Weather Station Bluetooth Mesh Network with ML

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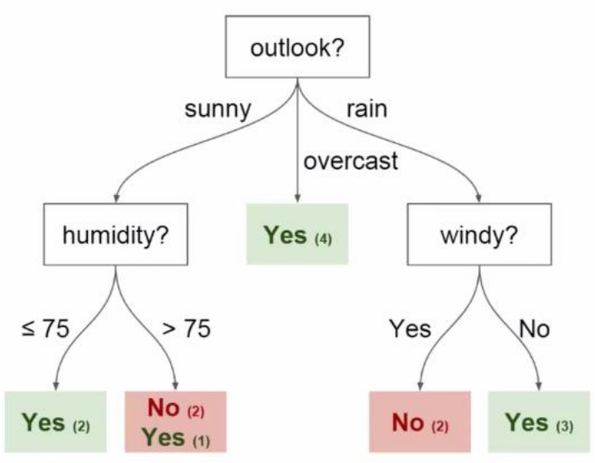
Project Overview: Expand prac 1 to create a sensor network using Thingy:52 or Particle Argon with SEN54

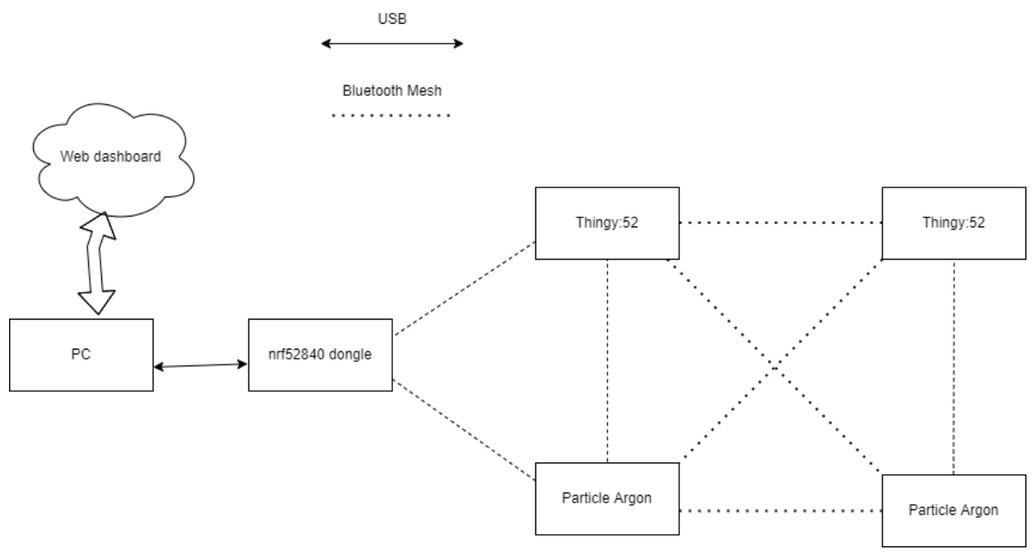
Aims (KPI)

- 1. Bluetooth Communications: have a robust communication network that is scalable and fault tolerant
- 2. Ensure weather station nodes can be powered sustainably with efficient code
- 3. Obtain accurate local sensor readings with validation
- 4. Have an interactive web dashboard to perform basic analysis of data and visualization
- 5. Advanced processing techniques: time synchronization, machine learning for weather prediction.



(https://blog.goodaudience.com/machine-learning-using-decision-trees-and-random-forests-in-python-with-code-e50f6e14e19f)

System Overview



Base Node

- Provisioner of the network. Sets up network and adds new weather station nodes to it
- Interact with via shell or python listener script

Weather Station Node (Argon/Thingy)

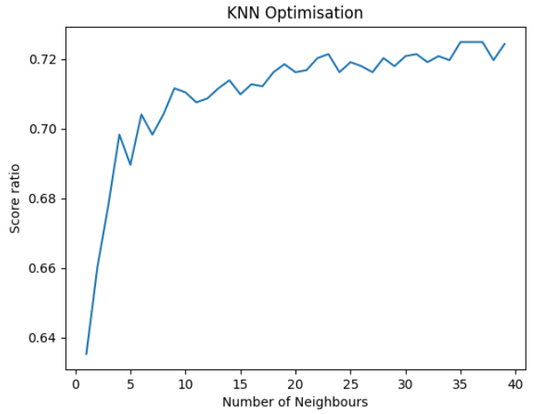
- Beacons itself to the network, then provisioned by base.
- Once network is established, messages are sent over Bluetooth mesh to nodes in the network to retrieve sensor readings.

PC

- Interfaces with Base node over USB, and publishes the data received over the mesh from the weather stations to a web dashboard, for visualization and analysis.
- Experiments with Machine Learning conducted to predict rainfall based off historical data.

Results

- Achieved mesh network functionality with relay nodes. Tested for range and robustness (~30 meters total coverage) Needs improvements in these areas (more reliable data transfer)
- Sensor readings accurate to ~10%.
- Conducted significant ML experiments, based off data gathered from web scraper. Models include KNN and Random Forests (0.7 training accuracy)



Conclusion

- **KPI1**: Successfully attained Mesh network implementation. Further testing and research required to make this more scalable to large networks
- **KPI2:** Setup solar power charging for all weather station nodes, however did not implement a duty cycle power management scheme, which needs to be implemented to improve KPI2 success.
- **KPI3**: Successfully setup sensor library to accurately read atmospheric data, including the new SEN54 with particle argon
- **KPI4**: Web dashboard setup with low latency (< 1 minute to update data), and insightful data visualisation and analysis functions. Further steps include linking the Machine Learning script to train a model on data collected by our mesh network (for localised weather prediction)
- **KPI5**: Synchronisation of time between base and weather station nodes when communicating allows data to be timestamped, and hence one can measure propagation delays throughout the network. Various machine learning models implemented with training accuracy approximately 70%.