**Signal Propagator Code Tutorial**

**Libraries Used**

Most of these files will likely already be installed. However, if these are not installed the code will not work.

* External Libraries
  + NumPy
  + Matplotlib
  + SciPy
* Internal Libraries
  + Dataclasses
  + CSV

**Code Organization**

Code is organized into 3 steps.

1. Initialize the input data
2. Execute ray tracing algorithm
3. Execute the scattering matrix method algorithm

File organization is separated into three folders which execute each step and 3 external files. The external files include the exact parameters which need to be input, the file which runs the code, and a global class file with miscellaneous functions and constants. A csv file must also be included into the main folder which contains the csv data, organization of this data will be explained in the next section. A visual of how the files are organized can be seen in the figure below.

A computer screen shot of a black screen

Description automatically generated

**Inputs File & CSV Organization**

The input file has 10 inputs necessary to run the code, 6 physical parameters and 4 computational parameters.

Physical Parameters

* X\_inital – the initial X-position of ray propagation
* Y\_initial – the initial Y-position of ray propagation
* Frequency – the frequency of the propagating rays (Hz)
* B\_field – the magnetic field vector being applied [Bx,By,Bz]
* Cfd\_data\_file – the name of the data file that data is being taken from (this should be a string).
* Artificial\_Antenna – location of artificial antenna (region of interest). [(x1,y1),(x2,y2)]

The computational parameters are set to default values that are recommended for data recording.

Computational Parameters

* angle\_range – the range of initial angles to propagate rays [θmin,θ­max].
* rays – the number of rays/angles to propagate from the initial coordinate point.
* ray\_tracing\_step\_size – time step size for calculating ray tracing.
* refinement – decides whether refinement should be done based on the artificial antenna (boolian).

The CSV file must have following labels for the corresponding headers:

* x > X-coordinates (m)
* y > Y-coordinates (m)
* refra\_O= > refractivity of O
* refra\_O2/RO\_O2= > refractivity of O2
* REFRA\_N= > refractivity of N
* REFRA\_N2= > refractivity of N2
* REFRA\_NO= > refractivity of NO
* e- > electron number density (m­­-3)
* Tv > vibrational temperature (K)
* rho\_air > density of air (kg/m3)

**Running Code**

To run the code, open the folder in your IDE and run the file Full\_Execute.py

**Appendix**

**(W.I.P.)**