**How Frequently Does Sound Disturb Our Daily Life**

1. **Executive Summary**

This project, which was conducted around Columbia University, aims to quantify and analyze the impact of noise pollution on urban environments, particularly in educational settings. By strategically placing sound sensors around the campus, the study records various noise sources such as vehicle traffic, sirens, and human activities. The ultimate goal is to provide data-driven insights that can be used to develop strategies for noise mitigation, thereby enhancing the quality of life and educational experiences on the campus. This involves identifying the most disruptive types of noise and the times of day they are most prevalent to inform potential changes in university policy or urban planning.

2. **Introduction, including context and motivations**

Noise pollution, often overlooked in urban planning, poses significant challenges to both health and cognitive functions. In urban academic settings like Columbia University, external noise can interrupt lectures, reduce the effectiveness of learning environments, and contribute to stress among students and faculty. The motivation behind this project is to address these challenges by mapping noise levels and identifying key sources of noise pollution. This understanding could lead to practical interventions that make urban educational environments more conducive to learning and mental well-being.

3. **Anecdotes: Two-three paragraphs about how you think about the relationship of your anecdote to the urban? In what ways are you thinking about the interrelationships between the two, or what gaps in knowledge/policy are you seeking to reveal?**

Two specific incidents illustrate the typical disturbances encountered in urban academic settings: first, a loud construction project adjacent to a study hall disrupted students during midterm exams; second, frequent ambulance sirens near the university's hospital distracted a lecture in progress. These anecdotes underscore the complex relationship between urban environments and academic settings, where noise not only disrupts immediate activities but also raises broader questions about the adequacy of existing noise regulation policies and the university's infrastructure planning. These gaps in knowledge and policy underscore the need for targeted research and tailored solutions to urban noise pollution.

4. **Local Interactions: Describe the scenarios, interactions and investigations at your local scale (1m? 10m? 100m?). In what ways does your installation require or instigate interactions, if any?**

Immediate Proximity (1m): The direct interaction with the sound sensors and the immediate environment where they are installed. This includes the setup, maintenance, and immediate data retrieval from the sensors placed around the university, such as near Schermerhorn Hall on Amsterdam Ave. At this scale, technicians or project members interact closely with the technology, perhaps adjusting settings or retrieving data from the SD card in real-time.

Local Area (10m): This scale could encompass interactions within a slightly larger perimeter around the sensor installations. It includes monitoring the responses of passersby to the noise or the sensor itself, and potentially engaging with individuals or small groups to gather subjective feedback on noise levels and disturbances. This could also involve observing how environmental factors like construction work or traffic flow influence the readings from the sensors.

Neighborhood Scale (100m): At this scale, your investigation takes into account the broader impact of noise pollution across a larger segment of the urban environment. This involves analyzing data collected from multiple sensors to assess noise patterns over time and across different parts of the campus and adjacent areas. Here, the interaction extends to a community level, possibly involving presentations to local stakeholders, including university officials and neighborhood groups, about the findings and recommended noise mitigation strategies.

5. **Technologies Used: What were you trying to measure, and how?**
   In Our Project in class, the primary goal was to measure sound levels using Arduino boards and microphone sound sensors. The Arduino served as the central processing unit, managing data input from microphone sensors, which captured ambient noise levels around the campus. These sensors were crucial for detecting volume and frequency, allowing the project to monitor baseline noise levels and identify significant noise events like traffic, construction, and sirens. Data collected were logged with timestamps, enabling detailed analysis of noise patterns and the identification of peak noise pollution times. This setup not only facilitated comprehensive data collection but also supported advanced data analysis, providing insights into the main contributors to noise pollution and their impact on campus life.

6. **Description of the sensors used, as well as your "device" if there were additional form/technological considerations.**
   To measure noise levels, the project utilized microphones connected to SD card readers and timekeeping modules. The sensors were programmed to record noise levels, convert these readings into decibels, and store the data along with timestamps. This setup allowed for precise measurement and analysis of noise at various times and locations.

7. **Write Up on the Pilot**
   Before proceeding with the test, we first performed several tests on the sensor's performance. In the initial experiments, our sensor faced a series of problems such as low sensitivity and short reception distance. After constant adjustments to the sensitivity, the sensor was able to detect a stable noise level, but the problem of the short reception distance remained unresolved. With the increase in sensitivity, the sensor itself is highly susceptible to interference problems caused by poor contact. For example, when there is a loose connection, the sensor tends to pick up extreme data (from 0db to over 1000db).

   After the targeted replacement of the sensors, we re-tested within the campus. This time the problem appeared significantly better, and we secured the connection by manually holding down the line. The problem this time around still centers on the fact that the sensors do not accurately represent true noise levels in real life. However, when we synchronized the measurement data with the sensor using noise level detection software such as cell phones and smartwatches, we found that the fluctuations in the data recorded by the sensor corresponded well to the fluctuations in noise volume in reality. It's worth noting that the sensor's results remain inaccurate in the face of prolonged noise level disturbances.

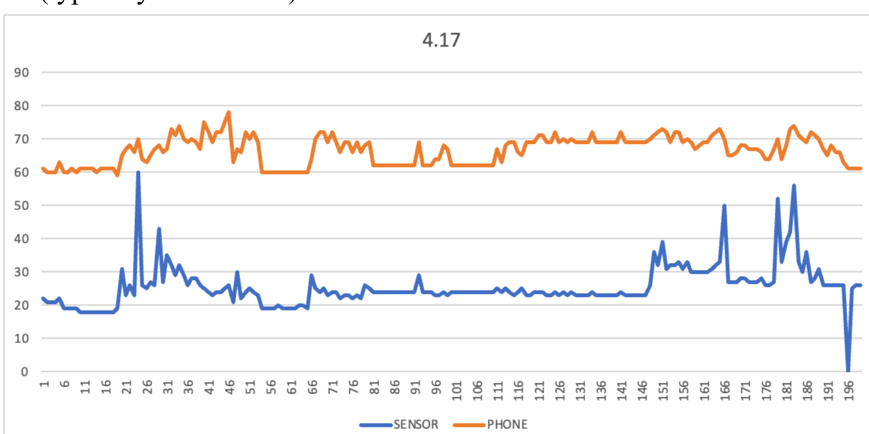
8. **Site, Considerations, Motivations**

Our Project is situated along Amsterdam Avenue near Schermerhorn Hall on the Columbia University campus in New York City. This location is pivotal due to its high traffic volume, both pedestrian and vehicular, alongside a complex mix of academic, residential, and commercial activities. The urban setting, characterized by dense building configurations and bustling street life, provides an ideal environment for studying the impact of urban noise.

Key considerations for the project included the strategic placement of sound sensors to accurately capture ambient noise while ensuring their security against potential tampering. Technical challenges such as sensor calibration, data accuracy, and connectivity were addressed to ensure reliable data collection. The project also focused on the potential community impact, aiming to engage with local stakeholders through discussions and presentations about the findings and their implications for noise reduction initiatives. Additionally, adherence to legal and ethical standards was rigorously maintained, aligning with local ordinances and university policies.
The project was motivated by several factors: the adverse effects of noise pollution on health and well-being, the disruption caused by noise to educational environments, and the need for data-driven urban planning and policymaking. The ultimate goal is to contribute to the creation of quieter, more sustainable urban spaces. This initiative not only supports Columbia University's academic mission by enriching the research landscape but also aligns with broader sustainability goals, emphasizing the importance of considering soundscapes in urban quality of life improvements.

## 9. Methodologies

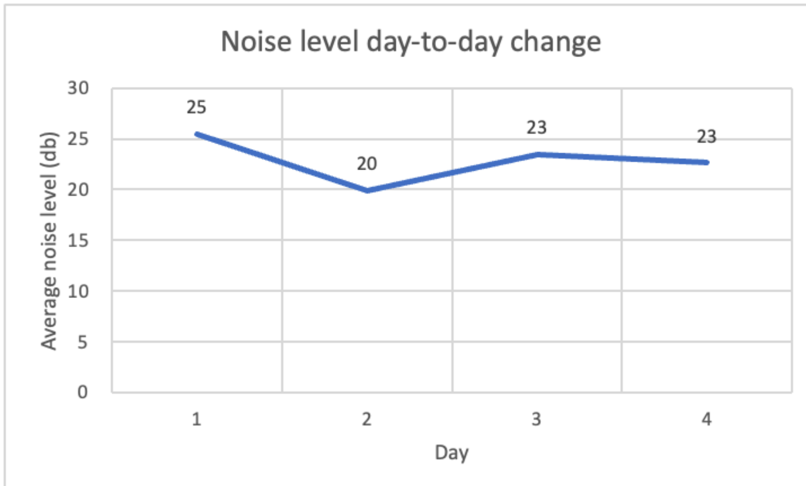
We record the data through a sound sensor and use software to analyze the data at a later stage. It is important to note that due to a number of factors our data collection is only accurate for a short period of time (typically 10 minutes).



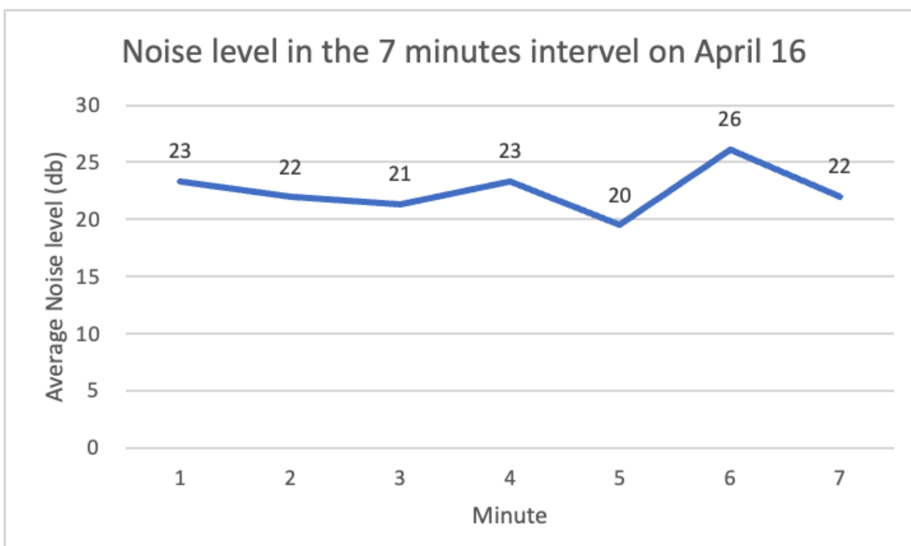

This is based on the fact that on April 17th we simultaneously collected data through the cell phone at the same frequency as the sensor. We can see that for a short period of time the sensor was able to provide a more realistic representation of the noise level in the street. At some moments, the sensor records appear as outliers due to technical problems with the sensors. We think this is due to poor contact.

**10. Analysis**

For data analysis and processing, we collected noise level data for a total of four days. First, we performed a basic analysis where we collected four days of average noise level data to analyze the daily variation over the span of days.

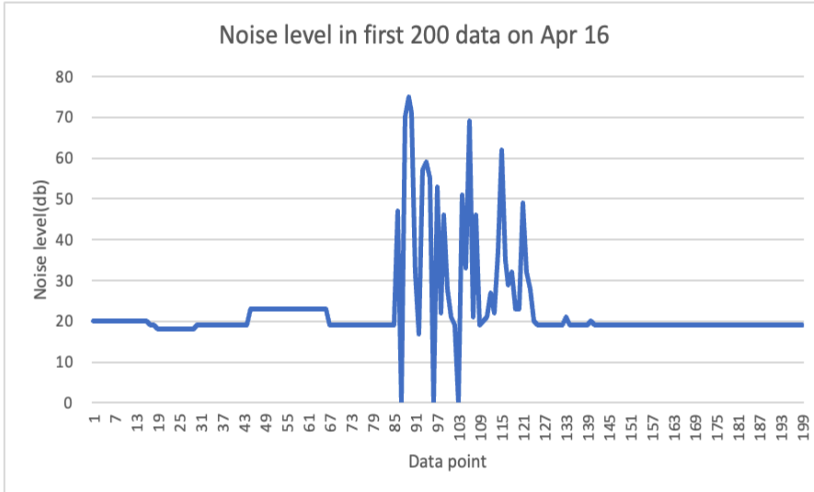


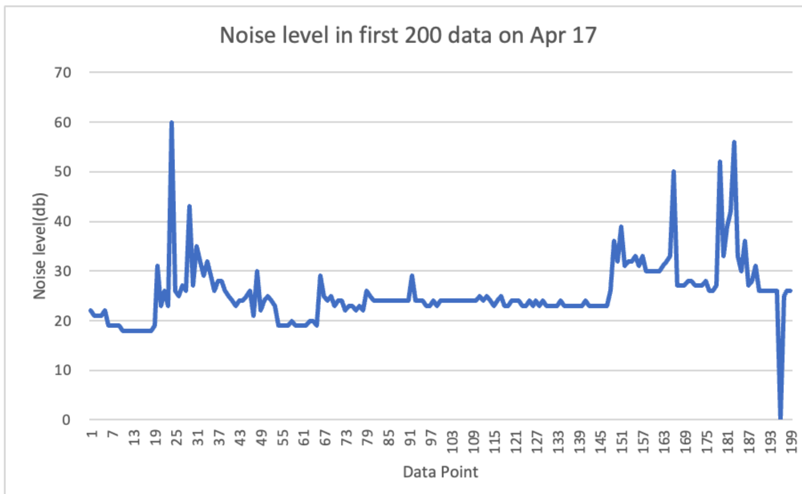

The data for all four days fluctuated almost exclusively around 23 db, while the data for April 16th reached 25 db. This was due to road construction on the street that resulted in higher noise levels on that day.

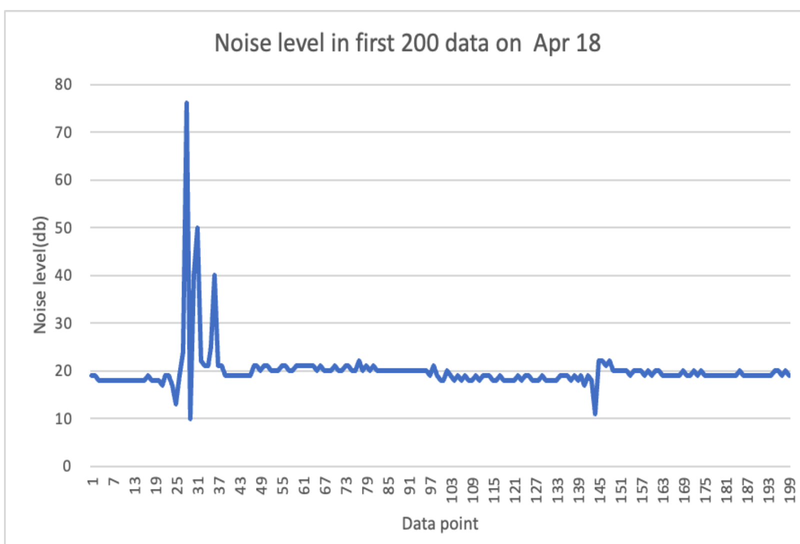


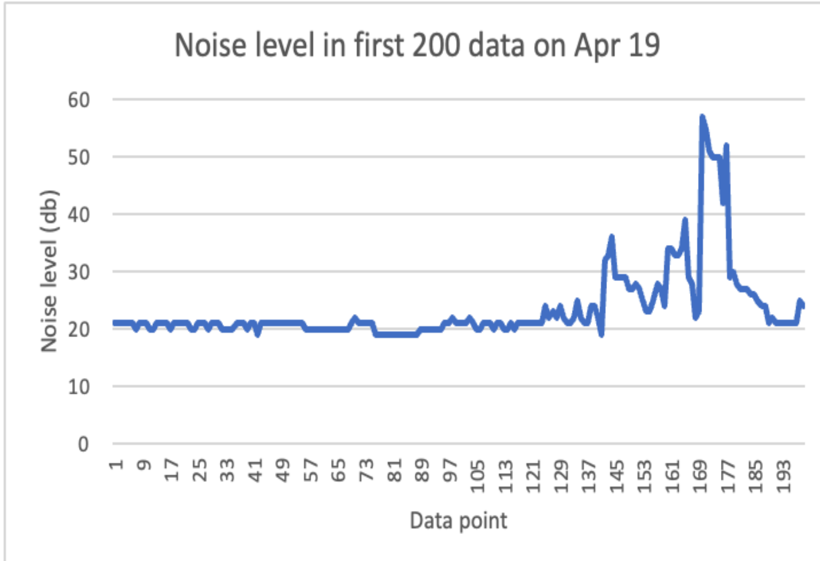

Next, we analyzed each 1-minute interval on April 16th. In a 7-minute analysis, we found that the volume fluctuations were phased. The main noise tends to come from vehicular traffic, and this phasing is often due to traffic signals.

Due to data instability and low accuracy over long time scales, we chose to analyze the first 200 data for each day of the four-day period.


Noise level in first 200 data on Apr 16
Noise level(db)
Data point


Noise level in first 200 data on Apr 17
Noise level(db)
Data Point


Noise level in first 200 data on Apr 18
Noise level(db)
Data point




In most cases, we found erratic and sudden high-decibel noise from street activity. This behavior is usually due to large vehicles such as trucks, sport cars, and ambulances.

Although the data is not accurate enough due to various factors. However, we are still able to conclude that, in general, the daily sound fluctuations on the streets are basically stable. Vehicular activity, especially large vehicles, on the other hand, seriously interferes with the tranquil environment.

## 11. Lessons Learned

Our Project at  provided numerous insights, highlighting the critical need for reliable equipment as poor sensor quality and connectivity significantly impacted data accuracy. Managing large datasets efficiently and strategic sensor placement were also key lessons, emphasizing the importance of advanced data analysis and careful site selection to capture comprehensive noise data. Engaging with stakeholders and integrating educational outreach proved essential in fostering community support and raising awareness about noise pollution. The findings underscored the importance of noise management in urban planning, informing policies like zoning and traffic control, and emphasizing noise pollution as a vital aspect of urban sustainability and quality of life. Overall, the project illustrated the complexities of urban noise management and the multifaceted approaches required to mitigate its effects effectively.

## 12. Urban Interactions: Imagine what the city could be like if these were deployed pervasively, or what differences are you highlighting between the two? What are the opportunities, challenges, and imagined realities of this future?

Noise Regulation Policies: Cities might develop stricter noise regulations to control the volume of sirens and vehicle exhaust systems. This could include specific decibel limits at different times of the day or in different zones (residential vs. commercial).

Urban Design and Zoning: Designating areas with different noise tolerance levels could help manage where louder activities can take place. For instance, keeping residential areas as low-noise zones and allowing higher noise levels in commercial or industrial areas.

Green Spaces and Buffer Zones: Creating green belts or parks to act as natural sound barriers between noisy areas and quiet residential zones.