GNN load_files.ipynb Summary

Datasets

Two HDF5 datasets are used in this application: nonswap and fluxswap files.

Nonswap: uses unoscillated neutrino flux from simulated beamline (consists of mostly muon interactions)

Fluxswap: switch muon and electron neutrino fluxes (consists of mostly electron neutrino interactions)

HDF File Structure

Each HDF5 file contains three tables:

1) Event tree: Each row holds one event comprised of a set of unique identifiers (run, subrun, event number) and metadata (neutrino energy)
2) Graph tree: Holds information on each hit and simulated particle and the three unique identifiers
3) Particle tree: Contains the same information as the graph tree

Hit and particle information for an event is extracted by choosing an event from the event tree and using its unique identifiers to index into the other two trees.

Functions for Information Retrieval

get_graph(idx): Returns the graph nodes by extracting the unique identifiers (run, subrun, event number) from the event tree and using it to index into the graph tree

get_particles(idx): Returns the graph nodes by extracting the unique identifiers (run, subrun, event number) from the event tree and using it to index into the particle tree

get_particle_type(idx): Queries the true particle (i.e. the simulated particle responsible for depositing the majority of energy for each hit) for each hit and returns the corresponding true particle

get_process(idx): Returns the process of the true particle

create_edges(idx): Constructs graph edges based on hit proximity. An edge is produced with a pair of indices pointing from one hit to the other if two hits are within 5 wires of each other

Plot Generation
By iterating over all event in the file and each plane within the event the following graphs are generated:
1) The graph containing the nodes (hits) color coded by the simulated particle that produced the hit
2) The same node plot with all potential graph edges in grey
3) The graph containing only edges with false edges in grey and true edges (an edge between two graph nodes produced by the same true particle) in black

Output Graph Plots
The following sample HDF files were used to generate a sample graph
Nonswap:
gcnhit_004a7d87-4609-4efb-a7c5-a92338c28245.h5
gcnhit_00f60daa-05d9-42fb-a88d-a8f66b587a91.h5
gcnhit_00f68949-bc35-4586-8123-9033761e0650.h5

Fluxswap:
gcnhit_002ff553-c67e-461d-99f8-1a700ecbc78c.h5
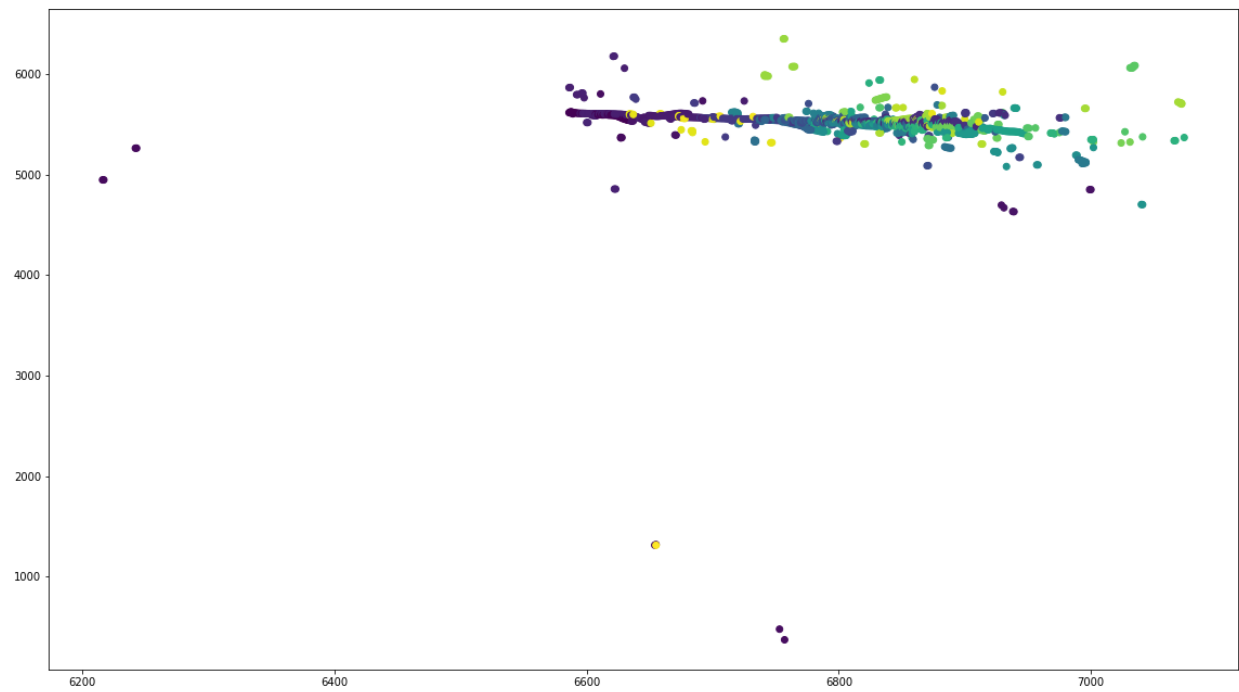gcnhit_00425452-7074-4222-84c3-e94ba82b5909.h5
gcnhit_008ad911-a222-4cce-aef3-8b457d8a7d1d.h5
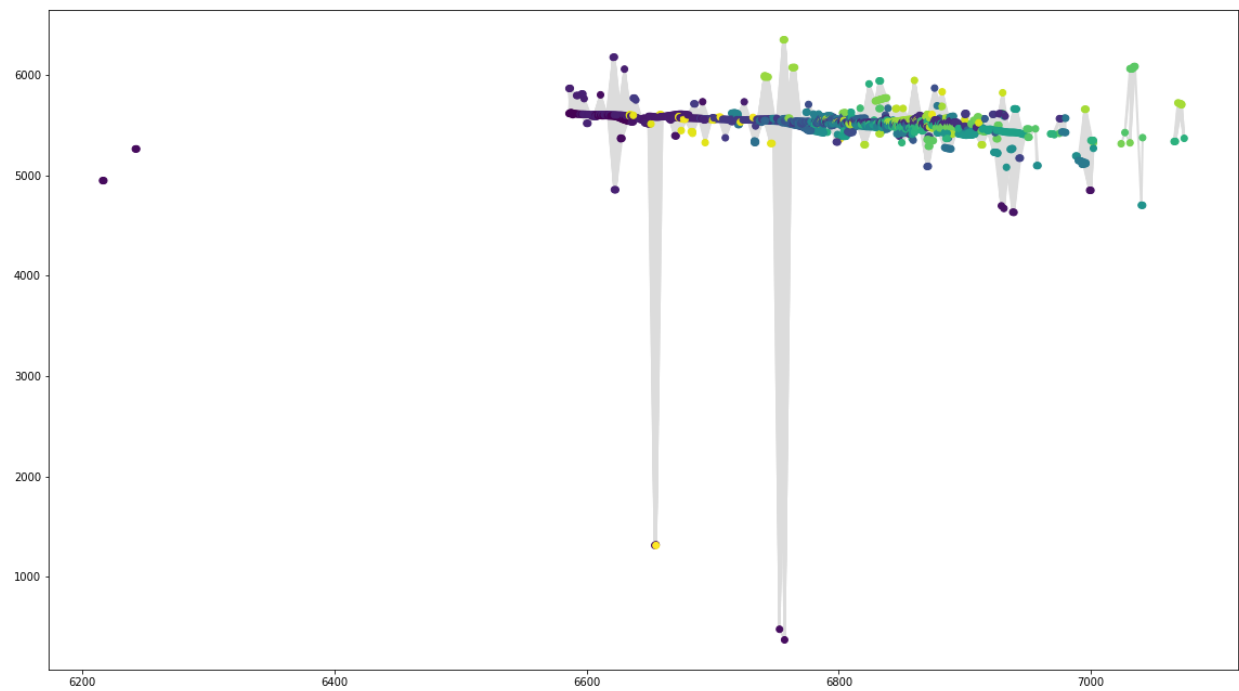
PNG images:
These output images (shown below) varied with event number, plane (0,1, or 2), and the type of information displayed (edges, nodes, entire plane). Can provide the zip file of all the created output files if necessary.
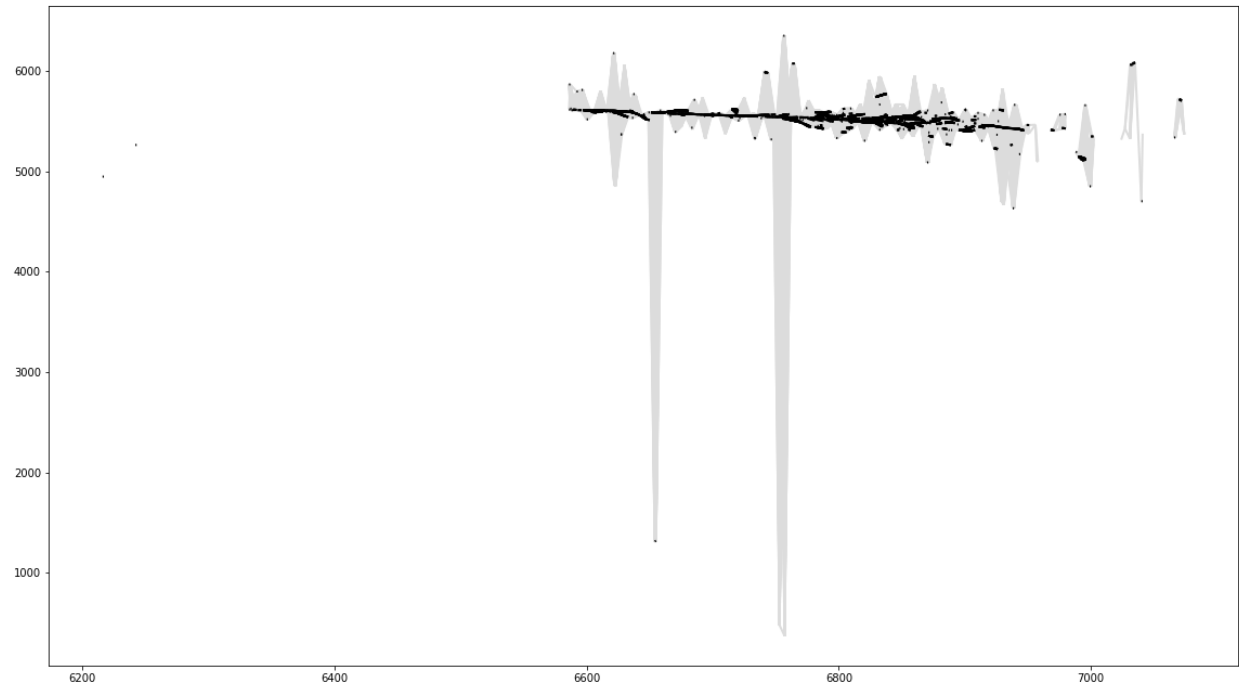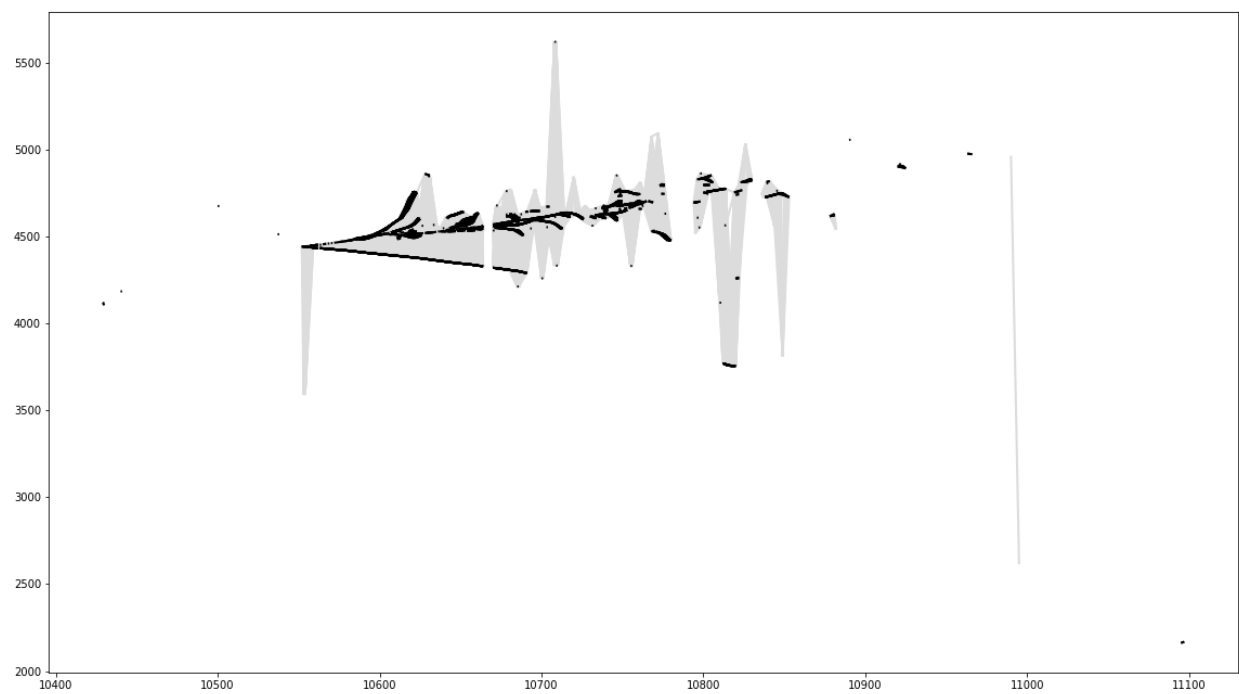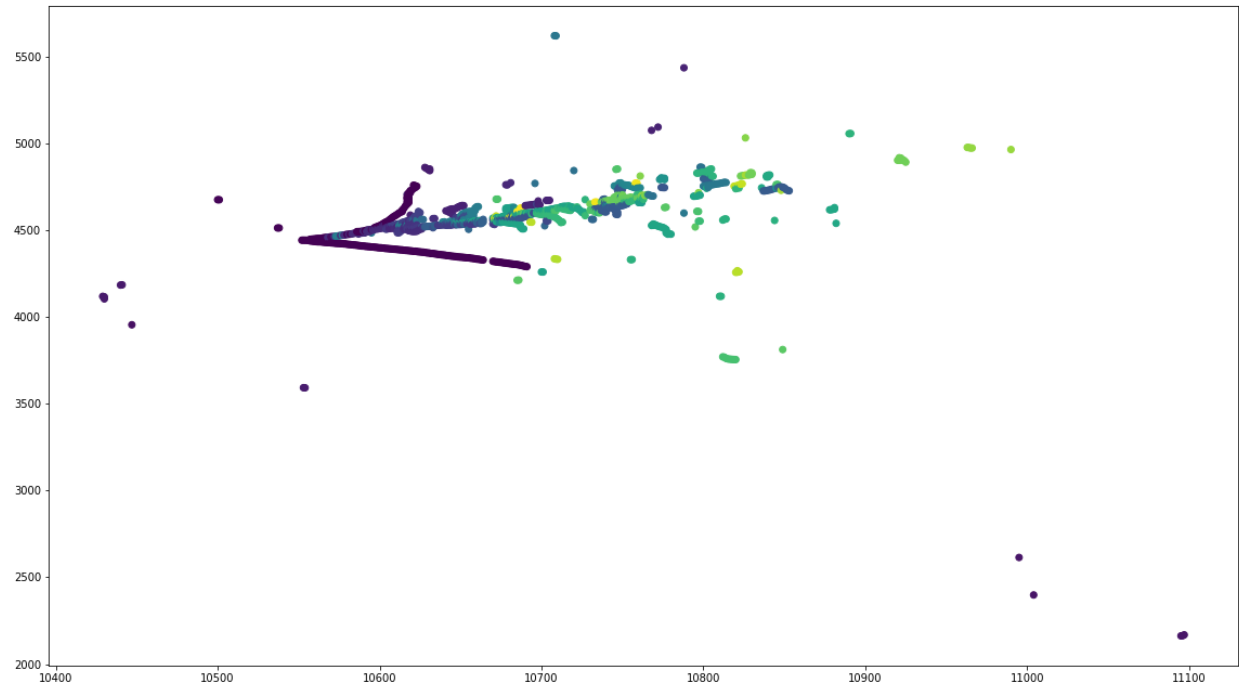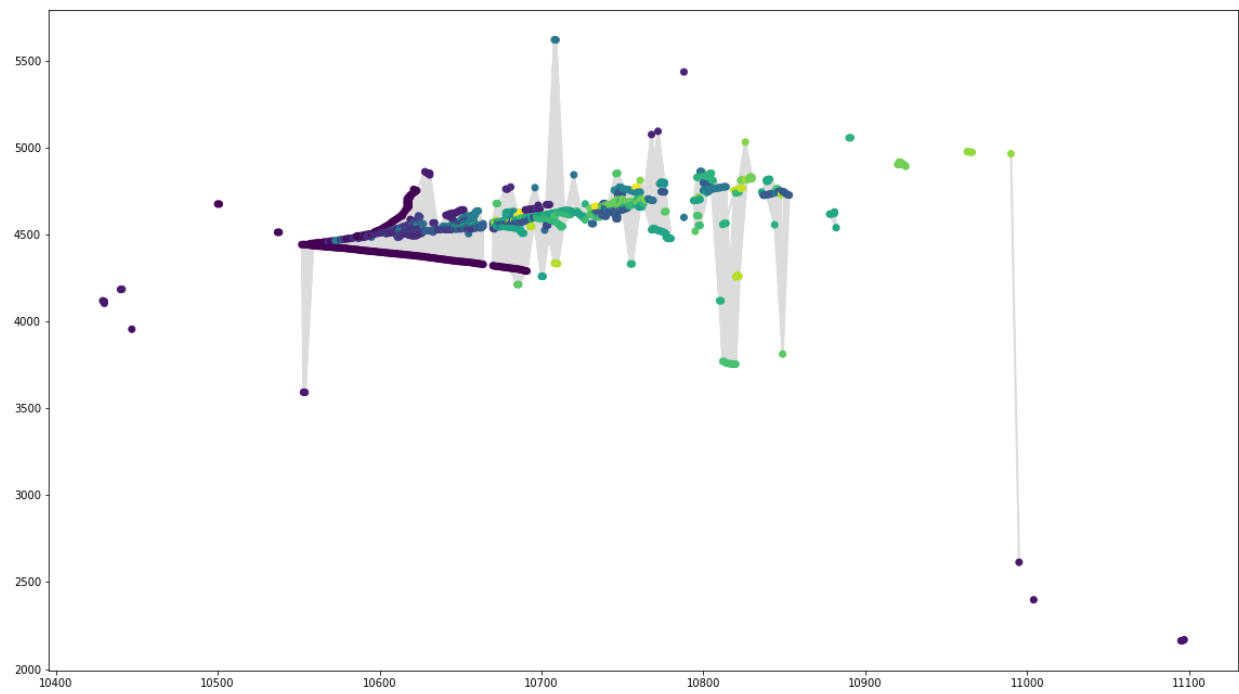
evt001_plane0_edges
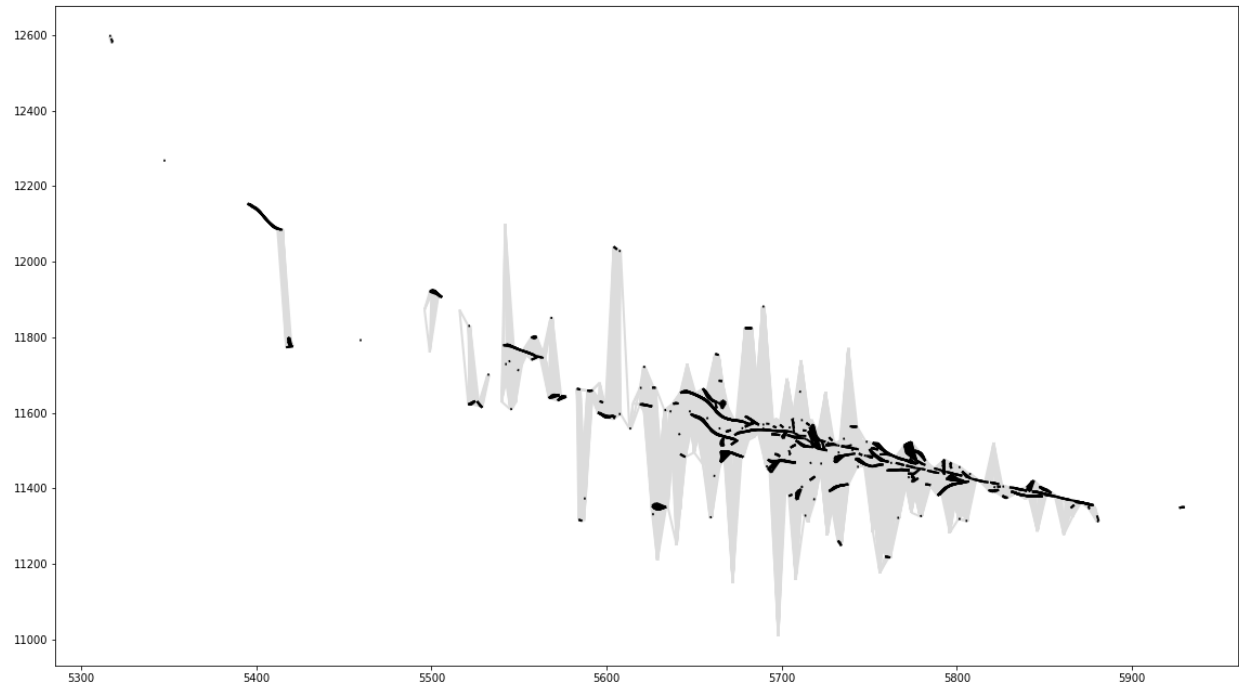

evt001_plane0_nodes

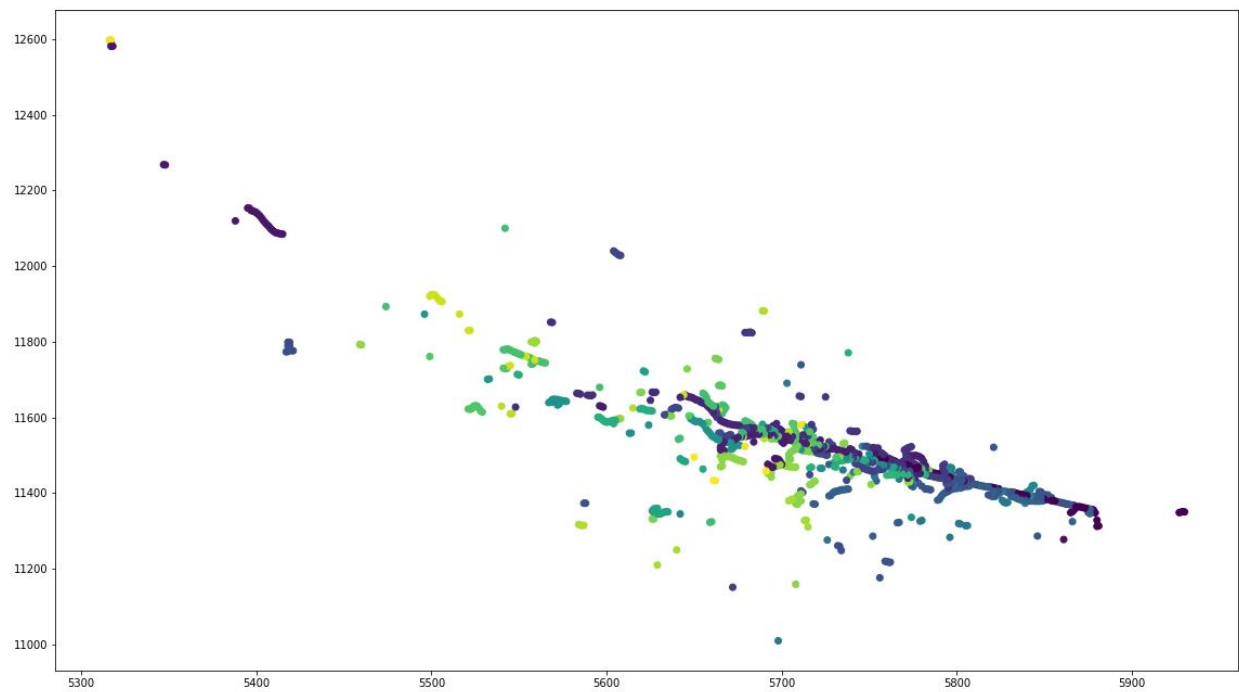evt001_plane0
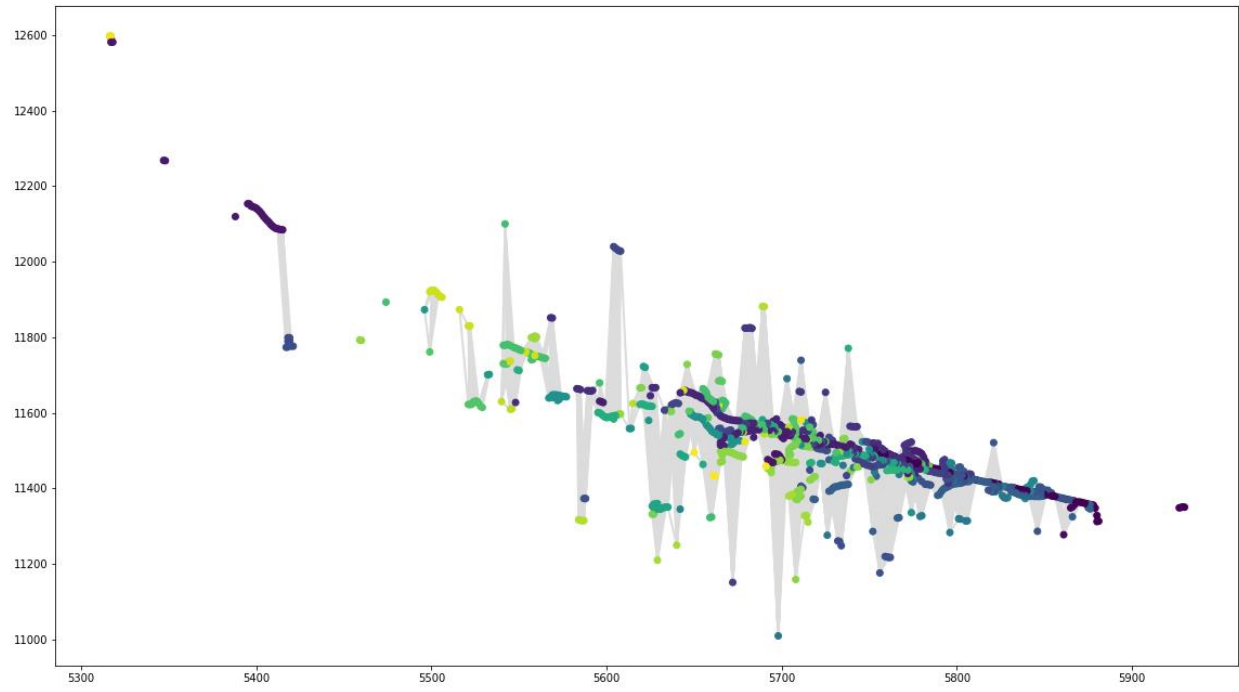

evt003_plane2_edges

evt003_plane2_nodes

evt003_plane2

evt023_plane1_edges

evt023_plane1_nodes

evt023_plane1