.Economic.Damage	Normalized.PL05	Normalized.CL05	X	X.1
1	1900	Galveston (1)	TX	4	30,000,000	77,961,217,075	71,883,312,422	NA	NA
2	1901	4	LA,MS	1	1,000,000	160,419,111	194,228,565	NA	NA
3	1903	3	FL	1	700,000	5,233,590,783	4,205,750,228	NA	NA
4	1904	2	SC	1	2,000,000	884,746,945	1,521,808,490	NA	NA
5	1906	5	AL,MS	2	4,000,000	1,781,764,478	2,013,732,631	NA	NA
6	1906	8	FL	3	200,000	1,449,580,271	1,180,430,774	NA	NA

	Year	Hurricane.Description	State	Category	Base.Economic.Damage	Normalized.PL05	Normalized.CL05	X	X.1
202	2005	Cindy	LA	1	320,000,000	320,000,000	320,000,000	NA	NA
203	2005	Dennis	FL	3	2,230,000,000	2,230,000,000	2,230,000,000	NA	NA
204	2005	Katrina	LA,MS	3	81,000,000,000	81,000,000,000	81,000,000,000	NA	NA
205	2005	Ophelia	NC	1	1,600,000,000	1,600,000,000	1,600,000,000	NA	NA
206	2005	Rita	TX	3	10,000,000,000	10,000,000,000	10,000,000,000	NA	NA
207	2005	Wilma	FL	3	20,600,000,000	20,600,000,000	20,600,000,000	NA	NA

```
[1] 207   9
```

	Year	Hurricane.Description	State	Category	Base.Economic.Damage	Normalized.PL05	Normalized.CL05
1	1900	Galveston (1)	TX	4	3e+07	77961217075	71883312422
2	1901	4	LA,MS	1	1e+06	160419111	194228565
3	1903	3	FL	1	7e+05	5233590783	4205750228
4	1904	2	SC	1	2e+06	884746945	1521808490
5	1906	5	AL,MS	2	4e+06	1781764478	2013732631
6	1906	8	FL	3	2e+05	1449580271	1180430774



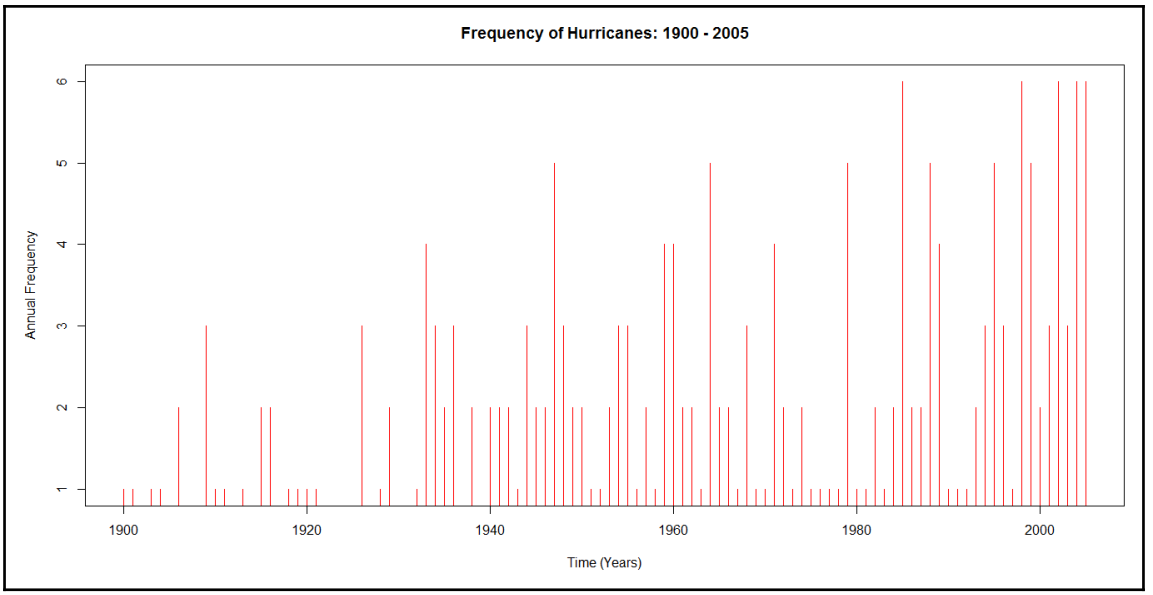

```
1900 1901 1903 1904 1906 1909 1910 1911 1913 1915 1916 1918 1919 1920 1921 1926 1928 1929 1932 1933 1934 1935 1936 1938 1940 1941 1942
   1    1    1    1    2    3    1    1    1    2    2    1    1    1    1    3    1    2    1    4    3    2    3    2    2    2    2
1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969
   1    3    2    2    5    3    2    2    1    1    2    3    3    1    2    1    4    4    2    2    1    5    2    2    1    3    1
1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996
   1    4    2    1    2    1    1    1    1    5    1    1    2    1    2    6    2    2    5    4    1    1    1    2    3    5    3
1997 1998 1999 2000 2001 2002 2003 2004 2005
   1    6    5    2    3    6    3    6    6
```

```
 [1] 1900 1901 1903 1904 1906 1909 1910 1911 1913 1915 1916 1918 1919 1920 1921 1926 1928 1929 1932 1933 1934 1935 1936 1938 1940 1941
[27] 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967
[53] 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993
[79] 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
```

```
 [1] 1900 1901 1903 1904 1906 1909 1910 1911 1913 1915 1916 1918 1919 1920 1921 1926 1928 1929 1932 1933 1934 1935 1936 1938 1940 1941
[27] 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967
[53] 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993
[79] 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
```

```
[1] 1902 1905 1907 1908 1912 1914 1917 1922 1923 1924 1925 1927 1930 1931 1937 1939
```

	years	frequency
1	1900	1
2	1901	1
3	1903	1
4	1904	1
5	1906	2
6	1909	3




```
[1] 1.95283
```

```
Call:  glm(formula = frequency ~ years, family = poisson(link = "identity"),
    data = StormDamageData, start = lm(frequency ~ years, data = StormDamageData)$coefficients)

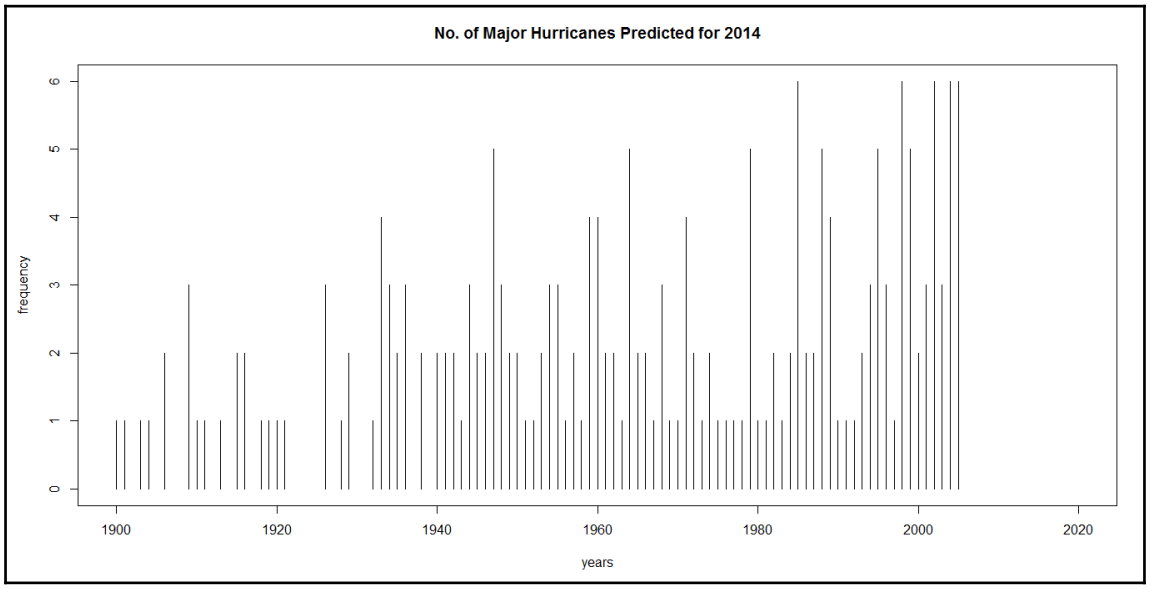
Coefficients:
(Intercept)        years
  -48.69248      0.02594

Degrees of Freedom: 105 Total (i.e. Null);  104 Residual
Null Deviance:      143
Residual Deviance: 105.1        AIC: 342
```

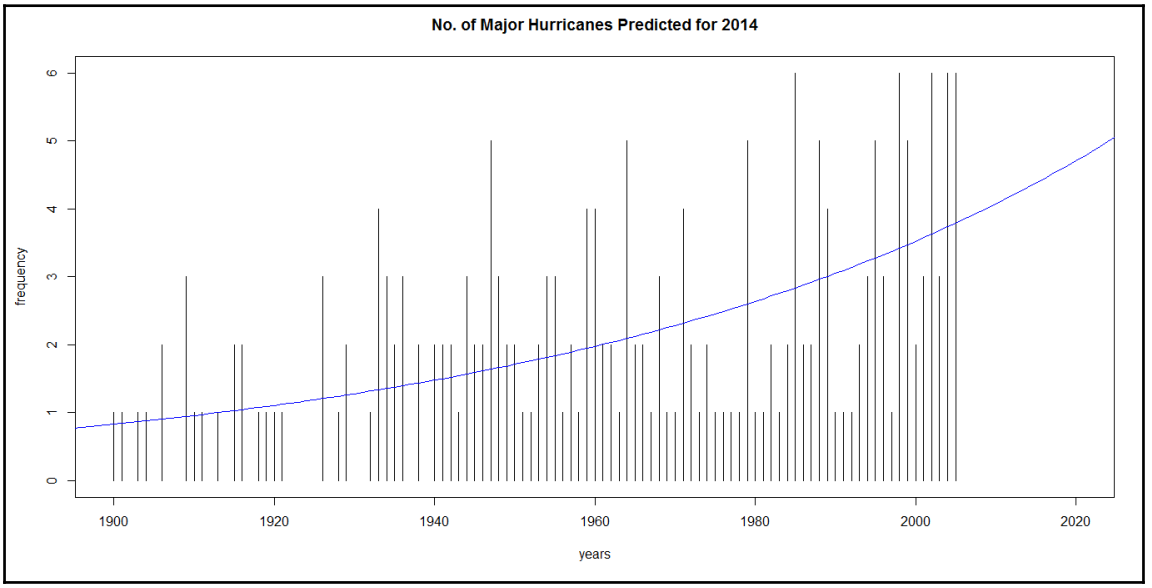
```
Call:  glm(formula = frequency ~ years, family = poisson(link = "log"),
    data = StormDamageData)

Coefficients:
(Intercept)        years
  -27.66036      0.01446

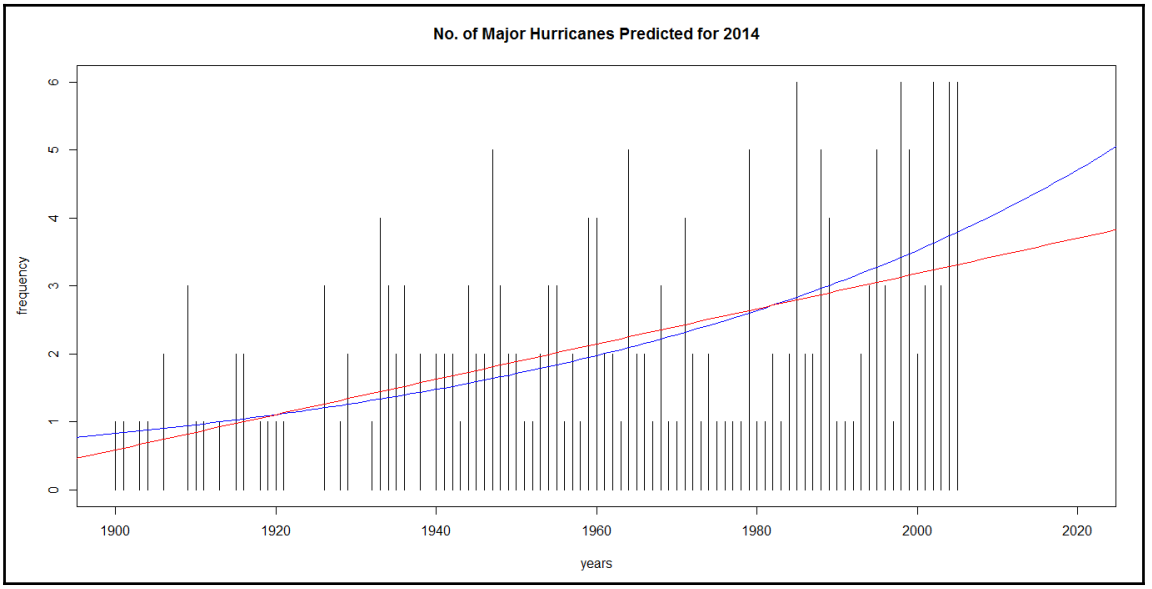
Degrees of Freedom: 105 Total (i.e. Null);  104 Residual
Null Deviance:      143
Residual Deviance: 104.7        AIC: 341.7
```

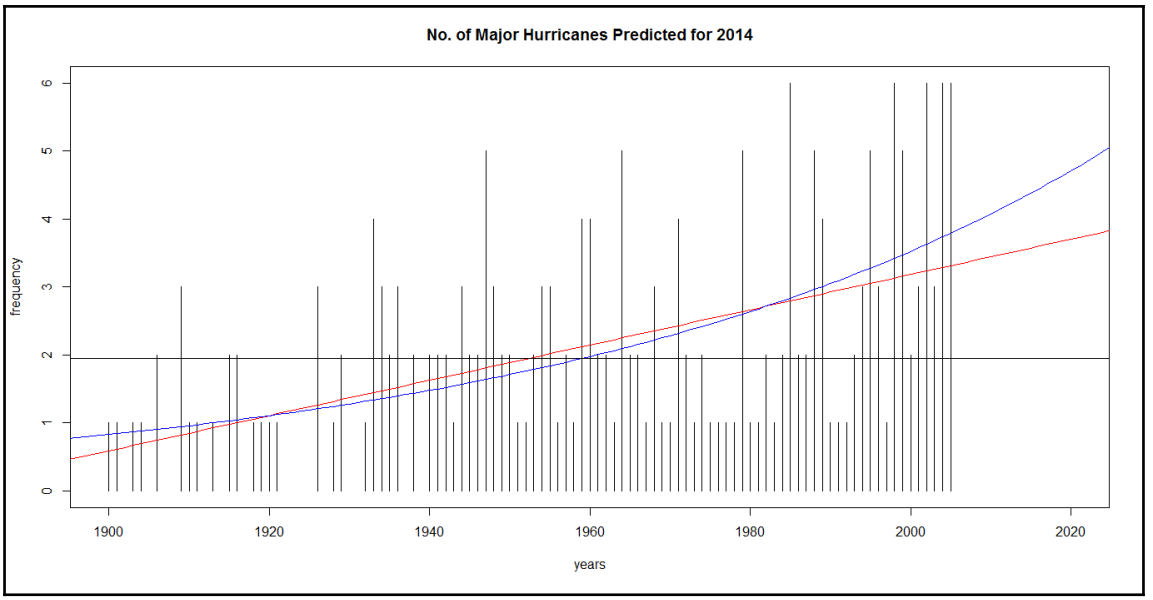


1	2	3	4	5	6	7	8	9	10	11
0.7185495	0.7290154	0.7396337	0.7504067	0.7613365	0.7724256	0.7836762	0.7950907	0.8066714	0.8184208	0.8303413
12	13	14	15	16	17	18	19	20	21	22
0.8424355	0.8547058	0.8671549	0.8797852	0.8925995	0.9056005	0.9187908	0.9321733	0.9457507	0.9595258	0.9735015
23	24	25	26	27	28	29	30	31	32	33
0.9876809	1.0020667	1.0166621	1.0314701	1.0464937	1.0617362	1.0772007	1.0928905	1.1088087	1.1249588	1.1413442
34	35	36	37	38	39	40	41	42	43	44
1.1579682	1.1748343	1.1919461	1.2093072	1.2269211	1.2447915	1.2629223	1.2813171	1.2999798	1.3189144	1.3381248
45	46	47	48	49	50	51	52	53	54	55
1.3576149	1.3773890	1.3974511	1.4178053	1.4384561	1.4594076	1.4806643	1.5022306	1.5241110	1.5463101	1.5688326
56	57	58	59	60	61	62	63	64	65	66
1.5916830	1.6148664	1.6383874	1.6622509	1.6864621	1.7110259	1.7359475	1.7612320	1.7868849	1.8129114	1.8393170
67	68	69	70	71	72	73	74	75	76	77
1.8661071	1.8932875	1.9208638	1.9488417	1.9772272	2.0060260	2.0352444	2.0648883	2.0949640	2.1254777	2.1564359
78	79	80	81	82	83	84	85	86	87	88
2.1878450	2.2197116	2.2520423	2.2848440	2.3181234	2.3518875	2.3861434	2.4208983	2.4561594	2.4919340	2.5282298
89	90	91	92	93	94	95	96	97	98	99
2.5650541	2.6024149	2.6403198	2.6787768	2.7177940	2.7573794	2.7975414	2.8382884	2.8796289	2.9215715	2.9641250
100	101	102	103	104	105	106	107	108	109	110
3.0072984	3.0511005	3.0955407	3.1406281	3.1863723	3.2327827	3.2798691	3.3276413	3.3761094	3.4252833	3.4751736
111	112	113	114	115	116	117	118	119	120	121
3.5257905	3.5771446	3.6292468	3.6821078	3.7357387	3.7901508	3.8453554	3.9013641	3.9581886	4.0158408	4.0743326
122	123	124	125	126	127	128	129	130	131	132
4.1336765	4.1938846	4.2549698	4.3169446	4.3798221	4.4436155	4.5083380	4.5740033	4.6406249	4.7082170	4.7767935
133	134	135	136	137	138	139	140	141		
4.8463688	4.9169576	4.9885745	5.0612345	5.1349528	5.2097449	5.2856263	5.3626129	5.4407209		

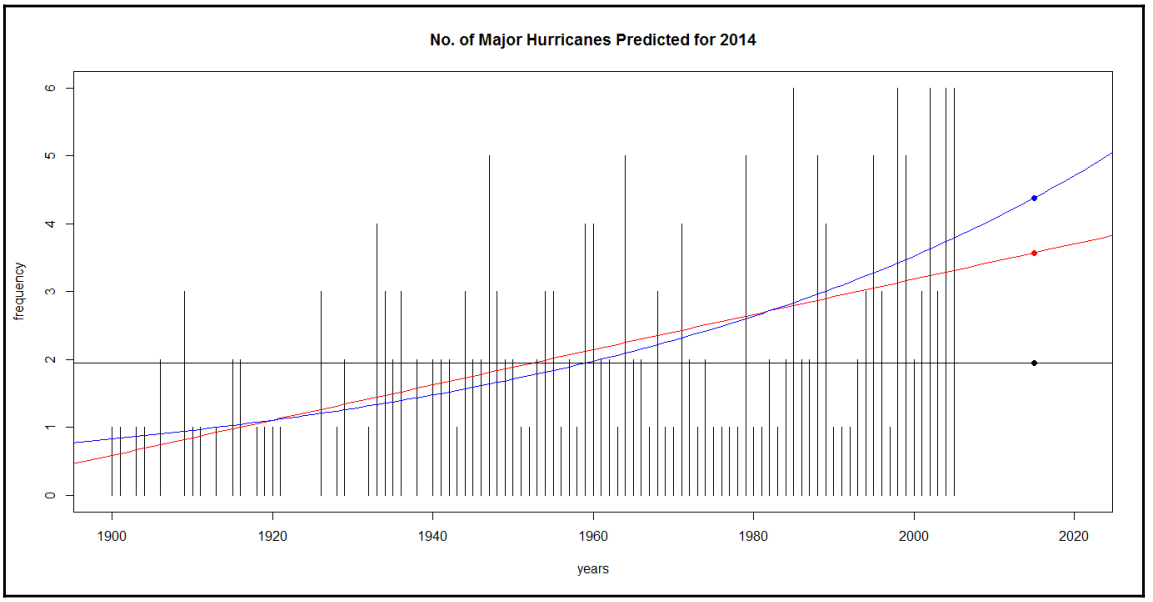


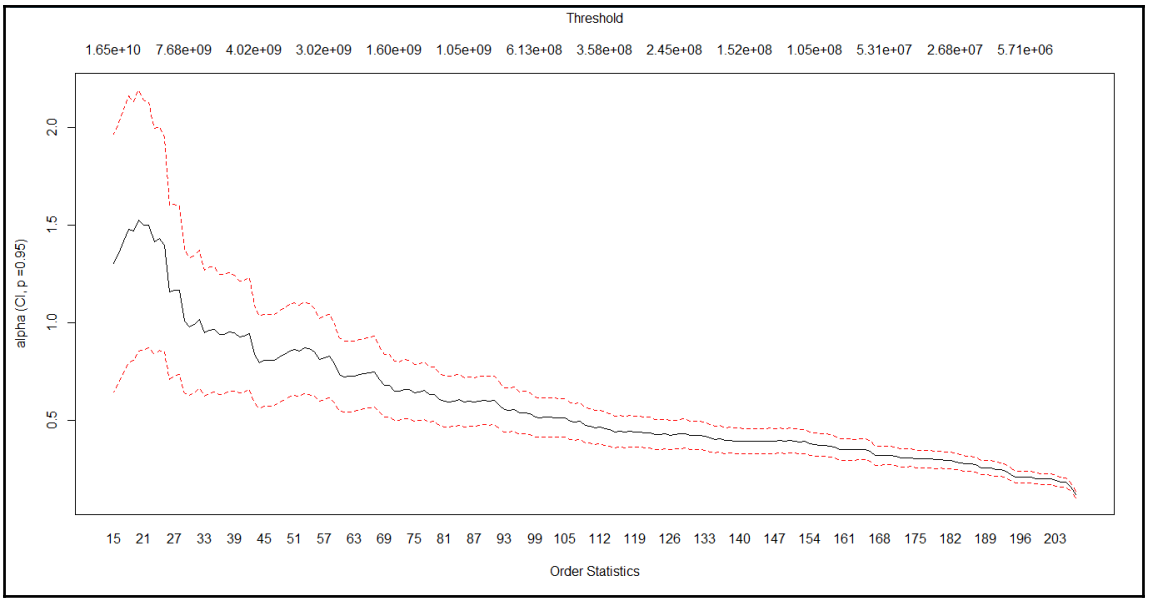
1	2	3	4	5	6	7	8	9	10	11
0.3316616	0.3576003	0.3835390	0.4094777	0.4354164	0.4613551	0.4872938	0.5132325	0.5391711	0.5651098	0.5910485
12	13	14	15	16	17	18	19	20	21	22
0.6169872	0.6429259	0.6688646	0.6948033	0.7207420	0.7466807	0.7726194	0.7985581	0.8244968	0.8504355	0.8763742
23	24	25	26	27	28	29	30	31	32	33
0.9023129	0.9282516	0.9541903	0.9801290	1.0060677	1.0320064	1.0579451	1.0838838	1.1098225	1.1357612	1.1616999
34	35	36	37	38	39	40	41	42	43	44
1.1876386	1.2135773	1.2395160	1.2654547	1.2913934	1.3173321	1.3432708	1.3692095	1.3951482	1.4210869	1.4470256
45	46	47	48	49	50	51	52	53	54	55
1.4729643	1.4989030	1.5248417	1.5507804	1.5767191	1.6026578	1.6285965	1.6545352	1.6804739	1.7064126	1.7323513
56	57	58	59	60	61	62	63	64	65	66
1.7582900	1.7842287	1.8101673	1.8361060	1.8620447	1.8879834	1.9139221	1.9398608	1.9657995	1.9917382	2.0176769
67	68	69	70	71	72	73	74	75	76	77
2.0436156	2.0695543	2.0954930	2.1214317	2.1473704	2.1733091	2.1992478	2.2251865	2.2511252	2.2770639	2.3030026
78	79	80	81	82	83	84	85	86	87	88
2.3289413	2.3548800	2.3808187	2.4067574	2.4326961	2.4586348	2.4845735	2.5105122	2.5364509	2.5623896	2.5883283
89	90	91	92	93	94	95	96	97	98	99
2.6142670	2.6402057	2.6661444	2.6920831	2.7180218	2.7439605	2.7698992	2.7958379	2.8217766	2.8477153	2.8736540
100	101	102	103	104	105	106	107	108	109	110
2.8995927	2.9255314	2.9514701	2.9774088	3.0033475	3.0292862	3.0552249	3.0811636	3.1071022	3.1330409	3.1589796
111	112	113	114	115	116	117	118	119	120	121
3.1849183	3.2108570	3.2367957	3.2627344	3.2886731	3.3146118	3.3405505	3.3664892	3.3924279	3.4183666	3.4443053
122	123	124	125	126	127	128	129	130	131	132
3.4702440	3.4961827	3.5221214	3.5480601	3.5739988	3.5999375	3.6258762	3.6518149	3.6777536	3.7036923	3.7296310
133	134	135	136	137	138	139	140	141		
3.7555697	3.7815084	3.8074471	3.8333858	3.8593245	3.8852632	3.9112019	3.9371406	3.9630793		





	constant	linear	exponential
126	1.95283	3.573999	4.379822






```
        xi       beta
0.4424669 0.6705315
```

```
[1] 0.1256039
```

```
[1] 1.95283
```

```
[1] 0.1256039
```

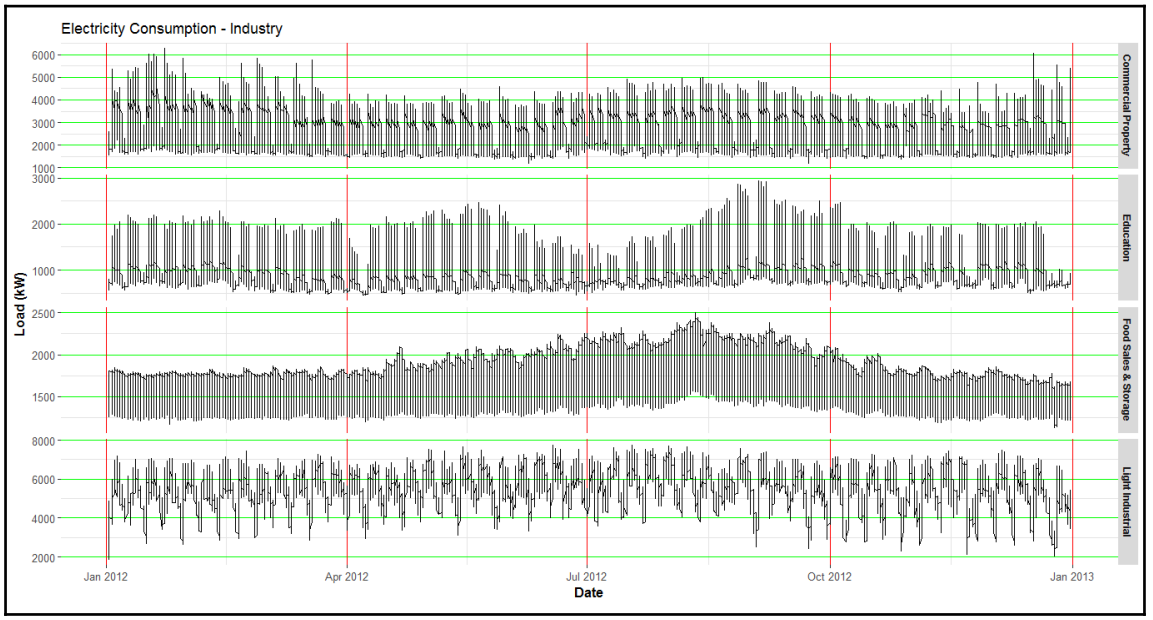
```
[1] 330.9865
```

```
[1] 81.18538
```

Chapter 14: Case Study - Forecast of Electricity Consumption

```
classes 'data.table' and 'data.frame':  70080 obs. of  5 variables:
 $ date_time: POSIXct, format: "2012-01-02 00:00:00" "2012-01-02 00:30:00" "2012-01-02 01:00:00" "2012-01-02 01:30:00"
...
 $ value    : num  1590 1564 1560 1585 1604 ...
 $ week     : chr  "Monday" "Monday" "Monday" "Monday" ...
 $ date     : Date, format: "2012-01-02" "2012-01-02" "2012-01-02" "2012-01-02" ...
 $ type     : chr  "Commercial Property" "Commercial Property" "Commercial Property" "Commercial Property" ...
 - attr(*, ".internal.selfref")=<externalptr>
```

	date_time	value	week	date	type
1:	2012-01-02 00:00:00	1590.210	Monday	2012-01-02	Commercial Property
2:	2012-01-02 00:30:00	1563.772	Monday	2012-01-02	Commercial Property
3:	2012-01-02 01:00:00	1559.914	Monday	2012-01-02	Commercial Property
4:	2012-01-02 01:30:00	1584.671	Monday	2012-01-02	Commercial Property
5:	2012-01-02 02:00:00	1604.281	Monday	2012-01-02	Commercial Property
6:	2012-01-02 02:30:00	1566.582	Monday	2012-01-02	Commercial Property

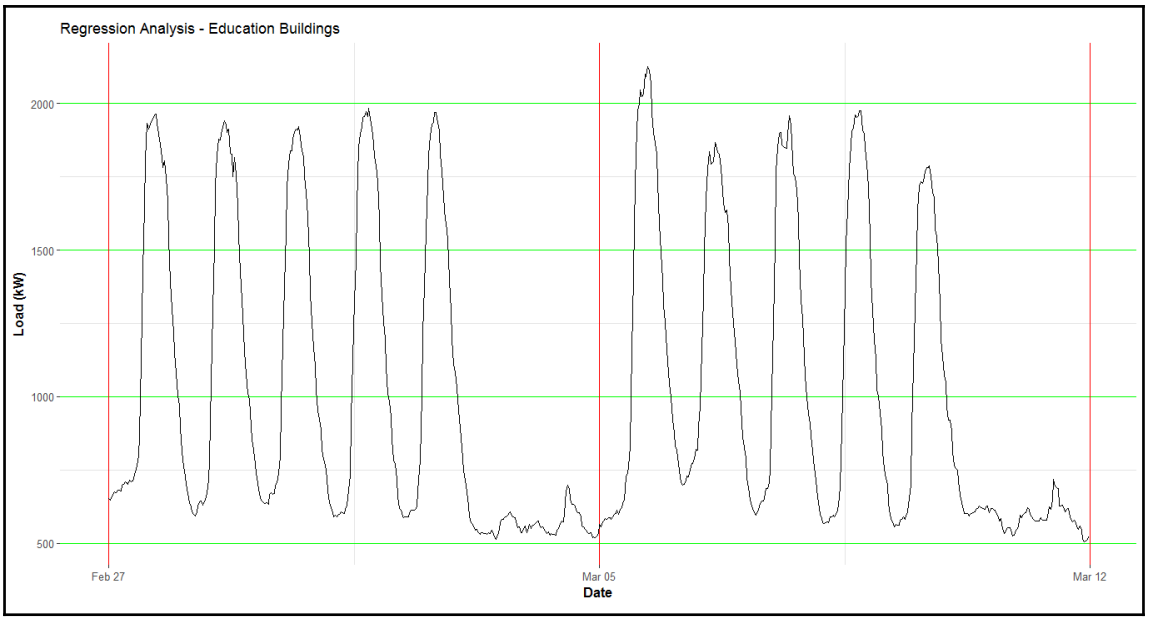


```
                date_time    value   week       date                type
     1: 2012-01-02 00:00:00 1590.210 Monday 2012-01-02 Commercial Property
     2: 2012-01-02 00:30:00 1563.772 Monday 2012-01-02 Commercial Property
     3: 2012-01-02 01:00:00 1559.914 Monday 2012-01-02 Commercial Property
     4: 2012-01-02 01:30:00 1584.671 Monday 2012-01-02 Commercial Property
     5: 2012-01-02 02:00:00 1604.281 Monday 2012-01-02 Commercial Property
    ---
 70076: 2012-12-31 21:30:00 3548.279 Monday 2012-12-31    Light Industrial
 70077: 2012-12-31 22:00:00 3488.161 Monday 2012-12-31    Light Industrial
 70078: 2012-12-31 22:30:00 3510.200 Monday 2012-12-31    Light Industrial
 70079: 2012-12-31 23:00:00 3533.678 Monday 2012-12-31    Light Industrial
 70080: 2012-12-31 23:30:00 3414.966 Monday 2012-12-31    Light Industrial
```

```
                date_time    value   week       date                type week_num
     1: 2012-01-02 00:00:00 1590.210 Monday 2012-01-02 Commercial Property        2
     2: 2012-01-02 00:30:00 1563.772 Monday 2012-01-02 Commercial Property        2
     3: 2012-01-02 01:00:00 1559.914 Monday 2012-01-02 Commercial Property        2
     4: 2012-01-02 01:30:00 1584.671 Monday 2012-01-02 Commercial Property        2
     5: 2012-01-02 02:00:00 1604.281 Monday 2012-01-02 Commercial Property        2
    ---
 70076: 2012-12-31 21:30:00 3548.279 Monday 2012-12-31    Light Industrial        2
 70077: 2012-12-31 22:00:00 3488.161 Monday 2012-12-31    Light Industrial        2
 70078: 2012-12-31 22:30:00 3510.200 Monday 2012-12-31    Light Industrial        2
 70079: 2012-12-31 23:00:00 3533.678 Monday 2012-12-31    Light Industrial        2
 70080: 2012-12-31 23:30:00 3414.966 Monday 2012-12-31    Light Industrial        2
```

```
[1] "Commercial Property"  "Education"            "Food Sales & Storage" "Light Industrial"
```

```
                date_time    value   week       date      type week_num
   1: 2012-02-27 00:00:00 652.0693 Monday 2012-02-27 Education        2
   2: 2012-02-27 00:30:00 646.6226 Monday 2012-02-27 Education        2
   3: 2012-02-27 01:00:00 658.3790 Monday 2012-02-27 Education        2
   4: 2012-02-27 01:30:00 669.0898 Monday 2012-02-27 Education        2
   5: 2012-02-27 02:00:00 675.9707 Monday 2012-02-27 Education        2
  ---
 668: 2012-03-11 21:30:00 514.5865 Sunday 2012-03-11 Education        4
 669: 2012-03-11 22:00:00 505.0426 Sunday 2012-03-11 Education        4
 670: 2012-03-11 22:30:00 508.6684 Sunday 2012-03-11 Education        4
 671: 2012-03-11 23:00:00 511.6602 Sunday 2012-03-11 Education        4
 672: 2012-03-11 23:30:00 522.0277 Sunday 2012-03-11 Education        4
```



	Load	Daily	Weekly
1:	652.0693	1	2
2:	646.6226	2	2
3:	658.3790	3	2
4:	669.0898	4	2
5:	675.9707	5	2

668:	514.5865	44	4
669:	505.0426	45	4
670:	508.6684	46	4
671:	511.6602	47	4
672:	522.0277	48	4

```
Call:
lm(formula = Load ~ 0 + ., data = matrix_train)

Coefficients:
  Daily1   Daily2   Daily3   Daily4   Daily5   Daily6   Daily7   Daily8   Daily9  Daily10  Daily11  Daily12
  964.46   925.54   874.87   842.27   821.33   799.04   767.56   737.28   722.42   715.04   708.85   709.57
Daily13  Daily14  Daily15  Daily16  Daily17  Daily18  Daily19  Daily20  Daily21  Daily22  Daily23  Daily24
  712.85   712.02   724.55   729.16   729.94   732.19   750.64   760.74   798.12   839.97  1006.45  1171.81
Daily25  Daily26  Daily27  Daily28  Daily29  Daily30  Daily31  Daily32  Daily33  Daily34  Daily35  Daily36
 1319.01  1458.93  1555.40  1603.95  1623.88  1628.66  1637.48  1658.36  1657.23  1653.48  1654.59  1623.13
Daily37  Daily38  Daily39  Daily40  Daily41  Daily42  Daily43  Daily44  Daily45  Daily46  Daily47  Daily48
 1573.42  1540.26  1514.78  1487.84  1427.99  1334.33  1239.45  1172.62  1108.44  1073.54  1013.76   973.76
Weekly2  Weekly3  Weekly4  Weekly5  Weekly6  Weekly7
  100.99  -516.80  -539.96    54.58    86.11    61.52
```

```
Call:
lm(formula = Load ~ 0 + ., data = matrix_train)

Residuals:
    Min      1Q  Median      3Q     Max
-561.87 -149.34  -15.13  181.13  477.75

Coefficients:
        Estimate Std. Error t value Pr(>|t|)
Daily1    964.46      71.40  13.508  < 2e-16 ***
Daily2    925.54      71.40  12.963  < 2e-16 ***
Daily3    874.87      71.40  12.253  < 2e-16 ***
Daily4    842.27      71.40  11.797  < 2e-16 ***
Daily5    821.33      71.40  11.503  < 2e-16 ***
Daily6    799.04      71.40  11.191  < 2e-16 ***
Daily7    767.56      71.40  10.750  < 2e-16 ***
Daily8    737.28      71.40  10.326  < 2e-16 ***
Daily9    722.42      71.40  10.118  < 2e-16 ***
Daily10   715.04      71.40  10.015  < 2e-16 ***
Daily11   708.85      71.40   9.928  < 2e-16 ***
Daily12   709.57      71.40   9.938  < 2e-16 ***
Daily13   712.85      71.40   9.984  < 2e-16 ***
Daily14   712.02      71.40   9.972  < 2e-16 ***
Daily15   724.55      71.40  10.148  < 2e-16 ***
Daily16   729.16      71.40  10.212  < 2e-16 ***
Daily17   729.94      71.40  10.223  < 2e-16 ***
Daily18   732.19      71.40  10.255  < 2e-16 ***
Daily19   750.64      71.40  10.513  < 2e-16 ***
Daily20   760.74      71.40  10.655  < 2e-16 ***
Daily21   798.12      71.40  11.178  < 2e-16 ***
Daily22   839.97      71.40  11.764  < 2e-16 ***
Daily23  1006.45      71.40  14.096  < 2e-16 ***
Daily24  1171.81      71.40  16.412  < 2e-16 ***
```

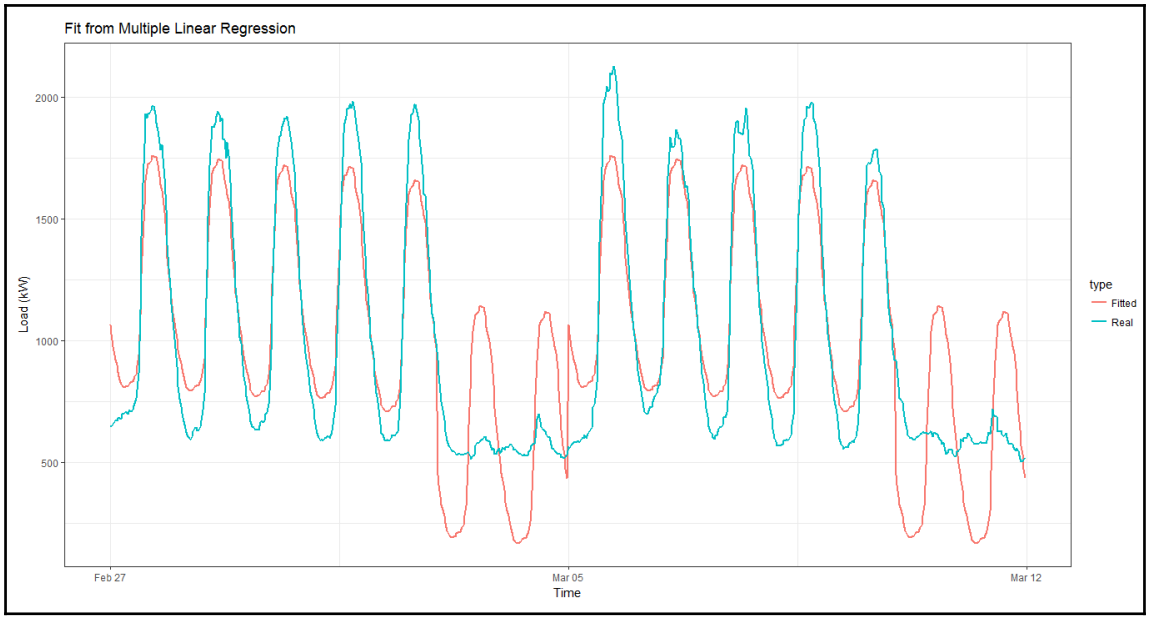
```
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

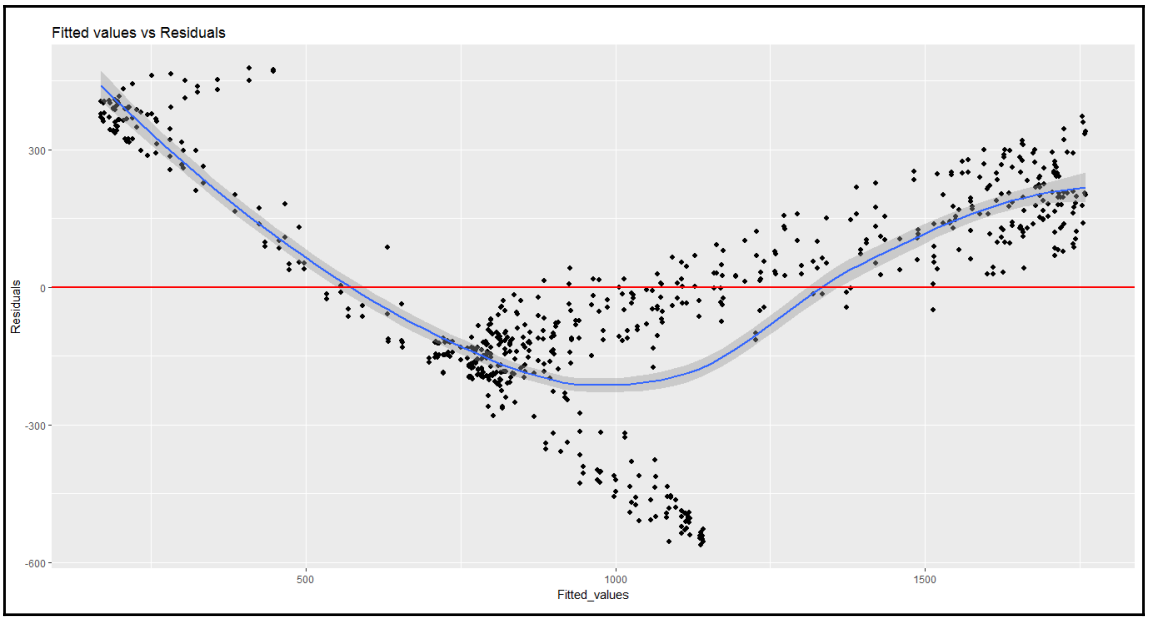
Residual standard error: 251.9 on 618 degrees of freedom
Multiple R-squared:  0.9547,    Adjusted R-squared:  0.9508
F-statistic: 241.3 on 54 and 618 DF,  p-value: < 2.2e-16
```

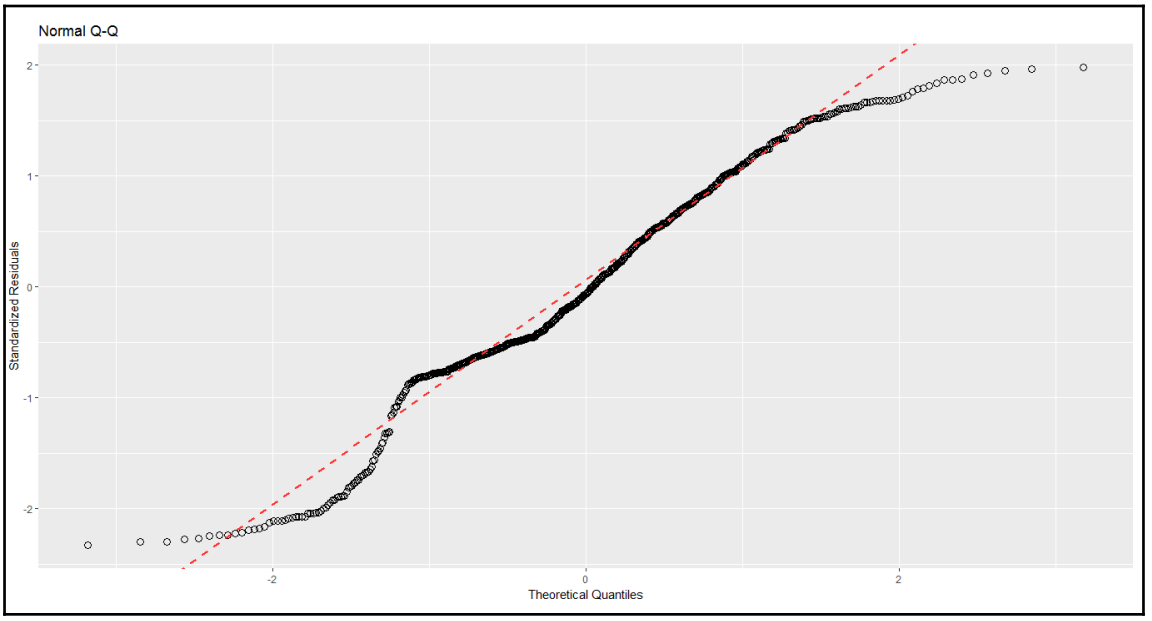
```
[1] "R-squared:  0.955 , p-value of F test:  0"
```

	value	date_time
1:	652.0693	2012-02-27 00:00:00
2:	646.6226	2012-02-27 00:30:00
3:	658.3790	2012-02-27 01:00:00
4:	669.0898	2012-02-27 01:30:00
5:	675.9707	2012-02-27 02:00:00

1340:	632.6548	2012-03-11 21:30:00
1341:	568.4755	2012-03-11 22:00:00
1342:	533.5817	2012-03-11 22:30:00
1343:	473.8017	2012-03-11 23:00:00
1344:	433.7951	2012-03-11 23:30:00




Fitted values vs Residuals
Residuals
300
0
-300
-600
500
1000
1500
Fitted_values

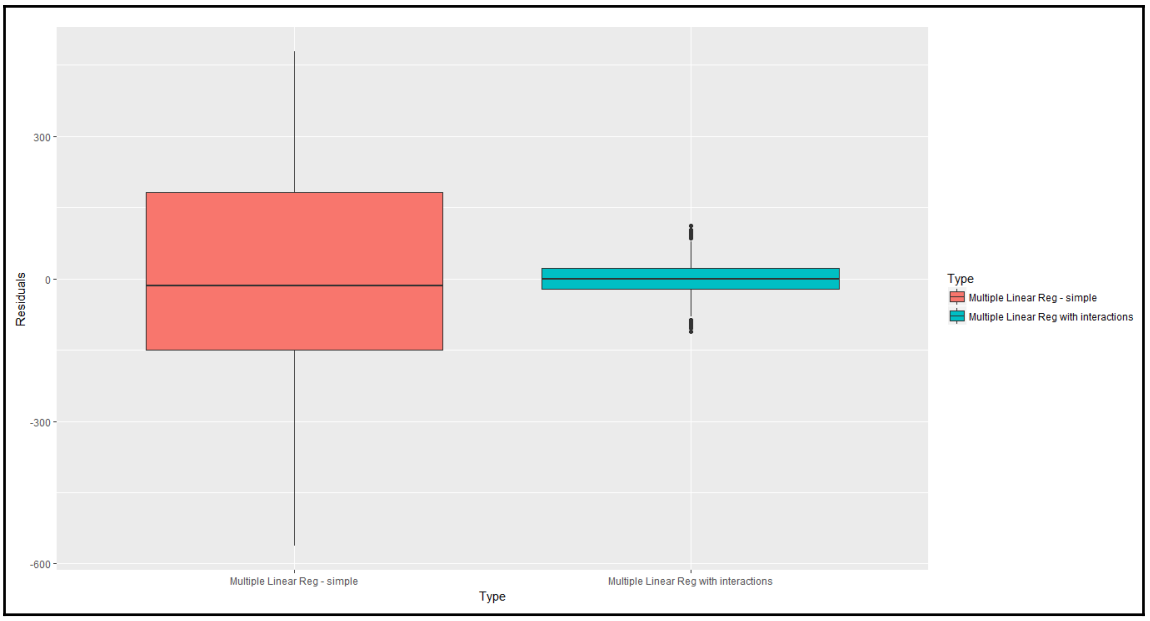

Normal Q-Q
Standardized Residuals
2
1
0
-1
-2
-2
0
2
Theoretical Quantiles

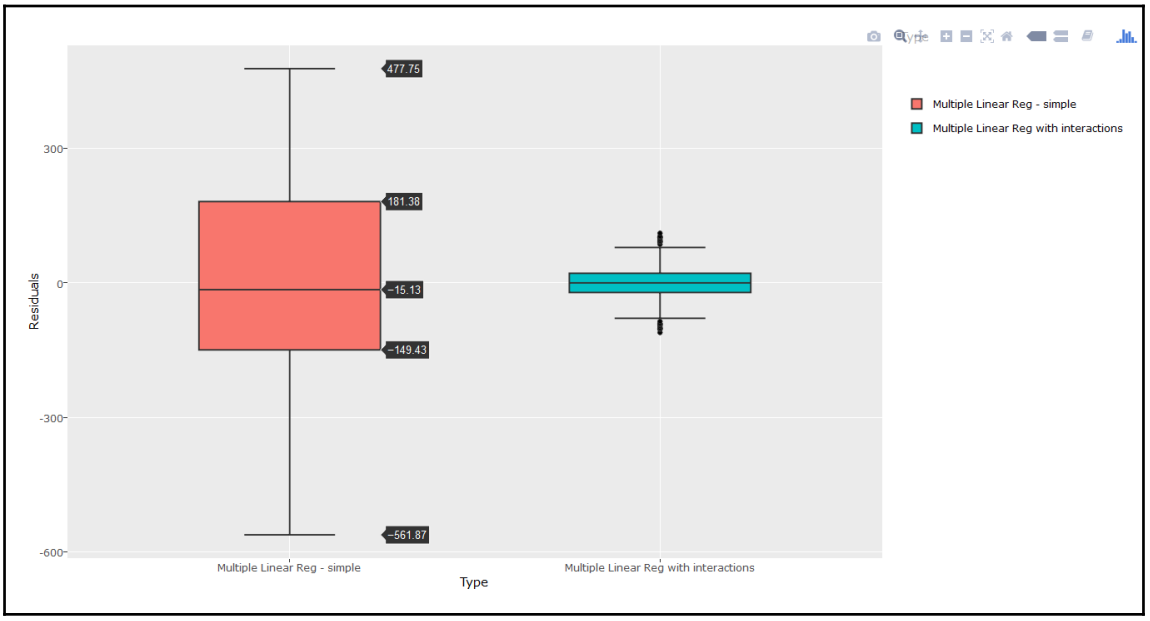
```
Call:
lm(formula = Load ~ 0 + Daily + Weekly + Daily:Weekly, data = matrix_train)

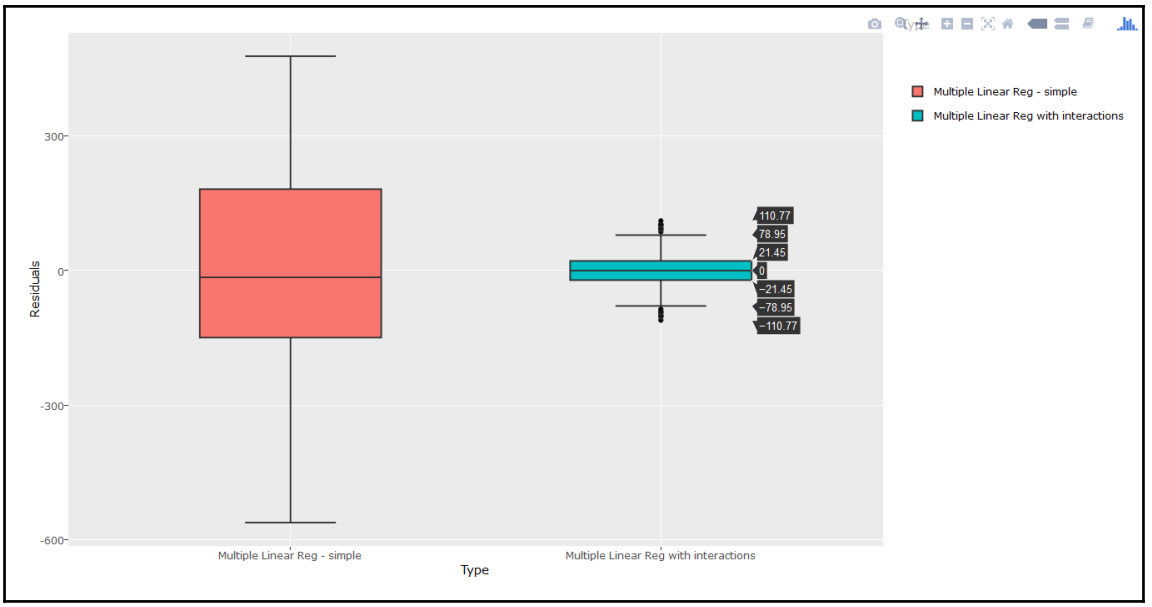
Coefficients:
```

Daily1	Daily2	Daily3	Daily4	Daily5	Daily6	Daily7
963.6868	910.1281	832.4827	767.9888	746.0964	709.4052	646.7310
Daily8	Daily9	Daily10	Daily11	Daily12	Daily13	Daily14
607.0952	593.1229	579.3818	571.4749	577.7818	575.1910	576.0727
Daily15	Daily16	Daily17	Daily18	Daily19	Daily20	Daily21
590.8817	596.6877	599.9783	596.8332	605.5058	617.2628	685.2319
Daily22	Daily23	Daily24	Daily25	Daily26	Daily27	Daily28
742.3322	951.7756	1158.7365	1339.7397	1530.8187	1680.5525	1772.6732
Daily29	Daily30	Daily31	Daily32	Daily33	Daily34	Daily35
1812.0905	1827.8779	1834.1506	1869.0104	1875.9046	1860.0126	1846.6024
Daily36	Daily37	Daily38	Daily39	Daily40	Daily41	Daily42
1789.6251	1731.6673	1682.2293	1586.0122	1571.6402	1496.8899	1358.2929
Daily43	Daily44	Daily45	Daily46	Daily47	Daily48	Weekly2
1245.7848	1166.1215	1091.9825	1066.7010	997.4765	955.2032	-355.3522
Weekly3	Weekly4	Weekly5	Weekly6	Weekly7	Daily2:Weekly2	Daily3:Weekly2
-42.9479	-383.8207	-47.4477	43.1739	38.2679	46.9318	138.6611
Daily4:Weekly2	Daily5:Weekly2	Daily6:Weekly2	Daily7:Weekly2	Daily8:Weekly2	Daily9:Weekly2	Daily10:Weekly2
211.0272	238.7233	273.2973	342.3193	382.9568	393.0218	420.0024
Daily11:Weekly2	Daily12:Weekly2	Daily13:Weekly2	Daily14:Weekly2	Daily15:Weekly2	Daily16:Weekly2	Daily17:Weekly2
433.0777	432.5059	439.6293	428.7760	429.8100	424.0835	429.2114
Daily18:Weekly2	Daily19:Weekly2	Daily20:Weekly2	Daily21:Weekly2	Daily22:Weekly2	Daily23:Weekly2	Daily24:Weekly2
441.2555	483.8489	489.4588	450.5552	461.8552	547.1952	614.2202
Daily25:Weekly2	Daily26:Weekly2	Daily27:Weekly2	Daily28:Weekly2	Daily29:Weekly2	Daily30:Weekly2	Daily31:Weekly2
635.9273	645.8638	629.4519	538.6554	531.7929	506.9881	510.5959
Daily32:Weekly2	Daily33:Weekly2	Daily34:Weekly2	Daily35:Weekly2	Daily36:Weekly2	Daily37:Weekly2	Daily38:Weekly2
516.8237	507.8630	524.8920	514.2205	531.7239	513.5249	515.8282
Daily39:Weekly2	Daily40:Weekly2	Daily41:Weekly2	Daily42:Weekly2	Daily43:Weekly2	Daily44:Weekly2	Daily45:Weekly2
603.7991	572.5889	557.3761	561.1792	551.5947	539.1175	529.6320
Daily46:Weekly2	Daily47:Weekly2	Daily48:Weekly2	Daily2:Weekly3	Daily3:Weekly3	Daily4:Weekly3	Daily5:Weekly3
491.0887	477.7638	443.8735	5.5692	10.2973	32.1318	32.9816

Previous	New
0.9547247	0.9989725


300
0
-300
-600
Residuals
Multiple Linear Reg - simple
Multiple Linear Reg with interactions
Type
Type
Multiple Linear Reg - simple
Multiple Linear Reg with interactions


477.75
181.38
−15.13
−149.43
−561.87
300
0
-300
-600
Residuals
Multiple Linear Reg - simple
Multiple Linear Reg with interactions
Type
Multiple Linear Reg - simple
Multiple Linear Reg with interactions

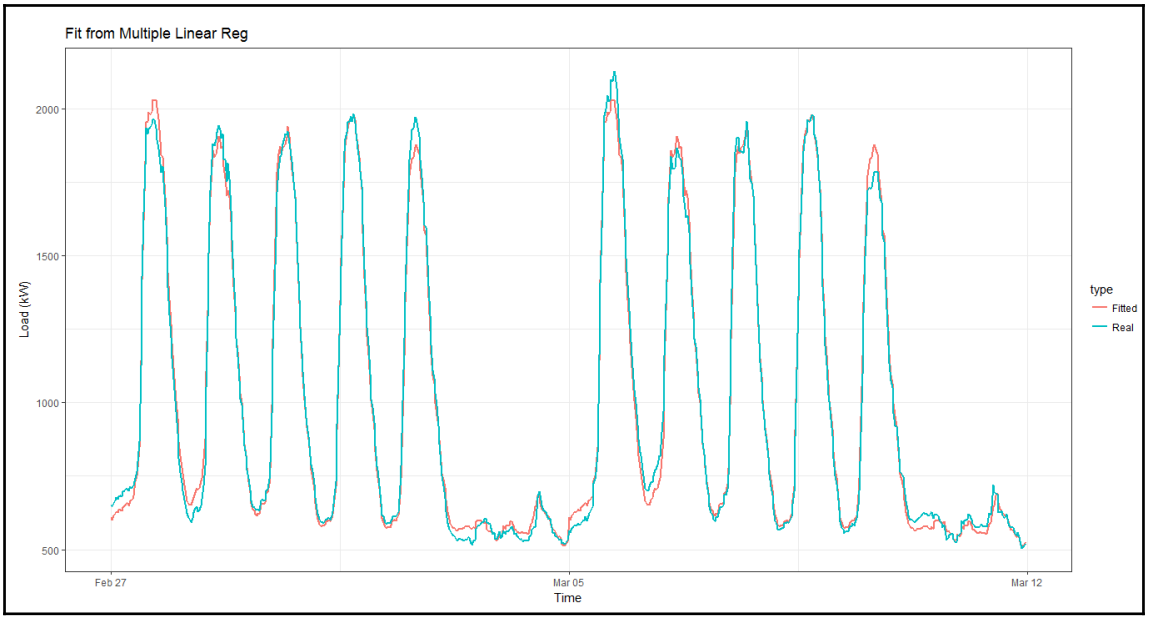


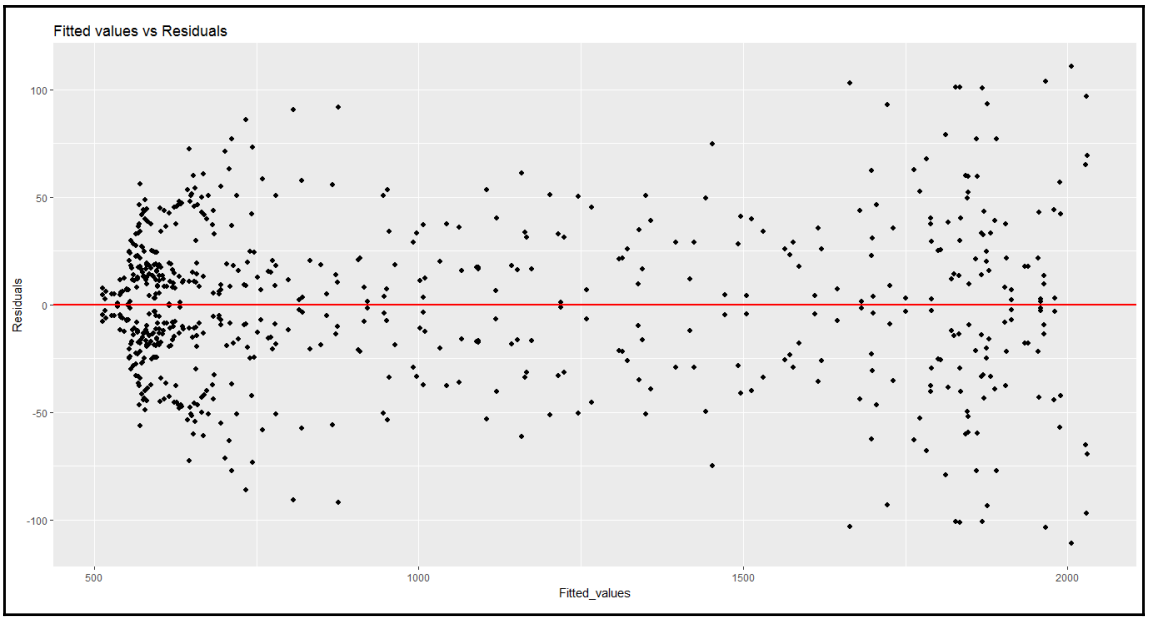
	value	date_time
1:	652.0693	2012-02-27 00:00:00
2:	646.6226	2012-02-27 00:30:00
3:	658.3790	2012-02-27 01:00:00
4:	669.0898	2012-02-27 01:30:00
5:	675.9707	2012-02-27 02:00:00

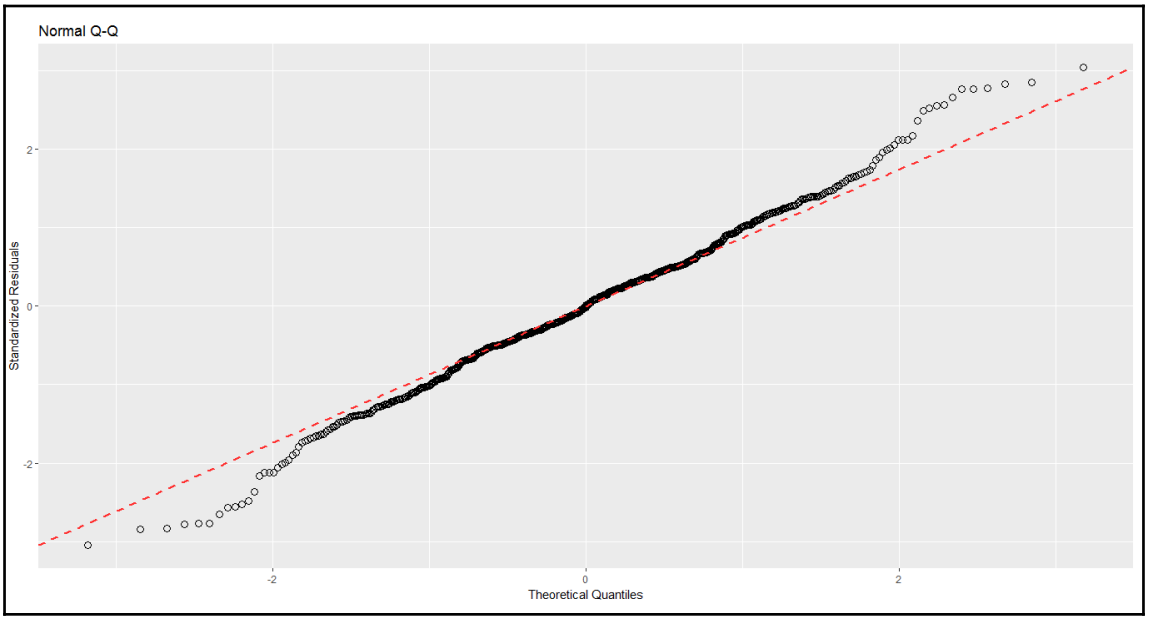
1340:	517.3413	2012-03-11 21:30:00
1341:	512.7296	2012-03-11 22:00:00
1342:	513.3986	2012-03-11 22:30:00
1343:	517.8433	2012-03-11 23:00:00
1344:	527.1080	2012-03-11 23:30:00

	value	date_time	type
1:	652.0693	2012-02-27 00:00:00	Real
2:	646.6226	2012-02-27 00:30:00	Real
3:	658.3790	2012-02-27 01:00:00	Real
4:	669.0898	2012-02-27 01:30:00	Real
5:	675.9707	2012-02-27 02:00:00	Real

1340:	517.3413	2012-03-11 21:30:00	Fitted
1341:	512.7296	2012-03-11 22:00:00	Fitted
1342:	513.3986	2012-03-11 22:30:00	Fitted
1343:	517.8433	2012-03-11 23:00:00	Fitted
1344:	527.1080	2012-03-11 23:30:00	Fitted




Fitted values vs Residuals
Residuals
100
50
0
-50
-100
500
1000
1500
2000
Fitted_values


Normal Q-Q
Standardized Residuals
2
0
-2
-2
0
2
Theoretical Quantiles

```
[1] 50
```

```
 [1] 15.651678 11.885790 13.711592  7.216850  5.261544  8.074024  6.046631  5.175894 10.175659  6.573435  7.249069  5.189729
[13]  3.966611  3.537241  4.517766  4.259040  3.865752  4.564565  4.540562 14.533468  7.091113  6.321064 10.747477  8.175696
[25] 12.011780 10.181759  9.469939  5.571468  6.054342  5.065741  5.013238  7.510948  4.157744 15.843159  8.724484  7.609050
[37]  3.712756  3.912121  5.448236  3.866538  3.244851  6.641563  8.244843  8.190629 18.194939  6.481096  6.339300  8.457155
[49] 11.176872 15.880014
```

```
 [1] 10.084345  8.452523  8.100982 10.779631 12.290251 13.748548 13.185274  8.708880 13.608198  7.976265  7.786389 22.951015
[13] 12.754905 11.052129  5.624771  6.243265  4.557871  7.842977  5.464003  9.951756 13.658921 11.571770  7.876418 10.951769
[25] 10.921287  8.672482  7.639304 10.006915  9.030679  6.077076  9.848483  6.445102 14.021887 14.064280 13.624932  9.057978
[37]  4.276840  5.329250 11.452156 13.313456  9.835459 11.187358 12.744013  9.460053 34.312551 13.113285 12.155385  8.036420
[49] 10.614472 51.541775
```

```
 [1] 1.3494435 1.6115792 1.1212235 1.2100342 1.0249229 0.9645256 0.9538736 1.6206521 3.3962925 2.3641598 1.3481740 1.5083682
[13] 1.8310301 5.8381717 1.8980476 1.3625701 2.3412257 2.3754512 2.8773237 3.1063138 2.9674816 2.5777905 4.1572684 3.8093668
[25] 3.5908706 4.2735190 2.3578053 4.5968416 4.0791122 7.9821166 3.2058152 5.3319568 3.2213241 2.9283188 2.6655705 4.7280836
[37] 5.4562748 2.8417542 6.4128534 2.9900441 3.5614321 4.6741020 3.9244749 3.3571312 1.9261284 2.6419782 2.4853783 2.7261717
[49] 2.3941716 6.1437349
```

```
 [1]  8.647721  7.375660  5.463200  7.180215  6.029445  5.736619  8.209645 10.220787  8.049561  7.831923  5.942506  7.537182
[13]  5.957011  5.871259  5.924100  7.175428  7.107502  6.602283  5.144848 13.114200  7.087625  9.881252  5.949965  5.529862
[25] 12.620649 11.001515  8.630602  5.249746  5.037242  4.541921  6.132860 11.573741 10.771706 21.248055  9.164510 15.612347
[37]  9.994092  7.129103  8.642347  5.765497  7.846388 13.715063  9.045185 10.814154 29.182009 12.573626 12.319590  5.138492
[49]  6.550366 35.256450
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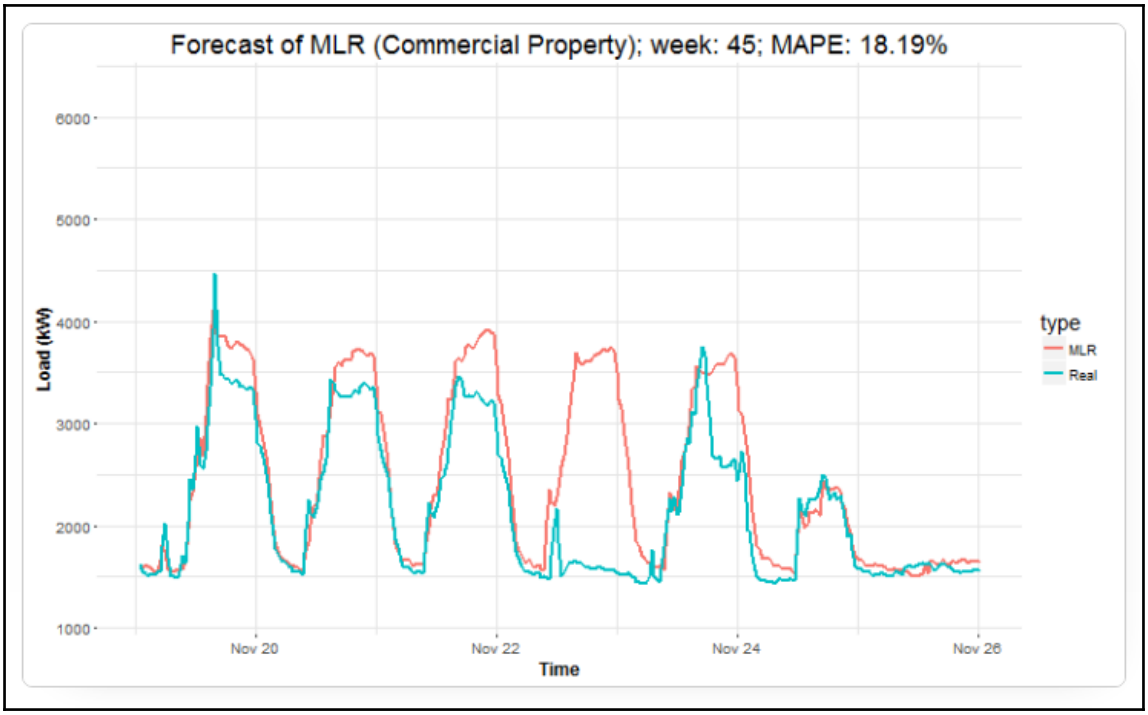
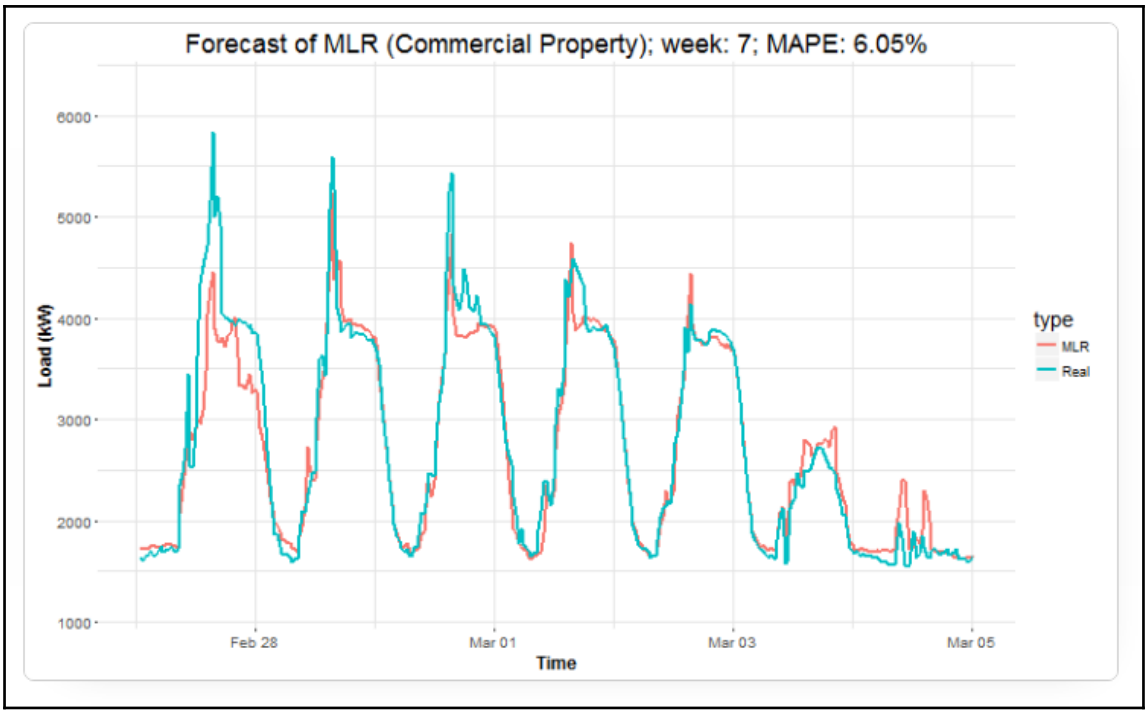
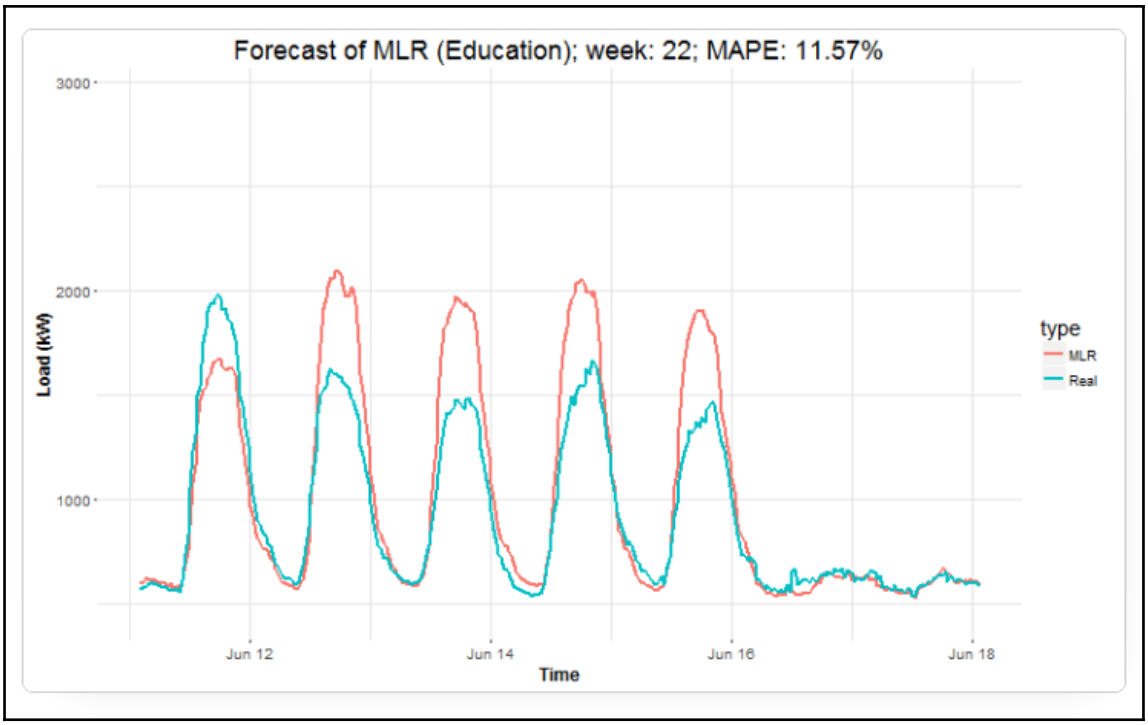
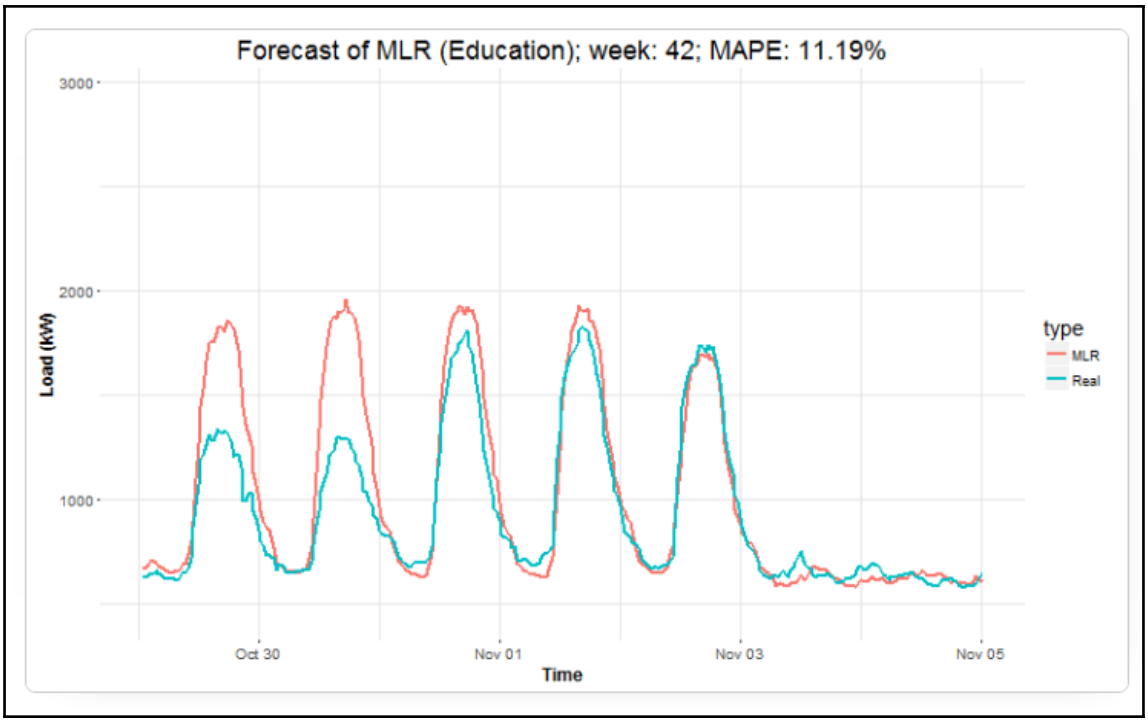
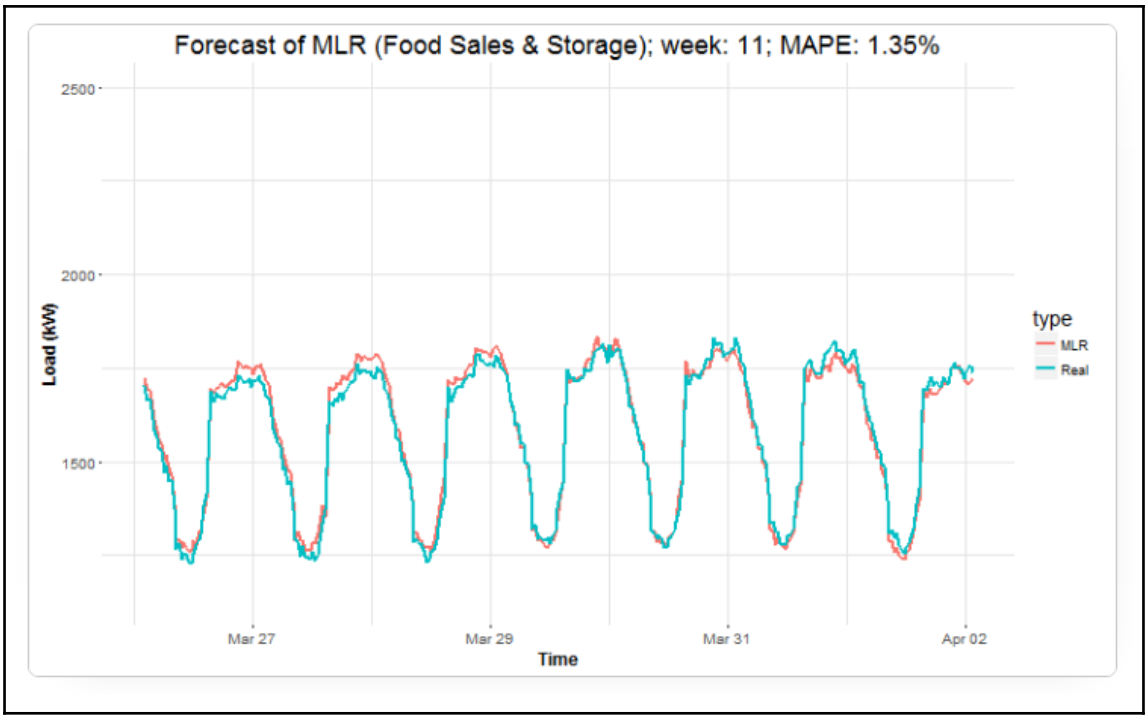
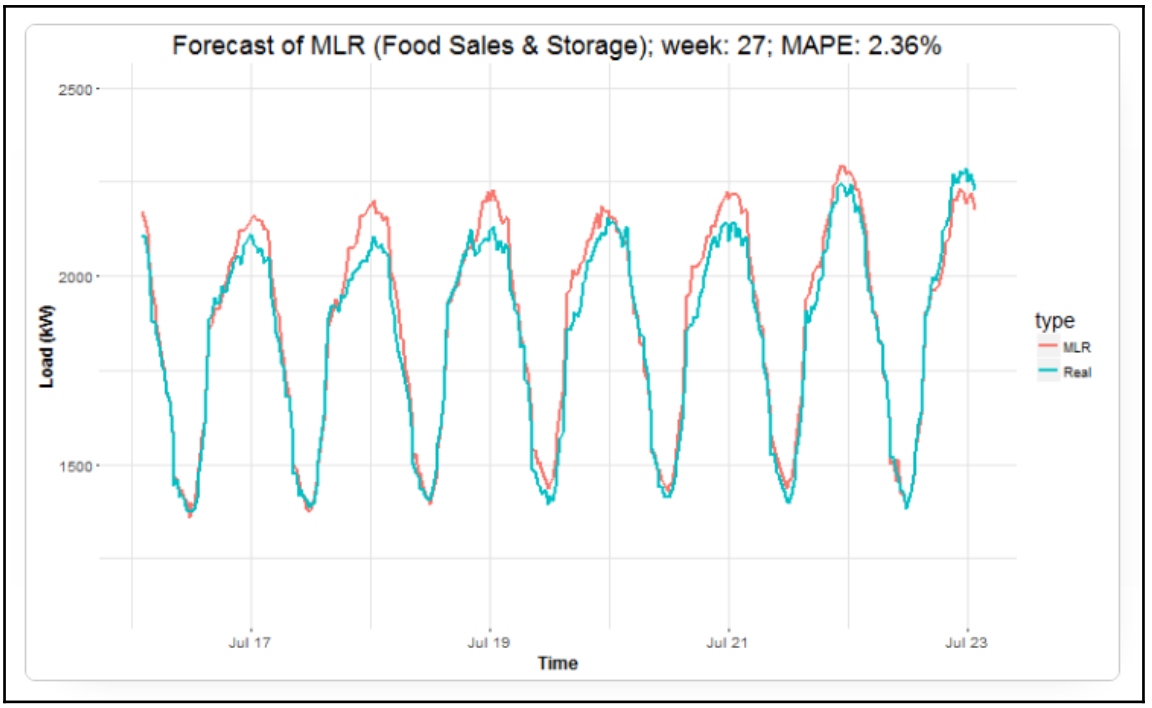


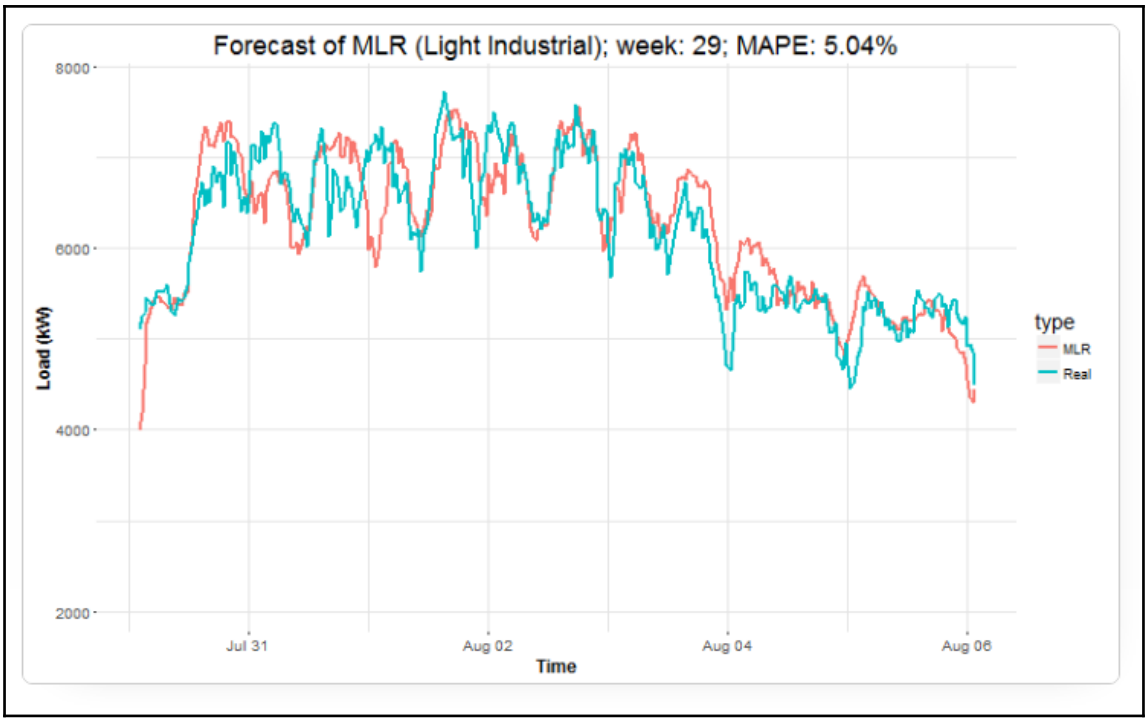

Forecast of MLR (Commercial Property); week: 7; MAPE: 6.05%
Load (kW)
6000
5000
4000
3000
2000
1000
Feb 28
Mar 01
Mar 03
Mar 05
Time
type
MLR
Real

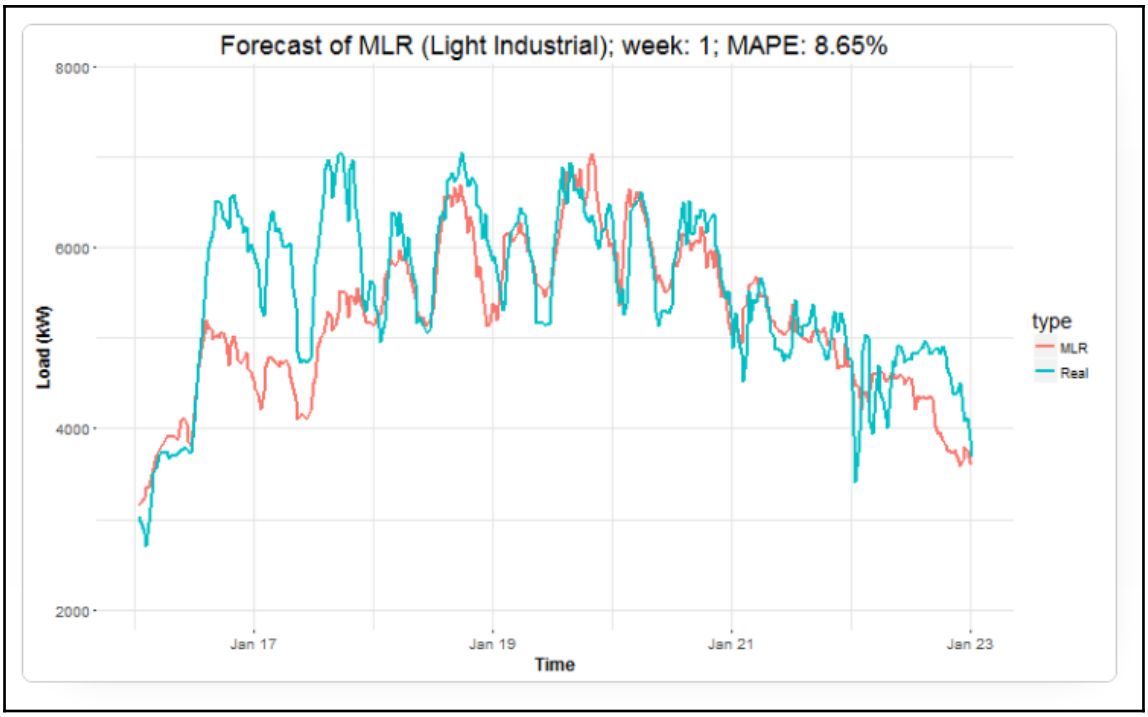

Forecast of MLR (Education); week: 22; MAPE: 11.57%
3000
2000
1000
Load (kW)
Jun 12
Jun 14
Jun 16
Jun 18
Time
type
MLR
Real


Forecast of MLR (Education); week: 42; MAPE: 11.19%
3000
2000
1000
Load (kW)
Oct 30
Nov 01
Nov 03
Nov 05
Time
type
MLR
Real


Forecast of MLR (Food Sales & Storage); week: 11; MAPE: 1.35%
2500
2000
1500
Load (kW)
Mar 27
Mar 29
Mar 31
Apr 02
Time
type
MLR
Real


Forecast of MLR (Food Sales & Storage); week: 27; MAPE: 2.36%
2500
2000
1500
Load (kW)
Jul 17
Jul 19
Jul 21
Jul 23
Time
type
MLR
Real


Forecast of MLR (Light Industrial); week: 29; MAPE: 5.04%
8000
6000
4000
2000
Load (kW)
Jul 31
Aug 02
Aug 04
Aug 06
Time
type
MLR
Real


Forecast of MLR (Light Industrial); week: 1; MAPE: 8.65%
8000
6000
4000
2000
Load (kW)
Jan 17
Jan 19
Jan 21
Jan 23
Time
type
MLR
Real