Pattern recognition of particle trajectories in hexagonal geometry drift detectors

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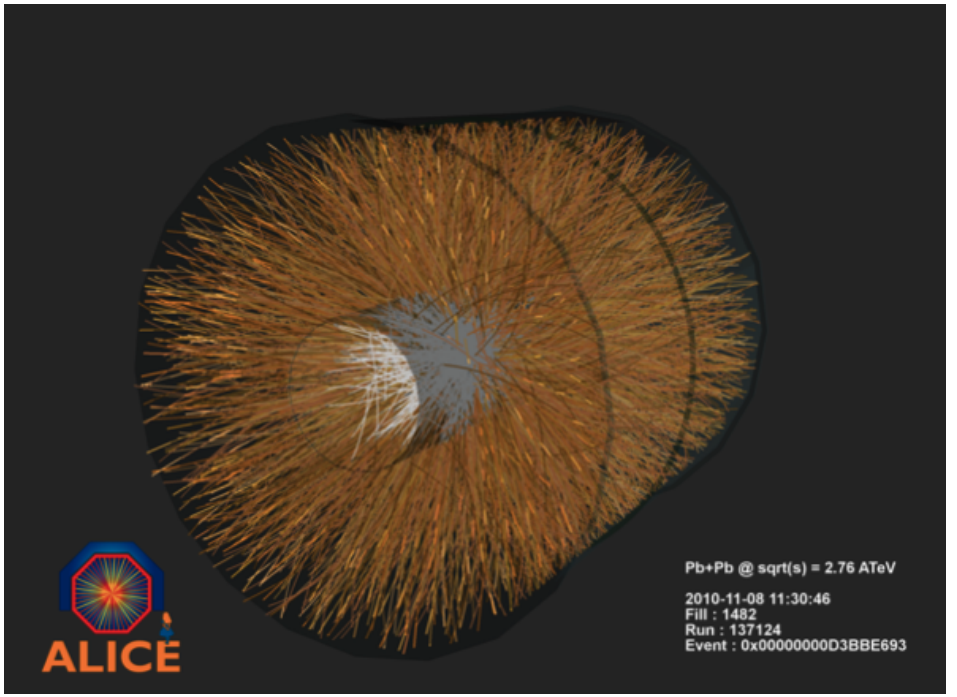
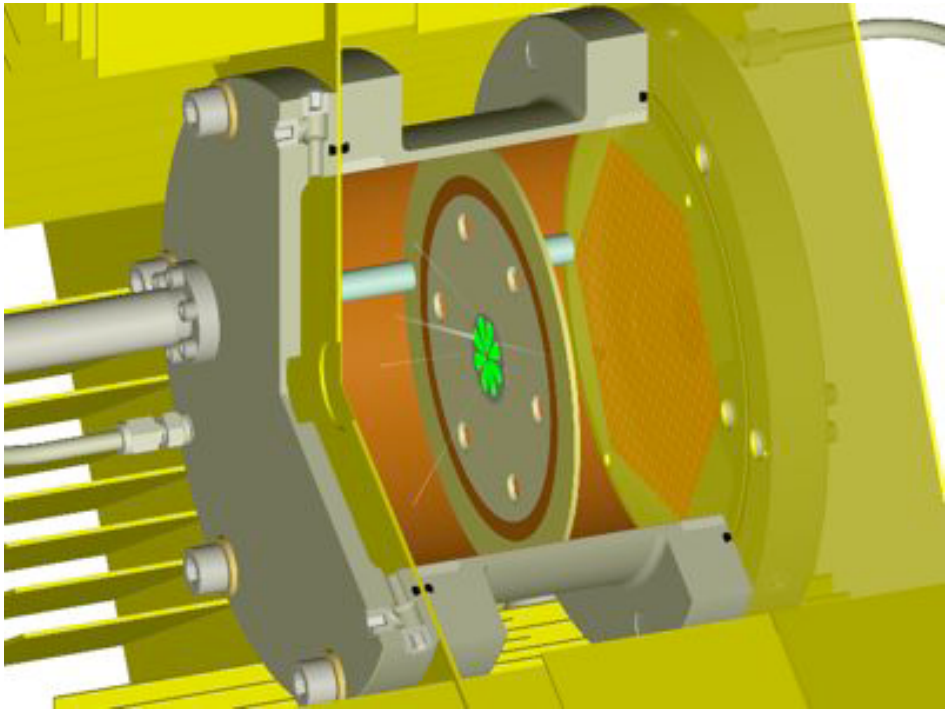
Drift Detectors

- High energy particles ionize gas inside chamber
- Electric field causes ions to drift to sensor pads
- 3-D “voxels”
- Reconstruct reaction trajectory



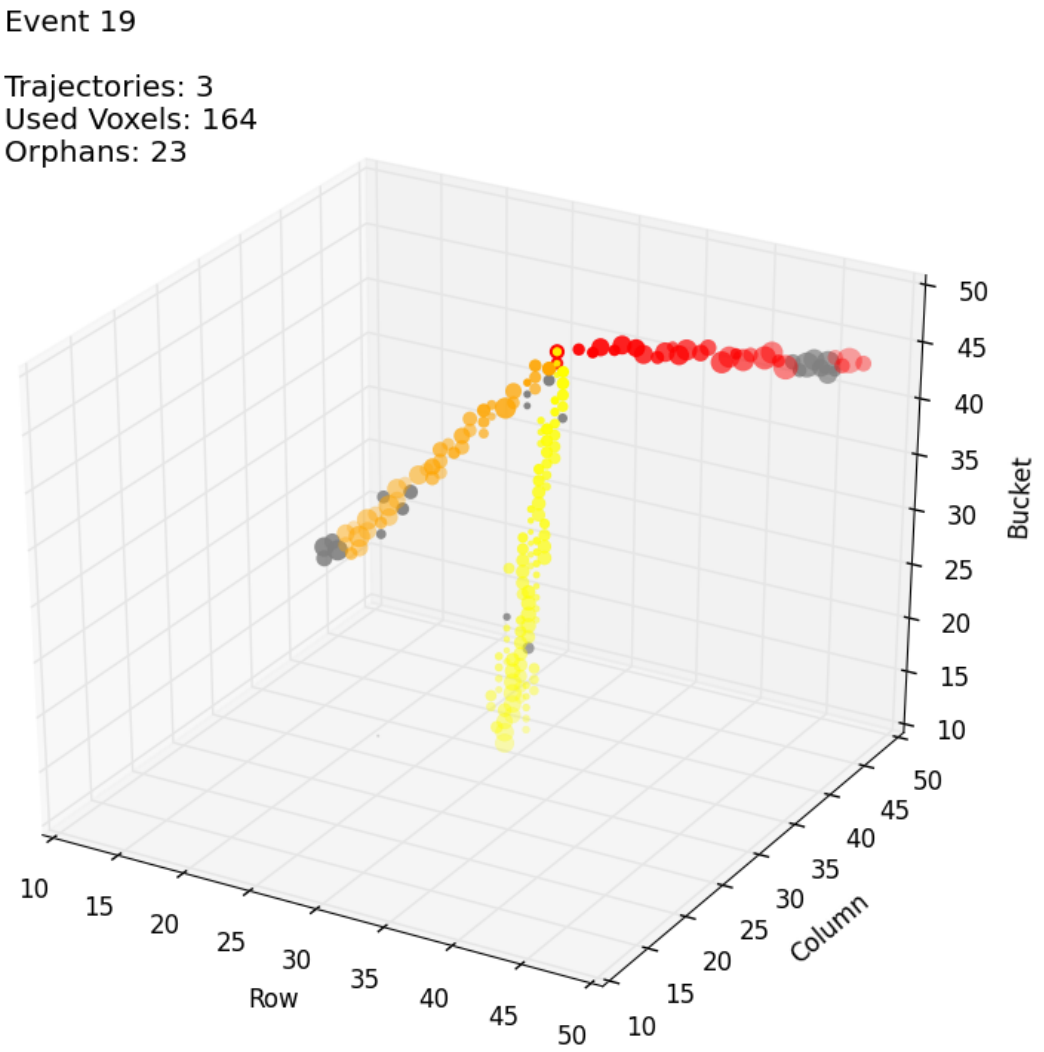
NIFFTE

- Heavy element fission
- Particles move in straight lines
- Few daughter particles
- Hexagonal voxels



Overview of the Task

- Separate tracks
  - Human easy
  - Ambiguities challenge computers
- Written in Python
  - Matplotlib
  - iPython notebook

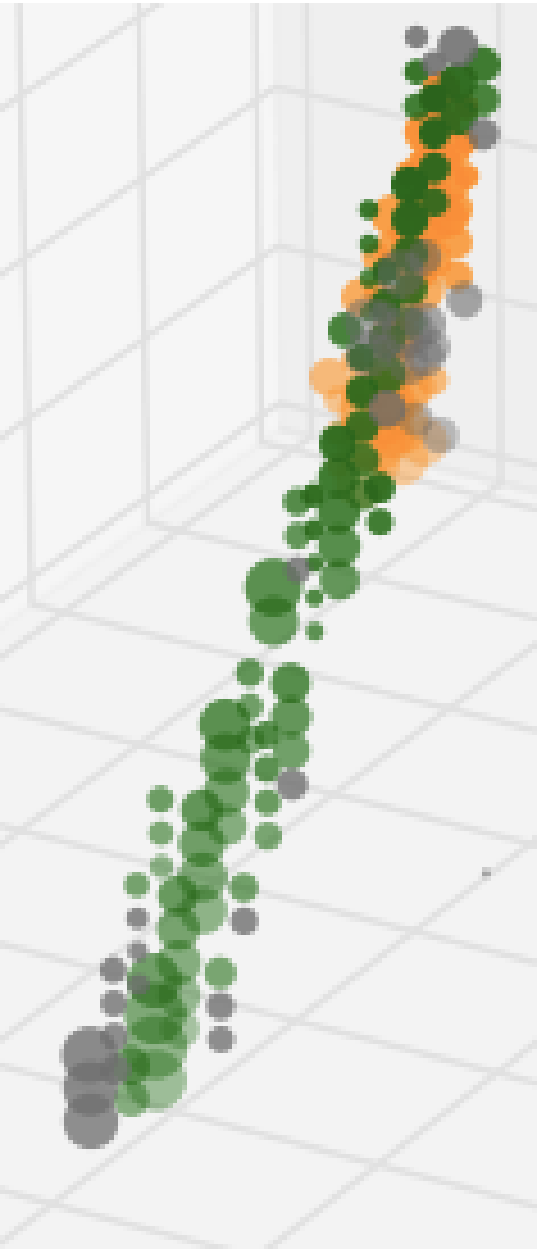


Other Recognition Methods

- Hough Transform
  - Similar to principal component analysis
- Follow-your-nose
  - Start outside, work inwards
- Both have limitations

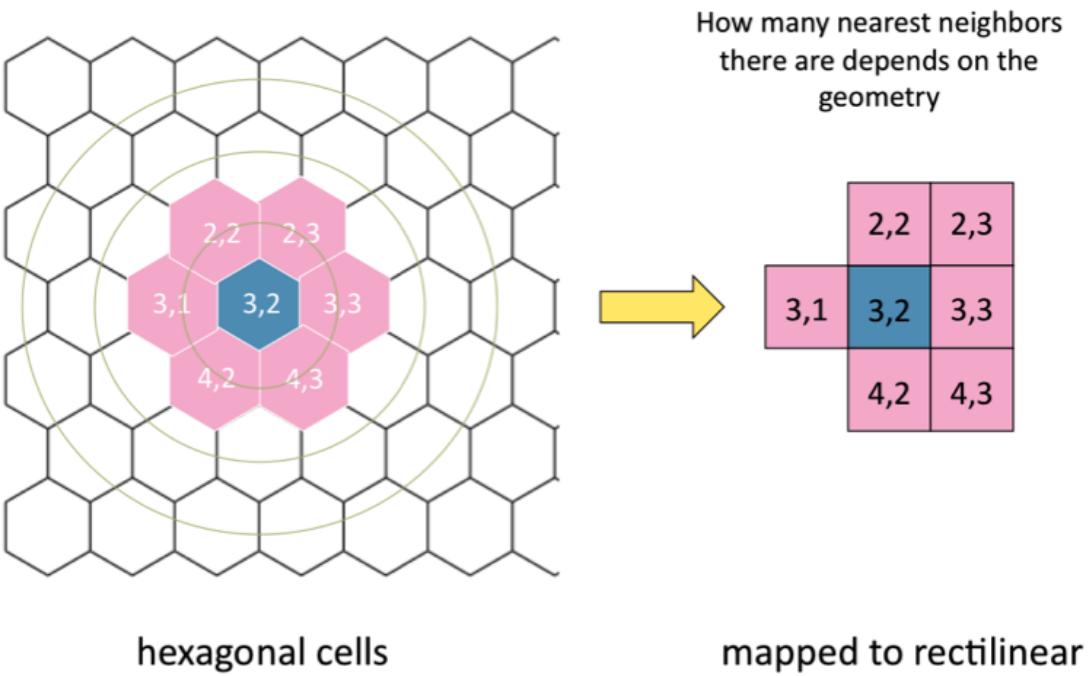
Code Classes

- Voxel
  - Basic data unit
  - Functions as a 3-D pixel
- Trajectory
  - Two voxel lists: spine and flesh
  - Direction only based on spine
- Event
  - Stores all voxels and trajectories
  - Unused voxels as orphans



Heart of the Algorithm

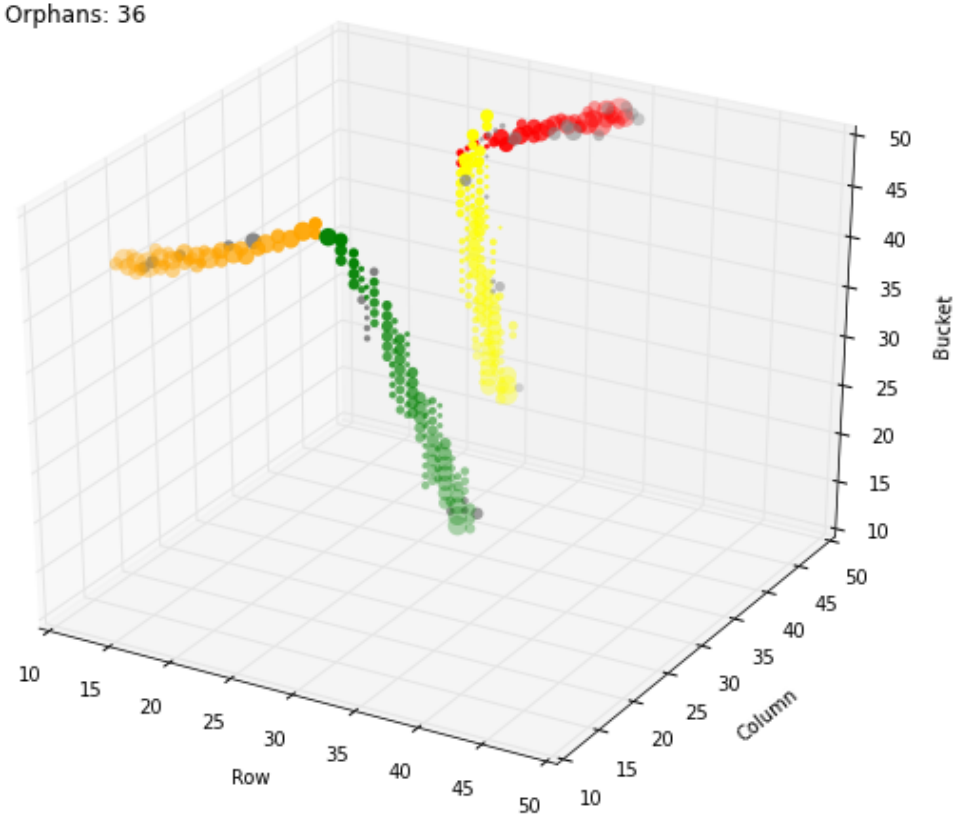
- Build spines
  - Neighbors to find candidates
  - Gradient and directionality to choose best ones
- Repeat until all voxels used
- Merge trajectories
  - Match directions
  - Check endpoints



Successful Matches

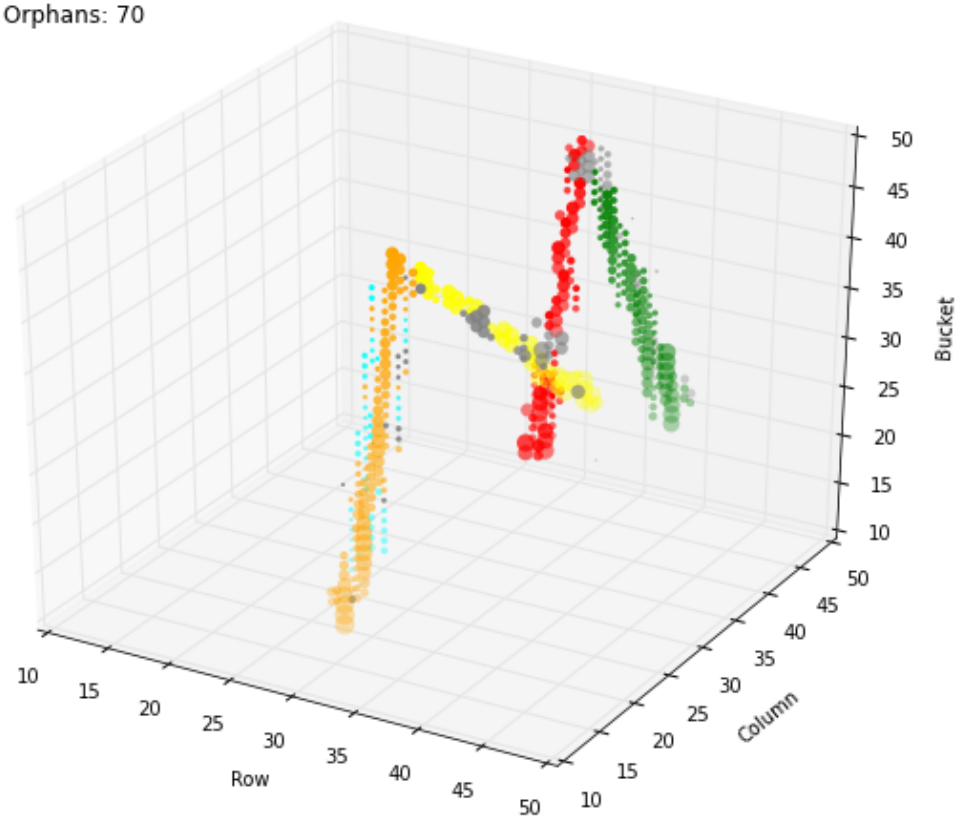
Event 70

Trajectories: 4
Used Voxels: 315
Orphans: 36



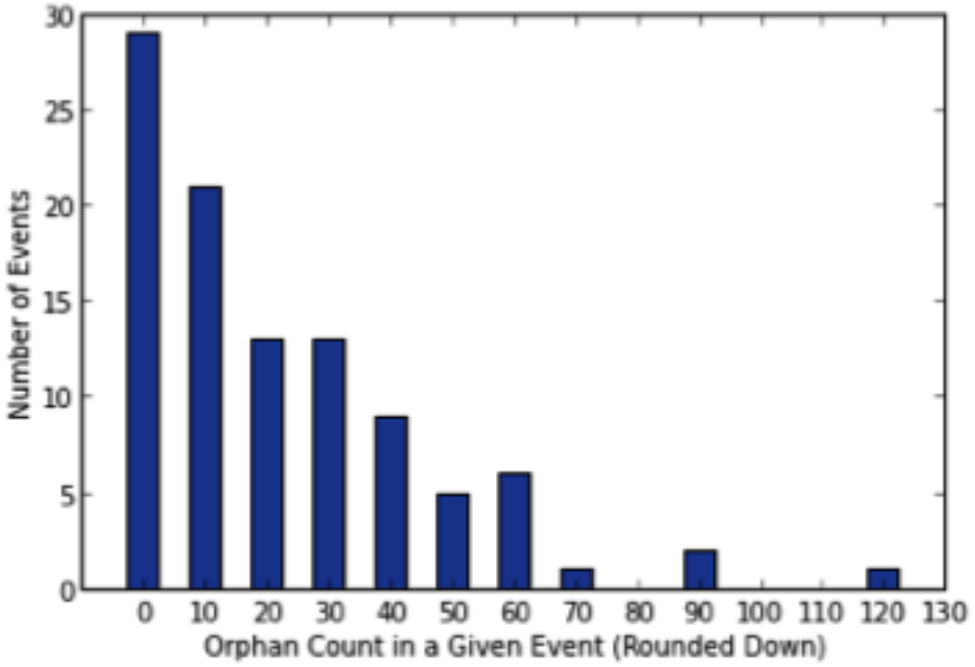
Event 31

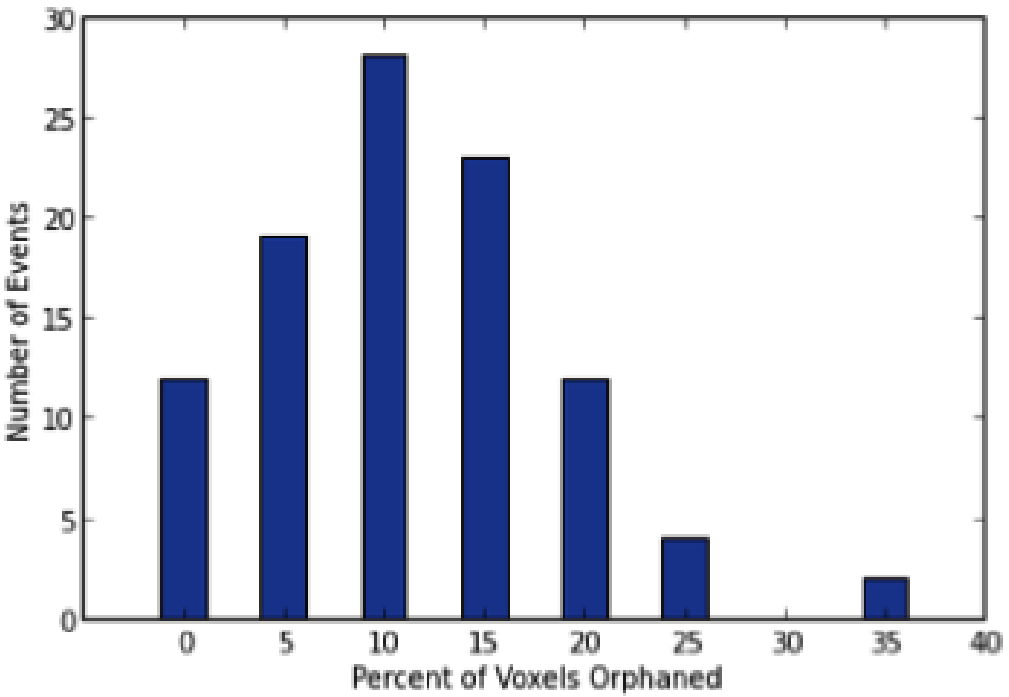
Trajectories: 5
Used Voxels: 383
Orphans: 70



Overall Statistics (100 events)

- Orphans are one measure of algorithm's success
- Several threshold parameters can be adjusted

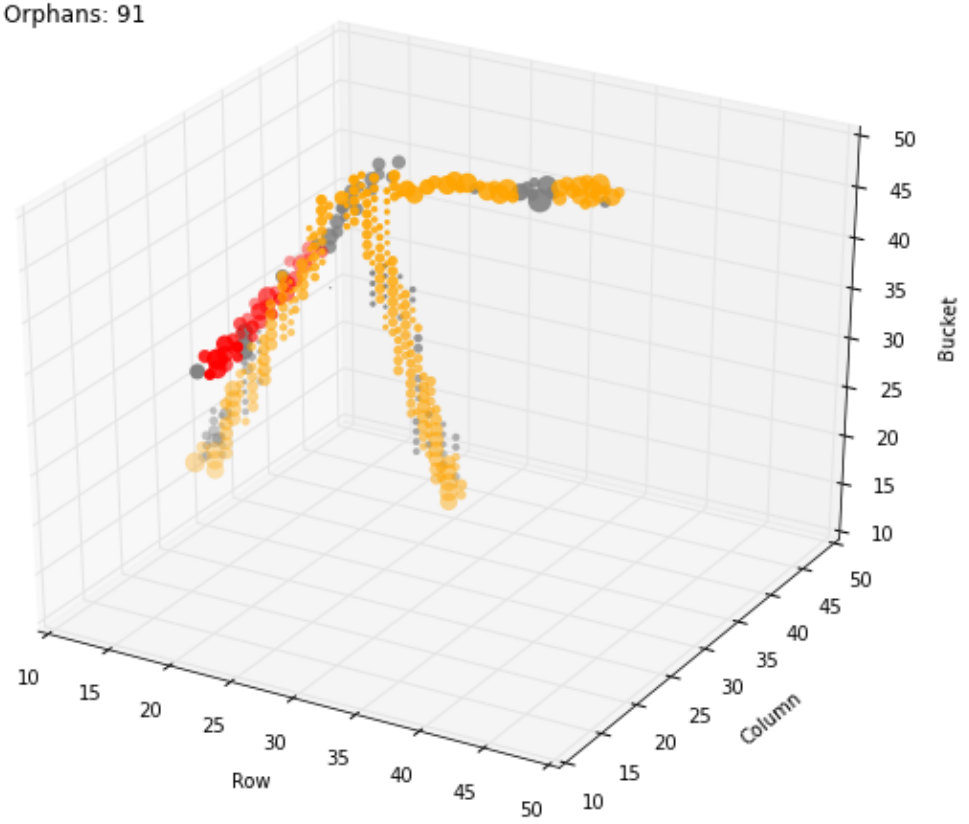




Room for Improvement

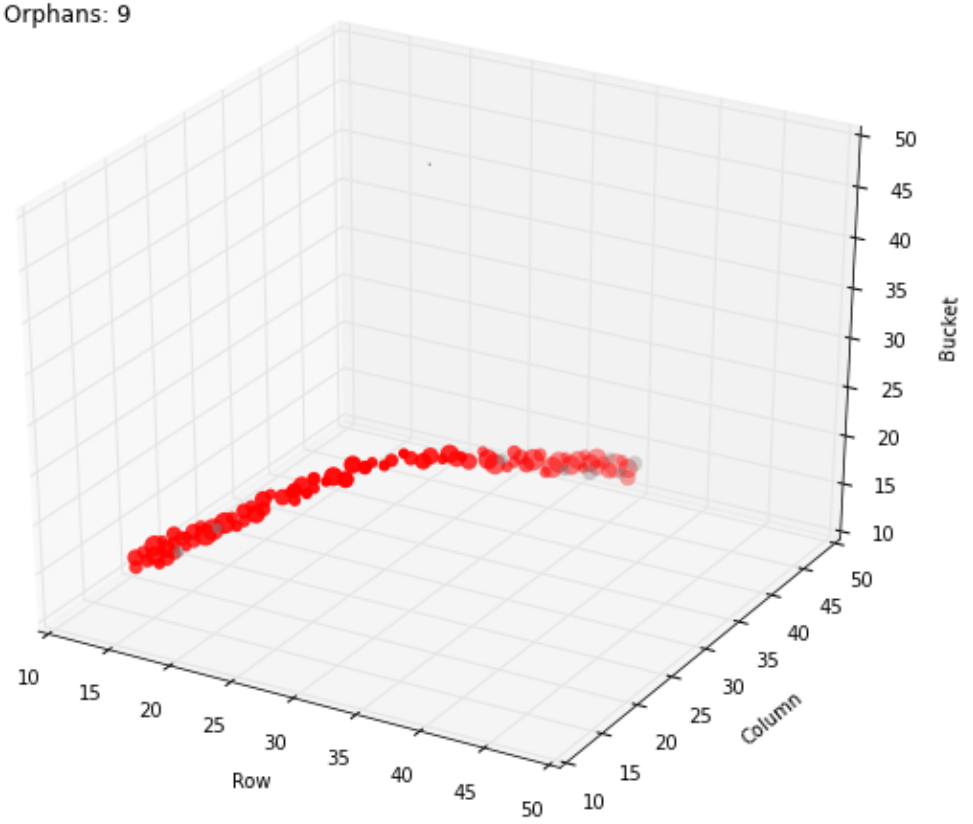
Event 18

Trajectories: 2
Used Voxels: 258
Orphans: 91



Event 88

Trajectories: 1
Used Voxels: 84
Orphans: 9



Looking Forward

- 3-D linear least squares fit
  - Get a direction vector
  - Calculate momenta from energy gradient
- Apply to more data
- Incorporate into NIFFTE framework