Ch2 Hmwk

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# An Introduction to Statistical Learning

## Chapter 2 Questions

### Question 1

1. The sample size n is extremely large, and the number of predictors p is small.

* We would expect a inflexible method ot perform better here. With many observations of few variables, we are likely to encounter many outliers. Since we can’t intelligently explain this variance we are better off developing a more rigid and certain model.

1. The number o fpredictors p is extremely large, and the number of observations n is small.

* We would expect a fexible model to perform better with this amount of information. Vice Versa to (a).

1. The relationship between the predictors and response is highly non-linear.

* We would expect a fexible method to perform better. Rigid models depend on linear relationships, a flexible model has build in methods to intelligently serve the unique underlying relations in the data.

1. The variance of the error terms, i.e. o^2 = Var(e), is extremely high.

* We would expect a inflexible method to perform better in this scenario. There is a high amount of variance, and a flexible model is likely to be swayed heavily by the outlier noise.

### Question 2

1. We collect a set of data on the top 500 firms in the US. For each firm we record profit, number of employees, industry and the CEO salary. We are interested in understanding which factors affect CEO salary.

* This is a regression problem, and we are most concerned about inference. n = 500 p = 4

1. We are launching a new product and wish to know whether it will be a success or a failure. We collect data on 20 similar products that were previously launched. For each product we hace recorded whether it was a success or failure, price charged for the product, marketing budget, competition price, and ten other variables.

* This is a classification problem, and we are most concerned about prediction. n = 20 p = 14

1. We are interested in predicting the % change in the USD/Euro exchange rate in relation to the weekly changes in the world stock markets. Hence we collect weekly data for all of 2012. For each week we record the % change in the USD/Euro, the % change in the US market, the % change in the British market, and the % change in the German market.

* This is a regression problem, and we are concerned with prediction. n = 52 p = 4

### Question 10

library(MASS)  
Boston

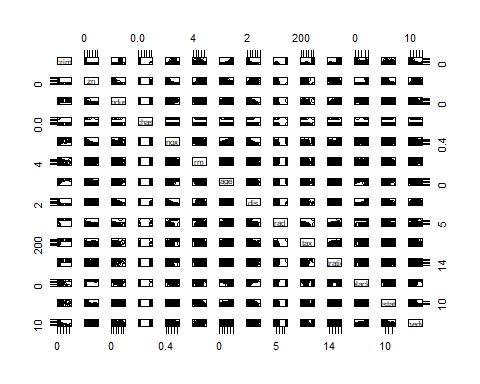
## crim zn indus chas nox rm age dis rad tax ptratio  
## 1 0.00632 18.0 2.31 0 0.5380 6.575 65.2 4.0900 1 296 15.3  
## 2 0.02731 0.0 7.07 0 0.4690 6.421 78.9 4.9671 2 242 17.8  
## 3 0.02729 0.0 7.07 0 0.4690 7.185 61.1 4.9671 2 242 17.8  
## 4 0.03237 0.0 2.18 0 0.4580 6.998 45.8 6.0622 3 222 18.7  
## 5 0.06905 0.0 2.18 0 0.4580 7.147 54.2 6.0622 3 222 18.7  
## 6 0.02985 0.0 2.18 0 0.4580 6.430 58.7 6.0622 3 222 18.7  
## 7 0.08829 12.5 7.87 0 0.5240 6.012 66.6 5.5605 5 311 15.2  
## 8 0.14455 12.5 7.87 0 0.5240 6.172 96.1 5.9505 5 311 15.2  
## 9 0.21124 12.5 7.87 0 0.5240 5.631 100.0 6.0821 5 311 15.2  
## 10 0.17004 12.5 7.87 0 0.5240 6.004 85.9 6.5921 5 311 15.2  
## 11 0.22489 12.5 7.87 0 0.5240 6.377 94.3 6.3467 5 311 15.2  
## 12 0.11747 12.5 7.87 0 0.5240 6.009 82.9 6.2267 5 311 15.2  
## 13 0.09378 12.5 7.87 0 0.5240 5.889 39.0 5.4509 5 311 15.2  
## 14 0.62976 0.0 8.14 0 0.5380 5.949 61.8 4.7075 4 307 21.0  
## 15 0.63796 0.0 8.14 0 0.5380 6.096 84.5 4.4619 4 307 21.0  
## 16 0.62739 0.0 8.14 0 0.5380 5.834 56.5 4.4986 4 307 21.0  
## 17 1.05393 0.0 8.14 0 0.5380 5.935 29.3 4.4986 4 307 21.0  
## 18 0.78420 0.0 8.14 0 0.5380 5.990 81.7 4.2579 4 307 21.0  
## 19 0.80271 0.0 8.14 0 0.5380 5.456 36.6 3.7965 4 307 21.0  
## 20 0.72580 0.0 8.14 0 0.5380 5.727 69.5 3.7965 4 307 21.0  
## 21 1.25179 0.0 8.14 0 0.5380 5.570 98.1 3.7979 4 307 21.0  
## 22 0.85204 0.0 8.14 0 0.5380 5.965 89.2 4.0123 4 307 21.0  
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## 24 0.98843 0.0 8.14 0 0.5380 5.813 100.0 4.0952 4 307 21.0  
## 25 0.75026 0.0 8.14 0 0.5380 5.924 94.1 4.3996 4 307 21.0  
## 26 0.84054 0.0 8.14 0 0.5380 5.599 85.7 4.4546 4 307 21.0  
## 27 0.67191 0.0 8.14 0 0.5380 5.813 90.3 4.6820 4 307 21.0  
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## 29 0.77299 0.0 8.14 0 0.5380 6.495 94.4 4.4547 4 307 21.0  
## 30 1.00245 0.0 8.14 0 0.5380 6.674 87.3 4.2390 4 307 21.0  
## 31 1.13081 0.0 8.14 0 0.5380 5.713 94.1 4.2330 4 307 21.0  
## 32 1.35472 0.0 8.14 0 0.5380 6.072 100.0 4.1750 4 307 21.0  
## 33 1.38799 0.0 8.14 0 0.5380 5.950 82.0 3.9900 4 307 21.0  
## 34 1.15172 0.0 8.14 0 0.5380 5.701 95.0 3.7872 4 307 21.0  
## 35 1.61282 0.0 8.14 0 0.5380 6.096 96.9 3.7598 4 307 21.0  
## 36 0.06417 0.0 5.96 0 0.4990 5.933 68.2 3.3603 5 279 19.2  
## 37 0.09744 0.0 5.96 0 0.4990 5.841 61.4 3.3779 5 279 19.2  
## 38 0.08014 0.0 5.96 0 0.4990 5.850 41.5 3.9342 5 279 19.2  
## 39 0.17505 0.0 5.96 0 0.4990 5.966 30.2 3.8473 5 279 19.2  
## 40 0.02763 75.0 2.95 0 0.4280 6.595 21.8 5.4011 3 252 18.3  
## 41 0.03359 75.0 2.95 0 0.4280 7.024 15.8 5.4011 3 252 18.3  
## 42 0.12744 0.0 6.91 0 0.4480 6.770 2.9 5.7209 3 233 17.9  
## 43 0.14150 0.0 6.91 0 0.4480 6.169 6.6 5.7209 3 233 17.9  
## 44 0.15936 0.0 6.91 0 0.4480 6.211 6.5 5.7209 3 233 17.9  
## 45 0.12269 0.0 6.91 0 0.4480 6.069 40.0 5.7209 3 233 17.9  
## 46 0.17142 0.0 6.91 0 0.4480 5.682 33.8 5.1004 3 233 17.9  
## 47 0.18836 0.0 6.91 0 0.4480 5.786 33.3 5.1004 3 233 17.9  
## 48 0.22927 0.0 6.91 0 0.4480 6.030 85.5 5.6894 3 233 17.9  
## 49 0.25387 0.0 6.91 0 0.4480 5.399 95.3 5.8700 3 233 17.9  
## 50 0.21977 0.0 6.91 0 0.4480 5.602 62.0 6.0877 3 233 17.9  
## 51 0.08873 21.0 5.64 0 0.4390 5.963 45.7 6.8147 4 243 16.8  
## 52 0.04337 21.0 5.64 0 0.4390 6.115 63.0 6.8147 4 243 16.8  
## 53 0.05360 21.0 5.64 0 0.4390 6.511 21.1 6.8147 4 243 16.8  
## 54 0.04981 21.0 5.64 0 0.4390 5.998 21.4 6.8147 4 243 16.8  
## 55 0.01360 75.0 4.00 0 0.4100 5.888 47.6 7.3197 3 469 21.1  
## 56 0.01311 90.0 1.22 0 0.4030 7.249 21.9 8.6966 5 226 17.9  
## 57 0.02055 85.0 0.74 0 0.4100 6.383 35.7 9.1876 2 313 17.3  
## 58 0.01432 100.0 1.32 0 0.4110 6.816 40.5 8.3248 5 256 15.1  
## 59 0.15445 25.0 5.13 0 0.4530 6.145 29.2 7.8148 8 284 19.7  
## 60 0.10328 25.0 5.13 0 0.4530 5.927 47.2 6.9320 8 284 19.7  
## 61 0.14932 25.0 5.13 0 0.4530 5.741 66.2 7.2254 8 284 19.7  
## 62 0.17171 25.0 5.13 0 0.4530 5.966 93.4 6.8185 8 284 19.7  
## 63 0.11027 25.0 5.13 0 0.4530 6.456 67.8 7.2255 8 284 19.7  
## 64 0.12650 25.0 5.13 0 0.4530 6.762 43.4 7.9809 8 284 19.7  
## 65 0.01951 17.5 1.38 0 0.4161 7.104 59.5 9.2229 3 216 18.6  
## 66 0.03584 80.0 3.37 0 0.3980 6.290 17.8 6.6115 4 337 16.1  
## 67 0.04379 80.0 3.37 0 0.3980 5.787 31.1 6.6115 4 337 16.1  
## 68 0.05789 12.5 6.07 0 0.4090 5.878 21.4 6.4980 4 345 18.9  
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## 71 0.08826 0.0 10.81 0 0.4130 6.417 6.6 5.2873 4 305 19.2  
## 72 0.15876 0.0 10.81 0 0.4130 5.961 17.5 5.2873 4 305 19.2  
## 73 0.09164 0.0 10.81 0 0.4130 6.065 7.8 5.2873 4 305 19.2  
## 74 0.19539 0.0 10.81 0 0.4130 6.245 6.2 5.2873 4 305 19.2  
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## 77 0.10153 0.0 12.83 0 0.4370 6.279 74.5 4.0522 5 398 18.7  
## 78 0.08707 0.0 12.83 0 0.4370 6.140 45.8 4.0905 5 398 18.7  
## 79 0.05646 0.0 12.83 0 0.4370 6.232 53.7 5.0141 5 398 18.7  
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## 81 0.04113 25.0 4.86 0 0.4260 6.727 33.5 5.4007 4 281 19.0  
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## 89 0.05660 0.0 3.41 0 0.4890 7.007 86.3 3.4217 2 270 17.8  
## 90 0.05302 0.0 3.41 0 0.4890 7.079 63.1 3.4145 2 270 17.8  
## 91 0.04684 0.0 3.41 0 0.4890 6.417 66.1 3.0923 2 270 17.8  
## 92 0.03932 0.0 3.41 0 0.4890 6.405 73.9 3.0921 2 270 17.8  
## 93 0.04203 28.0 15.04 0 0.4640 6.442 53.6 3.6659 4 270 18.2  
## 94 0.02875 28.0 15.04 0 0.4640 6.211 28.9 3.6659 4 270 18.2  
## 95 0.04294 28.0 15.04 0 0.4640 6.249 77.3 3.6150 4 270 18.2  
## 96 0.12204 0.0 2.89 0 0.4450 6.625 57.8 3.4952 2 276 18.0  
## 97 0.11504 0.0 2.89 0 0.4450 6.163 69.6 3.4952 2 276 18.0  
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## 113 0.12329 0.0 10.01 0 0.5470 5.913 92.9 2.3534 6 432 17.8  
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## 115 0.14231 0.0 10.01 0 0.5470 6.254 84.2 2.2565 6 432 17.8  
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## 159 1.34284 0.0 19.58 0 0.6050 6.066 100.0 1.7573 5 403 14.7  
## 160 1.42502 0.0 19.58 0 0.8710 6.510 100.0 1.7659 5 403 14.7  
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## 176 0.06664 0.0 4.05 0 0.5100 6.546 33.1 3.1323 5 296 16.6  
## 177 0.07022 0.0 4.05 0 0.5100 6.020 47.2 3.5549 5 296 16.6  
## 178 0.05425 0.0 4.05 0 0.5100 6.315 73.4 3.3175 5 296 16.6  
## 179 0.06642 0.0 4.05 0 0.5100 6.860 74.4 2.9153 5 296 16.6  
## 180 0.05780 0.0 2.46 0 0.4880 6.980 58.4 2.8290 3 193 17.8  
## 181 0.06588 0.0 2.46 0 0.4880 7.765 83.3 2.7410 3 193 17.8  
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## 184 0.10008 0.0 2.46 0 0.4880 6.563 95.6 2.8470 3 193 17.8  
## 185 0.08308 0.0 2.46 0 0.4880 5.604 89.8 2.9879 3 193 17.8  
## 186 0.06047 0.0 2.46 0 0.4880 6.153 68.8 3.2797 3 193 17.8  
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## 189 0.12579 45.0 3.44 0 0.4370 6.556 29.1 4.5667 5 398 15.2  
## 190 0.08370 45.0 3.44 0 0.4370 7.185 38.9 4.5667 5 398 15.2  
## 191 0.09068 45.0 3.44 0 0.4370 6.951 21.5 6.4798 5 398 15.2  
## 192 0.06911 45.0 3.44 0 0.4370 6.739 30.8 6.4798 5 398 15.2  
## 193 0.08664 45.0 3.44 0 0.4370 7.178 26.3 6.4798 5 398 15.2  
## 194 0.02187 60.0 2.93 0 0.4010 6.800 9.9 6.2196 1 265 15.6  
## 195 0.01439 60.0 2.93 0 0.4010 6.604 18.8 6.2196 1 265 15.6  
## 196 0.01381 80.0 0.46 0 0.4220 7.875 32.0 5.6484 4 255 14.4  
## 197 0.04011 80.0 1.52 0 0.4040 7.287 34.1 7.3090 2 329 12.6  
## 198 0.04666 80.0 1.52 0 0.4040 7.107 36.6 7.3090 2 329 12.6  
## 199 0.03768 80.0 1.52 0 0.4040 7.274 38.3 7.3090 2 329 12.6  
## 200 0.03150 95.0 1.47 0 0.4030 6.975 15.3 7.6534 3 402 17.0  
## 201 0.01778 95.0 1.47 0 0.4030 7.135 13.9 7.6534 3 402 17.0  
## 202 0.03445 82.5 2.03 0 0.4150 6.162 38.4 6.2700 2 348 14.7  
## 203 0.02177 82.5 2.03 0 0.4150 7.610 15.7 6.2700 2 348 14.7  
## 204 0.03510 95.0 2.68 0 0.4161 7.853 33.2 5.1180 4 224 14.7  
## 205 0.02009 95.0 2.68 0 0.4161 8.034 31.9 5.1180 4 224 14.7  
## 206 0.13642 0.0 10.59 0 0.4890 5.891 22.3 3.9454 4 277 18.6  
## 207 0.22969 0.0 10.59 0 0.4890 6.326 52.5 4.3549 4 277 18.6  
## 208 0.25199 0.0 10.59 0 0.4890 5.783 72.7 4.3549 4 277 18.6  
## 209 0.13587 0.0 10.59 1 0.4890 6.064 59.1 4.2392 4 277 18.6  
## 210 0.43571 0.0 10.59 1 0.4890 5.344 100.0 3.8750 4 277 18.6  
## 211 0.17446 0.0 10.59 1 0.4890 5.960 92.1 3.8771 4 277 18.6  
## 212 0.37578 0.0 10.59 1 0.4890 5.404 88.6 3.6650 4 277 18.6  
## 213 0.21719 0.0 10.59 1 0.4890 5.807 53.8 3.6526 4 277 18.6  
## 214 0.14052 0.0 10.59 0 0.4890 6.375 32.3 3.9454 4 277 18.6  
## 215 0.28955 0.0 10.59 0 0.4890 5.412 9.8 3.5875 4 277 18.6  
## 216 0.19802 0.0 10.59 0 0.4890 6.182 42.4 3.9454 4 277 18.6  
## 217 0.04560 0.0 13.89 1 0.5500 5.888 56.0 3.1121 5 276 16.4  
## 218 0.07013 0.0 13.89 0 0.5500 6.642 85.1 3.4211 5 276 16.4  
## 219 0.11069 0.0 13.89 1 0.5500 5.951 93.8 2.8893 5 276 16.4  
## 220 0.11425 0.0 13.89 1 0.5500 6.373 92.4 3.3633 5 276 16.4  
## 221 0.35809 0.0 6.20 1 0.5070 6.951 88.5 2.8617 8 307 17.4  
## 222 0.40771 0.0 6.20 1 0.5070 6.164 91.3 3.0480 8 307 17.4  
## 223 0.62356 0.0 6.20 1 0.5070 6.879 77.7 3.2721 8 307 17.4  
## 224 0.61470 0.0 6.20 0 0.5070 6.618 80.8 3.2721 8 307 17.4  
## 225 0.31533 0.0 6.20 0 0.5040 8.266 78.3 2.8944 8 307 17.4  
## 226 0.52693 0.0 6.20 0 0.5040 8.725 83.0 2.8944 8 307 17.4  
## 227 0.38214 0.0 6.20 0 0.5040 8.040 86.5 3.2157 8 307 17.4  
## 228 0.41238 0.0 6.20 0 0.5040 7.163 79.9 3.2157 8 307 17.4  
## 229 0.29819 0.0 6.20 0 0.5040 7.686 17.0 3.3751 8 307 17.4  
## 230 0.44178 0.0 6.20 0 0.5040 6.552 21.4 3.3751 8 307 17.4  
## 231 0.53700 0.0 6.20 0 0.5040 5.981 68.1 3.6715 8 307 17.4  
## 232 0.46296 0.0 6.20 0 0.5040 7.412 76.9 3.6715 8 307 17.4  
## 233 0.57529 0.0 6.20 0 0.5070 8.337 73.3 3.8384 8 307 17.4  
## 234 0.33147 0.0 6.20 0 0.5070 8.247 70.4 3.6519 8 307 17.4  
## 235 0.44791 0.0 6.20 1 0.5070 6.726 66.5 3.6519 8 307 17.4  
## 236 0.33045 0.0 6.20 0 0.5070 6.086 61.5 3.6519 8 307 17.4  
## 237 0.52058 0.0 6.20 1 0.5070 6.631 76.5 4.1480 8 307 17.4  
## 238 0.51183 0.0 6.20 0 0.5070 7.358 71.6 4.1480 8 307 17.4  
## 239 0.08244 30.0 4.93 0 0.4280 6.481 18.5 6.1899 6 300 16.6  
## 240 0.09252 30.0 4.93 0 0.4280 6.606 42.2 6.1899 6 300 16.6  
## 241 0.11329 30.0 4.93 0 0.4280 6.897 54.3 6.3361 6 300 16.6  
## 242 0.10612 30.0 4.93 0 0.4280 6.095 65.1 6.3361 6 300 16.6  
## 243 0.10290 30.0 4.93 0 0.4280 6.358 52.9 7.0355 6 300 16.6  
## 244 0.12757 30.0 4.93 0 0.4280 6.393 7.8 7.0355 6 300 16.6  
## 245 0.20608 22.0 5.86 0 0.4310 5.593 76.5 7.9549 7 330 19.1  
## 246 0.19133 22.0 5.86 0 0.4310 5.605 70.2 7.9549 7 330 19.1  
## 247 0.33983 22.0 5.86 0 0.4310 6.108 34.9 8.0555 7 330 19.1  
## 248 0.19657 22.0 5.86 0 0.4310 6.226 79.2 8.0555 7 330 19.1  
## 249 0.16439 22.0 5.86 0 0.4310 6.433 49.1 7.8265 7 330 19.1  
## 250 0.19073 22.0 5.86 0 0.4310 6.718 17.5 7.8265 7 330 19.1  
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## 252 0.21409 22.0 5.86 0 0.4310 6.438 8.9 7.3967 7 330 19.1  
## 253 0.08221 22.0 5.86 0 0.4310 6.957 6.8 8.9067 7 330 19.1  
## 254 0.36894 22.0 5.86 0 0.4310 8.259 8.4 8.9067 7 330 19.1  
## 255 0.04819 80.0 3.64 0 0.3920 6.108 32.0 9.2203 1 315 16.4  
## 256 0.03548 80.0 3.64 0 0.3920 5.876 19.1 9.2203 1 315 16.4  
## 257 0.01538 90.0 3.75 0 0.3940 7.454 34.2 6.3361 3 244 15.9  
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## 272 0.16211 20.0 6.96 0 0.4640 6.240 16.3 4.4290 3 223 18.6  
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## 278 0.06127 40.0 6.41 1 0.4470 6.826 27.6 4.8628 4 254 17.6  
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## 281 0.03578 20.0 3.33 0 0.4429 7.820 64.5 4.6947 5 216 14.9  
## 282 0.03705 20.0 3.33 0 0.4429 6.968 37.2 5.2447 5 216 14.9  
## 283 0.06129 20.0 3.33 1 0.4429 7.645 49.7 5.2119 5 216 14.9  
## 284 0.01501 90.0 1.21 1 0.4010 7.923 24.8 5.8850 1 198 13.6  
## 285 0.00906 90.0 2.97 0 0.4000 7.088 20.8 7.3073 1 285 15.3  
## 286 0.01096 55.0 2.25 0 0.3890 6.453 31.9 7.3073 1 300 15.3  
## 287 0.01965 80.0 1.76 0 0.3850 6.230 31.5 9.0892 1 241 18.2  
## 288 0.03871 52.5 5.32 0 0.4050 6.209 31.3 7.3172 6 293 16.6  
## 289 0.04590 52.5 5.32 0 0.4050 6.315 45.6 7.3172 6 293 16.6  
## 290 0.04297 52.5 5.32 0 0.4050 6.565 22.9 7.3172 6 293 16.6  
## 291 0.03502 80.0 4.95 0 0.4110 6.861 27.9 5.1167 4 245 19.2  
## 292 0.07886 80.0 4.95 0 0.4110 7.148 27.7 5.1167 4 245 19.2  
## 293 0.03615 80.0 4.95 0 0.4110 6.630 23.4 5.1167 4 245 19.2  
## 294 0.08265 0.0 13.92 0 0.4370 6.127 18.4 5.5027 4 289 16.0  
## 295 0.08199 0.0 13.92 0 0.4370 6.009 42.3 5.5027 4 289 16.0  
## 296 0.12932 0.0 13.92 0 0.4370 6.678 31.1 5.9604 4 289 16.0  
## 297 0.05372 0.0 13.92 0 0.4370 6.549 51.0 5.9604 4 289 16.0  
## 298 0.14103 0.0 13.92 0 0.4370 5.790 58.0 6.3200 4 289 16.0  
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## 300 0.05561 70.0 2.24 0 0.4000 7.041 10.0 7.8278 5 358 14.8  
## 301 0.04417 70.0 2.24 0 0.4000 6.871 47.4 7.8278 5 358 14.8  
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## 303 0.09266 34.0 6.09 0 0.4330 6.495 18.4 5.4917 7 329 16.1  
## 304 0.10000 34.0 6.09 0 0.4330 6.982 17.7 5.4917 7 329 16.1  
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## 306 0.05479 33.0 2.18 0 0.4720 6.616 58.1 3.3700 7 222 18.4  
## 307 0.07503 33.0 2.18 0 0.4720 7.420 71.9 3.0992 7 222 18.4  
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## 310 0.34940 0.0 9.90 0 0.5440 5.972 76.7 3.1025 4 304 18.4  
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## 317 0.31827 0.0 9.90 0 0.5440 5.914 83.2 3.9986 4 304 18.4  
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## 325 0.34109 0.0 7.38 0 0.4930 6.415 40.1 4.7211 5 287 19.6  
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## 327 0.30347 0.0 7.38 0 0.4930 6.312 28.9 5.4159 5 287 19.6  
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## 330 0.06724 0.0 3.24 0 0.4600 6.333 17.2 5.2146 4 430 16.9  
## 331 0.04544 0.0 3.24 0 0.4600 6.144 32.2 5.8736 4 430 16.9  
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## 333 0.03466 35.0 6.06 0 0.4379 6.031 23.3 6.6407 1 304 16.9  
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## 335 0.03738 0.0 5.19 0 0.5150 6.310 38.5 6.4584 5 224 20.2  
## 336 0.03961 0.0 5.19 0 0.5150 6.037 34.5 5.9853 5 224 20.2  
## 337 0.03427 0.0 5.19 0 0.5150 5.869 46.3 5.2311 5 224 20.2  
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## 345 0.03049 55.0 3.78 0 0.4840 6.874 28.1 6.4654 5 370 17.6  
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## 347 0.06162 0.0 4.39 0 0.4420 5.898 52.3 8.0136 3 352 18.8  
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## 353 0.07244 60.0 1.69 0 0.4110 5.884 18.5 10.7103 4 411 18.3  
## 354 0.01709 90.0 2.02 0 0.4100 6.728 36.1 12.1265 5 187 17.0  
## 355 0.04301 80.0 1.91 0 0.4130 5.663 21.9 10.5857 4 334 22.0  
## 356 0.10659 80.0 1.91 0 0.4130 5.936 19.5 10.5857 4 334 22.0  
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## 358 3.84970 0.0 18.10 1 0.7700 6.395 91.0 2.5052 24 666 20.2  
## 359 5.20177 0.0 18.10 1 0.7700 6.127 83.4 2.7227 24 666 20.2  
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## 6 394.12 5.21 28.7  
## 7 395.60 12.43 22.9  
## 8 396.90 19.15 27.1  
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## 27 376.88 14.81 16.6  
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## 43 383.37 5.81 25.3  
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## 55 396.90 14.80 18.9  
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## 61 395.11 13.15 18.7  
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## 65 393.24 8.05 33.0  
## 66 396.90 4.67 23.5  
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## 68 396.21 8.10 22.0  
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## 422 319.98 15.70 14.2  
## 423 291.55 14.10 20.8  
## 424 2.52 23.29 13.4  
## 425 3.65 17.16 11.7  
## 426 7.68 24.39 8.3  
## 427 24.65 15.69 10.2  
## 428 18.82 14.52 10.9  
## 429 96.73 21.52 11.0  
## 430 60.72 24.08 9.5  
## 431 83.45 17.64 14.5  
## 432 81.33 19.69 14.1  
## 433 97.95 12.03 16.1  
## 434 100.19 16.22 14.3  
## 435 100.63 15.17 11.7  
## 436 109.85 23.27 13.4  
## 437 27.49 18.05 9.6  
## 438 9.32 26.45 8.7  
## 439 68.95 34.02 8.4  
## 440 396.90 22.88 12.8  
## 441 391.45 22.11 10.5  
## 442 385.96 19.52 17.1  
## 443 395.69 16.59 18.4  
## 444 386.73 18.85 15.4  
## 445 240.52 23.79 10.8  
## 446 43.06 23.98 11.8  
## 447 318.01 17.79 14.9  
## 448 388.52 16.44 12.6  
## 449 396.90 18.13 14.1  
## 450 304.21 19.31 13.0  
## 451 0.32 17.44 13.4  
## 452 355.29 17.73 15.2  
## 453 385.09 17.27 16.1  
## 454 375.87 16.74 17.8  
## 455 6.68 18.71 14.9  
## 456 50.92 18.13 14.1  
## 457 10.48 19.01 12.7  
## 458 3.50 16.94 13.5  
## 459 272.21 16.23 14.9  
## 460 396.90 14.70 20.0  
## 461 255.23 16.42 16.4  
## 462 391.43 14.65 17.7  
## 463 396.90 13.99 19.5  
## 464 393.82 10.29 20.2  
## 465 396.90 13.22 21.4  
## 466 334.40 14.13 19.9  
## 467 22.01 17.15 19.0  
## 468 331.29 21.32 19.1  
## 469 368.74 18.13 19.1  
## 470 396.90 14.76 20.1  
## 471 396.90 16.29 19.9  
## 472 395.33 12.87 19.6  
## 473 393.37 14.36 23.2  
## 474 374.68 11.66 29.8  
## 475 352.58 18.14 13.8  
## 476 302.76 24.10 13.3  
## 477 396.21 18.68 16.7  
## 478 349.48 24.91 12.0  
## 479 379.70 18.03 14.6  
## 480 383.32 13.11 21.4  
## 481 396.90 10.74 23.0  
## 482 393.07 7.74 23.7  
## 483 395.28 7.01 25.0  
## 484 392.92 10.42 21.8  
## 485 370.73 13.34 20.6  
## 486 388.62 10.58 21.2  
## 487 392.68 14.98 19.1  
## 488 388.22 11.45 20.6  
## 489 395.09 18.06 15.2  
## 490 344.05 23.97 7.0  
## 491 318.43 29.68 8.1  
## 492 390.11 18.07 13.6  
## 493 396.90 13.35 20.1  
## 494 396.90 12.01 21.8  
## 495 396.90 13.59 24.5  
## 496 393.29 17.60 23.1  
## 497 396.90 21.14 19.7  
## 498 396.90 14.10 18.3  
## 499 396.90 12.92 21.2  
## 500 395.77 15.10 17.5  
## 501 396.90 14.33 16.8  
## 502 391.99 9.67 22.4  
## 503 396.90 9.08 20.6  
## 504 396.90 5.64 23.9  
## 505 393.45 6.48 22.0  
## 506 396.90 7.88 11.9

?Boston

## starting httpd help server ... done

1. The Boston dataset has 506 rows and 14 columns. Each row is a town within Boston suburbia, each column is a town housing value.

pairs(Boston)

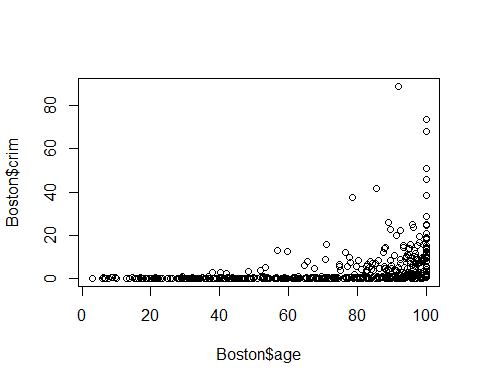


1. From the pairwise plots you can see:

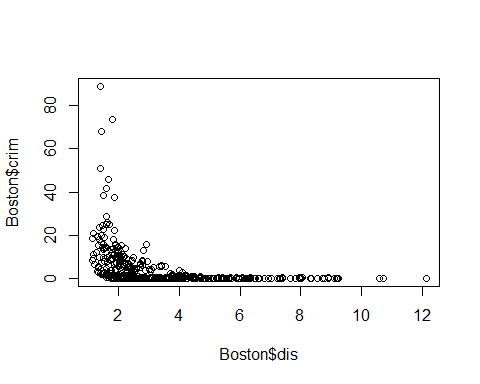
crim correlates with age, dis, rad, tax, and ptratio zn correlates with indus, nox, age, and lstat indus correlates with age and dis nox correlates with age and dis dis correlates with lstat and lstat correlates with medv

1. Are any related to per captia crime

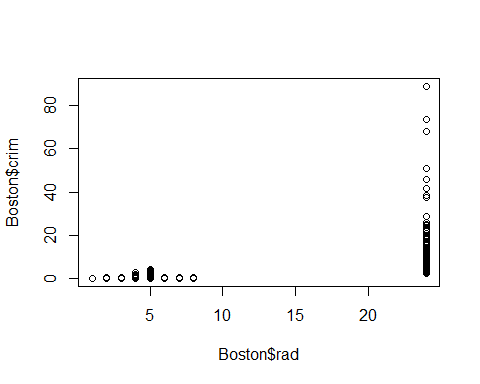
plot(Boston$age, Boston$crim)



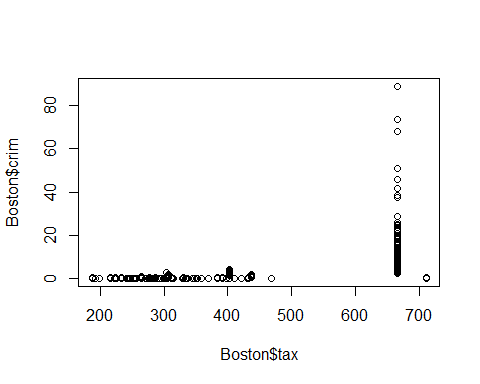
# Older homes, more crime  
plot(Boston$dis, Boston$crim)



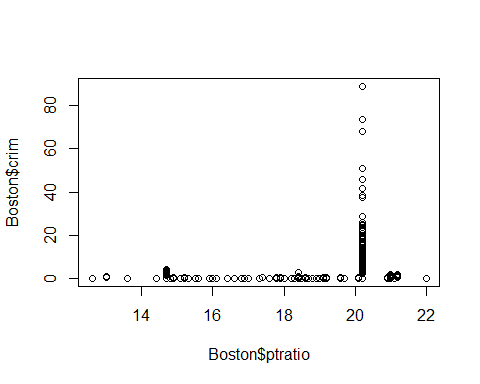
# Closer to work-area, more crime  
plot(Boston$rad, Boston$crim)



# Higher index of accessibility to radial highways, more crime  
plot(Boston$tax, Boston$crim)



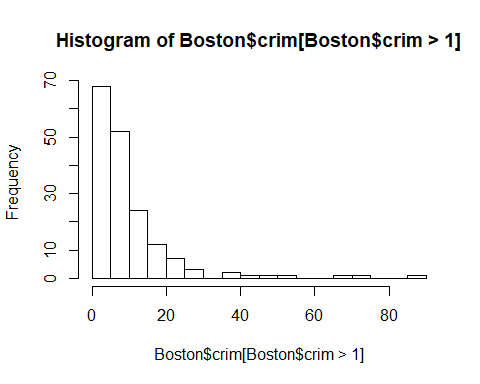
# Higher tax rate, more crime  
plot(Boston$ptratio, Boston$crim)



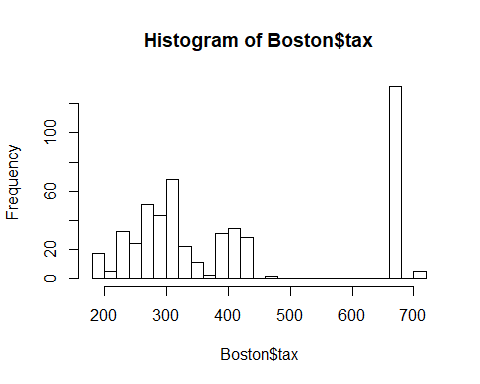
# Higher pupil:teacher ratio, more crime

1. Any high outliers of crim, tax, ptratio?

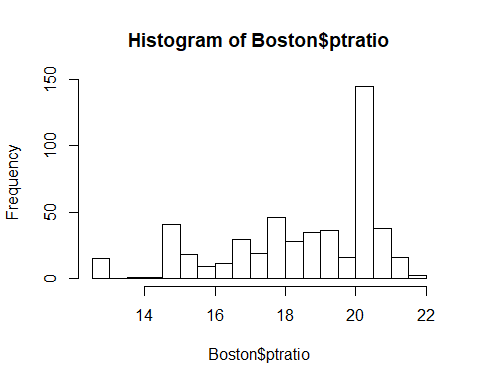
hist(Boston$crim[Boston$crim>1], breaks=25)



# most cities have low crime rates, but there is a long tail: 18 suburbs appear  
# to have a crime rate > 20, reaching to above 80  
hist(Boston$tax, breaks=25)



# there is a large divide between suburbs with low tax rates and a peak at 660-680  
hist(Boston$ptratio, breaks=25)



# a skew towards high ratios, but no particularly high ratios

1. How many suburbs in this dataset cound the Charles river?

dim(subset(Boston, chas == 1))

## [1] 35 14

# 35 suburbs

1. Median ptratio?

median(Boston$ptratio)

## [1] 19.05

# 19.05

1. Lowest median owner occupied home? Comment on predictors.

t(subset(Boston, medv == min(Boston$medv)))

## 399 406  
## crim 38.3518 67.9208  
## zn 0.0000 0.0000  
## indus 18.1000 18.1000  
## chas 0.0000 0.0000  
## nox 0.6930 0.6930  
## rm 5.4530 5.6830  
## age 100.0000 100.0000  
## dis 1.4896 1.4254  
## rad 24.0000 24.0000  
## tax 666.0000 666.0000  
## ptratio 20.2000 20.2000  
## black 396.9000 384.9700  
## lstat 30.5900 22.9800  
## medv 5.0000 5.0000

summary(Boston)

## crim zn indus chas   
## Min. : 0.00632 Min. : 0.00 Min. : 0.46 Min. :0.00000   
## 1st Qu.: 0.08204 1st Qu.: 0.00 1st Qu.: 5.19 1st Qu.:0.00000   
## Median : 0.25651 Median : 0.00 Median : 9.69 Median :0.00000   
## Mean : 3.61352 Mean : 11.36 Mean :11.14 Mean :0.06917   
## 3rd Qu.: 3.67708 3rd Qu.: 12.50 3rd Qu.:18.10 3rd Qu.:0.00000   
## Max. :88.97620 Max. :100.00 Max. :27.74 Max. :1.00000   
## nox rm age dis   
## Min. :0.3850 Min. :3.561 Min. : 2.90 Min. : 1.130   
## 1st Qu.:0.4490 1st Qu.:5.886 1st Qu.: 45.02 1st Qu.: 2.100   
## Median :0.5380 Median :6.208 Median : 77.50 Median : 3.207   
## Mean :0.5547 Mean :6.285 Mean : 68.57 Mean : 3.795   
## 3rd Qu.:0.6240 3rd Qu.:6.623 3rd Qu.: 94.08 3rd Qu.: 5.188   
## Max. :0.8710 Max. :8.780 Max. :100.00 Max. :12.127   
## rad tax ptratio black   
## Min. : 1.000 Min. :187.0 Min. :12.60 Min. : 0.32   
## 1st Qu.: 4.000 1st Qu.:279.0 1st Qu.:17.40 1st Qu.:375.38   
## Median : 5.000 Median :330.0 Median :19.05 Median :391.44   
## Mean : 9.549 Mean :408.2 Mean :18.46 Mean :356.67   
## 3rd Qu.:24.000 3rd Qu.:666.0 3rd Qu.:20.20 3rd Qu.:396.23   
## Max. :24.000 Max. :711.0 Max. :22.00 Max. :396.90   
## lstat medv   
## Min. : 1.73 Min. : 5.00   
## 1st Qu.: 6.95 1st Qu.:17.02   
## Median :11.36 Median :21.20   
## Mean :12.65 Mean :22.53   
## 3rd Qu.:16.95 3rd Qu.:25.00   
## Max. :37.97 Max. :50.00

# The values on average are slightly better than other towns.

1. How many average above 7 rooms per dwelling? 8? Comment.

dim(subset(Boston, rm > 7))

## [1] 64 14

# 64  
dim(subset(Boston, rm > 8))

## [1] 13 14

# 13  
summary(subset(Boston, rm > 8))

## crim zn indus chas   
## Min. :0.02009 Min. : 0.00 Min. : 2.680 Min. :0.0000   
## 1st Qu.:0.33147 1st Qu.: 0.00 1st Qu.: 3.970 1st Qu.:0.0000   
## Median :0.52014 Median : 0.00 Median : 6.200 Median :0.0000   
## Mean :0.71879 Mean :13.62 Mean : 7.078 Mean :0.1538   
## 3rd Qu.:0.57834 3rd Qu.:20.00 3rd Qu.: 6.200 3rd Qu.:0.0000   
## Max. :3.47428 Max. :95.00 Max. :19.580 Max. :1.0000   
## nox rm age dis   
## Min. :0.4161 Min. :8.034 Min. : 8.40 Min. :1.801   
## 1st Qu.:0.5040 1st Qu.:8.247 1st Qu.:70.40 1st Qu.:2.288   
## Median :0.5070 Median :8.297 Median :78.30 Median :2.894   
## Mean :0.5392 Mean :8.349 Mean :71.54 Mean :3.430   
## 3rd Qu.:0.6050 3rd Qu.:8.398 3rd Qu.:86.50 3rd Qu.:3.652   
## Max. :0.7180 Max. :8.780 Max. :93.90 Max. :8.907   
## rad tax ptratio black   
## Min. : 2.000 Min. :224.0 Min. :13.00 Min. :354.6   
## 1st Qu.: 5.000 1st Qu.:264.0 1st Qu.:14.70 1st Qu.:384.5   
## Median : 7.000 Median :307.0 Median :17.40 Median :386.9   
## Mean : 7.462 Mean :325.1 Mean :16.36 Mean :385.2   
## 3rd Qu.: 8.000 3rd Qu.:307.0 3rd Qu.:17.40 3rd Qu.:389.7   
## Max. :24.000 Max. :666.0 Max. :20.20 Max. :396.9   
## lstat medv   
## Min. :2.47 Min. :21.9   
## 1st Qu.:3.32 1st Qu.:41.7   
## Median :4.14 Median :48.3   
## Mean :4.31 Mean :44.2   
## 3rd Qu.:5.12 3rd Qu.:50.0   
## Max. :7.44 Max. :50.0

summary(Boston)

## crim zn indus chas   
## Min. : 0.00632 Min. : 0.00 Min. : 0.46 Min. :0.00000   
## 1st Qu.: 0.08204 1st Qu.: 0.00 1st Qu.: 5.19 1st Qu.:0.00000   
## Median : 0.25651 Median : 0.00 Median : 9.69 Median :0.00000   
## Mean : 3.61352 Mean : 11.36 Mean :11.14 Mean :0.06917   
## 3rd Qu.: 3.67708 3rd Qu.: 12.50 3rd Qu.:18.10 3rd Qu.:0.00000   
## Max. :88.97620 Max. :100.00 Max. :27.74 Max. :1.00000   
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## Min. :0.3850 Min. :3.561 Min. : 2.90 Min. : 1.130   
## 1st Qu.:0.4490 1st Qu.:5.886 1st Qu.: 45.02 1st Qu.: 2.100   
## Median :0.5380 Median :6.208 Median : 77.50 Median : 3.207   
## Mean :0.5547 Mean :6.285 Mean : 68.57 Mean : 3.795   
## 3rd Qu.:0.6240 3rd Qu.:6.623 3rd Qu.: 94.08 3rd Qu.: 5.188   
## Max. :0.8710 Max. :8.780 Max. :100.00 Max. :12.127   
## rad tax ptratio black   
## Min. : 1.000 Min. :187.0 Min. :12.60 Min. : 0.32   
## 1st Qu.: 4.000 1st Qu.:279.0 1st Qu.:17.40 1st Qu.:375.38   
## Median : 5.000 Median :330.0 Median :19.05 Median :391.44   
## Mean : 9.549 Mean :408.2 Mean :18.46 Mean :356.67   
## 3rd Qu.:24.000 3rd Qu.:666.0 3rd Qu.:20.20 3rd Qu.:396.23   
## Max. :24.000 Max. :711.0 Max. :22.00 Max. :396.90   
## lstat medv   
## Min. : 1.73 Min. : 5.00   
## 1st Qu.: 6.95 1st Qu.:17.02   
## Median :11.36 Median :21.20   
## Mean :12.65 Mean :22.53   
## 3rd Qu.:16.95 3rd Qu.:25.00   
## Max. :37.97 Max. :50.00

# lower crime, lower lstat, higher medv, low range tax