Advanced Statistics
Assignment 1
Claude M. Schrader

Research Question:

How well do the percentage of population that are college graduates, the percentage of households with broadband availability in January 2004, and population density explain the variation in percentage of Kentucky households subscribing to broadband internet in 2005?

Measures:

adopt05 is the percentage of Kentucky households subscribing to broadband from a 2005 survey. This is the dependant variable.

college tracks the percent of college graduates in the population in 2004.

hhpct_0401 is the percentage of Kentucky households with broadband available to them.

popden2000 is the Population Density as of the 2000 census.

	adopt05	college	hhpct_0401	popden2000
nbr.val	120.000000000	120.000000000	120.00000000	120.000000
nbr.null	0.000000000	0.000000000	0.00000000	0.000000
nbr.na	0.000000000	0.000000000	0.00000000	0.000000
min	0.071000000	0.041000000	0.00400000	16.100000
max	0.548000000	0.472000000	1.00000000	1336.700000
range	0.477000000	0.431000000	0.99600000	1320.600000
sum	28.654000000	24.981000000	67.18200000	9964.300000
median	0.214500000	0.196000000	0.60050000	45.300000
mean	0.238783333	0.208175000	0.55985000	83.035833
SE.mean	0.009236575	0.007408363	0.02594906	13.992603
CI.mean.0.95	0.018289340	0.014669299	0.05138173	27.706752
var	0.010237717	0.006586062	0.08080245	23495.153075
std.dev	0.101181606	0.081154554	0.28425771	153.281287
coef.var	0.423738141	0.389838134	0.50773906	1.845966

Methods:

The Null hypothesis: college, hhpct_0401, and popden2000 do not have a statistically significant effect on adopt05

The Alternative hypothesis: these three variables will have a statistically significant effect on adopt05.

The regression test performed will try to fit a line to a scatterplot of each of the dependent variables with adopt05, and generate data that will enable us to quantify the accuracy and significance of this test.

For the test statistic, R will perform a T test, which uses the t distribution to give you the t score for a particular value. In this case, it will perform a T test on the slope of each fitted line and of the intercept. If this T value is greater than 1.96 or less than -1.96, the value in question is statistically significant at the 95% confidence level.

The line fitted to the dataset can also be useful for drawing inferences about other samples than the data. This line isn't aware of things like the fact that a percentage cannot be greater than 100%, so some careful attention to this inferred data is necessary.

Results:

After trying a few models, I settled on model 6, which has adopt05 as the dependent variable, and college, hhpct_0401, and popden2000 as the three independent variables. With the highest R^2 and adjusted R^2, this model explains the largest amount of variance in adopt05. With t scores over 1.96, and p values for the t test less than 0.01, the fit lines for all three independent variables are statistically significant. The p value of the F statistic is also less than .01, which indicates that the fit of the line is statistically significant.

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Model 1:

             Estimate Std. Error t value     Pr(>|t|)

(Intercept) 0.0673175  0.0312489   2.154       0.0333 *

medhhinc    0.0046882  0.0008243   5.687 0.0000000953 ***

Residual standard error: 0.09002 on 118 degrees of freedom

Multiple R-squared:  0.2151, Adjusted R-squared:  0.2085

F-statistic: 32.35 on 1 and 118 DF,  p-value: 0.00000009531


Model 3:

             Estimate Std. Error t value Pr(>|t|)

(Intercept)  0.402968   0.168809   2.387 0.018597 *

medhhinc     0.001405   0.001071   1.312 0.192023

college      0.503936   0.136904   3.681 0.000354 ***

medage      -0.007055   0.003502  -2.015 0.046249 *

Residual standard error: 0.08291 on 116 degrees of freedom

Multiple R-squared:  0.3455, Adjusted R-squared:  0.3286
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F-statistic: 20.41 on 3 and 116 DF,  p-value: 0.0000000001087


Model 6:

              Estimate Std. Error t value  Pr(>|t|)

(Intercept) 0.08623234 0.02123268   4.061 0.0000890 ***

college     0.42934669 0.10008186   4.290 0.0000372 ***

hhpct_0401  0.08673592 0.02800457   3.097  0.002450 **

popden2000  0.00017598 0.00005173   3.402  0.000918 ***


Residual standard error: 0.07628 on 116 degrees of freedom

Multiple R-squared:  0.446,  Adjusted R-squared:  0.4316

F-statistic: 31.12 on 3 and 116 DF,  p-value: 0.000000000000007787
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Conclusion:

The results of model 6 seem reasonable to me, at first analysis. College grads, broadband availability, and population density all have a statistically significant effect on broadband adoption. This seems to indicate that more urban areas had higher broadband adoption in 2005, This all seems to make sense when you consider the concentration of white collar jobs in urban areas, and the difficulty in maintaining affordable and reliable broadband in rural areas.

To refine this analysis, I would want to repeat it for multiple years, looking for trends and changes over time. It would also be useful to gather data on education and marketing campaigns if possible, to help determine whether any effort and money spent on outreach was allocated properly.

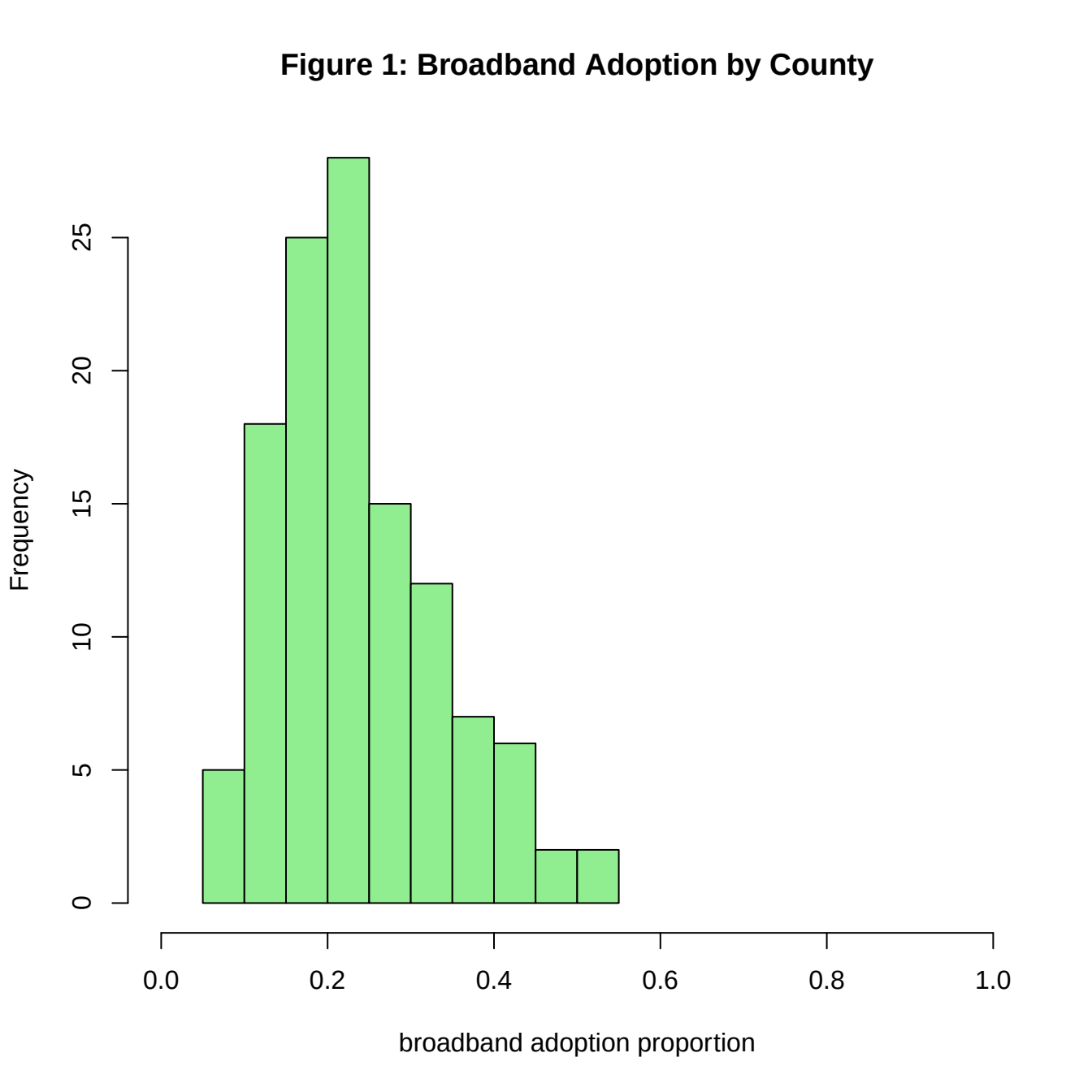


Figure 1: Broadband Adoption by County
Frequency
0
5
10
15
20
25
0.0
0.2
0.4
0.6
0.8
1.0
broadband adoption proportion

Figure 2: Broadband adoption vs. availability

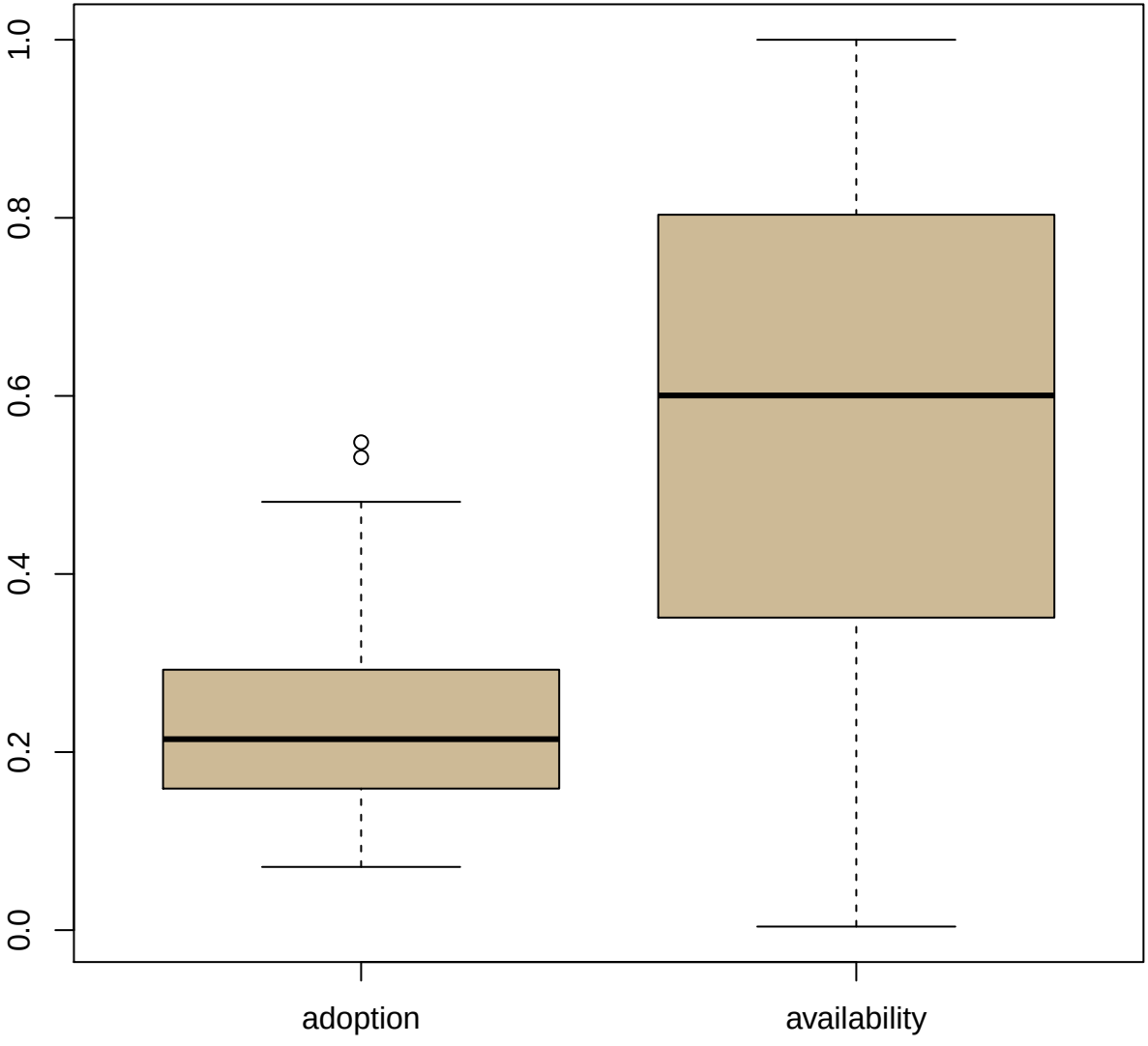
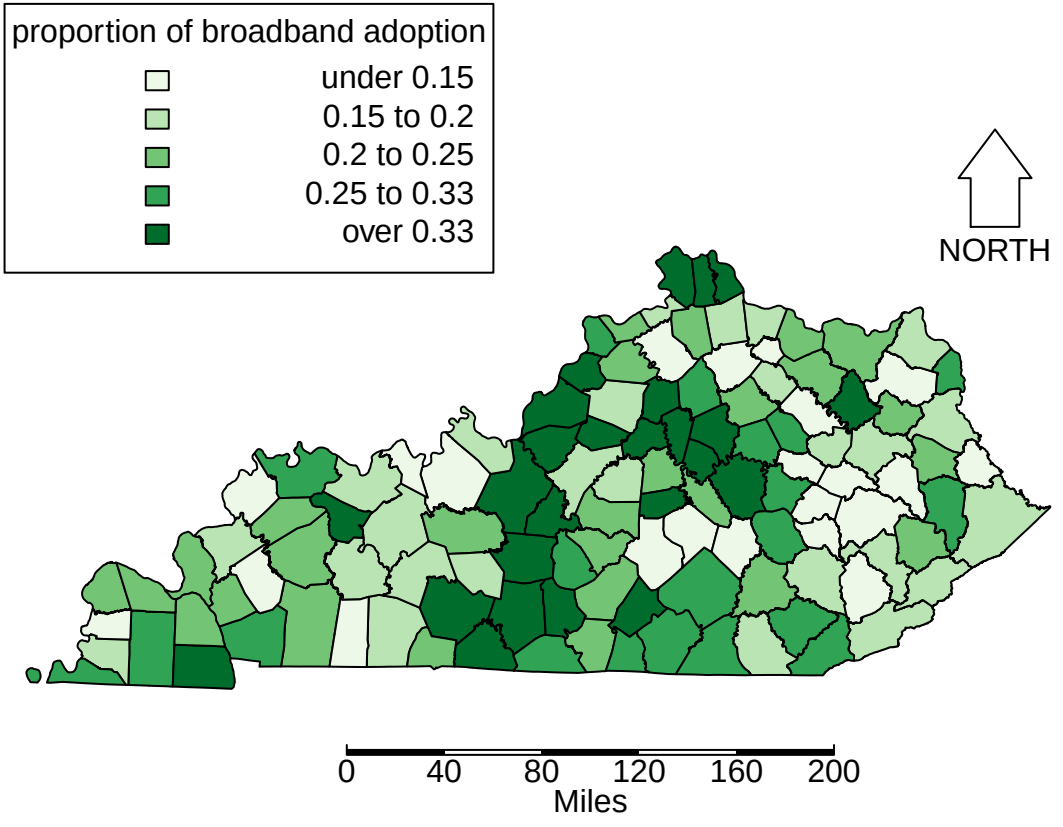
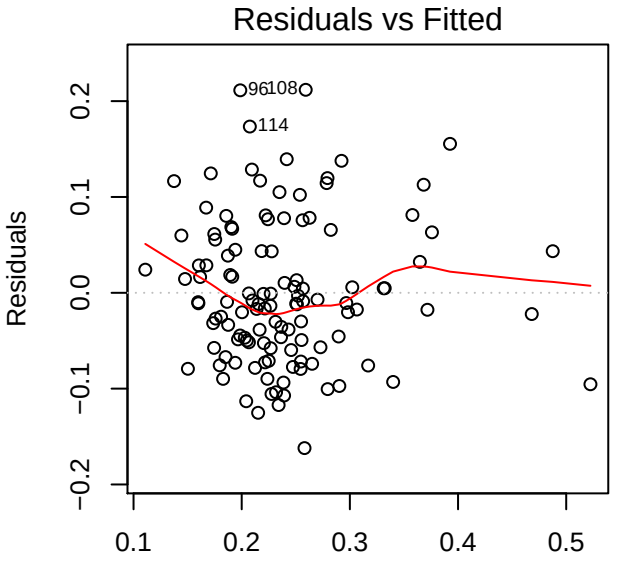
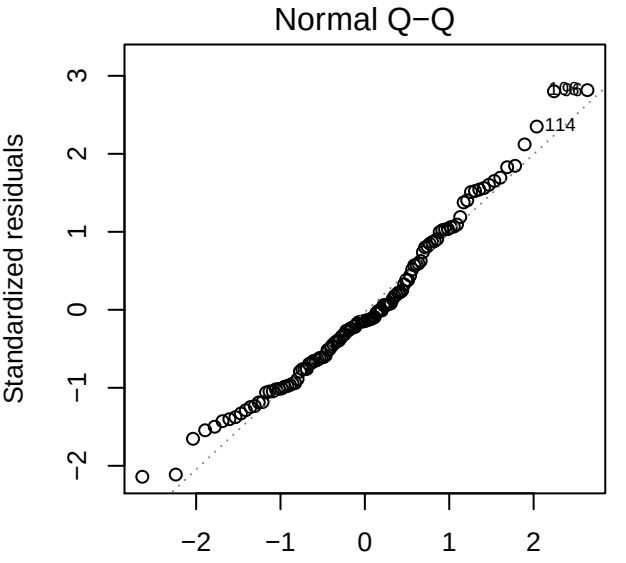
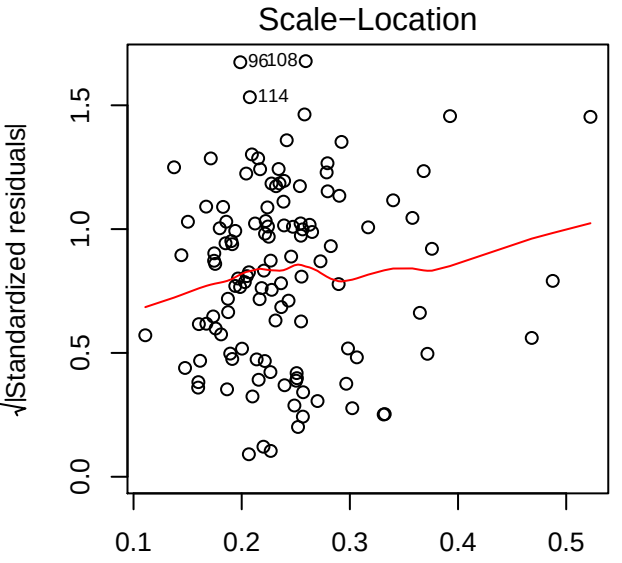


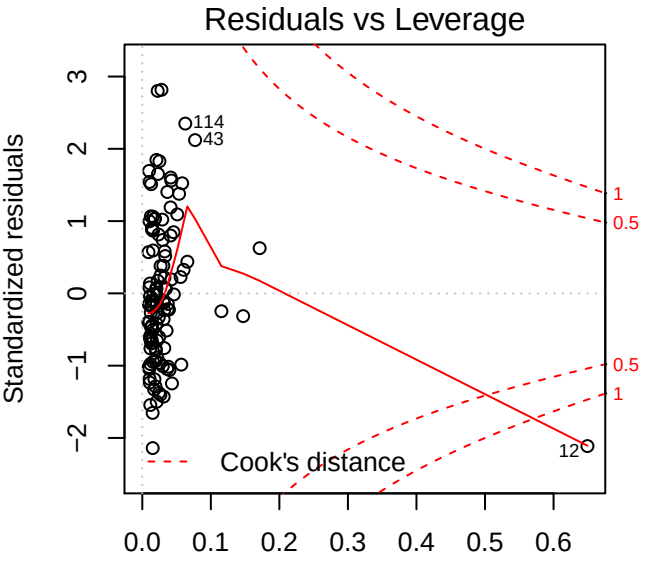
Figure 3: Kentucky Broadband Adoption Rate




Residuals vs Fitted
Residuals
96108
114
0.2
0.1
0.0
−0.1
−0.2
0.1
0.2
0.3
0.4
0.5


Normal Q−Q
Standardized residuals
96
114
3
2
1
0
−1
−2
−2
−1
0
1
2


Scale−Location
√|Standardized residuals|
96108
114
1.5
1.0
0.5
0.0
0.1
0.2
0.3
0.4
0.5


Residuals vs Leverage
Standardized residuals
114
43
12
Cook's distance
1
0.5
0.5
1
3
2
1
0
−1
−2
0.0
0.1
0.2
0.3
0.4
0.5
0.6