Creating A Vector Map

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Aim:

In this project we want to calculate global co ordinates of any point in some given screen shots(ss) with respect to a global origin.The user will be given the ss and he can choose any point in those screenshots whose global co ordinate he is interested in.

Methodology:

I have described the whole method in another pdf named "Description of Code".There I have written how we did the project along with how the user should use the code.

Description of data:

This part is also mostly explained in the other pdf I have attached.I have also attached another excel file named "Guide Map" which contains some landmarks with co-ordinates(details of which can be found in the second pdf) and also the 9 ss from which the user can pick any location of his interest and save it by an appropriate name.The screenshots are taken from google maps at the same zoom level.

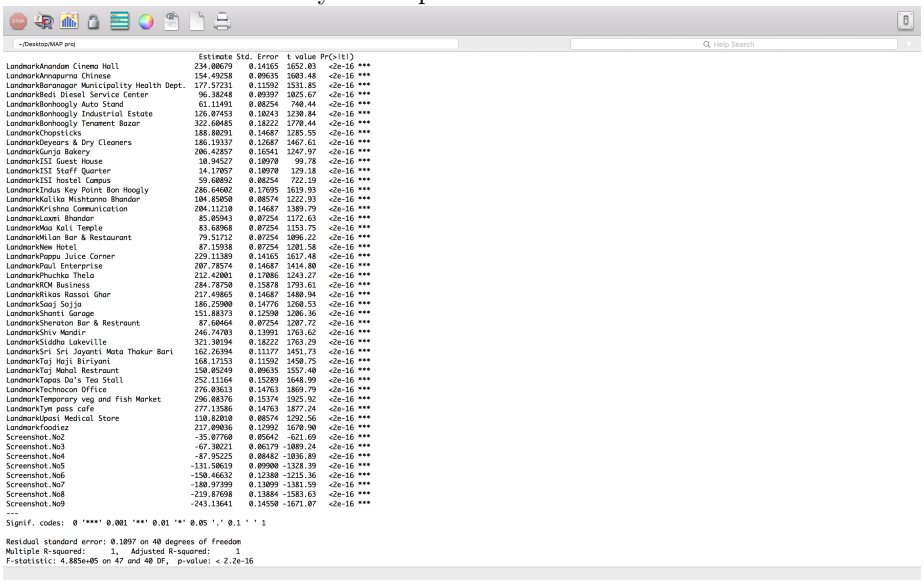
Model:

We will ask the user to take at least 2 attempts when they mark any point in any ss.
Let x_{ijk} be the x co-ordinate of the j^{th} landmark of SS "i" at k^{th} trial.
α_i is the negative of the distance of ss "i" from the global origin (G) along x axis.(i is from 1 to I)
β_j is the distance of j^{th} landmark from G along x axis.(j is from 1 to J)
ϵ_{ijk} is the random error while taking the measurement of j^{th} landmark in ss "i" at k-th trial.
Now we can write the linear model as follows:

$x_{ijk} = \alpha_i + \beta_j + \epsilon_{ijk}$
We have information on x_{ijk}.We need to estimate β_j and α_i for all j=1 to J and i=1 to I given $\alpha_1 = 0$ since we have taken our global origin same as the origin of first ss.**Hence rank of our data matrix is (I+J-1)**.The process is exactly the same for estimating the global y co-ordinates.Since screenshots and locations have no connection between them we expect no interaction term to be present.An important thing to note here is that any two ss must have atleast one area in common.Otherwise it is impossible to carry on this estimation.

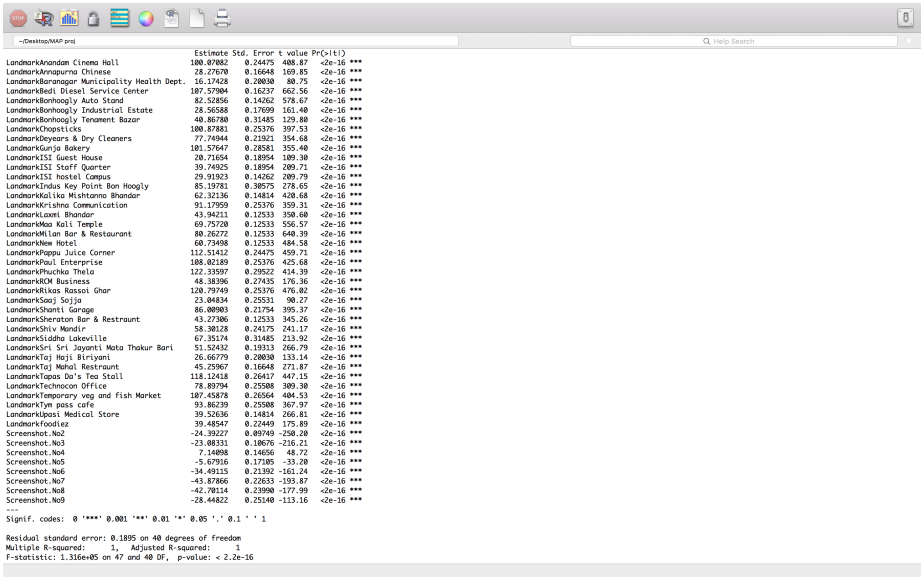
Fitting model to our pre-specified data without any user input:

In the other PDF I have explained the process.In a nutshell we will be providing to the user a data with some landmarks.These landmarks will ensure that all the 9 ss are connected and hence the user is advised to use them.So we will now fit our model on these landmarks already specified in the data.We expect our fit to be a "very" good fit here with no outliers in our residuals.Then only we can say that when there is some discrepancy in output the user had made some mistake in selecting or naming the landmarks and it is not due to our pre specified data.
First we check the summary of our plots.



```
                                      Estimate Std. Error  t value Pr(>|t|)
LandmarkAnandam Cinema Hall         234.00679    0.14165  1652.03   <2e-16 ***
LandmarkAnnapurna Chinese           154.49258    0.09635  1603.48   <2e-16 ***
LandmarkBaranagar Municipality Health Dept.  177.57231    0.11592  1531.85   <2e-16 ***
LandmarkBadi Diesel Service Center   96.38248    0.09397  1025.67   <2e-16 ***
LandmarkBonhoogly Auto Stand         61.11491    0.08254   740.44   <2e-16 ***
LandmarkBonhoogly Industrial Estate 126.07453    0.10243  1230.84   <2e-16 ***
LandmarkBonhoogly Tenament Bazar    322.60485    0.18222  1770.44   <2e-16 ***
LandmarkChopsticks                  188.80291    0.14687  1285.55   <2e-16 ***
LandmarkDeyears & Dry Cleaners      186.19337    0.12687  1467.61   <2e-16 ***
LandmarkGunja Bakery                206.42857    0.16541  1247.97   <2e-16 ***
LandmarkISI Guest House              10.94527    0.10970    99.78   <2e-16 ***
LandmarkISI Staff Quarter            14.17057    0.10970   129.18   <2e-16 ***
LandmarkISI hostel Campus            59.60892    0.08254   722.19   <2e-16 ***
LandmarkIndus Key Point Bon Hoogly  286.64602    0.17695  1619.93   <2e-16 ***
LandmarkKalika Mishtanna Bhandar    104.85050    0.08574  1222.93   <2e-16 ***
LandmarkKrishna Communication       204.11210    0.14687  1389.79   <2e-16 ***
LandmarkLaxmi Bhandar                85.05943    0.07254  1172.63   <2e-16 ***
LandmarkMaa Kali Temple              83.68968    0.07254  1153.75   <2e-16 ***
LandmarkMilan Bar & Restaurant       79.51712    0.07254  1096.22   <2e-16 ***
LandmarkNew Hotel                    87.15938    0.07254  1201.58   <2e-16 ***
LandmarkPappu Juice Corner          229.11389    0.14165  1617.48   <2e-16 ***
LandmarkPaul Enterprise             207.78574    0.14687  1414.80   <2e-16 ***
LandmarkPhuchka Thela               212.42001    0.17086  1243.27   <2e-16 ***
LandmarkRCM Business                284.78750    0.15878  1793.61   <2e-16 ***
LandmarkRikas Rassoi Ghar           217.49865    0.14687  1480.94   <2e-16 ***
LandmarkSaaj Sojja                  186.25900    0.14776  1260.53   <2e-16 ***
LandmarkShanti Garage               151.88373    0.12590  1206.36   <2e-16 ***
LandmarkSheraton Bar & Restraunt     87.60464    0.07254  1207.72   <2e-16 ***
LandmarkShiv Mandir                 246.74703    0.13991  1763.62   <2e-16 ***
LandmarkSiddha Lakeville            321.38194    0.18222  1763.29   <2e-16 ***
LandmarkSri Sri Jayanti Mata Thakur Bari  162.26394    0.11177  1451.73   <2e-16 ***
LandmarkTaj Haji Biriyani           168.17153    0.11592  1450.75   <2e-16 ***
LandmarkTaj Mahal Restraunt         158.05249    0.09635  1557.40   <2e-16 ***
LandmarkTapas Da's Tea Stall        252.11164    0.15289  1648.99   <2e-16 ***
LandmarkTechnocon Office            276.03613    0.14763  1869.79   <2e-16 ***
LandmarkTemporary veg and fish Market  296.08376    0.15374  1925.92   <2e-16 ***
LandmarkTym pass cafe               277.13586    0.14763  1877.24   <2e-16 ***
LandmarkUpasi Medical Store         110.82010    0.08574  1292.56   <2e-16 ***
Landmarkfoodiez                     217.09036    0.12992  1670.90   <2e-16 ***
Screenshot.No2                      -35.07760    0.05642  -621.69   <2e-16 ***
Screenshot.No3                      -67.30221    0.06179 -1089.24   <2e-16 ***
Screenshot.No4                      -87.95225    0.08482 -1036.89   <2e-16 ***
Screenshot.No5                     -131.50619    0.09900 -1328.39   <2e-16 ***
Screenshot.No6                     -150.46632    0.12380 -1215.36   <2e-16 ***
Screenshot.No7                     -180.97399    0.13099 -1381.59   <2e-16 ***
Screenshot.No8                     -219.87698    0.13884 -1583.63   <2e-16 ***
Screenshot.No9                     -243.13641    0.14550 -1671.07   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1097 on 40 degrees of freedom
Multiple R-squared:      1,   Adjusted R-squared:      1
F-statistic: 4.885e+05 on 47 and 40 DF,  p-value: < 2.2e-16
```

This is the summary of our fitted x co-ordinates and it looks perfect with all the ss and landmarks significant and adjusted r square is 1.



```
~/Desktop/MAP proj                                                    Help Search

                                          Estimate Std. Error t value Pr(>|t|)
LandmarkAnandam Cinema Hall              100.07082   0.24475  408.87   <2e-16 ***
LandmarkAnnapurna Chinese                 28.27670   0.16648  169.85   <2e-16 ***
LandmarkBaranagar Municipality Health Dept.  16.17428   0.20030   80.75   <2e-16 ***
LandmarkBedi Diesel Sl Service Center    107.57904   0.16237  662.56   <2e-16 ***
LandmarkBonhoogly Auto Stand              82.52856   0.14262  578.67   <2e-16 ***
LandmarkBonhoogly Industrial Estate       28.56588   0.17699  161.40   <2e-16 ***
LandmarkBonhoogly Tenament Bazar          40.86780   0.31485  129.80   <2e-16 ***
LandmarkChopsticks                       100.87881   0.25376  397.53   <2e-16 ***
LandmarkDeyears & Dry Cleaners            77.74944   0.21921  354.68   <2e-16 ***
LandmarkGunja Bakery                     101.57647   0.28581  355.40   <2e-16 ***
LandmarkISI Guest House                   20.71654   0.18954  109.30   <2e-16 ***
LandmarkISI Staff Quarter                 39.74925   0.18954  209.71   <2e-16 ***
LandmarkISI hostel Campus                 29.91923   0.14262  209.79   <2e-16 ***
LandmarkIndus Key Point Bon Hoogly        85.19781   0.30575  278.65   <2e-16 ***
LandmarkKalika Mishtanno Bhandar          62.32136   0.14814  420.68   <2e-16 ***
LandmarkKrishna Communication             91.17959   0.25376  359.31   <2e-16 ***
LandmarkLaxmi Bhandar                     43.94211   0.12533  350.60   <2e-16 ***
LandmarkMaa Kali Temple                   69.75720   0.12533  556.57   <2e-16 ***
LandmarkMilan Bar & Restaurant            80.26272   0.12533  640.39   <2e-16 ***
LandmarkNew Hotel                         60.73408   0.12533  484.58   <2e-16 ***
LandmarkPappu Juice Corner               112.51412   0.24475  459.71   <2e-16 ***
LandmarkPaul Enterprise                  108.02189   0.25376  425.68   <2e-16 ***
LandmarkPhuchka Thela                    122.33597   0.29522  414.39   <2e-16 ***
LandmarkRCM Business                      48.38396   0.27435  176.36   <2e-16 ***
LandmarkRikas Rassoi Ghar                120.79749   0.25376  476.02   <2e-16 ***
LandmarkSaaj Sojja                        23.84834   0.25531   90.27   <2e-16 ***
LandmarkShanti Garage                     86.00903   0.21754  395.37   <2e-16 ***
LandmarkSheraton Bar & Restraunt          43.27306   0.12533  345.26   <2e-16 ***
LandmarkShiv Mandir                       58.30128   0.24175  241.17   <2e-16 ***
LandmarkSiddha Lakeville                  67.35174   0.31485  213.92   <2e-16 ***
LandmarkSri Sri Jayanti Mata Thakur Bari  51.52432   0.19313  266.79   <2e-16 ***
LandmarkTaj Haji Biriyani                 26.66779   0.20030  133.14   <2e-16 ***
LandmarkTaj Mahal Restraunt               45.25967   0.16648  271.87   <2e-16 ***
LandmarkTapas Da's Tea Stall             118.12418   0.26417  447.15   <2e-16 ***
LandmarkTechnocon Office                  78.89794   0.25508  309.30   <2e-16 ***
LandmarkTemporary veg and fish Market    107.45878   0.26564  404.53   <2e-16 ***
LandmarkTym pass cafe                     93.86239   0.25508  367.97   <2e-16 ***
LandmarkUpasi Medical Store               39.52636   0.14814  266.81   <2e-16 ***
Landmarkfoodiez                           39.48547   0.22449  175.89   <2e-16 ***
Screenshot.No2                           -24.39227   0.09749 -250.20   <2e-16 ***
Screenshot.No3                           -23.08331   0.10676 -216.21   <2e-16 ***
Screenshot.No4                             7.14098   0.14656   48.72   <2e-16 ***
Screenshot.No5                            -5.67916   0.17105  -33.20   <2e-16 ***
Screenshot.No6                           -34.49115   0.21392 -161.24   <2e-16 ***
Screenshot.No7                           -43.87866   0.22633 -193.87   <2e-16 ***
Screenshot.No8                           -42.70114   0.23990 -177.99   <2e-16 ***
Screenshot.No9                           -28.44822   0.25140 -113.16   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1895 on 40 degrees of freedom
Multiple R-squared:      1,   Adjusted R-squared:      1
F-statistic: 1.316e+05 on 47 and 40 DF,  p-value: < 2.2e-16
```

This is the summary of our fitted y co-ordinates and it looks perfect with all the ss and landmarks significant and adjusted r square is 1.

Now we can check the ANOVA table.

```
Analysis of Variance Table

Response: x.coordinate
              Df Sum Sq Mean Sq F value    Pr(>F)
Landmark      39 233353  5983.4  497229 < 2.2e-16 ***
Screenshot.No  8  42908  5363.6  445717 < 2.2e-16 ***
Residuals     40      0     0.0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

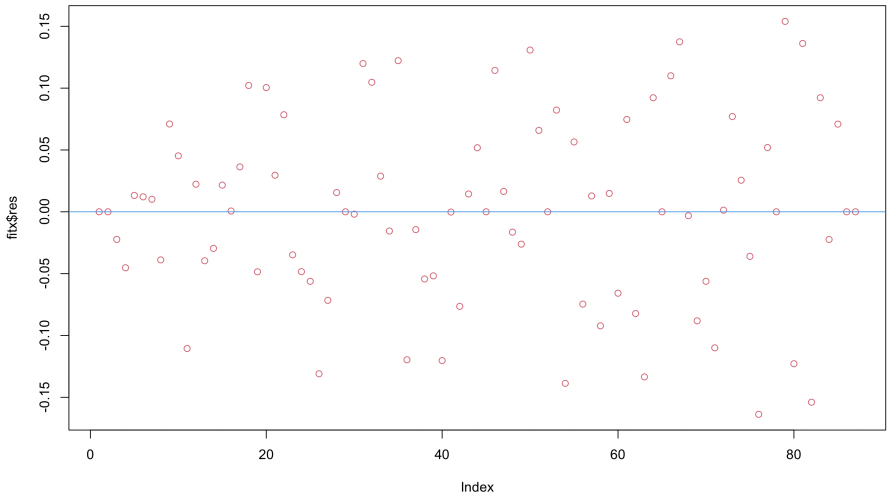
This is the ANOVA table for x co-ordinates.It looks perfect till now.

```
Analysis of Variance Table

Response: y.coordinate
              Df Sum Sq Mean Sq F value    Pr(>F)
Landmark      39 213886  5484.3  152652 < 2.2e-16 ***
Screenshot.No  8   8382  1047.8   29164 < 2.2e-16 ***
Residuals     40      1     0.0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

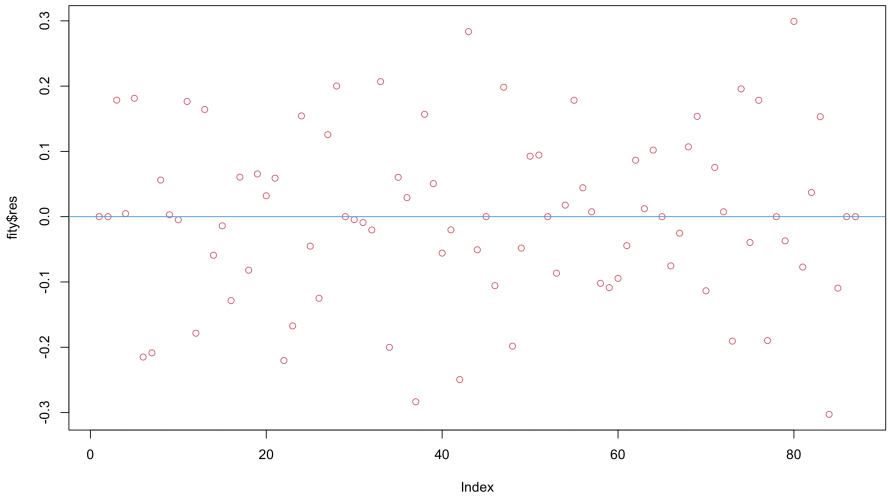
This is the ANOVA table for y co-ordinates.It looks perfect till now.

Residual Analysis:

We first check our residual plots of the fit.



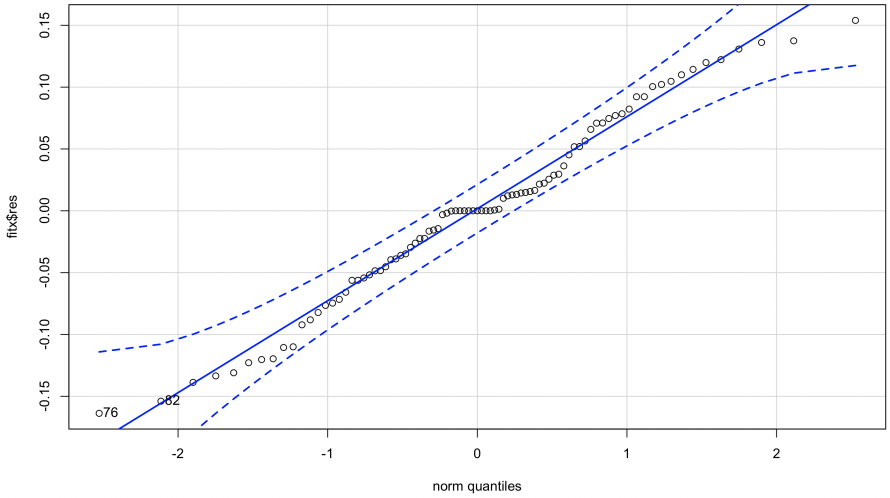
This is the residual plot of our x co-ordinates which looks quite good.



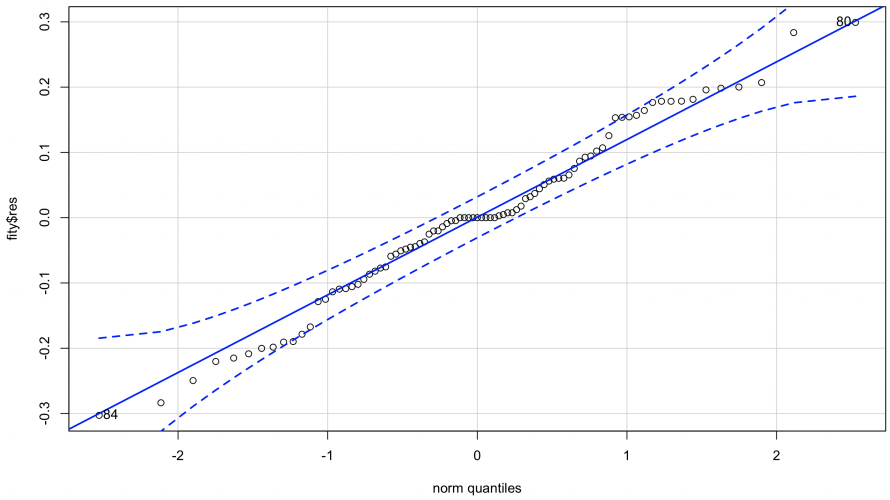
This is the residual plot of our y co-ordinates which also looks quite good.
Now from the plot it seems there is no outliers in our residuals.Also there is no pattern in residuals which is also desired.Still we can try out a method to see if there are any outliers in our residuals.
The method is as follows:

- Define Q1 as the 1^{st} quartile of our data and and Q3 as 3^{rd} quartile of our data.
- Define Inter Quartile Range (IQR) as Q3-Q1
- We can call a point outlier if it lies out of the interval [Q1-1.5*IQR,Q3+1.5*IQR].

Using this method we found out that the residuals for both the fits (x and y co ordinates) there are no points outside this interval and hence we can say there are no outliers. Finally we can perform a QQ plot.



This is the qq plot for the residuals of the fit of x co-ordinates.This is quite a nice fit.



This is the qq plot for the residuals of the fit of y co-ordinates.This is also a very good fit.
We also found out a list of places which are probably influential.Some of the places connect two ss and hence is influential since if we drop them the entire map gets disconnected.So as long as the residual plots are fine we need not worry about the influential points.

```
 [1] "ISI hostel Campus"                  "Bonhoogly Auto Stand"
 [3] "Laxmi Bhandar"                      "Sheraton Bar & Restraunt"
 [5] "Milan Bar & Restaurant"             "Bedi Diesel Service Center"
 [7] "New Hotel"                          "Bonhoogly Industrial Estate"
 [9] "Taj Mahal Restraunt"                "Annapurna Chinese"
[11] "Upasi Medical Store"                "Taj Haji Biriyani"
[13] "Deyears & Dry Cleaners"             "foodiez"
[15] "Sri Sri Jayanti Mata Thakur Bari"   "Shiv Mandir"
[17] "Tym pass cafe"                      "Pappu Juice Corner"
[19] "Technocon Office"                   "RCM Business"
```

```
 [1] "ISI hostel Campus"                  "Bonhoogly Auto Stand"
 [3] "Laxmi Bhandar"                      "Sheraton Bar & Restraunt"
 [5] "Milan Bar & Restaurant"             "Maa Kali Temple"
 [7] "New Hotel"                          "Bedi Diesel Service Center"
 [9] "Kalika Mishtanno Bhandar"           "Bonhoogly Industrial Estate"
[11] "Taj Mahal Restraunt"                "Annapurna Chinese"
[13] "Taj Haji Biriyani"                  "Baranagar Municipality Health Dept."
[15] "foodiez"                            "Deyears & Dry Cleaners"
[17] "Pappu Juice Corner"                 "Paul Enterprise"
[19] "Shiv Mandir"                        "Anandam Cinema Hall"
[21] "Tapas Da's Tea Stall"               "Technocon Office"
[23] "RCM Business"
```

The first one is a list of the influential points found while doing the fit for x-co

ordinate and the second one is for y co-ordinate.
We also calculated the correlation between fitted and residual values for each of the estimate of x and y co-ordinates.They came out to be $7.825654 * 10^{-18}$ and $4.192693 * 10^{-17}$ respectively.So finally we can say that the residuals follow iid normal with mean 0 and are homoscedastic.This implies that our model fits perfectly for the pre-specified data.Hence we can safely say that if the user finds there is any error in estimating any of the landmarks that he chose in the ss then it is due to his mistake while choosing some landmarks.We can also give a super set of the probable mistakes that he made.All our data is stored in the alldat[] variable.So once we find out the serial number of the datas whose residuals are outliers we can check out those from our alldat[] matrix.We will do this for the residuals of both the fits for x as well as the y co-ordinate.Even if we find that estimate of only one co ordinate of a particular location has an outlier residual we will include it in our probable mistakes list.We will illustrate this in the following example.

Fitting the model when the user has given input for landmarks:

Now we know that our given data is perfect.So we will now take some user inputs and try to fit the model to our user input and given data.

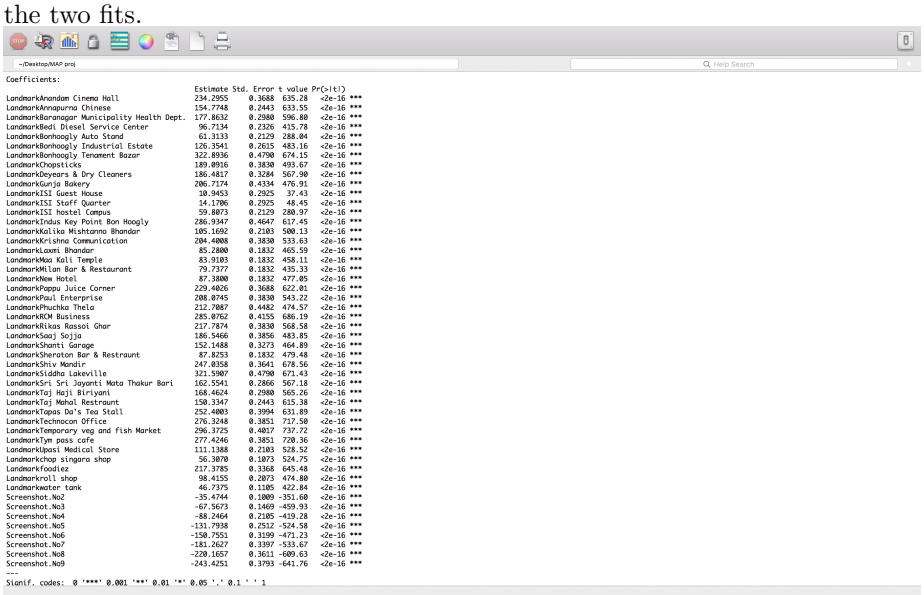
```
Call:
lm(formula = x.coordinate ~ Landmark + Screenshot.No - 1, data = alldat)

Coefficients:
                  LandmarkAnandam Cinema Hall                   LandmarkAnnapurna Chinese  LandmarkBaranagar Municipality Health Dept.          LandmarkBedi Diesel Service Center 
                                       234.30                                      154.77                                      177.86                                       96.71 
               LandmarkBonhoogly Auto Stand          LandmarkBonhoogly Industrial Estate              LandmarkBonhoogly Tenament Bazar                        LandmarkChopsticks 
                                        61.31                                      126.35                                      322.89                                      189.09 
             LandmarkDeyears & Dry Cleaners                        LandmarkGunja Bakery                        LandmarkISI Guest House                    LandmarkISI Staff Quarter 
                                       186.48                                      206.72                                       10.95                                       14.17 
                 LandmarkISI hostel Campus          LandmarkIndus Key Point Bon Hoogly                 LandmarkKalika Mishtanno Bhandar                    LandmarkKrishna Communication 
                                        59.81                                      286.93                                      105.17                                      204.40 
                   LandmarkLaxmi Bhandar                       LandmarkMaa Kali Temple                      LandmarkMilan Bar & Restaurant                          LandmarkNew Hotel 
                                        85.28                                       83.91                                       79.74                                       87.38 
                LandmarkPappu Juice Corner                       LandmarkPaul Enterprise                          LandmarkPhuchka Thela                       LandmarkRCM Business 
                                       229.40                                      208.07                                      212.71                                      285.08 
                  LandmarkRikas Rassoi Ghar                           LandmarkSaaj Sojja                        LandmarkShanti Garage                LandmarkSheraton Bar & Restraunt 
                                       217.79                                      186.55                                      152.15                                       87.83 
                    LandmarkShiv Mandir                      LandmarkSiddha Lakeville  LandmarkSri Sri Jayanti Mata Thakur Bari                      LandmarkTaj Haji Biriyani 
                                       247.04                                      321.59                                      162.55                                      168.46 
              LandmarkTaj Mahal Restraunt                  LandmarkTapas Da's Tea Stall                    LandmarkTechnocon Office  LandmarkTemporary veg and fish Market 
                                       150.33                                      252.40                                      276.32                                      296.37 
                  LandmarkTym pass cafe                     LandmarkUpasi Medical Store                  Landmarkchop singara shop                           Landmarkfoodiez 
                                       277.42                                      111.14                                       56.31                                      217.38 
                       Landmarkroll shop                          Landmarkwater tank                          Screenshot.No2                          Screenshot.No3 
                                        98.42                                       46.74                                      -35.47                                      -67.57 
                          Screenshot.No4                          Screenshot.No5                          Screenshot.No6                          Screenshot.No7 
                                       -88.25                                     -131.79                                     -150.76                                     -181.26 
                          Screenshot.No8                          Screenshot.No9 
                                      -220.17                                     -243.43 
```

These are our estimates of global x co-ordinate.

```
Call:
lm(formula = y.coordinate ~ Landmark + Screenshot.No - 1, data = alldat)

Coefficients:
                  LandmarkAnandam Cinema Hall                   LandmarkAnnapurna Chinese  LandmarkBaranagar Municipality Health Dept.          LandmarkBedi Diesel Service Center 
                                       100.053                                      28.259                                      16.156                                      107.558 
               LandmarkBonhoogly Auto Stand          LandmarkBonhoogly Industrial Estate              LandmarkBonhoogly Tenament Bazar                        LandmarkChopsticks 
                                        82.516                                      28.548                                      40.850                                      100.861 
             LandmarkDeyears & Dry Cleaners                        LandmarkGunja Bakery                        LandmarkISI Guest House                    LandmarkISI Staff Quarter 
                                        77.731                                     101.558                                      20.717                                      39.749 
                 LandmarkISI hostel Campus          LandmarkIndus Key Point Bon Hoogly                 LandmarkKalika Mishtanno Bhandar                    LandmarkKrishna Communication 
                                        29.907                                      85.180                                      62.301                                      91.161 
                   LandmarkLaxmi Bhandar                       LandmarkMaa Kali Temple                      LandmarkMilan Bar & Restaurant                          LandmarkNew Hotel 
                                        43.928                                      69.743                                      80.249                                      60.721 
                LandmarkPappu Juice Corner                       LandmarkPaul Enterprise                          LandmarkPhuchka Thela                       LandmarkRCM Business 
                                       112.496                                     108.004                                     122.318                                      48.366 
                  LandmarkRikas Rassoi Ghar                           LandmarkSaaj Sojja                        LandmarkShanti Garage                LandmarkSheraton Bar & Restraunt 
                                       120.779                                      23.030                                      85.992                                      43.259 
                    LandmarkShiv Mandir                      LandmarkSiddha Lakeville  LandmarkSri Sri Jayanti Mata Thakur Bari                      LandmarkTaj Haji Biriyani 
                                        58.283                                      67.334                                      51.506                                      26.650 
              LandmarkTaj Mahal Restraunt                  LandmarkTapas Da's Tea Stall                    LandmarkTechnocon Office  LandmarkTemporary veg and fish Market 
                                        45.242                                     118.106                                      78.880                                     107.441 
                  LandmarkTym pass cafe                     LandmarkUpasi Medical Store                  Landmarkchop singara shop                           Landmarkfoodiez 
                                        93.844                                      39.506                                      84.982                                      39.467 
                       Landmarkroll shop                          Landmarkwater tank                          Screenshot.No2                          Screenshot.No3 
                                        61.435                                      83.955                                     -24.367                                     -23.067 
                          Screenshot.No4                          Screenshot.No5                          Screenshot.No6                          Screenshot.No7 
                                         7.159                                      -5.661                                     -34.473                                     -43.861 
                          Screenshot.No8                          Screenshot.No9 
                                       -42.683                                     -28.430 
```

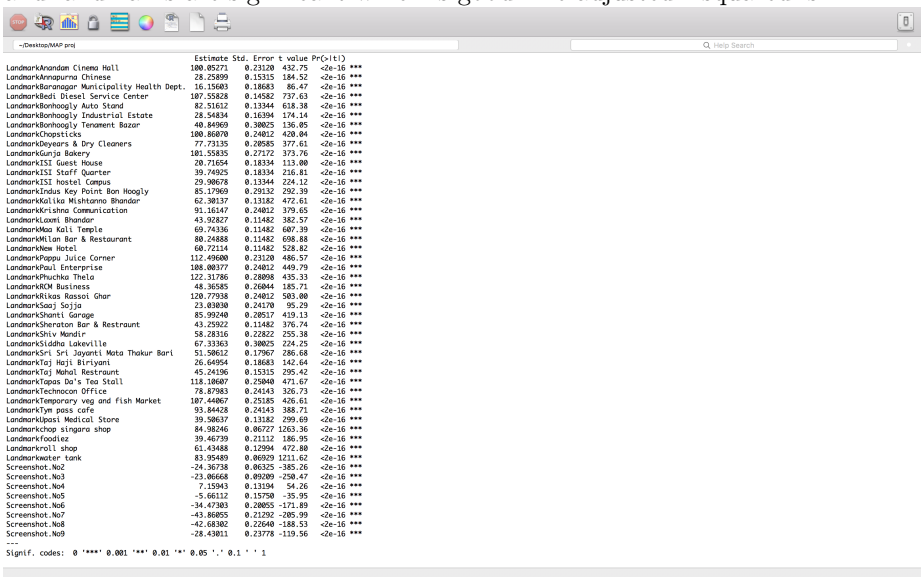
These are our estimates of global y co-ordinate. We can check the summary of

the two fits.



```
~/Desktop/MAP proj

Coefficients:
                                          Estimate Std. Error t value Pr(>|t|)
LandmarkAnandam Cinema Hall               234.2955     0.3688  635.28   <2e-16 ***
LandmarkAnnapurna Chinese                 154.7748     0.2443  633.55   <2e-16 ***
LandmarkBaranagar Municipality Health Dept. 177.8632   0.2980  596.80   <2e-16 ***
LandmarkBedi Diesel Service Center         96.7134     0.2326  415.78   <2e-16 ***
LandmarkBonhoogly Auto Stand               61.3133     0.2129  288.04   <2e-16 ***
LandmarkBonhoogly Industrial Estate       126.3541     0.2615  483.16   <2e-16 ***
LandmarkBonhoogly Tenament Bazar          322.8936     0.4790  674.15   <2e-16 ***
LandmarkChopsticks                        189.0916     0.3830  493.67   <2e-16 ***
LandmarkDeyears & Dry Cleaners            186.4817     0.3284  567.90   <2e-16 ***
LandmarkGunja Bakery                      206.7174     0.4334  476.91   <2e-16 ***
LandmarkISI Guest House                    10.9453     0.2925   37.43   <2e-16 ***
LandmarkISI Staff Quarter                  14.1706     0.2925   48.45   <2e-16 ***
LandmarkISI hostel Campus                  59.8073     0.2129  280.97   <2e-16 ***
LandmarkIndus Key Point Bon Hoogly        286.9347     0.4647  617.45   <2e-16 ***
LandmarkKalika Wishtanna Bhandar          105.1692     0.2103  500.13   <2e-16 ***
LandmarkKrishna Communication             204.4008     0.3830  533.63   <2e-16 ***
LandmarkLaxmi Bhandar                      85.2800     0.1832  465.59   <2e-16 ***
LandmarkMaa Kali Temple                    83.9103     0.1832  458.11   <2e-16 ***
LandmarkMilan Bar & Restaurant             79.7377     0.1832  435.33   <2e-16 ***
LandmarkNew Hotel                          87.3800     0.1832  477.05   <2e-16 ***
LandmarkPappu Juice Corner                229.4026     0.3688  622.01   <2e-16 ***
LandmarkPaul Enterprise                   208.0745     0.3830  543.22   <2e-16 ***
LandmarkPhuchka Thela                     212.7087     0.4482  474.57   <2e-16 ***
LandmarkRCM Businnss                      285.0762     0.4155  686.19   <2e-16 ***
LandmarkRikas Rassoi Ghar                 217.7874     0.3830  568.58   <2e-16 ***
LandmarkSaaj Sojja                        180.5466     0.3856  483.85   <2e-16 ***
LandmarkShanti Garage                     152.1488     0.3273  464.89   <2e-16 ***
LandmarkSheraton Bar & Restraunt           87.8253     0.1832  479.48   <2e-16 ***
LandmarkShiv Mandir                       247.0358     0.3641  678.56   <2e-16 ***
LandmarkSiddha Lakeville                  321.5907     0.4790  671.43   <2e-16 ***
LandmarkSri Sri Jayanti Mata Thakur Bari  162.5541     0.2866  567.18   <2e-16 ***
LandmarkTaj Haji Biriyani                 168.4624     0.2980  565.26   <2e-16 ***
LandmarkTaj Mahal Restraunt               150.3347     0.2443  615.38   <2e-16 ***
LandmarkTapas Da's Tea Stall              252.4003     0.3994  631.89   <2e-16 ***
LandmarkTechnocon Office                  276.3248     0.3851  717.50   <2e-16 ***
LandmarkTemporary veg and fish Market     296.3725     0.4017  737.72   <2e-16 ***
LandmarkTym pass cafe                     277.4246     0.3851  720.36   <2e-16 ***
LandmarkUpasi Medical Store               111.1388     0.2103  528.52   <2e-16 ***
Landmarkchop singara shop                  56.3870     0.1073  524.75   <2e-16 ***
Landmarkfoodiez                           217.3785     0.3368  645.48   <2e-16 ***
Landmarkroll shop                          98.4155     0.2073  474.80   <2e-16 ***
Landmarkwater tank                         46.7375     0.1105  422.84   <2e-16 ***
Screenshot.No2                            -35.4744     0.1009 -351.60   <2e-16 ***
Screenshot.No3                            -67.5673     0.1469 -459.93   <2e-16 ***
Screenshot.No4                            -88.2464     0.2105 -419.28   <2e-16 ***
Screenshot.No5                           -131.7938     0.2512 -524.58   <2e-16 ***
Screenshot.No6                           -150.7551     0.3199 -471.23   <2e-16 ***
Screenshot.No7                           -181.2627     0.3397 -533.67   <2e-16 ***
Screenshot.No8                           -220.1657     0.3611 -609.63   <2e-16 ***
Screenshot.No9                           -243.4251     0.3793 -641.76   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

This is a summary of the fitted x co ordinates.As we can see all the screenshots and landmarks are significant which is good.The adjusted r squared is 1.



```
~/Desktop/MAP proj

                                          Estimate Std. Error t value Pr(>|t|)
LandmarkAnandam Cinema Hall               100.05271    0.23120  432.75   <2e-16 ***
LandmarkAnnapurna Chinese                  28.25899    0.15315  184.52   <2e-16 ***
LandmarkBaranagar Municipality Health Dept.  16.15603  0.18683   86.47   <2e-16 ***
LandmarkBedi Diesel Service Center        107.55828    0.14582  737.63   <2e-16 ***
LandmarkBonhoogly Auto Stand               82.51612    0.13344  618.38   <2e-16 ***
LandmarkBonhoogly Industrial Estate        28.54834    0.16394  174.14   <2e-16 ***
LandmarkBonhoogly Tenament Bazar           40.84969    0.30025  136.05   <2e-16 ***
LandmarkChopsticks                        100.86070    0.24012  420.04   <2e-16 ***
LandmarkDeyears & Dry Cleaners             77.73135    0.20585  377.61   <2e-16 ***
LandmarkGunja Bakery                      101.55835    0.27172  373.76   <2e-16 ***
LandmarkISI Guest House                    20.71654    0.18334  113.00   <2e-16 ***
LandmarkISI Staff Quarter                  39.74925    0.18334  216.81   <2e-16 ***
LandmarkISI hostel Campus                  29.90678    0.13344  224.12   <2e-16 ***
LandmarkIndus Key Point Bon Hoogly         85.17969    0.29132  292.39   <2e-16 ***
LandmarkKalika Wishtanna Bhandar           62.30137    0.13182  472.61   <2e-16 ***
LandmarkKrishna Communication              91.16147    0.24012  379.65   <2e-16 ***
LandmarkLaxmi Bhandar                      43.92827    0.11482  382.57   <2e-16 ***
LandmarkMaa Kali Temple                    69.74336    0.11482  607.39   <2e-16 ***
LandmarkMilan Bar & Restaurant             80.24888    0.11482  698.88   <2e-16 ***
LandmarkNew Hotel                          60.72114    0.11482  528.82   <2e-16 ***
LandmarkPappu Juice Corner                112.49600    0.23120  486.57   <2e-16 ***
LandmarkPaul Enterprise                   108.00377    0.24012  449.79   <2e-16 ***
LandmarkPhuchka Thela                     122.31786    0.28098  435.33   <2e-16 ***
LandmarkRCM Business                       48.36585    0.26044  185.71   <2e-16 ***
LandmarkRikas Rassoi Ghar                 120.77938    0.24012  503.00   <2e-16 ***
LandmarkSaaj Sojja                         23.03030    0.24170   95.29   <2e-16 ***
LandmarkShanti Garage                      85.99240    0.20517  419.13   <2e-16 ***
LandmarkSheraton Bar & Restraunt           43.25922    0.11482  376.74   <2e-16 ***
LandmarkShiv Mandir                        58.28316    0.22822  255.38   <2e-16 ***
LandmarkSiddha Lakeville                   67.33363    0.30025  224.25   <2e-16 ***
LandmarkSri Sri Jayanti Mata Thakur Bari   51.50612    0.17967  286.68   <2e-16 ***
LandmarkTaj Haji Biriyani                  26.64954    0.18683  142.64   <2e-16 ***
LandmarkTaj Mahal Restraunt                45.24196    0.15315  295.42   <2e-16 ***
LandmarkTapas Da's Tea Stall              118.10607    0.25040  471.67   <2e-16 ***
LandmarkTechnocon Office                   78.87983    0.24143  326.73   <2e-16 ***
LandmarkTemporary veg and fish Market     107.44067    0.25185  426.61   <2e-16 ***
LandmarkTym pass cafe                      93.84428    0.24143  388.71   <2e-16 ***
LandmarkUpasi Medical Store                39.50637    0.13182  299.69   <2e-16 ***
Landmarkchop singara shop                  84.98246    0.06727 1263.36   <2e-16 ***
Landmarkfoodiez                            39.46739    0.21112  186.95   <2e-16 ***
Landmarkroll shop                          61.43488    0.12994  472.80   <2e-16 ***
Landmarkwater tank                         83.95489    0.06929 1211.62   <2e-16 ***
Screenshot.No2                            -24.36738    0.06325 -385.26   <2e-16 ***
Screenshot.No3                            -23.06668    0.09209 -250.47   <2e-16 ***
Screenshot.No4                              7.15943    0.13194   54.26   <2e-16 ***
Screenshot.No5                             -5.66112    0.15750  -35.95   <2e-16 ***
Screenshot.No6                            -34.47303    0.20055 -171.89   <2e-16 ***
Screenshot.No7                            -43.86055    0.21292 -205.99   <2e-16 ***
Screenshot.No8                            -42.68302    0.22640 -188.53   <2e-16 ***
Screenshot.No9                            -28.43011    0.23778 -119.56   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

This is a summary of the fitted y co ordinates.As we can see all the screenshots and landmarks are significant which is good.The adjusted r squared is 1.

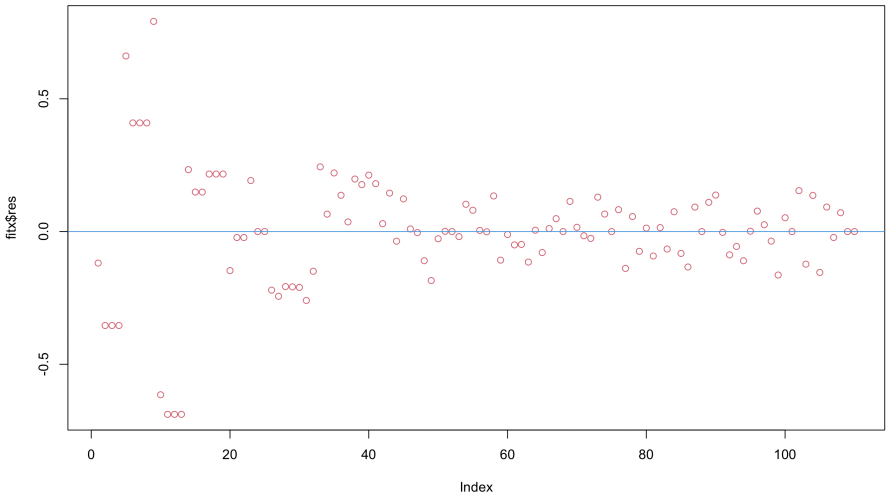
```
Analysis of Variance Table

Response: x.coordinate
              Df Sum Sq Mean Sq F value    Pr(>F)
Landmark      42 258430  6153.1   71941 < 2.2e-16 ***
Screenshot.No  8  48831  6103.9   71365 < 2.2e-16 ***
Residuals     60      5     0.1
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

This is the anova table for x co-ordinates which is perfect.

```
Response: y.coordinate
              Df Sum Sq Mean Sq F value    Pr(>F)
Landmark      42 317335  7555.6  224788 < 2.2e-16 ***
Screenshot.No  8  11122  1390.3   41362 < 2.2e-16 ***
Residuals     60      2     0.0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

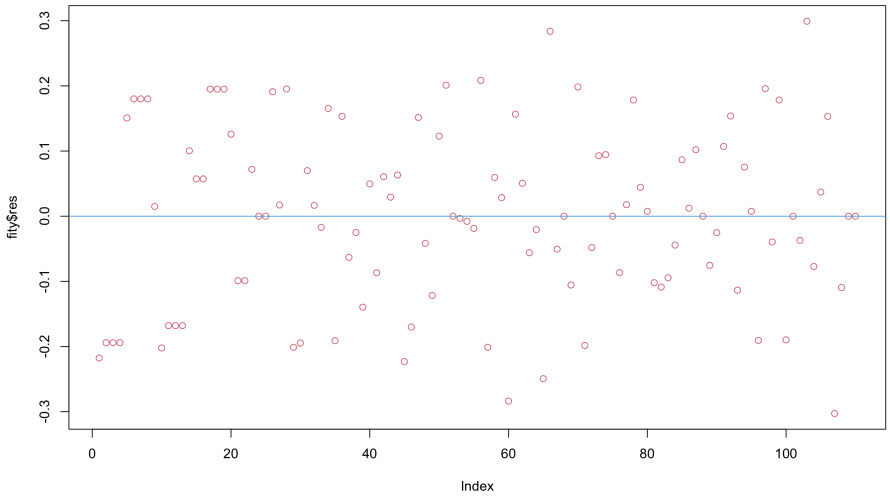
This is the anova table for y co-ordinates which is perfect.

Residual Analysis:

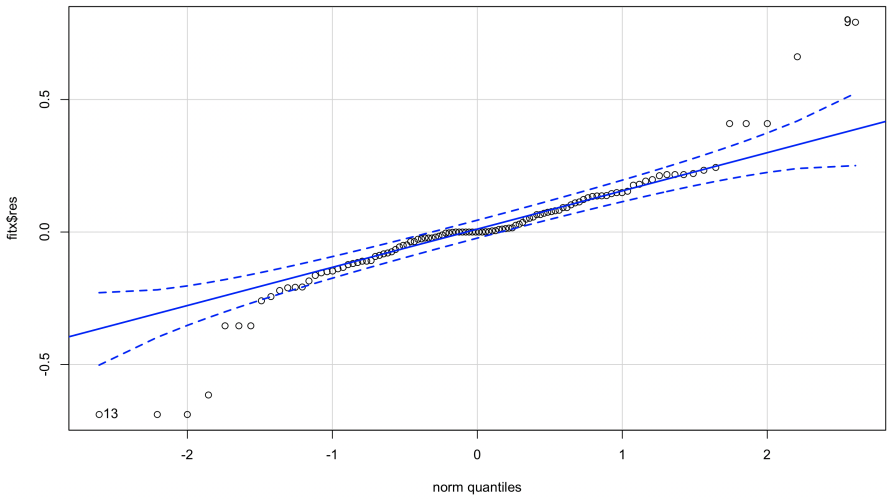


This is plot of residuals of the fitted global x co-ordinates.It seems there are some outliers unlike the last time.We checked if any of these residuals lie before 1.5*IQR of Q1 or after 1.5*IQR of Q3.We found out that all entries numbered 5,6,7,8,9,10,11,12,13 does.We checked out from alldat[] file and found out that these numbers correspond to a landmark that the user has selected in addition to

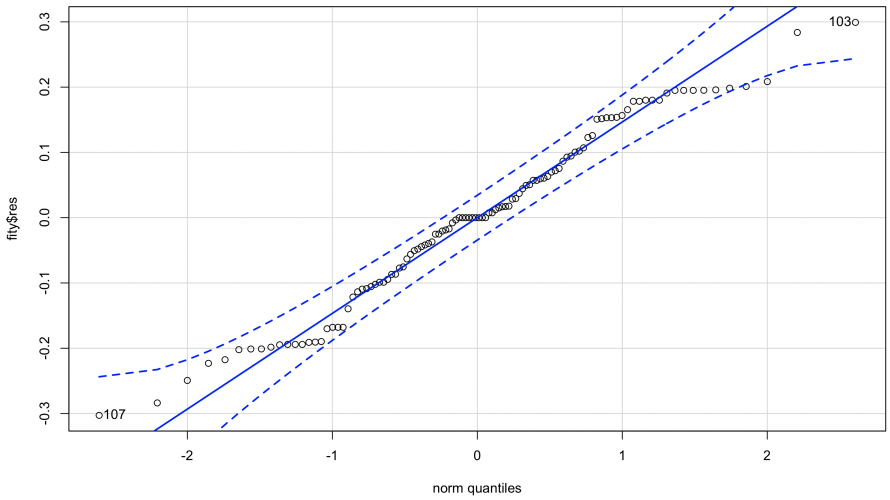
our pre existing data i.e. those in "Guide Map" namely "chop singara shop".So the user is advised to take verify the location of "chop singara shop" once again.



Now this is the residual plot of the estimated global y co-ordinates.This looks better.We do our IQR test and find out that there are no as such outliers in fit residuals of y co-ordinates.So our probable mistakes list here contains only "chop singara shop".
Now we do a QQ plot of our residuals.



This is a QQ plot of the x co-ordinates.For the bulk of data it looks ok but there are some deviations which is indicating some problem with user input.



This is a QQ plot of the y co-ordinates.This looks better and there are lesser deviations.
We also calculated the correlation among the fitted and residual values for both the estimates of x and y co-ordinates.The former came out to be as low as $2.562009 * 10^{-17}$ and the latter was $3.926711 * 10^{-17}$.

Success and Limitations of the project:

The limitations of the project are we considered only same zoom level and no rotation.If we include zoom level then good amount of care must be taken to estimate the errors as in those case errors may not be homoscedastic or even maybe correlated if we include rotation also .Except that the project went fine.We did include some roads also in the map which is shown in the other pdf.We have also allowed the user to click on multiple points on the map to know the names of the place.From the residual analysis we can see the fits are quite good unless the user messes up really bad.We also provided an extra data with landmarks and co ordinate i.e "Guide Map" which will always make the map connected no matter what location the user chooses so that should make it more user friendly.We have also converted the name that user gives to a landmark of his choice to lower case alphabets so that next time even if by mistake he uses any capital letters at a different place this will not cause any trouble.At the same time there is one more limitation that if he by mistake misspells any location the code will take it as a new entry.It would have been nice if we could have generated a warning message in that case.