PSTAT126 Project Step-2

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Introduction

Our data source is from: Anna Montoya, DataCanary. (2016). House Prices - Advanced Regression Techniques. Kaggle.Obtained from https://kaggle.com/competitions/house-prices-advanced-regression-techniques (https://kaggle.com/competitions/house-prices-advanced-regression-techniques) (https://kaggle.com/competitions/house-prices□advanced-regression-techniques (https://kaggle.com/competitions/house-prices□advanced-regression-techniques))

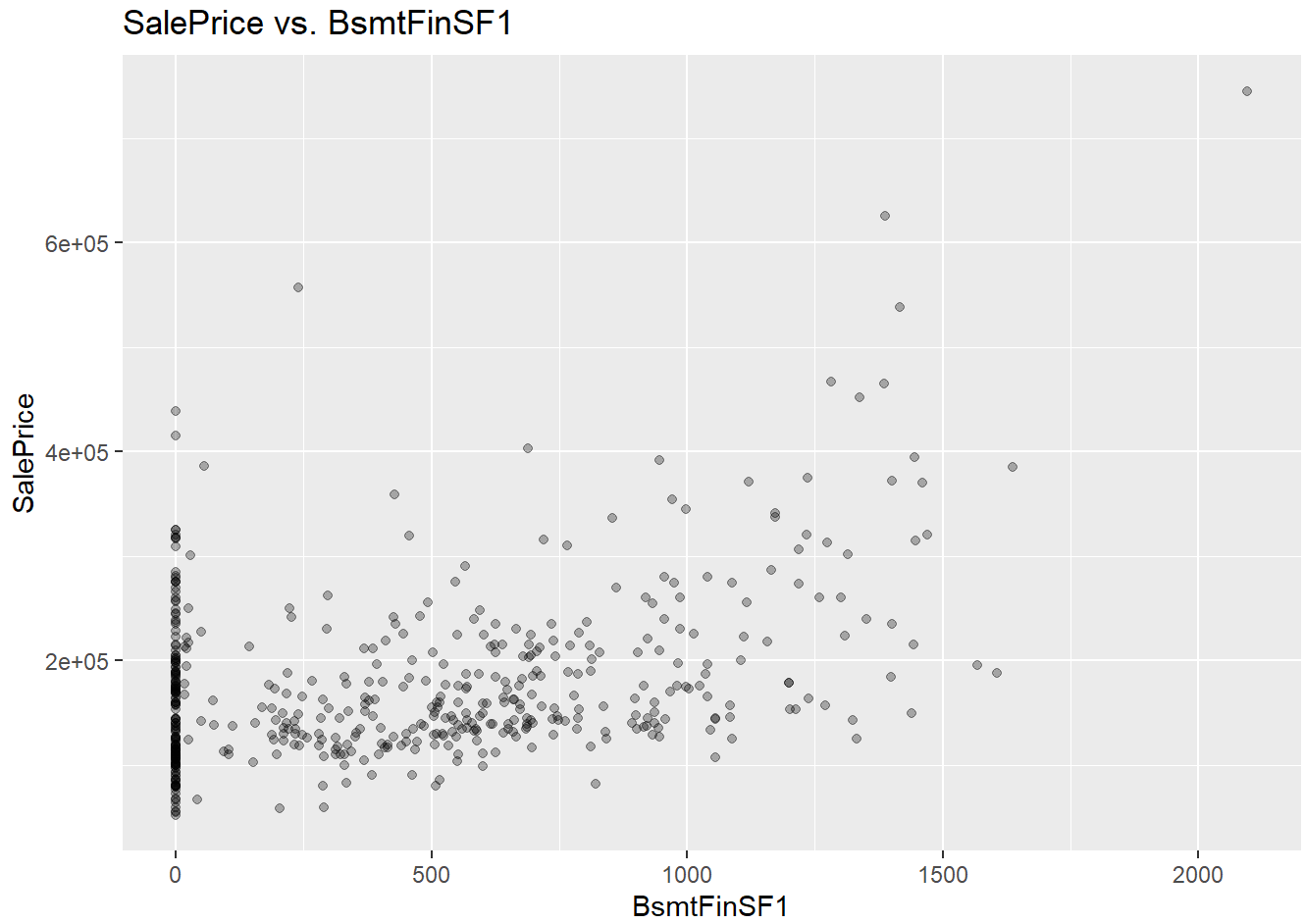
The population that we are inferring our results on are all residential houses in Ames, Iowa.

We are using the variables BsmtFinSF1 and SalePrice as our variables of interest. The BsmtFinSF1 variable is our predictor variable that we will use for hypothesis testing and plotting. The BsmtFinSF1 variable refers to the basement finished area square feet in the overall housing data. The SalePrice variable refers to the property's sale price in dollars, and it is our response, or dependent, variable that is affected by BsmtFinSF1.

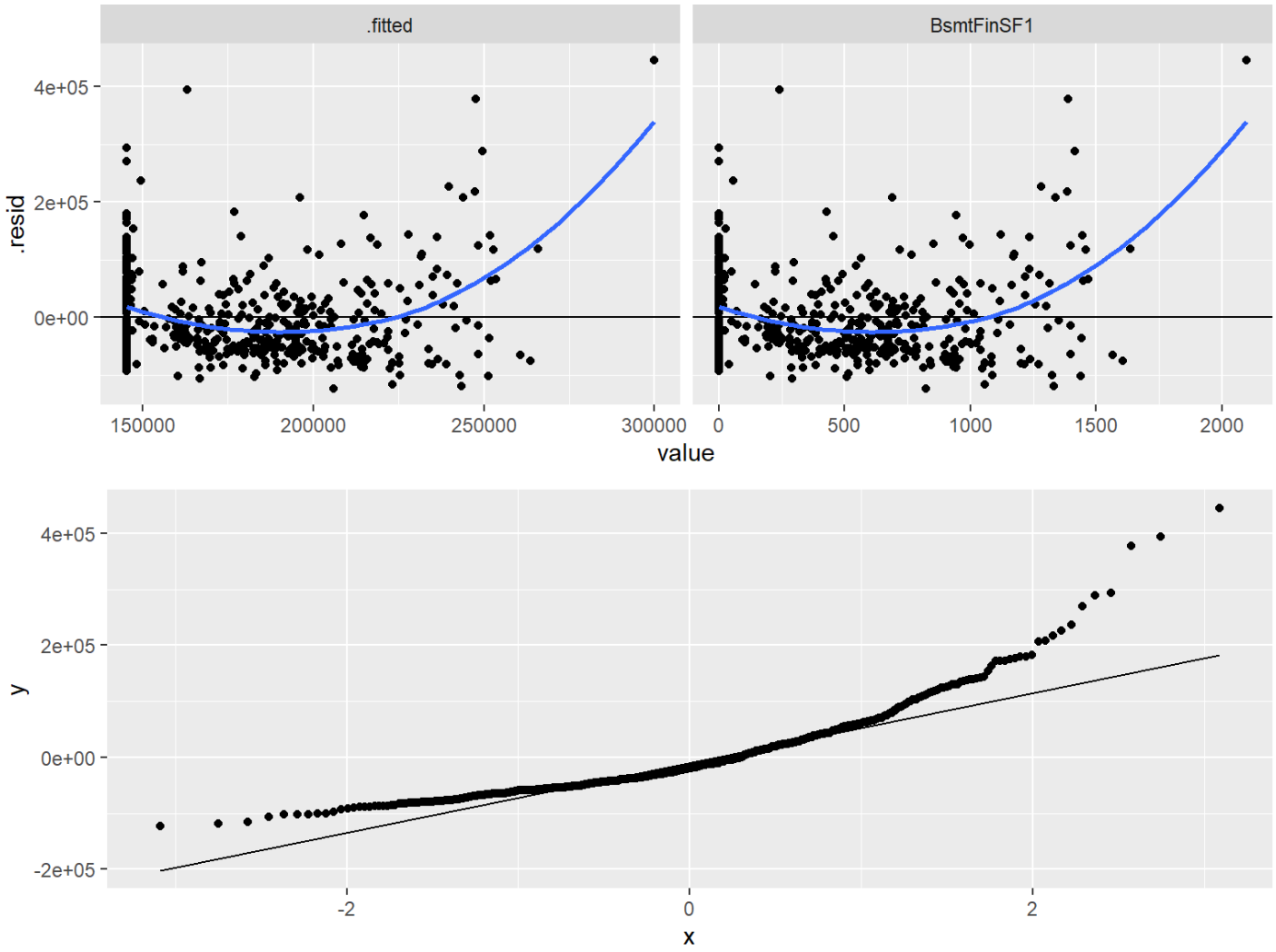
We first fitted a simple linear model, and after exploring the data and checking model assumptions, we did a log-transformation on our response variable in order to fit the model better.

Hypothesis: Our hypothesis is based on the predictor variable, BsmtFinSF1, and the response variable, SalePrice. Our null hypothesis is that BsmtFinSF1 and SalePrice are not linearly correlated, beta_1 = 0. Our alternative hypothesis is that BsmtFinSF1 and SalePrice are positively correlated, beta_1 > 0.

Simple Linear Model



Assumption checks for the simple linear model

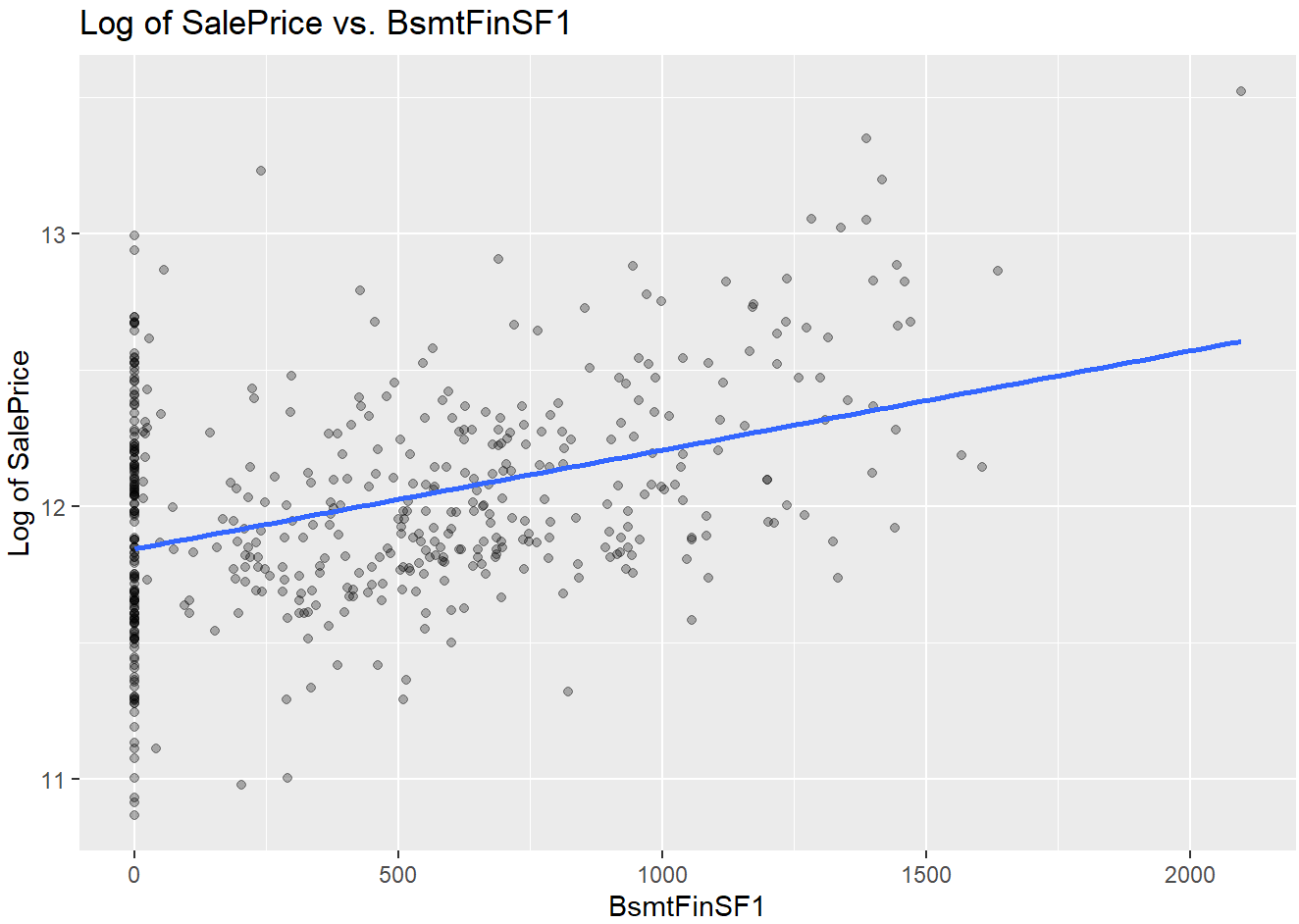


The residual vs. fitted plot showed some slight pattern(i.e. greater variance at the two ends and smaller variance in the middle), and the qq plot also showed a slightly curved line, so we decided to try log transforming our response variable SalePrice to get a more constant variance.

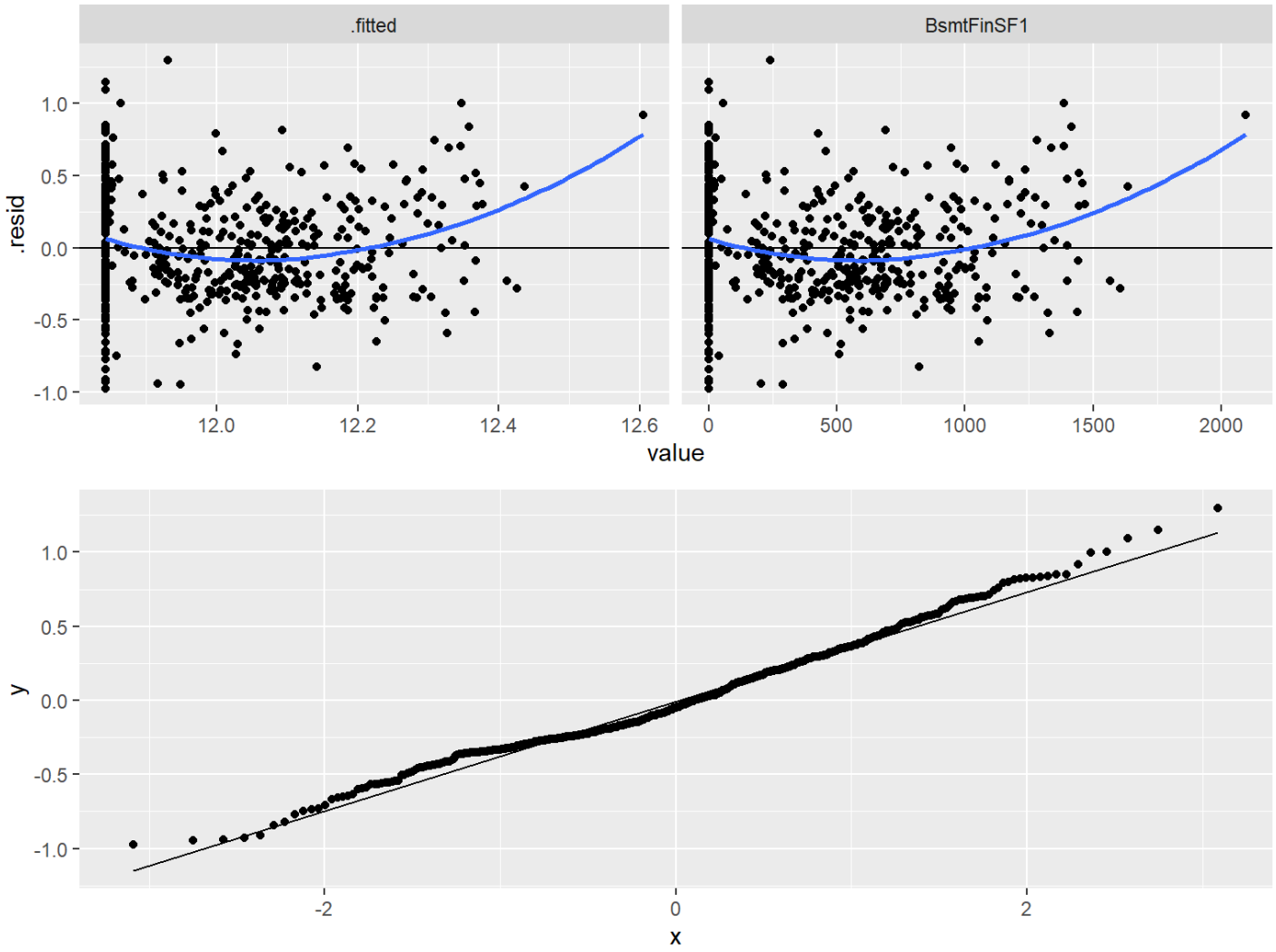
Log Model

In the following section we attempted to do a log transformation on the response variable, SalePrice, and fit the explanatory variable, BsmtFinSF1, linearly with the log transformed response.

Plot log transformed data



Assumption checks for log model



As we can see from the residual vs. fitted plot and qq plot for the log model, the log transformation makes the variance of the residuals more constant throughout our data set, and the qq plot fits a straight line much better after the log transformation. These tells us that the log transformed model meets the assumptions we made better, thus we decided to proceed with the log transformed model.

T-test for beta_1

We performed a t-test on the coefficient of BsmtFinSF1 in our linear model, beta_1.

Hypothesis: Our hypothesis is based on the predictor variable, BsmtFinSF1, and the response variable, SalePrice. Our null hypothesis is that BsmtFinSF1 and SalePrice are not linearly correlated, beta_1 = 0. Our alternative hypothesis is that BsmtFinSF1 and SalePrice are positively correlated, beta_1 > 0.

p value:

```
##                Estimate   Std. Error    t value     Pr(>|t|)
## (Intercept) 1.184366e+01 2.395519e-02 494.408910 0.000000e+00
## BsmtFinSF1  3.626989e-04 3.868634e-05   9.375375 2.413948e-19
```

Conclusion: We are doing a one sided test, so the p-value will be divided by 2. As a result, we get a very small p-value, 2.41e-19, which allows us to reject our null hypothesis that beta_1 = 0 and accept our alternative hypothesis that beta_1 > 0. Our conclusion from the t-test is that BsmtFinSF1 is positively correlated with the log of the SalePrice.

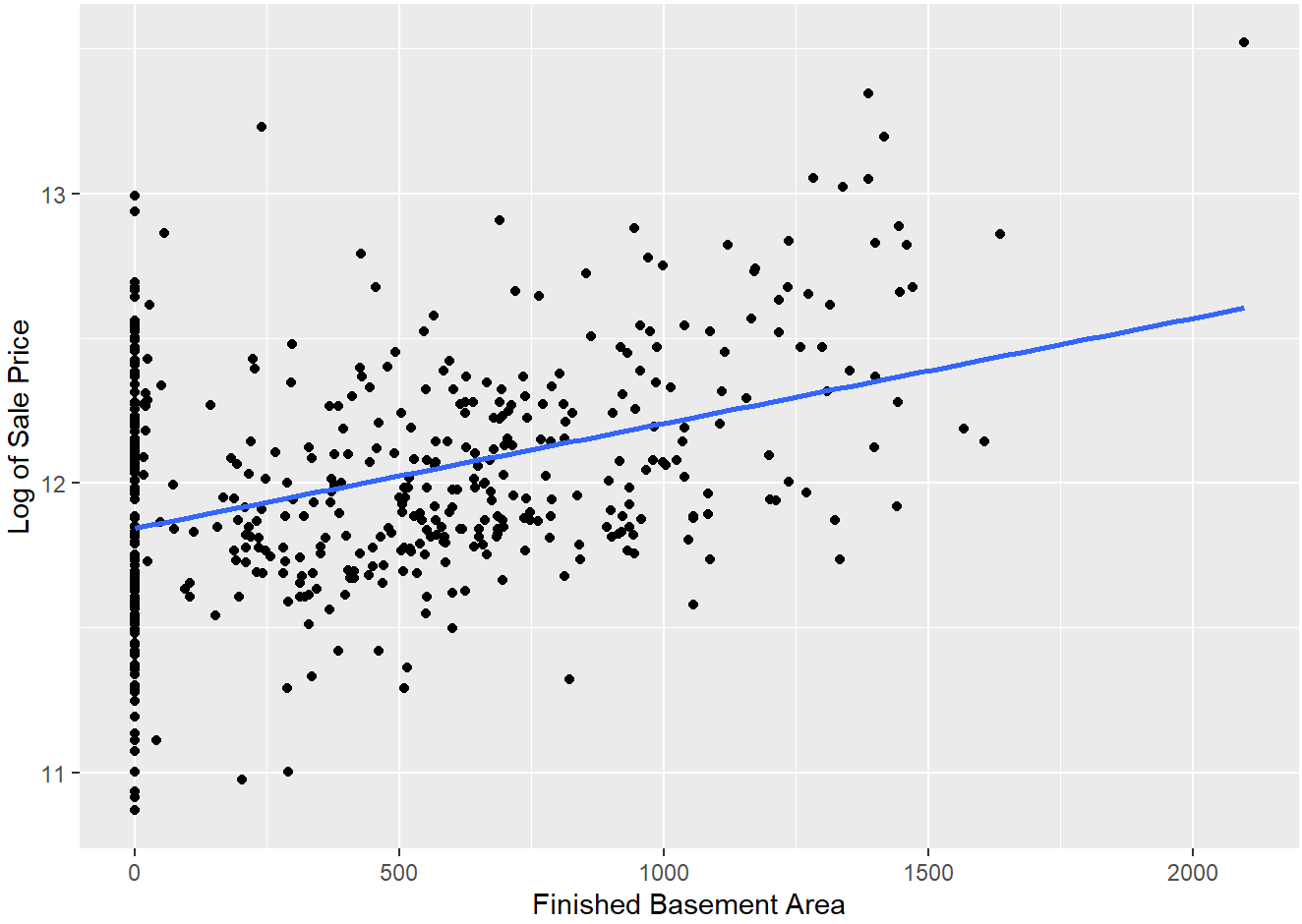
confidence interval for beta_1(BsmtFinSF1)

The confidence interval we computed for beta_1 is:

```
##                   2.5 %       97.5 %
## BsmtFinSF1 0.0002866904 0.0004387075
```

Interpretation: With 95% confidence, a 1 square foot increase in basement square feet is associated with an increase in average of the log of the sales prices between an estimated 0.0002866904 and 0.0004387075.

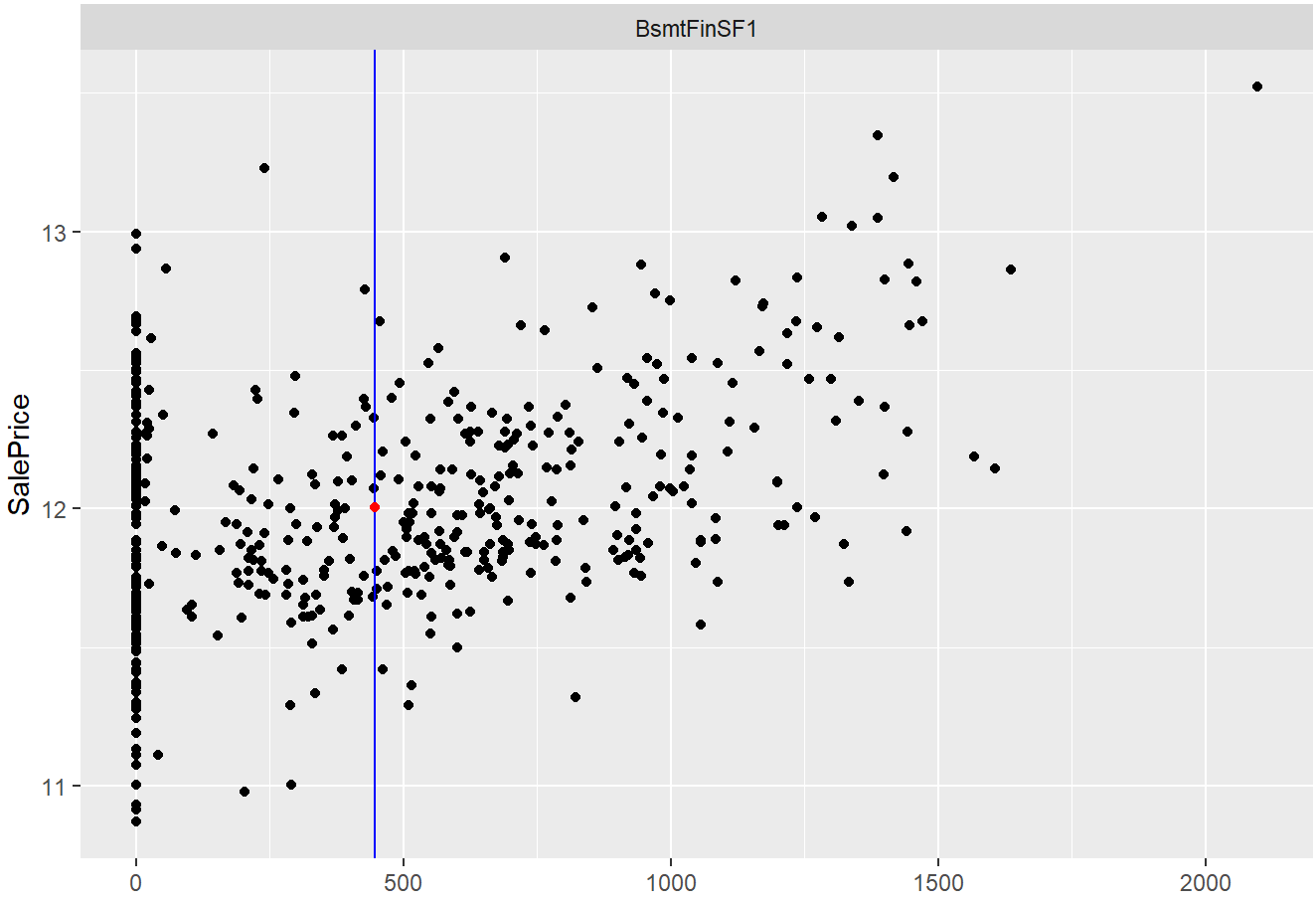
Plot transformed with fitted linear line



Confidence interval for mean and individual response

Confidence interval for mean

The following graph displays the mean of BsmtFinSF1(basement finished area), at which the following CI is calculated and the fitted value of response at the mean of BsmtFinSF1.



Confidence interval:

```
##       fit      lwr      upr
## 1 12.0053 11.97263 12.03798
```

Interpretation: With 95% confidence, the mean of the log SalePrice for a house with basement area equal to the average in the data is estimated to be between 11.97263 and 12.03798.

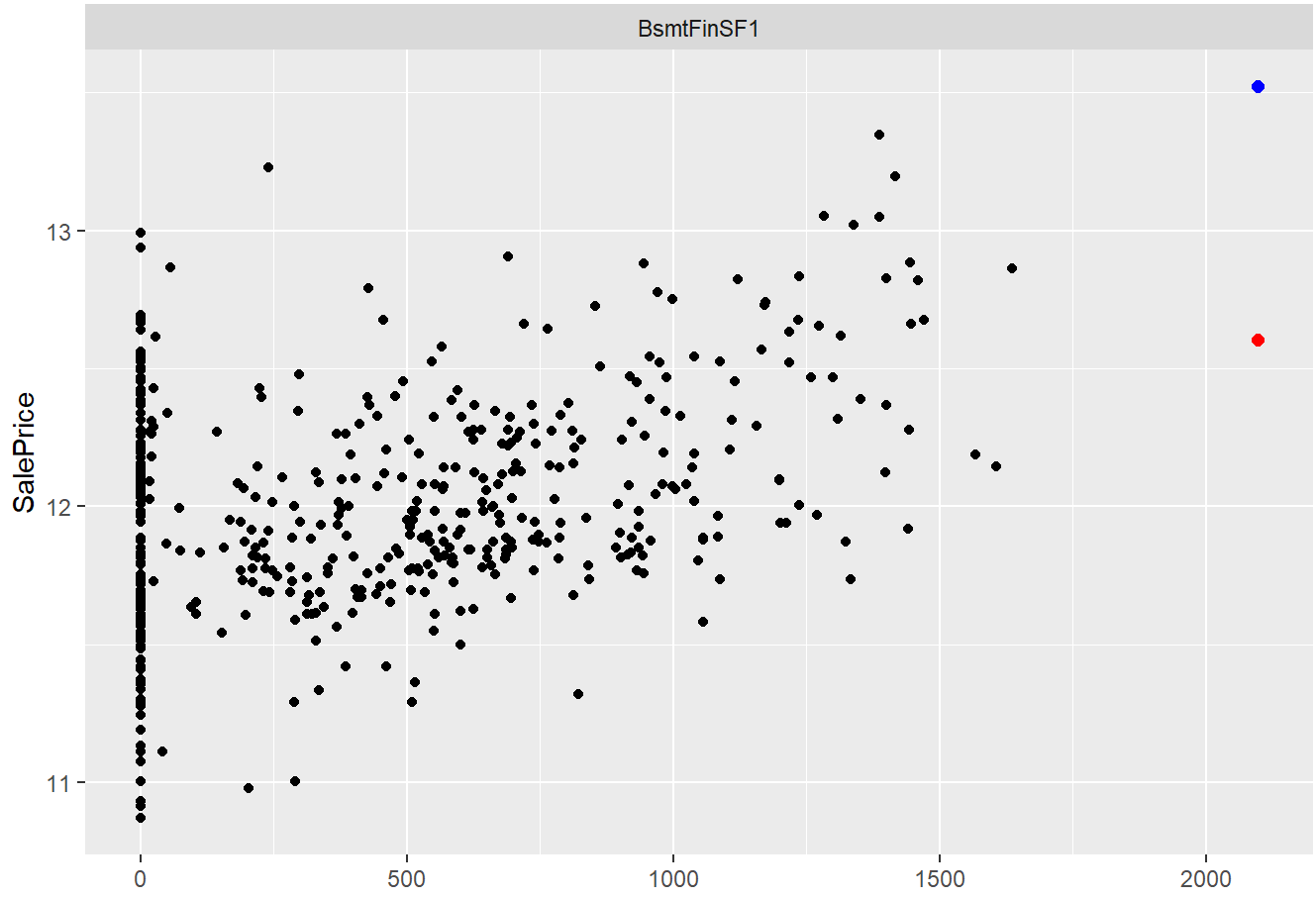
Confidence interval for individual response at an interesting x value

We used the point with x(basement finished area) value of 2096 as our point of interest, because this is the largest basement finished area in the 500 observations we used and the point is an outlier in our data.

```
## [1] 2096
```

```
## # A tibble: 1 × 1
##   BsmtFinSF1
##        <dbl>
## 1       2096
```

In the following graph, the actual data point at x = 2096 is shown in blue and the fitted value of our model is shown in red.



Confidence interval:

```
##        fit      lwr      upr
## 1 12.60388 11.86181 13.34594
```

Interpretation: With 95% confidence, the predicted log of the SalePrice of a house with a finished basement area of 2096 square feet is estimated to be between 11.86181 and 13.34594.

Interesting feature: The actual value of the log of the sale price of the house with a finished basement area of 2096 square feet is outside(greater than) the prediction interval we obtained using our model. This is interesting because it tells us it is very challenging to predict sale prices of houses that are extremely large(judged by its basement area), potentially some luxury properties, using a simple linear model as the one we built.

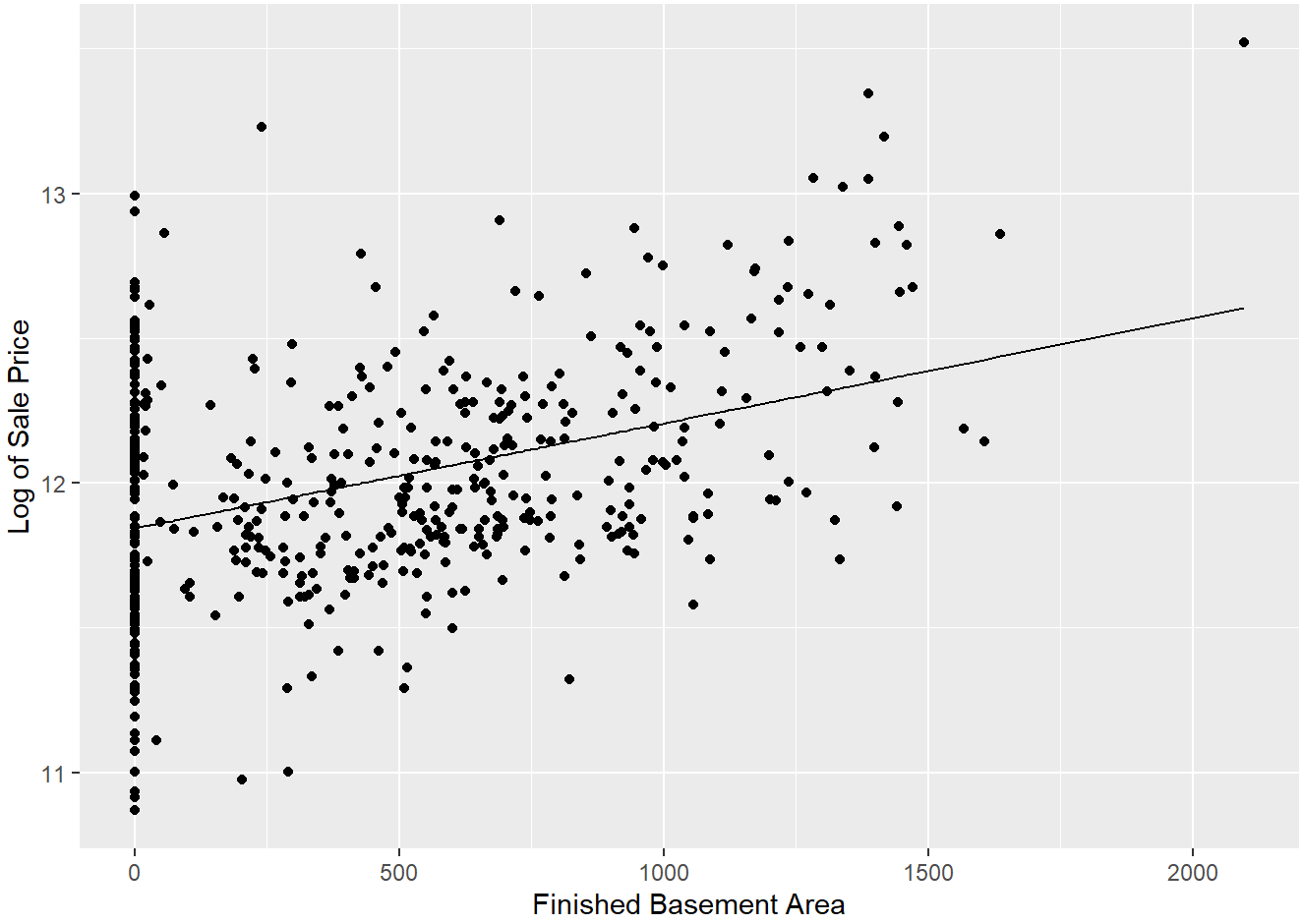
R^2

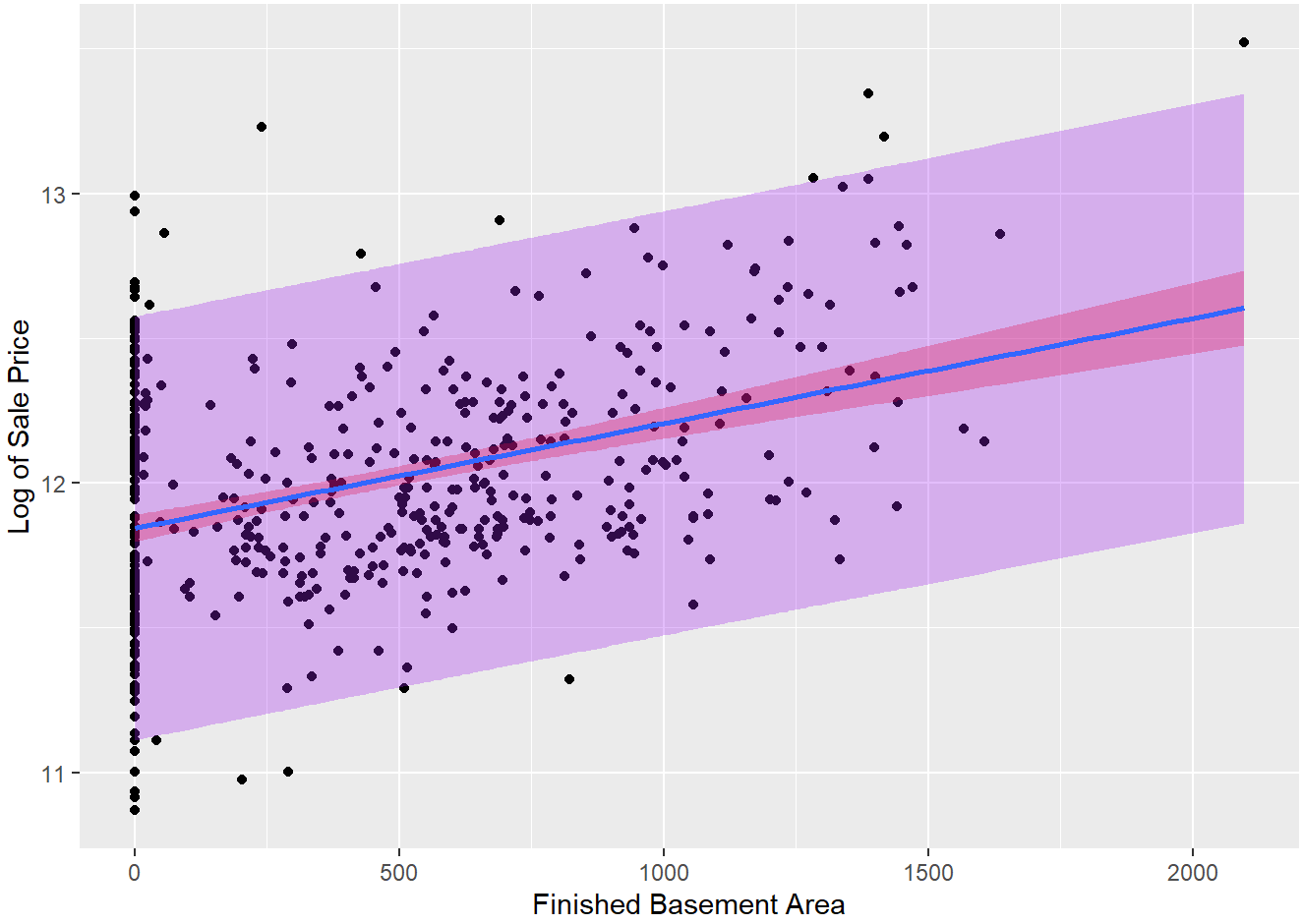
```
## [1] 0.1483154
```

Our model has an Adjusted R-squared value of 0.1482. This tells us that 14.82% of the variance in SalePrice is explained by our simple linear model with the explanatory variable basement finished area(BsmtFinSF1). This means our model explains only a relatively small amount of the variance, but it is reasonable considering we are only using one variable.

Add confidence bands + prediction bands

This gives us the path:


Log of Sale Price
13
12
11
0
500
1000
1500
2000
Finished Basement Area


Log of Sale Price
13
12
11
0
500
1000
1500
2000
Finished Basement Area

Conclusion:

We have obtained the results of our hypothesis about whether we reject or fail to reject the hypothesis that B0=0. We then checked the assumptions for linear regression, with the results being
Next, we computed the test and found the CI for B1, with the results being a 1 square foot increase in basement square feet being associated with an increase in average sales prices from 58.24 to 89.14 with 95 percent confidence. We then plotted our predictor variable with our response variable, with the CI for the mean and individual response being . We have done the log transformation to our model in order to better compare and fit our model, and to make our data as well as hypothesis testing more meaningful. We also have the fit of our model and the R^2 value for the residuals of our plot being an Adjusted R-squared value of 0.1482.

The test of CI for B1 is of interest to us since an increase in average sales prices from 58.24 to 89.14 with 95 percent confidence is certainly notable given our data and residuals plot.
Another interesting aspect was our Adjusted R-squared value of 0.1482 showing that 14.82% of the variance in SalePrice is explained by the simple linear model, meaning our model explained a relatively small amount of the variance. This is interesting information to us given the nature of our regression model as a single variable model, giving us validation that we were in the right direction.

The data we obtained were mostly what we expected to get since the plot turned out to be along our expectations.

Other questions that we would like to ask about the data is whether the data can be influenced by other variables. Also, another question of interest may be whether a transformation of the residuals plot by a function would impact the linearity and residuals of the plot.