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WiFi Analysis

Student version

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WiFi Analysis

Motivation

There is an increasing dependence on having wireless internet access available everywhere we go. Measuring the WiFi signal strength at home is quite easy with a mobile device, although the signal can appear quite erratic due to complex interference and reflections of the electromagnetic waves the signal consists of. Still, a measurement of the WiFi signal strength is handy for solving connectivity issues by for example revealing issues with the location of the wireless router.

In this experimental task we design and conduct an experiment to investigate how much various items and materials attenuate the WiFi signal. We practice testing a hypothesis, and carefully identifying and mitigating the external disturbances that can be present in our experimental setup.

Equipment list

- Wireless router, mobile hotspot, or some other wireless access point.
- Smartphone, tablet, or computer with a network analyzer app giving a reading of the WiFi signal strength. For Apple devices, the app AirPort allows a continuous measurement giving a list of (time, strength) points. For Android, we have been unable to find a free app that gives such a log of measurements. Network Signal Info Pro has this feature, but it is not free. Still, the free version of the app Network Signal Info or any other app which displays the current value of the signal strength can be used.
- Various items to investigate their properties of attenuation of the WiFi signal, such as books, chairs, oven trays, aluminum foil, etc.
- Graphing and analysis software (Origin, Python, GeoGebra, SciDAVis, anything will do)
- Spreadsheet software can be useful

Experimental skills in focus

Designing an experiment, testing a hypothesis, dealing with outliers.

Task description

The signal strength is measured in units of dBm. Find out and explain what a dBm means and show how to convert that into SI units.

Design an experiment around the following research question: What kind(s) of materials appear to significantly attenuate the WiFi signal? Gather a variety of items (5-10 different items of various materials and thicknesses) from your home and formulate a hypothesis: which items would you expect to attenuate the signal a lot and which items would perhaps not have such a significant impact, and why so. Perform your experiment to test your hypothesis. Pay extra attention to making the experiment reproducible and eliminating possible external effects (other attenuating materials between the measuring device and the access point, reflections, how to place the objects etc). Hint: start by measuring the signal strength with yourself between the WiFi access point and the receiving device. What implications does this have for your experimental setup?

Due to the somewhat erratic nature of the WiFi signal, your data will likely contain some outliers, i.e., measured signal strengths that significantly deviate from the average even when nothing visibly changed in the experimental setup. Consider carefully whether outliers should be included in or excluded from the analysis. You can use for example Chauvenet's criterion or exclude measurements

that deviate over 3 standard deviations from the average, but it is up to you to choose a consistent criterion.

Guiding questions and hints:

- Think about your hypothesis and how to test it most comprehensively when choosing the items to be used to attenuate the signal in the experiment.
- Given that there are typically fluctuations in the WiFi signal, how do you measure a value to which you can reliably compare the signal strengths for each item between the measuring device and the access point?
- Can you perform statistical analysis on your measured values? How long should you run each measurement for?

Assessment

Prepare a short report consisting of your data using a suitable representation and roughly one or two pages of text where you discuss the following points:

- Describe your experimental setup. Especially how you eliminated possible external disturbances that could affect the measurement.
- Discuss outliers in the data and how you dealt with them.
- Make an argument on whether your hypotheses were supported or rejected by the data (or whether it is impossible to say either way).
- Discuss why specific items attenuate the WiFi signal more than others if such items were found.

Bonus: Think about your results in the context of the availability of the WiFi signal in your apartment.