Homework 3

R Markdown

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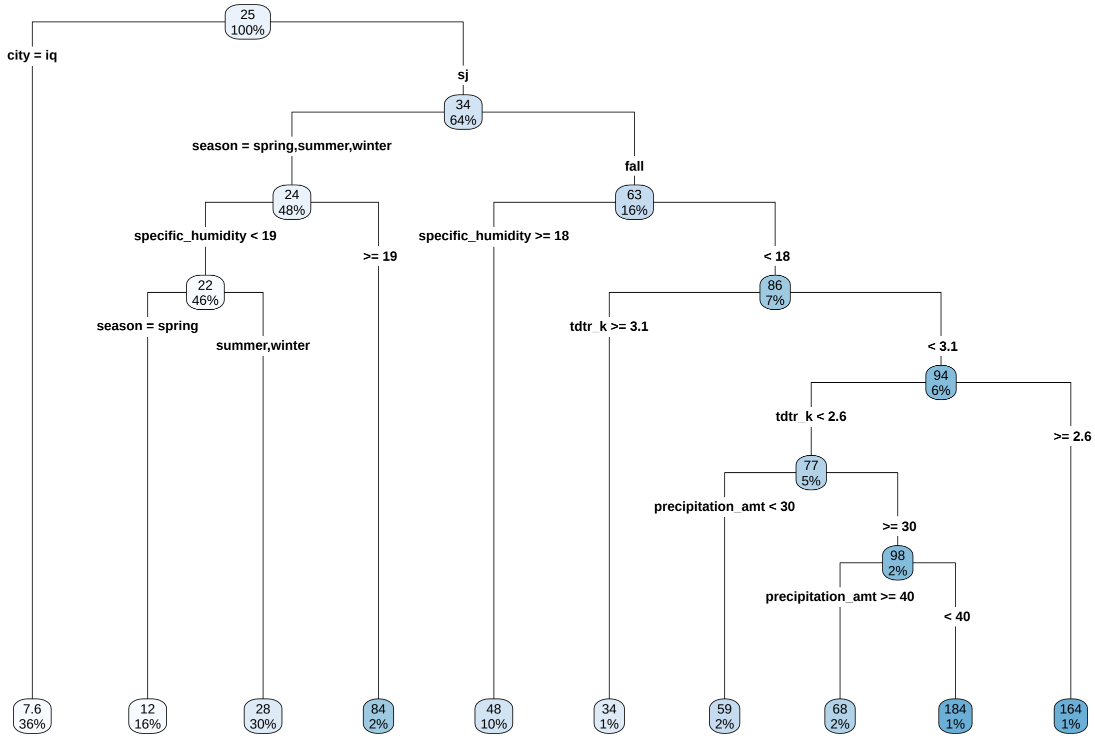
When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

The reason why is that different towns may have demographic differences. One town may have extremely poor residents, who are just more likely to turn to a life of crime, despite a higher presence of police. If we do not control for other variables, they could exert an effect on the dependent variable that is not correlated with our independent variable of interest. They used the instrumental variable of the event where there is heightened police presence without a crime rate-related trigger. They discovered that the "high alert" variable did exert a negative effect on crime occurrence. The control for "metro ridership" is to control for a proxy for population throughput in the area. We can reasonably assume that the more people in the area, the more likely a crime will be committed due to the increased presence of opportunity. The model estimated here places a differential on the effect of being on high alert on crime rate based on the geographic area in DC.

```
# CART
dengue_split = initial_split(dengue, prop = 0.8)
dengue_train = training(dengue_split)
dengue_test = testing(dengue_split)

dengue_tree = rpart(total_cases ~ city + season + specific_humidity + tdtr_k + precipitation_amt, data=

rpart.plot(dengue_tree, type=4)
```




```
print(dengue_tree)
```

```
## n= 1456
##
## node), split, n, deviance, yval
##       * denotes terminal node
##
##   1) root 1456 2765389.000  24.675140
##     2) city=iq 520   60149.780   7.565385 *
##     3) city=sj 936 2468442.000  34.180560
##       6) season=spring,summer,winter 702  753319.000  24.420230
##        12) specific_humidity< 18.53929 676  440566.700  22.110950
##          24) season=spring 232   23842.000  11.500000 *
##          25) season=summer,winter 444  376954.300  27.655410 *
##        13) specific_humidity>=18.53929 26  215418.500  84.461540 *
##       7) season=fall 234 1447622.000  63.461540
##        14) specific_humidity>=17.65714 139  250747.400  48.107910 *
##        15) specific_humidity< 17.65714 95 1116164.000  85.926320
##          30) tdtr_k>=3.071429 13    5509.692  33.846150 *
##          31) tdtr_k< 3.071429 82 1069804.000  94.182930
##            62) tdtr_k< 2.592857 66  586233.100  77.272730
##             124) precipitation_amt< 29.84 35  176320.300  59.142860 *
##             125) precipitation_amt>=29.84 31  385419.900  97.741940
##               250) precipitation_amt>=39.64 23  137732.400  67.739130 *
##               251) precipitation_amt< 39.64 8  167460.000 184.000000 *
##            63) tdtr_k>=2.592857 16  386846.900 163.937500 *
```

```
summary(dengue_tree)
```

```
## Call:
## rpart(formula = total_cases ~ city + season + specific_humidity +
```

```
##     tdtr_k + precipitation_amt, data = dengue)
##   n= 1456
##
##           CP nsplit rel error    xerror      xstd
## 1 0.09118036      0 1.0000000 1.0014057 0.1625460
## 2 0.03519717      2 0.8176393 0.8268290 0.1337546
## 3 0.02918587      3 0.7824421 0.8544935 0.1331805
## 4 0.02487439      4 0.7532562 0.8428738 0.1290559
## 5 0.01893411      6 0.7035075 0.8528178 0.1322453
## 6 0.01438148      8 0.6656392 0.8496371 0.1306825
## 7 0.01000000      9 0.6512578 0.8386561 0.1292312
##
## Variable importance
##           tdtr_k            season              city specific_humidity
##               29                24                18                17
## precipitation_amt
##               12
##
## Node number 1: 1456 observations,    complexity param=0.09118036
##   mean=24.67514, MSE=1899.306
##   left son=2 (520 obs) right son=3 (936 obs)
##   Primary splits:
##       city              splits as  LR,           improve=0.08562884, (0 missing)
##       tdtr_k            < 3.807143 to the right, improve=0.08456586, (10 missing)
##       season            splits as  RLLL,         improve=0.07499072, (0 missing)
##       specific_humidity < 16.17429 to the left,  improve=0.02231077, (10 missing)
##       precipitation_amt < 39.875   to the right, improve=0.00425222, (13 missing)
##   Surrogate splits:
##       tdtr_k            < 4.378571 to the right, agree=0.991, adj=0.975, (0 split)
##       precipitation_amt < 46.19    to the right, agree=0.700, adj=0.160, (0 split)
##       specific_humidity < 19.06143 to the right, agree=0.652, adj=0.027, (0 split)
##
## Node number 2: 520 observations
##   mean=7.565385, MSE=115.6726
##
## Node number 3: 936 observations,    complexity param=0.09118036
##   mean=34.18056, MSE=2637.225
##   left son=6 (702 obs) right son=7 (234 obs)
##   Primary splits:
##       season            splits as  RLLL,         improve=0.108368500, (0 missing)
##       specific_humidity < 16.145   to the left,  improve=0.046732810, (6 missing)
##       precipitation_amt < 16.01    to the left,  improve=0.017904020, (9 missing)
##       tdtr_k            < 1.807143 to the right, improve=0.009452844, (6 missing)
##   Surrogate splits:
##       specific_humidity < 18.07214 to the left,  agree=0.76, adj=0.038, (0 split)
##
## Node number 6: 702 observations,    complexity param=0.03519717
##   mean=24.42023, MSE=1073.104
##   left son=12 (676 obs) right son=13 (26 obs)
##   Primary splits:
##       specific_humidity < 18.53929 to the left,  improve=0.12994630, (6 missing)
##       season            splits as  -LRR,         improve=0.07598967, (0 missing)
##       tdtr_k            < 1.892857 to the right, improve=0.01550045, (6 missing)
##       precipitation_amt < 15.375   to the left,  improve=0.00824373, (9 missing)
```

```
##
## Node number 7: 234 observations,    complexity param=0.02918587
##   mean=63.46154, MSE=6186.419
##   left son=14 (139 obs) right son=15 (95 obs)
##   Primary splits:
##       specific_humidity < 17.65714 to the right, improve=0.05575370, (0 missing)
##       tdtr_k            < 1.778571 to the right, improve=0.01985307, (0 missing)
##       precipitation_amt < 5.75     to the right, improve=0.01286678, (0 missing)
##   Surrogate splits:
##       precipitation_amt < 20.22    to the right, agree=0.667, adj=0.179, (0 split)
##       tdtr_k            < 1.664286 to the right, agree=0.607, adj=0.032, (0 split)
##
## Node number 12: 676 observations,    complexity param=0.01438148
##   mean=22.11095, MSE=651.7259
##   left son=24 (232 obs) right son=25 (444 obs)
##   Primary splits:
##       season            splits as  -LRR,         improve=0.090271020, (0 missing)
##       tdtr_k            < 2.535714 to the right, improve=0.025131630, (6 missing)
##       specific_humidity < 18.26571 to the left,  improve=0.015093980, (6 missing)
##       precipitation_amt < 45.29    to the left,  improve=0.007513767, (9 missing)
##   Surrogate splits:
##       tdtr_k < 2.992857 to the right, agree=0.683, adj=0.078, (0 split)
##
## Node number 13: 26 observations
##   mean=84.46154, MSE=8285.325
##
## Node number 14: 139 observations
##   mean=48.10791, MSE=1803.938
##
## Node number 15: 95 observations,    complexity param=0.02487439
##   mean=85.92632, MSE=11749.1
##   left son=30 (13 obs) right son=31 (82 obs)
##   Primary splits:
##       tdtr_k            < 3.071429 to the right, improve=0.03659903, (0 missing)
##       specific_humidity < 16.71071 to the left,  improve=0.03385087, (0 missing)
##       precipitation_amt < 16.59    to the left,  improve=0.01315308, (0 missing)
##   Surrogate splits:
##       specific_humidity < 15.43714 to the left,  agree=0.874, adj=0.077, (0 split)
##
## Node number 24: 232 observations
##   mean=11.5, MSE=102.7672
##
## Node number 25: 444 observations
##   mean=27.65541, MSE=848.9961
##
## Node number 30: 13 observations
##   mean=33.84615, MSE=423.8225
##
## Node number 31: 82 observations,    complexity param=0.02487439
##   mean=94.18293, MSE=13046.39
##   left son=62 (66 obs) right son=63 (16 obs)
##   Primary splits:
##       tdtr_k            < 2.592857 to the left,  improve=0.09041301, (0 missing)
##       specific_humidity < 16.84643 to the left,  improve=0.03487083, (0 missing)
```

```
##       precipitation_amt < 0.315    to the left,  improve=0.01509650, (0 missing)
##
## Node number 62: 66 observations,    complexity param=0.01893411
##   mean=77.27273, MSE=8882.32
##   left son=124 (35 obs) right son=125 (31 obs)
##   Primary splits:
##       precipitation_amt < 29.84    to the left,  improve=0.04178009, (0 missing)
##       specific_humidity < 17.26071 to the left,  improve=0.04099777, (0 missing)
##       tdtr_k            < 1.85     to the right, improve=0.03896871, (0 missing)
##   Surrogate splits:
##       tdtr_k            < 2.007143 to the right, agree=0.697, adj=0.355, (0 split)
##       specific_humidity < 17.30143 to the left,  agree=0.667, adj=0.290, (0 split)
##
## Node number 63: 16 observations
##   mean=163.9375, MSE=24177.93
##
## Node number 124: 35 observations
##   mean=59.14286, MSE=5037.722
##
## Node number 125: 31 observations,    complexity param=0.01893411
##   mean=97.74194, MSE=12432.9
##   left son=250 (23 obs) right son=251 (8 obs)
##   Primary splits:
##       precipitation_amt < 39.64    to the right, improve=0.20815610, (0 missing)
##       specific_humidity < 16.91357 to the left,  improve=0.08434850, (0 missing)
##       tdtr_k            < 1.864286 to the right, improve=0.02292126, (0 missing)
##   Surrogate splits:
##       specific_humidity < 16.40214 to the right, agree=0.774, adj=0.125, (0 split)
##
## Node number 250: 23 observations
##   mean=67.73913, MSE=5988.367
##
## Node number 251: 8 observations
##   mean=184, MSE=20932.5
```

```
predict (dengue_tree, newdata=dengue)
```

```
##          1          2          3          4          5          6          7
##  11.500000  11.500000  11.500000  11.500000  11.500000  27.655405  27.655405
##          8          9         10         11         12         13         14
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405
##         15         16         17         18         19         20         21
##  27.655405  27.655405  27.655405  27.655405  33.846154  48.107914  48.107914
##         22         23         24         25         26         27         28
##  67.739130  48.107914  48.107914  48.107914  48.107914  48.107914  48.107914
##         29         30         31         32         33         34         35
##  59.142857  59.142857 184.000000  27.655405  27.655405  27.655405  27.655405
##         36         37         38         39         40         41         42
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405
##         43         44         45         46         47         48         49
##  27.655405  27.655405  11.500000  11.500000  11.500000  11.500000  11.500000
##         50         51         52         53         54         55         56
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000
##         57         58         59         60         61         62         63
##  11.500000  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405
```

```
##         64         65         66         67         68         69         70 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##         71         72         73         74         75         76         77 
##  48.107914  48.107914  48.107914  48.107914  48.107914 184.000000  59.142857 
##         78         79         80         81         82         83         84 
## 163.937500 163.937500 163.937500  67.739130  59.142857 184.000000  27.655405 
##         85         86         87         88         89         90         91 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##         92         93         94         95         96         97         98 
##  27.655405  27.655405  27.655405  27.655405  27.655405  11.500000  11.500000 
##         99        100        101        102        103        104        105 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        106        107        108        109        110        111        112 
##  11.500000  11.500000  11.500000  11.500000  27.655405  27.655405  27.655405 
##        113        114        115        116        117        118        119 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        120        121        122        123        124        125        126 
##  27.655405  27.655405  27.655405  67.739130  59.142857  67.739130  48.107914 
##        127        128        129        130        131        132        133 
##  67.739130  48.107914 163.937500  59.142857 163.937500  48.107914  67.739130 
##        134        135        136        137        138        139        140 
##  67.739130  67.739130  27.655405  27.655405  27.655405  27.655405  27.655405 
##        141        142        143        144        145        146        147 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        148        149        150        151        152        153        154 
##  27.655405  27.655405  11.500000  11.500000  11.500000  11.500000  11.500000 
##        155        156        157        158        159        160        161 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        162        163        164        165        166        167        168 
##  11.500000  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        169        170        171        172        173        174        175 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        176        177        178        179        180        181        182 
##  67.739130  48.107914  48.107914  48.107914  48.107914  48.107914  59.142857 
##        183        184        185        186        187        188        189 
##  67.739130  59.142857  59.142857  59.142857  67.739130  59.142857  27.655405 
##        190        191        192        193        194        195        196 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        197        198        199        200        201        202        203 
##  27.655405  27.655405  27.655405  27.655405  27.655405  11.500000  11.500000 
##        204        205        206        207        208        209        210 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        211        212        213        214        215        216        217 
##  11.500000  11.500000  11.500000  11.500000  27.655405  27.655405  27.655405 
##        218        219        220        221        222        223        224 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        225        226        227        228        229        230        231 
##  27.655405  27.655405  27.655405 163.937500  67.739130 184.000000 163.937500 
##        232        233        234        235        236        237        238 
## 163.937500 163.937500 163.937500  67.739130  59.142857 184.000000 184.000000 
##        239        240        241        242        243        244        245 
##  48.107914  59.142857  27.655405  27.655405  27.655405  27.655405  27.655405 
##        246        247        248        249        250        251        252 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
```

```
##       253       254       255       256       257       258       259 
## 27.655405 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 
##       260       261       262       263       264       265       266 
## 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 
##       267       268       269       270       271       272       273 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       274       275       276       277       278       279       280 
## 84.461538 84.461538 27.655405 84.461538 27.655405 27.655405 48.107914 
##       281       282       283       284       285       286       287 
## 48.107914 48.107914 48.107914 48.107914 48.107914 67.739130 48.107914 
##       288       289       290       291       292       293       294 
## 48.107914 59.142857 59.142857 67.739130 59.142857 27.655405 27.655405 
##       295       296       297       298       299       300       301 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       302       303       304       305       306       307       308 
## 27.655405 27.655405 27.655405 11.500000 11.500000 11.500000 11.500000 
##       309       310       311       312       313       314       315 
## 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 
##       316       317       318       319       320       321       322 
## 11.500000 11.500000 27.655405 27.655405 27.655405 27.655405 27.655405 
##       323       324       325       326       327       328       329 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       330       331       332       333       334       335       336 
## 27.655405 48.107914 48.107914 48.107914 48.107914 59.142857 48.107914 
##       337       338       339       340       341       342       343 
## 59.142857 48.107914 59.142857 48.107914 184.000000 67.739130 67.739130 
##       344       345       346       347       348       349       350 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       351       352       353       354       355       356       357 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 11.500000 
##       358       359       360       361       362       363       364 
## 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 
##       365       366       367       368       369       370       371 
## 11.500000 11.500000 11.500000 11.500000 11.500000 27.655405 27.655405 
##       372       373       374       375       376       377       378 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       379       380       381       382       383       384       385 
## 27.655405 27.655405 27.655405 27.655405 48.107914 48.107914 48.107914 
##       386       387       388       389       390       391       392 
## 48.107914 48.107914 48.107914 48.107914 48.107914 163.937500 59.142857 
##       393       394       395       396       397       398       399 
## 59.142857 48.107914 48.107914 27.655405 27.655405 27.655405 27.655405 
##       400       401       402       403       404       405       406 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       407       408       409       410       411       412       413 
## 27.655405 27.655405 11.500000 11.500000 11.500000 11.500000 11.500000 
##       414       415       416       417       418       419       420 
## 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 84.461538 
##       421       422       423       424       425       426       427 
## 11.500000 27.655405 84.461538 27.655405 27.655405 27.655405 27.655405 
##       428       429       430       431       432       433       434 
## 27.655405 27.655405 84.461538 84.461538 84.461538 84.461538 84.461538 
##       435       436       437       438       439       440       441 
## 48.107914 48.107914 48.107914 48.107914 48.107914 48.107914 48.107914
```

```
##        442        443        444        445        446        447        448 
##  48.107914  48.107914  48.107914  48.107914  67.739130  59.142857  27.655405 
##        449        450        451        452        453        454        455 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        456        457        458        459        460        461        462 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  11.500000 
##        463        464        465        466        467        468        469 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        470        471        472        473        474        475        476 
##  11.500000  11.500000  11.500000  11.500000  11.500000  27.655405  27.655405 
##        477        478        479        480        481        482        483 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  84.461538 
##        484        485        486        487        488        489        490 
##  27.655405  27.655405  27.655405  27.655405  48.107914  48.107914  48.107914 
##        491        492        493        494        495        496        497 
##  48.107914  48.107914  67.739130  48.107914  48.107914  48.107914  59.142857 
##        498        499        500        501        502        503        504 
##  48.107914  48.107914  33.846154  27.655405  27.655405  27.655405  27.655405 
##        505        506        507        508        509        510        511 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        512        513        514        515        516        517        518 
##  27.655405  27.655405  11.500000  11.500000  11.500000  11.500000  11.500000 
##        519        520        521        522        523        524        525 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        526        527        528        529        530        531        532 
##  11.500000  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        533        534        535        536        537        538        539 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        540        541        542        543        544        545        546 
##  48.107914  48.107914  48.107914  48.107914  48.107914  33.846154  48.107914 
##        547        548        549        550        551        552        553 
##  33.846154  48.107914  33.846154  33.846154 163.937500  59.142857  27.655405 
##        554        555        556        557        558        559        560 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        561        562        563        564        565        566        567 
##  27.655405  27.655405  27.655405  27.655405  11.500000  11.500000  11.500000 
##        568        569        570        571        572        573        574 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        575        576        577        578        579        580        581 
##  11.500000  11.500000  11.500000  27.655405  27.655405  27.655405  27.655405 
##        582        583        584        585        586        587        588 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  84.461538 
##        589        590        591        592        593        594        595 
##  84.461538  27.655405  48.107914  48.107914  48.107914  48.107914  48.107914 
##        596        597        598        599        600        601        602 
##  48.107914  48.107914  48.107914  48.107914  33.846154  67.739130  33.846154 
##        603        604        605        606        607        608        609 
##  33.846154  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        610        611        612        613        614        615        616 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        617        618        619        620        621        622        623 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        624        625        626        627        628        629        630 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  27.655405 
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##       631       632       633       634       635       636       637 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       638       639       640       641       642       643       644 
## 27.655405 27.655405 27.655405 27.655405 27.655405 48.107914 48.107914 
##       645       646       647       648       649       650       651 
## 48.107914 48.107914 48.107914 48.107914 48.107914 48.107914 48.107914 
##       652       653       654       655       656       657       658 
## 33.846154 163.937500 163.937500 59.142857 27.655405 27.655405 27.655405 
##       659       660       661       662       663       664       665 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       666       667       668       669       670       671       672 
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##       673       674       675       676       677       678       679 
## 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 
##       680       681       682       683       684       685       686 
## 11.500000 11.500000 27.655405 27.655405 27.655405 27.655405 27.655405 
##       687       688       689       690       691       692       693 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       694       695       696       697       698       699       700 
## 84.461538 48.107914 48.107914 48.107914 48.107914 48.107914 48.107914 
##       701       702       703       704       705       706       707 
## 48.107914 48.107914 48.107914 33.846154 48.107914 48.107914 59.142857 
##       708       709       710       711       712       713       714 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       715       716       717       718       719       720       721 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 11.500000 
##       722       723       724       725       726       727       728 
## 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 
##       729       730       731       732       733       734       735 
## 11.500000 11.500000 11.500000 11.500000 11.500000 27.655405 27.655405 
##       736       737       738       739       740       741       742 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       743       744       745       746       747       748       749 
## 27.655405 27.655405 84.461538 27.655405 48.107914 48.107914 48.107914 
##       750       751       752       753       754       755       756 
## 48.107914 48.107914 48.107914 48.107914 48.107914 48.107914 67.739130 
##       757       758       759       760       761       762       763 
## 59.142857 67.739130 59.142857 27.655405 27.655405 27.655405 27.655405 
##       764       765       766       767       768       769       770 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 
##       771       772       773       774       775       776       777 
## 27.655405 27.655405 27.655405 11.500000 11.500000 11.500000 11.500000 
##       778       779       780       781       782       783       784 
## 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 11.500000 
##       785       786       787       788       789       790       791 
## 11.500000 84.461538 27.655405 27.655405 84.461538 84.461538 84.461538 
##       792       793       794       795       796       797       798 
## 27.655405 27.655405 84.461538 84.461538 84.461538 84.461538 27.655405 
##       799       800       801       802       803       804       805 
## 84.461538 48.107914 48.107914 48.107914 48.107914 48.107914 48.107914 
##       806       807       808       809       810       811       812 
## 48.107914 48.107914 48.107914 48.107914 184.000000 59.142857 59.142857 
##       813       814       815       816       817       818       819 
## 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405 27.655405
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##        820        821        822        823        824        825        826 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  11.500000 
##        827        828        829        830        831        832        833 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        834        835        836        837        838        839        840 
##  11.500000  11.500000  11.500000  11.500000  11.500000  27.655405  27.655405 
##        841        842        843        844        845        846        847 
##  27.655405  84.461538  27.655405  27.655405  27.655405  27.655405  27.655405 
##        848        849        850        851        852        853        854 
##  27.655405  27.655405  27.655405  84.461538  48.107914  48.107914  48.107914 
##        855        856        857        858        859        860        861 
##  48.107914  48.107914  48.107914  48.107914  48.107914  48.107914  59.142857 
##        862        863        864        865        866        867        868 
##  59.142857  33.846154 163.937500  27.655405  27.655405  27.655405  27.655405 
##        869        870        871        872        873        874        875 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        876        877        878        879        880        881        882 
##  27.655405  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        883        884        885        886        887        888        889 
##  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000  11.500000 
##        890        891        892        893        894        895        896 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        897        898        899        900        901        902        903 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  48.107914 
##        904        905        906        907        908        909        910 
##  48.107914  48.107914  48.107914  48.107914  48.107914  48.107914  59.142857 
##        911        912        913        914        915        916        917 
## 163.937500  59.142857  33.846154  67.739130  59.142857  27.655405  27.655405 
##        918        919        920        921        922        923        924 
##  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405  27.655405 
##        925        926        927        928        929        930        931 
##  27.655405  27.655405  27.655405  27.655405  11.500000  11.500000  11.500000 
##        932        933        934        935        936        937        938 
##  11.500000  11.500000  11.500000  11.500000  11.500000   7.565385   7.565385 
##        939        940        941        942        943        944        945 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##        946        947        948        949        950        951        952 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##        953        954        955        956        957        958        959 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##        960        961        962        963        964        965        966 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##        967        968        969        970        971        972        973 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##        974        975        976        977        978        979        980 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##        981        982        983        984        985        986        987 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##        988        989        990        991        992        993        994 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##        995        996        997        998        999       1000       1001 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
##       1002       1003       1004       1005       1006       1007       1008 
##   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385   7.565385 
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##     1009     1010     1011     1012     1013     1014     1015 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1016     1017     1018     1019     1020     1021     1022 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1023     1024     1025     1026     1027     1028     1029 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1030     1031     1032     1033     1034     1035     1036 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1037     1038     1039     1040     1041     1042     1043 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1044     1045     1046     1047     1048     1049     1050 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1051     1052     1053     1054     1055     1056     1057 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1058     1059     1060     1061     1062     1063     1064 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1065     1066     1067     1068     1069     1070     1071 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1072     1073     1074     1075     1076     1077     1078 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1079     1080     1081     1082     1083     1084     1085 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1086     1087     1088     1089     1090     1091     1092 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1093     1094     1095     1096     1097     1098     1099 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1100     1101     1102     1103     1104     1105     1106 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1107     1108     1109     1110     1111     1112     1113 
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##     1114     1115     1116     1117     1118     1119     1120 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1121     1122     1123     1124     1125     1126     1127 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1128     1129     1130     1131     1132     1133     1134 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1135     1136     1137     1138     1139     1140     1141 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1142     1143     1144     1145     1146     1147     1148 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1149     1150     1151     1152     1153     1154     1155 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1156     1157     1158     1159     1160     1161     1162 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1163     1164     1165     1166     1167     1168     1169 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1170     1171     1172     1173     1174     1175     1176 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1177     1178     1179     1180     1181     1182     1183 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1184     1185     1186     1187     1188     1189     1190 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1191     1192     1193     1194     1195     1196     1197 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385
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##     1198     1199     1200     1201     1202     1203     1204 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1205     1206     1207     1208     1209     1210     1211 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1212     1213     1214     1215     1216     1217     1218 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1219     1220     1221     1222     1223     1224     1225 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1226     1227     1228     1229     1230     1231     1232 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1233     1234     1235     1236     1237     1238     1239 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1240     1241     1242     1243     1244     1245     1246 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1247     1248     1249     1250     1251     1252     1253 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1254     1255     1256     1257     1258     1259     1260 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1261     1262     1263     1264     1265     1266     1267 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1268     1269     1270     1271     1272     1273     1274 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1275     1276     1277     1278     1279     1280     1281 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1282     1283     1284     1285     1286     1287     1288 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1289     1290     1291     1292     1293     1294     1295 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1296     1297     1298     1299     1300     1301     1302 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1303     1304     1305     1306     1307     1308     1309 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1310     1311     1312     1313     1314     1315     1316 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1317     1318     1319     1320     1321     1322     1323 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1324     1325     1326     1327     1328     1329     1330 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1331     1332     1333     1334     1335     1336     1337 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1338     1339     1340     1341     1342     1343     1344 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1345     1346     1347     1348     1349     1350     1351 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1352     1353     1354     1355     1356     1357     1358 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1359     1360     1361     1362     1363     1364     1365 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1366     1367     1368     1369     1370     1371     1372 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1373     1374     1375     1376     1377     1378     1379 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
##     1380     1381     1382     1383     1384     1385     1386 
## 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 7.565385 
```
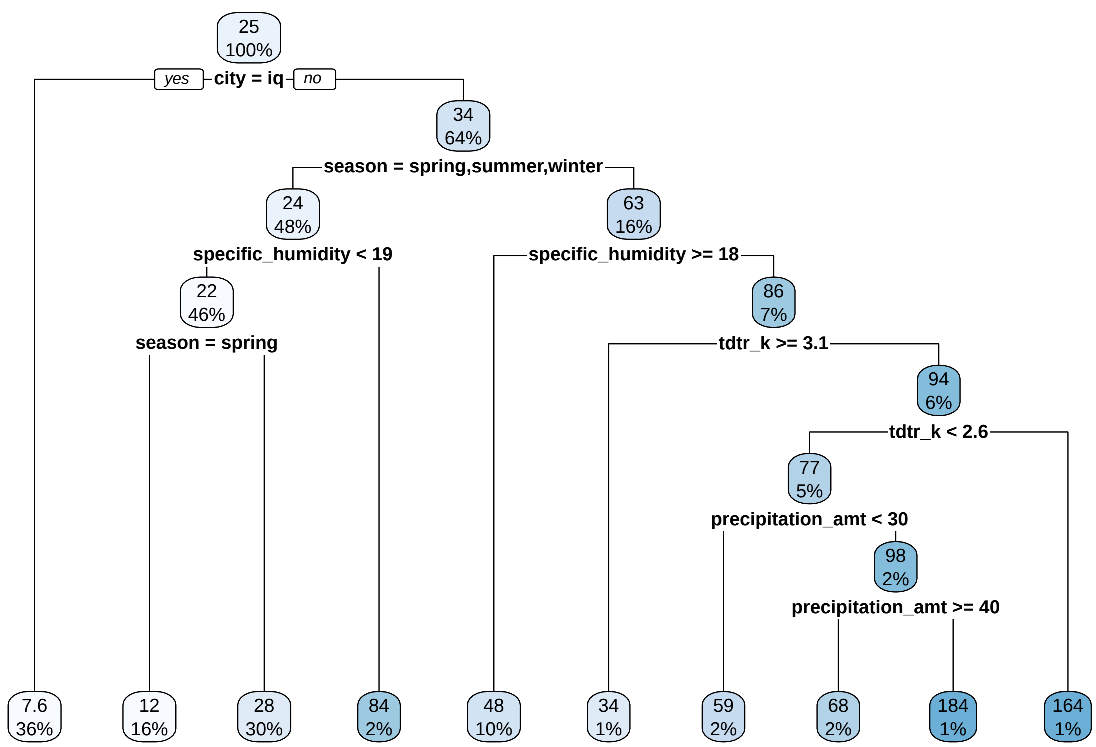
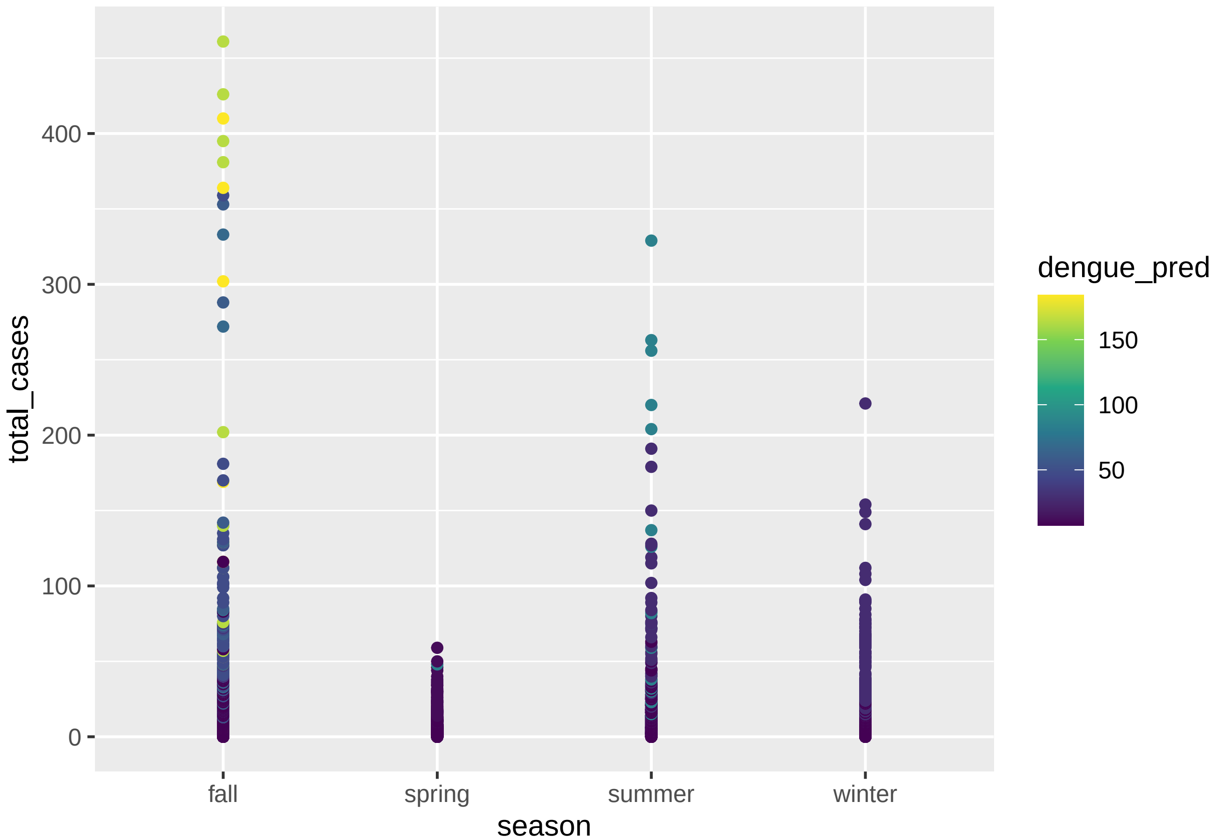

```
##      1387      1388      1389      1390      1391      1392      1393
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1394      1395      1396      1397      1398      1399      1400
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1401      1402      1403      1404      1405      1406      1407
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1408      1409      1410      1411      1412      1413      1414
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1415      1416      1417      1418      1419      1420      1421
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1422      1423      1424      1425      1426      1427      1428
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1429      1430      1431      1432      1433      1434      1435
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1436      1437      1438      1439      1440      1441      1442
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1443      1444      1445      1446      1447      1448      1449
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
##      1450      1451      1452      1453      1454      1455      1456
##  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385  7.565385
```

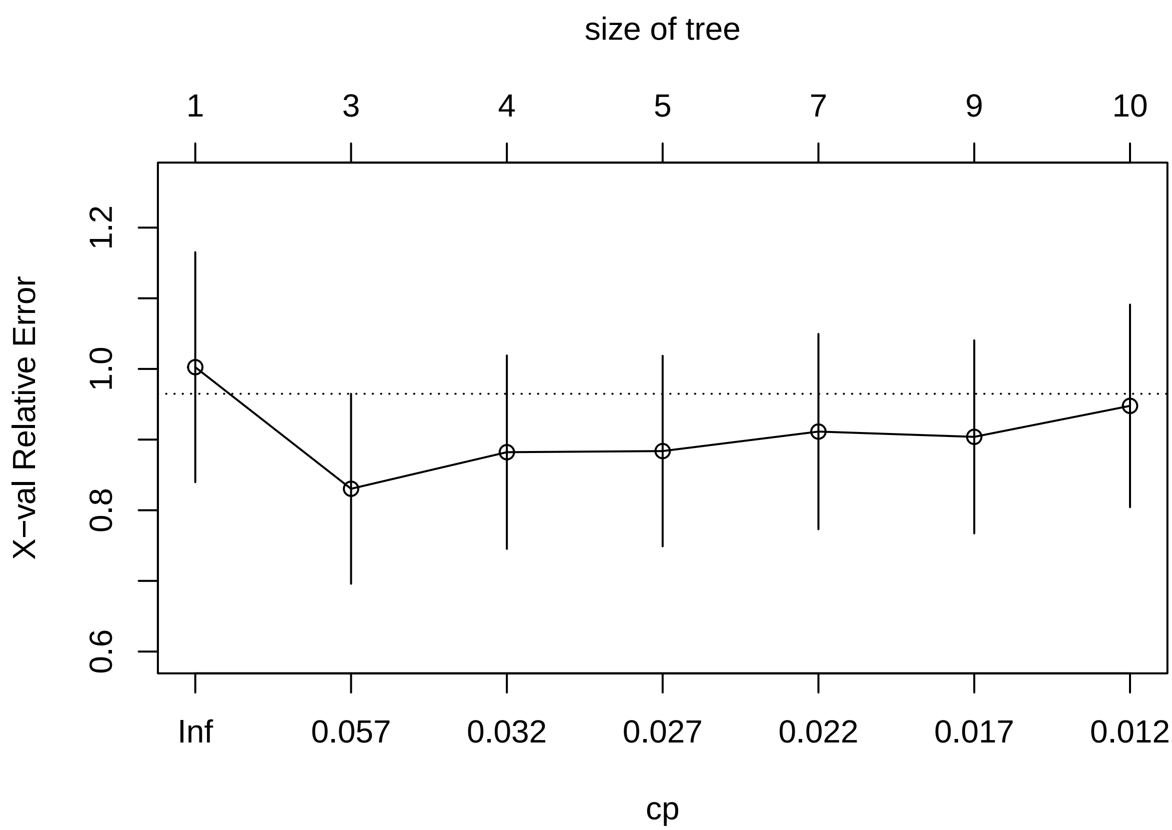
```
load.tree = rpart(total_cases ~ city + season + specific_humidity + tdtr_k + precipitation_amt,  data =
rpart.plot(load.tree)
```



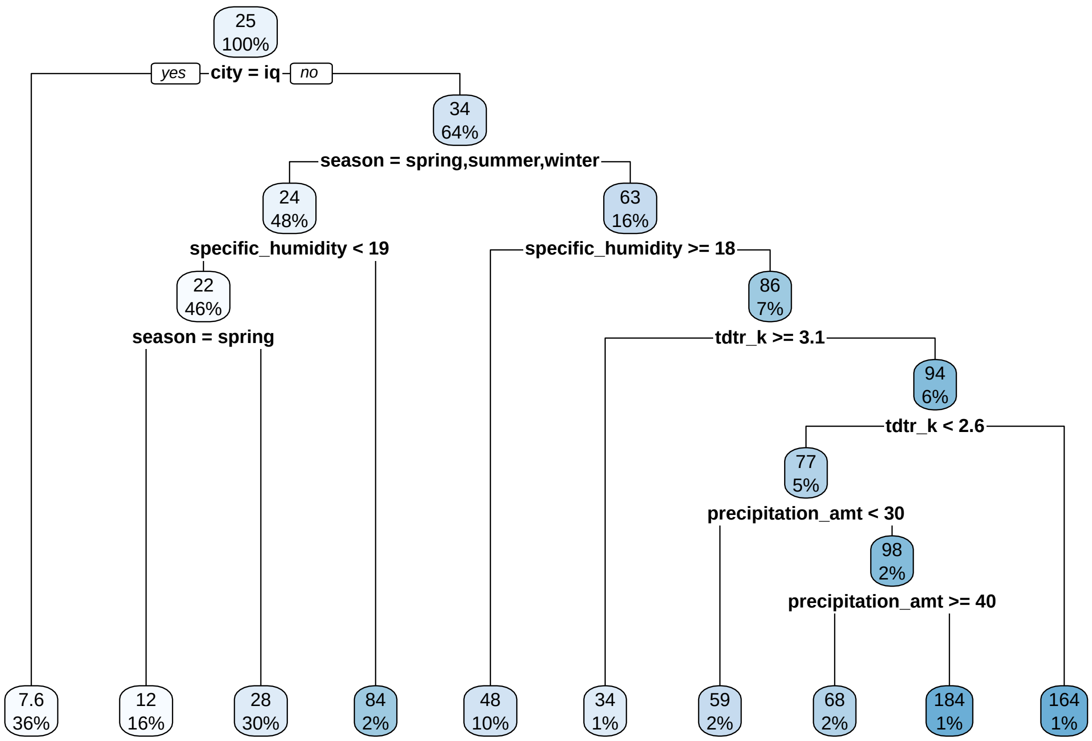

```
reg_dengue = reg_dengue %>%
 mutate (dengue_pred = predict(load.tree)) %>%
  arrange(total_cases)

ggplot(reg_dengue) +
  geom_point(aes(x=season, y=total_cases, color=dengue_pred)) +
  scale_color_continuous(type = "viridis")
```




```
plotcp(load.tree)
```



```r
rpart.plot(load.tree)
```




```r
printcp(load.tree)
```

```
##
## Regression tree:
## rpart(formula = total_cases ~ city + season + specific_humidity +
##     tdtr_k + precipitation_amt, data = reg_dengue)
##
## Variables actually used in tree construction:
## [1] city              precipitation_amt season            specific_humidity
## [5] tdtr_k
##
## Root node error: 2765389/1456 = 1899.3
##
## n= 1456
##
##          CP nsplit rel error  xerror    xstd
## 1 0.091180      0   1.00000 1.00251 0.16275
## 2 0.035197      2   0.81764 0.83037 0.13445
## 3 0.029186      3   0.78244 0.88218 0.13689
## 4 0.024874      4   0.75326 0.88376 0.13485
## 5 0.018934      6   0.70351 0.91134 0.13824
## 6 0.014381      8   0.66564 0.90388 0.13662
## 7 0.010000      9   0.65126 0.94772 0.14340
```

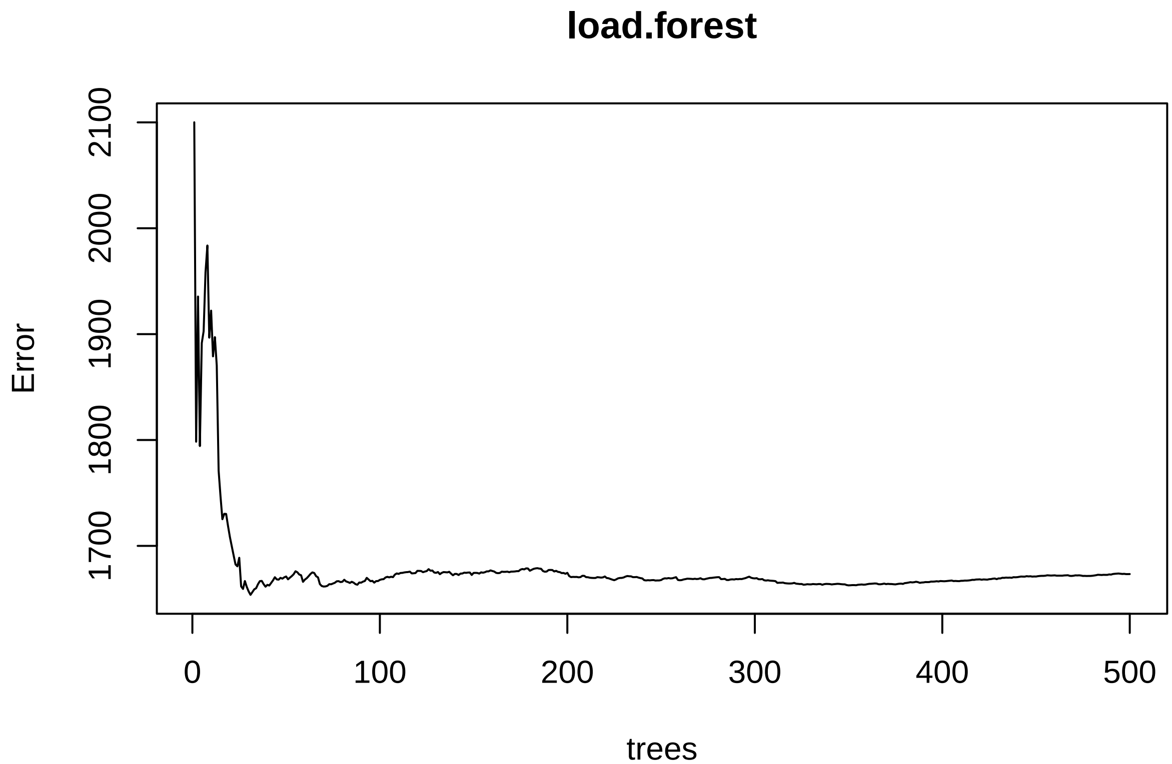
```r
#Random Forrest

load_tree2= read.csv("https://raw.githubusercontent.com/jgscott/ECO395M/master/data/dengue.csv")
head(load_tree2)
```

```
##   city season total_cases   ndvi_ne   ndvi_nw   ndvi_se   ndvi_sw
## 1   sj spring           4 0.1226000 0.1037250 0.1984833 0.1776167
## 2   sj spring           5 0.1699000 0.1421750 0.1623571 0.1554857
## 3   sj spring           4 0.0322500 0.1729667 0.1572000 0.1708429
## 4   sj spring           3 0.1286333 0.2450667 0.2275571 0.2358857
## 5   sj spring           6 0.1962000 0.2622000 0.2512000 0.2473400
## 6   sj summer           2        NA 0.1748500 0.2543143 0.1817429
##   precipitation_amt air_temp_k avg_temp_k dew_point_temp_k max_air_temp_k
## 1             12.42   297.5729   297.7429         292.4143          299.8
## 2             22.82   298.2114   298.4429         293.9514          300.9
## 3             34.54   298.7814   298.8786         295.4343          300.5
## 4             15.36   298.9871   299.2286         295.3100          301.4
## 5              7.52   299.5186   299.6643         295.8214          301.9
## 6              9.58   299.6300   299.7643         295.8514          302.4
##   min_air_temp_k precip_amt_kg_per_m2 relative_humidity_percent
## 1          295.9                32.00                  73.36571
## 2          296.4                17.94                  77.36857
## 3          297.3                26.10                  82.05286
## 4          297.0                13.90                  80.33714
## 5          297.5                12.20                  80.46000
## 6          298.1                26.49                  79.89143
##   specific_humidity   tdtr_k
## 1          14.01286 2.628571
## 2          15.37286 2.371429
## 3          16.84857 2.300000
## 4          16.67286 2.428571
## 5          17.21000 3.014286
## 6          17.21286 2.100000
```

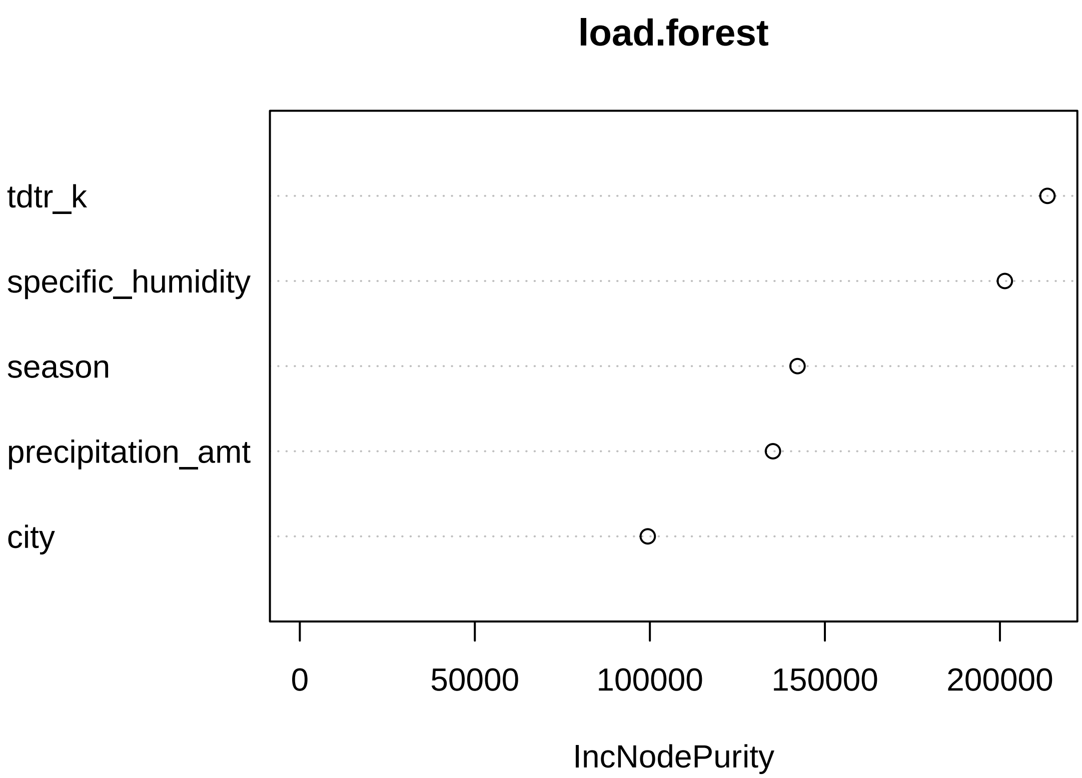
```r
load_split =  initial_split(load_tree2, prop=0.8)
load_train = training(load_split)
load_test  = testing(load_split)

load.forest = randomForest(total_cases ~ city + season + specific_humidity + tdtr_k + precipitation_amt

plot(load.forest)
```




```
vi = varImpPlot(load.forest, type=2)
```




```
par(mfrow=c(3,3))
nms = names(load_train)[1:9]
for(i in 1:9) plot(load.forest,i=nms[i])
```

```
## Warning in plot.window(...): "i" is not a graphical parameter

## Warning in plot.xy(xy, type, ...): "i" is not a graphical parameter

## Warning in axis(side = side, at = at, labels = labels, ...): "i" is not a
## graphical parameter

## Warning in axis(side = side, at = at, labels = labels, ...): "i" is not a
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```

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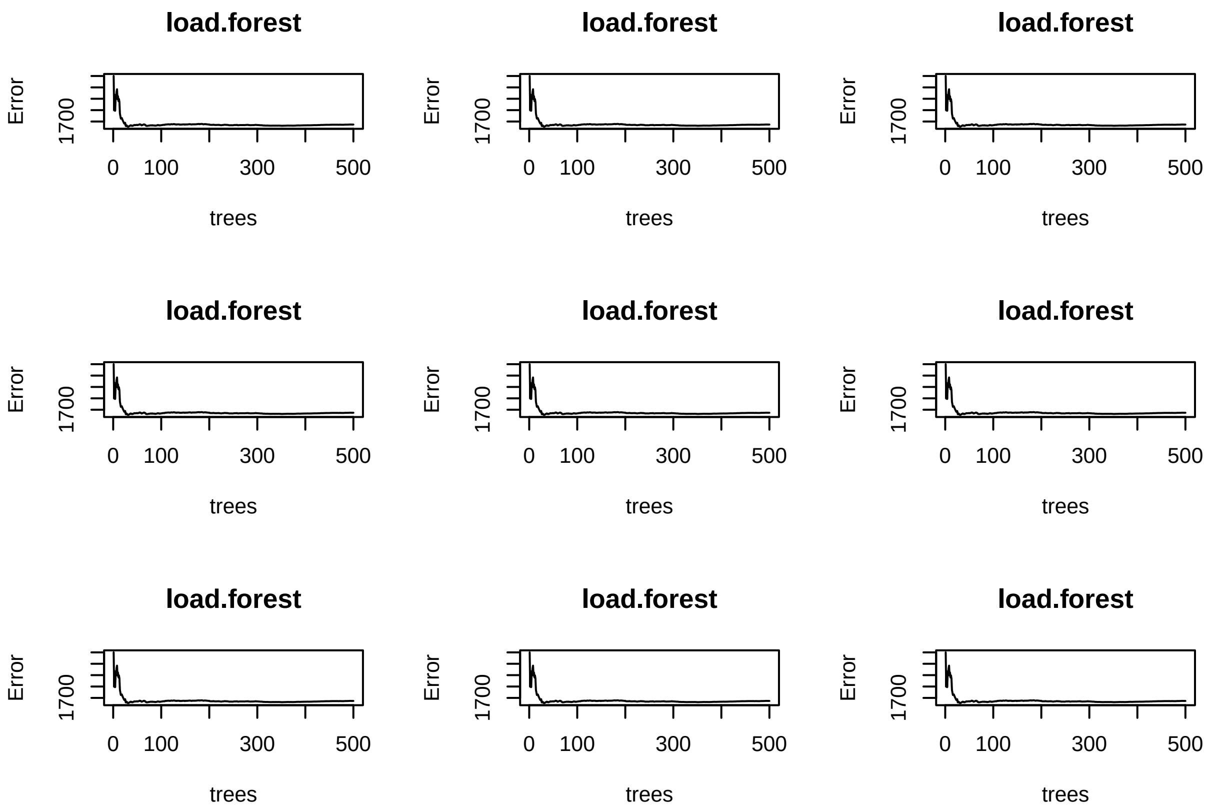
## Warning in title(...): "i" is not a graphical parameter
```




```r
boost1 = gbm(total_cases ~ factor(city) + factor(season) + specific_humidity + tdtr_k + precipitation_am
               interaction.depth=2, n.trees=300, shrinkage=.05)
```

```
## Distribution not specified, assuming gaussian ...
```

```r
gbm.perf(boost1)
```

```
## OOB generally underestimates the optimal number of iterations although predictive performance is reas

## [1] 31
## attr(,"smoother")
## Call:
## loess(formula = object$oobag.improve ~ x, enp.target = min(max(4,
##     length(x)/10), 50))
##
## Number of Observations: 300
## Equivalent Number of Parameters: 24.11
## Residual Standard Error: 1.54
```

```r
modelr::rmse(load.forest, load_test)
```

```
## [1] 32.77927
```

```r
modelr::rmse(load.tree, load_test)
```

```
## [1] 33.46296
```

```r
modelr::rmse(boost1,load_test)
```

```
## Using 300 trees...

## [1] 34.30779
```

```
gbm.perf(boost1)
```

```
## OOB generally underestimates the optimal number of iterations although predictive performance is reas

## [1] 31
## attr(,"smoother")
## Call:
## loess(formula = object$oobag.improve ~ x, enp.target = min(max(4,
##     length(x)/10), 50))
##
## Number of Observations: 300
## Equivalent Number of Parameters: 24.11
## Residual Standard Error: 1.54
```

```
# The Cart Model has the lowest RMSE, we will construct PDP based on it

load.tree %>%
  partial(pred.var = "specific_humidity" ) %>% autoplot
```

```
## Warning: Use of `object[[1L]]` is discouraged. Use `.data[[1L]]` instead.

## Warning: Use of `object[["yhat"]]` is discouraged. Use `.data[["yhat"]]`
## instead.
```

```
load.tree %>%
  partial(pred.var = "precipitation_amt" ) %>% autoplot
```

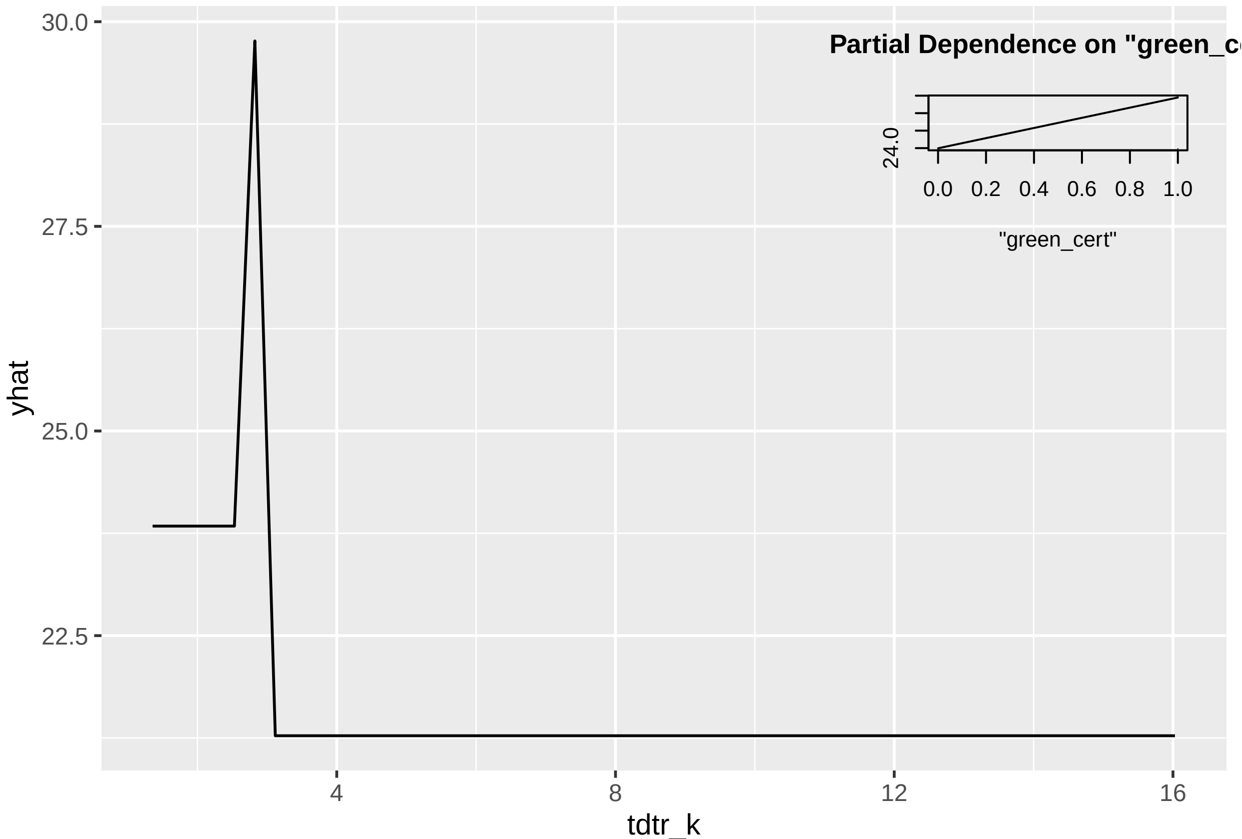
```
## Warning: Use of `object[[1L]]` is discouraged. Use `.data[[1L]]` instead.

## Warning: Use of `object[["yhat"]]` is discouraged. Use `.data[["yhat"]]`
## instead.
```

```
load.tree %>%
  partial(pred.var = "tdtr_k" ) %>% autoplot
```

```
## Warning: Use of `object[[1L]]` is discouraged. Use `.data[[1L]]` instead.

## Warning: Use of `object[["yhat"]]` is discouraged. Use `.data[["yhat"]]`
## instead.
```

```
#Green Building

green = green %>%
  mutate(green_cert =  ifelse( LEED == 1 | Energystar == 1,
                        yes=1, no=0))%>%
  mutate(revenue =  Rent* leasing_rate/100)%>%
  mutate(lrevenue = log(revenue))


forest_green = randomForest(revenue ~ class_a + stories + size + cluster + age + renovated + green_cert




pd_green = partialPlot(forest_green,green, "green_cert")

print(pd_green)
```

```
## $x
## [1] 0 1
##
## $y
## [1] 23.99526 25.44774
```



Report for Green Building.

By using a random forest model, I fitted a predicative model for the revenue per square foot per calendar that took in to considerations the age, stories, size and location of the building, as well as the build qualit. By building the partial depedence plot, I was able to isolated the effect of having a green certificated (LEED or Energy Star), to about $1.3 dollars increase in revenue.

You can also embed plots, for example:

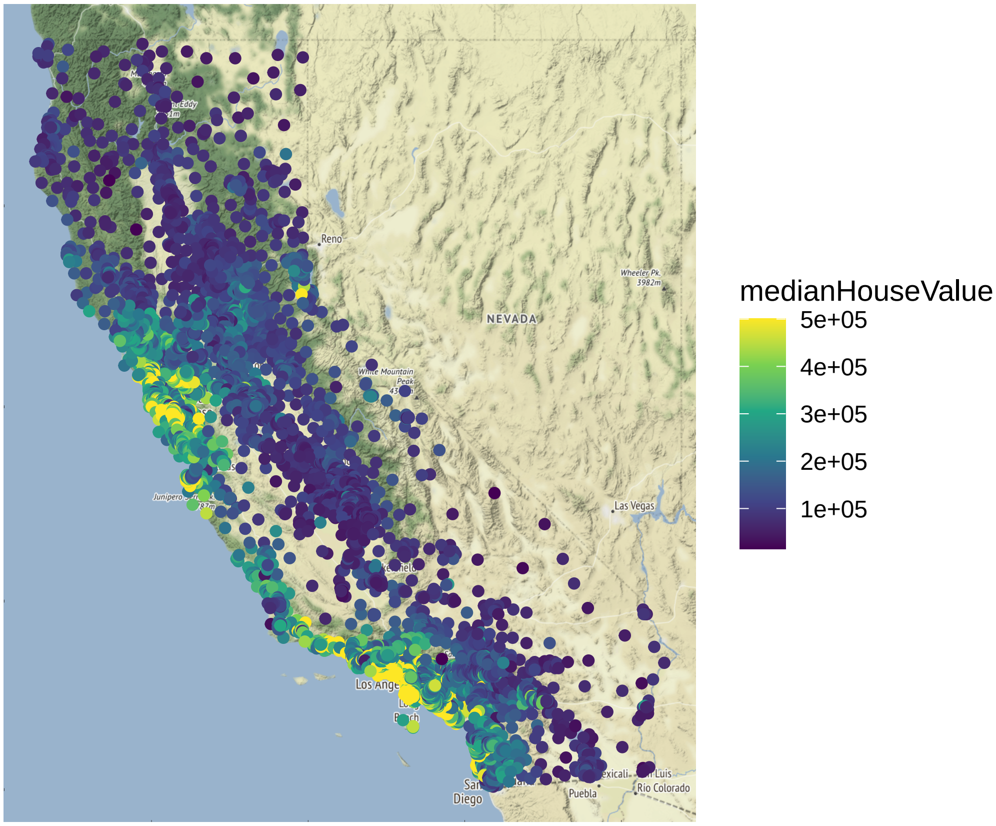
```
## # A tibble: 6 x 9
##   longitude latitude housingMedianAge totalRooms totalBedrooms population
##       <dbl>    <dbl>            <dbl>      <dbl>         <dbl>      <dbl>
## 1     -122.     37.9               41        880           129        322
## 2     -122.     37.9               21       7099          1106       2401
## 3     -122.     37.8               52       1467           190        496
## 4     -122.     37.8               52       1274           235        558
## 5     -122.     37.8               52       1627           280        565
## 6     -122.     37.8               52        919           213        413
## # ... with 3 more variables: households <dbl>, medianIncome <dbl>,
## #   medianHouseValue <dbl>
```

```
## Using zoom = 7...
```

```
## Source : http://tile.stamen.com/terrain/7/19/47.png
```

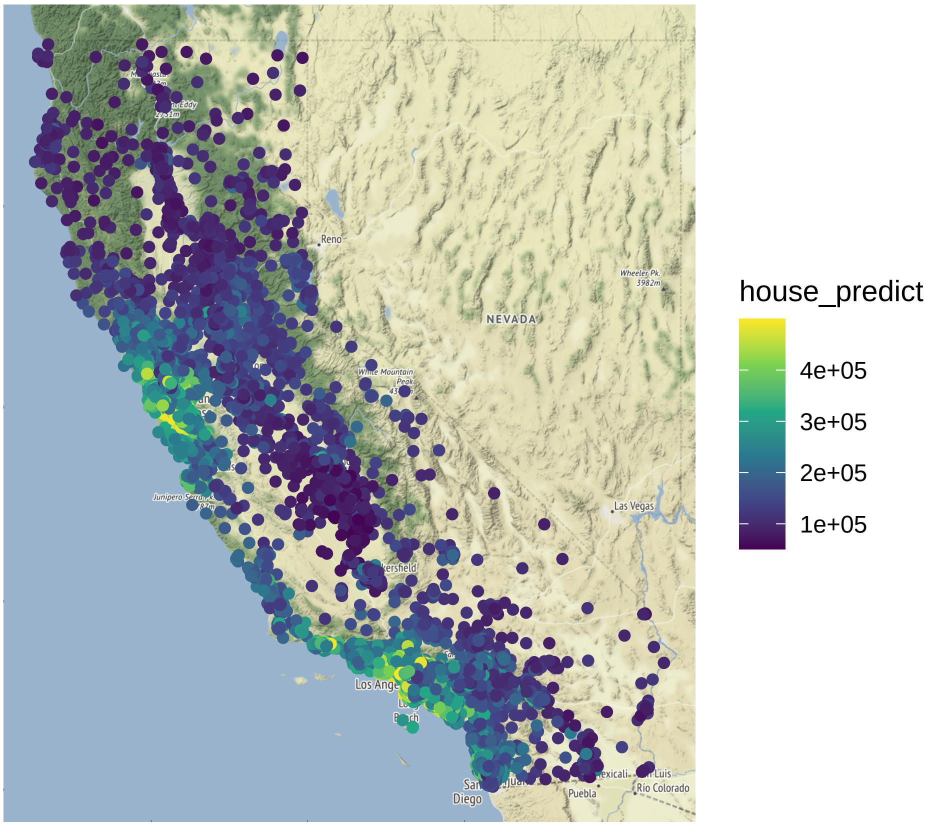
```
## Source : http://tile.stamen.com/terrain/7/20/47.png
## Source : http://tile.stamen.com/terrain/7/21/47.png
## Source : http://tile.stamen.com/terrain/7/22/47.png
## Source : http://tile.stamen.com/terrain/7/23/47.png
## Source : http://tile.stamen.com/terrain/7/19/48.png
## Source : http://tile.stamen.com/terrain/7/20/48.png
## Source : http://tile.stamen.com/terrain/7/21/48.png
## Source : http://tile.stamen.com/terrain/7/22/48.png
## Source : http://tile.stamen.com/terrain/7/23/48.png
## Source : http://tile.stamen.com/terrain/7/19/49.png
## Source : http://tile.stamen.com/terrain/7/20/49.png
## Source : http://tile.stamen.com/terrain/7/21/49.png
## Source : http://tile.stamen.com/terrain/7/22/49.png
## Source : http://tile.stamen.com/terrain/7/23/49.png
## Source : http://tile.stamen.com/terrain/7/19/50.png
## Source : http://tile.stamen.com/terrain/7/20/50.png
## Source : http://tile.stamen.com/terrain/7/21/50.png
## Source : http://tile.stamen.com/terrain/7/22/50.png
## Source : http://tile.stamen.com/terrain/7/23/50.png
## Source : http://tile.stamen.com/terrain/7/19/51.png
## Source : http://tile.stamen.com/terrain/7/20/51.png
## Source : http://tile.stamen.com/terrain/7/21/51.png
## Source : http://tile.stamen.com/terrain/7/22/51.png
## Source : http://tile.stamen.com/terrain/7/23/51.png
```

Orginal Data



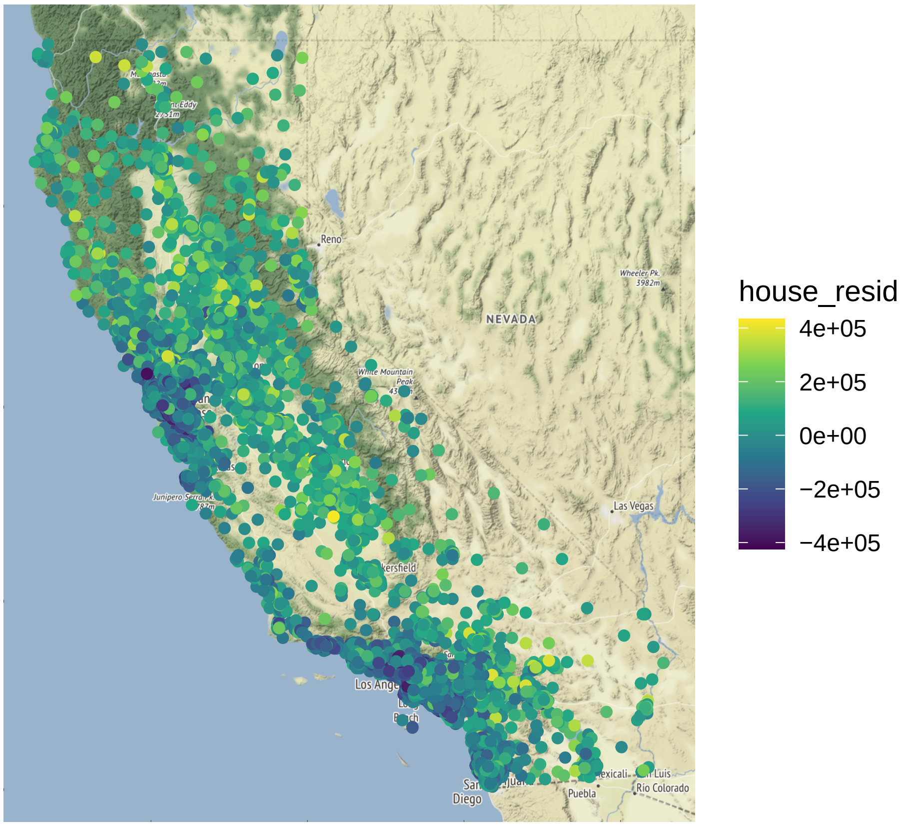

```
## Using zoom = 7...
```

Model Predication



Using zoom = 7...

Residuals




```
## [1] 51405.59
```

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.