LINEAR MODELS PROJECT REPORT

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❋ Objective

In this project, our aim was to take several screenshots that share some common locations and stitch them into a whole map.

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In this project, I took several screenshots of satellite images from Google Maps of the area in Bangalore and stitched them into a whole map. However, the code that I used for this, works fine for any and every area on Google Maps.

❋ Methodology

Model

Suppose, I have m screenshots and n distinct places to locate on the map.I stored the screenshot number(as ss variable), the name of the place(as place variable) and the co-ordinates of the place with respect to that screenshot. I fitted linear model for predicting the x-ordinate and the y-ordinate separately. For the y-ordinate the model is,

$$y_{ij} = ss_i + place_j + \epsilon_{ij} \text{ where } i = 1, \cdots, m; j = 1, \cdots n_i \text{ and } \epsilon_{ij} \overset{IID}{\sim} N(0, \sigma^2)$$

Note that both the inputs are factor. This is a 2-way ANOVA model. We have only two indices (i, j) as for each type (i, j) we have only one observation. Similarly for the x-ordinate the model is,

$$x_{ij} = ss_i + place_j + \epsilon_{ij} \text{ where } i = 1, \cdots, m; j = 1, \cdots n_i \text{ and } \epsilon_{ij} \overset{IID}{\sim} N(0, \sigma^2)$$

Design Matrix

Number of columns in design matrix is $m + n$. Number of rows in design matrix = Total number of clicks= C (let). the dimension of the design matrix is =(number of clicks x (number of distinct place+ number of screenshots)) = $C \times (m + n)$

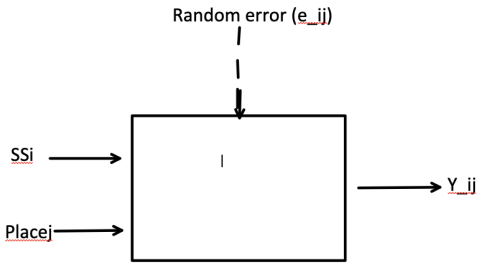

Figure 1: Blackbox diagram

Rank of the design matrix

Claim: The map formed by the screenshots is connected iff rank(design matrix) = m+n-1.

Proof: To understand the idea, consider the screenshots as vertices of a graph and draw an edge between them if they have at least one marked place common. We know if a graph is connected there exists at least (m-1) many edges.

If place(j) is common in k many of the screenshots, there exist at least $k-1$ many edges in the graph. Hence total number of edges in the graph is $\sum_j^n (k(j)-1) = C-n$ where $k(j)$ = number of times place(j) has occurred.

Now, for the columns, if we add all the columns corresponding to place variable we get a vector of 1's. Similarly adding up all the columns w.r.t. ss variable we get a vector of 1's. All the ss variables are independent of each other and all the place variables are independent of each other. Hence, column rank of the design matrix = m+n-1.

Combining two cases we get, the map is connected iff rank (design matrix)= m+n-1 Using this I checked for faulty clicks from the users in my software later.

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❋ Documentation for R codes and outputs