Boston University
Electrical and Computer Engineering

EC 463 Senior Design Project

First Prototype Report

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Aerial 5G Network Modeling

Team 17

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1.0 Prototype Setup Summary:

1.1 Required Materials

Hardware:

- Phone with 5G cellular connection
- DJI Flame Wheel Drone
  - F450 Frame Kit
  - 2312E 800KV Motors
  - 30A ESC Brushless Speed Controllers
  - 10 inch FPV 1045 Propeller
  - 2x 3000mAh LiPo battery
  - Flysky FS-i6X Transmitter

Software:

- Data collection
  - Ookla Speedtest application
  - Python3
    - Speedtest-cli
    - Firebase_admin

- Data display and management
  - Python3
    - Pandas
    - Plotly
    - Numpy
    - Scipy
    - Matplotlib
    - Sklearn

1.2 Data collection

The first step of our demonstration involved running the Ookla speedtest to collect data for the next section of the project. We used our own phones for the prototype, as we had not yet received our 5G device/Sim-Card from our client. We collected the data through our automated data collection prototype. Since our team does not have access to the Ookla SDK, we designed a python script for automated data collection. The Python script can be run on mobile devices through an app called “Qpython.” This allows us to run Python scripts in mobile environments, which greatly facilitates our data collection process. The script runs an Ookla network speed test and saves the result in a database as text. Collected data can also be exported to a .csv file for use in our data visualization and modeling.

1.3 Data visualization

During the next section of our demonstration, our python script created a visual representation of the data including testing locations and speed. We were able to display both the newly collected data as well as previous tests displayed. These were shown in various colors representing the speed of tests at each location. This format aids in visualizing the variety of data. Different maps show upload speeds, download speeds and latency. In the future we will use a similar method to display our predictive model's results, based on our 5G data.

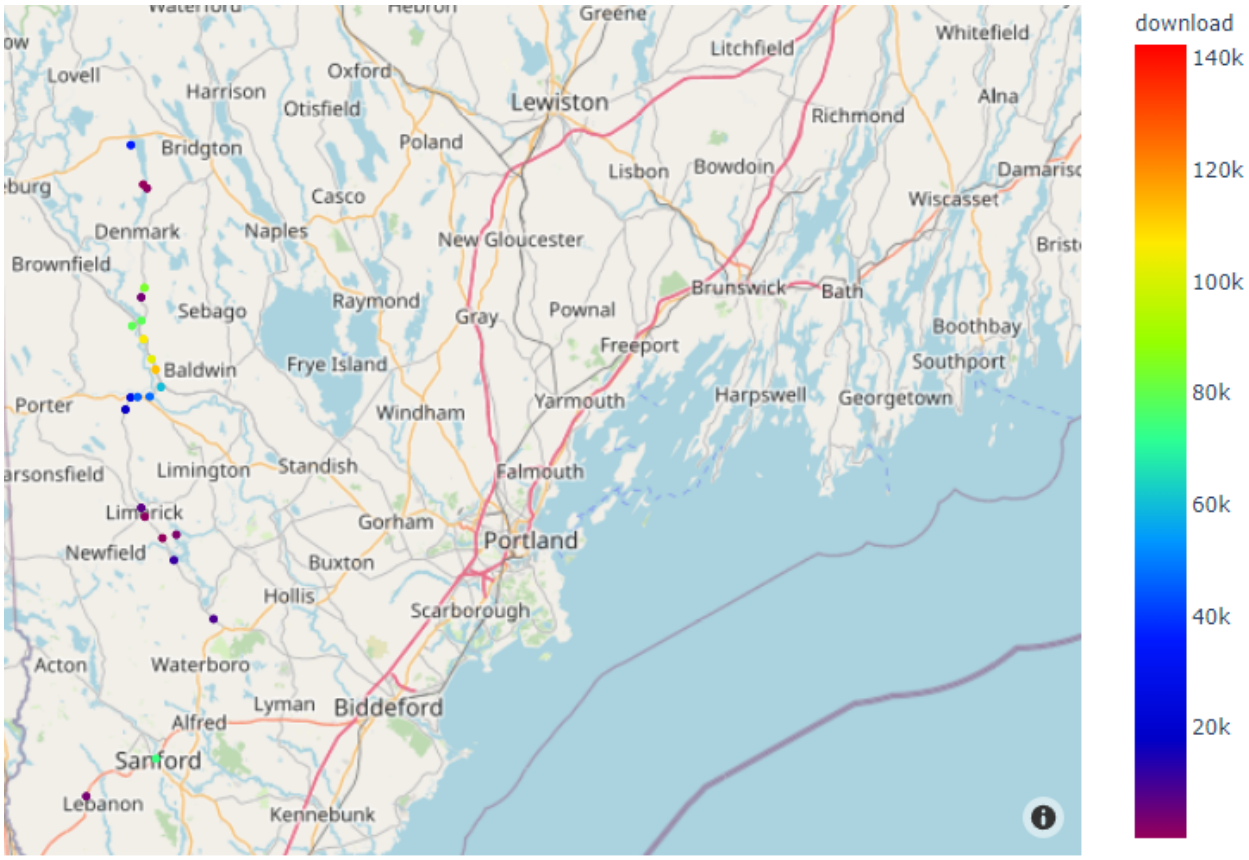

Figure 1. Example of mapping and scale

1.4 ML Modeling

We displayed our basic linear regression model for the data that we have collected so far, using libraries such as pandas, numpy, matplotlib, and sklearn. The processes for this model include:

- Setting/splitting datasets
- Fitting the multiple variables into linear regression model
- Finding the intercept/coefficient
- Visual comparison between predicted and actual values
- Model evaluation using different error rate calculations.

The trend of the predicted values vs actual values have a linear relationship so far, and calculated error rates with:

- R-squared
- Mean Squared Error
- Root Mean Squared Error

These are all below 10%, which gives us a rather accurate linear regression model for predicting values with our current, limited dataset.

2.0 Measurements

2.1 Collected Data

We collected additional data related to the network speeds within the Photonics Building and then added this to our growing test dataset gathered using our various personal phones. This data seemed consistent with previous tests in the same geographic area. Additionally, the data mapped well into our data visualization system, which proved useful during the demonstration of the prototype. We also used this data in our basic predictive model, which we will continue to iterate over as we build our number of samples.

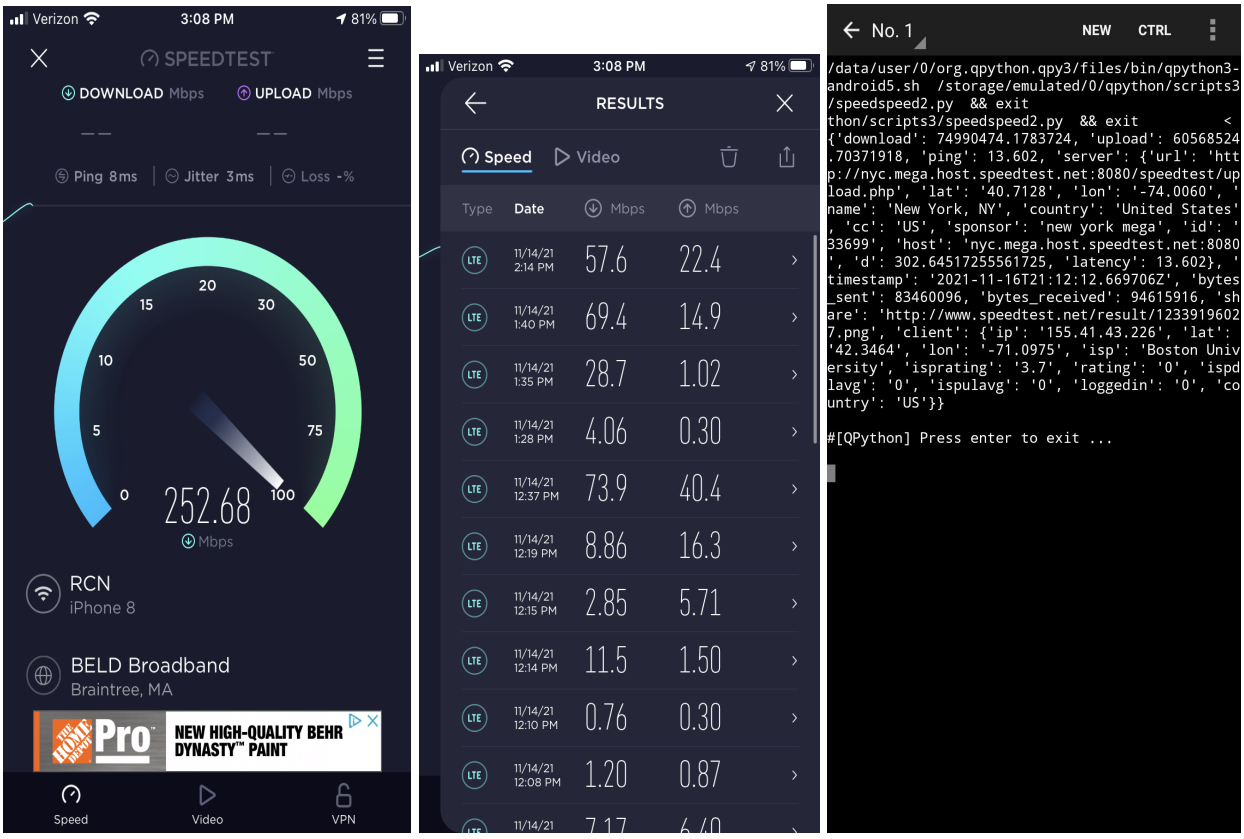

Figure 2: Ookla Speedtest Application and automated collection

3.0 Conclusions

3.1 Results

As previously mentioned, our prototype performed as expected in both the data collection, data visualization and modeling portions of our tests. We were able to work well as a team to present our work so far and demonstrate our project is beginning to function as intended. We know we need to improve our current model. That will allow us to expand our visualization which will better represent our data as it grows and includes other factors, such as altitude and weather. These will be important in the performance of our Linear Regression Model, and other models to be written.

3.2 Future Plans

Professor Osama mentioned that we were making good progress on our design as shown in our prototype. We are pleased with this assessment and now plan on looking forward to the improvements we plan for the remainder of the semester. Next steps include working to integrate the Ookla SDK into our current automatic testing system and gathering altitude data with our current tests before advancing into collecting our final 5G dataset. Additional data will be added to the machine learning model we have worked on this semester. This will allow us to check for predicted network performance and accuracy rates. We will also be looking at other modeling methods like Neural Networks with additional processes such as normalization and optimizers to test for better accuracy and better overall predicted values.