

May 12, 2023

The results below are generated from an R script.

```
title: "Assignment8.3_week8_9"

## Warning: NAs introduced by coercion
## Error in title:"Assignment8.3_week8_9": NA/NaN argument

author: "Ghanta, Madhavi"

## Error in eval(expr, envir, enclos): object 'author' not found

date: "2023-05-12"

## Warning: NAs introduced by coercion
## Error in date:"2023-05-12": NA/NaN argument

library(readxl)
library(dplyr)
library(purrr)
library(tidyverse)
library(ggplot2)

## Set the working directory to the root of your DSC 520 directory
setwd("C:/Users/mghan/Documents/dsc520/Week8_9")

housing_df <- read_excel("week-7-housing.xlsx")
housing_df

## # A tibble: 12,865 x 24
##   'Sale Date'      'Sale Price' sale_reason sale_instrument sale_warning sitetype
##   <dtm>           <dbl>      <dbl>          <dbl> <chr>      <chr>
## 1 2006-01-03 00:00:00    698000        1            3 <NA>      R1
## 2 2006-01-03 00:00:00    649990        1            3 <NA>      R1
## 3 2006-01-03 00:00:00    572500        1            3 <NA>      R1
## 4 2006-01-03 00:00:00    420000        1            3 <NA>      R1
## 5 2006-01-03 00:00:00    369900        1            3 15        R1
## 6 2006-01-03 00:00:00    184667        1           15 18 51      R1
## 7 2006-01-04 00:00:00   1050000        1            3 <NA>      R1
## 8 2006-01-04 00:00:00    875000        1            3 <NA>      R1
## 9 2006-01-04 00:00:00    660000        1            3 <NA>      R1
## 10 2006-01-04 00:00:00    650000        1            3 <NA>      R1
## # i 12,855 more rows
## # i 18 more variables: addr_full <chr>, zip5 <dbl>, ctynome <chr>, postalctyn <chr>,
## # lon <dbl>, lat <dbl>, building_grade <dbl>, square_feet_total_living <dbl>,
## # bedrooms <dbl>, bath_full_count <dbl>, bath_half_count <dbl>, bath_3qtr_count <dbl>,
## # year_built <dbl>, year_renovated <dbl>, current_zoning <chr>, sq_ft_lot <dbl>,
## # prop_type <chr>, present_use <dbl>
```

```

myvars <- c('Sale Price','bedrooms','bath_full_count','bath_half_count','year_built',
            'sq_ft_lot','prop_type')

final_df <- housing_df[myvars]
names(final_df)[names(final_df) == 'Sale Price'] <- 'sale_price'
final_df

## # A tibble: 12,865 x 7
##   sale_price bedrooms bath_full_count bath_half_count year_built sq_ft_lot prop_type
##   <dbl>      <dbl>      <dbl>      <dbl>      <dbl>      <dbl> <chr>
## 1    698000         4         2         1        2003     6635 R
## 2    649990         4         2         0        2006     5570 R
## 3    572500         4         1         1        1987     8444 R
## 4    420000         3         1         0        1968     9600 R
## 5    369900         3         1         0        1980     7526 R
## 6    184667         4         2         1        2005     7280 R
## 7   1050000         5         3         0        1993    97574 R
## 8    875000         4         2         1        1988    30649 R
## 9    660000         4         2         1        1978    42688 R
## 10   650000         4         1         0        1976    94889 R
## # i 12,855 more rows

#B - i
#I subsetting the data to include only 7 total columns. A lot of the other columns
#had bad or missing data and thus I dropped them. They also seemed unimportant
#to Sale Price. #I also changed the variable name from Sale Price to sale_price

#B - ii
simple_price_lm <- lm(sale_price ~ sq_ft_lot, data = final_df)
multiple_price_lm <- lm(sale_price ~ sq_ft_lot + bedrooms + bath_full_count + year_built,
                        data = final_df)

#in the multiple_price_lm, I included predictors like sq_ft_lot, bedrooms, bathrooms,
#and year built because those are often the key factors that go into pricing a home.
#At least that's what I've learned from years of watching HGTV :-)

#B - iii
summary(simple_price_lm)

##
## Call:
## lm(formula = sale_price ~ sq_ft_lot, data = final_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2016064  -194842   -63293    91565   3735109
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.418e+05  3.800e+03  168.90  <2e-16 ***
## sq_ft_lot    8.510e-01  6.217e-02  13.69  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 401500 on 12863 degrees of freedom

```

```
## Multiple R-squared:  0.01435, Adjusted R-squared:  0.01428
## F-statistic: 187.3 on 1 and 12863 DF,  p-value: < 2.2e-16

summary(multiple_price_lm)

##
## Call:
## lm(formula = sale_price ~ sq_ft_lot + bedrooms + bath_full_count +
##     year_built, data = final_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2397853  -150440   -48427    64995   3675206
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -8.993e+06  4.373e+05  -20.57  <2e-16 ***
## sq_ft_lot       9.351e-01  5.900e-02   15.85  <2e-16 ***
## bedrooms       8.091e+04  4.003e+03   20.21  <2e-16 ***
## bath_full_count 8.469e+04  6.081e+03   13.93  <2e-16 ***
## year_built     4.616e+03  2.208e+02   20.90  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 374700 on 12860 degrees of freedom
## Multiple R-squared:  0.1418, Adjusted R-squared:  0.1416
## F-statistic: 531.3 on 4 and 12860 DF,  p-value: < 2.2e-16

#r2 for simple: 0.01  adjusted: 0.01
#r2 for multiple: 0.14 adjusted: 0.14
#RSquared is a statistical measure of fit for the model.
#These low RSquared values mean that the model is not a great fit.
#The multiple regression was better, but still not ideal.

#B - iv
lm(scale(sale_price) ~ scale(sq_ft_lot) + scale(bedrooms) + scale(bath_full_count)
  + scale(year_built), data = final_df)

##
## Call:
## lm(formula = scale(sale_price) ~ scale(sq_ft_lot) + scale(bedrooms) +
##     scale(bath_full_count) + scale(year_built), data = final_df)
##
## Coefficients:
##              (Intercept)          scale(sq_ft_lot)          scale(bedrooms)
##              -1.012e-15              1.317e-01              1.753e-01
## scale(bath_full_count)          scale(year_built)
##              1.363e-01              1.966e-01

#the above are the standardized beta coefficients. This measures the degree of change in the
#outcome variable based on one unit of change in the predictor variable.

#B - v
predict_df <- predict(multiple_price_lm, interval = "confidence")
head(predict_df)
```

```
##          fit          lwr          upr
## 1 751552.8 742985.8 760119.7
## 2 764404.4 755220.9 773587.9
## 3 594696.2 582219.2 607173.3
## 4 427168.8 414638.0 439699.6
## 5 480619.5 470057.2 491181.8
## 6 761387.6 752446.7 770328.5

#this is a confidence interval for the expected result. This means that
#we are 95% confident that given the inputs, the sale price will be within these
#two bounds.

#B - vi
anova(simple_price_lm, multiple_price_lm)

## Analysis of Variance Table
##
## Model 1: sale_price ~ sq_ft_lot
## Model 2: sale_price ~ sq_ft_lot + bedrooms + bath_full_count + year_built
##   Res.Df      RSS Df Sum of Sq    F    Pr(>F)
## 1   12863 2.0734e+15
## 2   12860 1.8052e+15   3  2.6814e+14 636.71 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

#Here the change is notable but not overly significant. Worth nothing how small
#the p-value is.

#B - vii
install.packages('Hmisc')

## Error in install.packages : Updating loaded packages

library('Hmisc')

#hist.data.frame(final_df)

#B - viii
final_df.stdres <- rstandard(multiple_price_lm)
final_df.stdres

##          1          2          3          4          5          6
## -0.1429435494 -0.3053991286 -0.0592509407 -0.0191364532 -0.2955440184 -1.5393976959
##          7          8          9         10         11         12
##  0.2508697026  0.4543731638 -0.0263471956  0.0673843733 -0.0071707124 -0.3986775210
##          13         14         15         16         17         18
## -0.1940582289 -2.1297253007  0.2928739296 -0.4500858470  0.0088161184 -0.4512585945
##          19         20         21         22         23         24
##  0.1476746022 -0.3513742029 -0.2246121925 -0.4971570642 -0.0647233582 -0.1359724936
##          25         26         27         28         29         30
## -2.0658234773  1.5186100319  0.0899939274 -0.1177034287 -0.5535368352 -0.1956361069
##          31         32         33         34         35         36
## -0.5267927328 -0.5902739276 -0.5065994232  0.0639826653  0.3722542369  0.1773896012
##          37         38         39         40         41         42
## -0.1922557825  0.0143326871 -0.1591209103 -0.2883892031 -1.0570285153 -0.3453272044
```

##	43	44	45	46	47	48
##	-0.1179125107	-0.3605775309	-0.4352230268	-0.4927684873	1.6985791629	0.1671724330
##	49	50	51	52	53	54
##	0.0684246513	-0.1233585710	0.1030289112	-0.0159683951	-0.1014051080	-0.4489998006
##	55	56	57	58	59	60
##	-0.3128493276	-0.1846858544	-0.1068190462	-0.4523808098	-0.3985907093	1.2090774486
##	61	62	63	64	65	66
##	0.3754695440	0.6284047459	-0.4390661063	-0.1751318107	-1.1254827431	0.0049674636
##	67	68	69	70	71	72
##	0.3288112154	-0.1855589606	-0.4266035997	-0.3625108825	-1.3870516700	2.9241634070
##	73	74	75	76	77	78
##	1.0534156721	-0.4018593603	-0.7370005544	-0.4554036512	-0.2710792758	-0.1720809700
##	79	80	81	82	83	84
##	-0.2076019766	-0.1880749426	0.6621753226	0.0199754765	0.1471374769	-0.3616260752
##	85	86	87	88	89	90
##	-0.0766379836	-0.2962580523	-0.3188486929	-0.3720173332	0.0223507369	0.3081702915
##	91	92	93	94	95	96
##	0.3693189177	-0.1814993532	-0.0439401622	-0.3312067246	-0.3744923332	0.1686902511
##	97	98	99	100	101	102
##	0.0711159938	-0.6780150477	-0.4497930453	-0.4503913362	-0.2110562752	-0.0741765672
##	103	104	105	106	107	108
##	-0.6823796995	-0.7674948724	-0.7691323651	-0.7162588753	-0.2797085188	2.4331384873
##	109	110	111	112	113	114
##	-0.1201585150	-0.5660256020	-0.2260182926	-0.1505748277	-0.4929608243	-0.6234812788
##	115	116	117	118	119	120
##	2.8423943519	1.4111602878	0.2254533446	-0.2946965284	-0.4558894070	-0.0637381568
##	121	122	123	124	125	126
##	-0.1397322554	0.0661406670	-0.3320748794	0.3405951320	0.2494624482	-0.4850146903
##	127	128	129	130	131	132
##	-0.5141479810	0.2291292367	-0.0604022043	0.1062215892	-0.6998919755	-0.1131644285
##	133	134	135	136	137	138
##	-0.1660039939	-0.2168961140	-0.0611473024	-0.2139524984	0.2201882789	0.0006722869
##	139	140	141	142	143	144
##	-0.1167194696	-0.2870021752	-0.0747441088	-0.4200756655	-0.2490329807	0.1440154847
##	145	146	147	148	149	150
##	-0.0246897420	-0.1392052435	-0.3331371094	-0.3956407793	-0.0952731390	0.0864877714
##	151	152	153	154	155	156
##	-0.3378156778	-0.1359516128	-0.3331371094	-0.5453853755	-0.5176450401	-0.1967467470
##	157	158	159	160	161	162
##	-0.1005695165	-0.4915101371	-0.3834934870	-0.7164879889	-0.4763105297	0.3725252487
##	163	164	165	166	167	168
##	0.3754695440	-0.4639658398	-0.4438590660	-0.4369892543	-0.3769080955	0.0023452617
##	169	170	171	172	173	174
##	-0.2911123509	-0.7318006092	-0.2954632355	-1.3930381304	-0.0908650723	-0.0830742852
##	175	176	177	178	179	180
##	-0.5693122280	-0.5123318080	-0.4582636326	-1.8366961566	0.0389114214	-0.0445475026
##	181	182	183	184	185	186
##	-0.4763352574	-0.0786376701	-0.2457906546	1.0172102009	0.4671112370	-0.4299185259
##	187	188	189	190	191	192
##	0.2171465567	-0.3313254054	-0.0663701519	-0.4844159744	0.2617301376	-0.3807991015
##	193	194	195	196	197	198
##	-0.3397441553	-0.4016046782	-0.5176165652	1.1682564005	0.0909013671	0.2560200126
##	199	200	201	202	203	204
##	-0.2720401526	-0.4709121065	-0.3995092219	-0.0860281995	0.1366051046	-0.2609064099

##	205	206	207	208	209	210
##	-0.0567729752	-0.5788132067	-0.4159129438	1.1294837367	-0.3377952148	-0.4141533060
##	211	212	213	214	215	216
##	0.8904188224	-0.0849980181	-0.4514398593	1.3920777235	-0.3117914945	-0.2237406823
##	217	218	219	220	221	222
##	-0.0823845617	-0.4940017385	-0.1449083318	-0.1492512610	-0.0773777959	-1.4060220387
##	223	224	225	226	227	228
##	0.6123959804	0.0083511095	-0.3809746018	-0.0715477094	0.1304050199	-0.0375555031
##	229	230	231	232	233	234
##	-0.6798657900	0.3692217078	0.0168907586	-0.1532693153	0.1404969797	-0.0987444860
##	235	236	237	238	239	240
##	-0.0177364562	0.6287816798	-0.3243309072	-0.5278562914	2.6359097013	0.6133891433
##	241	242	243	244	245	246
##	0.0187418510	-0.2896805224	-0.3298481204	-0.4038935951	2.4439651991	3.5543334117
##	247	248	249	250	251	252
##	-0.2123007531	-0.2251103393	-0.4286426319	0.0159163315	0.1843892431	-0.3134409648
##	253	254	255	256	257	258
##	-1.3178106116	0.5364174625	-0.2198237314	-0.2870604311	0.1422467520	-0.0772172915
##	259	260	261	262	263	264
##	-0.4255092705	0.0958089362	-0.1388818554	0.3009884773	-0.0542150394	-0.0057820287
##	265	266	267	268	269	270
##	-0.1574538182	0.0138013039	-0.1073367532	0.0187775913	-0.2057839130	-1.4909068395
##	271	272	273	274	275	276
##	0.3397427210	-0.3160285518	-0.2331648997	-0.2839175927	-0.4490481908	0.0073435159
##	277	278	279	280	281	282
##	-0.2923386156	-0.3540761738	-0.2466609003	0.3929566817	-0.0177094850	-0.2241059109
##	283	284	285	286	287	288
##	-0.1084404033	0.1808529839	-0.2165442939	-0.0690155437	-1.7361985632	0.2393666273
##	289	290	291	292	293	294
##	0.1885650653	0.0789198327	0.0555490398	-0.2279249481	-0.2478686295	-0.2429704049
##	295	296	297	298	299	300
##	-6.7926766042	0.2044919452	-0.1420750364	-0.1534985777	-0.4794426405	-2.2299709407
##	301	302	303	304	305	306
##	0.2563613930	-0.2277114611	-0.3419086740	-0.3490694659	-0.1725888609	0.0551264280
##	307	308	309	310	311	312
##	-0.0135256141	-0.3378163832	0.0864877714	-0.4155245047	-0.4155245047	-0.2571569735
##	313	314	315	316	317	318
##	1.2206325339	0.0739278476	0.1624481783	-0.3062231991	0.4914885261	-0.0122272896
##	319	320	321	322	323	324
##	-0.2494990753	0.1231832836	-0.1205468955	-0.3729952600	0.0718551906	0.0749368091
##	325	326	327	328	329	330
##	-0.1645564212	0.0426699774	0.0510071878	0.2893969618	0.0267879455	-0.3336291173
##	331	332	333	334	335	336
##	-0.0360667743	-0.5239480542	-0.4820334066	-0.3378703423	0.0292850387	-0.4638230958
##	337	338	339	340	341	342
##	-0.2199366883	-0.1062706500	-0.5248872566	-0.0643432762	-1.3884209177	-2.2845344501
##	343	344	345	346	347	348
##	-0.1694553266	-2.7537580041	-2.7537580041	0.1465777456	-0.2401597808	-0.0987444860
##	349	350	351	352	353	354
##	-0.0644545023	-0.4682766566	-0.3735067916	-0.5143525571	0.9223549928	0.2073474148
##	355	356	357	358	359	360
##	-0.2835031913	-0.5043286347	0.1636201666	-0.5377790812	-2.0835810487	-0.4283439925
##	361	362	363	364	365	366
##	0.1650172099	-0.1864745122	0.0558823369	-0.0519641883	1.2206325339	-0.1381341943

##	367	368	369	370	371	372
##	-0.0761025207	-0.6213533184	-0.4668617016	-0.0845276069	-0.5563311007	-0.0720380658
##	373	374	375	376	377	378
##	-1.5504253892	-0.1161483183	-1.1493574099	1.3809565600	0.8354507678	-0.1333194411
##	379	380	381	382	383	384
##	-0.0753178737	-0.1059182063	-0.3476568582	-0.3482223013	-0.4057537909	-0.7082926517
##	385	386	387	388	389	390
##	4.5681750352	0.8641207661	-0.0200028524	-0.5327155275	-0.2815446519	-0.2041991715
##	391	392	393	394	395	396
##	0.0709935137	-0.2517410217	-0.1544713736	-0.6092505980	-0.5098156815	3.0993108697
##	397	398	399	400	401	402
##	0.1068730653	-0.1837442444	-0.0517606838	-0.0055698746	-0.0356642182	0.1531511521
##	403	404	405	406	407	408
##	-0.3046673536	-0.2711367715	-0.3677475047	-0.2363310828	0.2801798242	0.1319194279
##	409	410	411	412	413	414
##	-0.5712773388	-0.0383615924	-0.0041285600	-0.4029585312	-0.3970753666	-0.3247482506
##	415	416	417	418	419	420
##	-1.3770630626	1.0233068984	1.0677631221	0.6103898518	-0.2541930144	-0.0980053347
##	421	422	423	424	425	426
##	-0.4697098930	-0.4626233683	-0.0984038106	-0.1674038250	0.0287332698	-0.0501673067
##	427	428	429	430	431	432
##	-0.2025528233	-0.6596053039	0.1373841529	0.8499367489	0.3310838072	-0.7505378835
##	433	434	435	436	437	438
##	-0.3476756182	-0.5199313982	0.0523418462	-0.3832440711	-0.3574280074	-0.8058474026
##	439	440	441	442	443	444
##	-0.3704831036	-0.2327474109	0.0971776079	-0.0566893252	-0.2052633673	0.7317382011
##	445	446	447	448	449	450
##	0.1333524300	-0.0181923589	-0.3929503612	-0.3422525781	0.6065586042	0.1020917573
##	451	452	453	454	455	456
##	0.1258645385	-0.0708584276	-0.2241308709	-0.0995110850	-0.5783783301	-0.1306896055
##	457	458	459	460	461	462
##	-0.4249239101	-0.7887214263	-1.7493420152	0.1020917573	-0.1922240382	-0.0081332730
##	463	464	465	466	467	468
##	-0.0267464991	-0.2709350558	-0.0945409065	-0.3355281312	-0.1944767698	1.2968061258
##	469	470	471	472	473	474
##	-0.0522535042	0.0609758869	-0.0924777382	-0.1516664722	-0.5323612499	-0.5267442635
##	475	476	477	478	479	480
##	2.7987616496	1.4237461290	-0.2573866226	-0.1350700636	-0.3526706976	-0.2055889969
##	481	482	483	484	485	486
##	0.0210651559	-1.9346300832	0.0987511090	-0.0233455587	-0.1241354406	-0.4347368538
##	487	488	489	490	491	492
##	-0.0932093910	-0.2893178872	0.2749856026	0.2749856026	-0.5955344796	-0.2635047790
##	493	494	495	496	497	498
##	-0.1774628447	-0.4303010428	-0.0787174480	-0.3363804300	-0.2796903067	-0.6803160815
##	499	500	501	502	503	504
##	-0.5526563041	-0.2036755646	0.1420830331	-0.0252388968	-0.1694413595	0.1085453900
##	505	506	507	508	509	510
##	-0.0612574061	0.0087215635	-0.0275596881	-2.8931364800	-0.0991521759	0.0937612852
##	511	512	513	514	515	516
##	0.1101415132	-0.0779410876	0.4924445604	0.4609622291	-0.2355748521	-0.1701639247
##	517	518	519	520	521	522
##	-0.5175608651	-0.1407495033	1.9667011874	0.2126945528	0.1430165461	-0.1951403735
##	523	524	525	526	527	528
##	0.0567148905	-0.0223115523	0.0534382179	-0.2216448638	-0.6327371940	-1.4322888916

##	529	530	531	532	533	534
##	0.0162854246	0.2916558806	0.2595530328	-0.5716478811	-0.0978719883	-0.2657607379
##	535	536	537	538	539	540
##	0.1940767175	-0.1172161787	-0.3238469521	-0.1504138740	-0.2996775822	-0.3943916186
##	541	542	543	544	545	546
##	0.1230500733	-0.1680966021	0.0427490091	0.0222184866	0.1461132499	-0.2583822189
##	547	548	549	550	551	552
##	-0.0243348520	0.0415474745	0.6698593036	0.1853228776	-0.1181862914	-0.0377177293
##	553	554	555	556	557	558
##	-0.2446282082	-0.3194613007	-0.5416826458	-0.8743488906	-0.1924597637	-1.0336259650
##	559	560	561	562	563	564
##	-1.1420726325	-0.2134975680	0.1693200171	-0.0783479297	0.0810029075	0.1626770763
##	565	566	567	568	569	570
##	0.3936435544	-0.0944922520	-0.1215420579	-0.0261056227	0.5342631138	-0.0151357914
##	571	572	573	574	575	576
##	-0.0981435060	0.1095375071	-0.2151552019	-0.2702345912	-0.4401858602	-1.9483120024
##	577	578	579	580	581	582
##	-0.1260324830	0.2978618407	0.1284274828	-0.1329525052	0.0894281888	-0.4418732350
##	583	584	585	586	587	588
##	-0.4418732350	-0.2801368820	-0.2907294712	0.1040246319	-0.2927548102	0.0085689135
##	589	590	591	592	593	594
##	-0.2139860261	-0.9273929640	-1.0969460592	0.2132328647	0.1213644940	-0.5534013555
##	595	596	597	598	599	600
##	0.6026126181	0.4008965790	-0.0916828945	-0.1980749773	0.0421563187	-0.0500233933
##	601	602	603	604	605	606
##	2.1355538190	0.6026126181	0.2767786037	0.3140513449	-0.0500382518	-0.2629948933
##	607	608	609	610	611	612
##	-0.1735339009	0.1231341523	0.1324244297	-0.3495058608	-0.1805800803	2.6824529937
##	613	614	615	616	617	618
##	0.2955411873	-0.0824076402	-0.2412900978	0.0241784586	-0.0099338872	-0.6000324632
##	619	620	621	622	623	624
##	0.0317288584	-0.0560785739	-0.3116436774	-0.3119956093	-0.3307467803	-0.3334243845
##	625	626	627	628	629	630
##	-0.2190314566	0.2729087792	-0.5819628444	-1.0562059529	-0.0123466051	0.8767689964
##	631	632	633	634	635	636
##	0.1143435038	0.1313540870	0.0303261327	0.1107283509	-0.2596558652	-0.2780146243
##	637	638	639	640	641	642
##	1.3247469608	0.4443315407	0.1218666410	-0.1831197573	-0.5457763901	-0.0610447282
##	643	644	645	646	647	648
##	-0.4445917197	-0.4615550932	-0.4964032280	-0.0463095857	-0.2939752703	-0.5456084708
##	649	650	651	652	653	654
##	0.1065348564	0.1522754292	0.0815611532	0.0084658952	-0.1547310662	-1.1828852815
##	655	656	657	658	659	660
##	-0.7181546398	2.4996815406	0.0122915728	-0.2281165542	0.2026899524	-0.1239860907
##	661	662	663	664	665	666
##	4.1659038225	2.6077527791	0.7718004298	-0.0195229210	0.0499908877	-0.2542420779
##	667	668	669	670	671	672
##	0.0085924926	-0.2827621601	-0.2691696407	5.0026855576	2.0105748405	-0.0481367052
##	673	674	675	676	677	678
##	-0.0256407592	-0.3023722596	-0.2761415825	-0.8490202870	-0.1034475138	-0.1114045993
##	679	680	681	682	683	684
##	-2.2882201908	-1.5808210942	-1.3795343163	0.1886587784	0.1152524190	0.1822763640
##	685	686	687	688	689	690
##	-0.6003921321	-0.0180848970	-0.5608600129	-0.6600136496	0.3487829839	0.1250400780



##	691	692	693	694	695	696
##	-0.1943380771	-0.3430816735	-0.3711922314	-0.2605995643	-0.3159694489	1.3683339713
##	697	698	699	700	701	702
##	0.7058830298	-0.0463095857	-0.3350752372	0.0722345429	-0.2514804998	-0.5168254323
##	703	704	705	706	707	708
##	-0.2788743952	-0.3461974043	-0.3043780668	0.2395807253	-0.0778907404	-0.2018682936
##	709	710	711	712	713	714
##	-0.0805343116	0.0679277808	-0.3203152037	-0.0458220943	-0.3372417741	0.0681383106
##	715	716	717	718	719	720
##	0.0558661234	0.0174451941	0.0835192724	0.0981854005	-0.6586297853	-0.3766148904
##	721	722	723	724	725	726
##	-0.9726403016	-0.0007438923	1.9923029953	1.4473083082	-0.0214578563	0.0894281888
##	727	728	729	730	731	732
##	-0.0305013015	-0.3132942463	0.0094102238	-0.0438747669	-0.3381971499	-0.5709369885
##	733	734	735	736	737	738
##	-0.3791053169	-0.1166796309	-0.4958085308	-0.0937612592	0.5220462553	0.1865077291
##	739	740	741	742	743	744
##	0.0454261878	0.0454261878	0.5593873957	-1.3073820456	0.0091573882	-0.6031302037
##	745	746	747	748	749	750
##	0.0369252468	0.0619989623	0.0619989623	0.4994080705	0.0342072825	-0.6472665319
##	751	752	753	754	755	756
##	1.8822050856	1.8892972270	-0.3954401778	-0.6000324632	-0.4767793404	0.3548652004
##	757	758	759	760	761	762
##	-0.5266707319	-0.4595884906	-0.4958209832	-0.1537988087	-0.7834860416	0.1927361840
##	763	764	765	766	767	768
##	0.1955539020	-0.1531143946	-0.2162098230	-0.3933216070	0.0857176960	-0.3259443565
##	769	770	771	772	773	774
##	0.7617391975	0.2498323180	0.0895973506	-0.4155073471	-0.0898373374	0.0930073811
##	775	776	777	778	779	780
##	0.0977018613	-0.0374406199	0.1572296500	-0.1327693207	-0.3030269812	-0.5388637488
##	781	782	783	784	785	786
##	0.2239185132	0.5675950403	-0.4354617909	-1.5986011344	2.6923840942	1.5194763098
##	787	788	789	790	791	792
##	0.4326496533	-0.2839400392	0.9140148649	0.1650406148	0.0525608072	-0.0502567918
##	793	794	795	796	797	798
##	-0.1503959474	-0.0430160665	0.0457713226	0.0860796213	0.1283757718	-0.2467167407
##	799	800	801	802	803	804
##	-0.6567133013	-0.2200167219	-0.1787940697	-1.9241566491	-0.0513289256	-0.1710429211
##	805	806	807	808	809	810
##	-0.2197762836	-0.0292041461	0.2685897936	0.3238937339	-0.3240171087	-0.6307564037
##	811	812	813	814	815	816
##	5.9976977192	1.6248855419	0.5134958661	1.1737231424	0.2497799773	0.1576117952
##	817	818	819	820	821	822
##	-0.1691861184	0.0249002712	-0.4757960686	0.4077589993	-0.4958130737	-0.2348712987
##	823	824	825	826	827	828
##	1.6241905575	0.0179618607	0.2424775079	-0.1229366619	0.1591671260	-0.0715481873
##	829	830	831	832	833	834
##	0.3605021328	-0.0752482020	-0.0972902762	-0.0207109026	-1.3306573377	0.3571350550
##	835	836	837	838	839	840
##	-0.2378962163	0.1274556302	-0.2812238684	-0.3694411331	-0.1584937750	-1.4434363061
##	841	842	843	844	845	846
##	0.3460220533	0.4091662349	-0.2072531392	0.1213588549	-0.2952848722	-0.5258060942
##	847	848	849	850	851	852
##	-0.0363034764	-0.2988865727	0.0953095618	-0.2431200569	-0.1071243929	-1.9797404260

```

##          853          854          855          856          857          858
## 2.2507546454 0.6805451663 0.0284793786 -0.0330728939 0.1650318804 -0.0861695457
##          859          860          861          862          863          864
## -0.0781102407 -0.1995018817 -0.0791782432 -0.4206522322 0.4195001728 0.3765502374
##          865          866          867          868          869          870
## 0.2256332189 1.3433945645 -0.0518753030 -0.4806117466 0.9512308981 0.1488167319
##          871          872          873          874          875          876
## -0.4177327140 0.1863348815 -0.1650932694 0.1139294082 -0.3216836854 -0.3022215031
##          877          878          879          880          881          882
## -2.4096236326 -0.0277985319 0.2470056847 -0.6156531006 -0.2332828203 0.0925188007
##          883          884          885          886          887          888
## -0.2203550920 -0.4398486698 -0.1476875381 -0.8203671355 -0.7759005205 0.2781792469
##          889          890          891          892          893          894
## 0.1194049717 -0.1591174017 -0.0838398391 -0.0869966761 -0.3890081931 -0.5964211687
##          895          896          897          898          899          900
## -0.7904984389 -0.5369806491 0.2309295901 0.0809297376 0.0257281840 0.1708113229
##          901          902          903          904          905          906
## -0.7687998623 0.2190685942 0.8229976833 -0.0362385792 -0.0791489897 0.1582102425
##          907          908          909          910          911          912
## -0.1597410174 -0.5237669416 1.5908139187 0.2342777092 -0.1582757984 0.4333170108
##          913          914          915          916          917          918
## 0.1164316100 -0.1548335819 -0.5223610899 -2.0952674136 -0.6395991471 -0.0305804573
##          919          920          921          922          923          924
## 0.1539386222 -0.2759556335 0.2078067149 -0.0021481585 -0.0331387198 -0.4039409808
##          925          926          927          928          929          930
## -0.4955228721 -0.5579369890 -0.0021164879 -0.6445344858 2.5387066823 -0.1778985153
##          931          932          933          934          935          936
## 0.0965951811 -0.5817002103 -0.2955697687 1.7710135089 0.7238361357 -0.1724625916
##          937          938          939          940          941          942
## -0.3857532382 0.1135708745 0.0184702357 -0.4428120828 -0.3306492841 0.3953970828
##          943          944          945          946          947          948
## 0.3599861557 -0.0076434125 -0.1370571323 -0.0516556522 0.0858683265 0.0079253919
##          949          950          951          952          953          954
## -0.4229912873 -0.4316332876 -0.5327404854 -0.8208963074 0.1578170440 -0.3388343308
##          955          956          957          958          959          960
## 0.0449706435 -0.5026688061 -0.1366303703 -0.1296912030 -0.3089145216 -0.4015023864
##          961          962          963          964          965          966
## -0.5179455575 -0.1292747425 -0.1655891638 -0.4596853809 -0.7834221093 2.0557499821
##          967          968          969          970          971          972
## 0.5500756821 0.3754859510 -0.5283479266 -0.9424623108 0.2223576538 1.0069527654
##          973          974          975          976          977          978
## 0.0586709132 -0.6088215572 -0.0679779047 -0.1155743142 -0.0357525718 0.2041361556
##          979          980          981          982          983          984
## -0.2629214357 0.0297078221 -0.3234413489 -0.2030001512 -0.4020997883 0.1740405773
##          985          986          987          988          989          990
## 0.3926385809 -0.1434825133 -0.4568388890 0.1420161913 0.2047215737 0.1439944848
##          991          992          993          994          995          996
## -0.1211434138 -0.4678955620 -0.4810570511 -0.4634451813 -0.7119151257 0.6303540278
##          997          998          999          1000
## -0.4377385181 -0.9674374867 0.0840415250 -0.1244952692
## [ reached getOption("max.print") -- omitted 11865 entries ]

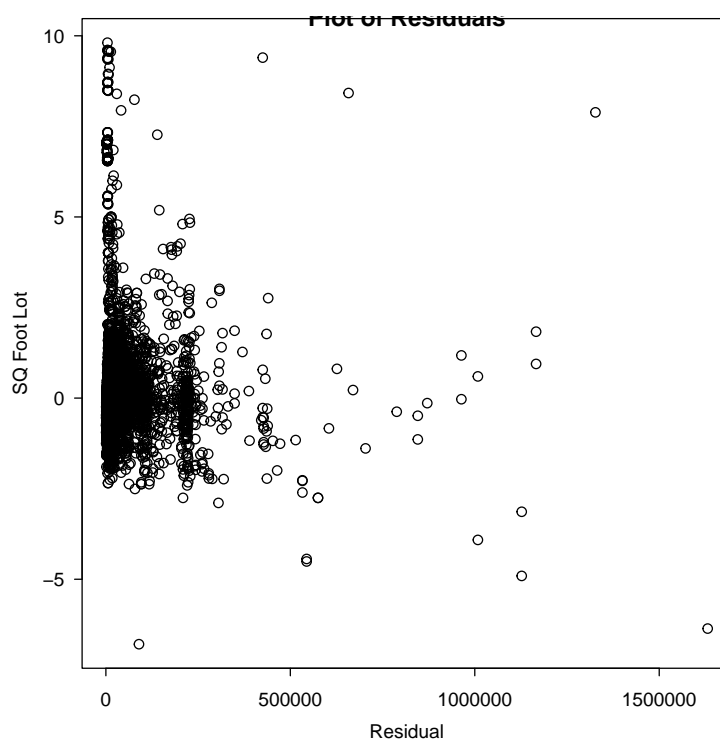
```

```

plot(final_df$sq_ft_lot, final_df.stdres, ylab = "SQ Foot Lot",
      xlab = "Residual",

```

```
main = "Plot of Residuals")
```



```
#B - ix
#Deviance is a function to find the residual sum of squares.
deviance(multiple_price_lm)

## [1] 1.805239e+15

#Here, the residual sum of scares is astronomically large. This implies a very poor fit
#between the model and the data.

#B - x
install.packages("car")

## Error in install.packages : Updating loaded packages

library("car")
outlierTest(multiple_price_lm)

##          rstudent unadjusted p-value Bonferroni p
## 6438  9.846686      8.5288e-23    1.0972e-18
## 6437  9.640498      6.3964e-22    8.2289e-18
## 6430  9.639536      6.4562e-22    8.3059e-18
## 6439  9.624535      7.4633e-22    9.6016e-18
## 6442  9.613318      8.3167e-22    1.0699e-17
## 6431  9.612041      8.4198e-22    1.0832e-17
## 6429  9.609779      8.6055e-22    1.1071e-17
## 6432  9.604236      9.0778e-22    1.1679e-17
## 6436  9.593181      1.0098e-21    1.2991e-17
## 11992 9.429903      4.7998e-21    6.1750e-17
```

```
#This function identifies the outliers in the input variables to the model.
```

```
#B - xi
```

```
leverage <- as.data.frame(hatvalues(multiple_price_lm))
```

```
leverage
```

```
##      hatvalues(multiple_price_lm)
## 1      0.0001360764
## 2      0.0001563660
## 3      0.0002886367
## 4      0.0002911306
## 5      0.0002068451
## 6      0.0001482161
## 7      0.0005969580
## 8      0.0001198879
## 9      0.0001970306
## 10     0.0004077764
## 11     0.0001567835
## 12     0.0001470318
## 13     0.0002919190
## 14     0.0019445587
## 15     0.0002539954
## 16     0.0001467253
## 17     0.0001480569
## 18     0.0001496206
## 19     0.0002514513
## 20     0.0002279699
## 21     0.0003699101
## 22     0.0001374175
## 23     0.0004825083
## 24     0.0003472029
## 25     0.0011785693
## 26     0.0003783551
## 27     0.0001505612
## 28     0.0001687080
## 29     0.0001461684
## 30     0.0003700167
## 31     0.0003700073
## 32     0.0002519931
## 33     0.0001574083
## 34     0.0004741434
## 35     0.0001264983
## 36     0.0001505930
## 37     0.0003691829
## 38     0.0001497270
## 39     0.0001302484
## 40     0.0001718833
## 41     0.0005604467
## 42     0.0002966870
## 43     0.0002008178
## 44     0.0003700156
## 45     0.0002292494
## 46     0.0003169388
## 47     0.0004325544
```

## 48	0.0001218341
## 49	0.0002013478
## 50	0.0003042299
## 51	0.0003446926
## 52	0.0001487129
## 53	0.0001452238
## 54	0.0001501979
## 55	0.0003642730
## 56	0.0004571933
## 57	0.0003589002
## 58	0.0001342428
## 59	0.0002036961
## 60	0.0003682857
## 61	0.0001228325
## 62	0.0001490657
## 63	0.0004745228
## 64	0.0001429517
## 65	0.0014709827
## 66	0.0003780404
## 67	0.0002144502
## 68	0.0003700864
## 69	0.0001494173
## 70	0.0001469631
## 71	0.0001378713
## 72	0.0004438934
## 73	0.0001496815
## 74	0.0003737035
## 75	0.0001368142
## 76	0.0002593396
## 77	0.0001518600
## 78	0.0003729676
## 79	0.0003406794
## 80	0.0003744213
## 81	0.0004423102
## 82	0.0001504745
## 83	0.0003730770
## 84	0.0001493239
## 85	0.0001353478
## 86	0.0001483742
## 87	0.0011333172
## 88	0.0002156731
## 89	0.0003037761
## 90	0.0001468635
## 91	0.0001882985
## 92	0.0007517916
## 93	0.0001454650
## 94	0.0001406081
## 95	0.0002742763
## 96	0.0003731380
## 97	0.0001420133
## 98	0.0004872307
## 99	0.0001569388
## 100	0.0001498037
## 101	0.0003742562

## 102	0.0004699474
## 103	0.0001316190
## 104	0.0003891246
## 105	0.0003888362
## 106	0.0001314650
## 107	0.0002004788
## 108	0.0008688627
## 109	0.0001490171
## 110	0.0003815528
## 111	0.0003737467
## 112	0.0002827739
## 113	0.0001310043
## 114	0.0002052849
## 115	0.0026624605
## 116	0.0011746397
## 117	0.0003731795
## 118	0.0003740144
## 119	0.0003737988
## 120	0.0003014325
## 121	0.0002983820
## 122	0.0001219290
## 123	0.0001493689
## 124	0.0003236220
## 125	0.0001388992
## 126	0.0011441657
## 127	0.0003211245
## 128	0.0002834137
## 129	0.0002367347
## 130	0.0001489040
## 131	0.0010422599
## 132	0.0002921284
## 133	0.0002877573
## 134	0.0003515238
## 135	0.0003737209
## 136	0.0004746816
## 137	0.0001627434
## 138	0.0003535311
## 139	0.0001561872
## 140	0.0002239999
## 141	0.0002838139
## 142	0.0001461684
## 143	0.0002930826
## 144	0.0003044234
## 145	0.0011469823
## 146	0.0001348578
## 147	0.0001377506
## 148	0.0003343535
## 149	0.0002199789
## 150	0.0002919848
## 151	0.0001467668
## 152	0.0003695588
## 153	0.0001377506
## 154	0.0001236466
## 155	0.0001471930

## 156	0.0002950879
## 157	0.0003026494
## 158	0.0001491247
## 159	0.0002111428
## 160	0.0033123852
## 161	0.0009593327
## 162	0.0001487680
## 163	0.0001228325
## 164	0.0003904385
## 165	0.0001482687
## 166	0.0001380808
## 167	0.0001467628
## 168	0.0002001556
## 169	0.0003701574
## 170	0.0001377334
## 171	0.0002061088
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## 903	0.0001484105
## 904	0.0001552452
## 905	0.0001432698
## 906	0.0003048455
## 907	0.0002129688
## 908	0.0003626566
## 909	0.0001242710
## 910	0.0001316959
## 911	0.0001207666

## 912	0.0001992029
## 913	0.0002810247
## 914	0.0002870578
## 915	0.0001509604
## 916	0.0023711129
## 917	0.0001767393
## 918	0.0001504538
## 919	0.0001768122
## 920	0.0001570192
## 921	0.0004355309
## 922	0.0003045912
## 923	0.0002021346
## 924	0.0003735323
## 925	0.0001482872
## 926	0.0003729466
## 927	0.0003702051
## 928	0.0006062681
## 929	0.0003184310
## 930	0.0001567744
## 931	0.0002797497
## 932	0.0001323242
## 933	0.0005386163
## 934	0.0003690123
## 935	0.0004422098
## 936	0.0001429517
## 937	0.0003783959
## 938	0.0002121474
## 939	0.0003544140
## 940	0.0003287502
## 941	0.0002911624
## 942	0.0001479712
## 943	0.0001559845
## 944	0.0004325459
## 945	0.0003662091
## 946	0.0001494305
## 947	0.0001936084
## 948	0.0002416806
## 949	0.0003734318
## 950	0.0003737467
## 951	0.0003639940
## 952	0.0003740876
## 953	0.0004699654
## 954	0.0001380737
## 955	0.0003043628
## 956	0.0008129010
## 957	0.0001363411
## 958	0.0002372763
## 959	0.0001408319
## 960	0.0009144612
## 961	0.0001368602
## 962	0.0003426646
## 963	0.0004357041
## 964	0.0003700300
## 965	0.0003741422

```

## 966      0.0003777764
## 967      0.0001355344
## 968      0.0001322820
## 969      0.0001331749
## 970      0.0001686403
## 971      0.0103691282
## 972      0.0001169979
## 973      0.0002968542
## 974      0.0001502917
## 975      0.0002930041
## 976      0.0012305648
## 977      0.0003210085
## 978      0.0002001703
## 979      0.0003734172
## 980      0.0003886876
## 981      0.0002046569
## 982      0.0002026946
## 983      0.0003819982
## 984      0.0003014479
## 985      0.0002496303
## 986      0.0002236736
## 987      0.0010130248
## 988      0.0004710099
## 989      0.0004714034
## 990      0.0002161202
## 991      0.0002326621
## 992      0.0001502879
## 993      0.0003738134
## 994      0.0003615224
## 995      0.0002808682
## 996      0.0001209074
## 997      0.0008187781
## 998      0.0004724171
## 999      0.0002306966
## 1000     0.0002097545
## [ reached 'max' / getOption("max.print") -- omitted 11865 rows ]

#All of the leverage values are miniscule, and since nothing is >2 we know that they do not
#have high leverage values.

#B - xii
t.test(final_df$sale_price,final_df$bedrooms, paired = TRUE)

##
## Paired t-test
##
## data: final_df$sale_price and final_df$bedrooms
## t = 185.33, df = 12864, p-value < 2.2e-16
## alternative hypothesis: true mean difference is not equal to 0
## 95 percent confidence interval:
## 653745.9 667722.6
## sample estimates:
## mean difference
## 660734.3

```

The R session information (including the OS info, R version and all packages used):

```
sessionInfo()

## R version 4.2.2 (2022-10-31 ucrt)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 10 x64 (build 22621)
##
## Matrix products: default
##
## locale:
## [1] LC_COLLATE=English_United States.utf8  LC_CTYPE=English_United States.utf8
## [3] LC_MONETARY=English_United States.utf8 LC_NUMERIC=C
## [5] LC_TIME=English_United States.utf8
##
## attached base packages:
## [1] stats      graphics  grDevices  utils      datasets  methods   base
##
## other attached packages:
## [1] car_3.1-2      carData_3.0-5  Hmisc_5.1-0    lubridate_1.9.2 forcats_1.0.0
## [6] stringr_1.5.0  readr_2.1.4    tidyr_1.3.0    tibble_3.2.1    ggplot2_3.4.1
## [11] tidyverse_2.0.0 purrr_1.0.1    dplyr_1.1.1    readxl_1.4.2
##
## loaded via a namespace (and not attached):
## [1] tidyselect_1.2.0 xfun_0.38      colorspace_2.1-0 vctrs_0.6.1
## [5] generics_0.1.3   htmltools_0.5.5 yaml_2.3.7      base64enc_0.1-3
## [9] utf8_1.2.3       rlang_1.1.0    pillar_1.9.0    foreign_0.8-83
## [13] glue_1.6.2       withr_2.5.0    lifecycle_1.0.3 munsell_0.5.0
## [17] gtable_0.3.3     cellranger_1.1.0 htmlwidgets_1.6.2 evaluate_0.20
## [21] knitr_1.42       tzdb_0.3.0     fastmap_1.1.1   fansi_1.0.4
## [25] highr_0.10       htmlTable_2.4.1 scales_1.2.1     backports_1.4.1
## [29] checkmate_2.2.0  abind_1.4-5    gridExtra_2.3    hms_1.1.3
## [33] digest_0.6.31    stringi_1.7.12 grid_4.2.2       cli_3.6.1
## [37] tools_4.2.2      magrittr_2.0.3 Formula_1.2-5    cluster_2.1.4
## [41] pkgconfig_2.0.3  data.table_1.14.8 timechange_0.2.0 rmarkdown_2.21
## [45] rstudioapi_0.14  R6_2.5.1       rpart_4.1.19    nnet_7.3-18
## [49] compiler_4.2.2

Sys.time()

## [1] "2023-05-12 17:43:03 PDT"
```