WiFi Speed Test Proposal

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Introduction

Since the internet is an important source of information, people need high-speed WiFi to study, work and keep in touch with people. People realize that the WiFi speed is related to whether there is an obstacle between the router and their devices, how far their devices are from their router, and the number of users. In this experiment, I will conduct a balanced three-factor factorial study to test the main effects of these three variables, as well as the potential effects of interactions among these three variables on WiFi speed.

Study Design

In this experiment, there are three factors: obstacle (2 levels: with or without), distance between WiFi router and WiFi users (three levels: 10, 30 and 50 feet), and number of users (four levels: 1, 2, 3, or 4 users, all using Apple devices). The response variable is WiFi download speed for the chosen user measured in Mbps using the testmy.net website. There are five independent replications at each of the 2 3 4 treatment combinations. So the design size is 120 (2 3 4 5). There is no randomization from the three factors as all of them are fixed. But we will completely randomize the order of the 120 experimental units.

My questions of interest include the following:

- Will obstacle affect WiFi speed?
- How does the distance between WiFi router and WiFi users affect the WiFi speed?
- How does the number of WiFi users affect WiFi speed?
- Is there any interaction among these three factors?

In this design, all the three factors are fixed, and my model is: $y_{ijkl} = \mu + \tau_i + \beta_j + \gamma_k + (\tau\beta)_{ij} + (\tau\gamma)_{ik} + (\beta\gamma)_{jk} + (\tau\beta\gamma)_{ijk} + \xi_{ijkl}$, where:

- y_{ijkl} is the WiFi speed $l^{th} observation from the$(i,j,k)th experiment.
- μ is the baseline mean of WiFi speed.
- τ_i, β_j, γ_k are the main factor effects for the factors obstacle, distance, and number of users, respectively.
- $(\tau\beta)_{ij}$, $(\tau\gamma)_{ik}$, $(\beta\gamma)_{jk}$ are the two-factor interaction effects for the interactions *obstacle * distance*, *obstacle * number of users*, and *distance * number of users*.
- $\tau\beta\gamma_{ijk}$ is the three factor interaction effects for the *obstacle * distance * number of users* interaction.
- ξ_{ijkl} is the random error of the l_{th} observation from the $(i,j,k)^{th} treatment. assumed \xi_{ijkl} \sim$ IID N(0, σ^2).

My hypotheses based on my questions of interest includes as follows:

- H_0: $\tau_1 = \tau_2 = 0$; H_a:$\exists\ \tau_i \neq 0$
- H_0: $\beta_1 = \beta_2 = \beta_3 = 0$; H_a: $\exists\ \beta_j \neq 0$.
- H_0: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$; H_a: $\exists\ \gamma_k \neq 0$.
- H_0: $(\tau\beta)_{11} = (\tau\beta)_{12} = ... = (\tau\beta)_{23} = 0$; H_a: $\exists\ (\tau\beta)_{ij} \neq 0$
- H_0: $(\tau\gamma)_{11} = (\tau\gamma)_{12} = ... (\tau\gamma)_{24} = 0$; H_a: $\exists\ (\tau\gamma)_{ik} \neq 0$.
- H_0: $(\beta\gamma)_{11} = (\beta\gamma)_{12} = ... = (\beta\gamma)_{34} = 0$; H_a: $\exists\ (\beta\gamma)_{jk} \neq 0$.

- H_0: $(\tau\beta\gamma)_{111} = (\tau\beta\gamma)_{112} = ... = (\tau\beta\gamma)_{234} = 0$; H_a: $\exists\ (\tau\beta\gamma)_{ijk} \neq 0$.

Protocol

With an assistant, I will collect data in the early morning, to minimize noise from nearby networks. In order to maintain the independence of the 120 experimental units, we will try to prevent the webpage from referencing stored WiFi speed data from our previous experiment by using Google Incognito tabs which dont store previous data. Furthermore, no other activities that require WiFi will be allowed during the experiment.

- The obstacle will be simulated by using a computer monitor and a board to simulate a wall containing wiring. The obstacle when present is between WiFi router and WiFi users.
- The distance within the house that I live in will be measured in a straight line free of obstacle.
- I will have each group of 1 to 4 users download the same file (12 MB data) at the same time.

After collecting the data, I will run a power analysis to find the power for the given design size (120) and the mean estimates. Based on the chosen users downloading experience, my criterion for a significant change of WiFi speed is a decrease by 50% from its maximum value at the closest distance. Moreover, I will first use diagnostic plots to check the assumptions for testing the affects of these three variables that I will use, such as a three-factor ANOVA analysis, then I will use a multiple comparison Tukey procedure to compare pairwise means of WiFi speed that under different treatments in this study.